Enterprise Cloud Mask (ECM)

STAR / NESDIS / NOAA

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ECM Format Basics

- The primary output of the ECM is the cloud probability for each VIIRS M-band pixels (CloudProbability in the netCDF file)
- A 4-tier cloud mask with the same categories as with the VCM may be found as well (CloudMask)
- The binary cloud mask, generally not used but required as an output, is found in CloudMaskBinary
- We encourage users to employ cloud probability, as in that form the users may set whatever value they close to determine clear or cloudy conditions
- The breakdown of the individual elements is found in CloudMaskPacked
  - It is not in CloudMaskFlags, there is no use of this for VIIRS based output

Individual ECM Outputs

- The description of the individual bits in the 8 byte CloudMaskPacked output is found in Table 4 of the ECM ATBD
  - For those who have the current version, be aware the Surface Type values given are off by one (Deep Water is 001, Shallow Water 010, etc.)
- Note the original ECM was developed for GOES-R, and hence there are embedded tests that are not applicable to VIIRS
  - BTM11
  - RTCT
  - BTD11_6.7 thermal contrast
  - BTD11_6.7 thermal covariance
  - EMISS4
  - Ref0.63STD
- Each of the other tests are used as described in the ATBD

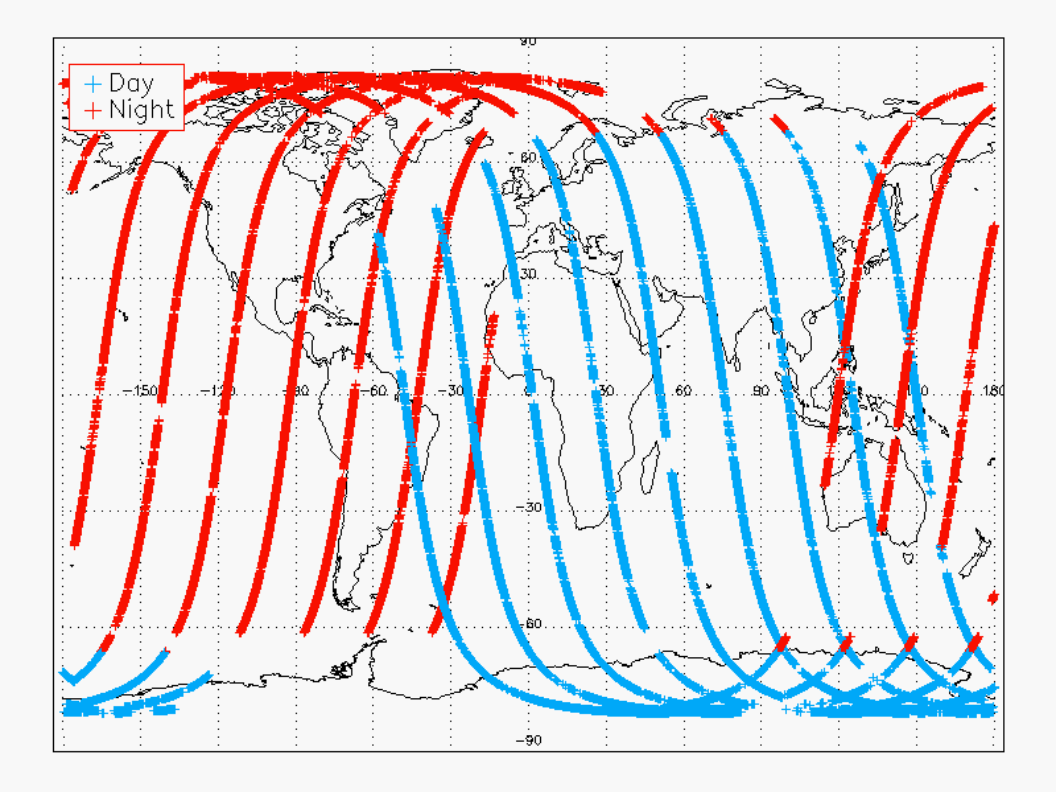
Individual ECM Outputs

- The individual cloud detection tests, contained in bytes 3 through 7, may be 00 (clear), 01 (probably clear), 10 (probably cloudy), or 11 (cloudy)
- The 6 unused cloud detection tests will always contain values of 00
- The remaining tests will contain a climatological value for conditions where they are not executed (e.g. reflective tests at night)
  - Be aware this default value is often one of the probable conditions, and it can vary with surface type
  - The internal logic of the ECM knows when a value is from climatology and when it has been determined by internal logic
  - The thin cirrus bit is a special case and will be described in an update to the ECM ATBD

Notes:

- In this part of analysis VIIRS – CALIOP 1 and 5 km collocation data from January 03, 2015 is used to evaluate the following Cloud Masks performance :
  - CLAVR-x Current Trunk,
  - CLAVR-x Trunk with DNB Off,
  - CLAVR-x AIT Delivery Version,
  - Framework ECM,
  - IDPS VCM.
- Only data with ±0.2 hour (±12 minute) collocation window between VIIRS and CALIOP is used.
- All Cloud Masks are treated as binary.
- Only clear pixels or COD > 1.0 filter is applied.
- Other applied filters are mentioned above each table.

