Status of Libya-4 Activities - RAL

Dr David L Smith

Preparation for reprocessing

AATSR

- Long term drift correction LUT version 2.09 implemented in reprocessing
- V3.00 available based on revised BRF modelling
- No adjustment to align to MERIS

ATSR-2

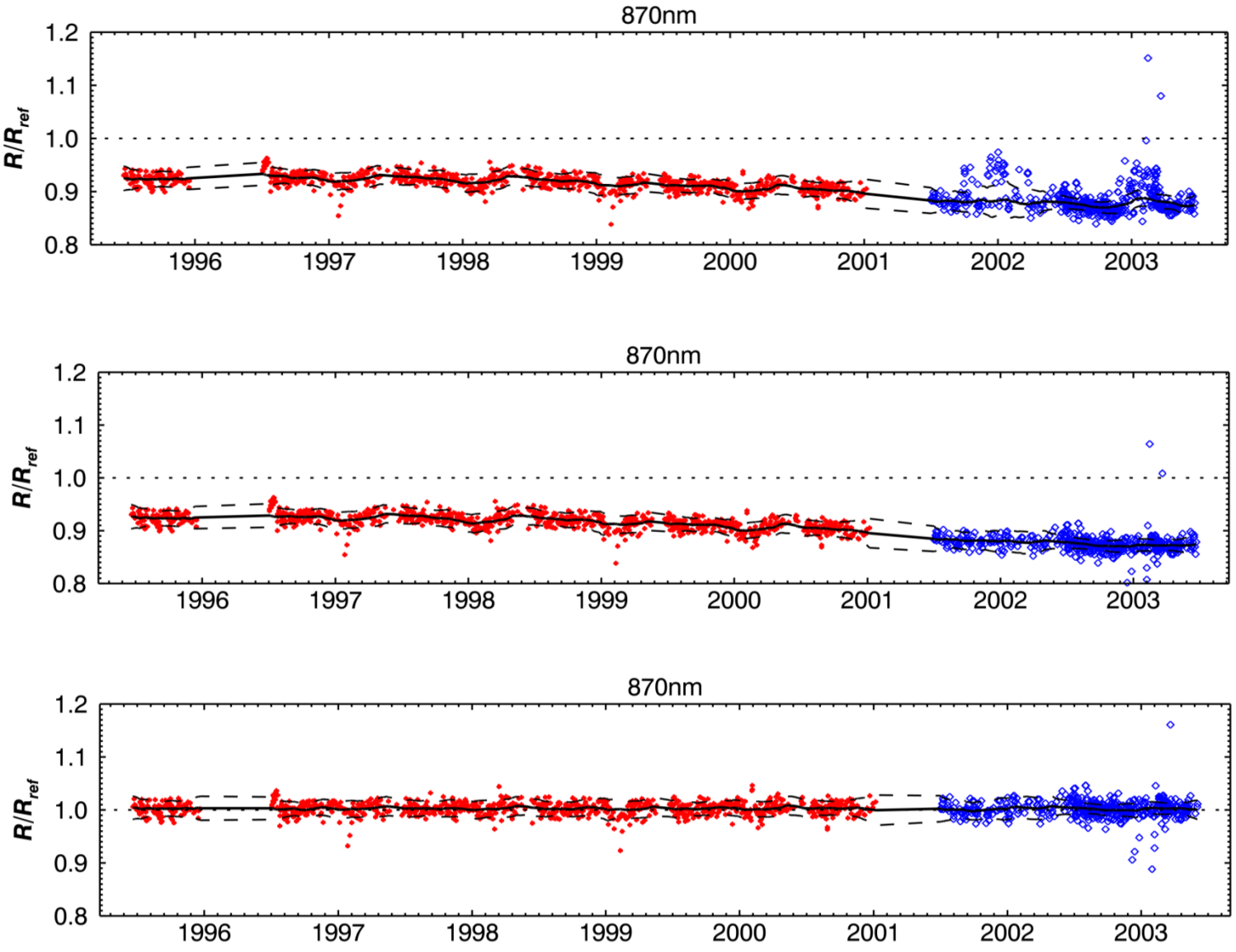
- New drift table generated (v4.00) should improve calibration for zero gyro mode.
  - Original table (v2.00) did not filter for poor VISCAL data.
- Calibration adjusted to AATSR

ATSR-2 Calibration

Current version as processed (V2.2 table)

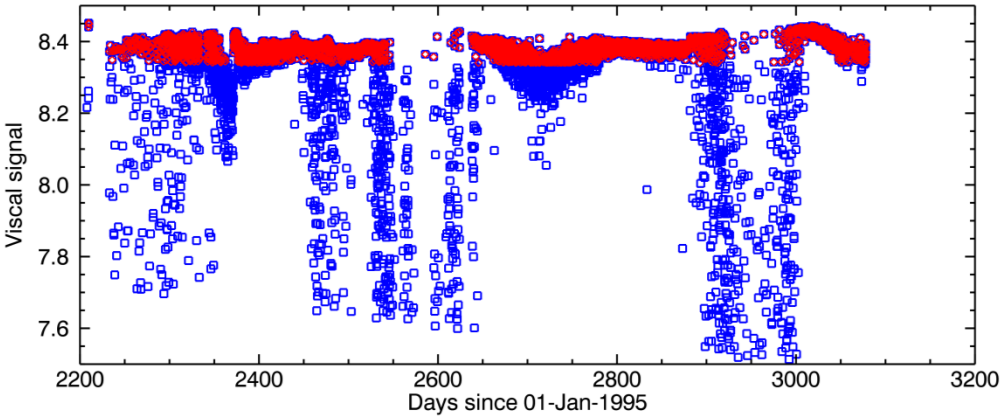
Recalibrated using filtered table (V3.0)

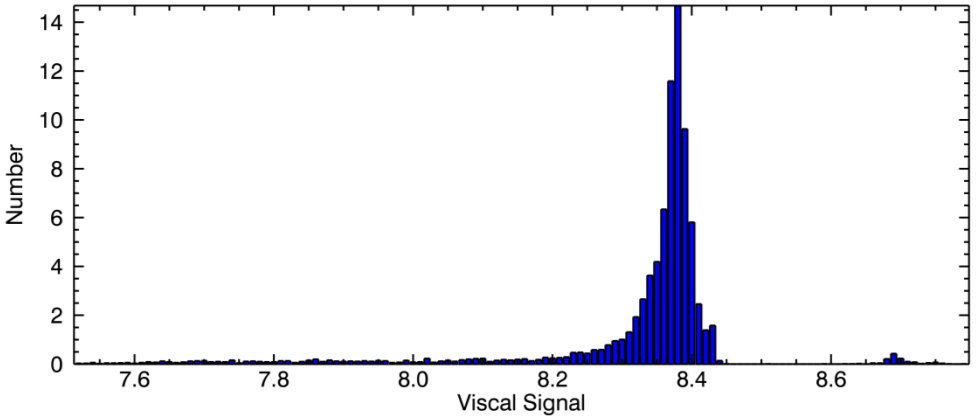
Filtered, Drift corrected + Adjusted to AATSR (V4.0)



VISCAL Smoothing

- Loss of ERS-2 gyros affected the pointing of the VISCAL wrt. Sun leading to many poor acquisitions of calibration signal (blue points).
- Filtering by using a histogram test enables only ‘good’ measurements to be used for calibration (red points).
  - Not implemented for first version of .E1 product
- Next reprocessing will incorporate this filtered table





Preparation for Reprocessing

ATSR-1

- First release of the ATSR-1 L1b products in ENVISAT format (.E1 files) uses the following calibration

```
aav16_nad[scans][i]  = (int)((double)aav16_nad[scans][i] * cor1 + cor2)
cor1 = 1.95664, cor2  = -1.85314
```

- Calibration did not account for two factors
  - ATSR-1 calibration does not allow for variation in Sun-Earth distance.
  - ATSR-1 UBTs are scaled in range 0-10000 which is inconsistent with scale of cor2

- Calibration coefficients have been recomputed taking into account these factors so

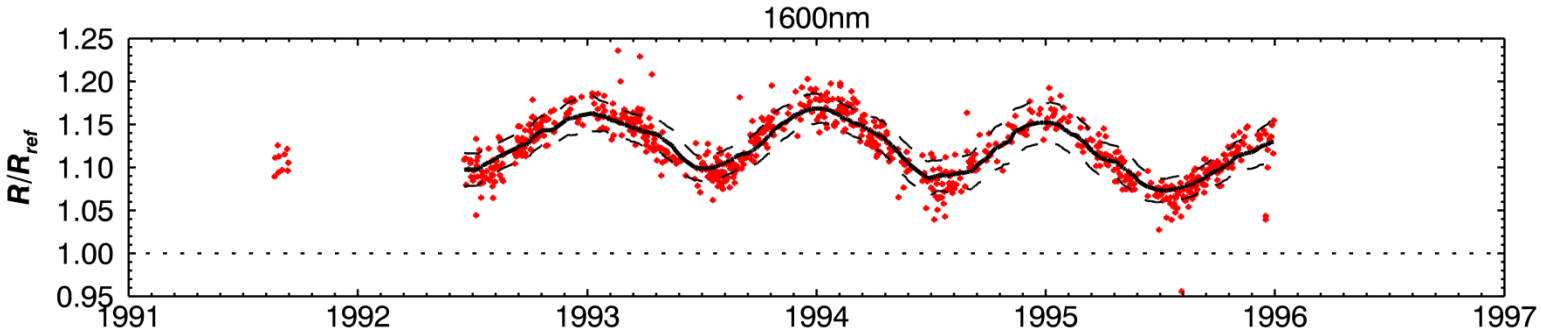
```
cor1 = 1.778615, cor2  = 0.0
```

Preparation for Reprocessing

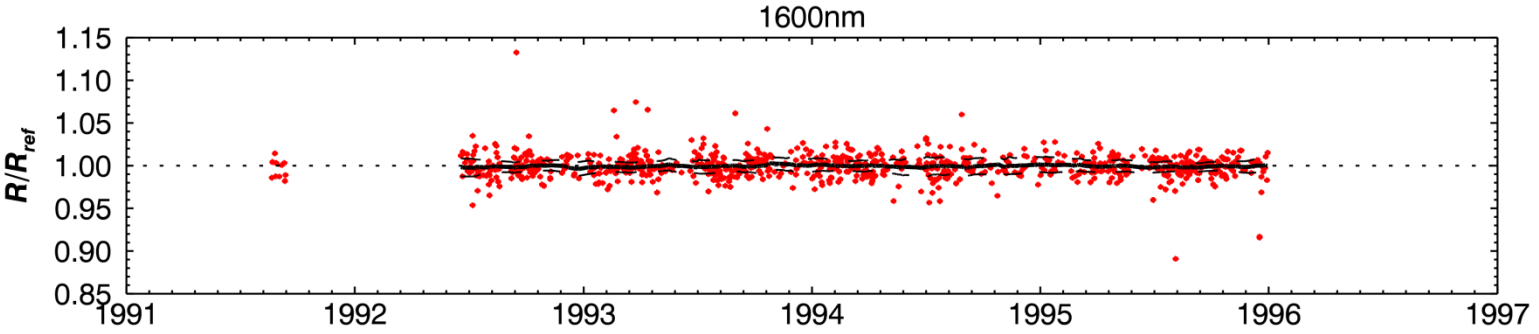
ATSR-1 (Cont)

- Drift table has been generated to account for new calibration coefficients and Sun-Earth distance

