Synthetic GOES-R Imagery from the NSSL-WRF

1. Background

Forecast output from the NSSL 4-km WRF-ARW is used daily to generate synthetic satellite radiances for several GOES-R Bands. The motivation for this product is two-fold: 1) to familiarize forecasters with some new spectral bands that will be available on the Advanced Baseline Imager (ABI) on GOES-R, and 2) to provide a quick and easy way to view the WRF-ARW forecast in terms of satellite imagery. More details on this aspect appear in the individual band descriptions below.

2. Model Information

The NSSL WRF-ARW uses WSM-6 microphysics, a 1 moment package. It is run at 00 UTC every evening, and as soon as the output is available, several 12- to 36-hour forecast fields are sent to CIRA for processing. These fields include pressure, temperature, water vapor, heights, canopy temperature, cloud water, cloud ice, snow, graupel and rain. That data is used as an input to a radiative transfer model at CIRA, and the output is satellite radiances and brightness temperatures. These synthetic images are then provided to the SPC for display on their NAWIPS system. Each morning, the 12 UTC Day 1 forecast through the 12 UTC Day 2 forecast is available, hourly. The first 2 bands listed below will be available first thing in the morning when the EFPS convenes; the remainder will trickle in a little later.

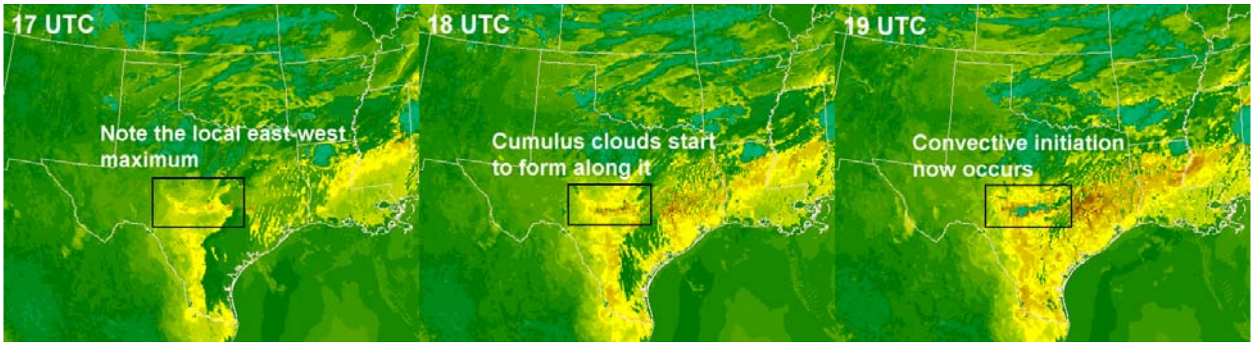
3. Simulated Bands and Difference Products

a) 6.95 µm: This band lies in the water vapor absorption portion of the spectrum and is quite similar to the current GOES' 6.5 and 6.7 µm bands. Having a slightly longer central wavelength, its weighting function is shifted a little lower in the atmosphere, meaning the clear-sky brightness temperatures are warmer than in the current GOES water vapor bands. The primary use for this band is to locate model shortwaves, jet streaks, and mid-to-upper-level regions of dry air.

b) 10.35 µm: This band lies within an Infrared (IR) window region, and is even cleaner than the current GOES' 10.7 µm band. Its brightness temperatures are nonetheless quite comparable to the current IR band. Primary uses for the 10.35 µm band are for model cloud (both low and high) identification and convective trends, including convective initiation timing and location, and convective mode (along with the simulated radar reflectivity field).

c) 7.34 µm: This alternate water vapor band has a weighting function that peaks even lower in the atmosphere, often around 500-600 mb. Its weighting function is also broader vertically, meaning the information is coming from a deeper layer than the other water vapor bands. Its uses are similar to the 6.95 µm band, except it may be able to better identify mid-level model features, such as jet streaks and vort maxes, that don't extend into the upper troposphere.

d) 10.35-12.3 µm difference product: This product is less useful for forecasting purposes during the 2011 Spring Experiment, but is instead being produced to illustrate one of the new capabilities that will be possible with GOES-R. The 10.35 µm band is a clean window band, so there is very little water vapor absorption. 12.3 µm is the so-called dirty window because water vapor does do some absorbing at that wavelength. So taking the 10.35-12.3 difference will effectively subtract out the surface temperature effect and you're left with information about water vapor (WV) in the atmosphere. This difference is most sensitive to boundary layer WV because that's where the highest WV densities exist. It's most useful to simply look qualitatively for local regions having 10.35-12.3 increasing with time (faster than the surrounding regions). This means the WV must be increasing in that column, and most often this is due to low level convergence pooling WV. We hope that this product will be useful for identifying low level moisture convergence before any clouds have formed, essentially predicting where cumulus clouds and possible convection will form later in the day. The example below from 20 April 2011 over central Texas illustrates the use of this difference product to anticipate convective cloud formation.



4. Known Biases

The biases listed below are from either the WRF-ARW or the RTM used to generate the synthetic imagery, and none of them have been quantified. They are simply features that the developers have noticed in viewing the output on a daily basis.

- MCS cloud shields appear much too small and "holey" in the simulated imagery compared to observed

- The size of convective anvil clouds appear too small in the imagery, even though the storm itself may be the correct size in the model

- Thin cirrus often appears too cold in the IR brightness temps and therefore looks unrealistic at times, even if the type and placement of the clouds are correct

5. How to load in NMAP2

1. Open new data source under: **IMAGE/SAT/PG/SIMULATED**
2. Select desired band or band difference
3. Adjust **Range/Int -> CAL -> +1 day**
4. Select desired times on the timeline and load
5. Apply proper color enhancements using **Option -> Enhancement**
    a. For WV, use “wv_tpc”….. IR, use “ir_sab”….. band difference, use “ir_rgbv”