

Features of modern dust activity and long range transport of dust from Patagonia based on satellite and surface observations

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Rolf Weller (AWI, Germany)

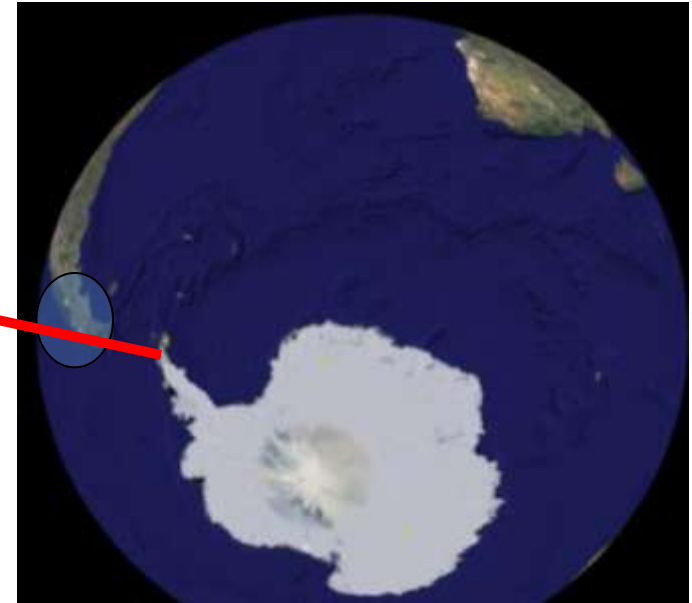
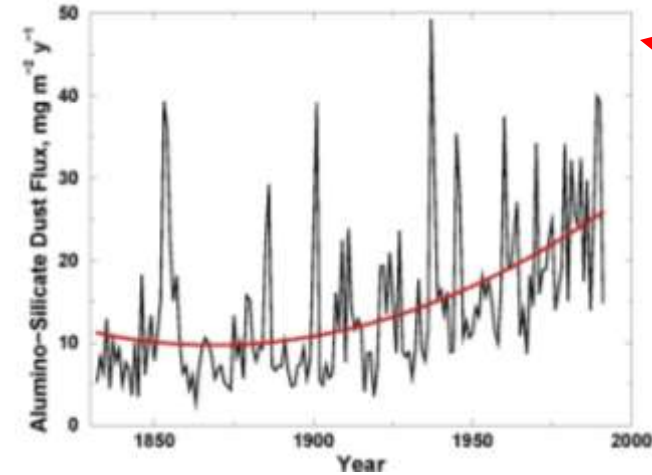
Objectives of this talk

- What does a satellite guy have in common with a paleoclimatologist?
- Illustrate modern dust activity in Southern South America (particularly Patagonia)
- Point what we can say about modern dust activity with existing observing and modeling tools
- Point out some features (how often, how much , where it goes)
- Datasets useful for this group

There is recent unexplained dust deposition in Antarctica

Recent Dust deposition,
last 100 years (J. Ross Island)

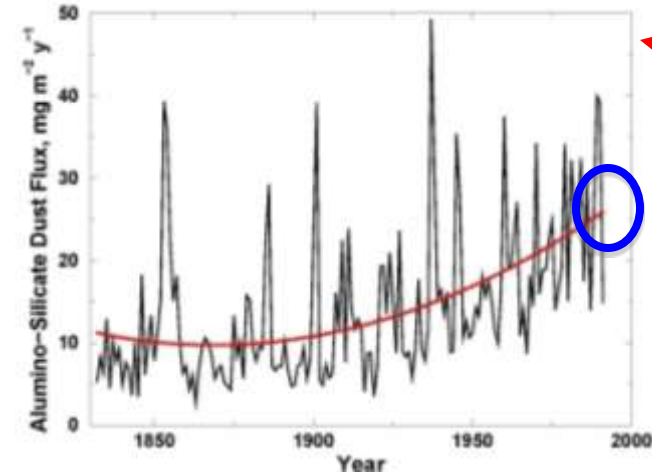
McConnell et al., 2007



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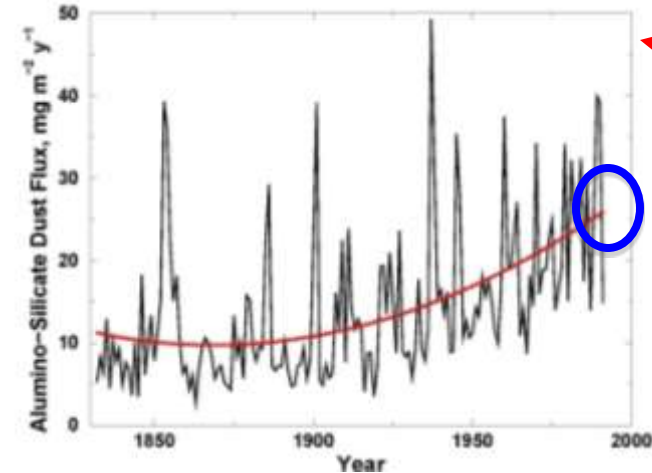
Satellite era
time frame



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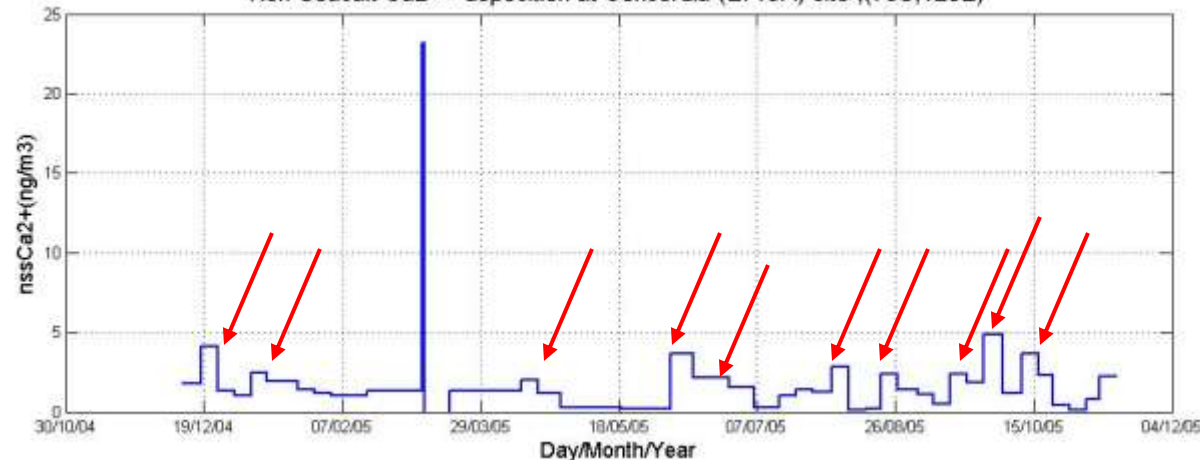


Satellite era
time frame



2004-2005 Deposition in Concordia

Non-Seasalt Ca^{2+} deposition at Concordia (EPICA) site, (75S, 123E)



*More Datasets are
becoming available that
can be used for detailed
studies!*

Data by "Station Concordia" Project at Dome C
– University of Florence .

