Climate sensitivity of different organic aerosol schemes over the Mediterranean basin

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MISTRAL – 17 october 2017

Introduction/Questions

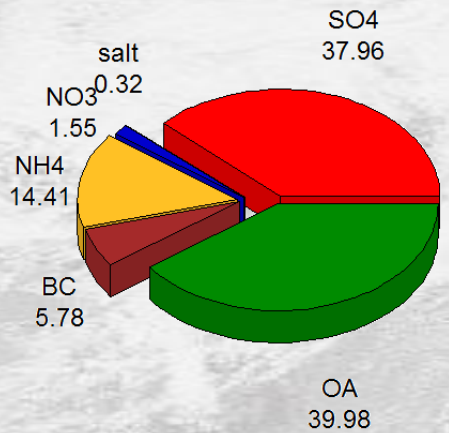
Climate change → important impacts on air quality

Pollutants → major climate forcing agents

Mitigating climate change ↔ impacts on air quality

PMs → one of the most important factors for air quality

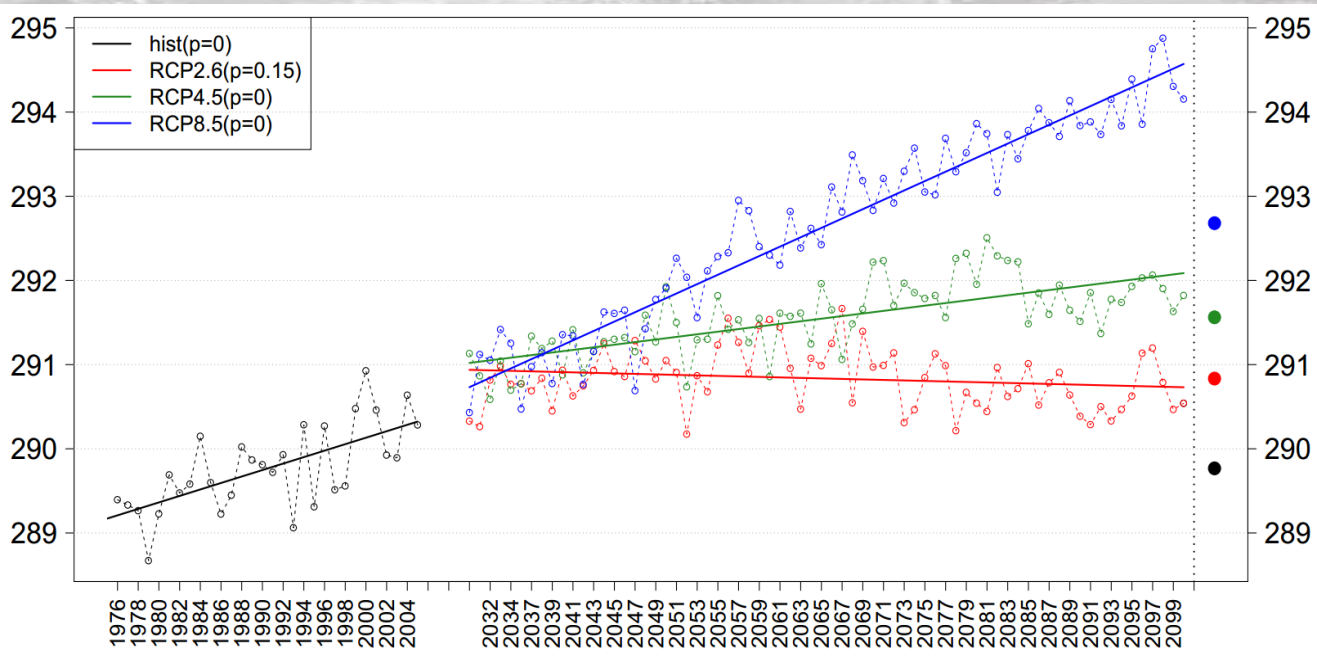
OM in the mediterranean → important part of the PM



PM1
Cap Corse
July-august 2013

Questions :

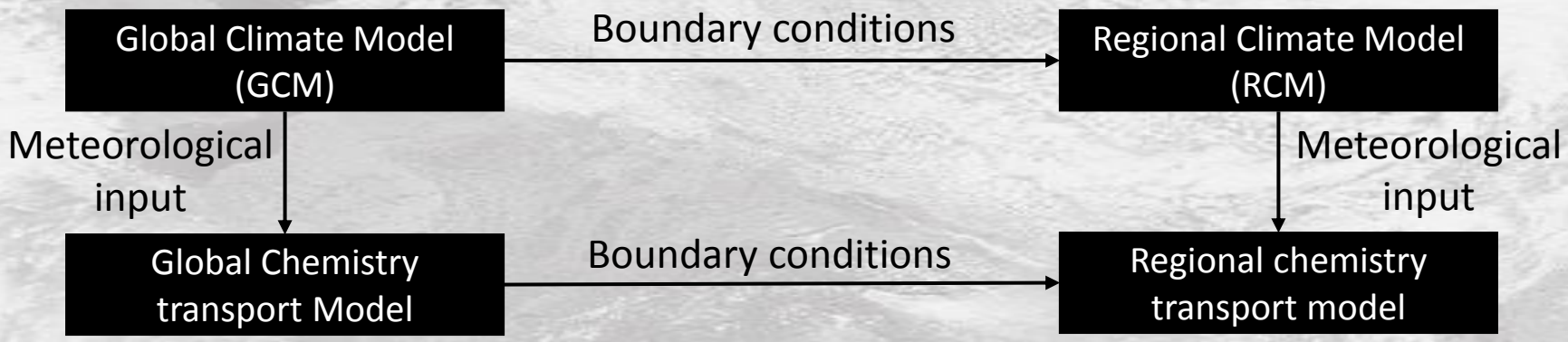
- What are the effects of climate change
  - On future $PM_{10}/PM_{2.5}$ concentration
  - On different components of $PM_{10}/PM_{2.5}$?
  - On these factors if organic simulation scheme is changed?



RCP → Representative Concentration Pathways
*https://cmip.llnl.gov/cmip5/index.html

RCPs * → RCP2.6 : radiative forcing till 2100 fixed to 2.6 $W.m^{-2}$
RCP4.5 : radiative forcing till 2100 fixed to 4.5 $W.m^{-2}$
RCP8.5 : radiative forcing till 2100 fixed to 8.5 $W.m^{-2}$

Modeling framework for climate impact study



Name	Global Climate model	Global Chemical transport Model	Regional Climate Model	Regional chemistry transport model	Anthropogenic emissions	Biogenic emissions	Organic aerosol scheme
Historic (1976-2005)	IPSL-CM5A-MR	LMDZ-INCA	WRF historic	CHIMERE 2013-b	ECLIPSE-CLE 2010	MEGAN-v4.02	CHIMERE Standard scheme
RCP2.6 (2030-2100)			WRF RCP2.6				
RCP4.5 (2030-2100)			WRF RCP4.5				
RCP8.5 (2030-2100)			WRF RCP8.5				

RCP → Representative Concentration Pathways

The Chimere chemistry-transport model

input data

domain

configuration

Concentration for different altitudes/species

Emissions

ECLIPSE

MEGAN

Boundary Conds.

