Air quality & Ocean color from space

GEO-CAPE

Decadal Survey White Paper 105: Earth's First Time-Resolved Mapping of Air Pollution from Space

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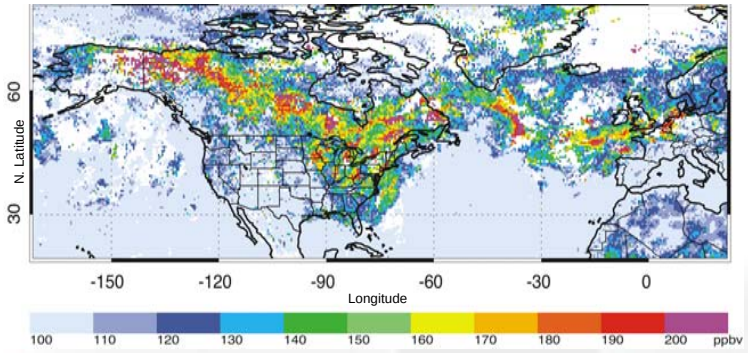
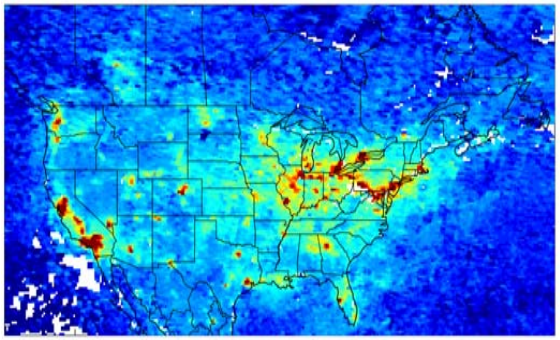
GeoTRACE is a mission concept to observe air pollution for the first time in the same way that weather is observed: *every hour, from space, across the continent.*

- GeoTRACE measures tropospheric columns of chemically linked constituents: O_3, aerosols, CO, HCHO, NO_2, and SO_2 every hour.
- Geostationary obit provides continuous access to the continental domain (5000 km x 5000 km – North America).
- System provides ~5 km horizontal spatial resolution.
- "Staring" enables high signal-to-noise observations.

Notional GeoTRACE payload features proven, robust measurement systems.		
Item	Value/Summary	
Sensor type	IR correlation radiometer	UV-visible spectrometer
Spectral bands/range	2.3 μm, 4.6 μm	300 nm -650 nm
Number of spectral channels	20	2 x 1024 [2]
Size, meters x meters x meters	0.7 × 0.4 × 0.5	0.5 × 0.4 × 0.5
Mass with contingency, kg and %	37 (20%)	65 (20%)
Power with contingency (nominal, peak, duty cycle, standby), watts and %	300 incl. 20% contingency for all 4 operating states	
Data rate with contingency, Mbps and %	50 including 66% contingency	
Ground and on-orbit calibration scheme	Ground radiometric, spectral, spatial, and polarization response cal	
	In-flight blackbody simulator, reflected solar, 170K cold patch, and space view	In-flight solar diffuser, Tungsten-halogen lamp (*WLS*), and Solar Fraunhofer lines for λ-calibration





Above: SCIAMACHY tropospheric NO_2 in August 2004, analyzed as part of the ICARTT field study linking surface, aircraft, and space-based measurements, and models in an Integrated Observing System. Courtesy Randall Martin, Dalhousie University.

Time-resolved air pollution measurements meet established requirements for space observations.

All observations are delivered with unprecedented 1 hour time resolution, at nominal 5 x 5 km^2 horizontal spatial resolution, with vertical resolution similar to existing low Earth orbit science observations of these constituents.

* indicates fraction of full scale radiance

Observation	Band	Accuracy	Sensitivity
Tropospheric O_3	Huggins (325-340 nm)	4 DU	* 2 x 10^{-3}
	Hartley (290-307nm)	4 DU	* 4 x 10^{-3}
Tropospheric NO_2	Visible (420-460 nm)	1×10^{15} cm^{-2}	* 2 × 10^{-3}
Cloud Height	Ring Effect/ Fraunhofer	50 hPa	n/a
Total/boundary layer CO	SWIR (2.3 μm)	15 ppbv	3 ×10^{-8} W m^{-2} sr^{-1}/cm^{-1}
Free troposphere CO	MWIR (4.67 μm)	15 ppbv	3 ×10^{-7} W m^{-2} sr^{-1}/cm^{-1}
Column HCHO	UV (335-360 nm)	2.5×10^{15} cm^{-2}	* 1 ×10^{-3}

Left: MOPITT free tropospheric CO mixing ratio for one week in July, 2004. Intense wildfires in Alaska produced plumes of pollution that can be traced across North America and the Atlantic Ocean. GeoTRACE will provide North American transport every hour. Courtesy D. Edwards, National Center for Atmospheric Research.

GeoTRACE **Addresses Exciting Earth Science and Applications Objectives.**	
Tropospheric Chemistry and Air Quality	
	Determine variability in air quality (near surface chemistry) due to local emissions and regional transport.
	Identify drivers of local high pollution events and improve their prediction.
	Assist in model evaluation by simultaneous measurements of ozone and precursors.
	Determine lightning NO_x emissions and their contribution to ozone production.
	Use hourly time samples to enable evaluation of chemical transport model representation of diurnal variations in tropospheric chemistry.
	Identify the roles of meteorological variability, increased emissions due to increased demand for household cooling, increased biogenic emissions due to changes in isoprene emissions, and changes in ozone export on the interannual variability of ozone pollution.
Transport of Air Pollutants	
	Facilitate investigations of pollution transport from near the surface to the free troposphere, and then allow upper troposphere plume tracking after convection has dissipated using the suite of measured constituents and CO profiling.
	Identify and monitor important pollution events in remote areas, such as wildfires, and continuously monitor fire growth and plume propagation.
	Evaluate model representation of synoptic transport/subgrid-scale parameterizations of boundary layer height, turbulent mixing, and convective venting.
Improve Emission Characterization and Inventories	
	Separate local primary pollution production from the contributions of transported and secondary pollution.
	Using inverse modeling, identify emissions at high time and space resolution, separating different processes and sources, including both fixed local sources (plants, factories), and diffuse sources (traffic, fires, domestic emissions, biogenic emissions).
	Contribute to improving EPA's National Emissions Inventory.

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