Aerosol_cci attempts on a joint aerosol-cloud products from SEVIRI

Yves Govaerts, Marta Luffarelli, Elisa Pinat

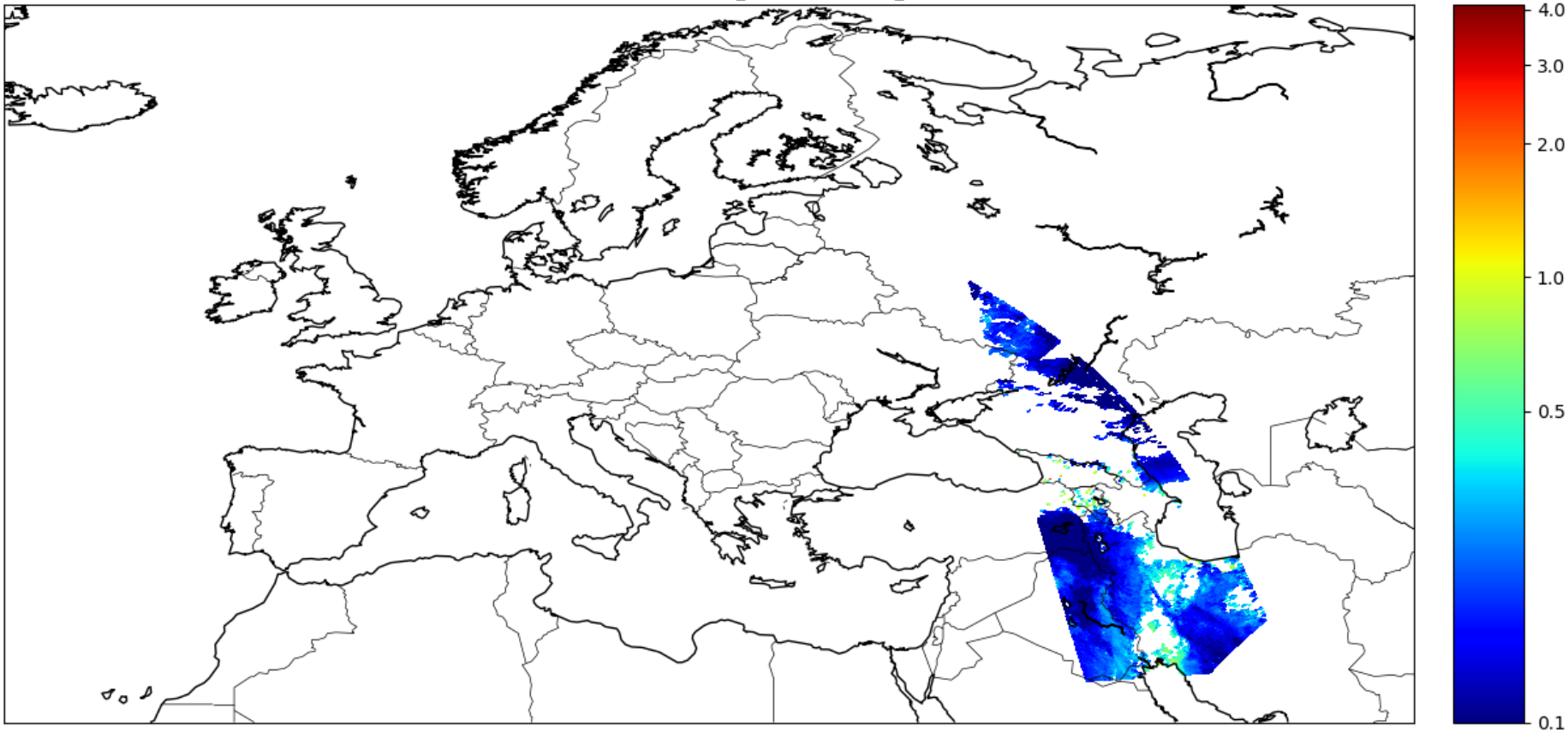
Rayference

5th AeroSAT Workshop

October 12 – 13, 2017

FMI, Helsinki , Finland

AOD550 [SEVIRI]



DATE: 2008/07/15 -- HOUR: 03

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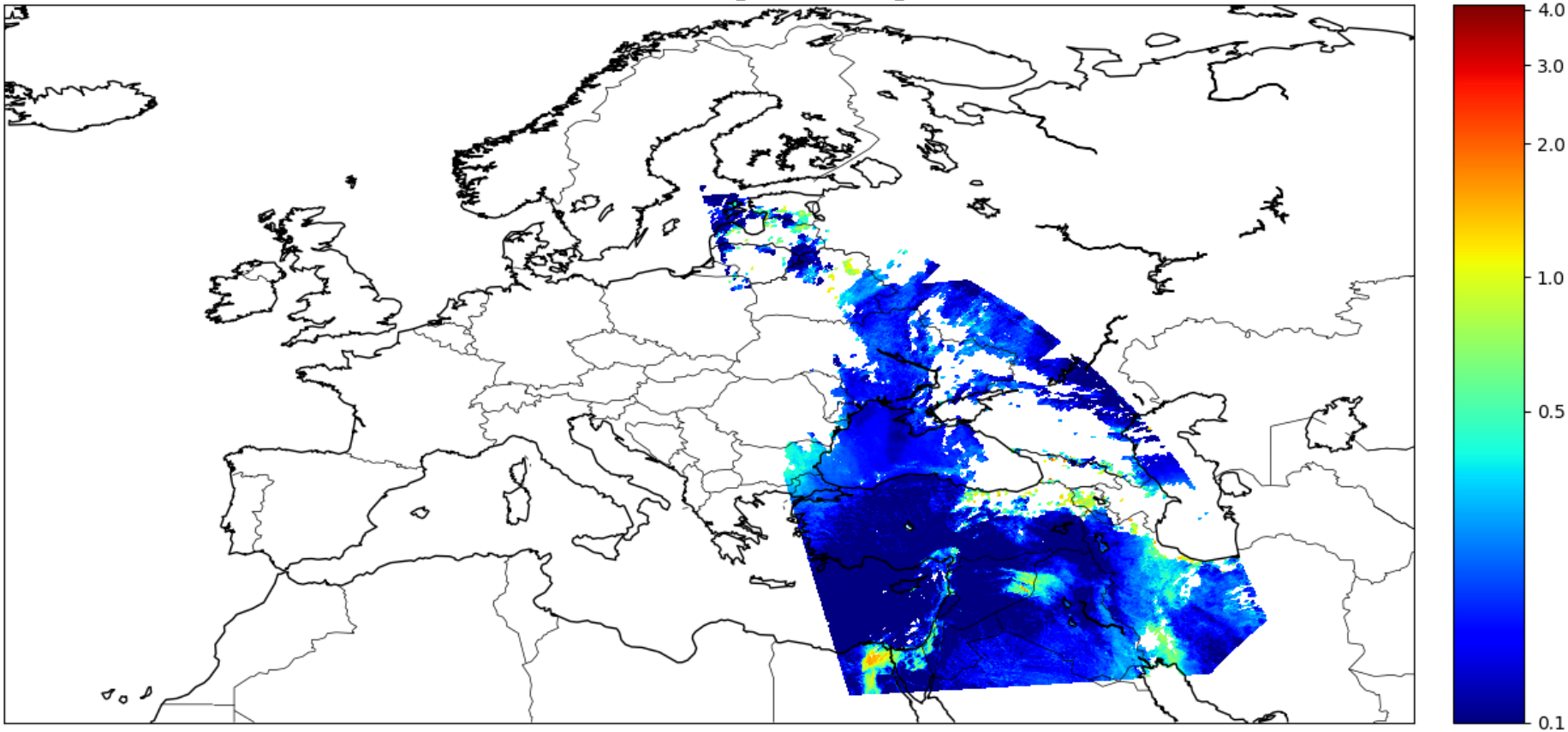

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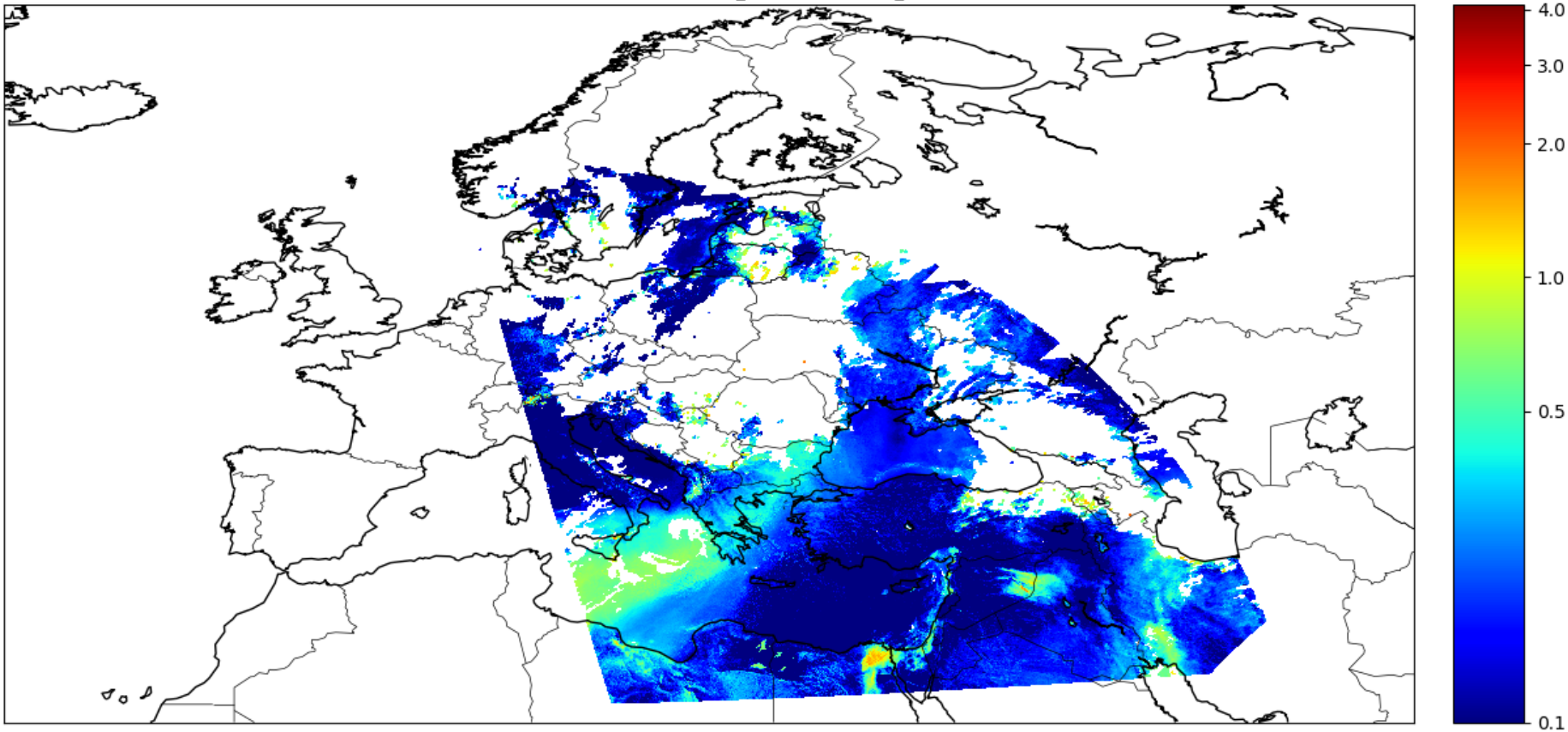

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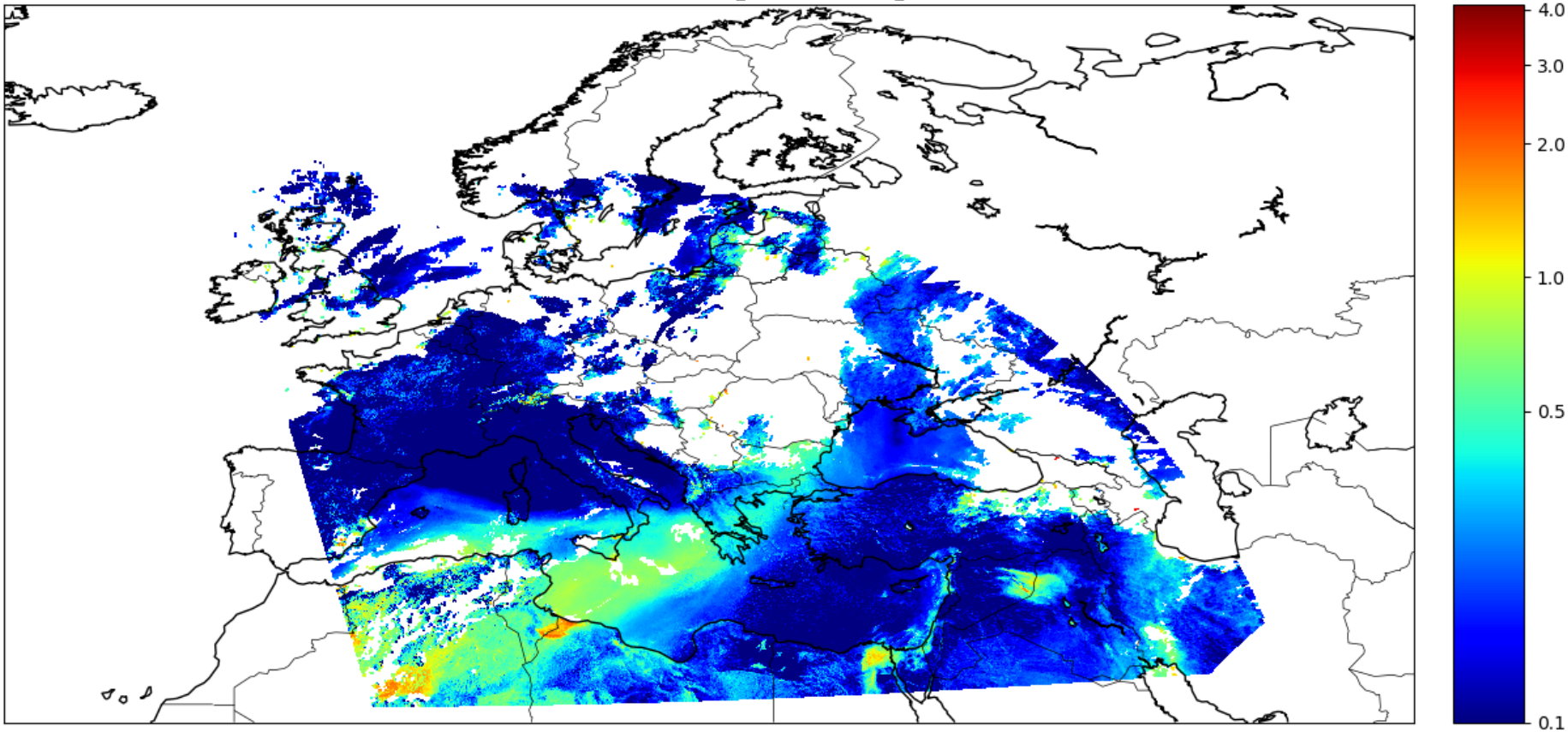

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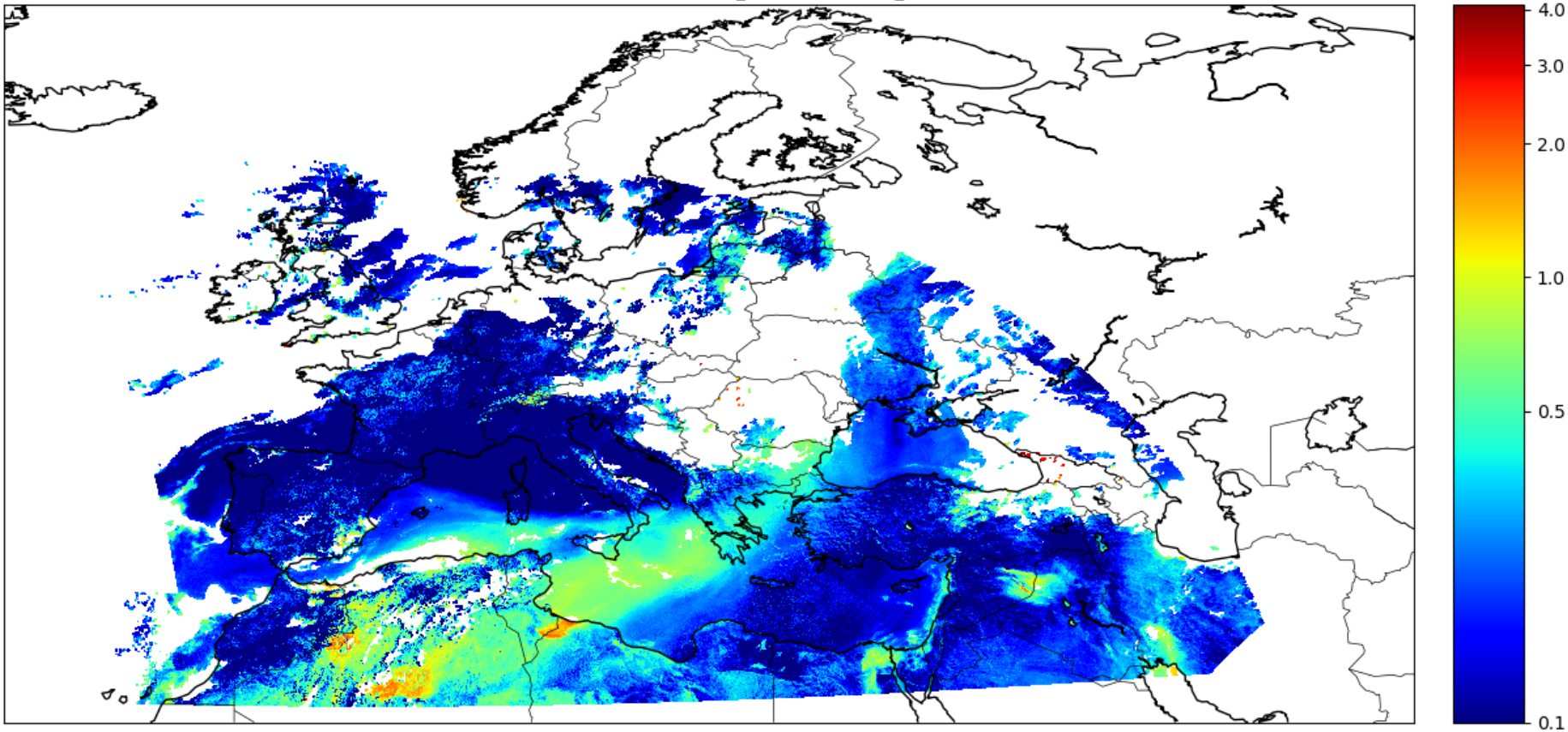

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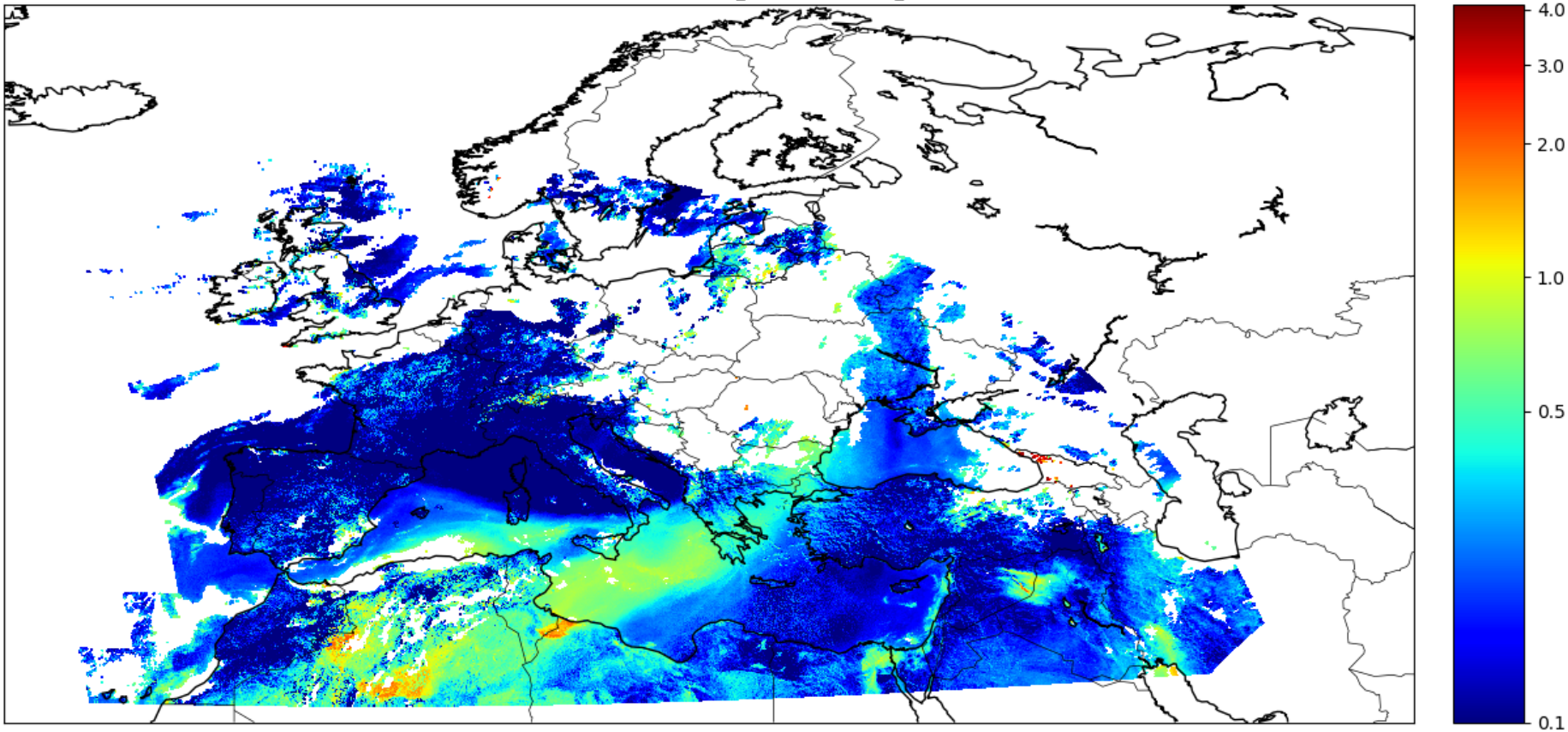

