Aerosol Results from Bremen

Wolfgang von Hoyningen-Huene

Martin Freitag

Abraham Amankwah

Overview:

Objective

Satellite Retrieval

SeaWiFS, MERIS, SCIAMACHY

Ground-based Validation Data

Bremen, AERONET

Summary, Conclusion

Universität Bremen

Objective

Aerosol information is required:

Atmospheric correction for surface remote sensing
• Climate research (direct and indirect aerosol effects)
• Environmental control (pollution)

✍ Regional and temporal distribution of AOT and aerosol type
✍ Aerosol remote sensing also over land surfaces

Validation requires:

Aerosol products + data for comparison
No real regular aerosol product is scheduled, respective available

over land:	over ocean
Only AAI, no AOT ✍ difficult	AOT sparse validation data

Validation only possible, if retrievals of aerosol information from satellite is available

Universität Bremen

ENVISAT
CARING FOR THE EARTH

SCIAMACHY

Satellite Retrieval

Activities:

1. BAER algorithm (Bremen AErosol Retrieval) developed and validated with SeaWiFS data L1 data.
    Gives AOT over land and ocean,
    use a linear mixing of predefined surface types, tuned by
    NDVI or NDPI.

$$? _{Surf}(?) ? C_{Veg} ? _{Veg}(?) ? (1 ? C_{Veg}) ? _{Soil}(?)$$

2. Adaptation of BAER to MERIS L1 data.

3. Presently first preliminary validation of retrievals with MERIS L1 data.

4. Adaptation of BAER to SCIAMACHY L1c data

Universität Bremen

ENVISAT
CARING FOR THE EARTH

SCIAMACHY
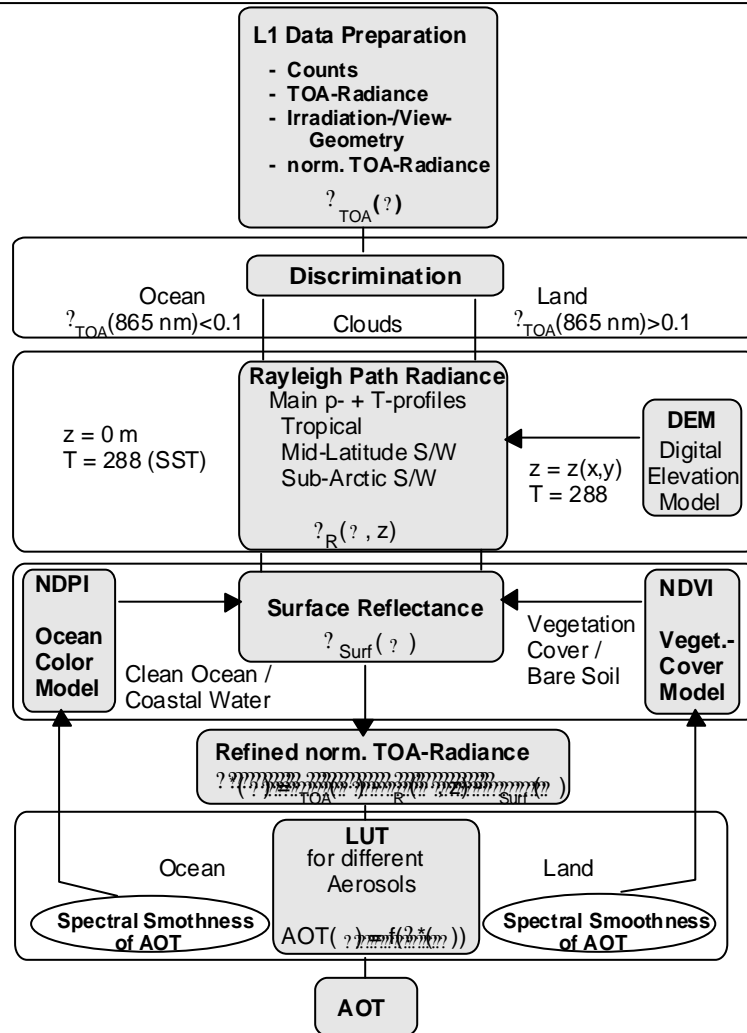
Data preparation

Case discrimination

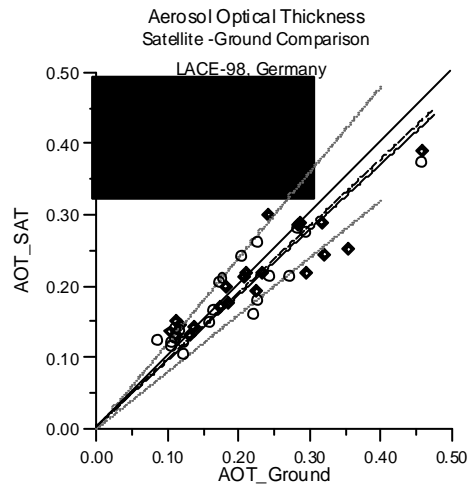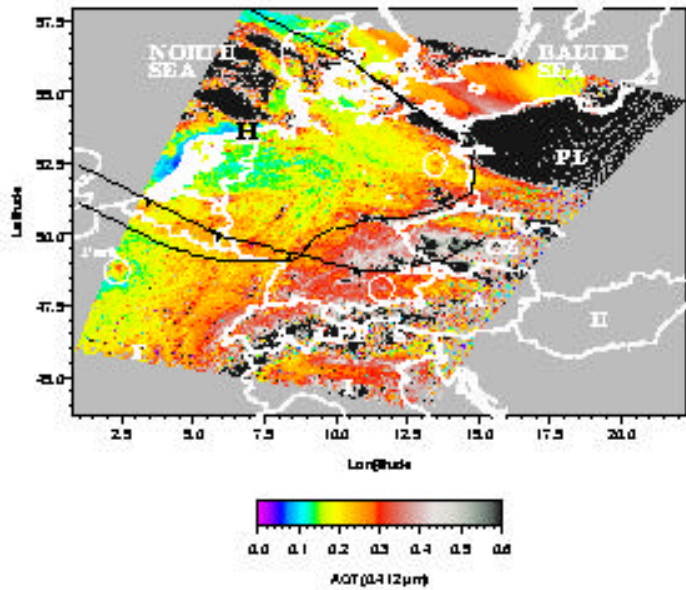Subtracting Rayleigh path reflectance

Subtracting surface reflectance

Applying look-up-tables and smoothness criteria

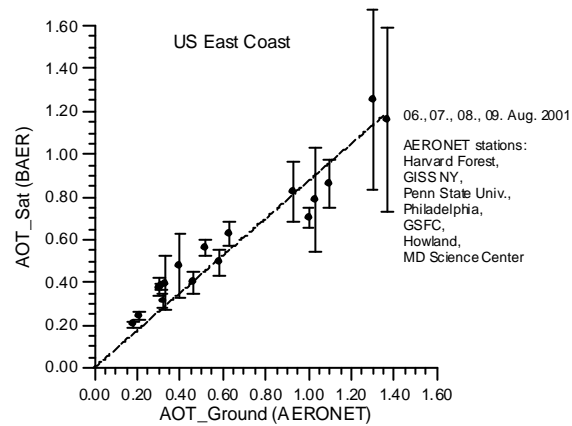von Hoyningen-Huene et al.: JGR vol 108 No D9 4260. 2003

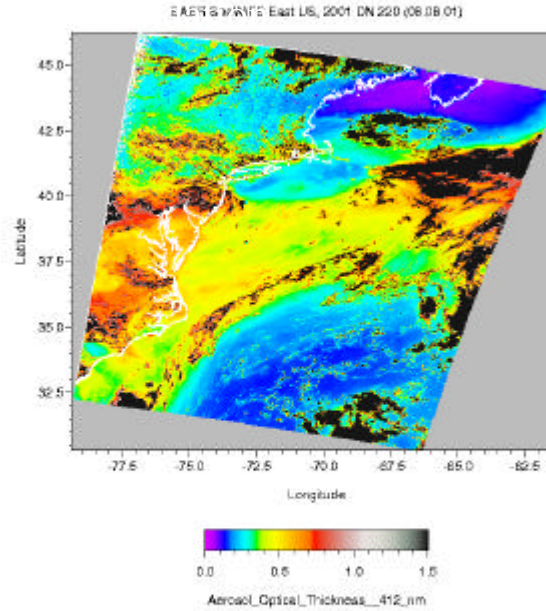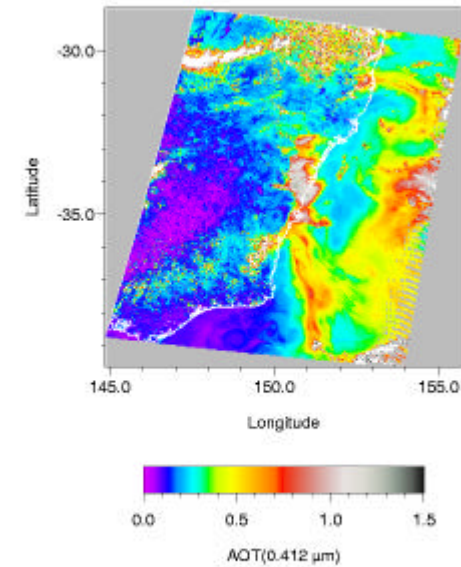Universität Bremen

