Method to generate a reference cloud mask for MTG-IRS

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Objectives and requierements

EUMETSAT and the ESA have initiated joint preparatory activities for the definition of the Meteosat Third Generation (MTG) geostationary system, as a replacement for the second generation satellites (MSG) near 2018-2020. The program is based on two separated platforms with the Flexible Combined Imager (FCI) on MTG-I and the InfraRed Sounding (IRS) instrument, with similar characteristics than IASI and CrIs, on MTG-S.

Preparatory activities have started at EUMETSAT for the definition of the level2 processing facility (LéPF) of IRS. Only in cases where the IRS Field of View contains no clouds, a level 2 product will be derived from the observations at EUMETSAT L2PF. A cloud detection method based on IRS alone has already been developed using IASI data as proxy and is documented in the MTG-IRS ATBD [1]. Since the IASI observations are quite different from the MTG-IRS observations, the available static data (thresholds, …) are not applicable to process real MTG-IRS observations.

The IRS static data will be generated through a CAL/VAL process and involves the application of the cloud detection method to real MTG-IRS observations and the comparison of the outcome to a reference cloud mask. The CAL & VAL of the cloud detection module need be done at the beginning of the commissioning phase of the MTG-S satellite, during a limited period of time to allow for calibration – validation of the other processes.

This implies the availability of a reference cloud mask, collocated in space and time with the IRS observations and with a samilar spatial resolution as the MTG-IRS observations.

Purpose of this study

To formulate recommendations to EUMETSAT for the generation of reference cloud mask datasets during the commissioning phase for the CAL/VAL of the MTG-IRS. To demontrate the validity of the recommendations through a relevant set of proxy data.

To answer to the following questions:

1. for the calibration reference cloud mask:
   - what are the potential sources of observations
   - What are the requierements in terms of spatial and time collocation of the two cloud mask products
   - how it can be generated within the implicit time constrains of the CAL process.
   - the necessity to repeat or not the CAL/VAL during the commissioning to capture all the weather types encountered during one year on the MTG disk
2. for the validation reference dataset:
   - Is there the need of a completely independent dataset, or a subset of the calibration dataset could be used.
   - If a completely independent dataset is needed, how this independent dataset can be generated within the time constrains given.

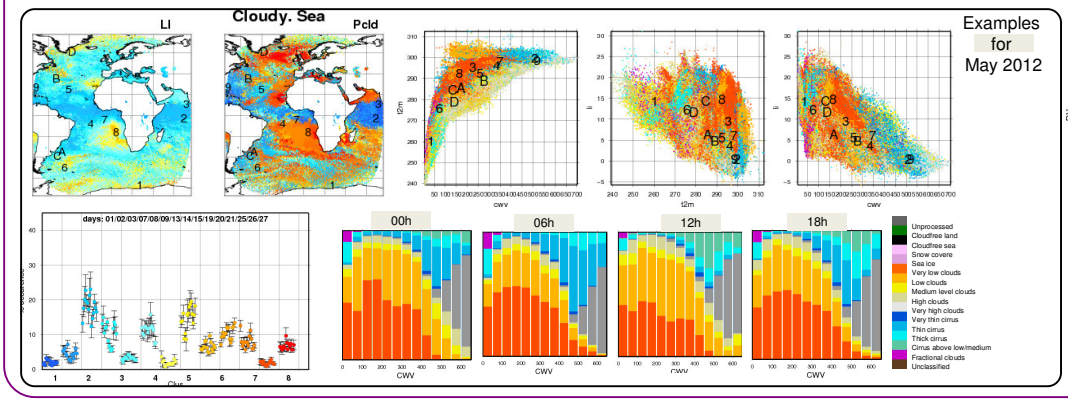
Representative meteorological classes

The purpose is to identify a set of meteorological classes representative of the full range of atmospheric situations observed during an annual cycle on the MTG disk

On the MSG disk, we created monthly datasets for one year (September 2011-August 2012) with the time sampling of 3days/6 and a 3h step (00, 03, 06..) of collocated:

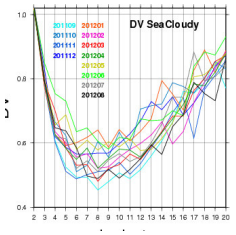
- SAFNWC SEVIRI cloud products (mask, type, pressure, emissivity) with a spatial sampling of 1pixel/5, 1line/5
- analysis and forecast ECMWF surface temperature, total water content and instability index from a grid at a 0.5° resolution

Meteorological classes are defined using the K-Means method for 4 conditions (clear-cloudy-land-sea) and established as function of 5 parameters: cloud height, cloud effective emissivity, total water content, instability index and surface temperature. The SEVIRI cloud types are used as verification.



