Use of VIIRS Cloud Products For NWP

Andrew Heidinger
Yue Li, Steve Wanzong
JPSS Cloud Team

Motivation

There are several ways in which VIIRS Enterprise Cloud Products can influence NWP.

- VIIRS Cloud Heights and Cloud Detections will be used to assist in the identification of clear CrIS pixels.

- VIIRS Cloud Heights are used in the NESDIS Polar Winds Product which is used by NWP.

We placing high priority in characterizing and improving the JPSS Enterprise Cloud Products for these applications.

This talk will demonstrate our work in this area.

VIIRS Cloud Properties for CrIS Cloud Clearing

VIIRS Cloud Products for CrIS Cloud Detection

- Currently, NESDIS creates a BUFR that provide the following information from VIIRS within each CrIS Field of View (FOV)

- The maximum VIIRS Cloud Height
- The cloud fraction from all VIIRS pixels within the CrIS FOV

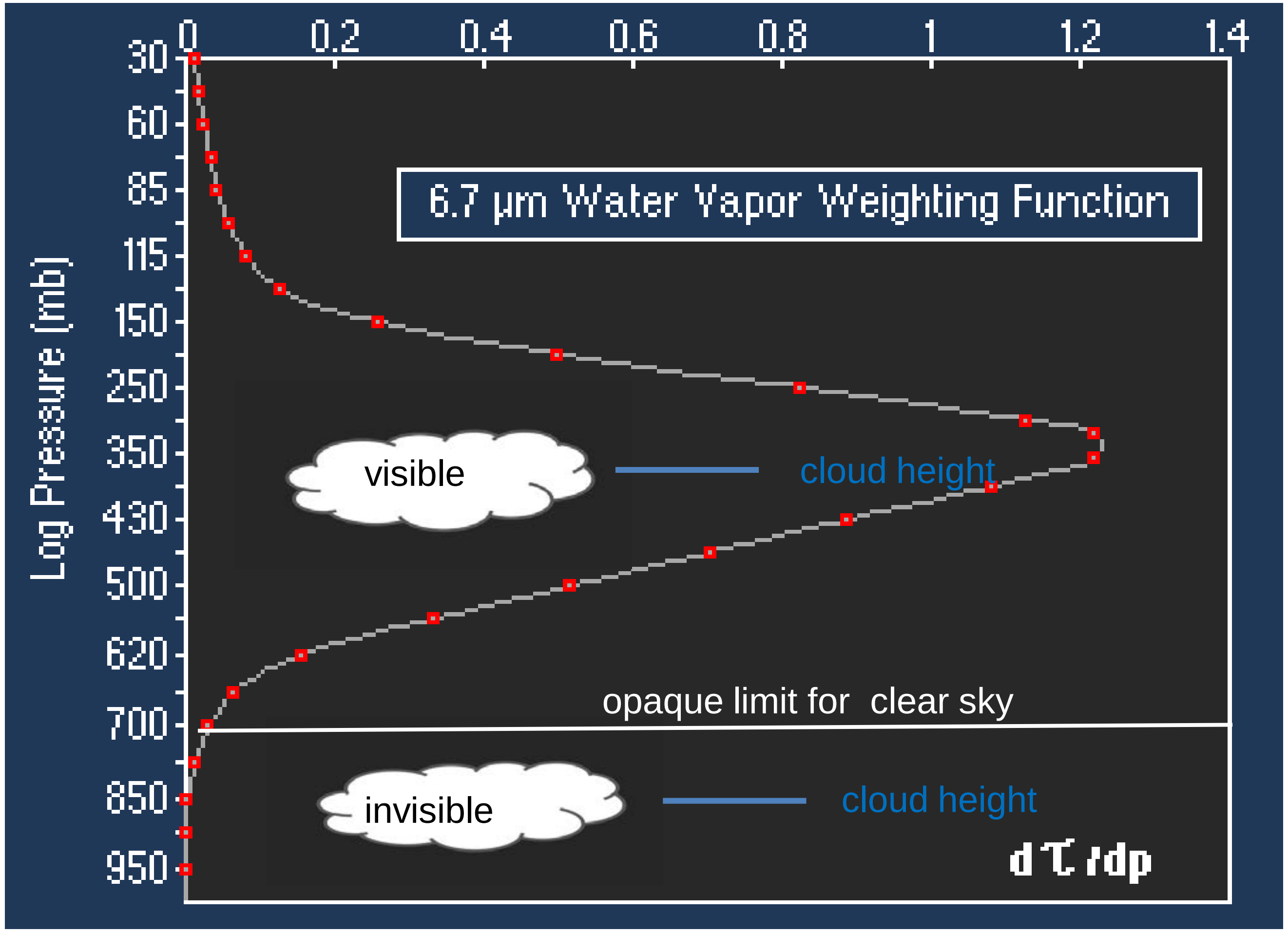
- Starting in November 2016, the NOAA Enterprise products from the ACHA and ECM algorithms will be ingested into that Buffer File.

  - Jim Jung and Andrew Collard are leading the effort to explore how to use this information for improving the detection of clear CrIS field of views.

  - The JPSS cloud team is trying to ensure that VIIRS cloud products are of sufficient accuracy for this application. Here we demonstrate a relevant analysis.

Basic Idea of How VIIRS Cloud Properties Could Be Used.

- IR channels in absorbing bands are not influenced by features below the level where their weighting functions approach zero.
- Cloud heights can be used to flag clouds that should be visible or invisible with CrIS observation.
- The maximum cloud height in CrIS FOVs can be used as conservative estimate of cloud vertical extent.
- Actually logic for the use of this information is being developed by Jim Jung and NCEP.
- ***This analysis is just to see if the VIIRS cloud products support this basic approach.***

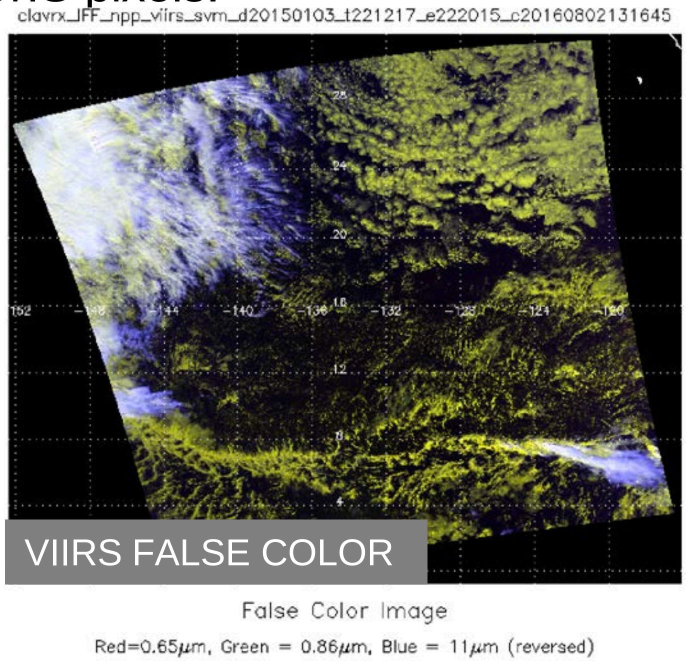


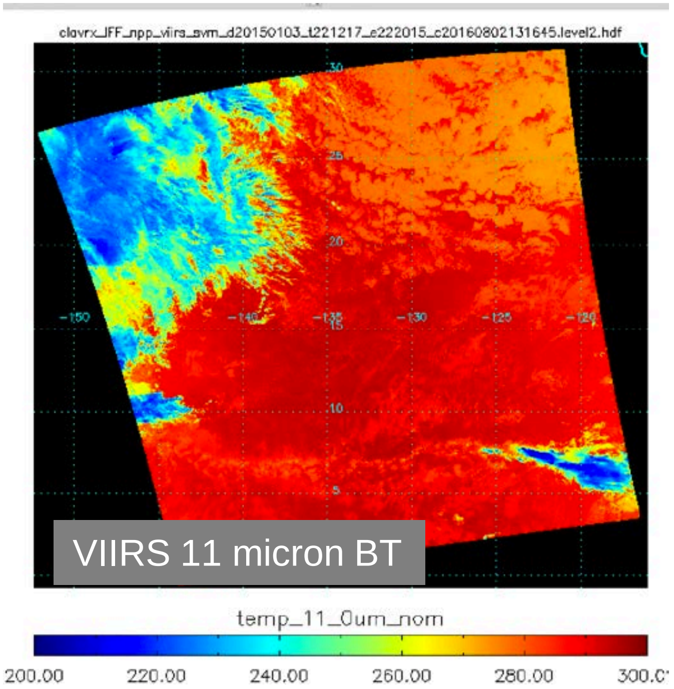
Examples of Using VIIRS Cloud Products for CrIS Cloud Detection

