

Saharan dust outbreaks towards Europe: 3 years of systematic observations (2000-2003)

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Saharan dust outbreaks to Europe:

Objectives and Methodology

Implementation of a routine monitoring scheme, mainly in the south and central European region, for the observation of specifically high aerosol loads in the lower troposphere, resulting from extreme dust events (Saharan dust outbreaks)

Forecasting scheme

Use dust forecasting models (DREAM/ICOD, SKIRON/UOA, NAAPS/NOAA/NRL models), Satellite data (EP/TOMS AI, SeaWiFS AOT, NOAA/AVHRR AOT)

Coordination

NTUA Group (Warnings: -24-48 h)

Ancillary Measurements

Spectral UV-B Measurements, Sun photometers, Meteorological observations

Validation tools

- **Air-mass back-trajectory analysis**

German Meteorological Service (DWD/GME Model)

- **Satellite data analysis**

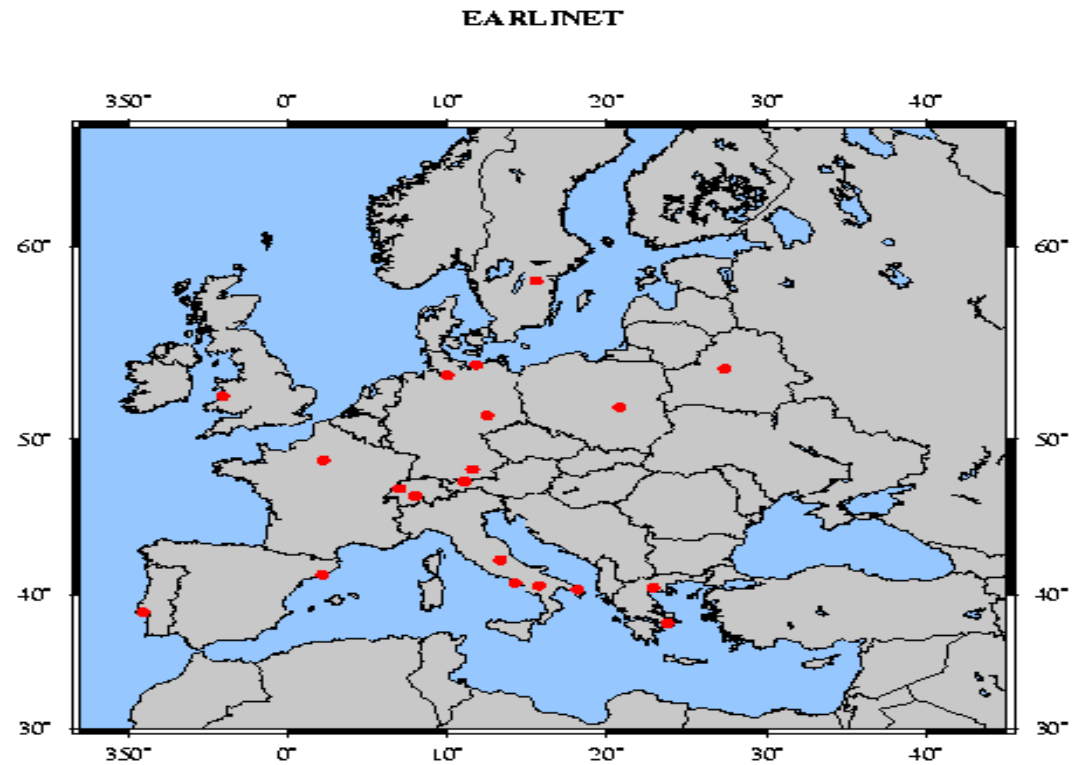
EP/TOMS & SeaWiFS data

- **Sun photometer data analysis**

Saharan dust events (2000-2003)

>105 cases forecasted, 85 cases followed up

EARLINET LIDAR MONITORING STATIONS



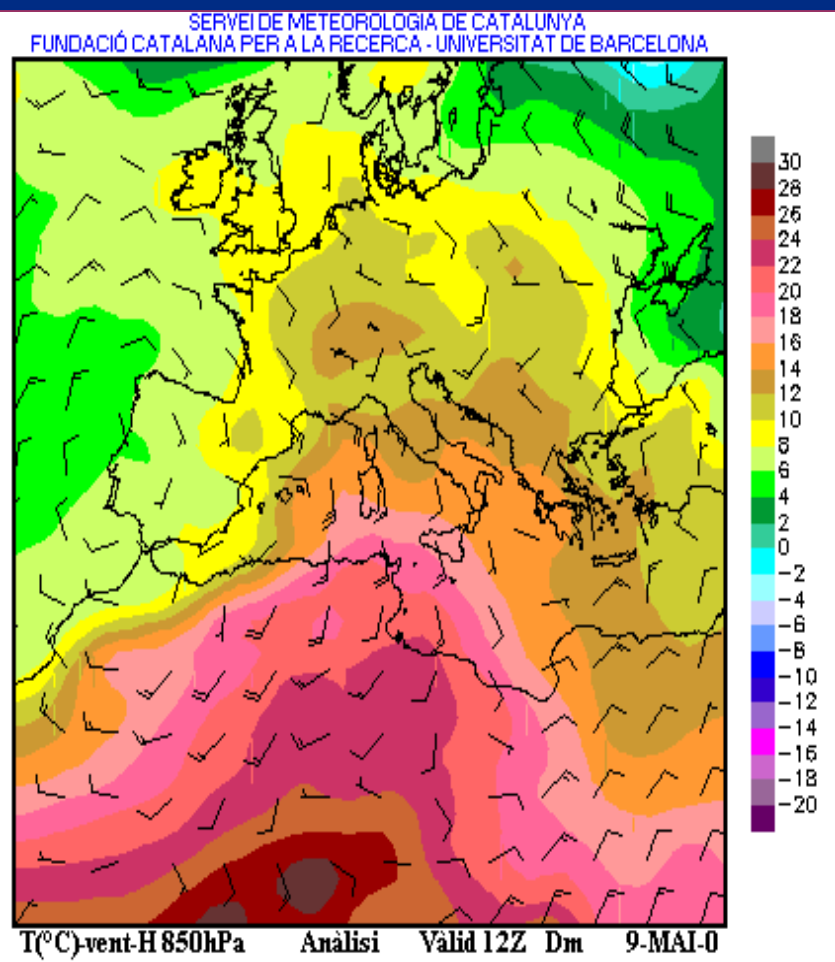
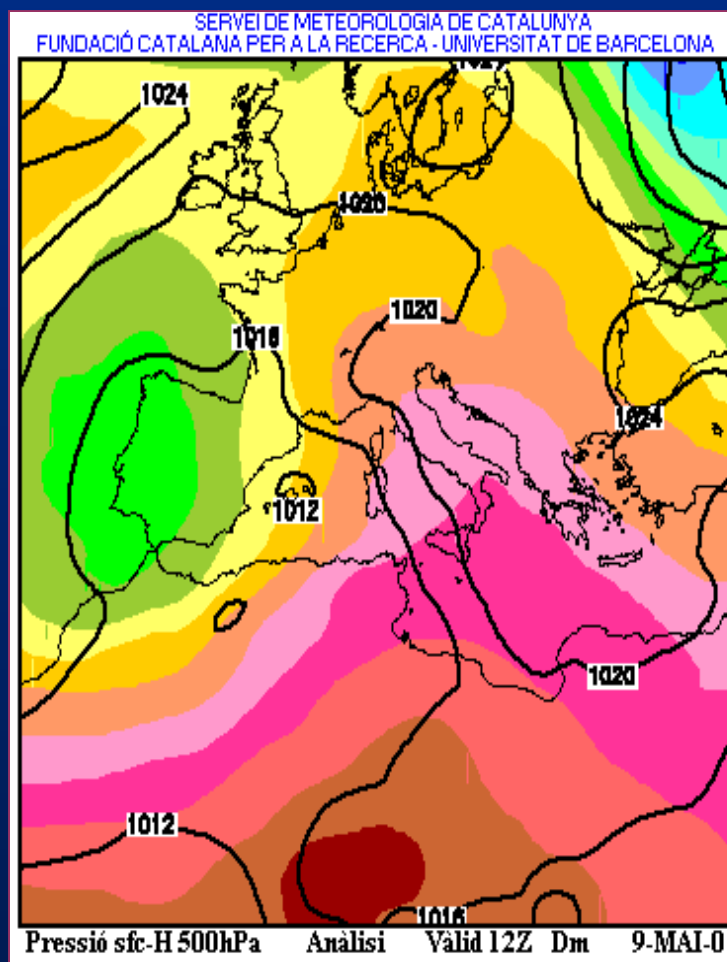
Selection of Saharan Dust Events

CASE I: SAHARAN DUST EVENT (08-11.05.00)

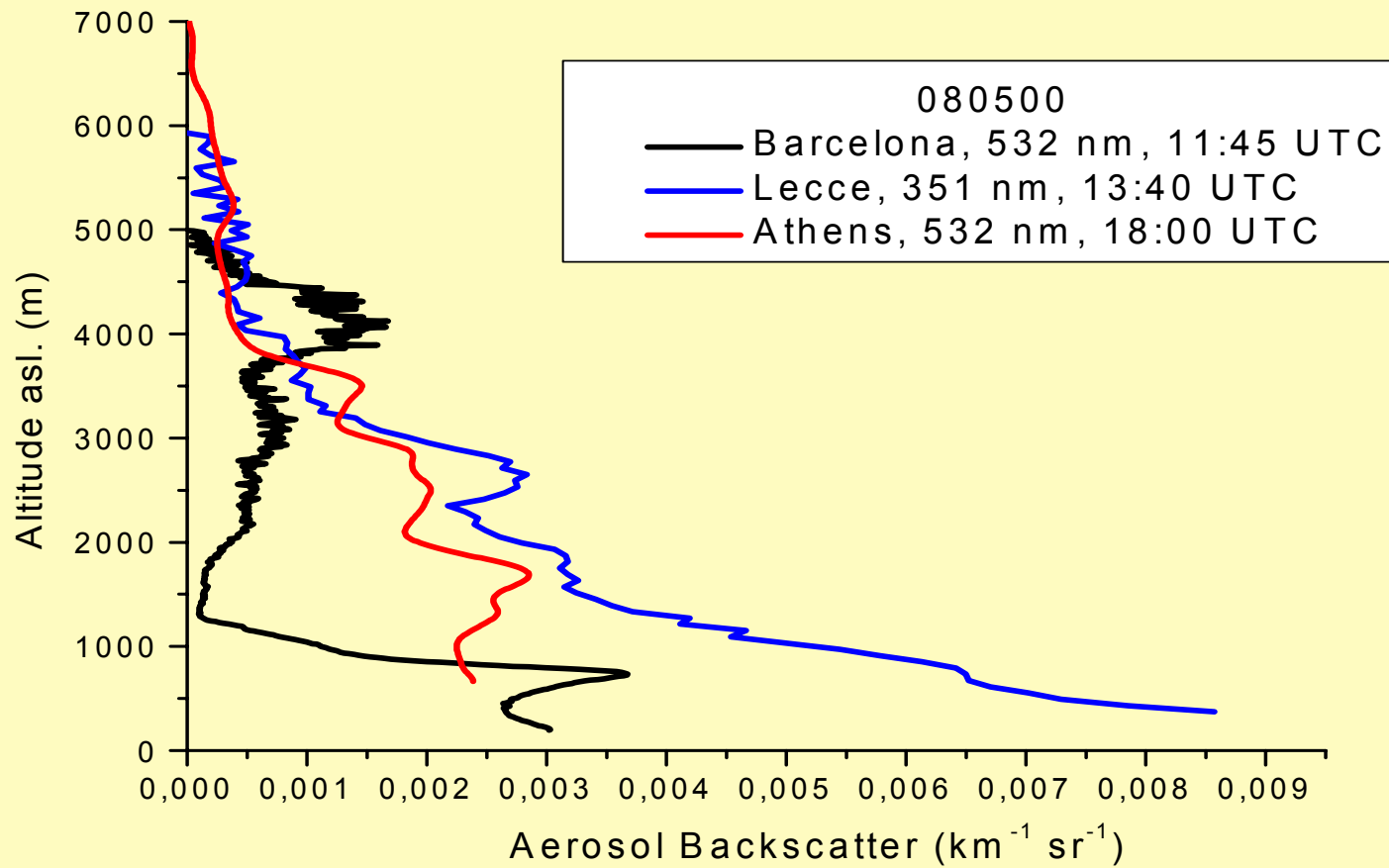
Typical Case

SAHARAN DUST EVENT (08-11.05.00)

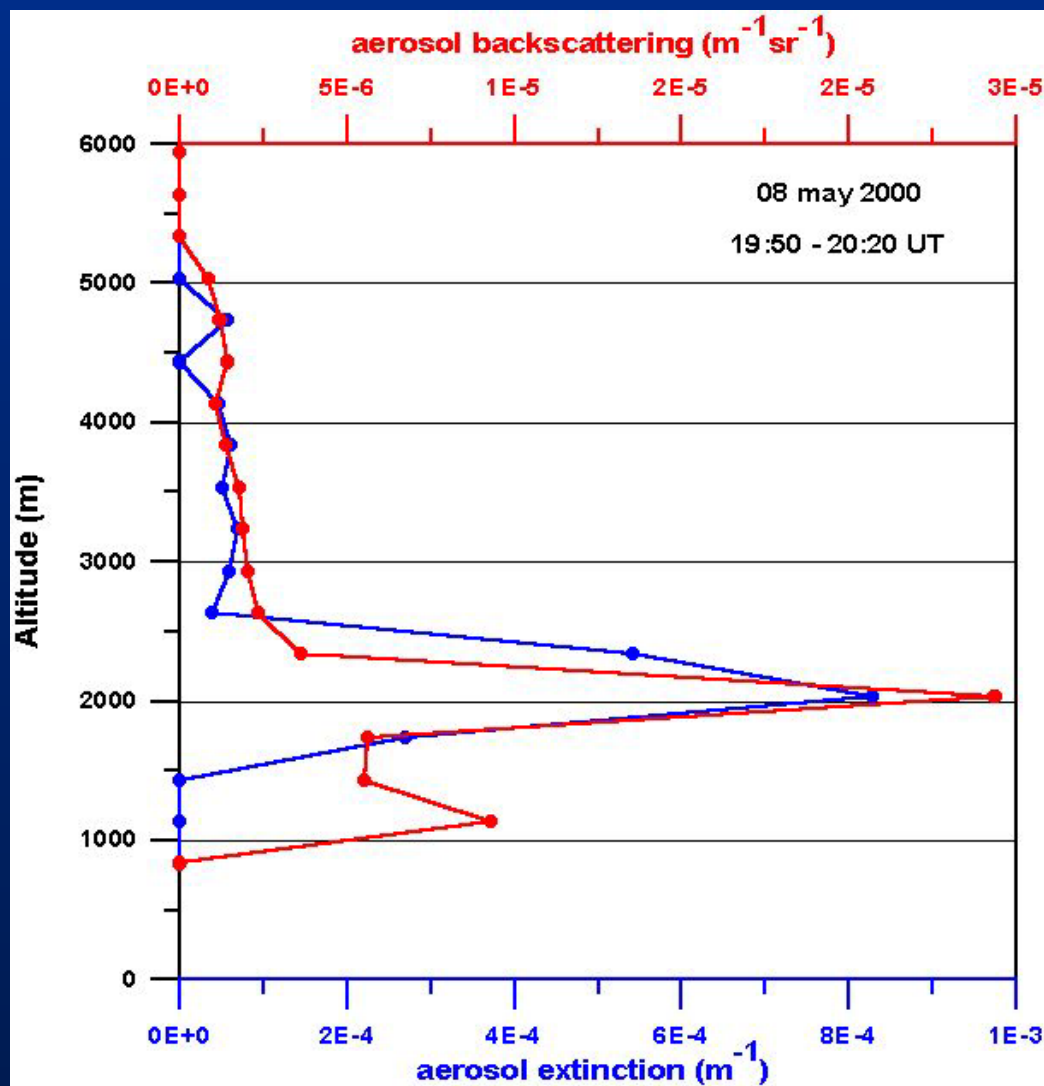
METEO SPAIN 090500 12UT



SAHARAN DUST EVENT (08-11.05.00)



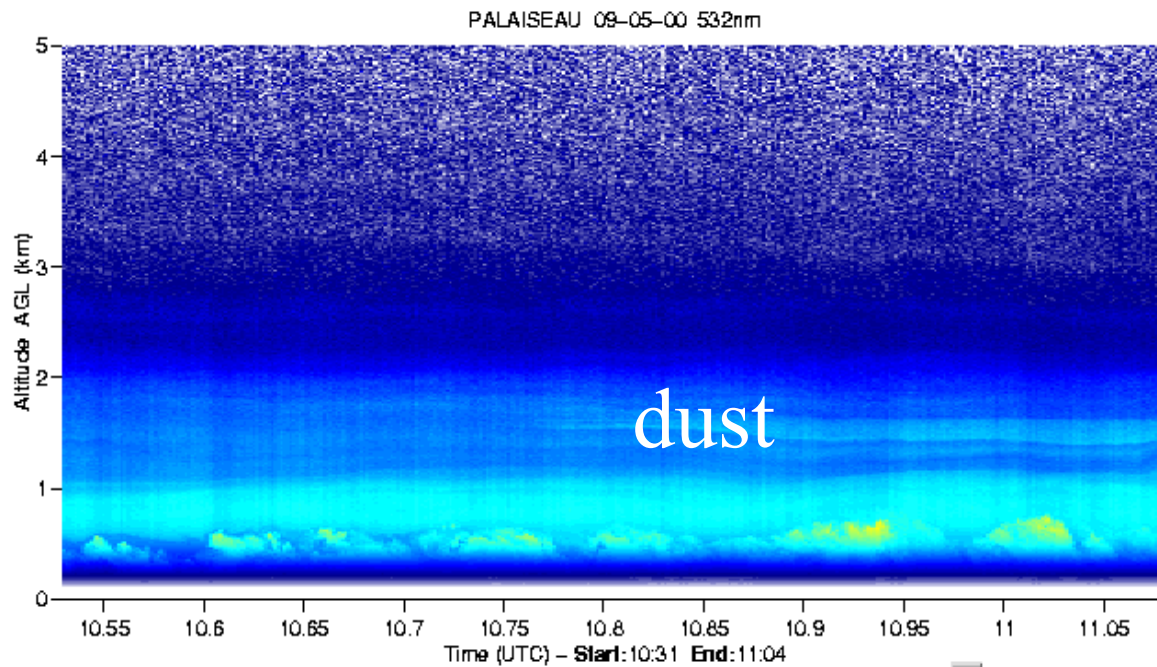
SAHARAN DUST EVENT (08-11.05.00)