Udisti et al., Chemical composition and seasonal pattern
of all-year-round size-segregated aerosol at Dome C,
East Antarctica. In preparation.

A brief description of Southern South America dust activity.



- Can you guess where these images are from?

Modern Dust Activity in Southern South America is comparable to other arid regions



Melbourne, Australia

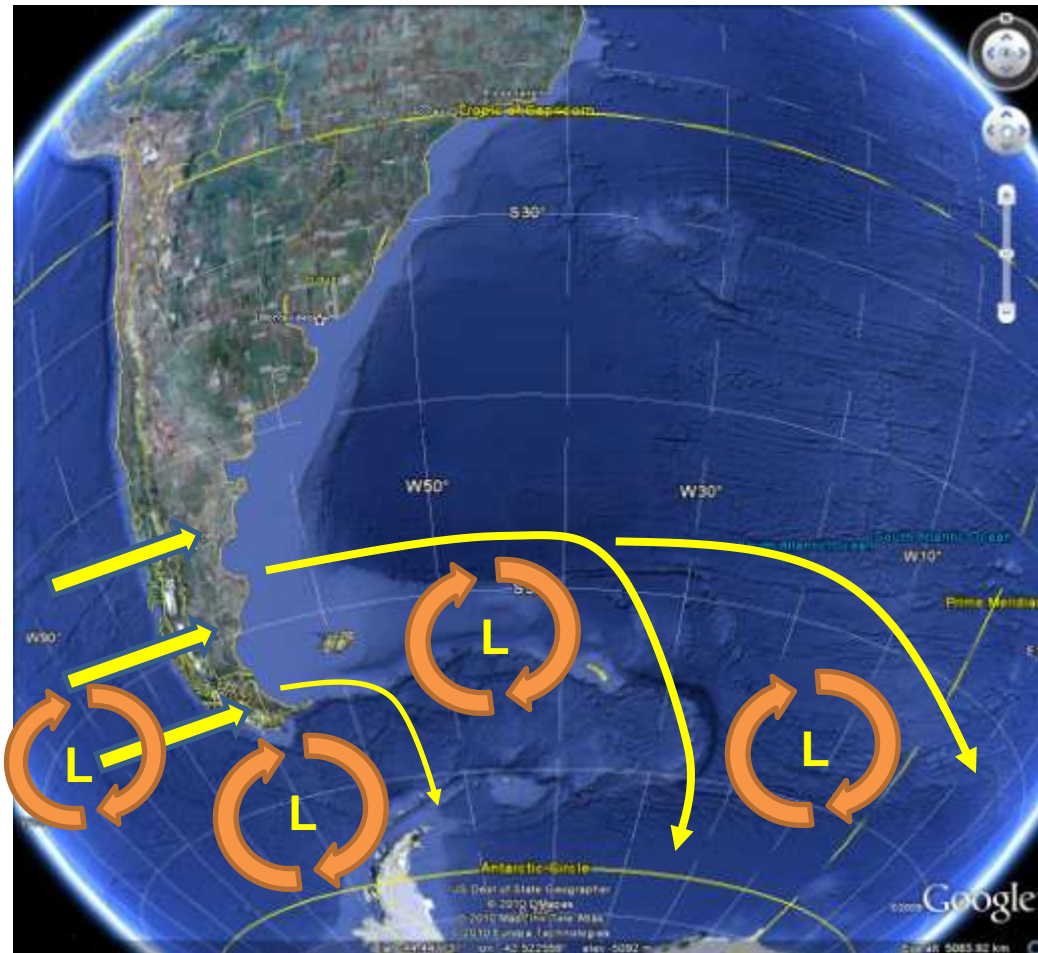


Arizona Desert



Punta Alta, Argentina
(northern Patagonia)

Two Regions under different dynamical regimes



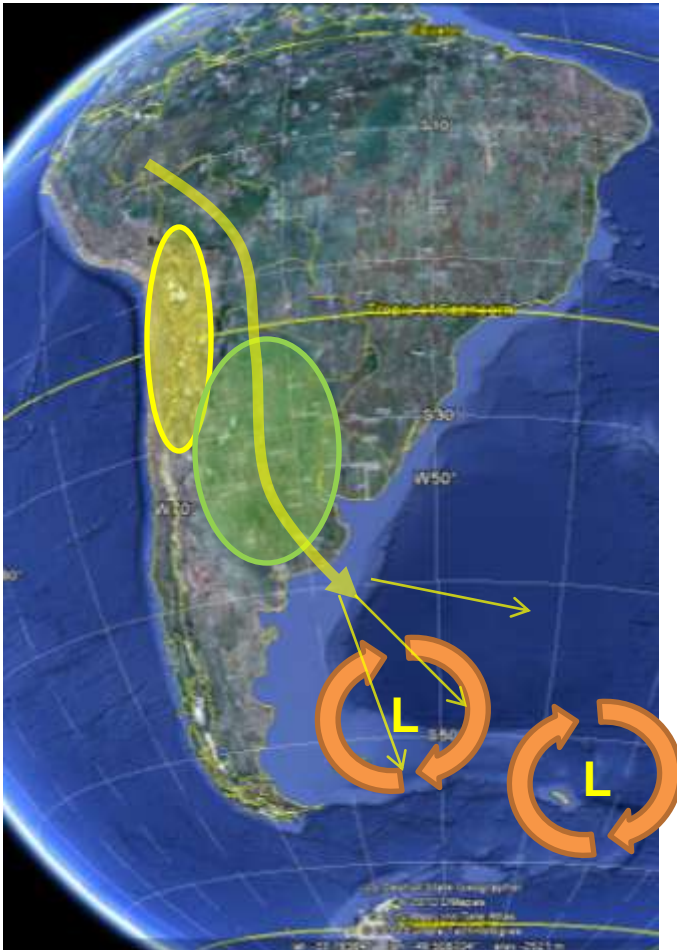
Region 1:

Dominated by the strong winds from permanent low pressure belt

Source Region is the Patagonia Desert

Delivery to Antarctica is determined by the location of the different Low pressure systems

Two Source Regions under different dynamical regimes



Region 2:

Transport is dominated by the Low Level Jet and Low Pressure systems of the S. Atlantic

Two source regions:

