MERIS solar diffuser BRDF modelling

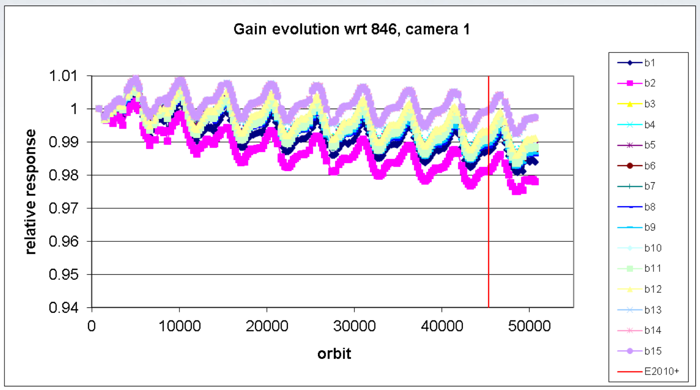
Gerhard Meister and Ewa Kwiatkowska

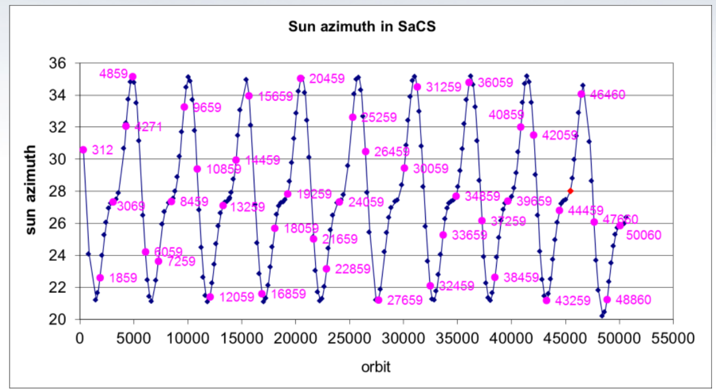
MERIS QWG-27 meeting, 12-14 June, 2013

EUMETSAT

Motivation for the solar diffuser model reanalysis

MERIS radiometric gains display a seasonal pattern dependent on Sun azimuth direction on the solar diffuser





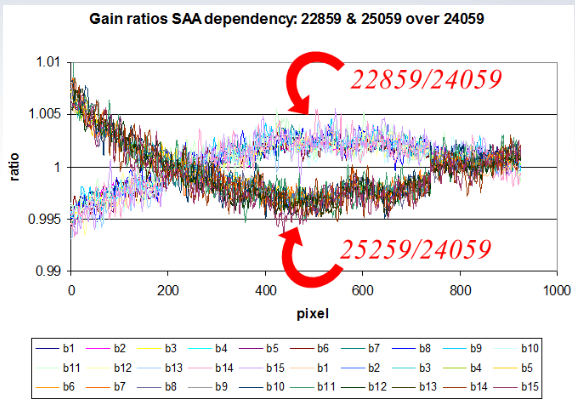
The pattern reduces the accuracy of the instrument degradation modeling

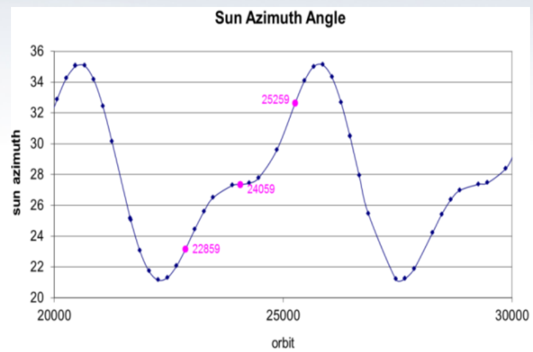
Several workarounds have been proposed

- normalizing the seasonal trend using NIR band 900nm to derive degradation parameters (diffuser 1)
- using calibrations acquired at middle solar azimuths 27.3^0 to derive reference gains (diffuser 2)
- performing radiometric calibrations at a predefined set of solar azimuth angles that will repeat from year to year; this requires special planning of calibration events

