



# Seasonal variability of atmospheric dust over Cape Verde islands

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## Presentation based on CVDUST project:

***“CVDUST - Atmospheric aerosol in Cape Verde region: seasonal evaluation of composition, sources and transport”***

- **Joint initiative of : *University of Aveiro; Technological and Nuclear Institute; Cape Verde University.***
- **Support of the *Cape Verde Atmospheric Observatory (CVAO).***
- **Funding through *Portuguese FCT .***



# Why study atmospheric dust in Cape Verde?

Estimated Global Emission rates of particles into the Atmosphere (Tg yr<sup>-1</sup>)

	Fine Particles	Coarse Particles
Sea Salt	82.1	2460
Dust	250	1000-4875
Carbon	81	
Sulfate	150	
Nitrate	11.3	
Ammonium	33.6	

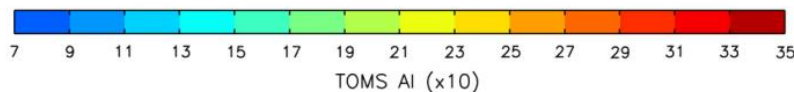
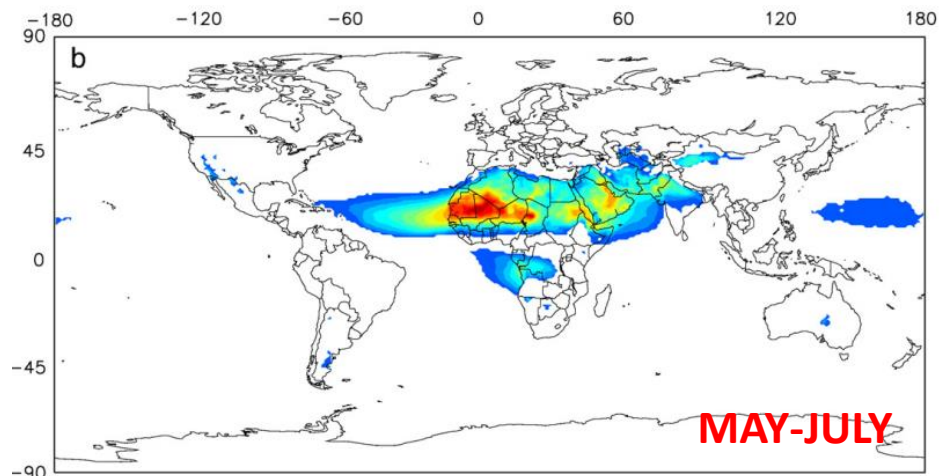
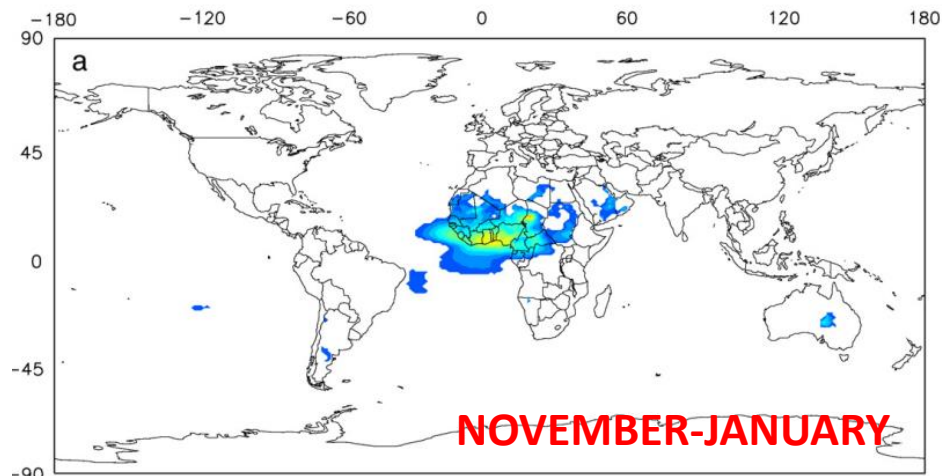
ref: Raes et al., (2000)

- Dust Sources:**
- **Natural Soil;**
  - Agriculture (example “Dust Bowl” in USA);
  - Transports;
  - Industry (cement; mining)



# TOMS satellite seasonally averaged values of Aerosol Index in the period 1980-92

- Sahara emissions predominate
- Higher AI values during summer



(ref: Engelstaedter, 2006)

<http://ozoneaq.gsfc.nasa.gov/TOMSAerosol.md>



# Impacts of desert dust emissions

- **Atmospheric Heat Balance and Climate Control**
  - *Weakening of Atlantic Tropical Cyclones*
- **Biogeochemical Cycles**
  - *Biogeochemical Cycles in Atlantic and Amazon Basin*
  - *Toxic Algae Blooms*
- **Human Health**
  - *Spreading of meningitis in Sahel (Sultan et al., 2005)*
  - *Kawasaki disease in Japan and Western USA (Fraser, 2012)*



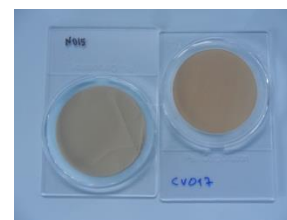
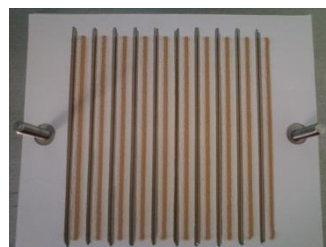
# Objectives of Project CVDUST:

- 1. Monitoring and sampling atmospheric dust during one year**
- 2. Chemical and structural characterization of collected samples**
  - Water Soluble ions*
  - Carbonate and Carbonaceous forms*
  - Elemental Composition (NAA)*
  - Mineralogical Composition (XRD; TEM; SEM)*
  - Organic Species (GC/MS)*
  - Microbial and fungi characterization*
- 3. Source Identification; Transport and Deposition Modeling**
  - Source Apportionment (PMF; PCA/MLRA)*
  - Transport Modeling (Trajectory Analysis; DREAM Model)*
- 4. Quantify African dust input to Cape Verde Air Quality**
- 5. Explain processes governing dust production, transport, and removal from atmosphere over the Atlantic**



# Monitoring and Sampling:

Performed at Praia airport during one year (Jan2011-Jan2012)



