GCOM-W1 AMSR2 Algorithm Software Processor (GAASP)

Day 1 Products
Algorithm Readiness Review

April 10, 2014

Presented By: Paul Chang\textsuperscript{3}, Zorana Jelenak\textsuperscript{2}, Patrick Meyers\textsuperscript{4}, Suleiman Alesweiss\textsuperscript{5}, Letitia Souliard\textsuperscript{1}, and Tom King\textsuperscript{1}

\textsuperscript{1}IMSG
\textsuperscript{2}UCAR
\textsuperscript{3}NOAA/NESDIS/STAR
\textsuperscript{4}CICS
\textsuperscript{5}GST
### Review Agenda

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<td>CTR Report</td>
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<td>Requirements</td>
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<tr>
<td>Software Architecture</td>
<td>9:30 – 9:40</td>
<td>Letitia Souliard</td>
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<td>Validation</td>
<td>9:40 – 10:50</td>
<td>Suleiman Alsweiss, Patrick Meyers, and Letitia Souliard</td>
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<td>Risk and Actions</td>
<td>10:50 – 11:00</td>
<td>Tom King</td>
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<td>Summary and Conclusions</td>
<td>11:00 – 11:05</td>
<td>Paul Chang</td>
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Review Outline

- Introduction
- CTR Report
- Requirements
- Software Architecture
- Validation
- Risks and Actions
- Summary and Conclusions
Introduction

Presented by

Paul Chang
NOAA/NESDIS/STAR
The "Global Change Observation Mission" (GCOM) is a series of JAXA Earth missions lasting 10-15 years designed to obtain observations related to water and climate.

The GCOM-W1 platform was launched May 18, 2012 and is the first satellite of the GCOM-W series.

GCOM-W1 is in a sun-synchronus orbit (~700 km altitude) and part of the “A-Train” with an ascending node equator crossing time of 13:30 UTC.

The AMSR2 (Advanced Microwave Scanning Radiometer 2) instrument onboard the GCOM-W1 satellite will continue Aqua/AMSR-E observations of water vapor, cloud liquid water, precipitation, SST, sea surface wind speed, sea ice concentration, snow depth, and soil moisture.
Stakeholder Roles

- The NOAA JPSS Office (NJO) is providing funding to OSD, STAR, and OSPO to operationally generate and make available AMSR2 SDR and EDR products to support NOAA’s user needs.

- OSD, through their ESPDS development contract, will have their contractor (Solers) develop a system called the GCOM-W1 Processing and Distribution System (GPDS) to perform the following tasks.
  » Ingest AMSR2 RDRs and ancillary data.
  » Run the JAXA RDR-to-SDR software.
  » Run the STAR GCOM-W1 AMSR2 Algorithm Software Processor (GAASP).
  » Transfer products for distribution.
  » Interact with OSPO monitoring and control systems.
Stakeholder Roles

• **STAR will:**
  » Develop a software package, called the GCOM-W1 AMSR2 Algorithm Software Processor (GAASP), to generate the AMSR2 EDRs and perform product reformatting to netCDF4.
  » Develop operational documentation for the GAASP package and the EDR algorithms following existing SPSRB templates.
  » Deliver the GAASP and documentation to the OSD contractor for integration into their GPDS.

• **OSPO will:**
  » Receive the GPDS (with JAXA and GAASP packages integrated into it) from the OSD contractor.
  » Operationally run and maintain the GPDS for the lifecycle of the project.
GCOM-W1 Project Organization

**Customers/Users**
- NWS, GMAO, NRL/FNMOC
- STAR, NCDC/CLASS
- UK Met Office, ECMWF, DWD
- Meto-France, CMC, EUMETSAT

**Project Manager - Kirk Liang**
- Project Scientist – Paul Chang

**PMO**
- Thomas Brigham

**OSD/ESPDS**
- Rick Vizbulis (ESPDS PM)
- Kirk Liang (GCOM PM)
- Gene Legg (System Development)
- Tom Schott (System Requirements)
- Geoff Goodrum (System Interface - NDE)

**STAR**
- Paul Chang (STAR Project Lead)
- Ralph Ferraro (STAR Project Deputy)
- Walter Wolf (Integration Lead)
- Zorana Jelenak (EDR lead)
- Fuzhong Weng (SDR lead)

**OSPO**
- Limin Zhao (OSPO GCOM-W1 Project Lead, PAL)
  - formerly Joe Mani (System Integration – ESPC Infrastructure)
- Paul Haggerty (ESPC Operations Team Lead)

**EDR Development and Validation**
- Zorana Jelenak (Lead)
- Jun Park - EDR Science Support
- Patrick Meyers – EDR/Precipitation Science Support
- Suleiman Alsweiss – SDR/EDR Science Support
- Qi Zhu – Scientific Programming Support
- Micah Baker – IT support
- Jeff Key – Science Lead (ice/snow)
- Walt Meir – Science Support (ice)
- Cezar Kongoli – Science Support (snow)
- Eileen Maturi/Andy Harris – Science Support (SST)
- Xiwu ‘Jerry’ Zhan – Science Lead (soil moisture)
- Jicheng Liu – Science Support (soil moisture)

**Data Providers**
- JAXA, NSC/NSAT

**Solers GPDS WA#8**
- Dan Beall (Prog. Manager)
- Ed Richard (Proj. Manager)
- Robert Mann (Sys Engr)
- David Chang (Soft Engr)

**SDR Validation & Monitoring**
- Fuzhong Weng (Lead)
- Hu Yang – Science Support

**OSD/ESPDS**
- Rick Vizbulis (ESPDS PM)
- Kirk Liang (GCOM PM)
- Gene Legg (System Development)
- Tom Schott (System Requirements)
- Geoff Goodrum (System Interface - NDE)

**GAASP Development**
- Tom King (Development Lead)
- Letitia Soulliard (Development)
- Michael Wilson (Algorithm Integration)
- Peter Keehn (Algorithm Integration)
- Yunhui Zhao (CM)
- Larisa Koval (Documentation)
- Yi Song (BUFR)
GAASP development will result in 4 deliveries:

Delivery 1 (12/18/2013):

» Day 1 GAASP Product Capability
   » Microwave Brightness Temperature (MBT)
   » Total Precipitable Water (TPW)
   » Cloud Liquid Water (CLW)
   » Precipitation Type/Rate (PT/R)
   » Sea Surface Temperature (SST)
   » Sea Surface Wind Speed (SSW)

» GAASP netCDF4 Reformatting Capability
» SPSRB documentation
STAR GAASP Development

- **Delivery 2 (9/15/2014)**
  - Day 2 GAASP Product Capability
    - Soil Moisture (SM)
    - Sea Ice Characterization (SIC)
    - Snow Cover/Depth (SC/D)
    - Snow Water Equivalent (SWE)
    - Surface Type (ST)
  - Updated GAASP netCDF4 Reformatting Capability
  - Updated SPSRB Documentation

- **Delivery 3 (9/21/2015) and 4 (9/19/2016)**
  - Updates and enhancements to existing EDRs
<table>
<thead>
<tr>
<th>ID</th>
<th>Task Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>STAR GCOM-W1 Project</td>
</tr>
<tr>
<td>2</td>
<td>Algorithm Definition</td>
</tr>
<tr>
<td>3</td>
<td>Evaluate existing algorithms</td>
</tr>
<tr>
<td>4</td>
<td>Define preliminary ancillary datasets</td>
</tr>
<tr>
<td>5</td>
<td>Preliminary algorithm evaluation</td>
</tr>
<tr>
<td>6</td>
<td>Preliminary system design</td>
</tr>
<tr>
<td>7</td>
<td>Preliminary Design Review</td>
</tr>
<tr>
<td>8</td>
<td>Hardware definition</td>
</tr>
<tr>
<td>9</td>
<td>Define/Choose algorithms</td>
</tr>
<tr>
<td>10</td>
<td>Prepare documents for CDR</td>
</tr>
<tr>
<td>11</td>
<td>Critical Design Review</td>
</tr>
<tr>
<td>12</td>
<td>Begin developing product NetCDF4 readers and writers</td>
</tr>
<tr>
<td>13</td>
<td>Initial product validation</td>
</tr>
<tr>
<td>14</td>
<td>Test case processed</td>
</tr>
<tr>
<td>15</td>
<td>Sample Algorithm Package Delivery</td>
</tr>
<tr>
<td>16</td>
<td>Conduct Code Test Review</td>
</tr>
<tr>
<td>17</td>
<td>Extensive product validation</td>
</tr>
<tr>
<td>18</td>
<td>Initial algorithm package delivery</td>
</tr>
<tr>
<td>19</td>
<td>OSPO Contractor Staff Training for GCOM L2 system</td>
</tr>
<tr>
<td>20</td>
<td>Software Code Review</td>
</tr>
<tr>
<td>21</td>
<td>Pre-operational product output evaluated &amp; tested within the ESPC environment</td>
</tr>
<tr>
<td>22</td>
<td>Prepare Documentation</td>
</tr>
<tr>
<td>23</td>
<td>Update software</td>
</tr>
<tr>
<td>24</td>
<td>All SPSRB documentation is complete</td>
</tr>
<tr>
<td>25</td>
<td>Prepare for Transition to Operations</td>
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<tr>
<td>26</td>
<td>Conduct Algorithm Readiness Review</td>
</tr>
<tr>
<td>27</td>
<td>Algorithm update delivery_1 to operations</td>
</tr>
<tr>
<td>28</td>
<td>Validate Pre-Operational Products</td>
</tr>
<tr>
<td>29</td>
<td>Transition pre-operational system to operations</td>
</tr>
<tr>
<td>30</td>
<td>Operational Phase Begins</td>
</tr>
<tr>
<td>31</td>
<td>Algorithm update delivery_2 to operations</td>
</tr>
<tr>
<td>32</td>
<td>Algorithm update delivery_3 to operations</td>
</tr>
<tr>
<td>33</td>
<td>Algorithm update delivery_4 to operations</td>
</tr>
<tr>
<td>34</td>
<td>Operational product quality assurance and validation</td>
</tr>
<tr>
<td>35</td>
<td>Product enhancements and refinements</td>
</tr>
<tr>
<td>36</td>
<td>Final software and documentation deliver to CLASS</td>
</tr>
</tbody>
</table>

![Project Timeline Diagram](image)
The purpose of the Algorithm Readiness Review (ARR) is to:

- Present the results of the product validation to show that the products are meeting the requirements.
- Present and verify the contents of the Delivered Algorithm Package (DAP)
- Review any updates to project schedule, requirements, and risks.
GAASP ARR
Entry Criteria

- Updated Requirements Allocation Document (RAD)

- Review Item Disposition (RID)

- Updated Code Test Review (CTR) slide package.

- GAASP Day 1 Delivered Algorithm Package as a Delivered Algorithm Package (DAP) containing:

  - Algorithm Readiness Review (ARR) slide package
GAASP ARR
Exit Criteria

• Update RAD, if necessary

• Review Item Disposition (RID)
  » Updated to contain ARR risks and actions.
  » Closure date provided for any open risks.

• Updated ARR slide package
Review Outline

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The GAASP CTR Report is available as the Review Item Disposition (RID) shared on Google Docs (GAASP_Review_Item_Disposition).

The RID covers all open and closed risks, actions, issues, and mitigations throughout the lifecycle of the project.

Risks closed in previous reviews are not shown here, but are located in the RID.

Risks shown here that are marked as “closed” will be closed with the approval of this review.
**PDR Risk**

- **Risk #1**: External interfaces to the GAASP package and associated requirements are not yet determined. This information needs to be provided as soon as possible by the OSD contractors. There could be wasted resources and development delays if we assume the wrong interfaces to GPDS.

- **Risk Assessment**: Low
- **Impact**: Low
- **Likelihood**: Low
- **Risk Mitigation**:
  - The GAASP team will meet regularly with the GPDS developers to work out the run requirements, software interfaces, and production rules. Initial meetings have gone well and the OSD contractors have not indicated any concerns with our initial design.
  - GAASP developers plan to make early prototype deliveries of GAASP to test production rules and interfaces to the GPDS.

- **Status**: Closed
• **Risk #3**: Development team needs to know if there is an archive requirement. This evaluation must happen even before the SA and metadata are developed.

• **Risk Assessment**: Low

• **Impact**: Low

• **Likelihood**: High

• **Risk Mitigation**:
  » The GAASP development team has put metadata into the netCDF4 headers that they believe will meet the potential needs of CLASS and end users.

• **Status**: Open
PDR Risk

- **Risk #8**: Brightness temperature calibration issues
- **Risk Assessment**: Medium
- **Impact**: Medium
- **Likelihood**: Medium
- **Risk Mitigation**: GAASP science team has identified significant biases. These have been brought to JAXA’s attention over 2 telecons and are being addressed.
- **Status**: Open
Risk #9: RFI impacts on C and X-band brightness temperatures

Risk Assessment: Medium
Impact: Medium
Likelihood: Medium
Risk Mitigation:
» These have been characterized. The GAASP science team has been working with JAXA on correction/flagging routines.

Status: Open
PDR Risk

- **Risk #10:** Rain and Snow Flag Quality. May lead to Erroneous EDR product values because of incorrect rain and snow identification.

- **Risk Assessment:** Low
- **Impact:** Low
- **Likelihood:** Low
- **Risk Mitigation:**
  - Characterize the quality flag performance utilizing and implement changes as needed.
  - Will need to collect data over a seasonal cycle to fully characterize.
- **Status:** Open
Risk #12: There is a general risk for changes that need to be made to the JPSS L1RD Supplement section 6 to align product requirements with the capabilities of the instruments and the algorithms as well as with actual user needs.

Risk Assessment: Medium

Impact: Medium

Likelihood: Medium

Risk Mitigation:
» Work with NJO to update GCOM product requirements.

Status: Open
- **Risk #13:** GAASP error notifications are made by email. This should be optional.
- **Risk Assessment:** Low
- **Impact:** Low
- **Likelihood:** Low
- **Risk Mitigation:**
  - Tish will make the updates.
- **Status:** Closed
CTR Risk

- **Risk #14:** If rain algorithm (GPROF) fails, the ocean EDRs should still be produced. However, currently this is not the case.

- **Risk Assessment:** Low
- **Impact:** Low
- **Likelihood:** Low
- **Risk Mitigation:**
  » Tish will make the updates to allow ocean EDRs to still be produced if there’s no GPROF output.
- **Status:** Closed
• **Risk #15:** There should be checks on the age of the ancillary data provided to the GAASP code. Currently, these checks are not in place.

