# Coupling COSMO-CLM with NEMO for the North and Baltic seas

**Trang Van Pham[1], J. Brauch[2], B. Früh[2], B. Ahrens[3]**

[1] LOEWE - Biodiversity and Climate Research Center, Frankfurt am Main
[2]Deutscher Wetterdienst, Offenbach am Main
[3]Institute for Atmospheric and Environmental Sciences, Goethe University Frankfurt, Frankfurt am Main

**7th Study Conference on BALTEX , 13.06.2013**

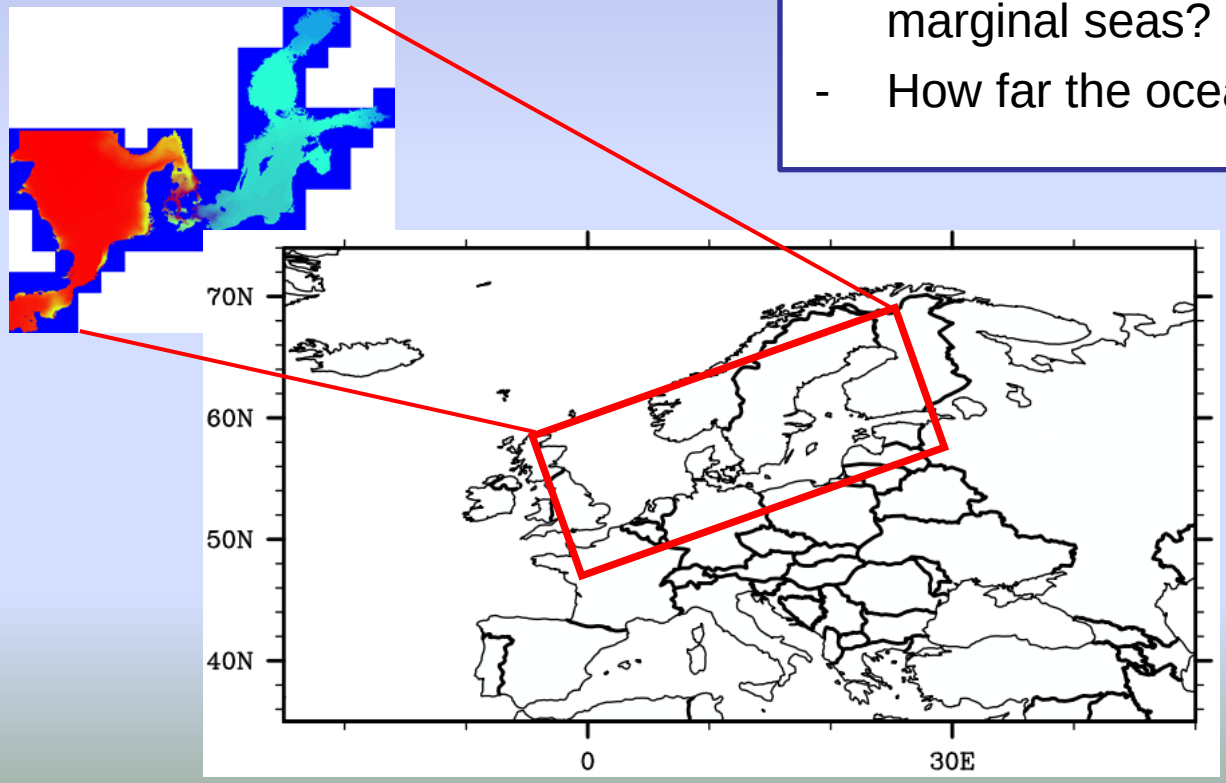
# Content

- Motivation
- Atmospheric model COSMO-CLM
- Ocean/Ice model NEMO-LIM3
- Coupled system: COSMO-CLM and NEMO-BALTIX
- Evaluation data
- Results
- Summary

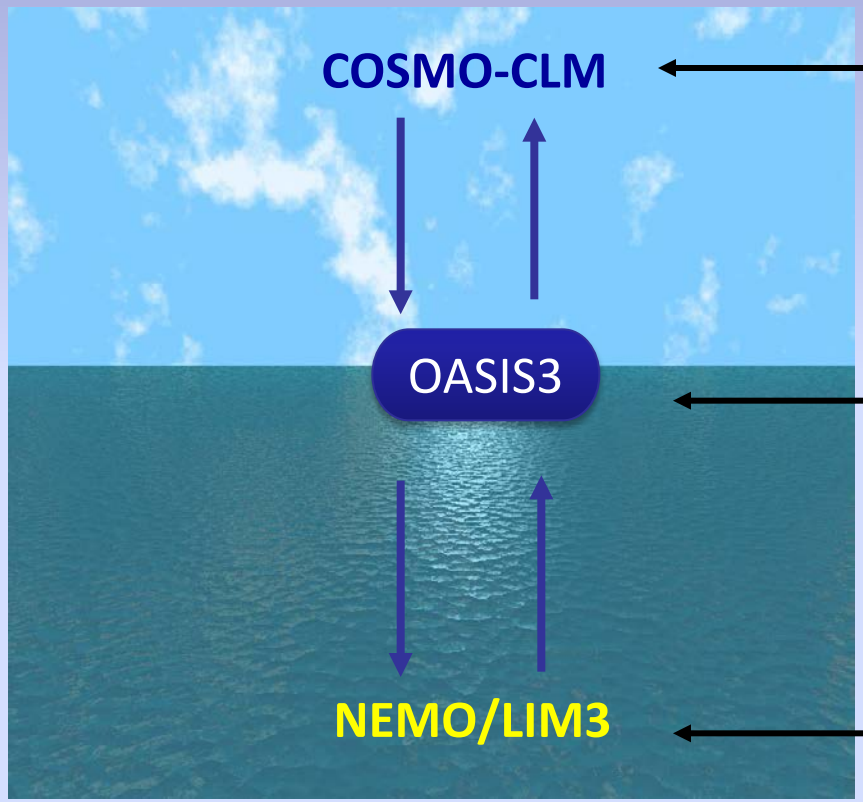
# Motivation

Study the impact of the North and Baltic seas on the climate of Central Europe:

- Which area is more affected by the marginal seas?
- How far the ocean influence goes?



# Coupling atmospheric and ocean/ice models




**Atmospheric model**

**Interface model**

-Gathers info from component models

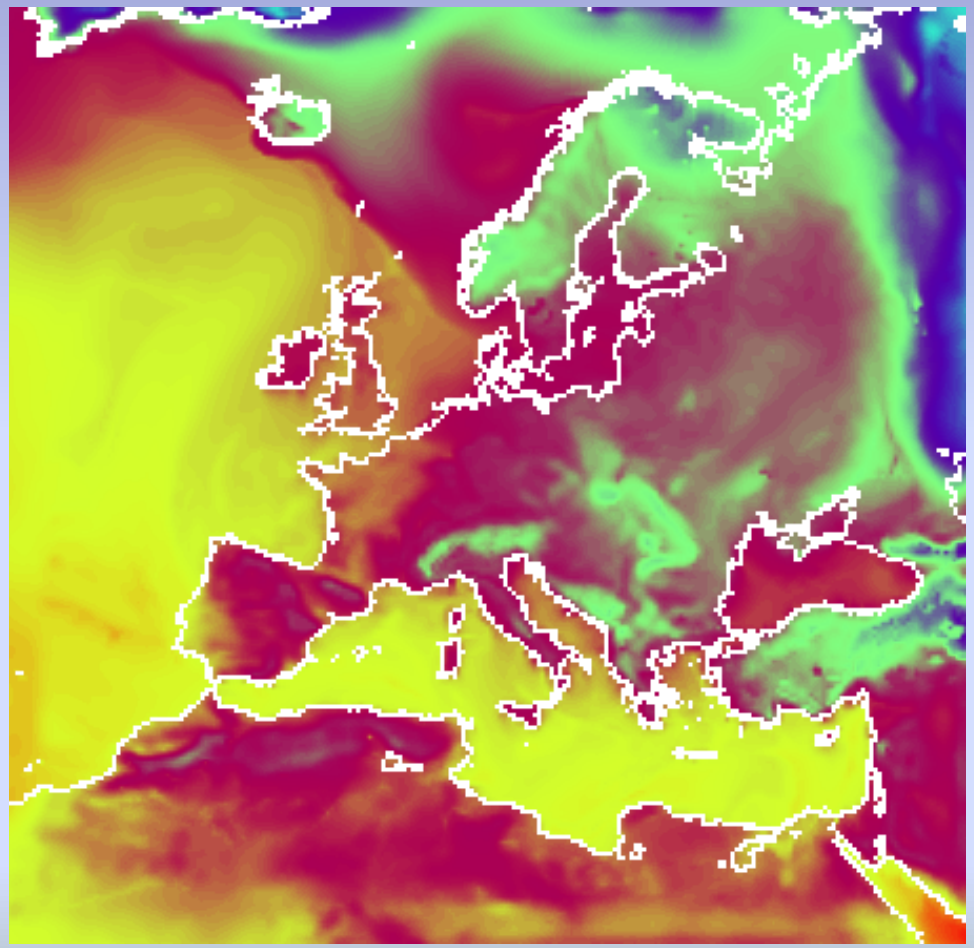
-Interpolates to component models' grids

