CSPP Geo Status and Plans

Graeme Martin, Liam Gumley, Nick Bearson, Jessica Braun, Geoff Cureton, Alan De Smet, Ray Garcia, Dave Hoese, Tommy Jasmin, Scott Mindock, Eva Schiffer, Kathy Strabala

University of Wisconsin – Madison, Space Science & Engineering Center (SSEC) / Cooperative Institute for Meteorological Satellite Studies (CIMSS)

Tenth Asia-Oceania Meteorological Satellite Users’ Conference
4th December 2019
Melbourne, Australia
Outline

• Project Overview
• CSPP Geo Users
• GOES-16 and GOES-17
• CSPP Geo Software Packages
What is CSPP Geo?

- CSPP Geo = “Community Satellite Processing Package for Geostationary Data”
- The CSPP Geo project creates and distributes software allowing direct broadcast users to create products from geostationary satellite data
- The project draws on experience creating software allowing direct broadcast users to process data from polar orbiters (CSPP and IMAPP projects)
- Funded by the NOAA GOES-R Program Office
- Supported missions: GOES-16, GOES-17, Himawari-8, GOES-13 and GOES-15
- Level 2 products are generated by algorithms that were developed for ABI under GOES-R AWG
Software philosophy

• CSPP Geo software is:
  • Publicly available and free of charge: http://cimss.ssec.wisc.edu/csppgeo/
  • Distributed as binary packages for 64-bit CentOS6-compatible Linux
  • Distributed with all required 3rd party software bundled
  • Easy to install and run
  • Released with an optional test data package
  • High level of user support (csppgeo.issues@ssec.wisc.edu)

• Software is intended to be run on rack-mounted commodity hardware

• GOES-R series challenge: processing high data volume on a modest, shared memory system

• Recommended hardware specs for each software package are on the CSPP Geo website

• Ancillary data is staged on servers at the U. of Wisconsin

• Generally Level 2 software is developed in collaboration with scientists, while Level 1 / ingestor software may be developed from scratch
Collaborators

**NOAA / ASSISTT / AIT:** Walter Wolf, Shanna Sampson, Tom King and team

**GEOCAT:** Mike Pavolonis

**GOES-R Cloud team:** Andy Heidinger (lead), Denis Botambekov, Corey Calvert, Pat Heck, William Straka, Andy Walther, Steve Wanzong

**Imagery:** Tim Schmit, Kaba Bah, Jordan Gerth, Mat Gunshor
CSPP Geo registration database on 2018-11-06 comprises 341 registrants in 35 countries

- CSPP Geo software is used at half of all GRB receiving stations around the world (as of early 2018, per GRB User Group survey)
- Users include NOAA / NWS, NASA, international meteorological agencies, receiving station vendors, data and weather service providers, and the university and research community
GOES-R series

• The GOES-R series is the new generation of US geostationary satellites with greatly enhanced capabilities

• GOES-16 was launched in November 2016 and is now the operational GOES-East satellite, located at W 75.2°

• GOES-17 was launched in March 2018 and is now the operational GOES-West satellite at W 137.2°

GOES-R series instruments

• Advanced Baseline Imager (ABI)
• Geostationary Lightning Mapper (GLM)
• Solar Ultraviolet Imager (SUVI)
• Space Environment In-Situ Suite (SEISS)
• Extreme Ultraviolet and X-ray Irradiance Sensors (EXIS)
• Magnetometer (MAG)

Advanced Baseline Imager (ABI)

• 16 visible and IR bands at 0.5 to 2-km resolution

• Mode 6 (“flex mode”) produces one full disk every 10 minutes, one CONUS every 5 min and one meso every 30 sec

Tim Schmit et al, NOAA / CIMSS
GOES Rebroadcast (GRB)

• GOES-R direct broadcast stream is called GOES Rebroadcast (GRB)
  • Includes data from all instruments

• GRB receiving systems are currently available from vendors

• NOAA provides information on GRB including a list of receiving station vendors at http://www.goes-r.gov/