Pixels Used for Evaluation



CALIOP - VIIRS Matchup Pixels Within Maximum
± 0.2 Hour (± 12 Minutes) Time Difference
CALIOP: Clear or COD > 1.0
01/03/2015

VIIRS-CALIOP Stats 1

90N – 90S, Ocean/Land, Day/Night, No Snow/Snow/Ice

Algorithm	Sample Size	Cloud fraction				Probability of		
		CALIOP	VIIRS	Pr. Clear	Pr. Cloudy	Detection	False D.	Miss Cld.
CLAVR-x Trunk	274466	0.673	0.650	0.073	0.070	0.894	0.041	0.064
CLAVR-x No DNB	274466	0.673	0.641	0.083	0.076	0.892	0.038	0.071
CLAVR-x AIT Delivery	274466	0.673	0.634	0.069	0.091	0.896	0.032	0.072
Framework ECM	274060	0.673	0.623	0.076	0.084	0.861	0.044	0.095
VCM IDPS	272416	0.675	0.631	0.070	0.028	0.870	0.043	0.087

60N – 60S, Ocean/Land, Day/Night, No Snow/No Ice

Algorithm	Sample Size	Cloud fraction				Probability of		
		CALIOP	VIIRS	Pr. Clear	Pr. Cloudy	Detection	False D.	Miss Cld.
CLAVR-x Trunk	174618	0.673	0.675	0.028	0.015	0.942	0.030	0.028
CLAVR-x No DNB	174618	0.673	0.658	0.046	0.021	0.938	0.024	0.038
CLAVR-x AIT Delivery	174618	0.673	0.636	0.027	0.046	0.931	0.016	0.053
Framework ECM	174336	0.672	0.629	0.030	0.046	0.887	0.035	0.078
VCM IDPS	172599	0.675	0.654	0.064	0.022	0.938	0.021	0.041

These statistical evaluations are presented to show algorithms' performance over globe and multiple different surface conditions.

VIIRS-CALIOP Stats 2

60N – 60S, Ocean, Day, No Snow/No Ice

Algorithm	Sample Size	Cloud fraction				Probability of		
		CALIOP	VIIRS	Pr. Clear	Pr. Cloudy	Detection	False D.	Miss Cld.
JPSS L1RDS-2457						0.940	0.050	0.010
CLAVR-x Trunk	57693	0.677	0.680	0.013	0.006	0.945	0.029	0.026
CLAVR-x No DNB	57693	0.677	0.680	0.013	0.006	0.945	0.029	0.026
CLAVR-x AIT Delivery	57693	0.677	0.672	0.008	0.008	0.949	0.023	0.028
Framework ECM	57439	0.675	0.669	0.010	0.012	0.905	0.045	0.051
VCM IDPS	56853	0.682	0.680	0.070	0.016	0.944	0.027	0.030

60N – 60S, Ocean, Night, No Snow/No Ice

Algorithm	Sample Size	Cloud fraction				Probability of		
		CALIOP	VIIRS	Pr. Clear	Pr. Cloudy	Detection	False D.	Miss Cld.
JPSS L1RDS-2457						0.850	0.080	0.050
CLAVR-x Trunk	75884	0.739	0.759	0.043	0.022	0.936	0.042	0.022
CLAVR-x No DNB	75884	0.739	0.728	0.067	0.033	0.935	0.027	0.038
CLAVR-x AIT Delivery	75884	0.739	0.684	0.044	0.085	0.916	0.015	0.070
Framework ECM	75868	0.739	0.677	0.043	0.083	0.875	0.032	0.093
VCM IDPS	75010	0.739	0.716	0.074	0.032	0.934	0.022	0.044

Comparison of cloud mask algorithms to JPSS L1RDS requirements (green) over Ocean. Statistics which are not matching requirements in red.

VIIRS-CALIOP Stats 3

60N – 60S, Land, Day, No Snow/No Ice

Algorithm	Sample Size	Cloud fraction				Probability of		
		CALIOP	VIIRS	Pr. Clear	Pr. Cloudy	Detection	False D.	Miss Cld.
JPSS L1RDS-2457						0.900	0.070	0.030
CLAVR-x Trunk	19970	0.377	0.338	0.019	0.009	0.940	0.011	0.050
CLAVR-x No DNB	19970	0.377	0.338	0.019	0.009	0.940	0.011	0.050
CLAVR-x AIT Delivery	19970	0.377	0.351	0.013	0.009	0.950	0.012	0.038
Framework ECM	19958	0.378	0.361	0.030	0.017	0.902	0.041	0.057
VCM IDPS	19804	0.379	0.351	0.033	0.006	0.946	0.013	0.041

60N – 60S, Land, Night, No Snow/No Ice

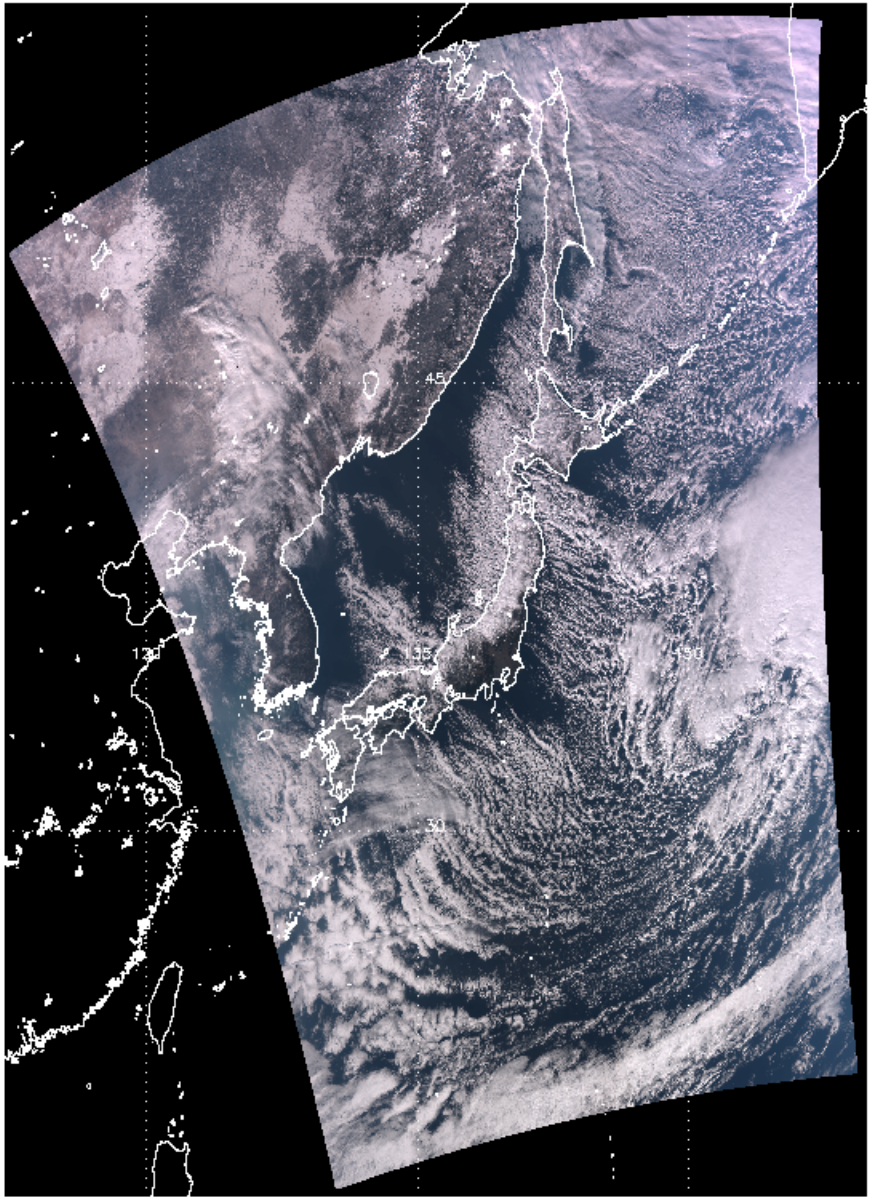
Algorithm	Sample Size	Cloud fraction				Probability of		
		CALIOP	VIIRS	Pr. Clear	Pr. Cloudy	Detection	False D.	Miss Cld.
JPSS L1RDS-2457						0.880	0.080	0.050
CLAVR-x Trunk	11099	0.782	0.734	0.028	0.025	0.947	0.003	0.051
CLAVR-x No DNB	11099	0.782	0.685	0.114	0.048	0.901	0.001	0.098
CLAVR-x AIT Delivery	11099	0.782	0.672	0.048	0.052	0.882	0.004	0.114
Framework ECM	11099	0.782	0.600	0.050	0.038	0.812	0.003	0.185
VCM IDPS	11061	0.782	0.688	0.032	0.008	0.904	0.001	0.095

