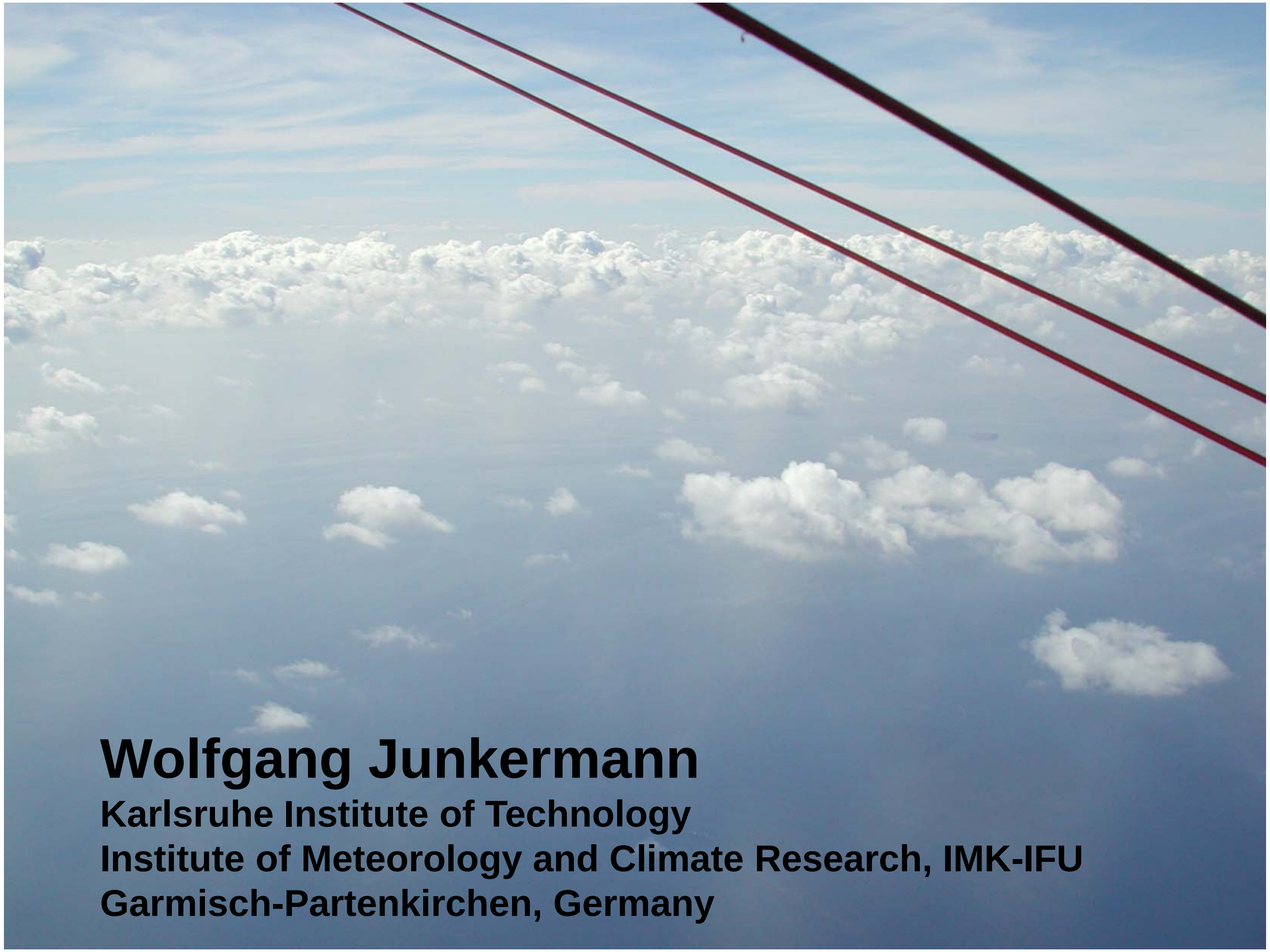
Aerosols over the Mediterranean



Wolfgang Junkermann
Karlsruhe Institute of Technology
Institute of Meteorology and Climate Research, IMK-IFU
Garmisch-Partenkirchen, Germany

Aerosols over the Mediterranean

Karlsruhe Institute of Technology

TYPES
CLIMATE IMPACT
TRENDS

Aerosols over the Mediterranean

Aerosols over the Mediterranean

Aerosols over the Mediterranean

DESERT DUST

Range: up to 2000 ug/m3

Aerosols over the Mediterranean

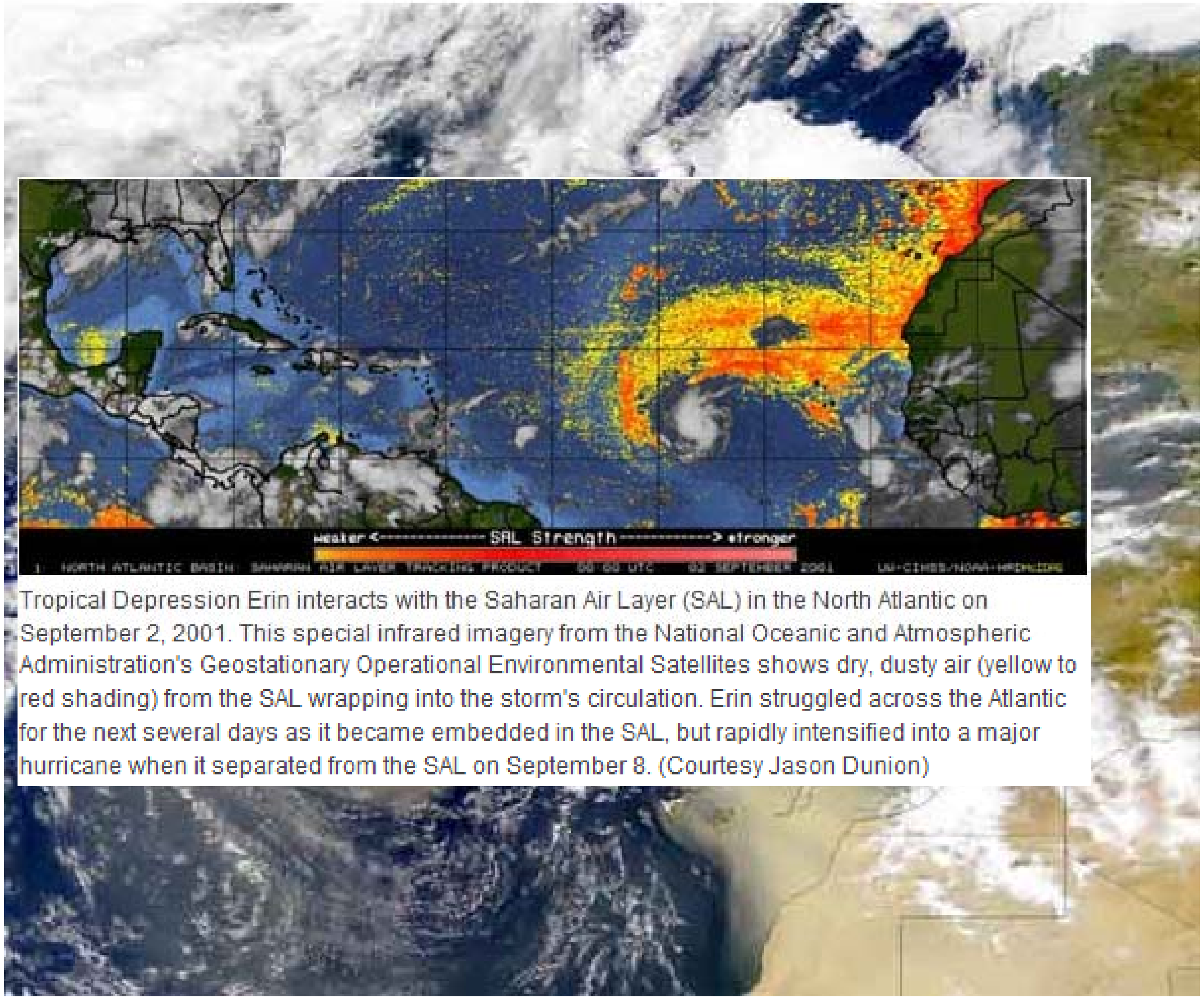
DESERT DUST
Climate impact: affecting shortwave radiation

Aerosols over the Mediterranean

DESERT DUST
Climate impact: affecting shortwave radiation

Less evaporation
Less convective energy

Aerosols over the Mediterranean

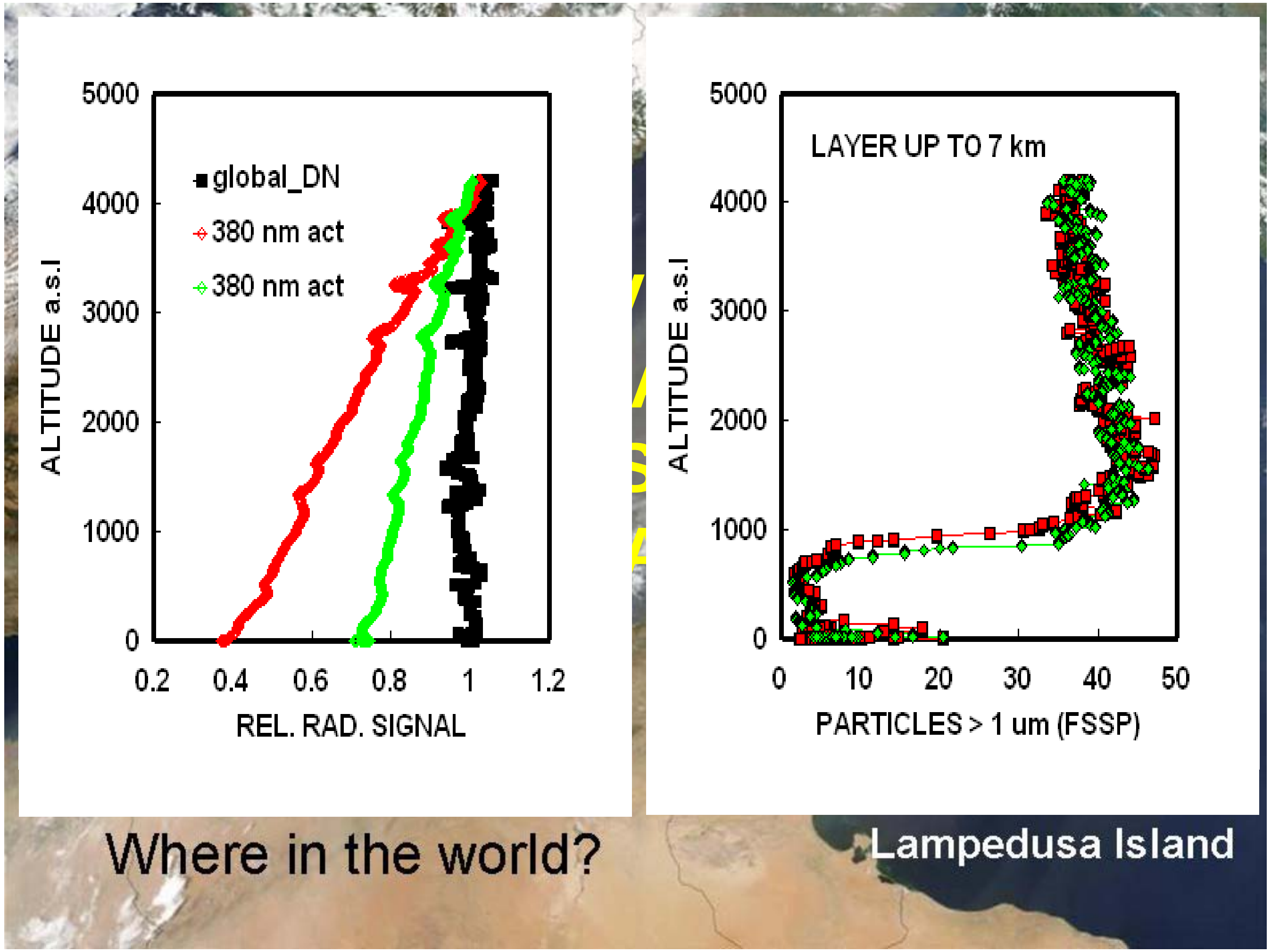


Tropical Depression Erin interacts with the Saharan Air Layer (SAL) in the North Atlantic on September 2, 2001. This special infrared imagery from the National Oceanic and Atmospheric Administration's Geostationary Operational Environmental Satellites shows dry, dusty air (yellow to red shading) from the SAL wrapping into the storm's circulation. Erin struggled across the Atlantic for the next several days as it became embedded in the SAL, but rapidly intensified into a major hurricane when it separated from the SAL on September 8. (Courtesy Jason Dunion)

DESERT DUST
Climate impact: affecting shortwave radiation

Reducing storm activity

Aerosols over the Mediterranean



DESERT DUST
Climate impact: affecting shortwave radiation

DUST LAYER + RADIATION LAMPEDUSA, 14.5.1999

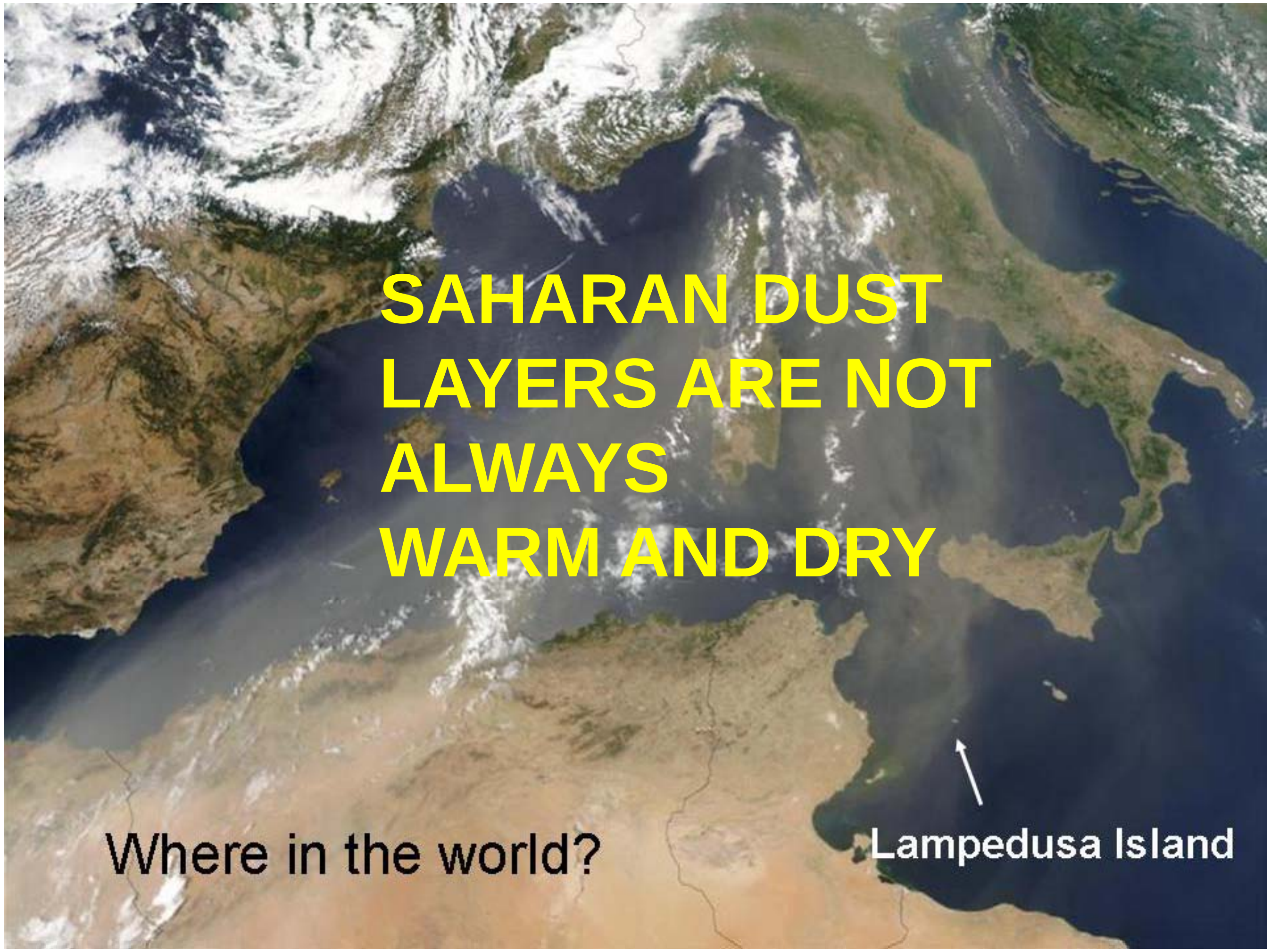
up to 500 cm^{-3}

Aerosols over the Mediterranean

DESERT DUST
Climate impact: affecting shortwave radiation / Clouds

Depending on vertical distrib. of clouds and dust, CCN?