• **Risk Assessment:** Low

• **Impact:** Low

• **Likelihood:** Low

• **Risk Mitigation:**
  » Tish to make modifications and work with science teams to get the meaningful thresholds.

• **Status:** Closed
**Risk #16:** The ocean EDRs should be able to run if there is no Sea Ice ancillary data. This capability is currently not present.

- **Risk Assessment:** Low
- **Impact:** Low
- **Likelihood:** Low
- **Risk Mitigation:**
  - Tish to make modifications to allow ocean EDRs to run if there’s no Sea Ice ancillary data.
- **Status:** Closed
CTR Risk

- **Risk #17:** The metadata in the GAASP netCDF4 output files should contain the ancillary input file names.
- **Risk Assessment:** Low
- **Impact:** Low
- **Likelihood:** Low
- **Risk Mitigation:**
  » Tish to make modifications to add in this information.
- **Status:** Closed
• **Risk #18:** The units for some of the ocean products need to be corrected.

• **Risk Assessment:** Low

• **Impact:** Low

• **Likelihood:** Low

• **Risk Mitigation:**
  » Tish to make modifications.

• **Status:** Closed
CTR Risks

- **Risk #19**: Need to change output file names from GAASP to AMSR2 to avoid confusion with the existing GASP product at OSPO.
- **Risk Assessment**: Low
- **Impact**: Low
- **Likelihood**: Low
- **Risk Mitigation**: Tish to make modifications.
- **Status**: Closed
CTR Risks

- **Risk #20:** GAASP file name content and name patterns need to meet both GPDS and NDE requirements if GAASP is to run in NDE version 2.0. The risk is that we want to avoid changing file names and contents on the end users in the middle of the operational lifecycle of this project.
  - **Risk Assessment:** Low
  - **Impact:** Low
  - **Likelihood:** Low
  - **Risk Mitigation:**
    - Tish to make modifications to files. The DARs transferring data to DDS and transferring data to STAR need to be updated.
  - **Status:** Closed
CTR Report Summary

- 14 Risks Total:
  - 3 Medium
  - 11 Low

- With the approval of the ARR reviewers:
  - 9 risk can be closed
    - 9 Low
  - 5 risks will remain open
    - 3 Medium
    - 2 Low
Review Outline

- Introduction
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Requirements

Presented by

Tom King
IMSG
GAASP Requirements

- All requirements presented here are contained within the GAASP Requirements Allocation Document (RAD) made available in Google Docs (GAASP_RAD_1.3.docx).

- Requirements were obtained from the following:
  » Project Office Requirements (JPSS L1RD Supplement v2.7)
  » Project Plan (GCOM-W1_Project_Plan_April_30_2012.doc)
  » Contacting users (identified by coordinating Limin Zhao, Ralph Ferraro, and Eileen Maturi).
  » SPSRB process (coding/security standards and documentation requirements for OSPO).
  » Requirements associated with running within the GPDS and in OSPO (production rules, interfaces, QC/monitoring, delivery/packaging).
The requirements have already presented in the previous reviews (PDR, CDR, CTR).

The requirements have not changed since CTR. The slides are here for completeness, but it will not be presented again.
## AMSR2 Products and Users

<table>
<thead>
<tr>
<th>Product</th>
<th>Format</th>
<th>User</th>
</tr>
</thead>
</table>
| Microwave Brightness Temperatures| netCDF4 | EMC (NCEP) for SMOPS - Michael Ek  
OSPO (SAB) need 36.5 and 89 GHz channels...both H and V polarities - Sheldon Kusselson, Michael Turk  
NWS/NHC - Michael Brennan  
NAVOCEAN – Bruce McKenzie         |
| Total Precipitable Water         | netCDF4 | NWS (CPC, NWSFO, NHC) for use in blended products - Jim Heil, Mike Johnson, Michael Brennan  
OSPO (SAB) - Sheldon Kusselson, Michael Turk |
| Cloud Liquid Water               | netCDF4 | NCEP/EMC - Brad Ferrier                                                                                                             |
| Precipitation Type/Rate          | netCDF4 | NWS (CPC, NWSFO, NESDIS, NHC) - Pingping Xie, Jim Heil, Michael Brennan  
OSPO (SAB) - Sheldon Kusselson, Michael Turk  
NCEP/EMC - Brad Ferrier           |
| Sea Surface Temperature          | netCDF4 | EMC (NCEP) - Bert Katz  
NWS/NHC - Michael Brennan  
CoastWatch/OceanWatch - Kent Hughes  
Coral Reef Watch - Mark Eakin  
Global High Resolution Sea Surface Temperature Group (International) - Peter Minnette  
NWS/NCEP/EMC/MMAB - Robert Grumbine  
NWS/NCEP/OPC - Joe Sienkiewicz - Ming Ji,  
NWS/NHC - Jiann-Gwo Jing  
NWS/NCEP/CPC - Pingping Xie  
NMFS/Pacific Marine Lab - Cara Wilson  
JCSDA - Eric Bayler  
NWS/NCEP/EMC/MMAB - Avichal Mehra  
Navy - Bruce McKenzie  
NASA/SPoRT - Gary Jedlevoc  
OAR/AOML - Gustavo Goni  
OAR/ESRL - Gary Wick               |
# AMSR2 Products and Users

<table>
<thead>
<tr>
<th>Product</th>
<th>Format</th>
<th>User</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea Surface Winds</td>
<td>netCDF4</td>
<td>OSPO (SAB) - Sheldon Kusselson, Michael Turk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NWS/NHC - Michael Brennan</td>
</tr>
<tr>
<td>Soil Moisture</td>
<td>netCDF4</td>
<td>EMC (NCEP) via SMOPS - Michael Ek</td>
</tr>
<tr>
<td>Sea Ice Characterization</td>
<td>netCDF4</td>
<td>NIC - Sean Helfrich</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NAVOCEAN – Bruce McKenzie</td>
</tr>
<tr>
<td>Snow Cover/Depth</td>
<td>netCDF4</td>
<td>NIC - Sean Helfrich</td>
</tr>
<tr>
<td>Snow Water Equivalent</td>
<td>netCDF4</td>
<td>NIC - Sean Helfrich</td>
</tr>
<tr>
<td>Surface Type</td>
<td>netCDF4</td>
<td>NWS (CPC, NWSFO) for use in blended hydro products - Jim Heil</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EMC – SMOPS Mike Ek</td>
</tr>
</tbody>
</table>

*Is SMOPS funded to ingest and use AMSR2 Soil Moisture/Surface Type EDRs? Mike Ek has indicated via email that he would like to receive AMSR2 soil moisture from SMOPS.*
**Basic Requirement 1.0**

**Requirement 1.0:** The STAR GCOM processing system shall produce a GCOM imagery product.

<table>
<thead>
<tr>
<th>EDR Attribute</th>
<th>Threshold</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable conditions</td>
<td></td>
<td>1. Delivered under &quot;all weather&quot; conditions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Each channel shall be provided at its highest native resolution.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. All channels shall be Vertically and Horizontally polarized.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. All channels sampled at 10 km except 89 GHz, which is at 5 km.</td>
</tr>
<tr>
<td>Horizontal sampling interval</td>
<td>10 km, except 89 GHz which is at 5 km</td>
<td>Same as threshold</td>
</tr>
<tr>
<td>Mapping uncertainty, 3 sigma</td>
<td>5 km</td>
<td>3 km</td>
</tr>
<tr>
<td>Refresh</td>
<td>At least 90% coverage of the globe about every 20 hours (monthly average)</td>
<td>Not Specified</td>
</tr>
<tr>
<td>Latency</td>
<td>16 minutes</td>
<td></td>
</tr>
</tbody>
</table>

Change “Horizontal sampling interval” to “Horizontal Cell Size”. This will make it consistent with the EDR requirements that follow.
Basic Requirement 2.0

- **Requirement 2.0:** The STAR GCOM processing system shall produce a total precipitable water (TPW) product.

### Table 2.0 GCOM Total Precipitable Water

<table>
<thead>
<tr>
<th>EDR Attribute</th>
<th>Threshold</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal cell size</td>
<td>10km (21 GHz FOV sampling)</td>
<td>5 km</td>
</tr>
<tr>
<td>Mapping uncertainty, 3 sigma</td>
<td>5 km</td>
<td>1 km</td>
</tr>
<tr>
<td>Measurement range</td>
<td>1 – 75 mm</td>
<td>1 - 100 mm</td>
</tr>
<tr>
<td>Measurement uncertainty</td>
<td>2mm or 10% whichever is greater</td>
<td>1 mm or 4% whichever is greater</td>
</tr>
<tr>
<td>Measurement accuracy</td>
<td>1 mm</td>
<td>0.2mm</td>
</tr>
<tr>
<td>Refresh</td>
<td>At least 90% coverage of the globe about every 20 hours (monthly average)</td>
<td>Not Specified</td>
</tr>
<tr>
<td>Coverage</td>
<td>Ice-free global ocean</td>
<td>Ice-free global ocean</td>
</tr>
<tr>
<td>Latency</td>
<td>16 minutes</td>
<td></td>
</tr>
</tbody>
</table>
Basic Requirement 3.0

- **Requirement 3.0:** The STAR GCOM processing system shall produce a cloud liquid water (CLW) product.

<table>
<thead>
<tr>
<th>Table 3.0 GCOM Cloud Liquid Water</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EDR Attribute</strong></td>
</tr>
<tr>
<td>Applicable conditions</td>
</tr>
<tr>
<td>Horizontal cell size</td>
</tr>
<tr>
<td>Vertical reporting interval</td>
</tr>
<tr>
<td>Mapping uncertainty, 3 sigma</td>
</tr>
<tr>
<td>Measurement uncertainty (1 kg/m² = 1 mm)</td>
</tr>
<tr>
<td>Measurement Accuracy</td>
</tr>
<tr>
<td>Coverage</td>
</tr>
<tr>
<td>Refresh</td>
</tr>
<tr>
<td>Range (1 kg/m² = 1 mm)</td>
</tr>
<tr>
<td>Latency</td>
</tr>
</tbody>
</table>

There is no known CLW product over land derived from microwave data.
**Requirement 4.0:** The STAR GCOM processing system shall produce a precipitation type/rate (PT/R) product.

<table>
<thead>
<tr>
<th>EDR Attribute</th>
<th>Threshold</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable conditions</td>
<td></td>
<td>Delivered under &quot;all weather&quot; conditions</td>
</tr>
<tr>
<td>Horizontal cell size</td>
<td>5 km land (89 GHz FOV); 5 km ocean (37 GHz FOV size); 5-10 km sampling</td>
<td>5.0 km</td>
</tr>
<tr>
<td>Mapping uncertainty, 3 sigma</td>
<td>&lt; 5 km</td>
<td>3.0 km</td>
</tr>
<tr>
<td>Measurement range</td>
<td>0 – 50 mm/hr</td>
<td>Not Specified</td>
</tr>
<tr>
<td>Measurement precision</td>
<td>0.05 mm/hr</td>
<td>0.05 mm/hr</td>
</tr>
<tr>
<td>Measurement uncertainty</td>
<td>2 mm/hr over ocean; 5 mm/hr over land</td>
<td>2 mm/hr</td>
</tr>
<tr>
<td>Refresh</td>
<td>At least 90% coverage of the globe about every 20 hours (monthly average)</td>
<td>Not Specified</td>
</tr>
<tr>
<td>Precipitation type</td>
<td>Stratiform or convective</td>
<td>Not Specified</td>
</tr>
<tr>
<td>Latency</td>
<td>16 minutes</td>
<td></td>
</tr>
</tbody>
</table>

HCS for 37GHz FOV is 10km. Change (threshold) 5km ocean to 10km ocean; (objective) 5km both ocean and land Mapping uncertainty need to be consistent within all AMSR-2 EDRs. Currently set to 5km for other EDRs and 1km Obj.
**Basic Requirement 5.0**

- **Requirement 5.0:** *The STAR GCOM processing system shall produce a snow cover/depth (SC/D) product.*

<table>
<thead>
<tr>
<th>EDR Attribute</th>
<th>Threshold</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable conditions</td>
<td></td>
<td>Delivered under &quot;all weather&quot; conditions</td>
</tr>
<tr>
<td>Sensing depth</td>
<td>0 – 60 cm</td>
<td>1 m</td>
</tr>
<tr>
<td>Horizontal cell size</td>
<td>10 km</td>
<td>5 km</td>
</tr>
<tr>
<td>Mapping uncertainty, 3 sigma</td>
<td>5 km</td>
<td>1 km</td>
</tr>
<tr>
<td>Snow depth ranges</td>
<td>5 – 60 cm</td>
<td>&gt; 8 cm; &gt; 15 cm; &gt; 30 cm; &gt; 51 cm; &gt; 76 cm</td>
</tr>
<tr>
<td>Measurement uncertainty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-- Clear</td>
<td>80% probability of correct snow/no snow classification; Snow Depth: 20 cm (30 cm if forest cover exceeds 30%)</td>
<td>10% for snow depth</td>
</tr>
<tr>
<td>-- Cloudy</td>
<td>80% probability of correct snow/no snow classification; Snow Depth: 20 cm</td>
<td>Not Specified</td>
</tr>
<tr>
<td>Refresh</td>
<td>At least 90% coverage of the globe about every 20 hours (monthly average)</td>
<td>Not Specified</td>
</tr>
<tr>
<td>Latency</td>
<td>16 minutes</td>
<td></td>
</tr>
</tbody>
</table>
**Requirement 6.0:** The STAR GCOM processing system shall produce a surface type (ST) product.

| Table 6.0   -   Surface Type (AMSR-2) |
|-------------|--------------------------------------|
| **EDR Attribute** | **Threshold (1)** | **Objective** |
| Applicable conditions | Delivered under “all weather” conditions | Delivered under “all weather” conditions |
| Horizontal cell size | 25 km | 1 km |
| Mapping uncertainty, $3\sigma$ | 5 km | 1 km |
| Measurement Range | 8 hydrological classes (2) | 13 classes of land types listed in Note (3) |
| Measurement Precision | 5% | 2% |
| Measurement Accuracy | 70% for 17 types | 80% |
| Refresh | >90% coverage of globe every 20 hrs (4) | n/s |
| Latency | 16 minutes |  |

**Note:**

(1) Satisfied by VIIRS under “probably clear” and “probably cloudy” conditions.
(2) 1) Standing water, 2) Dense veg (jungle), 3) Herb veg, 4) Desert, 5) Snow, 6) Urban, 7) Wetland, 8) Raining area
(4) Consistent with AMSR2 cross-track swath width of 1450km.
**Basic Requirement 7.0**

- **Requirement 7.0:** The STAR GCOM processing system shall produce a soil moisture (SM) product.

