The Evolving Role of Space-based Measurements in a Global Carbon Monitoring System

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Early flux inversion studies indicated that space-based observations of column-averaged dry-air mole fractions of carbon dioxide (X_{CO2}) with accuracies of 1 ppm on regional scales at monthly intervals could substantially improve our understanding of carbon dioxide (CO_2) sources and sinks. Recent products from the OCO-2 mission are meeting or exceeding this target. In spite of this progress, and that anticipated from the growing fleet of greenhouse gas (GHG) missions, improvements in measurement accuracy, precision, resolution, and coverage are still needed to deliver timely information about CO_2 sources and sinks on the scale of individual nations or to track subtle trends in the natural carbon cycle resulting from climate change. Spatially- and temporally-correlated X_{CO2} biases must be reduced to vanishingly-small values (<< 1 ppm) to enable accurate local to regional scale CO_2 flux inversions. Greater single-sounding precision is needed to quantify trends in emissions from localized sources such as mega cities and power plants. Higher spatial and temporal resolution is needed to isolate discrete sources and sinks and to track their variations over diurnal to seasonal time scales. Improved coverage is needed, especially at high northern latitudes of the winter hemisphere and in tropical regions covered by persistent, optically-thick clouds. Some of these needs will require improved space-based instruments, calibration techniques, X_{CO2} retrieval algorithms, validation capabilities, and flux inversion strategies. Others must be addressed by carefully coordinating the available space-based, aircraft, and ground-based sensors to produce a more effective GHG monitoring system. This presentation will summarize the progress and plans in these areas.

Figure 1. Currently operating GHG satellites: Greenhouse Gases Observing Satellite (GOSAT), OCO-2, TanSat, Sentinel-5p, FengYun 3D, and Gaofen-5.

Mission (Agency)	CO_2	CH_4	FOV	Orbit
ENVISAT SCIAMACHY (ESA)	•	•	30x60 km^2	SS LEO (10:30)
GOSAT TANSO-FTS (JAXA-NIES-MO	•	•	10km (d)	SS LEO (13:00)
OCO-2 (NASA)	•		1.25x2.25 km	SS LEO (13:00)
TanSat CDS (CAS-MOST-CMA)	•		2x2 km^2	SS LEO (13:30)
Sentinel 5P TROPOMI (ESA)		•	7x7 km^2	SS LEO (13:30)
Feng Yun 3D GAMI (CMA, NRSCC)	•	•	10 km (d)	SS LEO (14:00)
Gaofen 5 GMI (CNSA)	•	•	10.5 km (d)	SS LEO (10:30)
GOSAT-2 TANSO FTS (JAXA-NIES-M	•	•	9.7 (d)	SS LEO (13:00)
OCO-3 (NASA)	•		0.7x2.6 km^2	LEO (51.6° incl.)
MicroCarb (CNES)	•		4.5x9 km^2	SS LEO (13:30)
MERLIN (DLR-CNES)		•	0.135 km (w)	SS LEO (06:00/18:00)
GeoCarb (NASA)	•	•	3x6 km^2	GEO (85° West)
MetOp-SG Sentinel 5 (ESA)		•	7x7 km^2	SS LEO (09:30)

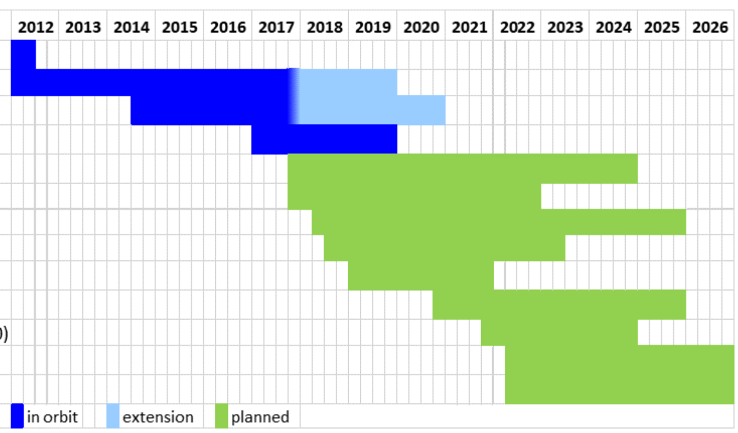

Figure 2. Past, present, and planned GHG satellites.