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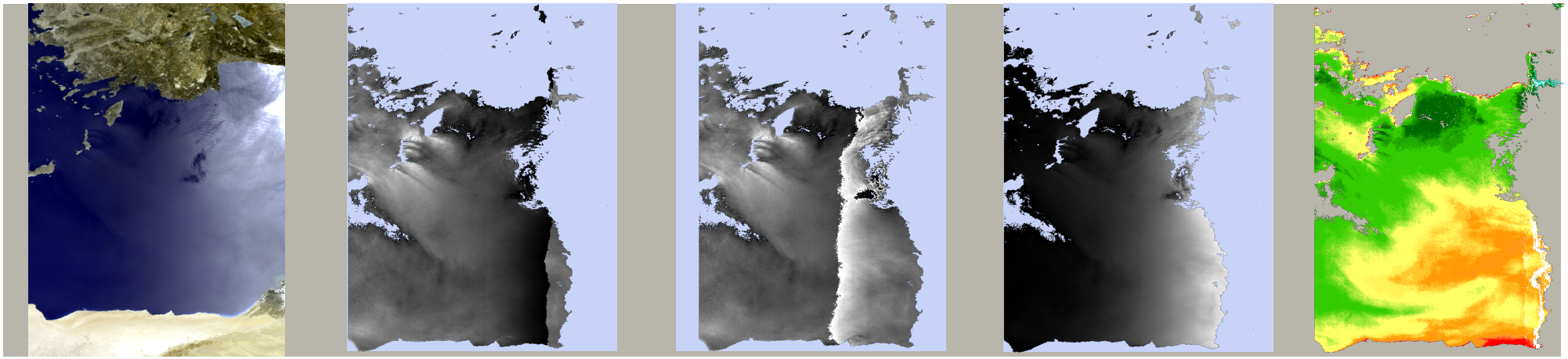


Aerosol Remote sensing over Ocean in glint contaminated regions using thermal IR and 3.7µm

Jürgen Fischer and Rene Preusker

(Free University Berlin)

Motivation

Problems: remember that the main objective of MERIS is Ocean Color remote sensing, but

1. due to ENVISATs overpass time many pixel are “sun glint contaminated” (example follows)
   - water leaving radiance is low → little sun glint destroys information
   - wind speed from external sources (e.g. ECMWF or scatterometer on different satellites) are not accurate enough / wind is to variable
   - contaminated pixel are trashed (current solution)
2. MERIS is a “silicon” sensor and has no SWIR information

Solution:

- Use AATSR SWIR
- Use AATSR thermal information to estimate the *glint*: ***FLINT***
- Aerosol retrievals using *glint* as lower boundary condition: ***SynAO***

FLINT

AATSR 11µm, 12µm and 3.7µm

⇩

effective windspeed

⇩

sun glint at **any** wavelength and geometry

⇩ ⇩

AGC (R.Doerffer)

