

SAFNWC/GEO cloud products

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Madrid

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SAFNWC/GEO Cloud products: plan

-CDOP2:

- **v2013** main features
- **v2015** main features

-CDOP3:

- **v2017** main features
- **MTG day 1** main features
- **MTG day 2**

V2013 Cloud main features (CDOP2)

-Three cloud products:

- Cma cloud mask ; include dust and volcanic ash flag
- Ct cloud type ; include cloud phase flag
- Ctth cloud top temperature, pressure and height

-Unchanged since v2011

-Robust (in case missing NWP, channels)

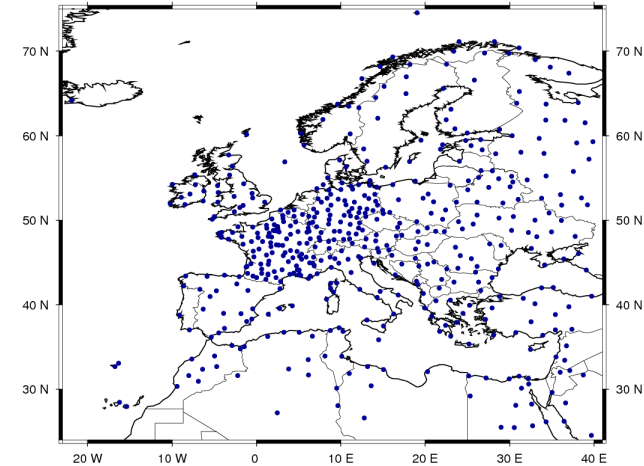
-Validated over European area and full disk

-Widely used (NMS, SAF, users, Eumetsat) as SW and as products (satmos, safcm reprocessing, Eumetcast dissemination)(cf user survey)

-Applied to different geostationary satellites

V2013 CMa validation over land on Europe

	Cloud detected	Clear detected
Cloud observed	H	M
Clear observed	Fa	cr



POD=[**H**/(**H**+**M**)] is the rate of correctly detected cloud observations

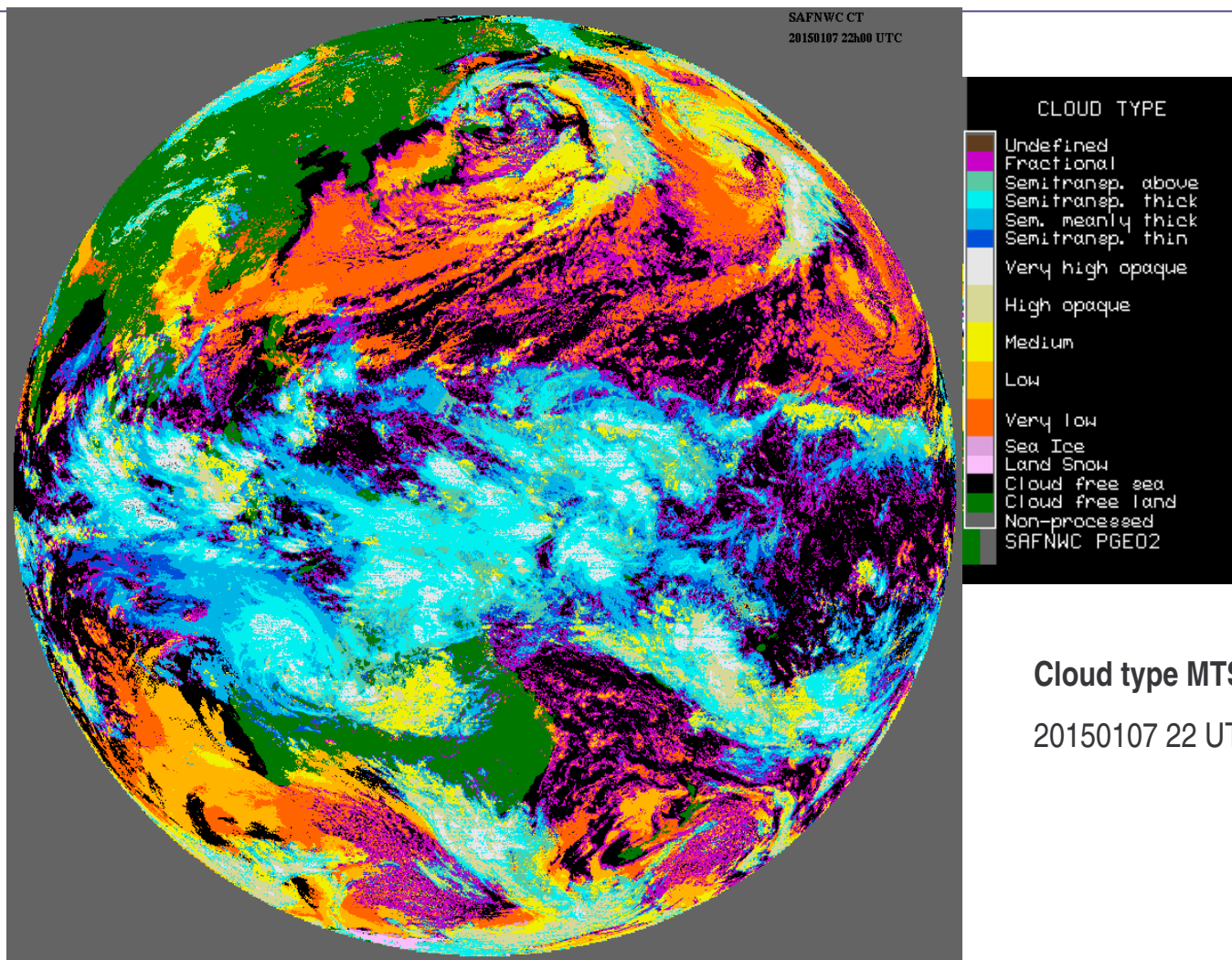
FAR=[**Fa**/(**Fa**+**cr**)] is the rate of false flagging of clouds