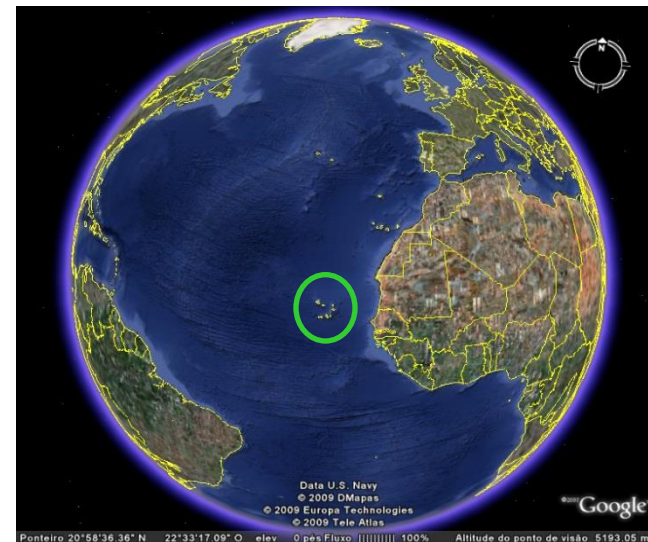
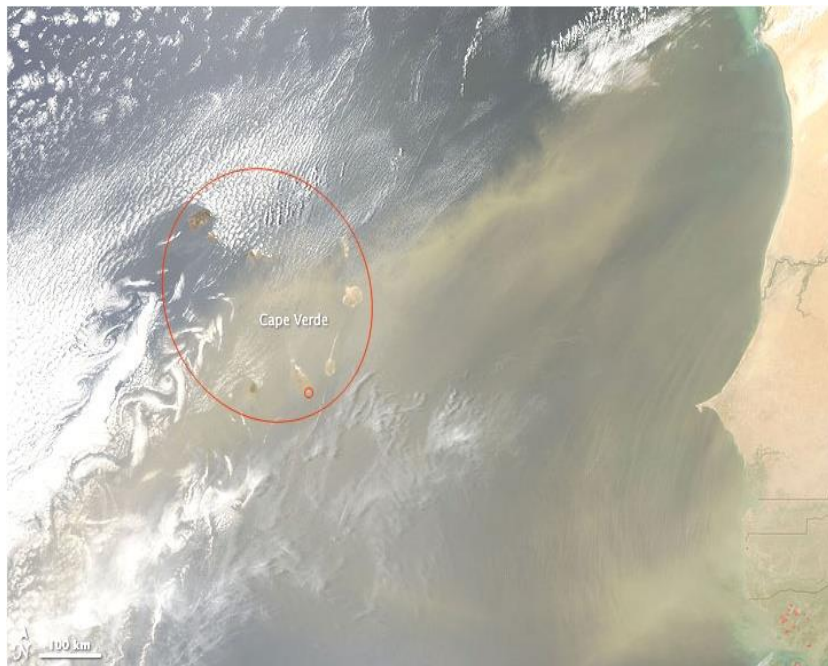
## Equipment:

- 1 GRIMM Aerosol Spectrometer (0.25->32 $\mu$ m) 31 channels
- 1 Aethalometer (7 wavelength channels)
- 2 PM10 LowVol filter samplers
- 1 PM10 HighVol filter Samplers
- 1 Berner LowVol impactor (0.063-16  $\mu$ m) 8 stages
- 1 HighVol impactor (<0.49-10 $\mu$ m) 6 stages
- 1 Meteo Station



# Special Conditions of Cape Verde to perform Sahara Dust Studies:

- Out of West Africa Coast (900 km)
- Dust Season Period (Bruma Seca – Dry Fog)
- Safety and Electricity Supply
- Good relations and Low Cost



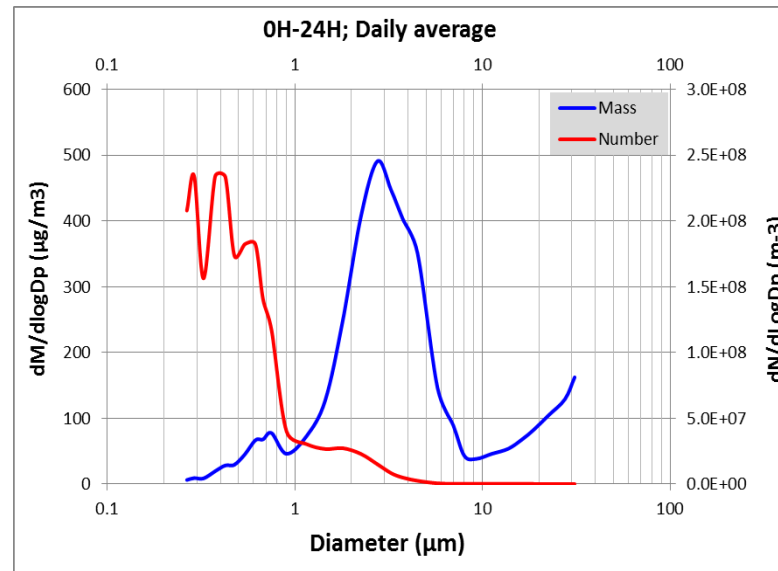




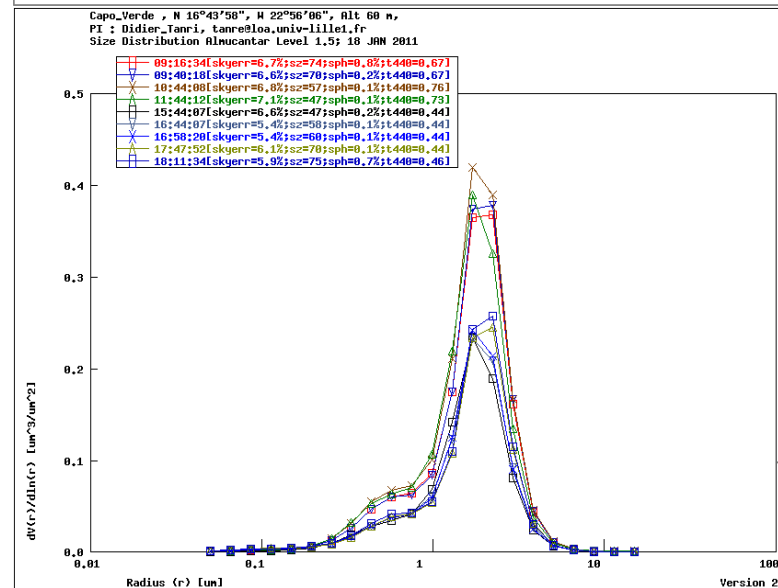
# Dust Size Distribution

❖ Dust mass mainly in size range 1-10  $\mu\text{m}$

Average dust size profile measured with the GRIMM Optical Spectrometer , for 18 Jan 2011, at Praia, Santiago Island



