Global Precipitation Measurement

GPM Microwave Imager (GMI) Algorithm Development Approach

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**GMI L1 Algorithm Responsibilities**

- **Explanation of level 1**
  - L1a granules are maintained in CCSDS scan packets
    - Quality control and packets grouped into designated granules
    - Current plans call for a granule to be an orbit (but without overlap scans as in TRMM)
  - L1b granules are $T_b$
    - Calibrated and geolocated
    - Current plans call for a granule to be an orbit
    - No overlap scans at beginning and end of the orbit as in TRMM
  - L1c granules are intercalibrated $T_b$ ($T_c$)
    - Intercalibration done only if necessary
    - Current plans do not call for an intercalibration algorithm to be applied to GMI
    - Intercalibration algorithm is a “community” accepted algorithm to be applied among radiometer $T_b$ products

- **Level 1a algorithm code is implemented by Precipitation Processing System (PPS)**
- **Level 1b algorithm are developed jointly by**
  - the PPS (which also implements the code)
  - contractor calibration subcontractors (RSS)
  - designated GPM instrument scientist (Dr. Jim Shiue)
- **Level 1c intercalibrated algorithms (where necessary for GMI) jointly prepared by the intercalibration algorithm team and PPS**
GMI contractor has responsibility for conducting calibration activities that will demonstrate that the GMI is operating within specifications.

RSS who has been subcontracted by Ball (GMI contractor) to carry out their calibration responsibility has proposed both a short-term and long-term calibration effort:
- RSS will provide calibration code to PPS
- RSS has allowed PPS to incorporate all or part of their calibration approach into the GMI L1b algorithm code

PPS and the GMI instrument scientist have the responsibility for developing the operational calibration code for GMI L1b routine production:
- PPS will based GMI calibration code upon the TMI code merged with the operationally implementable parts of the RSS calibration code produced for Ball
- Much of the RSS approach can be integrated into the L1b code as it can be applied in an automated and routine fashion
- Those “after the fact” aspects of the RSS calibration approach will be included in a quality control process and for long-term checking of GMI calibration.

Experience with calibration of previous microwave imagers has shown that warm load issues have contributed to calibration issues:
- GPM & GMI thermal design incorporates much to mitigate the warm load problem
- GMI design includes noise diodes that could be used to check (or when necessary) replace/adjust problematic warm load anomalies.
Local Orbit Noon, Local Orbit Midnight, & Phase in Orbit with respect to Midnight

-90, or 270 degree phase

"SolarPhaseInOrbit" variable included in ancillary 1X HDF file along with "SolarBetaAngle" and "SunPresenceFlag" to show shadow periods.
• While it is unlikely that GMI will have the same issues with emissive antenna as TMI, it is important to calculate and record information that would allow calibration adjustments.

• Sun Angle data to be captured for GMI
  - SolarBetaAngle -- Sun elevation above the orbit plane
  - SolarPhaseInOrbit -- phase around orbit from local midnight
  - SunPresenceFlag -- =0 for spacecraft in shadow, =1 in sunlight
  - BodySunVector -- Sun Vector in spacecraft/instrument coordinates
  - BodySunElev -- Sun elevation above instrument horizontal plane
  - BodySunBeta -- Sun elevation in body X-Z plane, positive toward -Y
  - BodySunPhase -- Sun phase around body X-Z plane, from +Z toward +X
  - SunVecGCI -- Sun vector in geocentric inertial coordinates
• **For ensuring the appropriate testing of algorithm code PPS is developing synthetic data**
  - PPS defines synthetic data as made from the combination of data from similar channels from multiple existing satellites
  - So from PPS perspective synthetic data comes primarily from observational rather than from solely from model data
  - For details of current PPS synthetic data efforts, see poster: Simulation of Global Precipitation Measurement Microwave Imager level 1 and Level 2 data by Yimin Ji
  - Synthetic data is not the best way to ensure appropriate data completeness and inclusion. So, may not be the best and certainly not a complete way to test the science contained in algorithms

• **PPS will generate many synthetic data orbits to allow early testing of GMI algorithm code.**
  - PPS will generate only GMI synthetic data
  - We will reverse $T_b$ synthetic data to instrument counts to test the level 1B code
  - By processing 1A should essentially reproduce the synthetic $T_b$
  - Did this for TRMM and other projects such as Aquarius also do.

• **Under the sponsorship of the science team and GPM Project Scientist, Dr. Tao’s group is working on a satellite simulator for GPM**
  - Generate both GMI and PR data
  - Based on modeling
  - Correctly represent all aspects of the GMI/PR data within the GPM satellite track and inclination
  - Allow testing of the science contained in the retrieval algorithms
  - Should be able to generate instrument counts
  - Available for mission simulations and Operational Acceptance Testing (OAT)
Synthetic GMI Tb of 89 GHz V Channel

See Yimin Ji poster for explanation
Synthetic GMI Tb of 183 ± 3 GHz Channel

See Yimin Ji poster for explanation
Conclusions

• PPS has responsibility for the coding of L1A, L1B and some of L1C GMI code

• Considerable experience is brought forward from TMI calibration. However substantial interactions are taking place with the GMI contractor calibration efforts
  – Incorporate contractor calibration efforts into the production calibration
  – Integrate and translate all contractor provided calibration code
  – Use all appropriate calibration efforts to quality control calibration

• Provide data early in the project for testing of algorithms
  – PPS generate orbits of synthetic data
  – GPM science team provided satellite simulator data for science code testing: appropriate months of data to allow testing of level 3 data

• Simulated data used
  – Project mission simulations and
  – Operational acceptance testing