Calibration and validation of ASCAT backscatter

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Introduction

The ASCAT Calibration and Validation plan describes the strategy and methods for calibrating the instrument and validating the Level 1b and Level 2 products

http://www.eumetsat.int/idcplg?IdcService=GET_FILE&dDocName=pdf_ten_eps_ascat_calval_plan&RevisionSelectionMethod=LatestReleased

Next evolution of the plan is planned for the first half of 2009, in preparation for the Metop-B commissioning

Overview of the calibration – initial settings

Calibration estimated pre launch from on-ground instrument characterisation and revised in-flight soon after launch:

Internal calibration coefficients

Revised so that the calculated power-gain product is close to unity: data from Oct/Nov 2006 over transponder test site, ascending pass (night, hence thermally stable)

Receiver gain calibration constant

Revised so that the rainforest γ_0 values were approximately -6.5 dB in all beams. Data from Oct/Nov 2006 over rainforest

Antenna gain patterns estimation and normalisation into calibrated backscatter

Revised using transponder calibration data acquired Nov/Dec 2006

External Calibration - Overview

Absolute radiometric calibration with three active ground transponders

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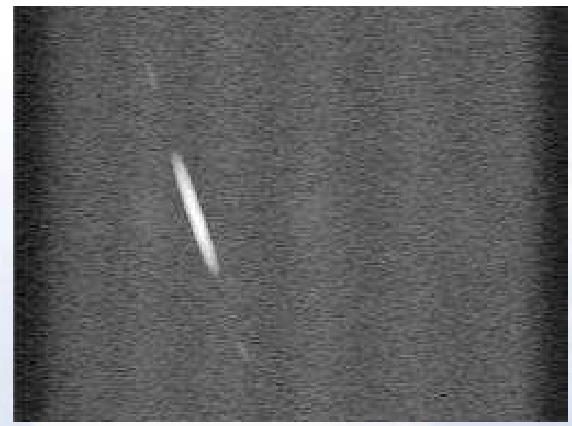
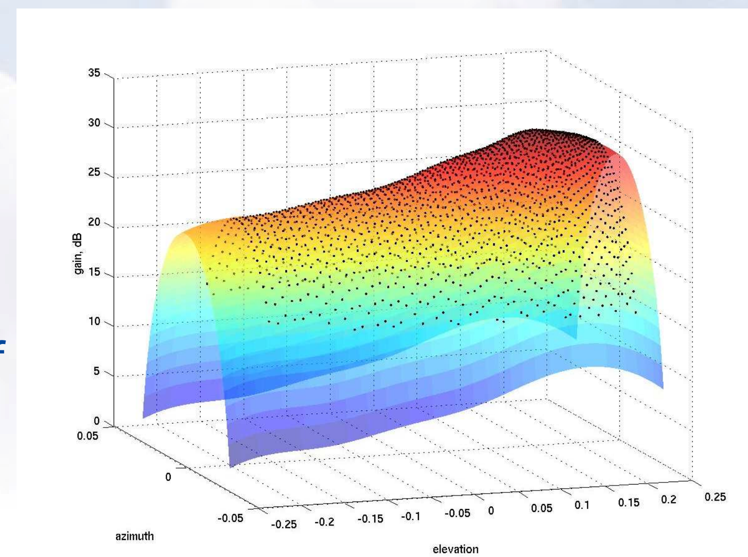
Each ASCAT pass over transponders allows to estimate an antenna gain value

A set of antenna gain values is then used to fit a model of 2D antenna gain and pointing (3 angles)

The antenna gain model and a reference Metop orbit is then used to generate a static representation of Power-to-sigma0 normalisation factors





External Calibration – History and status

External calibration campaigns performed so far

- Nov/Dec 2006 (1 month), using 1 transponder
- Nov 2007/Feb 2008 (3 months), using the 3 transponders

Sigma0 normalisations used since launch

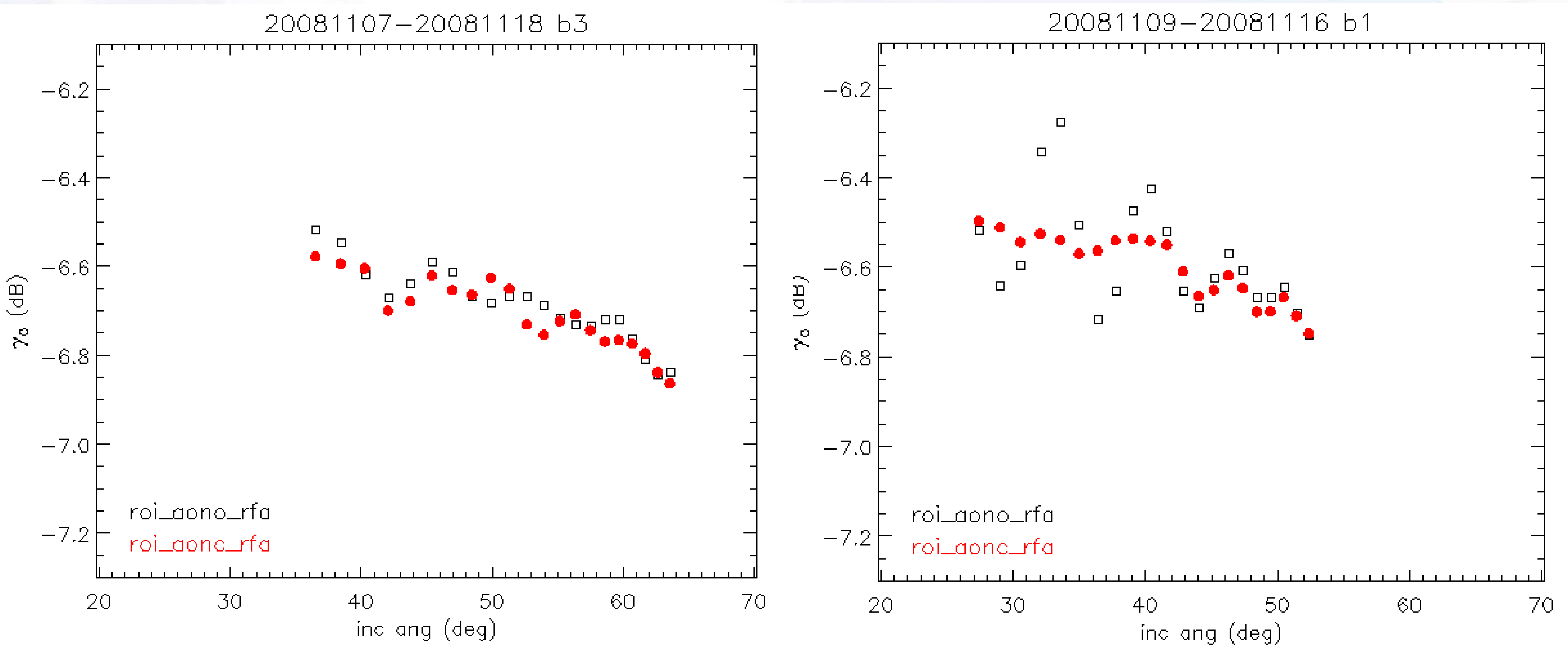
- February 2007, data from only one transponder
- September 2007, improvements to front end processing
- March 2008, data from three transponders
- December 2008, tuning of minimisation algorithm to improve mid-left beam characterisation

