Hitatregðan

Salomé Avrillaud
Lisa Degenhardt
Haraldur Ólafsson

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RMetS
Royal Meteorological Society

International Journal of Climatology

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RESEARCH ARTICLE

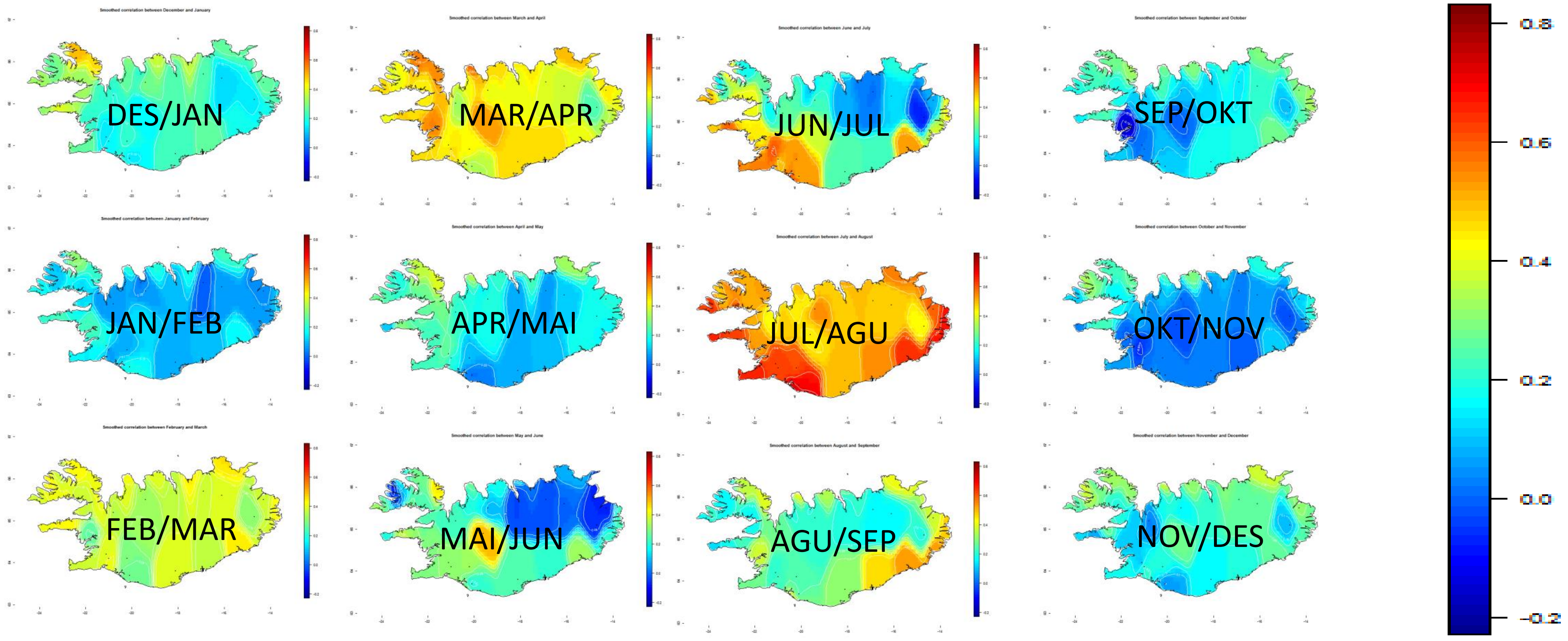
Persistence of observed air temperatures in Iceland

Lisa Degenhardt, Haraldur Ólafsson,

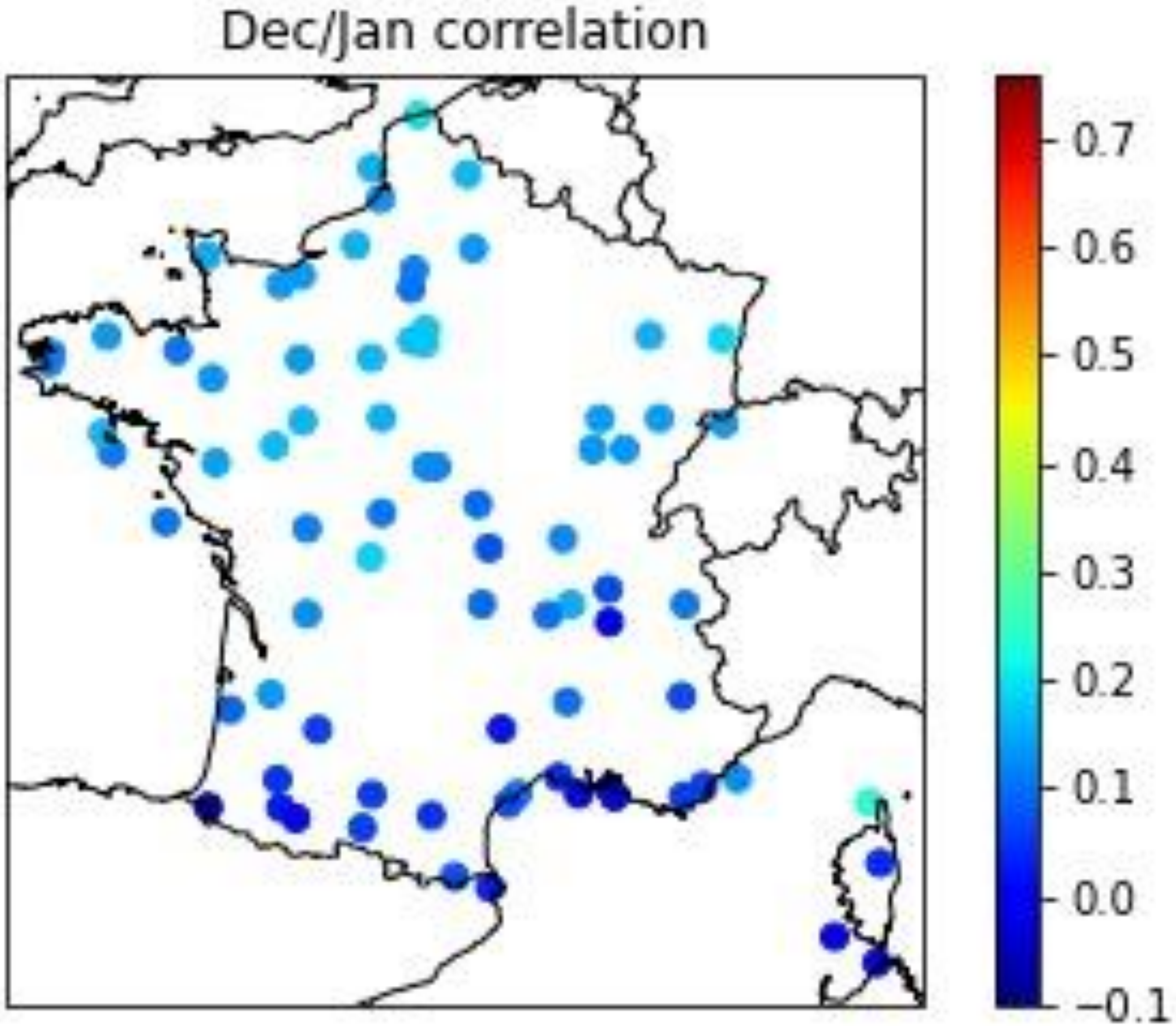
Hvað ræður tregðunni?

- “Minni” yfirborðs jarðar (vatn, snjór og klaki, hafís)
- Stöðugleiki loftmassa
- Frávik í loftstraumum

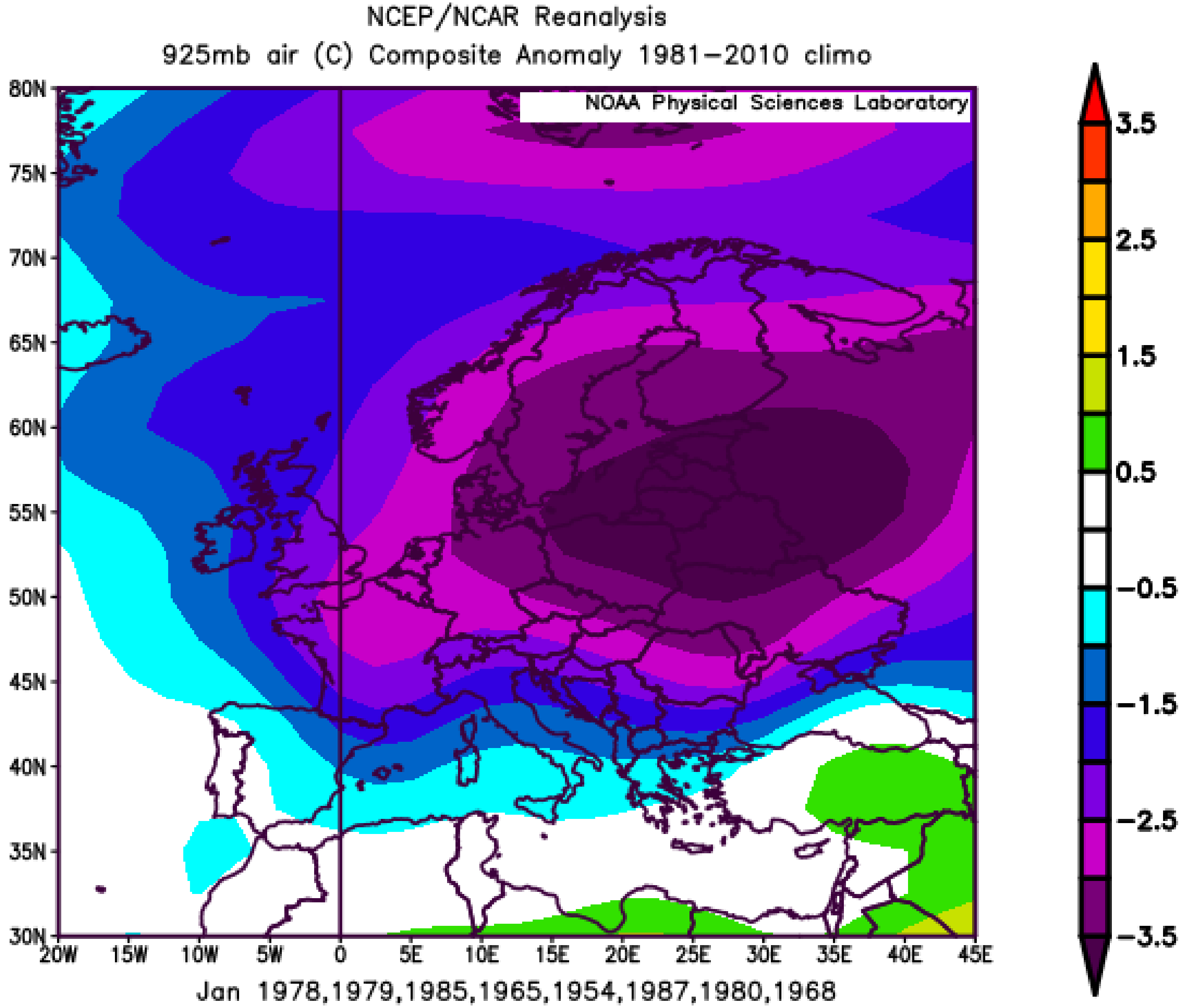
Meðalhitafylgni milli aðliggjandi mánaða



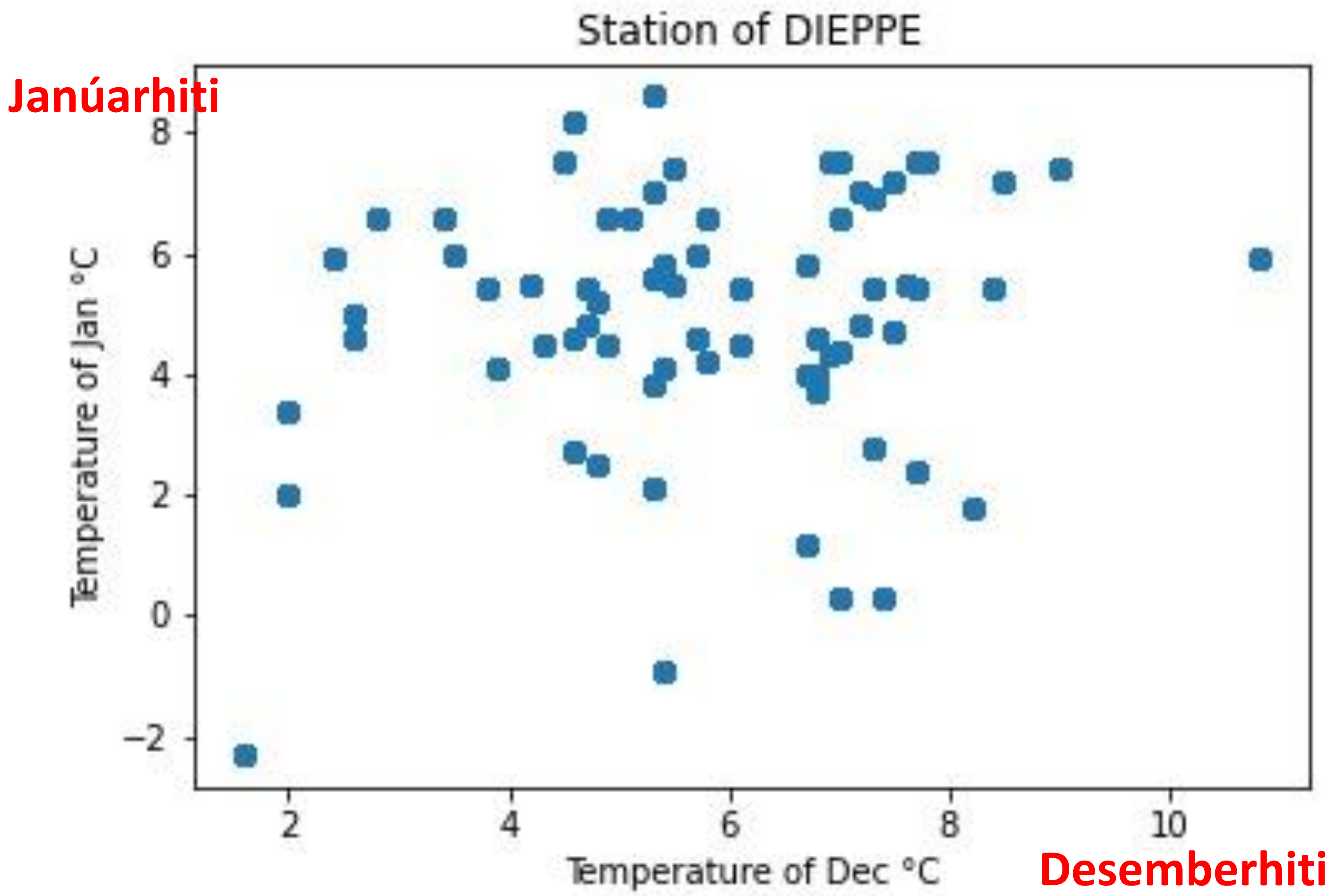
Salomé Avrillaud


Dec/Jan correlation
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
−0.1

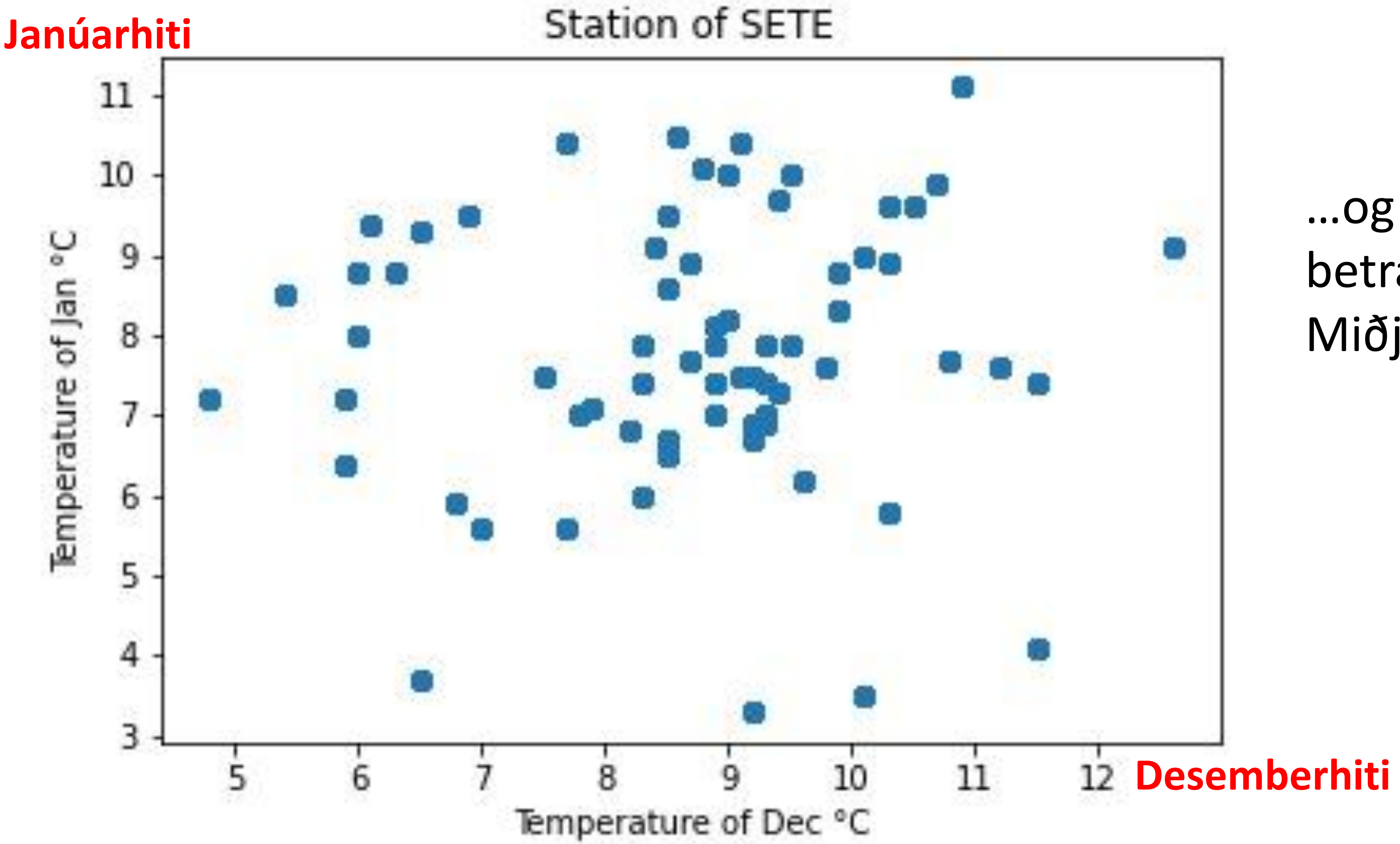
Kuldakast í Frakklandi á sér að jafnaði hámark í A-Evrópu



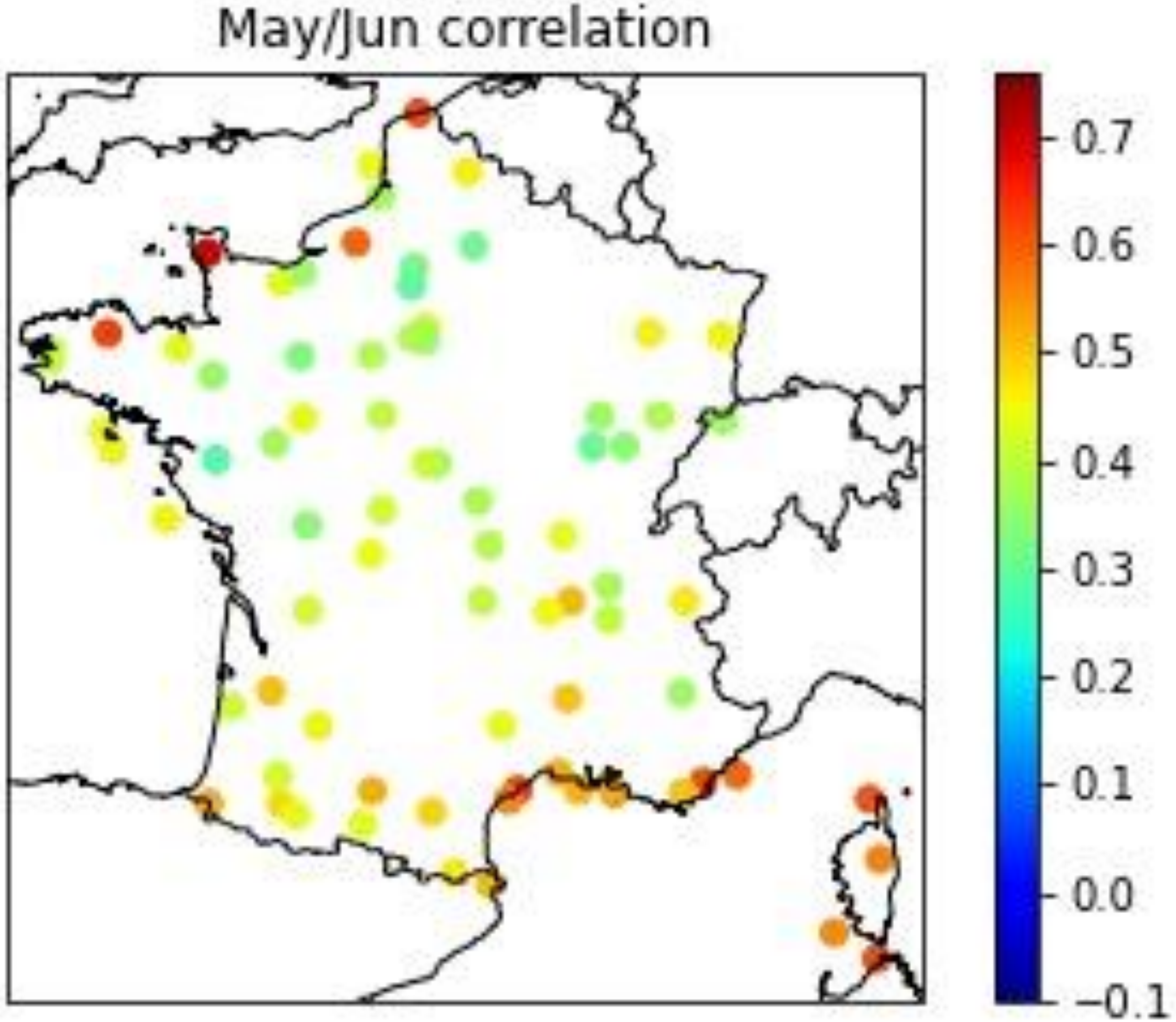

Töluverð tregða er í kuldafrávikum í A-Evrópu
Kuldaköst í Frakklandi leitast við að spilla sér
H

