ChArMEx

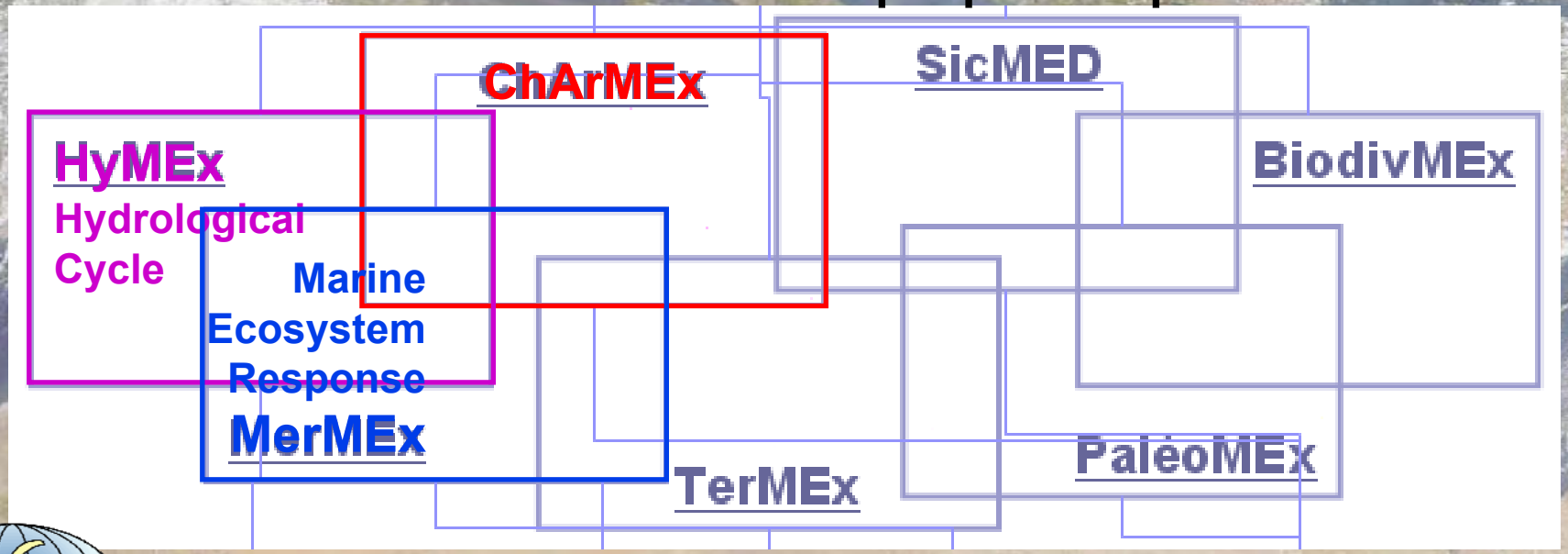
https://charmex.lsce.ipsl.fr/

MISTRALS

Mediterranean Integrated STudies at Regional And Local Scales

The Chemistry-Aerosol Mediterranean Experiment

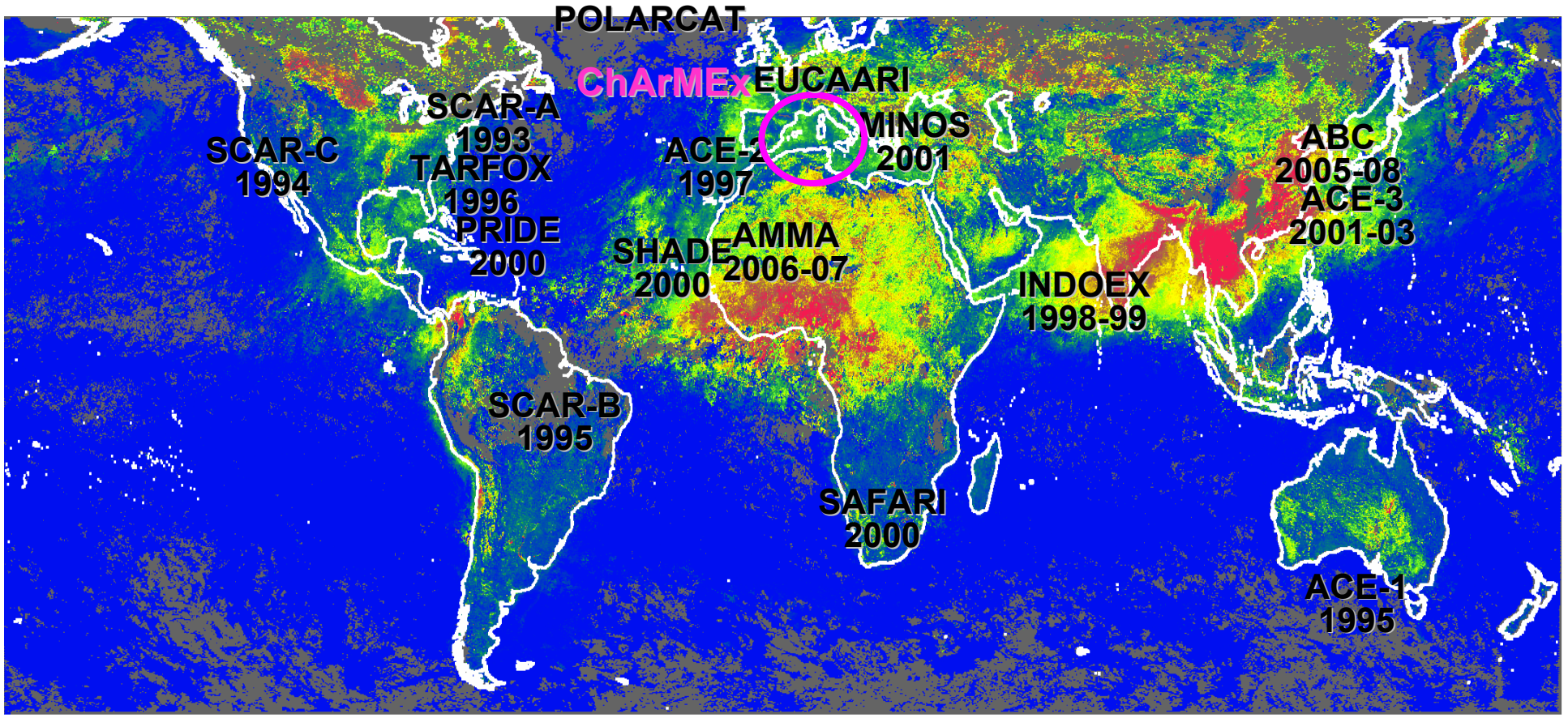
ChArMEx is the atmospheric chemistry component of MISTRALS: it deals with short-lived tropospheric species