<table>
<thead>
<tr>
<th>Table 7.0 - GCOM-W Soil Moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EDR Attribute</strong></td>
</tr>
<tr>
<td>Applicable conditions</td>
</tr>
<tr>
<td>Sensing depth</td>
</tr>
<tr>
<td>Horizontal cell size</td>
</tr>
<tr>
<td>Mapping uncertainty, 3 sigma</td>
</tr>
<tr>
<td>Measurement Uncertainty</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Measurement range</td>
</tr>
<tr>
<td>Refresh</td>
</tr>
<tr>
<td>Latency</td>
</tr>
</tbody>
</table>

**Note:**
(1) Per AMSR-E legacy and user convenience, 25km can be obtained.
(2) Absolute soil moisture unit (m³/m³ volume %) is preferred by most users of NWP community.
(3) This Refresh requirement is consistent with the AMSR-2 Cross-track Swath Width design of 1450 km for a single orbit plane.
Basic Requirement 8.0

- **Requirement 8.0:** The STAR GCOM processing system shall produce a sea ice characterization (SIC) product.

<table>
<thead>
<tr>
<th>EDR Attribute</th>
<th>Threshold</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable conditions</td>
<td></td>
<td>Delivered under “all weather” conditions</td>
</tr>
<tr>
<td>Vertical coverage</td>
<td>Ice surface</td>
<td>Ice surface</td>
</tr>
<tr>
<td>Horizontal cell size</td>
<td>10 km</td>
<td>5 km</td>
</tr>
<tr>
<td>Mapping uncertainty, 3 sigma</td>
<td>5 km</td>
<td>3 km</td>
</tr>
<tr>
<td>Measurement range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-- Ice concentration</td>
<td>1/10 – 10/10</td>
<td>0 – 100%</td>
</tr>
<tr>
<td>-- Ice age classes</td>
<td>Ice free, first-year, multiyear ice</td>
<td>Ice free, nilas, grey white, grey, white, first year medium, first year thick, second year, and multiyear; smooth and deformed ice</td>
</tr>
</tbody>
</table>
### Table 8.0.2 GCOM Sea Ice Characterization

<table>
<thead>
<tr>
<th>EDR Attribute</th>
<th>Threshold</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement uncertainty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-- Ice concentration</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>Probability of correct typing of ice age classes</td>
<td>70%</td>
<td>90%</td>
</tr>
<tr>
<td>Refresh</td>
<td>At least 90% coverage of the globe about every 20 hours (monthly average)</td>
<td>Not Specified</td>
</tr>
<tr>
<td>Geographic coverage</td>
<td>All ice-covered regions of the global ocean</td>
<td>All ice-covered regions of the global ocean</td>
</tr>
<tr>
<td>Latency</td>
<td>16 minutes</td>
<td></td>
</tr>
</tbody>
</table>

This should be a daily product?
**Requirement 9.0**: The STAR GCOM processing system shall produce a sea surface temperature (SST) product.

<table>
<thead>
<tr>
<th>EDR Attribute</th>
<th>Threshold</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable conditions</td>
<td></td>
<td>Delivered under “all weather” conditions</td>
</tr>
<tr>
<td>Horizontal cell size</td>
<td>40 km</td>
<td>20 km</td>
</tr>
<tr>
<td>Mapping uncertainty, 3 sigma</td>
<td>5 km</td>
<td>3 km</td>
</tr>
<tr>
<td>Measurement range</td>
<td>271 – 313 K</td>
<td>271 – 313 K</td>
</tr>
<tr>
<td>Measurement accuracy, skin &amp; bulk</td>
<td>0.5 K</td>
<td>0.1 K</td>
</tr>
<tr>
<td>Measurement uncertainty</td>
<td>1.0 K</td>
<td>0.5 K</td>
</tr>
<tr>
<td>Refresh</td>
<td>At least 90% coverage of the globe about every 20 hours (monthly average)</td>
<td>Not Specified</td>
</tr>
<tr>
<td>Geographic coverage</td>
<td>Global oceans</td>
<td>Global oceans</td>
</tr>
<tr>
<td>Latency</td>
<td>16 minutes</td>
<td></td>
</tr>
</tbody>
</table>

*MW radiometers measure skin not bulk SST*
Basic Requirement 10.0

- **Requirement 10.0:** The STAR GCOM processing system shall produce a sea surface wind (SSW) product.

### Table 10.0.1 GCOM Sea Surface Wind – Speed

<table>
<thead>
<tr>
<th>EDR Attribute</th>
<th>Threshold</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable conditions:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delivered under “all weather” conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal cell size (Wind speed)</td>
<td>33 km (10.7 GHz FOV size); 10 km sampling</td>
<td>1 km</td>
</tr>
<tr>
<td>Mapping uncertainty, 3 sigma</td>
<td>TBS-11</td>
<td>1 km</td>
</tr>
<tr>
<td>Measurement range (Speed)</td>
<td>2 – 30 m/sec</td>
<td>1 – 50 m/sec</td>
</tr>
<tr>
<td>Measurement uncertainty (Speed)</td>
<td>Greater of 2.0 m/sec or 10%</td>
<td>Not Specified</td>
</tr>
<tr>
<td>Measurement Accuracy</td>
<td>0.5 m/sec</td>
<td>0.2 m/sec</td>
</tr>
<tr>
<td>Refresh</td>
<td>At least 90% coverage of the globe about every 20 hours (monthly average)</td>
<td>Not Specified</td>
</tr>
<tr>
<td>Geographic Coverage</td>
<td>Global Ice-free Oceans</td>
<td>Global Ice-free Oceans</td>
</tr>
<tr>
<td>Latency</td>
<td>16 minutes</td>
<td></td>
</tr>
</tbody>
</table>

Threshold requirement cannot have 2 different HCS requirements. Objective HCS not compatible with AMSR-2 capability. (Threshold) 33km (10.7GHz FOV); (Objective) 10km. Mapping uncertainty need to be consistent within all AMSR-2 EDRs. Currently set to 5km for other EDRs.
**Requirement 11.0:** The STAR GCOM processing system shall produce a snow water equivalent (SWE) product.

<table>
<thead>
<tr>
<th>Table 11.0 GCOM Snow Water Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EDR Attribute</strong></td>
</tr>
<tr>
<td>Applicable conditions</td>
</tr>
<tr>
<td>Horizontal cell size</td>
</tr>
<tr>
<td>Mapping uncertainty, 3 sigma</td>
</tr>
<tr>
<td>Measurement range</td>
</tr>
<tr>
<td>Measurement uncertainty</td>
</tr>
<tr>
<td>-- Shallow to moderate snow packs (10 – 100 mm)</td>
</tr>
<tr>
<td>-- High snow accumulation (above 100 mm)</td>
</tr>
<tr>
<td>Refresh</td>
</tr>
<tr>
<td>Latency</td>
</tr>
</tbody>
</table>
Basic Requirement 12.0

- **Requirement 12.0:** The STAR GCOM-W1 AMSR2 Algorithm Software Processor (GAASP) development team shall deliver the GAASP software package to the OSD contractors for integration into their data handling and scheduling system, the GCOM-W1 Processing and Distribution System (GPDS).

  » It is our understanding that the OSD contractor-built system will, in turn, be delivered to OSPO where it will run operationally.

- **Requirement 12.1:** The GAASP package shall be delivered to the OSD contractors as part of a Delivered Algorithm Package (DAP). The DAP shall contain all the code (programs and scripts), test data, and SPSRB-required documentation.
• **Requirement 12.2:** The STAR GCOM-W1 GAASP code contained within the DAP shall adhere to SPSRB coding standards and ESPC security standards.

• **Requirement 12.3:** The STAR GAASP development team shall deliver to the OSD contractors the following SPSRB-required documentation as part of the DAP:
  
  » A System Maintenance Manual (SMM)
  » An External Users Manual (EUM)
  » An Algorithm Theoretical Basis Document (ATBD)
Basic Requirement 12.0

- **Requirement 12.4:** The GAASP software shall consist of the STAR EDR algorithm code wrapped in Perl scripts. These scripts will be scheduled and invoked by the GPDS.

  » These scripts shall also drive the additional front and back end data format tailoring programs to assist the science code. This approach will minimize modification of the science code while providing users with the required format and providing a common interface to the GPDS.
Basic Requirement 12.0

- **Requirement 12.5:** The GAASP software shall be able to compile and run on the ESPC production platform (64-bit Linux running Red Hat).
  
  » Details about target platform such as available memory, disk space, CPUs, and compilers are to be determined.

- **Requirement 12.6:** The GAASP code shall be able to compile such that it does not require access to compiler libraries at run time (compilers not allowed on OSPO production machines).
Basic Requirement 13.0

- **Requirement 13.0**: The GAASP software shall be able to generate all the required GCOM EDR products.

- **Requirement 13.1**: The GAASP software shall read and use the AMSR2 SDR (native and remapped) HDF5 files produced by the JAXA code. The data from these HDF5 files will be read in by the GAASP preprocessor code, RFI and bias corrections will be applied, and the output passed to the actual EDR programs will be HDF5.

- **Requirement 13.2**: The GAASP postprocessor software shall tailor the STAR EDR program output files for delivery into netCDF4.
Basic Requirement 13.0

- **Requirement 13.3:** The GAASP software shall perform error checking, handling, and logging.
  
  » The GAASP software shall check the return value of all system-level and script level commands within the driver scripts. Success or failure of a given run shall be returned to the data handling and scheduling system (GPDS). All exits shall be graceful.
  
  » The GAASP software shall generate detailed human-comprehensible error messages; these shall be directed to log files in the local working directory.

- **Requirement 13.4:** The GAASP software shall produce flags that indicate “degradation” and “exclusion” conditions for products as defined in section 3.3 of the JPSS L1RD Supplement V2.7.
• **Requirement 13.5:** All GAASP output files made available to the distribution interface shall adhere to a slightly modified version of the NDE file naming convention.
  » Note: Date/Time strings will be in YYYYMMDDhhmms instead of YYYYMMDDhhmmssss (no tenths of second as this was an IDPS convention).

• **Requirement 13.6:** The GAASP software shall be able to read a Production Control File (PCF) produced by the GPDS and it will produce a Production Status File (PSF) containing the names of the successfully generated output files. The contents of these files shall adhere to existing NDE standards.
  » Note: Production rules associated with invocation of the algorithms (PCF generation) shall be negotiated with the OSD contractors and documented in the System Maintenance Manual.
Basic Requirement 14.0

- **Requirement 14.0:** The GAASP development team shall perform quality assurance on the software package and data products as well as assist with product quality monitoring activities at OSPO.

- **Requirement 14.1:** The GAASP developers shall conduct unit tests of the GAASP software. The unit tests shall be conducted, documented and then presented in a Code Test Review. This will validate the software functionality and the product quality.
Basic Requirement 14.0

- **Requirement 14.2:** The GAASP software shall produce data sets for the OSPO science quality monitoring of EDRs and stability monitoring of SDRs. This is also a requirement defined by sections 3.4 and 3.5 in the JPSS L1RD V2.7. Details are to be determined as this will require coordination with a separate joint OSPO/STAR project getting underway.

- **Requirement 14.3:** The GAASP software shall be submitted to OSPO for a Software Code Review to verify that the software meets SPSRB coding standards and ESPC security standards.
GAASP Requirements Summary

- Basic and derived requirements have been identified. They are recorded in the GAASP RAD and presented here.

- There is still additional work to be done regarding derived requirements for Day 2. These are identified as risks which will be summarized toward the end of this presentation.

- Updated requirements will be presented at the Day 2 ARR.
Review Outline

- Introduction
- CTR Report
- Requirements
- Software Architecture
- Validation
- Risks and Actions
- Summary and Conclusions
Software Architecture

Presented by

Letitia Soulliard
IMSG
• The GAASP Day 1 software architecture has already presented in the previous reviews (PDR, CDR, CTR).

• There have been some minor adjustments to the architecture since CTR. All of the software architecture slides are here for completeness, but only the updates made since CTR will be presented. These are highlighted in green.
GAASP Processing Architecture

- **Hardware Environment**
  - STAR Science/System Development and Test
  - Integration/Test and Production

- **Software Description**
  - System Level Flow
  - Unit Level Flow
GAASP Processing Architecture

- Data Files
  - Input Files
  - Ancillary Files (Dynamic/Static)
  - Output Files
  - Log/Monitoring Files
  - Resource Files
  - File Formats
GAASP Production and Development Hardware

- **STAR Development Hardware** (rhs8142.star1.nesids.noaa.gov)
  - Architecture: 64-bit Intel® Xeon™ X5680
  - OS Version: Red Hat Enterprise Linux 6
  - Diskspace: 72TB raw disk, ~30TB unallocated to logical volumes.
  - Number of Processors: 12
    - dual 6-core processors
  - Total Memory: 96GB RAM, DDR3
  - Processor Clockspeed: 3.33GHz
  - Fortran Compiler: Intel Fortran Composer XE (Version 12.1.3)
GPDS/GAASP
Integration Hardware

- Integration Hardware
  - 2 Dell PowerEdge 6850 (From the MODIS project)
  - Architecture: 64-bit Intel® Xeon™ 7100
  - OS Version: Red Hat Enterprise Linux 6 (update 2)
  - Diskspace: 72 GB (only)
  - Number of CPUs: 16
    - 2 machines with 4 dual core processors
  - Total Memory: 16 GB
    - 2 machines with 8 GB each
  - Processor Clockspeed: 3.0 GHz
GPDS/GAASP
Production Hardware

- Production Hardware
  - 3 Dell PowerEdge 6850 (From the MODIS project)
  - Architecture: 64-bit Intel® Xeon™ 7100
  - OS Version: Red Hat Enterprise Linux 6 (update 2)
  - Diskspace: Details of SAN are TBD
  - Number of CPUs: 24
    - 3 machines with 4 dual core processors
  - Total Memory: 24 GB
    - 3 machines with 8 GB each
  - Processor Clockspeed: 3.0 GHz
The following slide shows our best understanding of the full GCOM Processing and Distribution System (GPDS) and its external interfaces.

