Baseline instruments planned for the GOES-R series

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With input from several authors from the 3rd GOES-R Users Conference

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GOES R Instruments

• Advanced Baseline Imager (ABI)
• Hyperspectral Environmental Suite (HES)
  – Disk Sounding
  – Severe Weather Mesoscale
  – Coastal Imager
• Geostationary Lightning Mapper (GLM)
• Solar Imaging Suite (SIS)
• Space Environment In Situ Suite (SEISS)
## SYSTEM IMPROVEMENTS

<table>
<thead>
<tr>
<th>GOES-I/P Instruments</th>
<th>GOES-R Notional Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Imager</strong></td>
<td>Advanced Baseline Imager (ABI)</td>
</tr>
<tr>
<td>5 Channels</td>
<td>16 Channels At Higher Spatial And Temporal Resolution</td>
</tr>
<tr>
<td><strong>Multispectral Sounder</strong></td>
<td>Hyperspectral Environmental Suite (HES)</td>
</tr>
<tr>
<td>19 Sounding Bands</td>
<td>1500 Sounding Bands</td>
</tr>
<tr>
<td>N/A</td>
<td>HiRes Imaging Bands</td>
</tr>
<tr>
<td><strong>Solar X-Ray Imager</strong></td>
<td>Solar Imaging Suite (SIS)</td>
</tr>
<tr>
<td>Space Environmental Monitor</td>
<td>Space Environmental In-Situ Suite (SEISS)</td>
</tr>
<tr>
<td>N/A</td>
<td><strong>Geostationary Lightning Mapper (GLM)</strong></td>
</tr>
</tbody>
</table>
## The Advanced Baseline Imager:

<table>
<thead>
<tr>
<th></th>
<th>ABI</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spectral Coverage</strong></td>
<td>16 bands</td>
<td>5 bands</td>
</tr>
<tr>
<td><strong>Spatial resolution</strong></td>
<td>0.64 μm Visible</td>
<td>0.5 km</td>
</tr>
<tr>
<td></td>
<td>1.0 km</td>
<td>Approx. 1 km</td>
</tr>
<tr>
<td></td>
<td>2 km</td>
<td>Approx. 4 km</td>
</tr>
<tr>
<td><strong>Spatial coverage</strong></td>
<td>Full disk 4 per hour</td>
<td>Every 3 hours</td>
</tr>
<tr>
<td></td>
<td>CONUS 12 per hour</td>
<td>~4 per hour</td>
</tr>
<tr>
<td><strong>Visible</strong></td>
<td>On-orbit calibration</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
</tr>
</tbody>
</table>
Visible and near-IR channels on the ABI

AVIRIS spectra

The current GOES has only one visible band.
Weighting Functions for the IR channels on the ABI

Weighting functions for the standard atmosphere at a local zenith angle of 40 degrees.
## ABI Bands

<table>
<thead>
<tr>
<th>Future GOES Imager (ABI) Band</th>
<th>Wavelength Range (µm)</th>
<th>Central Wavelength (µm)</th>
<th>Sample Objective(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.45-0.49</td>
<td>0.47</td>
<td>Daytime aerosol-over-land, Color imagery</td>
</tr>
<tr>
<td>2</td>
<td>0.59-0.69</td>
<td>0.64</td>
<td>Daytime clouds fog, insolation, winds</td>
</tr>
<tr>
<td>3</td>
<td>0.84-0.88</td>
<td>0.86</td>
<td>Daytime vegetation &amp; aerosol-over-water, winds</td>
</tr>
<tr>
<td>4</td>
<td>1.365-1.395</td>
<td>1.38</td>
<td>Daytime cirrus cloud</td>
</tr>
<tr>
<td>5</td>
<td>1.58-1.64</td>
<td>1.61</td>
<td>Daytime cloud water, snow</td>
</tr>
<tr>
<td>6</td>
<td>2.235 - 2.285</td>
<td>2.26</td>
<td>Day land/cloud properties, particle size, vegetation</td>
</tr>
<tr>
<td>7</td>
<td>3.80-4.00</td>
<td>3.90</td>
<td>Sfc. &amp; cloud/fog at night, fire</td>
</tr>
<tr>
<td>8</td>
<td>5.77-6.6</td>
<td>6.19</td>
<td>High-level atmospheric water vapor, winds, rainfall</td>
</tr>
<tr>
<td>9</td>
<td>6.75-7.15</td>
<td>6.95</td>
<td>Mid-level atmospheric water vapor, winds, rainfall</td>
</tr>
<tr>
<td>10</td>
<td>7.24-7.44</td>
<td>7.34</td>
<td>Lower-level water vapor, winds &amp; SO₂</td>
</tr>
<tr>
<td>11</td>
<td>8.3-8.7</td>
<td>8.5</td>
<td>Total water for stability, cloud phase, dust, SO₂</td>
</tr>
<tr>
<td>12</td>
<td>9.42-9.8</td>
<td>9.61</td>
<td>Total ozone, turbulence, winds</td>
</tr>
<tr>
<td>13</td>
<td>10.1-10.6</td>
<td>10.35</td>
<td>Surface properties, low-level moisture &amp; cloud</td>
</tr>
<tr>
<td>14</td>
<td>10.8-11.6</td>
<td>11.2</td>
<td>Total water for SST, clouds, rainfall</td>
</tr>
<tr>
<td>15</td>
<td>11.8-12.8</td>
<td>12.3</td>
<td>Total water &amp; ash, SST</td>
</tr>
<tr>
<td>16</td>
<td>13.0-13.6</td>
<td>13.3</td>
<td>Air temp &amp; cloud heights and amounts</td>
</tr>
</tbody>
</table>

