Impact of climate aggregation over different scales on regional NPP modelling

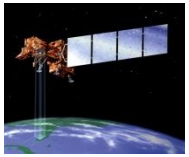
M. Kuhnert, J. Yeluripati, P. Smith, H. Hoffmann, F. Ewert, M. van Oijen, et al.

http://scale-it.net/

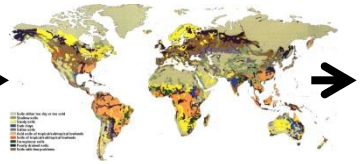
Input data for spatial modelling

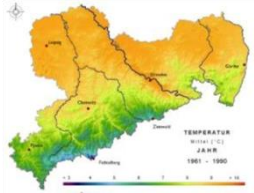
soil

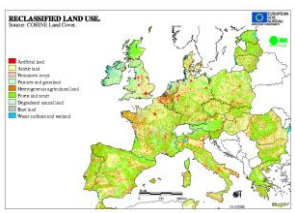
climate

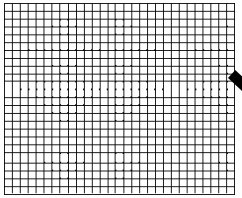


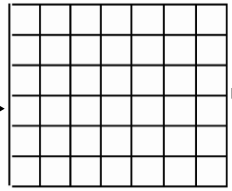
land use

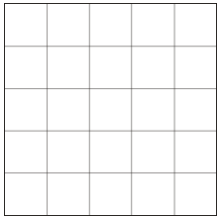


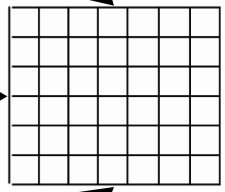








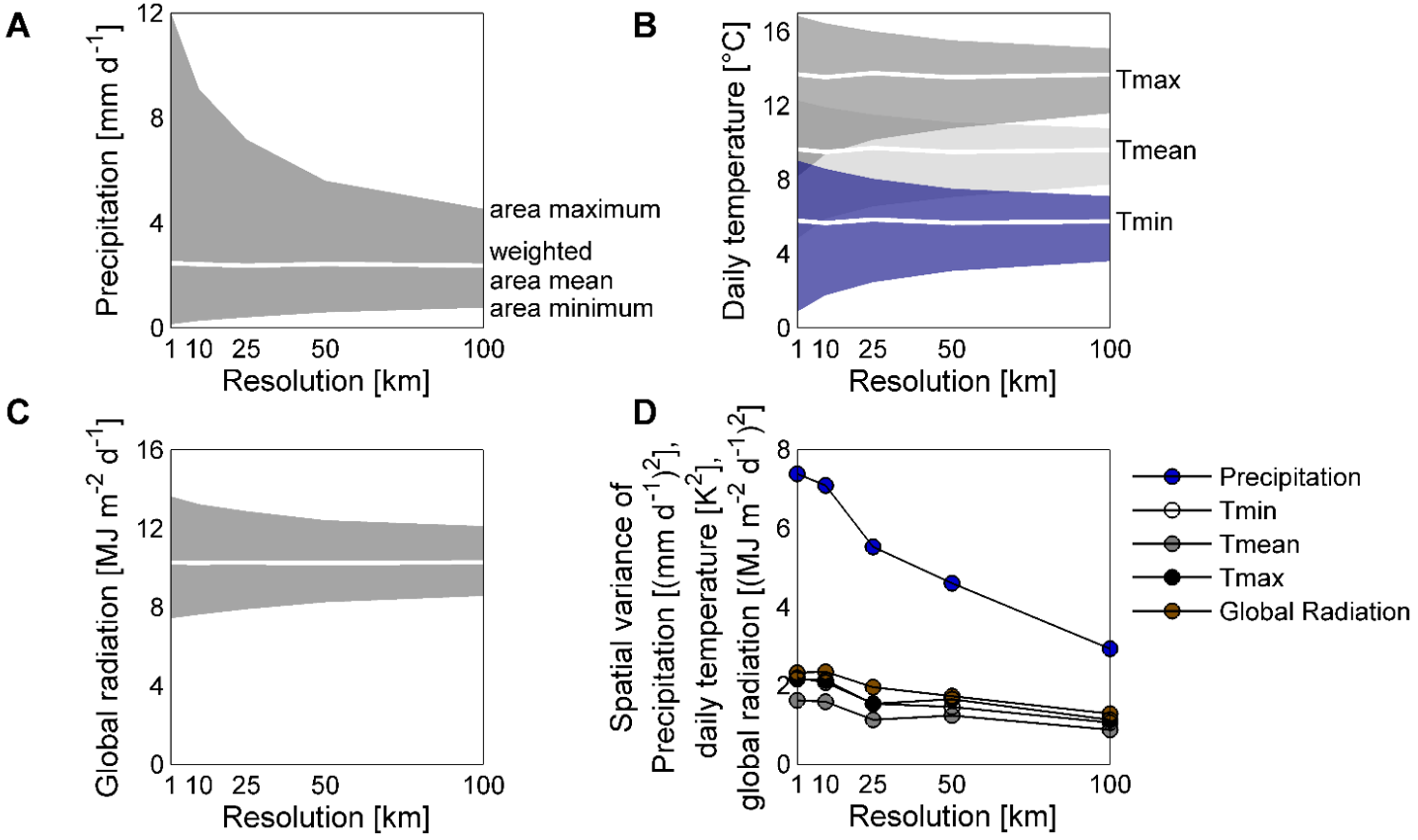




Model

NPP

Change in resolution affects a decrease of extreme weather:



Hoffmann et al., submitted

Objective of the talk

1. Estimate the impact of scale effects of weather data on net primary production (NPP).

2. Test the impact extreme weather events on different scales.

Is there a clear trend?

Settings for model approach

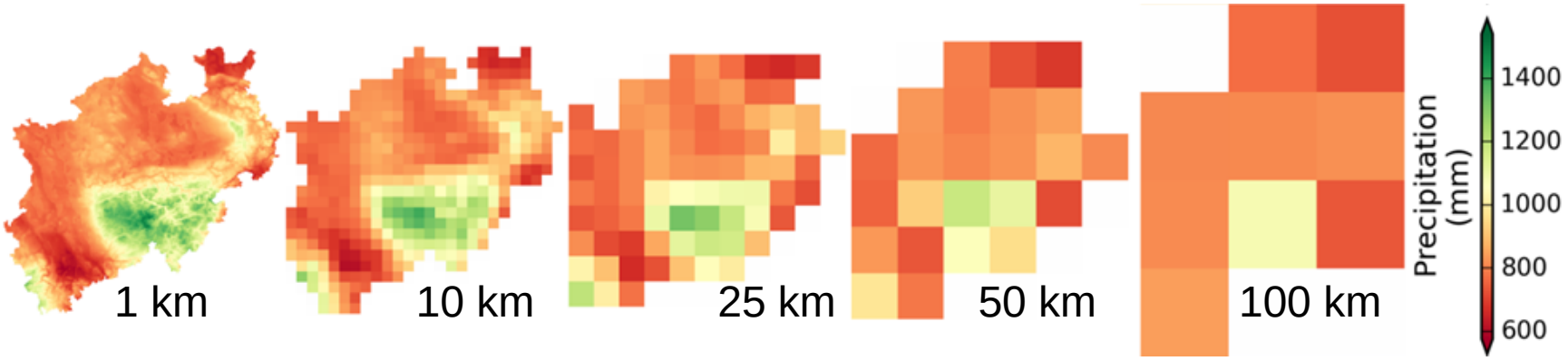
-2 crops: wheat, maize

-constant management and soil type

-potential growth (**PLP**) and consideration of water stress (**PLW**)

-11 models: HERMES, APSIM2, COUP, DAILYDAYCENT, APSIM, STICS
CENTURY, AgroC, LandscapeDNDC, LINTUL, MONICA

-5 different resolutions of climate data:

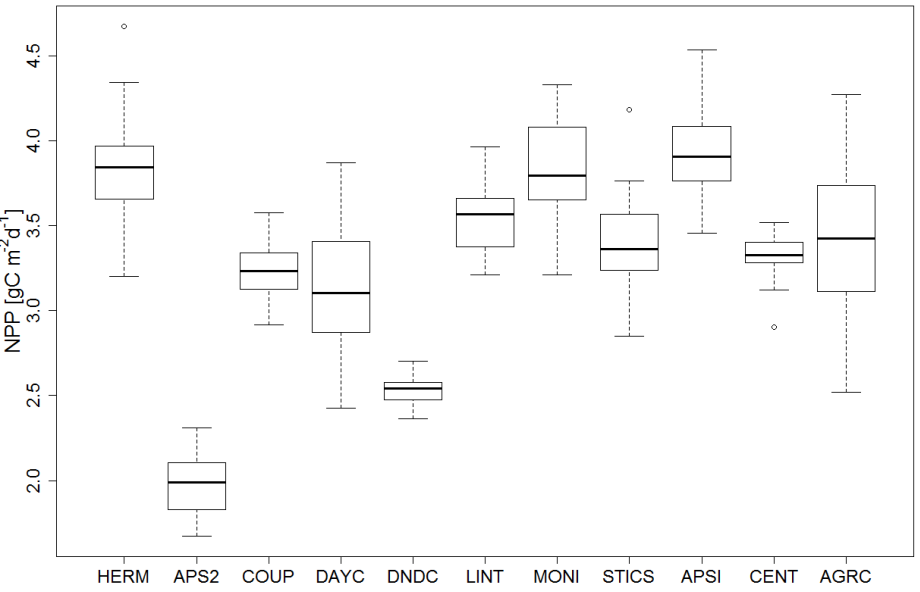


Zhao et a., submitted

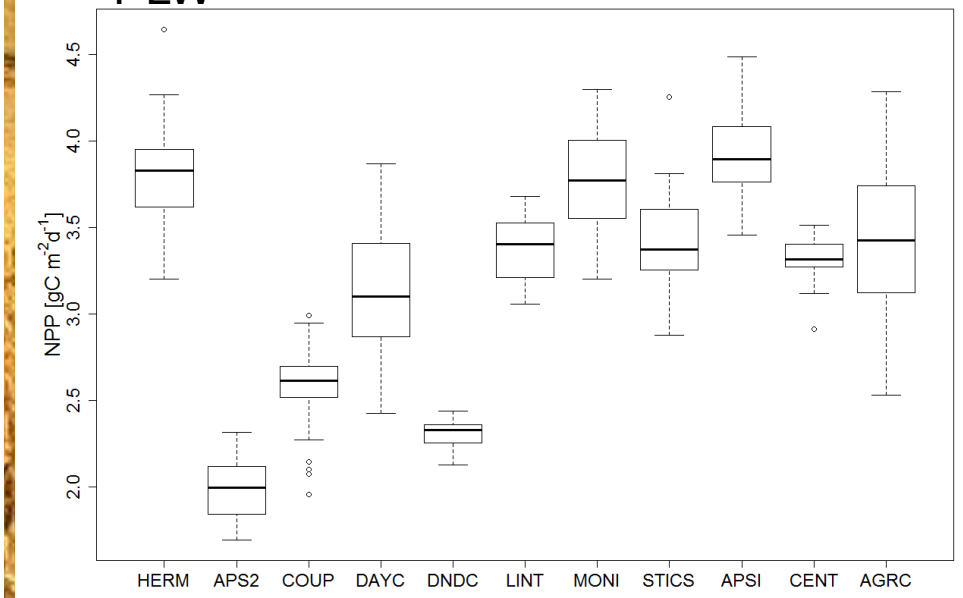
Results NPP

WHEAT

PLP



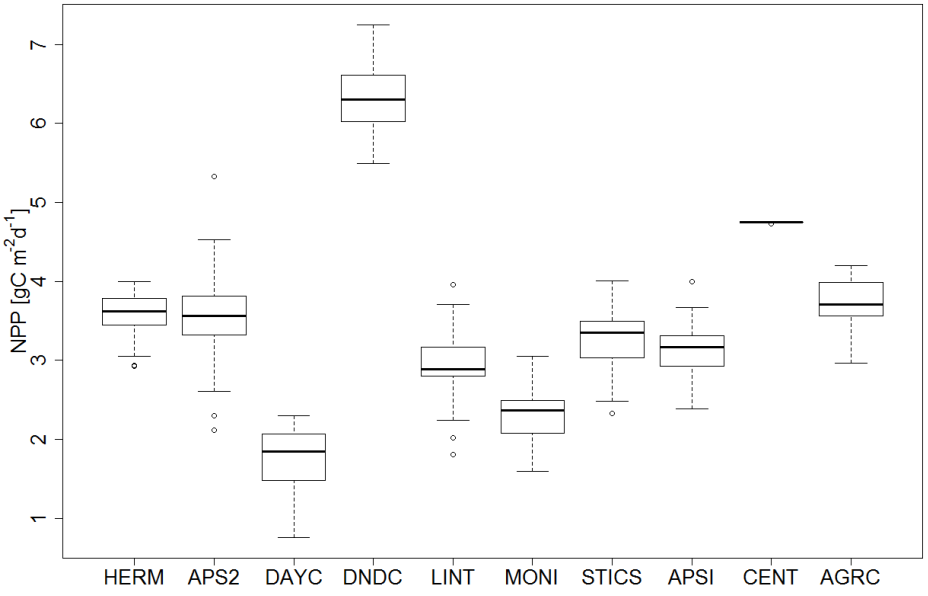
PLW



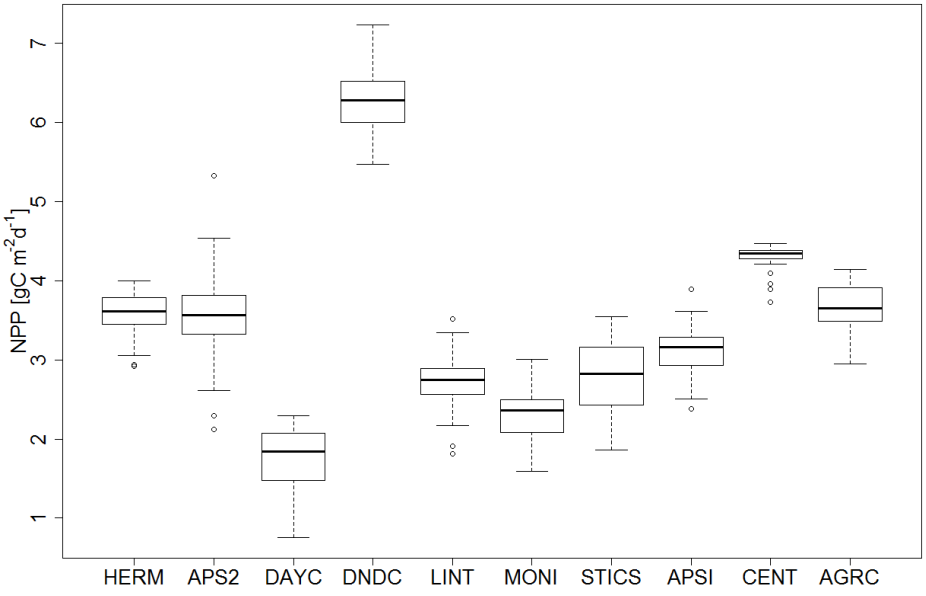
