Aerosol

Climate Change Initiative

Stratospheric Aerosol Activities in the framework of Aerosol_CCI

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MARIE CURIE ACTIONS

7th Atmospheric Limb Conference • 17-19.06.2013 • Bremen

Aerosol_CCI

Framework

- Climate Change Initiative = ESA response to GCOS requirements :
  - Development of improved data records for the main *Essential Climate Variables*
  - Valorisation of ESA archives
- Motivation:
  - Products between different sensors/algorithms: agree qualitatively but differ quantitatively
  - Overall accuracy differs for each product, season, region, aerosol regime

OBJECTIVES

- Identify and understand differences, strengths, weaknesses of existing algorithms
- Consolidate and improve existing algorithms
- Integrate major European EO teams / focus on ENVISAT and European sensors:

  { ATSR-2, AATSR, MERIS, SCIAMACHY, OMI, GOME, AVHRR, GOMOS }

- Important involvement of user community (AEROCOM, MetNo, NILU)

Aerosol_CCI

Teams involved

Earth's Observation

FINNISH METEOROLOGICAL INSTITUTE

DLR

Swansea University Prifysgol Abertawe

aeronomie.be

Universität Bremen

cnrs

KNMI

Science & Technology Facilities Council
Rutherford Appleton Laboratory

UNIVERSITY OF OXFORD

HYGEOS

User and Validation

cnrs

Norwegian Meteorological Institute
met.no

NILU

PAUL SCHERRER INSTITUT
PSI

System Engineering

cnrs

UNIVERSITY OF OXFORD

Science & Technology Facilities Council
Rutherford Appleton Laboratory

DLR

Max-Planck-Institut für Meteorologie

Aerosol_CCI

Goals and strategy

SPECIFIC GOALS

- Inter-comparison of datasets through a Round Robin procedure
- Develop initial combined / synergetic products
- Provide quantitative error information (validation, pixel-wise)
- As final product, delivery of one year improved aerosol datasets (2008)

METHODOLOGY

- Harmonization definition of micro-physical / optical aerosol types
- Improvement and harmonization of cloud masking between 4 ATSR and AVHRR/3
- Inter-comparison of different approaches for treatment of surface reflectance and BRDF
- Definition, when possible, of common choices for auxiliary data used by the different retrievals (elevation, land cover, ocean reflectance, BRDF, humidity, ...)

Aerosol_CCI

Goals and strategy

STRATOSPHERIC AEROSOLS (focus on GOMOS)

- Use the new algorithm provided by the Aergom project as input for Aerosol_CCI (Aergom: cf. presentation F. Vanhellemont)
- Improve stratospheric occultation product
- Include the longitudinal dependence in the final binned product
- Produce a quality dataset for year 2008 using the GOMOS instrument.
  - AOD + extinctions with error at 550 nm, PSC flags, Angstrom exponent
  - Monthly binned product: 2.5° lat. x 10° lon. x 1 km
  - Specific use for trop. Aerosols: Correction of nadir products for volcanic cases
- Investigate the potential of SCIAMACHY aerosol data (collaboration with the SCIA team)
- Investigate how to link GOMOS and SAGE II

- Progress in data merging topic:
  - Proposed merging algorithm: OSIRIS + GOMOS (option with U. Saskatchewan)
- Validation by NILU with CALIPSO (K. Stebel)

GOMOS products

Main milestones of the project :

- A delay in GOMOS reprocessing (GOPR, v.5 → v.6) impeded the achievement of Aergom algorithm for the start of Aerosol_CCI

- Consequently, start of Aerosol_CCI with temporary datasets:
  - GOMOS official v5 (GOPR) as starting point
  - Later: use of AerGom scientific data

- Opportunity to investigate the new Aergom algorithm using the Matlab breadboard code in the meantime

- Extensive analysis and validation of Aergom
  - Analysis of the influence of the star and occultation parameters

- **Strong interaction with the Aergom project along the whole project**

GOMOS products

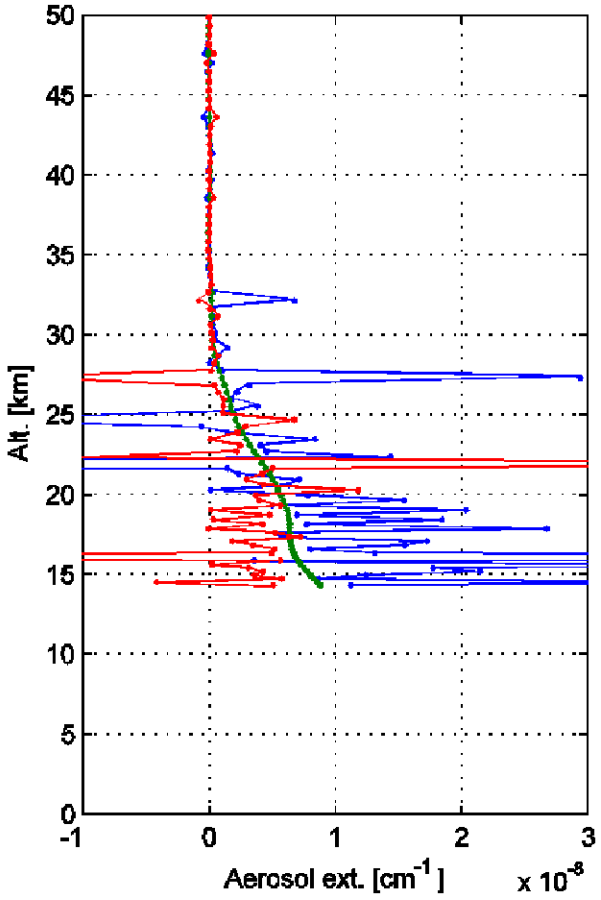
Official vs AerGom

	Official GOMOS processor	AerGom
Spectral inversion	❑ SPA ❑ NO_2, NO_3: DOAS ❑ O_3, aerosols: LM fit ❑ Aerosol spectral model: rather strange quadratic polynomial	❑ SPA, SPB1 (outside O2 band) ❑ NO_2, NO_3, O_3, aerosols: simultaneous LM fit ❑ Aerosol spectral model: more physical parameterization using a polynomial in inverse wavelength
Spatial inversion	❑ All species separately, discarding covariances from the spectral inversion ❑ Tikhonov altitude regularization (one for aerosols)	❑ All species together, using the entire spectral retrieval covariance matrix ❑ Tikhonov altitude regularization for each species

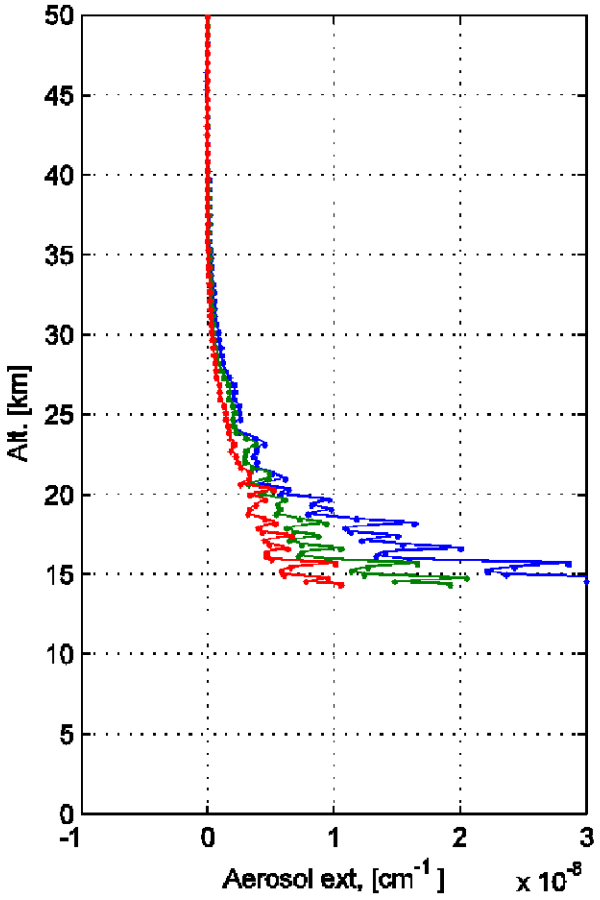
GOMOS products

Official vs AerGom

Official product (v5)