Overall accuracy of the external calibration

- RMS of the residual: 0.05 dB

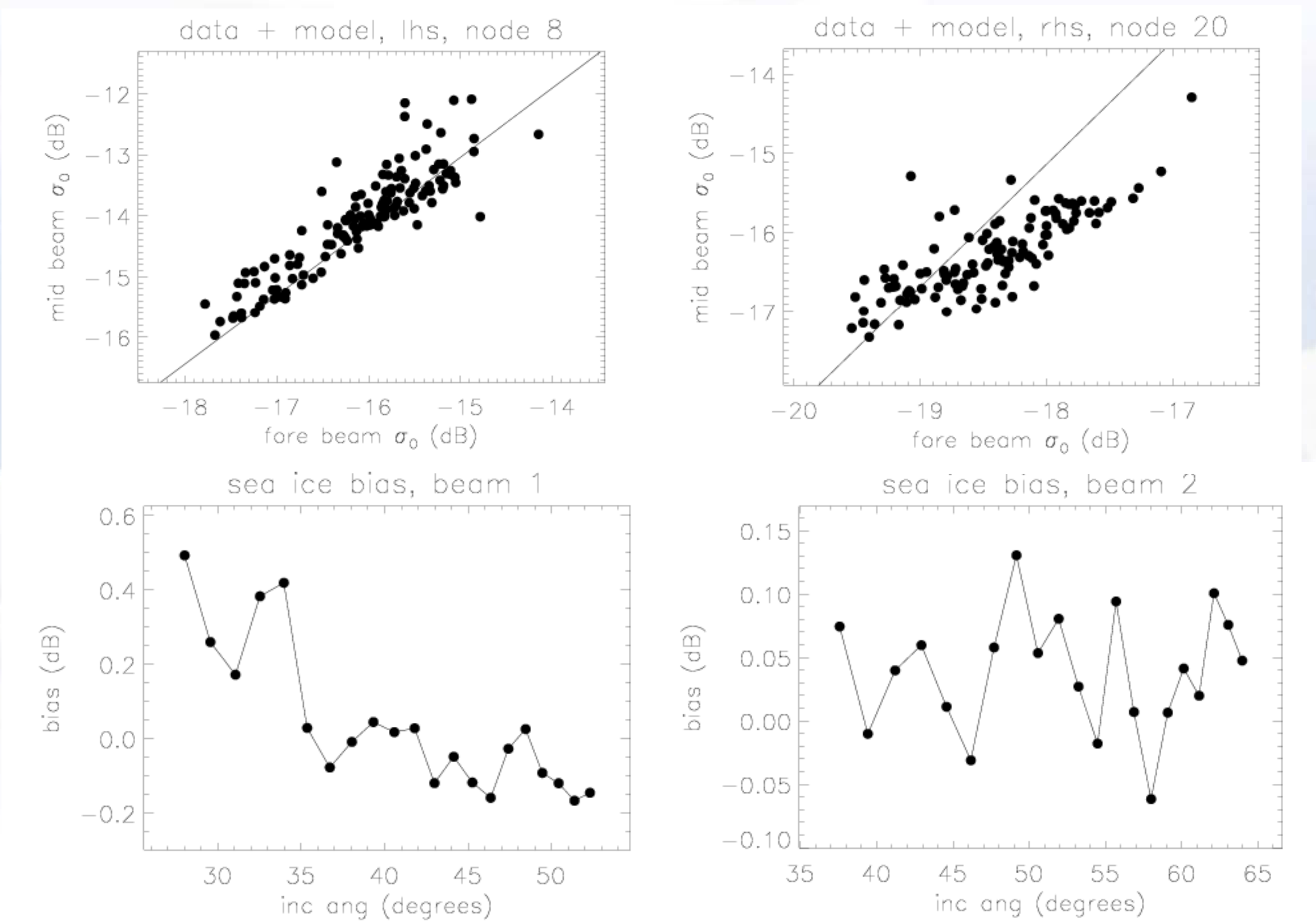
Level 1B Product Validation – Rainforest

The parameter $\gamma_0 = \sigma_0/\cos\theta$ is approximately constant with respect to incidence angle, geographical location and time with a value of about -6.6 dB, according to our experience with ERS scatterometers



Level 1B Product Validation – Sea Ice

Analysis using ERS shows that backscatter from some regions of sea ice is approximately stable and can be modelled: Sea Ice line (Haan & Stoffelen, 2001).