Bolivia (Salar de Uyuni)
Chile (Atacama)
Argentina Altiplano

} Need Winds from the Pacific

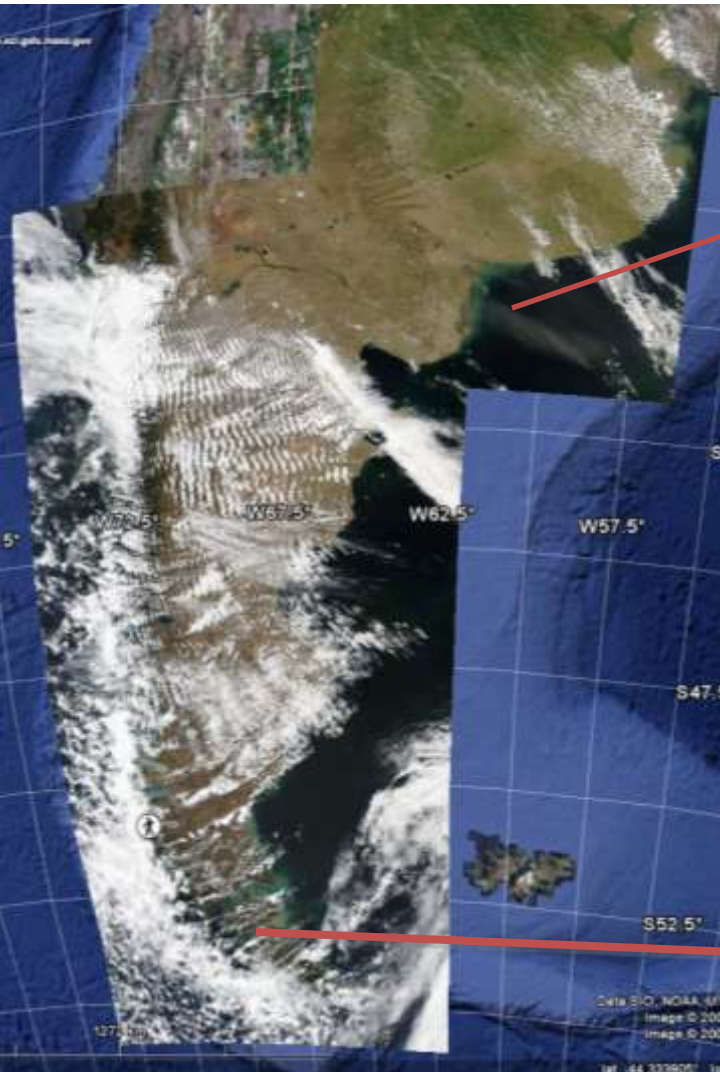
Central Argentina : becoming increasingly active due to anthropogenic activity

Monitoring Dust Activity in Patagonia: A Typical Satellite View



- Dust activity is accompanied by abundant cloudiness resulting in very difficult conditions for automatic dust detection from satellite

Dust Sources are active through the extent of Patagonia

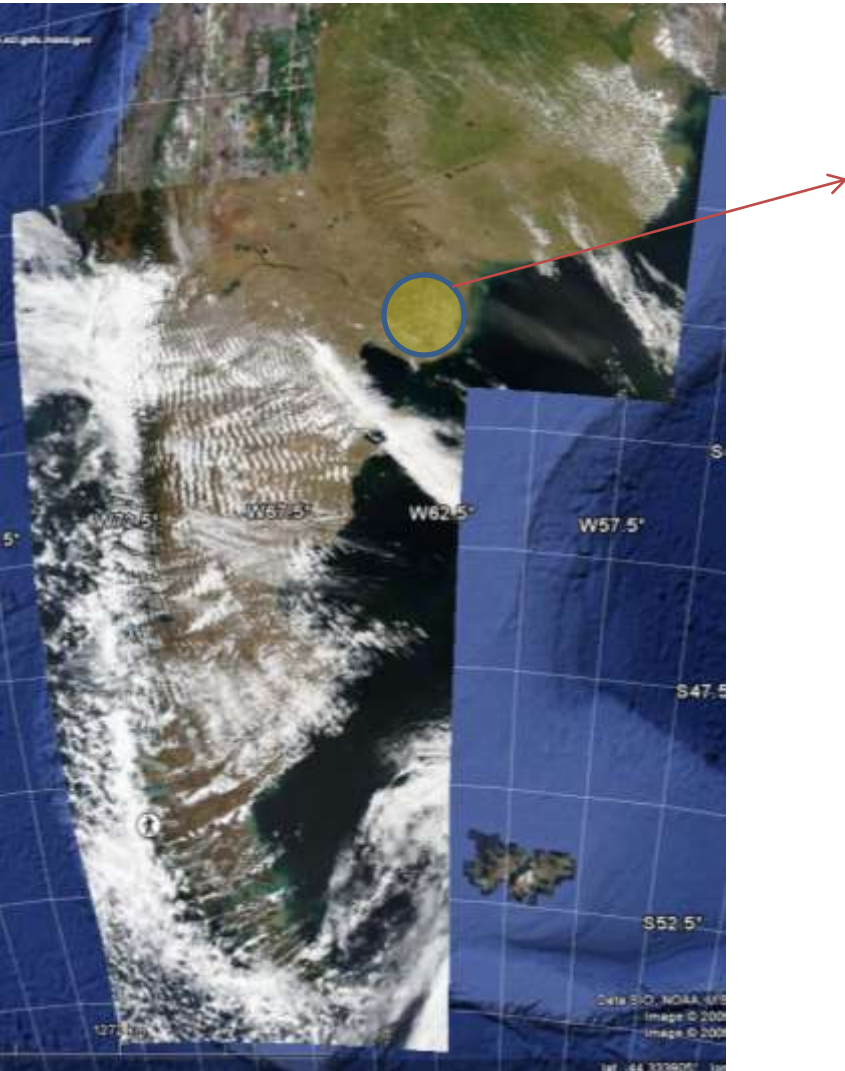


Dust

- Two sources actives on the same day! , separated by more than +1500 km.....
Dust sources span the whole length of the desert



On the sources...



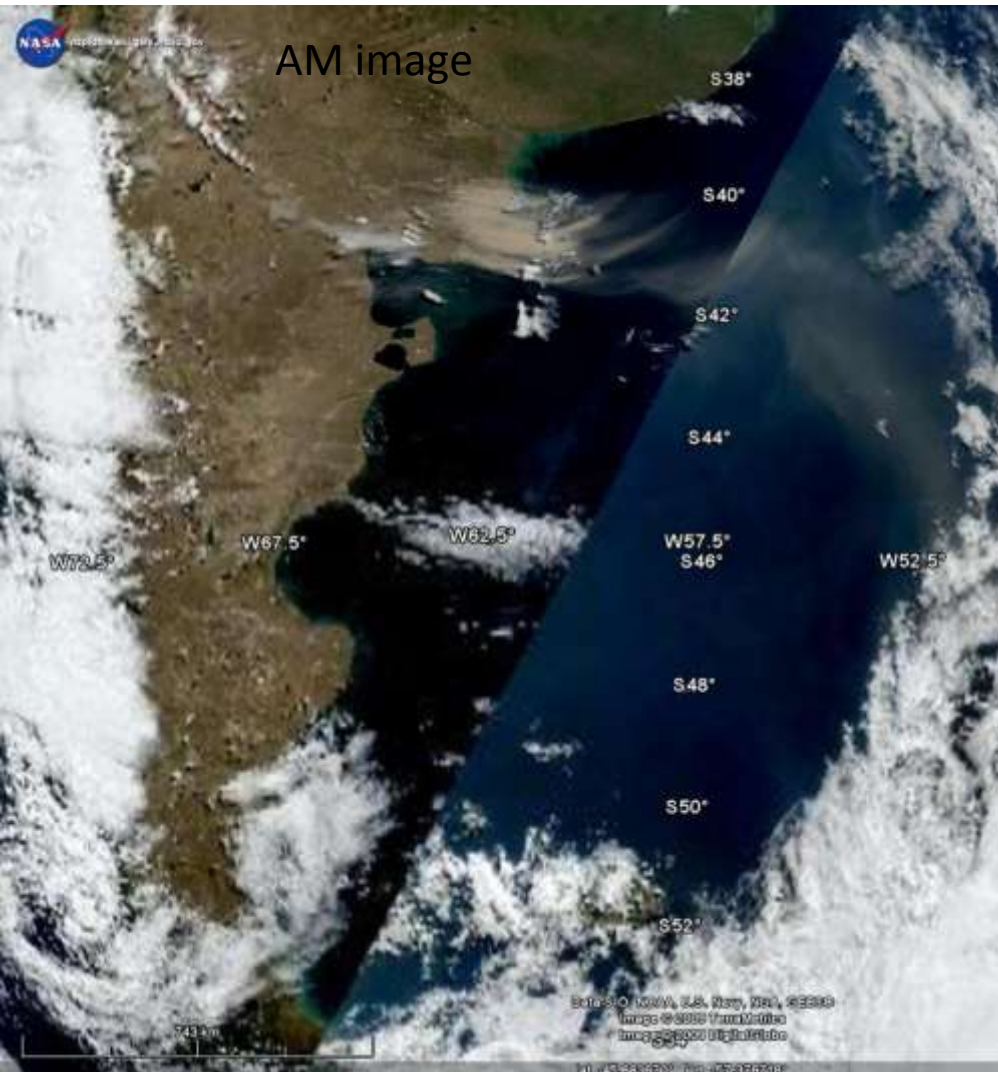
- Most of degradation is anthropogenic in northern Patagonia