AerGom product



Blue: 400 nm

Green: 500 nm

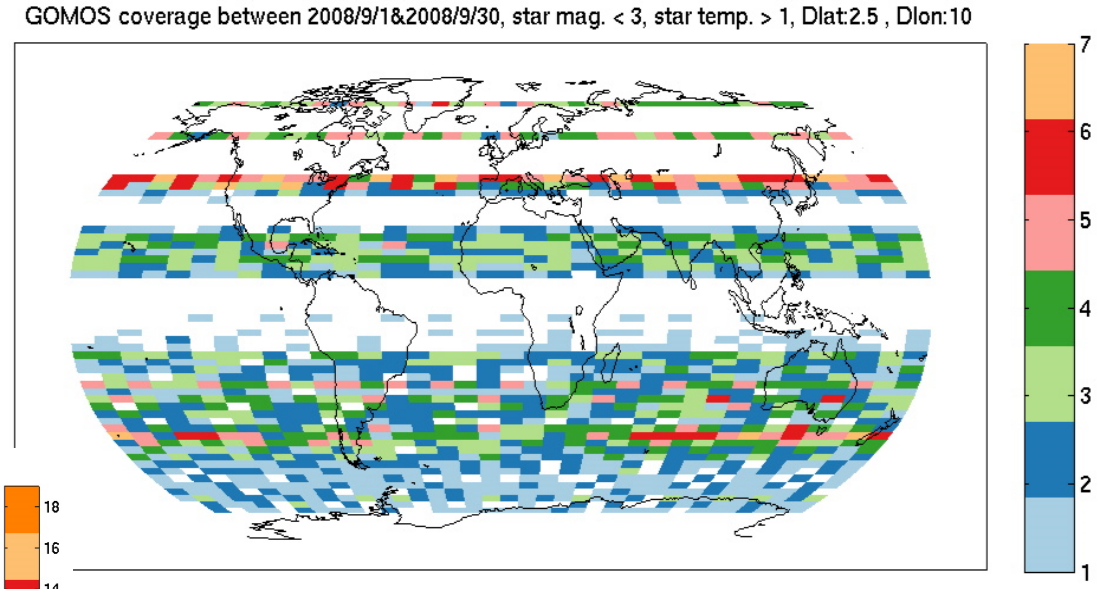
Red: 600 nm

AerGom

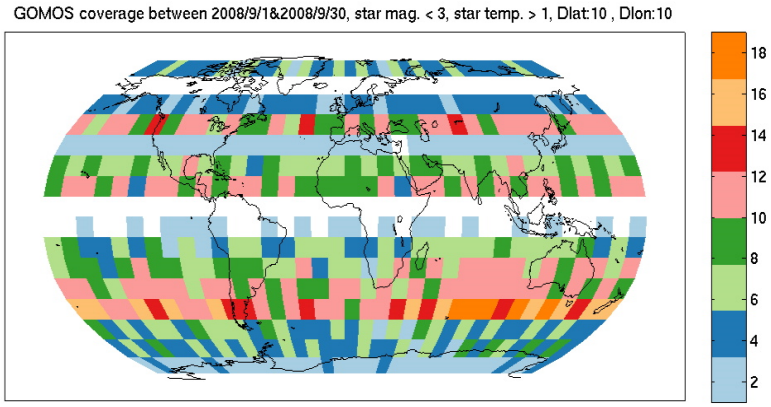
GOMOS coverage

- GOMOS coverage for September 2008 :
  (Stars of Magnitude <= 3)

2.5°x10°



10°x10°



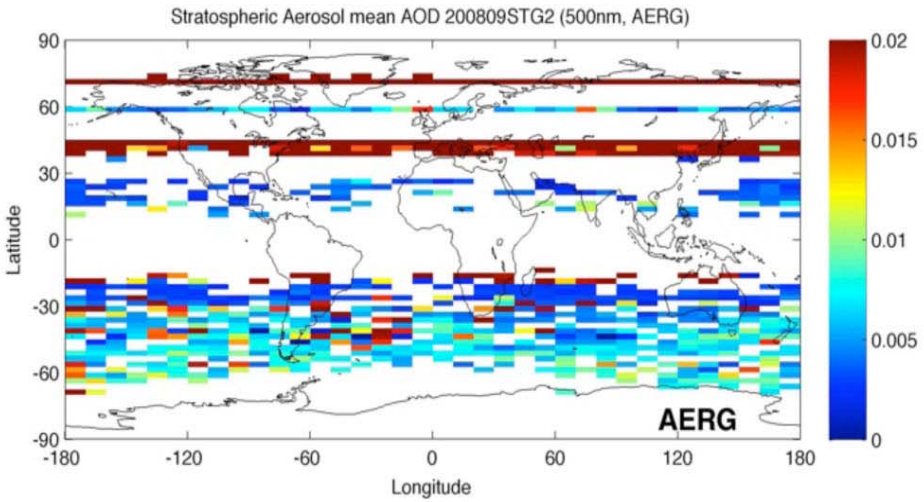
AerGom

Unexpected problem: Anomalous profiles

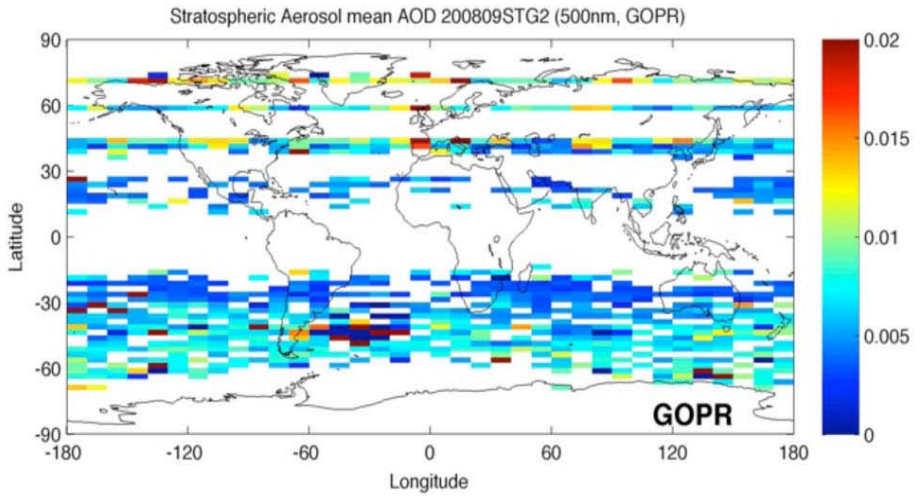
Comparison of the first Aerosol_CCI/AERGOM dataset with Official GOMOS dataset (GOPR)

