NASA's Carbon Cycle OSSE Initiative - Informing future space-based observing strategies through advanced modeling and data assimilation

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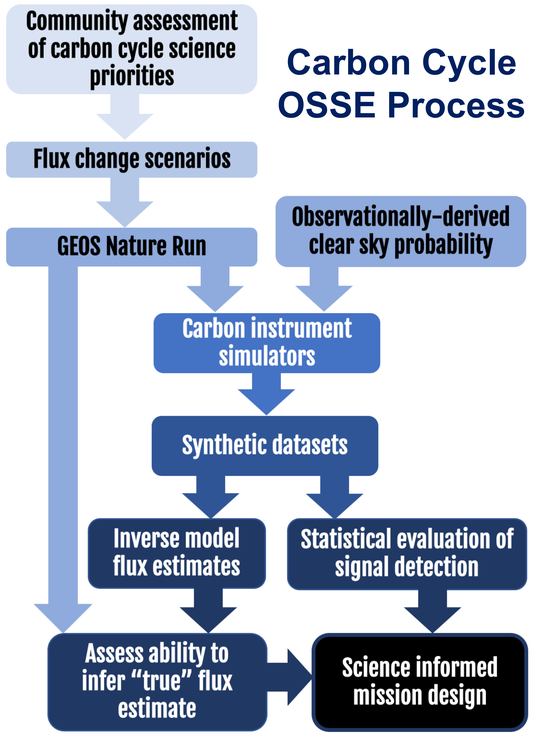
GMAO
Global Modeling & Assimilation Office

Motivation

Land and ocean carbon sinks absorb half of human CO_2 emissions. The fate of these sinks in a changing world is unknown, introducing large uncertainties in climate projections. Satellite measurements of atmospheric CO_2 are required to better understand the processes governing carbon uptake. Careful planning of future missions using Observing System Simulation Experiments (OSSEs) can help ensure that they meet the needs of the scientific and policy communities. NASA's Carbon Cycle OSSE Initiative brings together researchers from multiple universities and NASA centers to create model-derived data products in support of informed mission planning.

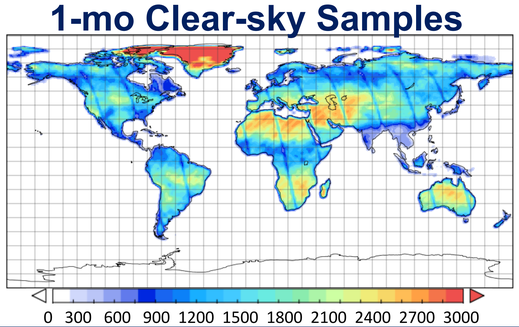
Carbon Cycle OSSE Process



Community Assessment of Priorities

Key Flux Process	Primary Region	Passive LEO	Active LEO	Passive GEO
Human Emissions	Megacities	???	???	●
Arctic-Boreal warming	NH high latitudes	✖	●	✖
Mid-latitude carbon uptake	NH Mid-latitudes	●	●	●
Tropical forests, LUC	Tropical land	●	●	●
Southern Ocean circulation	Southern Ocean	✖	???	✖
Unexplained methane emissions	NH mid- and high latitudes, tropical land	???	●	???

1-mo Clear-sky Samples

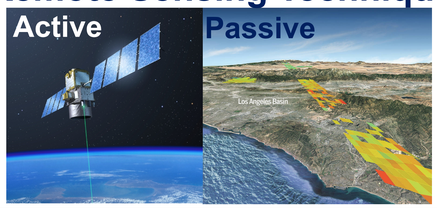


Clouds Matter

Many of the key regions associated with uncertainty in the carbon cycle are cloudy, obstructing the ability of satellites to observe flux changes. A diurnally-varying, observationally-derived cloud product provides insight into the relative advantages of active and geostationary approaches