Contact: *Francois.Dulac@cea.fr*

Chemistry/aerosol-climate interaction studies are based on regional experiments

⇨ The western Med has been neglected up to now



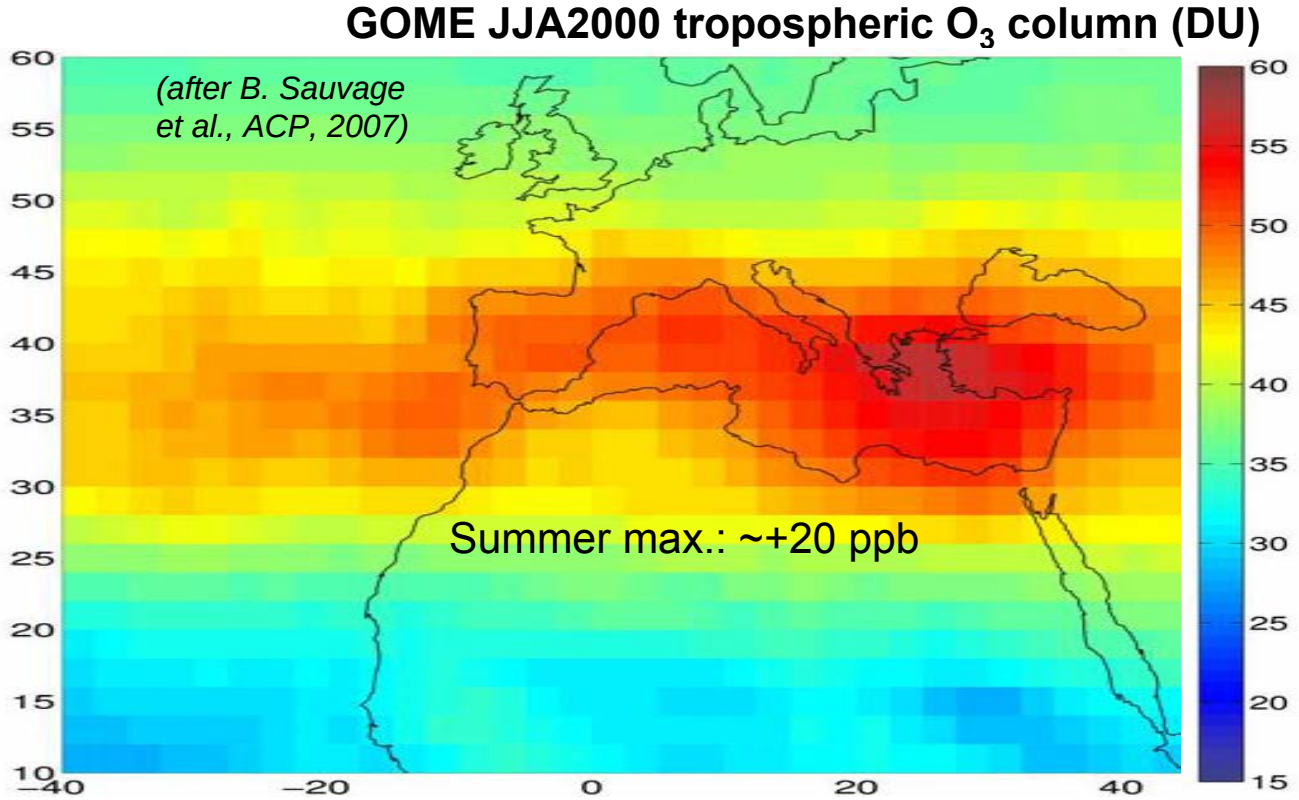
0 Polder Aerosol Index (March 1997) 0.5

POLDER Data: CNES/NASDA
Processing: LOA/LSCE

Our motivation

- The western basin is sill missing a large field campaign and atmospheric background observatories
- The remote Mediterranean atmosphere offers the best combined possibilities
  - to follow very diverse polluted continental air masses over the basin using satellites (clear sky), background monitoring (observatories) and field campaigns (proximity)
  - to constrain coupled chemistry-transport and chemistry-climate models ability to simulate all relevant dynamical and chemical processes
- In addition, the oligotrophic Mediterranean waters offers the best opportunity to couple atmospheric and marine biogeochemical models to study atmos. deposition impact
- MISTRALS offers a major opportunity for regional multidisciplinary coupled approaches necessary to improve our knowledge of the regional Earth system in the Mediterranean (ChArMEx-HyMeX-MERMEX)

The Mediterranean: an intense summer photochemistry with a regional ozone peak



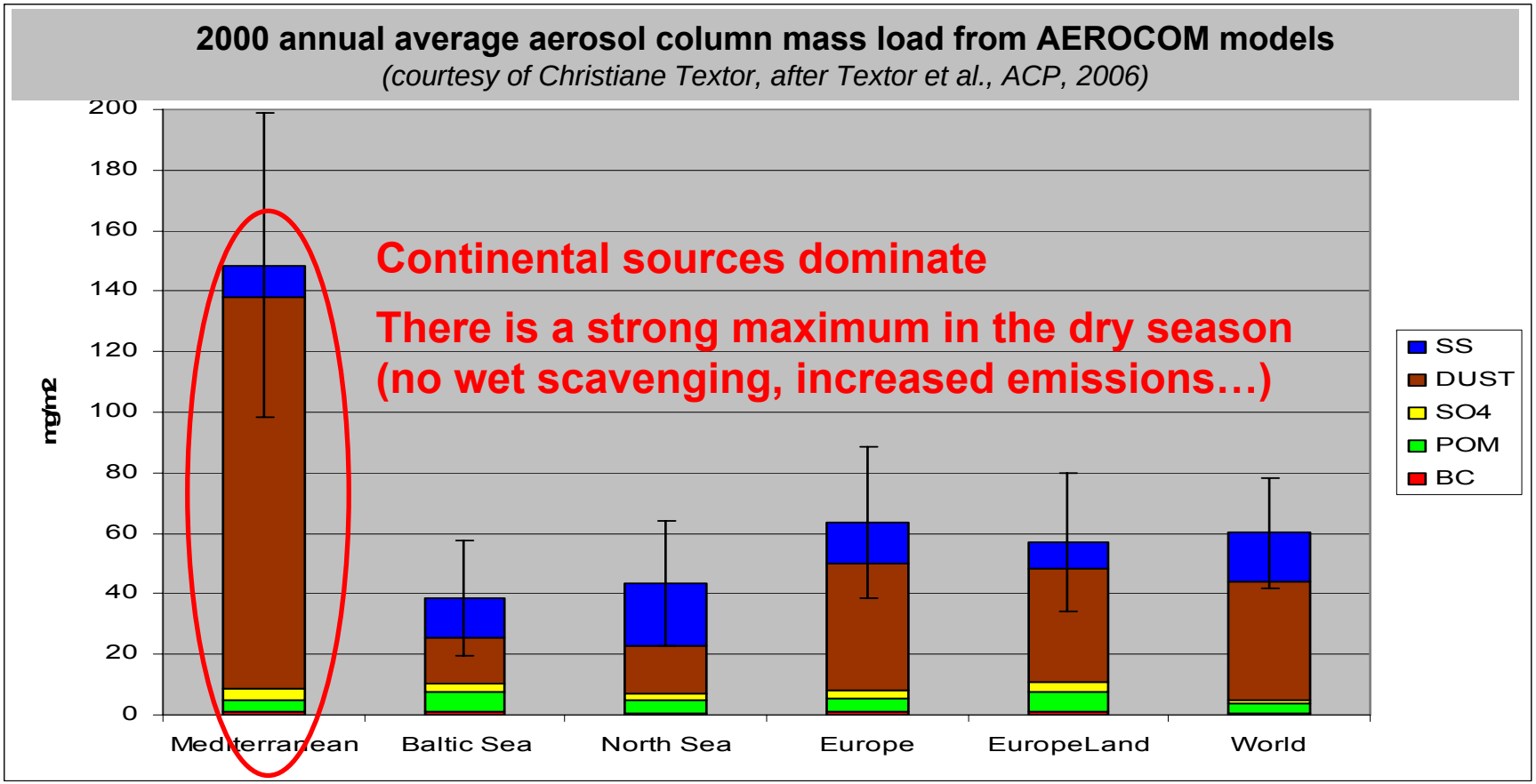
⇨ **Example of open questions:**

- **Relative contributions of long-distance transport and regional pollution sources (decreasing European emissions)**
- **Long term trends and evolution**

The Mediterranean: the regional European maximum in aerosol

2000 annual average aerosol column mass load from AEROCOM models

(courtesy of Christiane Textor, after Textor et al., ACP, 2006)



⇨ **Many open questions:**

- model components not validated (organics, deposition …)

