Title of Grant / Cooperative Agreement:	2013 GEO-CAPE Mission Pre-formulation Study Activity: GEO-CAPE Atmospheric OSSE Development and Analysis of July 2011 DISCOVER-AQ Period
Type of Report:	Summary of Research
Name of Principal Investigator:	Allen Lenzen
Period Covered by Report:	
Name and Address of recipient's institution:	University of Wisconsin System, 21 N park St Ste 6401, Madison, WI 53715
NASA Grant / Cooperative Agreement Number:	NNX13AN17G

Reference 14 CFR § 1260.28 Patent Rights *(abbreviated below)*
The Recipient shall include a list of any Subject Inventions required to be disclosed during the preceding year in the performance report, technical report, or renewal proposal. A complete list (or a negative statement) for the entire award period shall be included in the summary of research.

Subject inventions include any new process, machine, manufacture, or composition of matter, including software, and improvements to, or new applications of, existing processes, machines, manufactures, and compositions of matter, including software.

Have any Subject Inventions / New Technology Items resulted from work performed under this Grant / Cooperative Agreement?	No ◉	Yes ○
If yes a complete listing should be provided here: Details can be provided in the body of the Summary of Research report.		

Reference 14 CFR § 1260.27 Equipment and Other Property (abbreviated below)
A Final Inventory Report of Federally Owned Property, including equipment where title was taken by the Government, will be submitted by the Recipient no later than 60 days after the expiration date of the grant. Negative responses for Final Inventory Reports are required.

Is there any Federally Owned Property, either Government Furnished or Grantee Acquired, in the custody of the Recipient?	No ◉	Yes ○
If yes please attach a complete listing including information as set forth at § 1260.134(f)(1).		

Attach the Summary of Research text behind this cover sheet.

Reference 14 CFR § 1260.22 Technical publications and reports (December 2003)
Reports shall be in the English language, informal in nature, and ordinarily not exceed three pages (not counting bibliographies, abstracts, and lists of other media).

A Summary of Research (or Educational Activity Report in the case of Education Grants) is due within 90 days after the expiration date of the grant, regardless of whether or not support is continued under another grant. This report shall be a comprehensive summary of significant accomplishments during the duration of the grant.

Summary of Research

NASA Grant NNX13AN17G

2013 GEO-CAPE Mission Pre-formulation Study Activity: GEO-CAPE Atmospheric OSSE Development and Analysis of July 2011 DISCOVER-AQ Period

Period of Performance: 1 July 2013 to 31 December 2013

The CIMSS contribution to the 2013 GEO-CAPE Mission Pre-formulation Studies included continuation of Regional Observing System Simulation Experiment (OSSE) development initiated in FY12 and contributing to the initiation of Urban OSSE for GEO-CAPE multi-spectral ozone retrievals.

The 2013 GEO-CAPE OSSE activities included:

1) Generation of Regional and Urban nature atmosphere.
2) Development of surface reflectivity and emissivity data bases
3) Conducting forward radiative transfer calculations on a representative subset of the profiles.
4) Generation of multi-spectral (UV, VIS, IR) ozone retrievals from the subset of nature atmosphere radiances
5) Development of averaging kernel (AK) regressions based on the sub-set of the nature atmosphere retrievals
6) Generation of a full set of nature atmosphere retrievals using the AK regression applied to the original nature atmosphere profiles.

CIMSS 2013 contributions to these activities are summarized below.

1) Generation of Regional and Urban nature atmosphere profiles

CIMSS developed and delivered atmospheric temperature, water vapor, relative humidity, ozone (O3), nitrogen dioxide (NO2), formaldehyde (HCHO), sulfur dioxide (SO2), and carbon monoxide (CO) and speciated aerosol extinction profiles for 14 representative urban and rural sites to JPL for use as input for forward radiative transfer calculations. These profiles were obtained from the "nature" atmosphere that will be used as truth in the Regional OSSE experiment. The nature atmosphere was constructed for July 2011 by combining stratospheric temperature, water vapor, and ozone profiles from the NCEP Global Forecasting System (GFS) with tropospheric temperature, water vapor, and trace gas profiles from a nested NAM-CMAQ air quality simulation that used GFS ozone and meteorology for lateral boundary conditions. Stratospheric NO2, HCHO, SO2 and CO were obtained from the Real-time Air Quality Modeling System (RAQMS) [Pierce et al., 2007], which was also used to adjust upper tropospheric/lower stratospheric ozone. The aerosol extinction calculations used Community Modeling and Analysis System (CMAS) AEROVIS software which uses humidity dependent

aerosol mass to extinction regressions based on measurements from the Interagency Monitoring of Protected Visual Environments (IMPROVE) network. Figure 1 shows resulting ozone and aerosol profiles during July 2011 for Atlanta, GA. The Regional OSSE nature run shows realistic daily and diurnal variability in ozone with night-time titration and daytime production of ozone within the boundary layer (below 900mb) and significant day to day variability in the upper troposphere and lower stratosphere. Aerosol extinction is largest below 600mb with reasonable day to day variability and a clear indication of transport into the free troposphere associated with diurnal growth of the boundary layer and an overnight residual layer.

