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Mineral Aerosol Profiling from Infrared Radiances: Recent developments, validation, applications



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Why profiling dust?

Radiative effects of dust depend on its vertical distribution
(surface cooling, atmospheric local heating, cloud impact, ...)

Most **current** dust datasets provide **OD**, sometimes **mean altitude** (or similar)

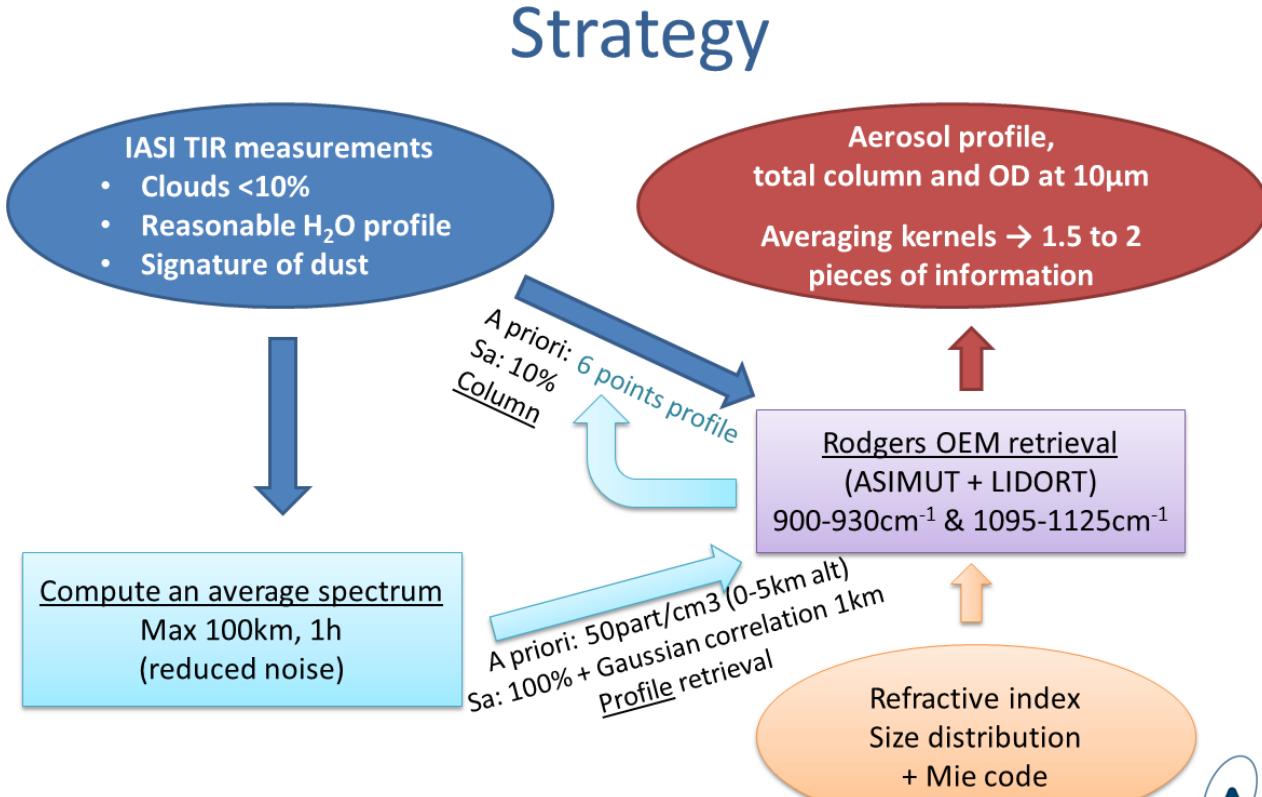


Mean altitude is not always enough...

Especially close to source areas with non-negligible amounts of two-layers scenes

MAPIR: what's new?

3 years ago...



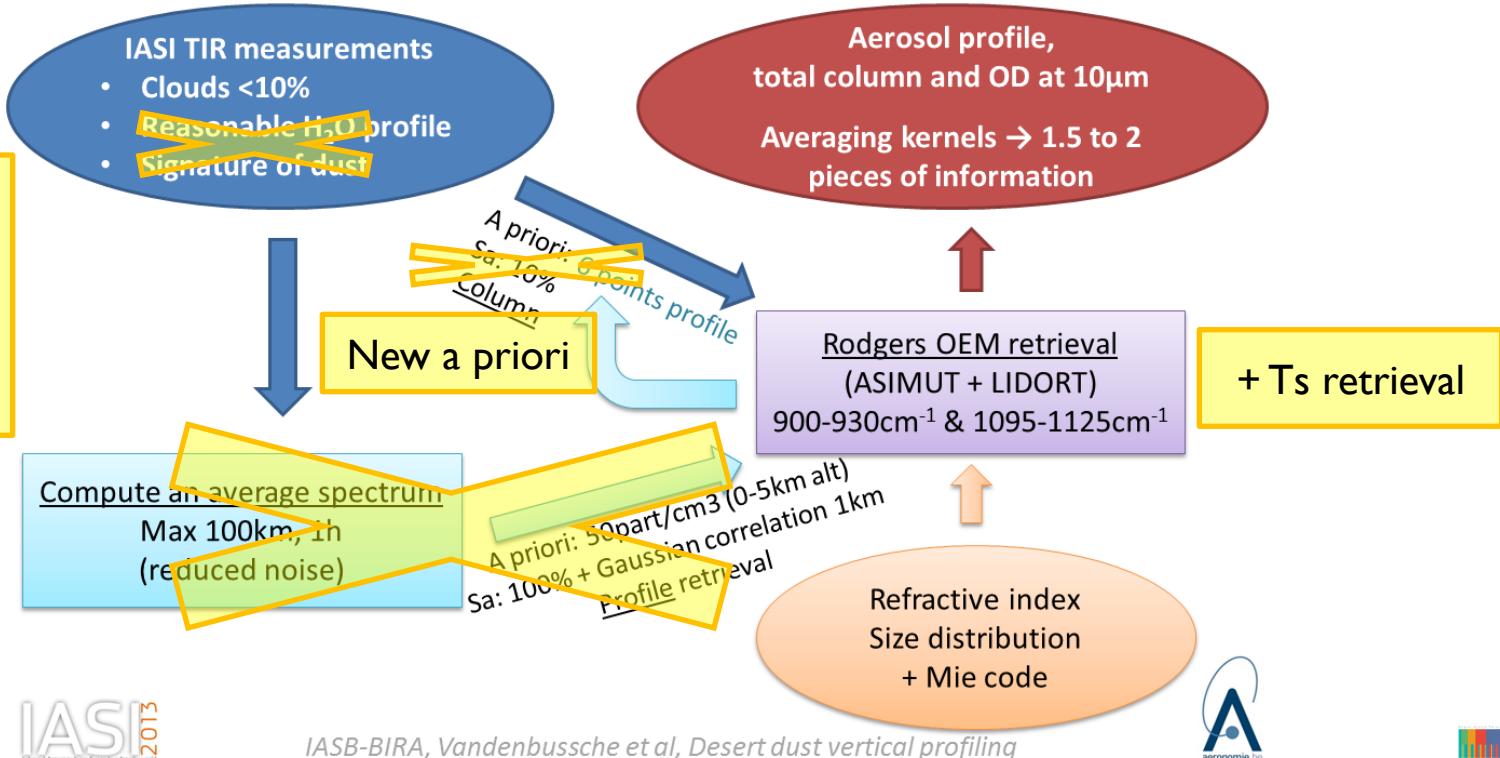
MAPIR: what's new?

Now...



Strategy

From single test-case to almost operational chain



MAPIR: what's new?

Now...



aerosol
cci

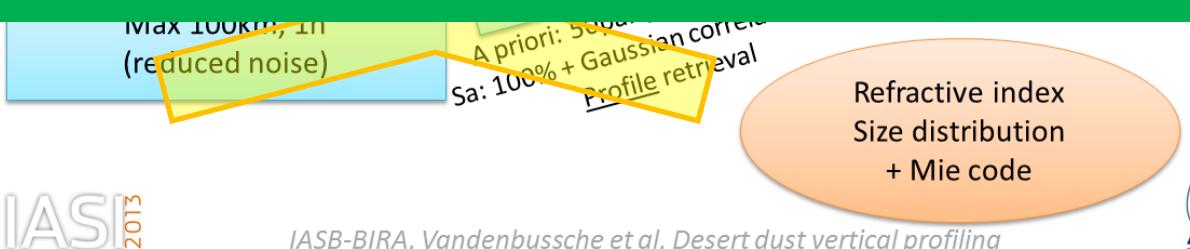
Strategy



We use IASI level2 clouds, T and H₂O profiles
Increasing quality has non-negligible impact on our retrievals

From
test-
a
ope
c

al



IASB-BIRA, Vandenbussche et al, Desert dust vertical profiling



MAPIR: what's new?