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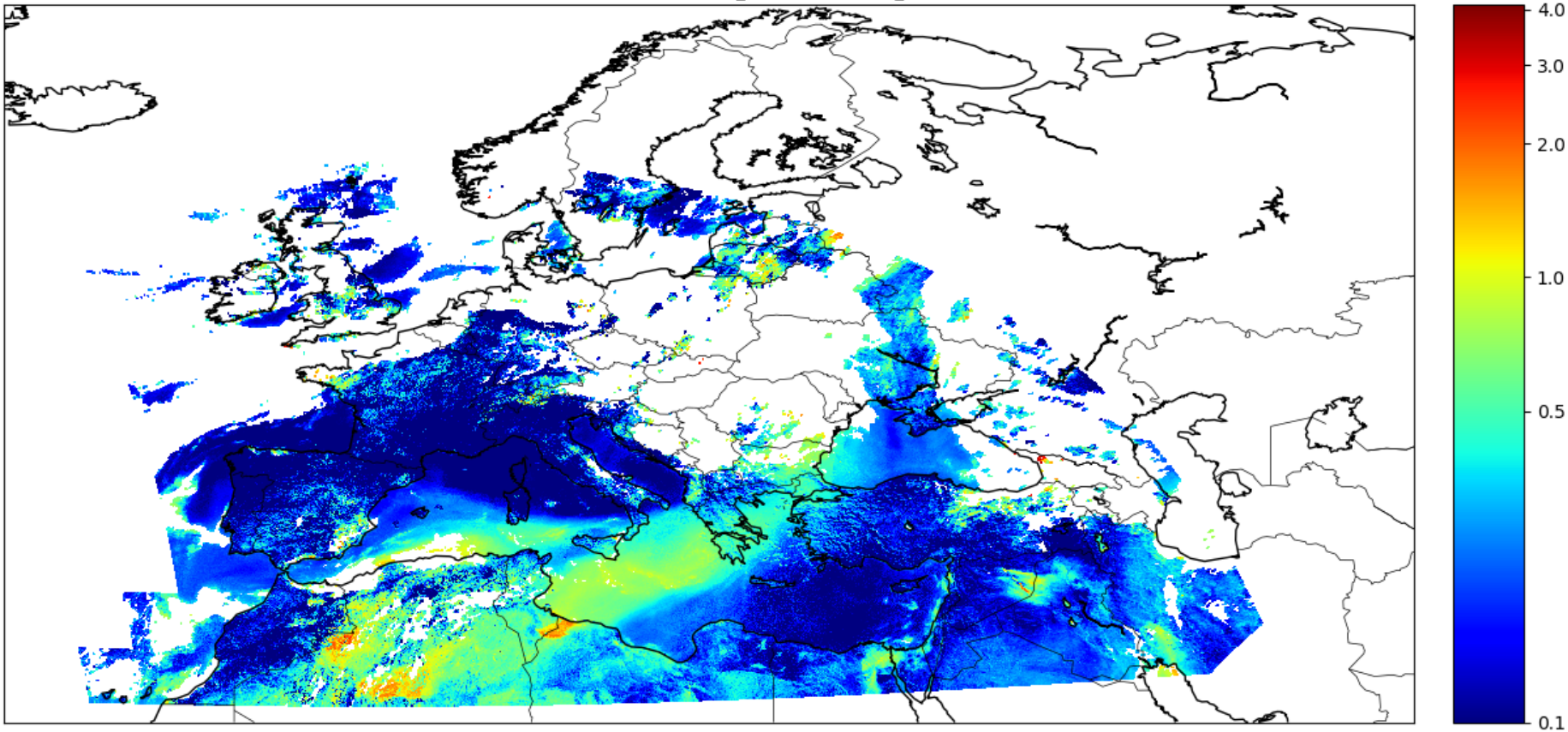

DATE: 2008/07/15 -- HOUR: 09

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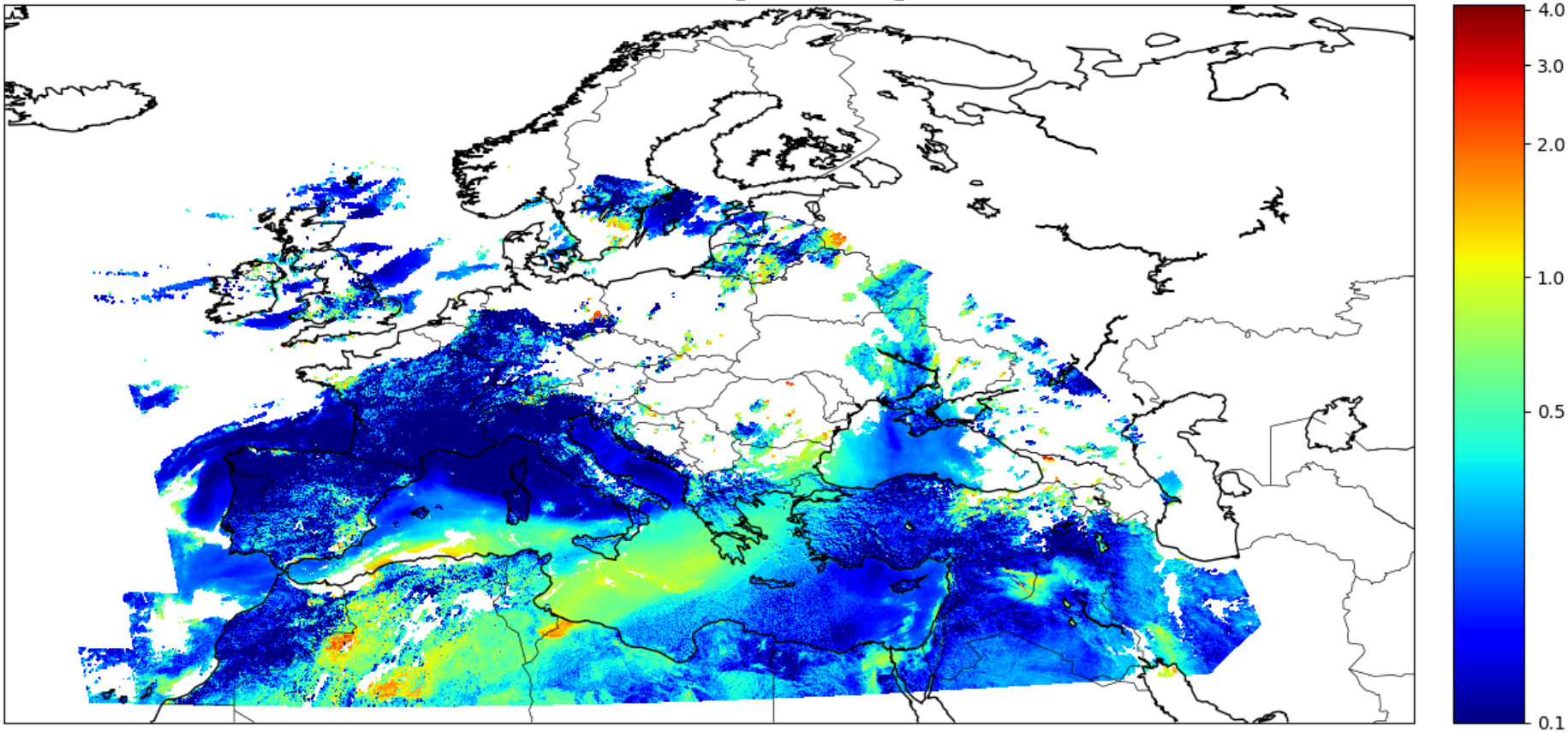

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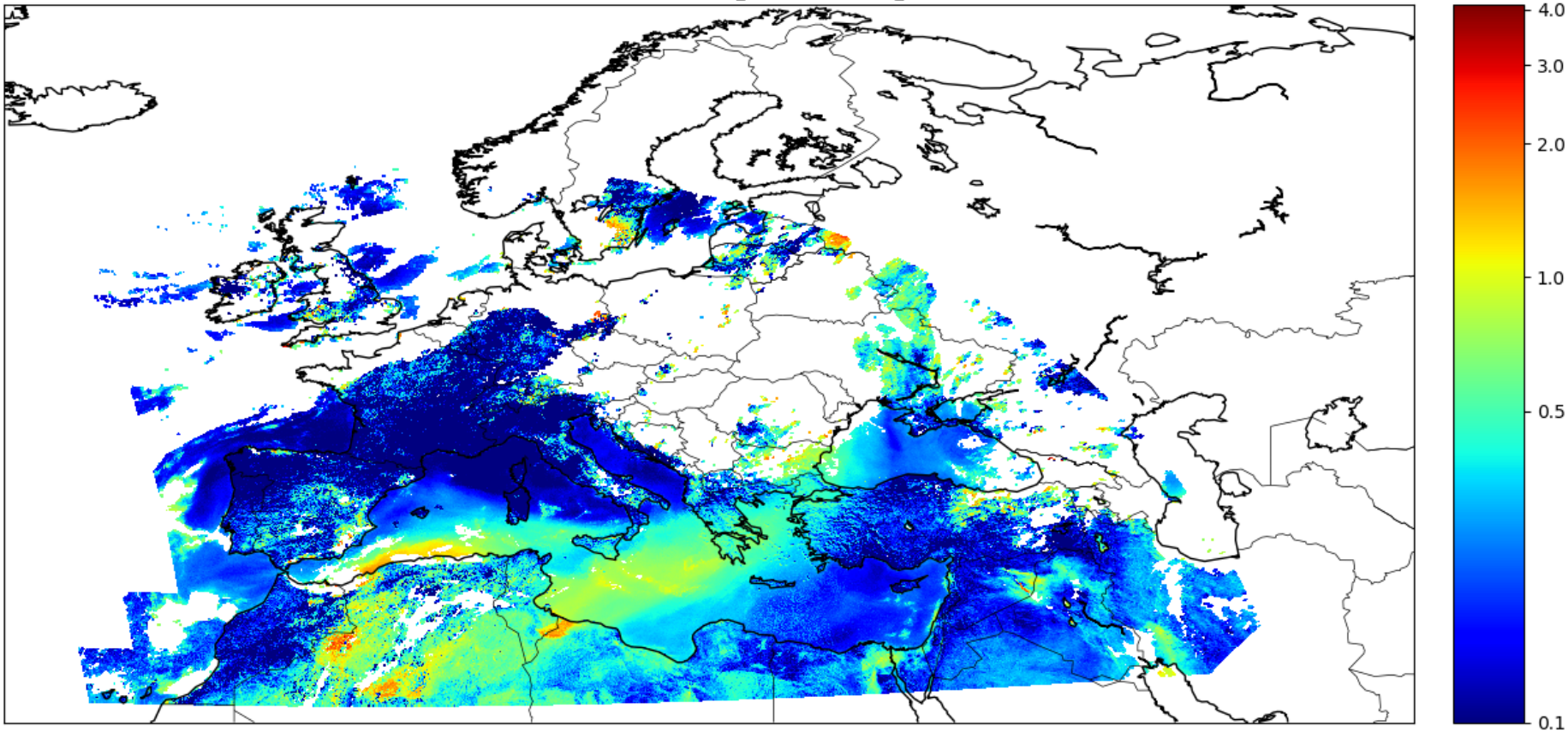

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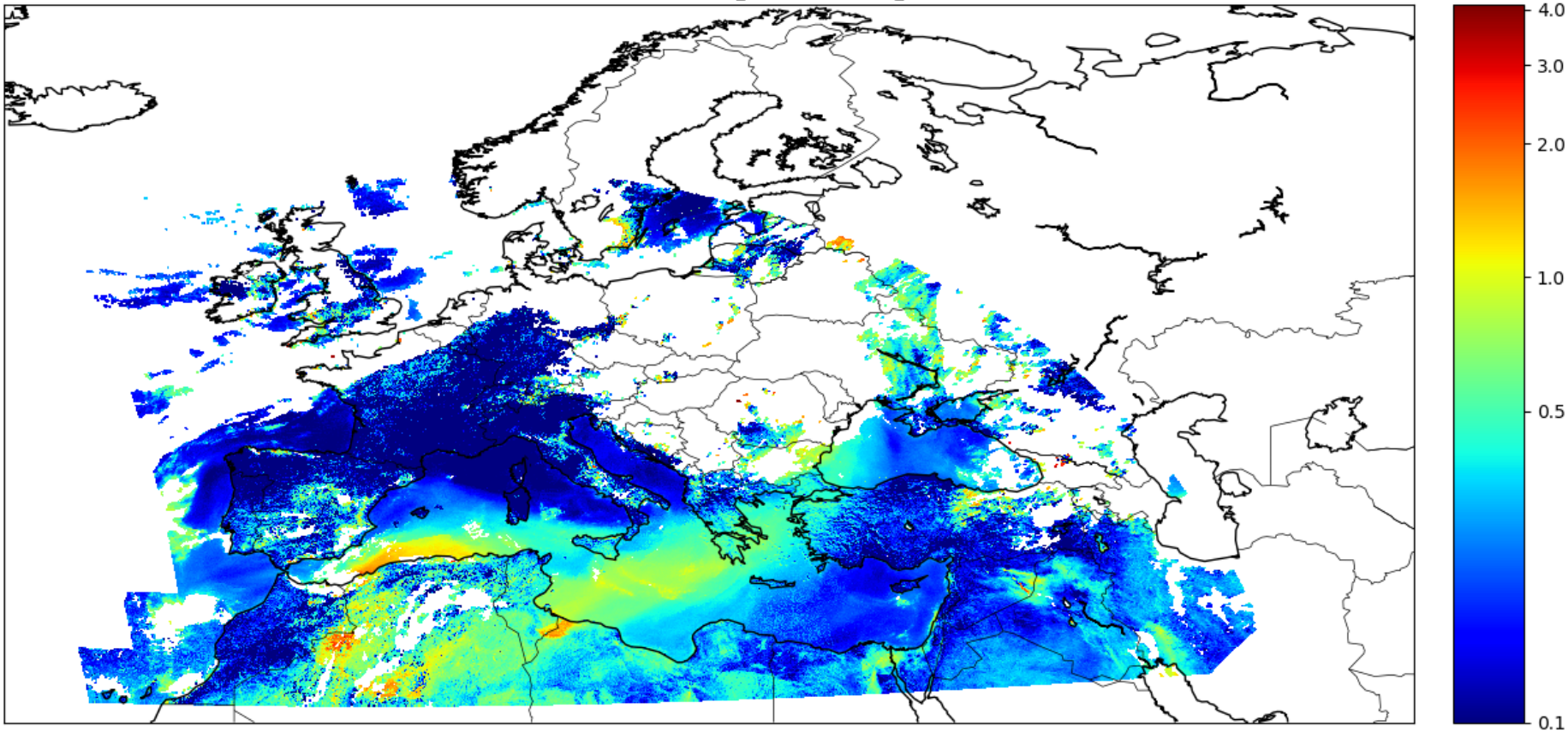

DATE: 2008/07/15 -- HOUR: 12

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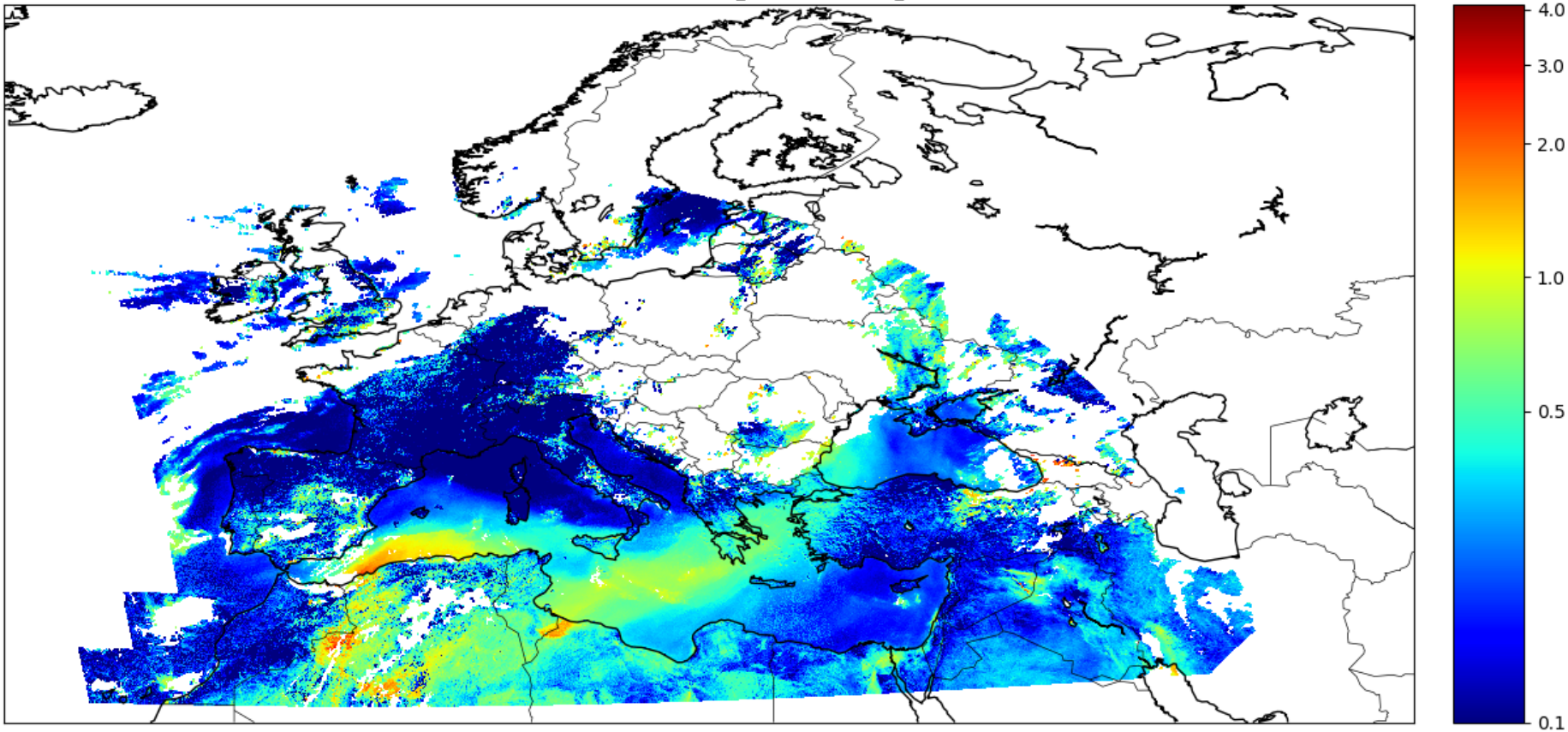

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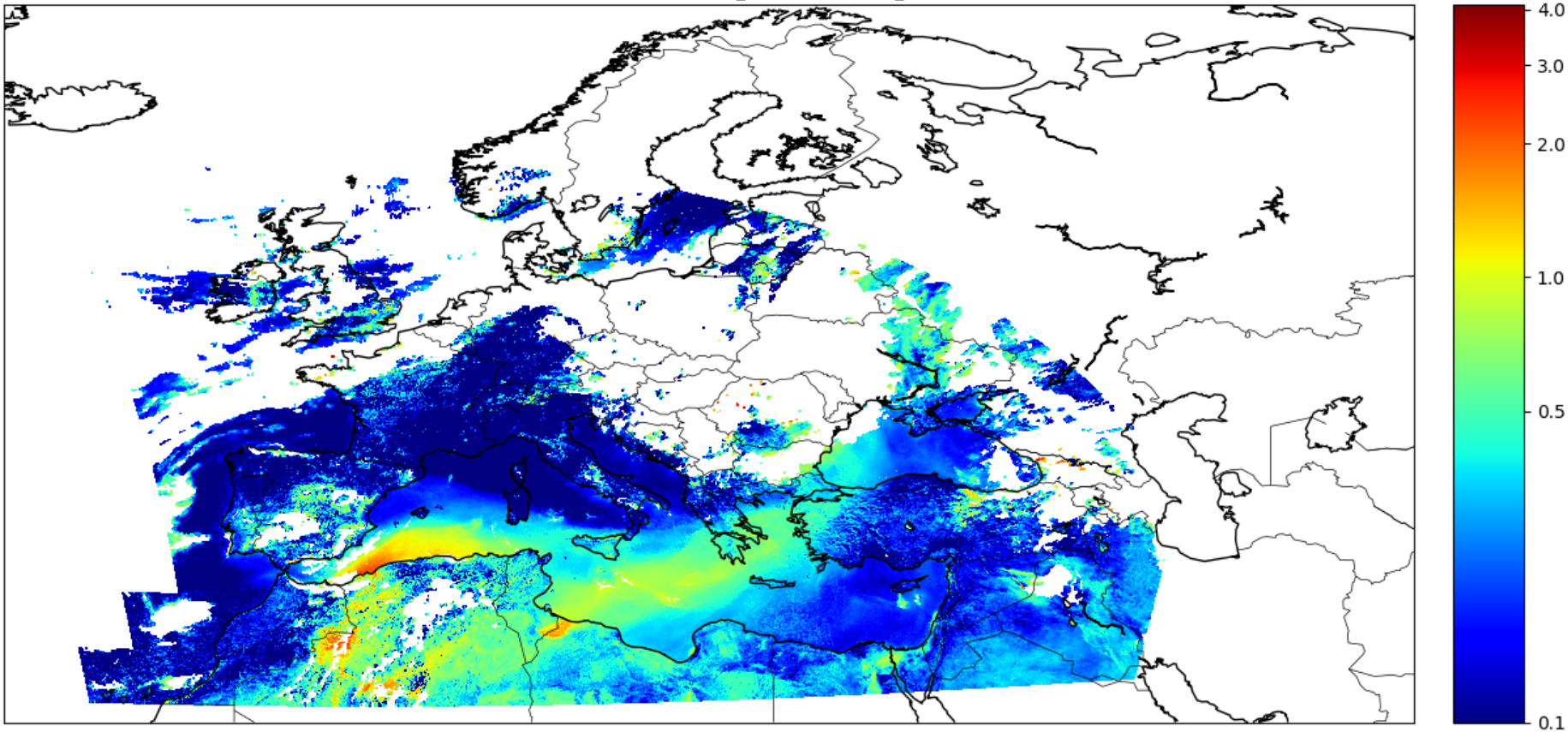

