# Hitatregðan á heimskautaslóðum

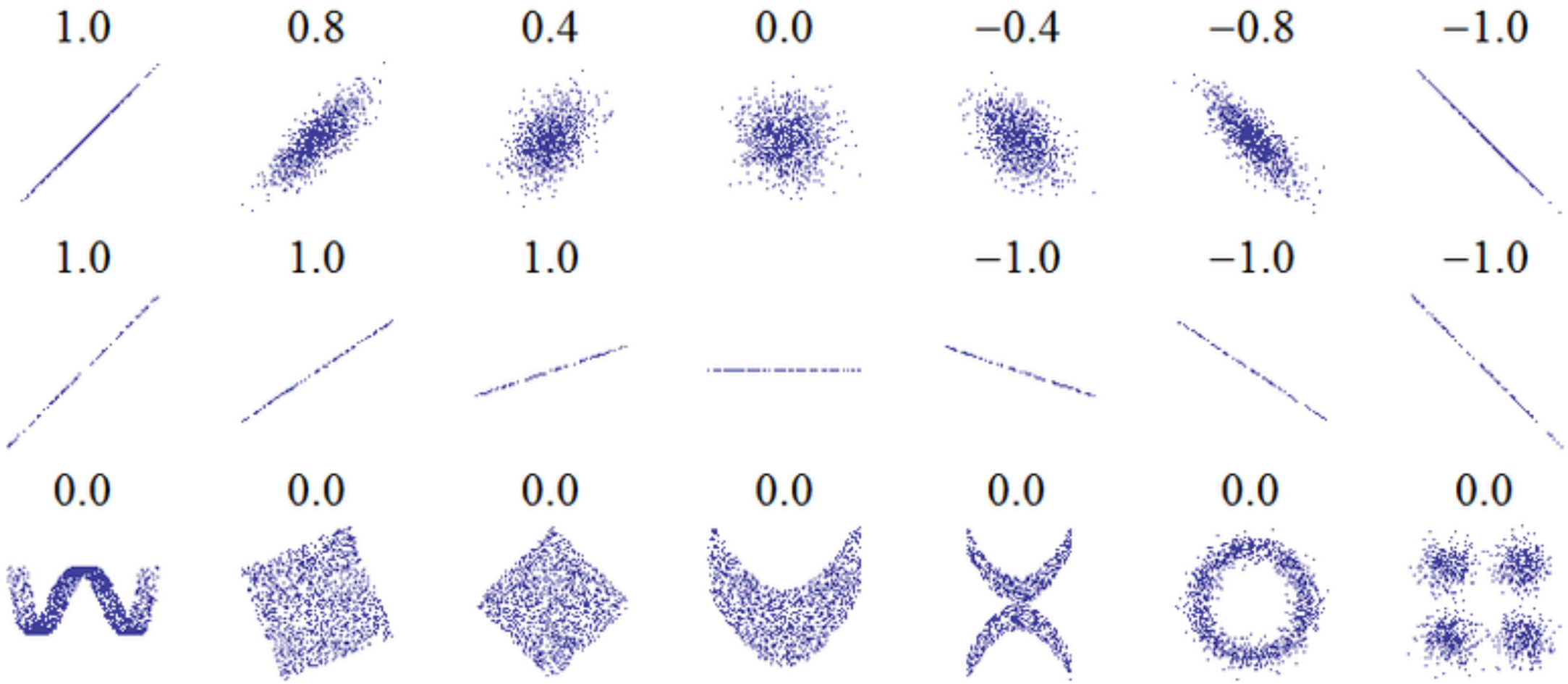
Negar Ekrami
Haraldur Ólafsson

# Hvað ræður tregðunni í meðalhita aðliggjandi mánaða?

- “Minni” yfirborðs jarðar (vatn, snjór og klaki, hafís)
- Stöðugleiki loftmassa
- Frávik í loftstraumum sem leiða af fráviki í ástandi yfirborðs jarðar
- Breytileiki í samspili veðurþátta

# Correlation coefficient

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



# Hitatregðan

Salomé Avrillaud (Frakklandi)

Lisa Degenhardt (Íslandi)

RMetS
Royal Meteorological Society

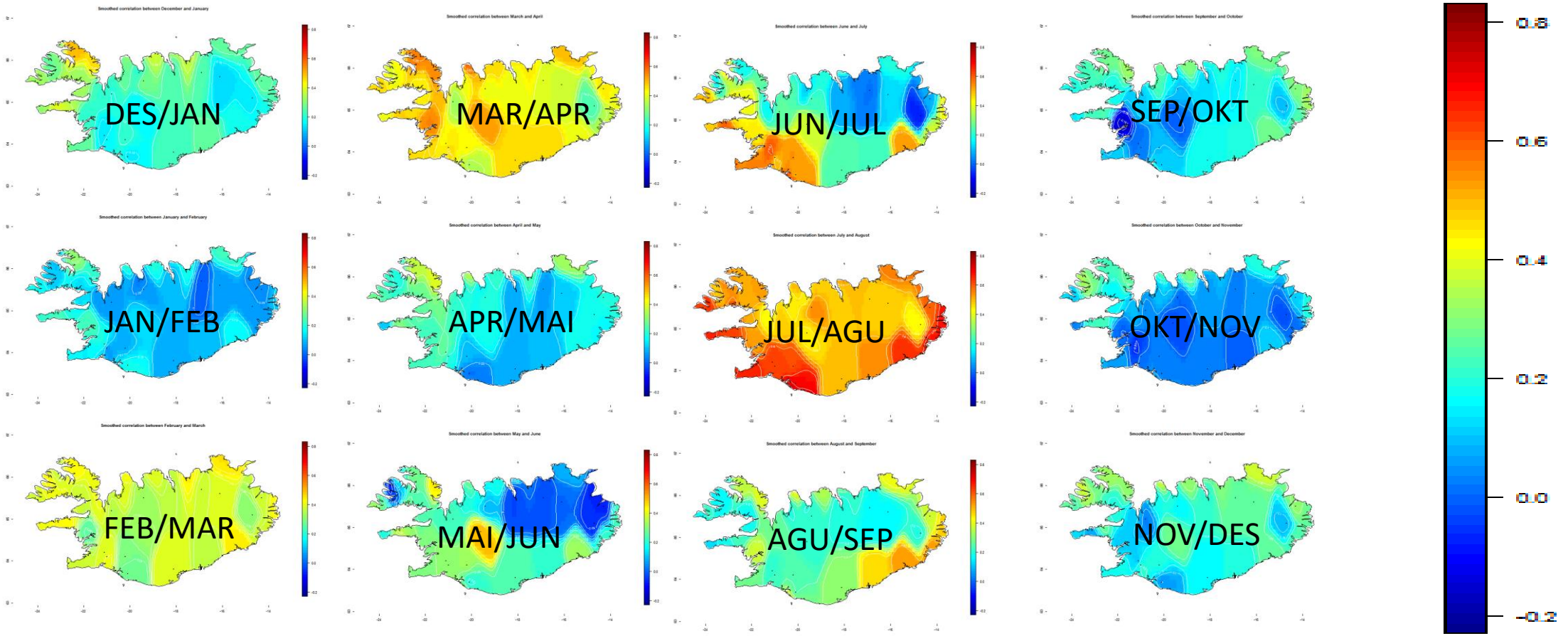
International Journal of Climatology

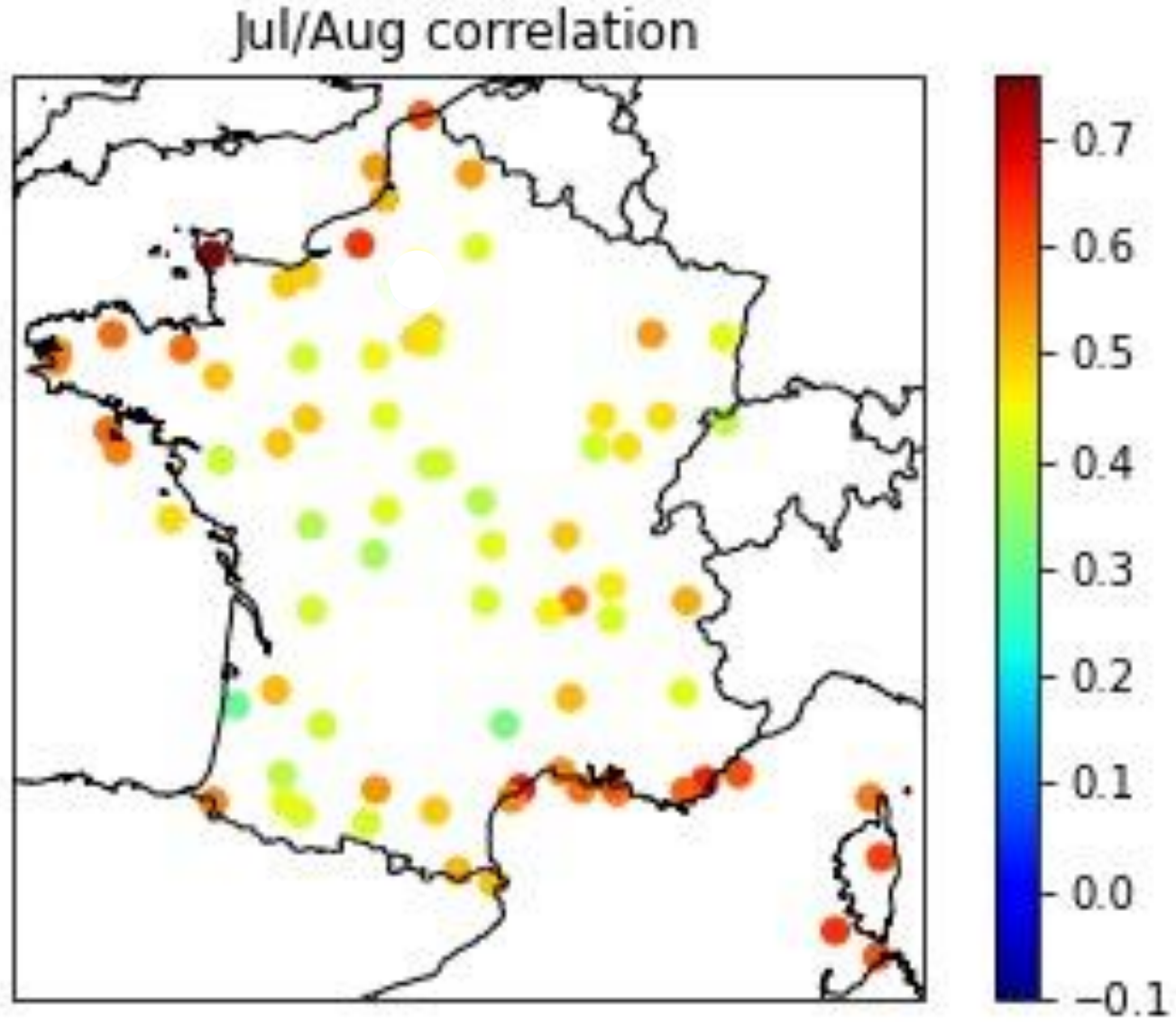
RESEARCH ARTICLE

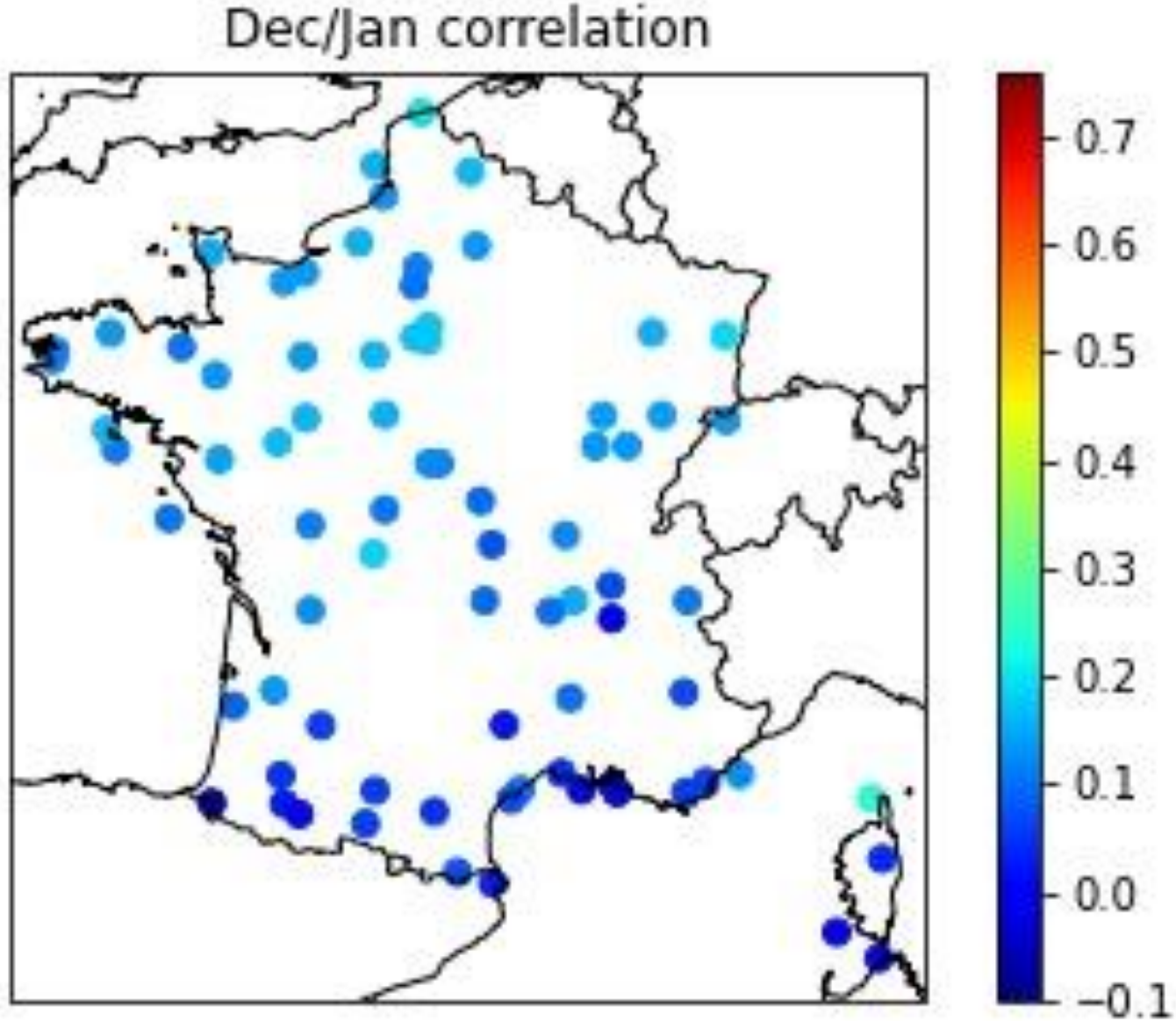
# Persistence of observed air temperatures in Iceland

