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Pathfinder Mission for CLARREO

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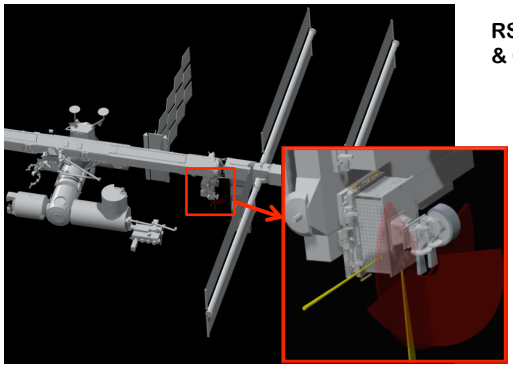
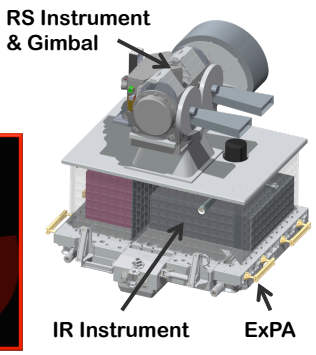
The Climate Absolute Radiance and Refractivity Observatory (CLARREO) is a Tier 1 mission recommended by the NRC Decadal Survey 2007.[1] The foundation of CLARREO is the ability to produce highly accurate climate records to test climate projections in order to improve models and enable sound policy decisions. The CLARREO mission accomplishes this critical objective through accurate SI-traceable decadal observations that are sensitive to many of the key climate parameters such as radiative forcings, climate responses, and feedbacks.[2] Uncertainties in these parameters drives uncertainty in current climate model projections.

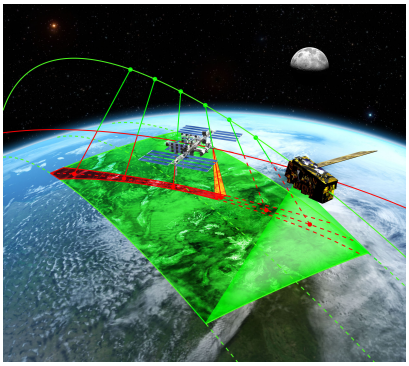
In 2016, the CLARREO project received funding for a Pathfinder mission to demonstrate essential measurement technologies required for the full mission. The appropriated funds potentially support the flight of two instruments, a Reflected Solar (RS) and an Infrared (IR) spectrometer, hosted on the International Space Station (ISS) in the 2020 time frame. The key features of the CLARREO Pathfinder (CPF) mission are shown in Figure (a) location on the ISS, slotted on the ExPRESS logistics carrier (ELC-1), (b) CPF payload integrated with the ExPA.



(a) CLARREO Pathfinder location on the ISS.



(b) CLARREO Pathfinder Payload



(c) CLARREO Pathfinder RS inter-calibration

The CPF provides high accuracy spectral reflectance and radiance measurements enabled by an RS spectrometer operating between 350 – 2300 nm contiguous spectral coverage ($> 95\%$ of reflected energy) with uncertainty $< 0.5\%$ broadband and $< 1\%$ spectral ($k = 2$)[3], an IR spectrometer operating between 200 – 2000 cm^{-1} with contiguous spectral coverage ($> 95\%$ of emitted thermal energy) with uncertainty < 0.1 K ($k = 3$). The solar spectrometer will be capable of pointing to the moon and sun for calibration, as well as tracking time and angle matched observations when used for reference inter-calibration of other radiometers as shown in Figure (c). Both spectrometers will provide Earth nadir observations between 52° N and 52° S latitude with full diurnal cycle sampling in approximately 1 month.

The CPF will reduce risks of the full CLARREO mission by demonstrating higher accuracy, SI-traceablity, on-orbit calibration approaches and demonstrating that high-accuracy reference inter-calibration with other on-orbit sensors (CERES, VIIRS, CrIS) is achievable. Moreover, the lessons learned from CLARREO Pathfinder will produce benefits across many NASA Earth Science Missions through: (1) Improved laboratory SI-traceable calibration approaches, (2) Development and testing of innovative on-orbit SI-traceable methods, (3) Inter-calibration of key sensors in operation at time of CLARREO Pathfinder, and an (4) Improved lunar spectral irradiance calibration standard.

[1] National Research Council, Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond. National Academies Press, Washington, D.C., 426 pp, 2007.

[2] Wielicki et al., "Achieving Climate Change Absolote Accuracy in Orbit," BAMS, pp. 1519 – 1539, October 2013.

[3] We use general coverage factor k, and, $k = 2$ means confidence level is 95%, as 2σ for a Gaussian distribution.