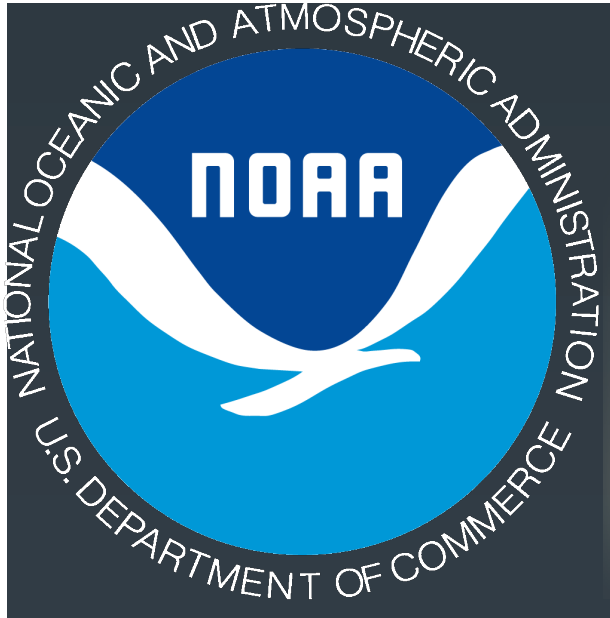
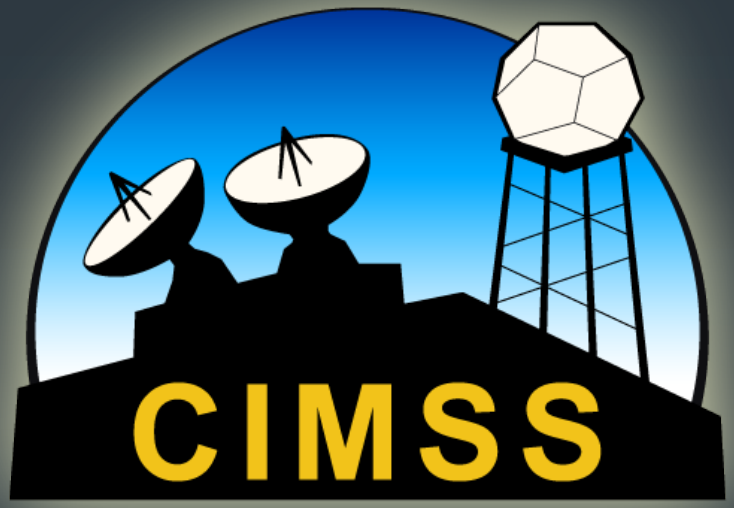




Extension of the CREW-type Analysis to VIIRS

Andrew Heidinger, Andi Walther, Yue Li and Denis Botambekov
NOAA/NESDIS and UW/CIMSS, Madison, WI, USA

CREW-4 Grainau, Germany, March 2014

Motivation

- Important time in VIIRS cloud products. Almost all operational agencies are getting ready to official release VIIRS cloud products.

Goals

- Conduct a comparison of VIIRS Cloud Products like was done for SEVIRI in past CREW Workshops.
- Facilitate discussions between VIIRS algorithm developers.
- Only a sample of results shown here, full results are available.

The VIIRS Sensor

- Launched by NASA on the Suomi-NPP Mission in 2011 (right after CREW3). Will be the operational NOAA polar imager.

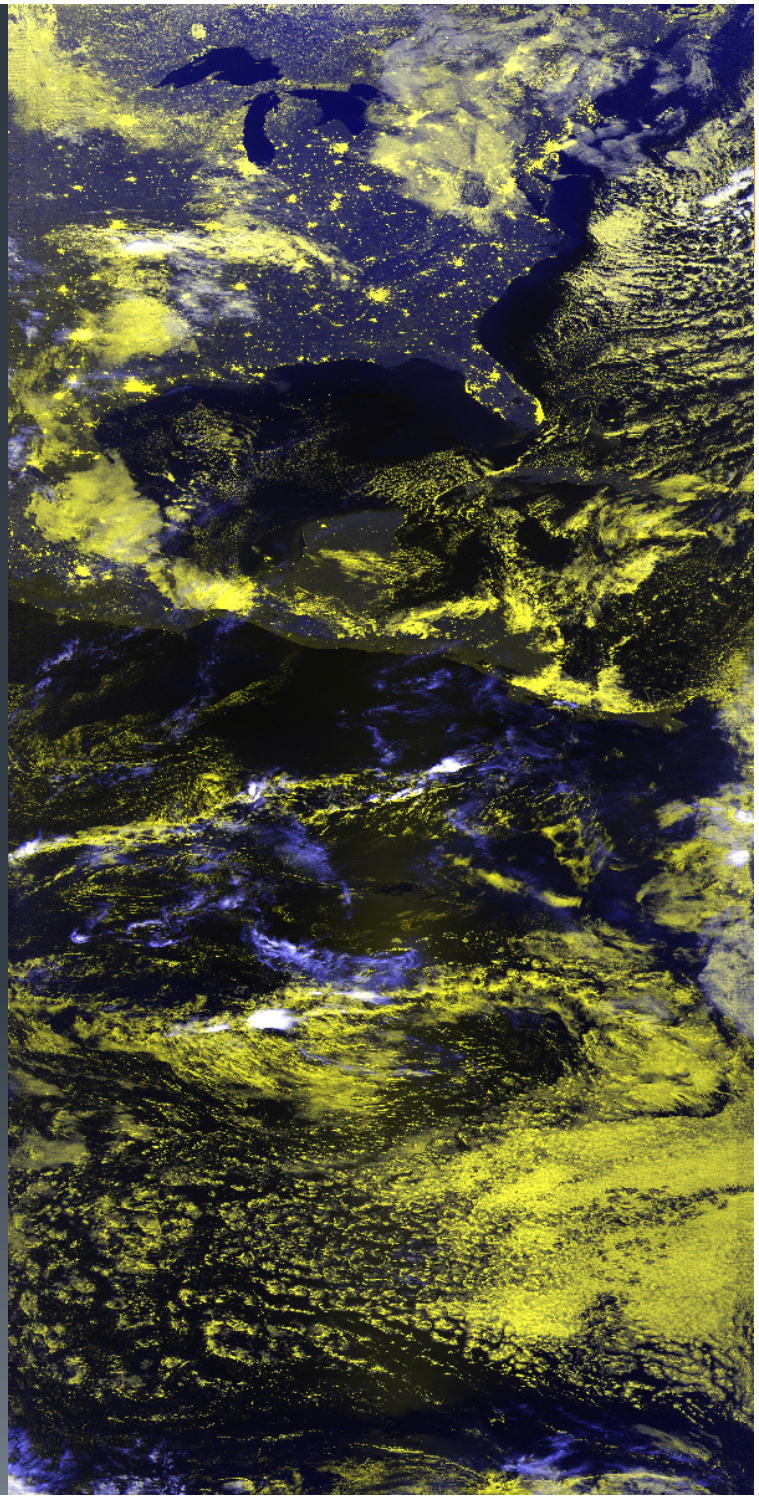
- VIIRS offers a nearly full complement of solar reflectance channels but provides only the 8.5, 11 and 12 μm channel in the Far-IR.
  - ***Many multi-layer and cloud-height approaches developed with MODIS don't apply.***

- The most unique feature of VIIRS is the Day/Night Band (DNB) which offers well-calibrated and very sensitive observations of lunar reflectance. Image on left shows a DNB-DNB-11μm (rev) false color image from Mar 29, 2012.

- VIIRS M-bands have a spatial resolution of 750m that grows in size with angle but only by a factor of 2.

- VIIRS I-bands provide multiple channels at 375 m.

- Several groups are working on CrIS + VIIRS data sets.