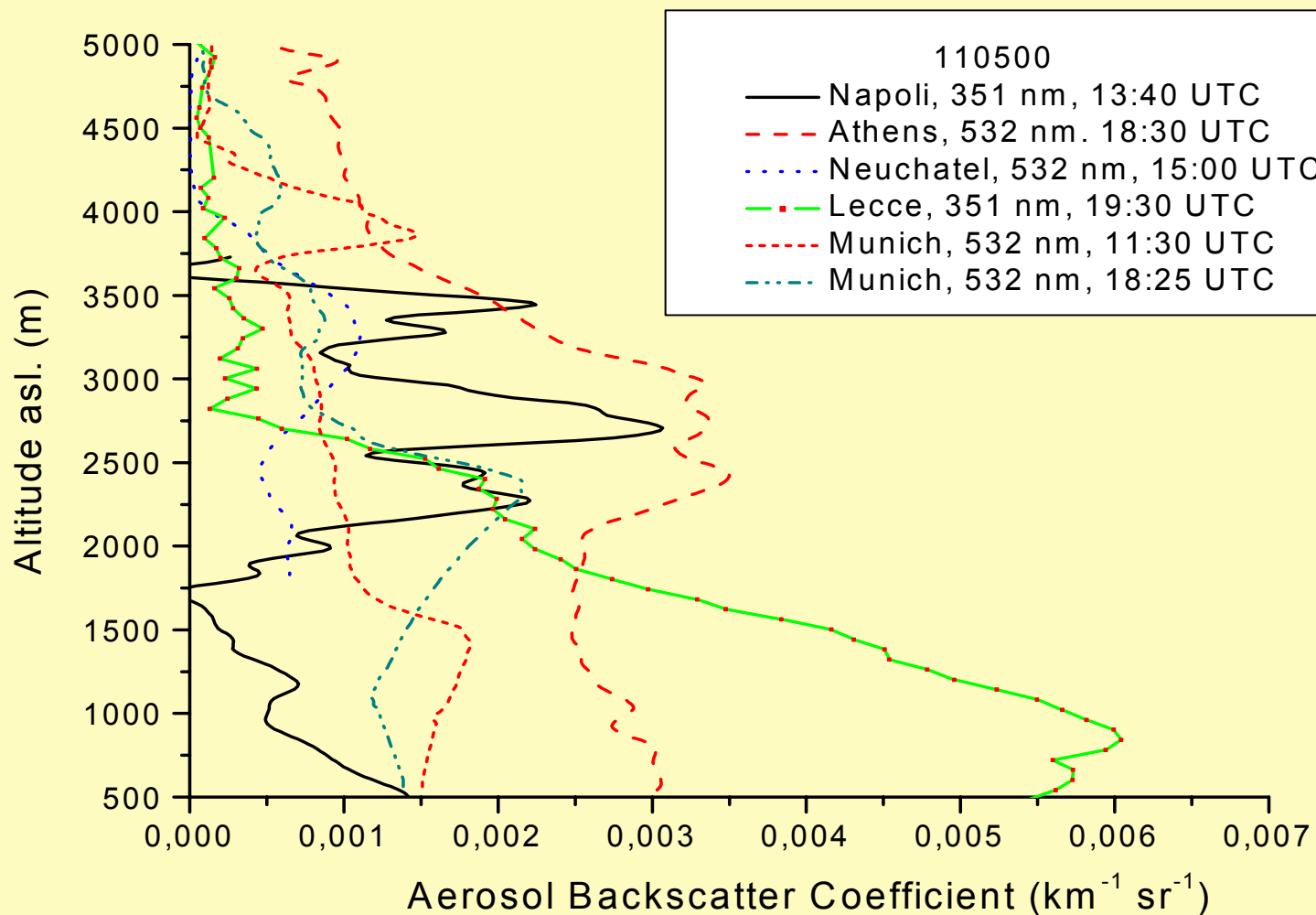
Laquila, 080500

SAHARAN DUST EVENT (08-11.05.00)

Palaiseau, 090500

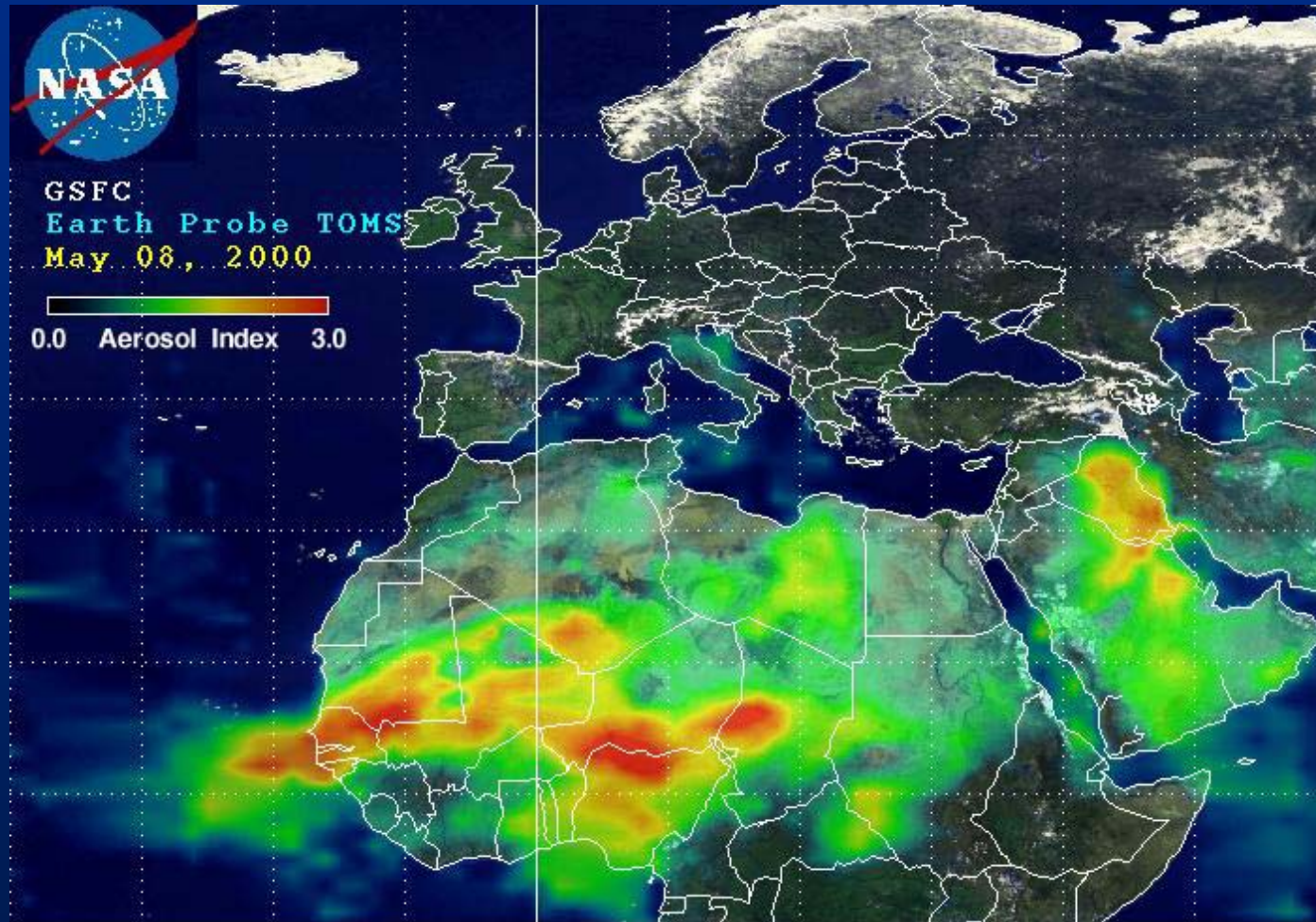


SAHARAN DUST EVENT (08-11.05.00)



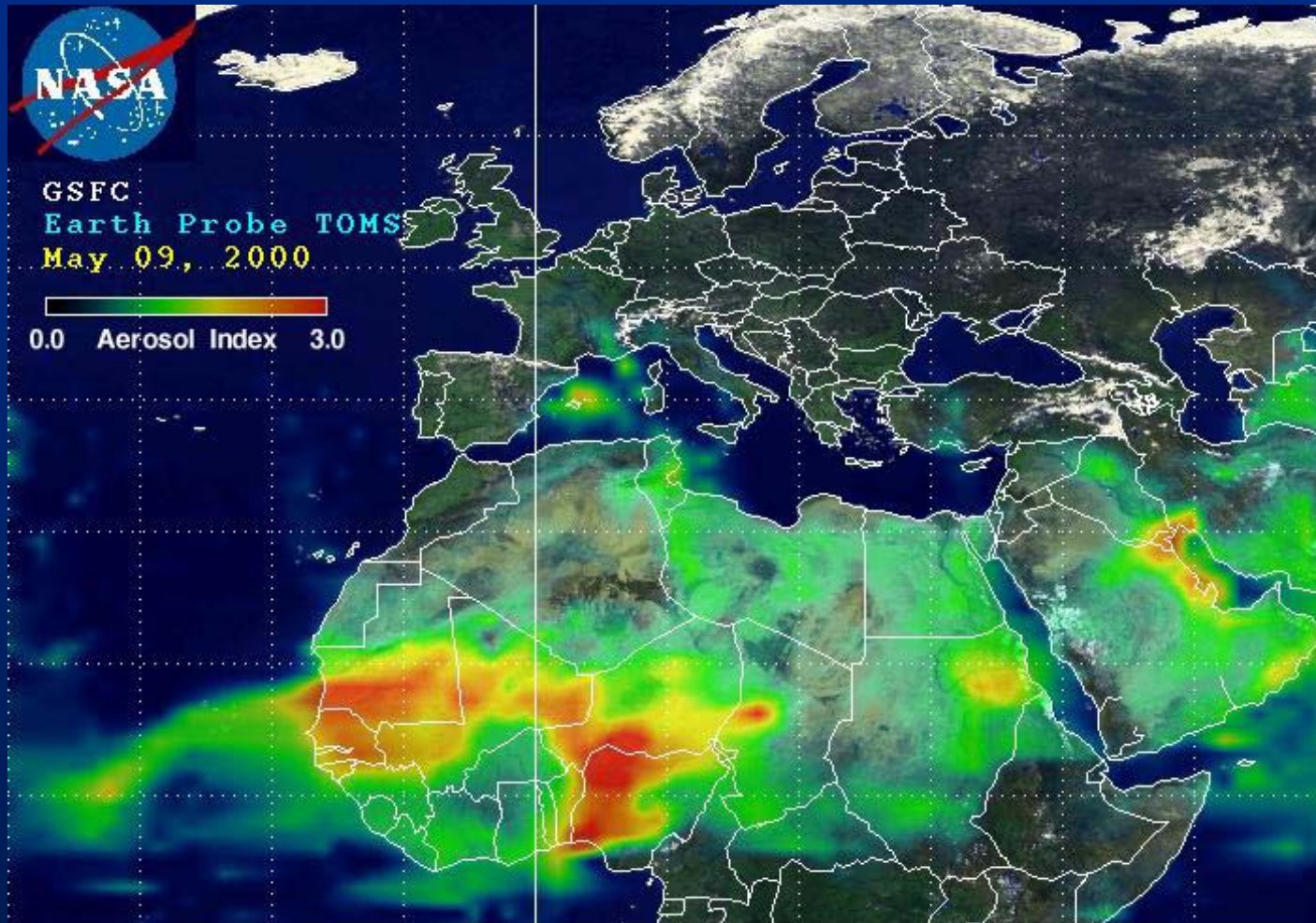
SAHARAN DUST EVENT (08-11.05.00)

NASA EP/TOMS Aerosol Index 080500



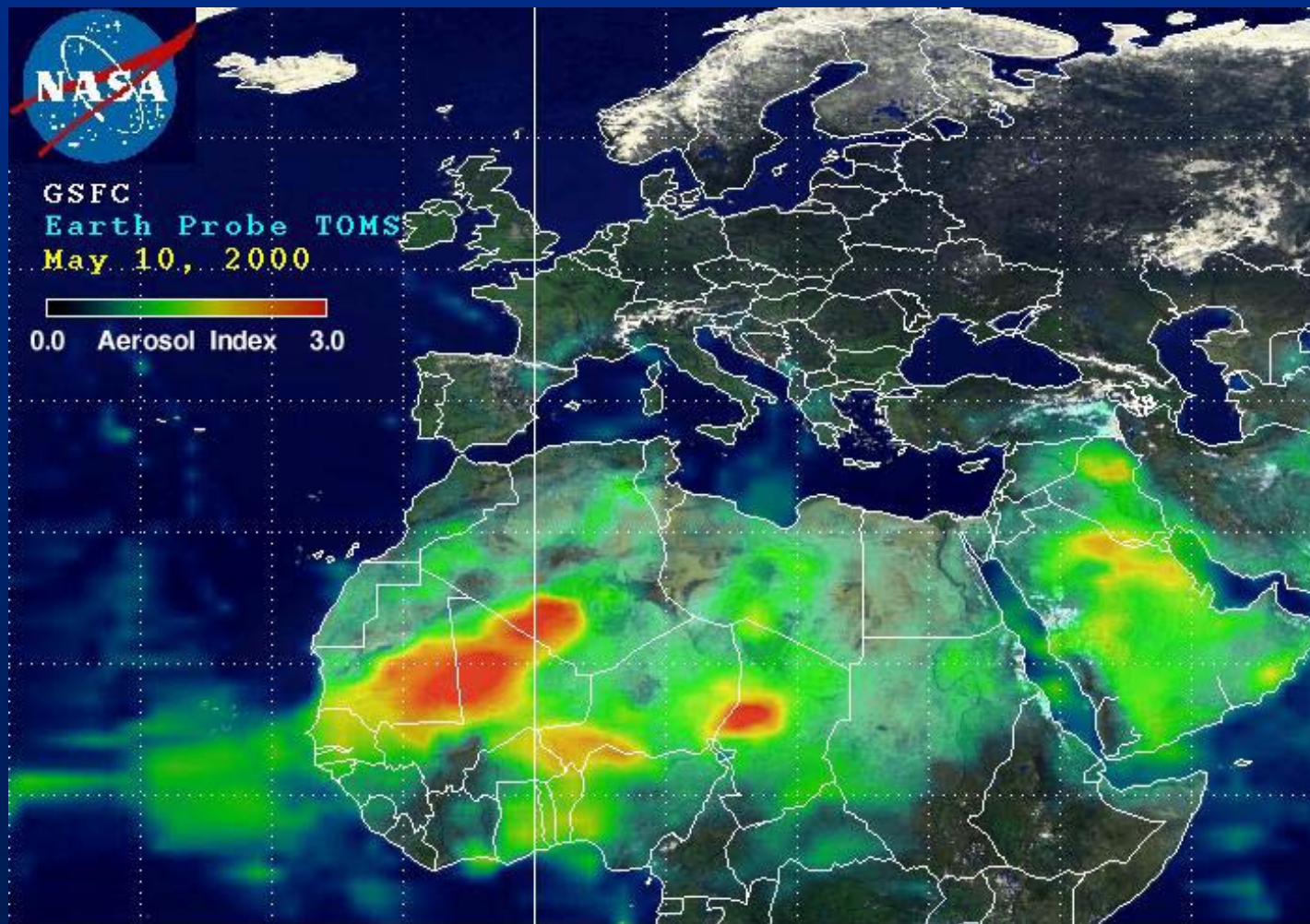
SAHARAN DUST EVENT (08-11.05.00)