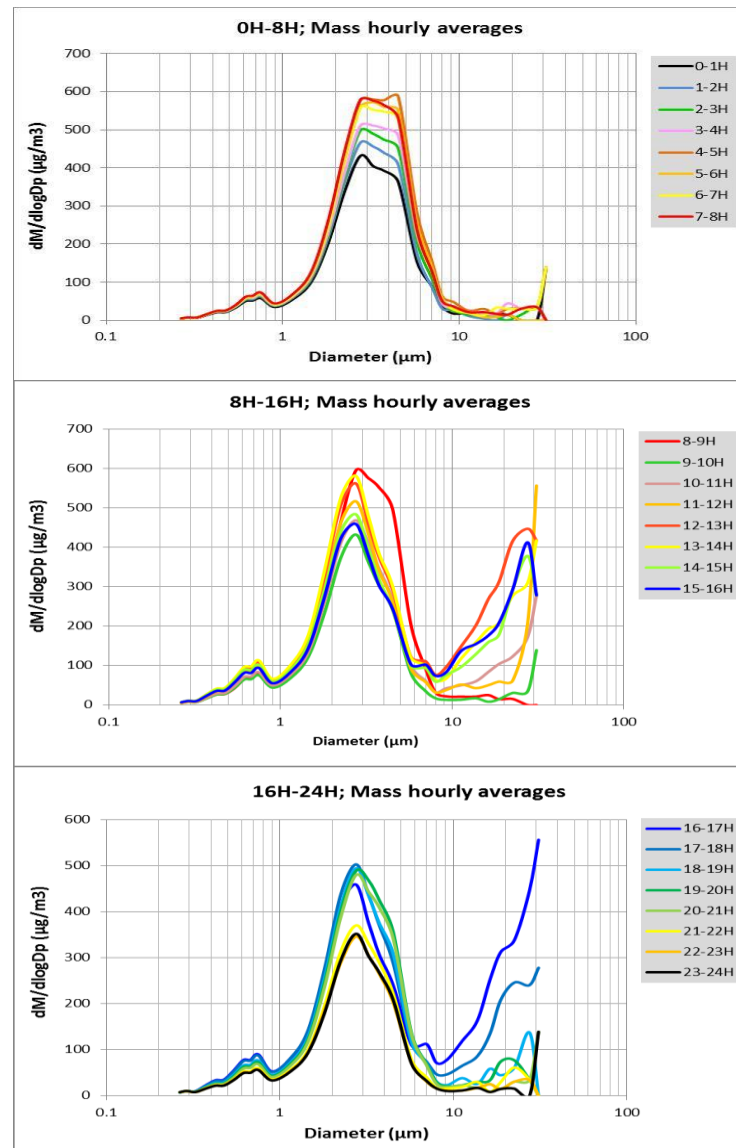
AERONET Integrated Air Column Size Profile Dust Volume Concentration, for 18 Jan 2011, in Sal Island





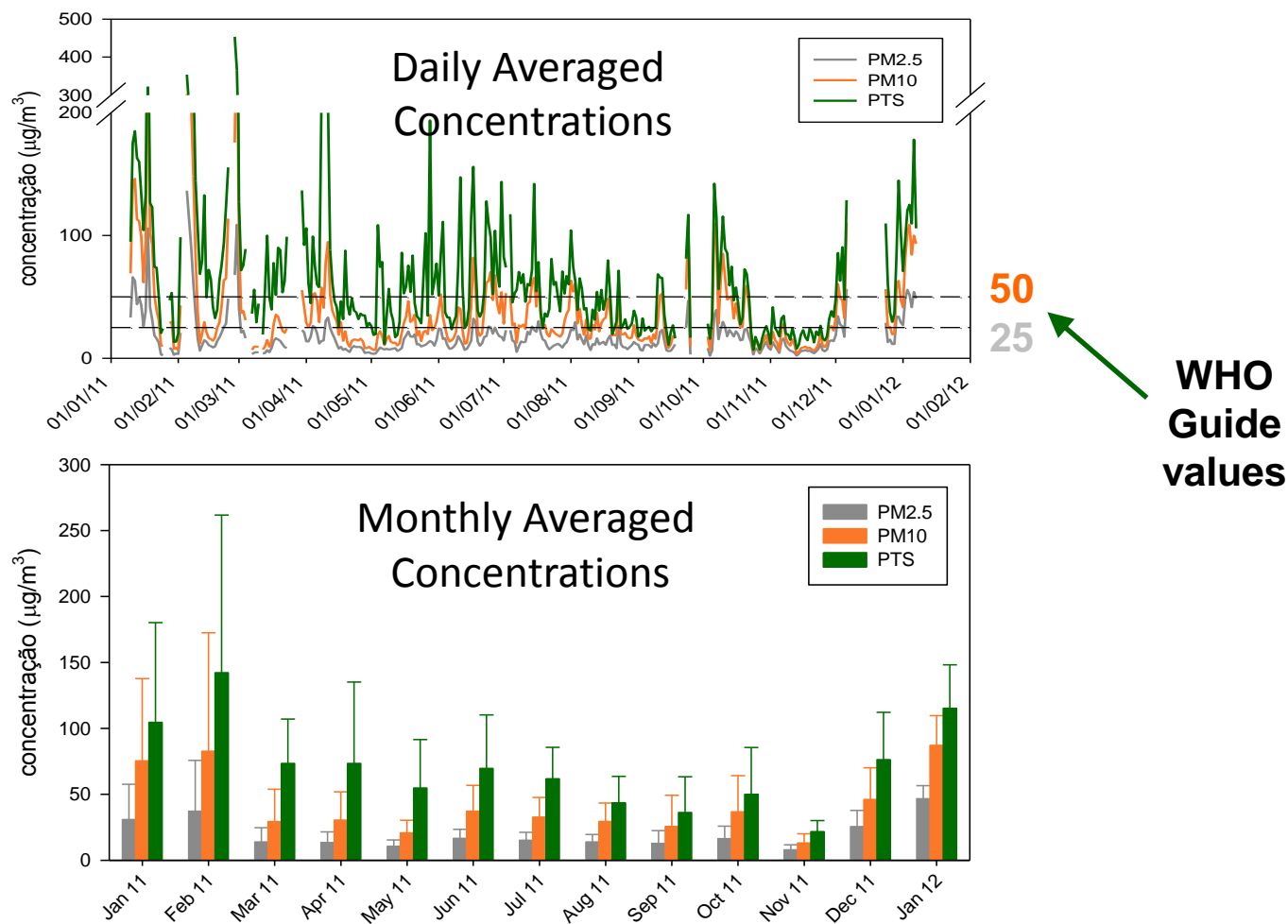
# Hourly averaged dust size distribution variability along the day 18 Jan 2011

