



## **ANNEXES**

### **Transcripts of Speeches and Questions and Answers**

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## **ANNEX A**

### **PANEL 1:**

**Weather Services Infrastructure: Sustaining what we have and building for tomorrow**

## CONVENOR: JACK HAYES



It is late in the fourth or so day in the conference and I want to thank you all for taking the time at the end of the day to participate. Welcome to you to this session on how to increase collaboration across three sectors.

My name is Jack Hayes and I am the Vice President Senior Account Manager for Weather Products and Services for Harris Corporation so private sector. I was asked several months ago to organize and I want to thank Jerry Langoasa and Michel Beland for having confidence that I was the guy to ask and supported me in this endeavor. I want to thank the Organizing Committee Jim Abraham, Harinder Ahluwalia, Bill Gail and Brian Mills. Four of us started meeting with incredible intersection of personalities where we talked debated and developed the plan which you will see this afternoon and tomorrow is the result of several months of work. I also have to thank our moderators and our panelists, we are all busy people, and people who invested a lot of their time in helping the Enterprise move forward. I am not going to say much other than to say why this session. I really don't need to tell all the people who are sitting in the audience why this session when we hear discussion of changing climate and growing vulnerability to society, when we look at the incredible pace of science and technology is offering opportunities for us to do what we do for society. I think our purpose here is to see what are the gaps, where we can work together to improve what we do for the society.

We have got three panels:

- 1) Weather Services supporting infrastructure
- 2) Weather Services panel tomorrow morning and
- 3) Tomorrow afternoon strategies to improve collaboration

We have asked panelists across the three sector who are recognized leaders in weather community to come forward and help. We are very careful not to give them direction about what to say – draw from them their perceptions about gaps, opportunities and where we could work together. I think what we have here is three 90 minutes panels, 60 minutes devoted to the remarks from the panelists which have to be 10 minutes or less, then we reserve 30 minutes for questions and answers. I am really hoping that we have a dialogue, a dialogue across the table and a dialogue with you all. Target against actions we can take as a community what we can do for society. The sessions are being recorded because our intent is to produce a White Paper which we will get to WMO to be used for strategic planning of the WMO and hopefully to improve the impact that weather services have for society. I think I have one final remark and to me – my objective is more than just to engage have an enlightened discussion here; it is really what we do here triggers actions afterwards and I am hoping that we can spark some enthusiasm for collaborating which can be done given the science and technology capability which exists among the three sectors.

So without further ado I am going to introduce Dave Parsons who is the Director of the School of Meteorology University of Oklahoma. Dave asked me to keep it short, Jack, and I will. So Dave over to you.

## 1 Moderator: Dave Parsons



We have quite a distinguished panel today. I will introduce them one by one as I ask each panelist to (present) prepared remarks with or without viewgraph, 5 to 10 minutes long so we hopefully will stir things up and hear some different opinions. This is the first of the exact set of three panels. This is one to set up the key issues that will be dealt with in third panel later.

### 1.1 INTRODUCTION KRYSTIN LYNG



The first panelist is Krystin Lyng who is the Chief Legal Officer at the Norwegian Meteorological Institute. Her main responsibility is to manage data policy and formal aspect of distributing and to make data. She is in demand both as legal expert on licensing of data and International negotiations. She is currently a member of the Data Policy Advisory Committees of European Centres - Eumetsat and Ecomet. She is working with the National Policy on open data at the Norwegian Meteorological Institute. Thank you.

#### Krystin Lyng

First, thank you for inviting me to this special session. I feel honored I thought Albert here could give nice back drop to say something about how it feels to be a lawyer standing in front of scientists; and trying to explain anything about policies; that can be hard from time to time.

But at the same time trying to explain to my friends in the law business what exactly I was going to do here in Montreal was also equally challenging. These guys in the law business, they are still wearing funny wigs and they are using fountain pens and they are still fighting on the incidents that happened in the past.

My point is that you are looking into the future and you have, as opposed to lawyers fighting over things that happened in the past, the power is to influence the future. How our lives are going to be and the new services that you will have the power to develop.

We are asked to be visionary here today and I would like to take the opportunity to explain what role the National Institute can have in this development.

In 2007, the Norwegian Meteorological Institute made a remarkable decision; we decided to implement an open data policy, meaning making data and product available for free. This is not only observation but also model data. So the decision was to have data and products that are produced by the core service for use in the core service for free. This principle is also valid for the software that we develop at Institute. These are licensed under general public licenses, open licenses and also for the scientific work that we are doing; those should be accessible under open access. I thought it would be interesting in this introduction to tell you about the three principles that we have outlined on which this decision about open data policy rests on.

**The first is about user orientation** – the decision about open data policy is not about asking what do the user need, this is not the basis of the decision. The basis of the decision is a belief that the products and data that we produce in the core service are public goods, they are paid by the tax payers and should be available to the tax payers.

However, user orientation is highly interesting when it comes to considering how data and products are made available. We are providing download facilities in order to make data and products easily available technically. And we are also working on having standardized licenses that are easy to understand and with as few restrictions as possible.

Our goal to go with this decision is to have as much use of data this data that we produce as possible.

**The second principal is about quality** and this is quite interesting and I have been asked a lot of questions about this point earlier. I expected to have some interesting questions regarding this. But the principal is that we believe that the quality of data and products that are produced by the core service for the use in our core service will be good enough for the re-users also. It would be funny at least we think that if the quality is good enough for us in the National Service but will not be good enough for the re-users.

**The third principle is how we are making use of feedback.** We have actually made use of the feedback, it has established some kind of quality assurance system for us to have an open data policy. We have a different collaboration with the re-users now than what we had when we made this decision. We are actively making use of this feedback in short term projects and also long term projects.

Now to round it up, I would like to challenge all of us to think about the new ways of using meteorological data. If the National Institutes were to have role in weather enterprises in future, we should do our job. We should make data open and available but it's the responsibility of the community to make use of these data in a new innovative way. Thanks.

## 1.2 INTRODUCTION BOB MARSHAL



The next speaker is Bob Marshal. Bob is the CEO and co-founder of the Earth Networks, a company with comprehensive monitoring networks seeking to help cities, regions, nations, enterprises, build resilient communities to climate change and associated high impact weather. Earth Networks has been involved in public and private partnerships around the world including NOAA's National Weather Service, Space Research in Brazil and a unique partnership Guinea Africa where they teamed with their officials for their first comprehensive Early Warning system for severe weather warning and alerting that was done with a least developed country. Earth Networks also has research partnership with leading academic institutions including the SCRIPTS, Institute of Oceanography, the University of Oklahoma and some place called Harvard University.

### **Bob Marshal**

Thanks Dave. Appreciate the opportunity to be here. Thank Jack for helping to get me here. It is great to be here and I think one message that I am going to lead with is change – the world is changing, our world is changing, and I mean that in many many ways. Climate is changing, weather is changing, the impact of weather on society is changing, technology is changing rapidly, in countries socio economic conditions are changing. Even the Least Developed Countries are developing and the reality is that the change is accelerating. So we as a community, the Public and the Private sectors, the academic sector are going to have to embrace the change at the end of the day because it is going to happen and certainly the private sector is all about change, innovation and driving speed and so we are going to go. We are a data company, we are big data company. I am all about big data, that's my background as engineer is data. We all know in this community that we need data for our forecasts, warnings, our models need it; we need it every day all day, 24 hours a day.

The developed countries largely have a good observational capability, I know there are some gaps, particularly in the boundary layer in the developed countries. But then there is huge swath of the planet that have little or no observation capabilities to be able to produce high quality forecasts and warnings and that is something that we are very focused on. Then when you layer in the fact that Internet of things, a term that has really gained a lot of traction lately and that is something which is very core to our company for sure. Everything is connected; IBM Smarter Planet people say that there is trillion connected sensors now across the globe - everything is connected. We know about airplanes sending data, we know about mesonets and we know about thermostats, we know about refrigerators sending data. We are going to have Eric talk about big satellites sending more data, Anne is going to talk about small satellite that are funded by private sector companies that are going up in the sky. There is going to be an



explosion of data and data is a good thing, we just have to find the signal and the noise which is what we are about as a company.

On top of the changing climate that we face in the world, we have, these things really provide a good back drop. And these two National Academy's studies, I think we all know about, I am not going to talk about much here – but the Fair Weather Report certainly speaks of the partnerships, public private partnerships and then the bottom up, from the ground up - Network of Networks report - speaks to one of the things we have been through out there, the need for the government to take advantage of the existing infrastructure and infrastructure which is going to grow on its own accord. Leverage the data from existing things before unnecessarily investing in new. So long story short, there is going to be a very profound impact because with all this change on all three sectors and I am going to go just a little bit here and I think when you look at the logos up on the screen, these are some of the larger private sector companies, this is not exhaustive by any means, it does not include companies that produce a lot of instruments and hardware, and certainly does not include big satellite companies. These are the companies which drive most of their revenues from services to consumers or customers but there is nearly a billion dollars in revenue may be more just on that screen there. And I think that that has a huge impact in a number of ways because if you go back even 10 years ago 15 years ago, a lot of these companies were much smaller, we are now much bigger. That means that we have resources to invest. When we see an issue that needs to be solved and there is a business opportunity there, we are going to go and we are going to go fast because we have resources to invest ourselves and that might not have been the case 10 or 15 years ago, certainly not to a degree that it is right now. Dave referenced some of the partnerships that we have in place. We are big believers in public private partnerships. I think we have a long longstanding relationship with the National Weather Service going back to the inception of the company that began using our data in an adhoc way which now is much more formal partnership now. When I talk about partnerships, it is not outsourcing, outsourcing is a completely different thing than the partnership. We as a Private Sector company, we are taking risk, we are investing in technology, in observations, in products, in services in advance that our public sector partners can take advantage of it if they want. But that is a big difference when we are doing that on our own nickel and making investments. These are academic partnerships and these are unique to us and many private sector companies have similar relationships here. It is just a function of us being bigger, we have resources, we want to reach out and we are doing much more science today. We fund research and development both internally and externally with some of the best scientists in the world to drive forward solutions. We are making progress on the network of network support. We have dozens of non-federal observation systems that are a part of a coalition of people that bring together data do quality control and make sure that we get good data to NOAA and other partners there.

So I am going to finish up on a couple of things here. We talked early on about the vast swaths of the planet that don't have any observations and really the lack for forecasts and warnings and





these are some of the most vulnerable countries. I will share a little project we did - we did a public private partnership with the National Meteorological Institute in Guinea, West Africa. Unfortunately they are in the news a lot lately because of the Ebola crisis. We partnered with Cellcom Guinea. We went in - the infrastructure in these places is horrible. That is an example of a typical weather station. If they did get a Radar funded by the World Bank, it is typically not working. They don't have capacity and the technology or expertise to do it. We put in a mesonet in Guinea. We put 12 sensors where those blue dots are. We literally did it in two weeks. We partnered with the Cell carriers, we trained their staff, and we installed the sensors, the mesonet sensors on the Cell Towers that included total Lightning Sensors. As soon as we plugged these things in, then voila. In the middle of one of the poorest Least Developed Countries in the world, you basically have proxy Radar tracking storms, tracking precipitation measurements for thunder storms producing purple polygons, automated there that you see on the screen. That I have shown here in North America, they produce warning that in many cases are at par with those produced by the National Weather Service. That kind of infrastructure through the innovation through Internet and advanced technologies in place and we want to solve this issue for 6 Billion people, as I see it of the 7 billion people on the planet 6 billion of them really truly lack good forecast in the morning.

And then the other last example that I have is kind of tied over to climate. We talked a lot about weather and that is really climate adaptation and helping countries and cities become resilient. But on the climate side we have partnered with SCRIPTS and Harvard and NIFS and NOAA to try and expand the observation network on our own nickel to this point, we are generating some revenues now but we went out in front and made the investment ourselves millions of dollars invested to install the largest Green House Gas Network in the World. So we are beginning to really see the fruits of that now, obviously you need weather data to track this thing - the high concentrations of CO<sub>2</sub> over Los Angeles Southern California based on WRF model with Chemistry that use the observations from our weather network in California and the GHG network there. This is a kind of pace of innovation that we see and I will wrap it up here with again that if all three sectors embrace that change and raise the head to solve these problems for Society. I know the private sector is certainly ready to roll and I hope that all the sectors can go at a fast pace to get it done. I think we have a great opportunity ahead. Thank you.

## 1.3 INTRODUCTION ANNE MIGLARESE



Our next speaker is Anne Miglasrese. She is the President and CEO of Planet IQ. She has extensive, government and private sector experience particularly in GIS, Remote Sensing and Geospatial arenas. Her past extensive activities include being principal director with Goose Allen Hamilton, serving as President and CEO of Earth Data International now known as Furgu Earth Data. Instrumental in the establishment of Novice Coastal Service Centre and served as its Chief for 10 years and also the first Chair of the National Geospatial Advisory Committee in several Board of Directors and Board of Visitors including University of Maryland College of Computer, Mathematical and Natural Sciences.

### **Anne Miglarese**

It's a pleasure to be here today and share with you a planet IQ prospective, about the change that Bob mentioned. I think the change is happening rapidly and I think in this room and people across the globe they care about this topic, if we can find way to create the dialog through some difficult issues. The most important thing is we work together to create better forecast and I think there is road forward for that.

So just to give you a very brief primer on planet IQ so that you understand where I am coming from. Planet IQ will launch a constellation of 12 satellites by the end of 2017 in low earth orbit. They will all be carrying GPS, Radio occultation sensors on board.

That data will move in real time. The latency will be less than 3 minutes to get it back out to our customer anywhere in the world and we will get about 30000 occultations a day of temp, pressure and water vapour because we will see all 4 GNSS constellations. That is all private capital coming into the company and we will be launching the first 4 before the end of 2016.

We are looking to sell that data around the globe under a license to primarily to the global forecasting organizations - the 13 organizations around the world now that create a global forecast and additional commercial customers as well.

There are no private sector weather satellite anywhere in the world and I know this is a difficult issue. But this is an issues that 3 other industries have looked at and successfully made their way to the process. In 1960 President John F Kennedy created COMSAT and now the commercial satellite industries is at least a 19 billion dollar industry, full of innovations and the United States Defense Department General Shelton said 6 month ago that he believes the United States Department of Defense could buy all of its satellite coms from the commercial sector. United States Department of Defense used to entirely control satellite com, a monopoly.



Same is true in the early 2000 for the commercial imagery world, the world that I come from, when commercial imagery was coming on the ground I actually worked for NOAA and represented NOAA and Dept. of Commerce to all of the intelligence community on satellite imaging issues. And the exact same situation faced that community that this community faces today.

The NRO's future imagery architecture constellation was over budget and dramatically behind schedule and there was the real risk of a gap; the gap that the U.S would not be able to support the U.S war fire across the globe and the generals got together and they were 3 small imagery companies trying to come out of the ground and said we cannot afford this risk, and so the pentagon allowed working with the NRO and it wasn't something NRO enjoyed. Working with NRO allowed those companies to come out of ground and today we have a global commercial imagery market and not only does U.S lead that market with company called Digital Globe, but we now see what is called New Space, the New Space industry is led by a couple of start-ups out of California called Sky Box and I don't know how many of you know them. They have flown 2 small satellites in LEO; they were brought 3 weeks by Google for 500 million dollars. There is another company Planet Labs and launching 100 CubeSats and I think 70 or so are already on orbit they are funded again entirely by venture capital.

The satellite imagery world came out of the ground for the exact same reason and what's the benefit, the innovation that is occurring. The innovation is occurring with private capital at very quick speed.

Who would have imagined of the US citizen in this room some 8 years ago that we would rely on commercial companies to take our astronauts to orbit and we would see the tremendous growth in space transportation that now is 7 billion dollars a year business and is happening quickly and there is a tremendous amount of innovation again on all private capital.

Why is the weather world any different, it's not really? I totally agree that weather forecast is global social public good. I don't think we are going to get in the way of that. In fact I think Planet IQ and there are 3 others - start-up companies - just in US; I am sure that there are others around the globe. I think we can lower the cost of the observation, we can drive speed and innovation with a private capital and your forecast still a global social public good.

So what the size of weather market; I purposely left that empty and speaking to Bob's remarks; Weather market is much larger than imagery market and in my conversation with people who have billions of dollar to put to work; they want to put it to work in this sector because they see the commercial need for weather. They are concerned about climate change our atmosphere is finite element model and we are just doing very poor job of sampling because we don't have the public resources to do it.

We are going to need to change that model, I would argue. I would say the size of weather market is north of 8 billion \$ right now and climbing.



So why have we found ourselves here. I spent 18 years in government. I loved govt. service. I loved the mission, I loved mission of National Oceanic & Atmospheric Administration and other public agencies I worked for.

But it's hard even a very best govt. employee, every single employee in govt. with a A+++ , it is damn near impossible to innovate in the federal govt. because of the bureaucracy because at least in US in our democracy we have put chains on public officials because we are worried of grafting, corruption and so we should, because there are many many many layers of approval, because perhaps the tenet individual employees are exactly right, the pace of innovation in government is very slow. Constrained; budgets again in US at least; our budget are not going to get bigger for these programs and they are going to get smaller and there is no doubt about that and we gone have learn how to innovate and find different ways to work together to continue to improve the forecast. And then finally in the US again, we have very in inefficient procurement model called FAR, the Federal Acquisition Regulation. And they make sure to slow anything down. By the time we launch the satellite it has been in planning for 3-4 years, then it has been in procurement for 3 or 4 years and in production for 3 or 4 years and then it is at the launch site for a year and then it is old technology. Alright, I think it is a fact.

The private sector, we have access to unlimited capital, if we have good idea and real business model & we can be very market driven.

So I certainly understand WMO 40 and I understand much of the constraints and frustration and I think with Planet IQ model or how we perceive it is that we are going to get in the way of the barter system that exists via WMO 40.

And I would say this is not "and / or", we need to -lookup this as an "and". This is the system that exists today plus a commercial system or several commercial systems.

I think the joint polar system that exists today: NOAA flies the afternoon orbit, the DOD - USDOD - flies the morning orbit and Eumetsat flies the mid-morning orbit; that works. It enables a global provision of data.

Are there delays, Yep.

Are there going to budget short falls? Yep. Although. ATSS and GOES-R are great programs and they are going (31.42) forward. They are programs of record, they are established. NO one talking about threatening those.

Are they higher cost, is this slow in innovation? YEP; no doubt about that.

Does it drain funding from other programs, does it drain funding from science; does it drain funding from compute capacity? It's a limited budget and there are a lot of pieces of that pie versus what we are looking at doing is selling our data to the 13 governments around the globe. The global forecast that comes out of that process is pretty good.



It is a product of NOAA or ECMWF or UK met, it moves as it always has. It just the core data, the raw data that we will not allow to be redistribute.

Does it enable a global provision? YES.

Does it built resiliency into the system? YES.

Does it lower cost? YES.

So I believe that there are advantages. Whenever this topic comes up there is discussion of WMO 40 and open records law. First of all, WMO 40 hasn't been touched since 1995. It's been a lot of innovation since 1995 like the cell phones, like the iPhones, like the iPads.

Things have changed, it's a different world; alright. We need to keep these policy to be kept up to date with what's possible.

Both government and commercial sectors are focused on meeting the mission, the mission is a better forecast. And I think we can work that together. I would say however WMO 40 as it is written today has an expressed commercial bias throughout the document.

It is largely predicated on an inaccurate perception and misapplication of Commercial model that exist today. It's inconsistent with other US guidelines that are much more recent, UN guide lines that are much more recent and it certainly does not have the force of law. It is a policy.

WMO 40 was designed to oversee the deployment of government, civil government systems not private sector systems. Private sector data is developed and used for forecast now the vast majorly of it is ground based or aircraft it's just not satellite based and it is licensed.

WMO 40 explicitly acknowledges the rights of governments to be exempt and exempt of certain other data sets.

So I think of there is plenty of opportunity for us to revisit this language and think about how we work together to enable a way forward.

As I stated early on, I think the imagery world is the exact corollary for this, and I think there is lot to be learnt from that. Look at the Innovation, look at Sky Box and look at Planet Labs, look at Canadian company Earth Cast which is start up imagery company.

Governments around the world already purchase this type of data.

As I have stated before value add for the GPSRO data is for the global forecast. So GPSRO will be ingested by those 13 countries; they create global forecast and forecast will still move freely around the world. It is just the source data that is licensed.

Most importantly for this community we will make our data available free of charge for all research use, we believe that the data can dramatically help in weather forecast research and in climate change research.

So, if it is true research, absolutely we have setup private foundation of planet IQ foundation to make sure that data moves freely around the world for the research use.

So, I think with open mind and an open dialogue we can work together on these policies whether be as it relates to buying weather satellite data or greater partnership with other commercial organizations to other governments to increase the resiliency of the enterprise and infrastructure to drive innovation, to lower the cost and most importantly to significantly improve weather forecast.

Thank You.

## 1.4 INTRODUCTION JULIA SLINGO



Our next distinguished speaker is Dame Julia Slingo; I know we were told not to use titles but female equivalent of being knighted as a meteorologist, climatologist is worth mentioning. Julia is Met Office Chief Scientist. She oversees as you know from this meeting of broad research from weather forecasting to climate prediction, climate change projections. She has been the director of Climate Research in the National Centre for Atmospheric Research down at the Walker Institute and has a long career in Atmospheric Physics and Climate Science making contribution around the world. Thank

you Julia.

