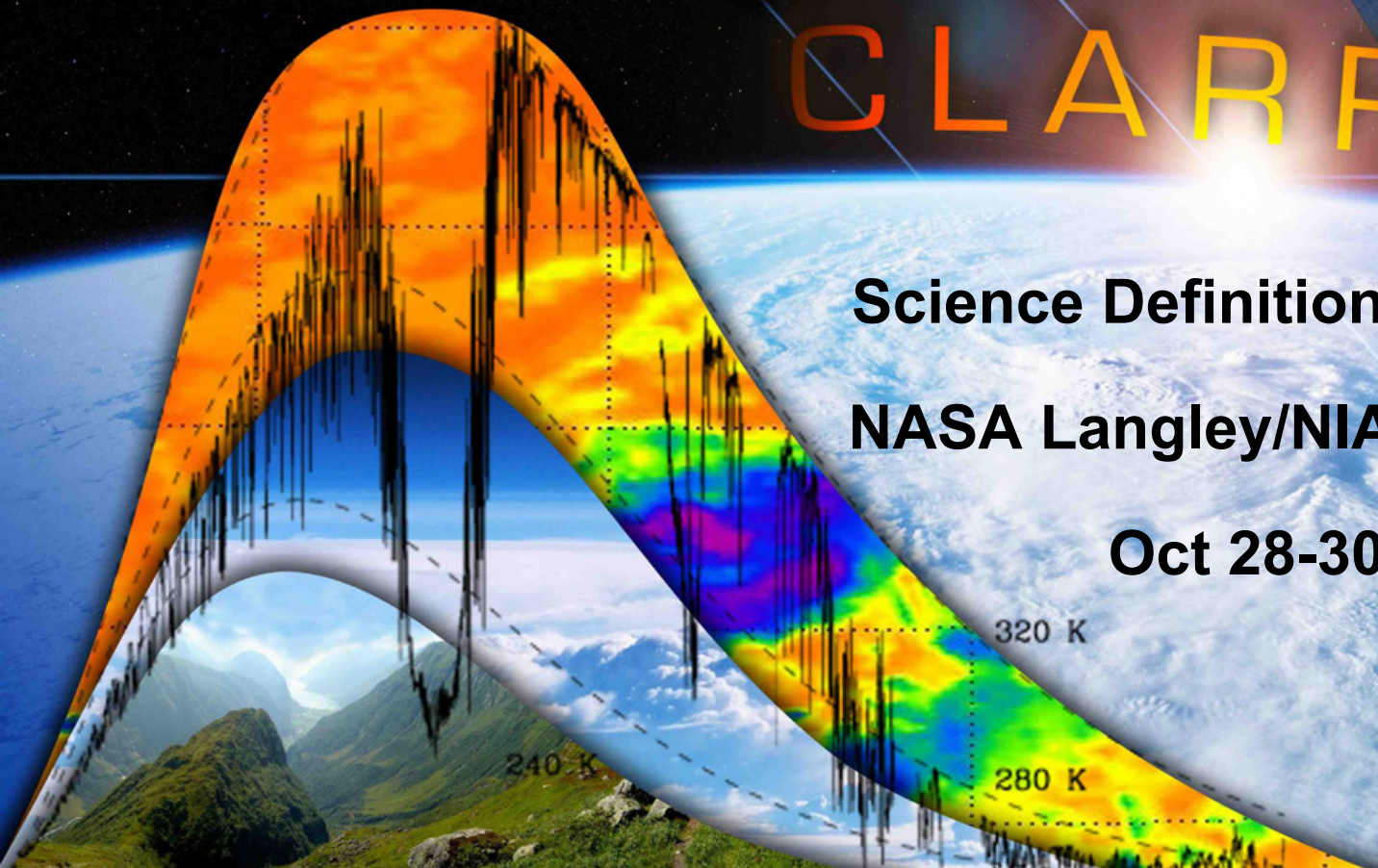
SDT Meeting Intro/Goals

Climate Absolute Radiance & Refractivity Observatory

Bruce Wielicki and Rosemary Baize

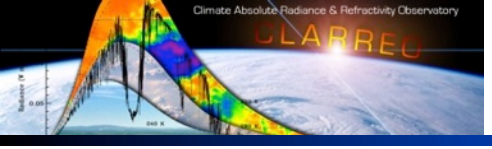


CLARREO

Science Definition Team Meeting

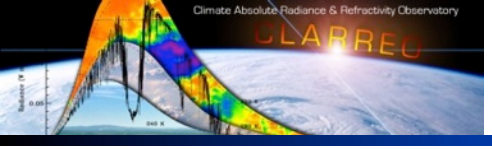
NASA Langley/NIA, Hampton, VA

Oct 28-30, 2014



CLARREO Mission Status

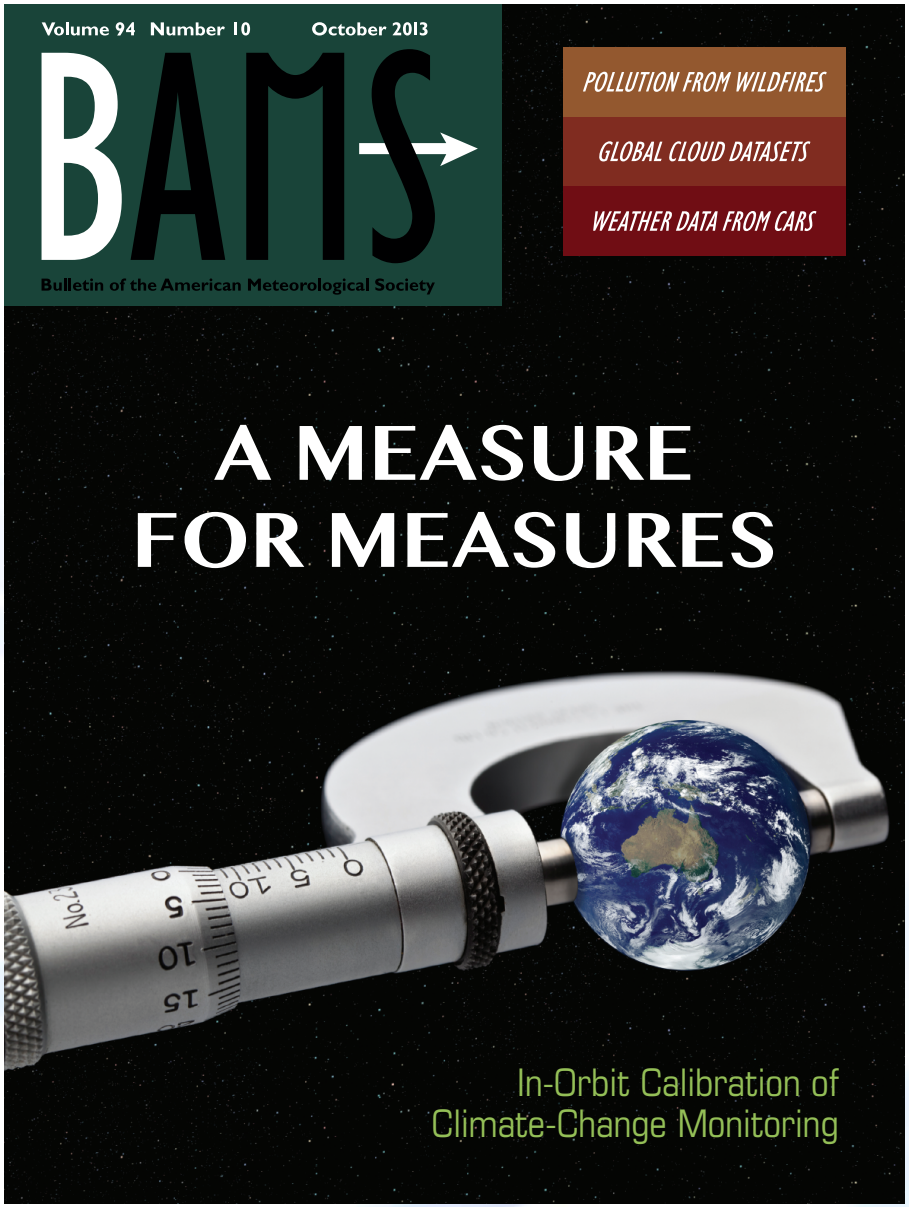
- Passed Mission Concept Review Nov 2010
- Science Definition Team selected in Jan 2011
- NASA Earth Science budget reduction in Feb 2011 has caused a delay.
- Remains in pre-phase A studies, launch no earlier than 2023
- 2 RS and 2 IR instrument calibration demonstration systems underway (CU-LASP/GSFC for RS, UW/LaRC for IR)
- Climate Model OSSEs and Intercalibration simulation studies
- Alternative less costly mission studies: ISS best option to date
- International collaboration options with UK, Italy, India in study
- *No climate observing system: factor of 3 to 4 underfunded*
- *Return on Investment in a climate observing system is ~ 40:1*