Playas, Dry lakes and Coastal Sources are major contributors



Example of a Major Storm (March/09)

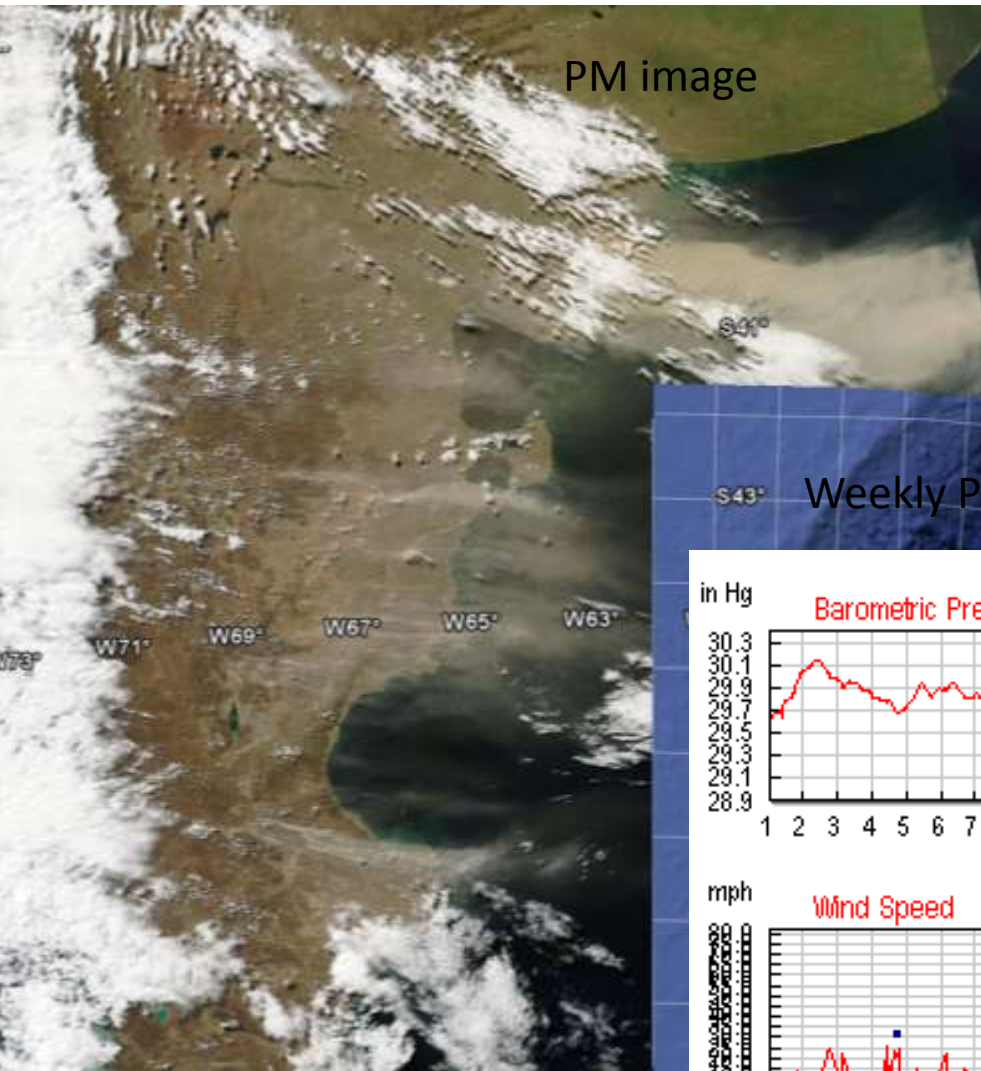
Morning Satellite pass



- Strong winds favors rapid transport (24hrs ~1000 km from coast)
- Timid start in the AM

Example of a Major Storm (March/09)

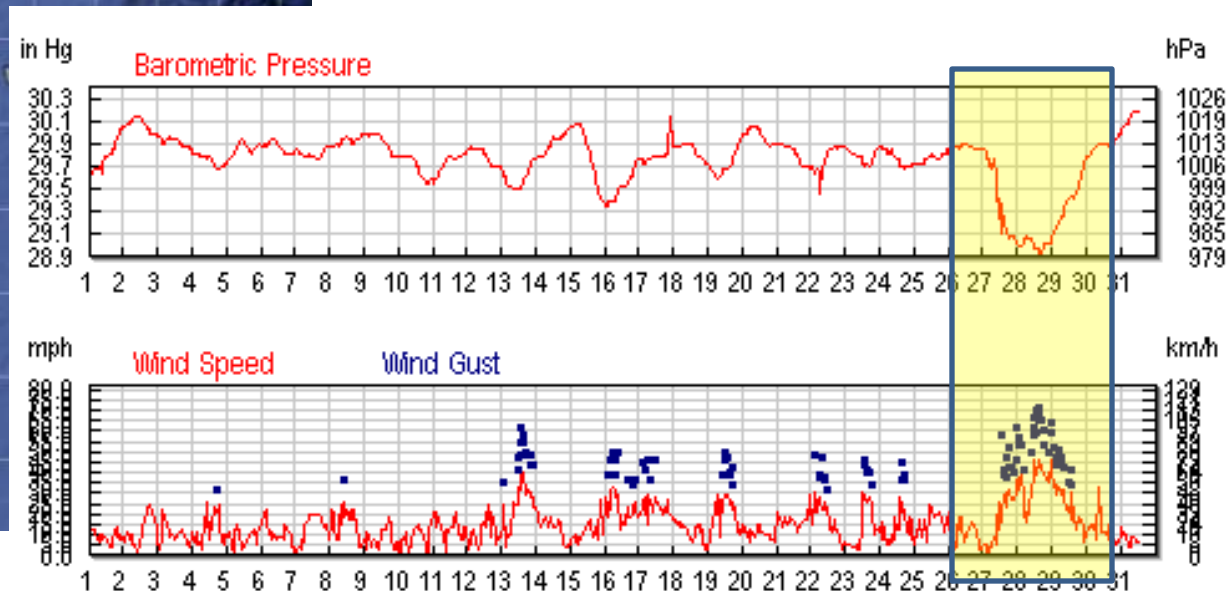
Afternoon Satellite pass



By the afternoon, it became a major dust storm, spanning a +700km front and lasted ~30hrs

Weekly Plan Wind Speed

+70 mph gusts
30 mb drop



Existing Tools that I use to evaluate current dust activity and transport

Visibility: surface observations at airports (~10 in Patagonia). Data available since the 50's although the better quality of data starts in the 90s.

