Introducción a detección de aerosoles con el detector OMI (satélite Aura) y Caracterización del transporte de polvo patagónico

Santiago Gassó
NASA/MSU
Santiago.Gasso@nasa.gov
@SanGasso

NASA Goddard SPACE FLIGHT CENTER

MORGAN STATE UNIVERSITY
GROWING THE FUTURE LEADING THE WORLD

- Introduction

Core Funding Project :

- Aerosol detection with the detector OMI

Independent projects:

- Detection of volcanic activity in cloudy conditions

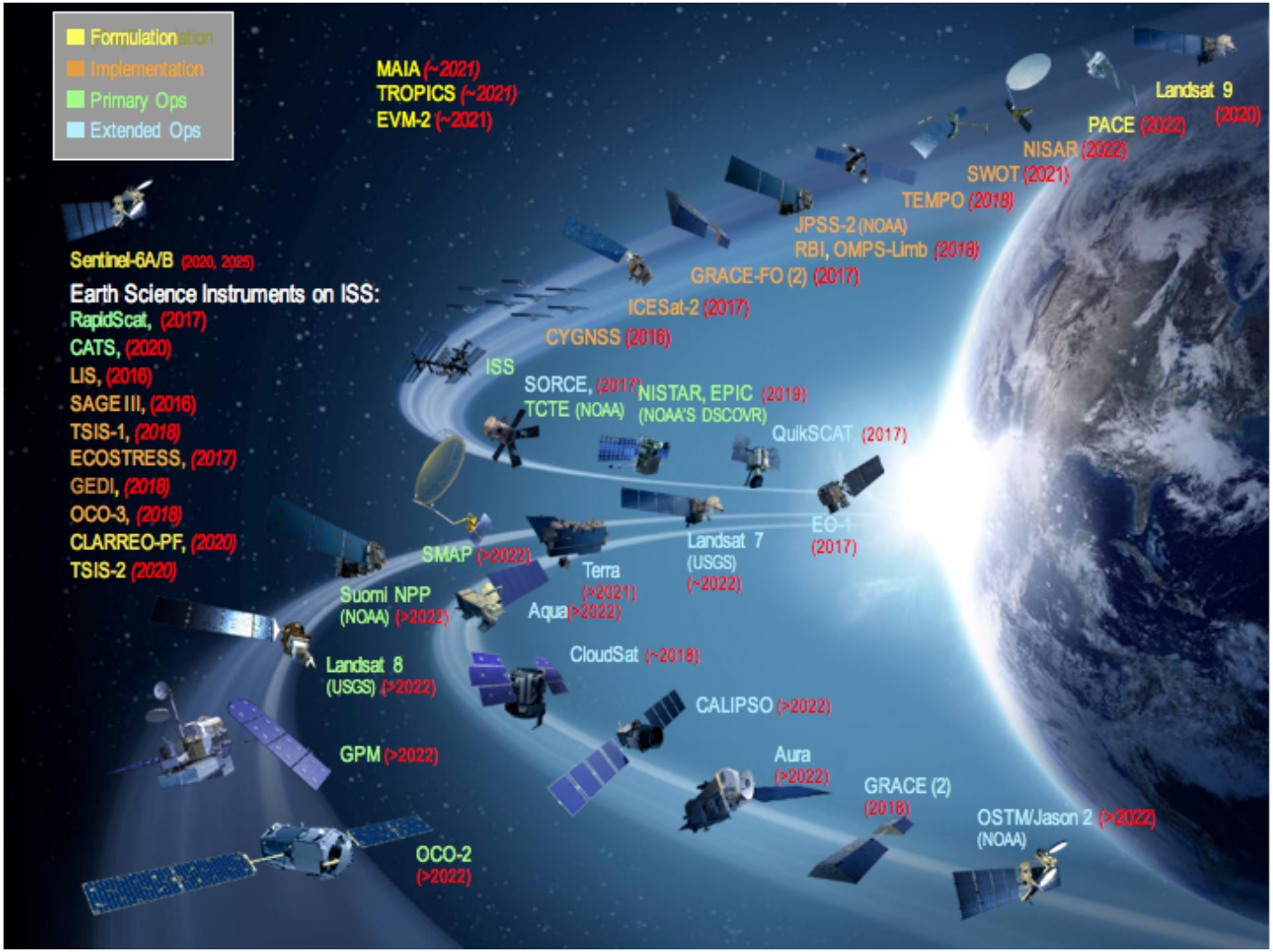
- High latitude Dust: Dust in Patagonia

About me …

NASA Goddard Space Flight Center, Greenbelt, Maryland

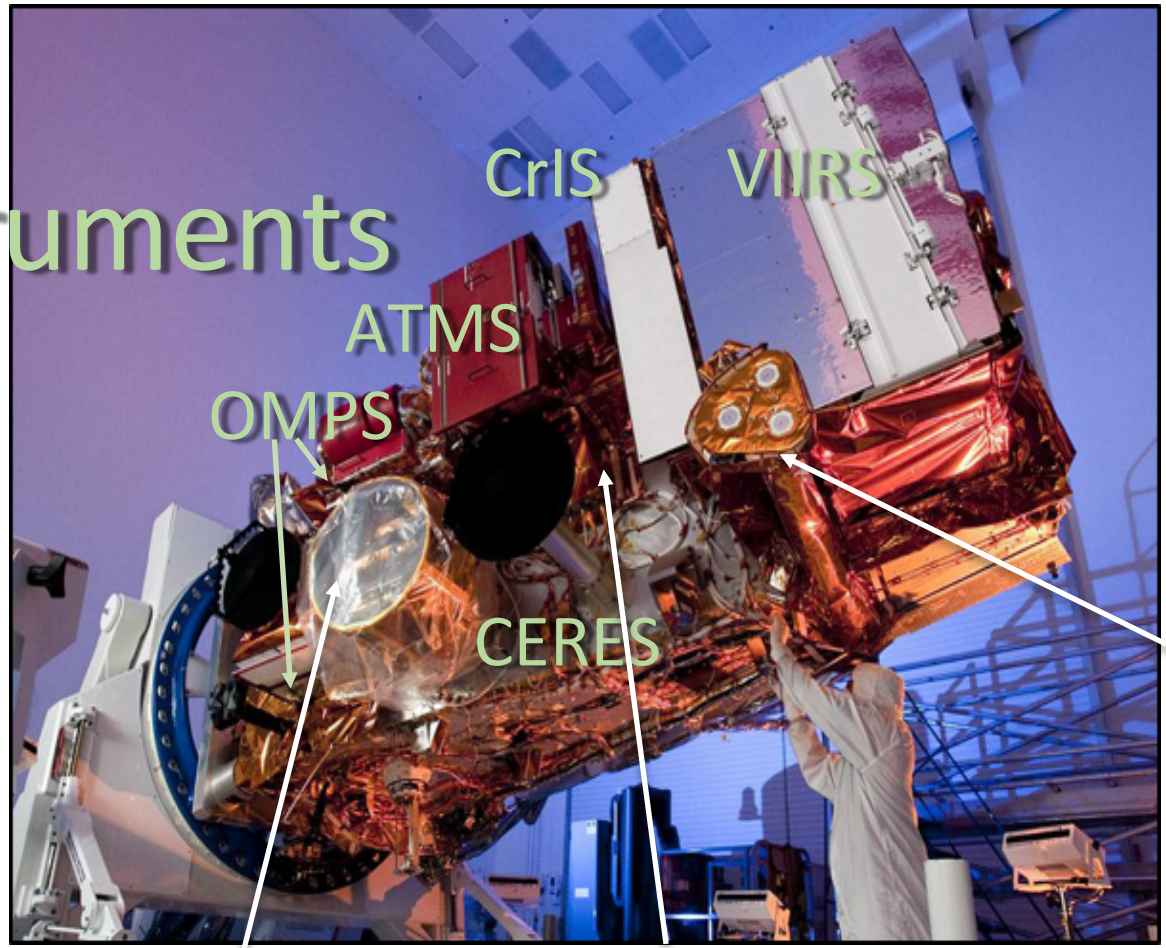
- MSc Physics, Exactas, BsAs, 1992
- MSc and PhD Geophysics (Atmos Sc.) University of Washington, Seattle, 1997 and 2001
- Post-Doc, NASA/GSFC, MD,2002-2004
- Research Scientist,2004-now

Past, Present and Future NASA satellite Earth missions



What's on a Satellite?

NASA-NOAA JPSS Satellite 4m x 2.6m 2040 kg



Communication and Commanding Antennas

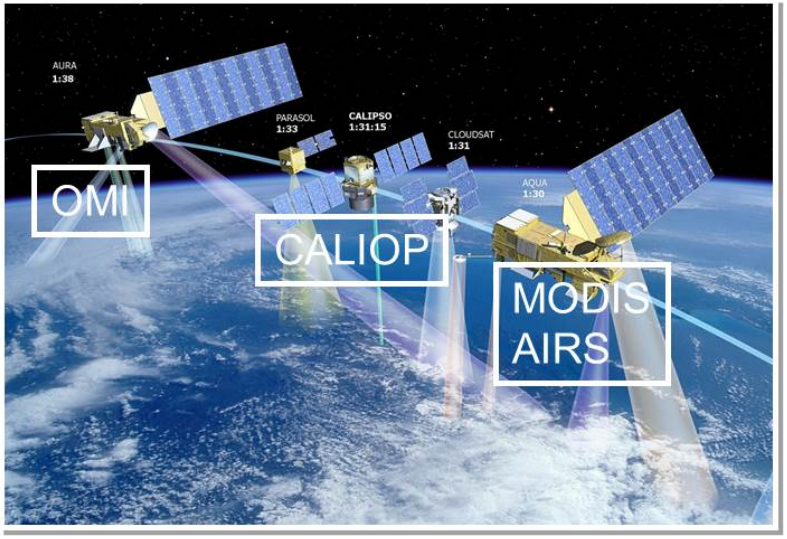
Low Data Rate antenna: S-band for spacecraft commanding

High Data Rate (300 Mbps) antenna: X-band to polar ground stations

Low Data Rate (25 Mbps) antenna: X-band to user ground stations

A pollution Sensor: Ozone Monitoring Instrument (OMI)

An international project: Holland, USA, Finland



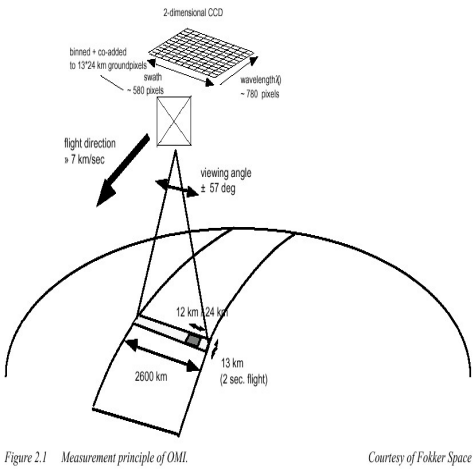


Figure 2.1 Measurement principle of OMI. *Courtesy of Fokker Space*

Nadir solar backscatter spectrometer
-270-500 nm

-13X24 km pixel

-2600 km swath width

-Launched on 07-15-04

Aura is one of the A-train satellites, OMI is one of four sensors on the Aura platform

Retrieval Products:
-Column O_3, NO_2, BrO, HCHO, SO_2
-O_3 profile
-Cloud top pressure
-Aerosols

A-B-C of OMI Near UV Aerosol Product

- In the UV, most of the signal is coming from the atmosphere
- Retrieved Products:

  Absorbing Aerosol Index (AAI)
  388 Aerosol Extinction Optical Depth (AOD)
  388 Aerosol Single Scattering Albedo (SSA)

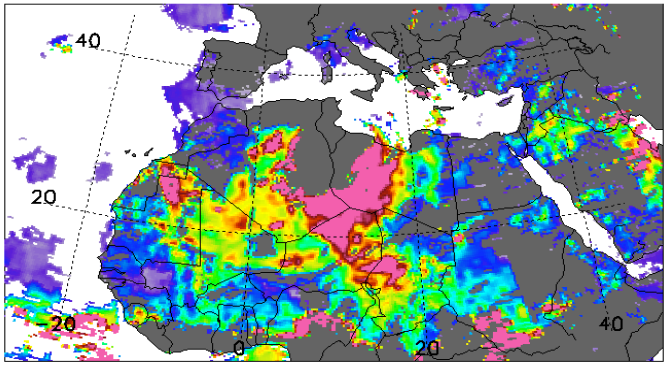
Some unique features (MODIS/VIIRS cannot do this)

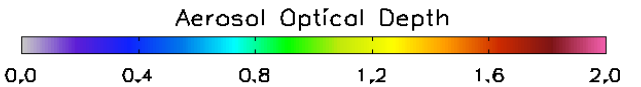
- Derive AOD over bright surfaces
- Derive Aerosol absorption optical depth
- Sensitive to Aerosol absorption in clear and cloud condition
- Sensitive to Aerosol height.

