

A Joint Mission to Explore Critical Climate Questions

By Aaron Dalton

A new collaboration between UCLA and NASA's Jet Propulsion Laboratory is focusing on the complex issues that involve global climate change and its effect on regions and environments.

The lifeblood of Southern California is snow.

This land of beaches, valleys and palm trees depends on the snow pack in the mountain ranges of California for almost all of its water. The snow that falls in the Sierra Nevada, the Sierra Madre, the San Gabriel Mountains and other peaks melts into the water that allows Southern California to thrive.

But how might shifts in climate—such as weather change associated with global warming—affect the seasonal snow pack in California's mountains? Estimates vary widely.

“The California Climate Change Center released a report in 2006 suggesting that snow pack levels could decrease, possibly dropping from 30 to 90 percent over the next 50 years, depending on the amount of warming,” said Randall Friedl, chief scientist in the Earth Science and Technology Directorate of the Jet Propulsion Laboratory (JPL).

JPL, the Pasadena-based NASA laboratory, is renowned for its work on the design of unmanned spacecraft that explore the Solar System. But JPL also looks inward to global studies, and has launched Earth-orbiting satellites like CloudSat and CALIPSO to record data on the behavior of clouds and airborne particles in the atmosphere.

The scientists and engineers at JPL are masters at data collection—which comes back to the question of snowfall in California. The report by the California Climate Change Center packs an ominous punch if its worst-case scenario is correct, but with the currently available data, or lack thereof, that's a big “if.”

“If we had a 90 percent decrease in snowfall in the state over the next 50 years, the implications would be pretty dramatic,” said Friedl. “A lot of that uncertainty is due to how much warming will take place. Even with a given amount of warming, there are questions around how much less snowfall we will get. That in turn depends on elements like cloud cover and soil moisture.”

JPL develops findings about cloud cover and data collection, but the experts on building models to understand the implications of the data are based at UCLA. The university had been working with JPL for several years on isolated projects, but both organizations agreed last year to formalize the working relationship into a

The Southern California coast—a delicate interaction between urban and natural forces. What are the changing factors that affect weather and ecosystems? The Joint Institute for Regional Earth System Science and Engineering is starting new studies of these questions—especially how they affect California climate.

new collaborative organization, naming it the Joint Institute for Regional Earth System Science and Engineering, or JIFRESSE (www.jifresse.ucla.edu).

The institute officially opened on the UCLA campus last October. Since then, work has begun in earnest on developing a regional climate model encompassing land, ocean and the atmosphere to analyze data pouring in from the JPL satellites. Thus far, seven UCLA faculty members and nine JPL scientists have committed themselves to JIFRESSE's work. As funding for the Joint Institute grows, K.N. Liou, the director of the institute, hopes to have 15 UCLA researchers working alongside 15 JPL scientists in the next year.

"Regional climate change is our focus," said Liou, who is also a professor of atmospheric sciences and former chair of the Department of Atmospheric and Oceanic Sciences. "This is a topic of interest to both California and the nation. Our findings here can be applied to other regions—even to the Tibetan plateau."

JIFRESSE is in the process of recruiting more post-doctoral scholars and recently named JPL research associate Brian Kahn, who studied at UCLA, as a visiting researcher.

"Brian is a bridge between the two institutions," said Liou. "We intend to recruit other post-docs; by July of next year, we will have several more post-docs than we have now."

Complimentary Capabilities

When Friedl talks about JPL's motivation for working with UCLA to create JIFRESSE, he uses words like "momentum" and "vision." JPL and UCLA had worked together for years before forming the Joint Institute, but these earlier collaborations lacked the scale needed to obtain the best results.

"We thought about the way our two institutions' skills match," said Friedl. "JPL launches lots of satellites. We have ten Earth-looking satellites or instruments operating right now. Our main focus is on getting lots of data. UCLA, on

the other hand, looks at processes. The university has a lot of modeling capability."

JPL and Friedl recognized that the frontier in earth science involved connecting data from models in a way that could make progress on improving the credibility of the analysis.

Think of the weather forecast. Networks compete to attract viewers based on accurate predictions and showmanship. Each station has access to basically the same data—temperature, barometric pressure and so forth—so the difference can only be in the algorithms and models they use to analyze the data.

Whether the climate is rainy, snowing or clear depends on a mind-boggling range of variables that interact with each other in ways that scientists work to understand using computer models.

The only way to improve climate models is by using physically-based scientific methods: test, analyze and repeat.

"We are starting to create an environment in which we take data, format it correctly and inject it into models to test those models," said Liou. "The JIFRESSE researchers can run a model that tells us how the world should look, correct it using real data from satellites that know how the world does look, then use this new data to try to close the disparity between the model and reality."

Think Globally, Analyze Locally

Climate change overall, and global warming in particular, are now part of the public agenda more than ever before. And while many scientists agree that global average temperatures have been creeping upward, much uncertainty exists over how these global changes will be distributed in regions and microclimates around the planet. Friedl says that so far it's been difficult for earth science models to predict with a reasonable degree of certainty how specific areas like

Southern California will fare if the Earth warms.

For Californians and specifically for Los Angeles residents, not to mention government officials, obtaining more accurate forecasts is of paramount importance in making policy and lifestyle decisions. A 30 percent drop in the Sierra's snowpack in 2057 might hurt only skiers and cause occasional concerns about drought. A 90 percent decrease would be much more damaging.

The California Climate Change Center publishes its report every two years; Liou and Friedl are hoping that JIFRESSE will have the first results from its models in time to help the commission speak with greater confidence on the potential affects of climate change on the Southern California landscape.

To accomplish this goal, the UCLA and JPL researchers will have to untangle a web of interlinked climatic causes and effects. For example, conventional wisdom holds that if

the Earth warms, plants will tend to grow more vigorously. This sounds positive, except consider the fact that plants emit hydrocarbons, one of the precursor gases to ozone formation. Combine those hydrocarbons with the nitrogen oxide pouring out of automotive tailpipes and ozone is formed. Ozone works its way up in the stratosphere to block dangerous UV rays, but breathing it

regularly corrodes lung tissue and can cause infections.

So should Americans start wearing gas masks or ventilators? Not just yet.


"Most predictions say that air quality will worsen in a warmer climate if all things are equal, but this outcome is highly uncertain," said Friedl.

The problem with the real world—unlike models—is that all things are never equal. Variables change all the time, either independently of each other or because adjust-

ments in one variable have a ripple effect into another variable down the line.

Seeking to give planners and decision makers clues on what steps can be taken to keep us all from breathing ozone soup, the JIFRESSE team is developing new instruments to take air quality measurements across the Los Angeles Basin. Placed in a small laboratory on the top of Mount Wilson, the researchers will assess whether the measurements they take can improve air quality forecasts.

One of these instruments is an ozone spectrometer that measures light absorption along certain wavelengths to detect the presence of ozone. Another tool is an aerosol radiometer that measures the size and types of aerosols in the atmosphere. The radiometer being deployed on Mount Wilson is a next-generation version of one currently flying in orbit around the Earth aboard the MAISer (MultiAngle Imaging Spectroradiometer) satellite. Friedl described these radiometers as "advanced concept" devices that can analyze the way an aerosol polarizes light in order to deduce the shape (and thus the identity) of the aerosol particle.

Liou said that the researchers are making good progress on complex work. The earliest results from JIFRESSE's measurements and models will be released in the second quarter of 2008—a vital step in understanding the complex and critical questions about climate change that affect us all. 

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K.N. Liou, professor of atmospheric sciences and director of the Joint Institute for Regional Earth System Science and Engineering.

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