MERIS

Ocean Color, glint cleared

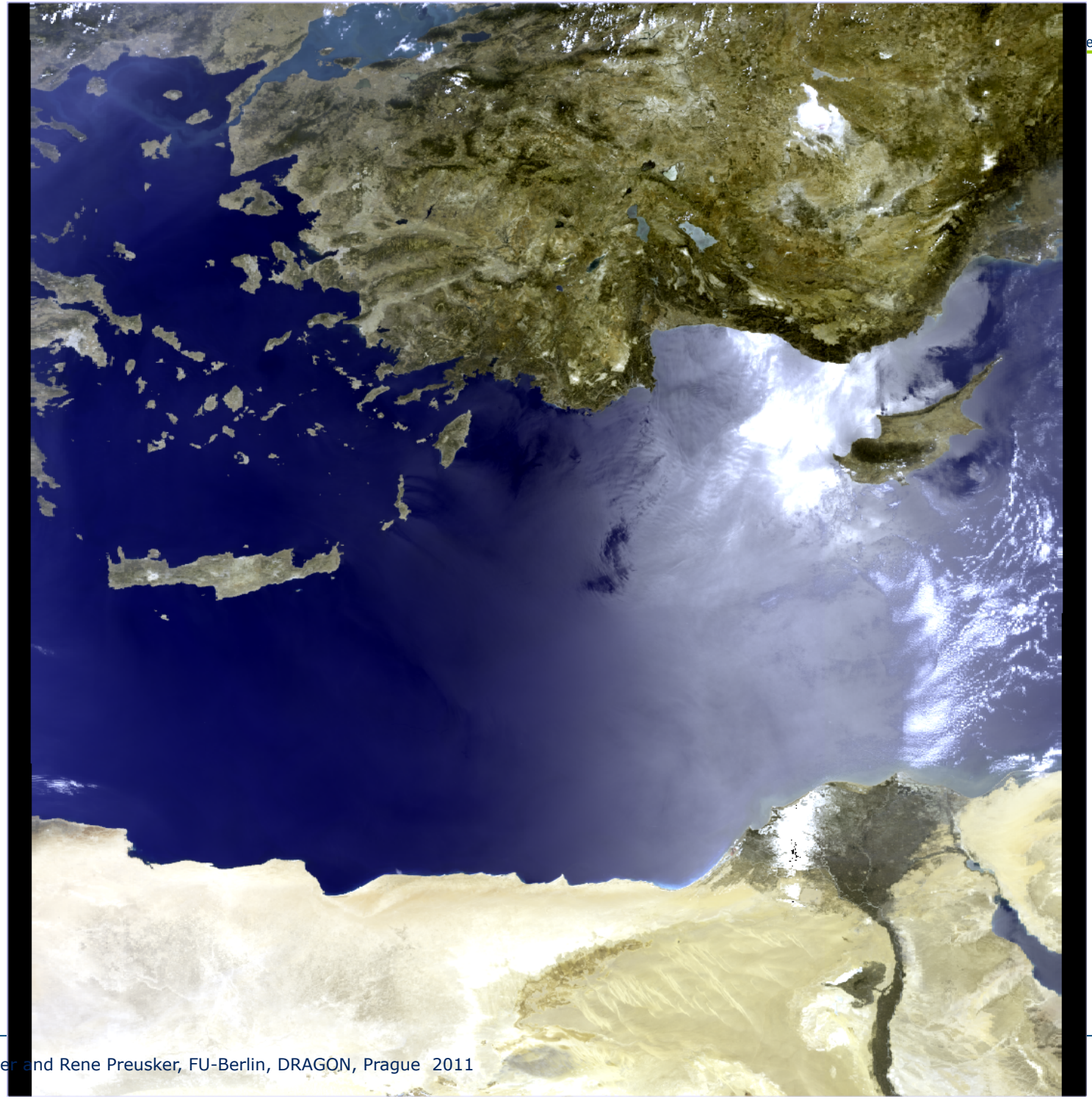
SynAO

MERIS + AATSR

Aerosol Properties

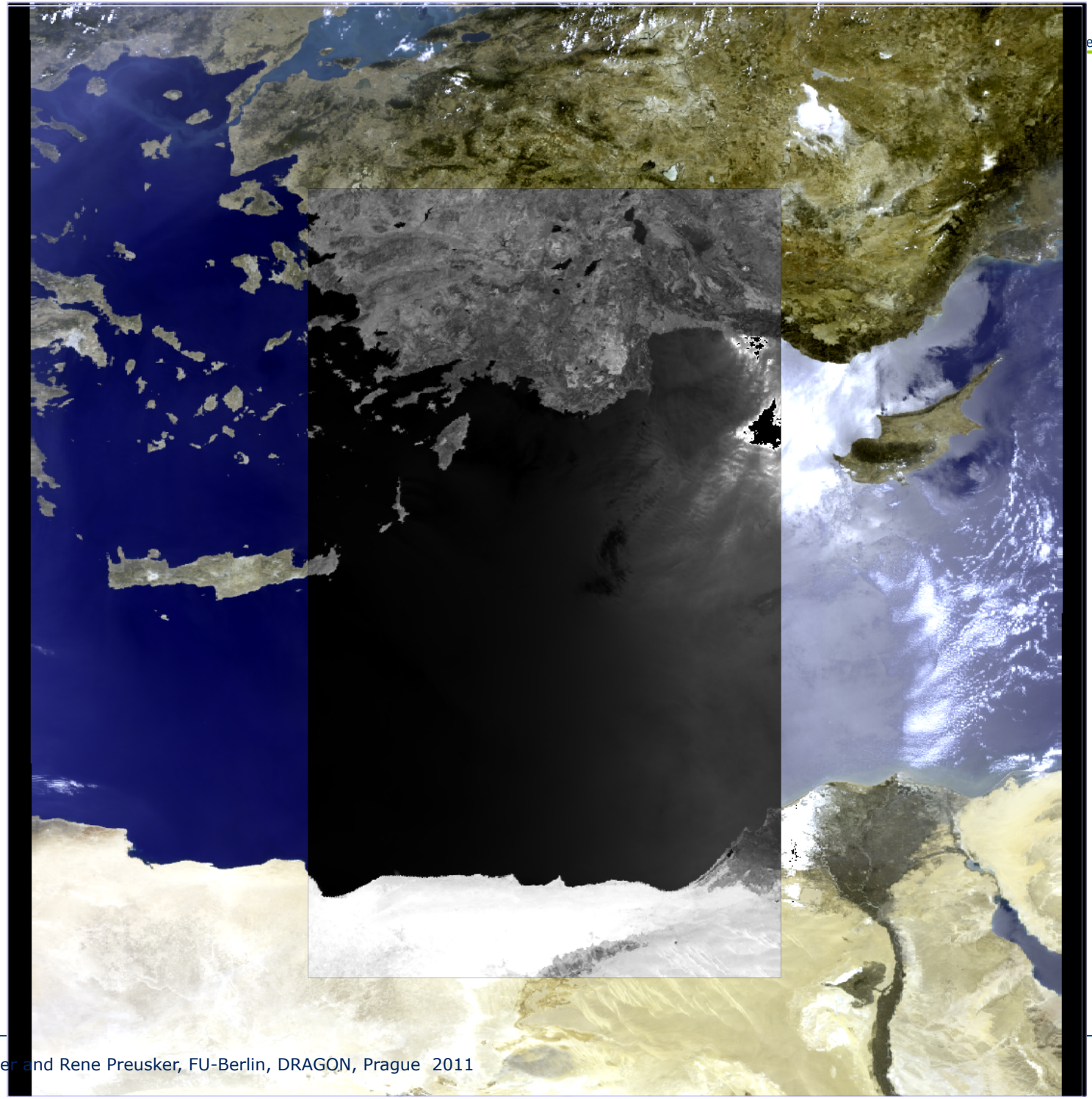
FLINT as a comic

MERIS RGB



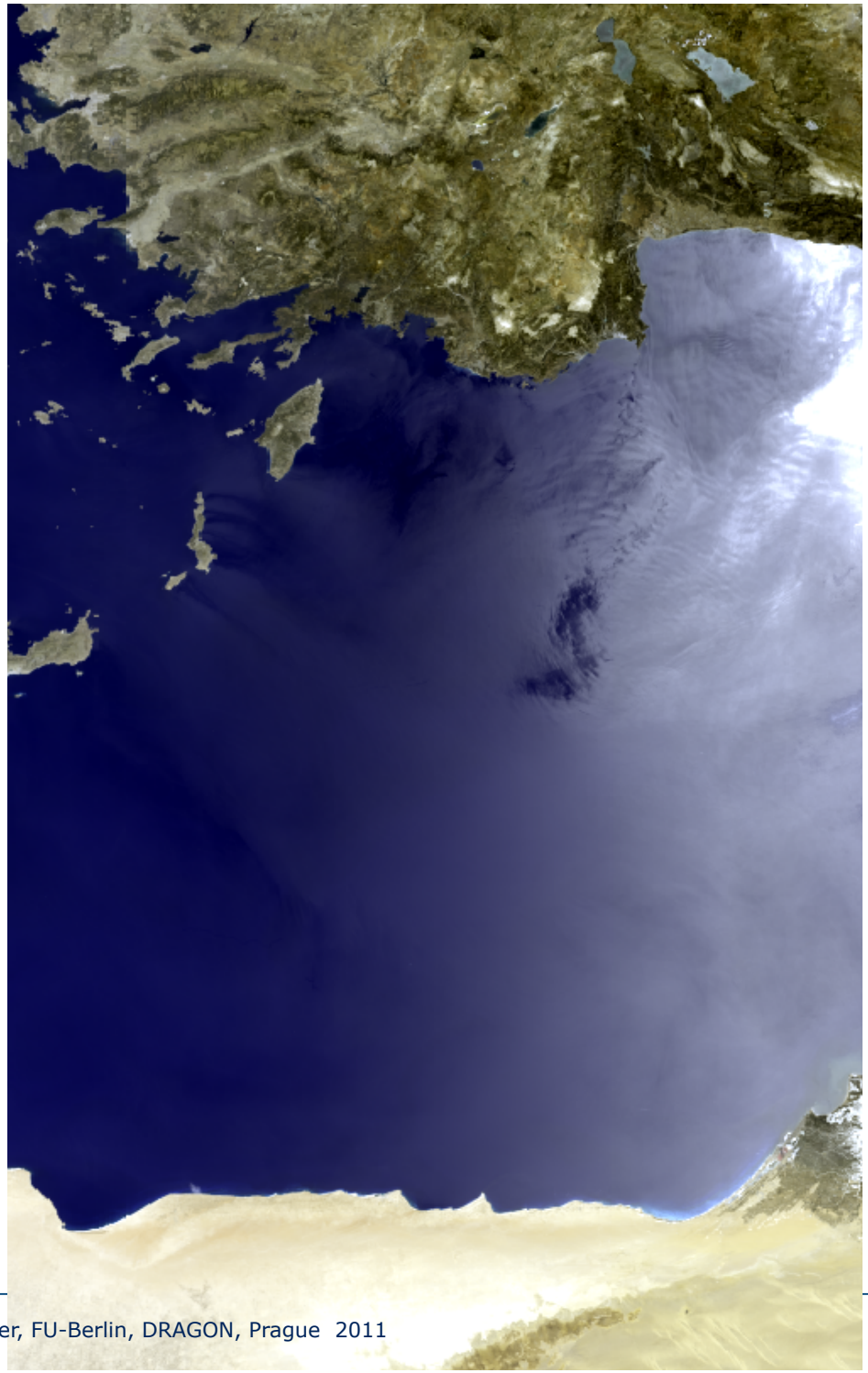
MERIS RGB

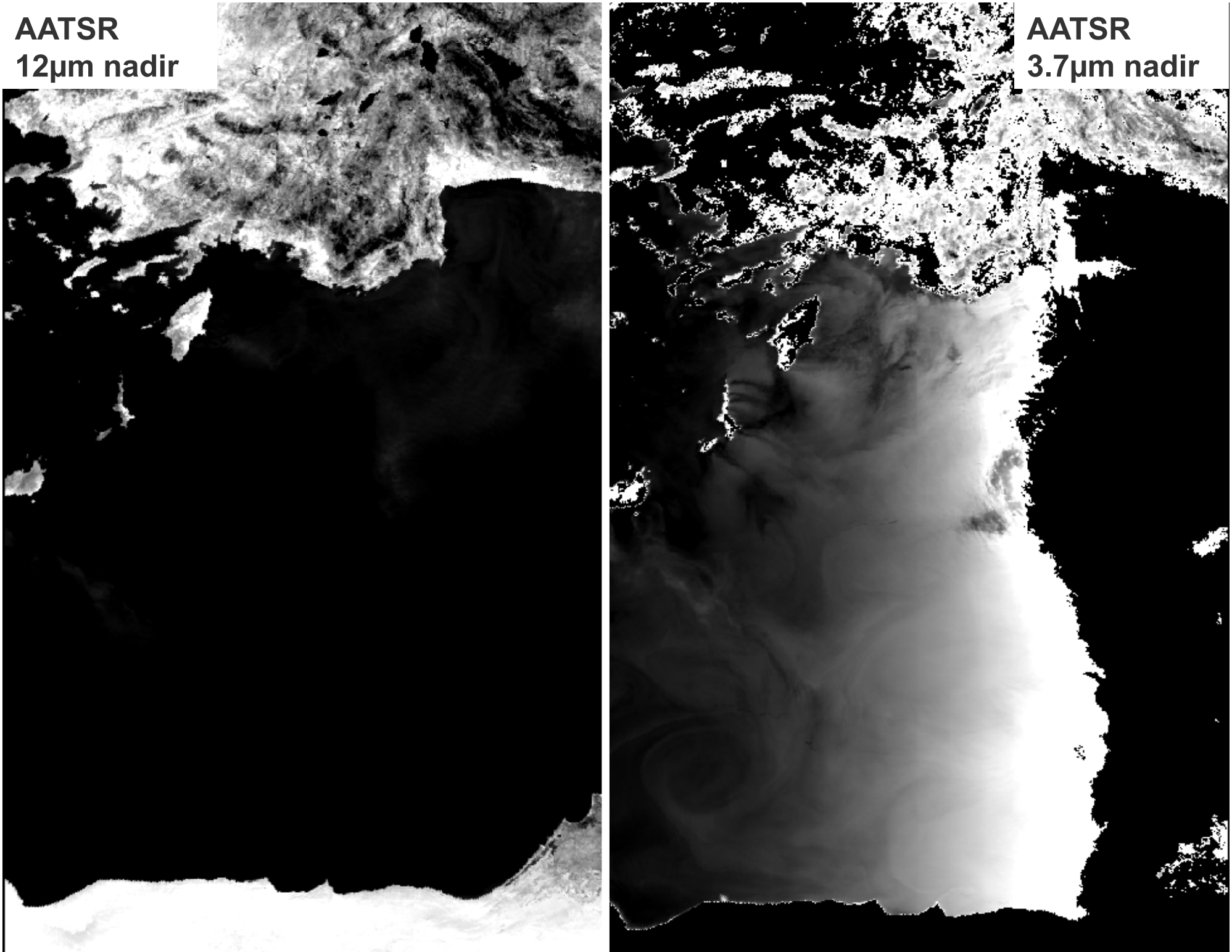
AATSR 1.6 over



MERIS RGB

common area



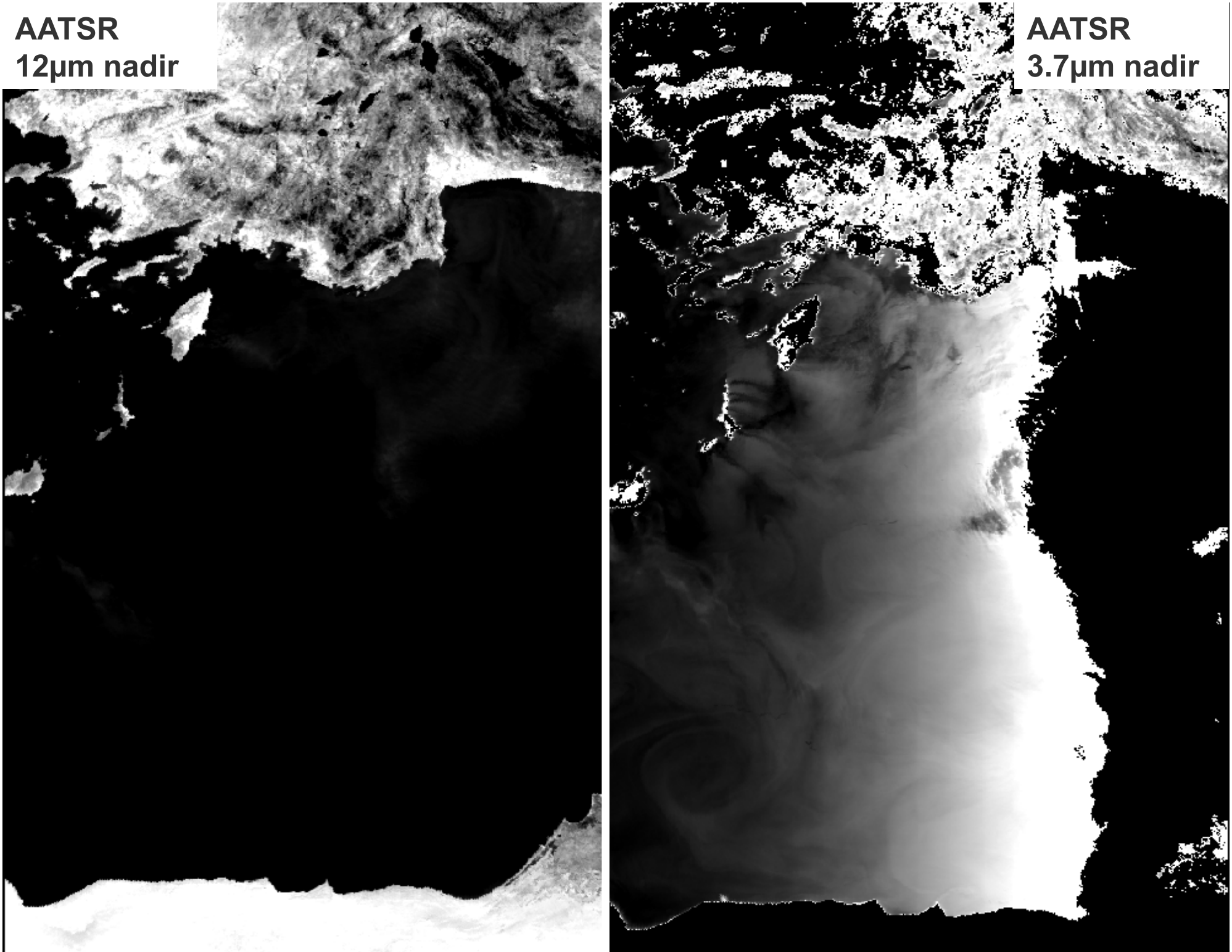

AATSR
12µm nadir
AATSR
3.7µm nadir

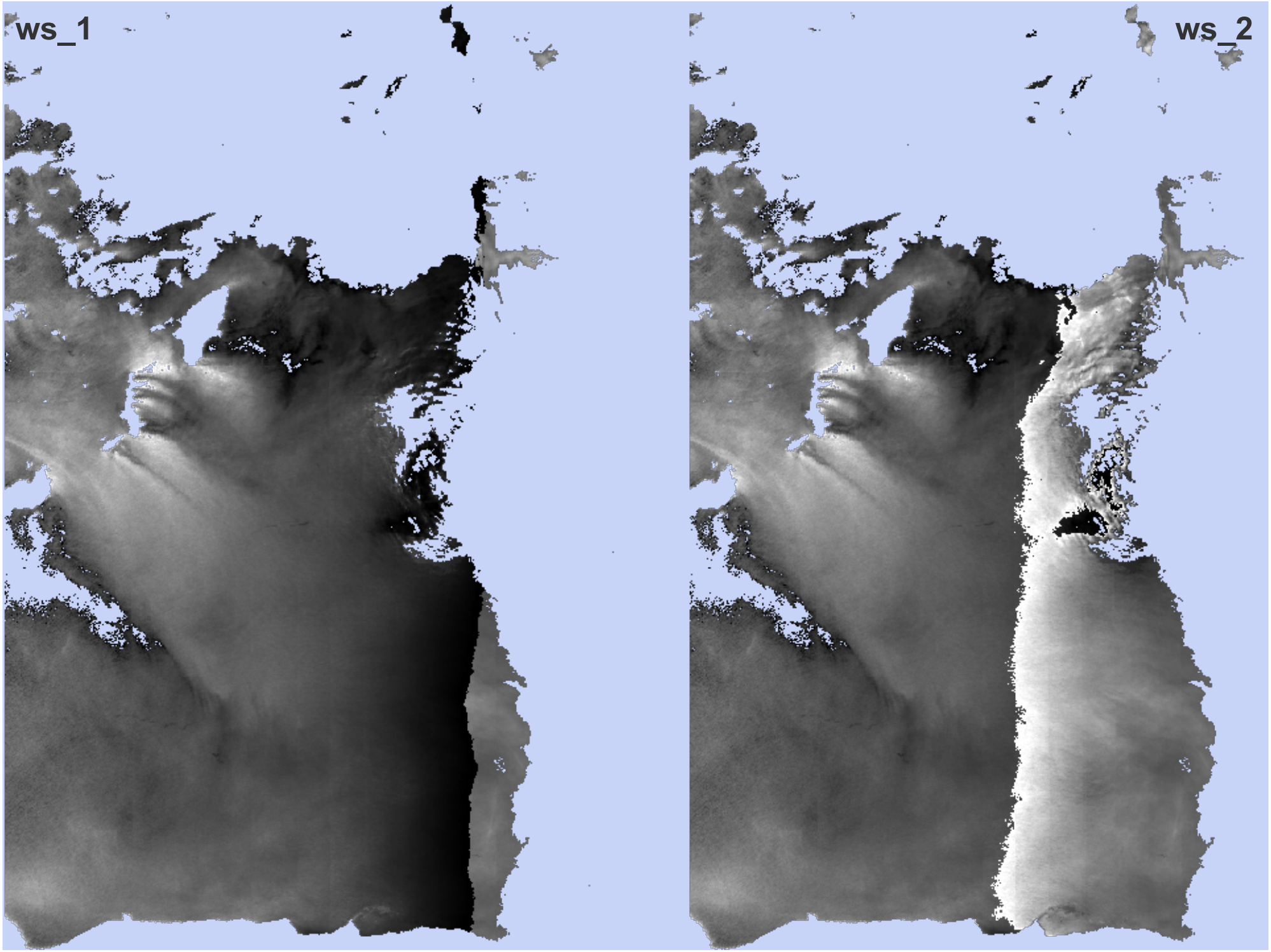
- Linear Combination (11µm & 12µm) = 3.7µm_thermal
  (Its only Planck and a bit water vapor!)