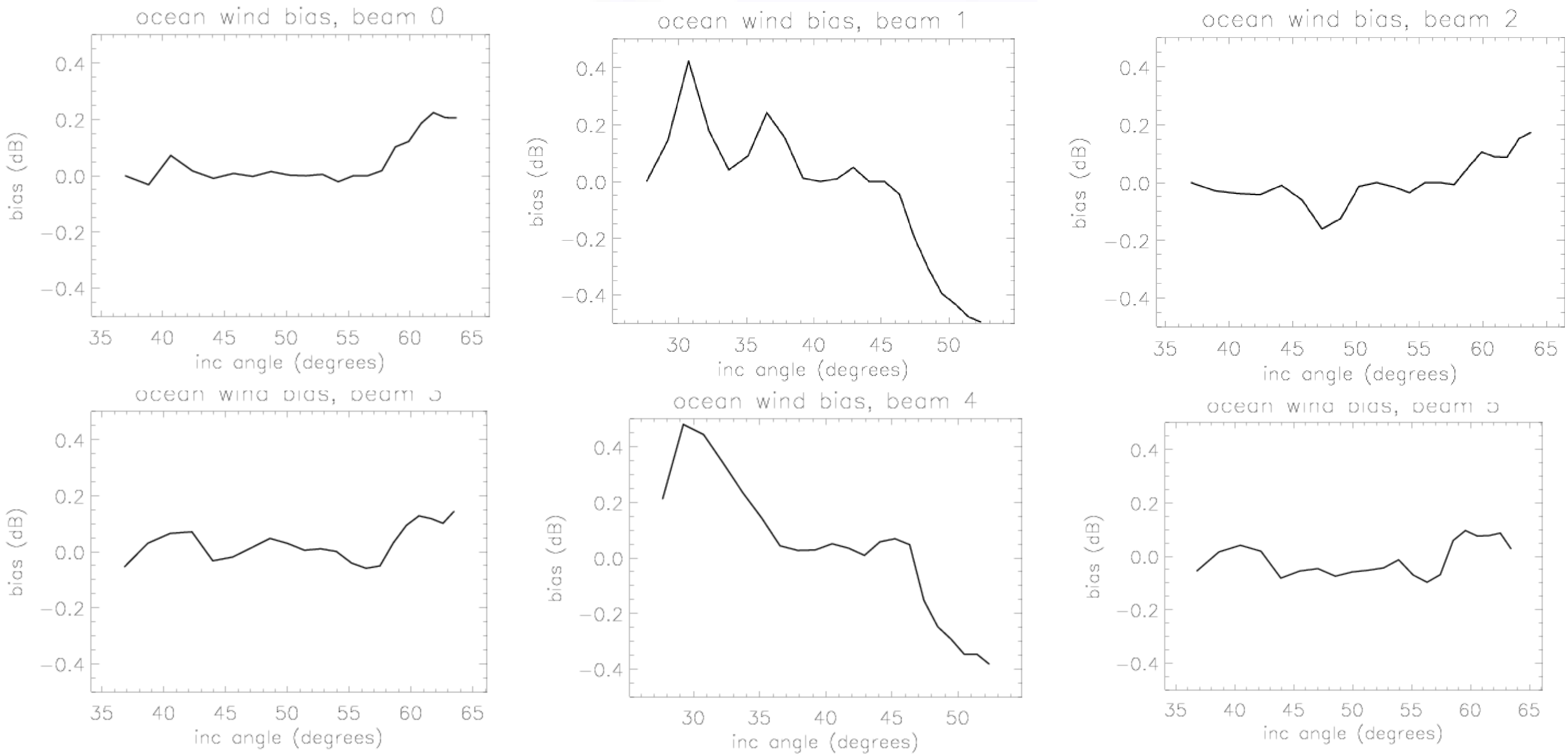
Applicability of ERS-SCAT model good on common incidence angle range

