Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Three decades of cloud properties from HIRS - a new climate dataset by CMSAF

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CM SAF
Climate Monitoring

LMD

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CM SAF cloud datasets

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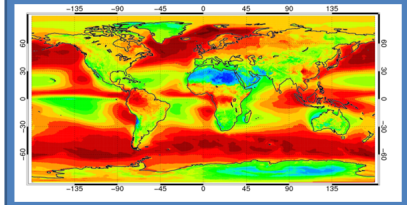
Current cloud property dataset of the Satellite Application Facility for Climate Monitoring (CM SAF)

- CLARA-A1/2 (AVHRR-based, Karlsson et al., 2013, ACP)
- CLAAS-1/2 (SEVIRI-based, Stengel et al., 2014, ACP)
- HIRS high clouds (Wylie et al., 2005, J. Climate) [1982 - 2002]

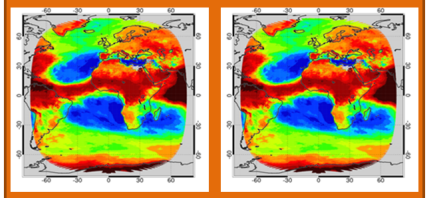
CLARA-A2: global, AVHRR-based, long-term



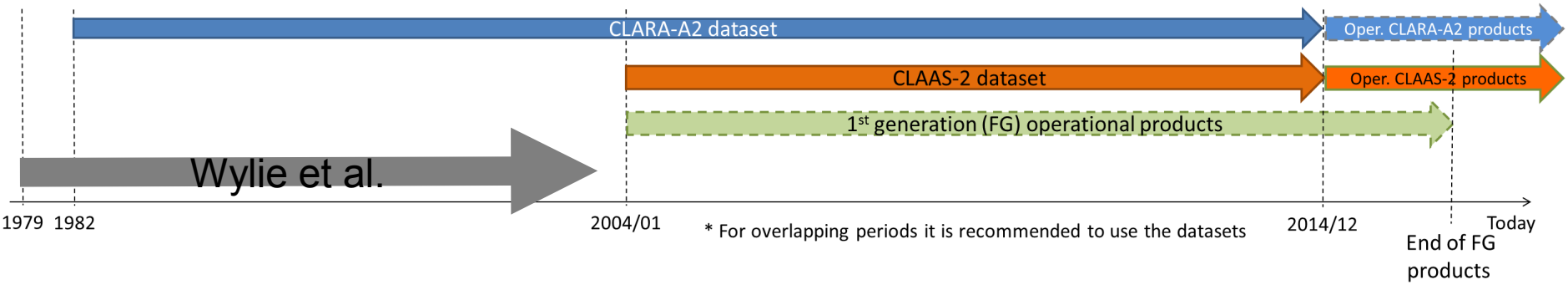
Products :
-cloud fraction, cloud phase
-cloud top pres./height/temp.
-cloud optical thickness, LWP, IWP

- Daily, monthly mean, monthly histograms
- 0.25° lat/lon grid (1.0° for JCH)

CLAAS-2: SEVIRI disk (Europe, Atlantic, Africa)



Products:
- Cloud fraction, cloud phase
- cloud top pres./height/temp.
- cloud optical thickness, LWP, IWP, JCH
- Hourly, daily, monthly means
- Monthly histograms, mean diurnal cycles
- 0.05° lat/lon grid, (0.25° for JCH)



CM SAF cloud datasets

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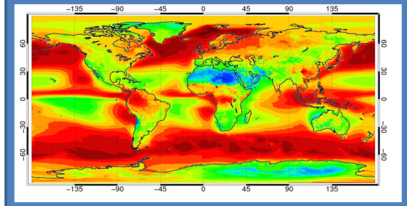
Current cloud property dataset of the Satellite Application Facility for Climate Monitoring (CM SAF)

- CLARA-A1/2 (AVHRR-based, Karlsson et al., ACP)
- CLAAS-1/2 (SEVIRI-based, Stengel et al., ACP)
- New: HIRS-based cloud dataset with focus on high clouds

CLARA-A2: global, AVHRR-based, long-term



Products :
-cloud fraction, cloud phase
-cloud top pres./height/temp.
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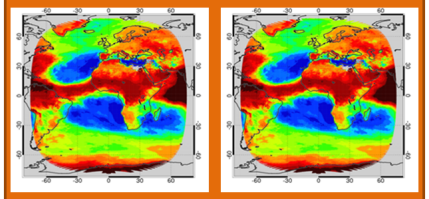
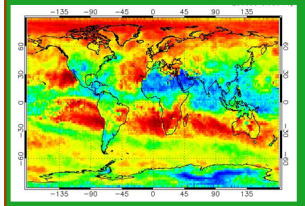
- Daily, monthly mean, monthly histograms
- 0.25° lat/lon grid (1.0° for JCH)

CLAAS-2: SEVIRI disk (Europe, Atlantic, Africa)

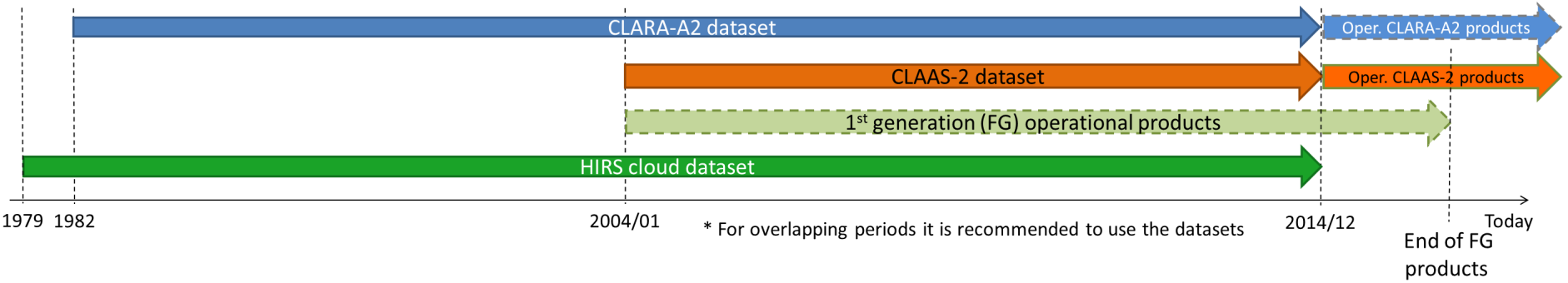


Products:
- Cloud fraction, cloud phase
- cloud top pres./height/temp.
- cloud optical thickness, LWP, IWP, JCH
- Hourly, daily, monthly means
- Monthly histograms, mean diurnal cycles
- 0.05° lat/lon grid, (0.25° for JCH)