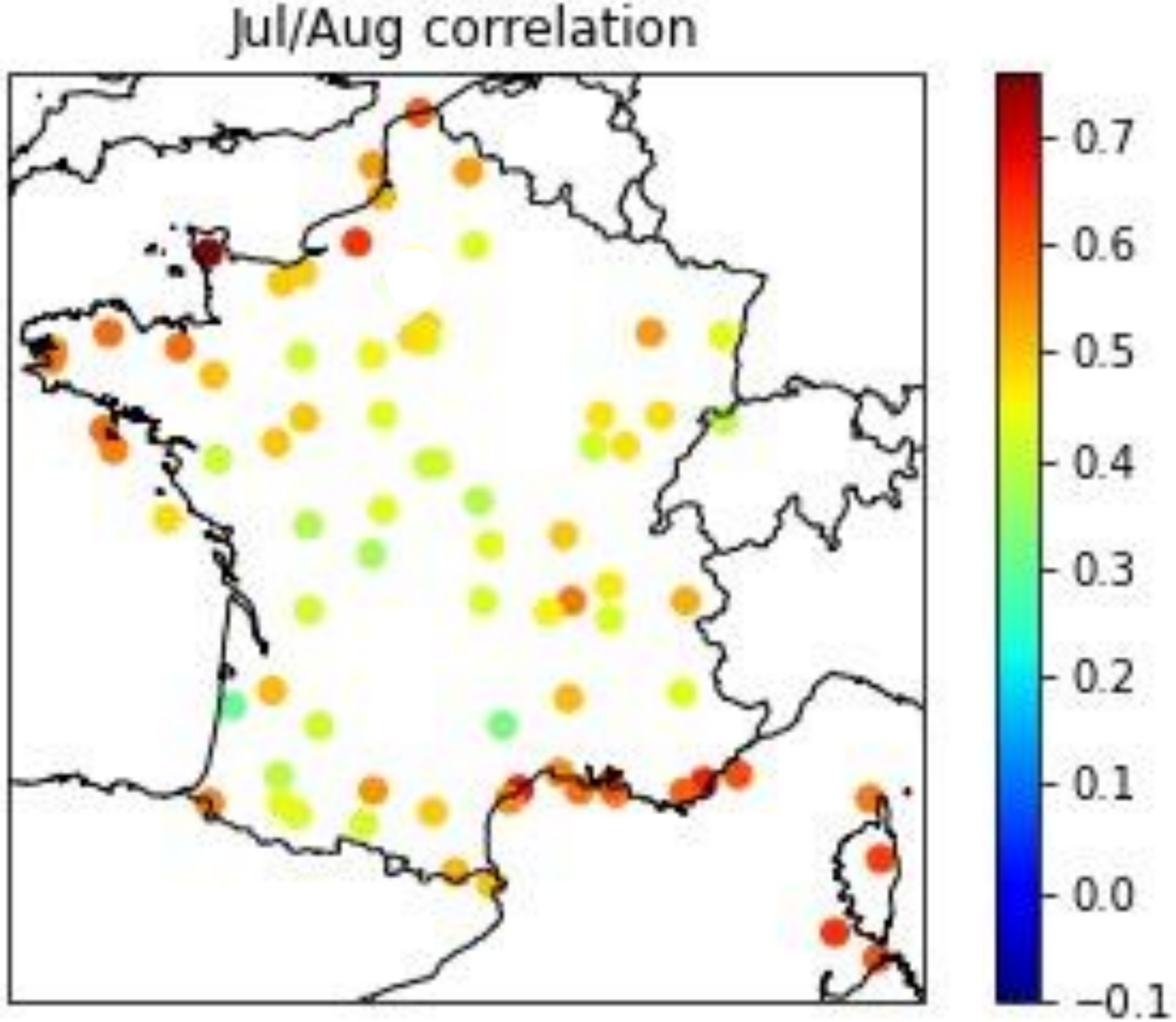


Hræðilega slök fylgni við Ermarsund

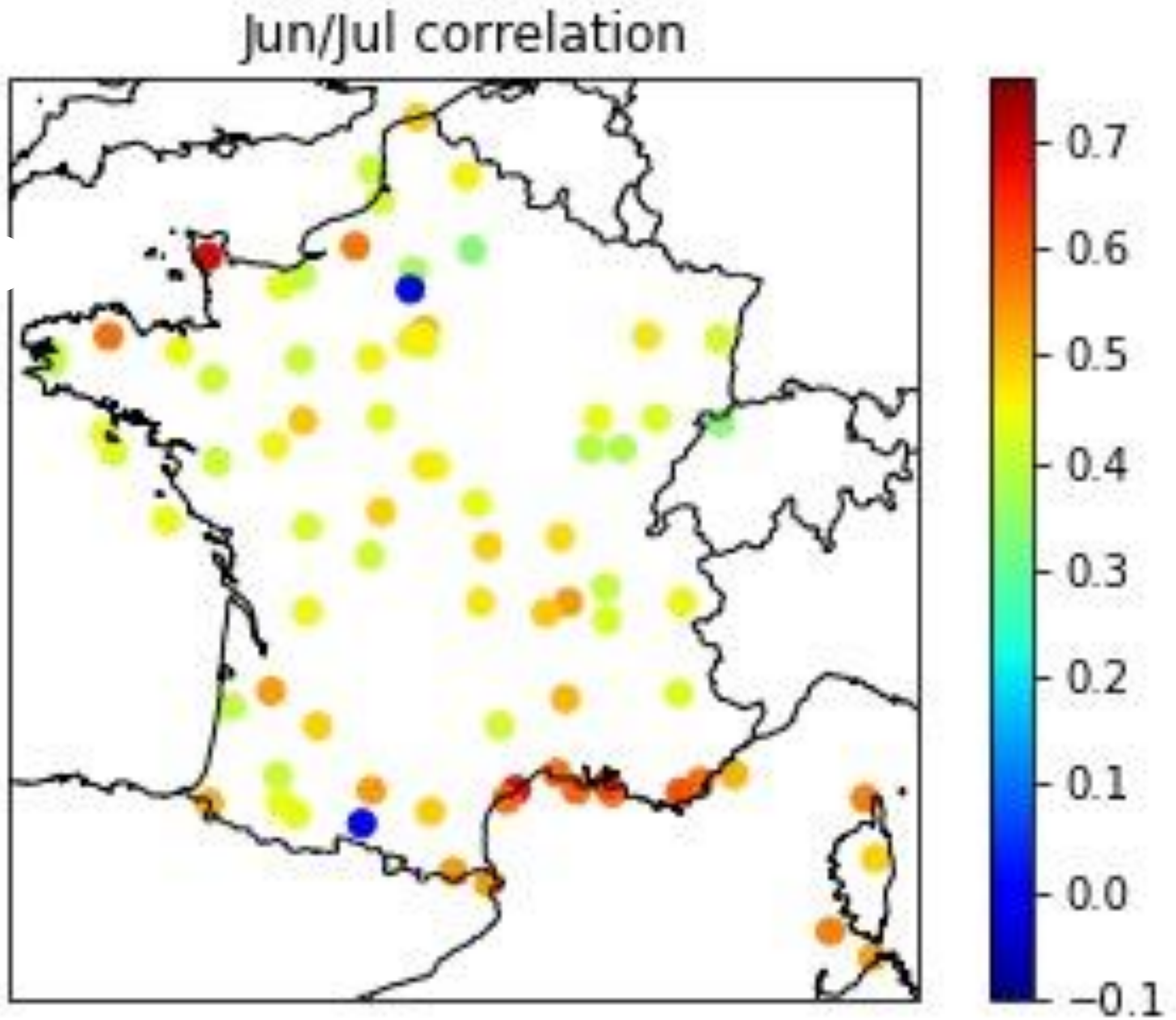


...og ekki er það betra við Miðjarðarhaf

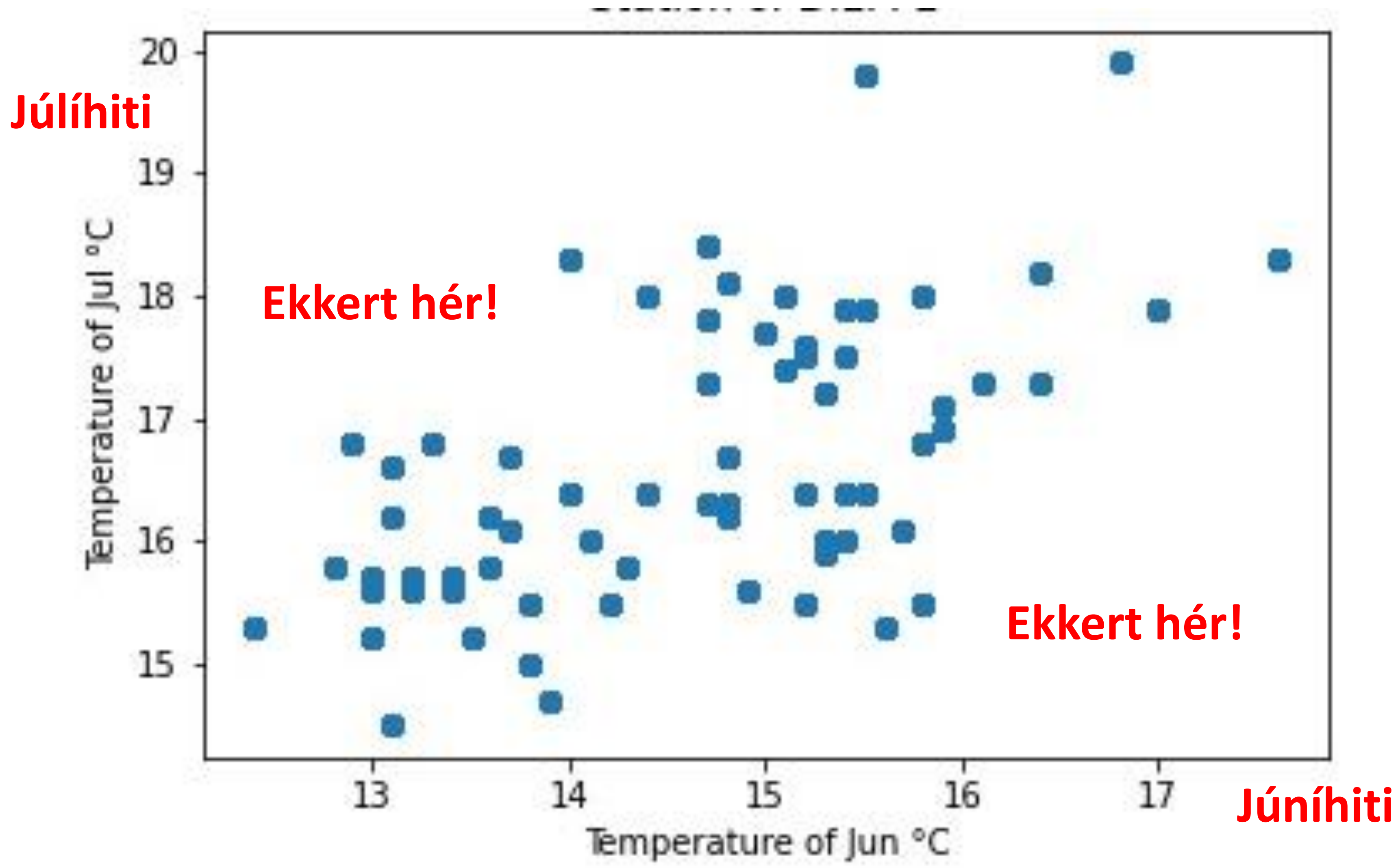

May/Jun correlation
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
−0.1


Jul/Aug correlation
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
−0.1

Mikil tregða við strendur, nema við Biskayaflóa

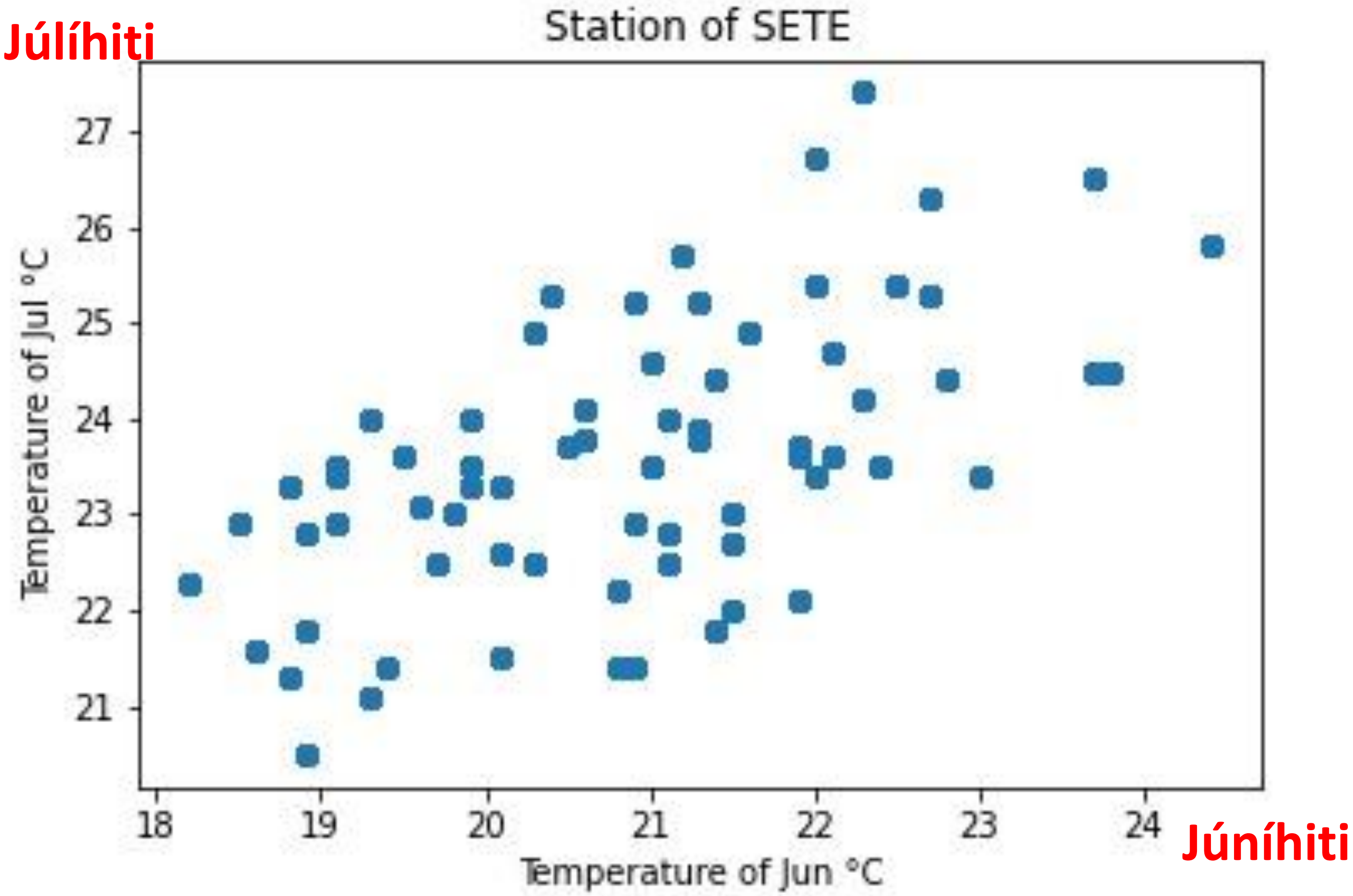


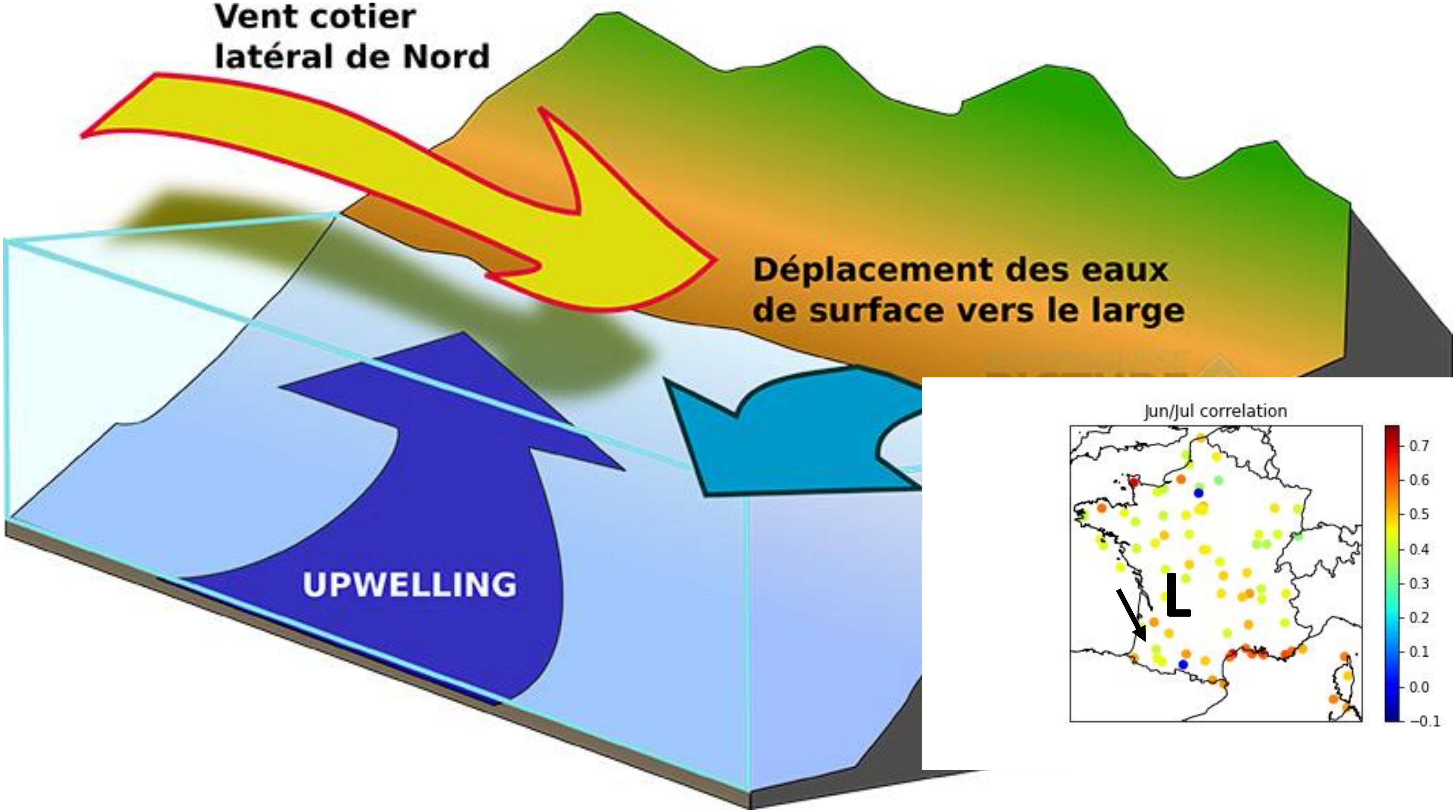
Dieppe við Ermarsund



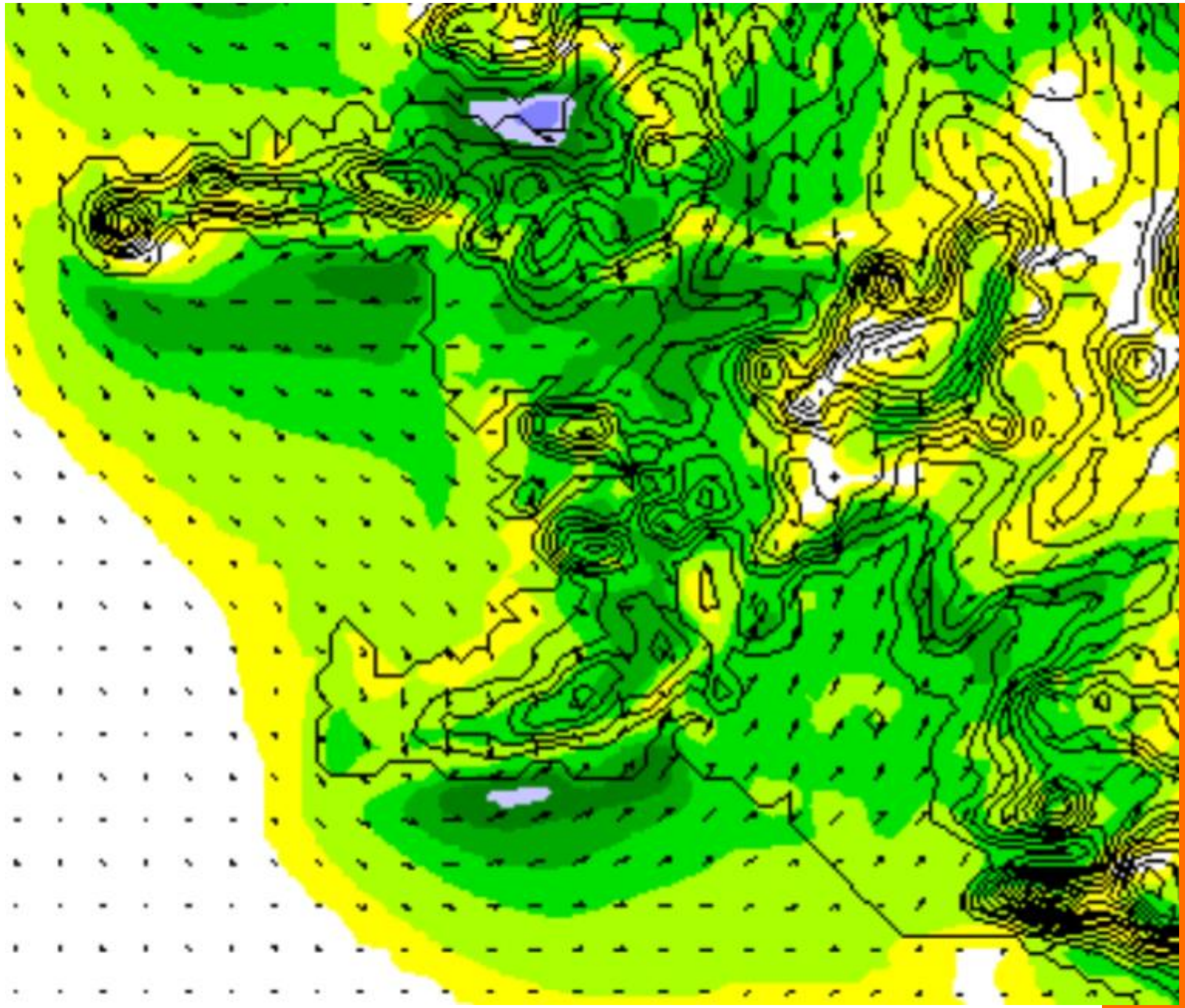
Dieppe 1942

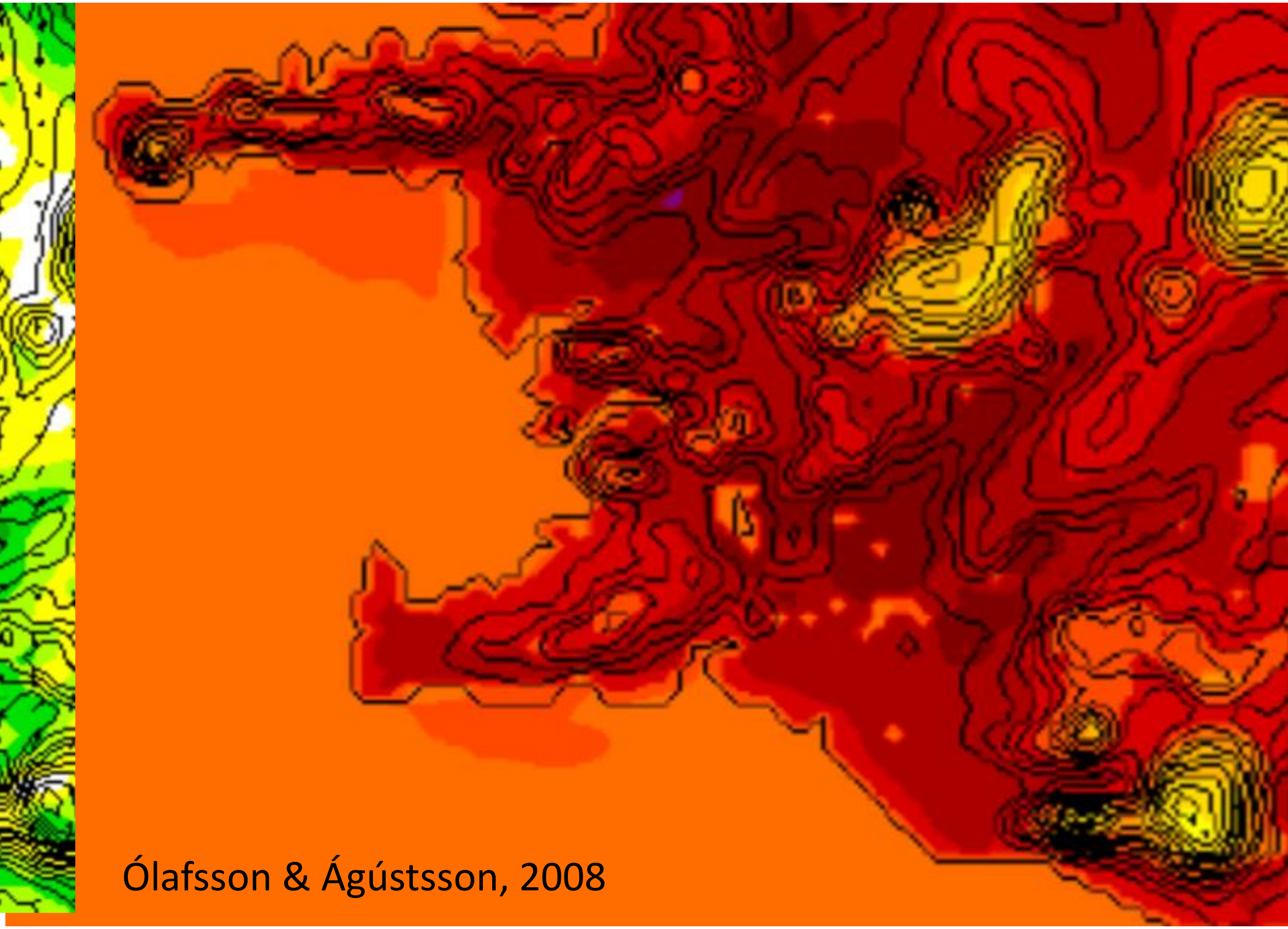
Setur við Miðjarðarhafsströnd



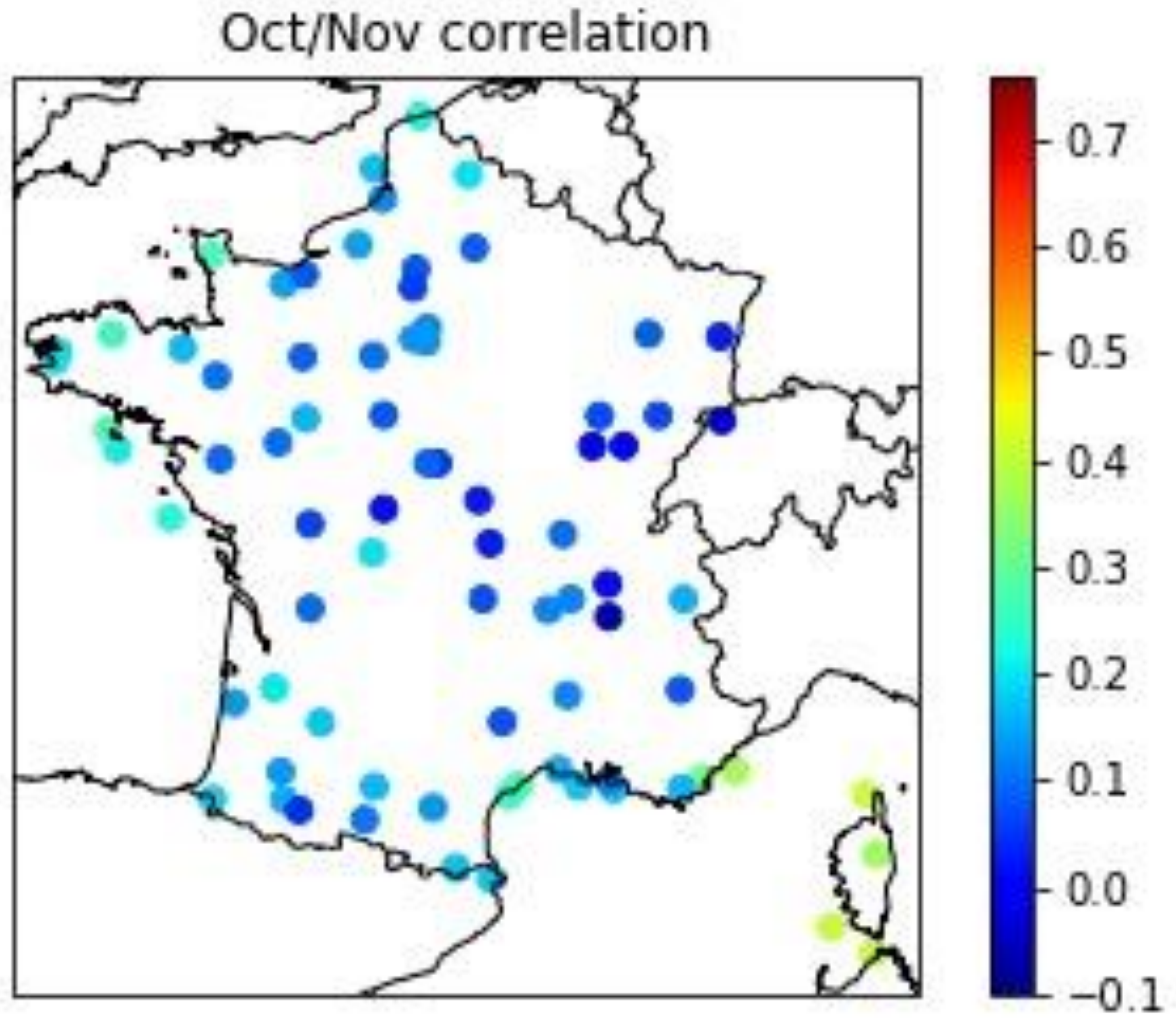

Vent cotier
latéral de Nord
Déplacement des eaux
de surface vers le large
UPWELLING
Jun/Jul correlation
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
−0.1
L

