Turbulence Estimation Techniques for COSMIC Occultation Data

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The Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC) satellite constellation is an excellent source of GPS radio occultation data, already used extensively to generate global atmospheric temperature and pressure profiles. The use of these data for detecting atmospheric turbulence would further expand the understanding of the dynamics of the atmosphere and ionosphere and provide critical information to improve aircraft safety.

The theoretical effects of turbulence on the amplitude and phase of GPS signals have been discussed by Cornman, et. al. [1], among others. Turbulence introduces fluctuations in the index of refraction which modify the amplitude and phase of the received GPS signal. The effects of turbulence can be seen in the spectra of the received signal amplitude and phase. Parameters that affect the spectra are the turbulence extent, intensity, position, and length scale. The geometry of the occultation also impacts the frequency span of interest. Fortunately, the geometry of the LEO occultations and the sampling rates used on COSMIC afford the opportunity to observe the turbulence parameters of interest.

The models of amplitude and phase spectra due to turbulence, developed by Cornman et. al. [1], have been applied to the COSMIC occultation geometry to assess the possibility of retrieving turbulence parameters from GPS occultation measurements. Several retrieval methods based on these models have been developed to extract estimates of the combined turbulence extent and intensity, and the position of the turbulence along the ray path from the measured spectra. We will describe the estimation methods based on least squares, reduced-order statistics, and maximum likelihood estimators and present results for simulated and experimental data from COSMIC. 1. Cornman, L. B., R. Frehlich and E. Praskovskaya, 2004: The detection of upper level turbulence via GPS occultation methods. Proceedings of the First International Workshop on Occultations for Probing the Atmosphere and Climate. Springer-Verlag Press.