### **Julia Slingo**

Thank you very much for the opportunity to be on this panel. I have just one slide that I am going to talk around little bit in next 5 minutes or so.

I am really coming at this from a very different position, I think from previous speakers very much from the scientist point of view particularly the scientist who wishes to make that science useful to the global public.

And of course the UK Met Office is a national met service with primarily to serve the public good. We are also trading funds within UK system and we do have a considerable commercial interest in exploiting the forecast and the prediction, climate prediction that we produce.

When I look at the scale of the enterprise that we embarked on, when we produced the first numerical weather forecast, some at least in the Met Office 50 years ago. The progress since my first days in the office in the 1970s has been truly remarkable. But it is also very daunting and fantastic range of science and applications that we are hearing about this week is both immensely exciting but also somewhat terrifying because the scale of the enterprise you now need to provide the level of forecast skill and detail that public, businesses, government expect of us is really extremely challenging.





Whilst I would say, I welcome the involvement of now the private sector into observing the planet and all those opportunities does that provides, let's not underestimate the challenge of actually taking those observations and using them in the forecasting process.

Observation tell you what happening to the world now, but they don't tell you what will happen to the world in a day's time or in a week's time and so forth, and that is the job of many of us who are in this conference this week.

One of the big things that we have been fighting for so many years now is super computing power. Our science and our ability to observe the earth has run ahead of super computing power that we have to make that science, to make observation worth to society.

It's been a terrific battle, and unless we keep fighting that battle and actually find a way may be as we are through the observations now of delivering the level of super computing power that we need if we are truly going to realize the enormous potential of some of the things we are seeing this week. Examples of simulations in single forecast, it is just amazing but to do that operationally will require orders of magnitude more investment in supercomputing than all subjects currently have.

So we have to find a way to arrive at that and whether it is through national facilities or may be through collaborative more international facilities I don't know. But there is no doubt that alongside the millions, billions of investment in earth observation, we have to have that same level of investment in super computing power otherwise we cannot use the data that these observing systems throw at us.

We need as I am here to say clearly alongside the supercomputing of course sustained investment in national and global observation infrastructure, and that will test the change rapidly.

As we see, we are destined to finer and finer detail in our forecast model but how well do we known that detail is correct, our model is going through so called fairyland. And all of that can be done from space; a lot of that will have to be done in-situ at the surface, and to me one of the great challenges is how do on earth we observe the oceans. That is where some of the big technological challenges will be, and all of that if you look at the scale of the enterprise which will involve, means no single institute however strong, however good their research, however good their forecasting can go it alone anymore we have to forge stronger science and operational partnership that has become very central plank of the science program at the Met Office and indeed Met-Office as a whole is playing its role in global community and reaching out to those who cannot sustain the scale of the enterprise; the major Global forecasting Centres around the world do.

And it's not just our science, science that goes on in academic so the little picture you can see there, Met Office academic partnership scheme which we established with leading universities in the UK to really align our science & to enable academic science to be pulled through much more rapidly in operational forecasting & prediction system.

Likewise we have an international UN partnership where other countries use operationally our complete forecasting systems and our Climate Prediction models.

And that is how I think we are going to have to work - in partnership because the scale of the enterprise, the sophistication and complexity of the technologies we require are no longer something that a single organization or even a single country can sustain - and that's going to be very important & then I think finally of course it is this bridging the Valley of death so to speak: - How do we make our science relevant to the challenges that the world throws at us today and that again it is a collective potential to deliver products and services that address societies needs for environment information.

It is about partnership this time with the customer in a broader sense, whoever that may be & it's a dialogue that you have to have because unless we shape our science and our services to meet that customer's needs, then we are not doing the job that we were given to do.

And so again partnerships comes into that and also partnerships across many sciences.

So from Met Office prospective huge challenges for the future, I think the world of weather forecasting and climate prediction will look very different in 10 year time and we will need to change and we need to change the way we work, and we need to change the nature of the infrastructure that we rely on and where that infrastructure comes from & who pays for it, if we truly to be able to advance science that is paid by society who undoubtedly requires us to do in the coming years.

So prospective from Met Office somewhat different from what we heard here but I believe very strongly that the public sector, the government sector, institutions like the national Met services and their role in the WMO is absolutely critical to making sure that the forecasting enterprise which is at the end of the day what really matters and what really makes the difference goes forward in the way that it should and goes on the best possible science that we are doing in all our institutes around the world not just in the Met-Services.

Thank You

## 1.5 INTRODUCTION AJIT TYAGI



Our next speaker is Ajit Tyagi. He is a Kotswaran Professor which is the main chair within the Ministry of Earth Sciences of India. He was formerly the Director General of Indian Meteorological Department where he served as permanent representative of India with WMO where I had the pleasure to work with him on several issues. Prior to his time as Director General, he was the Assistant Chief of Air Staff of the Indian Air Force focusing on meteorology retired as Air Vice-Marshal.



## **Ajit Tyagi**

Thanks a lot for giving this opportunity. After listening to Julia and other esteemed co-panelists, I feel reassured about the bright future of weather enterprises and more so about the evolving cooperation between the public-private academic and research institutions and with this positive note I will be making the presentation from the perspective of a developing country and I have certain observations to make.

World is changing but as far as weather and climate is concerned, international cooperation. I think, we are good that world is not changing. We continue to have sound international cooperation that started from the very early stage of this so called weather enterprise and this continues to be a success story and hallmark to the present day where WMO has been playing a very critical role and a very important role and key role in developing the building blocks of so called global weather enterprise – be the World Weather Watch, Global Observation Systems, the Global Telecommunication Systems, the Regional Forecasting Centres, World Meteorological Centres, the field experiments to support the research in meteorology the GARP the Thorpex and now the service oriented Global Framework Climate Services and this is one thing which we have to take into note. But this is one part of the story.

Now when we come historically, the weather enterprise essentially consisted just the National Weather Services and now as we have seen the presentations, and there is a demand and there is a scope for expanding this to include other sectors and this is very welcome but then it is with certain caveats. Caveat is that this weather enterprise consists of the countries which are at different state of economic, social political, scientific state and therefore this enterprise is not homogeneous and this we have to take note of it and there cannot be any solution which is going to fit one size all.

Now essentially the infrastructure which weather enterprises have got for observation, communication, processing, modelling along with the capacity building in all these sectors and ultimately the services which the national weather service or this enterprise has to provide.

Now weather enterprise is for what. Is it for making money? I am sure it is not for that; it is to provide science based improved weather and climate services for the safety and well-being of citizens and sustainable economic development. This is the bottom line if we are looking for weather enterprise and this is what has also come out of the world climate conference which was held; yes we have to have considering the impending challenges and dangers of the climate change, that we have to come out with a climate service, structured climate service for the good of the humanity. And if we see the baseline survey which was done in 2012 before this GFCS (Global Framework of Climate Services) what is the various state of the countries which are there. So we had:

Category 1 countries which had just basic climate observation – some of them don't even have that – some climate data management and some interaction with users,



Then there were Category 2 countries; they were doing climate monitoring and seasonal climate outlooks they were providing

Category 3, they were providing specialized climate products and decadal climate predictions and then

Category 4 countries which were fully developed which were able to provide so called customized climate products and Climate Application Tools.

And this survey showed us that there are 70 countries in the world which are in category 1; they just have the basic and some of them don't even have the basic capability to provide climate and weather service; 56 are in Category 2; 39 in Category 3 and just 24 are Category 4.

So this is the background which we have to keep in mind when we are talking about weather enterprise and capacity building and developing infrastructure for providing climate services. Now observations; everybody talks of data, the observations and this is what the true picture on the ground is – even the basic surface data – the synoptic data - which is the building block of any monitoring and the prediction, you see the gaps. There are no observations and where observations are there, there are many stations which are not reporting so rather than going forward, we are going backward. We have 390 stations which are not reporting which were established not reporting and 400 to 500 report less than 50% of time. So there is large number of gaps which exist even today in our network where we are talking about tedium sensors with a leap frogging of technologies but then the hard reality is that there are many areas of the world which don't have even the basis data available which is to be used in the forecasting and climate monitoring and this what the major gaps, needs and challenges is there.

And this particular slide, let me tell you have taken form a presentation which was made in 2004 or 2005 by LDC countries' representatives. The state has not changed much even today. This is where there are the large gaps, needs and challenges. In fact we don't have many of these basic networks are closing down in many of the countries so we have to look in. Now again we go back to who is going to be responsible. Essentially, this is a national need; so the prime responsibility for having the basic network is essentially going to be with the National Governments because we have to enable and do the capacity building of these countries to sustain these observing networks. It has happened many a times that under various projects the networks have been installed but they wither away after the funding agency is withdrawn. And this is going to happen with many of the commercial entities also (1:17:27) if they go to certain countries; I am not sure whether they are going to sustain such networks for years to come to be called as climate stations. So we have to be careful when we are talking of basic networks and the responsibility has to be with the national agencies and we need to do support and this weather enterprise has to support the national agencies sustaining these things. So we need to extend the National Meteorological Hydrological Services. Yes international cooperation, there are many areas where we can do it; I think it is a welcome move that the space private services launch satellites and data is made available.



Ocean is another area where deployment of buoys and many other things is being done by international cooperation where private sectors can come and play very important role. The field experiments, the research components are obviously being done and they can participate with academic and research institutions and they can contribute. So private sector yes, it is positively a very welcome move but then we should understand the different state of the countries and what they can absorb and really assimilate and what private sector can really contribute to these countries. Developed countries positively, there is a talk of network of networks. So even today there are many networks are there but even the advanced countries are not able to integrate into their networks; this is a challenge. We may be talking here; but are we really using the data into our networks, very limited may be one odd country may be doing it, I am not sure but it is not there.

Developing countries, private sector has got some presence which is very welcome they are supporting the national initiatives including their weather services; but here again there are areas where they can complement because obviously the National Weather Service cannot provide services - value added services - to all the sectors like in India we have got Agro-insurance sector. Now we cannot, as a National Weather Service Agency cannot have weather station in each block or in each village level so we have to provide, the private sector can come there; the energy sector is there. There are many emerging sectors where we can have this and Least Developed Countries of course we have to leap frog and provide them technologies which are simple, easy to maintain, easy to sustain and that is what we expect from them. Public, Academic and Private Partnerships should be there to develop new technologies which are cheaper, easy to maintain and user friendly. This is what, I think, weather enterprise should look into it. And we should look for creation of trust fund which could support and sustain, because even today, I was listening to a presentation where the World Bank is willing to fund \$20 Million to Mozambique upgradation but they are afraid that after they leave, (whether) the federal government will be able to sustain it or not. So this is a real challenge going to be there. GTS, yes I am sure the Public Private Partnership is already working at high end in communications and computers but still there are many countries where the basic network is not there and I am sure that Internet capability there should be able to help us. Data Processing and Forecasting, this is a positive part, yes we have again global centres doing very good forecasting and prediction but is it percolating down, how it is getting used at the national levels which are not able to absorb these products and this is where the capacity building has to come and this is where I think with least efforts we can achieve a great success. See you don't have to put millions of rupees in creating a network but you can train certain amount of people there to the capacity building we can use the forecast even by the UKMet Office or the NCEP and various other agencies, how to down scale to their or apply to their region, this is there.

Modelling, yes again the research part is there to sort out but ultimately the forecasting aspect has to be the responsibility of the National Weather Service and private sector can engage in data management and many other activities part of it.

Services, as far as for public good I think the National Met Agencies for time to come will have to continue to play a role. But yes for value added services, I think the private sector is welcome and they can contribute immensely and there is a large market everywhere. And academic institutions should carry out/continue to do research and capacity development and multidisciplinary R&D. It is an excellent concept and private sector can contribute a role - it will vary from country to country and challenges of viability and sustainability of observation networks, promotion of alliances and partnerships and establishing and maintaining the networks in data sparse regions and capacity building of using the NWP and other forecasts products and the climate products in many of the countries which as of now do not have this capacity.

This is what the target of BFCS for the next 10 years is setting and I am sure, if the Weather Enterprise works towards it, this will be a great success and contribution of weather enterprise to achieving this particular target.

Thank you very much.

## 1.6 INTRODUCTION ERIC WEBSTER



The next speaker is Eric Webster, Vice President, Director of Environmental Intelligence at Exelis formerly ITT. He oversees the company's weather and climate satellite business unit which extends across programs for NOAA, NASA and international customers. He began there in 2008 working on Government relations and business development.

### **Eric Webster**

Thanks Dave for the introduction and special thanks to Jack Hayes for inviting me to come and speak to you all with a pretty distinguished panel of guests. Want to talk today about the future of the weather satellites. I think Anne did a really good job of setting the stage. Most people would probably assume that I have a lot of differences. But I think as you see it as I go through from my perspective and my path I have a lot of similarities in how I think we view things in trying to determine the best path forward.

So in terms of the, I guess, the state of the weather satellites industry, in a way it is kind of tale of two cities, it is the best of times and it is worst of times. There is optimism and anticipation about the next generation of instruments that is getting ready to be launched and all the new capabilities that it will bring but there is also anxiety and concern and frustration over the cost and the schedule delays, the potential gaps but as Anne mentioned that affords some



opportunities. We need to figure out as a community how we want to address those opportunities.

As a non-engineer and a non-scientist, I like to try to explain a little bit how space instruments work. These things are extremely complicated, they can be very costly and I think most folks don't realize how much data and information and products you glean from having these pretty incredible instruments in space. So what I attempted to do is to just show you through visible channels and infrared channels and microwave channels. They are basically filters and bands and as you slice those and provide the data you get certain characteristics for ocean colour or clouds, or temperature. The important part is no one instrument can do all of these; you have to have several different instruments trying to measure these different capabilities. The finer scale you want for Green House Gases, you are not able to see things like in the next column which might be important as cloud at night and other things.

Few countries can actually afford and build these instruments. I think that is another aspect similar to Anne's comparison to commercial imagery which I will talk about in a minute and I think that has some role to play and how we as an enterprise move forward with the understanding of what these instruments are and what we need them to do. From an anticipation stand point and optimism - this is the example of the Advanced Space Line Imager. There are 7 in production, 4 have been – two were delivered last year two will be delivered this year. First one was delivered to NOAA last year. Japanese actually with JMA is expected to launch the first instrument later this fall.

The capability increase is pretty incredible. If you notice from the news there have been lot of typhoons and a lot of hurricanes and lot of other severe weather that people have been very concerned about and the increase in understanding where and how those things happen. The ABI instrument will provide 5 times the temporal aspect, so currently Geo imagers do 30 minutes full disk, this will do 5 minutes full disk. Currently when you do Mesoscale mode to view a particular event in a way like a hurricane or tornadic activity that data goes to the Weather Services or Severe Storm Lab roughly every 7.5 minutes. With the next generation instruments it will get there every 30 seconds. Three times the spectral band – remember those slices I showed you earlier, two times the spatial resolution .5 km vs 1 km today – all from 36,000 kms. It is pretty amazing what it is going to be able to do and additional products and capabilities.

Similarly on the LEO side NPP was launched in 2011. We are getting ready to complete the next set of instruments for JPSS1 to launch in 2017. The Hyperspectral sounder - the previous generation we built had 19 channels; this has the capability of 2000 channels. Again from 2000 slices of the atmosphere and dated information that when vertically resolved can provide unprecedented insight into atmosphere temperature and humidity. These are the instruments that allow the National Weather Service Severe Storm Lab to tell you that in 5 days there is likely to be a tornadic activity in the certain part of Oklahoma. They are not going to get the city right but they are going to get the general area 5 days in advance – pretty amazing. But I think

the previous speaker spoke about the need for modelling capabilities and super computers and I know that the Weather Service and other agencies around the world have struggled with that. I do think that there is a need for continuous investment in those aspects to ensure that we get the full capability out of these instruments.

Similarly the Europeans are beginning their next generation both on the GEO side and the LEO side somewhat similar to what US has done. China is also making significant investments in their weather forecasting capabilities and the role of China, I think, should be whole other panel discussion in how the US and other nations within WMO incorporate and utilize that. I know that that is something that has been of interest in the US from all different policy perspectives.

But with great optimism and anticipation also comes great frustration and anxiety and concern. So from the LEO perspective, in the US, we rely on roughly about 15 LEO satellites today between NASA, US Air Force, the Europeans and all the different NOAA satellites. It just need- just in the polar orbit. By 2019-2020 we will be down to just 2 satellites from 15 to 2. The European METOP-C satellite actually will have an Imager which will be 12 years old before it is launched and then the JPSS satellites to launch in 2017 doesn't have a backup. From that perspective of an opportunity that Anne talked about I think NOAA and NASA and the US and others are trying to figure out what do we do, how we deal with this potential gap.

Here in Canada they have been studying the Polar Communication and Weather mission for several years. So the concept is to fly a satellite with GEO-like imagery capability as well as communications needs. The interesting thing is flying in a highly elliptical orbit, more specifically a Tundra Orbit would actually provide 24 hour coverage 7 days a week coverage of the arctic which has very minimal coverage today. – there is very few Radars, they get fewer of those LEO satellites that I mentioned and especially in the future with only two it is going to be significant. So I think the capability for climate change in the arctic and melting of the ice is all pushing the community forward to determine how we can we better monitor and understand what is going on in the Arctic from Aviation to marine, tracking ice as well as national security issues. The interesting thing as well about the highly elliptical orbit is that it will allow for imaging of between 4 and 16 hours of the rest of the globe with GEO like dwell time.

From Antarctica to other parts of the globe you would get continuous geo capabilities and mesoscale capability that I mentioned earlier to provide 1 min, 5 min, 10 min coverage rates of places around the globe. More interesting though I think from an enterprise stand point, while a lot of time and effort has been looked at the capability, it is the business model aspect of the PCW I think is most intriguing. It is this opportunity of the Government weighing to do a potentially a data buy, if you will, a services contract vs the traditional procurement. So the concept of having a large company build and procure, launch and operate this communication and weather satellite and then sell the data back to the Canadian Government. The concept also has participation from international community, the US potentially with instruments or ground capability, other countries in the arctic providing potential as well. So I think this is one of those transition points of how we get from historically traditional procurement model to this



bigger capability of utilizing the private sector commercial aspect. So there is a lot of potential here and we need to keep the momentum going.

Anne did a great job of, I think, talking about commercial imagery aspect and it is something I want to raise as well. The countries like Peru, Vietnam, UAE, Azerbaijan – all now want and are buying and paying for commercial imagery capability where before no nation had besides the US and some others had that type of desire or ability because of the lower cost, technology, the ability to get services without having a huge infrastructure. So I think, the difference is, there is a national security aspect to this that countries really want, they want to know what their neighbors are doing and they want to know what is happening within their borders. As I mentioned, the capabilities have gotten cheaper easier for smaller companies and others to do venture capital as well as look for cooperation with other entities to do smaller satellites and less. They do not need big huge systems and then again there is a pride in wanting to have a space capability. So many of these nations before never worried to have space capability.

In studying some issues for a different conference that I attended, dealing with geospatial intelligence as Anne is familiar with, similarly if you look at what geospatial intelligence is and what weather intelligence is, they are pretty much the same thing. I think the difference though is in have these nations determine that the weather is as important as their ability to watch what their neighbors are doing and I don't know whether we have gotten there yet. I think there is more work that we need to do on our end as a community to develop capability similar in terms of the commercial imagery that other countries can afford and that will fit within their system.

So what will the future bring, new technology, I think companies are developing new sensors, there is UAVs, there is in-situs, there is cubesats, all trying to get better forecasts; who knows Google might figure out a way to do all this without anybody's help. There is definitely increased environmental impact with extreme weather melting of the polar ice cap, different atmospheric impacts and effects that we as a community have to try to address and satellites are critical to understanding those. The budgets are getting smaller whether they are in the US or Europe or around the world. We have to deal with the fact that these programs can't cost 10 B or 8 B \$s and have a huge infrastructure. The future is going to bring new business models – who and what is driving the requirements – does it have to be government related, can it be commercial oriented and one aspect, though is how do you ensure the full complement of needs. Anne talked about GPS Radio occultation which they focused on. But there are other capabilities and needs, that are the foundation of the weather enterprise also still have to be maintained whether commercially or through the traditional government sector and there needs to be an overlay of those two to ensure the enterprise can fulfill its mission. I think that the kind of 3 takeaways in a sense are:

The anticipation of the new capabilities going forward is tremendous.

I think the anxiety is real and today. But the question about how we move forward these next generation instruments that are being launched will last long time. The ABI instrument will last 15 years – 10 years in orbit, 5 years in storage.

You are talking about major programs going until 2025, 2030. Even PCW in Canada if launched in 2020 would last until 2035. So there is some disconnect between when and how we can move forward with augmentation or different systems and the investment by the Government in infrastructure today.

Then finally, again kind of as a history major, I found this quote from Atlantic Monthly article from 1862. But I think as you read it, it kind of shows, the whole reason we are here, the passion and the commitment that we have as an enterprise can actually make a difference in weather. It is not just the day to day lives or livelihood of people, it makes a difference for the future for our kids and grandkids, whether it is weather or climate change and our ability to measure, monitor and make good forecasts and understand what to do is paramount to that.

Thank you for your attention.

## **David Parsons- Moderator**

There were a couple of questions that were brought up for this particular session, really:

- What are the gaps that we currently have now?
- What we should be doing to increase the value?

