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 2.3 μm 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 4.6 μm. First generation instrument 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 ZEMA X and CAD model).

International collaboration for high-resolution infrared radiometry from space continues with the MAPS instrument on the Shuttle and the MOPITT instrument on the Terra satellite. The MAPS mission on the Space Shuttle completed its first flight in 1999. The MOPITT mission on the Terra spacecraft was launched in December 1999. The MOPITT team estimates a factor of 5 more instrument noise in NIR than in TIR measurements.

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

Our project requirements focus on developing a software-based IRCR 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 infrared correlation radiometer (IRCR) subsystem designed specifically to measure carbon monoxide from a geosynchronous platform.