- (3.7µm_measured - 3.7µm_thermal) = 3.7µm_glint

- 3.7µm_glint (transmission corrected, wv from MERIS L2)
  & inverse modeling → *effective* wind-speed

- *effective* wind-speed is the quantity that enables the calculation of the glint at any other geometry and wavelength (refractive index!)

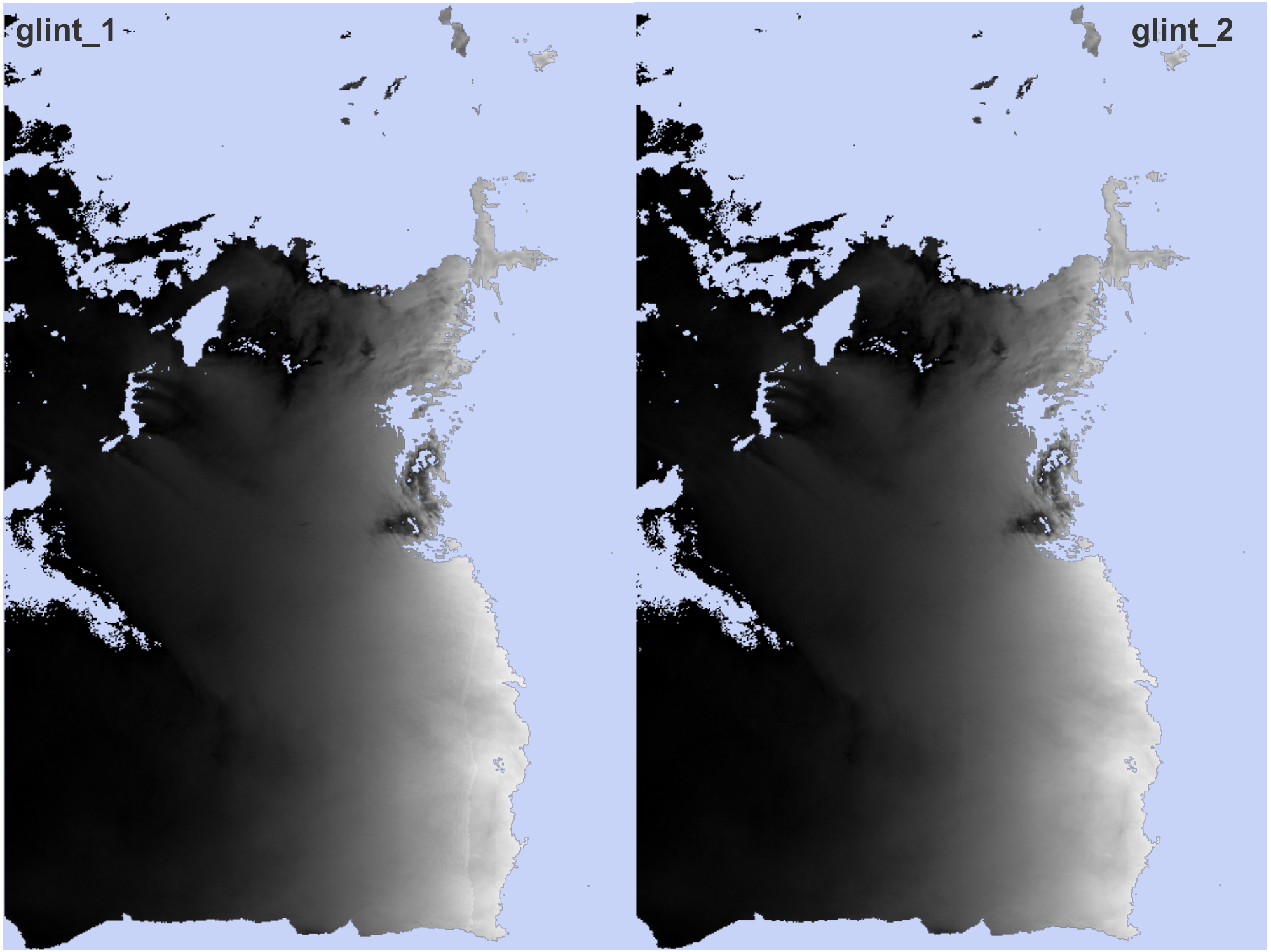

AATSR
12µm nadir
AATSR
3.7µm nadir


ws_1
ws_2

- Linear Combination (11µm & 12µm) → 3.7µm_thermal
- (3.7µm - 3.7µm_thermal) → 3.7µm_glint
- (3.7µm glint (transmission corrected)
  & inverse modeling) → *effective* wind-speed

One 3.7µm_glint can (sometimes) belong to two effective wind-speeds!

- next step: Calculate the glint at MERIS and AATSR wavelengths and viewing geometry.


glint_1
glint_2

- LK (11µm & 12µm) → 3.7µm_without_solar
- (3.7µm - 3.7µm_without_solar) → 3.7µm_glint
- (3.7µm glint (transmission corrected)
  & inversere modelling) → *effective* wind-speed

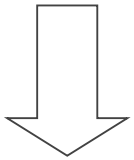
One 3.7µm_glint can (sometimes) belong to two effective wind-speeds!

BUT: This ambiguity is in most cases harmless!

(Taking the mean ws or ECMWF … would be harmfull!)

SynAO

FLINT + MERIS + AATSR



Aerosol Properties

Procedure:

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For all (1 or 2) windspeeds (*ws*)

For all 6 (7) combinations of wavelengths and geometry:
ME: 865, 890, AN: 865,1600,
AF: 865,1600

Calculate L_TOA for τ [0-2]
and α [min-max] (using appropriate **interpolated** LUTs)

Minimize cost
$(L\_TOA(\tau,\alpha,\lambda,ws) - L\_TOA\_MEA)^2$

Choose *ws* with the lowest cost

Example: RGB

Calculated Glint

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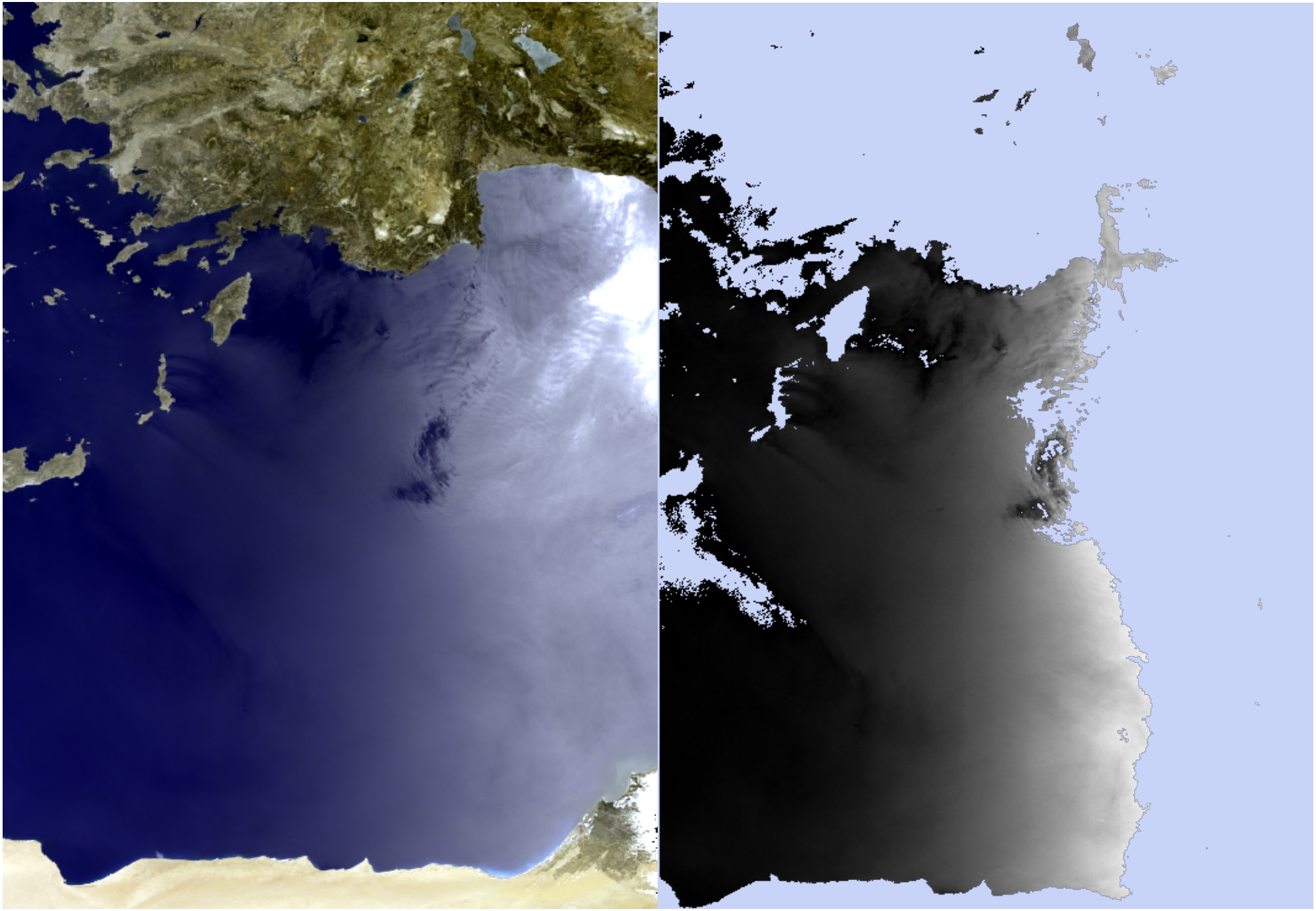

Example: RGB

Calculated AOT (0-0.3)