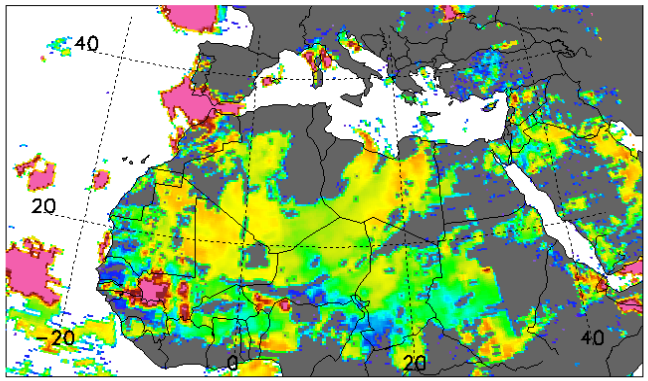
OMI NASA Aerosol Products

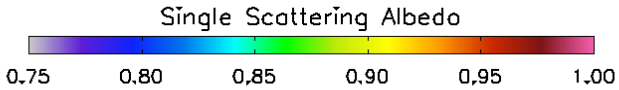
AOD and SSA under cloud-free conditions

Clear Sky Products (03-09-2007)





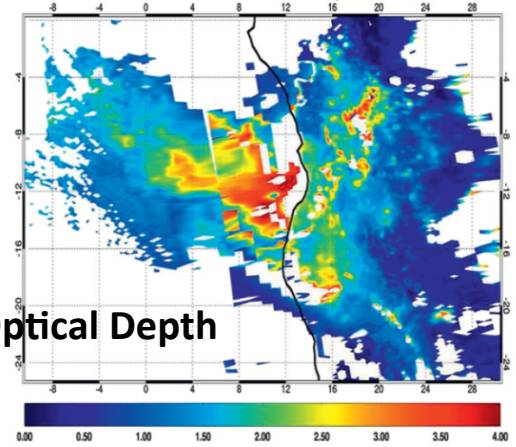


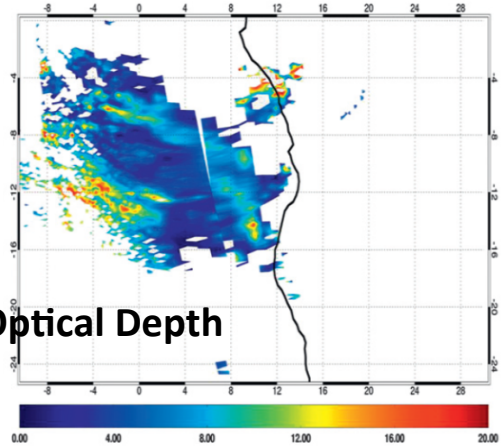


Torres et al., 2007; 2013

COD and AOD of aerosol layers above clouds.

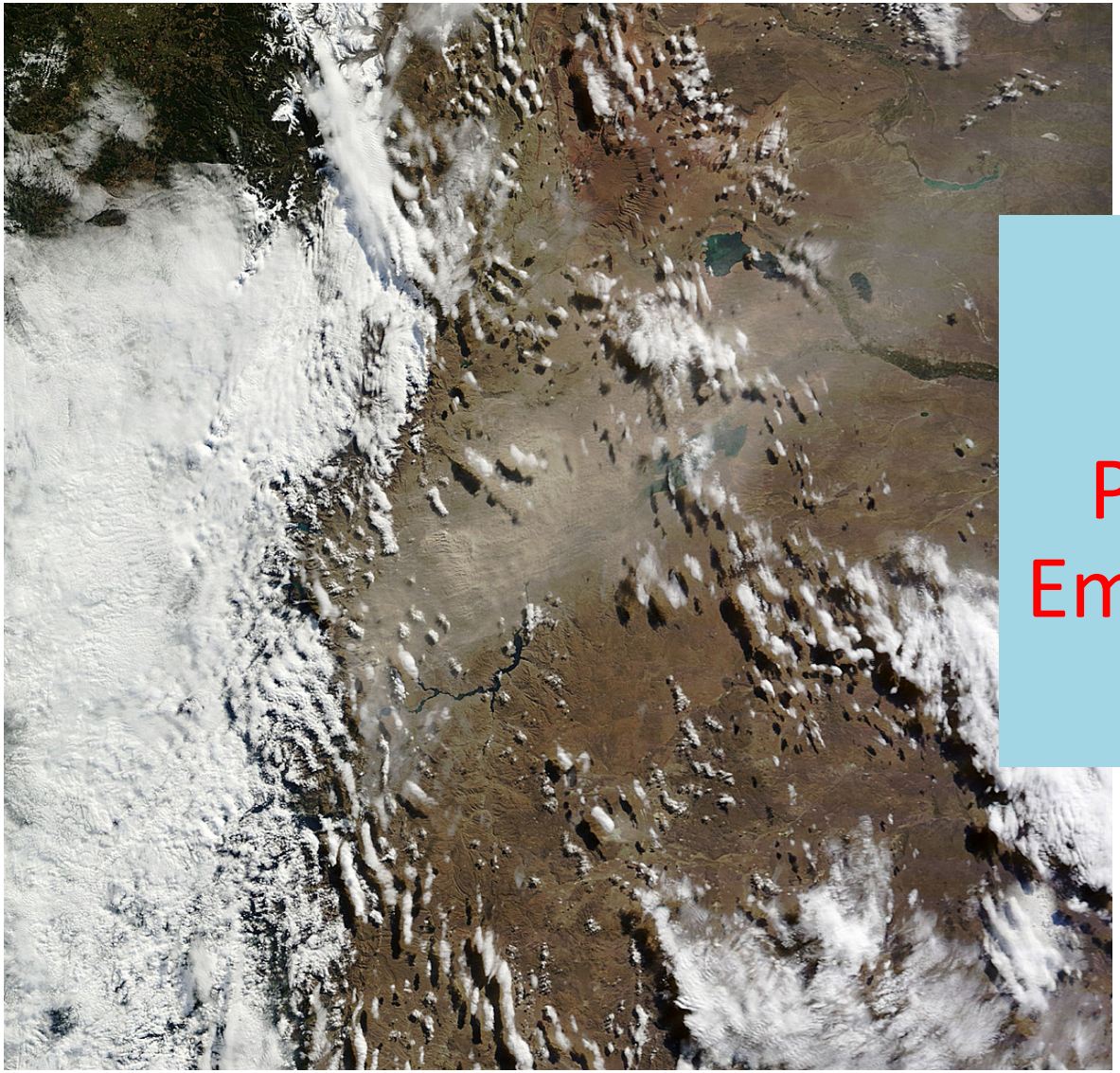
Above Cloud Products (08-31-2005)





Torres et al., 2012; Jethva et al., 2014

Satellite Monitoring of Passive Volcanic Emissions in Cloudy Condition



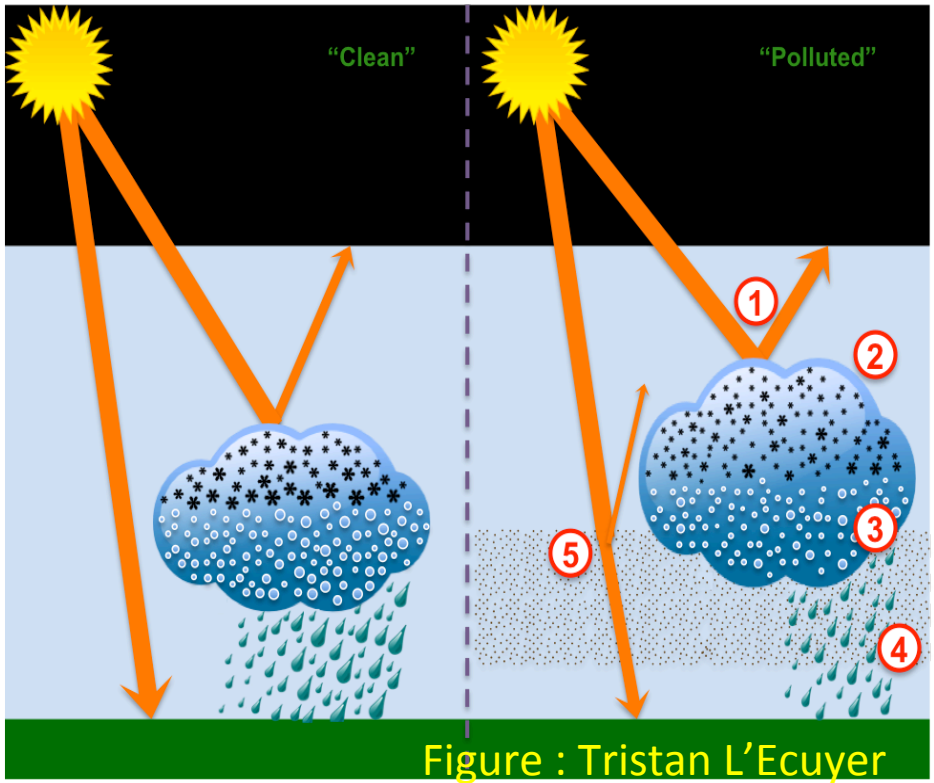
Satellite Monitoring of Passive Volcanic Emissions in Cloudy Conditions

Visible RGB – 0.47um,0.67um,0.87 um

May 03, 2015 – S. Chile/Argentina Andes

A well known phenomenon in the Cloud – Aerosol Physics:

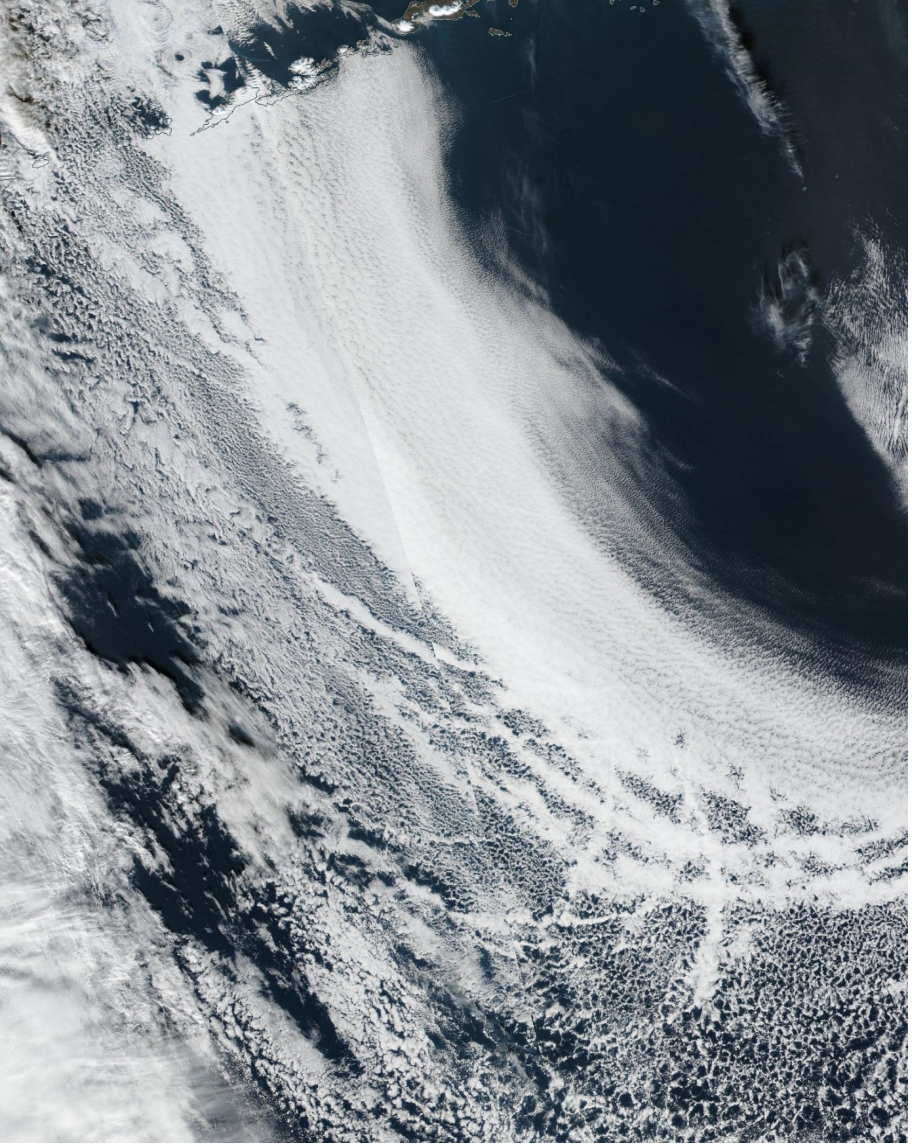
Aerosol Indirect Effect



"Clean" "Polluted"