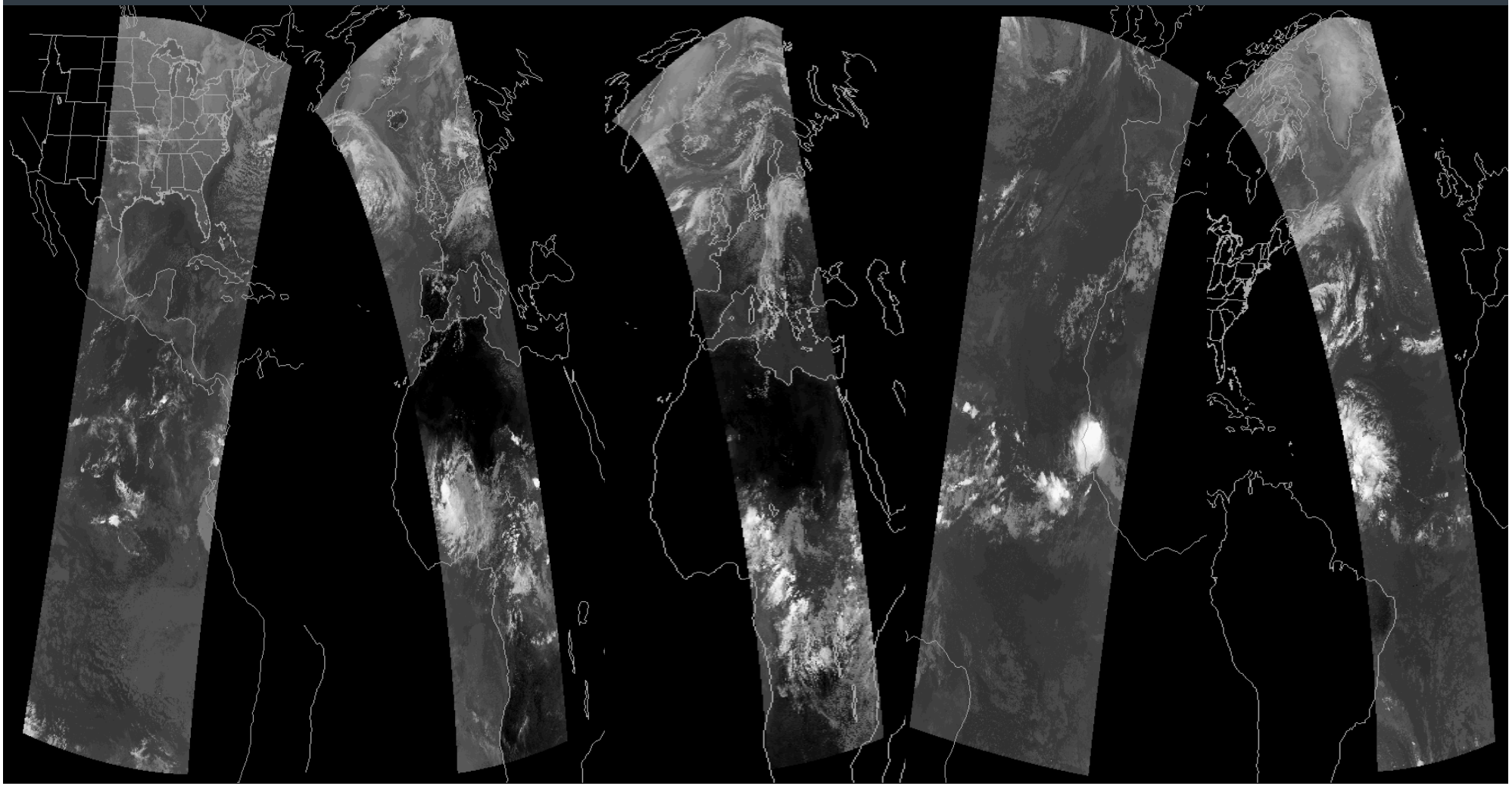
Data Providers

- **IDPS** = Official VIIRS cloud products developed by Private Industry for the JPSS program.
- **CLAVR-x = NOAA Algorithms (aka PATMOS-x)**
  - **DCOMP** = optical depth and particle size algorithm in CLAVR-x
  - **ACHA** = cloud height algorithm in CLAVR-x
- **MODAWG** = The NASA GSFC MODIS + NOAA AWG suite of VIIRS cloud products
- **PPS** = Polar Platform System from SMHI and NWCSAF
  - **CPP** = cloud optical depth and particle size in PPS
- **LARC** = NASA LaRC VIIRS products

Data

- 5 scenes chosen to be co-located with A-train. 3 day / 2 night
- 4 scenes chosen to fall within SEVIRI domain for future comparison
- Each scene is approximately 20 minutes in length (1/4 orbit)
- Night scenes chosen to have good lunar viewing conditions.

March 29 | August 12 | August 20 | August 23 | September 26



What is a CREW-type Analysis

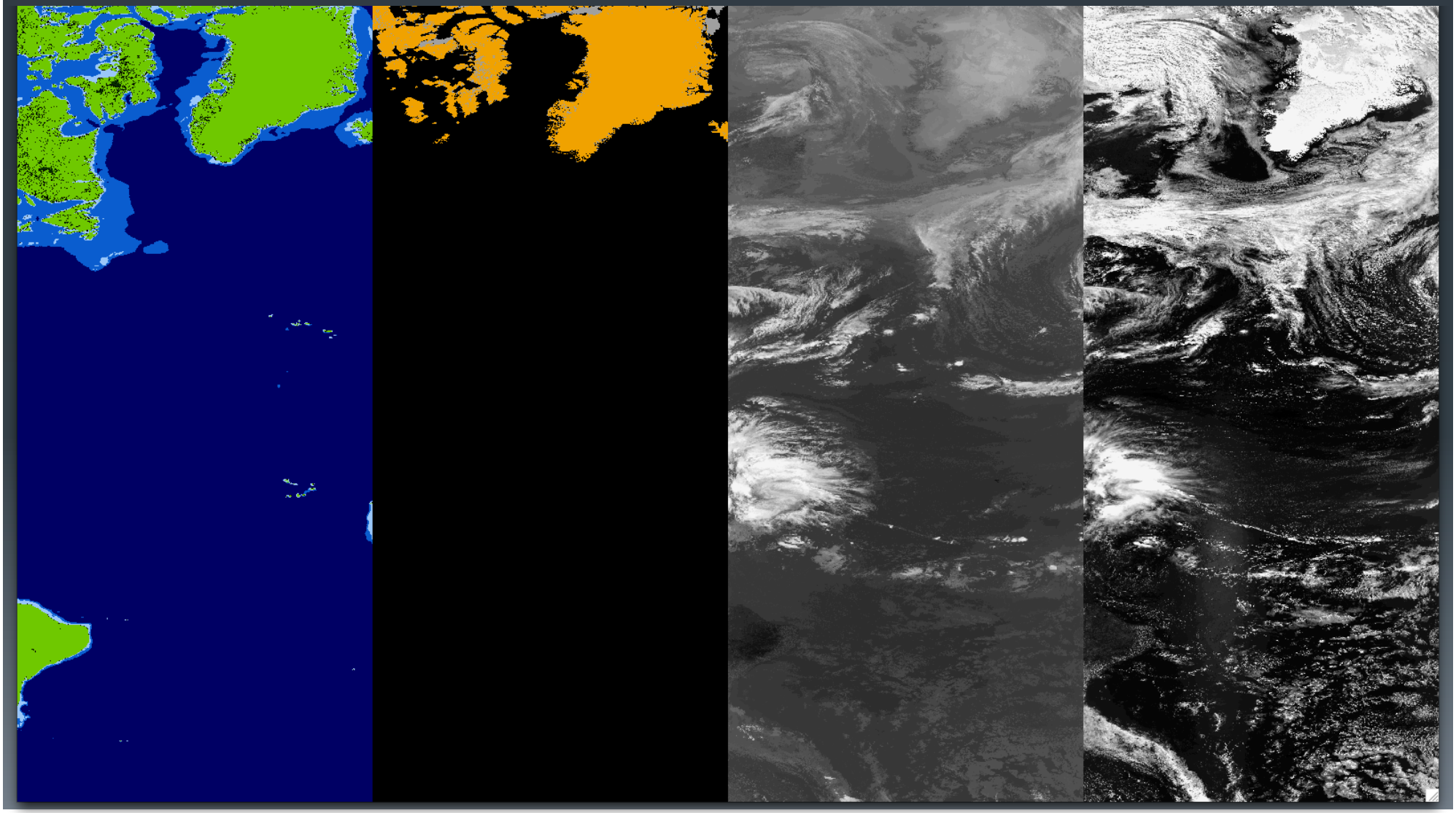
- Pixel-level comparisons of mask, phase, height, optical depth and particle size.
- Images showing the controversial pixels
- The N x N matrix of scatter-plots.
- A document is available will all results.

For this talk, we'll show only subset of results.

