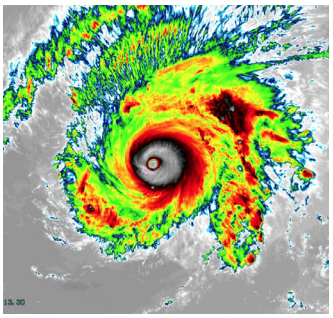
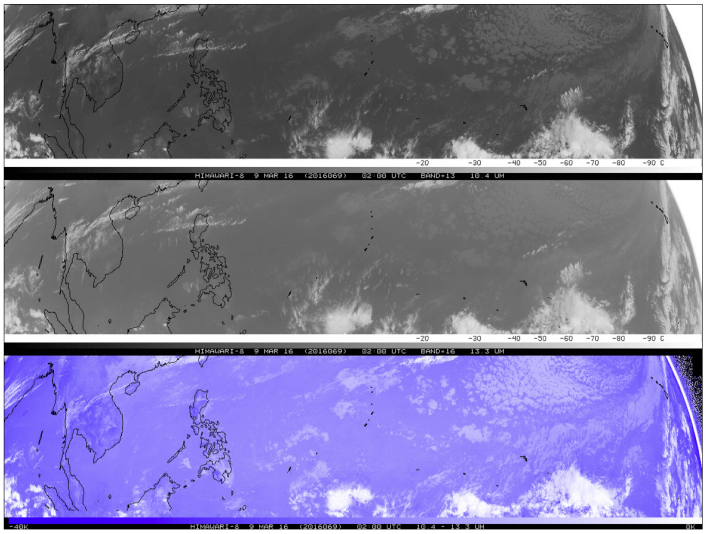
GOES-R ABI Fact Sheet Band 16 ("CO_2" longwave infrared band)

The "need to know" Advanced Baseline Imager reference guide for the NWS forecaster



The Advanced Himawari Imager (AHI) 13.3 µm band image for Typhoon Maysak from March 31, 2015, at 6 UTC. Credit: CIMSS and JMA

The 13.3 µm "carbon dioxide" band is used for mean tropospheric air temperature estimation, tropopause delineation, and as part of quantitative cloud products for cloud opacity estimation, cloud-top height assignments of cloud-drift motion vectors, and supplementing Automated Surface Observing System (ASOS) observations. It has been possible to demonstrate products created with the 13.3 µm band using the GOES-12 through GOES-15 imagers (since GOES-12 launch in 2001), as well as the current GOES sounders (since GOES-8 launch in 1994). This band is also useful when generating Red-Green-Blue (RGB) composite imagery, to highlight the high, cold, and likely icy clouds. *Source: Schmit et al., 2005 in BAMS, and the ABI Weather Event Simulator (WES) Guide by CIMSS.*



The top panel shows the "clean" longwave infrared window, AHI Band 13 centered at 10.4 µm, over the western Pacific Ocean on March 9, 2016, at approximately 2 UTC. The image is a brightness temperature plot where the warmer pixels are darker colors and the colder pixels are lighter colors. The middle panel uses the same color range at the same valid time, but depicts AHI Band 16 centered at 13.3 µm band. There are overall colder values, especially in cloud-free air, compared to the top panel. This is highlighted in the bottom panel, which is a difference of the above two AHI bands. The brightness temperature difference range goes from -40 K on the left to 0 K on the right. Cooler brightness temperatures due predominantly to CO_2 absorption in cloud-free skies are evident. Credit: ASPB

In a nutshell

GOES-R ABI Band 16 (approximately 13.3 µm central, 13.0 µm to 13.6 µm)

Similar to MODIS Band 33, SEVIRI Band 11, AHI Band 16

Available on current GOES (imager and sounder)

Nickname: "CO_2" longwave infrared band

Availability: Both day and night

Primary purpose: Air temperature, clouds

Uses similar to: None

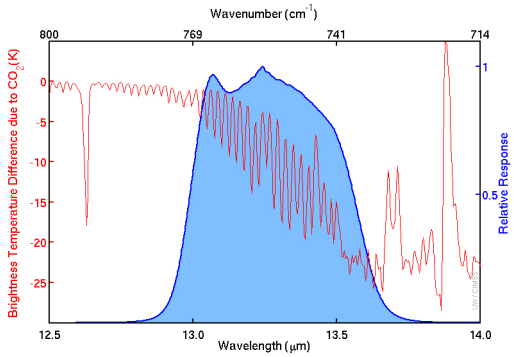
Did You Know?

