

## Executive Summary of Geo-CAPE Science Working Groups Meeting

St. Petersburg, FL

Wednesday – Friday, March 24-26, 2010

The meeting focused on preparing for mission design studies with goals of: endorsing draft Science Traceability Matrices (STMs) as starting points for mission design studies; identifying any needed instrument design studies; and specifying initial mission design studies and preparations. During this meeting, **draft Geo-CAPE Atmospheric and Ocean Color Science Traceability Matrices were endorsed by voice consensus as a sufficient, although not immutable, starting point for preliminary mission planning work.** As living documents, the STMs are expected to further evolve pending the outcome of ongoing science pre-formulation studies. By the close of the meeting, the Science Working Groups (SWG) and Mission Design Coordination Group agreed to conduct a sequence of 3 mission design studies beginning immediately. The studies are intended to scope mission implementation alternatives ranging from a threshold science mission feasible for an approximate 2017 launch to a baseline science mission feasible for launch by 2020. Priority topics for ongoing SWG studies were also identified.

The Atmospheric Science Questions that Geo-CAPE will address are:

1. What are the temporal and spatial variations of emissions of gases and aerosols that are important for air quality and climate?
2. How do physical, chemical, and dynamical processes determine tropospheric compositions and air quality over scales ranging from urban to continental, diurnally to seasonally?
3. How does air pollution drive climate forcing and how does climate change affect air quality on a continental scale?
4. How do we improve air quality forecasts and assessments for societal benefit?
5. How do regional and intercontinental transport affect local and regional air quality?
6. How do episodic events, such as wild fires, dust outbreaks, and volcanic eruptions, affect atmospheric composition and air quality?

The Ocean Color Science Questions that Geo-CAPE will address are:

1. How do short-term coastal and open ocean processes interact with and influence larger scale physical, biogeochemical and ecosystem dynamics?
2. How are variations in exchanges across the land-ocean interface related to changes within the watershed, and how do such exchanges influence coastal and open ocean biogeochemistry and ecosystem dynamics?
3. How do natural and anthropogenic changes including climate-related forcing impact coastal ecosystem biodiversity and productivity?
4. How do airborne-derived fluxes from precipitation, fog and episodic events such as fires, dust storms and volcanoes significantly affect the ecology and biogeochemistry of coastal and open ocean ecosystems?
5. How do episodic hazards, contaminant loadings, and alterations of habitats impact the biology and ecology of the coastal zone?

March 24<sup>th</sup> consisted of breakout sessions for the individual SWGs to review what has been accomplished during the past year and to discuss current work. Four Atmospheric sub-teams reported out. The Variability Sub-Team determined that new information on trace gases and aerosols can be found on all spatial scales. The Sensitivity/Simulation Sub-Team's next steps will focus on quantifying the sensitivity of the most promising wavelength combinations to resolve near-surface and free tropospheric O<sub>3</sub> when including clouds in the radiative transfer calculations. Reviewing the science drivers for separating the free troposphere from the lower troposphere is needed to better define capabilities required to meet the science objectives. The Aerosol Sub-Team proposed that Aerosol Extinction Optical Depth be the single threshold product, with additional baseline products of AAOD, UVAI and AOC. The STM sub-group worked to incorporate aerosol requirements, which emerged since the September 2009 workshop into an STM that could be agreed upon by all. The group concurred that Geo-CAPE *baseline* measurements will include O<sub>3</sub>, NO<sub>2</sub>, CO, SO<sub>2</sub>, HCHO, CH<sub>4</sub>, NH<sub>3</sub>, CHOCHO (4-km product at nadir); AOD, AAOD, AI, AOC and a cloud-detection capability (4-km product at nadir). *Threshold* measurements will include O<sub>3</sub>, NO<sub>2</sub>, CO, SO<sub>2</sub> (8-km product at nadir); and AOD (8-km product at nadir). In both baseline and threshold, CO and ozone are to be measured with two pieces of information in the troposphere, with sensitivity to the lowest 2 km. Achieving that resolution is likely to require better pixel resolution in order to avoid clouds. There is not yet consensus on how best to communicate both the engineering and science requirements for each product in the STM without eliminating viable instrument options.