It's been the provocative panel, I know the audience is probably getting ready to ask some questions and answer some question probably too.

And for myself, being in university now "are we preparing students for this new world in right way?"

How we are going to guide this enterprise, certainly observation are important we have heard lot about that and for 0 to 3 Hrs that the driving force for the global NWP.

The biggest advances have come from data simulation systems and better & higher resolution models so how we are going to guide this?

Let's here from the audience a bit.

## **1.7 QUESTIONS - ANSWERS**

### **Question 1.1: Peter (from Weather Company)**

Thank you very much to panel, very provocative, very thought provoking discussion here. My mind just going out of million different directions with all the comments. One, I think I will bring up though is I was struck by Anne's challenge of WMO 40 and I was thinking more generally about



the WMO and how it relates to our evolving weather enterprise. The WMO was constructed with an era when a weather enterprise was fundamentally nothing more than national met service but today our weather enterprise is much more robust with multinational private entities, other NGO's, academic institution don't necessarily follow national bounds.

I don't think we have today a real entity that serves the weather enterprise of today. Whether or not we need to recreate the WMO or evolve the WMO to serve the weather enterprise of today. So fundamentally with that basis, what are the thoughts of the panel whether or not my statements are shared by others?

**Answer 1.1.1      Bob Marshal**

Peter, I think it is a good prospective and I worry about that as well. So I put up to Public, Private and Academic sector and are we all ready to engage in the change and work together to do this, not in reference to WMO specifically. I have talked to Jack about this. It is an organization that is a large organization, its multinational organization. Obviously by its core and that itself-creates constraint relative to how fast we can go. But I think it does probably need to be looked at. Things are evolving so rapidly but there is key role for WMO, there is very key role for the National Meteorological and Hydrological Organizations in the countries and so there is a role but probably it does need to be thought about little bit.

**Answer 1.1.2      Anne Miglarses**

My response to that question is, having travelled the world, having talked to most of the Met Agencies, there is a desire to get the data, absolutely desired to get GPS RO data and they believe strongly that it will drive a better global forecast but there is political concern, clearly an organizational concern about WMO 40.

When we had our lawyer, who is an expert in open data records and in space law, take a look at its age and the number of exemptions that are within that particular resolution; it's like Swiss cheese and so you know the long pole in the tent for Planet IQ and our good competimates the other three companies, at least in US, is having this policy discussion and one of the major messages I wanted to deliver today is there are a lot of good reasons for the countries to barter these data sets and to work together to create this global good. But it's not covering the entire range of data opportunities, it is certainly not driving innovation and that policy is, I believe, biased against the commercial sector and dramatically out of date. So I would argue it in particular need update or fresh look and the concept of the WMO as whole, I can't speak to that.

**David Parsons- Moderator**

Julia/ Ajeet you want to comment on that before we move to the next question.

### **Answer 1.1.3 Ajit Tyagi**

WMO president is here so he is the best suited to make a comment. I as a representative of a country can make a comment that's all, but not on behalf of WMO.

### **Question 1.2: Brian (From Met Office UK)**

I listen with great interest to the private sector contribution which were entirely focused I think on different ways of getting observation which are the fundamental input to what we do. However my experience with the development of satellite based, using satellite based observations is the innovations have to be taken forward in parallel between the models, the modelling and data simulation in particular and development of satellite instruments. It's a long time since the elite meteorological agencies took satellite data and computed product from them. The product come from integrating the satellite data in the model which describe the structure of atmosphere, the structure of surface and carried out integration with other sources of information.

It's not clear to me how the model that has been suggested of putting up independently developed speculatively developed instruments into space without involvement of the scientific community in developing the concurrent processing technique including the bias radiant data into the models.

How that will lead to advancement because if you wait till you got the new data before you start developing the new science, the instruments is disappeared from the space before you taken advantage of it and that's what used to happen. We have got over that by having have much closer integration between instrument development and simulation development and don't understand how a sort of approach you have been suggesting will enable us to carry on close integration.

### **Answer 1.2.1 Anne Miglarses**

So I think the GPS RO in particular is the absolute bright data set to overcome that very real concern because as you know the Taiwanese cosmic one program was a tremendous success and I believe the first launch of cosmic 2 will occur and the agencies around the global want more of it, have the ingest system, have the simulation process and so the barriers for that data stream just that one data stream does very important linkages that you rightly point out have been dealt with.

I do believe and I know in speaking particular with NOAA; those are very real concerns about the internal process that is required on the government part to receive this data, to ingest this data, to assimilate it into its model and the front end of that is very important process.

There are other companies that are looking to apply technologies well that will be absolutely critically, I can't speak to what they are doing to work closely with customer through that process. But in case of GPS radio occultations, I believe that is very well known path, the infrastructure exists, the assimilation process exists and more of that data is wanted.

**Answer 1.2.3      Bob Marshal**

Couple of things on that issue from my perspective, one thing I certainly talked a lot of observations, I guess, but the reality is when I think about business, probably only 10% to 15% of our business is actually the sale of actual observations. We actually produce products and decision tools for enterprises, energy companies, transportation companies, aviation companies, our consumer products are, Weather bug, we have 30 million consumers that take our data and that's half of the business roughly so we monetize, we actually use that data for very specific application and decision tools for a very broad spectrum of customers. And then we do work very closely with assimilation into the models. We work very closely with our academic partners trying to further that enterprise we are working very closely with NOAA Boulder on the research side. They are doing some excellent work assimilating the data that is being done in partnership in many cases without any money changing hands in some cases. We want our information to be used, used effectively to support the mission of the National Met Services.

**Question 1.3      (From WMO)**

I am quite interested to listen and happy to provide some points from my perspective.

First I fully support the idea from Anne that there should be role of government and private sector not an "and / or", but it is "plus". Because it is really, actually it is not new and that has happened in the older history of WMO. If you think about the last year, WMO celebrated the 50 years of water weather watch because of the first satellite which kicked off the process.

Then all the past 50 years the most important successful story of WMO is critical the collaboration among governments as well collaboration with private sector. The enterprises are critical example which is already more than 50 years and will continue forever, I believe.

Second I also would like to highlight the power, the political power of WMO Resolution 40 because this is the only most important political document for WMO to really to consolidate all the government effort for such kind of beautiful global infrastructure. You can imagine how powerful that continues to be, every day, every second the data exchanges across the national borders all the Global NWP Centres which makes the Global NWP including weather all the research, all the operation, all the service possible today.

Yes sure resolution WMO 40 was designed in 1995, however the real content and the resolution and the real data exchange across the border, are exchanging every day. The data volumes increased enormously in the past 20 years. So first the structure, the principle is still great but the real content exchanges increased greatly, because that is the definition under the framework of Resolution 40, they have Annex which they released.

But I would also like state my idea, my suggestion for the future, because the WMO standard practice, we call the rolling review of requirements clearly three steps: first regularly to review the requirement and for this part and the private sector has role to play, to identify different social

economic sector, the requirement. Second is compare with existing observing capability and certainly this part is also to engage the private sector in addition to the government observing system and what are the private observing system they can contribute to existing observing capabilities. The most important, the third part is GAP analysis which is comparison between another requirement with existing capability to develop a GAP picture and global picture and this in future, in long term planning and future development I believe that government can find a way how to fill the gap and private sector can also contribute by filling different gaps which will also benefit to their future business.

We I see very strong complementary role I really see development of private sector.

I will like to highlight another point that globally private sector development is very uneven, unbalance. You see US example but if you look at other developing country example, the picture is quite different. So I really would like to see how orderly we can working together to development a very healthy partnership for our common purpose. Thank you,

### **David Parsons- Moderator**

Thank you. I know that there is one proponent of the first talk, Krystin was on the open data policy and do you want to say how Norwegian Met Institute views on this or move on to another topic. Your call.

#### **Answer 1.3.1 Krystin Lyng**

I am highly interested in some suggestions, what we to do with resolution 40, you are saying it is against private sector. I have to say that I had some lively discussion in the data policy committees that I am representing the institute & please advise me if you have any good ideas, I will convey them to my committee.

#### **Answer 1.3.2 Anne Miglarses**

Yeah I think that we have taken a long hard look at a WMO 40 & so we have had a lawyer develop a number of briefs & I will introduce to you & share all of those briefs. You know I go back to the intent of WMO 40 & as the gentleman said that the ability to share the data across the globe and work on requirements globally, that has worked very well for this community for a long time & so, but I do believe there is express commercial biases in WMO 40, there are tremendous number of loop holes for those countries that have quasi government, quasi commercial Met Offices. There are express exemptions for certain data types AMDARs. So it was at a point of time, 20 years ago worked quite well. I am not suggesting you throw it out. I am suggesting lets update it or lets realize that it is not a constraints truly to buying commercial weather satellite data. To the open data policy issue; open data policy primarily is least interpreted in the US is government transparency & the movement of data has been paid for by the tax payers, tax payers across the globe, I presume to move freely to enhance the public good to enhance research, to enhance

commercial operation. It doesn't apply to commercial products (data products). Companies can choose to open up their data & several companies have some interesting models particularly in Europe that are developing for open data models, I think the approach that we are taking is opening our data to the research community to drive better research.

**Question 1.4 (represents the company Meteo Services )**

I represent a venture company Meteo Service. Our company is busy with statistical post processing like model output statistics already for more than 20 years. It came to existence because of the proposal to append an European centre for statistical post processing to ECMWF that in vain more than 20 years ago & today I ask myself quite often why don't have sort of global centre of provision for statistical post processed forecasts because this will bring the accuracy of local weather forecast 20 to 30 years ahead, so this statistical forecast have an error variant only half of the direct model output forecast & if we would blend all the good models ,global models which we have to put together, bring together all the global observations which we have, we could make the really heavy step forward.

So my question may be not to the audience but to the people from WMO, who have all the record of this, why don't we have such global centre, for statistical post processing which can bring us really much forward on a fraction of 1% of the effort for numerical weather prediction satellite technology which is behind this.

**Question 1.5 Joe Myers (former CEO of Accuweather)**

Joe Myers, former President of Accuweather. Well capitalism is alive and so is entrepreneurship & creativity. Things are changing rapidly and in the United States, when I started the business, the 98% of weather forecast reaching the public came from the government. Today 2% of the forecasts reaching the public come from the Government, So, things are going to change globally, whether governments change or not; it is already happening , people with their cell phones and tablets are already getting weather forecast making decision based on this forecast getting better & better. Since, met services' interest to make the data available in their countries because that will improve the accuracy & the value of the forecast that the people in that country are getting .if they withhold it & minimize what's allowed out, it's only harming the people in those countries, which are getting many of forecast from outside sources anyway.

**David Parsons - Moderator**

OK, Accuweather sponsored this session. So let's hear response.

Fair Weather (Report) focused on observations but actually it is very true that not only different forecasts coming from the private sector but different ways sometimes you are getting the weather service forecasts.

That's an interesting point, I will say something and then hand it over to the Panel because one of the issues is actually who is making sure that you are not missing anything. So if Accuweather or some private companies are giving warnings to Amtrak to the Government not down at that level to make sure that no one is missed. So any comments.

**Answer 1.5.1      Bob Marshal**

I am not sure what Dave did. The question was exactly, but I mean yes. I mean there are very wide range of opportunities to provide forecasts and warnings and we do that; we provide forecast and warning specifically for the customers. We work with Bill Gail's company on this statistical post processing of the forecast and really come up with a better forecast tailored to customer tailored to localities that have specific observations and things like that.

We recently surveyed wide range of commercial customers like that Accuweather does and, WSI and other companies.

**Answer 1.5.2      Krystin Lyng**

I would like to add to that the Norwegian Meteorological services are serving the public with the general forecast to the service that we are providing but in addition to that an open data policy we see that more specialized services are made by businesses. One of the companies you (Bob Marshal) showed in your presentation Strong Geo is building up a huge enterprise in Maritime Forecasting Services and they have their headquarters in Norway so this could be a parallel development.

**David Parsons- Moderator**

I think that we will hear from Sheldon and Jack; those will be the last two speakers/people,

**Question 1.6:      Michel Beland**

Thank you Dave. I guess I am a bit surprised in hearing the discussion from the following point of view because I thought there will be much more business opportunities in the private sector from actually developing ever more complex or general applications out of the database that comes out of the Global Prediction Centres. We had a presentation this week where roughly only less than 1% of the data that is produced for global run actually makes it to out to users. So 99% - and we are talking of terra bytes of data which just stays there in the computers and goes into the archives. So as opposed to trying to produce more data in the form of observations that would be used by the Global Prediction Centres and I remind people here that there are about a dozen of those around the World; I am a bit curious why we haven't heard from our panelists here about the huge business opportunity of trying to get full access to that database that comes out of the data assimilation and global prediction process in ensemble format to actually develop applications which would add a huge value to the raw data. I think that there is much more money



to be made from the added value applications than from the raw data. Perhaps there are some opinions on that.

**Answer 1.6.1      Bob Marshal**

From my perspective, we clearly would like to see all the data come out and I think most private sector companies would like to see – we do take the model data and use the model data. We are very supportive of the large organizations that run the global forecasting models and there is no question that it wasn't discussed in the Panel today, absolutely, more data that can come out, the more information private sector companies can work with tailor, localize and produce specific forecasts, value add to it so 100% supportive of that and we would like to see that go forward.

**Question 1.7:      Jack Hayes**

Well I am going to try not to be too profound. You know I lived a lot of this and I heard very compelling presentations focused on observations and what the private sector could do, I have met with Accuweather and Weather companies and I see what private sector could do in delivering products and services to the people we all serve and I am struck by, Julia said in her presentation it is time to change the way we do business and I say why we are not changing the way we do business and in the lot what I heard today is because I like the way I do business today, I mean look in the mirror and say that. I mean changing the way we do business involves risk and I have heard that if you start down the path and the government becomes completely dependent on GPS-RO from your company and you decide that the numbers aren't fair, I am done, then the government is left holding the bag. Now I say who the heck will sign on that kind of agreement from government side. I mean if GPS-RO is important then we are going to have some frank discussions.

Bob I like what you are doing in Guinea. I think back to two AMS' ago where the head of the Met Service said to me, Jack I look at all this technology, I know we could never afford it in Guinea. I would just take what the people who buy this are throwing away and trying to make it work. And I said I am so enthused with that concept, that there's got to be something that we can do about it. I would tell you over a year later I had to have look him into his eyes and say I can't believe how many road blocks there are to getting you used observing equipment. To me, I am going to put on rose colored glasses and not be defensive about it. The climate is changing, we see those impacts every day, I walk in the path of 5 tornados in Alabama and people lost their lives. I look at what goes on in Africa and I look at what goes on in the Southern part of Asia with monsoons and tropical cyclones and I say we can do a better job for people and that means don't hunker down and let the people who manage the system feel threatened by change and stop it from changing. When Jerry asked me to put this together, he was very careful to say if you create controversy, you are going to stop or nip in the bud what



we are trying to be threatening. May be it's time to get some sober disciplined people together and say what we want to do for the world before we pass on to the next world.

**David Parsons- Moderator**

May be those should be the concluding remarks, we are a bit over time. Julia had another engagement. Thank you very distinguished Panel one more time.





## **ANNEX B**

### **PANEL 2:**

# **Weather Services – Present Status, Trends, and Innovations**

## 2 Moderator: Jim Abraham



I am Jim. I retired from the Weather Services. I am part of the organizing Committee. In the Met Service of Canada, I looked after research and weather monitoring, climate and water services before I retired. Neil Gordon who is the Chair of this session was unable to do it today so he asked me to step in. This is the second in the series of three Panels on the Future of the Weather Enterprise. Those of you who attended last evening there was an engaged discussion around data and data policy and importance of data and then this afternoon right after lunch there will be the final (Panel) in this series with the topic how we move forward to maximize the benefit to Society. The format will be similar to last evening and each of the speakers will be given between 5 and 10 minutes. Then I will be asking the Panelists whether they have any questions of each other and we will take 5 or 10 minutes to do that and give you folks some time maybe last 20 or 30 minutes on engaged discussion between the Panel and the Forum.

### 2.1 INTRODUCTION: MICHAEL EILTS



Our first speaker is Mike Eilts. Mike is the President and CEO of WDT – Weather Decision Technology – in Norman Oklahoma. He received most of his education at the University of Oklahoma including an MBA. He is also a Harvard Senior Executive fellow and fellow of the AMS. I had the pleasure of going to Oklahoma to meet up actually with Mike shortly after he started WDT and certainly it has been a pleasure to see the growth in WDT. Before that Mike was with the National Severe Storm Lab in Norman for 18 years, last 7 of which he was the assistant director. Indeed WDT has grown and it has 95 employees and it really focuses on big data, weather decisions and analytics and he provides a global service. So I am pleased to turn the Mike over to Mike.

#### Mike Eilts

Thank you Jim. First I just want to thank Neil Gordon, Jim, Jack Hayes and other people that helped to form this three sessions. I think it's great for all of us to be part of it.

So let just start, I just want to talk, goals five minutes right! I just want to talk a little bit about trends, a little bit about the need for standards, standardized and open access to observations and government services. So as our company and myself, we look at the industry; we look at what are the trends, couple of talks yesterday about change is accelerating. We really believe that, its rapid scientific & technological innovation & there is so much in meteorology & this technology itself. The other thing great is the number & amount of metrological data that is available now and it going to continue to accelerate, better radars, faster radars, satellite we talked about yesterday many many things it's just more and more data available which is great.



## Transcripts of Speeches and Q&A Session of Panel 2

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A constant growth of cheaper and faster computers especially in cloud & you can do lot of that & if you are worried about trying to create analytics, or forecasts or prediction of weather phenomenon, this makes it easier to do. Of course it's compared to just – I will show you an example - but just three years ago we couldn't do something global, we could do it today and just keeps getting faster and faster, the ability to disseminate data or access data over the cloud is just rapid acceleration.

You know study shows may be trillion devices are now connected to internet and many of them have GPS devices. So the ability to target customers with weather services becomes very very (much) faster, easier (and) better basically. And of course the government is making even larger investments in better resources and I think every increasing private sector is making larger investments enterprise & better services as a goal. So the trend is going to be in the next decade much bigger role for the Private Sector.

I will show you an example of project that we have done over the last couple of years. I apologize my graphic person had a lot of fun with this one. She is trying to do in the office really cool stuff. But bottom line is, we tried to do this 3 years ago but we couldn't do it, but technology in the last year actually got fast enough to do things. So we were taking, inter partnership with METRA in Australia & New Zealand, we are accessing data from 63 radars, the raw data, raw full volume, Radar by Radar data, we are pumping it over the cloud, back to our data center, we are doing some of the computing in the cloud, some of the computing in our Data Center with extra meteorologist and story that we always tell is somebody opens up his iPhone and looks an app and see the radar image and gets an alert for lightning prediction next 5 minutes from now, sending a message lightning is going to be in 15 minutes from now and you will be OK 30 minutes from now . All those analytics were actually done in Dallas data center and the person does you know takes 40 seconds to move all the data to the analytics & pump it back to iPhone app for example.

So the point here is that this is just one example but if we all just step back & think that what can happen 3 or 5 years from now the ability do such kind of things is just amazing & the value it can create for end-users thinking globally is quite different than it was just say 2-3 years ago.

So if I look at the bigger picture; if data are available and we are deep data Grinder kind of Company and we want to hold our hands on raw data and do things with it. If data are available we will create new things will add value. The Private sector is really really good at communicating forecast warning that's what they do public & business and I do believe it's really important for local warning & advisory especially for citizens that we have a single voice of authority to government needs to have to provide to the citizens.

Businesses may be lesser so because businesses become very reliant on a weather service to provide, but I think as citizens we need to see a single voice of authority. Availability of raw data too, not just gif images whatever is really really important & I think the private sector which is continue to add value over the time & ultimately making data available will create full economic

value for a countries, will enhance the safety of citizens & business in countries, will greatly amplify total value in the process.

So my last side is, I think vision should be for all of us is that all metrological data collected and created by government agencies should made available to all sectors at cost or at reasonable cost I say or at no cost.

The other problem we have when we work on things is often government warnings and advisories come as, I think United States & Canada is doing pretty well, but there are certain places where we gave warnings say southeast one third of a province has a heavy rain alert. It is very hard for anybody to grab that data & do something with it in a geo reference way. So I know there is CAP standard, we work with CAP standards & other things but getting all those standards to be used by as many people & as many organizations in the world will really help in the process of providing services to everybody.

So the bottom-line I think if we make data available to anyone and everyone we will see over the next decade, unbelievable things we can't imagine today will be done by private sector and by academia and by the government. Thank you.

## 2.2 INTRODUCTION: DAVID GRIMES



Our next speaker is David Grimes. I have had the pleasure of working with David most of the 38 years that he has been with the Met Service of Canada and through that time David has had a very large leadership role in advancing weather forecast operations, climate services, science policy development in particular and most recently and I certainly benefitted by it myself the innovation and thinking he did in order to argue for the investment in the modernization of the Weather Service, in spite of the fiscal restraints that we are undergoing, David has been very successful in getting the investment into certainly the Weather Service and the weather observing infrastructure. Since 2006 David has been the Head of the Environment Canada's Meteorological Service as Assistant Deputy Minister. He is also of course the principal representative and permanent representative with the WMO and as well the principal representative on the Group of Earth Observations. He is a busy guy; and as well the President, I was lucky enough to be there in 2011 when he became the President for the WMO at the 16<sup>th</sup> Meteorological Congress. He undertakes a lot of leadership roles in the WMO and in particular he has taken up a leadership role in global framework for climate services and the implementation of that challenge. I would like to welcome David Grimes.