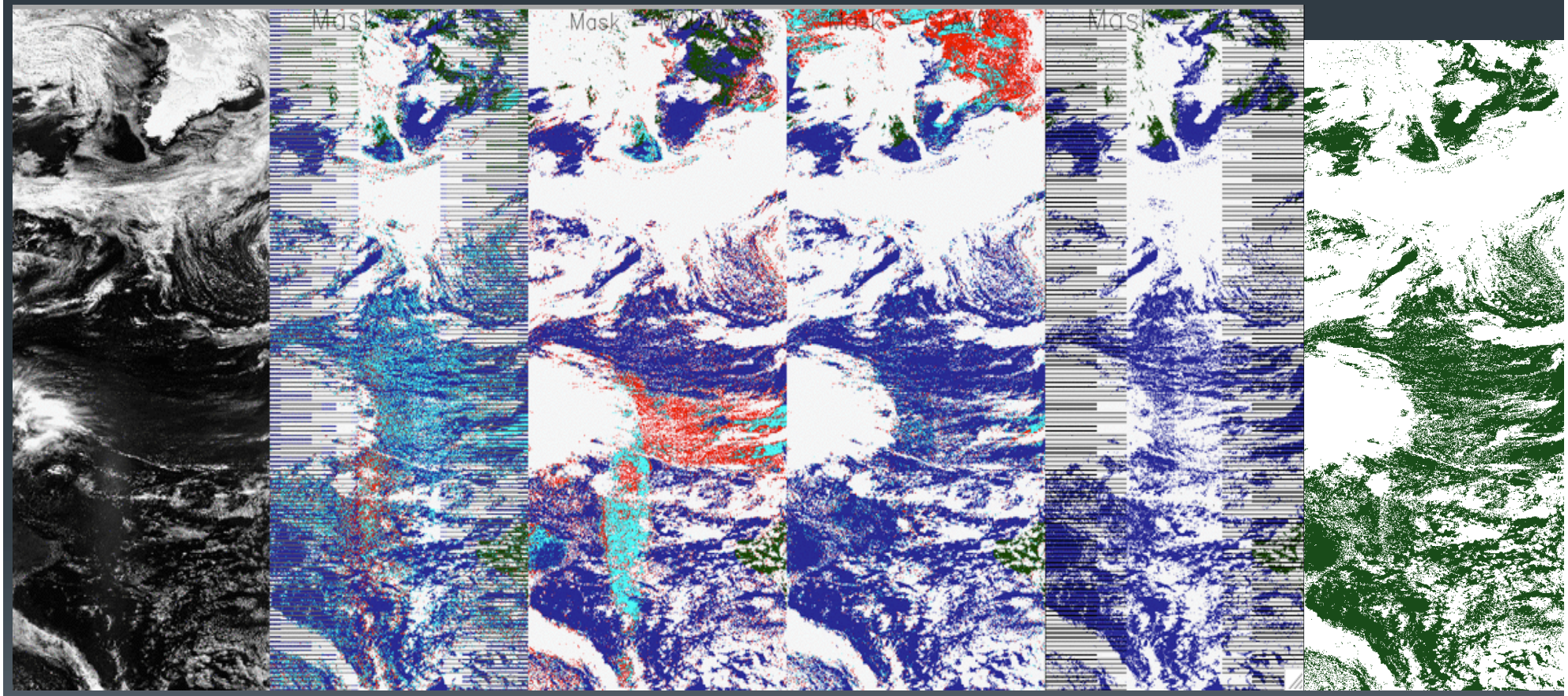
CLOUD MASK COMPARISON

September 26, 2013 (Daytime)

Land Class | Snow Class | 11 μm B.T (K) | 0.65 μm Refl. (%)

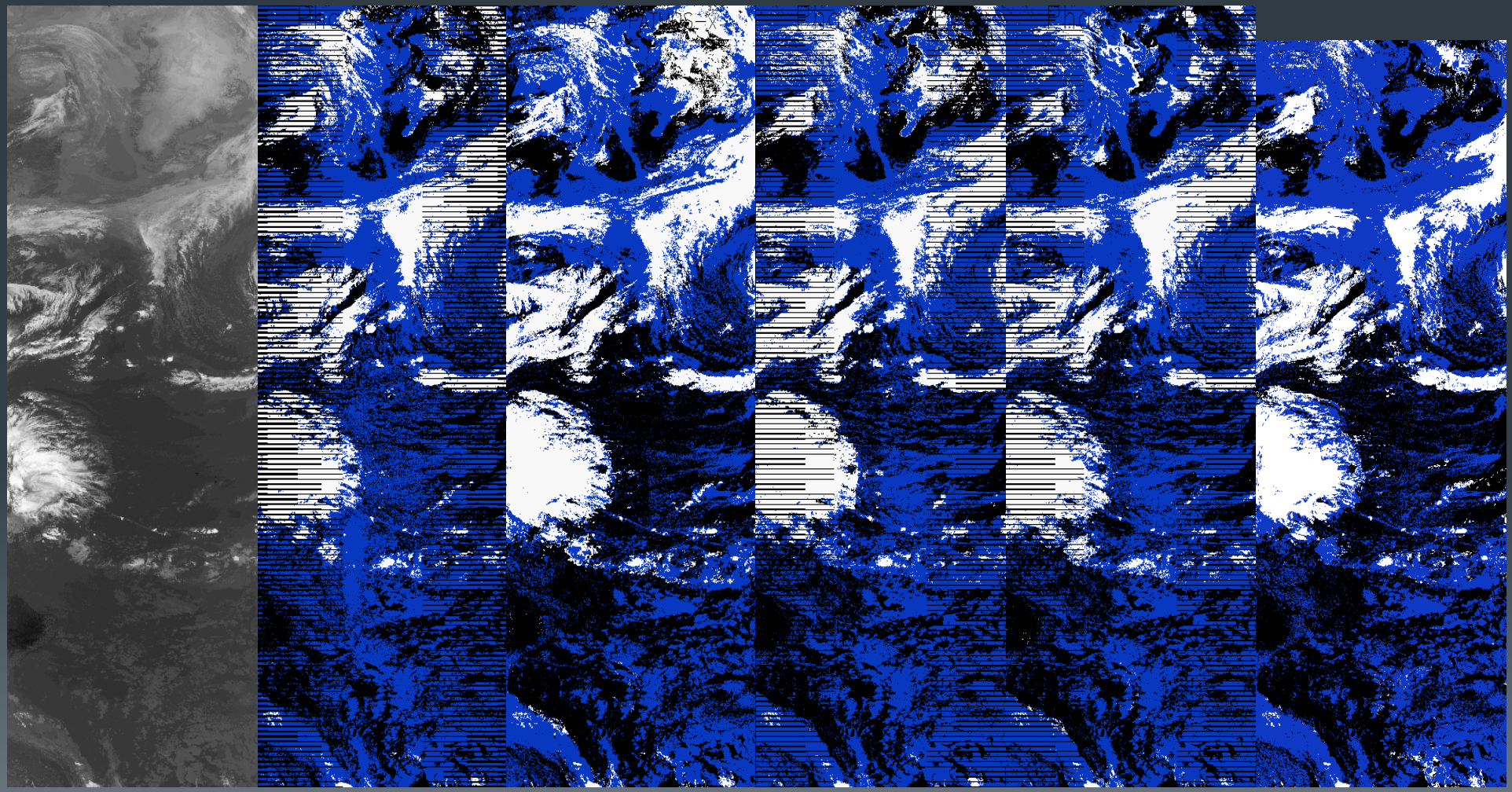


Cloud Mask Comparison (09/26 Day)



Cloud Phase Comparison (09/26 Day)

