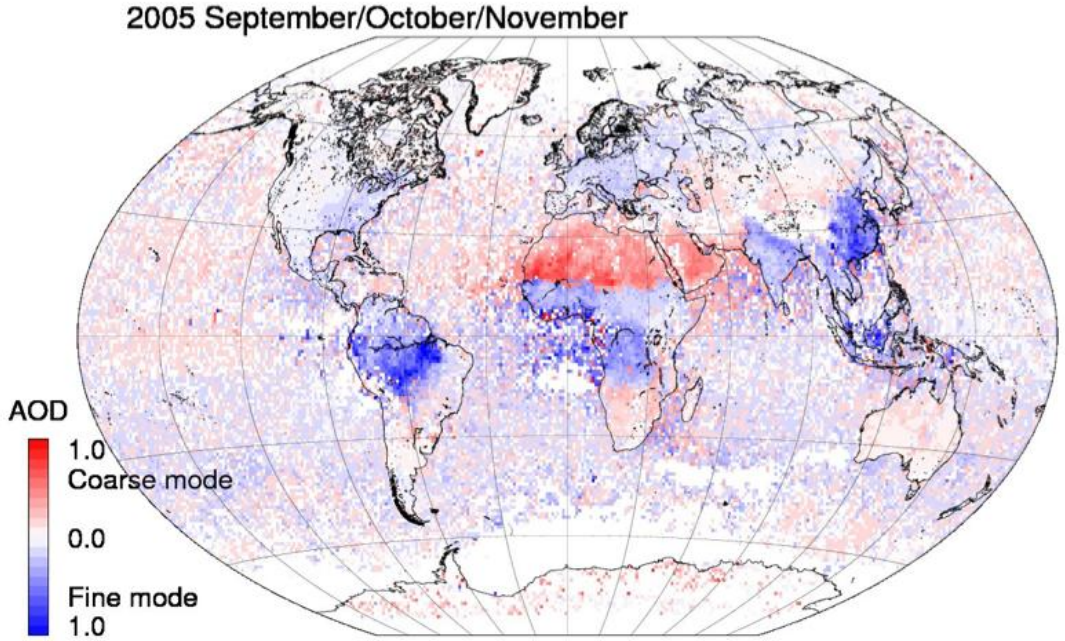
# Global retrieval of long-term aerosol datasets from ERS-2, ENVISAT and Sentinel-3




***Peter North, Swansea Univ., UK***

**Acknowledgements:** Andreas Heckel, Suanne Bevan, ESA Aerosol CCI and Synergy teams,

# Long term aerosol record from (A)ATSR

(Dual angle retrieval)

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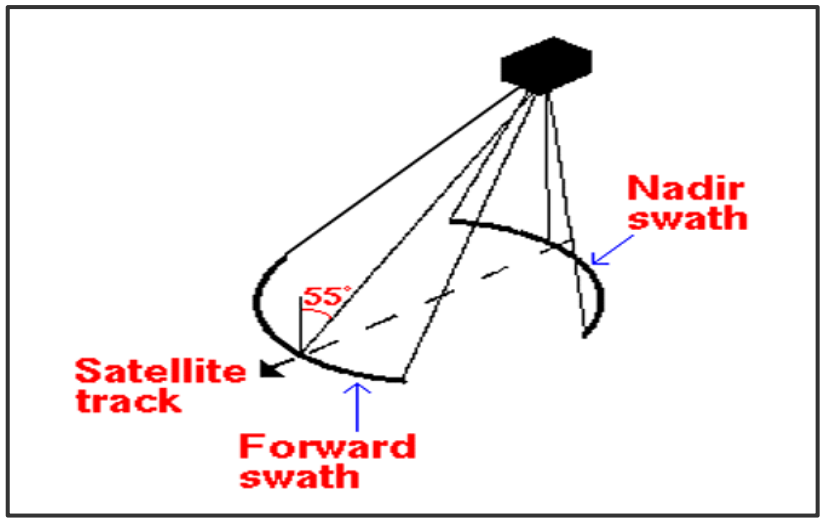
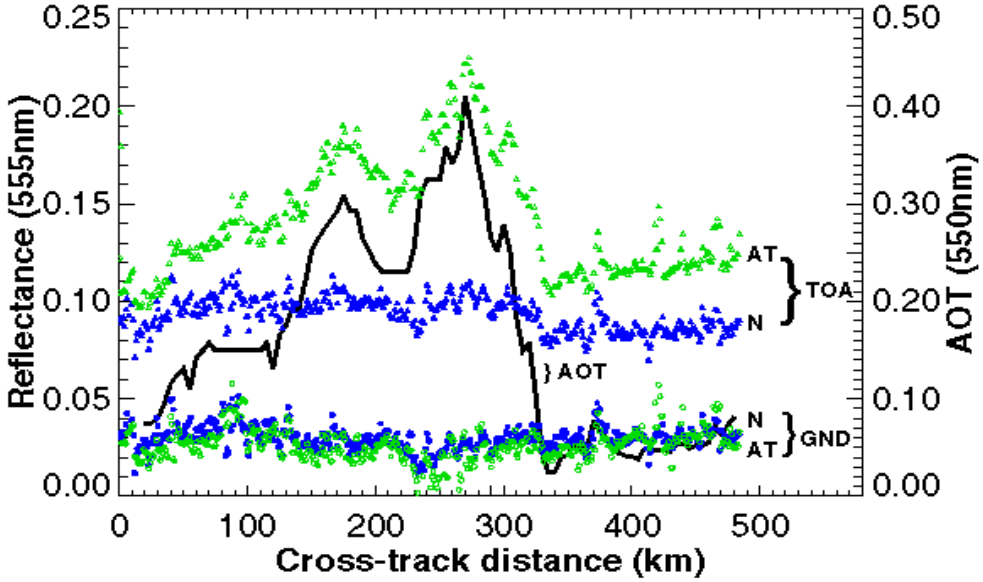
Prifysgol Abertawe



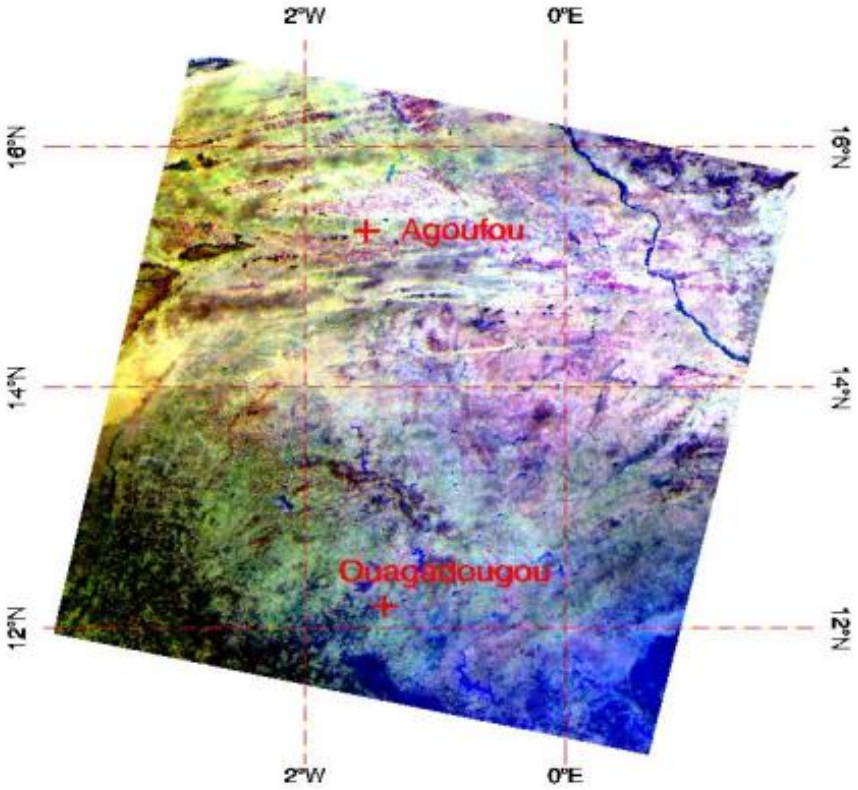

**Long term record (1995-2030)**:

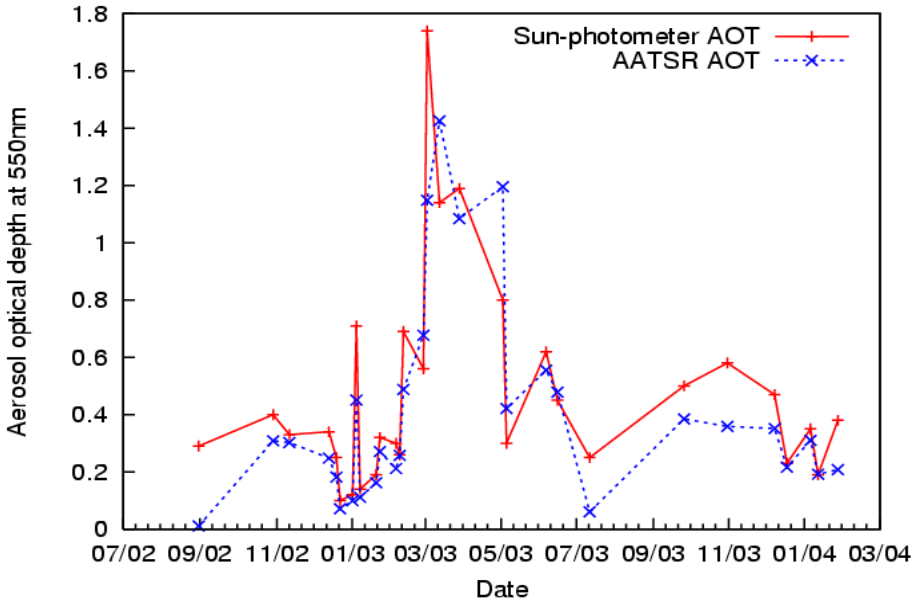
i. ERS-2 1995-2003 (ATSR-2)
ii. ENVISAT (2002-2010) (AATSR, MERIS)
iii. Continuity with Sentinel-3 (2014-2030)

*North et al., IEEE TGARS (1999); North JGR (2002)*

Swansea University
Prifysgol Abertawe

# Ouagadougou, Birkina Faso AERONET Site




Channels

Forward view 555nm (Visible)

Nadir View 870nm (NIR)

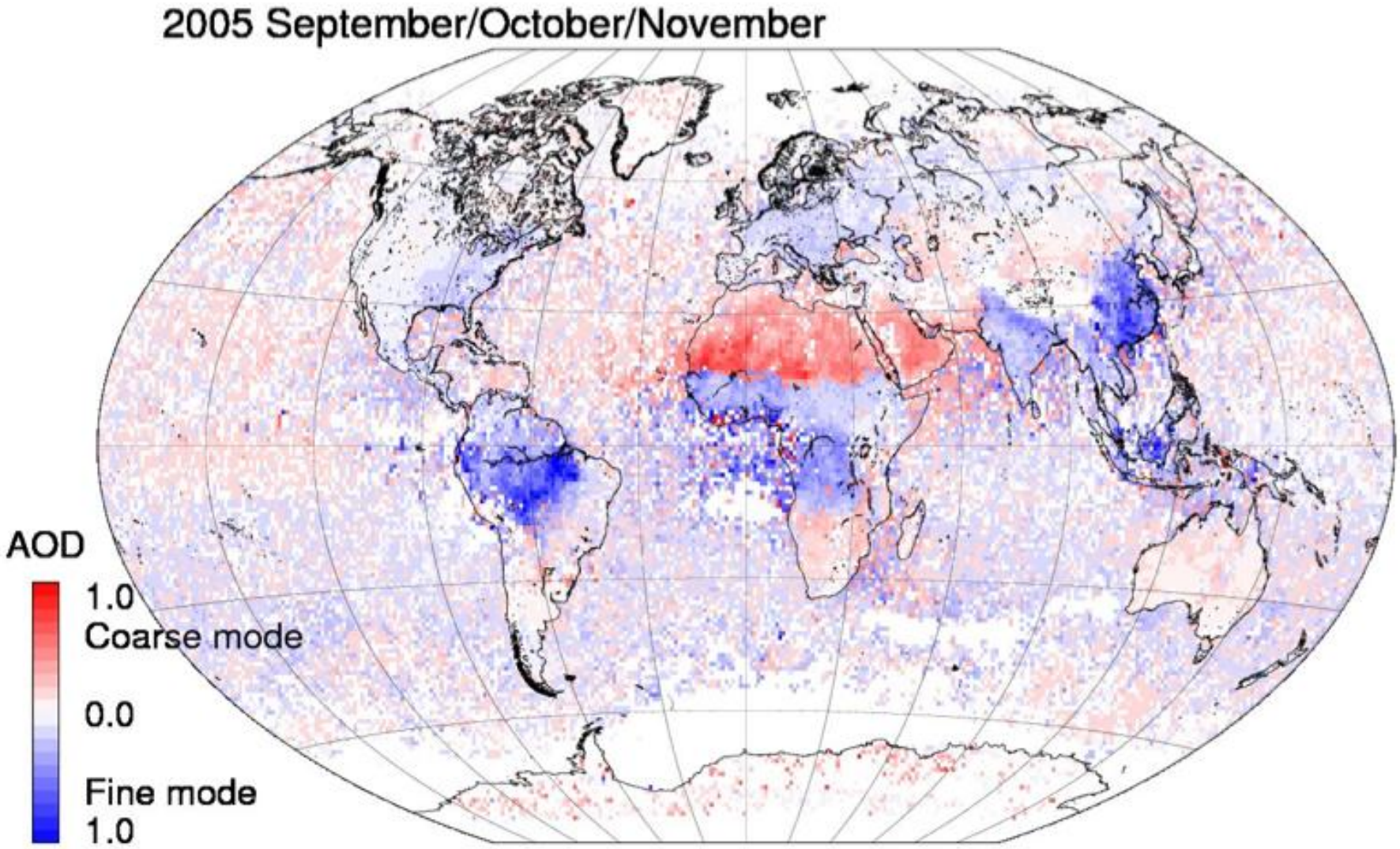
Nadir View 1630nm (SWIR)