HIRS clouds: global, long-term



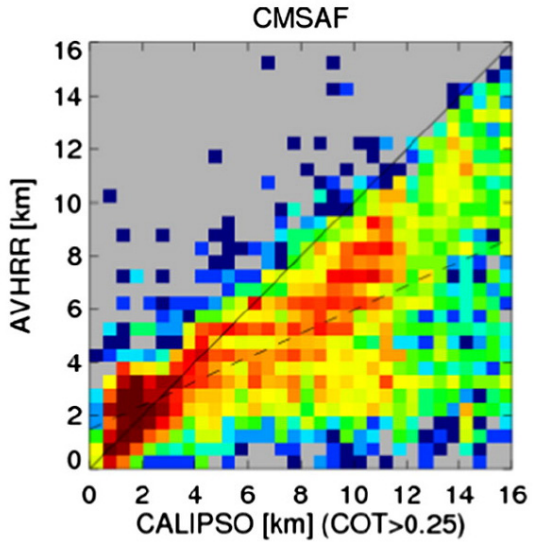
Products:
- Cloud fraction,
- cloud top pres./height/temp.
- Daily, monthly means, L2b
- Monthly histograms, mean diurnal cycles
- 0.5° lat/lon grid

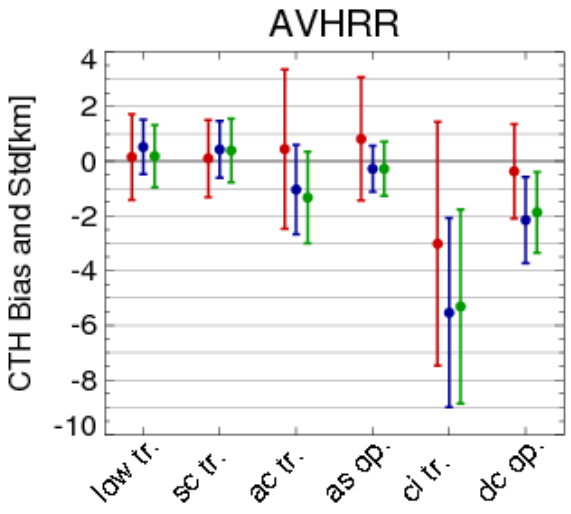


* For overlapping periods it is recommended to use the datasets

Background & Motivation

- Passive imagers are well suited for retrieval of microphysical properties and cloud masking; the vertical placement of clouds is often systematically wrong (if absorption channels are not present), i.e. for high semi-transparent clouds





(Stengel et al., 2013, RSE)

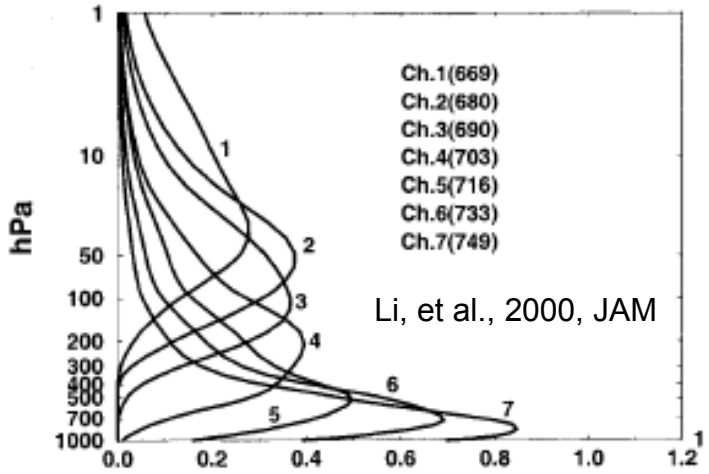
Cloud properties from HIRS (infrared sounder) are complementing AVHRR

HIRS retrieval used

- Cloud retrieval from InfraRed Sounders (CIRS), developed at LMD for AIRS
- Adaptation made at DWD to be applicable to HIRS
- Use 4 absorption channels: 4,5,6,7 and window channel 8
- MIN(CH^2) -> cloud top layer

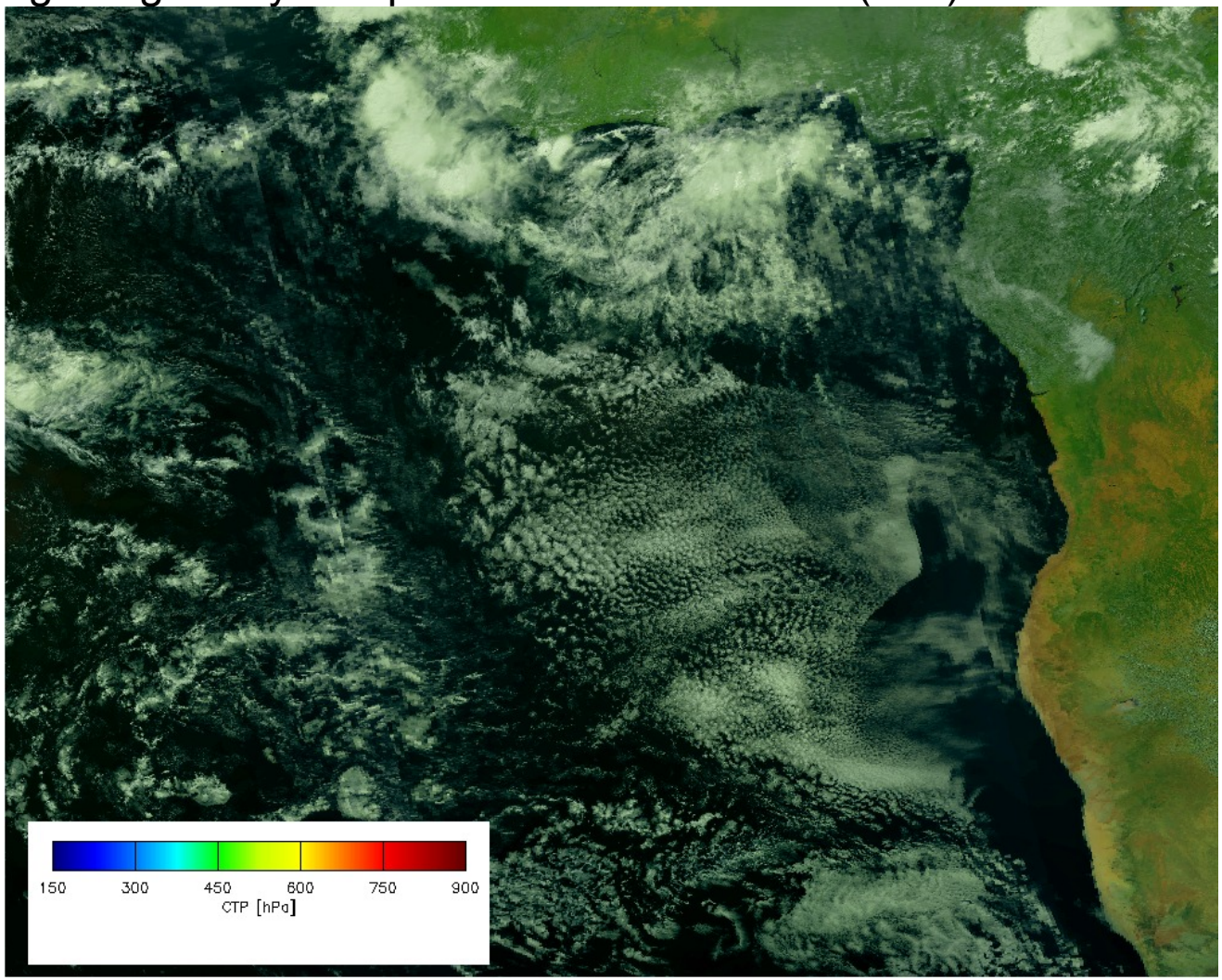
$$CH^2(p_k) = \sum_i \frac{\left(I_{opaque}(p_k, \nu_i) - I_{clear}(\nu_i)\right) \varepsilon(p_k) * \left(I_{measure}(\nu_i) - I_{clear}(\nu_i)\right)^2}{\sigma^2}$$