Hafgola er ósamhverf við stóra skaga

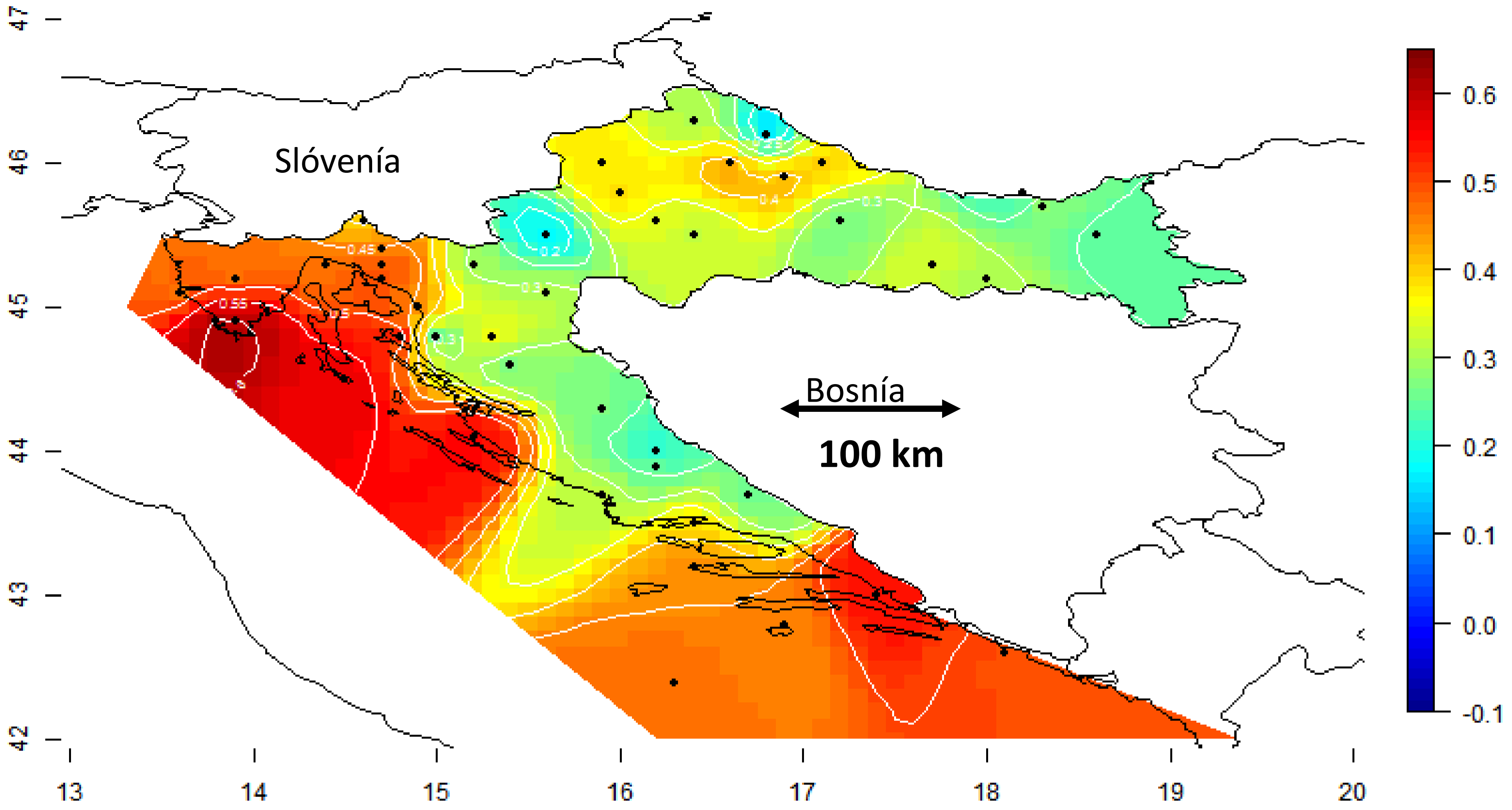




Vísbendingar um neikvæða fylgni á haustin

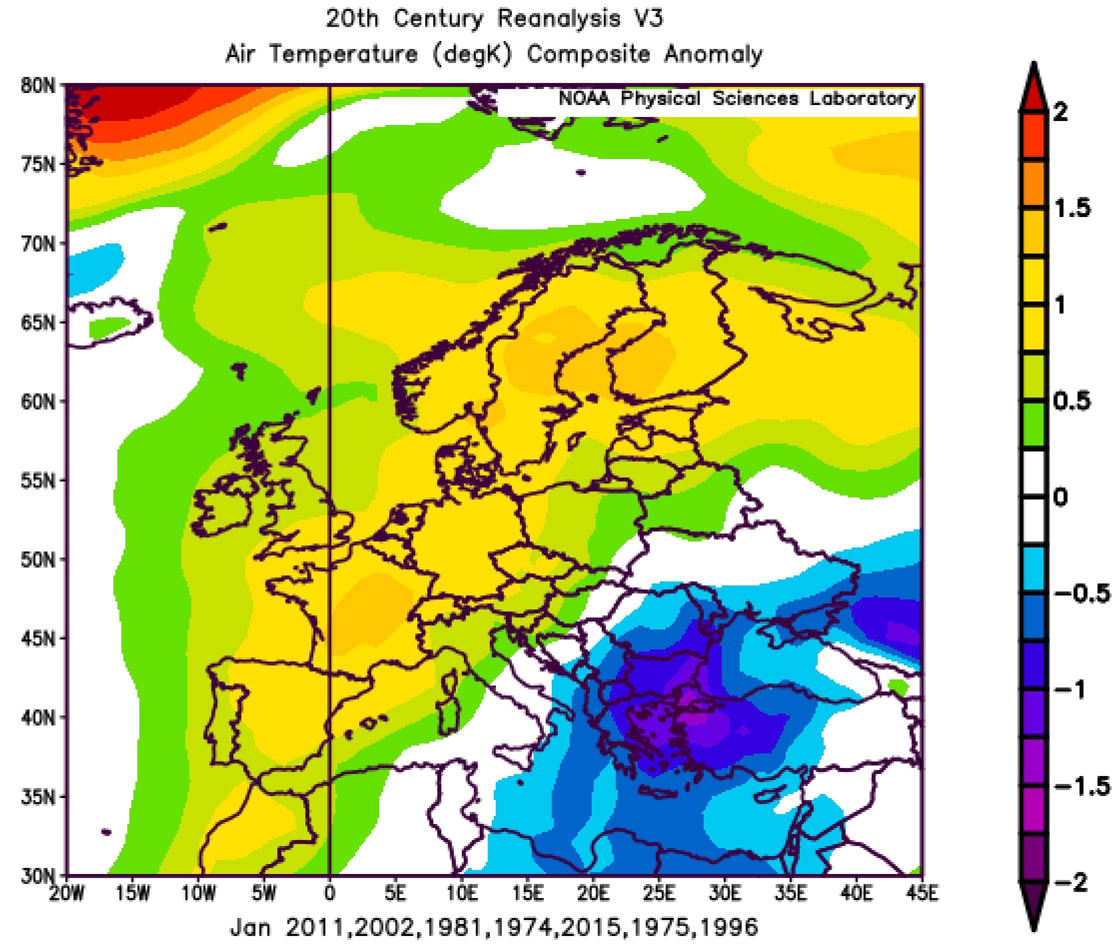


Fylgni T_{2m} Júní/Júlí

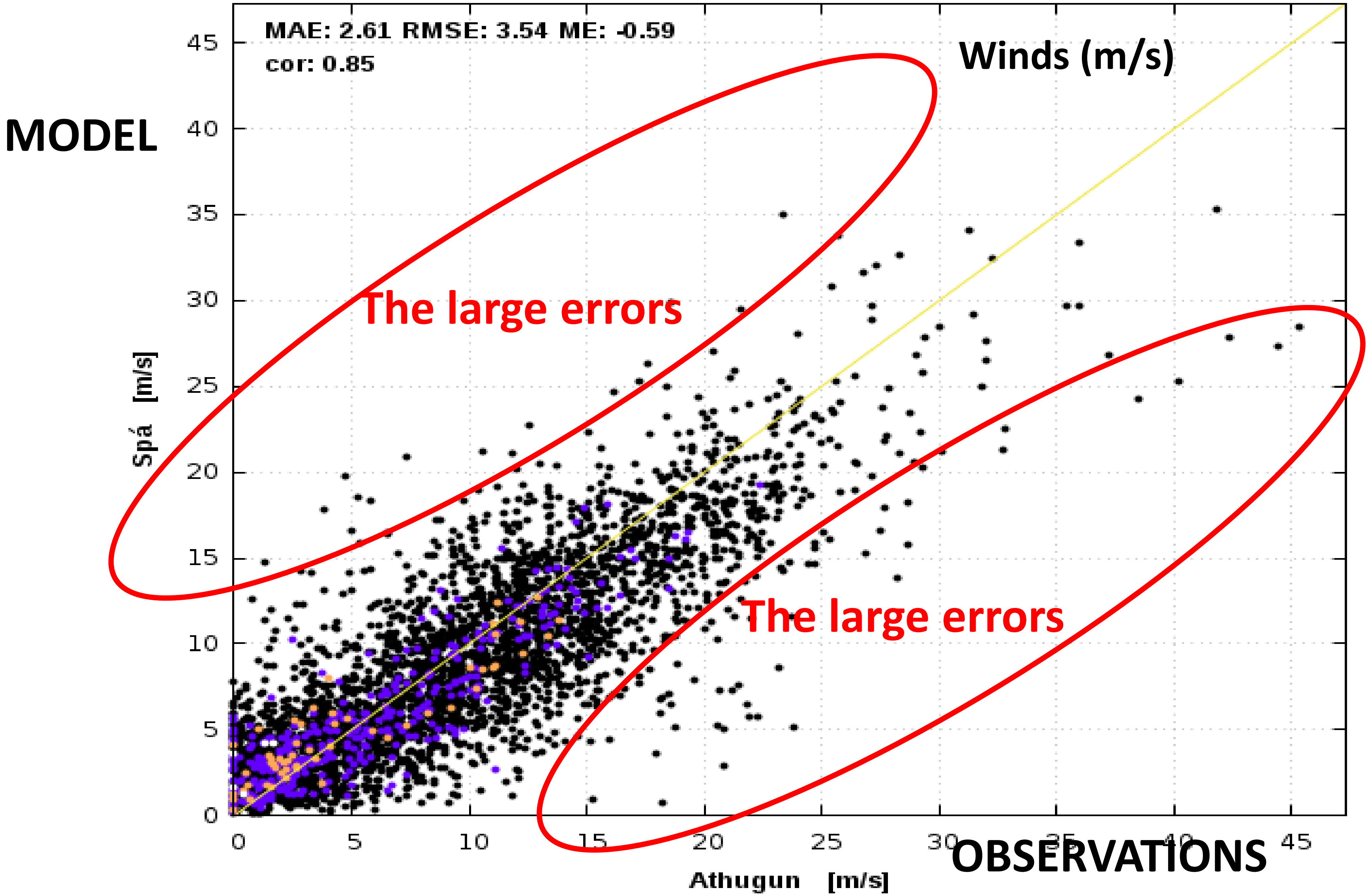


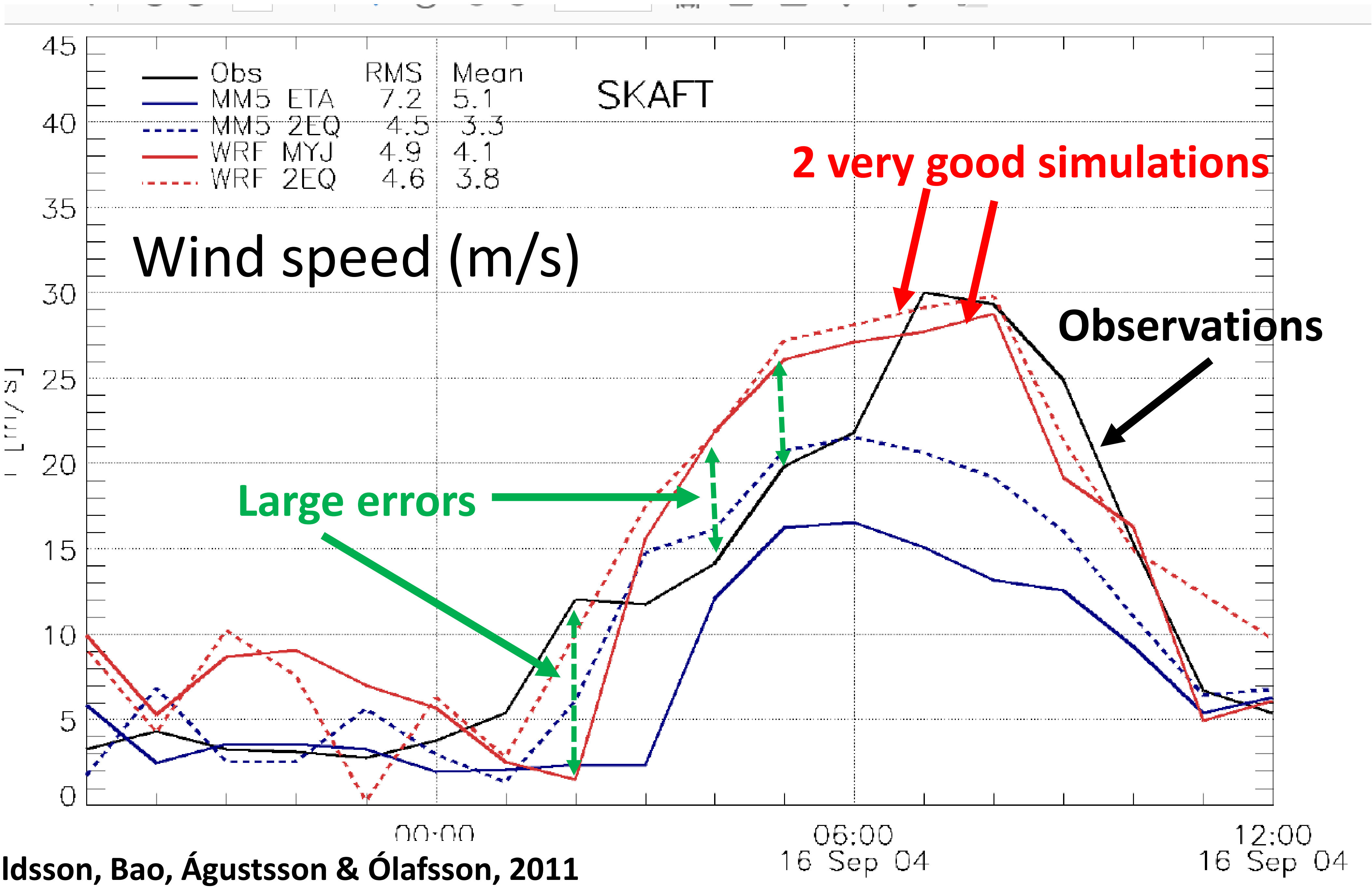
Til umhugsunar

- Hitatregðan er víðar en á Íslandi, og sumsstaðar við ströndina dugir hún til að gera mánaðarhitaspá að sumarlagi
- Sterkar vísbendingar eru um að frávik í meðalhita mánaða leiði af sér kerfisbundin frávik í loftstraumum sem skila sér aftur í hitafrávikum

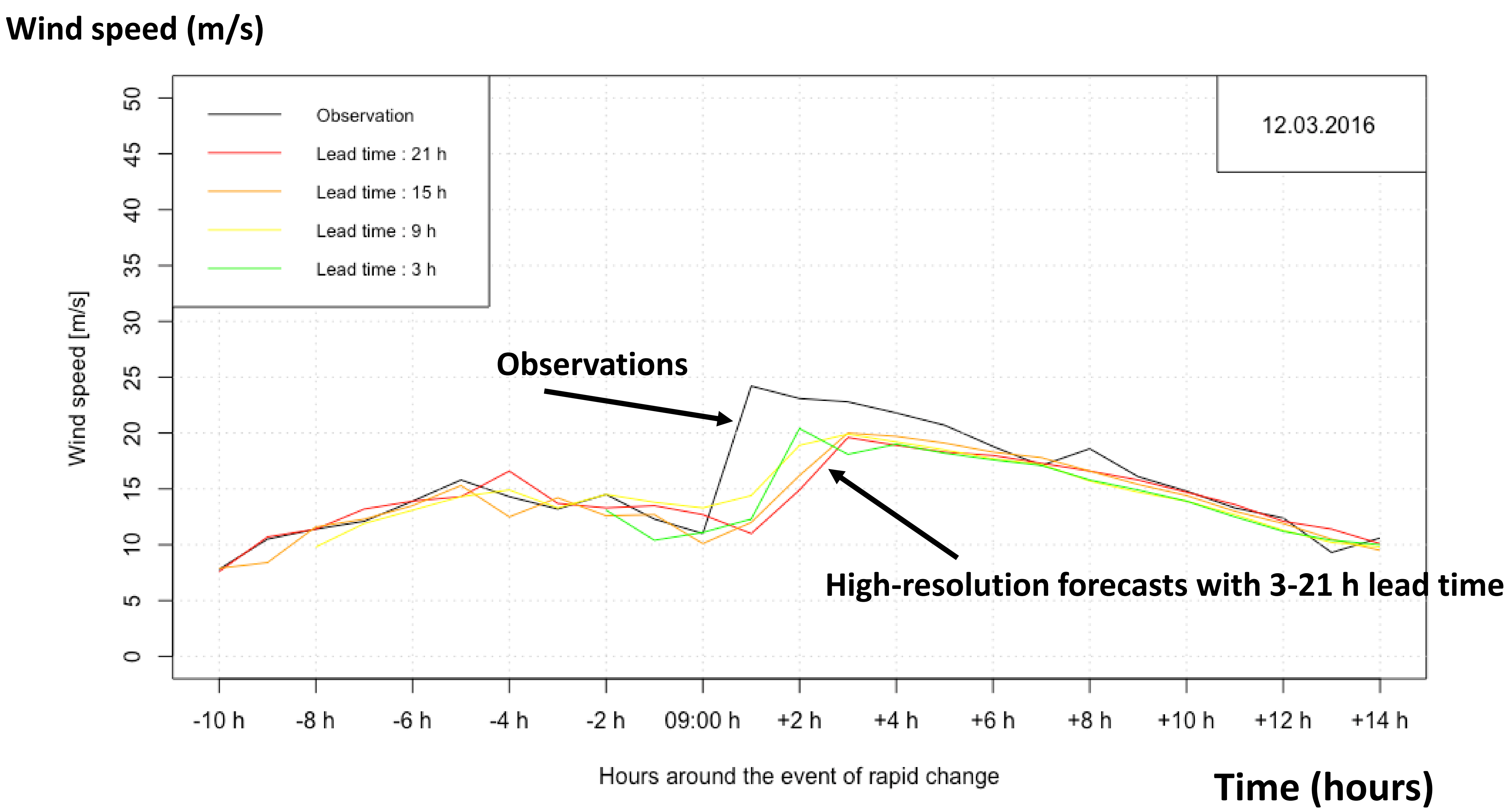


20th Century Reanalysis V3
Air Temperature (degK) Composite Anomaly
NOAA Physical Sciences Laboratory
80N
75N
70N
65N
60N
55N
50N
45N
40N
35N
30N
20W
15W
10W
5W
0
5E
10E
15E
20E
25E
30E
35E
40E
45E
Jan 2011,2002,1981,1974,2015,1975,1996
2
1.5
1
0.5
0
−0.5
−1
−1.5
−2

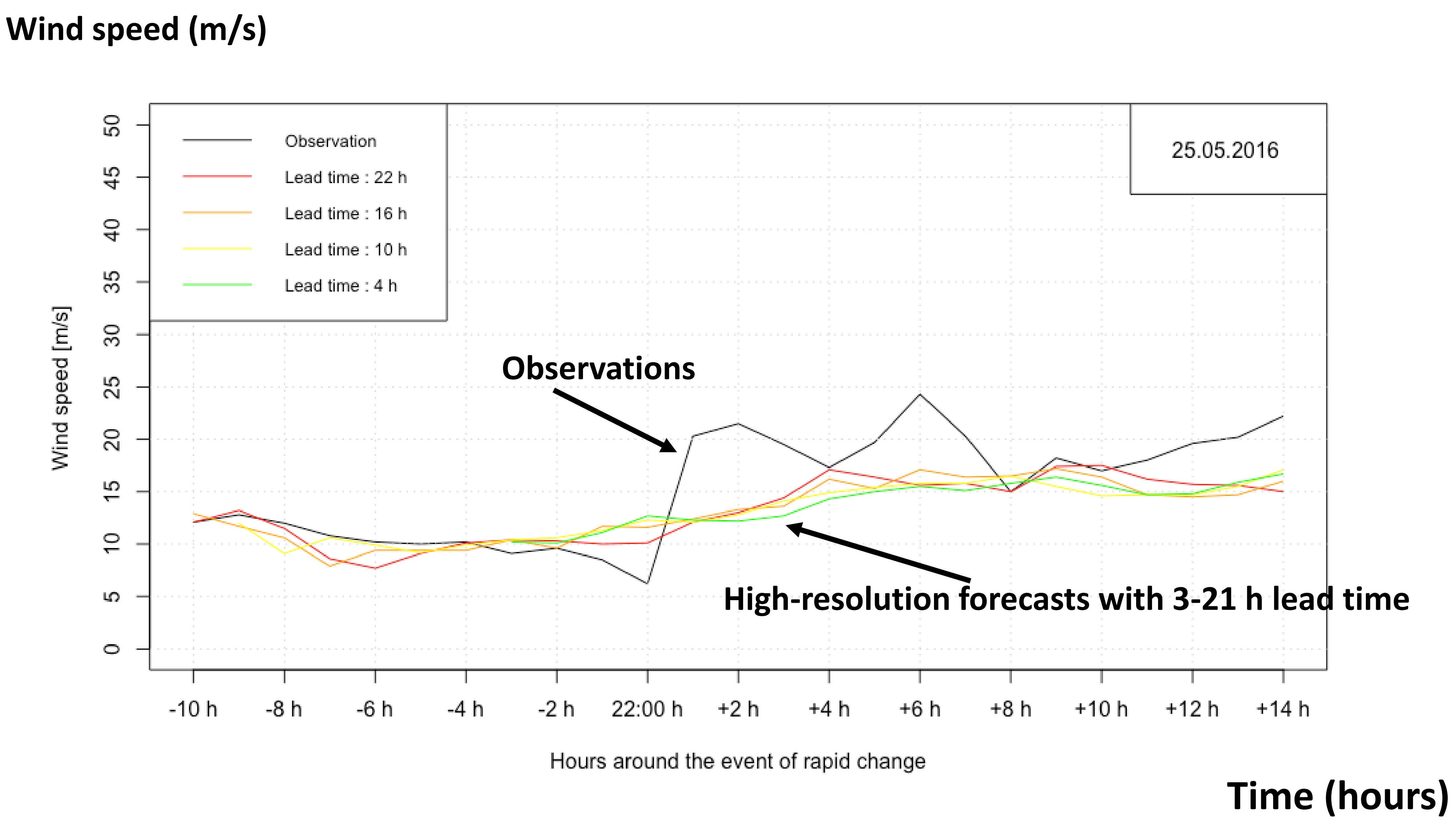

MAE: 2.61 RMSE: 3.54 ME: -0.59
cor: 0.85
Winds (m/s)
MODEL
The large errors
The large errors
Spá [m/s]
Athugun [m/s]
OBSERVATIONS
0
5
10
15
20
25
30
35
40
45



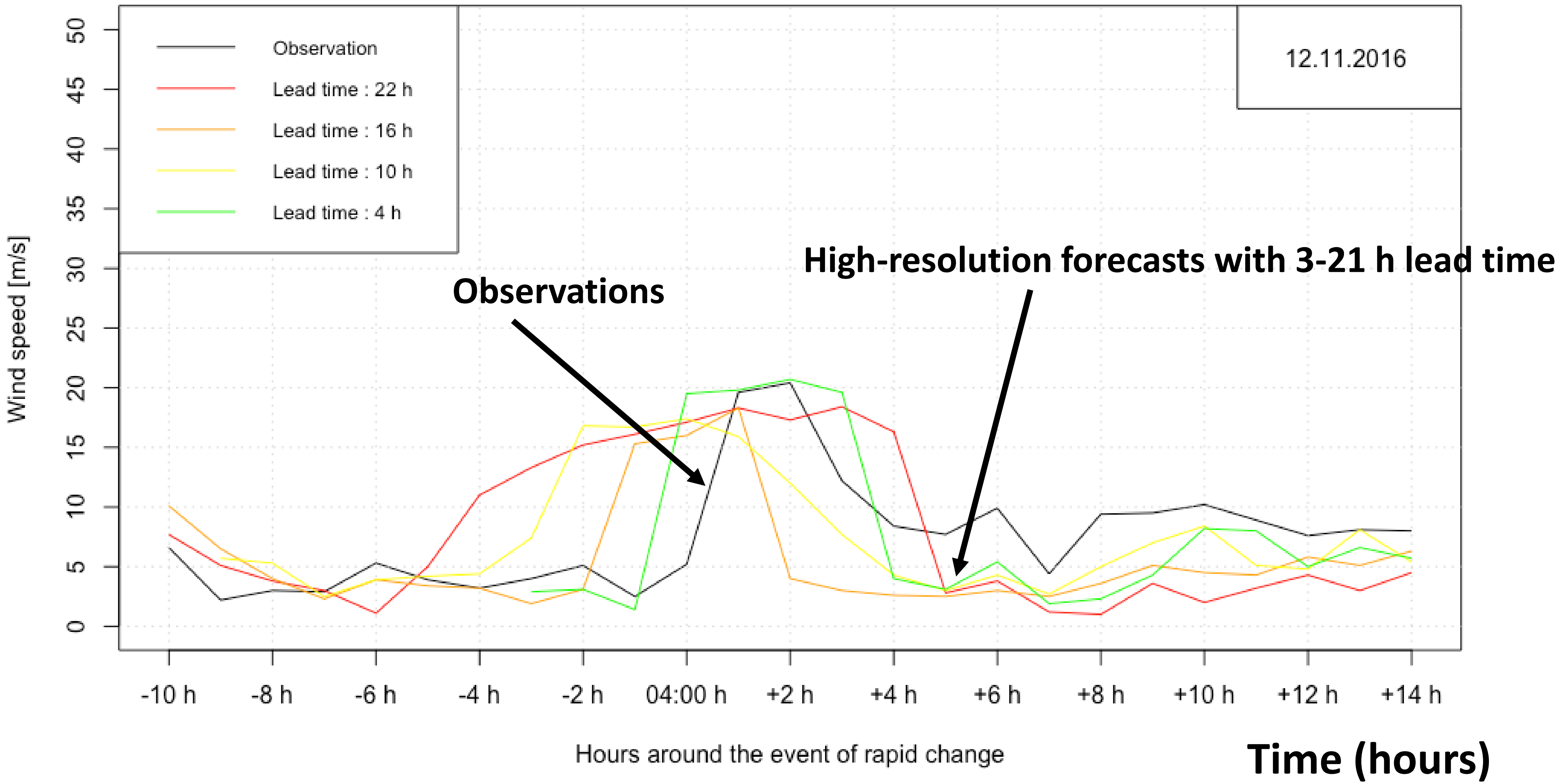
Rögnvaldsson, Bao, Ágústsson & Ólafsson, 2011



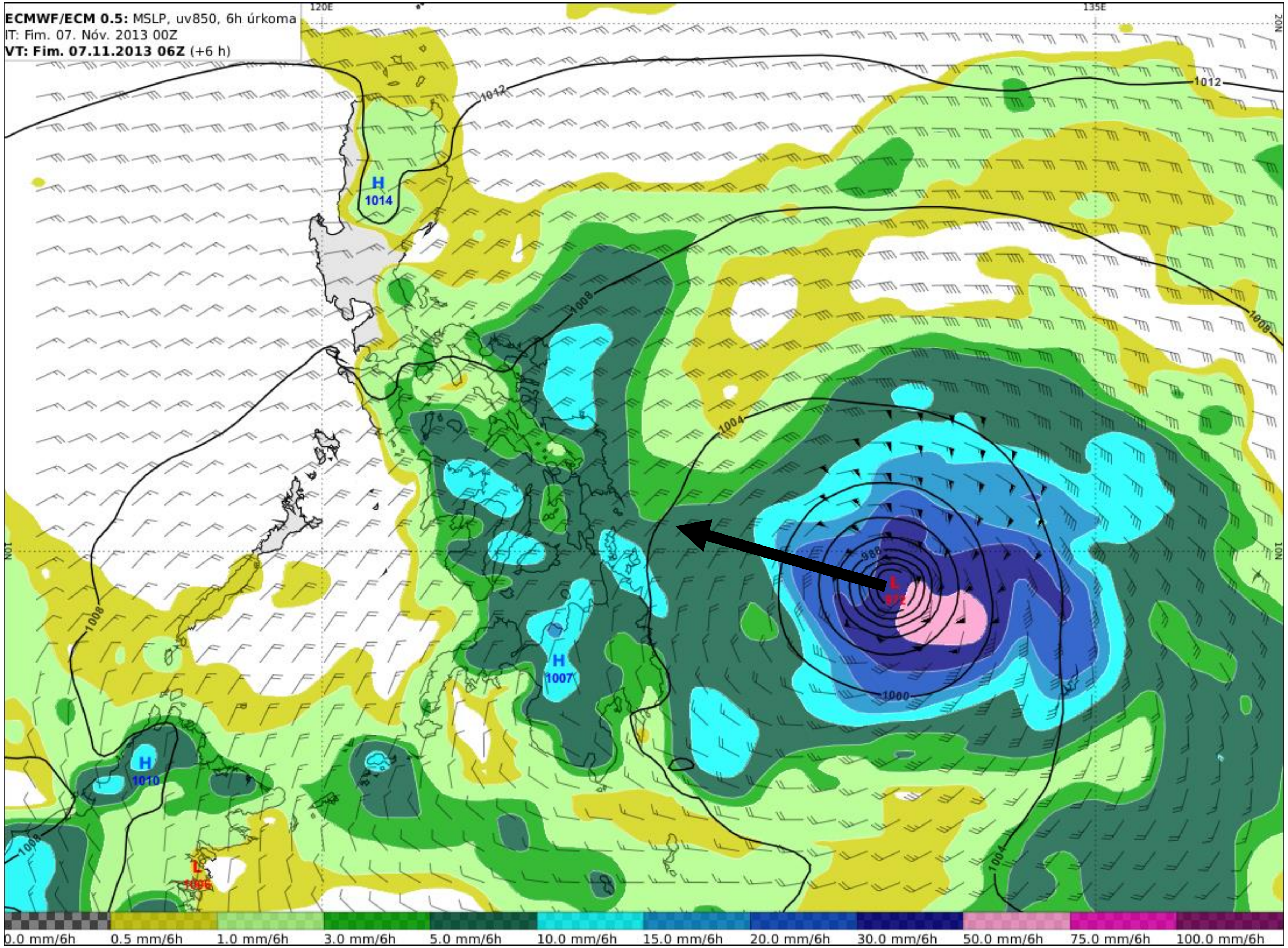
Wind speed (m/s)
Wind speed [m/s]
0
5
10
15
20
25
30
35
40
45
50
Observation
Lead time : 21 h
Lead time : 15 h
Lead time : 9 h
Lead time : 3 h
12.03.2016
Observations
High-resolution forecasts with 3-21 h lead time
-10 h
-8 h
-6 h
-4 h
-2 h
09:00 h
+2 h
+4 h
+6 h
+8 h
+10 h
+12 h
+14 h
Hours around the event of rapid change
Time (hours)


Wind speed (m/s)
Observation
Lead time : 22 h
Lead time : 16 h
Lead time : 10 h
Lead time : 4 h
25.05.2016
Observations
High-resolution forecasts with 3-21 h lead time
Wind speed [m/s]
0
5
10
15
20
25
30
35
40
45
50
-10 h
-8 h
-6 h
-4 h
-2 h
22:00 h
+2 h
+4 h
+6 h
+8 h
+10 h
+12 h
+14 h
Hours around the event of rapid change
Time (hours)

Wind speed (m/s)