*North et al., JGR (2002); Grey et al IEEE TGARS (2006)*

# AATSR Global Dataset

Aerosol AOD and size distribution, surface reflectance

Swansea University
Prifysgol Abertawe



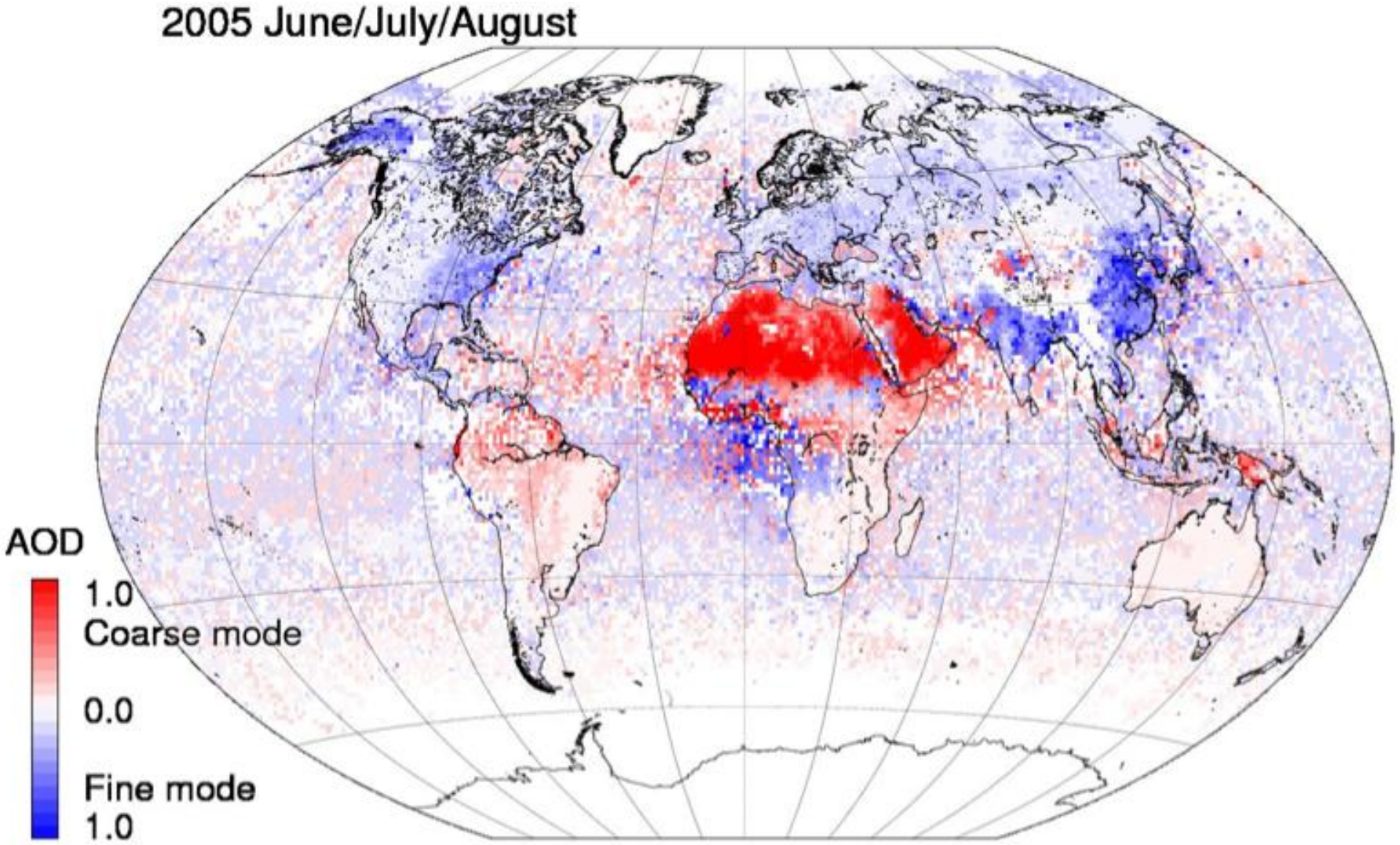

*Bevan, S.L., North et al., (2009), JGR* 114, D09204

*Bevan, S.L., North et al., (2012), RSE* 116, 199-210

# AATSR Global Dataset

Aerosol AOD and size distribution, surface reflectance

Swansea University
Prifysgol Abertawe




*Bevan, S.L., North et al., (2012), RSE* 116, 199-210

# Amazonia: precipitation / aerosol feedback?

Amazonia: 13 year record

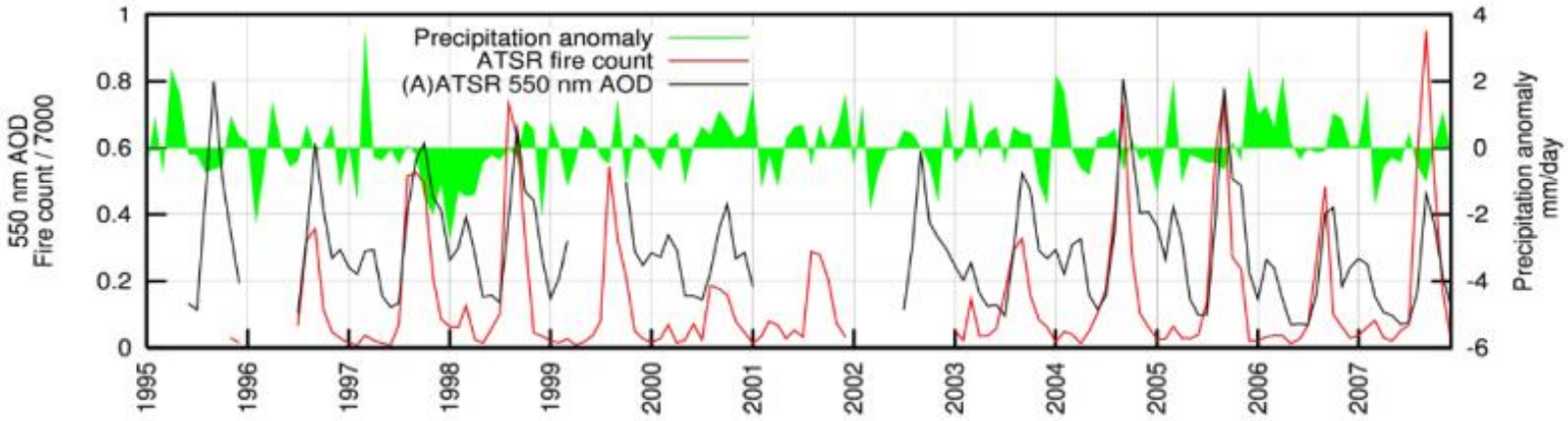
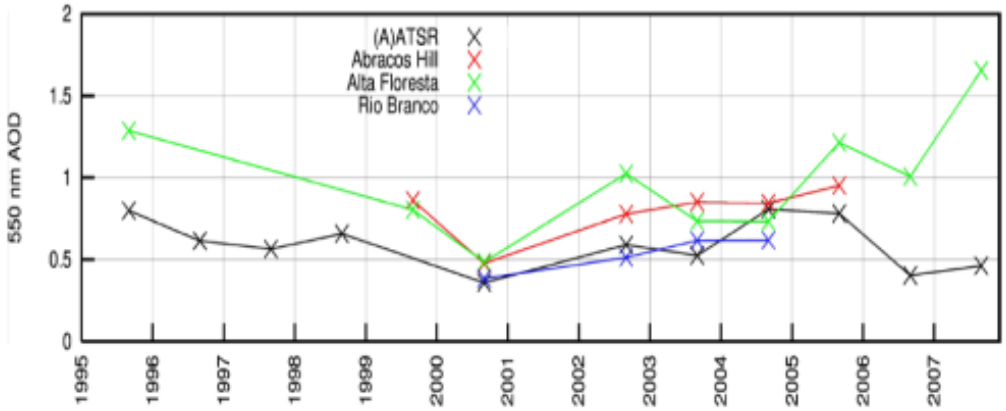
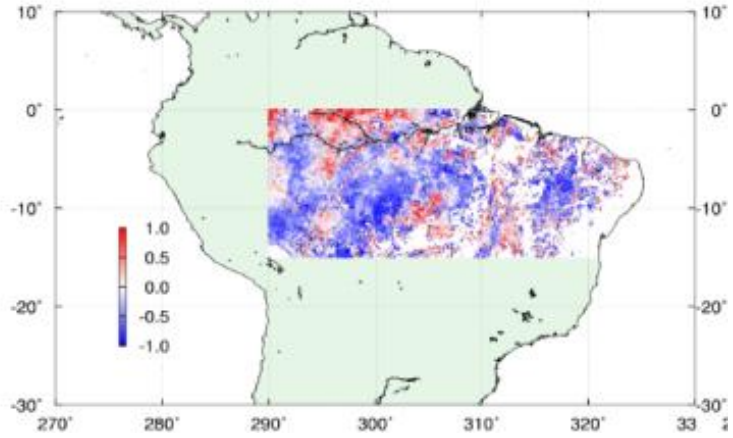



**Figure 3.** Mean monthly AOD and precipitation anomaly for the region 50°–70° W, 5°–15° S.




Trend 1995 - 2008




Precip vs AOD

*Bevan, S.L., et al, 2009. The impact of atmospheric aerosol from biomass burning on Amazon dry-season drought, J. Geophys. Res. 114.*

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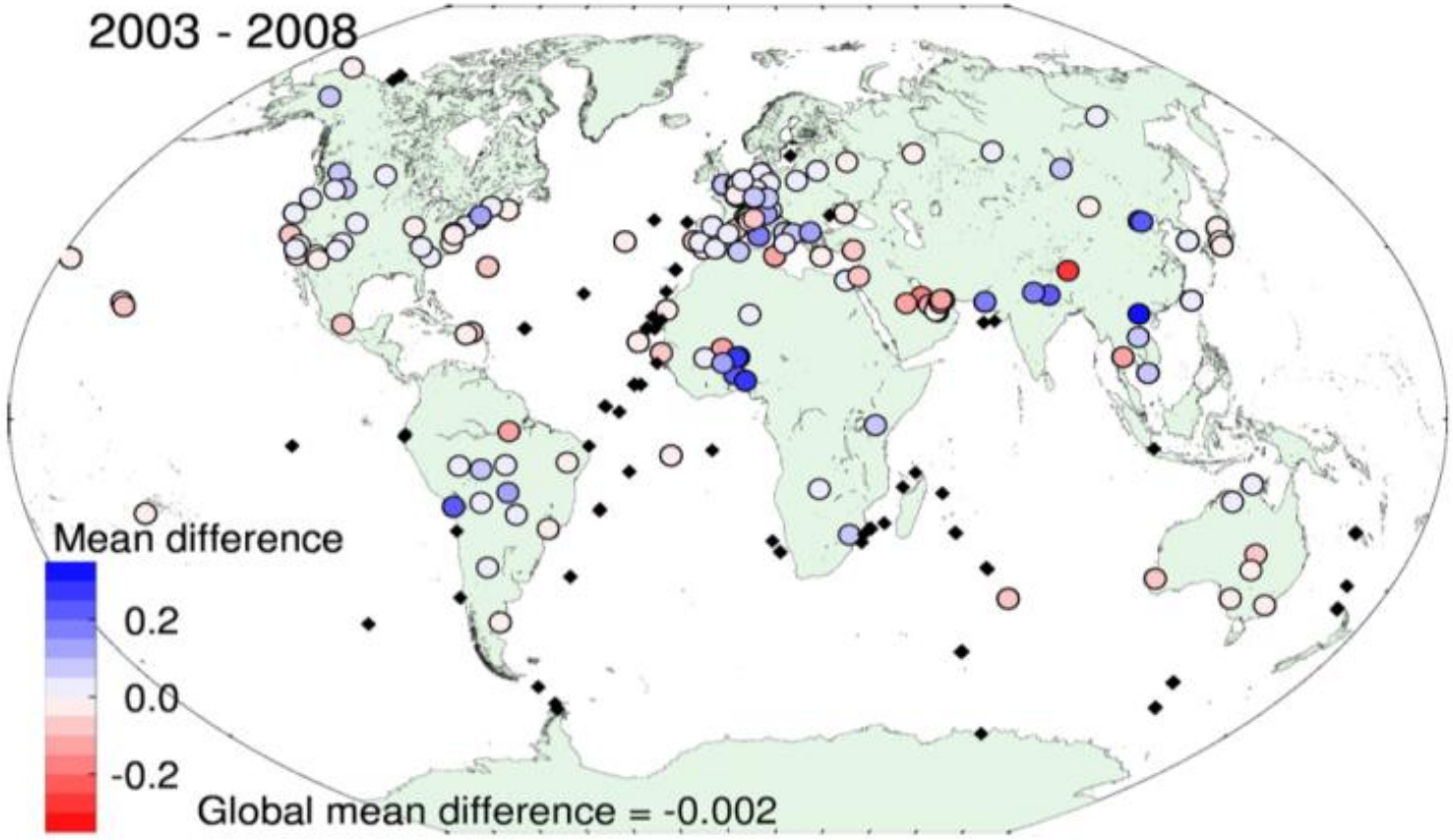
# Dual-view AATSR Aerosol retrieval vs Aeronet

Mean bias (AERONET-AATSR)