The blue boxes in the figure represent the 3 delivered software components that need to run within the GPDS.
GPDS Interfaces

- KSAT
  - GCOM
  - ASD
- IDPS
  - RDR
- NDE
  - RDR
- OSPO Monitoring & Control
- HDF5 to ASD Unit
  - RDR
  - ASD
  - SDR
- JAXA Unit
  - ASD
- GAASP Unit
  - SDR
  - EDR
- DDS
  - CLASS
  - NWP
  - SAB
  - STAR
- Ancillary Dynamic Data
GAASP External Interfaces

- External input and output files are identified in the tables on the following 2 slides, respectively.
  - Input files include both input data files and ancillary data.
  - The tables identify the file name patterns, formats, and sources (for input files).
  - Files needed/produced for Day 1 and Day 2 products are identified.
  - GAASP will follow the NDE output file naming convention for products.
  - netCDF files will contain the NDE-compliant metadata.
  - The transfers of external files to and from GAASP will be automated by the GPDS.
# GAASP External Dynamic Input Data

<table>
<thead>
<tr>
<th>Input File</th>
<th>Name Pattern</th>
<th>Source</th>
<th>Update Frequency</th>
<th>When</th>
<th>EDR</th>
<th>Type</th>
<th>Format</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMSR2 SDR</td>
<td>GW1AM2_?????????????_????_L1SGBT BR_1110110.h5</td>
<td>IDPS via NDE</td>
<td>9 minutes</td>
<td>Day 1</td>
<td>MBT, SST, SSW, TPW, CLW, PR, SM, ST, SC, SD, SWE</td>
<td>Input</td>
<td>HDF5</td>
<td>9.2 MB</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GW1AM2_?????????????_????_L1SGRT BR_1110110.h5</td>
<td>IDPS via NDE</td>
<td>9 minutes</td>
<td>Day 1</td>
<td>SST, SSW, TPW, CLW, SIC</td>
<td>Input</td>
<td>HDF5</td>
<td>12.7 MB</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GFS Forecast</td>
<td>gfs.t??z.pgrb2f?.?????????</td>
<td>DDS</td>
<td>6 hours</td>
<td>Day 1</td>
<td>SST, SSW, TPW, CLW</td>
<td>Ancillary</td>
<td>GRIB2</td>
<td>18.5 MB</td>
</tr>
<tr>
<td>(0.5 degree)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>avhrr-only-v2.?????????_preliminary</td>
<td>DDS</td>
<td>Daily</td>
<td>Day 1</td>
<td>PR, SST, SSW, TPW, CLW</td>
<td>Ancillary</td>
<td>Binary</td>
<td>1.8 MB</td>
</tr>
<tr>
<td>*Daily OI SST</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>seaice.t00z.5min.grb2.??????????</td>
<td>DDS</td>
<td>Daily</td>
<td>Day 1</td>
<td>RFI</td>
<td>Ancillary</td>
<td>GRIB2</td>
<td>0.5 MB</td>
</tr>
<tr>
<td>*Sea Ice</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Daily OI SST will only be needed by GPROF for the first year. After that, GPROF will use the GAASP SST produced internally.
## GAASP External Output Data

### External Output Data

<table>
<thead>
<tr>
<th>Output File</th>
<th>Name Pattern</th>
<th>Update Frequency</th>
<th>When</th>
<th>Format</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMSR2 SDR Native Res</td>
<td>AMSR2-MBT_v1r0_GW1_sYYYYMMDDhhmsss_eYYYYMMDDhhmsss_cYYYYMMDDhhmsss.nc</td>
<td>9 minutes</td>
<td>Day 1</td>
<td>netCDF4</td>
<td>18.7 MB</td>
</tr>
<tr>
<td>AMSR2 SDR Native Res</td>
<td>AMSR2-MBT-LR_v1r0_GW1_sYYYYMMDDhhmsss_eYYYYMMDDhhmsss_cYYYYMMDDhhmsss.bufr</td>
<td>9 minutes</td>
<td>Day 1</td>
<td>BUFR</td>
<td>3.5 MB</td>
</tr>
<tr>
<td>AMSR2 SDR Native Res</td>
<td>AMSR2-MBT-89A_v1r0_GW1_sYYYYMMDDhhmsss_eYYYYMMDDhhmsss_cYYYYMMDDhhmsss.bufr</td>
<td>9 minutes</td>
<td>Day 1</td>
<td>BUFR</td>
<td>3.4 MB</td>
</tr>
<tr>
<td>AMSR2 SDR Native Res</td>
<td>AMSR2-MBT-89B_v1r0_GW1_sYYYYMMDDhhmsss_eYYYYMMDDhhmsss_cYYYYMMDDhhmsss.bufr</td>
<td>9 minutes</td>
<td>Day 1</td>
<td>BUFR</td>
<td>3.4 MB</td>
</tr>
<tr>
<td>Ocean (CLW, TPW, SST, SSW)</td>
<td>AMSR2-OCEAN_v1r0_GW1_sYYYYMMDDhhmsss_eYYYYMMDDhhmsss_cYYYYMMDDhhmsss.nc</td>
<td>9 minutes</td>
<td>Day 1</td>
<td>netCDF4</td>
<td>7.9 MB</td>
</tr>
<tr>
<td>Precip (PT/R)</td>
<td>AMSR2-PRECIP_v1r0_GW1_sYYYYMMDDhhmsss_eYYYYMMDDhhmsss_cYYYYMMDDhhmsss.nc</td>
<td>9 minutes</td>
<td>Day 1</td>
<td>netCDF4</td>
<td>3.3 MB</td>
</tr>
<tr>
<td>Land (SM &amp; ST)</td>
<td>AMSR2-LAND_v1r0_GW1_sYYYYMMDDhhmsss_eYYYYMMDDhhmsss_cYYYYMMDDhhmsss.nc</td>
<td>9 minutes</td>
<td>Day 2</td>
<td>netCDF4</td>
<td>6.4 MB</td>
</tr>
<tr>
<td>Snow (SC/D &amp; SWE)</td>
<td>AMSR2-SNOW_v1r0_GW1_sYYYYMMDDhhmsss_eYYYYMMDDhhmsss_cYYYYMMDDhhmsss.nc</td>
<td>9 minutes</td>
<td>Day 2</td>
<td>netCDF4</td>
<td>3.1 MB</td>
</tr>
<tr>
<td>Sea Ice (SIC)</td>
<td>AMSR2-SICE_v1r0_GW1_sYYYYMMDDhhmsss_eYYYYMMDDhhmsss_cYYYYMMDDhhmsss.nc</td>
<td>9 minutes</td>
<td>Day 2</td>
<td>netCDF4</td>
<td>3.0 MB</td>
</tr>
<tr>
<td>SDR/EDR QA products</td>
<td>TBD</td>
<td>9 minutes</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
</tr>
</tbody>
</table>
The Day 1 GAASP will consist of a single Perl driver script that wraps the individual units.

- This script will be run by the GPDS and will in turn run the entire Day 1 processing for a single input granule (i.e. SDR to EDR)
- Within the driver script everything is run serially (no forking of processes)
- The individual units are also Perl scripts that wrap the Fortran executables.
- These units scripts will handle direct interfaces and arguments for individual algorithm executables (science code)
- The driver and it’s unit scripts will:
  - Conduct file management (e.g. creating, removing, and renaming) in the local working directory (only)
  - Perform of error handling and generate higher-level error logs for OSPO production monitoring
  - Drive the product tailoring executables where necessary
- All science code will be written Fortran 90/95 (Compiled using the Intel Compiler). There will be no science code written in an interpreted or high-level language like IDL and Matlab.
GAASP System Design

- The Day 1 GAASP driver script will be invoked by the GPDS and may be run in parallel by the GPDS.
  - The production rules for the driver script are documented in the System Maintenance Manual and will be delivered as part of the DAP.
  - Interfaces between GPDS and GAASP will consist of PCF and PSF files (like that of NDE).

- GAASP will NOT do the following as these tasks are understood to be task performed by GPDS:
  - Schedule jobs
  - Invoke its own driver scripts
  - Fork processes or load manage jobs
  - Set up and manage system directories
  - Ingest, distribute, or transfer files
  - Interact directly with the OSPO monitoring
GAASP System Design

- **NOAA Product Reformatter (NPR) Unit:**
  - Tailor L1B hdf5 output to BUFR

- **Preprocessor unit:**
  - Perform brightness temperature bias correction
  - Assign the RFI flag
  - Output the HDF5 intermediate files (L1B and L1R) to be used by all downstream EDRs
  - Output the netCDF MBT EDR file

- **Ocean unit:**
  - Generate all ocean EDRs (TPW, CLW, SST, SSW)

- **Precipitation unit:**
  - Generate land/ocean precipitation EDR
  - Output the netCDF PRECIP EDR file

- **Postprocessor unit:**
  - Bundle EDRs where necessary (e.g. add the Precip EDR to the Ocean EDR)
  - Generate QA metadata or products for OSPO monitoring. Details are TBD
The internal file format for files within the driver script will be HDF5.

Ancillary data will be obtained by the GPDS from DDS (see table) and made available to the Day 1 GAASP driver script.
The interface between the GPDS and the GAASP driver script will consist of an NDE-style Production Control File (PCF) and Production Status File (PSF) files.

- **PCF contains:**
  - All the required input files to process a granule, including paths if they're located outside the working directory. This includes input instrument and ancillary data, static files such as templates and lookup tables.
  - Any run parameters or flags

- **PSF contains all successfully generated output files**

During production, a PCF for a given run is produced by the GPDS and made available to an instance of the GAASP driver in a local working directory.

- The contents of the PCF are based on the production rules defined in the System Maintenance Manual.

The GAASP driver runs and produces its output and a PSF file in the same working directory. The GPDS then reads this file, determines the output file name(s) from it, and distributes it to DDS.
Here's an example of a GAASP PCF from the Code Test Review:

WORKING_DIR=/home/GAASP/SATELLITE_DATA/GCOM-W1/test/2013/03/11/201303112359_179D
GRANULE=201303112359_179D
PSF_FILE=GAASP_201303112359_179D_20130311.PSF
L1B_FILE=GW1AM2_201303112359_179D_L1DLBTBR_0000000.h5
L1R_FILE=GW1AM2_201303112359_179D_L1DLRTBR_0000000.h5
EMAIL_ERROR_FLAG=YES
OPS_MACHINE=letitias@rhs8142.star1.nesdis.noaa.gov
OPS_MAIL=letitia.soulliard@noaa.gov
LOG_FILE=/home/GAASP/SATELLITE_DATA/GCOM-W1/test/2013/03/11/201303112359_179D/GAASP.log
PERL_LOC=/usr/bin/perl
PERL_LIB=/home/GAASP/OPS/scripts/lib
SCRIPT_OPS=/home/GAASP/OPS/scripts
H5DUMP_LOC=/usr/local/bin/h5dump
WGRIB2_LOC=/usr/local/bin/wgrib2
UUID_LOC=/usr/bin/uuidgen
OPS_BIN=/home/GAASP/OPS/Common_Bin
CDL_TEMPLATES=/home/GAASP/OPS/CDLFILES
SEAICE_FILE=/home/GAASP/DATA/seaice/seaice.t00z.5min.grb.grib2.20130311.nc
SST_FILE=/home/GAASP/DATA/sst/avhrr-only-v2.20130311
GFS_FILE_DIR=/home/GAASP/DATA/gfs
NPR_ANCDIR=/home/GAASP/OPS/ancillary/npr
OCEAN_ANCDIR=/home/GAASP/OPS/ancillary/ocean
GPROF_ANCDIR=/home/GAASP/OPS/ancillary/gprof
RUN_NPR_FLAG=YES
RUN_L1R_CORRECTION_FLAG=YES
RUN_OCEAN_FLAG=YES
RUN_PRECIPITATION_FLAG=YES
And here’s the PSF produced for that same run:

/home/GAASP/SATELLITE_DATA/GCOM-W1/test/2013/03/11/2013031123590_179D/AMSR2-MBT-LR_v1r0_GW1_s201303112359590_e201303120008580_c201307221919120.bufr
/home/GAASP/SATELLITE_DATA/GCOM-W1/test/2013/03/11/2013031123590_179D/AMSR2-MBT-89A_v1r0_GW1_s201303112359590_e201303120008580_c201307221919150.bufr
/home/GAASP/SATELLITE_DATA/GCOM-W1/test/2013/03/11/2013031123590_179D/AMSR2-MBT-89B_v1r0_GW1_s201303112359590_e201303120008580_c201307221919180.bufr
/home/GAASP/SATELLITE_DATA/GCOM-W1/test/2013/03/11/2013031123590_179D/AMSR2-MBT_v1r0_GW1_s201303112359590_e201303120008580_c201307221919440.nc
/home/GAASP/SATELLITE_DATA/GCOM-W1/test/2013/03/11/2013031123590_179D/AMSR2-PRECIP_v1r0_GW1_s201303112359590_e201303120008580_c20130722191950.nc
/home/GAASP/SATELLITE_DATA/GCOM-W1/test/2013/03/11/2013031123590_179D/AMSR2-OCEAN_v1r0_GW1_s201303112359590_e201303120008580_c201307221920090.nc
GAASP System Design: Error Handling and Monitoring

- All system calls within scripts and all functions and statements in the compiled code will have their return values and/or returned content checked where applicable to allow for graceful exits in the event of an error.

- All standard output and standard error from scripts and programs is logged so it can be made available to the GPDS and OSPO monitoring efforts.

- Contents of logs were shown in the Code Test Review held on 8/1/2013 and the code was checked for security and coding standards in the Software Code Review held on 9/18/2013.

- The GAASP driver script produces a single high-level log file that the GPDS can parse in the event of an error. If there is an error:
  » Perl driver returns to the GPDS a non-zero value
  » There may be no output file(s) written in the PSF depending upon at what stage the error occurred
GAASP System Design: Error Handling and Monitoring

- All error conditions and messages written into the log files are identified and described in the System Maintenance Manual.

- The GPDS will need to obtain these error codes and messages and pass these on to the OSPO production monitoring.

- GAASP science quality monitoring will likely be a separate effort. SDR and EDR quality monitoring data and metadata would support ongoing OSPO science quality monitoring efforts. This work is not yet funded so details are TBD.
• The following slides contain tables showing all the GAASP Day 1 unit level input and output.

• Required input data fields are identified for each unit.

