GOES-R Ground Segment
Product Readiness & Operations
(Science Algorithms & Products)

Heather Kilcoyne
Outline

• GOES-R Launch
• Algorithm Development and Cal/Val Organization
• Cal/Val Program
• Data Distribution and Access
• Readiness Activities
GOES-R Launch

- GOES-R launches in March 2016
- Launch and orbit raising: 12 days
- Level 1b products will be validated during Post Launch Test (six months) and will be available through GOES-R Rebroadcast (GRB) service as products are certified
- Level 2+ product certification begins after L1b products and will be distributed on a product-by-product basis as they mature
- GOES-16 extended validation: Sept 2016 – March 2017
- GOES-16 operational: March 2017 at TBD orbit location
**Objectives Served**

- Unifies algorithm readiness and ops activities and SMEs in a single team
- Aligns product maturity phases under appropriate government leads (dev under OSGS, quality under Program, ops under OSPO)
- Structure persists through all phases of program and algorithm maturity

**Chairmanship**

- ARB Pre-Product Handover: Program delegates to Satya as chair
- ARB Post-Product Handover: OSPO delegates to Matt as chair
- AIRAT (Alg IR Action Team): Product Quality to Heather as chair
GOES-R Calibration/Validation Program

• Goal of the Cal/Val Program is to have Provisional L1b (and CMI) and Beta L2 data products at the Operations Handover to be held about 6 months post-launch
  – Provisional = Ready for users to assess in their applications for operational use
  – Beta = Product is minimally validated and may contain significant errors

• Calibration Working Group (CWG) will conduct Post-Launch Performance Tests to calibrate and validate the L1B data products
  – CWG will identify, report and collaborate with instrument vendors to resolve issues with ground segment algorithms
  – CWG will modify calibration tables as needed

• Algorithm Working Group (AWG) will also perform post-launch analyses to calibrate and validated the L2 data products
  – AWG will identify, report, and resolve issues with ground segment algorithms.
  – AWG will modify configuration tables as needed.
Validation and Availability for GOES-R Baseline Products

Milestone: GOES-R Launch to 89.5° West

Program Phase:
- Pre-Launch
- PLT (6 months)
- Post-Handover

Operations Handover (includes Products) Extended Validation

On-Orbit East/West Operations

L1b Product Activities
- L1b Validation - Products recertified against pre-launch instrument performance
- ‘First Light’ Data captures shared from Instruments
- Insertion of L1b products into GRB service is controlled by ground system and will occur as products are certified

L2+ Product Activities
- L2+ Validation – Same certification process as L1b products
- However, L2+ certification begins after L1b products and the portfolio will mature at an overall slower rate with some products certified post-Operations Handover

Distribution Testing
- Testing of Distribution Requirements for GRB, AWIPS, and PDA will occur with Integration & Test Customers, utilizing a terrestrial test-purpose data flow from Wallops to NSOF

Mission Notifications
- Mission notifications will inform users of new product operations and caveats (e.g. GOES maneuver data caveats) leading up to, during, and after Operations Handover
Operational Software

- Operational software for the L2 data products has been made available to STAR through access to the Ground Configuration Management system, and STAR will provide Delivered Algorithm Packages with any necessary algorithm changes to be implemented on the operational system via the Ground Contractor.

- Operational software for the L1b data products is available to the CWG, though funding has not been provided for facilities to run the software offline.

Data Access

- CWG may access L0 through the Level Zero Storage System (LZSS) at WCDAS remotely

- CWG may access L1b data from the NSOF/WCDAS Development Environments (DEs) from the NSOF (secured area)

- AWG may access L2 data from the DE at the NSOF (not as secure area)

- STAR will also access the L1b and L2 from PDA
  - DE will be for anomaly resolution and diagnostic data not distributed over PDA
GOES-R Distribution to Users

- Raw Data
- GRB Raw Data
- GRB AWIPS
- Sectorized CMI

Primary Processing
Product Distribution & Access (PDA)

Product Generation
- L0
- L1b (+GLM)
- L2+

Product Distribution
- Format - Sectorize - Distribute

Enterprise Management - Monitor - Supervise

Mission Management - TT&C

Antenna System

RBU

Physical Security Boundary

Primary Processing

Backup Processing

GOES-R Functionality

Site External to Core GS

Government Furnished Property

External to Core GS

External Systems

GOES-R Site

GOES-R Functionality

Other Payload Services
- SARSAT
- HRIT/EMWIN
- DCS

Other GRB Receivers
- NWS Centers
- NWS WFOs
- Non-NOAA Users

N-WAVE

ANCF BNCF

Ancillary Data

SBN AWIPS

Sectorized CMI

GOES-S

Raw Data, GRB, TLM

TLM

CMD

Raw Data, GRB

Antenna System

Mission Management - TT&C

Enterprise Management - Monitor - Supervise

Product Generation - L0 - L1b (+GLM) - GRB - Recover L1b - L2+ - CMI

Product Distribution - Format - Sectorize - Distribute

L0 Pkt, GRB

L1b, L2+

GLM, L2+, CMI

Product Users

Products

L1b / L2+

CLASS

ANCF BNCF

SBN

GOES-S

Backup

Ground Processing

Primary Ground Processing

RBU

GOES-R Raw Data

GOES-R Distribution

GOES-R Raw Data
How to get to Data

SSD/NSD: L1 Area, High Security, access via workstation at NSOF (or WCDAS)
NSD/PPZ: L2 Area, Lower Security, access remotely for pull, working for push access

SSD = SCADA Security Zone
SOZ = Satellite Operations Zone
NSD = Non SCADA security Domain
PPZ = Product Processing Zone