Now...



aerosol
cci

Strategy



We use IASI level2 clouds, T and H₂O profiles

Increasing quality has non-negligible impact on our retrievals



We dream of level2 v6.2 full reprocessing

Max 100km, TH
(reduced noise)

A priori: 5000
Sa: 100% + Gaussian corre
Profile retrieval

Refractive index
Size distribution
+ Mie code



IASB-BIRA, Vandenbussche et al, Desert dust vertical profiling



MAPIR: what's new?

Now...



aerosol
cci

Strategy



We use IASI level2 clouds, T and H₂O profiles
Increasing quality has non-negligible impact on our retrievals



We dream of level2 v6.2 full reprocessing
And also level1 PCS...



Max 100km, IN
(reduced noise)

A priori: 5000
Sa: 100% + Gaussian correc.
Profile retrieval

Refractive index
Size distribution
+ Mie code

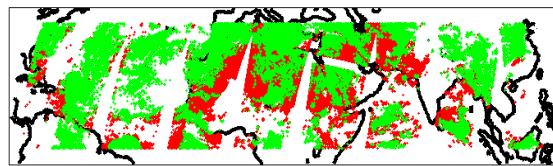


IASB-BIRA, Vandenbussche et al, Desert dust vertical profiling

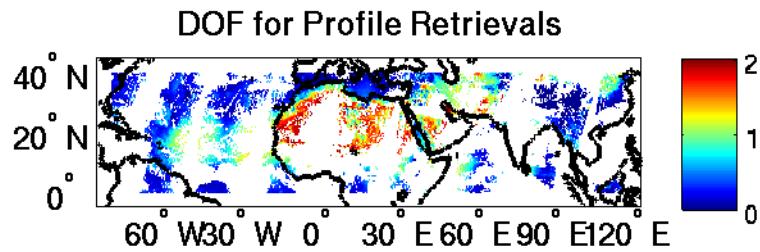
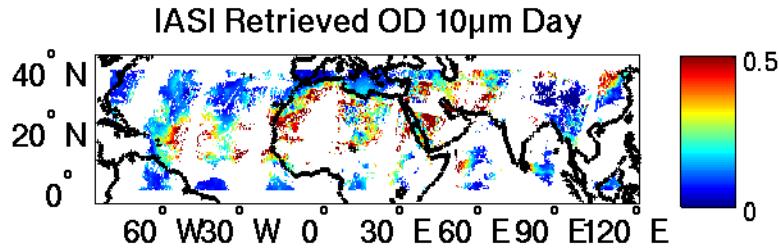


MAPIR: example 15 June 2013

Quality check: GOOD if RMS<1K over sea, 2K over land



Retrievals still have issues over central Sahara and some other very dusty places, in summer mostly...

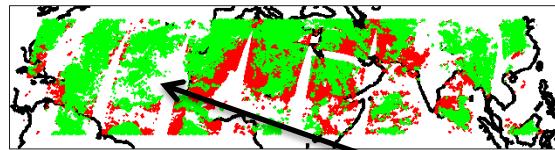


Higher information content when OD is higher

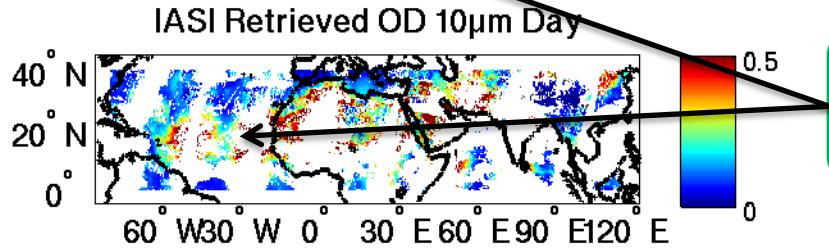
Higher information content over land

MAPIR: example 15 June 2013

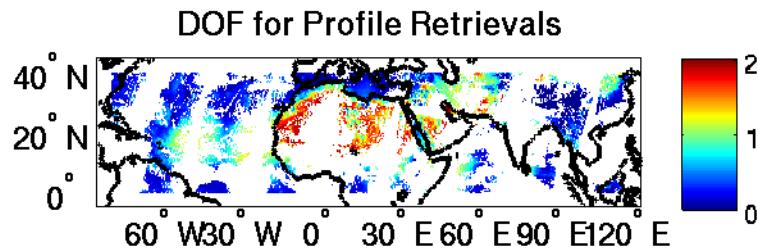
Quality check: GOOD if RMS<1K over sea, 2K over land



Retrievals still have issues over central Sahara and some other very dusty places, in summer mostly...



Some high load dust scenes are flagged « cloudy »



New dust flag... full reprocessing??

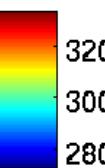
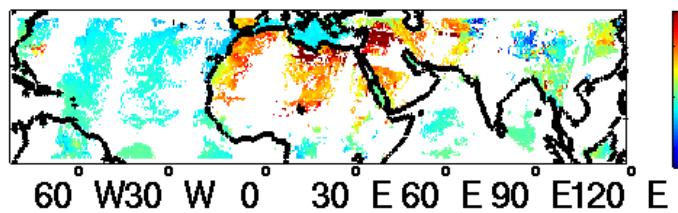


Higher information content when OD is higher

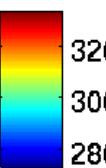
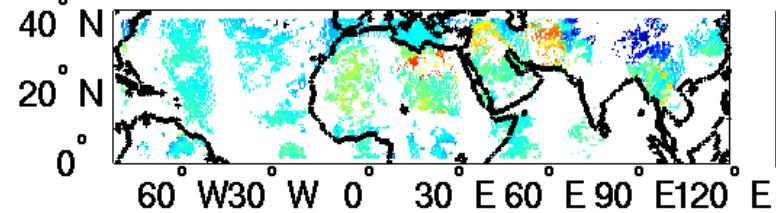
Higher information content over land

MAPIR: example 15 June 2013

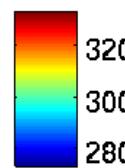
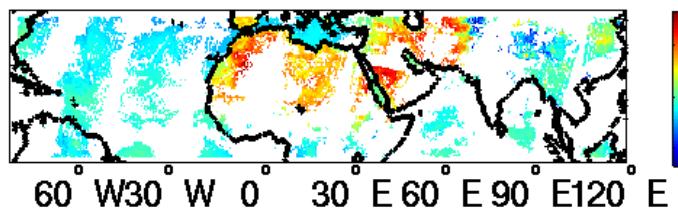
IASI Ts day



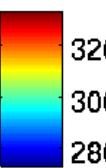
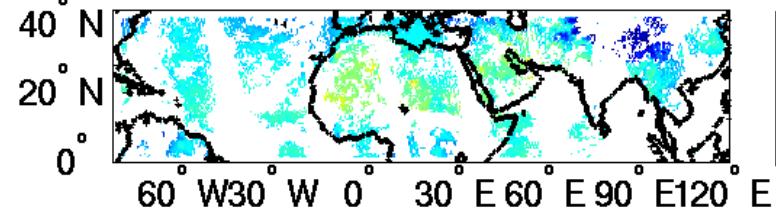
IASI Ts night



Retrieved Ts day



Retrieved Ts night

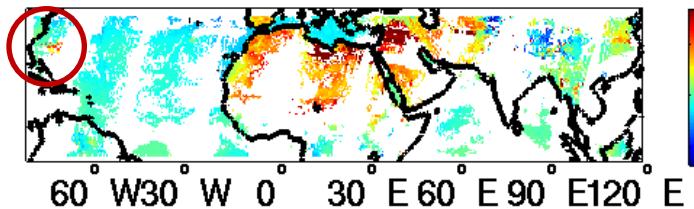


MAPIR: example 15 June 2013

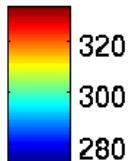
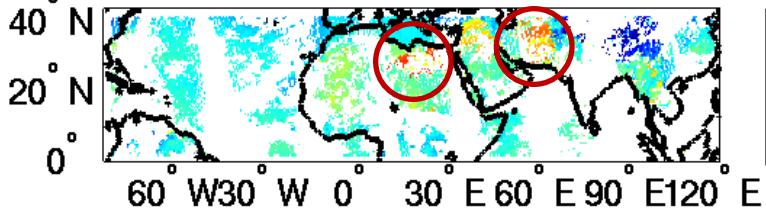
L2v5 Ts « anomalies »



