aerosol_cci

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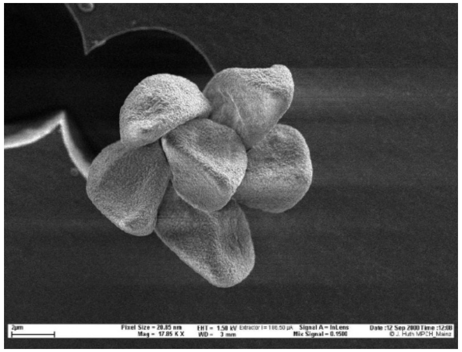
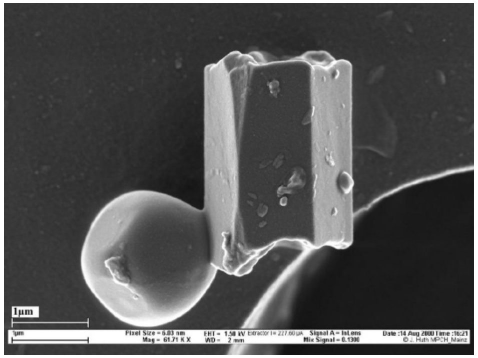
on behalf of

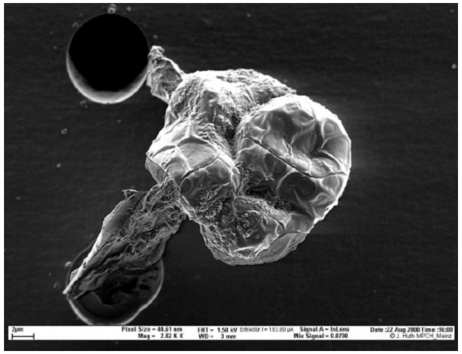
Thomas Holzer-Popp (DLR), **Gerrit de Leeuw** (FMI)

& the aerosol_cci team

aerosols



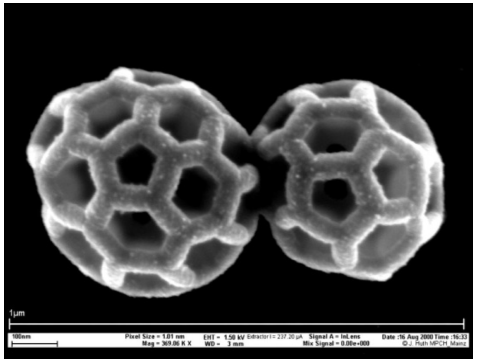


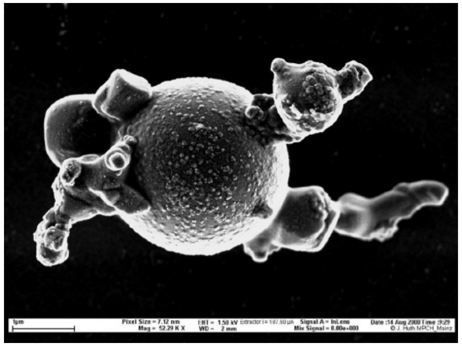


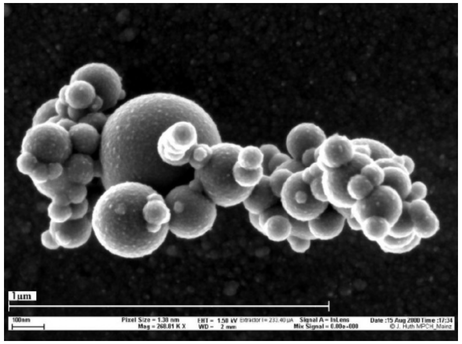
liquid or solid particles

suspended in the

atmosphere







aerosols

Micro-physical aerosol properties

spectral complex refractive index

size distribution

particle shape, mixing state

Optical aerosol properties

extinction coefficient

absorption coefficient

phase function (matrix)

<u>as function of wavelength, location, season, height</u>

multi-spectral Aerosol Optical Depth AOD (λ)

derived: Angstrom coefficient, fine/coarse mode fraction, type,

effective radius, non-sperical fraction, …

sources



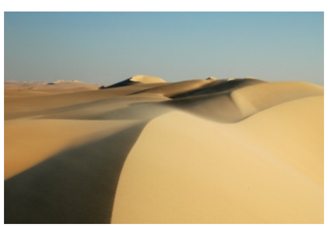


many different sources for atmospheric aerosol


five main aerosol classes:
water soluble, soot, mineral dust, sea salt, biogenic

external and internal mixing of aerosol species

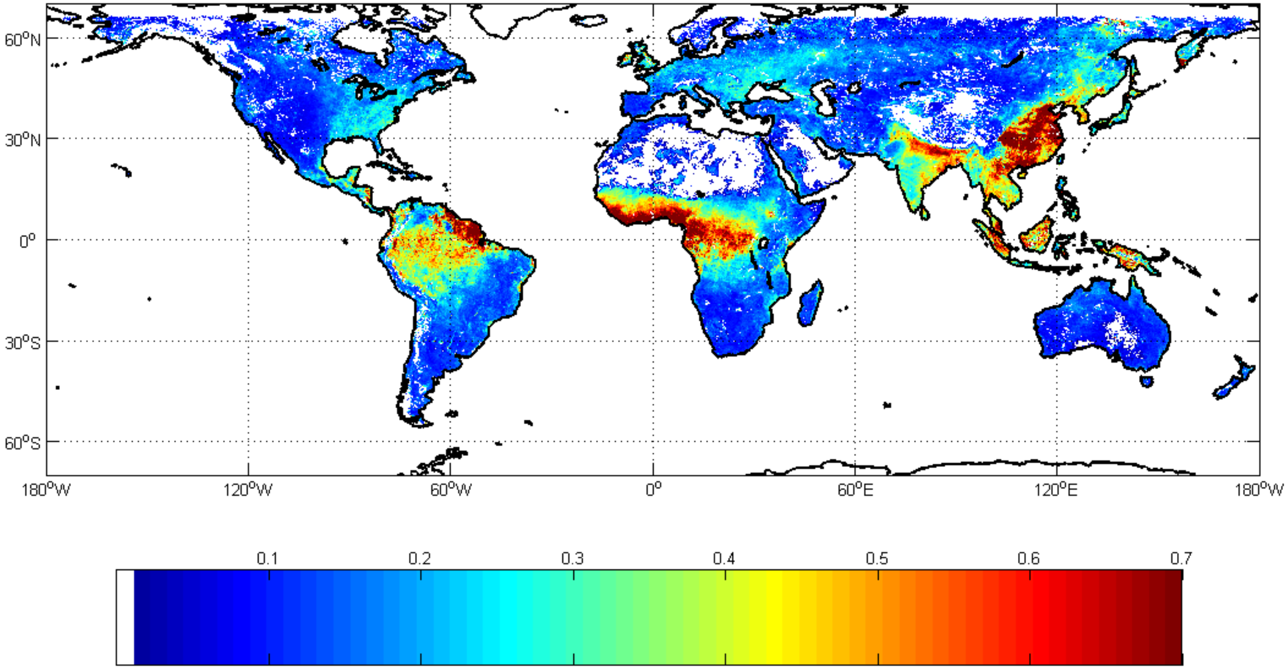
vertically seperated aerosol layers (e.g. dust and soot)