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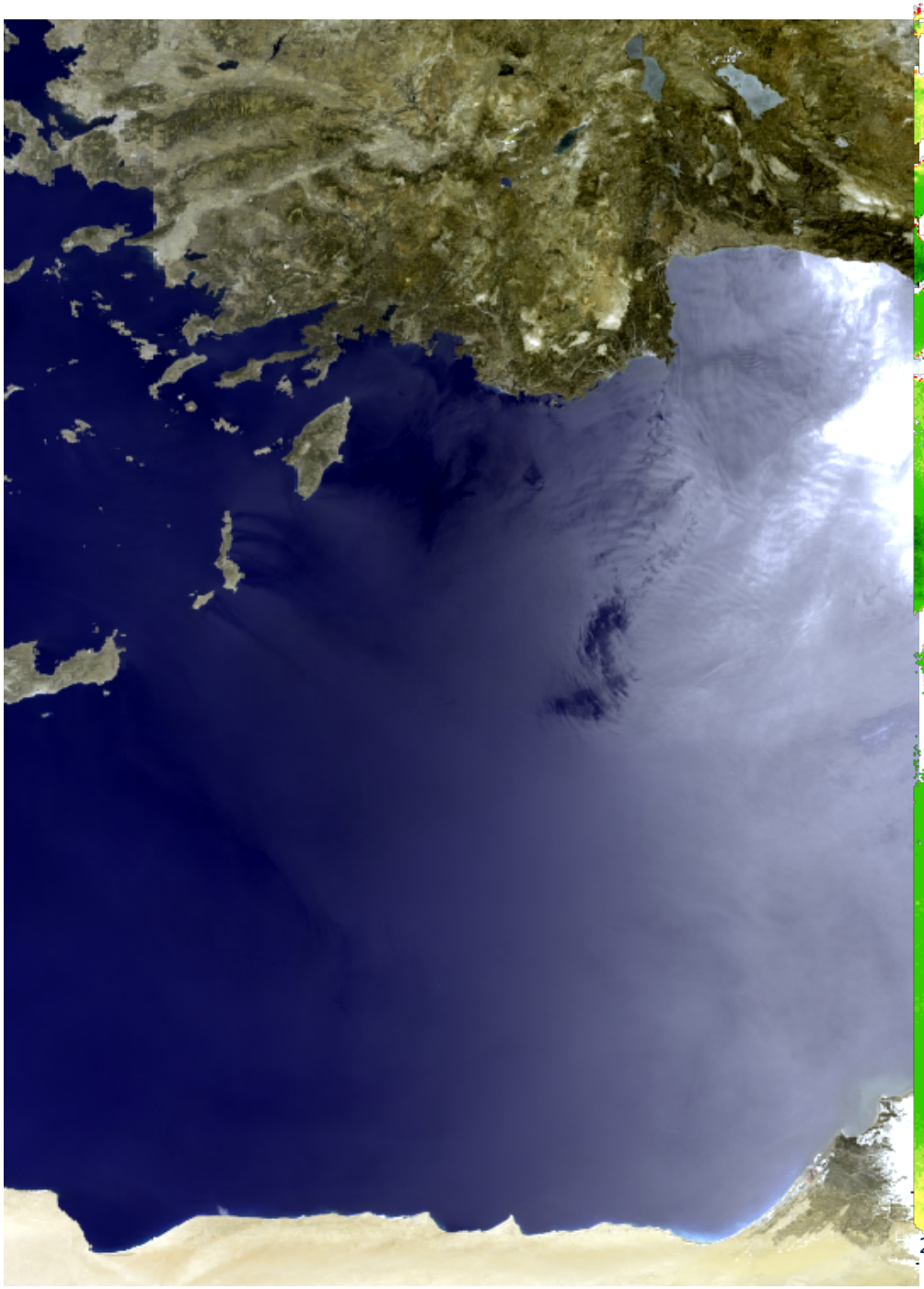
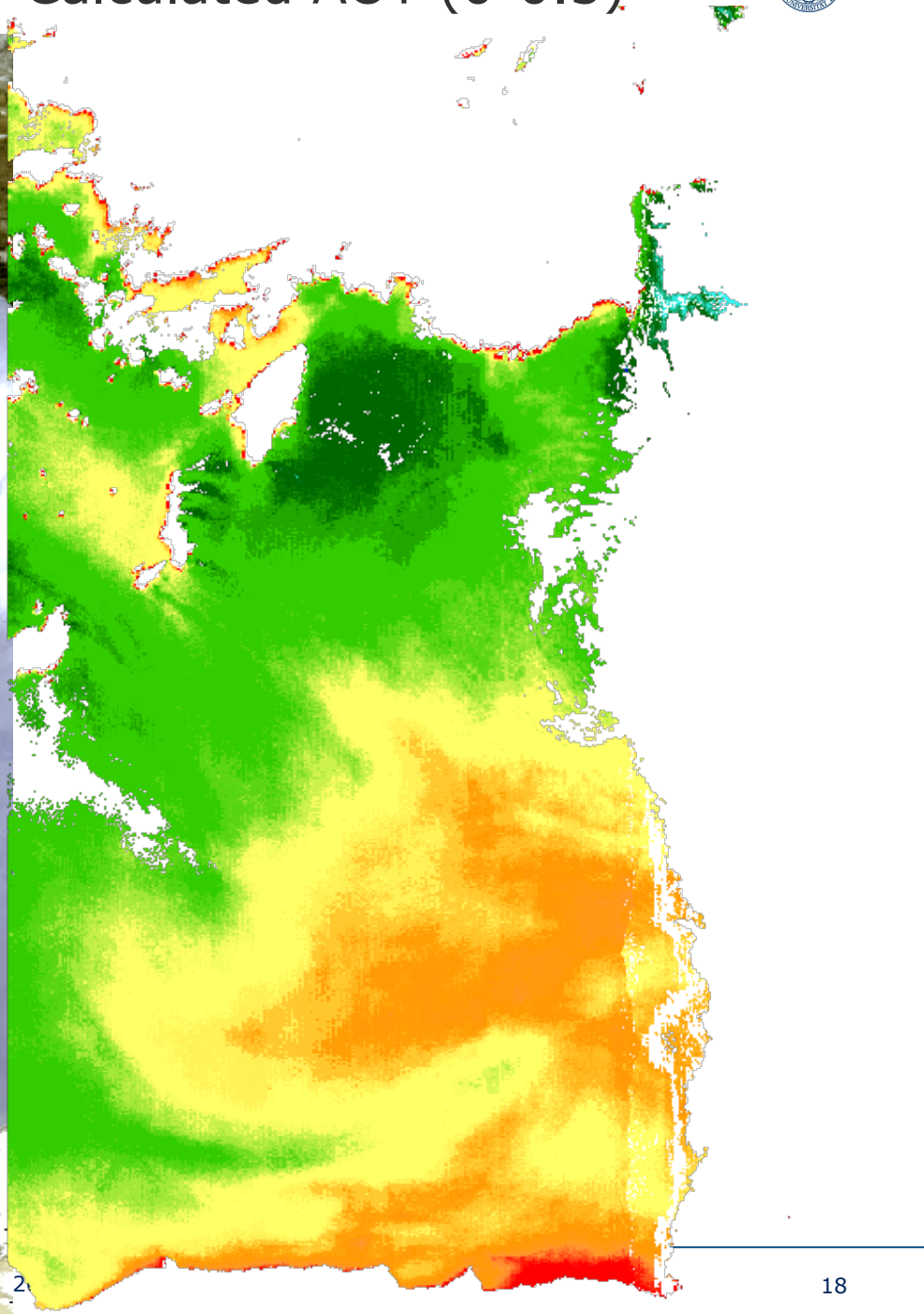
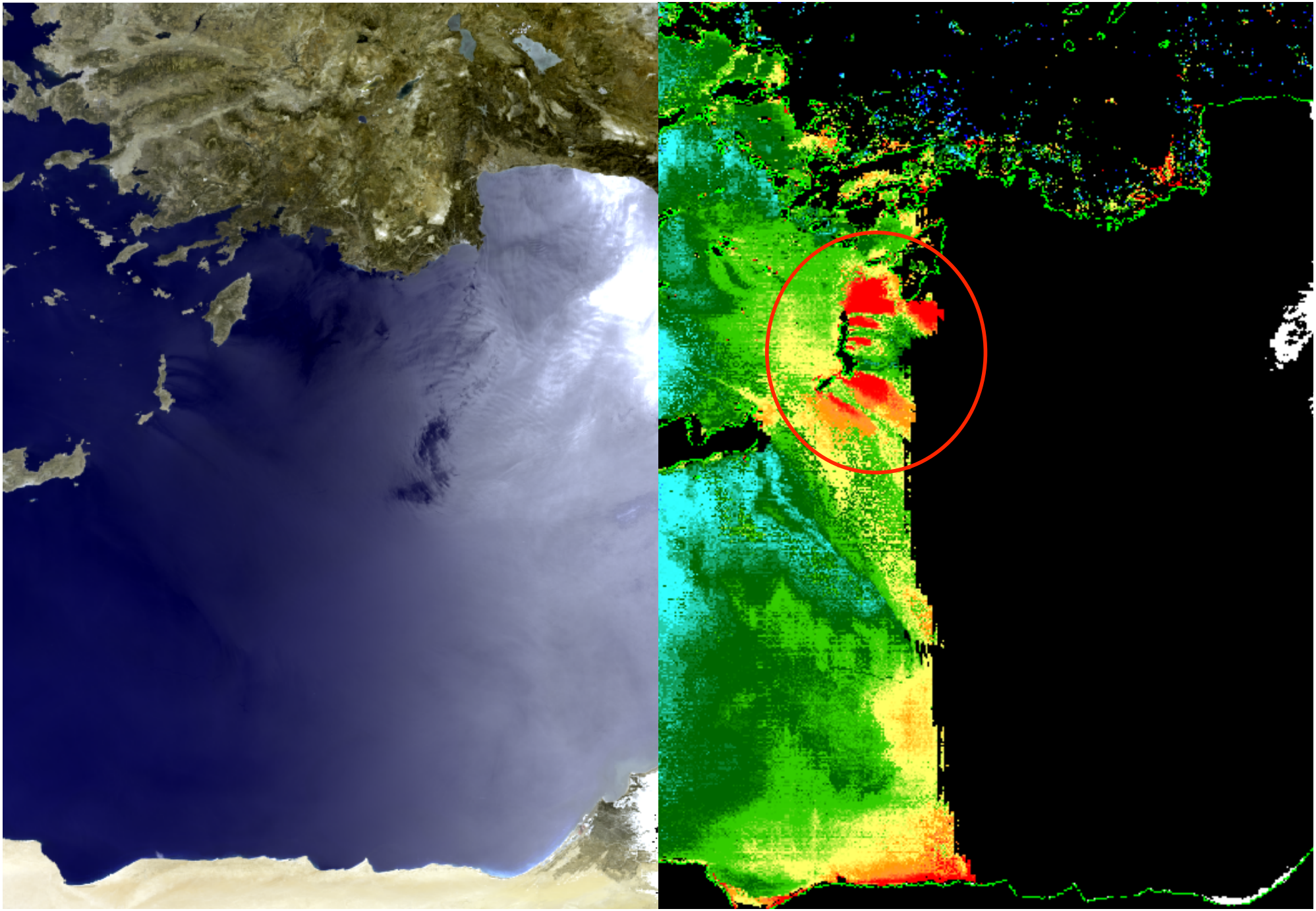




Example: RGB

MERIS L2 AOT (0-0.3)