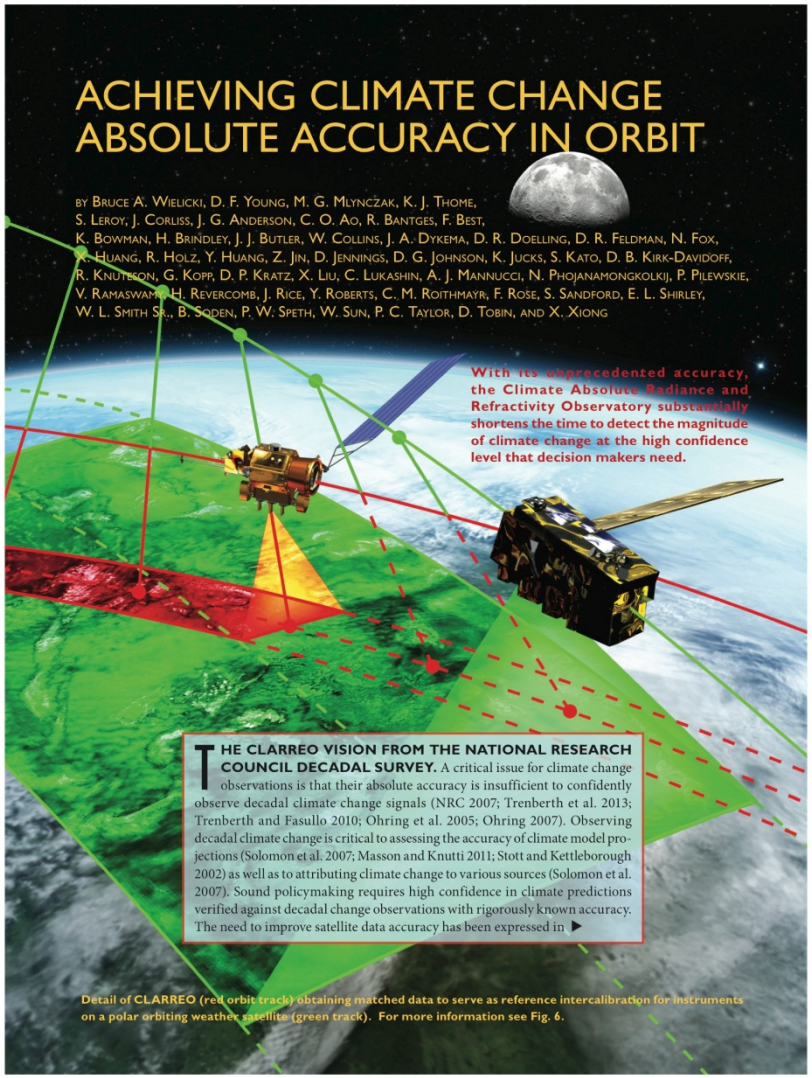


2014 Progress: Journals

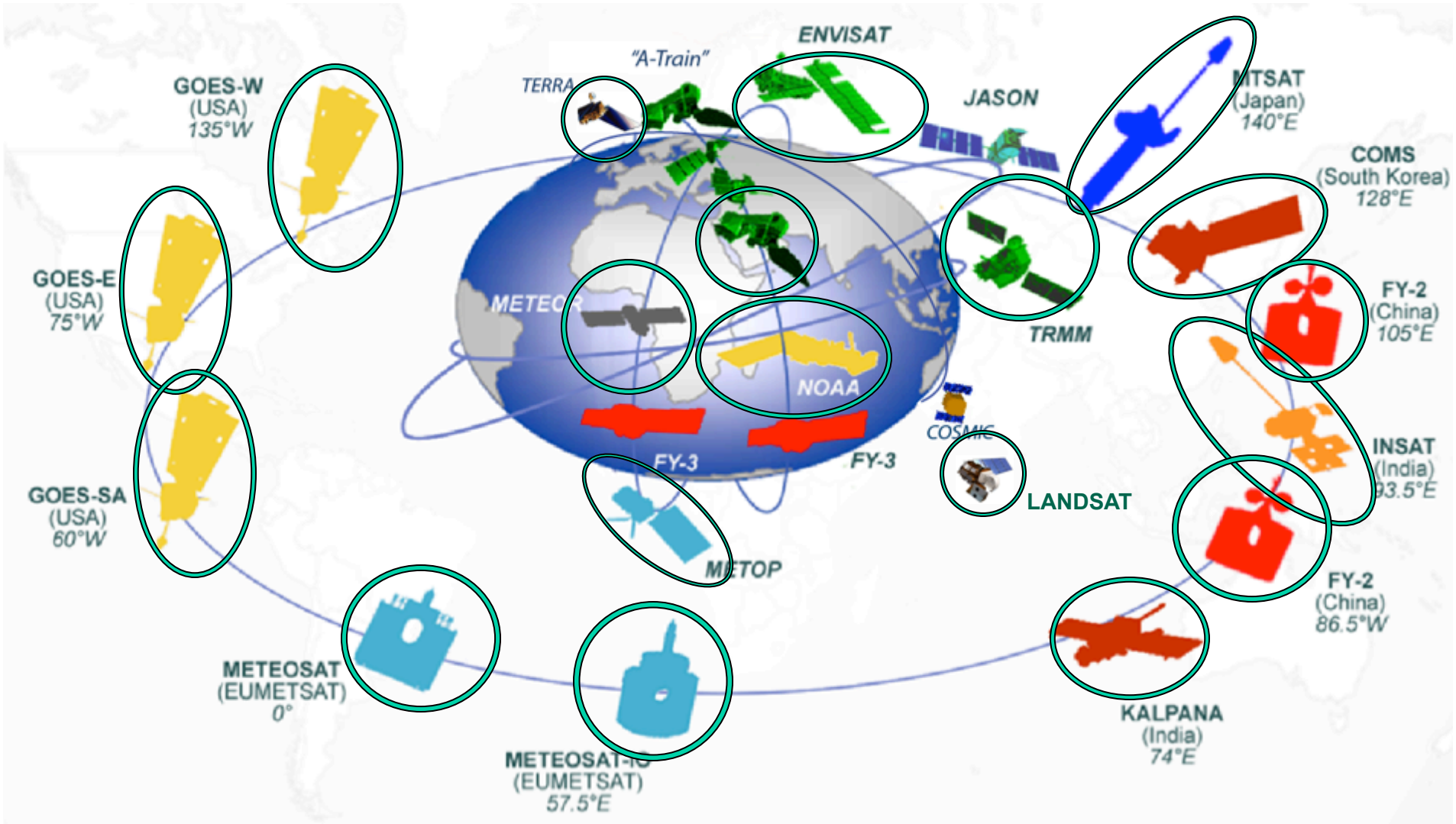
- 26 journal papers published/in press in 2014
- 10 papers submitted/in review
- 8 papers in preparation
- 26 journal papers were published in 2013
- 105 total journal papers to date
- This SDT meeting will give us a fresh view of science study progress and directions

CLARREO Mission BAMS Cover Paper





Intercalibration to CLARREO for Climate Change Accuracy



Intercalibration of 30 to 40 instruments in LEO and GEO orbits

Economic Value of Climate Observations

Springer Link

Environment Systems and Decisions
Formerly The Environmentalist

10.1007/s10669-013-9451-8

Value of information for climate observing systems

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Abstract

The Interagency Working Group Memo on the social cost of carbon is used to compute the value of information (VOI) of climate observing systems. A generic decision context is posited in which society switches from a business as usual (BAU) emissions path to a reduced emissions path upon achieving sufficient confidence that a trigger variable exceeds a stipulated critical value. Using assessments of natural variability and uncertainty of measuring instruments, it is possible to compute the time at which the required confidence would be reached under the current and under a new observing system, if indeed the critical value is reached. Economic damages (worldwide) from carbon emissions are computed with an integrated assessment model. The more accurate observing system acquires the required confidence earlier and switches sooner to the reduced emissions path, thereby avoiding more damages which would otherwise be incurred by BAU emissions. The difference in expected net present value of averted damages under the two observing systems is the VOI of the new observing system relative to the existing system. As illustration, the VOI for the proposed space-borne CLARREO system relative to current space-borne systems is computed. Depending on details of the decision context, the VOI ranges from 2 to 30 trillion US dollars.