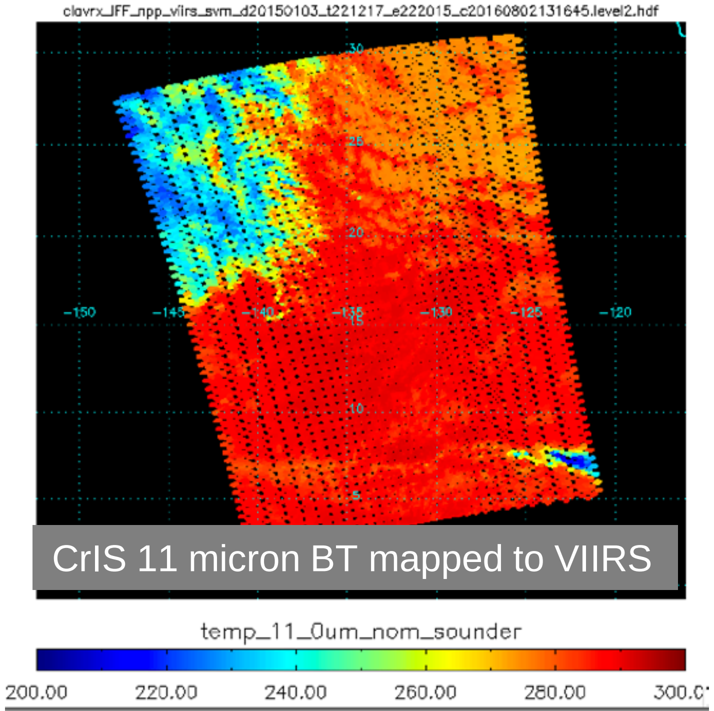
- SSEC has developed tools to map VIIRS into CrIS FOVs and vice versa. These tools create MODIS IR channels from the CrIS spectra.

- We have implemented these tools into CLAVR-x and are expanding the Enterprise Algorithms to use VIIRS and CrIS data (funded by JPSS -RR)

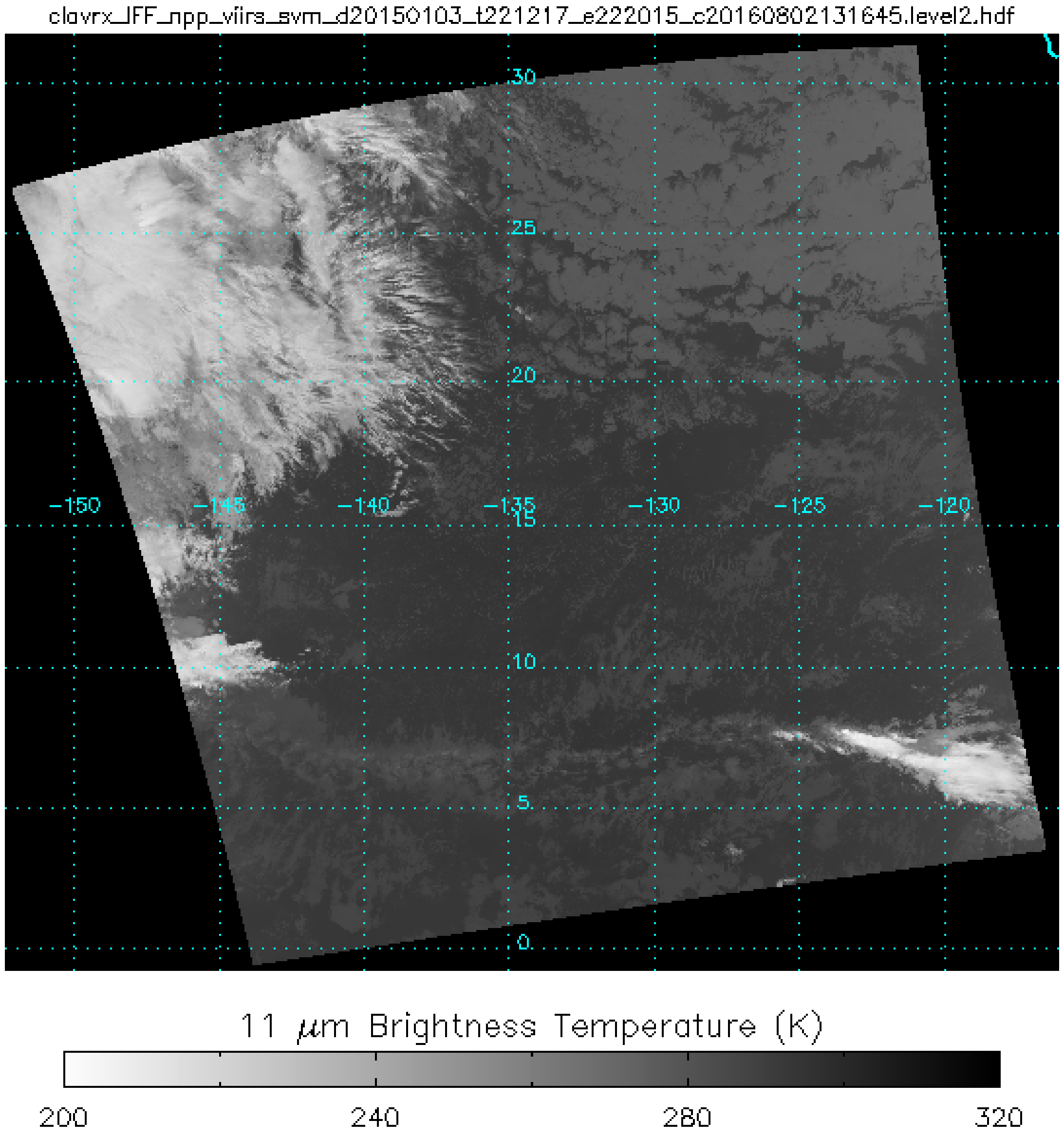
- This gives us the chance to experiment with the use of Enterprise Cloud Properties for detecting clear CrIS pixels.