Original Calibration

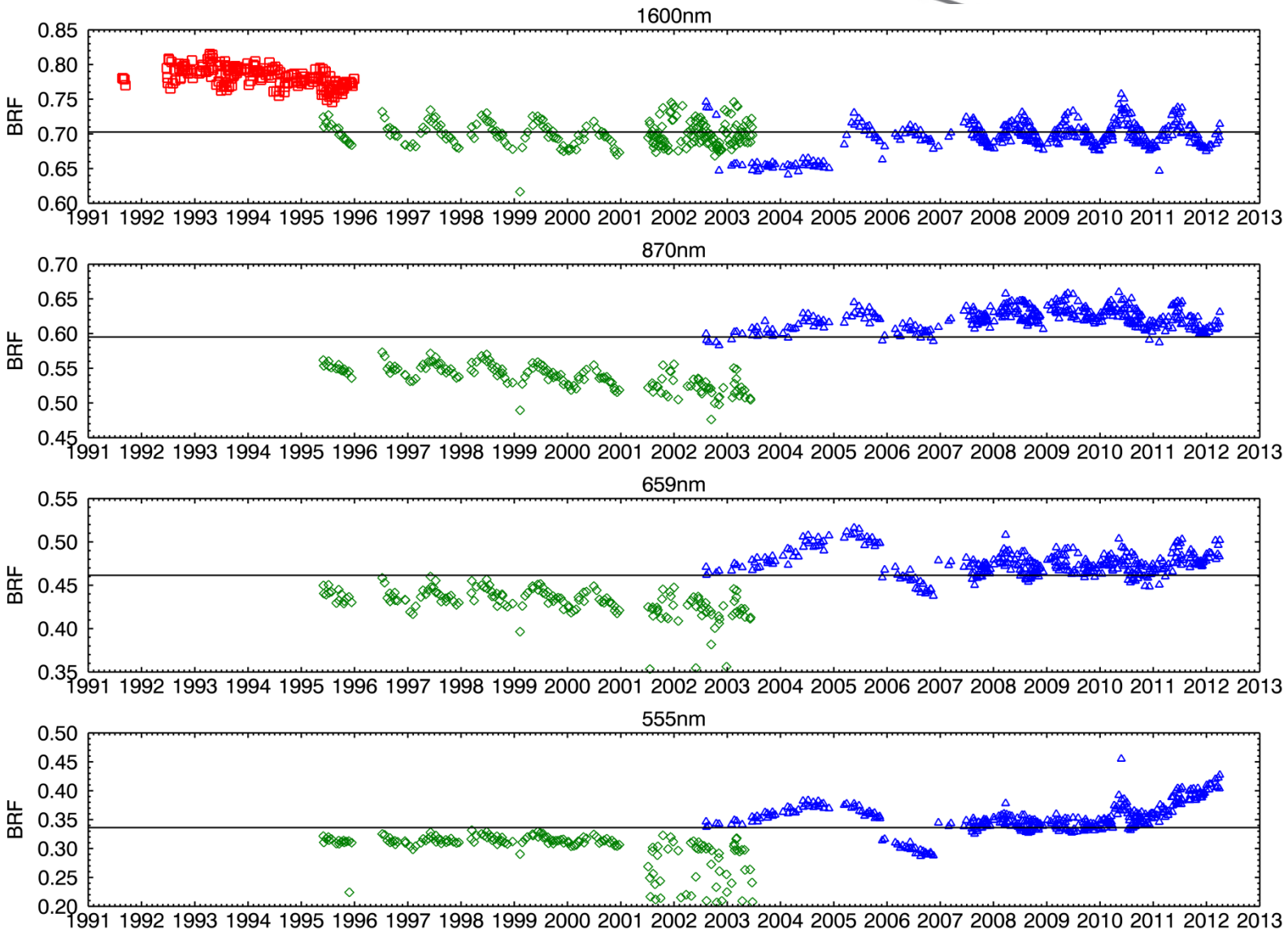


Revised Calibration

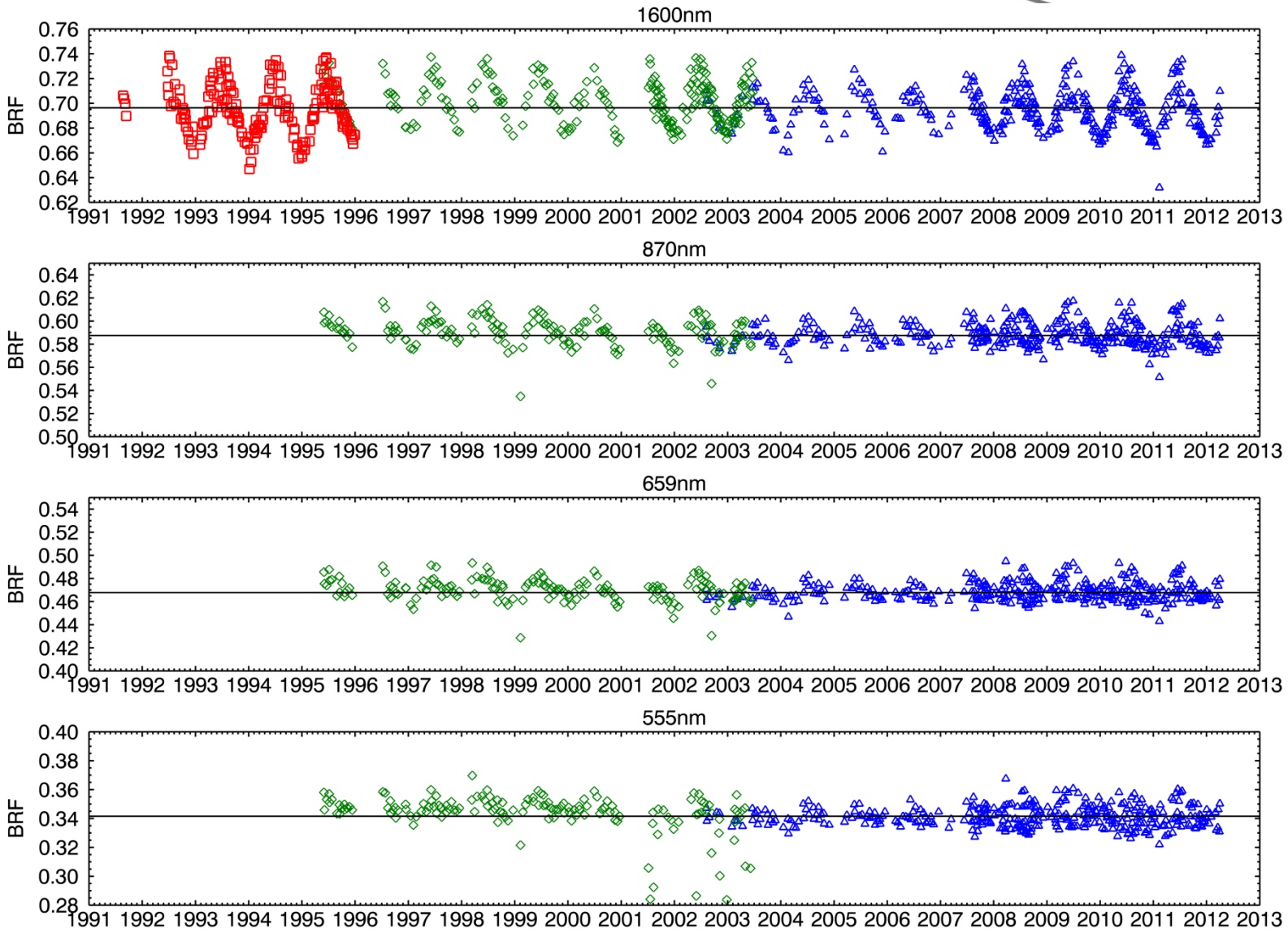


ATSR-1 relative to AATSR – corrected for directional effects

Libya-4 BRF - Uncorrected

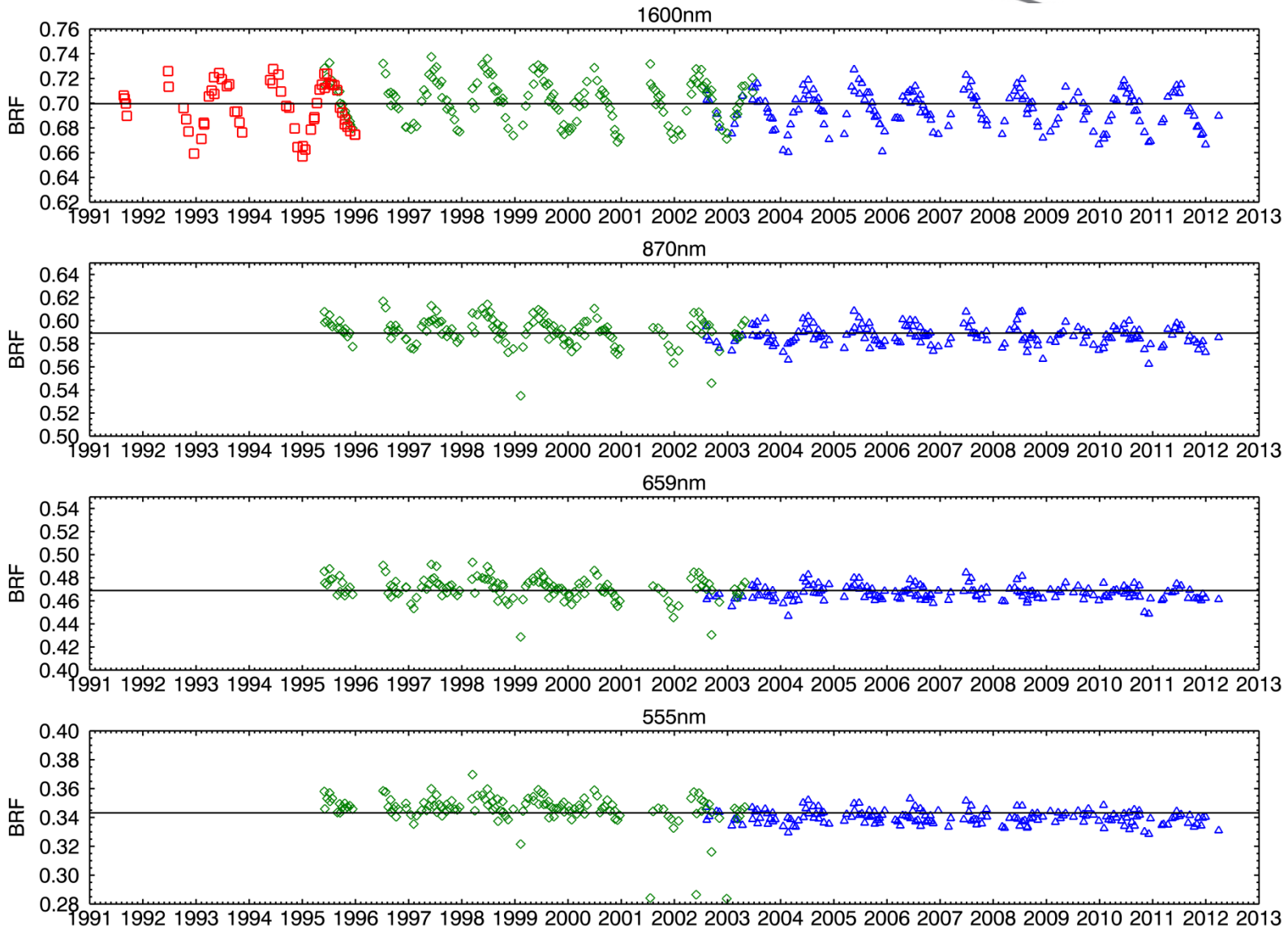


Libya-4 BRF – With Corrections (full swath)