• GRB User Group meets quarterly to discuss issues affecting GRB
  • Contact Jim McNitt: james.mcnitt@noaa.gov
CSPP Geo GRB Software Package

- Runs as a server, processing the raw GRB data stream
  - reads CADUs from two sockets
- Ingestor component is a modified version of NASA RT-STPS
- Extracts data payloads, decompresses, reconstructs datasets as they were created on the Ground Segment
- Generates products from all GOES-R instruments
  - Level 1 ABI and space weather, Level 2 GLM
- Requires multiple cores, hardware specs published on website
- Includes an experimental tracking interface allowing data to be used as it arrives
CSPP Geo ABI quicklooks

GOES-17

ABI L1 Reflectance (Band 3)
from 2019-01-04 19:15:38.8Z

GOES-16

GOES-16, ABI L1 Reflectance (Band 3)
from 2019-01-04 19:15:36.0Z

Data created by CSPP Geo GRB v1.0.19. Plotted using CSPP ABI Quicklooks v0.5.1beta.
GRB Package – recent and planned activities

- Version 1.0 milestone was in 2018
- GRB software patches are sometimes needed to allow continued product generation when changes are made to the GOES-R ground system
- GRB Version 1.1 is planned for late Spring/Summer 2020.
  - First significant upgrade in capabilities since v1.0
  - TCP support
  - Various bug fixes and performance improvements
  - Logging improvements and monitoring tools

<table>
<thead>
<tr>
<th>Release Date</th>
<th>Version</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug 2018</td>
<td>GRB v1.0.14</td>
<td>initial V1.0 release of GRB package including provisional support for G-17 and ABI Mode 6, UDP multicast support, robustness and performance improvements, logging and interface improvements</td>
</tr>
<tr>
<td>Oct 2018</td>
<td>GRB v1.0.15</td>
<td>Changes for DO.07 update to ground system</td>
</tr>
<tr>
<td>Dec 2018</td>
<td>GRB v1.0.18</td>
<td>Cumulative bug fixes, minor improvements</td>
</tr>
<tr>
<td>Jan 2019</td>
<td>GRB v1.0.19</td>
<td>Changes for DO.07.01 update to ground system (live date was Jan 18, 2019)</td>
</tr>
<tr>
<td>Jan 2019</td>
<td>GRB v1.0.19</td>
<td>Changes for DO.07.01 update to ground system</td>
</tr>
<tr>
<td>Aug 2019</td>
<td>GRB v1.0.21</td>
<td>Update to improve product yield when upstream data issues occur</td>
</tr>
<tr>
<td>Nov 2019</td>
<td>GRB v1.0.23</td>
<td>Changes for DO.08.01 update to ground system</td>
</tr>
</tbody>
</table>
The AIT Framework Software Package

- Further processes ABI L1B data to generate Level 2 products
- Core processing software was developed by the ASSISTT group at NOAA STAR as an integration point for research implementations of GOES-R Level 2 product algorithms
- Software was developed at UW for Imagery generation, data conversion, quicklooks, ancillary download and infrastructure
- Product algorithm updates are delivered by ASSISTT to CSPP Geo team and NOAA PRO team at the same time
- AIT Framework v1.0 was released in Jul 2019
  - Generates a subset of the GOES-R Baseline products
  - Software, documentation and test data are available from the CSPP Geo website

Initial set of products:

- Aerosol Detection: Smoke and Dust
- Aerosol Optical Depth
- Clear Sky Masks
- Cloud and Moisture Imagery
- Cloud Optical Depth (day/night)
- Cloud Particle Size Distribution (day/night)
- Cloud Top Height
- Cloud Top Phase
- Cloud Top Pressure
- Cloud Top Temperature
- Land Surface Temperature (Skin)
AIT Framework quicklooks

GOES-16, ABI L2+ Cloud Top Pressure from 2018-08-29 15:19:37.5Z

Data created by csgg-gen-xlf/1.0.2beta. Plotted using CSPP ABI Quicklooks v6.6beta.