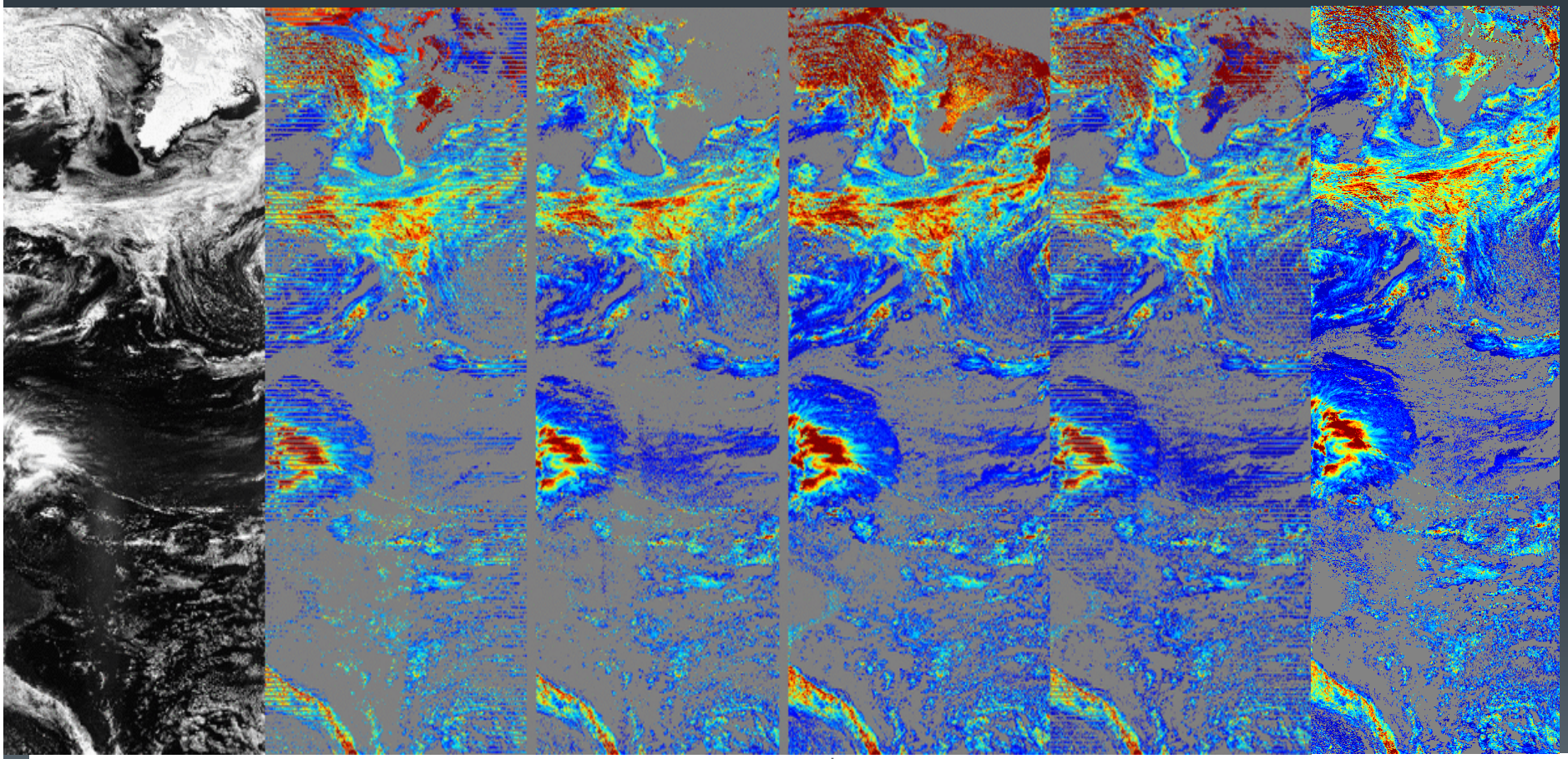
11 μm BT. IDPS CLAVR-x CPP PPS LARC

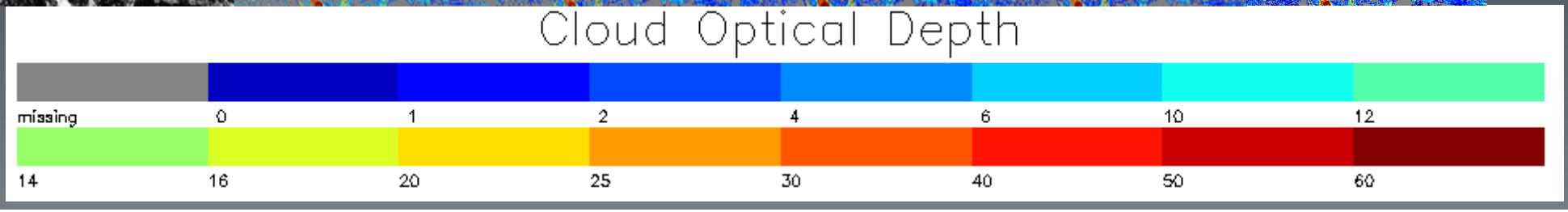


black = clear / blue = water / white = ice

CLOUD OPTICAL DEPTH COMPARISON

Cloud Optical Depth 09/26





Cld. Optical Depth Ice Phases 09/26

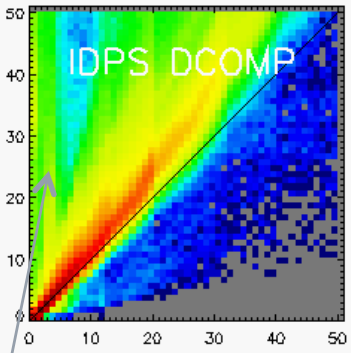
- Less agreement than water (expected)
- Highest correlation is GSFC and CPP.
- Lowest correlation is DCOMP and IDPS.
- DCOMP shows largest bias.
- IDPS shows low values for a wide range of values of other data.

IDPS
mean: 20.6
median: 6.3
stddev: 62.8
#: 8616798

DCOMP IDPS
bias: 6.2
rmse: 49.0
corr: 0.55
#: 6701630

GSFC IDPS
bias: −5.7
rmse: 38.5
corr: 0.69
#: 5472435

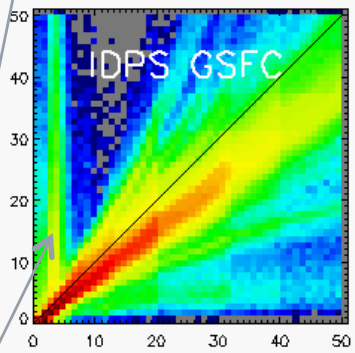
CPP IDPS
bias: 2.7
rmse: 46.9
corr: 0.60
#: 6818046

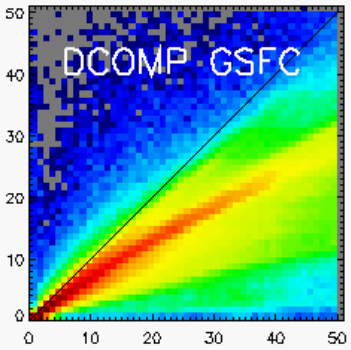


DCOMP
mean: 27.0
median: 7.8
stddev: 43.7
#: 11082000

GSFC DCOMP
bias: −11.2
rmse: 25.3
corr: 0.85
#: 6773061

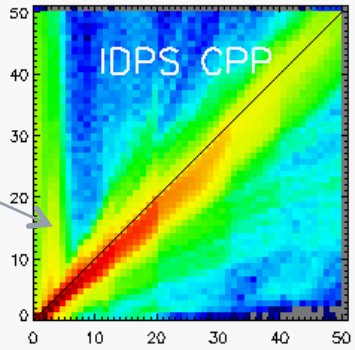
CPP DCOMP
bias: −1.7
rmse: 35.3
corr: 0.78
#: 7389615