Electronic supplementary material

The online version of this article (doi:10.1007/s10669-013-9451-8) contains supplementary material, which is available to authorized users.

Keywords Value of information – Climate observing system – Social cost of carbon – DICE – CLARREO

Journal of Environment, Systems, and Decisions

Cooke et al., 2013

Available free and open access online @ http://link.springer.com /article/10.1007%2Fs10669-013-9451-8

Results and Sensitivity to Assumptions

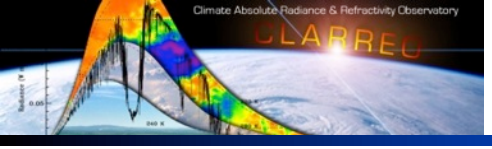
World Wide Economic Benefits

Parameter Change	CLARREO/Improved Climate Observations VOI (Trillion US 2015 dollars, NPV) 3% discount rate
Baseline*	$11.7 T
BAU => AER	$9.8 T
0.3C/decade trigger	$14.4 T
2030 launch	$9.1 T

*** Baseline uses 0.2C/decade trigger, 95% confidence in trend, BAU => DICE optimal emissions, 2020 launch**

- **Delaying launch by 10 years reduces benefit by $2.6 T**

Each year of delay we lose $260B of world benefits



2014 Progress: Instruments

- UW Instrument Incubator Program (IIP) demonstrated space environmental testing to reach TRL-6 on their CLARREO prototype infrared (IR) interferometer

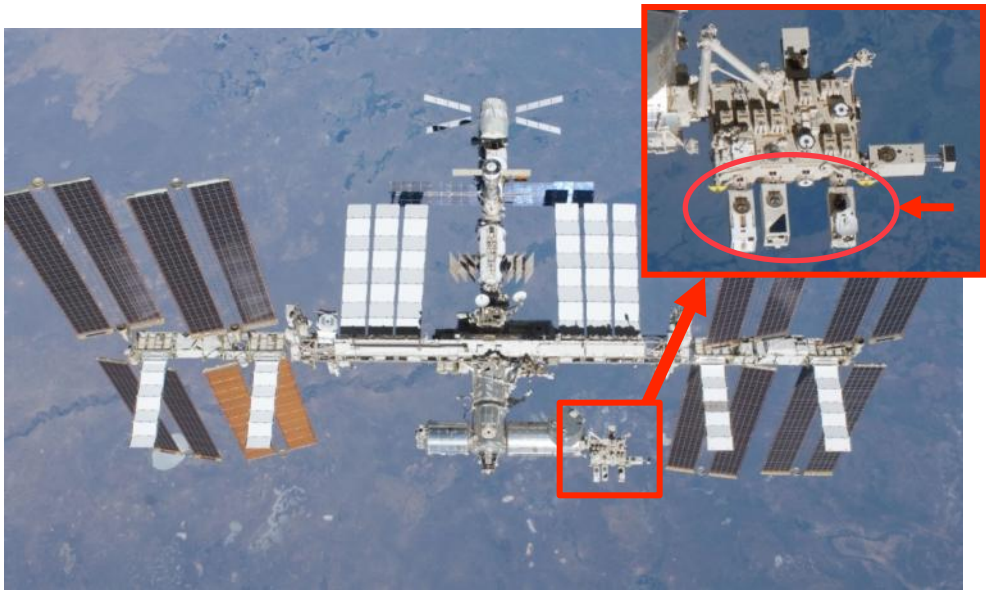
- LaRC IR Calibration Demonstration System (CDS) held successful NIST peer review: now within a factor of 2 of CLARREO requirements with next step to implement small nonlinearity corrections, MCT flight like detectors