Satellite : since the 80s (TOMS) but the really good satellite imagery starts in early 2000s

These observations are complemented by using the HYSPLIT aerosol dispersion model.

Visibility: Take home bits



Highly variable from year to year activity from Bahía Blanca (38S) to Río Grande (53S) ... (+ 2000 km front)

Events tend to last a few hours a day (rarely they span more than 24 hrs) --→ very difficult to monitor with satellites.

Visibility does not capture all dust activity in Patagonia due to spacing between stations.

Satellites:

what can and cannot tells us?

In addition to source detection and tracking of the aerosol , it can:

- Derive aerosol concentration in the column (aerosol optical depth)
- Aerosol type present: Dust? Smoke? Pollution? (aerosol sphericity, aerosol absorption)
- Aerosol size (accumulation or coarse mode dominated)
- Aerosol height (lidar)

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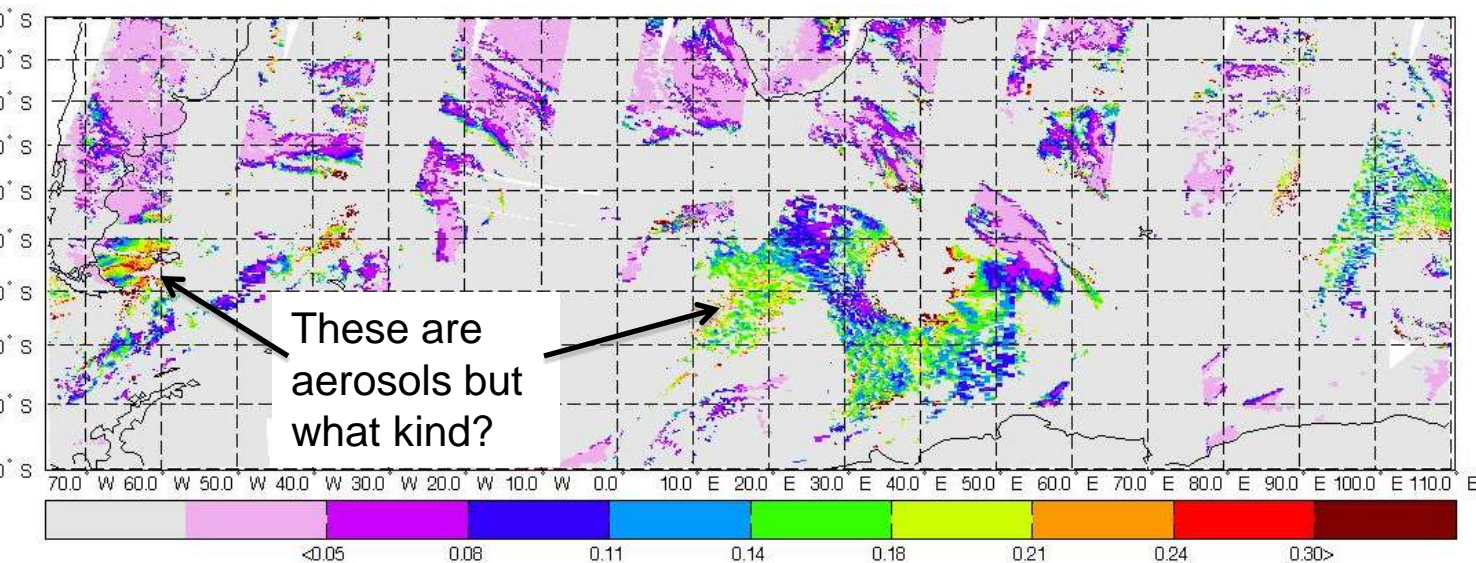
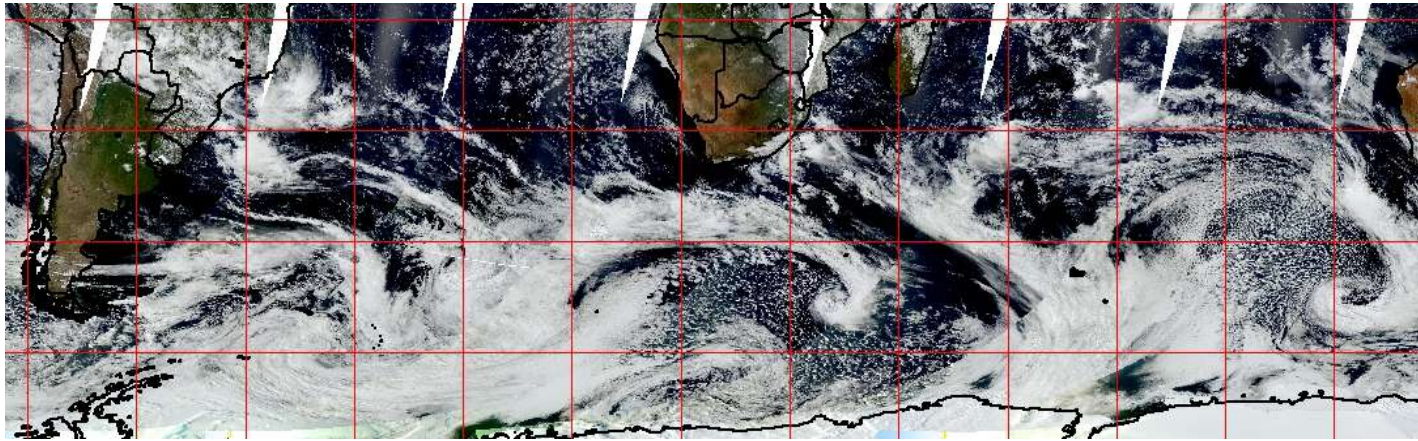
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It cannot, for example,

- Measure deposition
- See aerosol under clouds
- Not reliable at low aerosol concentrations .

