



VIIRS Cloud Team Overview

JPSS Science Team Meeting

August 27, 2015



Algorithm Cal/Val Team Members



PI	Organization	Team Members	Roles and Responsibilities
Andrew Heidinger	STAR & CIMSS	Andi Walther, Yue Li, Denis Botambekov	NOAA Enterprise Cloud Products. IDPS Cloud Product Maintenance
Tom Kopp	Aerospace	Bill Thomas, Rich Frey	VCM Maintenance
Michael Pavolonis	STAR & CIMSS	Corey Calvert	Cloud Phase (Enterprise and VCM)
Steve Miller / Dan Lindsey	STAR & CIRA	Y.J Noh, Curtis Seamen, John Forsythe	Cloud Base and Cloud Cover Layers
Bob Holz	SSEC	Greg Quinn	CALIPSO tools and validation site.

Cloud EDRs are derived from VIIRS (M,I and DN Bands)

Visible Infrared Imaging Radiometer Suite (VIIRS)

- Primarily use M-bands
- I-bands used in cloud mask for spatial filtering
- VIIRS provides excellent spectral information for cloud remote sensing in VIS/SWIR (similar to MODIS).
- Lack of IR channels in CO₂ and H₂O absorption bands can be mitigated with CrIS obs. (RR)
- DNB also being used for cloud properties. (RR)
- Exceeds MODIS in resolving spatial variation in clouds.

Band name	Wavelength (nm)	Bandwidth (nm)	Use in algorithm
M1*	412	20	M
M2*	445	14	none
M3*	488	19	none
M4*	555	21	none
M5*	672	20	M,O
M6	746	15	none
M7*	865	39	M
M8	1,240	27	O
M9	1,378	15	M
M10	1,610	59	M,O
M11	2,250	47	M,O
M12	3,700	191	M,T,O
M13	4,050	163	M
M14	8,550	323	M,T,H
M15	10,763	989	M,T,H
M16	12,016	864	M,T,H

*dual gain, M: Mask, T:Type, O=Optical, H=Height



S-NPP VCM summary



- The VIIRS Cloud Mask (VCM) continues to meet or exceed its documented requirements
- Noticeable improvements occurred with the implementation of a daily (versus monthly) snow/ice field on 1 December 2014
- Over the last year concerns from users have been addressed concerning:
 - Cloud Shadows
 - Ephemeral Water
- The clouds over fires mitigation is on track to be implemented in Build 8.12.
- One more tuning event before the Block 2.0 freeze is planned in 4-6 weeks to address leakage over cold backgrounds and deserts
- More details in a presentation on Thursday



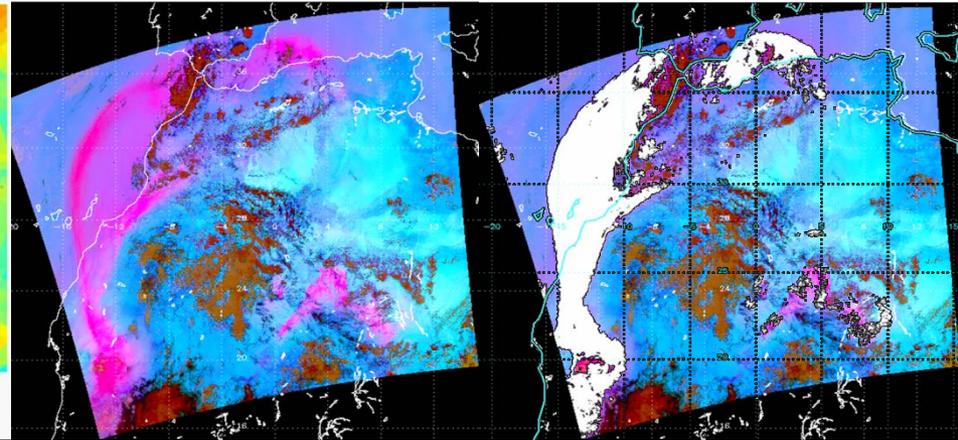
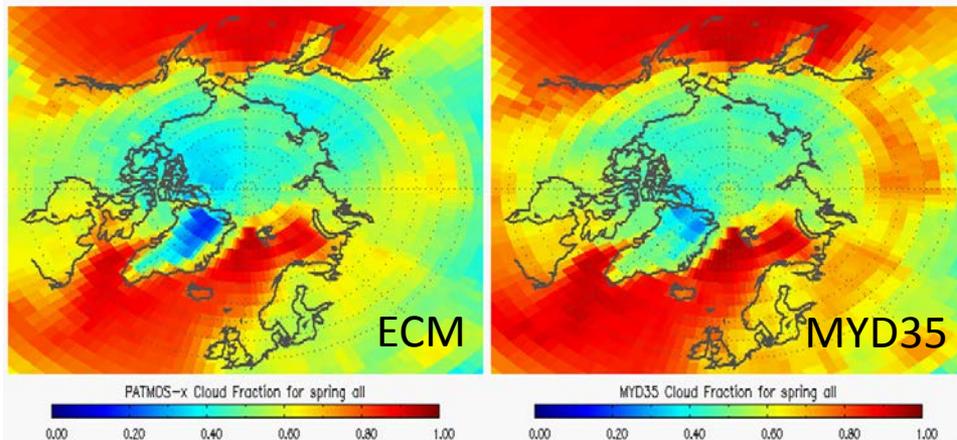
S-NPP NOAA Ent. Cloud Mask



- Delivered to SAPF since April 2015. ARR scheduled in a month.
- **Presentation on the use of the NOAA Enterprise Cloud Mask (ECM) in on Thursday.** ECM provides a 4-level mask like VCM but also provides a floating point (0.0-1.0) cloud probability (CP).
- We want teams to use the CP to optimize ECM for their application.
- As requested ECM includes masks for Dust, Shadow, Fire Smoke and Glint. (see below). Feedback on these masks sought.
- Completed a comparison to C6 MYD35 over 2002-2014 to test robustness of ECM.