AOT over Central Europe, Aug. 1998

Pollution outbreak from US East coast, Aug. 2001

Australian forest fires, Dec. 2001

Aerosol Optical Thickness
Satellite -Ground Comparison
LACE-98, Germany

US East Coast

06., 07., 08., 09. Aug. 2001

AERONET stations:
Harvard Forest,
GISS NY,
Penn State Univ.,
Philadelphia,
GSFC,
Howland,
MD Science Center

Some Examples with SeaWiFS

✍ Gives validated results for SeaWiFS

Universität Bremen

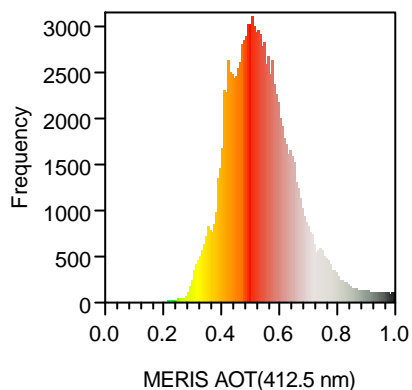ENVISAT — CARING FOR THE EARTH

SCIAMACHY

Case of
21. Aug. 2002

BAER Algorithm
principially
applicable to
MERIS too

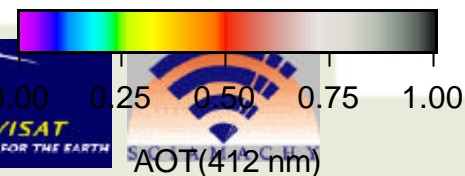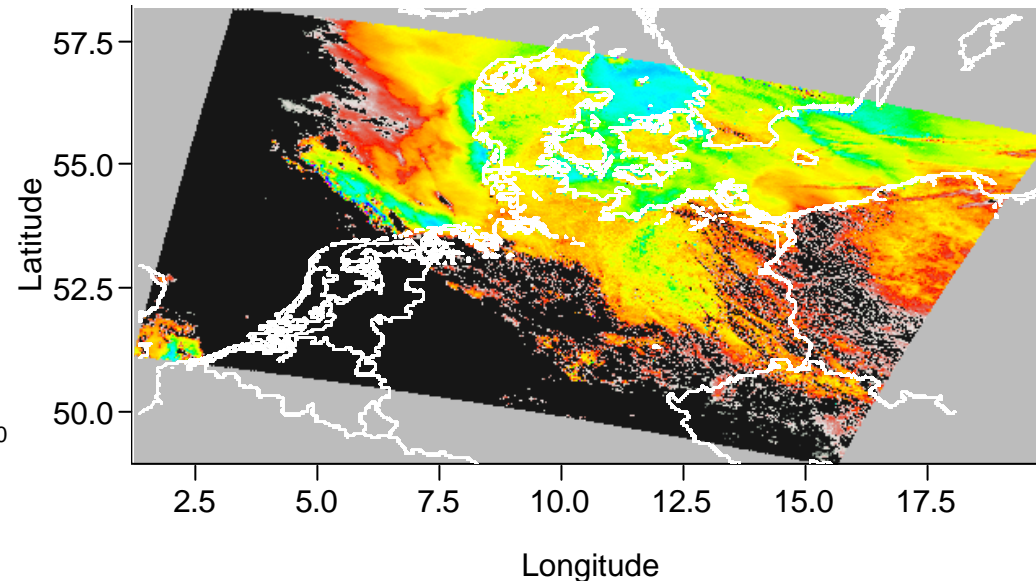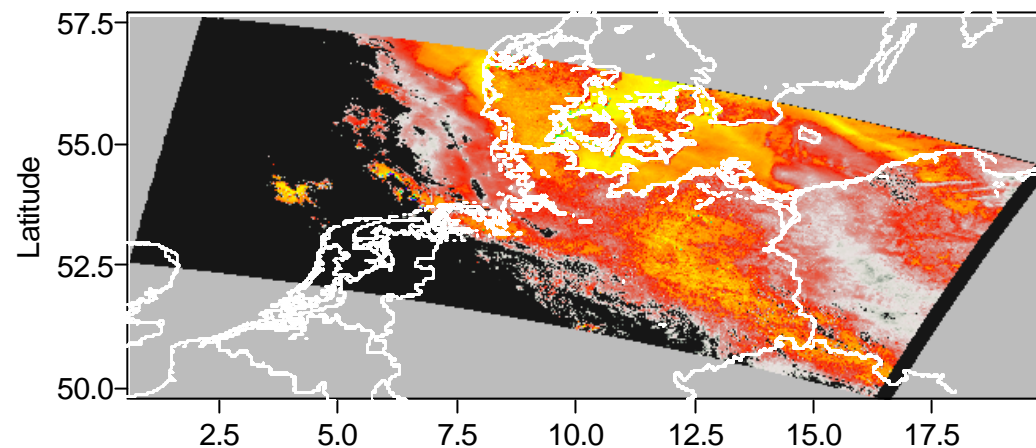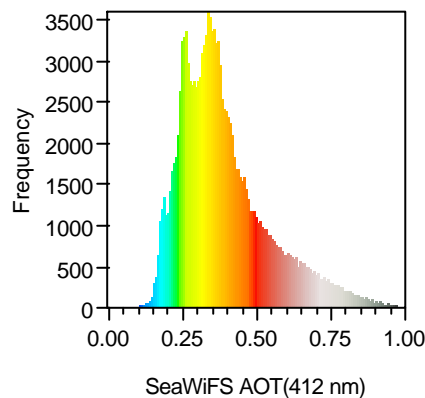Still systematic
differences in AOT
between SeaWiFS
and MERIS

Still larger land sea
discrepancies in
MERIS

Observable
aerosol - cloud
interaction

MERIS 10:06 UTC

SeaWiFS 12:03 UTC

Universität Bremen

AOT(412 nm)

Consequences for the Algorithm

Adaptation of the surface model to the other spatial scale: 1.1 km -> 0.3 km

Larger variability of different separate surface types:
check variability of vegetation and soil spectra,
selection of seasonal and regional variable spectra from a data base
for the mixing

Higher NDVI causes lover estimates for the surface reflectance:
-> increase scaling factor for estimated surface reflectance
(made empirically)

Higher sensitivity for sub-pixel clouds, needs a better cloud screening

✍ Modification of the surface model for the retrieval with MERIS data

$$?_{Surf}(?) ? C_{Veg} ?_{Veg}(?) ? (1 ? C_{Veg}) ?_{Soil}(?)$$

Universität Bremen

ENVISAT
CARING FOR THE EARTH

SCIAMACHY

First MERIS Validation Results

Used scenes:

MER_RR_20020803_092852

MER_RR_20020821_100639

MER_RR_20020912_101751

MER_RR_20021005_095511

Ground-based data from:

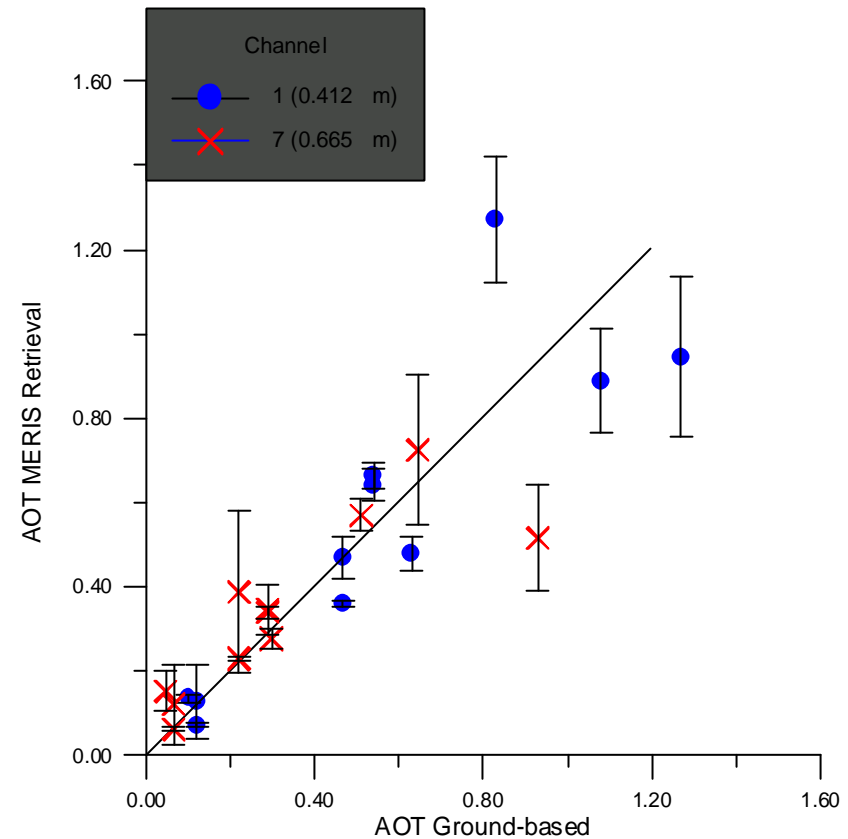Heligoland (North Sea, AERONET)

Zingst (Land + Baltic Sea, DWD)

Sopot (Land + Baltic Sea, AERONET)

Toravere (Land, Aeronet)

Ispra (Land, AERONET)

Comparison Retrieval - Ground-based Measurements
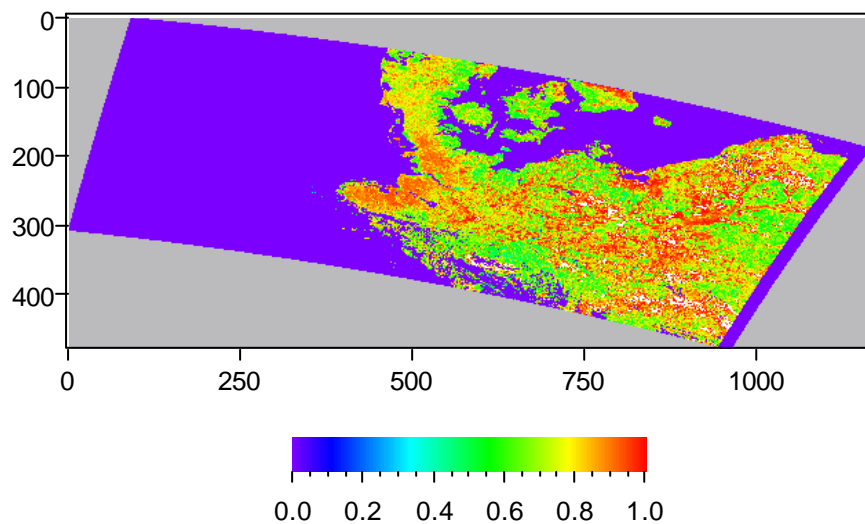
Universität Bremen