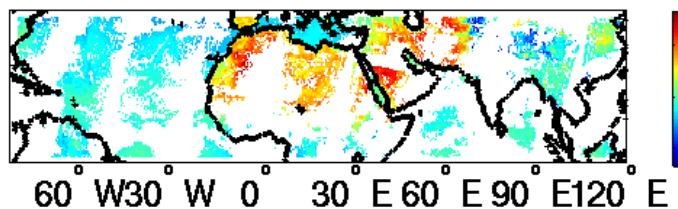
IASI Ts day



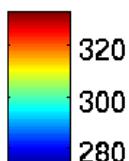
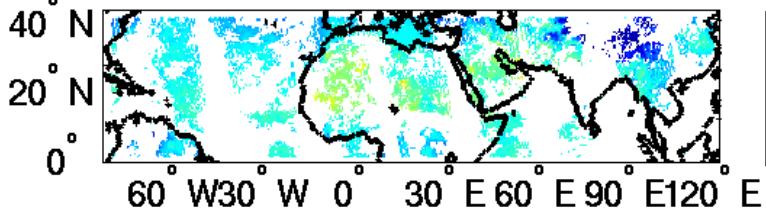
IASI Ts night



Retrieved Ts day



Retrieved Ts night



MAPIR: example 15 June 2013

L2v5 Ts « anomalies »



IASI Ts day



320
40° N

IASI Ts night

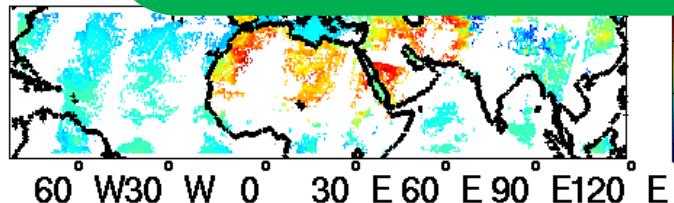


320
300
280

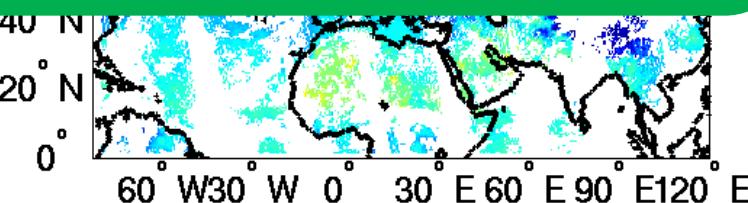
These are not present anymore in l2v6
So... again...



We dream of l2v6.2 full reprocessing



320
300
280



320
300
280

Works over all surfaces

Works even for very low OD (but with reduced information content)

Missing high load dust scenes

- ❖ Flagged « cloudy »
- ❖ Failed retrievals...





Works over ocean and land

Works even for very low OD (but with reduced information content)



Missing high load dust scenes

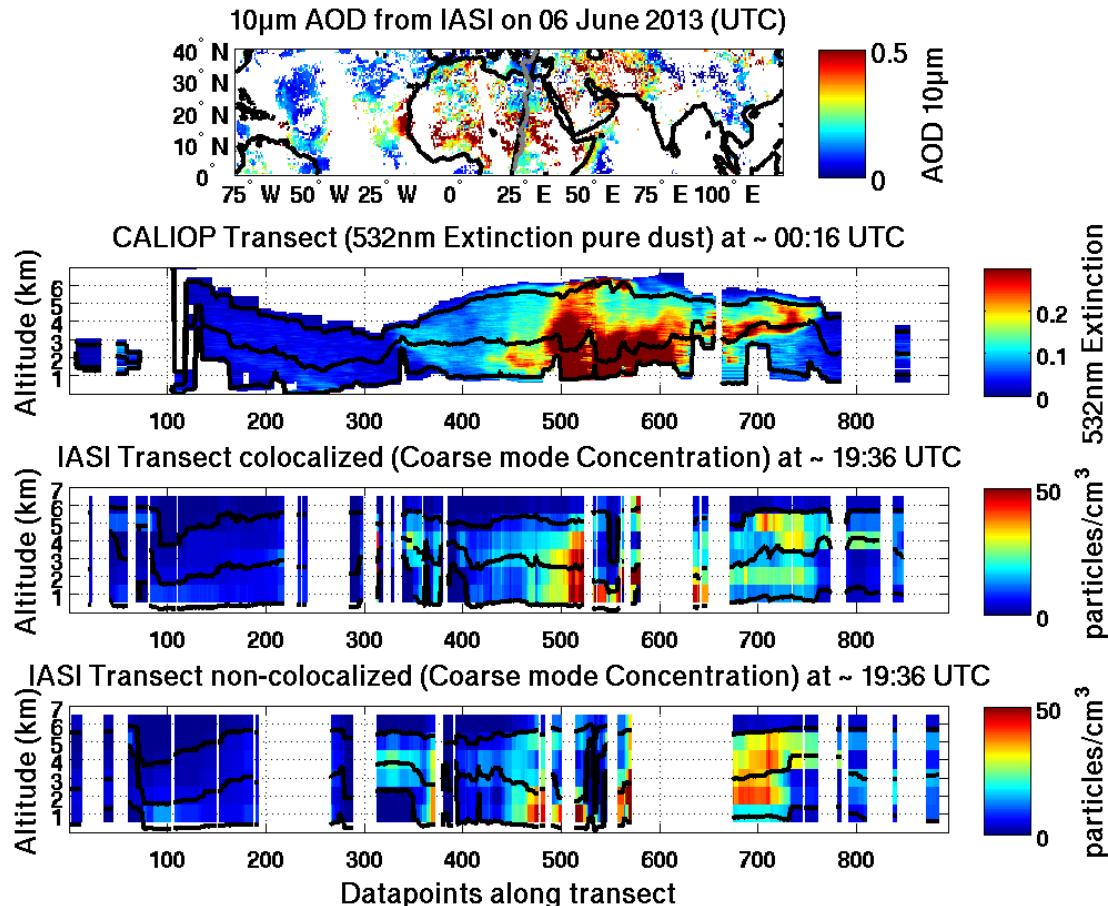
- ❖ Flagged « cloudy »
- ❖ Failed retrievals...

could be linked to trouble in T profiles
for high dust load scenes



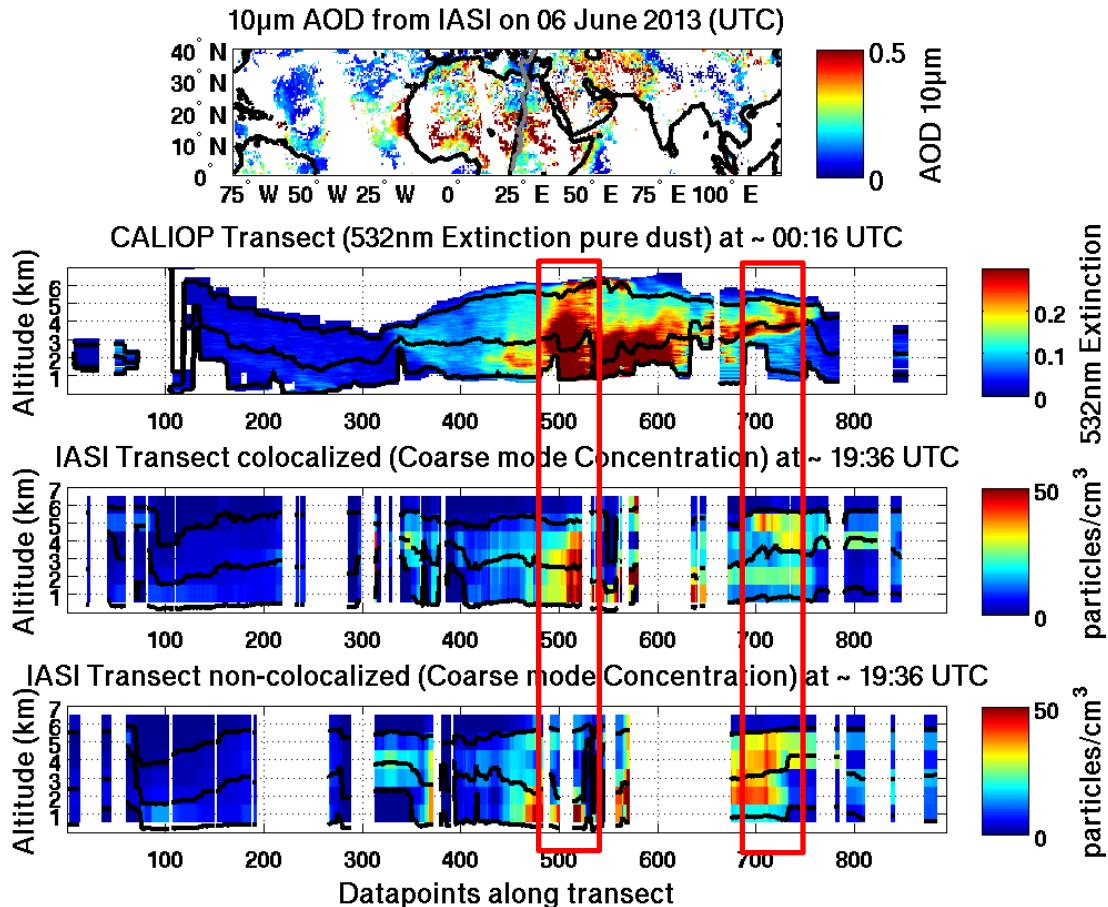
So... again...