*Bevan, S.L., North et al., (2012), RSE* 116, 199-210

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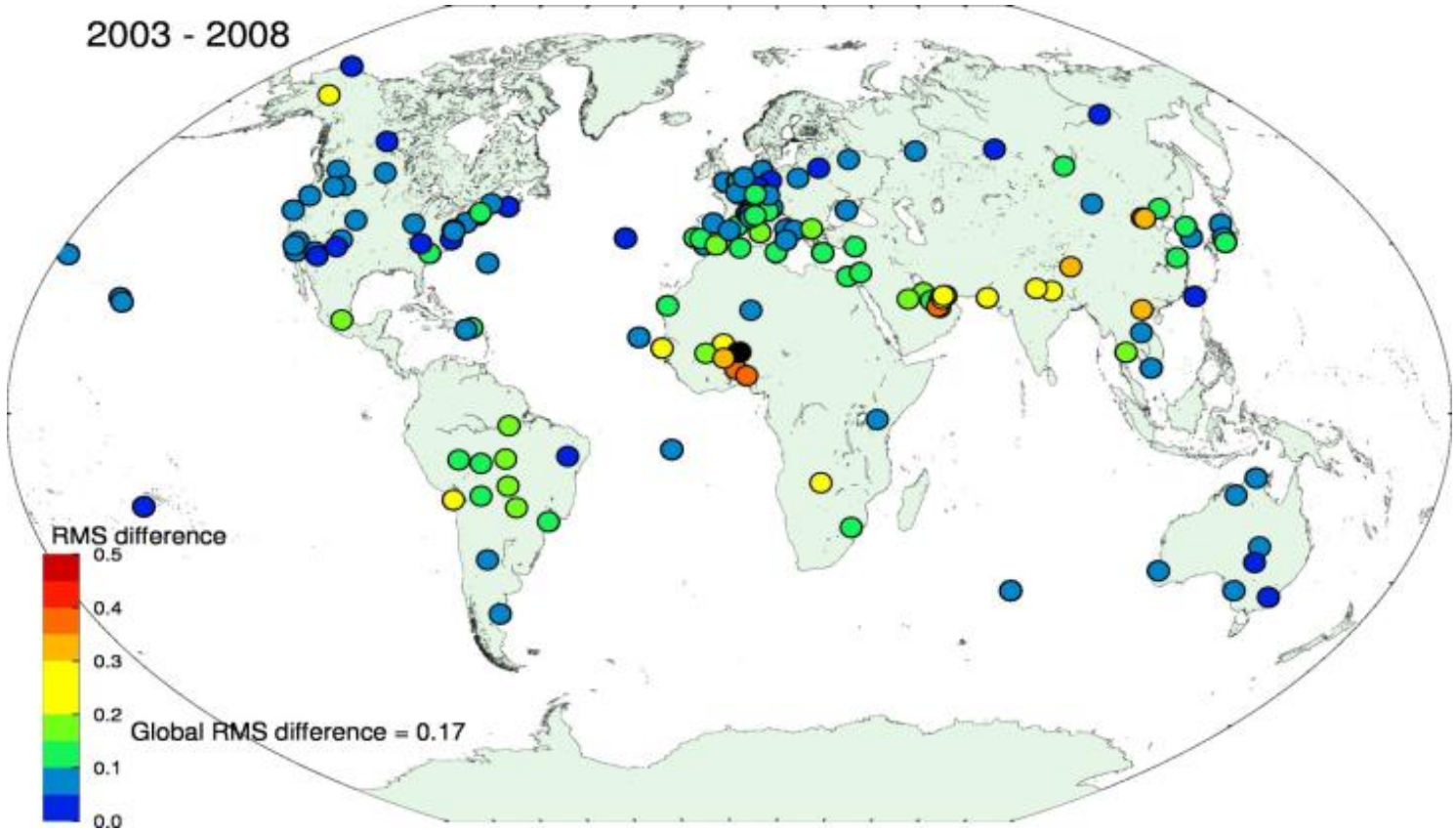
# AATSR Aerosol retrieval vs Aeronet

RMS difference




*Bevan, S.L., North et al., (2012), RSE* 116, 199-210

# AATSR Aerosol retrieval vs photometer

(AERONET and MAN)

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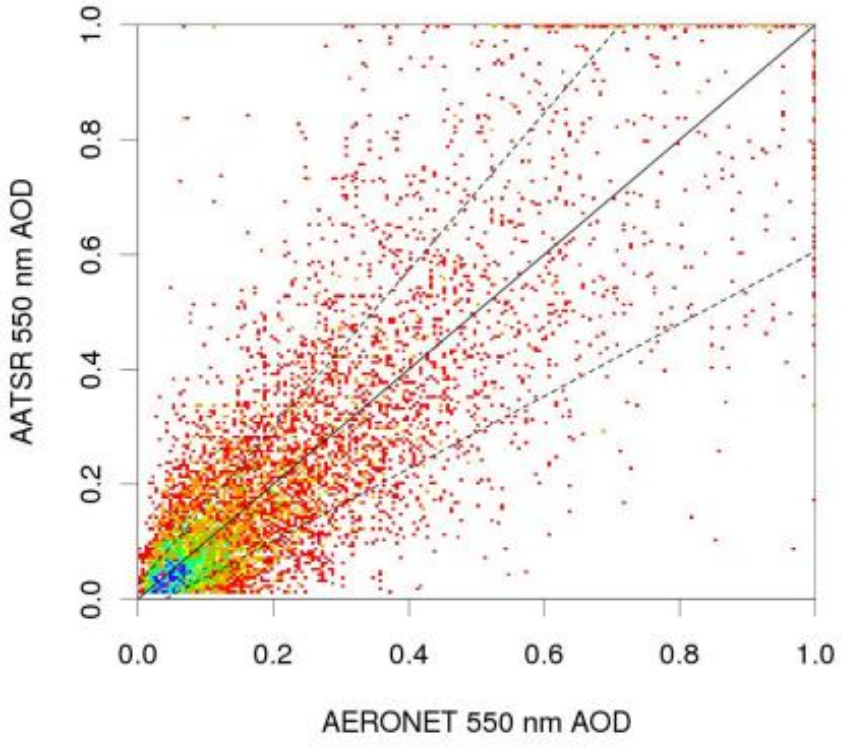
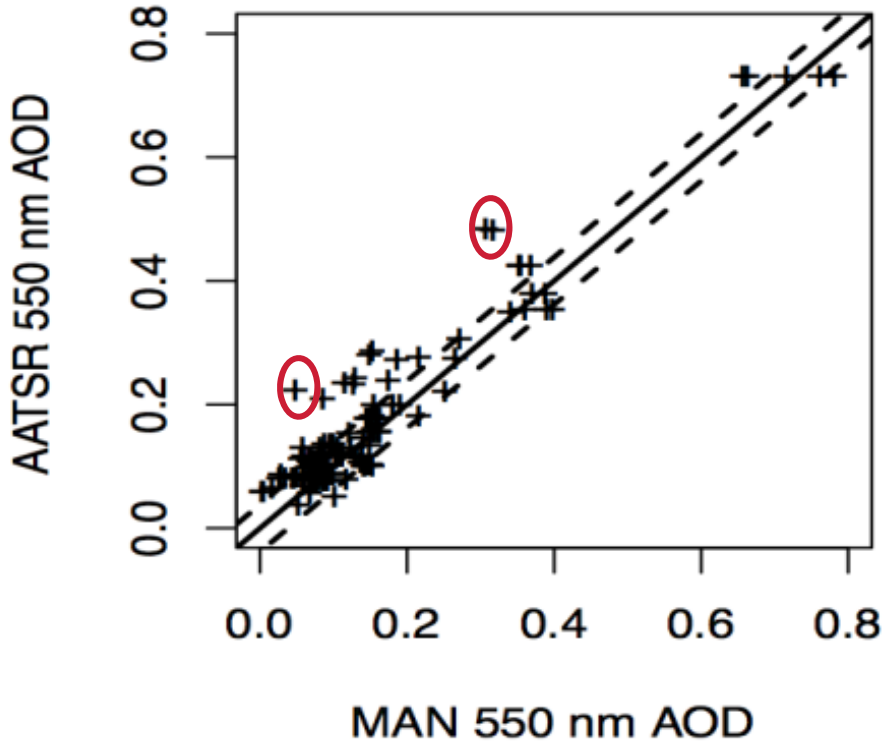



**R=0.8, σ = ±0.025 ±0.4 $\tau_a$**




**R=0.92, σ = ±0.04**

*Bevan, S.L., North et al., (2012), RSE* 116, 199-210

# Aerosol size class vs AERONET Angstrom

(Modal class, $\tau_a$>0.2)

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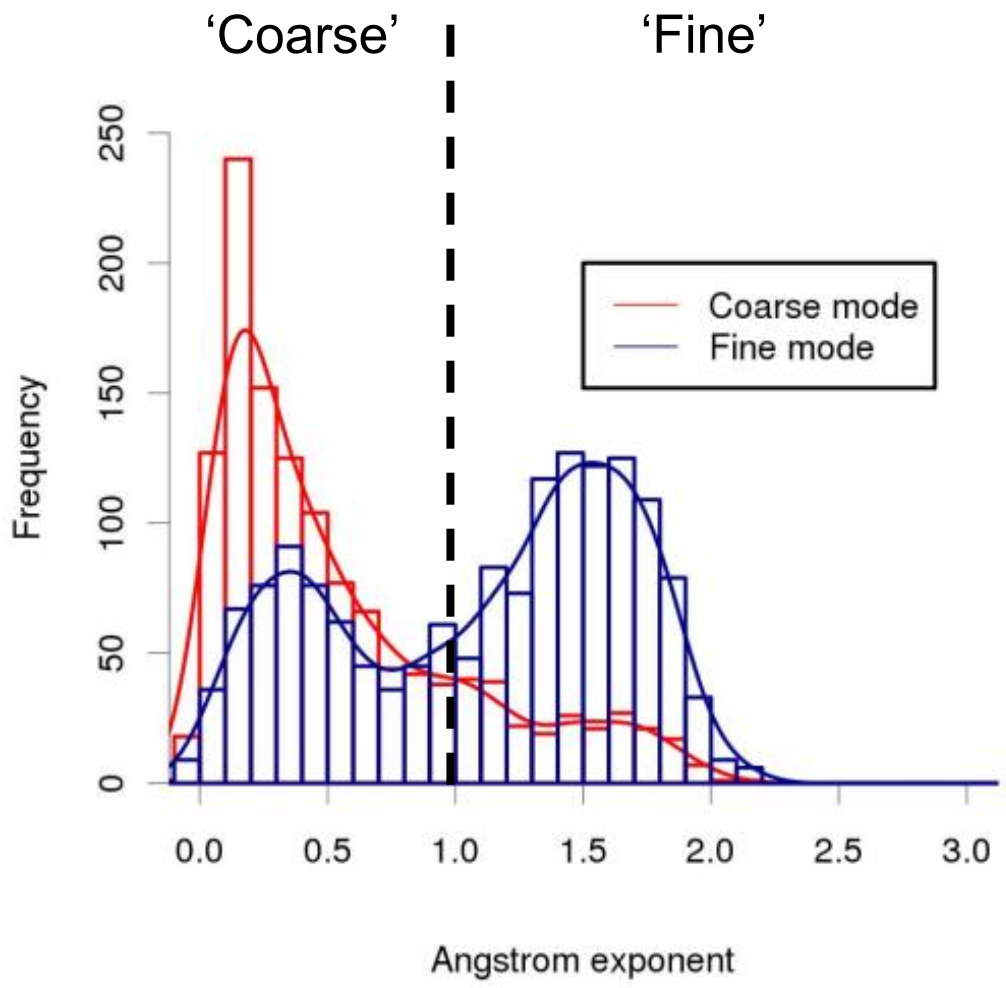


Correspondence:

$\alpha$<1 Coarse mode: 67%

$\alpha$>1 Fine mode: 79%

*Bevan, S.L., North et al., (2012), RSE* 116, 199-210

# Comparison with MODIS & MISR

Monthly 1° composites

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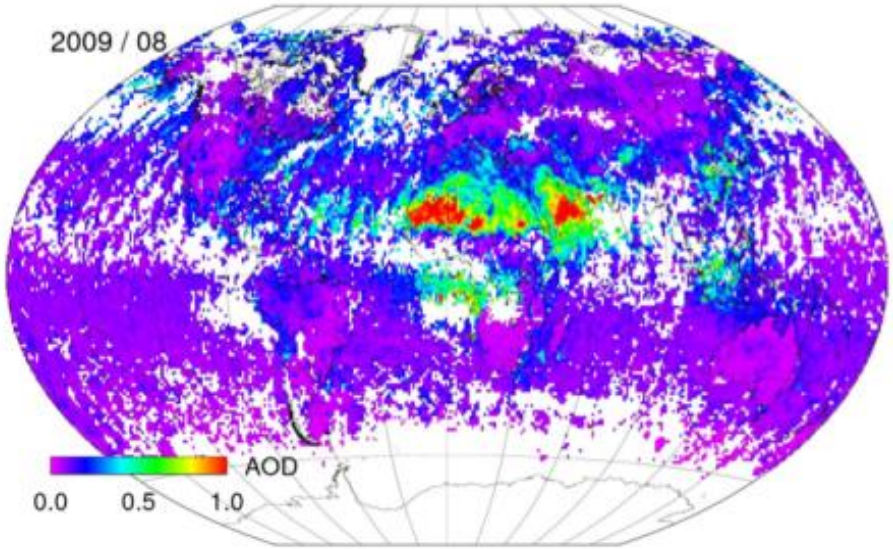
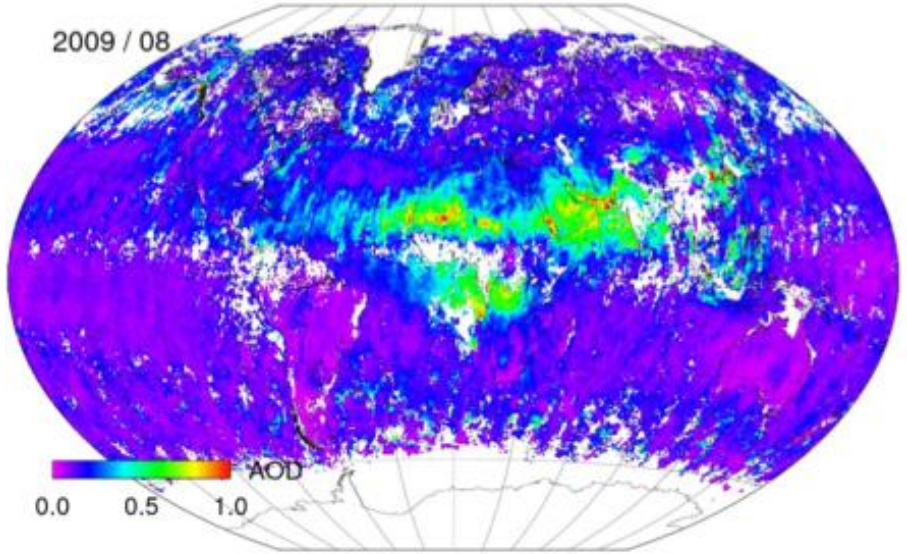
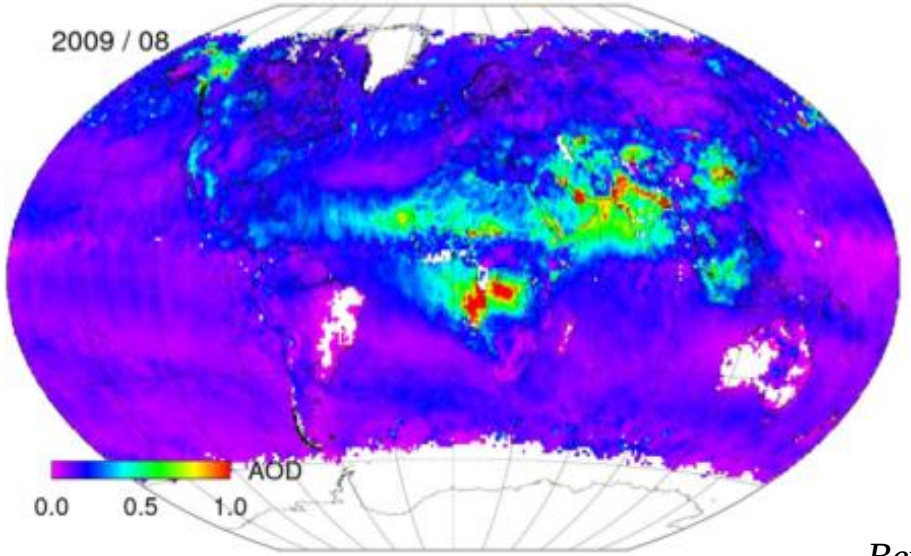
Prifysgol Abertawe