Comparison mean Winter Arctic Cloud Fractions from ECM and MYD35 C6. Trends over 2003-2014 agree well.

Example of the ECM Dust Mask applied VIIRS 8/6/2015



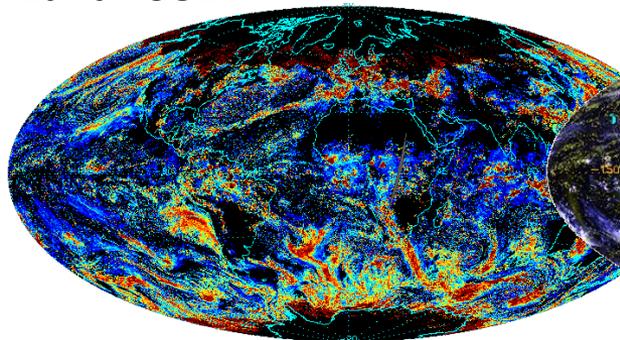


S-NPP NOAA Ent. Cloud Props

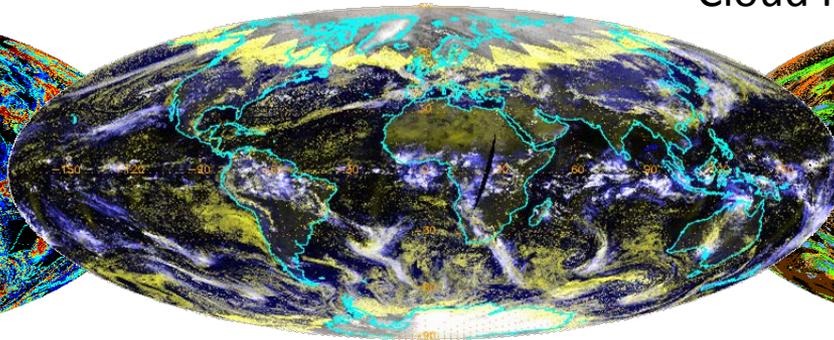


- NOAA Enterprise algorithms transitioned to SAPF in July.
- TRR held and ARR coming in September.
- Same versions of most cloud algorithms in are available to the community via CLAVR-x CSPP v2015.
- Reprocessed entire S-NPP record in limited regions for LTM.
- Operational in early 2016 along with other Enterprise algs.
- SIPS at SSEC is now running them globally.
- Making global and polar composites for ESRL Global Model Val.