Based on experience from: Current GOES Imagers, MSG/AVHRR/ Sounder(s), MODIS, Aircraft, etc
Fog -- Based on GOES Imager 3.9 µm

5 March 2001 - Nocturnal Fog/Stratus Over the Northern Plains

ABI 4 minus 11 µm Difference

GOES-10 4 minus 11 µm Difference

Both images are shown in the GOES projection.

ABI image (from MODIS) shows greater detail in structure of fog.
Higher Spatial Resolution GOES Channels

Simulated ABI (from MODIS)
Enhanced “V”:
IR windows
May 25, 2000

concentric anvil-layer waves

Enhanced “V”

Actual GOES

http://cimss.ssec.wisc.edu/goes/misc/000525.html
Using MODIS, MET-8 and AIRS to simulate the spectral bands on the Advanced Baseline Imager (ABI)
Similar bands on the GOES-12 Imager

“0.64µm”

“3.9µm”

“6.19µm”

“11.2µm”

“13.3µm”
HES Tasks

• HES - Disk Sounding (HES-DS)
  – Provide vertical moisture and temperature information, and other environmental data with 10 km footprint size, over the near full disk in one hour.

• HES - Severe Weather / Mesoscale (HES-SW/M)
  – Provide vertical moisture and temperature information and other environmental data with 4 km footprint size, over a 1000 by 1000 km area in 4 minutes.
HES Tasks

• HES – Coastal Waters Imaging
  – 14 channels from 0.40 µm to 1.0 µm
  – Coverage within 400 km of coastline every 3 hours
  – 300 m footprint size
  – Improved observation of:
    • Ocean color
    • Harmful algal blooms
    • Sediment plumes
    • Chaotic coastal zone currents
Example 1

Example 2

Important lines for cloud emissivity and cloud type

"Traditional Side of H2O absorption"

CO2 weak H2O
Hourly HES Scan Scenario -- Targeted Observations

Local Zenith Angle = ~62 Degrees

N.H.-East

Selectable Target 1

Selectable Target 2

105 W

CURRENT HOURLY GOES SOUNDER COVERAGE
# Sounder Comparison (GOES-Current to HES-Req)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Current</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverage Rate</td>
<td>CONUS/hr</td>
<td>Sounding Disk/hr</td>
</tr>
<tr>
<td>Horizontal Resolution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Sampling Distance</td>
<td>10 km</td>
<td>10 km</td>
</tr>
<tr>
<td>- Individual Sounding</td>
<td>30-50 km</td>
<td>10 km</td>
</tr>
<tr>
<td>Vertical resolution</td>
<td>~3 km</td>
<td>1 km</td>
</tr>
<tr>
<td>Accuracy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>2 deg. K</td>
<td>1 deg. K</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>20%</td>
<td>10%</td>
</tr>
</tbody>
</table>
Moisture Weighting Functions

