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 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 degree phase

-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
Synthetic and Simulated Data

• **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