First evaluation of the MAIA VIIRS cloud detection scheme for the OSISAF SST production

Lydie Lavanant , Pascale Roquet

lydie.lavanant@meteo.fr

Météo-France/DP/CMS/R&D

METEO FRANCE
Toujours un temps d'avance

In the frame of the Eumetsat Satellite Application to support Ocean and Sea Ice applications (OSISAF) an operational production of SSTs from NPP-VIIRS HRPT local acquisitions will be done at Météo-France, CMS, Lannion. The cloud detection is provided by the MAIA version4 cloudmask. The main characteristics of the MAIA cloudmask are:

- Grouped thresholding approach with dynamic thresholds determined in-line from look-up tables using the geometry and the surface temperature + total water vapor content background

- Satellite-dependant look-up tables derived off-line from RTTOV using the ECMWF climatological profiles database (Chevallier) and from 6S for visible channels.

- Use of ancillary data: SST + Reflectance climatologies, Snow/Ice cover, Land-type and Topography maps, NWP forecast parameters.

- Many different spectral features (single channels, ratios and differences) + local texture (using the 350m imaging channels for VIIRS), depending on the surface type and the solar zenith angle

- The distance to the thresholds provides a confidence in the detection

- For clear marine pixels, computes the SST using the OSI SAF models

- For cloud contaminated pixels, checks whether the cloud is opaque and provides a cloud top height for these situations.

- For cloudy pixels, ten cloud categories are defined (five opaque clouds according to their altitude, three semi-transparent classes according to their thickness, one class of semi-transparent clouds above lower clouds, one fractional clouds class)

- For VIIRS, provides a characterisation in cloud phase (Water Cloud, Mixed Phase Cloud, Opaque Ice Cloud, Cirrus Non-Opaque Cloud, Cloud Overlap).
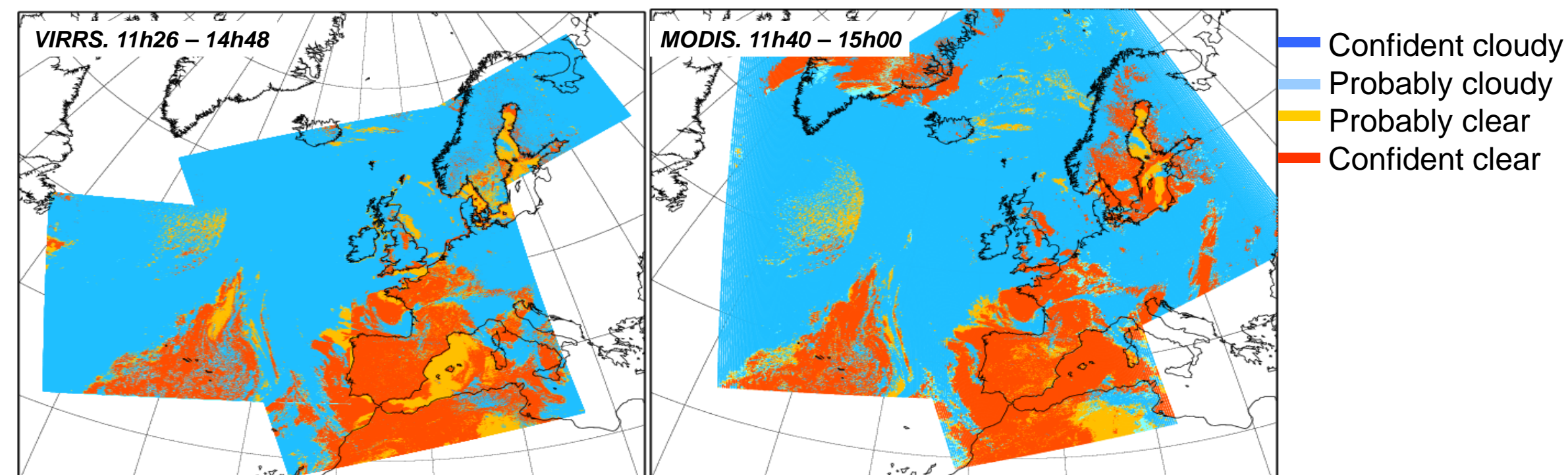
- For VIIRS, detects aerosols and dust.

The MAIA v3 used in the METOP-AVHRR SST global production is implemented in the AAPPv6 NWP SAF package. The MAIAv4 for VIIRS and AVHRR will be implemented in the AAPPv7 package.