CMa v2013 performance estimated from collocated SYNOP and MSG-2/SEVIRI observations **over land on Europe for 2010** (one day every three).

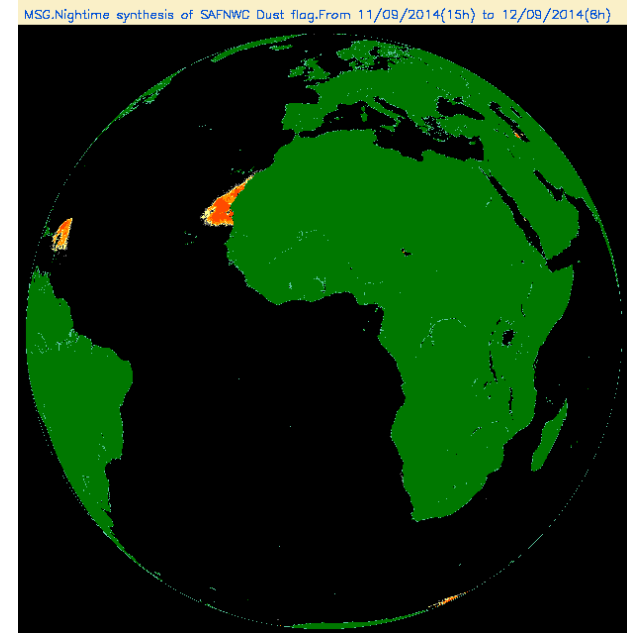
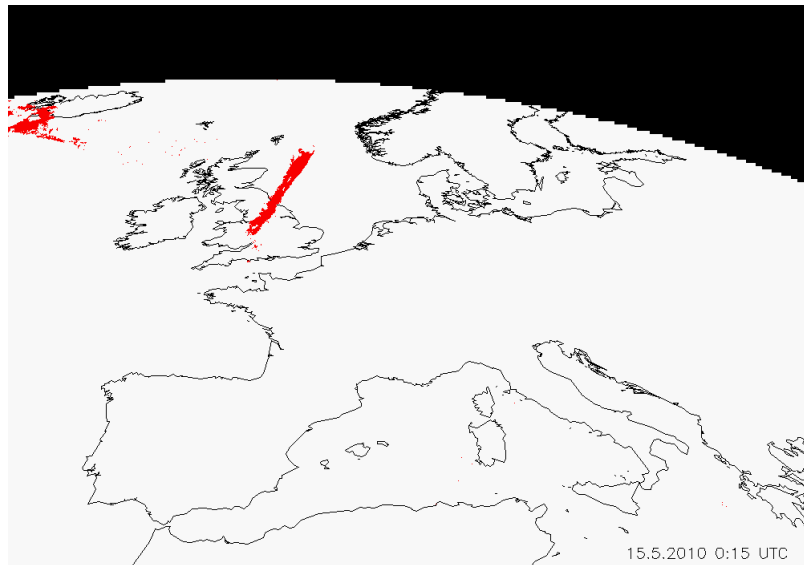
Cma V2013	POD(%)	FAR(%)
All illumination	97.1	4.1
Daytime	98.5	2.3
Night-time	95.8	7.3
Twilight	95.7	1.8

