ARM Climate Research Facility Operations Update April 30, 2005

This biweekly report provides a brief summary of significant accomplishments and activities in the operations area of the ARM Climate Research Facility (ACRF).

New Microwave Radiometer Makes Water Vapor Measurements in the Cold a Snap

Scientific research increasingly shows evidence of climate change first appearing in the Arctic. Unfortunately, typical instruments for measuring water vapor – like the microwave radiometers used at the ACRF Southern Great Plains and Tropical Western Pacific locale – struggle to obtain accurate moisture readings in highly arid conditions like the Arctic. Using a DOE Small Business Innovative Research grant, ACRF pursued the development of a microwave radiometer that could operate near 183 GHz — a rate as much as 100 times more sensitive to water vapor than other ACRF microwave radiometers. In March, ACRF operations staff and developers from ProSensing deployed a prototype of the new 183 GHz microwave radiometer at the ACRF North Slope of Alaska site in Barrow. Although similar microwave radiometers have been demonstrated in Barrow for short periods, this prototype will operate through the 2005-2006 winter. This long-term deployment will permit refinements to the design based on actual Arctic conditions and will allow ARM scientists to have access to accurate water vapor measurements over an entire annual cycle.

Because of its very low water vapor content, a region of the infrared spectrum (around 20 µm) that is opaque in most places becomes transparent in the Arctic. That is, infrared energy (heat) that would normally be trapped and used to help regulate the Earth's global temperature, instead escapes into space. As the Arctic climate warms and causes the thin ocean ice pack to shrink, more open water will be exposed, thereby allowing more water vapor to reach the Arctic atmosphere. This, in effect, will "close the window" at 20 µm, producing yet more warming. The key to modeling this effect is an accurate measurement of the amount of water vapor in the Arctic atmosphere.

The 183 GHz radiometer, protected inside an insulated enclosure (inset), is installed on the roof of the primary instrument shelter at Barrow. To prevent snow from accumulating on the mylar window, a blower mounted beneath the radiometer directs air through a duct to a standard Y-shaped fitting mounted on top of the radiometer

The new radiometer actually measures at 183.31 GHz ±1, ±3, ±7, and ±14 GHz. The 183.31 ±1 GHz channel is useful when conditions are very cold and very dry, but as the Arctic winter gives way to spring and then summer, the amount of water

vapor increases and the ±1 GHz channel saturates (i.e., the signal no longer increases as the water vapor amount increases). The ±3 and ±7 GHz channels allow the radiometer to still provide useful water vapor data while the ±14 GHz channel permits the amount of liquid water in the thin Arctic clouds to be accurately determined.