- Here: Stratospheric AOD at 500 nm, September 2008

AERGOM data



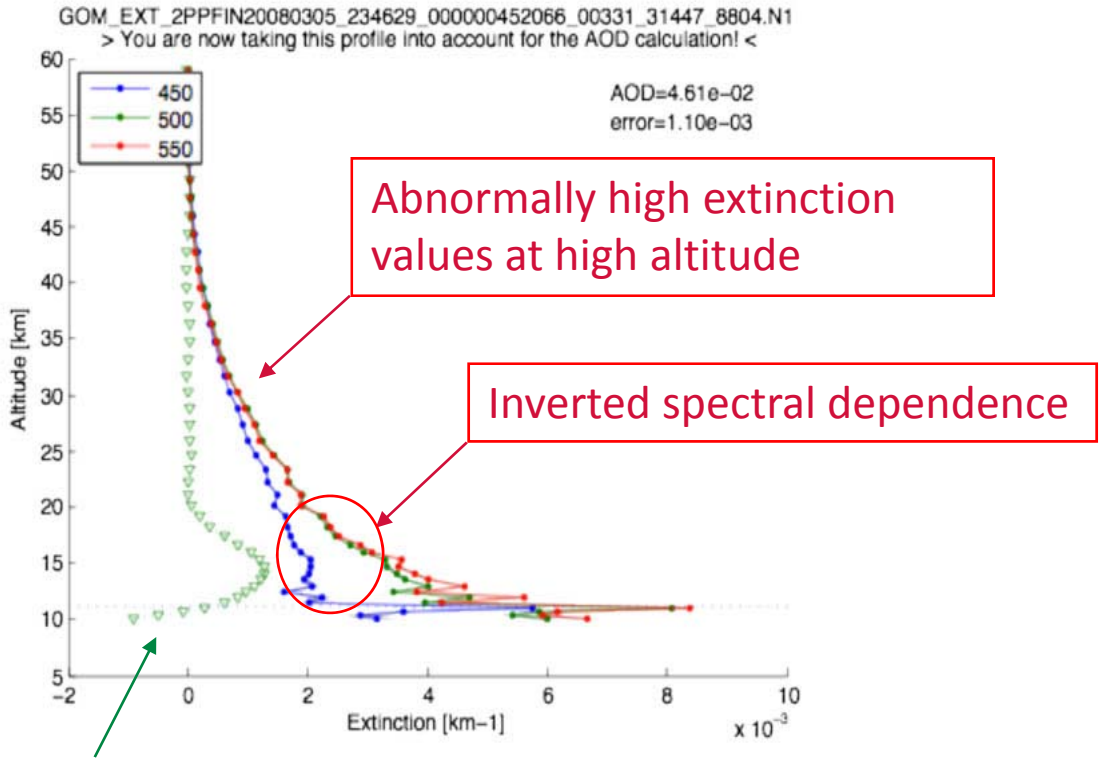
Official GOMOS product



AerGom

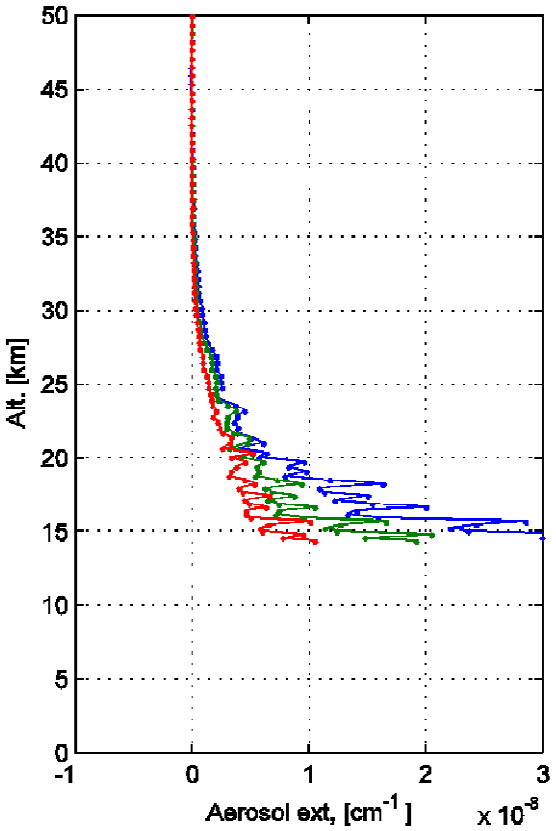
Unexpected problem: Anomalous profiles

IDENTIFICATION OF ANOMALOUS EXTINCTION PROFILES



Light green (triangles) :
Extinction at 500nm, Official product

Expected behaviour



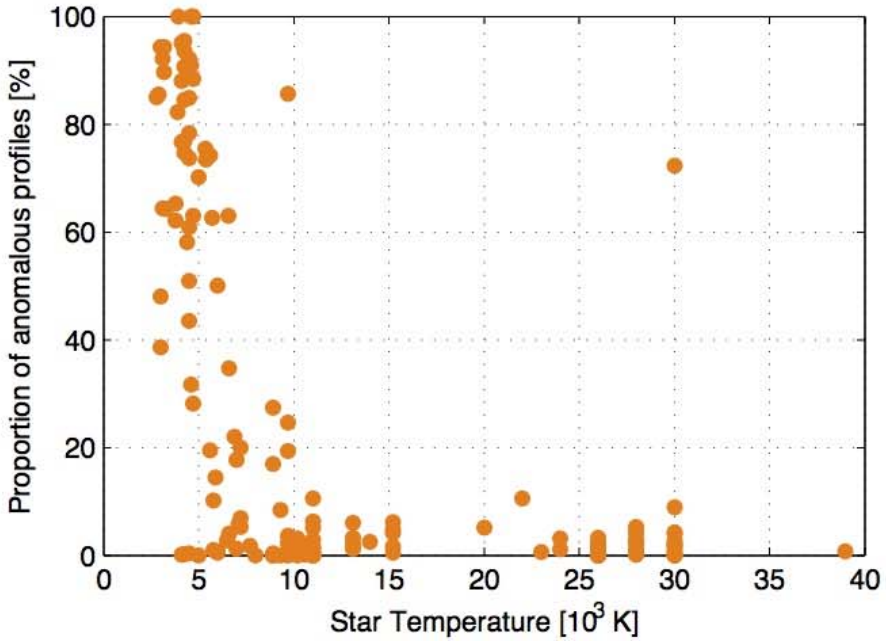
AerGom

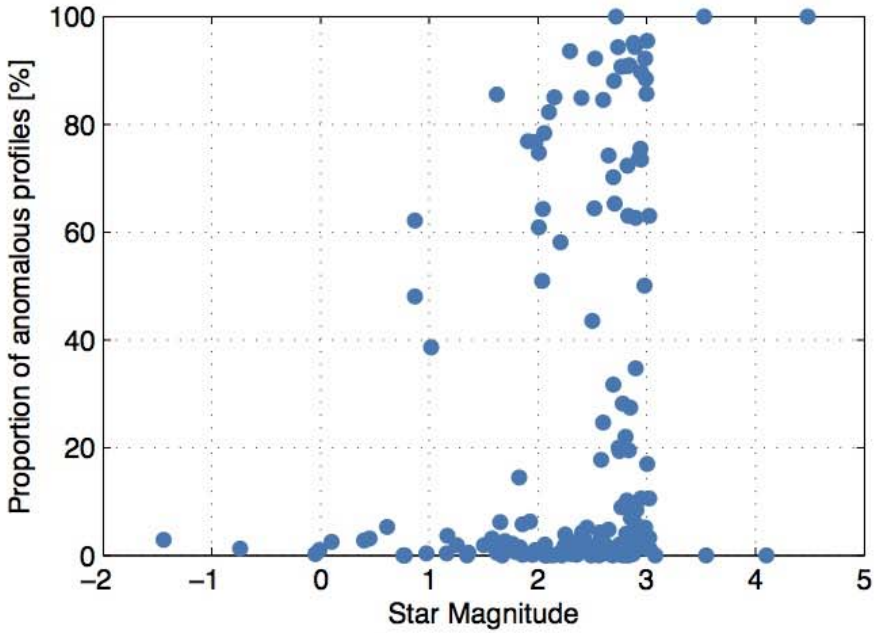
Unexpected problem: Anomalous profiles

Diagnostic

The problem occurs with occultations performed with:

- Cold stars
- Dim stars

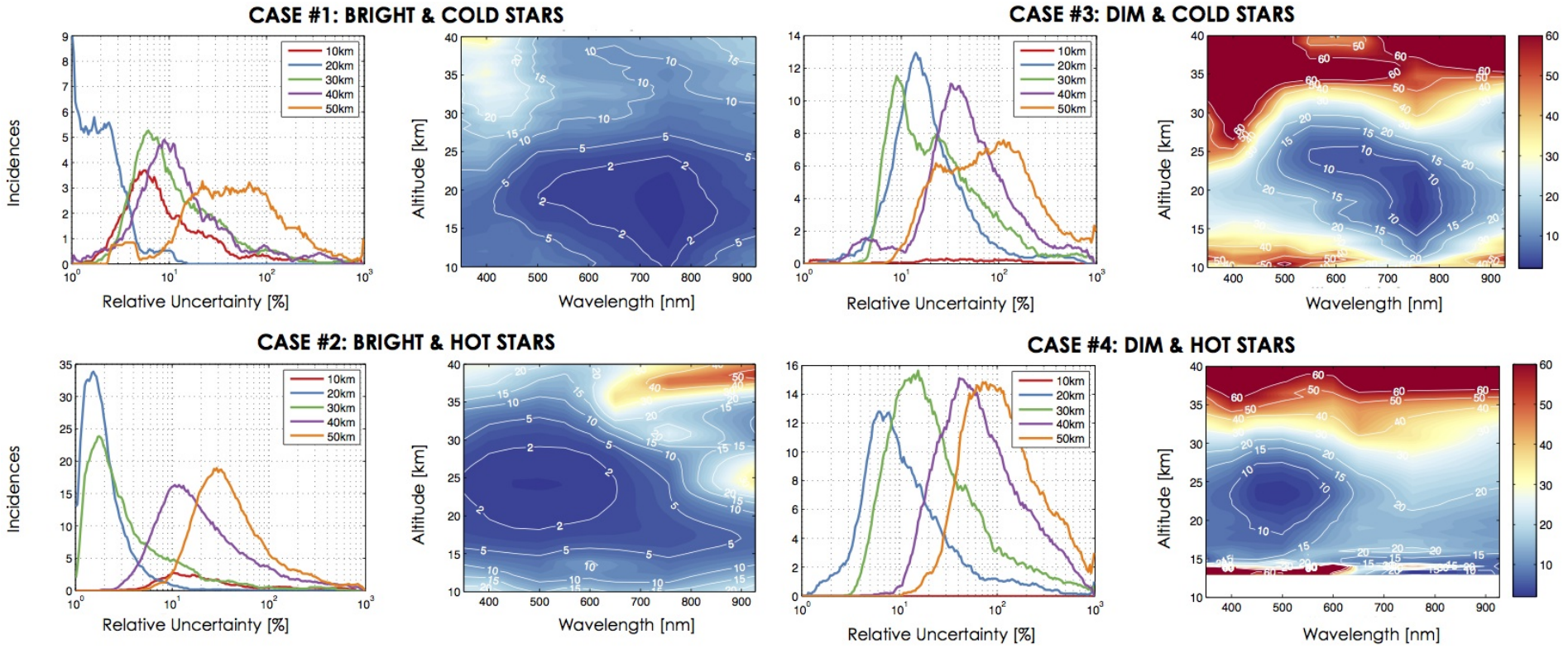




AerGom

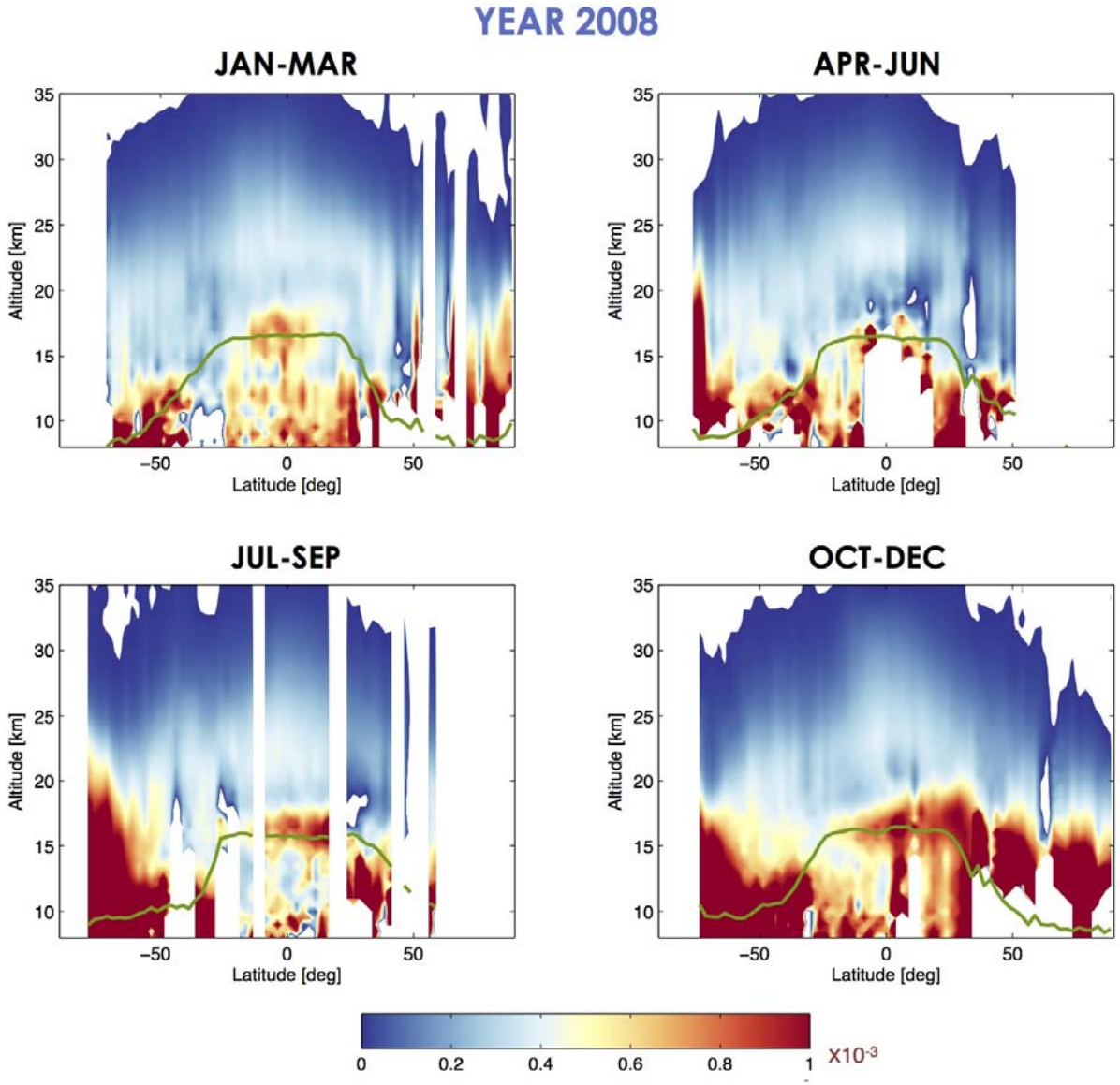
Error characterization

Extinction relative uncertainty for different star properties



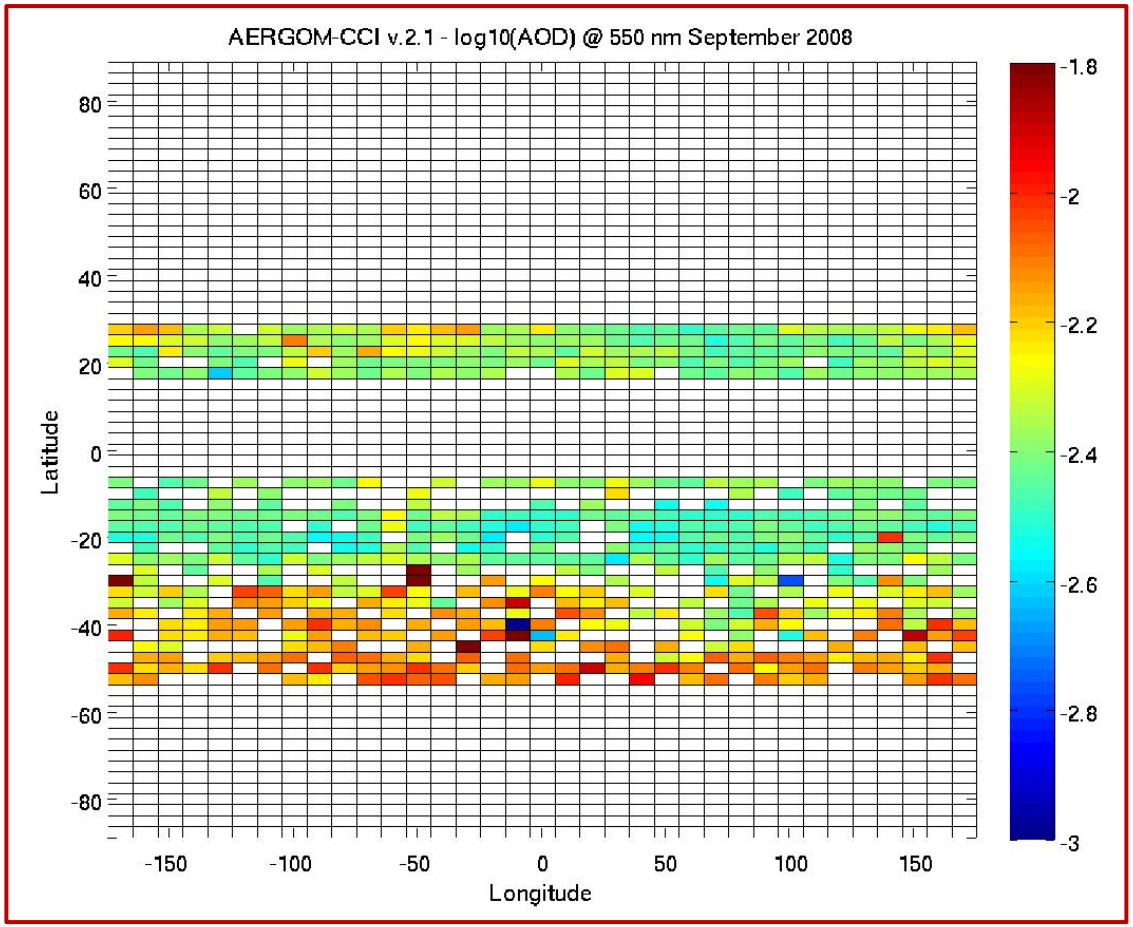
AerGom

Typical results: AOD at 550 nm



AerGom

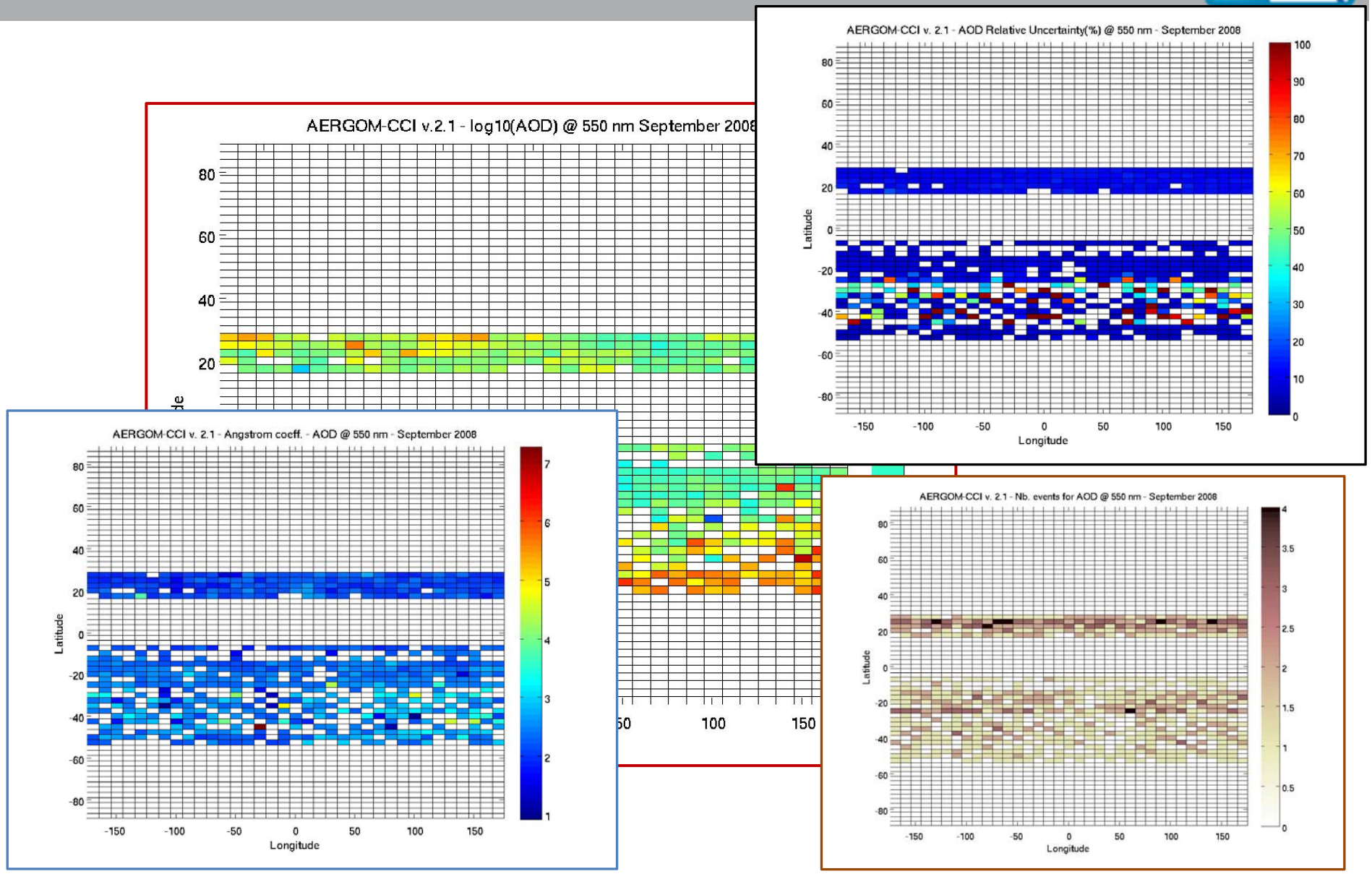
Latest version: Product detail



- AOD product at 550 nm

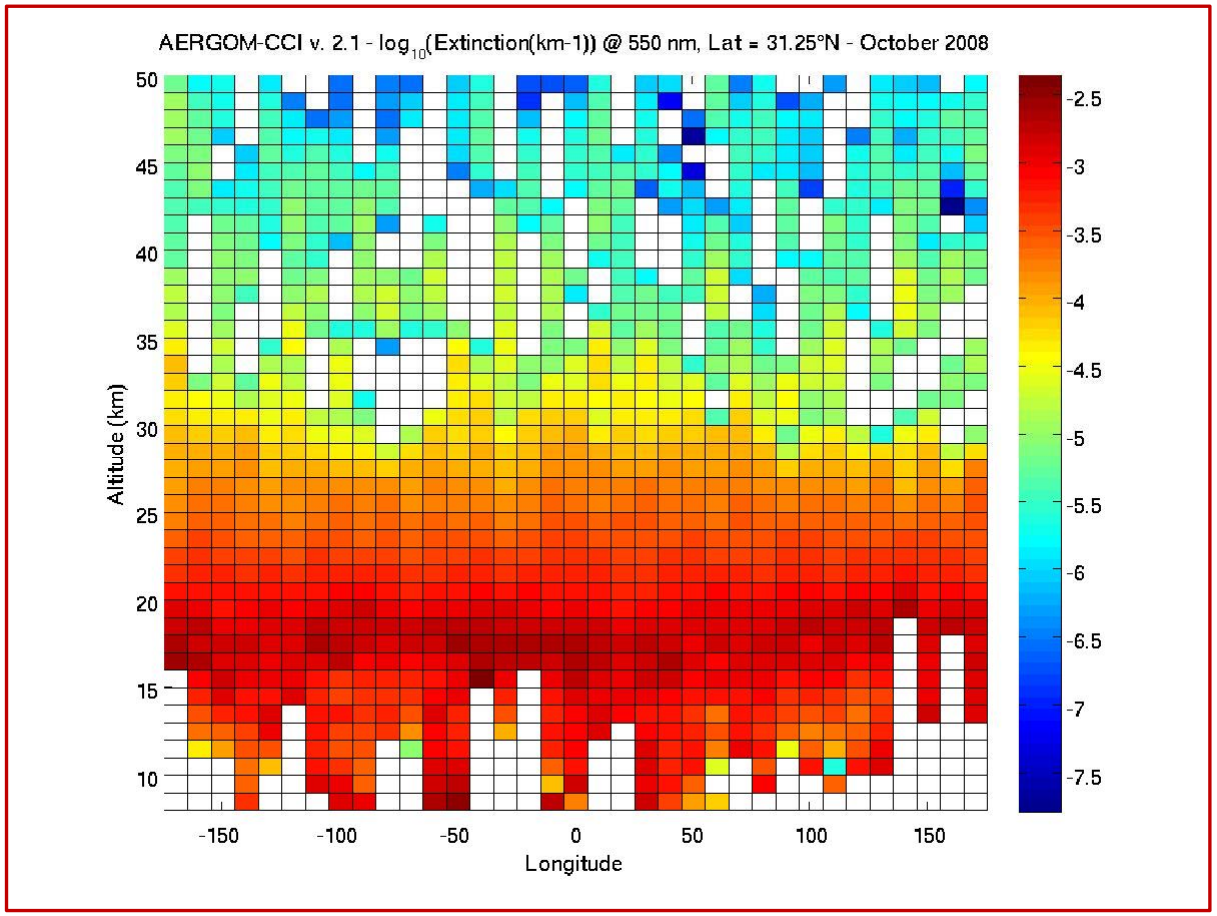
AerGom

Latest version: Product detail



