NOAA Near-Real Time Arctic GOES/POES Composite Satellite Imagery Products

Banghua Yan*
NOAA/NESDIS/OSPO

Matthew Lazzara\textsuperscript{1,2} and Rick Kohrs\textsuperscript{1}
\textsuperscript{1}UW-Madison/CIMSS and \textsuperscript{2}Madison College

*Other Contributors: David Mikolajczyk, J. Guo, C. Davenport, A. Irving, and J. Key
Outline

- Significance
- Composite Methodology Briefing
- NOAA NRT Composite Imagery Product Briefing
- Product Access Information
Significance of Arctic Composite Imagery Products

- Improves operational forecasting for the North Pacific and North Atlantic from 50°N to 90 °N in the following fields:
  - Climate (Climate Observations and Monitoring)
  - Weather and Water (Local Forecast and Warnings; Coasts, Estuaries & Oceans)
    - Understanding weather patterns and phenomena, ultimately improving forecasts, e.g., high-latitude atmospheric motion vectors from composite satellite data (Lazzara et al., 2013)
    - Arctic Research of the Composition of the Troposphere from Aircraft and Satellites (ARCTAS) project
  - Commerce and Transportation
    - Marine Transport Systems
    - Marine Weather
    - Surface Weather
Project Background

- The Arctic Satellite Composite Project, originally funded by National Science Foundation, was funded since 2012 by NOAA/NESDIS Satellite Product and Services Review Board (SPSRB) to generate near-real time (NRT) POES/GOES Arctic composite imagery products over Arctic polar region of the globe.
  - The algorithm and code were developed by University of Wisconsin Space Science and Engineering Center (SSEC) (Atmospheric Research, Kohrs et al., 2014).
  - Non-operational Arctic composite images of various wavelengths over the Arctic polar region of the globe are also run at SSEC (Lazzara et al., http://arctic.ssec.wisc.edu/).
**Composite Algorithm Overview**

(Reference: Atmospheric Research, Kohrs et al., 2014)
**OSPO Environment IT Architecture for Arctic Imagery Products**

NRT Arctic GOES/POES Composite Imagery Operational Product Specifications

- **Products:**
  - Near-real time 4-km hourly Arctic GOES/POES composite imagery products.

- **Satellite Imagery Bands**
  - Visible (~0.65 µm): VIS
  - Shortwave Infrared (3.7 to 3.9): SW
  - Water vapor (~6.7 µm): WV
  - Infrared (~11.0 µm): IR
  - Longwave Infrared (~12.0 µm): LW

- **Timeliness and Latency**
  - Composites are made hourly, however for inclusion of as much satellite data as possible, they are made approximately 3 hours after the target image time

- **Formats:**
  - McIDAS Area, netcdf, and gif
Ingested GOES/POES Satellites Data

- Geostationary satellite imagery:
  - GOES-13 (East)
  - GOES-15 (West)
  - Meteosat-7
  - MSG-10
  - Himawari-8

- Polar orbiting satellite imagery:
  - NOAA-18
  - NOAA-19
  - Metop-A
  - Metop-B
  - Aqua
  - Terra
## GOES Ingest Data Band Description