Results NPP

MAIZE

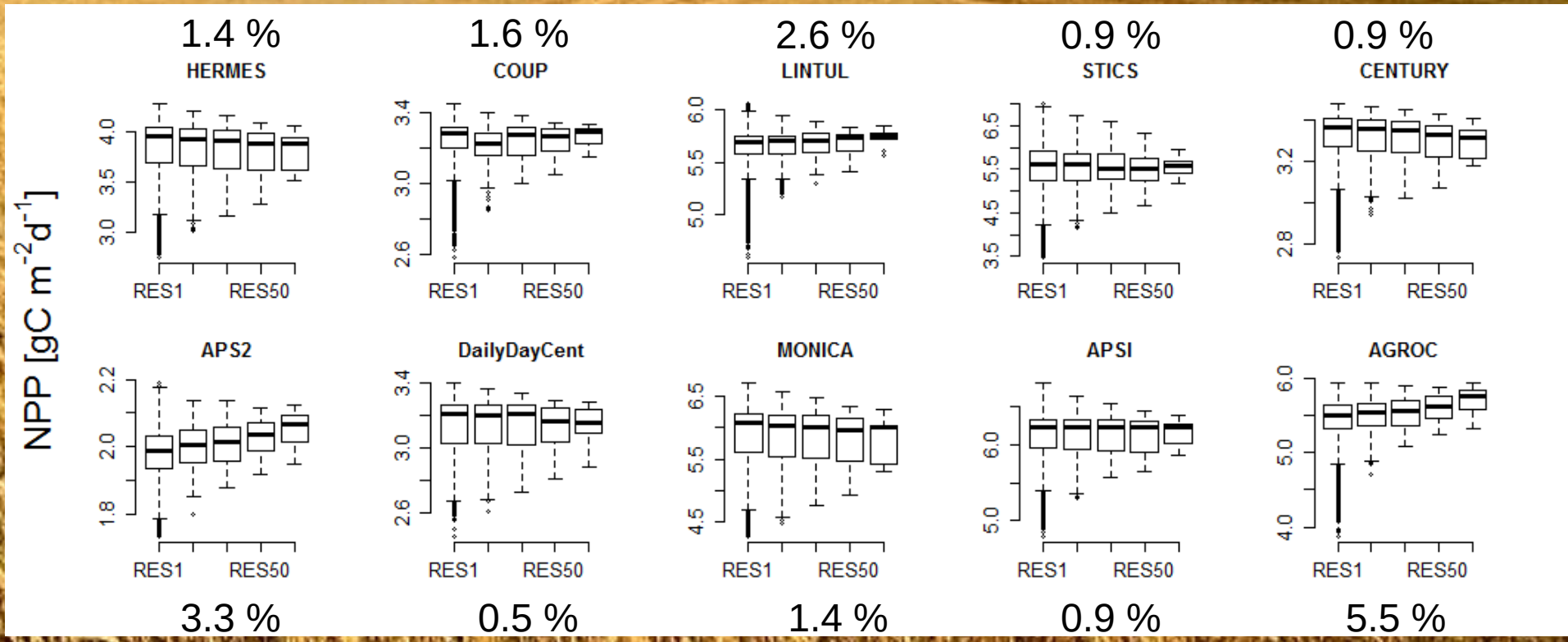
PLP



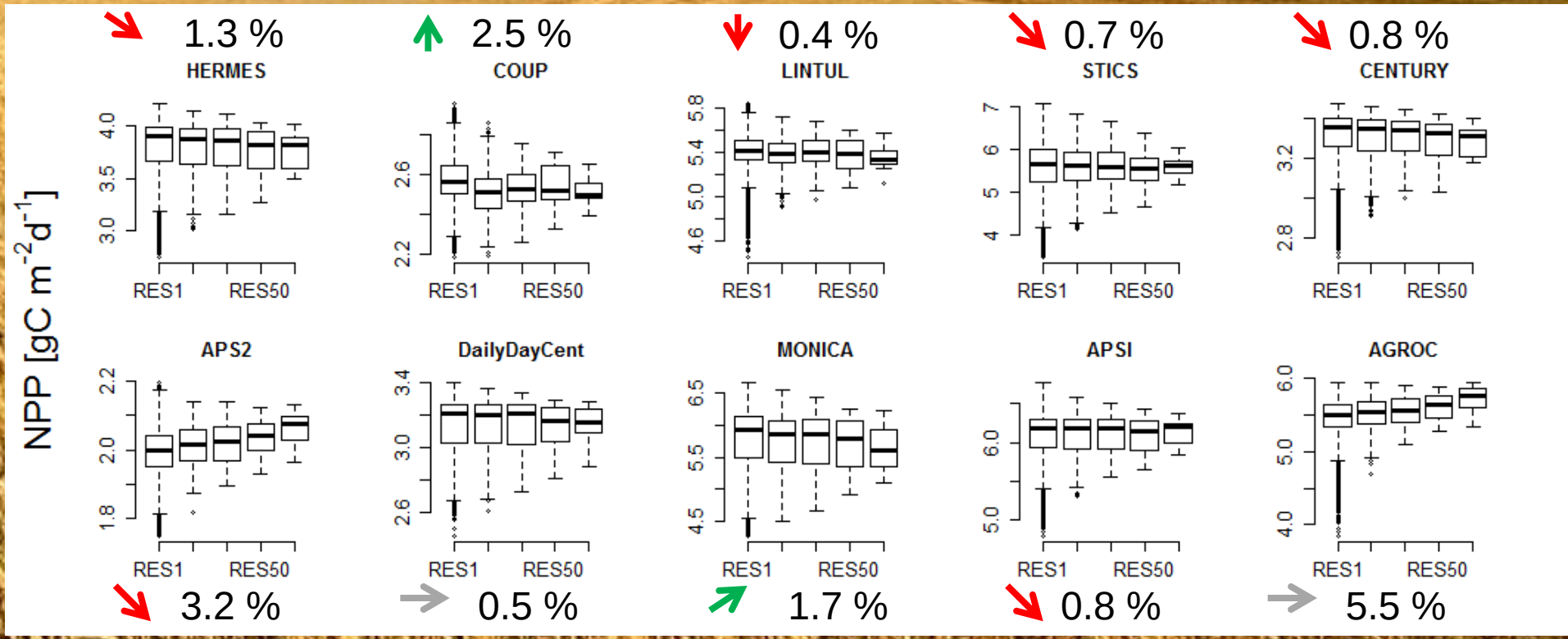
PLW



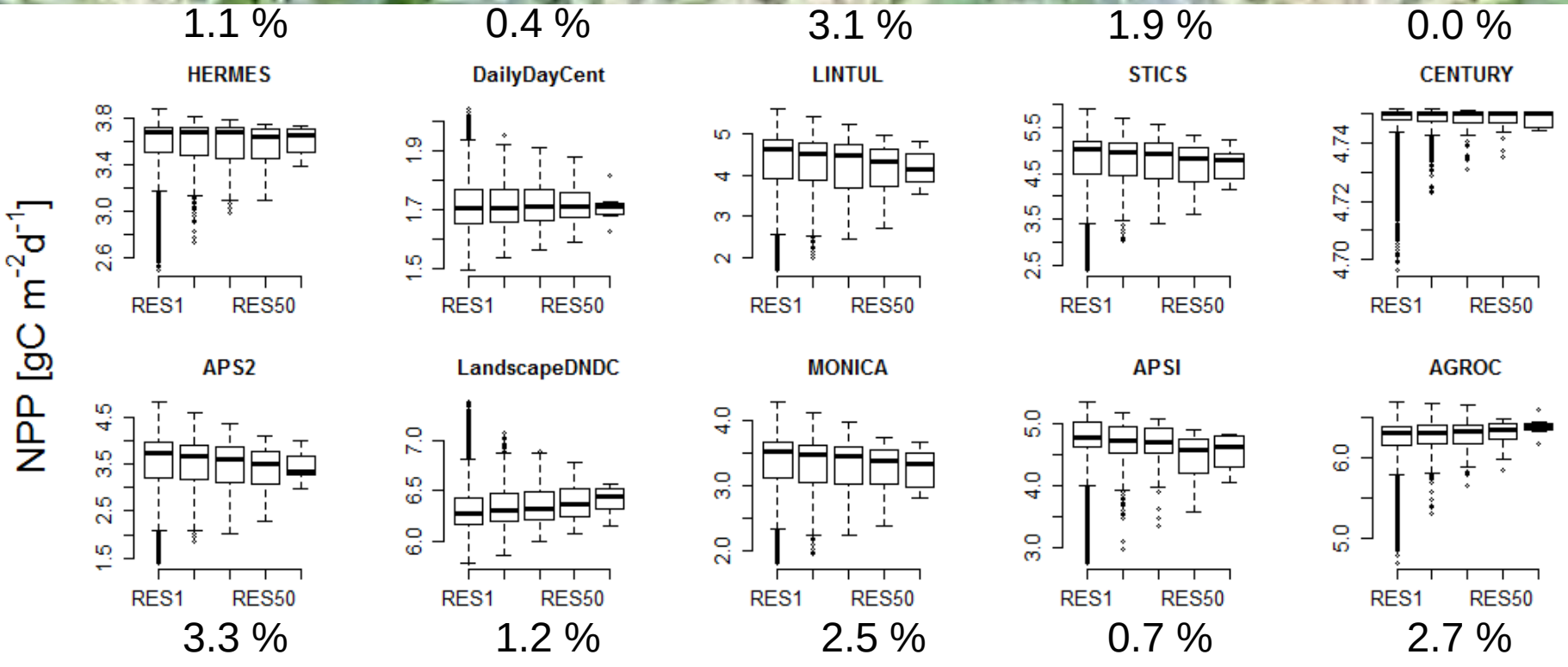
Results for wheat NPP (PLP)