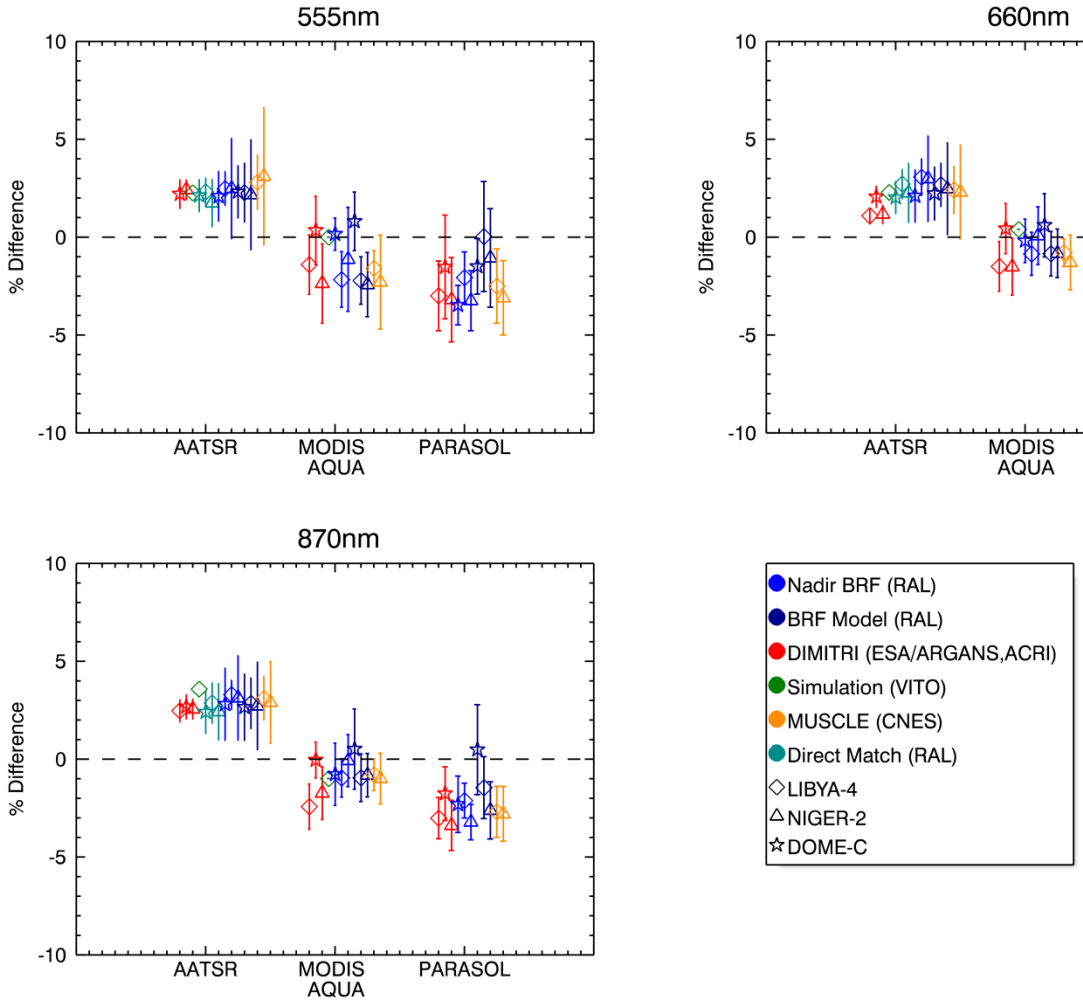


Libya-4 BRF – With Corrections (view < 7.5º)

RAL Space



Intercomparison summary
Adjusted for estimated spectral errors



The Remote Sensing Problem
A very indirect measurement

Noise
Responsivity
Spectral Response
Resolution
Coverage
Stability…

Atmosphere (absorption, scattering, emission), surface state, geometry, illumination...

'Real world'
e.g. SST, cloud...

Instrument
Calibration
Parameters

Uncertainties are introduced at ALL levels and will affect the final physical quantity of interest

Validation
x_v and S_v

Instrument measurements (y_m) and uncertainty (S_y)

Accurate Physics and Environment

Retrieval
Forward model y(x)

Retrieved parameters and uncertainty
x and S_x

A priori information (x_a) And uncertainty (S_a)

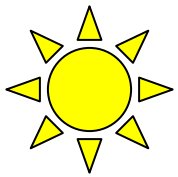
$$J(\mathbf{x}) = (y(\mathbf{x}) - y_m)\mathbf{S}_y^{-1}(y(\mathbf{x}) - y_m)^T + (\mathbf{x} - \mathbf{x}_a)\mathbf{S}_a^{-1}(\mathbf{x} - \mathbf{x}_a)^T$$

Cost function

Knowledge of environment

Understanding of what was missed

Vicarious calibration model over sites



$L_{scene} = (R_{surf}(R_{sol,0}+\tau_{sol})(R_{view,0}+\tau_{view,0}) + R_{sol,scatt})I_{sun}\cos(\theta_s)/\pi$

$R_{scene} = L_{scene}/(I_{sun}\cos(\theta_s)/\pi)$

Sensor

Direct scattering
$R_{sol,scatt}(\lambda,\theta_s,\theta_v,\varphi_{sol\text{-}view},P,\ldots)$

Scattering from surface
$R_v(\lambda,\theta_{view},P,\ldots)$

Gaseous Absorption
$\tau_{sol}(\lambda,\theta_{sol},P,\ldots)$

Gaseous Absorption
$\tau_{view}(\lambda,\theta_{view},P\ldots)$

Scattering from Sun
$R_{sol,0}(\lambda,\theta_{sol},P\ldots)$

Surface BRF
$R_{surf}(\lambda,\theta_{sol},\theta_{view},\varphi_{sol\text{-}view},t)$

Key Issue to Address

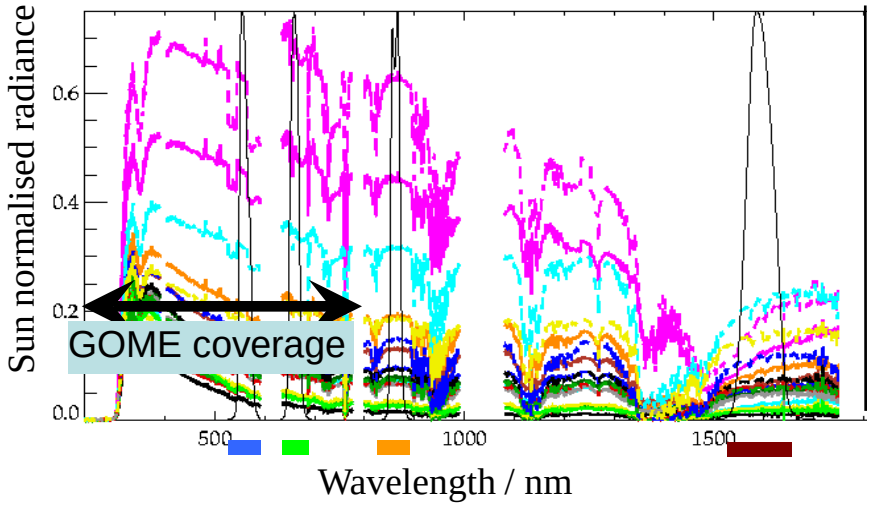
Surface BRF model

- Most models are tied to sensor acquisitions – hence not an absolute calibration method
- Sensors on Sun synchronous orbits do not cover complete geometric space
- CNES BRF model for Libya-4 site (based on Synder model and Parasol data) has been made available – to be implemented for AATSR comparisons.

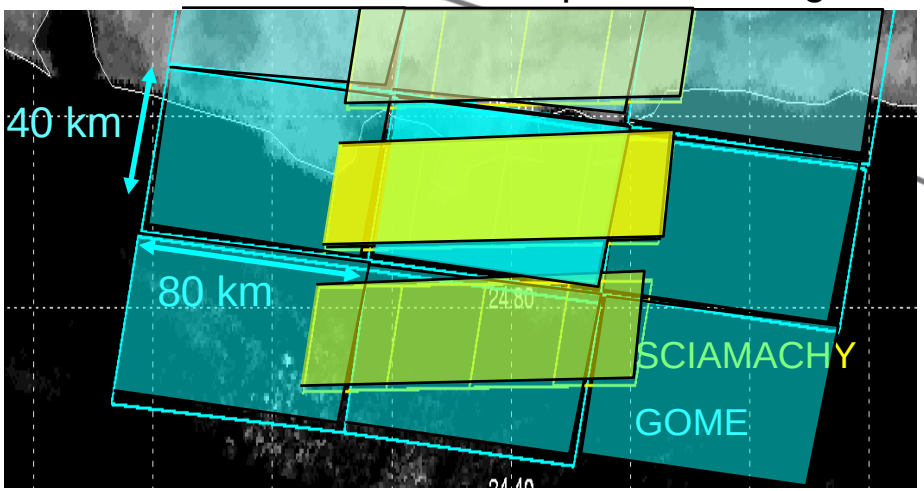
Spectral Differences

- Can give 5% bias if unaccounted for – even for small differences in bands
- Can be correlated with geometric effects – i.e. optical depth vs. sun zenith angle.

Intercomparisons via spectrometers

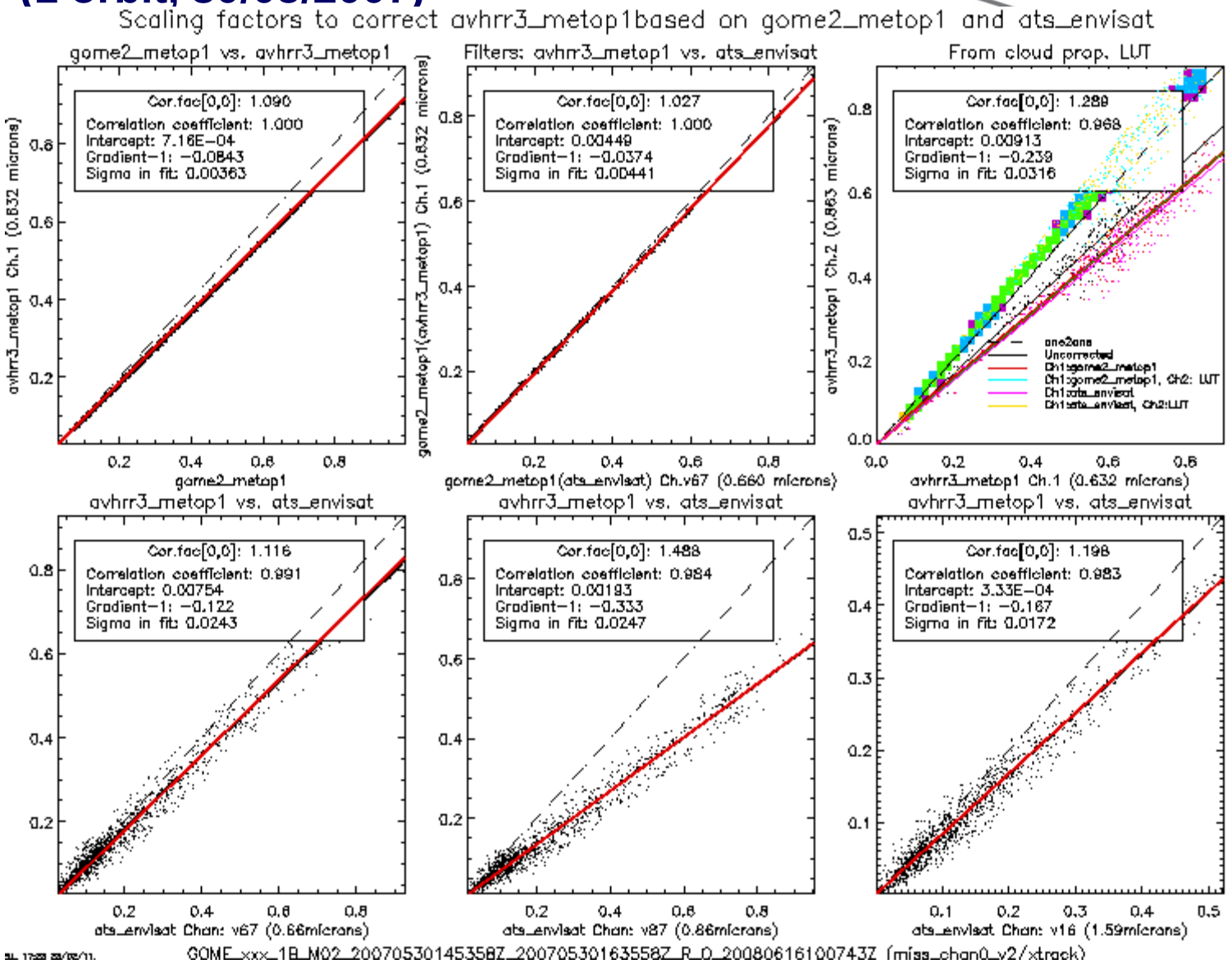


AATSR / SCIA / GOME spatial coverage



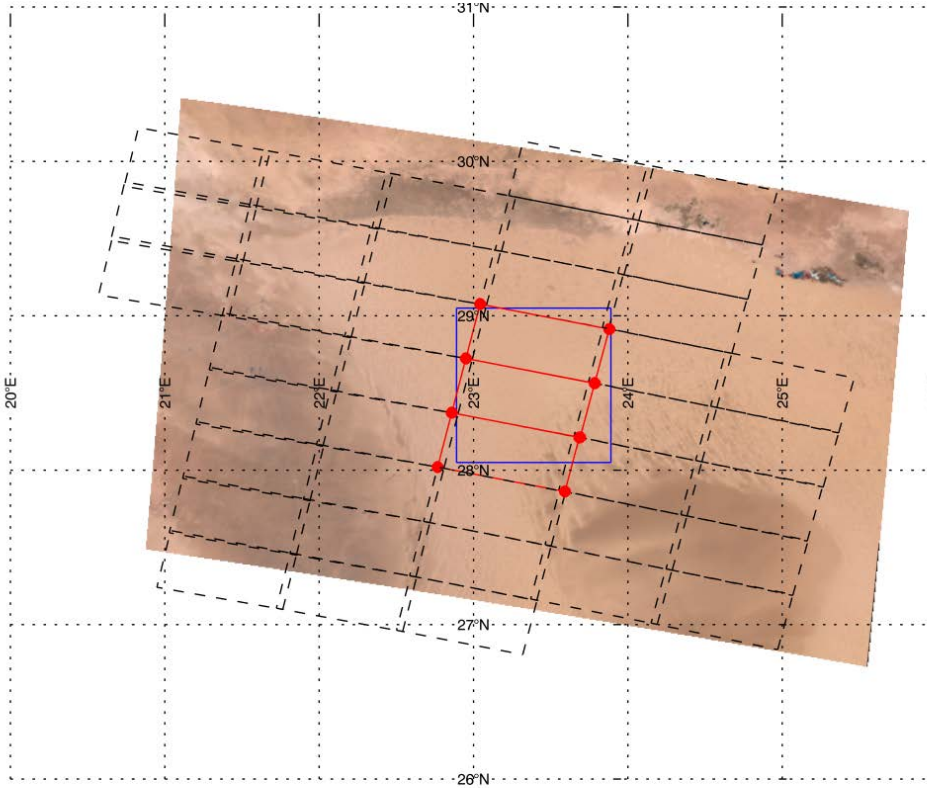
- Inter-comparison requires
  - *Spectral* averaging of SCIA/GOME
  - *Spatial* averaging of AATSR/ATSR-2
- GOME & SCIA pixels not same size or coincident, therefore
  - Perform comparison for accurately co-located GOME/ATSR-2
  - Average SCIA to give scene comparable to GOME; compare to properly averaged AATSR
  - Associate nearest GOME/SCIA pixels to allow cross platform comparison; accept “noise” due to scene variation (time difference).

