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HOUSE OF REPRESENTATIVES

STANDING COMMITTEE ON INDUSTRY, SCIENCE AND INNOVATION

Reference: Long-term meteorological forecasting

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HOUSE OF REPRESENTATIVES

STANDING COMMITTEE ON INDUSTRY, SCIENCE AND INNOVATION

Wednesday, 17 June 2009

Members: Ms Vamvakinou *(Chair)*, Fran Bailey *(Deputy Chair)*, Mr Bidgood, Mr Champion, Mr Cheeseman, Dr Jensen, Mr Johnson, Mr Ramsey, Ms Rishworth and Mr Symon

Members in attendance: Fran Bailey, Mr Bidgood, Mr Cheeseman, Dr Jensen, Mr Johnson, Mr Ramsey, Mr Symon, Ms Vamvakinou

Terms of reference for the inquiry:

To inquire into and report on:

Long-term meteorological forecasting with particular reference to:

- The efficacy of current climate modelling methods and techniques and long-term meteorological prediction systems;
- Innovation in long-term meteorological forecasting methods and technology;
- The impact of accurate measurement of inter-seasonal climate variability on decision-making processes for agricultural production and other sectors such as tourism;
- Potential benefits and applications for emergency response to natural disasters, such as bushfire, flood, cyclone, hail, and tsunami, in Australia and in neighbouring countries; and
- Strategies, systems and research overseas that could contribute to Australia’s innovation in this area.

WITNESSES

Committee met at 10.08 am

Larson, Professor Jay, Private capacity

CHAIR (Ms Vamvakinou)—Welcome. The inquiry into long-term meteorological forecasting is being conducted by the House of Representatives Standing Committee on Industry, Science and Innovation. The inquiry arises from a request to this committee by Senator the Hon. Kim Carr, the federal Minister for Innovation, Industry, Science and Research. Written submissions were called for and 33 have been received to date. The committee is now conducting a program of public hearings and inspections. This hearing is the third for the inquiry. Dr Larson, do you have any comments to make on the capacity in which you appear?

Prof. Larson—I am appearing as a private individual. I do not represent employers or institutions with whom I am affiliated. I know that I mentioned that in my introduction. It was simply to say, 'Hey, take me seriously.' But, other than that, we should keep my employer out of this. They do not necessarily share my opinions, even if they should.

CHAIR—Although the committee does not require you to give evidence under oath, I should advise you that these hearings are formal proceedings of the parliament and, consequently, they warrant the same respect as proceedings of the House itself. It is customary to remind witnesses that giving false or misleading evidence is a serious matter and may be regarded as a contempt of parliament. We thank you for your submission and now welcome you to make a brief opening statement before we proceed to questions.

Prof. Larson—In my case, I really do not have an opening statement. I would rather just let you folks ask questions, if that is all right; if that does not catch anyone off balance. I do not have my submission here. It is on my laptop. I can pull it out if we need to refer to it point by point.

Mr RAMSEY—Thank you, Jay. Just looking through your statement, I am interested in where you think we are deficient, or where you think we have fallen behind in our climate forecasting schedule because of the underinvestment in computer sciences, as I read your response.

Prof. Larson—Right.

Mr RAMSEY—I might point out that, when the committee for this inquiry was recently in Melbourne, we had a look at the new super computer at the Australian Bureau of Meteorology, which is yet to crank up but it is getting pretty close. Bearing that in mind, where do you think that has actually affected our physical capacity to provide at least seasonal forecasting, if not climate forecasting?

Prof. Larson—I will not comment on the specifics of the forecasting but, as I understand things from dealing with people at the bureau in the past, over time they have been running short on money. This country punches above its weight—traditionally it has—in this area. If I had to say who were the natural leaders in this area, it would be Australia. Even though Australia is a country with 21 million people and an economy that is not as big as Germany's or the UK's or the United States', it is in that leading pack, and it certainly has been in the past. In particular, spectral modelling of the atmosphere was pioneered here. Bill Bourke was an early leader in this field. That model was taken up by the National Centre for Atmospheric Research in the United States. That is decades ago now, but it gives you an idea of the kind of talent that you have at your disposal here. I have nothing but respect for these folks.

I think that what has happened is that for the past decade there have been increasing demands on the computation front but also on the algorithmic front on weather forecasting models and another key thing which you have probably been told about—data assimilation. You can talk about the traditional thing with a computer program—garbage in, garbage out—but data assimilation is the process of combining observational data with model calculations so as to come up with some kind of estimate of the state of the atmosphere or any system in general. It is how one produces initialisations for forecasts to these systems. One of the things that the bureau really needed for a new system was what is called ‘four dimensional data assimilation’ or 4DDA. Did they mention this at all in Melbourne?