Comparison of cloud mask algorithms to JPSS L1RDS requirements (green) over Land. Statistics which are not matching requirements in red.

Comparison Example

- This part of analysis is concentrated on 7 daytime granules of VIIRS from 2015-01-03 from 03:40:22 to 03:50:19 UTC over Japan region.
- There are 2 masks:
  - CLAVR-x2AIT is the CLAVR-x Version Delivered to AIT;
  - ECM_AIT is the AIT Framework Output.

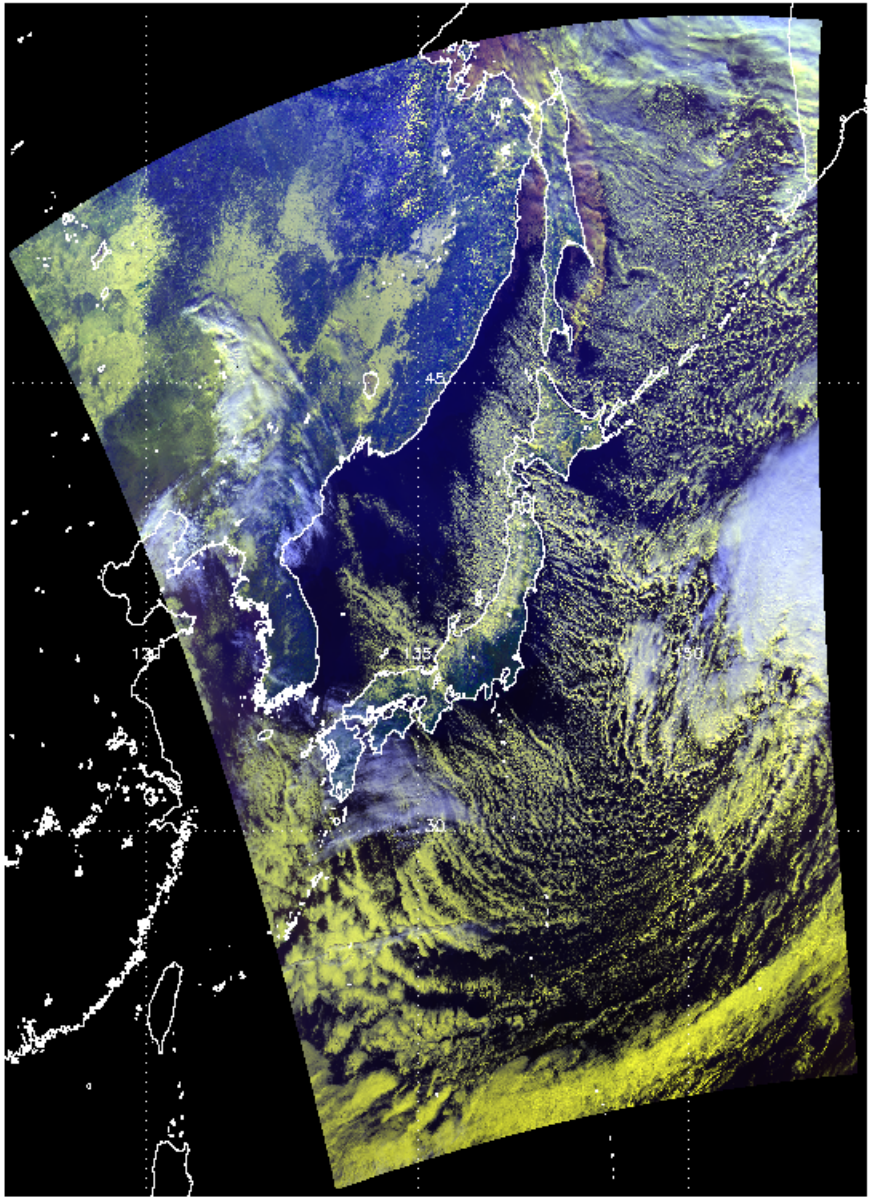
clavrx_npp_d20150103_t0348553_e0350195_b16497