NASA EP/TOMS Aerosol Index 090500



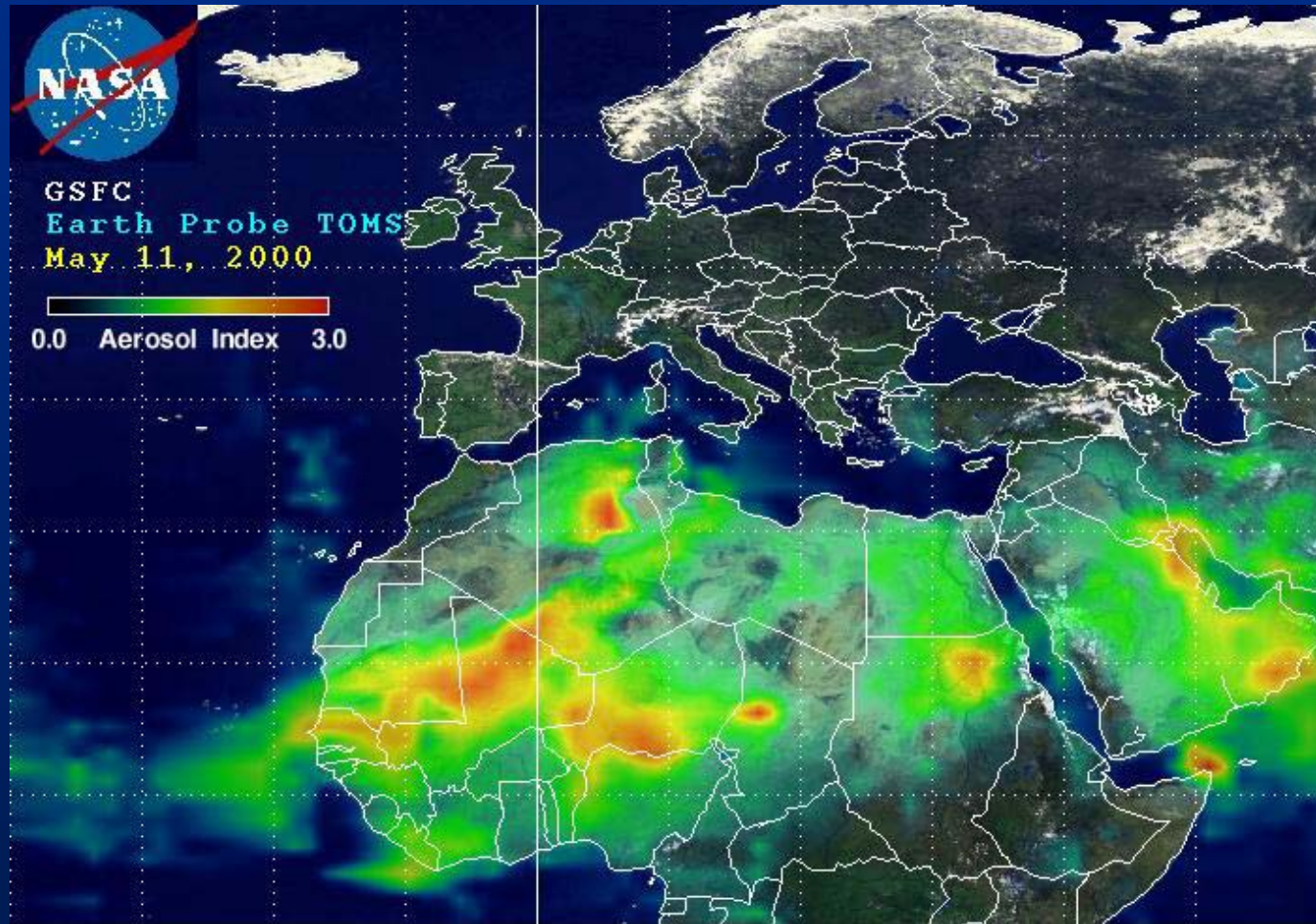
SAHARAN DUST EVENT (08-11.05.00)

NASA EP/TOMS Aerosol Index 100500



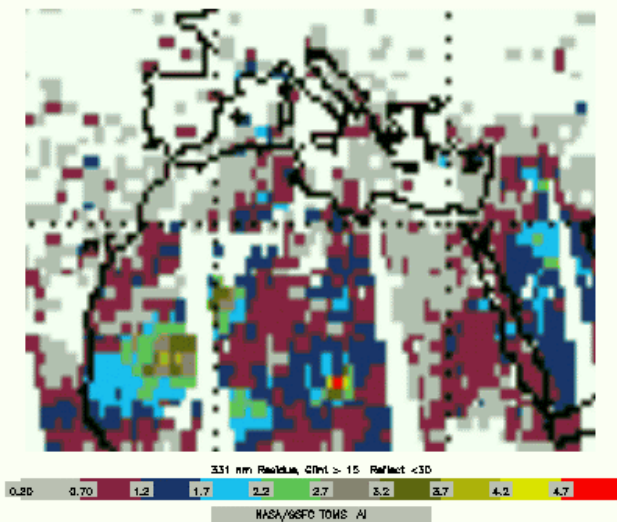
SAHARAN DUST EVENT (08-11.05.00)

NASA EP/TOMS Aerosol Index 110500

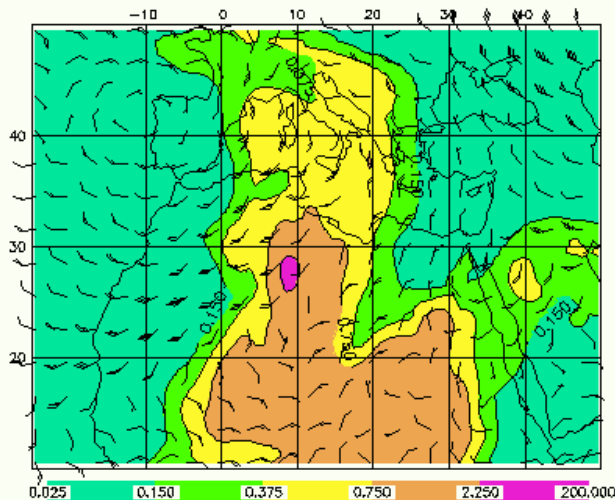


SAHARAN DUST EVENT (08-11.05.00)

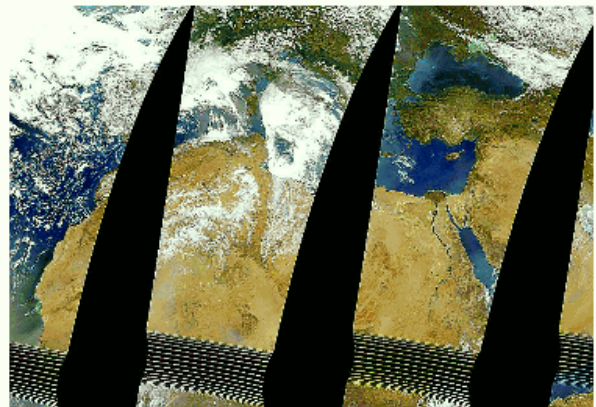
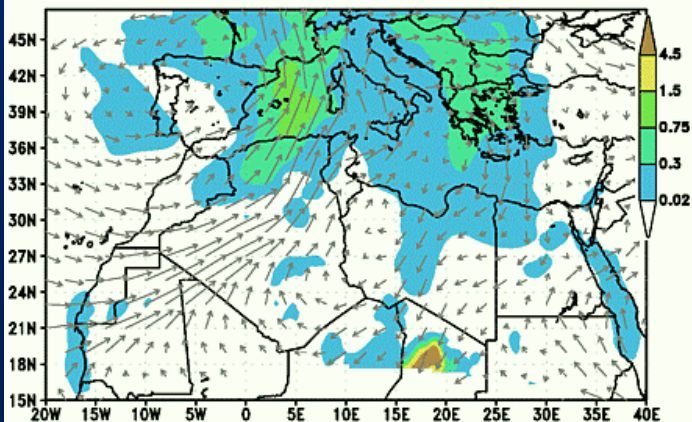
NASA/GSFC TOMS AI 131/2000



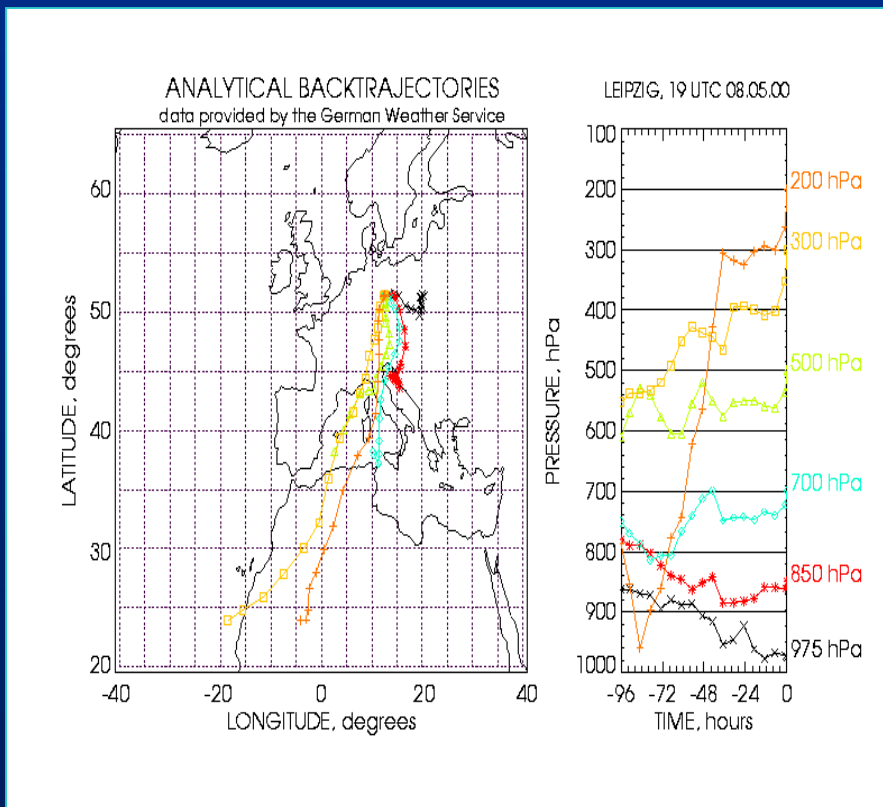
NAAPS Dust Optical Depth, 700 mb winds for 12:00Z 10 May 2000
 (= dust loading of 50, 300, 750, 1500, and 4500 mg/m^2)



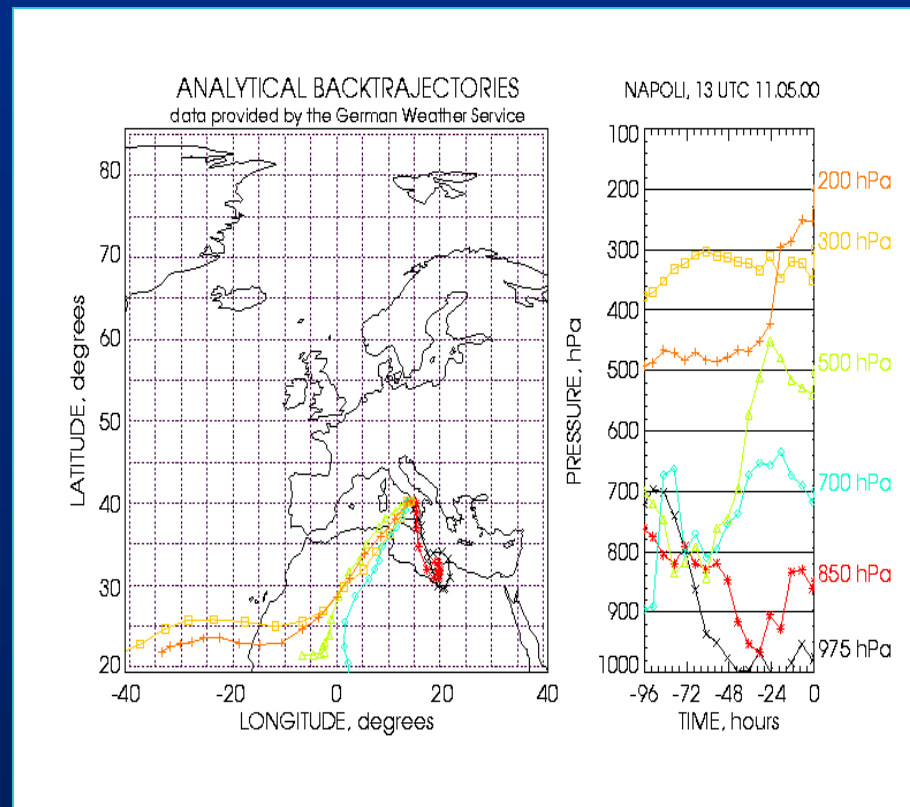
ICoD/DREAM Dust Loading (g/m^2) and 3000m Wind
 0h forecast for 12z 10 MAY 00



SAHARAN DUST EVENT (08-11.05.00)

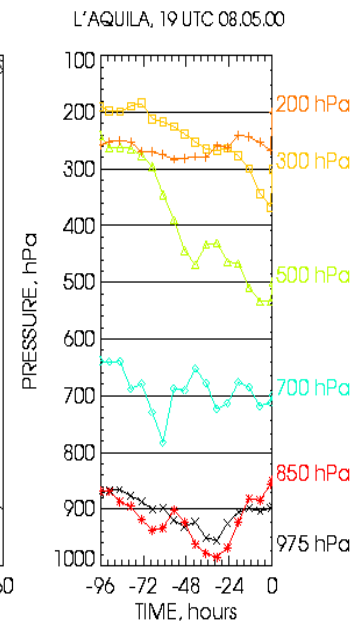
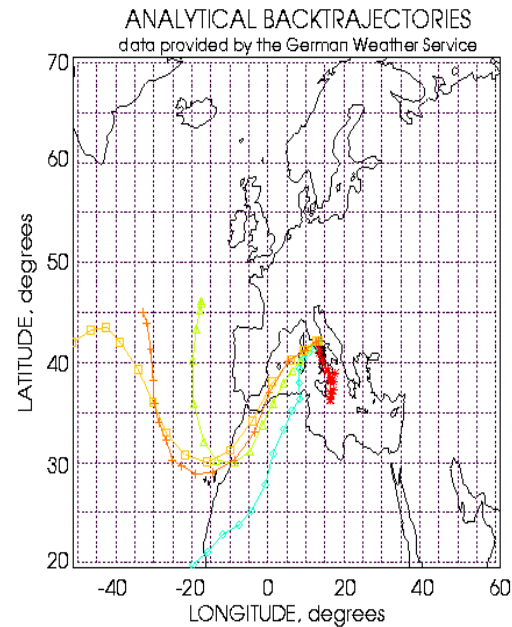
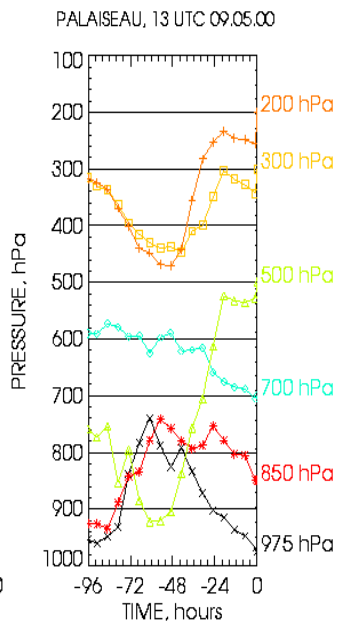
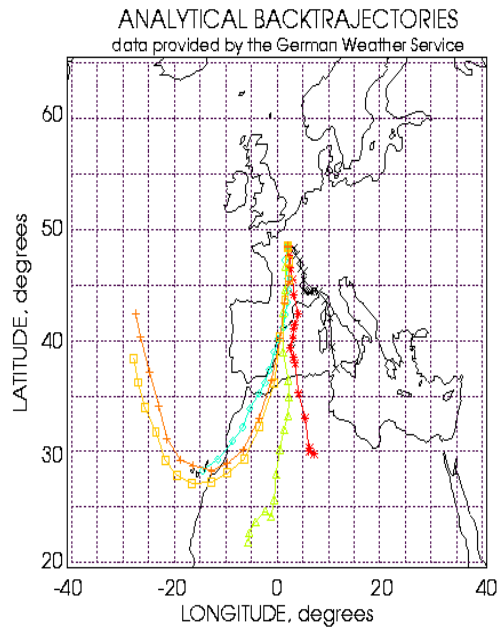


Leipzig, 19UT, 080500



Napoli, 13UT 110500

SAHARAN DUST EVENT (08-11.05.00)



