Impacts of clouds in the generation of Climate Data Records at EUMETSAT from Meteosat within the Copernicus Climate Change Service (C3S)

Climate Change

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Madison, Thursday 1st November 2018
CGMS 2nd International Cloud Working Group

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Outline

1. Meteosat TCDR Generation
2. Cloud Retrieval
3. Atmospheric TCDRs
4. Land TCDR
5. Conclusions

TCDR: *Thematic **C**limate **D**ata **R**ecord*

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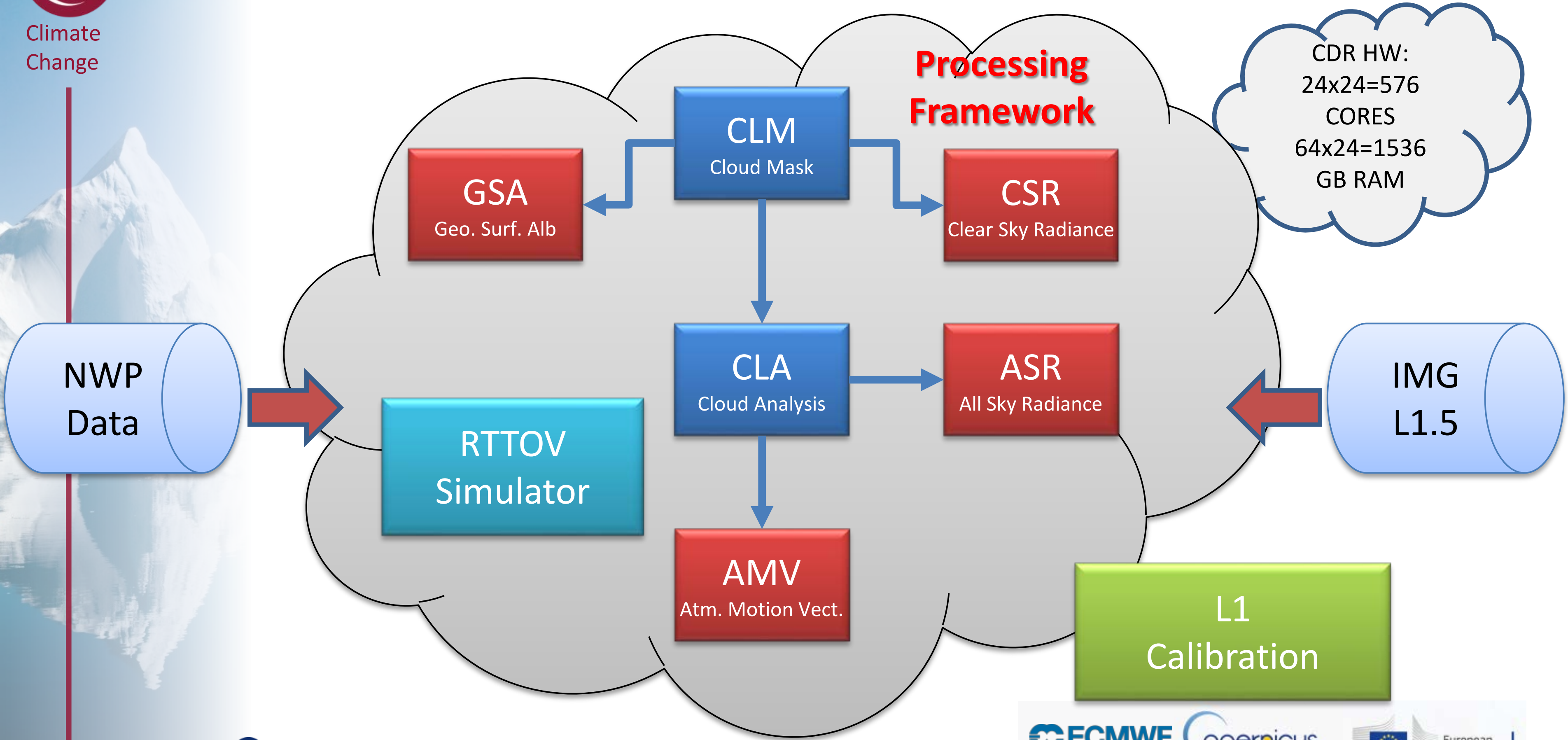
Meteosat TCDR Generation



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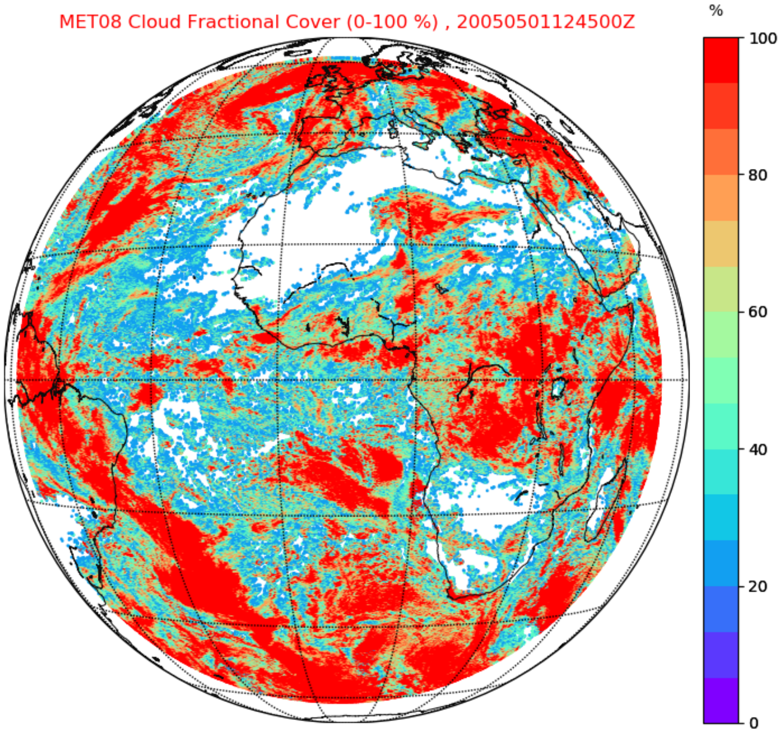
Meteosat TCDR Generation

Processor selection guidelines

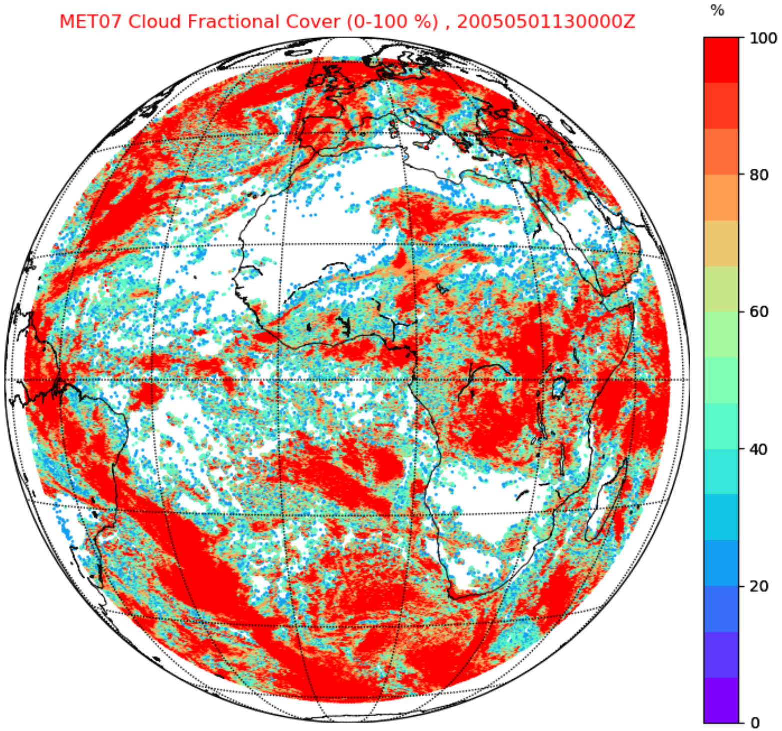
- Applicable to both MVIRI and SEVIRI
- Potentially expandable to other GEO
- Fast ~1 year/day
- Robust and (ideally) fully tested
- Standalone (plug&play interface)
- All above: fully ready within 6-8 weeks