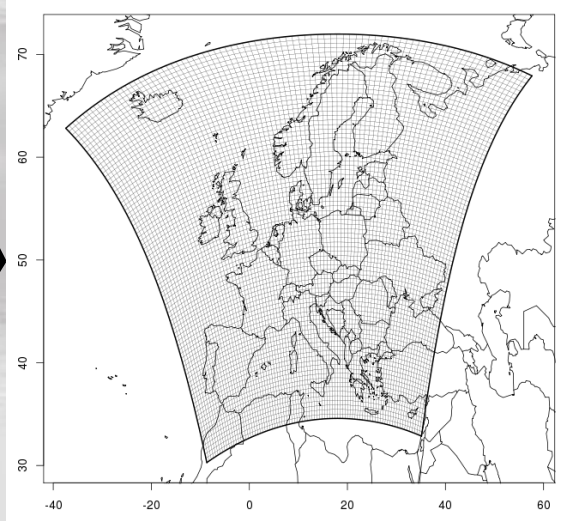
INCA

Meteorology

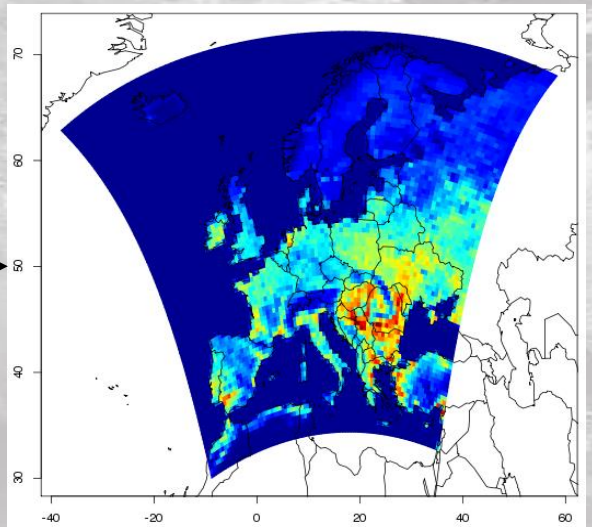
WRF

Institut Pierre Simon Laplace

L-IPSL Labex

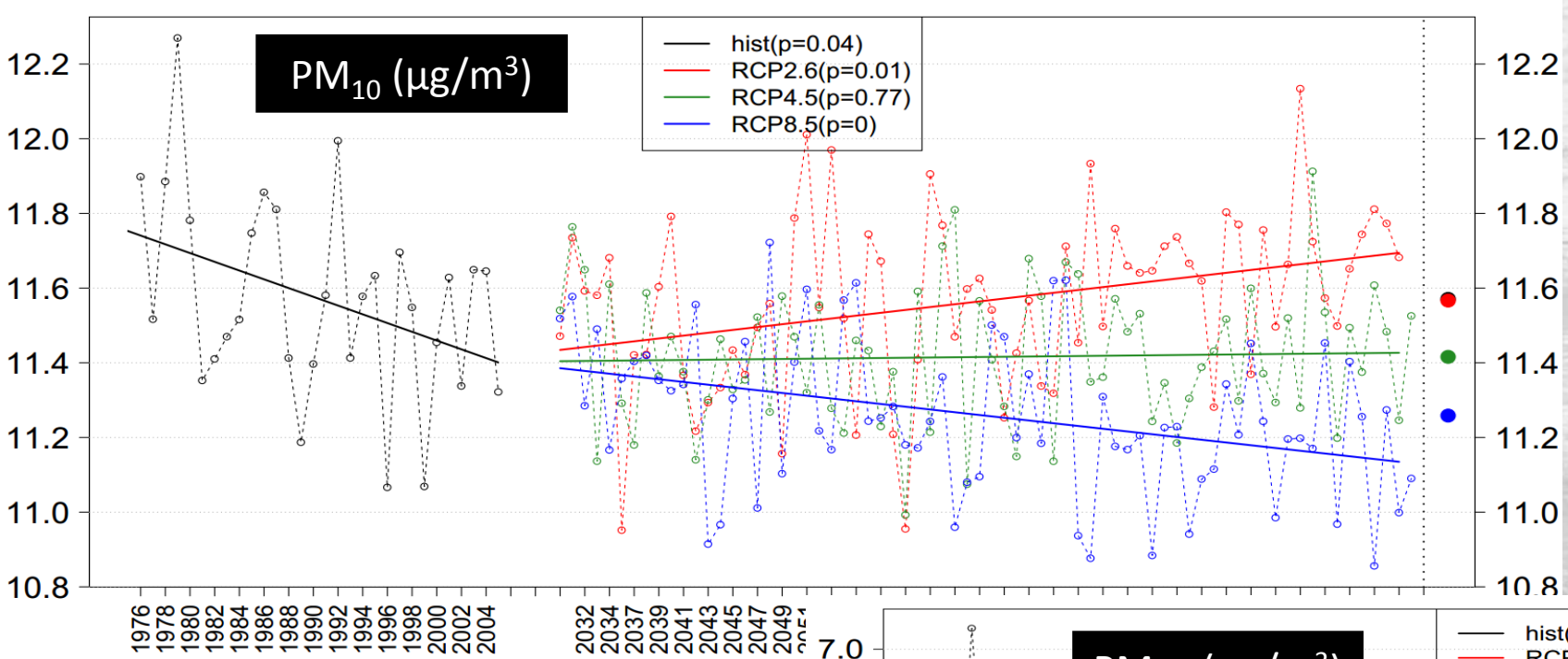


Domain horizontal resolution : 0.5°

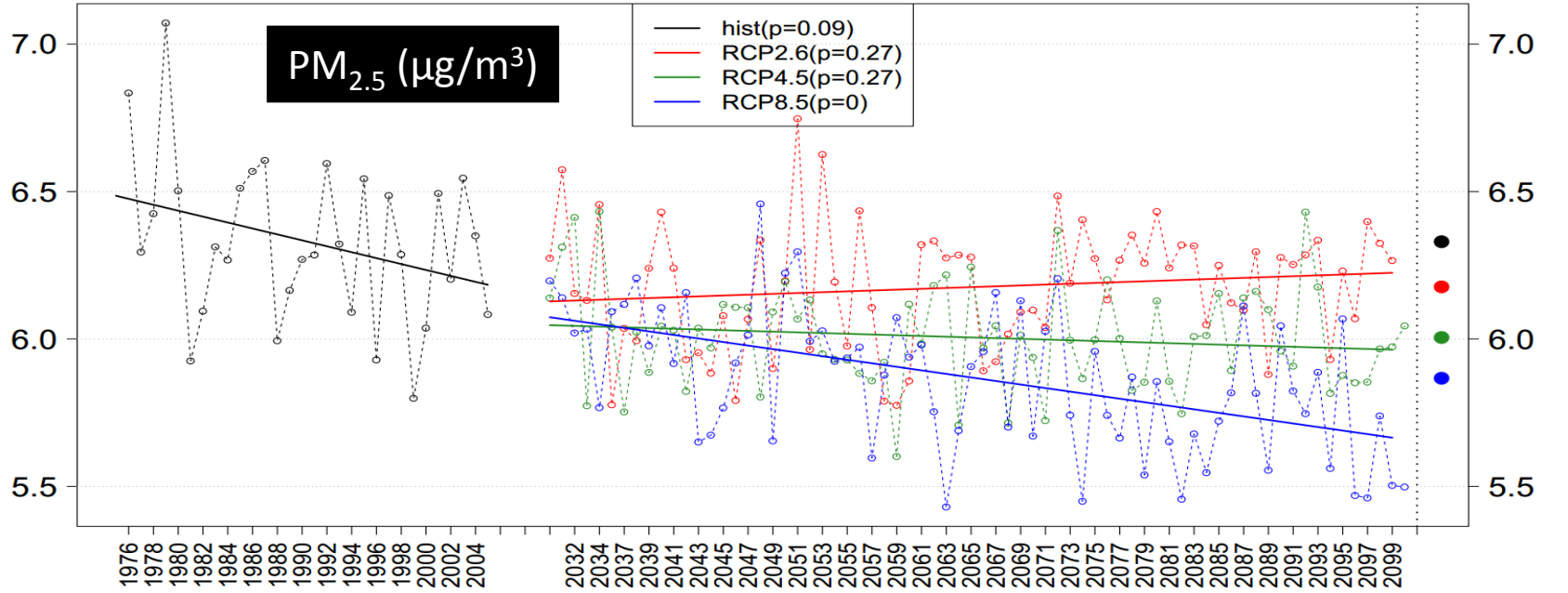


Vertical levels : 9 (997 – 500 mb)

Climate effects on $PM_{10}/PM_{2.5}$

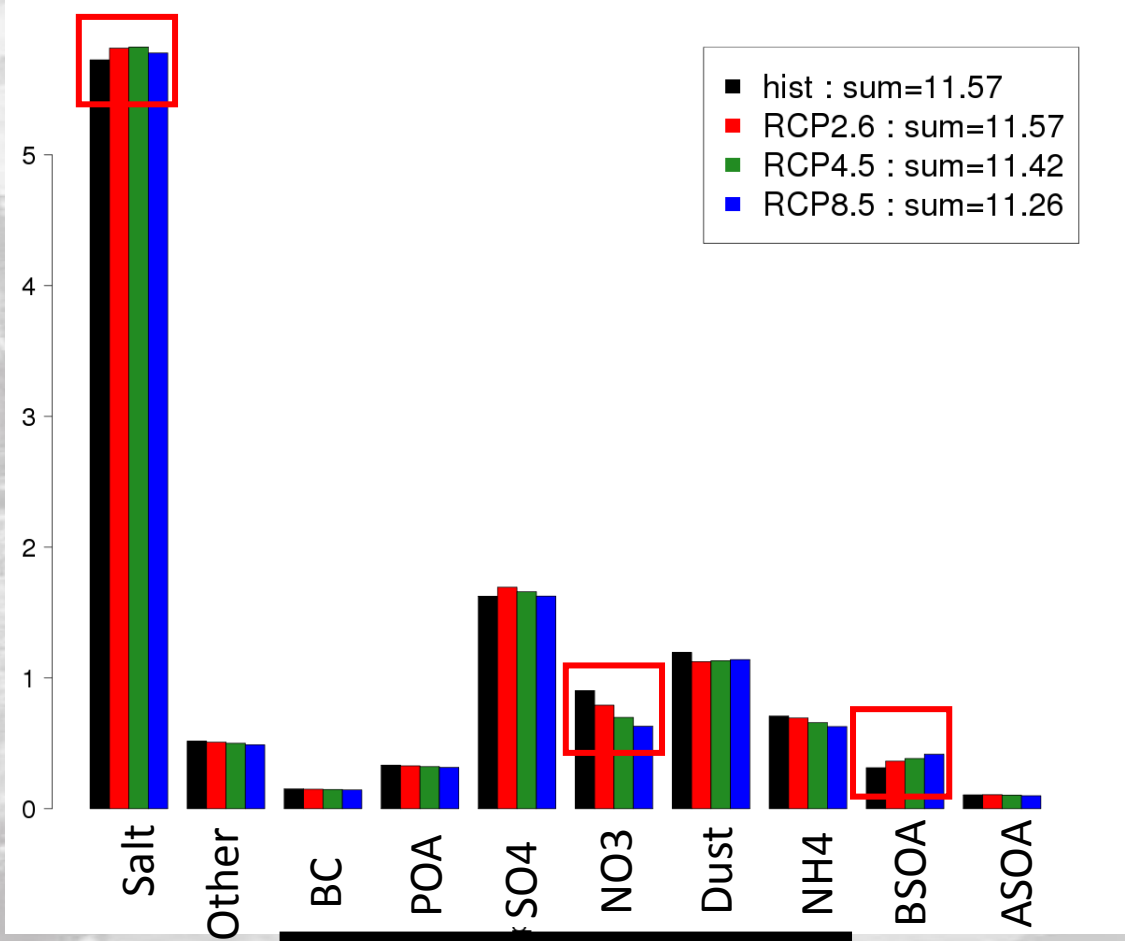


Average on whole domain



- Decreasing trend of PM for RCP8.5, Increasing trend for RCP2.6, constant trend for RCP4.5
- Compared to historical average :
  - All scenarios show a decrease