True Color Image

Red=0.65μm, Green = 0.55μm, Blue = 0.48μm

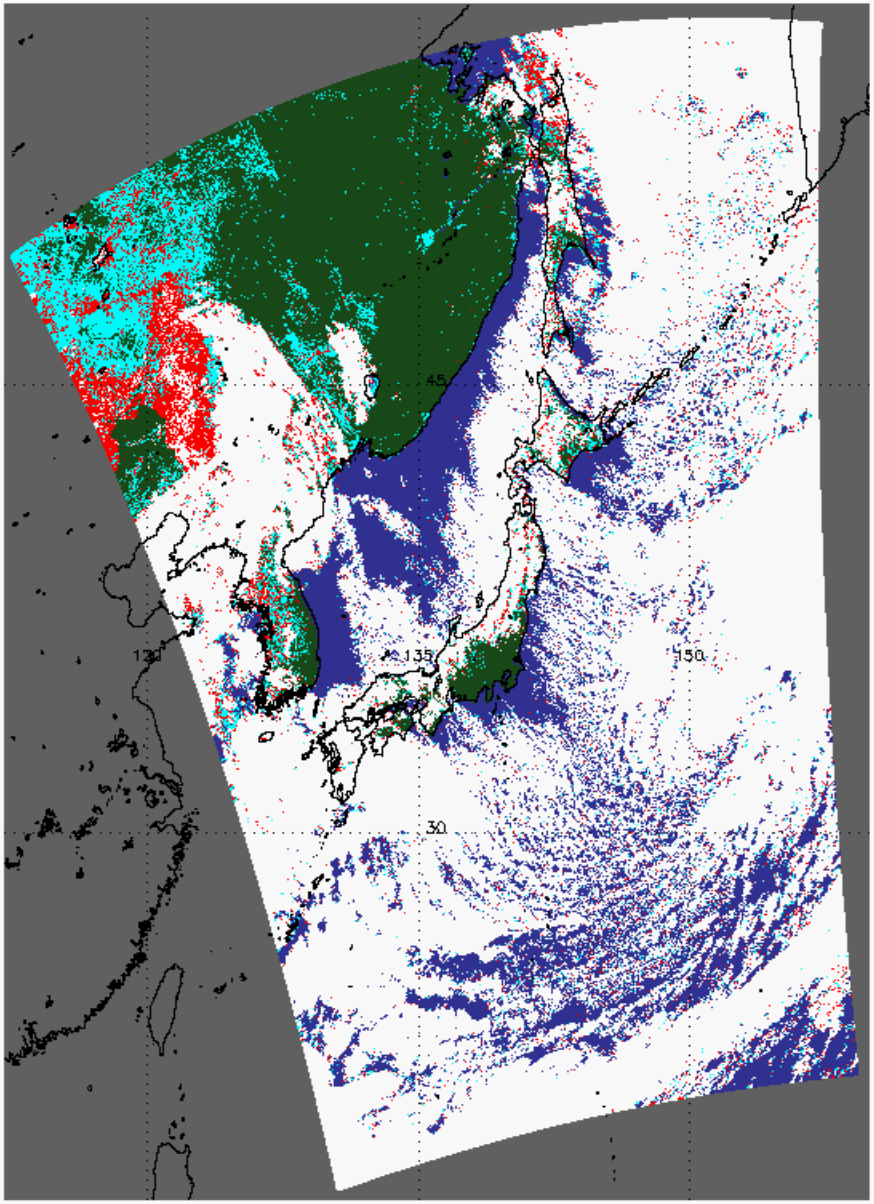
clavrx_npp_d20150103_t0348553_e0350195_b16497



False Color Image

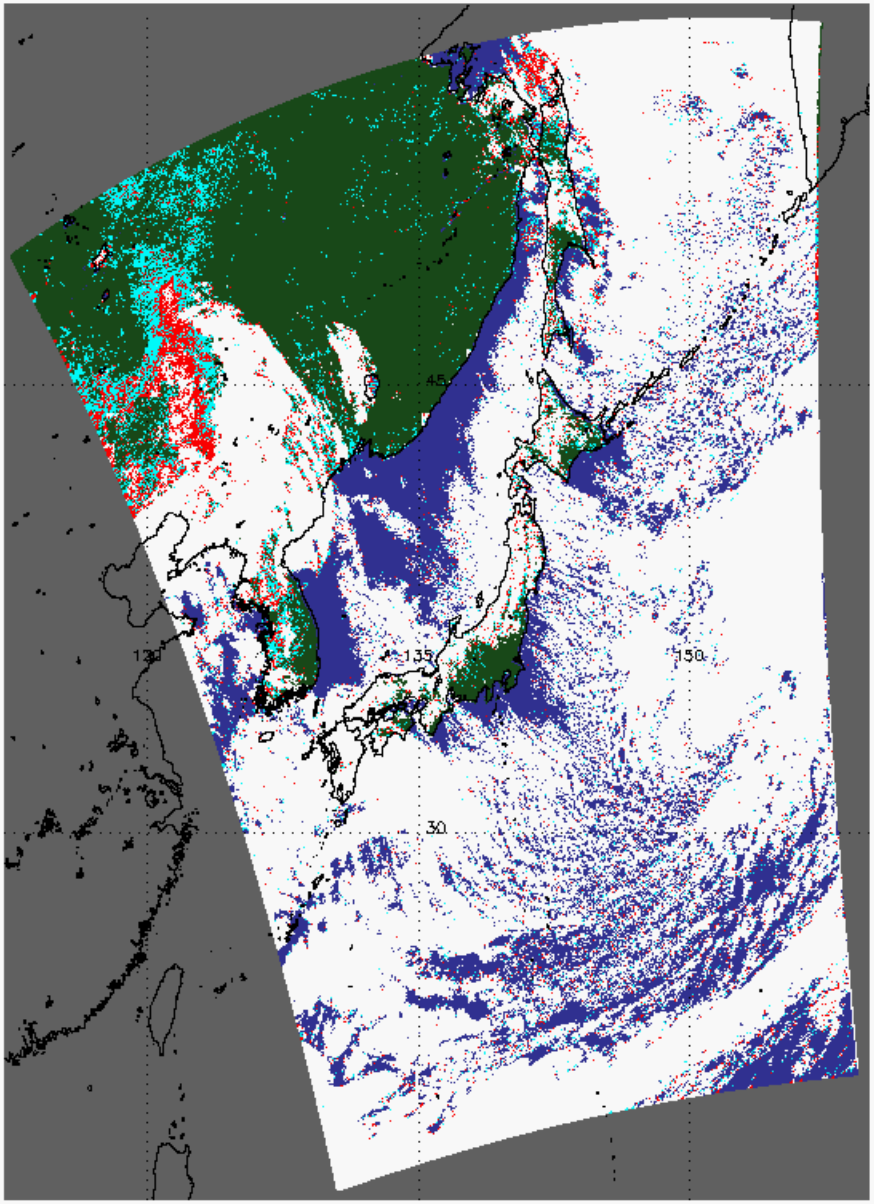
Red=0.65μm, Green = 0.86μm, Blue = 11μm (reversed)