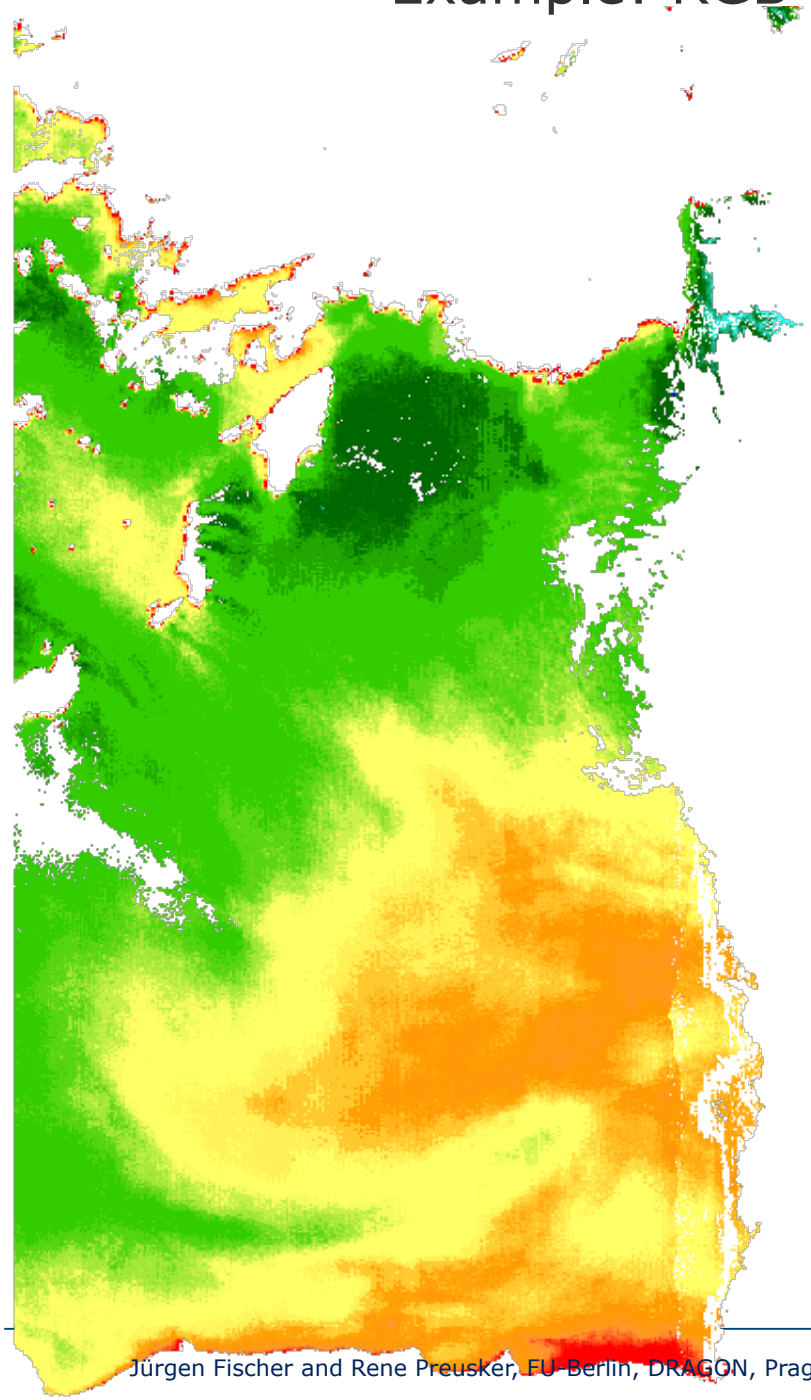
Freie Universität Berlin

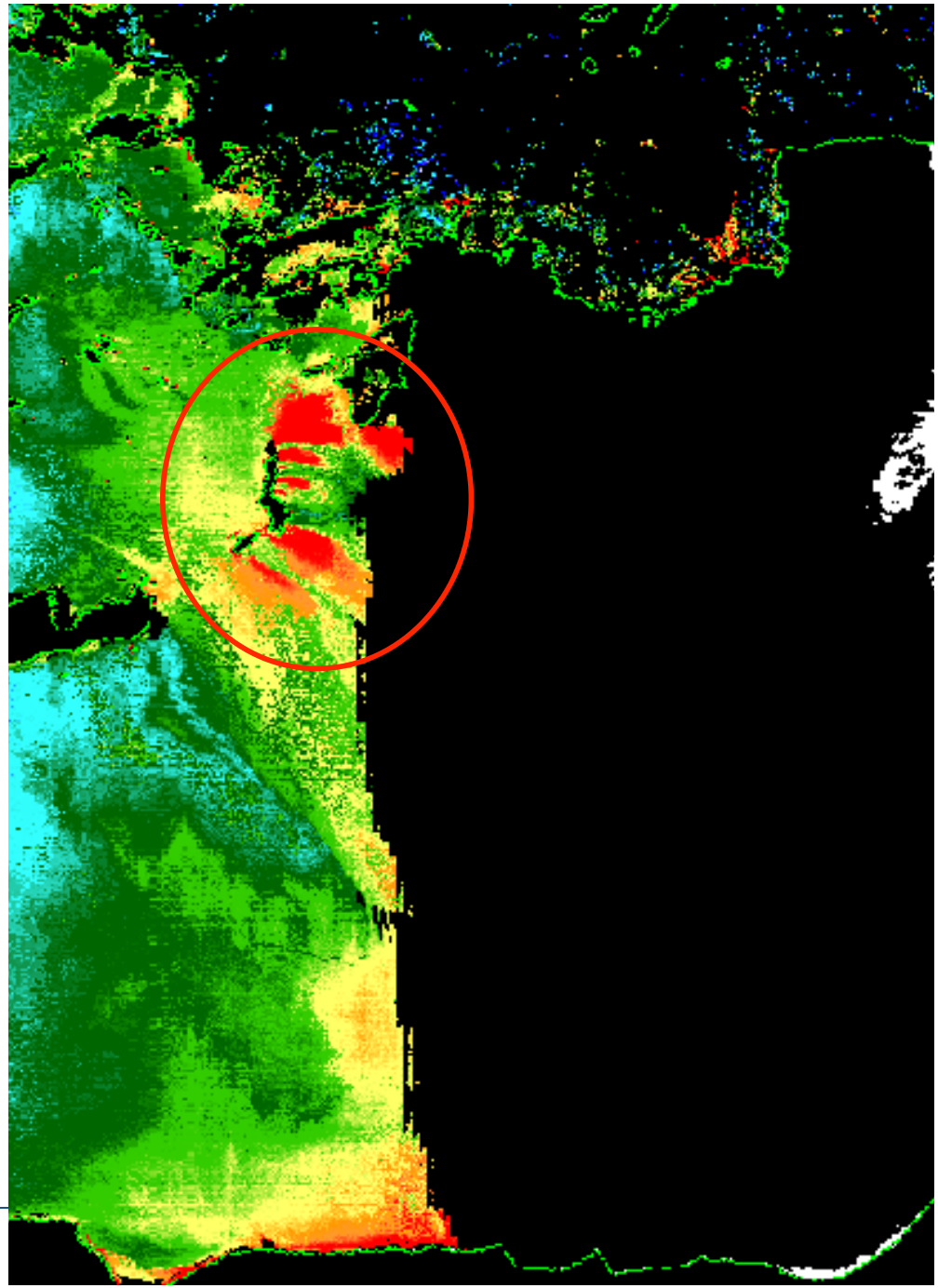


Example: RGB

MERIS L2 AOT (0-0.3)

Freie Universität Berlin

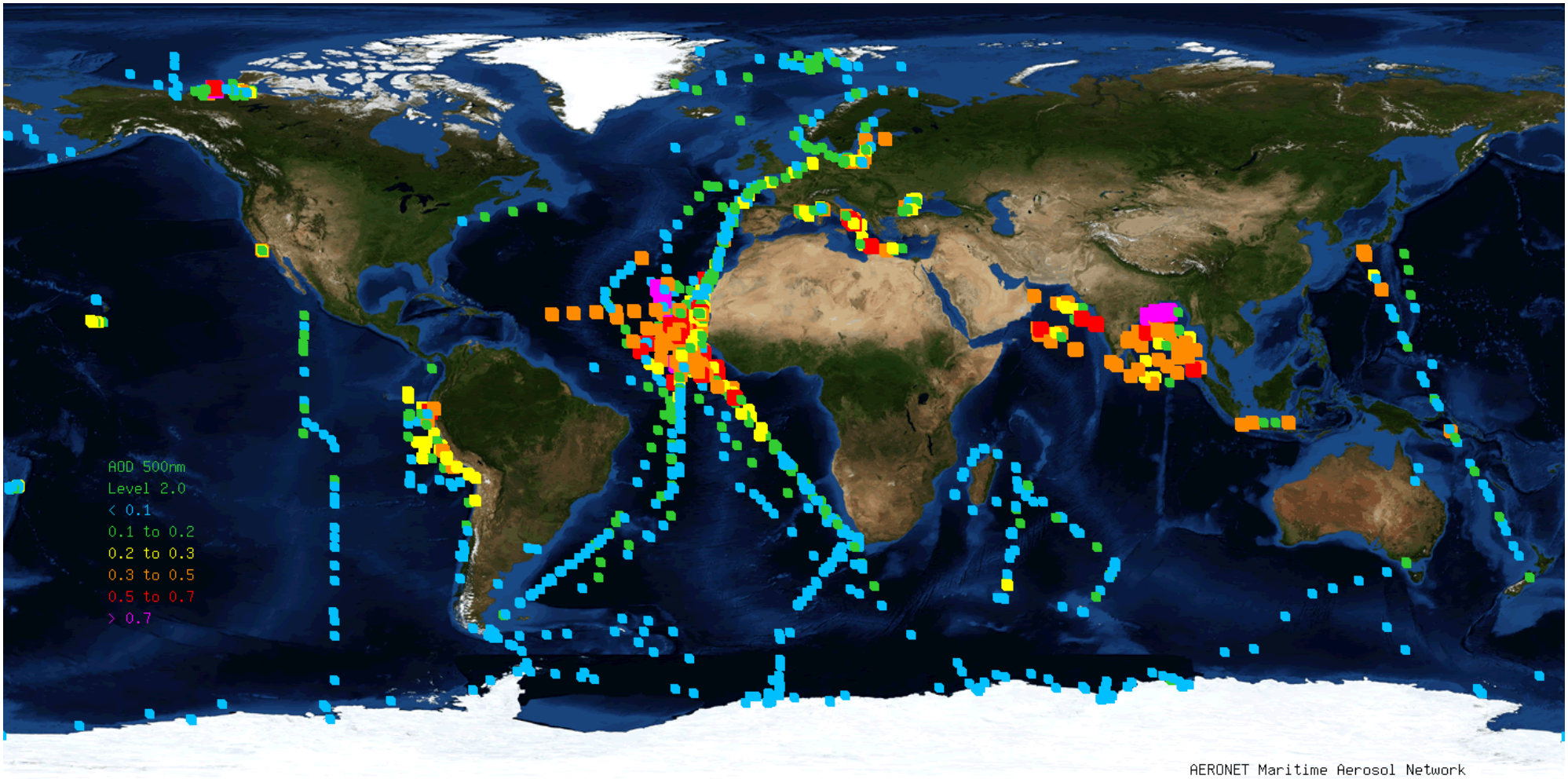




Provisional Validation:

Freie Universität Berlin

1. Comparison with ground truth
2. Comparison with MERIS in common valid area
3. Comparison with MERIS in particular valid area



Provisional Validation

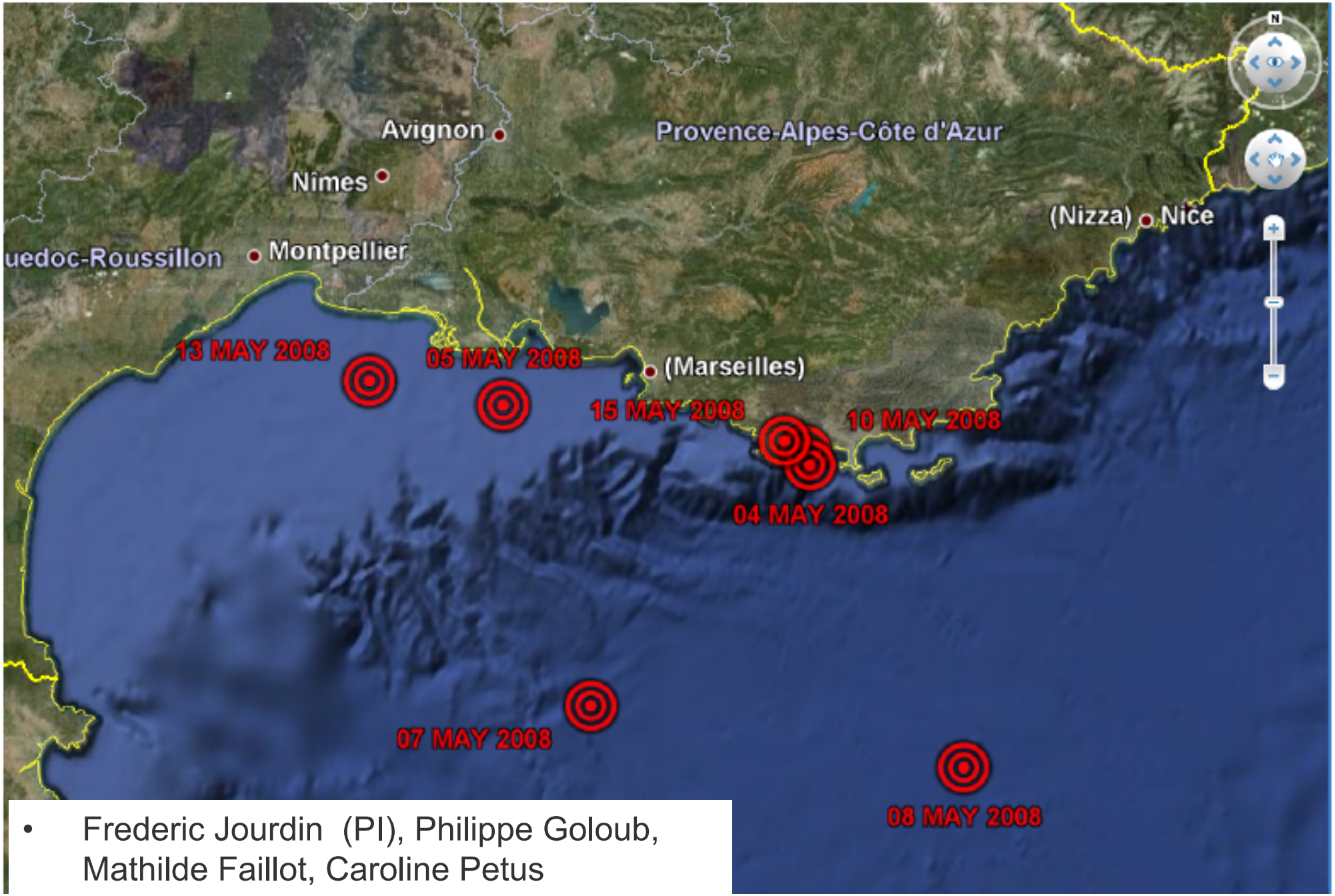
Freie Universität Berlin

1. Comparison with ground truth
2. Comparison with MERIS in common valid area
3. Comparison with MERIS in particular valid area

MAN Publication Reference:
Smirnov, A., B. N. Holben, I. Slutsker, D. M. Giles, C. R. McClain, T. F. Eck, S. M. Sakerin, A. Macke, P. Croot, G. Zibordi, P. K. Quinn, J. Sciare, S. Kinne, M. Harvey, T. J. Smyth, S. Piketh, T. Zielinski, A. Proshutinsky, J. I. Goes, N. B. Nelson, P. Larouche, V. F. Radionov, P. Goloub, K. Krishna Moorthy, R. Matarrese, E. J. Robertson, and F. Jourdin (2009),

Maritime Aerosol Network as a component of Aerosol Robotic Network, *J. Geophys. Res.*, 114, D06204, doi:10.1029/2008JD011257.