Overall confirms rainforest validation results

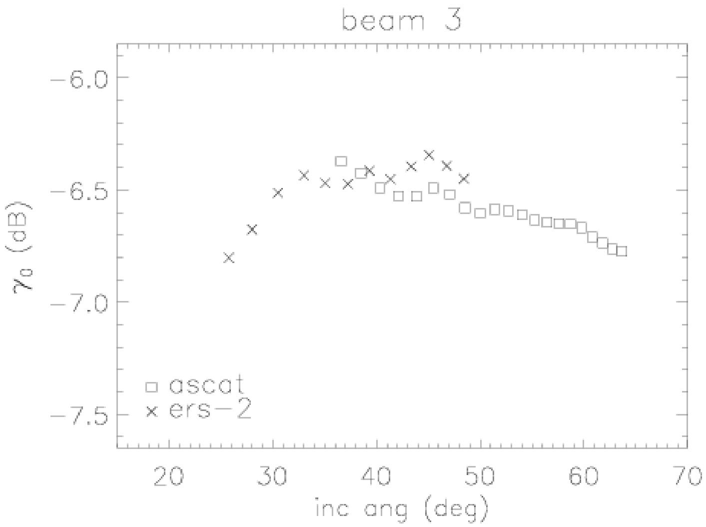
Data March 2008

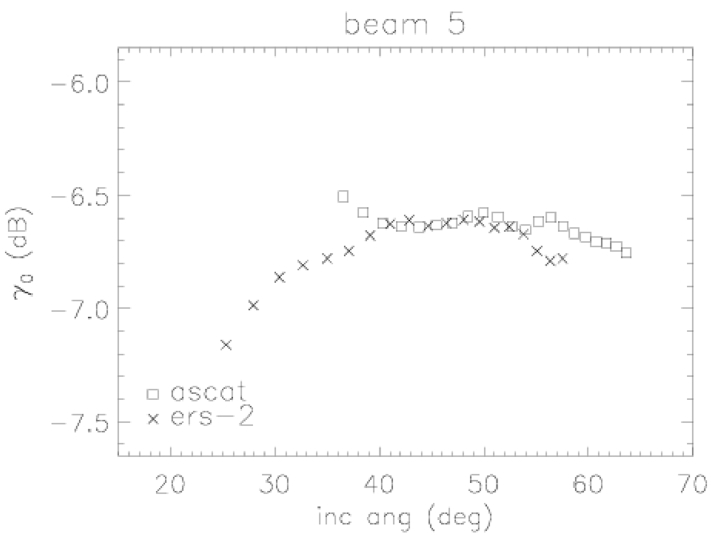
Level 1B Product Validation – Ocean

The reference model of how the ocean is seen by the scatterometer is CMOD5, according to our experience with ERS

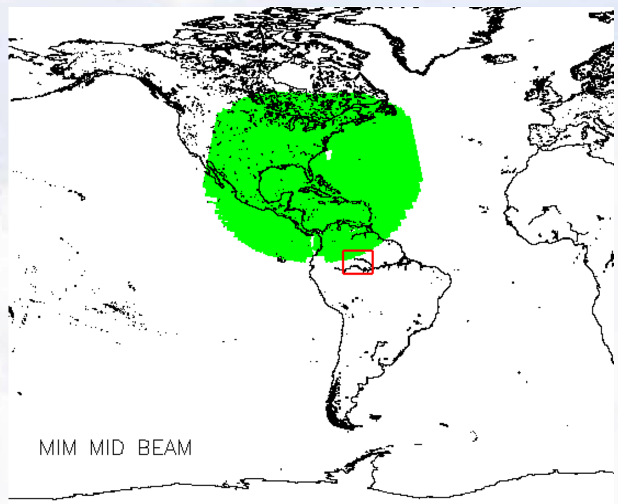


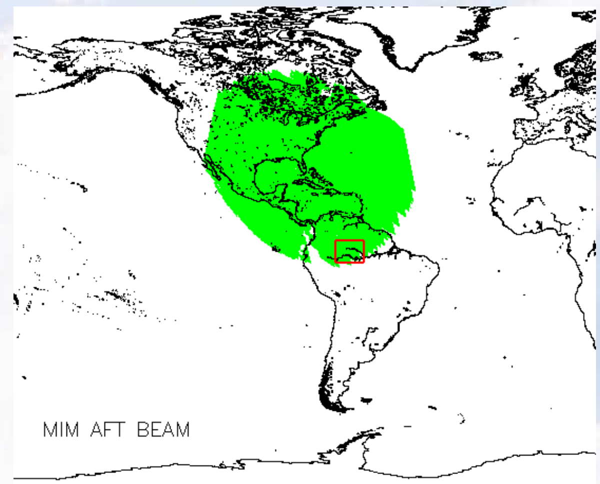
Level 1B Product Validation – ERS2 SCAT





Cross-validation with ERS-2 SCAT over rainforest shows good agreement for fore and aft beams in the common incidence angle range. For mid beam, not enough collocations have been found