DATE: 2008/07/15 -- HOUR: 14

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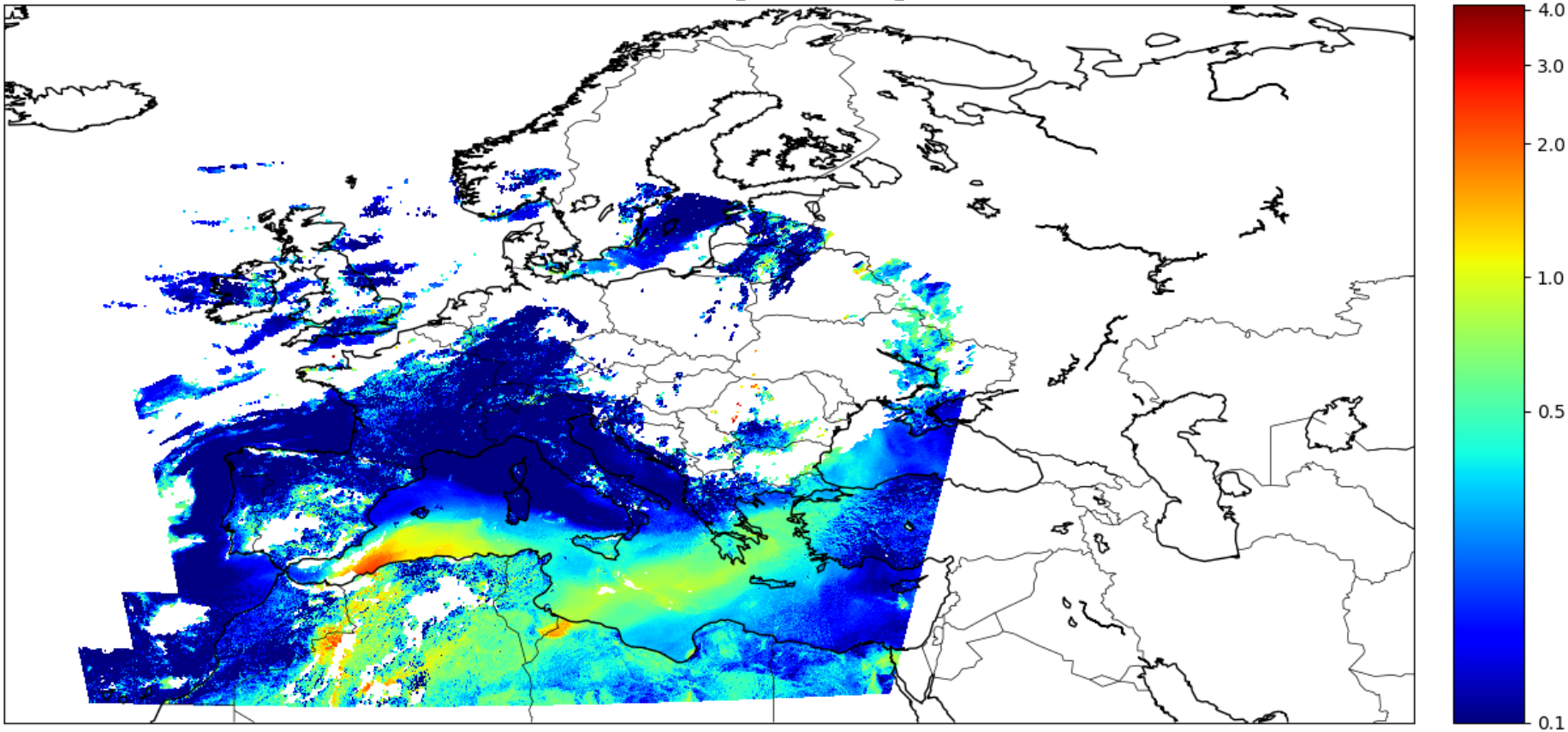

DATE: 2008/07/15 -- HOUR: 15

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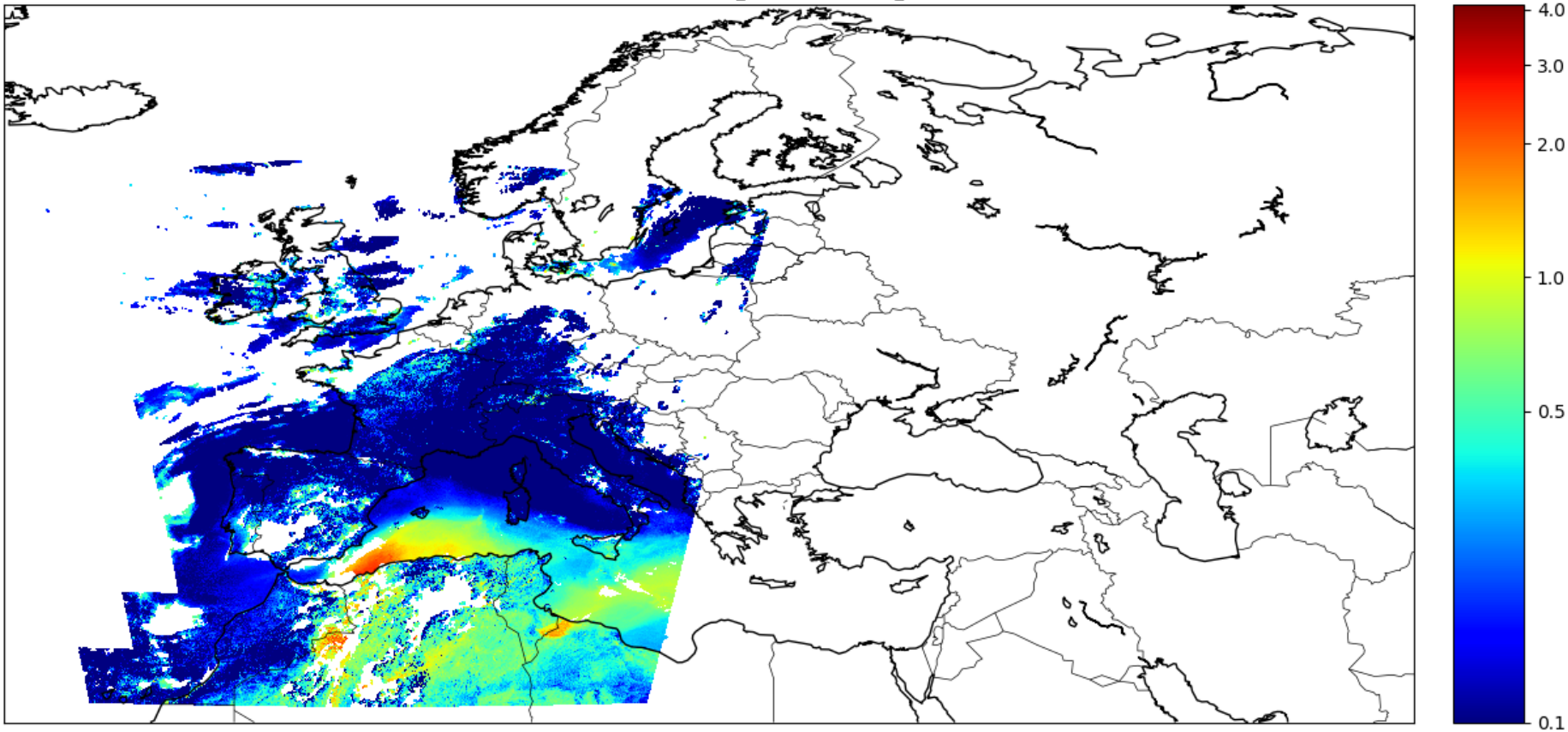
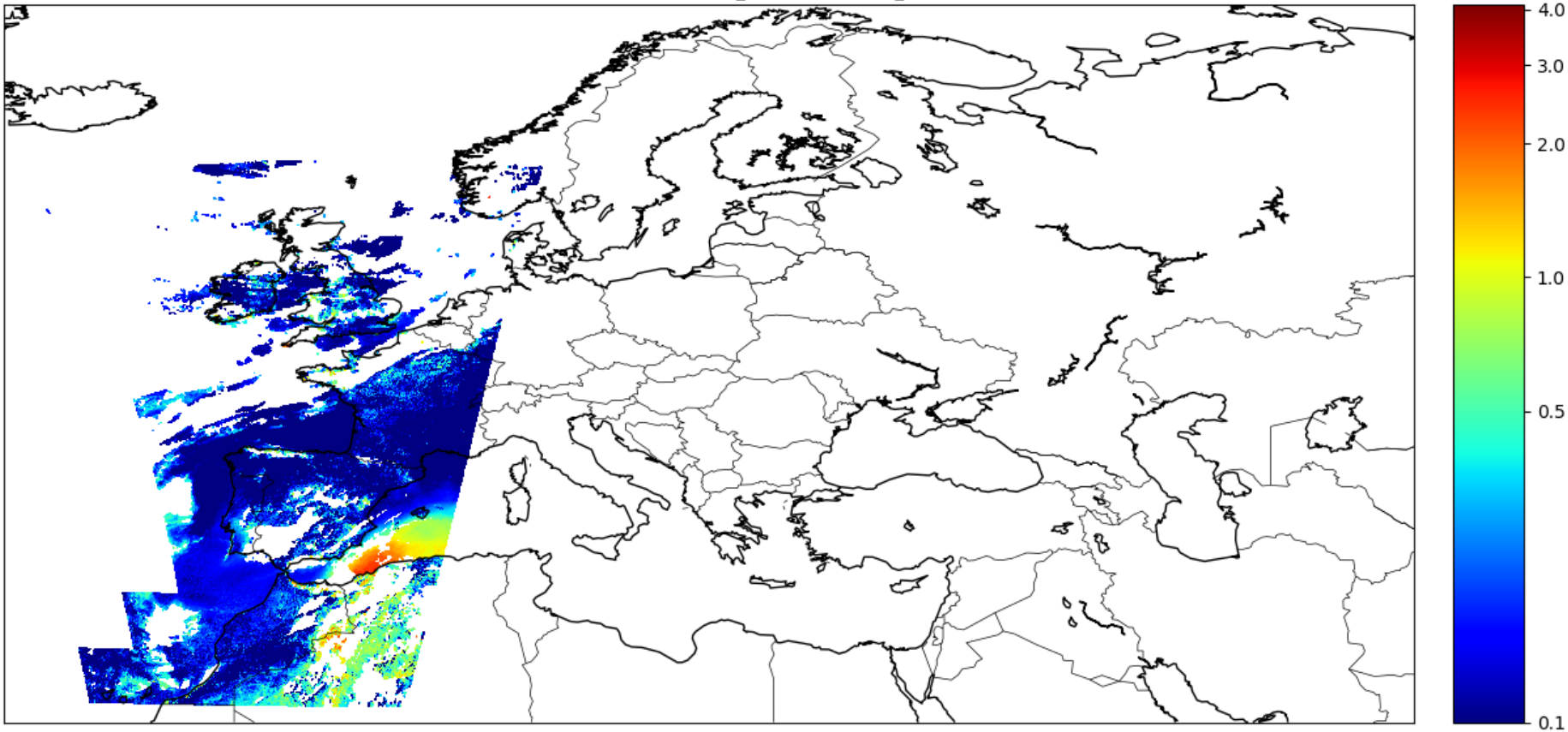


DATE: 2008/07/15 -- HOUR: 16

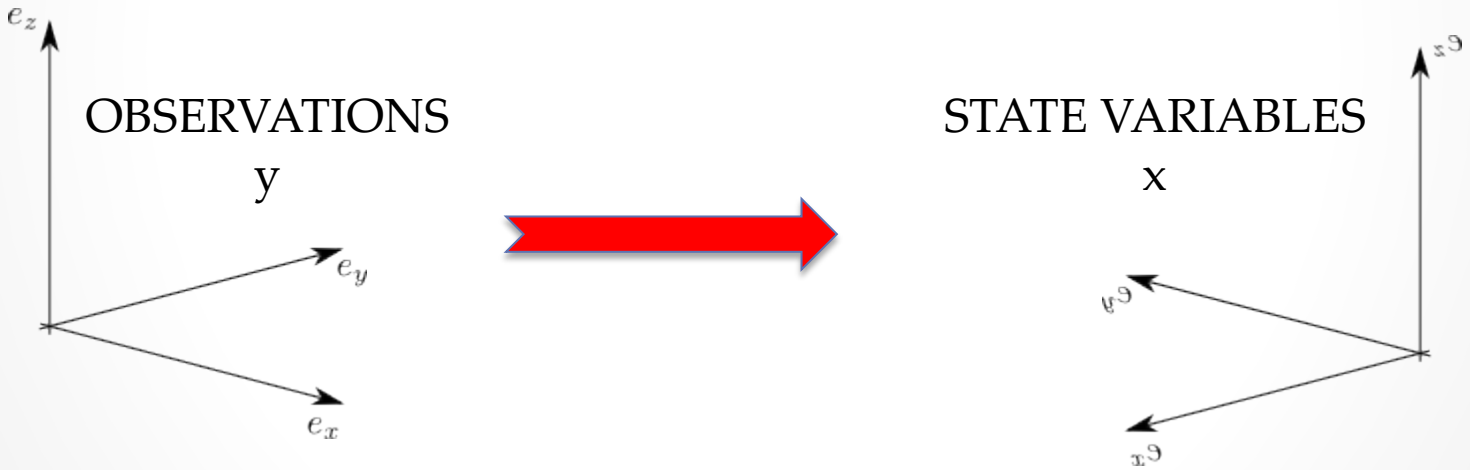
AOD550 [SEVIRI]



DATE: 2008/07/15 -- HOUR: 17

OPTIMAL ESTIMATION AND AEROSOL CLASSES

Optimal Estimation (OE) approach is a powerful mathematical framework to find the best balance between the information coming from the observations and any prior information.



Continuous observation

Continuous sampling

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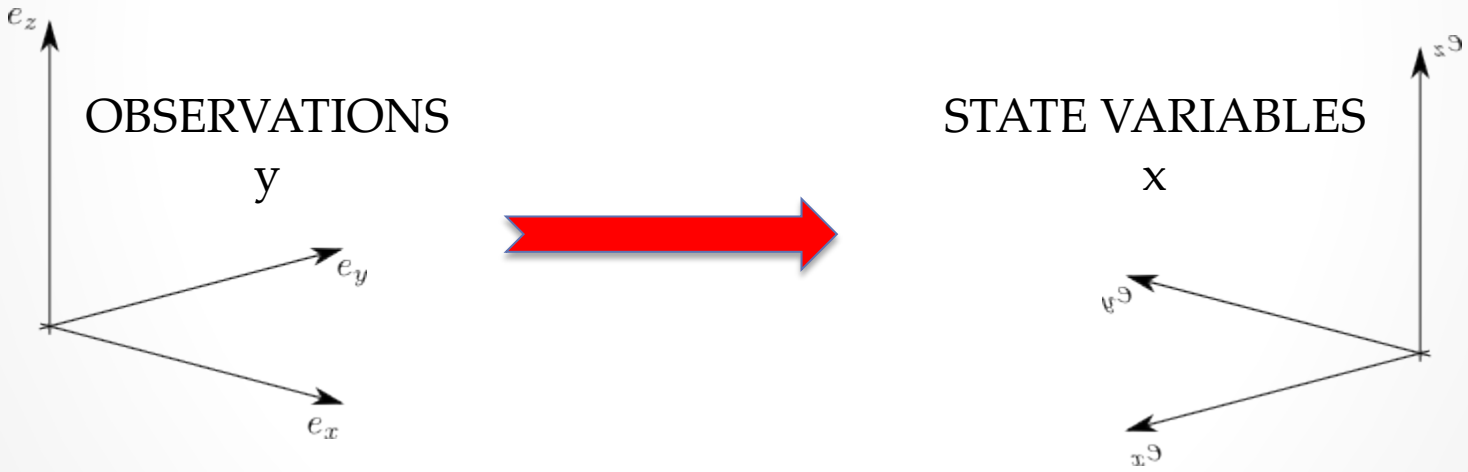


Continuous observation

Continuous sampling

The use of aerosol classes does not allow a continuous sampling of the solution space

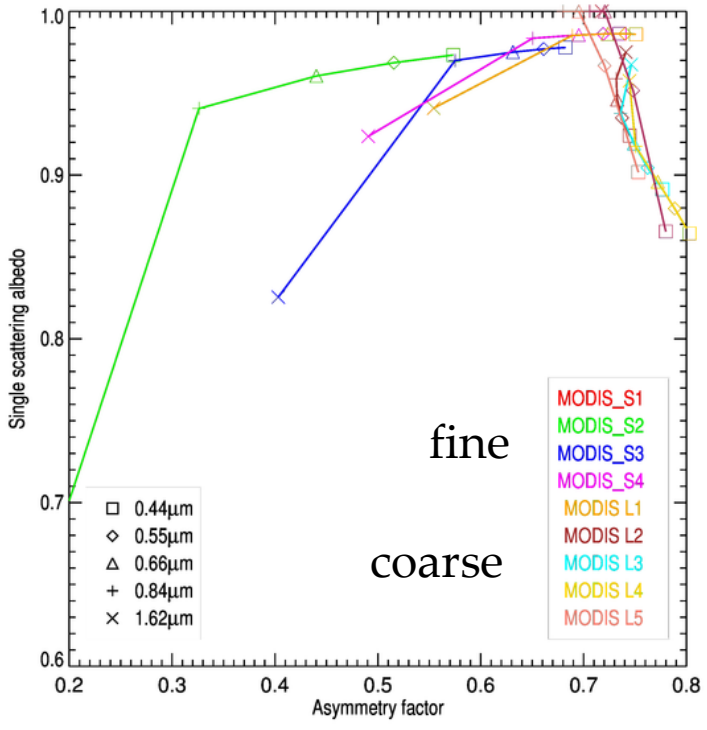
AEROSOL SOLUTION SPACE

- In the radiative transfer equation, the aerosol state variables include:
  - The single scattering albedo: defines how much radiation is scattered;
  - The phase function: defines in which direction the radiation is scattered.
- These variables constitute the aerosol single scattering properties.