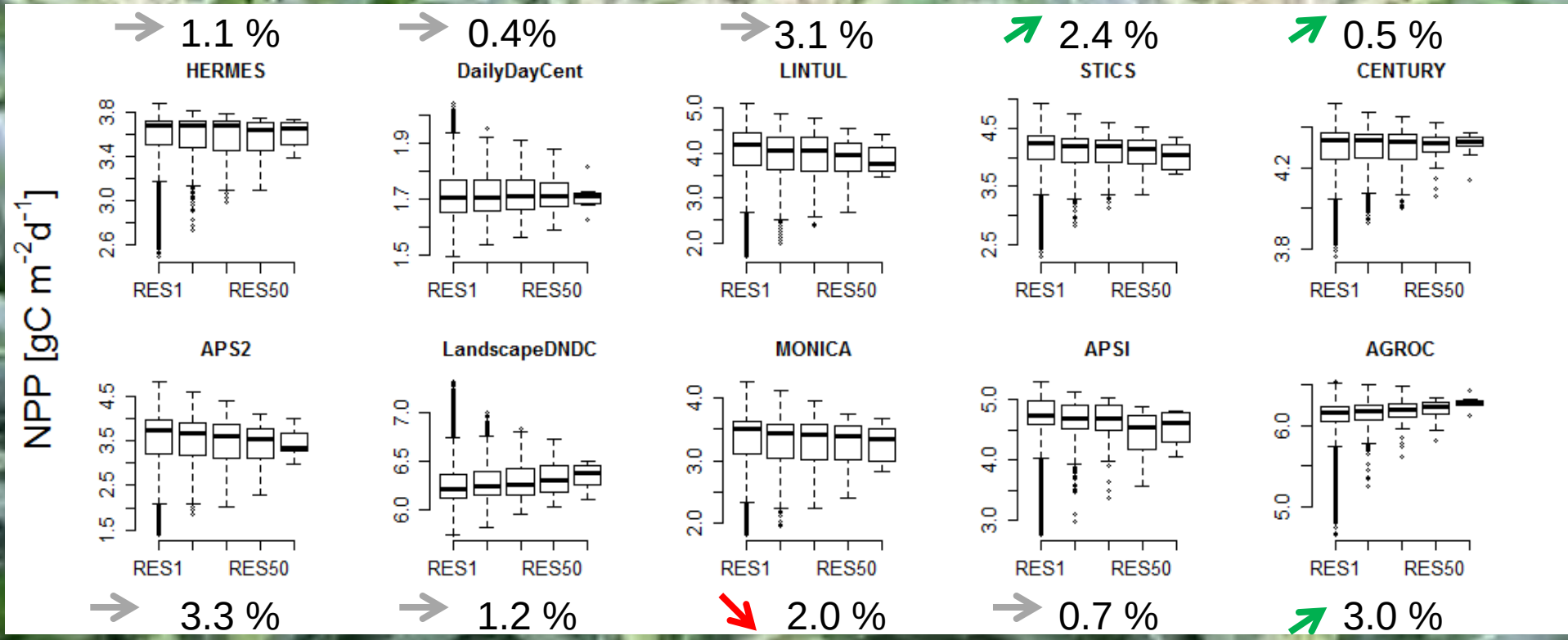
Results for wheat NPP (PLW)



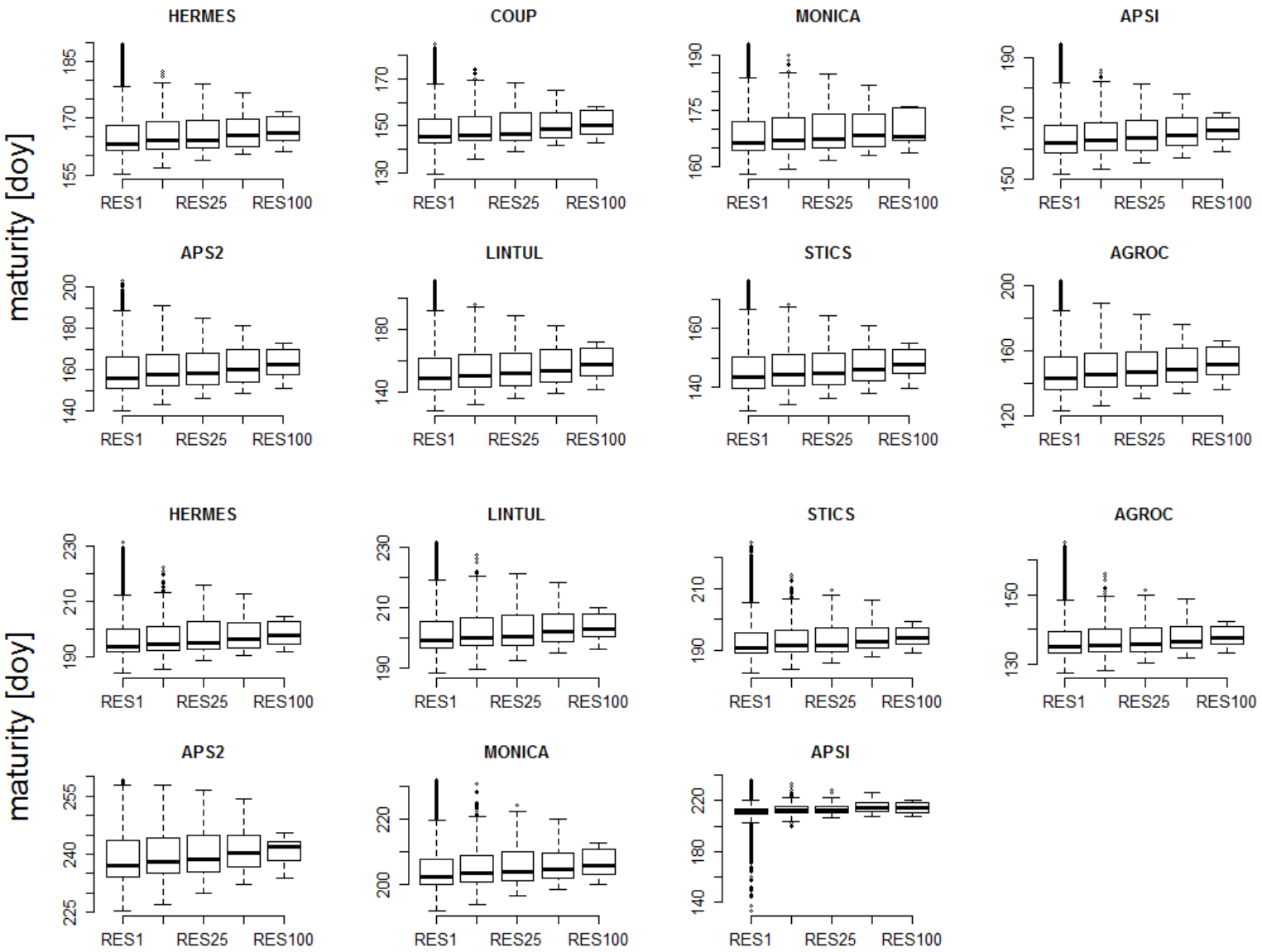
Results for maize NPP (PLP)



Results for maize NPP (PLW)



Length of Growing Season



Wheat

1.5-5 days

Maize

1-2 days

How define an extreme event?