Mr RAMSEY—Not to my memory.

Prof. Larson—I will just skim through this. I think it was one of the key elements that they needed. We could go through the technicalities of that, but the idea is that the sort of traditional picture of data assimilation is that you take all of your observations covering, say, a six-hour period and you treat them as if they occurred at the same time. This is a three-dimensional thing in which you have three spatial dimensions and you fix time. The oldest of these systems, optimal interpolation, uses that approach. So they needed to go to this sort of thing where the more you run the model forward there is data, and you use an adjoint model to assimilate the data as you go. You can think of it as driving a truck forward and rolling over something a few times and picking it up and then going forward. Implementing a system like that is particularly hard. They needed that. I think that was a key reason why they chose the Hadley Centre Unified Model. They could get this in the bargain: they could get atmospheric 4D data assimilation. The model itself has pretty good physics. It is a non-hydro static model.

Mr RAMSEY—I can see how that would have a real impact on weather forecasting as in day to day. Does that have an impact on seasonal forecasting and climate forecasting? Readings of variations within a day really have very little to do with what is going to be happening in three months, five months or six months time.

Prof. Larson—Yes. If you are doing seasonal forecasting, the key thing is that you want to have good estimates of things such as sea surface temperatures—future estimates or forecasts for them. I do not know for a fact how that is done, and I do not know how that might change from the older version of the Predictive Ocean and Atmosphere Model for Australia, POAMA—the currently operational one—to a new version that uses the UM. So I am not sure whether I am really answering that part of the question very well for you.

Mr RAMSEY—We are just exploring areas.

Prof. Larson—Okay. That is good. I do not have anything on. We can do this for as long as you need.

CHAIR—Did you get a chance to finish your answer?

Prof. Larson—I am not sure if I—

Mr RAMSEY—I do not know whether my question was very clear. You identify a lack of computing and research capacity.

Prof. Larson—Let us go back to that.

Mr RAMSEY—What I am saying is: how does that actually translate to where you see deficiencies in the products that are being delivered?

Prof. Larson—One thing that I would say right now is that, for any kind of operational system, if you need to move it to new computer hardware, that is a big deal. What I think is going on is that there is not the kind of resourcing there that makes it easier to move these systems to new hardware. We call it 'performance portability'. You can move these kinds of codes that run on large numbers of processors. Have they talked about parallel computing as part of this whole activity?

Dr JENSEN—I do not know the details but I think they would have mentioned parallel computing.

Prof. Larson—Okay. This to me is a bit of a concern because I have worked on developing things like this, and one of the things that we would always try to do is get accounts on other machines that have slightly different operating systems, different compilers. A compiler is something that takes program source code and creates an executable that the machine runs to do the work. You run your code through a lot of different compilers. It is very good at finding bugs; things that are somehow non-standard. And you also test things on different systems. Again, there is not the resourcing there to do that. I am a little concerned about the UM. The Hadley Centre does a portable, unified model release only once every few years.

Their claim is that things move so rapidly that they cannot shake down versions of the code. It is true: it is an operational system and stuff changes quickly. My point would be that, yes, it is does. But I would turn that around and say that it is an operational system. People are taking off and landing aeroplanes based on what comes out of it. They are deciding to sail. They are telling people not to go to sea in response to what comes out of these things. I think there should be more of an emphasis on testing. I am sure they have test suites for certain cases, and I think that is perfectly rational. This is a large enough thing, and I am a little concerned that I do not get the sense that the Hadley Centre is trying to test the code on lots of different platforms. For example, I am involved in various software projects. I am not writing code these days, but I can think of one project that I am part of where there is literally a daily build of the software on a lot of different platforms. I get email at a time that corresponds to about two or three in the morning in the United States which says that certain tests have failed. People who have made certain changes in the code base are on the hook to fix or find out what is going on or to explain what is wrong. That is one example of underresourcing that worries me.

But the other thing you get out of this, not only in terms of code quality, is that you as the customer buying machines probably can force more pitched competition for your money among vendors if your code is relatively portable. If it is a complete headache to port the code to other machines, people might say, 'This isn't worth the trouble for me to put a couple of employees on getting this stuff working to respond to a tender.' That concerns me as well. An organisation like the bureau has a lot of money, so people are willing to put up with a lot of inconvenience. That is one example that I can come up with. I felt that probably there is not enough synergy between the scientific computing community and the bureau and CSIRO. I worry about that a little. We can go into what I mean by that and how that differs in my experience overseas. I do not know, but have I—

Mr RAMSEY—Another member might like to ask some questions.

CHAIR—We might come back to that. Mr Symon.