- Optical (1:albedo)
- Microphysics (2,3:droplet and ice size)
- Macrophysical (4: rain, spatial extent)

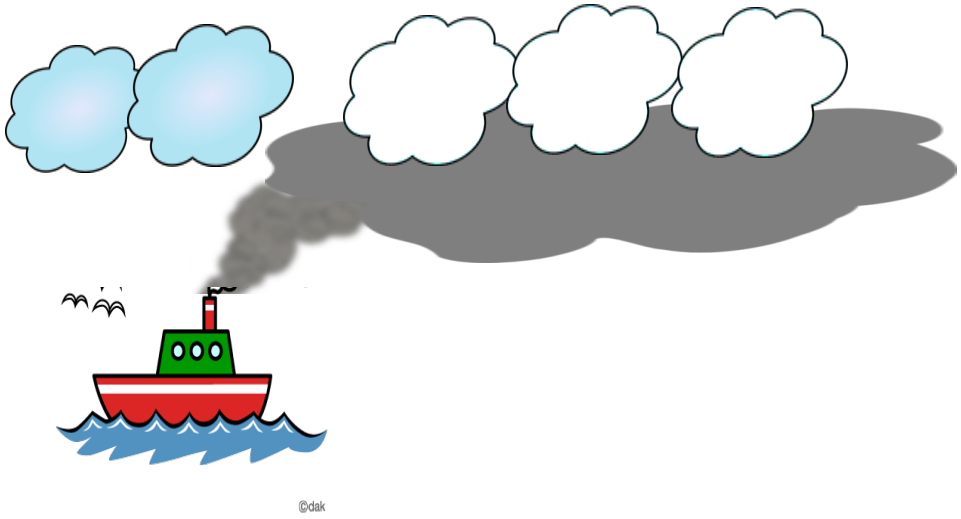
properties change due to particles (i.e. pollution, ashes, smoke) entering (or near) a cloud

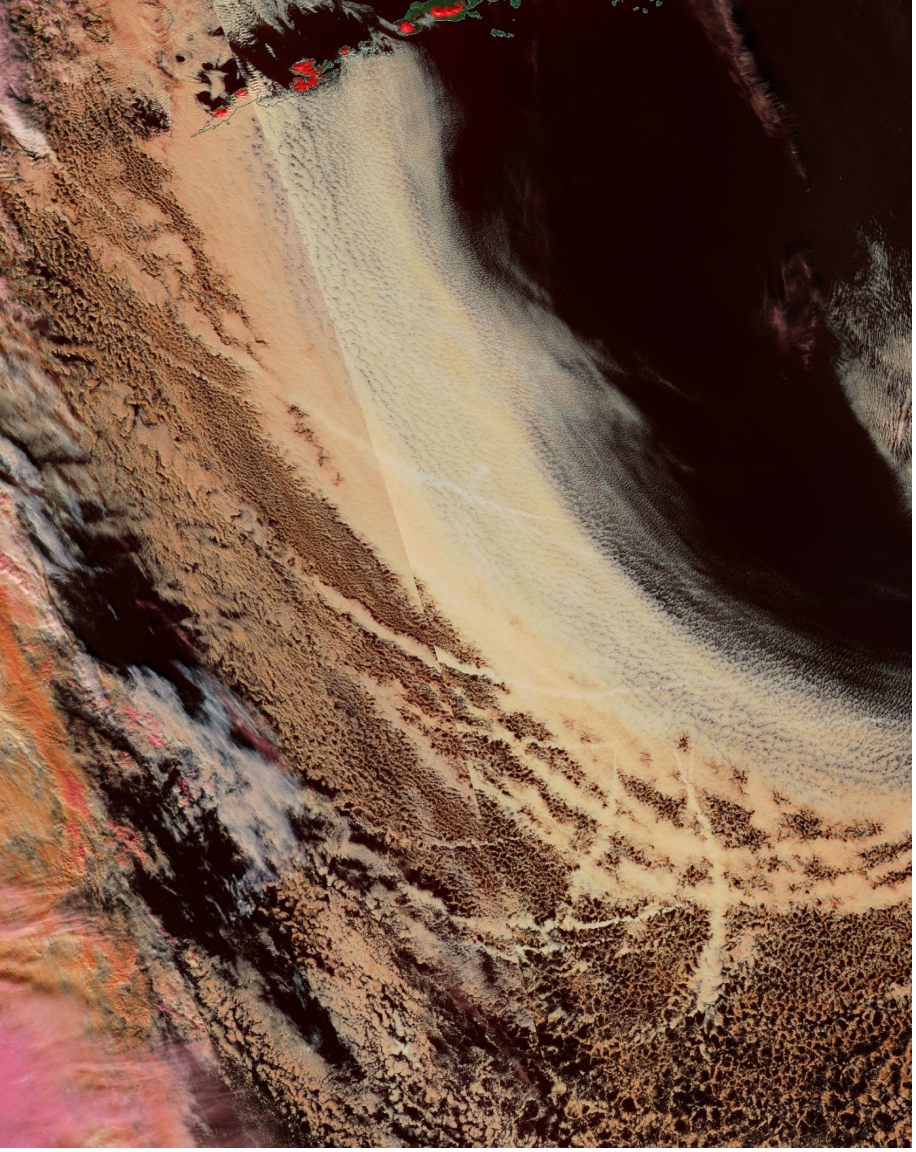


NE Pacific, south of Aleutians Islands

A Good Example

Modification of clouds by ship emissions (or Ship-Tracks)

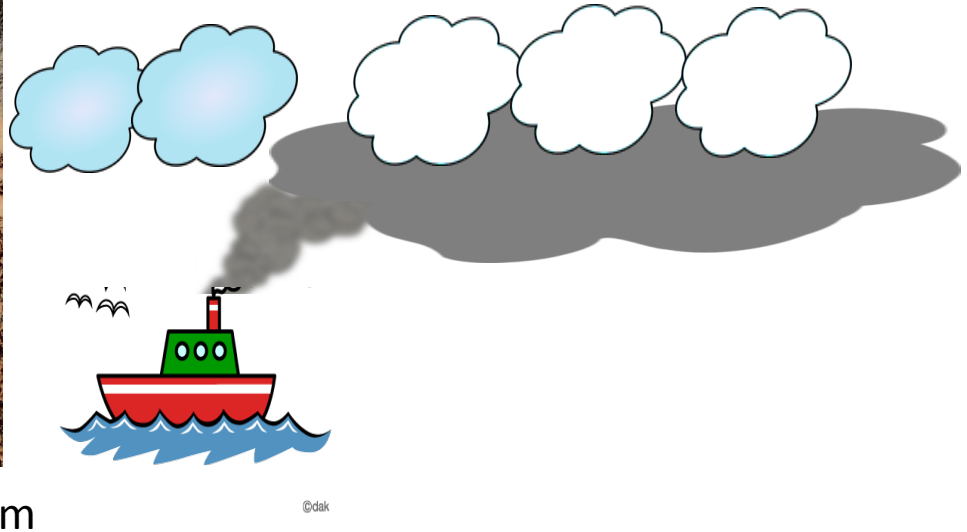




False Color RGB – 0.47um,1.65um,2.1 um

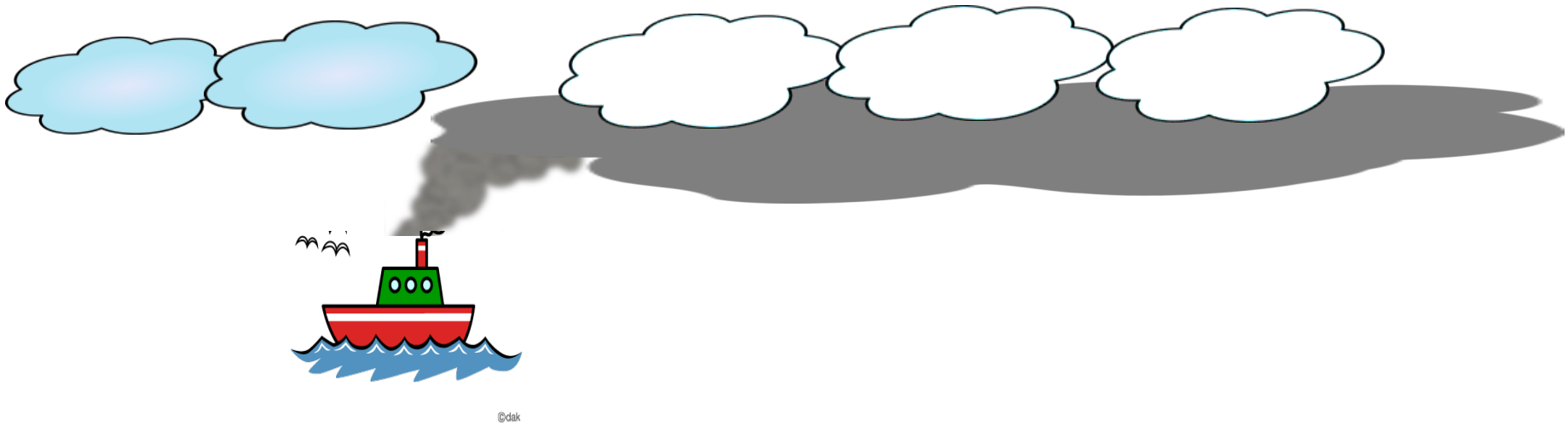
A Good Example

Modification of clouds by ship emissions (or Ship-Tracks)



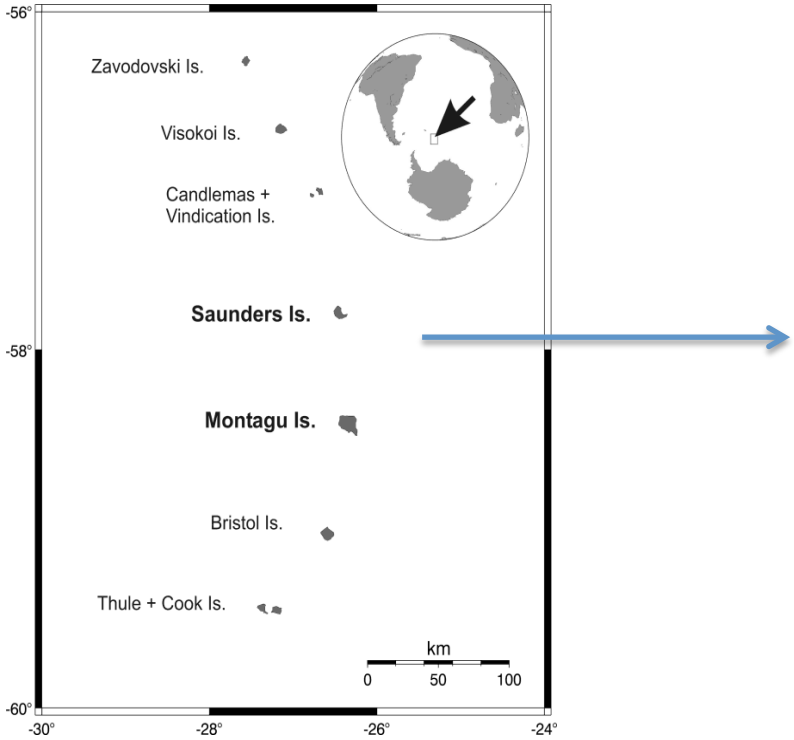
The Aerosol indirect Effect on clouds is more apparent in the near-infrared band (such as the 2.1um or 3.7um bands available in MODIS)