- ❖ Local re-suspension processes probably responsible for dust particles above 10  $\mu\text{m}$





# Aerosol concentration variability at Praia during 2011

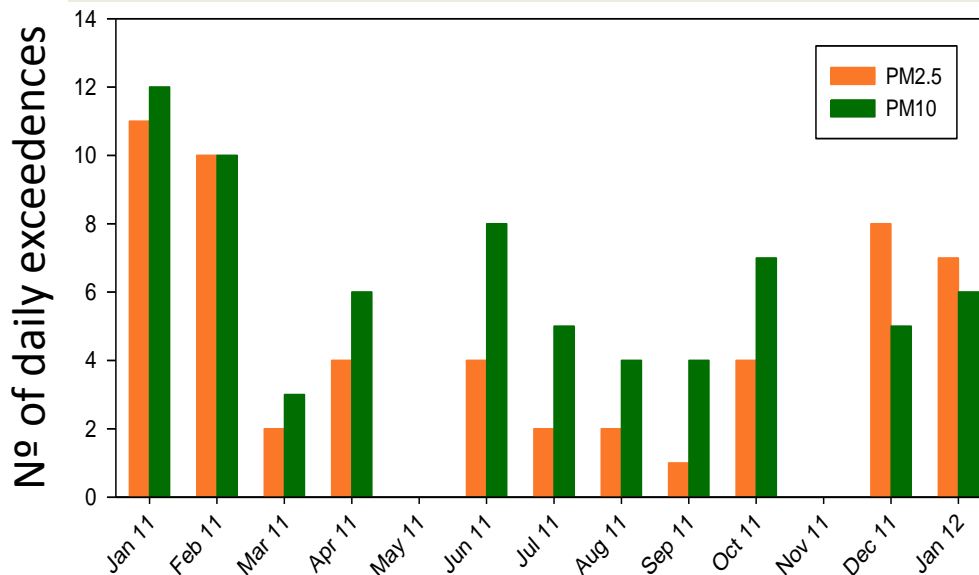




# Particulate Pollution Levels and daily exceedences, at Praia

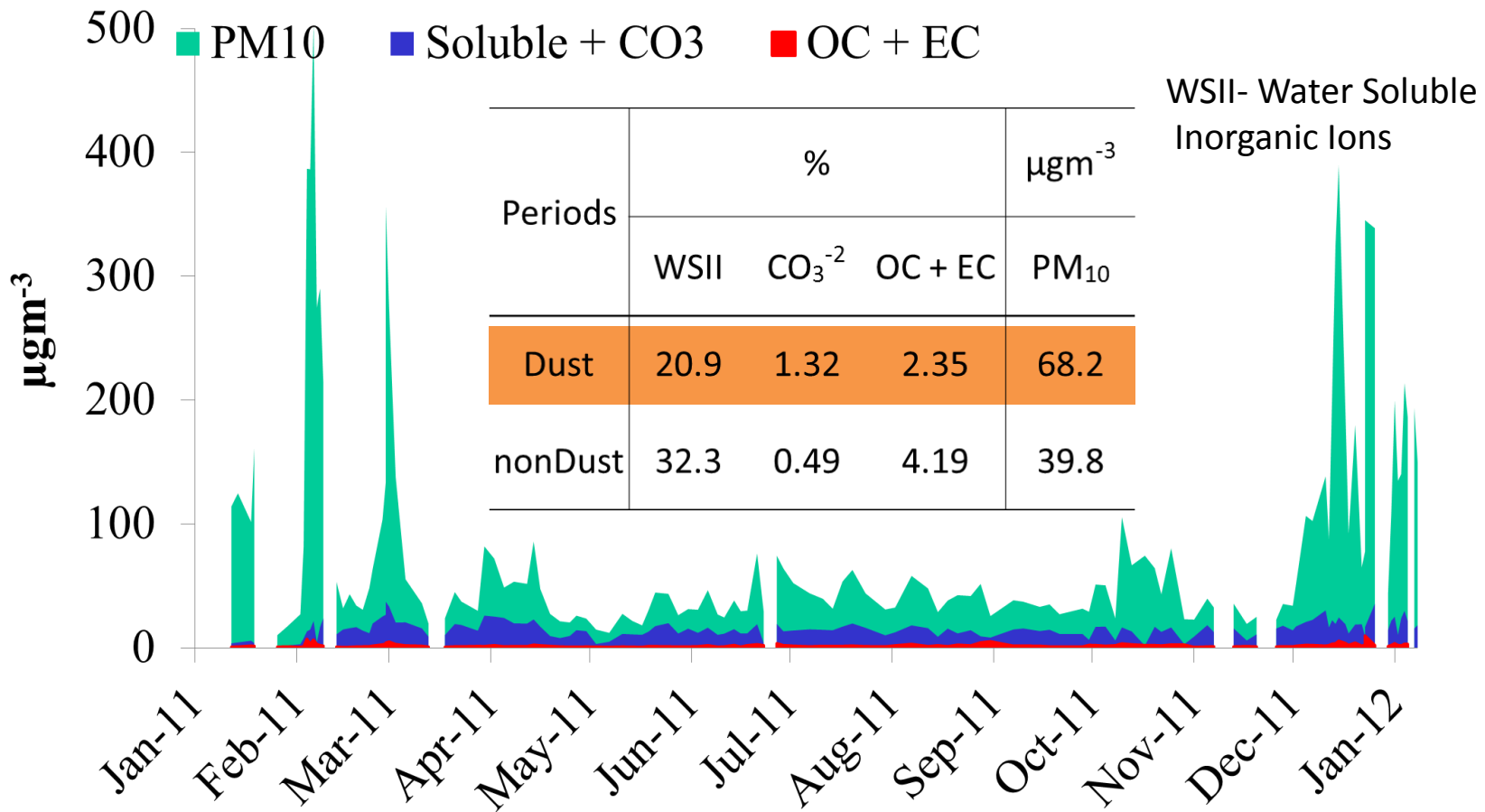
❖ **Particulate pollution levels clearly exceed WHO Guides and probably affect local Human Health, principally during “BRUMA SECA” Season**

