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

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The EUMETSAT Network of Satellite Application Facilities

CM SAF Climate Monitoring

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

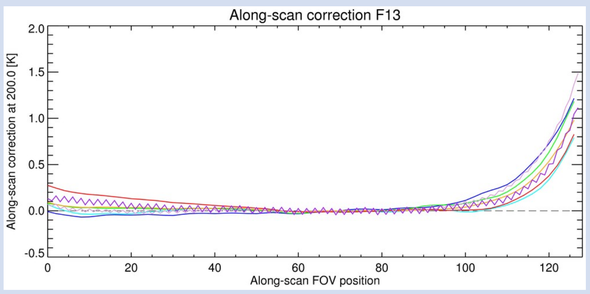
Introduction and Motivation

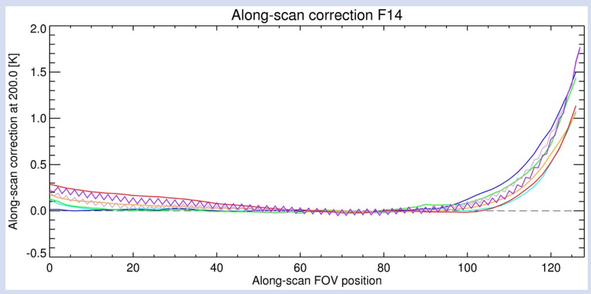
- Predecessors of this FCDR and the processing chain have been developed at the MPI-M and University of Hamburg for the Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data (HOAPS, http://www.hoaps.org/).
- HOAPS is a compilation of climate data records for analysing the water cycle components over the global oceans based on Special Sensor Microwave/Imager (SSM/I) observations.
- The SSM/I instruments are providing a time-series of microwave observations from the same type of instrument from 1987 to 2008.
- Since the 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.

Applied Corrections and Normalization

Along Scan Correction

- Non-uniformity of the measured TAs along a scan line caused by intrusion of cosmic background into antenna feedhorn.
- Rapid fall-off at the end of the Earth scan of 1.5 – 2K.
- FOV dependent correction for each instrument and channel. Correction normalized to the unaffected FOV positions in scan centre (50 – 90).
- Derive pitch and roll corrections from curvature and skewness of polarization differences.

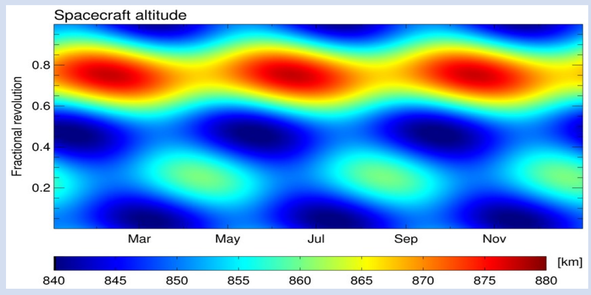


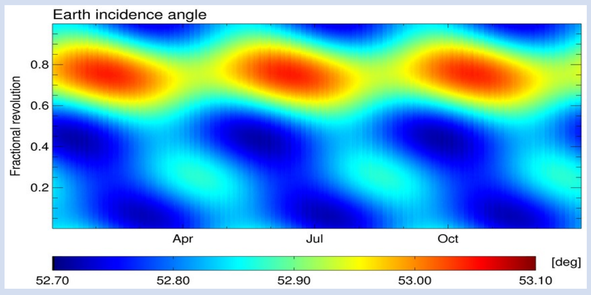


Along-scan correction for SSM/I F13 and F14. The images show the along-scan correction applied to a scene temperature of 200K. Colours are as follows: cyan 19v, blue 19h, green 22v, orange 37v, red 37h, plum 85v, violet 85h.