sources

AOD at 550 nm / AATSR (FMI-ADV) 2008

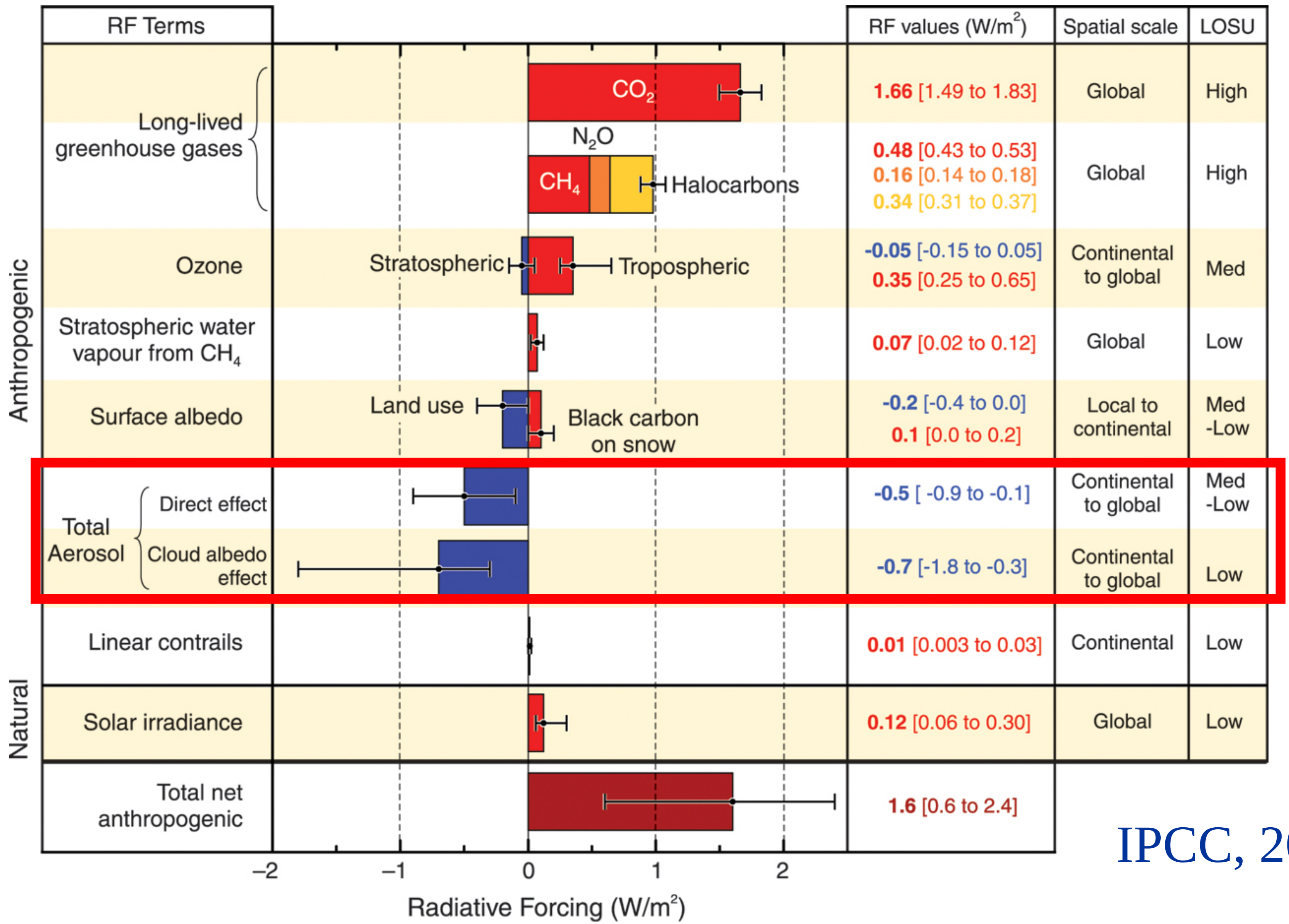


High spatial and temporal variability

Large variety with aerosol types

esa

climate relevance



IPCC, 2007

GCOS requirements

- Aerosol optical depth

	goal	threshold
• accuracy	0.01	0.02
• stability	0.005 / decade	N/A
• resolution	1 km / daily	10 km / weekly

- Other aerosol properties
  - to supplement AOD
  - e.g. single scattering albedo