AerGom

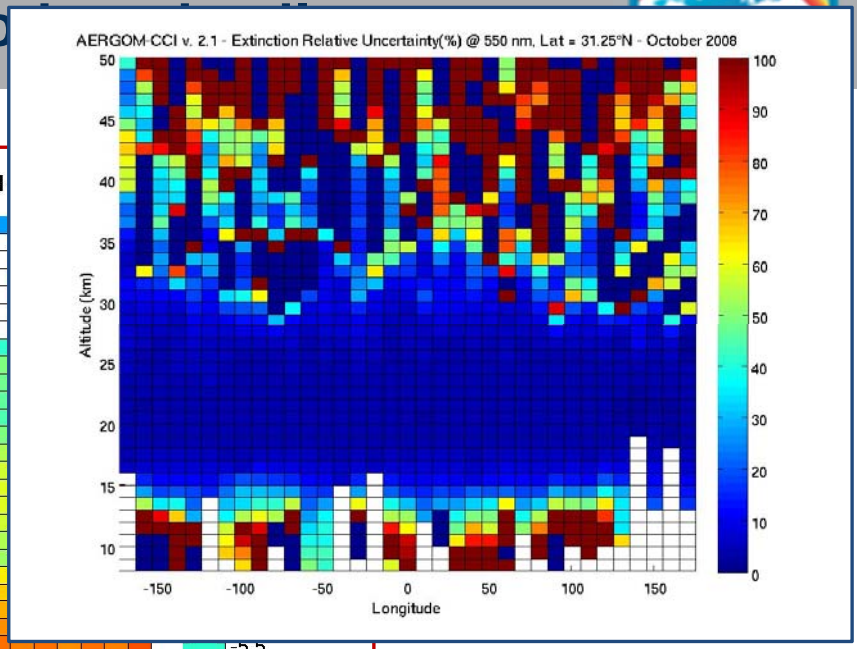
Latest version: Product detail

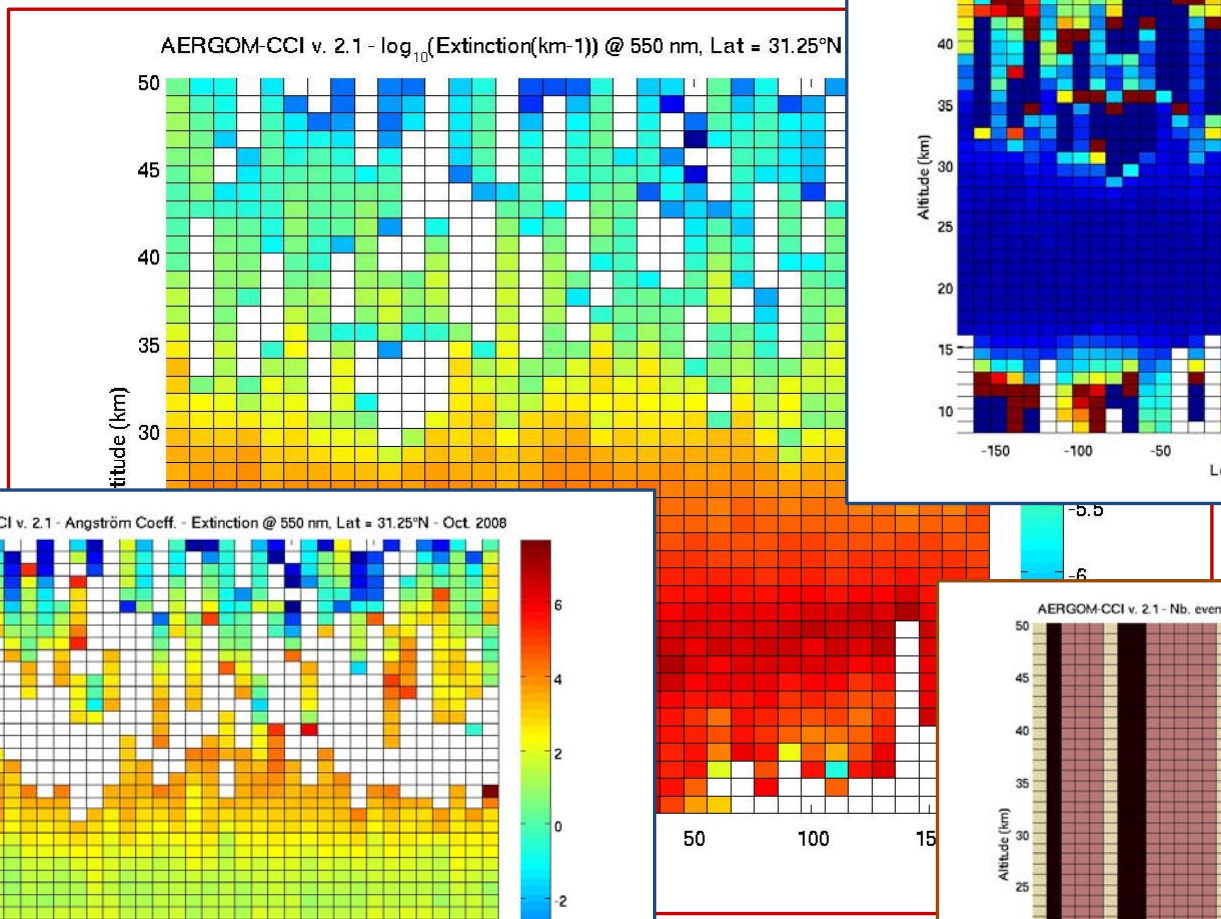


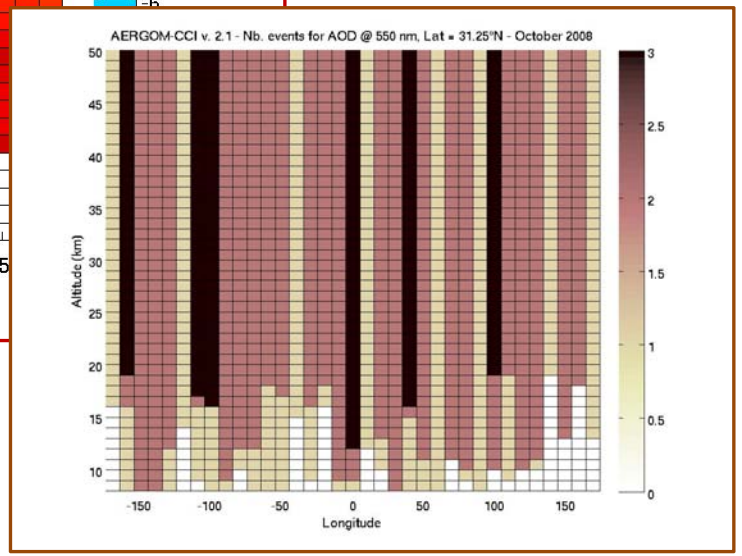
- Extinction product at 550 nm

AerGom

Latest version: Pro

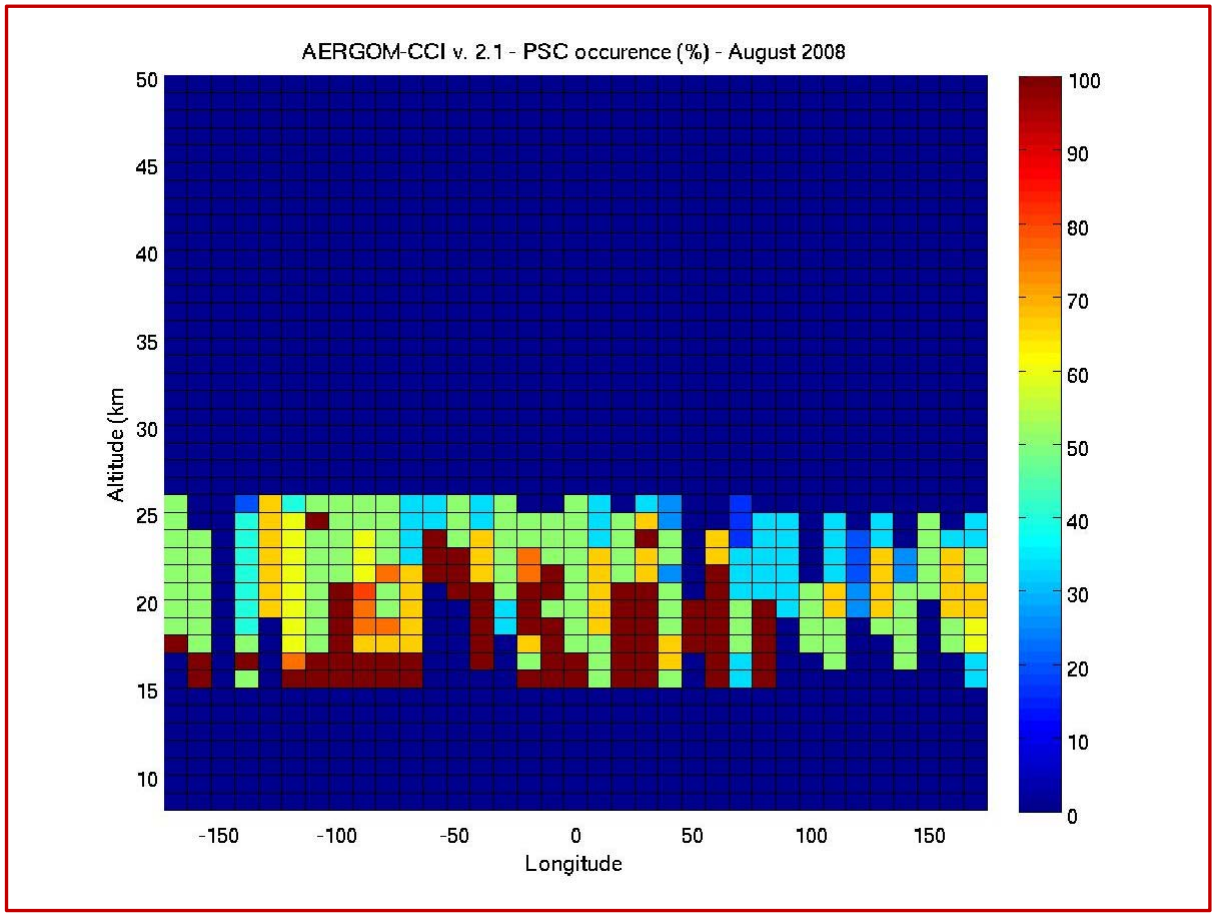






Aerosol_CCI

Option



PSC occurrence

Aerosol_CCI

Data merging

Multi-sensor stratospheric extinction dataset

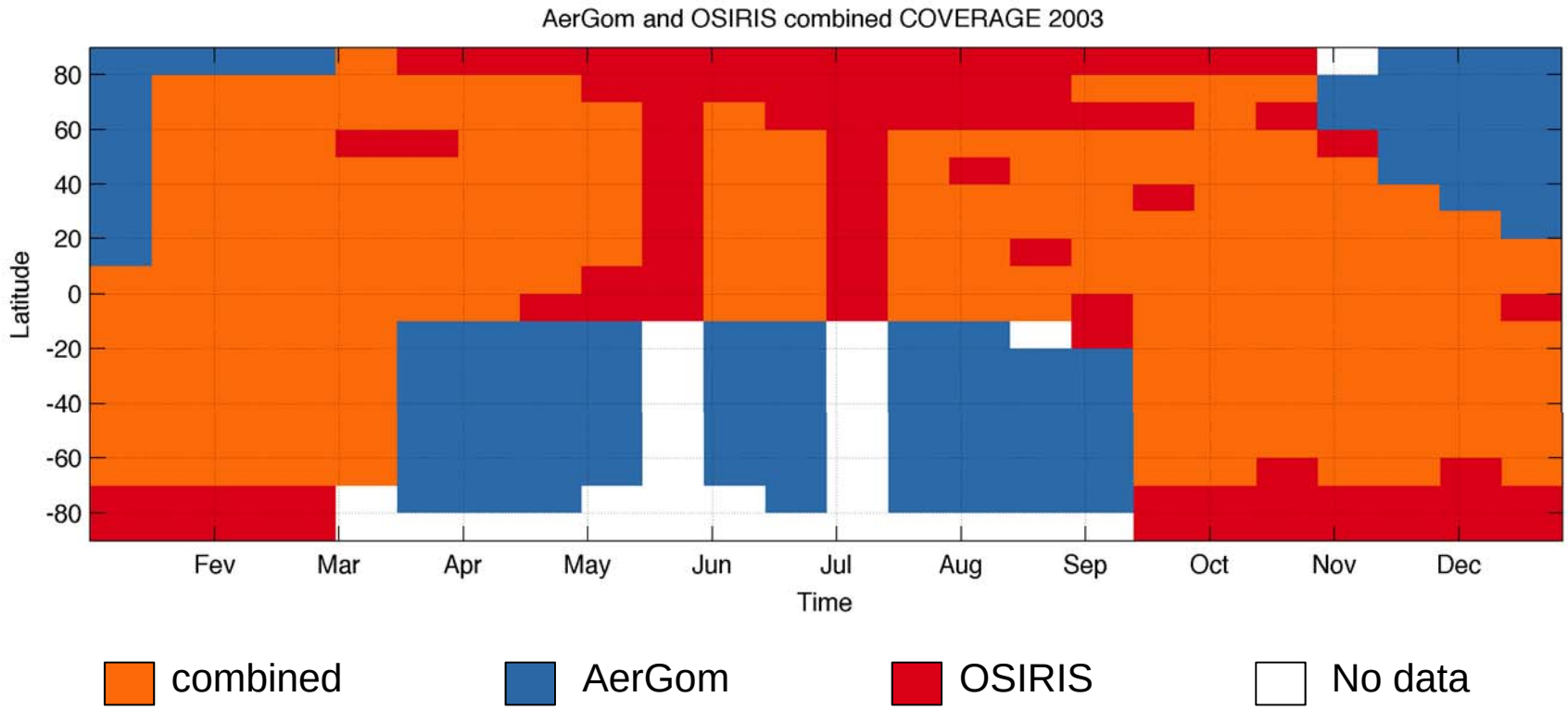
- Use of AerGom and OSIRIS to produce a merged stratospheric extinction dataset
