The Abdus Salam
International Centre for Theoretical Physics

United Nations
Educational, Scientific and
Cultural Organization

IAEA
International Atomic Energy Agency

2210-4

MedCLIVAR Workshop on: "Scenarios of Mediterranean Climate Change under Increased Radiative Active Gas Concentration and the Role of Aerosols

23 - 25 September 2010

Impact of large-scale mid-latitude circulation on regional climate model trends in the Mediterranean area

PAXIAN Andreas and Paeth H.

Institute of Geography, University of Wuerzburg
Am Hubland, D-97074
Wuerzburg
GERMANY

Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

KLIWEX-MED

Impact of large-scale mid-latitude circulation on regional climate model trends in the Mediterranean area

Andreas Paxian, Heiko Paeth

Geographical Institute, University of Wuerzburg

5th ESF-MedCLIVAR Workshop, 23 September 2010, Triest

Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Overview

- Model and observation data
- Validation of T+P trends (1961-1990)
- Validation of mid-latitude circulation (1961-1990)
- Multiple regression: T+P ←→ circulation
- Circulation-related and -unrelated T+P trends
- Results for future time period (1961-2050)

Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

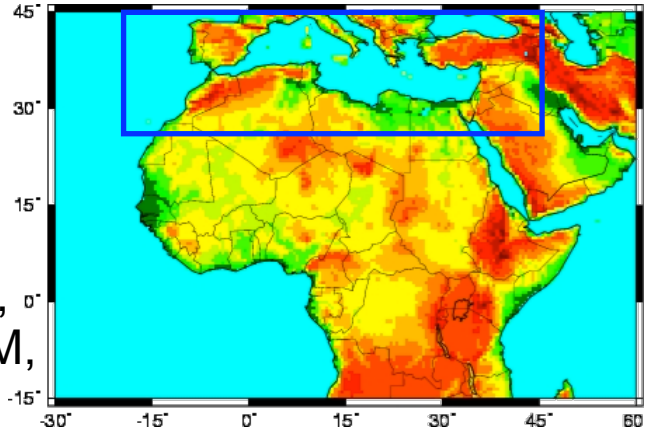
Overview

- Model and observation data
- Validation of T+P trends (1961-1990)
- Validation of mid-latitude circulation (1961-1990)
- Multiple regression: T+P ←→ circulation
- Circulation-related and -unrelated T+P trends
- Results for future time period (1961-2050)

Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Models and observations

- Model data:
  - T, P → REMO [JACOB et al. 2001]:
    - RCM of MPI Hamburg, 0.5°
    - IMPETUS simulations: 1960-2050, 3 runs, forced by coupled GCM ECHAM5/MPI-OM, A1b, B1, land use scenarios



  - SLP → ECHAM5 [ROECKNER et al. 2003]:
    - GCM of MPI Hamburg, T42 ~ 1.875°

- Observations:
  - T, P → E-OBS 2.0 [HAYLOCK et al. 2008]:
    - Gridded daily station data, 0.5°, 1950-2008
  - SLP → NCEP/NCAR [KALNAY et al. 1996]:
    - Global monthly reanalysis data, 2.5°, 1948-today

Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

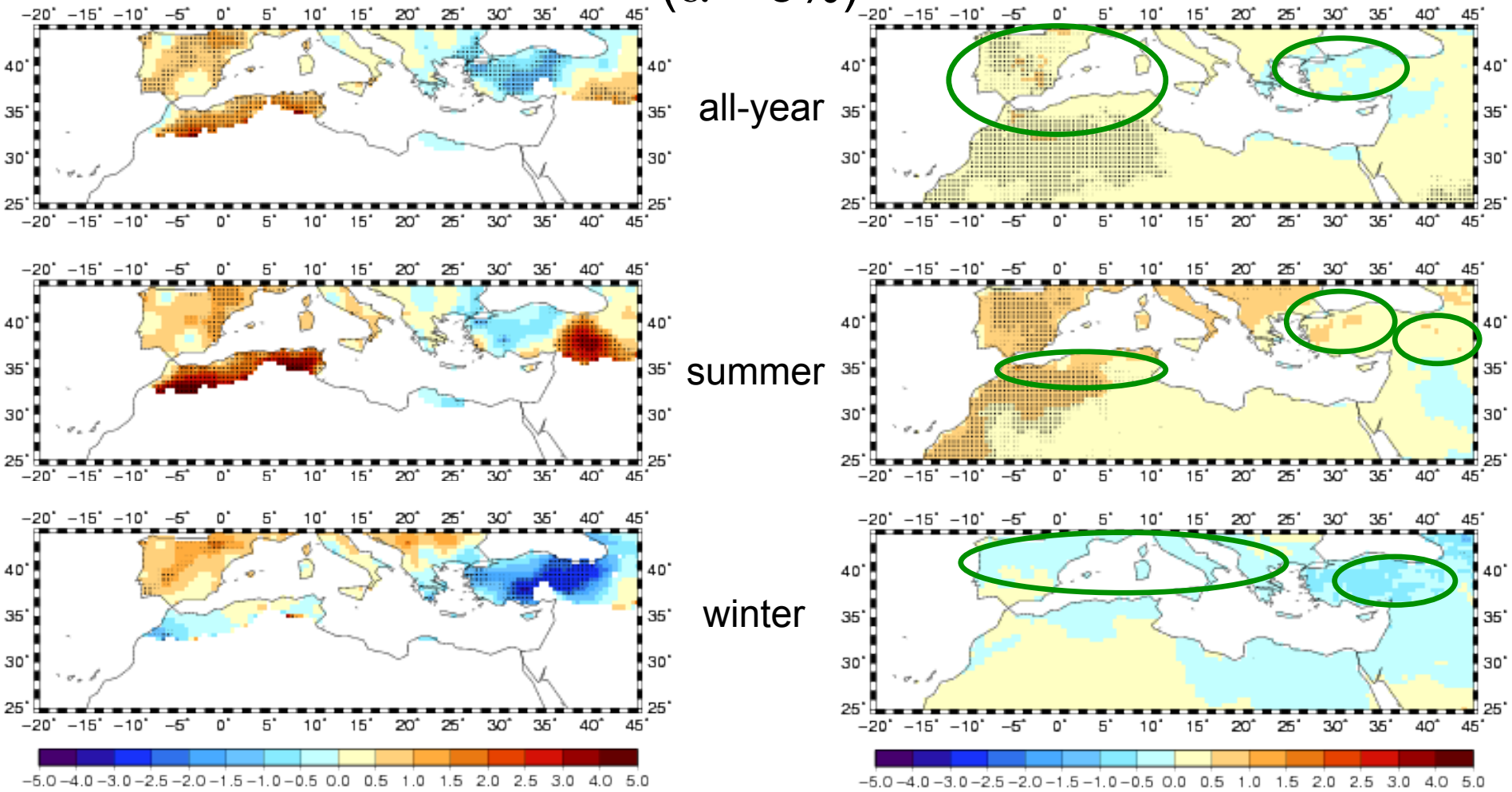
Overview

- Model and observation data
- Validation of T+P trends (1961-1990)
- Validation of mid-latitude circulation (1961-1990)
- Multiple regression: T+P ←→ circulation
- Circulation-related and -unrelated T+P trends
- Results for future time period (1961-2050)

Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Temperature Trends 1961-1990

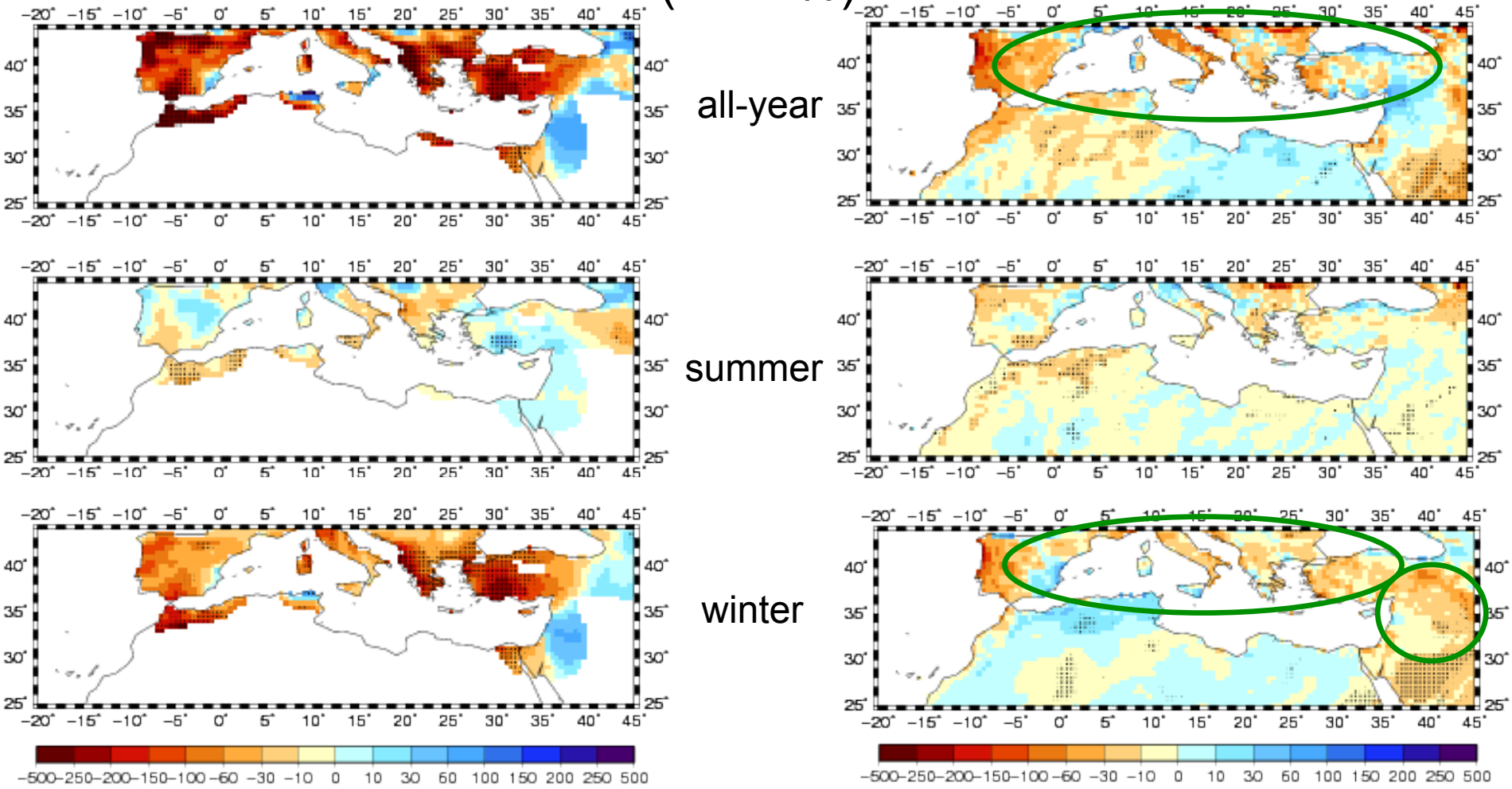
E-OBS | Linear Regression (α = 5%) | REMO



Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Precipitation Trends 1961-1990

E-OBS | Linear Regression (α = 5%) | REMO



Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Overview

- Model and observation data
- Validation of T+P trends (1961-1990)
- Validation of mid-latitude circulation (1961-1990)
- Multiple regression: T+P ←→ circulation
- Circulation-related and -unrelated T+P trends
- Results for future time period (1961-2050)

Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Winter Circulation 1961-1990