V2013 applied to different geostationary satellites

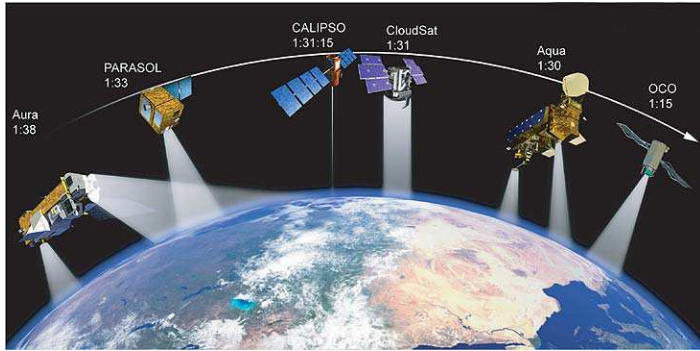
MTSAT-2



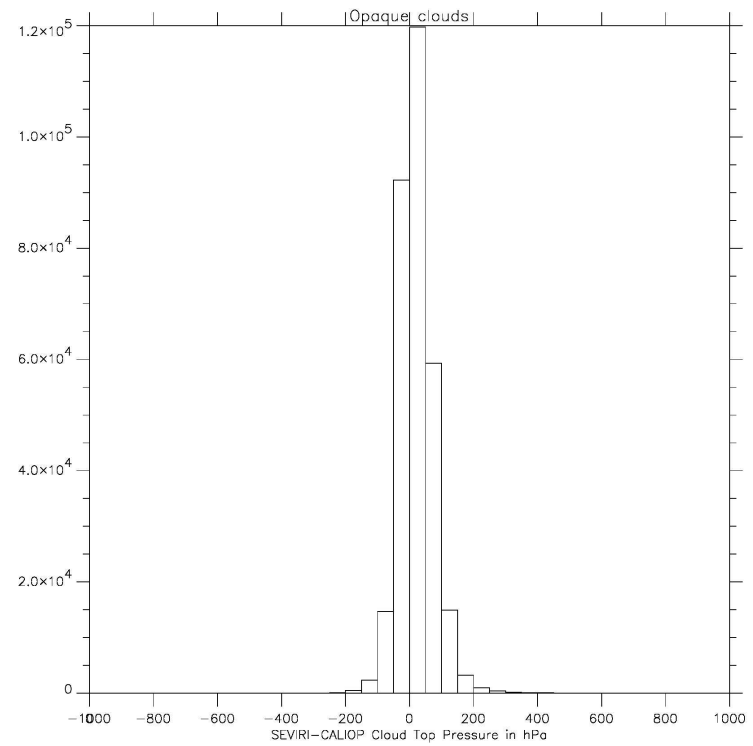
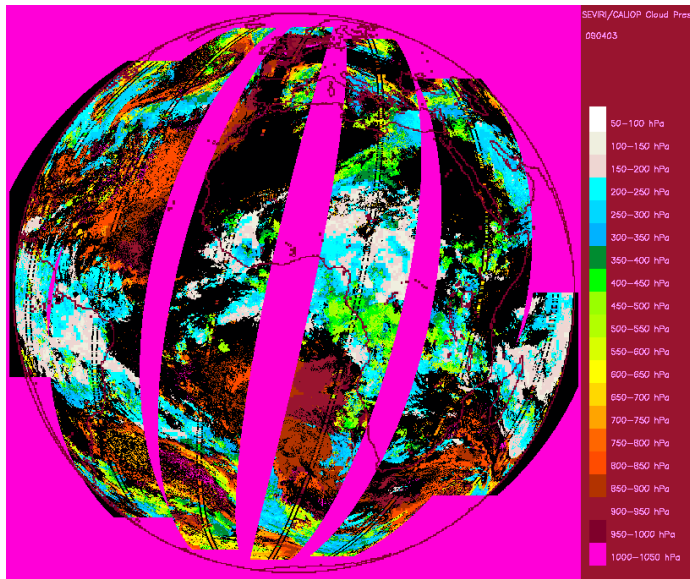
V2013 Cloud volcanic & dust flag