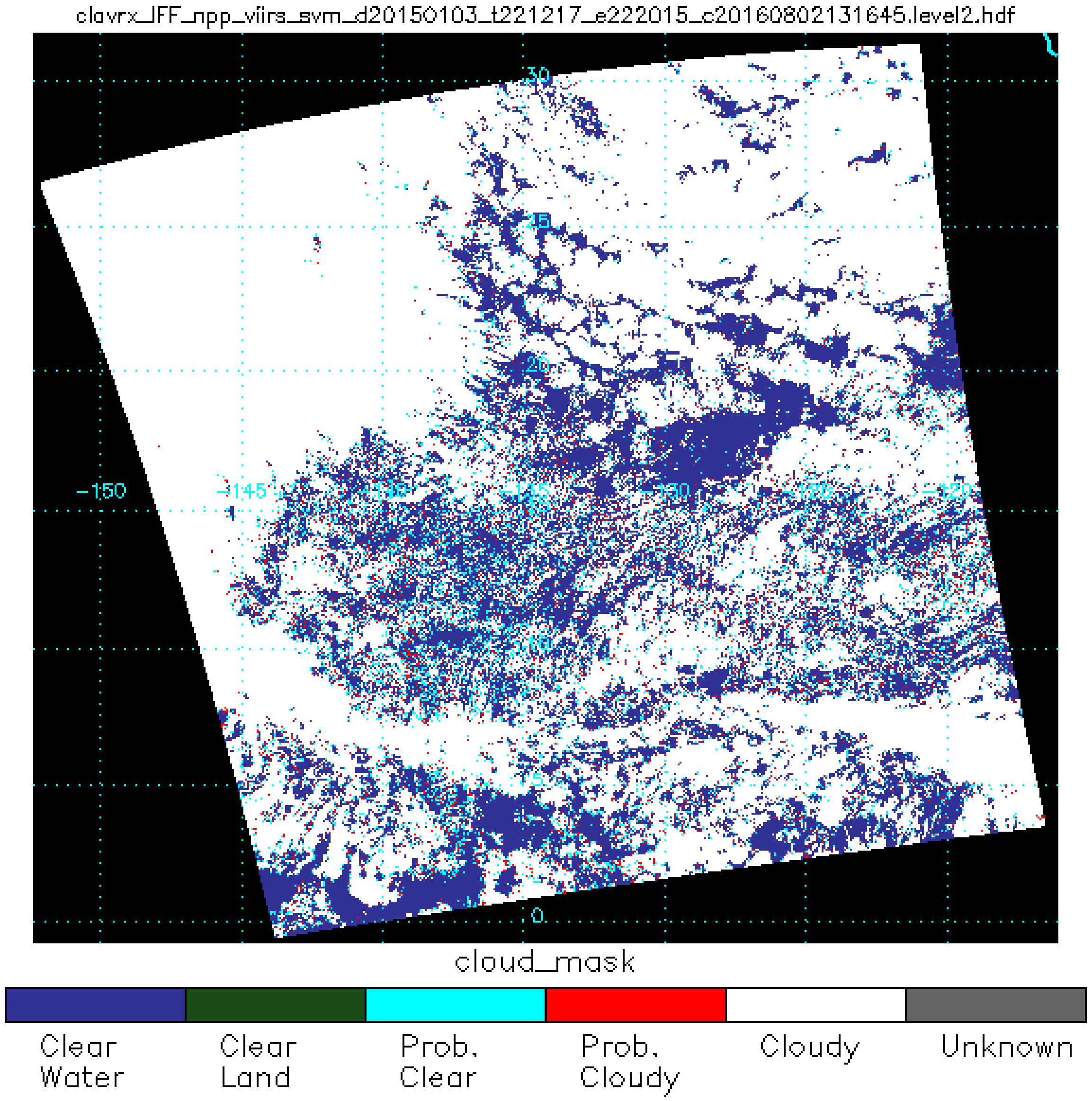




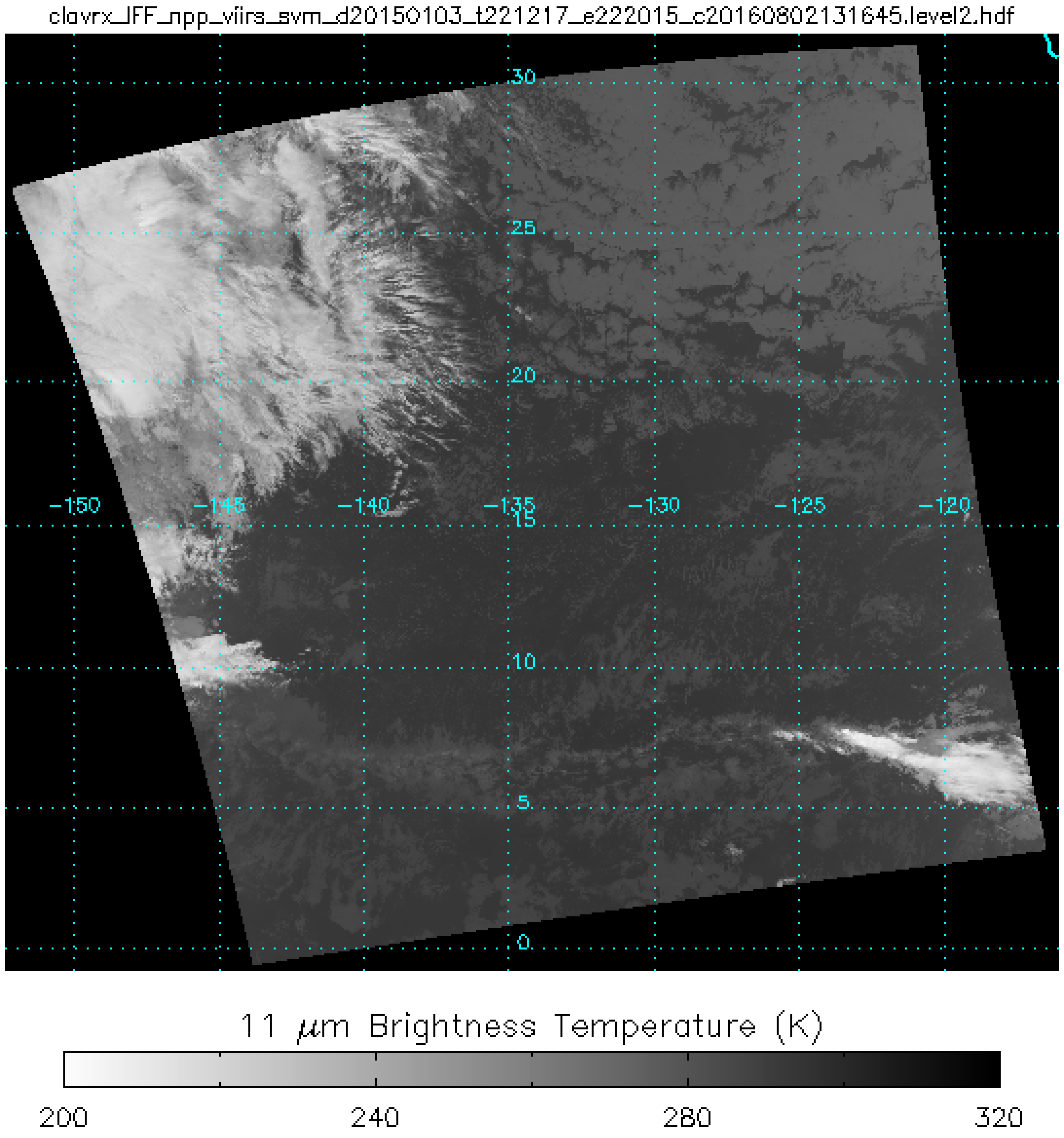


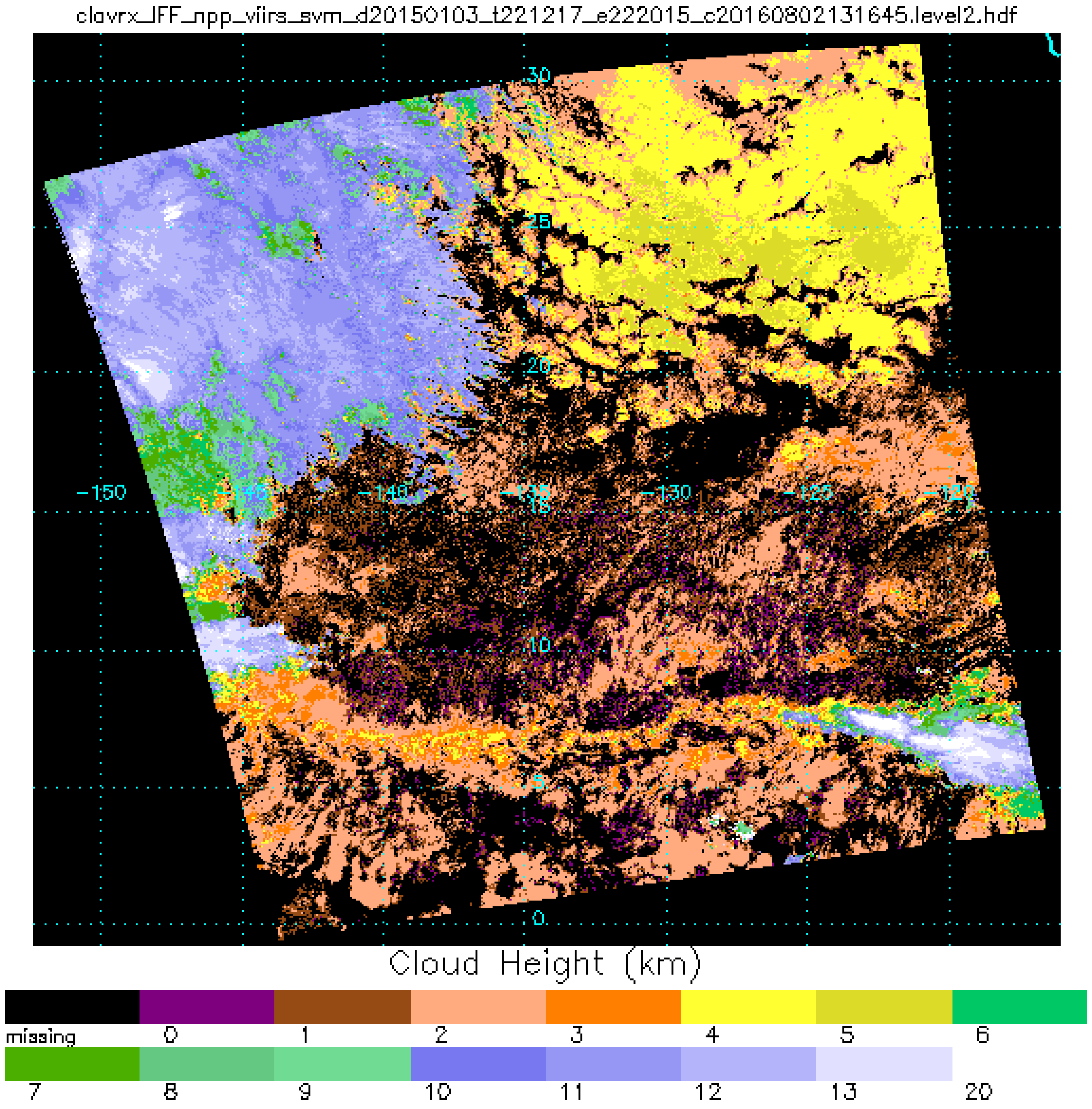
Cloud Mask Result (cloud fraction is mapped into CrIS FOVs.