• accuracy	0.02
• stability	0.015 / decade

- Comprehensive ground-based independent validation

-> can not be met (per pixel) by any satellite product

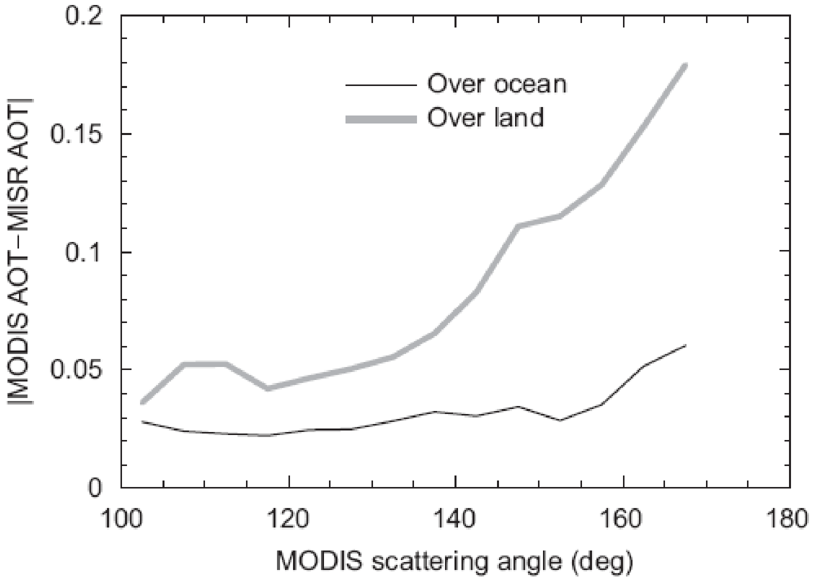
state of the art: AOD (1)

- products between different sensors / algorithms
  - agree qualitatively
  - but differ quantitatively
    (e.g. Myhre, et al., ACP, 2005 / Mishchenko, JQSRT, 2009)

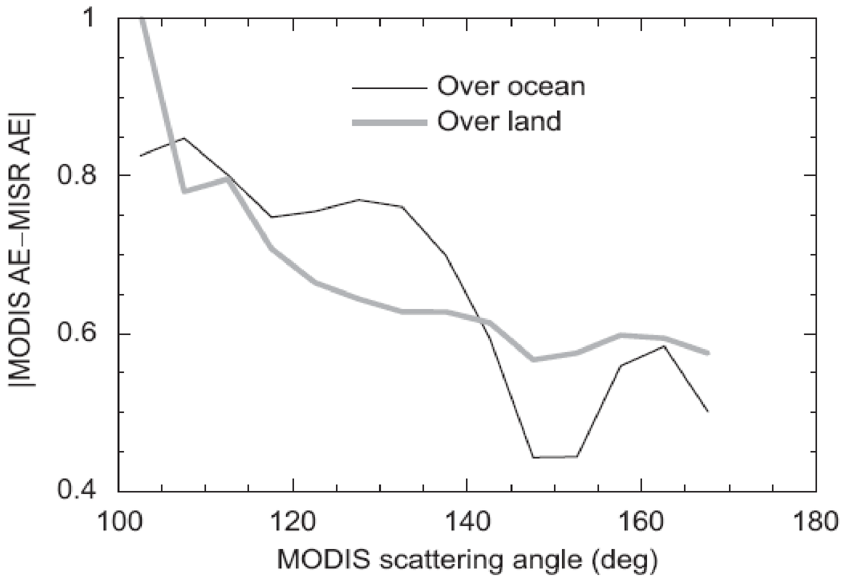
- underlying reasons
  - ill-posed retrieval problem
  - different information content (spectral, angular, polarization)
  - different assumptions
  - different sampling

state of the art: AOD (1)