**AATSR**




**MISR**




**MODIS**

*Bevan, S.L., North et al., RSE (2012)*

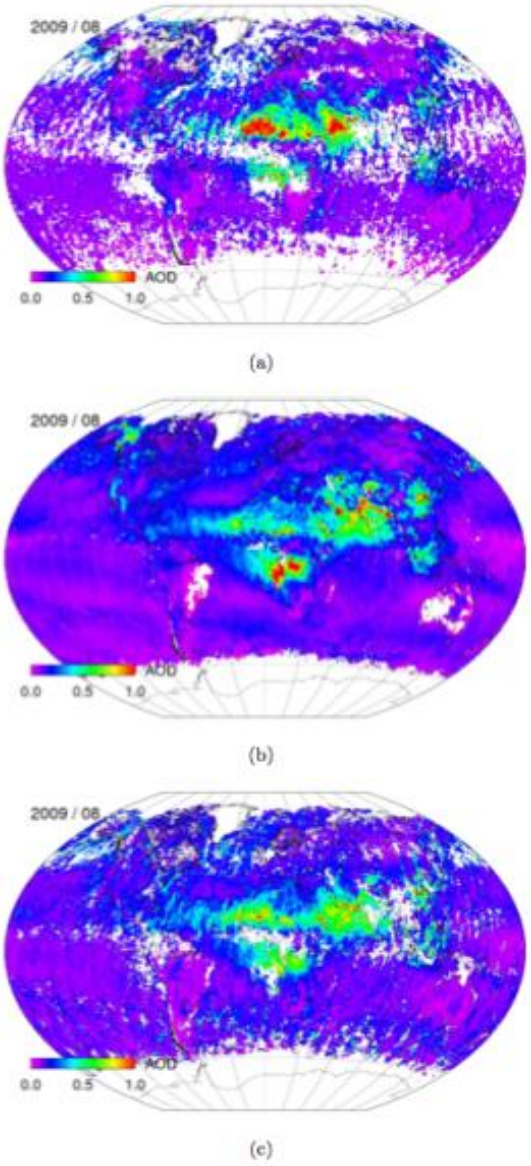
# Comparison with MODIS & MISR

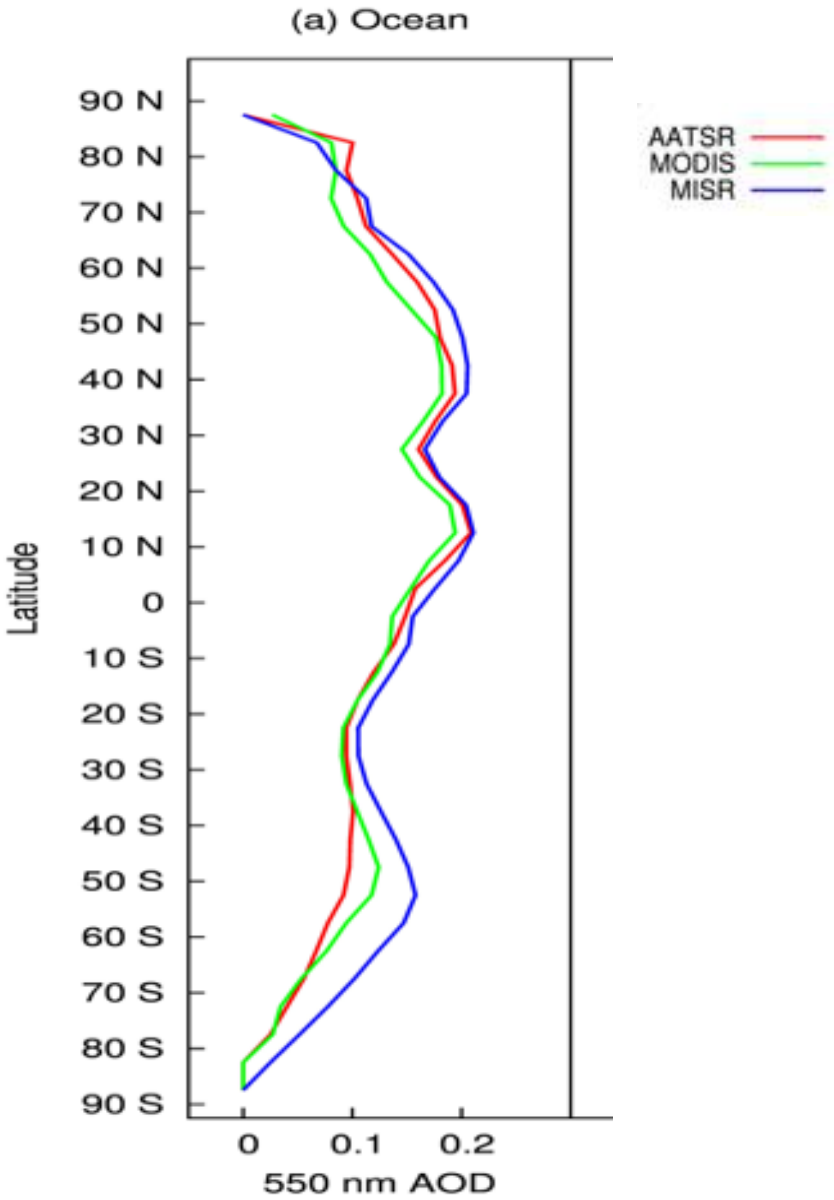
Swansea University
Prifysgol Abertawe

**AATSR**

**MODIS**

**MISR**



# Comparison with MODIS & MISR

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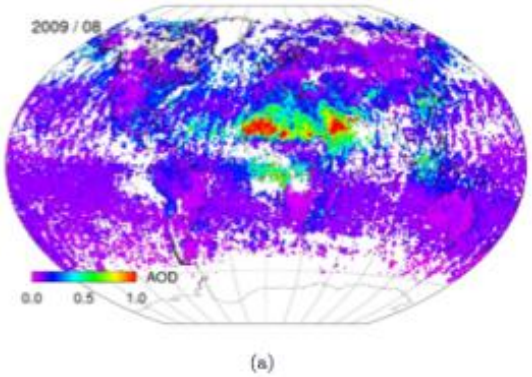
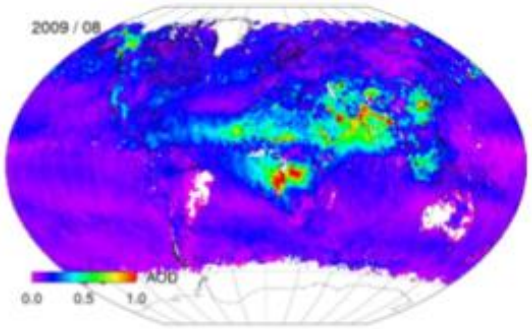
Prifysgol Abertawe

**AATSR**



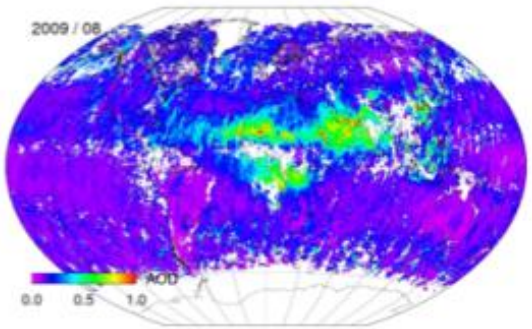

(a)

**MODIS**

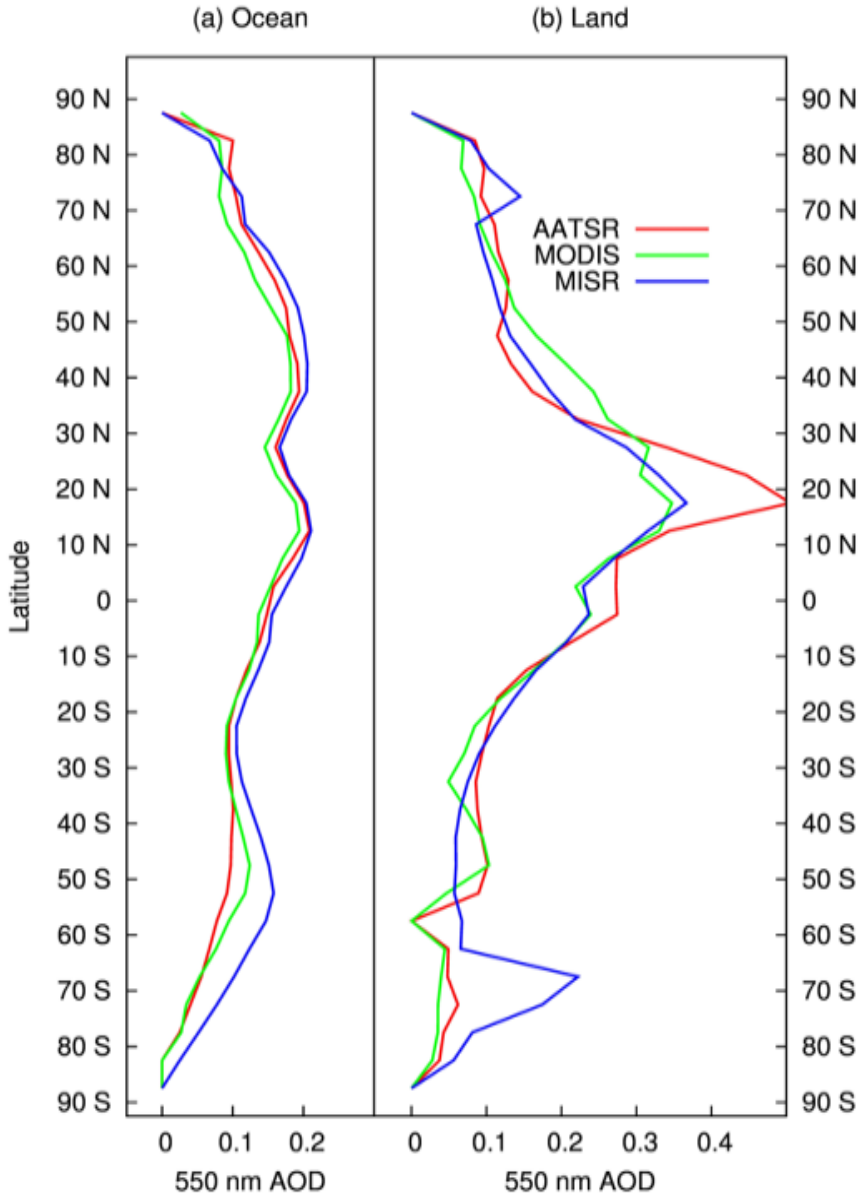



(b)

**MISR**



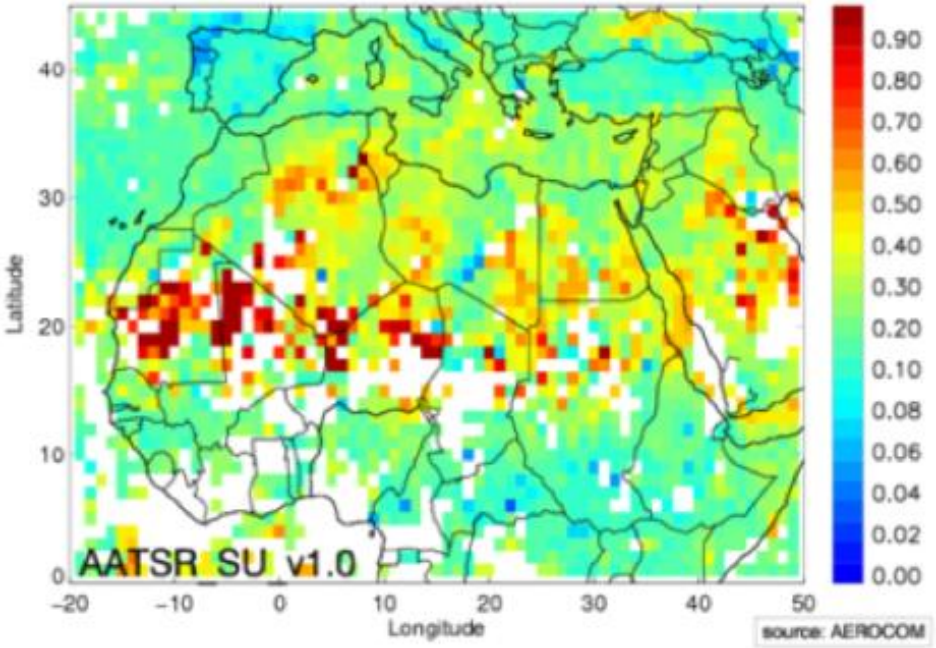

(c)