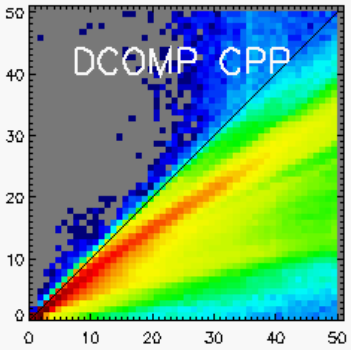


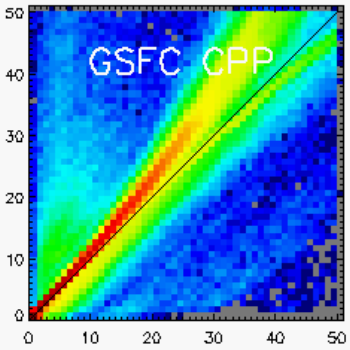


GSFC
mean: 14.2
median: 5.9
stddev: 25.8
#: 7427165

CPP GSFC
bias: 6.0
rmse: 26.7
corr: 0.88
#: 5701590





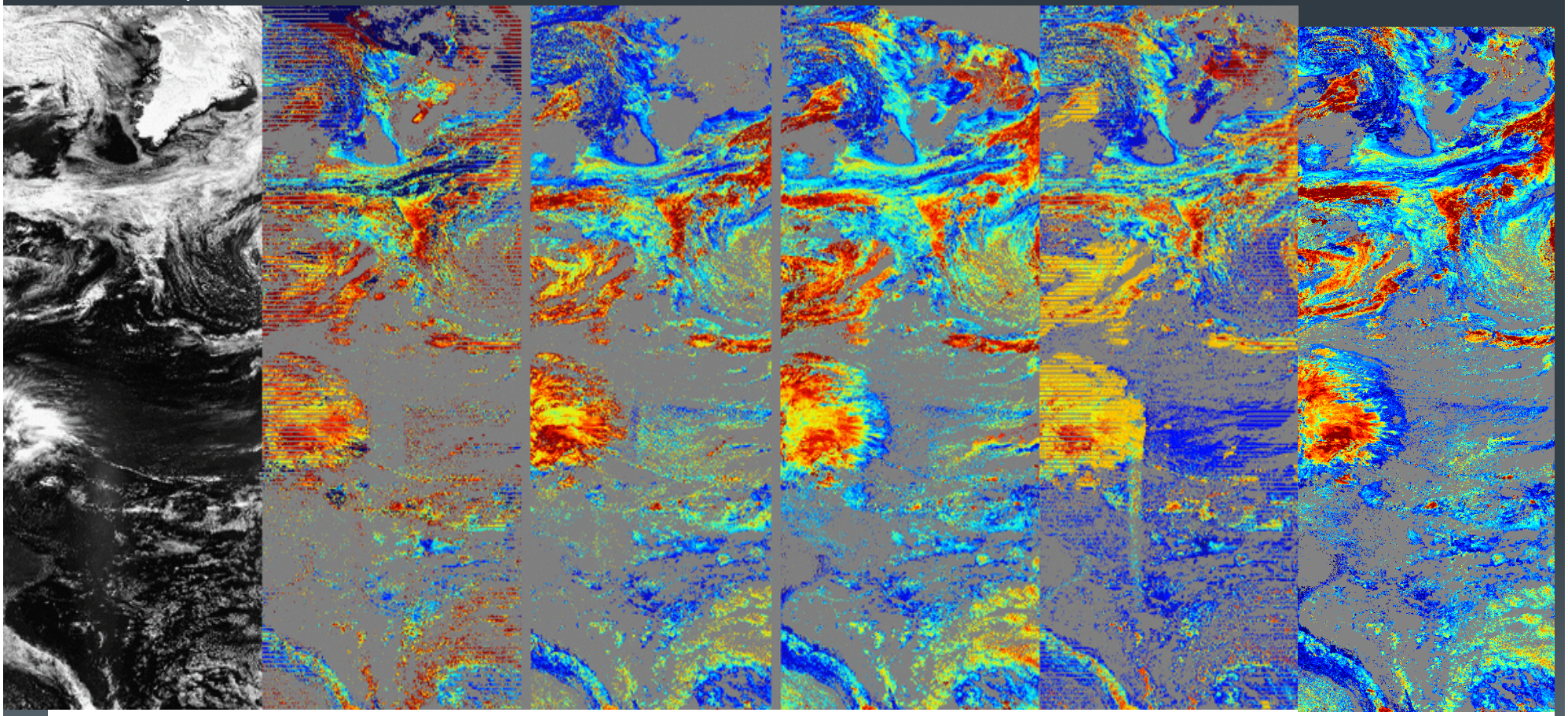


CPP
mean: 25.7
median: 5.1
stddev: 61.0
#: 9325580

CLOUD PARTICLE SIZE COMPARISON

Cloud Effective Radius (09/26)

Comparison for September 26, 2013



Cld. Particle Size All Phases 09/26

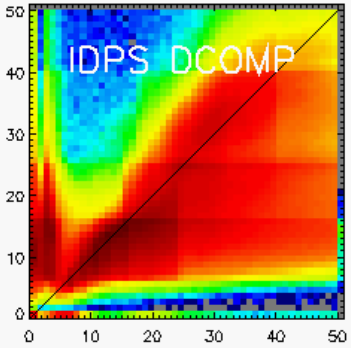
- Small particle mode for IDPS apparent.
- CPP shows preferred values
- Highest correlation GSFC and DCOMP
- Lowest correlation CPP and IDPS
- Lowest numbers are for IDPS
- Highest numbers for DCOMP.

IDPS
mean: 27.9
median: 22.5
stddev: 26.9
#: 21294340

DCOMP IDPS
bias: −9.3
rmse: 24.1
corr: 0.43
#: 20002664

GSFC IDPS
bias: −5.1
rmse: 20.5
corr: 0.39
#: 16274544

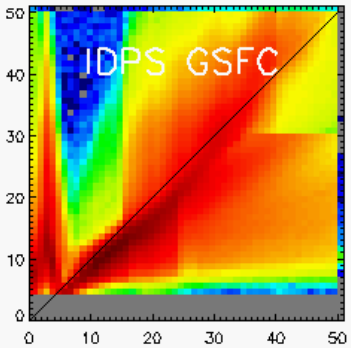
CPP IDPS
bias: −8.2
rmse: 25.4
corr: 0.28
#: 20498744

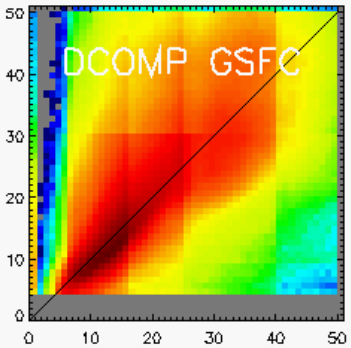


DCOMP
mean: 19.5
median: 16.2
stddev: 10.4
#: 30223780

GSFC DCOMP
bias: 1.7
rmse: 8.4
corr: 0.72
#: 21061088

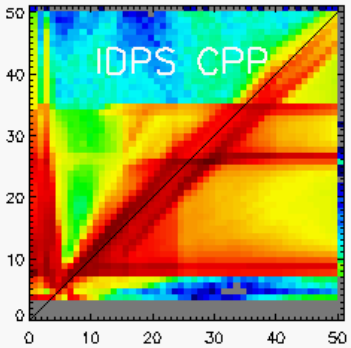
CPP DCOMP
bias: −0.2
rmse: 8.5
corr: 0.61
#: 24616488

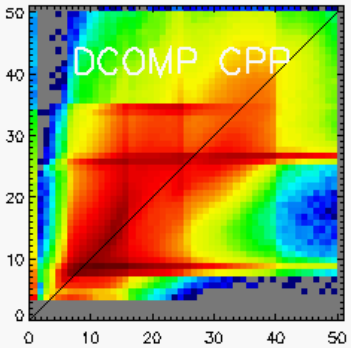


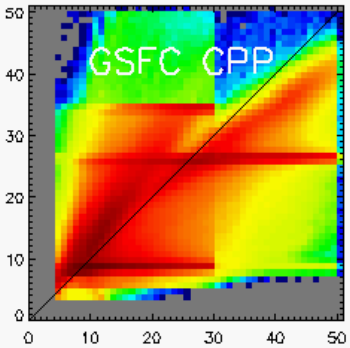


GSFC
mean: 20.2
median: 17.0
stddev: 11.6
#: 22279082

CPP GSFC
bias: −1.7
rmse: 8.9
corr: 0.66
#: 19075822







CPP
mean: 17.7
median: 15.3
stddev: 9.8
#: 28177748

Cld. Particle Size All Phases 09/26

Cld Opd > 4

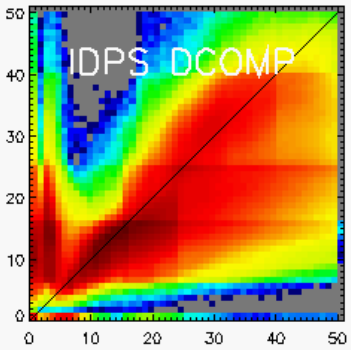
- These results show impact of removing cloud optical depth < 4.
- CPP artifacts largely disappear.
- IDPS artifacts remain.
- This means IDPS is not converging for clouds with optical depth > 4 because QF filter removes them.

IDPS
mean: 21.0
median: 18.8
stddev: 16.1
#: 15151765

DCOMP IDPS
bias: −3.3
rmse: 12.6
corr: 0.61
#: 13870549

GSFC IDPS
bias: −1.1
rmse: 10.9
corr: 0.61
#: 11363022

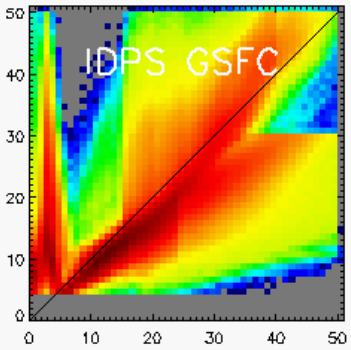
CPP IDPS
bias: 0.0
rmse: 9.7
corr: 0.74
#: 12906358