-Send info

**Ocean/Ice model**

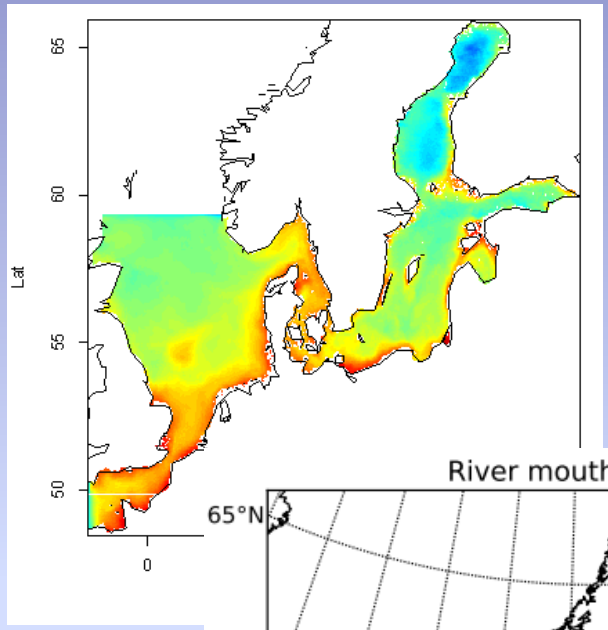
# Atmospheric model COSMO-CLM

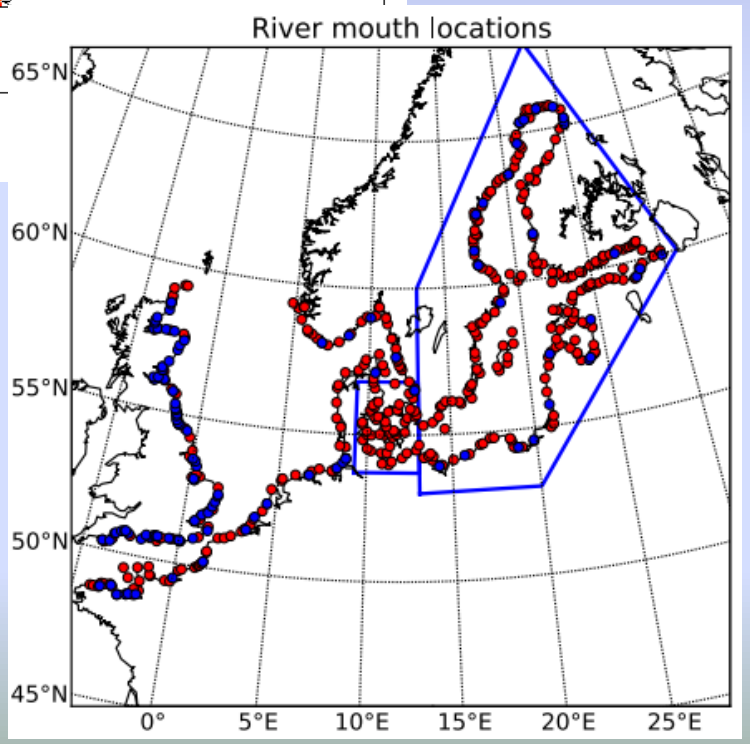
- CORDEX-EU domain:
  - Covers Europe and North Africa, Atlantic and Mediterranean Seas
  - Resolution 0.44 degree
  - Initial and lateral boundary condition: ERA-INTERIM re-analysis
  - Simulation period 01.01.1979 - 31.12.2010
  - Lower boundary condition: ERA-INTERIM re-analysis (in stand-alone mode) and NEMO-BALTIX (in coupled mode)
  - 122x119 grid cells; 40 layers



# Ocean/Ice model NEMO-LIM3

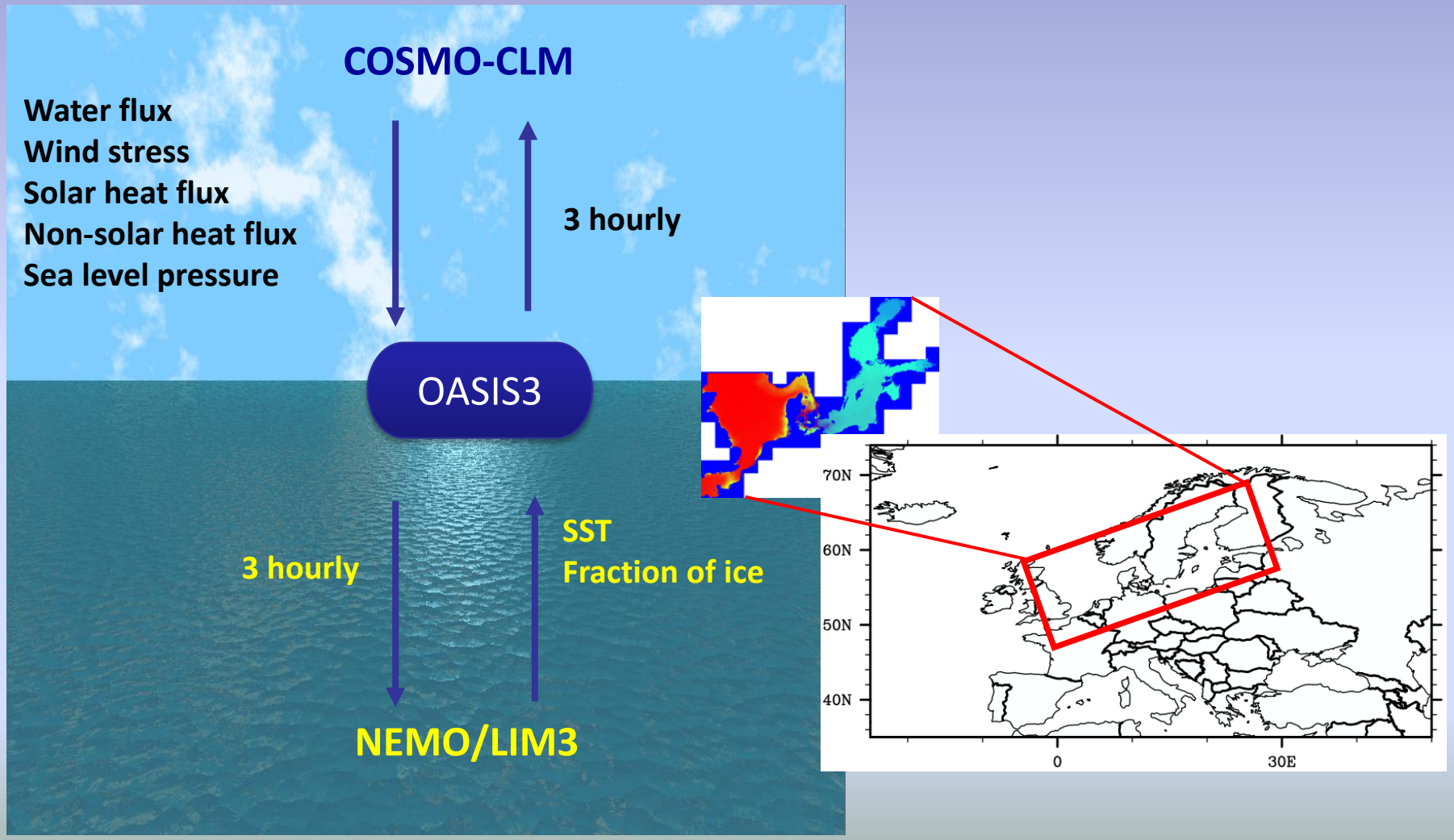
- NEMO (Nucleus for European Modelling of the Ocean) has sea ice model - NEMO-LIM3
- NEMO-BALTIX:
  - Based on NEMO v3.3, courtesy of Sweden‘s Meteorological and Hydrological Institute (SMHI)
  - Adapted to the North- and Baltic Sea region
  - Resolution 2 minutes
  - 619 x 523 grid points and 56 levels
  - Open boundaries are prescribed for the Atlantic Ocean with Levitus climatology
  - River runoff:
    - around 400 river inflows, evenly distributed along coast line
    - daily values from E-HYPE run forced by ERA-INTERIM