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Image Type</th>
<th>Band Number</th>
<th>Wavelength</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GOES-East</strong></td>
<td>Visible</td>
<td>1</td>
<td>0.65 µm</td>
</tr>
<tr>
<td></td>
<td>Shortwave IR</td>
<td>2</td>
<td>3.90 µm</td>
</tr>
<tr>
<td></td>
<td>Water Vapor</td>
<td>3</td>
<td>6.80 µm</td>
</tr>
<tr>
<td></td>
<td>Infrared</td>
<td>4</td>
<td>10.7 µm</td>
</tr>
<tr>
<td><strong>GOES-West</strong></td>
<td>Visible</td>
<td>1</td>
<td>0.63 µm</td>
</tr>
<tr>
<td></td>
<td>Shortwave IR</td>
<td>2</td>
<td>3.90 µm</td>
</tr>
<tr>
<td></td>
<td>Water Vapor</td>
<td>3</td>
<td>6.70 µm</td>
</tr>
<tr>
<td></td>
<td>Infrared</td>
<td>4</td>
<td>10.7 µm</td>
</tr>
<tr>
<td><strong>Meteosat Second Generation</strong></td>
<td>Visible</td>
<td>1</td>
<td>0.60 µm</td>
</tr>
<tr>
<td></td>
<td>Shortwave IR</td>
<td>4</td>
<td>3.90 µm</td>
</tr>
<tr>
<td></td>
<td>Water Vapor</td>
<td>6</td>
<td>7.30 µm</td>
</tr>
<tr>
<td></td>
<td>Infrared</td>
<td>9</td>
<td>10.8 µm</td>
</tr>
<tr>
<td></td>
<td>Longwave IR</td>
<td>10</td>
<td>12.0 µm</td>
</tr>
<tr>
<td><strong>Meteosat First Generation (INODEX)</strong></td>
<td>Visible</td>
<td>1</td>
<td>0.75 µm</td>
</tr>
<tr>
<td></td>
<td>Infrared</td>
<td>8</td>
<td>11.5 µm</td>
</tr>
<tr>
<td></td>
<td>Water Vapor</td>
<td>10</td>
<td>6.90 µm</td>
</tr>
<tr>
<td><strong>Himawari-8</strong></td>
<td>Visible</td>
<td>3</td>
<td>0.64 µm</td>
</tr>
<tr>
<td></td>
<td>Shortwave IR</td>
<td>7</td>
<td>3.90 µm</td>
</tr>
<tr>
<td></td>
<td>Water Vapor</td>
<td>9</td>
<td>6.90 µm</td>
</tr>
<tr>
<td></td>
<td>Infrared</td>
<td>13</td>
<td>10.4 µm</td>
</tr>
<tr>
<td></td>
<td>Longwave IR</td>
<td>15</td>
<td>12.4 µm</td>
</tr>
</tbody>
</table>
## POES Ingest Data Band Description

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Image Type</th>
<th>Band Number</th>
<th>Wavelength</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Terra MODIS</strong></td>
<td>Visible</td>
<td>1</td>
<td>0.64 μm</td>
</tr>
<tr>
<td></td>
<td>Shortwave IR</td>
<td>20</td>
<td>3.78 μm</td>
</tr>
<tr>
<td></td>
<td>Water Vapor</td>
<td>27</td>
<td>6.76 μm</td>
</tr>
<tr>
<td></td>
<td>Infrared</td>
<td>31</td>
<td>11.0 μm</td>
</tr>
<tr>
<td></td>
<td>Longwave IR</td>
<td>32</td>
<td>12.0 μm</td>
</tr>
<tr>
<td><strong>Aqua MODIS</strong></td>
<td>Visible</td>
<td>1</td>
<td>0.64 μm</td>
</tr>
<tr>
<td></td>
<td>Shortwave IR</td>
<td>20</td>
<td>3.78 μm</td>
</tr>
<tr>
<td></td>
<td>Water Vapor</td>
<td>27</td>
<td>6.76 μm</td>
</tr>
<tr>
<td></td>
<td>Infrared</td>
<td>31</td>
<td>11.0 μm</td>
</tr>
<tr>
<td></td>
<td>Longwave IR</td>
<td>32</td>
<td>12.0 μm</td>
</tr>
<tr>
<td><strong>NOAA-18</strong></td>
<td>Visible</td>
<td>1</td>
<td>0.64 μm</td>
</tr>
<tr>
<td></td>
<td>Shortwave IR</td>
<td>3</td>
<td>3.90 μm</td>
</tr>
<tr>
<td></td>
<td>Infrared</td>
<td>4</td>
<td>10.4 μm</td>
</tr>
<tr>
<td></td>
<td>Longwave IR</td>
<td>5</td>
<td>12.4 μm</td>
</tr>
<tr>
<td><strong>NOAA-19</strong></td>
<td>Visible</td>
<td>1</td>
<td>0.64 μm</td>
</tr>
<tr>
<td></td>
<td>Shortwave IR</td>
<td>3</td>
<td>3.90 μm</td>
</tr>
<tr>
<td></td>
<td>Infrared</td>
<td>4</td>
<td>10.4 μm</td>
</tr>
<tr>
<td></td>
<td>Longwave IR</td>
<td>5</td>
<td>12.4 μm</td>
</tr>
<tr>
<td><strong>METOP-A</strong></td>
<td>Visible</td>
<td>1</td>
<td>0.63 μm</td>
</tr>
<tr>
<td></td>
<td>Shortwave IR</td>
<td>3</td>
<td>3.74 μm</td>
</tr>
<tr>
<td></td>
<td>Infrared</td>
<td>4</td>
<td>10.8 μm</td>
</tr>
<tr>
<td></td>
<td>Longwave IR</td>
<td>5</td>
<td>12.0 μm</td>
</tr>
<tr>
<td><strong>METOP-B</strong></td>
<td>Visible</td>
<td>1</td>
<td>0.63 μm</td>
</tr>
<tr>
<td></td>
<td>Shortwave IR</td>
<td>3</td>
<td>3.74 μm</td>
</tr>
<tr>
<td></td>
<td>Infrared</td>
<td>4</td>
<td>10.8 μm</td>
</tr>
<tr>
<td></td>
<td>Longwave IR</td>
<td>5</td>
<td>12.0 μm</td>
</tr>
</tbody>
</table>
Satellite Data Coverage Map: An Example