CLAVR-x2AIT Jan 03, 2015, 0340 UTC, VIIRS

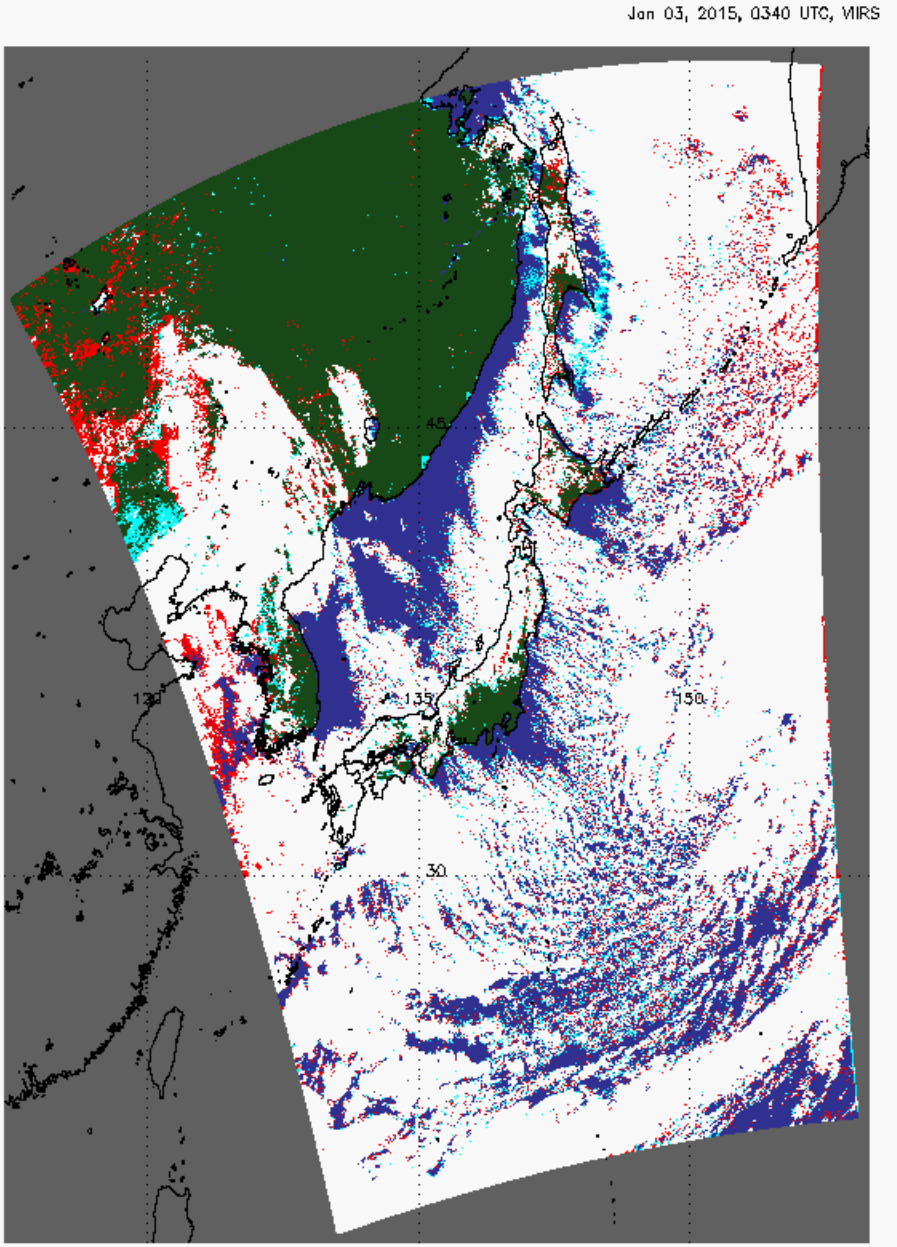


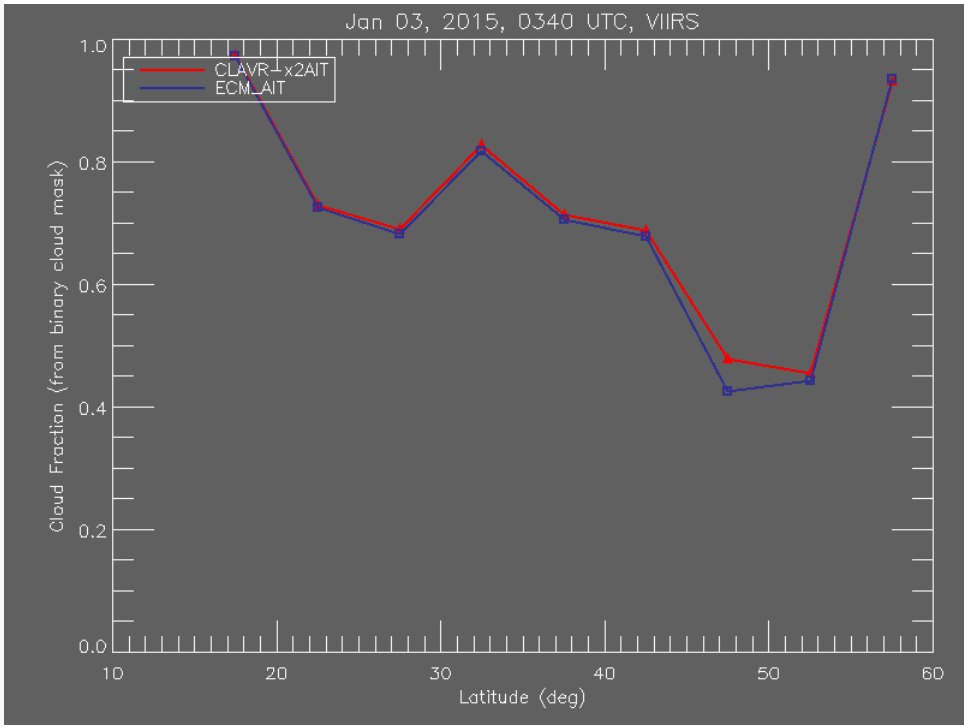
Clear Water | Clear Land | Prob. Clear | Prob. Cloudy | Cloudy | Unknown