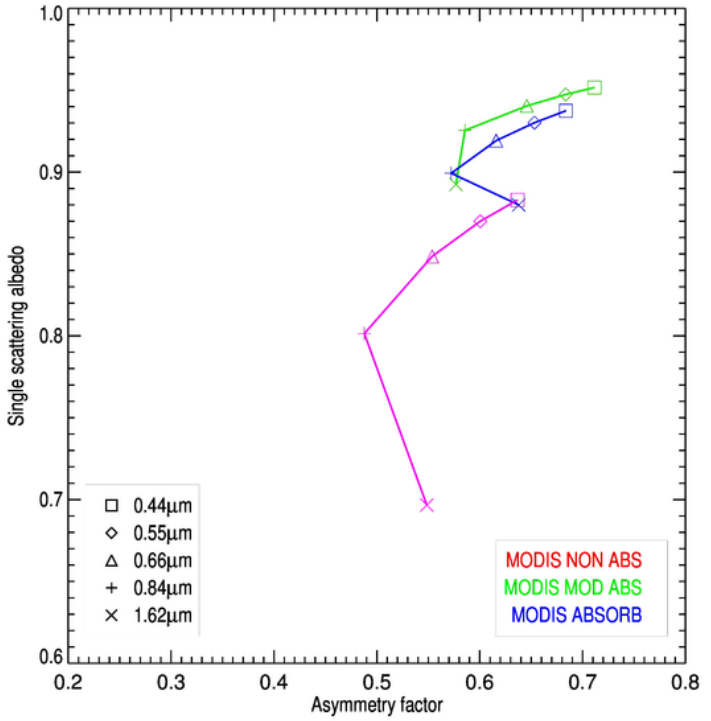
AEROSOL STATE VARIABLES

MODIS (C5) aerosol types

OCEAN (mono-modal radius)



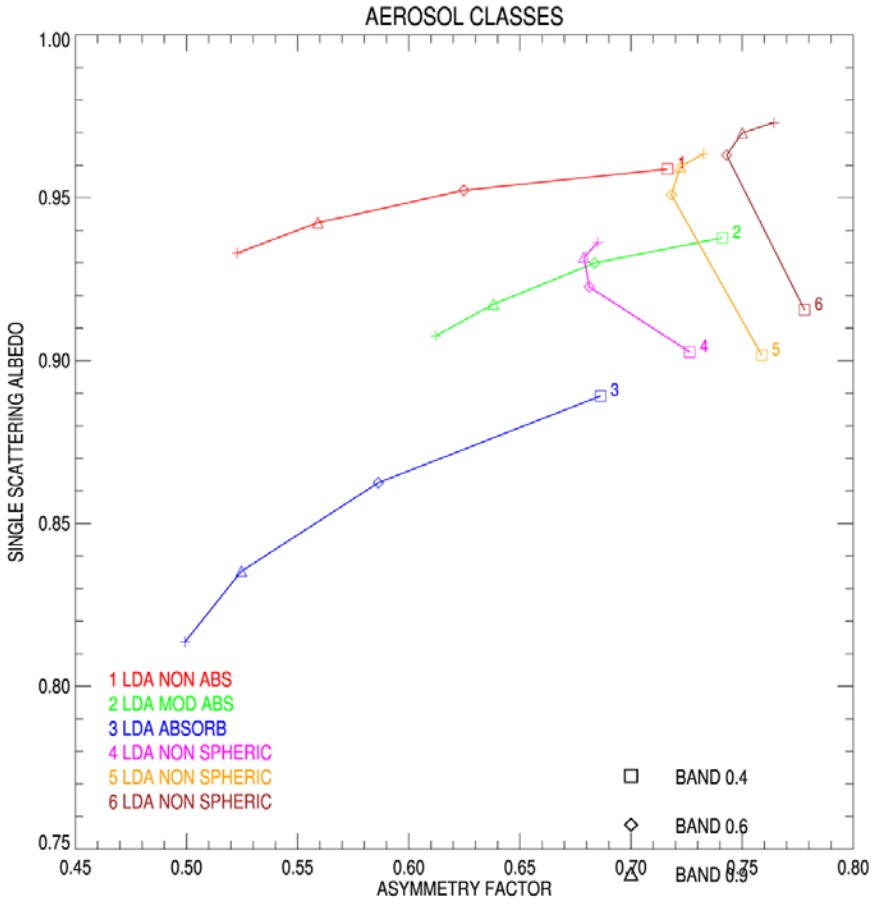
LAND (dual-mode radius)



AEROSOL SOLUTION SPACE

AEROSOL STATE VARIABLES

In Govaerts et al., (2010) dual mode aerosol classes are defined from the aggregation of AERONET data to optimise the sampling of the solution space



CISAR

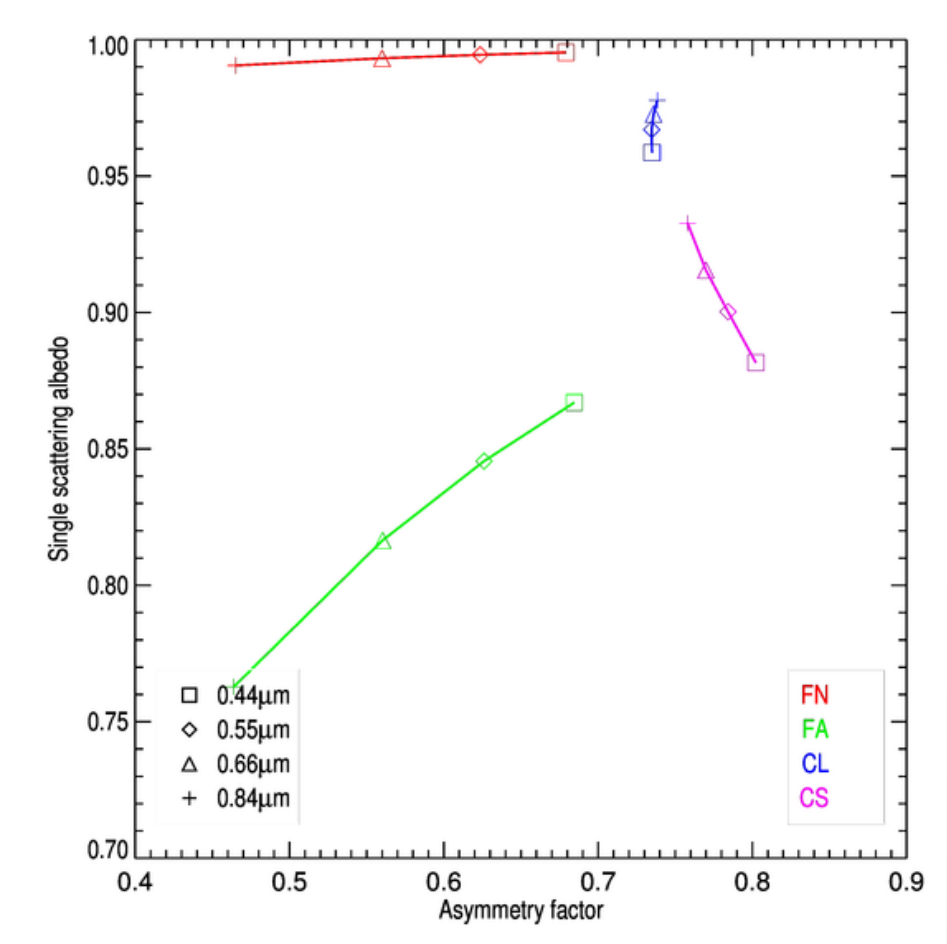
- The Combined Inversion of Surface and AeRosols (CISAR) algorithm for the joint retrieval of aerosol properties and surface reflectance with a continuous variation of the state variables in the solution space

  - Govaerts, Y. and Luffarelli, M.: Joint retrieval of surface reflectance and aerosol properties with continuous variations of the state variables in the solution space: Part 1: theoretical concept, *Atmos. Meas. Tech. Discuss.*, doi:10.5194/amt-2017-29, in review, 2017

  - Applied on PROBA-V data in the ESA PV-LAC study
  - **Applied on SEVIRI data in the ESA aerosol_cci study**

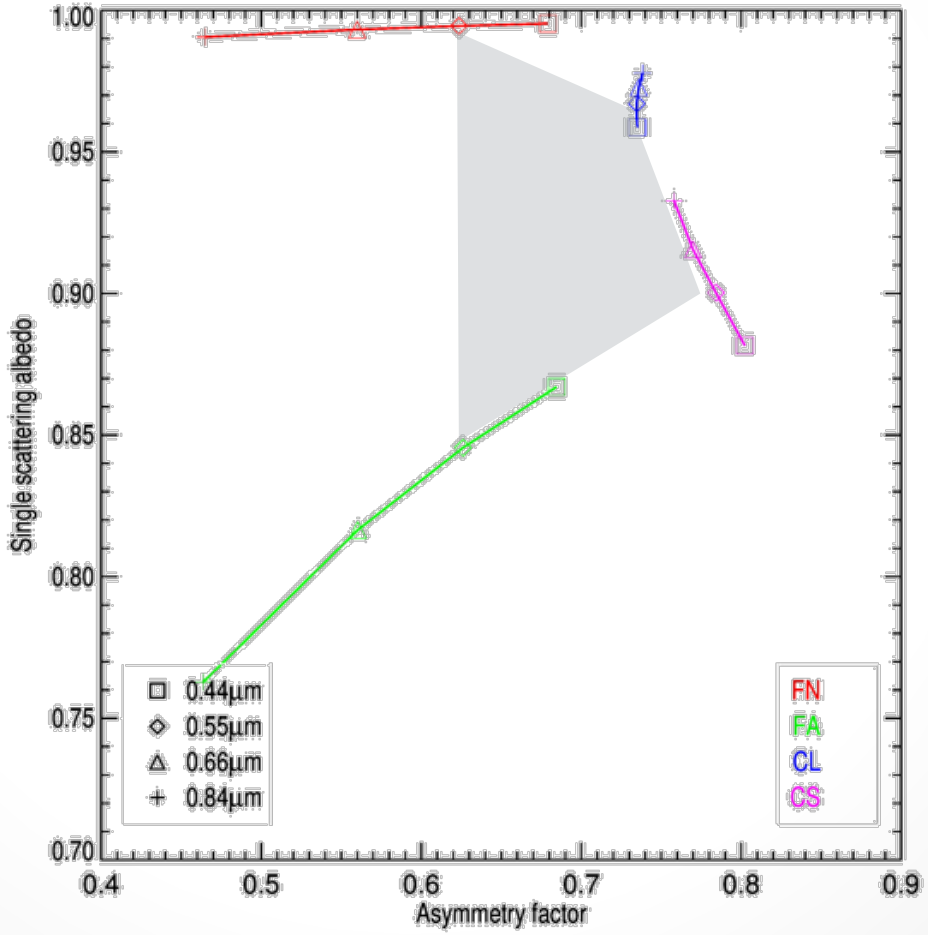
CISAR ALGORITHM

Definition of **mono-modal mode vertices** that bounds the solution space



CISAR ALGORITHM

Definition of mono-modal mode that bounds the solution space
Solution space in the red spectral region



CISAR ALGORITHM

Definition of mono-modal mode that bounds the solution space
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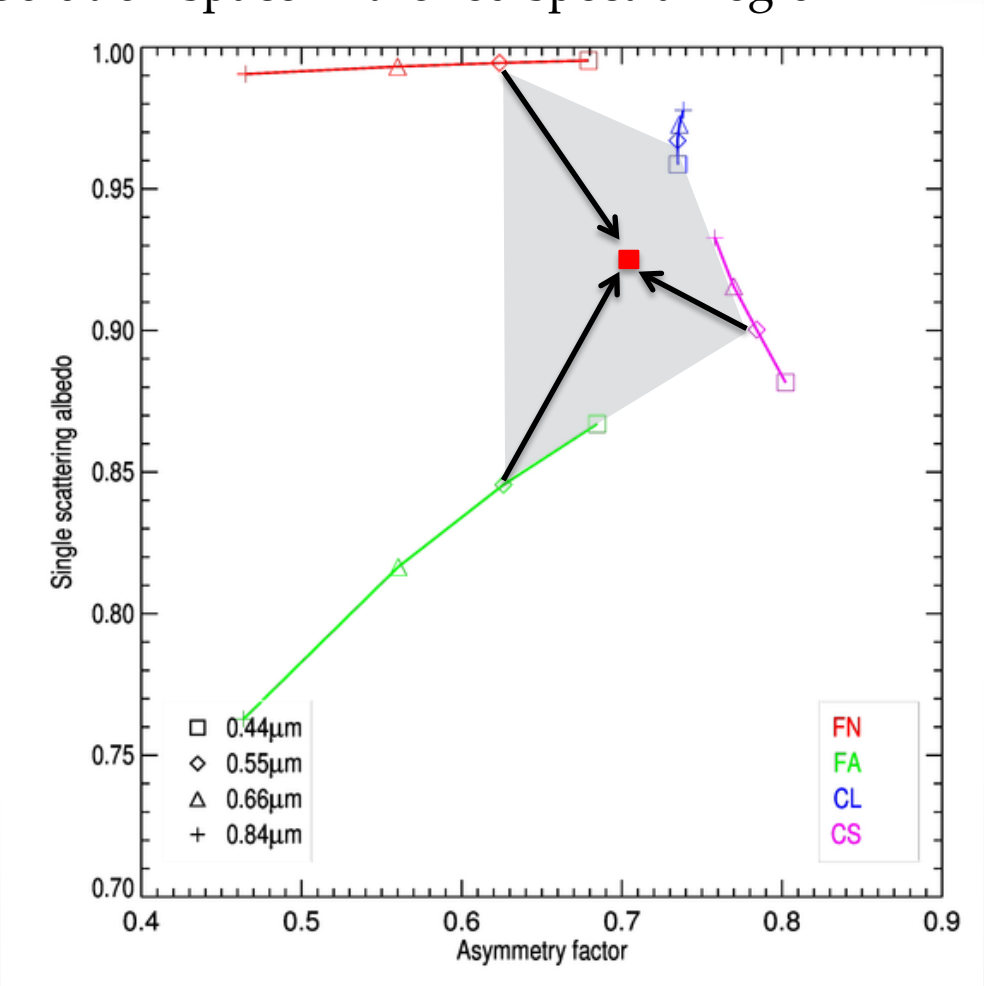
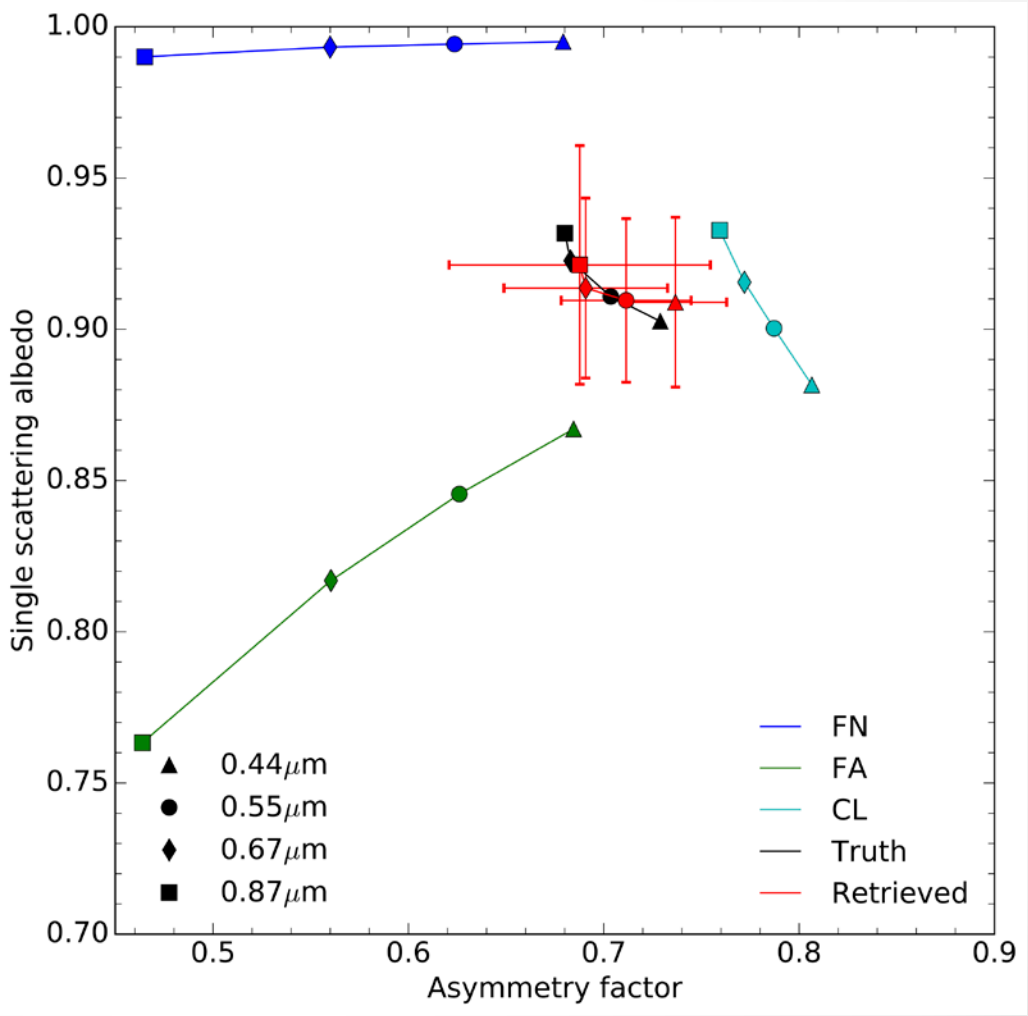


CISAR ALGORITHM

Noise-free simulation in the principal plane with a dual-mode aerosol model.

Retrieval of the single scattering properties from the combination of two fine mono-mode and one coarse mono-mode.

Govaerts and Luffarelli, (2017).



