Long-term evaluation of water cycle parameters in the COSMO model

Towards a paper…..

Synthesis of input from Tom, Tim, Christoph, Susanne, …

- Paper 1 lead by Nicole on temporal evolution of biases and CTW-dependent biases in the mean fields
- Paper 2 lead by Tom on the spatial distribution of the biases

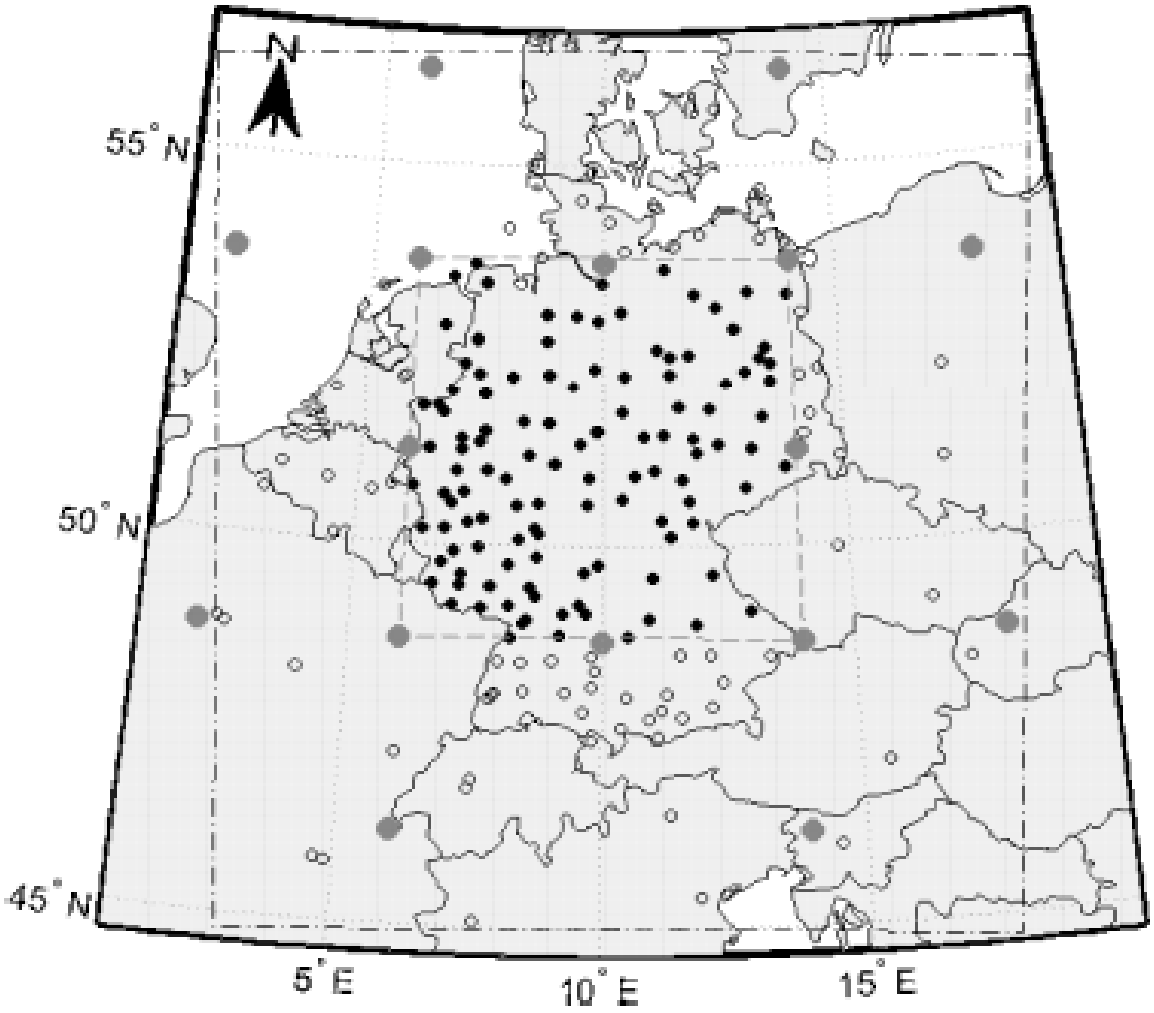
Introduction

- State-of-the-art in the domain of model evaluation
- GOP is an important dataset suitable for model evaluation
- This dataset can be explored to develop new strategies for model evaluation
- It can be applied to the COSMO model to better understand the behavior of this model
- ……

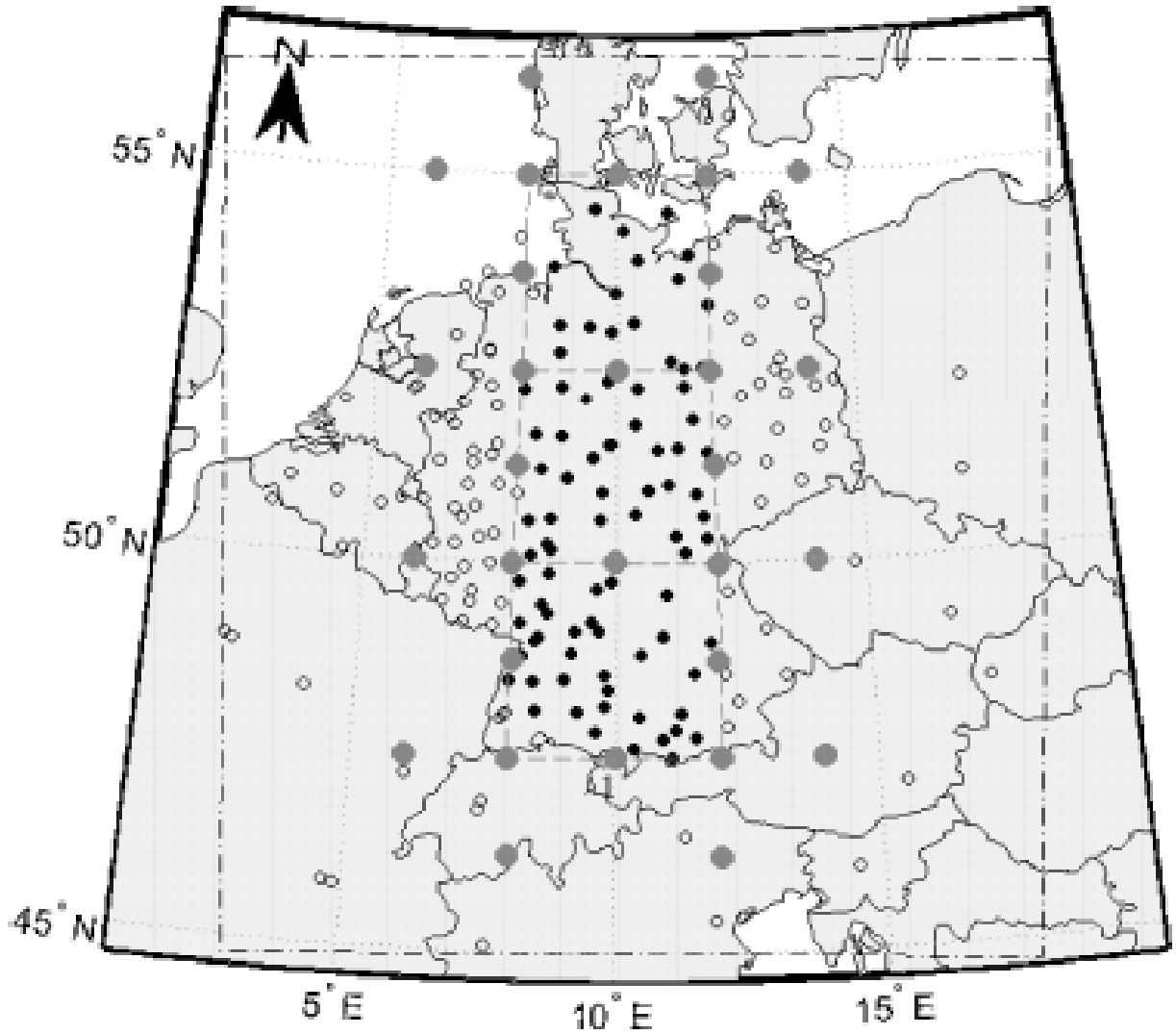
Material and methods

- Description of the COSMO model
- Description of the measurements
- Description of the method to derive CWTs

