Inter-calibration Requirements / Algorithms for the VIS/NIR:

Starting Points for Discussion

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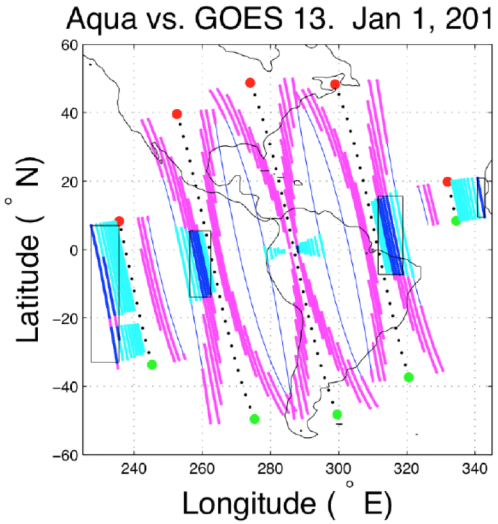
GSICS Web Meeting

Inter-Calibration of Sensors in VIS/NIR: Current



Results from C. Roithmayr

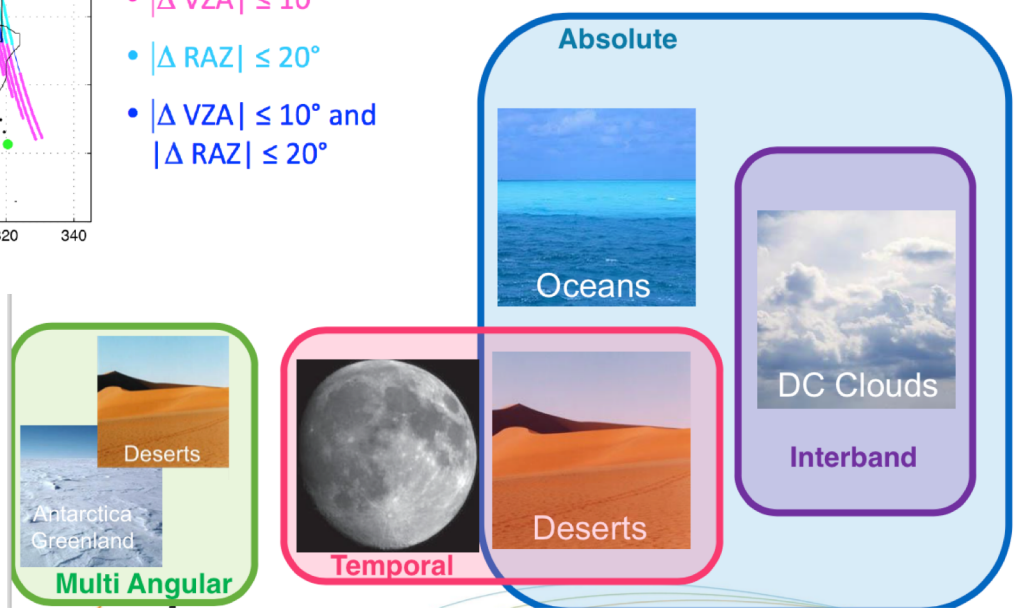
Temporal matching: 30 minutes

• • • Aqua ground track

Aqua swath

- |Δ VZA| ≤ 10°
- |Δ RAZ| ≤ 20°
- |Δ VZA| ≤ 10° and |Δ RAZ| ≤ 20°

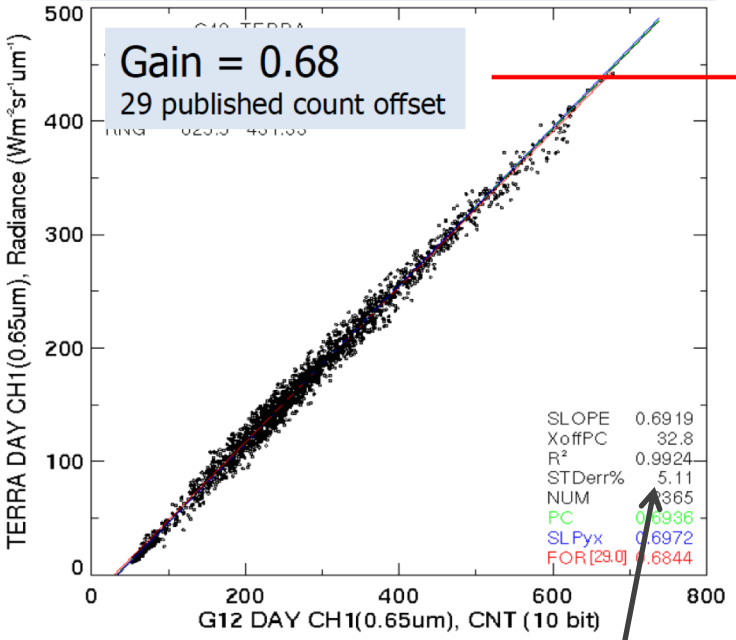
From the GSICS Report