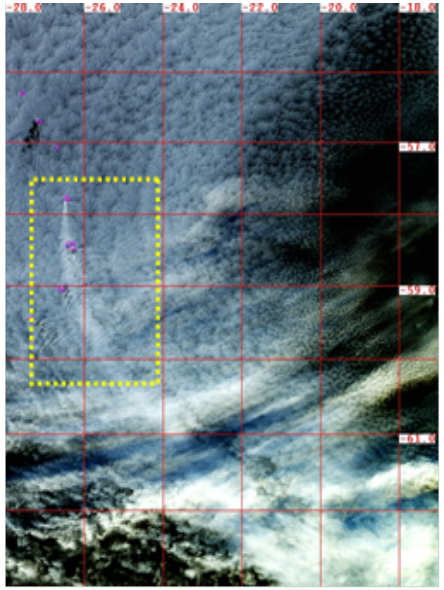
By analogy, the concept of Volcano Track

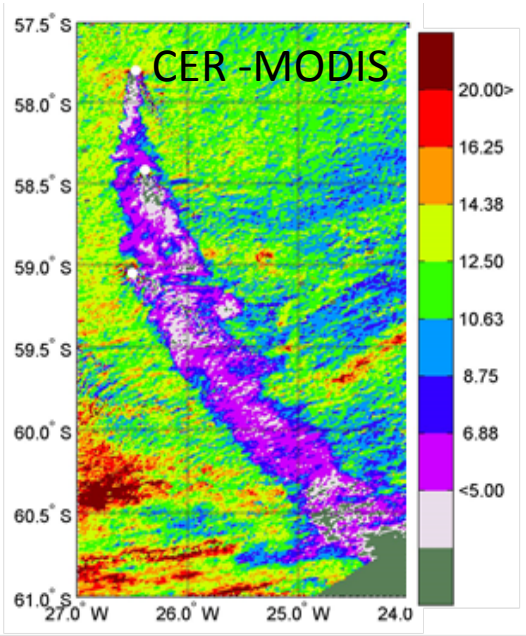


Low / passive volcanic activity (VEI<2)

First Observations of Volcano Tracks (Gassó, 2008, JGR)

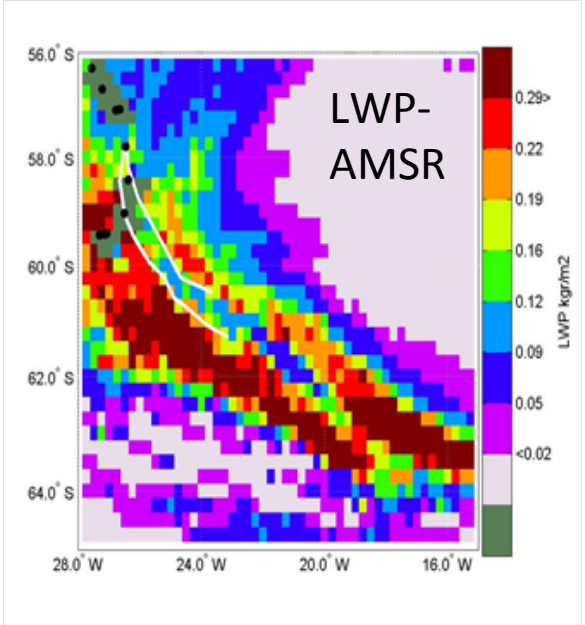






- Analysis of Case Studies in the South Atlantic.
- Confirmed decrease in droplet size and depression in water content, higher cloudiness.

Figure 2: A) Visible image of the S. Sandwich area from MODIS-Aqua for April 27, 2006 (16:15 UTC). B) Cloud effective radii (CER) retrieved by MODIS-Aqua for the box shown in figure A. C) A regional view of the distribution of cloud water path retrieved by AMSR-E onboard of Aqua. The white line is the envelope of 10um CER from figure 2B.



Gassó, S. (2008), Satellite observations of the impact of weak volcanic activity on marine clouds, J. Geophys. Res.,doi:10.1029/2007JD009106.

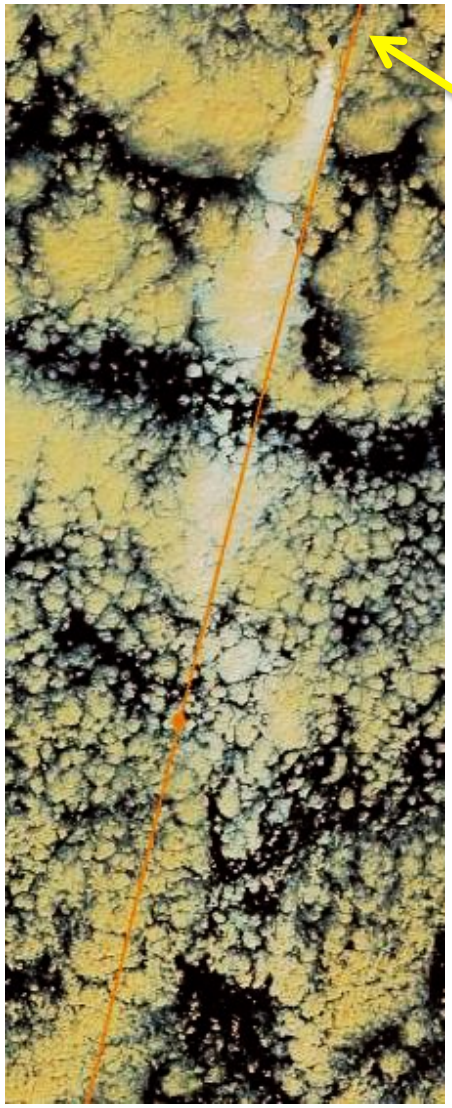
This is not a common phenomenon (*)……

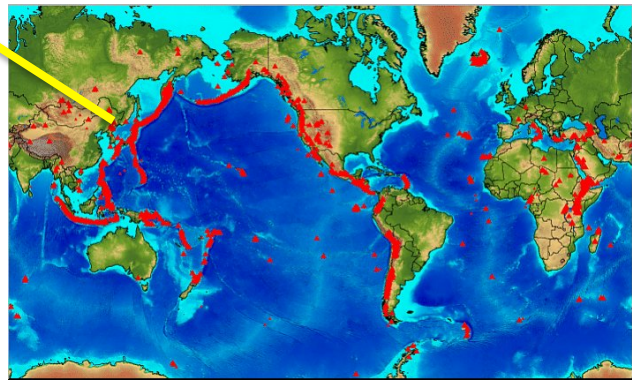
Some conditions must be met:

- Homogenous cloud field
- Clouds must no be very thick
- Distance between Volcano top and cloud base are very important

However, it may well be relevant particularly if considering the global location of volcanoes and their respective heights…

Some Examples





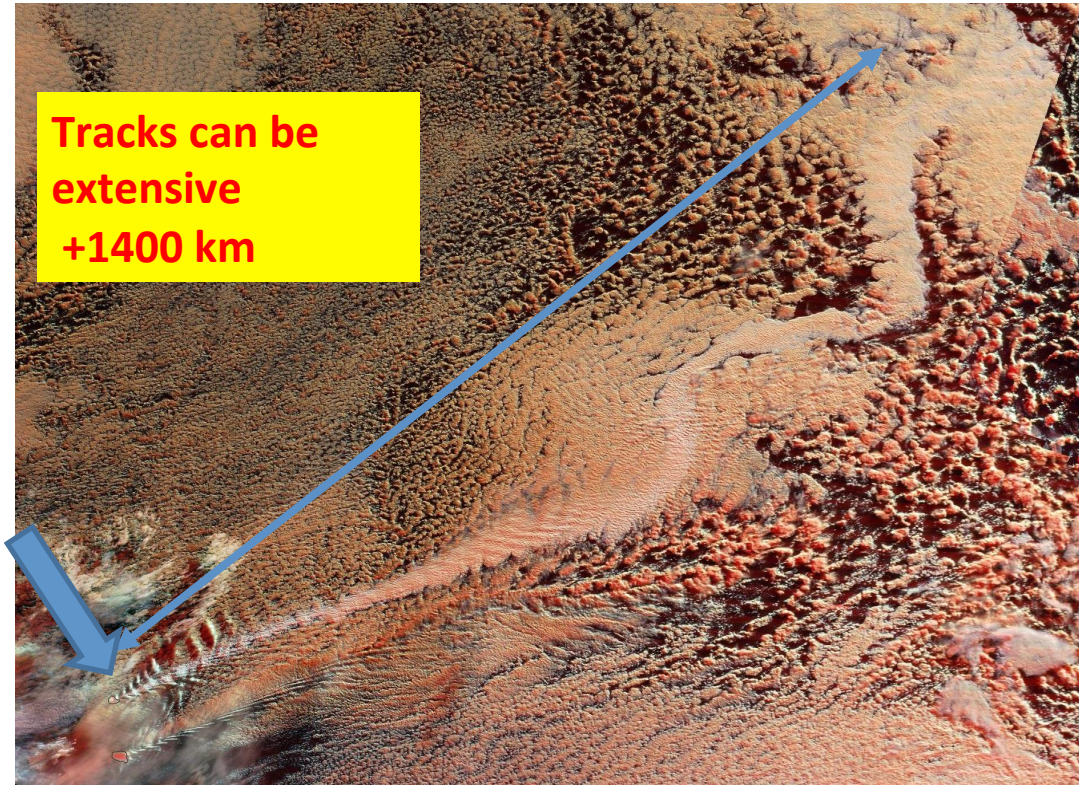
Nishima-Shima, a Volcano at the Ocean Surface.

No ambiguity: this is a plume under a cloud.