Lisa Degenhardt, Haraldur Ólafsson ✉,

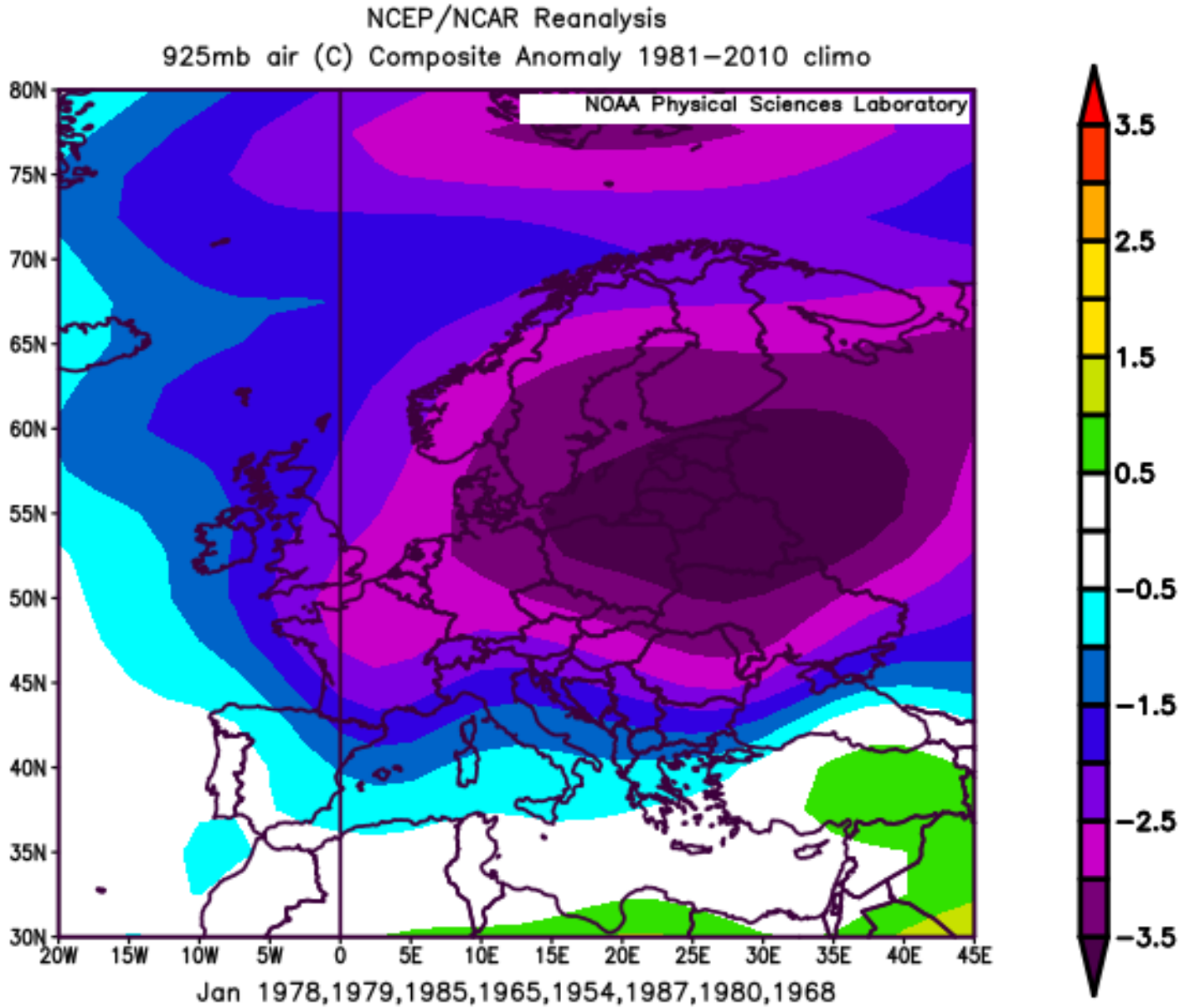
# Meðalhitafylgni milli aðliggjandi mánaða




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


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

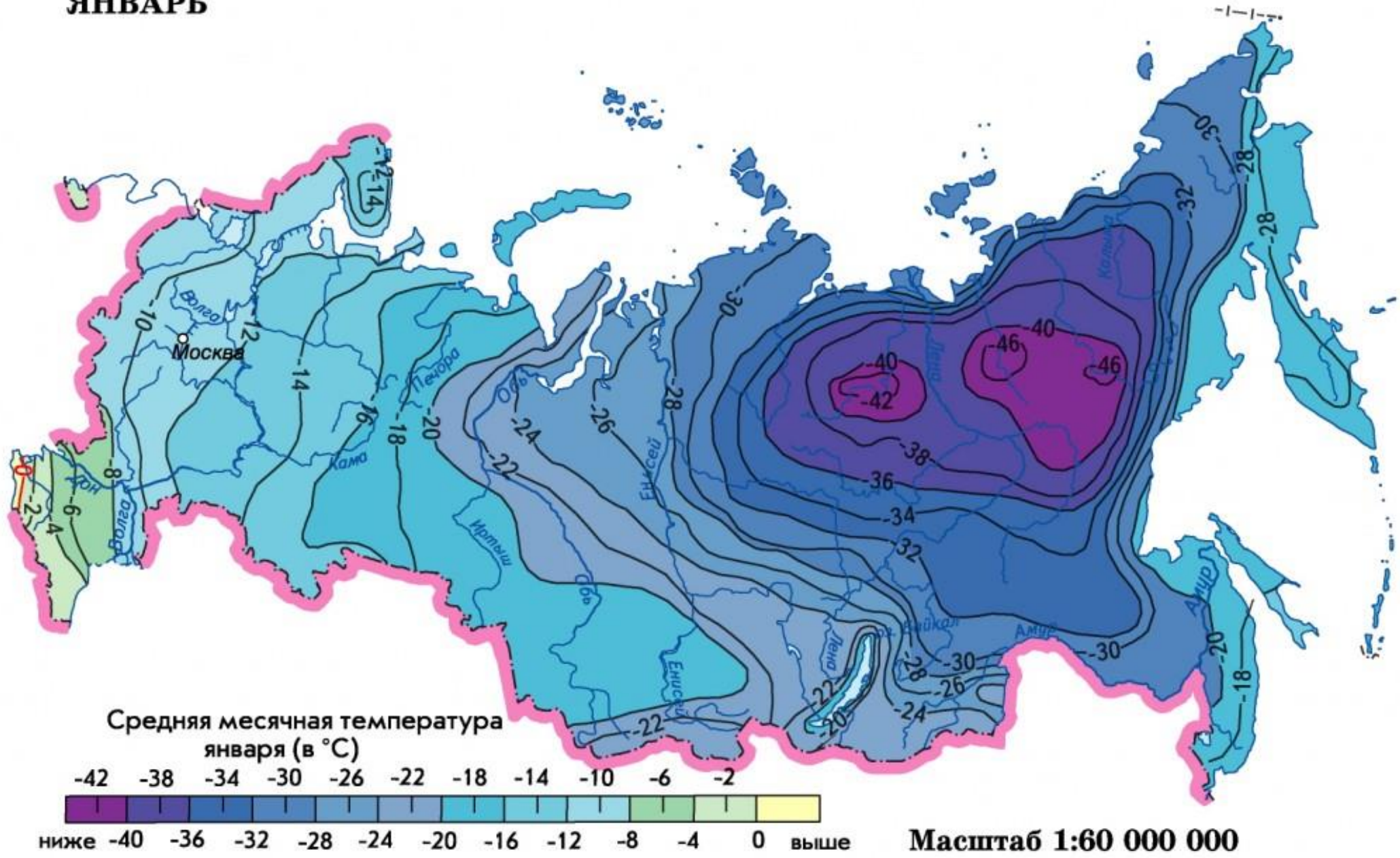


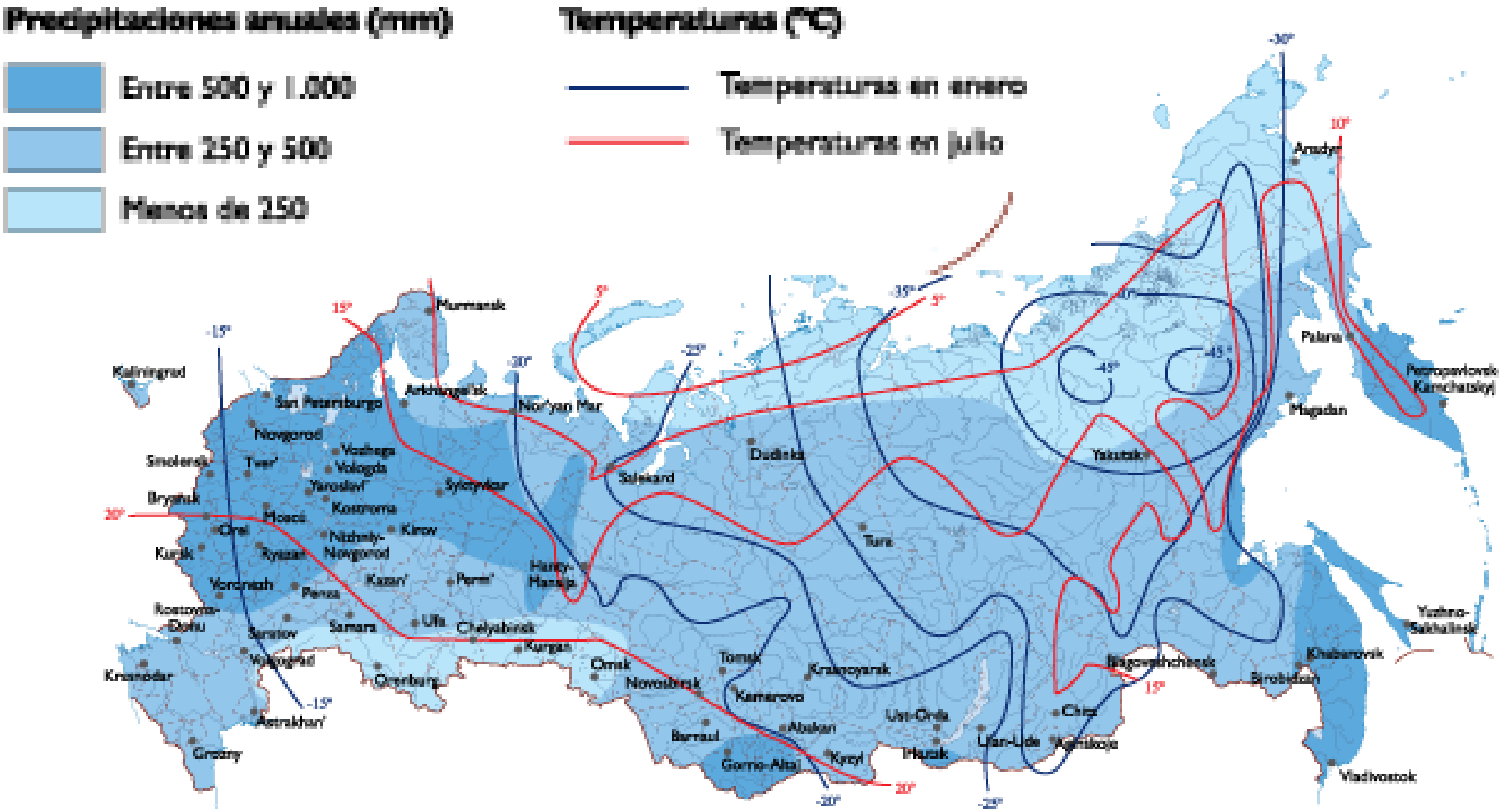
Töluverð tregða er í kuldafrávikum í A-Evrópu
Kuldaköst í Frakklandi leitast við að spilla sér

