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# **How well do Regional Climate Models simulate and parametrize surface wind speed and wind gust across Scandinavia?**

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# INTRODUCTION

**Ulbrich et al. (2013):** In Europe windstorms and extreme wind events cause more than half of the economic loss associated with natural disasters

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Ulbrich U., G. C. Leckebush, and M. G. Donat, 2013  
*Windstorms, the most costly natural hazard in Europe*

**Nikulin et al. (2011):** “Unfortunately there is no available observational database to evaluate the simulated maximum wind gust”

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Nikulin et al., 2011  
*Evaluation and future projections of temperature, precipitation and wind extremes over Europe in an ensemble of regional climate simulations*

# AIM

## Focused on wind conditions across Scandinavia:

- Near-surface wind speed (WS) – daily means
  - Daily Peak Wind Gust (DPWG) – *the highest near-surface wind gust speed recorded in 24 hours*
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## Research questions:

- 1) What are the observed climatologies of DPWG and WS across Scandinavia?
- 2) How well do models capture the observed climatologies?

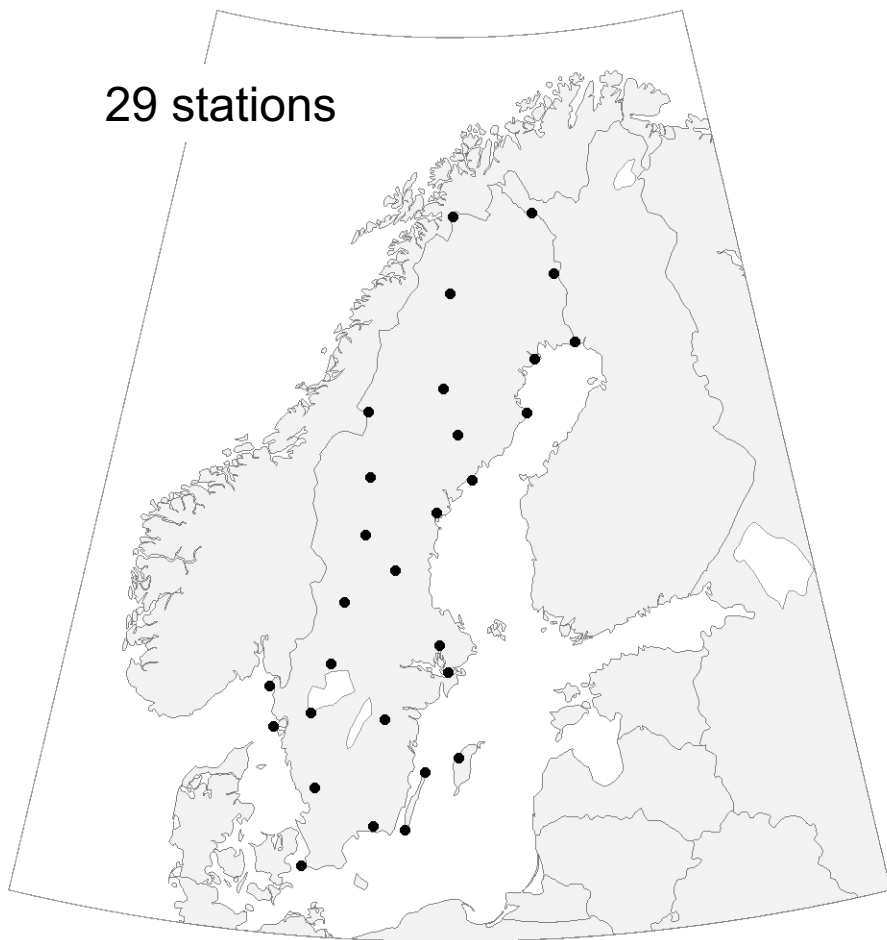


# STATION-BASED OBSERVATIONS



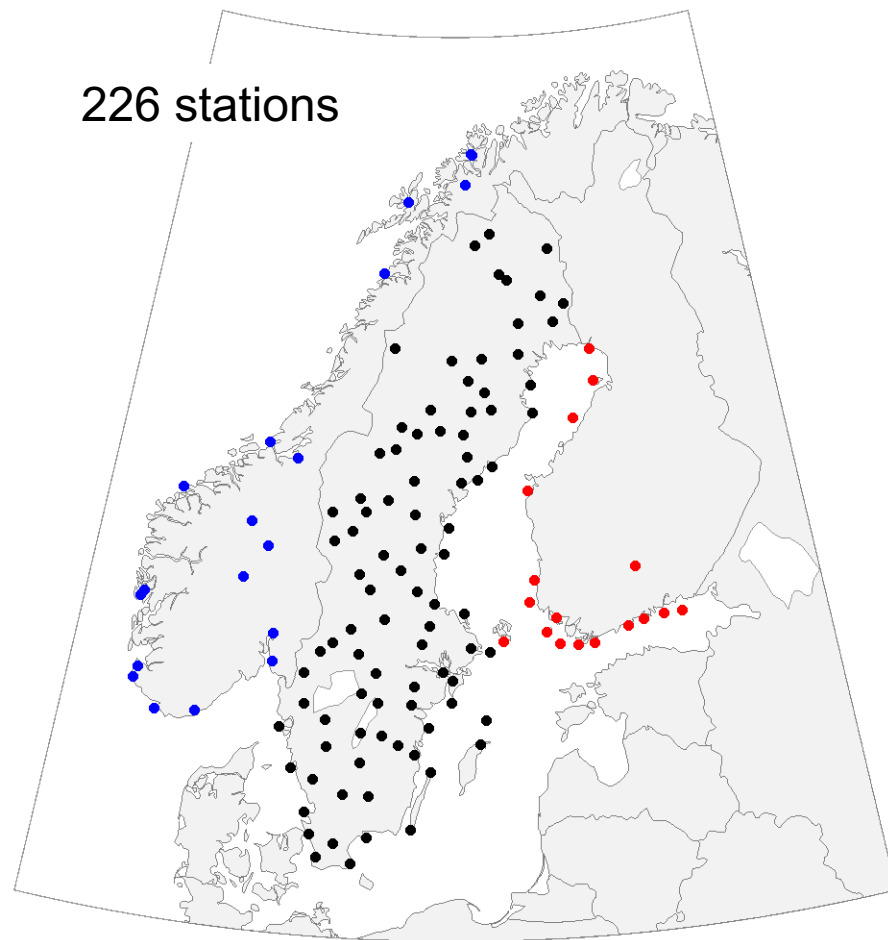
## Wind Speed

29 stations



## Daily Peak Wind Gust

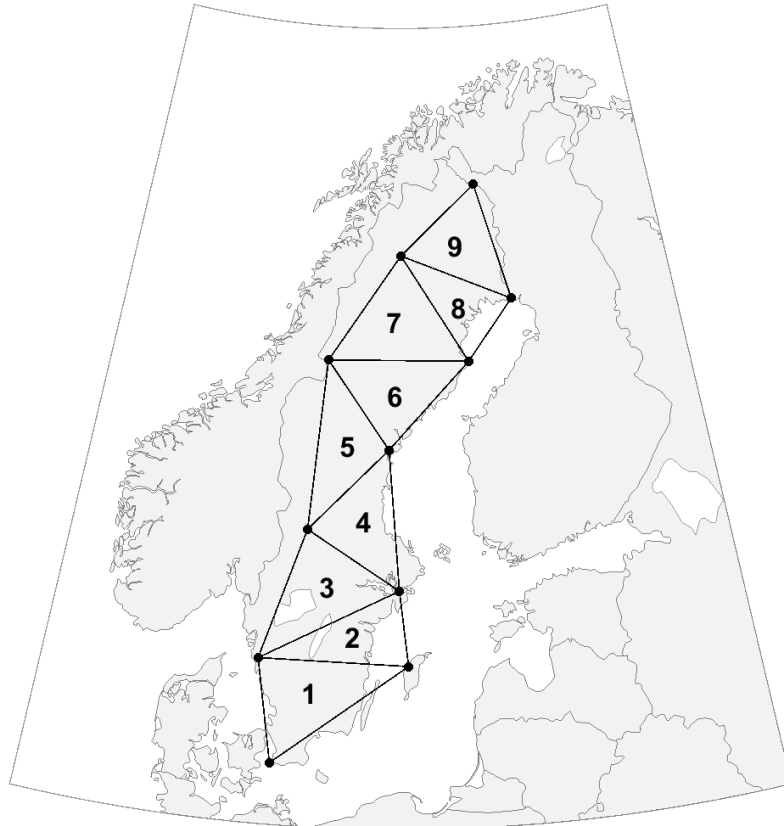
226 stations





# HOMOGENIZATION

Observed series have been corrected from inhomogeneities  
(as anemometer height changes, station relocation)  
using the **CLIMATOL** package (<http://www.climatol.eu/>)



*Reference series:*  
**Geostrophic wind speed**  
from observed Sea Level Pressure  
triangles as in Minola et al. (2016)