- Methodology:
  - Focus on how to minimize discrepancies (geolocations, measurement times, spectral differences, gap identification)
  - Assessment of both datasets with respect with one another
  - Development of a merging strategy
  - Production of one year dataset (2003)

AerGom/OSIRIS

Combined Coverage

Synergy of OSIRIS and AerGom coverage for 2003

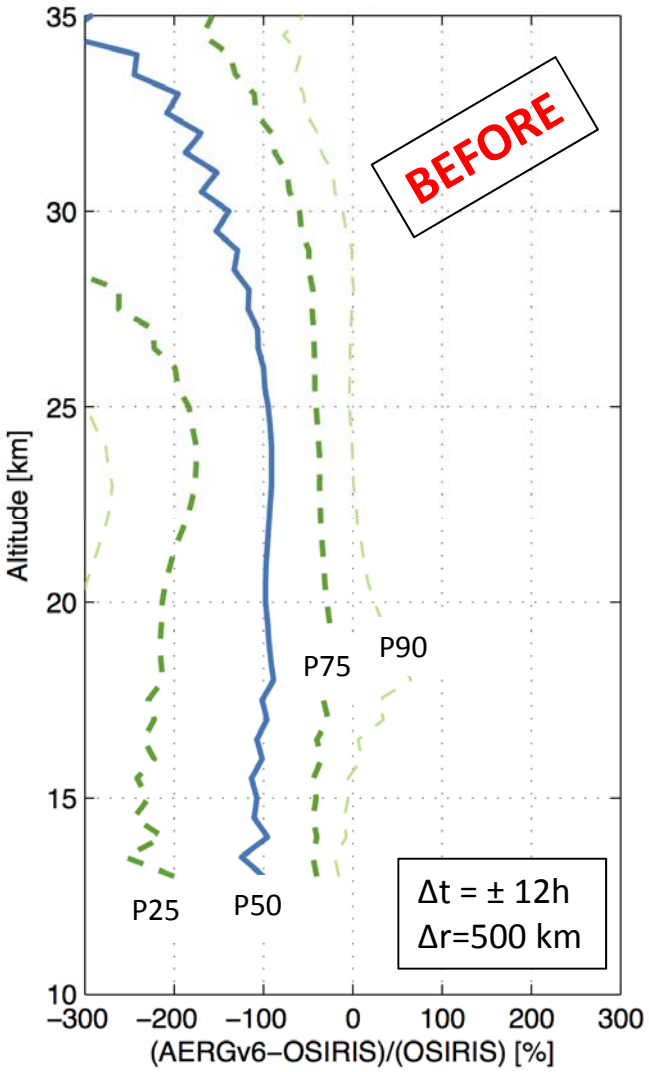
- Binning parameters: Δt=15 days ; Δlat=10 ; Δz=1km