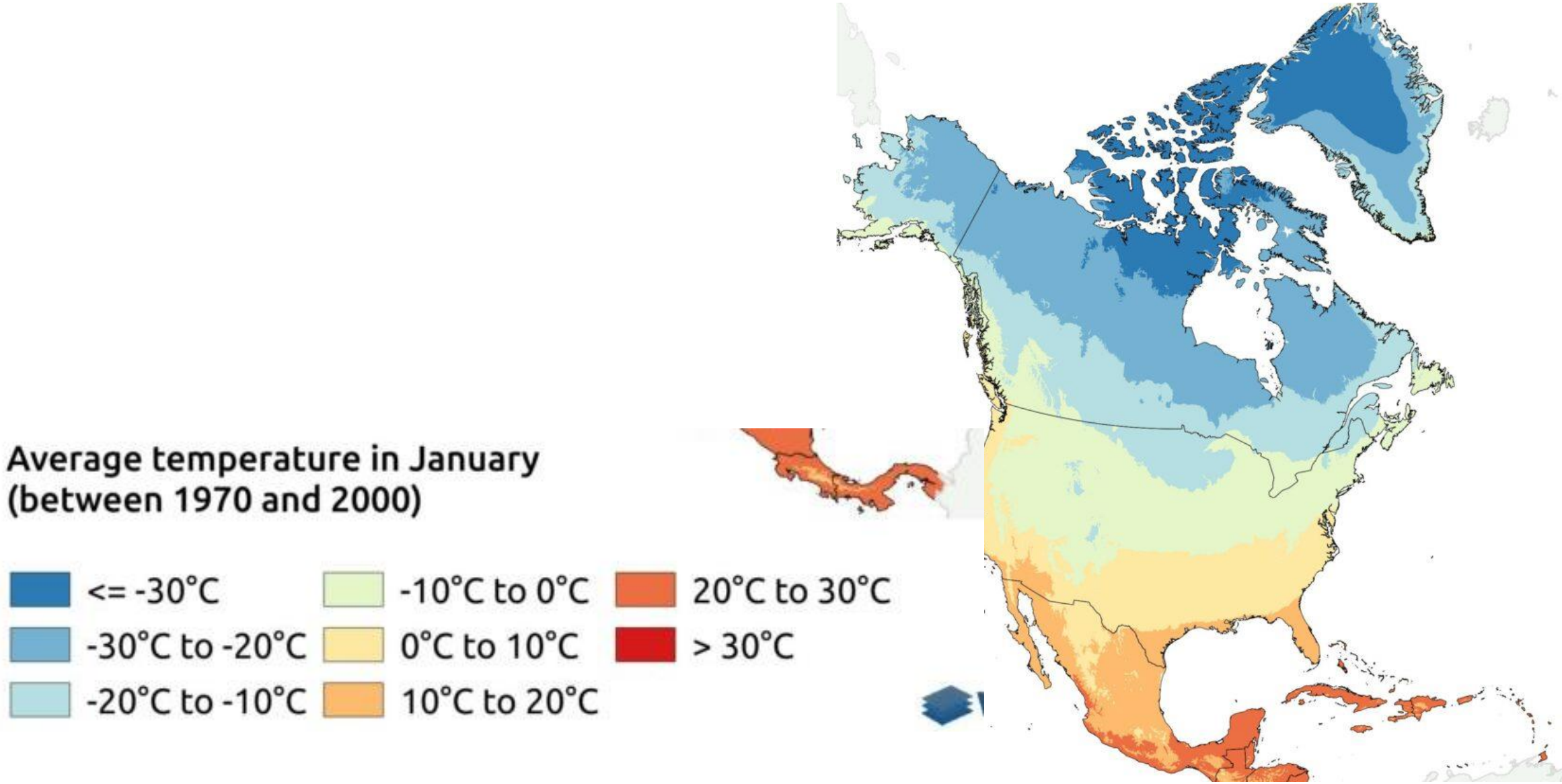
# Negar Ekrami


Hitatregðan á heimskautaslóðum, vetur og vor

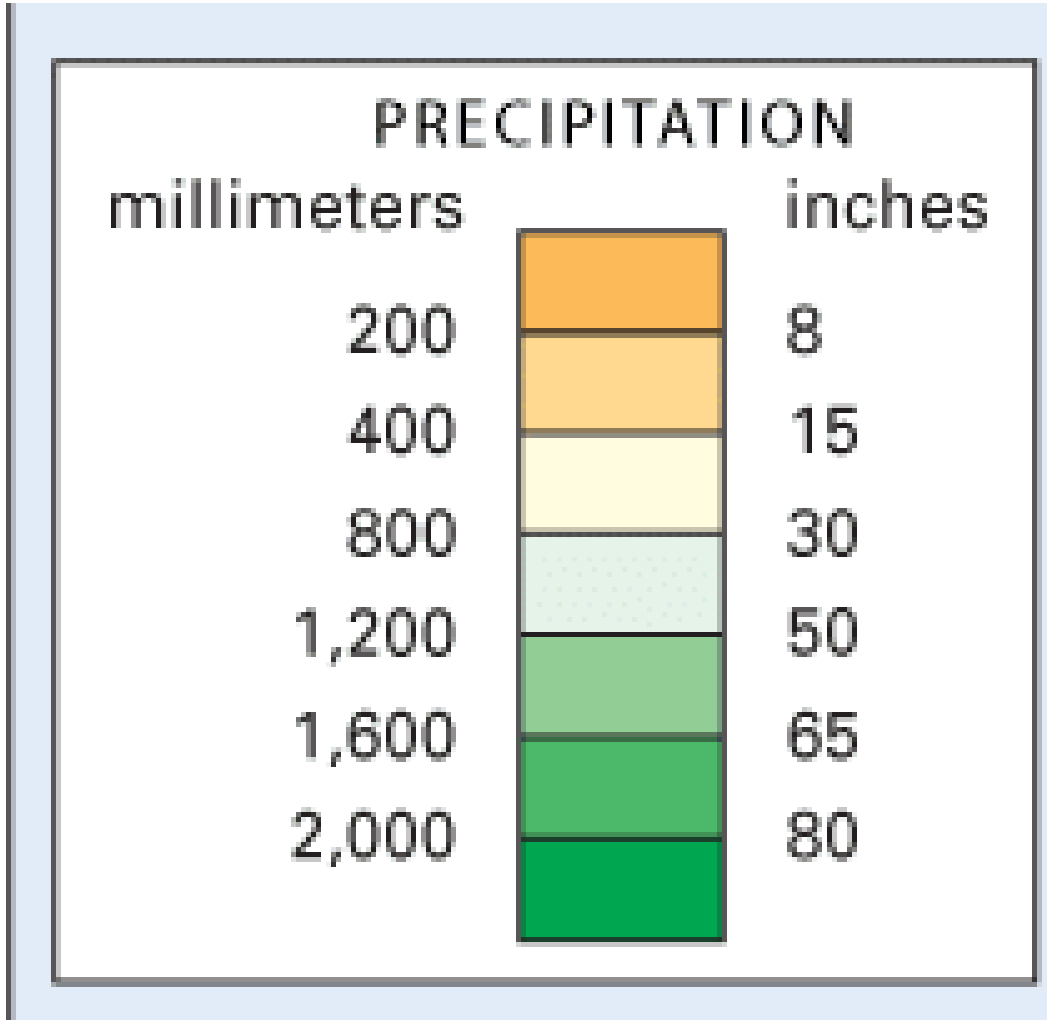
# ЯНВАРЬ


Москва
Волга
Печора
Обь
Енисей
Кама
Иртыш
Дон
Лена
Байкал
Амур
Колыма
Средняя месячная температура января (в °С)
-42 -38 -34 -30 -26 -22 -18 -14 -10 -6 -2
ниже -40 -36 -32 -28 -24 -20 -16 -12 -8 -4 0 выше
Масштаб 1:60 000 000


Precipitaciones anuales (mm)
Entre 500 y 1.000
Entre 250 y 500
Menos de 250
Temperaturas (°C)
Temperaturas en enero
Temperaturas en julio
Murmansk
Arkhangel'sk
San Petersburgo
Kaliningrad
Nor'yan Mar
Dudinka
Salekard
Yakutsk
Anadyr'
Palana
Magadan
Petropavlovsk Kamchatskiy
Novgorod
Vologda
Yaroslavl'
Syktyvkar
Smolensk
Tver'
Bryansk
Kostroma
Moscú
Orel
Kirov
Nizhniy-Novgorod
Kursk
Ryazan'
Kazan'
Perm'
Voronezh
Penza
Ufa
Samara
Chelyabinsk
Kurgan
Saratov
Volgograd
Orenburg
Astrakhan'
Krasnodar
Grozny
Tomsk
Omsk
Novosibirsk
Krasnoyarsk
Kemerovo
Barnaul
Gorno-Altaj
Abakan
Kyzyl
Ust-Orda
Chita
Ulan-Ude
Irkutsk
Blagoveshchensk
Birobidzan
Khabarovsk
Yuzhno-Sakhalinsk
Vladivostok


Average temperature in January
(between 1970 and 2000)
<= -30°C
-30°C to -20°C
-20°C to -10°C
-10°C to 0°C
0°C to 10°C
10°C to 20°C
20°C to 30°C
> 30°C

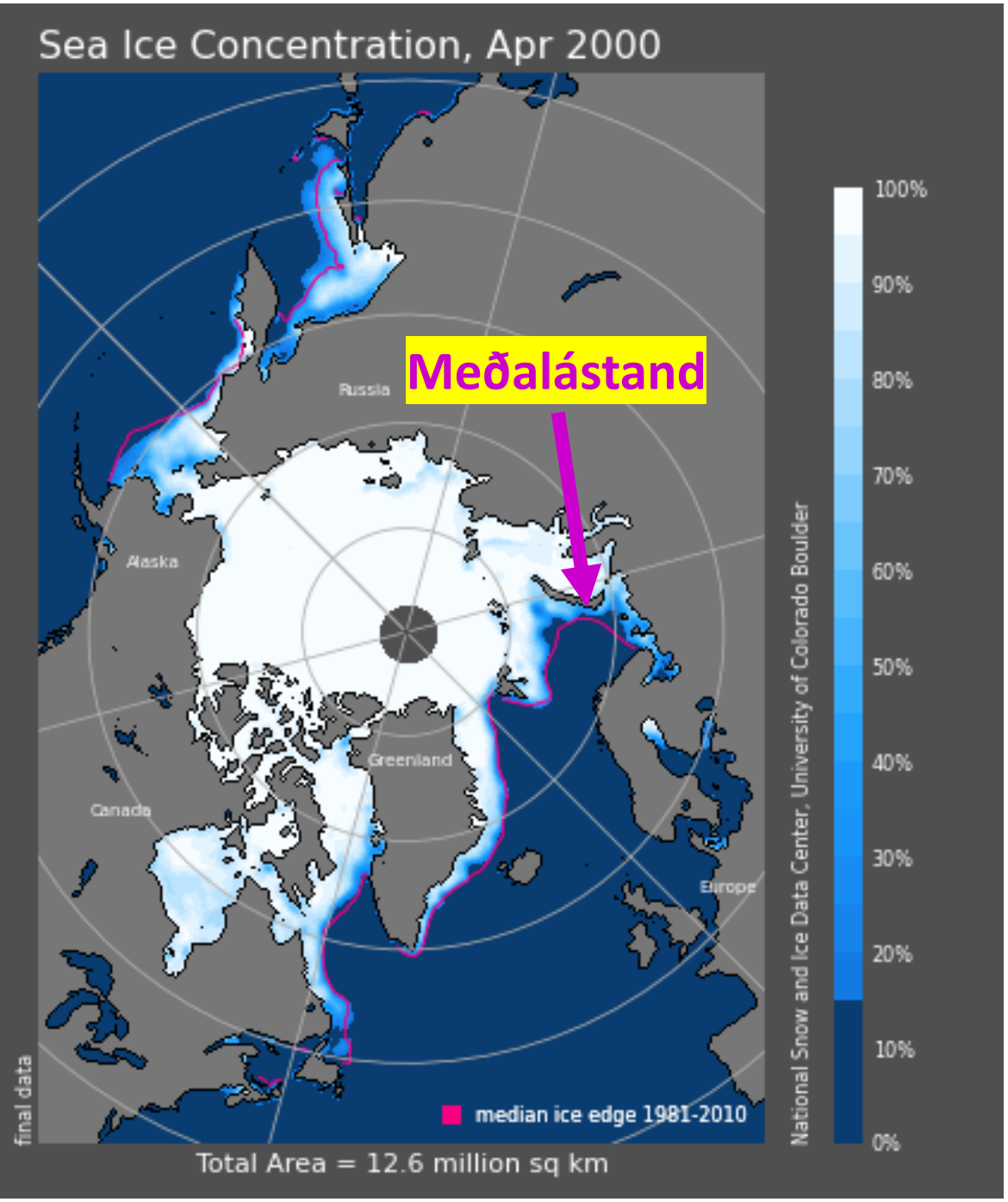
# Ársúrkoma

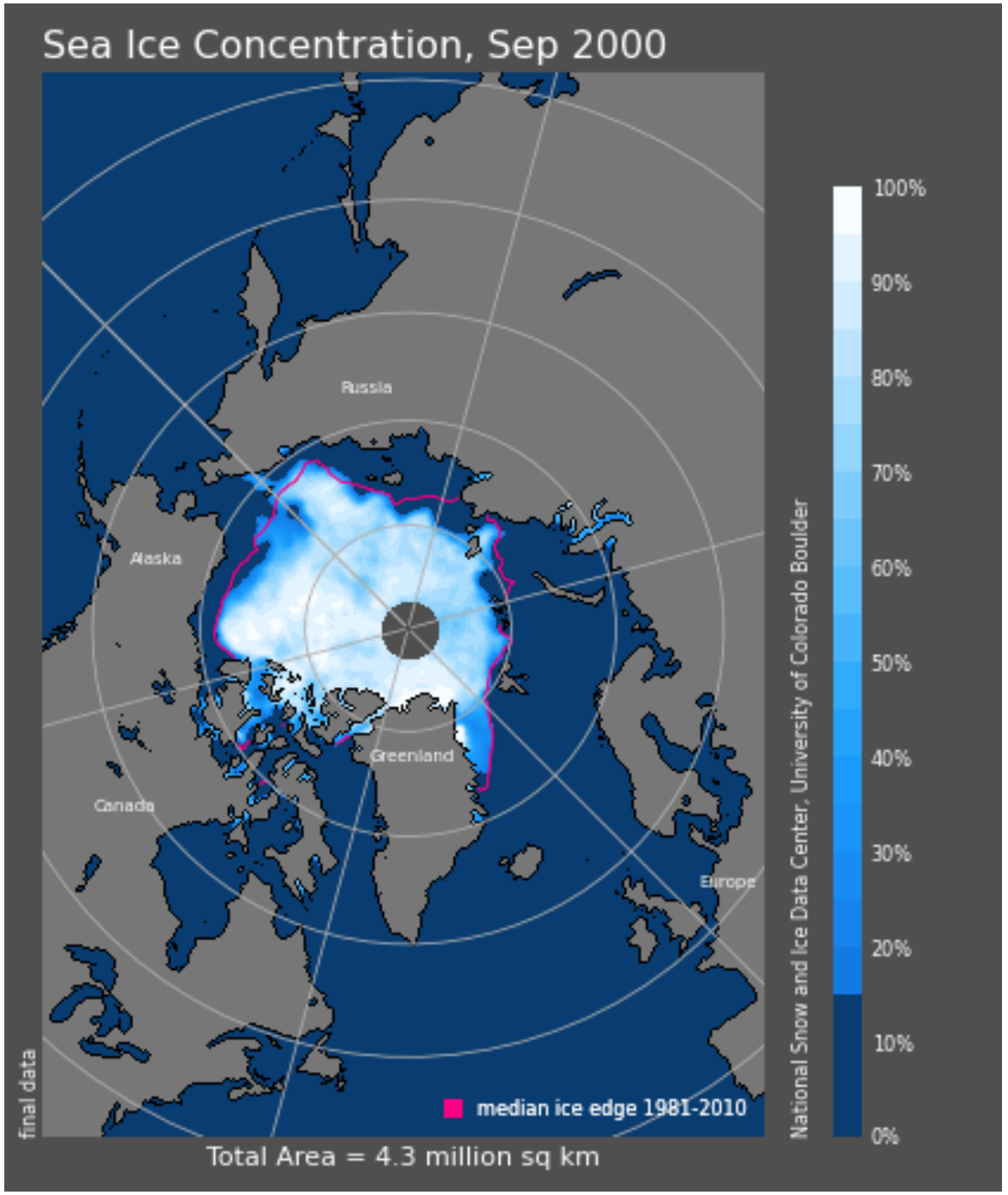

PRECIPITATION
millimeters
inches
200
8
400
15
800
30
1,200
50
1,600
65
2,000
80

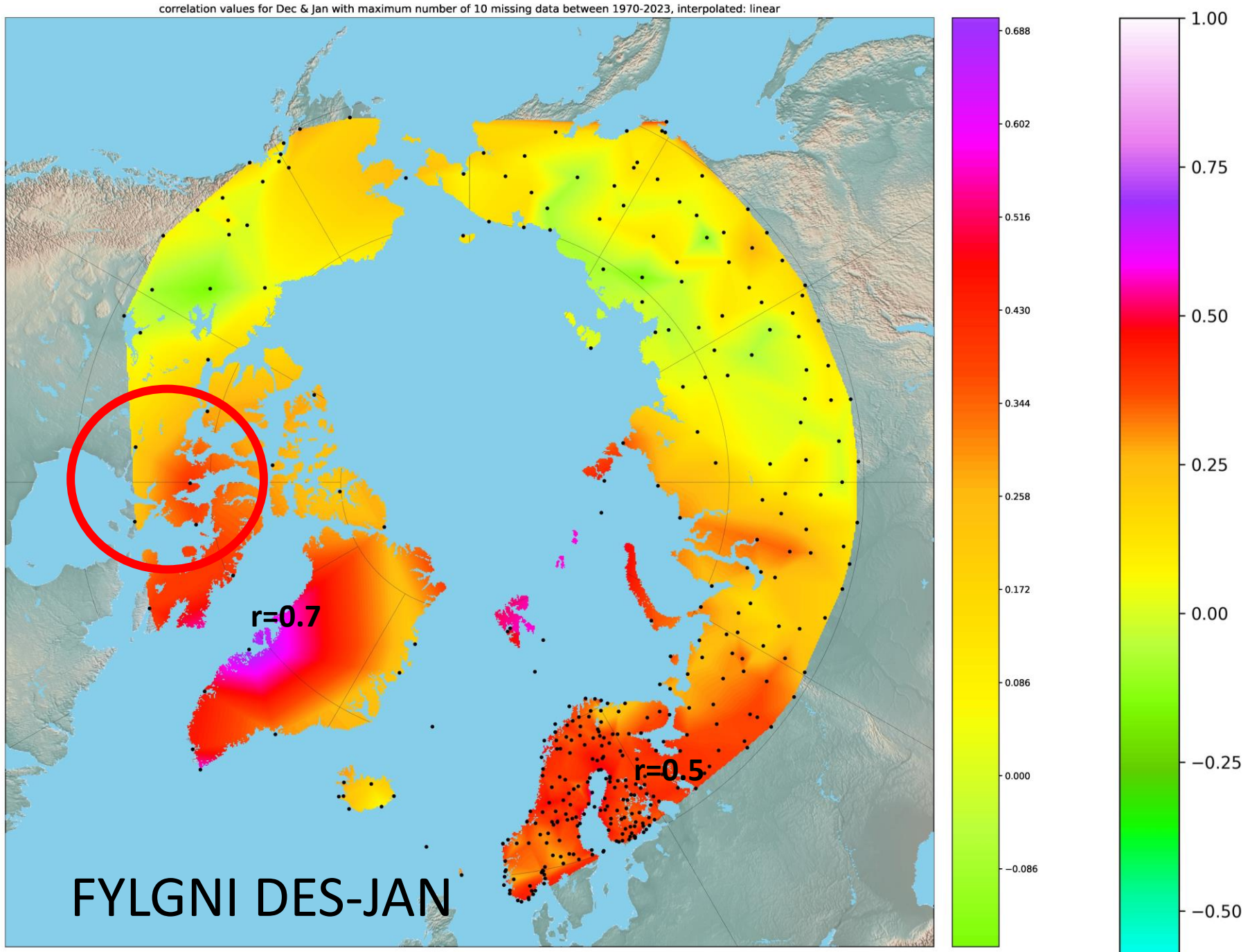

Anchorage
Godthåb
Seattle
Winnipeg
Montreal
New York
Denver
Chicago
Washington, D.C.
Los Angeles
Dallas
Atlanta
Miami
Havana
Kingston
Santo Domingo
Mexico City
Guatemala City
Panama City
PRECIPITATION
millimeters
inches
200
8
400
15
800
30
1,200
50
1,600
65
2,000
80
0
100
1,000 mi
0
500
1,000
1,500 km
© 2010 EB, Inc.