V2013 CTTH validation



Colocated SEVIRI/CALIOP



V2015 Cloud main features (CDOP2)

- Software completely rewritten
- New input (HRIT, netcdf for foreign satellite)
- New output: Netcdf ; different product content (classes, flags)
- New cloud product: CMIC
- Algorithm improvement:
 - **CMA**: RTTOV online
 - **CMIC**
- Validation on full disk:
 - **CMA**: synop & ship
 - **CTTH**: lidar & radar
 - **CMIC**: phase (lidar) and LWP (amsr)
- Ready for foreign satellites through Netcdf format

V2015 CMA new output, Netcdf file

- **Cma: Cloud Mask** (0 cloud free/1 cloudy)
- **Cma_cloudsnow: Cloud and snow mask** (0 cloud free; 1 cloud, except thin ice over snow; 2 thin ice clouds over snow; 3 snow/ice)
- **Cma_dust: Dust detection** (0 no dust; 1 dust; 2 undefined)
- **Cma_volcanic: Volcanic plume detection**
- **Cma_testlist1&2: Cma list of tests**

- **Cma_status: Informations on specific GEO CMA processing** (Low level thermal inversion, Cold snowy ground suspected, temporal algorithm passed, HRV used, RTTOV on line used, SST analysis available, snow map, ice map available ...)
- **Cma_conditions: Common geophysical and processing conditions** (illumination, high/rough terrain, land/sea/coast, satellite availability, NWP availability ...)
- **Cma_quality: Common quality indicators**

V2015 CT new output, Netcdf file

- **Ct: Cloud type** (15 classes: cloud-free (land/sea), snow/ice, very low, low, mid-level, high, very-high, fractional, semi-transparent (from thin to thick), semi-transparent over snow)
- **Ct_cumuliform: stratiform/cumuliform status, not performed in V2015**
- **Ct_multilayer: multilayer cloud detection** (0 no multilayer detected; 1 multilayer detected; 2 cloud free, 3 undefined)
- **Ct_status_flag: Informations on specific GEO CT processing** (Low level thermal inversion, Tropopause temperature available from NWP, 1.38 used for cirrus identification, High resolution satellite data used ...)
- **Ct_conditions: Common geophysical and processing conditions** (illumination, high/rough terrain, land/sea/coast, satellite availability, NWP availability ...)
- **Ct_quality: Common quality indicators**

V2015 CTTH new output, Netcdf file

- **Ctth_pres**: cloud top pressure in Pa
- **Ctth_alti**: cloud top altitude in m
- **Ctth_tempe**: cloud top temperature in Kelvin
- **Ctth_effectiv**: cloud effective cloudiness in %
- **Ctth_method**: method used

- **Ctth_status_flag**: Informations on specific GEO CTTH processing (cloud-free area, Low level thermal inversion, opaque cloud, fractional (no method), too thin (no method) multilayer suspected)
- **Ctth_conditions**: Common geophysical and processing conditions (illumination, high/rough terrain, land/sea/coast, satellite availability, NWP availability ...)
- **Ctth_quality**: Common quality indicators