Mr SYMON—I will probably refer to one of the areas you were just talking about, Professor. You have been speaking specifically about hardware, but in your submission you certainly mention the case of computational scientists and the support that does not seem to be there for said people at the moment. Firstly, how many people are trained in this who work in the climate, weather and ocean areas in Australia that you know of? It is obviously a very small field.

Prof. Larson—Yes, I think that one day most of these people realise that is what they do. These are people who typically do PhDs in some area of physics. They happen to be using computing to do things or they work in applied mathematics. So some of the people who work on things at the bureau I would call computational scientists in the sense that they might look at something and say, 'Oh, I think I can make this run faster or better or more accurately if I change things about how the model solves the primitive equations for the atmosphere.' It is that sort of computational science as opposed to information technology. I think a lot of people are hired as IT officers in these organisations and they are sort of clubbed in with the people you ring to say, 'I can't get the internet,' or, 'I can't print,' or, 'I have a virus.' This is a different skill set—it really is. Numerical analysis is a fairly deep field.

Mr SYMON—Following on from that, if they are clubbed in with, let us say, the help desk people—the software support—is that recognised in levels of status and remuneration for such a position?

Prof. Larson—I think they are treated that way and I think that is unfortunate. I would have said a lot of the people doing this work could be seen as software engineers—someone who gathers requirements and figures out a solution to a problem—and should be on the professional officer pay scale. If you look at the corporate agreement for some place like the bureau, there are professional officer grades, and that is where the scientists would be placed as well. I would say that definitely applies to the software engineers. Certainly 'professional officer' would apply to the people who are trying to figure out the numerics of these systems. I think probably we do not have lots of people worrying about that day to day simply because there is only so much money, this is a country of a certain size and there is a big job to be done. That is the way it is.

Mr SYMON—There is obviously a shortage, as you say. It is hard to get people into the field and there is a lack of resources.

Prof. Larson—I am concerned about it, yes.

Mr SYMON—If that is the case, then what is being done to attract people in there? Yes, I understand the resource argument. Everyone always needs more money.

Prof. Larson—Yes, I have no illusions. I do not think you guys are going to whip out your chequebook and say, 'Well, Dr Larson, we should treble their funding'!

Mr SYMON—From a recruitment point of view, what would cause a person at university considering a PhD to maybe lead into this field—where is the career path in it? How do they get pointed in that direction? How do they stay there?

Prof. Larson—Indeed. To some extent, my submission is throwing the questions back to you. The way this works is hard even in the United States. We could look at something like the National Center for Atmospheric Research, which develops a large climate model—the Community Climate System Model—that is used by a community of hundreds of users worldwide. There is a career path for the so-called software engineering people, and the most senior grade of software engineer is paid at a level between the two highest levels of scientists. If we look at the corporate agreements for CSIRO or the bureau, part of my argument is that a lot of these people should be bumped up into the senior professional officer area. The most senior of them might be roughly on par with principal research scientists—at both the Bureau and CSIRO, the most highly placed grades are principal scientist and senior principal scientist. Whoever is tapped to head up the software engineering working group for the ACCESS model, for example, will be in charge of a big project. We are talking about a group of probably 15 to 20 people—they probably should pitch that.

CHAIR—I have a feeling we will come back to this, because you have raised something that is very interesting. Firstly, we will go to Dr Jensen.

Dr JENSEN—Yours is a very interesting submission. I am going to get a little more philosophical here, but it will certainly be in line with your submission. You point out the aspect of effectively opening up data information and programs more widely so that it can advance the science.

Prof. Larson—Yes.

Dr JENSEN—I would like you to go into that a bit. I have a couple of concerns with that science is going at the moment. One concern is that a lot of discovery—particularly early in the 20th century in physics—took place when the area was open and information was freely disseminated. Nowadays it tends to be more closed or more in the way of commercial agreements and arrangements, which means that that information tends to get locked up for quite a considerable period of time. I would like you to comment on that, particularly with regard to, as you were saying, climate modelling—you pointed out the US model that is shared.

The other is that peer review is now taking a considerable period of time. The amount of time between when you initially submit a paper and when it might be published could be well over a year. What is your view on maybe looking at different ways of trying to do this? From my recollection, I do not think that the peer review process was taking as long, say, 50-odd years ago.

Prof. Larson—There are a number of points here. One is this open access and open source, if you will, with computer code. I would say again—with all due respect as to why decisions were made here; I am not here to criticise—that I do have concerns. For example, something like the Hadley Centre Unified Model is not open source, for better or worse. I think they have found it is a valuable product and, for whatever reasons, they want to keep the source to themselves and control its release.