AOT difference

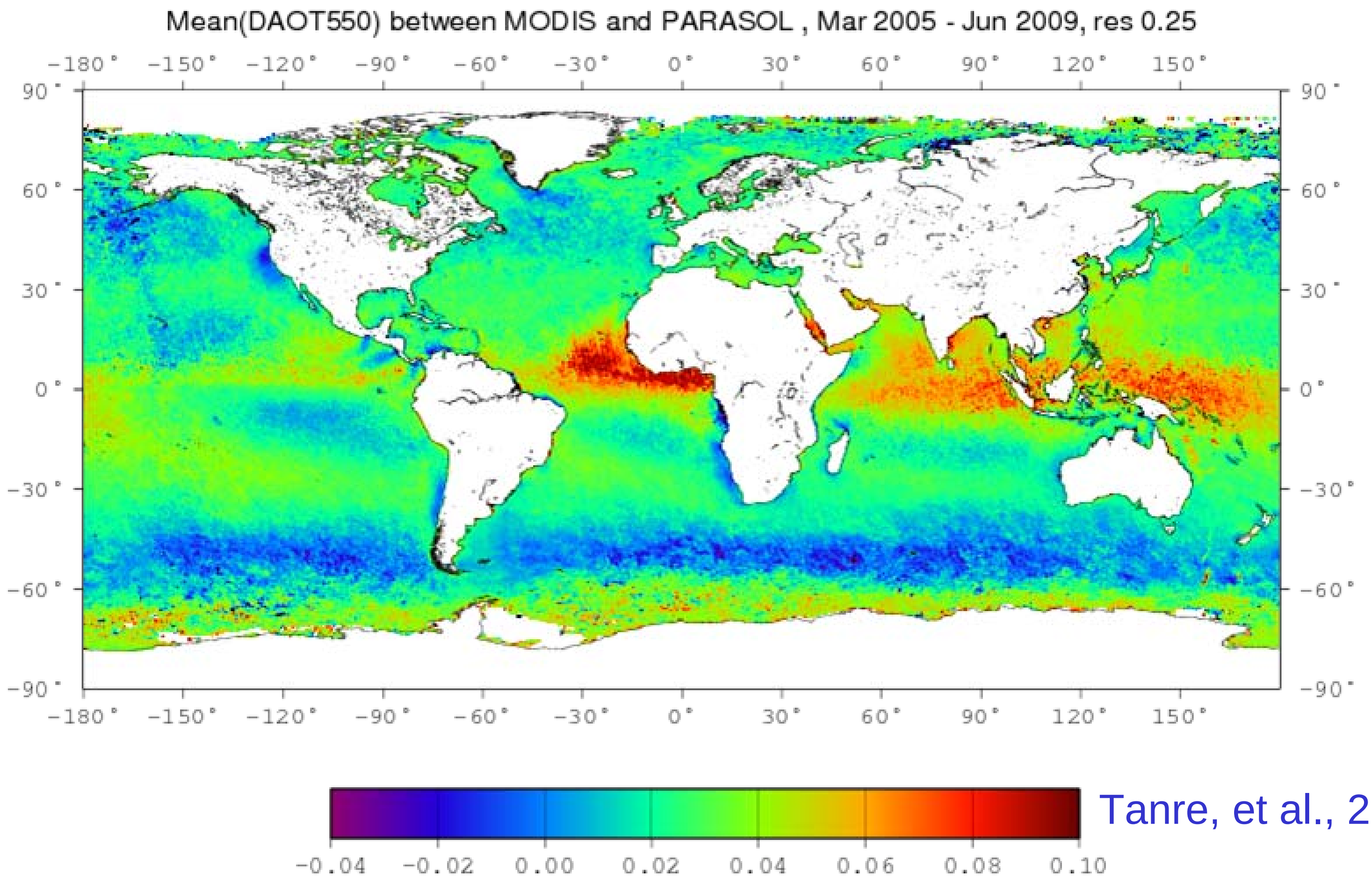


Angstrom exponent difference



Mishchenko et al, JQSRT, 2009: individual pixels, July 2007,
2 dedicated aerosol sensors: MODIS-MISR

state of the art: AOD (1)



Tanre, et al., 2010

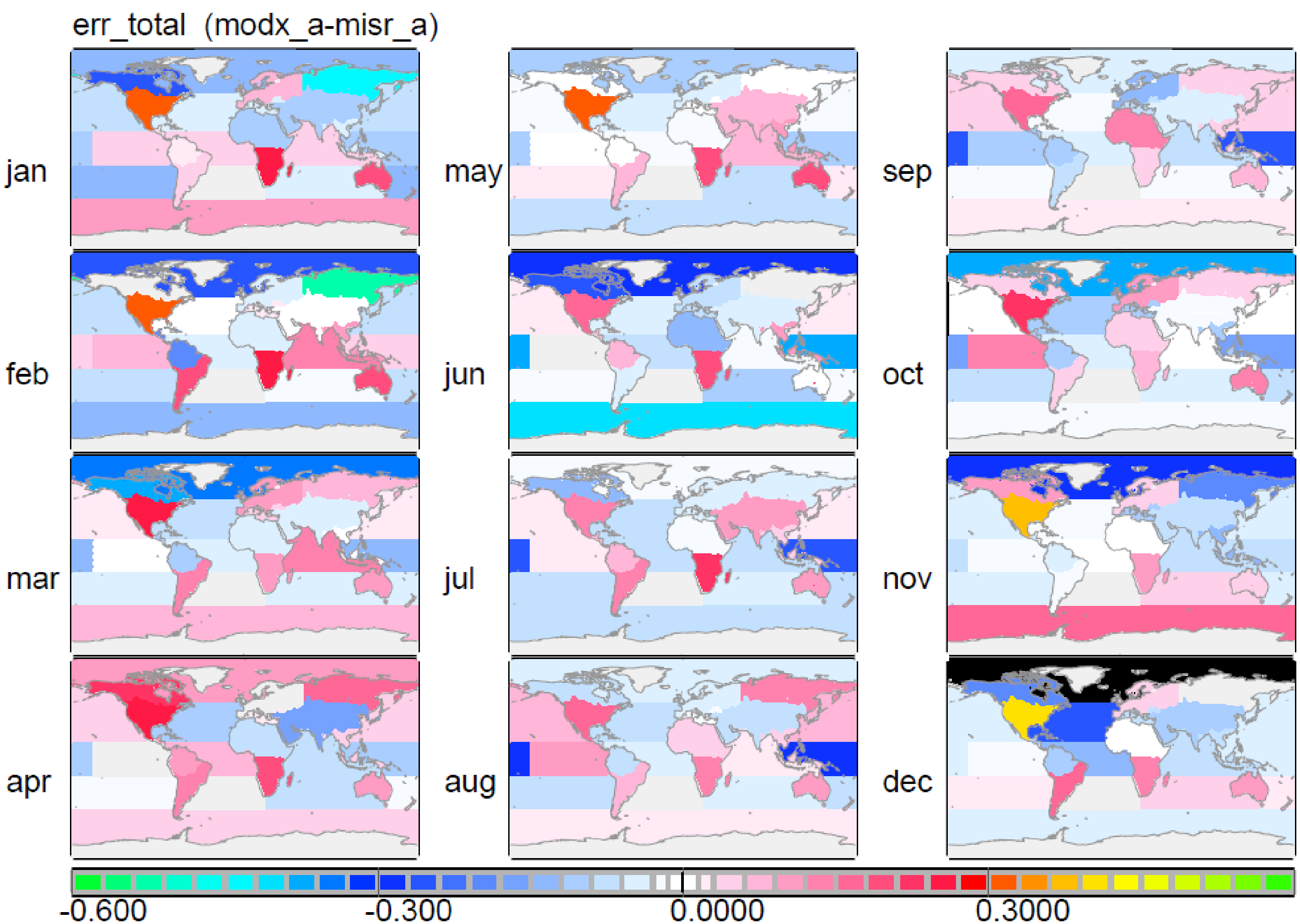
state of the art: AOD (2)

- AEROCOM shows that no single retrieval is best everywhere

- overall accuracy differs for each product, seasan, region, aerosol regime, …
  - over land at best ±0.05 ±15% (67% of pixels within)
  - over ocean at best ±0.03 ± 5% (67% of pixels within)