V2015 CMIC new output, Netcdf file

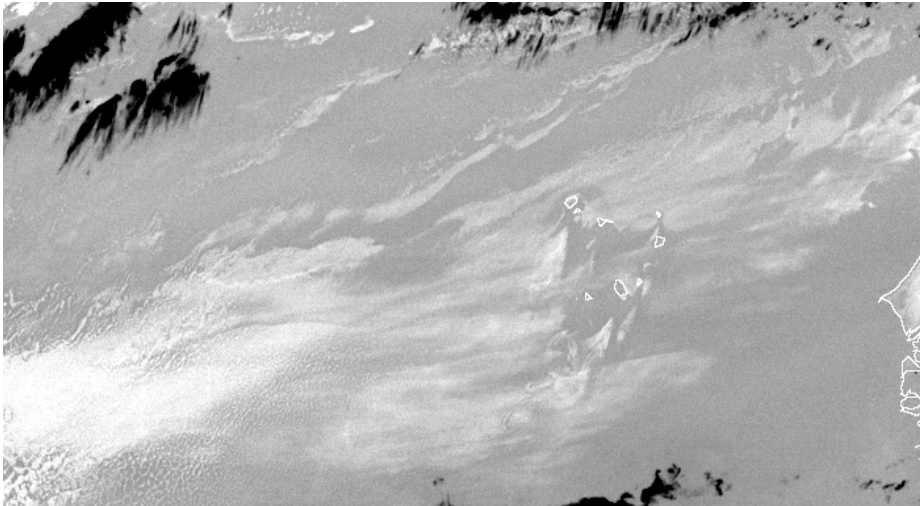
- **Cmic_phase**: Cloud top phase (5 classes: liquid, ice, mixed, cloud-free, undefined)
- **Cmic_reff**: cloud drop effective radius in m
- **Cmic_cot**: cloud optical thickness
- **Cmic_lwp**: cloud liquid water path in kg/m^2
- **Cmic_iwp**: cloud ice water path in kg/m^2

- **Cmic_status_flag**: Informations on specific GEO CMIC processing
- **Cmic_conditions**: Common geophysical and processing conditions (illumination, high/rough terrain, land/sea/coast, satellite availability, NWP availability ...)
- **Cmic_quality**: Common quality indicators

V2015 Algorithm improvement: RTTOV online

- **Main goal: improving the detection of**
 - warm low clouds at night over sea
 - cirrus clouds at night over sea
 - Low clouds over Europe at high viewing angles
 - **Without adding false alarms**
- **Tests applied to pixels flagged clear by the first set of tests**
 - Direct thresholding of T3.8 over sea
 - Direct thresholding of T10.8 over sea
 - T108-T120 over land, only at night
 - T87-T38 at night over barren surfaces
 - T108-T87 at high satellite angles (not applied over mountains)

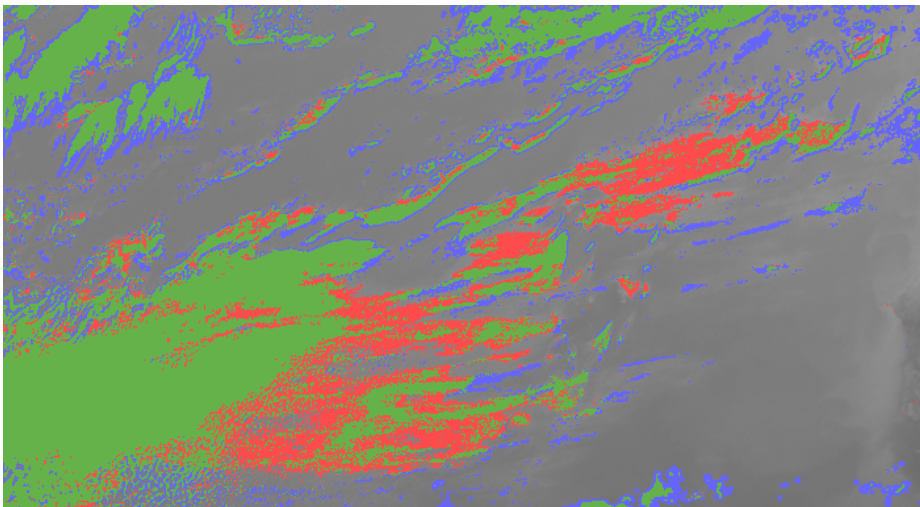
V2015 Algorithm improvement: RTTOV online