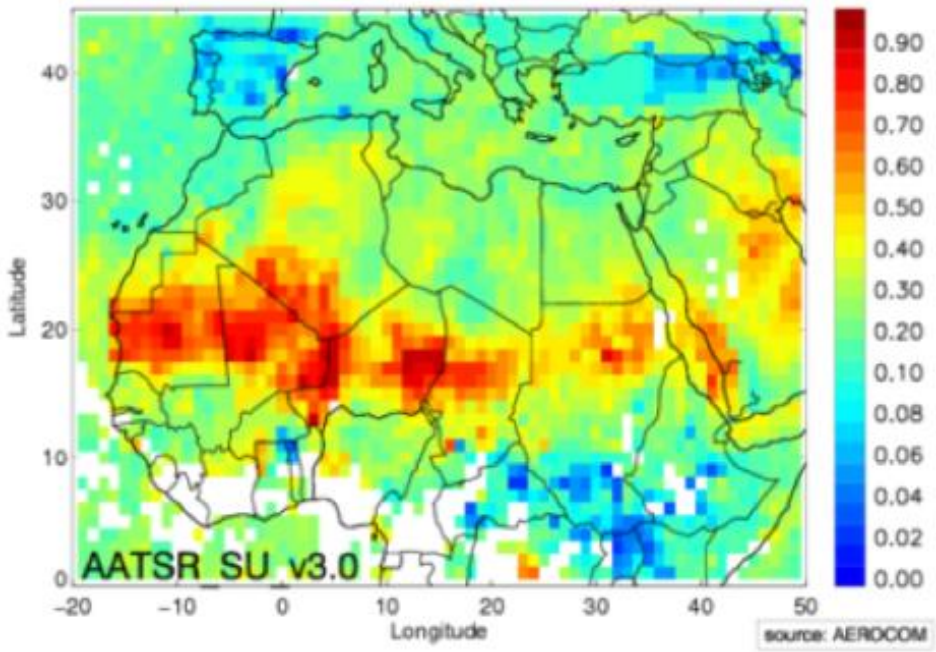


# Aerosol CCI / AERCOM Analysis

Daily 1° composites vs AERONET, Sep 2008

Swansea University
Prifysgol Abertawe




**Version 1.0:**

**•Spherical particles**

**• Free retrieval of aerosol type**

**AERONET:**

**N=92, R=0.64, RMS=0.120**

**Version 3.0:**

**• Also non-spherical particles (t-matrix)**

**• Free retrieval with property *a priori* properties from climatology (Kinne)**

**AERONET:**

**N=104, R=0.8, RMS=0.117**

*T. Holzer-Popp et al., in prep*

# Aerosol CCI / AERCOM Analysis

## SU ATSR vs MISR 2.2 (Sep 2008 & annual average)

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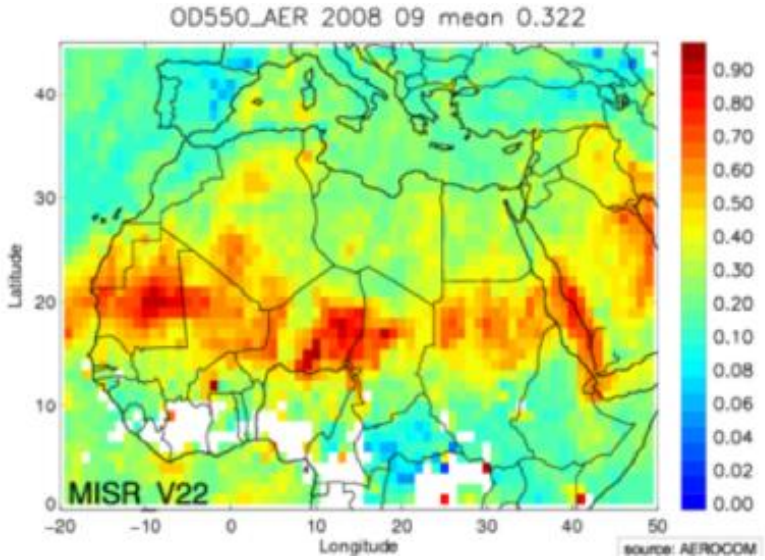
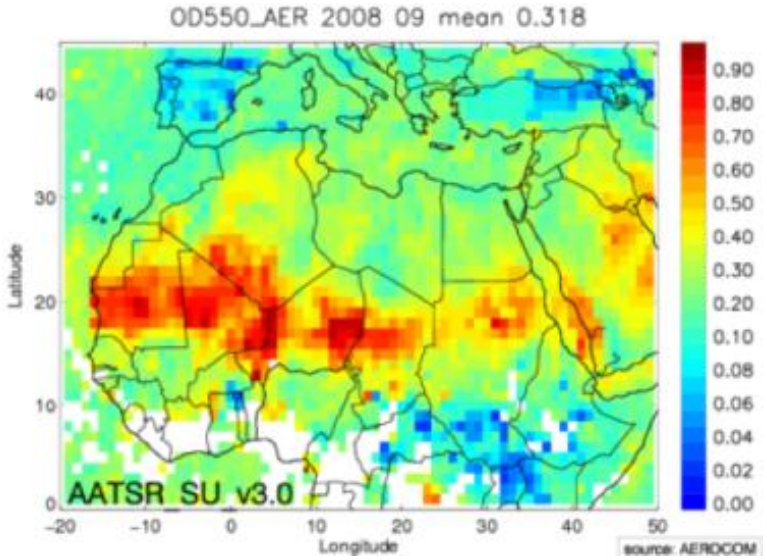
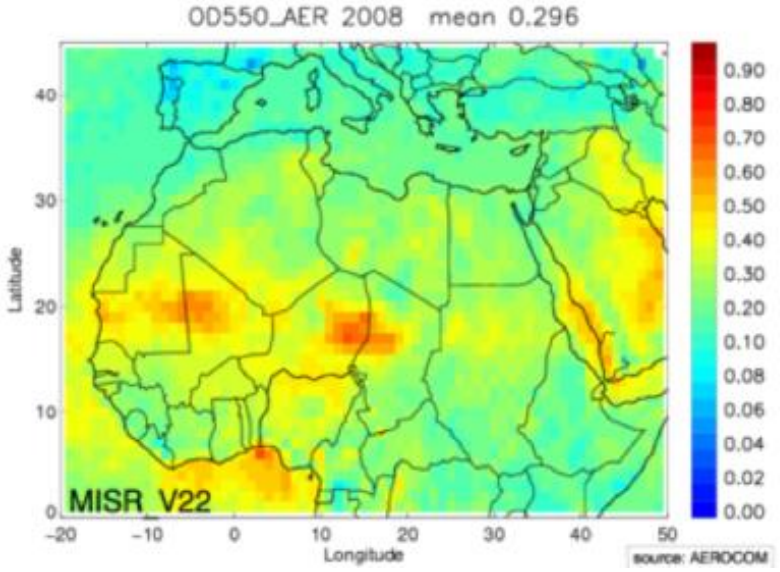
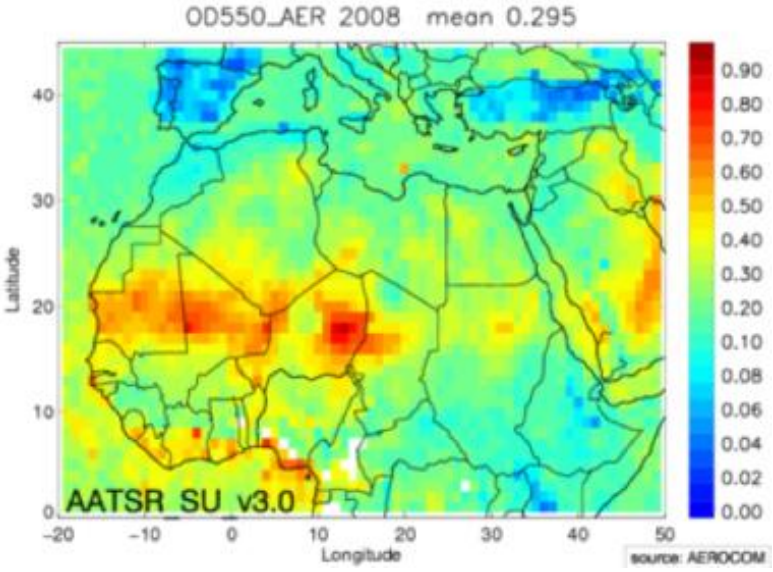
Prifysgol Abertawe




**Sep 2008**




**Average**

**MISR v 2.2**

**SU AATSR v 3.0**

# Synergy aerosol retrieval

MERIS/AATSR, OLCI/SLSTR

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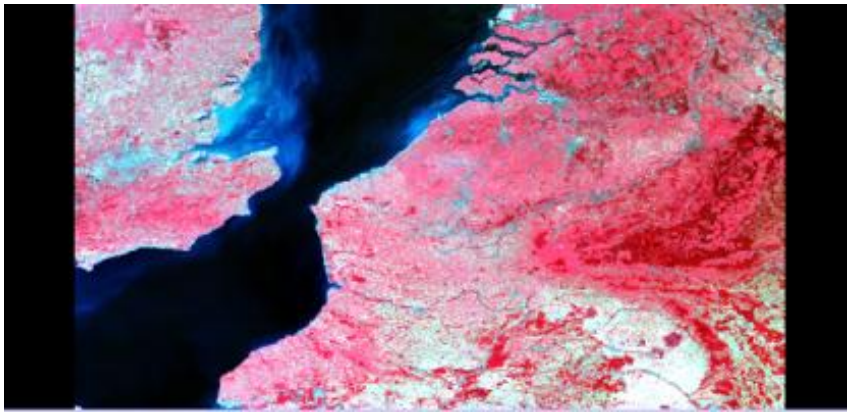
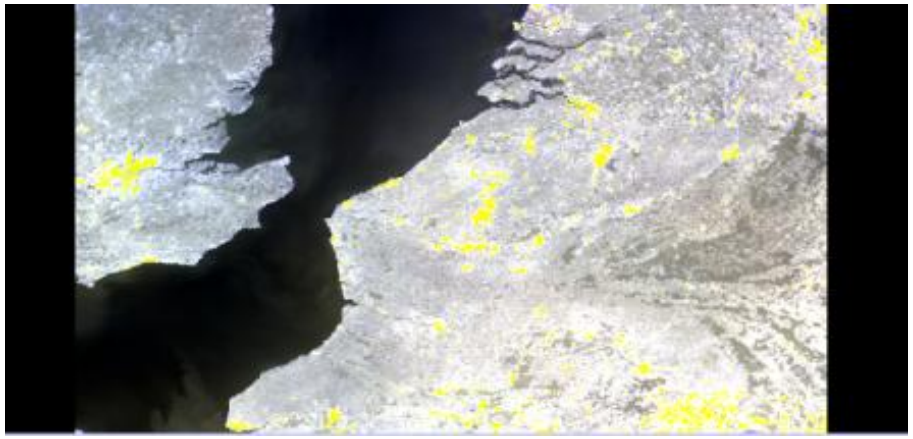
Prifysgol Abertawe

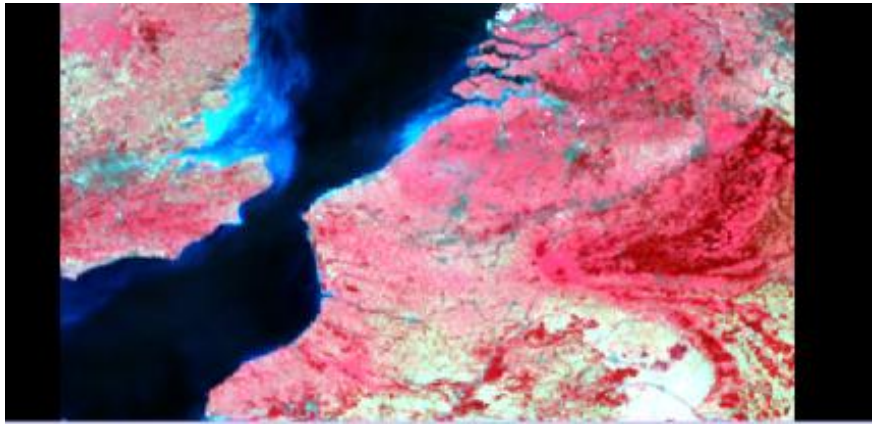
MERIS RGB



AATSR 870, 670, 555 nm (nadir)



AATSR 1.2,1.1,3.7 μm (nadir)



AATSR 870, 670, 555 nm (fwd)

esa BEAM

# Aerosol missions & requirements

(Sentinel-3: 2014-2030)