EOF1-4 of SLP

NCEP

EV patterns

PC time series

ECHAM5

EV patterns

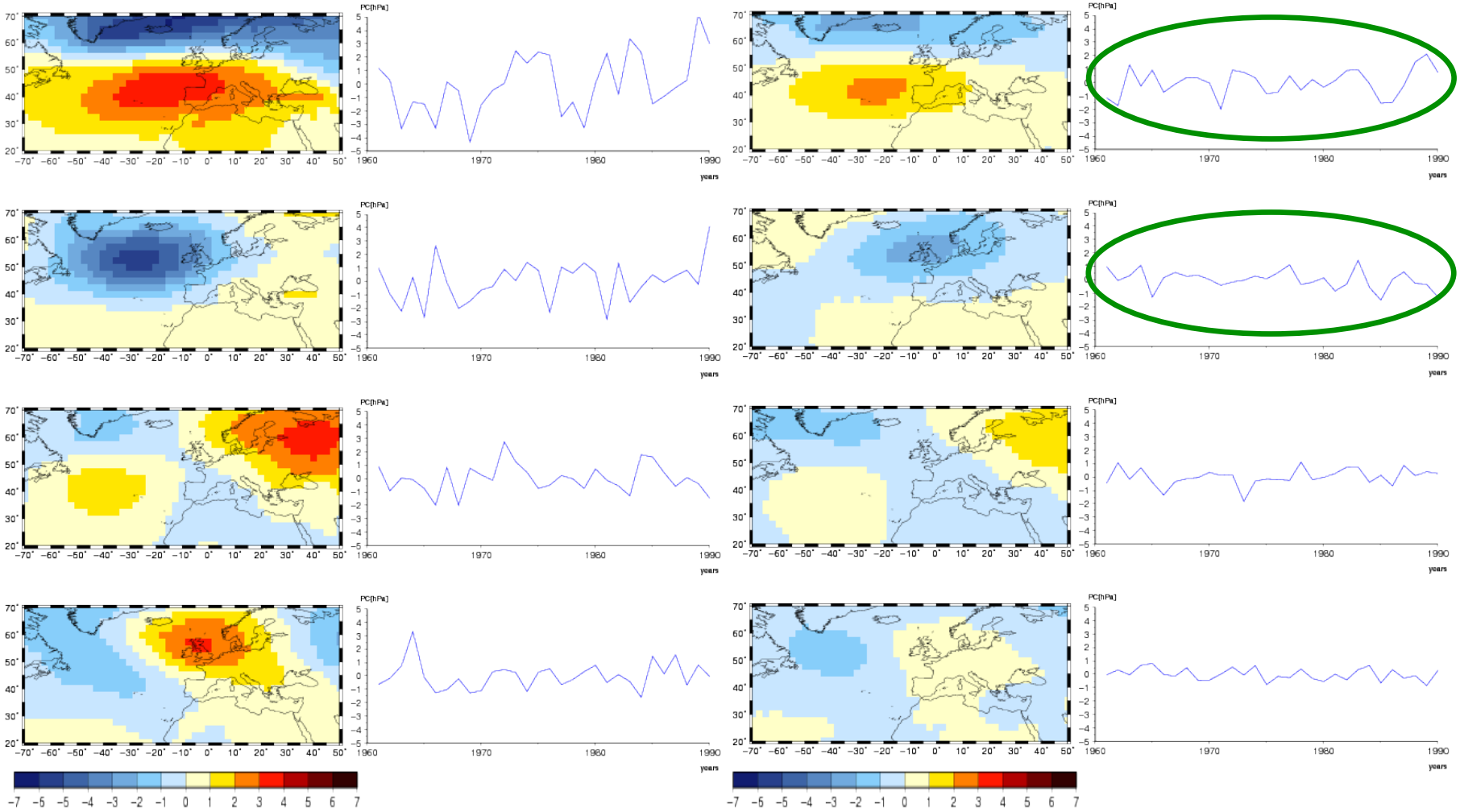
PC time series

NAO

EA

SCA

EA/ WR

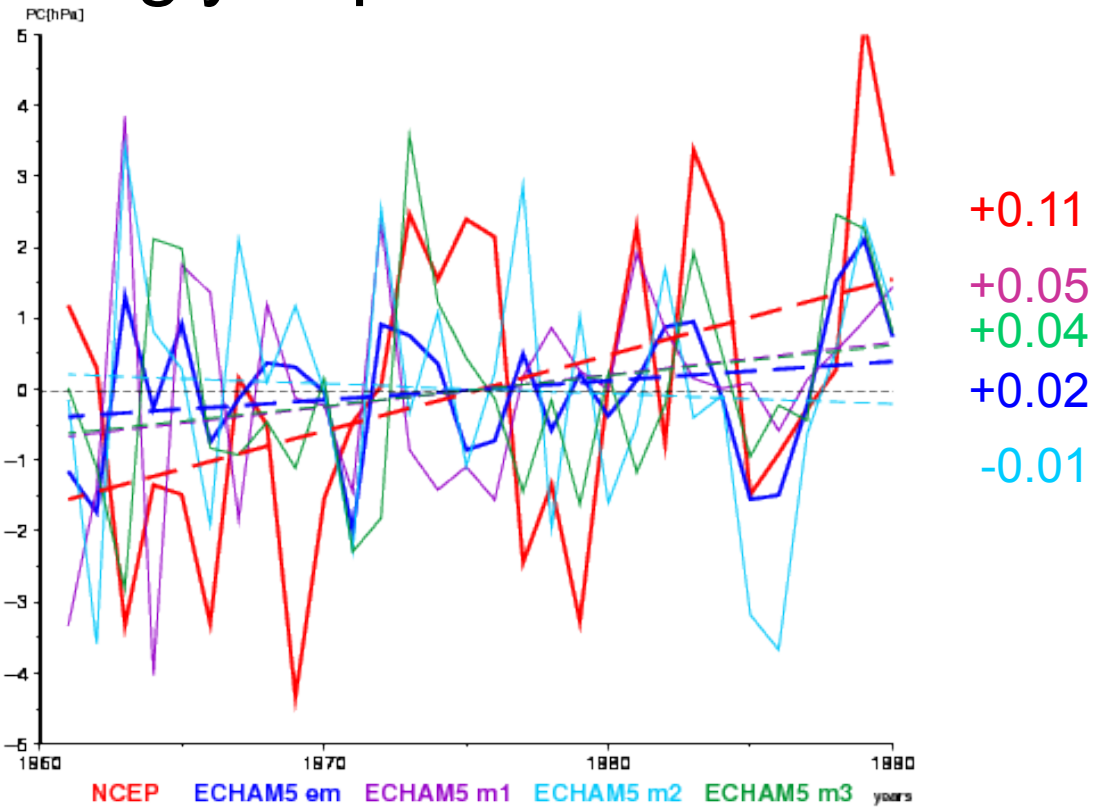


Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Circulation of model ensemble members