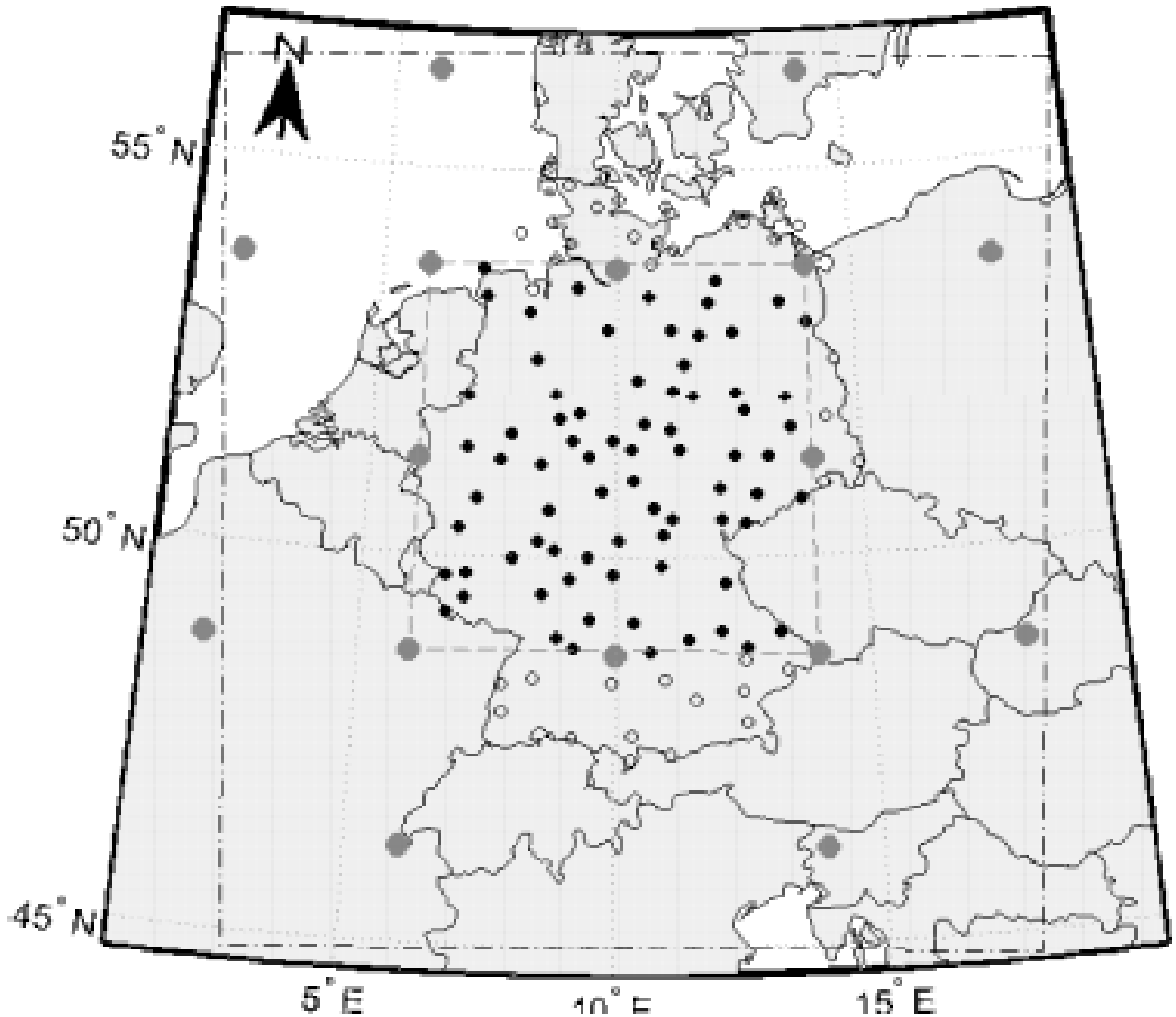
GPS stations



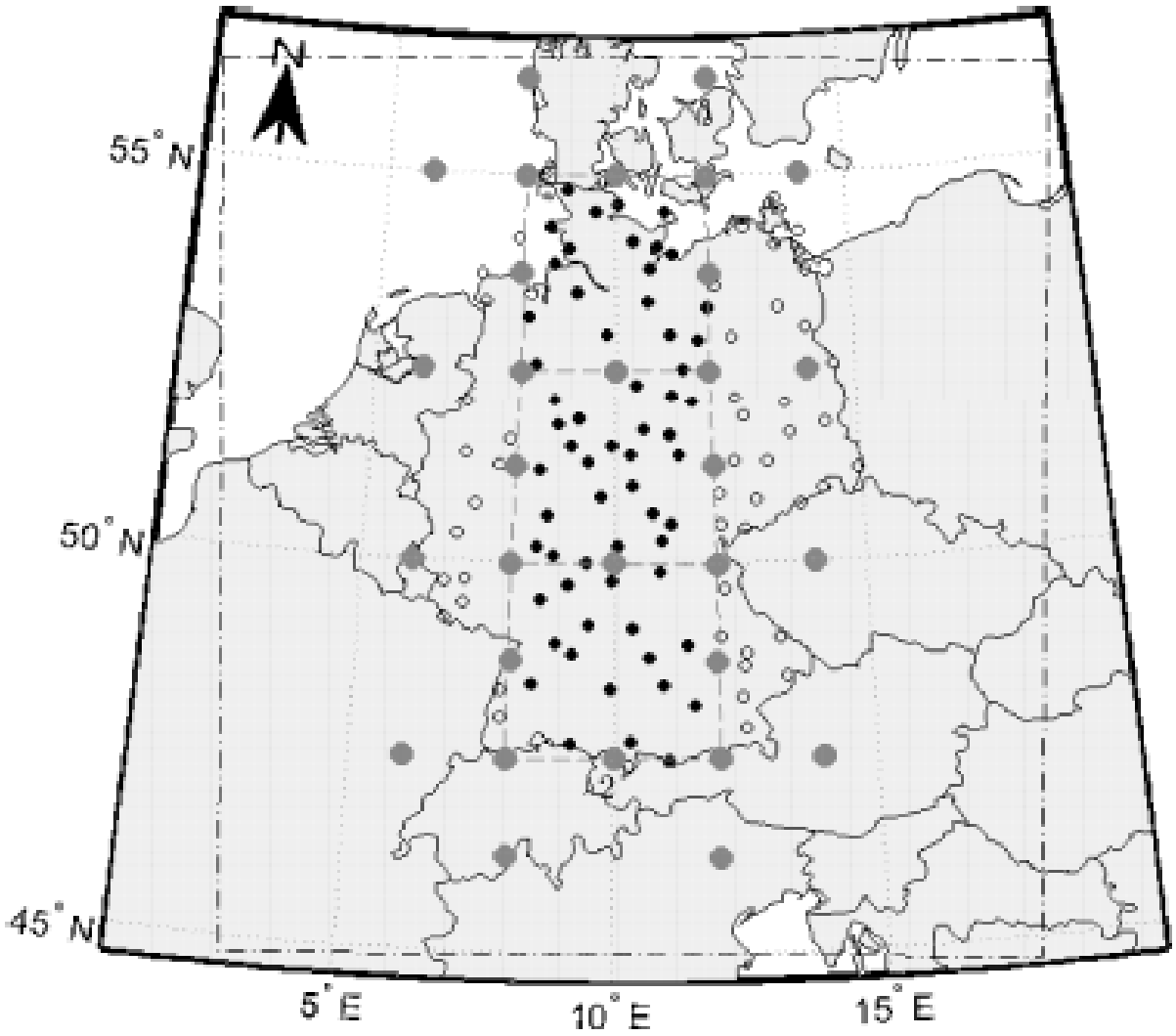
GPS stations



Ceilometers



Ceilometers



Method:

- Developped by Jenkinson and Collison (1977)
- Based on method by Lamb (1972)

Data:

- Geopotential at the 850 hPa level
- Using COSMO-EU data
- Calculation for every 3 hours 01/01/2007 - 31/12/2008

Data:

- **Geostrophic wind velocity:**

$$\vec{v}_g = 1 / f \quad \vec{k} \times \vec{\nabla} \Phi$$

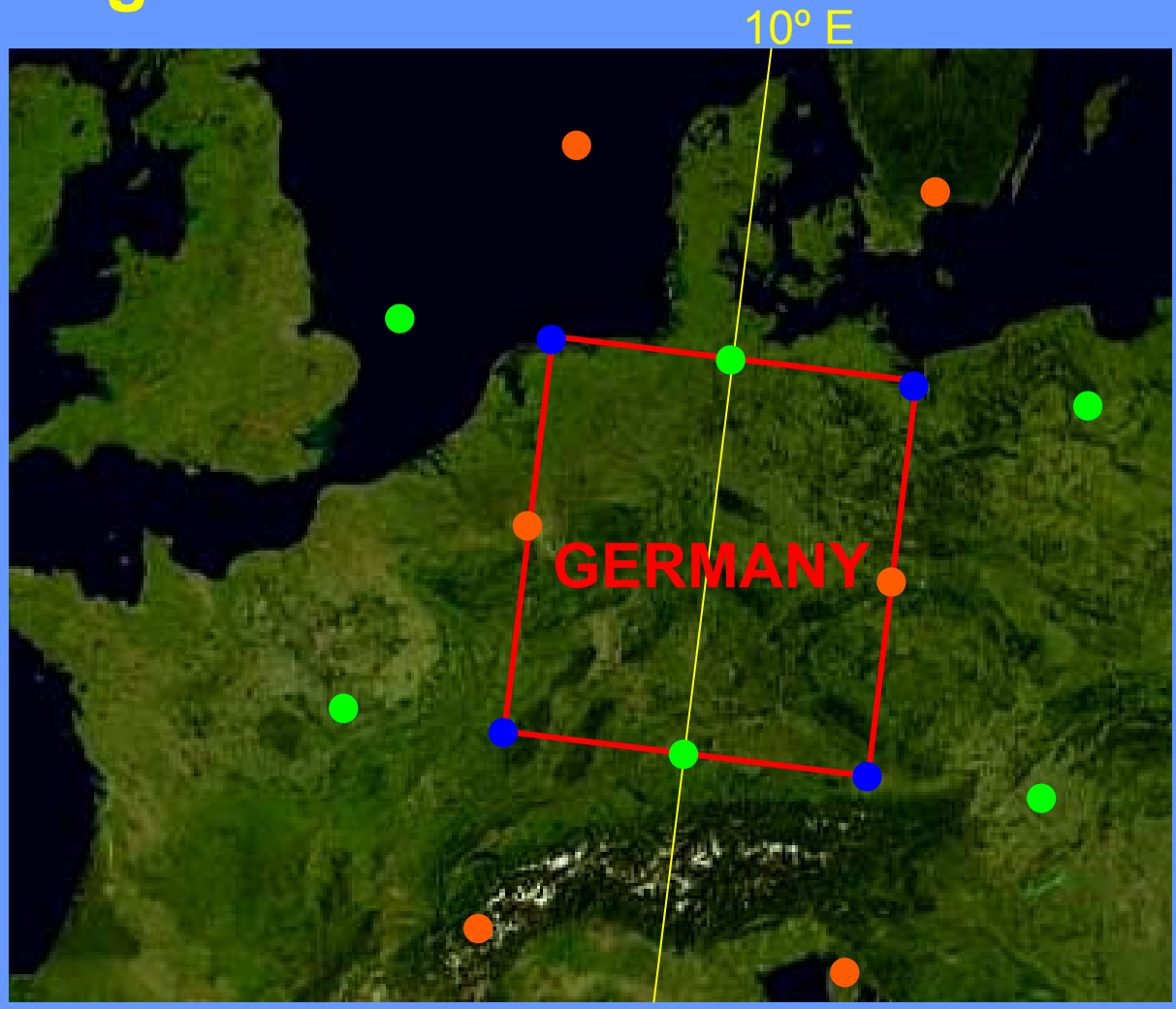
$$v_g = 1 / f \quad (\Phi_{i+1} - \Phi_i) / \Delta x$$

- **Vorticity:**

$$\varsigma = \vec{\nabla} \times \vec{v}_g = \partial v/\partial x - \partial u/\partial y$$