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Prifysgol Abertawe

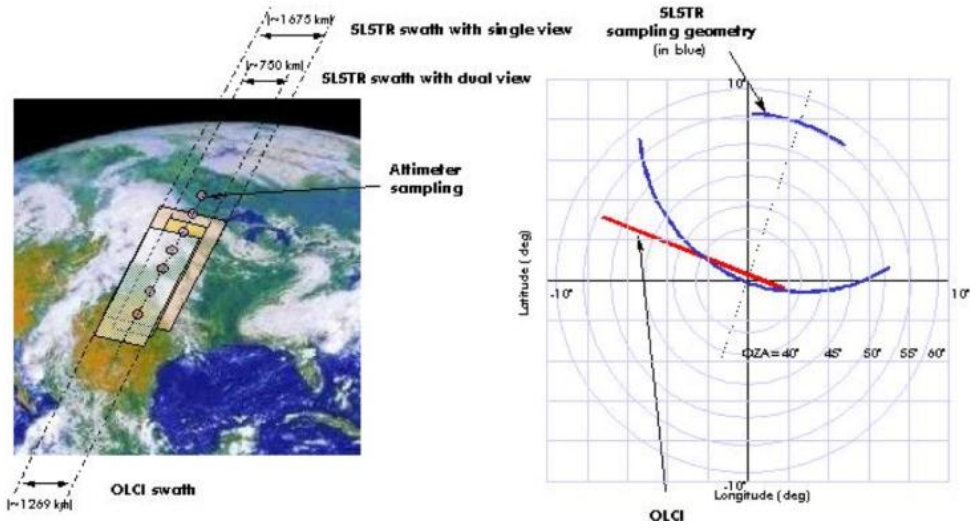
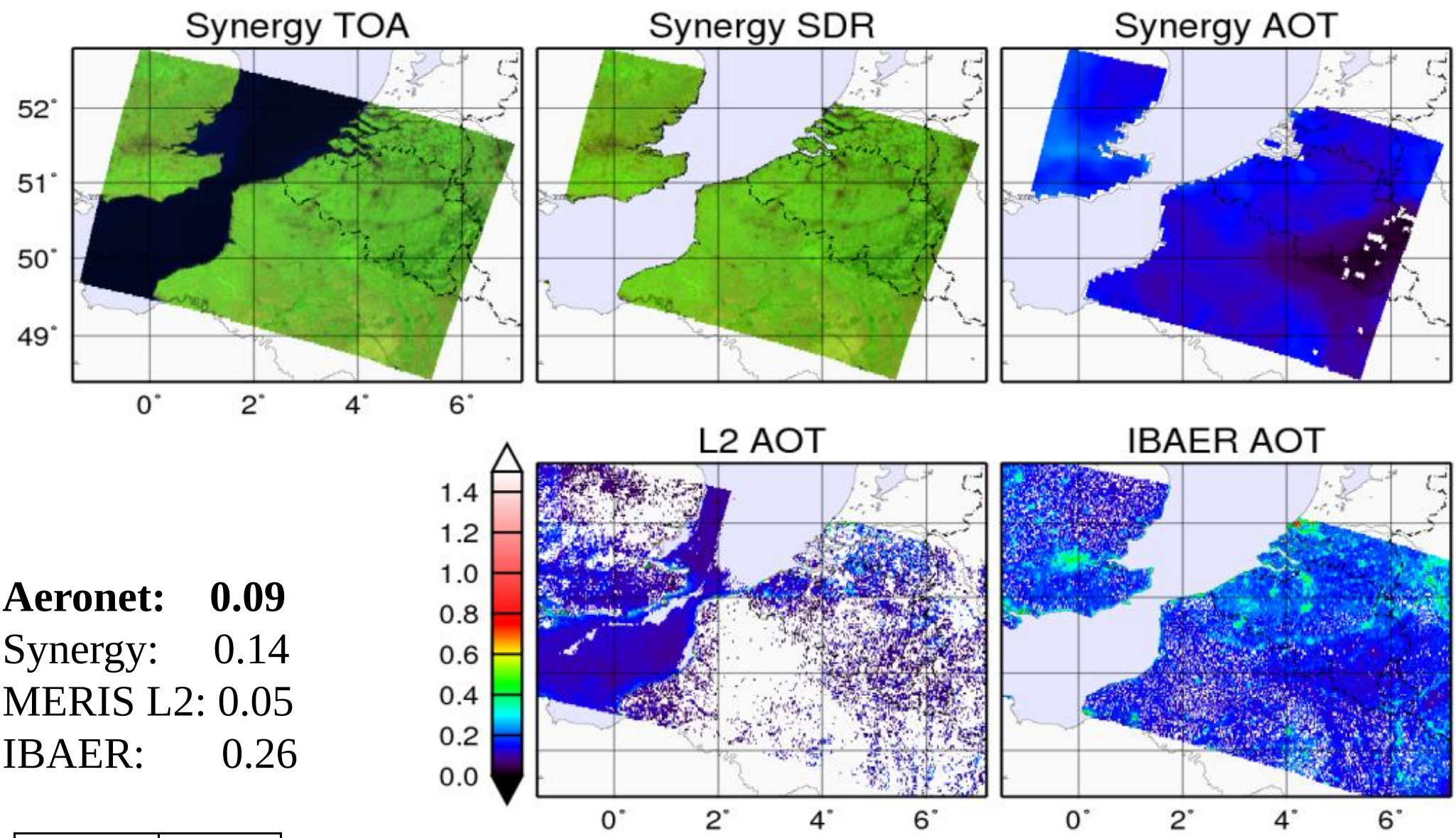



***Table 1: OLCI, SLSTR and VGT instrument characteristics.***

| Instrument | OLCI | SLSTR | VGT |
|---|---|---|---|
| Bands | Up to 21 between 0.4 and 1.0 µm | 9 channels (AATSR + 1.3 and 2.2 µm) | 4 |
| Swath Width | 1245 km | 1800 km nadir | ~2250 km |
| Spatial Resolution | ~300m | ~500 m | 1.15km |
| Range of view zenith angles | 0-55° | Forward: 55°<br>Nadir: 6-60° | 0-55° |

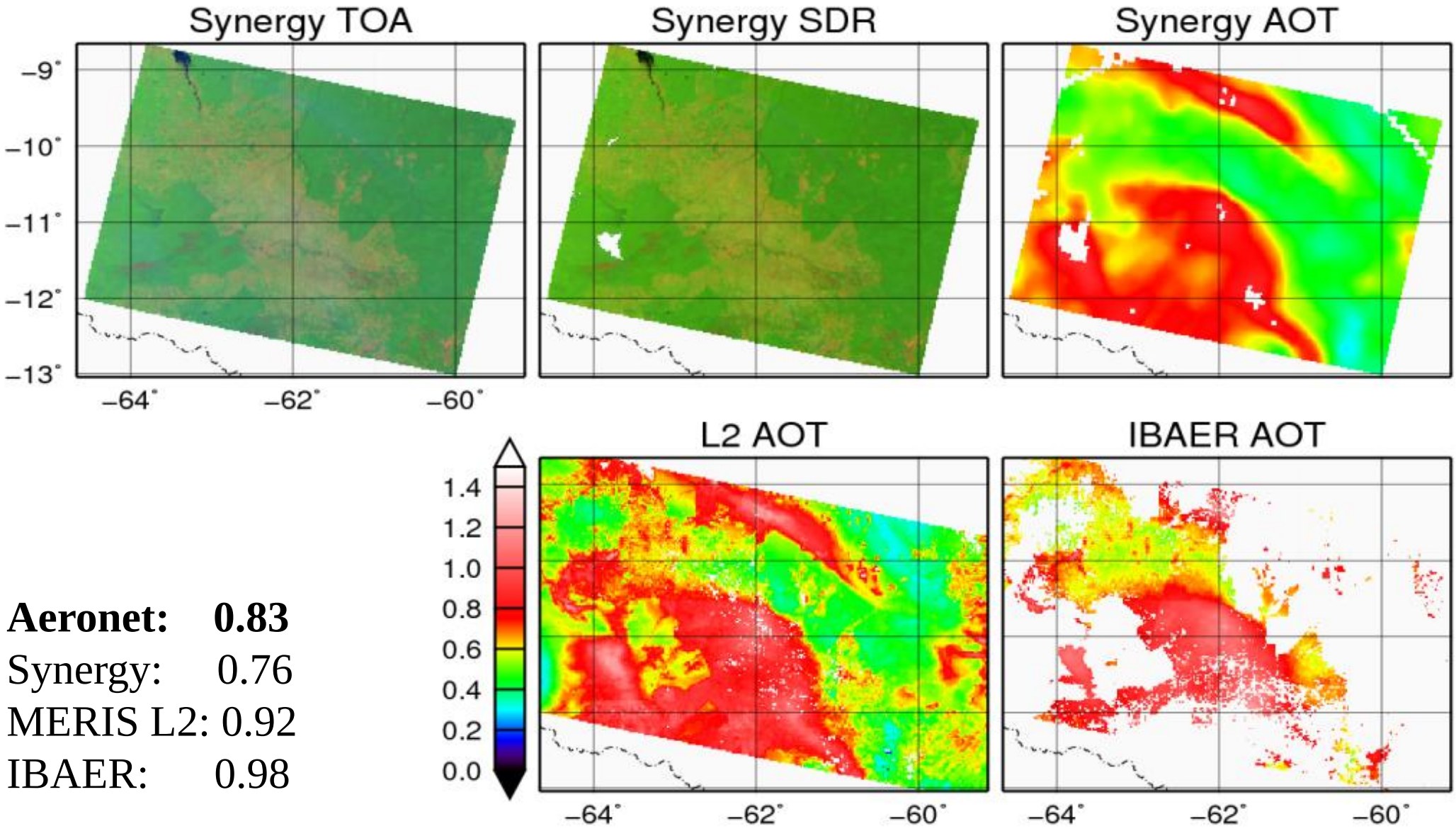
# Lille (20030714)




**Aeronet: 0.09**
Synergy: 0.14
MERIS L2: 0.05
IBAER: 0.26

| | |
|---|---|
| 50.6 ¡ N | 3.1 ¡ E |

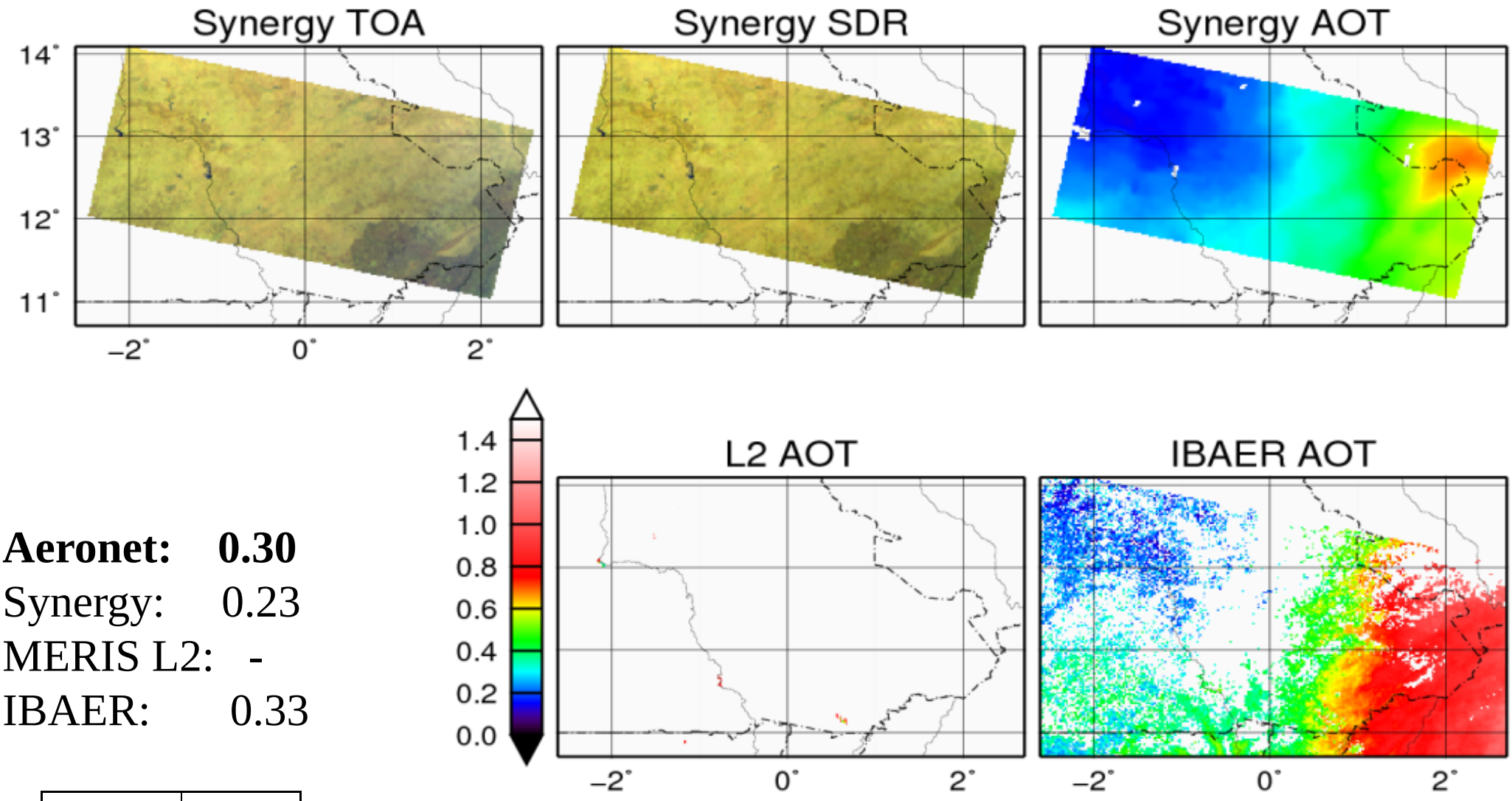
# Abracos_Hill (20050731)