If you look at something like the Community Climate System Model, you can literally go to a website, register and then, after registration has been completed, download the source, and you could try building it on the computer of your choice. I can guarantee it will not build with Windows, largely because most of us in the scientific community—

Dr JENSEN—Do not like Microsoft.

Prof. Larson—It is a bete noire, yes. You might get it to build on a Mac, but on the Unix system of your choice you have a pretty reasonable chance of getting it to build from source. I think it is good that things are open source like this. Here, for example, most of the modelling software is held quite tightly. You are saying, ‘Let’s talk about philosophy here.’ I think I understand why it is held tightly like this. In my opinion, it is that the people who develop these things are strapped for cash, that they do not think of their code as being on par with the publication, that instead they view it as a less valuable thing that they spend evenings and weekends building and getting to work, and that they have only so much support, so it is a way of cost recovery or a source of funding. I would say that to some extent a lot of this closed source approach is something where science is viewed as a cost that must be recovered rather than, ‘This is something that we fund,’ and there are products that come out of it—software tools—that are meant to be used by the community at large.

I know some people think, ‘That’s valuable intellectual property. What if somebody takes it and starts a company and uses it and makes lots of money?’ I think the philosophy in the US on this is that open source scientific software that results from NSF or Department of Energy funding is meant to be this kind of public asset and that the government really could care less if a company in the US grabs it, starts a business and makes millions of dollars with it, because the idea is that they will pay taxes on that. You could refine it a bit and say, ‘What if somebody takes it overseas and makes lots of money?’ That is another issue. I think that is the whole thing about this openness issue. If you had to ask my opinion on that, open source is a good thing because you can engage more collaborators and you can get people using your code and potentially finding bugs. Again, I think if you are building software you need to change your mindset—finding bugs is a good thing. Your life is no better if that bug was undiscovered. It is just good to find them, fix them and move on.

Also, if your code is open source I worry about the government funding researchers here who develop code that is not readily usable by others. If you look at, for example, a lot of websites where you can download scientific software, they will say, ‘The terms are: if you use this and publish a paper, acknowledge the use of the software; cite these papers.’ For example, if we look at a well-known product from my employer, the Portable, Extensible Toolkit for Scientific Computation, or PETSc, as it is called, that is on their webpage. In fact, they make it so easy for people that the citations—I have not looked lately; at least it used to be this way—were in a format that can be immediately cut and pasted into the scientific word-processing software that a lot of mathematicians use. It is right there. That is why I would advocate strongly that lowering these barriers is good. It is also a concern that, when you have high barriers like this, it is hard to engage students. I can think of one or two examples I would prefer not to go into that have occurred in this country. I do not blame the particular people involved; I think it is the general landscape.

CHAIR—It would probably assist us if you were able to illustrate, with examples, some of the things that you are saying.

Prof. Larson—One example is the CSIRO mark 3 low-resolution climate model. This is a climate model that I would classify as high throughput, where you can run lots of years of simulation relatively quickly, so the resolution is low. The idea of most of these climate models is you model the geographic distribution of weather and climate variables, and you do that by solving primitive equations for the evolution of the atmosphere and writing out data as you go. It is that simple. That means you write out a lot of data. So a high-throughput model has fairly low resolution—you only solve it at so many points compared to a higher resolution climate model.

The ARC funded a workshop that I participated in, which was attended by about 30 people, a lot of whom were beginning graduate students. The guy who developed the model was fantastic. He gave a great course on his model and had written a very nice manual for it, but his hands were sort of tied—either by CSIRO or his employer—in terms of intellectual property and the distribution of the code. So these licensing issues just cropped up and, though he had 30 people attending the course, nobody is really using this model a year on.

Like I said, I do not want to criticise the individuals involved in this. I think you, the government, need to lead on this. The best way to do that is to probably be a little more generous with the funding and then add strings and say, 'If you develop software with public funding, it is open source.' You could put certain restrictions on it such as, 'If you find embarrassing bugs, you need to talk to us first. You cannot go and write a paper about having found an embarrassing bug in a model. You need to be a gentleman or a lady about having found bugs.' That would be a specific example.

Dr JENSEN—We were going to discuss peer review as well.

Prof. Larson—Let us go on to peer review, which is interesting. Yes, things take a while, and why is that? I think that the productivity expectations on scientists have increased dramatically—such as the amount of papers people should publish in order to get tenure or to get promoted. I can remember as a grad student—and this is probably going to offer too much of a window into my thinking—being in the library at the College of William and Mary, where I did my PhD in theoretical physics. They had a binder in the library full of the CVs of all the faculty members. I remember thumbing through it, looking at the positions and knowing which ones were tenured and which ones were merely tenure-track. At some point in my early 20s, I remember looking through this and asking, 'Larson, how many papers do you need to publish in order to get that secure job?' On average, I came up with about seven peer reviewed journal articles. That was what was traditionally expected of people to be promoted from the position equivalent here to lecturer to senior lecturer.