AVHRR/3 vs. AATSR (via GOME-2)
(1 orbit, 30/05/2007)



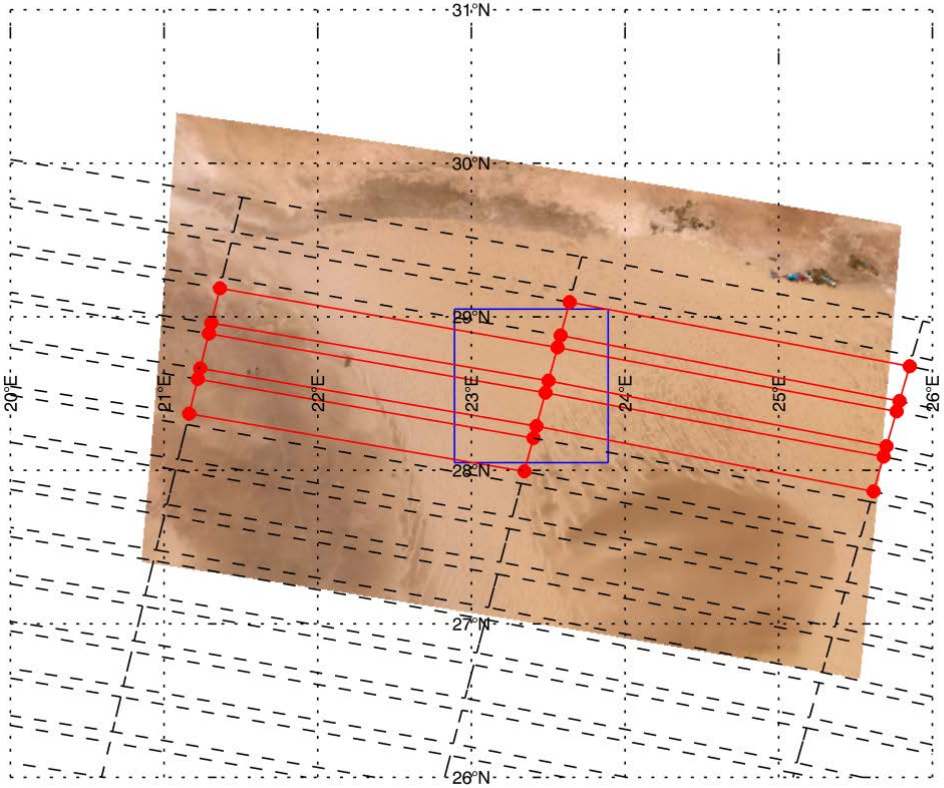
Spectrometers

GOME-2 Over Libya-4



Good temporal coverage
Spatial resolution within Libya-4 site
Spectral range up to 800nm
Co-registered with METOP-AVHRR

SCIA Over Libya-4



Poor temporal coverage (for Nadir)
Spatial resolution larger than site
Spectral range up to 2000nm
Co-Registered with AATSR/MERIS

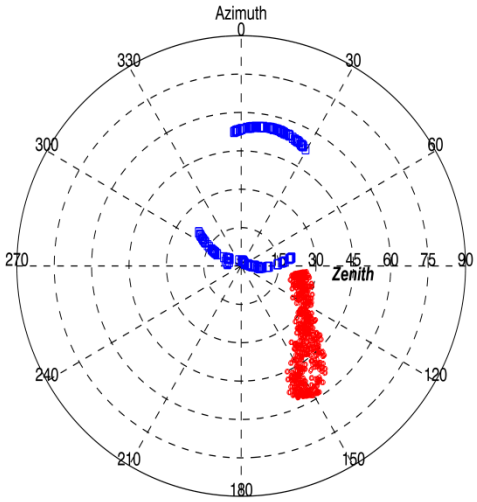
GOME-2 Extractions over Libya-4

- METOP GOME-2 orbital L1 products from EUMETSAT
  - Jan-2007 to present (up to 2025 expected)
  - At Issue 4.0 on BADC
  - Latest version Issue 5.3 – to be ingested

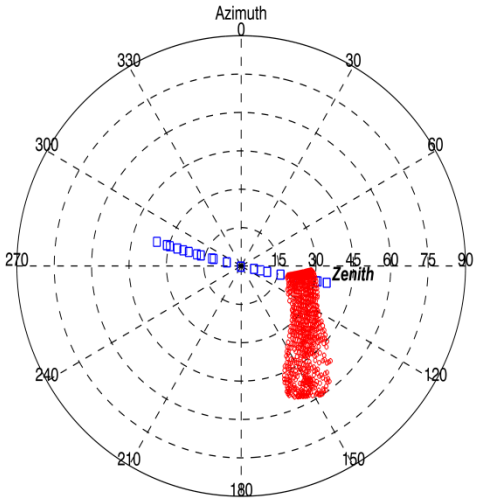
- Extractions performed for channels 3 (400-600nm) and 4 (600-800nm) pixels within ±2ºLon, ±1.5ºLat of site centre.
  - No spectral or spatial averaging – data are at native resolution
  - Spectral sampling (0.11-0.22nm) and resolution (0.24-0.53nm) dependent on wavelength
  - Channels 1 (240-315nm) and 2 (310-403nm) not extracted for this analysis

- ERS-2 GOME-1 Data are also available for 1996-2005
  - Data quality?