AerGom

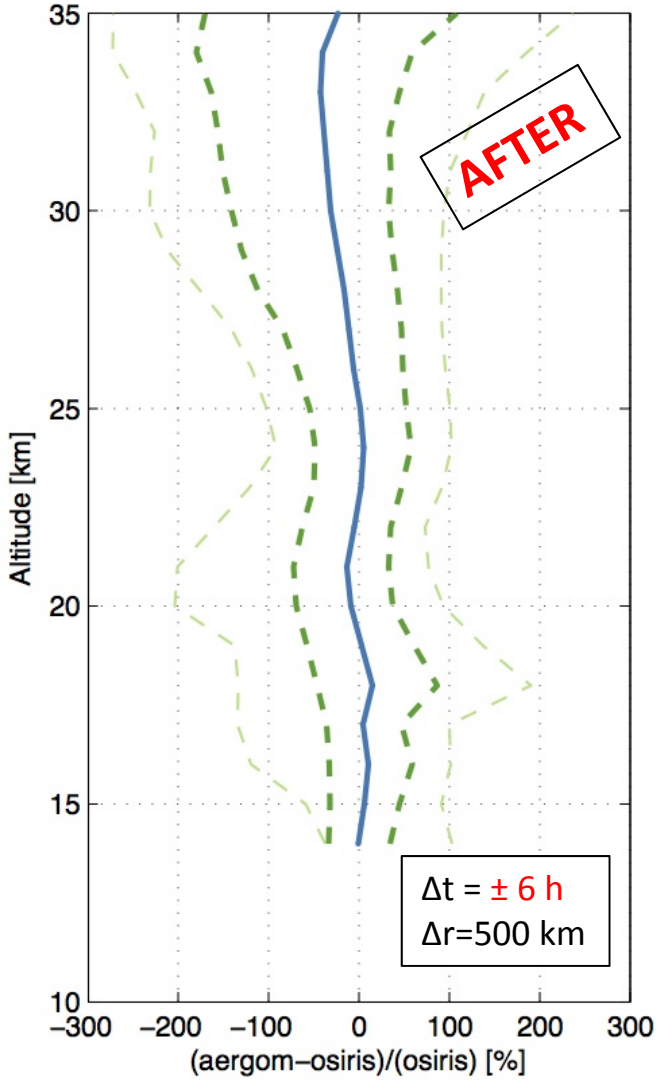
Comparison with OSIRIS

AerGom vs OSIRIS @750nm
(current Aerosol_cci version)



- Improved regularization parameters
- Spectral law

AerGom vs OSIRIS @750nm
(most recent version)



AerGom

Data Merging

Multi-sensor stratospheric extinction dataset

- Challenge: GOMOS results are best for λ∼500 nm while OSIRIS output is only available at 750 nm.

- Current way of working:

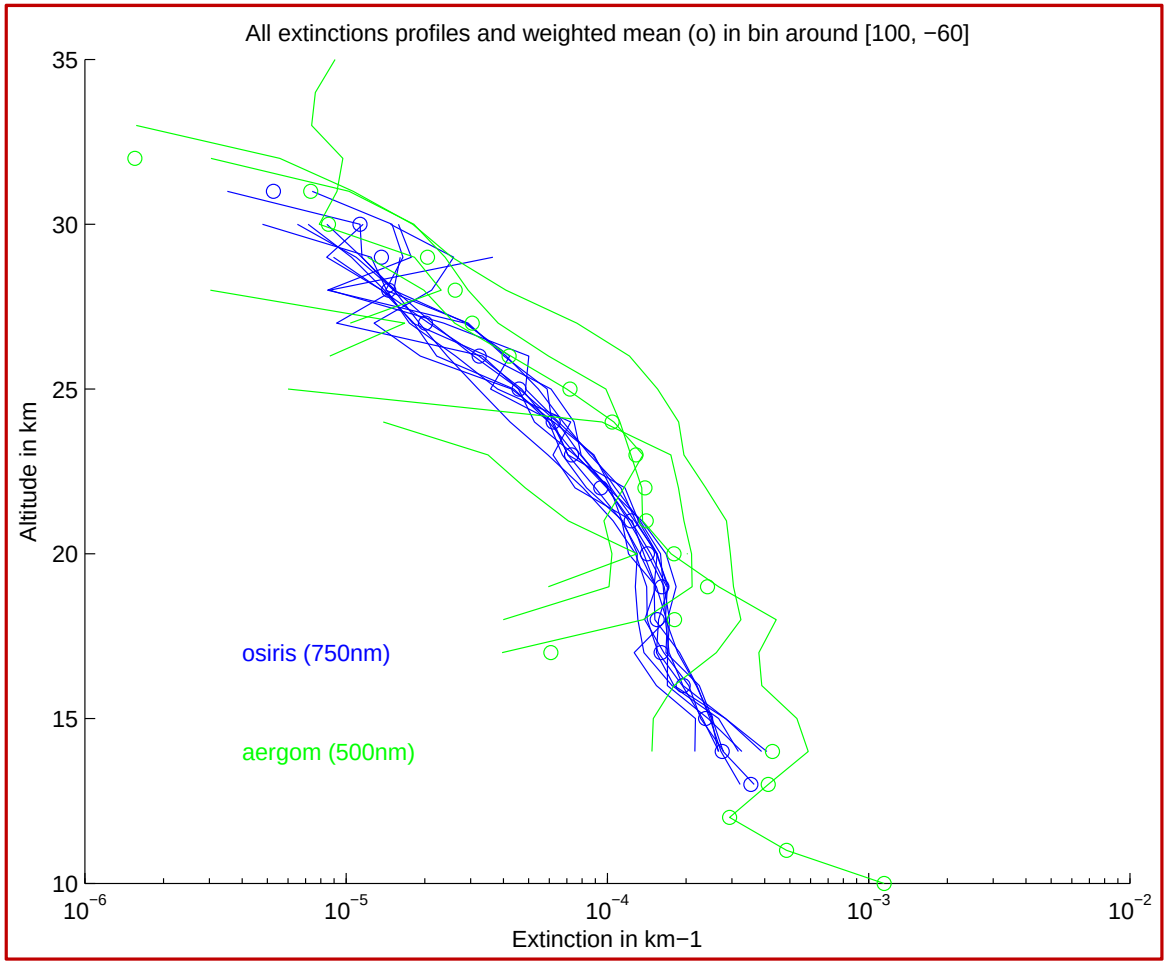
  - Individual binning of both extinction datasets
  - Fit of Mie particles through the combined Aergom-OSIRIS binned dataset
  - Reconstruction of the extinction using the particle size distribution

- **Ongoing work !**

AerGom

Data Merging

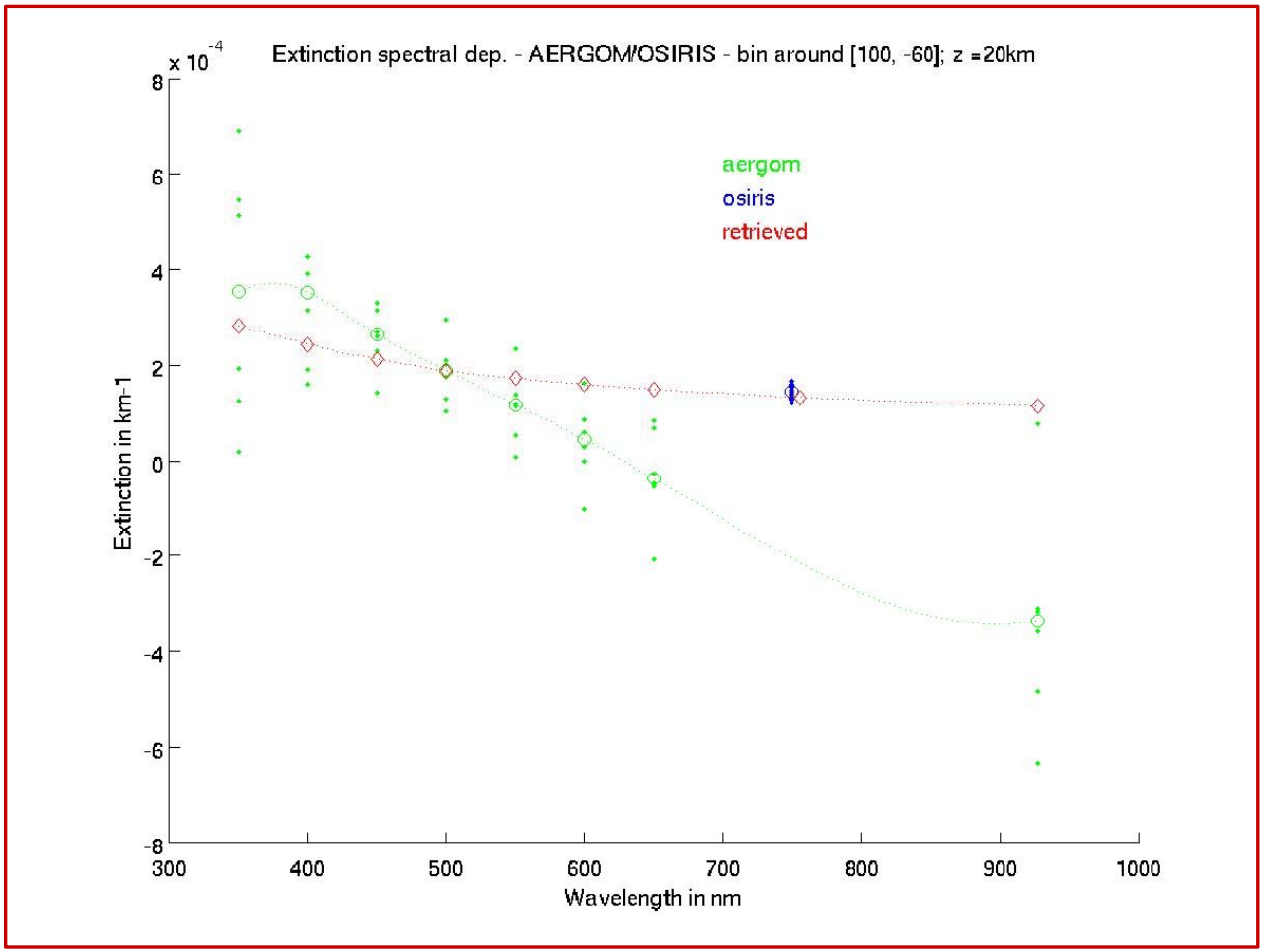
Step 1 : Collection of datasets; individual binning



