# INFRARED CORRELATION RADIOMETER FOR GEO-CAPE (IRCRg)

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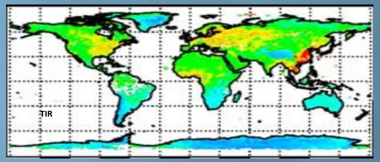
## THE SUCCESS OF NASA'S SHUTTLE-BASED MEASUREMENT OF AIR POLLUTION FROM SATELLITES (MAPS) AND TERRA/MOPITT INFRARED GAS CORRELATION RADIOMETERS FOR CARBON MONOXIDE MEASUREMENTS AT 4.7µm PLACES THE TECHNOLOGY FOCUS ON IMPROVING EXISTING 2.3 µm CO MEASUREMENT CAPABILITY.

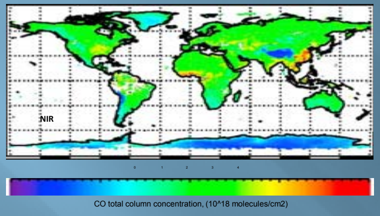

Mid-troposphere CO as archived by MOPITT for March 2006.

These data are part of MOPITT's 10-year record, based on CO measured at 4.67 um (TIR).




Lower-troposphere CO for March 2006 as presented in new work * by the MOPITT retrieval team.

The MOPITT team estimates a factor of 5 more instrument noise in NIR than in TIR measurements.




Deeter, M. N., D. P. Edwards, J. C. Gille, and J. R. Drummond (2009), CO retrievals based on MOPITT near-infrared observations, *J.Geophys. Res.*, 114, D04303, doi:10.1029/2008JD010872

## $IRCR_G$ PROJECT SCHEDULE

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|---|---|
| Complete plan for acquisition, fabrication, and assembly of components and subsystems. | Start + 4 months |
| Incorporate updated MOPITT measurement range data as input to instrument performance model (e.g., assign error magnitudes for spectral, spatial, intensity, thermal and other systematic errors). | Start + 7 months |
| Update instrument model for IRCRg concept. | Start + 11 months |
| Complete instrument characterization plan; conduct technical reviews of plan. | Start + 12 months |
| Assemble breadboard system and perform operational checkout. | Start + 15 months |
| Conduct Test Readiness Review. | Start + 16 months |
| Complete instrument characterizations | Start + 21 months |
| Incorporate results into Instrument Performance Model and run updated model for current GEO-CAPE requirements. | Start + 22 months |
| Final Integrated System Model and Documentation | Start + 24 months |

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## BECAUSE OF THE MATURITY OF THE IRCR TECHNOLOGY, NASA'S INSTRUMENT INCUBATOR PROGRAM CHOSE TO INVEST IN AN ANALYTICAL MODEL TO PROVIDE CAPABILITY TO OPTIMIZE NOISE PERFORMANCE IN THIS CHALLENGING MEASUREMENT FROM GEOSTATIONARY ORBIT.

As part of NASA's Instrument Incubator Program, we have structured the IRCRg project around an analytical performance model to enable rapid evaluation of design specifics once the mission is defined. Carbon monoxide (CO) measurements at 2.3 µm are uniformly sensitive throughout the troposphere, and 4.7 µm measurements are most sensitive to the free troposphere. In combination, the measurements yield information about this Criteria Pollutant near Earth's surface. We will characterize the performance of a 2.3 µm infrared correlation radiometer (IRCR) subsystem designed specifically to measure carbon monoxide from geostationary orbit.

We focus on characterizing the 2.3µm IRCR subsystem, although both 2.3 µm and 4.6 µm subsystems are required to obtain information in the lowermost troposphere. The challenges for GEO-CAPE are to improve precision and accuracy of existing 2.3 µm CO capability, while using this well-validated IRCR technique at GEO, nearly 50 times farther away than the Terra/MOPITT orbit. Our 24-month project enables high temporal and spatial resolution measurements of CO described in the Decadal Survey for public benefit. MAPS and MOPITT performed robustly at 4.6µm.

## AN INSTRUMENT ANALYTICAL MODEL POPULATED BY TEST AND CHARACTERIZATION DATA SUPPORTS "WHAT-IF" SCENARIO TESTING AND RAPID DECISION MAKING.

Our project requirements focus on developing a software-based IRCR instrument performance simulation model that can be used to simulate end-to-end IRCR system performance and CO measurement capability in a "dynamic" environment, and quantify individual critical IRCR CO measurement error sources, by the "static" state of the instrument as well as the "dynamic" state of the instrument/host vehicle.

To support this analytical model, we will construct a bench-top laboratory carbon monoxide IR Gas Correlation Radiometer (IRCR) instrument that can be used to characterize critical tropospheric CO measurement error sources arising from the "static" instrument and to provide inputs to and test the IRCR performance simulator, and raise the TRL of future flight IRCR for the GEOCAPE mission to provide continental-scale carbon monoxide mapping from a geosynchronous platform.

The IRCRg deliverable is an *analytical* instrument model updated with test and analysis results to support GEO-CAPE mission formulation.

First generation instrument model currently incorporates the following: Shot noise from photon statistics; Scene irradiance gradients (from terrestrial statistics); Read-out noise from FPA (from FPA testing); Constant dark current and non-uniformity factors (from FPA testing); Jitter from orbital platform (from satellite specifications); Optics misalignment (de-focus and FPA tilt allowances, from CAD model); Thermal expansion (from joint run of ZEMAX and CAD models). If FPA tests reveal these effects, they will be included: Non-uniformity correction and dark current dynamics (perhaps due to fluctuating temperatures, uneven bias voltages, or 1/*f* noise).