2008 RV L'Atalante Cruise



- Frederic Jourdin (PI), Philippe Goloub, Mathilde Faillot, Caroline Petus

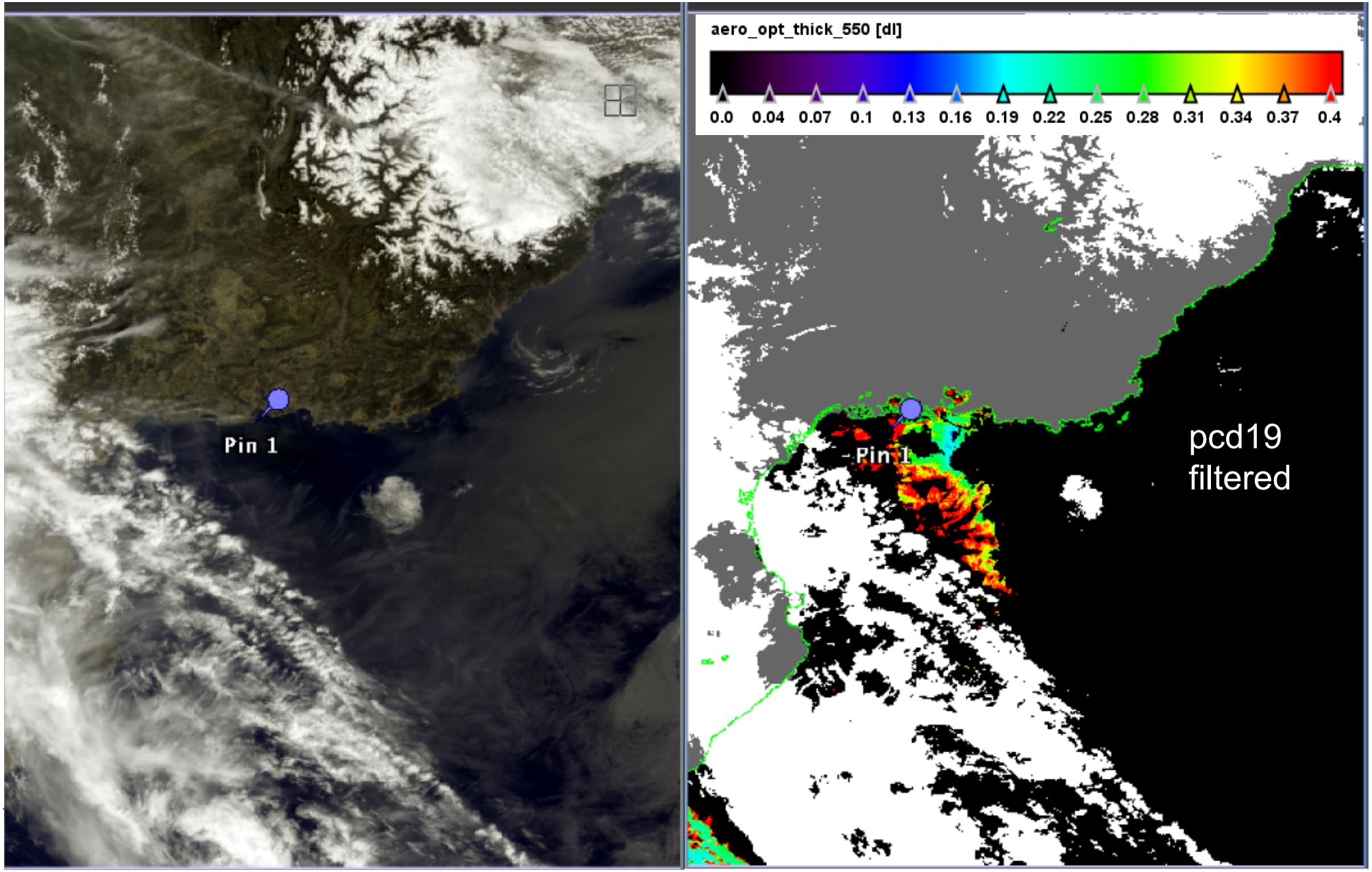
MatchUps

- 12 days cruise
- 9 close-by ENVISAT overpasses, 1 overcast
- 6 days measurements on the ship

→ 1 MatchUp within the AATSR swath

MatchUp

Freie Universität Berlin



MatchUp

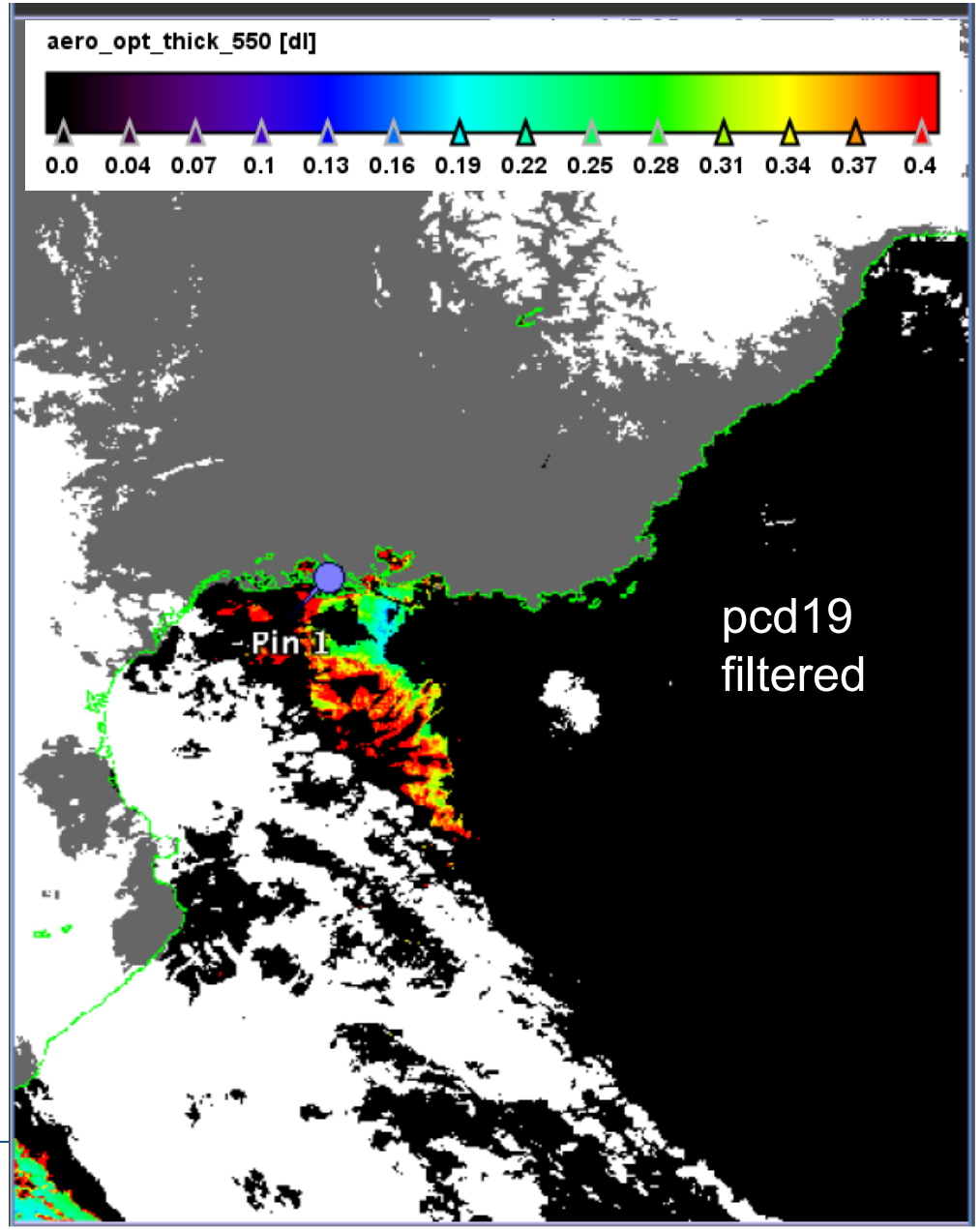
- Overpass 10:15
- Ship measurement 9:40
- heterogeneous situation