Aerosols over the Mediterranean



DESERT DUST
Climate impact: affecting shortwave radiation

Reducing storm activity

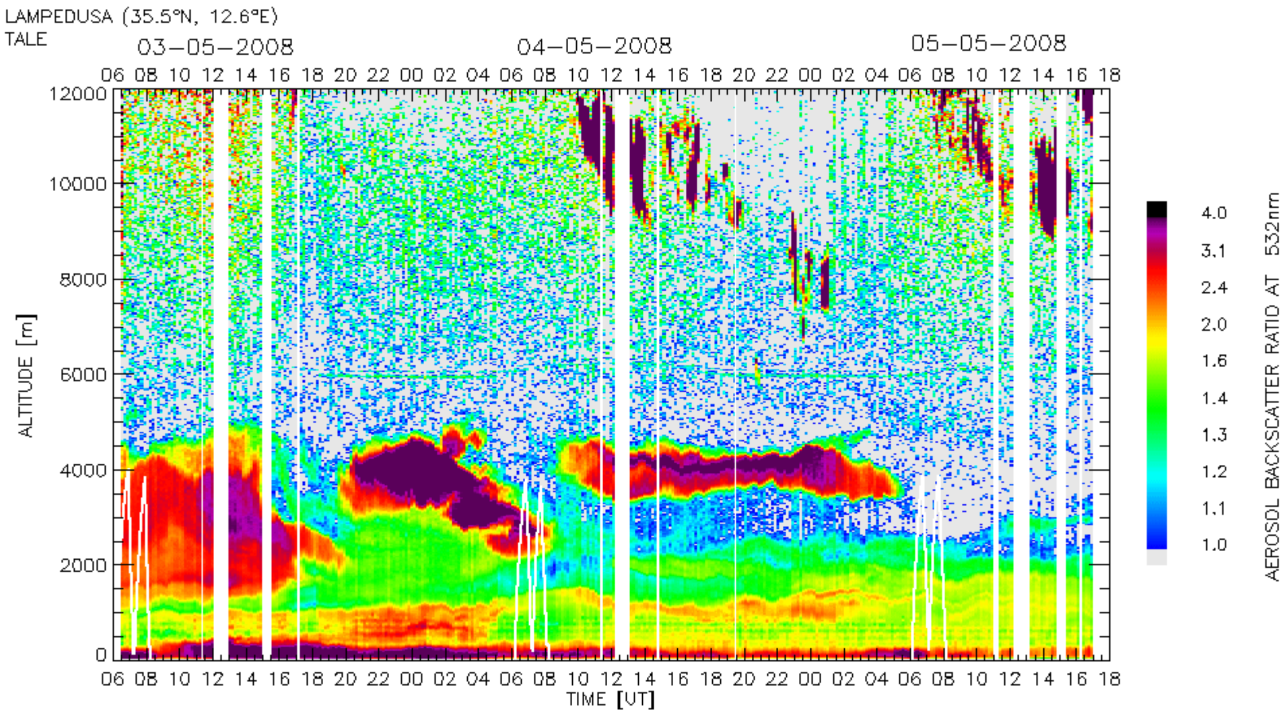
D- MIFU

Microlight aircraft

Ceiling	**4500 m**
Cruise speed	**25 m/sec**
Payload	**80 kg**
Endurance	**> 5 h**

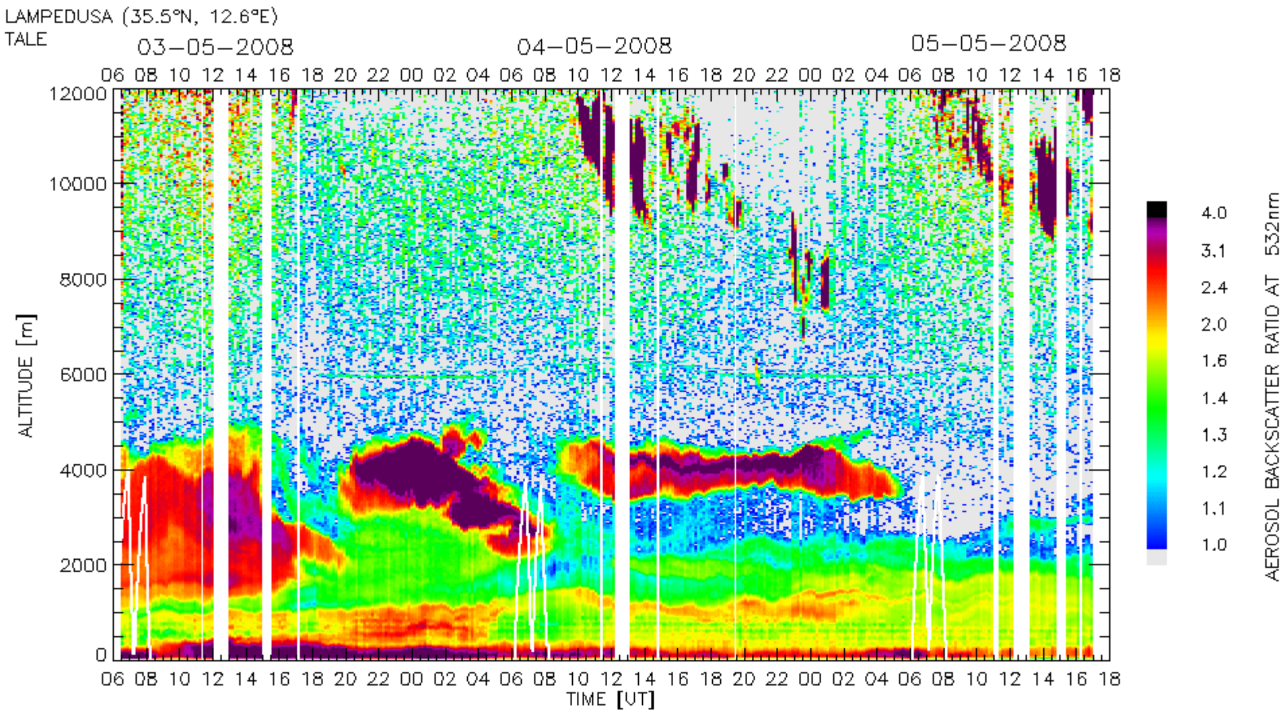
AIRBORNE VERTICAL PROFILE MEASUREMENTS

Aerosols over the Mediterranean



DESERT DUST
Climate impact: affecting <u>longwave</u> radiation

Aerosols over the Mediterranean

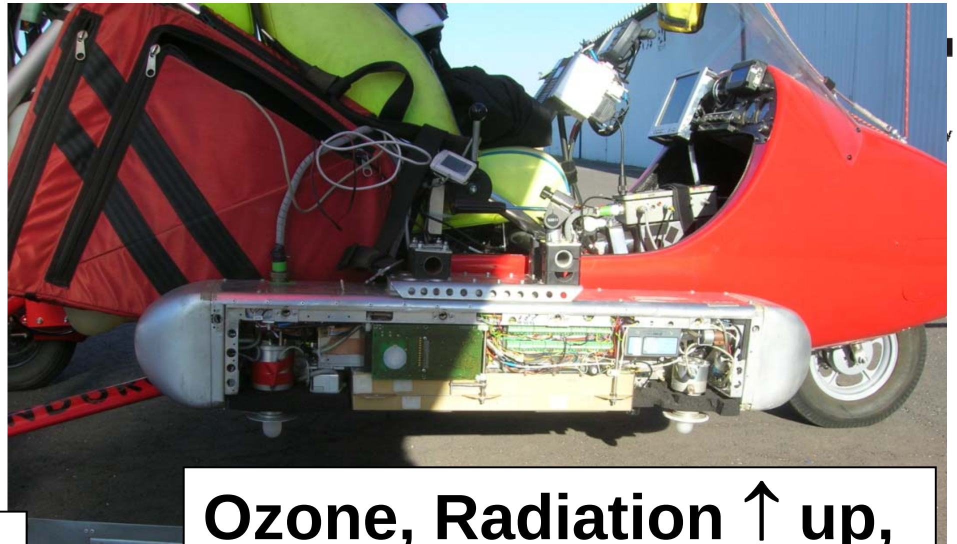


DESERT DUST
Climate impact: affecting <u>longwave</u> radiation

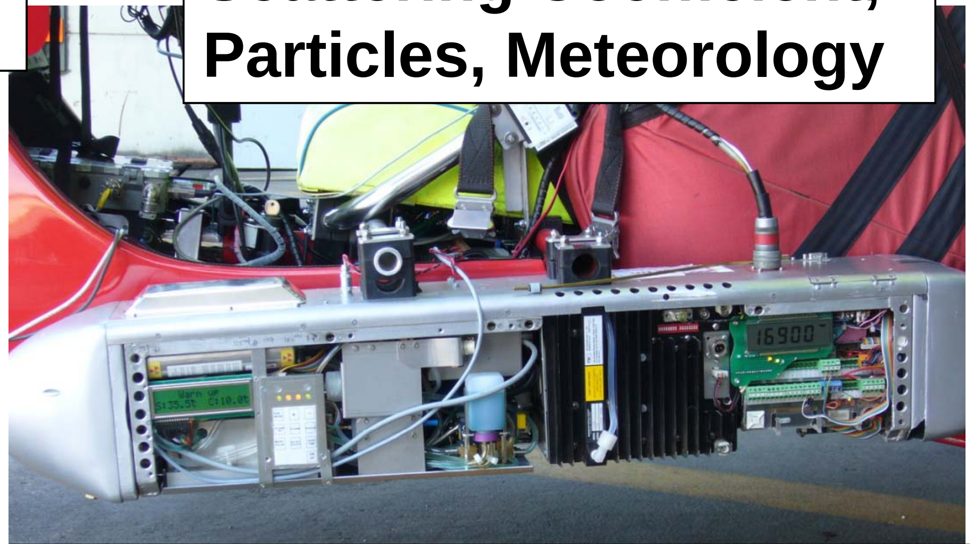
Ozone	UV-Photometer
Act. Rad. 300 nm JO1D	2 Filterradiometers
Act. Rad. 380 nm JNO2	2 Filterradiometers
Global radiation	2 LICOR Pyranometers
Albedo 400, 550, 650, 990 nm	2 four channel irradiance sensors
Spectral Actinic Flux	Spectroradiometer
Infrared	CGR4, Eppley Pyrgeometer
Temperature	Pt 100
Humidity	Chilled mirror
Pressure	
Position	GPS
Wind (horizontal)	GPS/Compass/INS
Surface Temperature	IR sensor
CN / number	TSI 3010
Aerosol / size distr.	OPC, 300 nm – 20 um
Submicron aerosol size distribution (SMPS) 4.5-350 nm	
Scatt. coeff. / visibility	HSS-AVMIII, 870 nm
Absorption coefficient	Magee 7 wavelength Aethalometer
Turbulence, 3D windvector	5 hole noseboom probe
Attitude / Heading	Oxford Tech. INS

Radiation Sensors ↓ dn
180 ° field of view

+ spectral and global irradiance



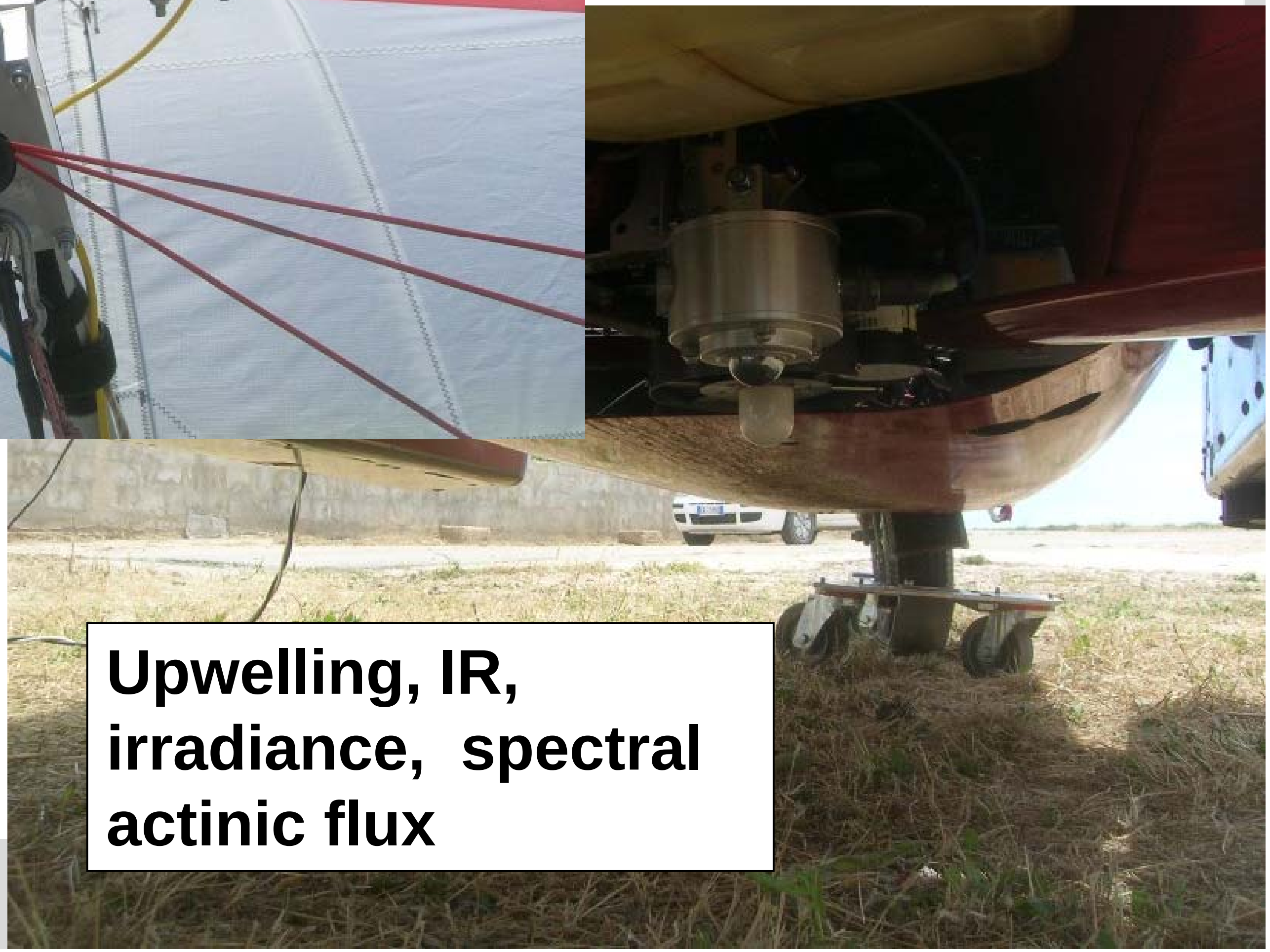
Ozone, Radiation ↑ up, Scattering Coefficient, Particles, Meteorology



