Copernicus Climate Change Service

Towards a climate data record of precipitation through merging satellite observations by passive microwave sounders and imagers

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Introduction

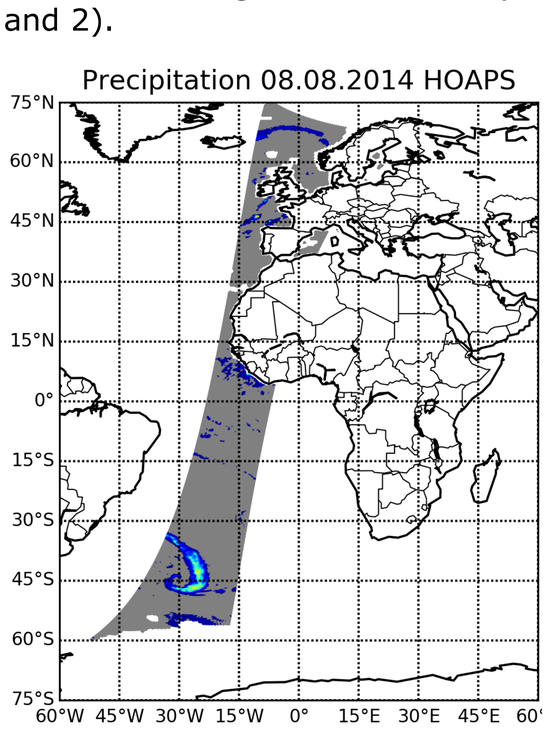
Copernicus is the European Union's flagship Earth observation programme. The European Centre for Medium-Range Weather Forecasts (ECMWF) has been appointed by the EU to operate the Copernicus Atmosphere Monitoring Service (CAMS) and the Copernicus Climate Change Service (C3S) on its behalf. Within C3S, the Climate Data Store (CDS, built by ECMWF) will provide open and free access to global and regional products of Essential Climate Variables (ECVs) based on satellite observations spanning several decades.

The German Weather Service (Deutscher Wetterdienst, DWD) has been contracted by ECMWF to provide high-quality satellite-based Climate Data Records (CDRs) in a cooperative framework comprising several European national weather services and scientific institutions. One of our envisaged ECVs is precipitation, a major component of the climate system and the hydrological cycle that greatly impacts human life.

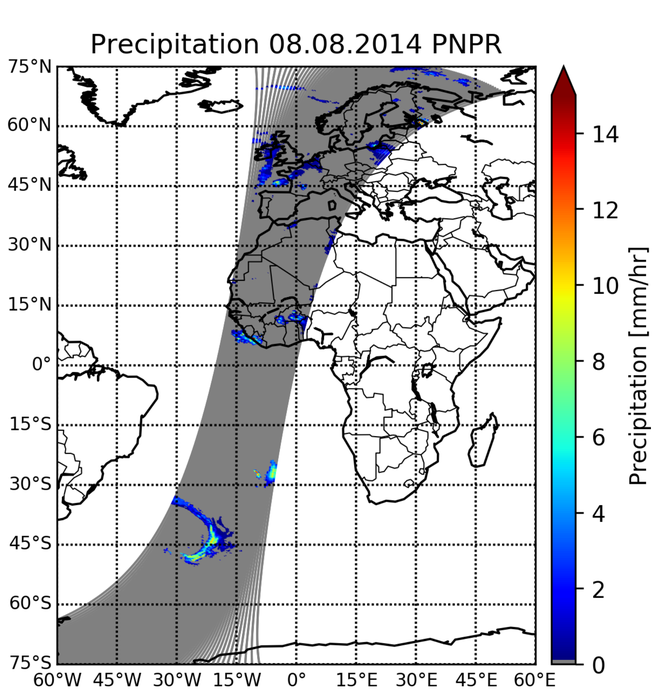
Here we outline our roadmap towards a global precipitation CDR that will be developed within C3S, based on merging satellite passive microwave imager and sounder observations. The release in the CDS is scheduled for 2021.