→hardly useable

Nevertheless,

microtops: 0.21

MERISL2: 0.2-0.4



MatchUp

Freie Universität Berlin

- Overpass 10:15
- Ship measurement 9:40
- heterogeneous situation

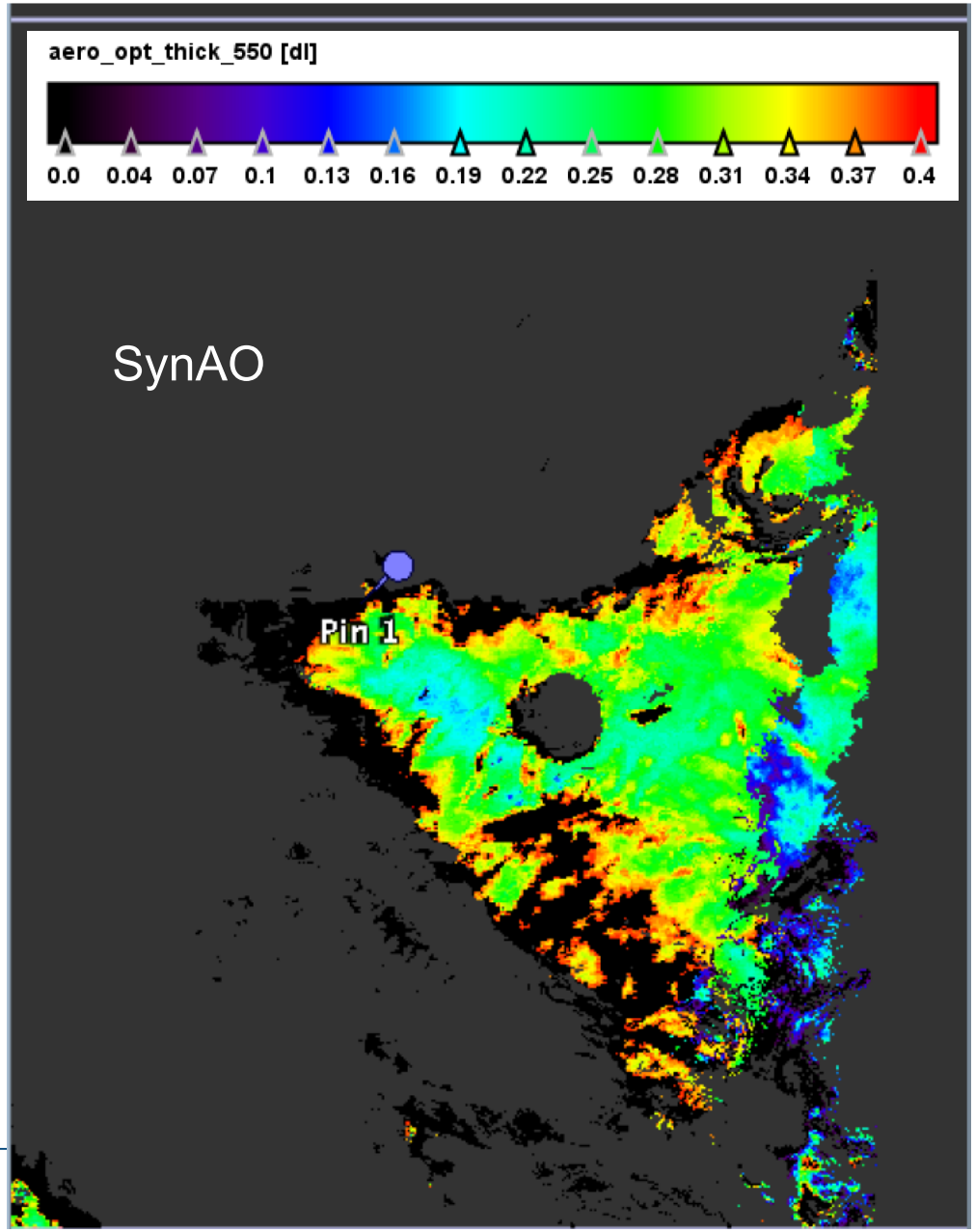
→hardly useable

Nevertheless,

microtops: 0.21

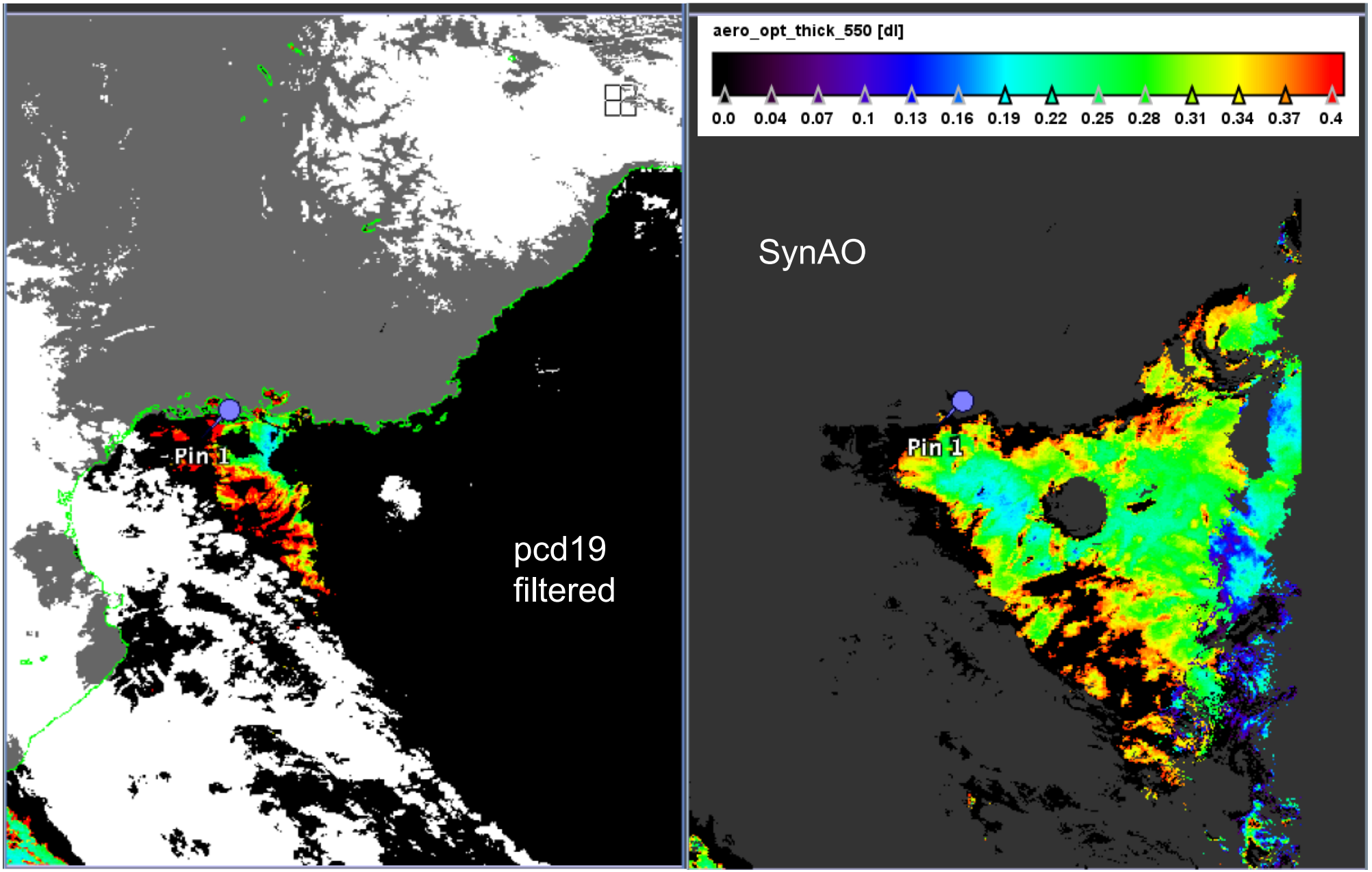
MERISL2: 0.2-0.4

SYNERGY: 0.2-0.4



MatchUp

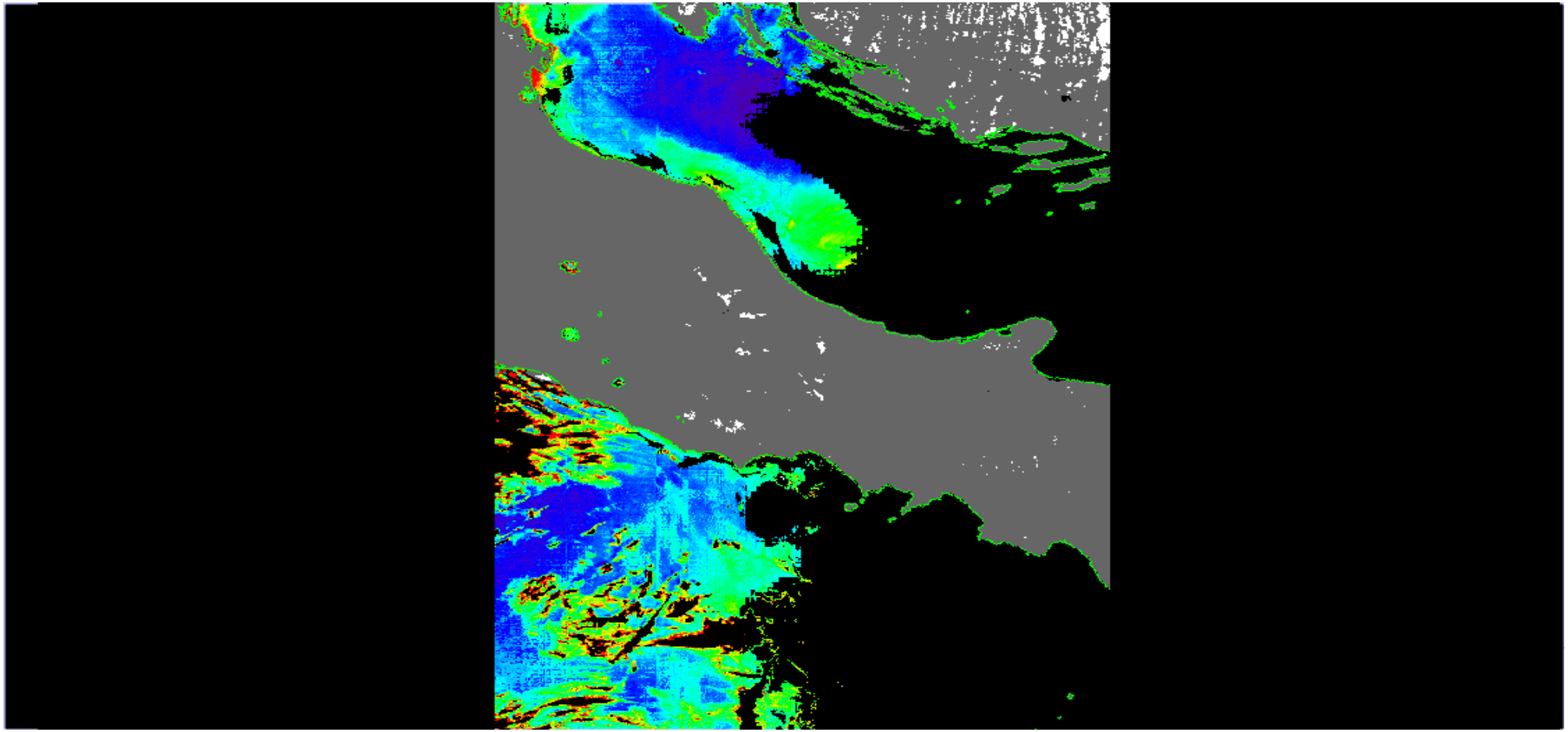
Freie Universität Berlin



Provisional Validation

Freie Universität Berlin

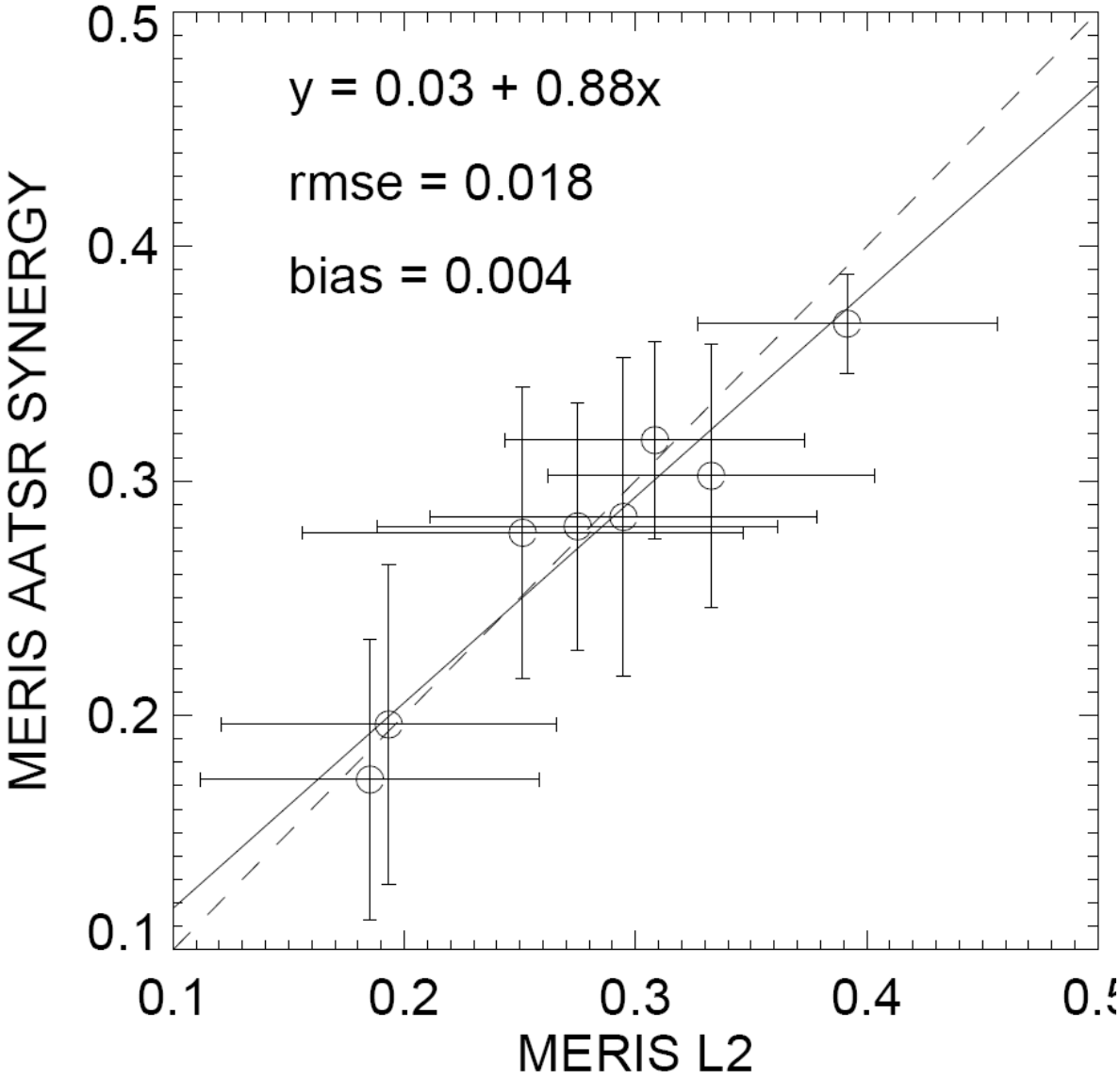
1. Comparison with ground truth
2. Comparison with MERIS in common valid area
3. Comparison with MERIS in particular valid area



Comparison with MERIS in common valid area

- 8 scenes
- circles: area means
- bars: area stdv.