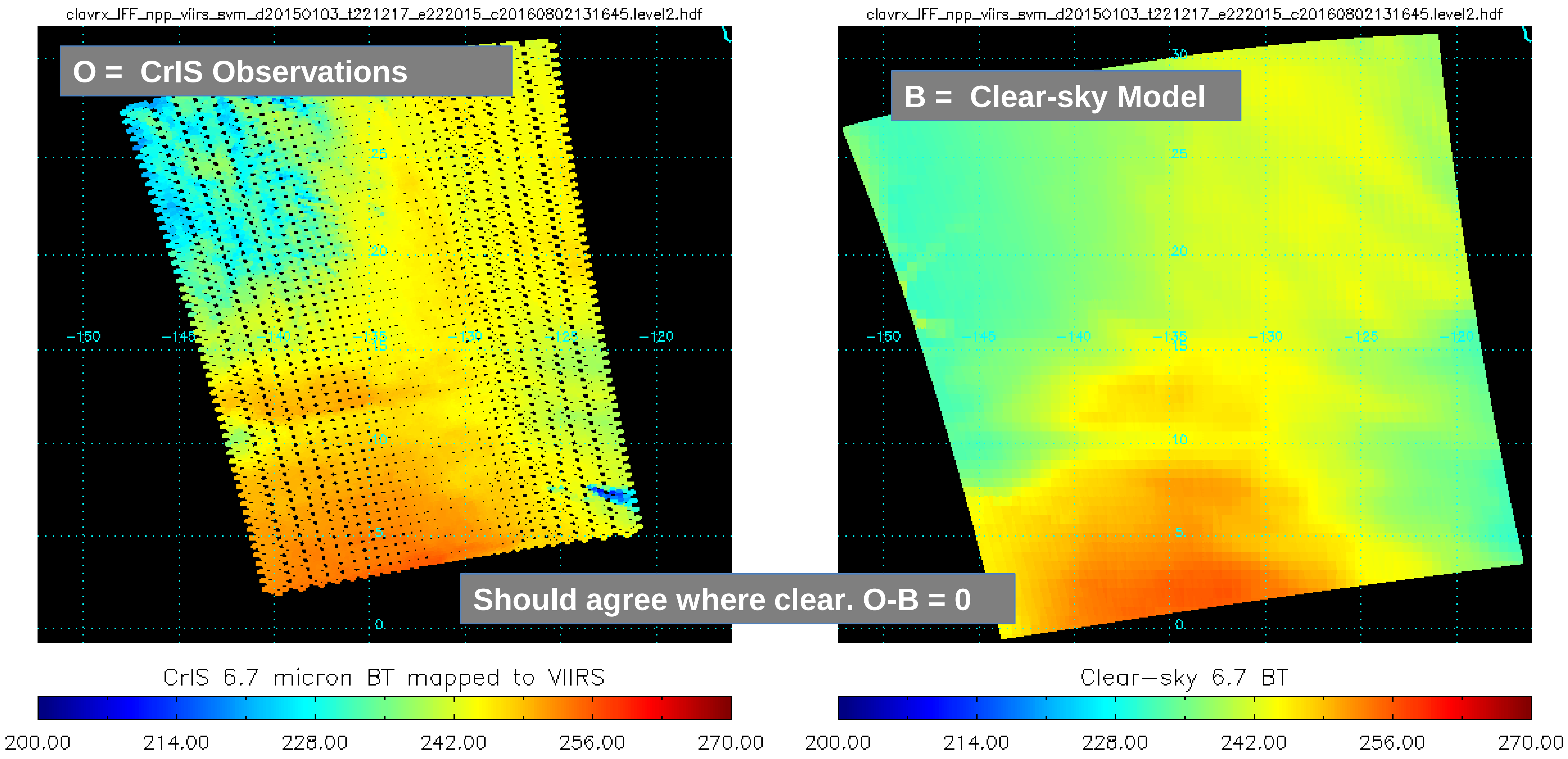


VIIRS Cloud Height (Maximum value in CrIS FOV is used)

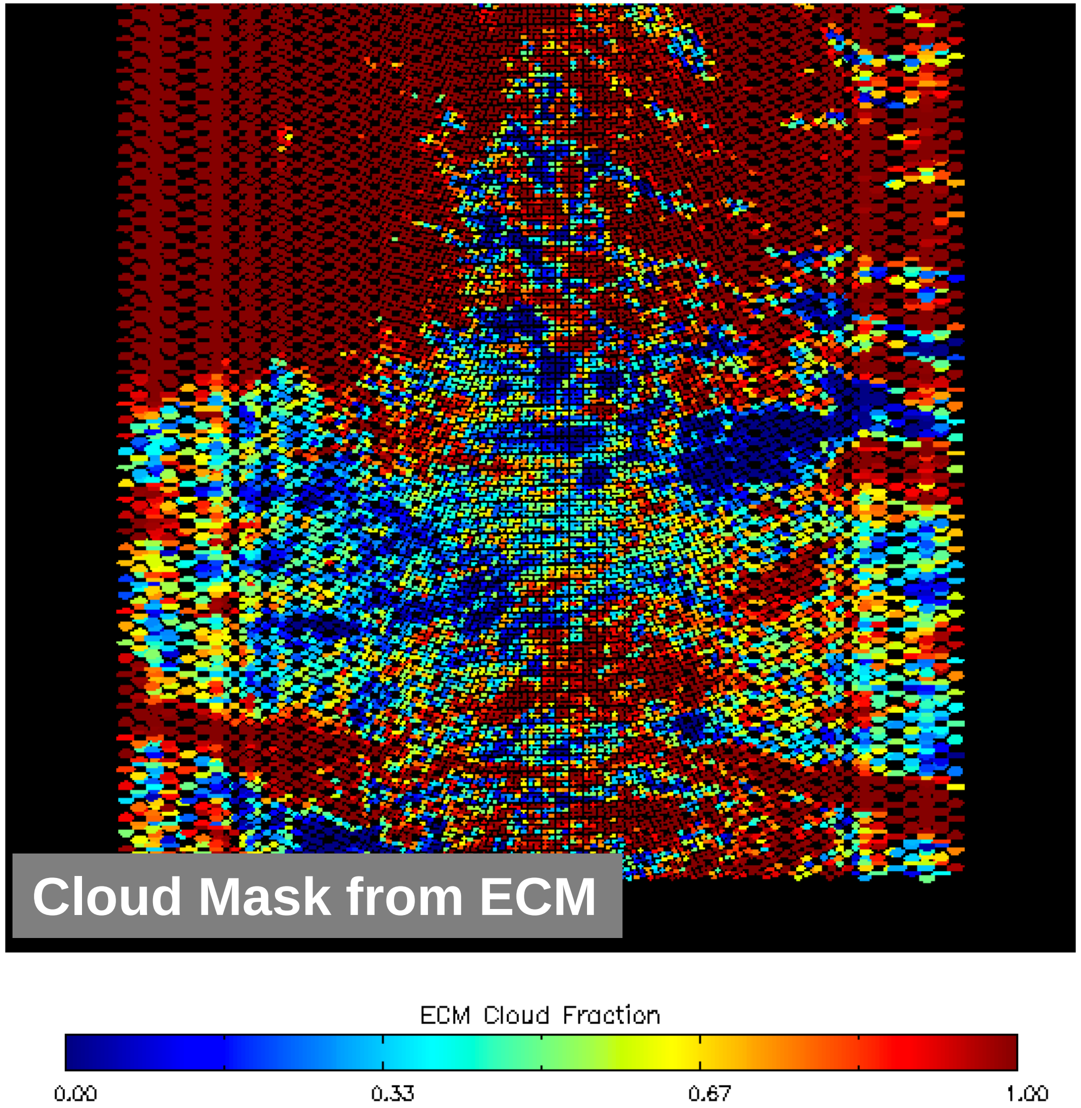


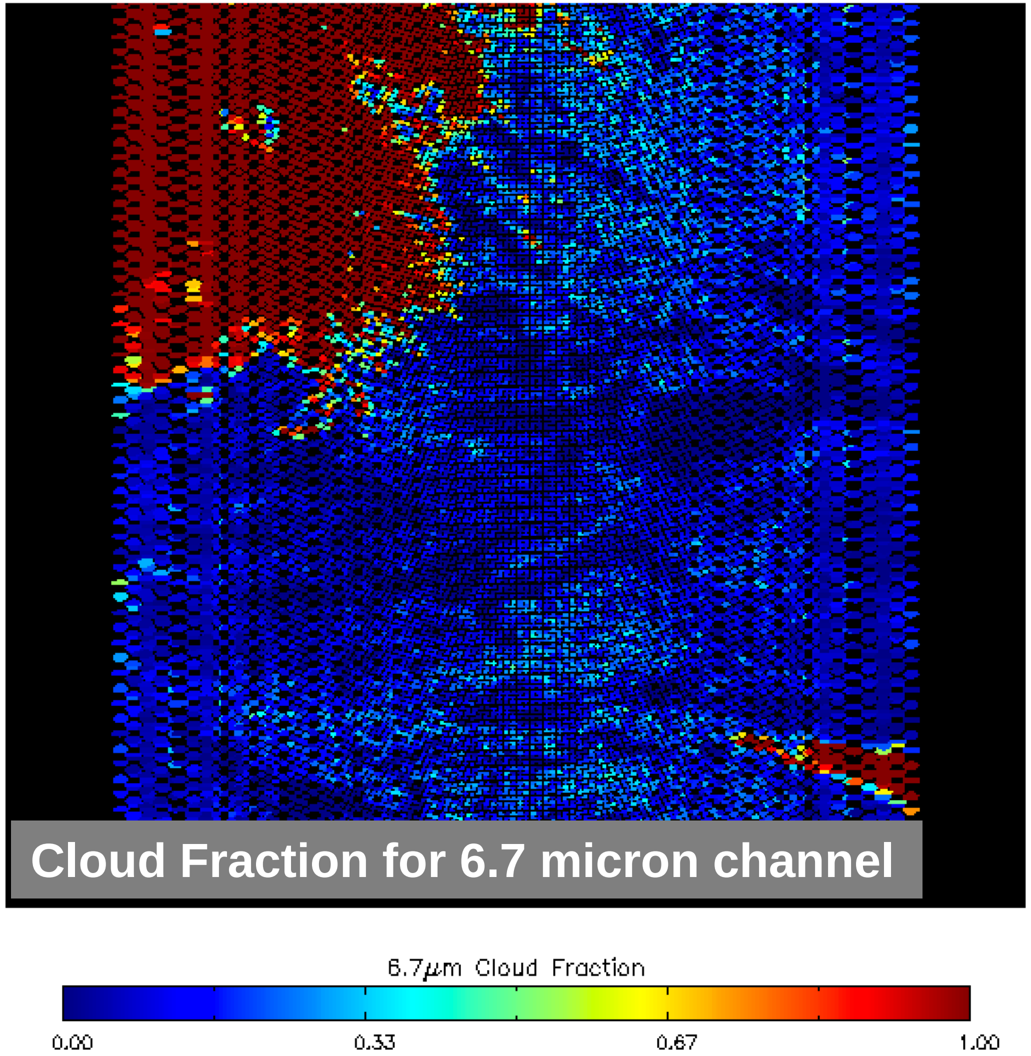


Validating the use of VIIRS Cloud Products for CrIS Cloud Detection



Resulting Cloud Mask for 6.7 micron channel.