- validation is complicated / method used needs thorough documentation
  - absolute <-> relative
  - many low AOD values
  - importance of outliers
  - spatial / temporal matching windows

state of the art: AOD (2)



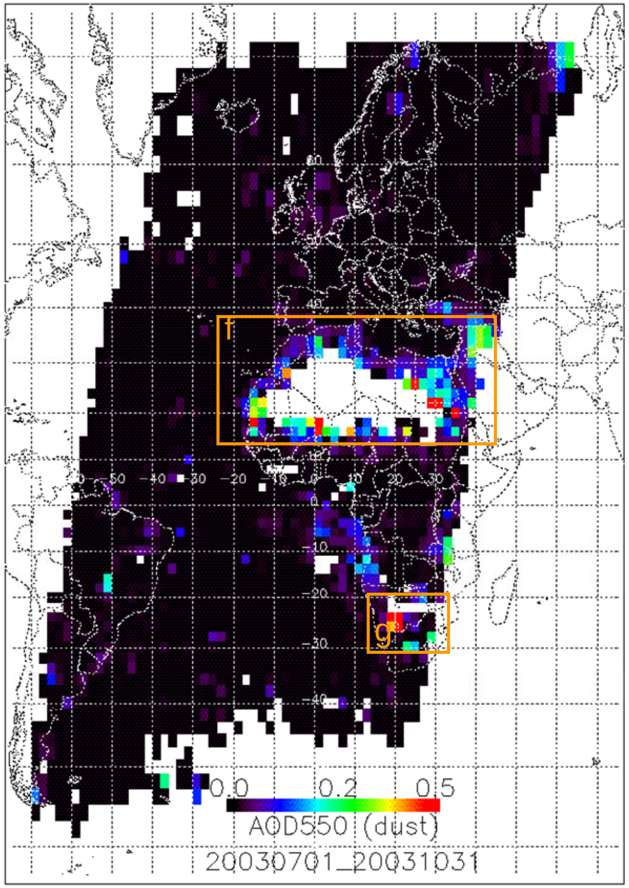
AEROCOM analysis

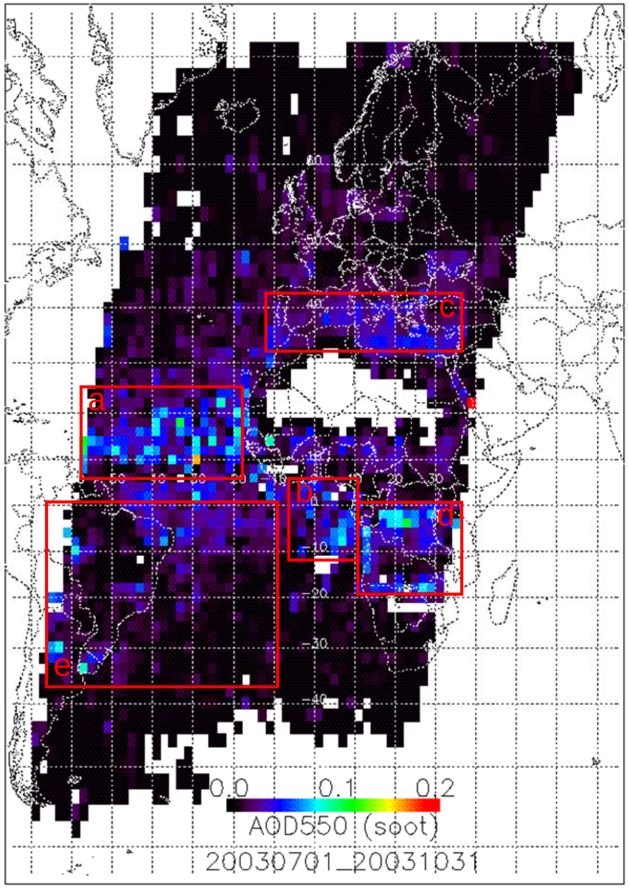
state of the art: other

- pathfinder products, case studies
  - Angstrom coefficient
  - fine / coarse AOD fraction
  - absorption AOD / absorbing aerosol index
  - aerosol type / composition
  - fraction of spherical particles
  - infrared dust products
  - vertical extent for plumes / aerosol layer height

- validation is very complicated / method used needs thorough documentation
  - sparcity of correlative data
  - ground-based in situ data need vertical profile for closure