### David Grimes

Thank you very much and thanks to the organizers for putting this together. It is clearly, you know this conference and I know that in particular Environment Canada and many of its staff



have played a leadership role working in the local organizing of this event. But I can't just understate how successful it has been by the community that we have brought together and having a topic what the future of the Weather Enterprise is, is also quite valuable. The first place to start is what do we mean by weather enterprise? In many aspects we get ourselves and I can think of in the context of World Meteorological Organization where the representation is by Governments, but Governments represent not just the National Meteorological and Hydrological Services of this organization, the two principal substructures that are reflected in WMO, it also reflects the needs and the wants and the capacity offered by the private sector and the academia. And WMO actually reaches out and has been quite successful over the last several years in reaching out and particularly building strong relationships with other international organizations which were sort of bringing the community together in terms of the academic community in particular and World Climate Program is an excellent example of that where we have been working with it for many many years. So as we think about the Weather Enterprise and go forward in the future one key message is to recognize all of the participants which includes those who provide those value added services. And there was a discussion yesterday in the panel and we already started off with the discussion what those value added services – not to steal a word from the next person who is going to speak –he coined a phrase which I thought was quite operable when he talked about operation to application – kind of the Apple way when you reflect that when you sort of tip your hat to the Apple and the Androids and the Google because they have actually changed the world. That to me is a marked change in how we reach communities. How we reach out and ensure that those services and we get the maximum value for the investment, the collective investments made by everyone in the Enterprise so that those are used to the optimum. I think that that is an important consideration. We had two really good talks this morning and Rowan and I only got to know Rowan over the last year or so but when he talked about the correlation between the capital risk and he talked about how they model and the insurance sector has spent a lot of time kind of modeling in this context that talks about modeling risks. In fact they are probably experts in that. When we think about the future, we are thinking about what are those risk variables that society needs to make in decision making. Some of them are in the prevue of Government and the institutions the government puts in place and some of them are in the context of those services that you would, the government would welcome having those services optimized. So you heard terms like big data, you heard about open data; not all countries of the world but some countries are starting to recognize that there is huge economic benefit, Canada is one of them, in ensuring that you have an open data or an open science approach to its provision. So if the dollars are collected or invested from tax payers, then the tax payer should get the best value for those investments, whether they are investments on modelling or investments on monitoring or on data collection. But those need to get into the hands of those who can actually turn those into value – create jobs, create economy and it stimulates and there was a term used earlier this week, stimulating economy. This is actually a large stimulation, actually it does not matter if you think the Weather Service has a particular foot print or a penetration on the economy whether it is one third, 10% or 80%, reality is that when you look at particularly developing economies,



developed economies, they are moving into the knowledge economy. That is why I go back to Google and Apple because it is not just about how they are going to collect more data for you, it is how they are going to be your conduit to your service decision making in the future. And frankly what you see today because if you go back 10 years, who thought about Google – Google is about 12 or 15 years old company if I get my math right And where were they 12 or 15 years ago. How big is your newspaper today? I used to get newspaper, I still get newspaper probably a dinosaur for that. The reality is that it was quite thick and now it is quite thin because people get information just in-time, when they need it what they need and they are able to search for specifically what they need. There is a challenge when I look at the future, it is promising. Look at the progress we have made in the science community over the course of the last two decades in particular and understand the advances that are being made in observational technology, the amount of information we have, we are a big data enterprise and that big data is going to provide huge value in answering some of the questions that Rowan raised this morning. But more importantly there are others who could have spoken about their particular challenges and in their particular risks how will we reach out.

My final point is that in the context of investment, you can start in a time when government made a lot of core financial investment and what we might call that meteorological infrastructure. When we talk about open data and availability and accessibility you are only getting a small subset of what actually is available. In Canada, we may have a lot of meteorological data and observations but we don't fill the page not 100%. So in this kind of evolution of the enterprise particular challenge is to think about how do we share more broadly and this comes from my GEO experience. I listen to the research community and the enterprise is saying that we got to make more and more and more data available and accessible. But the lion's share of some of that data is not in the hands of the government, it is in the hands of the private sector.

As we move forward in the future and how we want to optimize and improve the resolution of our modelling performance, for example, then data as you as you learn this week, data is an important consideration in the performance of the enterprise. So this kind of aspect of characterizing in the future what are the appropriate roles in the enterprise and how do we interact and work, you know partnership is where benefits accrued to all parties, and then how do those benefits accrue to all parties as we look across whole horizon. So from the President of the WMO and as we look to the future of the meteorological enterprise, the idea of finding ways of effectively engaging the whole community is an important consideration. More importantly getting access and sharing the value that the whole community brings and get the synergic benefit will make this enterprise stronger, better and more relevant to everyone we serve. Thank you.



## **Moderator Jim Abraham**

Thank you very much David. Just before we move on to David Kenny. I just want to say how much I appreciate the time and effort that these folks have made to join us today. These are very busy and influential people so we are very lucky in the organizing committee to certainly have them here today and I would like to thank Jack Hayes for the work he has done in organizing these Panels.

### **2.3 INTRODUCTION: DAVID KENNY**



Speaking of busy people, David Kenny, I never had the pleasure of meeting David before and certainly all of us are aware of the company that he is responsible for. He is the Chairman and Chief Executive Officer of the Weather Company. The Weather Company comprises of WSI, the Weather Channel, Weather.com and Weather underground. And now that I am retired I am able to do some other things including the media. Certainly the media work I do does benefit from the Weather Company. So I appreciate that. David's experience is extremely diverse I would spend a long time just going through his CV but the things he has done have one common thread "innovation". He pioneered the use of Banner Ads with a company called Digitaire, the digital advertising agency that he cofounded. He fueled the emergence of cloud-based computing when he was the President of Akamai Technology and now he is leading the transformation of the Weather Company which started as a successful cable company is now a multi-billion \$ weather decision company. So I would like to welcome David Kenny.

### **David Kenny**

Thank you all and thanks for having me, I have been in industry two and half years and it's been a warm welcome.

I did want to talk about Silicon Valley meets weather, which is the title (of my speech). Most of my carrier was in Silicon Valley, may be spent in computer sciences and internet technologies. And I was privileged to be offered to come to weather company and I chose it because to me at this point of time there is no better place to be, to do great innovation & good innovations that have great commercial values, and more importantly great innovation that can save life, protect property and hopefully extend the human use of our planet and I just think it's such a privilege to be in this industry at this time.

And when I thought about why weather? Because it's not what I have done before and there were two things I had been working on that I thought made sense? So the first is mobile, this of course by country where you see just from last year to this year, what percentage by region of internet access comes through a mobile-phone .It continues to be increasingly the dominant way that



people get information. So, we have got billions of users worldwide including some who never had accessed to a hi-skill forecast.

We have got new expectations that people expect it to be real time, expect it to be hyper local, expect it to be social connection because mobile device is 2-way, expect it to communicate and of course businesses, expect it to connect everything they do and in fact all of us through our sensors like my smart watch will be giving data as well as collecting it and that connectivity, I believe enables those human learning and machine learning and those are going to change the way, we use weather forecast.

And Second thing which was my last job is the very exciting progress that has been made in cloud computing, so everything I did was based on Moore's law of-course that we continue to increase computing power every two years that's the grey line, the green line is the amount of data that's available because when you got all that processing you can process more data and in fact we continue to double the speed with which we process data every couple of years & red line is for algorithms whether those be search algorithms or numerical weather forecast & the predicted reduction in the error & I am just so excited about our investments in the science & ability to reduce the error because reducing the error means more people can work on the decision & can take more actions & decisions and decision can be more precise & of course everything that's happening today in Silicon Valley is big data needs mobile & I think that there is nothing more exciting than weather doing that.

One of my close partner is Apple. I am not going to take time in brief remarks to show you their ad, you can find it on Apple.com & you probably saw that on television but Apple has an ad now for its i-pad & it tells the story of a guy named Jason West. Jason lives in Detroit & what he did to change Detroit was organized weekly bike rides for the community & bring people together and its really interesting story & of course the i-pad is there & in the end is the story about the Jason's favorite apps, these are the 10 apps he has to use to organize those bike rides & I am really happy that one of them is weather. What I also know about all 10 of these apps is that they were all developed in and around Silicon Valley & in fact there is weather data in 8 of the 10, so there is not just weather in the weather channel; there is not just weather in the weather channel (there is) weather data in 8 of the 10, we provided because we were with Apple but I think it is just important that we understand that we don't live in a silo, people use weather in other decisions and the more we become a platform that connects to every decision you are going to make, big or small, around the weather the more useful it is. The more we can sort of become a part of everybody's everyday life in the world and it kind of grows with ecosystems. What I really want to communicate in my contribution to this discussion day is how I hope our culture changes to be more like Silicon Valley because I also have to be someone direct that has been quite a culture shock to come to the weather world from Silicon Valley in something are similar & something are not. So there is kind of five things I would like us to focus on:

One is a native sense of purpose, I think we also individually but collectively Silicon Valley is really a social movement more than bare collection of corporation & people really do believe they are changing the world and we use that talk, but we don't necessarily set aside our own





egos & barriers to embrace that talk & I think we have a social purpose in this community that we need to pursue - our fellow citizens are relying on us to do big & important things.

Secondly Talent is the life blood of Silicon Valley. Talent is developed on the edge for the emerging technologies not just teaching what was in the past but teaching curious and what is new. It is so depended upon this fresh stream of scientists coming out of the universities in to this community & I think us focusing on this talent & bringing in new talent making room for young people not protecting but encouraging more fresh talent, I think is going to be key. The partnership between the Universities, the Public Sector and Private Sector has to focus on talent as much as it focuses on research. We don't have all the ideas in a community today. Our children are important to this progress & then when we get that talent I think we have to be a little more comfortable with it moving freely. Typically the way you do trip as in Silicon Valley is "2 years tour of duty". And most companies accept that people are going to move between these apps. We need to be more comfortable that we are going to move between the community & sometimes between the community & the computing science world then back, sometime between the public sector & the private sector. I am really proud of our scientists who take us time at NOAA and Head of the National Hurricane Center. It's awesome when it happen & great when they come back.

I think it has been said before that we have to be open source, everything that happens in Silicon Valley & everything that is happening today is because most – not everything – but many things are open source, they are shared, we build on each other that's the way science works that is the way computing science works & that's the way we can take advantage of this.

And lastly, and this is why I thought today was so important and I was so happy to come, we must design everything we do globally, neither the internet nor the atmosphere know anything about borders & frontiers that's not the way it works. The atmosphere is global and the more we design and share globally, the more we understand globally the more we understand that we are a part of global community, the better we will serve society. I didn't want to just give platitudes, I do think there are some good examples and I want to share one which is a project we have been working called forecast on demand & it's about the process. So, we had a big problem to solve, the way we work with Silicon Valley. So, there are two big companies Apple & Google we signed agreements with, long term agreements. So, with Apple we agreed that we will take over the preloaded weather widget; they can run all of IOS & also become their weather partner for every APP in the Apple like Ecosystems & in Google we have agreed to give them data feeds that whenever you search for weather, we would provide the first forecast and then you can link on just for more. Those required us to solve some huge huge problems, We had to increase the number of forecast by 11 fold so if 10 billion forecast requests a day, we are now 10 times bigger than Twitter volume. By trying to solve this huge volume & it needed to be updated real time & it had to be done in under 5 milliseconds to every phone in the world. So that was a big challenge & we weren't ready to do that, but we figured that out, we figured how to build for scale; not on our own. We figured out how to program scale using Amazon web services, working with Google, working with Verizon bringing in folks. We had to figure out in our

own company, how to get all our 250 meteorologist and 600 computer scientists to all be on the same team. We had to figure how to build one forecast that was global forecast by building on great models that come from all. We are building on statistical ensemble. Unfortunately we are unable to do infinite number of locations at the same time with all the machine learning there is still needs to be human. So, we needed to make room for human editing, add scale, without doing on every forecast, only doing when it matters and all that worked. You probably can't see, you can see little bit of one aspect of it because the skill is better. So left side is our forecast that we have done historically and right side is the forecast on demand. The resolution is much better if you like closely, we are doing it over time & I can say we are very encouraged by the process and the skill but more importantly, I think this is just the beginning, we are learning every day, we are getting smarter every day, we are using all the things we did with search algorithm and these algorithms and it's just often adopting new capability and I love seeing a great weather culture adopt some great silicon valley culture. It's working in all our company & I think it is also working with some of our partners and I hope it inspires all of us to do that together and I would also say, it's my sincere hope that is this conversation continues.

I want to bring more people from computing side here because I think that we are not going to solve this in weather community without also embracing the broader technology community.

I love the partners we have. We have great relationship with government & universities & UCAR and so many in this room. Thank you for embracing us, I am very committed that we can do more. I am excited to play a little part of it. I am excited to bring my friends from Silicon Valley to the weather team. Thank you.

## 2.4 INTRODUCTION: HANS-JOACHIM-KOPPERT



In the spirit of being a global community, I am really pleased that Hans Joachim Koppert has agreed to be part of the Panel. He is the head of the Business aspect of Weather Forecasting at Deutscher Wetterdienst (DWD) and that is the National Weather Service in Germany. He worked as a Research Scientist in the University Karlsruhe and joined DWD working in the development of forecast systems. So he is responsible for application development and during that time he was involved in aspects like the partial automation of the Forecast Production System, the Workstation, certainly Canada has been an important partner in the Ninjo Workstation and once becoming a member of the Executive Board, he was given responsibility for Numerical Weather Prediction. Currently he is also managing the Centralization of the DWD Forecast and Warning Operations. So he is interested in all aspects of the process, from modeling to customer service and certainly the warning service. Yesterday we talked quite a bit about data and the importance of data as well as this morning an important part of the infrastructure and I am really glad that Hans-Joachim is going to be talking about the Weather Forecasting Infrastructure.

## **Hans-Joachim Koppert**

Thank you very much for the introduction. So I am going to touch topics that went on right before. I will be talking about where we are today and where we might be going. You know we all need data that was stressed by many speakers and actual observing systems provide us with high resolution data in space and time. This helps our data assimilation systems to become better and also allows us to detect high impact weather; without Radars and Satellites, this would not be possible. And high impact weather is very important to us because this is part of our warning operation and we use Nowcasting tools to handle these severe weather object. We are advancing them in time and they are really a part of - very important part of - our warning process. These extrapolations are essentially linear - there is no development in this typically severe weather situation. If you want to get better on that you need to shift the paradigm from warning on detection to warning on forecast. This needs a lot of research and will I think take us into the next decade until system like this will be operational. Many weather services are now running convection permitting models and especially ensembles of these convection permitting models are a big step forward. So I am always stunned when I see the forecast of these models how realistic they are but unfortunately there are also cases where they are not able to forecast the right weather. I remember a case in Germany on which Sunday or Monday of this year where the model was not able to pick-up a bow echo.

So we still need a forecaster here to look at all the data that is incoming and checking. I will talk about the role of the forecaster later. The predictability in the short medium range is better than on a very short range. And here we have medium range ensemble system that provides really accurate and reliable forecast. And on these we can build a bunch of products automatically so we don't have to intervene with these forecasts. And newer developments are also providing early warning out of these models for winter storms, large scale flooding or extreme temperature events.

Now I said all in all we can automate most of our products. So there is very little necessity for the forecaster to intervene or to say ``to add additional value to it``. Only in high impact weather situations remains the domain of the forecaster. Here the forecaster will remain in the loop for quite some time providing the actual warnings and weather watches. Forecasters in this context, they really need to focus on these areas where models are not so strong and where Nowcasting applications can fail. And because the system is getting so complex, because the method that are providing and the model data that is provided is so complex, forecaster needs to have very good scientific understanding of the ways that these algorithms work. If he doesn't know that, he has no way to modify on a sound basis this automated first guess. And what is also very important, he has to concentrate on the meteorology alone. He should not tackle the technical parts that surround him for these technical parts we have computer technology that does this for him. So for example disseminating warnings or mapping his meteorological status to administrative unit, this is something technical assistant can do.



Besides this the forecaster will also get a additional focus. So he will need to provide advice to customers, talk to customers, find out their requirements and then interpret the data so that the customer can really use that forecast in the best possible way. Ensembles of probability forecast, lot of customers don't understand ensemble forecast. He has new high resolution models, he has to explain what the output of these models means to our customers. And only in this way we can introduce new products that are really useful to our customers. And as another point what I would think become increasingly important is collaborative decision making, we have for quite some time at the airports, where if a snow storm approaches the airport, all those parties that need to be informed come together and discuss this with the forecaster. We have this in Germany in the context of crisis management so if there is a river line flood the crisis management team, the forecaster is naturally a part of.

Now my last slide, National Met Services and the private sector. In Germany you know the private weather companies are fairly new compared to North America. I am mean they are also there for quite some time but compared to North America, it is a different story. And my take on that is, let each partner do what they do best. So for example, we stepped back about 10 years ago from providing weather maps to newspapers, providing videos to TV stations and all this type of things; we leave this to the private sector. It is not always good because the visibility decreases, so you are not - they do not realize that the weather service with all the infrastructure all that talent and all that data that is very usable. I think never the less it is a good way to split the work.

And I say cooperate when it makes sense. So I think we would be very lucky when the private sector in Germany and Europe will be help us to distribute our warnings because they really have more reach than what we have. The only fear I have is that this does not compromise the official single voice. But as you heard, this fear is not really, I don't have to fear so to say. Another thing where we can work together is, here is an example, forecasting for renewable energy. We are the ones that know how to optimize our models for this new task. So we are optimizing the winds at the hop height, we are optimizing the radiation for solar part. And the service providers after us then they can optimize their power forecasts.

So all in all there is lot of possibilities for cooperation, I guess, this was just one example. And I would like to explore these possibilities in the future even more. Thank you.

## 2.5 INTRODUCTION: BARRY MYERS



We are very lucky to have Barry Myers with us today. He is the Chief Executive Officer of Accuweather. He has been there since 2007 as CEO. Accuweather as we all know and wear brightly is really iconic as a brand in Weather Business. I certainly thank Barry for the support Accuweather has given to this meeting. Under his leadership the company has become really a leader worldwide in mobile weather delivery. I see that they have data access to over a billion devices worldwide. So the company services over a quadrillion pieces of weather information annually. Really the leadership role that Barry exercises goes well beyond within the Accuweather Company. Certainly he is the leader with respect to the weather services enterprise. So he has been involved and exercised leadership in a lot of public private partnerships certainly within the media industry. He has been an advisor to a number of Directors of US National Weather Service, he is an advisor within the Met Society, within the World Meteorological Organization, the World Federation of Scientists on topics related to weather data exchange, public private sector partnerships and currently he is on the Environmental Information Services Working Group with NOAA on its Science Advisory Board. So I do thank Barry for that contribution and thank him for joining us today.

### **Barry Myers**

Thank you very much for that introduction. I am afraid though it makes me sound older than I think I am.

I would like to thank Jack Hayes and a number of other people too numerous to mention and others have mentioned anyways for organizing this conference.

It was interesting for me yesterday to hear some discussions about WMO Resolution 40 because in September 1994, with the encouragement of the US National Weather Service, I was invited by the WMO to participate in their conference on economic benefits of the meteorological and hydrological services at the WMO Headquarters in Geneva and it was a year before the enactment of the WMO Resolution 40 and there was much talk about the draft version at the time of the conference. It was also the year before the creation of the Ecomet and there was much talk about that as well.



At that time movement I think that control of data and forecast information by government especially and create a consortium some said cartel of such data was evident everywhere. By doing so many countries believe that huge incomes will flow to those countries and their met services and that seemed especially true at that time for some of the European countries - by controlling and selling data to both citizens and businesses and controlling the incipient development of weather companies especially in Europe that was beginning there and elsewhere along the US Model.

I spoke to a Plenary Session of several hundred people representing those National Meteorological Services agencies from various countries of the world and I think my message was clear that while perhaps third of the world's economy is affected by weather and lives are at risk every day, people will pay little to get data or the daily forecasts. At that time Accuweather was already 30 years old and it was clear that business will pay relatively little and average person nothing at all. My message also was that the technology was advancing rapidly, electronic access was and will become common place and that information wants to be free. My talk was basically about the weather industry in United States and that was a model that was emerging from the shadow of government doing all the work to one of sharing the load between the growing weather industry and the government. I was all but booed out of the hall.

The next year WMO resolution 40 was passed, there were small little changes may be some one listened a little but not much. The next year ECOMET was incorporated and developed its catalogue. Weather companies, I think, were being seen as a threat not a partner and I might have felt like a total failure, but I didn't. The fact that information wants to be free and that the electronic revolution was on the way were the facts and no resolution or consortium was going to change it. So being here at a WMO Conference in 2014, some 20 years later and seeing all the conference participants wearing official conference lingers around their necks with beautiful orange Accuweather logos on them tells me something is different.

This is a map of the world, it is a 24 hour capture of locations from which electronic requests to Accuweather's computers have occurred during that one day period. We can debate the size of the dots; but the point is clear, we are global weather community and all this information is being made available to world's citizens basically for free. I know we don't charge for the over 1.5 billion people who now have access to this information through Accuweather APPS and devices. They are not paying for over one quadrillion requests our computers serve annually.