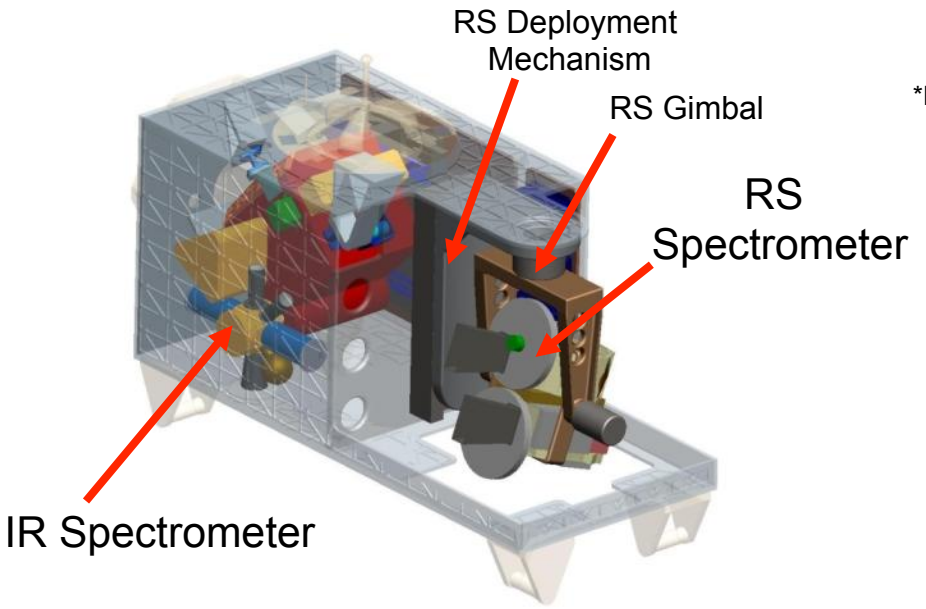
- CU LASP IIP successful high altitude balloon flight (30km) of their CLARREO prototype reflected solar (RS) spectrometer with solar and lunar views (Aug 2014)

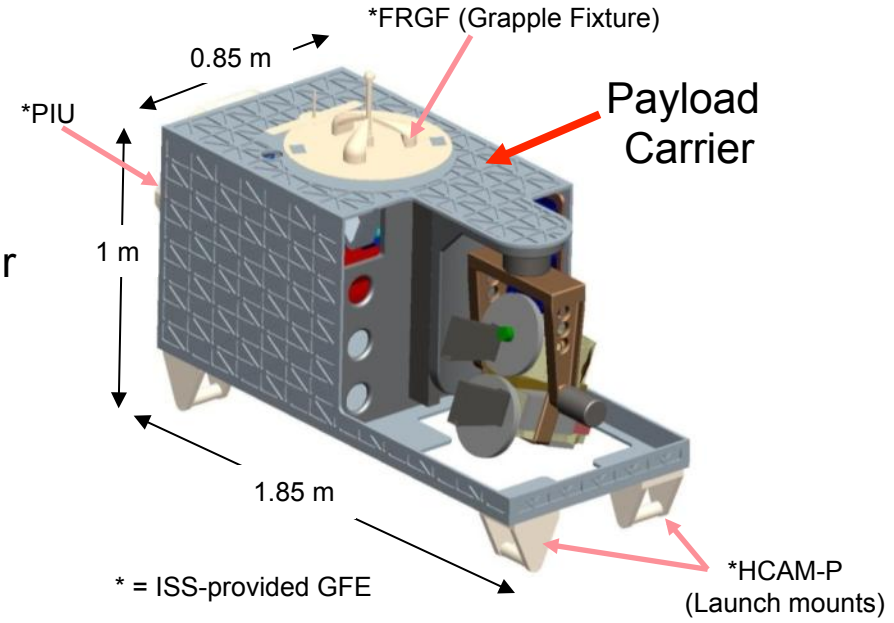
- GSFC RS CDS held successful NIST peer review, and participated in Landsat ground calibration campaign. On schedule for their successive accuracy steps to CLARREO levels. Currently demonstrating solar and lunar view performance, as well as SIRCUS calibrations

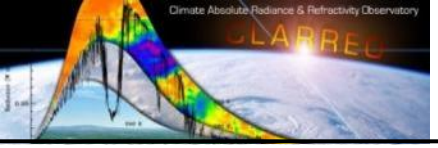
ISS Mission Concept

- Selected the Japanese Experiment Module Exposed Facility (JEM-EF) for this study
  - L/V, installation and JEM-EF interfaces defined and provided by ISS
  - Other ISS locations viable, but ram-side of JEM-EF is optimal for maximizing viewing opportunities
- Dual-instrument payload approach demonstrated by NRL's HREP









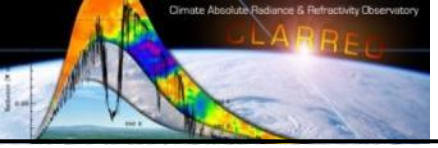
2014 Progress

- Held LaRC and GSFC instrument design lab studies for smaller RS and IR instrument concepts: better able to fit in Venture class and lower cost/mass/power requirements, same science.