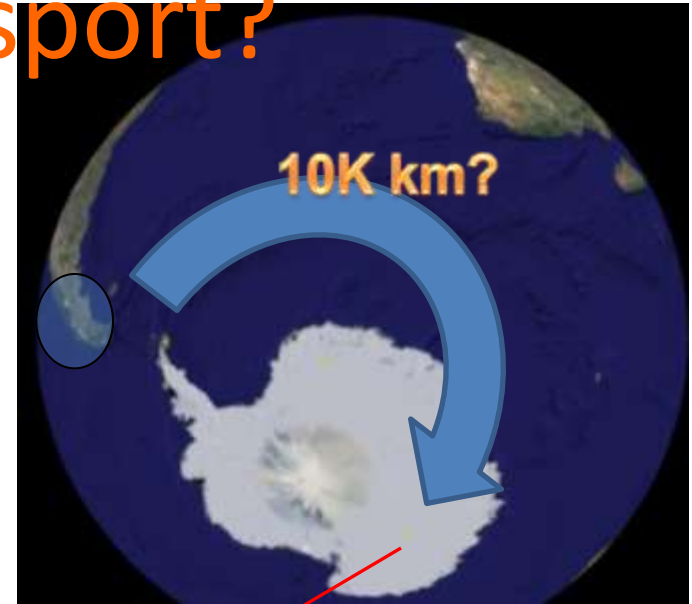
Typical scene with aerosols over the SO



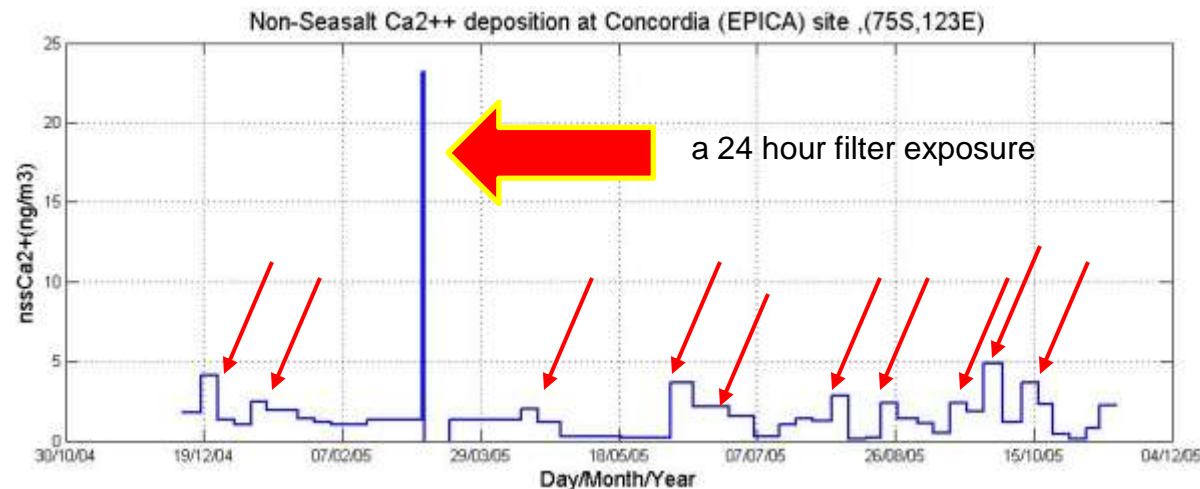
Example of
Aerosol
Optical Depth
Retrieval from
the MODIS
satellite.

How these tools help to characterize dust transport?

Is Patagonia the source of dust recently observed in Antarctica?

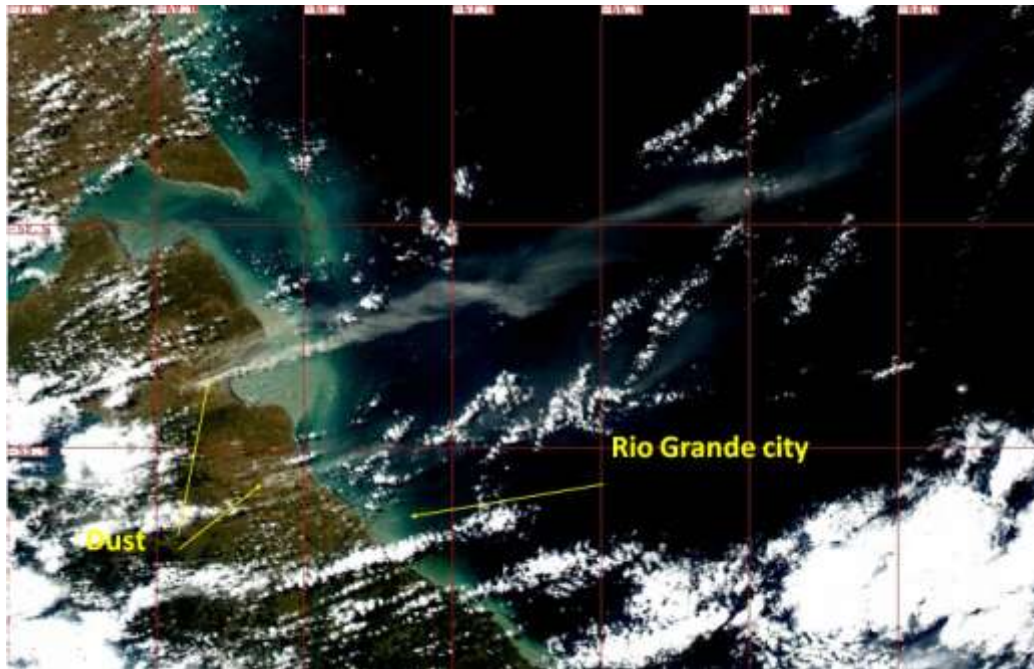


2004-2005 Deposition in Concordia

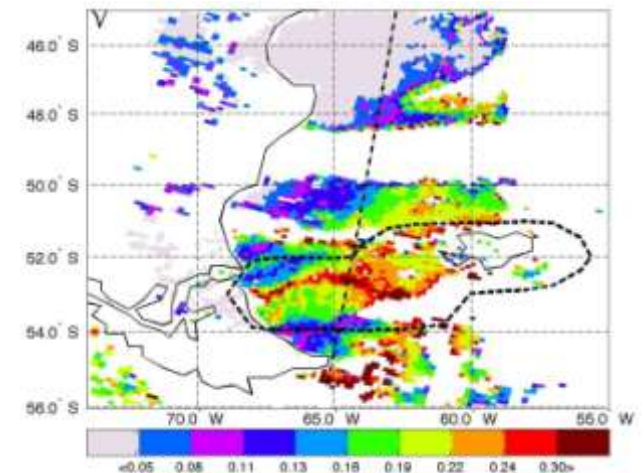


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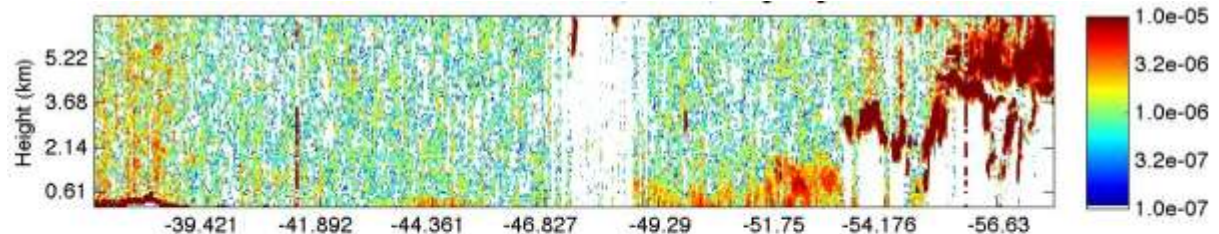
A dust event in Tierra del Fuego 10 days earlier injects dust in the BL (model and satellite agree)



