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NOAA CREST

Cloud-Top Pressure Estimation from VIIRS using Statistically-Reconstructed 13.3 micron Channel

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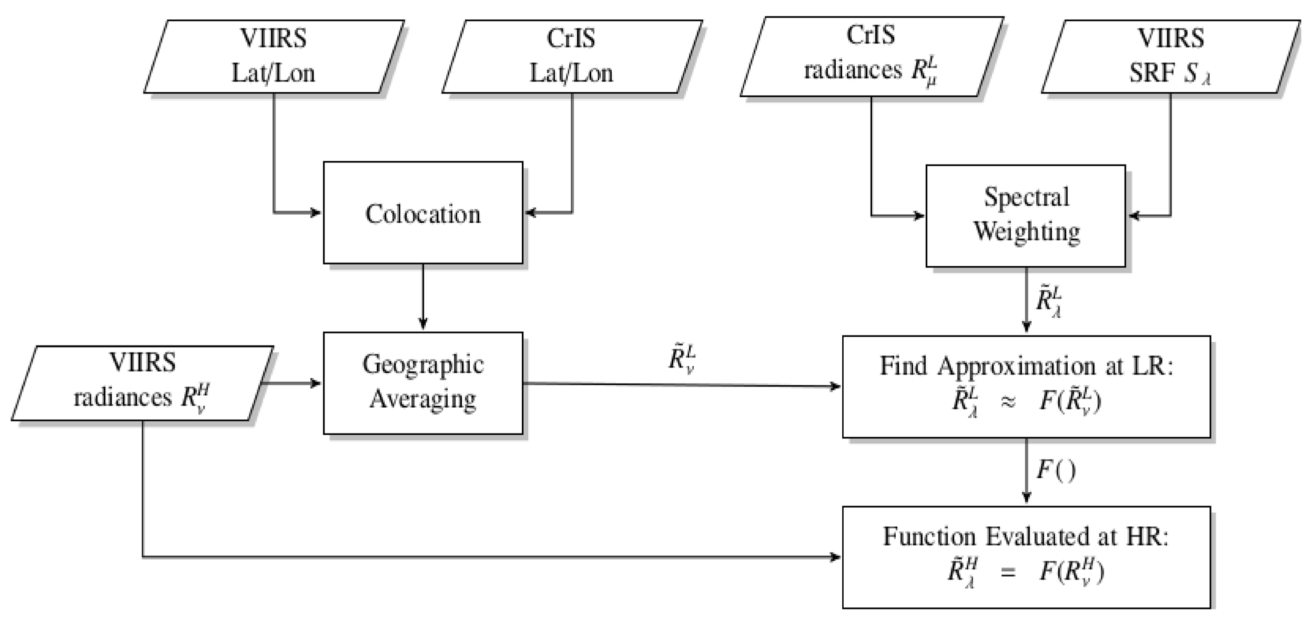
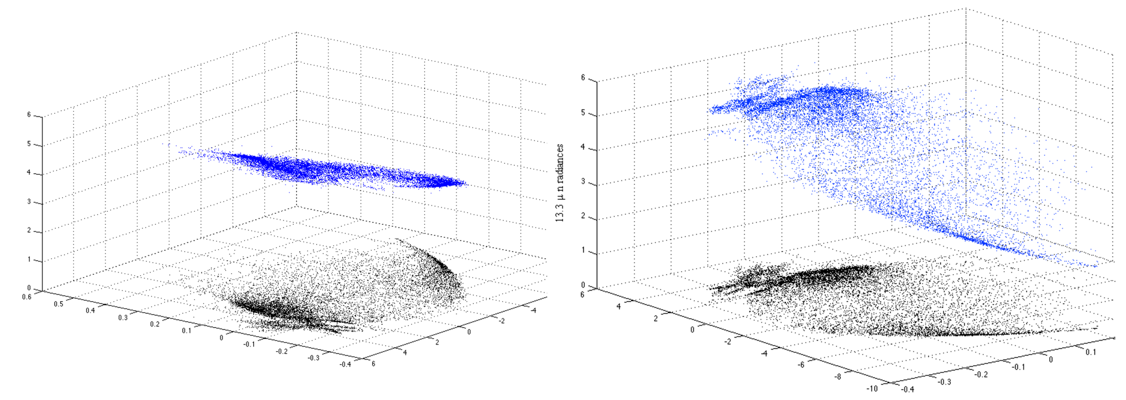
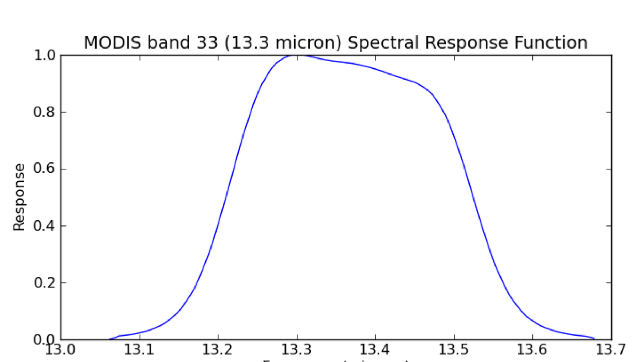
Motivations

