Radiative Heating in Underexplored Bands Campaign, Phase II

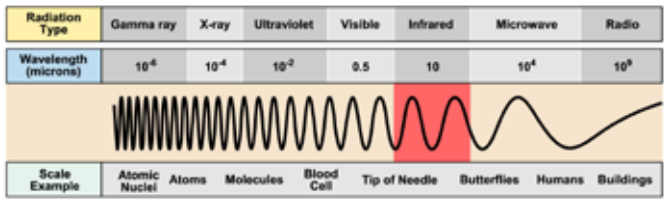
From August to October 2009, a team of researchers from the United States and Italy are gathering in Chile to obtain precious climate data from the far reaches of Earth's atmosphere. Sponsored by the U.S. Department of Energy's Atmospheric Radiation Measurement (ARM) Climate Research Facility, the second phase of the Radiative Heating in Underexplored Bands Campaign (RHUBC-II) takes place on Cerro Toco. This mountain rises from the Chajnantor Plateau in Chile's Atacama Desert at an altitude of more than 5300 meters (17,400 feet) above sea level.

The team is using a variety of highly sensitive instruments, called spectrometers, to measure the amount of infrared energy reaching the Earth's surface from the skies above the desert. In addition, more than a dozen other instruments are operating to obtain a record of the atmospheric conditions. Measurements from this combined instrument suite will allow scientists to improve the mathematical formulas used to calculate energy transfer in global climate models.

The arid atmosphere above the Chajnantor Plateau is ideal for obtaining measurements from the upper troposphere that are so important for modeling Earth's climate.

Science and Objectives

Scientifically useful measurements of radiation in many regions of the electromagnetic spectrum are normally very difficult to obtain from the Earth's surface. This is because water vapor in the atmosphere tends to obscure the signals. However, in the arid, low pressure conditions at Chajnantor—widely known as one of the driest places on Earth—the skies are considerably more transparent.



The Electromagnetic Spectrum. *All objects emit some amount of energy, or radiation, in the form of electromagnetic waves. The length of the waves corresponds to the amount of energy emitted; shorter wavelengths correspond to more energy and longer wavelengths to less energy. The entire range of this energy is referred to as the electromagnetic spectrum. From a climate perspective, the important portions—or bands—of this spectrum are the ultraviolet, visible, and infrared. During RHUBC-II, scientists are using spectrometers to measure the radiative energy in the infrared portion of this spectrum.*

Instruments deployed for RHUBC-II will obtain detailed measurements from these "opaque" water vapor absorption bands in the infrared and near-infrared (1-100 microns) regions of the spectrum. The key objectives of RHUBC-II are to:

- Obtain a data set of radiation measurements in extremely low water vapor conditions at nearly typical mid-tropospheric temperatures and pressures, plus ancillary data that specify the temperature, humidity and aerosol/cloud structure of the atmosphere.
- Use these data to improve detailed physical models that compute radiative transfer in the atmosphere, thereby reducing large uncertainties associated with water vapor absorption. Then, incorporate these updates into global climate models to improve the simulation of climate.

Research Instrumentation and Operations

Spectrometers – these highly sophisticated, narrow field-of-view optical instruments measure the properties of light over a specific portion of the electromagnetic spectrum. Onsite staff will operate these instruments daily.

- Atmospheric Emitted Radiance Interferometer (AERI), an infrared spectrometer covering the wavelength range from 3.3 to 18 microns, provided by the ARM Climate Research Facility
- Absolute Solar Transmittance Interferometer (ASTI), a solar tracking near-infrared spectrometer covering the range from 1 to 5 microns, provided by the University of Denver
- Far-Infrared Spectroscopy of the Troposphere (FIRST), a far-infrared spectrometer covering the range from 6.25 to 100 microns, provided by the National Aeronautics and Space Administration's Langley Research Center
- Radiation Explorer in the Far Infrared (REFIR), a far-infrared spectrometer covering the range from 10 to 100 microns, provided by the *Istituto di Fisica Applicata Carrara* (Institute of Applied Physics) in Florence, Italy
- Smithsonian Astrophysical Observatory Fourier Transform Spectrometer (SAO FTS), a sub-millimeter spectrometer covering the range from 86 to 1000 microns, provided by the Smithsonian Astrophysical Observatory in Cambridge, Massachusetts.

Other Instruments – this subset of ARM Climate Research Facility instruments obtain measurements of temperature, pressure, humidity, and incoming and outgoing radiative energy. These instruments operate continuously throughout the campaign.

- Millimeter-wave radiometer for measurements of water vapor
- Scanning microwave radiometer for measuring the homogeneity of the atmospheric temperature; instrument provided by the University of Cologne, Germany
- Lidar for measuring cloud and aerosol profiles
- Broadband radiometers for measurements of total direct and diffuse solar (0.3 to 4.0 microns) and infrared (4.0 to 50.0 microns) energy
- Meteorological station for temperature, humidity, wind, and pressure measurements
- Balloon-Borne Sounding System (BBSS), launched 3 to 5 times per day to record values of temperature, relative humidity, and pressure above the instrument suite.

Operations Platform – developed specifically for remote operations and tailored for the RHUBC-II high-altitude campaign, the Self Kontained Instrument Platform is a fully self-sufficient operations facility. It consists of several enclosures for personnel, instruments, a data system, and a workshop, plus oxygen enrichment equipment to provide relief for the staff as needed during the high-altitude operations.

This artist's rendering illustrates a general layout of the RHUBC-II instrument suite on Cerro Toco.

http://acrf-campaign.arm.gov/rhubcII/

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