aircraft's course in coordination with the other planes.

The five small airplanes in the experiment weighed 250 g each and measured a half meter in length. The researchers reported in a paper presented at a Conference on Embedded Network Sensor Systems in Australia that the planes flew autonomously in formation to different waypoints, where they circled awaiting further instructions.

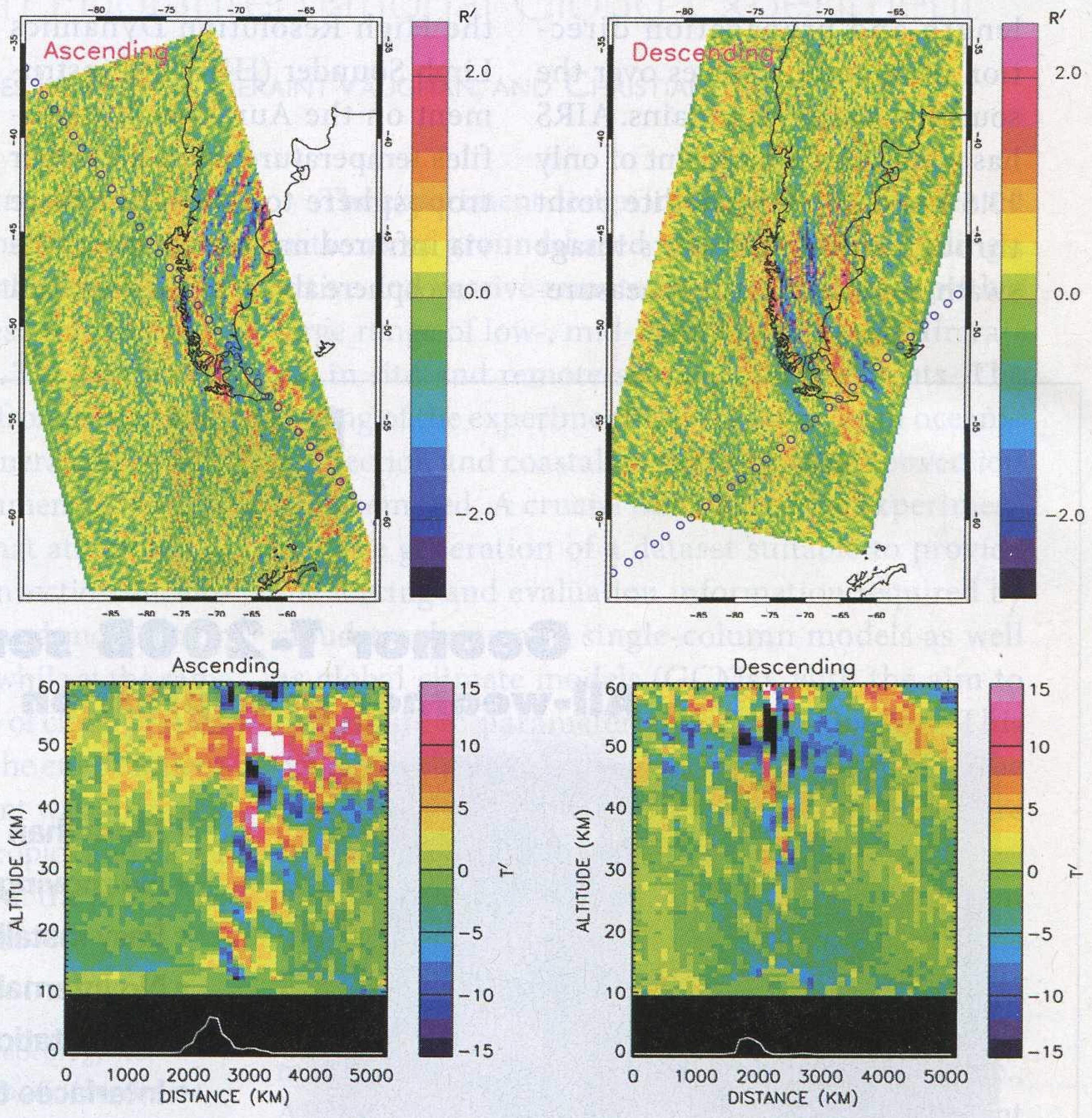
This year, plans are to fly 10 smaller versions of the plane to determine how well twice the number of aircraft will network. The new planes weigh just 40 g and measure 15 cm across. The new approach envisions dozens or even hundreds of mini robo-planes sporting sensors flocking toward a developing hurricane or mapping out a toxic cloud. A ground-based controller would send them out with general directions, and then the planes would make the necessary flying decisions to arrange themselves upon arrival.