MAIA is written in fortran90 and installs under Unix and Linux. It is interfaced in input to the SDR VIIRS data and for AVHRR to the in-house AAPP format (local acquisitions) and to the PFS format (global data). The output format is the HDR5 format and contains the pixel location together to the cloud products.

Comparison of VIIRS and SEVIRI clear and cloud classification on homogeneous matchups

Matchups have been selected over Europe with the following conditions: less than 7 minutes between VIIRS and SEVIRI acquisitions, an homogeneous classification in a local 3x3 pixels box around the matchup for SEVIRI and for VIIRS in a local 0.10° x0.10° box (to avoid problems with the complex navigation of the VIIRS instrument). The figure shows the agreement in % for each cloud class category. The coherence in clear detection is very good. The main disagreement concerns the semi-transparent clouds.

MAIA cloud type agreement with SEVIRI. Day

Clear Land / Clear Sea / Snow/Ice / Very Low / Low / Medium / High Opaq / Very-High Opa / Semi Thin / Semi Mean / Semi Thick / Semi Above

A special effort will be set up during the next months to validate and improve if necessary the cloud mask, this step being a key point in an operational production of the SST. This poster is a preliminary evaluation of the MAIA performances with the first 5 day acquisitions of the CMS HRPT station (2012/03/09 - 2012/03/13 daily situations), before any improvement of the software. In this work, the VIIRS MAIA cloud products are compared to the space and time nearest NWCSAF SEVIRI and MODIS MYD35 products.
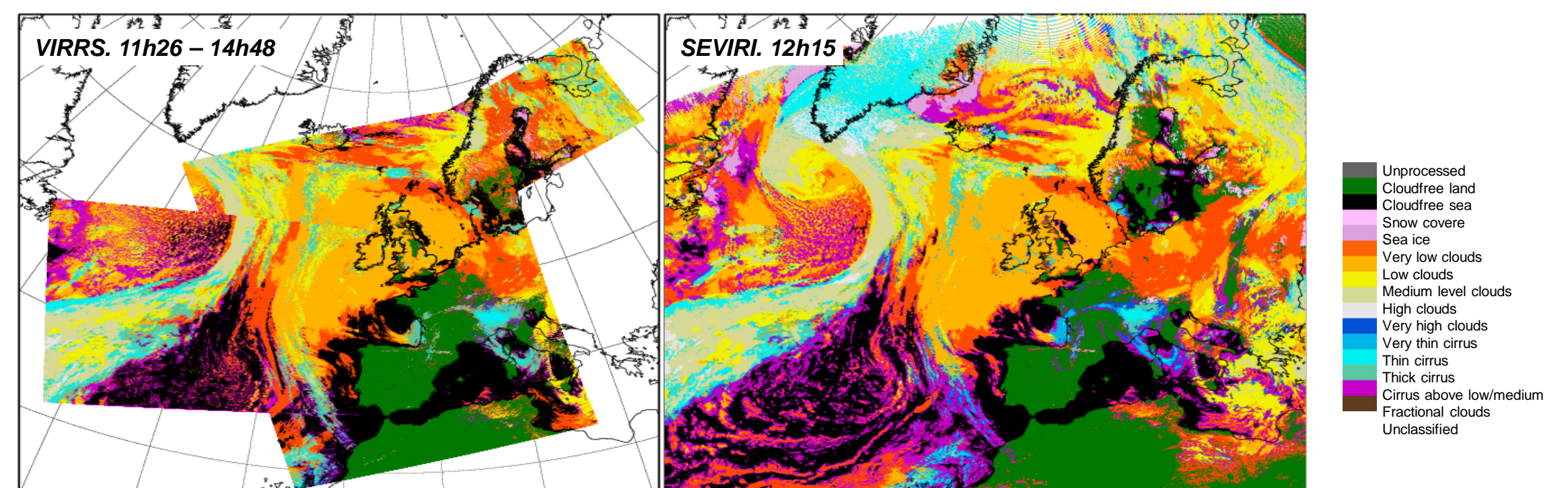
Comparisons to MODIS MYD35 cloud detection

The images below show the VIRRS cloud confidence and the corresponding MODIS MYD35 product for the 3 successive passes of 2012-03-12. The time departure between VIIRS and MODIS is about 15mn. The main differences concern the 'probably clear' class, due to the distance to the thresholds.

