NOAA Advances and Activities in Climate Prediction

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Alfred Beeton, Acting Chief Scientist at the National Oceanic and Atmospheric Administration, presented an overview of NOAA activities and recent advances in the area of climate prediction.

It is truly a pleasure to have this opportunity to come here and meet with many old friends. I started my research on the Great Lakes in 1955, so it has been a long time. I go back as far as Jim Bruce; he and I were junior people when we first met years and years ago. I have seen a lot of people here that I have not had a chance to visit with for a number of years, and it is great to see them all again.

I bring regrets to you from Jim Baker, the Administrator of the National Oceanic and Atmospheric Administration (NOAA). The Great Lakes now have greater visibility in Washington than they had in the past, consequently he looked forward to attending and discussing Great Lakes issues that are important to you and to NOAA. He was unable to attend because we are dealing with our 1998 budget, which will begin October 1st. There are innumerable hearings coming up all the time, and at the last minute, Congress scheduled a hearing for today. Therefore he could not make this trip and said "Al, you had better go." So I lucked out for a change!

The National Oceanic and Atmospheric Administration is a diverse agency, with many different facets, responsibilities, and obligations. NOAA was formed some twenty years ago, in response to the Stratton Commission Report, which recommended that ocean science, ocean operations, weather service, and related agencies be combined as one large agency. Consequently, NOAA houses the National Weather Service (NWS), National Marine Fisheries Service (NMFS), National Ocean Service (NOS), National Environmental Satellite, Data, and Information Service (NESDIS), and a unit called Ocean and Atmospheric Research (OAR). These are separate and distinct units under the umbrella of NOAA.

We are making some changes within NOAA, to refocus some of our programs. One of the challenges has been to get the research community within NOAA to work together more closely. With declining budgets and down-sizing we must work together as partners within the agency, as well as with academia, industry, and other agencies, to preserve our research agenda and move it ahead. Likely that is a concern to any administrator dealing with research.

Because of increasing recognition of the importance of coastal issues, NOAA will focus over the next four years on NOS. NOAA intends to refocus NOS to emphasize coastal issues. This may be of interest to the participants of this Symposium, because there have been proposals to include other parts of NOAA, such as the Sea Grant Programs, the National Undersea Research Program, and the Great Lakes Environmental Research Laboratory (GLERL) within that organization. The most likely to move would be GLERL, which would broaden the horizon of and increase responsibilities for that organization.

I wish to provide an overview of things being done at NOAA related to climate forecasting. Among the significant accomplishments have been major advances in the science of climate prediction. Climate system monitoring has improved dramatically because of better observations and the development of models that can predict tropical ocean variability up to a year in advance. This level of forecasting has several implications for the Great Lakes. Being able to predict such variability up to a year in advance will lead to being able to predict global climate regimes. With the basic research that set up this capability, we have a greatly improved understanding of mechanisms for climate variability, and especially the El Niño Southern Oscillation (ENSO). Also, NOAA has begun short-term climate predictions, based largely on a good understanding of the general circulation models (GCMs).

The outlook is that we will significantly increase the skill and utility of forecasts ranging from time scales that have primarily been in weeks to several seasons in the future. Currently, we are releasing some predictions for up to a year. New products will be developed to provide forecasts and warnings of severe short-term climate events, such as droughts and floods, and heat waves, and cold spells, which all have large economic and societal impacts. For example, during the heat wave we had just a few years ago in Chicago, many people lost their lives, more lives than are lost from tornadoes each year. We need to do a much better job on predictions. Much of the information lately has been centered on floods, such as the one on the Red River, because they have such a large impact and are so costly. If we could do a better job on predictions to allow mitigation measures to be taken, as much as 25% of the costs (some billions of dollars) of some of these natural disasters could be avoided.