Other scientists have flown multiple UAVs before, but this is the first time that a group of planes has coordinated its own movements in the air. (Source: NewScientistTech)

CONFERENCE NOTEBOOK

High-Resolution Satellite Observations of Mountain Waves

Although atmospheric mountain waves have small horizontal scales compared to the global scale, they nonetheless drive changes in the global circulation when they break or dissipate. This process of mountain-wave generation, dissipation, and mean-flow forcing is parameterized in nearly all modern global weather forecasting and climate models in use today. The parameterizations, however, are necessarily simplified. For example, wave amplitude and propagation direction must be specified to characterize the momentum flux, yet these are based on the characteristics of the unresolved topography, winds over the topography, and stability. Horizontal wavelength is also specified arbitrarily. Together these parameters determine the force that the unresolved mountain waves exert on the mean flow aloft in the model. Historical difficulty in observing all of the needed wave parameters (except during intensive field campaigns) allows large quantitative uncertainties to remain in the application of these parameterizations. Our research



Top panels show radiance anomalies R' (proportional to temperature anomalies) mapped in longitude/latitude over the Patagonian Andes on 8 May 2006 (left: ~1915 UTC; right: ~0545 UTC) as measured in the AIRS CO_2 emission channel at 667.8 cm^{-1} in units of mW m^{-2} cm sr^{-1}. The emission weighting function peaks near 40-km altitude. The bottom panels show profiles of temperature anomalies (K) measured by HIRDLS at the locations indicated by the open circle symbols in the top panels. The profiles are plotted as vertical cross sections as a function of horizontal distance (west-to-east, in km). The HIRDLS overpass times are (left panel) ~2030 UTC and (right panel) ~0245 UTC.

shows that more advanced satellite observations are now able to measure atmospheric temperature at high enough resolution to quantify many of the properties of mountain waves. But, to convert wave temperature amplitude to the needed momentum flux, the full three-dimensional structure of the wave must be observed.

Using the Atmospheric Infrared Sounder (AIRS) instrument on the *Aqua* satellite to image gravity wave temperature fluctuations in the stratosphere, we were able to determine the horizontal wavelength and propagation direction of mountain waves over the southern Andes Mountains. AIRS has a horizontal footprint of only 13.5 km at the subsatellite point through the center of its image swath, and the channel measurement integrates the emission in height, limiting the observation of waves to those with vertical wavelengths longer than 12 km. With additional knowledge of the vertical wavelength, we can further compute the wave temperature amplitudes from the radiance anomalies and calculate the vector momentum flux. Models then can identify observed wave events as mountain waves, thus permitting theoretical calculation of the vertical wavelength with knowledge of the background wind.

To complete the 3D analysis, the High Resolution Dynamics Limb Sounder (HIRDLS) instrument on the Aura satellite profiles temperature from the upper troposphere to the mesosphere via infrared measurements of the atmosphere above Earth's horizon (i.e. limb scanning) at locations overlapping AIRS on adjacent orbits. HIRDLS gives temperature at high vertical resolution of ~1.2 km between cloud tops and 60-km altitude. Temperature anomalies along these orbit segments show continuous propagation of mountain waves into the mesosphere. With HIRDLS we can observe the wave vertical wavelength, temperature amplitude, and a trace horizontal wavelength measured along the measurement path, allowing an upper-limit estimate of the true horizontal wavelength and a lower-limit estimate of the momentum flux.

Assuming the wave pattern is approximately stationary, we can combine the AIRS observation of the horizontal orientation with the HIRDLS measure of the vertical structure to determine the true horizontal wavenumber vector and vector momentum flux. Analysis of these high-resolution satellite observations gives new and stringent constraints on mountain wave parameterizations for global models.—M. Joan Alexander (Northwest Research Associates), H. Teitelbaum, S. Eckermann, J. Gille, J. Barnett, and C. Barnet. "*High Resolution Satellite Observations of Mountain Waves,*" *presented at the 14th Conference on Middle Atmosphere, 20–24 August 2007, Portland, Oregon.*