Examples for May 2012

number of representative classes



	Sea cloudy	Land cloudy
Sep	8	6
Oct	6	7
Nov	6	7
Dec	8	7
Jan	9	9
Fev	9	9
Mar	8	11
Apr	12	9
May	13	9
Jun	12	8
Jui	11	7
Aug	8	7

$DV = Intra + 0.7 * Inter$ Intra: intra-cluster compactness
Inter: inter-cluster separation

A set of 13 weather types over sea and 11 over land have been defined. We observe more variability during Spring and a diurnal evolution with higher clouds between 12-15h.

Perspectives

Preliminary results indicate that:

- a set of 13 (sea) and 11 (land) weather types are enough to represent the meteorological cloudy situations during one year over the MSG disk.
- the agreement in terms of cloud type and height depends on the cloud type and is mostly impacted by the time difference between the instruments.

This study is in progress. The following steps are:

- Evaluate the set of requierements as function of the weather types, season, geographical positions, viewing geometry using several ten days periods
- Take into account the spatial and temporal similarities of IRS and the reference instrument
- Evaluate the cloud mask differences in terms of IASI BT departures
- Propose a method to generate the reference cloud mask during the CAL/VAL
- Verify the applicability of the recommendations by creating a reference dataset using IASI as proxy data for IRS and proxy data for the collocated reference cloud mask

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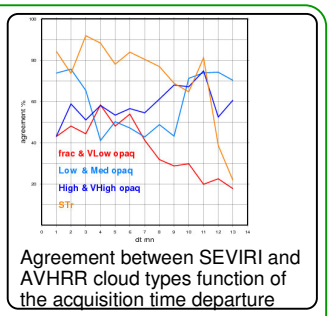
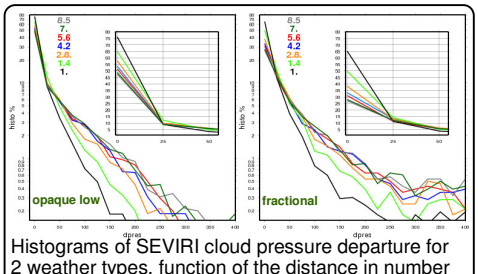
Spatial and time requierements for the collocation

The purpose is to identify the requirements in terms of spatial and time collocations and instrument for the Reference Cloud Mask datasets during the commissioning phase. We built a dataset including the meteorological classes defined, for a 10 days period (chosen as a possible duration of the cloud mask CAL/VAL during the commissioning), presently for 2 days in August 2012. The dataset contains :

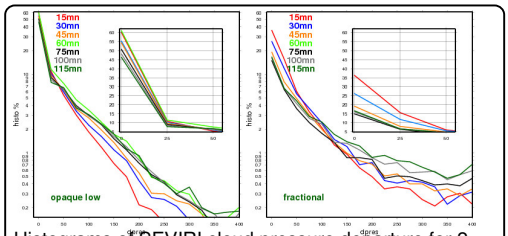
- SEVIRI SAFNWC cloud products (cover, type, height) every 15 mn
- time/space collocated AVHRR MAIA cloud mask (cover, type) in simulated IRS fov
- time/space collocated IASI observations & Co_2Slicing cloud products (cover, height)
- all needed environmental information (instrument geometry, time, …)
- T,q,o3 NWP profiles



Agreement between SEVIRI and AVHRR cloud types function of the acquisition time departure



Histograms of SEVIRI cloud pressure departure for 2 weather types, function of the distance in number of SEVIRI pixels



Histograms of SEVIRI cloud pressure departure for 2 weather types, function of the acquisition time difference

(1) Tjemkes S et al, 2012. Algorithm Theoretical Basis Document for Level 2 Processing of the MTG Infra-Red Sounder Data. EUM/MTG/DOC/11/0188
(2) Le Gléau H., M. Derrien, 2011. Algorithm Theoretical Basis Document for CMa-PGE01,CT-PGE02& CTTH-PGE03 Cloud Products, for SAFNWC v2011
(3) Lavanant, 2007. Operational cloud masking for the O&SI SAF global METOP SST production. EUMETSAT Conference proceedings.
(4) Lavanant et al, 2011. Comparison of cloud products within IASI footprints for the assimilation of cloudy radiances QJRMS, vol 137.

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