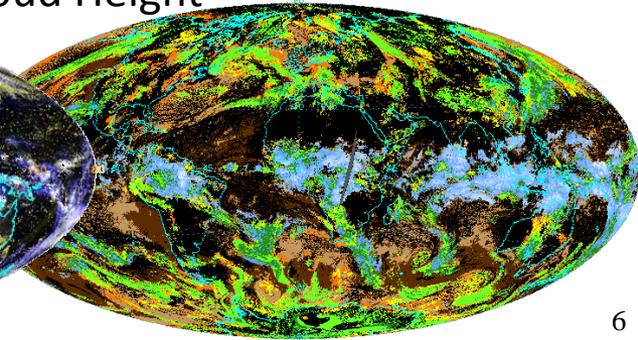
Lunar COD



Lunar False Color

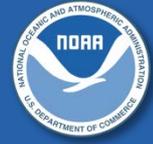


Cloud Height

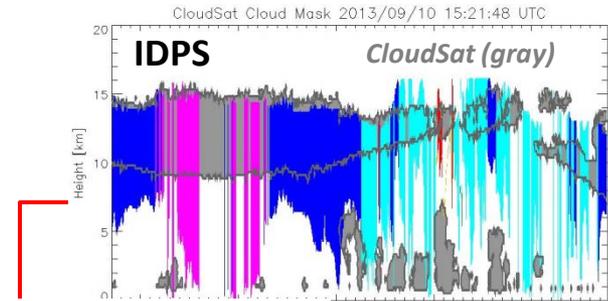




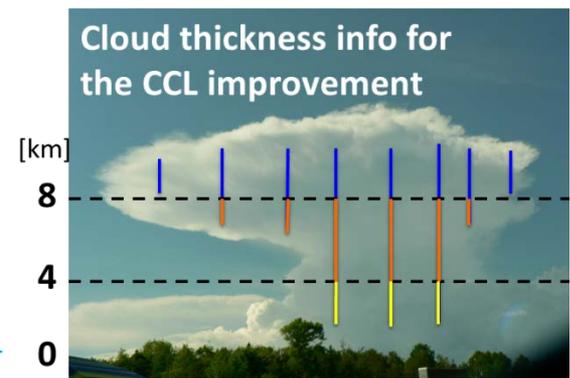
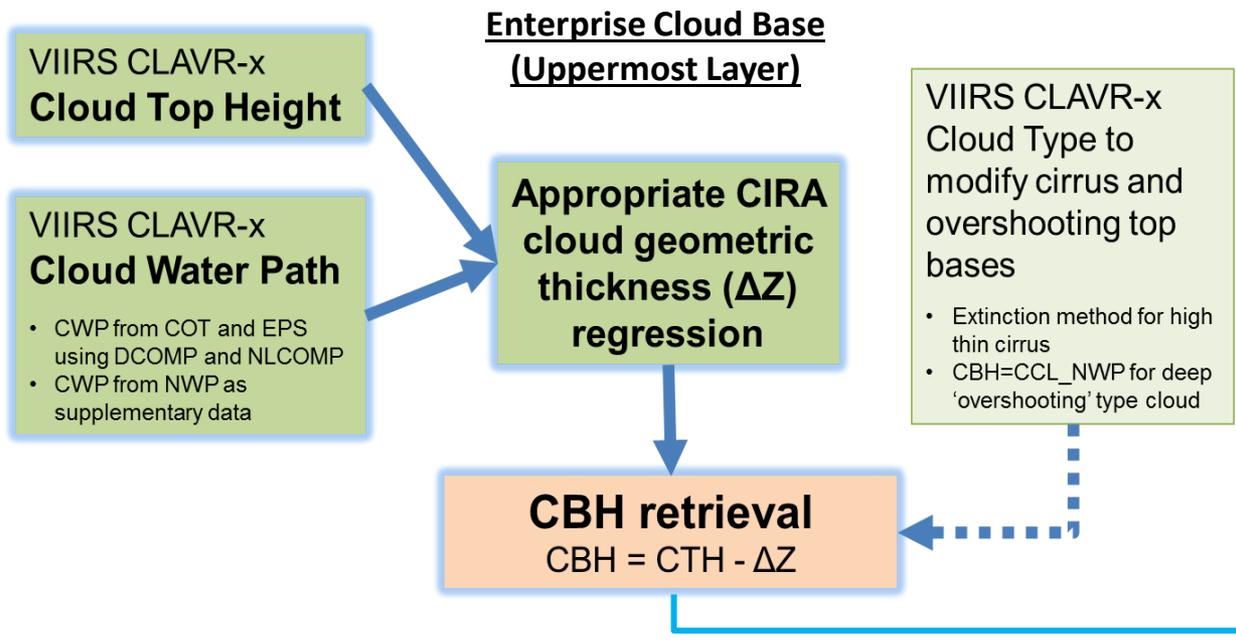
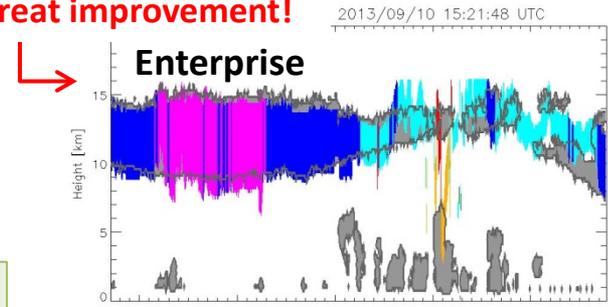
Cloud Base / Cloud Cover Layers Summary



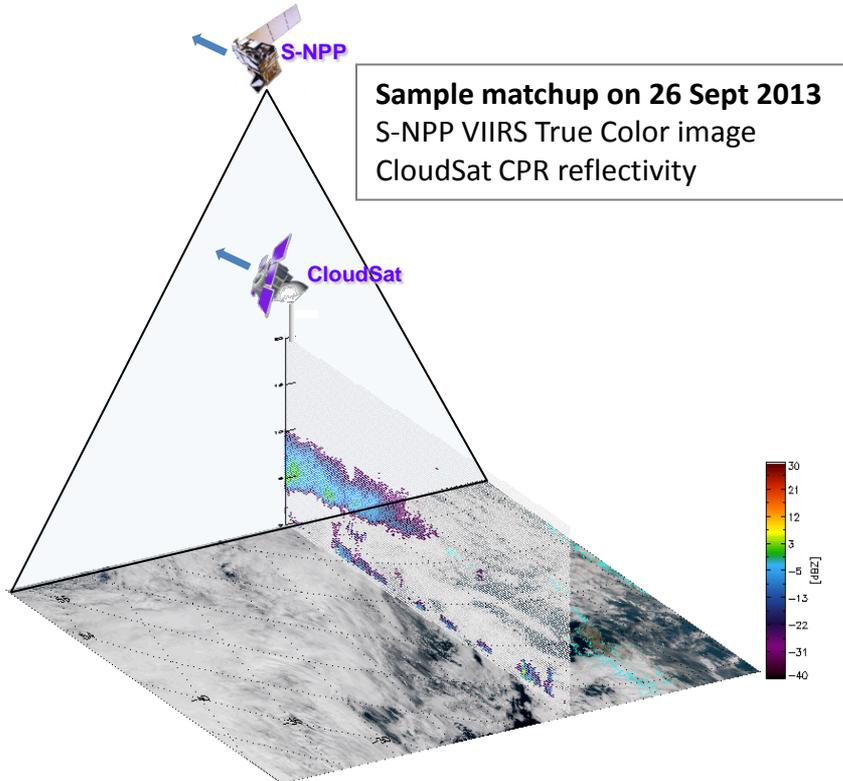
- CIRA developed a new statistical CBH algorithm constrained by CTH and CWP using A-Train satellites (July daytime data CloudSat/CALIPSO and Aqua MODIS data from 2007-2010).
- The enterprise CBH algorithm outperforms the IDPS one. The optimized cloud geometric thickness information can be used to modulate the layered cloud fraction by introducing additional cloud coverage at lower levels of the profile.



