

ECM Status and Planning

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Background

- The ECM will replace the VCM for JPSS-1 EDR products
 - The ECM is running operationally today on NDE
 - Became operational, that is available on PDA, 5 July 2017
 - There is no 30-day spin up needed as with the VCM
- The most significant difference between them is that the ECM is not "tuned", but "trained"
 - As such, any Look-up Table (LUT) updates will take longer to determine, test, and implement than tuning the VCM
 - Next ECM LUT update is scheduled to be implemented in Jan 2018
- However, similar to the SNPP, significant interaction is needed between the cloud mask team and dependent users of the ECM

Cloud Mask Cal/Val Plan

- The Cloud Mask Cal/Val plan was completed in July of 2015 as part of STARs overall commitment to finishing J1 Cal/Val plans by the end of 2015
 - It has not been modified since then
- The schedule in 2015 had to leave open the possibility that validation could occur with either the VCM or ECM
 - They have different paradigms even though the methods to validate either one are the same
- The Cloud Mask is not a KPP, however the need to accelerate its validation remains the same as with SNPP
 - Numerous dependent downstream products need the performance of the ECM sufficiently described earlier rather than later
 - Although the expectation is the ECM will perform similarly between SNPP and JPSS-1, this still has to be shown
 - Schedule needs to account for ECM update in January 2018
 - New 2-Dimensional map of prior values for cases of limited cloud detection tests (e.g. nighttime snow)
 - LUT update

ECM Cal/Val Schedule Adjustments

- The current "official" Cloud Mask Cal/Val plan contains the following schedule for the various phases of validation
 - Beta -> 8 months after launch
 - Provisional -> 9 months after launch
 - Validated -> 14 months after launch (one year of analyzed data)
- This schedule is not really tenable
 - 8 months for beta is too long; dependent users need quantitative insight into ECM performance before then
 - One month between beta and provisional not feasible, ECM updates will take longer than one month to test and implement
 - Amount of "truth" data may be more limited with likely loss of CALIPSO, impacts longer term timelines
- We propose the follow schedule be used for the ECM with JPSS-1 output
 - Beta -> 5 months after launch (mid-March assuming an October launch)
 - Provisional -> 9 months after launch
 - Validated -> 15 months after launch
- This schedule reflects the reality of the conditions under which the ECM will be validated
 - The shorter time frame for beta is necessary so dependent users understand better where the ECM is strong and where further work will be necessary
 - Schedule also accounts for LUT update in January
 - The larger amount of time for validated account for both the amount of time needed to retrain the ECM, if needed, and to allow for more data to validate with (account for the likely loss of CALIPSO)

Mitigating Loss of CALIPSO

- The Cloud Mask validation plan for JPSS-1 contains a strong dependence on CALIPSO and Cloud Sat
 - Significant concern CALIPSO will soon no longer be useable
 - CloudSat already is daytime only
- Other methods, tools, and sources will be used to compensate
 - Comparisons with cloud masks derived by other methods and/or from other sensors (e.g. SNPP, MODIS) will be performed regardless of the availability of CALIPSO or CloudSat
 - This includes the VCM if it is still running on the IDPS
 - Ground sources such as ARM sites are viable
 - The amount of "truth" from these sources will be small and leave large spatial gaps
- Aerospace is developing a cloud mask manual analysis tool to supplement the available resources
 - The new tool allows for manual "truth" to be derived from any VIIRS granule, allowing for quantitative validation over any desired scene
 - It will also allow for quantitative evaluation for any ECM update
 - Target date to complete the tool is October/November 2017, before validation of the ECM would begin
 - Snapshots of the tool, which is still in development, are on the next two slides
 - The tool will also mimic the prior VCM visualization tool in that it will also allow a user to visualize individual cloud test output
 - Visualizing ECM output will be independent of the manual analysis tool such that the manual analysis can be performed without the analyst being aware of the ECM results

Sample of Manual Analysis Tool

Select Cloud Mask Region of Interest GUI



Operational ECM

patmosx_npp_asc_2017_171.level2b



False Color Image Red=0.65 $\mu m,$ Green = 0.86 $\mu m,$ Blue = 11 μm (reversed)



- ECM is running operationally on NDE since July 2017.
- ECM provides the following information:
 - ➤ 4-level Cloud Mask
 - Binary Cloud Mask
 - Cloud Mask Packed Bits
 - Cloud Probability
 - Smoke Mask
 - ➤ Fire Mask
 - Dust Mask
- Global images like these are available from the STAR JPSS EDR Monitoring Site. Imaging code will be transferred to STAR.