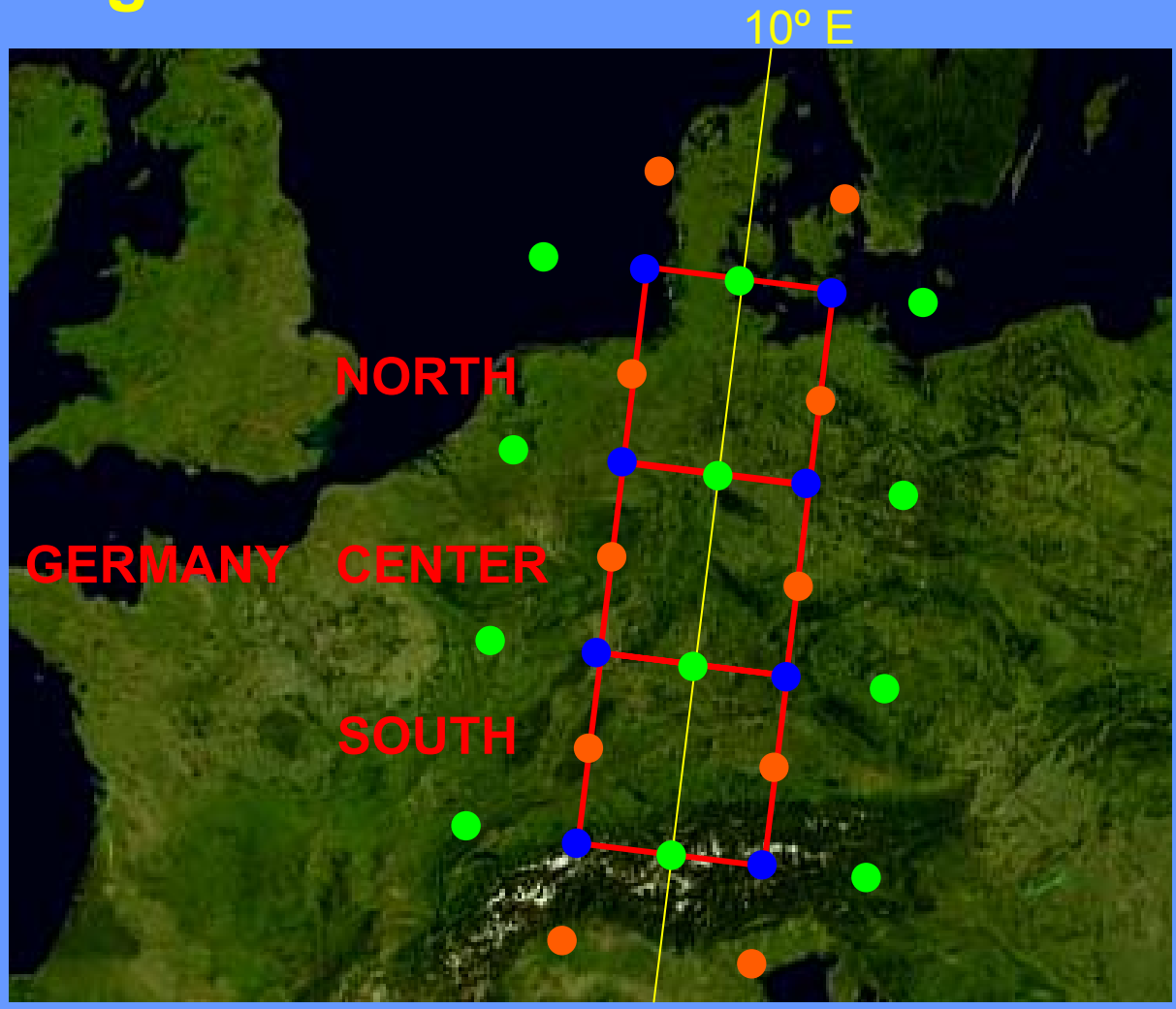
$$\varsigma = (v_{g_{i+1}} - v_{g_i}) / \Delta x$$

Regions of interest:



- Φ value for v_g
- Φ value for ξ_{lon}
- Φ value for ξ_{lat}

Regions of interest:



- Φ value for v_g
- Φ value for ξ_{lon}
- Φ value for ξ_{lat}

Criterium for wind direction / vorticity case:

Wind direction cases (8 classes):

$$v_g \geq \varsigma \, \Delta x$$

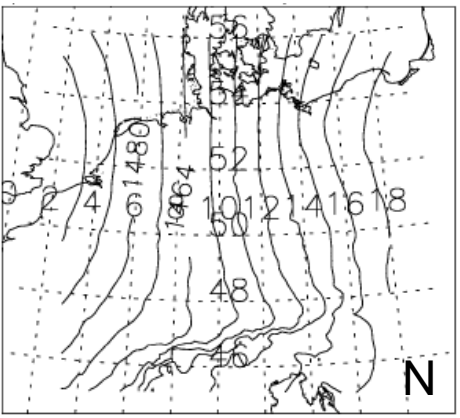
Vorticity cases (2 classes):

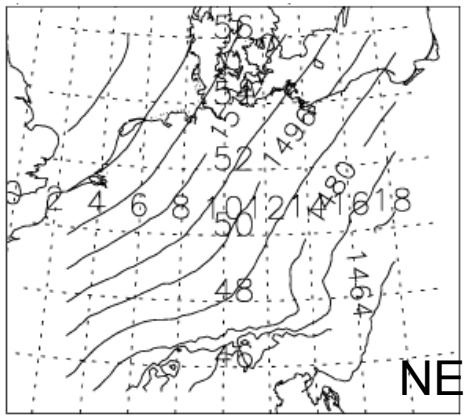
$$v_g < \varsigma \, \Delta x$$

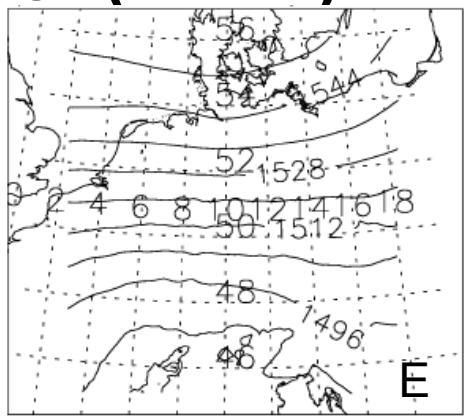
Minimum velocity: $v_g \geq 0{,}5 \text{ m s}^{-1}$

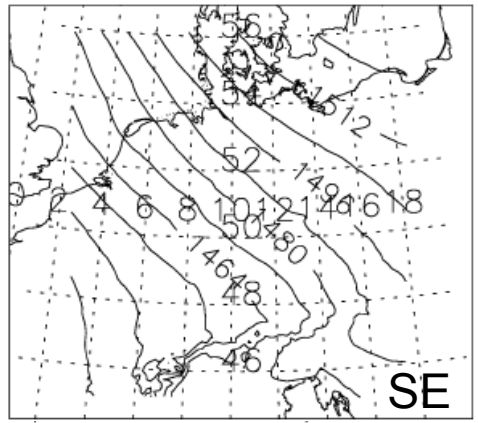
Δ x : **horizontal distance between 2 used data points**

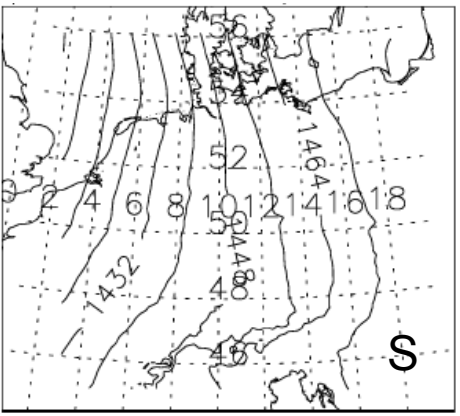
Composites for 2007-2008: Germany 850hPa (check all times)