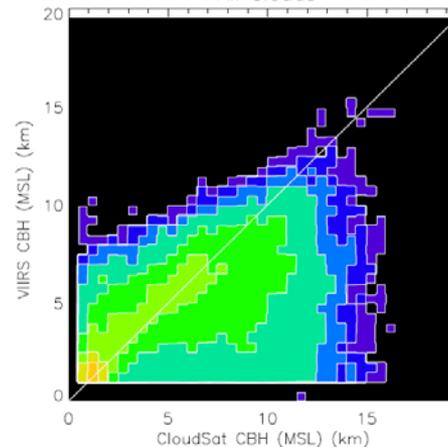
Great improvement!



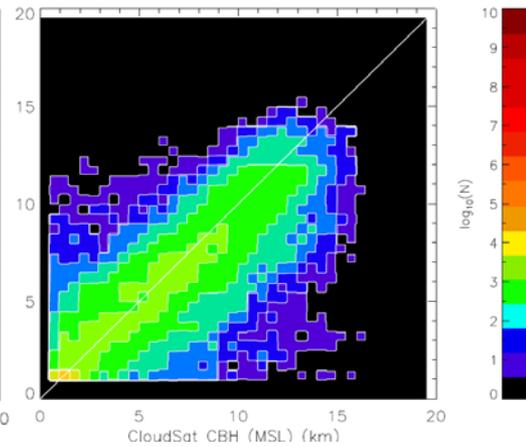
Validation of CBH algorithms using CloudSat IDPS vs. Enterprise CBH



The orig. IDPS with CLAVR-x input



Enterprise CBH



(82599 VIIRS-CloudSat matchup points when CTH is “within spec” for Sept-Oct 2013)

CBH [km]	Avg error	RMSE	Std of error	r ²
IDPS	0.7	2.7	2.6	0.45
Enterprise	0.3	1.8	1.8	0.76

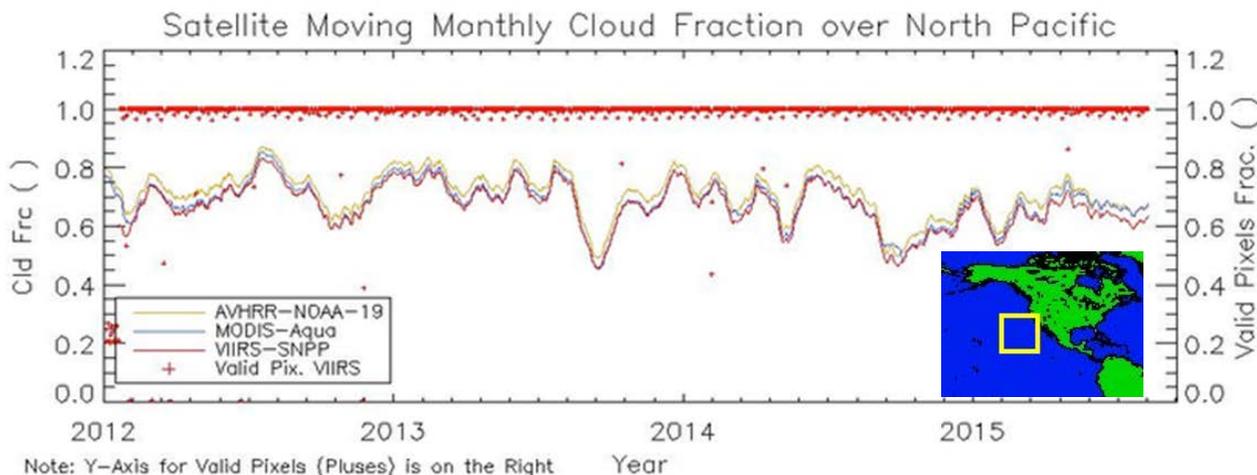
- The enterprise CBH algorithm outperforms the original IDPS algorithm.
- Validation efforts are ongoing for an extended CloudSat matchup period (Jan-May 2015) including nighttime CBH performance test with ARM ceilometer data and comparisons with CALIPSO for thin cirrus.



S-NPP Long-Term Monitoring Site Summary



- LTM site uses the NOAA Enterprise Algs in CLAVR-x.
- **We reprocess AQUA/MODIS, NOAA-19/AVHRR and SNPP/VIIRS from 2012 to present.**
- We choose a 20x20° region in North Pacific near California. It is dominated by stratus with a known annual and diurnal cycle.
- Sample images are available (see image on the right).
- Time-series of monthly means shown (see below).
- Cloud detection skill against CALIOP also shown.