• Output data fields are identified for the products coming out of each unit. These also show:
  » Variable names
  » Variable size (bytes)
  » Resolution
  » Dimensionality
  » Total file size
# Ocean EDR Inputs

## Table 15.0 GCOM Ocean Unit Inputs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Source</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brightness Temperatures</td>
<td>From AMSR2 SDR (L1B) and From AMSR2 SDR (L1R)</td>
<td>Dynamic</td>
</tr>
<tr>
<td>Geo location information</td>
<td>From AMSR2 SDR (L1B) and From AMSR2 SDR (L1R)</td>
<td>Dynamic</td>
</tr>
<tr>
<td>Land/Coastal mask</td>
<td>From AMSR2 SDR (L1B) and From AMSR2 SDR (L1R)</td>
<td>Dynamic</td>
</tr>
<tr>
<td>Model Wind Direction</td>
<td>From GFS Forecast Model</td>
<td>Dynamic</td>
</tr>
<tr>
<td>Model Sea Surface Temp</td>
<td>From GFS Forecast Model</td>
<td>Dynamic</td>
</tr>
<tr>
<td>Model Sea/Land Flag</td>
<td>From GFS Forecast Model</td>
<td>Dynamic</td>
</tr>
<tr>
<td>SST (Sea Ice data)</td>
<td>From daily IEEE OI-SST from AVHRR</td>
<td>Dynamic</td>
</tr>
<tr>
<td>CLW Coefficient files</td>
<td>From STAR algorithm development</td>
<td>Static</td>
</tr>
<tr>
<td>TPW Coefficient files</td>
<td>From STAR algorithm development</td>
<td>Static</td>
</tr>
<tr>
<td>WS and SST Coefficient files</td>
<td>From STAR algorithm development</td>
<td>Static</td>
</tr>
</tbody>
</table>
# Ocean EDR Output

## Ocean/Precip Products

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Size</th>
<th>scans</th>
<th>FOV</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>2</td>
<td>360</td>
<td>6</td>
<td>4320</td>
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<tr>
<td>Lat</td>
<td>4</td>
<td>360</td>
<td>243</td>
<td>349920</td>
</tr>
<tr>
<td>Long</td>
<td>4</td>
<td>360</td>
<td>243</td>
<td>349920</td>
</tr>
<tr>
<td>Scan Angle</td>
<td>4</td>
<td>360</td>
<td>243</td>
<td>349920</td>
</tr>
<tr>
<td>Earth Inc</td>
<td>4</td>
<td>360</td>
<td>243</td>
<td>349920</td>
</tr>
<tr>
<td>Compas</td>
<td>4</td>
<td>360</td>
<td>243</td>
<td>349920</td>
</tr>
<tr>
<td>Across Scan</td>
<td>4</td>
<td>360</td>
<td>243</td>
<td>349920</td>
</tr>
<tr>
<td>Along Scan</td>
<td>4</td>
<td>360</td>
<td>243</td>
<td>349920</td>
</tr>
<tr>
<td>SDR rec</td>
<td>4</td>
<td>360</td>
<td>243</td>
<td>349920</td>
</tr>
<tr>
<td>Surf Type</td>
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<td>349920</td>
</tr>
<tr>
<td>SDR QC</td>
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<td>360</td>
<td>486</td>
<td>699840</td>
</tr>
<tr>
<td>SST</td>
<td>8</td>
<td>360</td>
<td>243</td>
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</tr>
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<td>wspd</td>
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<td>360</td>
<td>243</td>
<td>699840</td>
</tr>
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<td>wv</td>
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<td>360</td>
<td>243</td>
<td>699840</td>
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<tr>
<td>clw</td>
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<td>699840</td>
</tr>
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<td>Rain Rate</td>
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<td>RR_Err</td>
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<td>EDR QC flag</td>
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<td>Model wdir</td>
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</tr>
<tr>
<td>Model sst</td>
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<td>Model mask</td>
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</table>

**Total:** 8927280
# Precipitation Unit Inputs

## Table 16.0 GCOM Precipitation Unit Inputs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Source</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brightness Temperatures</td>
<td>From AMSR2 SDR (L1B)</td>
<td>Dynamic</td>
</tr>
<tr>
<td>Geo location information</td>
<td>From AMSR2 SDR (L1B)</td>
<td>Dynamic</td>
</tr>
<tr>
<td>SST</td>
<td>From daily IEEE OI-SST from AVHRR</td>
<td>Dynamic</td>
</tr>
<tr>
<td>Profile database</td>
<td>Compiled TRMM’s Precipitation Radar by Dave Randel at Colorado State University</td>
<td>Static</td>
</tr>
<tr>
<td>Caspian Sea Ice Climo</td>
<td>Developed from RSS Weekly AMSRE</td>
<td>Static</td>
</tr>
<tr>
<td>Desert/Ice Climo</td>
<td>IGBP (Desert) IMS &amp; AMSRE (Snow)</td>
<td>Static</td>
</tr>
<tr>
<td>Elevation</td>
<td></td>
<td>Static</td>
</tr>
<tr>
<td>Land Mask</td>
<td></td>
<td>Static</td>
</tr>
<tr>
<td>Forward Model coefficient file</td>
<td>From STAR algorithm development</td>
<td>Static</td>
</tr>
<tr>
<td>TMI Correction files</td>
<td>From STAR algorithm development</td>
<td>Static</td>
</tr>
</tbody>
</table>
## Precipitation EDR Output

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Size</th>
<th>scans</th>
<th>FOV</th>
<th>Total</th>
</tr>
</thead>
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<td>6</td>
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</tr>
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<td>360</td>
<td>486</td>
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</tr>
<tr>
<td>Longitude</td>
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<td>174960</td>
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<tr>
<td>convectPrecipitation</td>
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<td>surfaceRain</td>
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<td>486</td>
<td>699840</td>
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</tbody>
</table>

Total: 3153600
## Microwave Brightness Temperature SDR

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Size</th>
<th>scans</th>
<th>FOV</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brightness_Temperature_6.9GHzV</td>
<td>4</td>
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<td>243</td>
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</tr>
<tr>
<td>Brightness_Temperature_6.9GHzH</td>
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<td>243</td>
<td>349920</td>
</tr>
<tr>
<td>Brightness_Temperature_7.3GHzV</td>
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<td>243</td>
<td>349920</td>
</tr>
<tr>
<td>Brightness_Temperature_7.3GHzH</td>
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<td>243</td>
<td>349920</td>
</tr>
<tr>
<td>Brightness_Temperature_10.7GHzV</td>
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</tr>
<tr>
<td>Brightness_Temperature_10.7GHzH</td>
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</tr>
<tr>
<td>Brightness_Temperature_18.7GHzV</td>
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<td>243</td>
<td>349920</td>
</tr>
<tr>
<td>Brightness_Temperature_18.7GHzH</td>
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</tr>
<tr>
<td>Brightness_Temperature_23.8GHzV</td>
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<td>Brightness_Temperature_23.8GHzH</td>
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<td>Brightness_Temperature_36.5GHzV</td>
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<td>Brightness_Temperature_36.5GHzH</td>
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<tr>
<td>Brightness_Temperature_89.0GHz-AV</td>
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<td>360</td>
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</tr>
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<td>Brightness_Temperature_89.0GHz-AH</td>
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<td>360</td>
<td>486</td>
<td>699840</td>
</tr>
<tr>
<td>Brightness_Temperature_89.0GHz-BV</td>
<td>4</td>
<td>360</td>
<td>486</td>
<td>699840</td>
</tr>
<tr>
<td>Brightness_Temperature_89.0GHz-BH</td>
<td>4</td>
<td>360</td>
<td>486</td>
<td>699840</td>
</tr>
<tr>
<td>Latitude_of_Observation_Point_for_6</td>
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<td>Longitude_of_Observation_Point_for_6</td>
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<td>349920</td>
</tr>
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<td>Latitude_of_Observation_Point_for_7</td>
<td>4</td>
<td>360</td>
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</tr>
<tr>
<td>Longitude_of_Observation_Point_for_7</td>
<td>4</td>
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<td>349920</td>
</tr>
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</tr>
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<td>Longitude_of_Observation_Point_for_10</td>
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<td>243</td>
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</table>
## Microwave Brightness Temperature SDR

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Size</th>
<th>scans</th>
<th>FOV</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latitude_of_Observation_Point_for_18</td>
<td>4</td>
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GAASP Architecture Summary

- **Hardware**
  - Development, Integration, and Production hardware are defined

- **Software Architecture**
  - A high-level system and unit-level designed are defined.
  - GAASP external interfaces will assume NDE-like interfaces.

- **Data Files (Input/Outputs)**
  - Input, output, and ancillary data types are defined
  - All dynamic ancillary data types and their sources have been identified
Review Outline

- Introduction
- CTR Report
- Requirements
- Software Architecture
- Validation
- Risks and Actions
- Summary and Conclusions
Ocean EDR Validation

Presented by

Suleiman Alsweiss
GST
Goal of NOAA GCOM-W1 product processing system is to provide validated operational Level-2 products from AMSR2 measurements:

- Meets scientific accuracy requirements
- Meets GCOM-W1 distribution to operational users requirements
- Easily maintainable over the life of the mission
- Adaptable to handle any required modifications
NOAA GCOM-W1 Processing System

- **SDR Postprocessor**
  - Address any AMSR2 residual calibration issues

- **EDR Preprocessor**
  - Reformatting & flagging
  - Prepare ancillary data

- **EDR Postprocessor**
  - Three EDR modules
    - Ocean Scene EDRs (SST, SSW, TPW, CLW)
    - Global Rain Rate (Ocean, Land and Coastal Region)
    - Snow and Sea Ice
AMSR2 In Orbit Calibration

- AMSR2 observed brightness temperatures (Tbs) will be used to infer several geophysical parameters over land and ocean.
- Calibrated AMSR2 Tbs significantly improve performance and accuracy of geophysical retrieval algorithms.
  » Identifying and correcting residual calibration biases in AMSR2 Tbs reduce retrievals errors.
Inter-calibration Methodology

- Direct comparison
  » Simple inter-calibration method involves direct comparison between observations of two sensors

- Errors associated with comparing two sensors with different frequencies & EIA are too big to ignore
  » Up to ~ 4K

- Even if the two radiometers to be compared have same center freq. & nominal EIA there can be differences
  » Attitude differences cause EIA variation
Inter-cal. Methodology – cont.

• Sensors direct comparison discrepancies can be mitigated using radiative transfer modeling (RTM) to simulate Tbs
  » RTM accounts for radiometer frequency, polarization & EIA

• Simulated Tbs are needed to calculate the “Single Difference” (SD)
  » SD is the difference between observed and simulated Tbs for the same sensor

\[ SD = Tb_{\text{obs.}} - Tb_{\text{sim.}} \]
Inter-calibration Methodology – cont.

• RTM may not accurately represent the physics
  » Oceanic & atmospheric environmental parameters from numeric weather models are imperfect estimates of true values

• The use of “Double Difference” (DD) alleviates RTM errors
  » Two instruments are needed (A & B) with one being the reference sensor

\[ DD_{AB} = SD_A - SD_B \]
Reference Radiometer

- Inter-calibration between sensors relies on finding collocated observations between different platforms.
- Sun-synchronous orbits collocate at high latitudes near poles.
  - Limits amount of available data for inter-calibration.
- For sun-synchronous radiometer like AMSR2, TRMM microwave imager (TMI) chosen as reference radiometer.
  - Non-sun-synchronous, low inclination orbiter will result in larger number of collocated observations.
Brightness Temperature Simulation

- AMSR2 & TMI radiances were simulated for all channels
  - CRTM version 2.1
  - Fastem5 surface model
- ECMWF global data
  - 0.25° spatial resolution

Diagram:
- ECMWF global field
- Sensor pars. (lat., long., time)
- Spatial & temporal interpolation
- CRTM
- Simulated Tb
- Sensor incidence angle, freq., & pol.
Double Difference Analysis

• Data
  » AMSR2: L1B 2013 release (V1.1)
  » TMI: 1B11 V7 calibrated Tbs

• AMSR2/TMI collocations
  » 30 minutes time difference & 10 km spatial difference
  » Separated by channel & ascending/descending

• Bad pixels excluded
  » Rain & clouds using TMI EDR maps (Remote Sensing Sys.)
  » Sun glint & RFI
Sun Glint & RFI

Sun Glint: \[Tbh6\_L1B - Tbh6\_sim.\], 08/02/2012

C-band RFI: \(\text{Abs}(Tbv6\_L1B - Tbv7\_L1B.) > 3\), 08/02/2012
AMSR2 Tb Bias Corrections

- Corrections developed based on double difference relation with AMSR2 Tbs
  - Correction = \( f(AMSR2\_L1B\ Tbs) \)
  - Different correction applied for each channel

**Input Data**
- Brightness temperatures (TB) for 6.9 V/H, 7.3 V/H, 10.7 V/H, 18.7 V/H, 23.8 V, 36.5 H/V, 89 H/V

**Output Data**
- Corrected ocean brightness temperatures

**Correction Function**
\[
\Delta T_{Bi} = \sum_{n} a_{in} T_{Bi}^{n} - \sum_{m} b_{i} T_{Bi}^{m}
\]
\[
T_{Bi} = T_{Bi} - \Delta T_{Bi}
\]
\[
i = AMSR2\_channel
\]
### Oceanic Mean Calibration Biases

<table>
<thead>
<tr>
<th>Channel</th>
<th>AMSR2 –TMI (ascending)</th>
<th>AMSR2 –TMI (descending)</th>
<th>AMSR2 –TMI (all)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10V</td>
<td>4.4 -0.3</td>
<td>4.4 0.05</td>
<td>4.4 -0.23</td>
</tr>
<tr>
<td>10H</td>
<td>5.1 -0.2</td>
<td>4.9 0.22</td>
<td>5.0 -0.1</td>
</tr>
<tr>
<td>18V</td>
<td>3.8 -0.32</td>
<td>4.0 0.05</td>
<td>3.9 -0.2</td>
</tr>
<tr>
<td>18H</td>
<td>2.5 -0.33</td>
<td>2.2 0.14</td>
<td>2.4 -0.17</td>
</tr>
<tr>
<td>23V</td>
<td>4.0 -0.2</td>
<td>4.3 0.14</td>
<td>4.1 -0.18</td>
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<tr>
<td>23H</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>36V</td>
<td>4.4 0</td>
<td>4.9 0.09</td>
<td>4.6 0.03</td>
</tr>
<tr>
<td>36H</td>
<td>5.2 0.05</td>
<td>5.7 0.06</td>
<td>5.4 0.05</td>
</tr>
<tr>
<td>89V</td>
<td>2.8 -0.1</td>
<td>3.1 -0.02</td>
<td>2.9 -0.08</td>
</tr>
<tr>
<td>89H</td>
<td>3.5 0.03</td>
<td>4.0 0.03</td>
<td>3.6 0.03</td>
</tr>
</tbody>
</table>