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Minola et al., 2016  
*Homogenization and Assessment of Observed Near-Surface  
Wind Speed Trends across Sweden, 1956–2013*

# SIMULATED WS AND DPWG

Simulated WS and DPWG from 2 different RCMs  
in the Coordinated Regional Climate Downscaling Experiment (CORDEX)

*RCM names* RCA4 and RACMO22E

*Domain* EUR-11

*Horizontal spatial resolution* 0.11 degree, about 12.5 km

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## RCMs

1) RCA4

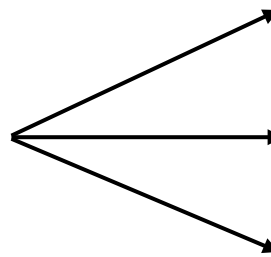
2) RACMO22E

## Driving models

1) ERAINT

2) ICHEC-EC-EARTH

3) MOCH-HadGEM2-ES



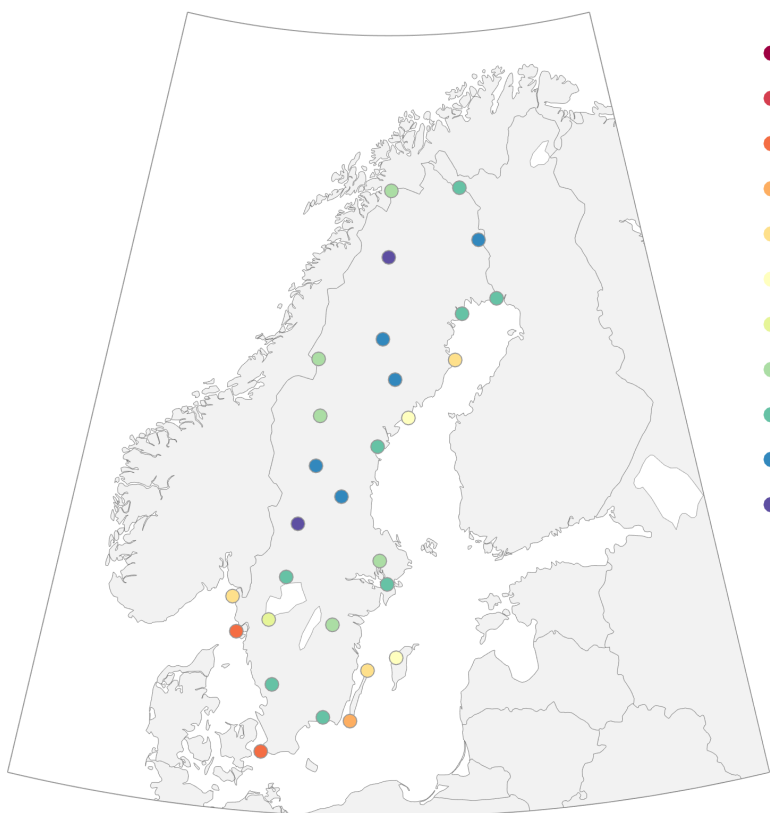


# OBSERVED CLIMATOLOGIES



Differences in mean between coastline, inland, and stations across the mountain range of the Scandes