HIRS CO2 channels



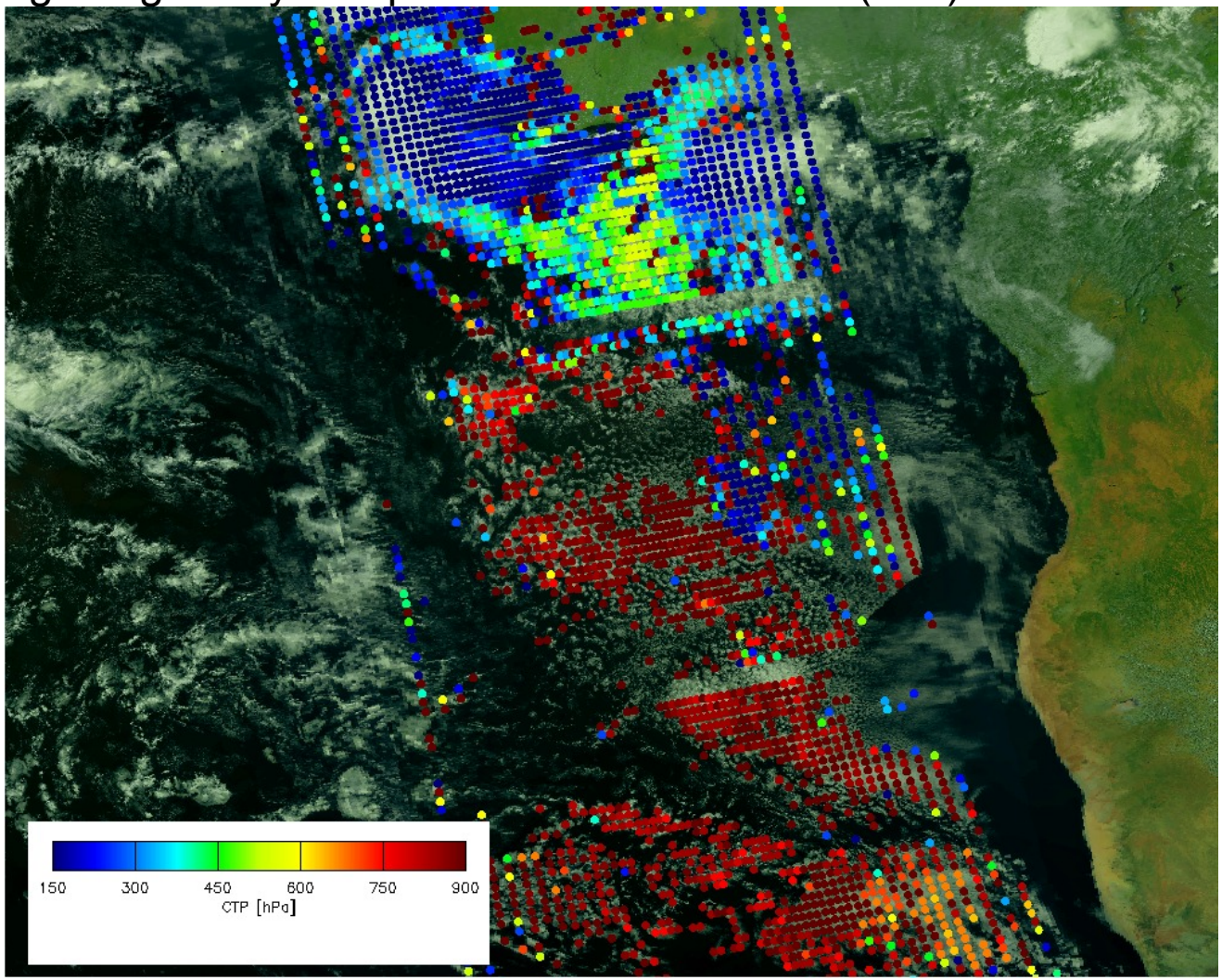
Example

➔ RGB image of globally sampled AVHRR radiances (L2b)