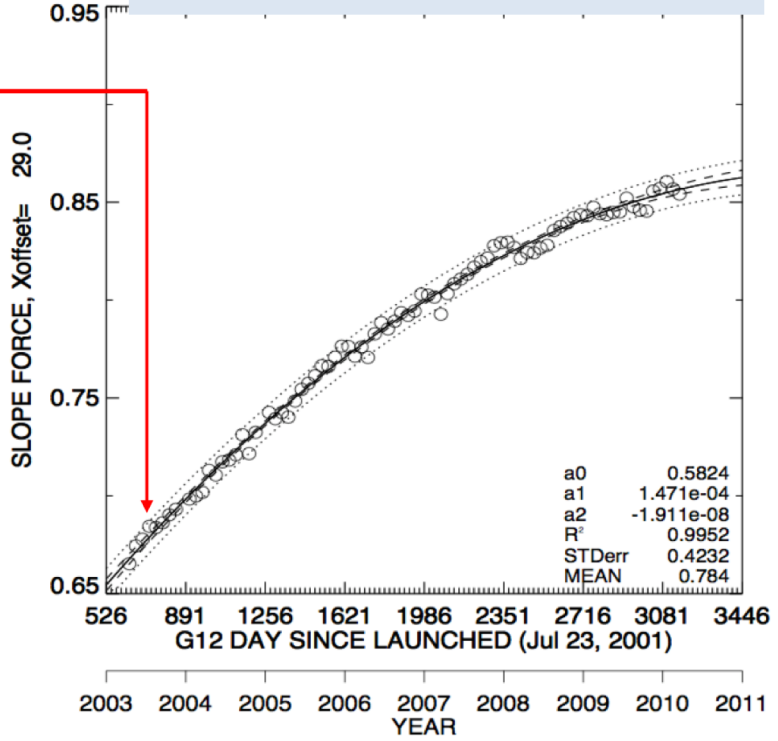
- ✧ LEO and GEO data matching when available (e.g. MODIS and GOES-13).
- ✧ Uniform and stable surface sites.
- ✧ Instrument stability by observing the Moon (e.g. SeaWIFS).
- ✧ Deep Convective Clouds, clear ocean & deserts: involve RT modeling.

Inter-Calibration of Sensors in VIS/NIR: Current

GOES-12/Terra-MODIS
July 2003



GOES-12 gain
based on Terra-MODIS



Results from the GSICS Report

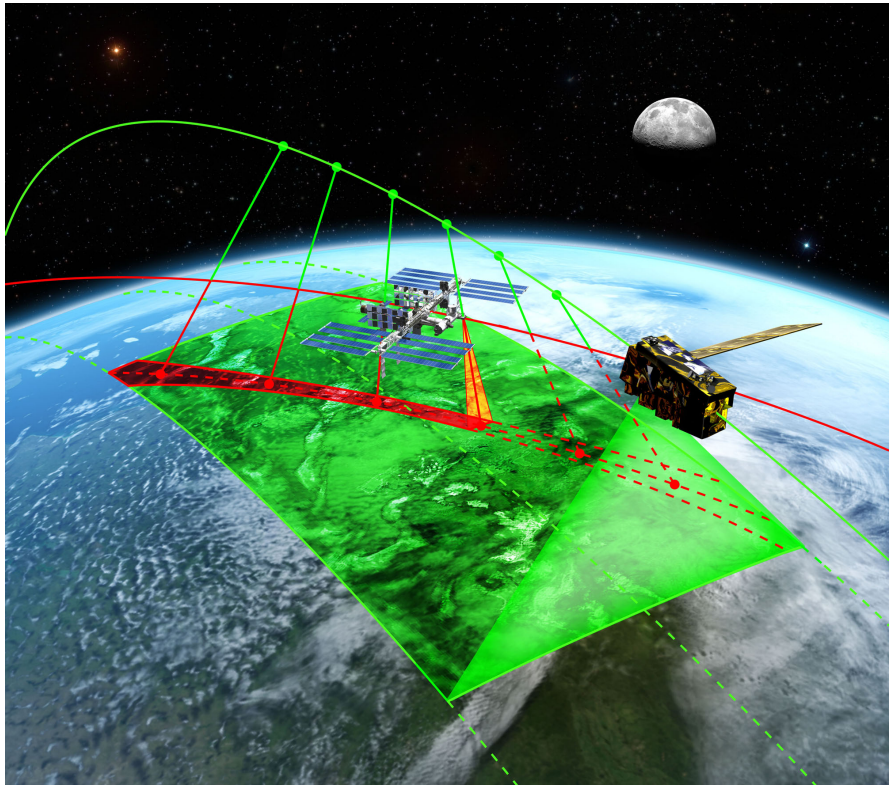
Fundamental limitation of current approach