PG* Only GRB (L1b) & Sectorized CMI generation [GRB includes L1b + GLM]
PD* Only GRB delivery to satellite, Sectorized CMI delivery to AWIPS, L0 to LZSS (WCDAS only)
PG** L1b reconstruction, L2+ generation
PD** L1b, L2+ delivery to PDA

Sectorized CMI

L1b & L2+

SSD = SCADA Security Zone
SOZ = Satellite Operations Zone
NSD = Non SCADA Security Domain
PPZ = Product Processing Zone

LZSS
L0
Readiness Activities

- Pre-Launch “rehearsals” will prepare the CWG and AWG for the post-launch activities
- DOEs are mission rehearsals executed by the Data Operations team
  - DOEs provide incremental readiness to prepare systems, operators, processes, and teams to support mission operations
  - Conducted in a “rehearse like we fly” manner
  - Both nominal and anomalous conditions are exercised
    - Problems encountered are recorded and opened for investigation
    - Unscripted events are injected including failover scenarios
    - Some long duration DOEs are planned to satisfy consumers’ needs
  - Goal is to ultimately exercise the entire ground system by processing various data sets from end-to-end, from L0 through L2+, including PDA in DOE-3 and DOE-4 (STAR and CIMSS may not have PDA Access for DOE-3,4)
  - DOE-4 will include participation by the NWS TOWR-S (Total Operational Weather Readiness - Satellites) project which is incorporating distribution to elements of the AWIPS community
Readiness Activities

• AWG and CWG participating in Ground Segment’s Data Operations Exercises (DOEs)
  – DOE-0: NOV 2014: Analysis of DOE 0 data is almost complete
  – DOE-1-2: 15-30 JUN 2015
    • Algorithm change
    • Manually transfer data off of OE to DE (NSOF PPZ DE)
  – DOE-3: AUG 2015
    • Analyze Space Wx Prototypes and Final Product Set updates (WCDAS DE)
  – DOE-4: OCT 2015
    • Cal INR update (Fast track LUT process)
Simulated Cloud & Moisture Imagery (CMI) from the First GOES-R Data Operations Exercise (DOE-0)

Simulated ABI Band_01(0.47um) 05-11-2014 05:56:51UTC
Additional PRO Activities

- Product Definition & Users Guide (PUG), metadata, and support POCs
- Calibration and Validation Planning and Rehearsals via Data Operations Exercises
- Science Products and Tools Verification & Validation
- Finalizing Anomaly Tracking, Configuration Management, Integration, Test, and Check-Out Processes
- Formalizing Mission Notice Language and SOPs
- Reviewing Transition & Handover Steps and Timelines
- Setting ‘First Light’ Imagery & Data Release Strategies
- Working on SOPs for GOES-R mode changes and mesoscale domain defaults and changes
  - Assisting NWS in updating their existing GOES-13/14/15 RSO request SOPs to also handle GOES-R
  - Writing SOPs for OSPO/SAB to request GOES-R mode and domain changes
  - Writing SOPs for ESPC Help Desk to receive and transmit requests to GOES-R Satellite Operations
- Initiating Processes for Baseline Product Enhancements and New Products
### NSC: GOES-R Product Portfolio Status

#### Baseline Products

<table>
<thead>
<tr>
<th>Advanced Baseline Imager (ABI)</th>
<th>Geostationary Lightning Mapper (GLM)</th>
<th>Space Environment In-Situ Suite (SEISS)</th>
<th>Magnetometer (MAG)</th>
<th>Extreme Ultraviolet and X-ray Irradiance Suite (EXIS)</th>
<th>Solar Ultraviolet Imager (SUVI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Cloud Optical Depth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Cloud Particle Size Distribution</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Cloud Top Height</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Cloud Top Phase</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Cloud Top Pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Cloud Top Temperature</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Derived Motion Winds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Derived Stability Indices</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Downward Shortwave Radiation: Surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Fire/Hot Spot Characterization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Hurricane Intensity Estimation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Land Surface Temperature (Skin)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Legacy Vertical Moisture Profile</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Legacy Vertical Temperature Profile</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Radiiances</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Rainfall Rate/QPE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. Reflected Shortwave Radiation: TOA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. Sea Surface Temperature (Skin)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. Snow Cover</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. Total Precipitable Water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. Volcanic Ash: Detection and Height</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Future Capabilities

<table>
<thead>
<tr>
<th>Advanced Baseline Imager (ABI)</th>
<th>GOES-R Key Performance Parameters</th>
<th>Prospective Post-Handover Implementation</th>
<th>Added to Baseline, required for Snow Cover</th>
<th>Prospective Prototype Wrapped Algorithms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absorbed Shortwave Radiation: Surface</td>
<td>Aerosol Particle Size</td>
<td>Aircraft Icing Threat</td>
<td>Cloud Ice Water Path</td>
<td></td>
</tr>
<tr>
<td>Cloud Layers/Heights</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cloud Liquid Water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cloud Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Convective Initiation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Currents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Currents: Offshore</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Downward Longwave Radiation: Surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhanced “V”/Overshooting Top Detection</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flood/Standing Water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ice Cover</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Cloud and Fog</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ozone Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probability of Rainfall</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rainfall Potential</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sea and Lake Ice: Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sea and Lake Ice: Concentration</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sea and Lake Ice: Motion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Snow Depth (Over Plains)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SO₂ Detection</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Albedo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Emissivity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tropopause Folding Turbulence Prediction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upward Longwave Radiation: Surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upward Longwave Radiation: TOA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetation Fraction: Green</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetation Index</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visibility</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>