Profile comparison with CALIOP

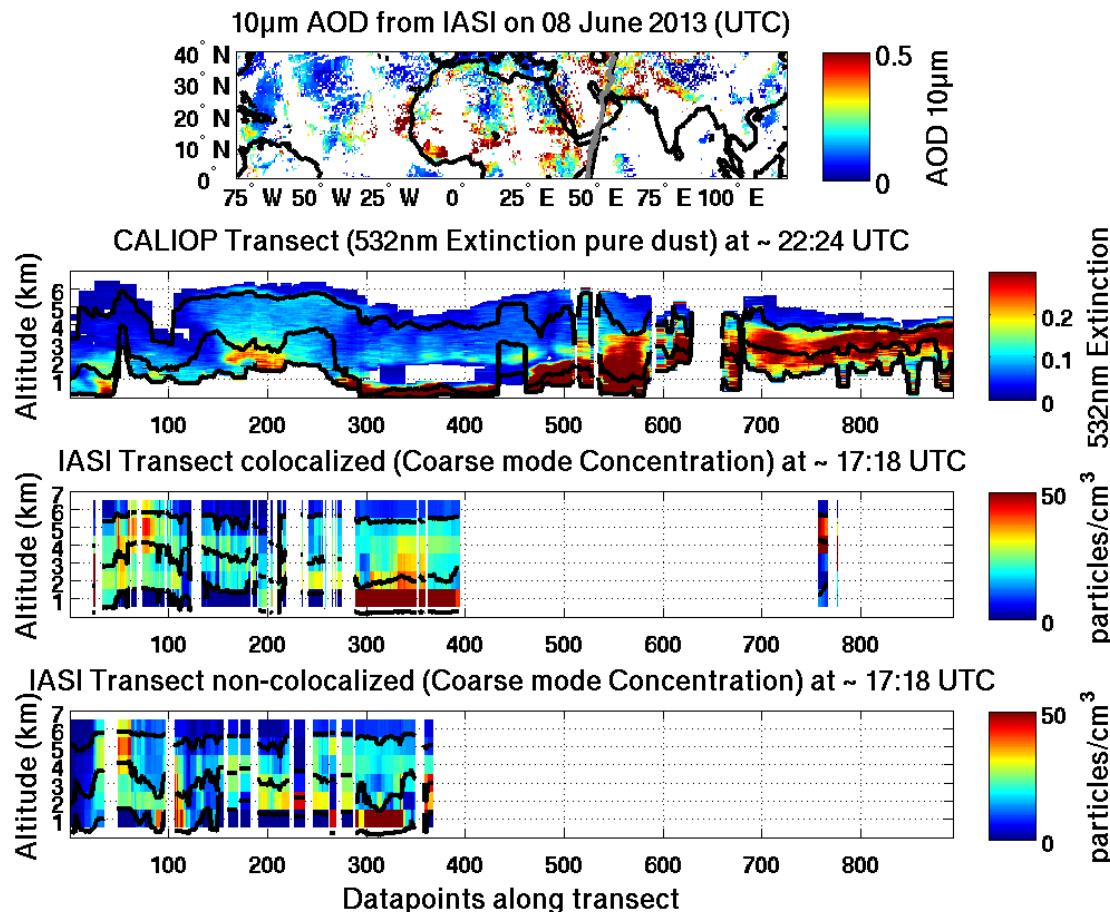


Using ECMWF horizontal winds

Profile comparison with CALIOP



Profile comparison with CALIOP



Using ECMWF horizontal winds

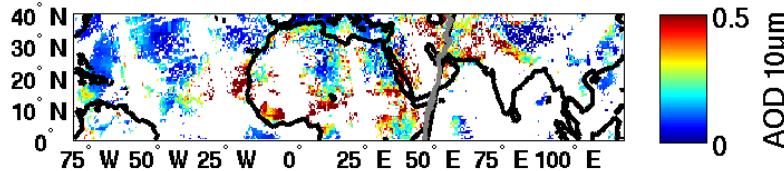
Profile comparison with CALIOP

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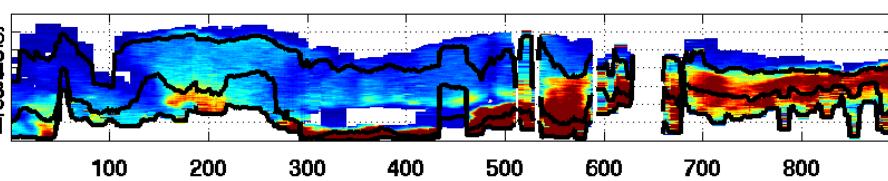
Using ECMWF
horizontal winds

10 μ m AOD from IASI on 08 June 2013 (UTC)



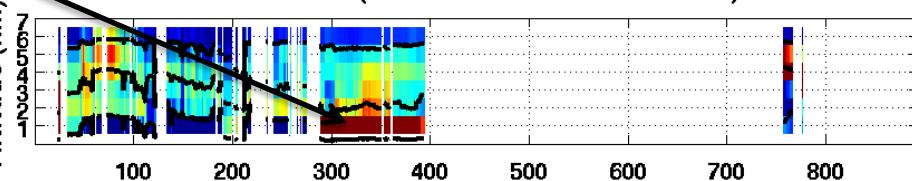
0.5
AOD 10 μ m
0

CALIOP Transect (532nm Extinction pure dust) at ~ 22:24 UTC



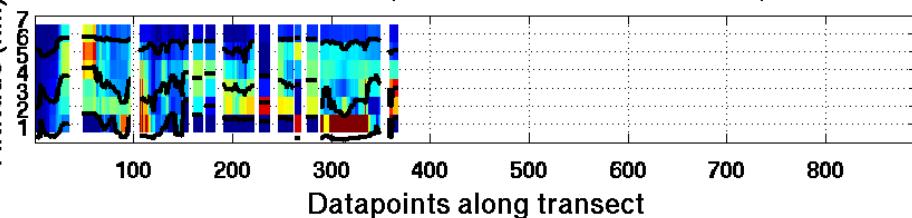
0.2
0.1
0
532nm Extinction

IASI Transect colocalized (Coarse mode Concentration) at ~ 17:18 UTC



50
0
particles/cm³

IASI Transect non-colocalized (Coarse mode Concentration) at ~ 17:18 UTC

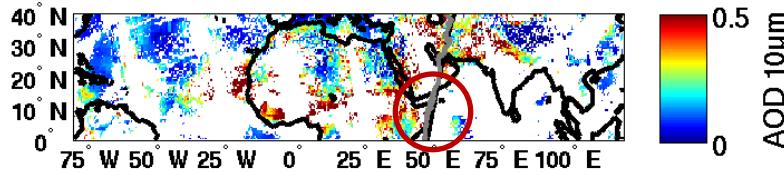


50
0
particles/cm³

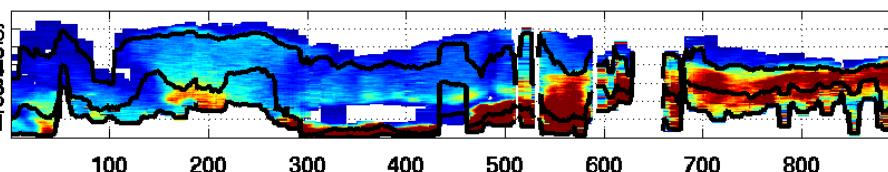
Profile comparison with CALIOP

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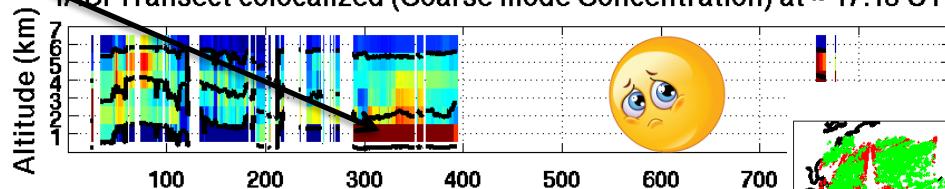
10 μ m AOD from IASI on 08 June 2013 (UTC)