Extreme weather conditions

Extreme → P < threshold

Effects on crops

Extreme → NPP < threshold

Extreme weather condition

-The **SPEI** drought index based on the difference of **P and PET**

-The calculation considers one **6 month** period (Jan.-Jun.) per year

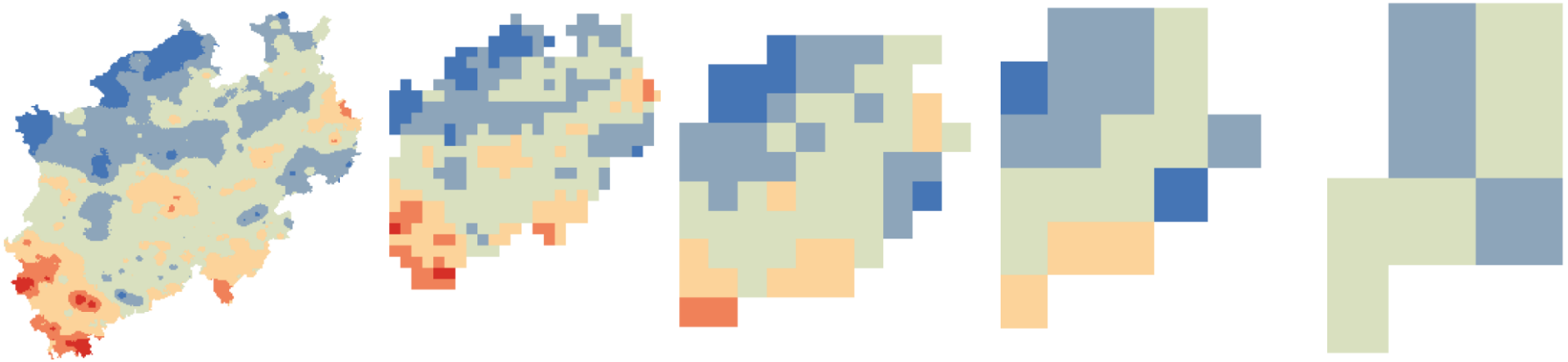
-Values **< -1** define extreme dry conditions

Vincente-Serrano et al., 2010; van Oijen et al., 2014

SPEI index [-]

- **< -1**
- **-1 - -0.5**
- **-0.5 - 0**
- **0 - 0.5**
- **0.5 - 1**
- **> 1**

Example maps for 1982



Risk/vulnerability analysis

Risk: $R = NPP_{non\ hazardous} - NPP$

Vulnerability: $V = NPP_{non\ hazardous} - NPP_{hazardous}$

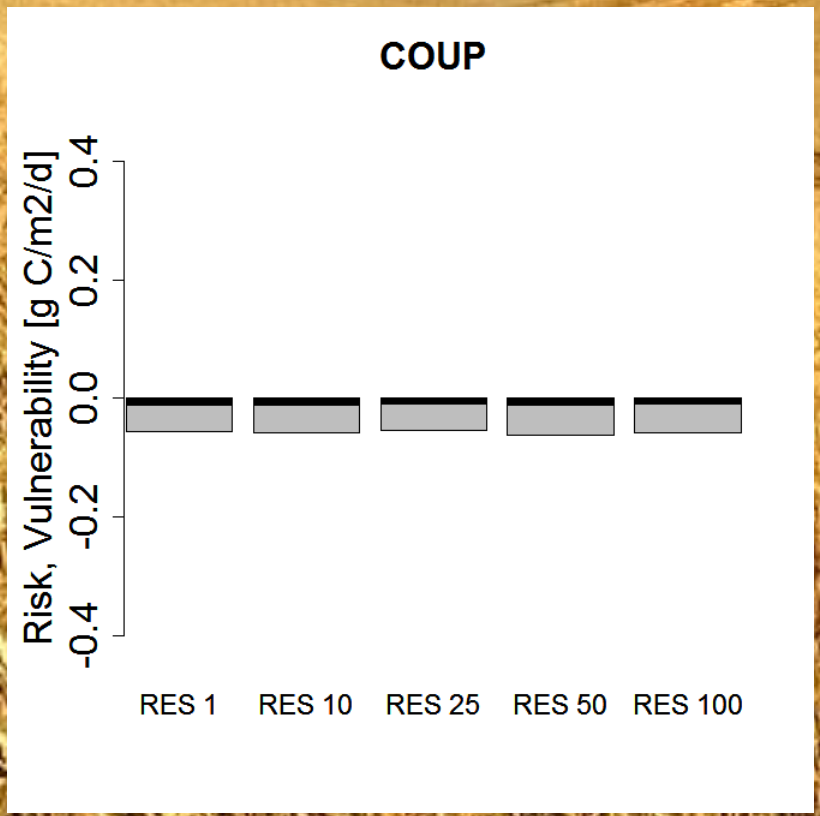
$NPP_{hazardous}$: average NPP over grid cells with SPEI < -1
$NPP_{non\ hazardous}$: average NPP over grid cells with SPEI > -1
NPP: overall average NPP

SPEI < -1: hazardous conditions
SPEI > -1: non hazardous conditions

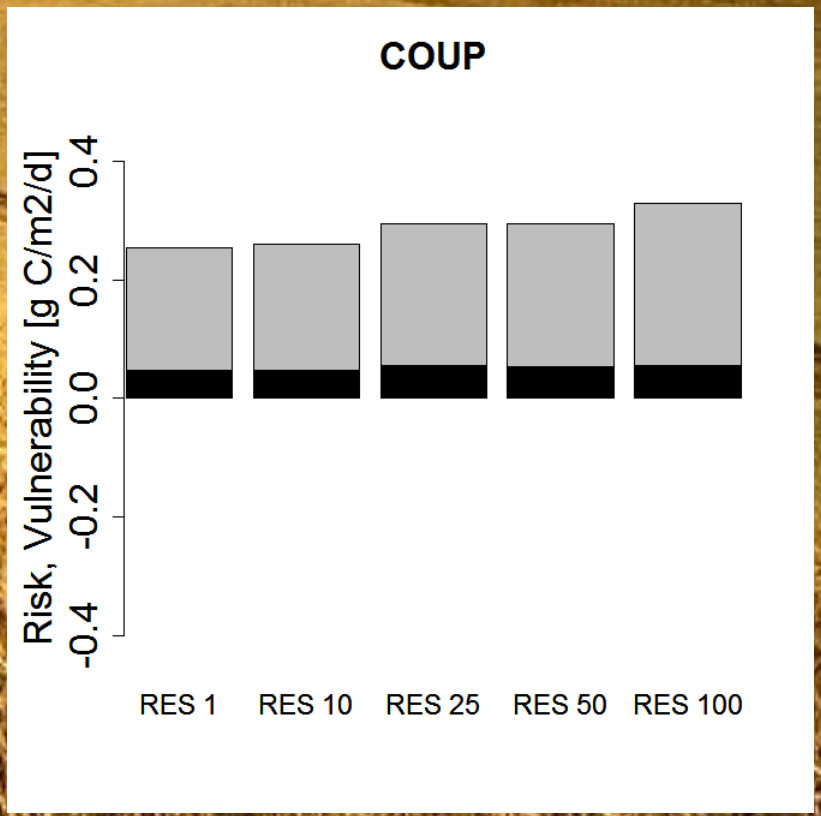
Van Oijen et al., 2014

Risk analysis for COUP (NPP)