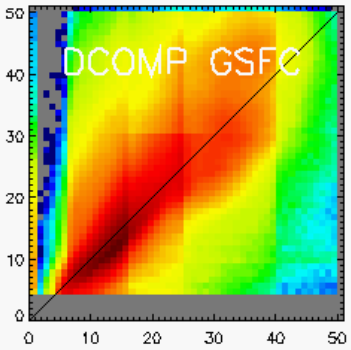


DCOMP
mean: 18.7
median: 15.6
stddev: 9.4
#: 19590540

GSFC DCOMP
bias: 1.1
rmse: 7.3
corr: 0.75
#: 13803505

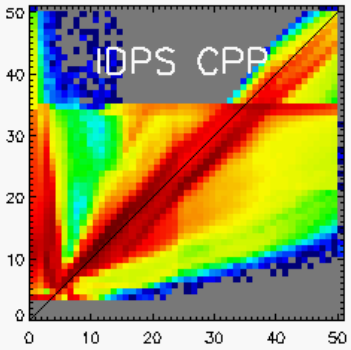
CPP DCOMP
bias: 2.6
rmse: 7.3
corr: 0.74
#: 14208885

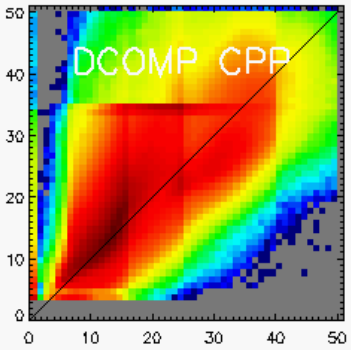


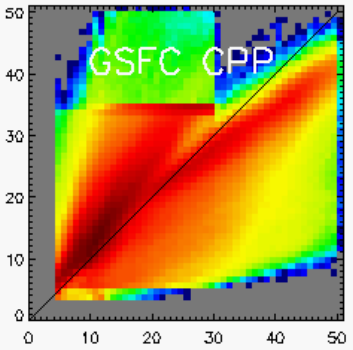


GSFC
mean: 18.8
median: 15.5
stddev: 10.9
#: 14321065

CPP GSFC
bias: 1.0
rmse: 7.6
corr: 0.73
#: 11961953







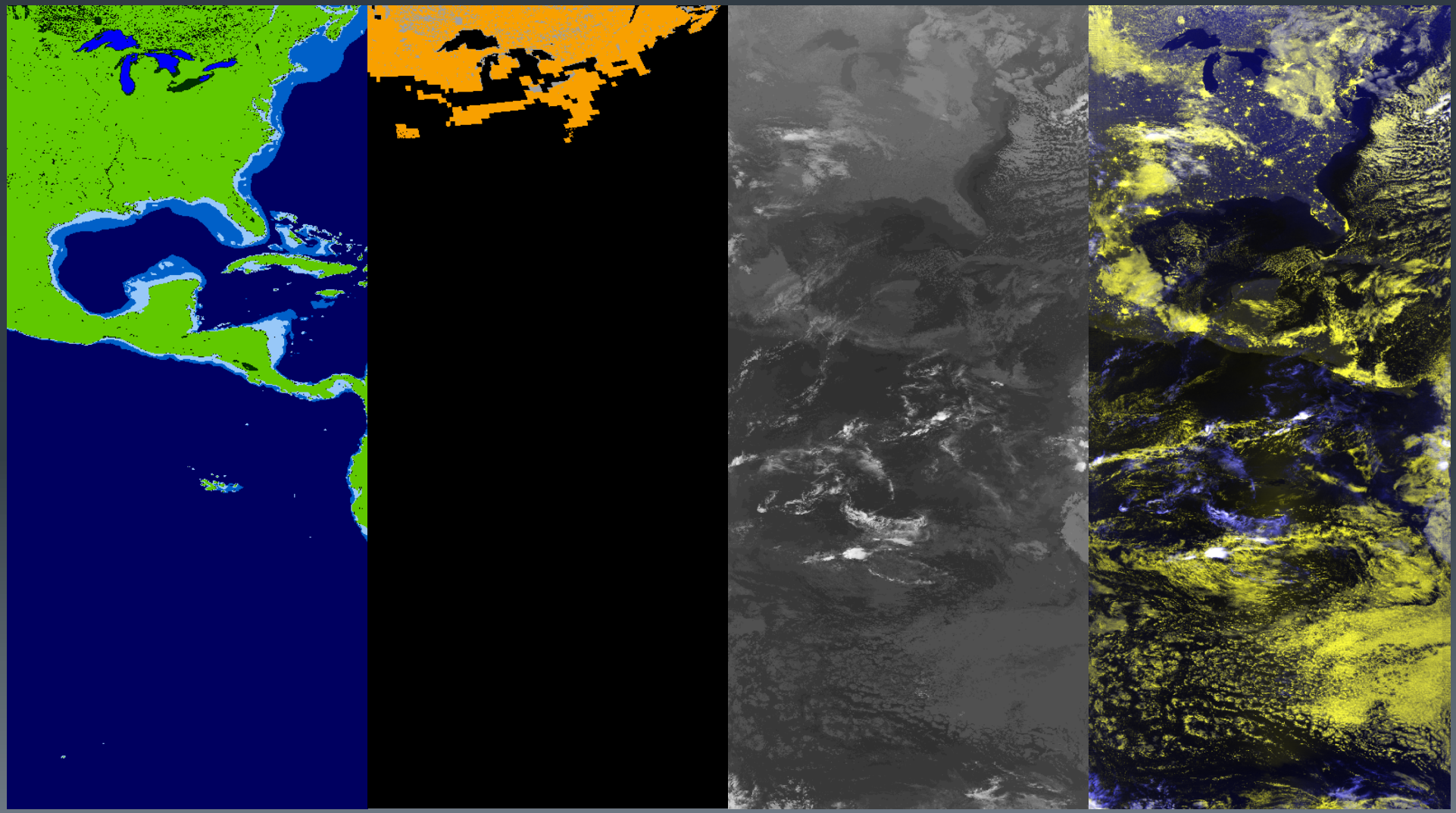
CPP
mean: 20.6
median: 18.9
stddev: 10.1
#: 15276673

CLOUD HEIGHT COMPARISON

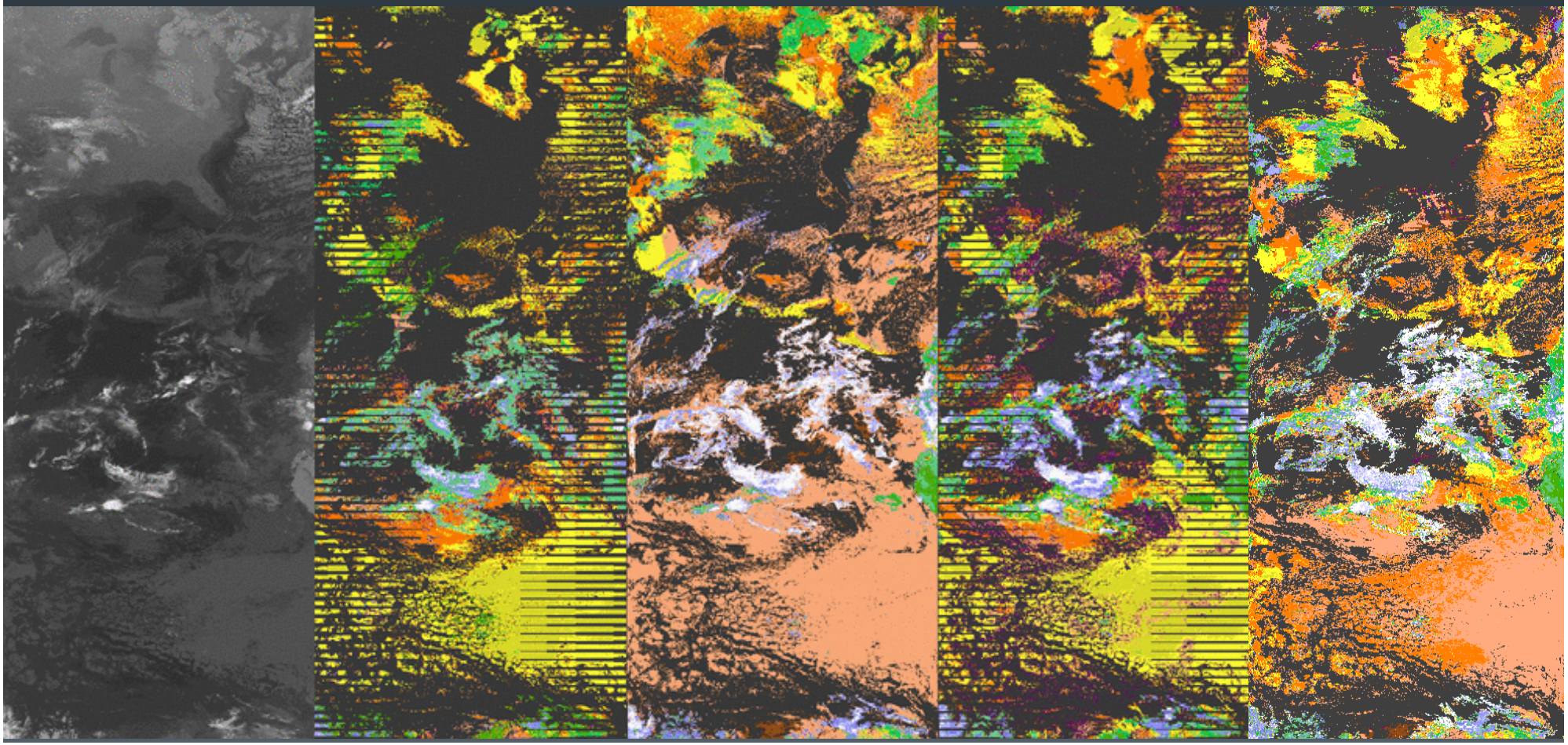
March 29, 2013 (Nighttime)

