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Inter-calibration of METEOSAT IR and WV channels using HIRS

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The detection of climate change and analysis of climate variability at inter-annual scales requires long-term, well calibrated observations that are homogenized in time and space. Observations from EUMETSAT's series of Meteosat First and Second Generation geostationary satellites span a period from 1982 to today for satellites operated over the Atlantic Ocean (sub-satellite longitude 0 degrees), and from 1997 to today for satellites operated over the Indian Ocean. Although these satellites provide data for climate analysis at multi-decadal scales, their applicability for such analysis is hampered by heterogeneities in the time series due to successive radiometers having different filter functions and changes in the calibration methodology. To improve the quality of these time series EUMETSAT has initiated an activity to inter-calibrate their data to community references, following the principles of the Global Space-based Inter-Calibration System (GSICS).

We present the strategy to inter-calibrate the complete time series of Water Vapour (WV, 6.3 μm) and Infrared (IR, 11.8 μm) channel radiances from the MVIRI instrument on Meteosat First Generation and the SEVIRI instrument on Meteosat Second Generation. Two different inter-calibration methods are evaluated i.e. (1) inter-calibrate to a homogenised time series of HIRS observations, and (2) inter-calibrate using the so called double differencing methodology. The latter method compares, for instance, observations from two Meteosat instruments to observations of one HIRS instrument, and then calculates the difference between the two Meteosat instruments, or vice versa. Both methods are validated against reference observations, for which observations from the IASI instrument are used. In addition, the stability of the HIRS on Metop is investigated with Metop IASI observations.

We have analysed the uncertainties introduced in both methods by changes in filter functions, collocation scene variability, instrument noise and calibration drift. A systematic review of spectral conversion functions, which often dominate the errors, indicates that the best set up is to use collocations under all conditions, i.e. all latitudes covered by the collocated observations, all atmospheric situations including cloudy scenes, and all viewing angles. Estimates of spectral conversion uncertainties have been computed among pairs of different instrument types (HIRS/2, HIRS/3, MVIRI and SEVIRI), and are almost an order of magnitude larger for the WV than the IR channel. For the WV channel spectral conversions from HIRS/2 to HIRS/3 and HIRS/4 have an uncertainty of approximately 1 K, whereas the conversion uncertainties from MVIRI to SEVIRI are about 0.5 K. With some exceptions the conversions among the same type of instruments, such as HIRS/3 to HIRS/4 or SEVIRI to SEVIRI, have uncertainties of less than 0.1 K.