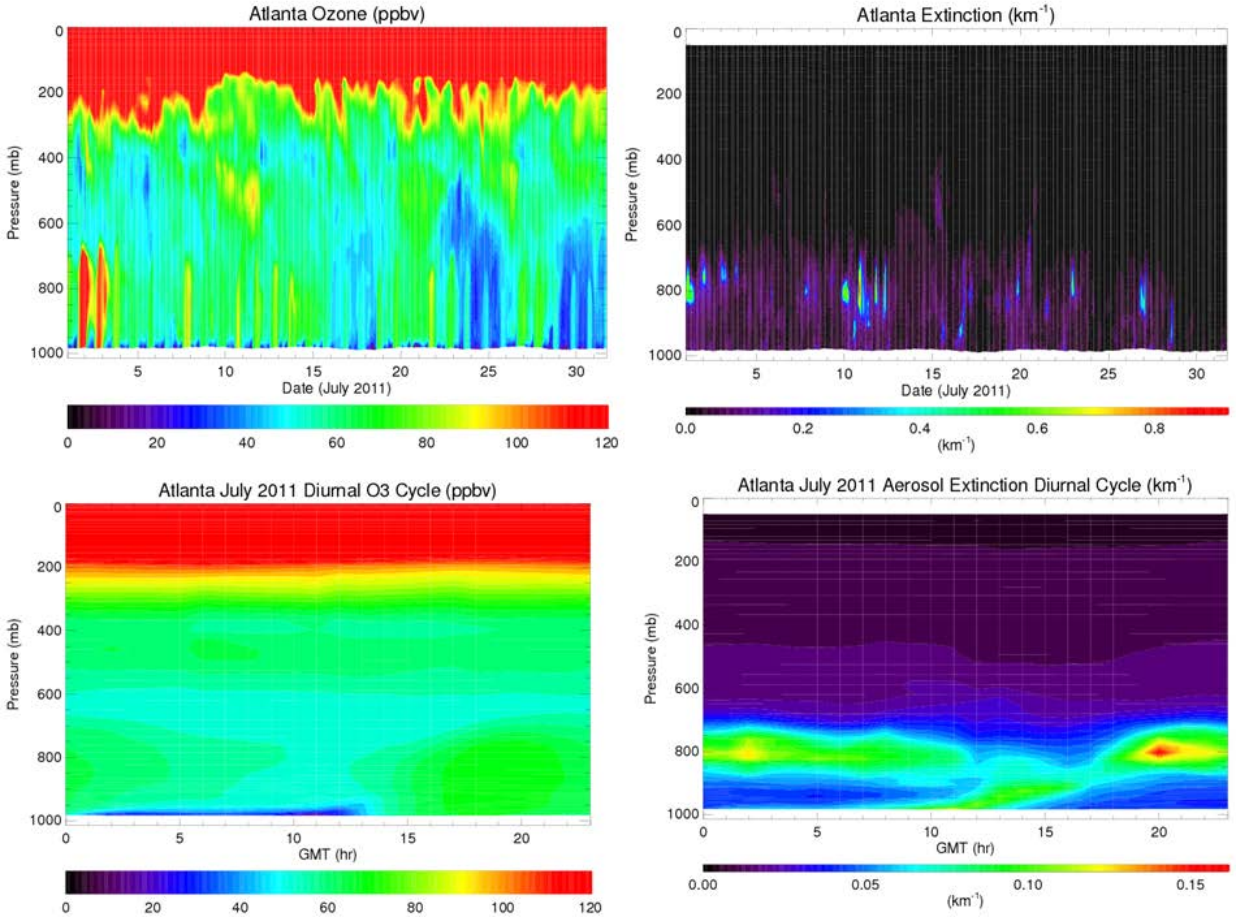

Figure 1: Daily variation of ozone (ppbv, upper left) and aerosol extinction (km^{-1}, upper right) for Atlanta, GA during July, 2011. Mean Atlanta diurnal variation of ozone (ppbv) and aerosol (km^{-1}) are shown in the lower left and lower right, respectively.