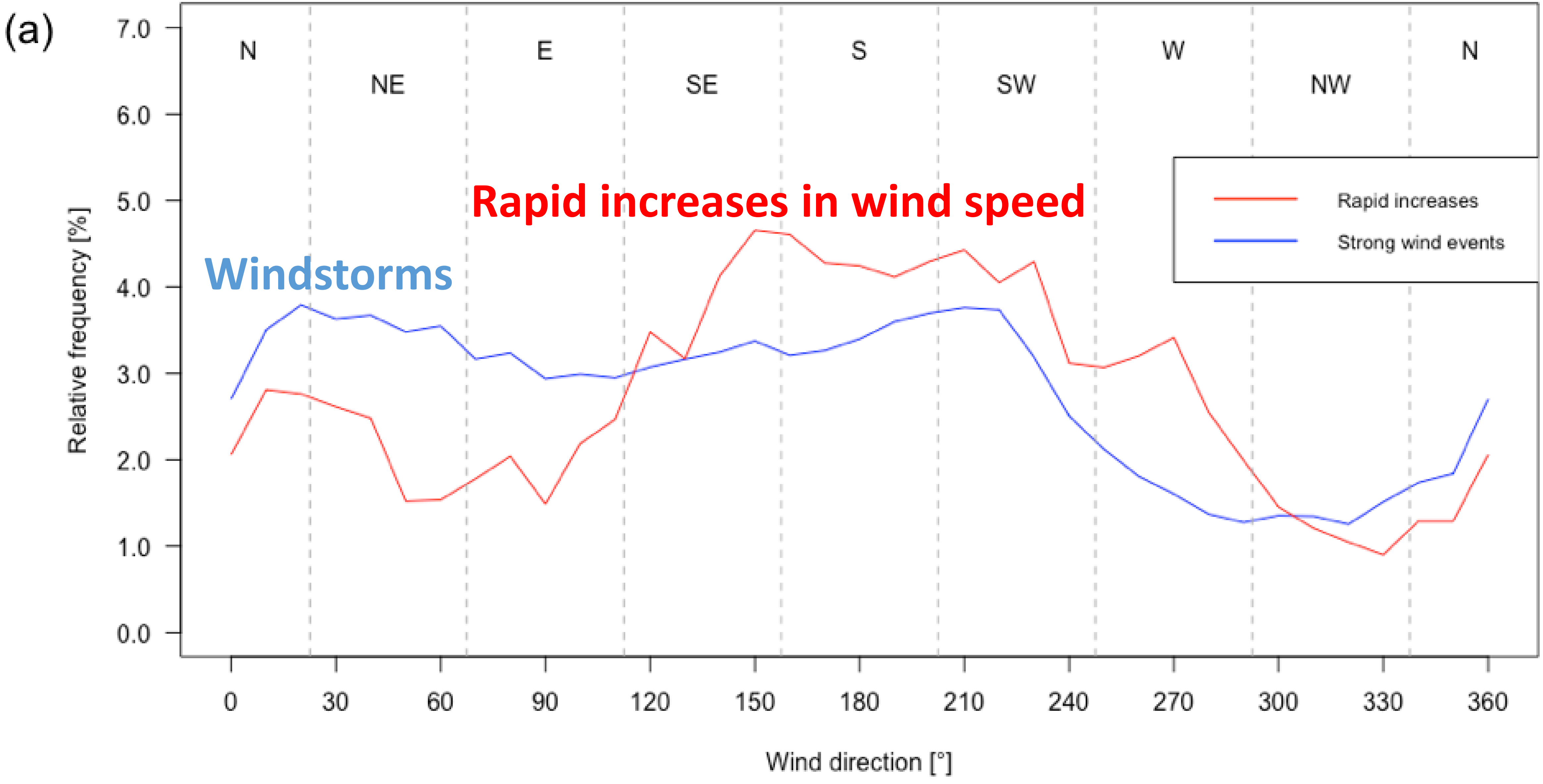


Time (hours)

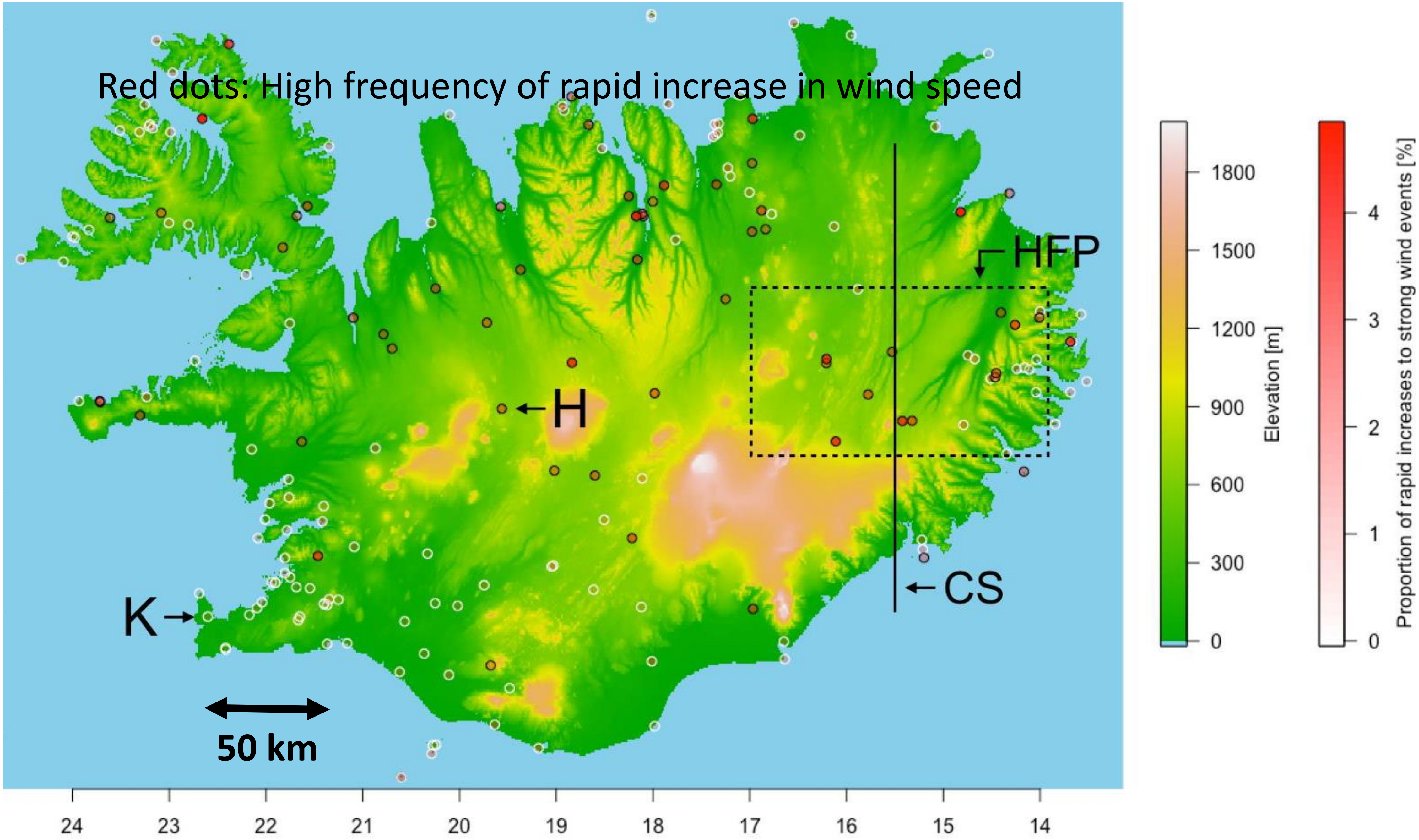


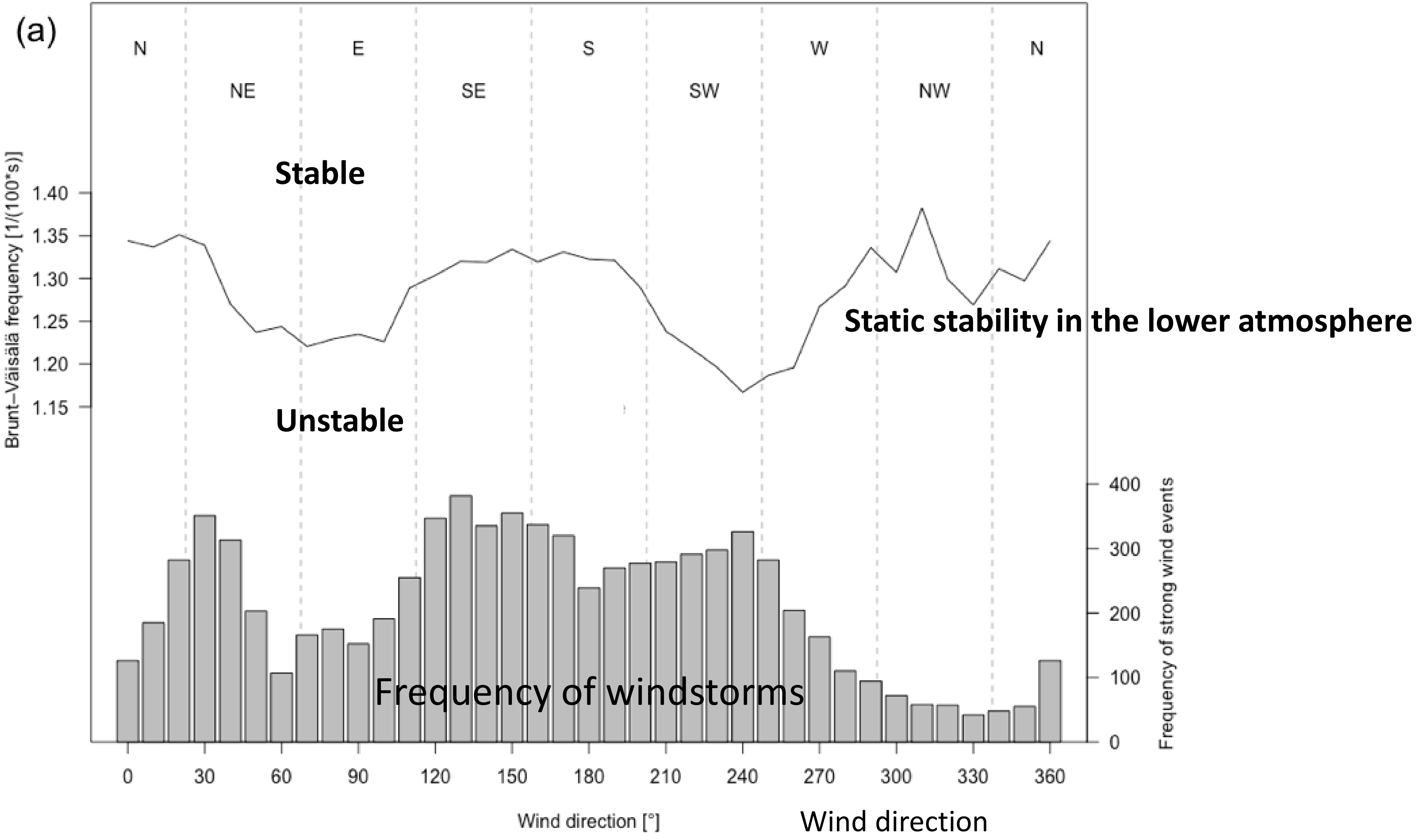
The NE winds increase steadlily, while the SW winds increase very rapidly once the typhoon has passed

200 Automatic weather stations in Iceland, 21 millions of hourly observations



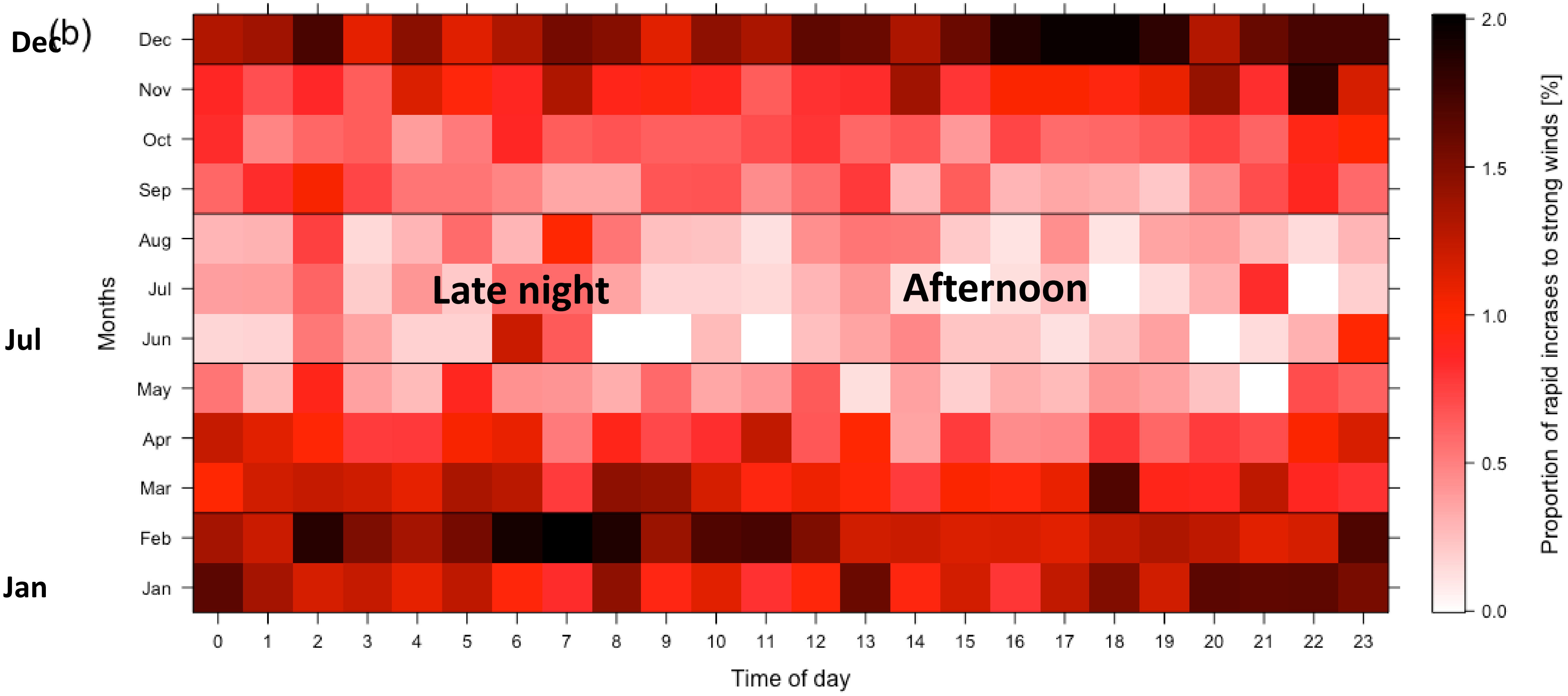
Red dots: High frequency of rapid increase in wind speed



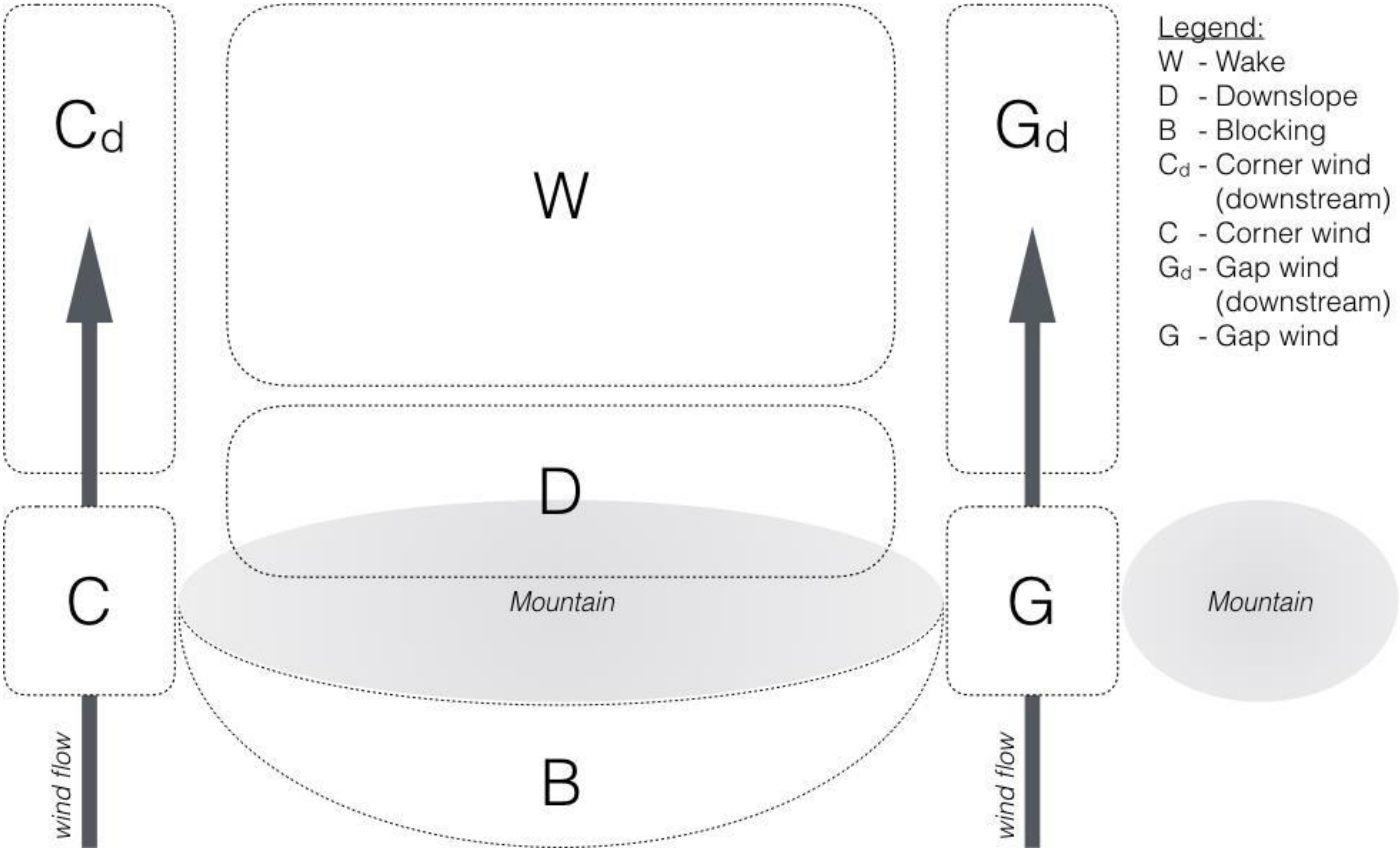


(a)
N
NE
E
SE
S
SW
W
NW
N
Stable
Unstable
Static stability in the lower atmosphere
Frequency of windstorms
Brunt–Väisälä frequency [1/(100*s)]
1.40
1.35
1.30
1.25
1.20
1.15
Frequency of strong wind events
400
300
200
100
0
0
30
60
90
120
150
180
210
240
270
300
330
360
Wind direction [°]
Wind direction

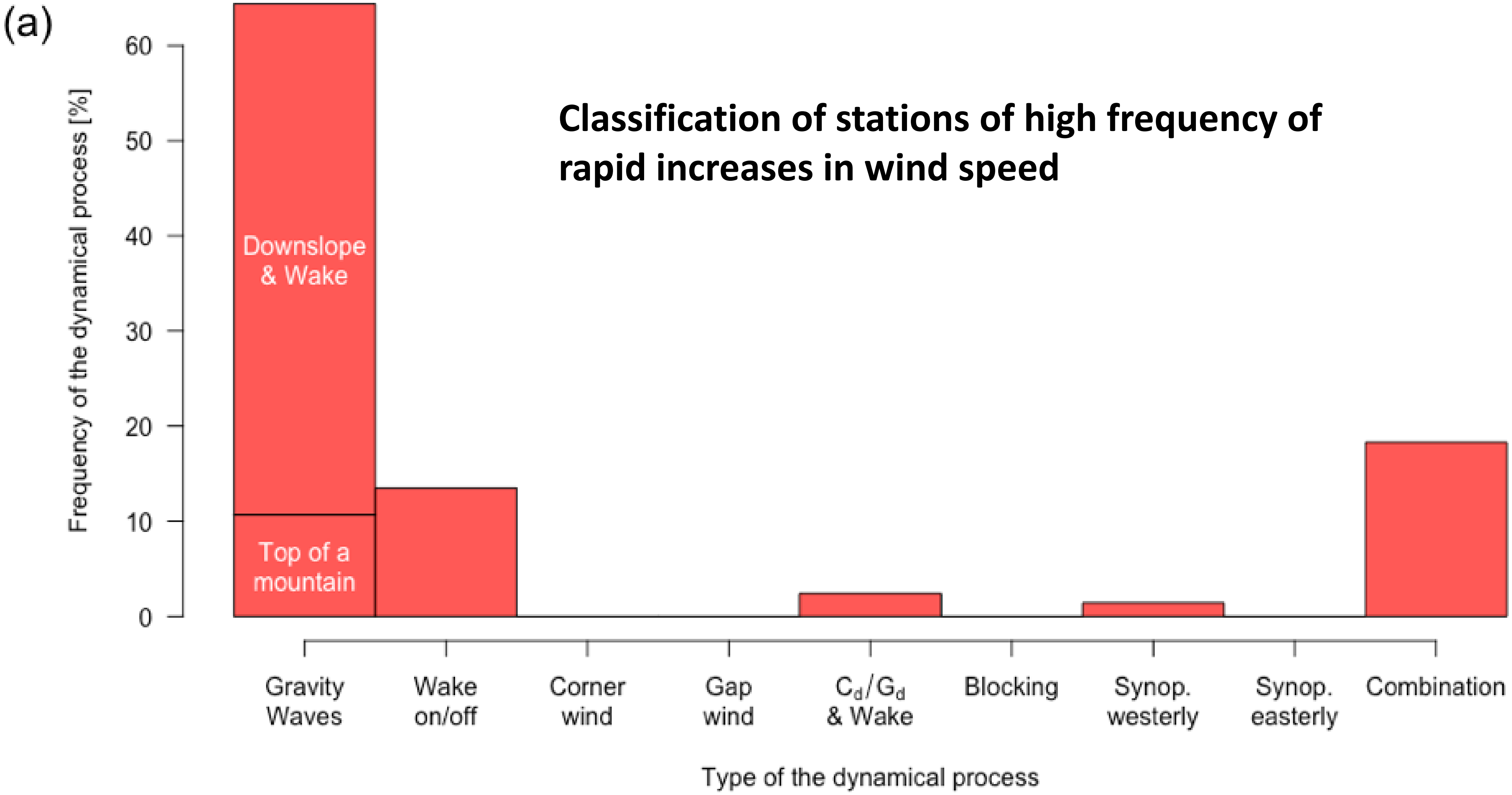
21 millions of observations

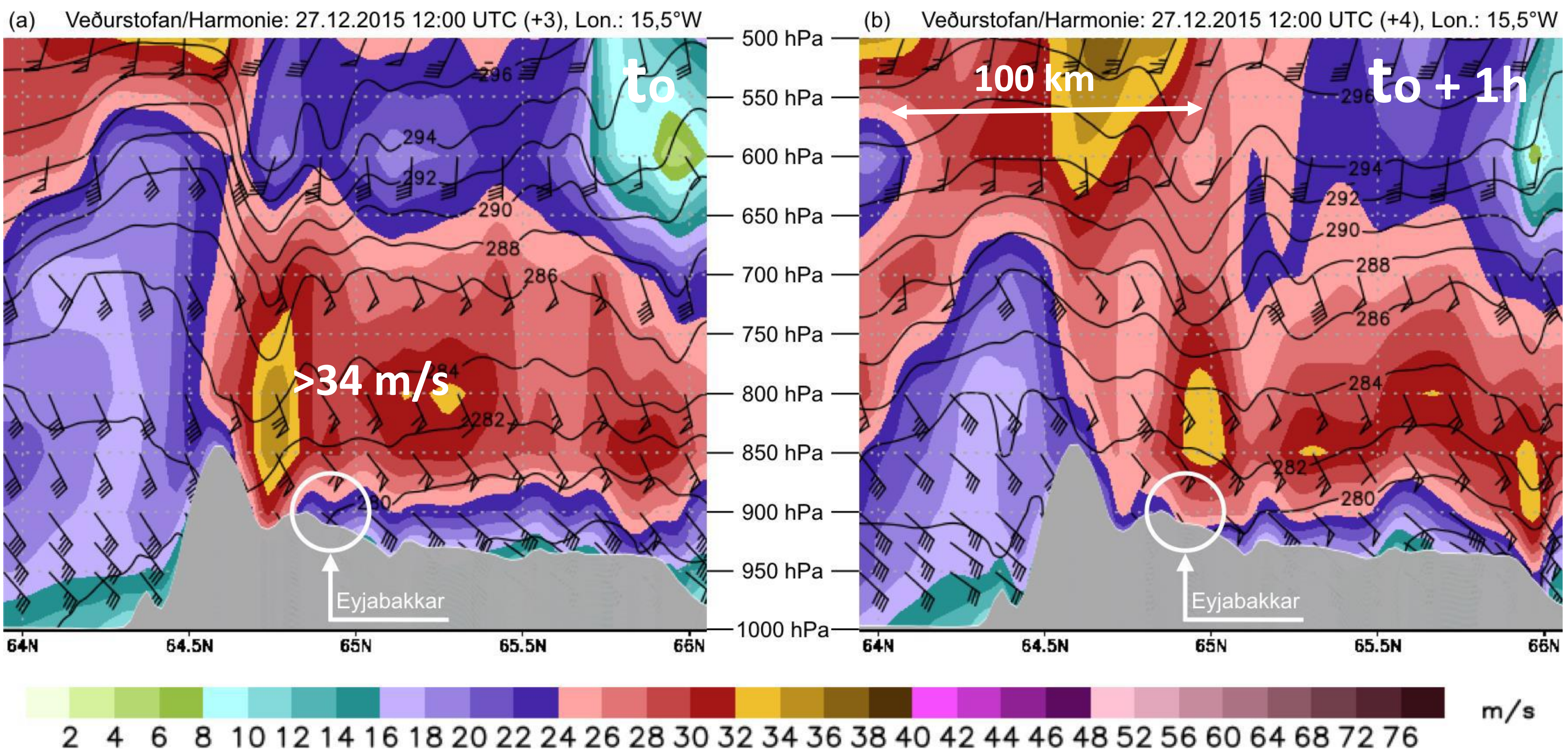


Frequency of rapid incrase of wind speed/frequency of windstorms


Cd
W
Gd
Legend:
W - Wake
D - Downslope
B - Blocking
Cd - Corner wind (downstream)
C - Corner wind
Gd - Gap wind (downstream)
G - Gap wind
D
C
Mountain
G
Mountain
B
wind flow
wind flow