Earth Incidence Angle Variations

- SSM/I designed to observe under a constant EIA of 53°.
- One degree deviation can lead to a 2K TB change.
- EIA varies mainly due to changes in altitude caused by the orbit eccentricity and the oblateness of the Earth.
- TB variation due to EIA variation must be accounted for during inter-calibration.
- TB normalization offsets over ocean available in the FCDR data files. (Furhop and Simmer, 1997)

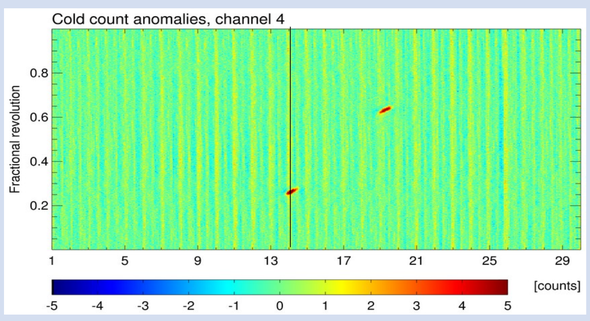


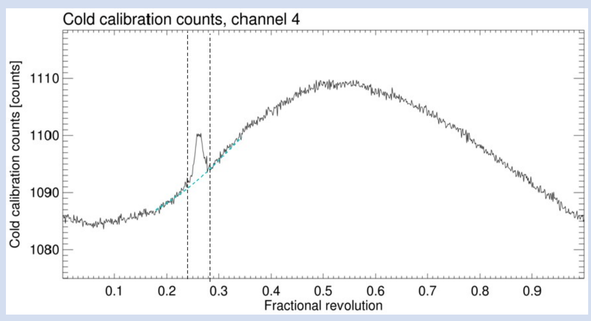


Variation of spacecraft F13 altitude (left) and Earth incidence Angle (right) for 2005. the y-axis represents the fractional orbit angle with ascending equator crossing an 0 and descending equator crossing a 0.5. The x-axis represents the time of the orbit start.

Cold View Intrusions (Moonlight)

- Cold calibration target is a mirror pointing to the cold space.
- Moon is visible in the cold view, depending on the orbit parameters about twice per month.
- Short-term positive anomalies in the cold view counts, depending on the antenna beam width.
- Intrusion events are detected and removed using a spline interpolation.

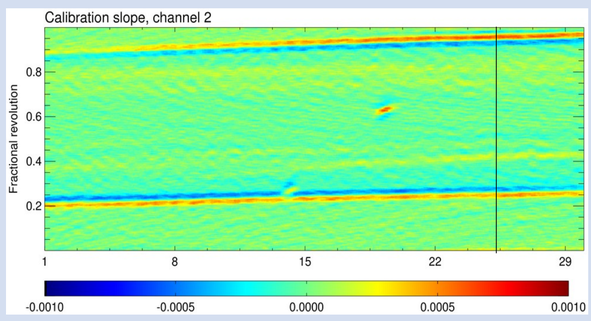


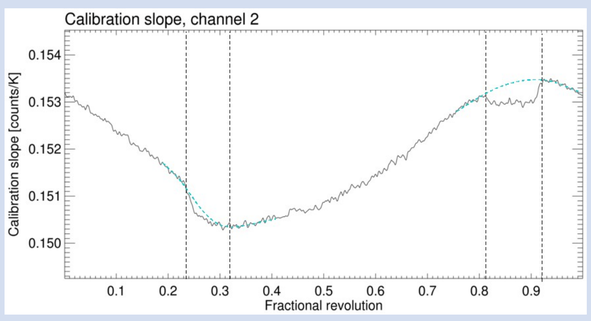


Cold count anomalies (left) from SSM/I F13 37GHz(v) in November 2005. A cross section of the absolute cold counts through the maximum of the first intrusion event is shown on the right. Positions with identified anomalies are between the vertical lines. The locally fitted reconstruction spline is plotted in cyan.