VIRRS. 11h26 – 14h48
MODIS. 11h40 – 15h00

- Confident cloudy
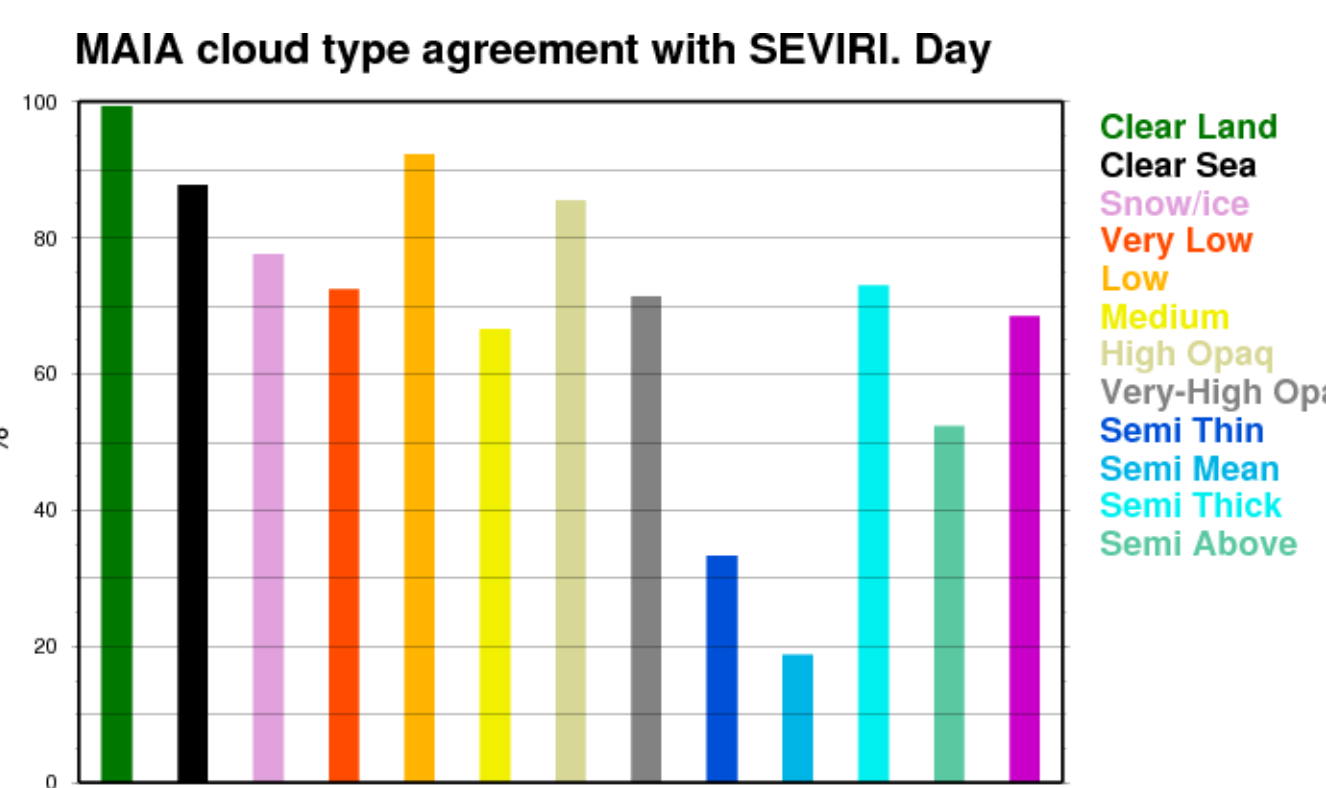- Probably cloudy
- Probably clear
- Confident clear

Comparisons to SAFNWC SEVIRI cloud type

The images show the VIIRS cloud classification and the corresponding NWCSAF SEVIRI product for the time-nearest acquisition over France. The different spatial resolution of the two instruments (VIIRS:750m and SEVIRI: ~4-5kms) has an impact in the characterization of the fractional clouds. Also SEVIRI detects more thin semi-transparent clouds in edge of clouds.

