AMISR BACKGROUNDER

NSF-Funded Radar Array Provides First Comprehensive View of the Upper Atmosphere

Advanced Modular Incoherent Scatter Radar (AMISR) is the first system to provide scientists with the technology necessary to collect critical data and study global climate trends from year to year. Scientists can now investigate the energy and momentum transfer among all layers of the Earth's upper atmosphere, accessing critical data on the complex physical processes that comprise the sun, magnetosphere, and ionosphere. Data collected from the high-latitude atmosphere and ionosphere provide an opportunity for early detection of climate-change phenomena. Space weather events, which can potentially damage and interrupt power grids and satellite and electronic communication, are also monitored.

AMISR measures 30 meters on a side and is made up of 4,096 antennas, giving a combined power of up to two megawatts. By phasing the signal coming from the individual antennas, the radar beam can be steered almost instantaneously from one position in the sky to another. This unique feature of AMISR is especially important for studying rapidly moving features of the atmosphere.

Collecting Incoherent Scatter Radar from an Array of Antennas

The term "incoherent scatter" refers to the way in which transmitted radio waves are reflected by ambient electrons in the atmosphere. Using high-powered transmitters and sensitive receivers, scientists can analyze the backscattered signals to determine the density, temperature, and velocity of electrons in the ionosphere over several hundreds of kilometers of altitude. Where other incoherent scatter radars use a single high-powered transmitter, AMISR uses an array of antennas, each of which is driven by a specially designed, solid-state, 500-watt transmitter.

AMISR can be operated remotely and also collect data from several directions at the same time. Currently, the radar is being used to study the aurora borealis and other dynamic features of the high-latitude ionosphere. By measuring the electric fields and particles at high latitudes, scientists can study how the magnetosphere, an immense comet-shaped structure around the Earth that extends tens of thousands of kilometers into space, changes in response to solar storms. This is important for predicting space weather, which can disrupt technical systems such as electric power distribution, navigation, communication, and aviation.

3D Views Provide Accurate and Comprehensive Space Weather Analysis

AMISR has enabled researchers to better understand how the magnetosphere and solar winds deposit energy into the Earth's atmosphere. By studying radar clouds and aurorae in three dimensions (two horizontal, one vertical), scientists can determine whether a change in the upper atmosphere at one location is caused by a real change in the overall system or simply the movement of a plasma cloud that already existed. (Did the plasma cloud form here or move from another location?) This is crucial for truly understanding this coupled system and to make predictions about future behavior.