Report: Evaluation of the SMHI coupled atmosphere-ice-ocean model RCA4-NEMO, C. Dieterich et al., 2013

# Coupled system: COSMO-CLM and NEMO-BALTIX



# Ice treatment in COSMO-CLM

- Stand-alone COSMO-CLM: no sub-grid ice, no ice mask

  On water grid points:

  - Surface $T^0 < -1.7^0C$: Ice surface → roughness L = 0.001m
  - Surface $T^0 >= -1.7^0C$: Open water surface → Charnock formula of roughness L:

    roughness $L = a_0 u_*^2/g$

    $a_0$ = 0.0123 Charnock constant

    $u_*$ friction velocity (m/s)

    g = 9.8 $m/s^2$ acceleration of gravity

- Coupled COSMO-CLM and NEMO: sub-grid ice, ice mask received from NEMO

  On water grid points:

  - Fraction of water = 1 - fraction of ice
  - Averaged roughness L = fr_ice x roughness_ice + fr_water x roughness_water

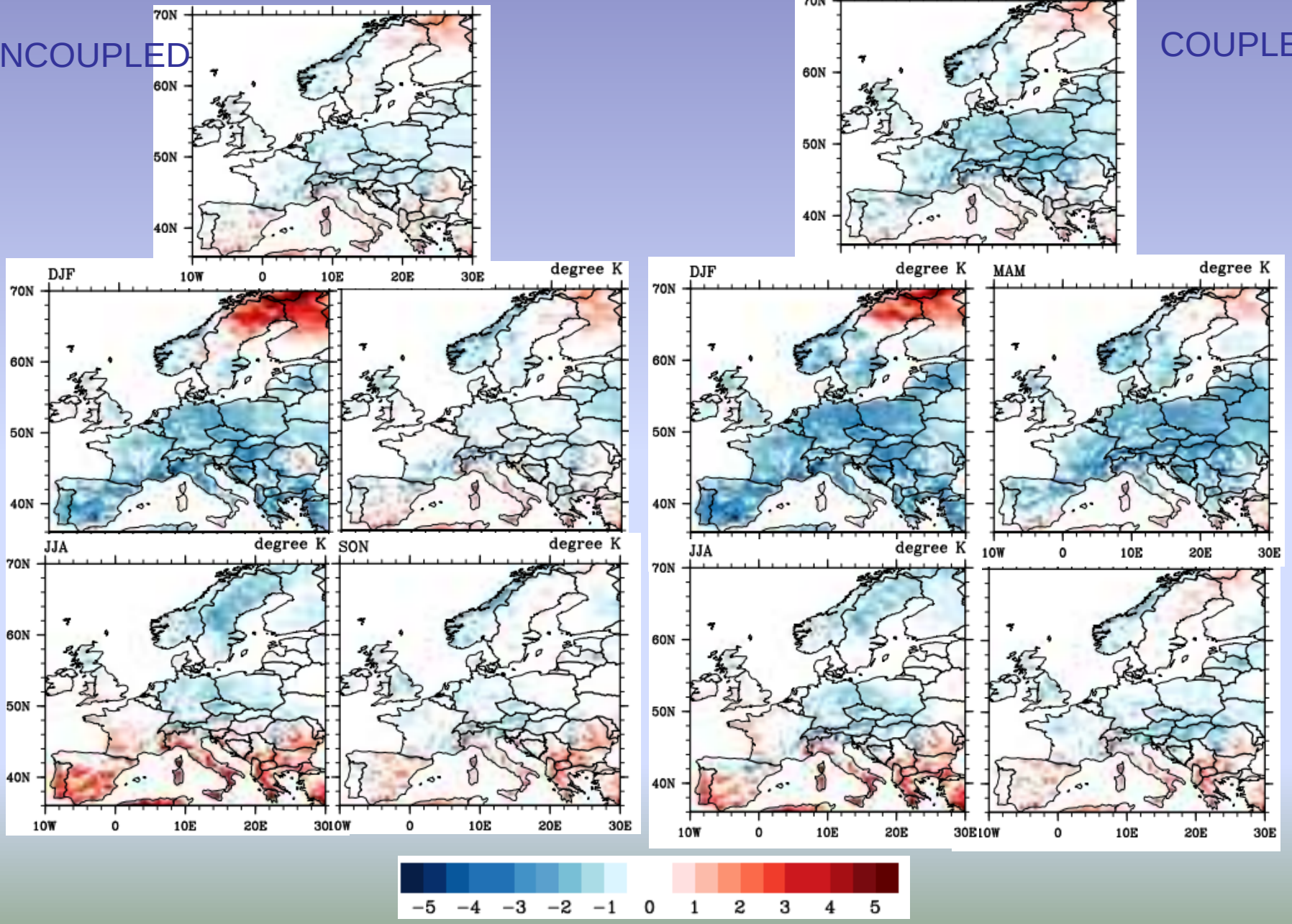
# Evaluation data

- E-OBS v7.0: T_2M, TMIN_2M, TMAX_2M, TOT_PREC, PMSL
- Evaluating:
  - yearly and seasonal mean differences of uncoupled and coupled runs compared with EOBS data
  - Yearly and seasonal mean differences between uncoupled and coupled runs
- Results shown for year 1981