**Aeronet: 0.83**
Synergy: 0.76
MERIS L2: 0.92
IBAER: 0.98

| | |
|---|---|
| -10.8°N | -62.4°E |

# Ouagadougou (20030206)




**Aeronet: 0.30**
Synergy: 0.23
MERIS L2: -
IBAER: 0.33

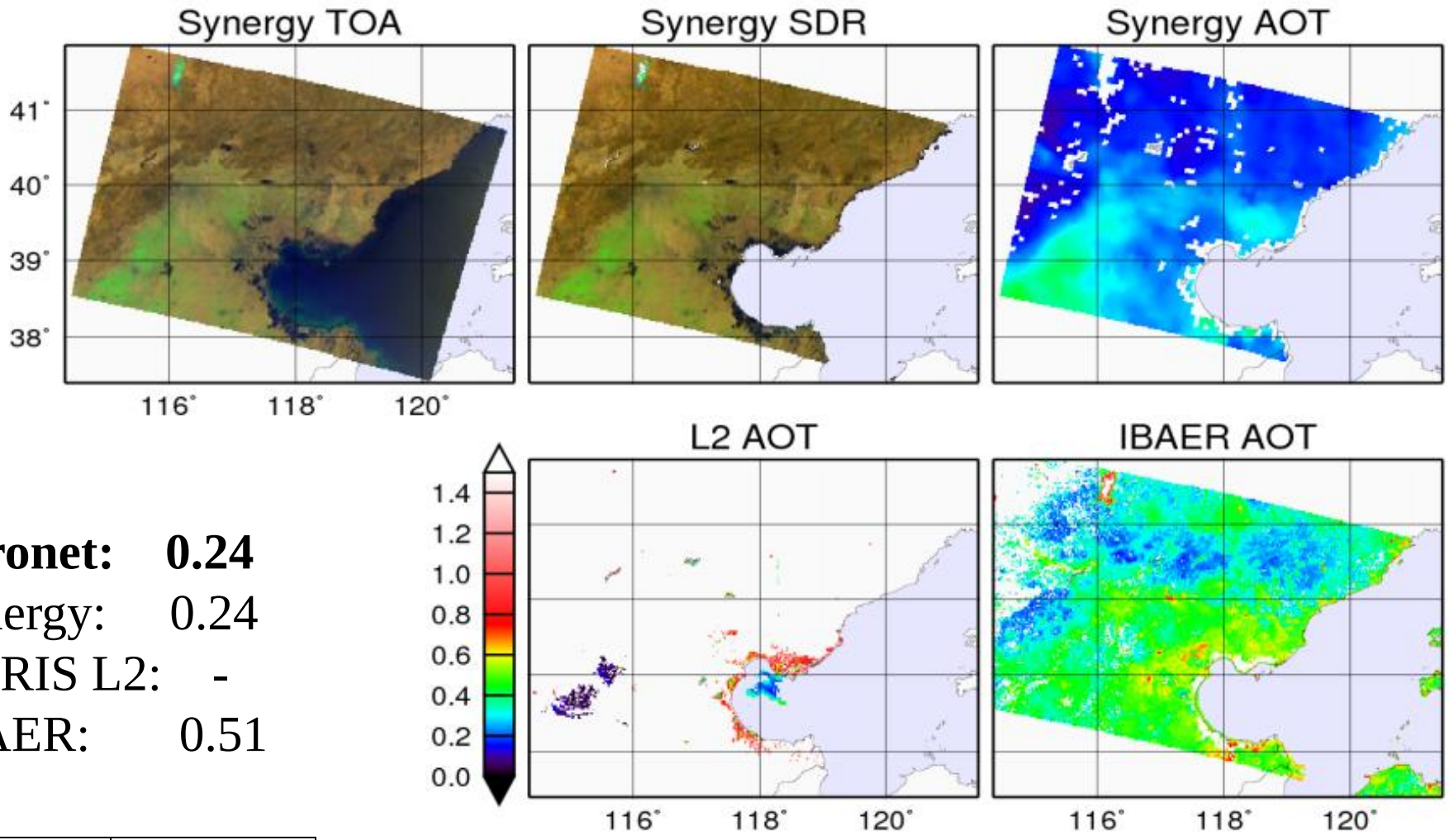
| | |
|---|---|
| 12.2¡N | 1.4¡E |

# AATSR / MERIS Synergy

(ENVISAT 2002-2010, Sentinel-3 2014-2030)

Swansea University
Prifysgol Abertawe

## Beijing (20060420)




**Aeronet: 0.24**

Synergy: 0.24

MERIS L2: -

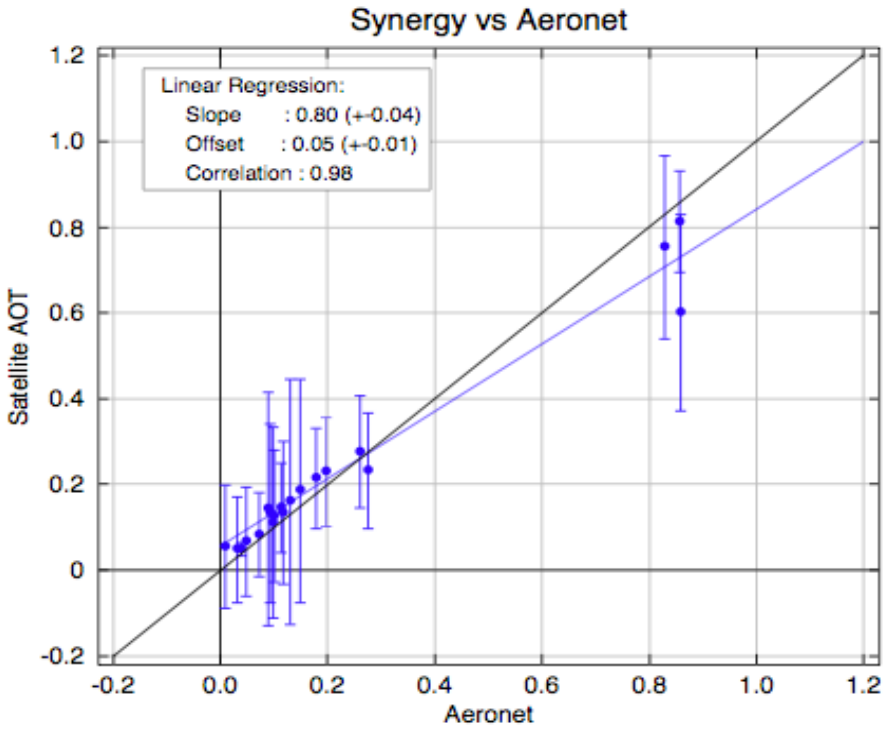
IBAER: 0.51

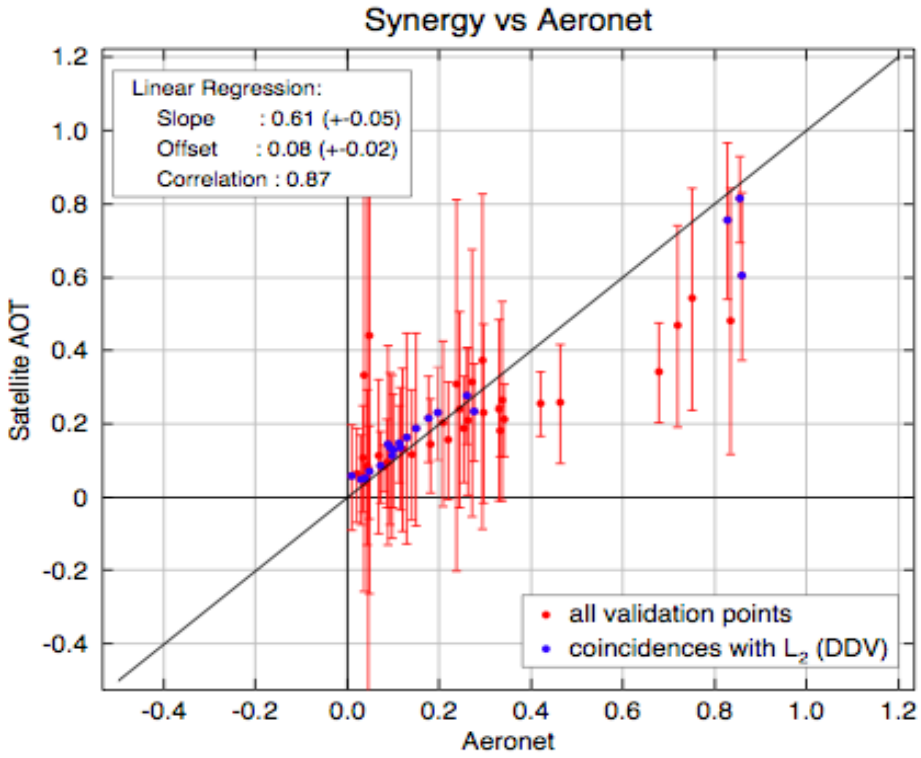
| | |
|---|---|
| 40.0 °N | 116.4 °E |

# AATSR / MERIS Synergy

(ENVISAT 2002-2010, Sentinel-3 2014-2030)

Swansea University
Prifysgol Abertawe




| Algorithm | Correlation coeff. *r* | Meanabs. error | Bias |
|---|---|---|---|
| Synergy | 0.98 | 0.04 | 0.00 |
| Synergy (ang) | 0.86 | 0.09 | -0.06 |
| Synergy (spec) | 0.96 | 0.09 | +0.06 |

| Algorithm | Correlation coeff. *r* | Meanabs. error | Bias |
|---|---|---|---|
| Synergy | 0.86 | 0.08 | -0.02 |
| Synergy (ang) | 0.78 | 0.12 | -0.09 |
| Synergy (spec) | 0.71 | 0.15 | +0.11 |

*North,P.R.J., Heckel A.et al., ESA Synergy ATBD (2010)*

# Long term global aerosol records from ESA ERS-2, ENVISAT and Sentinel-3

Swansea University
Prifysgol Abertawe

1) **Long term record (1995-2030)**:
   i. ERS-2 1995-2003 (AATSR)
   ii. ENVISAT (2002-2010) (AATSR, MERIS)
   iii. Continuity with Sentinel-3 (2014-2030)

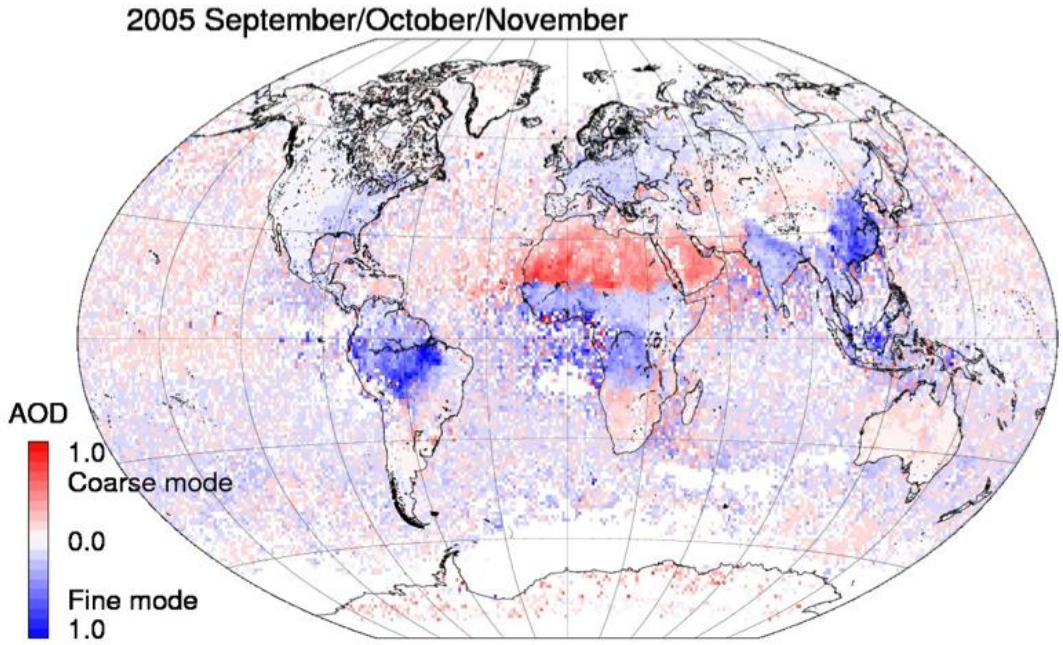
2) **New datasets (aerosol & SDR) available**
   Tools: ESA BEAM & GPOD

3) **Initial analysis & validation**:
   i. Retrieval error (land and ocean)
   ii. Aerosol composition - size distribution
   iii. Comparison with MISR & MODIS

4) **Open issues**: aerosol models, cloud, retrieval over snow/ice, Sentinel-3?

*Peter R.J. North, Swansea University UK,*

# Global retrieval of long-term aerosol datasets from ERS-2, ENVISAT and Sentinel-3




***(For dataset email p.r.j.north@swan.ac.uk)***

**Reference:** Bevan, S.L., **North, P.R.J.,** Los, S.O., Grey, W.M.F., (2012).
'A global dataset of atmospheric aerosol optical depth and surface reflectance from AATSR', Remote Sensing of Environment 116, 199-210.