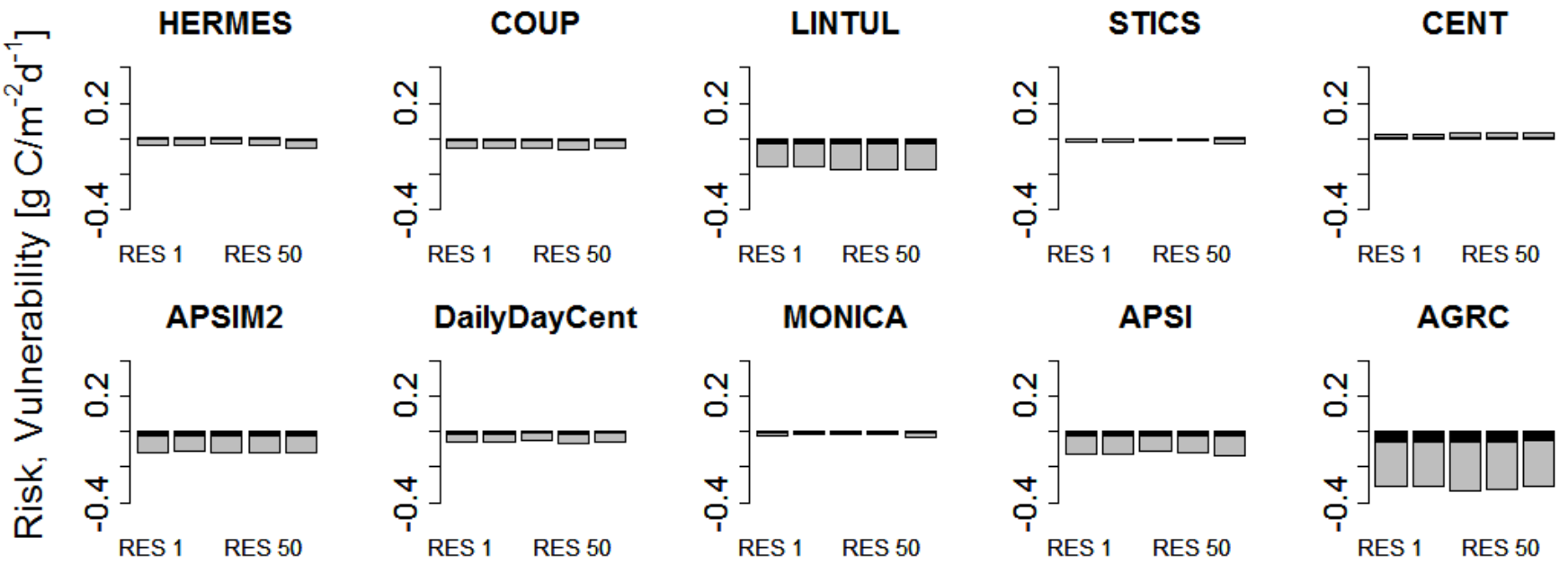
WHEAT PLP



WHEAT PLW

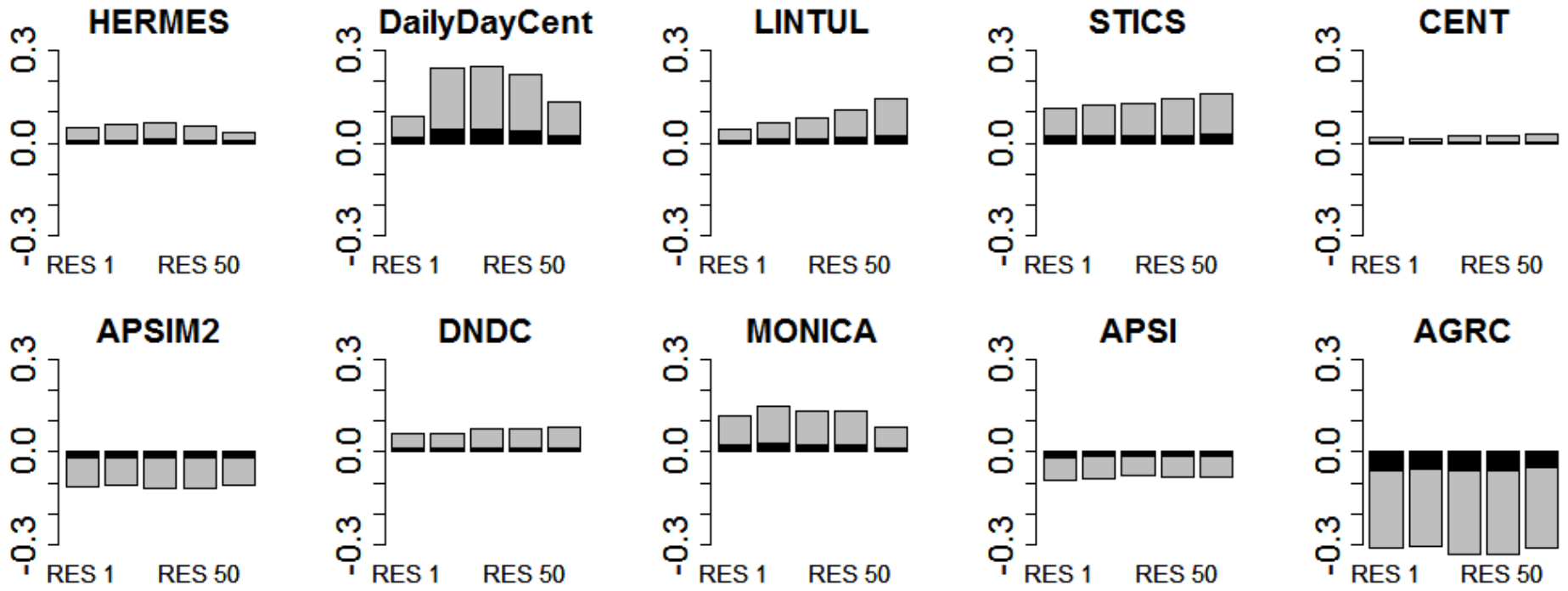


Risk analysis wheat (PLP)



Results for <u>wheat</u>: **Risk (black)** and **vulnerability (grey)**

Risk analysis wheat (PLW)