Palaiseau, 13UT, 090500

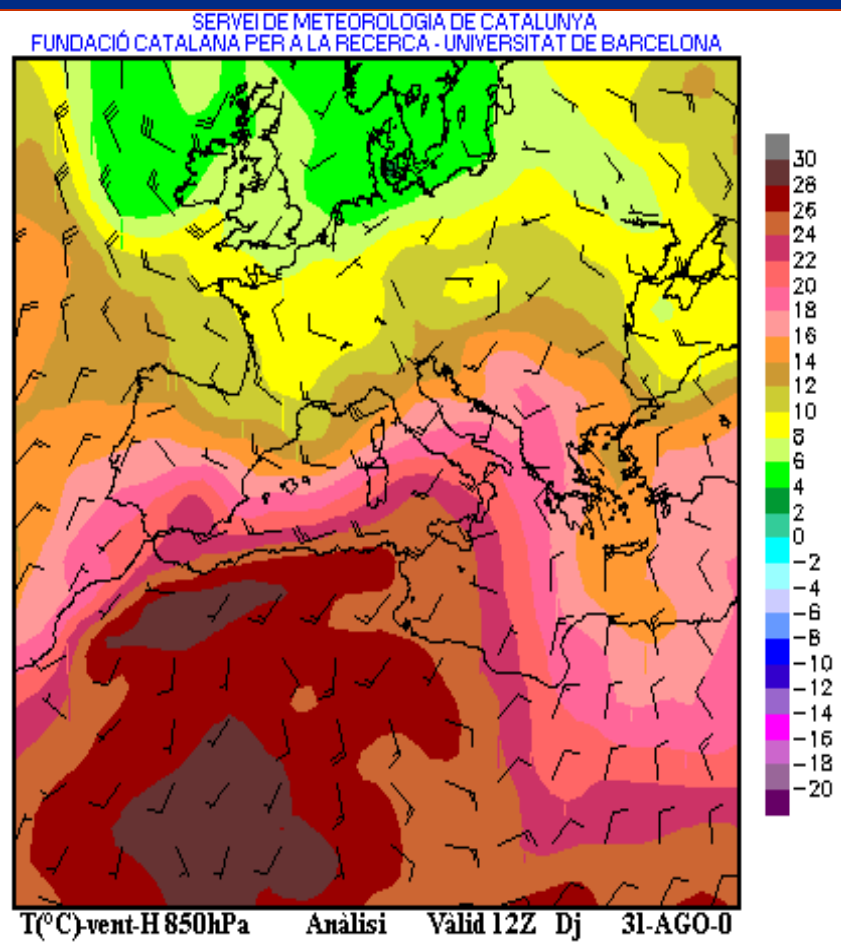
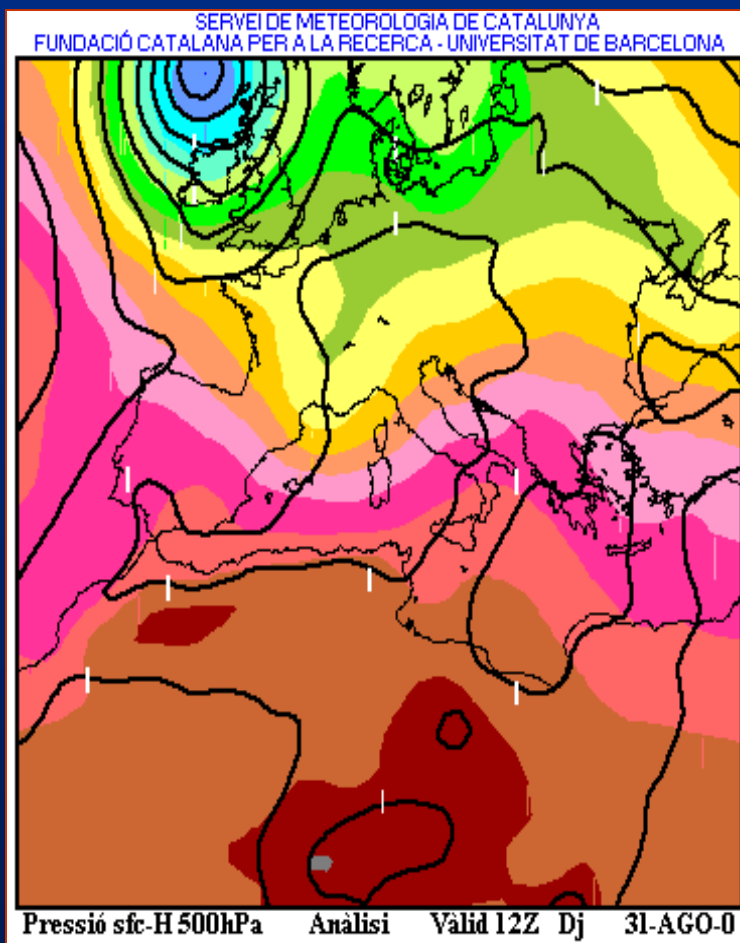
L'Aquila, 19UT 080500

CASE II: SAHARAN DUST EVENT (28-31.08.00)

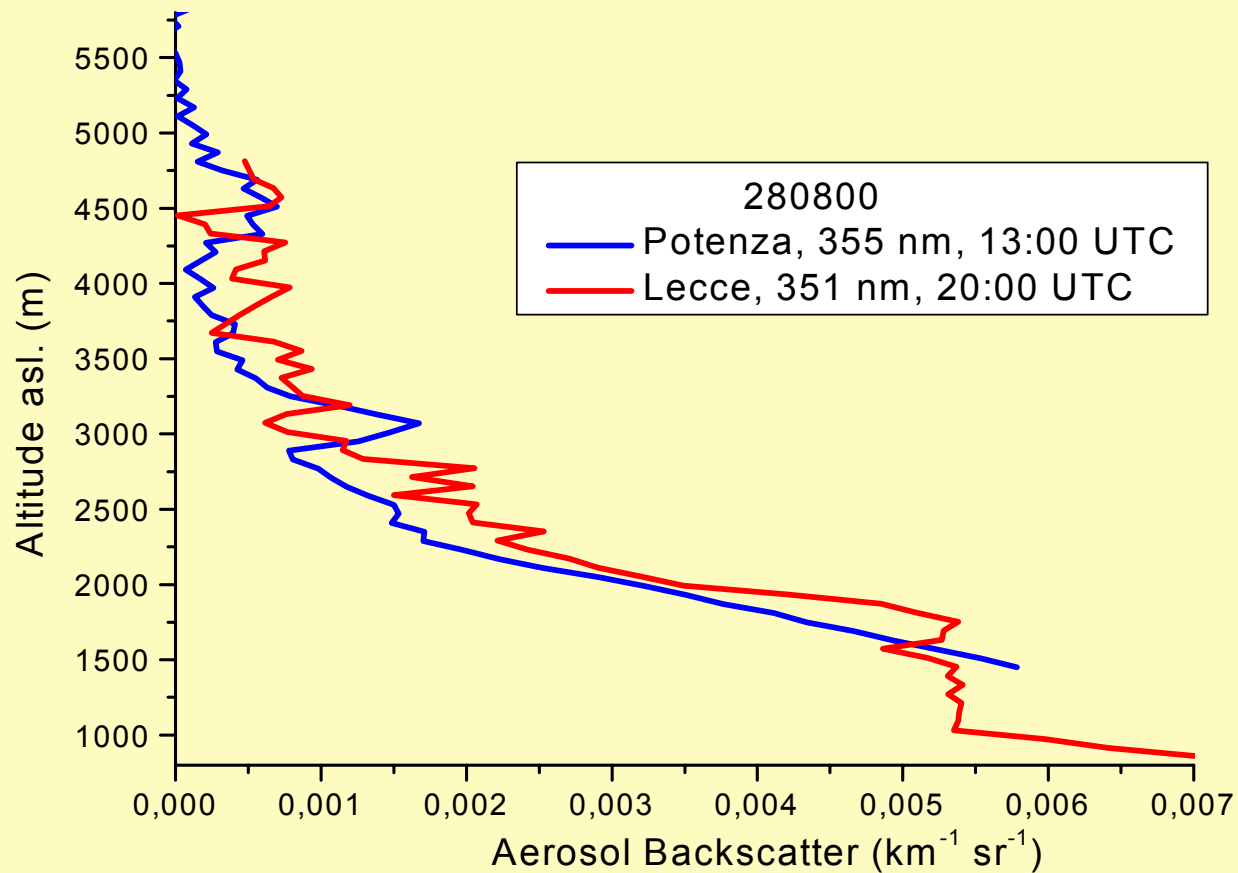
Intense Case

SAHARAN DUST EVENT (28-31.08.00)

METEO SPAIN 310800 12UT

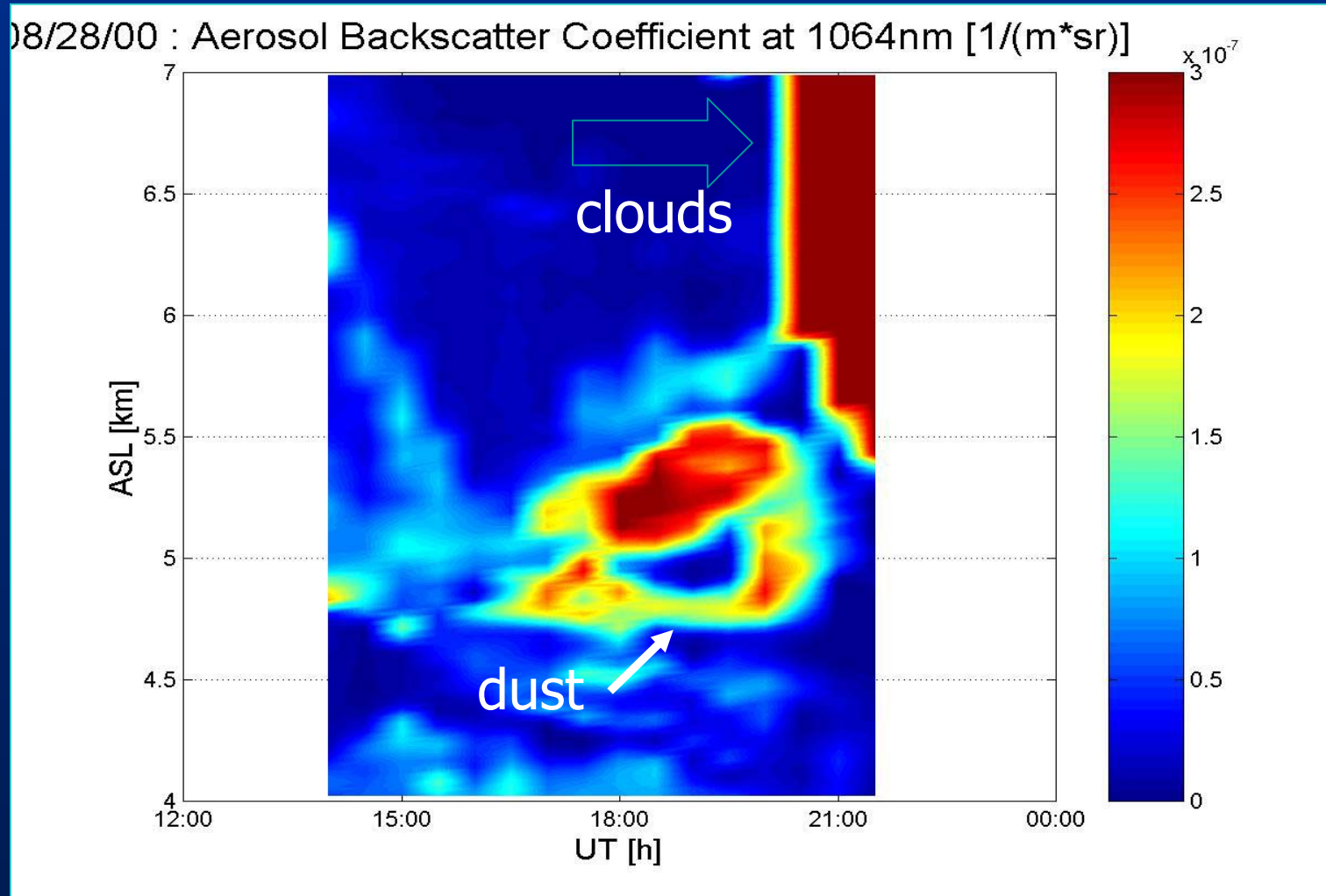


SAHARAN DUST EVENT (28-31.08.00)

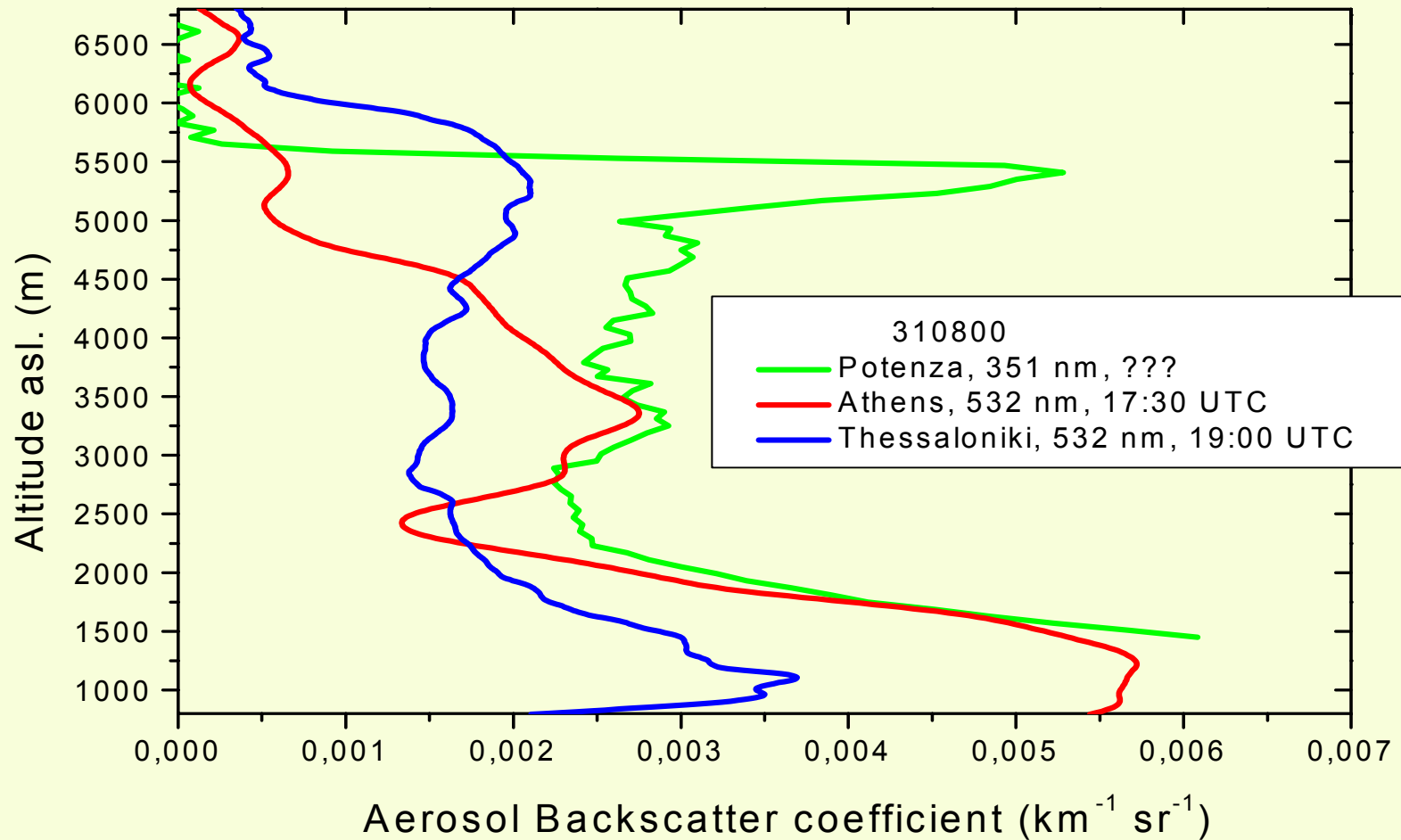


SAHARAN DUST EVENT (28-31.08.00)

Lidar Profiles (1064 nm) Jungfraujoch 280800



SAHARAN DUST EVENT (28-31.08.00)



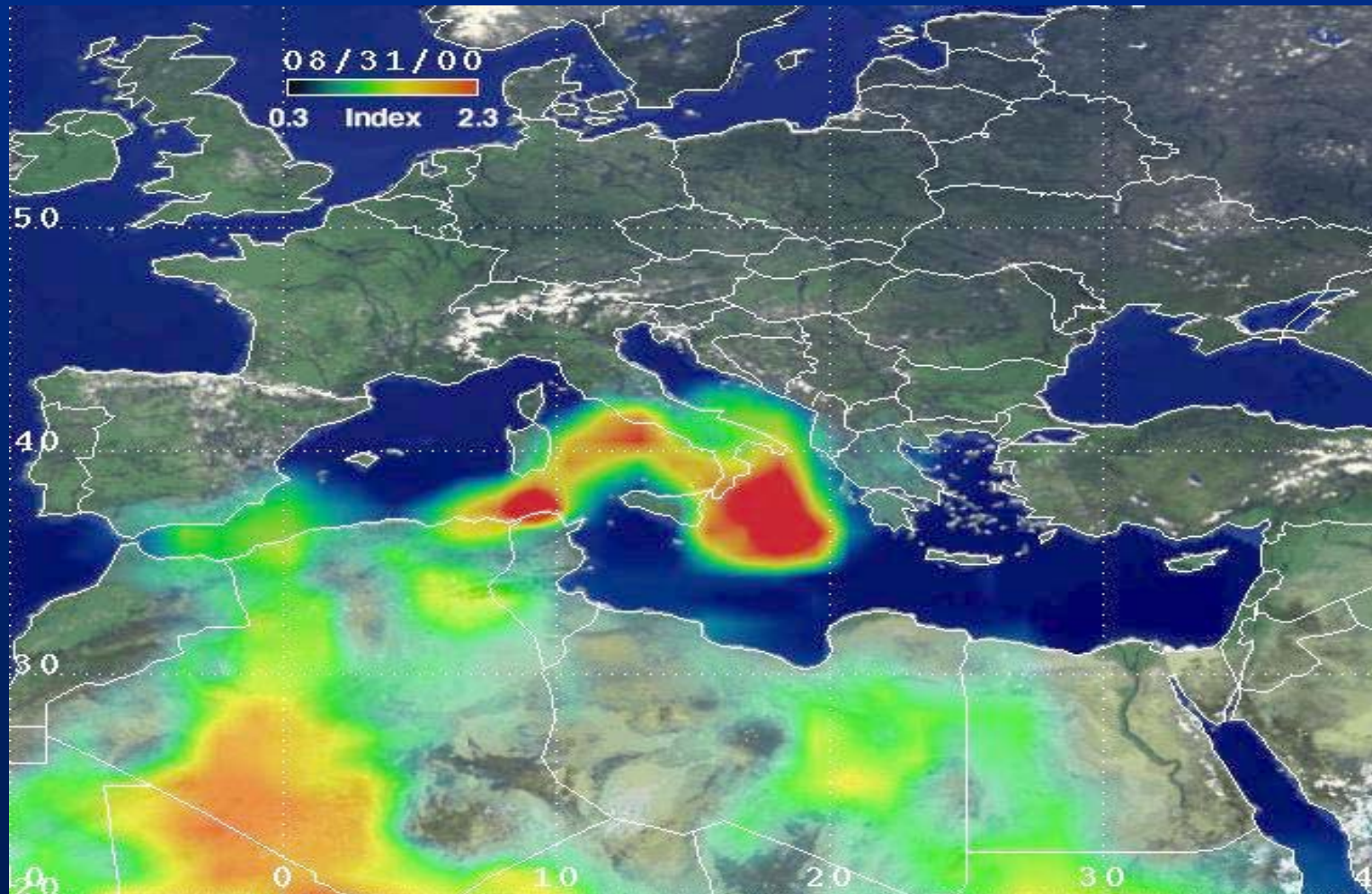
SAHARAN DUST EVENT (28-31.08.00)