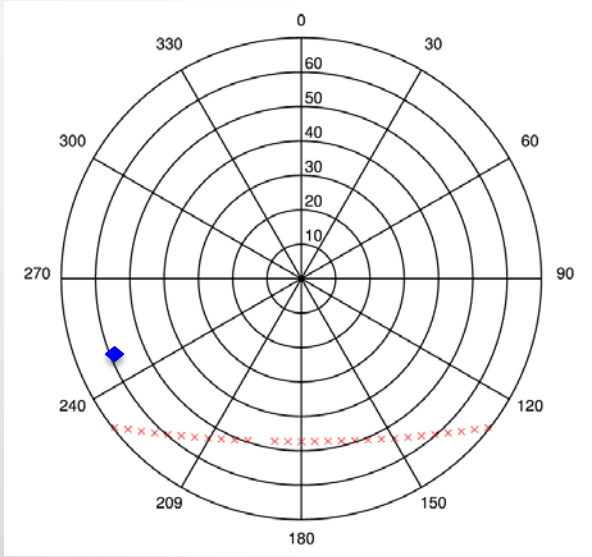
Aerosol_cci

SEVIRI HOURLY AEROSOL WITH CISAR

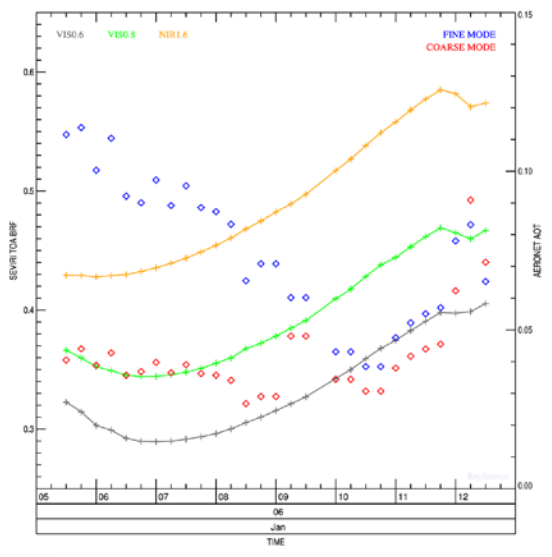
Daily variations of the Jacobians

Example over Solar Village on 06/01/2008

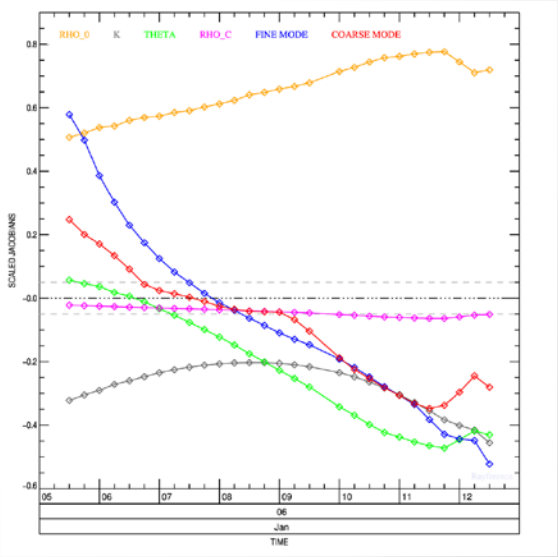
Geometry



Observations



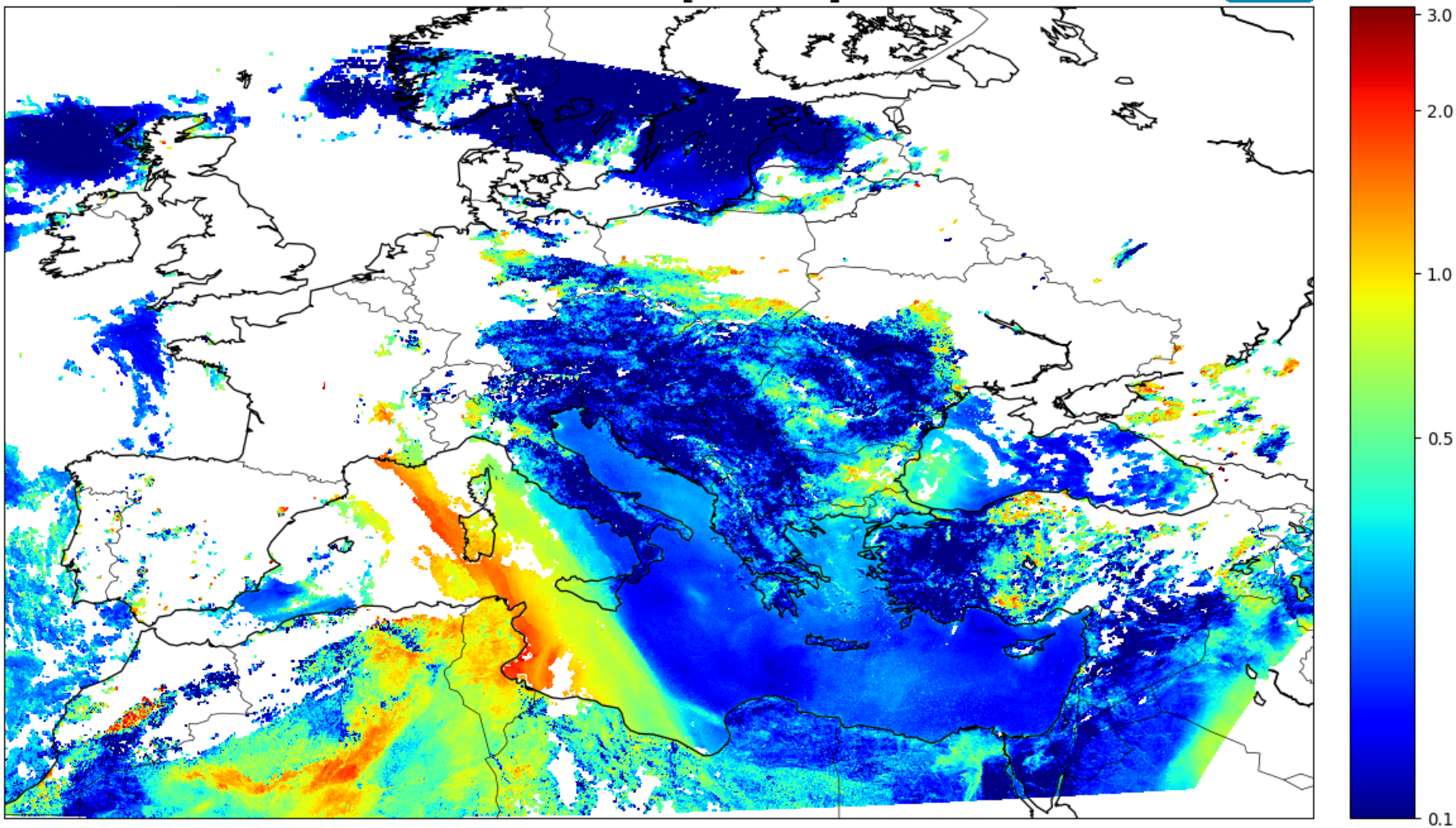
Jacobians VIS0.6



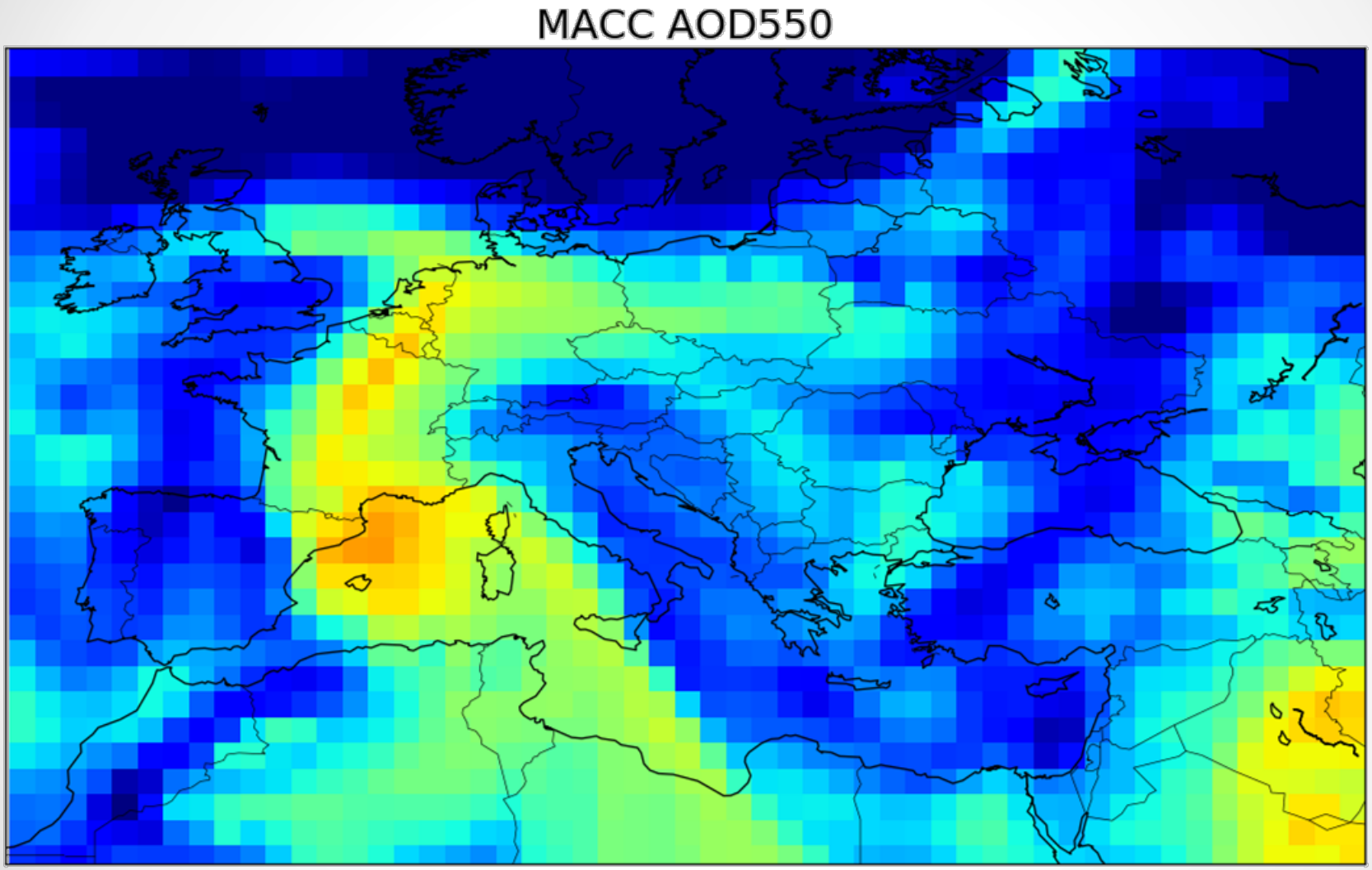
Prior information

The following prior information is used within the cost function:

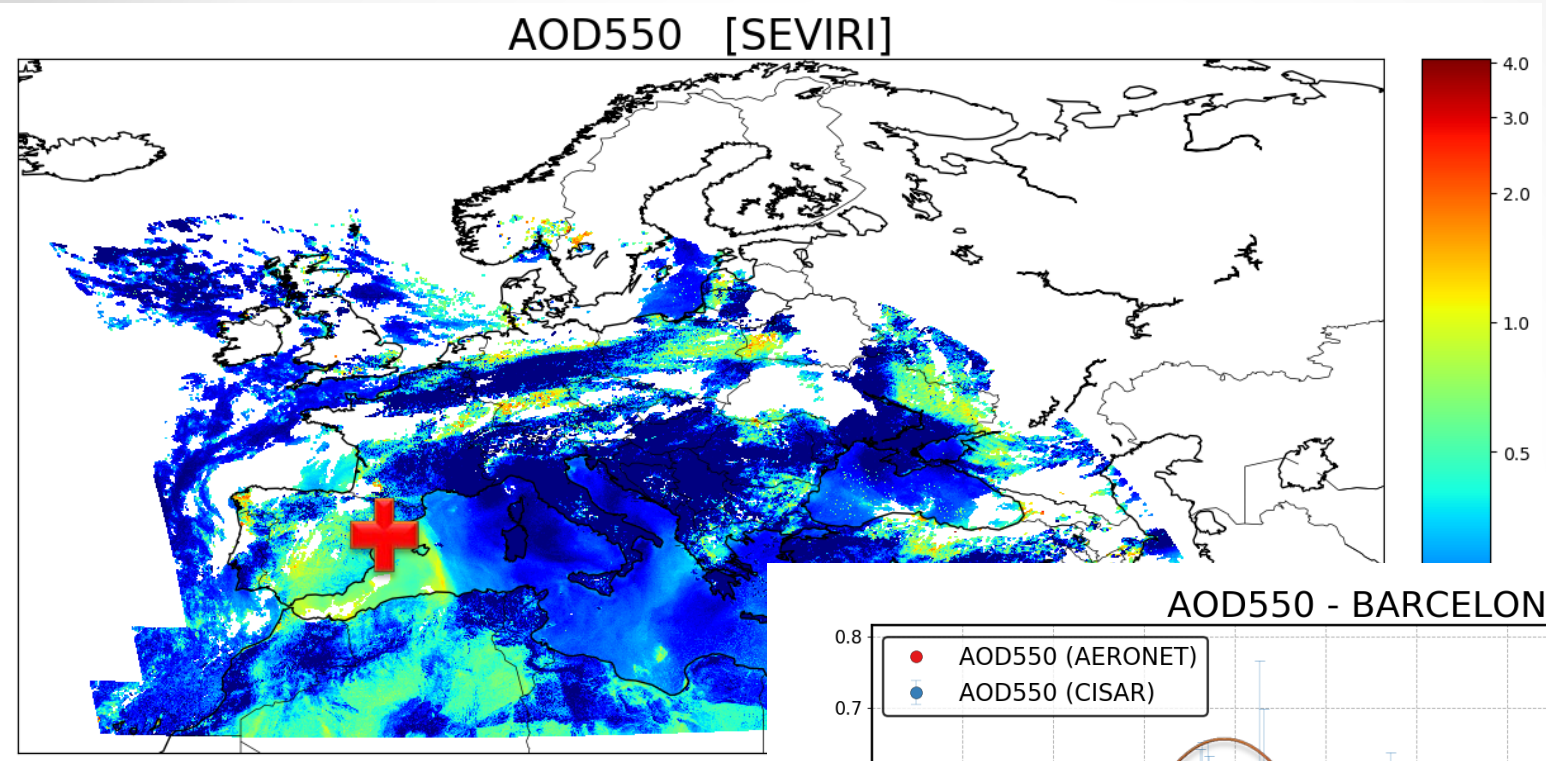
- The value of parameters of the surface BRF model and associated uncertainties retrieved from the previous inversion cycle;
- Regularization of AOT temporal variations;
- Regularization of AOT spectral variations.