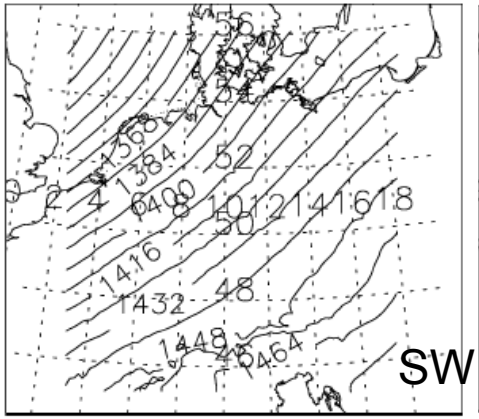


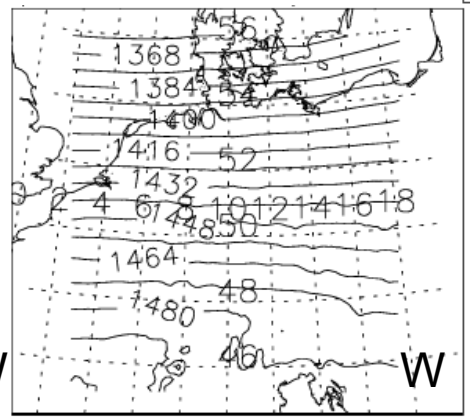


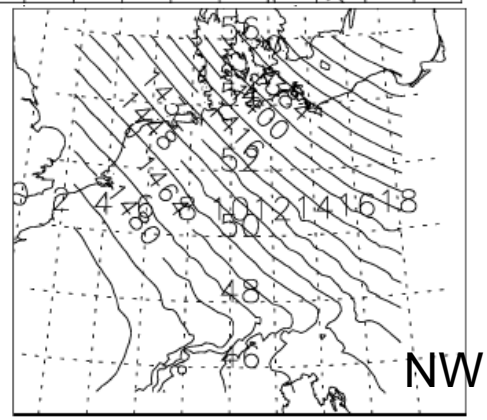


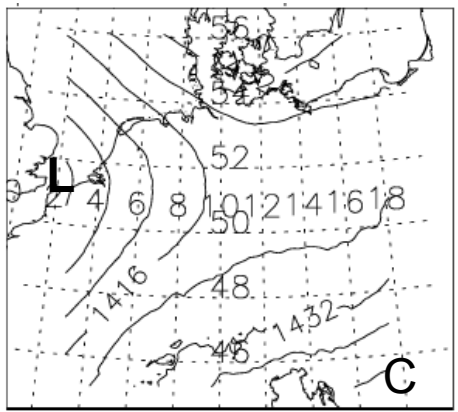


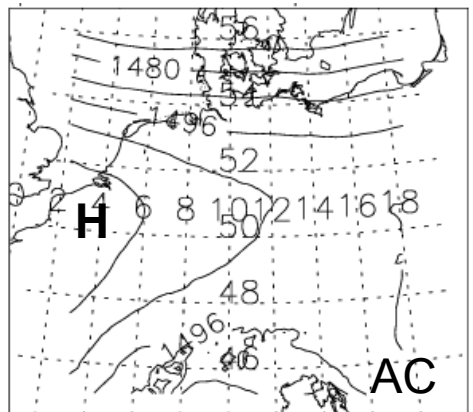




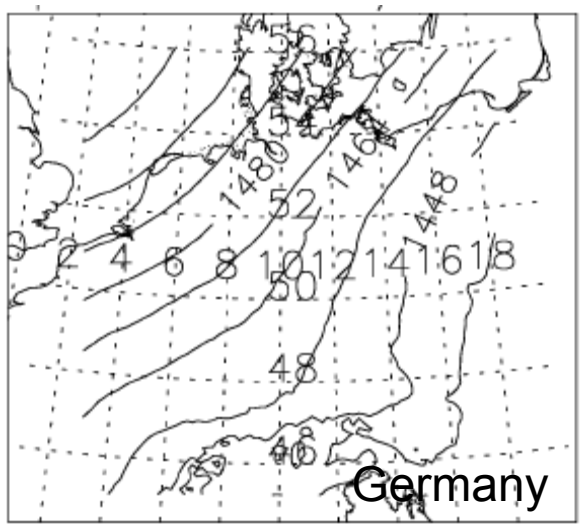


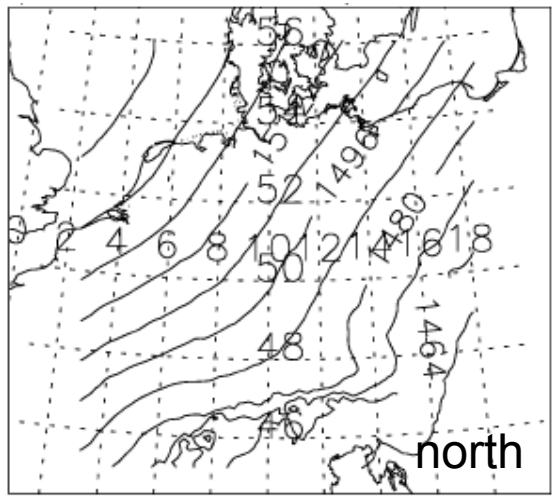


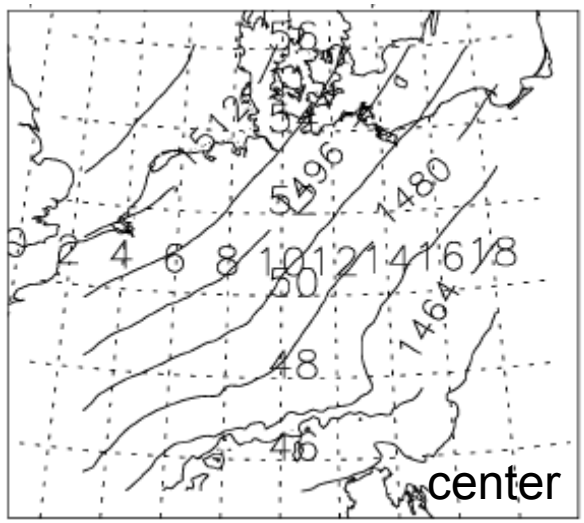


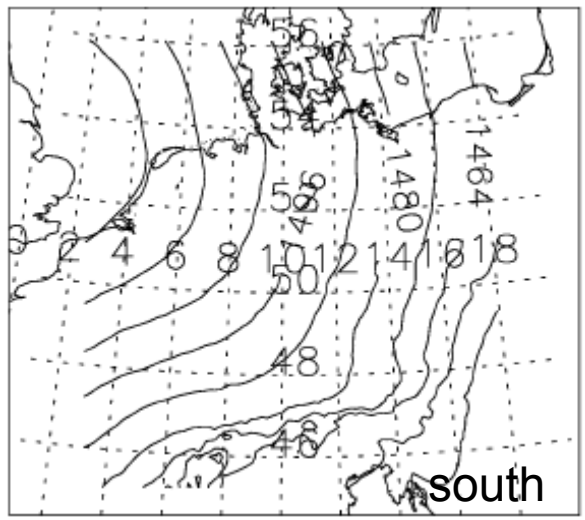


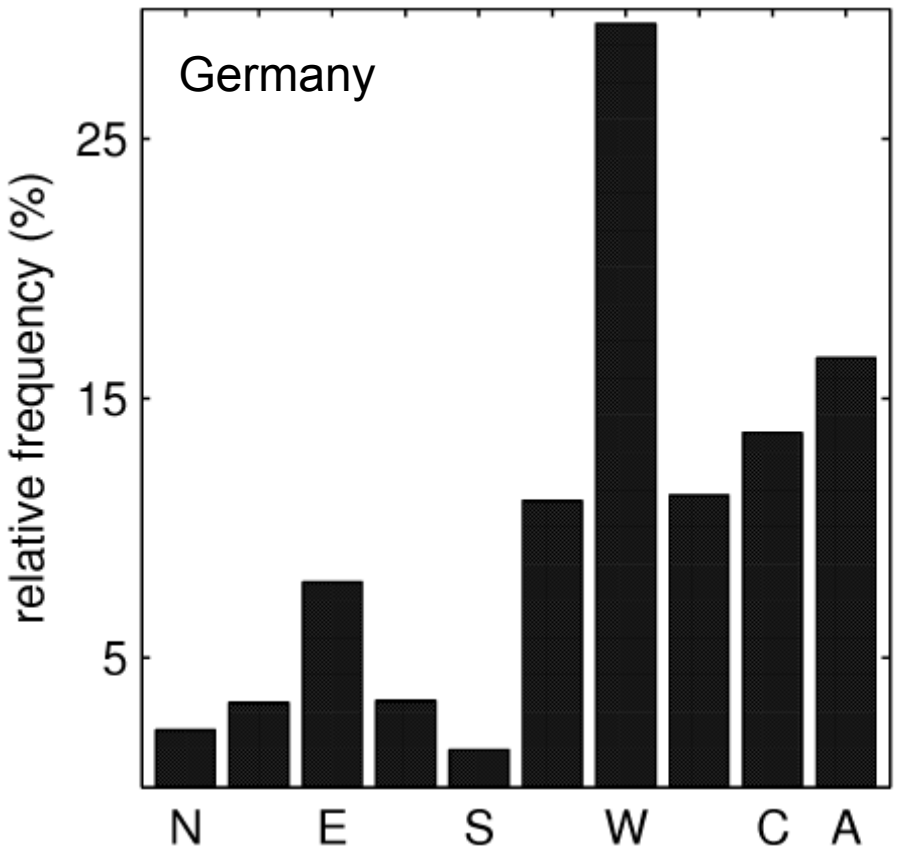
Composites for 2007-2008: NE

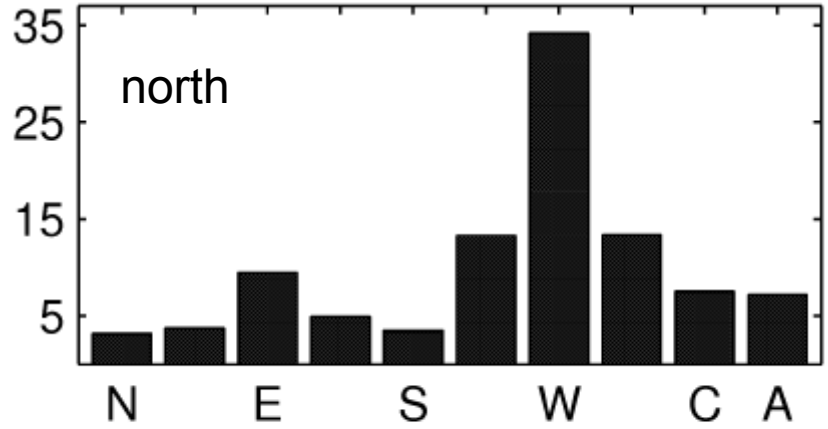


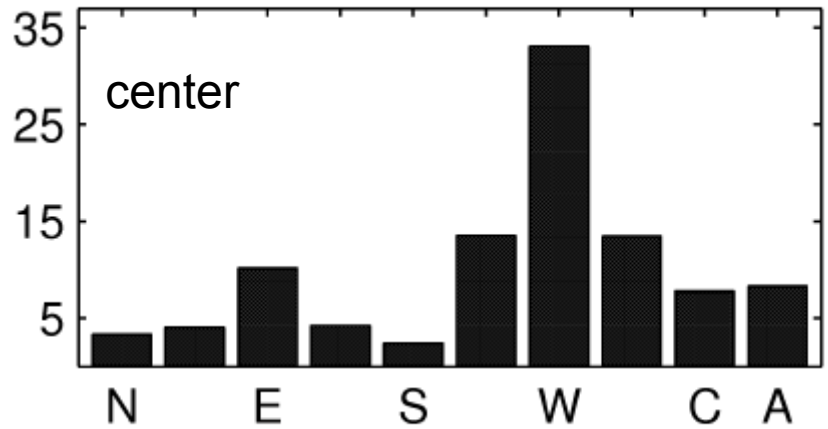


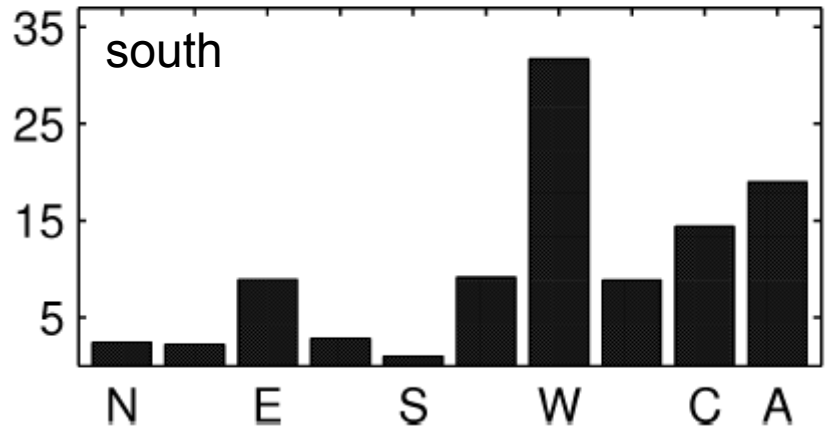




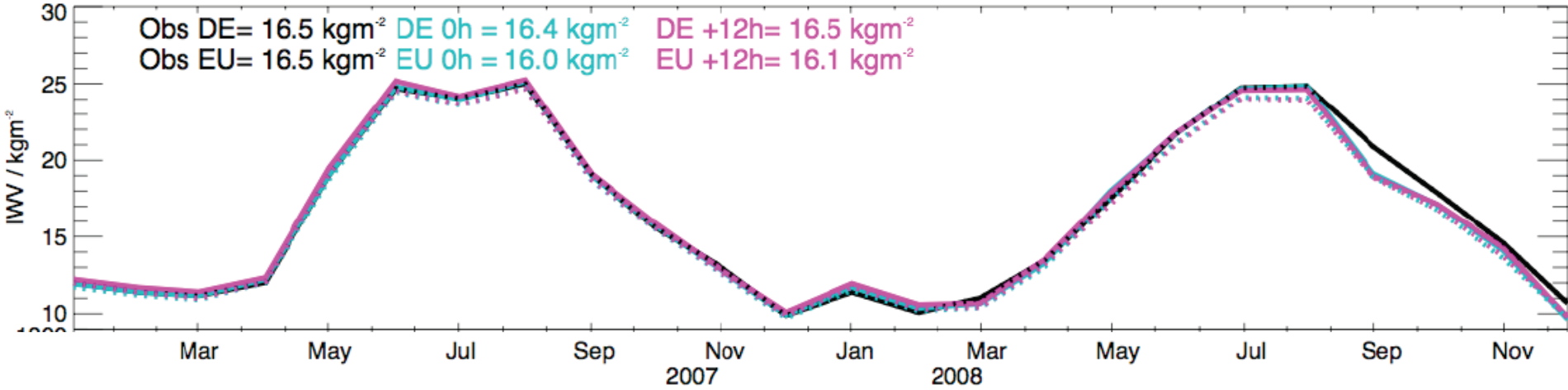