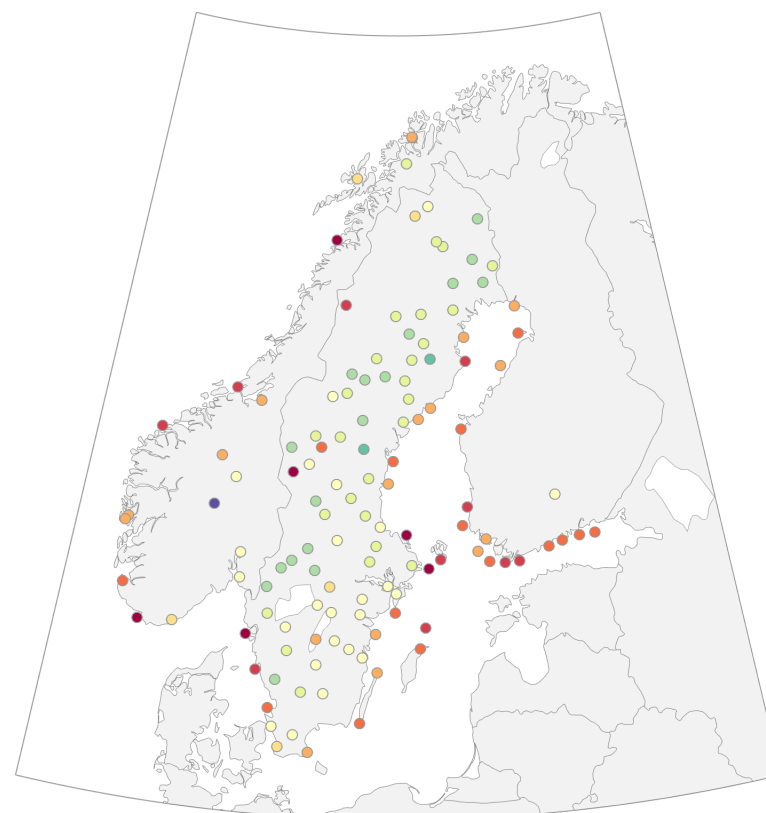
## Annual mean Wind Speed 1980-2005



[m/s]

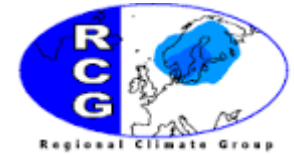
- > 8.5
- 7.8 - 8.5
- 7.1 - 7.8
- 6.4 - 7.1
- 5.7 - 6.4
- 5.0 - 5.7
- 4.3 - 5.0
- 3.6 - 4.3
- 2.9 - 3.6
- 2.2 - 2.9
- 1.5 - 2.2

## Annual mean Daily Peak Wind Gust 1996-2005



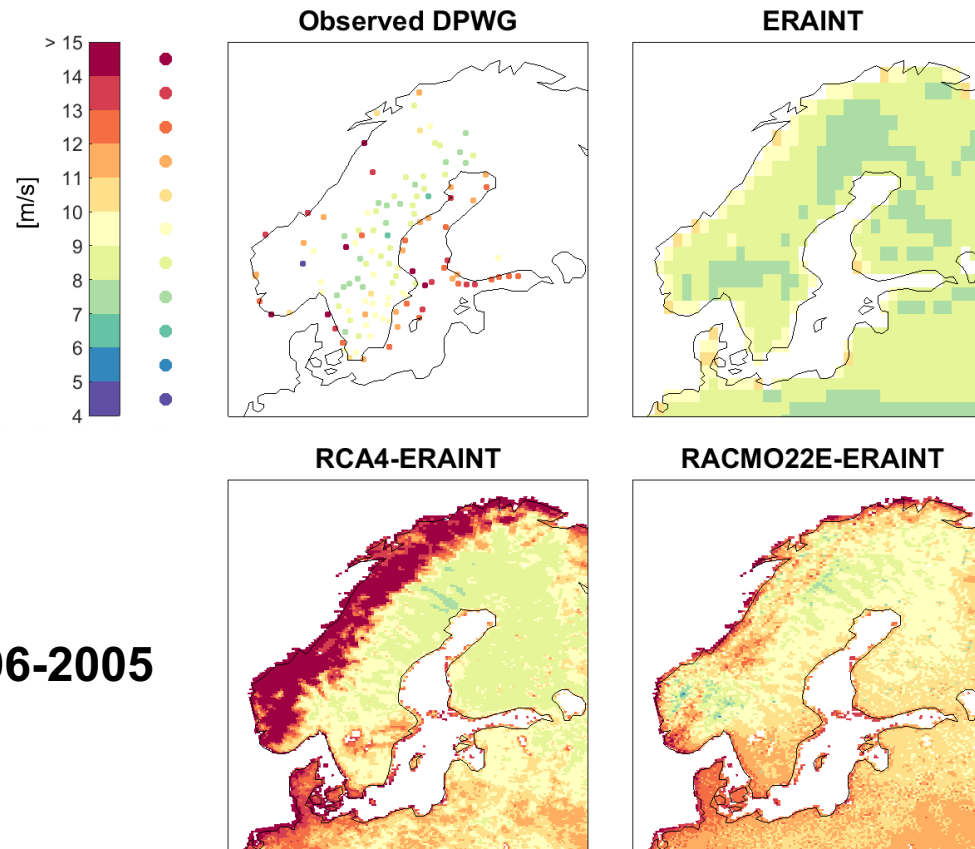
[m/s]

- > 14
- 13 - 14
- 12 - 13
- 11 - 12
- 10 - 11
- 9 - 10
- 8 - 9
- 7 - 8
- 6 - 7
- 5 - 6
- 4 - 5