Aerosols, fast CPC, Aethalo.
Size distribution 5 nm – 20 um

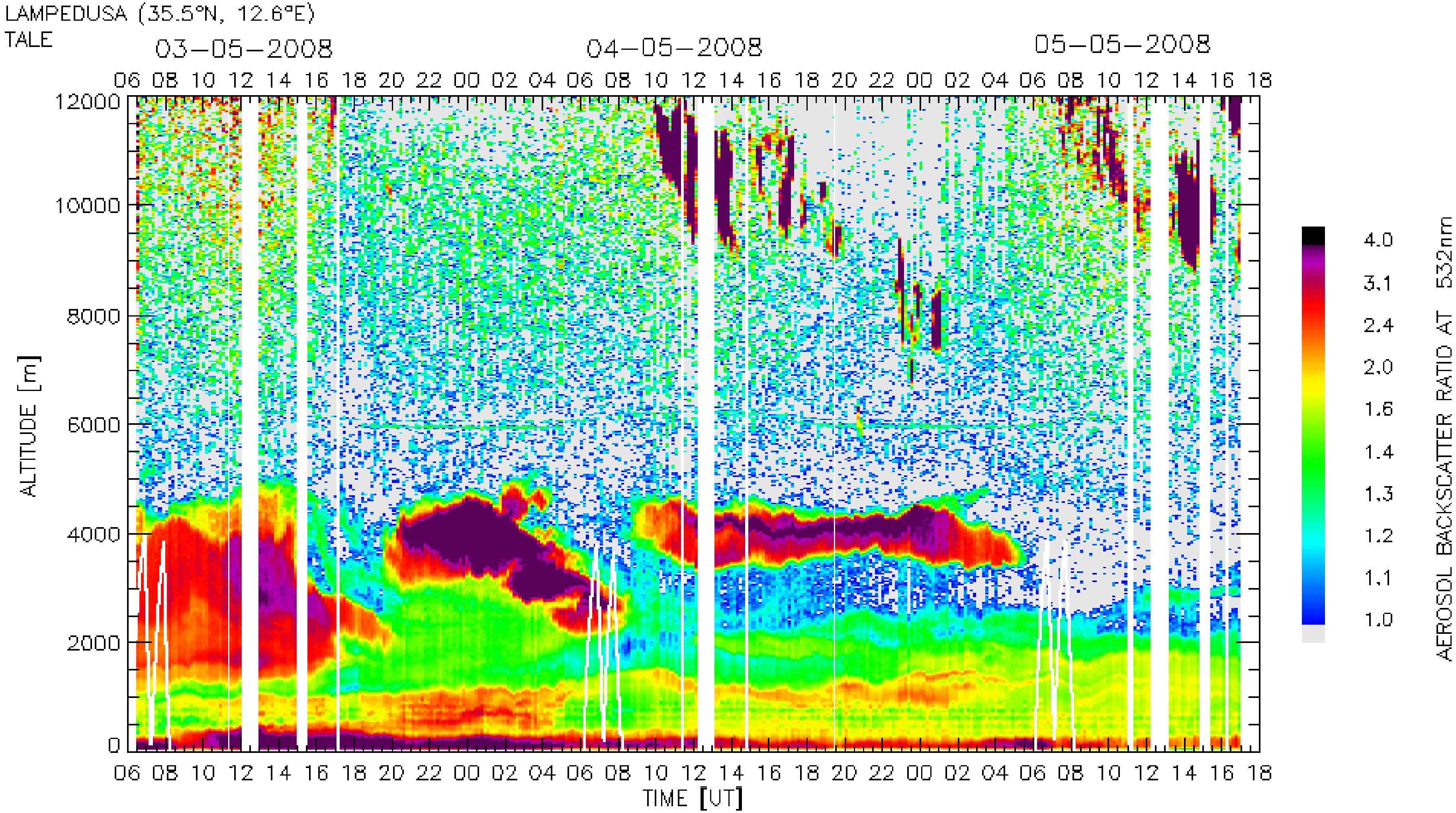
Radiation Sensors for GAMARF installed on gimballed platforms

