

CLARREO Mission - Earth's Climate Change Observations

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The Climate Absolute Radiance and Refractivity Observatory (CLARREO) is a high priority, Tier-1 Decadal Survey mission recommended by the National Research Council. It fills the critical need for unambiguous climate change measurements with an unprecedented level of accuracy. The CLARREO mission will provide a metrology laboratory in orbit for the purpose of accurately quantifying and attributing climate change. The mission also provides the first orbiting radiometers with accuracy sufficient to serve as reference calibration standards for other space sensors, essentially serving as a “NIST in orbit”. This will improve the accuracy, by a factor of 5 to 10, and relevance of a wide range of spaceborne instruments for observing Earth's changing climate.

1. CRITICAL OBSERVATIONS OF CLIMATE CHANGE:

- ◇ The climate benchmarks established by CLARREO are critical for assessing changes in the Earth system as society works to meet the challenge of optimizing strategies for mitigating and adapting to climate change. The CLARREO data will be used to test and validate climate models.
- ◇ CLARREO benchmarks are obtained from direct measurements of the Earth's thermal infrared spectrum, the spectrum of solar radiation reflected by the Earth and its atmosphere, and radio occultation from which accurate temperature profiles are derived.

2. NEAR TERM IMPACTS:

- ◇ CLARREO provides the first spectral observations of the far-infrared, which includes 50% of the Earth's energy emitted to space and contains most of the water vapor greenhouse effect.
- ◇ CLARREO's ability to establish a reference calibration standard for sensors in Earth's orbit will improve weather forecasting and data assimilation, and will improve the accuracy of a wide variety of climate-relevant observations including land processes, atmospheric state variables, aerosols and trace gases, surface temperature, and perhaps most importantly, the cloud and radiation data needed to narrow uncertainty in climate sensitivity¹.

3. CLARREO SOCIETAL BENEFITS:

- ◇ CLARREO provides the data necessary to accelerate decisions on public policy concerning climate change by 15 to 20 years. Earlier and better informed decisions provide a large economic benefit to the U.S. and the world, estimated to be ~ \$10 Trillion over the next 40 to 60 years².
- ◇ By reducing risk in climate prediction, CLARREO will impact U.S. international policy, strategic planning by government agencies (DOD and DOE), operation and sustainment of key national assets (Naval Station Norfolk, Langley Air Force Base, and Newport News Shipbuilding), and risk assessment by the reinsurance industry.

4. CLARREO PATHFINDER MISSION TO ISS BEGINS IN 2016!

- ◇ A CLARREO Pathfinder mission has begun development in 2016, planned for launch on the International Space Station (ISS) in 2020. The CLARREO Pathfinder will reduce risks of the full CLARREO mission by demonstrating higher accuracy, SI-traceability, on-orbit calibration approaches and demonstrating that high-accuracy reference inter-calibration with other on-orbit sensors.
- ◇ This development builds on the over 10 years of technology development and science led by NASA Langley with key partners including NASA GSFC, JPL, NIST, DOE, NOAA CIMMS at University of Wisconsin – Madison, and LASP at the University of Colorado.

¹Continuity of NASA Earth Observations from Space: A Value Framework, *National Acad. of Sciences Press*, 2015.

²Cooke et al., *J. Env. Sys. Decisions*, 2014; Cooke et al., *Climate Policy*, 2015.