Hot Load Intrusions (Sunlight)

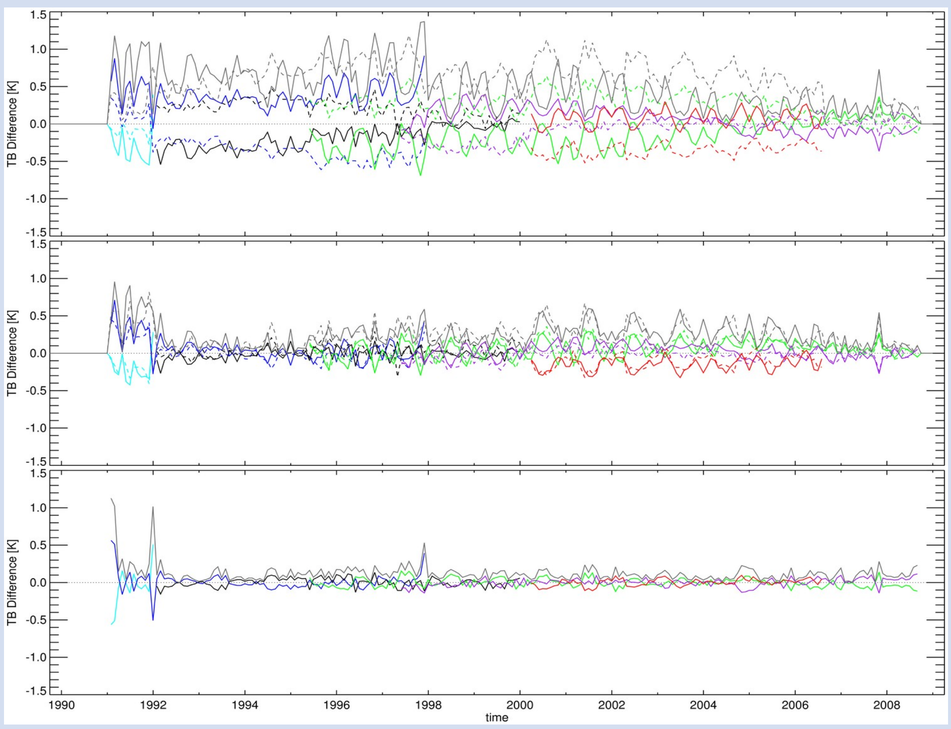
- Sunlight intrusions into the warm target are possible when the spacecraft leaves and enters the Earths shadow.
- Different response times of the instrument parts to sunlight causes anomalies in the calibration coefficients.
- Hot load intrusions are detected and removed via a spline interpolation.





Calibration slope anomalies (left) using edge detection from SSM/I F13 19GHz(h) in November 2005. Clearly visible are detected moonlight intrusions and position where the spacecraft leaves and enters the Earth shadow. A cross section of the absolute calibration slope is shown on the right. Positions with identified warm target anomalies are between the vertical lines. The locally fitted reconstruction splines are plotted in cyan.

Intercalibration Method and Results



Inter-Sensor Calibration

- Relative inter-calibration to reference instrument F11 with F10 and F13 as transfer standard.
- Intercalibration coefficients derived from gridded matchups of oceanic TBs (EIA and Diurnal Cycle normalized), sea-ice and cold land surface (> 60N, <-57S).
- Inter-calibration model accounts for scene dependent bias and non-linear calibration correction.
- Typical offsets are in the order of 1K before and about 0.2K after inter-calibration.
- Largest uncertainty in F08 because of only about 1 year overlap with F10.

Time-series of monthly mean TB differences between ensemble mean and individual instruments for 37GHz(h) before inter-calibration (top) with diurnal cycle removed (middle) and after inter-calibration (bottom). Afternoon orbits are solid lines and morning orbits dotted lines. Colours are as follow: cyan F08, blue F10, black F11, green F13, violet F14 and red F15. The gray lines show the maximum ensemble spread.

Summary

- Complete SSM/I time series from 1987 to 2008 reprocessed with new geolocation and calibration.
- FCDR data files also include sensor information, daily estimated NEDT, surface type with daily sea-ice mask, quality control flags for each scan, channel and FOV.
- EIA normalization and inter-calibration offsets are available as offsets and can be applied as required.
- Final release expected after EUMETSAT review (November).

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