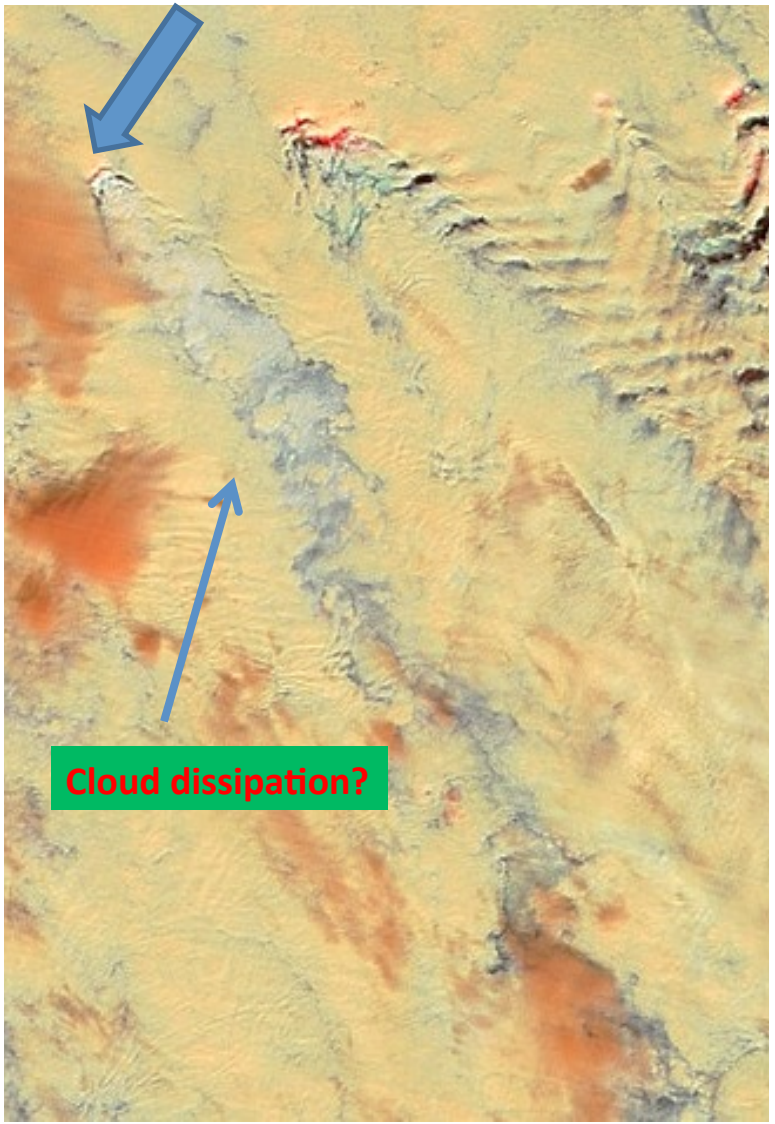
False Color RGB – 0.47um,1.65um,2.1 um

Scale and Diverse Impacts on Clouds

South Sandwich Islands, South Atlantic



Gareloi, Aleutians Islands

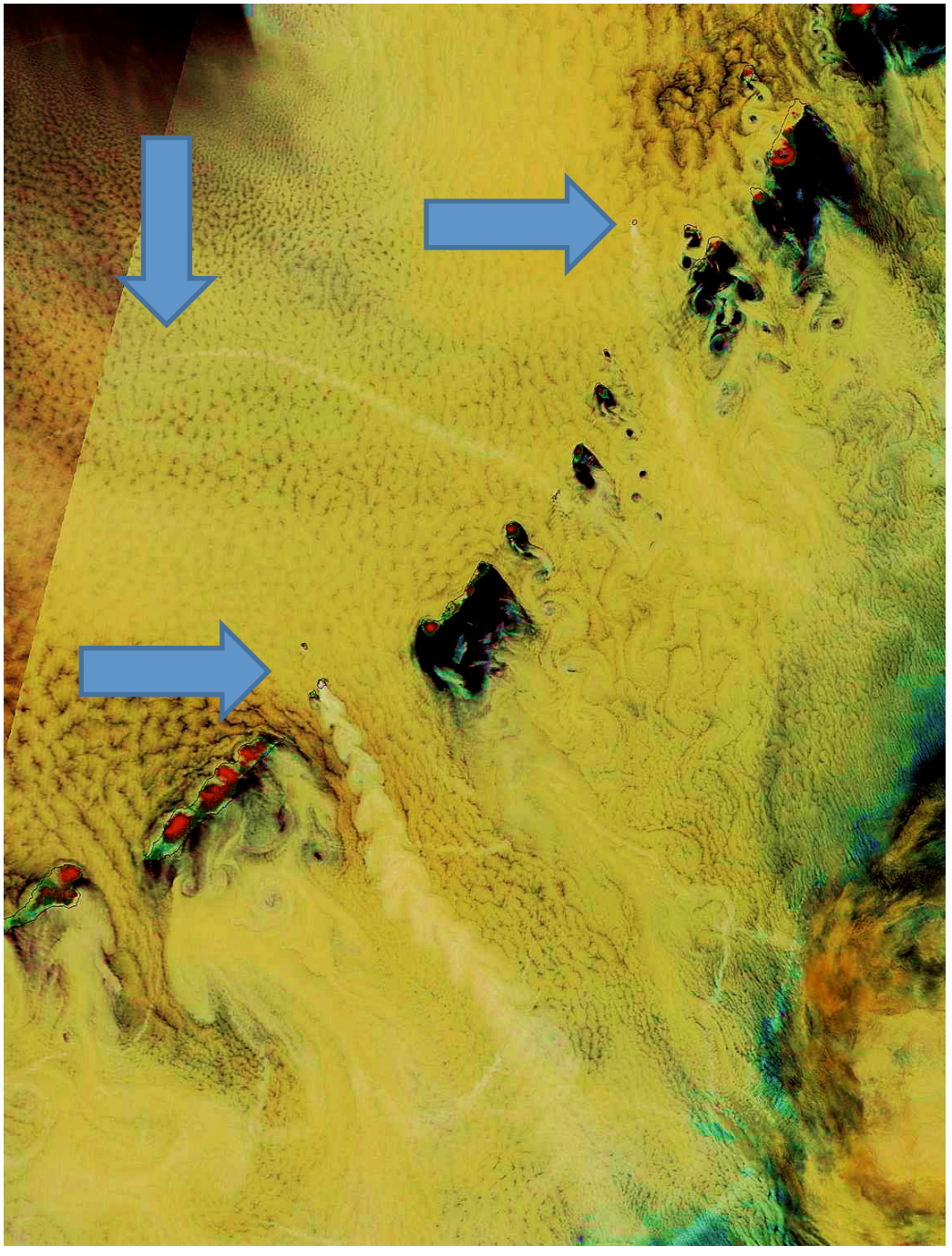


Ship Tracks and Volcano Tracks

An Anthropogenic and Natural Tracks in the Same scene

- Different aerosols
- Common synoptic conditions

A unique setting for aerosol-cloud studies

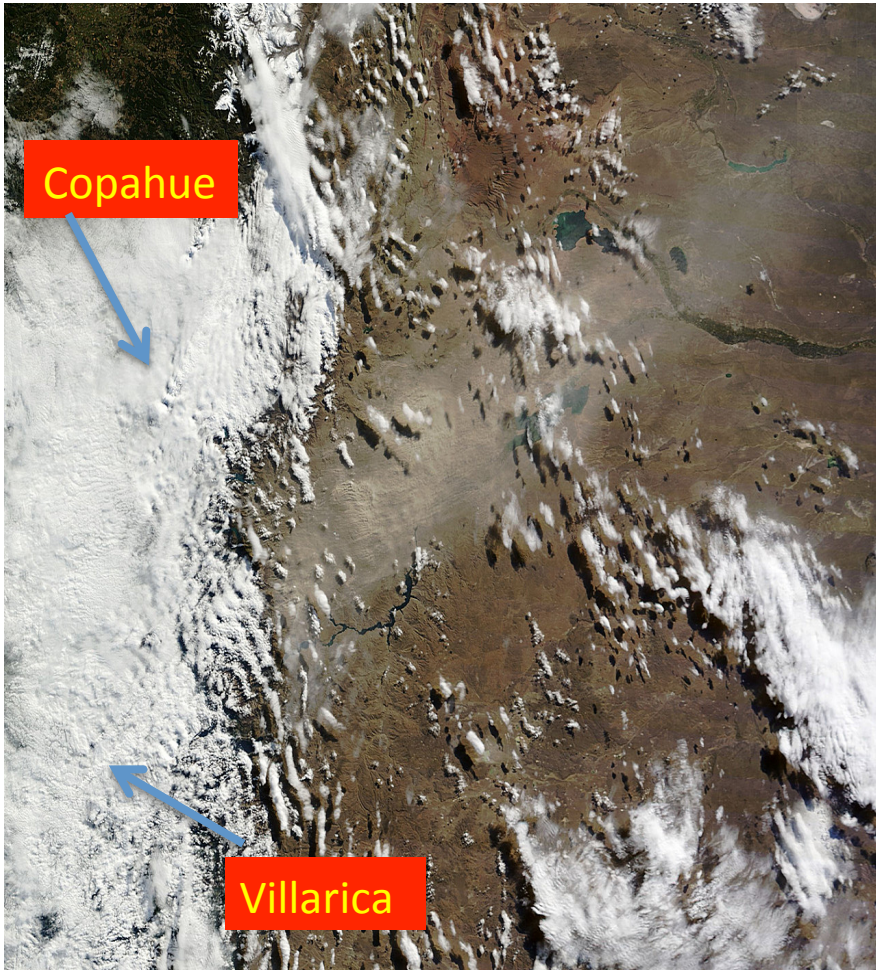


Summary

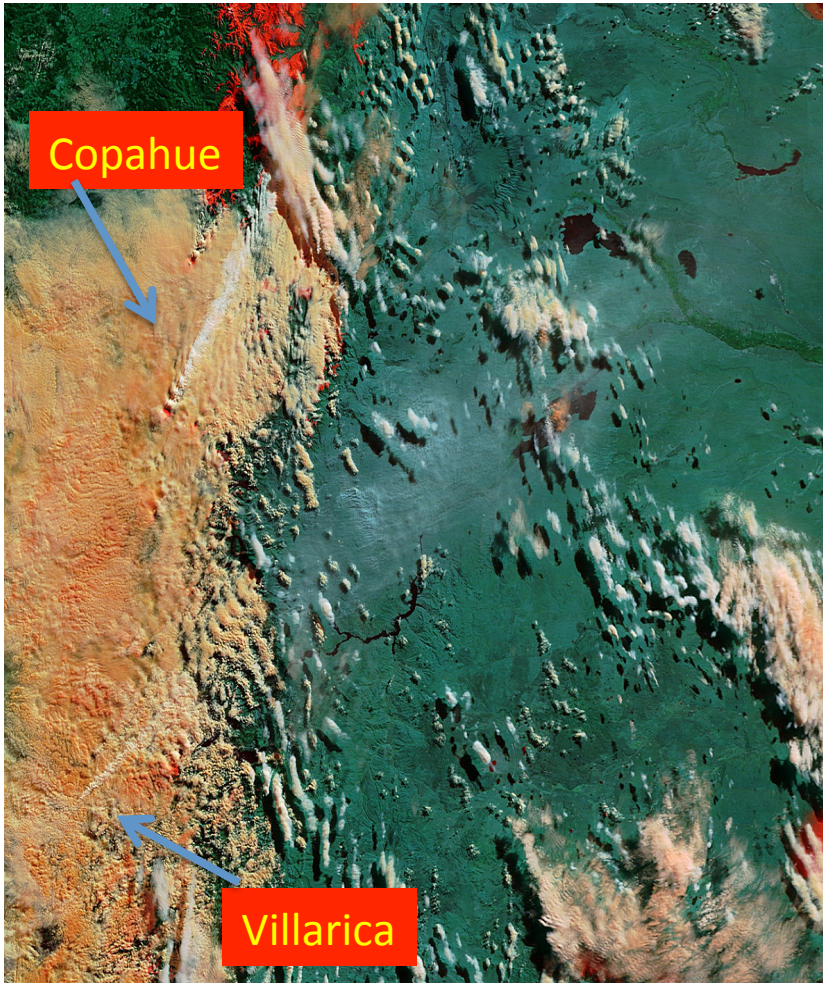
- Volcano Tracks are the result of volcanic emissions changing surrounding clouds
- Confirmation that it occurs downwind of many low altitude volcanoes with significant cloudiness around (tropical and high latitude, land / ocean)
- They can be easily identified by using currently available tools .

Going back to the beginning of this talk,..
in this unremarkable image (at first sight)

there are two active volcanoes, only apparent when using different wavelengths



Visible RGB – 0.47um,0.67um,0.87 um



False Color RGB – 0.47um,1.65um,2.1 um

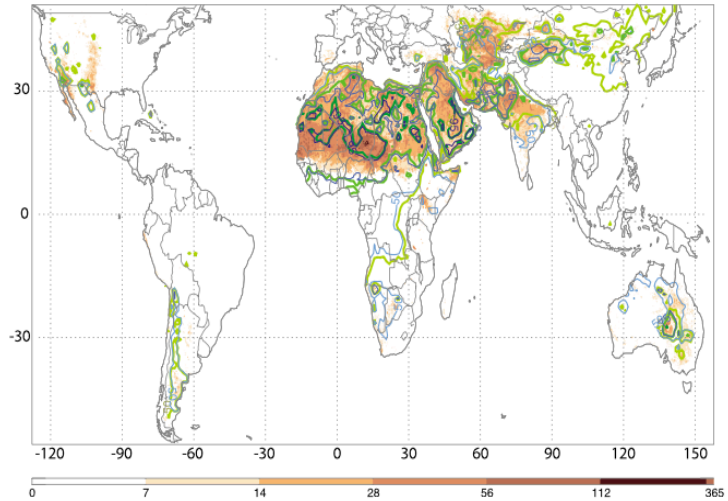
May 03, 2015 –Villarica and Copahue

High Latitude Dust

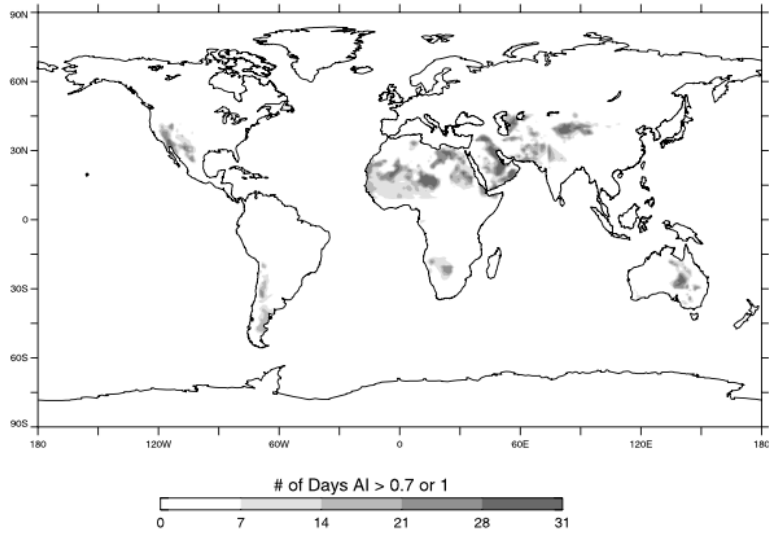
High Latitude Dust – a definition

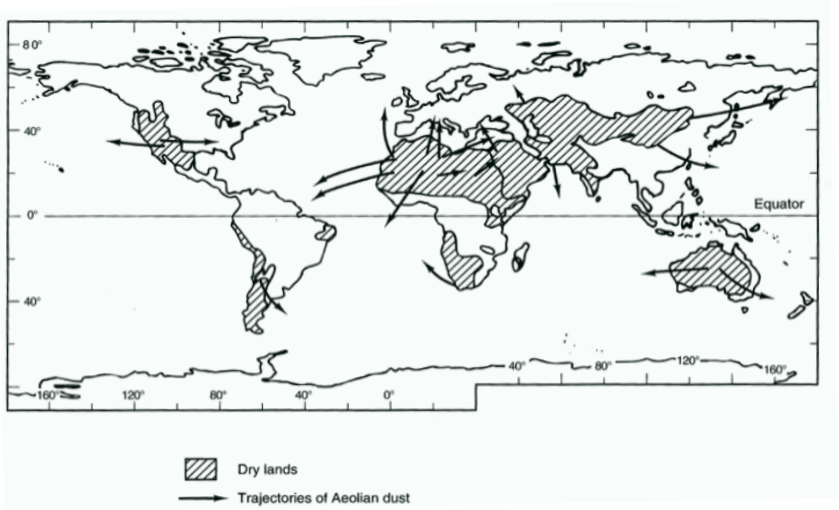
- Sources are typically paraglacial regions at high latitudes
- High latitudes are ≥50°N and ≥40°S
- Hemispheric differences in latitude reflect impact of extent and distribution of land masses