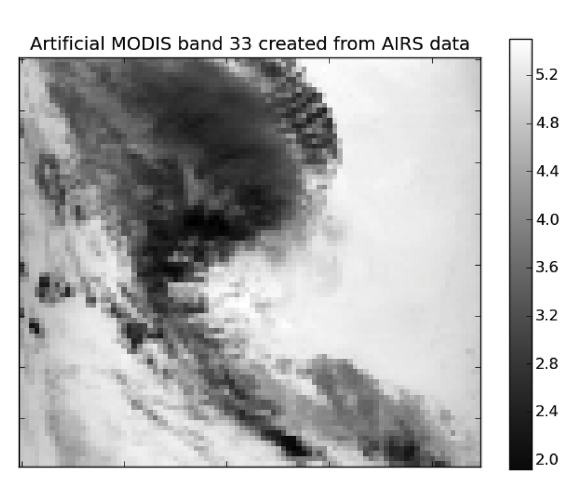
- VIIRS doesn't have 13.3μm band important for cloud-top pressure estimates
- CrIS has hyperspectral measurements in the CO_2 absorption band at lower spatial resolution
- Aqua has MODIS and AIRS which can serve as proxy for VIIRS and CrIS
- We have developed an algorithm which uses available VIIRS bands along with CrIS measurements for estimating a **virtual** VIIRS 13.3 micron band.
- Tests showed that similarly-synthesized data would allow VIIRS/CrIS to match GOES-R in terms of cloud-top pressure determination, to within the GOES-R specifications.



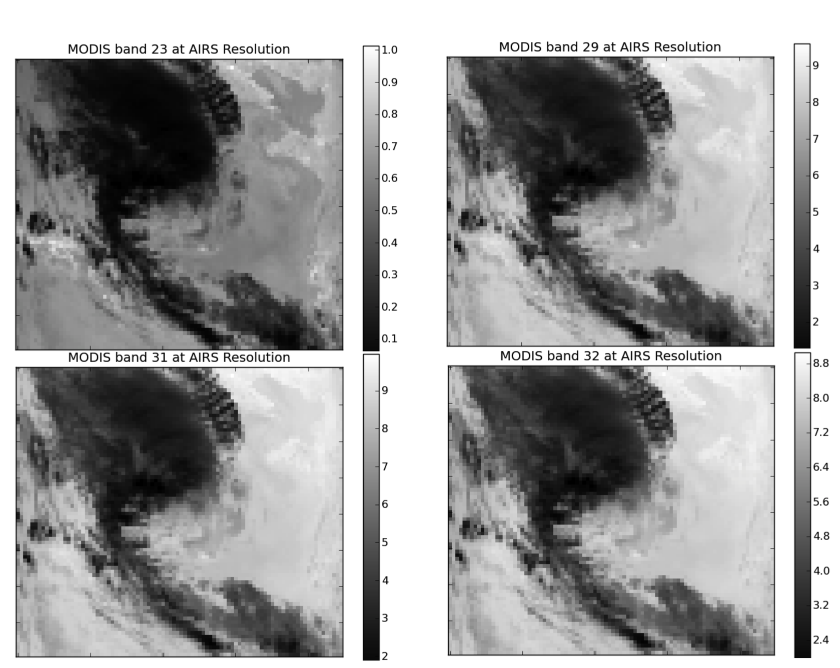


Functional relationship between input bands (first two principal components) and target band





SRF-interpolated artificial 13.3 micron band at low resolution (target band for training)