- Síbería

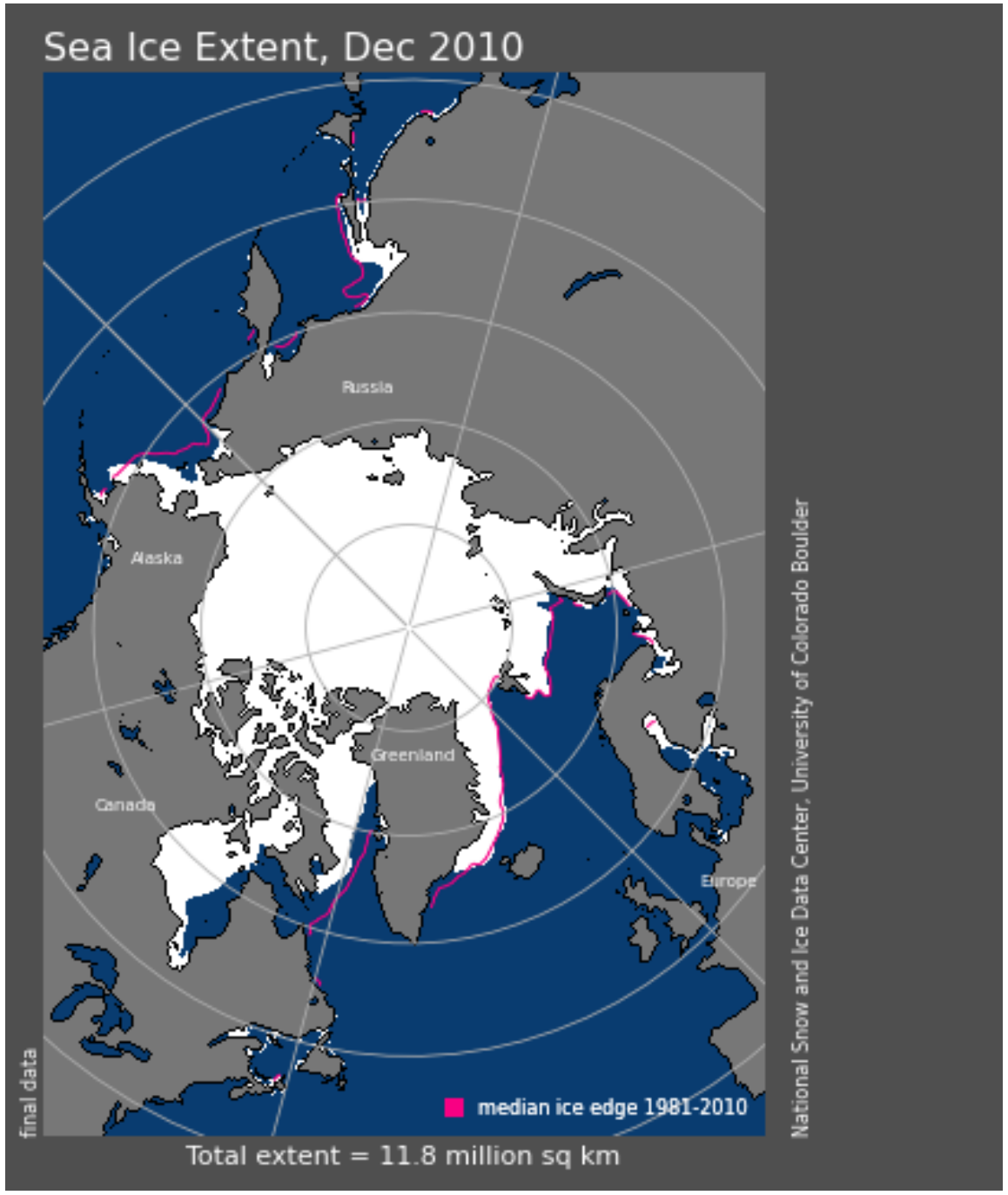

# Síbería

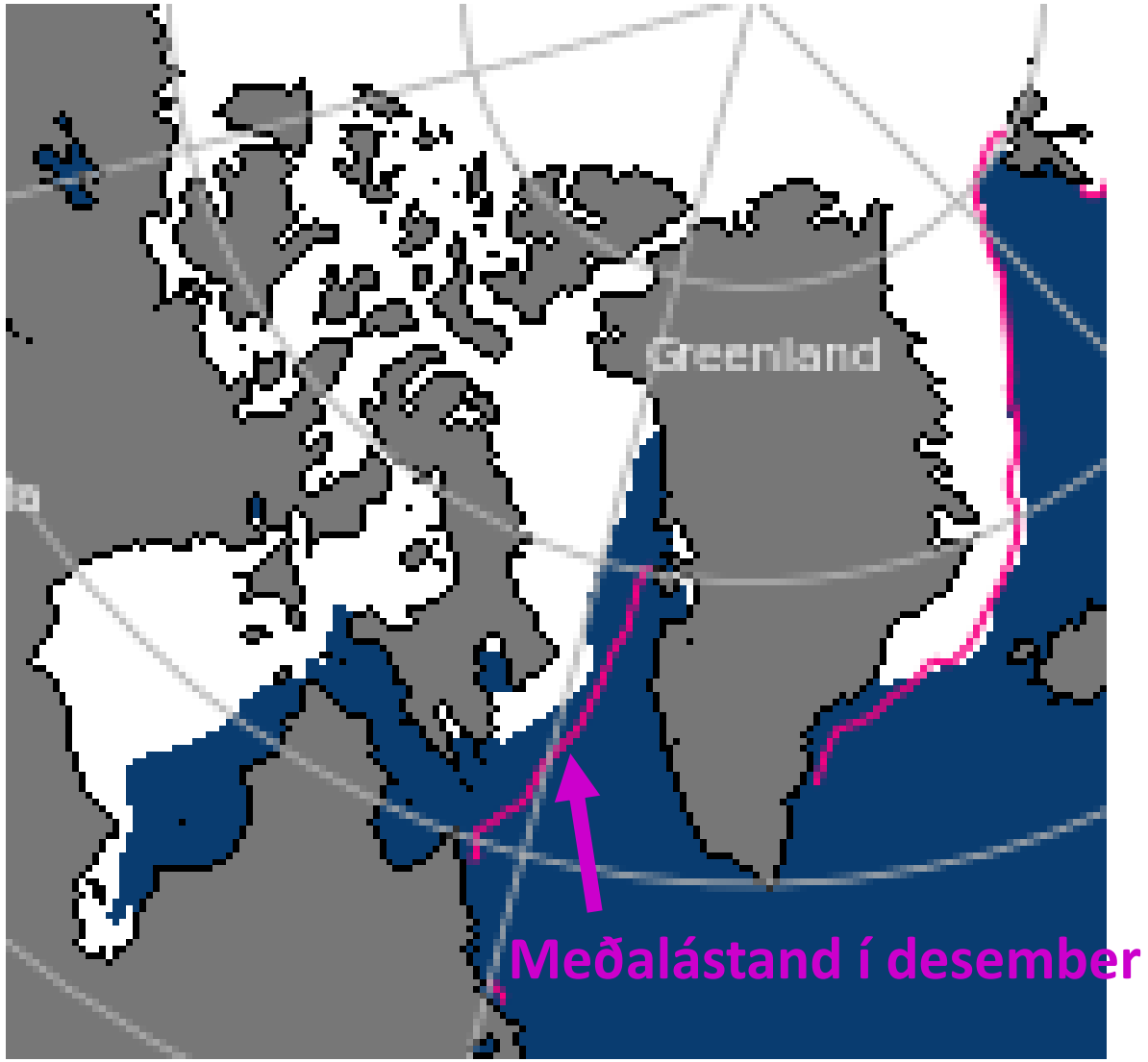


Sea Ice Concentration, Apr 2000
Meðalástand
Russia
Alaska
Canada
Greenland
Europe
median ice edge 1981-2010
final data
National Snow and Ice Data Center, University of Colorado Boulder
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Total Area = 12.6 million sq km

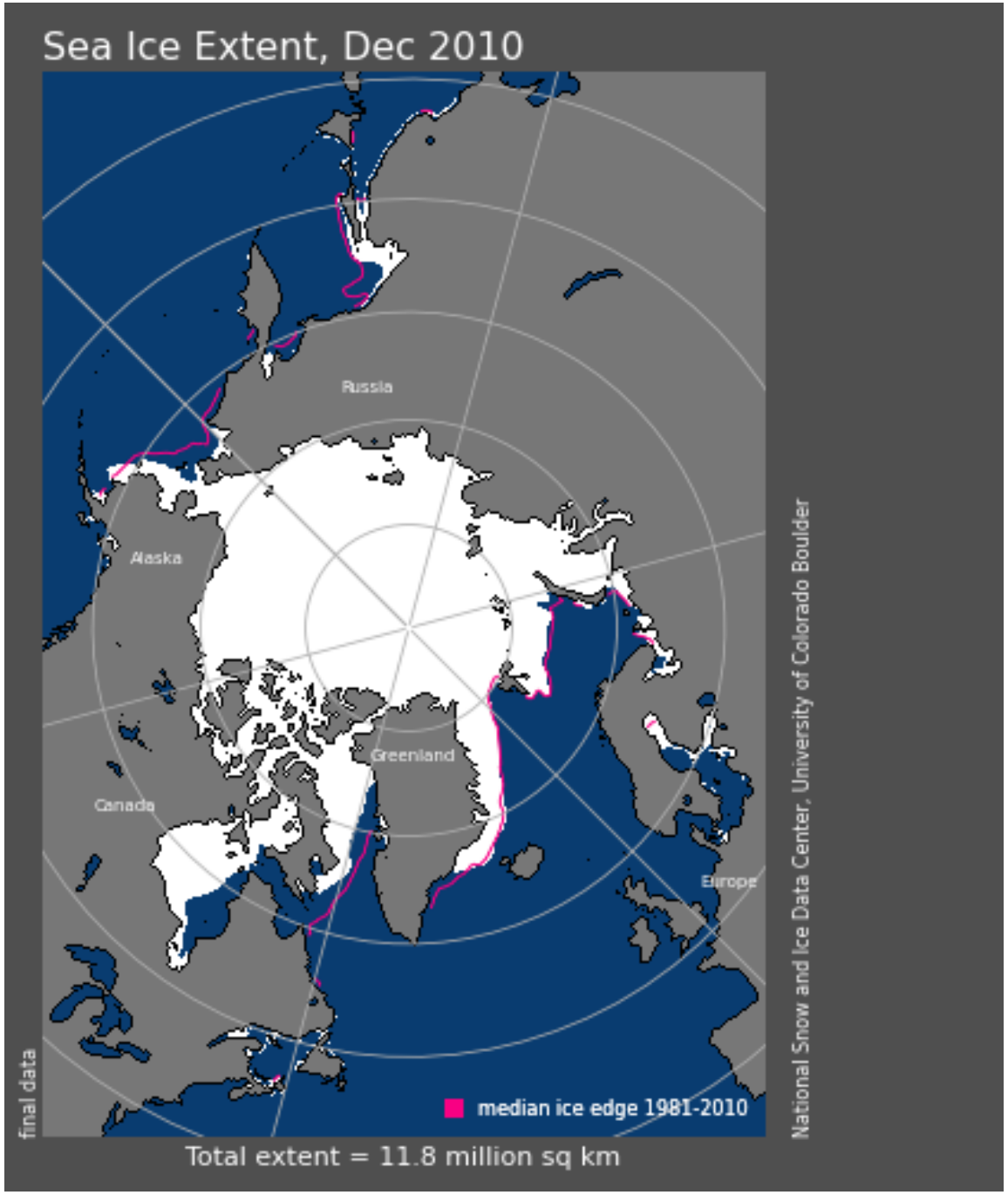

Sea Ice Concentration, Sep 2000
Russia
Alaska
Canada
Greenland
Europe
median ice edge 1981-2010
final data
National Snow and Ice Data Center, University of Colorado Boulder
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Total Area = 4.3 million sq km