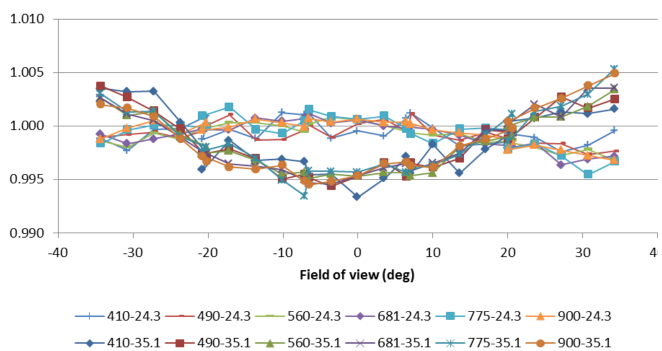
Gain seasonal patterns and the diffuser BRDF model

Relative gain differences measured on-orbit for July and December versus October, orbits 22859 and 25259 relative to 24059





Relative gain differences show similar pattern as solar diffuser BRDF model errors relative to lab measurements for solar azimuths 24.3^0 and 35.1^0 versus 27.5^0



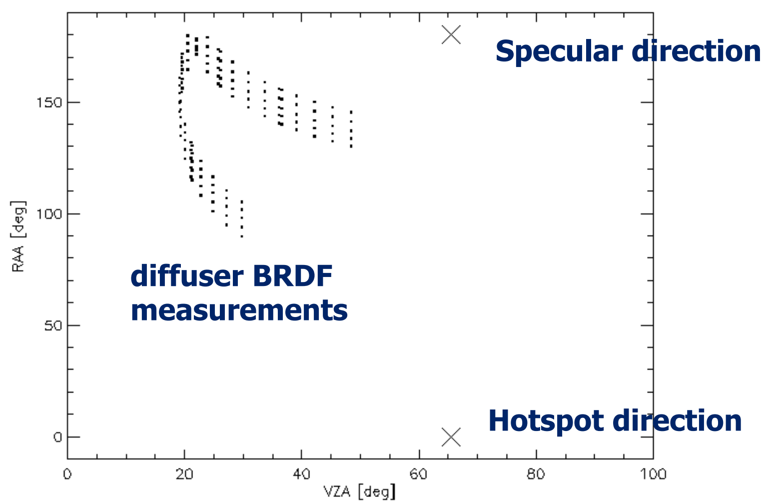
Existing solar diffuser BRDF modelling

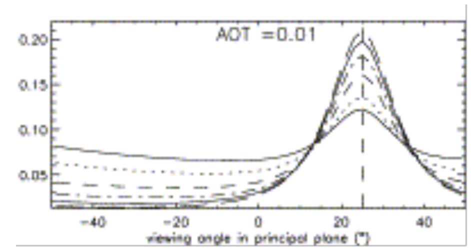
MERIS BRDF was measured in a lab over a limited set of angles

Rahman model was selected to describe the BRDF

Rahman model is used to calculate radiometric gains

Rahman model is optimized to model features in the principal plane, where most surfaces show the strongest variation, e.g. minima and maxima of vegetation





Hotspot and specular directions are far from diffuser BRDF measurements

New BRDF modelling

Simple polynomials were chosen to model BRDF given

limited angular coverage, and

consistent BRDF pattern at the available angles

Lab measurements contain BRDF values [1/sr] for bands 410, 490, 560, 681, 775 and 900nm, and geometries

- solar zenith on the diffuser in the diffuser reference frame (varies by 0.35^0 – not modeled) (gamma)
- solar azimuth in the instrument reference frame (beta) and relative azimuth in the diffuser reference frame
- view zenith in the instrument reference frame (delta) and in the diffuser reference frame