2) Development of surface reflectivity and emissivity data bases

A combined hyperspectral surface reflectivity/emissivity data base has been developed for the Regional OSSE. This data base utilizes a MODIS based visible and near infrared snow-free land surface Bidirectional Reflectance Distribution Function (BRDF) developed for the Radiative

Transfer for the Television Infrared Observation Satellite (TIROS) Operational Vertical Sounder (TOVS) (RTTOV) Forward Model [Vidot and Borbas, 2013], and infrared emissivity from the UW-Madison Baseline Fit Emissivity Database [Seemann et al, 2008], and a GOME based UV/VIS surface reflectance data base [Koelemeijer, 2003]. The spectral gap between the VIS/NIR reflectance and IR emissivity data bases is filled using dual regression fitting of spectra from the Version 2.0 of the ASTER spectral library [Baldridge et al, 2009]. Figure 2 shows the combined hyperspectral surface reflectivity for Atlanta, GA.

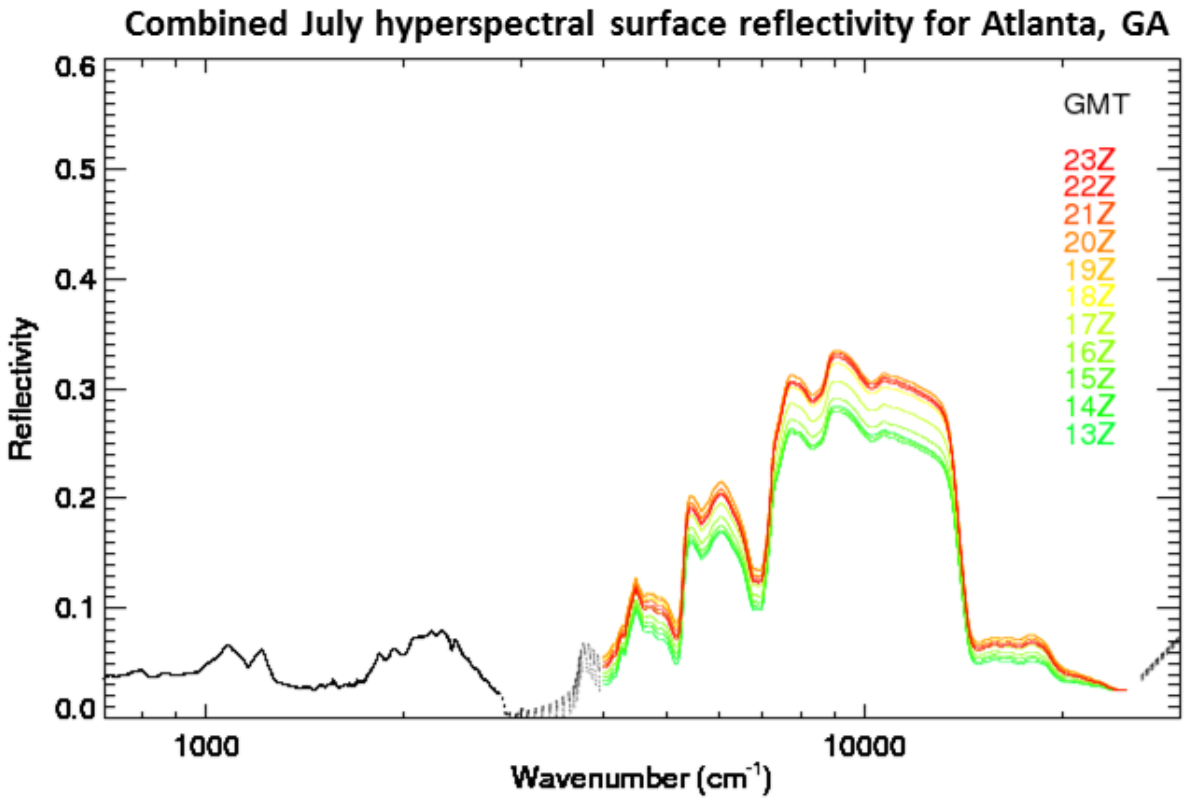

Figure 2: Combined July hyperspectral surface reflectivity for Atlanta, GA. The IR bands (700 to 2775 cm-1) are from the UW-Madison Baseline Fit (solid black). The VIS/NIR bands are based on solar zenith angle dependent BRDF and are colored by GMT. Dual regression fitting based on the ASTER spectral library data base is used to fill the spectral gap between 2775-4000 cm-1 (dashed). The Koelemeijer data base is used to extend into the UV (dashed).

3)&4) Conducting forward radiative transfer calculations and generation of multi-spectral (UV, VIS, IR) ozone retrievals on a representative subset of the profiles.

CIMSS has collaborated with scientists at JPL to port and benchmark the JPL forward radiative transfer code and multi-spectral ozone retrieval code onto the CIMSS firefly cluster so that these calculations can be completed in a timely manner.

References:

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