The 13.3 µm "carbon dioxide" band will not only have better spatial resolution compared to past geostationary satellites, but also less noise. One measure of image quality for an infrared band is the Noise Equivalent delta Temperature (NEdT). A smaller NEdT is desirable, but noise tends to increase with better spatial resolution. For the 13.3 µm band on the ABI, the specification for the NEdT (at a reference temperature of 300 K) is 0.3 K. This is three times greater than the specifications for NEdT of the other ABI infrared bands. Fortunately, the worst NEdT estimate for the 13.3 µm band on the ABI is only approximately 0.07 K. These values compare to the specification on the current GOES imagers of 0.32 K, with measured performance of 0.13 K on GOES-15. Hence, the NEdT for the 13.3 µm band on the ABI is expected to be better than the current GOES imager, even though the spatial resolution on the ABI is approximately four times finer.

Baseline Products by Band

Wavelength Micrometers	13.3
Band number	16
Baseline Products	
Aerosol Detection	
Aerosol Optical Depth	
Clear Sky Masks	
Cloud & Moisture Imagery	√
Cloud Optical Depth	
Cloud Particle Size Distribution	
Cloud Top Phase	
Cloud Top Height	√
Cloud Top Pressure	√
Cloud Top Temperature	√
Hurricane Intensity	
Rainfall Rate/QPE	
Legacy Vertical Moisture Profile	√
Legacy Vertical Temp Profile	√
Derived Stability Indices	√
Total Precipitable Water	√
Downward Shortwave Radiation: Surface	
Reflected Shortwave Radiation: TOA	
Derived Motion Winds	
Fire Hot Spot Characterization	
Land Surface Temperature	
Snow Cover	
Sea Surface Temperature	
Volcanic Ash: Detection/Height	√
Radiances	√

The system-level spectral response for ABI Band 16 (13.3 µm) is shown in blue. The red curve represents an Earth-emitted difference spectrum between an atmosphere with carbon dioxide present and one without. At the longest wavelengths in this plot, there is actually a region of net warming, due to a heightened sensitivity to carbon dioxide in the stratosphere. Credit: CIMSS



Tim's Topics

The heritage sensors for the 13.3 µm band on the ABI are the CO_2 bands on the current GOES sounders as well as the GOES imagers since GOES-12.

The 13.3 µm band on the ABI is used in several of the GOES-R baseline products. These include cloud-top height, pressure, and temperature. This band is also an input to the legacy moisture and temperature profiles, and hence the products derived from the profiles, such as total precipitable water and stability indices. This band is also used in the quantitative volcanic ash detection and height algorithm.

Tim Schmit is a research meteorologist with NOAA NESDIS in Madison, Wisconsin.

Ken's Corner

Meteorologists have had the 13.3 µm "carbon dioxide" band for several years now, but probably have not used it much, in part because this band is better for science products than visual interpretation.

Compared to the lower wavelength infrared window channels, the CO_2 band brightness temperatures will generally be cooler, especially in scenes absent clouds, due to the general homogeneous distribution of CO_2 in the troposphere (with the concentration of CO_2 slightly decreasing in the stratosphere). However, it is not possible to retrieve (explicitly measure) CO_2 with a single spectral band due to the variable temperature structure of the lower atmosphere (so do not expect to find any pollution from factories). In addition, the 13.3 µm band, like many other infrared bands, is sensitive to water vapor absorption, further complicating the interpretation of brightness temperatures and spatial patterns. Yet this band is not opaque from water vapor or CO_2 absorption for all but extreme viewing angles, so surface emission will also impact the brightness temperature, at least to a limited extent.

Ken Johnson is the SSD Chief in the NWS Eastern Region. Jordan Gerth contributed to this segment.

ABI Band	Approximate Central Wavelength (µm)	Band Nickname	Type	Nominal sub satellite pixel spacing (km)
16	13.3	"CO_2" longwave infared band	IR	2

Further reading

ABI Bands Quick Information Guides: http://www.goes-r.gov/education/ABI-bands-quick-info.html
ABI Weighting Functions: http://cimss.ssec.wisc.edu/goes/wf/ABI/
GOES-R COMET training: http://www.goes-r.gov/users/training/comet.html
GOES-R acronyms: http://www.goes-r.gov/resources/acronyms.html
GOES-R spectral "web app": http://cimss.ssec.wisc.edu/goes/webapps/bandapp/overview_goes-r.html
Near real-time RGB "web app": http://cimss.ssec.wisc.edu/goes/webapps/satrgb/overview_near_realtime.html