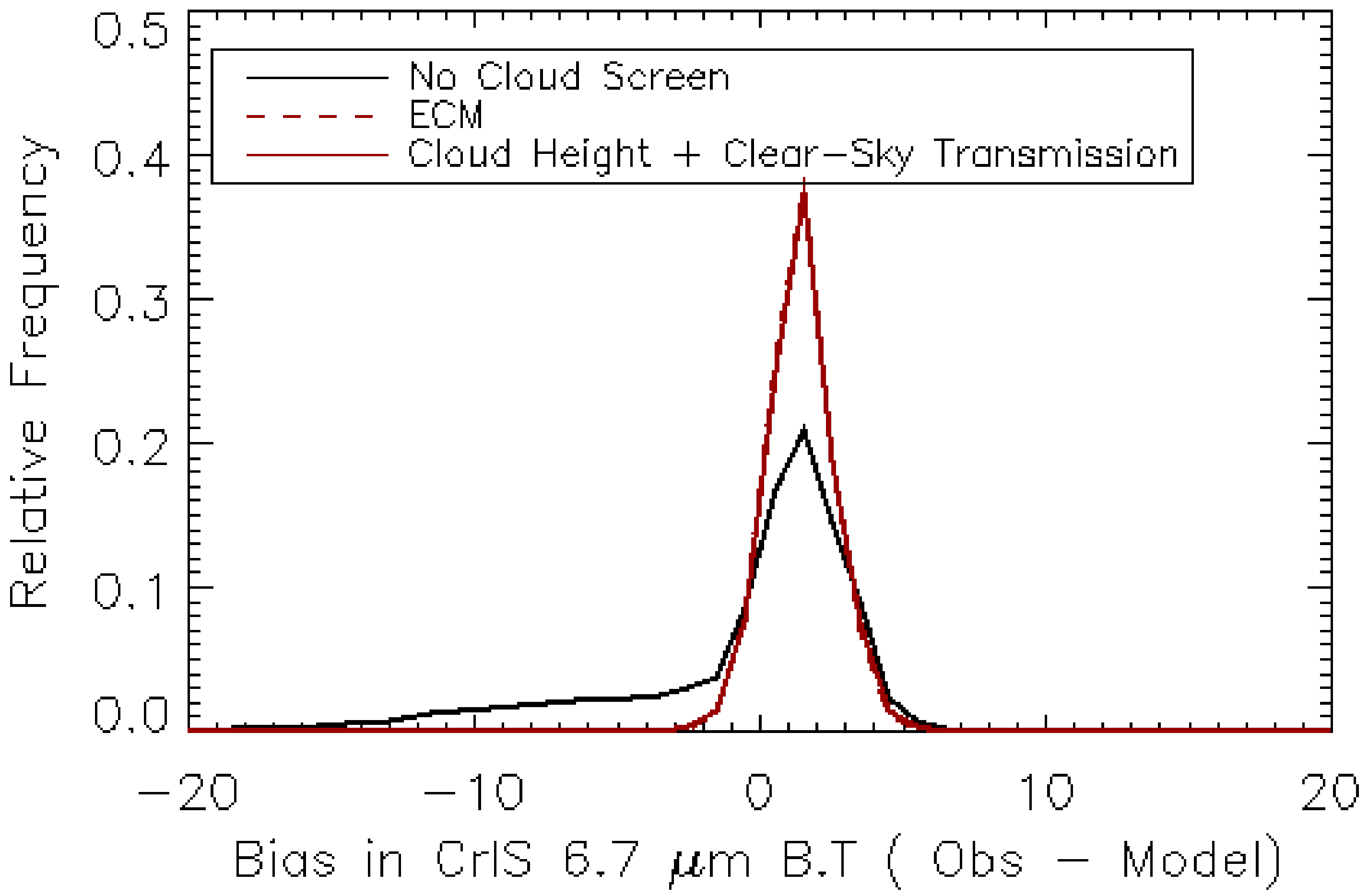
Results

- Our analysis shows that VIIRS cloud heights and cloud fractions are effective cloud screens for CrIS.

- This example shows that cloud heights coupled with the CrIS weighting functions can detect clouds that are invisible and reclassify them as clear.

- The resulting clear distribution matches that from the full cloud mask (ECM) but has many more points due to the recovery of CrIS FOVs with low clouds.

Clear-sky 6.7 radiance distribution using Cloud Height and RTM matches quality of direct use of ECM but provides many more pixels.



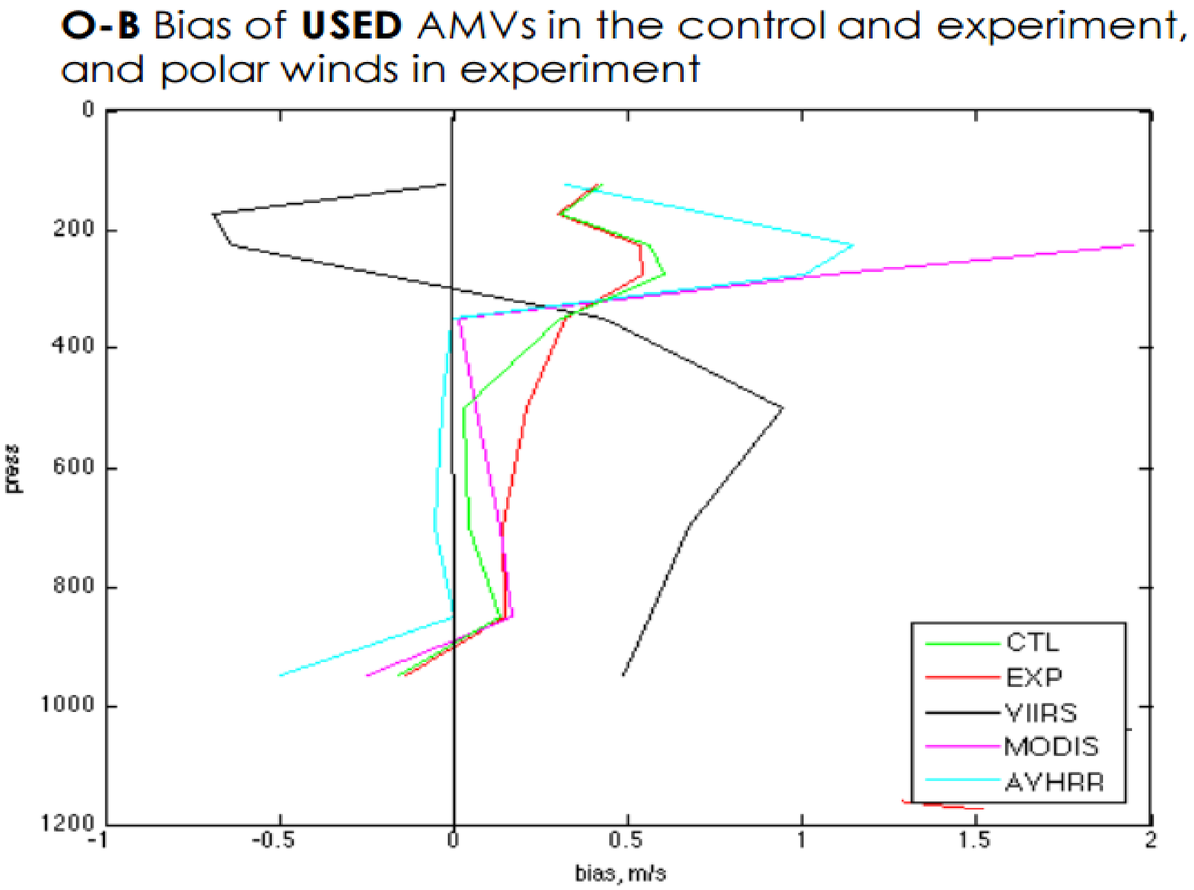
Cloud Heights for Polar Winds

What is Special about the Poles

- Large inversions are common which span from the surface to 2-4 km.
- Water clouds appear at much colder temperatures than at other latitudes and this makes IR cloud phase detection more challenging.
- Cloud detection is also a challenge. Clouds can be warmer than the surface and terminator conditions are prevalent at times.
- RTM accuracy is lower.

