Global Navigational Satellite Sounding (GNSS) of atmosphere and GNSS altimetry: prospects for geosciences

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With the emergence of large-scale geodetic ground networks, both regional and global, and affordable spaceborne GNSS scientific receivers, space geodetic techniques are finding diverse and unexpected new applications in many areas of Earth remote sensing. Basic GNSS navigation receivers are now all but indispensable to low earth orbiting missions of all kinds. Science applications of spaceborne GNSS today include centimeter-level precise orbit determination for gravity mapping, ocean altimetry, geocenter detection, and enhanced global geodesy; high resolution 3D imaging of the global ionosphere; occultation limb sounding to recover precise profiles of atmospheric refractivity, density, pressure, temperature, water vapor, and geopotential heights; and the experimental detection of GNSS ocean reflections for direct ocean altimetry and scatterometry. In the past five years there has been an explosion in the use of both ground and spaceborne geodetic receivers for direct sensing of the atmosphere to provide data for weather prediction and research in global climate change.

Atmospheric applications of space geodesy are generating increasing scientific interest. Dense GPS networks in Japan, North America, Scandinavia, Europe, and elsewhere are now routinely providing data for assimilation into daily weather forecasts. A constellation of six orbiting occultation receivers, such as the COSMIC mission to be launched in 2005, can measure atmospheric refractivity with a precision equivalent to 0.1 K in temperature within a climate region corresponding to 1/30 the earth's surface, with just a few weeks of data. Vertical resolution can reach below a hundred meters. This offers perhaps the most promising approach yet to detecting and discriminating among subtle forced climatic signals, which may amount to only a few tenths of a Kelvin average temperature change per decade.

More speculative, but having equally great potential, is the detection of GNSS reflections from the surface, primarily oceans and ice. This "bi-static" radar technique can be used, for example, to determine sea surface topography, significant wave height, surface winds, and possibly sea surface temperature and salinity, and could become valuable for monitoring the evolution of ice sheets. The technique is already practical from airborne platforms. With the prospect of substantially increased signal strength in the next decade from both GPS and Galileo, it may soon become a reality from space as well. This presentation will survey the techniques and Earth science applications of GNSS atmospheric sounding and bi-static radar, and will describe promising developments for the future.

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