Geographical limitation in current global maps of dust sources



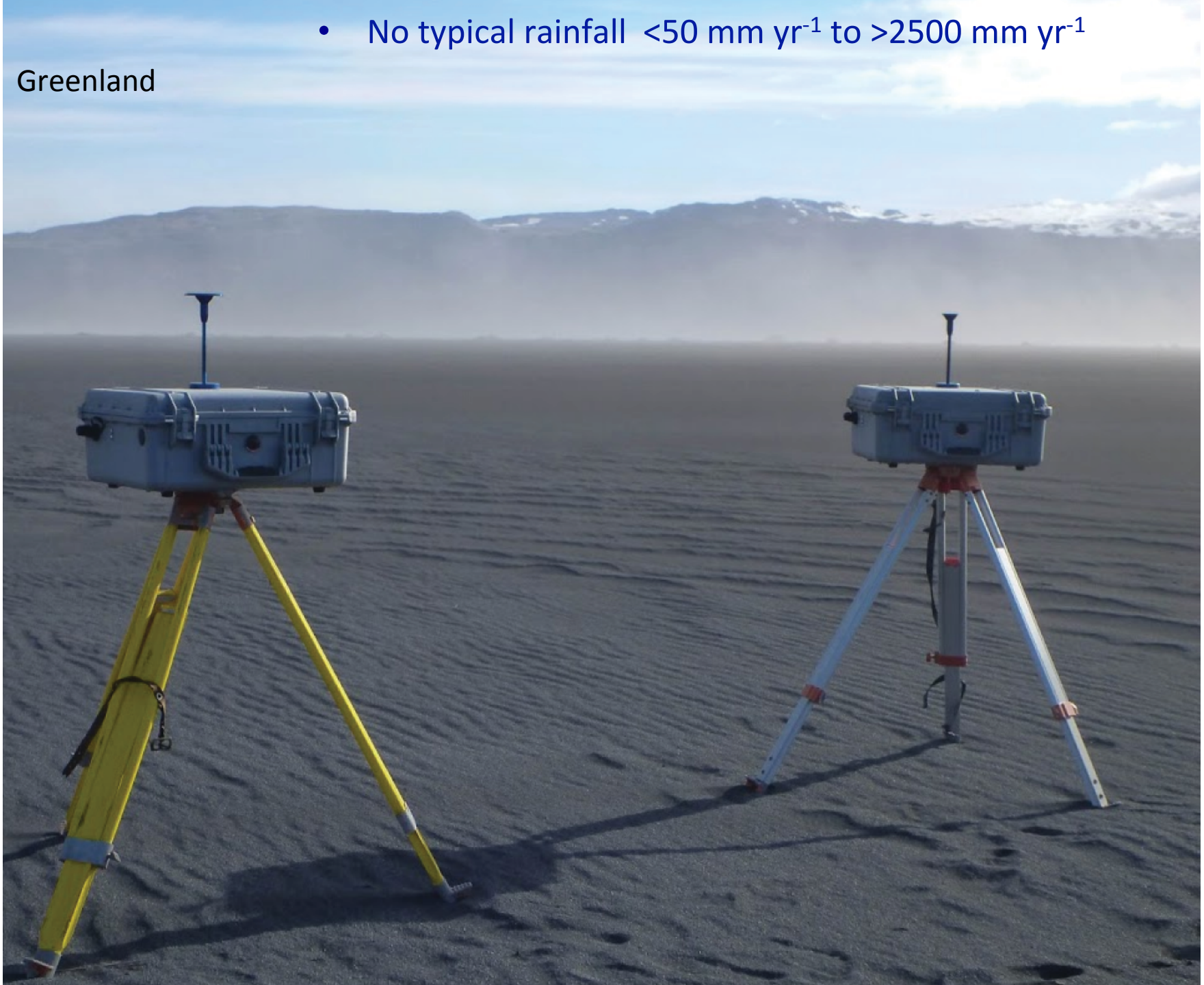
- TOMS maps restricted to 45°N and S
- Deep Blue (Ginoux et al.) 50°N and 55°S





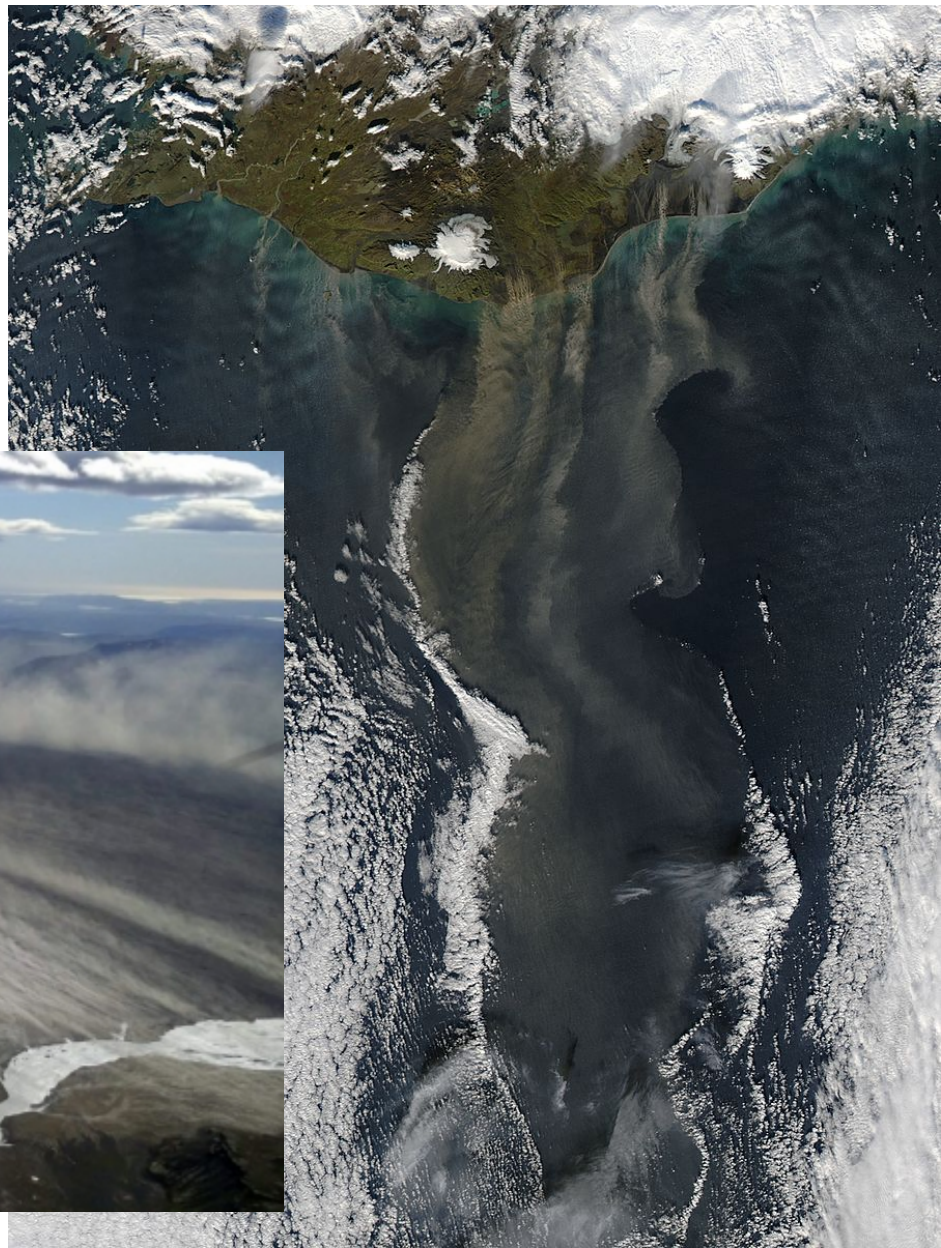
- No typical rainfall <50 mm yr^{-1} to >2500 mm yr^{-1}

Greenland



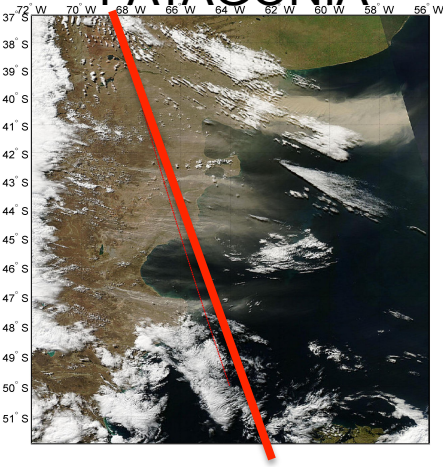

• Topographic lows – riverbeds, valley floors, glacial outwash plains
• Seasonality of emissions strongly controlled by sediment supply and snow cover

Iceland is a good example of high latitude dust, originating from glaciers and re-suspension of ash

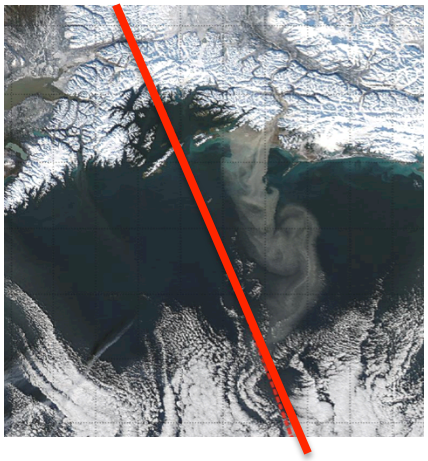


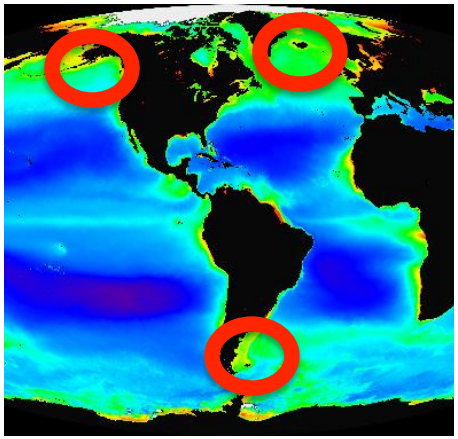
Patagonia as a **High Latitude Dust** phenomenon