Clear-sky Composites of True Color VIIRS Imagery in the Northwest Passage

- Clear sky composites generated from NOAA Enterprise cloud mask.
- Composite updated every day. Data older than 2 weeks is removed.
- Dark-sky composite provides a nice validation of the clear-sky composite.
- Provides quantitative information to traditional RGB users.





CLAVR-x NOAA Enterprise

AVR—x NOAA Enterprise Dark Composite RGB for 07 29 2017

Operational ECM Evaluation



VIIRS-CALIOP collocation pixels ± 12 minutes, COD = 0.0 or COD > 0.5 2017-04-22, 2017-05-11 and 2017-06-20

- To evaluate ECM performance 3 days with good CALIOP - VIIRS collocation were chosen.
- Statistics show that ECM over Ocean Day and Land Night do not quite meet spec, others do.
- A reason of lower performance are 2 bugs in the Static MODIS Albedo and impacts to the RTM (see next slide)

Sample Size	Cloud fraction				Required	Probability of						
	CALIOP	VIIRS	Pr. Clear	Pr. Cloudy	Detection	Detection	False Detect.	Missed Cloud				
Global, Ocean/Land, Day/Night, No Snow/Snow/Ice												
857300	0.680	0.635	0.082	0.098	-	0.878	0.039	0.083				
Ocean, Day, Global, No Snow/Snow/Ice												
170485	0.683	0.664	0.017	0.018	0.940	0.914	0.033	0.052				
Ocean, Night, Global, No Snow/Snow/Ice												
226368	0.685	0.611	0.052	0.091	0.850	0.883	0.021	0.095				
Land, Day, Global, No Snow/Snow/Ice												
81174	0.539	0.495	0.021	0.018	0.900	0.908	0.024	0.068				
Land, Night, Global, No Snow/Snow/Ice												
48581	0.523	0.406	0.048	0.033	0.880	0.878	0.003	0.120				

ECM Updates: RTM and Albedo Fix

NDE Operational Before the Fix AIT Delivery Early 2017 After the Fix



- NDE code didn't have an atmospheric correction for all pixels, because there was no RTM calculation.
- Also, Static Albedo file didn't have any value for water pixels. Hence,
 0.65 µm Reflectance test was off over water.
- Both bugs are fixed and updated code delivered to NDE early 2017.

ECM Updates: Glint Logic Update

NDE Operational

Water

AIT Delivery Early 2017



Land

Flag Set

Unknown

- Glint flag turns off several ECM tests. To improve performance over glint regions the logic of the Glint algorithm was revised. Hence, number of Glint pixels is reduced.
- The new algorithm logic was delivered to AIT at the beginning of 2017.

ECM Updates: Thin Cirrus Flag



RGB





Position of the Thin Cirrus Test Bit in the ECM Packed Bits

M9 & Thin Cirrus

- ECM users expressed an interest in Thin Cirrus information, similar to provided by the IDPS VIIRS Cloud Mask (VCM).
- ECM team developed the Thin Cirrus algorithm, which gives similar results as VCM.
- The result is saved at the ECM Packed Bits.
- Delivered to AIT in 2016.

ECM Updates: Dynamic Cloud Prior



- In Bayesian ECM calculation a Prior Probability Distribution (simply Prior) indicates probability of cloud before any calculation.
- To increase ECM performance a Dynamic Cloud Prior is calculated based on VIIRS - CALIOP collocation data separately for 10x10 degree boxes, and each month of a year.
- Delivered to AIT in 2016.

