JOINT SSC-SD-UNAVCO PROPOSAL: USE OF GLOBAL POSITIONING SYSTEM (GPS) PHASE MEASUREMENTS TO IMPROVE VERTICAL REFRACTIVITY PROFILES IN THE BOUNDARY LAYER

Randolph Ware
POB 3000, Boulder, CO 80307
303 497-8005, ware@ucar.edu
Award #N00014-97-1-0258

LONG TERM GOALS

Our long term goal is to provide the Navy with a stand alone shipboard system that utilizes GPS signals for refractivity profiling of the marine boundary layer.

OBJECTIVES

Our objective is to demonstrate a new method for refractivity profiling in the boundary layer for use in shipboard and land-based systems.

APPROACH

We propose to develop and demonstrate a new method for refractivity profiling in the boundary layer using GPS phase data. SSC-SD has previously demonstrated a GPS Sounder that uses GPS amplitude data to estimate refractivity profiles in the marine boundary layer (Anderson, 1994). We propose to work with SSC-SD to enhance the GPS Sounder by including GPS phase measurements. Both the amplitude and phase of GPS signals received at low elevation angles are sensitive to refractivity effects. Accurate sensing of GPS phase at elevation angles of 20 degrees or more has been demonstrated by UNAVCO scientists (Ware et al., 1997). The combination of amplitude and phase measurements will place stronger constraints on the inferred refractivity profiles, providing improved reliability for use in a variety of shipboard and land-based tactical assessment systems that rely on refractivity profile data.

RESULTS

We have observed with a Navy GPS receiver from San Diego. We analyzed these data using 5 minute clock solutions derived from the International GPS Service (IGS) global GPS tracking network. The results show phase delays as large as several meters for satellites at elevation angles of several degrees to the southwest above the ocean, and consistent 6 cm phase delays for two satellites at low angles and similar azimuths. The noise level for these measurements appears to be less than 1 cm. This suggests that we are sensing boundary layer refractivity structure. We will be analyzing these data with 30 sec clock solutions soon and expect to see more detailed structure of boundary layer

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refractivity. We have also developed methods for inverting GPS observations of two satellites from two sites that remove satellite and receiver clock errors. Application of this technique to data observed from San Diego and from an IGS site in Hawaii should allow 1 sec clock free observations of boundary layer phase delays. This will move us toward our goal of providing the Navy with a GPS stand alone marine boundary layer profiling system.

IMPACT

There are a variety of potential benefits to the Navy that will be provided by an enhanced GPS Sounder using phase and amplitude data to estimate improved refractivity profiles in the boundary layer. They include:

- Provides a passive, stand-alone, cost-effective method for shipboard and land-based boundary layer profiling and weather forecasting applications.
- Complements and strengthens ongoing SSC-SD GPS Sounder with no additional equipment required.
- Reduces reliance on high-cost, active radiosonde techniques which often cannot be used during EMCON.
- Leverages ~$15 B DoD investment in the GPS, ~$1 B U.S. commercial investment in GPS receiver equipment and technology development, and NASA and NSF's multi-$M R&D investment in GPS applications and technology development through UNAVCO.

TRANSITIONS

We are still in the demonstration phase. With the significant results obtained so far, we are planning to move forward with the demonstration of a prototype system. In addition, industry has recently developed advanced GPS tracking receivers and antennas with improved phase tracking performance at low elevation angles. Our results and the industry developments should enable transition to use in the Navy fleet after our demonstration is completed.

RELATED PROJECTS

We continue our collaboration with SSC-SD. We have proposed to demonstrate GPS tomography of tropospheric water vapor to the Department of Energy's Atmospheric Radiation Measurement program.

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RELEVANT WEB ADDRESSES

http://www.unavco.ucar.edu
http://www.unavco.ucar.edu/~rocken/realtime.html
http://pocc.gpsmet.ucar.edu