Integrated approach for testing Aeolus aerosol measurements using EMEP model & AeroCom database

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CalVal activities

- **Intention:** validate Aeolus L2A aerosol products against independent data (EMEP/MSC-W model and remote sensing measurements) using AeroCom tool.

**EMEP** - European Monitoring and Evaluation Programme is a scientifically based and policy driven programme under the UN Convention on Long-range Transboundary Air Pollution (CLRTAP) for international co-operation to solve transboundary air pollution problems.

**AeroCom** is an international science initiative on aerosols and climate.

- **Main objective:** assess the quality of Aeolus L2A data and check its validity for assessment of the chemical state of atmosphere, for evaluation of air quality and climate models and data assimilation in Chemical Weather Prediction models.

- Focus on consistency of ALADIN/Aeolus extinction profiles and AOD with data from other satellites which is necessary for constructing long-term time-series.
Tools for ADM-Aeolus CalVal

- **EMEP chemical transport model** will:
  
  link ADM-Aeolus data with other measurement and model data, will provide:
  
  - Aerosol extinction profiles (multi-wave)
  - AOD (multi-wave)
  - *3D aerosol fields, aerosol chemical composition and size distribution*
  - Further development in order to compare co-located modelled and ADM-Aeolus data

- **AeroCom** - validation/visualization tool
  
  - central within the international model inter-comparison initiative AeroCom
  
  - integrates data from chemical transport/ climate model calculations, remote sensing and surface monitoring measurements  
    (Schulz et al., IGAC Newsletter, No 41, May 2009)

  [http://aerocom.met.no](http://aerocom.met.no)
EMEP/MSC-W model
(Simpson et al., ACP, 2012)

- Eulerian chemical transport model - Open source http://emep.int
- **Horizontal grid**: down to 0.5° x 0.5° global and down to 0.1° x 0.1° regional
- **Vertical grid**: flexible 20-34 layers (up to 100 hPa)
- **Meteorology**: off-line 3h from ECMWF-IFS
- **Chemistry**: 130 species, 160 reactions
- **Aerosols**: \( \text{SO}_4^2-, \text{NO}_3^-, \text{NH}_4^+, \) elemental and organic carbon, sea salt, mineral dust

- Extensively evaluated with long-term EMEP monitoring and AirBase data

*) EMEP – European Monitoring and Evaluation Programme (within the UNECE Convention on Long-Range Transboundary Air Pollution; http://emep.int

MSC-W – Meteorological Synthesizing Centre – West hosted by the norwegian Meteorological Institute
EMEP model: AOD & Extinction profiles

**Bulk-mass aerosol - OPERATIONAL**

- 3D concentrations of fine and coarse aerosols
- Specific Extinction Efficiencies for aerosol components (Hess et al, 1998)
- Effective cross-sections; implicitly account for the effect of relative humidity (Chin et al, 2002)

**Size-resolved aerosol & Mie-theory – RESEARCH VERSION**

- PNC in 4 size modes (pre-assigned GMDs) – preliminary!
- Effective complex refractive index - volume weighted for internal mixture: Bruggeman (1935) mixing rule for homogeneous mixtures (Chylek et al., 2000); Maxwell&Garnett (1904) rule for EC and min. dust inclusions
- Extinction Efficiency from Mie-scattering look-up table

**Evaluated/compared:**

- for AOD - AERONET, MODIS, CALIOP, AATSR
- for extinction profiles – EARLINET, CALIOP
Aerosol Comparisons between Observations and Models

Visualization/verification tool and database

Data: model simulations, satellites (MODIS, CALIOP, AATSR, ATSR, MERIS), AERONET, EARLINET, air quality monitoring

Visualization/verification
Maps, profiles
Timeseries, scatter-plots, Statistics/scores

http://aerocom.met.no
Example: Visual comparison
AOD for 550nm from EMEP model and satellites

- **EMEPglob.v2801**
- **MODIS Aqua**
- **AATSR**
- **CALIOP**
Example: Evaluation of AOD from EMEP model with AERONET sun-photometers data for 2012

Bias

Correlation

Bias = 14%
R = 0.69
Example: Evaluation of AOD from EMEP model with AERONET data for different regions

Anthropogenic pollution

Europe

N. America

China

N. Africa

Anthropogenic + desert dust

Desert dust
Example: AOD monthly series from EMEP model and AERONET (2012)
Example: Extinction 355 nm from EMEP model vs. EARLINET climatology

Granada, Spain (37.16N; 3.60W; 880m)

Athens, Hellas (39.89N; 28.88E; 220m)

Thessaloniki, Greece (40.50N; 22.90E; 50m)

Evora, Portugal (38.57N; 7.91W; 290m)

Napoli, Italy (40.50N; 14.11E; 118m)

Potenza, Italy (40.60N; 15.72E; 760m)

Lecce, Italy (40.33N; 18.10E; 30m)

Evora, Portugal (38.57N; 7.91W; 290m)

Catania, Italy (37.50N; 15.07E; 190m)

L’Aquila, Italy (42.34N; 13.33E; 683m)

Model tends to under-predict on upper layers
Extinction: EMEP 2012 vs. EARLINET seasonal climatology

532nm

- **Spring**
  - Leipzig, Germany (51.35N; 12.43E; 90m)
  - Thessaloniki, Greece (40.50N; 22.90E; 60m)

- **Summer**
  - Leipzig, Germany (51.35N; 12.43E; 90m)
  - Thessaloniki, Greece (40.50N; 22.90E; 60m)

- **Autumn**
  - Leipzig, Germany (51.35N; 12.43E; 90m)
  - Thessaloniki, Greece (40.50N; 22.90E; 60m)

- **Winter**
  - Leipzig, Germany (51.35N; 12.43E; 90m)
  - Thessaloniki, Greece (40.50N; 22.90E; 60m)

355 nm

- **GR, Thess**
  - Athens, Hellas (39.89N; 28.88E; 220m)

- **GR, Athens**
  - Potenza, Italy (40.60N; 15.72E; 760m)

- **IT**

- **PT**

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NILU Meteorological Institute
EMEP Model

CALIOP

2008 annual mean
Modelled vs. CALIOP Extinction profiles (2009)

Different aerosol source regions

Europe

N. Africa

Model provides the contribution from different aerosols to total extinction

Identification of dominant aerosol types in different regions facilitates to better understanding of modelled extinction profiles and their comparison with measurements