Results and Problems
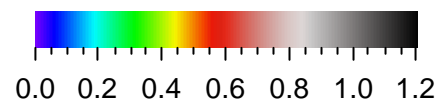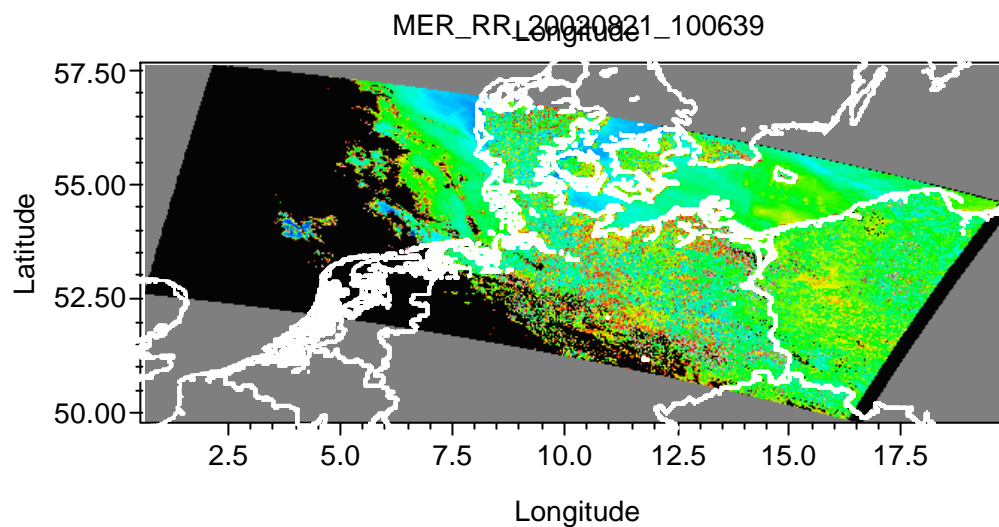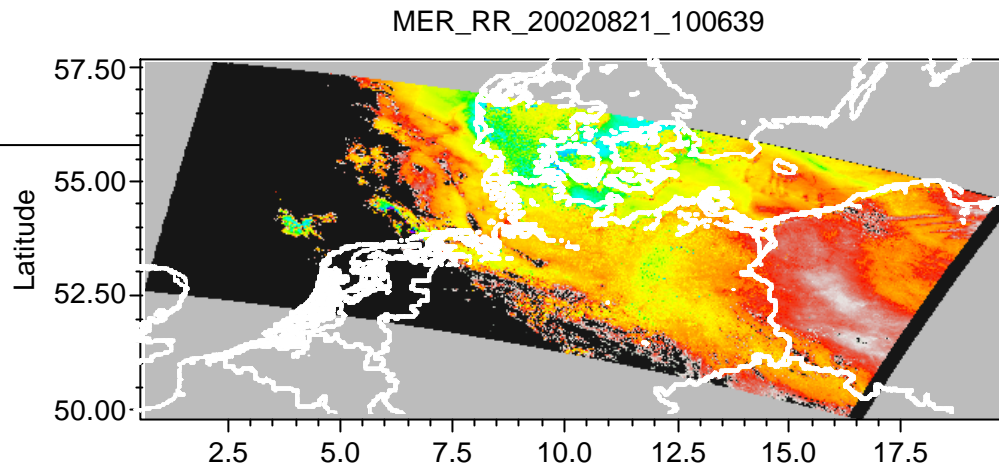
Reliable results for AOT at 412 nm

Data comparable with ground-based measurements and SeaWiFS

Larger variability at 665 nm, not connected with NDVI

Assumption: sub-pixel clouds or bright surface targets (ripe grain fields ?)

MER_RR_20020821_100639

MER_RR_20020821_100639

AOT(0.665 µm)

NDVI

Universität Bremen

ENVISAT
CARING FOR THE EARTH

SCIAMACHY

MERIS - SeaWiFS Channels + SCIAMACHY

Selected bands of SCIAMACHY corresponds with SeaWiFS or MERIS channels

——	MERIS
- - -	SeaWiFS
●(blue)	SCIAMACHY M 11.08.02
●(green)	SCIAMACHY L 11.02.02

TOA reflectance without poloarization

Surface mixing still open

Few pixels without clouds (cloud screening)

Ground-based Data for Comparison

Ground-based data required for:

1. Set-up of Look-up-Tables for the retrieval.

2. Comparison of retrieval results

Data sources:

Own measurements by sun photometer in Bremen

Use of other sources:

AERONET, DWD stations

AOT Measurements

Spectral Aerosol Optical Thickness
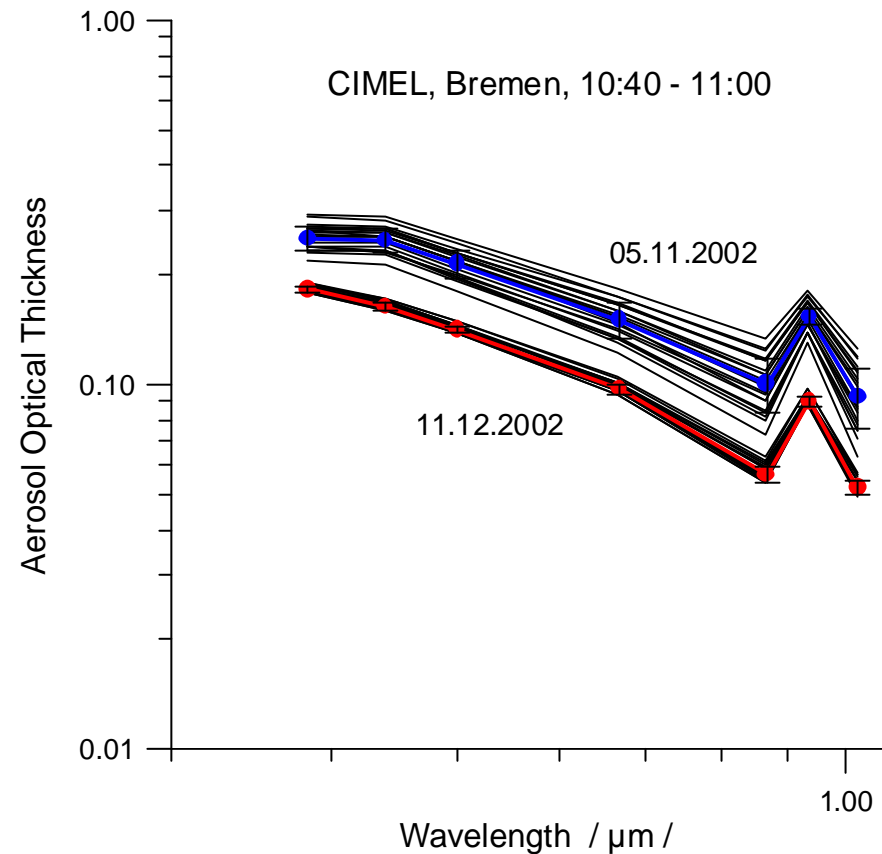
Use of CIMEL 218 CE sun photometer/sky radiometer

Calibration by Langley-plot at Zugspitze (in March 2002)

Laboratory measurements for the determination of filter wavelength and leakage (May – June 2002)
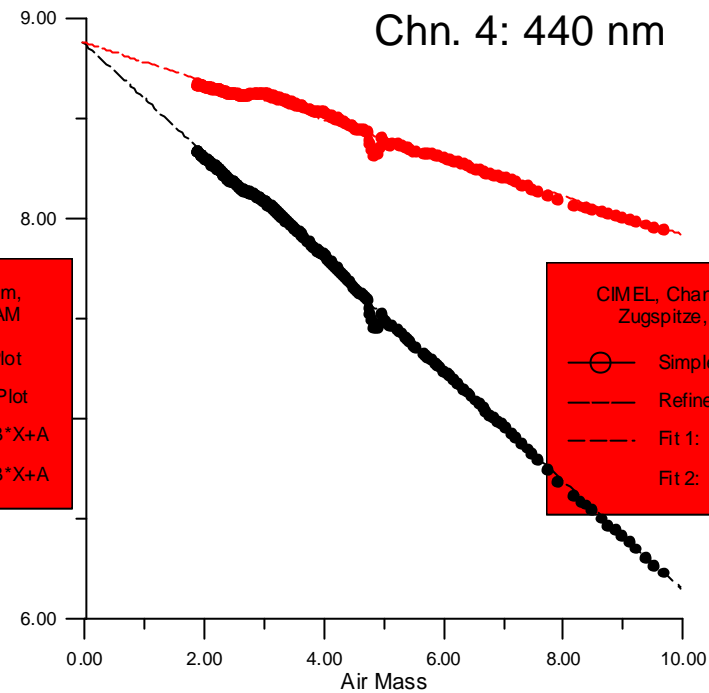
Fixing instrument and filter problems

