CLARREO MISSION DESIGN: ENGAGING USERS TO MAXIMIZE SOCIETAL BENEFIT AND SCIENCE VALUE

David F. Young

NASA Langley Research Center, Hampton, VA

1. INTRODUCTION

The Climate Absolute Radiance And Refractivity Observatory (CLARREO) is a climate-focused mission designed to rigorously observe climate change on decade time scales and to use these observations as a critical method to determine the accuracy of climate change projections such as those used in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) [1]. The CLARREO mission accomplishes this through highly accurate decadal change observations tied to SI standards and sensitive to many of the key uncertainties in climate radiative forcings, responses, and feedbacks that in turn drive uncertainty in current climate model projections. In so doing, CLARREO will provide accurate, broadly acknowledged climate records that are used to enable tested and trusted long-term climate projections that become the foundation for informed decisions on mitigation and adaptation policies that address the effects of climate change on society.

CLARREO will measure spectrally resolved reflected solar and infrared radiances and Global Navigation Satellite System Radio Occultation (GNSS RO) refractivities. The mission combines exacting on-orbit verification of the instrument performance with unbiased global sampling to produce high-confidence observations of long-term climate change trends. In addition, CLARREO will serve as a key component of the climate observing system by providing a set of reference spectrometers in orbit capable of improving the calibration of other weather and climate sensors.

This presentation will summarize the planned CLARREO observations, science priorities and requirements, and the baseline mission architecture along with the discussion of the uses of CLARREO data for societal benefit

2. CLARREO SCIENCE

The CLARREO science objectives are derived from the current understanding of what causes uncertainty in decadal climate projections and attribution as described in the National research Council Earth science Decadal Survey [2], the IPCC AR4[1], and the U.S. Climate Change Science Program (CCSP) Assessment Reports. While there are many existing ways to approach climate analysis, CLARREO is designed to enable two new approaches

in particular: Benchmark Measurement Fingerprinting, and Reference Inter-calibration. First, the optimal detection method [3] [4] [5] makes use of spectral fingerprinting signals directly measured by the CLARREO instruments to determine climate response and climate system feedbacks. The second approach is use CLARREO spectra to calibrate operational satellite system instruments that do not reach decadal change absolute accuracy. These include current and future instruments such as CrIS, IASI, CERES, VIIRS, Landsat, and all geostationary satellite radiometers. In this approach, CLARREO serves as an SI traceable reference standard in orbit, and provides Reference Inter-calibration for these other instruments. Recalibrated data from these instruments are then used to accurately retrieve changes in properties of the climate system on decade time scales.

3. ENGAGING USERS

In order to maximize the societal benefits and science value of CLARREO, the primary end users of these data have been engaged in the earliest phase of mission planning. Global climate modelers associated with models used by the IPCC have been performing Climate Observing System Simulation Experiments (OSSE). The results of these OSSE's have been used to define measurement and mission requirements and identify user-defined products. In order to address the highest priorities for calibration of the Earth Observing System, the team has also worked closely with user groups such as the Global Spacebased Inter-Calibration System (GSICS), Global Climate Observing System (GCOS), National Oceanic and Atmospheric Administration (NOAA), and EUMETSAT that are interested in the use of CLARREO as a reference intercalibration source.

The CLARREO team recognizes that there are additional potential users for both the highly accurate hyperspectral measurements that cover the full spectral range of Earth emitted and reflected energy and the GNSS RO atmospheric profiles. The CLARREO team is committed to working with these groups as we continue to plan the mission

4. REFERENCES

[1] IPCC Fourth Assessment Report, The Physical Science Basis, 2007.

[2] Space Studies Board, National Research Council. *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond.* Decadal Survey, Washington, D.C.: National Academies Press, 2007.

[3] Leroy, S S, J G Anderson, and J A Dykema. "Testing climate models using GPS radio occultation: A sensitivity analysis." *Journal of Geophysical Reearch - Atmospheres* 111, D17105, Sep 2006.

[4] Huang, Yi, and V Ramaswamy. "Evolution and Trend of the Outgoing Longwave Radiation Spectrum." *Journal of Climate* 22, no. 17, pp. 4637-4651, September 2009.

[5] Leroy, S, J Anderson, J Dykema, and R Goody. "Testing climate models using thermal infrared spectra." *Journal of Climate*, pp. 1863-1875, 2008.