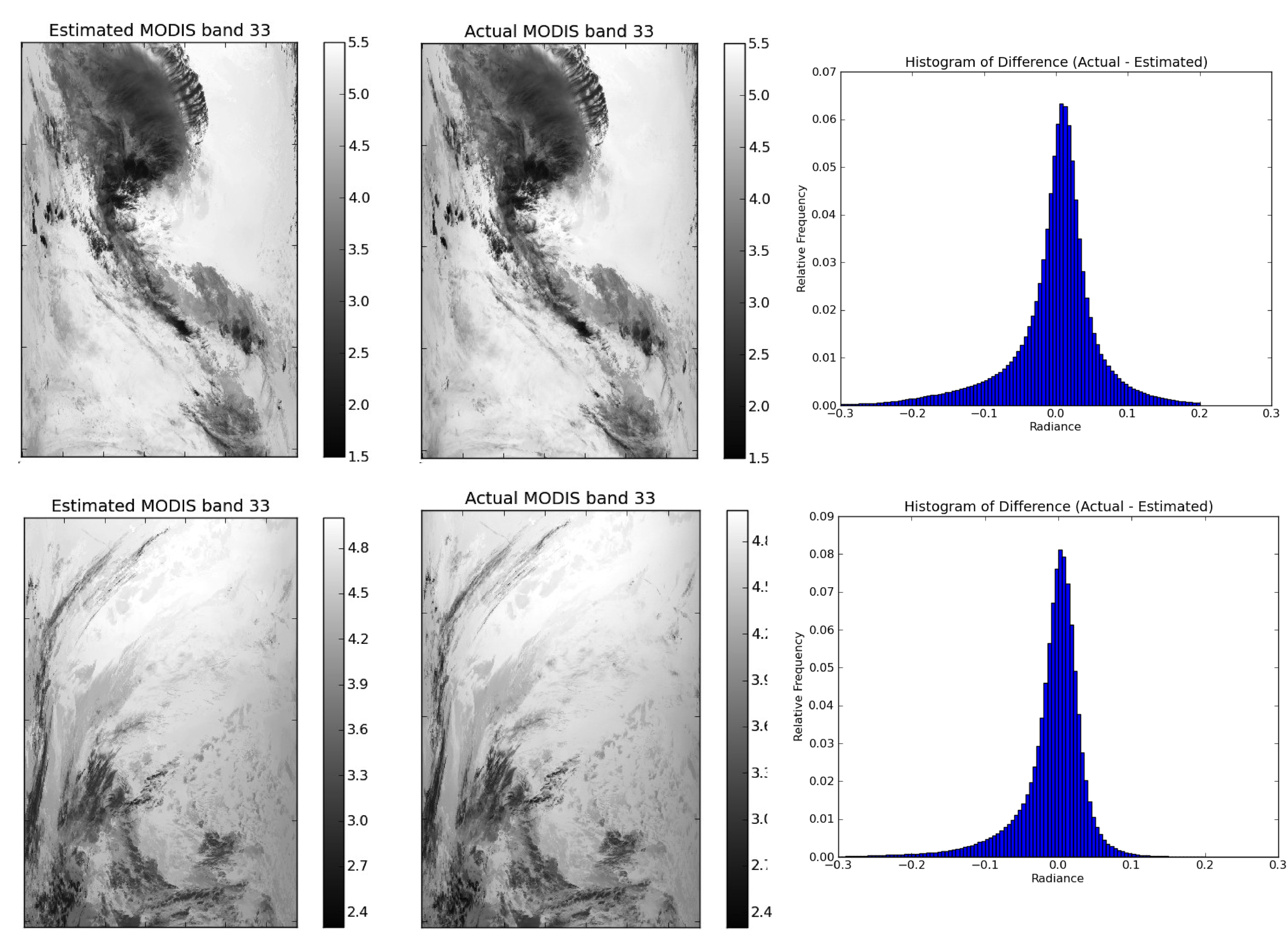
Spatially degraded MODIS bands (training input data)