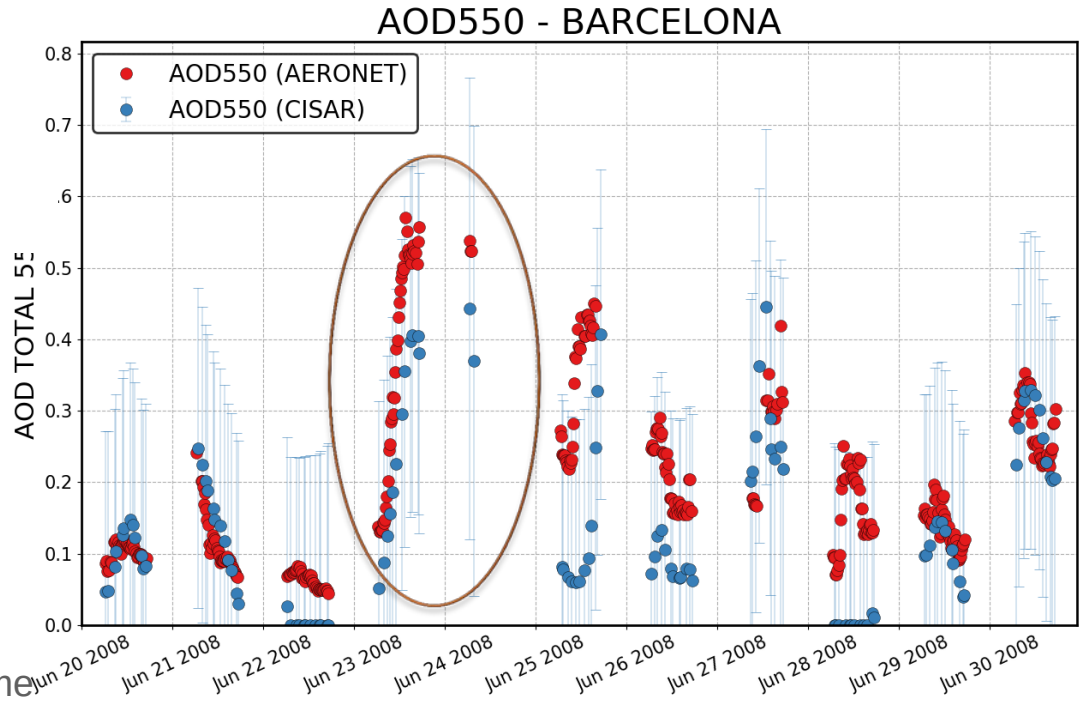

AOD550 [SEVIRI]
3.0
2.0
1.0
0.5
0.1
DATE: 2008/05/27 -- HOUR: 12

COMPARISON WITH CAMS



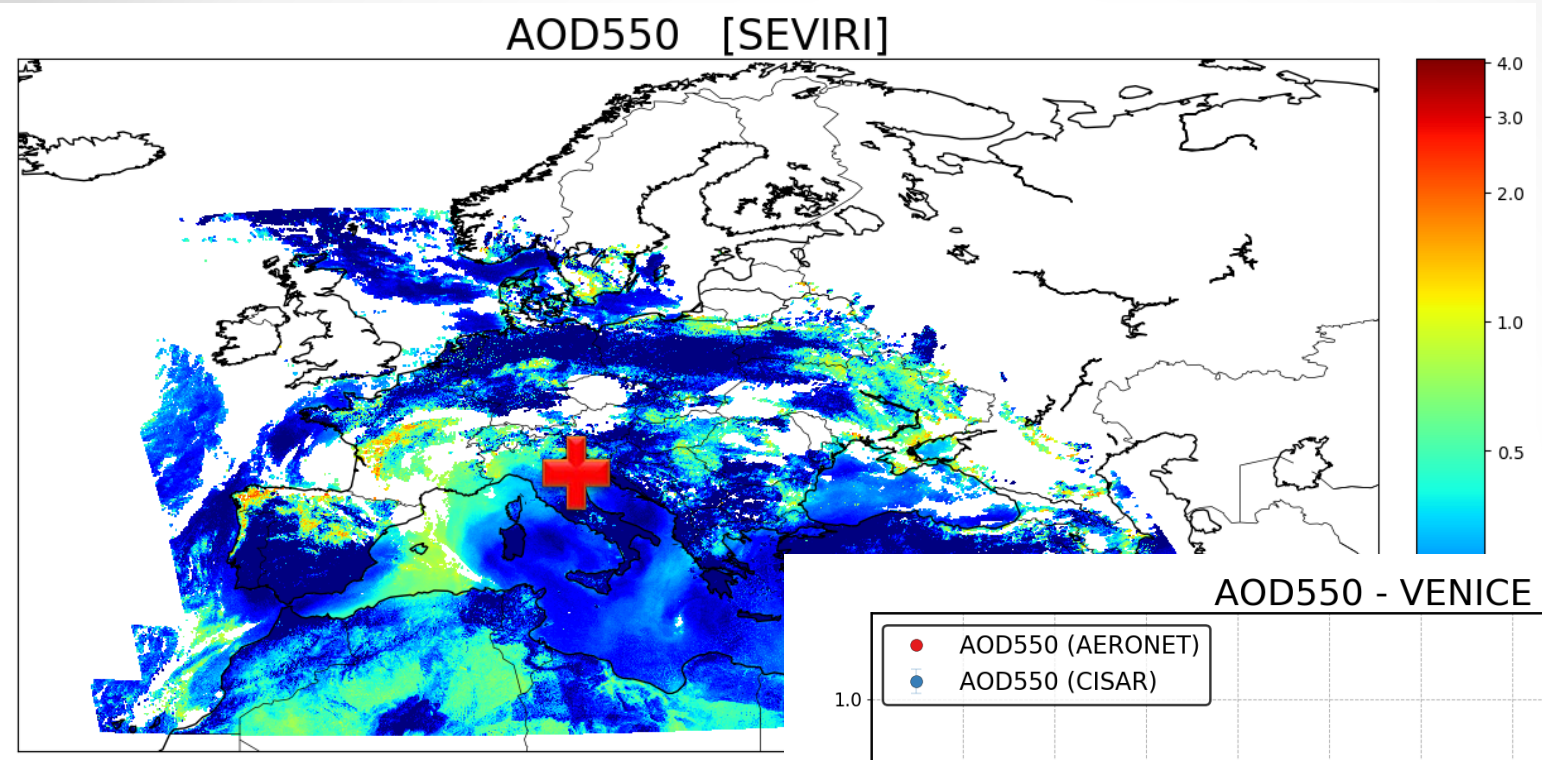
June 2008

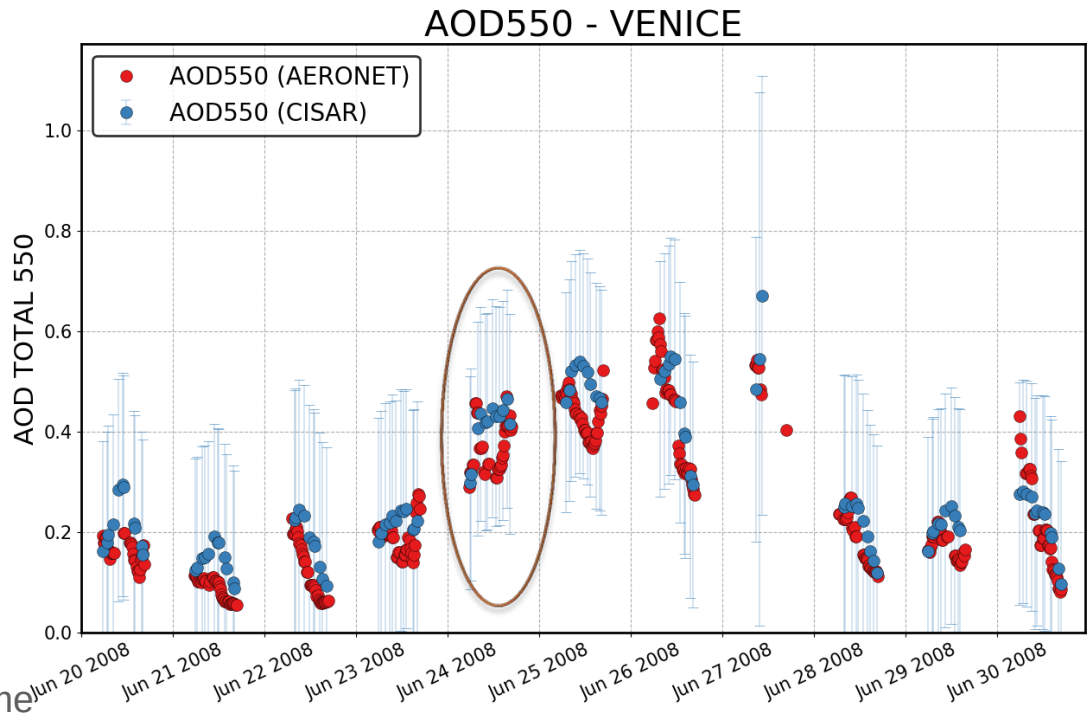




2008/06/23

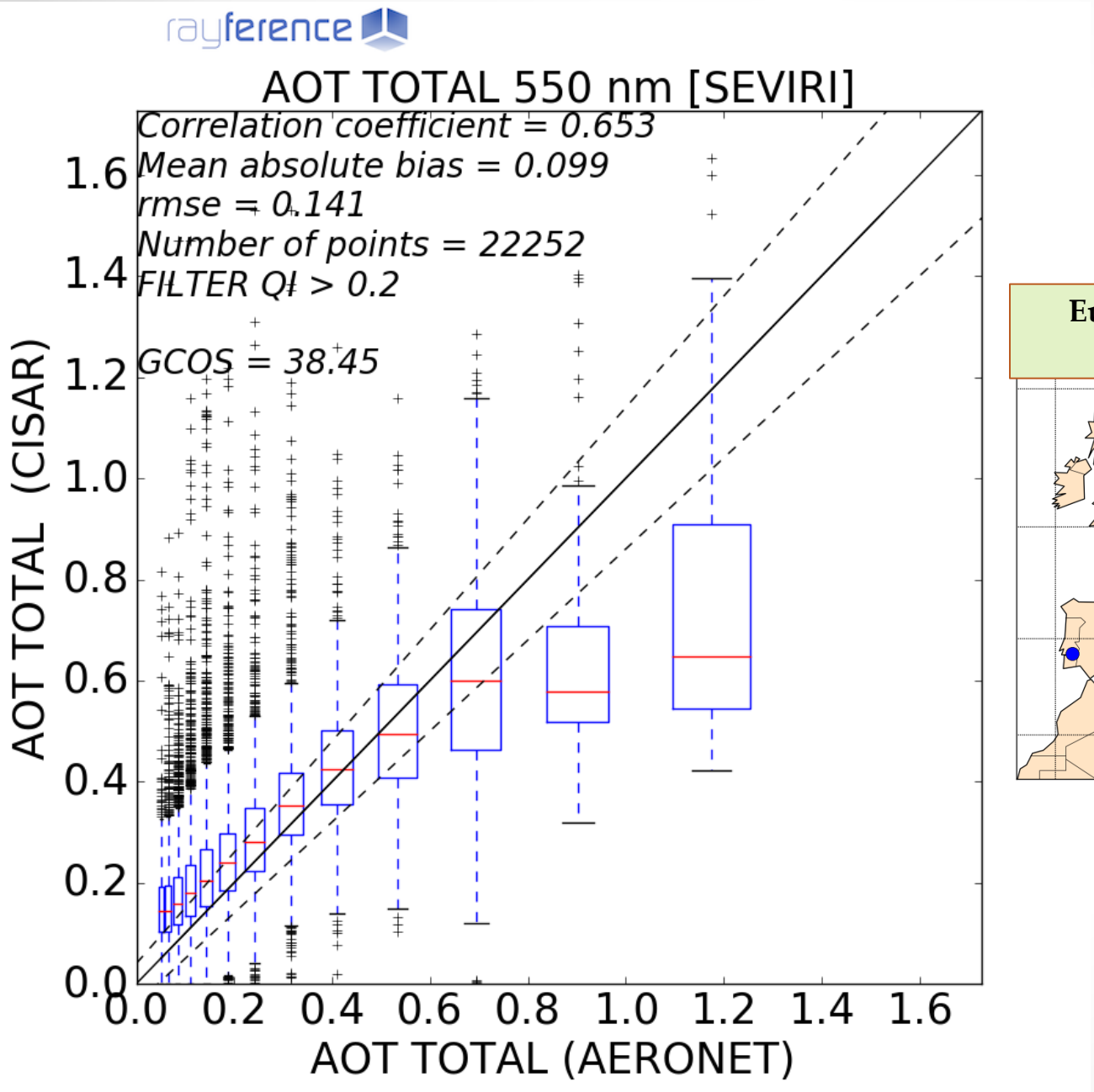
June 2008



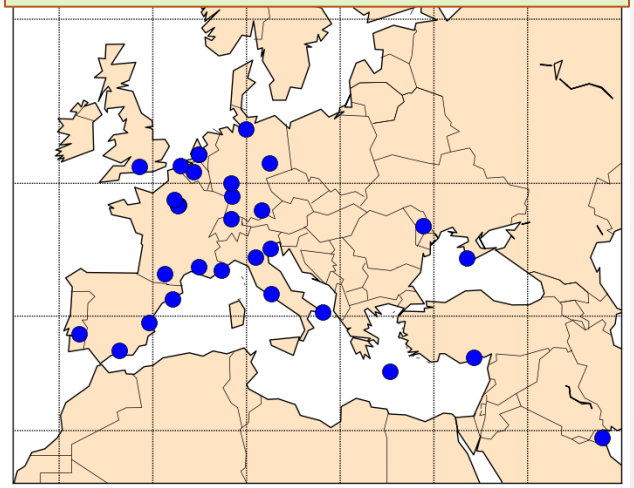


2008/06/24

AOT: Evaluation against AERONET - 2008

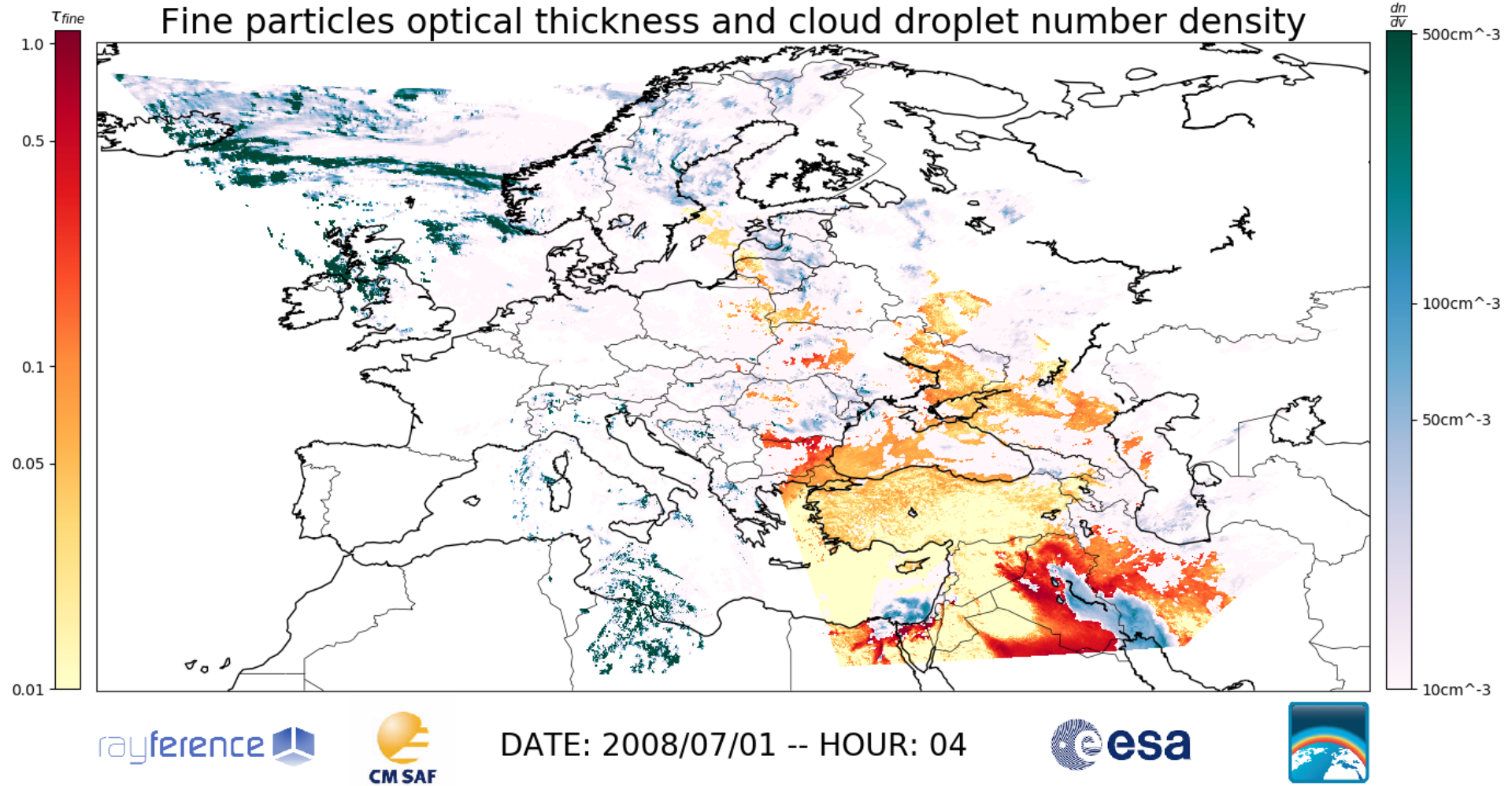


European and homogeneous AERONET stations

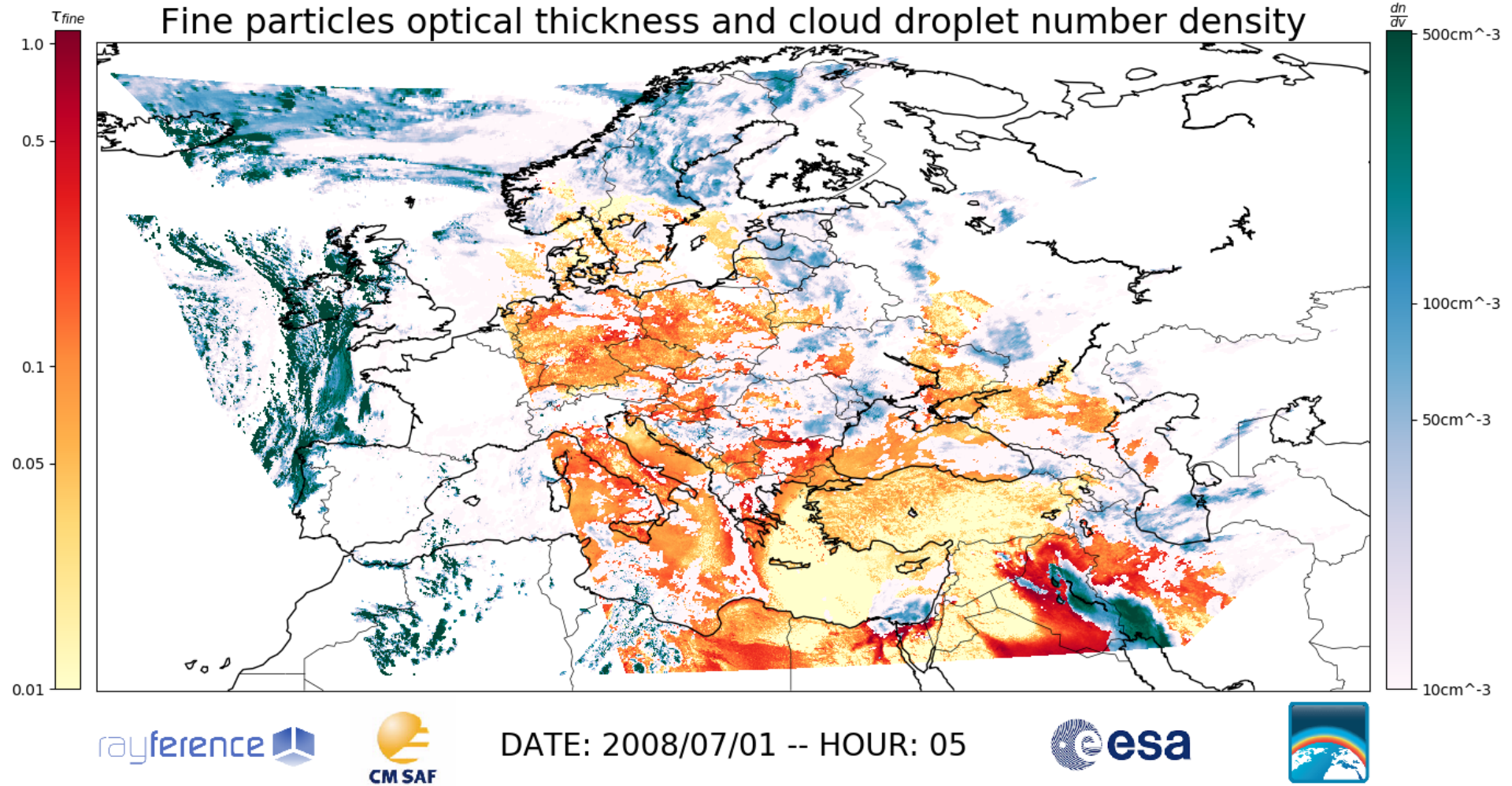


Level 3 Aerosol-cloud interaction

- Input:
  - Cloud Nuclei Concentration provided by the KNMI (CM SAF);
  - Aerosol fine mode AOT data generated by CISAR.
- Output:
  - L3 NetCDF files combining the two datasets


Fine particles optical thickness and cloud droplet number density
τfine
1.0
0.5
0.1
0.05
0.01
dn/dv
500cm^-3
100cm^-3
50cm^-3
10cm^-3
rayference
CM SAF
DATE: 2008/07/01 -- HOUR: 04
esa

Fine particles optical thickness and cloud droplet number density



rayference

CM SAF

DATE: 2008/07/01 -- HOUR: 05

esa

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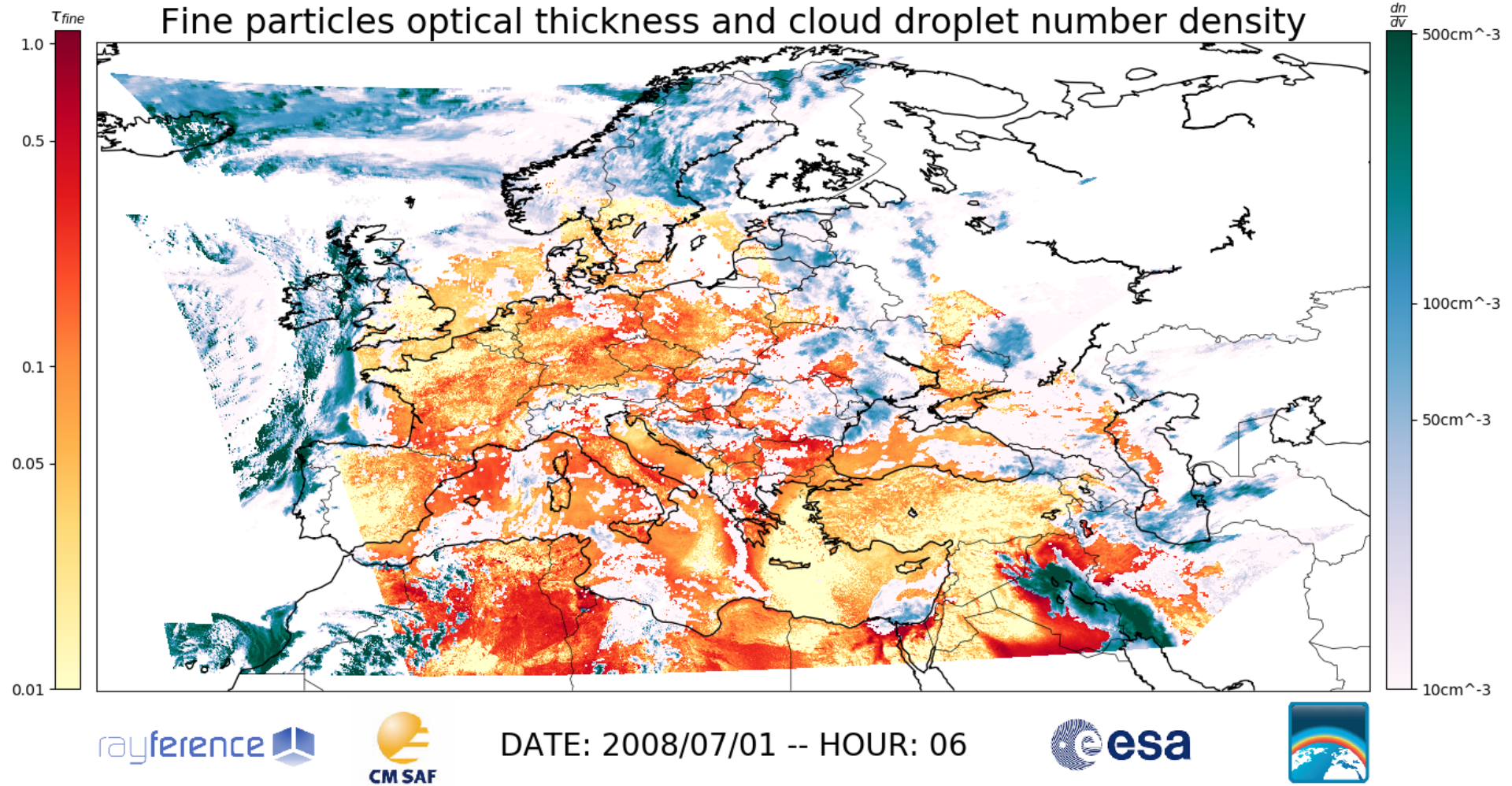
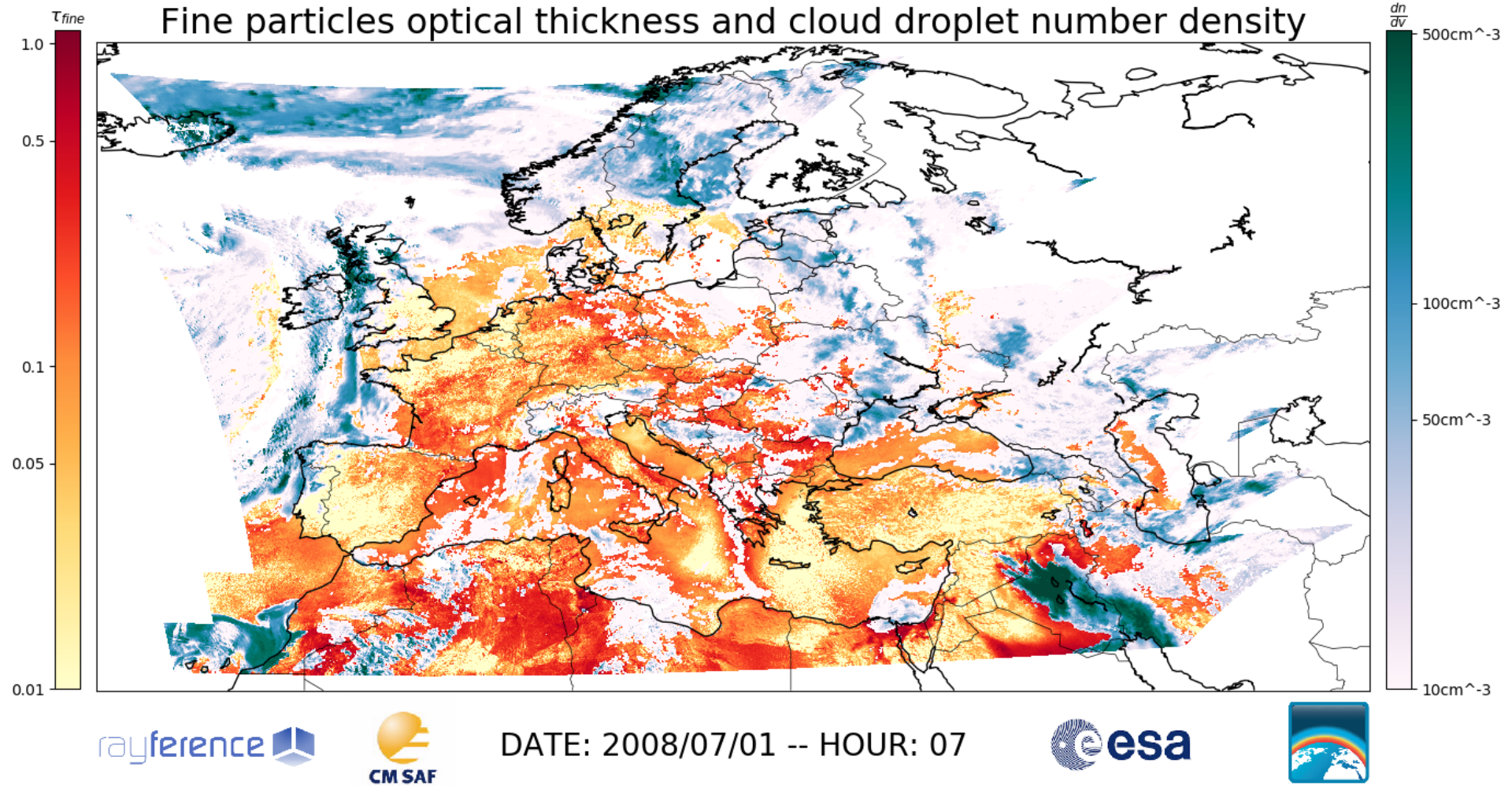


rayference

CM SAF

DATE: 2008/07/01 -- HOUR: 06

esa


Fine particles optical thickness and cloud droplet number density
τfine
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DATE: 2008/07/01 -- HOUR: 07
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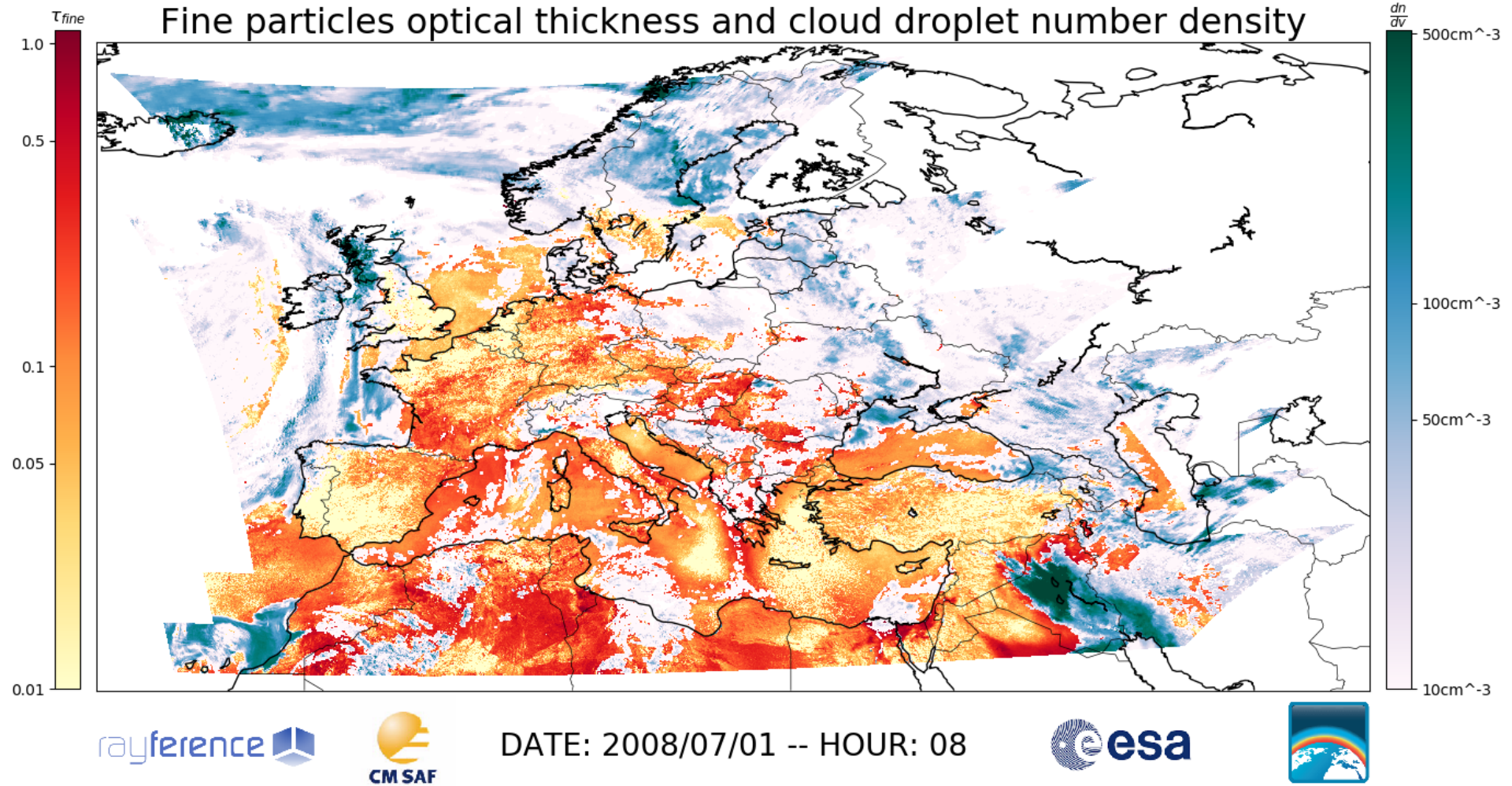