+- 0.3 degrees

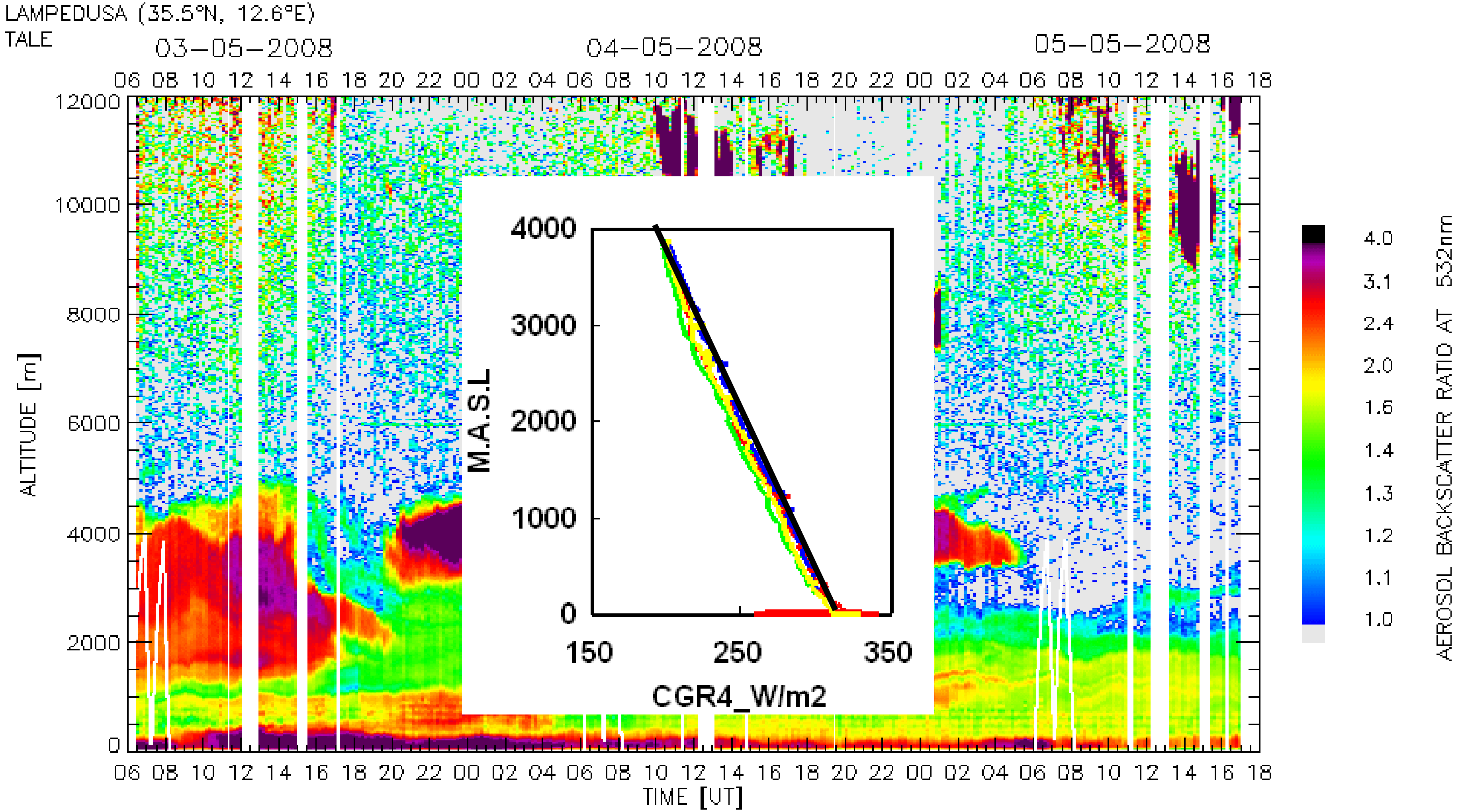


Upwelling, IR, irradiance, spectral actinic flux

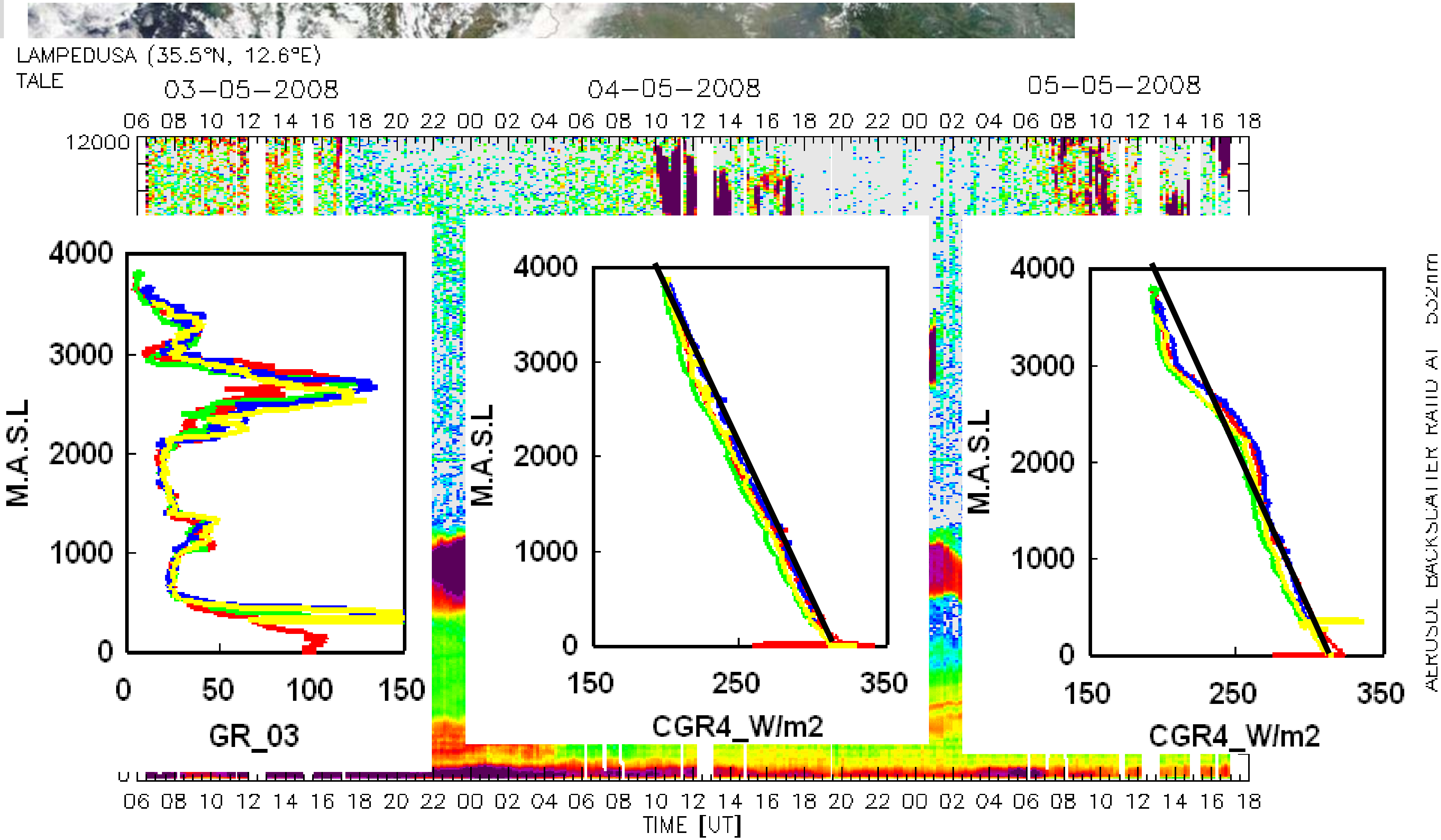
Aerosols over the Mediterranean



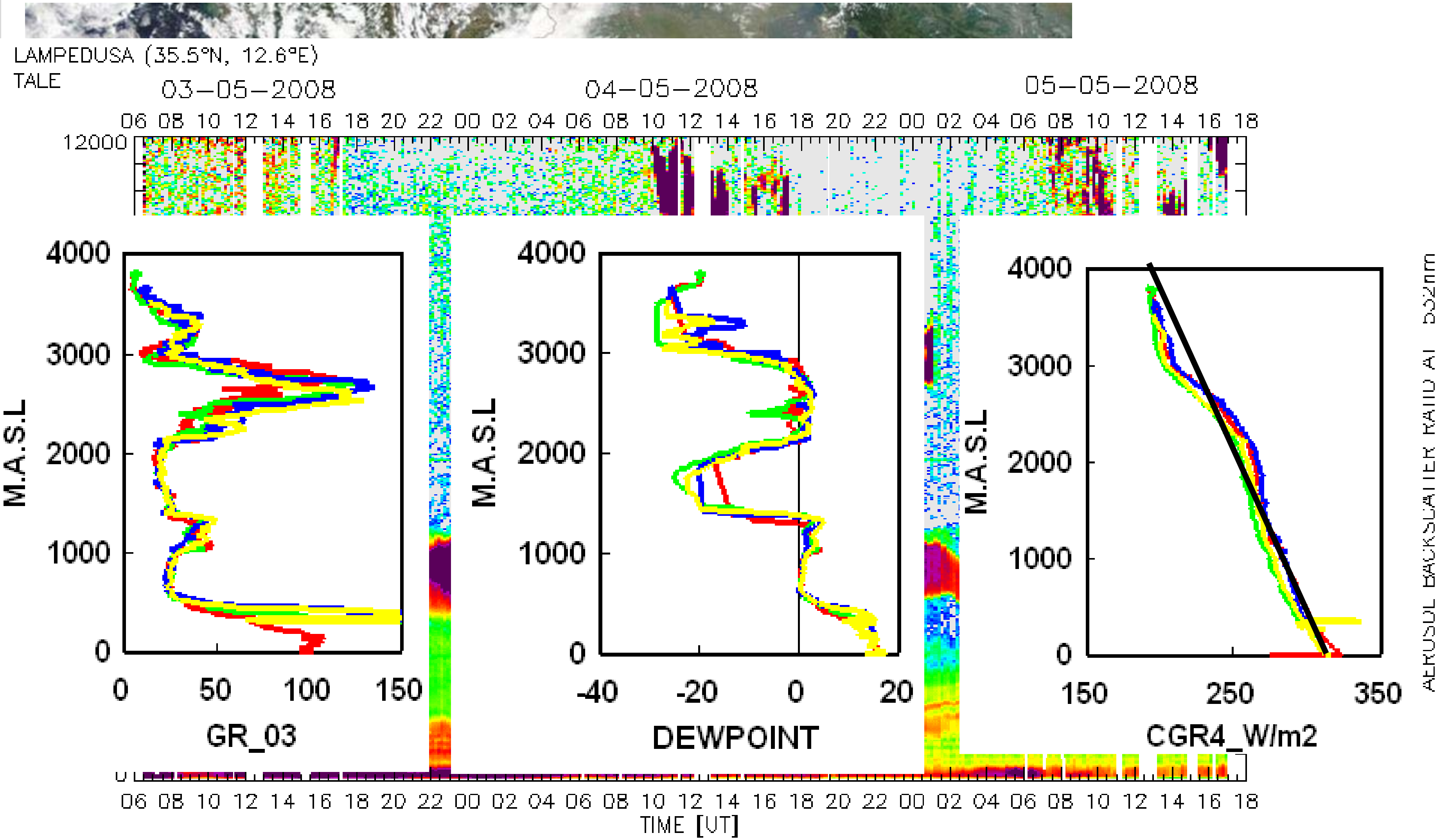
Aerosols over the Mediterranean



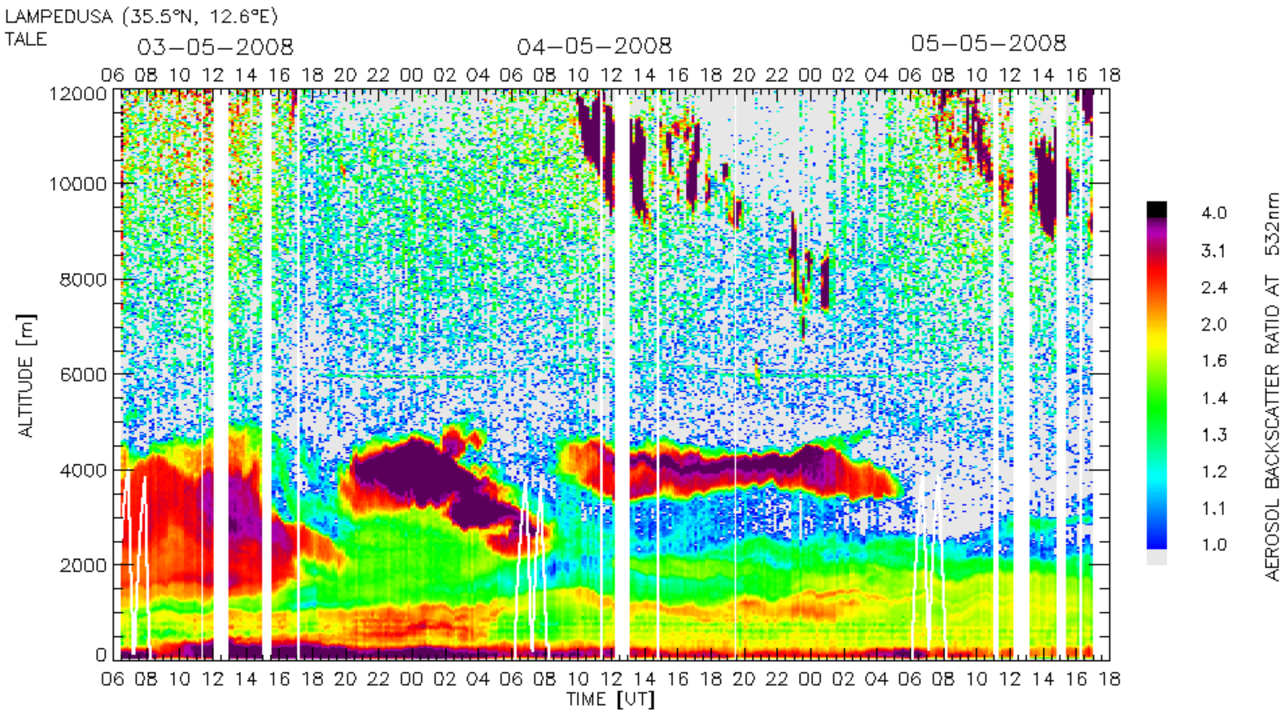
Aerosols over the Mediterranean



Aerosols over the Mediterranean



Aerosols over the Mediterranean

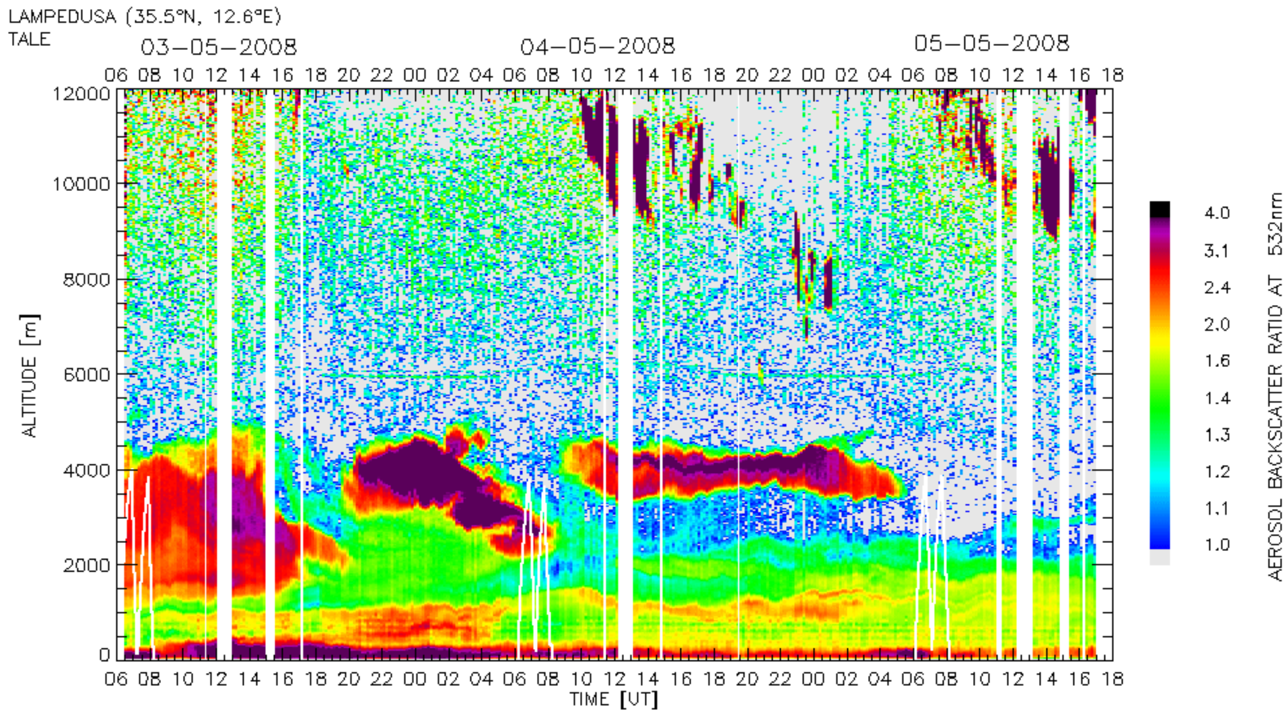


DESERT DUST
Climate impact: affecting <u>longwave</u> radiation

DUST OR WATER VAPOR

Meloni et al, 2014

Aerosols over the Mediterranean



DESERT DUST
Climate impact:
affecting
longwave
radiation

Aerosols over the Mediterranean

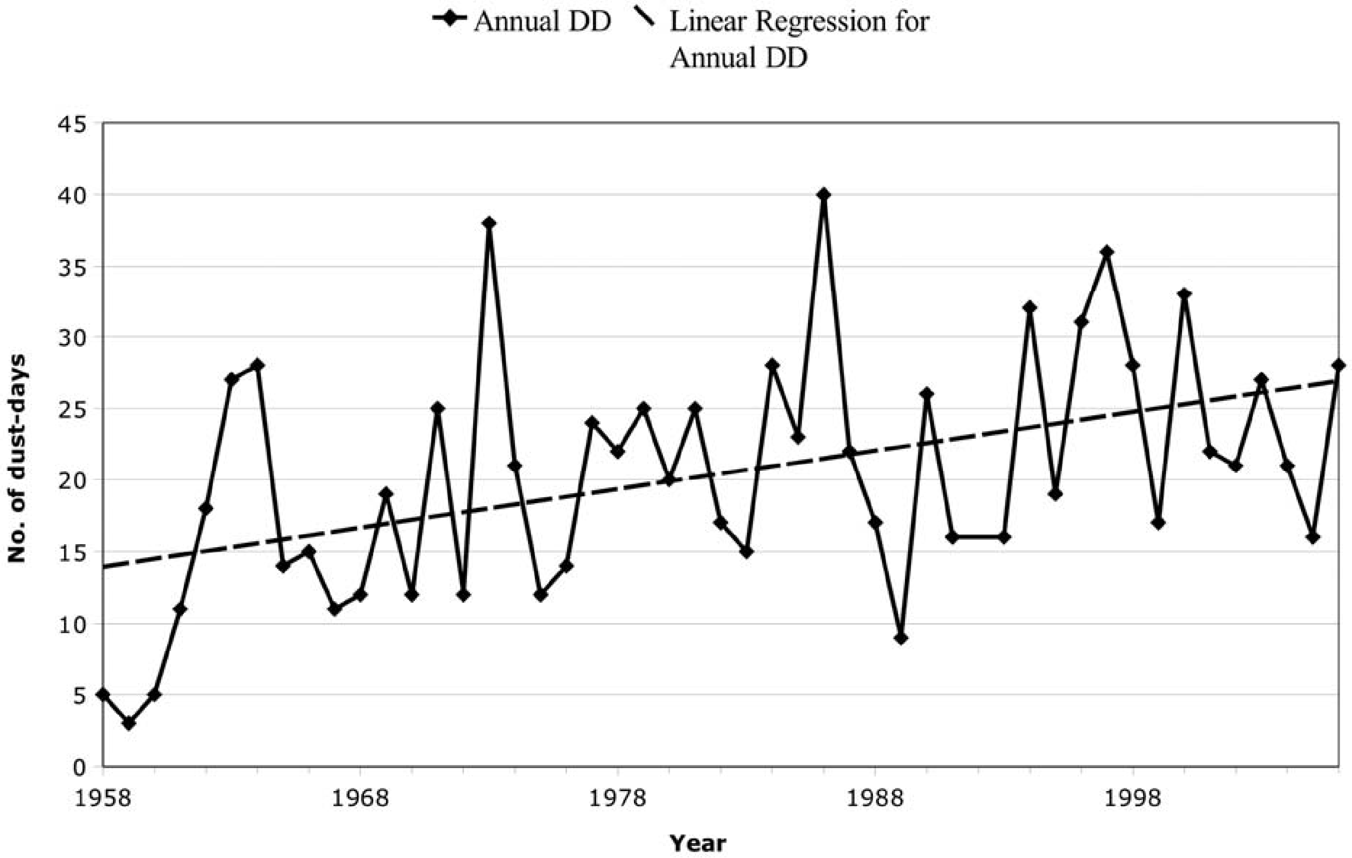
DESERT DUST

SOURCES

TRENDS AND

FUTURE?

Aerosols over the Mediterranean



DESERT DUST

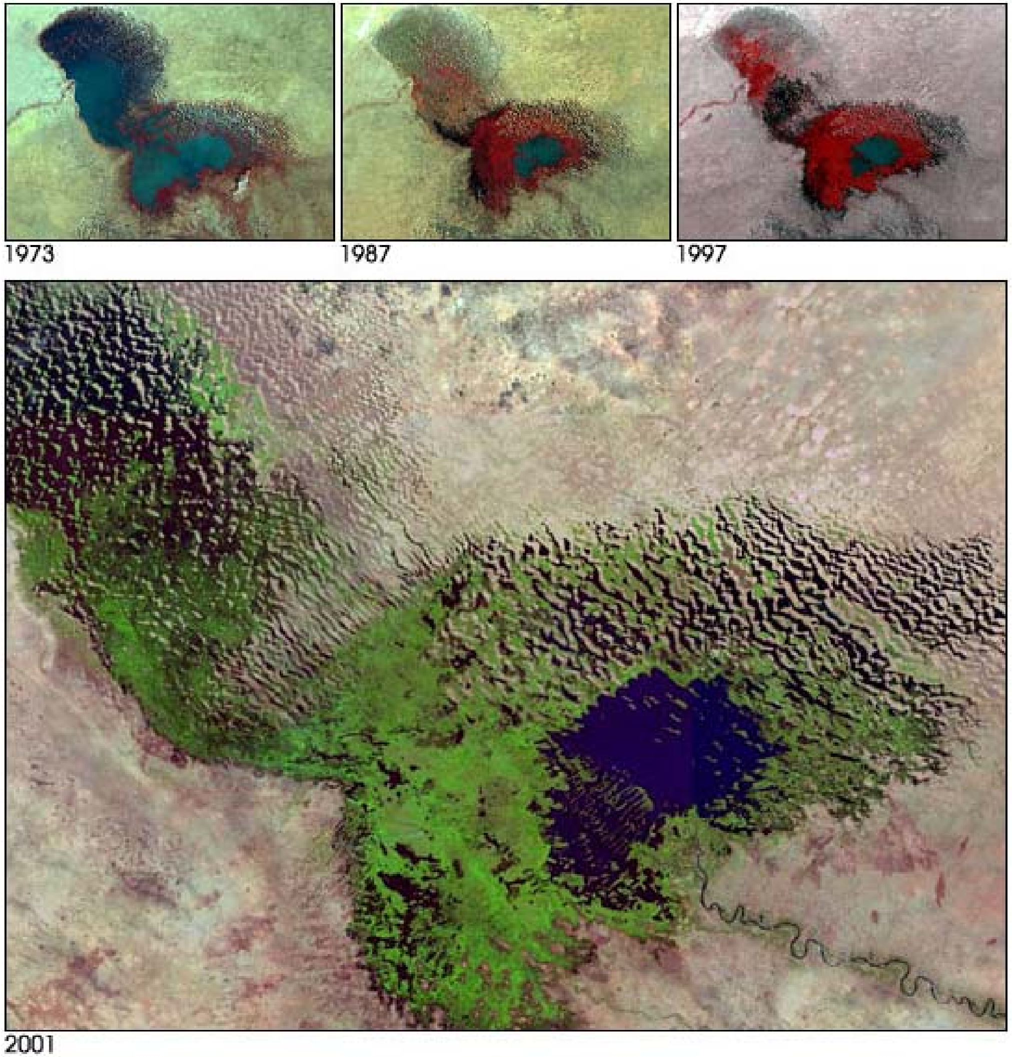
SOURCES

TRENDS AND

FUTURE?

Ganor, E., I. Osetinsky, A. Stupp, and P. Alpert (2010), Increasing trend of African dust, over 49 years, in the eastern Mediterranean, J. Geophys. Res., 115, D07201, doi:10.1029/2009JD012500

Aerosols over the Mediterranean



DESERT DUST

TRENDS AND

FUTURE?

MAJOR SOURCE LAKE CHAD AREA

Aerosols over the Mediterranean

FOREST FIRES
Climate impact:

Affecting Shortwave radiation budget

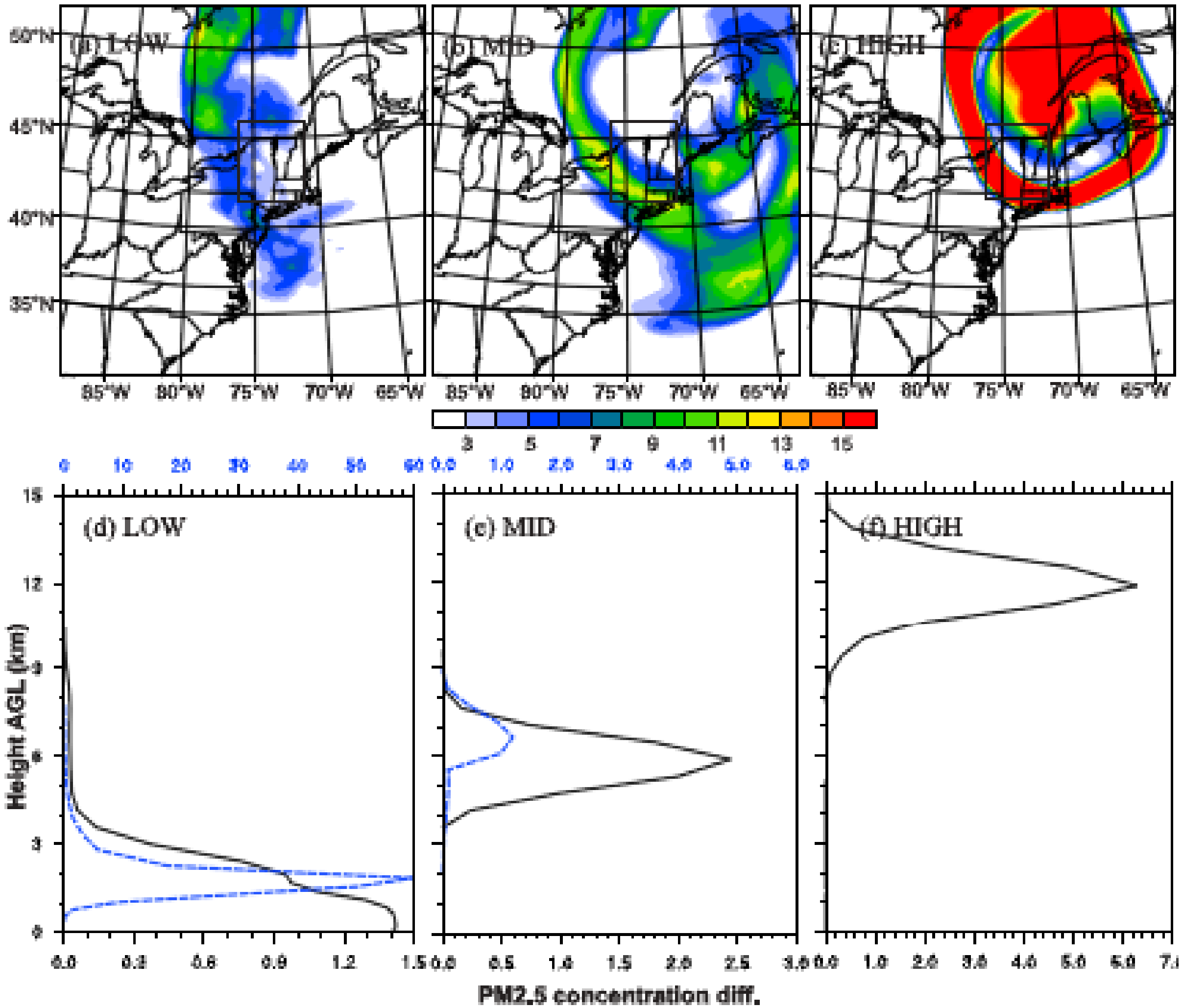
Dust / Biomass?
Scales / differences altitude, duration etc

Aerosols over the Mediterranean

FOREST FIRES
Climate impact:

Affecting Clouds

Aerosols over the Mediterranean

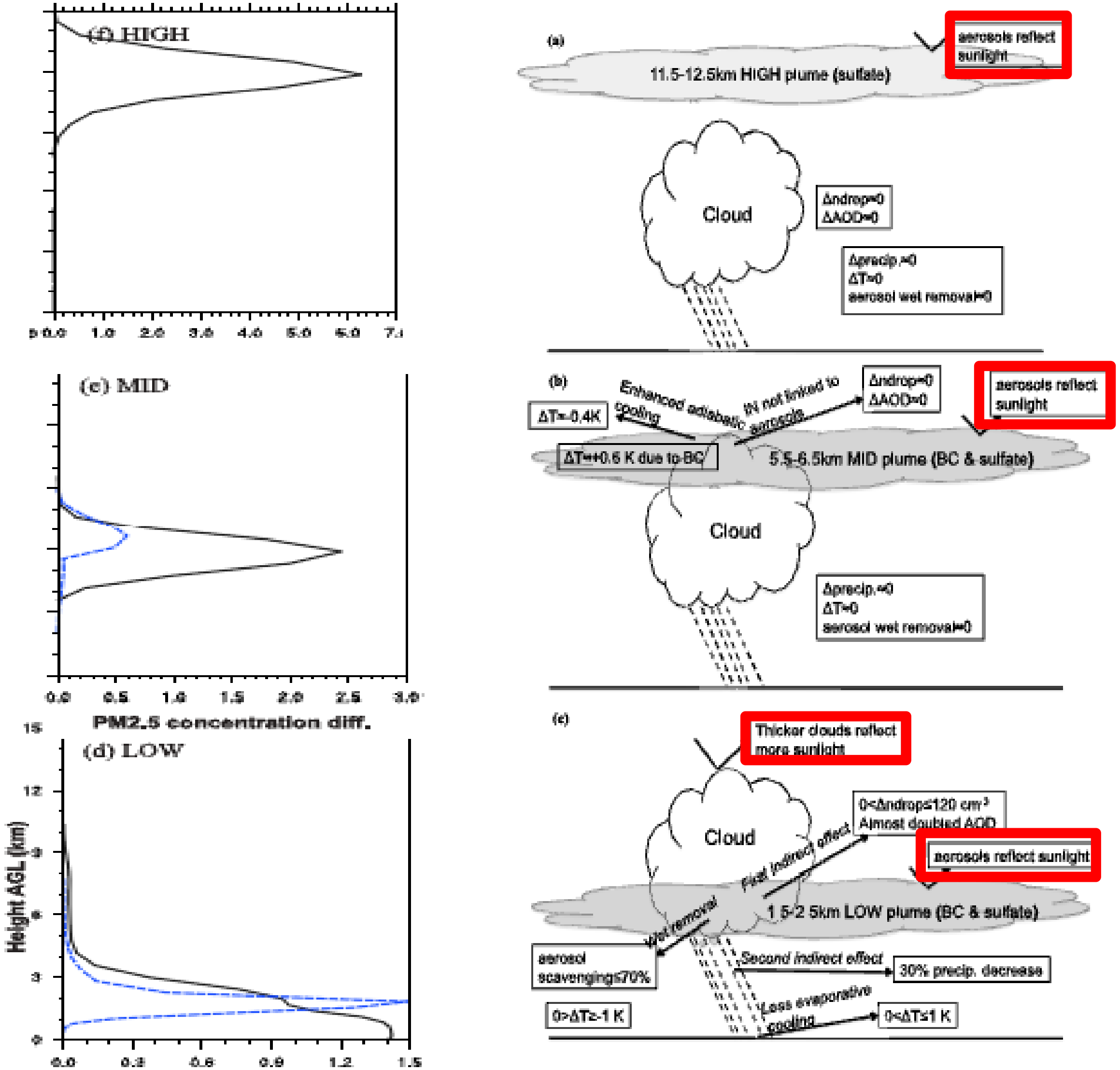


FOREST FIRES
Climate impact:

Affecting Clouds /rainfall

Zhan Zhao, Michael S. Pritchard, and Lynn M. Russell, JGR, 2012

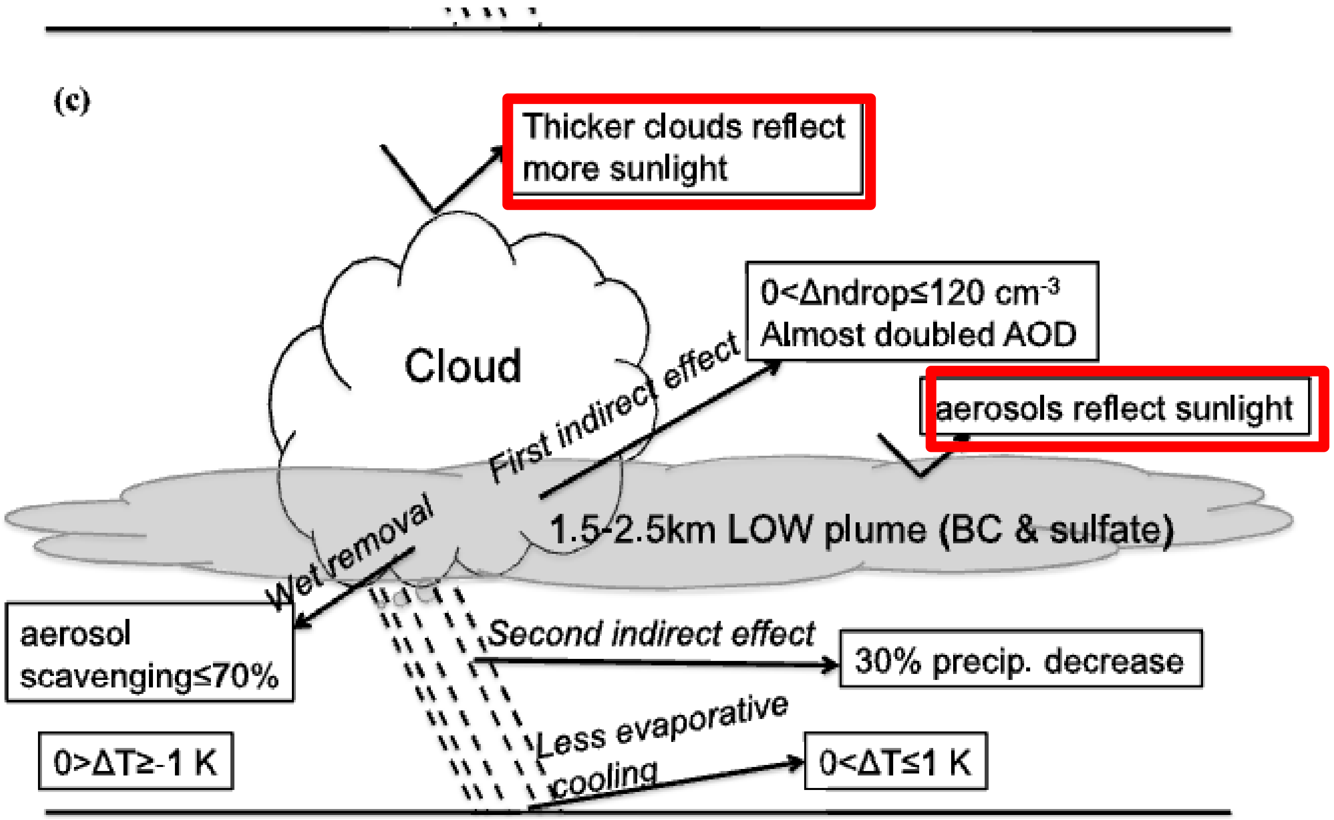
Aerosols over the Mediterranean



FOREST FIRES
Climate impact:

Affecting Clouds

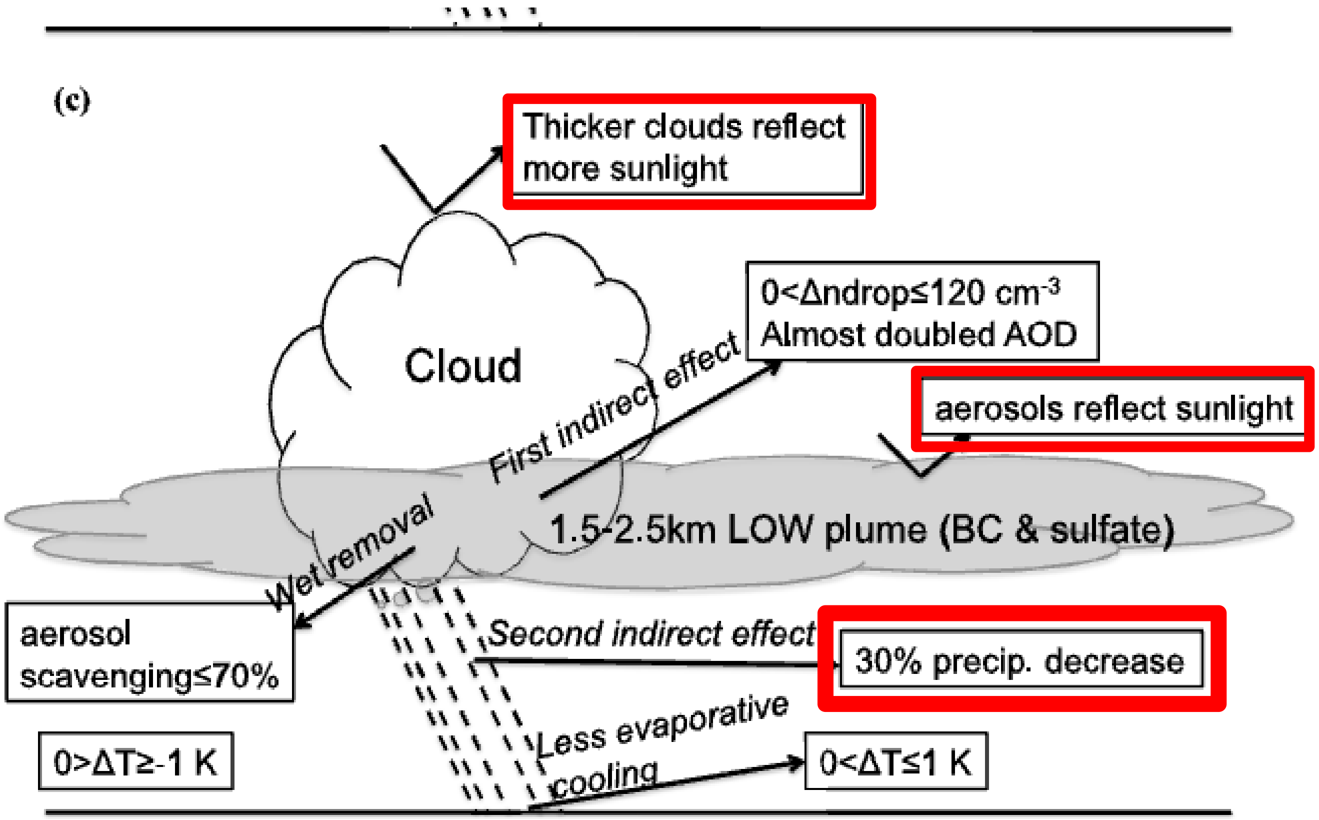
Aerosols over the Mediterranean



FOREST FIRES Climate impact:

Affecting Clouds

Aerosols over the Mediterranean



FOREST FIRES Climate impact:

Affecting Clouds and rainfall (-30 % over 1500 km)

Humans are the main cause of fire.

Negligence is responsible for 90% of all wildfires. Agricultural and forestry activities, children and barbecues are only a few cause of fire.

FOREST FIRES

Important indirect causes affecting the occurrence, behaviour and effects of wildfires are related to climatic factors.

TRENDS AND

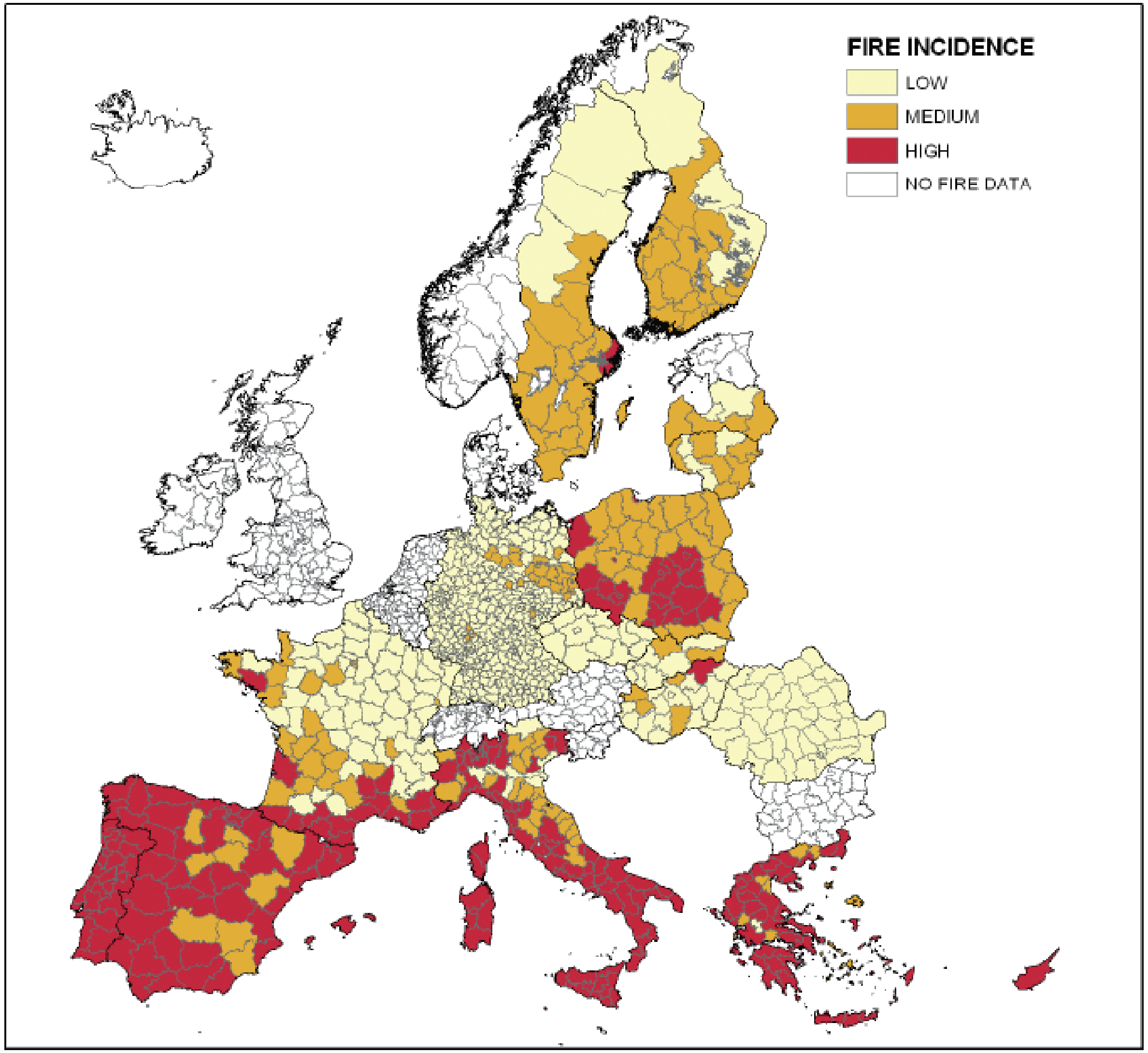
FUTURE?

Other majors fire causes are related to the fuel (i.e. the vegetation) characteristics in terms of biomass and its spatial distribution, as well as to its exposure to fire.

An old phenomenon

Fire is an ancient phenomenon. Fire is a method used in the old days to gain land from the forest. Fire helps some plants - "pyrophytes" plants like pine tree or the kermes oak – which evolve in fire-adapted or fire-dependent ecosystems.