Abstract

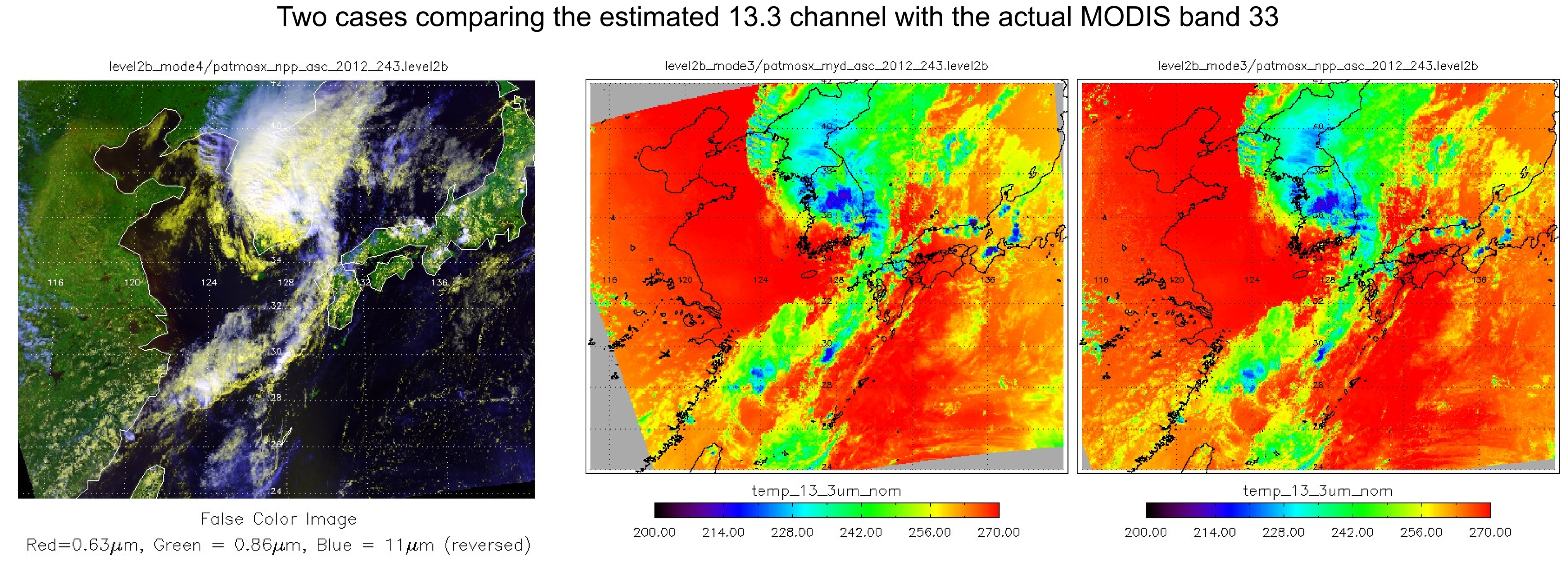
Meteorologists and other scientists rely heavily on remotely sensed data collected from instruments aboard orbiting satellites. The design of such instruments requires technical and economic trade-offs that results in certain desirable data not being directly available. One way to mitigate the lack of availability of this data, is to use machine learning techniques to estimate the data that is not directly observed. This can be accomplished by exploiting statistical correlations with information in available data sets. By combining the information from multiple other sources it is often possible to create an accurate estimate of the physical parameters which are not directly observed. We apply this idea toward the problem of estimating the 13.3 micron band for the Visible Infrared Imaging Radiometer Suite (VIIRS), an instrument aboard NOAA's operational satellite, Suomi NPP. The radiance from the 13.3 micron band is not directly available from VIIRS although this band has important applications such as estimating cloud-top pressure. We demonstrate that a reliable estimate of this band can be made using other VIIRS bands at 4, 9, 11 and 12 microns, as well as input from the Cross-track Infrared Sounder (CrIS), which produces data at much finer spectral resolution, making measurements in hundreds of nearby infrared bands, though with lower spatial resolution. We have tested the result as input values to an algorithm which estimates cloud top pressure using data from 11, 12, and 13.3 micron bands.

Evaluation with MODIS & AIRS data

- 13.3 micron MODIS band 33 has been used in cloud-top pressure algorithms
- MODIS as proxy has similar bands to VIIRS IR bands (32, 31, 29, 23)
- MODIS band 33 can be reconstructed at full spatial resolution from lower spatial resolution hyperspectral AIRS measurements in the the same way as VIIRS / CrIS
- True MODIS band 33 is used for comparison