Public access to weather on mobile devices is a global norm and the people who are getting this information for free are also not paying these costs. There are new models which keep evolving how to provide this information on mobile devices, tablets and other things. You can see here some of the challenges that existed in this particular field and I wouldn't go through them all but there is over an estimated 10,000 different devices floating around in the world currently and if you want build for all those, you have a herculean task and mobile devices tend to turn over very quickly in the market place and new ones keep popping up. But this is what companies in the weather industry are doing to reach the world.



There are also global patent issues that float around as well that some people may not have thought about at all and location-based services which all weather services are, may involve licenses of various kinds in various countries at various costs. Again people are not paying for those and all these things are being supported currently on an advertising model.

Bob Marshal of the Earth Networks mentioned yesterday that major weather companies may have reached the billion US dollars in annual revenues from the performance of these services; but we need to keep in mind that there are billions more being generated by companies building mobile devices that bring these wonderful services to the world and by electronics transmission services and providers that are also generating a lot of revenues and taxes throughout the world by delivering these weather services.

So I would just end by saying that Weather Enterprise is clearly alive and well and serving the global population needs in ways that were never envisioned 20 years ago. It was clear that something will change but the exact path was not. I didn't know that things will work out exactly as they have; I am certainly not a prophet. But I did believe that information wants to be free and technology will lucid on the world and today I believe billions more of the world's people will have access to vital lifesaving weather information in the coming years. People who did not know of a flood will wipe out their village 2 hours from now will know 2 days in advance to take precautions. Lives will be saved, people will be saved, government expenditures will be saved and partnering between government and weather industry should be looked upon in itself as a public good. Thanks.

## 2.6 INTRODUCTION: ROLAND STULL



I am really pleased to introduce Roland Stull. Roland is a member of the Academic Community. He was 16 years a professor at the University of Wisconsin in Madison where he focused on boundary layer and turbulence. In fact he authored a book, Introduction to Boundary Layer Meteorology. Then in 1995, he moved to Canada and he is Professor at the University of British Columbia in Vancouver and he changed his research focus into Numerical Weather Prediction. His research team is really making use of Ensemble Weather Forecast since his arrival or

shortly after his arrival to clients both in industry and government. Recently he actually authored an on-line book or chapters in an on-line book on Practical Meteorology and Algebra-based survey of Atmospheric Science. I had the pleasure of working with Roland as part of the team when we were developing the Canadian Weather Research Program to strengthen the links between Academia and the Weather Services Operations. Roland certainly has a strong view on these things. He is a professional certified Meteorologist both in Canada and USA as well as a certified Flight Instructor. So thank you very much Roland.



## **Roland Stull**

Thanks for inviting me here to represent universities. At UBC we do run operational numerical weather forecast. So I would like to talk a bit about my perspective and how that fits in.

So what is Academes place in the weather enterprise? Obviously, we are training the future employees of the enterprise. We are also doing research on how the atmosphere works including the ways of making, tailoring and delivering weather and climate forecasts. We are doing more than research. These days some universities are also making those operational forecasts. We are making daily operational ensemble weather forecasts, we sell them to clients and we deliver via the Internet and we charge for the service and there is also some universities have created some spin off companies from their research. What has enabled all of this - community models, initial boundary conditions are freely available, inexpensive cluster computers and in the case of Universities the fact that we don't have a mandate to make forecasts for the whole country or whole world, we can limit our limited resources to limited regions.

Why do we make operational forecasts? The ultimate goal is better research. We sell our forecasts, generate revenues, with the revenues we purchase better computers, pay salaries of talented people and enhance our research capability which of course is our goal. But then that research capability allows us to devise new forecast products which then have a market value that we can sell. So going around the circle on the screen operational forecasts is a means to generate revenues and to help generate better research.

I could get into trouble for this slide. But we are supposed to be provocative, what the heck. Comparing the merits of various sectors in which G represents Government, A Academe, P Private – different sectors have different strengths. In terms of responsiveness private sector is probably the fastest, government is not known to being speedy. Creation and foundation capabilities like, measurement infrastructure, climate stations, weather forecast centres Government leads the pack. What about tailoring and display of products private industry is doing an outstanding job like we heard from the speakers in the past few minutes. Regarding longevity, corporate memory government, most governments are long lasting as are their employees, private industries come and go and employees in private industries come and go even faster. But I think all different sectors are good in innovating in their respective interests. The important thing is here that different sectors have different strengths and by working together we could make overall better product for the citizens of the world.

So we were asked in for preparing for this discussion to try and look into some of the trends and somebody brought in the issue regarding human forecasters. Humans are doing less forecasting and are becoming more interpreters. In Canada for example, in the Canadian Government numerical forecasts, produces forecasts automatically and humans tweak it a little bit and are not allowed to modify forecast after day two. In Norway they have taken a step further – they have removed all humans from weather forecasting instead humans interpret, they write twitter feeds, face book posts apparently they are liked by many people.



So what do we do in Academe and how should we be training our undergrad students? Should we be training our undergrads with all the differential equations and the physics only for grad school because enterprise does not need that expertise anymore. Perhaps expertise they need more is in the way of computer skill, social networking, statistics, and presentation skills. This raises an issue should WMO and AMS change the meteorologist course requirements what is core requirement to be a meteorologist. That is an issue we are facing in the universities right now. That was one bullet in trends and another bullet we have also heard about is cloud and data sharing, also cloud sourcing is becoming bigger running cell phone e.g. PressureNets, lightening sensors, smart electric meters - all distributed sources of data input and also we have distributed computations that are growing recently.

One more trend again in my view, I see in a number of very large companies happening – they are creating pseudo monopolies in certain areas, global monopolies by some companies, the National Weather Services often having a monopoly in their own different countries. I have seen a backlash against some of these monopolies and backlash against data restrictions. This one example that is Blitztung in Germany - community based lightning detection network; I was surprised it even existed. Another aspect is side stepping of these restrictions. I was surprised to see a lot of the start-up private enterprise companies in Europe that were basing their forecasts on GFS and Ryan work model I was surprised why they were not using ECMWF forecasts. That must be embarrassing. In Canada we couldn't keep sounding in Tephigrams the official thermodynamic diagram for Canada because we couldn't get data from Environment Canada, we got the data from the States where it was served on Skew-T's. OK no big deal but again really embarrassing.

What are some of the road blocks? One is parochialism what a mess because of the borders, weather maps still stop at the borders. National favoritism Corporate or nationally produced products over some better higher quality international forecasts. Another roadblock tariff, go outside to buy ECMWF forecasts, to turn them around to sell commercially, that is out of my pocket book, I can't see that.

What about the mindset of National Forecast Centres, we have heard some of this from Barry Myers. For decades government forecast centres people were the only people who could do the forecasts because they had the tax dollar support for the big computers and the big staff. Over the years many National Agencies seem to have gotten the mindset that they are the only people who could make the forecasts. But I have heard that that feeling is changing now.

Also it has been sort a – I have seen some from some of our government forecast centres - bid on some contracts and underbid private companies because they could make use of their tax supported employees and did not include those in their actual cost of the bid.

What about more road blocks. Inability of the public to differentiate between good forecast and pretty forecast products and in fact many private companies have a made an awful lot of money because of this inability. We have heard about how important the cloud is. But if your cloud

computer is located in the US, then US Government is looking through all of your stuff. That is an issue regarding privacy.

Now strategic vision, I have heard in North America, US and Canadian Government claim that they have solved the one, two and three day forecasts and now they are looking at mid-range days 4,5 and 6. Forecasts. Well that might be the case with East coast, but on the west coast the pacific data void is still hurting us. And this relates to buoys in the pacific and the satellite lobby – I made the mistake of suggesting that some of the money spent on satellites should go back to some conventional sensors, you wouldn't believe the booing I got from that.

We know that a lot of you use satellites but a mix of data perhaps is better for the best forecasts.

Finally, I heard an appeal from all the panelists here to be bold and be creative and I look at physicist e.g. creative guans and quartz and you name it, and here in meteorology we are still using millibars ok we just switched over to hecto Pascals, this is embarrassing, let's get into kilo Pascals and kilometers for potential, height and stuff like that.

Hopefully I have stimulated some discussion regarding the place of enterprise, enablers, motivations, comparisons, trends and roadblocks. Thank you very much!

### **Moderator: Jim Abraham**

Thank you very much for all of that. That was a great job and thank you all the panellists; wonderful wonderful information shared with us. I have got some really good notes. One of the things we are going to do ism we are committed to providing a White Paper as a result of three panels and certainly that is going to be an important part of the outcome of this meeting.

Before, I turn it over to the audience for some questions and comments, I wonder if any of the panellists would like to make some additional comments or ask additional questions of each other from what they heard from each other.

## **2.7 QUESTIONS - ANSWERS**

### **Question 2.1: David Kenny**

One of the things we are concerned about is the forecast skill in less developed nations, forecast skills in southern hemisphere. I completely buy your argument about the importance of forecasting. How do we solve this problem in countries which don't have the tax base to afford this basic level?

### **Answer 2.1.1 Hans-Joachim Koppert**

Actually I am going to Madagascar in October to look at Weather Services & to see how we can implement our forecasting system there. So, we are really studying was say competence, where



are gaps & what can we do about it, we are working together with - we will have some money to fund it &, we are having a modelling system that we give away for free to less developed countries but we make sure that they are really able to run this & they make use of the data.

**David Kenny:** And German Government believes it is a good use of investment to do it.

**Hans-Joachim Koppert:** Yes

**David Kenny:** Perfect!

**Answer 2.1.2: David Grimes**

May be I answer that question from perspective of the World Meteorological Organization. You know its principal mandate is focussed on capacity development & initiate programs and that capacity developed is clear priority of the organisation & most of the activities are aimed at that. So, we organise ourselves so that expertise & often countries, and it doesn't matter which country, provide their expertise and support in order to ensure that like training for instance the UK met office has been in parts of Africa has trained many of the forecasters there and one element I might underscore where there is focus on automation & yes model are getting better & you can automate things but in others there is correlation between the needs or the impacts that are in a particular place & the context of that particular government and translation of those products. Although forecasters, many focus on high impact weather events, they also play an important role in communicating the context of what is going & what is the nature & consequence for that particular country and that may have a, for instance, be it significant drought and therefore even small amount of precipitation has to be characterised properly in that context. That is something the machine or a computer is not going to do; this is something where you need to have that forecaster. So, although you may say Roland we need tweekers instead of meteorologists, I kind of think in the world you still need meteorologists because national context is quite important in the provision of information & that is why the basis of having local Meteorological Authority still play a role in the comment I made in the beginning about understanding how we can characterize world & work more effectively together in sort of capitalizing on the energy, the whole community brings, will actually bring a better service at the end of the day to that developing country.

**Question 2.2: Jack Hayes**

David I thought you were going to steal my thunder not to use the pun. I had the opportunity to work for 2 years in Geneva as the Director of the World Weather Watch program & in then 5 yrs. to represent the United States with WMO. One of the my passions that was unleashed, was when I was working in Geneva, one of my roles was to organise commission for basic systems & I hosted the meeting and my emphasis was a side meeting on, how can we in the developed world help those in developing world & so David Kenny your comment hit home with me & I had a Canadian who worked for me Peter Chan who created a program called Severe Weather Forecast Demonstration Program & started as five countries in Southern Africa, South Africa did the computing using a German model & global weather output for ECMWF & INSA for this the collaboration. I am looking at how can we further this & grow it & I hosted a meeting in South



Korea & I found out that, UCAR has got programs in Africa. I knew they have got them not that I should but they are UCAR programs. Germany has got programs in Africa, France has programs in Africa, UK has programs, the United States & what we have a lot of peace parts & I look to what Peter was doing with the Severe Weather demo, it was Linda Makuleni, the permanent rep, the head of the South Africa Met Services; I said her face to face first meeting “Lindy you have to sign up to make this demo a permanent capability for ever & ever” and Linda went one beyond me. There are more than 5 countries that benefit from that, there is twenty one South African Governments that benefit from that. And there is one other thing that I think I learned in this process.

One - When Peter went down to South Africa I said - WMO’s role is orchestrate and not get in there & make this happen. Peter came and told me right on my face “Jack we, got High School forecasters in Mozambique & if I leave that to them to develop this program, we wouldn’t have a program in Mozambique. I always gave Peter hard time about travelling to South Africa; but I always supported him.

I think another challenge we faced was the former head of Senegalese Weather Services that Africans don’t want the developed world giving us their forecast, they want us to invest.

Then my last comment and really it is a question for the Panel, I am excited about the possibilities what can we do together in developed world to help the developing world. It is really Mamadou Lamine from Guinea & Bob Marshall is involved in Guinea came to an AMS meeting in Austin & as we every walked down to floor he said to me, he said “I am so disappointed when I came to see all this great technology because I would like to take, what the people who can afford to buy this are throwing away” and I was so enthused about what can we do; that is just something that we ought to be able to do and I spent, I won’t say better part of a year, but I would say significant time trying to find, I find trade barriers & I am just a meteorologist, I just hit the right people but I am looking for the people who can move & shake to help these developing countries who really need that help in a time when we have changing climate.

**Answer 2.2.1: David Grimes**

Well, that’s clearly an illustration of one key initiative that shows how we will build capacity; but there is couple of others that in the commission for basic systems right now that are looking at how you capitalise on the knowledge enterprise in a way that kind of orchestrate between the global centres that are operating large scale modelling & then looking at the role as these examples that Jack raised, which is developing the sort of regional specialised centres & then enabling this localized Met Services to be able to do that work they need to do. The other initiative is that WMO is moving to competency-based approach which means that we are looking at what are the competences that forecasters need to have which for academic of course quite important because now they can find what they need to teach too; also they have elements in those competence in relation to things like communication, ability to communicate, ability to interact with private sector. So it’s gone beyond this pure meteorology.

**Answer 2.2.2 Barry Myers**

I am really concerned that, we may be doing the same thing over that we did but in a different context in 2014. I understand that many of the developing countries of the world are looking at what exists elsewhere & not wanting to have that but wanting to be able to develop their own capabilities & certainty that should be supported. However, I am concerned that technology & communication are just going to sweep past that effort. Governments traditionally, both the ones helping and the ones being helped do not respond as quickly as the private sector does in many instances & I already know that our company alone makes weather information available as you could see that map of the world virtually everywhere in well over 100 languages & dialects & other companies who doing the same saying. So, there's got to be a cooperative way to bring together not only the governments but the weather industry in helping to develop whatever the capability are. The best route to help nations, citizen may or may not be developing a full internal capability; it may be working with other people that can bring that as a partner, that may be in the private sector.

**Answer 2.2.3 David Kenny**

I want to add is that's what I said before let's not live in our silos. So I am in a group called Internet.org which is organised by Mark Zuckerberg of Facebook; say it's a small group of about 20 CEO's most in there are Facebook, Google, Apple and a couple of telecoms on this issue of wiring the world because there are ways to do that & weather of course is an important topic. I would say what I have lot of time for is David Grimes point of view about needing a local context. So part of world thinking through & I am taking lead on it; how do we get forecast global but allow the local context before I talk about human editing its essential. I think we still need meteorologist but I also still think we need editors. So us finding a way that it is not just a machine blast to the world but also allow local editors to put the context in, it is what we are solving but I don't think we are going to solve it just in the weather community , I think we going to need the Internet technology community to solve it.

**Question 2.3 UCAR**

A lot of weather enterprise right now is very unidirectional as it should be since this skill set is sitting with the meteorological. One of the things we are finding in education & training is that the next generation is really demanding 2 way interaction & 2-way communication and we are adjusting our class rooms as a result of this. How do you see the weather enterprise changing if even a small portion of your end user community demands that 2 way interaction?

**Answer 2.3.1 Roland Stull**

Interesting. In Educating we heavily endorse 2-way interaction like just in time teaching, using "Quicker" & so forth. Your question is extending that to the end users. I think that's really a question to the companies & governments that are providing weather services. So, I turn it over to someone else.





**Answer 2.3.2      David Grimes**

I will answer more from my role at the Canadian Meteorological Service. We also are developing competency-based management approach and in that in particular, our recognition is that there have been a lot of discussions here over the last few days about this social science. You know it is not an after-thought, well social scientists would love it to be a before thought, but it is a sort of thought at the same time, in the beginning of process for us. Following process, some early exposure to what it is, is the recognition that Social Science capacity. So we have a very strong Social Sciences services strategy developed which actually is embedded within the forecast community, rather than people who are principally outside that. So the people who are actually preparing and adjusting forecasts, whether they be for warnings or whether they be for kind of understanding what a significant event might look like five days out and how it is going to sort of have an impact, is all about impact, high impact-based thinking that goes and edits the forecast products and we have active engagement with community at a regular - I have almost a dedicated work force again part of the forecast team that does that kind of outreach on an event by event focus rather than just a splash once a year.

**Answer 2.3.3      David Kenny**

All of our products have been designed to analyse social engagement, we got a million people a day doing weather checking now on the new mobile apps sending us photos & comments. I think it's all important to provide taxonomy because not every citizen knows how to communicate & they need to communicate in a way that others can understand. So, we do teaching, we give things. One of the controversial things we did was to put some names on Winners One system. Not that we love that answer but it got million, millions of people talking about this threat. But now we are working on taxonomy for climate change. So, people can be witnesses to what they are seeing real time & talk about it but you got to give it framework, if you want to have conversation with billions of people so they have a common language, language that is citizen accessible not meteorological for them to understand it. So, I don't think we have all the answers but I think it is really important that we provide that taxonomy because when people talk about something they understand a lot better. I am sure we are going to move their perception on climate change when there is conversation rather than preaching.

**Question 2.4      Yves Pelletier**

Hello, I am Yves Pelletier. I am mid-level Manager at the Canadian Meteorological Centre. I have a quick remark & then a question.

My remark has to do with Dr. Stull presentation where he says as a researcher to improve on his research he is compelled to do operational meteorology which is find very interesting observing that meteorological service at the government level anyways, in my view basically is an operational service but we are compelled to do research to improve our delivery. So, there is feedback loop somewhere that I find very interesting.



My question is quite different it has to do with dimensions of patent & I was wondering whether the panel & perhaps in particular Mr. Kenny could comment on whether there is a threat to weather enterprise through patent troll.

**Answer 2.4.1      David Kenny**

I can go first. Back to open source, I believe in technology we should compete on the basis of innovation & velocity & sometimes the patent system slows all that down and in fact it's why I am in support of turning all the patents into the open source in electric cars. Certainly we have limited number of patents but I don't spend a lot of time with lawyers and I don't think they help advance the business, they slow it down. I think what's more important is that we have mission to extend the planet & we have mission to save life & property, we should be sharing as much we can. So, patent control can slow you down as you know they are coming to argue for things, but I think that the more we embrace open protocol & more we embrace open source & stand up for the so less we are going to allow it. So that thing is really up to us not them, whether it slows it down.

**Question 2.5**

I am a Postdoc at George Mason University. I wanted to go back to something Dr. Stull mentioned as well as Mr. Kenny and i.e. you had in your table that everybody is very good at innovation side. However I think it needs to be coupled with what Mr. Kenny said which is silos. So, academia is really good at innovation but who are they innovating for & most of the time it seems to me at least that is for other academics. We are consuming our own product eventually which is why I feel some feel compelled to move in to the operational sector. So, when you think about these 3 components academia government & the private sector, a lot of the discussion from those in the private sector seems to be interfacing with national forecast offices. So, academia is kind of left in their beautiful pristine silo and when they do interact seems to be very marginal & also seems to be having to go through this bottleneck of interacting with National Weather Service first to get your new science injected into the forecast & then finally it will trickle down & that years which I think is why one of those reasons why stagnant innovation in terms of may be some of the more fundamental science injecting itself into the private sector because you have to go through this bottleneck. So yea there is great innovation happening but whose receiving it, who it is for but at the end of the day it doesn't really receive until 5-6 years later, and now Silicon Valley it becomes more difficult in my opinion.

**Answer 2.5.1      Mike Eilts**

I spent 18 years at the National Severe Storm Laboratory in the Research World. I was also on Adjunct Faculty at that time. Then I spun off and started a company. I have seen all three areas. I would agree that there is still a chasm between different areas. I talk to my friends in the research world; they are still graded by how many papers they produced not by what value they created in the community. In the private sector, we do a lot of research to operation; that's hard. The stuff we get then there is a licensing process and other processes. I agree with your thesis basically that each has there on, we talked about silos already up here. I think it is a big problem for all of



us who really want to the spot where the great innovations happening in academic and government research organizations to get them all the way to create value, not just in the weather service itself or just some more papers sake. Breaking down the silos and really getting into the spot where open source process is actually very very important and big universities trying to license the technology which R&D develops is painful. Typically, we just hire the employee ourselves and do some other things, otherwise do it our self, it is far easier rather than having that high bandwidth conversation that we would really like to have.

**Answer 2.5.2 Roland Stull**

The research that universities professors and students do, I would say, it's driven by funding and that funding source has changed dramatically. In the past there were large grants possible to do pure research – basic research - which could lead to what you just said, the research gets done, it is nice but nobody uses it for 5 or 10 years. But what I have seen in the universities now, it is a complete change where instead of getting generic grant for doing good research, now they are giving grants to create a product whether it is a product for a private company, these days also products for Government. Government has strategic aim point, they want research done in certain areas and they want to get research done by yesterday. So I am seeing like many things in the industry what gets done is based on the money; now money is coming with a very strong direction what needs to be done.