Classification of stations of high frequency of rapid increases in wind speed



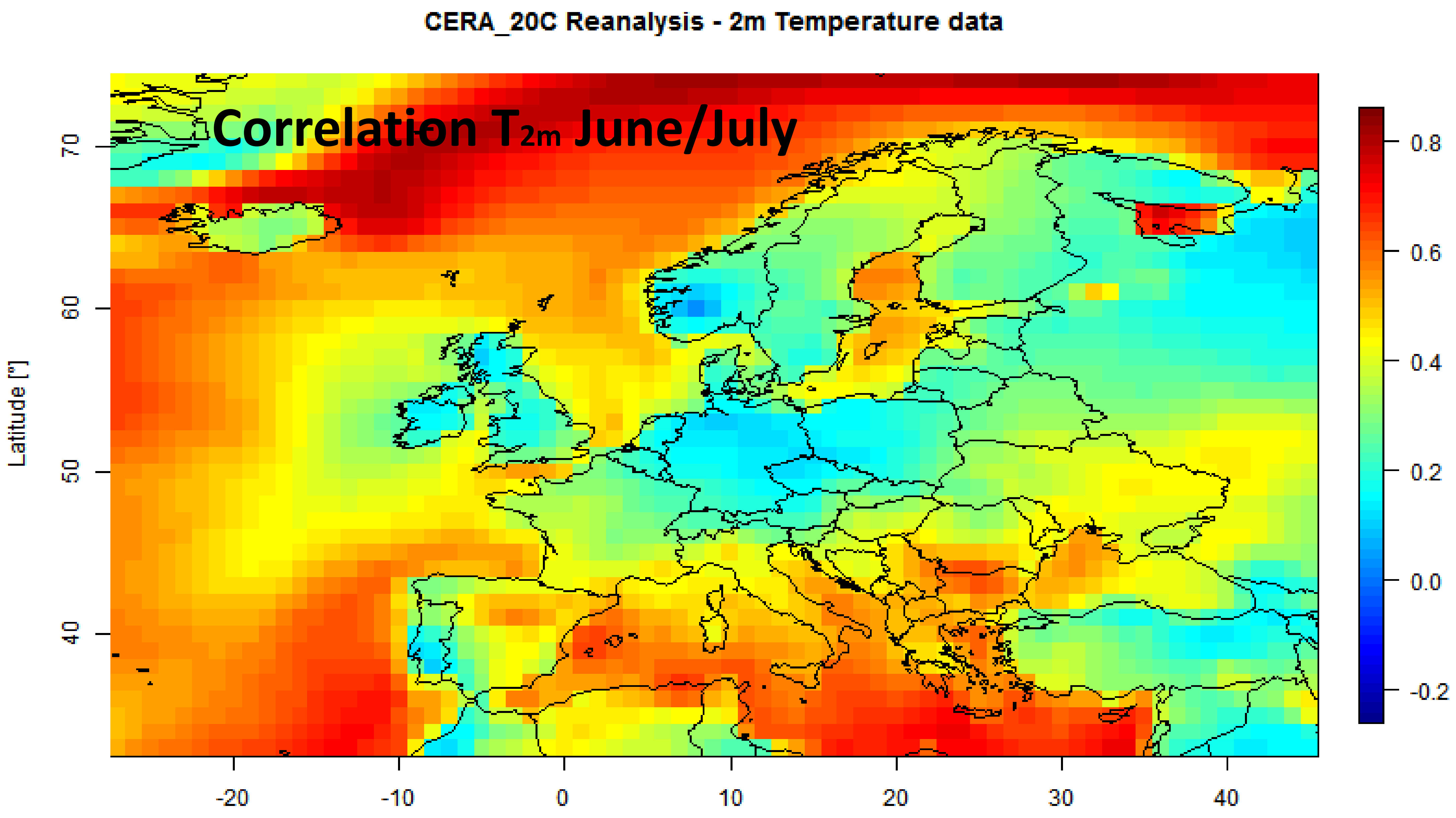


(a) Veðurstofan/Harmonie: 27.12.2015 12:00 UTC (+3), Lon.: 15,5°W
(b) Veðurstofan/Harmonie: 27.12.2015 12:00 UTC (+4), Lon.: 15,5°W
to
to + 1h
100 km
>34 m/s
500 hPa
550 hPa
600 hPa
650 hPa
700 hPa
750 hPa
800 hPa
850 hPa
900 hPa
950 hPa
1000 hPa
296
294
292
290
288
286
284
282
280
Eyjabakkar
Eyjabakkar
64N
64.5N
65N
65.5N
66N
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 52 56 60 64 68 72 76
m/s

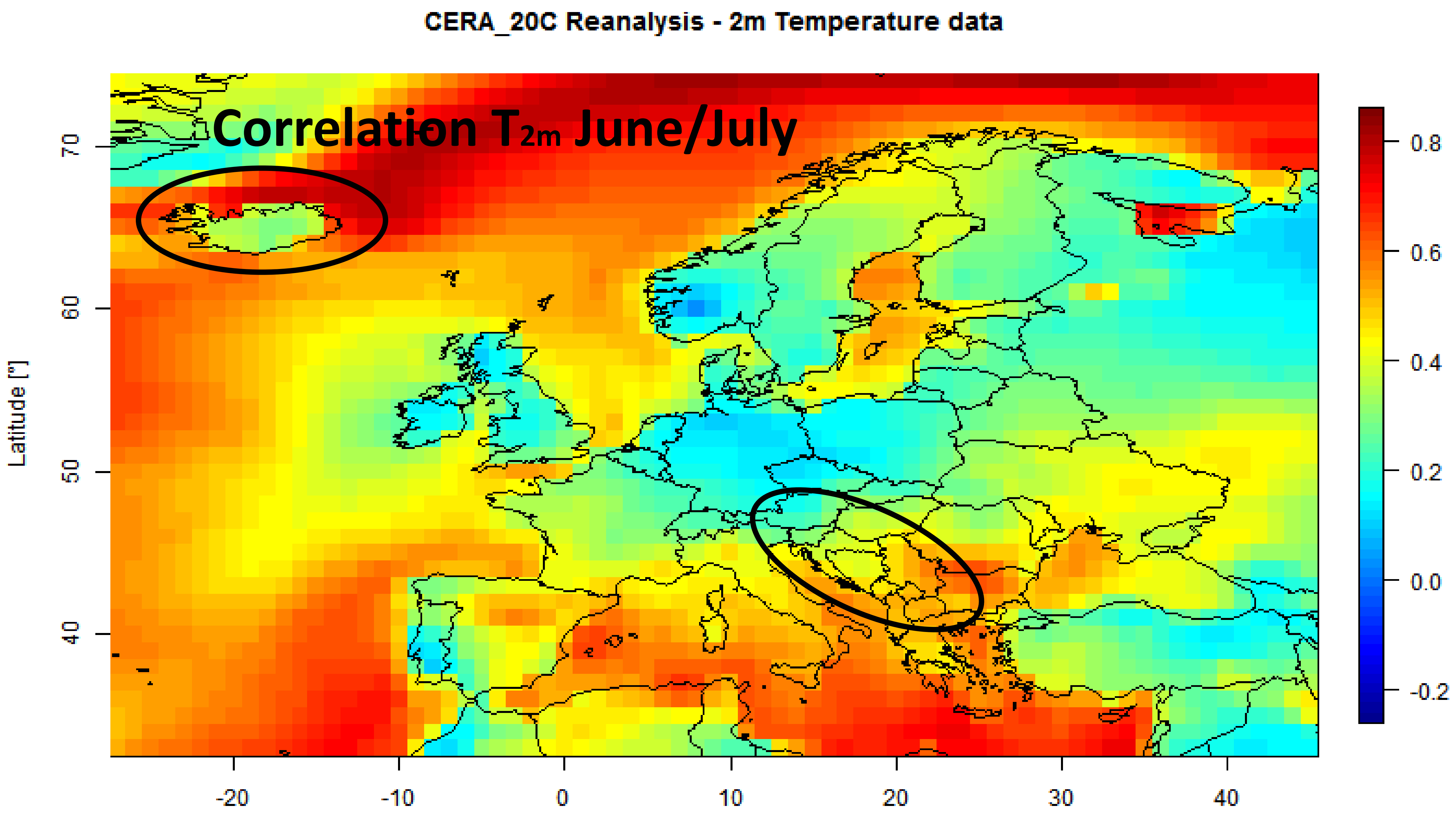
dx=2,5 km

Low-level static stability is an issue here

- The low level static stability of the atmosphere modulates the flux of information from the surface up through the atmosphere

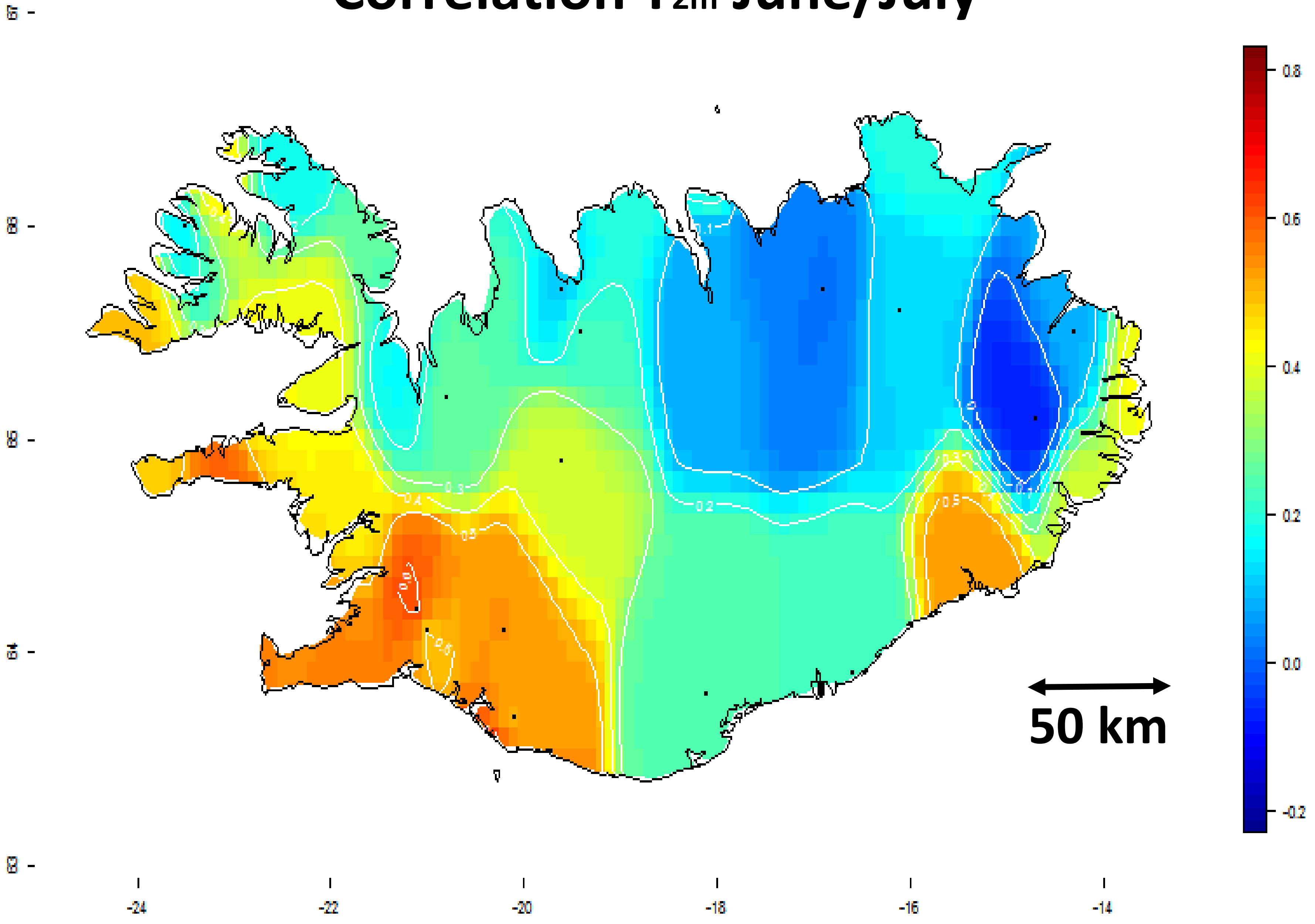


CERA_20C Reanalysis - 2m Temperature data
Correlation T2m June/July
Latitude [°]
70
60
50
40
-20
-10
0
10
20
30
40
0.8
0.6
0.4
0.2
0.0
-0.2

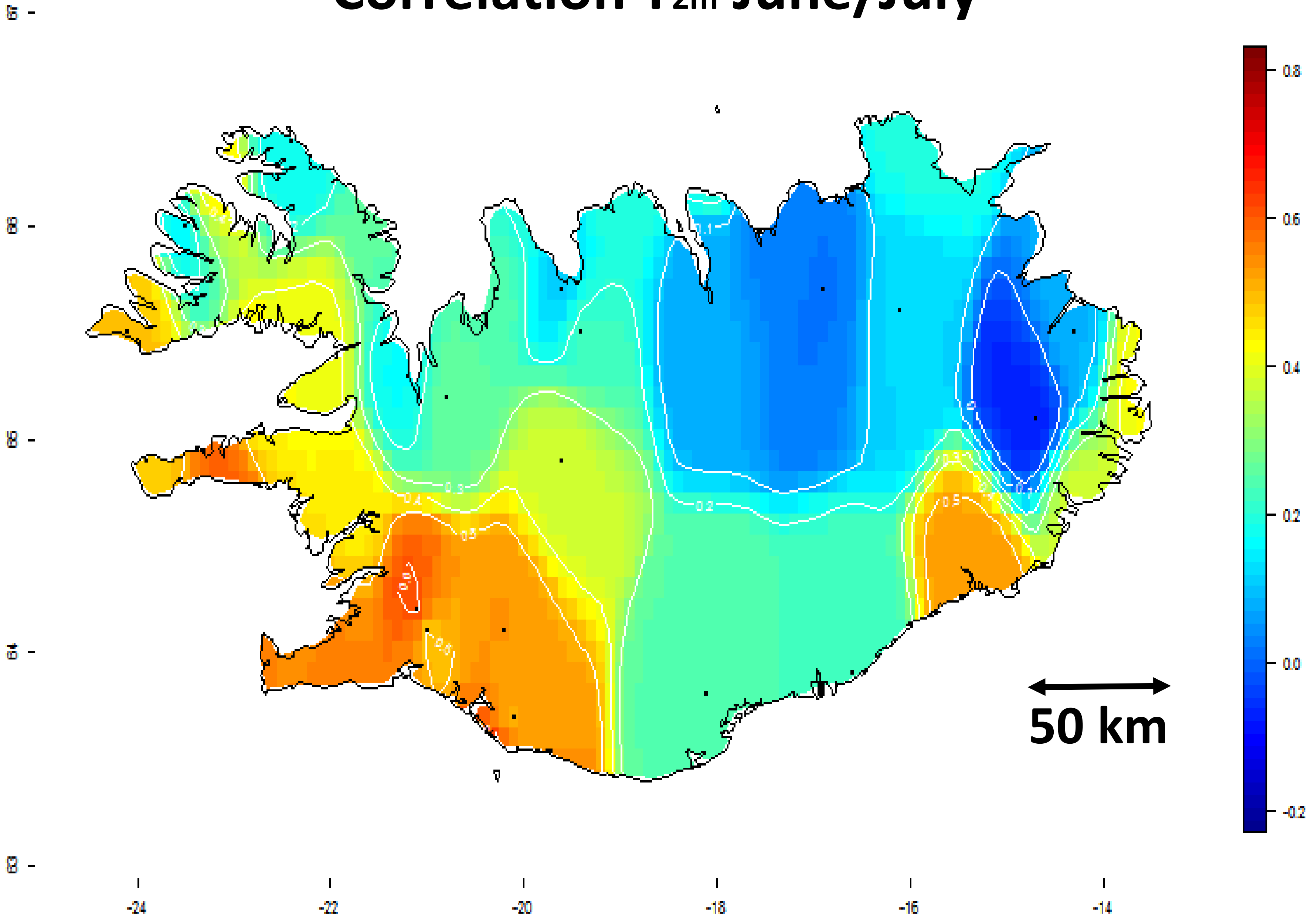


CERA_20C Reanalysis - 2m Temperature data
Correlation T2m June/July
Latitude [°]
70
60
50
40
-20
-10
0
10
20
30
40
0.8
0.6
0.4
0.2
0.0
-0.2

Correlation T_{2m} June/July

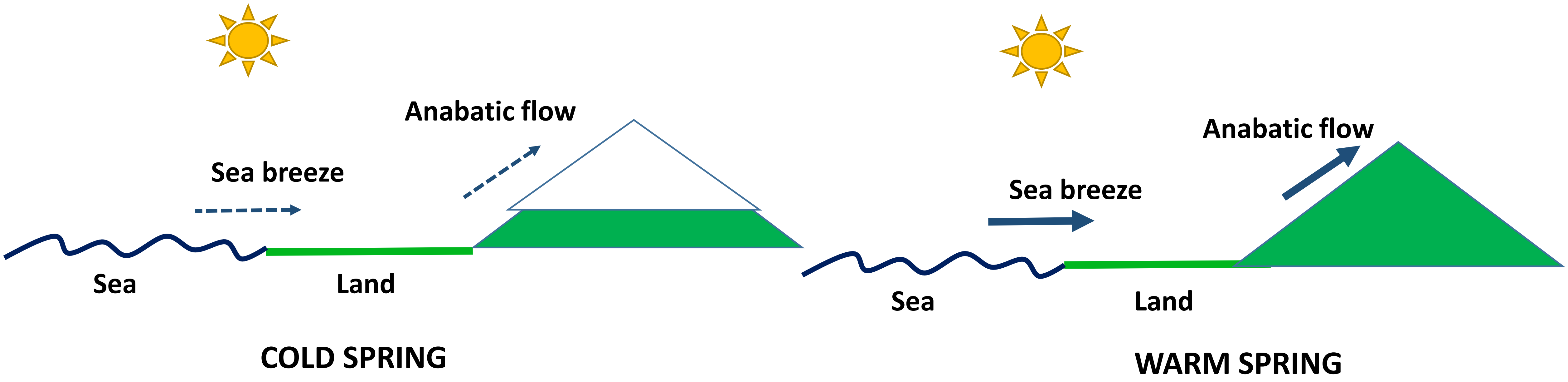



Correlation T_{2m} June/July

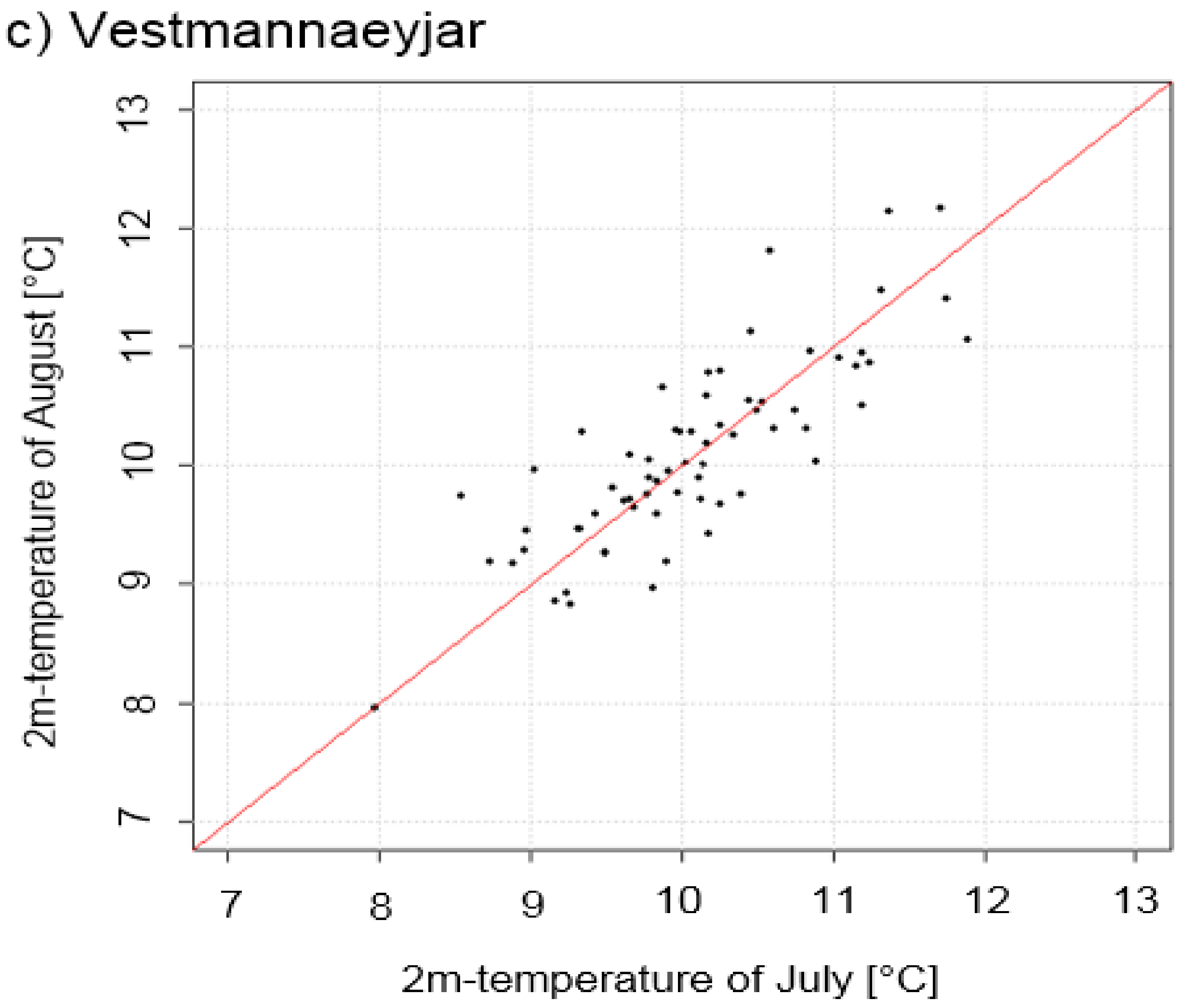


The mesoscale circulation negative feedback

How can a cold June give a warm July?



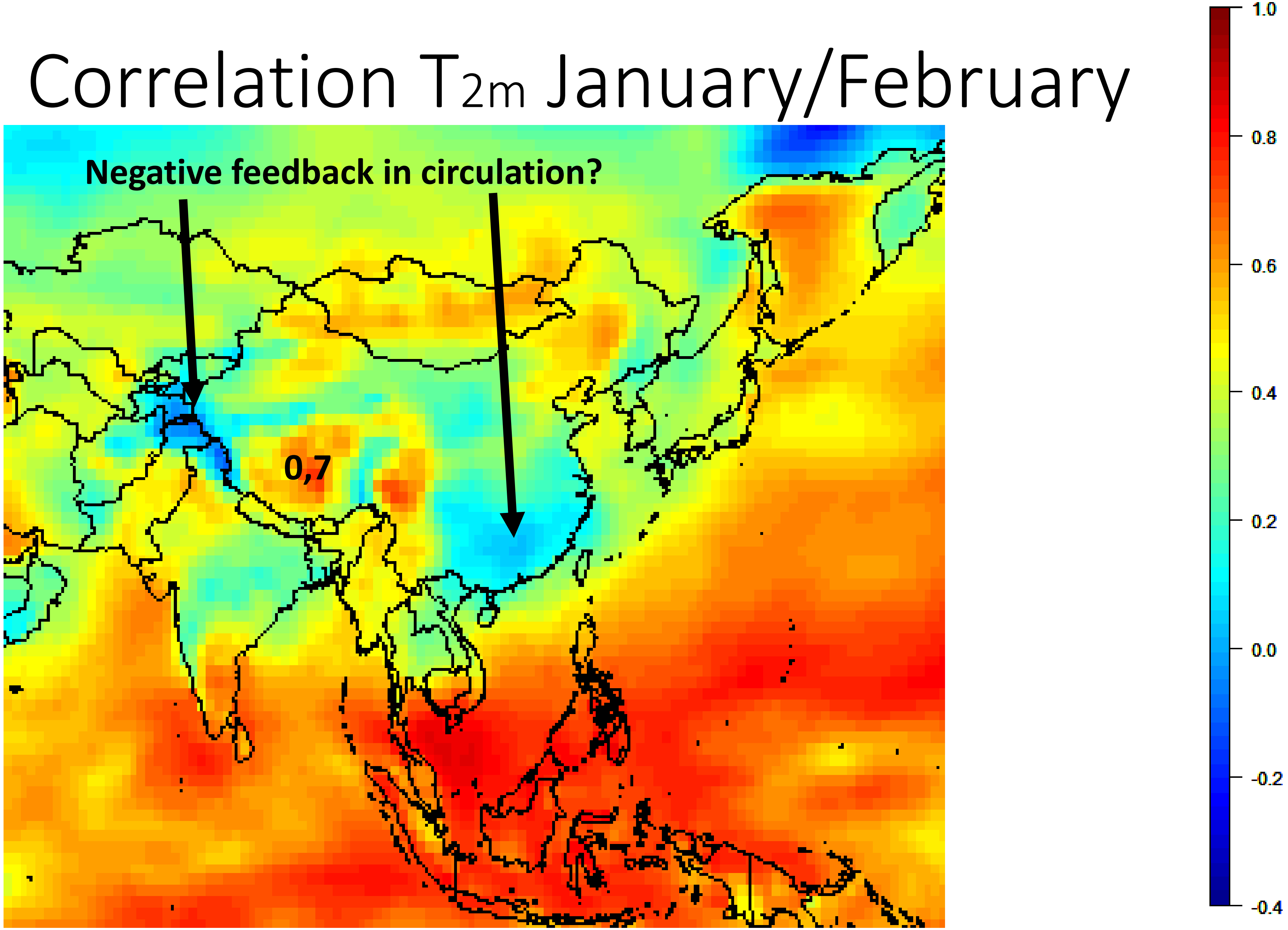
A cold spring gives much snow in the mountains, leading to weaker sea breeze and anabatic winds



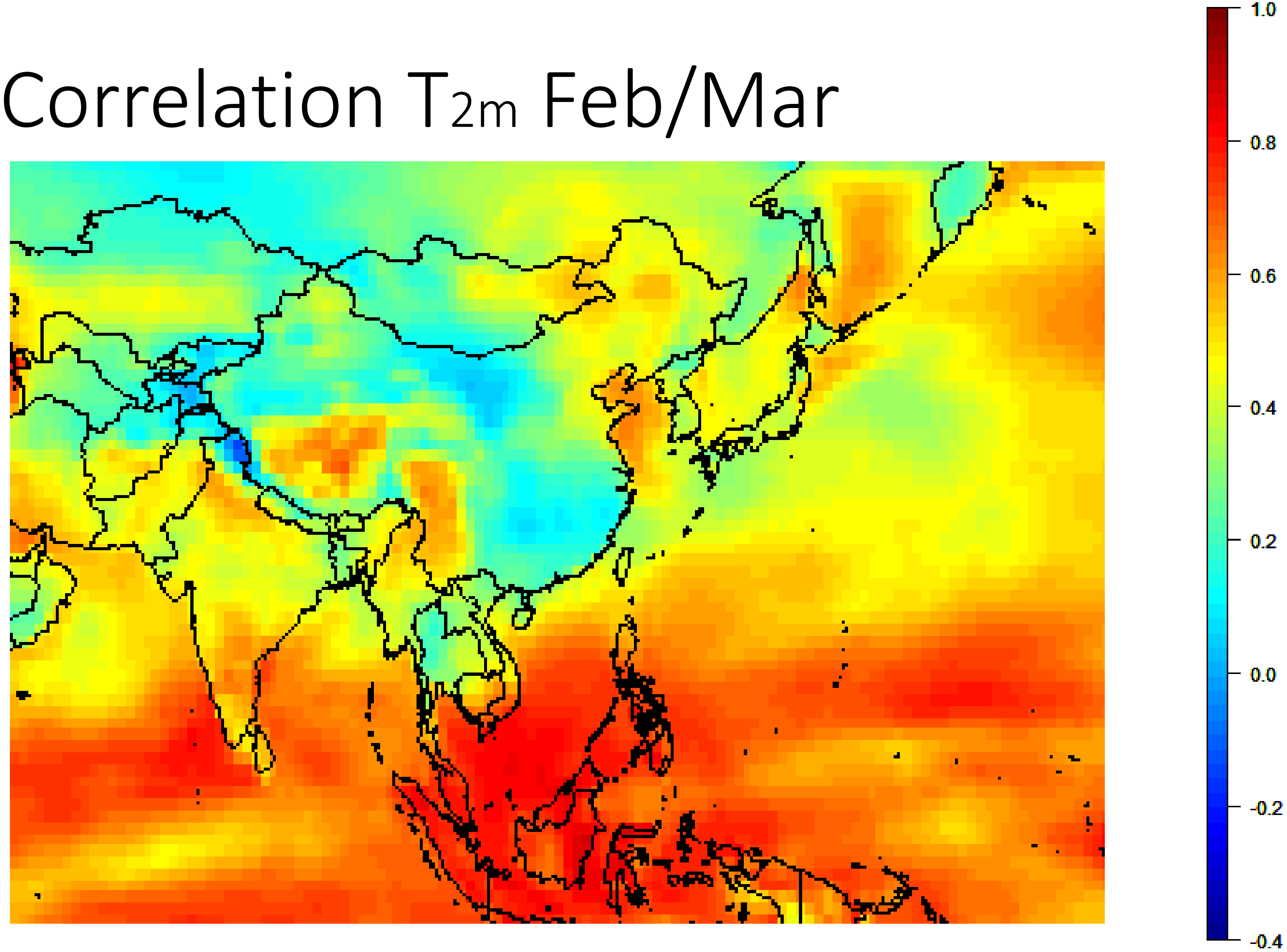
R=0,8 is very good and can be used as it is for one month forecasting of monthly mean T

However, this sub-seasonal forecast is a high-resolution task!