Cloud Height Comparisons using CALIPSO shown for this Scene

Land Class | Snow Class | 11 μm BT (K) | DNB + 11 μm RGB

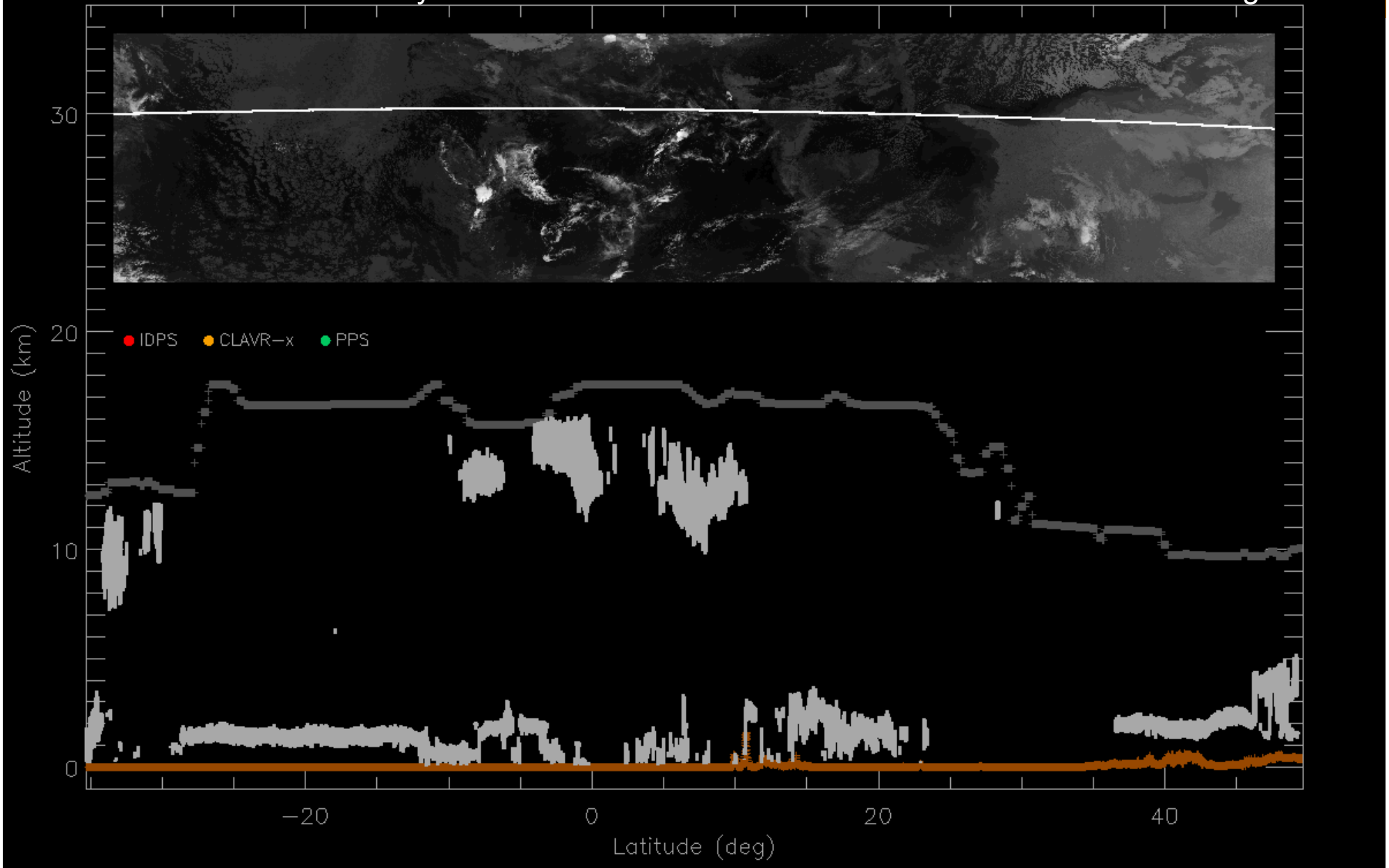


Cloud Height Comparison 03/29



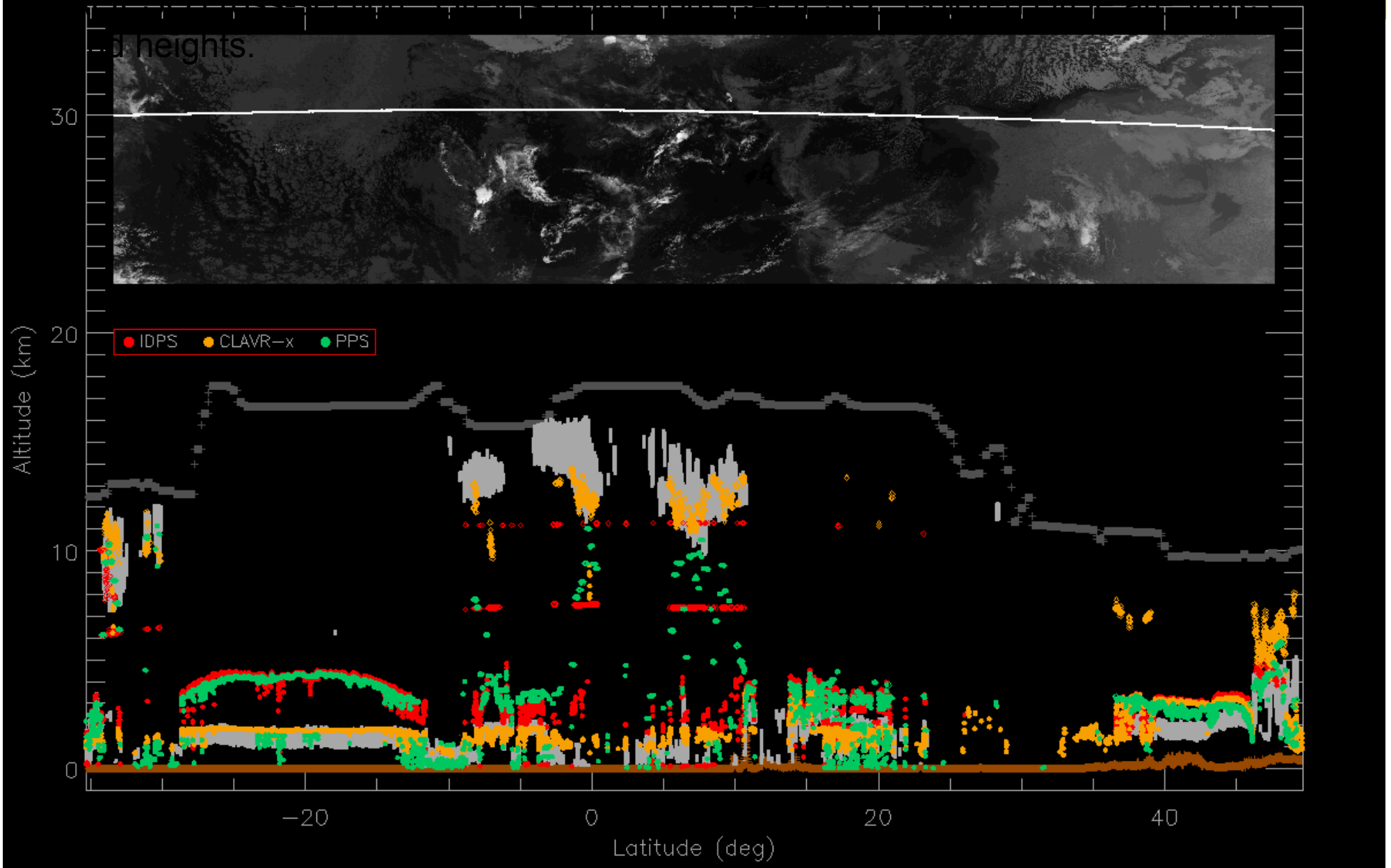
CALIPSO Comparison 03/29

CALIPSO cross-section. Grey is cloud from CALIPSO. Colored circle are VIIRS cloud heights.