Climate effects : PM_{10} different components



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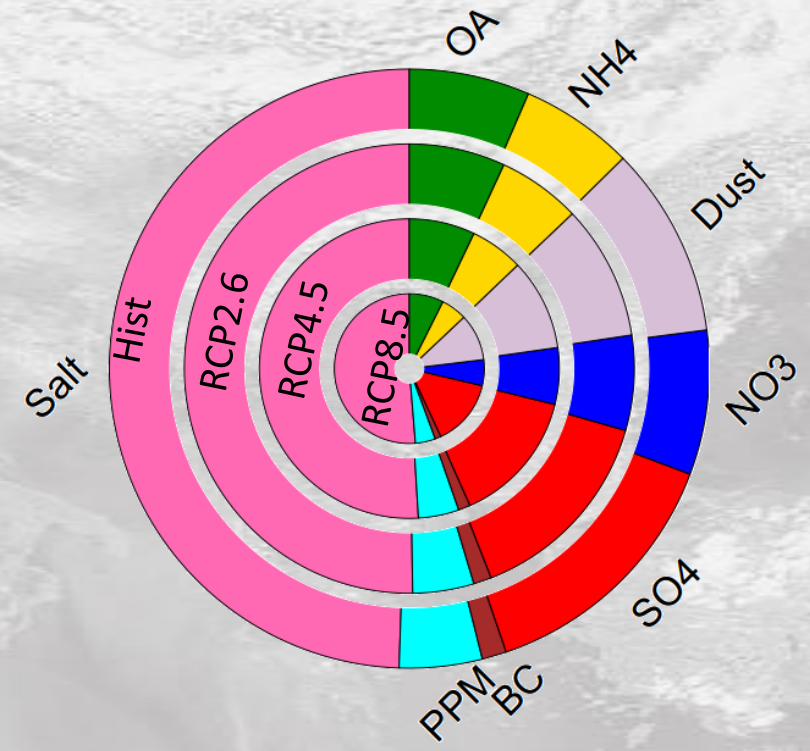
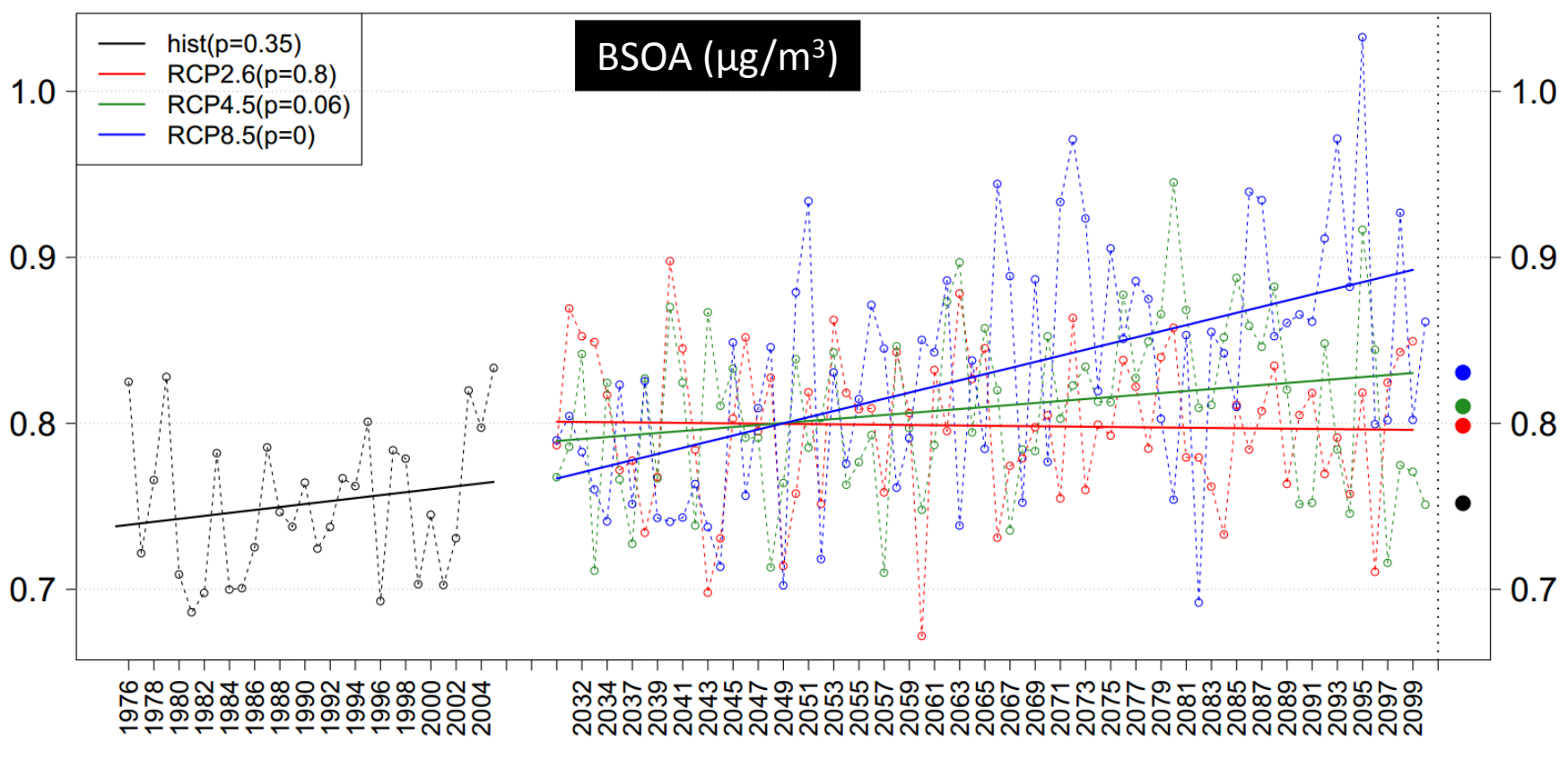