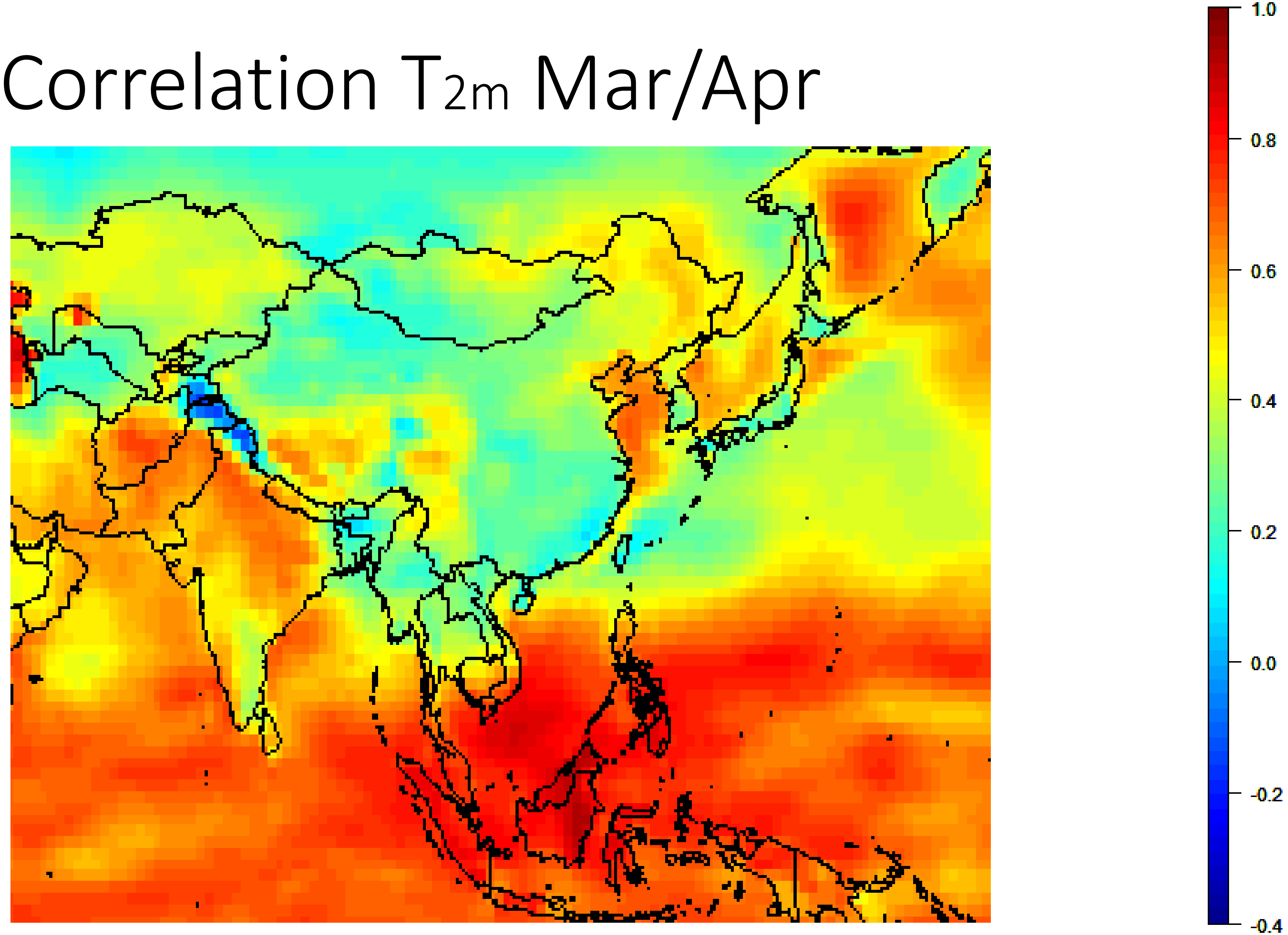
Correlation T_{2m} January/February



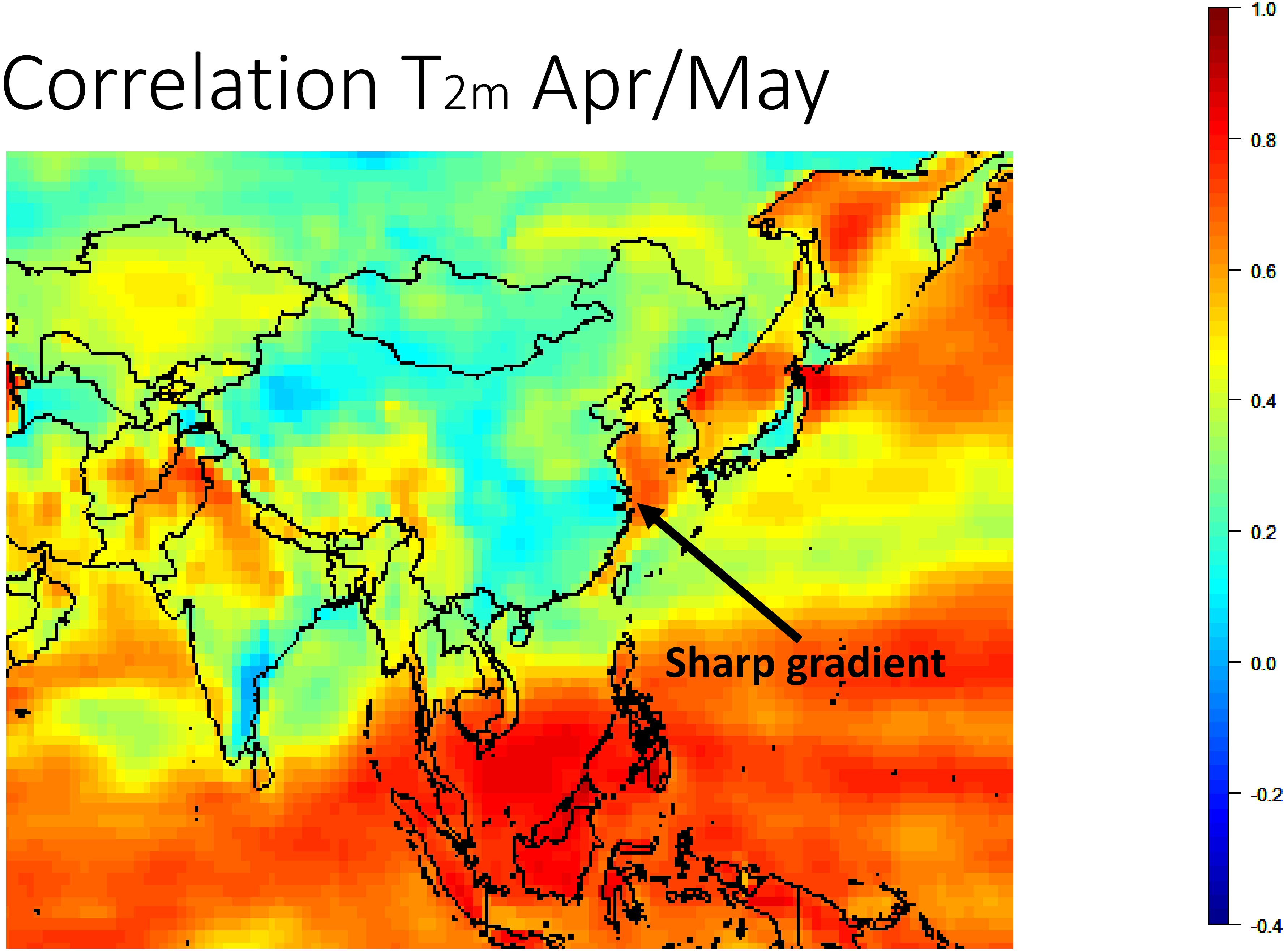
Correlation T_{2m} Feb/Mar



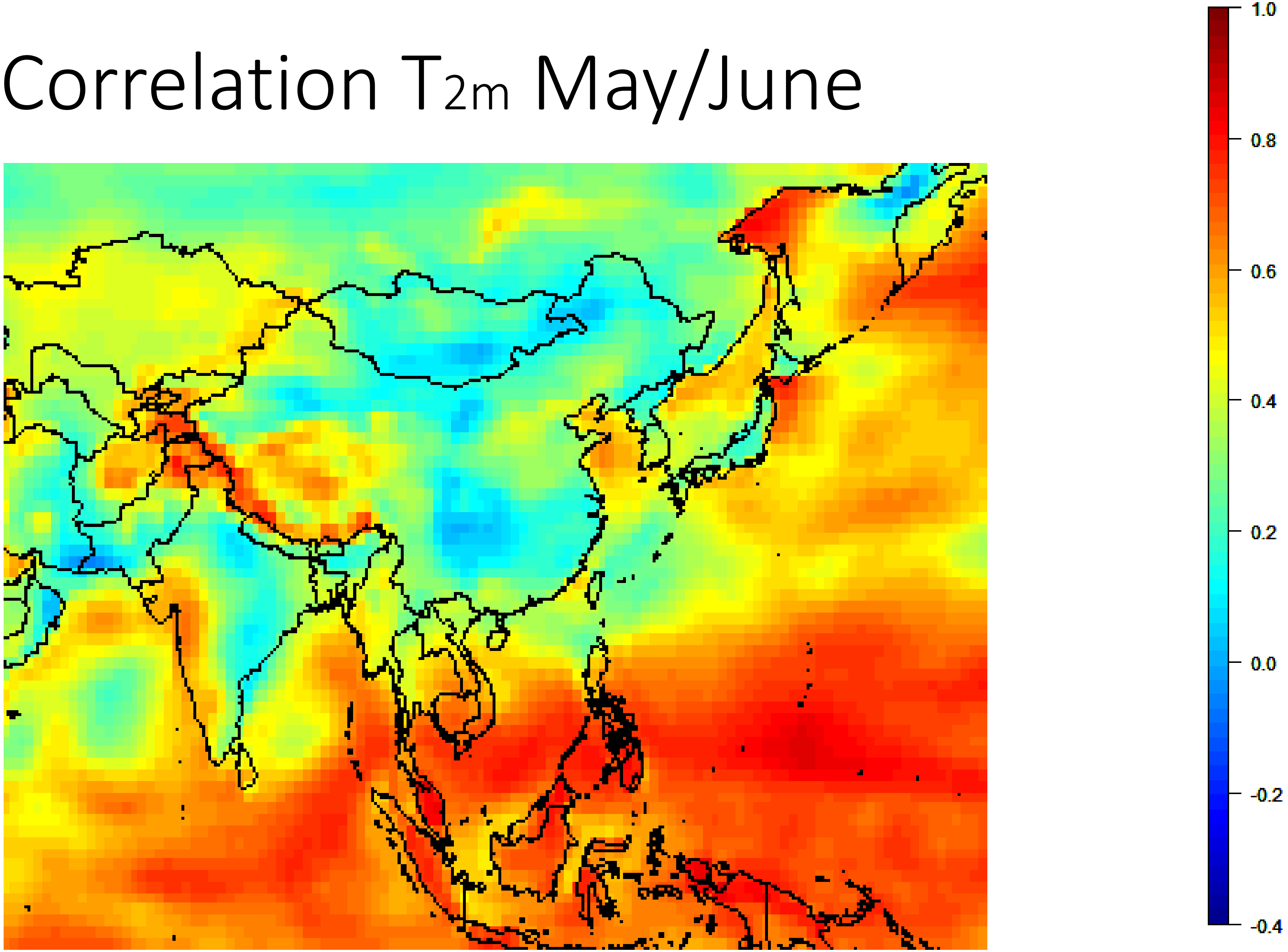
Correlation T_{2m} Mar/Apr

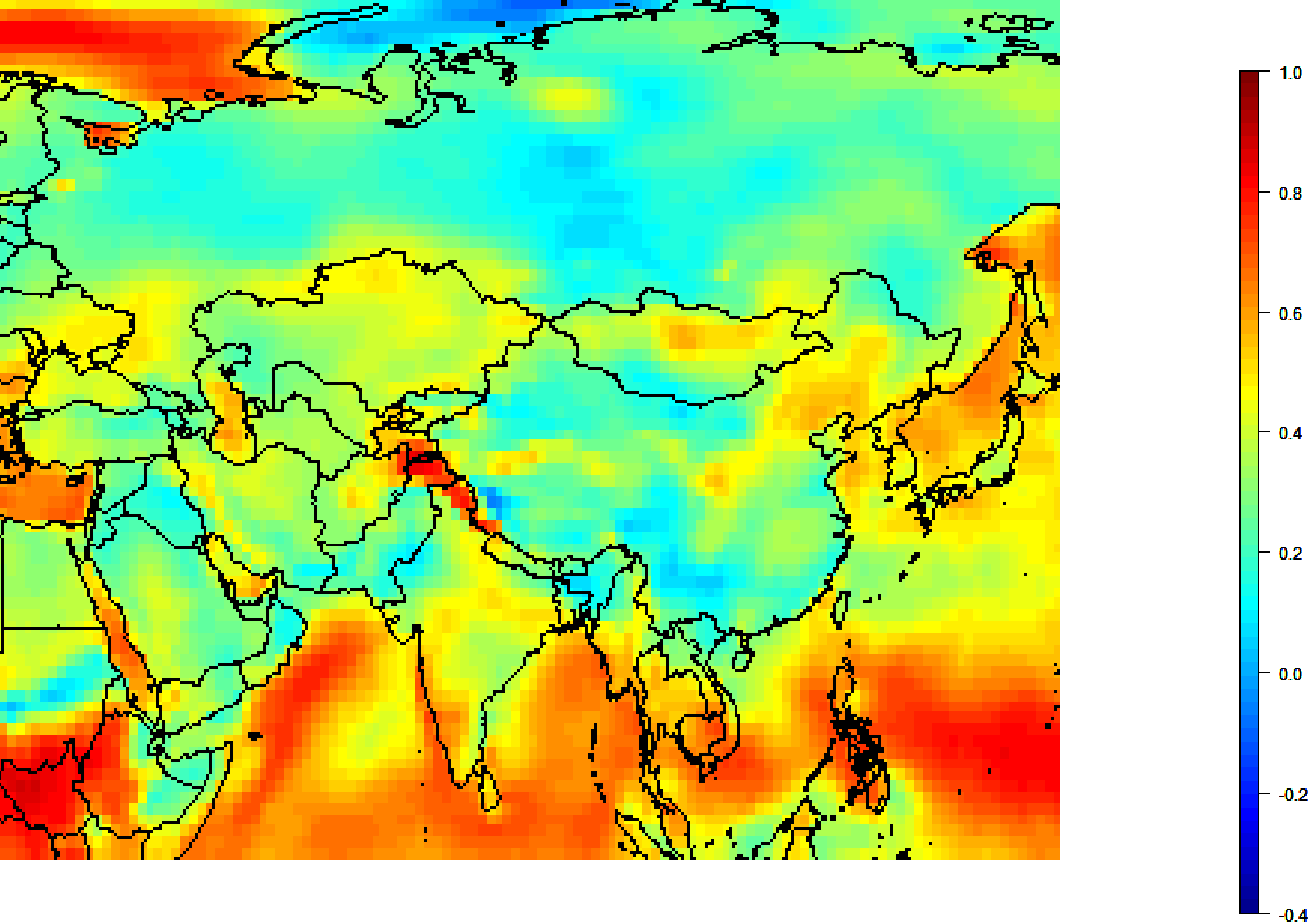


Correlation T_{2m} Apr/May

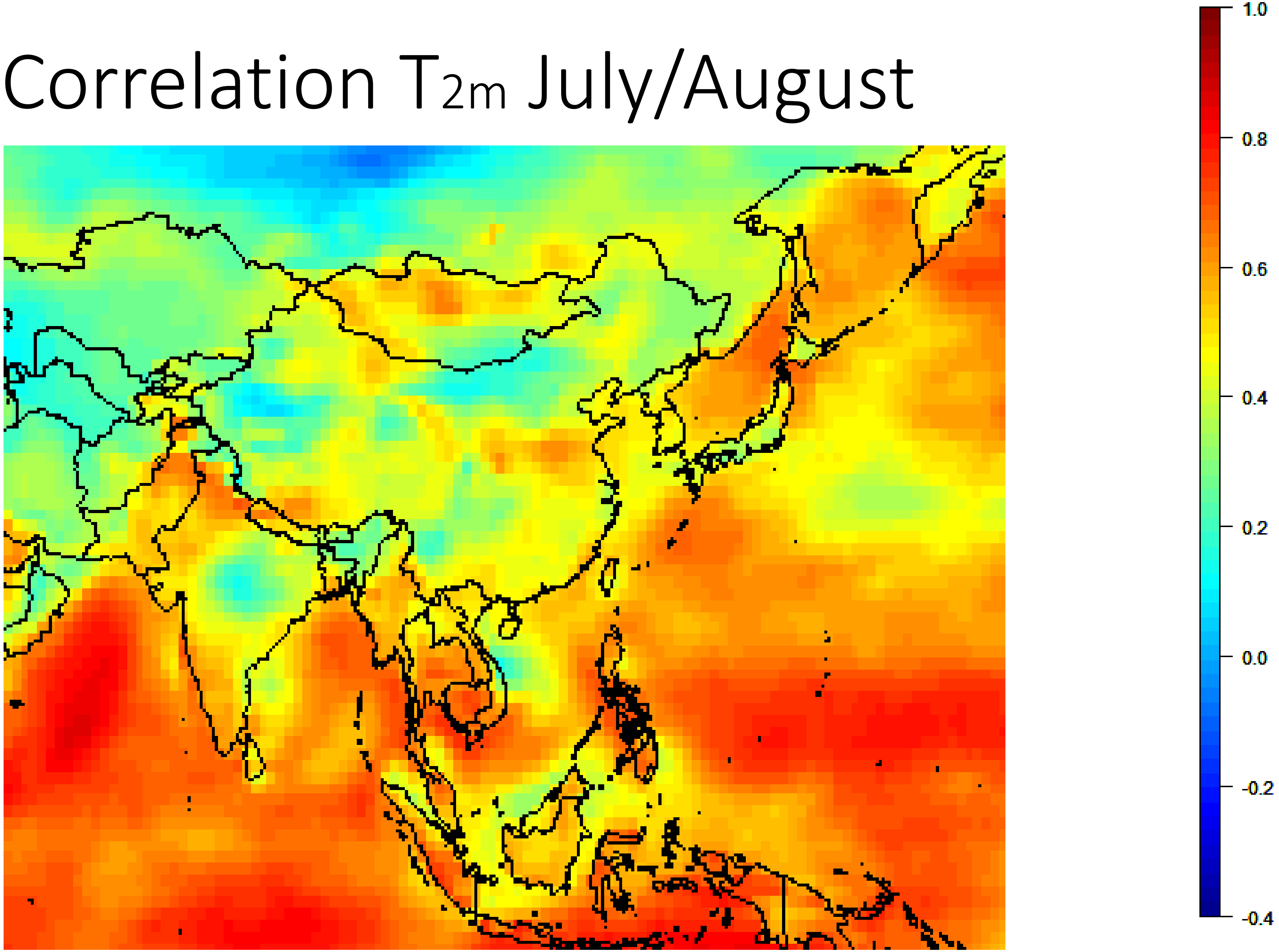


Correlation T_{2m} May/June

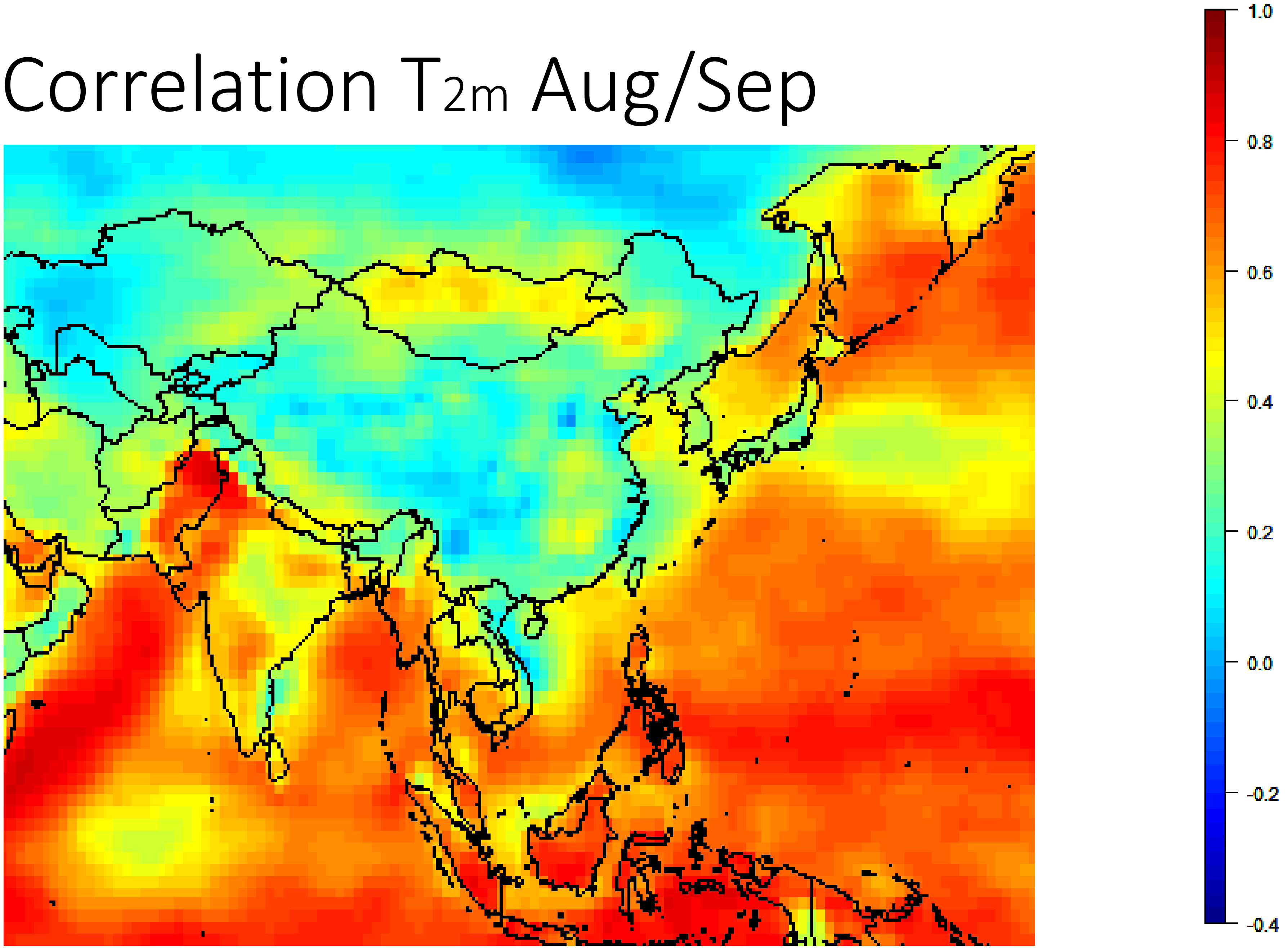



1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4

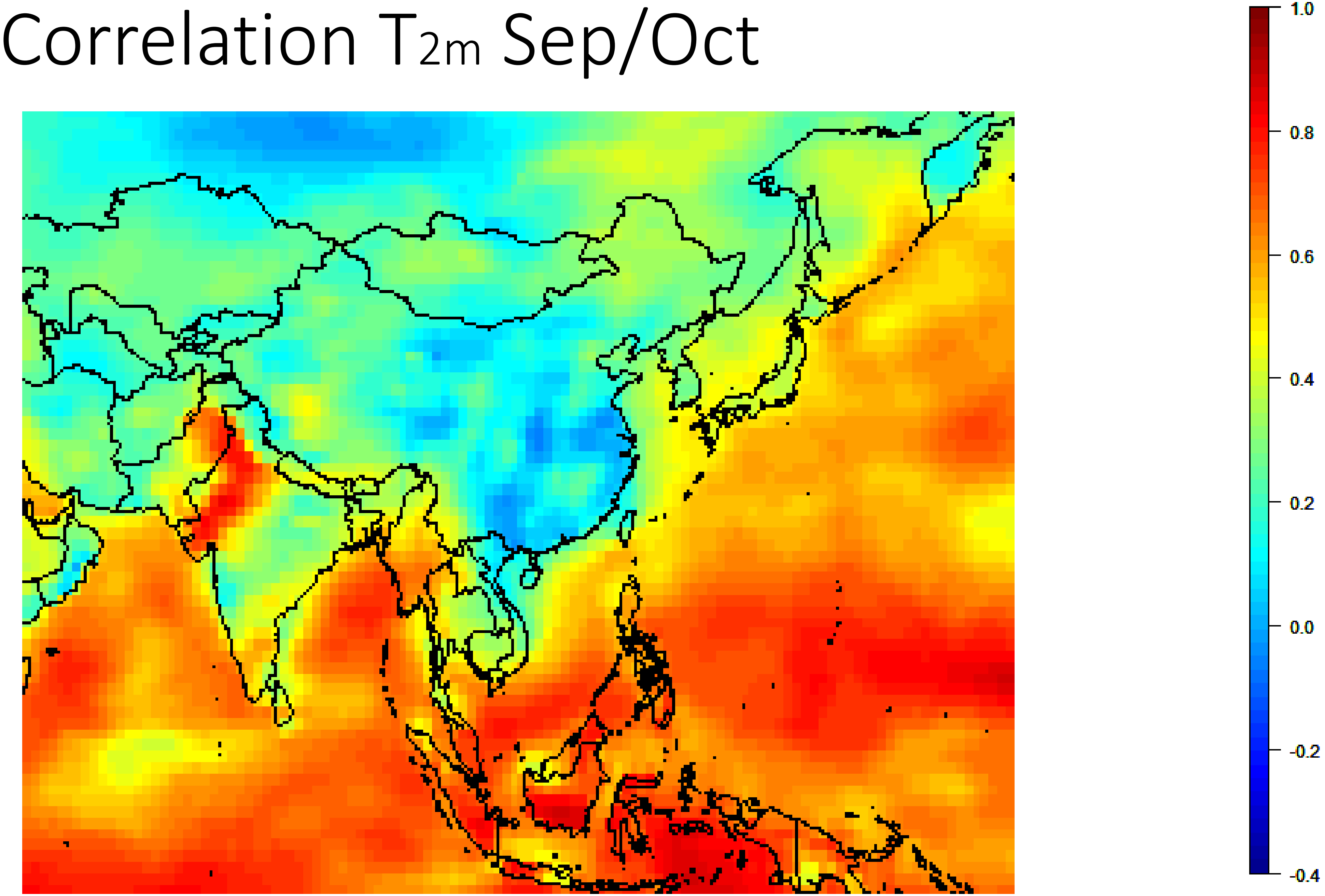
Correlation T_{2m} July/August



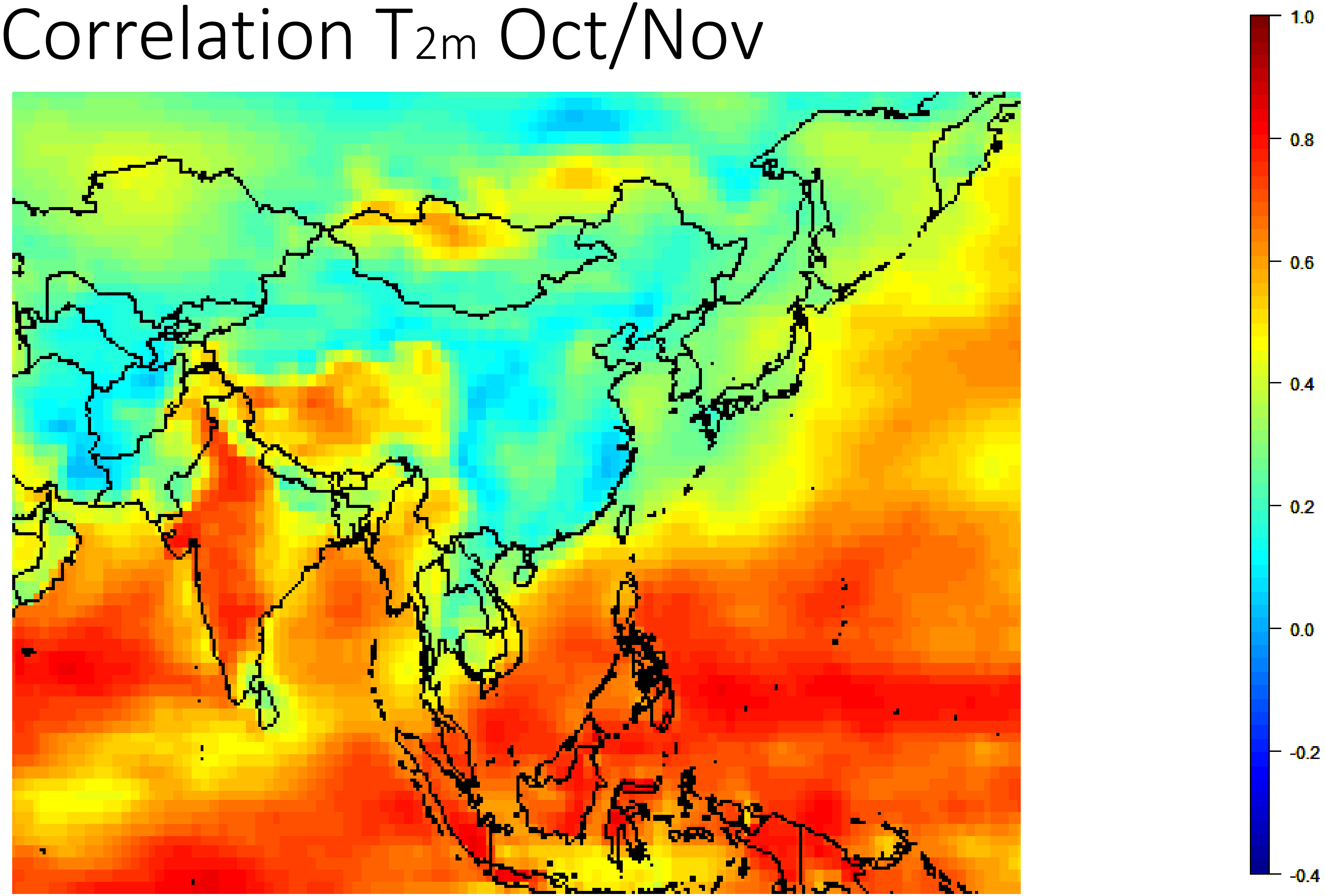
Correlation T_{2m} Aug/Sep



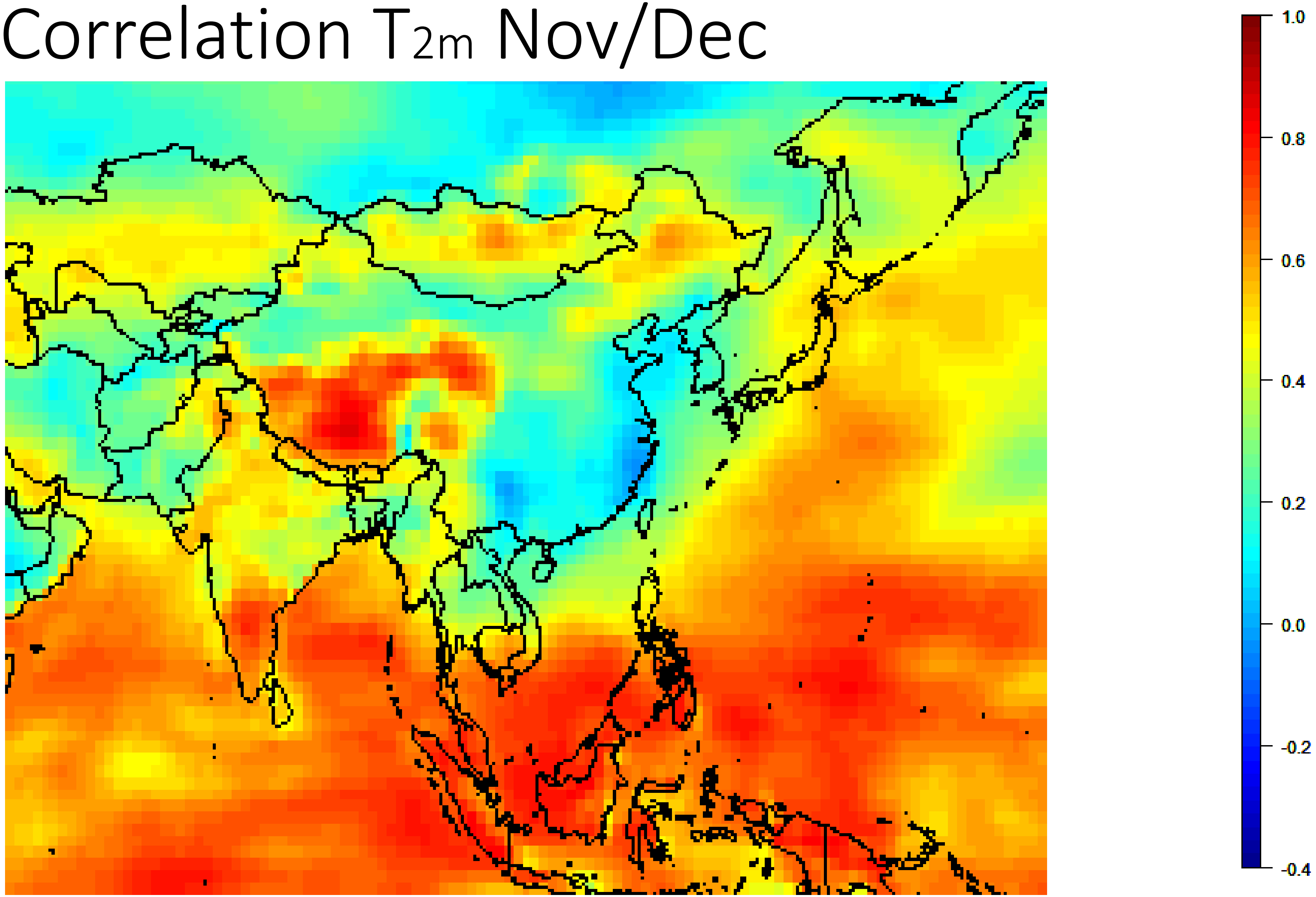
Correlation T_{2m} Sep/Oct



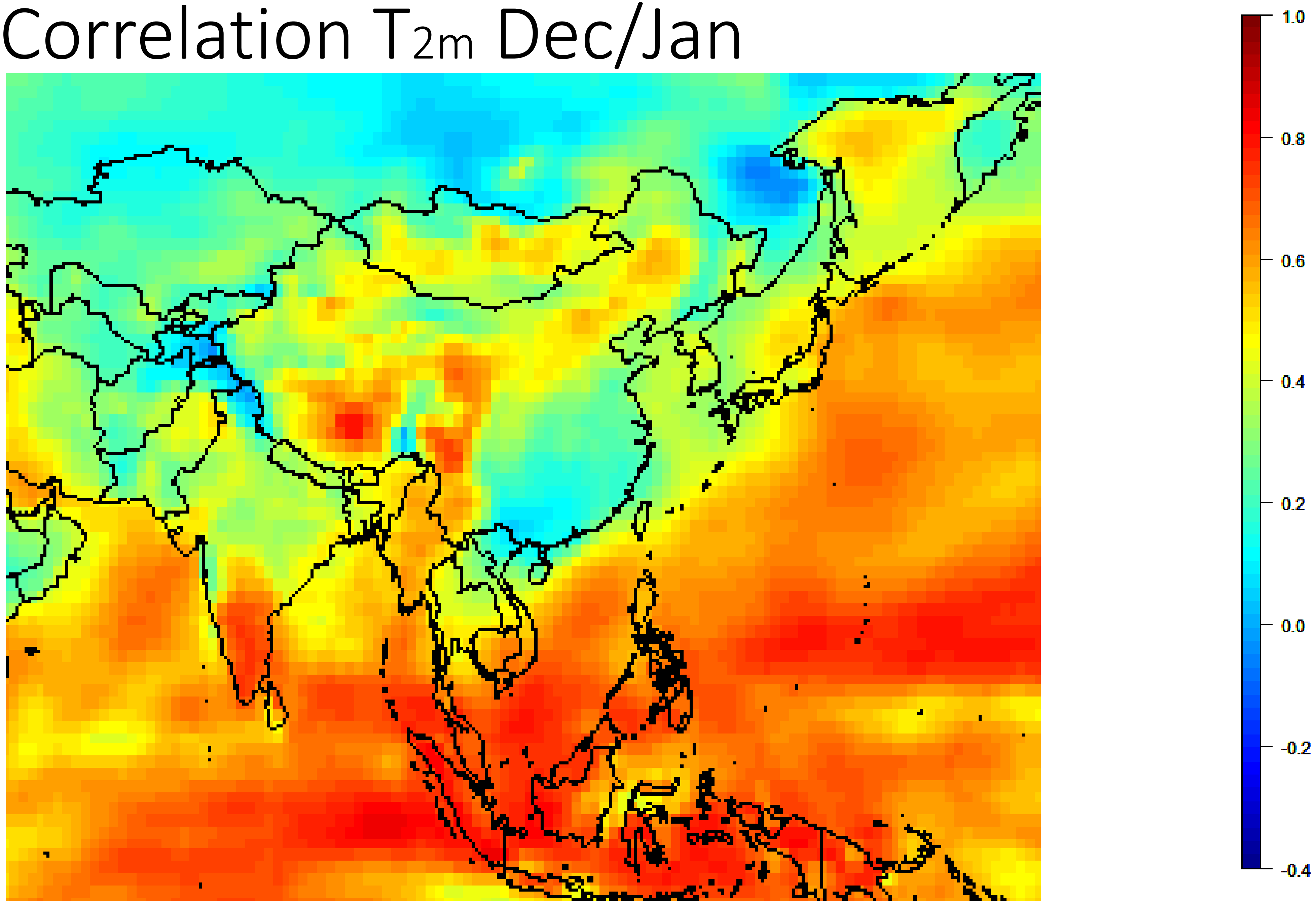
Correlation T_{2m} Oct/Nov



Correlation T_{2m} Nov/Dec

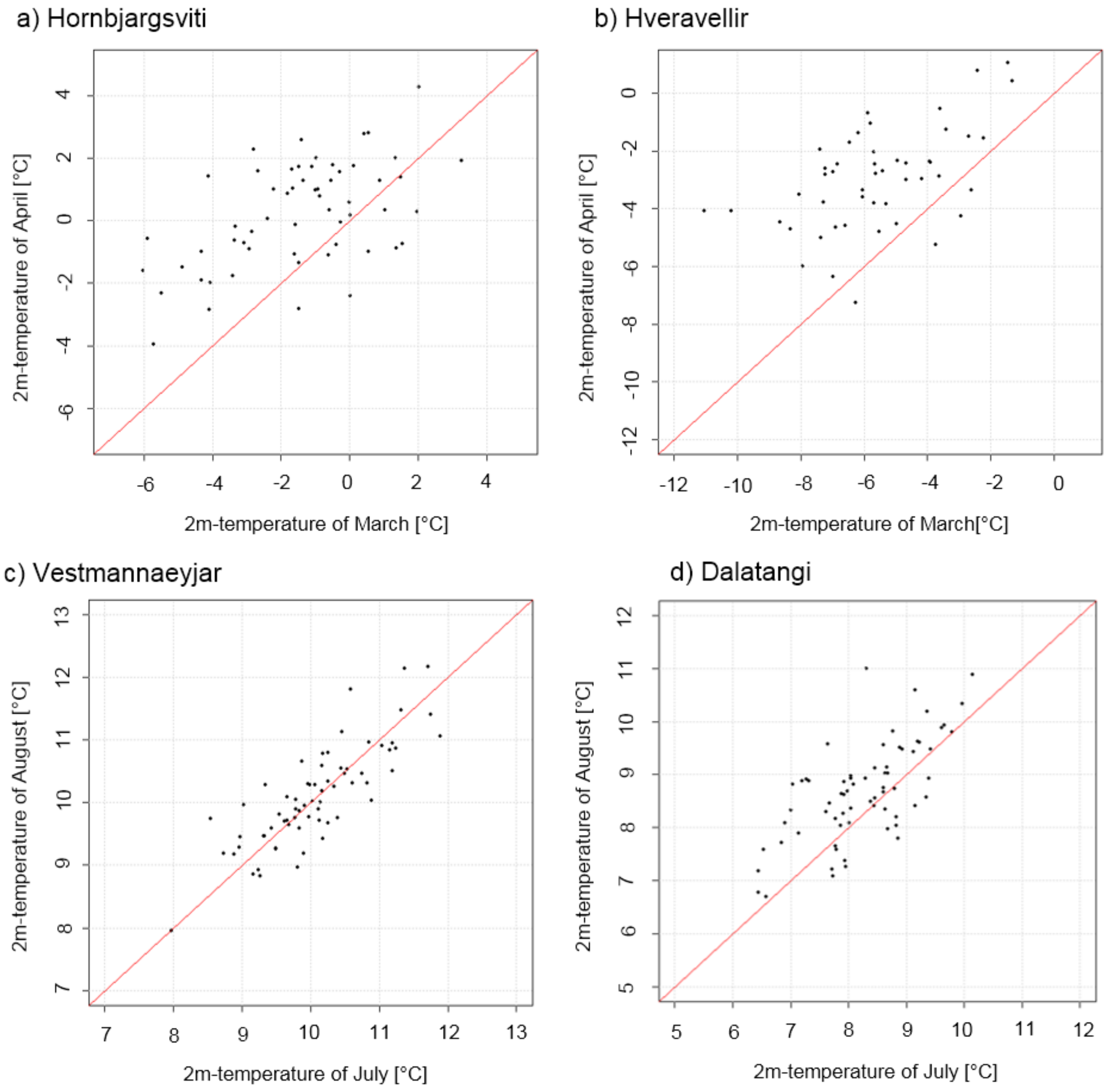


Correlation T_{2m} Dec/Jan

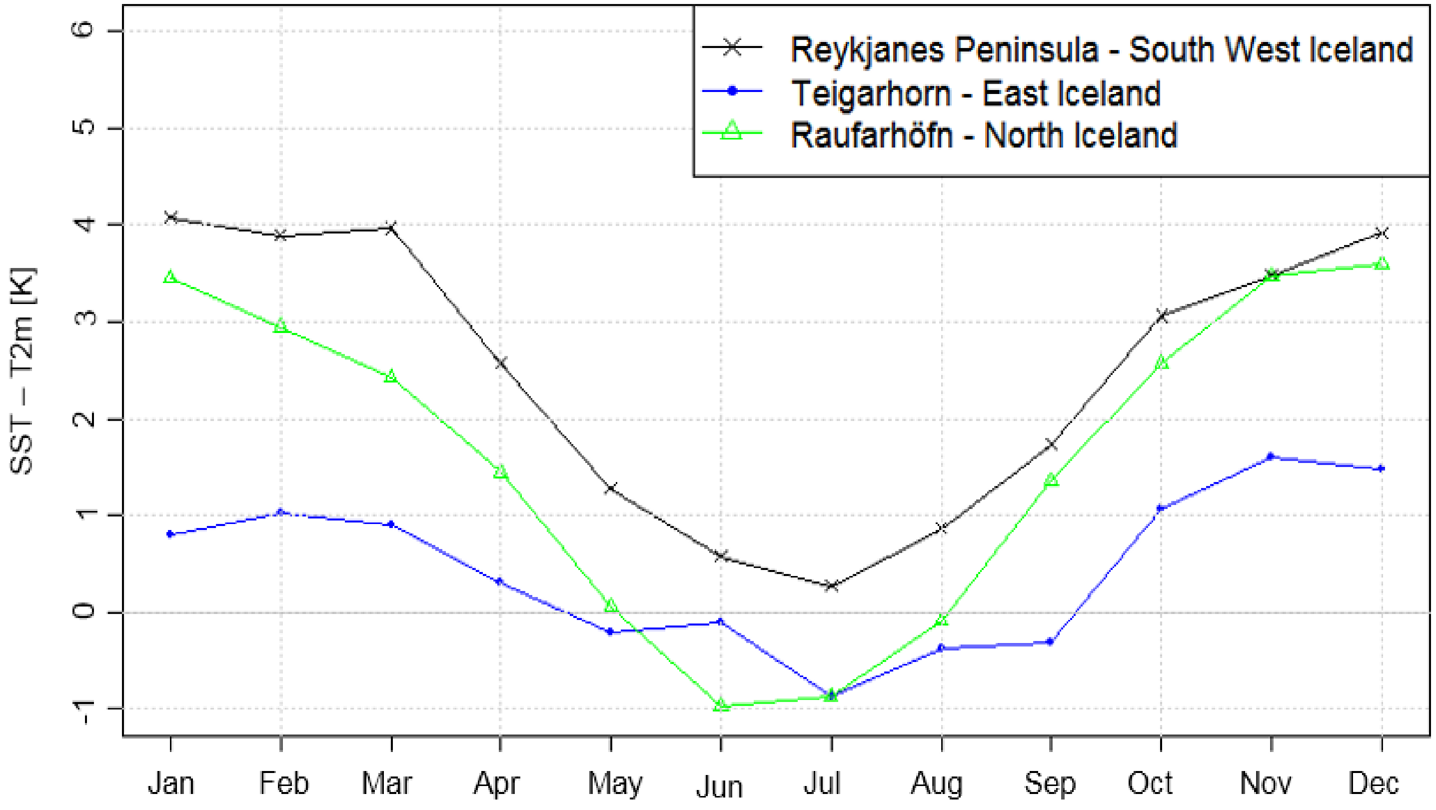


Some key points

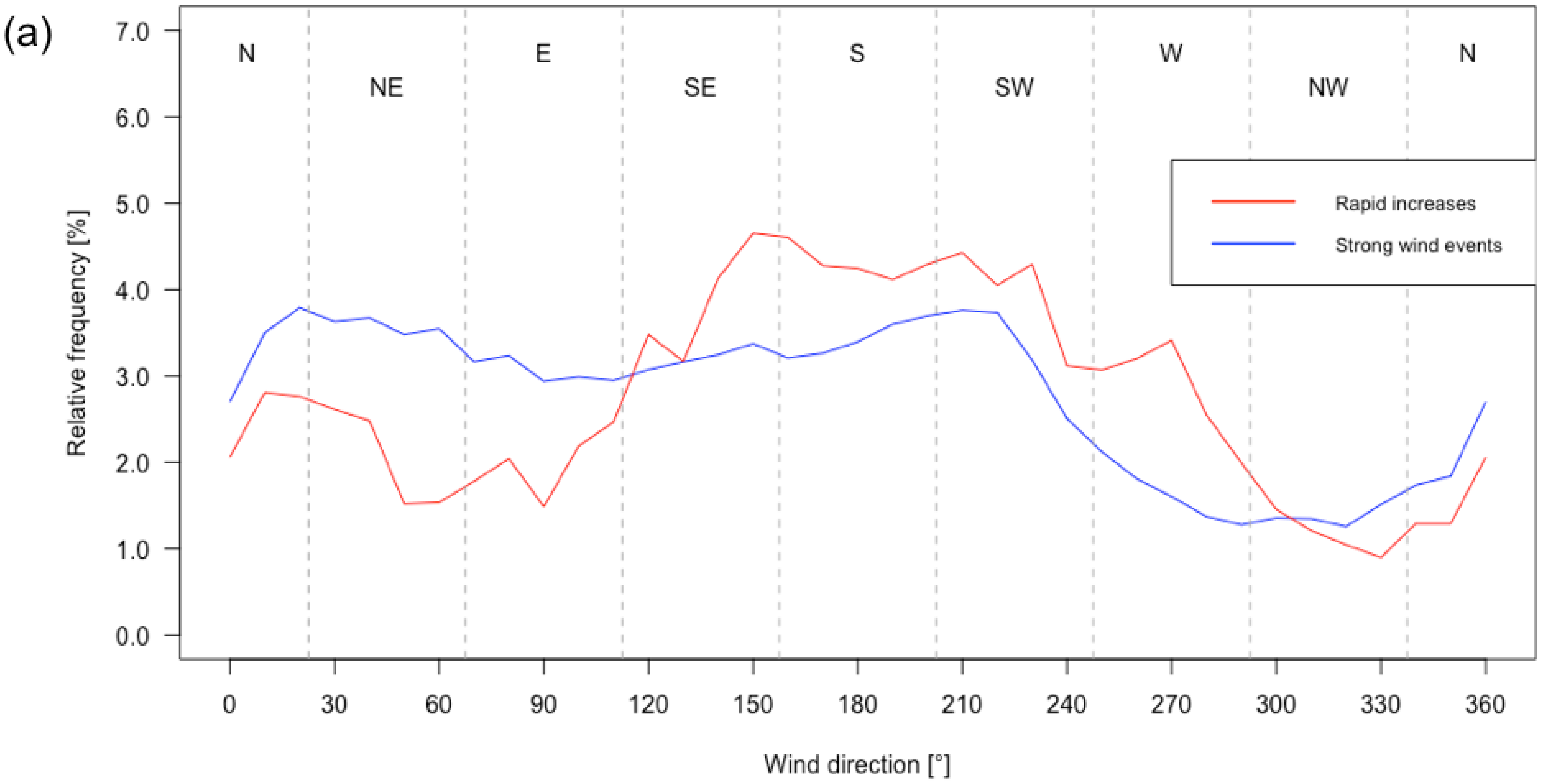
- Sub-seasonal forecasting is a high-resolution issue
- Rapid increase in surface winds are associated with surface conditions and processes that are small-scale of nature. The NWP models struggle with these rapid changes.