# MEAN SIMULATED DPWG

## Observations vs RCMs vs driving model



**Mean DPWG 1996-2005**

Downscaling of RCMs adds value compared to ERAINT

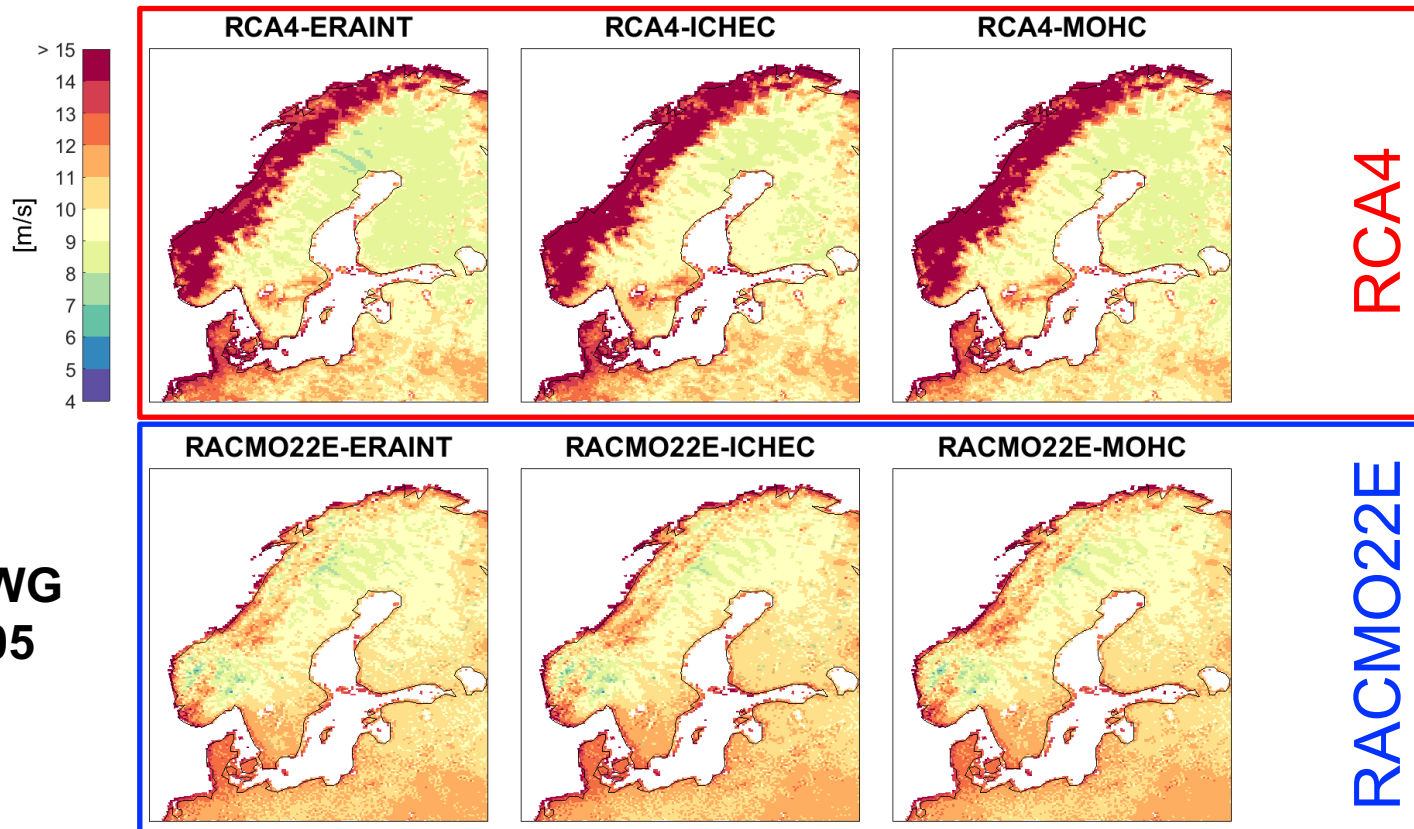
→ coastline differences and DPWG features across complex-topography regions





# MEAN SIMULATED DPWG

## RCMs with different driving model



Mean DPWG  
1996-2005

Practically no differences between the same RCM runs with different driving model  
Main differences between the two RCMs  
→ **modelled DPWG not sensitive to the driving models**



# ANNUAL MEAN DPWG

## Observations vs Simulations

Mean DPWG  
1996-2005

[unit: m/s]