Example

➔ RGB image of globally sampled AVHRR radiances (L2b) + HIRS CTP



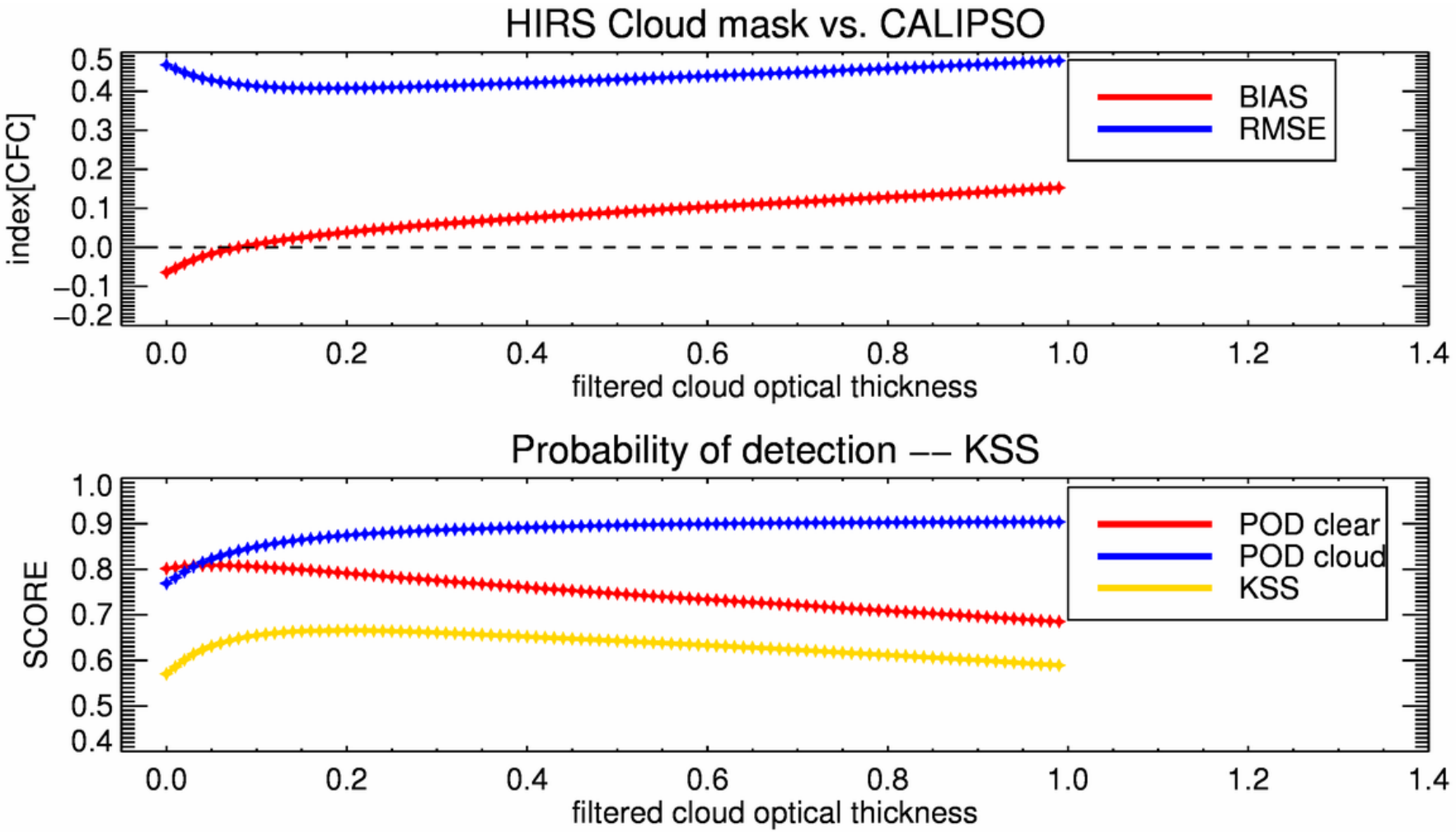
Cloud detection

- For cloud detection, two tests are applied:
  1) Standard deviation over all used channel radiances
     (the more homogeneous all radiances are, the more likely a cloud is observed.)
  2) Difference BT between 11.1µm thermal window and surface temperature
     (the larger this difference, the more likely a cloud is observed)

- Validating cloud fraction against CALIPSO:

CMSAF HIRS CALIPSO (COT>0.15)

Cloud detection

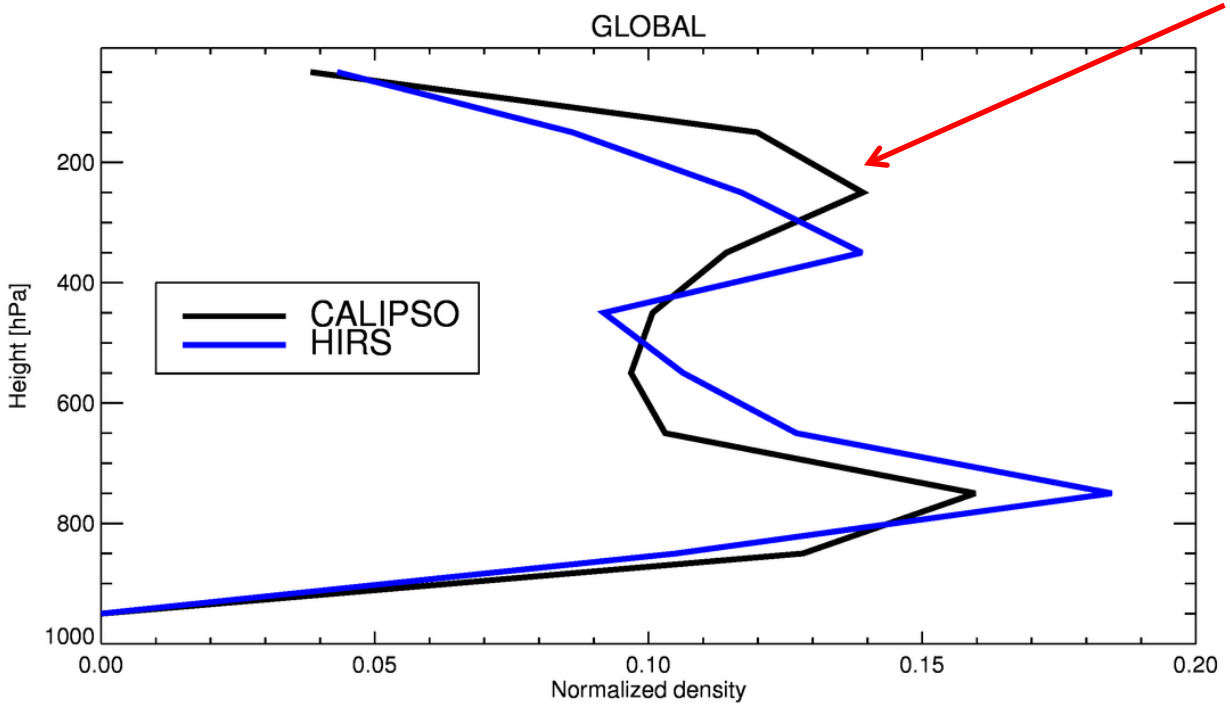


(2 years of NOAA-19/HIRS – CALIPSO colocation, 2011-2012)