Inter-calibration of gain:

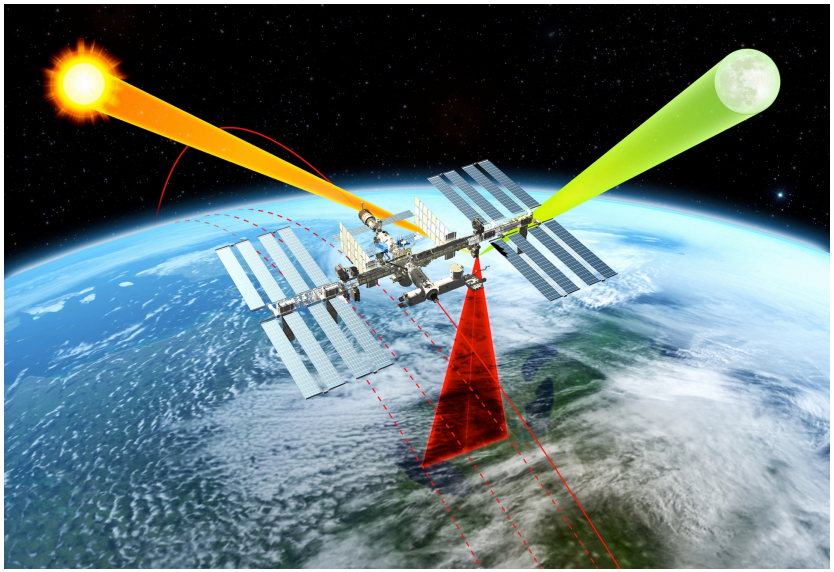
- Type A uncertainty (random) is 5.11% (k=1): due to data matching.
- Type B uncertainty (not random) is defined by the MODIS accuracy of 2% (k=1) [pre-launch].
- Spectral Type B uncertainty: due to difference in spectral response.

CLARREO Pathfinder Direct Inter-Calibration

Real time on-orbit operations for data matching



- CLARREO Pathfinder provides high-accuracy reference on orbit ≤ 0.3% (k=1)
- CLARREO Pathfinder has 2D pointing ability for real-time data matching.