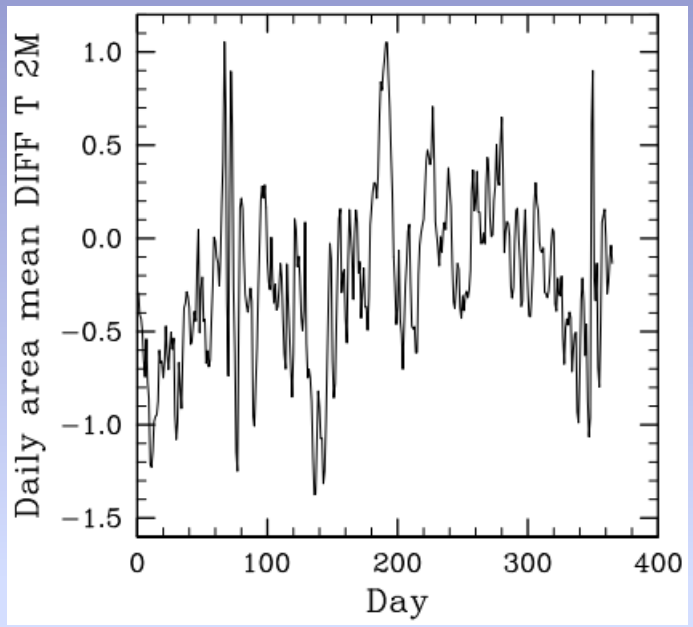
# CCLM –EOBS T_2M

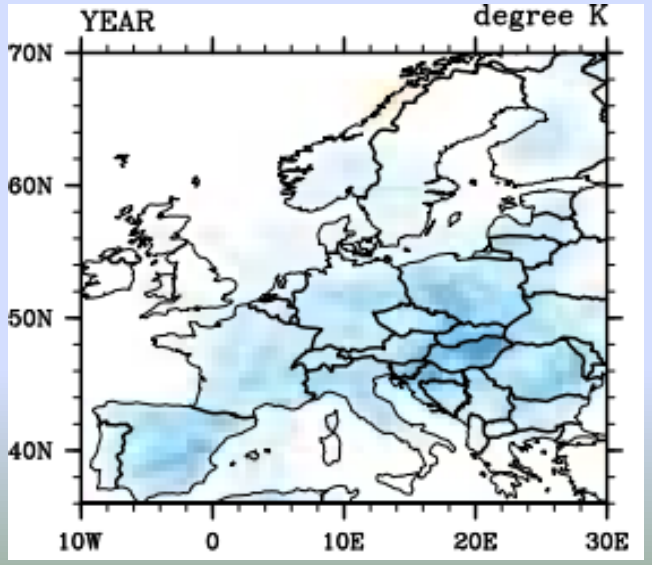
UNCOUPLED

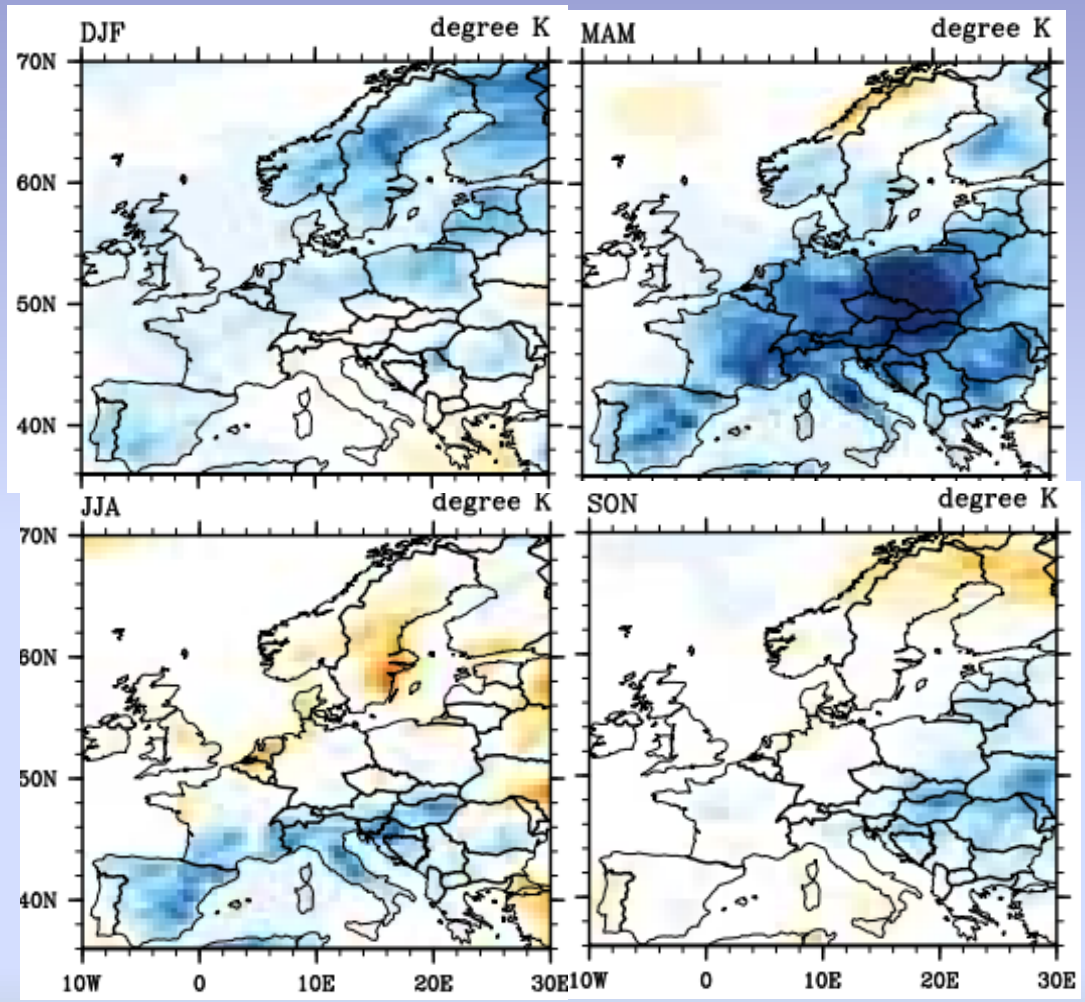
COUPLED

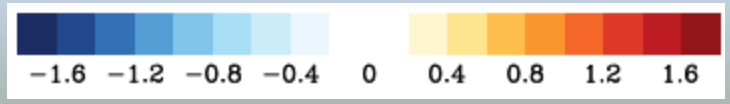


# COUPLE-CCLM T_2M

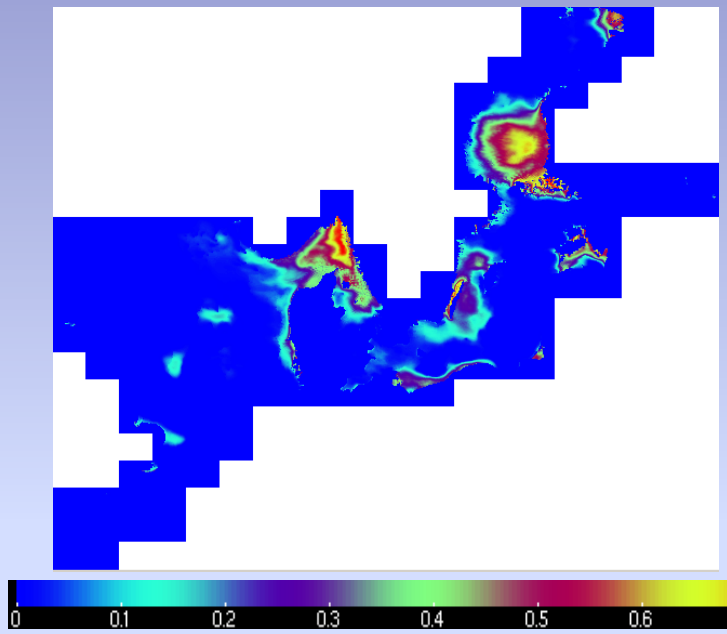


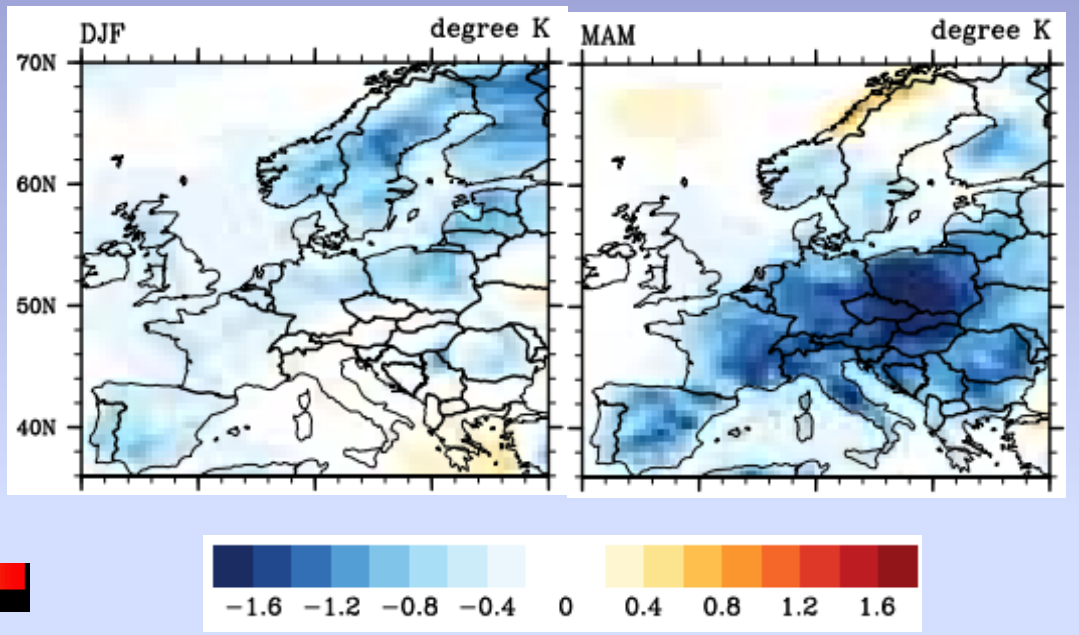



Ice cover during the previous winter DJF