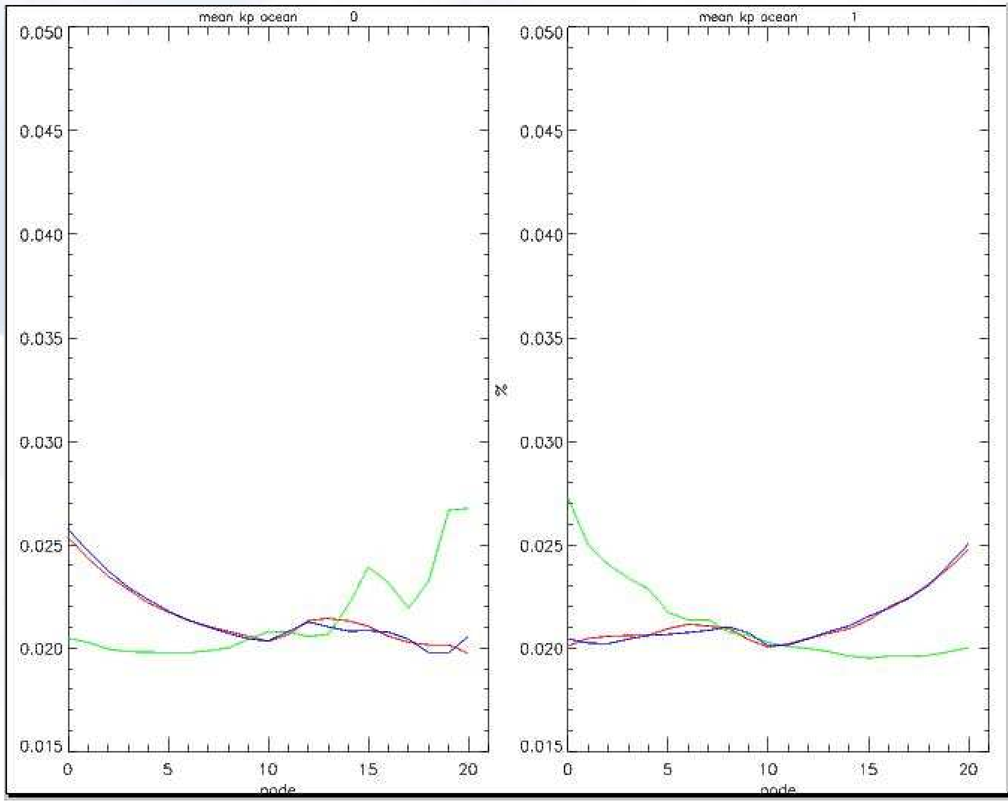


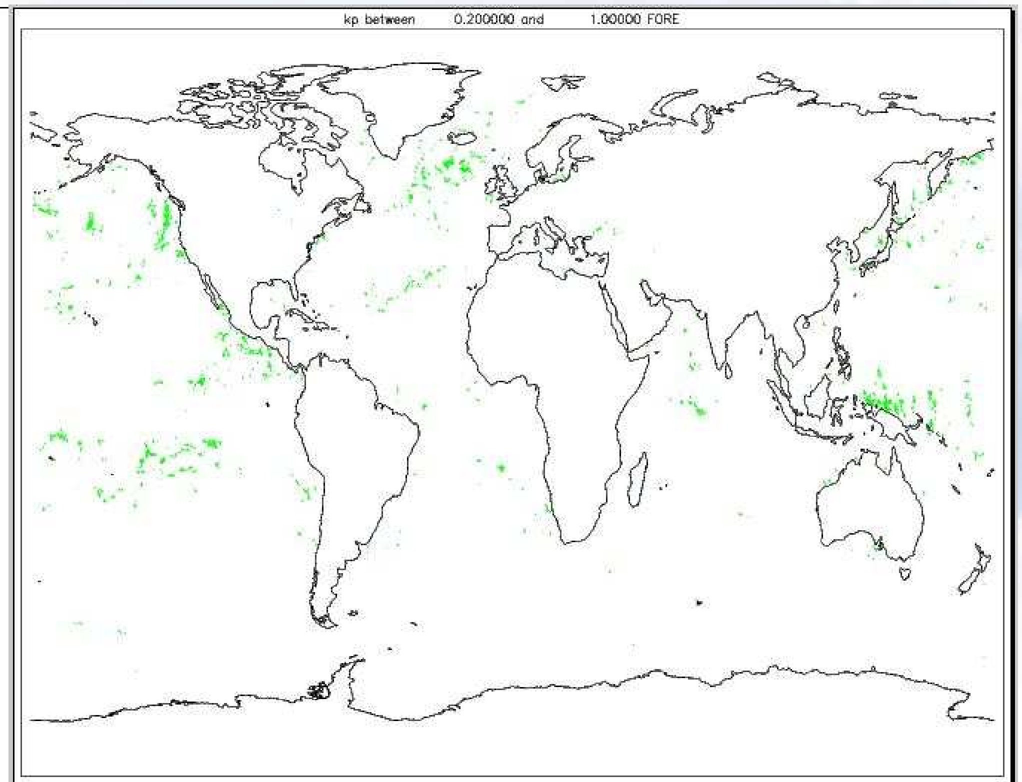
Data February 2008

Level 1B Product Validation - Kp Assessment

Kp in level 1b products are the normalised RMS error in the backscatter estimate.

Kp is generally found to be around 3% in land or open ocean. Over coastal areas Kp rises to around 5%. Values over 20% are occasionally seen and these are generally associated with very low values of ocean backscatter.





Summary and plans

ASCAT **absolute radiometric calibration** is based on accurate sampling of the antenna gain patters with measurements over ground transponders. **Natural targets** and the **backscatter models available from ERS SCAT** mission extremely useful in validating this calibration. Validation of the long term stability of the calibration using other types of natural targets (e.g. Dome C in Antarctica) is being considered

We are overall satisfied with the December 2008 absolute calibration of the ASCAT backscatter. Now **L2 C-band GMF tuning activities can start**, in order to be able to retrieve L2 (winds, sea ice and soil moisture) without applying s0correction biases. In order to facilitate this activity, a **re-processing of the full L1b ASCAT mission** will be carried out over Dec08/Jan09 with the latest calibration

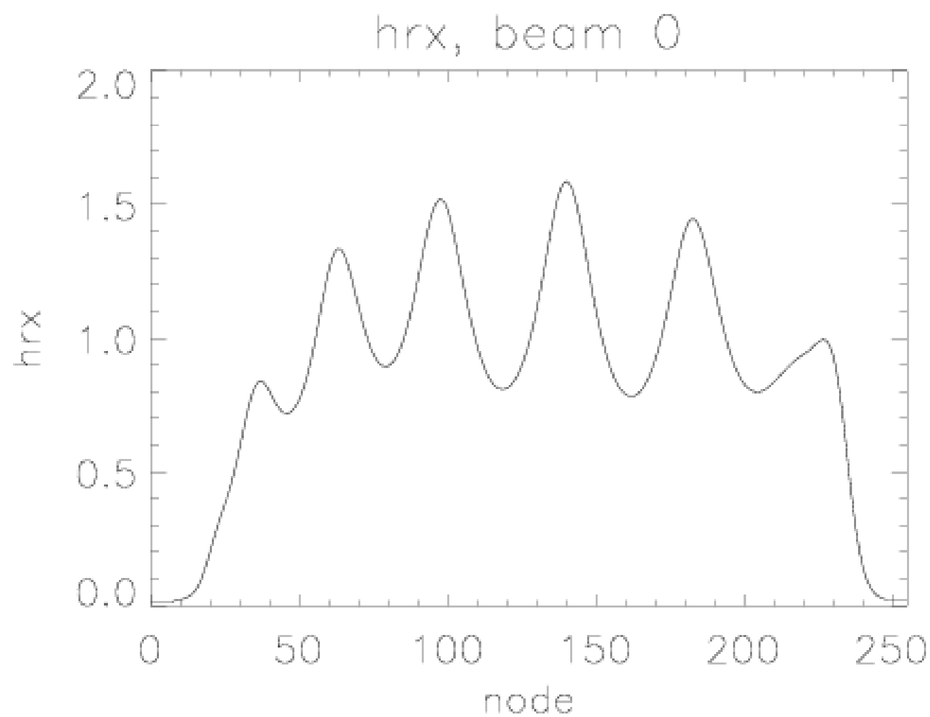
Plans are on-going to implement **dynamic generation of normalisation factors**, which not changing the calibration in itself, it will eliminate the errors introduced by the 'static orbit' assumptions