**Question 2.6: Jacob**

Hi, I am Jacob. First I want to thank the Panel that it is really incredible. Thank you Roland, it meant a lot. So my question is to the Panel about the nature of the Weather Service industry with regard to open science and open data. I think everybody says that and wants that; but I am not sure it is necessarily in line with revenue expectations in 10 and 20 years or the way we operate businesses. How much more data is being collected and analyzed by the private industry. How much of that is going out to everybody and at what cost and how do we produce all friction layers there between that open sharing. So one quick example, I know Accuweather has patented describe delivering weather forecasts to mobile devices. Accuweather is not a bully and I am not afraid of those patents but are those restrictive and similarly Weather Company and perhaps WDT as well, how much changes you make to the model and how much of that is open source. Do you have plans to make it open source. Thank you.

**Answer 2.6.1 Barry Myers**

I think that there are various aspects to the whole technology issues and patents and so forth; it is probably too big to get into detail here. I would second what David said earlier about more ubiquitous the technology can be made available to people the better. Clearly all universities, major corporations and so forth work to develop technology, protect that technology in various ways and use it for some sort of business purpose. It is a bigger discussion than we have to but I think people need to understand that we are living in a world of technological creativity and



protection systems that address the ways in which companies or government or academic institutions can recover their development cost at the very least.

**Question 2.7 Peter Neligan**

I am Peter Neligan from the Weather Company. One of the tensions that has existed in our Enterprise today came up in a couple of places in the Panel; it is the notion of the single authoritative voice in communicating weather information to the public. As Mike said and others have said that most of the private weather companies that produce and communicate their own forecast during high impact weather events will still communicate for the single authoritative message from the government. But you haven't really defined where the bounds of that should occur. I think it is worth a discussion in our community about defining the boundary where do we speak with one voice and where do we allow innovation and differentiation in our weather forecast to occur.

**Answer 2.7.1 Mike Eilts**

You raised a very good point where do we draw the boundaries. In some where I think it is going to end up being where is the value traded. For example quite often businesses become reliant on Weather Service so they no longer want as much from Government Source but the citizens may. We talked here in the Panel, the localization by the local meteorologist in the field is very very important. So I think as you said a conversation about that in the community is really really important in the Enterprise because where is the value proposition; who can create the most value and how you can communicate it.

**Answer 2.7.2 David Grimes**

I would add may be a couple of perspectives in look back the xxx in the three sectors we described Public, Private and Academia, are little bit different. Their kind of reason for being is also a little bit different. Their motivation is driven by different things and so one element that is very important if you are considering high impact event that will have a significant societal outcome. The method also going into the future is – so how do you create the interface between the various providers, particularly in the context of the media where you might call that Broadcast Out. In that context a lot of the roles that are played by the Panelists up here who are in this business and others are quite important because what is most important in an event like that is reach that people actually understand the risk and the danger. The difficulty is that when the message is not the same and it is different and you think you are going to be under risk and you are under risk that requires for me, collaboration. So there needs to be a mechanism that will be established that will allow this kind of interaction to take place. And you know that may be something we need to work on and make it better. But the value of having two different information actually increases the risk to the population that we are serving. So roles, responsibilities, motivations, expectations are different but collaboration is essential in how we communicate because even a forecast can convey different information than a warning that comes from a National Meteorological Service in any country of the world.



**Question 2.8**      **Bill Gail**

AMS President, Global Weather Corporation. I was going to ask basically the same question Peter asked. The question of – I want to switch it around though and ask you something from the user's side. One of the arguments is that people are not being able to manage multiple sources of information and we have to provide them a single authoritative information. Certainly in the US I think we have gotten past that to a large extent where people do know how to deal with sources of information coming from multiple places, some of them being authoritative and some of them perhaps not, people can sort that out. So my question is; are the differences between the developed nations and developing nations or different stages in the Enterprise where a single authoritative source is perhaps more important?

**Answer 2.8.1**      **David Grimes**

Let me just highlight. I think your point that National circumstances actually are very important in this discussion. In a country like United States or United Kingdom or Canada where government has acute awareness about the benefit of its investments in government-based infrastructure and sees the multiplier effect that has on the economy by having value added industry further develop capability. In developing countries, in least developed countries, often the visibility that service has for the government is pretty opaque and as a consequence when you provide a service that looks like you can provide a service, just frankly that is the only way in the Climate issue now and Climate services what you end up doing can undermine that critical monitoring that should have been made in that country. The government may elect that somebody else is providing that service. It creates a sense of difficulty actually in some of these countries where they fight very hard for very small budgets in trying to sustain a capability and have multiple sources of information come from a variety of different elements with almost no attribution back to that national government infrastructure that government has put in place. There is a benefit that could be made by this collaboration between the different sectors is to recognize that every sector plays a role and in that role in a least developed country or developing country their core investment that goes into infrastructure and forecasting infrastructure, etc. is a value that you may or may not use but is particularly important to that country. So I would suggest the one message can go out is the idea of providing some kind of attribution or advocacy for the importance of that local investment would be, I think, from a prospective and not to speak for all those nations that from what I have heard is that they would have a more open kind of engagement with the private sector community if they were given some sense of value for their contribution.

**Answer 2.8.2**      **David Kenny**

And I am all for the attribution. I want to go back to connect these equations. You asked about the end user and you asked about the open source. When we invest in weather underground, the thesis is weather for all. And we follow that principle. In fact we make the API available, we have 3000 other developers who develop very much in favor of most of our IP being open source. I think that's the right way to grow the Enterprise and that is the right way to grow our business. But we ask for attribution and we are using other sources we attribute to. I think attribution is key.



But the reason we do that and the reason that there are 3000 other weather APPS using our data is because not every citizen understands it the same way. And in a number of these countries, because these are used around the world, Social Media is more important than Broadcast Media - Broadcasters aren't trusted, governments aren't trusted. But remember that "Arab Spring" was completely fought on Twitter so can be weather warnings. So, it is important that there be cooperation and there be some rules. I think we have to be realistic that a new generation of citizens talk to each other, we have to engage with them on their terms, we have to bring the attribution into them as opposed to try to control it because if we control it we will lose the reach. So I think that you asked exactly the right question; it is interrelated. It is why the economics and why the technology need to adjust because there are more voices generally moving people in the same direction.

**Question 2.9      Peter**

My name is Peter and I am an operational meteorologist for Environment Canada and my question is basically more or less rehashing of last two questions. With the breaking of barriers and more social media and private sector, we know quite frankly, the private sector is not always for public safety and things like this are not always their first priority. Are we looking at any rules and regulations – even in Canada, Environment Canada puts out weather warnings as such that does not stop private media basically twisting and putting their own spin on these things, And again I keep hearing the terms social science and getting to the user and I agree that private sector will help with data as such but at the same time when you break the size of the silo or kind of knock down the walls here, you are putting yourself in quite a bit of danger of opening more and more voices of weather forecasting. We are getting people who are not qualified forecasters sending our mixed messages and it is hard enough to stay consistent within one organization and now you are talking about opening the door, flood gates of all these other private sector and again who do not have public safety or do not have the knowledge to be disseminating this information. And again is there any kind of outlook on that trouble because you can have the best model in the world and best information in the world but if it is not getting to the end user or is being manipulated by media as such, it makes our job a lot more difficult. Any comment on that?

**Answer 2.9.1      David Kenny**

In most democracies, you are going to have freedom of the press and freedom of speech. You are not going to stop them from talking. I think, it is too much at stake if we try to regulate so the alternative and we are glad to work with you to find a way to get your voice into the conversation. I think trying to regulate it – the conversation is going to happen anyway.

**Answer 2.9.2      Hans-Joachim Kopert**

As I stated in my talk, it is a question of visibility and acknowledge the provider of this information and If this is clear then I think that all this mess of messages of what so ever will not affect our warning reaching end user.



## **Moderator Jim Abraham**

Thank you. I would like to thank panellists as well as you for staying late and we started late and I know that it is lunch hour and I would like to congratulate everybody. I really sense and I will use the word David Kenny used and it is related to the last couple of questions – a shared sense of purpose here and really if we have a shared sense of purpose, I think that is what we need to advance the weather enterprise. I was really impressed with the conversation from the floor as well as Panel on that shared sense of purpose and we are going to continue that conversation at 1:30 and Jack will be chairing the last session and I hope you will be back.

## **Resolution 40 (Cg-XII)**

WMO policy and practice for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological activities.



## **ANNEX C**

### **PANEL 3 Transcripts: Enhancing Weather Community Collaboration to Meet Shared Goals for the Weather Enterprise**



### 3 Introduction - Jack Hayes



This is the third of the three Panel Sessions all focused on how to bring together three members of the Weather Community to improve the service that we provide to society. My name is Jack Hayes. I am the Vice-President Senior Executive Account Manager for Weather Products and Services for the Harris Corporation and we are sponsoring this session. I gave some opening remarks yesterday and if you were not here and I am not going to go through those again but I just thought that I will cover a couple of points, just to frame the discussion this afternoon. They all boil down to why we are having this session and the point I made yesterday is that we have a changing climate that is increasing the vulnerability of Society the things that we can't prevent. We have accelerating and rapid growth in science and technology that is furnishing us with tools to better serve society and what we tried to do in the first two sessions was to focus on where are the gaps, where are the opportunities for us. I have to step back and I listened very intently to the two Plenary Sessions yesterday and today and I heard presentations which really created resonance for me with regard to the criticality of us working together. So the previous two panels focussed on in little more depth on where there are gaps and where there are opportunities and we got into some discussions of barriers and what I have set out with this session this afternoon is the target of what we do about it. What can be done as an Enterprise and so I would like to start down that path and what we are going to do is we are going to try and keep our presentations to as close to 5 as we can but true to advertising when we invited these distinguished speakers we told them 5 to 10 minutes. So I am not going to restrain any one that needs more time. But they have all said that they will keep their remarks to generate plenty of time for discussion. Really what my target is that we plan to produce a White Paper following this session that will capture some of the key points that were made during the three sessions and really to use that as a foundation to generate actions that go beyond this talk. So with that in mind I would like to start down the path.

#### 3.1 INTRODUCTION: HARINDER AHLUWALIA



Our first panelist is Dr. Harinder Ahluwalia. He is the President of the Canadian Meteorological and Oceanographic Society (CMOS) which is the Voice of Canada for Meteorology and Oceanography. He is also the President and CEO of Info-Electronics Systems Inc. (IES) which is based in Montreal and has an office in New Delhi. He has been a member of the National Round Table on Environment and Economy advising the Government of Canada on Sustainable Development issues.

He has been a strong proponent of collaboration across the communities and a strong proponent of cooperation between nations. So without further ado, Harinder I am going to hand the floor over to you.



## **Harinder Ahluwalia**

Thank you very much Jack for that introduction. First of all good afternoon to distinguished panelists, ladies and gentlemen. My message is to about how the three sectors can collaborate most effectively. First of all I would like to show what the components are. We have Collaborating entities which are developed countries, developing countries and least developed countries. Then we have the Collaborating players which are Private Sector, Public Sector and Universities and that is followed by the field of collaboration we are looking for: Infrastructure, Services and R&D. Under infrastructure we know that there is a publically funded infrastructure and there are some private companies which are putting in infrastructure also and then there are a lot of networks within a given country put in by different organizations and we are saying that we should have a network of networks where all the data is available in a central location after the quality assurance..

As far as services are concerned, we know that overall forecasting and Nowcasting is provided by National Weather Services. But there is room there for specialized companies - private sector - to provide customized forecasts and now casts to the customers which are more location based and customer requirements based. The third part is the R&D collaboration between the three sectors. And obviously, commercialization of this R&D to get the maximum value out of it and that is mostly the private sector which could do it.

Examples of infrastructure which has been put by the Private Sector include Vaisala`s National Lightning Detection Network (NDLN), TOA`s United States Precision Lightning Network (USPLN) and Earth Network`s Total Lightning Network (ENTLN). They are all Lightning Detection Networks and they are very useful. It is a very good example of private sector participation and similar networks (for Doppler Weather Radars, Radar Wind Profilers etc.) can be put for other requirements. Of course they cost a lot more. Therefore, there has to be some kind of commitment from Weather Services that they will buy the data and it will be cheaper because that data can also be provided or sold to other organizations so the cost is shared.

The next I am presenting the model of collaboration between the three sectors. We have Public Sector on top. It has infrastructure on the left there. Then the private sector infrastructure. The Private Sector companies get data from the Public Infrastructure and also do R&D collaboration with them and the Universities and they produce products for Public Sector and Private Sector and Universities also deal with Public and provide them all kinds of information.

Basically, I personally like the model which has been implemented in the US where more than 100 universities are collaborating together under the banner of UCAR which has a National Centre for Atmospheric Research (NCAR) and also community programs such as COMET where training is given. And then they are an incubator for some of the companies such as Advanced Radar Corporation (ARC), Global Weather Corporation (GWC), and there are many others which have come out of that collaboration and that is fantastic model.



NOAA banner says that its mission is to unite inventors and US companies in mutually productive business relationships to maximize the benefits of public money to the society. This is achieved through its four components: National Environmental Satellite and Information Services, National Weather Service, Office of the Oceanic and Atmospheric Research and Office of Program Planning and Integration. The collaboration in NOAA is also illustrated in this slide which shows how NOAA transfers a wide range of technology, data and information to the private sector every day and publishes hundreds of articles on climate, weather, oceans and fisheries.

NOAA also collaborates for climate research with 22 universities and Private Sector Companies through its program managed by the office of the Office of Oceanic and Atmospheric Research (OAR).

Examples of collaboration in developed countries is basically in Commercial Weather Services, some infrastructure and R&D and some companies which come out of collaboration.

In the developing countries, they are hesitant to open the market. One of the reasons is that they feel that business of providing weather information belongs to Weather Service which might have been the thinking in North America also and in Canada also it was pretty long time till we could get free data. They do not wish to share data because they feel it belongs to them and because there has been public investment. But what they are forgetting is that this is a pot of gold and it is a mine, more open it is more brains use it more gold can be extracted from it. And that is to the public advantage, more companies will be created and they will contribute to the tax base. So I think open data is a very very important issue. Sometimes in these countries, the private sector is not trusted because they don't have experience yet because they never had such an opportunity to do so things. Finally they are afraid that private companies might use this data and create forecasts to sensationalize severe weather conditions to attract more customers. All these issues require maturity from both sides and will take time.

In the Least Developed Countries of course we have a situation where there is hardly any Private Sector and there is the Government Sector but they are also not very experienced and it needs a lot of capacity building and assistance through various organizations such as WMO itself and International Aid Programs from World Bank, from US Aid, CIDA, etc. It is very important because we see that nearly 2/3<sup>rd</sup> of the world does not have infrastructure required to produce good forecasts. Although a lot of data can be obtained from satellites, ground observations are also very very important.

So how do we help these countries? One of the ways is as I said, through these programs but not giving money to the Governments but actually getting involved in implementing the system. It might look a little bit derogatory but you have to do that because sometimes money gets lost. Encourage private sector to invest there. But for that I think some organization like WMO will have to assure that they are going to get paid and benefits are going to be there – some insurance has to be there. Then the private companies e.g. Earth Networks has installed a Lightning Detection Network along with some dataloggers in New Guinea. That network is

going to help that country and many other such things can be done. But there has to be an assurance of some return from all this. Basically GEOSS is a great program and I think we should follow it up very strongly because it will help every country in the world to generate the data we require for getting better and better forecasting and nowcasting.

What inhibits collaboration, this was one of the questions asked. I think fear of the unknown in some cases, dearth of funding in other cases and also lack of stronger Value Proposition to be presented to our governments that by investing that money how much benefits can be achieved. I think most of the times we cannot provide that value proposition to our governments where we say how many billions of dollars can be saved by spending say half a billion dollars. So that Value Proposition has to be worked out with the assistance of an organization like WMO to help obtain the funds.

The closing remark is that one of the greatest collaboration was when ICAO installed the World Area Forecast Services under that program called SADIS and ISCS – the two World Area Forecast Centres producing aviation weather information and distributing through satellite and now Internet to all the countries where at least in all countries at the airports you can get reasonable quality weather information because it is very important for the flights. This is a great model of collaboration and I believe that we should do many more of those. Thank you.

## 3.2 INTRODUCTION: TOM BOGDAN



Our next panelist is Dr. Tom Bogdan. Tom is the President of the University Corporation for Atmospheric Research which is a non-profit consortium of 103 colleges and universities offering degrees in atmospheric and related sciences. They manage the National Centre for Atmospheric Research on behalf of the National Science Foundation. Tom is an authority on solar terrestrial physics. He began his professional career at NCAR. He did his stint as a visiting professor in research in Germany. In 2001 he spent two years leave as NSF Program Director for solar terrestrial physics in Washington DC. In 2006 this is where I interfaced with Tom, he became the Director of the Space Weather Prediction Centre where he successfully transitioned first Numerical Space Weather Prediction Modelling to operations. He returned to NCAR/UCAR in 2012 to become its 6<sup>th</sup> President.

### **Tom Bogdan**

Thanks Jack. It's a pleasure to be here along with other panelists as well. I have a couple of remarks I want to share with you. Number one is that over the last 5 years our world has been rocked. It has been rocked by three very cataclysmic events that I think the future generation when they look back, they will be judging on how each one of us and every one of us tried to work through those events. Number one of course as David Kenny showed us earlier is this tremendous change in technology. We are drowning in data literally, data that we don't need sometimes data that is not the right data we want, data that we can't get to the data we need to



and yet that has colored our world to a tremendous extent that these machines that we hold in our palms are how we get so much of our information ye even our opinion about the planet.

Second, since the turn of the century we have been in an unprecedented economic decline, recession so to speak and our recovery has not gone fast globally and has led to a new sort of economy that we are going into and what has that caused, that has caused federal agencies that has caused the governments to question their spending on important things that over the years they have been very eager to support because of the public good.

There is a third consequence that is rocking our world and that is the impasse of weather, climate, air quality, even space weather on our infrastructure; that is because we are not renewing our infrastructure. We are cutting corners. We are building closer and closer to the margins. And as we build close to the margin, events in the past were not extreme events (have) become extreme events.

These three things I think motivate the three sectors and I think I even would like to add a fourth sector, we have government, we have industry, we have Academia and we have not for profit the foundations that are currently also playing a very large part in our world because of accumulation of capital. It motivates these four groups to start to come together and actually work as a team because they are seeing their business models changing, they are seeing their customer base is changing, they are seeing their global impact changing. We need to address those questions: who pays for it? Who subsidizes it? What is free and what is not free? What is an entitlement that everyone in this room and in the city of Montreal and across the globe deserve free of charge and what we should be paying for. It is only by the four sectors coming together in a neutral ground, in a fair and open place where they can be honest and open and transparent with each other that we can begin to make those agreements, those initial steps that are necessary for all four of us to work together because each sector has its strength, each sector has unique thing that it can bring to this venture of providing better guidance to citizens all over the planet. Who does what, how can we actually stand up and cover for each other when we have needs, as opposed to fighting one another? And if we make a path, can we agree on it, can we live by those outcomes because we all invested in its success. I am very hopeful that we can do that perhaps starting here with these panels here in Montreal and moving forward that there is a capacity for these sectors to come together. May be around a few small but significant and tangible activities that start to show that we each can bring our strength and we can all benefit from it.

UCAR is a consortium of 103 member universities, three of whom are in Canada. It is a unique place where we can talk to government, we have good relation with the Academic sector and we are opening our arms to industry and private sector. We are at an interesting intersection of all of those communities including foundations. And we are here; we are here to help and we are here to listen and if there is something we can do to bring this together, we would like to do it. Thank you!



### 3.3 INTRODUCTION: BRIAN DAY



Our next panelist is Brian Day. Brian is the CEO President of Campbell Canada which has been designing scientific research environment monitoring systems since 1981. He was elected Chair of the Hydro-meteorological Equipment Industry in June 2011 and he served as a co-Chair of the Private Sector Committee of the Canadian Meteorological and Oceanographic Society since 2007. He has also served as a delegate to WMO Congress in WMO Commission meetings. He obtained his Professional Meteorologist designation in 2013.

#### **Brian Day**

I have been attending a lot of papers and I have to comment that the organizers have done an extremely good job of bringing together a wide and diverse group of individuals and the quality of those papers and the amount that I have learnt over the two previous panel discussions as well as the papers I have attended they have changed my thinking a bit and my presentation has changed because of that.