- uncertain trends

- impacts not quantified…

ChArMEx scientific objectives

⇨ 1. Assessing the present state of the Mediterranean atmospheric environment

- Sources and budgets of aerosols and precursors of secondary species?
  - inventories of natural/anthropogenic sources
  - long-range transport/regional sources
  - trends and variability
- Chemical and dynamical processes?
  - chemical transformations, plume aging processes
  - air mass import/export (3D), orographic and see-breeze effects
  - stratification and variability in the vertical
- Atmospheric deposition?
  - nutrients (P, N), micronutrients (Fe), contaminants (Hg)
  - soluble/insoluble

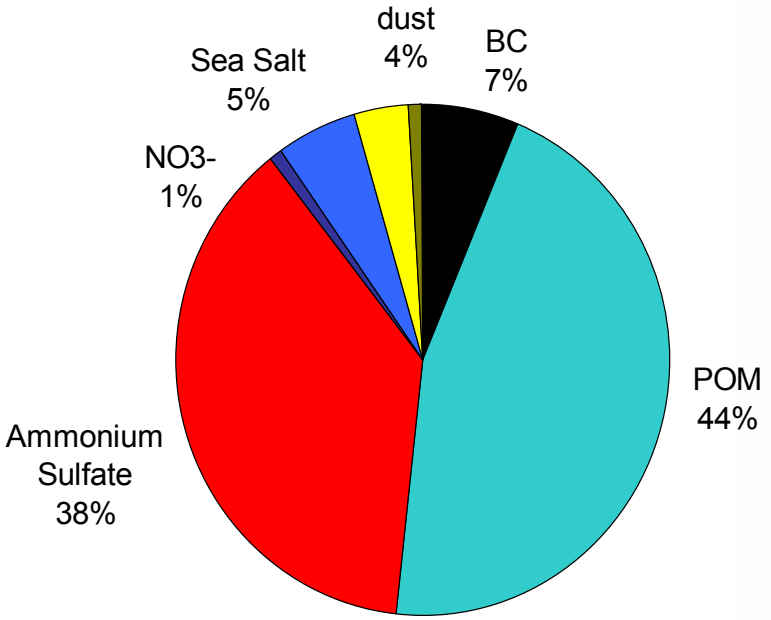
⇨ 2. Quantifying the impacts of aerosols and reactive gases

- On the surface air quality (long range vs regional contributions)
- On the Mediterranean radiative budget and regional climate (SST, evaporation, atmospheric heating, cloud cover, heat waves, photochemistry/oxidizing capacity)
- On the surface ecosystems (role of deposition, perturbation of incident radiation)

⇨ 3. Predict future evolution of these budgets and impacts

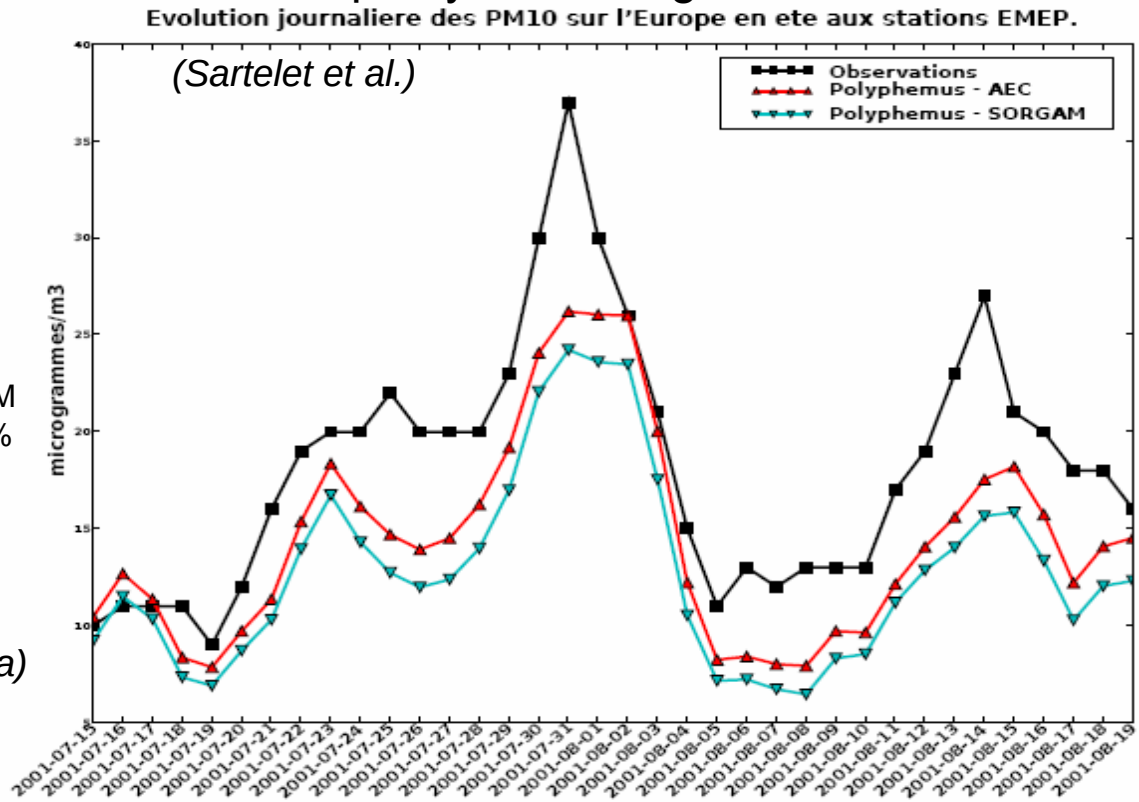
Poor organic aerosol simulations in PM air quality modelling

POM dominates the fine aerosol fraction in Corsica



(courtesy of Jean Sciare, unpublished data)

Under-estimation of PM10 simulated over Europe in summer is partly due to organic matter



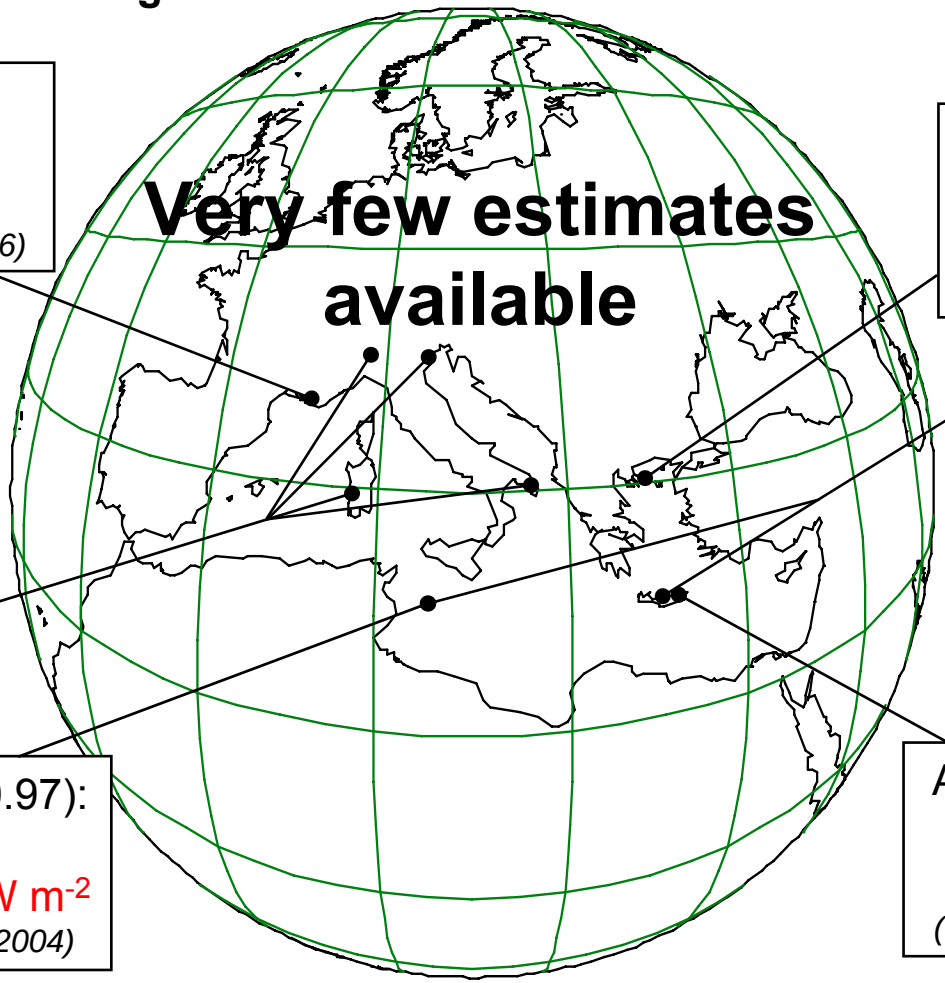
- **Uncertain biogenic (and dust) emissions, fires not taken into account** (~810 000 ha in Europe during JJA 2007)
- **Organic chemistry to be documented (isoprene chemistry…)**