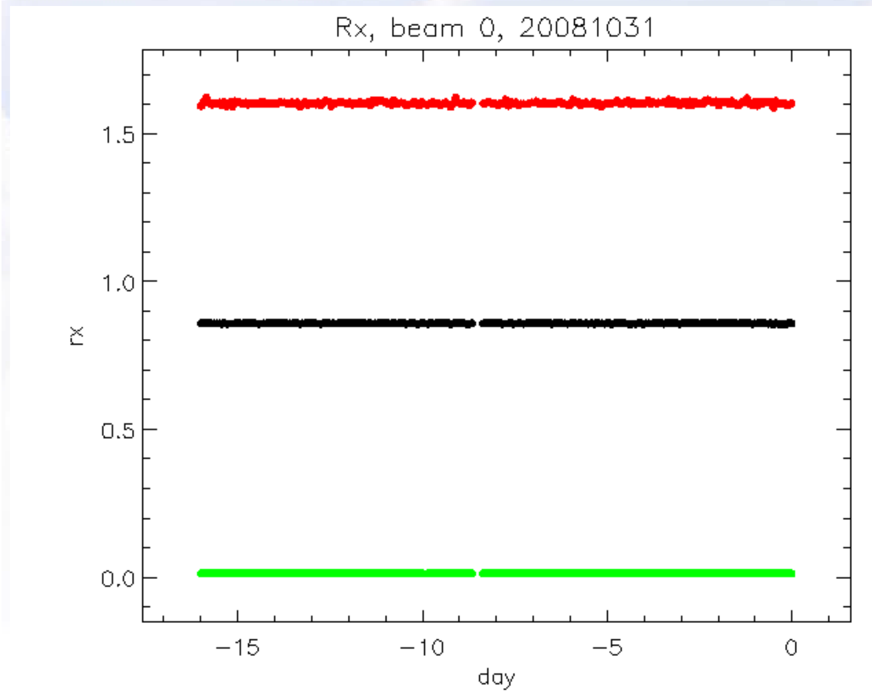
After initial validation of Kp, it falls well into what was specified and further work is now starting on assessing the **information content in the Kp estimates** and its usefulness in the L2 retrievals

ASCAT absolute radiometric calibration using ground transponders

L1a product monitoring: Receive filter shape

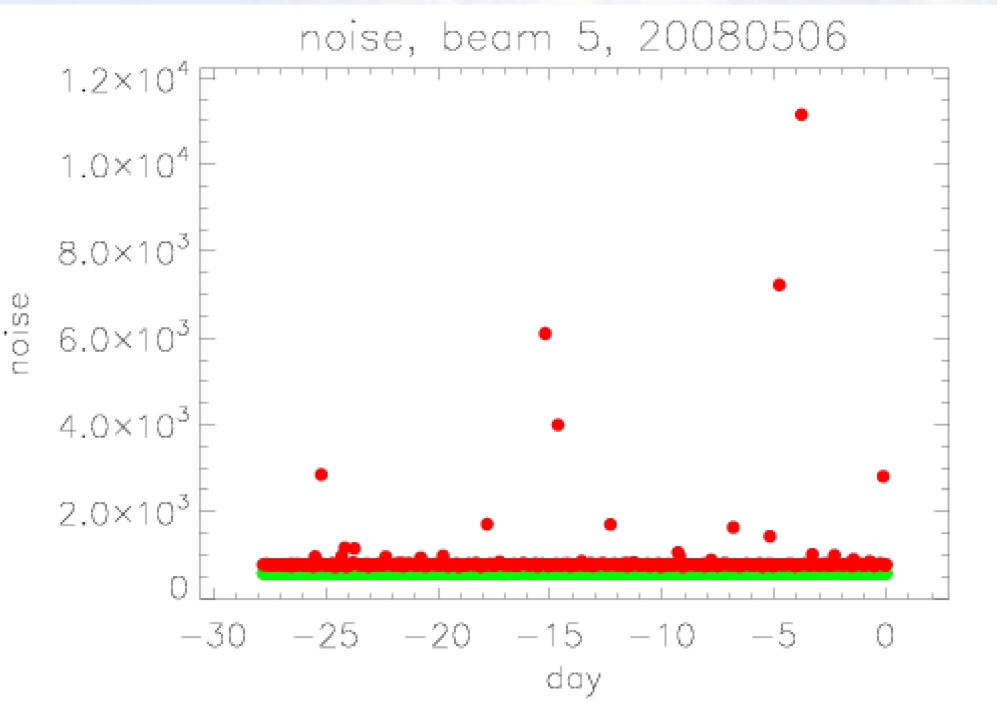
Weighted average of the received noise data. It should have characteristic shape and be constant in time. There was an initial problem in the near range (caused by strong nadir return) which was fixed by modifying the weights used in the averaging