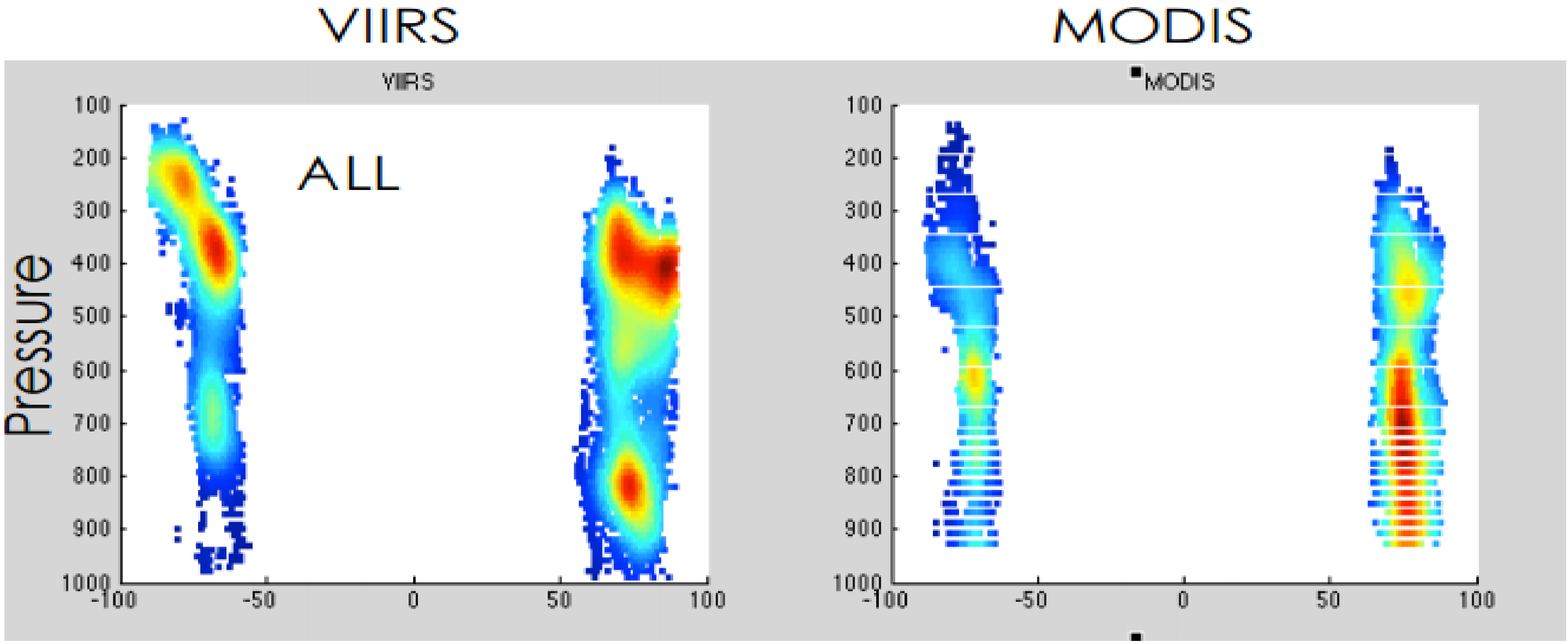
Impact on Polar Winds

- **Iliana Genkova (IMSG/NCEP@CIMSS) has found biases in the VIIRS Polar Winds.**
- **These biases are likely due to biases in the cloud height.**
- **NESDIS Polar Winds code is an older version of the Enterprise Algorithms that uses some aspects of the IDPS products.**
- **MODIS and AVHRR Polar Winds use a heritage system (WINDCO)**



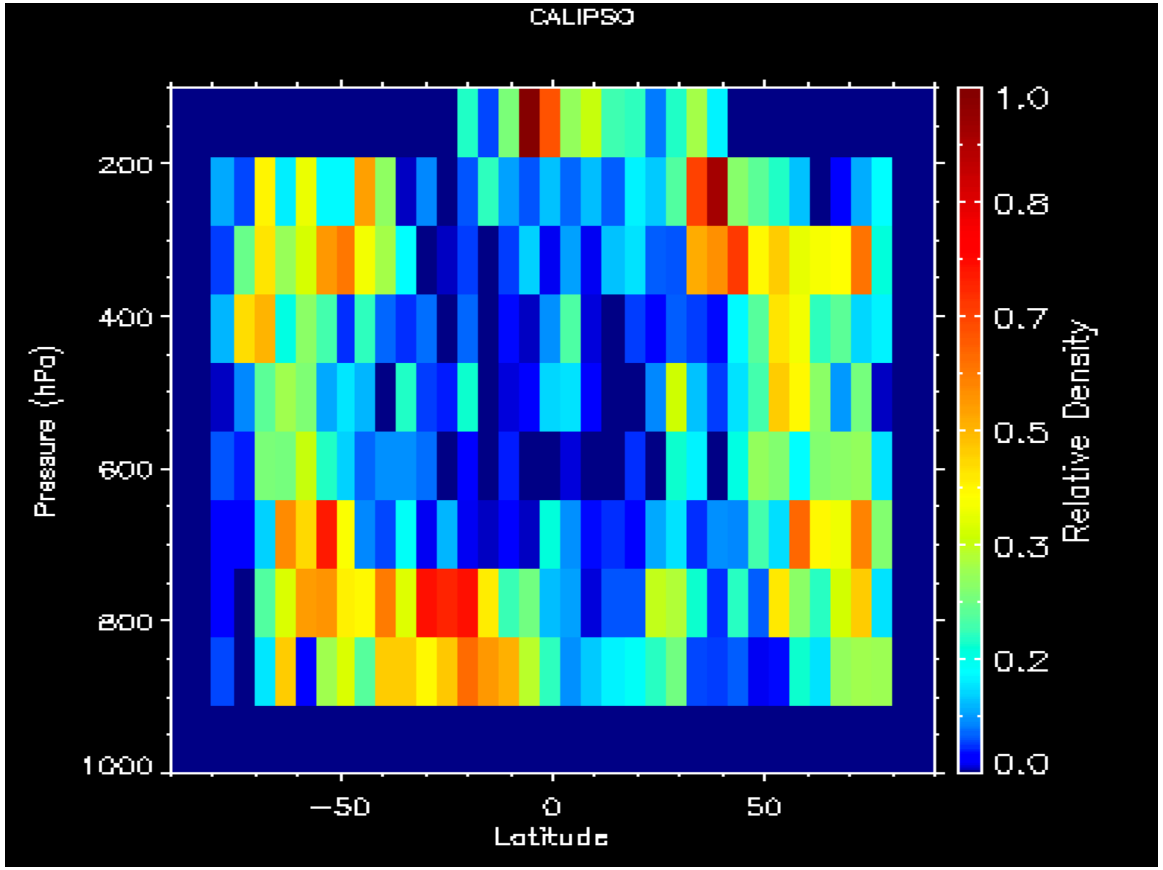
VIIRS Height Issues

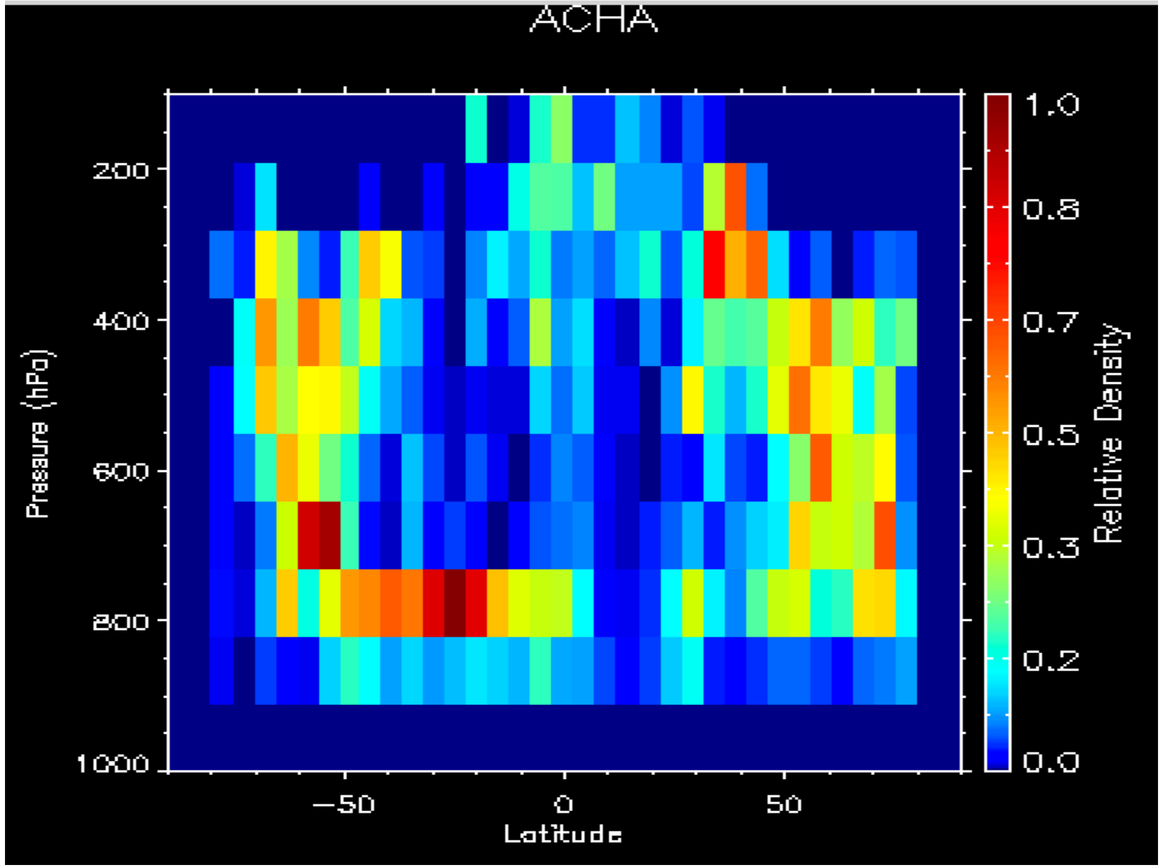
- Analysis by Iliana Genkova (EMC/IMSG) has indicated that the "Enterprise" heights distributions have higher clouds. 2 months of data shown (September and October)
- VIIRS results shows peaks at 300 – 400 hPa
- MODIS results don't show these peaks.
- Do we see this in the new Enterprise Data?