Meteosat-10, 3 March 2013 21h00 UTC ;

(top) enhanced T10.8-T3.8 with low clouds appearing clear gray, sea in intermediate gray and high clouds dark;

(bottom) red pixels correspond to those flagged as cloud by the prototyped RTTOV-based test of T3.8, green corresponds to pixels detected both by prototype and operational SAFNWC, and blue are detections by other operational SAFNWC test, grey pixels are T38 (warm is dark)



V2015 Algorithm improvement: RTTOV online

- **RTTOV v11.2**
- Pre-processing of satellite simulated fields by NWPMAP module
 - Radclear, transtot, dnclear
- Auxiliary data (mandatory) :
 - NWP (ECMWF model is highly recommended)
 - SST OSTIA (to be input by user)
 - Monthly emissivity atlases (included in NWCSAF SW)
 - File of biases (available for ECMWF ; otherwise to be input by user)
- RTTOV on line is **optional**: key **RTTOV_USE** in the CMA configuration file

V2015 CMIC Cloud microphysics

Cloud phase is retrieved **as in v2013**:

- ✓ High semi-transparent clouds are ice clouds
- ✓ Very warm (very cold) opaque clouds are water (resp ice) clouds
- ✓ Low $T_{8.7\mu\text{m}} - T_{10.8\mu\text{m}} (< -2^\circ\text{C})$ corresponds to water clouds
- ✓ High $T_{8.7\mu\text{m}} - T_{10.8\mu\text{m}} (> 0^\circ\text{C})$ corresponds to ice clouds

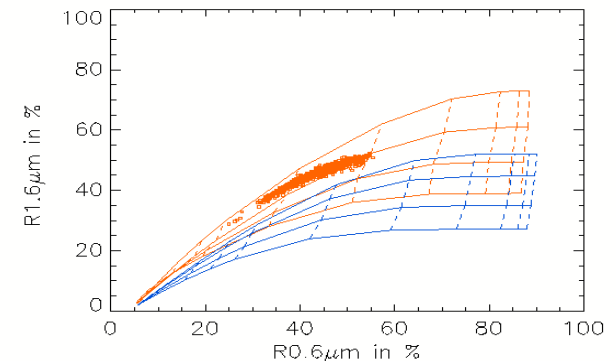
As in v2013:

Reflectances at $0.6\mu\text{m}$ & $1.6\mu\text{m}$ are compared to simulation:

- ✓ To retrieve particle size and optical depth
- ✓ To improve cloud phase retrieval

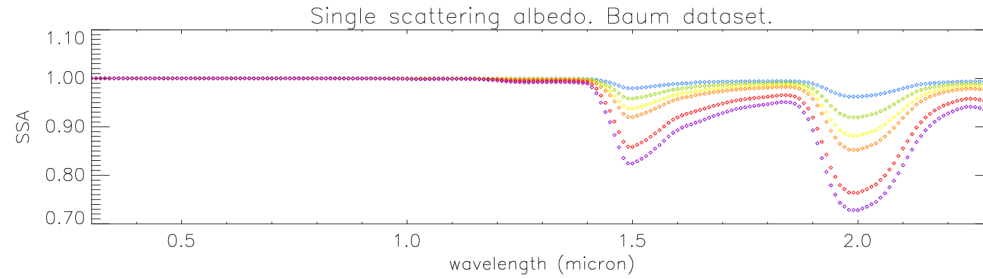
Change in v2015:

- ✓ Particle size and optical depth are official outputs
- ✓ Change in method to simulate $0.6\mu\text{m}$ & $1.6\mu\text{m}$ reflectances (DISORT, Mie & Baum)
- ✓ Measured reflectances in $0.6\mu\text{m}$ & $1.6\mu\text{m}$ are calibrated using post-launch coefficient provided by CM SAF