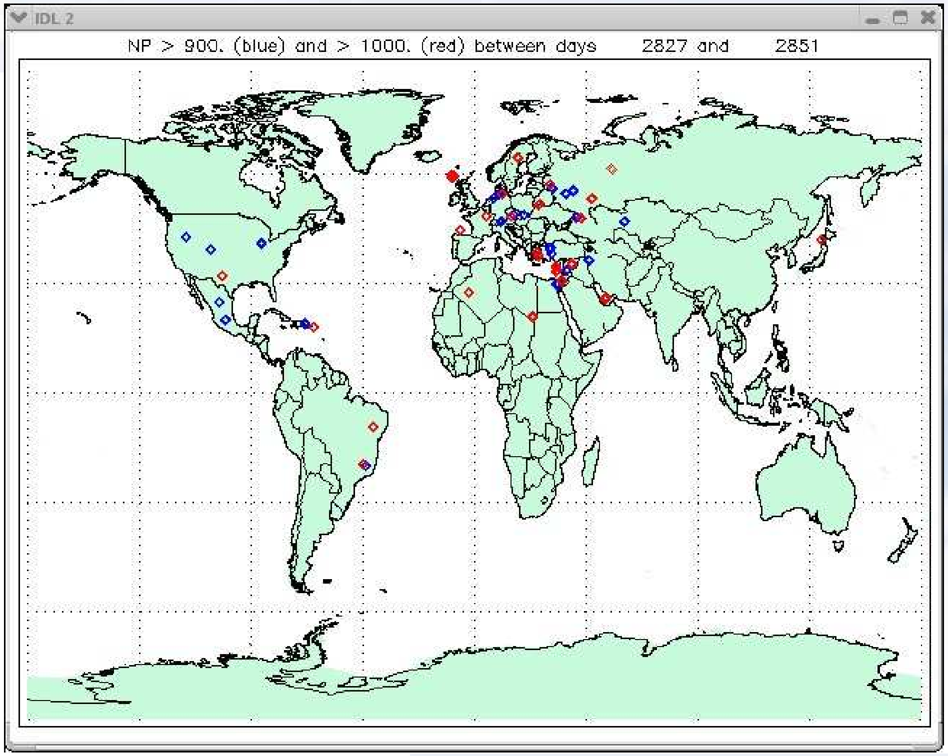




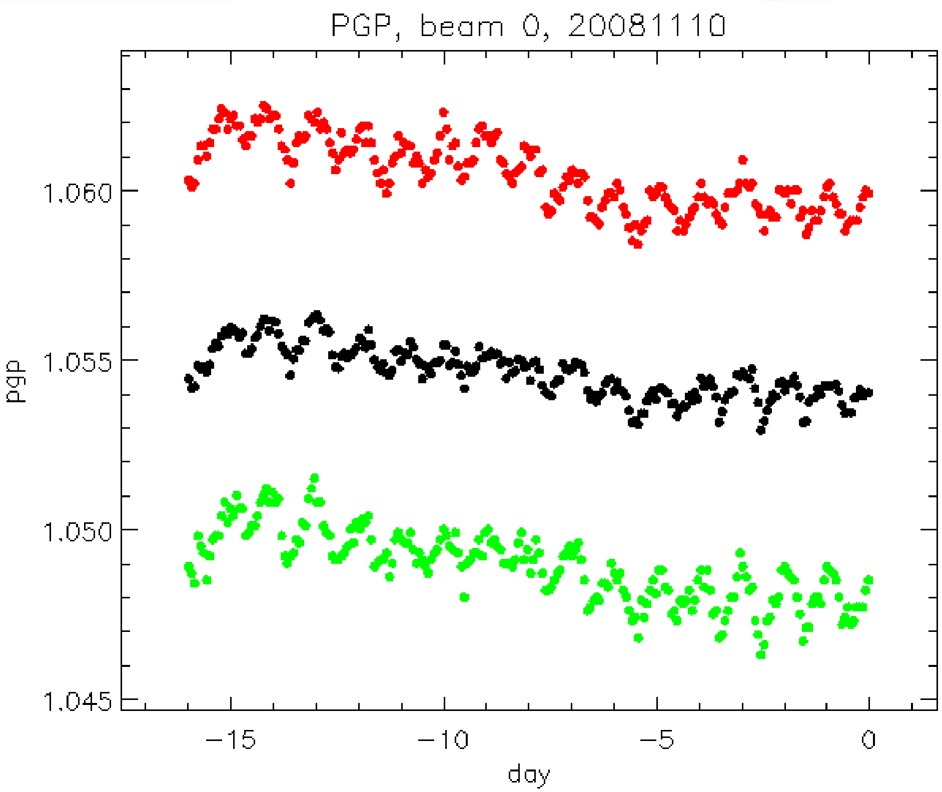
L1a product monitoring: Noise power

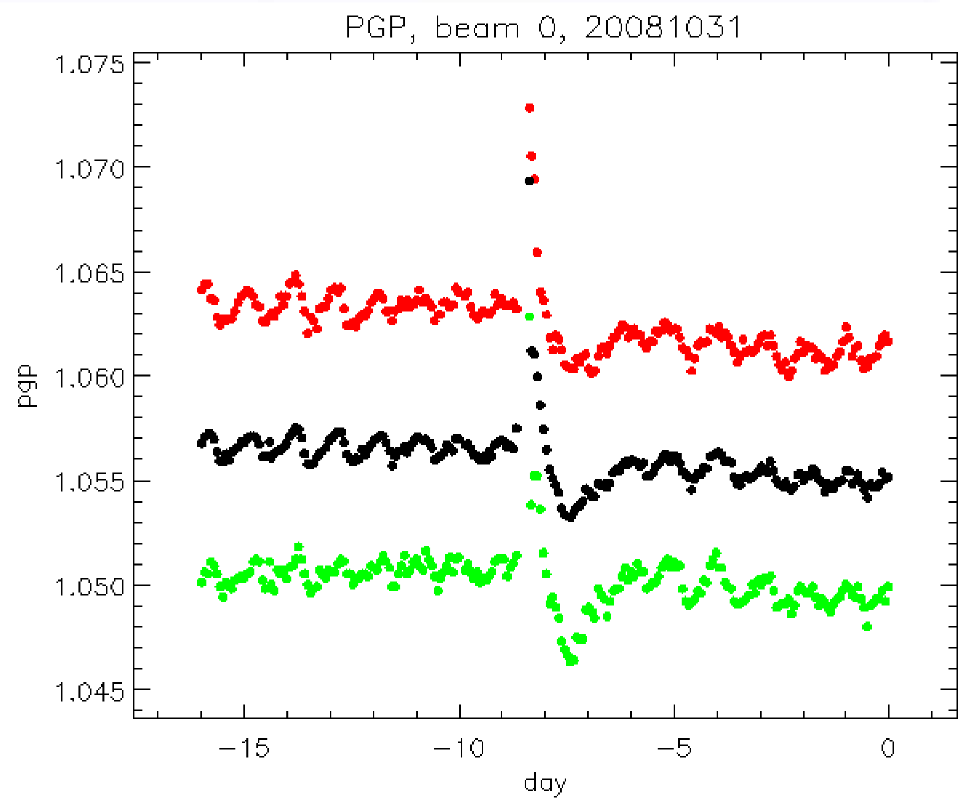
Soon after ASCAT was switched-on occasional very high noise values from point targets on the ground exceeded an onboard predefined threshold and ASCAT automatically switched off. Onboard algorithm was then modified so that several large noise values in succession were needed to trigger a switch-off.