Processor	Available	Solution
CLM	CM-SAF MeteoSwiss	Integration
CLA	Not available	Partially R&D
CSR/ASR	Not available	Development
AMV	EUMETSAT OPE standalone	Adaptation to MVIRI
GSA	EUMETSAT standalone	Integration

Cloud Retrieval: CLM



SEVIRI PS=3km, SCAN=12min



MVIRI PS=5km, SCAN=25min

Cloud Retrieval: CLA

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Read CLM

CFC > 50%

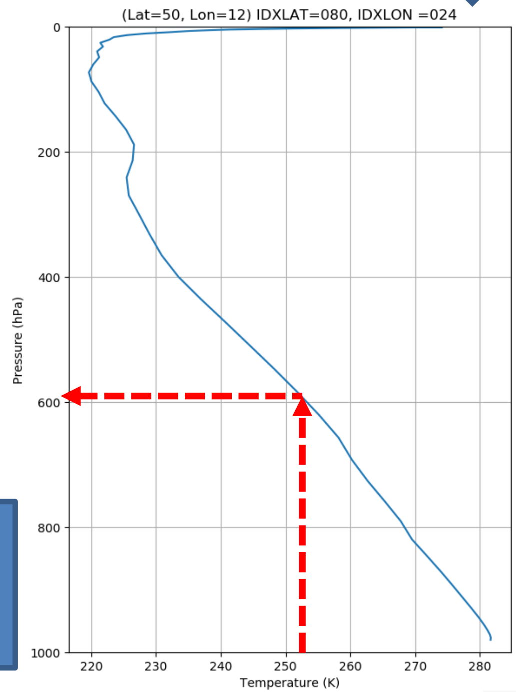
Check if really a cloud

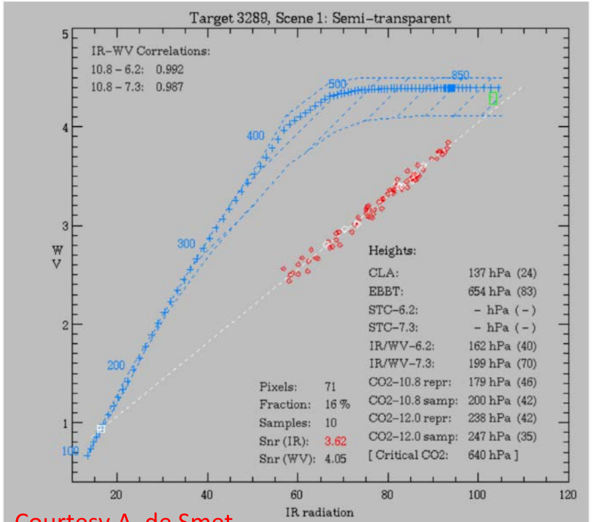
BT108 < BTCLP

OPA Cloud (EBBT)

STC (IR/WV)

Retrieve CTP exploiting: IR10.8 and WV6.2





Courtesy A. de Smet

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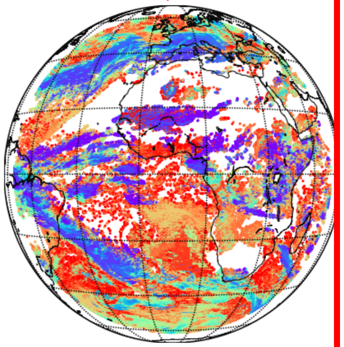
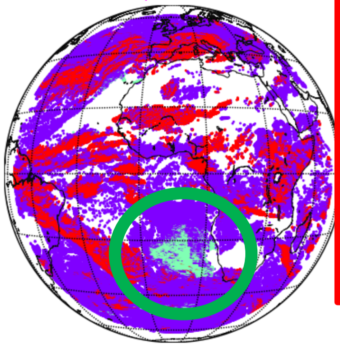
Cloud Retrieval: CLA

MET-10@201505011230 (SSP=0000,CFCTHR=50%)