AerGom

Data Merging

Step 2 : Particle size distribution retrieval and extinction rebuilt



CONCLUSION

- Strong interaction between AerGom and Aerosol_CCI:
  - Opportunity to widely investigate and test the AerGom algorithm
  - Dramatic improvement of AerGom
  - Very good insight into GOMOS' strengths and weaknesses

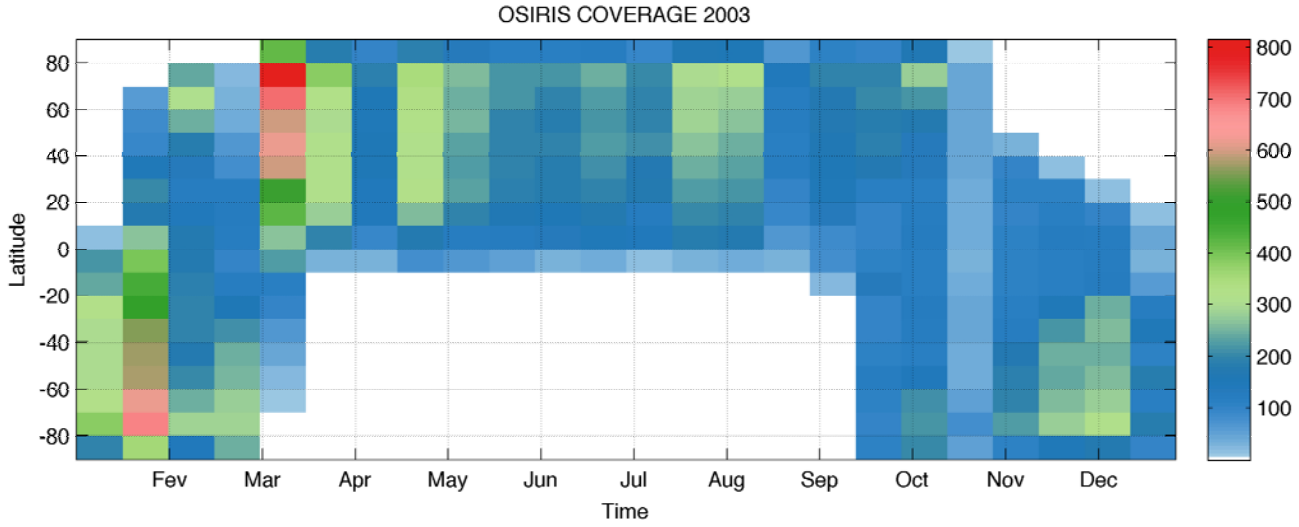
- GOMOS product: need of cautious event selection as a function of star properties

- Production of AOD and extinction records with associated Angstrom coefficient
  - All data provided with uncertainty

- Data merging issues is ongoing work. An important issue:
  - How to deal with bias ? Possible solutions in :
    - Use of multiple wavelengths for OSIRIS
    - Use of another spectral model for Aergom (linear inverse spectral law gives better agreement with OSIRIS)

Additional Material

Coverage


OSIRIS COVERAGE 2003
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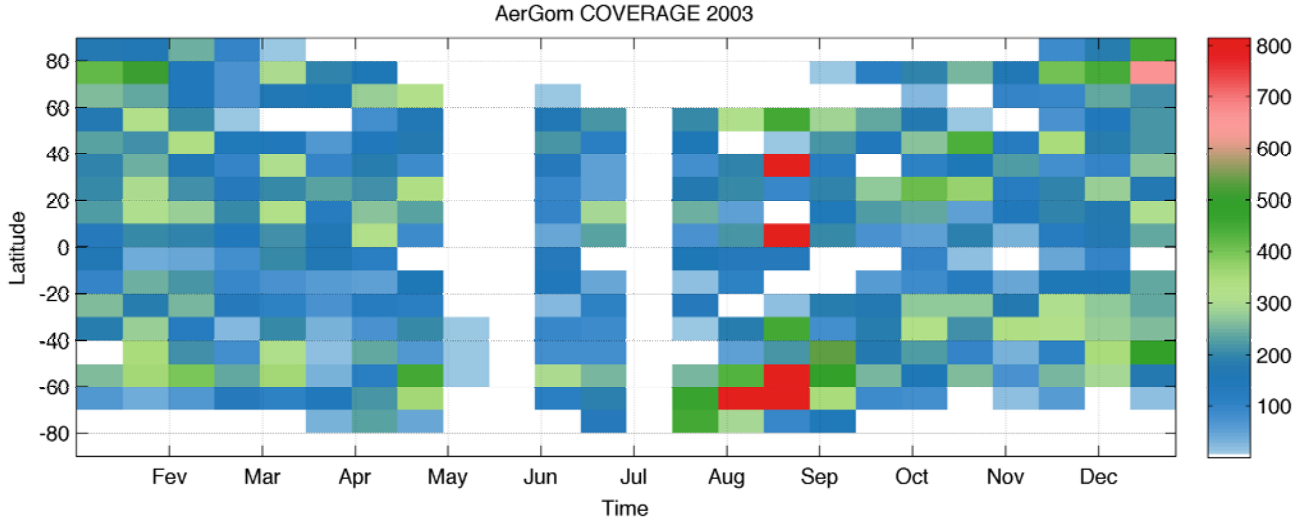
AerGom COVERAGE 2003
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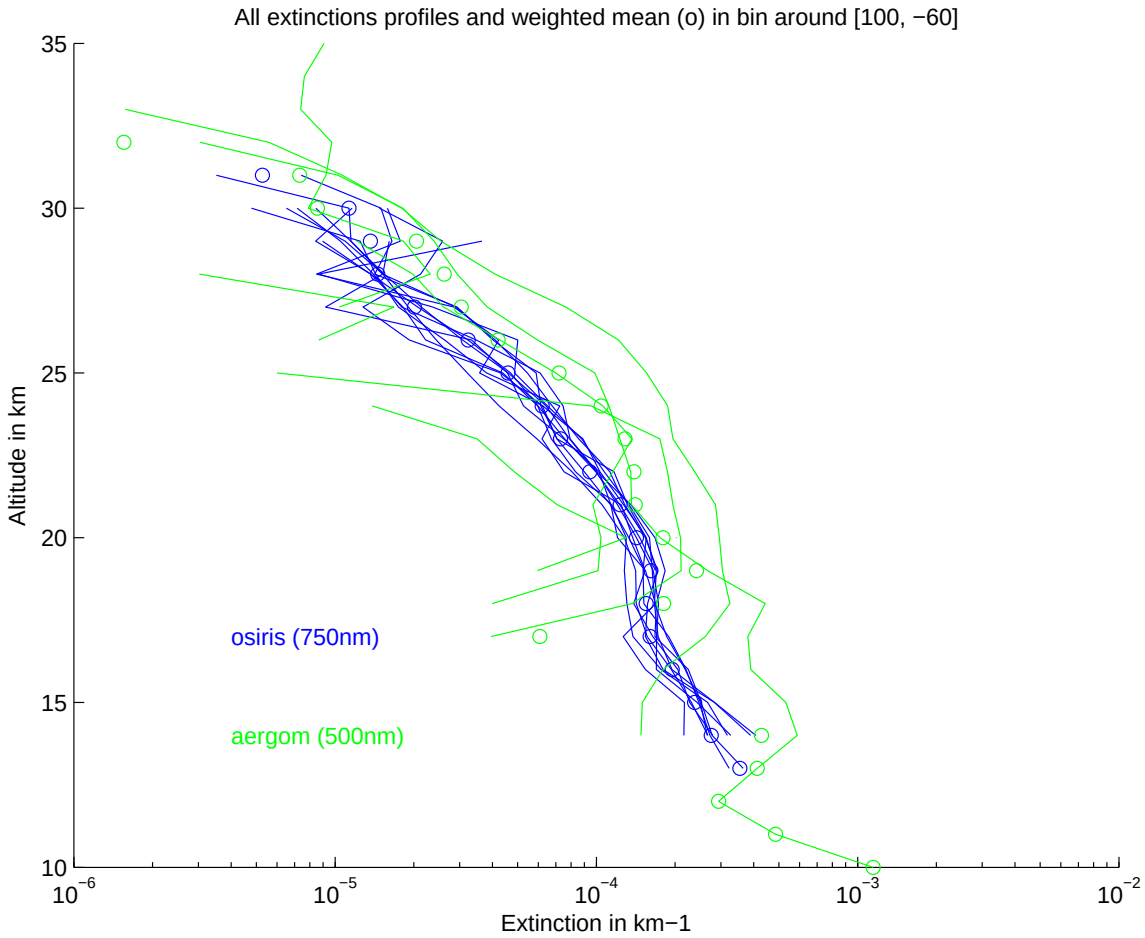
AerGom

Data Merging

Step 1 : Collection of datasets; individual binning



AerGom

Data Merging

Step 2 : Particle size distribution retrieval and extinction rebuilt