University of Wisconsin Space Science and Engineering Center (SSEC)
FY10 GEO-CAPE Science Working Group Activities
Final Report

SSAI Task Order 1-013
Subcontract Agreement 2616-08-062

Period of Performance:
January 1, 2010 through October 31, 2010
(with no-cost extension through January 31, 2011)

The primary focus of the research tasks summarized here is directed to the GEO-CAPE Science Working Group suggested task for FY2010 on "Atmospheric Variability". The proposed activities were conducted by staff scientists at the University of Wisconsin (UW) Space Science and Engineering Center (SSEC) in collaboration with R. Bradley Pierce (NOAA/NESDIS) who is co-located with SSEC staff within the Cooperative Institute for Meteorological Satellite Studies (CIMSS) at the UW. The research uses existing WRF-CHEM high resolution simulations and GOES-15 1km 5 minute visible reflectances to statistically characterize the spatial variability of targeted atmospheric constituents and clouds over the spatial scales relevant to GEO-CAPE.

Summary of Accomplishments:

I) The variogram analysis developed by Jim Crawford (NASA/LaRC) has been adapted for applications to generalized gridded model output. The approach is outlined below:

1. Compute surface to 10km column abundance from WRF-CHEM output
2. Compute time averaged column abundance means
3. Compute 15 minute column abundance horizontal differences
    a. n=1,2,3,4 nearest neighbors for each gridpoint
4. Average within 14 unique distance bins ranging from 4km to 22.6km
5. Average over time with 15 minute sampling
6. Normalize variogram by time averaged column abundance means
7. Compute mean variograms for upper 95th/50th and lower 5th/50th percentiles of time averaged column abundance means

II) Variogram analyses were completed for WRF-CHEM CO, O3, NO2, SO2, and cloud optical thicknesses and were compared to TEXAQS aircraft variograms by Crawford. An example of the CO variogram analysis is shown in Figure 1. Results show that:

1. Upper 95th and Lower 5th percentiles of column CO distribution show largest normalized difference with 1.5-2% variation at 4km and 5.5-6% variation at 20km

2. Lower 5th and 50th percentiles of column O3 distribution show largest normalized difference with ~1% variation at 4km and 3-4% variation at 20km

3. Upper 95th percentiles of column NO2 distribution show largest normalized difference with 12% variation at 4km and 40% variation at 20km

4. Upper 95th and 50th percentiles of column SO2 distribution show largest normalized difference with 10-12% variation at 4km and 44-46% variation at 20km

5. Upper 95th and 50th percentiles of column cloud optical thickness distribution show largest normalized difference with 60-65% variation at 4km and 110-130% variation at 20km

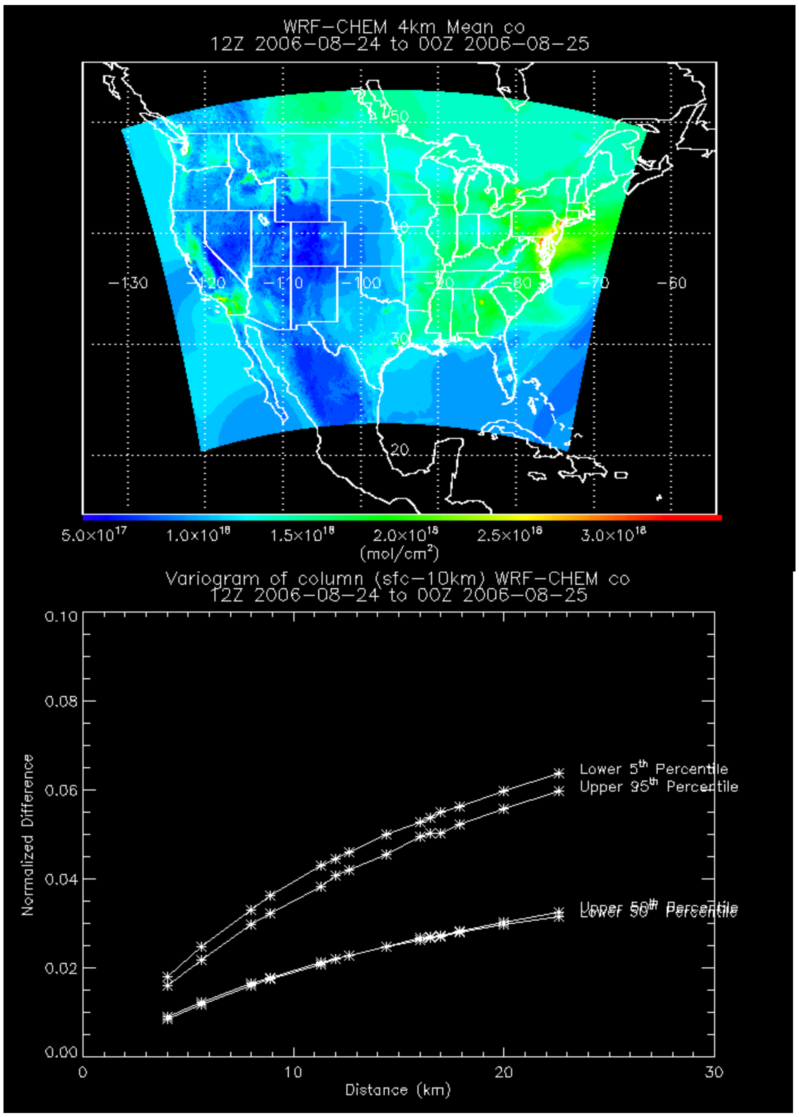

Figure 1: Mean WRF-CHEM 4x4km column CO distribution from 12Z 08/24/2006 to 00Z 08/25/2006 (upper) and normalized differences vs distance (km) for upper 95%, upper 50%, lower 50%, and lower 5% of mean CO distribution.