I do not really have a sense for how that is set up now, but I think the pace of things is increased and people really want people publish more papers and they want people to chase funding and funding is hard to chase. And this country is not alone on that front. In the United States there are a lot of programs to which one can submit grant applications. A typical faculty member in the States might be spending about one-third of his or her time chasing funding. There are a lot of people who are pretty seriously overworked, and reviewing papers may drop to a lower priority item. For example, I have a paper that I agreed to review. They wanted the review within four weeks and that was probably about six weeks ago. So I should write that down on my list of things to do this week. But I think peer review is a good thing.

Dr JENSEN—The reason I asked is that it is quite interesting at the moment because in some scientific blogs—if you want to call them that—there is discussion that is far more valuable, I think, than some of the peer review processes. These blogs become a living document in which the state of knowledge and the state of understanding of all parties progress rapidly. For peer reviewed journal papers, however, the process is very, very slow—that is, the elements of the dissemination of information and feedback.

Prof. Larson—I agree with you. In fact, if any of you want to examine the so-called consensus among the climate-modelling community, I would urge you to go to www.realclimate.org. That is an excellent place to look, in that it is a very well-crafted blog, there are a number of contributors, there is a lot of give and take, and a lot of debate. Again, we need to look at the rewards system for promoting people and say, ‘How do we count up their points to promote them?’ You raise an issue that is near to my heart. If you look in my CV, you will see that I supervised a master’s student last year. We were looking at this idea of whether there is generally a better way, and we concluded—among other things—that yes, there is. Though journal publications have gone electronic, they are still a technology that is 350 years old; the first scientific journals were in the 1650s. Yes, this should change.

FRAN BAILEY—We have got a job on this committee to make recommendations as to what is going to be the best way forward for Australia. My understanding is that the UK and the EU have signed off on the Hadley model. The first I have heard about this was the US system of open access. Given Australia’s geographic position, would its best way forward be almost to take a hybrid position? I understand the hardware component with the supercomputers, but would our scientists not be best placed to be picking the eyes out of the best software? At the end of the day, we are looking for the best application from our meteorological sciences for industry, agriculture and emergency management et cetera. Can I have your views on that?

Prof. Larson—I can understand that. You raise another issue that is fairly near and dear to my heart—there is only so much money to go around. There is only so much support one can give to these things. Australia has traditionally punched above its weight—to use that cliche again—so, if we could, we should still try to develop things locally. The CABLE land surface model is an excellent example of something where there is work going on here that is distinct from work around the world. Australian vegetation is actually a little bit different from what you see elsewhere. There are a number of little things. For example, phototropism—where the leaves place themselves according to the sun’s rays and stay there—does not occur here, as it does traditionally with deciduous trees.

If the leaves did that, they would get scorched. So they move around a little bit. If they heat up, they move back. There has been work on figuring out this angular leaf distribution. It was work that a mathematician here did. It is a famous inverse modelling problem. CABLE is embodying a lot of that kind of stuff. You are right: why don't we just cherry-pick things and be a really solid system integrator. On that level, I would say that is fine. You are actually very much on my turf at that point, because my claim to fame is that I am one of the architects of the coupling infrastructure in CCSM. I have devoted much of the past decade worrying about coupling high performance codes. If we look at things from that perspective, I would say that there are some things about the UM that make it a little harder to couple to other systems. If we want to go into the technical details of that, I can, or at least skim over them.

FRAN BAILEY—I am not sure that I would understand them.

Prof. Larson—Most kinds of atmosphere ocean models do something that I would classify as explicit coupling. You can think of it as 'fire and forget'. The ocean might say: 'Hi. I'm the ocean. Here's my sea surface temperature. You go do something with them, atmosphere.' It just hands over the data and the atmosphere works with them. Because of the UM's numerics—and I do not have all the details on this; I can find them on notice if you really want a lot of technical detail, but this is just in terms of talking to people—it does what is called 'implicit coupling'. You have to do this kind of computed self-consistent solution between the ocean and the atmosphere for what is going on at the surface. That is a harder problem to solve.