Cloud top level retrieval

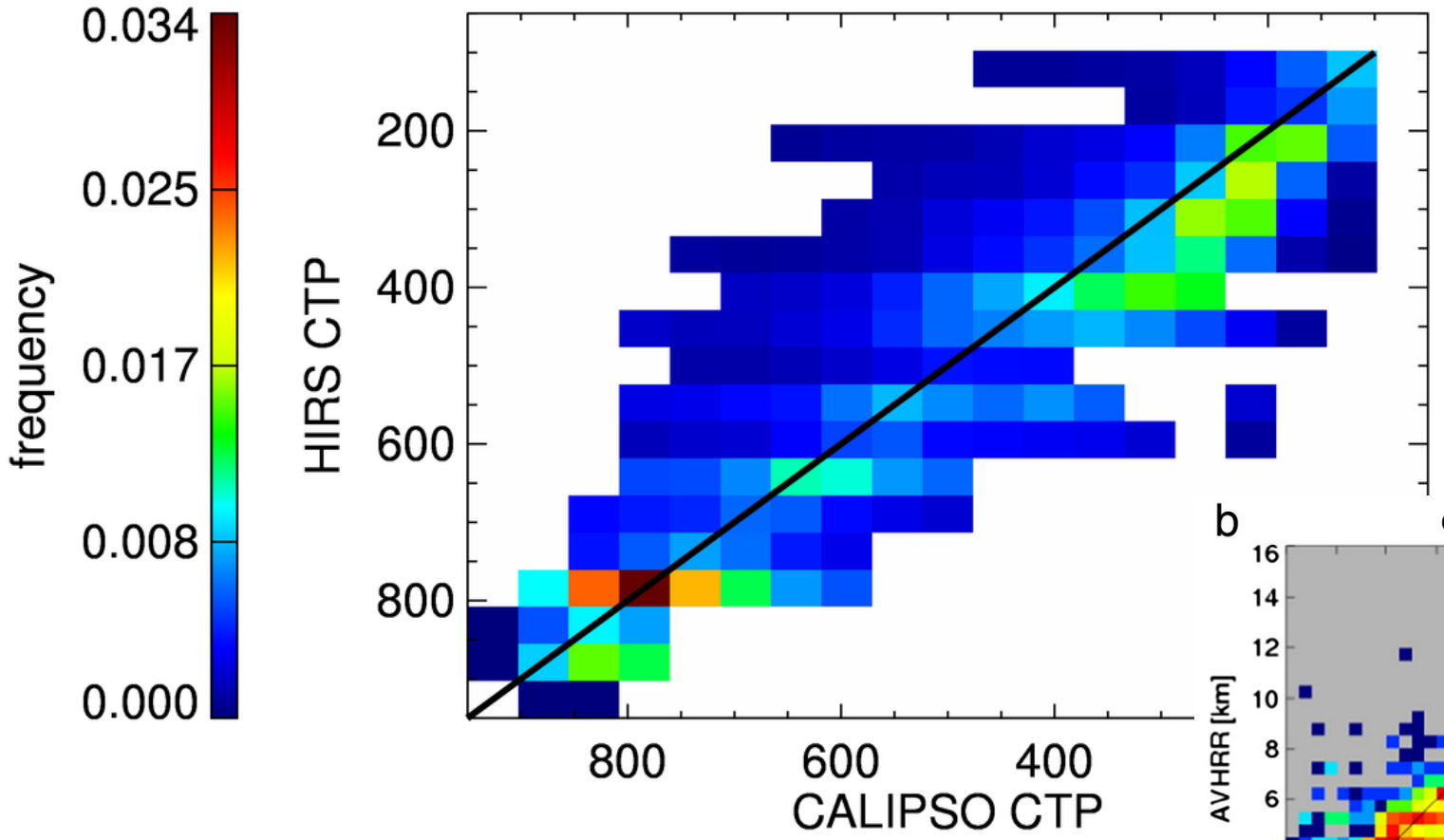
- Comparing NOAA19/HIRS CTP with CALIPSO:

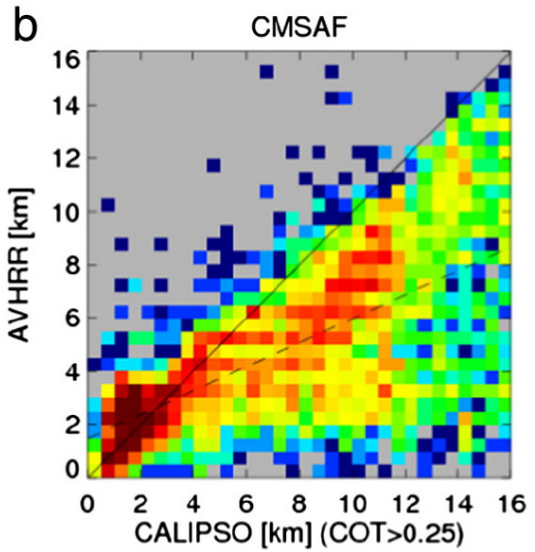
This peak is often completely missing in AVHRR-based data



(CALIPSO CTP taken at uppermost level for which COT > 0.15)