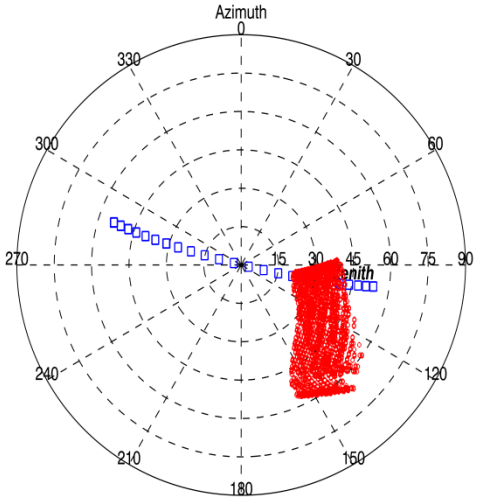
Libya-4 Geometry



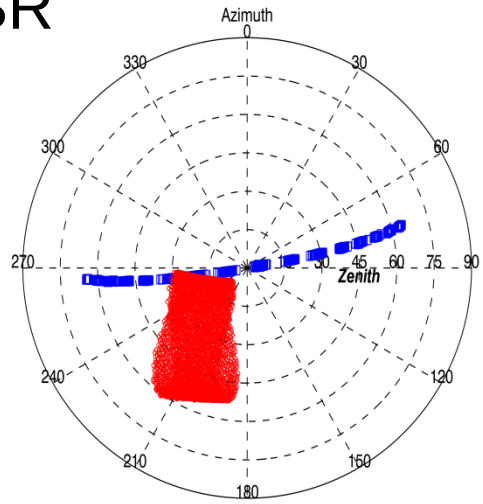
AATSR



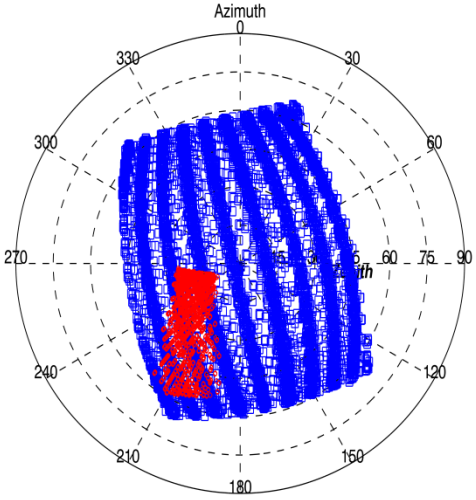
MERIS



GOME-2

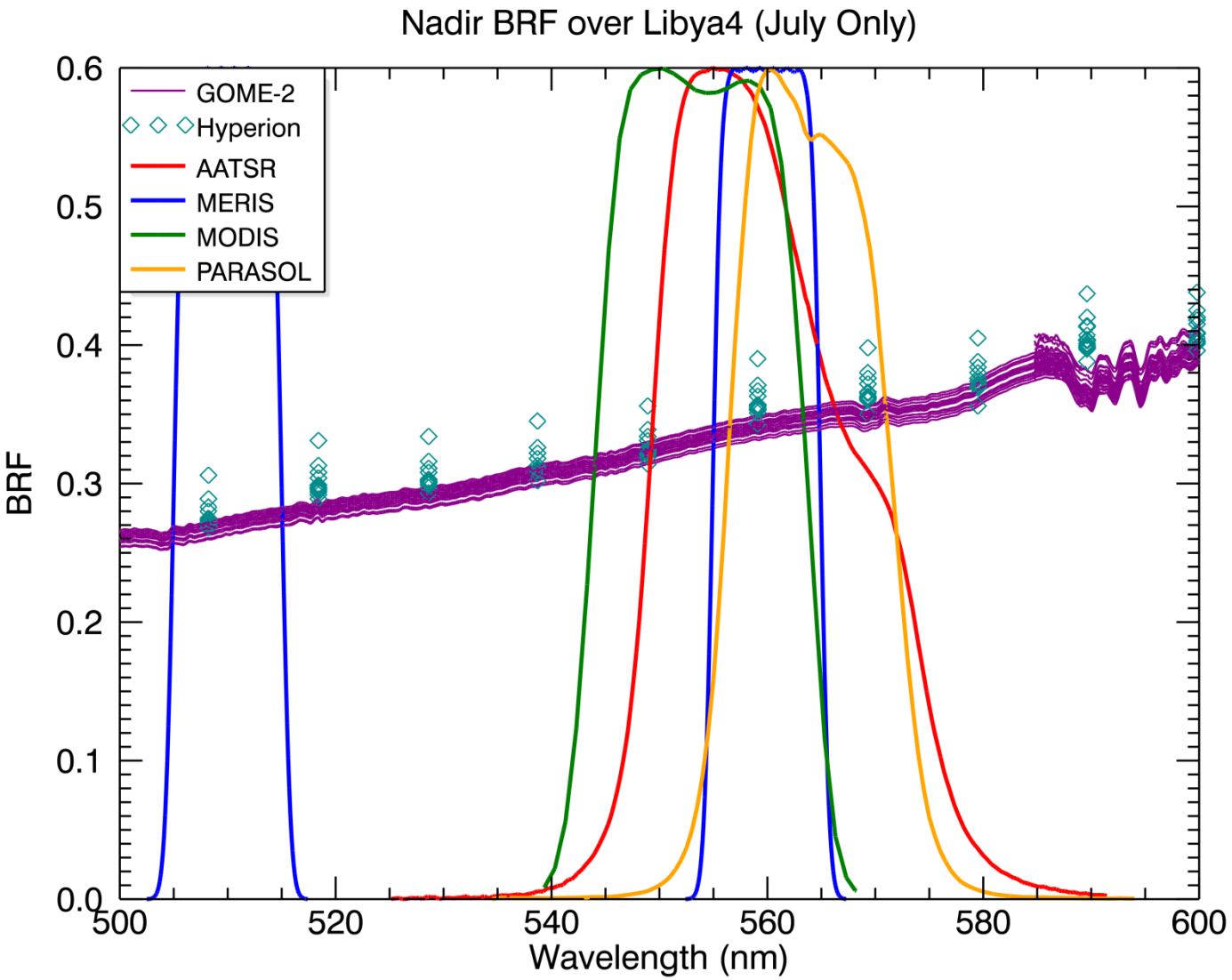


MODIS-A



PARASOL

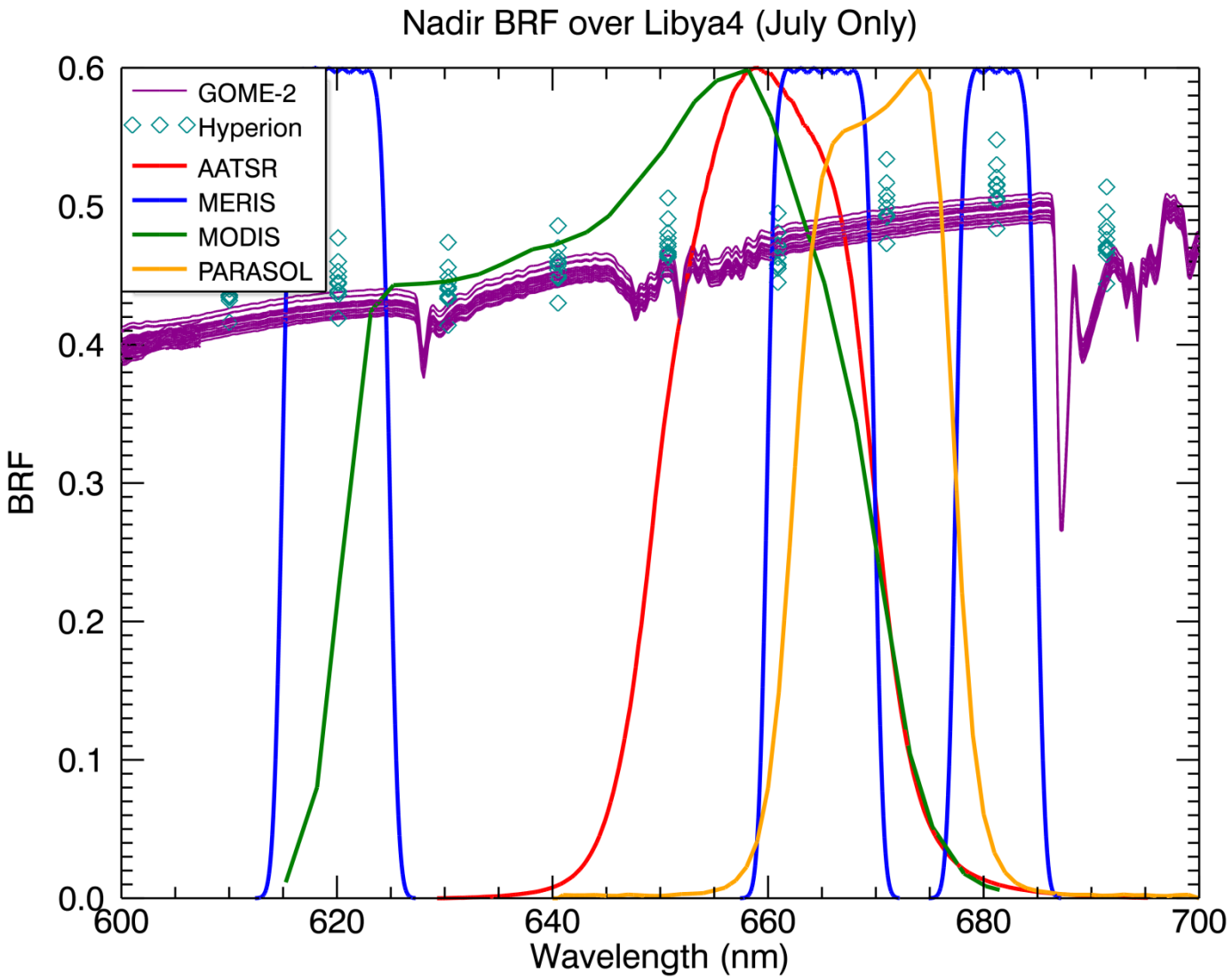
Libya-4 Site Spectra



500-600nm

Atmos mainly scattering + O_3

Libya-4 Site Spectra



600-700nm

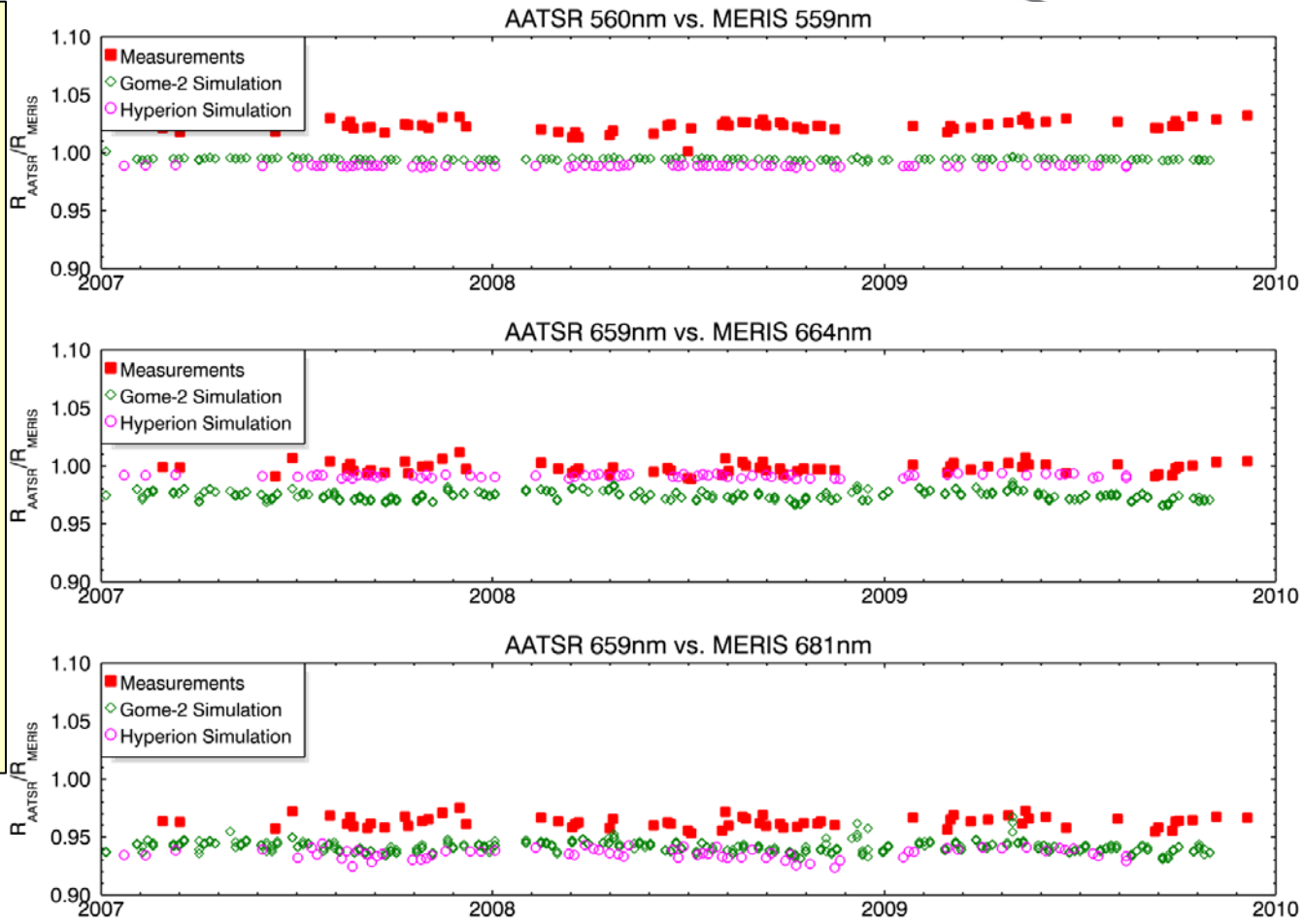
Atmos mainly scattering + O_3 +H_2O

Intercomparison – AATSR vs. MERIS Time Series

Gome-2 Spectra Integrated over sensor spectral bands

Reference is Meris 559nm, 666nm and 681nm

AATSR drift correction applied no bias correction

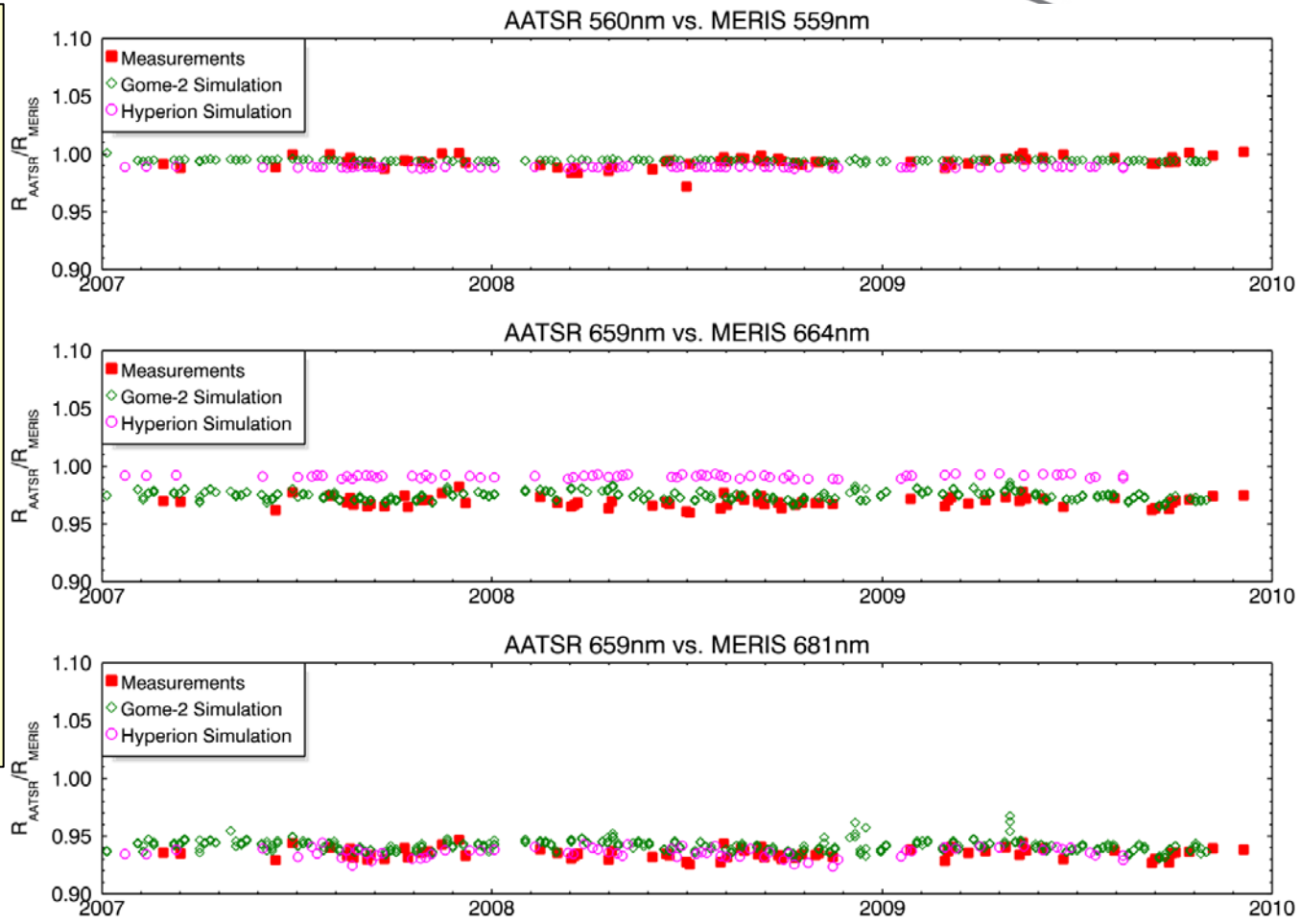


Intercomparison – AATSR vs. MERIS Time Series