Parameter	Annual Average* ( $\mu\text{g}/\text{m}^3$ )	WHO Guide Values ( $\mu\text{g}/\text{m}^3$ )
PM <sub>2.5</sub>	17.5	10
PM <sub>10</sub>	37.5	20
TSP	66.0	-



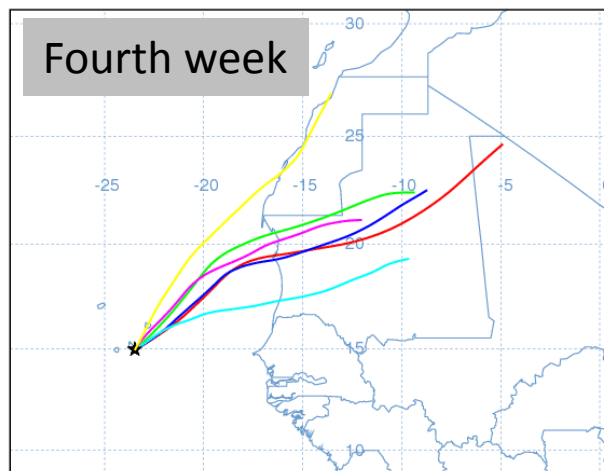
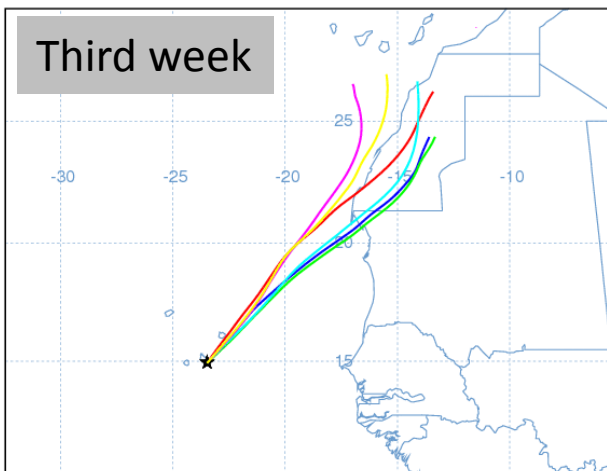
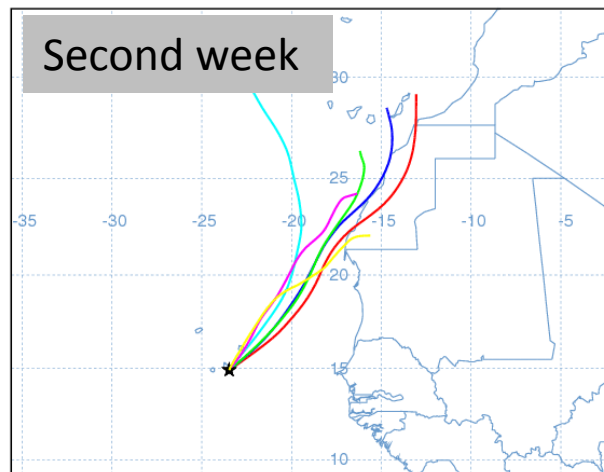
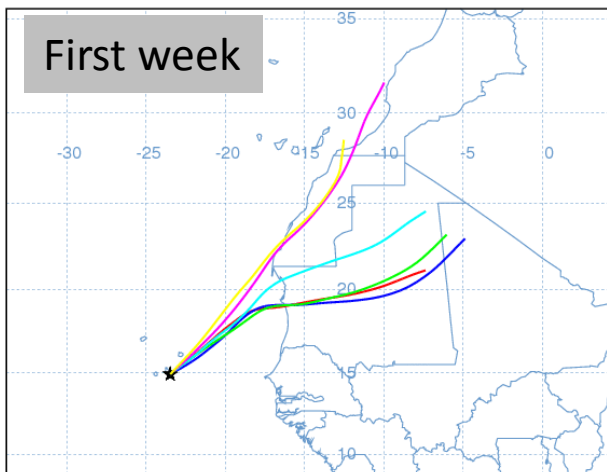


# Major Chemical Class Composition of Praia Aerosol



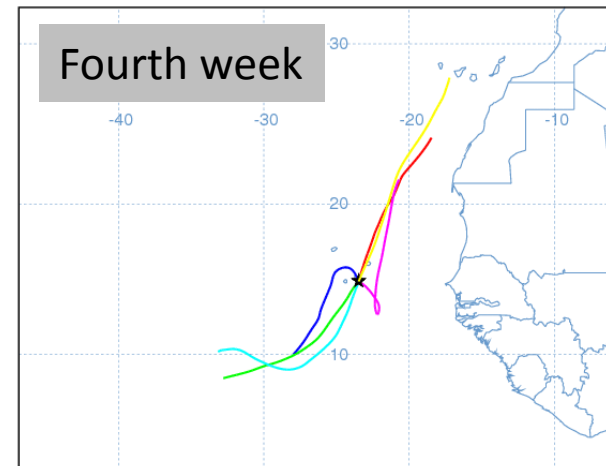
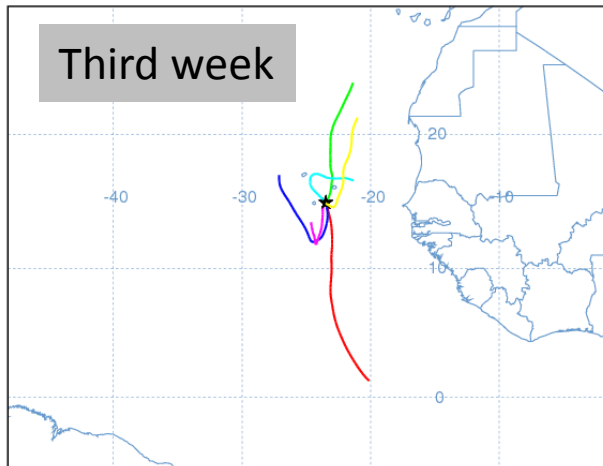
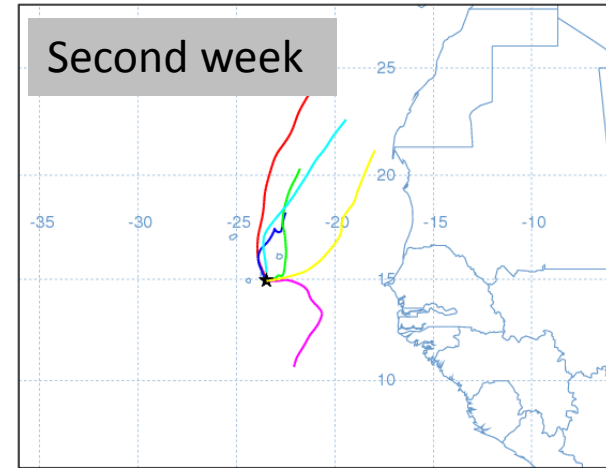
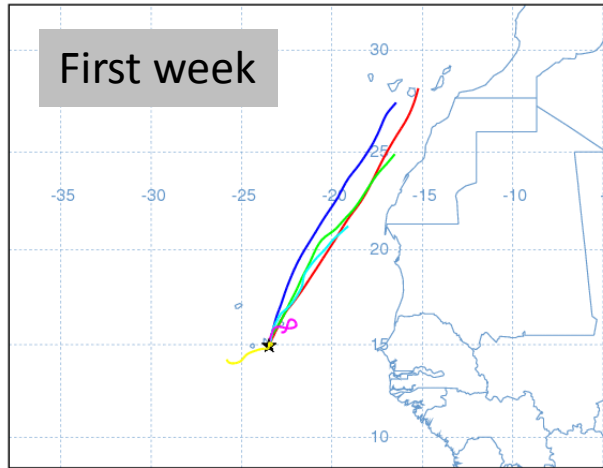