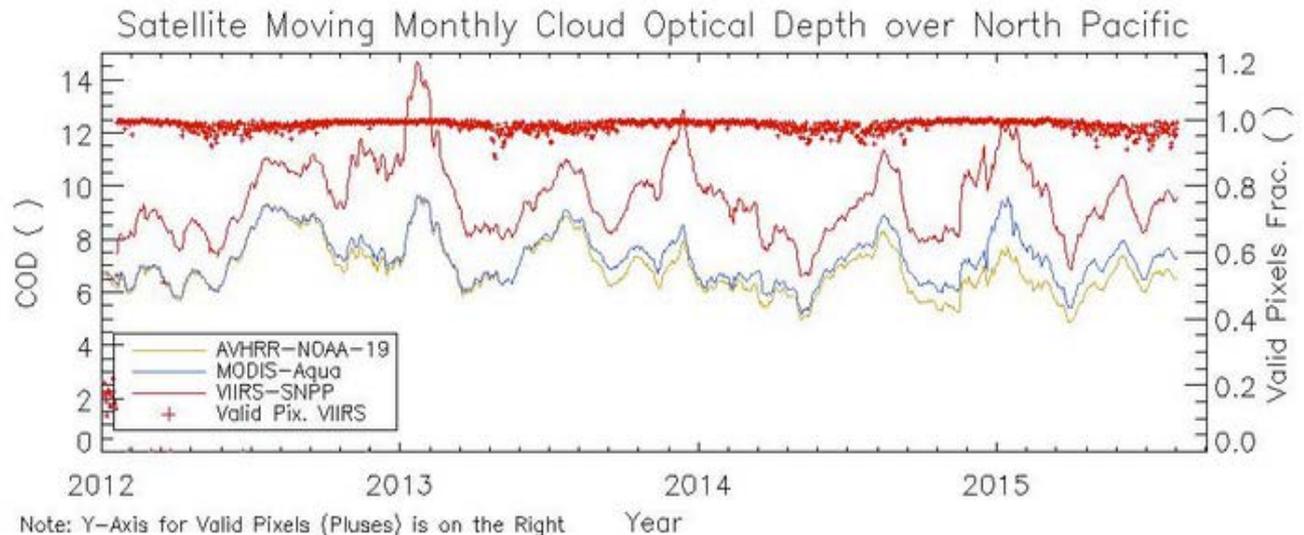
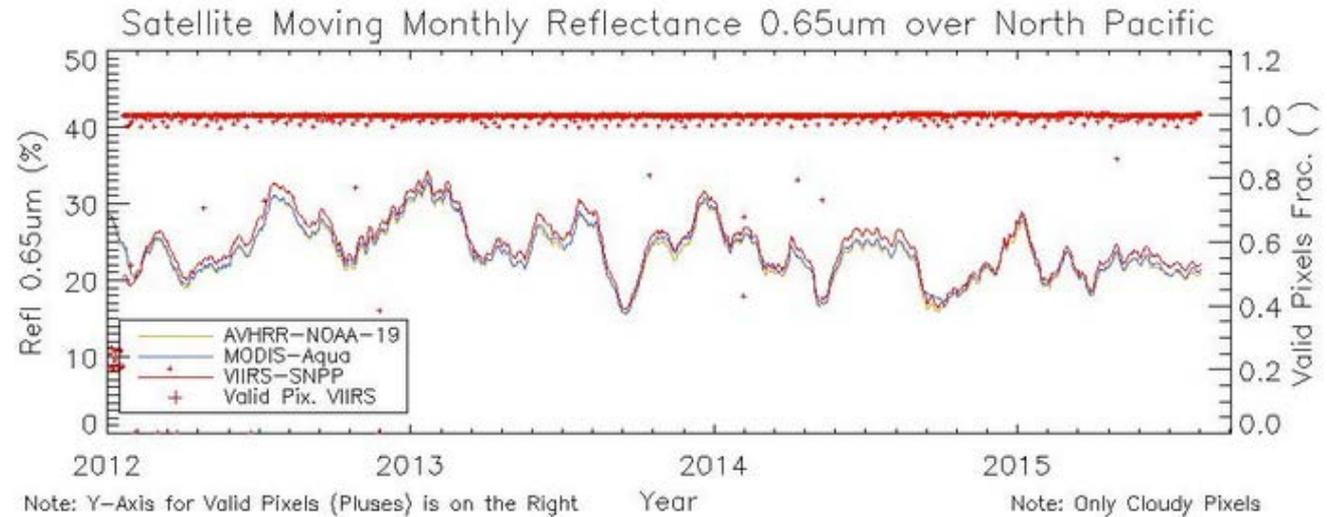




VIIRS/MODIS COD Discrepancy



- The reflectance shows a slight bias in VIIRS.
- The most obvious feature in LTM site is VIIRS bias in COD relative to MODIS and VIIRS.
- The COD bias is more significant ranging 1 to 4 and is persistent through the year.
- This could be a calibration issue or a spatial resolution issue?

