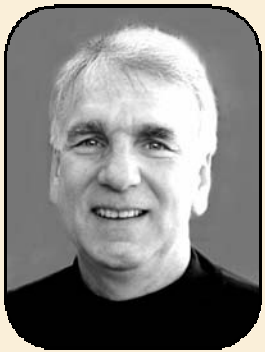
INTERVIEW

# What Climate Prediction Models Still Cannot Do: An Expert Speaks Out

*Dr. Robert Livezey questions ability to get regional climate trends right*



*by Michael A. Fortune*

Dr. Robert E. Livezey takes personal pride in two bold climate forecasts that the Climate Prediction Center put out. One was their confident prediction (six months in advance) that El Niño would cause unusual winter conditions in 1997–98, and the largely correct pattern of specific impacts in different parts of the country. "Our forecasts were unprecedented, and the scores for their accuracy set new records." The other was a bold prediction made during the coldest deep freeze in Washingtonian memory when the Potomac River froze over in December 1989. In front of top policy makers, he stood firm on their earlier forecast that the winter as a whole would be warm. Two months later, he was seen to be right.

But developing an effective office of climate services, his next job after he moved on from the Climate Prediction Center in 1999, was all too often an uphill effort. Finding qualified staff and appropriations was slow. Moreover, it was an effort to convince climate scientists that the National Weather Service (NWS) was serious in wanting to foster cutting-edge climate predictions for the US.

> "There should be no debate that this country has undergone a climate change."

Today, the NWS Climate Prediction Center, which produces the services his office now oversees, routinely makes predictions as far as one year in advance. Seasonal predic-

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tions even farther in advance are expected, although Livezey thinks that two years ahead may be a limit.

Many climate predictions are based on what meteorologists casually refer to as a "model," a simulation of the atmosphere in evolution, whether in the past or looking to the future. But Livezey points out that models have serious pitfalls in representing the real physics that goes on in the air in clouds – in rainfall, in the balance of energy and water, in chemical reactions. Predictions of just the atmosphere are difficult to "get right," but to get correct simulations of climate years into the future, requires joining atmospheric models with models of the ocean, of the ice, of the land surface, of chemical reactions and, perhaps, even of the biosphere – the world of living creatures. These "coupled models" are still experimental, with accuracy often untested.

When asked how confident he is that the current climate models can simulate climate trends and variations in the US, he said, "I have no confidence at all, especially if we want to use the models for future projections for the US. The models have to be able to reproduce the season-to-season and region-to-region differences in climate and the trends observed over the last 30 years or so. So far, the models have not."

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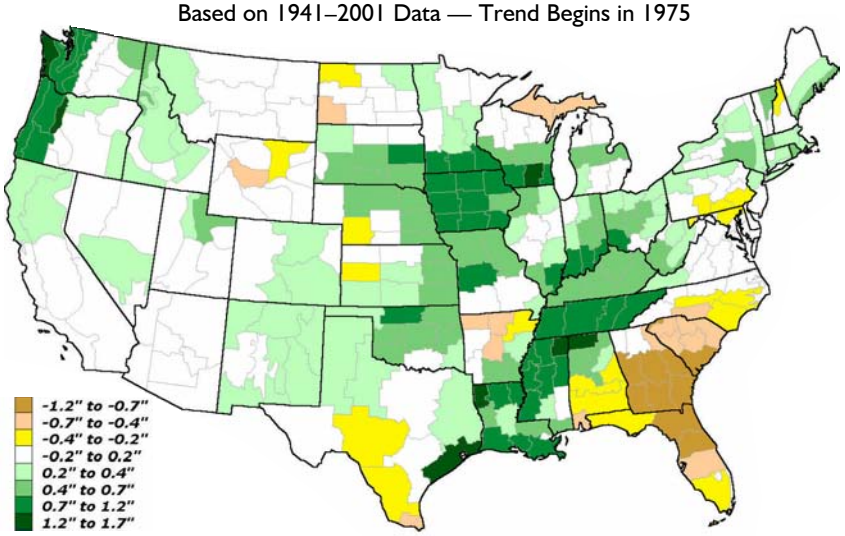
As an example, Livezey discusses the risk that the Great Plains might suffer a future drought as devastating as the dust bowl of the 1930s: before we can assess that risk, we have to be able to accurately simulate the region's past. But as far as he knows, the current models used to make such predictions fail to reproduce the trend toward wetter conditions in the last 25 years, especially in the growing season.