The Med. aerosols have a large and variable impact on the solar radiation

Aerosol direct radiative forcing
(daily values)

Pollution aerosol
(ω_o= 0.83-0.89):
-66 W m^{-2}
(Roger et al., Atmos. Env., 2006)

Aged biomass burning
(ω_o = 0.89):
-60 W m^{-2}
(Formenti et al. JGR, 2002)



Anthropogenic aerosol
yearly averages
(ω_o= 0.85-0.99):
≈ -5 W m^{-2}
(Bergamo et al., ACP, 2008)

Anthropogenic aerosol
yearly averages
(ω_o= 0.85-0.99):
≈ -3 W m^{-2}
(Bergamo et al., ACP, 2008)

Desert dust (ω_o= 0.73-0.97):
-13, -24, -37 W m^{-2}
Non dust: -37 and -39 W m^{-2}
(Meloni et al., JGR, 2003 and 2004)

Anthropogenic aerosol
(ω_o= 0.87):
-18 W m^{-2}
(Markowicz et al., GRL, 2002)

GHG forcing overwhelmed

ChArMEx working group overview

- **COORDINATION**

7 SCIENCE WPs:

- **EMISSIONS**
- **AGING, CHEM. PROC.**
- **TRANSPORT**
- **RADIATION and CLIMATE**
- **DEPOSITION (nutrients, Hg)**
- **TRENDS and VARIABILITY**
- **FUTURE**

7 Task Teams:

- **SURFACE MONITORING**
- **LIDAR**
- **AIRBORNE MEASUR.**
- **CAMPAIGNS, OPERATION CENTRE**
- **SATELLITE**
- **MODELLING**
- **DATA BASE**

⇨ **You are welcome to join and interact**

ChArMEx overall strategy

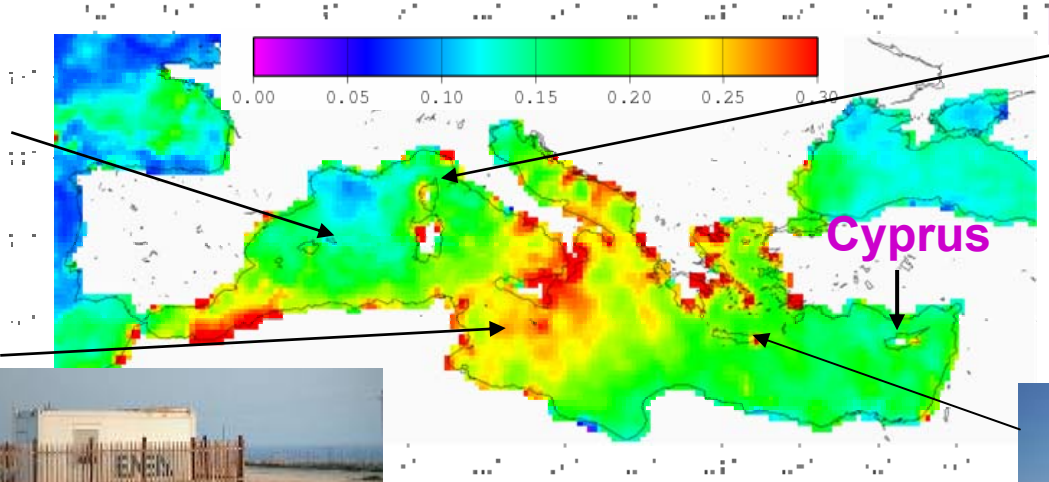
⇨ **AMMA-type: multi-scale integrated strategy**

- **3 levels of in situ field observation:**
  - **SOP: Special Observation Periods (~6 weeks, 2 successive yr)**
    - **detailed process studies at the regional scale**
    - **lagrangian and column type observations**
    - **intensive campaigns, extensive measurements, airborne means**
    - **support from real-time satellite products and model forecasts**
  - **EOP: Enhanced Observation Period (2-3 yr)**
    - **daily to seasonal variability**
    - **statistical approach by continuous monitoring incl. detailed chem.**
    - **normalized meas., stations distributed to account for N-S and E-W gradients**
  - **LOP: Long-term Observation Period (5-10^{+} yr)**
    - **trends**
    - **a few networked background observatories**
    - **basic chemical and radiative parameters**
- **Spaceborne remote sensing**
- **Data base**
- **Chemistry-transport and chemistry-climate modelling**

A new network of Mediterranean background observatories

Summer (JJA) 2007 aerosol optical depth at 865 nm from PARASOL

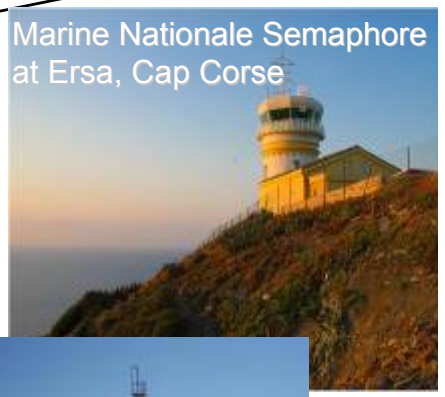
(courtesy of D. Tanré, J.-L. Deuzé and F. Ducos)



Balearic Isl.

Lampedusa

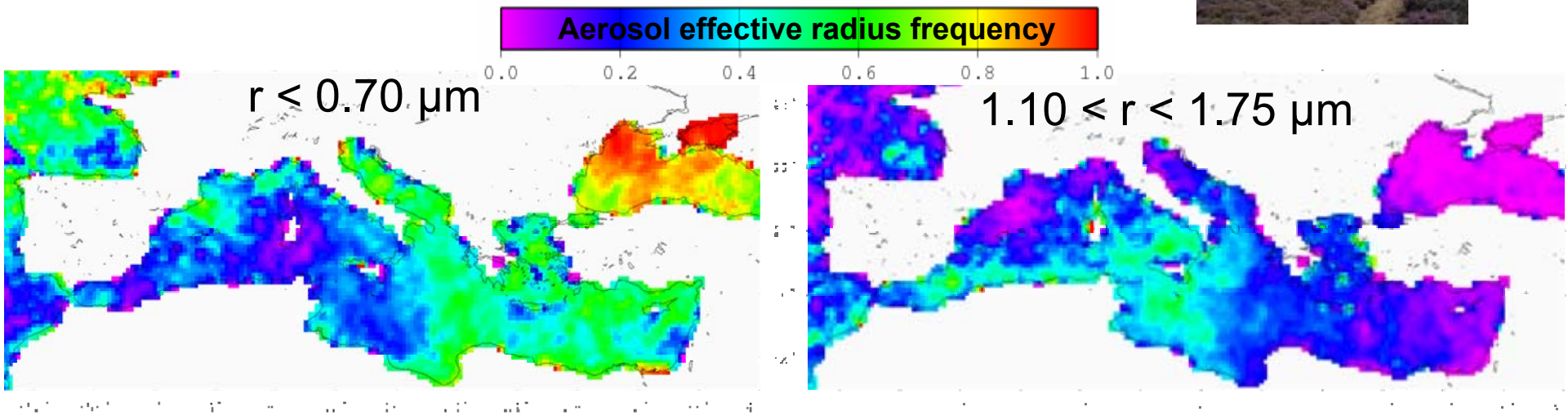
New: Corsica



Cyprus

Finokalia

+ existing background observatories (e.g. PAES, IAGOS…)