- Submitted Tech Demo Instrument concepts to NASA HQ in July 2014 and Sept 2014. Freilich reviewing. Volz now head of NOAA weather satellites (NESDIS). (LASP, UW, GSFC).

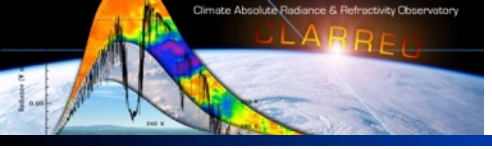
- Submitted to NASA HQ overguide budget request for Risk Reduction Unit instruments (less expensive EDU or Engineering Design Unit) in Oct 2014. (LaRC, GSFC).

- CLARREO SDT Report (led by Lukashin: ~ 200 pages and 98% complete. Now online on the CLARREO web site. Great resource for Decadal Survey or anyone interested in CLARREO.



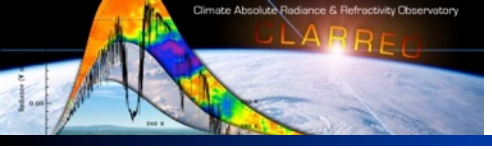
2014 Progress

- **Key Invited Talks on CLARREO and VOI:**
  - WCRP Grand Challenge on Climate Sensitivity, March 2014,Germany
  - AMS Radiation Conference, July 2014, Boston, MA
  - AOGS, August 2014, Sapporo, Japan
  - Indian Ministry for Earth Science (MoES) annual climate workshop, and Indian Institute for Tropical Meteorology, Sept 2014, India
    - *Indian space program growing*
    - *Great interest in a joint U.S./India CLARREO mission*
    - *Will explore in next few months possible instrument combinations with CLARREO spectrometers (e.g. aerosol or water vapor GPS profiling)*
    - *Might lead to 50% cost reduction for NASA. Freilich aware of interest.*
  - Climate Symposium 2014, October 2014, Germany
    - *Expect some sort of recommendation for high accuracy reference spectrometers in orbit.*
    - *Group may or may not admit that we have no climate observing system (seemed about 50/50 on this argument and VOI argument).*



2015 Directions

- Extend the science understanding of CLARREO requirements
- Support the next Decadal Survey (e.g. white paper)
- Educate the world on why CLARREO is a critical part of any climate observing system, and its economic value is very high
- Continue to reduce mission costs and risks



2015 Key Tasks

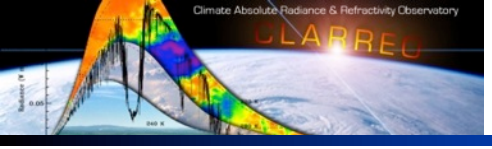
- Key journal papers we still need to publish: IR intercal and orbit sampling for spectral fingerprints. Next VOI paper, and potentially a paper in Foreign Affairs, Foreign Policy, PNAS, or Science/Nature journals for broad discussion of lack of a climate observing system and VOI of such a system.

- Publish CLARREO requirements as a function of wavelength using new science studies in combination with IIP and CDS instrument calibration studies (T(z), q(z), cloud properties, LW Cloud Radiative Forcing)

- Instrument Design sessions to look at smaller, lighter, less expensive instrument designs

- Continue to improve the SDT Summary Report for the CLARREO web site and for background support of decadal survey white paper

- Decadal Survey schedule and White Paper



Decadal Survey Schedule

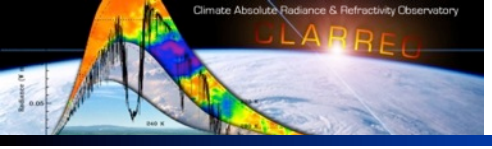
- NASA/NRC negotiating terms of study now
  - missions as in the last decadal survey? likely NRC preference
  - science topics and priorities? likely NASA preference
  - white paper content may or may not be set in study terms

- Still working Terms of Reference for the study with NRC, Freilich expects them to be completed in December, 2014.

- Expected call for White Papers: Jan 2015

- Expected due date for White Papers: June 2015

- Final report due out in 2017



Presentation & Team Discussion of 2015 Tasks

Thursday Morning (1.5 hours)