VIRRS. 11h26 – 14h48
SEVIRI. 12h15

Unprocessed / Cloudfree land / Cloudfree sea / Snow cover / Sea ice / Very low clouds / Low clouds / Medium level clouds / High clouds / Very high clouds / Very thin cirrus / Thin cirrus / Thick cirrus / Cirrus above low/medium / Fractional clouds / Unclassified
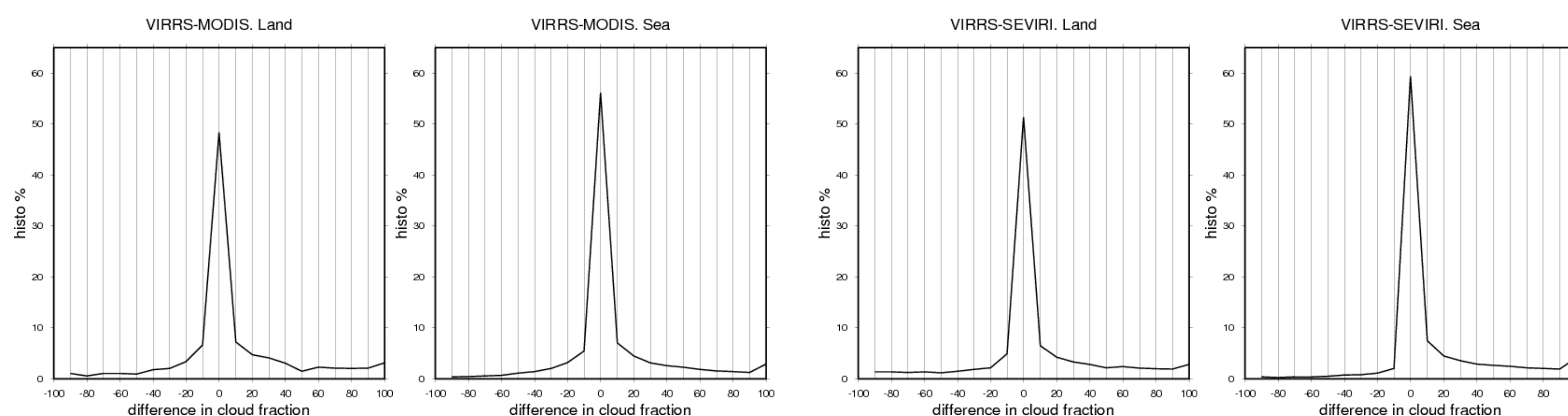
Comparison of Derived Sea Surface Temperatures

The cloud mask can also be validated by analyzing the quality of the clear radiances. Comparison of derived SST's using the OSISAF software from the MAIA characterized clear observations to the SST analysis fields can be used to validate the cloud detection. In this study, the SST's from the 5 days clear radiances over ice-free oceans are compared to ECMWF NWP SST. The figure shows the distribution of the differences in the observed SST and the analysis. Cloud contamination acts to slightly shift the distribution towards negative values.

VIRRS-ECMWF SST
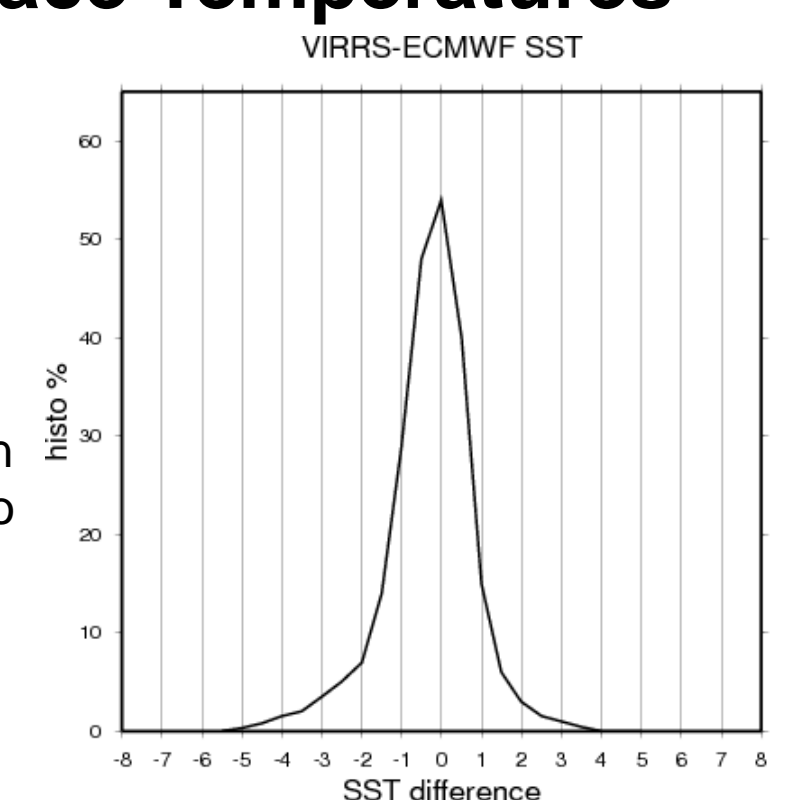
Comparison in cloud fraction