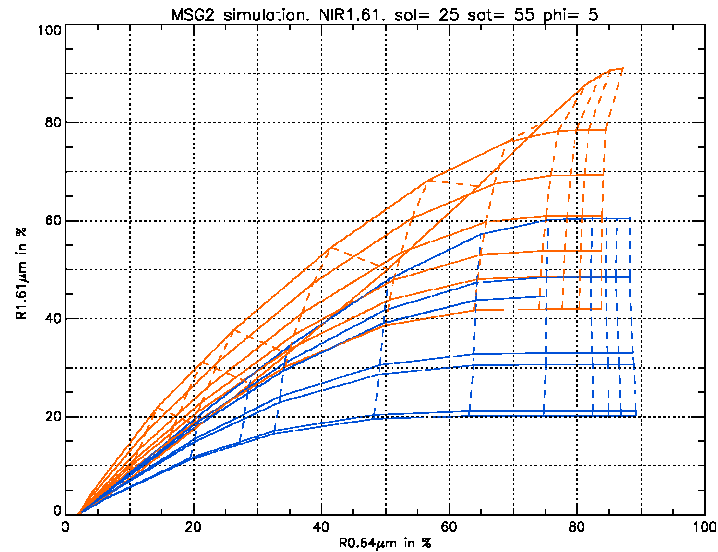


V2015 CMIC Cloud microphysics

Water & ice cloud scattering properties using MIE and BAUM dataset



Simulation of water & ice clouds reflectances based on the use of DISORT



V2017 main features (CDOP3)

Scientific development done in CDOP2 ; implemented and released in CDOP3

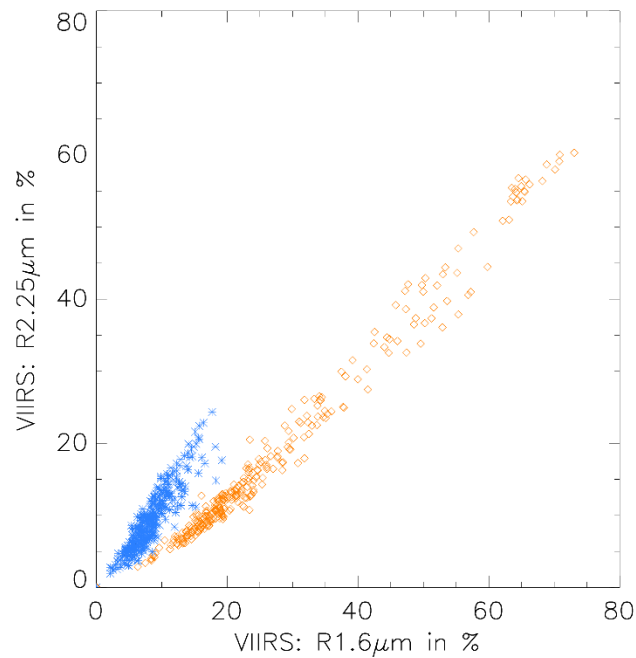
Algorithm improvement:

- CMA/CT: use of new channels (1.38 & 2.2) for cirrus/snow/broken clouds
- CTTH: for high clouds
- CMIC: use of 2.2 for cloud phase

Commitment for HIMAWARI-8

V2017 CMa/CT Use of new channels

- **2.25 μm Channel:**
 - Combined use of 1.6 μm & 2.25 μm reflectances useful for snow and land separation



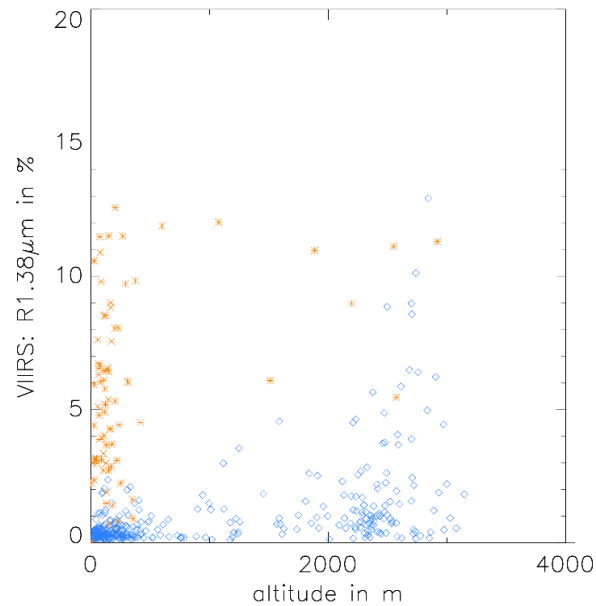
From VIIRS database of targets selected in the acquisition area and labelled by analysts as cloud free or covered by one specific cloud type.