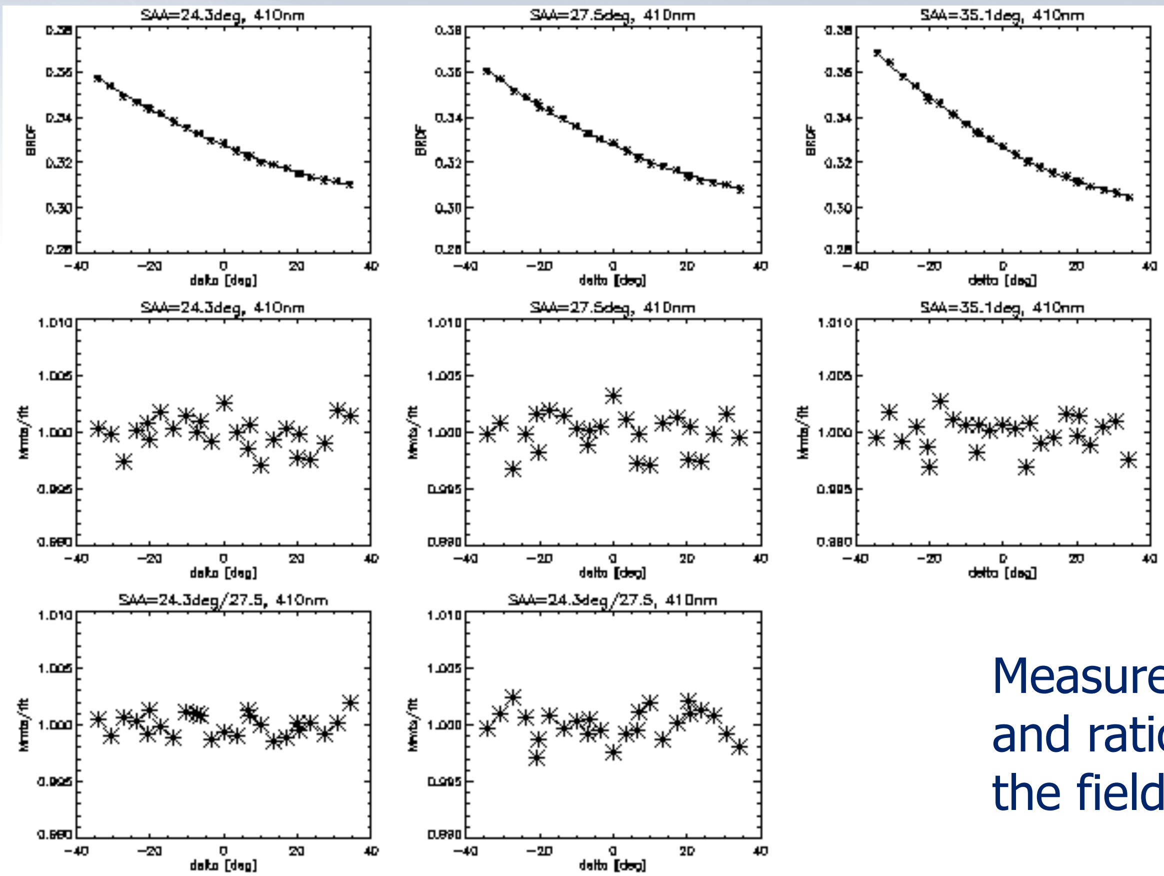
Second order polynomial was chosen

$$BRDF = a_0+a_1*d+a_2*d^2+a_3*b+a_4*b*d+a_5*b*d^2+a_6*b^2+a_7*b^2*d+a_8*b^2*d^2$$

Residual errors in the instrument reference frame showed to be better than those in the solar diffuser reference frame

Band 410nm, BRDF fit and measurement/model ratios

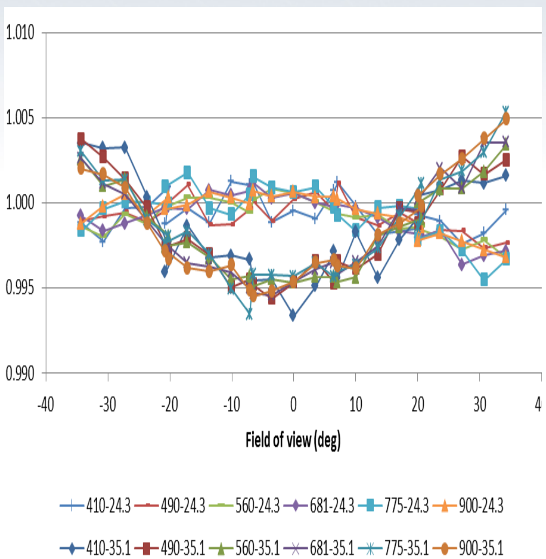
solar azimuth = 24.3^0 **solar azimuth = 27.5^0** **solar azimuth = 35.1^0**



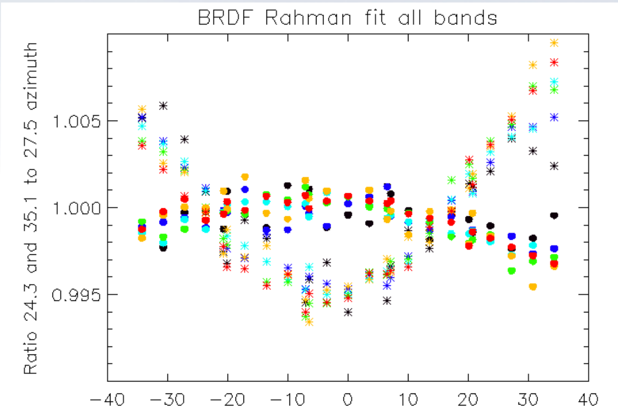
Measurements, model and ratios plotted across the field of view (FOV)