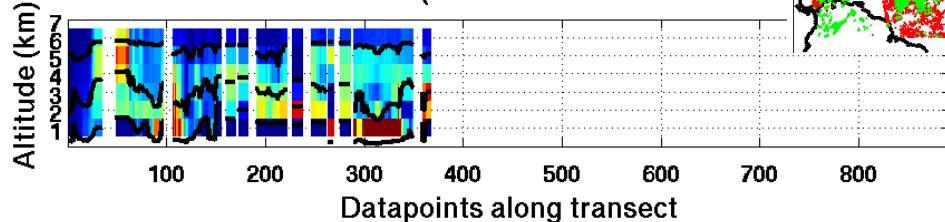
CALIOP Transect (532nm Extinction pure dust) at ~ 22:24 UTC



IASI Transect colocalized (Coarse mode Concentration) at ~ 17:18 UTC



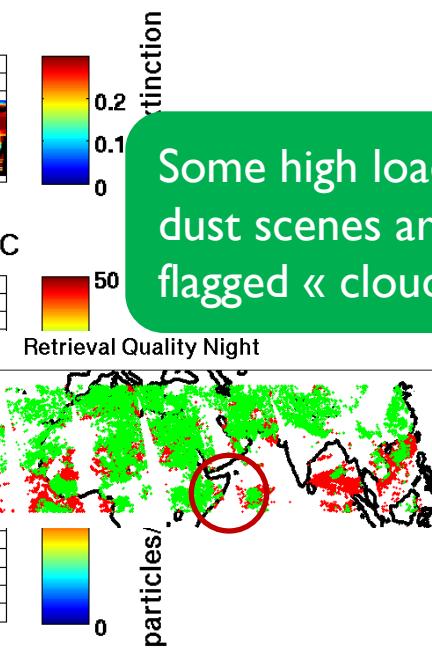
IASI Transect non-colocalized (Coarse mode Concentration)



Using ECMWF horizontal winds



Some high load
dust scenes are
flagged « cloudy »



Profile comparison with CALIOP

Using winds to co-locate air masses is important



Plume altitude is correct, even though it's a bit « noisy »

There is indeed sensitivity down to the surface, at least above land



Again: missing data for dense plumes

What do we do with those profiles?



Help in climate studies, by providing additional altitude information for dust

Benefit from surface dust information to study sources / deposition

Application: dust sources study



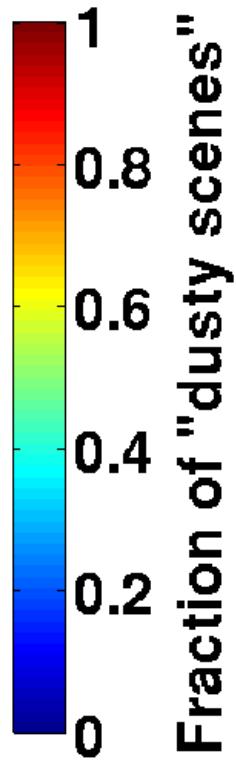
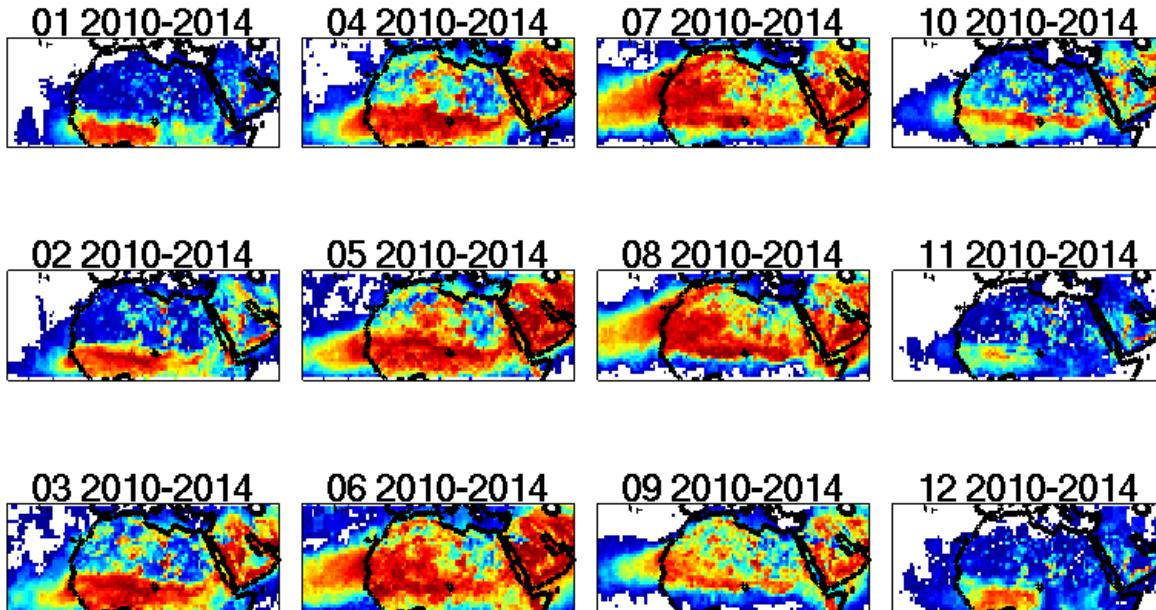
Credits: Wikimedia Commons

Application: dust sources study

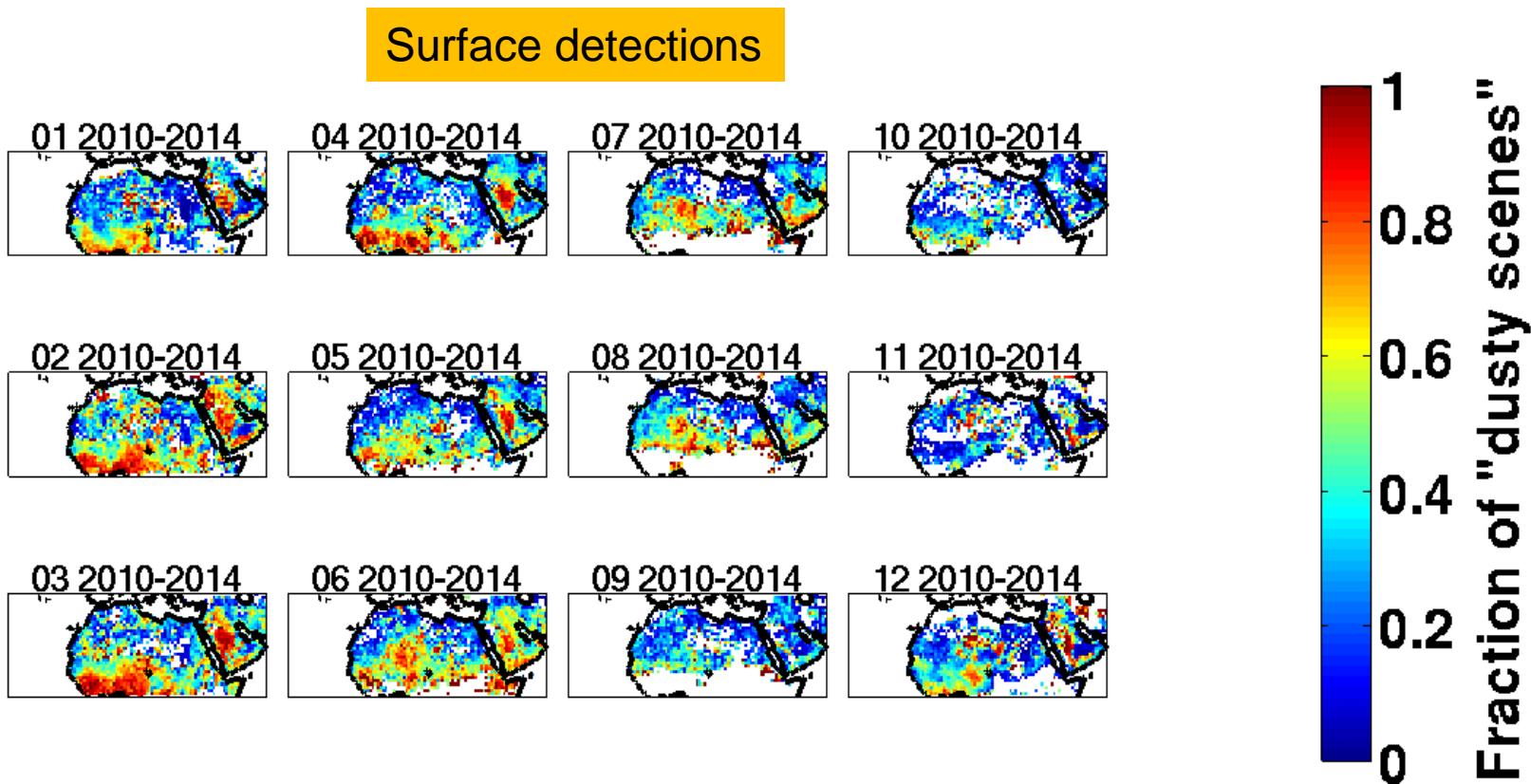
- Using only scenes for which:
 - Retrieval RMS < 2K (land) or 1K (sea)
 - For surface detections: AK in surface layer > 0.25 (might create a bias)
- « Dusty »: Min 0.3 OD at surface / in total column
- Currently 5 years of IASI-A, the rest to be processed soon
- Coverage issues: solved by using relative detections
- Missing very thick dust plumes: may lead to underestimating some source areas