Gome-2 Spectra Integrated over sensor spectral bands

Reference is Meris 559nm, 666nm and 681nm

AATSR drift correction + 3% bias adjustment applied



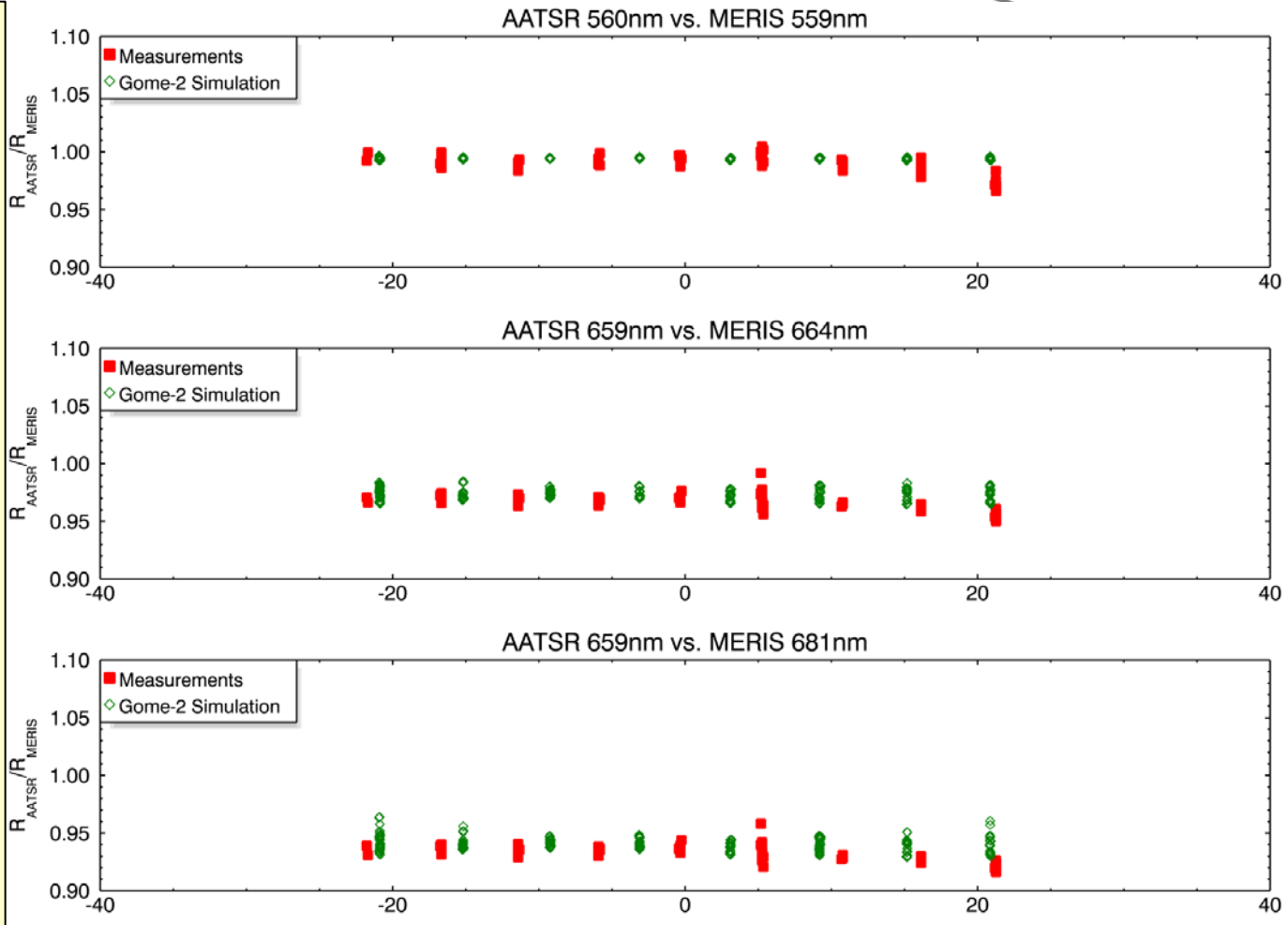
Intercomparison – AATSR vs. MERIS vs. View Angle

Gome-2 Spectra Integrated over sensor spectral bands

Reference is MERIS 559nm, 666nm and 681nm

$35^{O} < SZA < 45^{O}$

AATSR drift correction + 3% bias adjustment applied

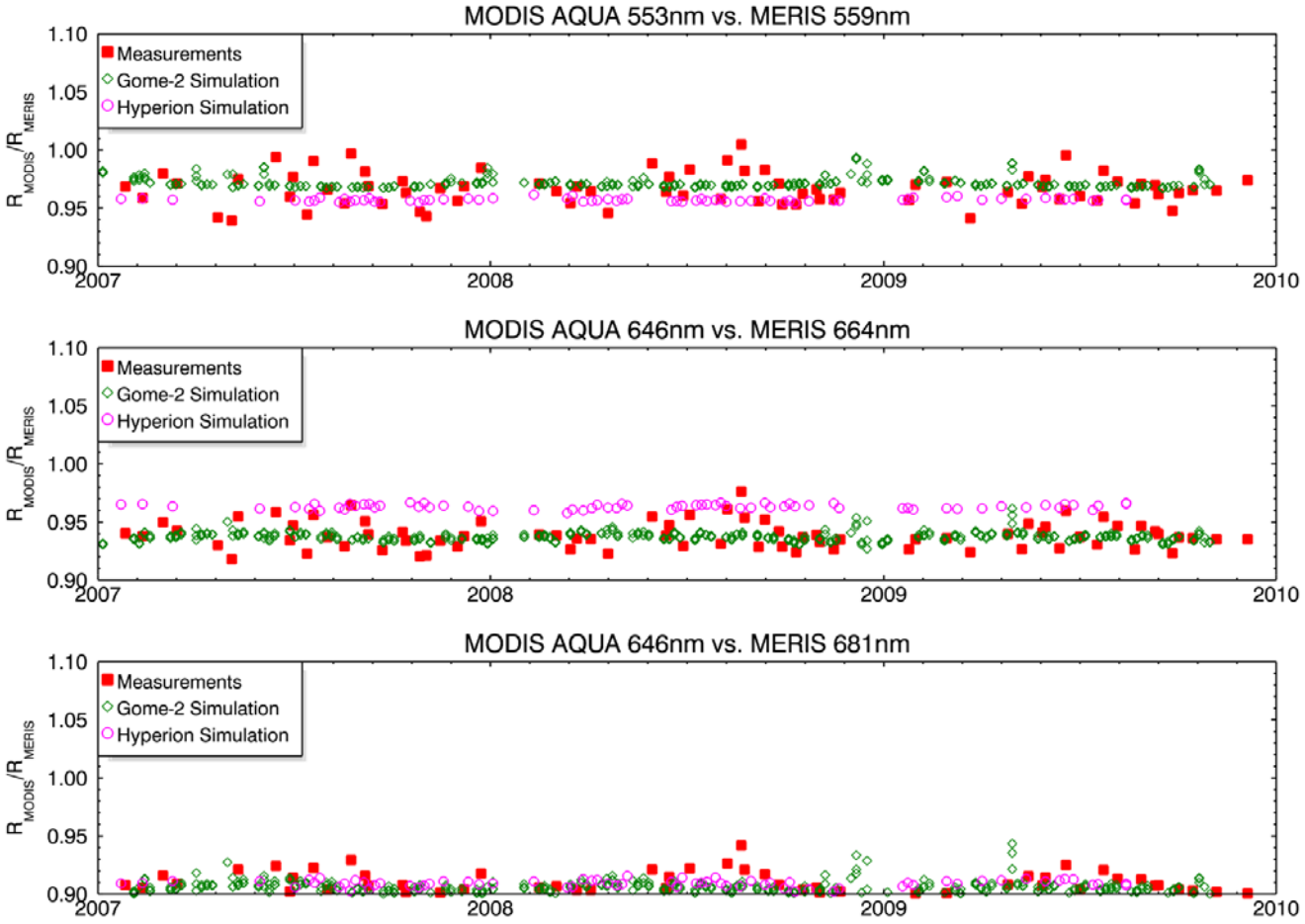


Intercomparison – MODIS vs. MERIS Time Series

Gome-2 + Hyperion Spectra Integrated over sensor spectral bands

Reference is MERIS 559nm, 666nm and 681nm

MODIS geometrically corrected to MERIS



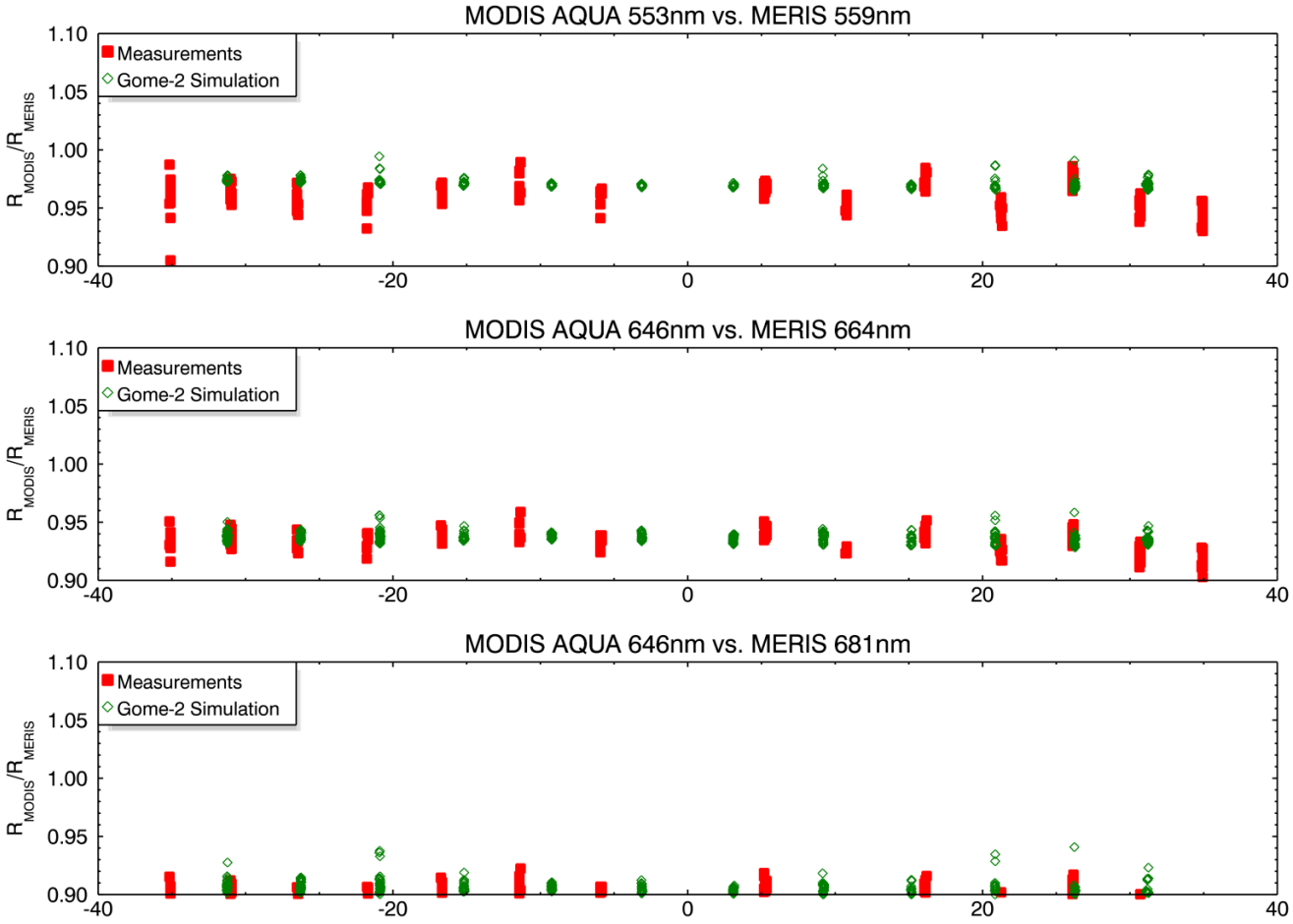
Intercomparison – MODIS vs. MERIS Vs. View Angle