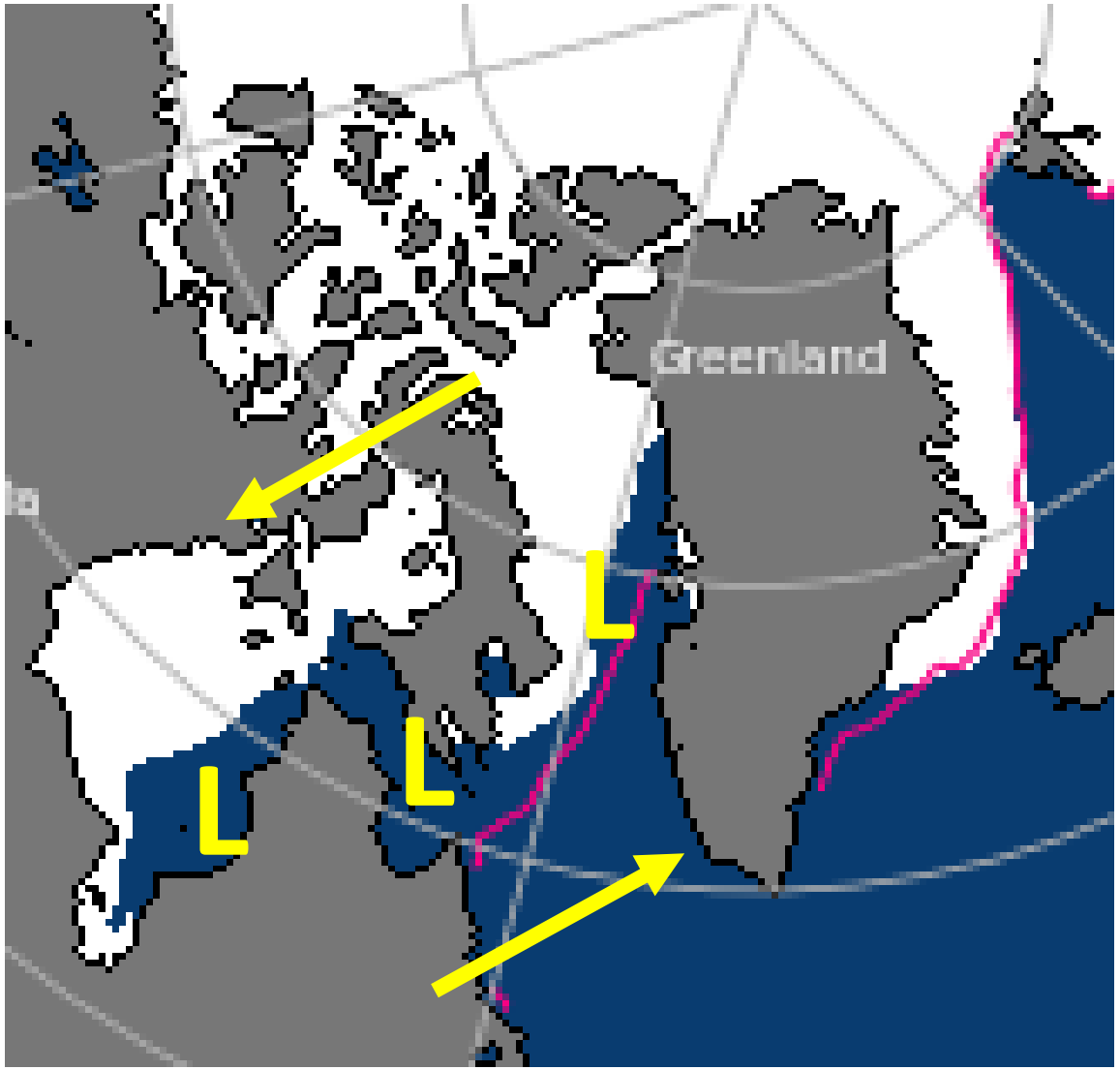


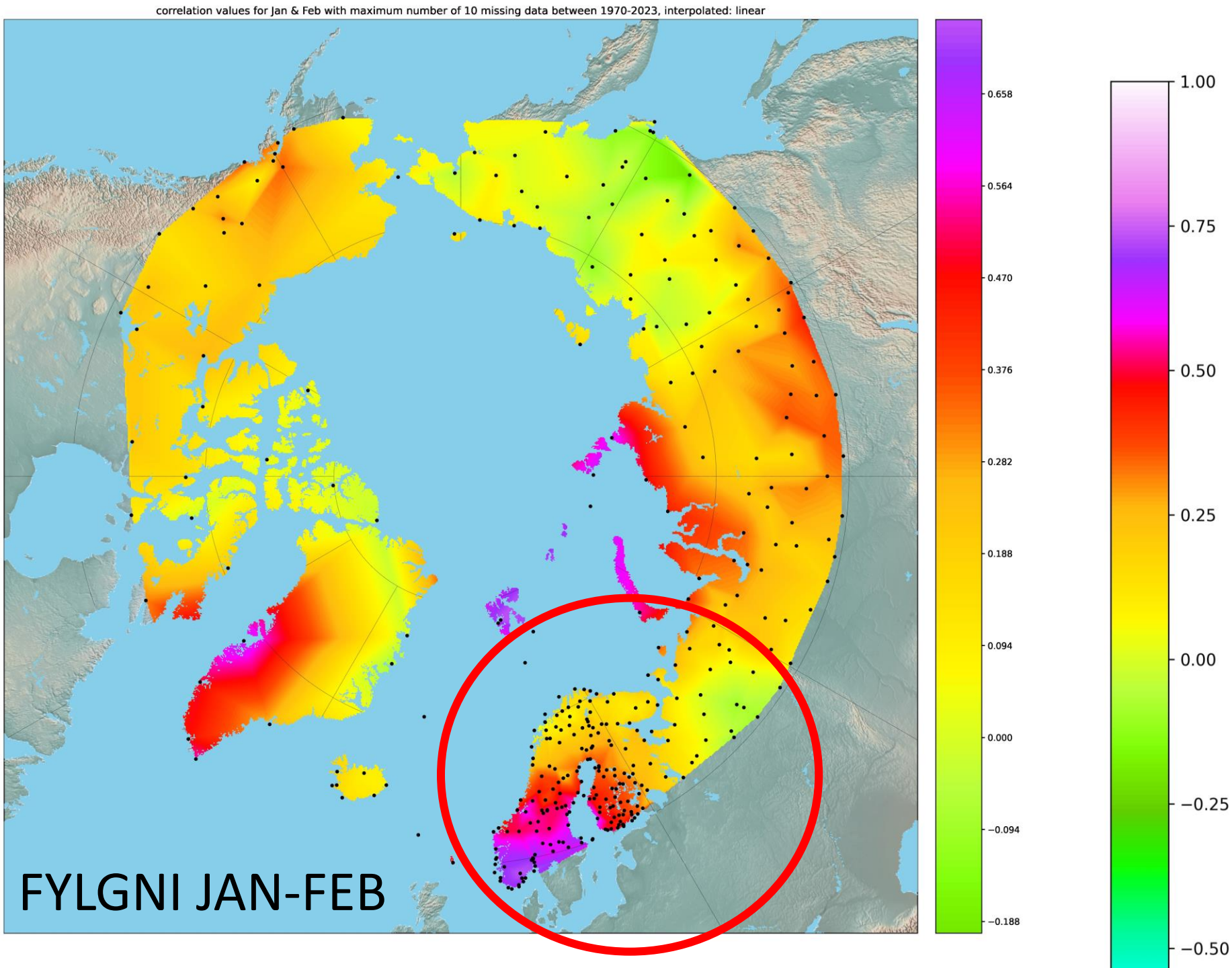

Gögn: mælingar í punktunum


Sea Ice Extent, Dec 2010
Russia
Alaska
Canada
Greenland
Europe
median ice edge 1981-2010
final data
National Snow and Ice Data Center, University of Colorado Boulder
Total extent = 11.8 million sq km

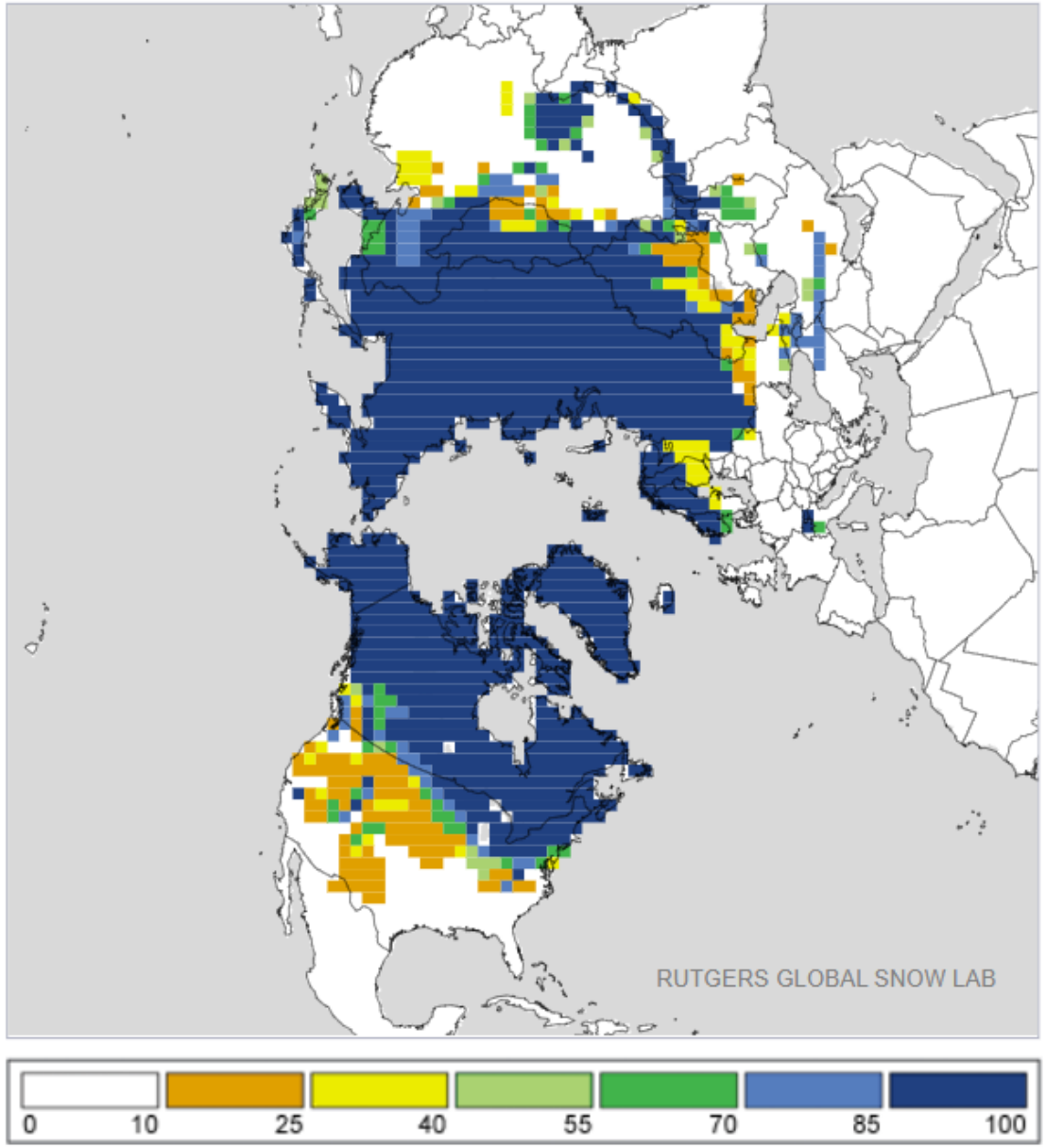

Greenland
Meðalástand í desember

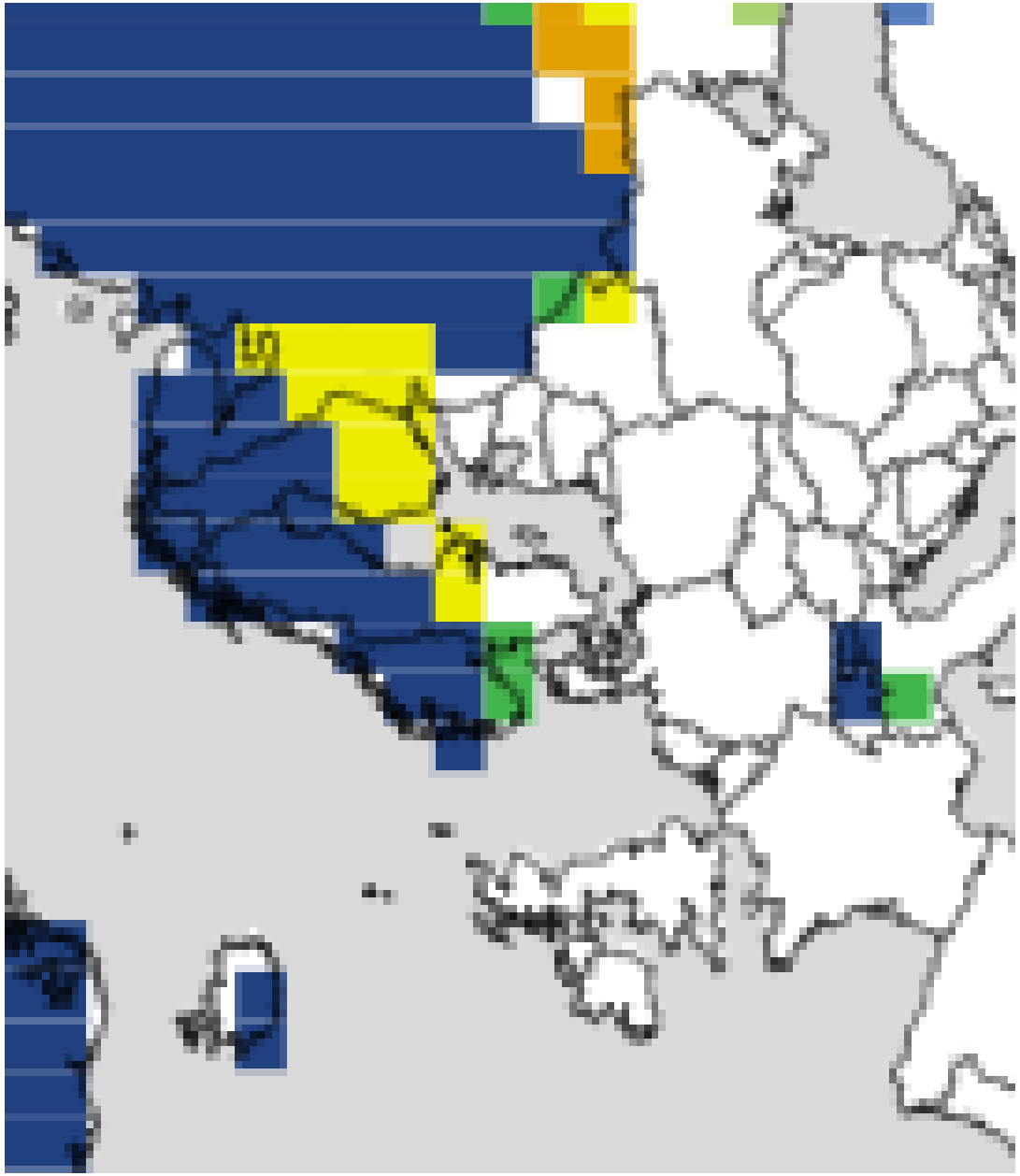

Sea Ice Extent, Dec 2010
Russia
Alaska
Canada
Greenland
Europe
median ice edge 1981-2010
Total extent = 11.8 million sq km
final data
National Snow and Ice Data Center, University of Colorado Boulder