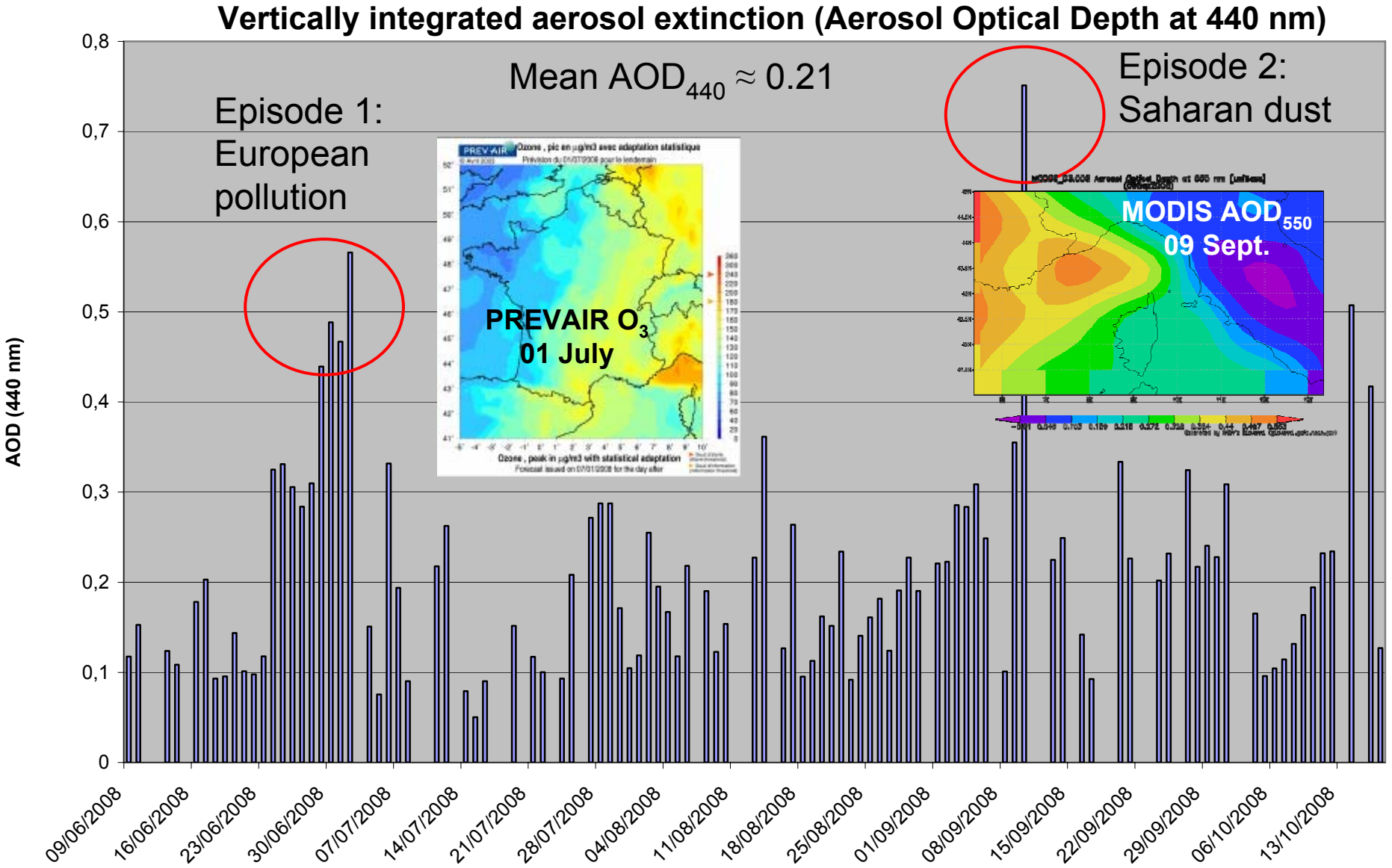


The semaphore of Ersa

CAP CORSE

⇨ Available room for an instrumented shelter or a new building

Large-scale transport episodes are well seen



(data available at http://aeronet.gsfc.nasa.gov)

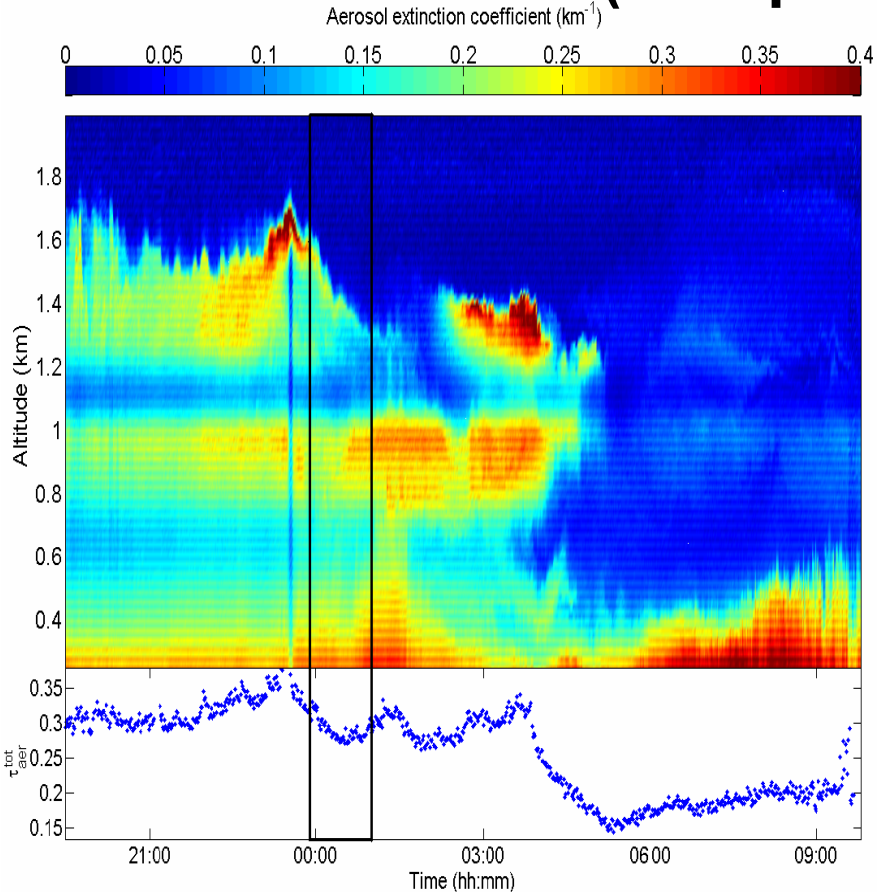
Planned instrumental payload (long-term)

Atmospheric gases	O_3, CO, N oxydes, SO_2, COV CO_2, CH_4, H_2O O_3 (and aerosol?) radiosounding (Ajaccio)
Gaseous + particulate Hg + Hg deposition	
Radon-222	
Aerosols	automated aerosol Lidar (incl. Raman) CIMEL sun photometer TEOM-FDMS aerosol balance with PM_{10} filter sampling in PM_1 and PM_{10} for detailed chemistry optical particle counter/sizer (GRIMM) 7-wavelength Aethalometer CCN counter
Deposition	wet and total deposition: rain chemistry, dust, nutrients
Radiation	Kipp and Zonen radiative flux instruments
Meteo	