- Distribution of PM_{10} in different scenarios stays quite similar

- Increase in Salt, Biogenic SOA, sulfates
- Decrease in nitrates, dust

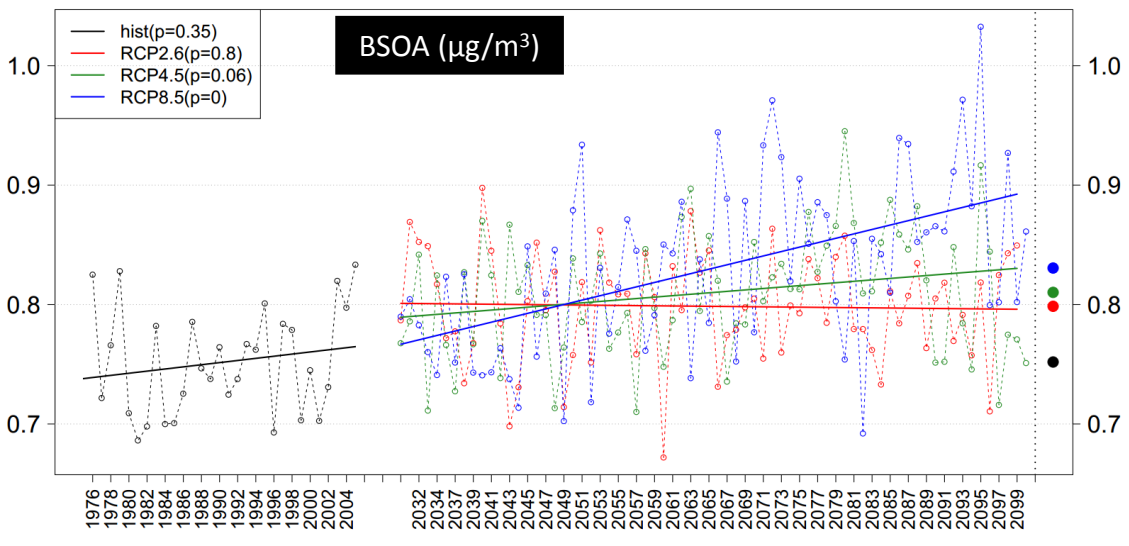
Climate effects : PM_{10} BSOA



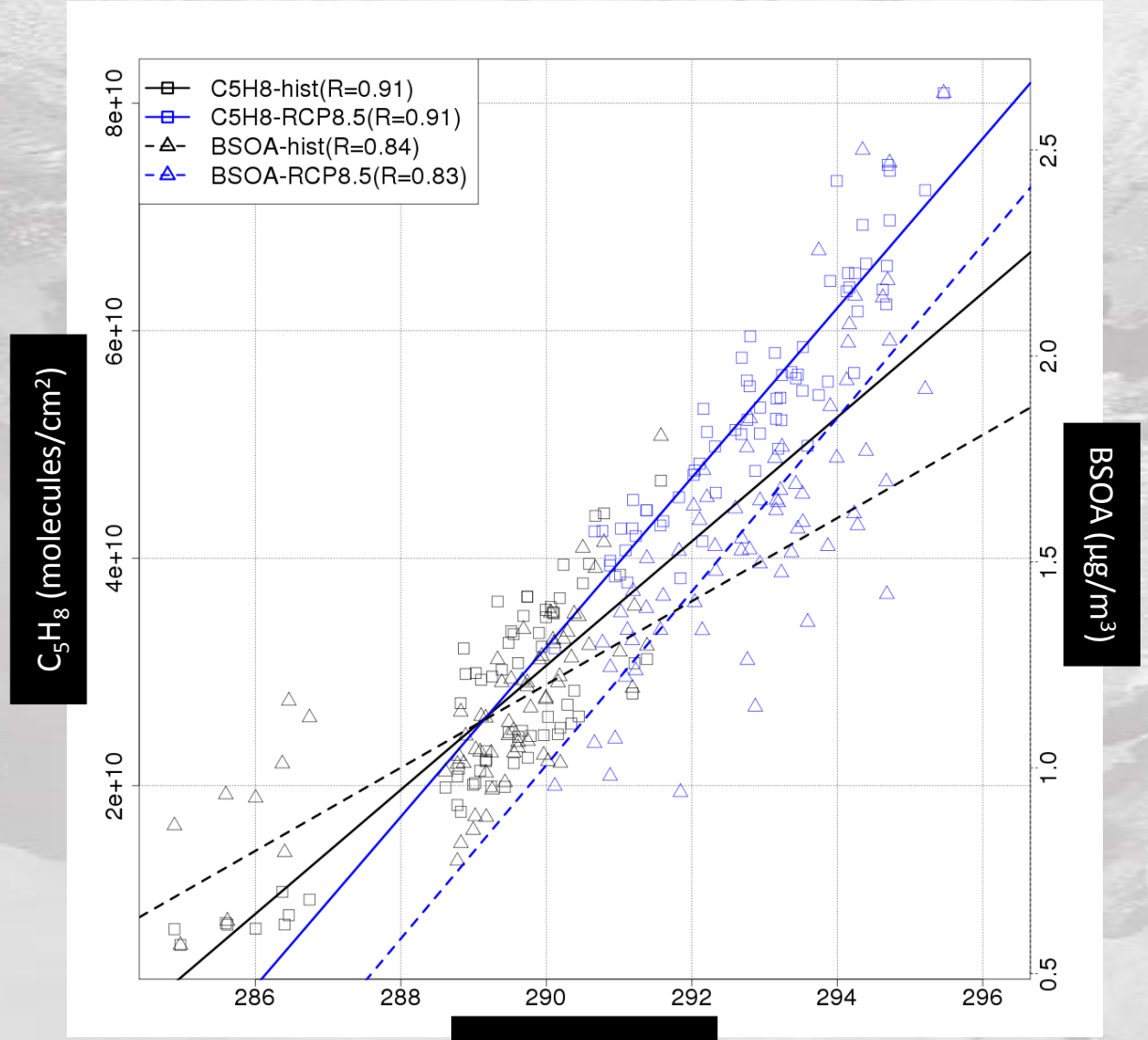
Average on whole domain

- Compared to historic simulations : Increase in all scenarios
- Significant trend line for RCP4.5 and RCP8.5
- Non-significant for RCP2.6