Snow in blue

Clear land in orange

V2017 CMa/CT Use of new channels

- 1.38 μm reflectance useful for:
 - Cloud mask: To identify thin cirrus
 - Cloud type:
 - to separate cirrus clouds from fractionnal low clouds
 - To identify thin cirrus over snow

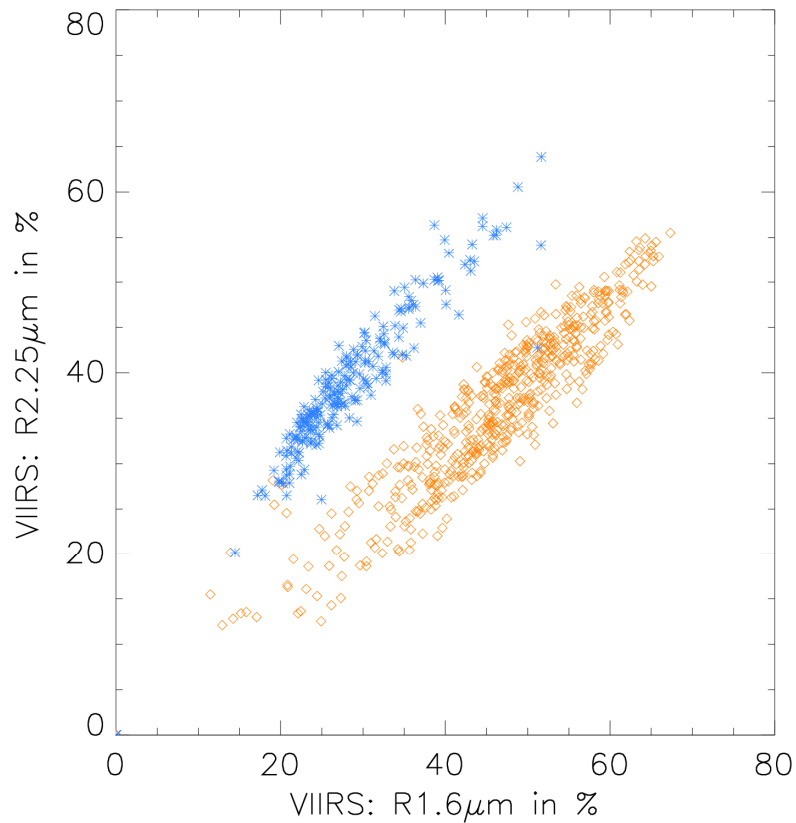


From VIIRS database of targets selected in the acquisition area and labelled by analysts as cloud free or covered by one specific cloud type.

Blue: snow

Orange: thin cirrus over snow

V2017 2.25 μm for cloud phase retrieval



From VIIRS database of targets selected in the acquisition area and labelled by analysts as cloud free or covered by one specific cloud type.

Blue: ice clouds (Cb/Cs)

Orange: water clouds (St/SC)

MTG day-1 main features (CDOP3)

- ✓ Reviewed according Eumetsat MTG review cycle
- ✓ ATBD reviewed in 2016 (CDOP2)
- ✓ based on v2017
- ✓ must be robust
- ✓ use of new channels fully tested with foreign satellites
- ✓ adaptation of validation tool to new sources (earthcare)
- ✓ must be ready on time for users

MTG-day2 (CDOP3)

Various options depending funding and user request:

- ✓ st/sc separation
- ✓ products at different spatial resolution
- ✓ height improvement (low level clouds)
- ✓ ...