- Different ECHAM5 ensemble members show different trends of winter NAO 1961-1990

→ Circulation strongly depends on initial conditions



PC time series and linear trend lines

Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Overview

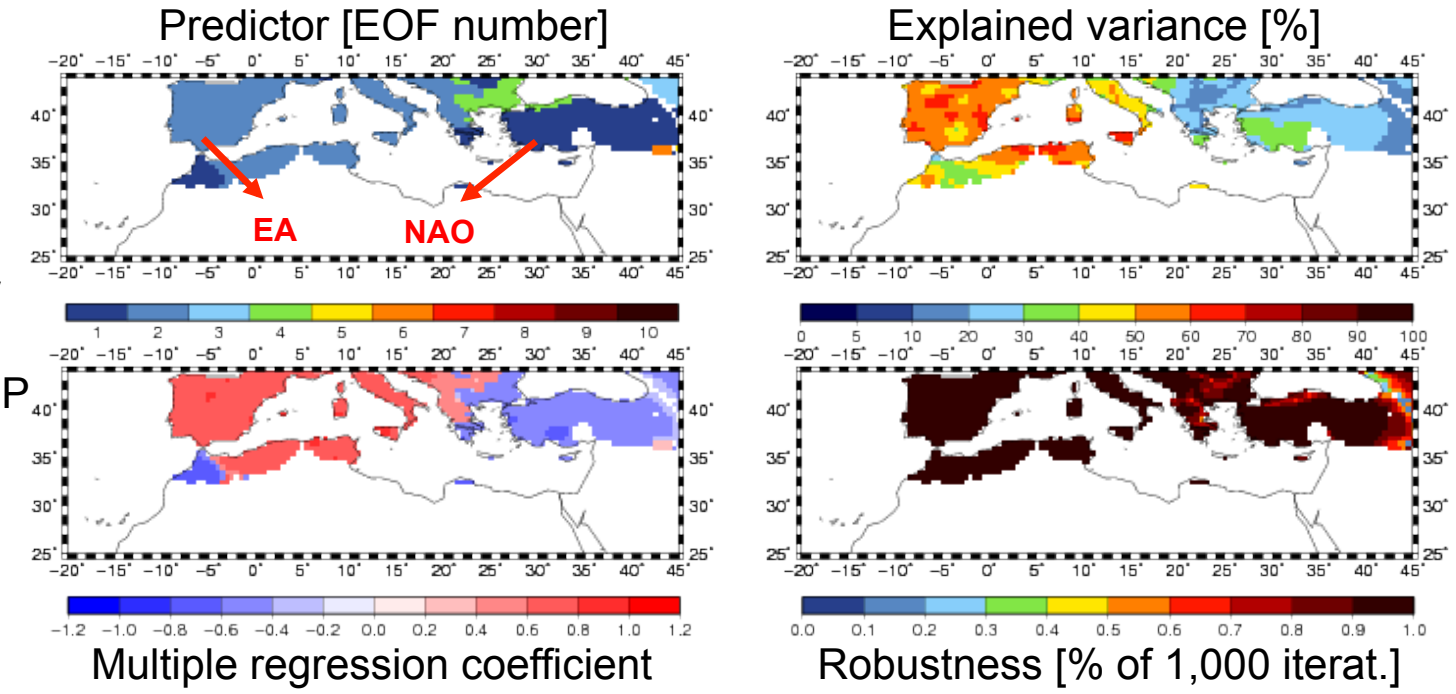
- Model and observation data
- Validation of T+P trends (1961-1990)
- Validation of mid-latitude circulation (1961-1990)
- Multiple regression: T+P ←→ circulation
- Circulation-related and -unrelated T+P trends
- Results for future time period (1961-2050)