In their breakout session, the Ocean Color SWG reviewed the results of the Instrument Design Study for "CEDI" held in Jan. 2010. For a spatial resolution of 375 m per pixel at nadir, major findings of the study were: baseline requirements can be met with 0.5 m aperture; 7.5 m<sup>3</sup> volume, 621 kg, 392 W; pointing of ~0.5 arc-sec. In the configuration studied, 11 scan boxes are needed to cover coastal US; 3 more to cover the Great Lakes and 5 for the Caribbean. If each scan could be extended E-W, only 5 boxes could cover coastal US, saving some time. The SWG discussed several areas for future consideration: 15-min scan time (<10 min would be better); pointing stability and image stabilization vs. spacecraft stabilization; need for a more capable processor; S-class electronics; prism vs. grating design; necessity of solar diffuser. Additional discussion topics included: cloud avoidance algorithms using near-real-time information as a means to preserve scan time, and NO<sub>2</sub> and O<sub>3</sub> measurement requirements (O<sub>3</sub>: 0.5 -3% error when using climatology, and only 0.3% error with real-time data; NO<sub>2</sub>: 3-5% error when using climatology, better to use real-time, 2 km should suffice, 4 km is too coarse due to clouds.)

The March 25 Plenary sessions highlighted glyoxal and IO in the marine boundary layer as one research question common to both communities. Discussion of cloud avoidance highlighted the potential limitation clouds pose to the observation of diurnal variations, and thus measurements are required every 1-2 hr at 1-2 km or finer spatial resolution. The cloud avoidance algorithm development, which is in progress for HypIRI, was also presented. The possibility of using the high spatial resolution (ocean color) instrument for aerosol measurements over land was briefly discussed.

In the Afternoon Atmosphere Breakout session, J. Fishman volunteered to lead the formulation of a white paper and a journal article on Geo-CAPE atmospheric measurements. In the context of interdisciplinary science, the Afternoon Ocean Color Breakout session questioned how far offshore the atmospheric SWG is planning to observe. Because image stability (jitter) is a significant concern, it was suggested that JPL, GSFC, and Korean engineers be approached for recommendations based on their experience with existing spacecraft. Another topic for near-term attention is a review of the current design for 2 km-resolution measurements for NO<sub>2</sub> (and potentially glyoxal) retrieval. It was suggested that the technology needed for cloud avoidance is available; we just need to decide on implementation. An outline for a white paper will be developed in the next 4-6 weeks, with a community-focused paper describing Geo-CAPE's ocean color goals to be developed in the next 3-6 months.

The March 26 Plenary began with a presentation on mission preformulation and formulation activities, and possible implementation pathways, followed by an interactive discussion of a strawman schedule (including studies, activities, reviews, and other milestones) for a 2020 launch of a complete Baseline Geo-CAPE mission. The majority of subsequent discussion time was spent identifying trade studies and other near-term needs for both SWGs. The need to plan for technology investments (e.g. hyperspectral UV-VIS-NIR in-water/above-water radiometers), field experiments for algorithm development, and other cal/val issues was addressed, particularly with regard to the ocean color sensor. There was much discussion regarding the level of specificity that was appropriate for the atmospheric sensors and how the solicitation and award process would proceed. There was agreement to pursue the following goals.

GOAL #1 : An Accelerated Threshold (minimum science) mission study, to include: conducting "brush-up" studies of the UV-vis spectrometer and TIR+NIR Gas Filter Correlation Radiometer (GFCR) instruments, gathering information about hosted payload options (one host to carry all, and also host each instrument on different platform), and conducting mission studies (hosted and dedicated).

GOAL #2: First Baseline (complete) mission study, to include: an instrument study of TIR only FTS and "brush-up" of NIR Tropospheric Infrared Mapping Spectrometer (TIMS), and a baseline mission study with 3 atmospheric instruments (all spectral regions) + ocean color imager.

GOAL #3: Second Baseline mission study, to include: conducting an instrument study of PanFTS to meet all atmospheric needs and a baseline mission study with PanFTS + ocean color imager.

The SWGs also identified other high-priority studies:

Ocean Priorities for Engineering Studies: 1) Pointing stability, 2) Spectral sampling for coastal ocean sensor, 3) Calibration / flat fielding, 4) Alternatives: other spectrometer designs; reorient optics to reduce mass (remove strongback) 5) Solar diffuser.

Atmospheric Priority Topics: 1) Document scientific basis for current requirements for product and pixel resolution, 2) Transition small sensitivity studies into combination with regional and global models, 3) Annotate the STM, 4) Publish variability and sensitivity studies, 5) Explore engineering possibilities for higher spatial resolution, 6) Explore possibility of aerosol science from high-resolution events imager.