# COUPLE-CCLM T_2M

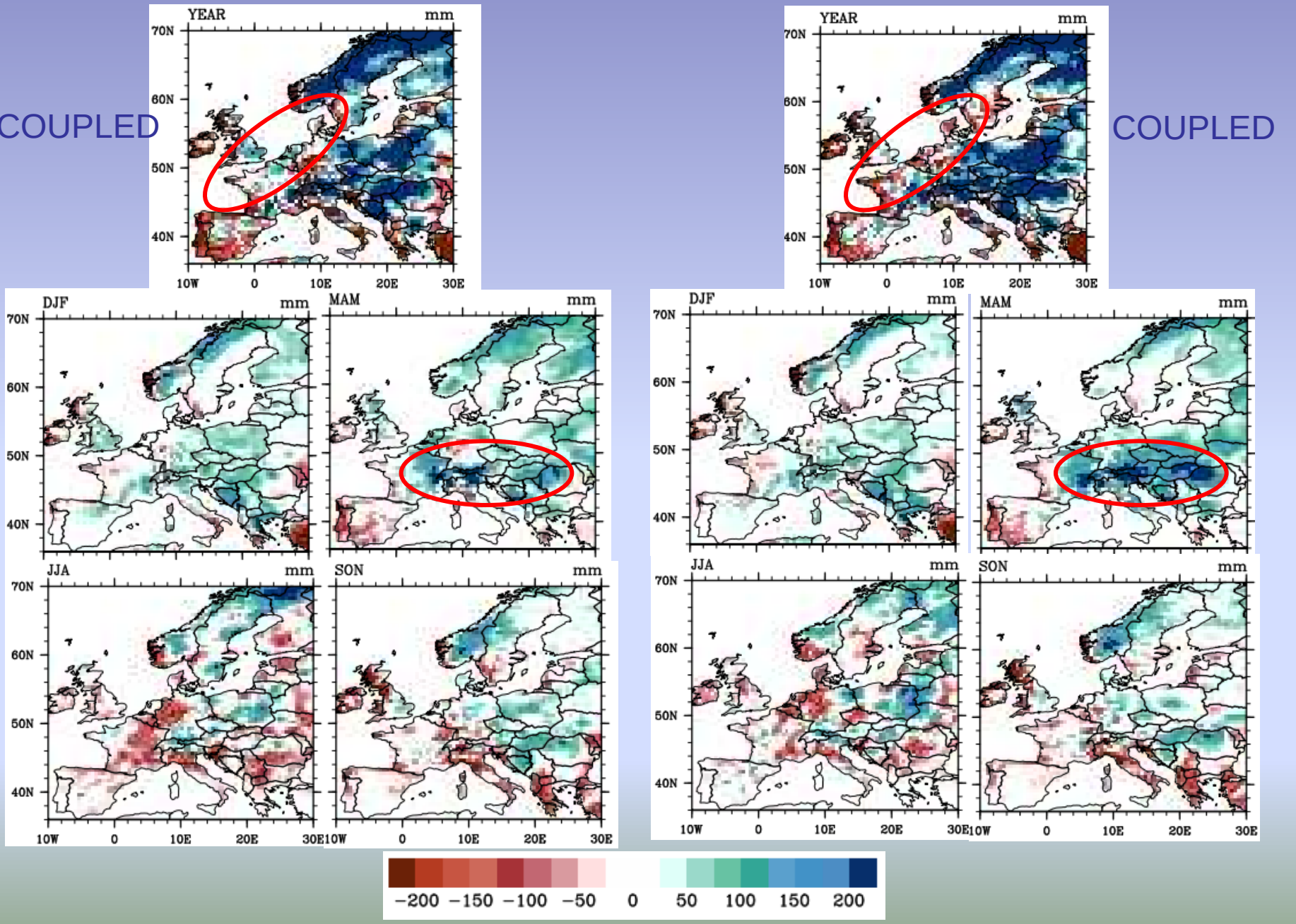



From March: no ice

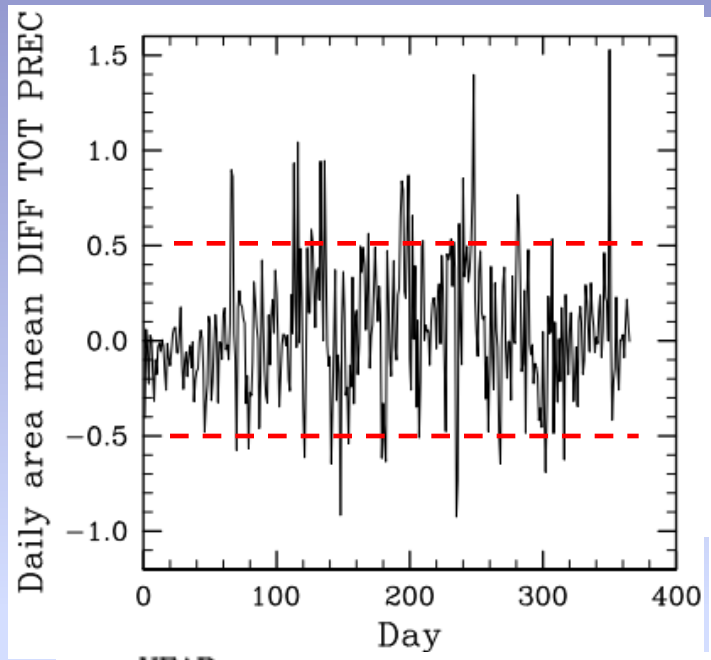
# CCLM –EOBS TOT_PREC

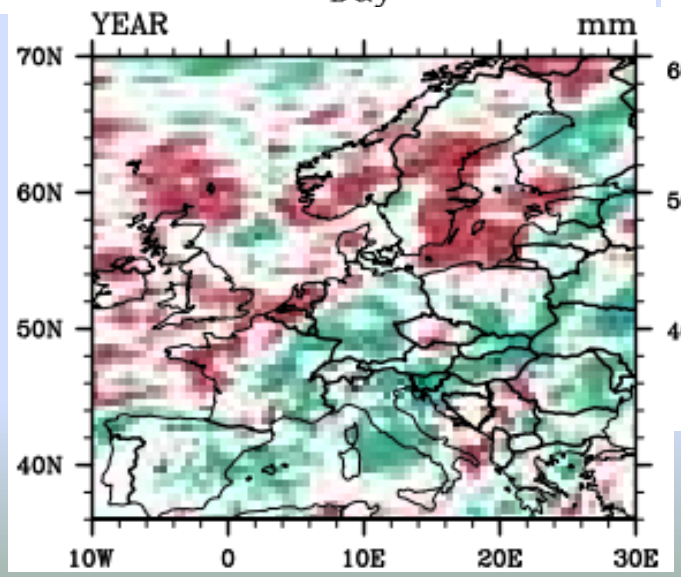
UNCOUPLED

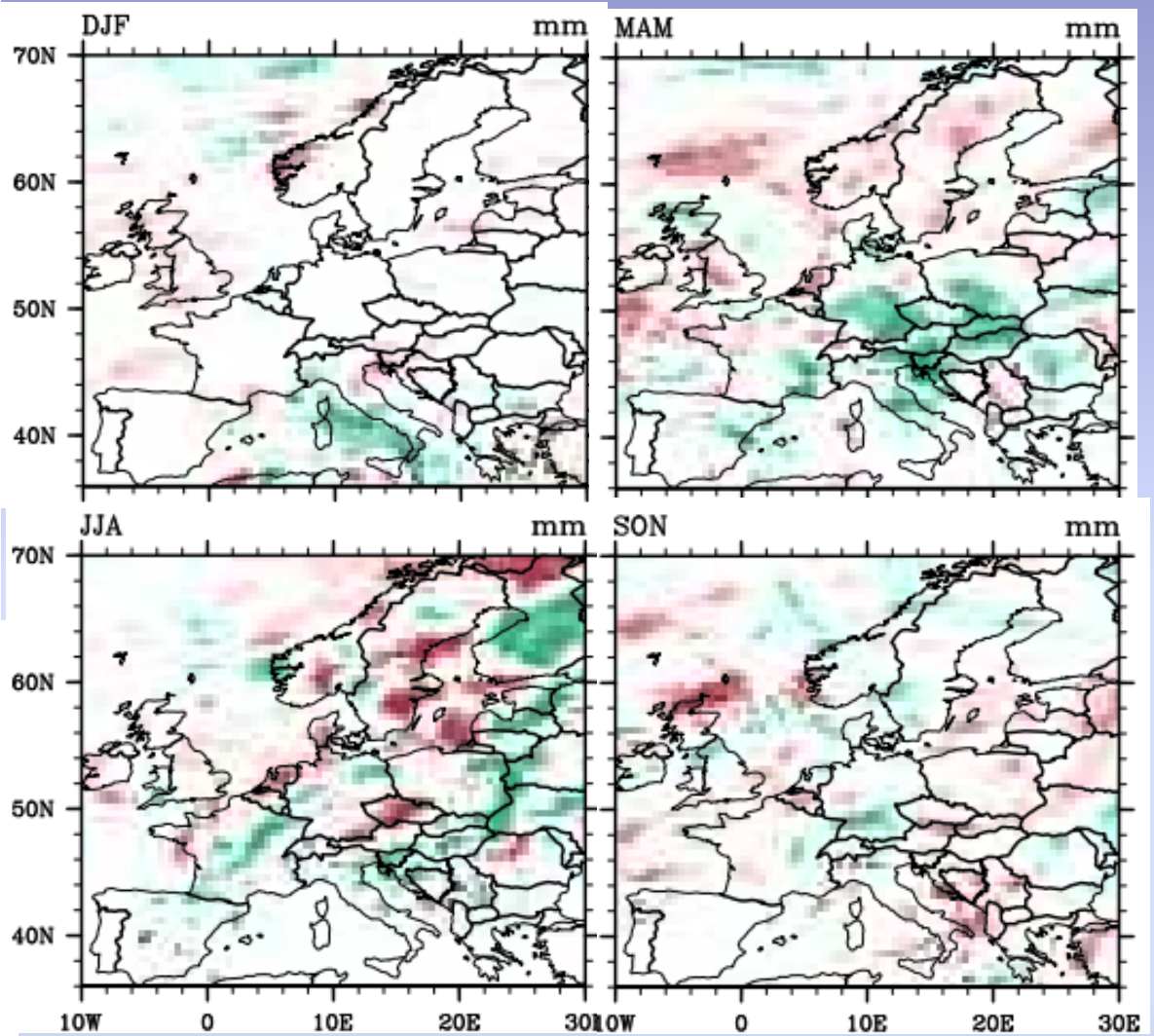
COUPLED

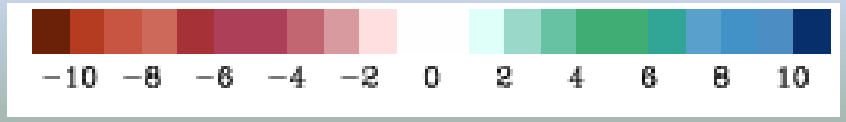


# COUPLE-CCLM TOT_PREC

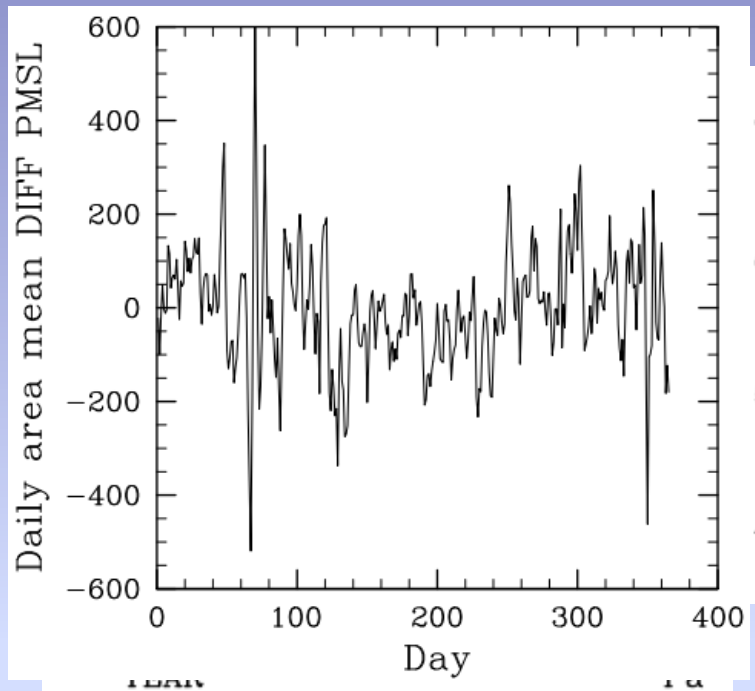