Julius-Maximilians-
UNIVERSITÄT WÜRZBURG

Multiple Regression: T/P ←→ Circulation

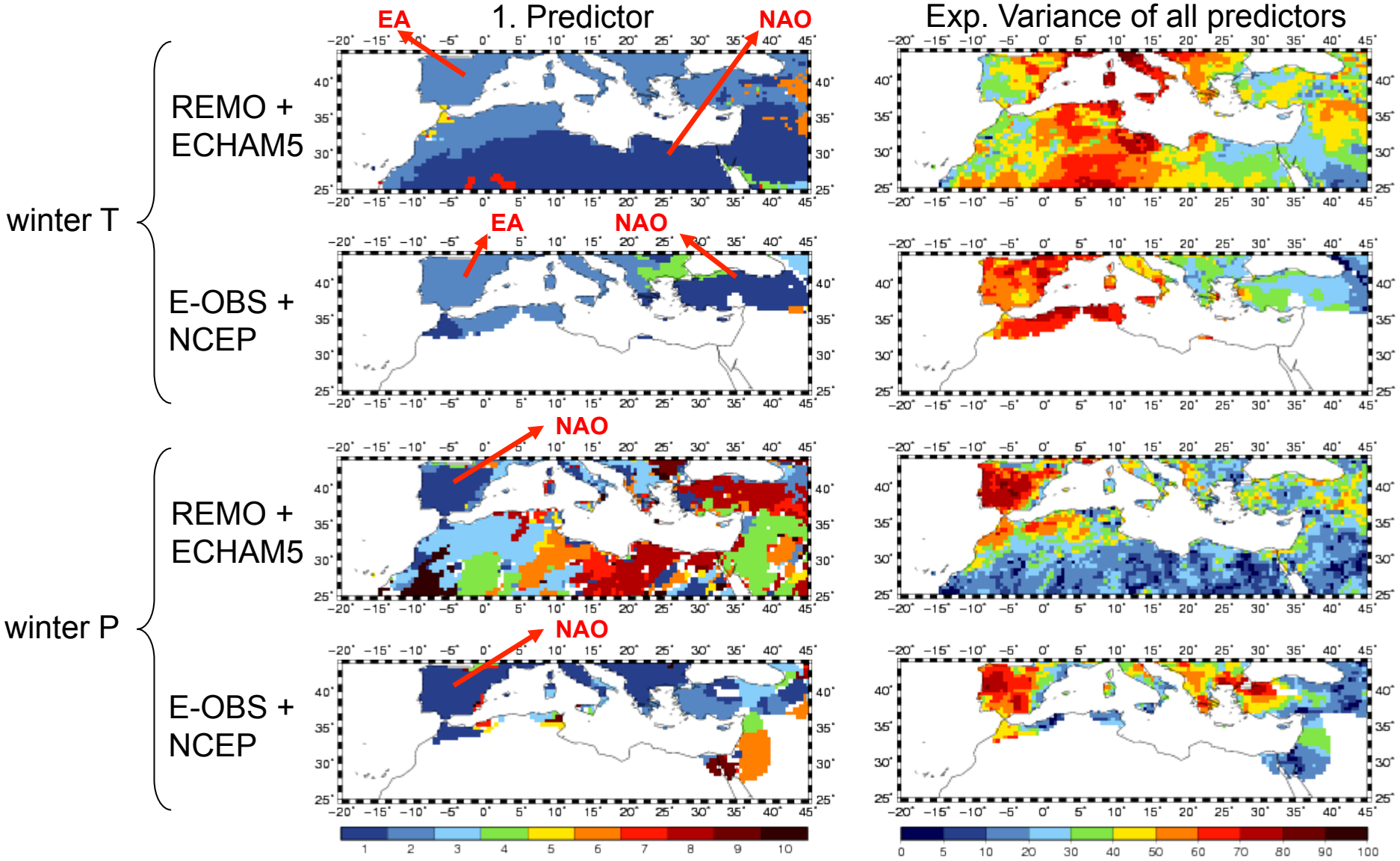
- Multiple Regression 1961-1990:
  - E-OBS T+P ←→ NCEP circulation modes
  - REMO T+P ←→ ECHAM5 circulation modes
  - Cross validation (6 bootstrap years, 1,000 iterations) → selection of predictors with robustness > 50%

Example:
first predictor
winter temp.
E-OBS+NCEP



Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Multiple Regression for Winter



Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

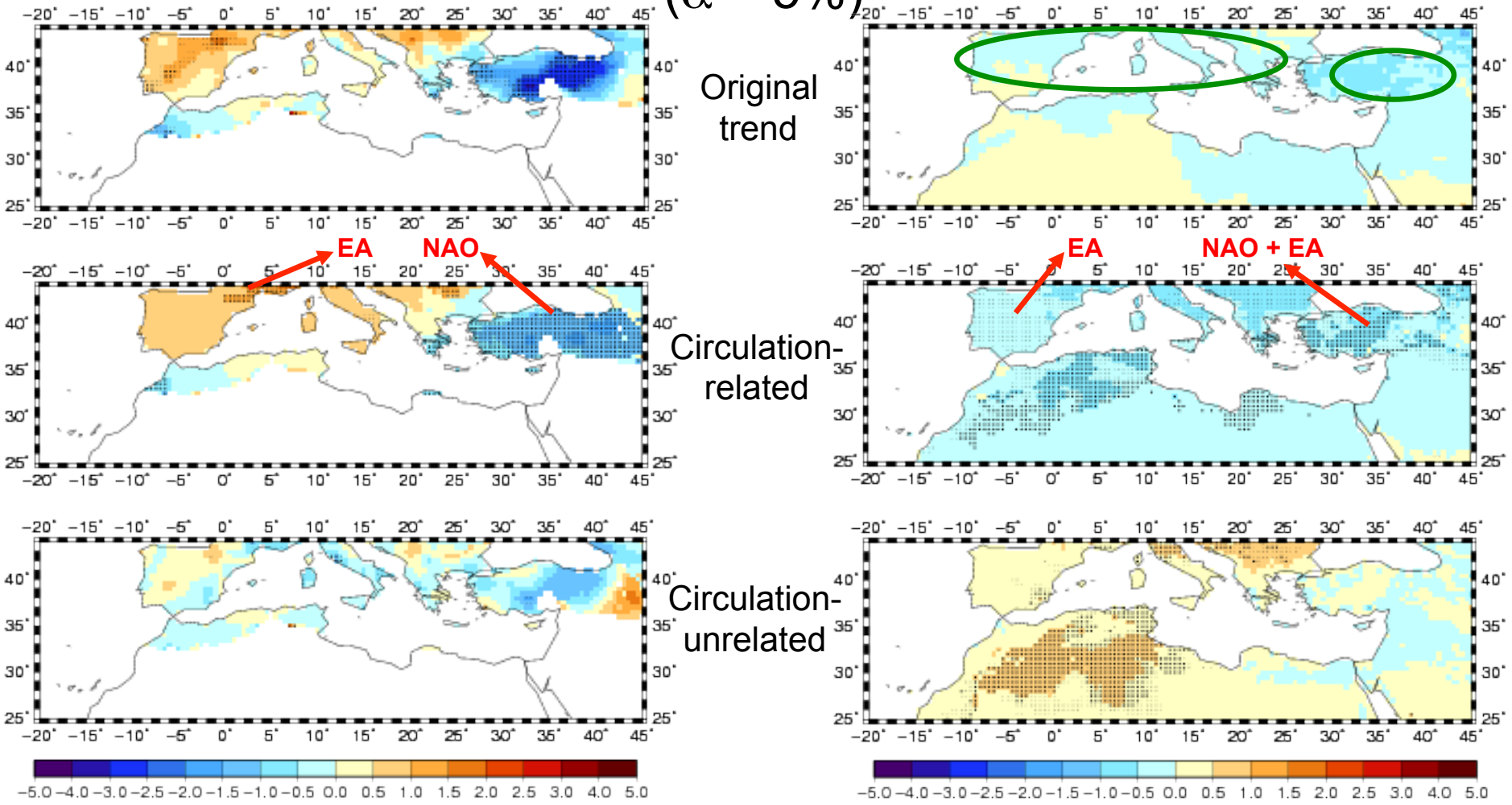
Overview

- Model and observation data
- Validation of T+P trends (1961-1990)
- Validation of mid-latitude circulation (1961-1990)
- Multiple regression: T+P ←→ circulation
- Circulation-related and -unrelated T+P trends
- Results for future time period (1961-2050)

Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

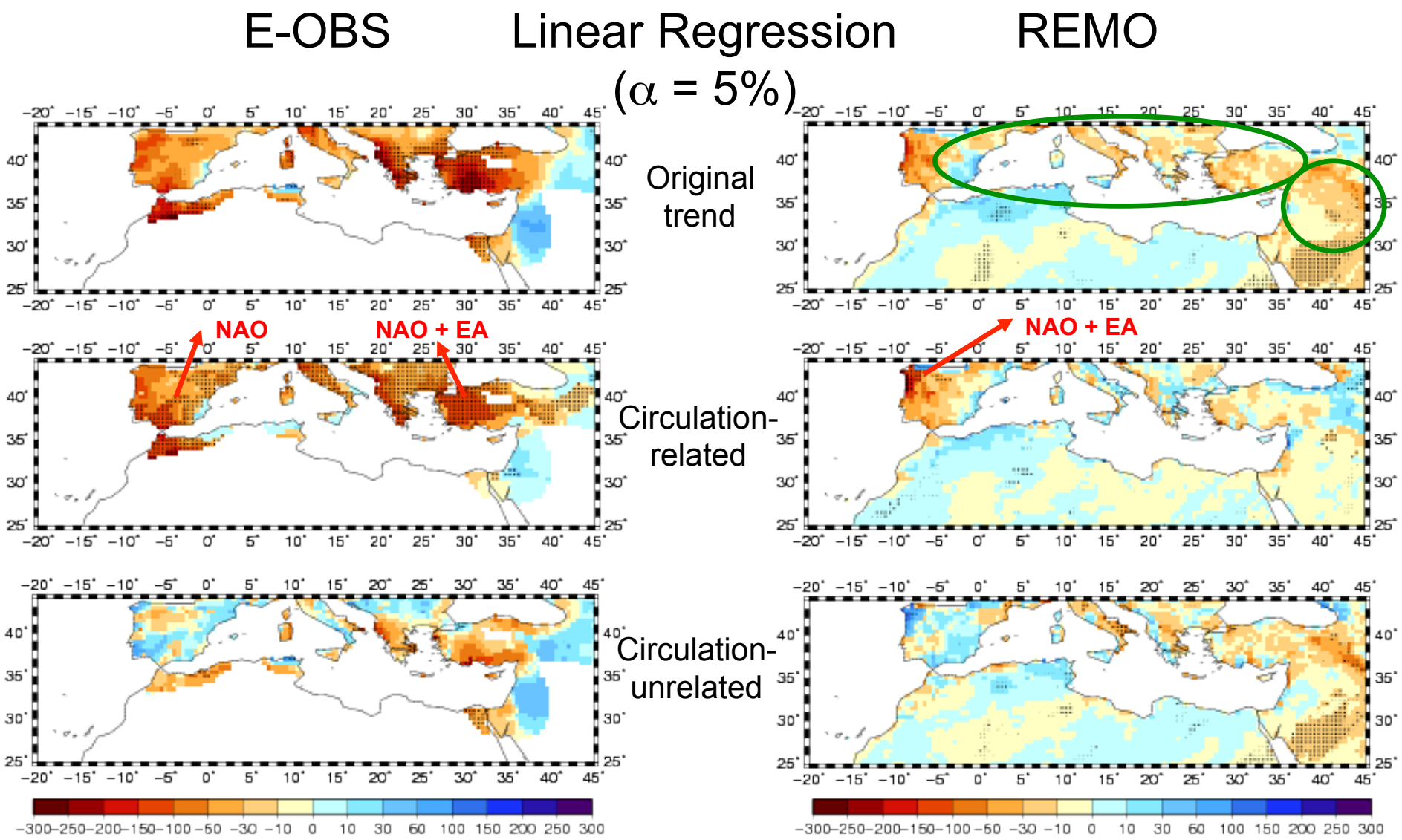
Winter Temperature Trends 1961-90

E-OBS Linear Regression (α = 5%) REMO



Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

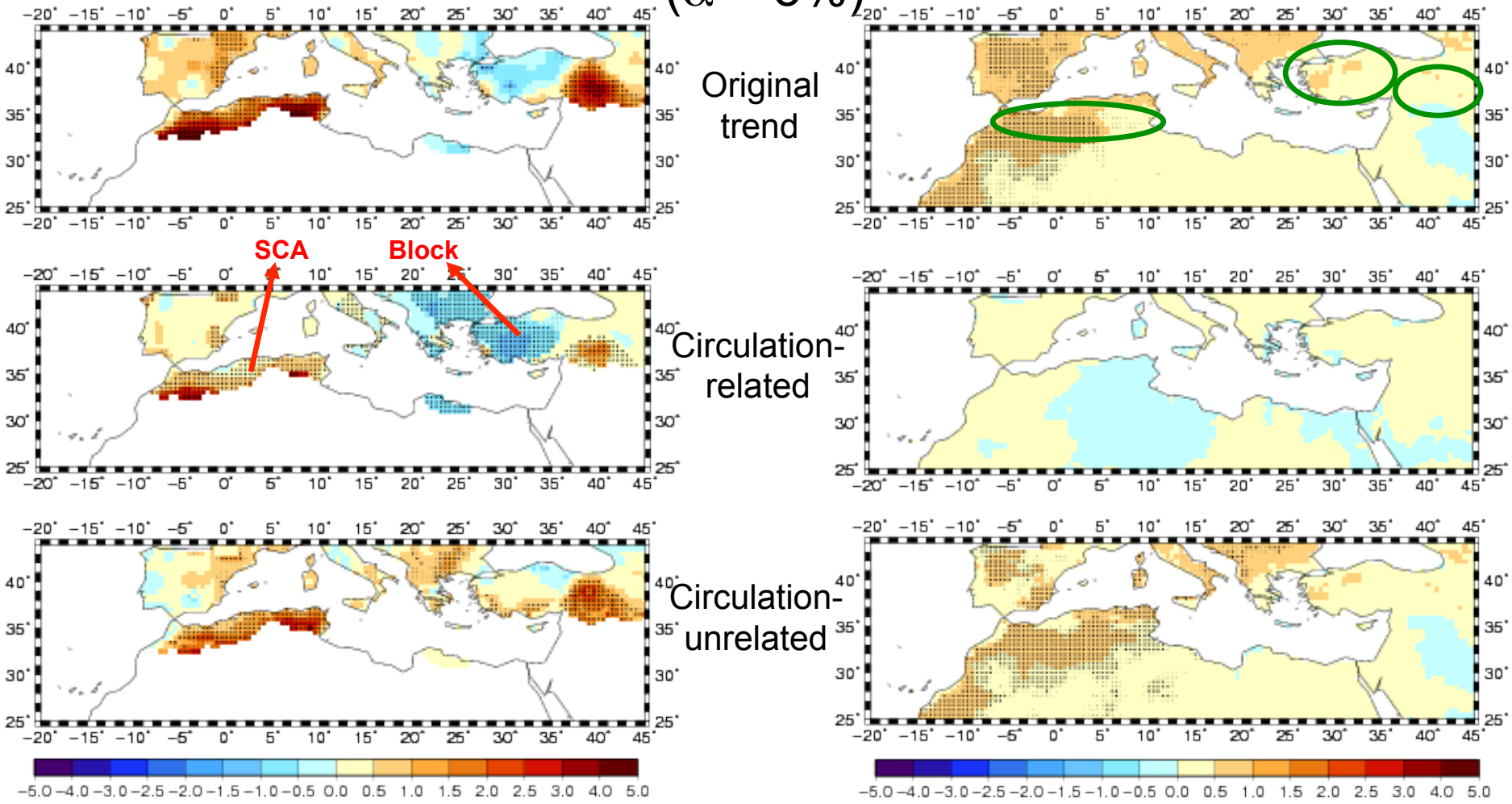
Winter Precipitation Trends 1961-90



Julius-Maximilians-
UNIVERSITÄT WÜRZBURG

Summer Temperature Trends 1961-90

E-OBS | Linear Regression (α = 5%) | REMO



Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

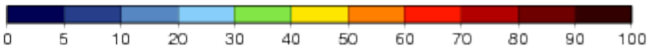
Overview

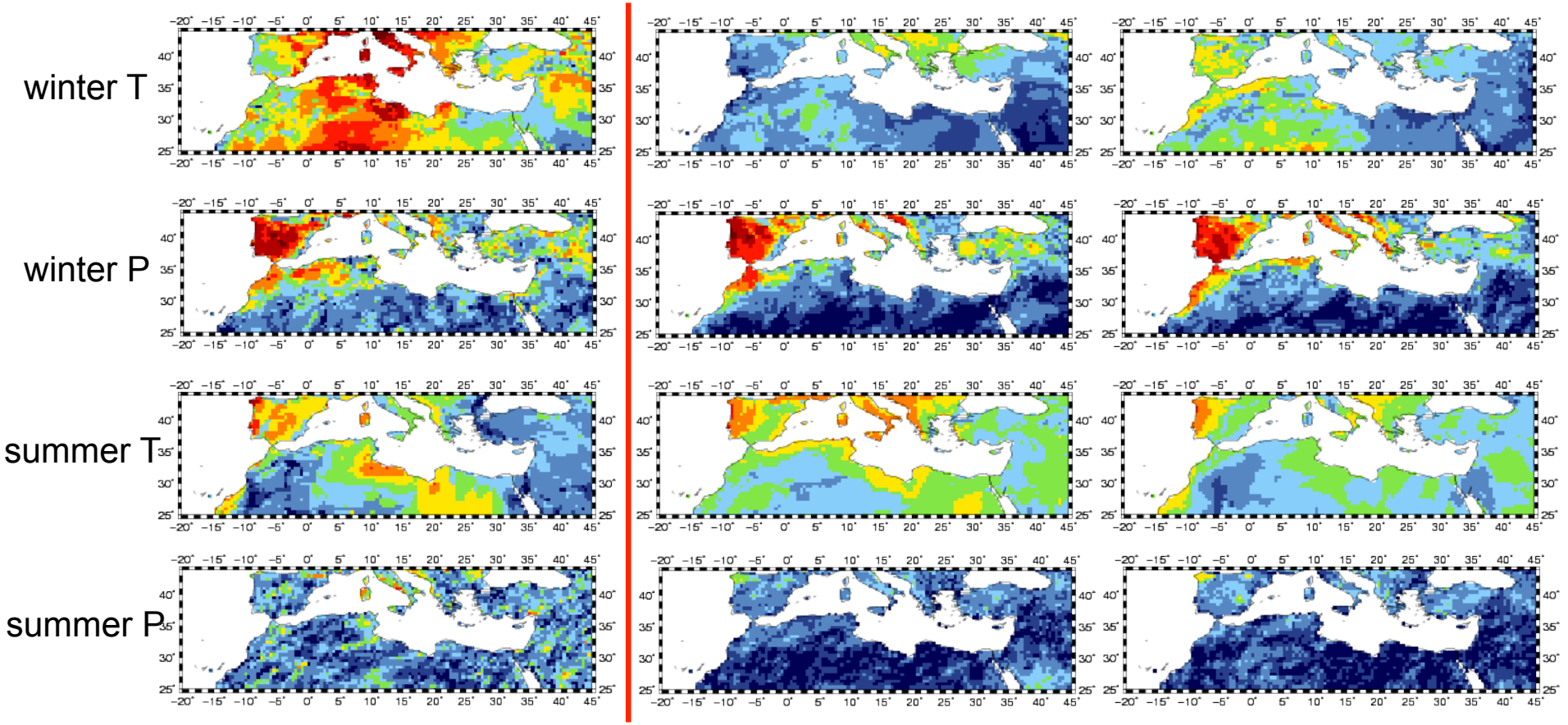
- Model and observation data
- Validation of T+P trends (1961-1990)
- Validation of mid-latitude circulation (1961-1990)
- Multiple regression: T+P ←→ circulation
- Circulation-related and -unrelated T+P trends
- Results for future time period (1961-2050)

Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Multiple Regression for 1961-2050

Explained variance of all predictors [%]:



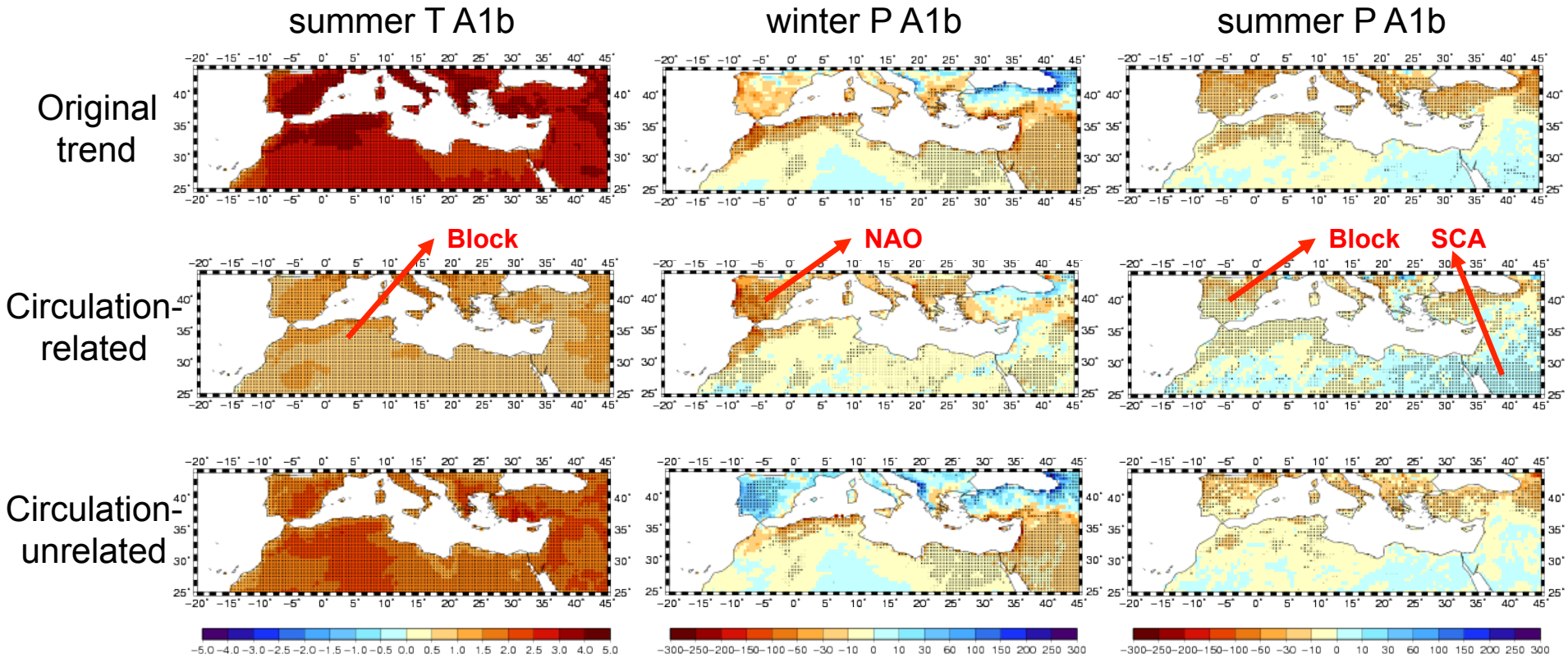


→ Future impact of circulation mostly decreases, esp. on winter T

Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Winter+Summer T+P Trends 1961-2050

Linear Regression (α = 5%):



→ More strong, significant circulation-unrelated trends than in 1961-90

→ Circulation amplifies circulation-unrelated trends, except for winter P

Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Summary and Conclusions

- Validation + Multiple Regression 1961-1990:
  - Weak circulation-unrelated trends, except for summer T
  - Circulation explains up to 80% of T+P variance in winter
  - Differences in T+P trends can be explained by differences in circulation (Win: NAO+EA, Sum: Block+SCA)
    → Physics of model circulation correct, but not in phase
  - Model circulation strongly depends on initial conditions

  → strong impact of initial conditions and interdecadal model variability (circulation) on present-day RCM trends

- Multiple Regression 1961-2050:
  - Strong circulation-unrelated trends of warming and drying
  - Impact of circulation mostly decreases, esp. for winter T

  → GHG signal seems to emerge from interdecadal variability

Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Attachment