III) Utilized special observing strategies during the NOAA GOES-15 Science Test to collect high spatial (1km) and temporal (5 minutes) measurements for conducting cloud optical thickness and surface reflectance variogram analysis.

1. NOAA conducted special GOES-15 5-minute scans over CONUS (C1CON) in support of NASA GEO-CAPE Science Working Group cloud sampling studies during August 11-13, 2010. A full diurnal cycle (daytime) is available for August 12, 2010.

2. GOES-15 COT retrievals were performed for each of the 5 minute scans using the Daytime Cloud Optical and Microphysical Properties (DCOMP) algorithm and 0.6 and 3.9 micron radiances. The DCOMP algorithm was developed under the GOES-R Advanced Baseline Imager (ABI) Cloud Algorithm Working Group by Andrew Heidinger (NOAA/NESDIS/STAR).

3. 1km 5-minute GOES-15 cloud optical thickness (COT) retrievals and IDL procedures to read the GEOCAT hdf files have been made available to the GEO-CAPE aerosol working group for analysis:

   ftp://ftp.ssec.wisc.edu/pub/raqms/GEO-CAPE/GEOCAT/

4. Variogram analysis shows that the majority of the GOES-15 COT distribution (both lower 50th and upper 50th percentiles) show variation (as measured by normalized differences) of 5 times the mean value at 1km and 9 times the mean value at 2km. Going from 4km to 1km pixel reduces normalized variation by a factor of 3 for GOES-15 COT retrievals.

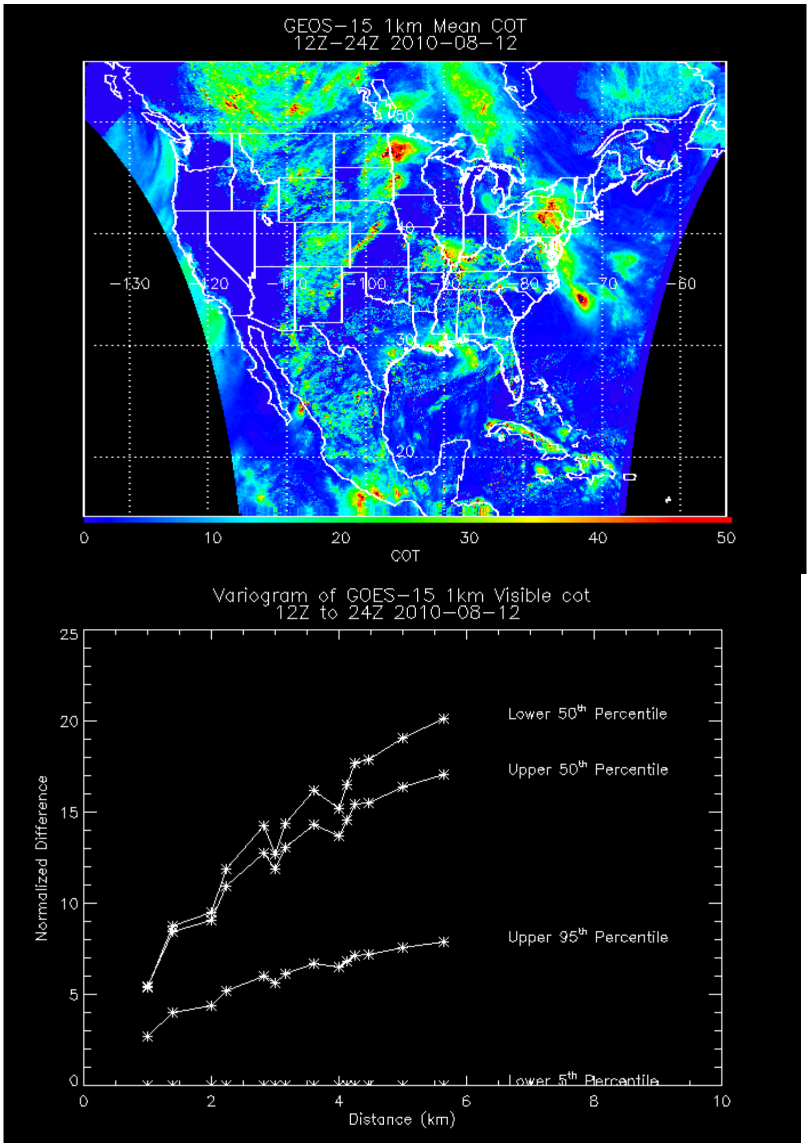

Figure 2: Mean GOES-15 1x1km Cloud Optical Thickness (COT) distribution from 12Z to 24Z on 08/12/2010 (upper) and normalized differences vs distance (km) for upper 95%, upper 50%, lower 50%, and lower 5% of mean COT distribution.