**Title (150 character limit):**

Infrared Radiance Intercalibration for Climate Quality Products and Benchmarking

**White Paper Description (350 character limit):**

Many infrared satellite radiance and derived products can be greatly improved through intercalibration with observations from a potential mission/sensor aimed at providing radiance products with unprecedented accuracy, verified using on-orbit international standards.

**File of White Paper (1500 word limit):**

**Infrared Radiance Intercalibration for Climate Quality Products and Benchmarking**

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There are many Earth system investigations of climate related processes and climate change that rely on observations which do not have the inherent accuracy and traceability for the intended use. That is, data from sensors designed and tested based on weather related specifications are frequently used in studies to understand and track climate, yet lacking the required basic measurement characteristics. Therefore, a key challenge which spans innumerous Earth System Science applications is to understand, and improve if possible, the accuracy of NOAA, NASA, and international satellite products. In particular, a challenge is to improve the radiance calibration accuracy of the large suite of infrared sensor observations including those from, for example, AIRS, IASI, CrIS, MODIS, VIIRS, AVHRR, HIRS, and GOES.

This improvement is possible with the proposed Climate Absolute Radiance and Refractivity Observatory (CLARREO) mission (Wielicki et al. 2013) which would provide coincident infrared observations that can be used for intercalibration. CLARREO will provide infrared observations with absolute calibration with uncertainty better than 0.1K 3-sigma and with in-orbit calibration verification. Analogous improvements for reflected solar observations are also possible via high accuracy CLARREO reflected solar observations.

The resulting improved calibration and characterization of the calibration uncertainties will provide benefits in two main areas: 1) improved radiances and derived products from the individual intercalibrated sensors, and 2) the ability of the intercalibrated radiance observations to contribute to the construction of a climate radiance benchmark.

The need for this type of reference observation capability is recognized and has been discussed in recent publications. For example, the need is summarized in the 2013 WMO/CEOS/CGMS report “Strategy Towards an Architecture for Climate Monitoring from Space” (Dowell et al. 2013): “To characterize climate and climate change, data need to be accurate and homogeneous over long time scales. The signals important for the detection of climate change can easily be lost in the noise of a changing observing system. This enforces the need for continuity in an observing system, where observations can be tied to an invariant reference. Such a system needs to be maintained over at least several decades and beyond. It is with these boundary conditions that a climate monitoring architecture needs to be formulated.”

Currently the international intercalibration community, organized around the Global Space based Inter Calibration System (GSICS, Goldberg et al. 2011), utilizes IASI, AIRS, and CrIS to serve as “reference sensors” for the intercalibration of other infrared observations, despite the relatively large uncertainty in these observations and the lack of in-orbit verification and traceability that is needed for the rigorous metrology required for climate studies and associated societal decisions. Other than CLARREO, there are no other existing or planned programs that will provide this capability. This is a challenge which must involve improved spaced based observations, and other existing and planned programs lack the high accuracy and in-orbit traceability required for this challenge.

The CLARREO mission was chosen as one of four Tier 1 missions in the 2007 Decadal Survey, and is currently in an extended definition phase. The science objectives (including this infrared intercalibration objective) and the required sensors for CLARREO are well defined and ready to go. Now is a crucial time for this challenge, as direct comparisons of CLARREO observations with concurrent sensors, including AIRS with its record starting in 2003 and IASI-A in 2007, have the potential to provide valuable data on the accuracy of the existing datasets before these missions reach the end of their lifetimes. There are many groups that will potentially be included in these intercalibration efforts, including the CLARREO science team, other various individual sensors and product teams, and the intercalibration community, namely GSICS. The CLARREO mission, with its primary climate benchmarking objective along with its potential benefits for the entire suite of infrared sensor observations via intercalibration, is certainly important for this Decadal Survey and deserves a strong recommendation to proceed expeditiously.

References:

Dowell et al., 2013: WMO/CEOS/CGMS report: Strategy Towards an Architecture for Climate Monitoring from Space. http://www.wmo.int/pages/prog/sat/documents/ARCH\_strategy-climate-architecture-space.pdf

Goldberg et al., 2011: The Global Space-Based Inter-Calibration System. *Bull. Amer. Meteor. Soc.*, **92**, 467–475.

Wielicki et al., 2013: Achieving Climate Change Absolute Accuracy in Orbit. *Bull. Amer. Meteor. Soc.*, **94**, 1519–1539.