Aerosols over the Mediterranean

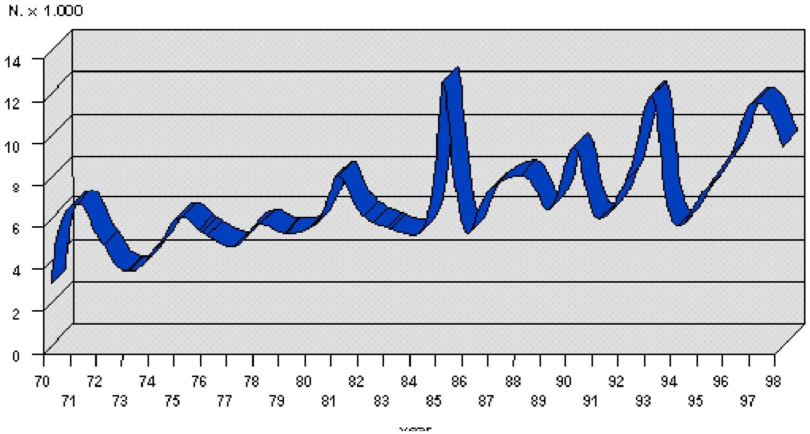


Fire incidence map for the EU.

Climate change will very likely increase the length and severity of the fire season, as well as the extension of areas of risk. Extreme conditions are likely to increase in many areas and with it the probability of large fires. Recurrent droughts and reduced precipitation are likely to imperil ecosystem regeneration after fire

Aerosols over the Mediterranean

ANNUAL NUMBER OF FOREST FIRES
1970 - 1998

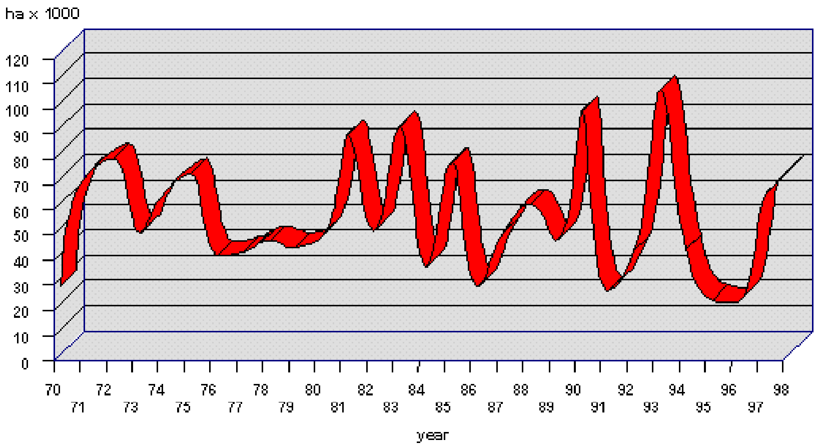


Forest Fires in Italy 1998
(IFFN No. 21 - September 1999,p. 60-70)

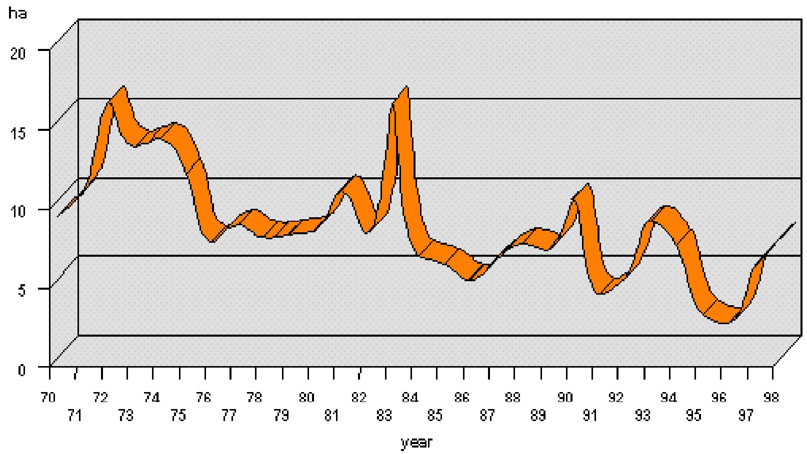
BIOMASS BURNING / FOREST FIRES

TRENDS

FOREST AREA STRUCK BY FIRES
1970 - 1998

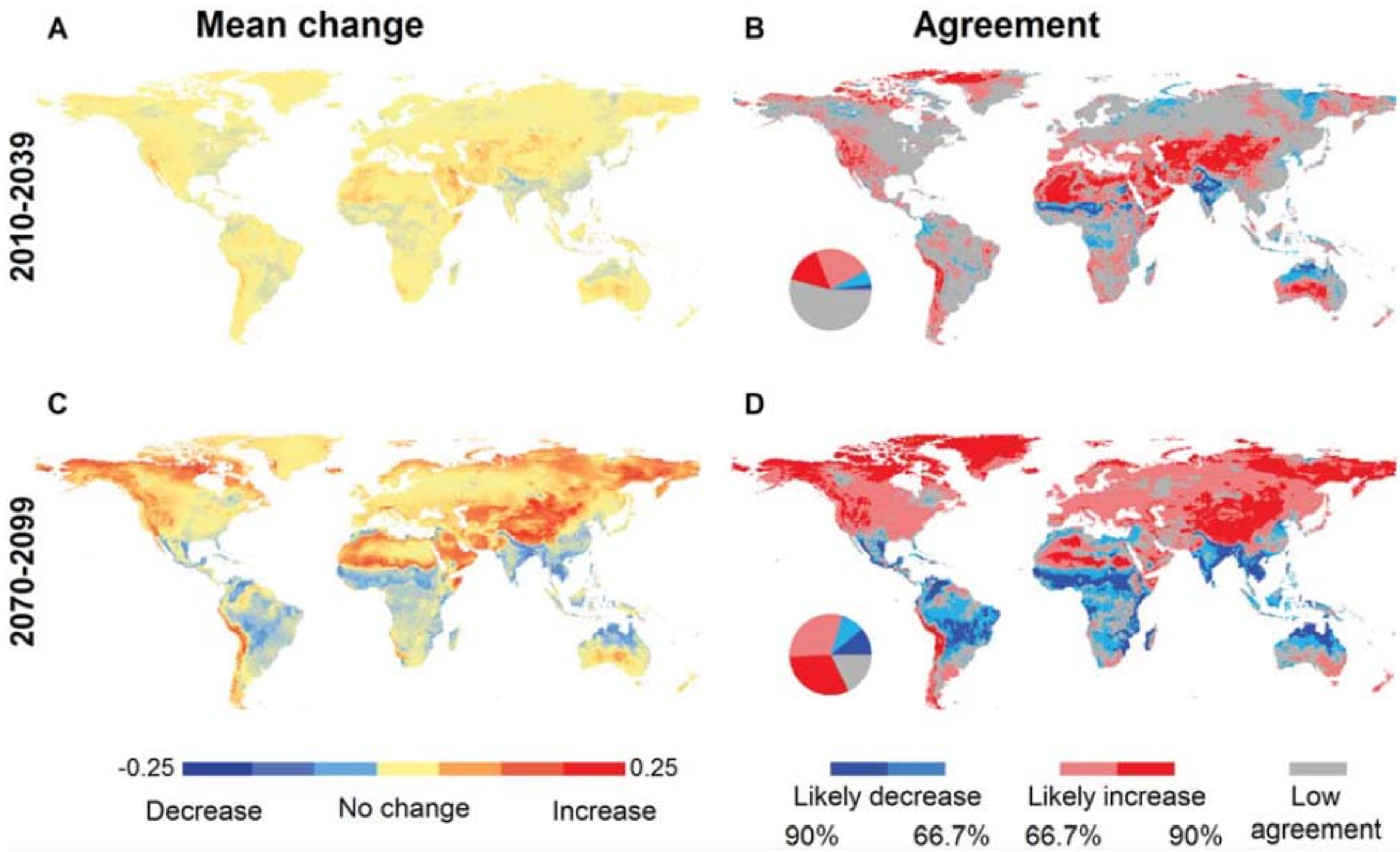


AVERAGE AREA PER FIRE
1970 - 1998



Aerosols over the Mediterranean

M.Moritz et al, Ecology, 2012



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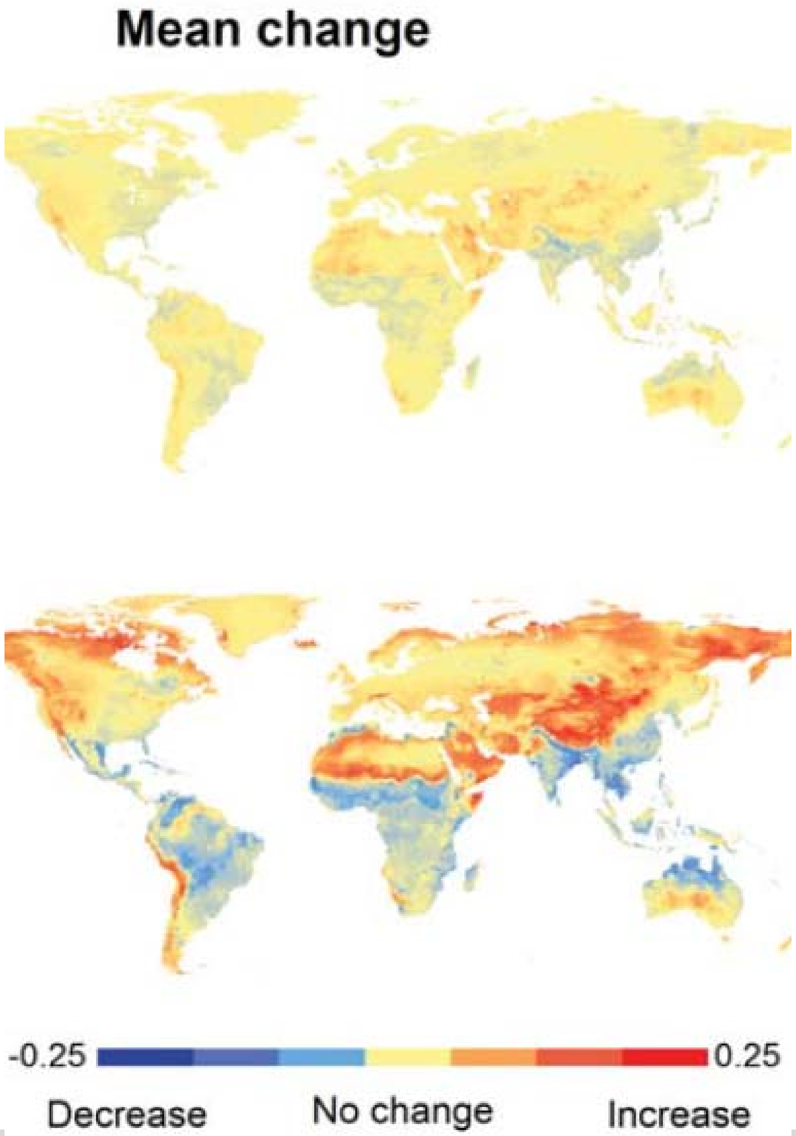


2010 -2039

2070 -2099

BIOMASS BURNING / FOREST FIRES

TRENDS ?

Variable name	Description (units)
NPP	Net primary productivity (g C/year)
Pann	Annual precipitation (mm)
Pdry	Precipitation of driest month (mm)
Tseas	Temperature seasonality (SD × 100)
Twet	Mean temperature of wettest month (°C)
Twarm	Mean temperature of warmest month (°C)

Aerosols over the Mediterranean

INVISIBLE
ULTRAFINE
PARTICLES
CCN

SOURCES

LEVELS?

Aerosols over the Mediterranean

206 M. Colacino and G. A. Dalu (Pageoph,

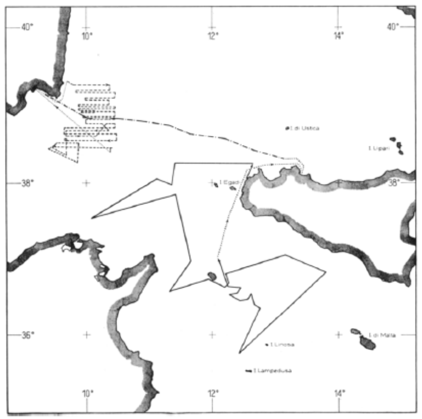


Figure 1
Routes of oceanographic ship 'Bannock' in the period 1st May – 30th June 1970

COLACINI & DALU, PAGEOPH, 1972

Elliott, AE, 1976

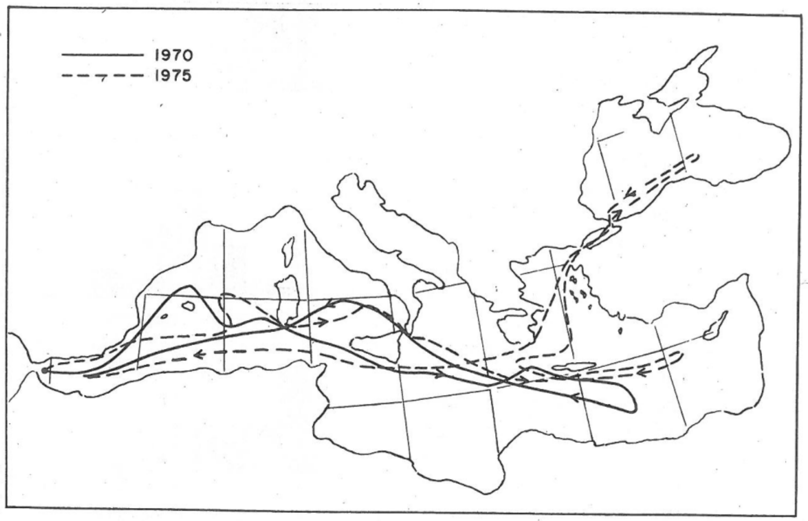


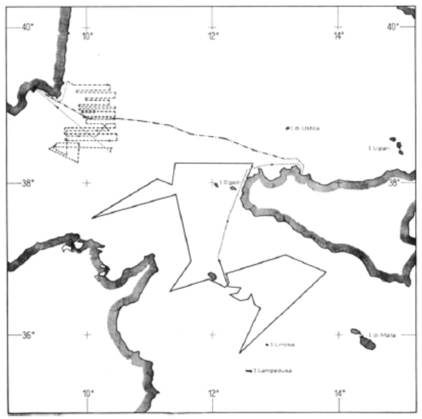
Fig. 1. Cruise tracks of *Glomar Challenger* in 1970 and 1975.
1091

ULTRAFINE PARTICLES

LEVELS

Aerosols over the Mediterranean

206 M. Colacino and G. A. Dalu (Pageoph,



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300 - 1000

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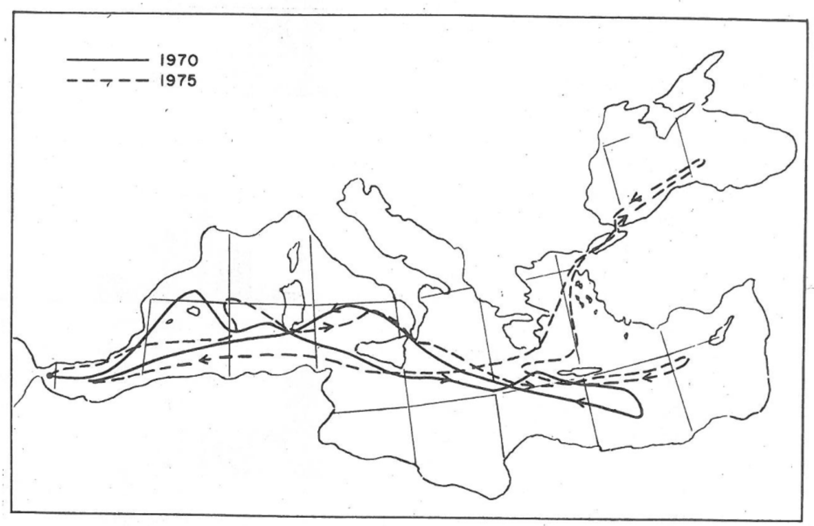

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1091

900 – 2000

max 7400

ULTRAFINE PARTICLES

LEVELS

Aerosols over the Mediterranean

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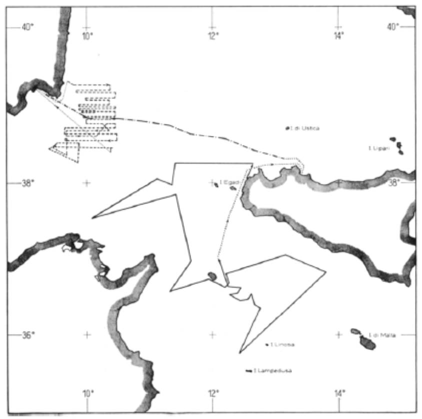