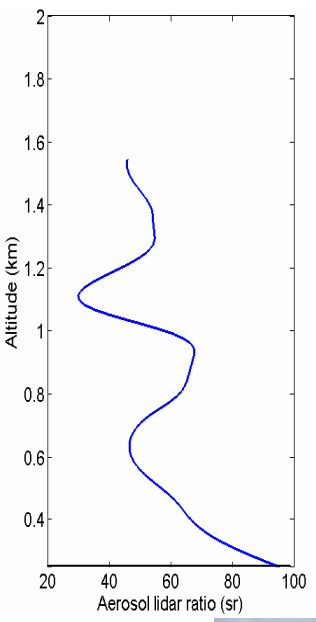
Total cost ~600 k€

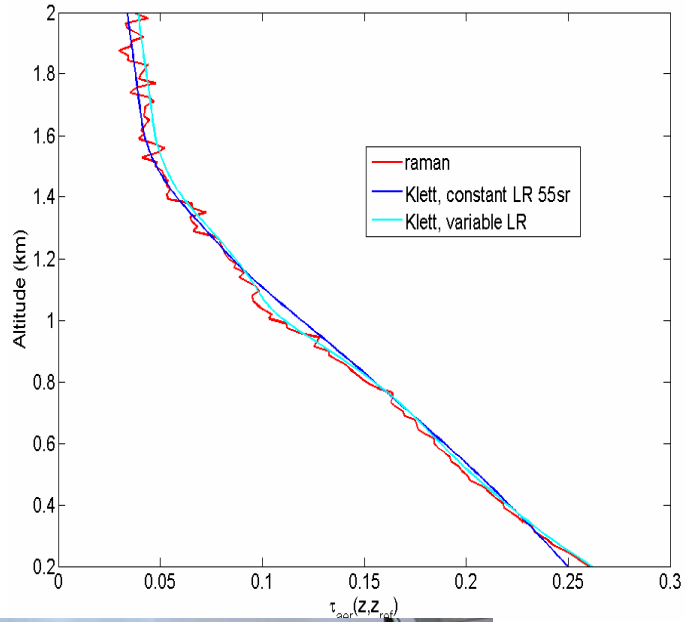
Automated lidar project for Corsica

⇨ **355 nm elastic (incl. polar) + Raman-N2**



(courtesy of Patrick Chazette)





A similar instrument will be implemented in Corsica

Aircraft operations (1/2)

⇨ French Falcon-20 aircraft

- MOZART-SAFIRE instrument for O3 & CO
- AMOVOC for VOCs (LISA)
- MOZAIC water vapour probe (FZJ-Julich)
- Micro aerosol backscatter lidar
- ALTO ozone lidar or LNG aeroso lidar
- Dropsonding system
- Aerosol passive remote sensor from LOA (OSIRIS)
- **New:** - Passive tracer releasing and sampling system from DLR (to be checked)
- - SPIRIT spectrometer from LPCE for H2O, O3, CO2, CO, CH4, N2O and NO2 or HCHO and HNO3

⇨ French ATR42 aircraft

- MOZART-SAFIRE for O3 and CO
- MONA for NOx/NOy
- PTRMS and AMOVOC for VOCs
- Airborne sun photometer PLASMA (LOA)
- Aerosol kinetic inlet with aerosol payload (LISA or LAMP-CNRM) and AMS (LACE-Villeurbanne or MPI)
- Aerosol filter sampling (LISA, LGGE)

Aircraft operations (2/2)

⇨ LSCE Ultralight ?

- Aerosol lidar measurements (355 nm)
- In situ scatterometer (870 nm)
- In situ meteorological measurements
- Broadband radiative fluxes

AMMA SOP-0, Niamey airport

⇨ FZK Ultralight (W. Junkermann) *TBC*

- In situ meteorological measurements
- In situ gas measurements: O_3, CH_2O, CO_2
- In situ aerosol size distribution and optical properties
- Upwelling and downwelling actinic fluxes from 290 to 700 nm
- Spectral albedo from 320 to 1000 nm (5 channels)
- Shortwave radiation balance
- Eventually infrared radiation (pyrgeometer)

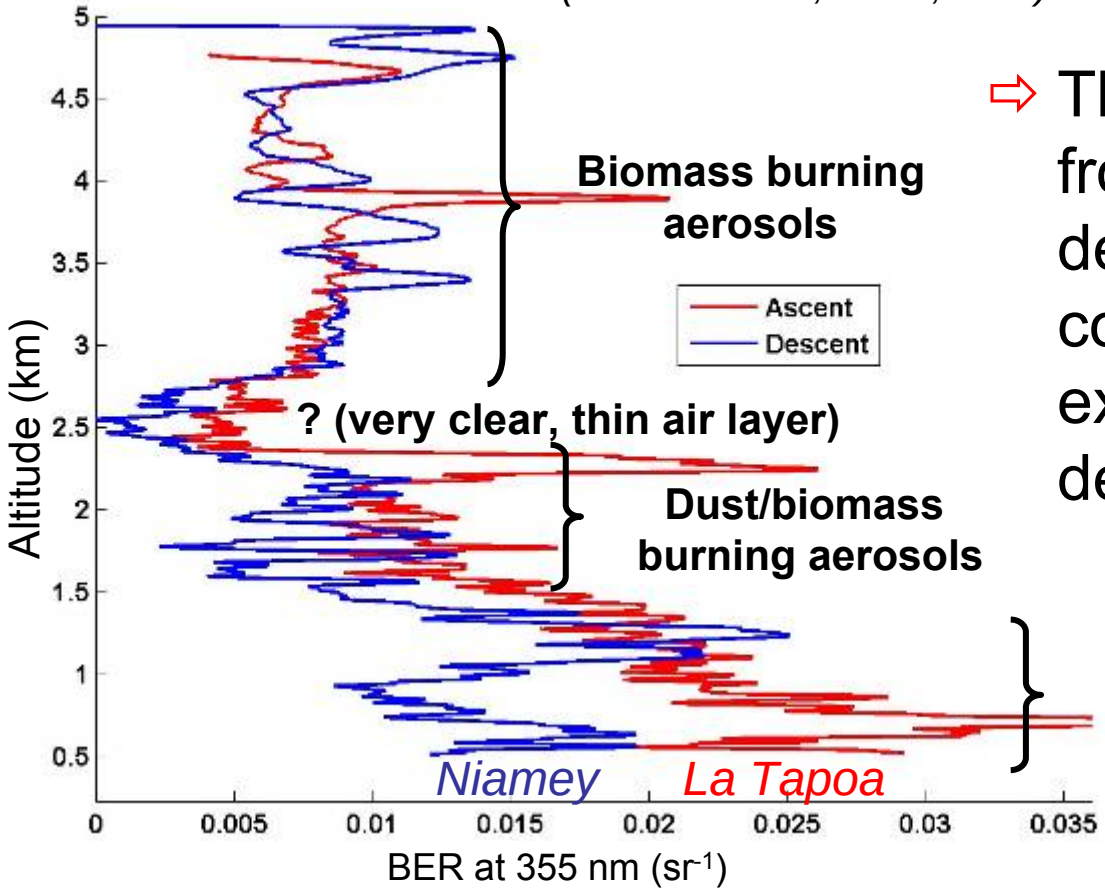
⇨ D-HALO and UK-BAe146 under discussion

⇨ Flight plans will include “lagrangian” plume studies, column chemical and optical closures, satellite validation

Backscatter to extinction lidar ratio retrieval

⇨ Horizontal pointing of the lidar during ascent and descent allows the retrieval of the extinction profile