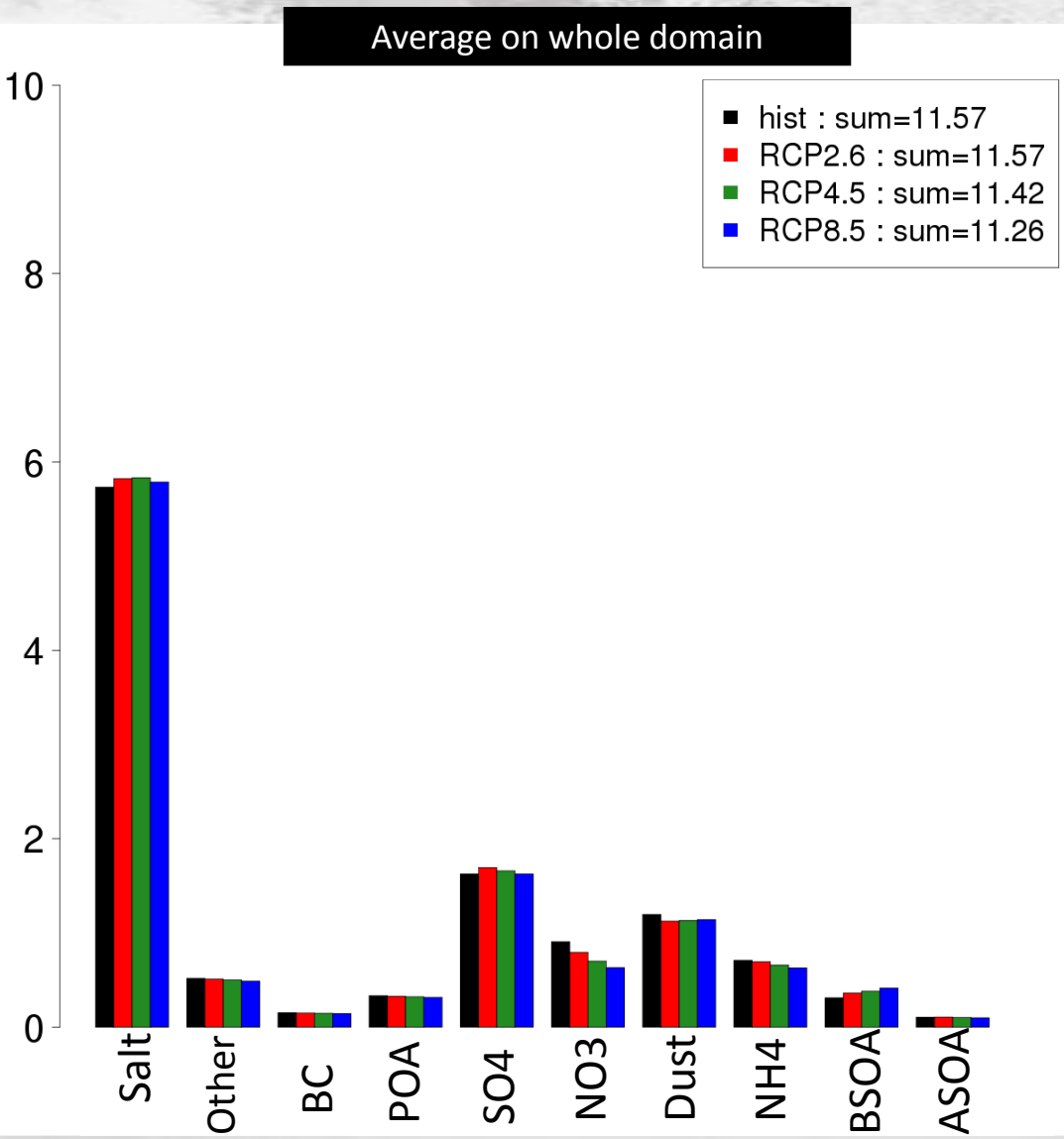
Climate effects : PM_{10} BSOA

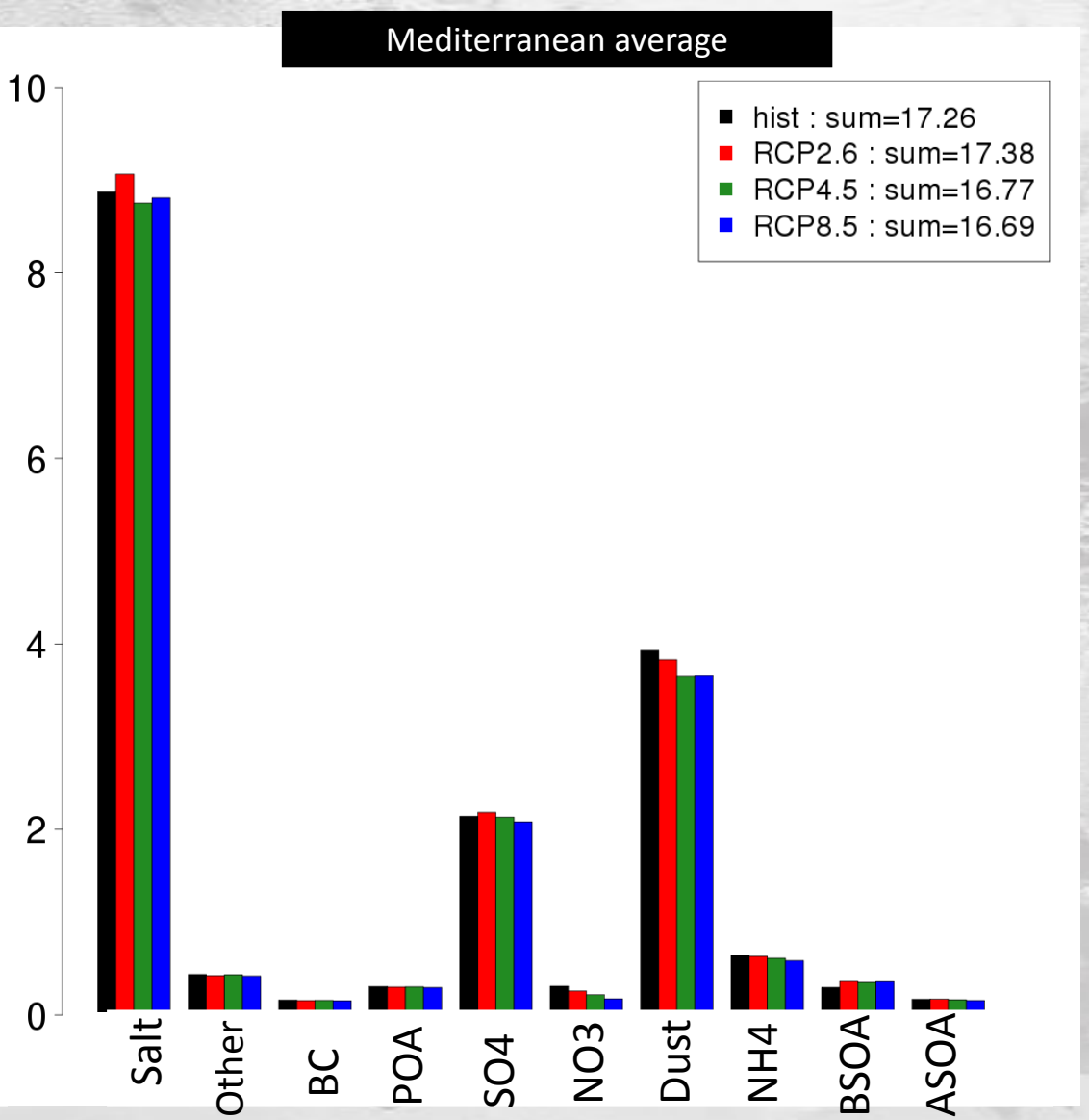


Average on whole domain



Climate effects : Sub-domains





Modeling framework for scheme impact study

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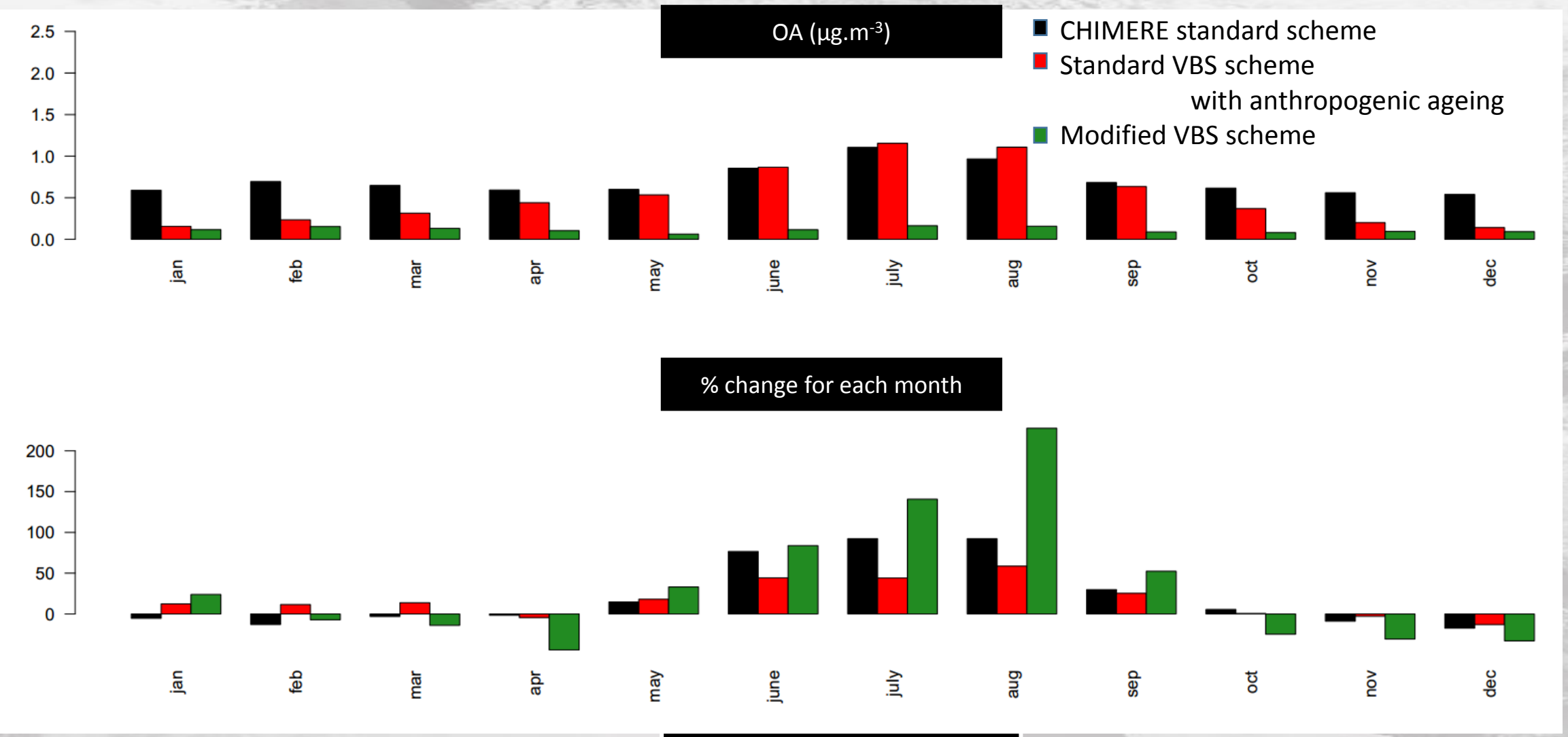
Historic (1976-2005)	IPSL-CM5A-MR	LMDZ-INCA	WRF historic	CHIMERE 2013-b	ECLIPSE-CLE 2010	MEGAN-v4.02	CHIMERE Standard
RCP8.5 (2030-2100)			WRF RCP8.5				
Historic (coldest 5 years)			WRF historic	CHIMERE 2014-b			VBS with anthropogenic aging
RCP8.5 (hottest 5 years)			WRF RCP8.5				
Historic (coldest 5 years)			WRF historic				Modified VBS
RCP8.5 (hottest 5 years)			WRF RCP8.5				

RCP → Representative Concentration Pathways
VBS → Volatility Basis Set

Scheme effects : monthly differences between schemes



RCP8.5 simulations
Average for whole domain

Conclusions/perspectives

- Climate effects :
  - $PM_{10}/PM_{2.5}$ decrease compared to historical simulations, but trends show an increase for RCP2.6, a decrease for RCP8.5 and constant trend for RCP4.5.
  - BSOA increases with temperature increase, while nitrates decrease.
  - Seasalt increases as a result of wind increase in the model
  - The mediterranean area shows higher dust and salt particle concentrations, while lower BSOA and nitrates concentrations.

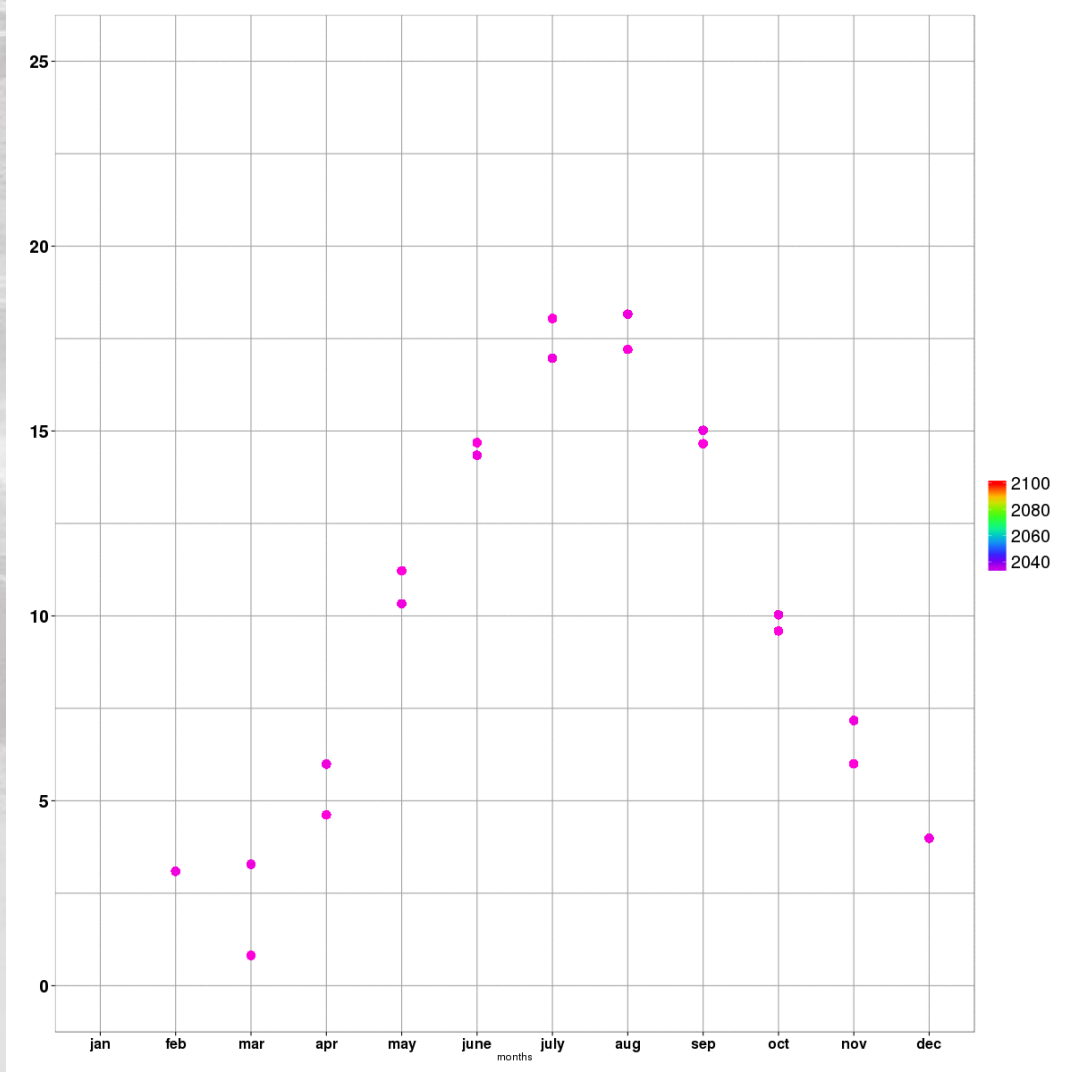
- Scheme effects
  - The monthly changes in BSOA averages change intesely with scheme change

- Perspectives :
  - High resolution simulations are to be done on the mediterranean coasts of France to see the effects of emission/land use changes on population.