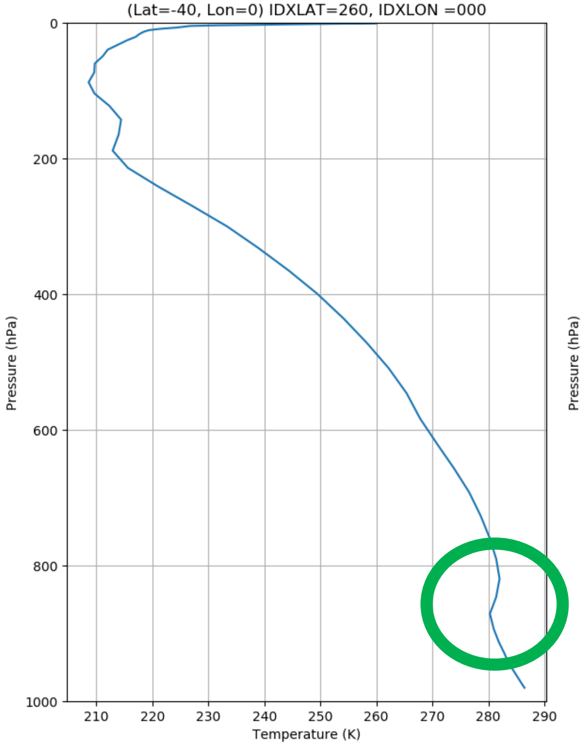
Cloud Top Pressure

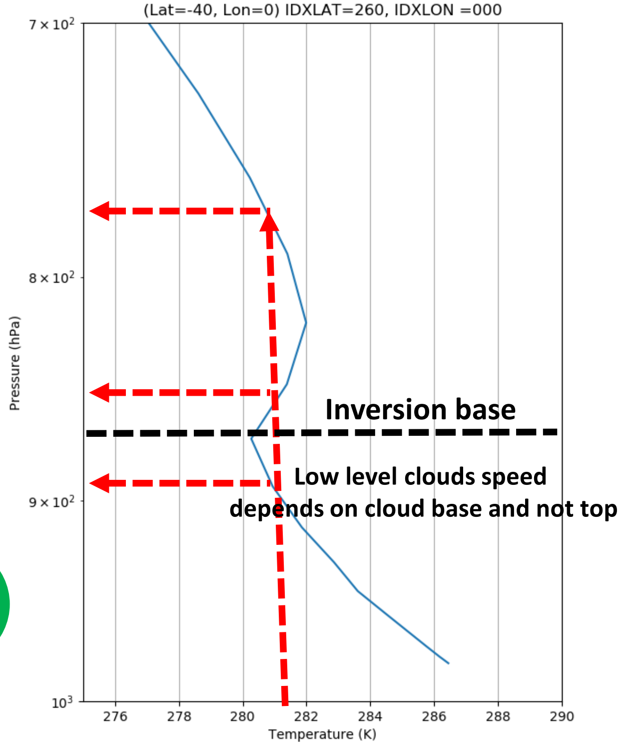


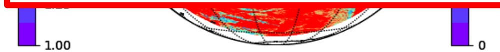
ctp method



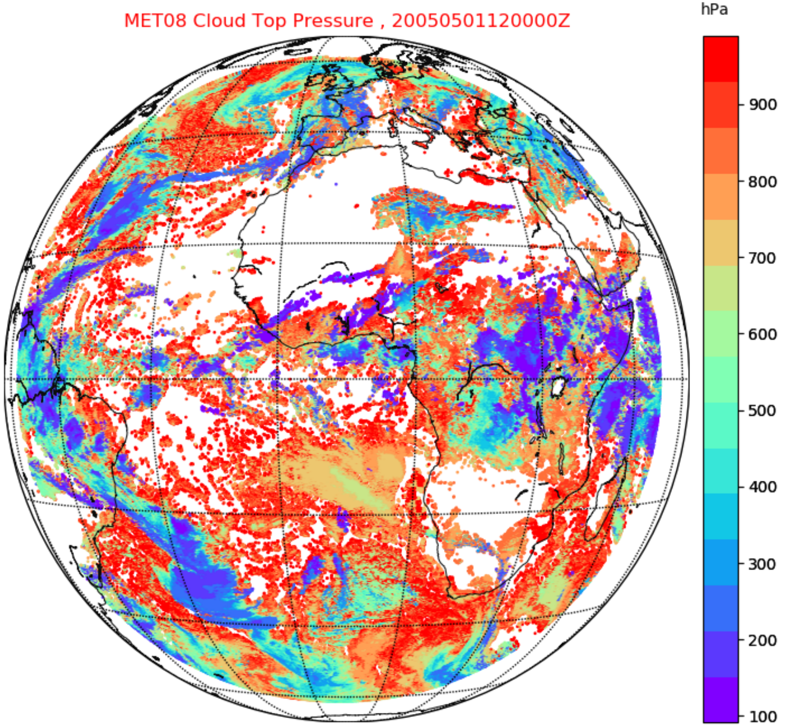
Low level inversion



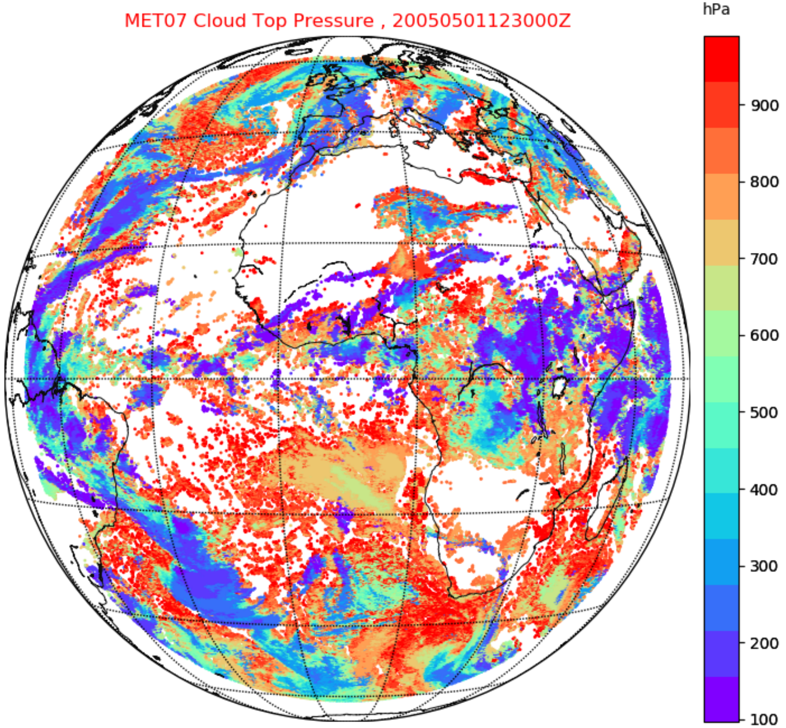




Cloud Retrieval: CLA



SEVIRI PS=3km, SCAN=12min



MVIRI PS=5km, SCAN=25min

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Atmospheric TCDR: ASR

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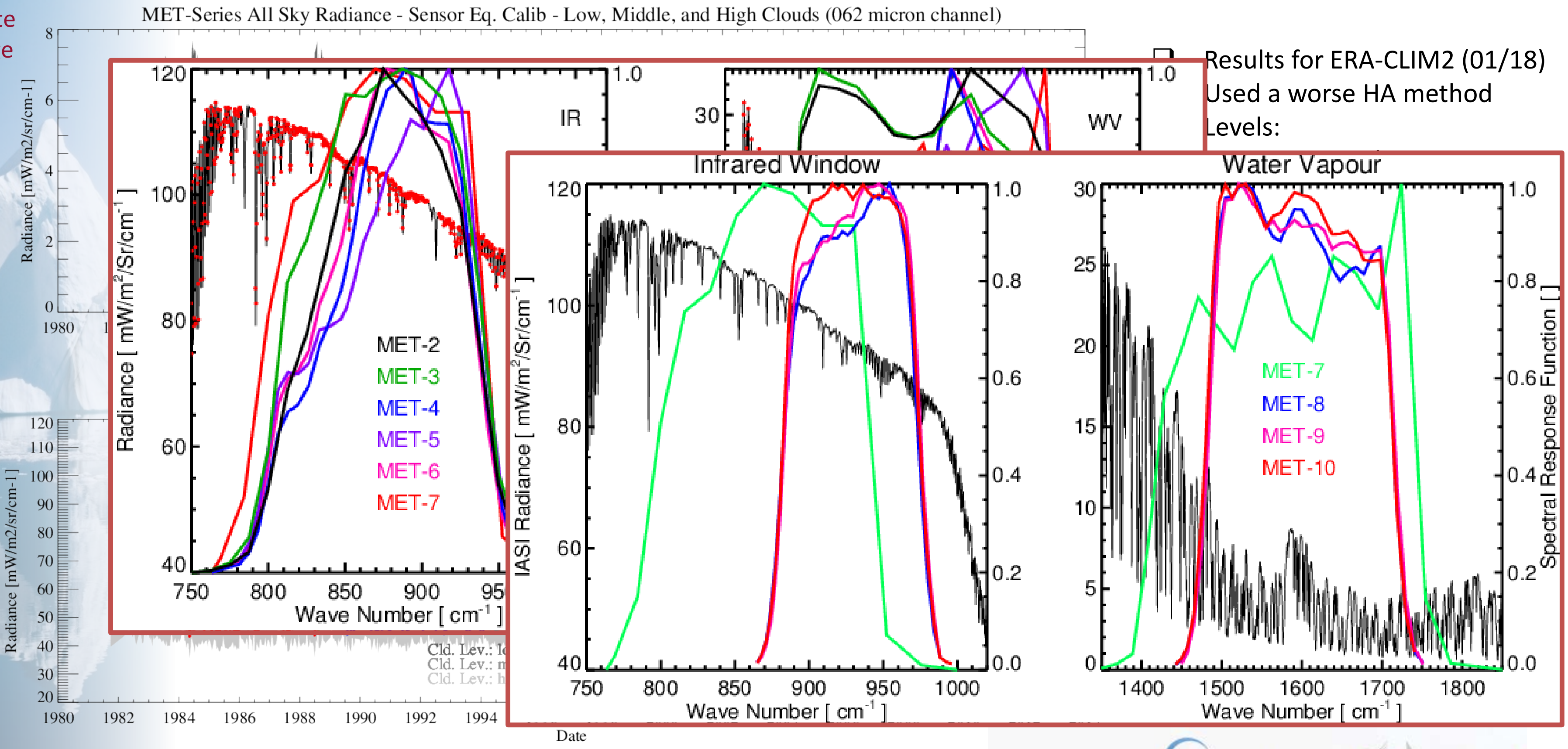
- Results for ERA-CLIM2 (01/18)
Used a worse HA method
Levels:



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Atmospheric TCDR: ASR

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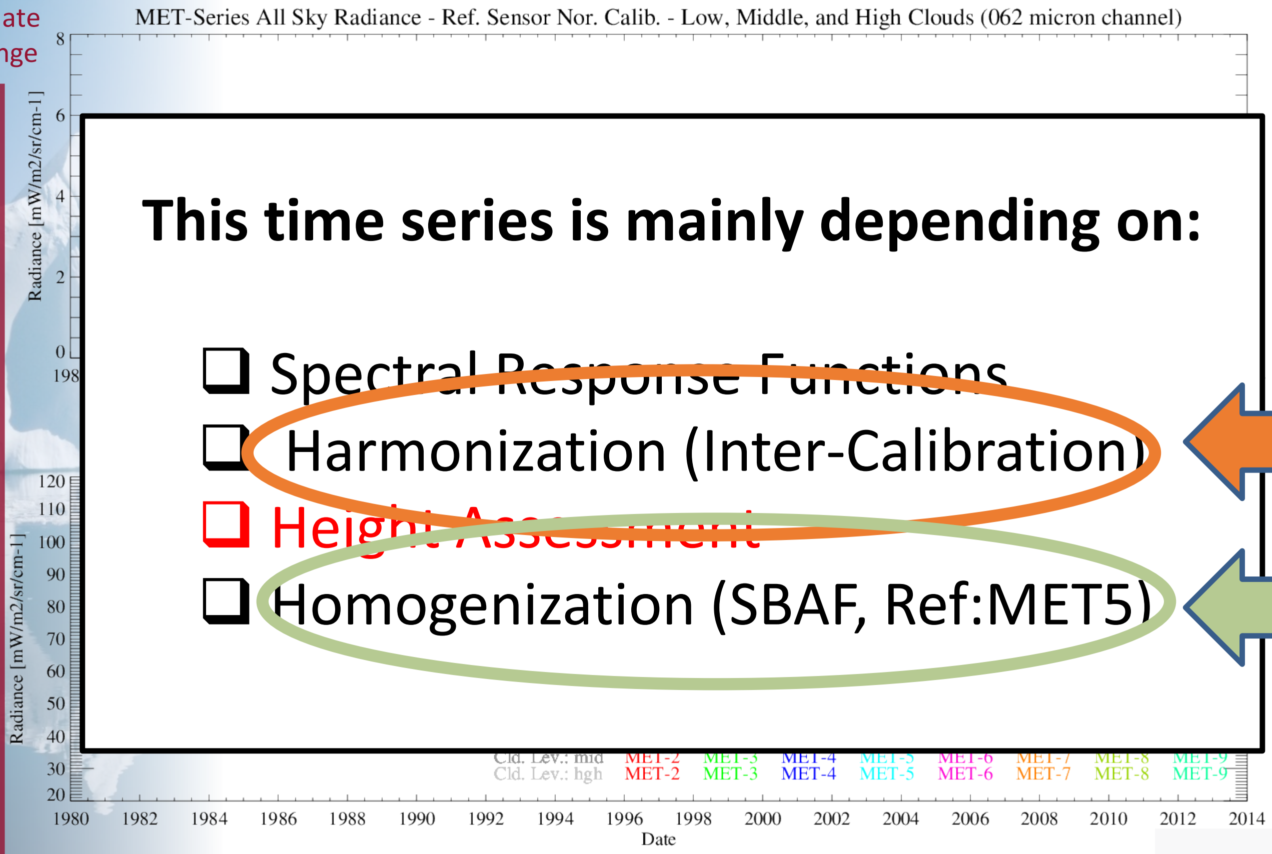

This time series is mainly depending on:

- ❑ Spectral Response Functions
- ❑ Harmonization (Inter-Calibration)
- ❑ Height Assessment
- ❑ Homogenization (SBAF, Ref:MET5)

Can we get a straight line?

Yes we can, using a reference Sensor and calculating the Spectral Band Adjustment Factor (SBAF)

Assimilation

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Atmospheric TCDR: AMV

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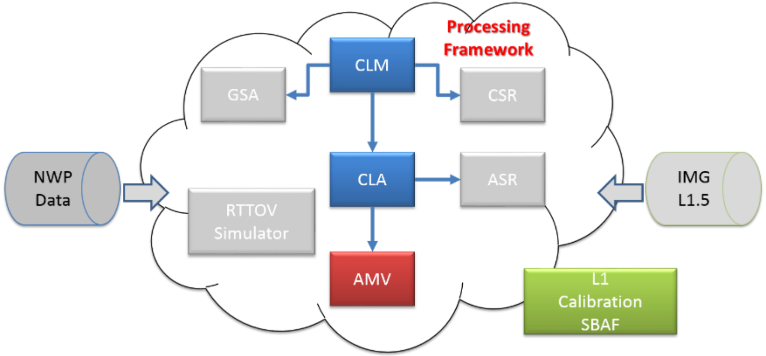
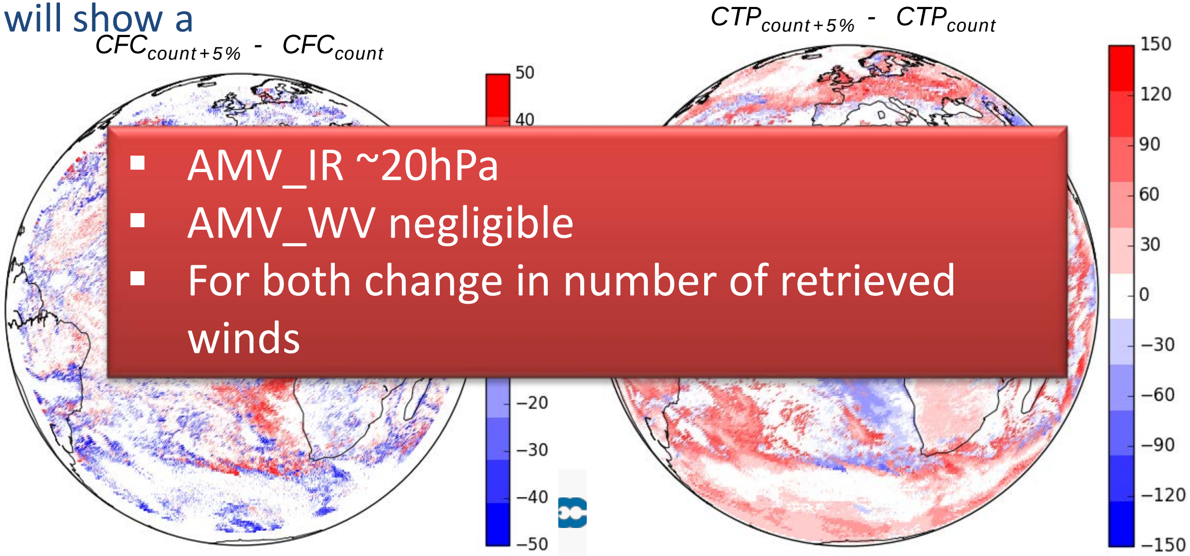
Sensitivity analysis on AMV (C3S report)

- Done using outdate CTP and AMV processors
- MVIRI Increase Radiance of each pixel of 5% ;
- CFC increases ~0.6% with a Standard Deviation of 14%;
- CFC in areas generally covered by low level clouds will increase while areas generally covered by high level clouds will show a decrease;
- CTP increases ~10±35 hPa;
- Clouds will be on average pushed more towards the surface;





- AMV_IR ~20hPa
- AMV_WV negligible
- For both change in number of retrieved winds