Application: dust sources study

Total column detections

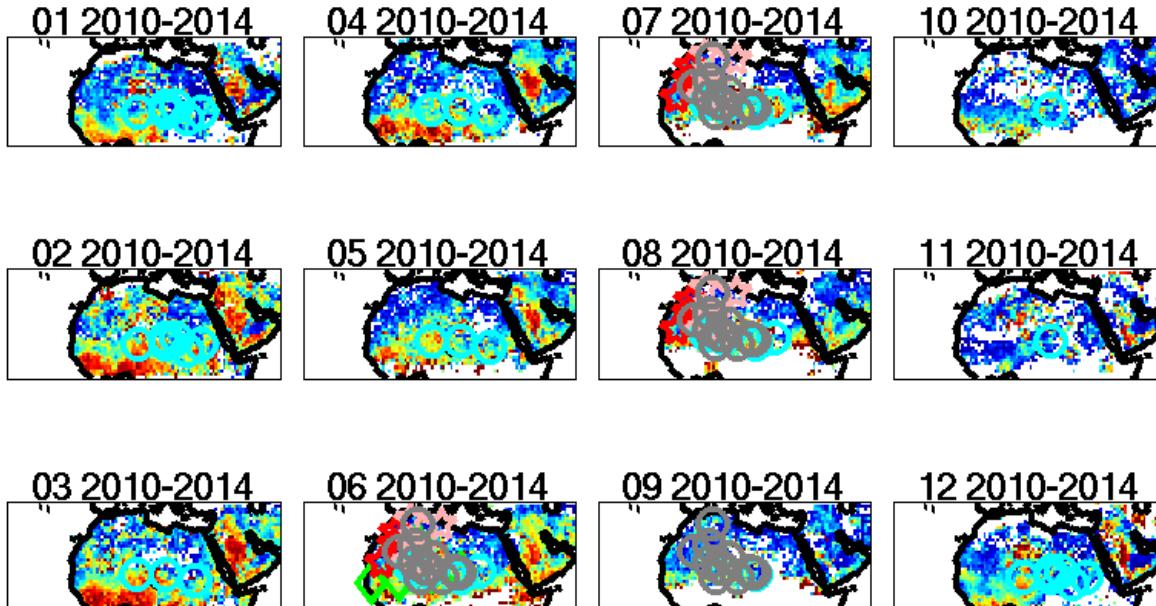


Application: dust sources study



Application: dust sources study

Surface detections

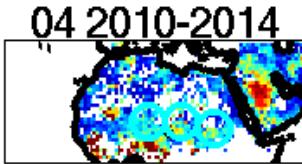
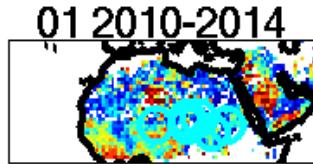


- Kocha et al, GRL 2013 - data from MODIS DB Aqua and Terra 06-2006
 - Ashpole et al, JGR 2013 - NW Africa, data from SEVIRI 06-08 2004-2010; mainly NLLJs
 - Ashpole et al, JGR 2013 - NW Africa, data from SEVIRI 06-08 2004-2010; mainly cold pools
 - Todd et al, AE 2016 - summer data from CALIOP 2006-2013
 - Schepanski et al, GRL 2007 - seasonal data from MSG 2006-2007

Fraction of "dusty scenes"

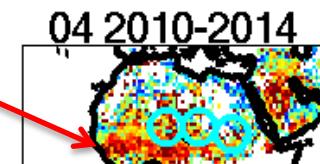
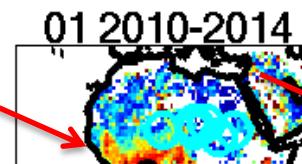
Application: dust sources study

DAY

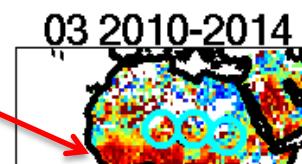
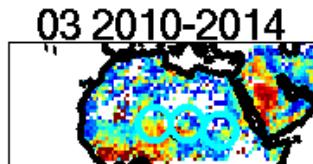
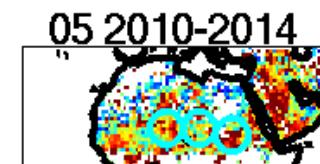
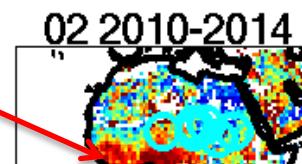
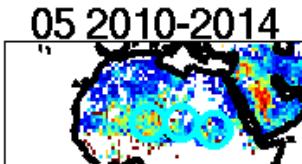
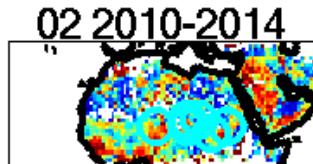


Surface detections Winter

NIGHT

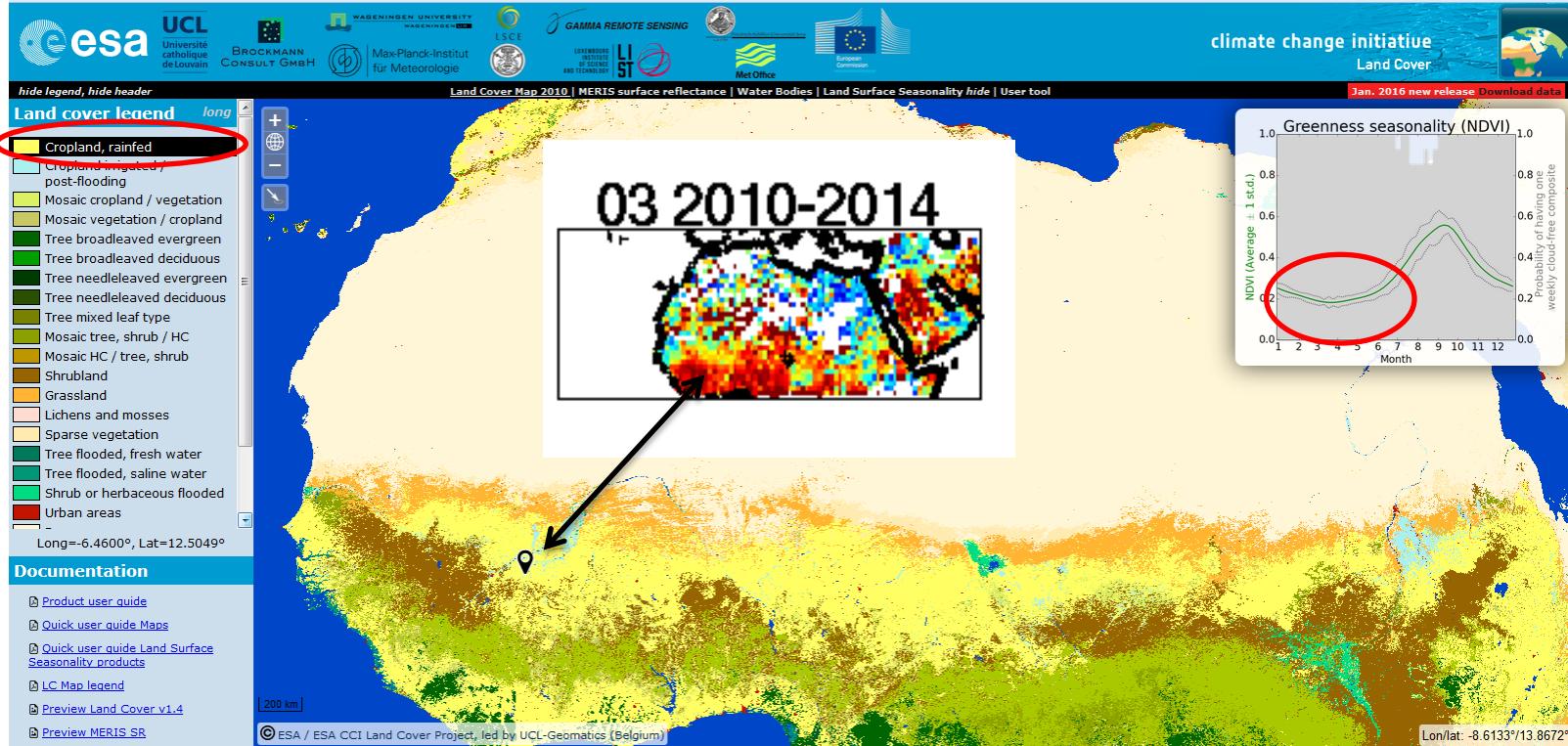


Additional
source
area??