Actual biases are modeled as functions of AMSR2 Tb, so they are not just one number.
Double Difference Map Bias
H-Pol

10Ghz

18Ghz

36Ghz
Double Difference Map Bias
V-Pol

10Ghz

18Ghz

36Ghz
Double Difference PDFs

V-Pol

Before correction

After correction

H-Pol

Before correction

After correction

V-pol AM2/TMI double diff. PDF

H-pol AM2/TMI double diff. PDF

Frequency labels:
- 10 GHz
- 18 GHz
- 23 GHz
- 36 GHz
- 89a GHz
- 89b GHz
AMSR2 Oceanic EDR Validation
NOAA AMSR2 Ocean EDR Products

- Ocean Scene EDRs include
  - Total Precipitable Water (TPW)
  - Cloud Liquid Water (CLW)
  - Sea Surface Wind Speed (SSW)
  - Sea Surface Temperature (SST)

- 1st Delivery
  - Multi stage regression ocean EDR algorithms

- 2nd Delivery
  - Iterative multistage regression & Bayesian probability
EDR Quality Control

- 16-bit QC flag included in AMSR2 EDR files
  - Bit0: RFI
  - Bit1: 0 < SSW < 30
  - Bit2: -2.5 < SST < 35
  - Bit3: 0 < CLW < 1
  - Bit4: 0 < TPW < 75
  - Bit5: 0 < RR < 70
  - Bit6: SSW > 20
  - Bit7: CLW > 0.18
  - Bit8: TPW > 60
  - Bit9: RR > 1
  - Bit10: SSW quality
  - Bit11: SST quality
  - Bit12: CLW quality
  - Bit13: TPW quality
  - Bit14: RR quality
  - Bit15: Spare

  0: good, 1: bad

  Check if value within boundaries

  Check if value in upper range

  Cross check parameters (e.g. if SSW > 17 and CLW > 0.3 then Bit11 will be set)
Validation Data Set

- Validation data set consists of one year worth of data
  - Year 2013
  - Several Data Sources
    - Models: GDAS, Reynolds
      - Data were spatially & temporally interpolated to AMSR2 observation time & location
    - Satellite measurements: TMI & NOAA-19
      - Collocation criteria: 10 km maximum distance & 30 minutes maximum time difference
    - Buoys: NCDC
      - Collocation criteria: 10 km maximum distance & 30 minutes maximum time difference
1\textsuperscript{st} stage regression:

- Channels used: 18, 23 and 36 GHz, H/V pol

\[
TPW = \sum_{i=1,6} \left( a_{1i} T_{bi} + a_{2i} T_{bi}^2 \right)
\]

2\textsuperscript{nd} stage regression:

- Using 1\textsuperscript{st} stage TPW to derive localized regressions
  - Every 2.5mm bins
- In overlapping bins final TPW is average TPW from adjacent bins
AMSR2 TPW Example
(04/01/2014)
## TPW Validation

- Ancillary data for AMSR2 TPW validation
  - Models: GDAS
  - Measurements: TMI, NOAA-19

### GCOM Total Precipitable Water Requirements

<table>
<thead>
<tr>
<th>EDR Attribute</th>
<th>Requirement</th>
<th>Status</th>
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<tbody>
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<td><strong>Measurement range</strong></td>
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<tr>
<td><strong>Measurement uncertainty</strong></td>
<td>2 mm or 10% whichever is greater</td>
<td>1.8</td>
</tr>
<tr>
<td><strong>Measurement accuracy</strong></td>
<td>1 mm</td>
<td>0.1</td>
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<table>
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<tr>
<th></th>
<th>GDAS</th>
<th>TMI</th>
<th>NOAA-19</th>
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<tbody>
<tr>
<td>1.8</td>
<td></td>
<td>1.1</td>
<td>1.4</td>
</tr>
<tr>
<td>0.1</td>
<td></td>
<td>0.0</td>
<td>0.7</td>
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</table>
TPW Validation / GDAS

Accuracy = -0.1 mm
Uncertainty = 1.8 mm

Accuracy = -1.0 mm
Uncertainty = 2.2 mm
TPW Validation / GDAS – cont.

TPW, Mean Bias: solid, RMSE: dashed

Reynolds SST, day 0

TPW, Mean Bias: solid, RMSE: dashed

NOAA
JAXA

GDAS Windspeed, m/s

TPW, Mean Bias: solid, RMSE: dashed

NOAA TPW
TPW Validation / TMI

Accuracy = 0.0 mm
Uncertainty = 1.1 mm
TPW Validation / NOAA-19

Accuracy = -0.7 mm
Uncertainty = 1.4 mm
CLW Algorithm

1st stage regression:
- Channels used: 6, 7 & 10 GHz H-pol, 18, 23 & 36 GHz H/V pol

\[
CLW = \sum_{i=1,3} (a_i T_{b_i}) + \sum_{j=1,5} (b_j \ln(285 - T_{b_j}))
\]

\[
T_{b_i} = T_{b_i}^{6H}, T_{b_i}^{7H}, T_{b_i}^{10H}
\]

\[
T_{b_j} = T_{b_j}^{18H/V}, T_{b_j}^{23H/V}, T_{b_j}^{36H/V}
\]

2nd stage regression:
- Using 1st stage CLW to derive localized regressions
  - Every 0.01mm bins
- In overlapping bins final CLW is average CLW from adjacent bins
AMSR2 CLW Example (04/01/2014)
CLW Validation

- Ancillary data for AMSR2 CLW validation
  - Models: GDAS
  - Measurements: TMI, NOAA-19

### GCOM Cloud Liquid Water Requirements

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<th>EDR Attribute</th>
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<tr>
<td>Measurement range</td>
<td>0.005 – 1 mm</td>
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<td>Measurement uncertainty</td>
<td>0.05 mm over ocean</td>
<td>0.09*</td>
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<tr>
<td>Measurement accuracy</td>
<td>0.01 mm</td>
<td>0.01</td>
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* CLW changes fastest of all other parameters. Interpolated 6H models are not expected to agree well with instantaneous measurements from AMSR2
CLW Validation / GDAS

Accuracy = 0.01 mm
Uncertainty = 0.09 mm

Accuracy = 0.01 mm
Uncertainty = 0.08 mm
CLW Validation / GDAS – cont.
CLW Validation / TMI

Accuracy = 0.01 mm
Uncertainty = 0.04 mm
CLW Validation / NOAA-19

Accuracy = 0.01 mm
Uncertainty = 0.03 mm
- Emissivity dependence on wind direction can reach ~2k peak-to-peak
  - Leads to significant error in wind speed retrievals
- Correction for wind direction requires ancillary source
  - NWS GDAS analysis used for training purposes
  - NWS GFS forecast fields used for NRT retrievals
% of flagged points (NOAA): ~ 12%
JAXA SSW Example (04/01/2014)

% of flagged points (JAXA): ~16%
SSW Validation

- Ancillary data for AMSR2 SSW validation
  - Models: GDAS
  - Measurements: TMI, Buoys

### GCOM Sea Surface Wind Speed Requirements

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<tr>
<td>Measurement uncertainty</td>
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<td>1.3</td>
</tr>
<tr>
<td>Measurement accuracy</td>
<td>0.5 m/s</td>
<td>0.1</td>
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<table>
<thead>
<tr>
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<th>TMI</th>
<th>Buoys</th>
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<tbody>
<tr>
<td>1.3</td>
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<td>1.5</td>
</tr>
<tr>
<td>0.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.1</td>
<td></td>
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<td>0.2</td>
</tr>
<tr>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SSW Validation / GDAS

Accuracy = - 0.1 m/s
Uncertainty = 1.3 m/s

Accuracy = 0.3 m/s
Uncertainty = 1.6 m/s
SSW Validation / GDAS - cont.
SSW Validation / TMI

Accuracy = - 0.3 m/s
Uncertainty = 0.9 m/s
SSW Validation / Buoys

Accuracy = -0.2 m/s
Uncertainty = 1.5 m/s
Correcting SST for wind speed signal utilizes PDF matching technique

- GFS model SST binned at every 10 deg. latitude and every 5 m/s wind speed bins
  - Retrieved wind speed
NOAA SST Example (04/01/2014)

% of flagged points (NOAA): ~ 11%
JAXA SST Example (04/01/2014)

% of flagged points (JAXA): ~ 30%
### SST Validation

- Ancillary data for AMSR2 SST validation
  - Models: Reynolds
  - Measurements: TMI, Buoys

#### GCOM Sea Surface Temperature Requirements

<table>
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<tr>
<td><strong>Measurement uncertainty</strong></td>
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<td>0.8</td>
</tr>
<tr>
<td><strong>Measurement accuracy</strong></td>
<td>0.5 k</td>
<td>0.0</td>
</tr>
</tbody>
</table>
SST Validation / Reynold

SST

Accuracy = 0.0 °C
Uncertainty = 0.8 °C

Accuracy = 0.1 °C
Uncertainty = 0.7 °C
SST Validation / Reynold – cont.
SST Validation / TMI

Accuracy = -0.1 c
Uncertainty = 0.9 c
SST Validation / Buoys

Accuracy = -0.1 c
Uncertainty = 0.8 c
Summary

- Double difference approach used to inter-calibrate AMSR2 residual biases in observed Tbs
- AMSR2 measures warmer Tbs when compared to TMI
  - AMSR2 L1B V1.1
  - TMI 1B11 V7
- Corrected AMSR2 Tbs were used in ocean EDR products
  - TPW, CLW, SST, and SSW
Summary – cont.

1\textsuperscript{st} delivery ocean EDR products were validated against several other products

» Models
  – GDAS
  – Reynolds

» Measurements
  – NOAA-19
  – TMI

Validations results show that AMSR2 1\textsuperscript{st} delivery ocean EDRs meet accuracy requirements
Precipitation EDR Validation

Presented by

Patrick Meyers
CICS
GPROF Structure

- L1B AMSR2 TBs
  - Preprocessor
    - Read in Ancillary Data
      - Assign Sfc Type
        - Land
          - Screening
            - Empirical Retrieval
        - Ocean
          - Screening
            - OE SST/TPW
        - Coast
          - Screening
            - Bayesian Inversion
      - Bayesian Inversion
    - Uniformity V
  - Postprocessor
Ocean Segment: Bayesian Retrieval

AMSRR2 Observed Tb

Database Tb

\[ P(R \mid T_b) \propto P(R) \times P(T_b \mid R) \]

R – Retrieved Conditions

\( T_b \) – Observed Brightness Temperatures
A-Priori Database

- Compare observed Tbs to database of known atmospheric profiles with corresponding Tbs
  - Collocated TRMM Precipitation Radar/TMI
    - Removes reliability on CRM in previous versions
  - Database of raining/non-raining pixels
  - Binned into 2 mm TPW and 1K SST bins
  - Clustered each bin to 2400 profiles for efficiency
  - Weight profiles based on uncertainty and absolute difference between observed and database Tbs
  - Utilizes 10-89GHz

\[ \hat{E}(R) = \sum_{j} R_j \frac{\exp\left\{ -\frac{1}{2} (Tb_0 - Tb_S(R_j))^T (O + S)^{-1} (Tb_0 - Tb_S(R_j)) \right\}}{\hat{A}} \]

Super-Typhoon Haiyan

Super-Typhoon Haiyan
07 NOV 2013: 0415 UTC

Super-Typhoon Haiyan
08 NOV 2013: 0500 UTC

Rain Rate (mm/hr)
Land Segment: Semi-Empirical Calculation

- Developed for TRMM with training dataset from PR & TMI
  - Requires adjustment from TMI to AMSR2 frequencies
- Separated into Convective/Stratiform rain rates

\[ RR = RR_{Conv} P(C) + RR_{Strat} [1 - P(C)] \]

- \( RR_{Conv} = (O_3(T89V)) \);
- \( RR_{Strat} = O_1(T89V) \)
- \( P(C[TbV(10, 37, 89), \sigma(T89V), \text{Minima of } T89V, [T89V-T89H])] \)
Tornado Outbreak
13 June 2013
Table 4.0 GCOM Precipitation Type/Rate

<table>
<thead>
<tr>
<th>EDR Attribute</th>
<th>Threshold</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable conditions</td>
<td></td>
<td>Delivered under &quot;all weather&quot; conditions</td>
</tr>
<tr>
<td>Horizontal cell size</td>
<td>5 km land (89 GHz FOV); 5 km ocean (37 GHz FOV size); 5-10 km sampling</td>
<td>5.0 km</td>
</tr>
<tr>
<td>Measurement range</td>
<td>0 – 50 mm/hr</td>
<td>Not Specified</td>
</tr>
<tr>
<td>Measurement precision</td>
<td>0.05 mm/hr</td>
<td>0.05 mm/hr</td>
</tr>
<tr>
<td>Measurement uncertainty</td>
<td>2 mm/hr over ocean; 5 mm/hr over land</td>
<td>2 mm/hr</td>
</tr>
<tr>
<td>Refresh</td>
<td>At least 90% coverage of the globe about every 20 hours (monthly average)</td>
<td>Not Specified</td>
</tr>
<tr>
<td>Precipitation type</td>
<td>Stratiform or convective</td>
<td>Not Specified</td>
</tr>
</tbody>
</table>

- **5 km sampling**
  - Land – 89 GHz FOV
  - Ocean – 37 GHz FOV
- **Precision:** 0.01 mm/hr
- **Measurements cover range**
- **Meets latency requirement**
- **Outputs total surface rain and convective rain rates**
Daily Rain Rates
6 April 2014

GPROF Operational Rain Rate

Rain Rate (mm/hr)
GPROF Validation with TMI

- TMI: Similar sensor; Similar algorithm
- Collocation within 30 minutes and 10 km
- High quality retrieval for both instruments
  - Land Flags: Snow/semi-arid/arid land
  - Ocean Flags: Non-convergence of Bayesian retrieval, low-quality SST/TPW
- Validation for Jan-Dec 2013
AM2/TMI Validation: Precipitation over Land
AM2/TMI Validation: Precipitation over Ocean