GOES-16, ABI L2+ Cloud Top Phase from 2018-08-29 16:12:19.5Z

Data created by csgg-gen-xlf/1.0.2beta. Plotted using CSPP ABI Quicklooks v6.6beta.
AIT Framework: future plans

- Products have been identified as high priority to users and targeted for release within the next 1-2 years
  - Rainfall Rate / QPE
  - Low Cloud and Fog
  - Cloud Cover Layers
  - Derived Motion Winds
  - Sounding products (Total Precipitable Water (TPW), Derived Stability Indices, Legacy Vertical Moisture Profile, Legacy Vertical Temperature Profile)
  - ACSPO Sea Surface Temperature
- Winds and Sounding algorithms will be computationally intensive and will likely require additional hardware
- Support for GOES-17 will be added as GOES-17 thermal anomaly mitigated algorithm versions become available
- Migration to “enterprise” algorithms with science improvements
- Migration to “Framework 2.0” core software
- Release timeline will depend on availability of algorithms / GOES-17 support
Geo2Grid Software Package

• Version 1.0 was released March 1, 2019
• Generates high quality imagery from GOES-16 and GOES-17 ABI and Himawari AHI data
  • “composite RGB” images (true color, natural color, airmass, ash, dust, fog, night microphysics)
  • single-band images
• Formats: geo-tiff and PNG with coastlines
• Uses open source “satpy” plotting library
• Users can remap and define grids (projections, resolutions and coverage)
• Animations can be created
• Patch release soon: minor bug fixes
Currently adding support for Korean AMI, expected for release in early 2020
Geo2Grid true color images include

- Rayleigh correction
- Artificial green band
- Sharpening to 500m
- Solar zenith angle correction
- Enhancement (logarithmic stretching to bands)
GOES-16 “Natural Color” GeoTIFF generated by Geo2Grid. Displayed in Real Earth: https://realearth.ssec.wisc.edu/
Himawari-8

- Japanese weather satellite launched in 2014, located at 140.7° East
- Advanced Himawari Imager (AHI), same manufacturer and design as GOES-R series ABI instrument
- HimawariCast direct broadcast stream is relayed via a comm satellite
- CSPP Geo packages supporting AHI
  - Geo2Grid (image generation)
  - GEOCAT (Level 2 products)
The GEOCAT Level 2 Software Package for AHI and GOES-15

- GEOCAT = “Geostationary Cloud Algorithm Testbed”
- Originally developed by NOAA Scientist Mike Pavolonis for GOES-R algorithm development
- Processes Himawari-8, GOES-13 and GOES-15
- Products are generated by research versions of GOES-R algorithms that have been updated and adapted for AHI
- CSPP Geo team integrated updated algorithms for AHI, developed “glue” code
- Parallel processing is needed to keep up with the data rate
- V1.0 beta was released in Fall 2016
  - To obtain the beta, contact csppgeo.issues@ssec.wisc.edu

Initial set of products:
- Cloud and Moisture Imagery
- Clear Sky Masks
- Cloud Phase
- Cloud Type
- Cloud Top Height
- Cloud Top Pressure
- Cloud Top Temperature
- Cloud Optical Depth (day/night)
- Cloud Particle Size Distribution (day/night)
- Cloud Liquid Water Path (day/night)
- Cloud Ice Water Path (day/night)
- Low Cloud and Fog
• V1.0 planned for early 2020
  • Ancillary handling improvements including better tolerance for missing ancillary data
  • Added user controls
Software Utilities

Himawari Ingest Library

- Reads AHI data in HSD and HRIT formats, transparently handling datasets spanning multiple files
- Compatible with C/C++, Fortran and Python
- Used in multiple programs maintained at U. of Wisconsin
- Open source gitlab repo: https://gitlab.ssec.wisc.edu/rayg/himawari

AXI-Tools

- Generates tiled / SCMI products from ABI and AHI radiances
- Creates ABI CMI product in mission-standard format
- Used by NWS to load ABI and AHI data into AWIPS
- Open source Gitlab repo: http://sift.ssec.wisc.edu/axi-tools-package/
For more information...

- Website: http://cimss.ssec.wisc.edu/csppgeo/
- User Support: csppgeo.issues@ssec.wisc.edu