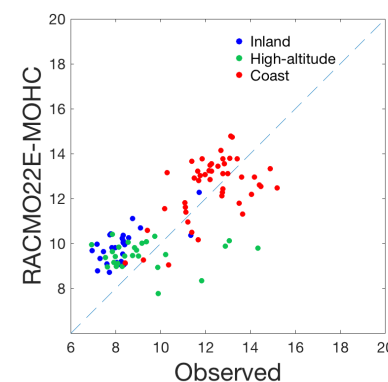
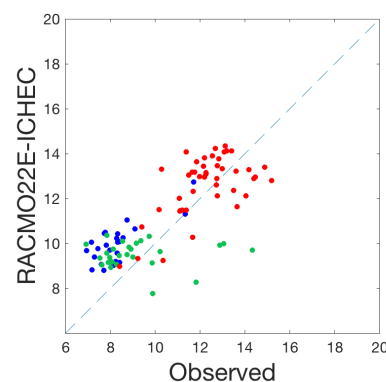
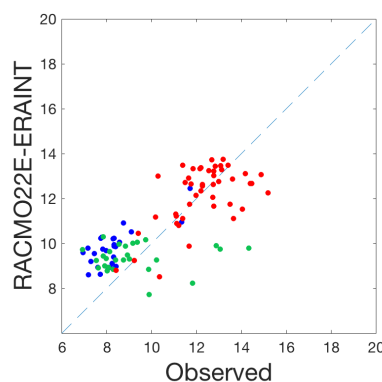
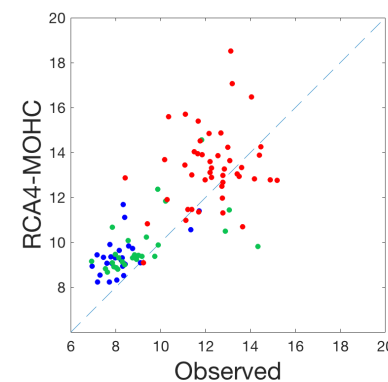
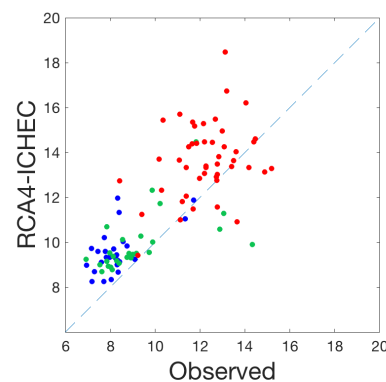
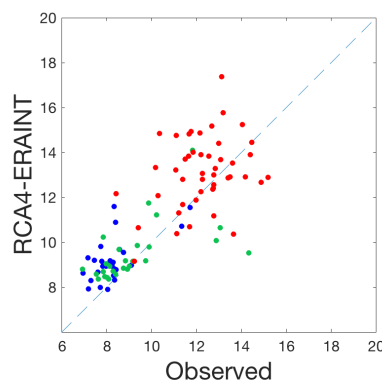
RCA4

