Testimony for the Hearing of the Senate Committee on Commerce, Science and Transportation on May 8, 2008 :

Improving the Capacity of U.S. Climate Modeling
for Decision-Makers and End-Users

My name is Edward Sarachik and I am Emeritus Professor of Atmospheric Science, Adjunct Professor of Oceanography, and Adjunct Professor of Applied Mathematics at the University of Washington. I am also Co-Director of the Center for Science in the Earth System (supported by NOAA) which contains two groups: a Climate Dynamics Group and a Climate Impacts Group. The Climate Dynamics Group studies the physical climate system relevant to the Pacific Northwest and the Climate Impacts Group examines the impacts of climate variability and change on the Pacific Northwest, and produces climate information products and derived predictions (e.g. streamflow forecasts) for a set of local stakeholders. The combined Center studies the general problem of making climate information useful to stakeholders in the Pacific Northwest. The range of our activities and a list of our stakeholders can be seen on our website: http://cses.washington.edu/.

I have also chaired two National Research Council committees: one that produced an National Academy Press report *Learning to Predict the Climate Variations Characteristic of El Niño* and the other, *Improving the Effectiveness of U.S. Climate Modeling*, both highly relevant to this hearing. I also chair the advisory group for the International Research Institute for Climate and Society at Columbia University which deals with the same problem as that of this hearing but in an international context.

What do stakeholders want?

They ask questions they would have asked in the absence of climate change: basically, some knowledge about the variability in the near future. Some examples from the Pacific Northwest:

- All stakeholders want to know next season's temperature and rainfall
- Power companies, city water utilities, and ski area operators want to know whether next winter's snowpack will be thick and long lasting or thin and early melting
- Fishers want to know if next season's coastal mixed layer will be deep or shallow, warm or cold
- The tourist industry wants to know if next summer will be clear or cloudy
- Insurance companies and state flood control agencies want to know if there be an unusual number of storms next winter, and the probability that there will be destructive windstorms

Then they ask questions about the very long term, say 50 years from now:

- Individuals and developers want to know if they should build near the ocean in the presence of rising sea level. Do they need a sea wall?
- Foresters want to know what species of tree should be planted in what climate regime. In particular, what will be the future range of temperature and precipitation?
- Wineries want to know if it will be too warm for specific grape varieties and whether or not irrigation will be needed
- Everybody wants to know if it will get too warm for salmon survival.

The progression of climate in a given small region is *not* what we are used to from global warming simulations. For temperature, the global average smoothes the record and the year to year variability is about half a degree F. Local temperature record has a year to year variability about 5°F. Since the year to year variability in a limited region is of order of the 50 year warming trend, constantly dealing with next year's climate over a long period of time gives practice about dealing with long term climate change since many (but not all) of the climate manifestations are similar.

The problem of producing climate information relevant to decisionmakers' needs then becomes

- Skillfully predicting next year's temperature and precipitation in a limited region

- Accurately simulating future variability of temperature and precipitation in a limited region.

Can existing climate models do this?

The answer is both yes and no.

YES. Next years climate can be predicted using current climate conditions, especially in the tropical oceans, as a starting point—this can only be done two or three seasons in advance. There are a number of groups in the world that produce such predictions and there exists a ocean observing system in the tropical Pacific that produce the current climate conditions. Estimates of the predictable part of seasonal temperature variability is about 30% for the Pacific Northwest and about 40% for the extreme Southeast part of the U.S. so that even if the prediction systems were perfect, only these percentages of future variations can be predicted. This makes predictions of next year's climate intrinsically probabilistic.

NO. Existing climate models used for the Intergovernmental Panel on Climate Change(IPCC) process are comprehensive global models and are designed for mitigation, on large space and time scales. The variability known to be important regionally (El Niño, Pacific Decadal Oscillation, North Atlantic Oscillation) in the current crop of models used in the IPCC has been neglected and is done poorly. The IPCC concentrates on global averages and freely admits that the smallest region for which the models are useful is the continental scale, about 3000 mile. On scales smaller than continental scale, the models are *not* useful and downscaling to smaller space scales by higher resolution models using the large global models as boundary conditions can not be expected to improve the situation. The output of existing models can be corrected to agree with past climate conditions and the correction used for future climates but there is no agreed upon methods for doing this.

What is the best path to producing useful regional climate information?

Ideally we want a comprehensive climate model (similar to the ones currently used for the IPCC process) but which does the known patterns of climate variability (El Niño, Pacific Decadal Oscillation, North American Oscillation, etc.) correctly and which is run globally at high resolution (20 miles rather than the current 100 miles).

This requires:

1. A set of model building institutions well resourced and interacting with the entire public and private research sectors,

2. Far more capable supercomputers. And, equally important, making these supercomputers and advanced models available to the entire research community.

Supercomputing is necessary, but it is not, by itself, sufficient. Also required is:

3. A research program to investigate the nature of climate variability (especially decadal variability) and assure the global climate models are capable of doing variability correctly and in the correct locations.

All research ultimately depends on having good observations—since we do not have a climate observing system, all future progress in climate research will depend on implementing one. So also required is:

4. A climate observing *system* producing regular and systematic climate observations.

Since the output of the climate observing system will never cover every point in the atmosphere, ocean and ice over the entire earth, the models themselves can be used for interpolation, just as current weather models are used to assimilate weather observations into consistent global fields. Therefore the last component required is

5. A monthly analysis of the climate system using the observations produced by the climate observing systems in 4. and the models developed in 1. and 2.

Because this hearing assumes it, it hardly necessary to add:

6. A distribution network for regional climate and resource information interacting directly with local stakeholders.

At least a major portion of 4., 5. and 6. could be accomplished by the establishment of a National Climate Service.

It may seem strange that starting with models for simulating local climate information we wound up with far more comprehensive requirements, but the ability to produce useful regional climate information to meet stakeholder needs depends on a healthy climate infrastructure. This is precisely the situation in that the ability to produce weather information for public and private use would be impossible without the weather infrastructure contained within the National Weather Service (NWS) *and* the research that is enabled by the observations and analyses emerging from the NWS. The ability to provide climate information to address end-user needs depends generally on the health of the climate infrastructure and the climate community.