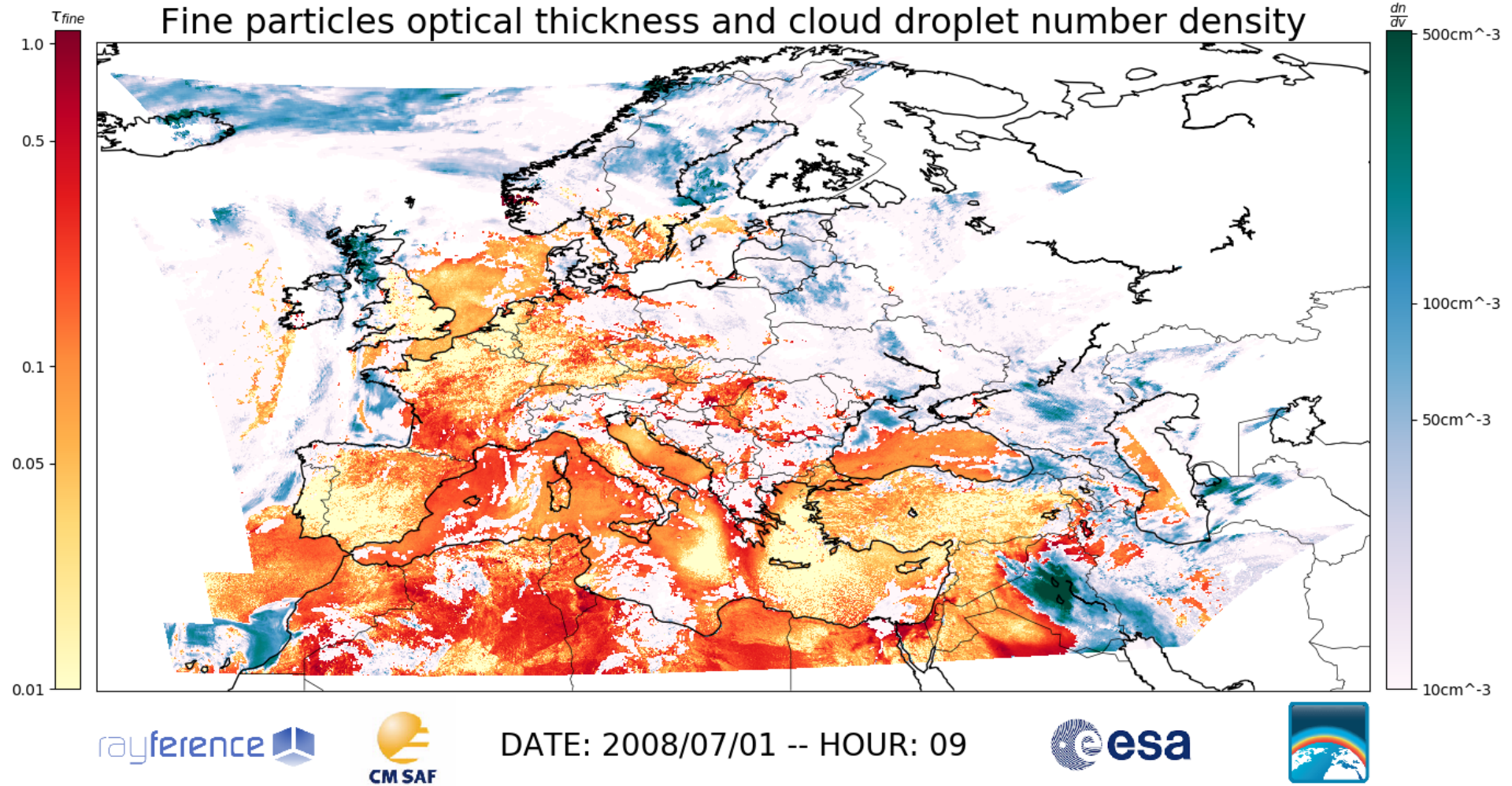
rayference

CM SAF

DATE: 2008/07/01 -- HOUR: 08

esa

Fine particles optical thickness and cloud droplet number density



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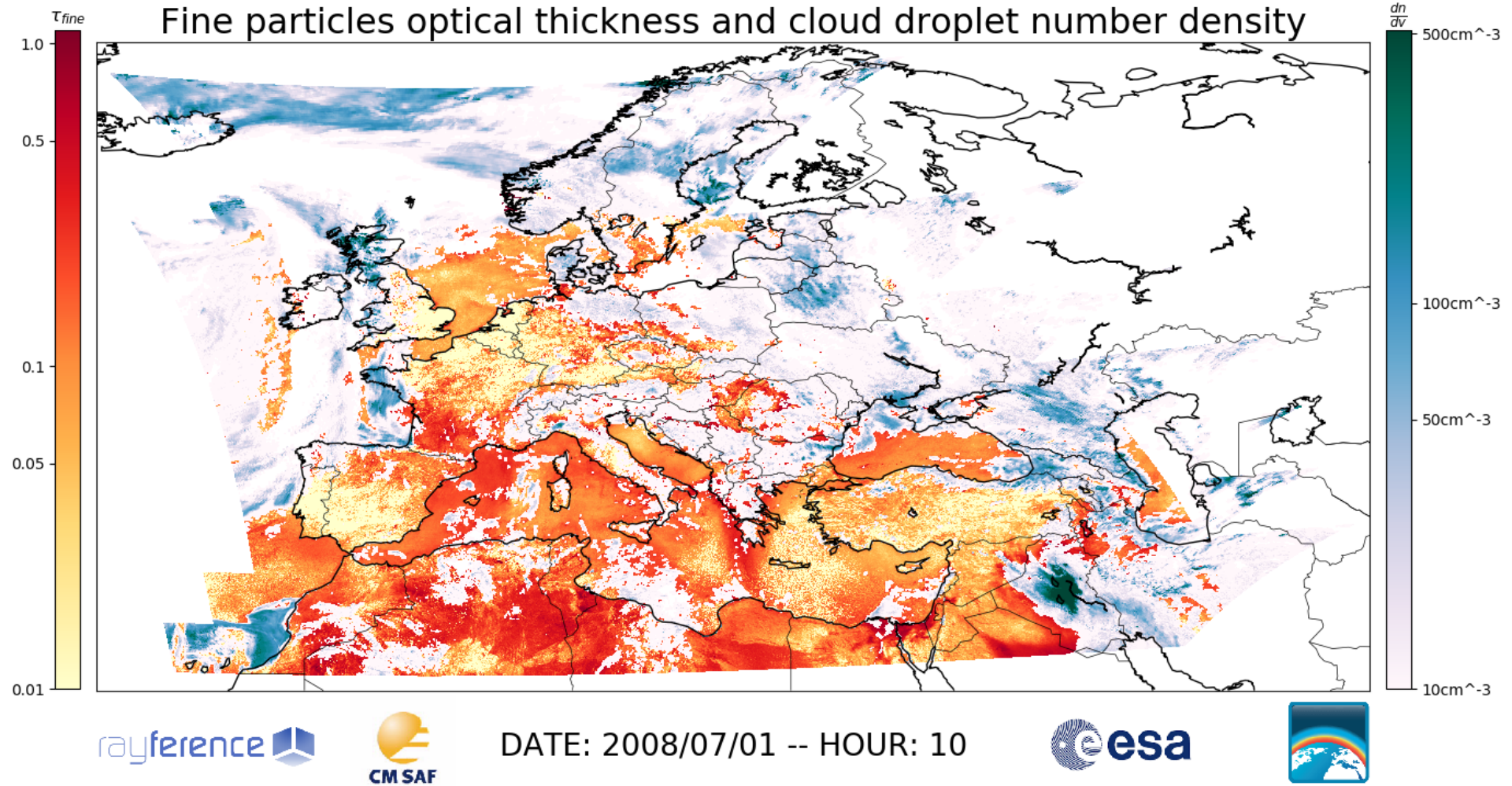
CM SAF

DATE: 2008/07/01 -- HOUR: 09

esa

rayference

Fine particles optical thickness and cloud droplet number density



rayference

CM SAF

DATE: 2008/07/01 -- HOUR: 10

esa

rayference

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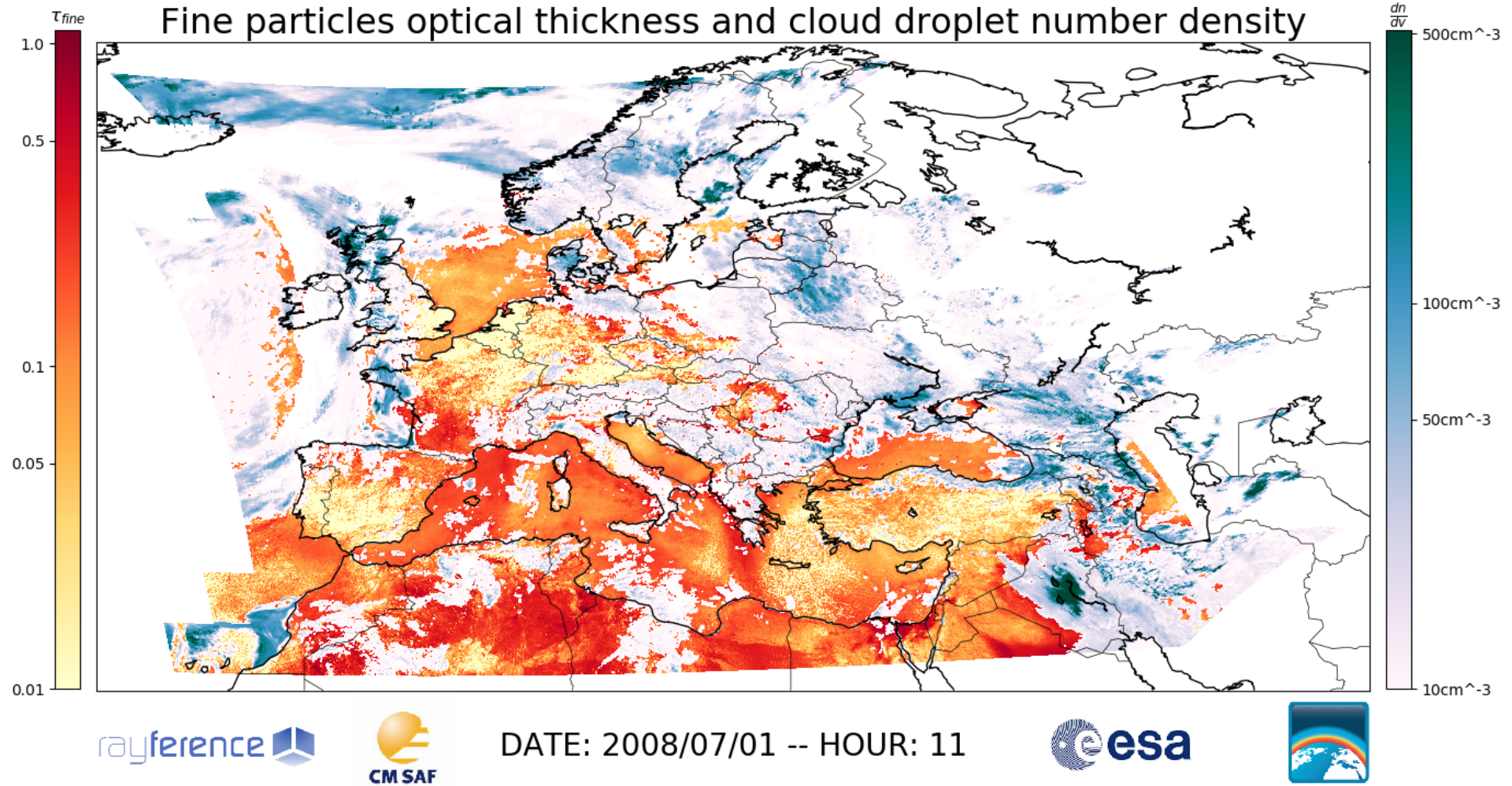

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DATE: 2008/07/01 -- HOUR: 11

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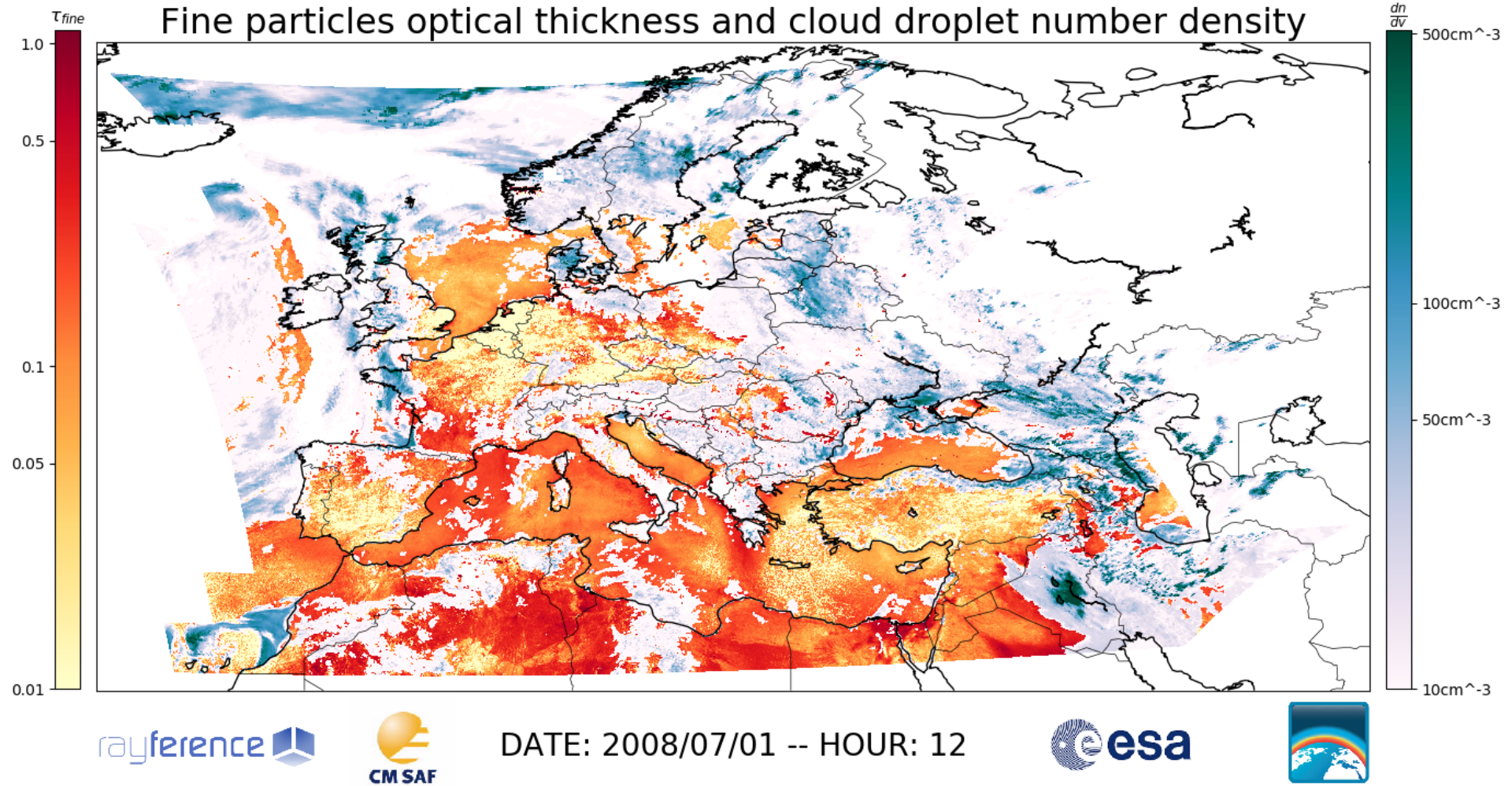
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DATE: 2008/07/01 -- HOUR: 12
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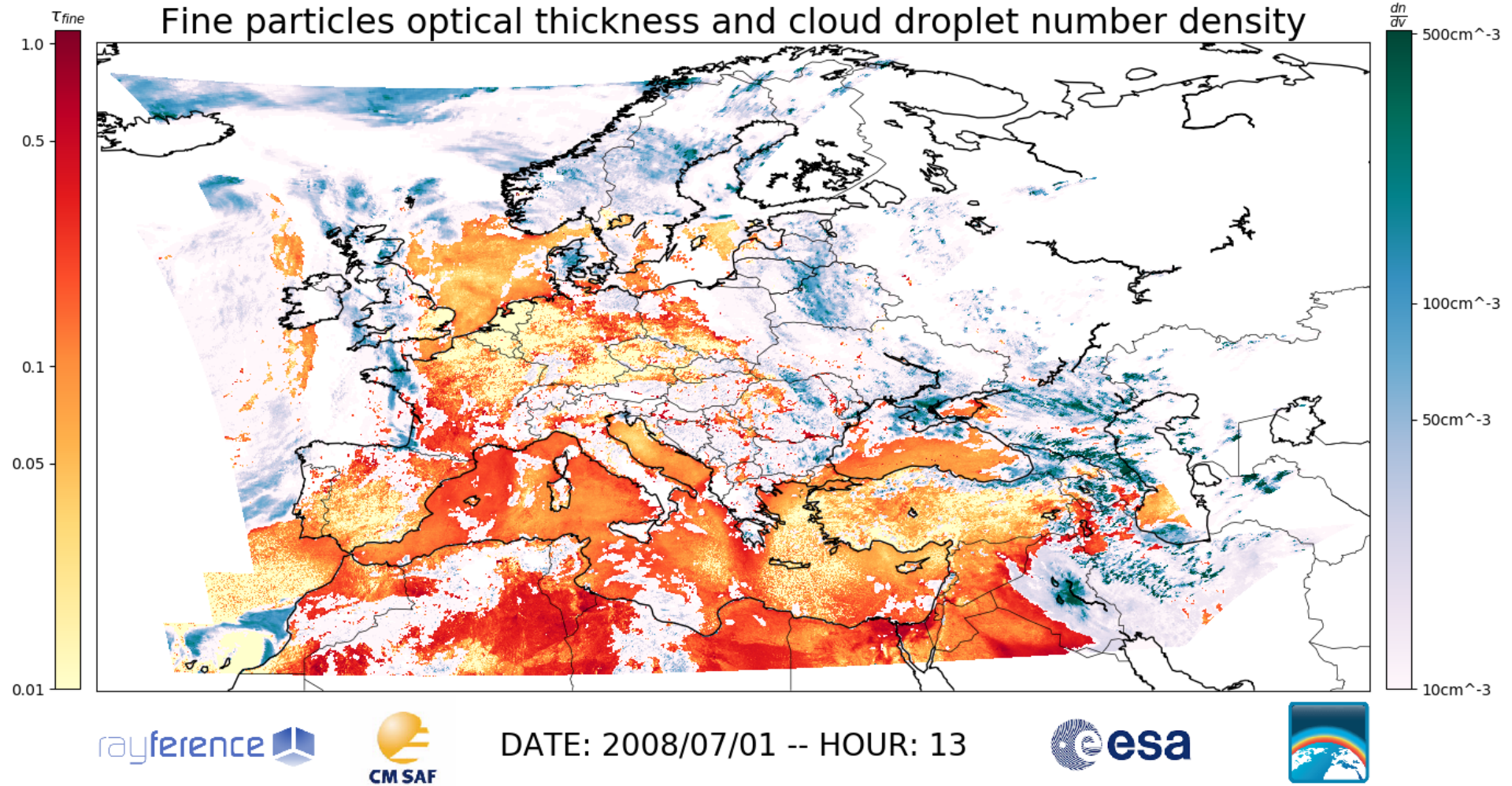
Fine particles optical thickness and cloud droplet number density