The Hydro-Meteorological Equipment Industry is not well known probably to many of you, It was formed in 2001 at the request of WMO. They were tired of dealing with 125 different manufacturers of Hydro-Meteorological Equipment and requested that we form an association. When we did that they gave us consultative status which allows us to serve on expert teams and technical committees to advise WMO on things like right specifications and standards. It is a diverse membership. We do everything from the space observing all the way to monitoring under water and everything in between So upper air, surface stations which is in my area of expertise for the last 30 some years. We are core industry. Everything our membership does the products that they provide get used by all other industries. We provide the data that allows nowcast to happen, forecast to be created. It is our data that is being used to test models and we also do ground truthing for satellites. The data is very important, it is the core of everything that we do. None of what we do can occur without it. But having sat through the meetings I realized something very clear and Jack brought something up to me today, and it struck me that maybe we need to change our name. Even though we provide all this data, the data is not meaningful to the public. It is all the applications that are being driven out into the web that people get to understand what is going on in our world around us. So maybe we need to go for a name change and instead of Equipment Industry make it the Hydro-meteorological Enterprise Industry and start including other companies into our organization. When I was preparing for the talk, we were given some documentation outlining some of the questions that might be asked and we should address and one of them which really jumped out at me was “What are the present impediments to a successful enterprise” and brought back the words that Dr. Calpini spoke who is the, President of CIMO at a general meeting of the HMEI two years ago and he said that the two goals should be to promote high quality information so that we can develop worldwide compatibility to ensure worldwide comparability. All those things if you look at actual



requirements to drive that we get down to the very basic things, specifications and standards of how equipment is installed as well as the specifications for the accuracies and how it is going to perform. Specifications run two folds. We use them at the capital acquisition level, we buy the product but we also use to them overall to describe the data that is being used in the applications over the web.

As an industry and our members will tell you that when we are looking at capital acquisitions that comes through in terms of Tender documents specifications written. Now WMO supports 6 official languages. I contend that they actually have seven official languages – that seventh one is the specifications and that is least understood. We see Tender documents that make no sense with the specifications that are provided. And we realize that in many programs and it is not true for all programs, but in many programs, we find the end user is buying the wrong equipment. If it fails to meet what they need to see on their computer screen to answer their questions. If they get the right equipment, we now have to look at maintenance and life cycle management. The equipment does not last forever, but if you maintain it, it will last for 10, 20 years. But we haven't always seen that happen in programs posing the developed world and the developing world. And the reason they fail the opportunities are actually three. One is Knowledge, they do not understand the need to carry on the maintenance, to maintain that level of specification, they don't have the passion and they haven't had the training. When you get down to the end, most maintenance programs fail and most measurement programs fail because they don't have sustainable funding. The funding dries up, or as I equate it, a young couple getting married and they haven't thought any more about marriage than how many bride's maids and ushers to have at the wedding. There is a whole part of the marriage that goes on after the marriage day and that is like the capital acquisition of the systems. Sometimes people just don't think about what has to happen afterwards and they don't plan for it.

So what do we know, we know that data is important and that we can put a dollar value on data value. We know how many data values we collect per year, we know how much it costs. We can divide the amount of data by the money and get x number of pennies per data value. And governments tend to look at that kind of information and decide whether they are going to continue their program. And I feel that that is somewhat narrow thinking. In Canada we have 150 to 160 years of data in our archives. That data is being used for models. Can you imagine, and that data is considered and I have asked people what would you put the value of that data; it is priceless and so imagine 150 years from now and even 50 years from now and we extend that data set out and that is how we need to start thinking about the data, not for the short term, 7 days forecast or today's forecast. What are people, future generations are going to use that data for, we don't know; one of the speakers said this morning, computing power is doubling every two years. Think about what we are going to be able to do in 50 years time. We know from all of the talks that we have seen there are worldwide data holes and the reason for that is that not all countries do as well as others when you are given programs. There are several development banks around the world that do capital acquisition, the equipment gets installed by



the vendor, the vendor takes the maintenance on for 5 years and does the training diligently and when they leave those programs are left out and fail and we end up back where we were 5 years earlier with the data hole.

So I come to the question, how we can do it differently. In our company we are developing a culture of, the answer is yes now what was your question. It immediately starts you working towards the solution. Sometimes we go all the way to the solution, we look at it and then we ask the question, can we do it differently, is it feasible to do it differently. But it takes off all the shackles from letting us dream forward.

I want to relate the story and it is the bullet train story and it talks about bullet train thinking. One of our directors was the CEO of Intuit and he narrated this story to us in a recent board meeting. I may have it wrong and other can correct it later. But in essence in Japan, they wanted to move a lot of people very quickly and so they went to the engineers and said design us a train. The engineers went away and they came back and they said well we can a train going at 150 kmph. No, that is not what we said; we said we wanted to go really fast. We want to move a lot of people really quickly. And the engineers said that on these two tracks that is the fastest you can go. The engineers were told, we did not say anything about the tracks. We didn't say anything about the infrastructure we have now. We want you to dream and think about how you can make it go really fast. The result was the Maridglove (*Shinkansen*) train which goes 300 Kms an hour and they built it.

So I am going to encourage that we actually take a look with academia, with the public sector, with the private sector and we get together as a group and just make it a small group and try and impose some bulletin train thinking on how we can fix the data hole and not think about borders, not talk about countries, not think about past; let's just open our mind and think about the problem differently. And maybe and just maybe we can come up with a better solution so that programs don't fail either in developing countries or I would even say in the developed countries there are agencies outside the National Meteorological Services that have the same problem as developing countries and that is the question I would leave with you. Would that make sense to develop that kind of panel and have them spend a year working through it developing a different solution. Thank you!

### 3.4 .INTRODUCTION: BILL GAIL



Our next speaker is Dr. William Gail. Bill is the President of the AMS as well as co-founder and Chief Technology Officer of Global Weather Corporation provider precision forecast for weather sensitive business sectors. He is a Ph.D. in Electrical Engineering from Stanford where his research was done in Earth's Magnetosphere. He participated as a member of two National Academy's Sciences Committees one that affected the organization I ran, the National Weather Service 2012, and other Decadal Survey for Earth Science.



He is currently a member of the Board of Atmospheric Sciences and Climate of the National Academy. He is also a fellow in AMS.

## **Bill Gail**

I think we live in a very exciting time in this field. We are fulfilling a scientific and technological revolution that started 50 or so years ago. It started with the advent of satellite observations, more sophisticated ground-based observations, proceeded to a second phase of advanced modeling in 1980s with advances in computer infrastructure and went on to web and mobile, something that we as a community are not responsible for but it is something huge in our ability to move forward; these three things, these three scientific and technological revolutions constitute what I would like to refer to is modern meteorology. We often forget that there is a fourth key part of this and that is the advances in the institutions and organizations that make all of this possible. That is what these panels have been about is those advances and how we help them push them forward even faster. Now the enterprise is built from three sectors, we have heard a lot about that academia, government, private sectors each with their own strengths; I like to say that there is a fourth sector may be this is the second fourth sector after Tom's Proposal for the fourth sector and that is Scientific and Professional Societies and they play an important role in the Enterprise, they play a sort of glue making the other three parts work well together, helping them all advance, providing the an intermediary that I think is the essential part helping the enterprise proceed. Now this is not always easy. We know that in the US we have gone through three phases, we are really entering the third phase of the enterprise now. And the first phase was may be prior to the year 2000 characterized by conflict particularly between the private sector and the public sector. And at least partly and may be largely as a part of the National Academy of Sciences' study called "Fair Weather" that many of you are familiar with in 2003, we laid out a means to progress to what I like to call the second phase of the Enterprise that was characterised by cooperation, efforts to reconcile our differences to meet to find ways to work together and now I think we are moving into the third phase of the enterprise – we have actually moved past this need to together and work out our differences to where we now have shared problems. We get together and talk about shared problems, not how things divide us and how we can move together towards that future and I think that it has been huge progress. And I think in the end this has resulted in a stronger and more well-established National Agencies through NOAA and through the Weather Service and I think it has been good for everyone - this progress.

Now the Fair Weather Report makes some really interesting observations – one of them is that some level of tension is inherent in this process between the three sectors and that tension is actually good in some ways. We don't want it to go away completely but we want to have a forum for resolving it – that is what they refer to in the comment, that the frictions and inefficiencies of the existing system can probably be improved and as a result of the Fair Weather Report and various actions which have been taken in response to that I think that we have made that sort of progress.



Now one part of their solution was this Recommendation 3 that the weather service and relevant organizations should ask or seek for a neutral host such as the American Meteorological Society and indeed the American Meteorological Society stepped up to that task and we formed a Commission on the Weather and Climate Enterprise and you can see from this org chart which I am not going to go through in detail, that it is a fairly well established fairly sophisticated set of activities and we provide in many ways a platform for the enterprise to come together and resolve those differences, to identify issues and to seek solutions to those issues to let the enterprise move forward.

Now there are many things that societies can do and accomplish as a part of the enterprise. So we provide Journals, Meetings, Education and communication is an interesting one, we provide a forum for communication sometimes when the parties can't talk to each other very well. We provide Policy insight, objective neutral policy insight that helps us all to move forward. Dialogue and Mediation again trying to bring the parties together. One that is new is shared planning. I will talk about that with an example. We put together an activity called the Forecast Improvement Group and expectation is that this becomes a neutral forum for planning. So if you look at all the bodies that exist for planning as a community, none of them are comprehensive so in the National Academy, you have limited Committee, you have Advisory Group for Weather Service and for NOAA that bring together a perspective that is guided by those agencies. So what we are really trying to do through the Forecasting improvement group is to create an open dialogue where anybody could be a member where we can bring together three sectors on equal terms and plan. And really this is a means for documenting scientific and technological vision of the community as a whole. We often get asked what the community thinks about this. You can't go to NOAA, you can really go to AMS as it is, you can't go to any particular body. What we are hoping to do is to fill that gap with the body that does speak for the community. To do that we have to reflect both the consensus and the non-consensus perspective – we have to reflect, when there is an agreement when there is not agreement and try to seek a path forward in in those situations even where there is not full agreement.

Two simple conclusions from this as ways to improve what we do – one is to enhance the role of meteorological societies in each nation and region to further enterprise development so play the glue both in developed nations and developing nations and one of the things I am thinking to do in my role at AMS is to build connections with meteorological societies. I think we can all help each other and I envision a future where we have a web of meteorological societies 10, 20, 30 years from now, all playing an important role as a glue in the global community.

### **3.5 INTRODUCTION: JERRY LANGOASA**



Our next panelist is a good friend Jerry Langoasa, the Deputy Secretary General of WMO. He took that position in March of 2010. Prior to that he was the Assistant Secretary General of the WMO from 8 August, 2005. Jerry's roots are in South Africa where he was the CEO for the South African Weather Service and permanent representative of South Africa with WMO and was a member of WMO's Executive Council. Jerry holds Master's Degree in Climatology and Development Management from Witwatersrand University, Johannesburg, South Africa, and for several years worked as a teacher and university lecturer in geography and environmental studies.

## **Jerry Langoasa**

Thank you very much Jack and good afternoon ladies gentlemen. First let me appreciate the efforts of Jack in pulling this together after brief conversation at the AMS meeting earlier this year. And we were contemplating at that time that it will not be possible to have something as big as this at this meeting and we can try for the future the way it was done. And also appreciate all the panelists for having taken time to participate in this very important dialogue. I call it a dialogue because in my view it should be the beginning of a conversation rather than an end to it.

I just wanted to share five thoughts. For me vision is like dreaming and there are different types of dreams. It could be a nightmare and it could be a kind of very surreal dream which never really ends and in that respect thinking of the future of the Enterprise, one has had to think a bit about not so much the constraints of the present but possibilities of the future. Jack in his opening remarks already alluded to a changing world and that changing World for us is characterized by changes in the geophysical environment which in the Weather Enterprise we are interested in and it is fair to say that the past in that respect is no longer a good indicator of the future and so this means that Julia this morning on the seamless prediction challenge from weather to climate scale and into the environment has brought to the fore the importance of the work that is done on the scientific side. But more than anything, I think even if we have a conversation among ourselves, as scientists about the improvements that we have made and the immense progress that has been made over the last few decades which has made tremendous contribution to society and the preservation of life as we know it on our planet with of course living with the risk of the development pathway that we have selected. It means that world is looking to this community to continue that progress over the next few years and decades especially in the face of what is a rapidly changing environment.

The second part which I think one needs to think carefully about is the future of the Weather Enterprise beyond the present. It is that for the first time and this conference is reflective of that we are opening ourselves up to be user driven and needs driven not so much by the capability that we have as a science but rather in addressing what society needs and what the end user needs. This of course opens up new pathways of thinking, new models of doing things, new volumes of data which will make big data seem very small and minute in comparison with to



new volumes we will face in the future driven by different types of applications than we are presently thinking of. To the global framework of climate services e. g. we identified four priority areas: Health, Water, food security and disaster risk reduction. And all of these have yielded through this User Interface platform very different ways of thinking about how the science is used and vice-versa and what gets developed in the process of the science to address what may be a very diverse societal need in some cases not very clearly articulated in other cases where the user is very clear about what they need. . One such example is on the health side. I have never known, well have been sick in the past including a bout of meningitis and so forth. I know it is a dangerous planet to live on. But I never had an idea that it is so dangerous until I started to speak to the individual parts of the WHO. Where every disease is so dangerous that everyone in every department of the WHO believes theirs is the most important, be they communicable diseases, non-communicable diseases whether they are epidemics or have potential of being epidemics or not. It is by engaging that community that we have started to understand what their needs are and how diverse they are and yet how all important they may be. And speaking to the energy sector again when you speak to the full value chain of the energy sector, you start to appreciate the different needs of the guy who has to run the utility, from the guy who has to run the mining extractive energy side or the mining side of energy to the one who has to run the distribution network which is much more susceptible in the chain. So user needs are going to drive our Enterprise and are we ready to take on the challenge of very diverse user needs and the applications. Thinking of the full value chain, I think we have to celebrate the successes that we have had as an Enterprise up to now but also be cognizant of the gaps we have and how to close them. I will take a very simplistic model and I think it has possibly been presented. But without taking up too much time, I will just issue a few challenges.

One, if you take the full value chain of our enterprise, the question can be asked on the supply side for this - are we only interested in the monetary exchange for widget. Now we know that a part of the community and success of the Enterprise is driven by the data acquisition technology, I call the widget. And in those widgets lies the whole health and wealth of information and the big Enterprise behind them and Brian already spoke about how WMO a few years ago requested that community to self-organize into an entity that could have influence on policy direction of WMO.

What hasn't happened of course in the WMO context are the conversations that have happened nationally between met services and the super-computing community where huge change in a business model a few years ago did not result in bankruptcy, well may be for some small ones, but certainly did not result in breakdown of the community, but however has enhanced the service level that they have offered to Centres like the ECMWF and the others in super-computing capability. That simple model business model change was from buying widgets to buying a service. The question then is, is that possible for data? Can we have data as a service and not simply as an exchange of widgets? That is the question for the future.

On the distribution side, you might say that indeed access to the end product has been enhanced through various types of technologies and we had in the earlier panels how the



mobile telephone has changed access to data and products. This is probably a success that we can celebrate but as we know it also raises some key challenges for the future. So it is not just about access to content, for those that distribute the content. But it should equally be interesting in how the content comes about and therefore, whether we can all play a role in sustaining that content and its accessibility going forward.

The third point, so the take away for me is that we should be cognizant of the past with all its constraints, different policies and different approaches but also not be constrained by that past. The other challenge which I think is important for the Weather Enterprise in going forward is and I will put it bluntly, Earth System Scientists are not born, they are made.

The key challenge then is are we ready as all sectors that play a role including the fourth and the fourth and the half that has been added; are we ready to play and meet the challenge and even if you take it as a philosophy on seamlessness from seamless predictions to seamless observations, etc. are we ready to create these earth system scientists who should take on the challenge of the new Enterprise in the not too distant future. So some thoughts which I think are also important to take into account is that indeed we should be open to a different policy engagement and involvement and by that I mean there are policies that have served us well in the past. They were in a context e.g. resolution 40 was in a specific context when we had very different models between Europe in particular and the US where rest of the world was watching a ping pong match between the two and resolution 40 was a good compromise that has served us very well over the years. But you also have to be aware of current changes in the context of both services specifically driven by service changes e.g. the change in the model of offering services to the aeronautical meteorological community that is going forward. We are going to have immense changes and impacts on the Weather Enterprise. The changes in technologies and some of my fellow panelists have already alluded to those but also changes in risk approaches in business and Rowan this morning alluded to the expectations of the future to minimize risks that will be placed not only governments but business as a whole and society as a whole.

So in closing my thoughts then are, are we ready to create a global weather and climate ready society. This is a pressing challenge of our times and the pressing challenge of the future Weather Enterprise. So Brian has already proposed a possible solution how we might include others who have been on the margins in the past. WMO is well posed, we had a similar conversation with the Broadcast community. And may be there lies the focus guy who brings the weather forecast to you every day but has excluded the huge value chain behind that to a large extent and perhaps the time to review that as well. And there are possibilities of course for new collectives and new ways of recognizing the existing ones and changing those. So those are some of my closing thoughts but I am really excited at the commencement of this conversation and certainly look forward to how WMO may play its role in ensuring that this conversation continues even if we were to select just a few things to focus on in the early part to celebrate our successes but also recognise the gaps and the most significant being a North South divide that needs to be narrowed. Thank you very much.



### 3.6 INTRODUCTION: LOUIS UCCILLINI



I would like now to introduce our final panelist, another good friend, Dr. Louis Uccellini the Director of the National Weather Service. He assumed that role in 2013 and is responsible for the day-to-day civilian weather operations for the United States, its territories, adjacent waters, and ocean areas. Louis was, prior to that the Director of National Centres for Environmental predictions for 14 years. He was Chief of the Weather Services' Met Operations division 1989 to 1994. He also has time in the NASA world as R&D scientist at the Goddard Space Flight Centre's Laboratory for Atmospheres from 1978 to 1989. He has served as the President of the AMS and he is the co-author of a well known book – a coauthor - on Winter Weather.

#### **Louis Uccellini**

And I could make pretty good prediction. I predicted that I will be the last one on the panel but I thought that was because of the alphabet, I am always the last one on the multi-author paper and I will have to summarize. I just want to remind folks that the title of this paper is enhancing weather community collaboration to meet shared goals for the Weather Enterprise. So I am just showing you, I promise you that this is the only slide I have. This is our strategic outcome of the National Weather Service in building a weather ready nation ready to respond and resilient - and you can see in this slide a number of things we have to do - better Forecast and warnings, extending Forecast and accuracy and consistency which is what we are hearing from our users. There is science community at large and observations and everybody else involved in the forecast, the physical and social sciences, heard a lot about that here, multiple dissemination pathways, we just heard about that and how technology has been out there that we have to take advantage of. Working with our partners to gain response, this is not just our users, working with our users but working with private sector providers and then with the consistency aspect there is a lot of gray area too. If we change this to creating a weather ready globe which Jerry just pointed to. We have similar issues – there are things obviously added on with respect to Least Developed Countries and Developed Countries that magnifies the need for partnership. So one of the things we have been emphasizing – this is thoroughly reviewed by National Academy of Public Administration. They thoroughly embraced this goal in fact they said it is one of the best goals coming out of a government agency and they said that you can't do it alone. And in fact what we have been working towards, not only working within NOAA and within its departments who have embraced this but amongst the other agencies now that are becoming partners with us in making this happen. It does point to the need for working as partnership within the entire enterprise to attain this goal.

Now I am just going to answer three of the seven questions Jack posed for us in terms of what does it mean with respect to these partnership. So what have we learned about the value of this three part partnership. This really comes back to the Fair Weather Report. Before that the



Public Sector and Private Sector in the United States did not work hand in hand in moving forward. One of main outcomes to that report was don't define boundaries, don't define a line; recognize grey areas and work through it. Establish the independent Commission to help you work through it and this has been tremendously successful, I contend. It has not only improved our forecast capability across the whole spectrum, but there is one important factor that has not been mentioned yet that since about 2000 which predated that Report if you look at the United States and all the new jobs that have been created in our enterprise, just the net sum of them, they have all been created in the private sector. There has been no growth in the weather service and in other components of NOAA, it has been no growth at all, it has actually been contracted. So when you are sitting and talking with the students in the universities, we have 100s of students coming out, we just remind them about that we have openings, we want the best and the brightest too but the growth that we see in the university community and the jobs that are out there for them, the new jobs, have been in the private sector.

I contend that this has been the direct result of this partnership that developed that the Fair Weather Report was the basis for and the enterprise working together instead of working against each other.

What actions can we take to improve the enterprise, this in fact is the second question.

I say rev up the existing momentum. We are seeing it in the private public sector as I just mentioned. We are also seeing it in the operational research world. When I was a student many many years ago now, I read a paper by T. Appler that described very clearly that the operational and research community could not even sit in the same room in the United States in 1950s. It has been a slow slow connection there. I was the one of the co-chairs of the US Weather Research Program, you could not get the research community and the operational community to accept shared goals that we absolutely needed to move that research program forward. It is mainly because of that that we had trouble getting funding for the US Weather Research Program. Once you put a goal on the table, the research community would say that that was an operational goal and because it was a stretch goal, the operational community would say, we can't do that we can't do that. We are seeing that now. I think people are pretty excited about working together and more of the research is becoming goal directed. It is an amazing transformation in the number of top researchers from around the world that want to work with us in the National Weather Service. I am sure that one of the success of the European Centre is that they made that work a lot earlier than we were able to make that work. And then the provider and the user, we have user sitting with us helping us redefine the where we should go what we should focus on. One of the aspects of that is the consistency and timeliness and they will tell you and I think I kind of heard it this morning from the answer to one of the questions was that that could be more important than improving our accuracy by little bit amount more. That there is a lot of stuff out there that is good enough and we have to get it out there sooner and in more consistent manner. That partnership will be very important.