(Chazette et al., ES&T, 2007)



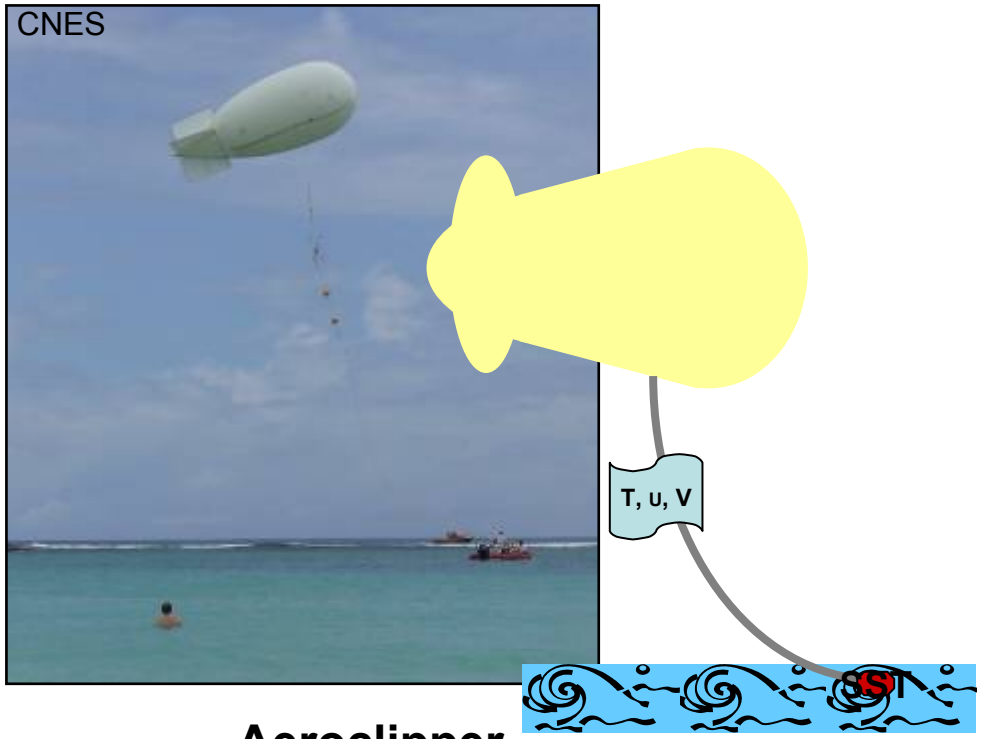
⇨ The closest lidar profiles from the ascent or descent are used in combination with the resp. extinction profiles to derive the BER

⇨ June 2007 CALIOP validation campaign *(Chazette et al., JGR, subm.)*

ChArMEx drifting balloons

Pressurized balloons (BP)
(up to ~3 km)

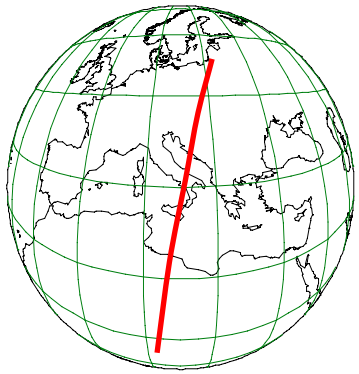
GPS, P, T, U
Aerosol optical counter/sizer
Brodband ↑ and ↓ shortwave
and longwave fuxes

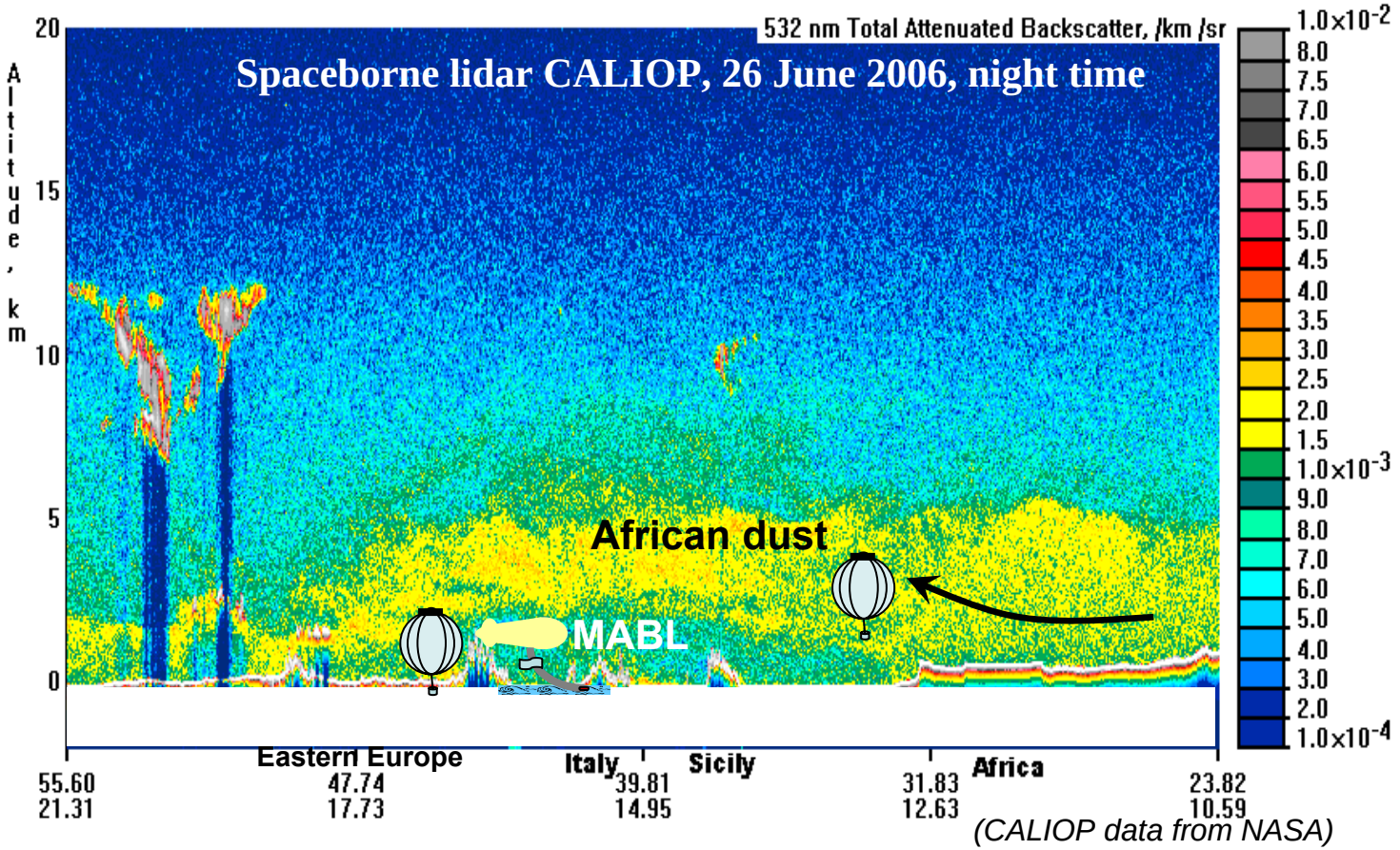


Aeroclipper

Surface fluxes
GPS,
SST
T, U, q at ~10 m (h to be known)
aerosol counter and radiation ?