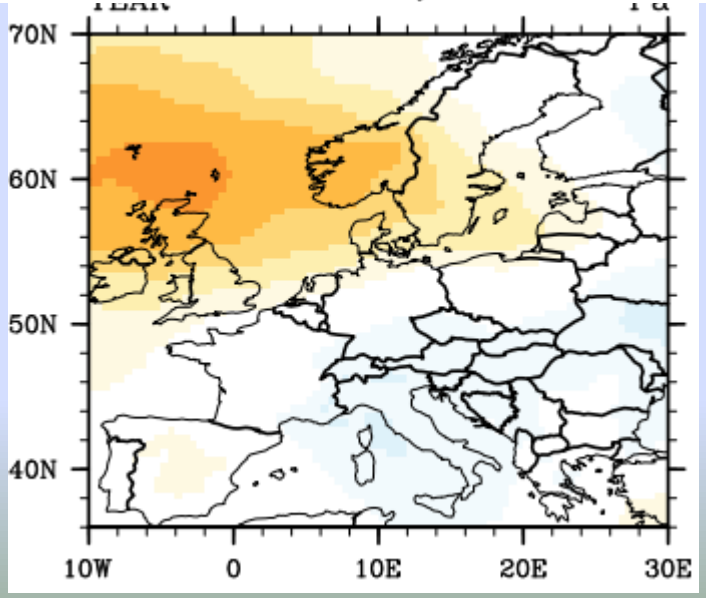



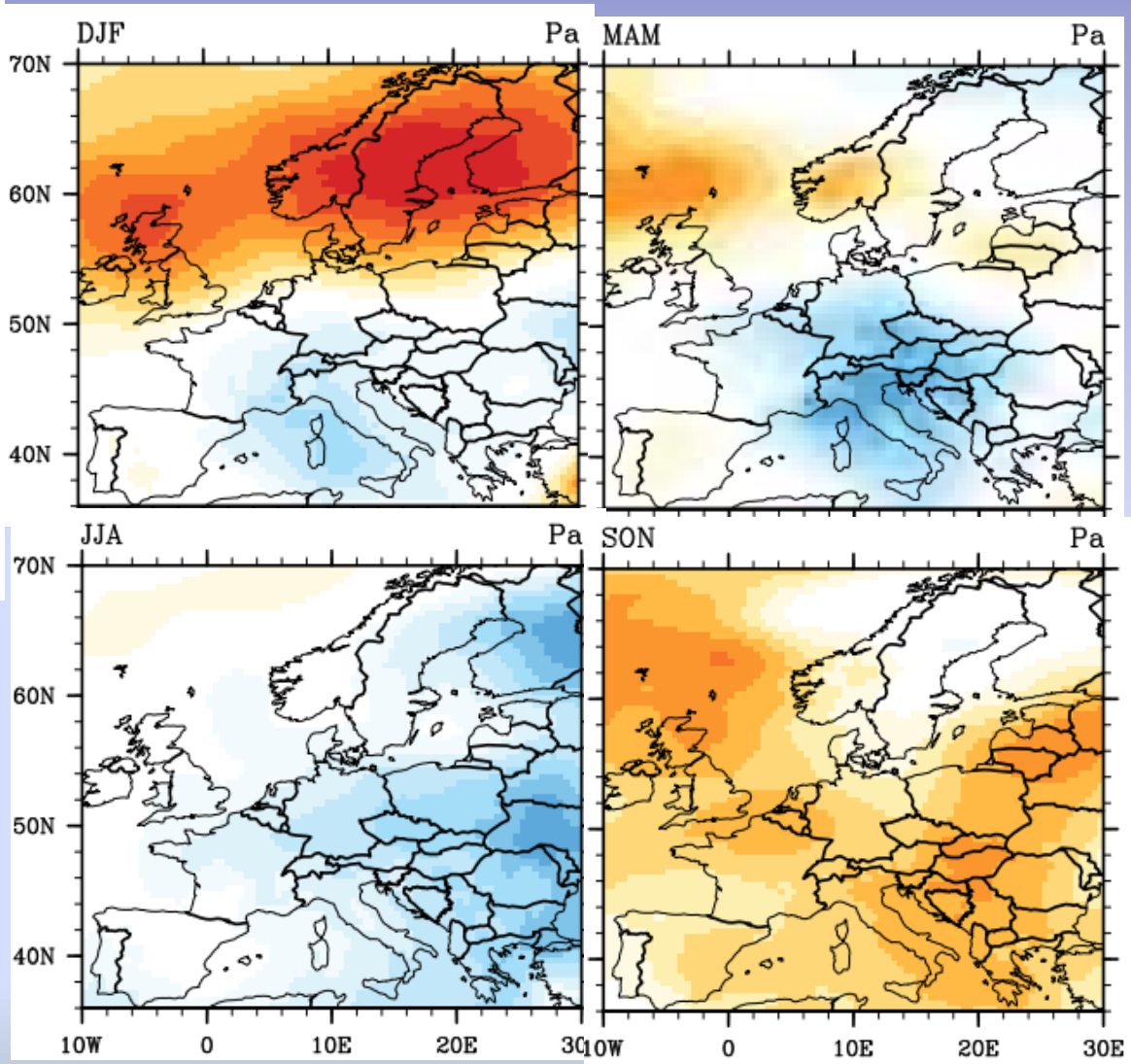



# COUPLE-CCLM PMSL



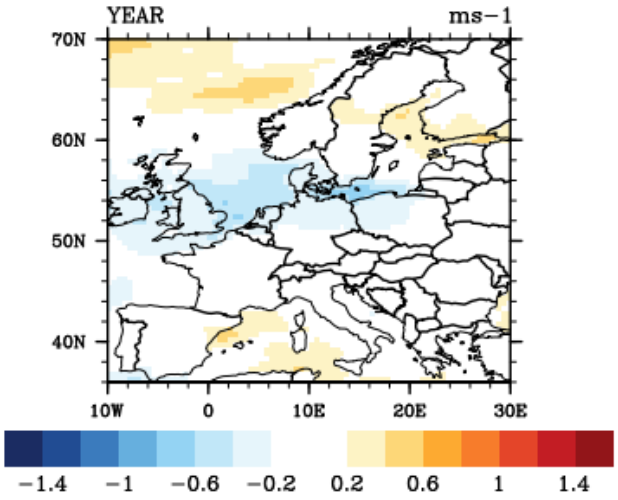



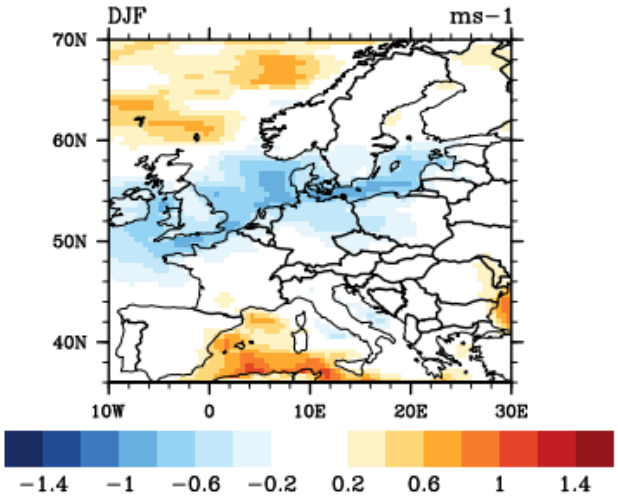
# Summary

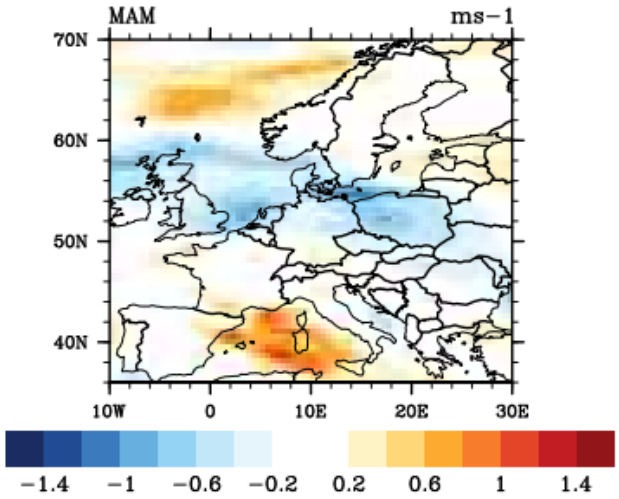
- T_2M has cold bias especially in Center Europe and in spring months. Coupled run is slightly colder than the uncoupled run, most pronounced in Center Europe (-1.5 degree)
- The difference in precipitation is small. Not clear pattern but the coupled run tends to be drier near the coast and wetter inland
- Very small change in large scale circulation. Marginal seas do not have large impact on large scale event