Most climate and atmosphere ocean models have gotten away with doing this as explicit coupling. It is a technical detail that makes coupling this to the rest of the system a little bit harder. The UM is not alone in this way. The Geophysical Fluid Dynamics Laboratory's model also does an implicit coupling. That is one technical detail that I would say is making things a little bit harder than they need to be. If I wanted to make a craven pitch for the software I peddle, I would be perfectly happy with Australia cherry-picking stuff from other places, and then the idea would be to try and come up with better coupling mechanisms. But the coupler that has been imported for access is a bit of a finicky thing as well—again, this view is from what I have heard from the people working with it. Maybe we ought to concentrate some effort on trying to roll our own system for sticking everything together.

FRAN BAILEY—Do we have the people who can do that?

Prof. Larson—Not really. We could find them.

CHAIR—Here or abroad?

Prof. Larson—Probably abroad. I certainly could train someone to do it. You could hire me to do it, if you paid me enough.

CHAIR—Do you think you could find people who were interested in being trained? This is such an obscure area and it is just not going to click with the general school population. I am just wondering where—

FRAN BAILEY—Yet it could be a really exciting area for scientists to work in.

CHAIR—We could assign Fran to jig up a curriculum!

Prof. Larson—I reckon it is an exciting area. The stump speech that I give for my software, the model coupling tool kit, is frequently: 'Ladies and gentlemen, in terms of software, this is a blunt instrument for battering down the doors into the unknown. You can do garage science. You can take a few different models and, with relatively little programming cost, figure out how to hook them together.' The next thing you know, you are doing what we call multiphysics modelling. The climate is a prime example of this: you have an ocean model and an atmosphere model and you have land processes and sea ice. You are trying to model the whole system rather than its individual parts.

FRAN BAILEY—It is the application of this knowledge to industry and to emergency management that I think is critical.

Prof. Larson—I would agree with you on that.

FRAN BAILEY—It is all very well for the scientists to be getting all excited about the very advanced physics and mathematics almost in isolation in a research capacity; but, at the end of the day, there has to be an application for that. Governments are not going to give money for all of this, unless there is an outcome to it.

Prof. Larson—Unless you decide that it is as beautiful as what comes out of the arts—if I can put it back to you that way. I think it is harder to find an audience for this and say: 'Look at this beautiful solution to something. Isn't this really clever and elegant?'

Dr JENSEN—We do do some of that with, for instance, astrophysics and cosmology and so on.

Prof. Larson—There is a famous story about Leon Lederman, who used to run Fermilab. Somebody bluntly asked him, 'What are you guys doing here at Fermilab with your particle physics to make America safe?' and his blunt response was: 'We make America worth defending.' That was probably a bit arrogant.

Mr CHEESEMAN—You mentioned a little earlier that if you input junk data into any model then you are going to get junk out.

Prof. Larson—Yes.

Mr CHEESEMAN—Currently, are there areas where we should or could dramatically improve the quality of data that is being capturing and putting into whatever models are being used? From your observations, have we got adequate data capture on, for instance, sea temperature? Do we need to improve one or two of those areas so that we get better outcomes with whatever the model is that we use?

Prof. Larson—This is outside of my area of expertise, I have to say. In terms of data, more is better than less. That is certainly true. If you look at the Australian land mass, you will see that it is comparable to the lower 48 in the US. The number of your surface weather stations—I do not know precisely how many—as I recall, is in an order of magnitude fewer than in North America.

Again, I think in previous submissions some people have said that large areas of Australia's landscape are fairly uniform compared to parts of North America or Europe. I do not know how many weather stations you should have. I do not know how many buoys you should have out in the oceans. I would say that certainly more data is better than less, which is not a very profound statement.

I cannot really make any comments on quality. These data assimilation systems always have some kind of off-line quality control, which is what is on the data before it goes into the system. And then there is typically an online quality control element in them. I have worked on an online quality control system that was used by NASA. What you are trying to do there is work with the background forecast, say, your first shot from the model, and the observational data and then trying to rule out some odd data that might be anomalous or where you think that there is a sensor that is malfunctioning.

There are perils in that as well. For example, there was a large storm in 1999 that hit Britain and the data was there. There were some extreme low-pressure measurements offshore, upstream from the storm, and they were excluded by the online quality control. It was almost as though they were saying, 'Surely that low pressure can't be right.' The system we worked on was that if you have neighbouring measurements that are also agreeing, they would be walked in. There are all these pieces to the puzzle that you have try to put together, and I do not know if I have really given you an adequate answer there.

Mr BIDGOOD—I have a couple of questions—firstly, to do with cost; the other to do with structural arrangements. Firstly, how much does the UK model cost to set up?

Prof. Larson—How much does it cost to set up? Do you mean how much you would have to pay the UK Met office or the Hadley Centre, or do you mean in terms of human resources?

Mr BIDGOOD—You mentioned that as a model, which could obviously be used here.

Prof. Larson—I certainly have some experience with this.