GPROF Rain Rates for AMSR2 vs TMI: Annual Ocean

RMSE: 1.11
Bias: 0.04
AMSR2 Validation with TRMM

- AMSR2 Level 2 swath retrievals
- 2A12: Level 2 TMI rain retrievals
- 3B42: Level 3 3-hr estimate from multiple satellites

<table>
<thead>
<tr>
<th>RMSD (mm/hr)</th>
<th>Land</th>
<th>Ocean</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements</td>
<td>5.0</td>
<td>2.0</td>
<td>–</td>
</tr>
<tr>
<td>TMI &amp; TMPA</td>
<td>3.1</td>
<td>1.2</td>
<td>1.6</td>
</tr>
<tr>
<td>AMSR2 &amp; TMI</td>
<td>3.6</td>
<td>1.2</td>
<td>1.8</td>
</tr>
<tr>
<td>AMSR2 &amp; TMPA</td>
<td>3.1</td>
<td>1.4</td>
<td>1.9</td>
</tr>
</tbody>
</table>
GPCP Comparisons

Monthly Precipitation

June 2013

AMSR2/GPROF

GPCP

Rain Rate (mm/day)
Precipitation Applications

CPC Morphing Technique (CMORPH)
- Global precipitation analysis at high spatial/temporal resolution
- Precipitation estimates from PMW propagated by geostationary IR motion vectors

Ensemble Tropical Rainfall Potential (eTRaP)
- Cumulative 6-hr rainfall estimate from an ensemble of PWM radiometers
- Produces probabilistic and deterministic forecasts of precipitation for tropical cyclones
- Typhoon Wipha – 15 Oct 2013 (left)
Unit Tests

Presented by

Letitia Soulliard
IMSG
Unit Tests

This second section will show the remaining unit test results for those few code updates made since the CTR (8/1/2013). These cover:

- Email notification option
- Checks for age of ancillary data
- Metadata identifies ancillary input
- Units in the ocean netCDF4 were corrected
- Updated output file names (GAASP to AMSR2)
- Tests for the addition on the AMSR2 MBT BUFR generation
GAASP CTR Updates

- GAASP error e-mail notifications should be optional
  » New entry in PCF file.
  » EMAIL_ERROR_FLAG=YES

- Ocean netCDF EDR is still created even if Precip EDR fails.
  » GAASP_Postrprocessor.pl checks only if GAASP_Ocean.pl ran correctly, doesn’t check for if GAASP_Precipitation.pl ran correctly.
  » If gprof.h5 doesn’t exist, it will skip trying to add it to the Ocean netCDF file.

```bash
if ( !-e $gprof_h5 ) {
  $error->error_check("", "GPROF output does not exist, so it won't be added".
                     " to the OCEAN netCDF file.","WARNING");
  last;
}
```
GAASP CTR Updates

- Provide checks that the ancillary data is not too old.
  - Ocean code will still run, just with out using the file.

```perl
my $file_age = file_age($seaice_filename,"seaice.t00z.5min.grb.grib2.YYYYMMDD.nc", @processing_date);
if ( $file_age eq "" || $file_age > 14 ) {
    my $seaice_file = "NONE";
}
```

- Precipitation code will return a fatal error message.

```perl
my $file_age = file_age($sst_filename,"avhrr-only-v2.YYYYMMDD", @processing_date);
if ( $file_age eq "" || $file_age > 14 ) {
    $error->error_check("","SST file is too old, not running precip algorithm.", "FATAL",1);
}
```

- Metadata contains ancillary file information

```
:sourcemap = "GW1AM2_201403091806_128D_L1DLBTBR_0000000.h5, seaice.t00z.5min.grb.grib2.20140309.nc, gfs.t18z.pgrb2f00.20140309, avhrr-only-v2.20140309";
```
Units in Ocean netCDF file have been updated

Time:units = "GMT";
Lat:units = "deg";
Long:units = "deg";
Scan_Angle:units = "deg";
Earth_Inc:units = "deg";
Compass:units = "deg";
Across_Scan:units = "";
Along_Scan:units = "";
SDR_QC:units = "";
SST:units = "Celsius";
wspd:units = "m/s";
wv:units = "mm";
clw:units = "mm";
Rain_Rate:units = "mm/hr";
RR_Err:units = "";
EDR_QC_Flag:units = "";
Model_wdir:units = "Degrees";
Model_sst:units = "Kelvin";
Model_mask:units = "";
GAASP CTR Updates

- Output filenames changed from GAASP to AMSR2
  - Also updated the seconds place to include tenths of seconds

  AMSR2-MBT-LR_v1r0_GW1_s201303112359590_e201303120008580_c201307221919120.bufr
  AMSR2-MBT-89A_v1r0_GW1_s201303112359590_e201303120008580_c201307221919150.bufr
  AMSR2-MBT-89B_v1r0_GW1_s201303112359590_e201303120008580_c201307221919180.bufr
  AMSR2-MBT_v1r0_GW1_s201303112359590_e201303120008580_c201307221919440.nc
  AMSR2-PRECIP_v1r0_GW1_s201303112359590_e201303120008580_c20130722191950.nc
  AMSR2-OCEAN_v1r0_GW1_s201303112359590_e201303120008580_c201307221920090.nc
Test Sequence/Results

- AMSR2 Microwave Brightness Temperature BUFR file can be produced successfully. Here is output of the toolkit run at 10:01 on March 14 2014:

```bash
rhs8142(ysong):/net/orbit247l/disk1/pub/ysong/intel/AMSR2/run>ls -lrt
total 9048
-rw-r--r--. 1 ysong orbit 7291 Dec  6 12:25 AMSR2_1B_BUFR_Table
-rw-r--r--. 1 ysong orbit 9234984 Dec  6 12:26 GW1AM2_201303112359_179D_L1DLBTBR_0000000.h5
-rw-r--r--. 1 ysong orbit 221 Dec 16 22:08 NPR.pl.PCF
rhs8142(ysong):/net/orbit247l/disk1/pub/ysong/intel/AMSR2/run>perl ../NPR.pl
rhs8142(ysong):/net/orbit247l/disk1/pub/ysong/intel/AMSR2/run>ls -lrt
total 19132
-rw-r--r--. 1 ysong orbit 7291 Dec  6 12:25 AMSR2_1B_BUFR_Table
-rw-r--r--. 1 ysong orbit 9234984 Dec  6 12:26 GW1AM2_201303112359_179D_L1DLBTBR_0000000.h5
-rw-r--r--. 1 ysong orbit 221 Dec 16 22:08 NPR.pl.PCF
-rw-r--r--. 1 ysong orbit 341 Mar 14 10:01 npr.filenames
-rw-r--r--. 1 ysong orbit 3547400 Mar 14 10:01 AMSR2-MBT-LR_v1r0_GW1_s201303112359597_e201303120008581_c201403141401310.bufr
-rw-r--r--. 1 ysong orbit 3364272 Mar 14 10:01 AMSR2-MBT-89A_v1r0_GW1_s201303112359597_e201303120008581_c201403141401310.bufr
-rw-r--r--. 1 ysong orbit 3381672 Mar 14 10:01 AMSR2-MBT-89B_v1r0_GW1_s201303112359597_e201303120008581_c201403141401310.bufr
-rw-r--r--. 1 ysong orbit 236 Mar 14 10:01 NPR.pl.PSF
-rw-r--r--. 1 ysong orbit 3572 Mar 14 10:01 NPR.pl.log
-rw-r--r--. 1 ysong orbit 3381672 Mar 14 10:01 AMSR2-MBT-89B_v1r0_GW1_s201303112359597_e201303120008581_c201403141401310.bufr
rhs8142(ysong):/net/orbit247l/disk1/pub/ysong/intel/AMSR2/run>cat NPR.pl.PSF
AMSR2-MBT-LR_v1r0_GW1_s201303112359597_e201303120008581_c201403141401310.bufr
AMSR2-MBT-89A_v1r0_GW1_s201303112359597_e201303120008581_c201403141401310.bufr
AMSR2-MBT-89B_v1r0_GW1_s201303112359597_e201303120008581_c201403141401310.bufr
rhs8142(ysong):/net/orbit247l/disk1/pub/ysong/intel/AMSR2/run>
```
Dumped the contents of the log file (NPR.pl.log) to show that everything ran correctly. There were no errors in the script itself, any of the system calls, the main program, its subroutines and BUFR library calls. This log file contains the starting and ending times indicating that everything completed within 9 second of clock time. The CPU time for the main program is 7.38 seconds for one 9-minute granule of AMSR2 Microwave Brightness Temperature data.

Starting at Fri Mar 14 10:01:31 EDT 2014
main_npr is now starting.
Starting AMSR2_1B_hdf5_to_bufr
ORBN= 4345
++++++++++++++BUFR ARCHIVE LIBRARY+++++++++++++++++
BUFRLIB: MAXOUT - THE RECORD LENGTH OF ALL BUFR MESSAGES CREATED FROM THIS POINT ON IS BEING CHANGED FROM 10000 TO 50000
++++++++++++++BUFR ARCHIVE LIBRARY+++++++++++++++++
LEAPSECONDS= 8 Seconds
Finishing AMSR2_1b_write_bufr
Finishing AMSR2_89A_write_bufr
Finishing AMSR2_89B_write_bufr
Finishing AMSR2_1B_hdf5_to_bufr
main_npr is now finished.
CPU time for the whole program is: 7.37587900000000 Seconds
Ending at Fri Mar 14 10:01:40 EDT 2014
The AMSR2 Microwave Brightness Temperature BUFR file can be decoded to verify the original encoding.

- This shows selected parts of the AMSR2 MBT BUFR file that are decoded with NCEP BUFR library.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Value</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>005041</td>
<td>SLNM</td>
<td>1.0 NUMERIC</td>
<td>Scan line number</td>
</tr>
<tr>
<td>005043</td>
<td>FOVN</td>
<td>1.0 NUMERIC</td>
<td>Field of view number</td>
</tr>
<tr>
<td>005001</td>
<td>CLATH</td>
<td>33.77758 DEGREE</td>
<td>Latitude (high accuracy)</td>
</tr>
<tr>
<td>006001</td>
<td>CLONH</td>
<td>19.62402 DEGREE</td>
<td>Longitude (high accuracy)</td>
</tr>
<tr>
<td>005022</td>
<td>SOLAZI</td>
<td>229.27 DEGREE TRUE</td>
<td>Solar azimuth</td>
</tr>
<tr>
<td>007022</td>
<td>SOEL</td>
<td>90.64 DEGREE</td>
<td>Solar elevation</td>
</tr>
<tr>
<td>025081</td>
<td>IANG</td>
<td>54.960 DEGREE</td>
<td>Incidence angle</td>
</tr>
<tr>
<td>025082</td>
<td>AANG</td>
<td>80.490 DEGREE</td>
<td>Azimuth angle</td>
</tr>
<tr>
<td>033032</td>
<td>ACQF</td>
<td>131072.0 FLAG TABLE(7)</td>
<td>Channel quality flags for ATOVS</td>
</tr>
<tr>
<td>002141</td>
<td>MTYP</td>
<td>NORMAL ( 6)CCITT IA5</td>
<td>Measurement type</td>
</tr>
<tr>
<td></td>
<td>++++ AMSRCH REPLICATION #  7 +++++++</td>
<td></td>
<td></td>
</tr>
<tr>
<td>002153</td>
<td>SCCF</td>
<td>18700000000.0 HZ</td>
<td>Satellite channel center frequency</td>
</tr>
<tr>
<td>021166</td>
<td>ALFR</td>
<td>1.000 NUMERIC</td>
<td>Land fraction</td>
</tr>
<tr>
<td>033083</td>
<td>VIIRSQ</td>
<td>0.0 FLAG TABLE</td>
<td>Radiance data quality flags</td>
</tr>
<tr>
<td>002104</td>
<td>ANPO</td>
<td>0.0 CODE TABLE</td>
<td>Antenna polarization</td>
</tr>
<tr>
<td>012163</td>
<td>TMBR</td>
<td>112.19 K</td>
<td>Brightness temperature (high accuracy)</td>
</tr>
<tr>
<td></td>
<td>++++ AMSRCH REPLICATION #  8 +++++++</td>
<td></td>
<td></td>
</tr>
<tr>
<td>002153</td>
<td>SCCF</td>
<td>18700000000.0 HZ</td>
<td>Satellite channel center frequency</td>
</tr>
<tr>
<td>021166</td>
<td>ALFR</td>
<td>1.000 NUMERIC</td>
<td>Land fraction</td>
</tr>
<tr>
<td>033083</td>
<td>VIIRSQ</td>
<td>0.0 FLAG TABLE</td>
<td>Radiance data quality flags</td>
</tr>
<tr>
<td>002104</td>
<td>ANPO</td>
<td>1.0 CODE TABLE</td>
<td>Antenna polarization</td>
</tr>
<tr>
<td>012163</td>
<td>TMBR</td>
<td>191.35 K</td>
<td>Brightness temperature (high accuracy)</td>
</tr>
</tbody>
</table>
Test Sequence/Results

Part of AMSR2 Microwave Brightness Temperature in the original HDF5 file.

DATASET "Latitude of Observation Point for 89A"
  DATATYPE H5T_IEEE_F32LE
  DATASPACE SIMPLE { ( 360, 486 ) / ( 360, 486 ) }
  DATA {
    (0,0): 33.7776, 33.738, 33.6978, 33.6577, 33.6176, 33.5775, 33.5375,
  }

DATASET "Longitude of Observation Point for 89A"
  DATATYPE H5T_IEEE_F32LE
  DATASPACE SIMPLE { ( 360, 486 ) / ( 360, 486 ) }
  DATA {
    (0,0): 19.624, 19.6324, 19.6411, 19.6501, 19.6594, 19.6689, 19.6786,
  }

DATASET "Sun Elevation"
  DATATYPE H5T_STD_I16LE
  DATASPACE SIMPLE { ( 360, 243 ) / ( 360, 243 ) }
  DATA {
    (0,0): 9064, 9070, 9077, 9083, 9089, 9101, 9107, 9113, 9119,
  }

DATASET "Brightness Temperature (18.7GHz,H)"
  DATATYPE H5T_STD_U16LE
  DATASPACE SIMPLE { ( 360, 243 ) / ( 360, 243 ) }
  DATA {
    (0,0): 11219, 11177, 11145, 11230, 11261, 11272, 11335, 11272, 11325,
  }

DATASET "Brightness Temperature (18.7GHz,V)"
  DATATYPE H5T_STD_U16LE
  DATASPACE SIMPLE { ( 360, 243 ) / ( 360, 243 ) }
  DATA {
    (0,0): 19135, 19156, 19196, 19094, 19176, 19135, 19206, 19176, 19237,
The AMSR2 MBT BUFR file can also be read with the ECMWF BUFR library and is therefore readable among other user communities.