Application: dust sources study

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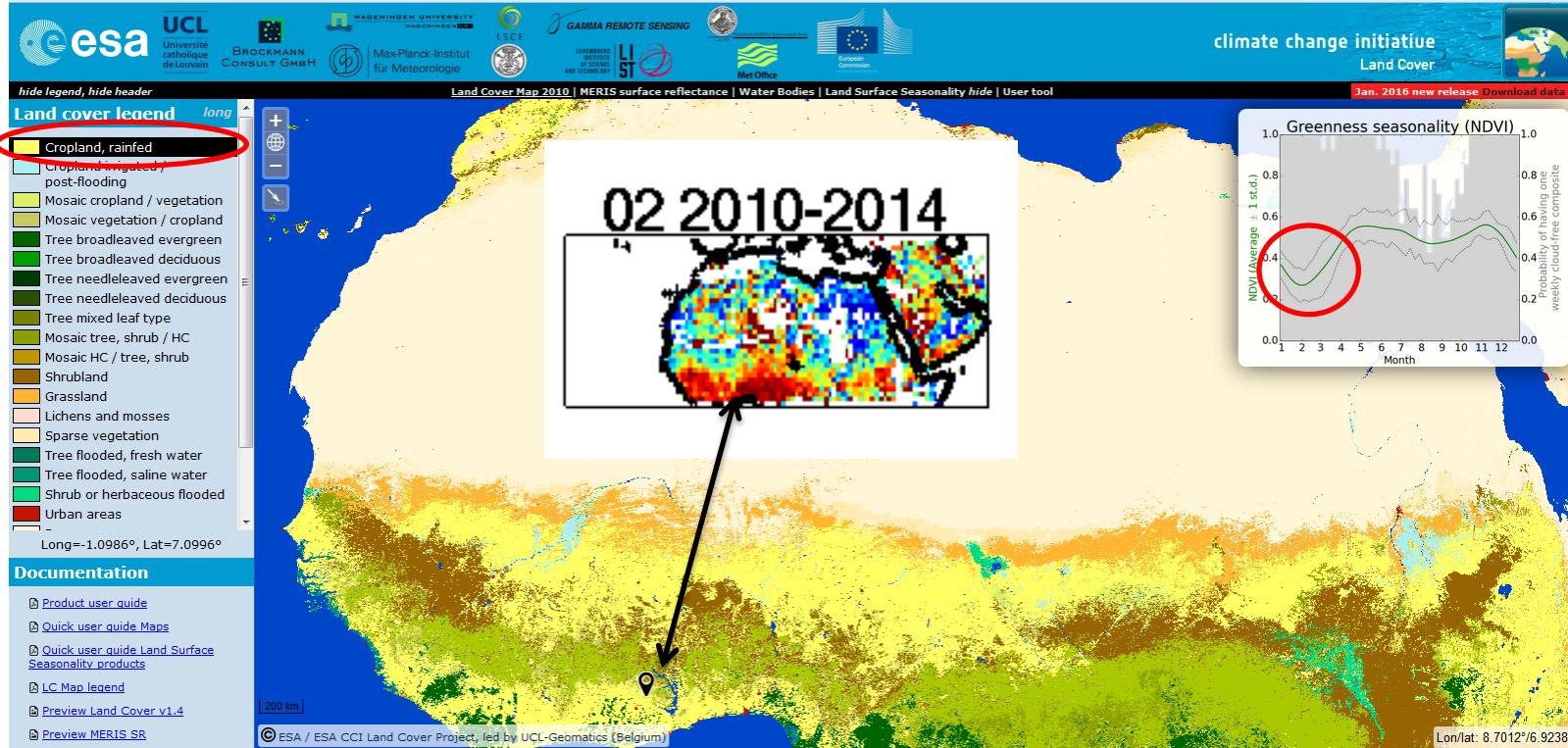


Winter &
Spring:
Almost as
arid as the
desert!

Minimum
in March &
April

Application: dust sources study

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Also at
some
places
quite
South

Application: dust sources study

- Column detections flag transport too (obviously)
- Summer months: surface detections are consistent with literature data (even though we don't detect the strongest events)
- Winter months: additional (mainly night time) new source area in South Sahel?
 - Present each year
 - Rainfed croplands, very low vegetation index during winter → arid
 - Need to look at other satellite data and surface winds to confirm

Conclusions: MAPIR

MAPIR provides vertical profiles of desert dust over ocean and land, even for very low OD

Overall good detection of dust events and periods

Plume altitude is correct, sensitivity down to the surface



Missing high load dust scenes, due to the cloud flag or retrieval issues maybe linked to T profiles



Overestimation of OD, « noisy » data

Conclusions: dust sources

- Strategy for the study needs to cope for the drawbacks to avoid too big biases
- Summer dust sources: coherent literature data
 - More specific studies in the pipeline
- Winter dust sources: discovery of an additional source in croplands during winter?
 - Need additional investigations to confirm



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Thank you and thanks to ...



Nicolas Kumps, Ann Carine Vandaele, Martine De Mazi  re
... and many of you for nice useful discussions!!!

Supplementary researcher program



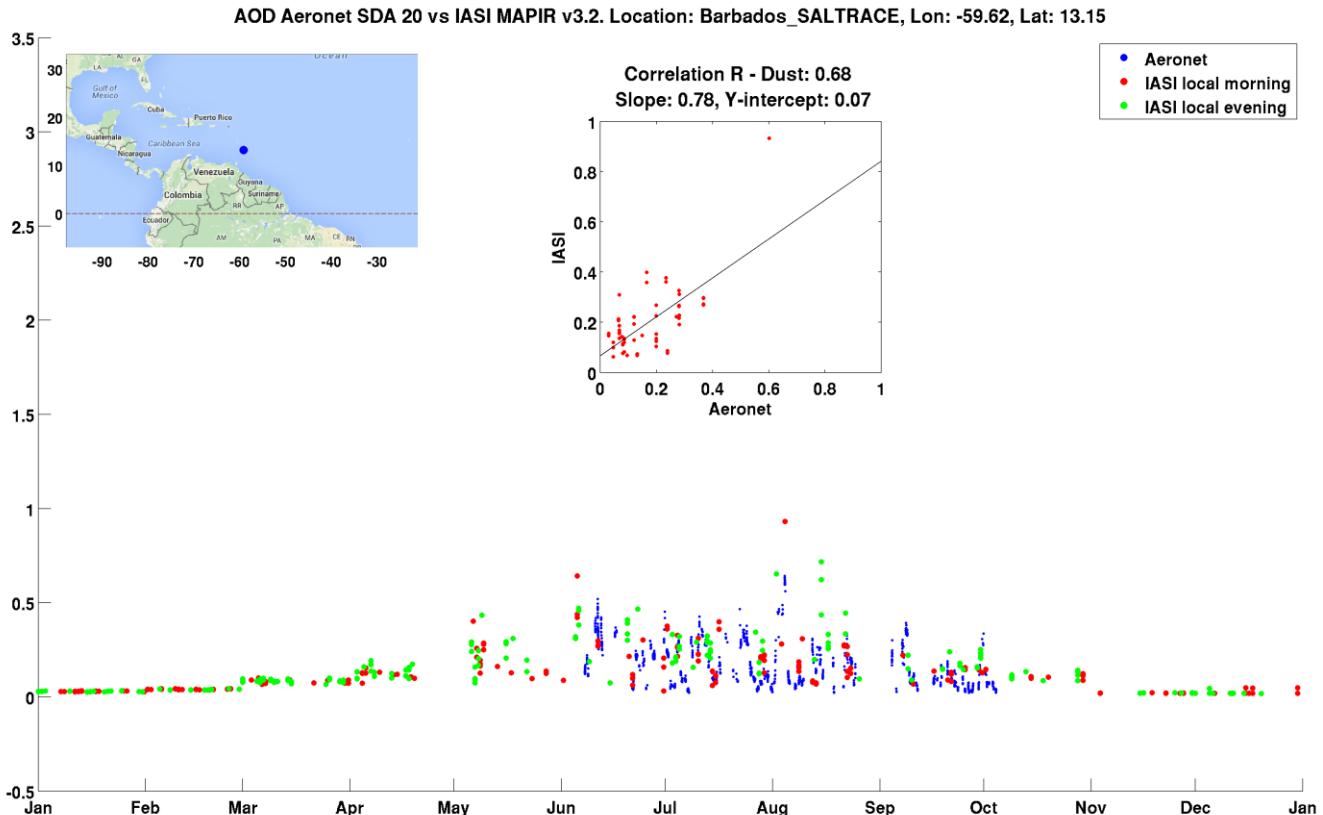
EUMETSAT scientists do an EXCELLENT job at
improving IASI data