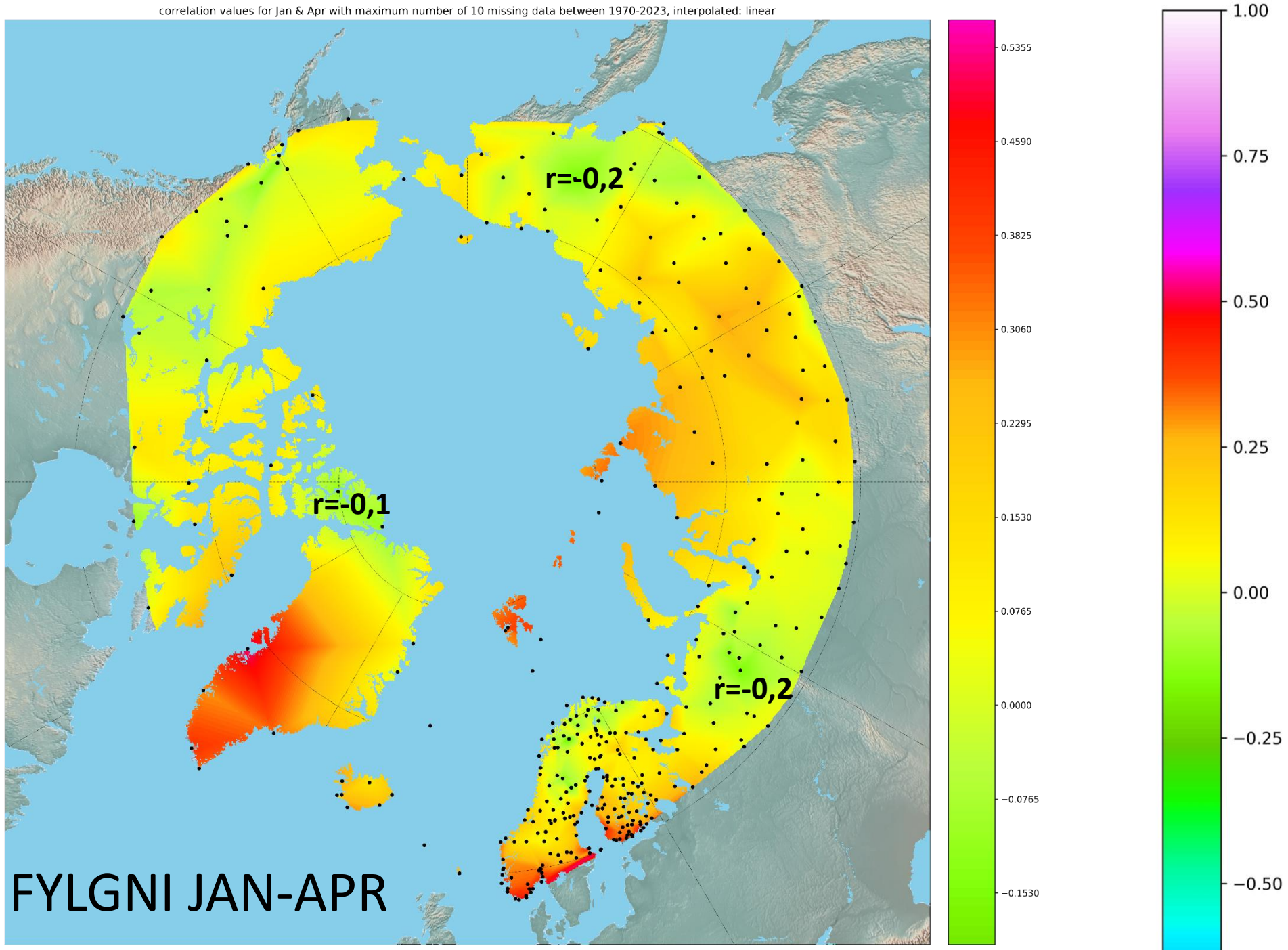

Greenland
L
L
L

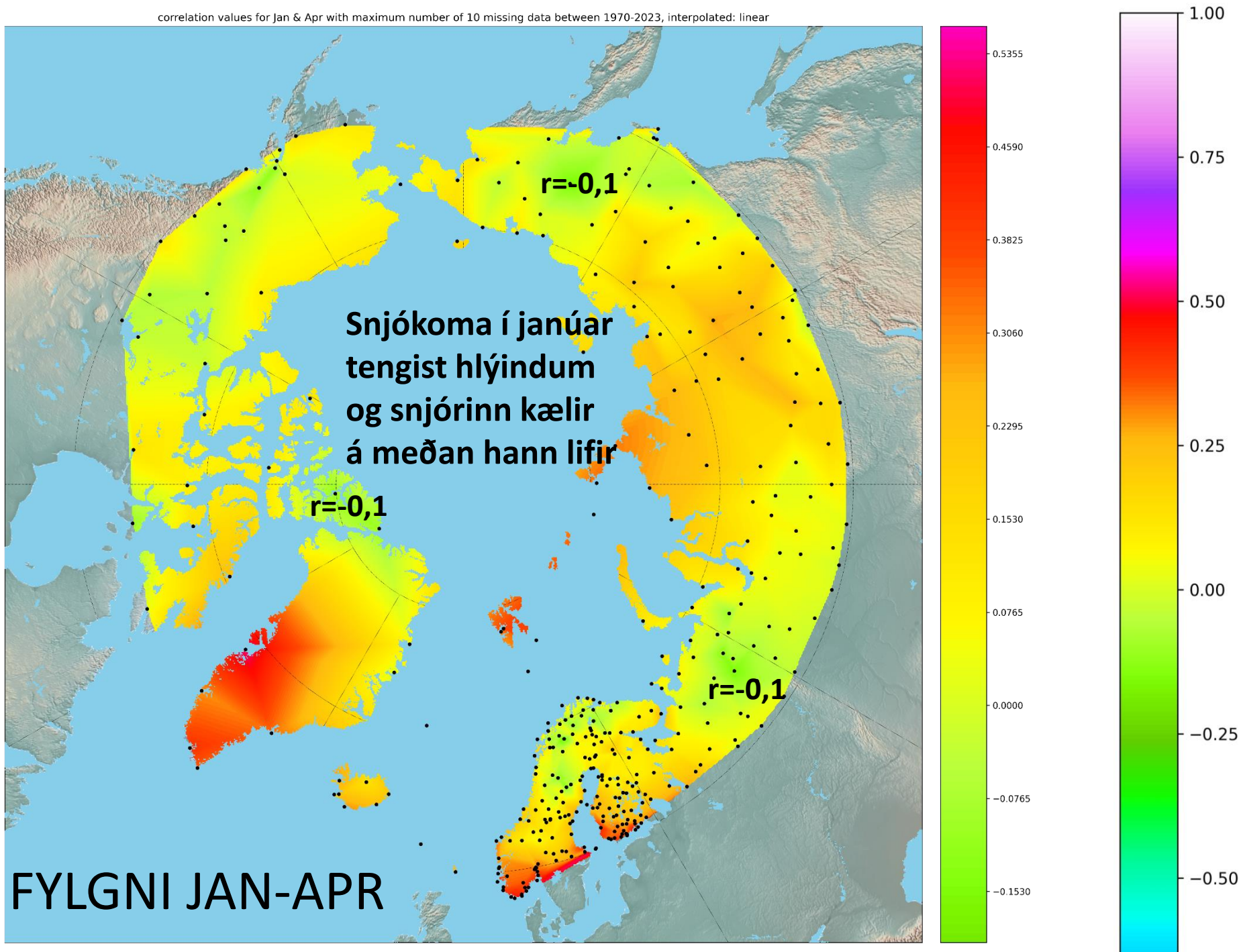

correlation values for Jan & Feb with maximum number of 10 missing data between 1970-2023, interpolated: linear
FYLGNI JAN-FEB
0.658
0.564
0.470
0.376
0.282
0.188
0.094
0.000
−0.094
−0.188
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50

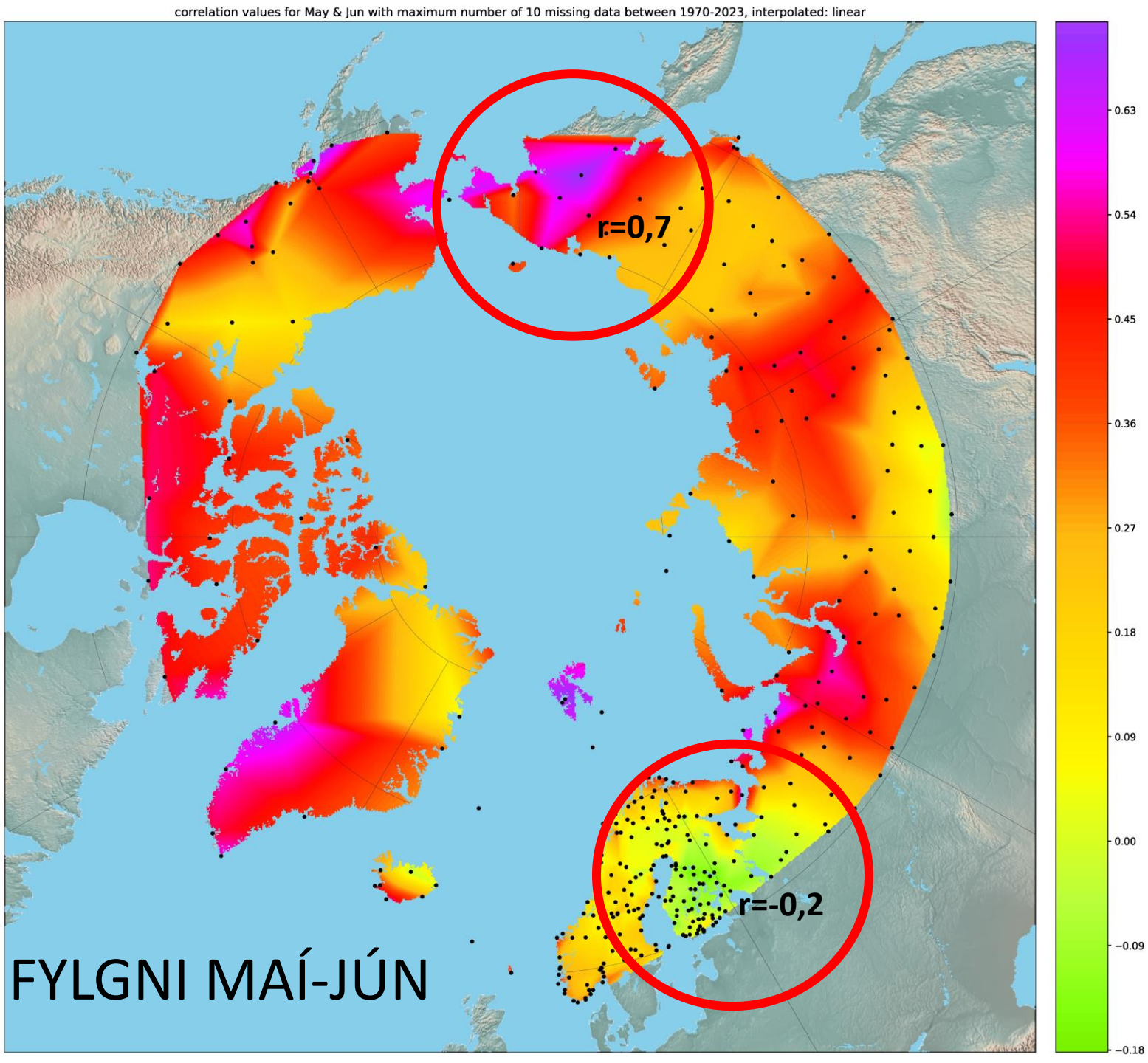
# Monthly Snow Cover Extent - January 1981

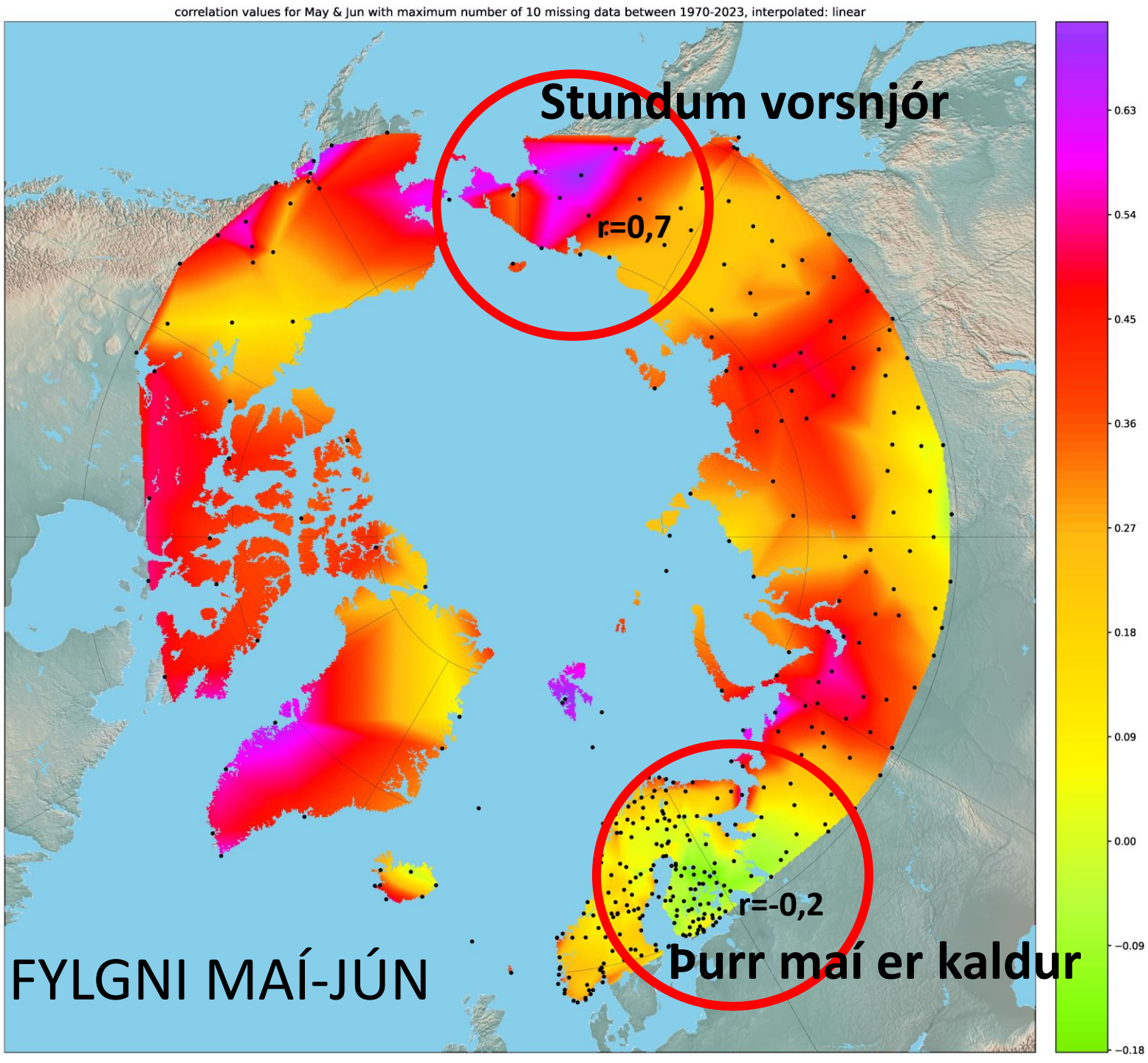


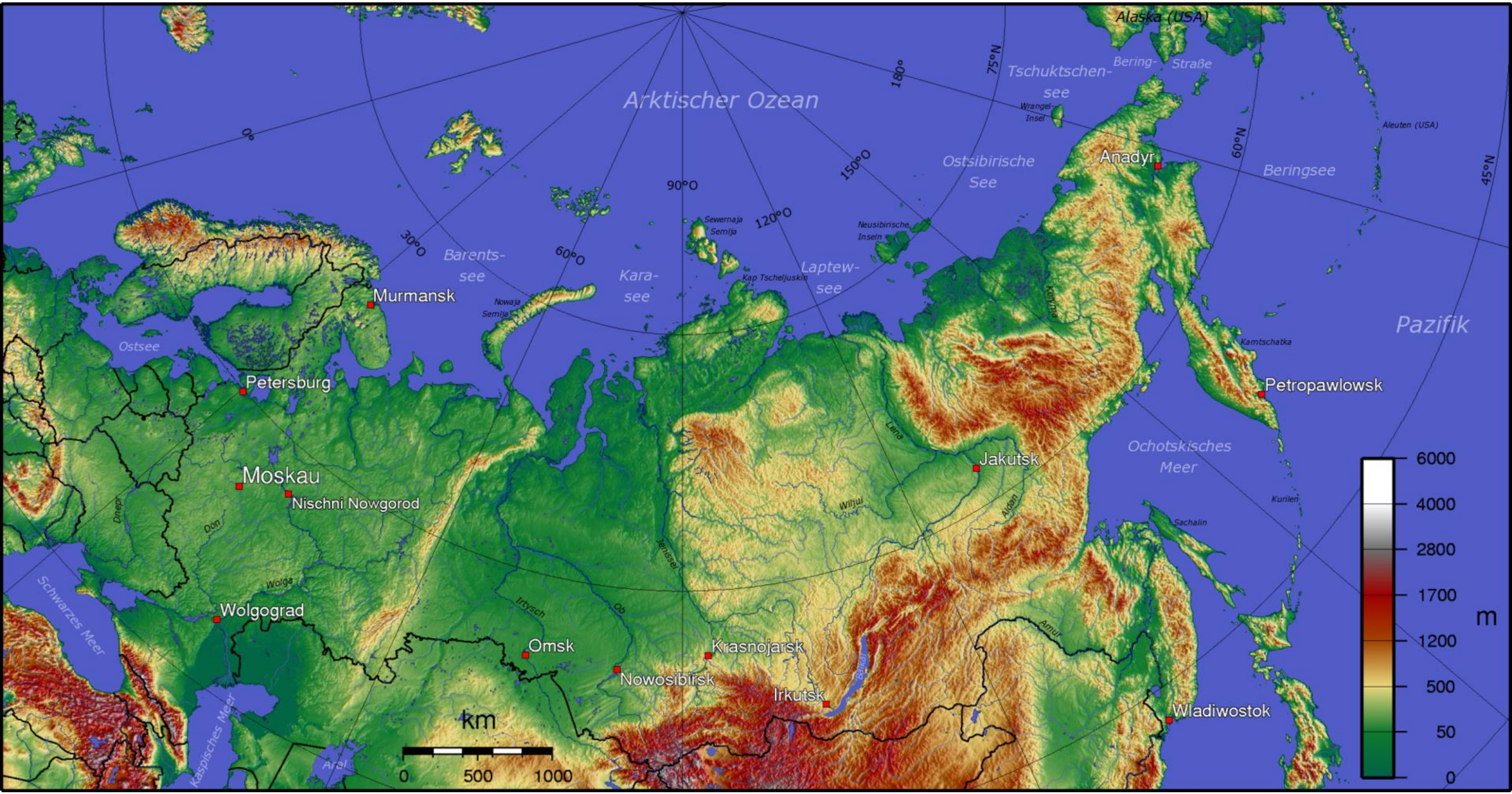




correlation values for Jan & Apr with maximum number of 10 missing data between 1970-2023, interpolated: linear
r=-0,2
r=-0,1
r=-0,2
FYLGNI JAN-APR
0.5355
0.4590
0.3825
0.3060
0.2295
0.1530
0.0765
0.0000
−0.0765
−0.1530
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50