Mr BIDGOOD—Do you know what the cost was in the UK? If we use that model here, how much will it cost to set up here? What will the cost to the Australian government be?

Prof. Larson—The cost will be significantly less than developing the code from scratch.

Mr BIDGOOD—Any idea how much?

Prof. Larson—I have no idea; I really could not tell you. I do know for a fact that two or three people—easily three—worked full time, with repeated trips to the UK, to get that model up and going on the NEC computers at HPCCC, which is the bureau's and CSIRO's computing centre down in Melbourne. This would have happened in 2007, I believe. It took considerable effort on a platform that is immediately supportable.

FRAN BAILEY—That is the basic platform that they keep upgrading.

Mr BIDGOOD—The main point of my question is the cost. I am particularly interested in the cost of things and the cost to set up. I also looked at what you said about the $40 million spent between the two departments: the NSF and the DOE. You said $40 million over nine years, which is about US$4 million per annum in a structural and shared arrangement. On the structural arrangement, I would like to know what Australian departments you see doing an arrangement like this. I am asking you to apply that example to Australia. As you look at the Australian structure, what departments do you see could couple together to share the cost?

Prof. Larson—This is one that I can give you good answers to.

Mr BIDGOOD—Good. And some costings possibly, or ballpark figures.

Prof. Larson—I do not know everybody's full-time employee rates. First of all, $4 million a year is the US Department of Energy funding for that interagency collaboration. NSF provides core funding to people at the National Centre for Atmospheric Research—they are the other part of the puzzle with CCSM; the other major player. That $4 million has been pretty constant over the past decade. What would the natural partners be in this? I would say that you have certainly identified them: the Bureau of Meteorology and the CSIRO—specifically CSIRO Marine and Atmospheric Research and BMRC, the research centre for the bureau. They have now formed this organisation called CAWCR.

FRAN BAILEY—Yes, you spoke to us about it.

Prof. Larson—Yes. There is a part of the puzzle, at least on the computational science front, that I still believe is missing. They do have some help from HPCCC, but I think there are other opportunities that are missing, so they probably should look to some place like CSIRO Mathematical and Information Sciences. At least on the intellectual side of the high-performance computing landscape in this country, rather than the hardware side, there are some individual people at universities who probably could contribute quite effectively to this, but I would say MIS at CSIRO is the first place I would think of. You might be able to engage some people there on the algorithms front, and for the rest of the people we could identify players at various universities around Australia. They will be spread here and there in mathematics departments or whatever.

Mr BIDGOOD—So you are saying that it would be reasonable for this committee to investigate structural linkages and get some cost benefits through sharing the research, the data and the computer modelling?

Prof. Larson—Yes. I think it would be hard to go wrong investing money in trying to engage researchers in this country in what I am broadly calling computational science, which is the new name for scientific computing. I do not think I ever defined it for you folks, but it combines computer science, applied mathematics, maybe a dash of software engineering and then some domain area science. Most people who identify themselves that way have skills in those areas.

Mr BIDGOOD—Chair, in the light of the information we have just received, we should consider asking people from these departments how they could work together to cost share to get the best benefit of the information and the analysis that we need. I think that is something that as a committee we need to consider in the light of what has just been said.

CHAIR—A good point.

FRAN BAILEY—One of the problems that we identified in our previous hearing was the lack of mathematical departments—

Prof. Larson—Oh, yes.

FRAN BAILEY—and you are speaking as an American.

Prof. Larson—I will augment this if you want—

FRAN BAILEY—Yes.

Prof. Larson—if you are looking for people to register a beef on that front.

Dr JENSEN—And on sciences generally.

Prof. Larson—I can think of two departments. I had meant to try to work this in, and thank you.

FRAN BAILEY—Here is your opportunity.

Prof. Larson—Two mathematics departments in this country have really gotten hammered. One is at James Cook University, up in Townsville. That would have happened probably around 2006. I think there were one or two forced retirements of fairly senior people. They were offered packages and probably thought, 'Hey, yes, this is less of a hassle than being there and getting squeezed.' I know that they went through some strife.

More significant was what happened to the University of Southern Queensland's mathematics department. One of Australia's great mathematical talents, Terry Tao—who is at UCLA, I might add—raised quite a ruckus over this, along with other mathematicians in this country. I lose track of time, but I think it happened in 2007 or 2008. The undergraduate program was effectively shut down there. I know, for example, that one of the great talents in that department, a full professor, just moved on to Adelaide. That, of course, was Tony Roberts, who is a very energetic mathematician. He does work in financial mathematics and dynamical systems and is also the editor of the electronic supplement of *ANZIAM Journal*, which is an open access journal. So I think that is a problem.