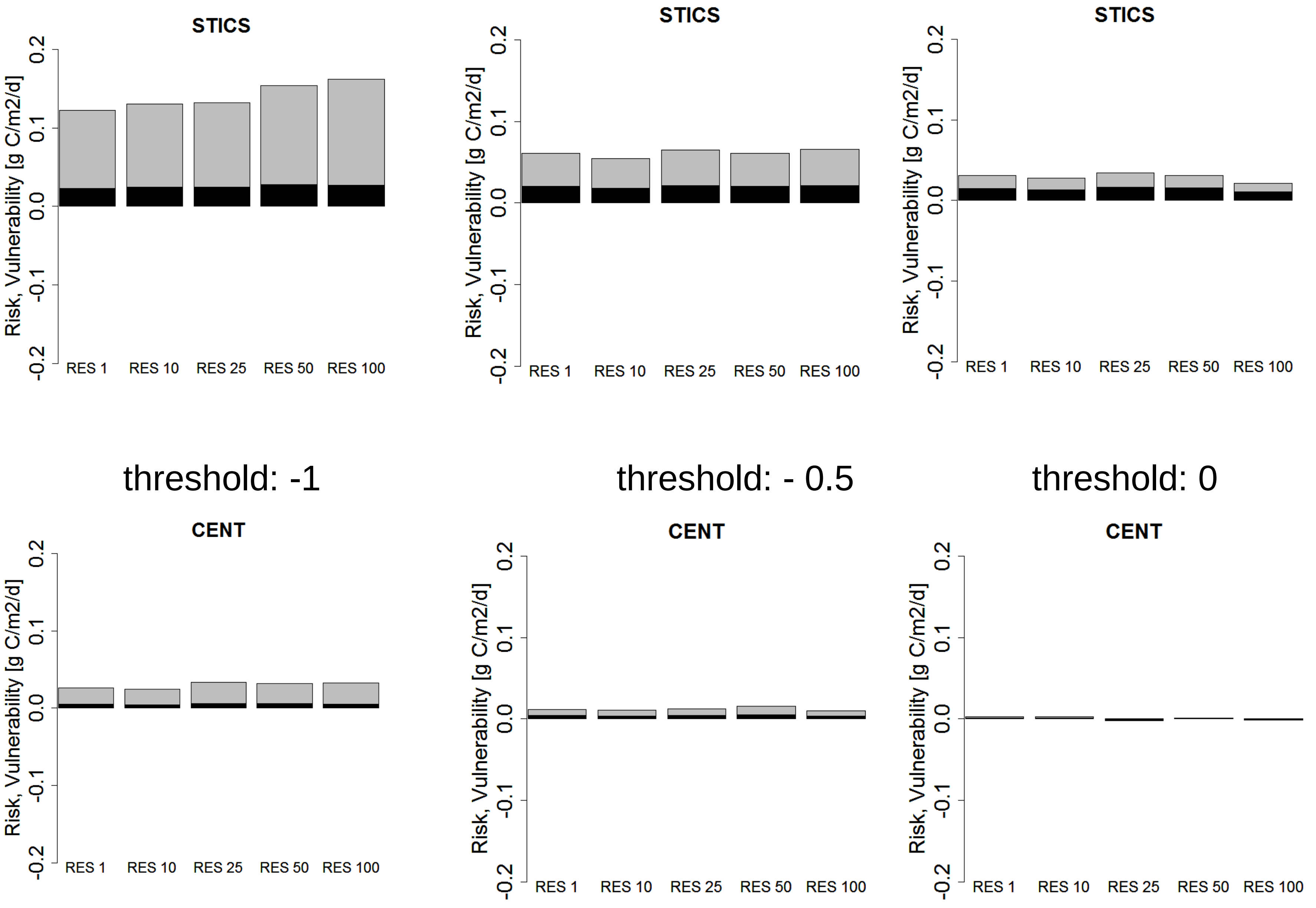


Results for wheat: **Risk (black)** and **vulnerability (grey)**

Summary

- The resolution affects 0.9-5.5 % (wheat) and 0-3.3 % (maize) changes on the simulated NPP values
- Except for the length of growing season there is no clear trend in the effects
- The impact of extreme weather on NPP is affected by the scale, but the impact of extremes is larger than the impact of scale


Thank you for your attention!
www.scale-it.net


STICS
STICS
STICS
threshold: -1
threshold: - 0.5
threshold: 0
CENT
CENT
CENT
Risk, Vulnerability [g C/m2/d]
0.2
0.1
0.0
-0.1
-0.2
RES 1
RES 10
RES 25
RES 50
RES 100

Method (2)

env (RAIN, mm y^{-1})	*sys* (NPP, g m^{-2} d^{-1})
200	**20**
400	**30**
400	**40**
600	70
600	80
600	80
800	90
800	100
800	100
800	110

Threshold: 500 mm precipitation

E(*sys*|*env* non-hazardous): 90 g m^{-2} d^{-1}

E(*sys*): 72 g m^{-2} d^{-1}

E(*sys*|*env* hazardous) : 30 g m^{-2} d^{-1}

Risk: $R = 90 \text{ g m}^{-2} \text{ d}^{-1} - 72 \text{ g m}^{-2} \text{ d}^{-1} = 18 \text{ g m}^{-2} \text{ d}^{-1}$

Vulnerability: $V = 90 \text{ g m}^{-2} \text{ d}^{-1} - 30 \text{ g m}^{-2} \text{ d}^{-1} = 60 \text{ g m}^{-2} \text{ d}^{-1}$

Van Oijen et al., unpublished

Method (2)

Precipitation alone is not a good indicator!

Drought indices:

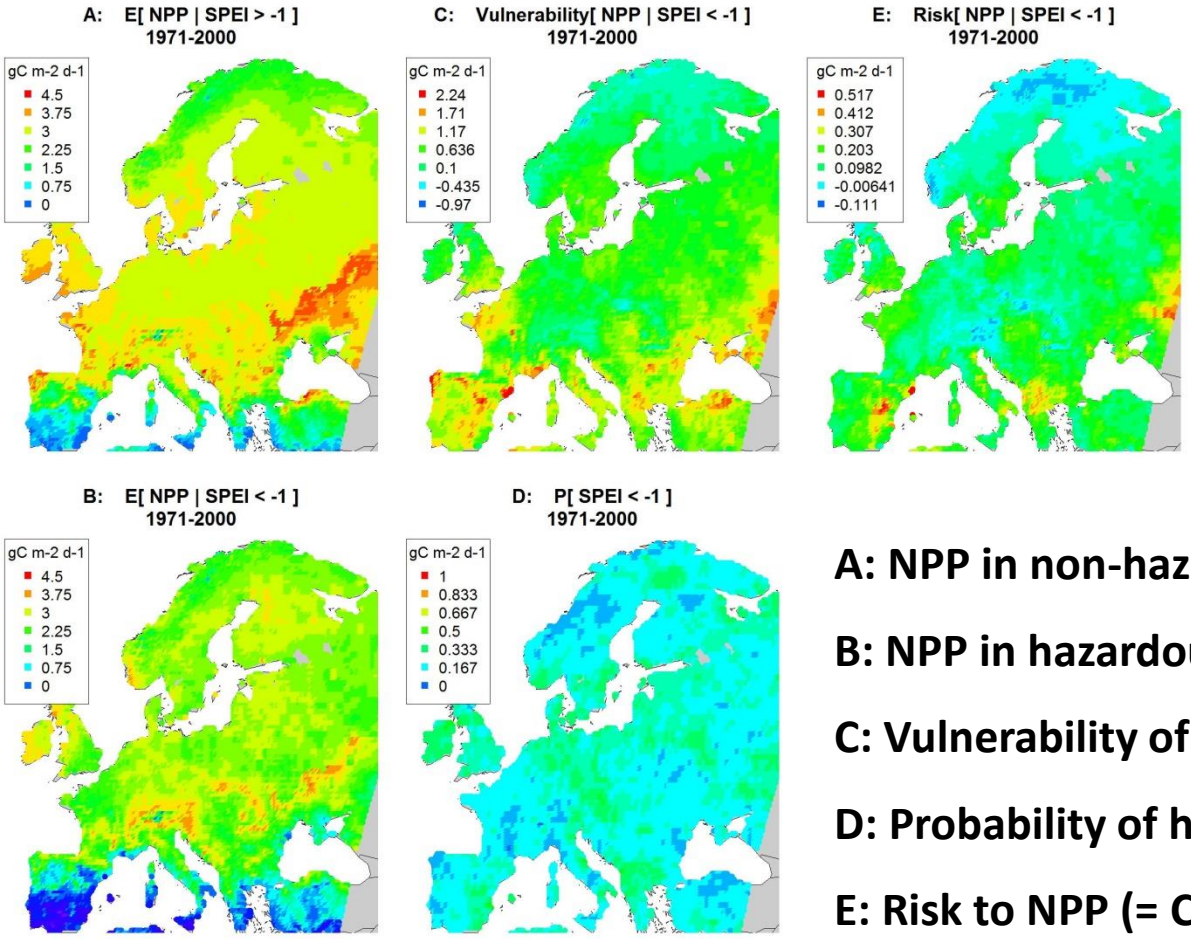
SPI: **based on precipitation**

SPEI: **based on potential evapotranspiration and precipitation**

Thresholds:

SPEI < -1 **SPEI < -2**

Results (2)



A: NPP in non-hazardous years.

B: NPP in hazardous years.