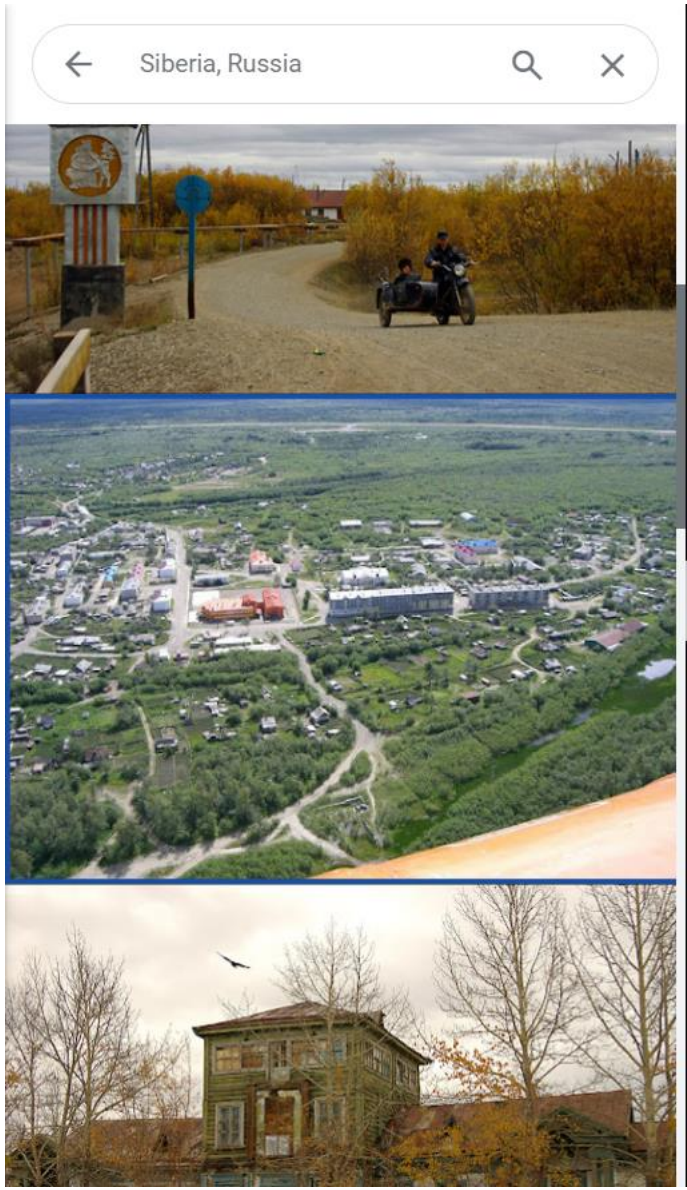

correlation values for Jan & Apr with maximum number of 10 missing data between 1970-2023, interpolated: linear
r=-0,1
Snjókoma í janúar
tengist hlýindum
og snjórinn kælir
á meðan hann lifir
r=-0,1
r=-0,1
FYLGNI JAN-APR
0.5355
0.4590
0.3825
0.3060
0.2295
0.1530
0.0765
0.0000
−0.0765
−0.1530
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50


correlation values for May & Jun with maximum number of 10 missing data between 1970-2023, interpolated: linear
r=0,7
r=-0,2
FYLGNI MAÍ-JÚN
0.63
0.54
0.45
0.36
0.27
0.18
0.09
0.00
−0.09
−0.18


correlation values for May & Jun with maximum number of 10 missing data between 1970-2023, interpolated: linear
Stundum vorsnjór
r=0,7
r=-0,2
Þurr maí er kaldur
FYLGNI MAÍ-JÚN
0.63
0.54
0.45
0.36
0.27
0.18
0.09
0.00
−0.09
−0.18

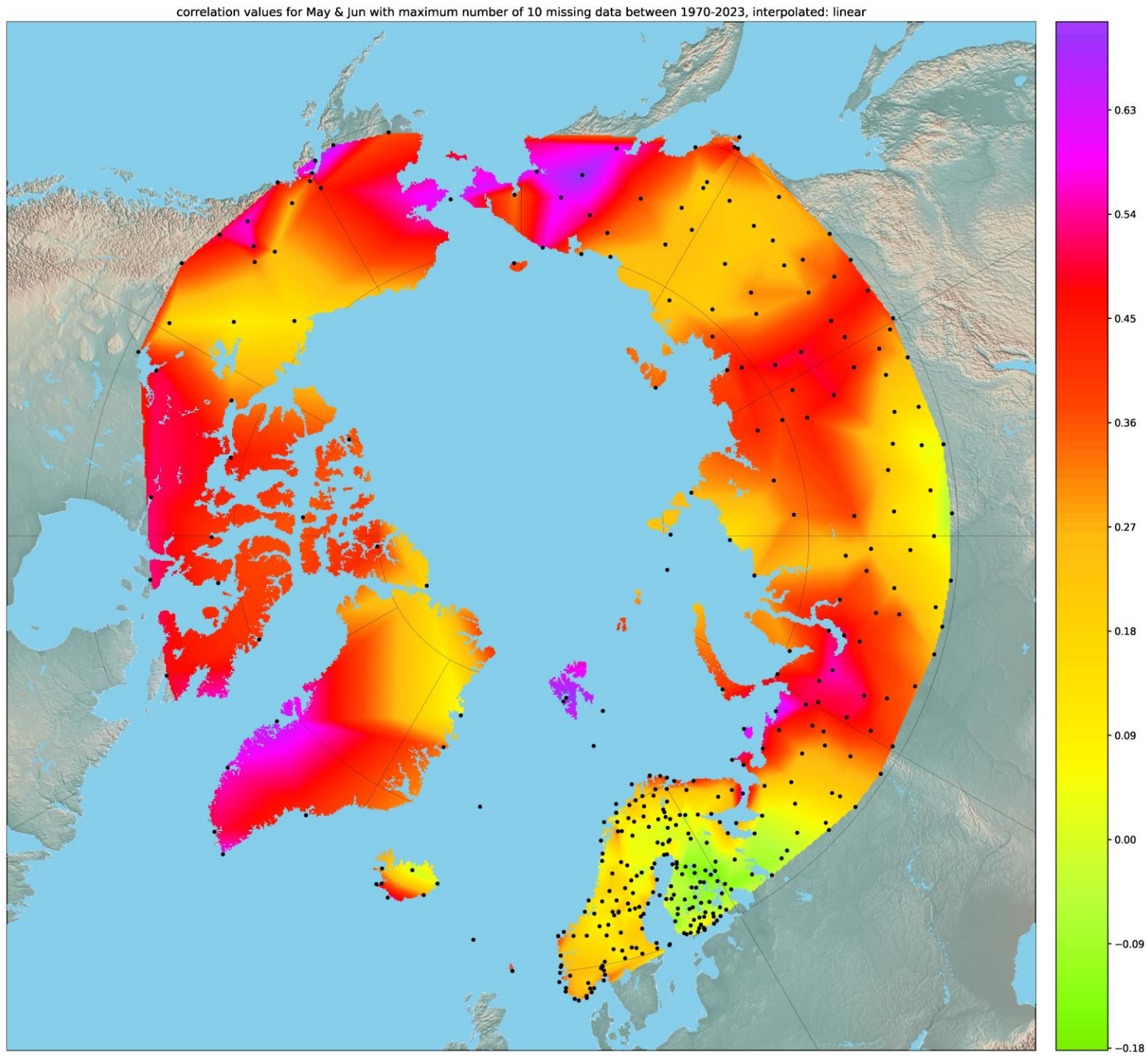

Arktischer Ozean
Alaska (USA)
Tschuktschen-
see
Bering-
Straße
Wrangel-
Insel
Aleuten (USA)
Anadyr
Ostsibirische
See
Beringsee
Pazifik
Kamtschatka
Petropawlowsk
Ochotskisches
Meer
Kurilen
Sachalin
Barents-
see
Kara-
see
Laptew-
see
Sewernaja
Semlja
Neusibirische
Inseln
Kap Tscheljuskin
Nowaja
Semlja
Kolyma
Lena
Murmansk
Ostsee
Petersburg
Moskau
Nischni Nowgorod
Dnepr
Don
Wolga
Wolgograd
Schwarzes Meer
Kaspisches Meer
Aral
Wiljui
Aldan
Jenissei
Irtysch
Ob
Amur
Omsk
Krasnojarsk
Nowosibirsk
Irkutsk
Baikal
Jakutsk
Wladiwostok
0°
30°O
60°O
90°O
120°O
150°O
180°
75°N
60°N
45°N
km
0
500
1000
6000
4000
2800
1700
1200
500
50
0
m

# Sveitin með mestu fylgnina




# Næst

- Sumar og haust á heimskautaslóðum


correlation values for May & Jun with maximum number of 10 missing data between 1970-2023, interpolated: linear
0.63
0.54
0.45
0.36
0.27
0.18
0.09
0.00
−0.09
−0.18

Northern Hemisphere

89x89 Visible Satellite

Monthly Snow Extent (percent of days snow covered)