Thank you for your attention !

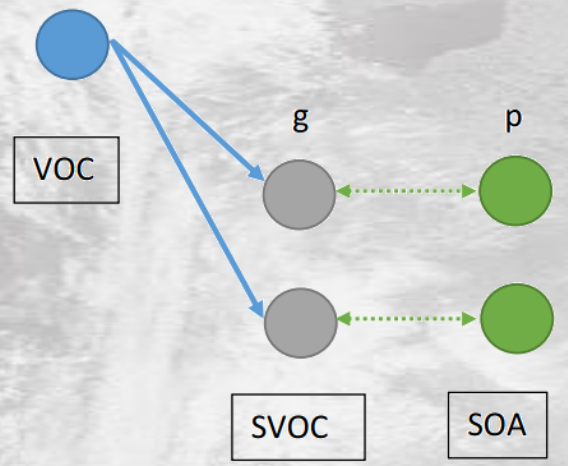
This work was performed using HPC resources from GENCI-[TGCC/CINES/IDRIS] (Grant 2017- t2015017232).

Introduction/Questions



Used SOA schemes

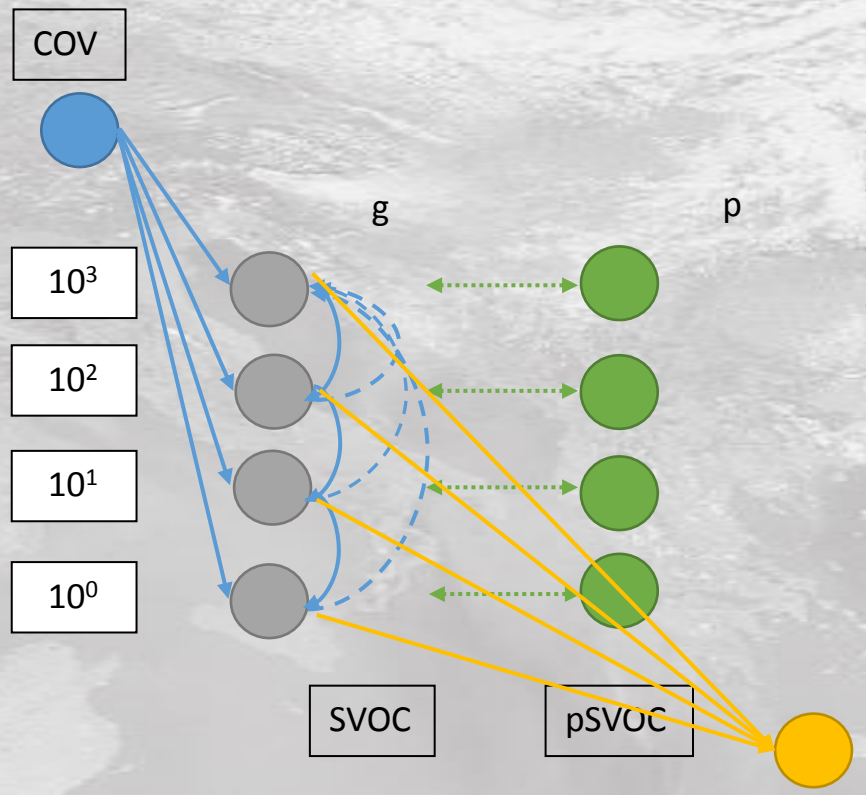
CHIMERE standard scheme



Emissions
Semi-volatile in gaseous phase
Particles
Non-volatile SOA

Functionalization
Gaz/particle distribution
Fragmentation
Non-volatile SOA formation

Pun et seigneur 2006



VBS standard
+anthropogenic ageing
+ biogenic ageing
+fragmentation
+non-volatile SOA formation

Robinson et al 2009
Shrivastava et al 2015

3 schemes are compared:
1. CHIMERE standard scheme
2. VBS scheme without BSOA ageing
3. Modified VBS scheme