NASA-EP/TOMS Aerosol Index 28.08.00

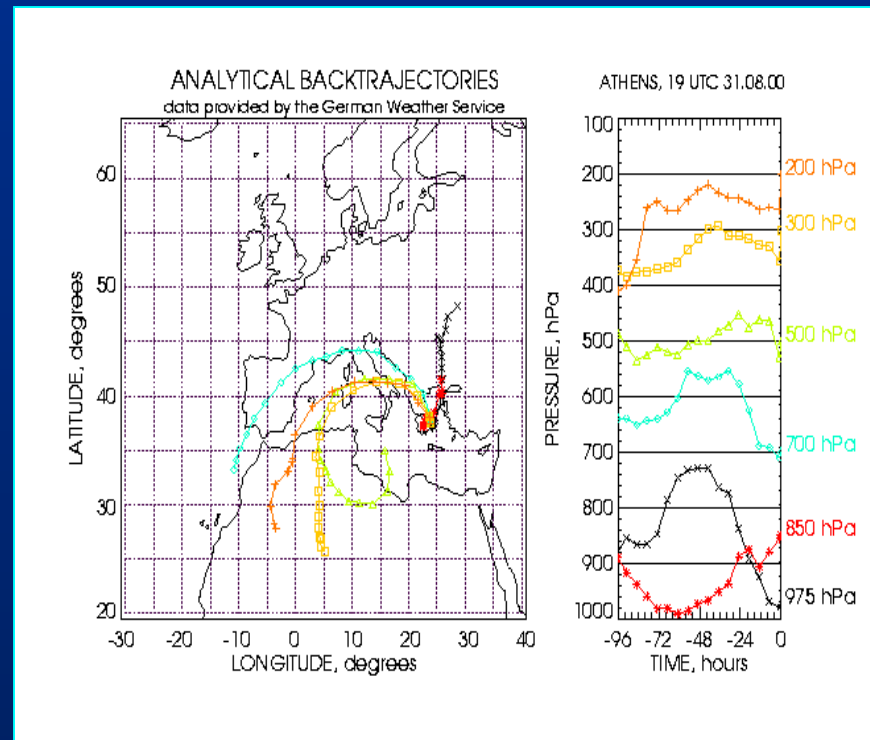
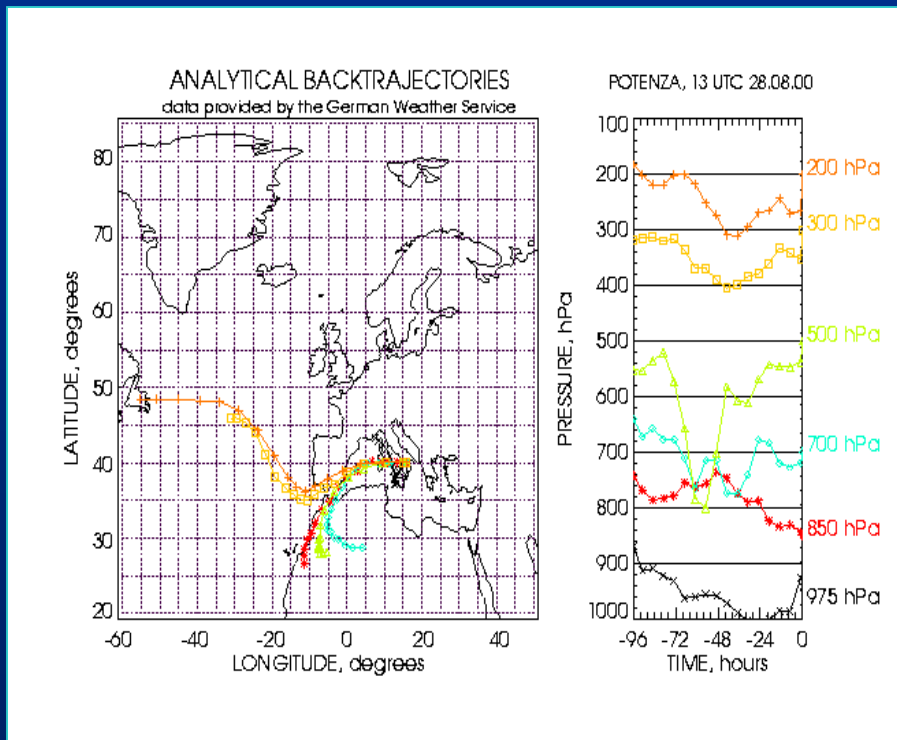


SAHARAN DUST EVENT (28-31.08.00)

NASA-EP/TOMS Aerosol Index 31.08.00



SAHARAN DUST EVENT (28-31.08.00)



Potenza, 13UT, 280800

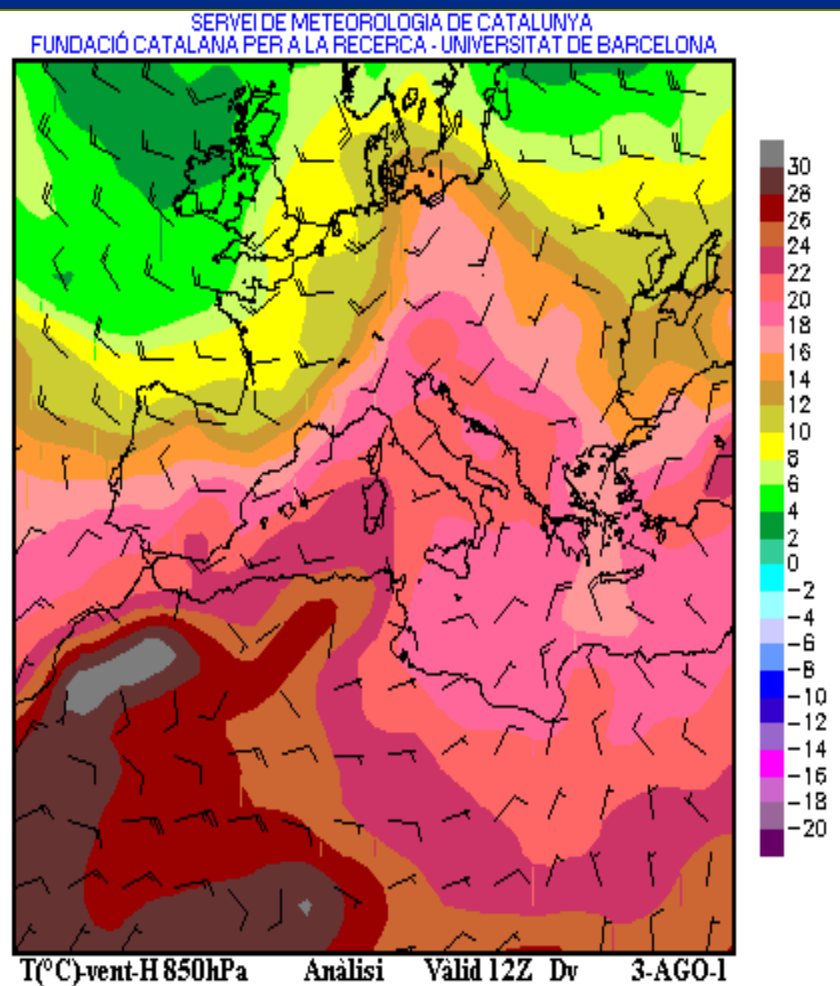
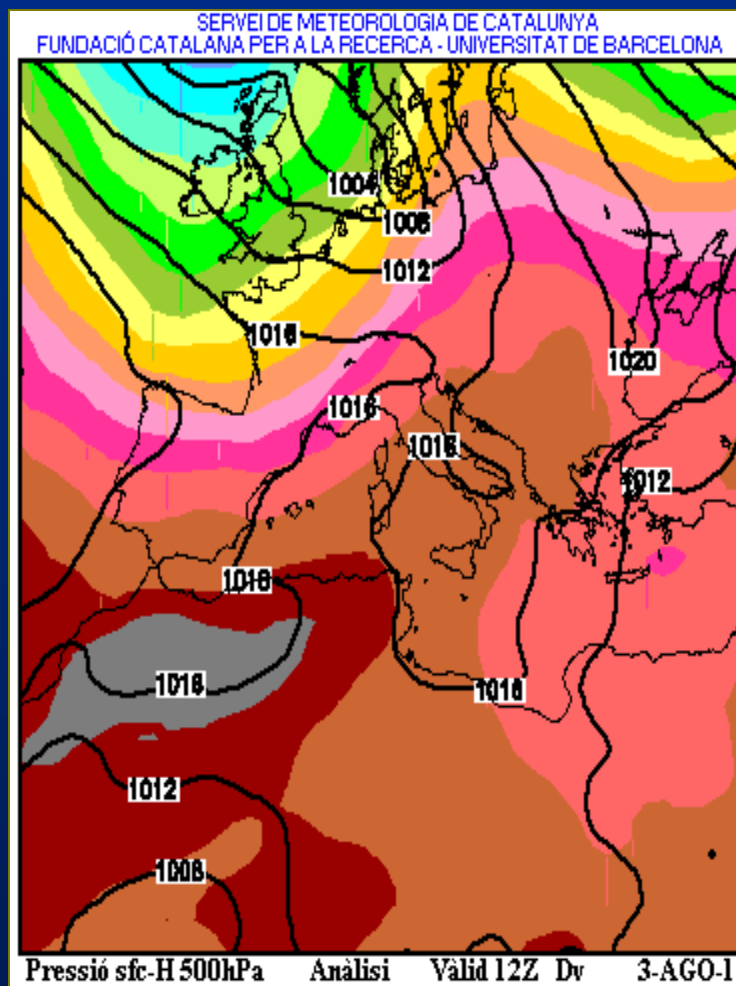
Athens, 19UT, 310800

CASE III: SAHARAN DUST EVENT (02-10.08.01)

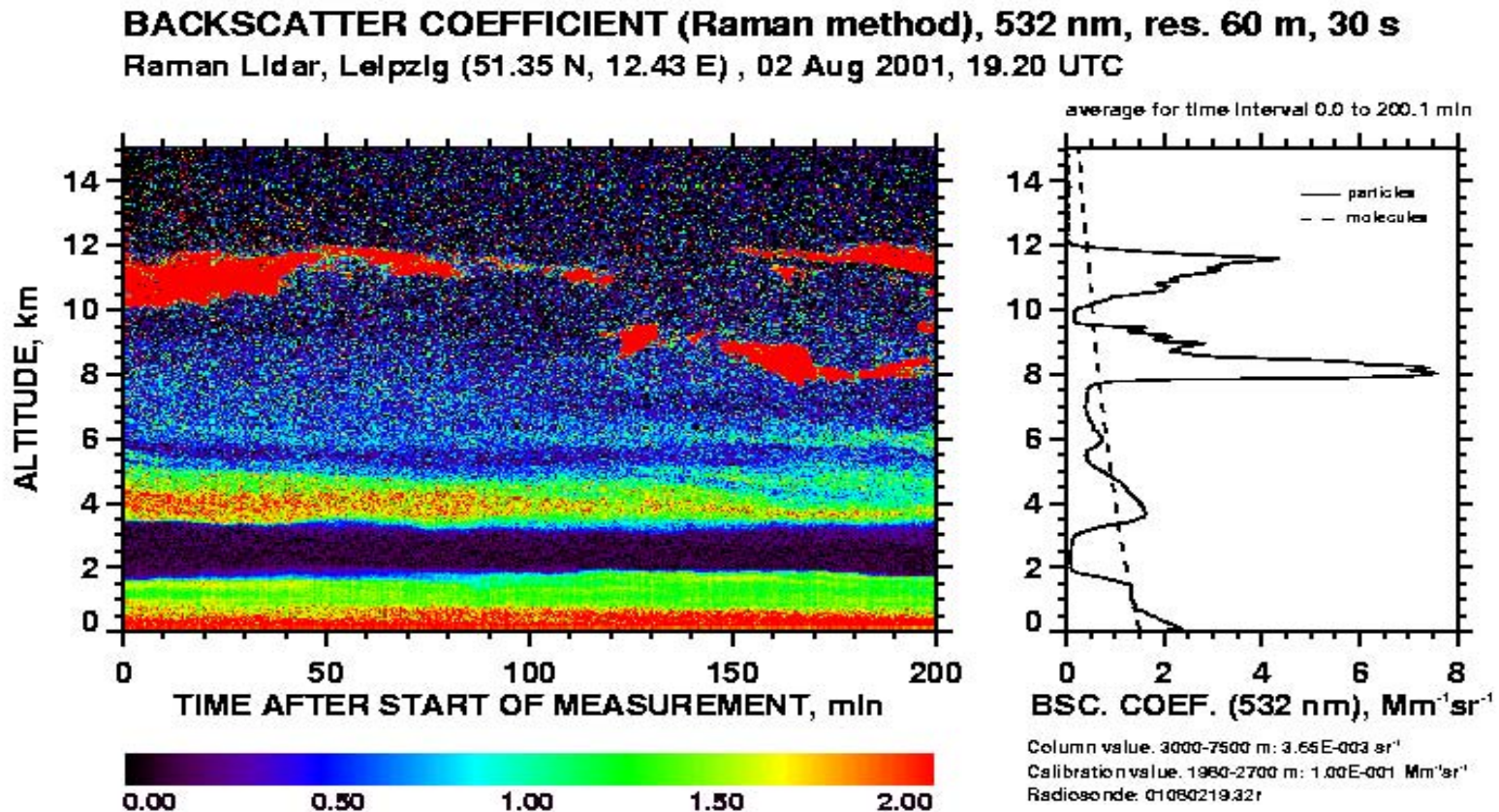
Intense Case

SAHARAN DUST EVENT (02-10.08.01)

METEO SPAIN 030801 12UT

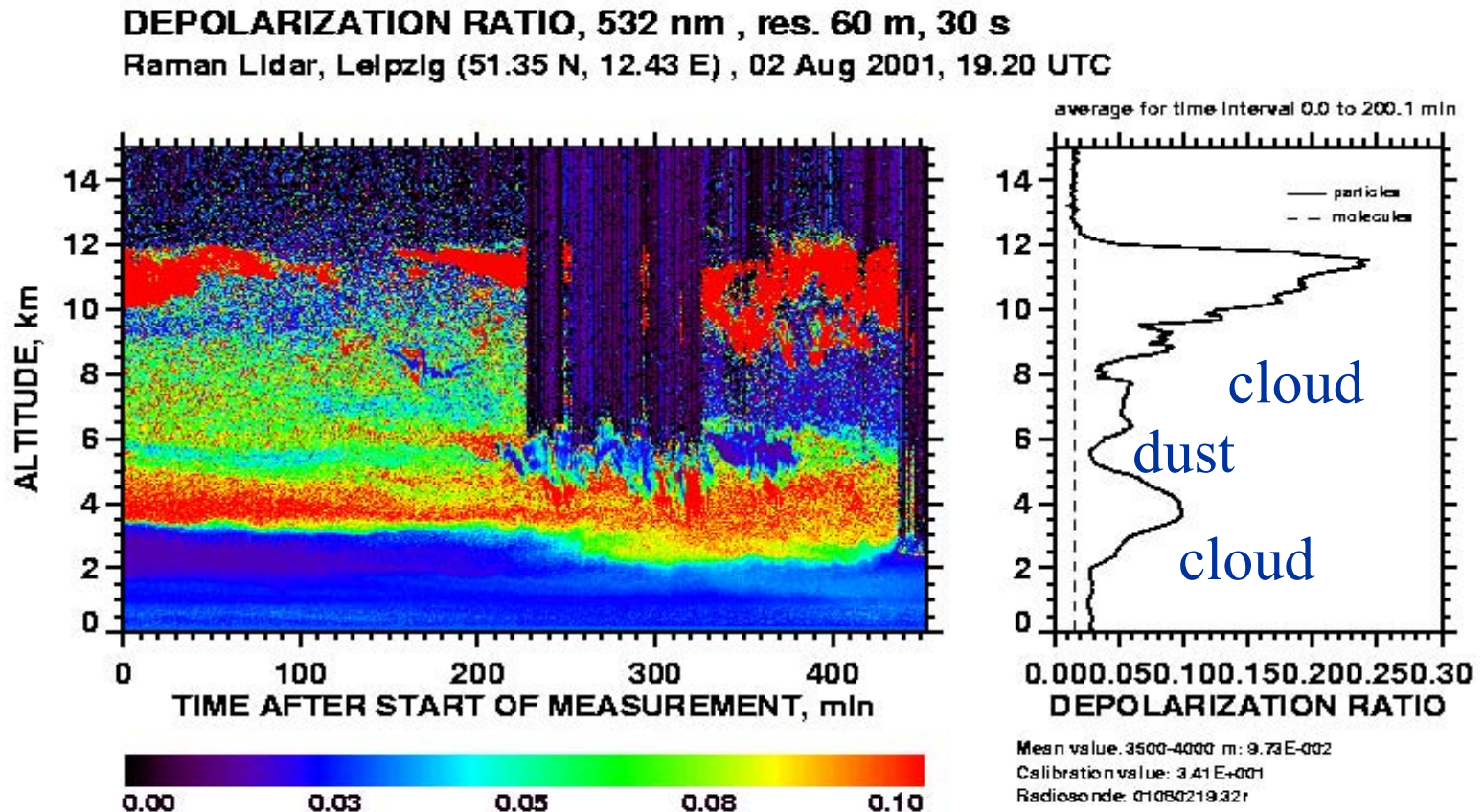


SAHARAN DUST EVENT (02-10.08.01)



Mattis et al., *Geophys. Res. Lett.*, **29**, No 9, 10.1029/2002GL014721, 2002.