Cloud top level retrieval

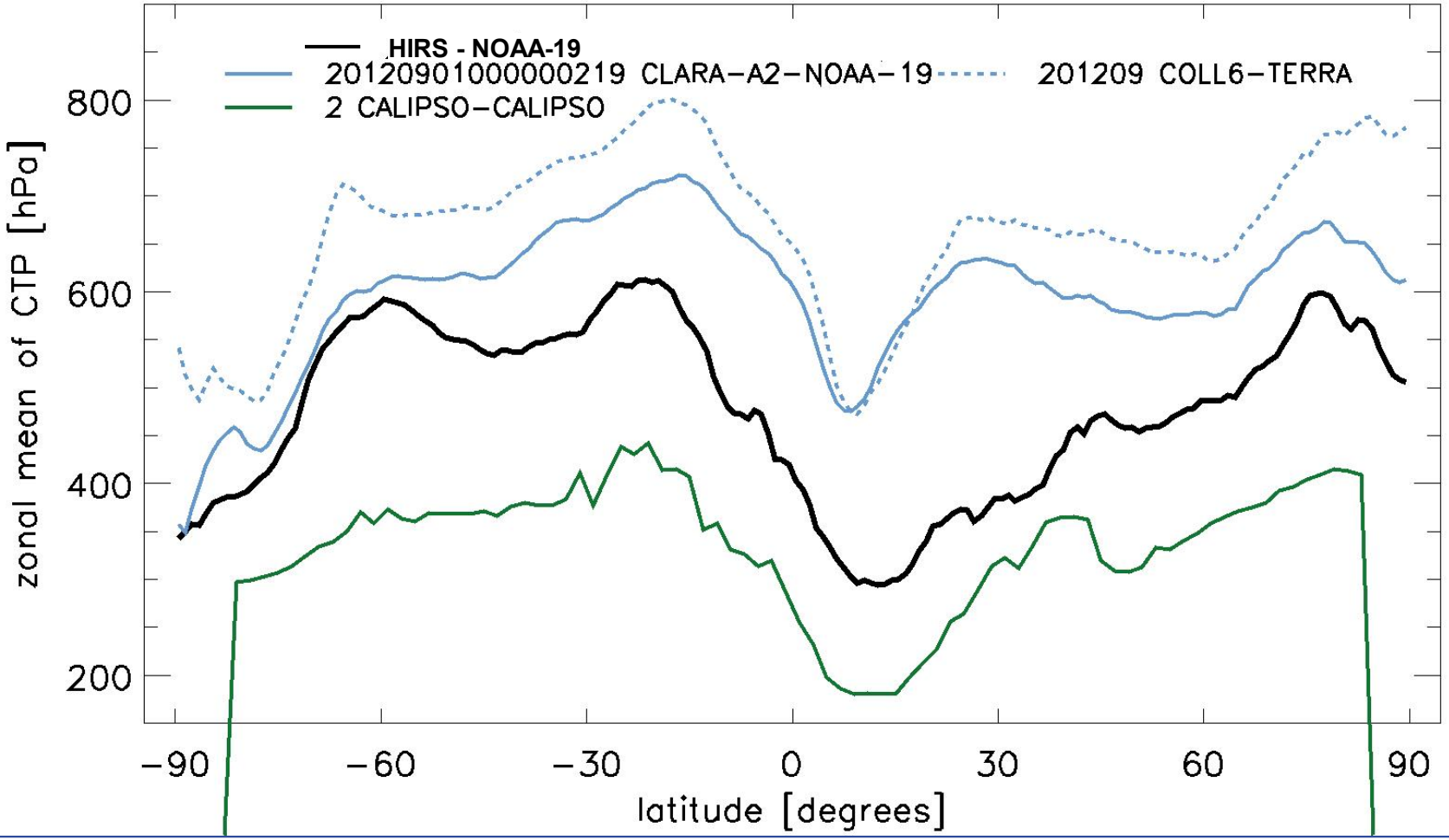




(CALIPSO CTP taken at uppermost level for which COT > 0.15)

Cloud top level retrieval

- Comparing NOAA19/HIRS monthly mean as zonal mean CTP with MODIS/TERRA coll. 6 / CLARA A2 / CALIPSO [all clouds]



Cloud top level retrieval

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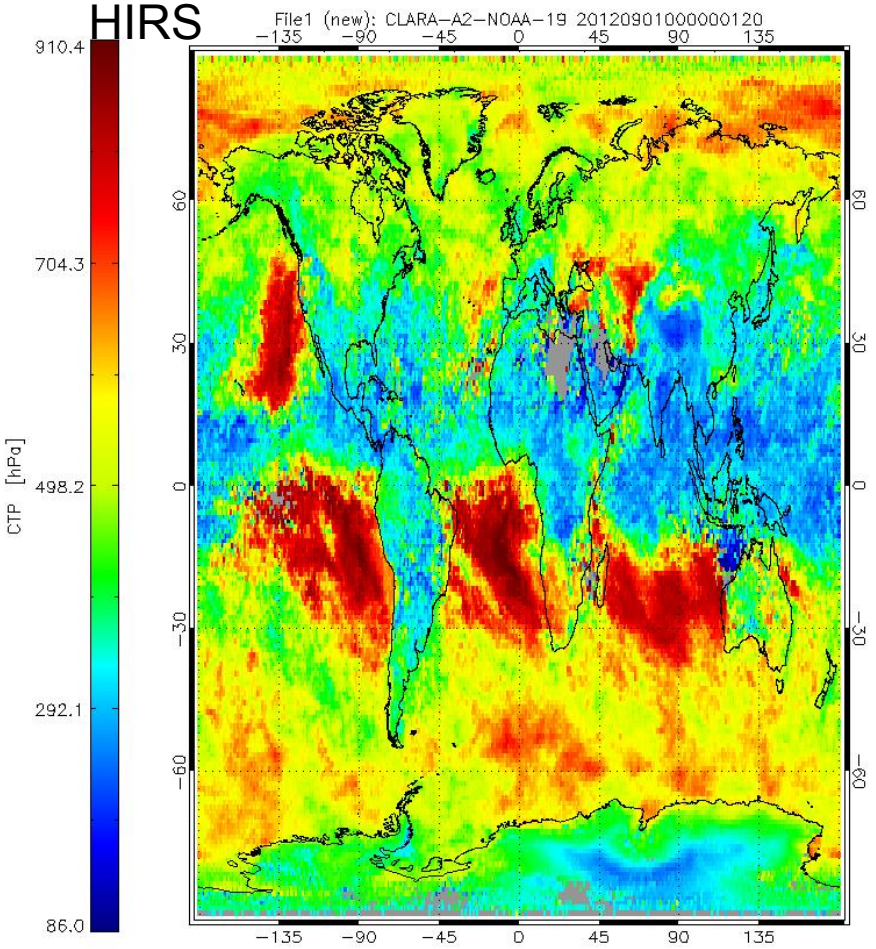
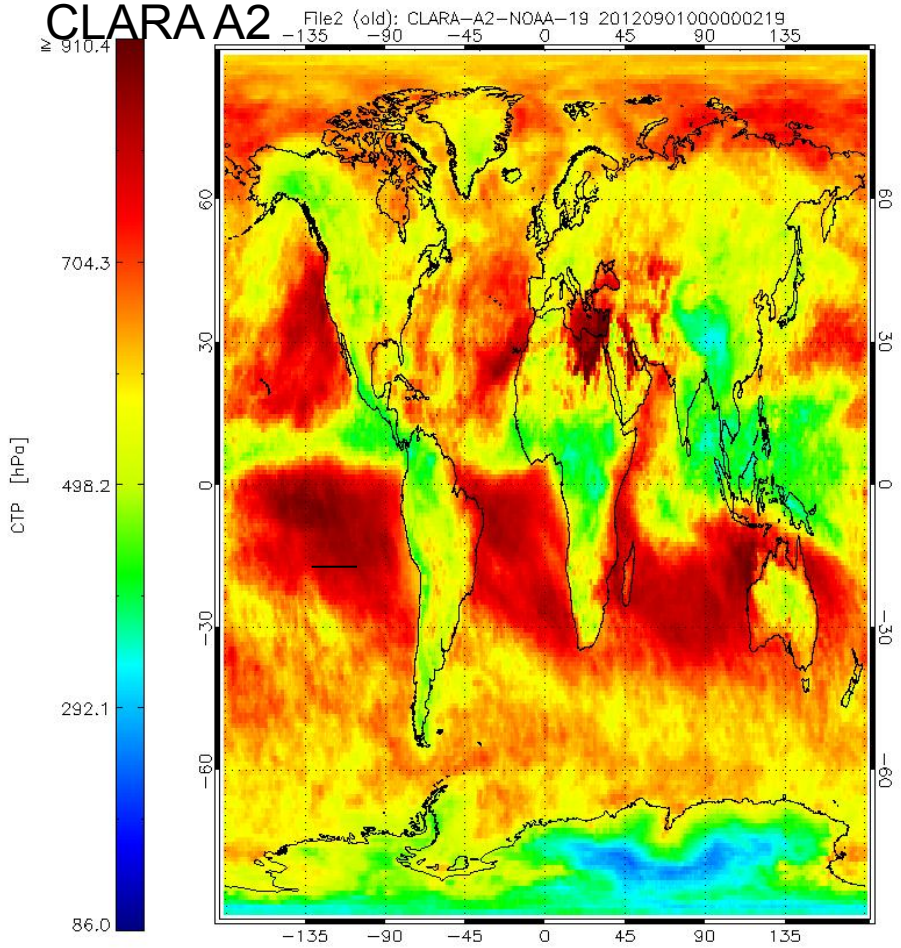
- Comparing NOAA19/HIRS monthly mean CTP with CLARA A2 [AVHRR]