Climate effects : Sub-domains

All → average on whole domain

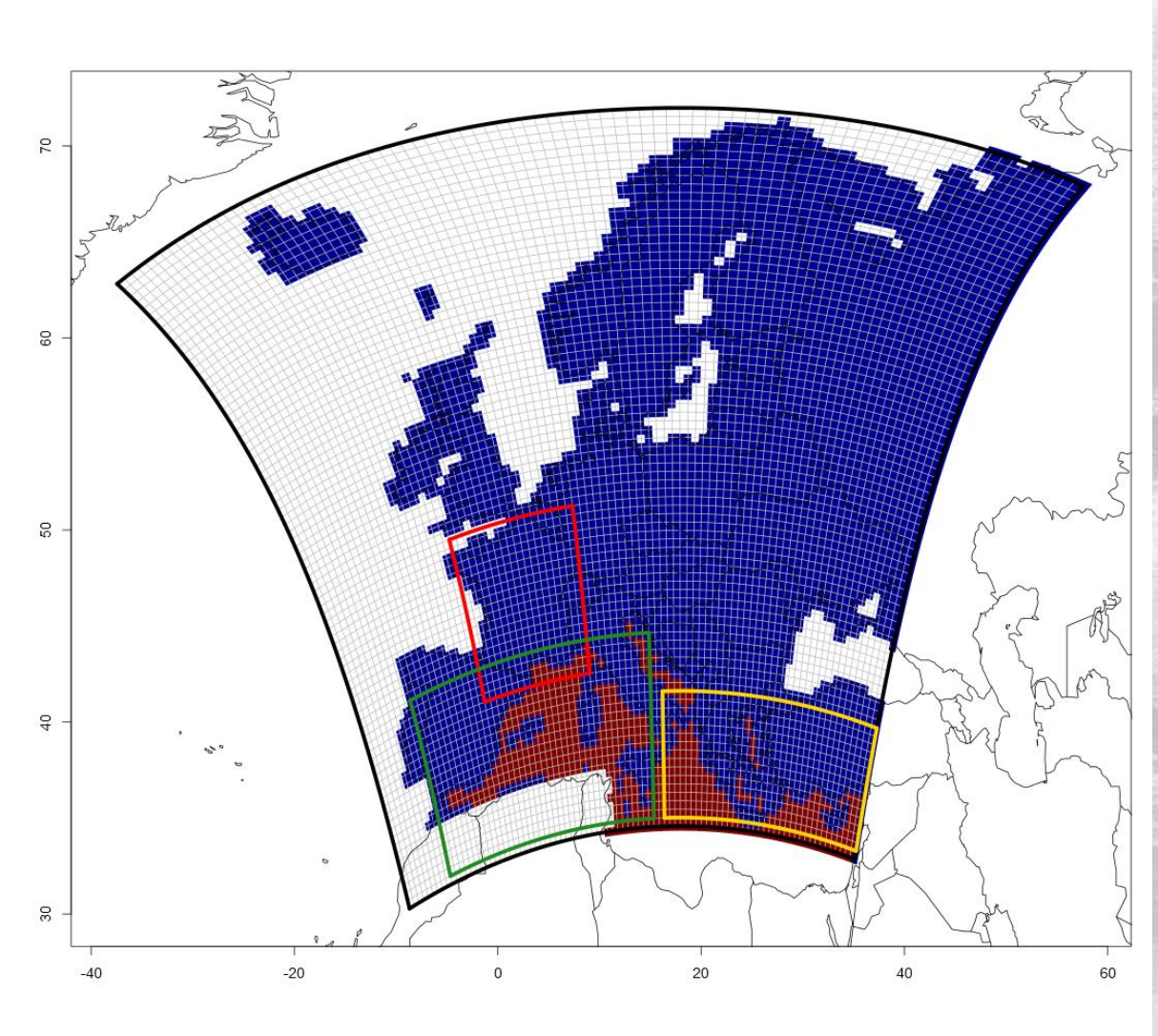
Eur → average on Europe, land-sea mask

Med → average on mediterranean, land-sea mask

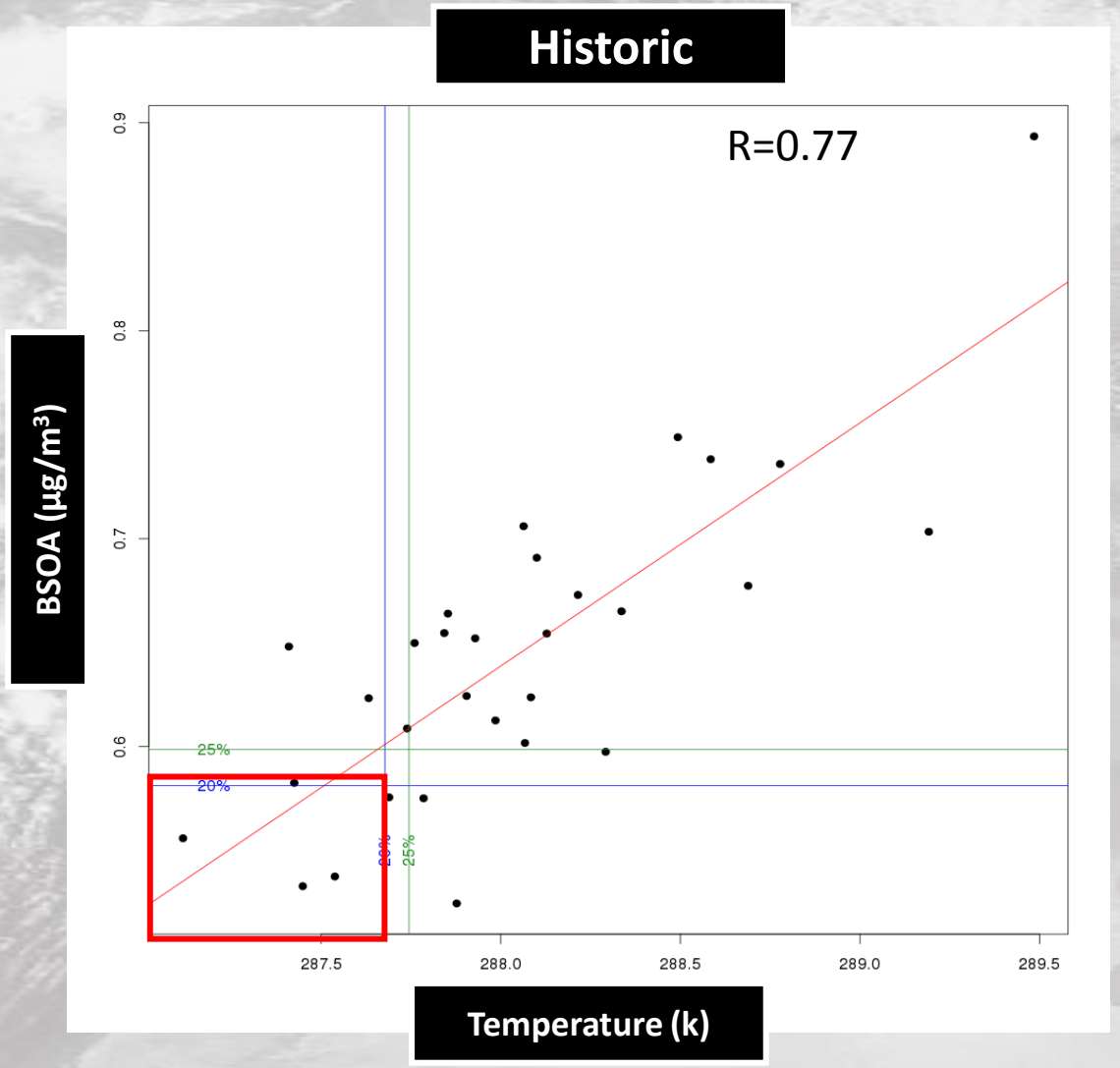
Fr → France

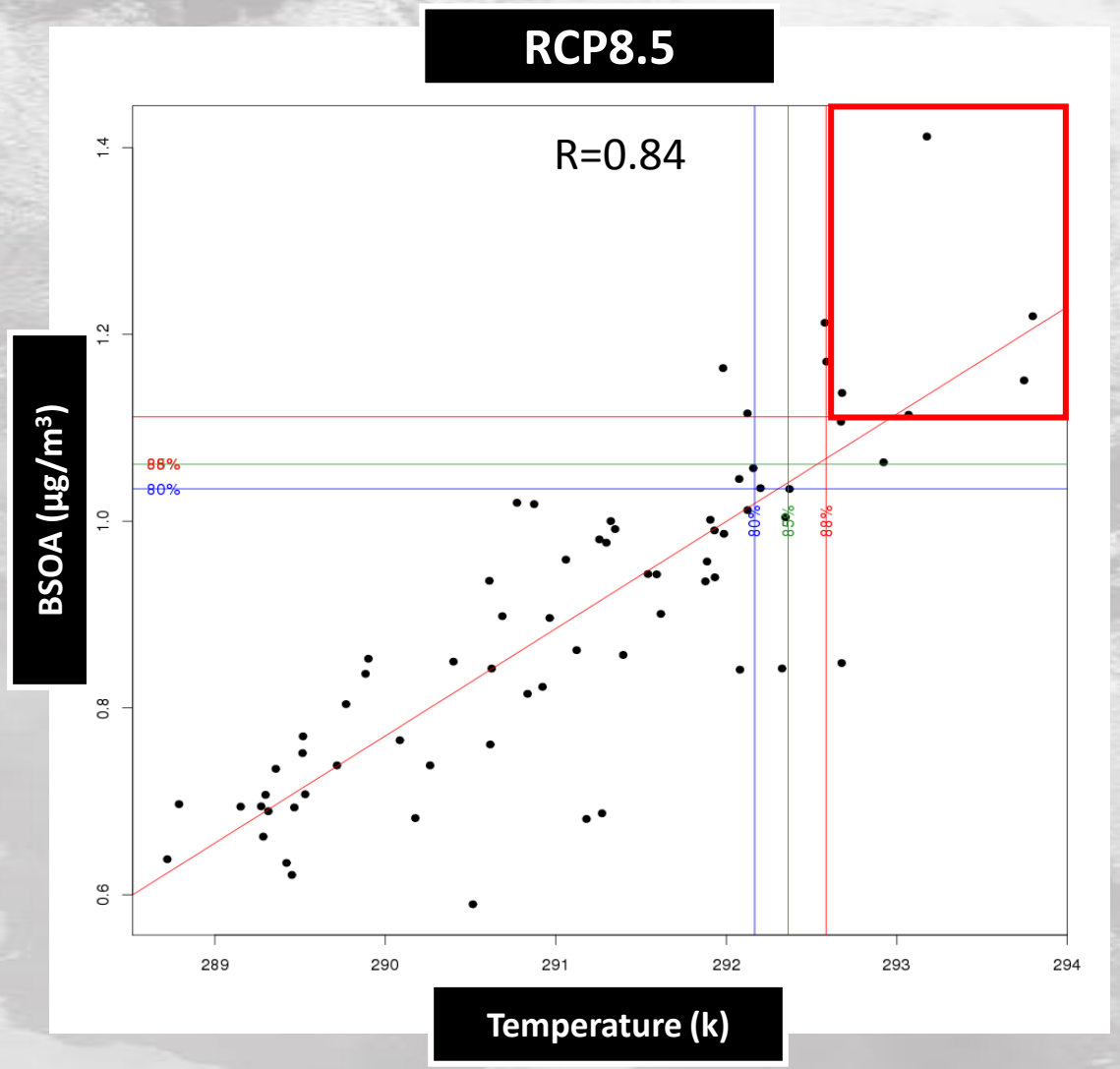
MedW → averagne on western mediterranean