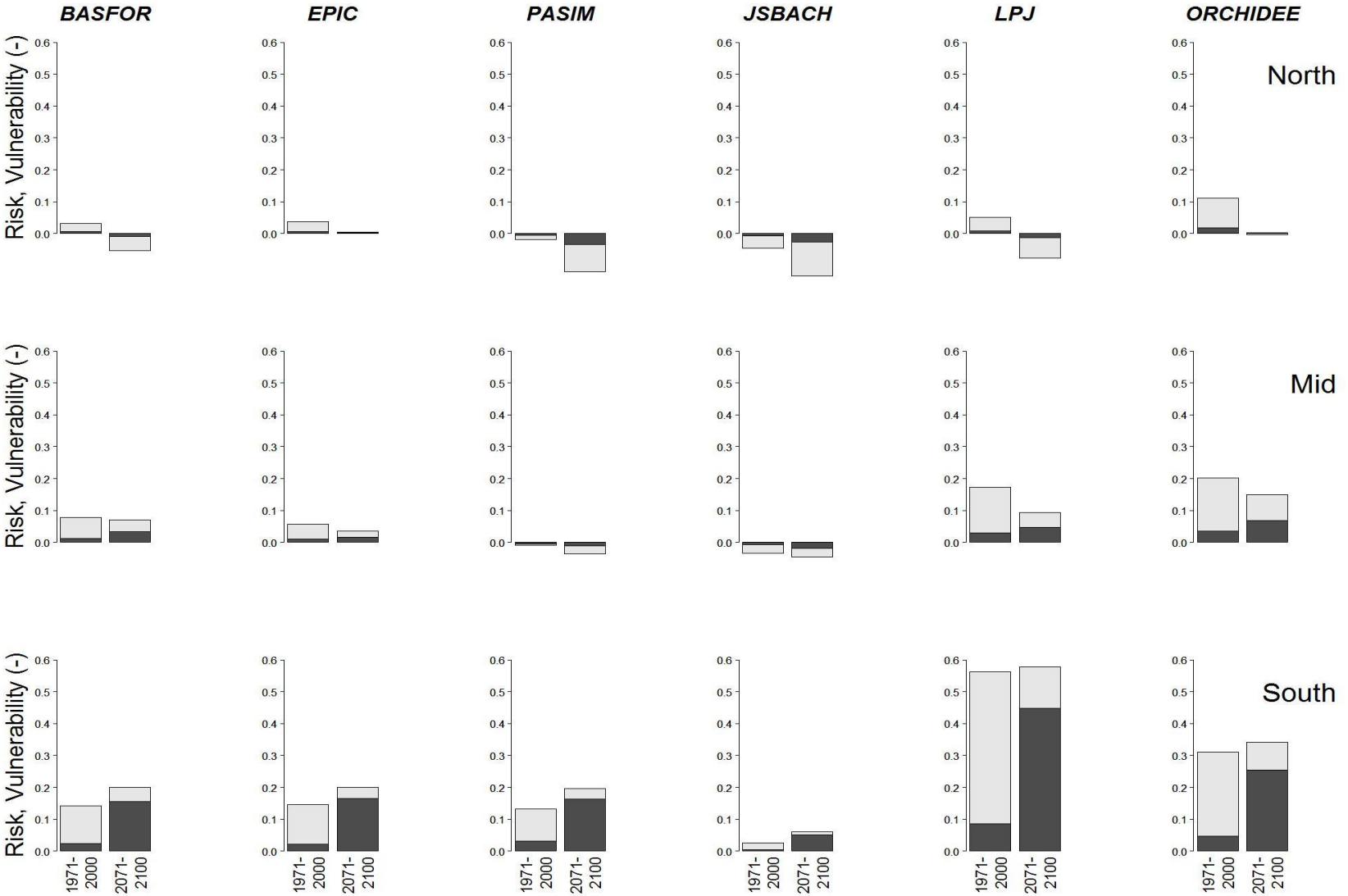
C: Vulnerability of NPP (= A-B).

D: Probability of hazard.

E: Risk to NPP (= C * D).

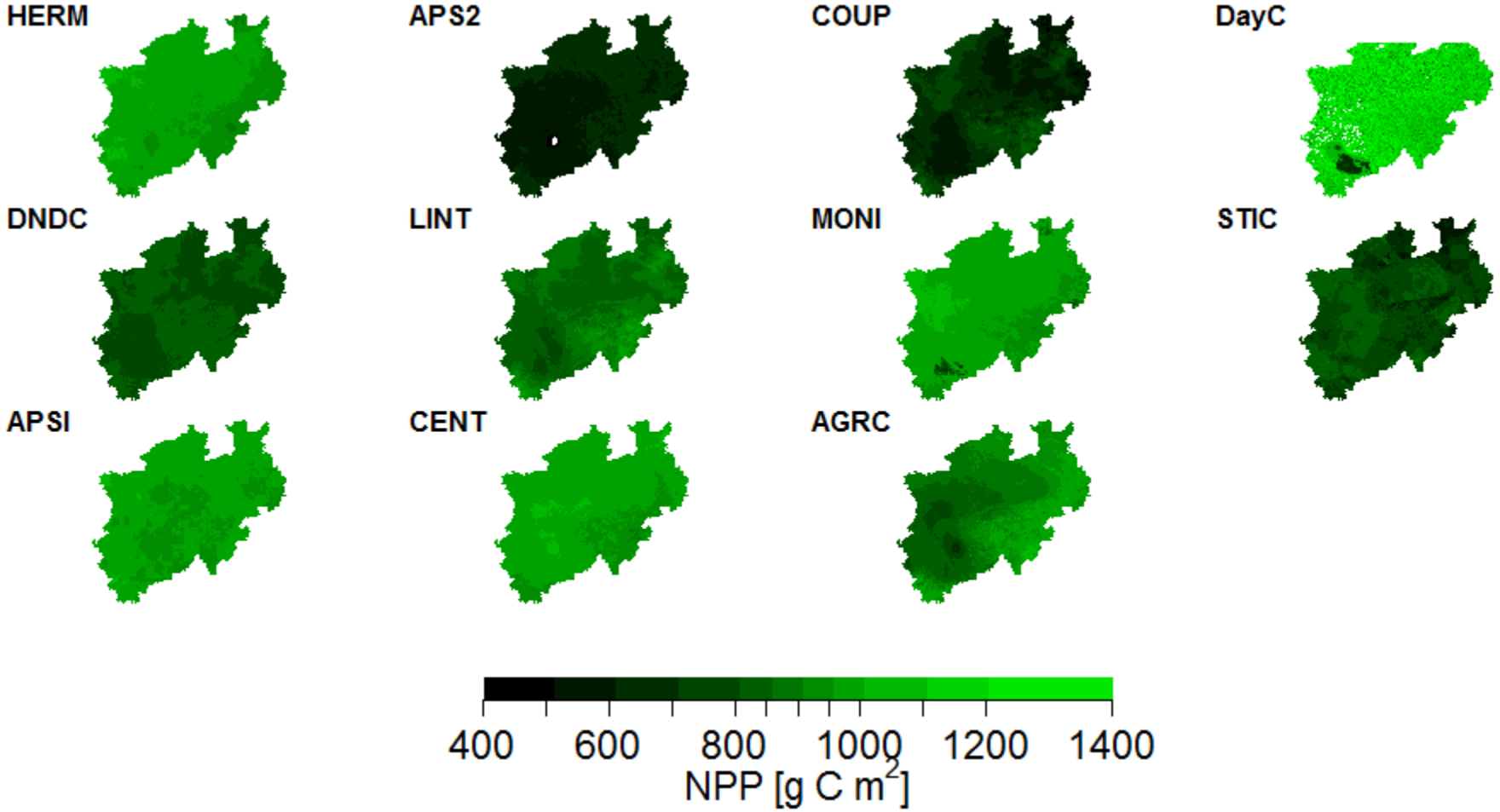
Van Oijen et al., submitted

Results (2)



Van Oijen et al., submitted

NPP 2003


HERM
APS2
COUP
DayC
DNDC
LINT
MONI
STIC
APSI
CENT
AGRC
400
600
800
1000
1200
1400
NPP [g C m^2]