SAHARAN DUST EVENT (02-10.08.01)

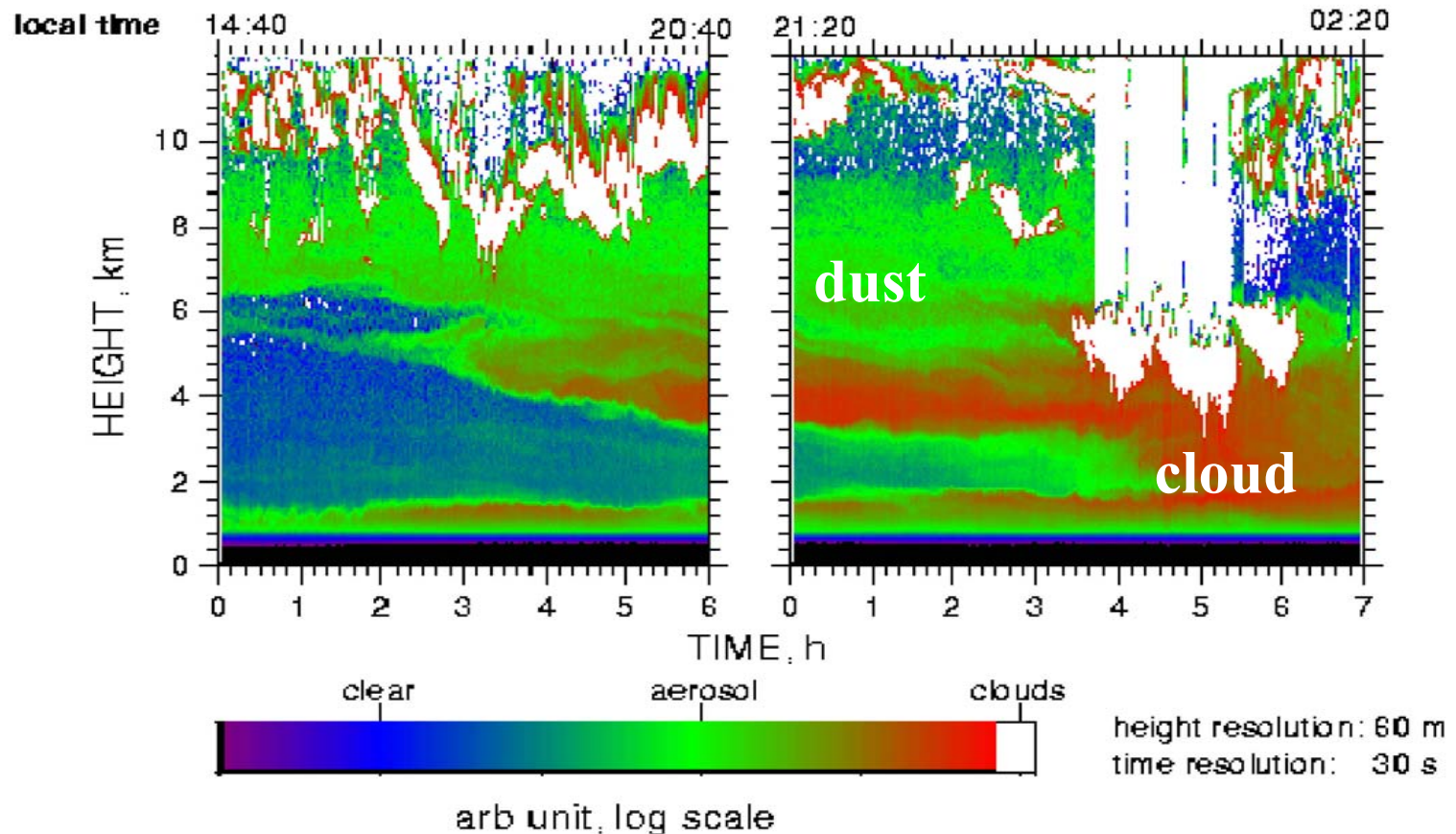


Mattis et al., *Geophys. Res. Lett.*, **29**, No 9, 10.1029/2002GL014721, 2002.

SAHARAN DUST EVENT (02-10.08.01)

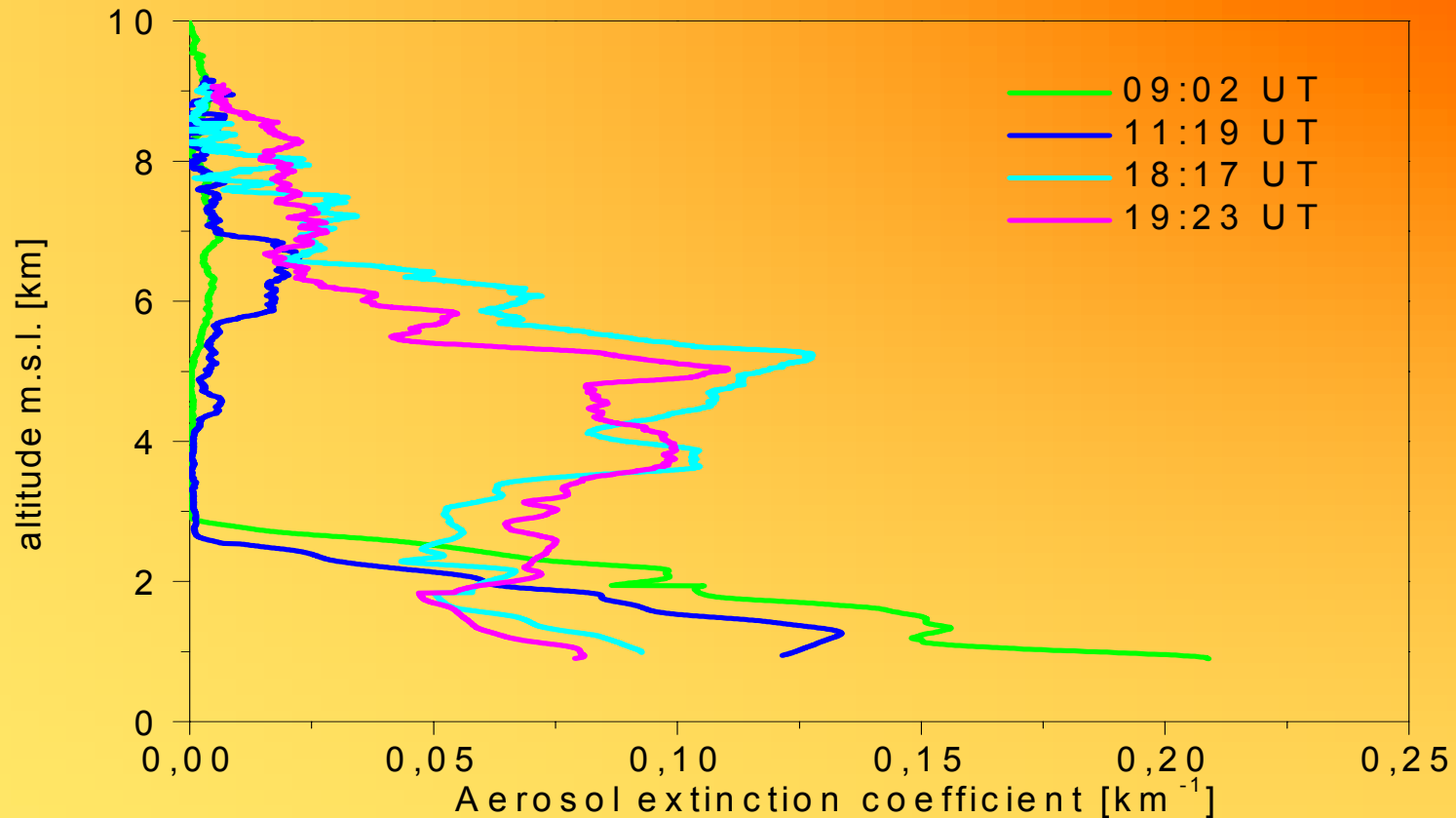
EARLINET special events: A Saharan dust episode

Range-corrected backscatter signal at 1064 nm Leipzig, 2nd and 3th August 2001



SAHARAN DUST EVENT (02-10.08.01)

Aerosol extinction coefficients at 532 nm - Saharan dust period 02.08.2001
Scanning aerosol lidar - Meteorological Institute University Munich



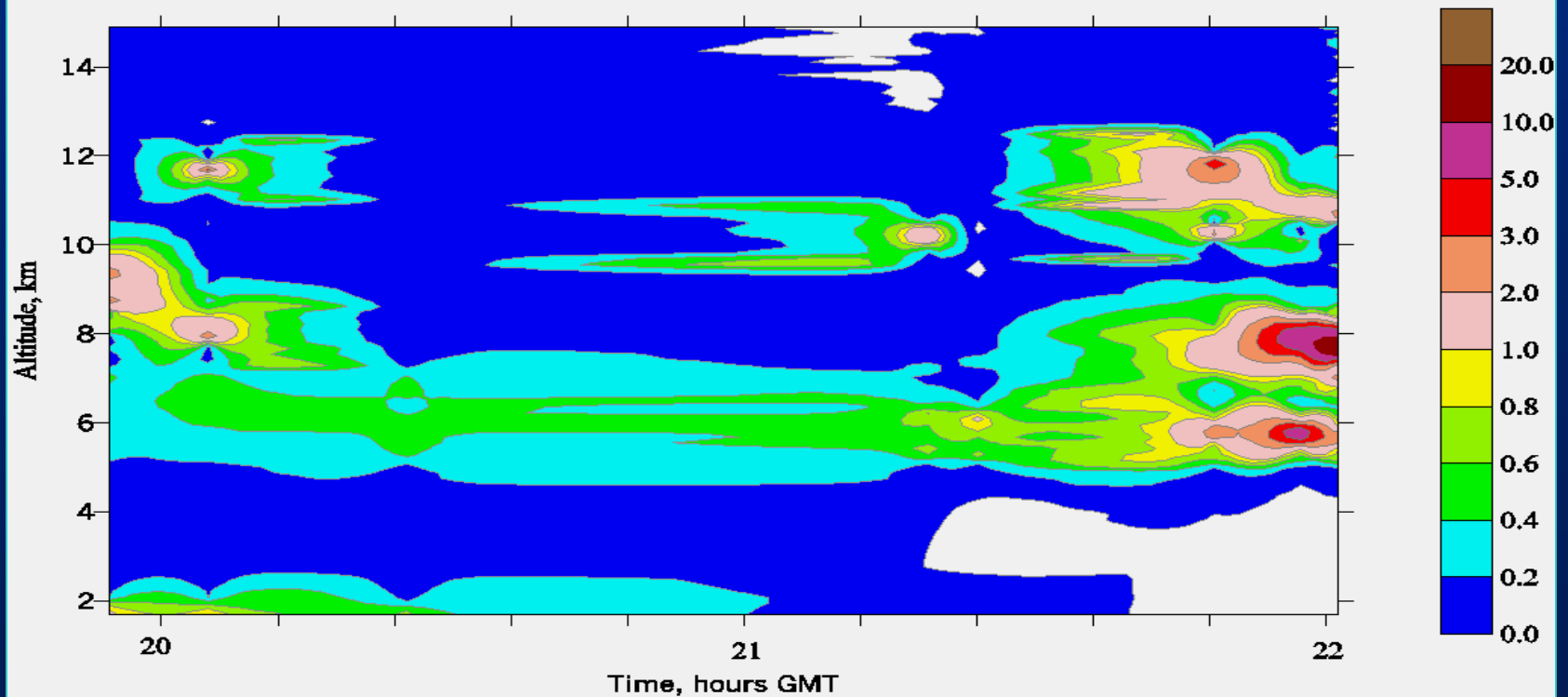
SAHARAN DUST EVENT (02-10.08.01)

Temporal transformation of aerosol optical parameters

03 August, 2001

Minsk, BELARUS, 53.85 N, 27.5 E

Backscatter coefficient, 532 nm

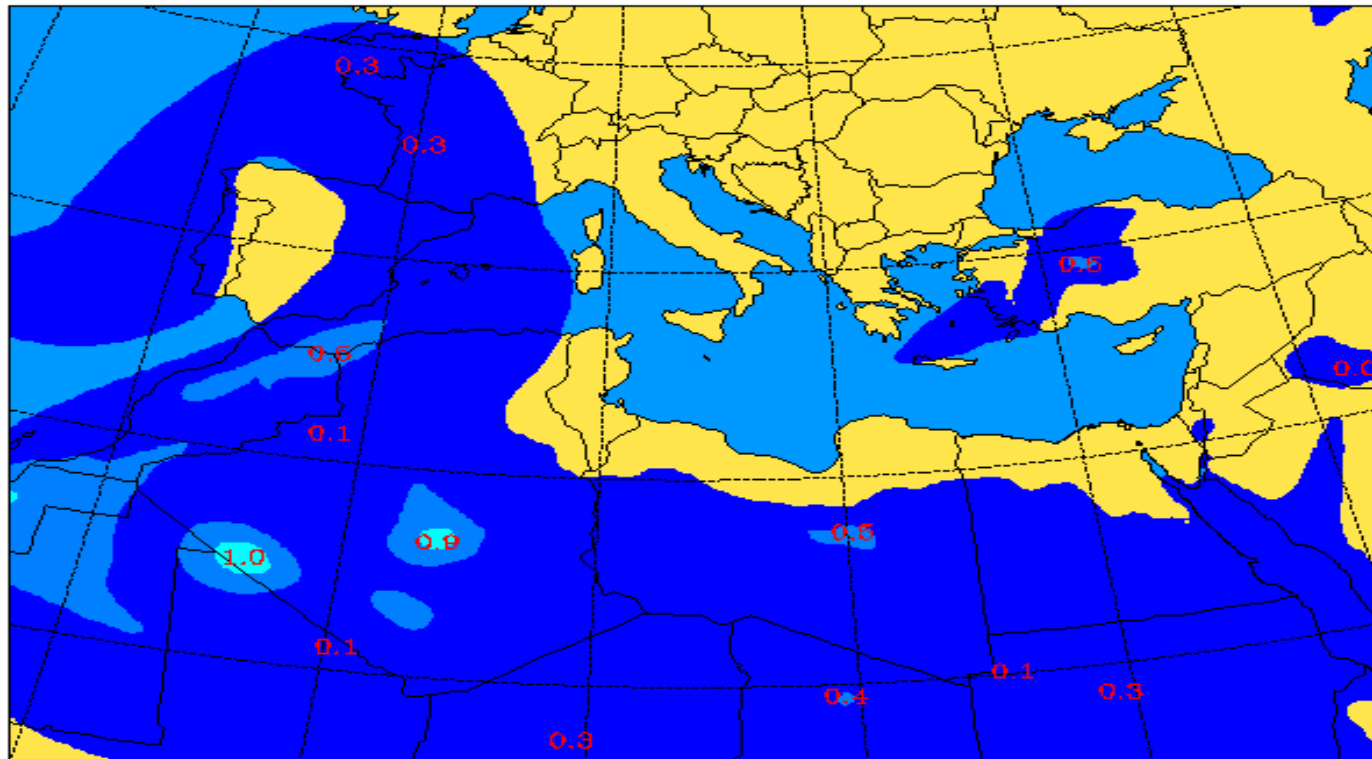


SAHARAN DUST EVENT (02-10.08.01)

University of Athens (AM&WFG)

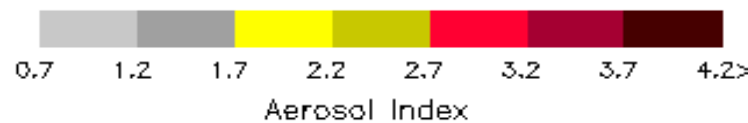
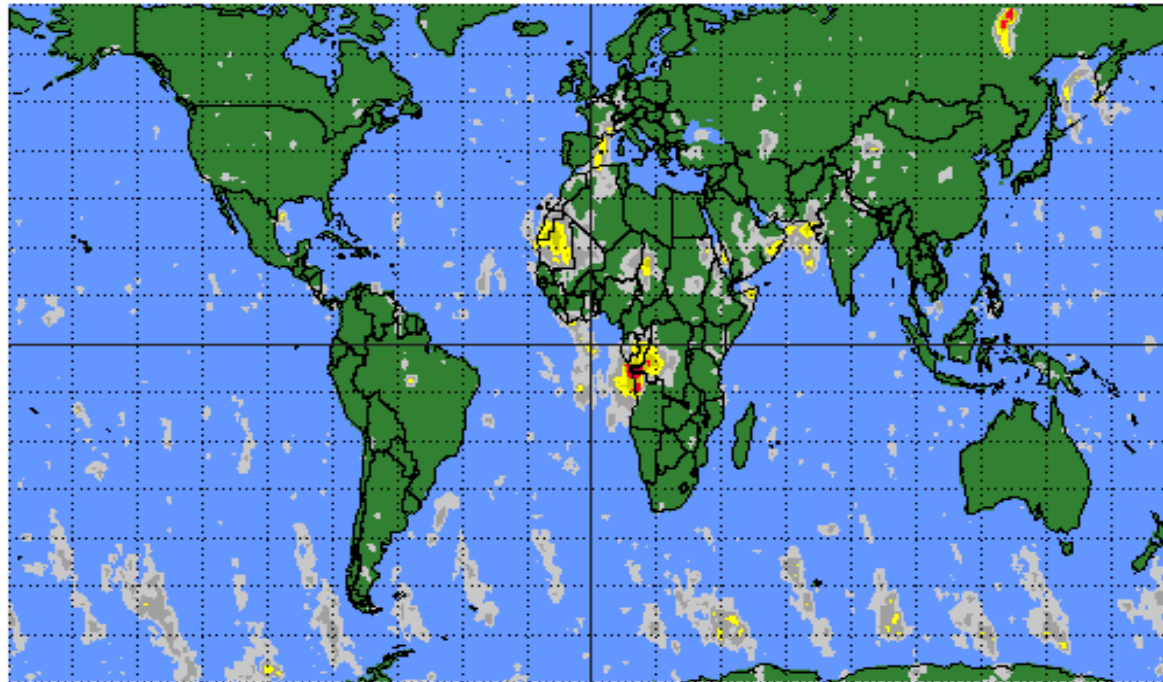
SKIRON Forecast