Balloon strategy





(CALIOP data from NASA)

⇨ **+ radiosounding O_3 (and aerosol?) balloons from Ajaccio**

- **1 per week during EOP, 2 per day during SOPs**

⇨ **+ UTLS transmed (Sicily-Spain) stratospheric balloon:**

- **1 per SOP, SPIRALE (O3, CO, CH4, CH2O, OCS, N2O, NO2, HNO3, HCl)**

Possible cooperation with Earlinet stations during campaigns with a mobile system

- **P. Chazette's instrumented van**

Lidar system under development:

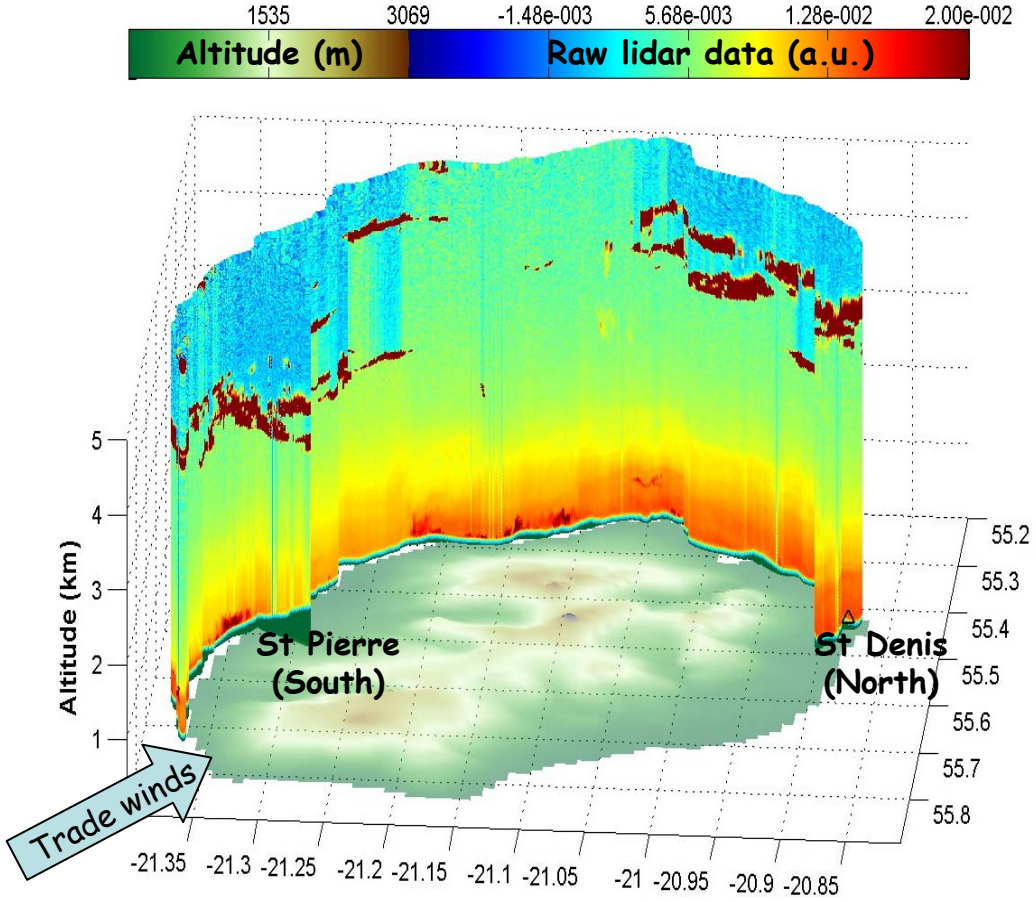
- 3 elastic channels (β)
- 2 N_2 Raman channels (α)

+ in-situ measurements (size distribution, aerosol chemistry, nephelometer, aethalometer, PM_{10} and $PM_{2.5}$…)

Alternative: a light mobile lidar system

Example: Planetary boundary layer on Reunion island

Objectives: air quality (anthropogenic emissions and volcano)



(courtesy of Patrick Chazette)

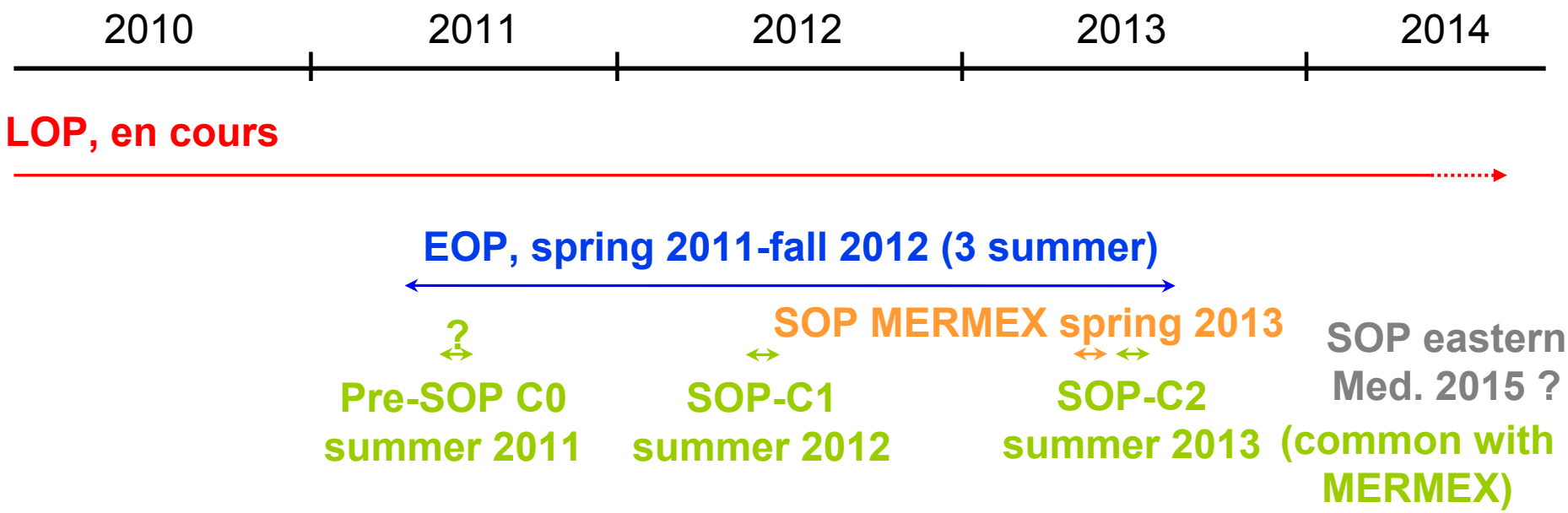
Lidar network ?

- ⇨ Benefit from Earlinet Mediterranean stations for long term survey (cooperation agreement ?)
- ⇨ Additional measurements on alert during intensive campaigns ?

- ⇨ New lidar stations to be implemented in Corsica, Majorca, and possibly North Africa to improve the coverage of the basin
- ⇨ A study of CCN combining ground-based and lidar data (Methodology of Roberts, Gomes et al., Météo-France)

ChArMEx 2010-2014 operation planning

- ⇨ **2009-2010: national and international funding requests**
- ⇨ **2010: new infrastructure for the Corsica observatory**



- ⇨ **Joint EOP with HyMeX and MERMEX**
- ⇨ **ChArMEX SOPs in alternance or joint with HyMeX-MERMEX SOPs during the joint EOP**

ChArMEx schedule

- 2009: preparatory phase funded by INSU
- 1st ChArMEx international workshop (early July 2009 in Toulouse)
  - Working meeting: posters and round-tables
- Rad. Budget science WG meeting, Paris, 12-13 Oct.
- Lidar task team meeting, Delft, 21 Oct.
- PRIMEQUAL: funding of first actions is pending
- INSU call end of Oct. 2009
- Reply to FP7 Environment (on going, deadline early 2010)
- Early 2010: integrated international project doc., coordination of national contributions
- ChArMEx 2nd international workshop (mid 2010), MISTRALS 1st int. workshop (late 2010)

https://charmex.lsce.ipsl.fr/

What is ChArMEx

First International Workshop

Documents

Links

Contacts