SAPF Enterprise Cloud Height Results October 2014

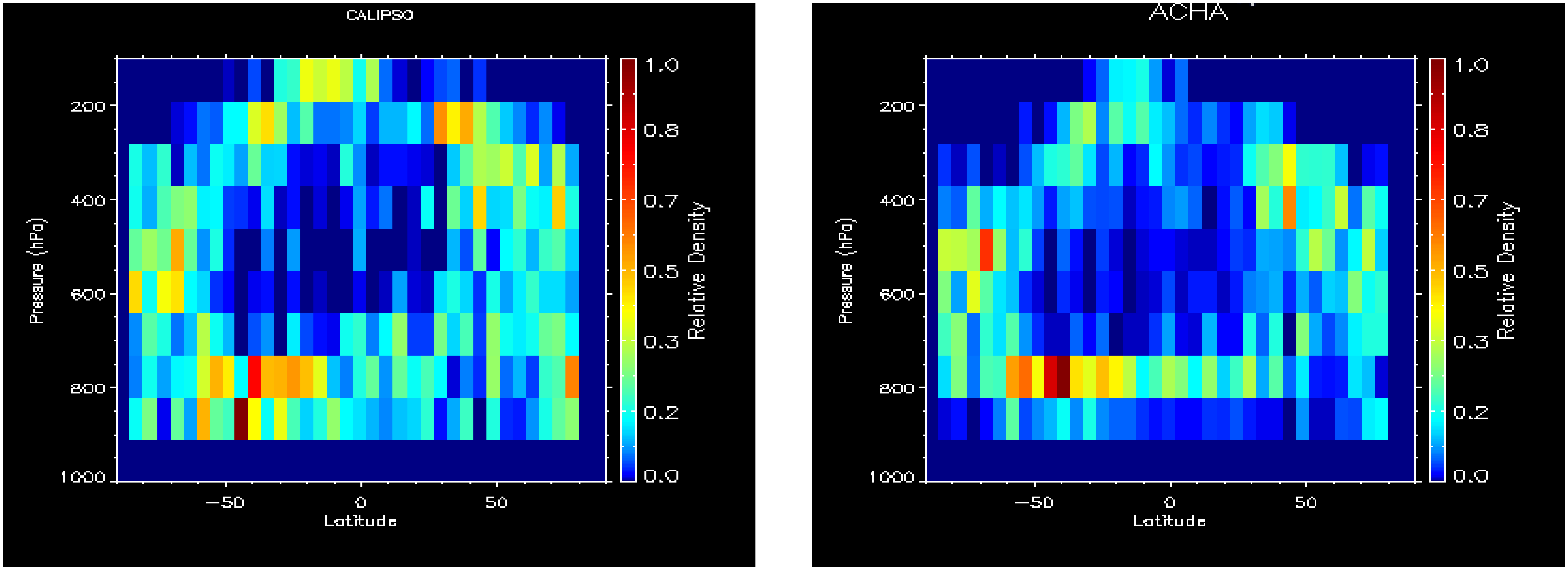
- Comparison of Latitude and Pressure distribution cloud top retrievals for October 2014
- We don't see the over-estimation of Arctic Heights for this day.
- We have limited SAPF output in the September-October period with CALIPSO matches.
- CALIPSO does not observe poleward of 80 degrees.
- CALIPSO = NASA spaceborne lidar
- ACHA = AWG Cloud Height Algorithm





SAPF Enterprise Cloud Height Results January 2015

- Comparison of Latitude and Pressure distribution cloud top retrievals for January 3, 2015



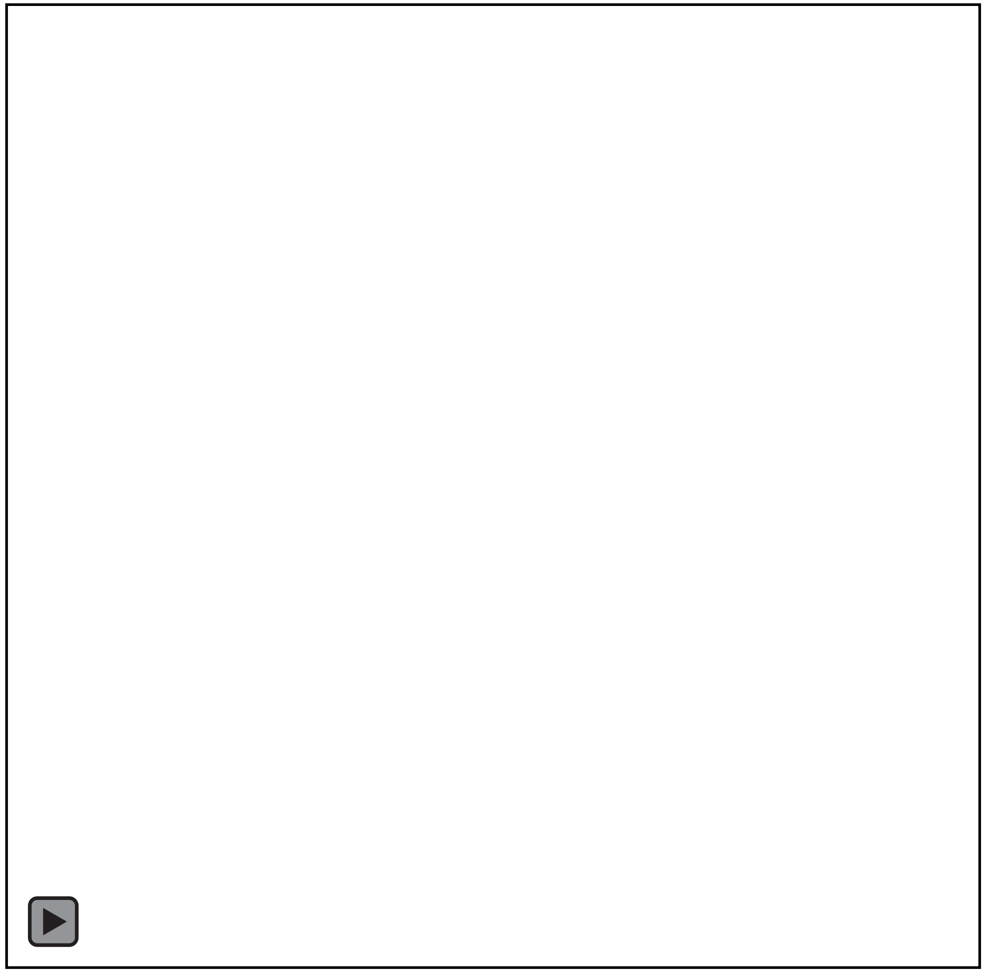
Collaboration with NOAA/CIMSS Polar AMV Team

- GOES-R AMV Software is operational at STAR with VIIRS. MODIS and AVHRR transition is ongoing.
- DB Sites (McMurdo, Sodankyla, Fairbanks, Barrow, and Rothera) continue to use the C version of WINDCO software for AMV production.

- Cloud products are also in demand from the DB sites.

- Collaboration Plan
  - Run CSPP for cloud products at DB sites.
  - Run GOES-R AMV software, using CSPP data as input.
  - Distribute new products to AMV/NWP community.

- Cloud Team will develop test cases to test impacts on Polar Winds for future updates.



Conclusions

- We are placing a high priority in ensuring Enterprise Cloud Products meet the needs of these two applications.