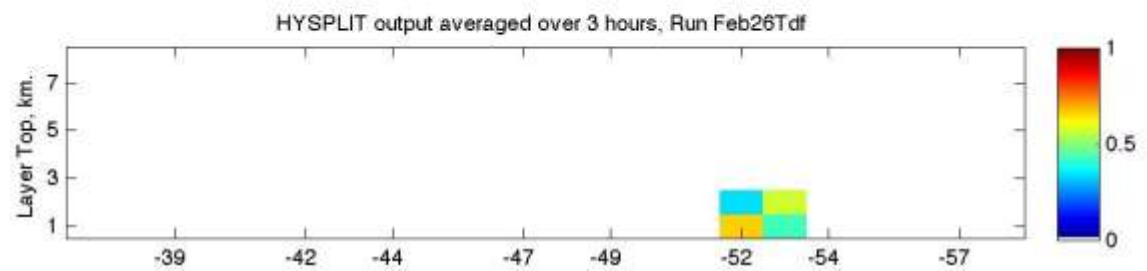
MODIS detects dust reaching Malvinas



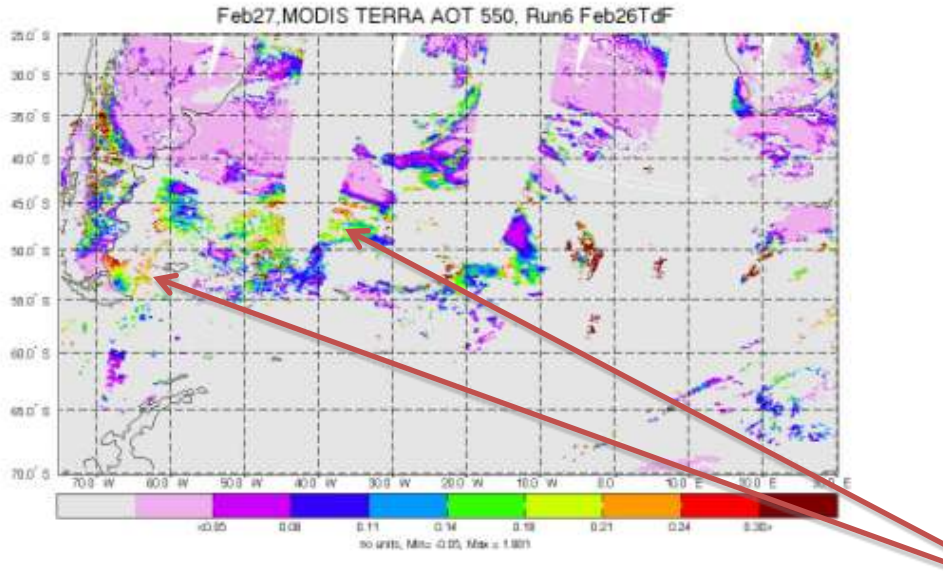
Lidar Confirms BL dust.



Model also places dust in the same place and height



The day after: where's the dust?

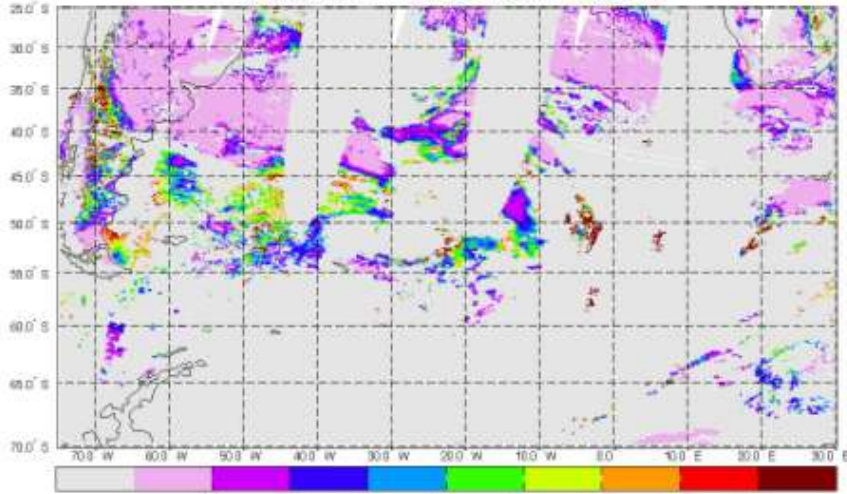


MODIS provides good spatial coverage but no aerosol differentiation. What is dust and what is sea-salt?

AOT ~0.15 - 0.2

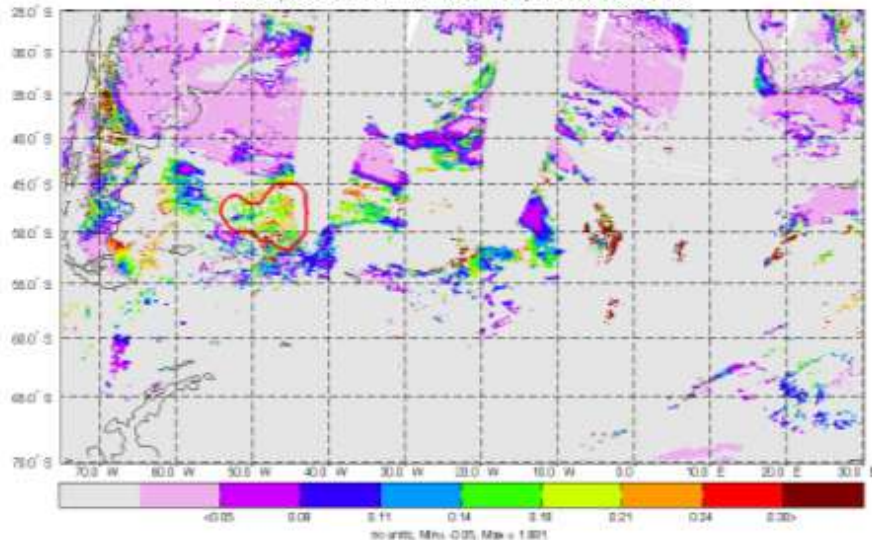
The day after: where's the dust?

Feb27.MODIS TERRA AOT 550, Run6 Feb26TdF



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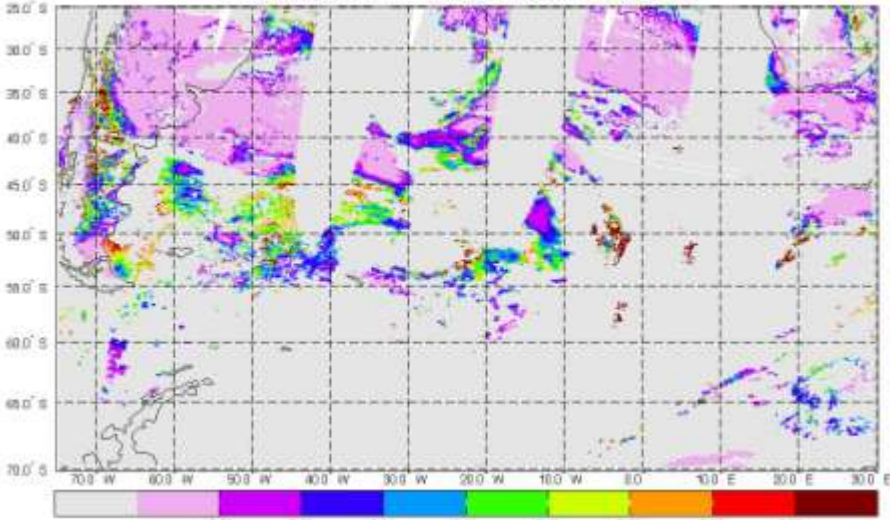
Feb27.MODIS TERRA AOT 550, Run16 Feb26TdF