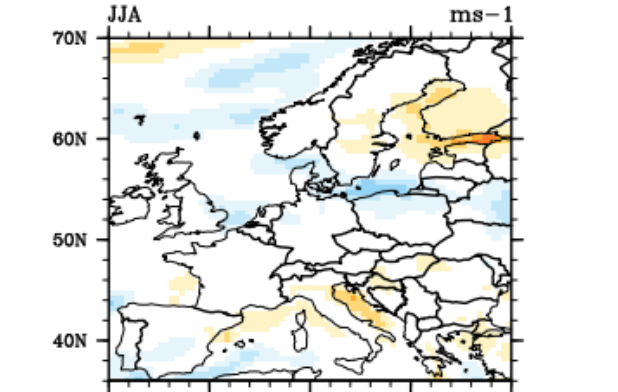
Thanks for your attention

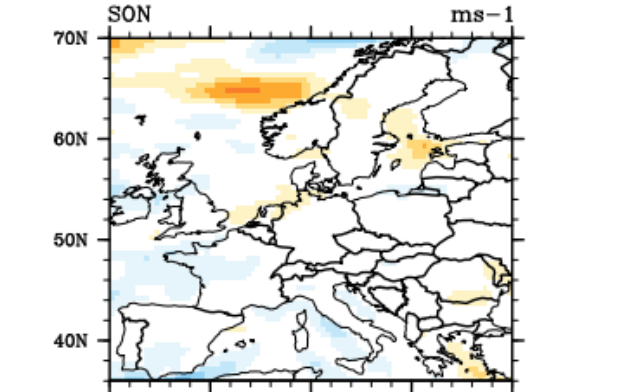
# COUPLE-CCLM
# U_10M



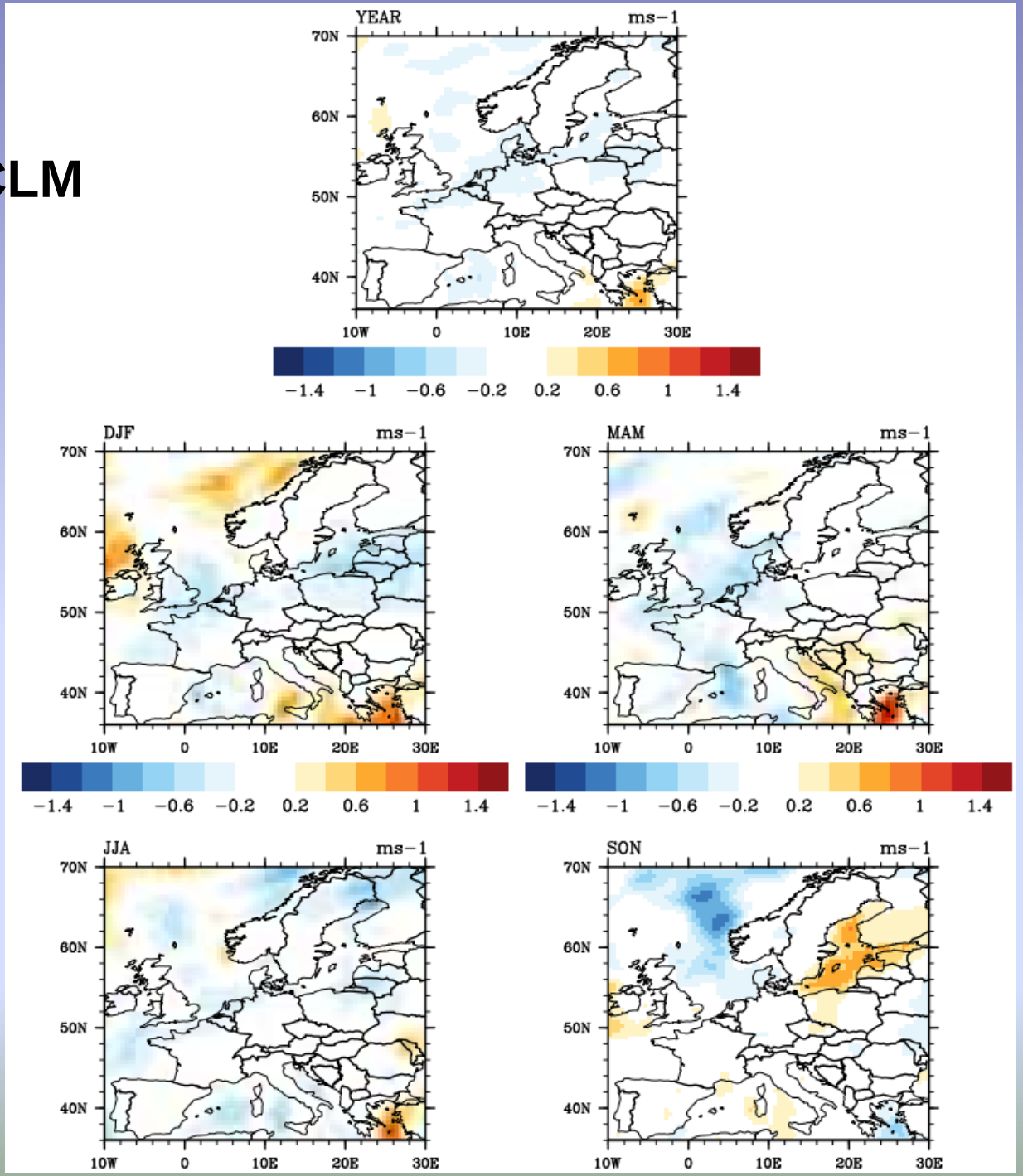



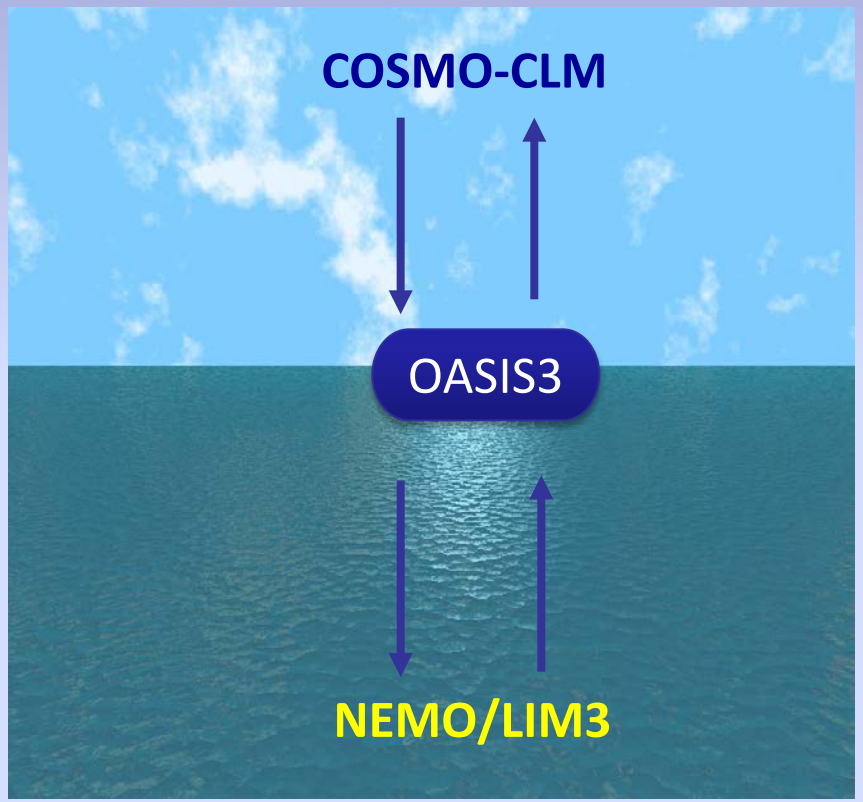



# COUPLE-CCLM
# V_10M



# Current research at German Weather Service



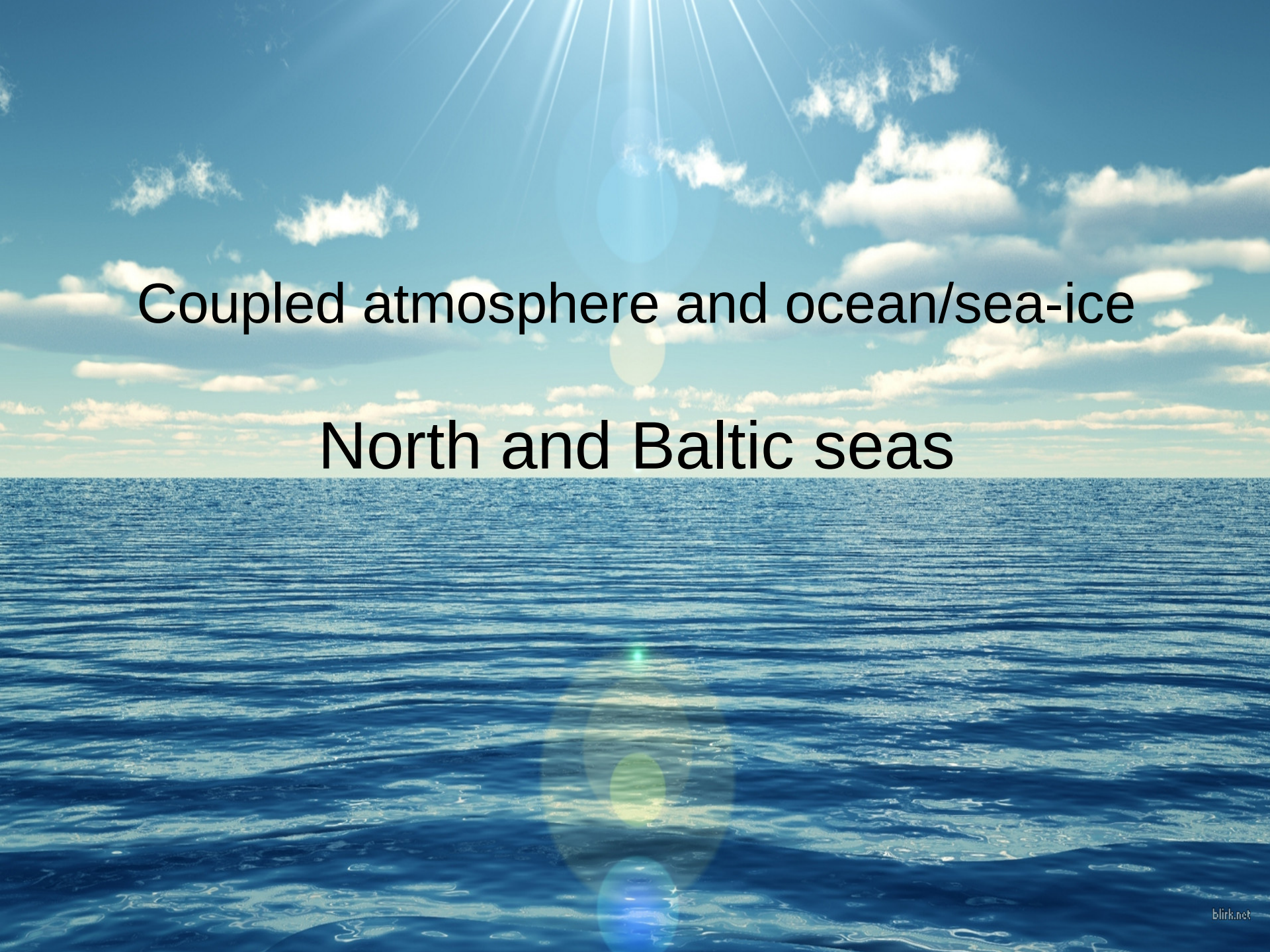

## Current work:

- Coupled COSMO-CLM and NEMO/LIM3 for the North and Baltic seas via OASIS3

- Coupled COSMO-CLM and NEMO for the Mediterranean sea via OASIS3

## On-going work:

-Unified interface COSMO-CLM and OASIS-MCT (fully parallized)


Coupled atmosphere and ocean/sea-ice
North and Baltic seas