HIRS

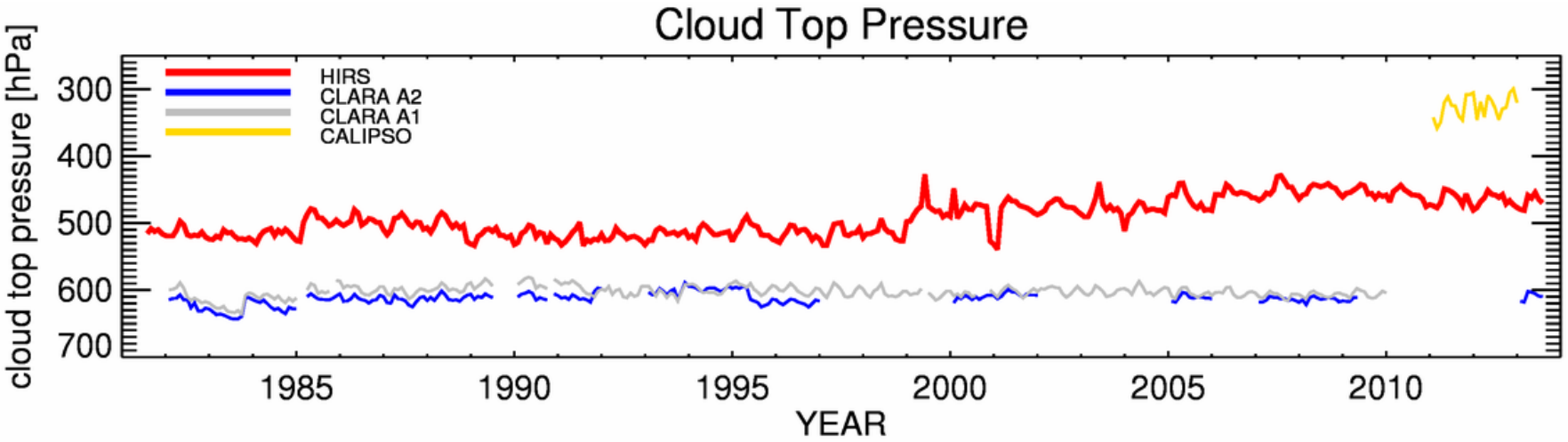


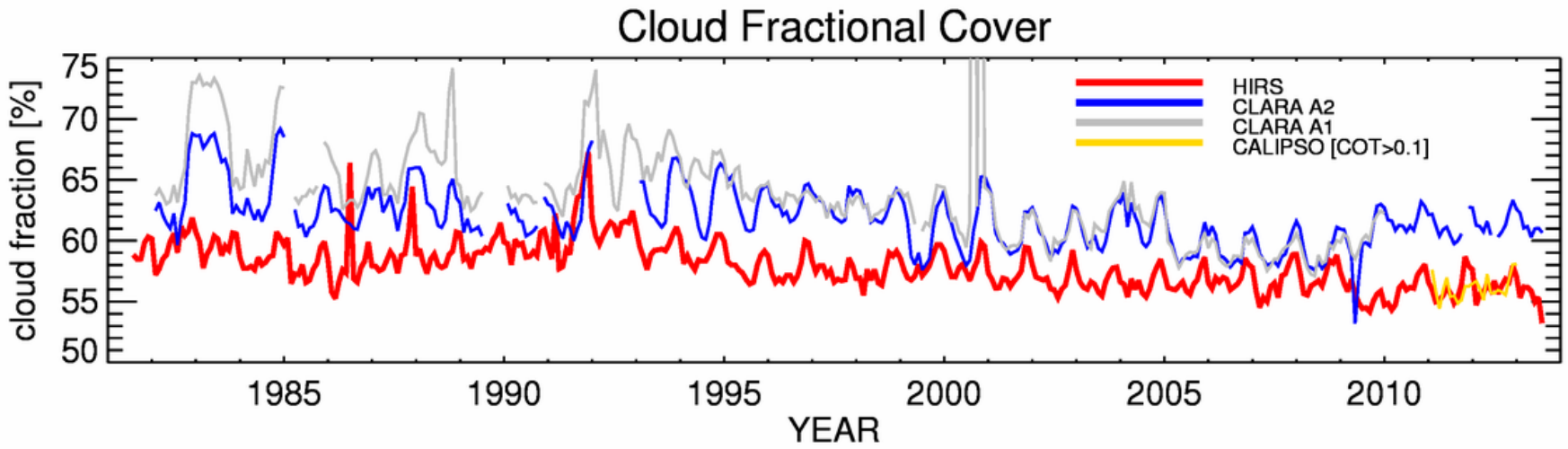
CLARA A2



(September 2012)