state of the art: other





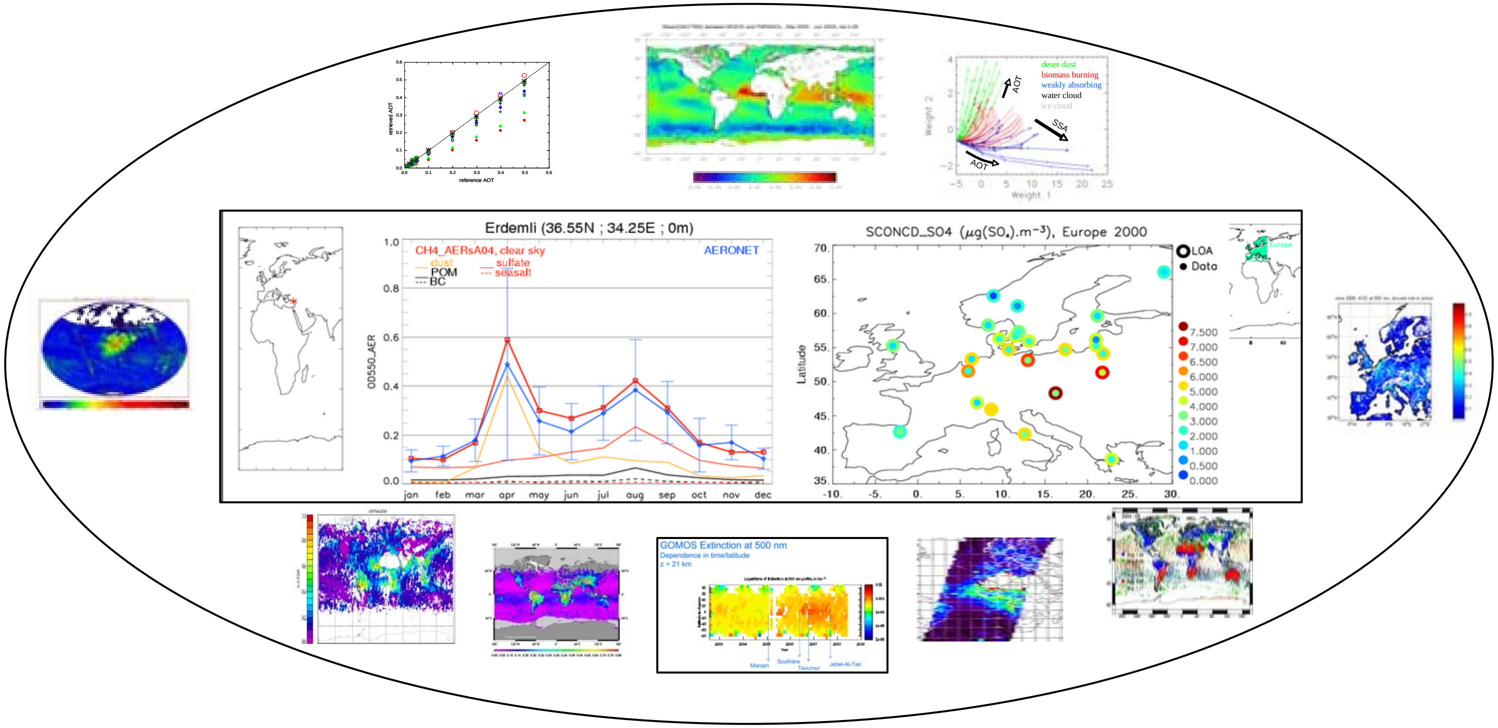
dust 7-10/2003 soot

Holzer-Popp, et al., ACP, 2008

aerosol_cci concept

understand differences
of various products

integrate major
European EO teams



work with AEROCOM
user community

focus on ENVISAT
and European sensors

aerosol scientific issues

- joint definition of **micro-physical / optical aerosol types**
  -> consistent inter-comparisons between different algorithms / use for all prototype ECVs

- **cloud masking** comparison and optimization between 4 ATSR and AVHRR/3 algorithms
  -> reference for sensors with lower resolution or smaller spectral coverage

- inter-comparison of different approaches for **treatment of surface reflectance and BRDF**
  -> optimal / combined solutions identified for ATSR, MERIS, POLDER instruments

- inter-comparison of **auxiliary data** used by the different retrievals
  -> harmonized datasets (elevation, land cover, ocean reflectance, BRDF, humidity, …)

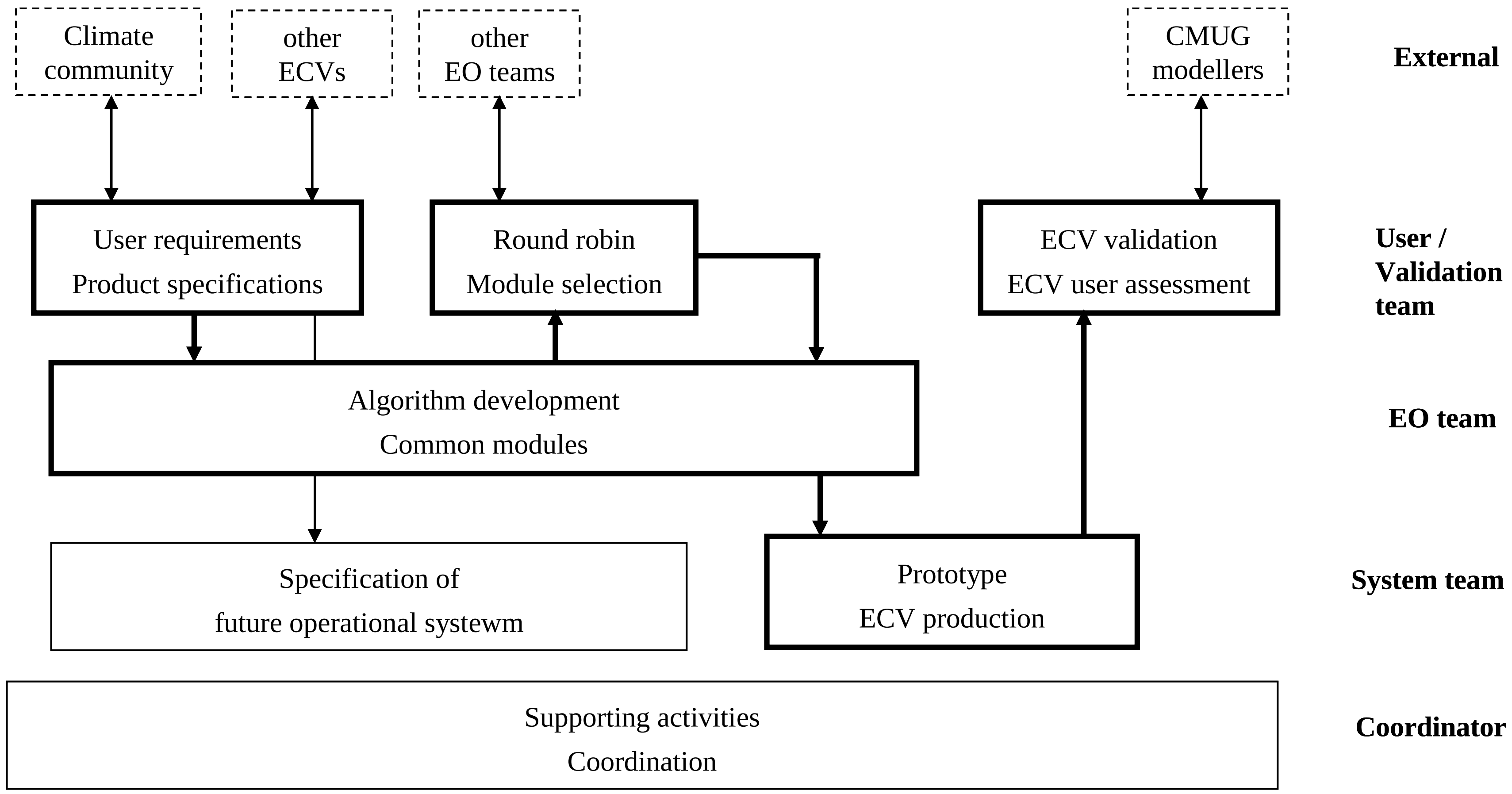
- investigate **merging of datasets and pixel selection** / outlier screening
  -> proper error weighting for merging different AOD from complementary sensors