- The data indicates that accurate and high-resolution representation of the surface is very important, not only for temperature, but also on the winds through the impact of the surface on static stability of the lowest part of the atmosphere



a) Hornbjargsviti
2m-temperature of April [°C]
2m-temperature of March [°C]
b) Hveravellir
2m-temperature of April [°C]
2m-temperature of March[°C]
c) Vestmannaeyjar
2m-temperature of August [°C]
2m-temperature of July [°C]
d) Dalatangi
2m-temperature of August [°C]
2m-temperature of July [°C]

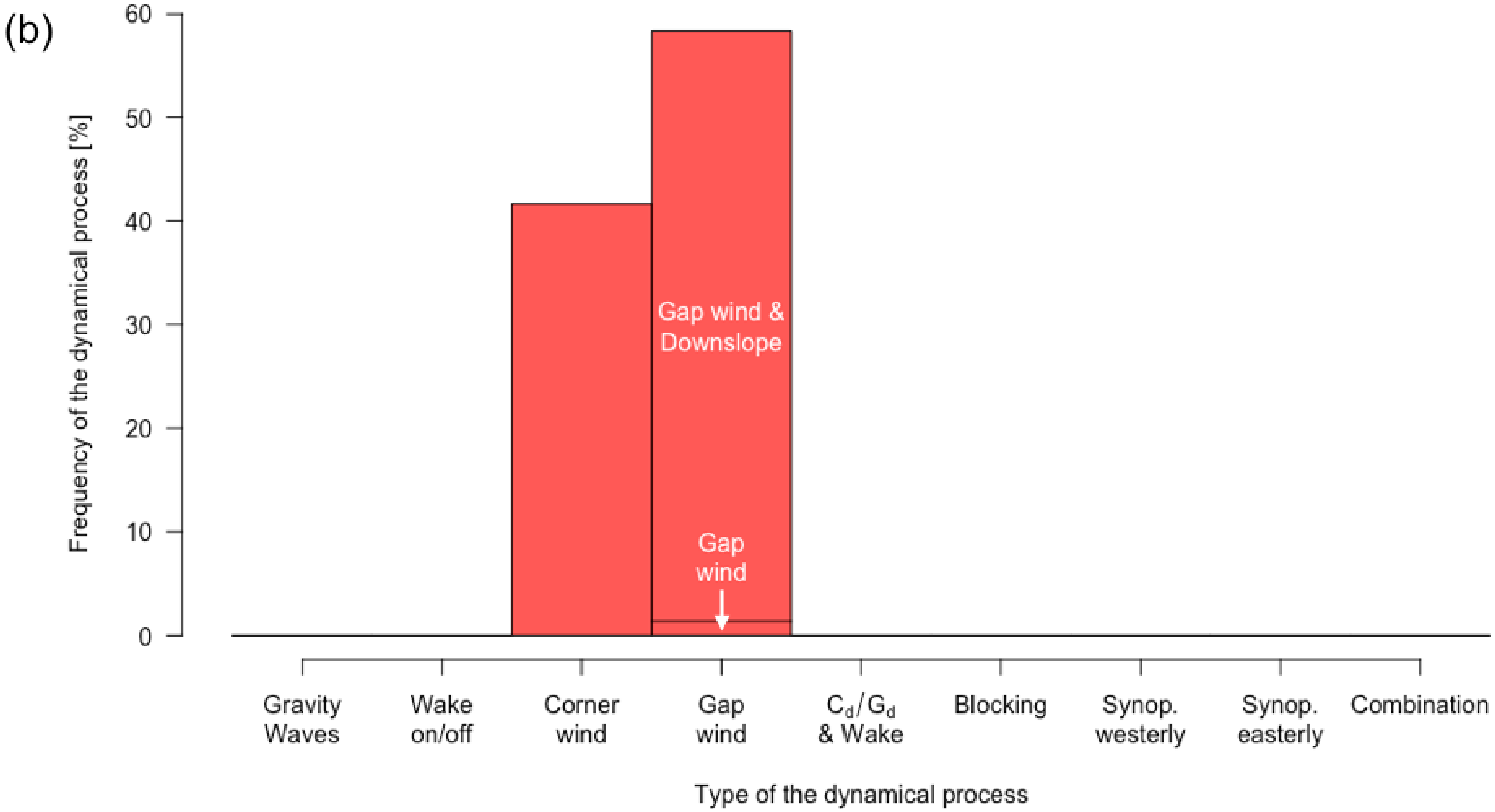


Reykjanes Peninsula - South West Iceland
Teigarhorn - East Iceland
Raufarhöfn - North Iceland
SST – T2m [K]
6
5
4
3
2
1
0
-1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



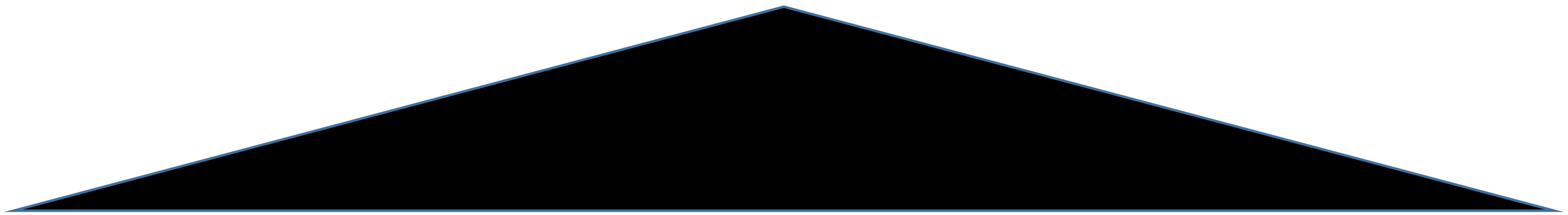
(a)
N
NE
E
SE
S
SW
W
NW
N
Rapid increases
Strong wind events
Relative frequency [%]
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
30
60
90
120
150
180
210
240
270
300
330
360
Wind direction [°]

