The Mediterranean basin.

- Diversity of emissions sources and chemical transport pathways
- Active photochemistry.
- Climate change hot spot.
- MedCORDEX Flagship Pilot Study:
  - MISTRALS IMPACTCC

-Role of the natural and anthropogenic aerosol in the Mediterranean region: past climate variability and future climate sensitivity

-Related outcomes include impact on regional air quality, energy production, biogeochemical impacts …

(1) Can we fully characterize the Mediterranean aerosol past variability and future evolution at climate scales? in particular using RCMs.

(2) Can we understand the role of the Mediterranean aerosols on the past regional climate variability? including issues related to regional climate change attribution and aerosols representation in climate models (GCM, RCM).

(3) Can we determine the role of regionally-born aerosols in the Mediterranean future climate sensitivity? in particular using RCMs as complementary approach to GCMs.

(4) What is the aerosol role in shaping the Mediterranean extreme events? (e.g. heat waves, heavy precipitation events)
Protocol 1: External Aerosol Forcing
(Prescribed Aerosol Climatologies)
1.A: Hindcast runs
1.B: Historical + Scenarios
including or not aerosol trends

Status 1.A:
CNRM-RCSM4 (done)
RegCM4 (in prep)
...

Status 1.B: most advanced, analysis going on
CNRM-ALADIN63 (done)
WRF-AUTH (done)
REMO2015 (done)
COSMO-CLM (done)
RegCM4 (finishing)
RACMO22E (running)

Status 2: Fully Interactive Aerosol
(On line approach)
2.A: Case studies (3 month test cases)
2.B: Hindcast runs
2.C: Historical + Scenarios
including emission evolutions

Status 2.A: ADRIMED – Analysis going on
CNRM-RCSM (done)
MOCAGE (done)
CHIMERE (done)
WRF-Chem (done)
RegCM4 (done)
COSMO-GMXe (done)
MesoNH (done)
IFS (done)

Status 2B-2C: CNRM-RCSM (done)
RegCM4 (new batch in prep)

17 participating groups - on going work-
cordexfps-aerosol@hymex.org
 Protocol 1.a : Single model study of aerosol trends impact on regional climate change during the historical period

Impact of aerosol clim on mean regional climate
Nabat et al. 2015

Average 2003/2009
(with – without aerosols)

Left column: Impact of anthropogenic aerosol on surface temperature and precipitations simulated with the Aldadin regional climate model.

Right column: Accounting for anthropogenic aerosol aerosol trends (decrease over Europe) allows a better simulation compared to observed SST trends.

Interest for climate change attribution studies over Europe

Aerosol trend taken into account in the new med-CORDEX baseline simulations
Protocol 2.a: Towards better constraints on aerosol processes and future evolution in RCMs

Models do generally agree on a decrease of sulfate and carbonaceous aerosol levels in the future driven by a reduction of emissions.

For other species such as dust, nitrate/ammonium and SOA, there is much more uncertain, since climate and land use changes will also play an important role.

Intercomparison of RCM vs more comprehensive atmospheric chemistry models allow to explain some of the reasons for disagreement and potential ways to better constrain RCM.

- Models agree on SO4, BC, POA, SSLT
- Models disagree on NH4+ / NO3-
- Models disagree on DUST
- RCM miss SOA components

Chimere CTM driven by WRF/LMDZ-INCA RCP4.5 and eclipse CLE emissions, evolution of surface concentrations of different component and main drivers (horizon 2046-2055)

Cholakian et al., ACP 2019

Drugé, 2019

ChArMEX / CCIMED

Figure: CNRM-RCM, evolution of surface concentrations for different scenarios (CMIP6, horizon 2020-2050)

e.g.1 AOD intercomparison during June 2013 dust event

e.g. 2 Sea-spray surface concentrations (not for direct comparison)

ADRIMED : experimental campaign during JJA 2013 over the western Mediterranean,

- evaluation of different CTM/RCMs using in-situ surface & aircraft observations,

- evaluation on physical/chemical & optical properties,

- first evaluation/comparison on AOD and primary marine sea-spray emissions,
Anthropogenic aerosol contribution to the regional climate change signal simulated by Aladin RCM using an interactive aerosol scheme:

SLP anomaly driven by a decrease of European aerosol is consistent with GCM/PDRMIP sensitivity study of climate response to an increase of European sulfates.

Potential added values of RCM in simulating regional responses (e.g. here on surface solar radiative flux and surface temperature).

Added value of interactive aerosol schemes vs. prescribed aerosol climatologies? -> comparison of protocol 1.B and 2.C on-going
Conclusion

- Importance of anthropogenic aerosol trend for the simulation of a consistent surface temperature climate change signal over Europe

- Inter-comparisons going on aiming at a better assessment of RCM aerosol simulations

- Climate change studies going on with interactive aerosol schemes / evaluation of added values compared to prescribed climatologies.

- Participation still open if interested, we always seek for new participants to join!