Solar azimuth dependence across FOV, all bands

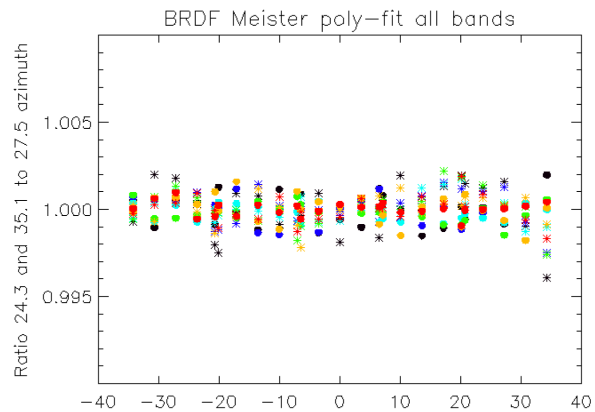
Relative BRDF model errors for solar azimuths 24.3^0 and 35.1^0 versus 27.5^0



Rahman model



Polynomial model

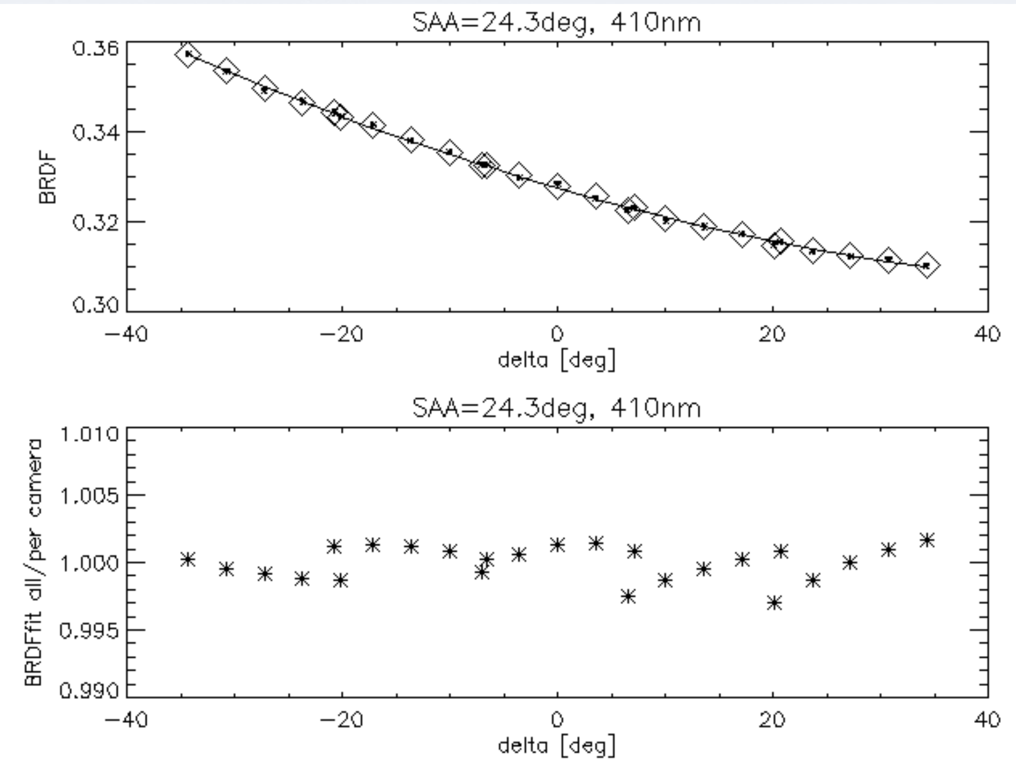


Typical deviation of the BRDF fit from the measurements is about 0.12%

BRDF polynomial model per camera

$BRDF = a_0+a_1*d+a_2*d^2+a_3*b+a_4*b*d+a_5*b^2$

Improved fit at camera edges

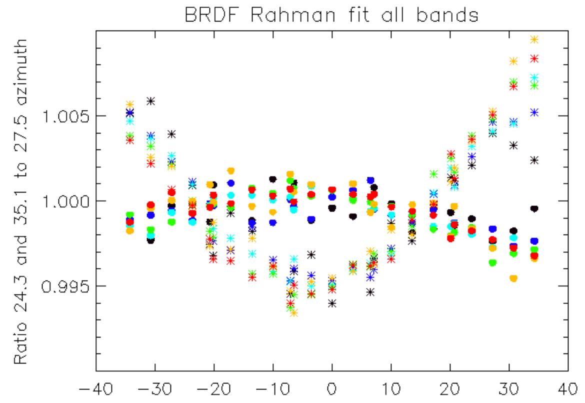


Ratio of the single model for all cameras to the per-camera models

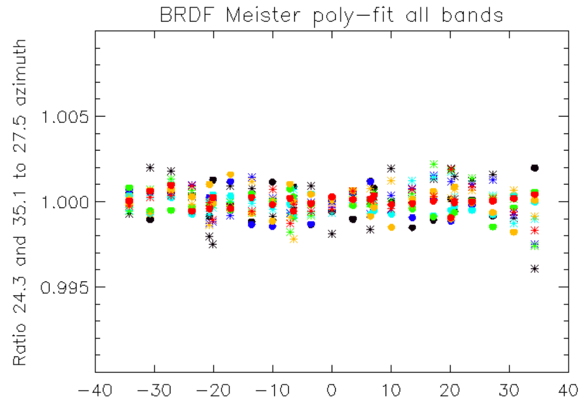
Solar azimuth dependence across FOV, all bands