The spatial and temporal scales we are concerned with range from short-term local weather to long-term regional climate regimes. When dealing with floods the time scale can be minutes to weeks. On the other hand, droughts usually span from months into decades. Looking at the atmospheric disturbances, tornadoes occur in minutes, thunderstorms and large fronts moving through have a scale of hours to days, hurricanes develop in days to weeks, and heat waves can be in the week to month scale. Events like ENSO extend from the scale of one to several years.

Developing an ability to predict climate has been aided significantly by a buoy system called TOGA, the Tropical Ocean Global Atmosphere Array, positioned across the Pacific Ocean. In addition, tide gauge stations are located around the Pacific Ocean, drifting buoys, volunteer observing ships, and expendable bathythermographs contribute to our understanding of thermal structure as well as sea surface temperatures.

When an El Niño develops, sea surface temperatures will increase, and barometric pressure will lower; these factors will affect climate conditions globally. Through 1997, temperatures have been increasing; the anomaly is up to 1.5^{o}C in the western Pacific, about 1^{o}C above what would be "normal" or usual. If you have a warm episode developing in the Pacific during the northern hemisphere winter periods, part of the southwestern Pacific region becomes very dry, because the storms that usually dump a lot of precipitation in this area have moved north and farther out to sea. Other parts of the world, like Indonesia and northern Australia, are dry, and the Gulf of Mexico region will have a wet and cool period. It will be warmer than usual in Alaska, and in southern Africa it will be dry and warm. It has been consistently shown that for the ENSO in the Northern Hemisphere during the summer period an expanding dry area in the southern part of the Caribbean and very warm areas in South America occur. On this

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basis, we are moving toward the ability to predict and forecast climate conditions on a global basis. Some countries are using this kind of information now for crop planning.

A cold episode essentially reverses the situations of the ENSO. As the Pacific air cools and the anomalies drop more than a degree, higher pressures occur over the Pacific, with the result that areas once quite dry are now wet. Storms are heavy over Indonesia and there is less rain over the Pacific. Summers are cool and wet, as opposed to dry during the warm period.

There are currently research projects underway on a global scale, to see to what extent we can expand our prediction ability. We can even do a better job by looking at other parts of the global ocean. Seventy percent of the globe is water, and that water is the determining factor for much of the climate that we see. Our global drifter array can accumulate limited information, about sea surface temperature, barometric pressure, and salinity. This system will lead to a possible expansion to a system similar to TOGA in other parts of the ocean.

Some climatologists feel confident enough to release long-term predictions. The National Weather Service, the National Centre for Environmental Predictions, and the Climate Prediction Centre released Volume 4, Number 4 for May 1997 to June 1998.

NOAA contributes to the global carbon cycle measurement network database in cooperation with other global agencies. Stations are positioned throughout the world. A few sampling locations have very high towers, and in some cases, aircraft are used to get CO_2 measurements. To obtain useful and valid data, we must have global partnerships and global cooperation.

Data from the NOAA Mauna Loa Observatory, American Samoa or the South Pole show similar long-term trends from in the 1970s and into 1994, although there are some slight short-term differences. These projects illustrate the benefits of global cooperation.

Questions/Comments

An unidentified questioner asked what triggers the ENSO phenomenon and where does the process initially start. A. Beeton explained in brief that the warming of the sea surface leads to additional evaporation and the development of a larger cloud cover, in turn affecting the distribution of moisture and temperature.

Interest in twelve monthly forecasts generated by the National Weather Service led to discussion about whether these might be extended into Canada. However, T. Croley (GLERL) mentioned that the Weather Service will not extend the maps into Canada because of Canadian forecasting responsibilities. During this discussion, A. Beeton mentioned the International Research Institute, which forecasts El Niño, will centralize functions associated with producing and disseminating forecast information.

J. Lacroix (Ministry of Public Security of Québec) asked what is the accuracy of the annual predictions. A. Beeton stated that short-term forecasts are quite good, but longer-term forecasts become less and less reliable the longer they try to predict. A user of such forecasts has to realize the limitations.