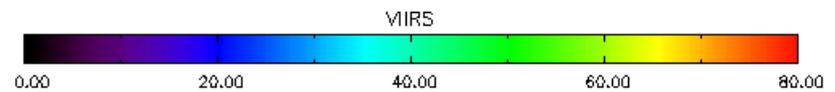
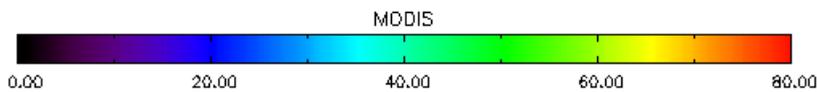
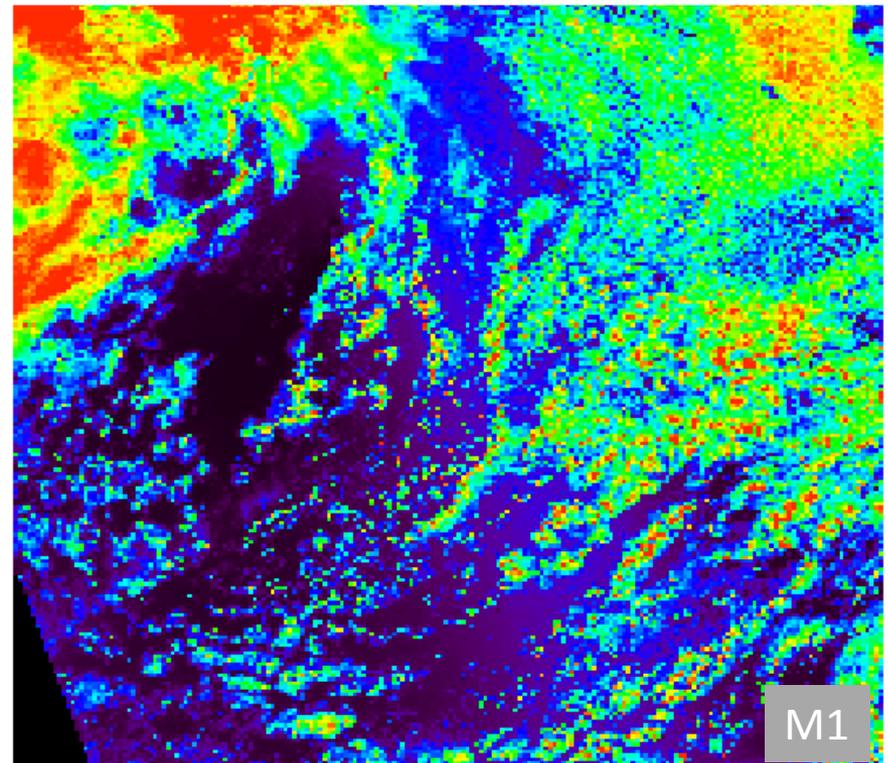
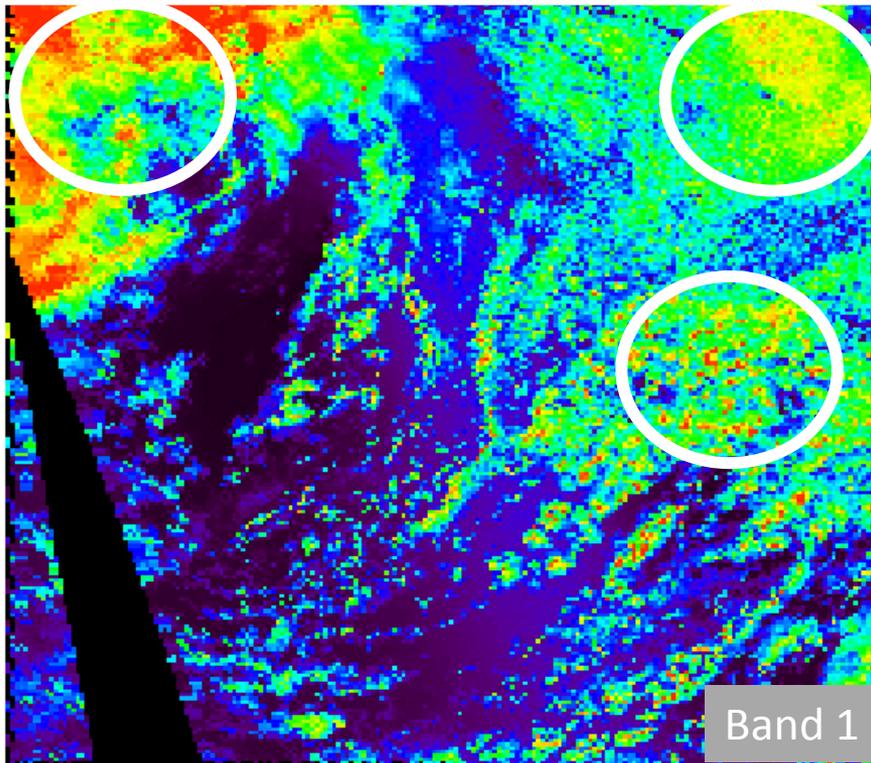




Investigation in VIIRS/MODIS COD Discrepancy



- Inspection of imagery does show that VIIRS has higher numbers of bright pixels
- These are not always in regions where spatial resolution should be an issue.