Livezey's research shows that, since 1976, the country has actually been getting wetter, not drier – especially in the Great Plains in the spring and summer and the Lower Mississippi in the fall. Figure 1 shows the regional trend of Spring rainfall over the last 26 years. The Mississippi valley has definitely become wetter, but even the Plains from Oklahoma to the Dakotas have become wetter, not drier. Also in Fig. 1, there has been drying in the Southeastern states, especially Florida and Georgia. That dry trend extends along the Gulf Coast for the summer period, but again, the Plains from Oklahoma north have had wetter summers. The US as a whole has been getting wetter at the rate of 0.6 inches (1.5 cm) of rainfall every ten years in all seasons.

Livezey asserts, "There should be no debate that this country has undergone a climate change." His work demonstrates that the nation as a whole has seen warming over the last 25 years, but the seasonal patterns are different, and the trends vary from region to region. The warming has primarily been in the winter, at least in the United States. Livezey and colleagues have updated their results to Spring 2002 and fitted the data since 1940 to a line with two parts: no trend before 1976 and an upward trend since 1976. We are pleased to share their latest results in these pages. Figure 2 strikingly depicts the national temperature change in each season. The winter has warmed 1°F per decade (2.5°F in the years since 1976) which far exceeds the change in other seasons – while the summer warming trend

**Figure 1. Precipitation Trend (inches per decade) — Spring**
Based on 1941–2001 Data — Trend Begins in 1975




*Dr. Robert E. Livezey is Chief of the Climate Services Division, Office of Climate, Water and Weather Services, National Weather Service; formerly Senior Scientist at the Climate Prediction Center. He is author of more than 50 refereed papers in climate journals, several book chapters, and more than 60 articles in non-refereed publications. All viewpoints are his own. Nothing in this article is an official statement of the National Weather Service or NOAA.*

is only one-fourth as much and the autumn has had no trend at all. Livezey adds that "east of the Rocky Mountains, there is no evidence yet of warmer summers in the US."

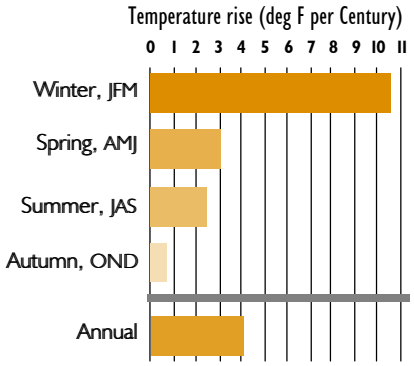
Figure 3 depicts the geography of the Winter temperature change: the nation as a whole has warmed in winter since 1976, but the Northern Plains near the border with Canada have warmed the most, 6°F during those years, while Alabama and east Texas warmed not at all. Also, the Western states have warmed in all seasons except autumn.

The autumn trend is different: there is either no temperature change, or a slight cooling, everywhere east of the Rockies and the Rio Grande. The summer pattern is similar, with little change in the East and Midwest over 30 years.

> "We don't have yet a credible regional climate forecast system."

"Global climate models", he says, "get the warming of the last 30 years right – the global annual average. *But they don't get the seasonal and regional details right.*" He sees no evidence that these models can make credible projections of a region's climate. A serious weakness is that no single model correctly reproduces the patterns of the three most important atmospheric oscillations that affect the climate variations over North America from month to month and year to year. These three phenomena are the El Niño/Southern Oscillation (ENSO); the North Atlantic Oscillation (NAO), and the Madden-Julian Oscillation (MJO). These phenomena control weather patterns, especially the differences from one continental region to another. Some

Figure 2. US Temperature Trend by Season




*Temperature trend based on 1941–2001 data with trend beginning in 1975. Winter = January, February, March, and so forth.*

models handle one or two of these phenomena well, but none (that he knows of) handles all three well.

"It's worse than that. Because the climate is changing . . . The rules we go by are changing." He explains that the basic state of the atmosphere will change, which can affect the nature and number of the planetary waves. In turn, these waves will affect weather patterns in new ways. "We may need different rules to forecast climate 50 years into the future. "

Livezey is saying that the computer models used to predict the future mean little if they do not accurately replicate the variations of the past. He explains that they do not yet even simulate properly the tropical patterns of rain and thunderstorms that are so important to North American weather, and concludes, "We have not completed Step One yet, to get the meteorology and oceanography right!"

What would it take to build his confidence in models as tools for climate prediction? Before we can take them seriously, he avers, developers must prove that their models can reproduce the trends over the last 30 years, especially for major regions of continents; that they correctly show the observed variation from one region to another; and most importantly, that they properly depict the three phenomena mentioned (El Niño, NAO, and MJO) – which for him means that the climatic variations from region to region, the changes through the seasons, and the trends since 1970 all have to be correct.

> "We have not completed Step One yet, to get the meteorology and oceanography right!"

**Figure 3. Temperature Trend (degrees F per decade) — Winter**
Based on 1941–2001 Data — Trend Begins in 1976