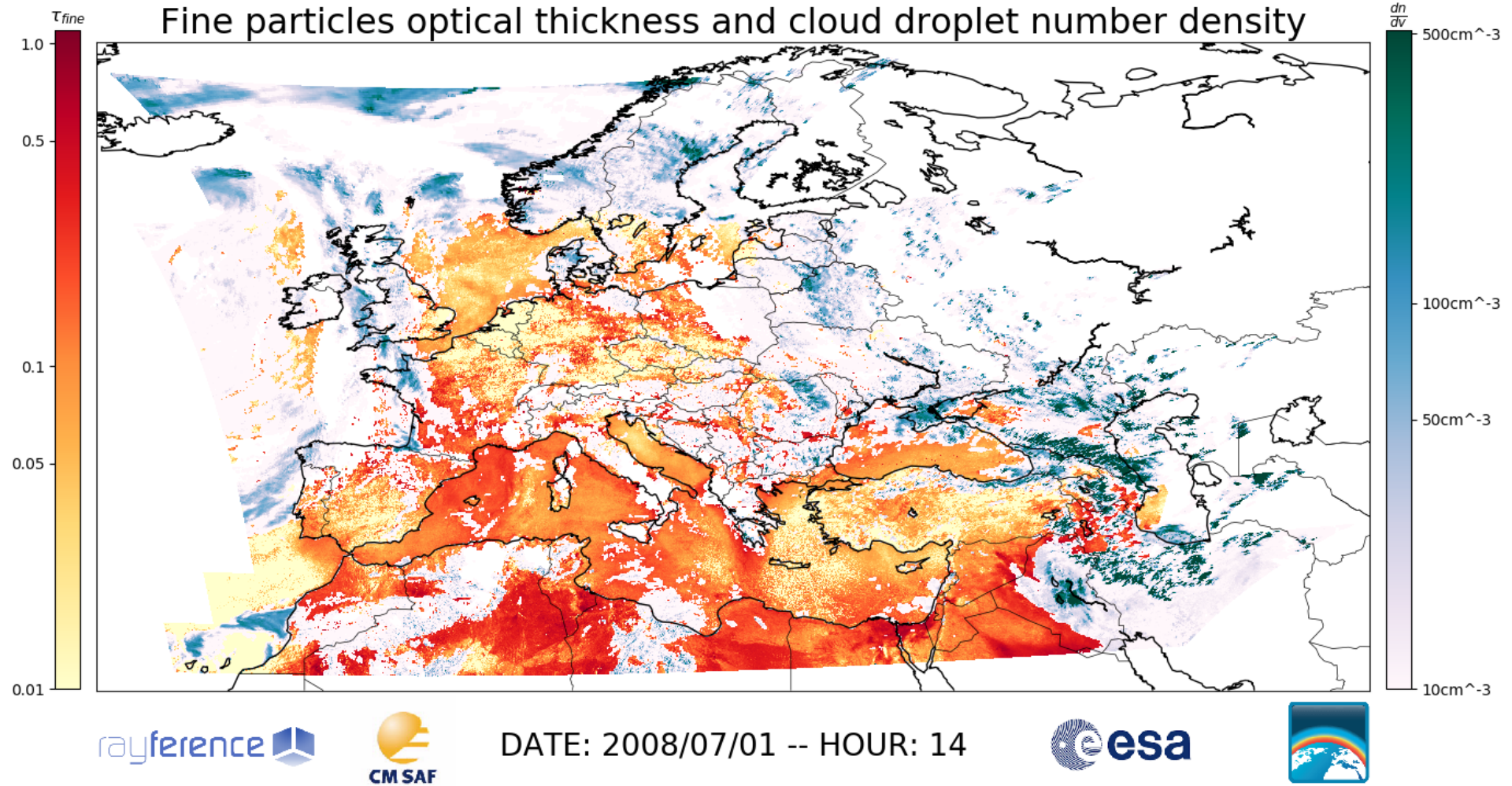
rayference

CM SAF

DATE: 2008/07/01 -- HOUR: 13

esa

rayference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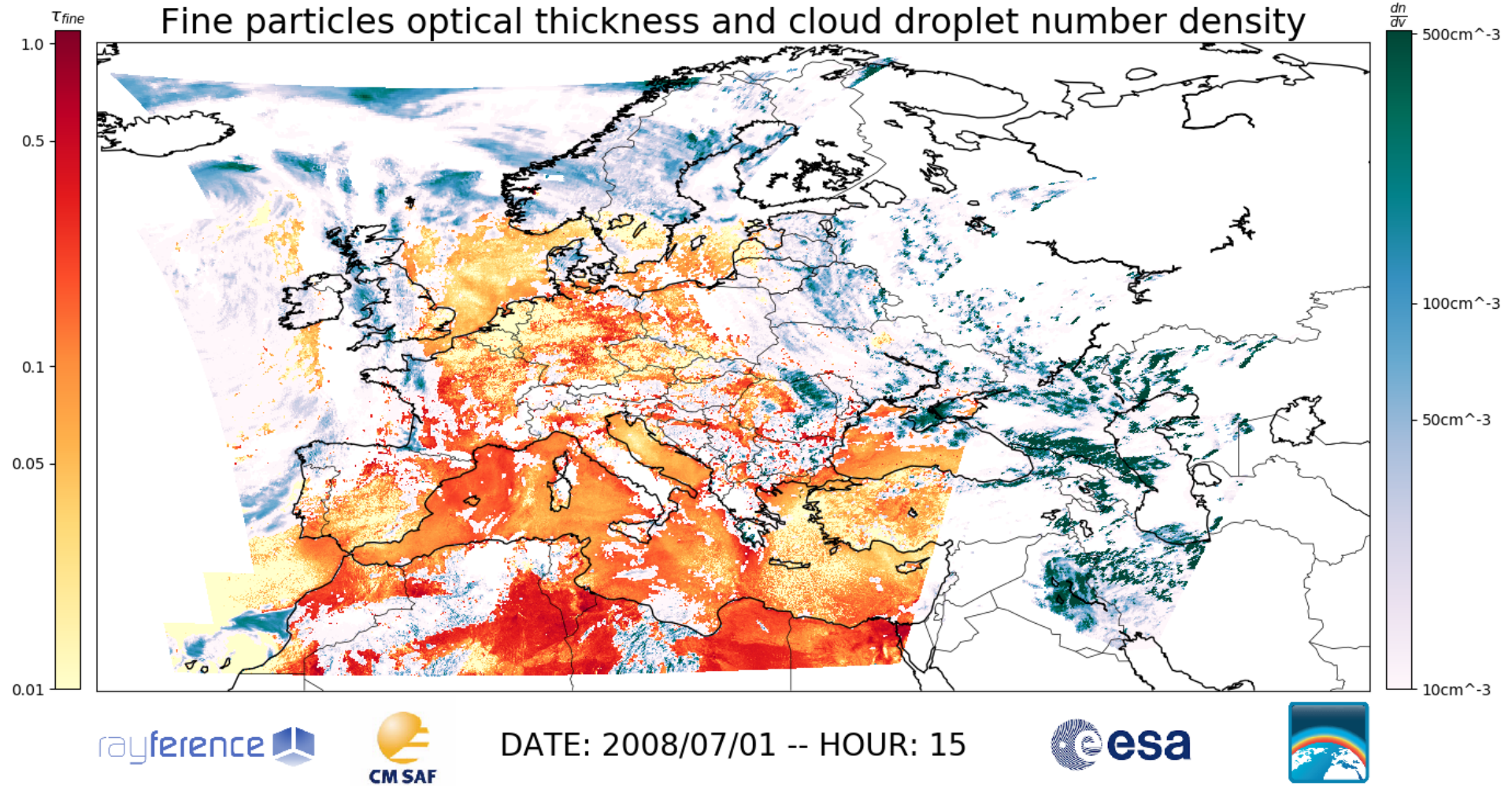
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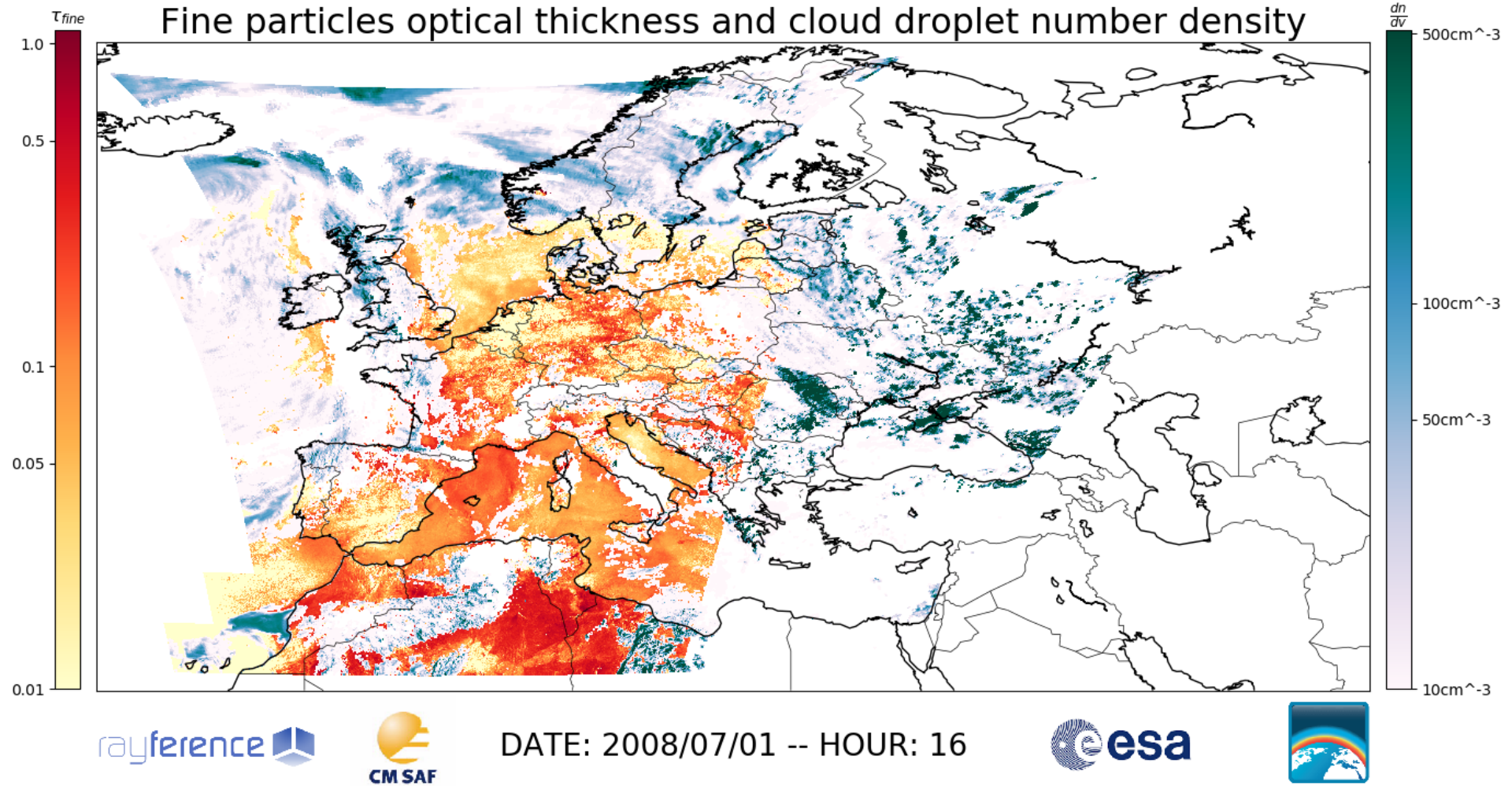
DATE: 2008/07/01 -- HOUR: 15
esa

Fine particles optical thickness and cloud droplet number density



rayference

CM SAF

DATE: 2008/07/01 -- HOUR: 16

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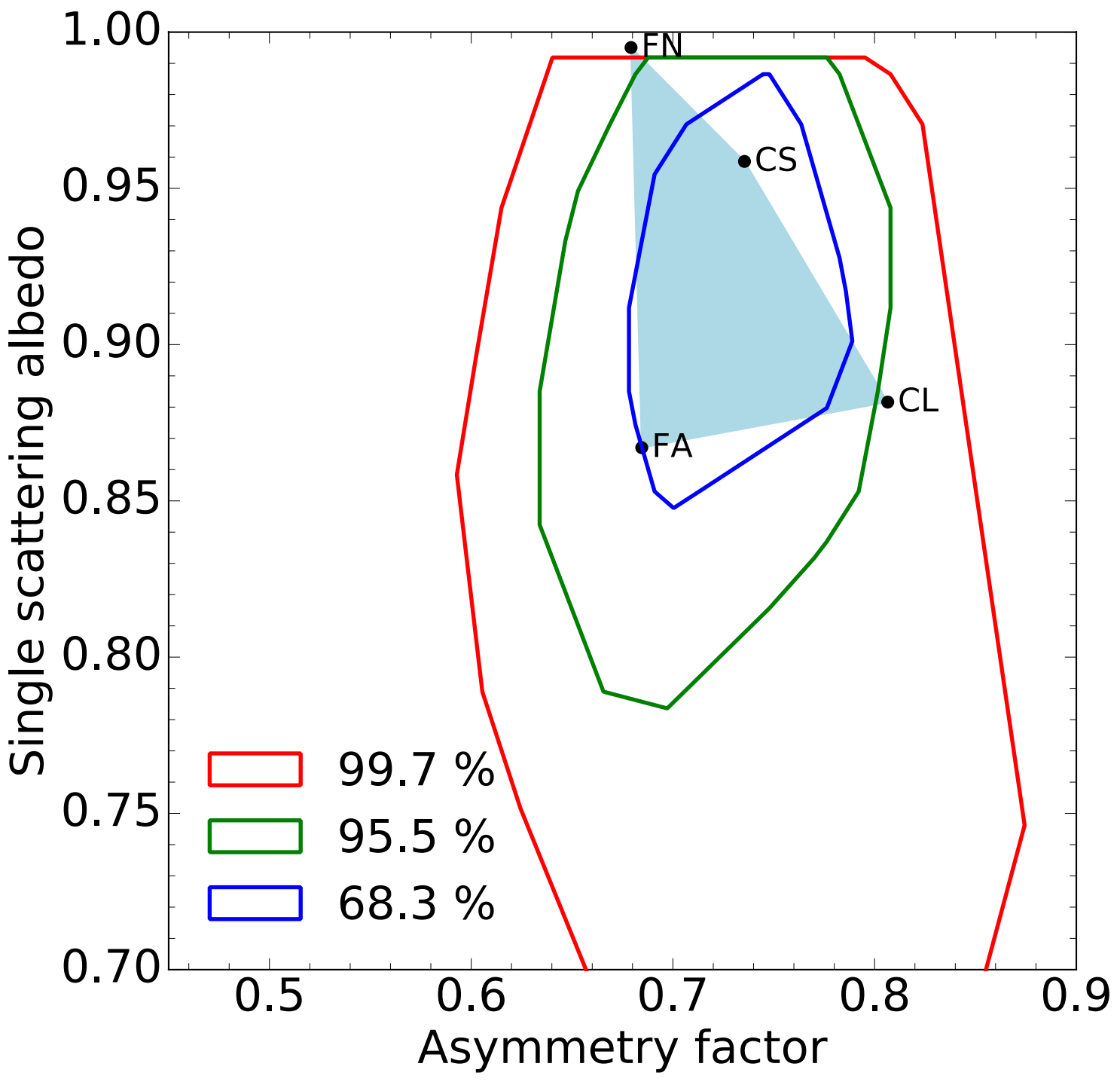
Cloud-aerosol data set

The purpose of this combined cloud nuclei concentration and fine mode aerosol optical thickness product is to characterize the cloud – aerosol interactions and their temporal evolution.

Future work

- Application of the CISAR algorithm on S3/SLSTR data for the joint retrieval of surface reflectance and aerosol properties;
- A similar approach will be used over cloudy pixels to avoid the use of a cloud mask;
- Feedback from the user community is welcome.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Single scattering albedo
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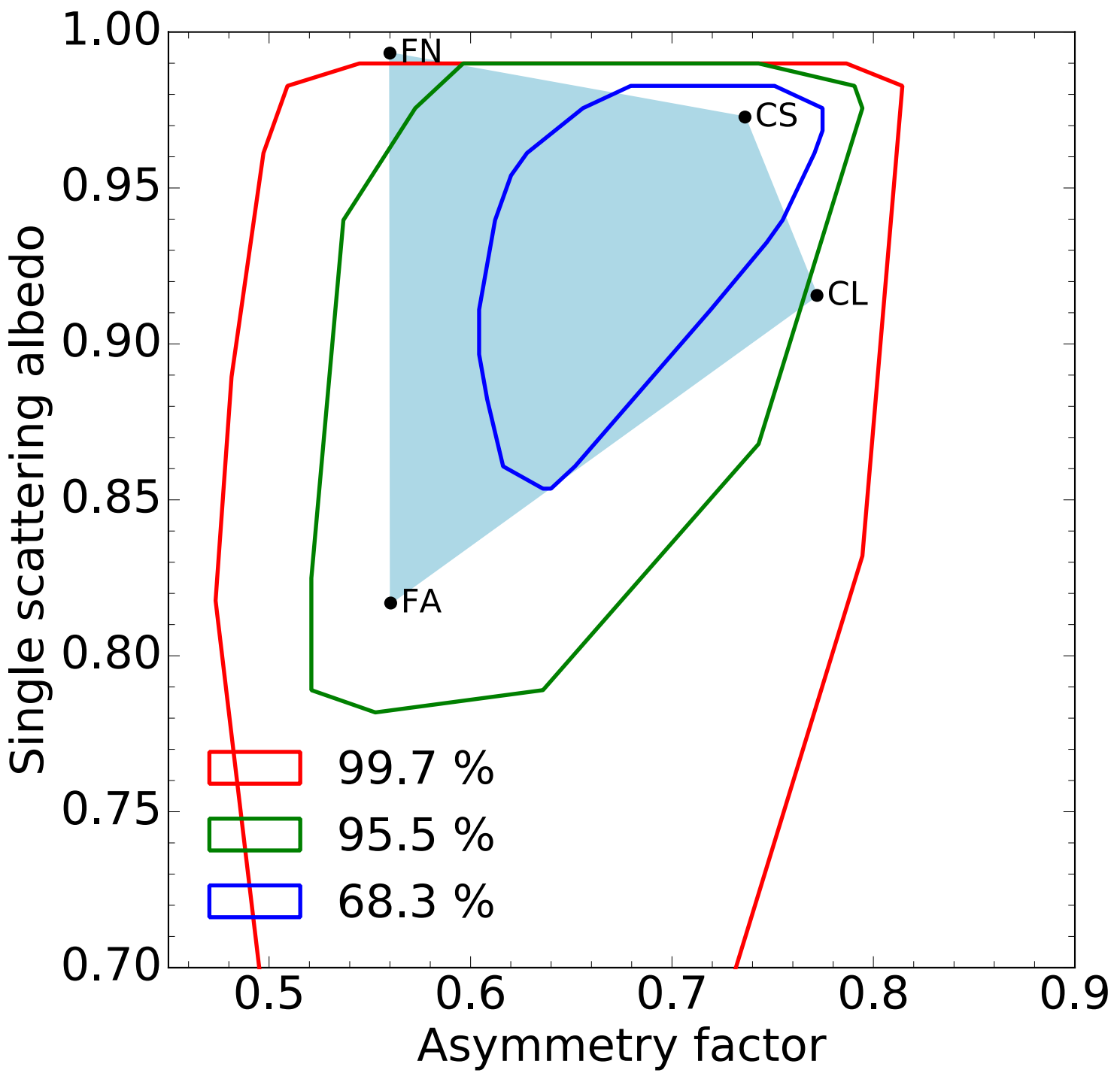
Asymmetry factor
FN
CS
CL
FA
99.7 %
95.5 %
68.3 %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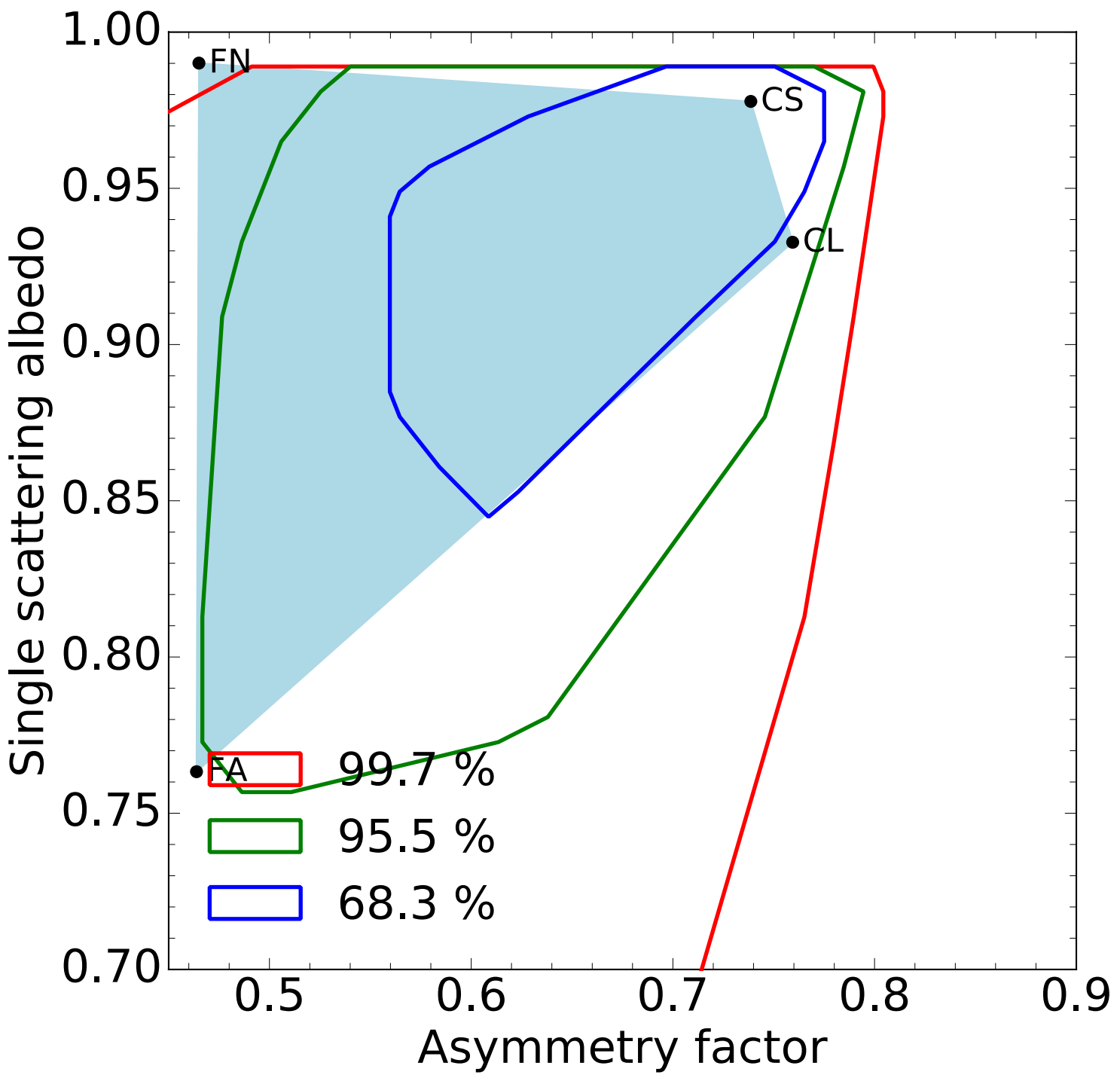
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