Germany
relative frequency (%)
25
15
5
N
E
S
W
C
A


north
35
25
15
5
N
E
S
W
C
A


center
35
25
15
5
N
E
S
W
C
A


south
35
25
15
5
N
E
S
W
C
A

Integrated water vapor

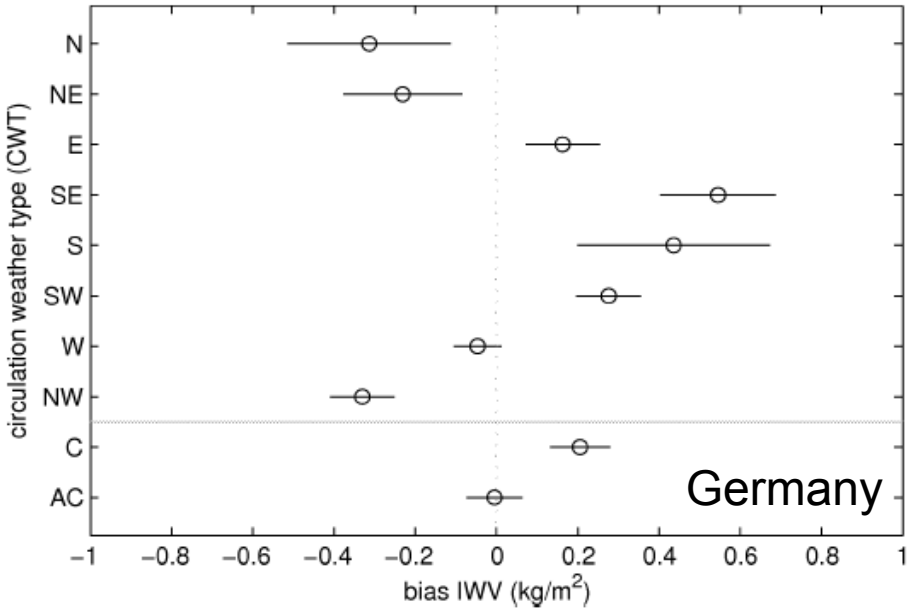


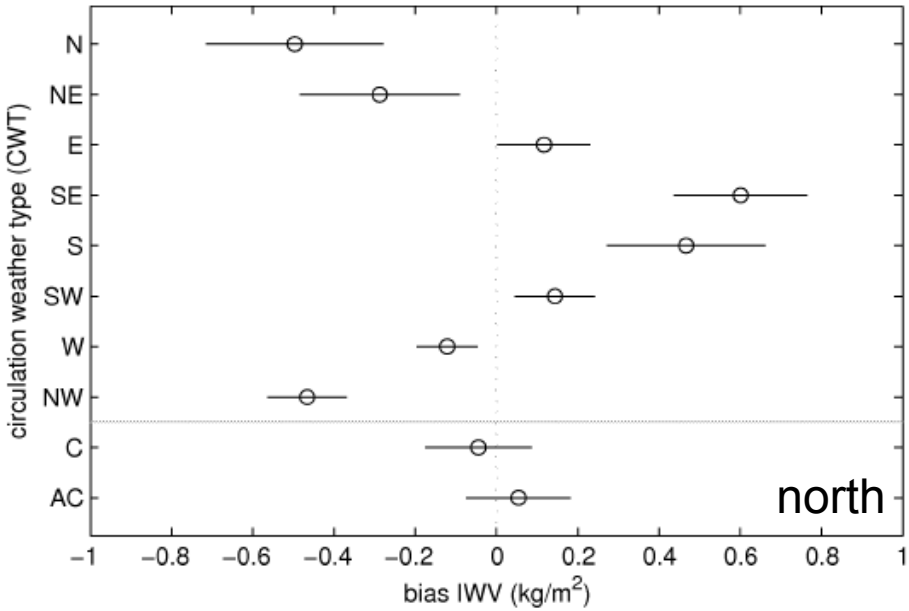
- Good correspondance except Sept (remove sept from analysis)
- Model gets drier towards the end (model changes)
- Add a plot with the bias

(dashed line is COSMO-EU)

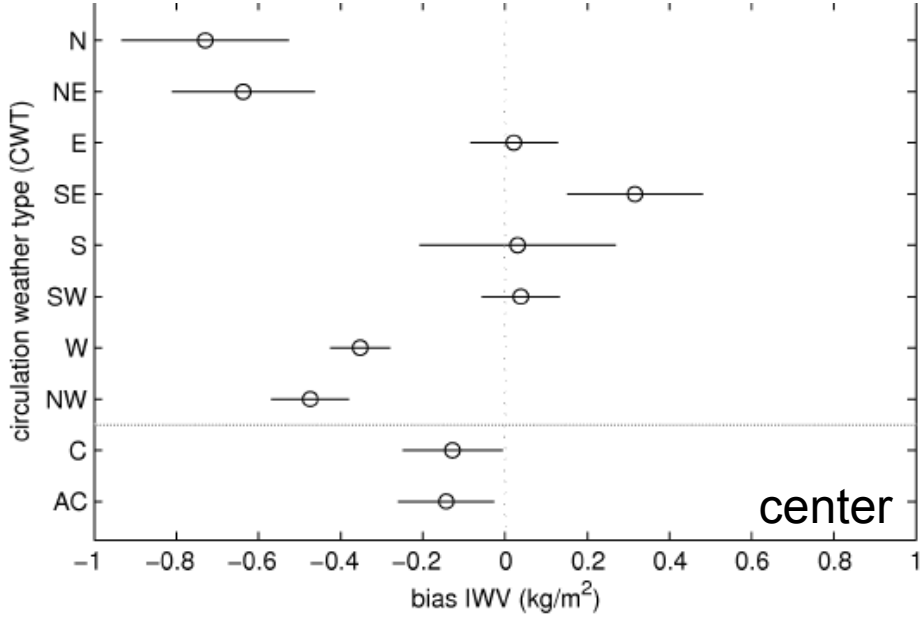
- But… slight dry bias during NE, N, NW, W compensates slight wet bias during E, SE, S, SW: Maritime versus continental advection

