GEOSTATIONARY HYPERSPECTRAL IMAGING AND SOUNDING: A REVOLUTIONARY BREAKTHROUGH IN SATELLITE DERIVED CLOUD MOTION VECTORS

James F.W. Purdom

Senior Research Scientist, Cooperative Institute for Research in the Atmosphere,
Colorado State University, Fort Collins, Colorado

ABSTRACT

The United States of America's future geostationary satellite series, GOES-R, is expected to be a geostationary constellation whose major meteorological observing instruments are an Advanced Baseline Imager (ABI) with up to 16 channels, and a Hyperspectral Environmental Suite (HES) that is comprised of a hyperspectral imager operating in the 0.4 to 1 micron range (HES-VIS/NIR) and an atmospheric sounder operating across the 4-15 micron portion of the spectrum (HES-IR). This talk will address the advantages of using high spatial resolution hyperspectral data in the 0.4 to 1 micron range, along with information from the ABI and HES-IR, for deriving exceptionally high quality, high-resolution cloud motion vectors.

The value of satellite borne multi-channel imagers and sounders are well recognized for analyzing a variety of atmospheric and surface phenomena. Based on experience from current previous generations of geostationary satellites, rapid interval imagery updates have proven valuable for nowcasting, cloud motion vector determination and providing opportunities for cloud free fields of view for surface related product generation. Yet, as valuable as information from those instruments are, there lies on the horizon the promise of new geostationary instrumentation that will revolutionize geostationary satellite applications: the high spatial and temporal resolution hyperspectral imager and sounder. Of particular interest is the GOES-R HES-VIS/NIR with a spatial resolution on the order of 100 to 150 meters operating at 10 nanometer spectral resolution across the 0.4 to 1.0 micron range across a domain of perhaps 100x100 kilometers or greater and capable of being refreshed at 5 to 10 times per minute.

Hyperspectral imagery has historically focused on land surface and ocean applications; however, it has valuable potential for atmospheric related applications, especially when employed as part of a geostationary constellation (affording stereo viewing). For example, hyperspectral information in the 0.4 to 1 micron band can be used for applications that rely on scattering such as haze, smoke, dust and aerosols, studies of cloud (especially in conjunction with an ABI) and very importantly determination of total column water vapor. For atmospheric motion determinations, high-resolution views of water vapor in the pre-convective environment (as can be determined form a combined HES suite) would be invaluable. After clouds begin to form, using HES-VIS/NIR can be used to monitor the growth of the boundary layer (w'), determine shear in the cumulus layer (u',v'), as well as detailed u and v measurements in regions where cloud updraft no longer effects cloud motion because of momentum transfer from one level to another. The ability to view in very high resolution at different angles (multiple geo-views) will allow for derivation of u, v, u', v' and w') in exceptionally complex situations – frontal regions, areas of squall line formation, hurricanes and hyper-baroclinic zones. This paper will address those possibilities and will use existing satellite data to demonstrate certain aspects of those capabilities.