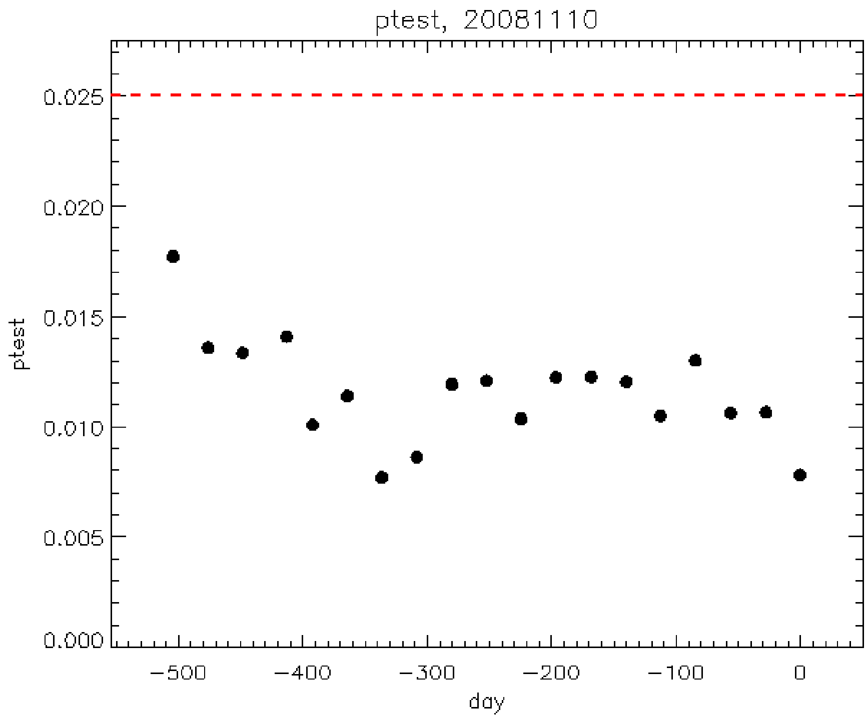


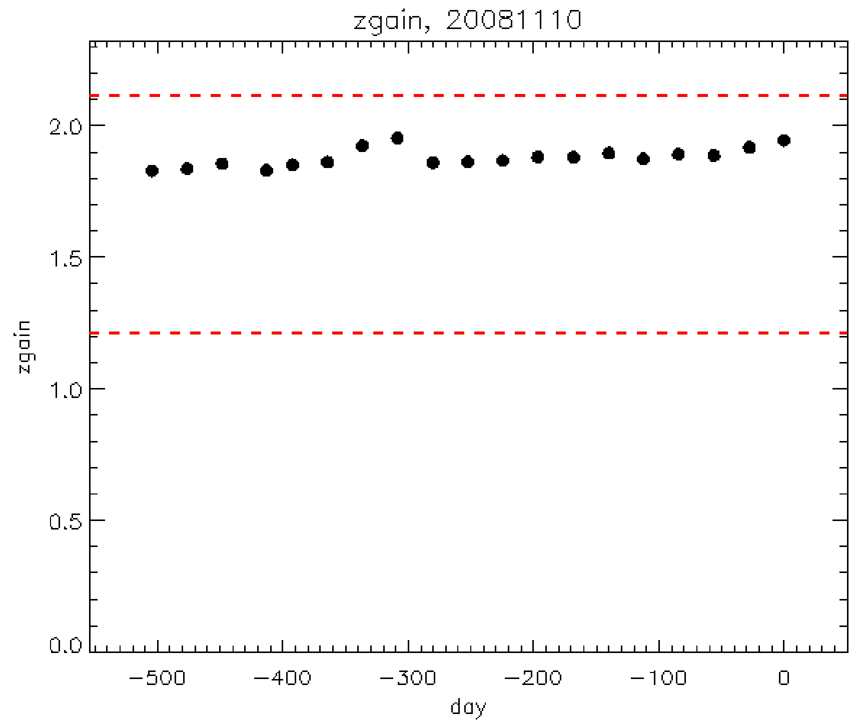
L1a product monitoring: Power-Gain product





ASCAT gain compression analysis and monitoring





Performed monthly to check the relationship between ASCAT drive level setting and transmitted power

ASCAT is operated with a sequence of different drive levels and effective transmitted power is estimated from data in instrument source packets. Two summary parameters are calculated:

- **Ptest measures linearity of drive level and transmitted power**
- **Zgain measures deviation of transmitted power from nominal**

ASCAT Level 1B on ground processing