GEO-CAPE ATMOSPHERES STM 09-09

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Today's Topics

- High level guidance for the activity
- The Atmosphere DRAFT STM
- Plans

Session Goal: Ratify/amend the draft aSTM

- General Guidance to STM Subteam
  - Basic approach is to maintain the standard of practice in measurement accuracy and precision for required measurements.
  - Significantly improve temporal sampling of required measurements.
  - Enable societal benefits.

- Develop the STM through Measurement Requirements
  - Provide mission's draft atmospheric science requirements to initiate pre-formulation studies and assess feasibility.
  - Be guided by the Decadal Survey description.
  - Avoid specifying instruments in the STM format.

Today's Objective

- Ratify the draft GEO-CAPE Atmosphere STM.
- Forward STM to Formulation Teams and iterate based on their feedback.
  - Draft high level guidance is needed to initiate pre-formulation activities.
  - Pre-formulation will feed back a feasibility assessment of the requirements and other necessary revisions that the SWG cannot identify.
  - There is additional work that can be done while pre-formulation starts.
  - Plan to iterate draft STM.

GEO-CAPE Atmosphere Science Questions in Priority Order

1. What are the emissions of gases and aerosols important for air quality and what are the processes controlling these emissions?
2. How do atmospheric transport, chemical evolution, and deposition determine tropospheric composition over scales ranging from urban to continental?
3. How do we improve air quality forecast and assessment models?
4. How do changes in air quality drive climate forcing on a continental scale?
5. How does intercontinental transport affect air quality?

Draft GEO-CAPE Atmospheres STM Priority 1: Emissions

Science Question	Measurement Objectives	Measurement Requirements				Measurement Rationale
What are the emissions of gases and aerosols important for air quality and what are the processes controlling these emissions?	Measure the following species with the temporal and spatial resolution needed to quantify the underlying emissions and understand emission processes: Priority 1 (most important): NO2, CO, SO2, HCHO, PM	Requirement	value	VCD (typical) molecules cm^{-2}	Precision	VCD = Vertical Column Density
		1. Tropospheric vertical spatial resolution	NO2, SO2, HCHO, PM	Tropospheric column		Current state of practice
			CO	Two pieces of information in the vertical with sensitivity to the boundary layer.		Separate the lower most troposphere from the free troposphere.
		2. Horizontal Spatial Resolution	8 x 8 km^2	--	--	Capture the scale of physical variability in the column.
		3. Land/Coastline measurement **NO2**	Every hour over land for SZA< 70	2.5×10^{15}	5×10^{14}	NO2 resolved peak is 20% greater than background. Distinguish background from enhanced/ polluted scenes.
		4. Land/Coastline measurement **CO**	Every hour over land for SZA< 70	2×10^{18}	2×10^{17}	Biomass burning events. Regional fossil fuel combustion. Oxidation of VOCs.
		5. Land/Coastline measurement **SO2**	3/day for SZA<50	1×10^{16}	5×10^{15}	Identify anthropogenic sources.
		6. Land/Coastline measurement **HCHO**	3-Hourly for SZA< 50	1.0×10^{16}	2.5×10^{15} 30-40% precision	Observe biogenic VOC emissions, expected to peak at midday
		7. Land/Coastline measurement **PM**	Hourly for SZA<70	AOD=0.3	0.1	Observe anthropogenic and natural emissions

Draft GEO-CAPE Atmospheres STM
Priority 1: Emissions, part 2

Science Question	Measurement Objectives	Measurement Requirements				Measurement Rationale
What are the emissions of gases and aerosols important for air quality and what are the processes controlling these emissions?	Measure the following species with the temporal and spatial resolution needed to quantify the underlying emissions and understand emission processes: Priority 2 (very important): CH4, NH3	Requirement	value	VCD (typical) molecules cm^{-2}	Precision	VCD= Vertical Column Density
		8. Land/Coastline measurement **CH4**	Twice daily	1.7×10^{19}	1% of column	Observe anthropogenic and natural sources
		8. Land/Coastline measurement **NH3**	Twice daily	2×10^{16}	5×10^{15}	Observe agricultural emissions
	Priority 3 (important): CH3OH, CHOCHO	10. Land/Coastline measurement **CH3OH**	Twice daily	2×10^{16}	5×10^{15}	Methanol is a tracer of continental biogenic emissions.
		11. Land/Coastline measurement **CHOCHO**	Twice daily	2×10^{14}	5×10^{13}	Glyoxal looks like an urban molecule in OMI data but a fire emission in SCIAMACHY data.
		12. Observing location: 95 West longitude		Primary observing domain: North America.		Provides optimal view of North America.