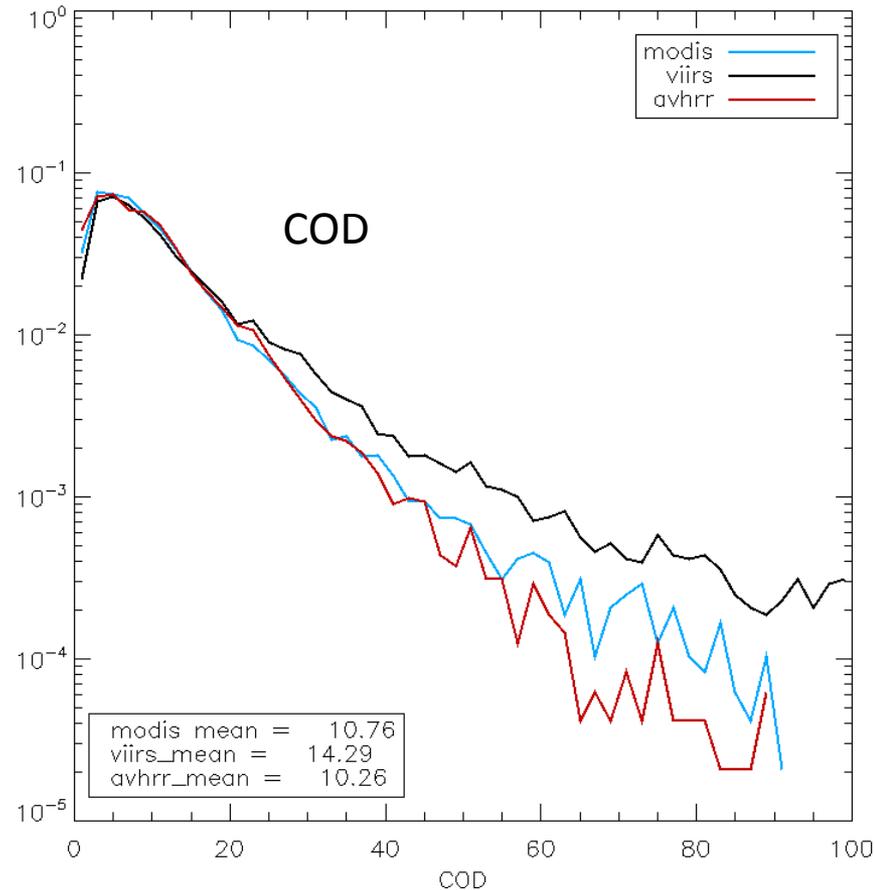
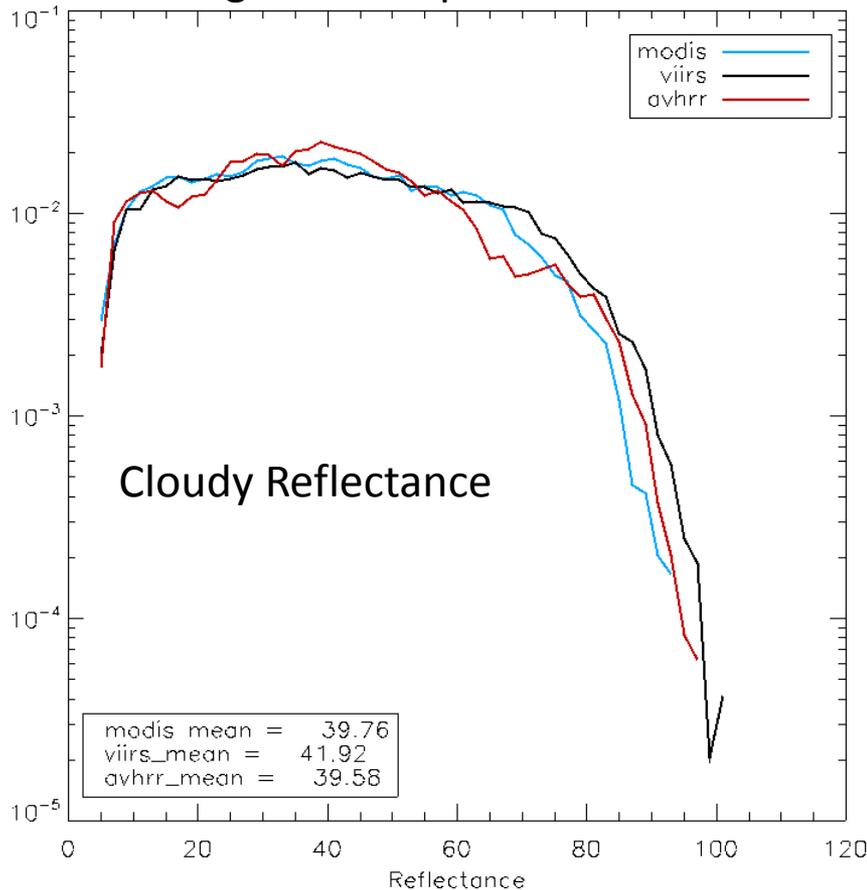
Day 149 of Year 2015; chosen due to similarity in MODIS and VIIRS viewing geometry.



Investigation in VIIRS/MODIS COD Discrepancy



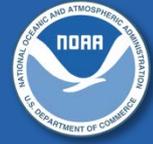
- Analysis of histograms confirms VIIRS always more brighter pixels (Ref > 60%)
- Resulting COD histogram shows typical bias. Note COD alg should handle all angular and spectral differences.



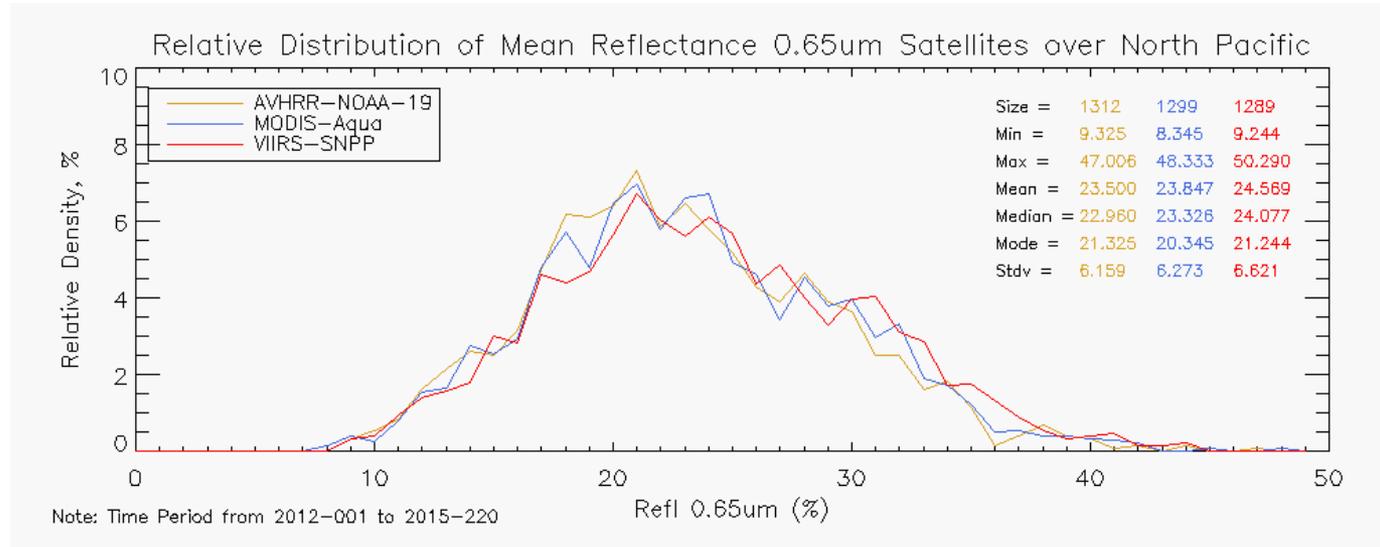
Similar findings by NPP Atmosphere Team. Continue to investigate.