# 48 Hours backward trajectories for every day in Febr. 2011



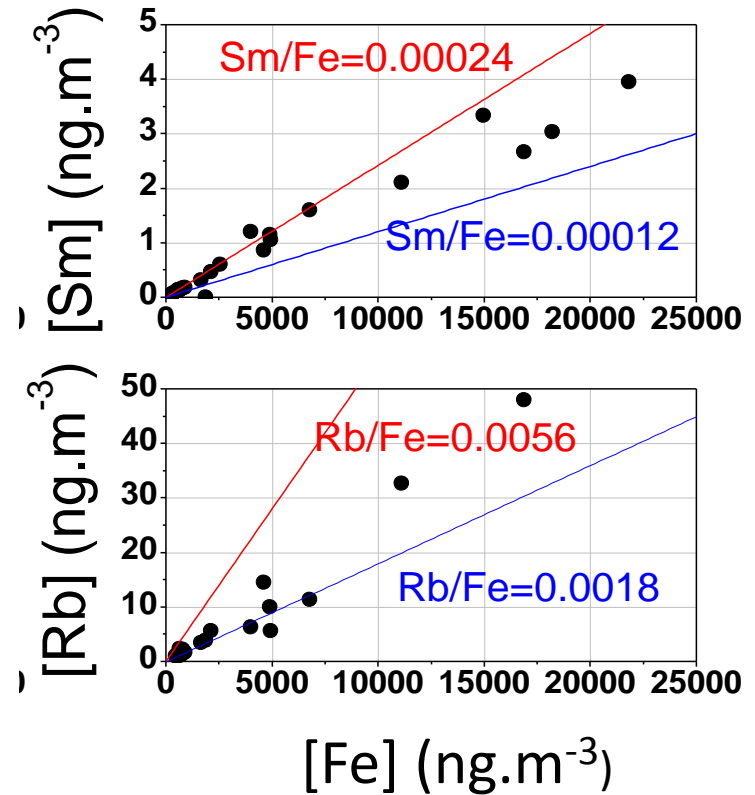
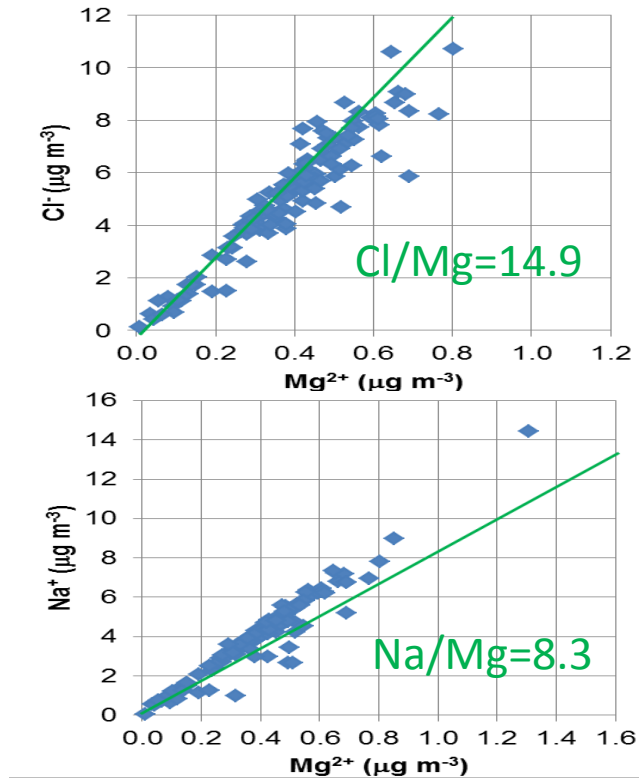


# 48 Hours backward trajectories for every day in August 2011





# Source apportionment: Composition relations



Green- Sea salt composition

Red- Saharan soil composition (Reguigui et al., 2002);

Blue- Global soil composition (Manson and Moore (1982)