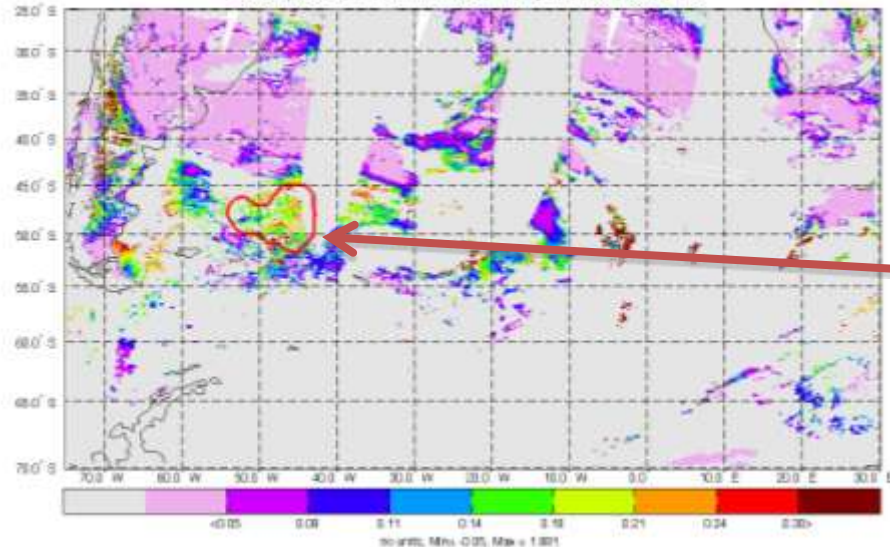
Addition of Model information helps to look for possible areas

The day after: where's the dust?

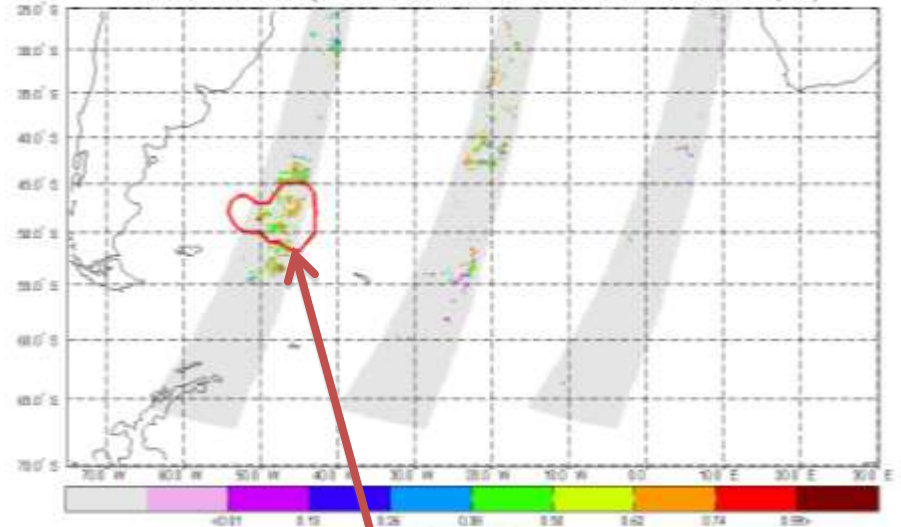
Feb27, MODIS TERRA AOT 550, Run6 Feb26TdF



Feb27, MODIS TERRA AOT 550, Run16 Feb26TdF



Feb27, MISR NonSph OD fraction for AOD > 0.11, Run16 Feb26TdF (red)



MISR detects a non-spherical aerosol in same area and agreeing with model and MODIS

Positive identification occurs when merging the 3 sources of information

What about after 48hrs of emission?

There is no conclusive satellite evidence of the pathways to Antarctica in this case study. However, it is likely the dust reached SW of S. Africa (in agreement w/model simulations).

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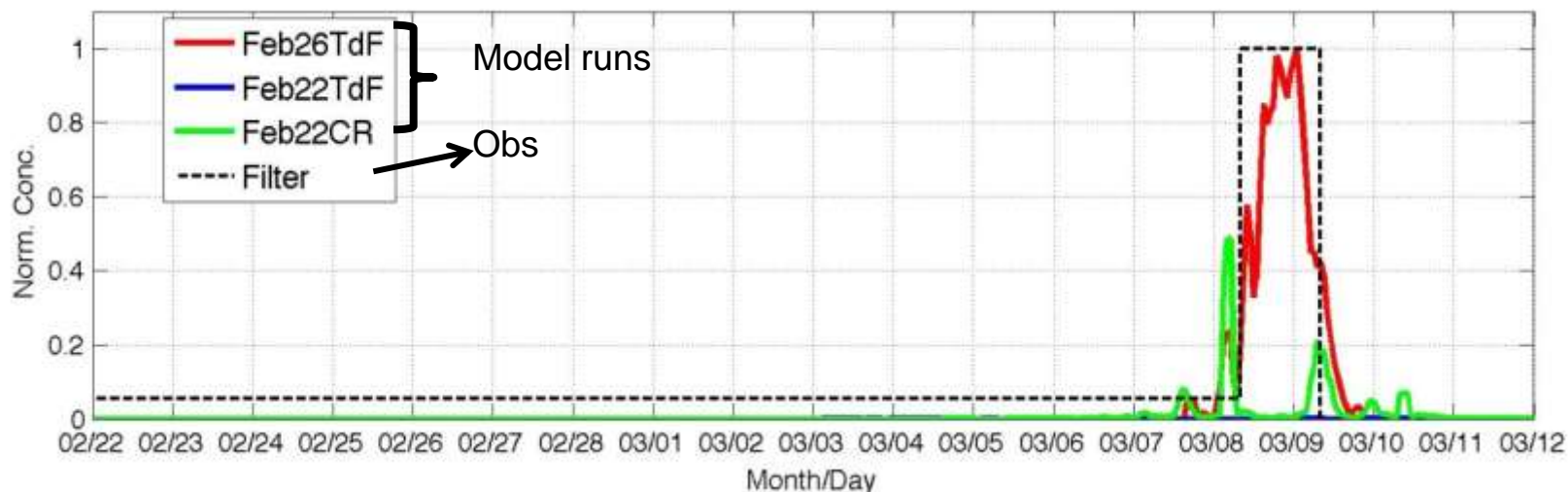
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Well model and surface obs in DC agree very well

Dome C - Normalized to Feb26TdF max



Work
available in
Gassó et
al., 2010.
ACPD

Wrapping up.. Data sets that might be useful for this group.

1. Visibility records from Patagonia stations along the coast. Available since 1950's. Useful for comparisons of recent dust deposition in Antarctica.
2. A daily record of dust activity satellite observations of Patagonia (and most of Argentina) since 2004. Useful for case study characterization , transport studies.