- We are optimistic that the Enterprise code going operational in the fall does not show the issues seen with the current products

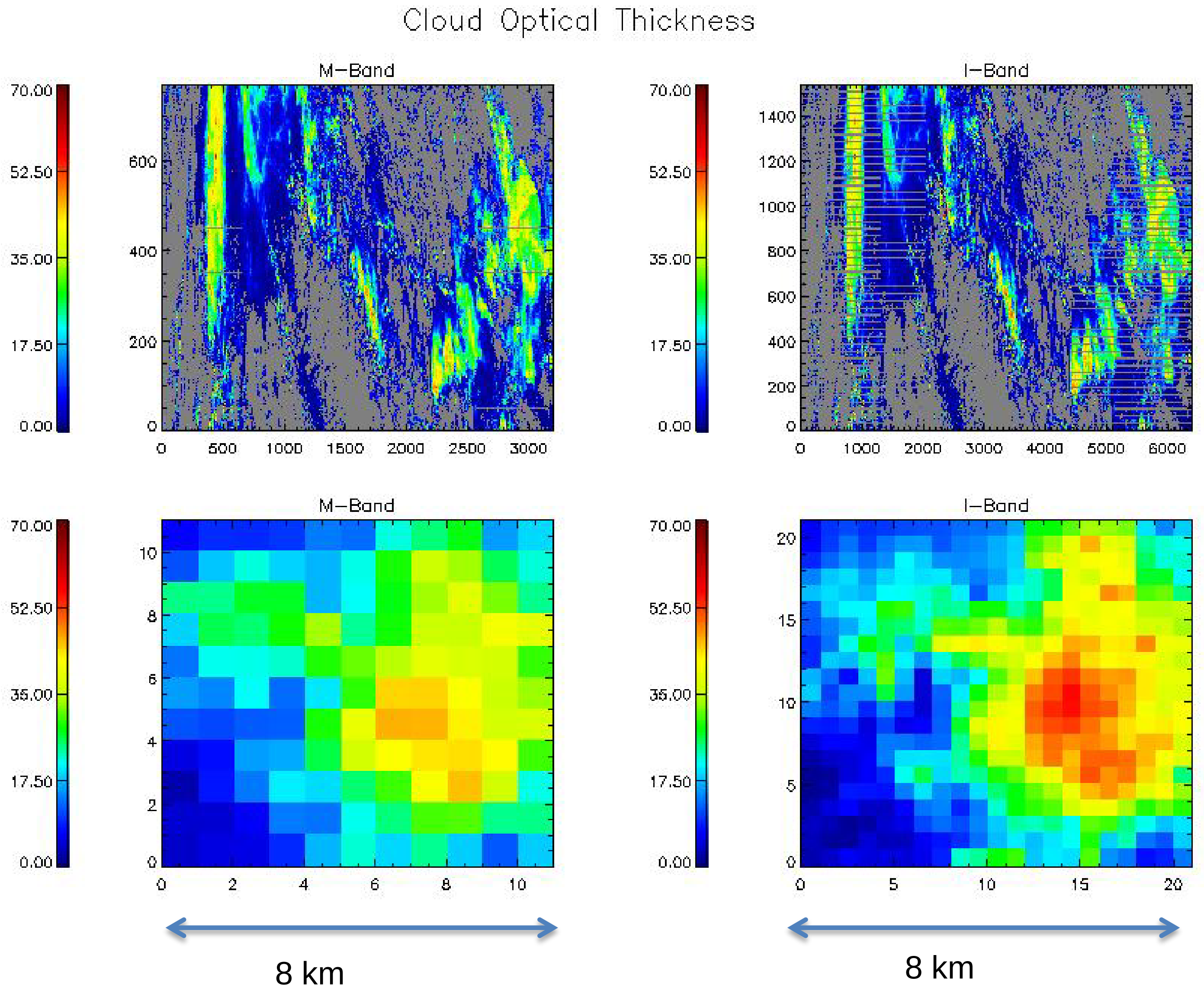
- We will will run our own Polar Winds test cases soon to dig deeper into this.

- We look forward to working with NCEP on the use of VIIRS products mapped into CrIS FOVs.

VIIRS I-Bands – An Area of Growth for Enterprise Cloud Algorithms

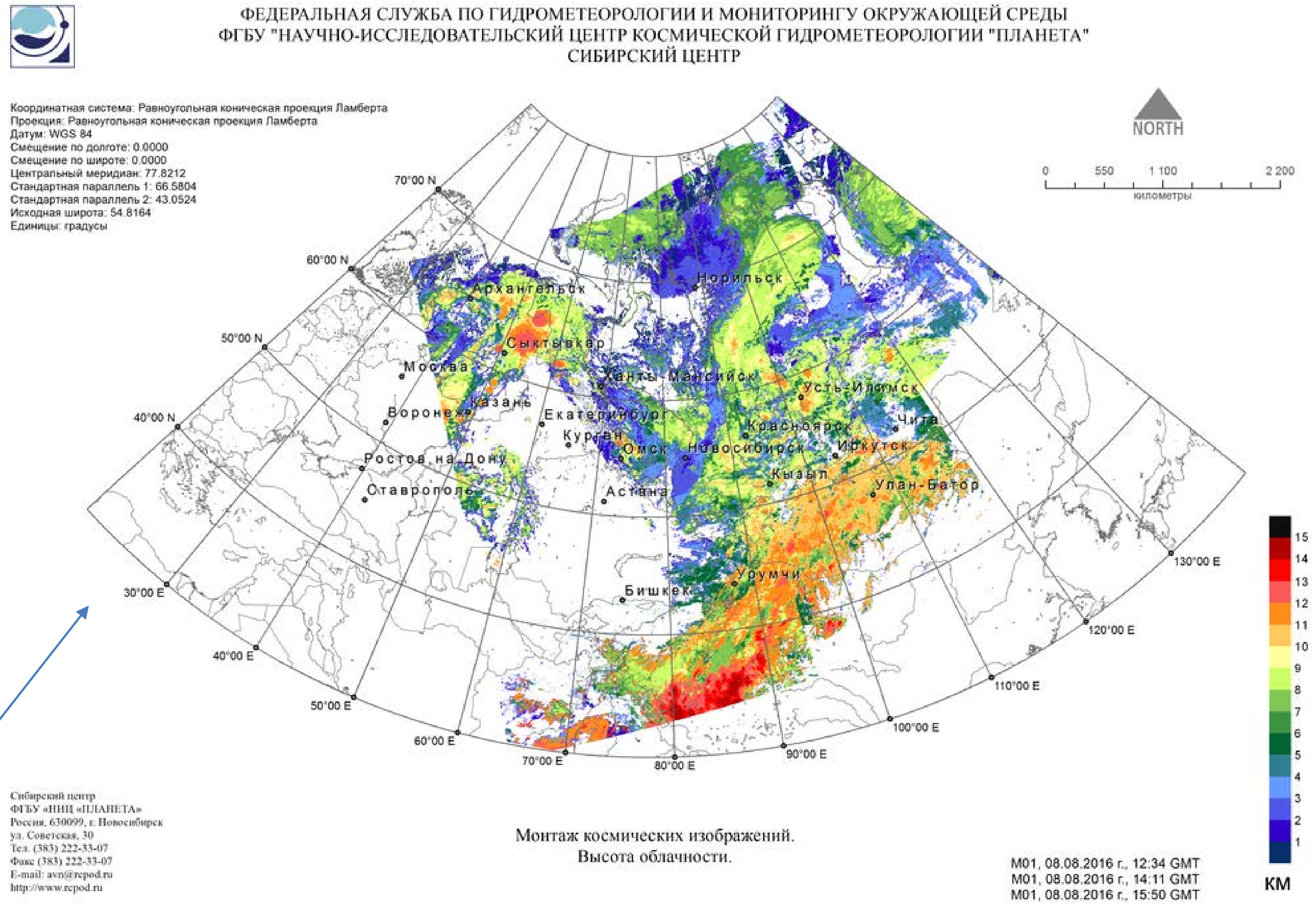
- Cloud features can be spatially finer than the VIIRS M-bands.
- The VIIRS I-bands over AVHRR-like capability at 375m.
- Since the Enterprise cloud algorithms are meant to process all data, they function on the VIIRS I-bands.
- CLAVR-x modified to do this but SAPF does already support I-bands.
- Example on right shows an example of DCOMP Cloud Optical Depth.
- Why is this important?

➢ Better resolution of cloud top microphysics in convective storms.
➢ Better characterization of CrIS pixels
➢ Better capture of small scale precip
➢ Better treatment of surface radiation gradients (solar energy).



CSPP LEO / CLAVR-x Providing NOAA Enterprise Clouds to DB

- The NOAA Enterprise Cloud Algorithms are distributed through UW/SSEC CSPP LEO.
- CSPP LEO runs NESDIS CLAVR-x.
- Provided good feedback for VIIRS Enterprise cloud products before operational in NDE this fall.
- Roughly 50 downloads
- Active communication with a Russian Remote Sensing Company that sells services to the Russian Weather Agency.
- Goal is to release updates in step with our deliveries to SAPF. (ahead of operations but in-sync with ASSIST)
- CSPP LEO supports VIIRS DNB usage. We hope to transition this to SAPF.



Example CSPP LEO CLAVR-x image provided by Russian CSPP customer

Cloud Effective Radius