over 36 FLUXNET and CEOP flux-towers. At the same time, the modifications improved the timing of GSWP2 simulations (using HTESSEL and TESSEL schemes) of monthly river discharges, with an average of 33% root-mean-square-error reduction, evaluated on 12 large river basins in the Northern Hemisphere, with river-gauge observations made available from GRDC. For the newly added carbon dioxide parameterization (CTESSEL), we realized an average root-mean-square error reduction of 12% in the CTESSEL simulated CO_2 Net Ecosystem Exchange, evaluated with the same number of FLUXNET and CEOP sites, over the well-established CASA-GFED3 carbon cycle model.

These results together with in-situ verification of soil moisture, snow depth, and near-surface temperatures indicate a better match to observations for several aspects of the land-surface interaction with the other components of the Earth system model, and therefore qualify the land changes as biophysical modeling improvements.—Gianpaolo Balsamo (ECMWF), C. Albergel, M. Balzarolo, A. Beljaars, S. Boussetta, J. C. Calvet, E. Dutra, T. Kral, D. Papale, P. de Rosnay, and I. Sandu. *"Usefulness of Benchmarking for Global Land-surface Model Development," presented at the 26th Conference on Hydrology, 22–26 January 2012, New Orleans, Louisiana.*

Numerical and Physical Investigation of the Properties of Superfog

Superfog refers to the dense fog that sometimes forms in the presence of smoldering fires in wildlands. Unlike the more commonly occurring radiation or advection fogs, superfog is characterized by visibilities of less than 3 m. Occurring primarily in the southeastern United States, superfog has been implicated in several major multiple fatality highway accidents, including the most recent on 29 January 2012 on I-75 near Gainesville, Florida, in which 11 people died. Our research aims to understand the processes that govern the formation of superfog, and then translate this understanding into a model that land managers and government agencies can use to predict and thus prevent the formation of superfog.

Superfog forms when cold, humid air flows over a smoldering fire. It is hypothesized that the strong reduction in visibility is caused by the influx of particles and water vapor, produced by the fire, into the overlying cold air. The condensation of water vapor onto the high concentration of particles results in the size and density of water droplets required to form superfog with its observed low visibilities.

We constructed a wind tunnel in which fuel with varying composition and moisture content is burned in air that has its humidity and temperature controlled at inflow by a refrigeration system. Temperature and humidity measurements at several downwind locations monitor the evolution of the fog, and visibility is measured through the reduction in the intensity of light transmitted through the fog. Our experiments, which were supported by the U.S. Joint Fire Science Pro-

(Left) Light smoke forms from the pine needle fuel bed under ambient temperature of 41°F, 76% relative humidity, and 7% fuel moisture content. (Right) Superfog forms from the same pine needle fuel under ambient temperature of 43°F, 88% relative humidity, and 40% fuel moisture content.

gram, have identified combinations of environmental and fuel variables that lead to superfog visibilities.

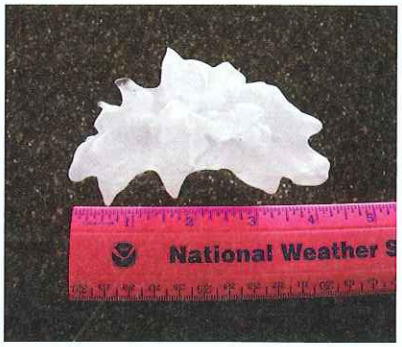
These experiments are guided by a model that transports heat, moisture, and particles from the smoldering fire into the ambient boundary layer, and then predicts the liquid water concentration in the resulting mixture. Visibility calculations indicate that the water concentrations give rise to superfog if the associated droplets are smaller than 2 μm with number concentrations over 10^5 per cm^3. We plan to evaluate our hypothesis with measurements of size distributions and number density of droplets in the laboratory superfog.

Once the comprehensive model has been evaluated with observations from the laboratory and the field, it will be parameterized into a form that can be readily used by land managers and government agencies to predict the formation of superfog. With the data and modeling tools developed in this research, these groups will be able to improve the current approach to prescribed burns while maintaining public safety.—Christian Bartolome (University of California, Riverside), H. Gonzalez, M. Princevac, A. Venkatram, D. R. Weise, G. Achtemeier, G. Aguilar, and S. Mahalingam. *"Numerical and Physical Investigation of the Properties of Superfog," presented at the 17th Conference on Air Pollution Meteorology with the A&WMA, 22–26 January 2012, New Orleans, Louisiana.*

ECHOES

"The rain here is not the same as it is elsewhere. It has a different flavor to it."

—Defense Secretary Leon Panetta on the rain in Hawaii. In March, Hawaii's famous sunny weather was drowned by thunderstorms, record hail, and the arrival of what weather officials say was the first tornado in four years to hit the islands. A 30-minute hailstorm over windward Oahu was unprecedented, according to Tom Birchard, senior meteorologist for the NWS in Honolulu. Not only is it highly unusual for hail to fall, but some stones measured in at over three inches—three times the size of the previous record hailstones in Hawaii. Governor Neil Abercrombie declared a disaster for Oahu and neighboring Kauai, due to nearly 100,000 gallons of a heavy mixture of storm water and untreated wastewater spilling into streams. (Source: The Associated Press)



Record-setting hail from the Hawaii supercell thunderstorm that hit Oahu on 9 Mar 2012.