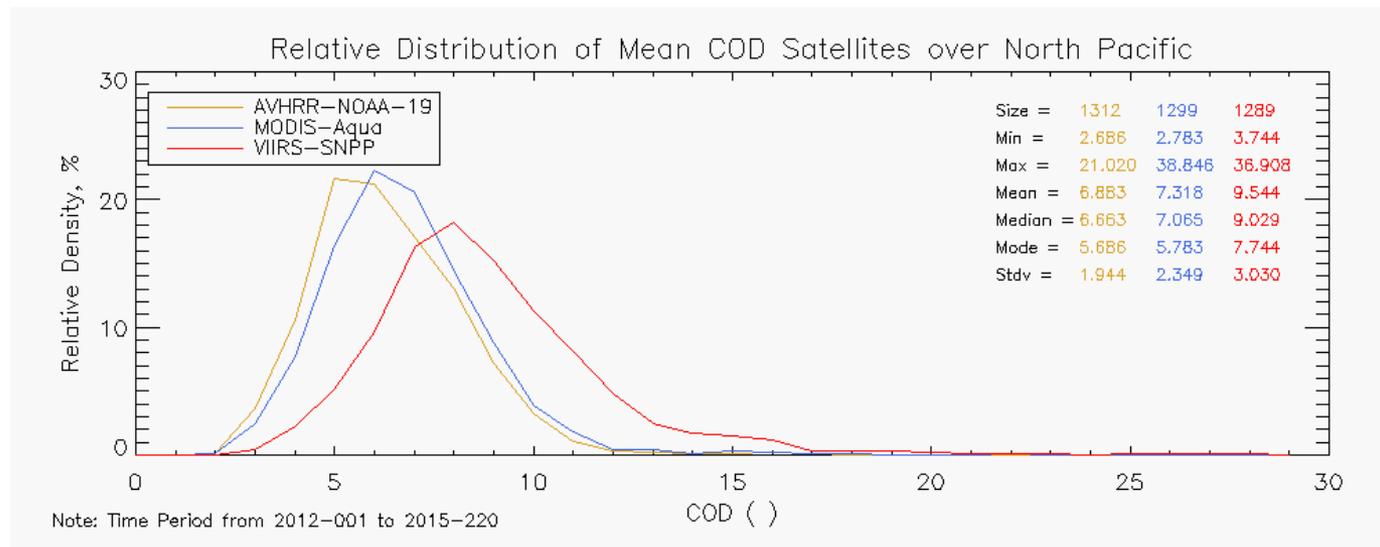
Distributions of Mean Values



- The images show the distribution of the daily mean values of M5 reflectance (top) and COD (bottom).



- Confirms the systematic bias of about 2 in VIIRS COD compared to MODIS and AVHRR.
- Similar findings by NPP Atmosphere Team.





JPSS-1 Readiness



- **J1 Algorithm Summary**
 - We want incorporate two major initiatives support by JPSS-RR
 - Incorporation of Lunar Reflectance in multiple cloud algorithms
 - Merger of Sounder with VIIRS to provide missing absorption channels.
 - Merging LEO and GEO cloud detection and heights.
- **J1 Cal/Val Overview**
 - +3 months (Beta), +6 months (Provisional), +18 months(Validated)
 - We plan to keep using active sensors but plan for new versions (CATS and EarthCare)
 - Cal/Val Plan Drafts delivered July, 2015.
 - Mask plan includes VCM and ECM. 30 day spin-up will be done as for S-NPP.
- **Major Accomplishments and Highlights Moving Towards J1**
 - Complete transition to the SAPF should occur in 2016 of JPSS-1 ready algorithms
 - Through RR and PG, we hope to mature our Lunar and VIIRS/CrIS modifications and transition to SAPF when appropriate.
- **Stake Holder Interactions, Users and Impact Assessment Plans**
 - List of Users/Stake Holders, include:
 - CSPP delivering Enterprise cloud products to DB community.
 - Global verification data being generated for NWP.
 - Cloud ceilings, heights and CCL for NWS AWC
 - Plan on putting VIIRS into the Alaska Cloud Products application (Tony Wimmers) which is supported by the Alaska NWS.



Summary & Path Forward



- Summary
 - We are looking forward to achieving operational status with the larger NOAA Enterprise effort in 2016 on S-NPP.
 - We have two current RR activities (Lunar Ref and VIIRS/CrIS) that leading to significant algorithmic improvements. (See talks in Cloud Breakout)
- Path Forward
 - Passing NOAA Enterprise ARR is critical.
 - Transition of Cloud Base and CCL is planned in 2016.
 - Success of cloud mask depends on interaction from the teams. Applies to VCM and ECM.



Thank you!