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Atmospheric TCDR: AMV

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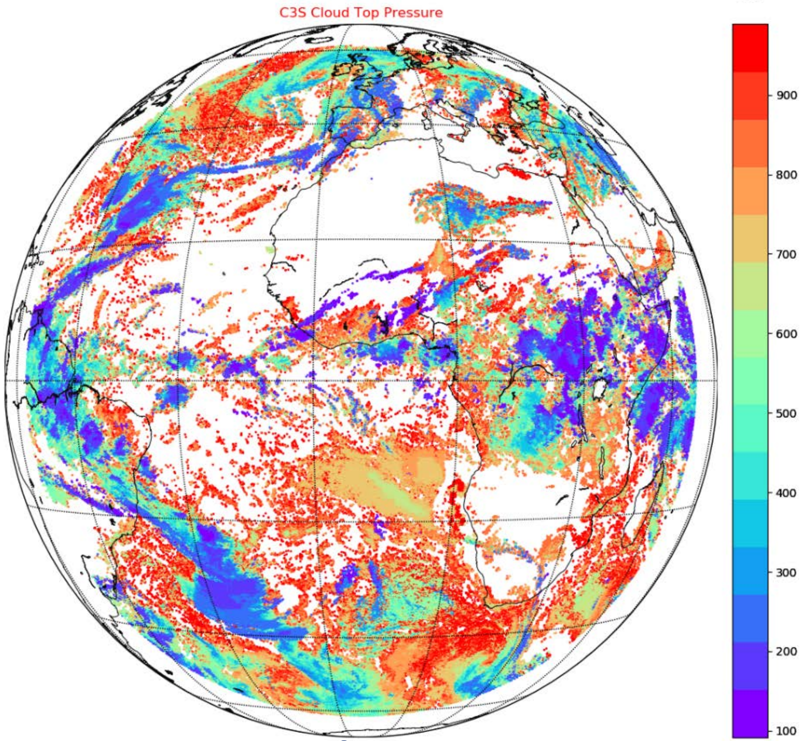
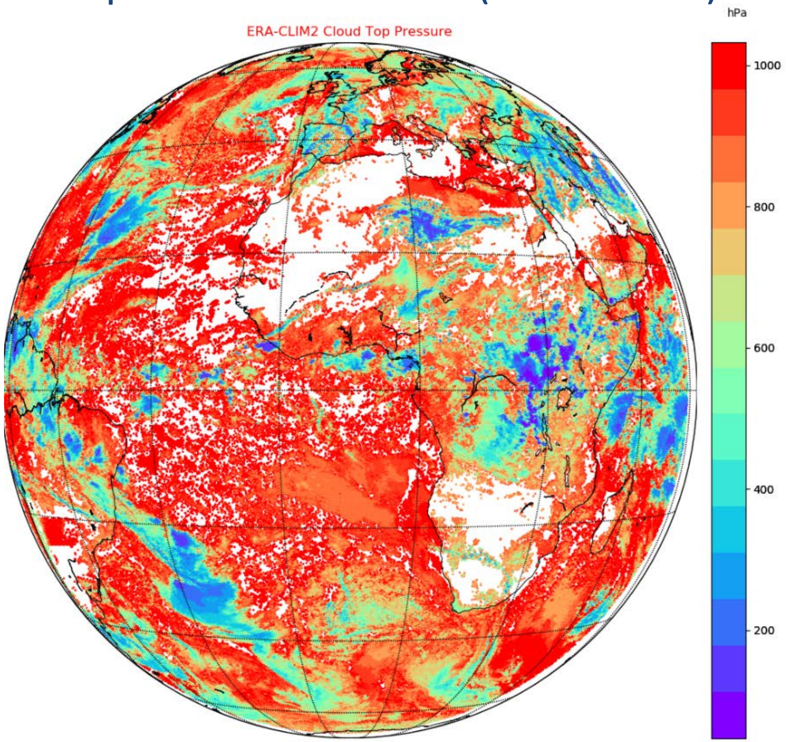
Current CLA (C3S)



SEVIRI PS=3km, SCAN=12min

Lapse rate driven HA (ERA-CLIM2)



SEVIRI PS=3km, SCAN=12min

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Atmospheric TCDR: AMV

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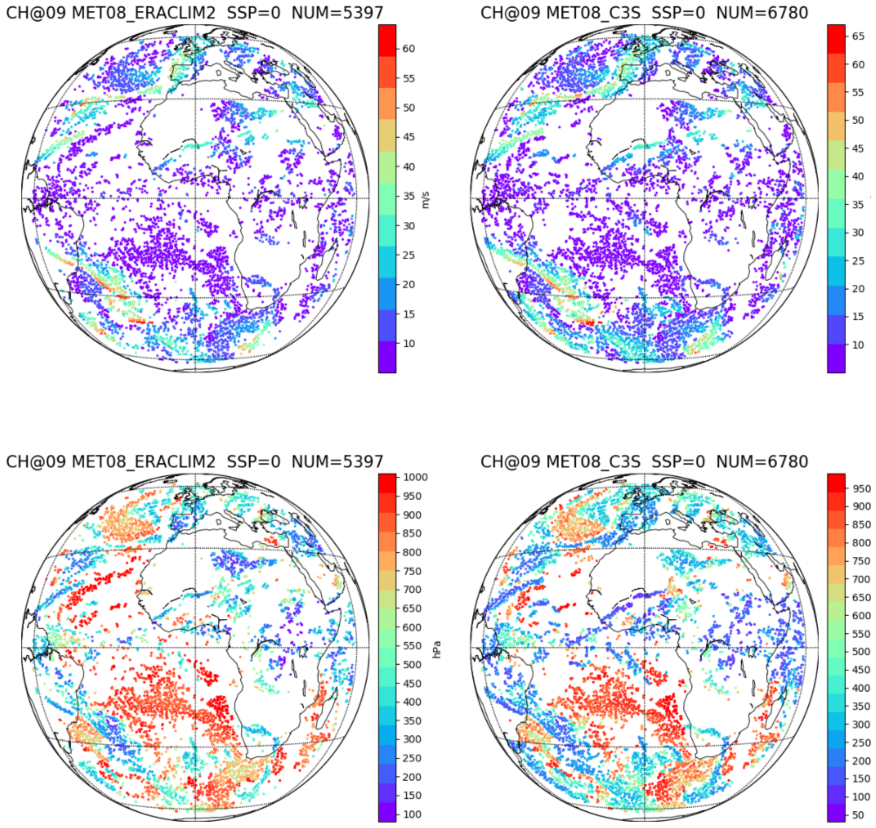
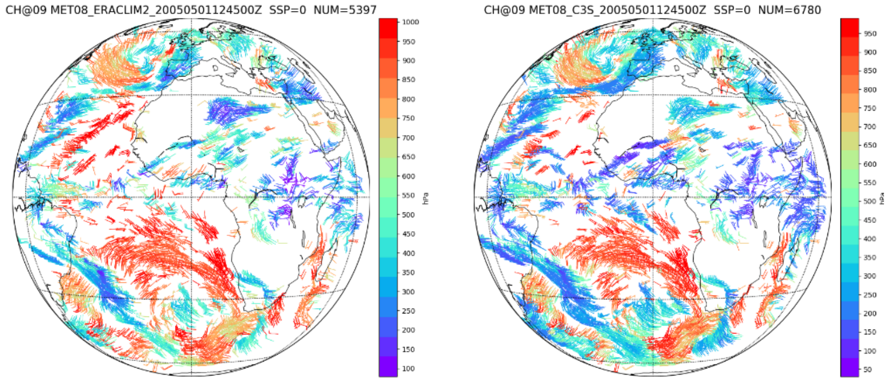


IR108: Comparison between simple Lapse rate depending HA (ERA-CLIM2) and current CLA (C3S)