MedE → average on eastern mediterranean

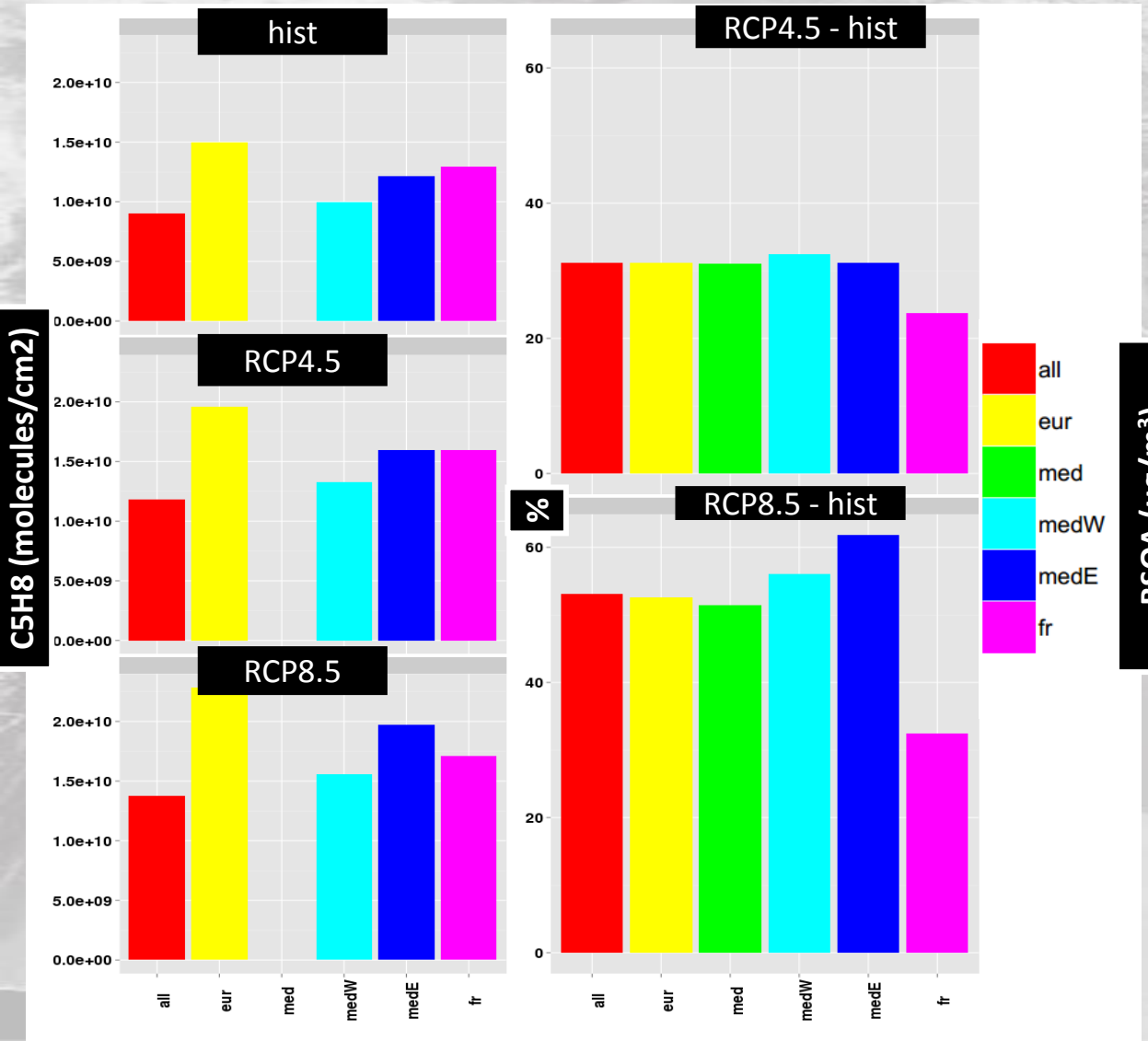


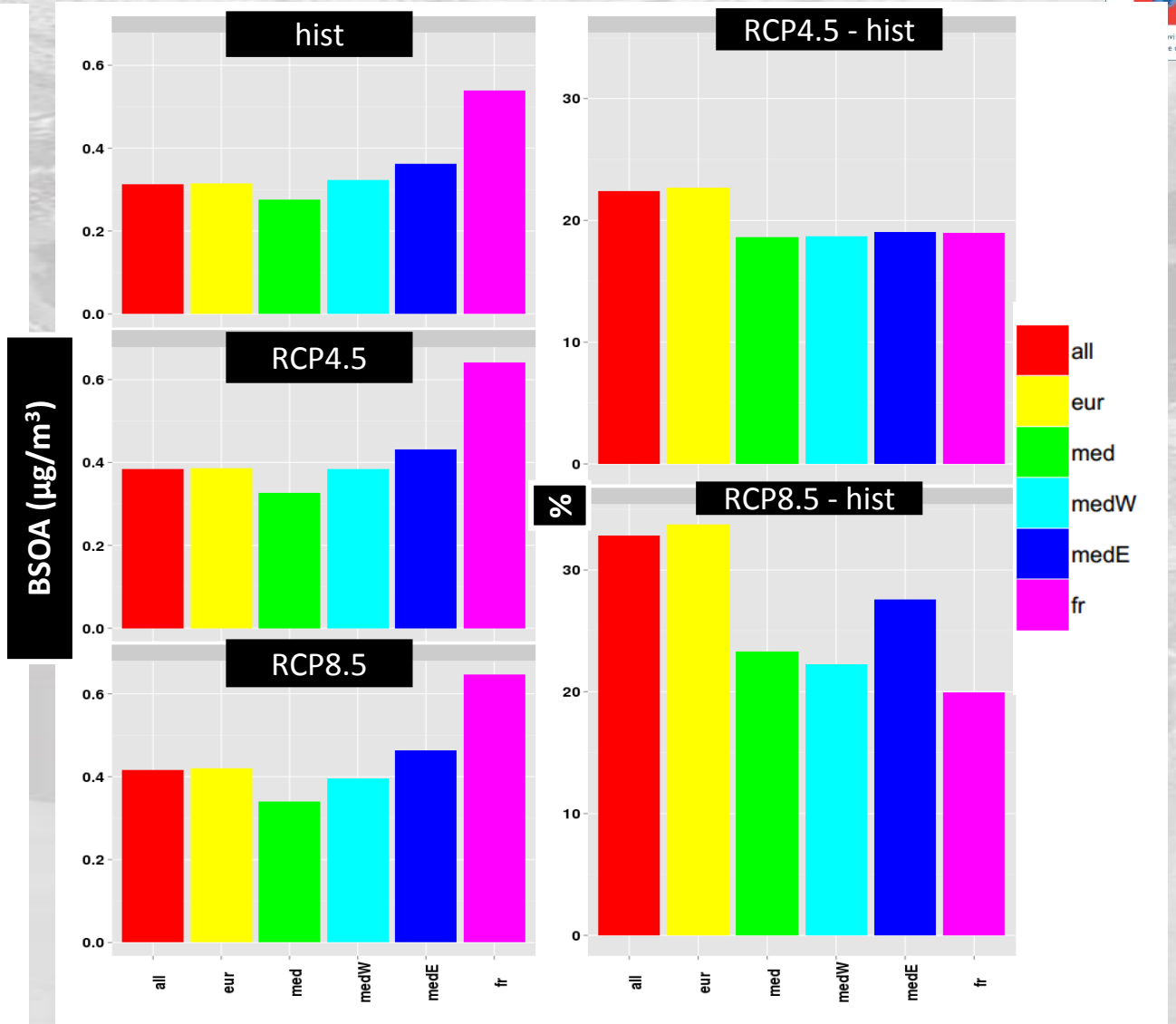
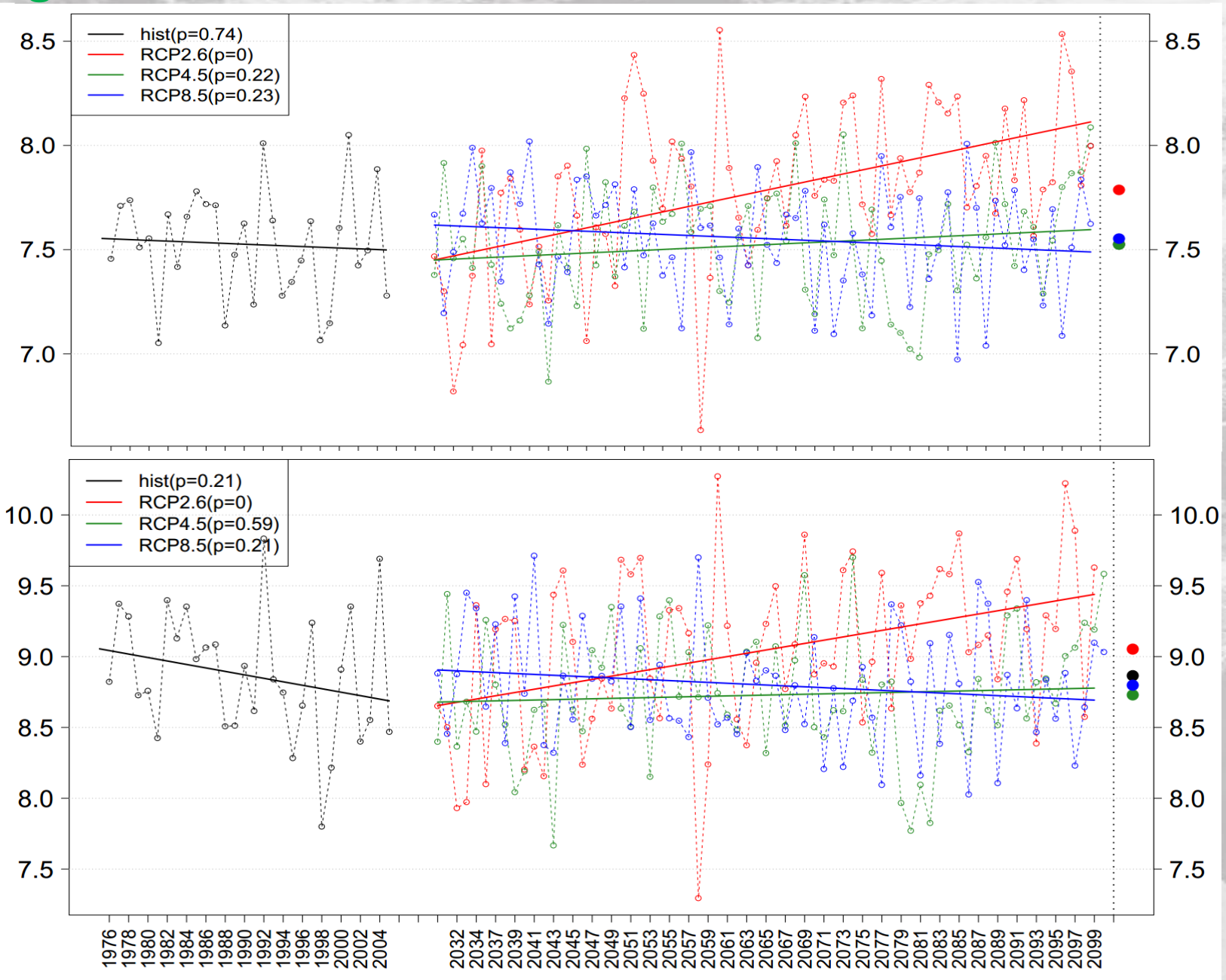
Scheme effects : Sampling protocol for years





Climate effects : PM_{10} BSOA for subdomains





Salt changes