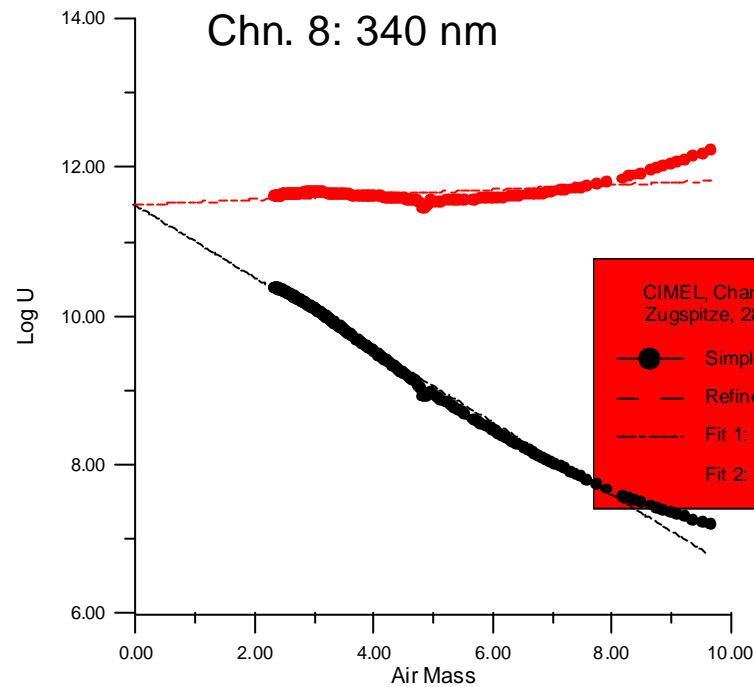Since Sept. 2002 measurements at cloud free overflight times of ENVISAT (09:30 – 11:00)

CIMEL, Bremen, 10:40 - 11:00

05.11.2002

11.12.2002

Aerosol Optical Thickness

Wavelength / µm /

Universität Bremen

ENVISAT
CARING FOR THE EARTH

SCIAMACHY

Instrument Problems

Langley-plots and laboratory measurments showed:

Filter of channel 8 (340 nm) has leaks for light of multiple wavelength, not usable

Stability of filters is changing with time, recalibration required.
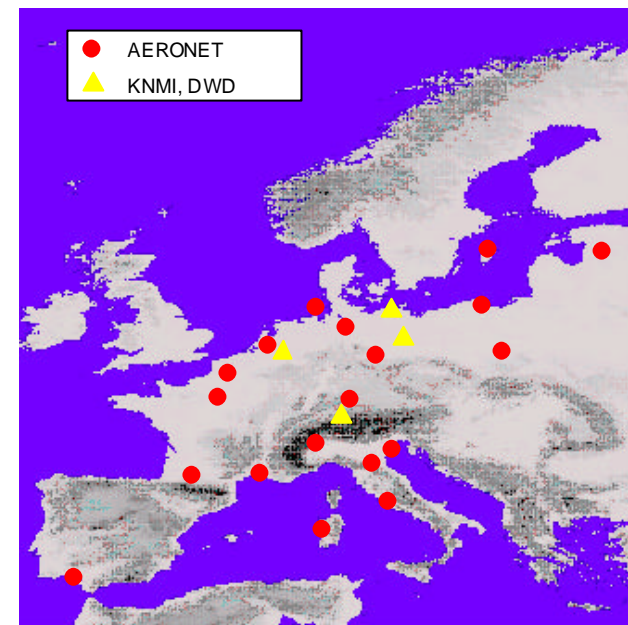
Additional Data Sources

Until now:

Few satellite scenes from ENVISAT as L1 data available for aerosol retrievals: SCIAMACHY, MERIS

No L2 data with aerosol products

Most not over Bremen

✍ Additional ground-based data required:

AERONET, DWD, KNMI

Universität Bremen

Summary, Conclusion

1.) AOT retrieval from satellite instrument data:

- BAER algorithm is able to give AOT also over land surfaces,
      Developed and tested with SeaWiFS
      Adaptation for the MERIS instrument in progress with first results
      Adaptation for SCIAMACHY is beginning

- Modifications within the surface model for each instrument characteristics required

- Modifications only can be done with ground-based validation data

- Problem: availibility of MERIS data (not free of charge !)

2.) Ground-based data from very different places required:

      available satellite scenes spread over different places

      all sources necessary (own measurements, AERONET, DWD)

3.) Use of satellite intercomparison as additional validation (SeaWiFS, MERIS, SCIAMACHY)

Universität Bremen

ENVISAT
CARING FOR THE EARTH

SCIAMACHY