- Speed fields not affected
- Pressure fields changed
- More High QI retrievals

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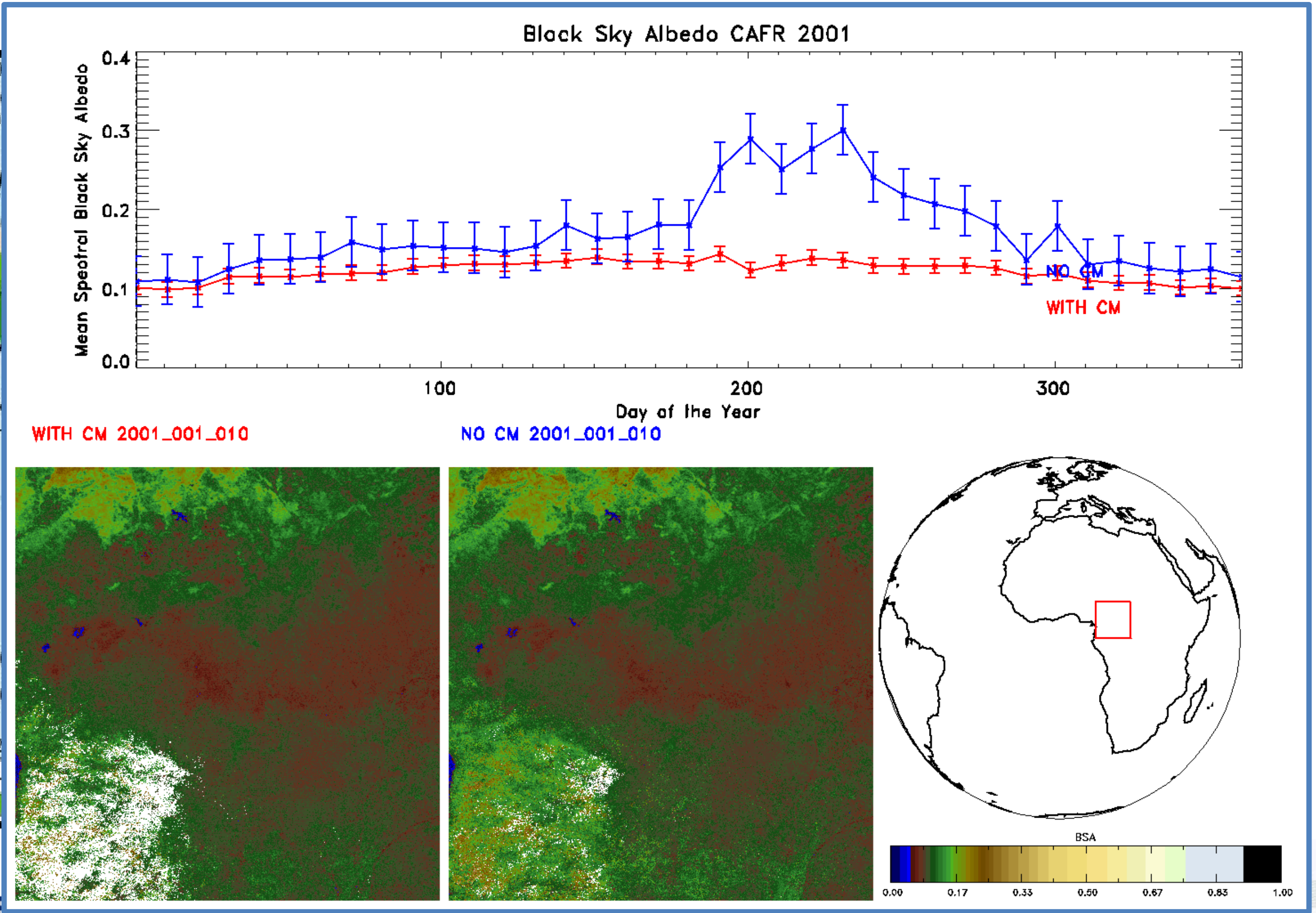
Land TCDR



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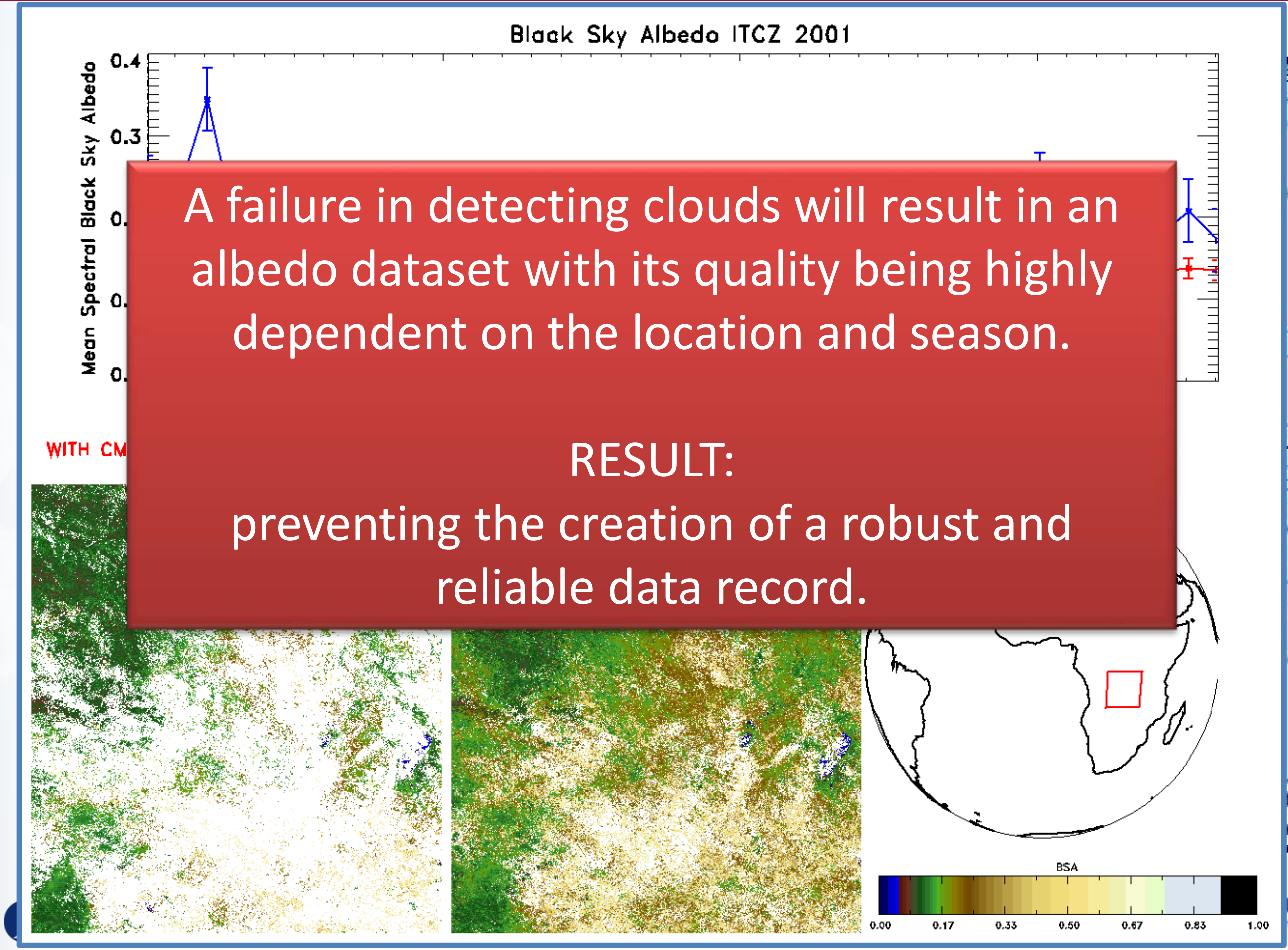
Land TCDR



A failure in detecting clouds will result in an albedo dataset with its quality being highly dependent on the location and season.

RESULT:

preventing the creation of a robust and reliable data record.