ECM Updates: 2D Classifiers

- Several combinations of 2D classifiers should increase performance of cloud detection over currently used 1D classifiers:
 - > 11 μ m Tropopause Emissivity vs 11 μ m BT Standard Deviation,
 - > Day 11 μ m Tropopause Emissivity vs 1.6 μ m Reflectance,
 - > Day 11 μ m Tropopause Emissivity vs 3.75 μ m Reflectance,
 - > Night 11 μ m Tropopause Emissivity vs 3.75 μ m BT.
- Planning to deliver to AIT in Fall 2017



2D Classifier: 11 micron Tropopause Emissivity and 1.6 micron Reflectance

ECM Updates: NEW LUT

Algorithm	Sample Size		Cloud f	raction		Required	Probability of					
		CALIOP	VIIRS	Pr. Clear	Pr. Cloudy	Detection	Detection	False Detect.	Missed Cloud			
	Global, Ocean/Land, Day/Night, No Snow/Snow/Ice											
ECM NDE	620281	0.667	0.604	0.087	0.045	-	0.880	0.029	0.091			
FW OLD LUT	620281	0.668	0.621	0.090	0.046	-	0.873	0.055	0.072			
FW NEW LUT	620281	0.668	0.638	0.140	0.074	-	0.895	0.042	0.063			
	Ocean, Day, Global, No Snow/Snow/Ice											
ECM NDE	132151	0.659	0.649	0.013	0.007	0.940	0.930	0.030	0.040			
FW OLD LUT	132151	0.657	0.644	0.020	0.009	0.940	0.943	0.022	0.035			
FW NEW LUT	132151	0.657	0.629	0.033	0.017	0.940	0.953	0.025	0.022			
	Ocean, Night, Global, No Snow/Snow/Ice											
ECM NDE	165140	0.705	0.686	0.048	0.029	0.850	0.917	0.032	0.051			
FW OLD LUT	165140	0.706	0.673	0.082	0.058	0.850	0.925	0.031	0.044			
FW NEW LUT	165140	0.706	0.695	0.201	0.073	0.850	0.936	0.027	0.037			
	Land, Day, Global, No Snow/Snow/Ice											
ECM NDE	88247	0.512	0.426	0.019	0.011	0.900	0.895	0.014	0.091			
FW OLD LUT	88247	0.512	0.474	0.052	0.022	0.900	0.900	0.041	0.059			
FW NEW LUT	88247	0.512	0.438	0.059	0.025	0.900	0.913	0.026	0.061			
	Land, Night, Global, No Snow/Snow/Ice											
ECM NDE	37577	0.693	0.604	0.081	0.031	0.880	0.902	0.004	0.093			
FW OLD LUT	37577	0.694	0.575	0.097	0.040	0.880	0.896	0.017	0.097			
FW NEW LUT	37577	0.694	0.609	0.314	0.090	0.880	0.908	0.028	0.063			

ECM NDE - Operational ECM NDE FW OLD LUT - Framework ECM with current operational LUT FW NEW LUT - Framework ECM with the new LUT

* The reason of ECM NDE not meeting specs (red numbers) was discussed previously (Slide 9).

- The current ECM LUT is based on the MODIS - CALIOP collocation data. The new LUT is calculated on the 1 year (2015) of VIIRS - CALIOP data.
- The new LUT gives around 1-2% improvement of ECM performance.
- This stats are calculated based on VIIRS - CALIOP data from 2015-08-15 and 2015-08-31.
- NEW LUT is delivered to AIT in August 2017, in ops in early 2018.

Conclusions

- The Cloud Mask plan was written in the summer of 2015 and assumes conditions no longer applicable to JPSS-1.
- The ECM Cal/Val plan will be adjusted accordingly.
 - The Cloud Mask team proposes to accelerate beta to support downstream dependent users in their validation efforts.
- In order to help address the loss of "truth", and to allow for quantitative analyses for entire granules, Aerospace is building a new tool that allows a "truth" to be developed via an experts' analysis.
 - •Key error for ocean day performance corrected.
 - •Thin cirrus added specifically to address user concerns.
 - •An important LUT update is delivered to AIT in August 2017, implementation expected in early 2018.