Gome-2 Spectra Integrated over sensor spectral bands

Reference is MERIS 559nm, 666nm and 681nm

$35^{O} < SZA < 45^{O}$

MODIS geometrically corrected to MERIS

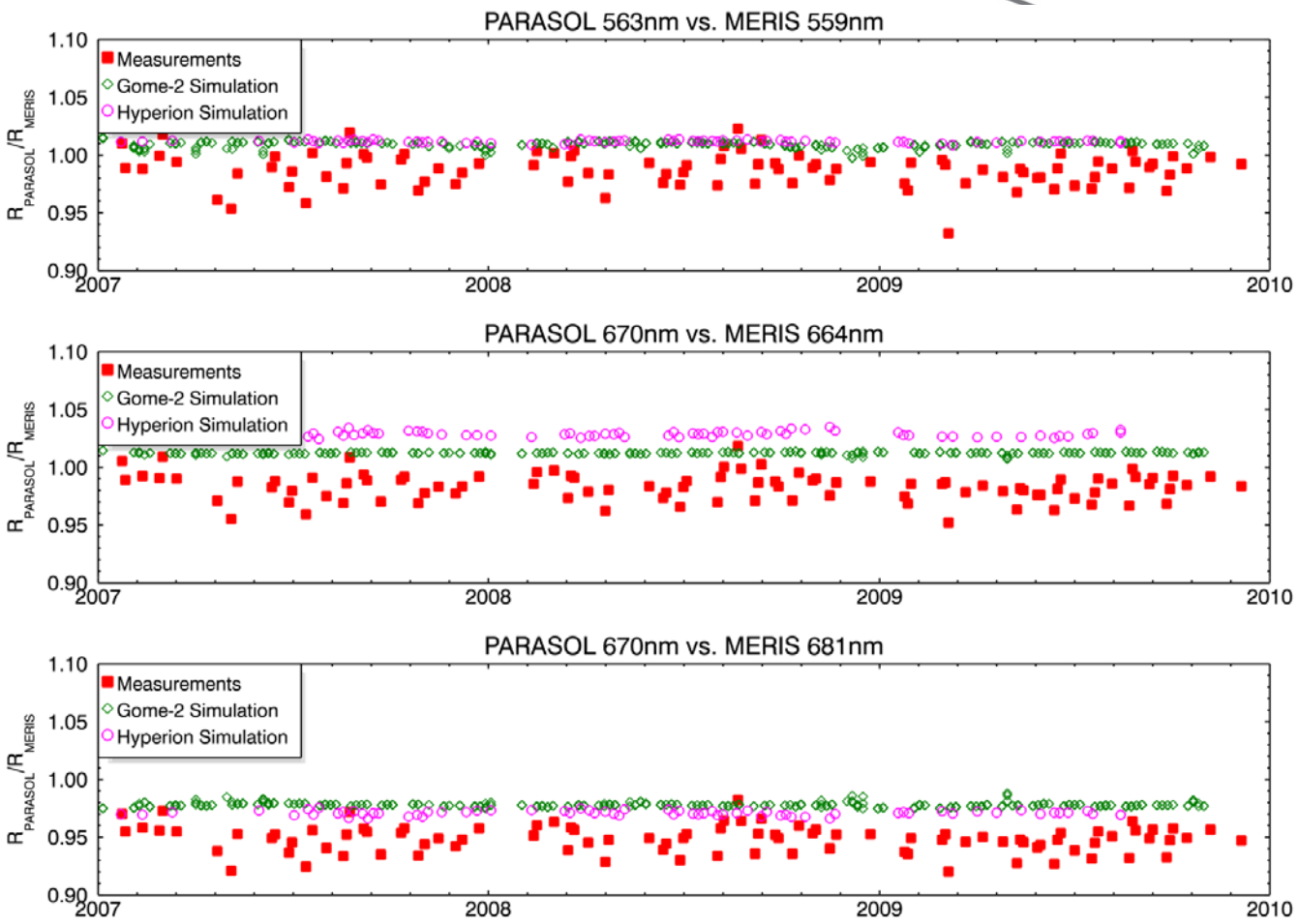


Intercomparison – PARASOL vs. MERIS Time Series

Gome-2 + Hyperion Spectra Integrated over sensor spectral bands

Reference is MERIS 559nm, 666nm and 681nm

PARASOL geometrically corrected to MERIS



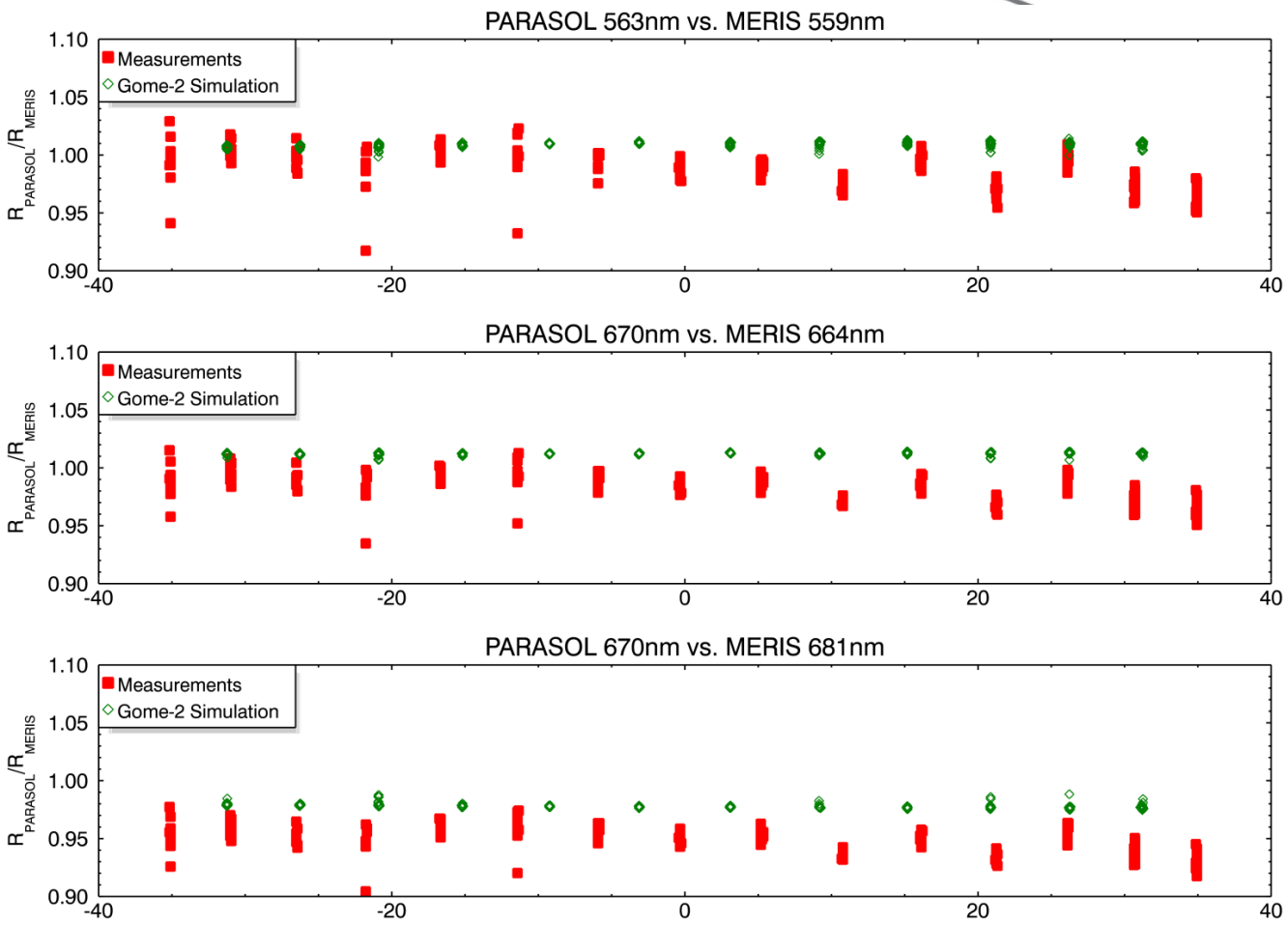
Intercomparison – PARASOL vs. MERIS Vs View Angle

Gome-2 Spectra Integrated over sensor spectral bands

Reference is MERIS 559nm, 666nm and 681nm

$35^{O} < SZA < 45^{O}$

PARASOL geometrically corrected to MERIS



Conclusions

- GOME-2 Spectra provide a good prediction of the biases due to spectral differences.

- Gome-2 Extractions have been performed for DOME-C, Algeria-3, Niger-2 and Greenland
  - Other sites possible (subject to further funding)

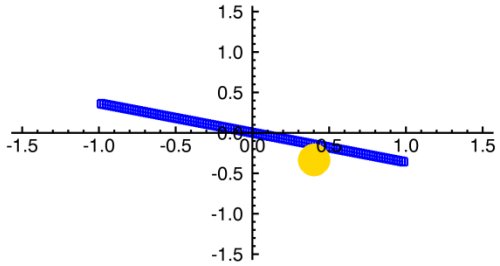
- Hyperion Data are under sampled spectrally.
  - Hence aliasing
  - Spectral interpolation is needed to reduce aliasing effects
  - Limited view geometry means that larger swath widths covered.

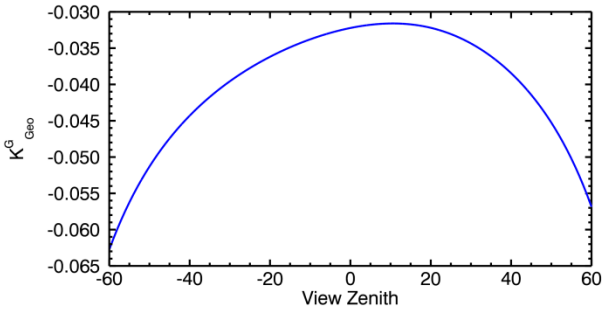
Snyder BRF + CNES Coefficients

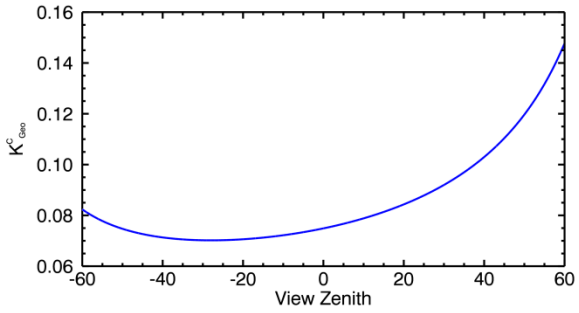
CNES have provided model and coefficients for Libya-4 site

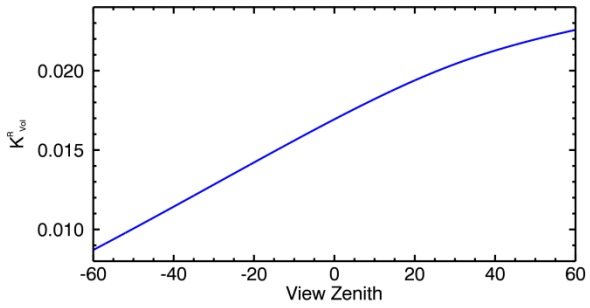
Model has been coded and tested with MERIS, AATSR + GOME-2

