The View from Space

OVERVIEW

The atmospheric measurements group at the Smithsonian Astrophysical Observatory (SAO) leads the TEMPO satellite mission and heads the retrieval algorithm and calibration effort of the MethaneSAT satellite mission. Both missions will provide revolutionary measurements of several atmospheric gases and aerosols which are important for understanding climate change and its interactions with atmospheric composition, surface emissions and ecosystems, and underlying physical, chemical and biological processes.

This fellowship will be based in the Atomic and Molecular Physics Division at the Center for Astrophysics | Harvard & Smithsonian in Cambridge, MA, where the fellow will work with SAO scientists on using satellite data to explore scientific questions at the nexus of air quality and climate.

IMPORTANCE

The link between climate change and atmospheric greenhouse gases of anthropogenic origin has been well established and forms the basis of climate science, climate projections and mitigation strategies. Numerous studies have demonstrated the importance of understanding how the transformation of ecosystems and landscapes through climate change can affect the emissions and sinks of greenhouse gases and other pollutants, and vice versa. These transformations include, among others, the frequency and extent of wildfires, Arctic greening, permafrost thaw, changes in coastal wetlands, rapid urbanization, agricultural practices, and ecosystem stress under extreme atmospheric conditions. Space-based observations of trace gases involved in these landscape transformations, such as methane, nitrogen dioxide and formaldehyde, are sensitive tracers of the physical, chemical, and biological processes of ecosystems, providing pathways to understand climate feedbacks and climate change.

TEMPO

The Tropospheric Emissions: Monitoring of Pollution (TEMPO; tempo.si.edu) instrument was launched in April 2023. The instrument will measure trace gases and aerosols at unprecedented spatial and temporal scales over North America. TEMPO's measurement suite includes hourly measurements of tropospheric ozone, aerosols, ozone precursors (nitrogen dioxide and formaldehyde), sulfur dioxide, glyoxal, bromine monoxide and water vapor. In addition, TEMPO spectra can provide vegetation indices and gross primary productivity over land, solar induced fluorescence, and ocean chlorophyll. When TEMPO makes its first measurements in mid-2023, scientists will be able, for the first time, to quantify the diurnal cycle of emissions and atmospheric chemistry over North America from space. This revolutionary dataset will help improve emission inventories and air quality forecasting, track wildfire pollution, assist in monitoring population, agriculture, and ecosystem exposure to pollutants, provide measurements of neighborhood-level pollution inequities in support of environmental justice, and enable effective emission-control strategies.

MethaneSAT

MethaneSAT (www.methanesat.org) is a satellite mission funded by the Environmental Defense Fund, partnered with the New Zealand Space Agency, and is the United States' first dedicated satellite mission to measure methane emissions. MethaneSAT will be used to determine global methane concentrations and leakage rates from oil and gas fields as well as natural and agricultural sources. It will also simultaneously measure carbon dioxide and water vapor. Furthermore, MethaneSAT will produce actionable data to reduce methane emissions from the oil and gas industry by 70% by 2030. MethaneSAT is scheduled to launch in January 2024. SAO is leading the retrieval algorithm development and instrument calibration of the MethaneSAT mission.

POTENTIAL RESEARCH THEMES

Climate and air quality are intricately linked through numerous feedbacks, such as radiative forcing, atmospheric circulation, and tropospheric chemistry. Changes in specific physical processes (e.g., biomass burning, volcanic eruptions, lightening, dust storms, biogenic sources, soil emissions, evapotranspiration, and atmospheric rivers) have implications for both air quality and climate change.

The SAO welcomes projects from fellows that use satellite measurements to address topics related to climate and air quality in general. Possible areas of research include, but are not limited to, trace gas retrievals, data analysis and numerical modeling.

Possible broad themes that could be addressed by the fellow include:

1. What are the temporal and spatial variations of emissions of gases and aerosols important for air quality and climate?
2. How does air pollution drive climate forcing and how does climate change affect air quality on a continental scale?
3. How do various physical processes, such as those mentioned above, affect air quality and climate?

Proposals that enhance links with other Smithsonian units and exploit other Smithsonian datasets or activities (ForestGEO, MarineGEO or the Methane Working Group for example) in combination with satellite data are particularly welcome. Projects that strengthen the Smithsonian Institution's unique role in climate research are encouraged.

ADVISORS

The fellow will join the atmospheric measurements group at the SAO, which includes postdoctoral fellows, visiting graduate students and staff scientists. Scientists Gonzalo Gonzalez Abad, Caroline Nowlan, Xiong Liu, Huiqun Wang and Iouli Gordon are available to act as advisors.