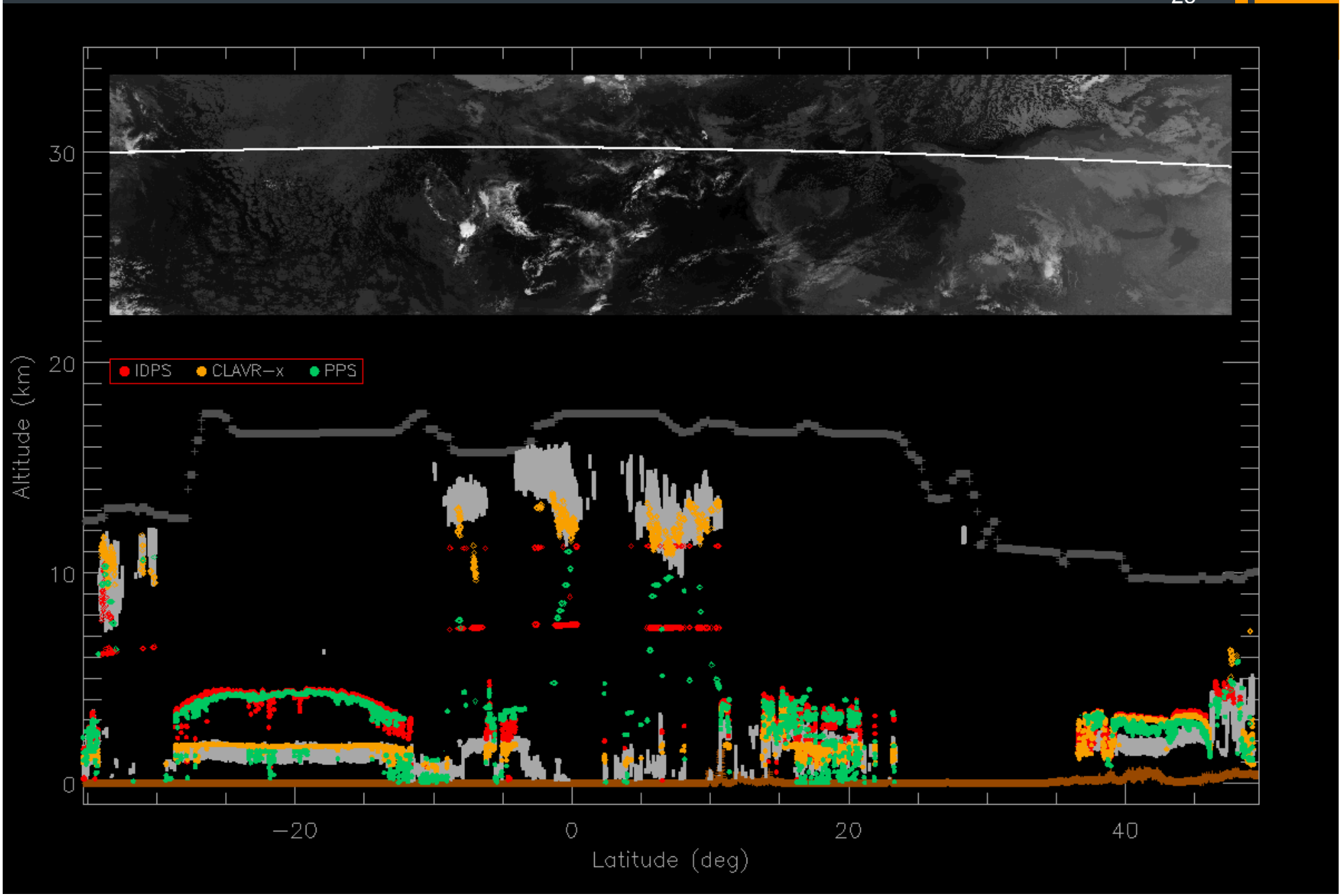


CALIPSO Comparison 03/29 –No Phase Filter

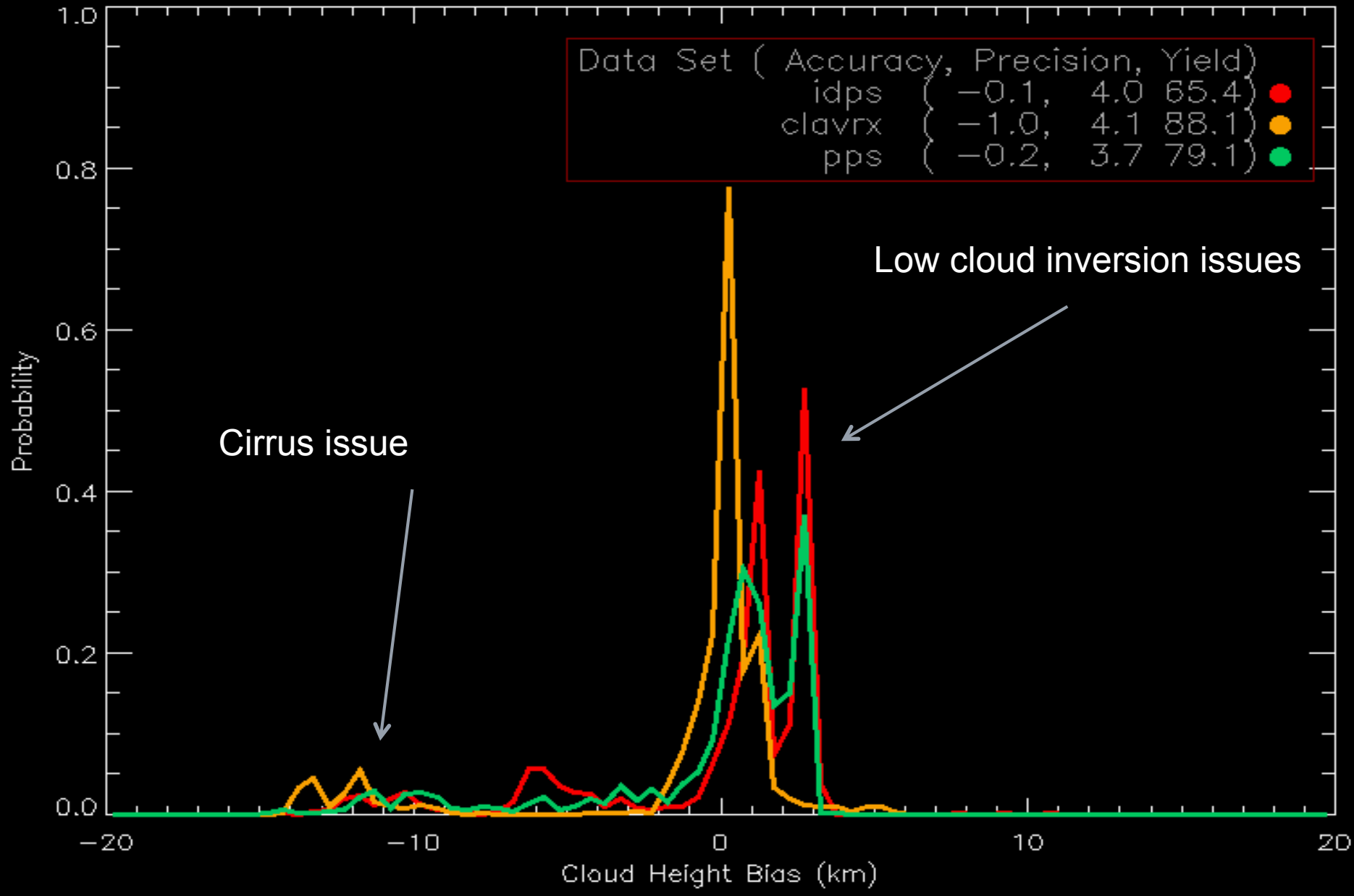
d heights.



CALIPSO Comparison 03/29 - Phase Filter



Bias Distribution 03/29 – No Phase Filter



Conclusions

- Thank you for the data!
- If you have VIIRS retrievals (especially for these scenes), please share.
- Issues that plagued the SEVIRI analysis remain.
  - Differences in Cloud Mask and Cloud Phase
  - Cloud optical depth over snow
  - Cloud particle size performance for thin clouds
  - Cloud height performance in complex vertical structures.