The Fundamental Climate Data Record of SSM/I Brightness Temperatures from CM SAF

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Satellite-Based Climate Monitoring, DWD
Background

- Predecessors of this FCDR and the processing chain have been developed at the MPI-M and University of Hamburg for the Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data climatology (HOAPS, http://www.hoaps.org/)

- HOAPS is a compilation of climate data records for analysing the water cycle components over the global oceans.

- Main satellite instrument employed to derive the parameters is the Special Sensor Microwave/Imager (SSM/I) providing a time-series of microwave observations from the same type of instrument from 1987 to 2008.

- SSM/I was designed for NWP and not for climate applications and the raw data records must be carefully homogenized and processed to the same standard for the complete time period to provide a Fundamental Climate Data Record (FCDR).
CM SAF FCDR Features

- Completely and consistently reprocessed data record, starting from measured counts.
- Calibration with smoothed cold and hot load readings.
  - Centred averaging kernel of ±5 scans with Gaussian weights.
- New geolocation based on smoothed daily TLEs.
- Data processing accounts for identified instrument issues:
  - Moonlight-intrusions,
  - Sunlight-intrusions,
  - Along-scan non-uniformity.
- Antenna pattern matching:
  - 85 GHz Brightness temperatures averaged to 37 GHz antenna pattern.
- Synthetic 85 GHz data over ocean for F08 period with defective 85GHz channels.
- Earth incidence angle normalization offsets (Furhop and Simmer, 1997).
- Non-linearity calibration coefficient.
- Scene dependent inter-calibration to F11 (as separate offset).
Sensor Health & Sensitivity

SSM/I Hot Load Temperatures

Radiometer sensitivities :: Hot Load Target :: V19

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<tbody>
<tr>
<td>F08</td>
<td>F10</td>
<td>F11</td>
<td>F13</td>
<td>F14</td>
<td>F15</td>
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<tr>
<td>0.42K</td>
<td>0.51K</td>
<td>0.47K</td>
<td>0.52K</td>
<td>0.47K</td>
<td>0.48K</td>
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Radiometer sensitivities :: Hot Load Target :: H85

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<tr>
<td>0.89K</td>
<td>0.63K</td>
<td>0.46K</td>
<td>0.55K</td>
<td>0.54K</td>
<td>0.64K</td>
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The diagram shows time series graphs for SSM/I Hot Load Temperatures and radiometer sensitivities for different targets (V19 and H85) over the years 1988 to 2008.
Limited dynamic range over ocean for scene-dependent inter-calibration.

Minimization procedure includes sea-ice and cold land scenes (>60° and <-60°) and all scenes as double differences.

Inter-calibration Model includes non-linearity calibration coefficient $d$, scene dependent scale factor $a$, offset $b$, and cross-polarization factor $c$

\[
T'_A = T_A + d \cdot \left( T_A - \langle T^H \rangle \right) \cdot (T_A - T^C) \quad \quad T''_B = a \cdot T'_B + b + c \cdot \Delta_{v,h}
\]
Inter-calibration Results
Global Maps

F13 – F15
RDR
CM SAF FCDR
RSS v6 FCDR
CSU FCDR

37v

37h

37v - 37h
## Inter-calibration Results

### Global Maps

<table>
<thead>
<tr>
<th>F11 – F10</th>
<th>RDR</th>
<th>CM SAF FCDR</th>
<th>RSS v6 FCDR</th>
<th>CSU FCDR</th>
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<tbody>
<tr>
<td>19v</td>
<td><img src="image1.png" alt="Map" /></td>
<td><img src="image2.png" alt="Map" /></td>
<td><img src="image3.png" alt="Map" /></td>
<td><img src="image4.png" alt="Map" /></td>
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<td>19h</td>
<td><img src="image5.png" alt="Map" /></td>
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<td><img src="image7.png" alt="Map" /></td>
<td><img src="image8.png" alt="Map" /></td>
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<tr>
<td>19v - 19h</td>
<td><img src="image9.png" alt="Map" /></td>
<td><img src="image10.png" alt="Map" /></td>
<td><img src="image11.png" alt="Map" /></td>
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Evaluation TB v19 Normalization
Evaluation TB v19 Normalization

SSM/I Hot Load Temperatures

CM SAF FCDR :: TB v19 Ensemble Anomalies :: Homogenised

F08  F10  F11  F13  F14  F15
Evaluation TB v19 Inter-calibration

CM SAF

RSS v6

CSU
Evaluation TB v22
Inter-calibration

CM SAF

RSS v6

CSU
Summary

- CM SAF SSM/I FCDR provides carefully inter-calibrated Brightness Temperatures for instruments aboard F08, F10, F11, F13, F14, and F15.
- FCDR data processing accounts for identified issues: moonlight-intrusions, sunlight-intrusions, along-scan correction and assigns quality control flags.
- Data files are available as daily collections in NetCDF-4 conforming to CF Metadata Conventions 1.5.
- Data files include all raw data record sensor information plus:
  - Quality control flags (scan, channel, FOV),
  - Earth incidence angles,
  - Averaged 85 GHz TBs,
  - Incidence angle normalization offsets (over ocean) as separate layer,
  - Inter-sensor calibration offsets as separate layer,
  - Sensor sensitivities (e.g. NEdT) as daily estimates,
  - Surface type based on daily sea ice masks.
Thanks for your attention!

FCDR is available from http://www.cmsaf.eu/wui, ATBD, PUM, and validation report from http://www.cmsaf.eu/docs

http://dx.doi.org/10.5676/EUM_SAF_CM/FCDR_SSMI/V001