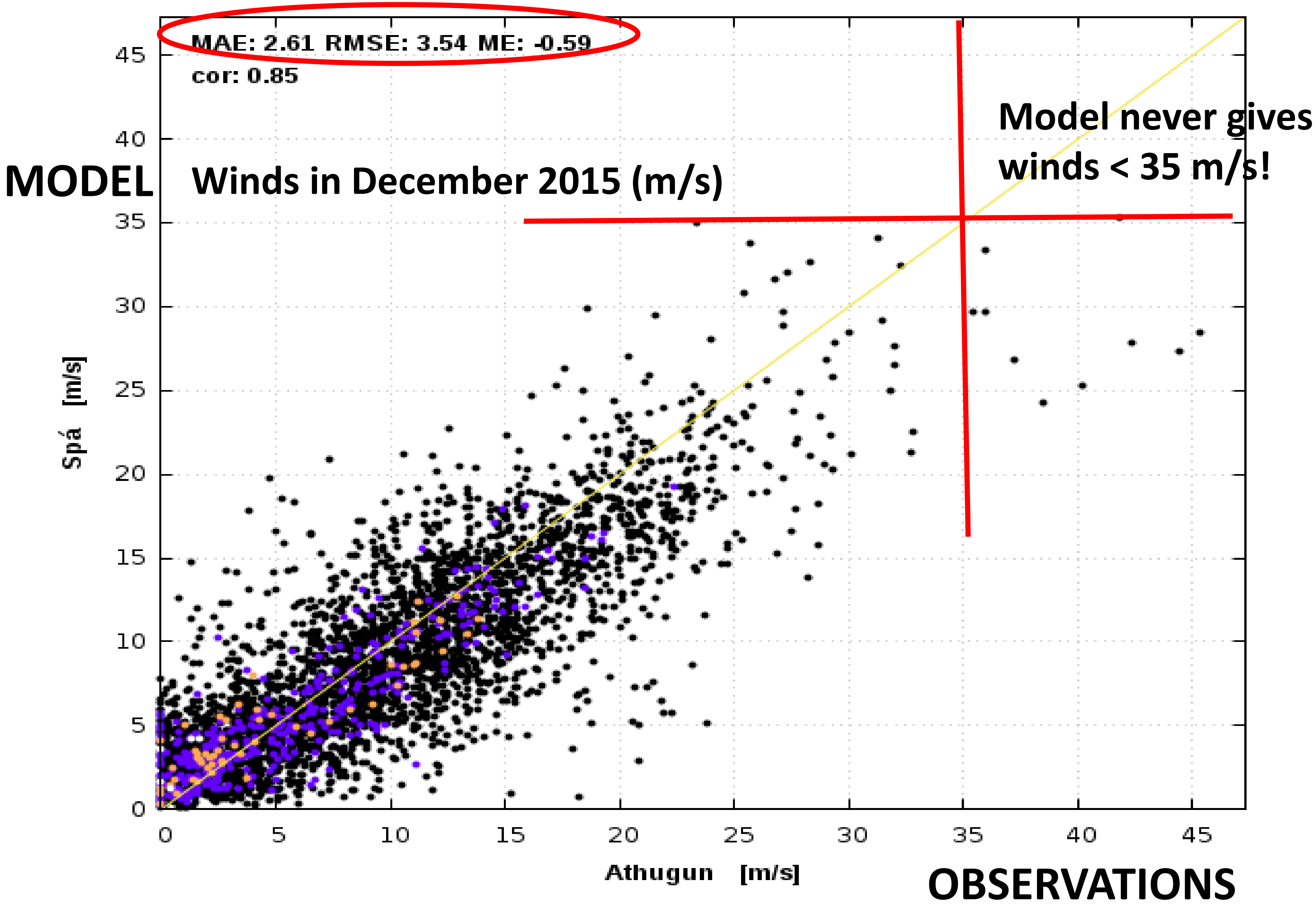
Type of the dynamical process

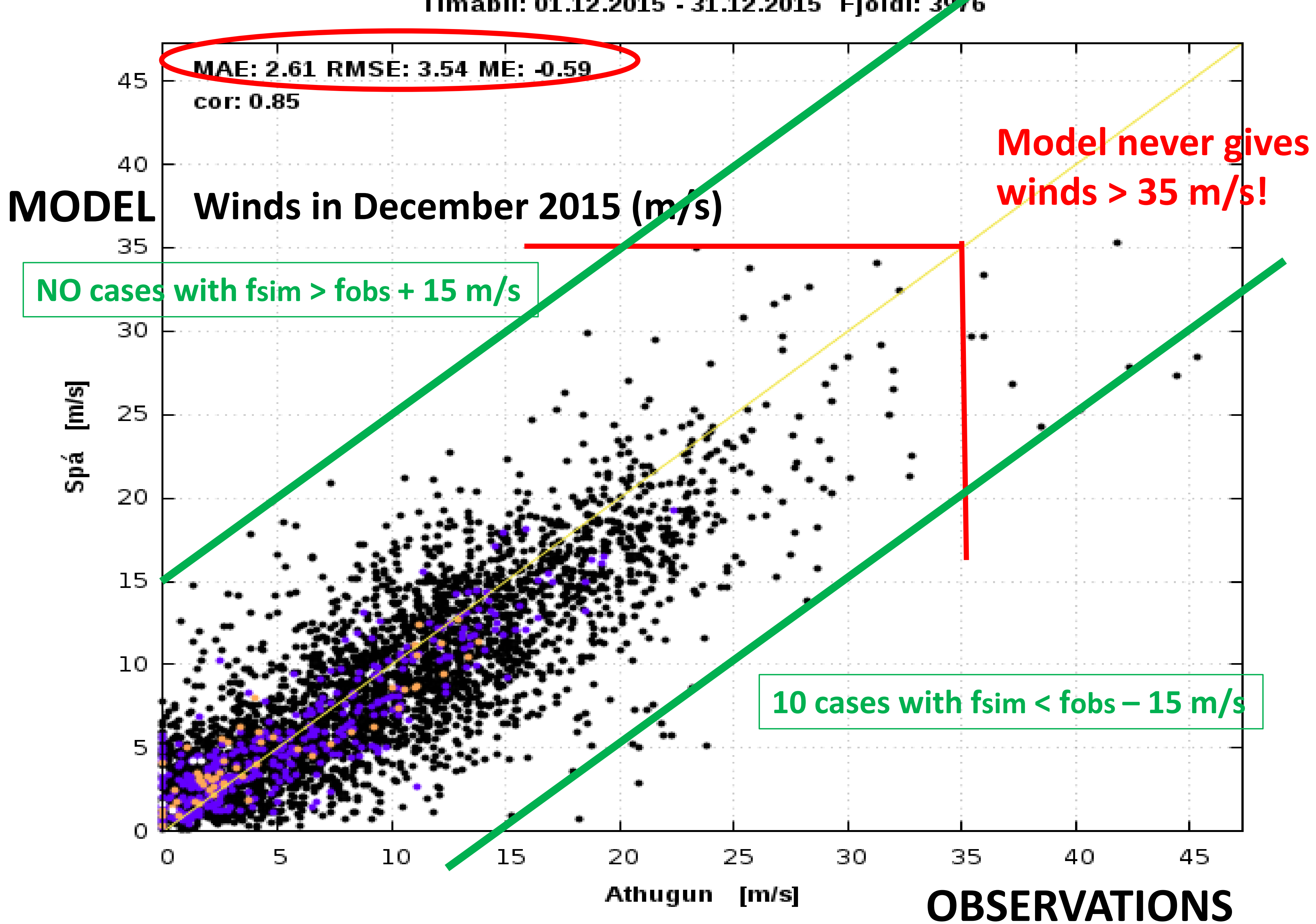


The mesoscale circulation negative feedback

How can a cold June give a warm July?




MAE: 2.61 RMSE: 3.54 ME: -0.59
cor: 0.85
MODEL
Winds in December 2015 (m/s)
Model never gives
winds < 35 m/s!
Spá [m/s]
Athugun [m/s]
OBSERVATIONS
0
5
10
15
20
25
30
35
40
45



Tímabil: 01.12.2015 - 31.12.2015 Fjöldi: 3976
MAE: 2.61 RMSE: 3.54 ME: -0.59
cor: 0.85
MODEL
Winds in December 2015 (m/s)
Model never gives
winds > 35 m/s!
NO cases with fsim > fobs + 15 m/s
10 cases with fsim < fobs – 15 m/s
Spá [m/s]
Athugun [m/s]
OBSERVATIONS

More about verifiation

Haraldur Ólafsson

With contribution from WRF user (Fowler/Jensen/Brown), Ó. Rögnvaldsson & H. Ágústsson

Why do we verify?

Assessment of the quality of the system for user purpose

Tool to improve the system

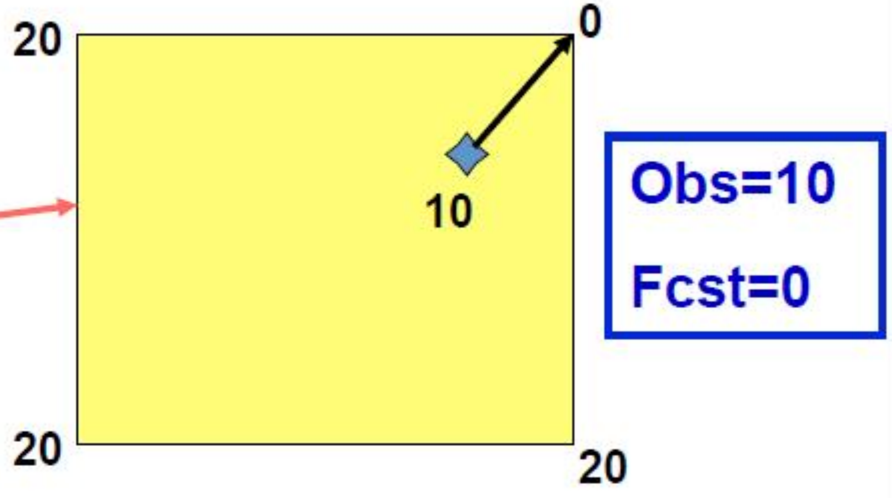
Matching forecasts and observations

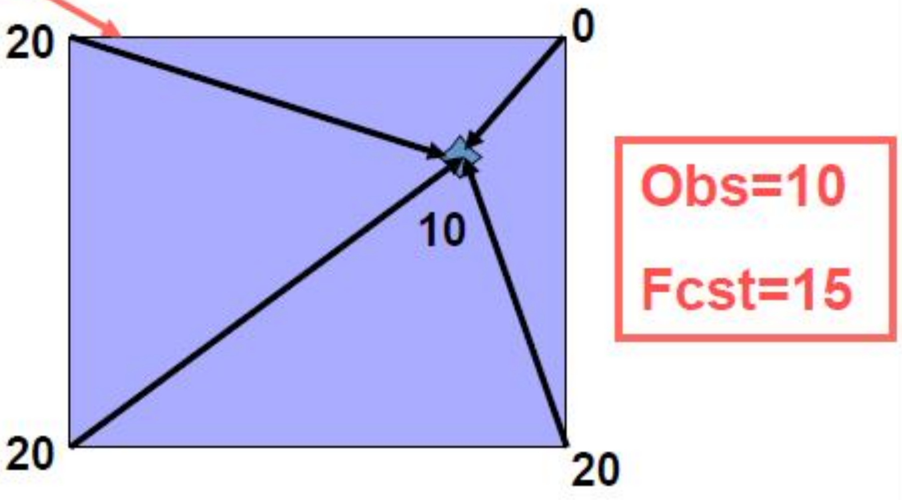
Example:

- Two approaches:
  - Match rain gauge to nearest gridpoint ***or***
  - Interpolate grid values to rain gauge location
    - Crude assumption: equal weight to each gridpoint
- Differences in results associated with matching:

"Representativeness" difference

Will impact most verification scores





$$\mathrm{MAE} = \frac{1}{n}\sum_{j=1}^{n}|y_j - \hat{y}_j|$$

Mean absolute error

$$\mathrm{RMSE} = \sqrt{\frac{1}{n}\sum_{j=1}^{n}(y_j - \hat{y}_j)^2}$$

Root mean square error

$$\mathrm{bias} = \frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)}{n}$$

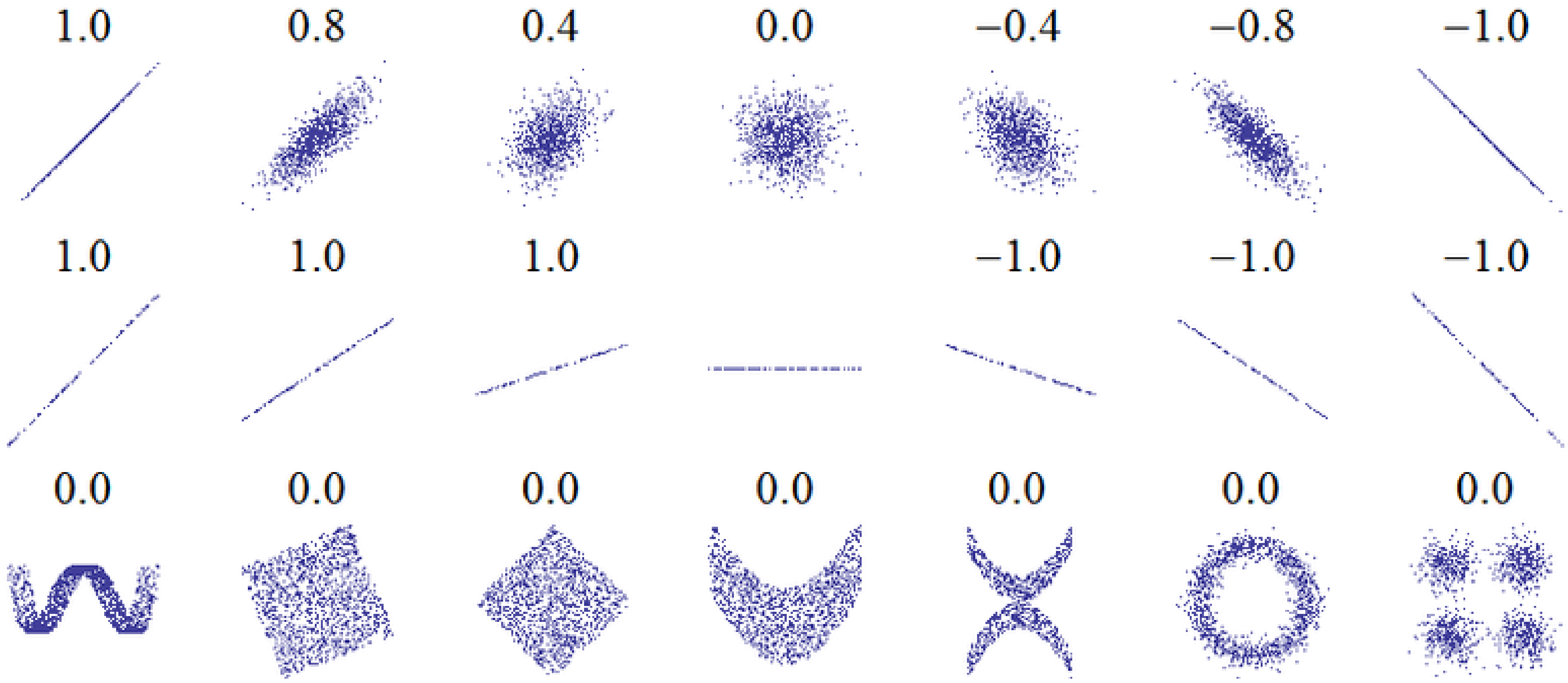
Bias

$$BS = \frac{1}{N}\sum_{t=1}^{N}(f_t - o_t)^2$$

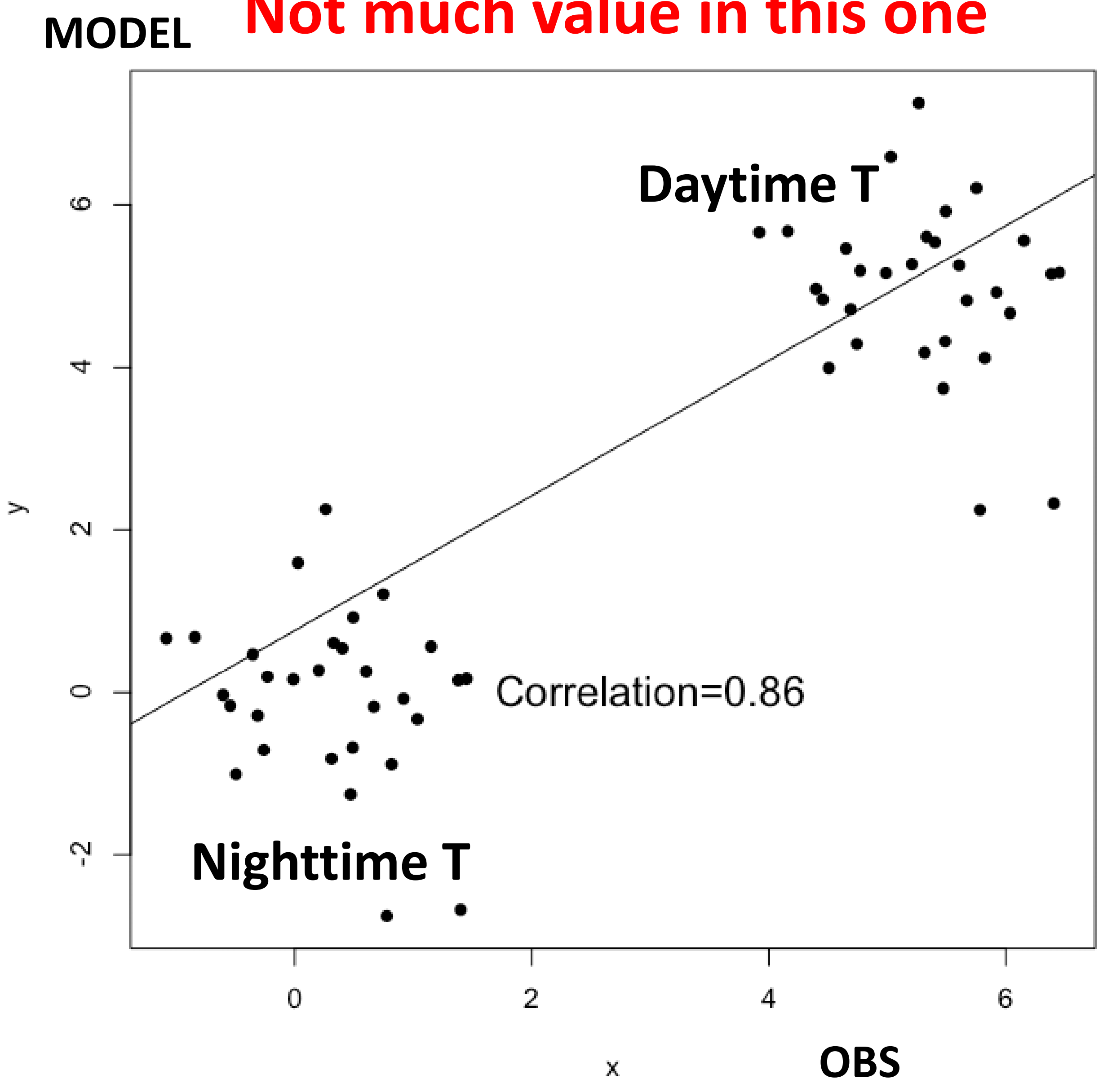
Brier score

Correlation coefficient

$$r_{fx} = \frac{\sum_{i=1}^{n}(f_i - \bar{f})(x_i - \bar{x})}{(n-1)s_f s_x}$$



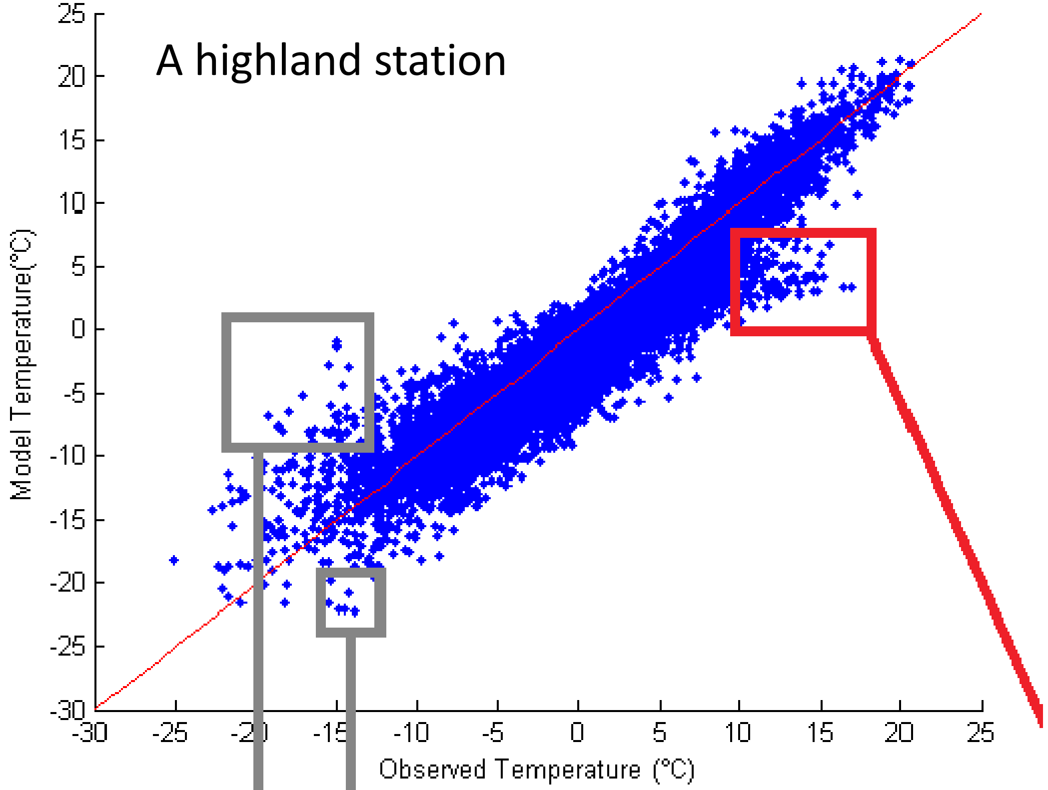
Not much value in this one



$$r_{fx} = \frac{\sum_{i=1}^{n}(f_i - \overline{f})(x_i - \overline{x})}{(n-1)s_f s_x}$$

Isolate errors in time and space and weather parameter space

Simulated T

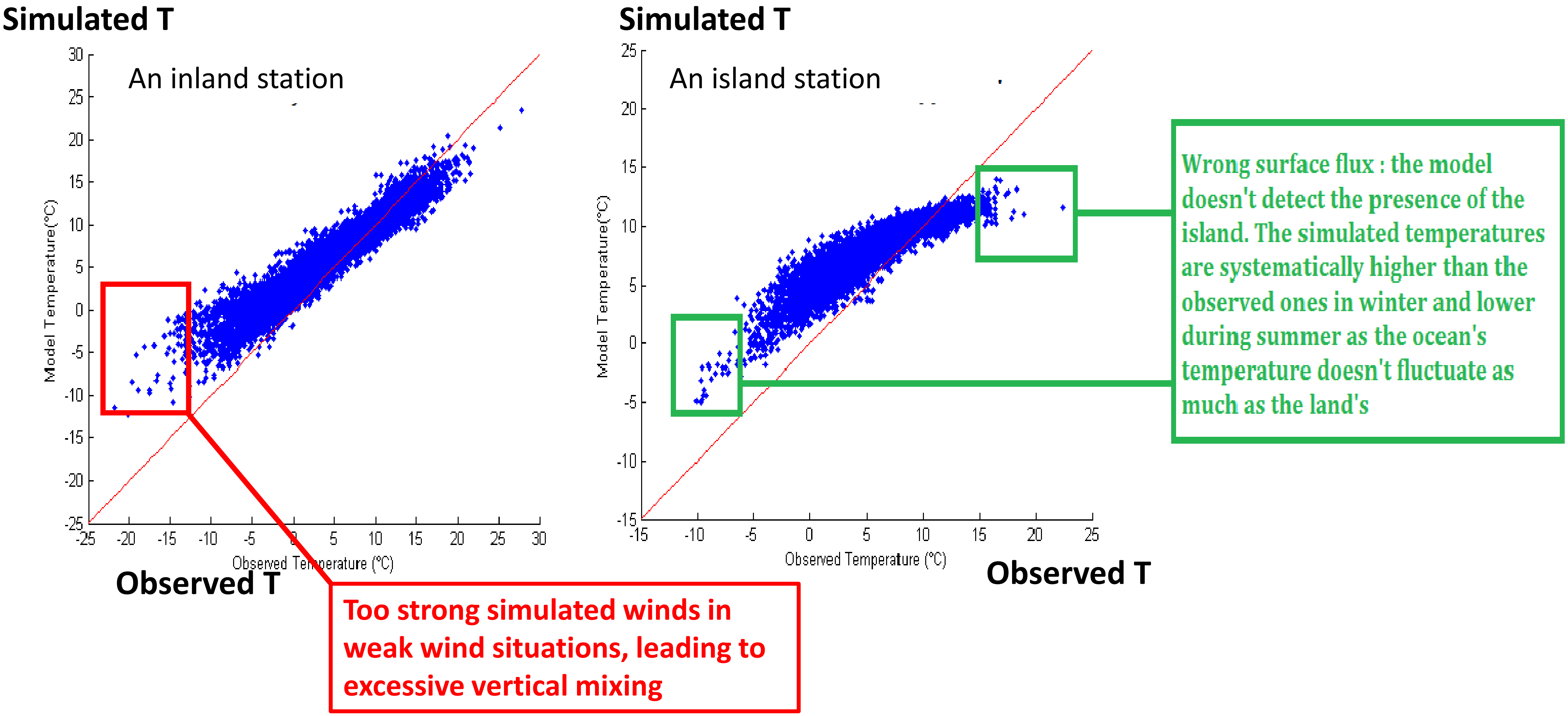


Observed T

Wrong radiation : the model fails to reproduce the cloud cover correctly

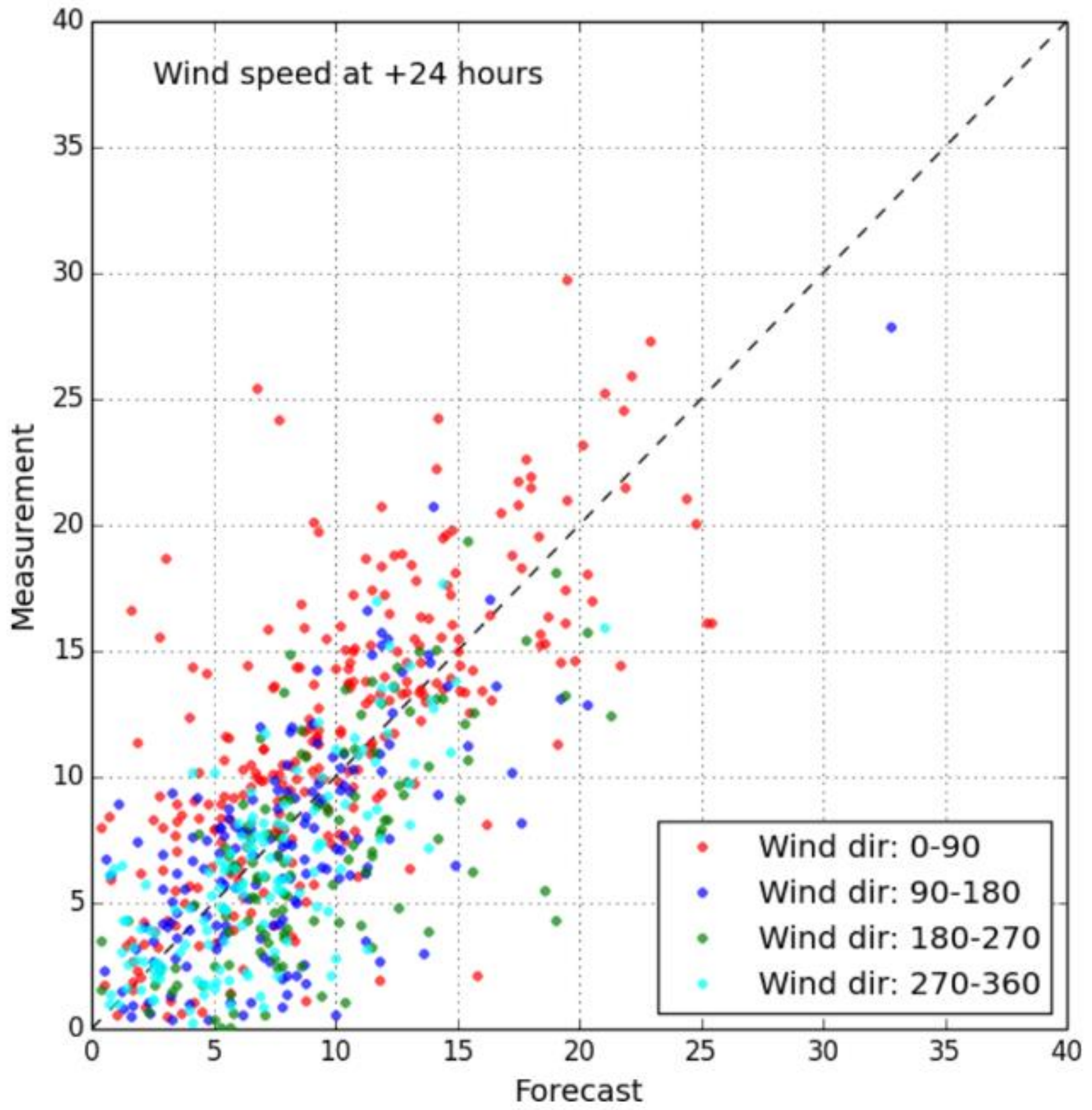
Wrong surface flux : in the highlands, the ice doesn't melt early enough in spring, implying lower simulated temperature than observations

Dynamic downscaling to dx=3km (Massad, Olafsson, Rögnvaldsson et al.)



Simulated T
An inland station
Model Temperature(°C)
Observed Temperature (°C)
Observed T
Simulated T
An island station
Model Temperature(°C)
Observed Temperature (°C)
Observed T
Wrong surface flux : the model doesn't detect the presence of the island. The simulated temperatures are systematically higher than the observed ones in winter and lower during summer as the ocean's temperature doesn't fluctuate as much as the land's
Too strong simulated winds in weak wind situations, leading to excessive vertical mixing

Northwesterly winds appear to result in a slight positive bias (appendix).



Classifying errors according to wind direction