Measurement noise and how to deal with it in data processing

Tae-Kwon Wee and Ying-Hwa (Bill) Kuo

COSMIC Project Office
University Corporation for Atmospheric Research, Boulder, Colorado
wee@ucar.edu

Noise in GPS RO measurements, when not corrected or filtered out, negatively affects the quality of higher-level data products. In high altitudes oftentimes the noise is comparable with or exceeds signal in amplitude. This leads to significant loss of information or undesired alteration in the retrieved parameters (i.e., artifacts) if crude mitigation techniques are applied. Noise propagation in the data processing chain is complicated. This makes it challenging to properly characterize the uncertainty in the data products. For instance, seemingly white (temporally uncorrelated) phase noise can evolve into systematic bending angle errors due to spectral leakage or aliasing, especially at optically sensitive areas in the lower atmosphere. The structural uncertainty in the estimated bending angle therefore questions whether a deterministic inversion algorithm gives sufficient justification to trust its retrieval.

We will present a few typical examples of measurement noise/error and demonstrate their influence in a RO data processing. We will then describe our efforts to mitigate the noise. The methods include wavelet transform, singular spectrum analysis, and multitaper method. We will also show that stochastic inversion approaches (e.g., Monte Carlo) yield more stable and reliable retrievals than a deterministic algorithm does. The ensemble-based inversion also provides a measure of uncertainty in each data product that is useful for subsequent atmospheric data assimilation schemes.