Relative BRDF model errors for solar azimuths 24.3^0 and 35.1^0 versus 27.5^0

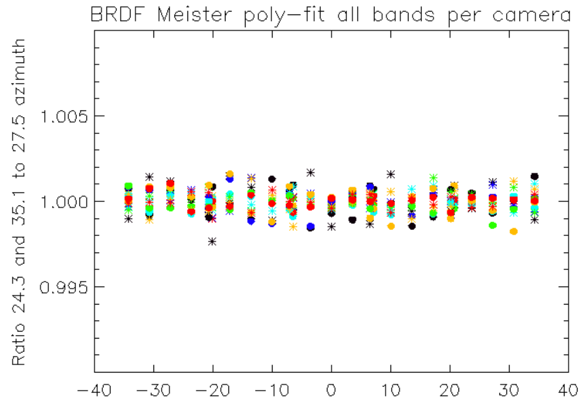
Rahman model



Polynomial model

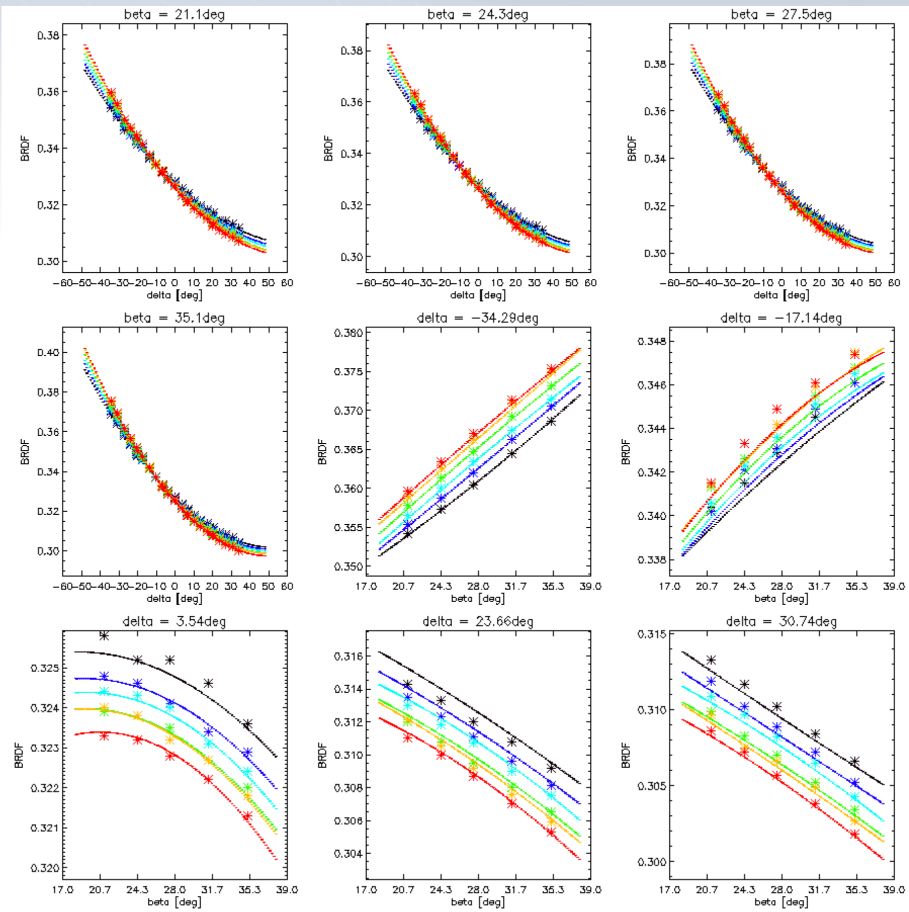


Polynomial models per camera

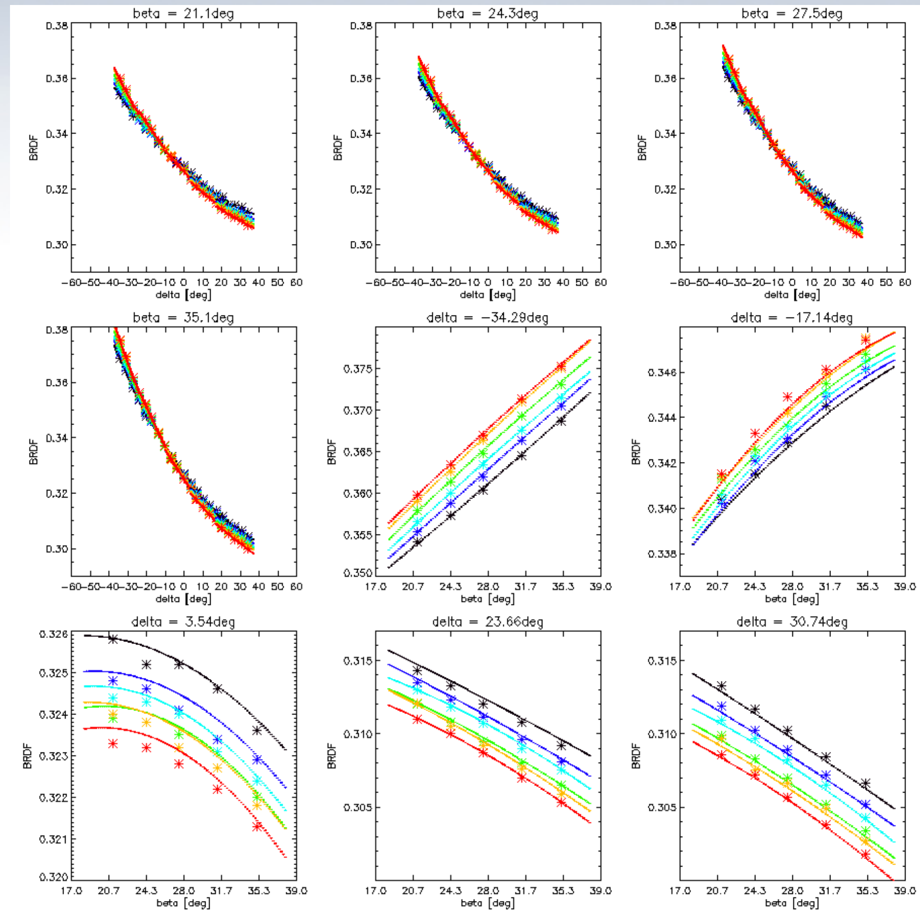


Poly fit extended ± 20% beyond measurement angles

Polynomial model



Polynomial model per camera



Recommendations

For MERIS:

Evaluate the polynomial BRDF models with real MERIS gains to see whether the seasonal patterns persist

Evaluate discontinuities at camera interfaces to see whether they improve with the per-camera BRDF polynomial models

For OLCI:

Increase the range of solar zenith angles at which BRDF lab measurements are made. The available MERIS dataset does not allow the derivation of a solar zenith angle dependence. Gerhard would suggest a variation of the solar zenith angle of at least 5^0, preferably 10^0.

Decide whether the polynomial models can be applied for OLCI

Decide whether the radiometric calibrations are still required at a predefined set of solar azimuth angles