The last thing I just noticed what the enterprise will look like. It is clearly going to be beyond weather and climate. We are seeing that here, water is going to become the main driver. There is a Proposal on the table for the commission in the AMS that Bill just referred to which is the Weather and Climate Commission to insert the word water in there. This is going to be obviously eco system, health, agriculture, energy dot dot dot. And one aspect that is important to recognize is why is everybody coming to us? I think it is because we were the first science to put prediction into that science and we got some progs with respect to the history. That makes us unique in many ways, it makes our information lot more valuable for our decision makers that have to make decisions for 4 and 5 days or weeks or seasons ahead of time. So we got to build on that as well and that gets us back to the lessons learnt just if you have doubts about working with the private sector or have doubts with operational community working with research community in effective way and you have doubts about working with the user community, just go back to the United States Weather situation in the 90's and 80's and see how we just kind of even when we were modernizing we were kind of stabilized and that as an Enterprise within United States we have just taken off. Thank you very much.

### **Remarks by Jack Hayes**

I guess I would make just a couple of comments. We heard from our panelists that I think represents very well the Weather Industry, Academia, Government, NGOs and Professional Societies. I think we heard there is a recognition of the need to work together and recognition that we will benefit society at a time when society needs us. We have heard what I would like to hear from some ideas from you all and from the panel about how we can move forward – not looking for pie in sky but I am thinking back to the comments made by Ron Douglas this morning. At a time where we have these vulnerabilities that face society, think big, think brave and think beyond your boundaries. So I would open the floor to questions for the panel.

## **3.7 QUESTIONS - ANSWERS**

### **Question 3.1      Laura K. Furgione**

Hi Jack, I am Laura Furgione, US permanent rep at the WMO and also Deputy Director for the Weather Service. So this question is not necessarily for Louis then because he told me not to ask him any questions but question for the rest of the panel then. But I have enjoyed the panel and thank you so much to the panelists, not only this one but other ones as well. Thanks again Jack for putting all this together. One of the components and I think where we are going here is defining the enterprise and where are we. I love Jerry's comment on the Global Weather and Climate Ready Society. So how can we move that forward and it really comes back to the concept within the WMO Resolution 40 and Barry Myers even saying that data wants to be free so let it be free. But I guess the question is really on the balance between commercial data buys and government's provision of this information. So what are the panel's thoughts on WMO



and how members could collectively address these major issues and emerging questions on issues such as commercial data buy. Thank you.

**Answer 3.1.1      Jerry Langoasa**

There is a paraphrase which I wanted to include earlier but decided to rather leave it out which is that in the end this is about power and the exercise of that power between different players. I think Rowland used more or less similar type of terminology which is the regulatory power of the private sector and the regulatory power of the state. Ultimately the policy that was agreed in WMO was the policy agreed between governments exercising that power that they have to legislate. And some members who are in the audience will tell you that once Resolution 40 was accepted at the international level, some had to go back to their own countries to get things changed to enable implementation of the Resolution 40. The whole question then is how do you balance the different power that different players in the Enterprise had. And I think it requires dialogue as to what the end intent of all of that is. We know that when we have agreed as much as a compromising policy like the Resolution 40 was, it enabled the science to advance, it enabled even the least member who has the smallest contribution in monetary terms because they have a small tax base to have an equally powerful say in the global collective. So it wasn't about and the ultimate aim was how to save lives everywhere in the world without a doubt. And I think again going forward is we can see the momentous change in National Data Policy. But those changes are largely happening in the Northern Hemisphere to a point where governments are incentivizing their public service entity to open up the data. Now that for me then says that we are going to have a situation where these debates and discussions will come up when you have 191 members sitting in one room and ultimately a new pathway will be found on how best to create a new data framework and policies that enable delivery of services globally that equally save lives.

**Answer 3.1.2      Louis Uccillini**

I am glad Jerry went first. So the build off of that and not to put too fine a point on it, from a Weather Service perspective, there is a very very small part of our budget is now directed towards this data buys type of an approach. Up until several years ago I did not have any appropriated money for data buy. Now what we are talking about is the satellite aspect and that is not going to be a little data buy. So all of the issues that were just spoken to with respect to free distribution of information that has allowed the enterprise to grow not only nationally but globally that's compounded by that because even in that little segment of where we buy data there are hooks put on to that about the proprietary nature, when we are not allowed to release the data versus releasing the forecast that is problematic for everything which has just been said. So this is a very complicated issue and it is going to take a fair amount of discussion to work out right through it and a fair amount of appropriation work done on the hill before I would be able to buy the data that people have been talking about here.

**Answer 3.1.3      Tom Bogdan**



Commercial data buys I think is an essential part of the future looks like and I think it might be that tangible first issue that the four sectors could come together to talk about because there needs to be a business case identified, a funding model in place, who pays for it who subsidises it what is free and what is not and it is only by gaining those agreements across sectors and across boundaries that we will really be able to open up the full opportunities for the commercial data buys.

**Answer 3.1.4      Bill Gail**

I think it is an interesting part of the answer is how much of it is resolved by policy and how much is resolved by practice. As we see increasing capabilities are in the commercial sector, as customers of this kind of data some of things are going to happen in situations where the policy may lag the practice. I can't say that how I see that future and how that gets resolved. It will be interesting to see how that proceeds.

**Comment: Jack Hayes**

One comment that I might make before I take the next question. Jerry talked about a mindset, instincts and constraints and he envisions the future when we think of possibilities. Now I will be the first to admit that I put on rose colored glasses and you can throw arrows at me for that way. But I look at the compelling need and in my simple life, things I really wanted to do, I couldn't do them all, but you know if I had the will to really do it, I could get pretty far down the path if I really wanted to do, even if I couldn't get all the way and in my mind, Tom your comment that says bring leaders together from the different partnerships talk through the challenges that we face with the common objective to benefit society and if we had those kinds of discussions. Louis I fought the same kind of budget battles I know the hair one loses and the grey hair you get trying to justify that funding but that is because you are have to do that by yourself today. And if you have other advocacies and you have other executives who share your pain towards a common objective, I would say we can move forward.

**Question 3.3.2      Al Howard**

My name is Al Howard and I am an Agriculture Meteorologist in Agriculture Canada. Actually first of before I start I would like to express my appreciation to the organizers also to the chairs and the panelists of all three panels for organizing this excellent series of discussions. But I did have a question and Bill Gail kind of answered it in a way in his talk and I want to may be phrase it as a comment. It seems to me that there is a lot of discussion has been going around the final product of what should the Enterprise really be producing and if it's really possible to forecast, the forecast is a targeted forecast for specific users or forecast in itself. And I think really there is need to go beyond that. Vulnerability is to me I think that is where the real value is in Vulnerability. There is clearly a positive relationship and probably a non-linear relationship in the value of the forecast and the vulnerability. I think this enterprise has one of the best



opportunities to go in and not only assess the risk but really start to assess the vulnerability within a whole bunch of different sectors. I know that we do it to a bit in Agriculture, but I think it needs to be broader than that. I also think that this group has a strong role in building the resiliency that really will be the solution to the vulnerability. And I guess I just wanted to emphasize that and perhaps get some comments back on where the Enterprise should really be ending up and seeing itself where are the edges of the Enterprise in its scope. Thank you.

**Answer 3.2.1 Bill Gail**

Let me sort generalize that question. I think one of the key challenges in opportunities in this Enterprise in the coming years is how far we want to go in terms of combining what we do, the information we provide with other information. We are getting to the point where weather information on its own I wouldn't say limited value, but the great value is when you combine it with other information. And so we can choose to be the providers of only the weather information and let those on the other side of the fence do the combining in Agriculture, Transportation, and whatever the case may be or we can step up and be the ones to do that. I think we should be the ones to step up and do that because the understanding of the meteorological component of that data combination information combination is really critical. I think people on the other side will not do it as well as we can do it. But it is a big step for us.

**Answer 3.2.2 Harinder Ahluwalia**

I am speaking from the point of view of less developed countries where Agriculture and disasters and all those things have a great impact and how we can improve their lot and part of it is infrastructure which I stressed in my presentation. How we can get these countries some help from World Bank Aid Programs to develop that infrastructure so that we are able to do a much better job even in those countries and that is my thought too that as Tom said, the four components of the Weather Enterprise sit together, and I think the societies in each country provide a good forum to coordinate this, so that we achieve better results.

On the issue of combining the information and its interpretation, the capability in those countries to a large extent does not exist and capacity building is strongly required to make use of this data in the best possible manner in those important areas such as Disaster Management, Agriculture, etc.

**Question 3.3 Sergey Frolov**

Thank you very much. Thank you the Panel comments and for your time for being the panel. I am Sergey Frolov from Naval Research Labs.

My question comes from the nexus of our existing Enterprise of Research and Operation. In a society that has limited resources, where do you think these resources should be directed, where do we are going to have biggest payoff, is it getting more computing to our enterprise, is it in the fundamental research, is it in getting more observations or is it in change in our institutions.



**Answer 3.3.1 Louis Uccellini**

Well, I don't think we have to make the choice between whether we need more computers or better science and models or better observations or how do use data simulation system. I think the fundamental thing that has to be done is the recognition that the research can be – I think the fundamental thing in United States that has to be done is that basic and applied goal directed research, the whole spectrum can be done of an operational system now. So that when our research is done after that operational when those advances are made, they can be more readily brought into the operational framework at a much more accelerated pace and with benefits to society that would therefore be accelerated. I can tell that's what for the most part is happening in Europe - another one of the advantages that they brought to the table. It has happened here in Canada. It has not happened very effectively in United States but is starting to happen now. So I think its Hobson's choice when we try and say "hey" do we need more research, or more computers or more observations; a weak link in any one of those items will bring you down. What we need is the operational to research connection so that we can accelerate from research to operation.

**Comment: Jack Hayes**

I might add a comment. I thoroughly support pushing the scientific envelop and I ran the office of Science and Technology. But I was intrigued this morning with a comment that Ron Douglas made when he was asked the question that science could be so much and we just cannot generate enough money to get finer scale models. His comment was I think our first priority is to make better use of what we have to benefit society and it was more along the line perfect is the enemy of good enough. Not saying that what we have is good enough but make better use of what we have.

**Question 3.4 Tyrone Sutherland**

Good afternoon everybody, my name is Tyrone Sutherland from Caribbean Meteorological Organization. I am a member of the WMO Executive Council and I know many people around the room here including you Jack. I am looking at this from a developing country's stand point because technology is moving so fast in the developed countries but its impact on developing countries isn't. The young people in developing countries are moving ahead with technology; the meteorological community is not. We are lagging behind. Lot of you mentioned resolution 40, the basis on which our community exists and shares data. But meteorological community is still protective of data rather than exploring the partnership the way we are talking about and we need to we need to explore the partnerships. Our first speaker talked about Lightning Detection Systems. Meteorological community cannot handle that on its own. It is clearly the private sector role and we need it. But the mindset in developing countries has yet to take that part and

I think it is a role that WMO has to take on to encourage this approach. As far as I am concerned we will slip behind if we are not careful. How we develop our products. My kids don't even ask me what the forecast is. But we are not developing our products in a way that young people need it. It is just a concern of mine that developing countries will be really left behind if some new method of bringing them together with rest of the community is not devised.

**Answer 3.4.1: Bill Gail**

I would go back to the first principal, this enterprise exists is to serve the public and not to serve ourselves. If we cannot test ourselves with that principle and answer that in fact what we are doing is serving the public first and not ourselves then we are not doing the right thing that applies across everything we did.

**Question 3.5**

I think the topic here is about enhancing collaboration and I just wanted to reflect on the fact that we reflect incredibly well for our global observing system and share observations enabling the Enterprise to go forward. We often say that it is becoming a very difficult problem, a complex problem to predict the planet that we need to collaborate. No one nation can do it on its own. I just wanted to reflect as you would expect me to ECMWF experience. ECMWF was established in 1975 explicitly with that goal. It was set up because European countries felt that they could not on their own deliver what ECMWF does on their own. So it is now 34 countries coming together with one single model to deliver prediction. I think just reflecting on situation that we have world-wide, I wonder if we could I wouldn't say mimic that model, but use that kind of concept and develop it further. There is great power in diversity of prediction, but also there is great overhead in having too much of it; maintain modelling systems and computing systems is extremely resource intensive. So I don't know what the right number of centres is and I don't know how they should be structured. All I can do is pose panel a challenge and that is in Europe I think it has been very effective to bring 34 countries together under single goal. I wonder whether that kind of model could be used elsewhere.

**Comment: Jack Hayes**

Thank you for the comment. I have long admired what ECMWF has been able to accomplish across the countries where they don't even speak the same language. I can remember when I was working for the WMO in Geneva, I asked Dave Burridge, how is it that United States with all the money that flows can't be superior to ECMWF. His answer was very quick that you have too much money. There is no incentive to collaborate. What you just said is really consistent with what I heard from Dave. I think it is more than money thing

**Question 3.6:**

I wouldn't say too much money. I think we all have too little money. I think the European experience is whatever money you got, you got to pool it together to make the total greater than the sum of the parts.

**Comment: Jack Hayes:**

I am not going to stand up and say to you that we have lot of money in the weather community, I am not. But I am going to say that there is an element of truth in what Dave said.

**Answer 3.6.1      Jerry Langoasa**

Thank you very much for that comment. But just reflecting globally, there are a number of things that are which are also counter intuitive. One of them is that at the moment there is about a quarter of a billion \$s that is being spent in Africa on observation systems. I am not sure that that is being discussed anywhere in the forum in terms of the impact of that into the future. But those investments are currently being made. The big discussion of course is that they are coming from the development community and whether they are sustainable into the future. The second part which I wanted to raise about sustainability is also interesting that you have in the order of ¾ billion being spent on super computing power outside of the ECMWF and the Eumetsat by individual member states of that collective and so you also have to ask the question then is what problem are they trying to resolve and is there a difference in solving the same challenge and whether in fact that model is more or less sustainable going forward.

**Answer 3.6.2      Louis Ucellini**

Again I am glad that I am following Jerry because this is exact what I was going to say. You think there are more global models in Europe now than we started off. Is there inherent force behind that that we have to at least recognize as individual countries make their decisions? It is clear that the European Centre is incredibly successful in managing the resources coming from these countries and producing the world's best global model. So I have often scratched my head and wonder why there were Global Model Centres in Europe. We face the issue in United States compounded, an order of magnitude different, we probably have more global models in United States than Europe; but people don't just gravitate towards one.

**Question 3.7      Ajit Tyagi**

I am Dr. Tyagi from India. I think I am happy that there is a consensus about the community collaboration here among the four partners. But what is the take home. What is going to be the vision statement of this Weather Enterprise? So if you could come out with one line statement (that) this is going to be the vision and in 10 years this is what we will be providing to the society and in my view aligning with the Global Framework of Climate Services of WMO would be a – because they have already identified four sectors where services could be improved in developing and least developed countries. If we can do this, it will generate a good will and all those data related issues will be taken care of. Thank you.

**Answer 3.7.1      Jerry Langoasa**

My comment Dr. Tyagi is probably that I would like to come back to your comment at the end of the conference because I think there are two things which are important about this conference.



As an Open Science Conference it tries to be as embracing – not only the science and the technical community but also the end user community. In that respect going towards the WMO Congress, the outcomes of this congress become important in doing two things. One is setting where the priorities are going to be for WMO programs going forward including especially the World Weather Research Program and I think a lot of those are being mulled around, that is going to be one key outcome. The second outcome I think is going to be where we focus on building new partnerships or how we strengthen existing ones. For me that is the expectation in the end of the conference that we are able to set a number of priorities because we cannot do everything with the resources available to us.

### **Response 3.7.2 Harinder Ahluwalia**

For me the most important thing which should come out of this discussion is the continuation of the dialogue like this and reaching certain conclusions and trying to implement them. Another thing I would like to state is that in future conferences like this, it would be better to involve the third world countries, the developing countries which can also help in planning the events so that their point of view is also taken care of in these discussions.

### **Question 3.8 Diane Campbell**

It's Diane Campbell and I the Director General of Prediction Services here in Canada. Just to comment I also would like to thank the organizers for creating these panels. I think it is a sign of a healthy organization and enterprise that you question these things and ask (whether) the time is right to do things differently. I am looking at this from a positive light point, it is not a question of whether we do it, we will do it. One thing I would like to make sure we take into account is to take the first few steps. I don't believe it is just four entities. We need to find a way to bring that societal priority and policy aspect from that societal priority into the mix. I agree with the comments made by our colleague from the Agriculture Canada. I think if we had more voices in the conference, we would have heard that most definitely. So I urge anybody who steps up to work on the theme of Enterprise to find a way to do that. Don't underestimate the value of the inspirational societal goal. The concept of social justice, I think, will guide us in the next version of our enterprise and if we can do some early creative thinking on how we use those inspirational goals and agree that all society is not just government and we all need to come out of this being innovative in our respective roles, we all need to come out of this being effective in our respective roles that forward work to set the context for the analysis for the next step will be well worthwhile. So it is just a comment. It builds on some of the comments made earlier on. But don't jump to something like a data policy without thinking where we want to go more broadly in society together.

### **Comment: Jack Hayes**

OK. We are on overtime and I promised that we will challenge each of our panelists what ideas they have and next time they would plan to take. Here we have got various sectors of our



Society or Enterprise represented. Let me start with Louis since he was the last to speak. Louis, next step!

### **Closing Remark: Louis Uccillini**

I have to assimilate everything. I think this Conference has been an amazing experience. I have been here since Saturday evening. May be I should have all these markers already set up. But everything we talked about today in terms of partnership, we have to think to build on what we have been doing successfully and where our growth areas are in the future. But as an explicit next step, I am certainly taking this back, what I learned by being here, I am taking this back to our Team we are assembling within headquarters and our connections out in the field and we are going to assimilate this information.

### **Closing Remark: Jerry Langoasa**

Thank you very much, Jack. Other than reviewing the White Paper that you will draw after this Conference summarizing what we have discussed. I think there are two parts to follow on. The first one is the discussion with HMEI which has kind of stone in the pond and there are ripples so (we need to) just follow-up on that. Other is to take this discussion to the Broadcasting community which we have self organized and have a dialogue with them what the future holds for the Enterprise especially as they are the intermediaries who bring the messages to many many thousands. And then in the earlier panels there were others who really had some fresh ideas, especially to Tylone's question on how we deal with the current generation. I have made a commitment to follow-up on those discussions to see how best we might take advantage of that even more.

### **Closing Remark: Bill Gail**

I am a great believe in the importance of the Enterprise in our success in serving the public; in particular the relative importance of the three parts of that Enterprise. I think it is a hugely successful model; but I don't think there is one model which fits all situations and a part of what we do next is to understand what different models can serve that basic criterion of the relative importance of those three roles within the model. How to differentiate that based on particular circumstances and apply it well in particular situation.

### **Closing Remark: Brian Day**

It has been an interesting week in I have learnt so much more again about our Weather Enterprise. It is a very successful group of companies, governments, WMO going towards public safety all the time and we do, what I consider, a very good job if you were to go back and look at 30 years ago and what we were able to provide versus what we provide today. On the panel and with the questions we focussed a lot on what we need to do now. I think it is always



in human nature to try and drive things forward. As things get more complex, I think we need more out of the box thinking. I think we need to take away all the boundaries and just look at the problem if we were starting from scratch how we will solve the problem. Whether you can solve the problem or not financially is another question. But we always need to start with the idea that there are no boundaries and we can solve this. It is what industry typically adopts. We see technical challenges, they are road blocks and we figure out ways to go around them, go over them, fix them, go through them so I would challenge going forward that we start taking down the boundaries because weather doesn't have any boundaries, why should we.

### **Closing Remark: Tom Bogdan**

The current Enterprise that we are engaged in is certainly sustainable on the time scale of the rest of my career may be some of yours as well. So when I go out and talk to undergrads, post-docs, grad students at my 103 Universities who are excited about their future and the role they can play in future, I am afraid that it is not sustainable in their time scales. It behooves us to do something to guarantee them a future albeit different than the one our predecessors gave us. But we are the leaders of the community and it is our job to look forward – if not us who, if not now when.

### **Closing Remark: Harinder Ahluwalia**

For me the take home is to continue this dialogue and actually come to specific conclusions which are achievable and executable and we keep in mind that it is for general public and not only for certain parts of the world but entire world. Therefore, we should involve those people more and more in these discussions and see how we can help them. I am trying to present the point of view (of developing and least developed countries) – although I live in Canada and we are doing well – I also look at other countries; the way they are doing and how we can help them. This kind of discussion, where the collaboration between the private sector, the government sector and the universities as well as the collaboration between different nations is discussed, can bring their lot up as far as capacity building is concerned. This will be very helpful for the developing and the least developed countries.





## Jack Hayes Closing Comment

I am going to make a final remark and I am going to tell you my commitment to moving forward. I will produce the White Paper with the help of my committee, the panelists and any of you who wants to contribute. I am not going to tell you that I am going to get it done next week because I have a day job. But I am going to deliver that. It may take me longer than I expect but I am going to deliver that. It may go over like a lead balloon or may produce flowers but I am going to deliver that. I think I am a passionate person and I try and think what is the right thing to do and I was moved by the presentations in the plenary sessions that there is a need for us and I heard it remarked in the morning session that what we as a community need to do is to develop a collective sense of purpose and I would submit – or our sense of purpose is to better the fate of the society in our lifetime and future lifetimes. My contribution may only be one straw in a giant hay stack but it will be one straw and I am going to take accountability for that. I would say everyone in this room as workers, as leaders have a responsibility to put their straw in that haystack. Thank you!