Draft GEO-CAPE Atmospheres STM Priority 2: Processes

Science Question	Measurement Objectives	Measurement Requirements		Measurement Rationale
How do atmospheric transport, chemical evolution, and deposition determine tropospheric composition over scales ranging from urban to continental?	2.1 Measure O3, CO, and PM to track pollution transport.	Measurement requirements for all constituents same as for Science Question 1 except: 1. Science Question 2 introduces a requirement for nighttime CO (no SZA limit on the hourly measurements).		
		2. Measure O3 (not covered by Science Question 1 (emissions)).	2.4 ×10^{16} cm^{-2} typical VCD 6 ×10^{15} cm^{-2} precision on VCD hourly for SZA<70	
	2.2 Measure NO2, SO2, O3, PM, to track chemical evolution downwind of emissions.	All constituents same as for Science Question 1 (emissions) except for ozone. Ozone as for Objective 2.1		
	2.3 Measure PM and NH3 to quantify deposition to land and coastal regions.	Same as for Science Question 1 (emissions).		

Draft GEO-CAPE Atmospheres STM Priority 3: Improve Models

Science Question	Measurement Objectives	Measurement Requirements	Measurement Rationale
How do we improve air quality forecast and assessment models?	3.1 Integrate the new knowledge gained from Science Questions 1 and 2 into improved representation of processes in air quality models.	Same as Q1, Q2	Directed toward research models for improved representation of processes, and toward operational models for demonstration purposes only.
	3.2 Combine the measurements with information from surface in situ networks and ground-based remote sensing to construct an improved observing system for air quality.	For space observations, same as Q1, Q2. For ground based data, quality control/protocols.	Integrated observing system necessary for science and applications.
	3.3 Measure O3, PM, and precursors with the spatial and temporal resolution needed to improve data assimilation for air quality forecasts.	Same as for Q1,Q2	Need to deliver ancillary data (averaging kernels and error statistics) with data products.
	3.4 Measure PM and SO2 with the spatial and temporal resolution needed to monitor large-scale air quality hazards (fires, dust events, volcanoes).	Daily data delivery.	Requirements for constituents that are monitored by GOES are allocated to GOES. No requirement for real time data delivery.

Draft GEO-CAPE Atmospheres STM Priority 4 AQ & Climate Change

Science Question	Measurement Objectives	Measurement Requirements	Measurement Rationale
How do changes in air quality drive climate forcing on a continental scale?	4.1 Measure the instantaneous radiative forcings associated with ozone and aerosols on the continental scale, and relate them quantitatively to anthropogenic and natural emissions of precursors.	Ozone as in SQ2. Aerosol as in SQ1. Precursors as in SQ1.	Relate forcing to location of emissions. Spatial and time variation of radiative forcing is important for aerosols, establishes link to precursors. Role of the upper trop in radiative balance. Need vertical resolution. Joiner et al used OMI (uv). Better use of non-absorbing aerosol features in the uv. CO2 observation allocated to OCO and ASCENDS.
	4.2 Observe pulses of methane emission from biogenic and anthropogenic releases.	Methane as in SQ1.	Inventory GHG to enable reductions. Note: GEO-CAPE focus is on CH4 and not on CO2.
	4.3 Quantify the continental outflows of ozone, CO, and aerosols.	Over water, coarser spatial and temporal resolution than over land. Longitudinal coverage to ~ 1000 km offshore.	Need to conduct evaluation of the spatial extent and time variability of pollution plumes over ocean. Use MODIS-like AOD for forcing over a range of wavelength (UV to NIR) Possible recirculation from the east is covered in Q5.1

Draft GEO-CAPE Atmospheres STM Priority 5 : Intercontinental Transport

Science Question	Measurement Objectives	Measurement Requirements		Measurement Rationale
How does inter-continental transport affect air quality?	5.1 Quantify the continental inflows of ozone, CO, and PM to determine the effects on surface air quality.	Observe over oceans to establish boundary conditions for North America.	Coarser spatial and temporal resolution than over land.	Consider primary observation domain = North America (includes Mexico) Dust from Africa is of interest. Pollution from Asia is of interest. Recirculation from Atlantic back to North America is of interest. Need to conduct evaluation of the spatial extent and time variability of pollution plumes over ocean.
	5.2 Better understand hemispheric transport of pollution through an integrated observing system including geostationary satellites over Europe and Asia together with LEO satellites and suborbital platforms.	Collaborate with Asian and European science working groups to share measurements.	Identify international coordination framework.	Outflow addressed in Q4.3 Linking concurrent observations from Asian and/or European located platforms permits process studies, for example ozone production in the eastern Pacific, not available from a single location. Linking concurrent observations by other satellites leverages observations from GEO-CAPE into a hemispheric observing system.

Open Questions

- Evaluate spatial and temporal variability of pollution plumes over ocean to set sampling and domain.
- Provide references in “Rationale” for current measurement precision and accuracy state of practice and for variability results.
- Additional…..

Next Steps

- Near term:
  - Revisions based on results of variability studies, detectability, and aerosol subteams and Workshop discussion.
  - Provide literature references for measurement requirements.
- Over the next year:
  - Fill in Science Data Products, Mission Requirements (spacecraft, ground data system, and operations requirements) “Columns to the right” based on formulation studies.
  - Chemical OSSEs .
  - Additional……