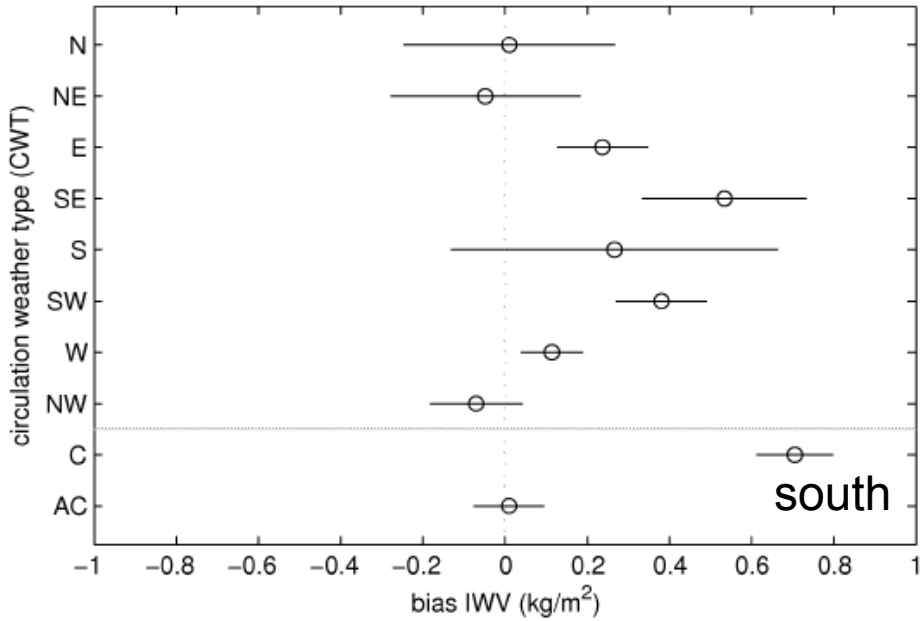
COSMO-DE



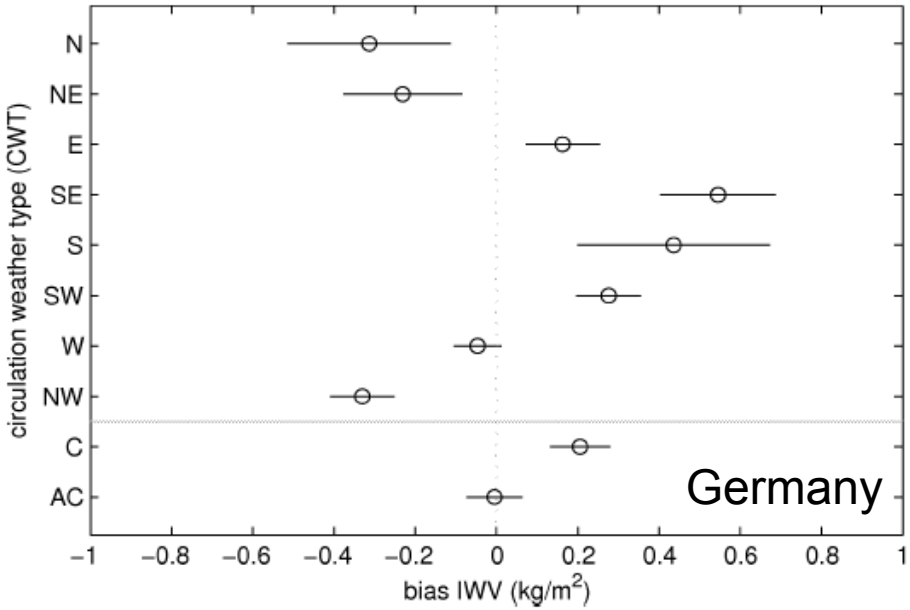


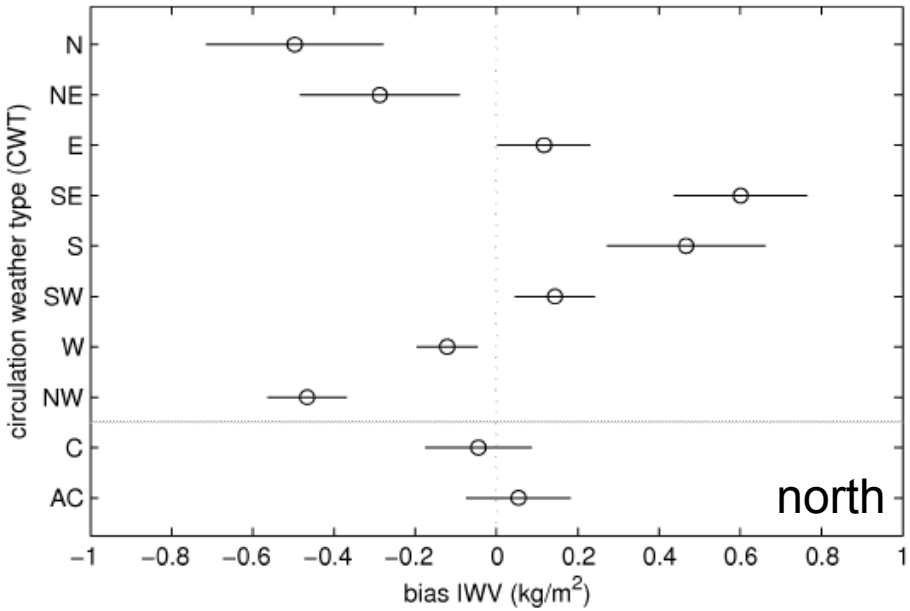
COSMO-DE



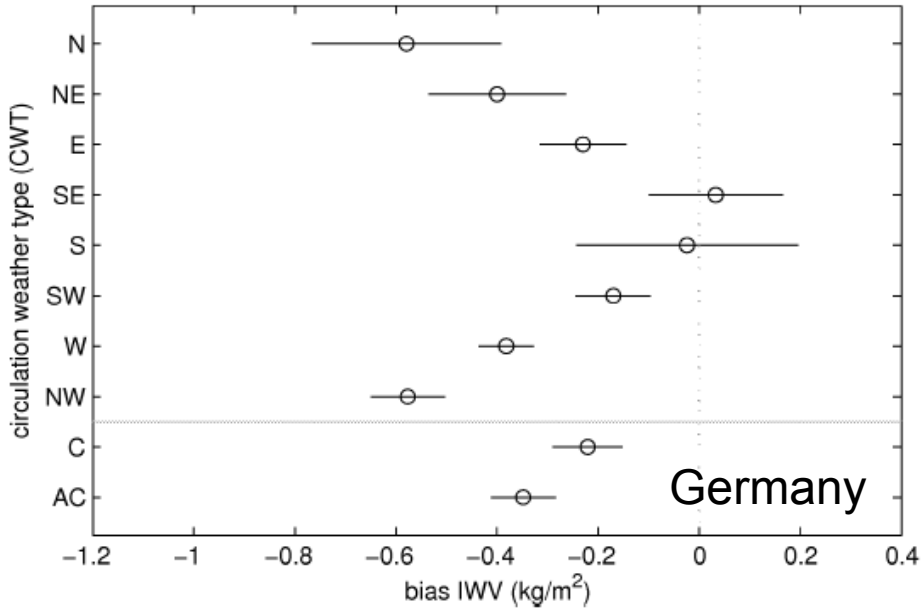


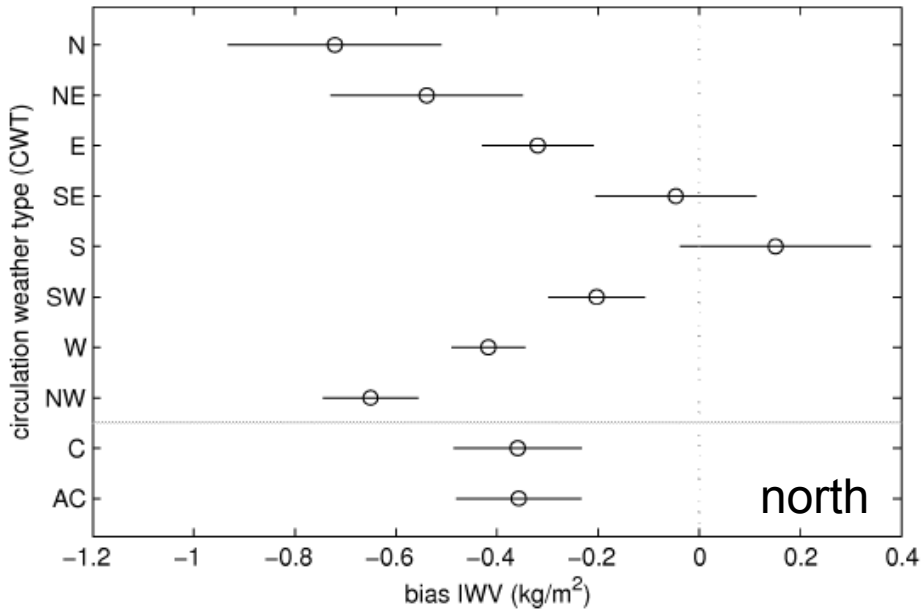
COSMO-DE





COSMO-EU

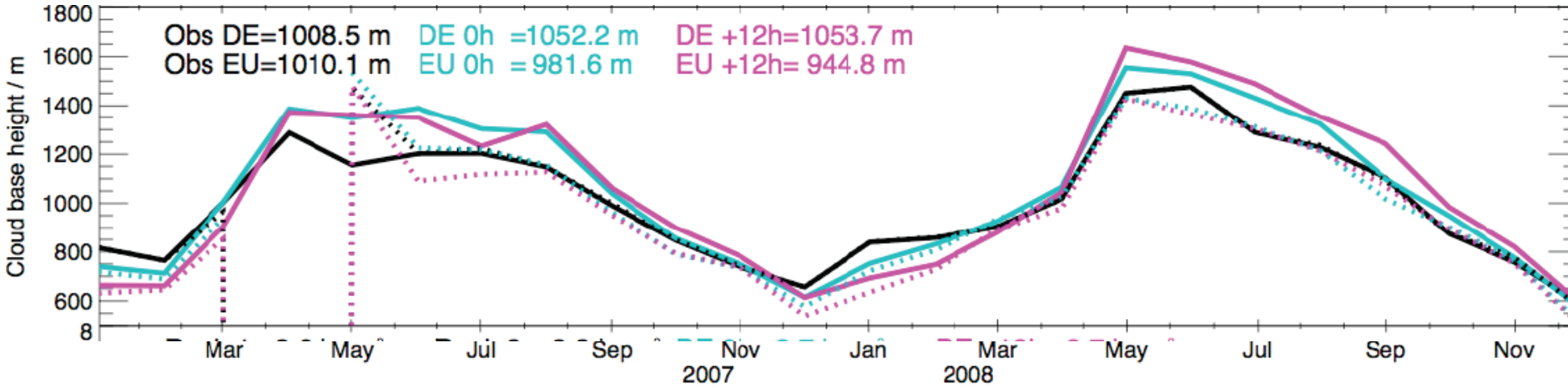




- Uncertainty in the measurements: can we compare with MWR data or are there other datasources to confirm this behavior?

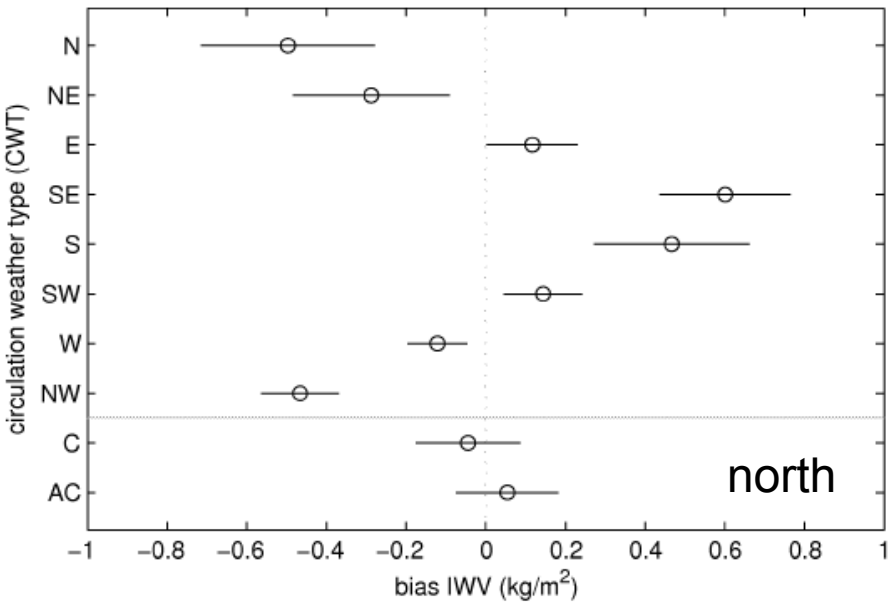
→ Cite existing studies on GPS validation