# Emission, Transport and Deposition Modeling

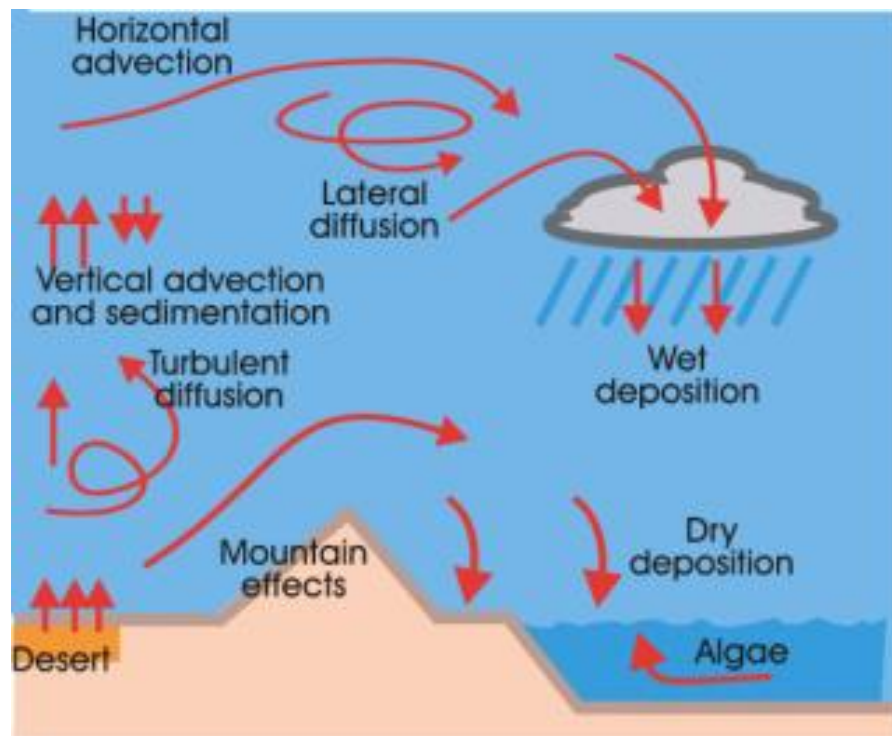
## DREAM - Dust REgional Atmospheric Model | BSC-DREAM8b

<http://www.bsc.es/projects/earthscience/DREAM/>

predicts the atmospheric life cycle of the eroded Saharan desert dust

### DUST PRODUCTION SCHEME:

- Type of soil
- Type of vegetation cover
- Soil moisture content
- Surface atmospheric turbulence





# DREAM adaptation/application to CV-DUST Project

## Outputs

- AEROSOL CONCENTRATION
- DUST LOAD COLUMN
- DRY / WET DEPOSITION

24 vertical layers

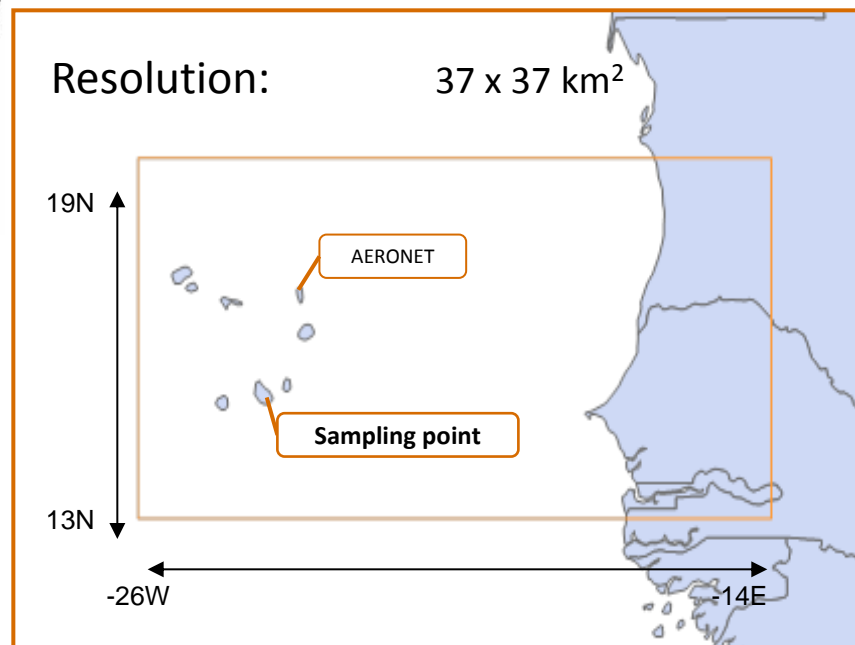
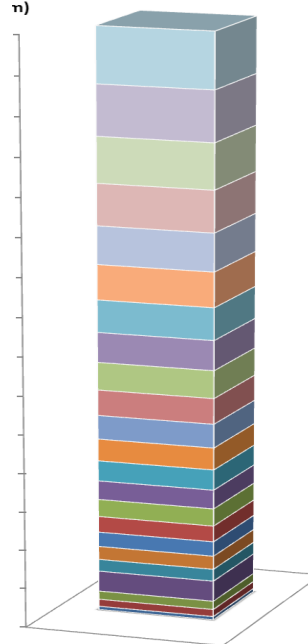
(km)