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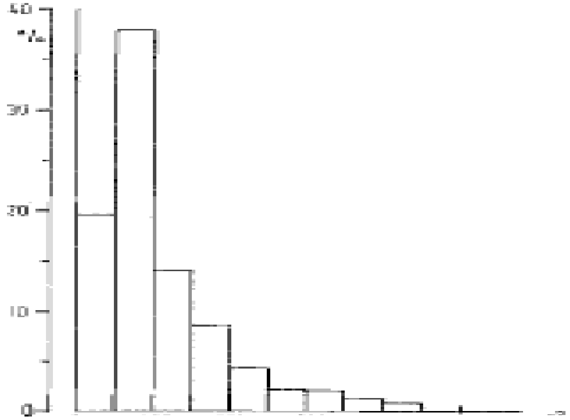
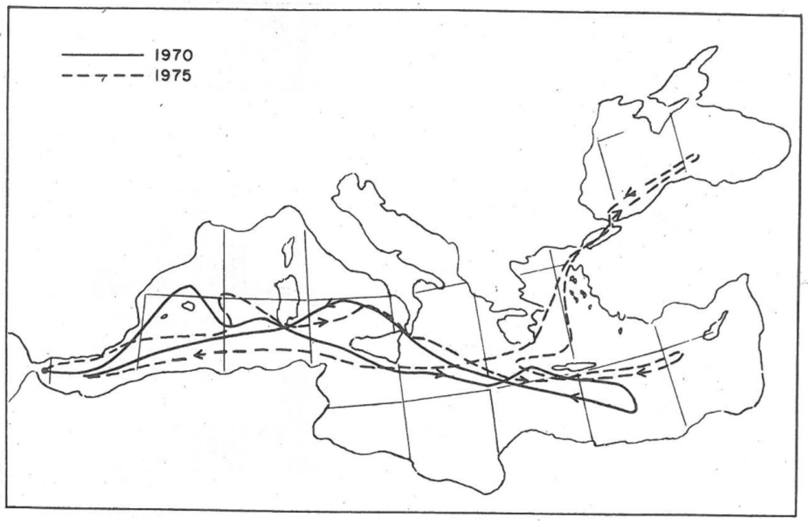


0 400 800 1200 1600 2000

Elliott, AE, 1976



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1091

900 – 2000

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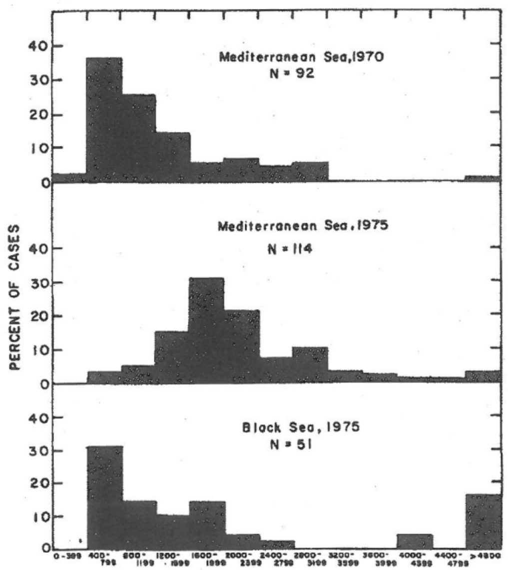
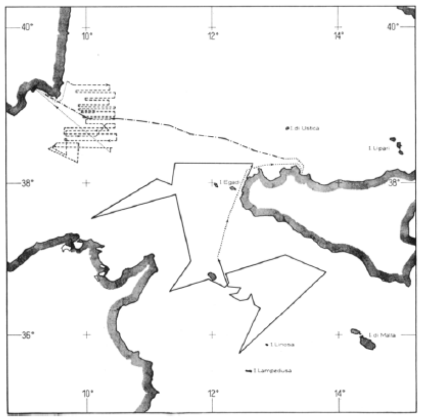


0 2500 5000

Aerosols over the Mediterranean

206 M. Colacino and G. A. Dalu (Pageoph,



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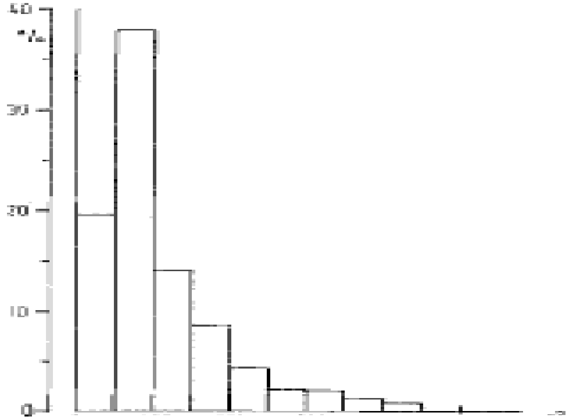

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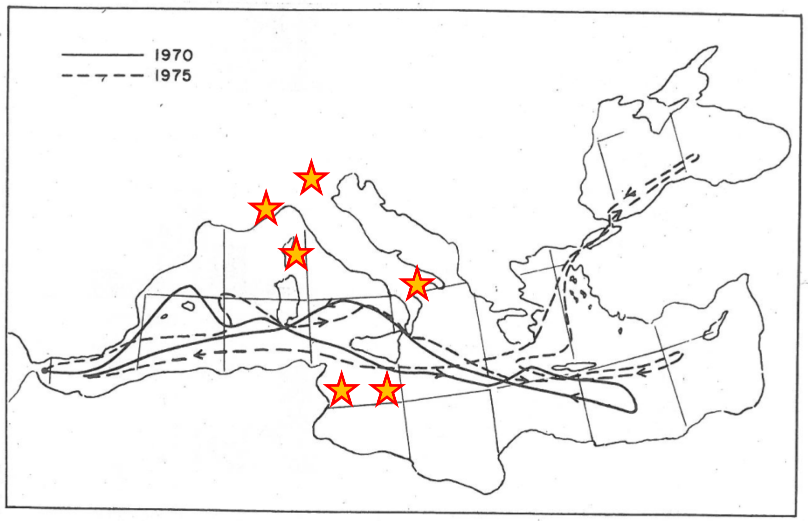

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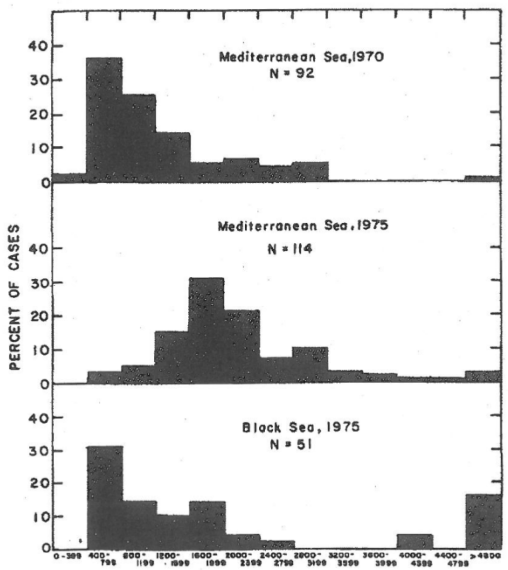
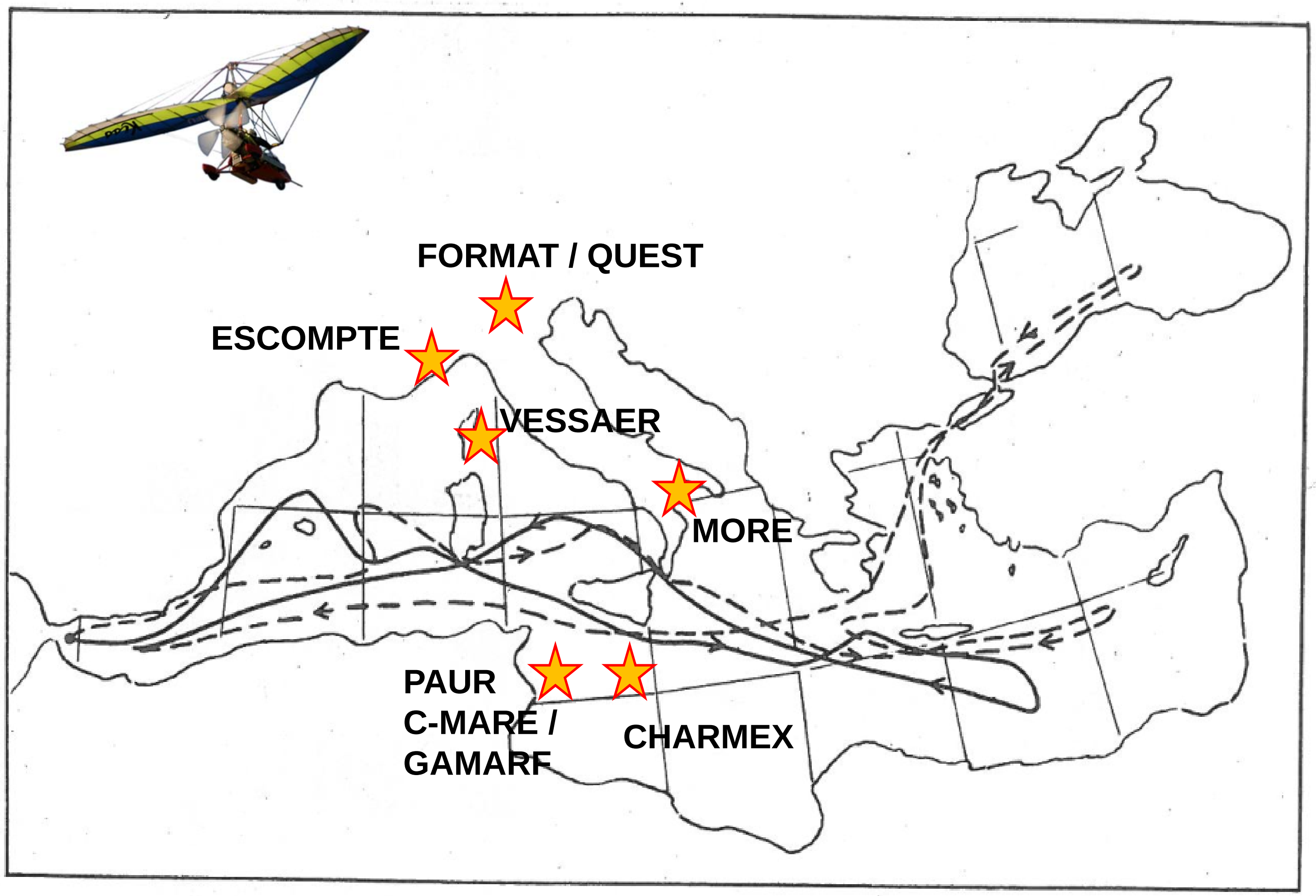


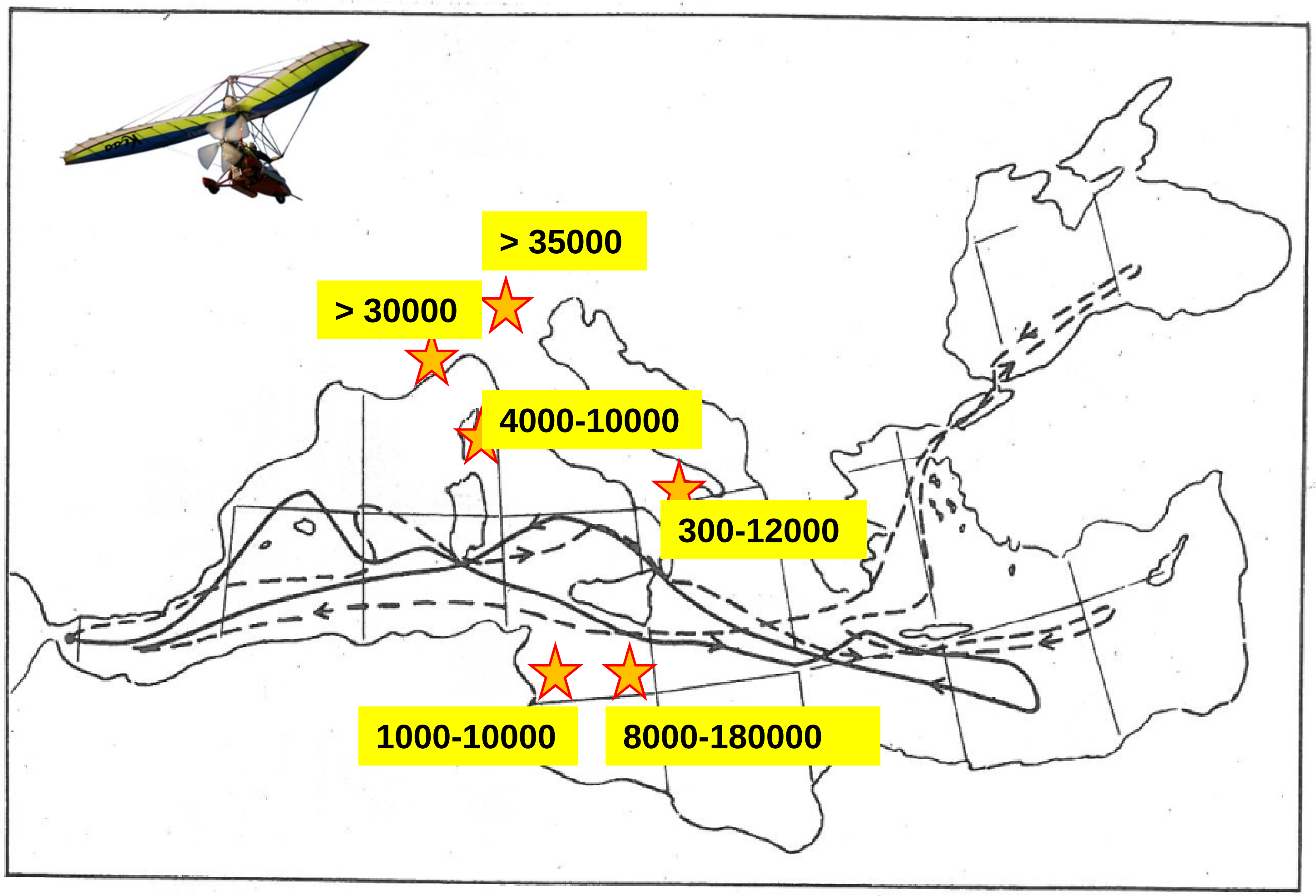
0 2500 5000

Aerosols over the Mediterranean



LOCATIONS WITH D-MIFU MEASUREMENTS

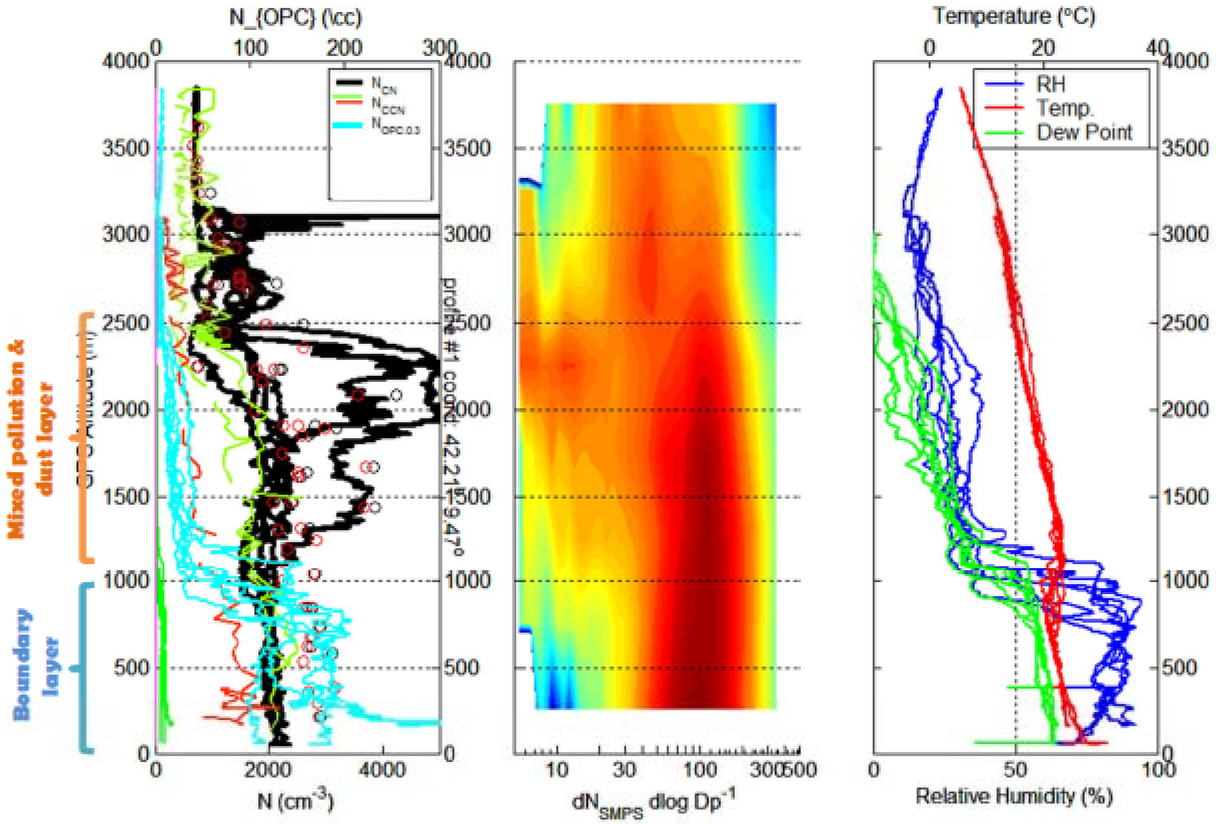
Aerosols over the Mediterranean



☆ **LOCATIONS WITH D-MIFU MEASUREMENTS**

Aerosols over the Mediterranean

Vertical profiles (8 July)