ECM_AIT Jan 03, 2015, 0340 UTC, VIIRS



Clear Water | Clear Land | Prob. Clear | Prob. Cloudy | Cloudy | Unknown





CLAVR-x2AIT and ECM_AIT
Zonal Fraction

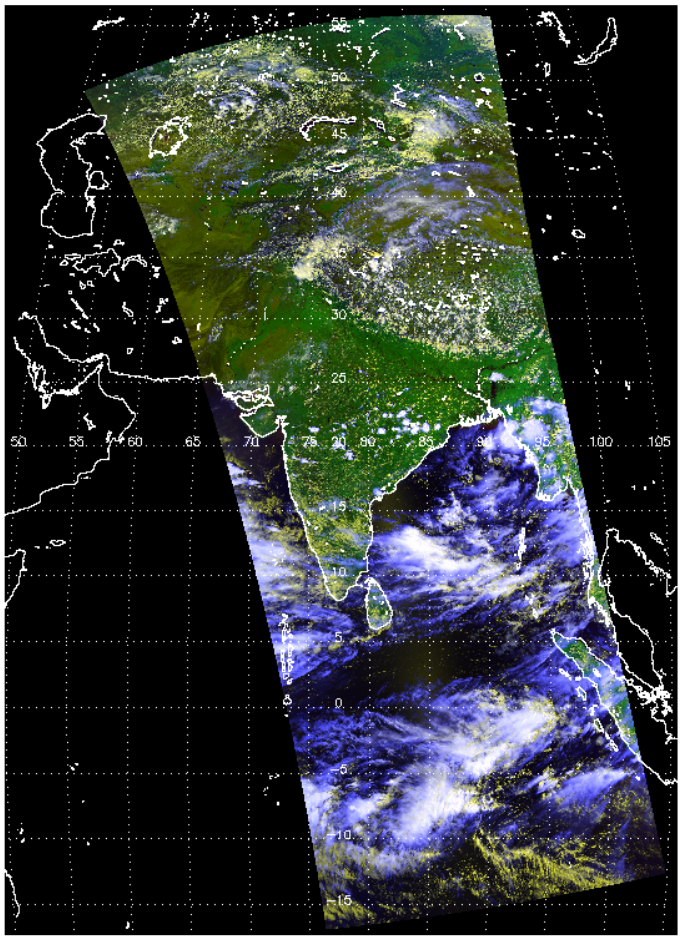
CLAVR-x2AIT and ECM_AIT
Binary Cloud Masks Difference

Thin Cirrus Addition

- Users asked to provide a Thin Cirrus bit in the Packed Bits Structure.
- Logic for Thin Cirrus in the ECM will be similar to that used in the VIIRS Cloud Mask (VCM)
- Thin Cirrus test development is nearly complete and will be part of the August 2016 delivery
- As will be shown, thin cirrus will be yes/no and not the same as the other cloud detection tests

VIIRS Enterprise Cloud Mask (ECM)

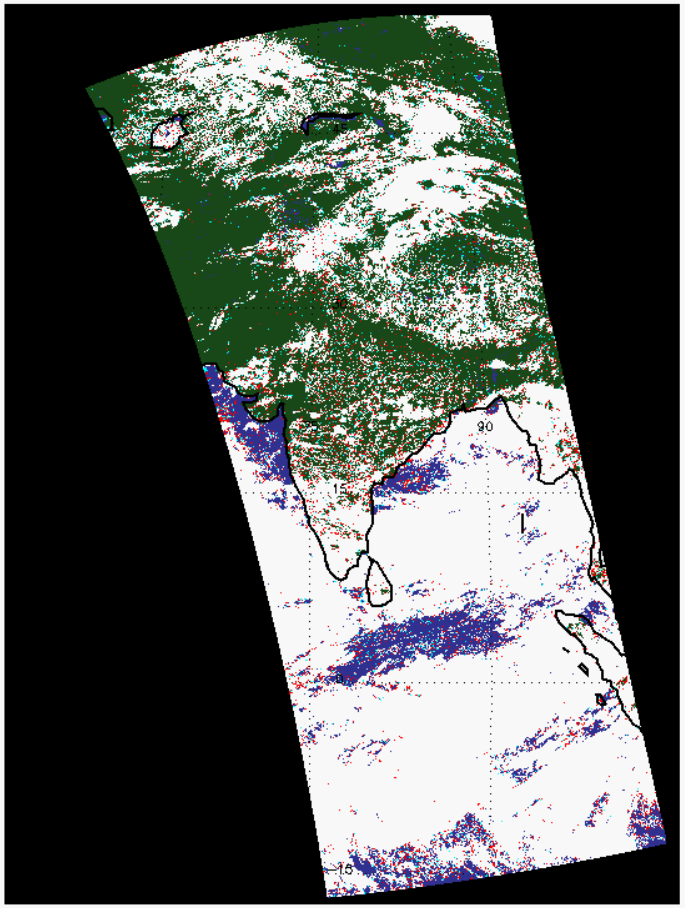
clavrx_npp_d20130913_t0749350_e0750592_b09732