**Acknowledgements:** Andreas Heckel, Will Davies, Suzanne Bevan, ESA Aerosol CCI and Synergy teams,

# References

Swansea University
Prifysgol Abertawe


- Bevan, S.L., North, P.R.J., Grey, W.M.F., Los, S.O. and Plummer, S.E. (2009). Impact of atmospheric aerosol from biomass burning on Amazon dry-season drought. *Journal of Geophysical Research*, **114**, D09204, doi:10.1029/2008JD011112.
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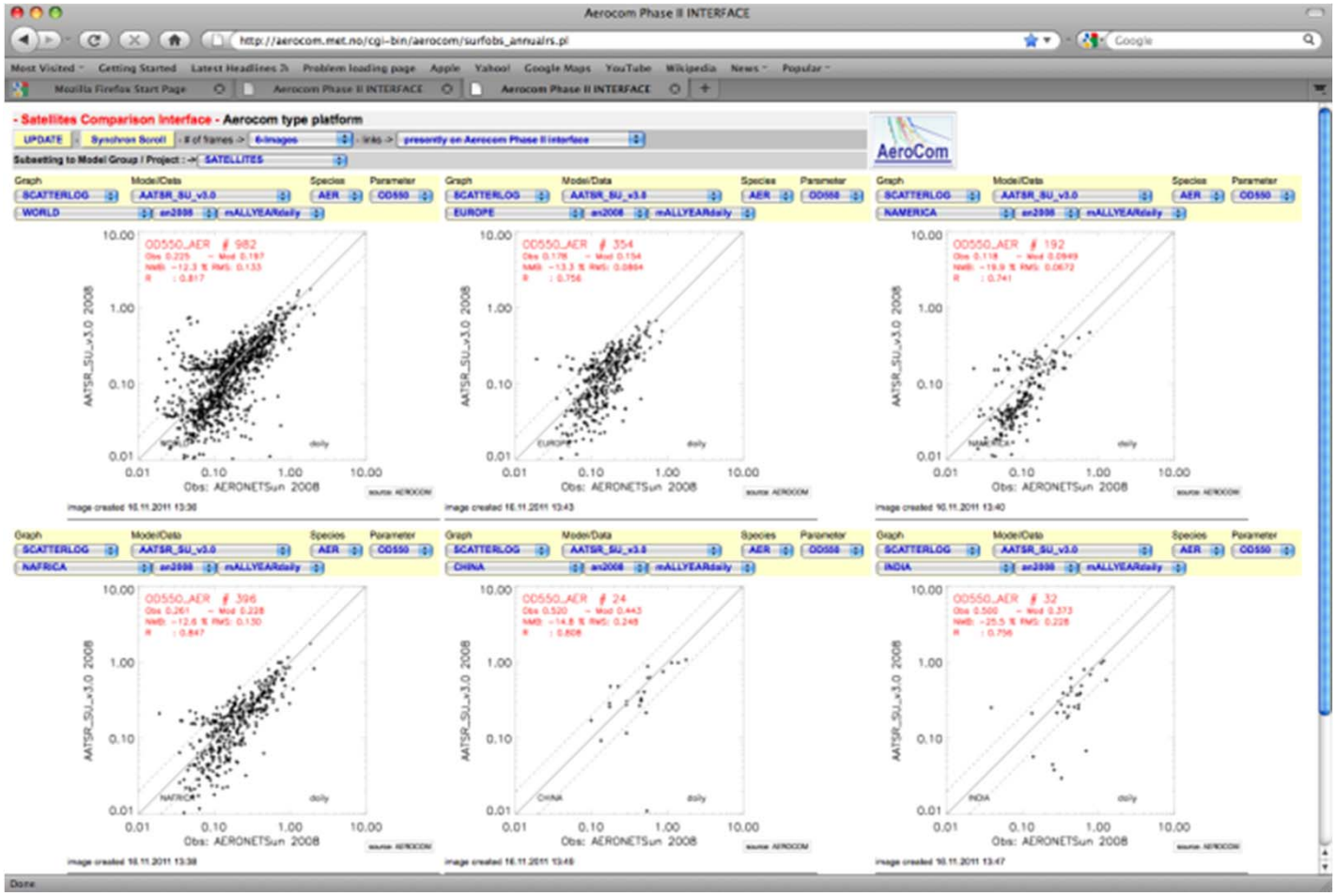
# SU AATSR – AERCOM by region

Swansea University
Prifysgol Abertawe

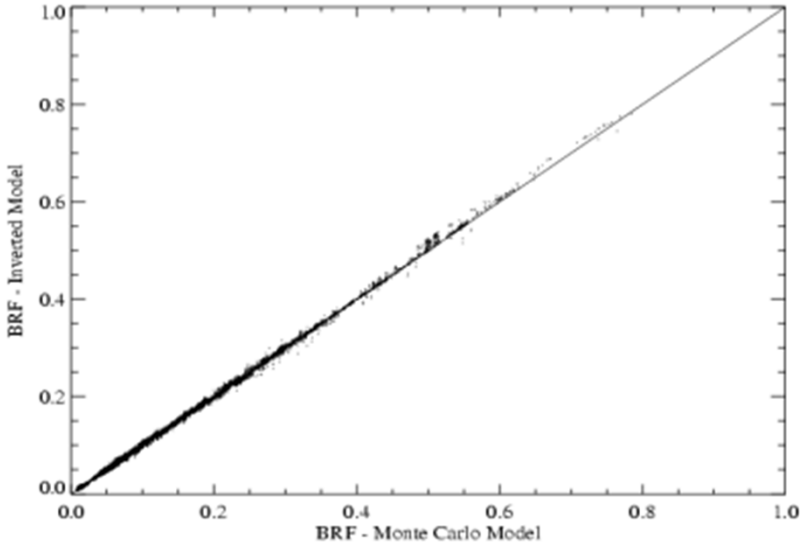


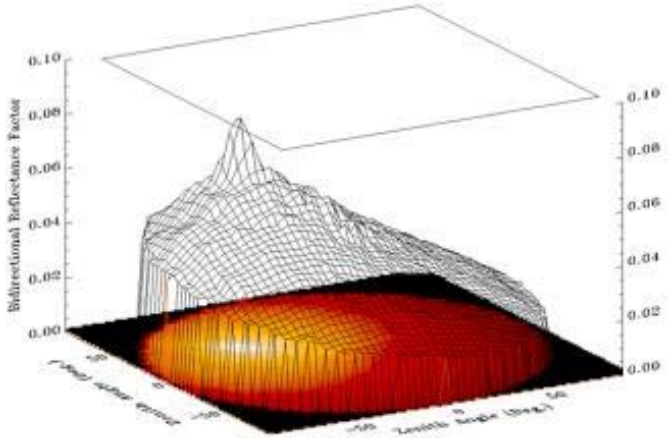

AERONET agreement good (0.13, 57%), R=0.82, NMB-12%. Low bias at low AOD? Retrieval: (US , Europe, N. Africa), > (China, E. Asia, India). NB L2 RMS may be lower by ~40%!

# Model fit to BRDF

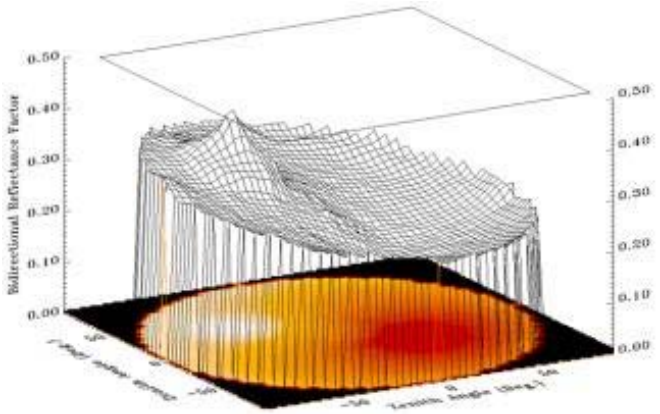
FLIGHT 3D model simulations & field BRDF

Swansea University
Prifysgol Abertawe




RED (670 nm)

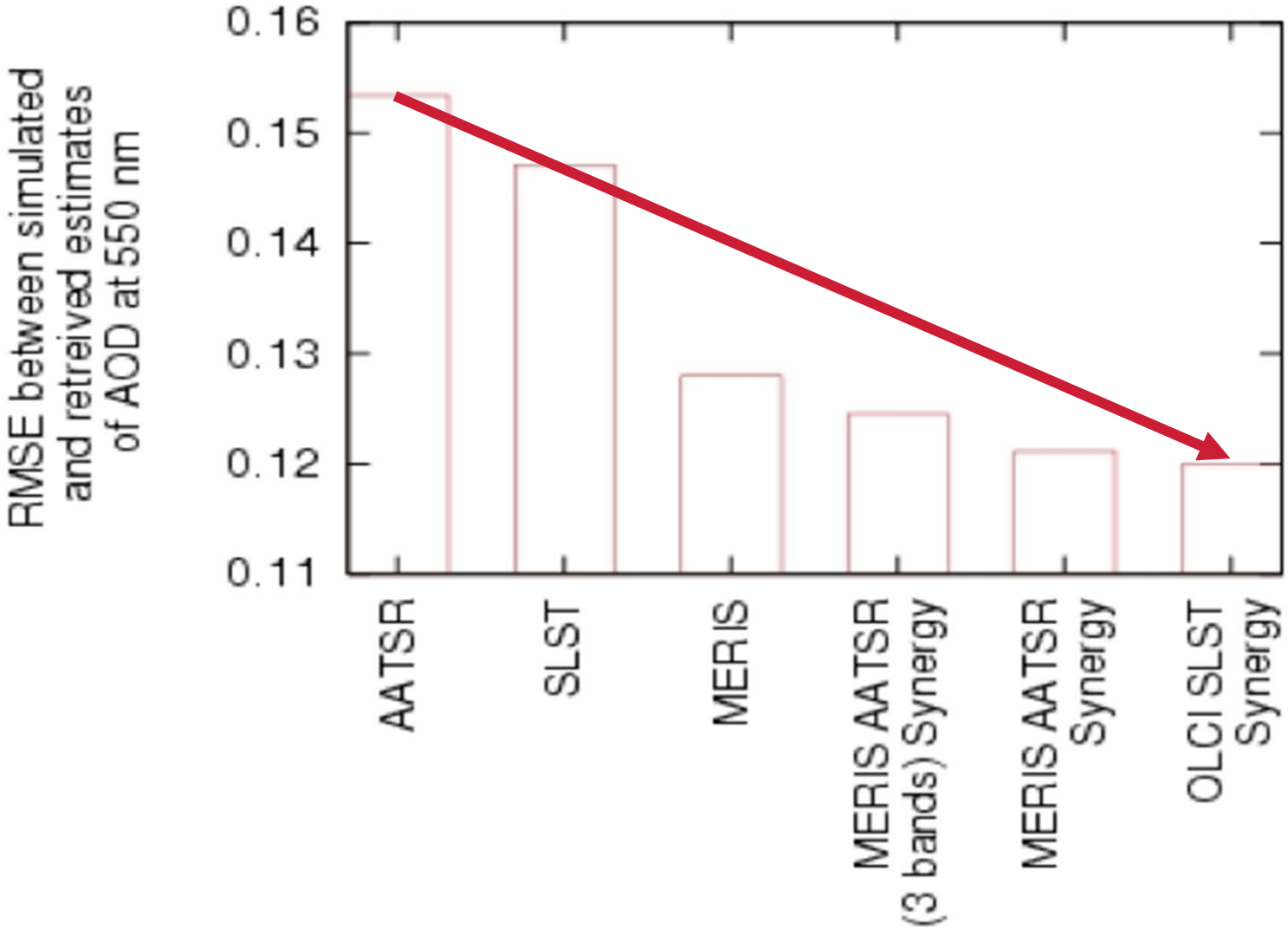



NIR (870 nm)

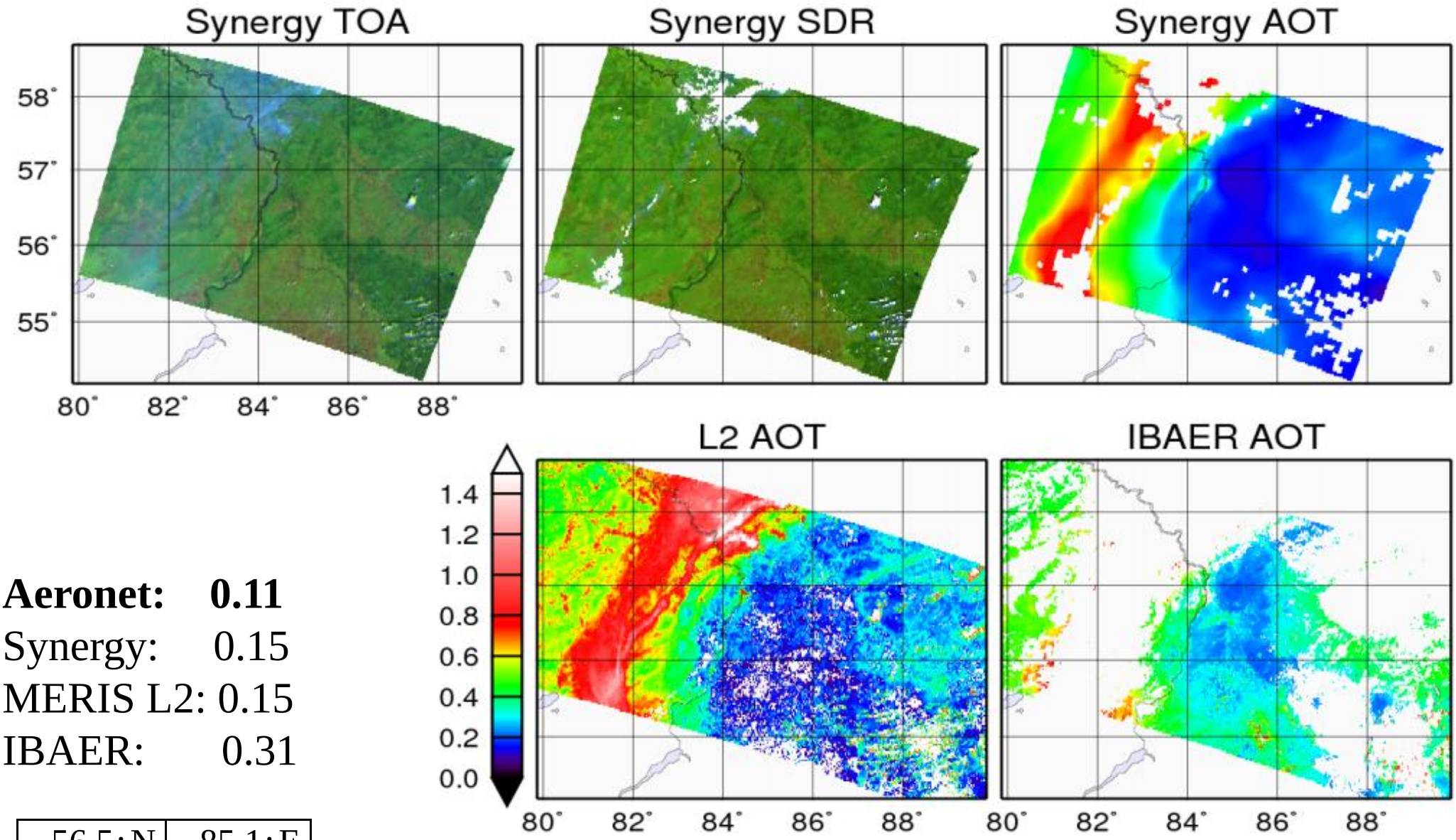
# OLCI/SLSTR Land aerosol & reflectance

(Simulated dataset, DDV)

Swansea University
Prifysgol Abertawe



# Tomsk (20030828)




**Aeronet: 0.11**
Synergy: 0.15
MERIS L2: 0.15
IBAER: 0.31

| | |
|---|---|
| 56.5¡N | 85.1¡E |

# Aerosol missions & requirements

(Sentinel-3: 2014-2030)

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