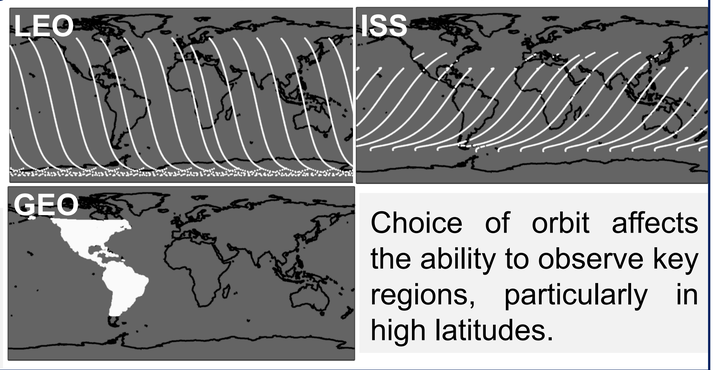
Mission Design Affects Science Yield

Remote Sensing Technique



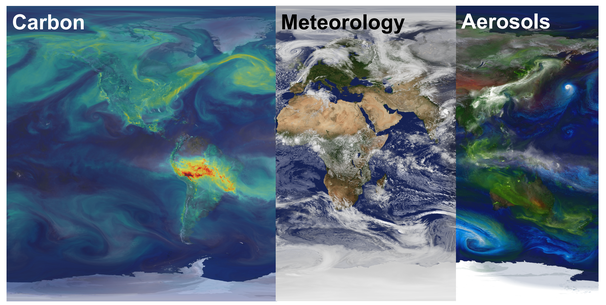
Current satellites measure CO_2 using reflected sunlight while active sensors provide their own illumination.

Choice of Orbit



Choice of orbit affects the ability to observe key regions, particularly in high latitudes.

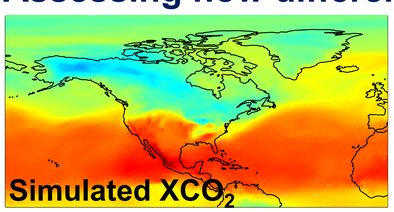
Carbon Nature Runs

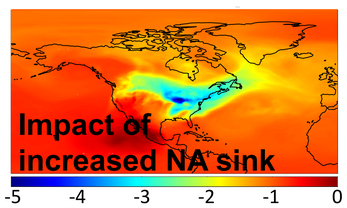


NASA's GEOS Model

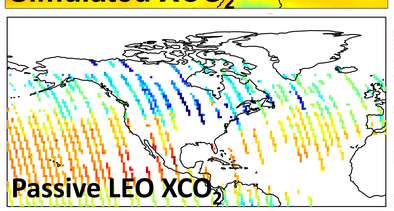
The Goddard Earth Observing System (GEOS) supports NASA's Carbon Cycle OSSEs by providing both high-resolution (14-km) carbon and aerosol simulations and a large library of 50-km simulations with perturbed fluxes.

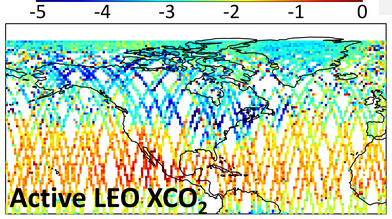
Assessing how different instruments view CO_2

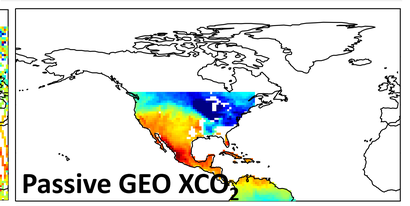


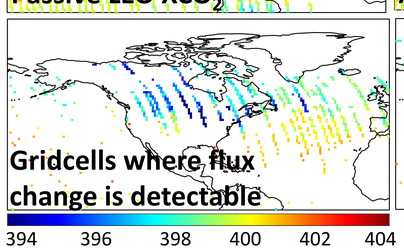


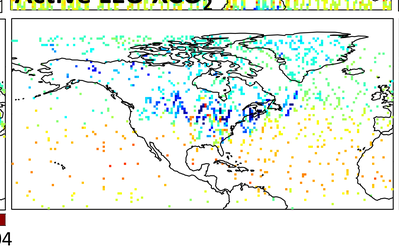
Sampling the Nature Run with instrument simulators allows the sensitivity to different perturbations to be assessed.

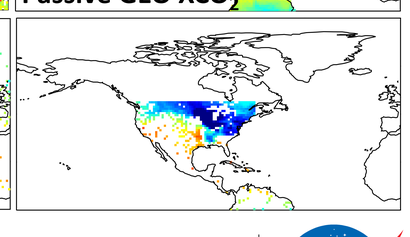












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