RACMO22E

ERAINT

ICHEC

MOHC

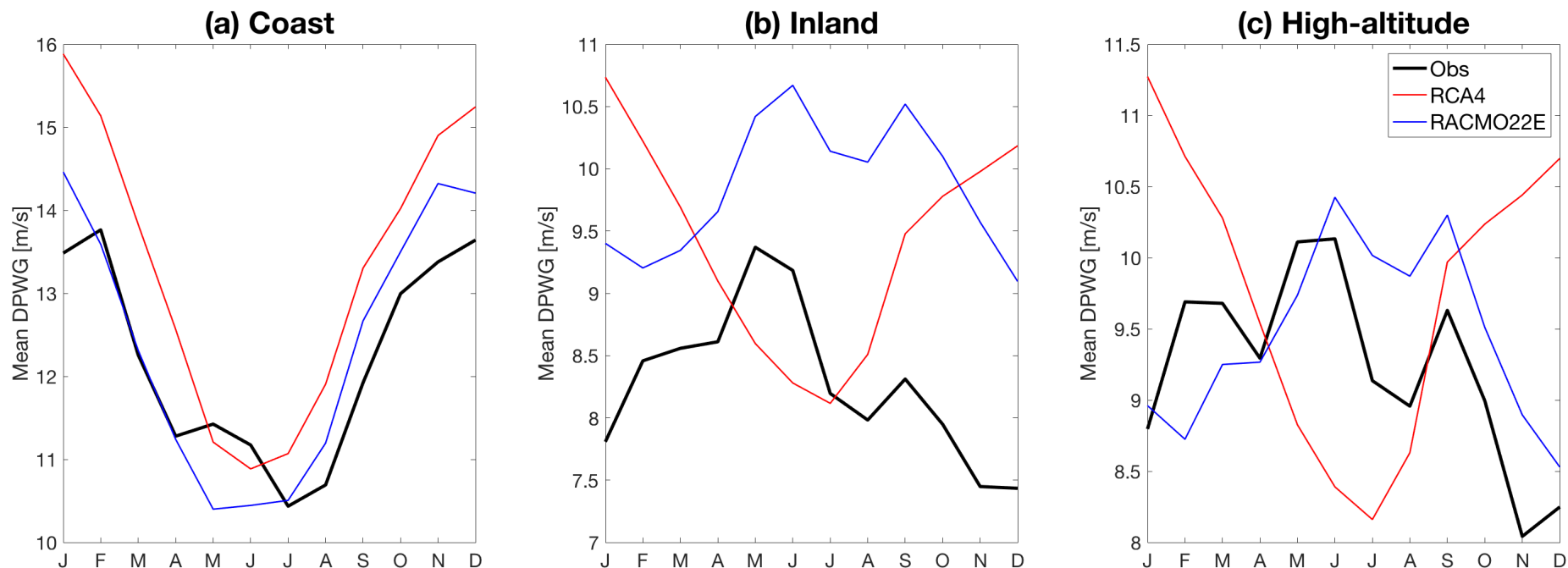


Location of stations matters!

# MEAN DPWG SEASONAL CYCLE

## Observations vs Simulations

Seasonal cycle for monthly 1996-2005 means



- 1) Coast → dominated by large-scale circulation OKAY!
- 2) Inland → processes strongly influenced by land surface NOT OKAY!
- 3) High-altitude → processes such as localized circulation? NOT OKAY!