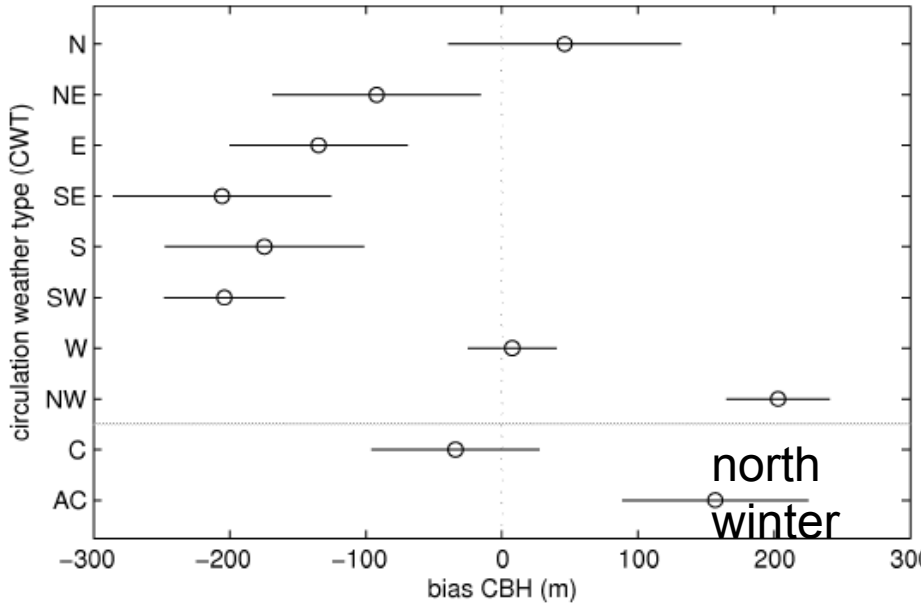
Cloud base height

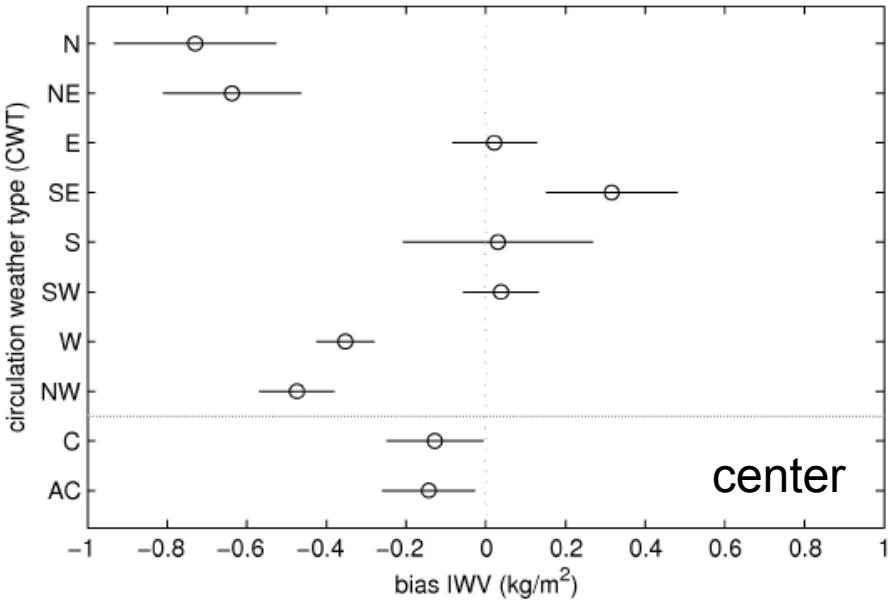


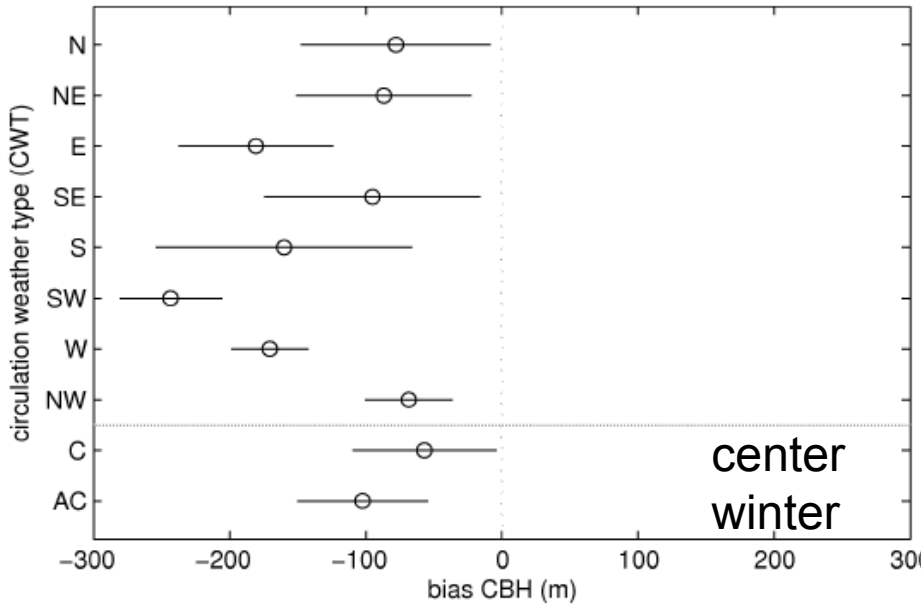
- CBH underestimated in winter and overestimated in summer
- Can CWT help finding out why?

COSMO-DE

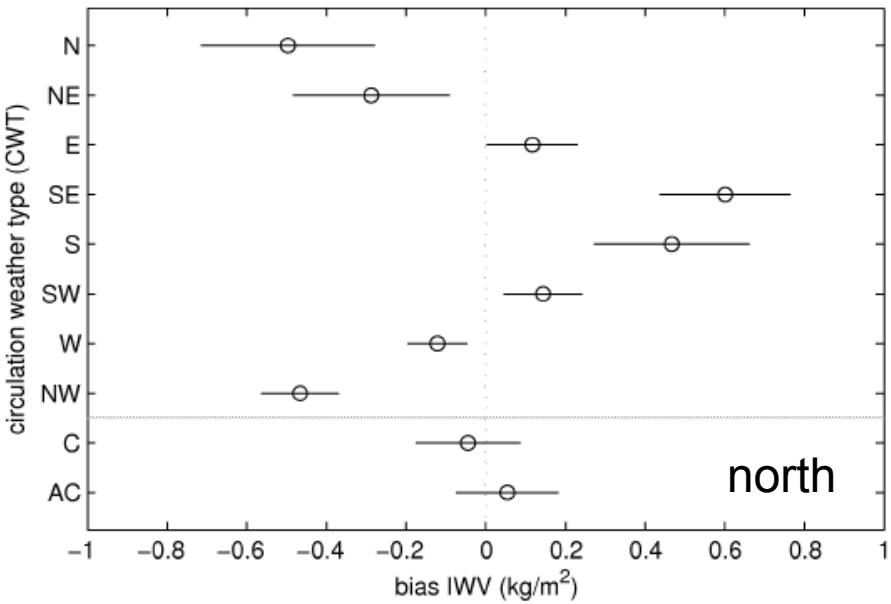

N
NE
E
SE
S
SW
W
NW
C
AC
circulation weather type (CWT)
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1
bias IWV (kg/m^2)
north

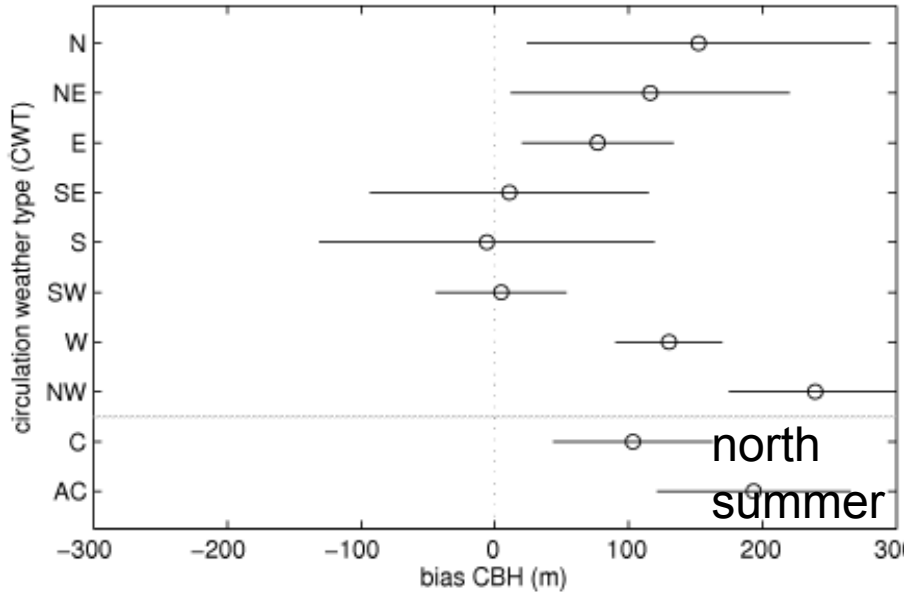

N
NE
E
SE
S
SW
W
NW
C
AC
circulation weather type (CWT)
−300
−200
−100
0
100
200
300
bias CBH (m)
north
winter

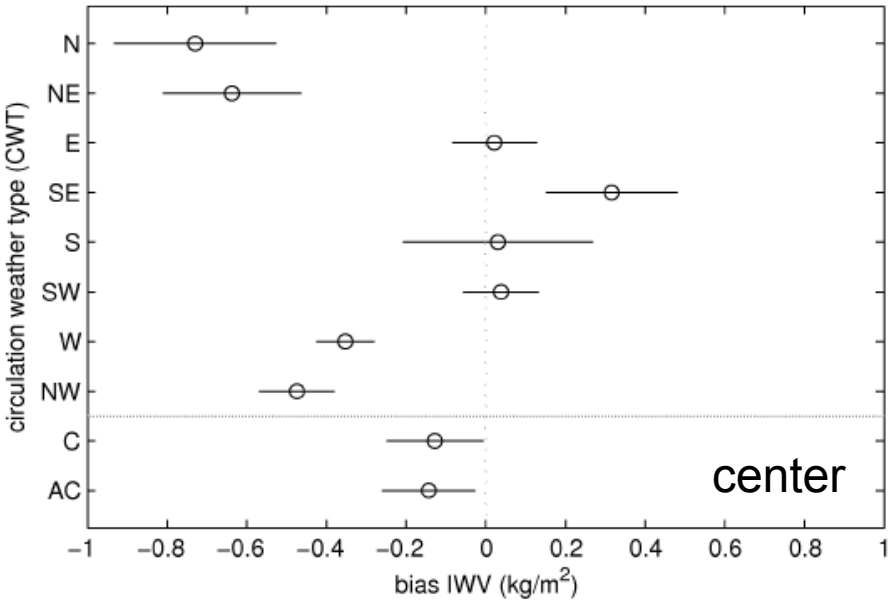

N
NE
E
SE
S
SW
W
NW
C
AC
circulation weather type (CWT)
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1
bias IWV (kg/m^2)
center

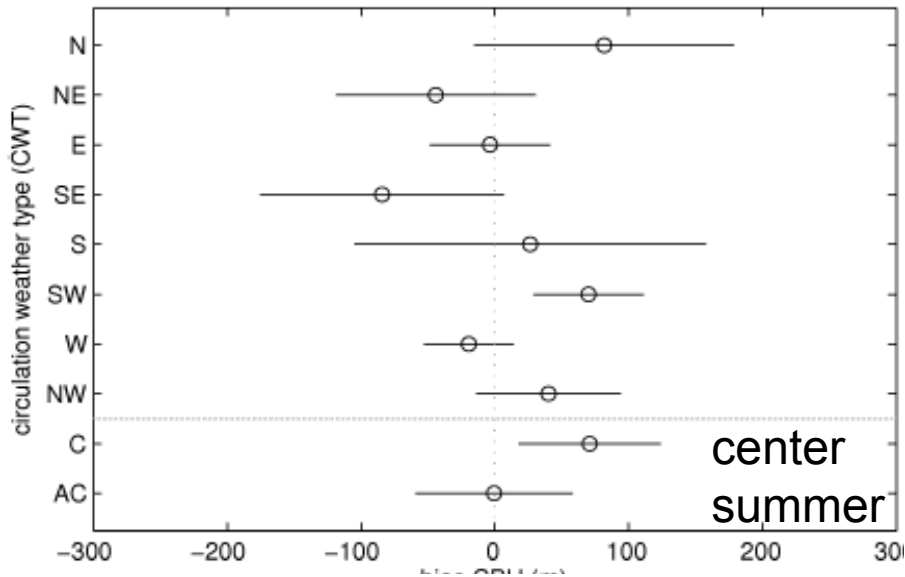

N
NE
E
SE
S
SW
W
NW
C
AC
circulation weather type (CWT)
−300
−200
−100
0
100
200
300
bias CBH (m)
center
winter

COSMO-DE


N
NE
E
SE
S
SW
W
NW
C
AC
circulation weather type (CWT)
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1
bias IWV (kg/m^2)
north