Dust Load (gr/m^2) 02.08.01 at 00 UTC



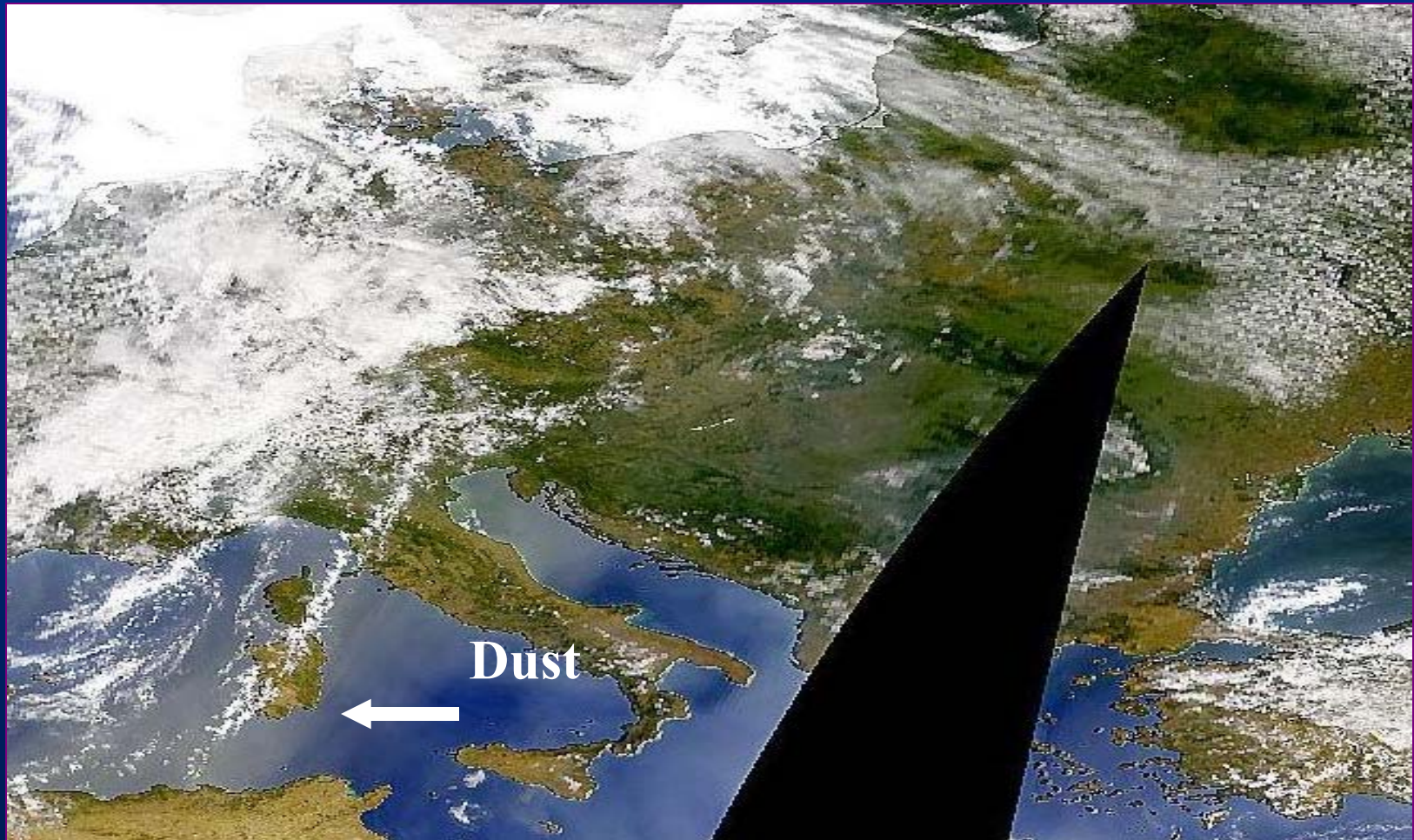
SAHARAN DUST EVENT (02-10.08.01)

Earth Probe TOMS Aerosol Index
on August 02, 2001

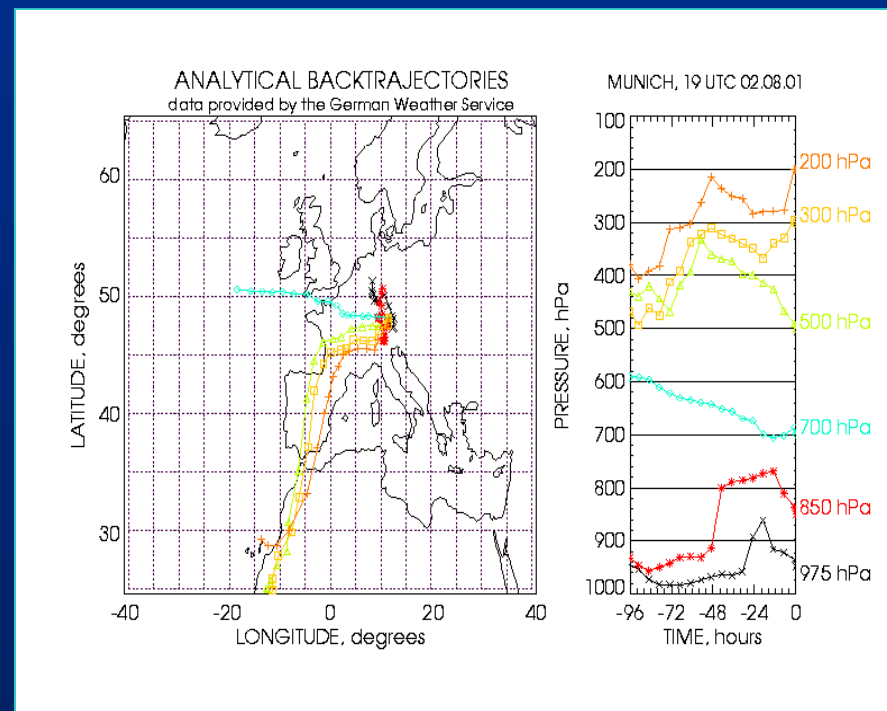
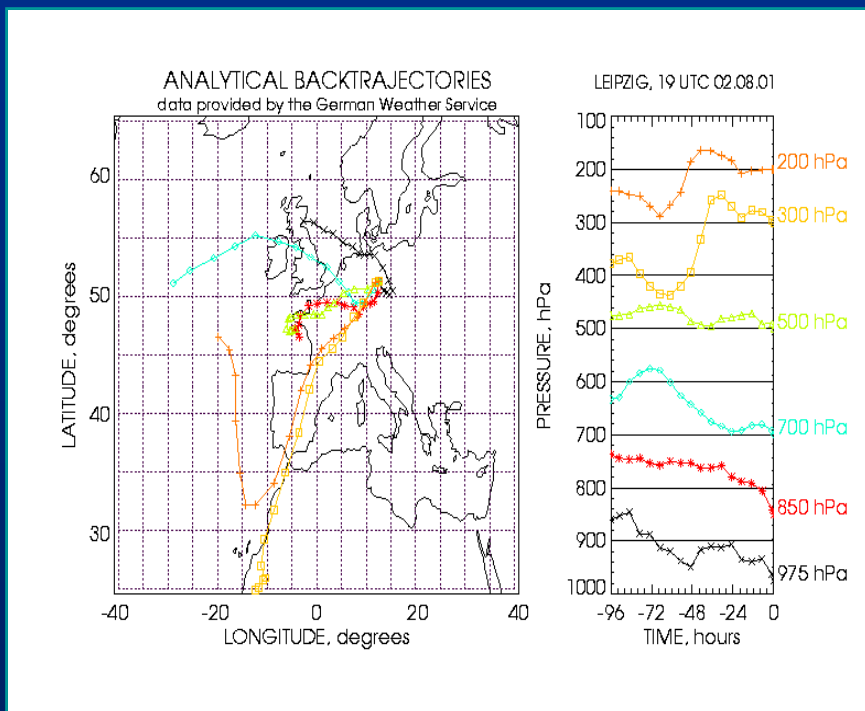


Goddard Space
Flight Center

SAHARAN DUST EVENT (02-10.08.01)



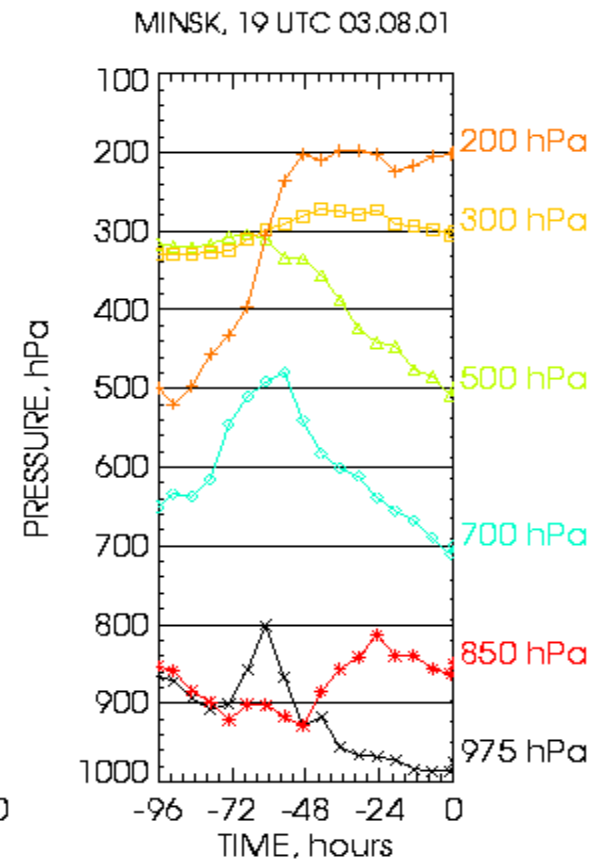
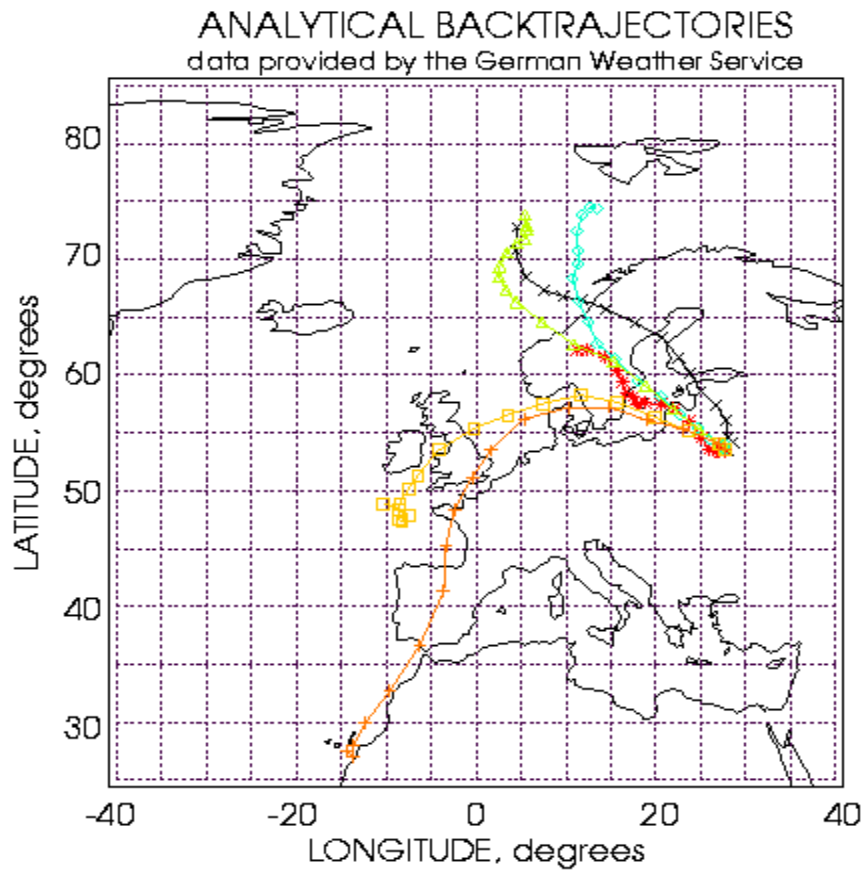
SAHARAN DUST EVENT (02-10.08.01)



Leipzig, 19UT, 020801

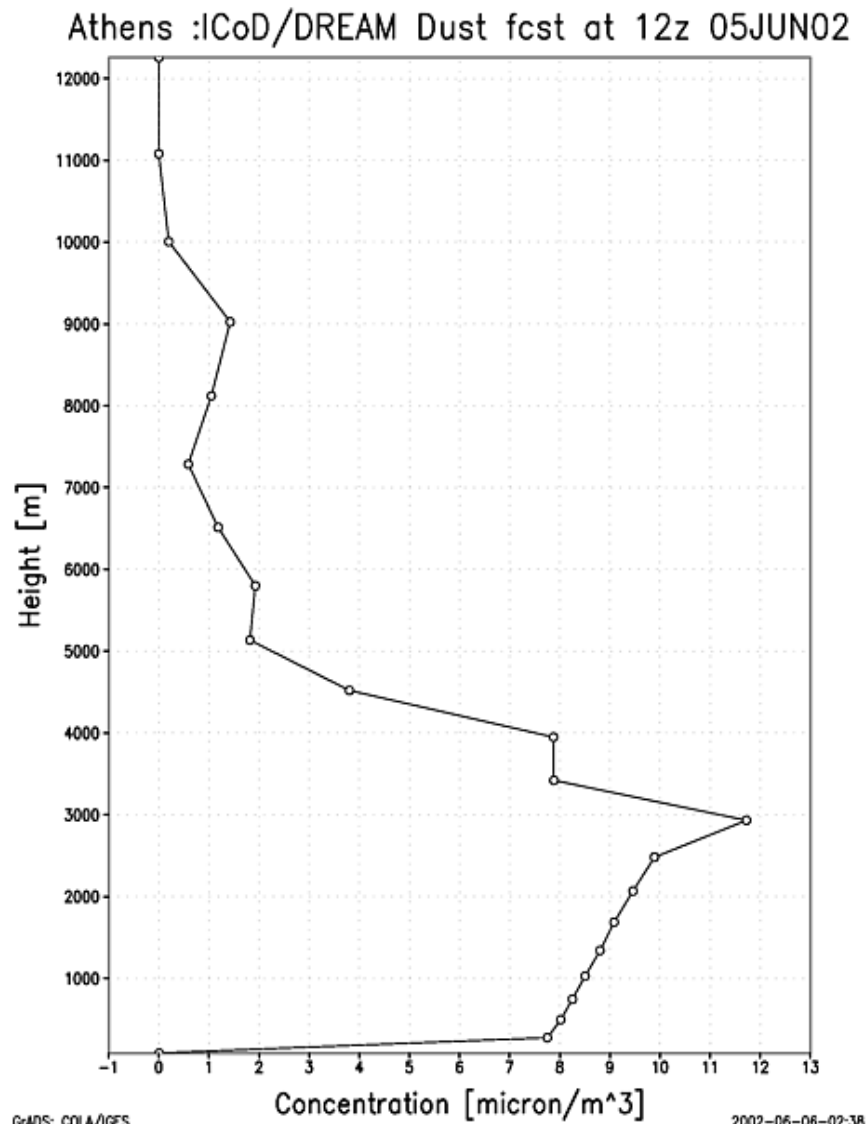
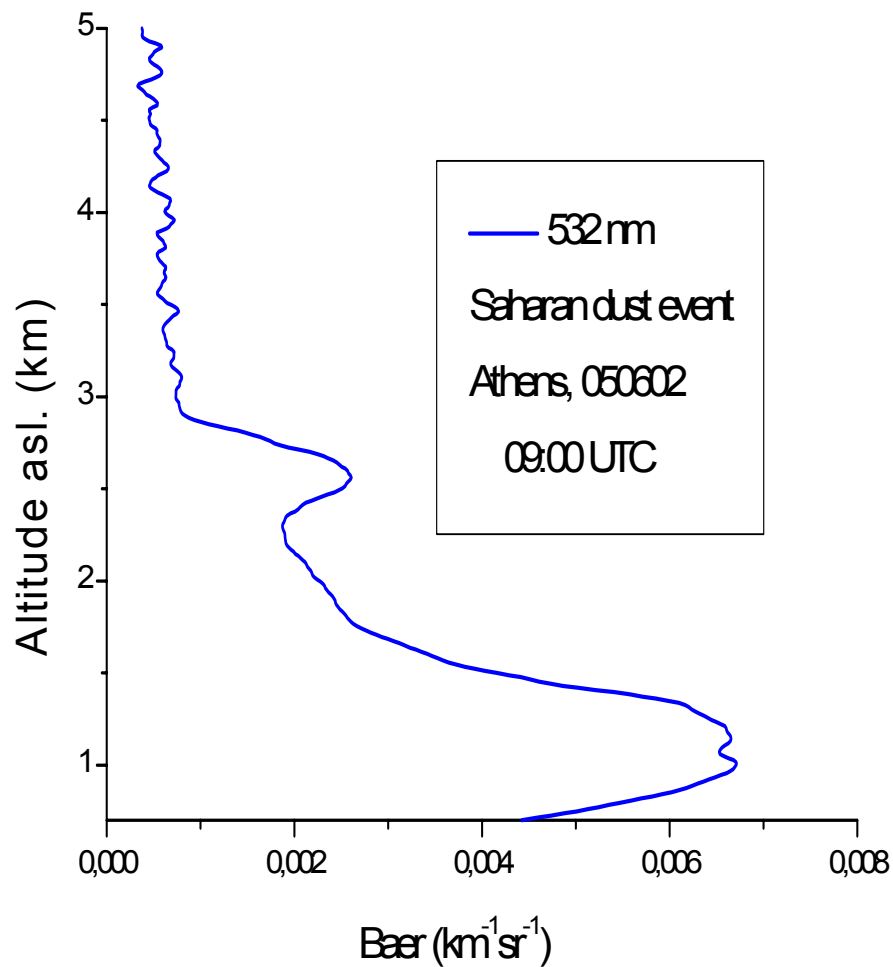
Munich, 19UT, 020801