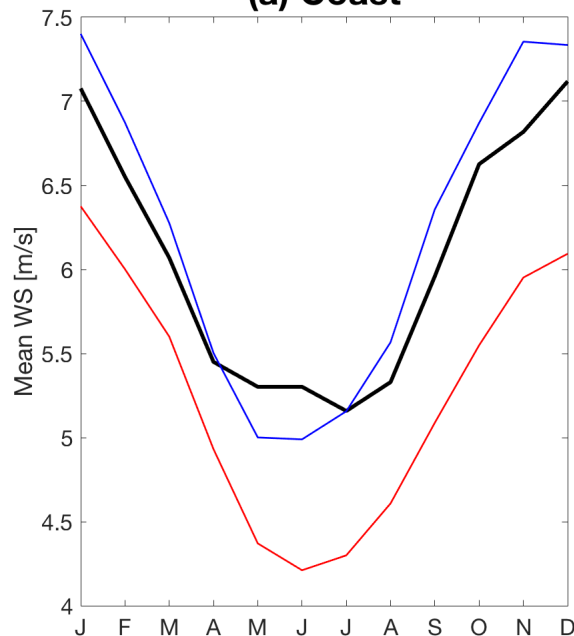


# MEAN WS SEASONAL CYCLE

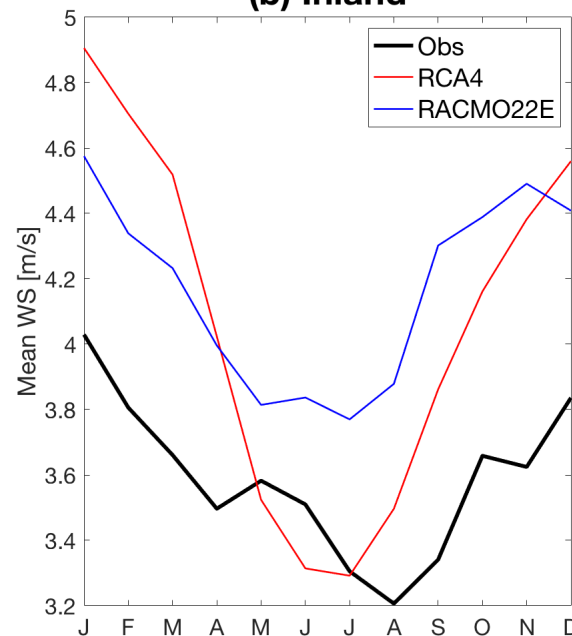
## Observations vs Simulations

Seasonal cycle for monthly 1980-2005 means

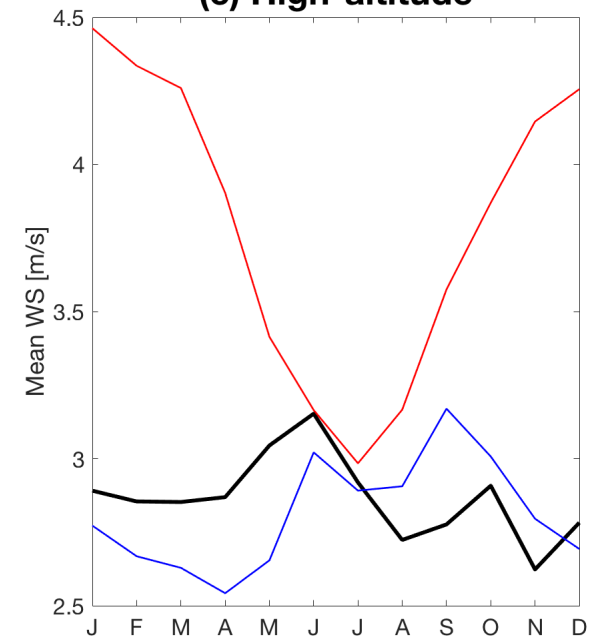
(a) Coast



(b) Inland



(c) High-altitude

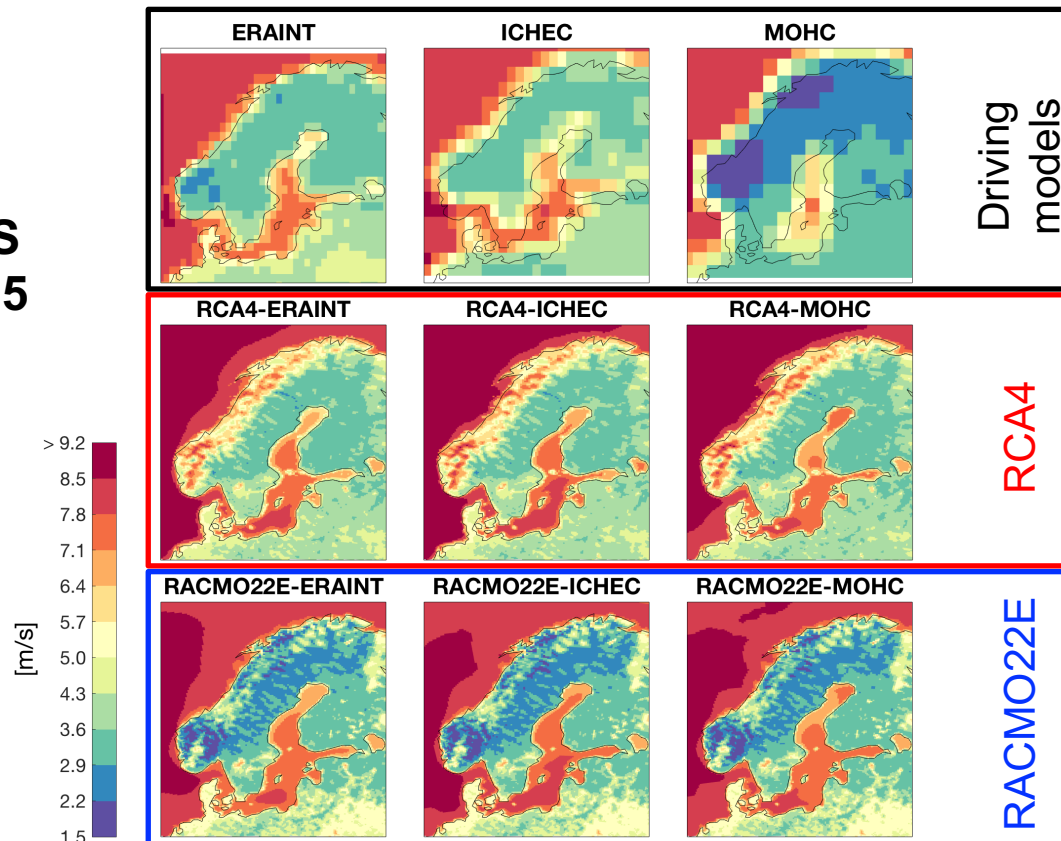


Over land, land surface processes and localized circulation  
more important than large-scale circulation  
 → larger discrepancies between observations and RCMs



# MEAN SIMULATED WS RCMs vs Driving models

Mean WS  
1980-2005



- Large-scale circulation features (like land-sea differences and coastline) captured by both RCMs and driving models
- Differences across land, where surface forcing plays a key role

# SUMMARY

- 1) Locations of the stations seem to be the most important factors for WS and DPWG, and it is useful to classify the location in three groups: coast, inland, and high-altitude
- 2) RCM downscaling is needed to distinguish the three groups and to get much more realistic simulations of wind climatologies compared to their driving models
- 3) The two RCMs cannot simulate the inland and high-altitude wind climate properly, which calls for a even higher resolution and/or better representations of relevant physical processes



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Thank you!



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