Conclusions

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- Basically all GEO CDRs generated at EUMETSAT are depending on some cloud retrieval, which is for us a means to an end;
- Key point is a cloud retrieval processor ideally working (having been fully tested) on any GEO platform. This might result in lower than possible quality retrievals for more advanced/recent sensor w.r.t. older one;
- CDR user requirements for Assimilation (harmonized) and Climate (homogenized) differ due to differences in their applications. Potential both should be generated;
- Cloud Mask is paramount for any land retrieval, as for Surface Albedo, and should not introduce seasonal and spatial dependent spurious signals;
- Cloud Top Height is paramount for any reasonable ASR and AMV retrieval. It is the factor introducing the highest uncertainty. Incorrect height assignment, due to a bad cloud analysis, will result in a poorer quality wind vectors.

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THANK YOU!

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Cloud Retrieval: CLM

From CMSAF Cloud Fractional Cover ATBD: **DOI: 10.5676/EUM_SAF_CM/CFC METEOSAT/V001**

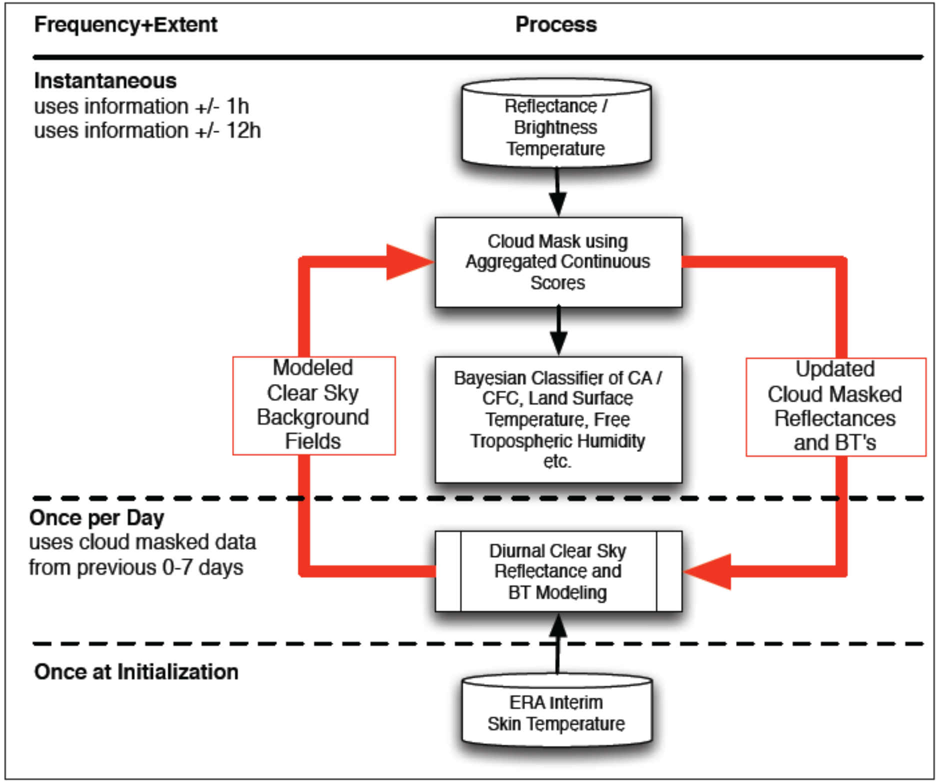

Figure 1: Schematic flowchart for the cloud mask and ECV processing of GeoSatClim .

1. Retrieve reflectances and brightness temperatures on native satellite grid.
2. Calculate preliminary cloud mask based on previous day's clear sky background fields.
3. Retrieve updated (this day's) clear sky background fields based on new cloud masked reflectances and brightness temperatures.
4. Calculate final cloud mask based on updated clear sky background fields.
5. Calculate downstream variables like CA, CFC, LST or FTH using cloudy or clear sky reflectances and brightness temperatures.
6. Spatially aggregate ECV's from native satellite grid to chosen geographical output projection (not shown).
7. Temporally aggregate ECV's from native satellite time resolution to hourly, daily and monthly time resolution (not shown).

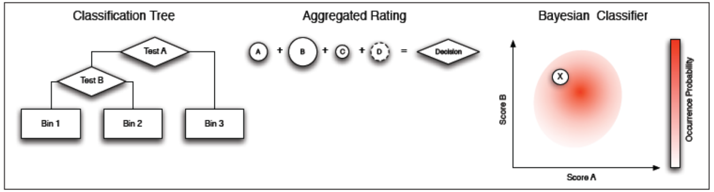

Figure 2: Three generations of cloud masking methods: classification based on a binary decision tree (left), classification using aggregated rating of continuous scores (center) and bayesian classification using cloud probability distributions (right).

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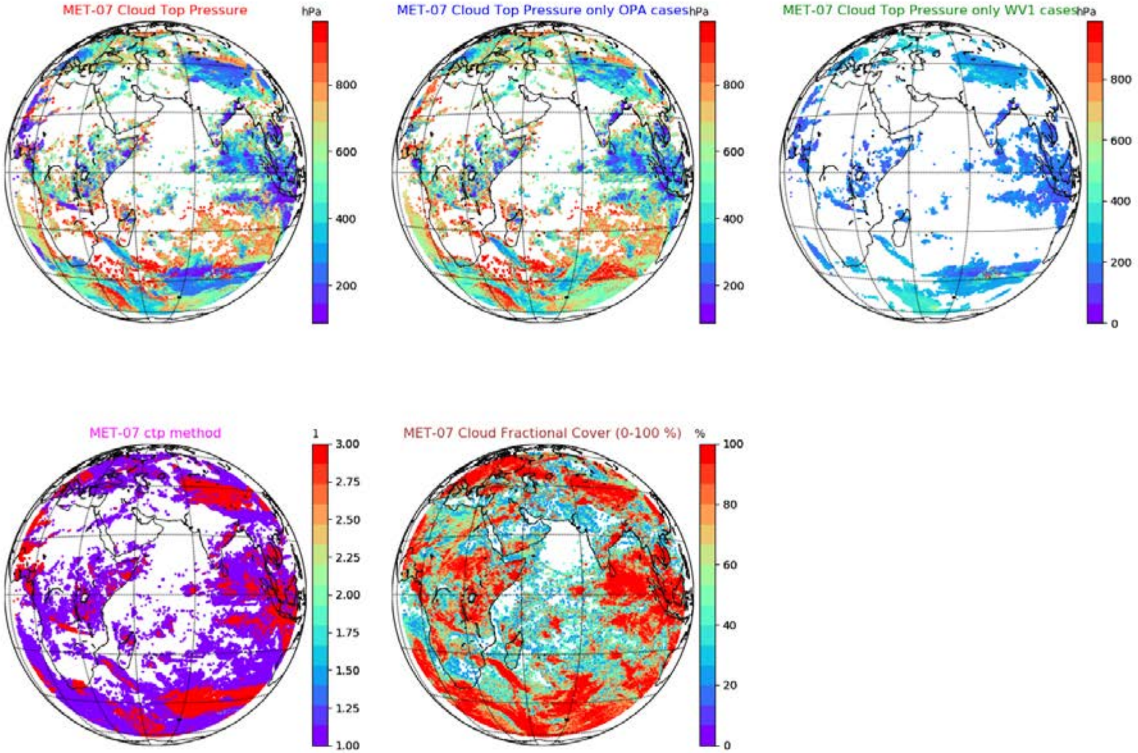
Cloud Retrieval: CLA

MET-07@201505011230 (SSP=0570,CFCTHR=50%)