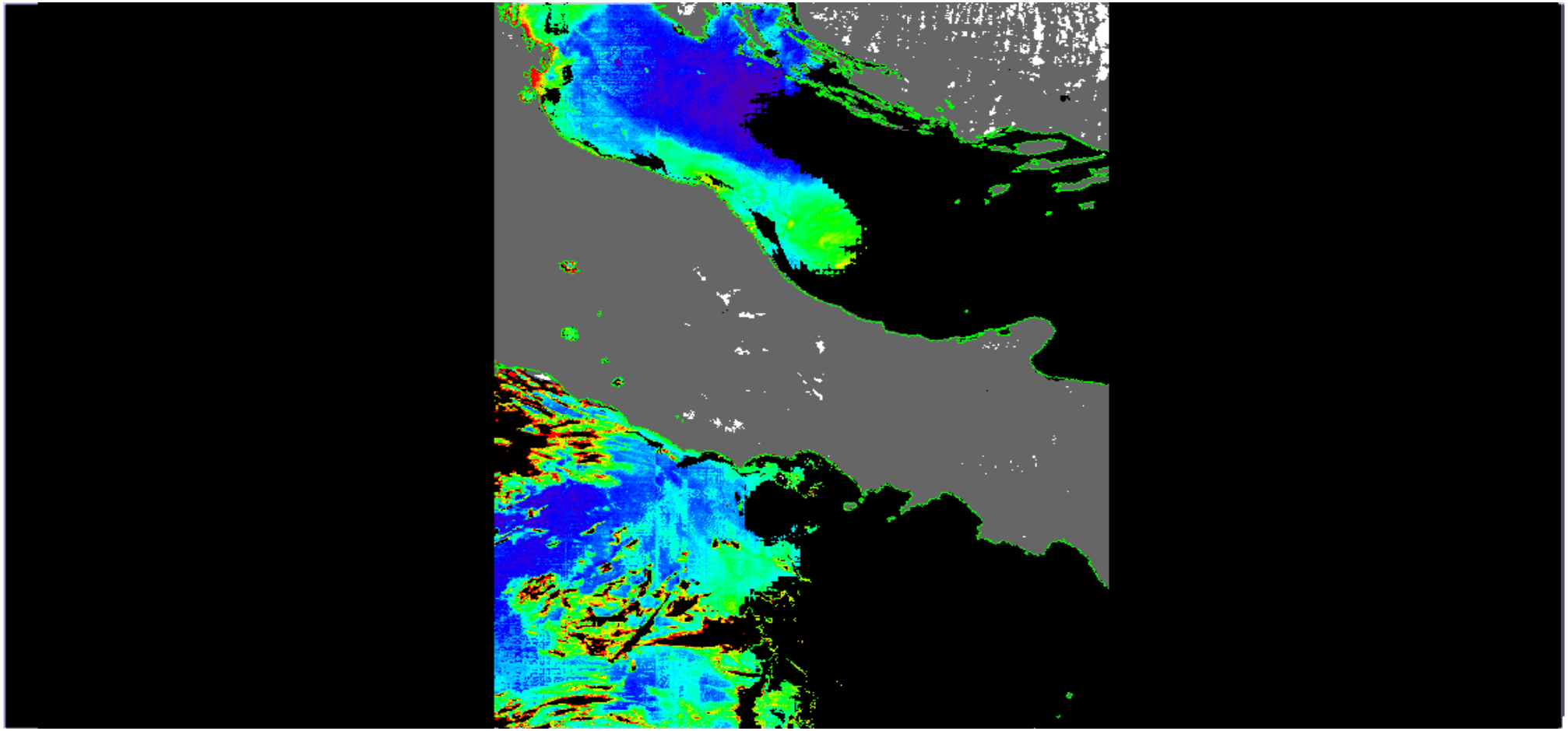
→vanishing bias
→0.02 rmse



Provisional Validation

Freie Universität Berlin

1. Comparison with ground truth
2. Comparison with MERIS in common valid area
3. Comparison with MERIS in particular valid area



Comparison with MERIS in resp. valid area

Why?

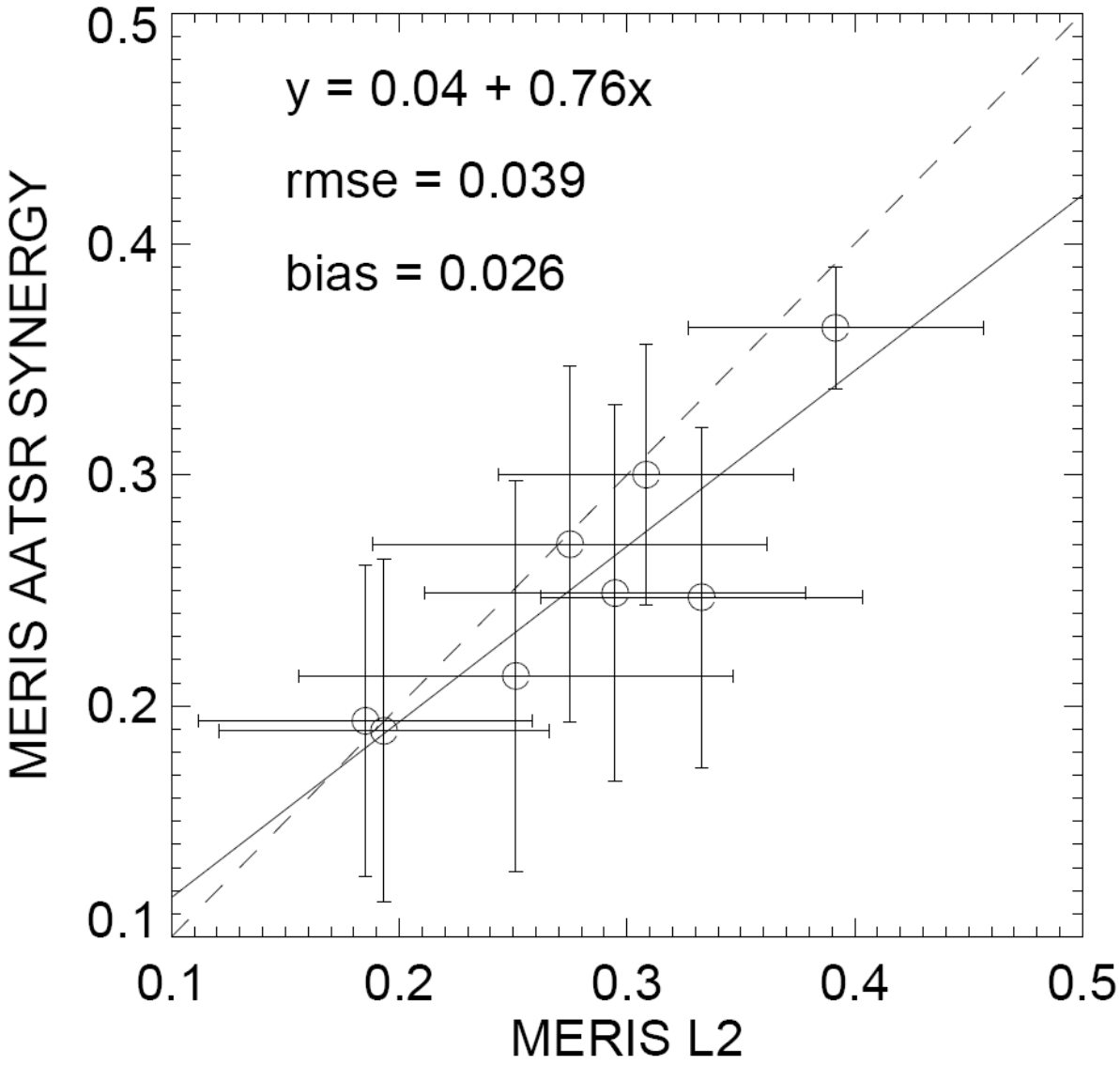
- The SynAO AOT must **not** systematically change in sun glint areas.
- This is a kind of bias monitoring.
- Needs a high number of observations!

Comparison with MERIS in resp. valid area

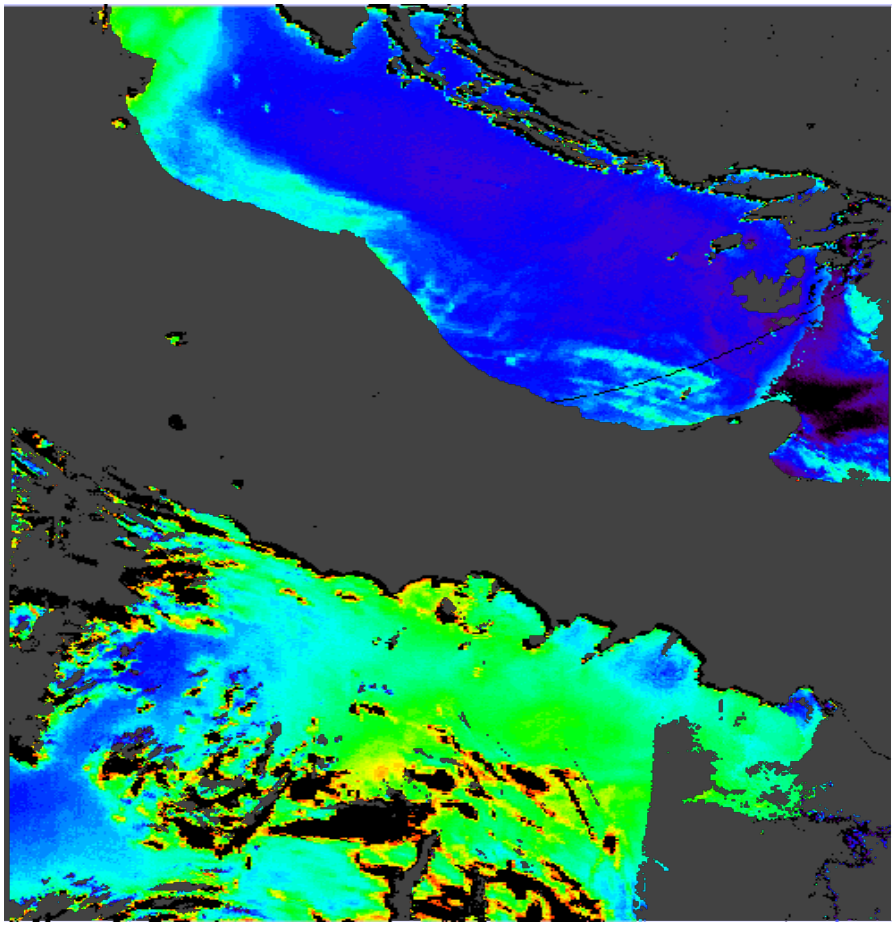
- 8 scenes
- circles: area means
- bars: area stdv.

→low bias of SynAO? (underestimating AOT in glint?)

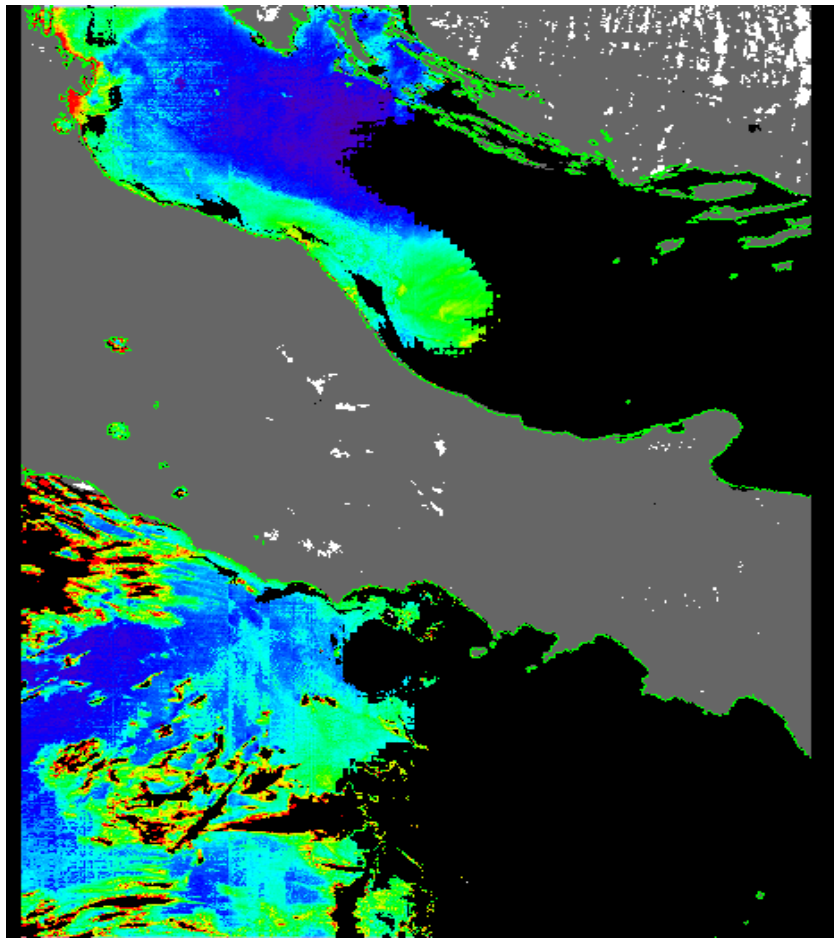
Not enough scenes!



Comparison with MERIS in resp. valid area



vs.



date	03/05	04/05	05/05	06/05	08/05	09/05	12/05	15/05
# L2	77103	1947	7204	42167	3451	46331	6711	40086
# SynAO	141764	8326	55459	81681	46606	103235	31445	91133
Ratio	1.8	4.3	7.7	1.9	13.5	2.2	4.7	2.3

Summary of provisional validation

- One data set (2008 RV L'Atalante Cruise) from AERONET

- 9 satellite scenes + 6 measurment days + AATSR swath + clouds = 1 match up

→ no ground truth validation yet

- Area-averaged AOT comparison at common valid areas

→ bias free , low rmse (0:02)

- Area-averaged AOT comparison at particular valid areas

→ larger bias (0:03) and rmse (0:04). Tendency of SynAO to lower AOTs in glint areas? (But too low number of scenes!)

- SynAO produces a higher number of valid pixel than MERISL2 (factor 2 to 13, specific for the location and season!)

Summary

1. Aerosol retrieval is working
   - Provisional validation was successful
   - much more valid pixel in glint affected areas
2. Further validation necessary
   - full MAN dataset (since match up probability is low)
   - high number of scenes for glint bias monitoring
3. Further development
   - more consistent Aerosol models (Aeronet based)
   - inclusion of absorbing aerosols

4. Perfect for SENTINEL 3 (but 3.7 must not saturate)