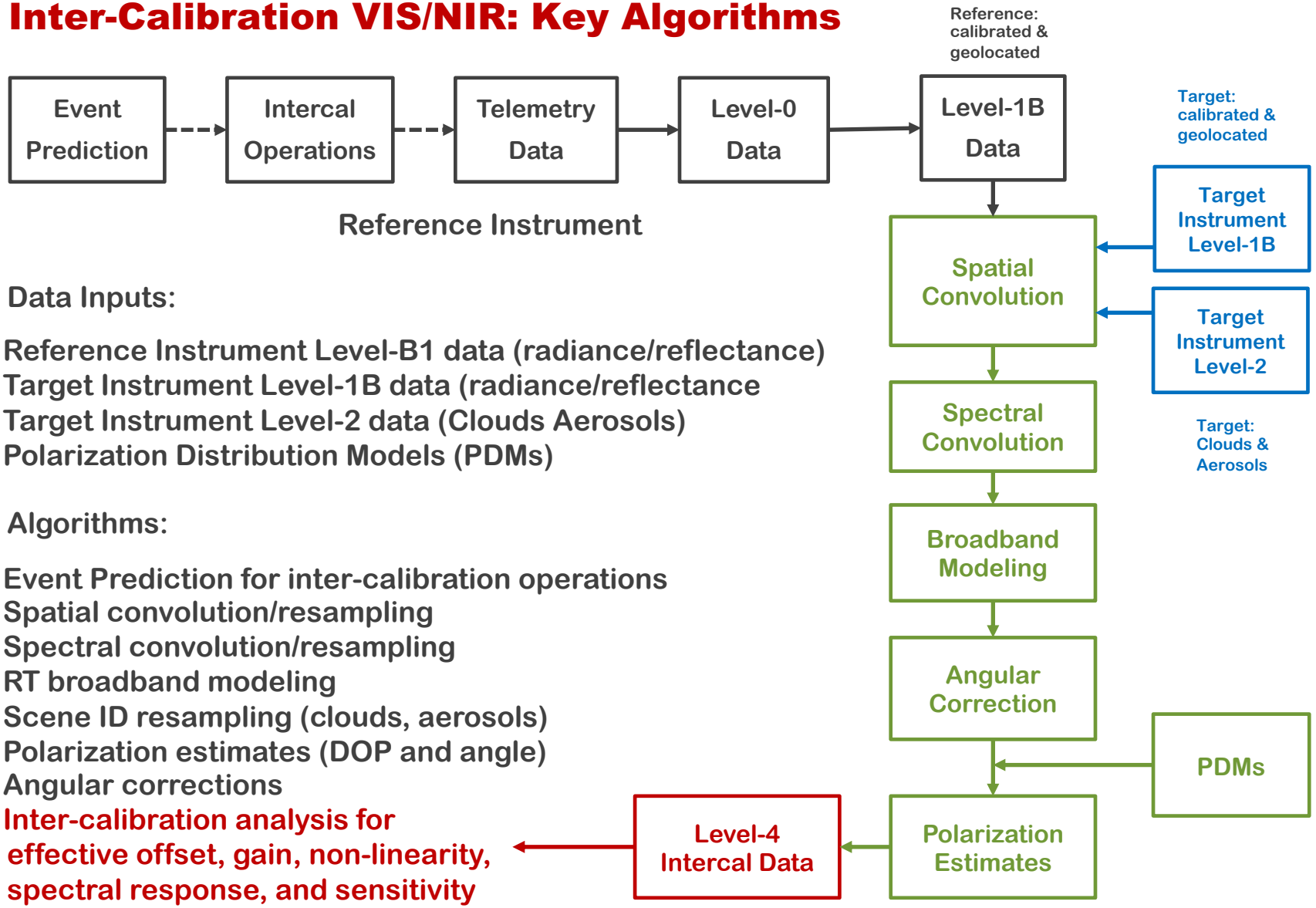


- CLARREO Pathfinder data matching with CERES and VIIRS on JPSS: temporal matching within 10 minutes, on-orbit angular matching < 1°
- CLARREO Pathfinder location on ISS: ELC-1 Site 3

Inter-Calibration VIS/NIR: Instrument Key Requirements

- On-orbit Type B uncertainty for spectral reflectance < 0.3% (k=1)
  Rationale: To provide an accurate reference
- On-orbit Type A uncertainty for spectral reflectance: can be relaxed
  Rationale: It will be reduced by averaging over inter-calibration sample
- Spectral range: 350 nm to 2300 nm
  Rationale: To cover most of RS broadband energy
- Nyquist spectral sampling < 4 nm
  Rationale: To limit narrowband re-sampling error
- Spatial sampling < 1 km
  Rationale: Comparable to inter-calibrated imagers (can be a trade)
- Spatial swath about 100 km
  Rationale: To provide sufficient sampling for large-FOV sensors
- 2D Pointing ability
  Rationale: To be able to match data on-orbit (time & angles), off-nadir sampling
- Obit selection – LEO, polar versus low inclination
  Rationale: Sampling distributions is more uniform for low inclination

Inter-Calibration VIS/NIR: Key Algorithms



Data Inputs:

- Reference Instrument Level-B1 data (radiance/reflectance)
- Target Instrument Level-1B data (radiance/reflectance
- Target Instrument Level-2 data (Clouds Aerosols)
- Polarization Distribution Models (PDMs)

Algorithms:

- Event Prediction for inter-calibration operations
- Spatial convolution/resampling
- Spectral convolution/resampling
- RT broadband modeling
- Scene ID resampling (clouds, aerosols)
- Polarization estimates (DOP and angle)
- Angular corrections
- **Inter-calibration analysis for effective offset, gain, non-linearity, spectral response, and sensitivity to polarization.**

Inter-Calibration VIS/NIR: Discussion

- Instrument Requirements & Algorithms: lots of trades
  Target instruments parameters and their orbits are the drivers !

- Current CLARREO Pathfinder averaging approach:

  - No by-detector inter-calibration of imagers (flat-fielding by imager team)
  - No high-spectral resolution inter-calibration (validation possible ?)

- Broad spectral range:
  Required only for broadband radiometers like CERES and GERB

- Lunar calibration and inter-calibration: very effective approach !

  - Calibration target is already in space (Moon as solar diffuser)
  - Need for improvement in combined uncertainty < 0.5% (k=1)
  - Need for accurate measurement base for new model: hyperspectral with broad range
  - Need for modeling from hyperspectral to the shortwave broadband

- Reference instrument calibration (and calibration generally) approach:

  - Need for improvement in uncertainty and SI-traceability on-orbit
  - Improved calibration sources on-orbit: Solar Spectral and Total Irradiance (TSIS)
  - Calibration by direct viewing Sun and Moon
  - On-board calibration sources in VIS/NIR: a challenge !