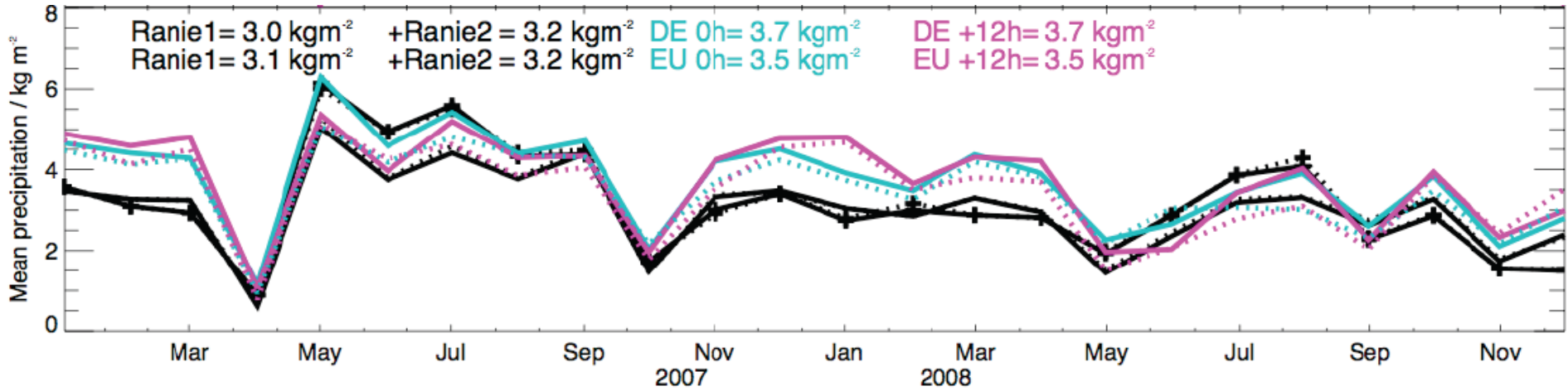

N
NE
E
SE
S
SW
W
NW
C
AC
circulation weather type (CWT)
−300
−200
−100
0
100
200
bias CBH (m)
north
summer


N
NE
E
SE
S
SW
W
NW
C
AC
circulation weather type (CWT)
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1
bias IWV (kg/m^2)
center

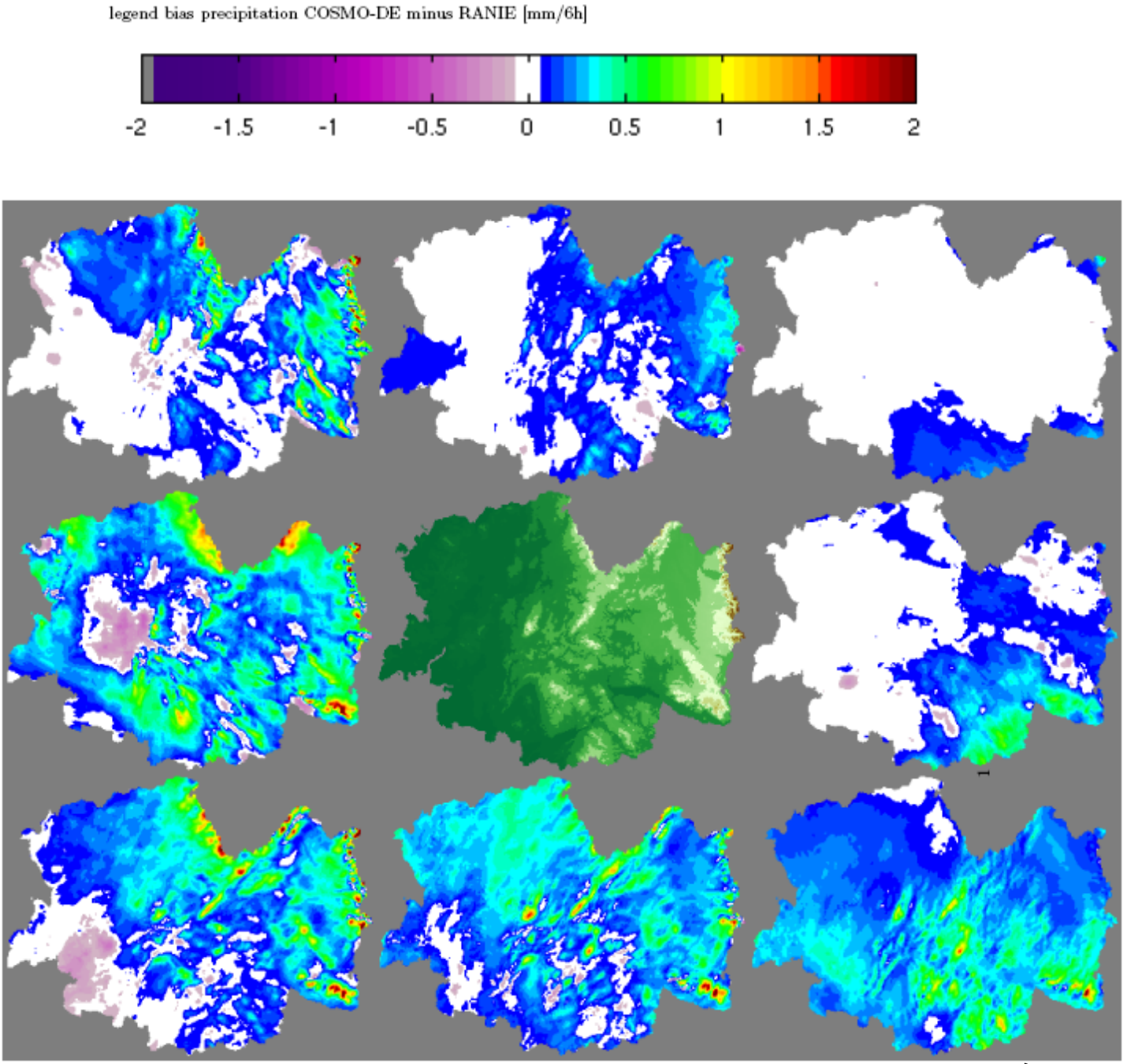

N
NE
E
SE
S
SW
W
NW
C
AC
circulation weather type (CWT)
−300
−200
−100
0
100
200
center
summer

- Inverse relation between CBH and CWT exist in the north both in summer and winter (CBH too low when atmosphere is too wet (→ test with radiosondes whether LCL is too low))
- Underestimation in winter mainly during E, SE, S, SW (continental advection) esp in north
- Overestimation in summer mainly during NE, N, NW, W (maritime advection)
- CWT gives a clue, but full understanding not reached yet

Precipitation



- 20% overestimation in winter
- Can CWT help finding out why?

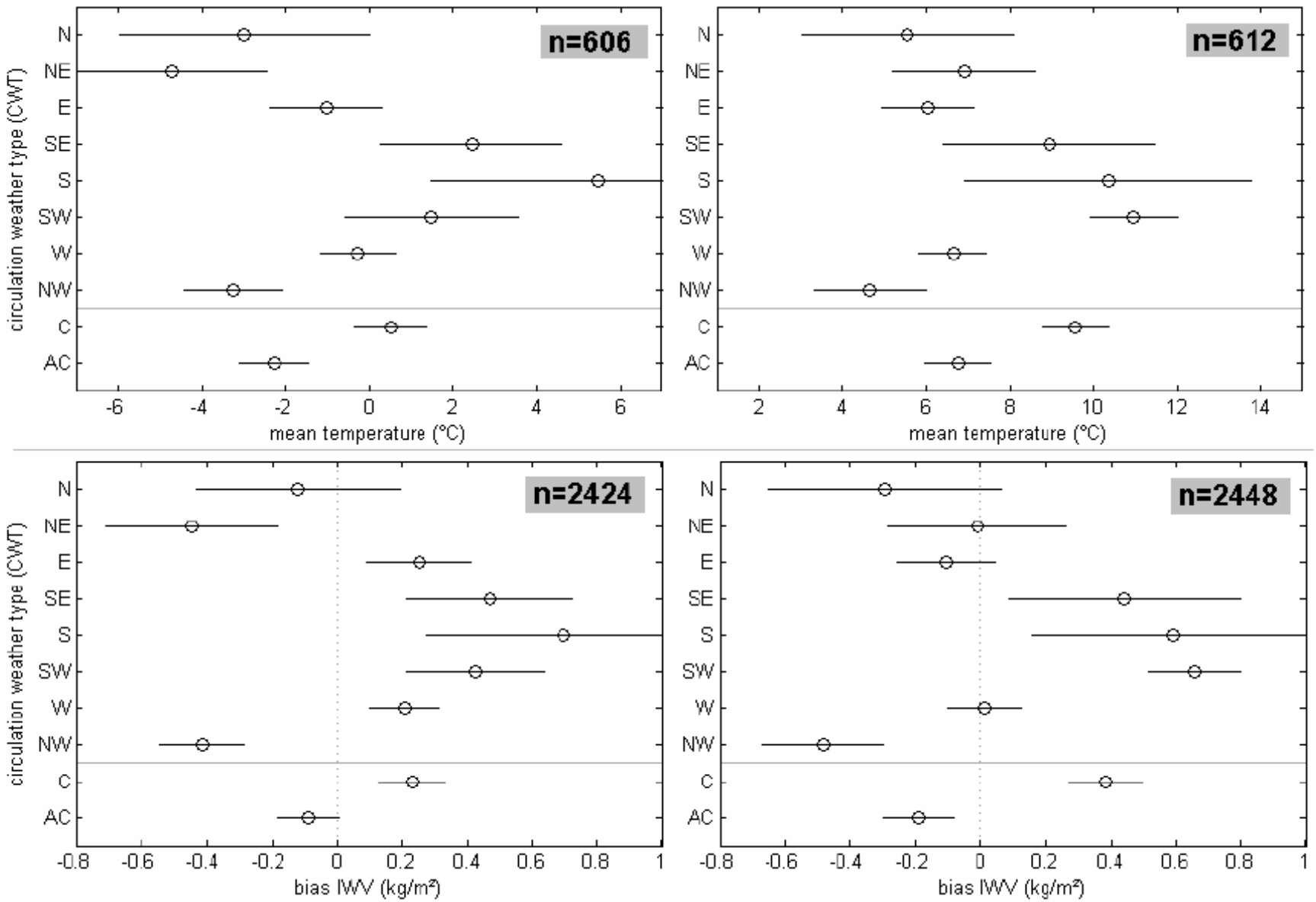


Bias COSMO-DE
winter

- Overestimation are mainly in orographic regions during northerly flow conditions
- Measuring solid precipitation is challenging
- Comparing with direct measurements
- Tom will tell you more about the spatial variability

Open questions

- How is the distribution of CWT during the seasons: can this help explaining the timeseries?
- Story of cyclonic versus anti-cyclonic is not so clear
- Understand correlation with temperature (overestimation of IWV during warm CWTs and underestimation during cold CWTs)


n=606
n=612
n=2424
n=2448
circulation weather type (CWT)
N
NE
E
SE
S
SW
W
NW
C
AC
mean temperature (°C)
bias IWV (kg/m²)

Future work

- Are CWT really the best classification? Should someone work on a classification distinction between stratiform convective precipitation (these classifications have been derived by radar meteorologists). Master student?