As I understand things here—and this is something I do not think we can fix today—university departments are funded primarily on student numbers, because there is not this sort of scope for freelancers showing up at a department and saying: 'Hey, this is my CV. If you hire me, I'll put in grant proposals; and let's see if I can support myself on soft money.' You will find a lot of university departments in the United States have people that we describe as having 'rolling tenure'. They just survive on packets of grant money year after year.

The way things like the ARC and other organisations work, you usually cannot get support for your own time unless you apply for a fellowship. That said, universities here tend to provide summer salary for people, so there are swings and roundabouts in all of this. What that means is that if a department is somehow unpopular—for example, because people look at it and say, ‘Mathematics, well that is hard and boring’; and I disagree with that completely—then its funding slowly evaporates. That is hurting the computer science departments right now in the wake of the dotcom bust. They are still recovering. I was talking to a fairly prominent Australian computer scientist at a conference I was at a few weeks ago and he said, ‘There will be no jobs anytime soon in computer science.’ Everybody is doing it tough.

FRAN BAILEY—And environmental science, now, is really so dependent on these skills.

Prof. Larson—That is the thing that worries me. You can train a lot of people who are deeply concerned about the environment, the climate and all of that, but, at the end of the day, they are going to have to have computational chops to build these kinds of systems and to do this kind of work. They are going to have to have the mathematical chops to do this kind of modelling. I worry about that.

CHAIR—It has become obvious listening to you speak today that it is all about the model. We are looking at the quality of our forecasting. We have heard evidence that talks about models, new models and transitions to new models. How confident can we be that we have the right model—that the CSIRO has the right model? Listening to you, the question of what the right model might be seems to be so transient. Maybe I have misunderstood you. I must confess I have had a bit of difficulty following all the technicality. Have we got the right model in this country? Feel free to speak frankly, freely and fearlessly, because we cannot make that determination.

Prof. Larson—I can speak frankly, fearlessly and from a position of imperfect knowledge. Given the fact that all of this is written down and I have to—

CHAIR—Live with the consequences of the written word. Okay, I will bear that in mind.

Prof. Larson—Yes, I can die poor and satisfied that I said my piece. What I would say is this: I think there is really an art to evaluating these numerical models and it is hard to say that one is better than others. There are some things that come out of them where you look at them and say, ‘Oh, there is something seriously wrong.’

I will annoy my American colleagues by pointing out a well-known defect in the Community Climate System Model. In the intertropical convergence zone in the atmosphere, very often, you get these Hadley cells. That model sometimes produces double Hadley cells. Instead of just one on each side of the equator, it will have a pair on each side of the equator. So that is something where the circulation is a little wrong.

There is still some debate about what the best skill score is for weather forecast models. I have my own views on that. I think that ones that use elements of information theory—I think that is also called a logarithmic scoring thing—are probably about the best thing going. I do not know what the bureau uses as its skill scoring mechanism. Forecast skill is about taking your forecast and then looking at an analysis later for the time of that forecast and saying, ‘How well did we do?’ You can compute statistics on that.

Do we have the right model? I do not really feel qualified to say yes or no to that. I think what you will get, given the people you have, will still be a good system. They are very good at what they do. They care about what they do. So in that sense I do not think you need to worry about that. These are very highly qualified professionals and they are doing the best they can under the circumstances in which they are working. So I in no way question that.

CHAIR—That is fine. That is very useful.

FRAN BAILEY—Were there any other points that you wanted to make?

Prof. Larson—I want to emphasise that I really feel there is this missing element that still concerns me: I would like to see more of a collaboration between the computational science community, be it within CSIRO or the universities, and the people working on these models. And that has to be approached with caution. I am employed at the Department of Energy lab, and the way we do it was not easy to set up. We tried once in the nineties before I was working for these guys and what happened was that the DOE computational scientists, the Department of Energy lab guys, went off and did things to the atmosphere model, and NCAR went and did something else. We had a code fork and they never came back together. So it really took a second time around saying, ‘You guys have to find some way to work together.’ That means that the kind of academic researchers—the computational science people—have to be aware that they are supporting something as well; that it is not the sort of thing like, ‘Ah, yes, I see you have square pegs but really what you want is something that will fit this round hole that I have developed.’ So it is the communications thing that is really the challenge with these kinds of collaborations.

CHAIR—Thank you very much.

Prof. Larson—Thank you for having me.

Resolved (on motion by **Dr Jensen**, seconded by **Mr Ramsey**):

That, pursuant to the power conferred by paragraph (o) of sessional order 28B, this committee authorises publication of the evidence given before it at public hearing this day.

Committee adjourned at 11.12 am