This output shows the same message as before, but read from the using the ECMWF BUFR library.

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCAN LINE NUMBER</td>
<td>0.100000000000000E+001 NUMERIC</td>
</tr>
<tr>
<td>FIELD OF VIEW NUMBER</td>
<td>0.100000000000000E+001 NUMERIC</td>
</tr>
<tr>
<td>LATITUDE (HIGH ACCURACY)</td>
<td>0.337775800000000E+002 DEGREE</td>
</tr>
<tr>
<td>LONGITUDE (HIGH ACCURACY)</td>
<td>0.196240200000000E+002 DEGREE</td>
</tr>
<tr>
<td>SOLAR AZIMUTH</td>
<td>0.229270000000000E+003 DEGREE TRUE</td>
</tr>
<tr>
<td>SOLAR ELEVATION</td>
<td>0.906400000000000E+002 DEGREE</td>
</tr>
<tr>
<td>INCIDENCE ANGLE</td>
<td>0.549600000000000E+002 DEGREE</td>
</tr>
<tr>
<td>AZIMUTH ANGLE</td>
<td>0.804900000000000E+002 DEGREE</td>
</tr>
<tr>
<td>SATELLITE CHANNEL CENTRE FREQUEN</td>
<td>0.187000000000000E+011 Hz</td>
</tr>
<tr>
<td>LAND FRACTION</td>
<td>0.100000000000000E+001 NUMERIC</td>
</tr>
<tr>
<td>RADIANCE DATA QUALITY FLAGS</td>
<td>0.000000000000000E+000 FLAG TABLE 33083</td>
</tr>
<tr>
<td>ANTENNA POLARISATION</td>
<td>0.000000000000000E+000 CODE TABLE 2104</td>
</tr>
<tr>
<td>BRIGHTNESS TEMPERATURE</td>
<td>0.112190000000000E+003 K</td>
</tr>
<tr>
<td>SATELLITE CHANNEL CENTRE FREQUEN</td>
<td>0.187000000000000E+011 Hz</td>
</tr>
<tr>
<td>LAND FRACTION</td>
<td>0.100000000000000E+001 NUMERIC</td>
</tr>
<tr>
<td>RADIANCE DATA QUALITY FLAGS</td>
<td>0.000000000000000E+000 FLAG TABLE 33083</td>
</tr>
<tr>
<td>ANTENNA POLARISATION</td>
<td>0.100000000000000E+001 CODE TABLE 2104</td>
</tr>
<tr>
<td>BRIGHTNESS TEMPERATURE</td>
<td>0.191350000000000E+003 K</td>
</tr>
</tbody>
</table>
The final Day 1 DAP will be:
ftp://ftp2.star.nesdis.noaa.gov/smcd/letitias/GCOM/GAASP_v1-0-20140410.tar.gz

The package contains:

- Code
  - GAASP code
  - BUFR Toolkit

- Documentation:
  - README
  - SMM, EUM, ATBD documents
  - PDR, CDR, CTR, and ARR slide packages

- Data
  - Sample data
  - Static ancillary data
## GAASP Code Details

<table>
<thead>
<tr>
<th>Language</th>
<th>GCOM</th>
<th>N4RT</th>
<th>Total</th>
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</thead>
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<tr>
<td>Fortran 90</td>
<td>66487</td>
<td>6927</td>
<td>73414</td>
</tr>
<tr>
<td>Fortran 77</td>
<td>0</td>
<td>30792</td>
<td>30792</td>
</tr>
<tr>
<td>C</td>
<td>0</td>
<td>1509</td>
<td>1509</td>
</tr>
<tr>
<td>Perl</td>
<td>2228</td>
<td>785</td>
<td>3013</td>
</tr>
</tbody>
</table>
Review Outline

- Introduction
- CTR Report
- Requirements
- Software Architecture
- Validation
- Risks and Actions
- Summary and Conclusions
Risks and Actions

Presented by

Tom King
IMSG
Open Risks

- **Risk #3:** ESPDS SOW is not clear about who handles the NCDC/CLASS archive Submission Agreement (SA) and metadata for archived SDRs and EDRs. The concern is that the archive process has an evaluation period that takes many months. This evaluation must happen even before the SA and metadata are developed.

  » **Risk Assessment:**
  
  - There are currently no archive requirements assigned to GAASP. If this changes the project will have to evaluate the work load and may need to ask for additional resources. It’s worth noting that Eileen Maturi already has an agreement to archive AMSR2 SST to NODC (in netCDF4) and the JPL DAAC in GHRSST netCDF4.

- **Status:** Open
• **Risk #8:** Brightness temperature calibration issues. This will hinder development of high quality EDRs.
  » **Risk Mitigation:**
  - GAASP science team has identified small biases. These have been brought to JAXA’s attention over 2 telecons and are being addressed.

• **Status:** Open

• **Risk #9:** RFI impacts on C and X-band brightness temperatures
  » **Risk Mitigation:**
  - These have been characterized. The GAASP science team has been working with JAXA on correction/flagging routines.

• **Status:** Open
Open Risks

- **Risk #10:** Rain and Snow Flag Quality. May lead to Erroneous EDR product values because of incorrect rain and snow identification.
  - **Risk Mitigation:**
    - Characterize the quality flag performance utilizing and implement changes as needed.
    - Will need to collect data over a seasonal cycle to fully characterize.
  - **Status:** Open

- **Risk #12:** There is a general risk for changes that need to be made to the JPSS L1RD Supplement section 6 to align product requirements with the capabilities of the instruments and the algorithms as well as with actual user needs.
  - **Risk Mitigation:**
    - Work with NJO to update GCOM product requirements.
  - **Status:** Open
New Risk

- **Risk #21**: FY14 funding is not yet available from NJO. This may cause schedule delays, particularly for Day 2 product development and delivery.
  - **Assessment**: Medium
  - **Risk Mitigation**:
    - Work with NJO, STAR management, and the contracting office to expedite the transfer of money to the contract.

- **Status**: Open
Risk Summary

- 6 Risks Total
  - 5 Old Risks
  - 1 New Risk

- Old Risks:
  - 3 Medium
  - 2 Low

- New Risk:
  - 1 medium
Review Outline

• Introduction
• CTR Report
• Requirements
• Software Architecture
• Validation
• Risks and Actions
• Summary and Conclusions
Summary and Conclusions

Presented by

Paul Chang
NOAA/NESDIS/STAR
Review Objectives Have Been Addressed

- The following have been reviewed
  - Project Requirements
  - Software Architecture
  - Validation
  - Risks and Actions
Next Steps for GAASP

- Gather reviewer feedback, make necessary updates to the ARR and the Review Item Disposition, and make these updates available to the review team.
- Assist OSPO with any transition to operations issues.
- Continue working to identify stakeholder needs to finalize Day 2 product requirements.
- Continue risk mitigation activities.
Next Steps for GAASP

- Continue Day 2 product development.
- Update bias corrections associated with JAXA code updates.
Open Discussion

- The review is now open for free discussion
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFWA</td>
<td>Air Force Weather Agency</td>
</tr>
<tr>
<td>AMSR2</td>
<td>Advanced Microwave Scanning Radiometer 2</td>
</tr>
<tr>
<td>AMSR-E</td>
<td>Advanced Microwave Scanning Radiometer – Earth Observing System</td>
</tr>
<tr>
<td>AMSU</td>
<td>Advanced Microwave Sounder Unit</td>
</tr>
<tr>
<td>APIID</td>
<td>Application Package IDentifier</td>
</tr>
<tr>
<td>ARR</td>
<td>Algorithm Readiness Review</td>
</tr>
<tr>
<td>ASCII</td>
<td>American Standard Code for Information Interchange</td>
</tr>
<tr>
<td>ASD</td>
<td>APID Sorted Data</td>
</tr>
<tr>
<td>ASI</td>
<td>Arctic Sea Ice</td>
</tr>
<tr>
<td>ATBD</td>
<td>Algorithm Theoretical Basis Document</td>
</tr>
<tr>
<td>BT</td>
<td>Bootstrap</td>
</tr>
<tr>
<td>BUFR</td>
<td>Binary Universal Form for the Representation of meteorological data</td>
</tr>
<tr>
<td>CDR</td>
<td>Critical Design Review</td>
</tr>
<tr>
<td>CICS</td>
<td>Cooperative Institute for Climate and Satellites</td>
</tr>
<tr>
<td>CIRES</td>
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<td>CLASS</td>
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<td>CLW</td>
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<td>Acronym</td>
<td>Definition</td>
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<tr>
<td>CM</td>
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<td>CMC</td>
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<td>COSMOS</td>
<td>COsmic-ray Soil Moisture Observing System</td>
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<tr>
<td>CPC</td>
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<td>CPU</td>
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<td>CTR</td>
<td>Code Test Review</td>
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<td>DAP</td>
<td>Delivered Algorithm Package</td>
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<td>DDS</td>
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<td>DPCA</td>
<td>Double Principal Components Analysis</td>
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<td>ECMWF</td>
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<tr>
<td>EDR</td>
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<tr>
<td>EIA</td>
<td>Earth Incidence Angle</td>
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<td>EMC</td>
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<td>EPL</td>
<td>Enterprise Product Lifecycle</td>
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<tr>
<td>ESPC</td>
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</tr>
<tr>
<td>ESPDSS</td>
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<tr>
<td>ESRL</td>
<td>Earth System Research Laboratory</td>
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### Acronyms

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<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>EUM</td>
<td>External Users Manual</td>
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<tr>
<td>EUMETSAT</td>
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<tr>
<td>FNMOC</td>
<td>Fleet Numerical Meteorology and Oceanography Center</td>
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<tr>
<td>FOV</td>
<td>Field of View</td>
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<tr>
<td>GAASP</td>
<td>GCOM-W1 AMSR2 Algorithm Software Processor</td>
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<tr>
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<td>Gigabyte</td>
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<td>GCOM</td>
<td>Global Change Observation Mission</td>
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<tr>
<td>GDAS</td>
<td>Global Data Assimilation System</td>
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<td>GEOSS</td>
<td>Global Earth Observation System of Systems</td>
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<td>GFS</td>
<td>Global Forecast System</td>
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<td>GHRSSST</td>
<td>Group for High Resolution Sea Surface Temperature</td>
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<td>GMAO</td>
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<td>GMT</td>
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<td>GRIB2</td>
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<td>HCS</td>
<td>Horizontal Cell Size</td>
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<tr>
<td>IASI</td>
<td>Infrared Atmospheric Sounding Interferometer</td>
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<td>IDPS</td>
<td>Interface Data Processing Segment</td>
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<tr>
<td>IGBP</td>
<td>International Geosphere-Biosphere Programme</td>
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<tr>
<td>IMS</td>
<td>Interactive Multisensor Snow and Ice Mapping System</td>
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<tr>
<td>IPT</td>
<td>Integrated Product Team</td>
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<tr>
<td>JAXA</td>
<td>Japan Aerospace Exploration Agency</td>
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<tr>
<td>JCSDA</td>
<td>Joint Center for Satellite Data Assimilation</td>
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<td>JPSS</td>
<td>Joint Polar Satellite System</td>
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<tr>
<td>KSAT</td>
<td>Kongsberg Satellite Services</td>
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<tr>
<td>MBT</td>
<td>Microwave Brightness Temperature</td>
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<td>MIRS</td>
<td>Microwave Integrated Retrieval System</td>
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<td>MMAB</td>
<td>Marine Modeling and Analysis Branch</td>
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<td>MODIS</td>
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<td>N4RT</td>
<td>NetCDF4 Reformatting Toolkit</td>
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<td>NDE</td>
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Acronyms

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<th>Acronym</th>
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<td>NDVI</td>
<td>Normalized Difference Vegetation Index</td>
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<td>NGDC</td>
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<td>NCDC</td>
<td>National Climate Data Center</td>
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<td>NCEP</td>
<td>National Center for Environmental Prediction</td>
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<td>NESDIS</td>
<td>National Environmental Satellite, Data, and Information Service</td>
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<td>network Common Data Format version 4</td>
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<td>NHC</td>
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<td>NMFS</td>
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<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
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<td>NPOESS</td>
<td>National Polar-orbiting Operational Environmental Satellite System</td>
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<td>NRL</td>
<td>Naval Research Lab</td>
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<td>NRT</td>
<td>Near Real-Time</td>
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<td>NSIDC</td>
<td>National Snow and Ice Data Center</td>
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<td>NSOF</td>
<td>NOAA Satellite Operations Facility</td>
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<td>NT2</td>
<td>NASA Team 2</td>
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<td>OSPO</td>
<td>Office of Satellite and Product Operations</td>
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<td>Operational Sea Surface Temperature and Sea Ice Analysis</td>
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<td>PDF</td>
<td>Probability Density Function</td>
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<td>PDR</td>
<td>Preliminary Design Review</td>
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<td>PSF</td>
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<tr>
<td>PT/R</td>
<td>Precipitation Type/Rate</td>
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<tr>
<td>QA</td>
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# Acronyms

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<td>Raw Data Record</td>
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<td>RFI</td>
<td>Radio Frequency Interference</td>
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<td>Satellite Meteorology and Climate Division</td>
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<td>SMM</td>
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<td>Soil Moisture Operational Products System</td>
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<td>Statement of Work</td>
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<td>Satellite Products and Services Review Board</td>
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<td>SSMI</td>
<td>Special Sensor Microwave/Imager</td>
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<td>SSMI/S</td>
<td>Special Sensor Microwave Imager/Sounder</td>
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<td>Sea Surface Salinity</td>
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<td>Sea Surface Temperature</td>
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<td>Center for Satellite Applications and Research</td>
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<td>SWE</td>
<td>Snow Water Equivalent</td>
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<td>To Be Determined</td>
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<td>TPW</td>
<td>Total Precipitable Water</td>
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## Acronyms

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<td>University Corporation for Atmospheric Research</td>
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<td>USCRN</td>
<td>U.S. Climate Reference Network</td>
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<td>UTC</td>
<td>Universal Time Coordinated</td>
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<td>VIIRS</td>
<td>Visible Infrared Imager Radiometer Suite</td>
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<td>V &amp; V</td>
<td>Validation and Verification</td>
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Backup Slides
Latency -
Test Sequence/Results

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