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Atmospheric TCDR: AMV

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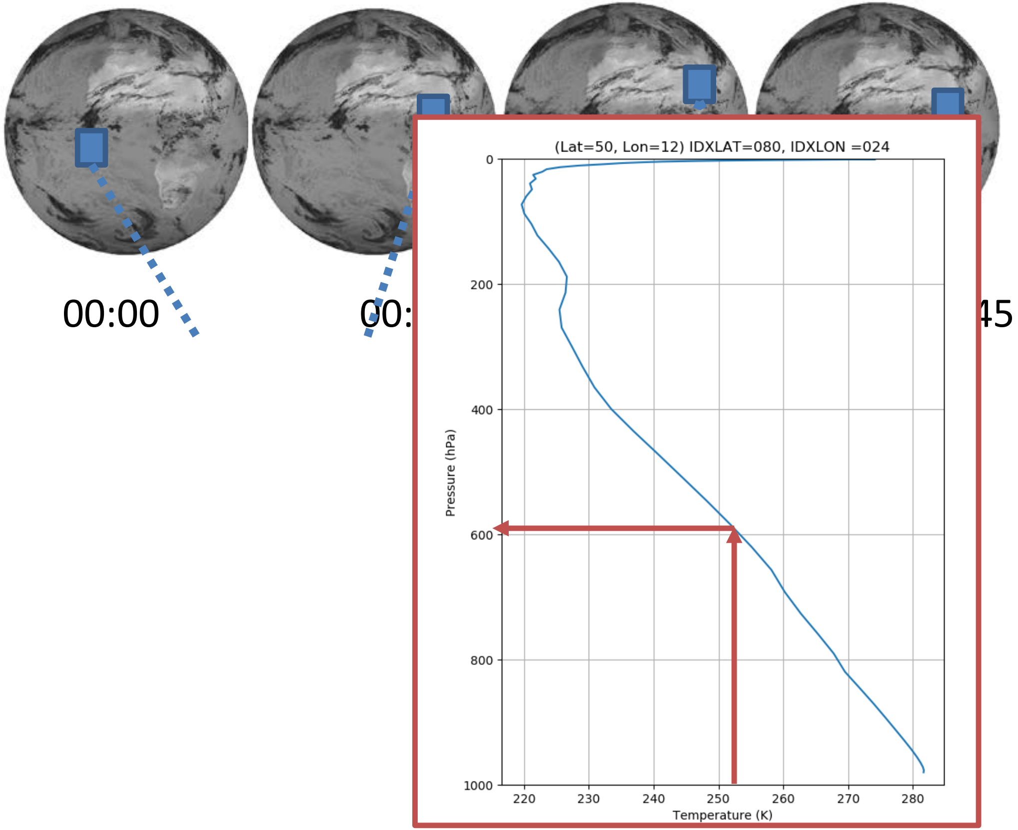
- ❑ Target Selection
- ❑ Tracking (displacement)
- ❑ Height Assignment
- ❑ Quality Indicator



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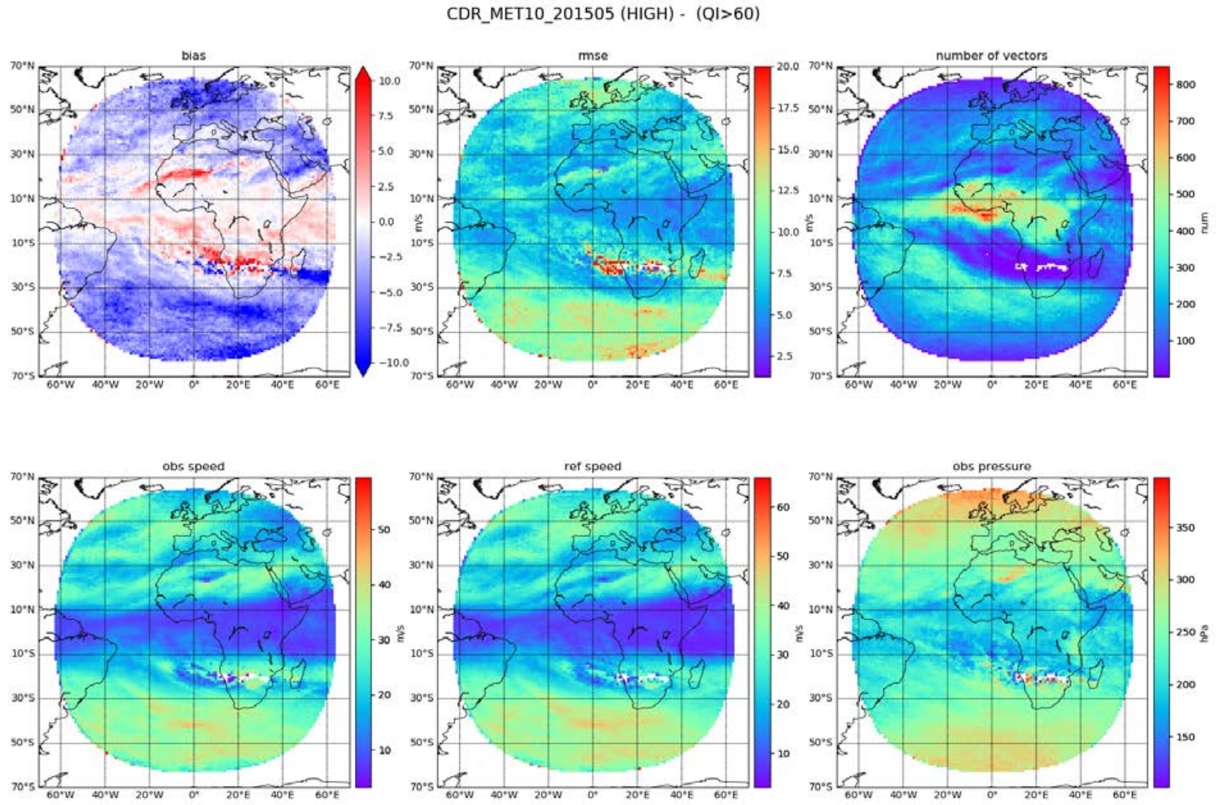
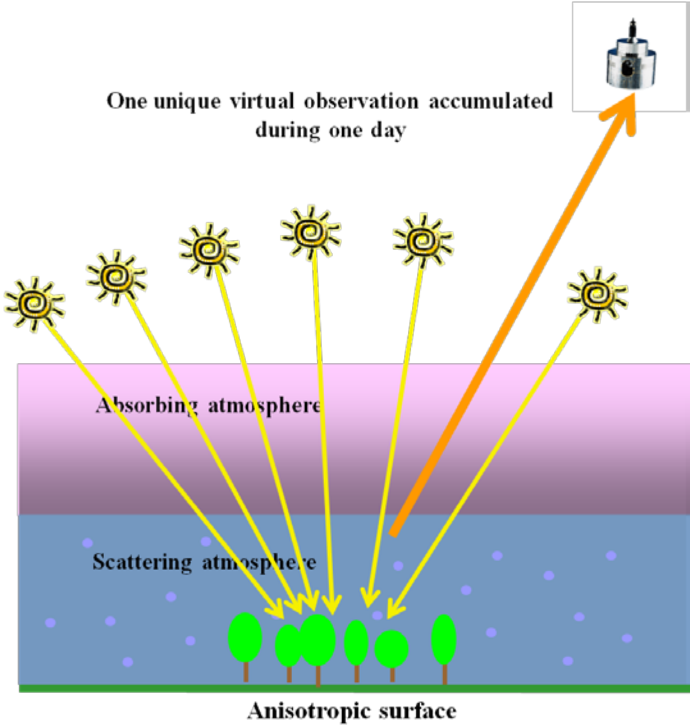
Atmospheric TCDR: AMV



Land TCDR

- The Geostationary Surface Albedo (GSA) is based on a method proposed by Pinty et al. in 2000 which:

  - *relies on a daily sampling of clear sky radiances*
  - *assumes applicability of the reciprocity principle*
  - *performs the inversion with a fast RTM*
  - *ingests TCWV and TCO3 as input parameters*



- GSA retrieves jointly albedo and aerosol load
- GSA processes single VIS band images
- Spatial resolution 2-3 km (instrument pixel size)
- Run time Assessment of measurement error
- Estimation of the retrieval uncertainty
- Final product: 10-days composite (minimizing the impact of cloud coverage)