High spectral resolution advanced sounder will have more and sharper weighting functions compared to current GOES sounder. Retrievals will have better vertical resolution.
The 1km vertical temperature retrieval RMSE (left panel) and 2km vertical water vapor (RH) retrieval RMSE (right panel) from HES LW only, SMW only, LW + SMW, and current GOES sounder. 463 independent profiles distributed globally are included in the retrieval statistics; TRD noise is used in the simulation.
Spectral resolution (0.3, 0.6, 1.2 cm**-1) impact on T/q retrieval

**LW**

**MW**
SIS/SEISS IMPROVEMENTS

• GOES-R Space Weather Instruments
  – Space Environmental In Situ Suite (SEISS)
    • proton, electron, and heavy ion fluxes
  – Solar Imaging Suite (SIS)
    • solar X-ray flux magnitude
    • solar EUV flux from 5 to 129 nm
    • coronal holes locations
    • solar flares
    • coronal mass ejections
  – Magnetometers

• GOES-R Improvements
  – Solar X-ray image dynamic range, resolution, and sensitivity
  – EUV measurements using 8 channels (5 channels) In improved modeling of ionosphere and thermosphere
  – Medium energy radiation environment responsible for spacecraft charging
GEOSTATIONARY LIGHTNING MAPPER

• Detects Total Strikes: In Cloud, Cloud To Cloud, And Cloud To Ground
  – Compliments Today’s Land Based Systems That Only Measures Cloud To Ground (About 15% Of The Total Lightning)

• Increased Coverage Over Oceans And Lands
  – Currently No Ocean Coverage, And
  – Limited Land Coverage In Dead Zones

• Parameters
  – Hemispheric Or CONUS Coverage
  – 10 Km Spatial Resolution (1 Km Goal)
Lightning Sensing from GEO

• Climate Monitoring
• Storm Development
• Ice-phase precipitation estimates
• Severe Weather Now-casting
• Data assimilation and model inputs
• Atmospheric chemistry
GEO
User Services

User Services on current GOES satellites, including the **Data Collection System (DCS)**, the **Low Rate Information Transmission (LRIT)**, and **Search and Rescue (SAR)** will continue through the GOES-R Series.

The GOES **DCS** is a communications relay system that handles information gathered by remotely located Data Collection Platforms (DCPs).
Summary

The great amount of information from the GOES-R series will offer not only a *continuation of current products* and services, but also vastly *improved or new capabilities*.

These products, based on validated requirements, will cover a wide range of phenomena. This includes applications relating to: weather, climate, ocean, coastal zones, land, hazards, solar and space.

The Advanced Baseline Imager (ABI), the Hyperspectral Environmental Suite (HES), the Geo Lightning Mapper (GLM), the space and solar instrument suites (Solar Imaging Suite (SIS), Space Environment In-Situ Suite (SEISS)) and the *user services* on GOES-R will enable much improved monitoring compared to current capabilities.
More information -- ABI

ABI Research Home page (with a link to all these links):
  • [http://cimss.ssec.wisc.edu/goes/abi/](http://cimss.ssec.wisc.edu/goes/abi/)

ABI Simulated images from NASA AIRS Direct Broadcast:
  • [http://cimss.ssec.wisc.edu/goes/abi/airs_broadcast/aniairs.html](http://cimss.ssec.wisc.edu/goes/abi/airs_broadcast/aniairs.html)

GOES and MODIS Galleries:
  • [http://cimss.ssec.wisc.edu/goes/misc/interesting_images.html](http://cimss.ssec.wisc.edu/goes/misc/interesting_images.html)
  • [http://terra.ssec.wisc.edu/~gumley/images.html](http://terra.ssec.wisc.edu/~gumley/images.html)

ABI Documentation from NASA:
  • [http://goes2.gsfc.nasa.gov/abihome.htm](http://goes2.gsfc.nasa.gov/abihome.htm)

ABI Simulated Spectral Response functions:
NASA’s (draft) HES PORD (PERFORMANCE AND OPERATION REQUIREMENTS DOCUMENT):
http://goes2.gsfc.nasa.gov/HEShome.htm

Industry Day briefings:
http://goes2.gsfc.nasa.gov/goesr_industry.htm

CIMSS page:
http://cimss.ssec.wisc.edu/goes/hes/

The GOES-R Users Conference
http://www.osd.noaa.gov


Architecture study web page:
http://www.osd.noaa.gov/goesr_arch_study/info/tech_docs.htm