CORSICA, VESSAER (GREG ROBERTS)

Aerosols over the Mediterranean

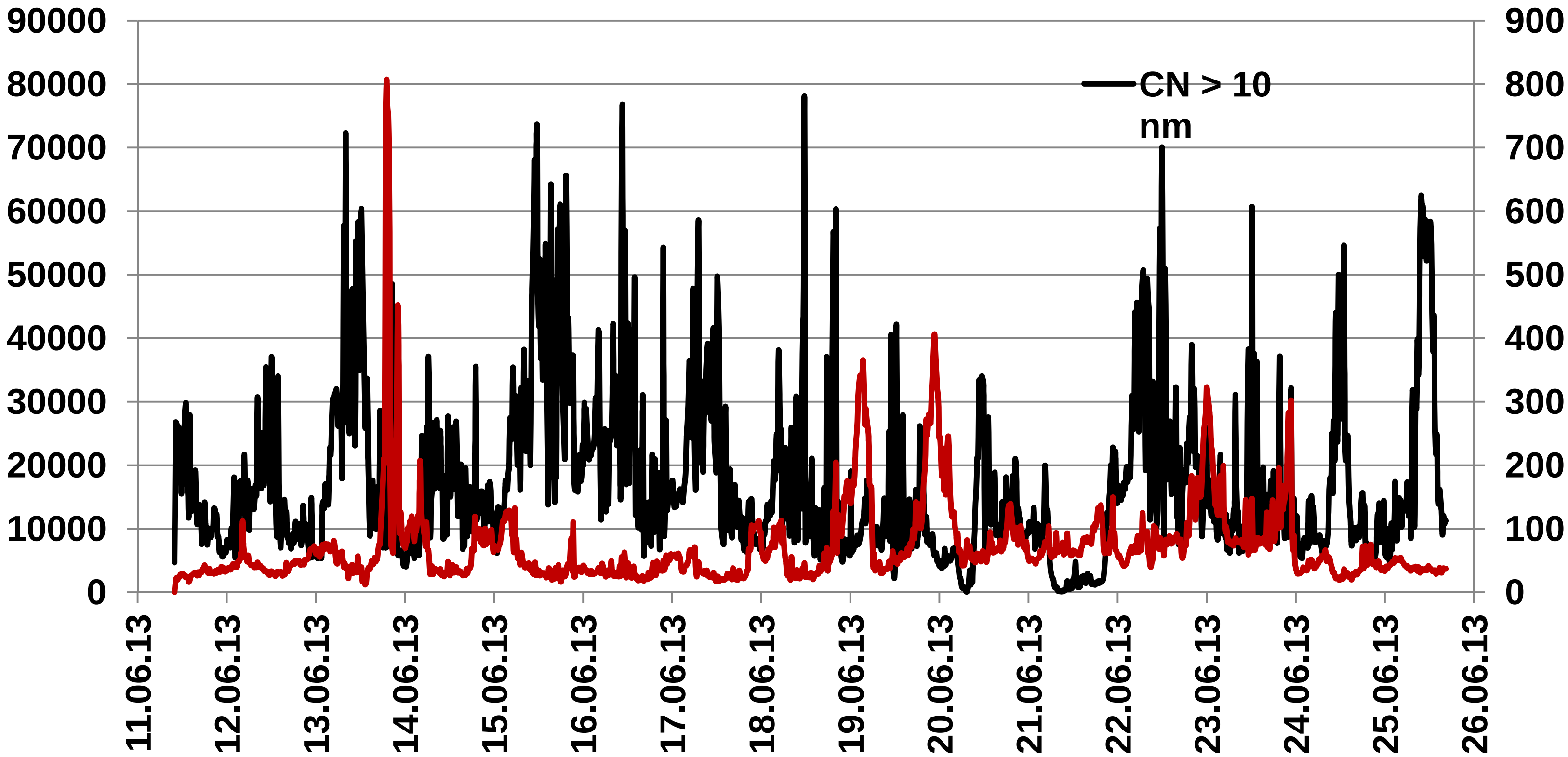
Karlsruhe Institute of Technology

Questions for planned studies:

- What are the contributions of sea salt, biomass burning and local sources? *Biomass burning plumes detected during one flight near Corte. Ultrafine particles not detected in PBL, which indicates local emissions do not contribute to general background (no measurements in Bastia or Ajaccio).*
- Is there a connection between high CCN in PBL to precipitation trends in Corsica? *All the aerosol particles in PBL are CCN at 0.3% Sc; presumably these are aged particles from the continent. AMS obs. indicate that sulfates are primary constituent in aerosol at Cap Corse.*
- How much does the aerosol hygroscopicity vary? What does this tell us about ageing during transport? *CCN / CN ratio near unity in PBL and < 0.5 in elevated pollution plumes. CCN / CN ratio near unity during dust events. Aerosol hygroscopicity generally increases with ageing of fresh emissions of pollution or dust making the aerosol more CCN-active. The time scale of these changes determine when (and where) the aerosol become active cloud nuclei.*

CORSICA, VESSAER (GREG ROBERTS)

Aerosols over the Mediterranean



MALTA, MARSAXLOKK, CHARMEX

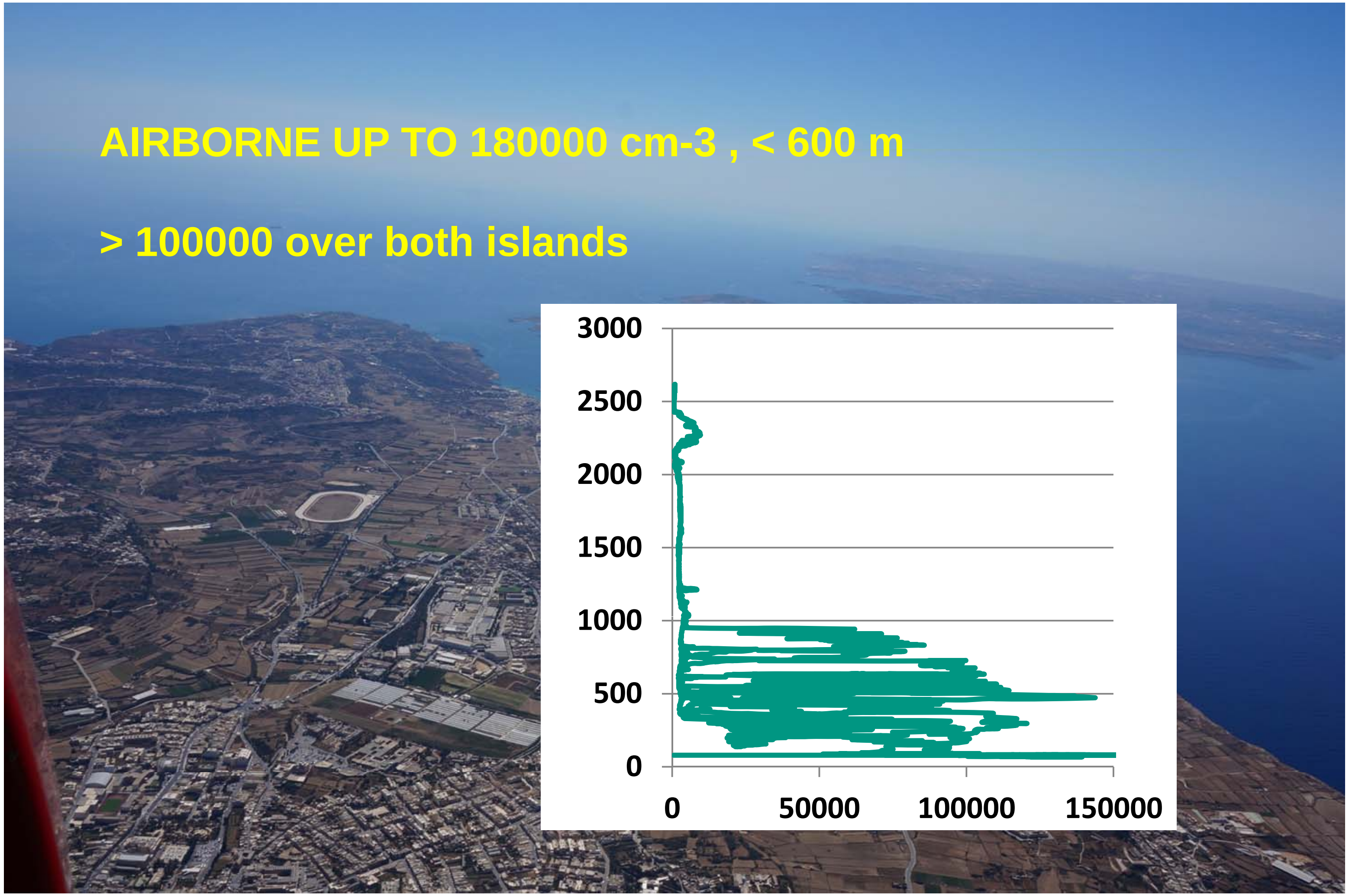
Aerosols over the Mediterranean

MALTA, 2013, MARSAXLOKK HARBOUR,

Aerosols over the Mediterranean

MALTA, 2013, CHARMEX

Aerosols over the Mediterranean



MALTA, 2013, CHARMEX

Aerosols over the Mediterranean

Karlsruhe Institute of Technology

FUTURE TRENDS

SOx EMISSIONS

NOx EMISSIONS

Aerosols over the Mediterranean

SUMMARY

AEROSOLS ARE HIGHY VARIABLE IN SIZE TEMPORAL AND SPATIAL DISTRIBUTION

TRENDS ARE OBSERVABLE FOR DESERT DUST DAYS (BODELE DEPRESSION?)

CONTRIBUTION OF BIOMASS AEROSOL UNCERTAIN

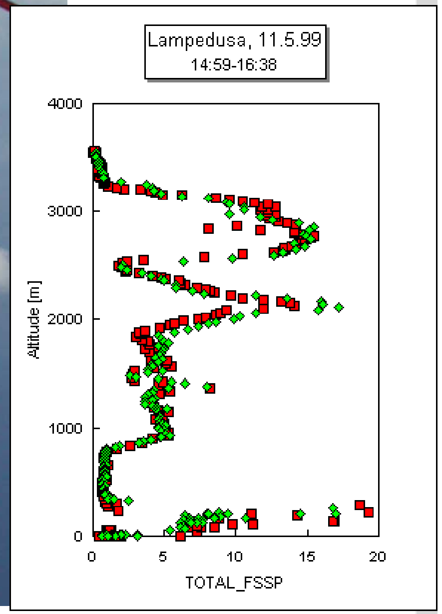
INCREASING ANTHROPOGENIC ULTRAFINE PARTICLES

Aerosols over the Mediterranean

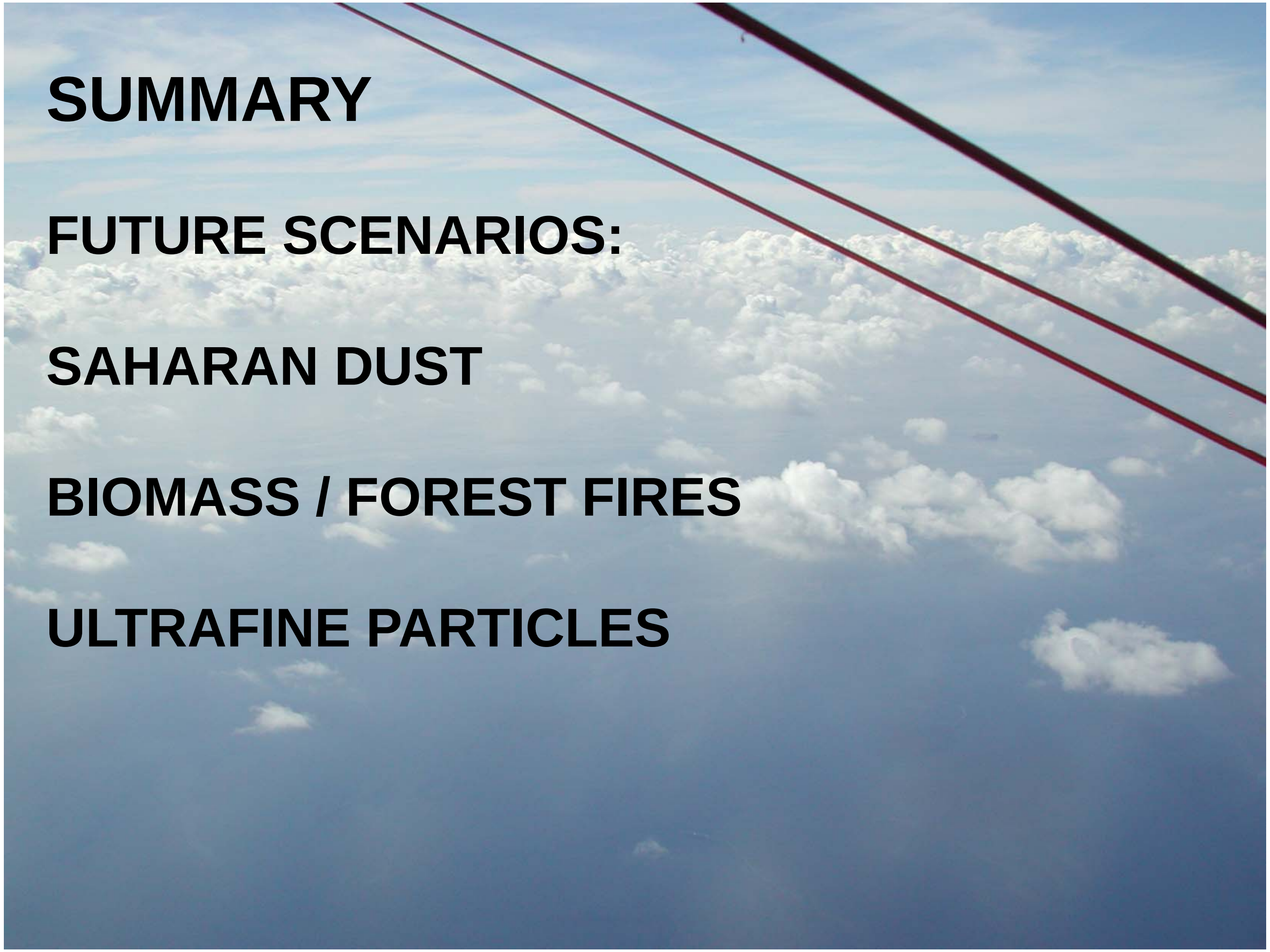
SUMMARY

AEROSOLS ARE HIGHLY VARIABLE IN SIZE AND SPATIAL DISTRIBUTION

VERTICAL STRATIFICATION HAMPERS GROUND (SHIP) BASED MEASUREMENTS



Aerosols over the Mediterranean



SUMMARY

FUTURE SCENARIOS:

SAHARAN DUST

BIOMASS / FOREST FIRES

ULTRAFINE PARTICLES

Aerosols over the Mediterranean


THANK YOU FOR YOUR ATTENTION