SMOS CALIBRATION SUMMARY

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Introduction

The calibration of the Soil Moisture and Ocean Salinity (SMOS) payload instrument, known as Microwave Imaging Radiometer by Aperture Synthesis (MIRAS), is based on characterization measurements which are performed initially on-ground prior to launch and, subsequently, in-flight. A good calibration is a prerequisite to ensure the quality of the geophysical data.

The instrument measures the crosscorrelations between all pairs of receivers, known as baselines, in order to synthesize the visibility function. In a first-order approximation, the brightness temperature of an external scene is computed as the inverse Fourier transform of the visibility function.

The ultimate aim of the calibration is to calibrate the baseline visibilities. For that purpose, a set of in-flight activities are periodically planned to retrieve the calibration parameters and their evolution. During the calibration, the instrument is measuring either internal reference sources or the deep sky. These activities create gaps in the sensing data, but calibration is essential to ensure the quality of the measurements.

In-Flight Calibration Activities

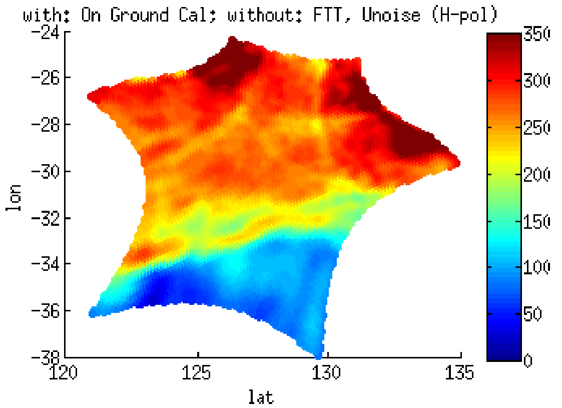
Local Oscillator calibration

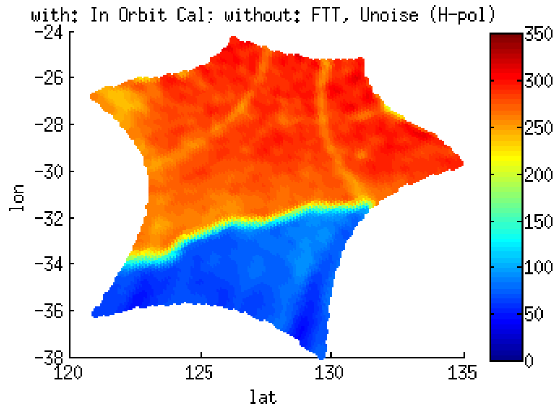
The instrument has a unique reference clock that is distributed to the Control and Monitoring units (CMN) located on the arms and hub. Each CMN uses the clock signal to generate a reference tone which provides to a group of six receivers.

Although every CMN should generate exactly the same tone, the phase of the tones drifts due to the temperature dependency of the CMN electronics. These phase drifts are adding non-coherent phase information to the measurements blurring the brightness temperature images.

The aim of the Local Oscillator (LO) calibration is to track the phase of the reference tones along time in order to correct the phase drifts introduced by the local oscillator. The LO phases are measured injecting a common internal reference signal, also known as correlated noise injection, to the receivers. The phase difference between the receivers' outputs allows the correction of the phase drifts in the processing.

The correlated noise injection for LO calibration purposes is executed every 10 minutes and takes 5 epochs (6 seconds).



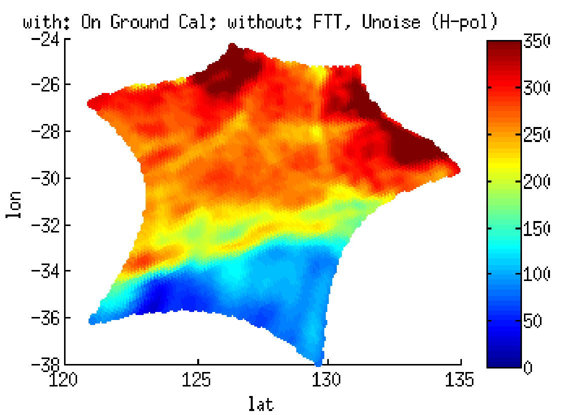


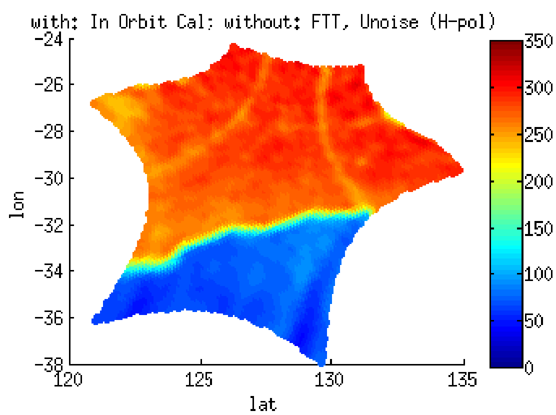
Long Calibration

The long calibration is the most complete activity to characterize in-flight the 72 receivers of the instrument. This activity consists on a sequence of steps injecting internal reference signals (noise sources) to the receivers. The parameters obtained from the data acquired during the long calibration update the on-ground characterization of the receivers. The use of the in-flight calibration parameters ensures the best accuracy of the measurements.