University of Wisconsin
(Himawari-8 Missing)

OSPO

No data coverage
Two or more satellites overlap
Merging Single Satellite Imagery into Composite Imagery: An Example

(a) minutes past nominal - 10
(b) minutes past nominal - 20
(c) minutes past nominal - 30
(d) minutes past nominal - 40
(e) minutes past nominal - 50
(f) minutes past nominal - 60
(g) minutes past nominal - 130
(h) minutes past nominal - 140
(i) minutes past nominal - 150
NRT Arctic Composite Imagery Products: Animation Examples

- Infrared Band
- Shortwave Band
- Longwave Band
- Visible Band
- Water Vapor Band
Arctic Composite and GFS Model Data

Infrared (10.7 um) 08-Jan-2017 00:00 UTC
Cold Front Analysis, GFS (Orange Arrows), Composite (White Arrows)
NRT Arctic Composite Imagery Products: OSPO Web-based QA Monitoring Tool

- Monitor in near real time hourly product imagery at five bands
- Monitor up to 7 days of product imagery
- Display current day animated imagery

Examples:

SW Band

WV Band
NRT Arctic GOES/POES Composite Operational Product Data Flow

GOES Satellites

- GOES-E (Geodist2)
- GOES-W (Geodist3)
- MSG-10 and Metosat10 (Geodist6)
- Himawari-8 (Geodist7)

POES Satellites

- NOAA-18/19, Metop-A/B (Geodist4)
- MODIS/Aqua and Terra (EOS2-1)

OSPO Arctic System

Arctic Products
Production and Testing
Geodist4t
Geodist4

Arctic Products
Development
Geodev

CM
(cm-espc)

NOAA Users (OPC, NWS)

Distribution Server
(Geodist1, ADDE)

NOAA Users (OPC, NWS, Aircraft)

Distribution Server
(DDS/PDA)

All users and OSPO Arctic Team

Web Server
(gp5)

Security at ESPC/NSOF

- Production Zone
- Development Zone
- Distribution Zone (DMZ)
- External User Zone
NRT Arctic Imagery Product Access Information

- **DDS/PDA**
  - The Arctic GOES/POES composite imagery in NetCDF format
  - Submit a Data Access Request (DAR) form to nesdis.data.access@noaa.gov for approval

- **ADDE**
  - The GOES/POES composite imagery in McIDAS Area

- **ESPC satepsanone ftp site**
  - [ftp://satepsanone.nesdis.noaa.gov/7day/arctic/](ftp://satepsanone.nesdis.noaa.gov/7day/arctic/) (gif format only)
  - [ftp://satepsanone.nesdis.noaa.gov/2day/arctic/](ftp://satepsanone.nesdis.noaa.gov/2day/arctic/) (standard netcdf and McIDAS Area formats)