- **improve stratospheric limb products** (longitudinal dependance)
  -> correction of nadir products for volcanic cases

aerosol_cci objectives

- Identify / understand differences, strengths, weaknesses of existing algorithms
- Consolidate / improve existing algorithms
- Define / implement elements for „community algorithms“
- Develop initial combined / synergetic products
- Provide quantitative error information (validation, pixel-wise)
- Produce initial improved aerosol ECV datasets (1 year global)

work breakdown



products (1)

Tropospheric level 2 products (10 km horizontal resolution)

multi-spectral aerosol optical depth and aerosol type probability

(**AATSR/ATSR-2, MERIS, PARASOL)**

Tropospheric level 2 products (50 km horizontal resolution)

synergetic multi-spectral aerosol optical depth and aerosol type probability

(**SCIAMACHY + AATSR, GOME-2 + AVHRR/3, GOME + ATSR-2**)

UV absorbing aerosol index with averaging kernels

(**OMI, SCIAMACHY, GOME**)

Stratospheric level 3 product (2.5° gridded)

extinction profile **GOMOS (SCIAMACHY)**

Tropospheric level 3 products

merged multi-spectral aerosol optical depth and aerosol type product(s)

global “climatology” (for the reference year) of aerosol type probability

products (2)

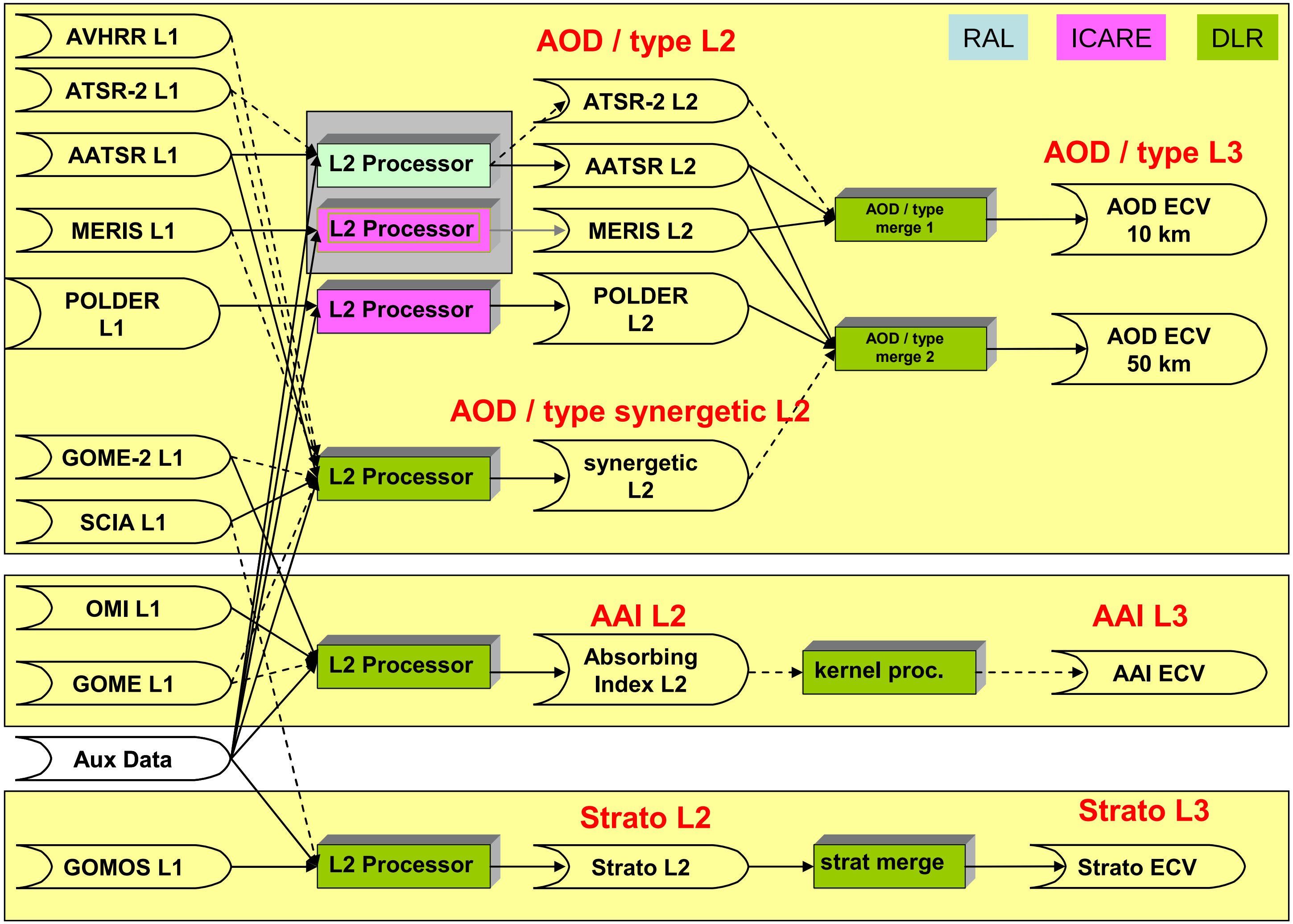
- **Datasets to be produced and validated**
  - reference: 2008 (current sensors)
  - additional: 1997 (ATSR, GOME, POLDER-1)
  - optional: 2003, 2006, 2011