False Color Image

Red=0.65μm, Green = 0.86μm, Blue = 11μm (reversed)

clavrx_npp_d20130913_t0749350_e0750592_b09732.level2.hdf

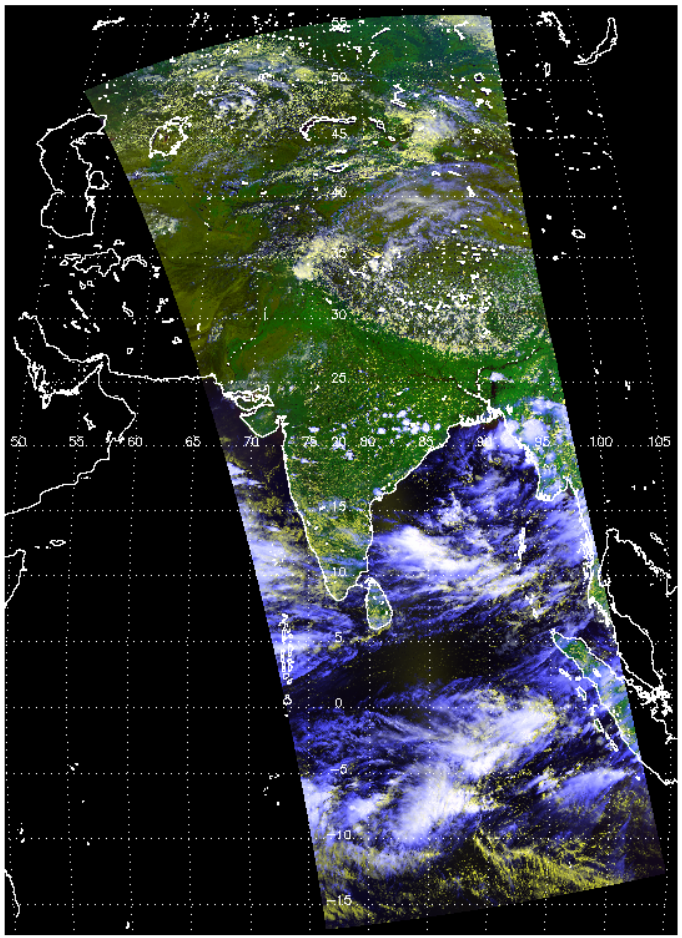


VIIRS Enterprise Cloud Mask

Clear Water | Clear Land | Prob. Clear | Prob. Cloudy | Cloudy | Unknown

VIIRS Cloud Mask (VCM)

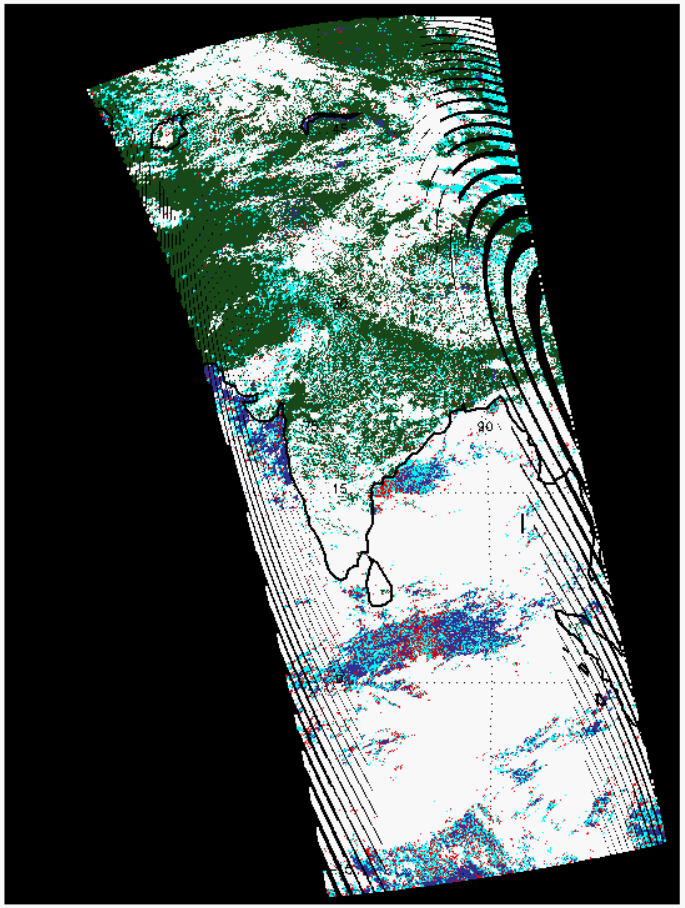
clavrx_npp_d20130913_t0749350_e0750592_b09732



False Color Image

Red=0.65μm, Green = 0.86μm, Blue = 11μm (reversed)