Observational basis for the new CDR

The new long-term global precipitation CDR developed within C3S will be based on merged microwave (MW) imager and sounder data (Figures 1 and 2).



▲ Figure 1: CM SAF HOAPS (Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite data record, Andersson et al., 2010, 2017) precipitation rate retrieved from microwave imager data (SSM/I and SSMIS) over ocean.



▲ Figure 2: PNPR (Passive microwave Neural network Precipitation Retrieval, Sanò et al., 2015) precipitation rate from microwave sounder data (AMSU-B and MHS) over land and ocean.

The new global precipitation product will feature:

- a new algorithm based on the PNPR approach (PNPR-CLIM) developed at CNR-ISAC for MW sounder data over land and ocean applied to the FIDUCEO AMSU-B/MHS Fundamental CDR (Hans et al., 2019)
- the HOAPS algorithm for MW imager data over ocean utilized within the EUMETSAT Satellite Application Facility on Climate Monitoring (CM SAF)
- merging of both datasets (HOAPS and PNPR) on a regular latitude longitude grid with 1° x 1° spatial resolution
- Global coverage
- Time series with daily and monthly temporal resolution from 2000 onwards

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Hans, I. et al (2019): An Uncertainty Quantified Fundamental Climate Data Record for Microwave Humidity Sounders, Remote Sens., 11(5), 548

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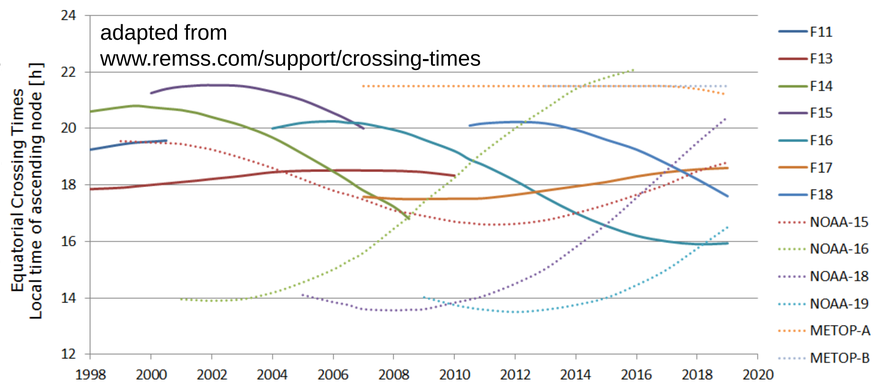
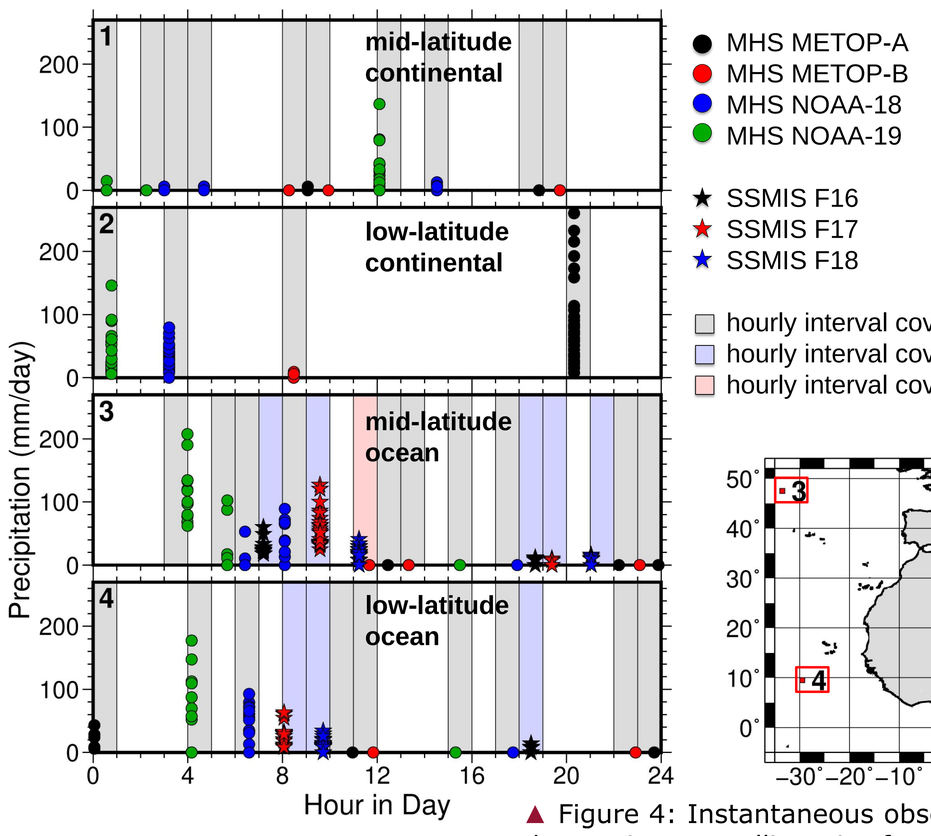
Improved coverage