Please allow for these HUGE progresses to be used
in LONG-TERM studies

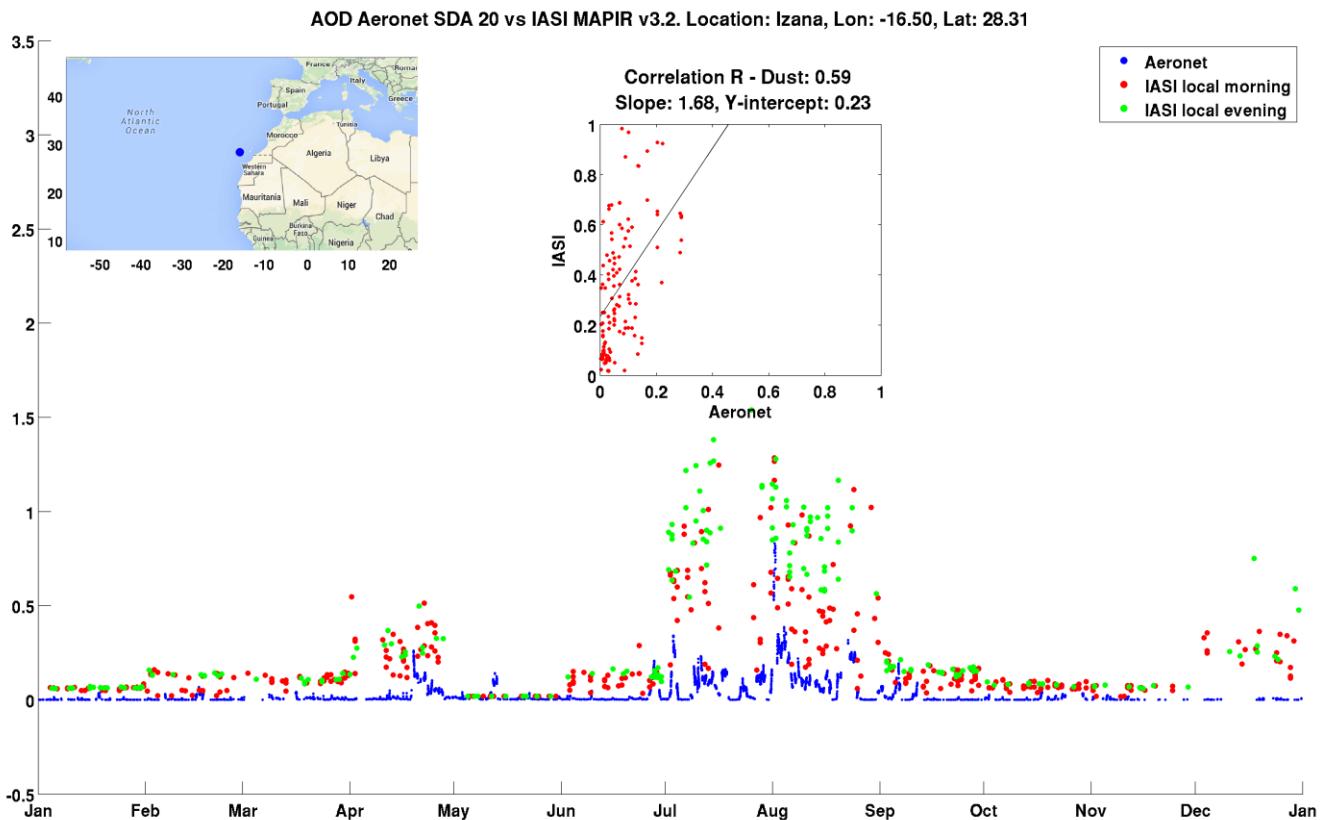
OD comparison with AERONET

Long-range
transport:
BARBADOS



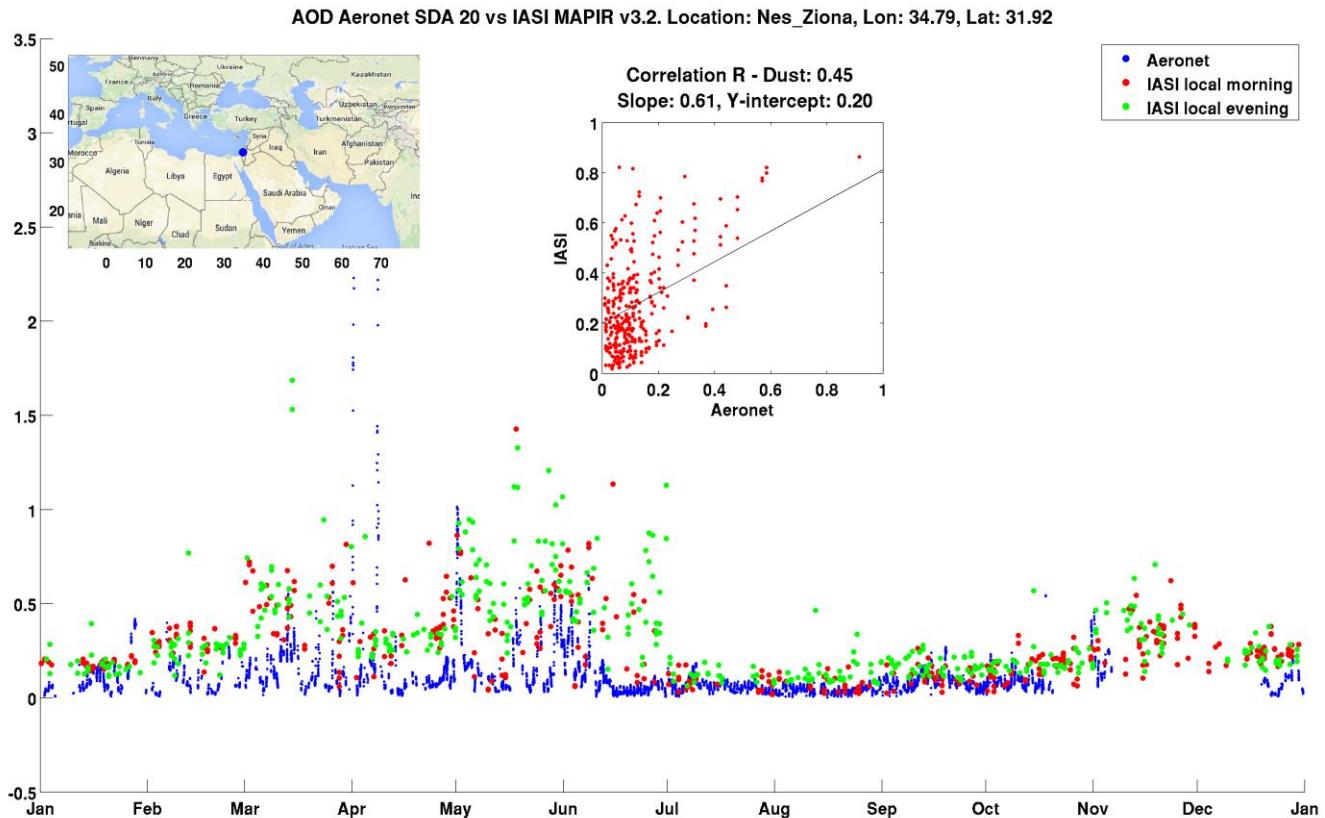
OD comparison with AERONET

Short-range
transport:
IZANA



OD comparison with AERONET

Close to
sources:
NES ZIONA



OD comparison with AERONET

Overall good detection of dust events and periods
Works « everywhere »



Overestimation of OD, but... more vertical information
Scattered comparisons