PATAGONIA

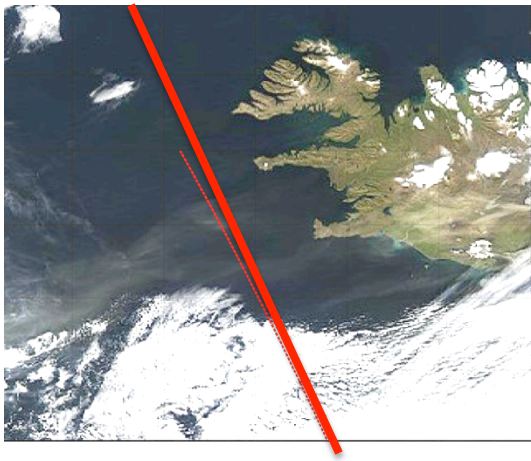


ALASKA





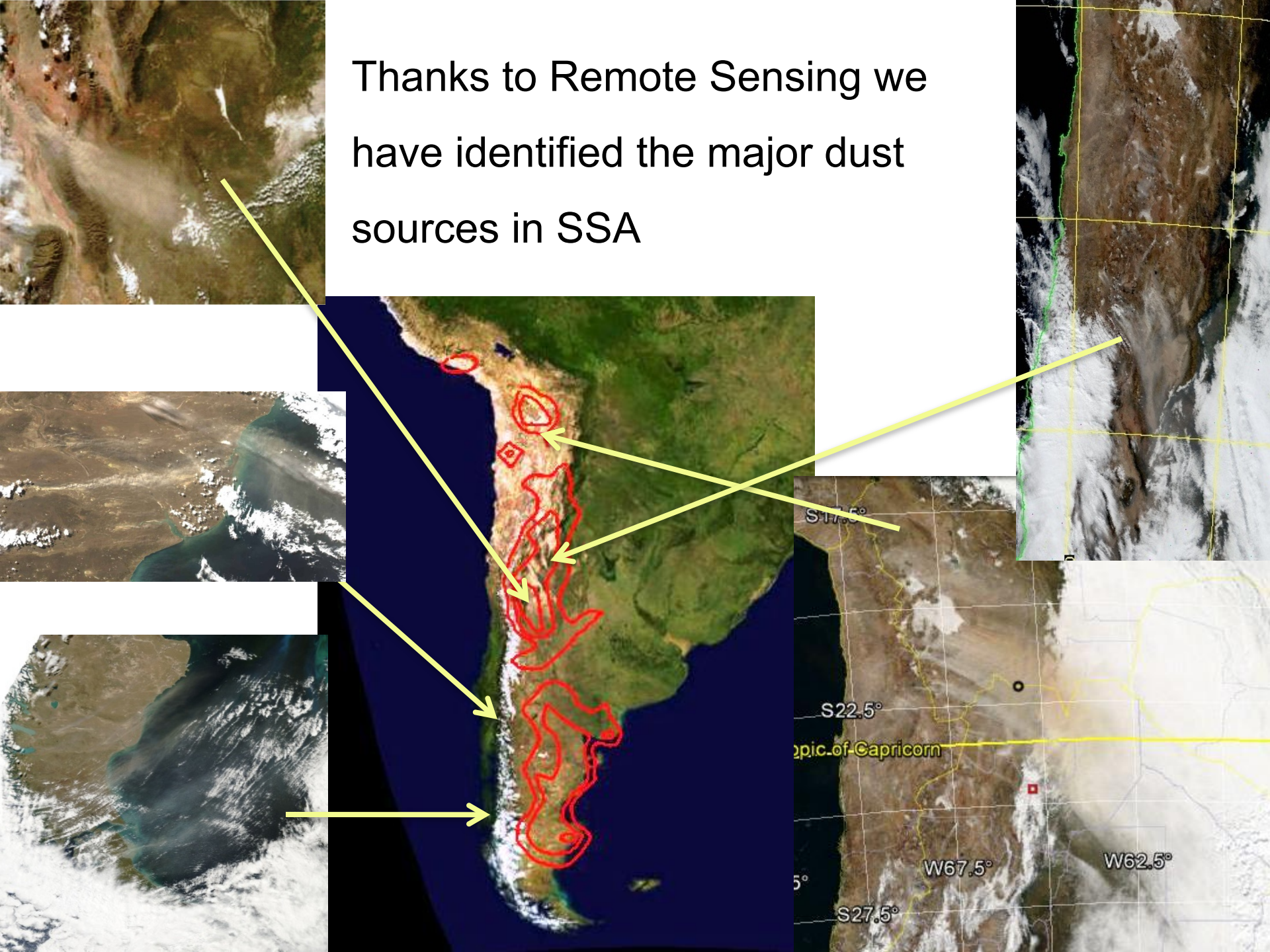
ICELAND



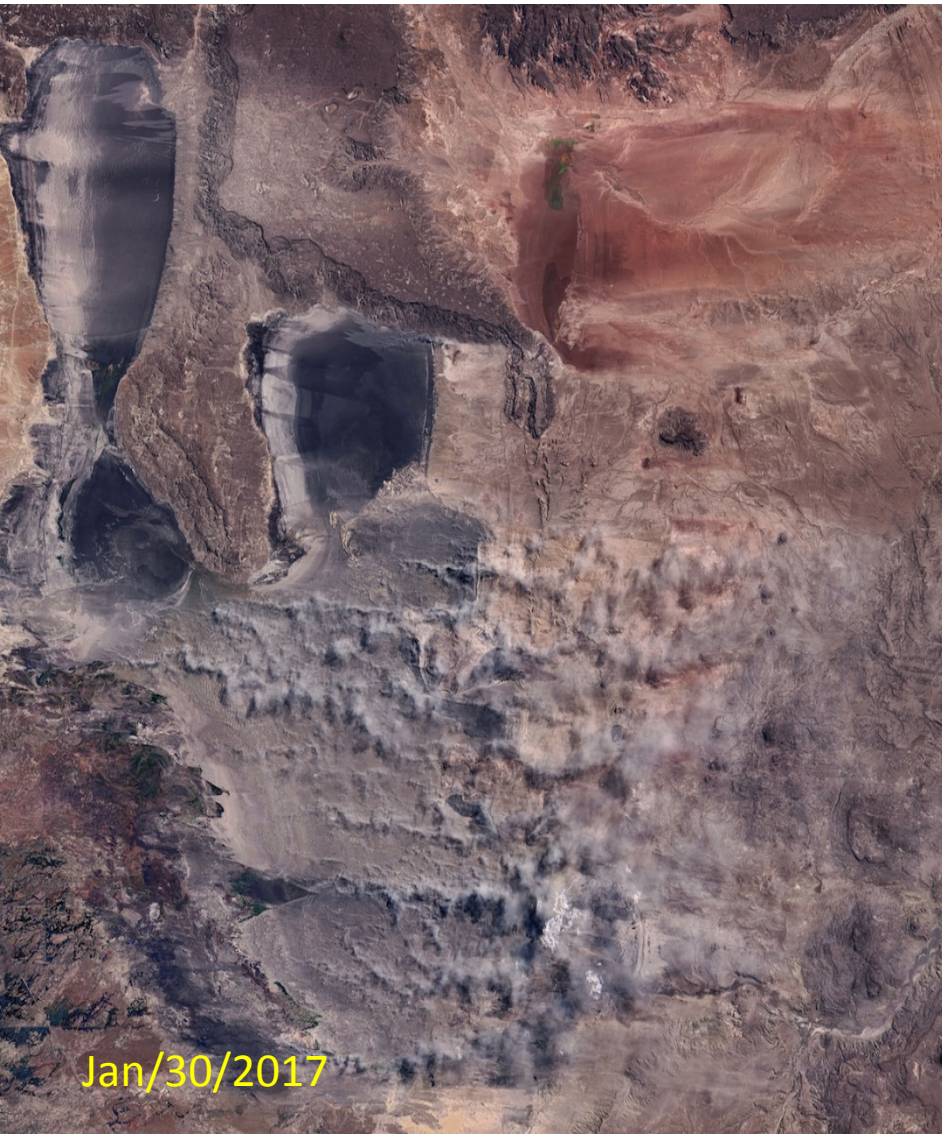
Common features:

- Upwind of major Fe deficient marine ecosystems
- Dust is rapidly delivered because low altitude
- Similar dynamic synoptic mechanisms are at play at emission

Thanks to Remote Sensing we have identified the major dust sources in SSA



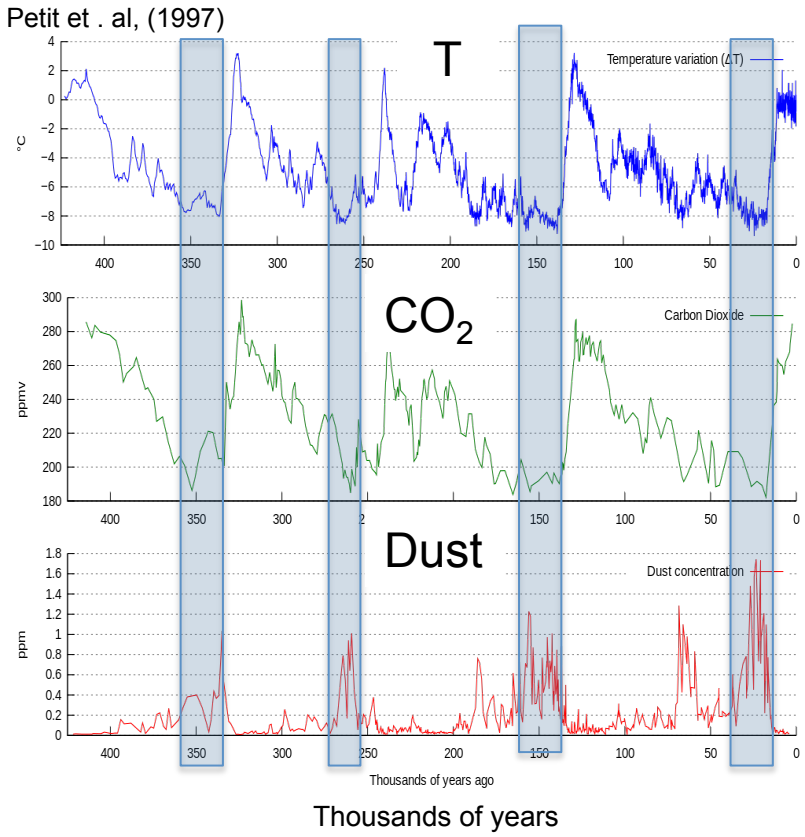
Characterization of Dust Activity at the largest source in Patagonia (Colhué Huapi Lake)



Santiago Gassó
NASA/MSU
USA
@SanGasso

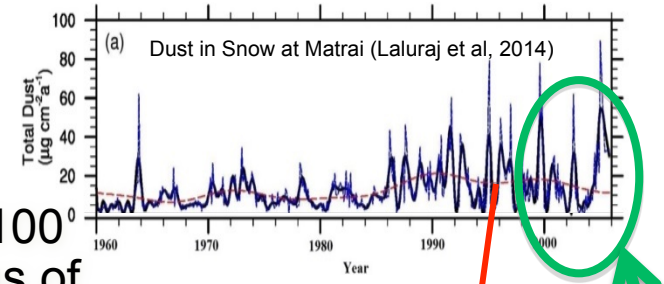
Diego Gaiero
University of Córdoba
Argentina

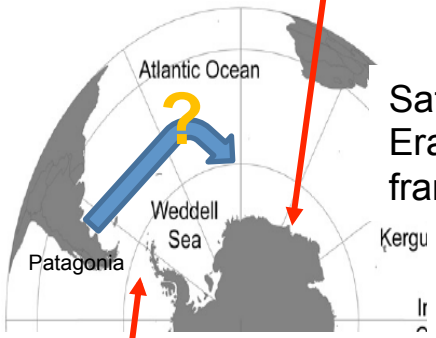
Dust is a Tracer of Past and Modern Climate Dynamics



Is the CO_2 decrease explained by intensified biological activity in the ocean due to dust fertilization?

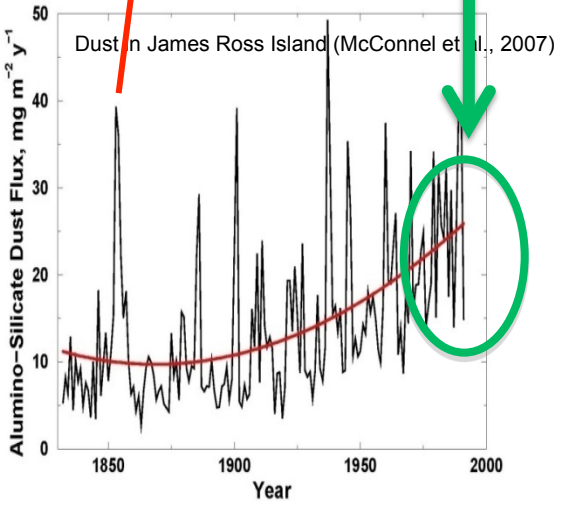
Recent (last 100 years) findings of unexplained dust deposition in Antarctica.





Satellite Era time frame

Can we study modern dust activity in Patagonia to understand transport to Antarctica?