SAHARAN DUST EVENT (02-10.08.01)



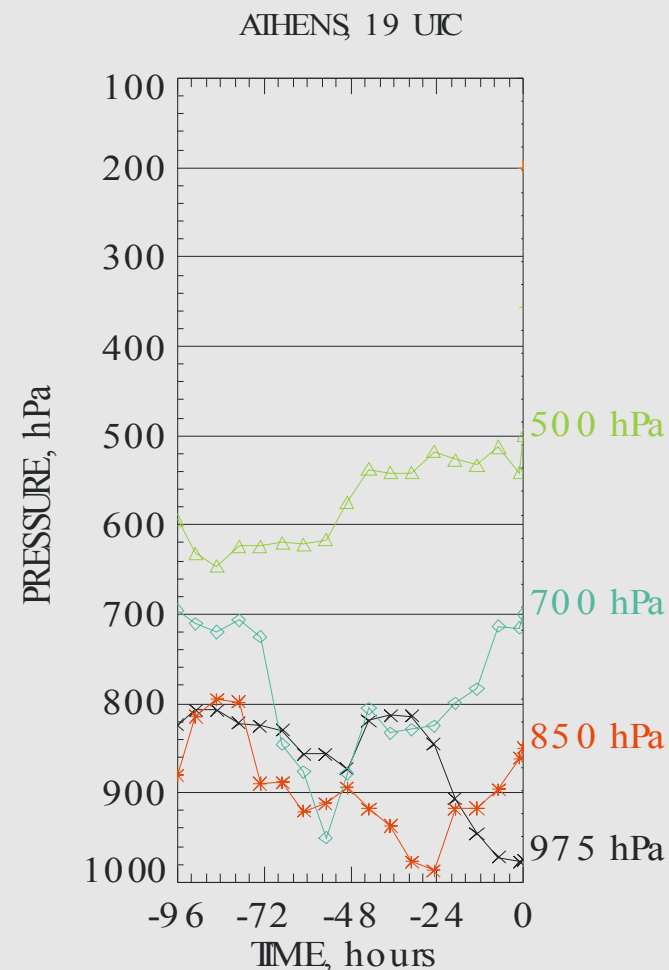
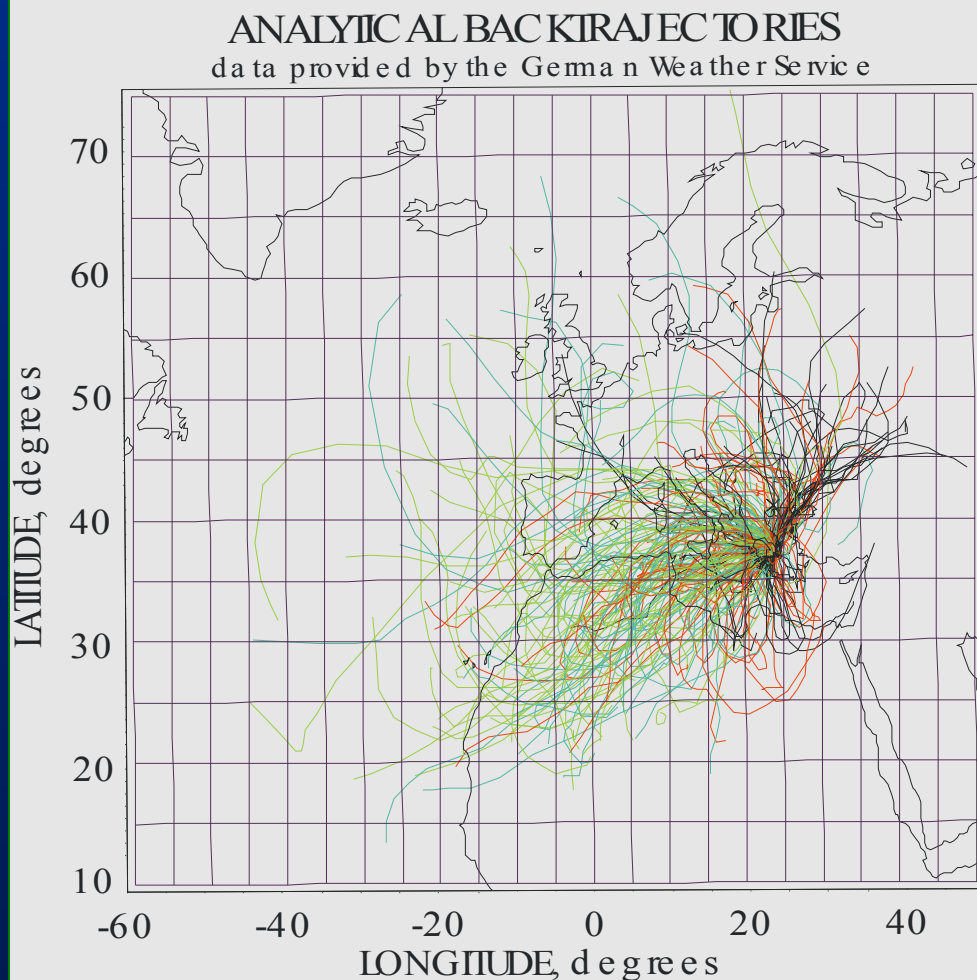
DREAM Model – LIDAR inter-comparison

Athens, 050602

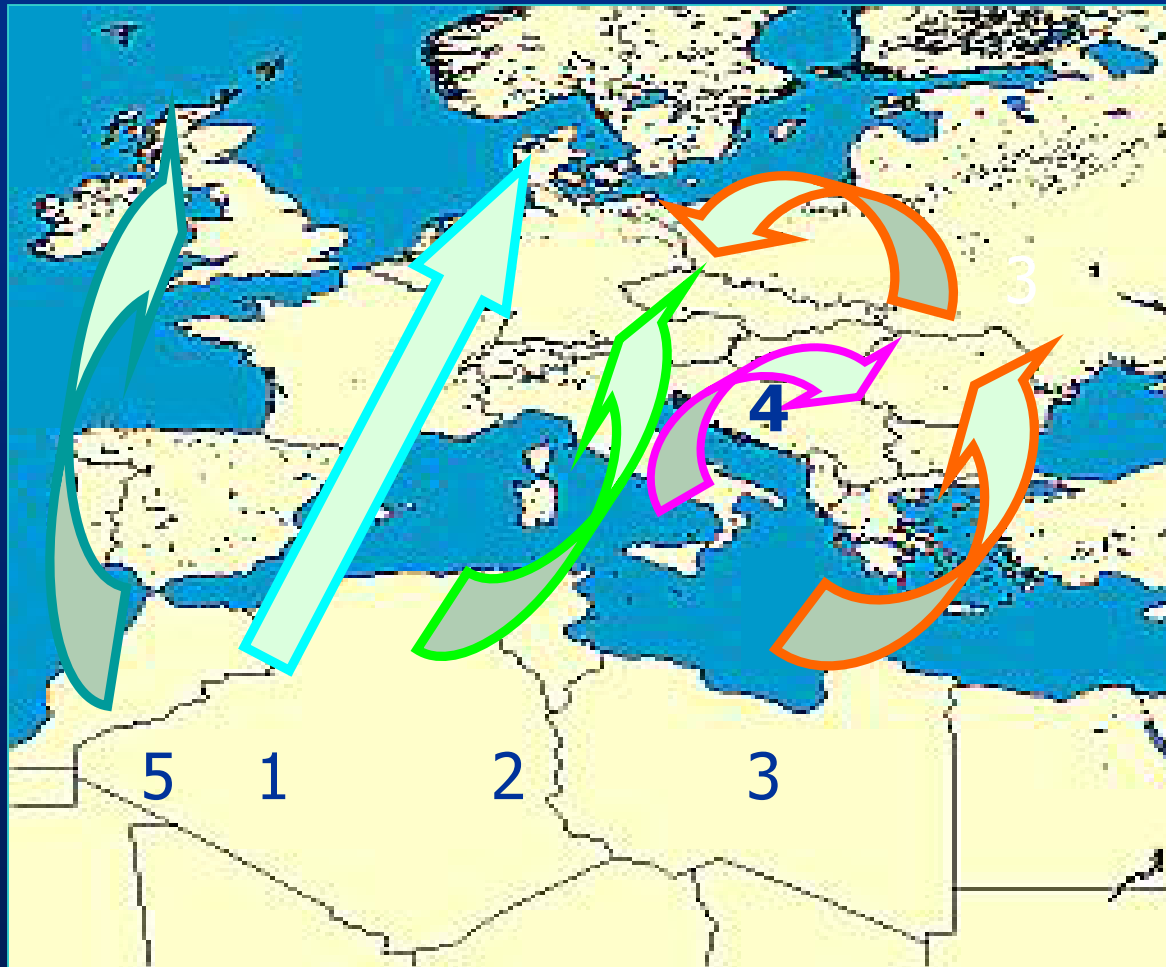


Pathways of Saharan Dust Transport to Athens

Years 2000, 2001, 2002 (67 days)



Possible Pathways of Saharan Dust Transport over Europe

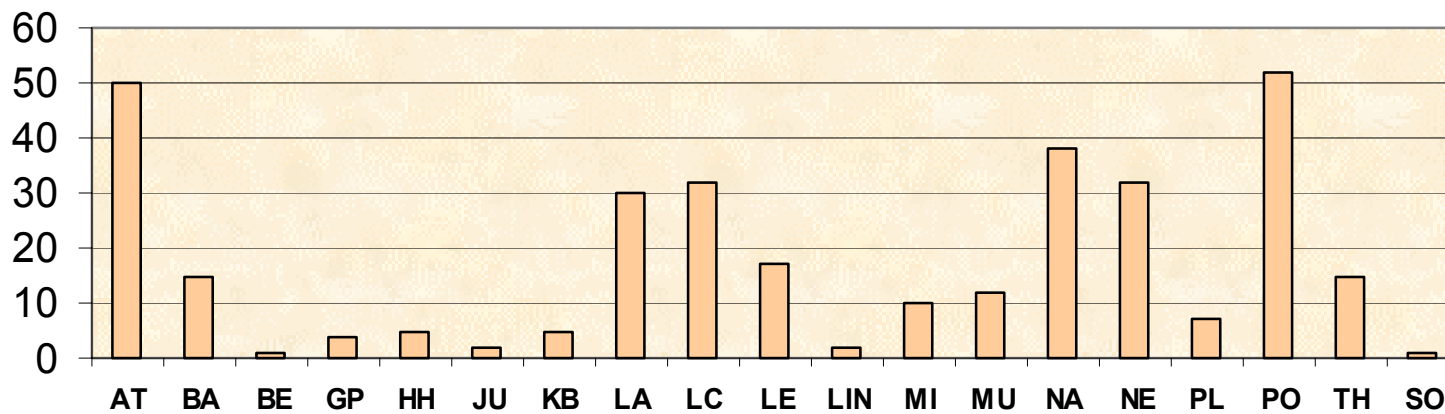


- 1: ~20 %
- 2: ~ 35 %
- 3: ~ 30 %
- 4: ~ 5 %
- 5: ~ 10 %

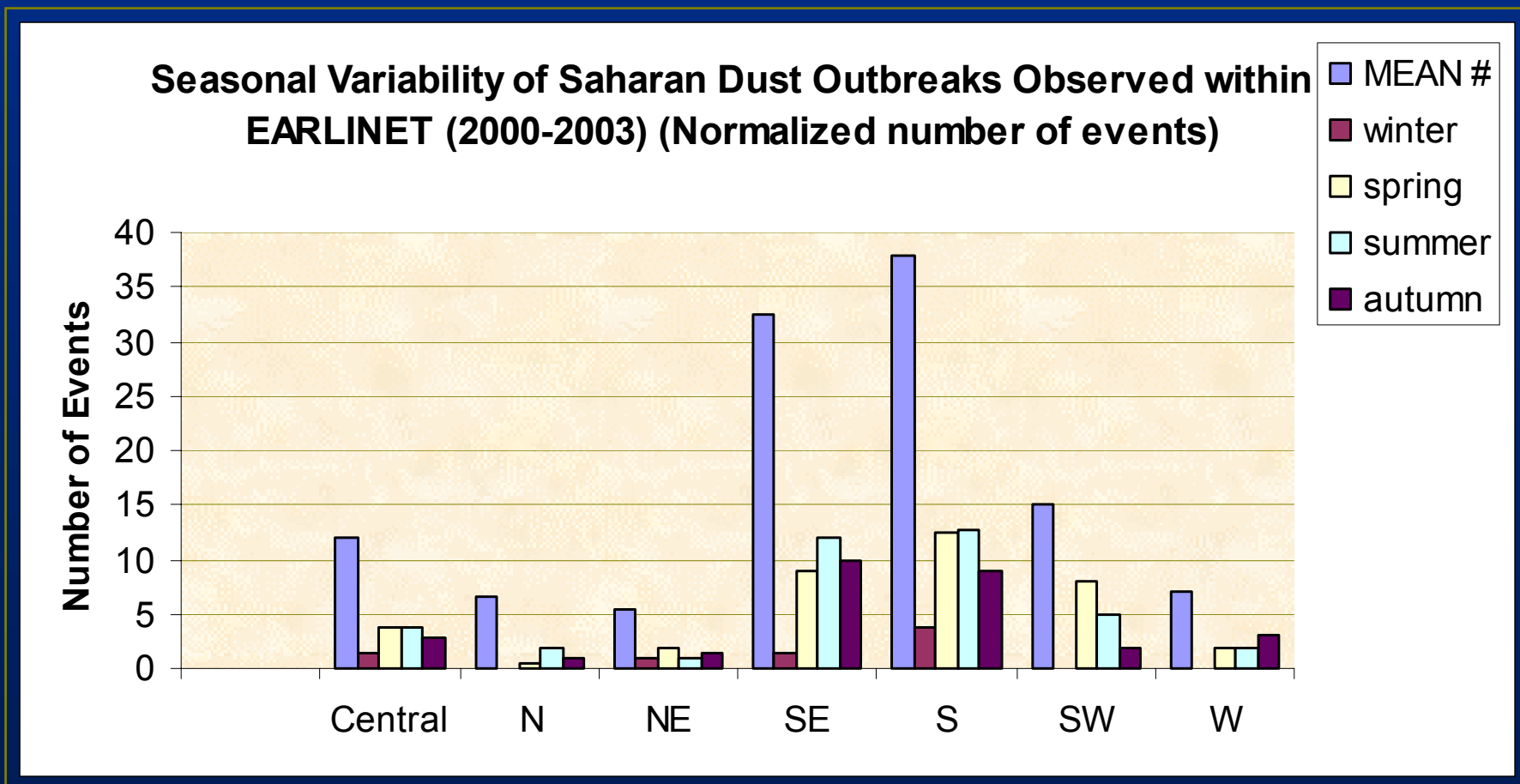
Saharan dust outbreaks observed per EARLINET station

Number of Saharan Dust Outbreaks Observed per EARLINET Station (2000 - 2003)

EVENTS



Seasonal Variability of Saharan dust outbreaks



Conclusions

- **Dust layer thickness (0.2-2.5 km), Dust layer height (1.5-6 km asl.)**
- **Dust Aerosols can penetrate deeply up to central Europe (up to 8-10 km height asl., where may co-exist with clouds)**
- **Transport time (2-5 days)**
- **Aerosol extinction/backscatter (lidar ratio) = 50-90 sr (355-532 nm)**
- **TOMS Aerosol Index (AI) values: 3-3.5 (Mediterranean Region), 1-2.5 (Central Europe)**
- **Max. of Dust Outbreaks: South-South-eastern Europe:**
 - * **Summer, autumn and spring period (S-SE Europe)**
 - * **Spring and summer (SW, central Europe)**

Acknowledgements

- **All EARLINET partners for providing their data**
- **NASA/GSFC (EP/TOMS Aerosol Index data)**
- **NASA/GSFC – ORBIMAGE (SeaWiFS data)**
- **NRL (NAAPS Model)**
- **UOA (SKIRON Model)**
- **German Weather Service-DWD (Air mass back-trajectory analysis)**
- **ENVIRONMENT EU PROGRAMS**