MAIA VIIRS –MODIS MYD35
VIRRS-MODIS. Land
VIRRS-MODIS. Sea

MAIA VIIRS – NWCSAF SEVIRI
VIRRS-SEVIRI. Land
VIRRS-SEVIRI. Sea

To reduce the problem of the difference in pixel size and navigation of the instruments, cloud amounts were computed in 0.5 degree cells over the region observed by the CMS HRPT receiving station for the VIIRS, SEVIRI and MODIS instruments. The results were separated by surface type. Over sea, VIIRS cloud fractions are slightly smaller than for SEVIRI, probably due to sub-clouds in the fov.

Future Work

- Extend this evaluation during a longer period to eliminate possible bugs, understand the observed differences with SEVIRI and MODIS cloud masks, update the fixed thresholds and possibly improve the test series.

- Extend this evaluation to include the cloud height, the cloud phase characterization and the aerosol and dust detection.

- Include Calipso and Cloudsat cloud products in the comparison

- Remove residual cloudy pixels through the analysis of the adjacent pixels in the cloud field.

- Adapt the MAIA version 4 to METOP-AVHRR before its implementation in AAPPv7.

References

Ackerman S., R. Frey, K. Strabala, Y. Liu, L. Gumley, B. Baum, P. Menzel. 2010. Discriminating clear-sky from cloud with MODIS ATBD (MOD35)

Derrien, M. and Le Gléau, H., 2005. MSG/SEVIRI cloud mask and type from SAFNWC, Int. J. of Remote Sensing, Vol. 26, No. 21, pp 4707-4732 .

Hutchison K.D., J. Roskovensky, J. Jackson, B. Lisager, R. Mahoney. 2011. VIIRS Cloud Mask (VCM) ATBD.

Lavanant, L., 2002. MAIA v3 AVHRR cloud mask and classification. . EUMETSAT contract documentation. Available at www.meteorologie.eu.fr/maia.html

Lavanant L., P. Marguinaud, L. Harang, J. Lelay, S. Péré, S. Philippe. 2007. Operational cloud masking for the OSI SAF Global Metop/AVHRR SST Product

	SEVIRI	VIIRS(NPP/JPSS)		AVHRR(METOP)		
Pixel size(sub-poni/nadir)	3km	750m		1.1km		
Channel	Sensitivity	Central Wavelength µm		Spectral Width, Δλ0 µm		
VIS 0.4	A	0.41		0.40-0.42		
VIS 0.5	Cc+A	0.49		0.48-0.50		
VIS 0.6	Cc+Ct+Cµϕ+A+V	0.65	0.67 0.63	0.56-0.71	0.66-0.68	0.58-0.68
VIS 0.8	Cc+Ct +Cµϕ+A+V	0.81	0.87 0.86	0.74-0.88	0.85-0.88	0.72-1.00
NIR 1.3	Cirrus+Cc+A	1.375		1.37-1.38		
NIR 1.6	Snow+Cc+Ct+A	1.64	1.61 1.61	1.50-1.78	1.58-1.64	1.58-1.64
NIR 2.2	Cµϕ + A	2.25		2.22-2.27		
IR 3.8	Cc+Ct+Ts+D+F	3.90	3.75 3.74	3.48-4.36	3.66-3.84	3.55-3.93
IR 8.7	Cµϕ	8.70	8.55	8.30-9.10	8.4-8.7	
IR 10.5	Cc+Ts +D+F	10.8	10.75 10.8	9.80-11.8	10.26-11.26	10.3-11.3
IR 12.3	Cc+Ct+Ts+D	12.0	12.0 12.0	11.0-13.0	11.54-12.49	11.5-12.5

Cc: Cloud cover / Ct: Cloud type / Cµϕ: Cloud mycrophysic / A: Aerosol / D:Dust, Ash / F:Fire / V: Vegetation