Reconstruction of Wave-Driven Ionospheric Perturbations from Sparse Measurements

Vesperix Corporation, Arlington VA

Principal Investigator: Tom Wallace, PhD

Norbert Weiner Center for Harmonic Analysis and Applications, University of Maryland

Principal Investigator: Prof. Kasso Okoudjou

Research Areas and Motivation

- Physics behind ionospheric effects on geolocation are well known
  - Atmospheric gravity waves drive many effects (e.g. TIDs)
- Relevant scales are much finer than most ionospheric models (e.g GAIM)
  - Temporal scales 10^2 - 10^4 seconds
  - Spatial scales 100 - 1000 km
- Temporal and spatial measurement densities are often insufficient to reconstruct ionospheric behavior to the desired accuracy

Capabilities

- We are developing extensions of classical sampling theory for functions that obey wave equations
- A simple example:
  - Traveling ionospheric disturbances modeled as a vertical displacement of the effective reflection height:

$$h_{eff}(f) = h_0(f) + d(x, y, t)$$

  - This displacement obeys a wave equation determined by the underlying atmospheric gravity wave:

$$\left(\nabla^2 + c\frac{\partial^2}{\partial t^2}\right) d = S(x, y, t)$$

- Using knowledge of the wave equation can reduce the spatial and temporal sampling densities needed to reconstruct wave-driven ionospheric perturbations by factors of 2-3

Teaming Interests

- Access to experimental data for testing
  - HFGeo Phase 1A performers
  - Other HF SIGINT organizations
- Integration with fine-scale ionospheric models
  - Coordinate registration models for OTH radar
  - TEC-based tomographic reconstructions

Contact Information

Tom Wallace

Vesperix Corporation

Email: tom.wallace@vesperix.com

Phone: (703) 224-4422

Website: www.vesperix.com