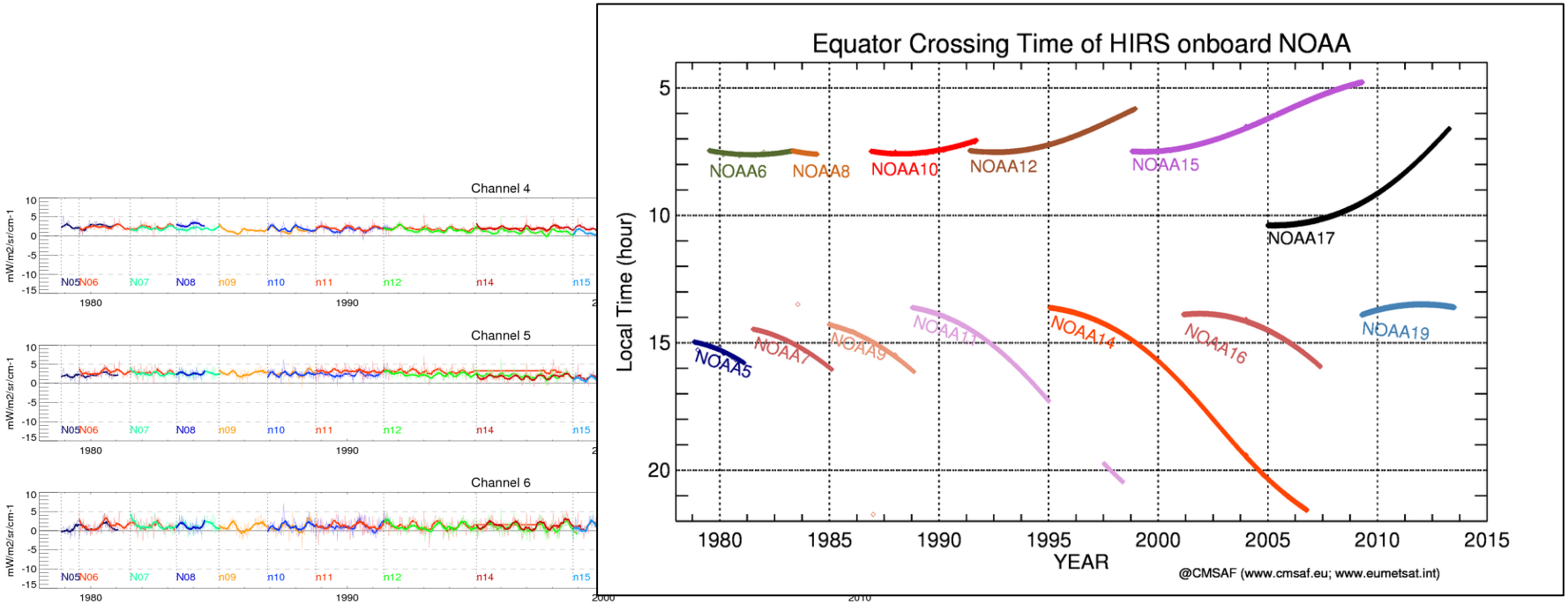
Cloud top level retrieval





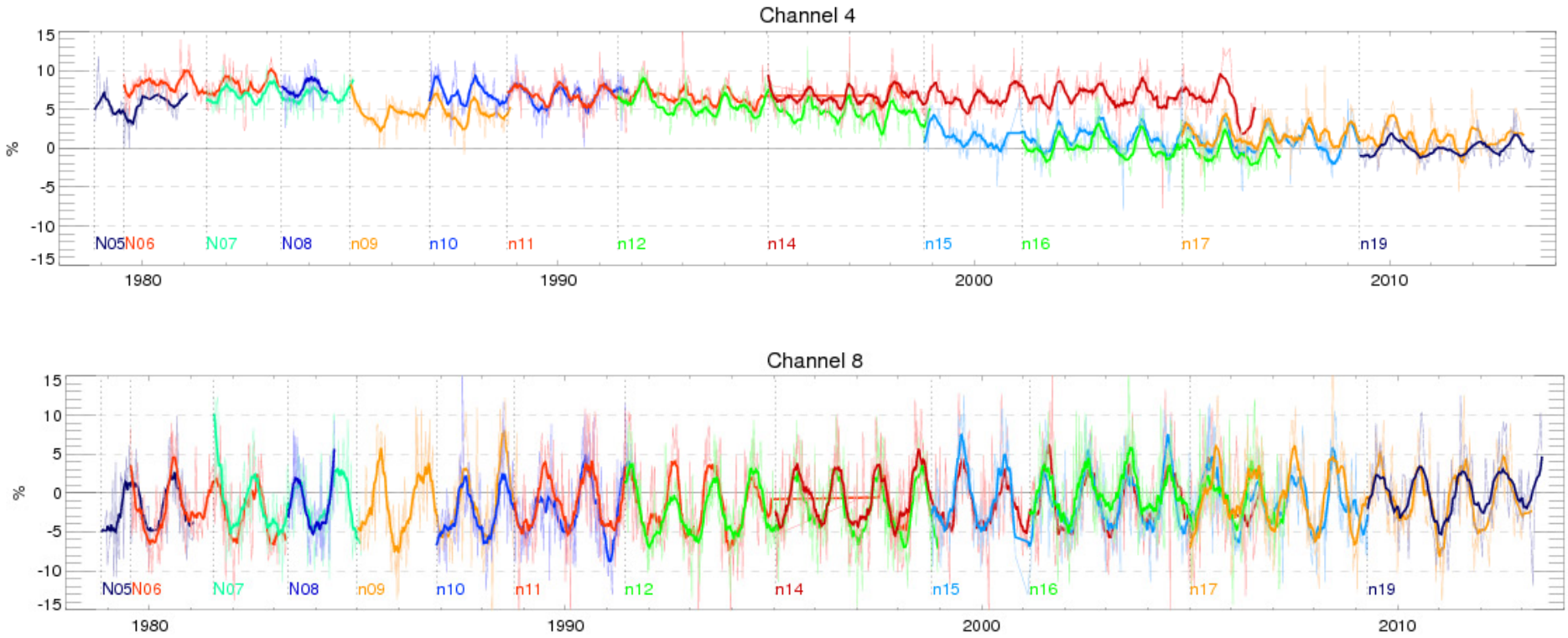
HIRS level 1 data

- Received 35 years of HIRS L1 data through EUMETSAT
- First version of quality control, data partitioning and reformatting included



HIRS level 1 data

- Initial data monitoring



Intercalibration needed for producing a TCDR!
Intercalibrated HIRS FCDR will be provided by the FIDUCEO project.

Summary & Outlook

- Generation of a HIRS-based cloud properties dataset as zero-version is finished
- Threshold based cloud mask developed and tested.
- HIRS cloud-top level retrieval scheme is in place, first tests have been conducted and show promising results.
- Further fine-tuning necessary

- L1 data has been received from EUMETSAT; METOP must be added
- Intercalibration necessary. Start with SNO approach.
- Waiting for HIRS FCDR from FIDUCEO project in 2017. Official HIRS clouds dataset release as CMSAF dataset in 2018.

- Combine HIRS dataset with CMSAF AVHRR dataset CLARA-A3?
- Further use of HIRS in CLARA A3 → longwave TOA radiative fluxes

Thanks‘ to the ITSC for the financial support