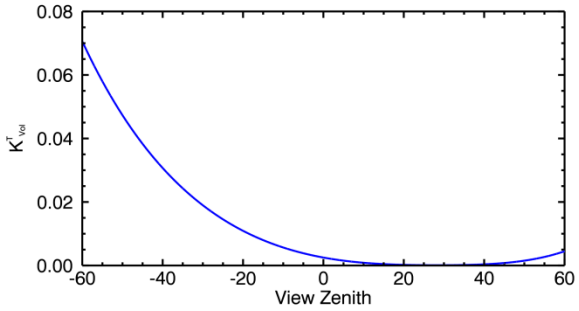
Initial results presented here

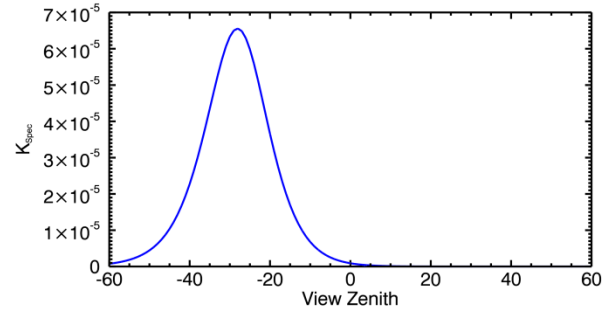




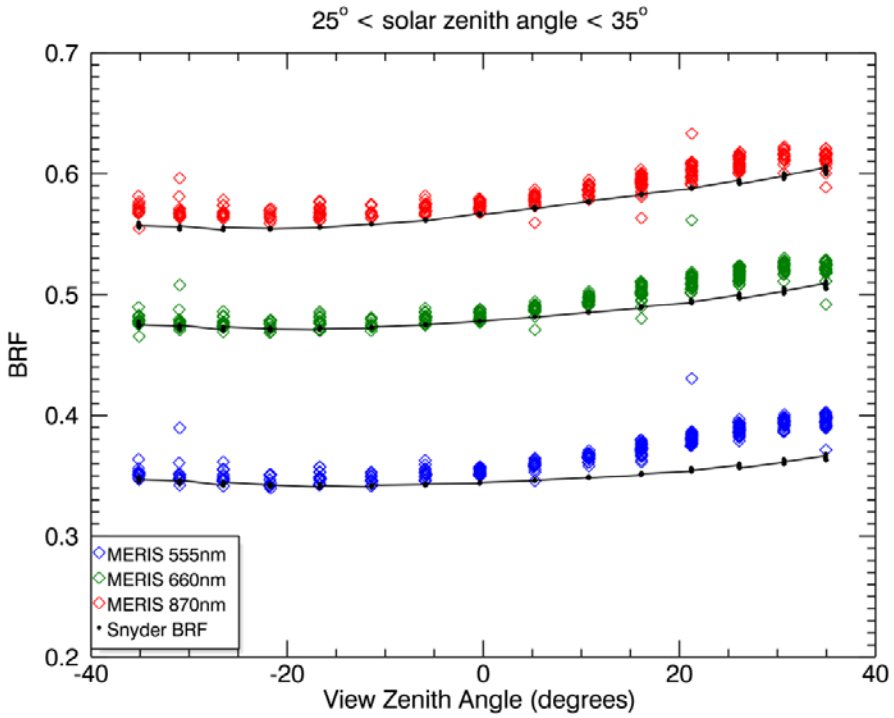


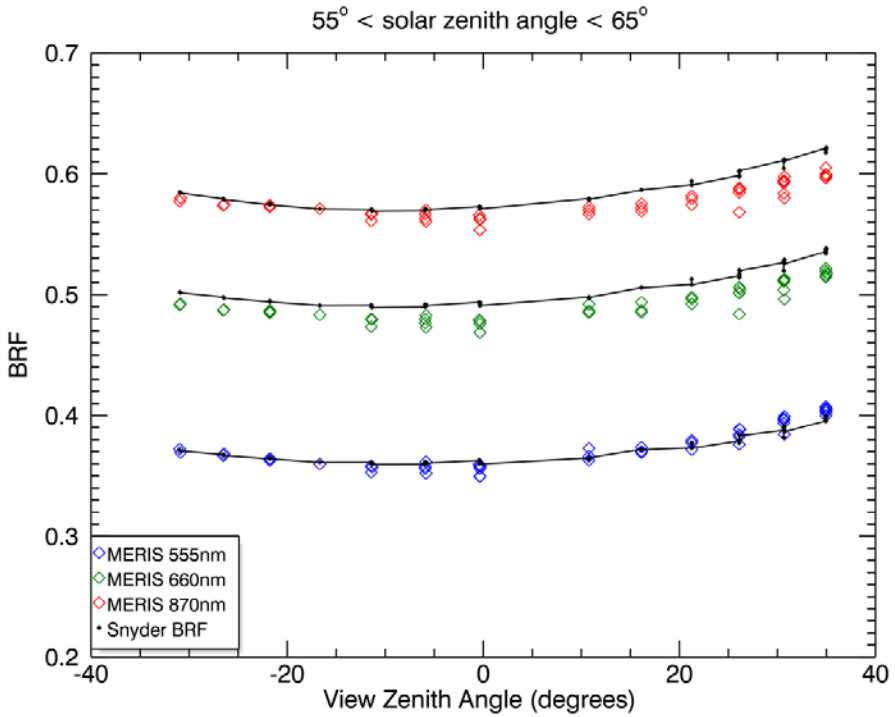




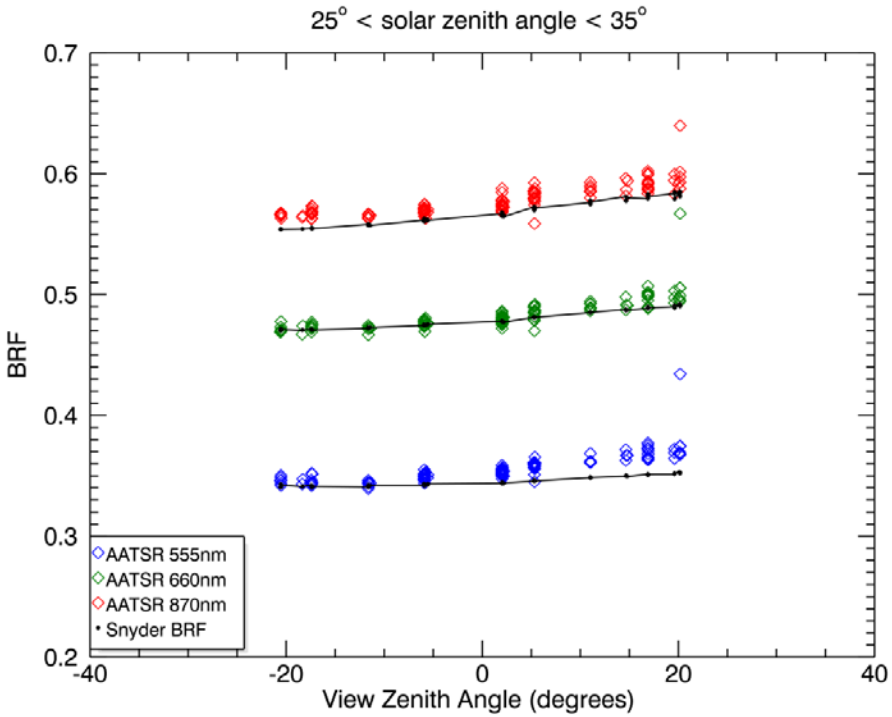


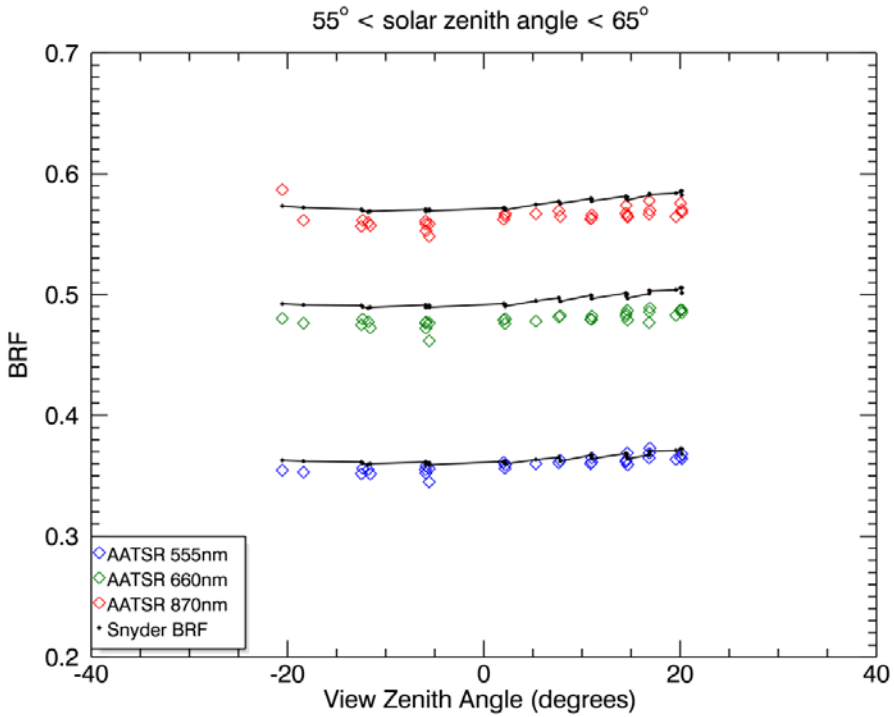
MERIS vs. Snyder



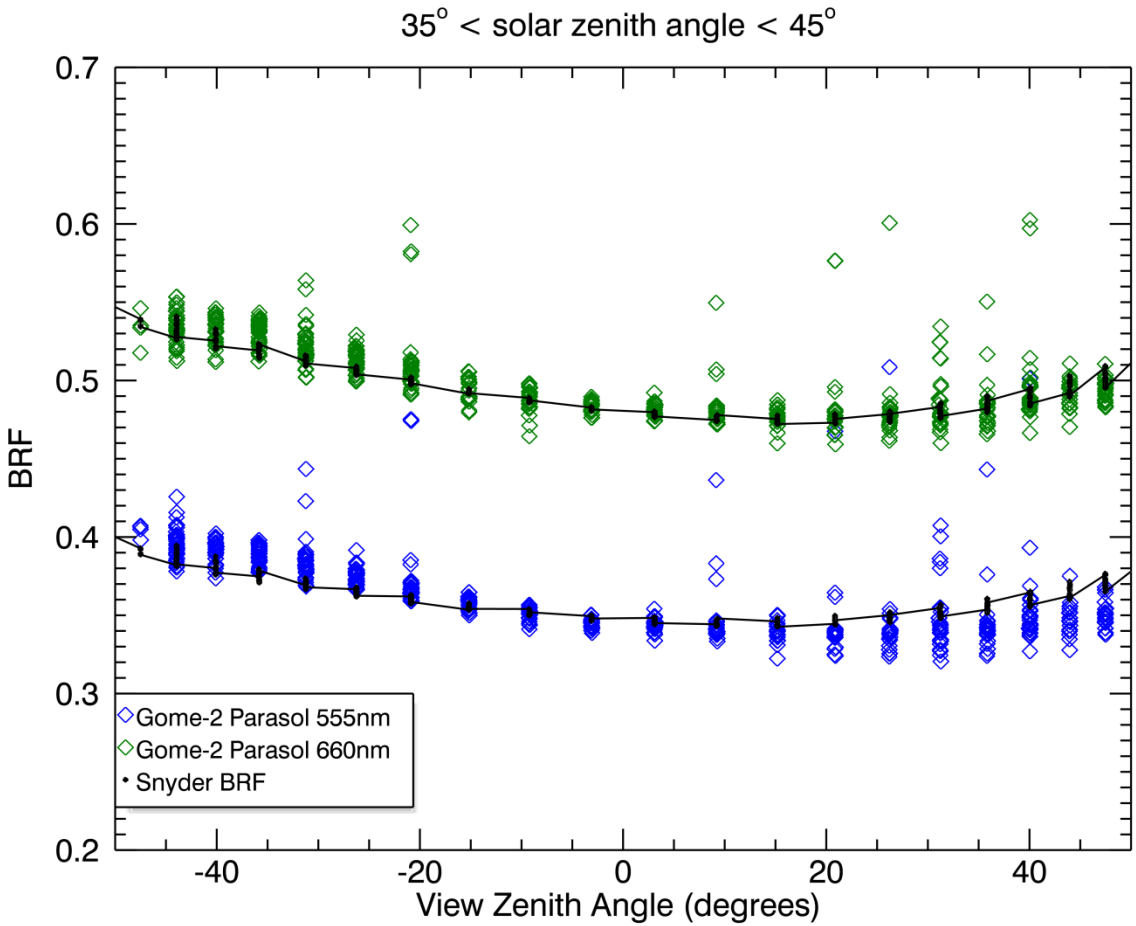


AATSR vs. Snyder





GOME-2 (Parasol) vs. Snyder



Snyder BRF - Conclusions

- Initial Results with Snyder Model look very promising.
  - Some differences in measurements (AATSR, MERIS, PARASOL) further investigation needed.
  - Comparison against parametric model (RAL) to be performed

- Test of code implementation using reference dataset is needed
  - CNES have provided this