15

10

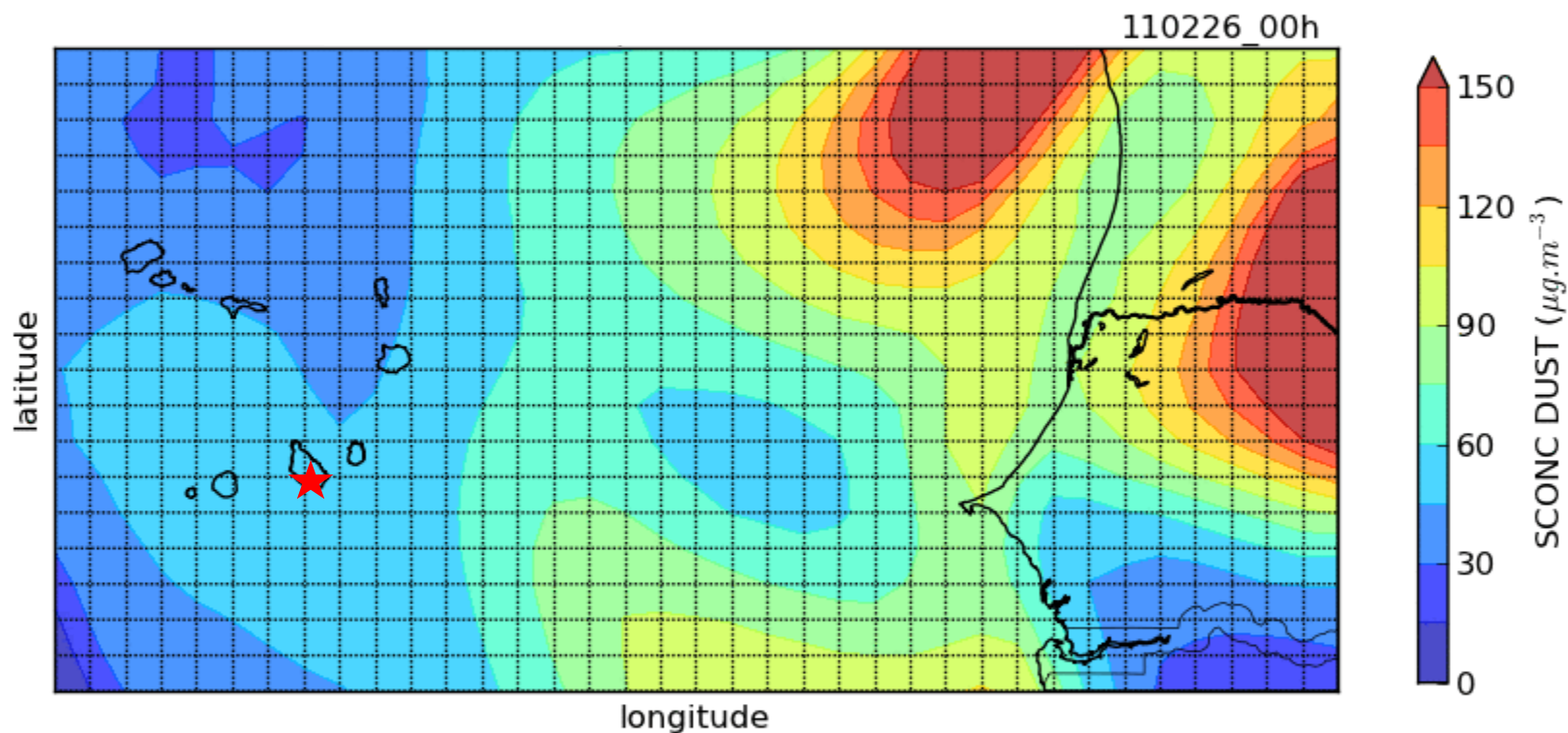
5

0



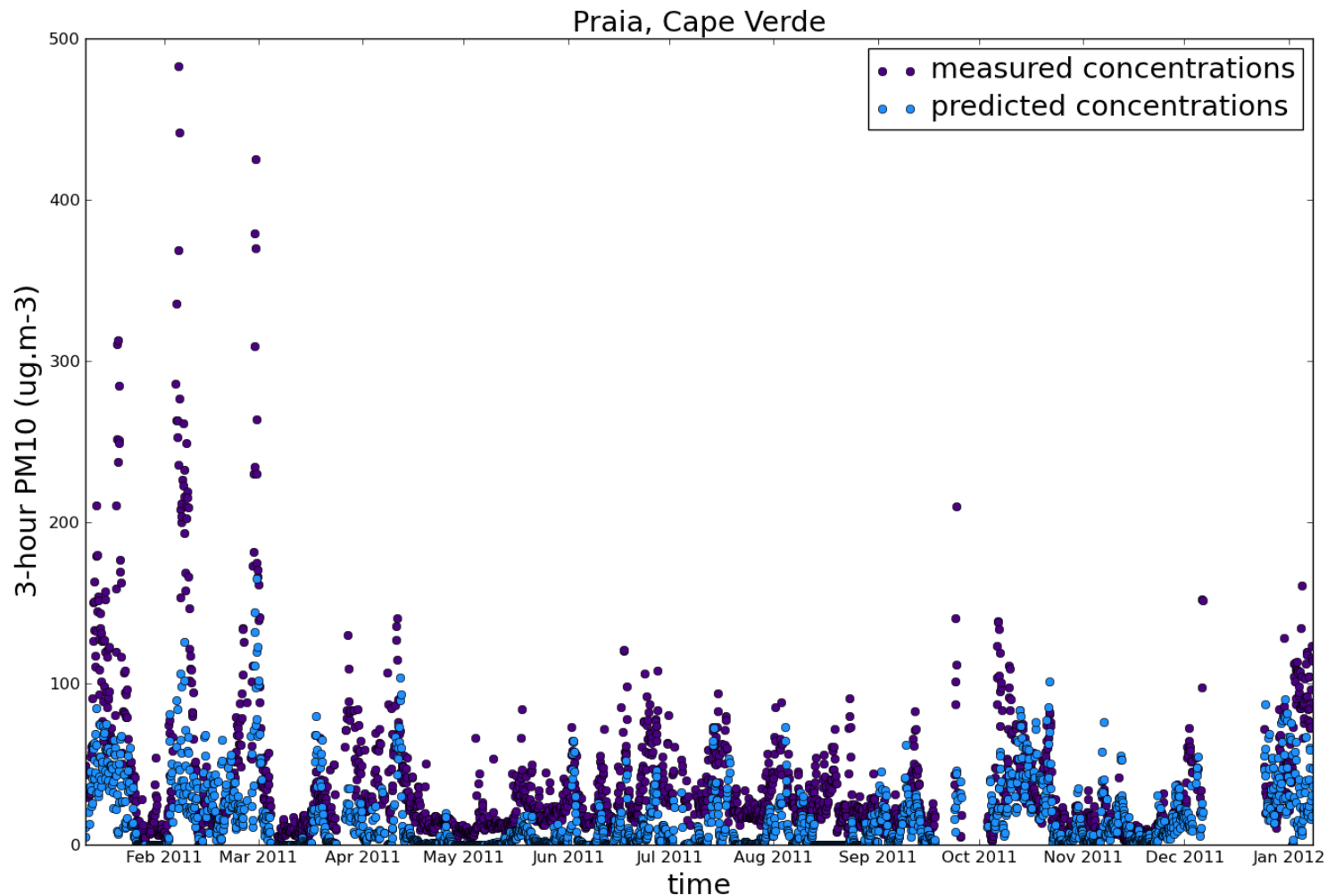
# DREAM Model output example

FOUR DAYS SURFACE AEROSOL CONCENTRATION, END FEBRUARY 2011





# DREAM - Intercomparison Model / Measurements





## PROVISIONAL CONCLUSIONS

- A complete chemical e physical composition seasonal data set for atmospheric aerosol offshore of northwest Africa, gathered;
- Clear existence of two seasons with different particulate pollution levels;
- Particulate pollution levels clearly above WHO health guides, principally during the “Bruma Seca” dust season;
- Chemical composition shows two predominant aerosol sources: sea salt spray and soil dust;
- DREAM model can reproduce reasonably the transport of dust and the aerosol loading in Cape Verde region;
- Continuation of analytical and modeling work in the near future are expected to permit further insight into source characterization and quantification and dust transport and deposition to the Atlantic.



# Thanks for your attention!

*Casimiro A. Pio*



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