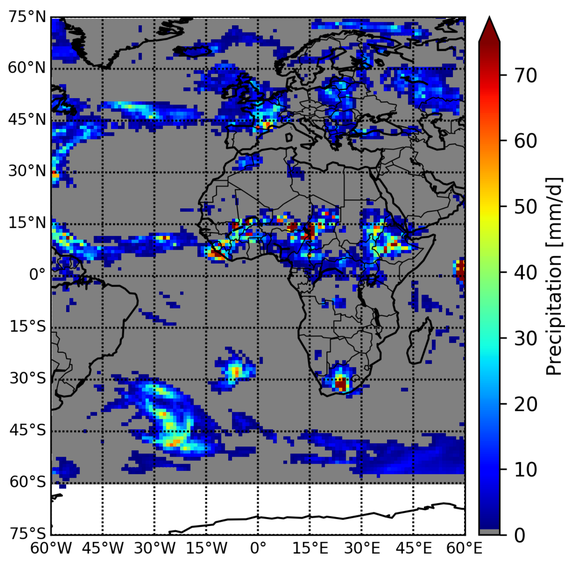
Combining precipitation observations by the MW sounders AMSU-B and MHS and MW imagers SSM/I and SSMIS implies up to 6 simultaneously available platforms over land and 9 over oceans (Figure 3). This provides improved daily coverage, especially over oceans (Figure 4), which is essential for estimating daily precipitation (Ciabatta et al., 2017). Figure 5 shows some first results based on test data.



► Figure 3: Equatorial crossing times of envisaged polar orbiting satellites; Solid lines: Microwave Imager (SSM/I; SSMIS) on DMSP platforms; Dashed lines: Microwave Sounder (AMSU-B; MHS) on NOAA and EUMETSAT platforms



▲ Figure 4: Instantaneous observations by the various satellites in four exemplary 1° x 1° grid cells (numbering corresponds to map at the bottom right) over one day, 08.08.2014, and the hourly intervals covered by these observations.



◄ Figure 5: Merged precipitation product of one day (08.08.2014) on a 1° x 1° grid.

Current gridding and accumulation procedure:

Observations are averaged per satellite in hourly intervals and per 1° x 1° grid cell (Figure 4). Then, hourly values are averaged where overpasses from more than one satellite are available. Temporal gaps in the hourly precipitation (Figure 4) are filled using nearest neighbor interpolation. Finally, the hourly values are accumulated as daily precipitation.

Open questions

- Consistency of the sounder and imager observations (bias, etc)
- Dependence of product quality on number of operating platforms
- Transition of product quality between land and ocean
- Snow / polar regions
- Possible revision of gridding and gap filling procedure

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For more information about C3S please visit:
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