- **Validation**
  - statistical inter-comparison to AERONET, AEROCOM, WMO-GAW in situ + lidar
  - pixel-wise error weighting

- **ECV product specification**
  - iterative with AEROCOM and CMUG users
  - priorities depend on user requirements:
  - synergetic, merged, aerosol index + kernels

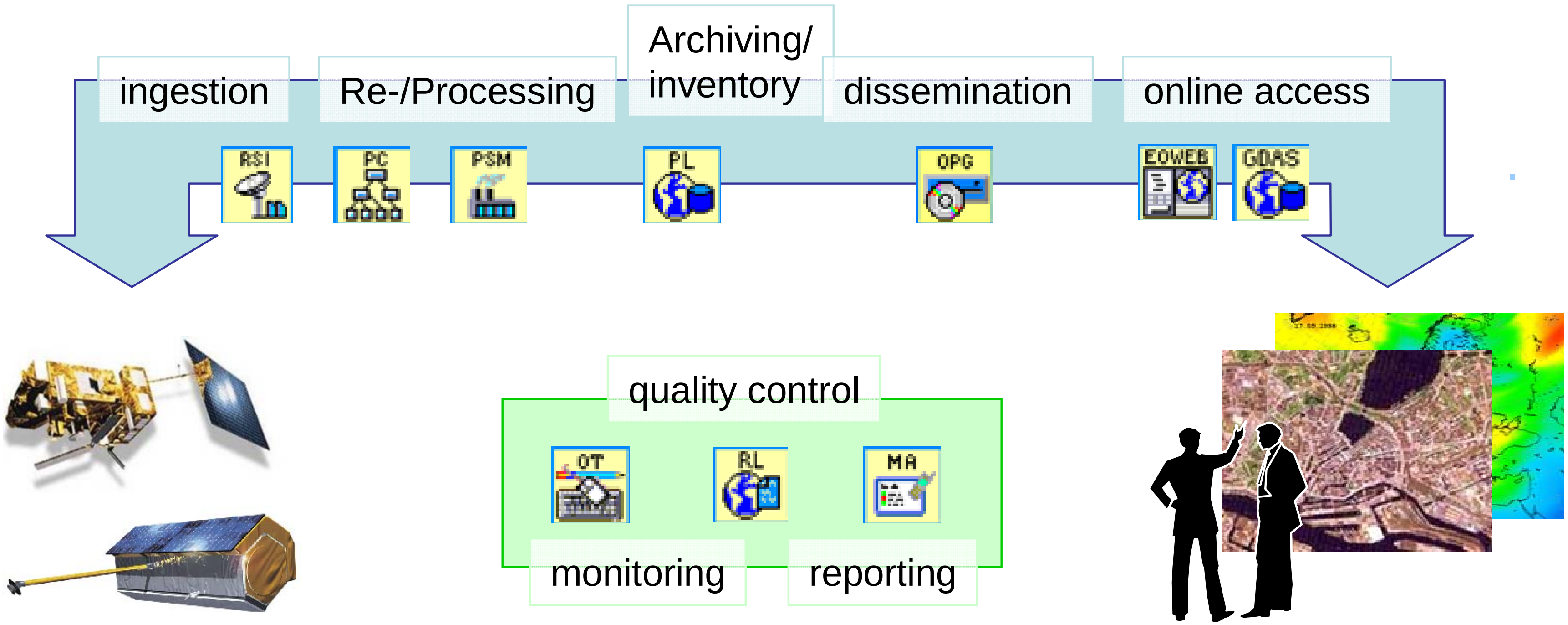
- **Pre-cursor algorithms**
  - ORAC (Ral/Oxford), ADV / ASV (FMI), dual view (Swansea)
  - BAER, ESA standard MERIS, PARASOL (LOA), SYNAER (DLR)
  - AAI (KNMI), AERGOM (BIRA)

decentralized system



by experienced data centers: DLR WDC-RSAT / DIMS, CNRS ICARE, RAL UK-PAC

decentralized system



by experienced data centers: DLR WDC-RSAT / DIMS, CNRS ICARE, RAL UK-PAC

aerosol_cci team

EO team

DLR

Ilmatieteen Laitos / Meteorologiska Institutet / Finnish Meteorological Institute

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aeronomie.be

KNMI

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University of Bremen Institute of Remote Sensing

HYGEOS

system engineer team

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University of Oxford

CNRS INSU

user / validation team

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Meteorologisk institutt met.no

Max-Planck-Institut für Meteorologie

Paul Scherrer Institut PSI

NILU

coordination

DLR

Ilmatieteen Laitos / Meteorologiska Institutet / Finnish Meteorological Institute

options

Freie Universität Berlin

international cooperation

- development of "community modules"
  - in particular the harmonisation of aerosol models between aerosol_cci and NASA products (work underway in cooperation with Ralph Kahn from the MODIS and MISR aerosol teams)
- extension of round-robin algorithm intercomparison work to fully include MODIS and MISR products
  - MODIS already to be used as an external comparison dataset
- potential to link aerosol_cci with the ongoing WMO Sustained, Co-Ordinated Processing of Environmental Satellite Data for Climate Monitoring (SCOPE-CM)project
  - aims to produce ongoing and continuous provision of satellite products addressing ECVs
  - currently has activities to produce cloud and aerosol from the AVHRR record and geostationary satellites
- strengthen links to the international modelling community by engaging in further data utilisation and model intercomparison studies
  - the existing links with the AERCOM community provide an ideal framework for this
  - EU FP7 projects (e.g. EUCAARI) and follow-ons also provide opportunities

The aerosol_cci team would also need funding for the extra effort involved