The in-flight characterization computes the in-flight amplitude, phase and offset of the receivers' chain, as well as the fringe washing function (its value at the origin and shape) for each pair of receivers which accounts for the signal decorrelation due to the limited frequency response of the receivers. All the calibration parameters are updated into the data processing chain with the exception of the fringe washing function shape which is used for monitoring purposes and it is only updated in case that major changes are observed. The current fringe washing shape used in the data processing was acquired on 2nd February 2010.

The Long Calibration is executed once every two months and it is decomposed in two consecutive half-orbits in the Southern hemisphere starting over the Indian Ocean and finishing over the Pacific. Each half-orbit is 2665 epochs (53.3 minutes).





Short Calibration

The short calibration is a calibration activity aimed to track the changes of the receiver's offset. The offset changes faster than the rest of the receiver calibration parameters. Although the receiver offset is calibrated during the Long Calibration, the two months periodicity is not enough to track its evolution.

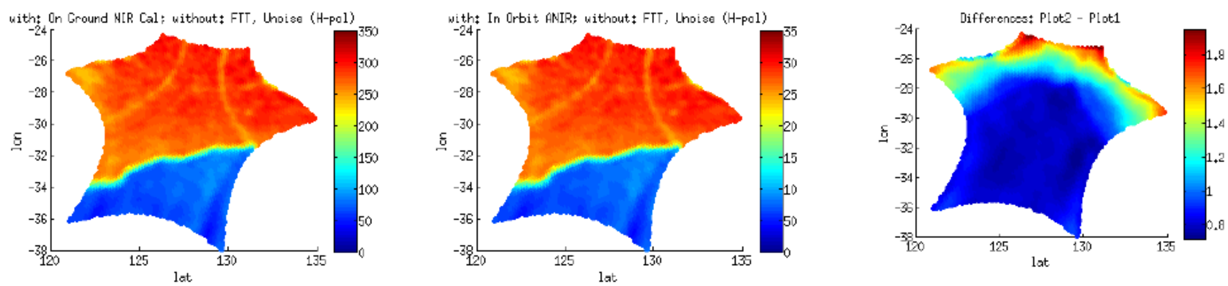
The Short Calibration is a small subset of the Long Calibration that it is executed once every week. It takes place over Antartica and it takes only 87 epochs (104.4 s).

External NIR calibration

The instrument is equipped with three reference power measuring systems, the so called Noise Injection Radiometers (NIR), which provide an accurate measurement of the average brightness temperature of the scene during measurement. Besides, NIRs are used to measure the power of the internal reference sources during the Long Calibration.

The calibration of the NIRs uses the deep sky as external reference. The successful NIR calibration reduces the bias in the measured brightness temperatures and improves the accuracy of the in-flight receivers' amplitude, phase and offset calibration.

The External NIR calibration is executed once every two weeks over the Pacific and it takes one orbit (about 100 minutes).

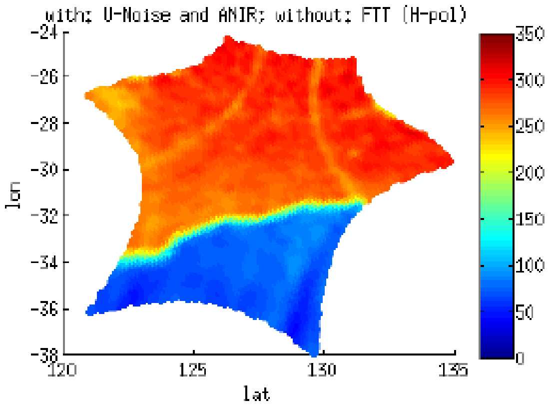


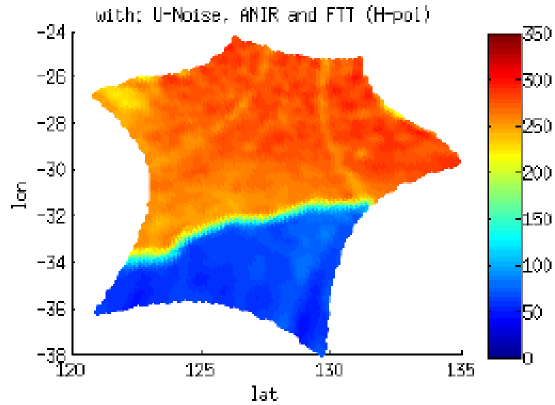
External Flat Target Measurement

The Flat Target Transformation (FTT) is the algorithm used in the processor to reduce the impact of the uncertainties of the instrument model in the imaging process. These uncertainties in the instrument model are the differences between the on-ground and in-flight antenna patterns and residual calibration errors.

The FTT requires the measured visibilities of a well known flat target. The used flat target is the deep sky since it fulfils that requirement. The application of the FTT in the imaging process improves the accuracy of the measured brightness temperature.

The External Flat Target Measurement is executed once every six months over the Pacific and it takes one orbit (about 100 minutes). The measurement is intended for monitoring the overall instrument response. Only in case major changes are observed in the Flat Target response, the new Flat Target Measurement is used in the nominal processing. The last update of the Flat Target response was acquired on 30th June 2011.





Reference document used for the introduction:

M. A. Brown, F. Torres, I. Corbella, and A. Colliander, “SMOS Calibration,” *IEEE Trans. Geosci. Remote Sens.*, vol. 46, no. 3, pp. 646–658, Mar. 2008.