clavrx_npp_d20130913_t0749350_e0750592_b09732.level2.hdf

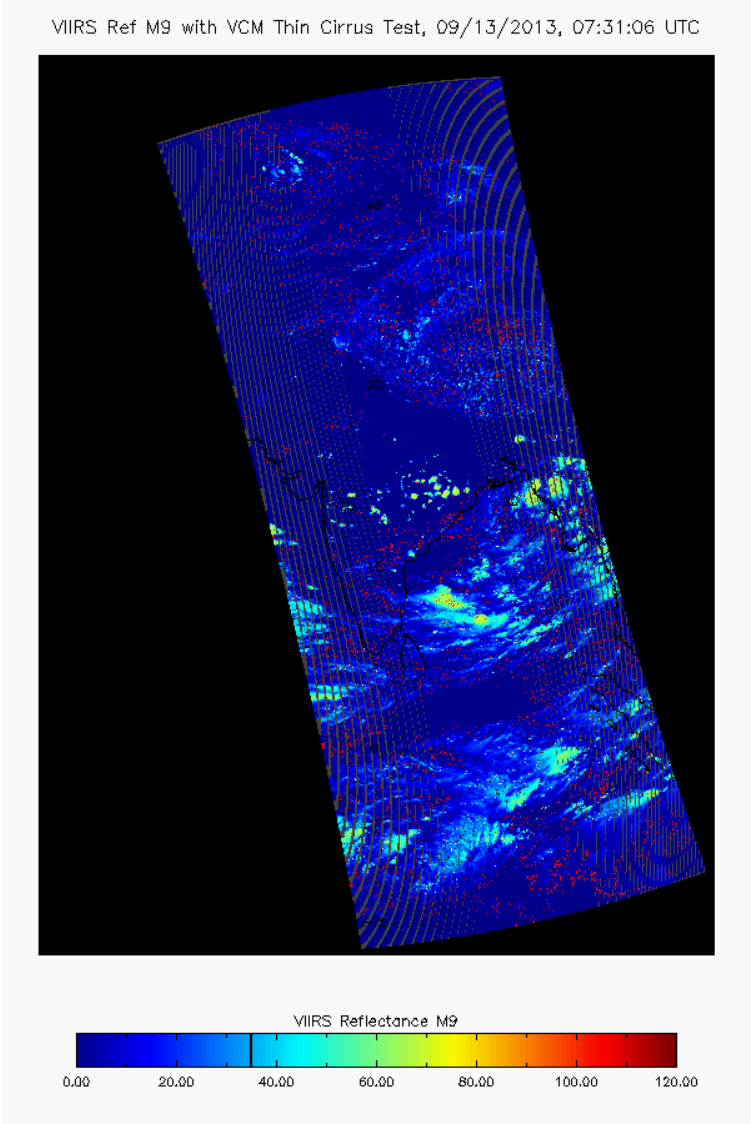


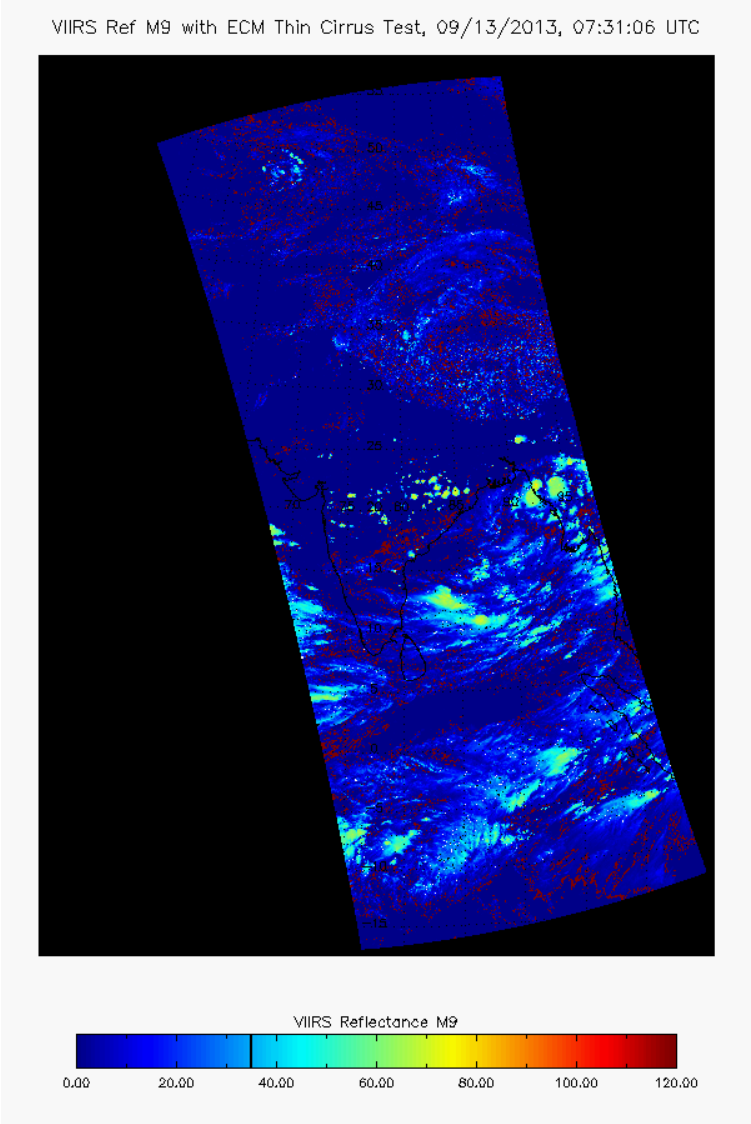
VIIRS Cloud Mask

Clear Water | Clear Land | Prob. Clear | Prob. Cloudy | Cloudy | Unknown

Thin Cirrus Test

VCM





ECM

ECM Bit Structure

- Proposed Place to Ingest Thin Cirrus Test bit to ECM

Byte	Bit	Flag Description Key	Result
2	0-2	Surface Type Used for Thresholds	001 = Deep Ocean 010 = Shallow Water 011 = Land 100 = Snow 101 = Arctic 110 = Antarctic + Greenland 111 = Desert
	3	Thin Cirrus Test	0 = Clear 1 = Cloudy
	4-5	BT11 – 11 μm Thermal Test	00 = Clear 01 = Probably Clear 10 = Probably Cloudy 11 = Cloudy
	6-7	RTCT – Relative Thermal Contrast Test	00 = Clear 01 = Probably Clear 10 = Probably Cloudy 11 = Cloudy

Table 4. Cloud mask tests and flags and their descriptions.
A Naïve Bayesian Cloud Mask Delivered to NOAA Enterprise ATBD.
Version 1.1, June 3rd, 2016.

https://www.dropbox.com/s/otrqhs4lpwu48i4/Cloud_Mask_Enterprise_ATBD_v1.1_2016.docx?dl=0

List of Current Work:

- Investigation of CLAVR-x Cloud Mask and Framework ECM differences.
- Upcoming August, 2016 code and LUTs update.
- Completing Thin Cirrus Test development.
- All tools for Framework ECM are developed and ready to train it against CALIPSO/CALIOP

Summary

- The ECM format is properly described in the ECM ATBD but users should be aware of the role of the individual tests within the ECM structure
- The ECM is ongoing pre-launch validation and known issues are being worked
- Work on the Thin Cirrus Test is nearly complete and will be part of the August 2016 update
- We are always interested in feedback from users