ABI and GOES-13 Weighting Function Lab Questions

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Use these web pages to investigate clear-sky forward model calculations:

http://cimss.ssec.wisc.edu/goes/wf/ABI/ and http://cimss.ssec.wisc.edu/goes/wf/GOES13/

Q1: What is the equivalent clear-sky brightness temperature for the ABI Imager band 14 infrared window (11.2 μm) when looking at nadir for the standard tropical atmosphere?

A1: 294.7K

Q2: For the US standard atmosphere, is the ABI Imager band 15 (e.g., 12.3 μm) colder or warmer than the IR window band 14 (11.2 μm)? By how much? Why?

A2: Colder, by 2.1K – due to additional absorption by moisture. Note that you can look at this in a panel, toggle, or fader-mode.

Q3: For the US standard atmosphere, at a view angle of 45 degrees, how similar are the GOES-13 Imager (band 4 at 10.7 μm) and ABI (band 14 at 11.2 μm) infrared window? [Note, open the GOES-13 page in another tab of your browser.] How about for the Standard Tropical atmosphere?

A3: For the US standard atmosphere, they are the same brightness temperature! If you look at the standard tropical atmosphere, the ABI band 14 is 0.5K colder. This is due to the different spectral responses and sensitivity to moisture.

Q4: For the US standard atmosphere (at nadir), which ABI IR band is the coldest? Why?

A4: Band 8 (6.19 um) 235.4K. Due to atmospheric moisture absorption.

Q5: How many ABI IR bands are there? On the legacy GOES imager?

A5: There are 10 IR bands on the ABI. There are four IR bands on the legacy imager, although which bands depend on if the imager was before or after GOES-12.

Q6: If you change the skin temperature by 10K when nadir-viewing, how much does the ABI "water vapor" band 8 (6.19 μm) change? Why?

A6: There is no change, due to moisture absorption, the band doesn't sense the surface changes for most atmospheres. (Although the 7.34 um band (10) does change with a dry winter atmosphere.)

Q7: For the mid-latitude summer atmosphere (when nadir-viewing), which ABI band has the largest sensitivity to an increase of 10K for the skin temperature? (Note that all the surface emissivities are assumed to be 1.)

A7: ABI band 7 (3.9 um) sees most of the 10K change. All other ABI bands show less of a change.

Q8: Which ABI "water vapor" band, 8 (6.19 μm), 9 (6.95 μm), or 10 (7.34 μm), is coldest due to H2O absorption? Infer this from the weighting functions.

A8: ABI Channel 8 (6.19 um) peaks the highest in the atmosphere, indicating it is the most sensitive to the H2O absorption.

Q9: When the zenith angle is increased, do the ABI bands tend to cool? Why?

A9: Yes, in general all the ABI bands cool with increasing view angle as the 'path length' viewed through the atmosphere increases. The more of the atmosphere the instrument looks through, the more radiation is absorbed by the atmosphere.

Q10: When decreasing the amount of moisture in the (standard tropical) atmosphere for a nadir view, would you expect the IR window (band 14 at 11.2 μm) to cool or warm? By approximately how much?

A10: The IR window warms by approximately 4K going from "all' the moisture to only 10% of the original amount. Remember to look at TPW in mm on the plots – note the plots are displayed in increasing moisture amounts.

Q11: Why does one band have a greater temperature range than another? (For example, compare the 11.2μm IR window to a water vapor band such as the 6.19 μm).

A11: As the band sees deeper into the atmosphere, it will see more temperature variability. These weighting functions are all for clear-sky calculations, but the disparity is even larger comparing a warm clear scene to a cold cloud top where the window channels see even broader temperature ranges in real Earth scenes than are shown here.

Q12: Is the ozone band (12 at 9.61 μm) warmer or colder than the IR window (band 14 at 11.2 μm)? Why?

A12: Colder. Absorption due to stratospheric ozone causes band 12 (9.61 μm) to be colder in clear sky conditions.

Q13: How might the brightness temperatures change for the IR window in the presence of thin or thick clouds compared to these clear-sky calculations?

A13: Cooler in the case of thin clouds, much colder in the case of thick clouds.

Q14: In general, how much warmer is the ABI band 8 (6.19 μm) than the GOES-13 Imager 'water vapor' band 3 (6.5 μm)?

A14: Trick question: it's about 3.3K colder (for the US standard atmosphere for a nadir view or 3.4K colder in the standard tropical atmosphere).

Q15: To the first approximation, how much of a difference is there between the ABI band 13 (10.35 μm) than the GOES-13 Imager IR window band 4 (10.7 μm)?

A15: Small difference (less than 0.5K). Depends on the atmosphere… 0.2K for the tropical, 0.4 for the mid-latitude summer, mid-latitude winter, and 0.5K for the standard atmosphere (GOES-13 is warmer than ABI).

Q16: How many water vapor bands in the water vapor absorption region are on the ABI and GOES Sounder, respectively? How many on the legacy Imager?

A16: Both the sounder and ABI have three. The legacy Imager has one.

Q17: Given the legacy imager, sounder and ABI all have a band centered near 13.3 or 13.4 μm, how similar are they? Explain any differences.

A17: The differences can be explained due to the differing spectral widths. (See the accompanying PowerPoint file). ABI band 16 (13.3 μm) is warmer than both the GOES-13 Imager and Sounder and the Sounder is the coldest.

Q18: Which ABI longwave window is most similar to the GOES Imager band 4 (10.7 μm)?

A18: In general, the ABI band 14 (11.2 μm) is more similar. That said, in some moist atmospheres (like the standard tropical), the ABI band 13 (10.35 μm) is more similar.

Q19: In general, which ABI band has the warmest brightness temperature?

A19: This is a trick question, usually, it's the 3.9 μm band (7), due to reflected solar radiation during the day – but this simulation doesn't include that component. The 11.2 μm band (14) is slightly warmer in the colder/drier atmospheres. Actually for the tropical atmosphere the 10.35 μm (band 13) is even warmer than the 11.2 μm (band 14).

Q20: In general, what might three "mid-level" water vapor band images add, over having just one band?

A20: More levels of atmospheric moisture (and motion) can be monitored. Total PW retrievals will be more accurate.