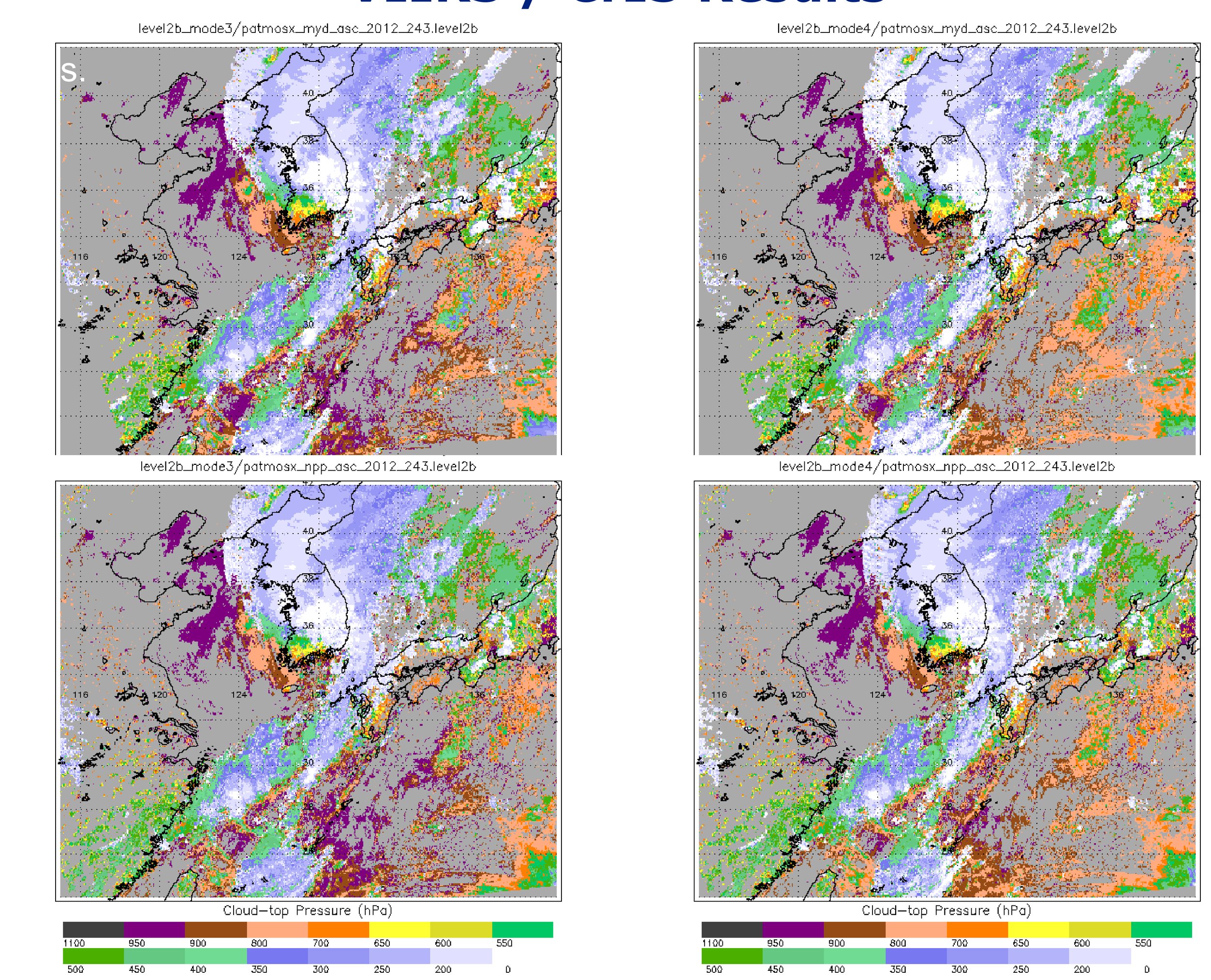


Two cases comparing the estimated 13.3 channel with the actual MODIS band 33



MODIS-based RGB image (left), actual MODIS 13.3 μm brightness temperature (center), and simulated 13.3 μm brightness temperature (right)

VIIRS / CrIS Results



Cloud-Top Pressure: MODIS with real 13.3um (Top Left), MODIS without 13.3um (Top-Right), VIIRS with pseudo 13.3um (Bottom Left), VIIRS without 13.3um (Bottom Right)

Conclusion

With preliminary examples using both Aqua MODIS and AIRS data as well as Suomi NPP VIIRS and CrIS data, we demonstrate that a reliable estimate of the imager 13.3 micron broadband radiance data can be statistically estimated from the sounder high spectral resolution infrared data guided by the imager spectral band radiances at 4, 8.6, 11, and 12 microns. We have successfully tested the resulting data as input values to an algorithm which estimates cloud top pressure using data from 11, 12, and 13.3 micron bands; we find good agreement between VIIRS and MODIS cloud top pressures when VIIRS has the assistance from the estimated 13.3 micron channel. These example results suggest that synergistic use of VIIRS and CrIS measurements can overcome the absence of a 13.3 micron channel on VIIRS. Routine application of this multi-sensor fusion approach should be investigated further.

References

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