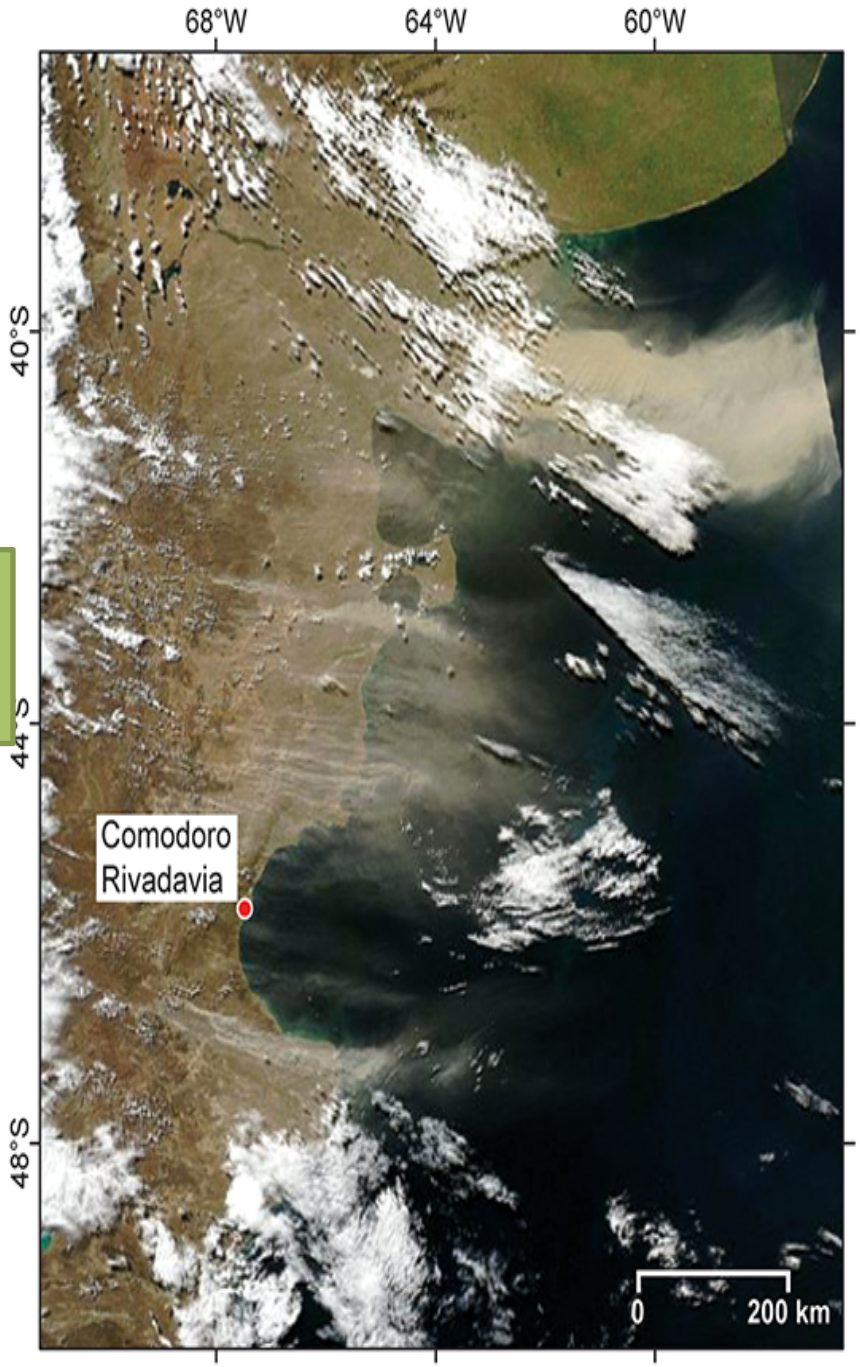
Patagonia as a supplier of dust found in East Antarctica

Simple questions as

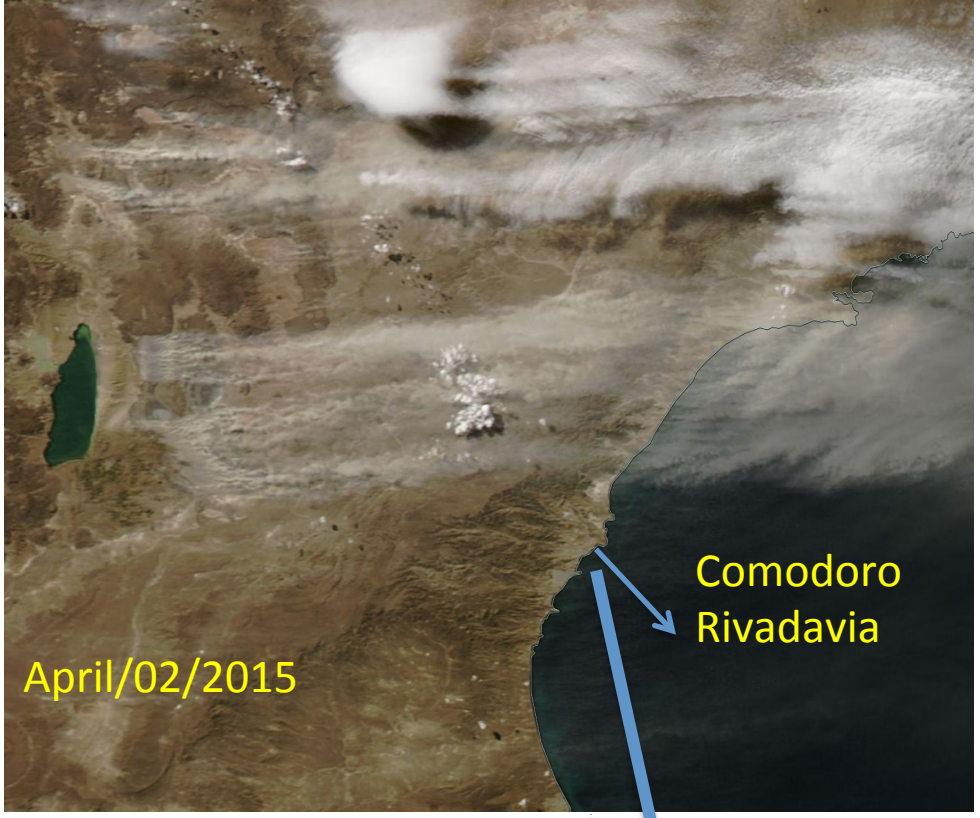
- When ?
- How often?
- How much?

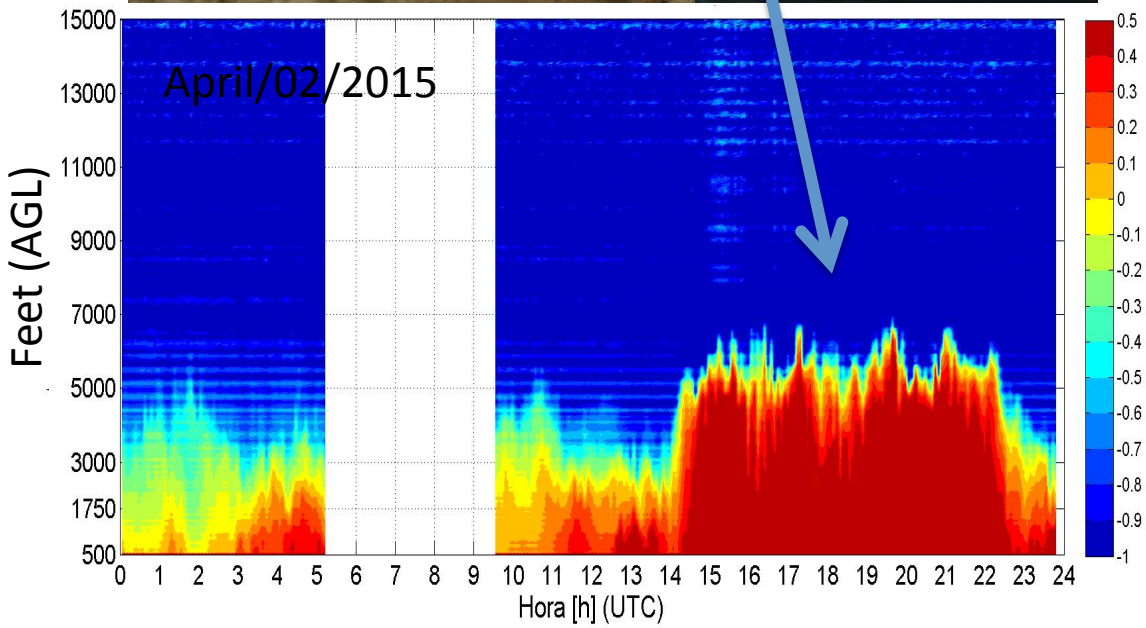
This talk: Information for dust provenance studies in East Antarctica

To date no objective assessments to answer these questions!

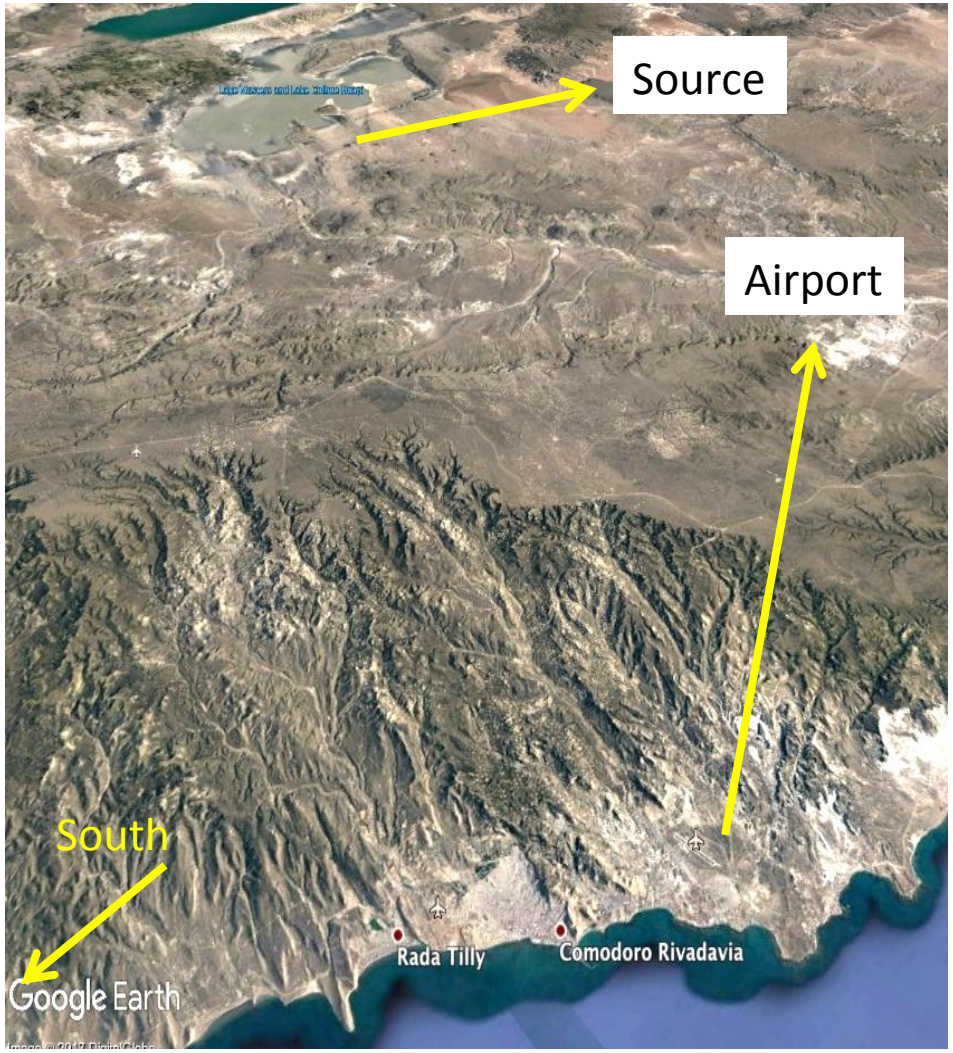


Colhué Huapi Lake (44.5S) is the most active dust source in Patagonia





Data : Surface Meteorological Observations at Local Airport



Comodoro Rivadavia Airport is an Excellent site for assessment of dust activity

What is a "Dust Day"(DD) ?

A day when a Dust Weather code was reported (6-9,30-35, 98)