Area of Snow Extent

Northern Hemisphere:
16.28 million sq. km

Eurasia:
7.26 million sq. km

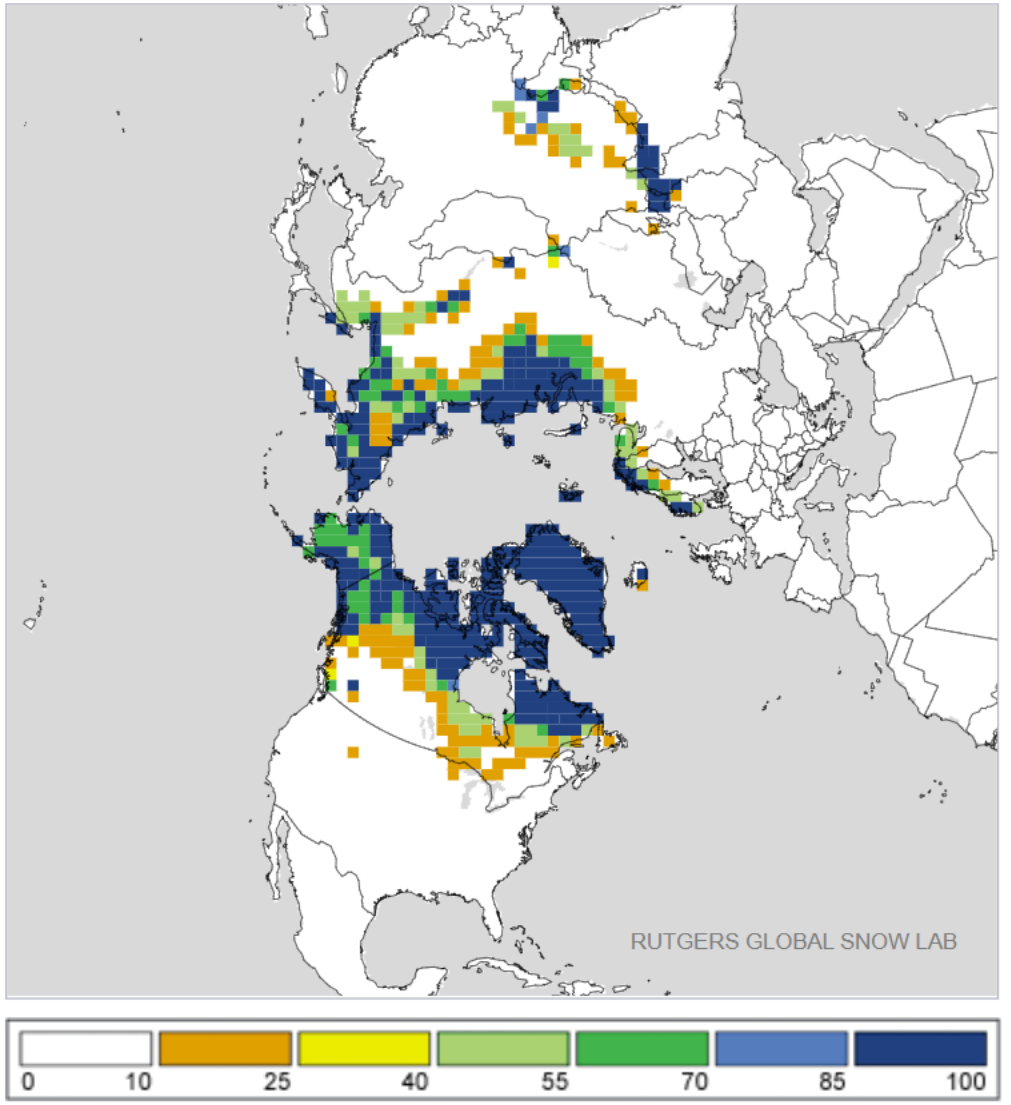
North America:
9.02 million sq. km

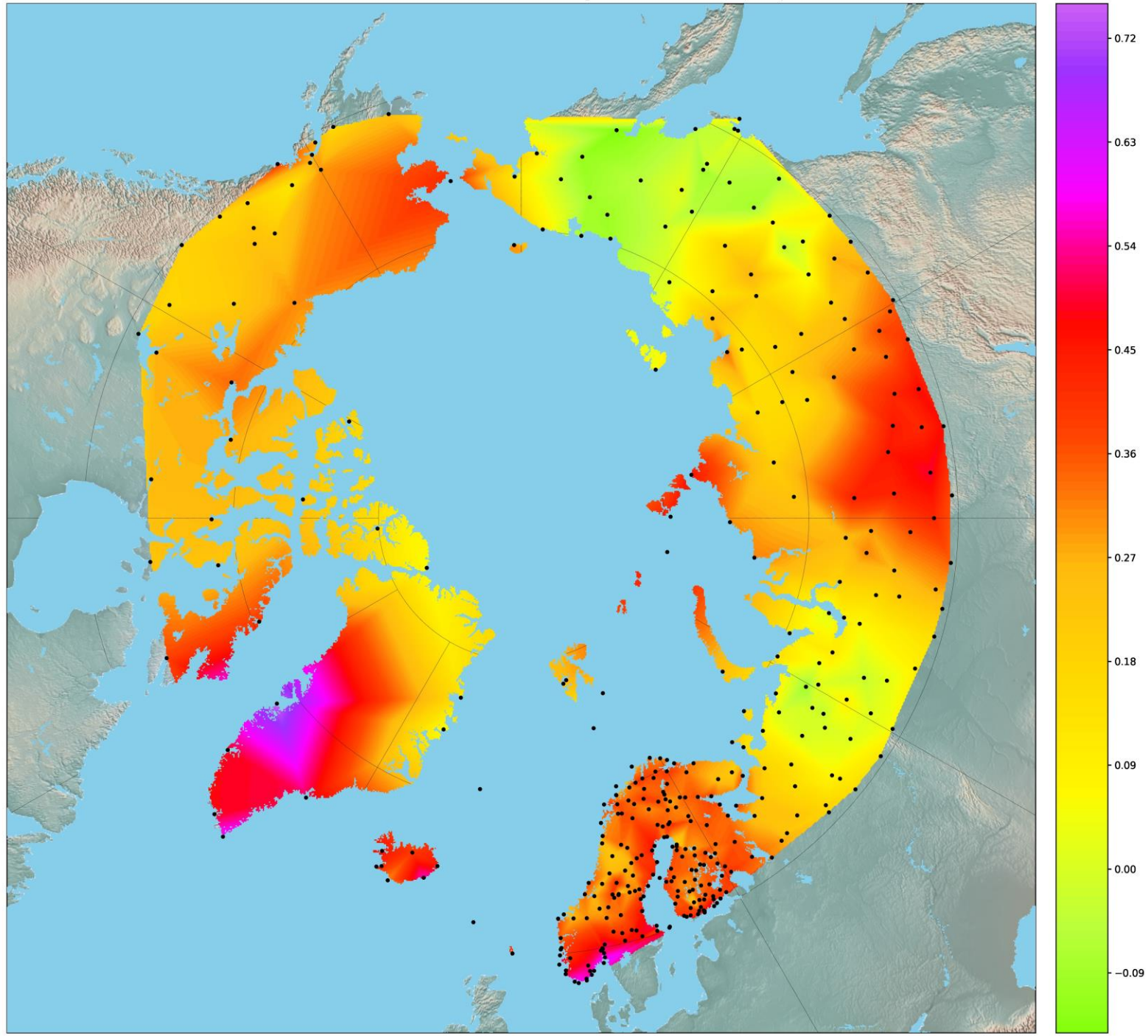
<< < YEAR > >>

< MONTH >

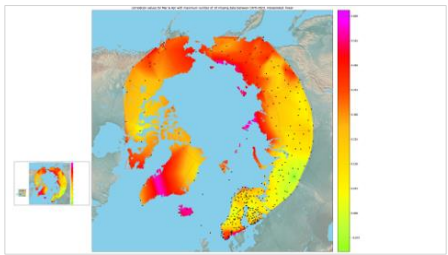
See Departure

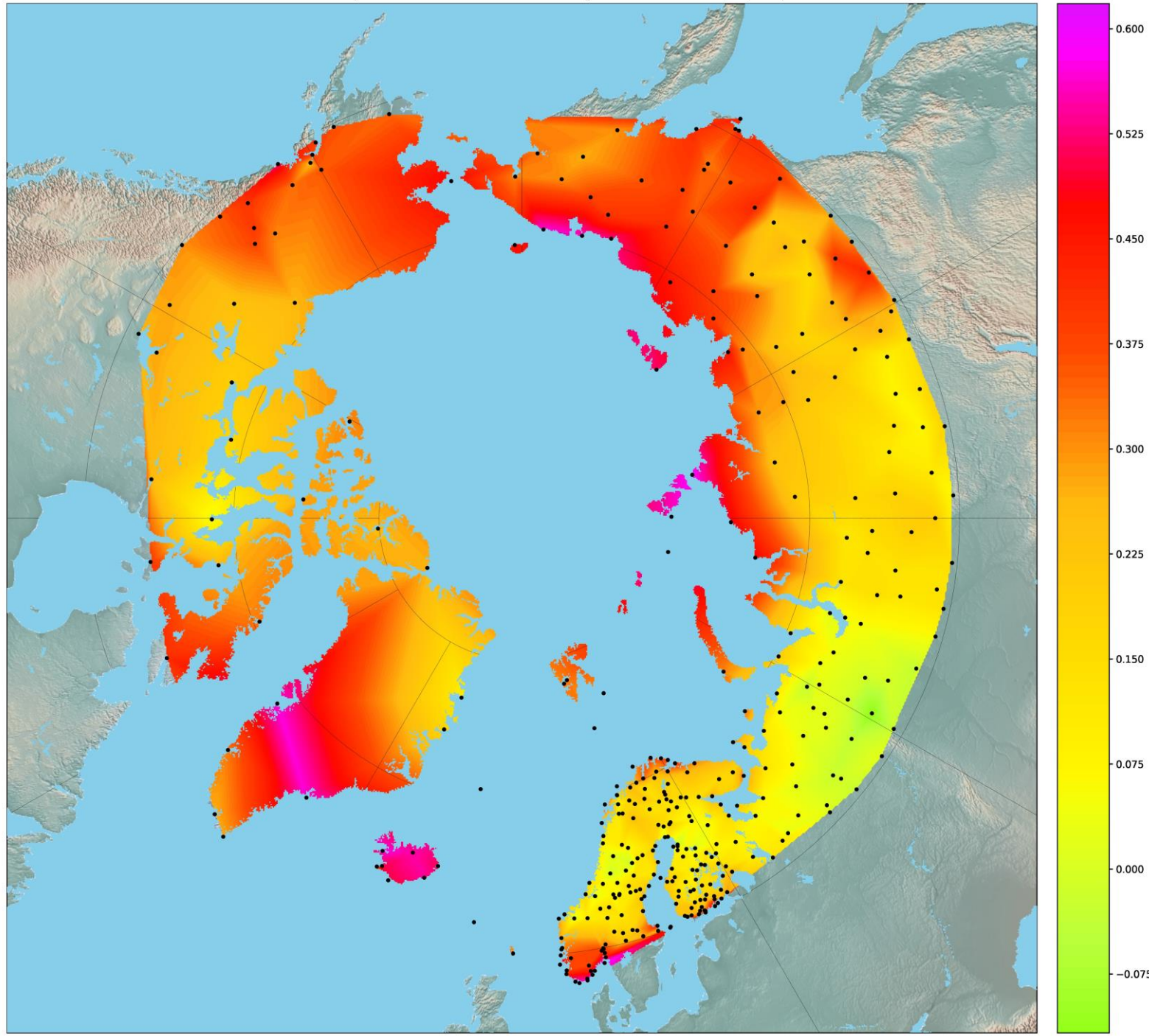
# Monthly Snow Cover Extent - May 2013

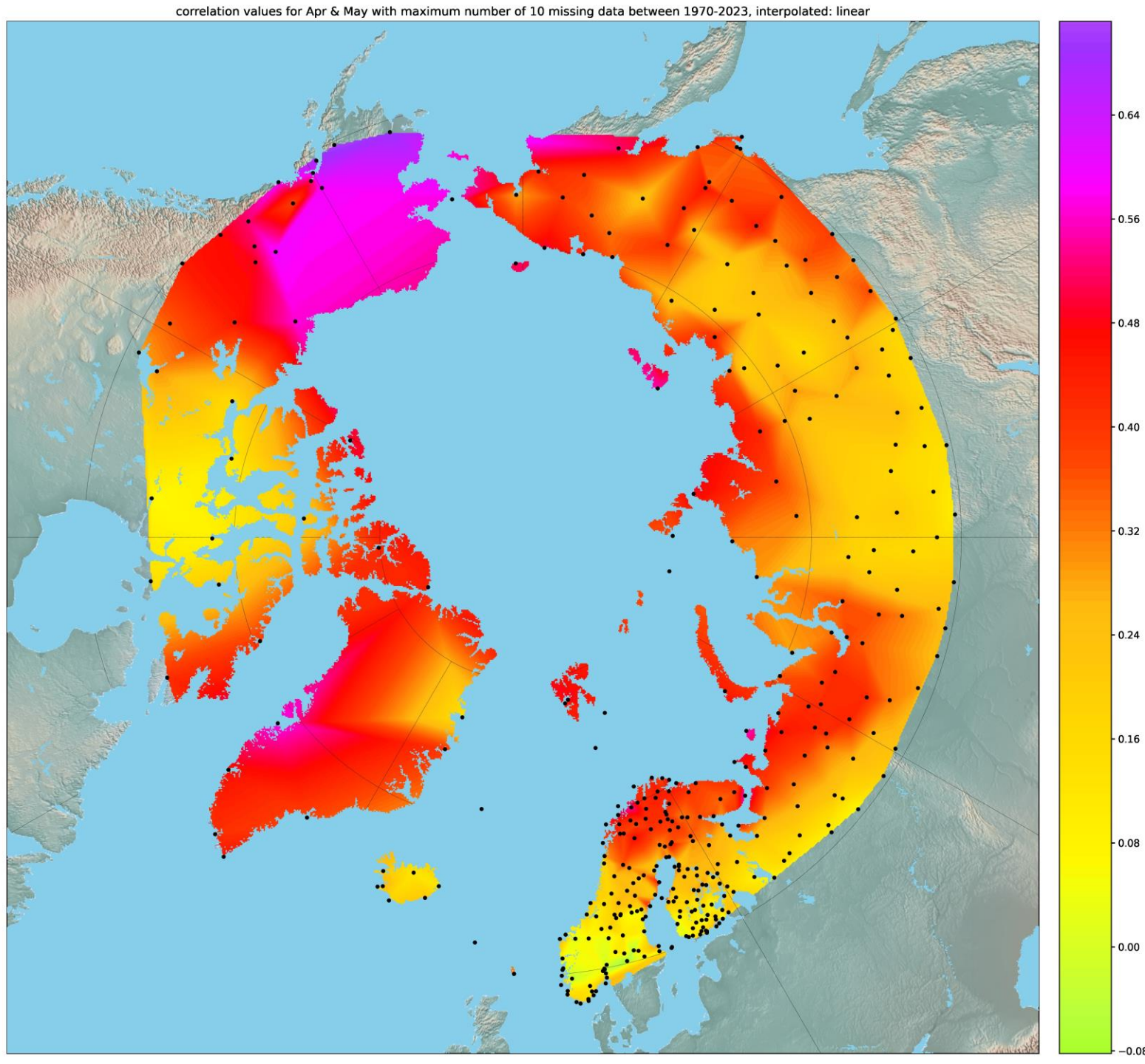



correlation values for Feb & Mar with maximum number of 10 missing data between 1970-2023, interpolated: linear
0.72
0.63
0.54
0.45
0.36
0.27
0.18
0.09
0.00
−0.09

correlation values for Mar & Apr with maximum number of 10 missing data between 1970-2023, interpolated: linear



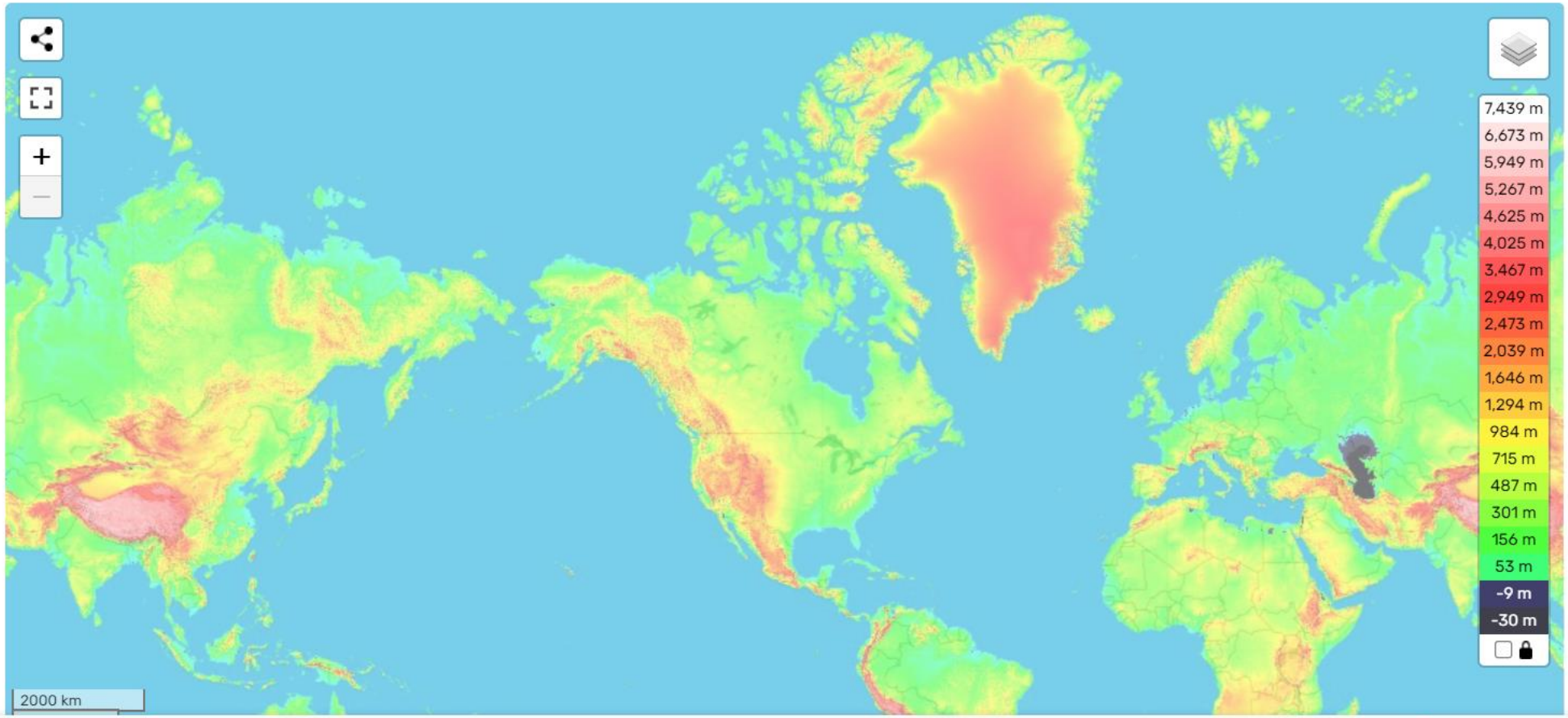



correlation values for Apr & May with maximum number of 10 missing data between 1970-2023, interpolated: linear
0.64
0.56
0.48
0.40
0.32
0.24
0.16
0.08
0.00
−0.08

en-ca.topographic-map.com/map-kc957/Canada/?center=58.63122%2C-99.84375

Derivative Calculato... Graphing Calculato... Detached House fo... FourCastNet — Mo... CARRA Iceland - Go... 9781009157971 me... Navlost – METAR /... Learn Icelandic Onli... mán 18:00 All Book

Click on the **map** to display **elevation**.

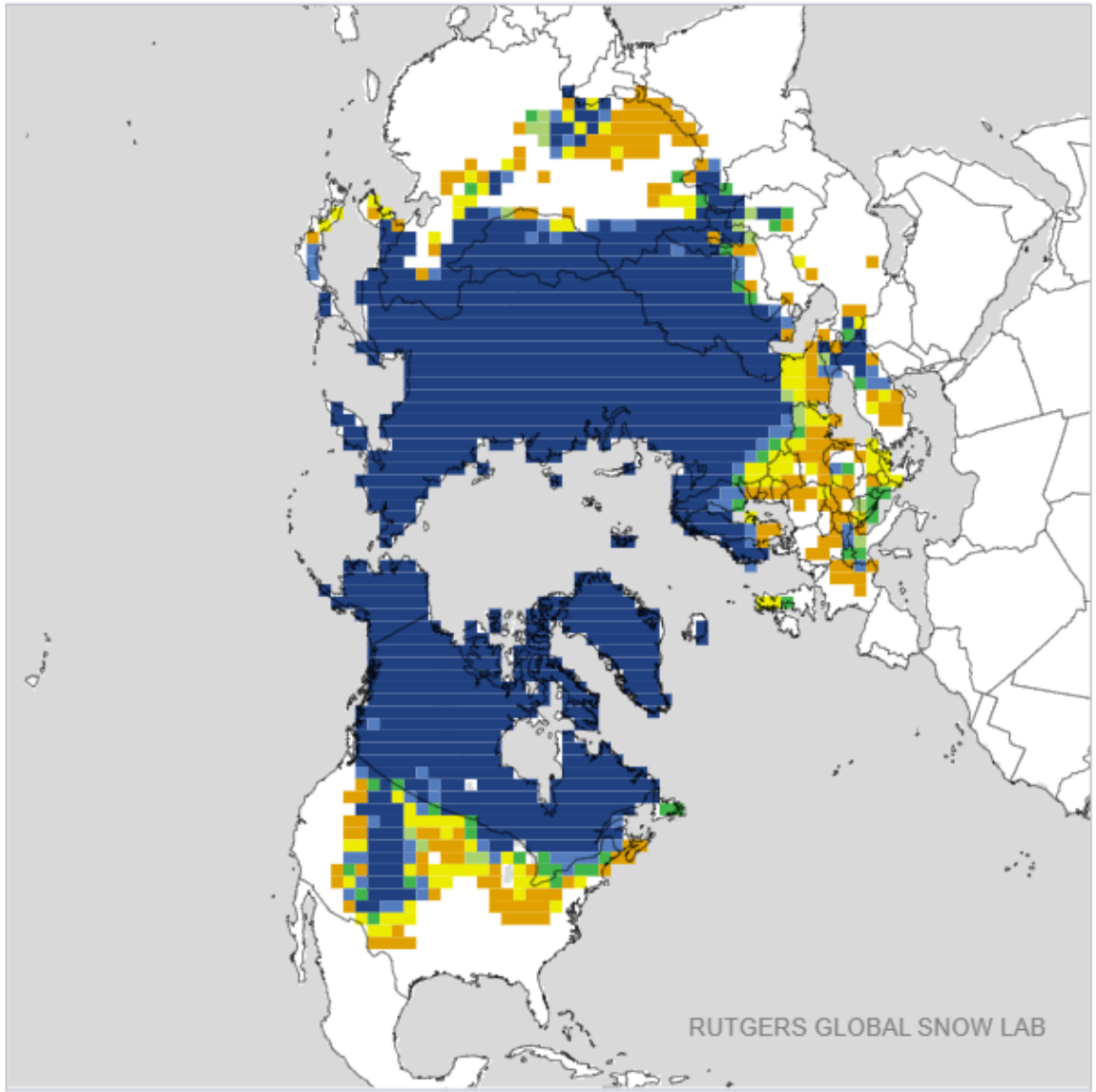


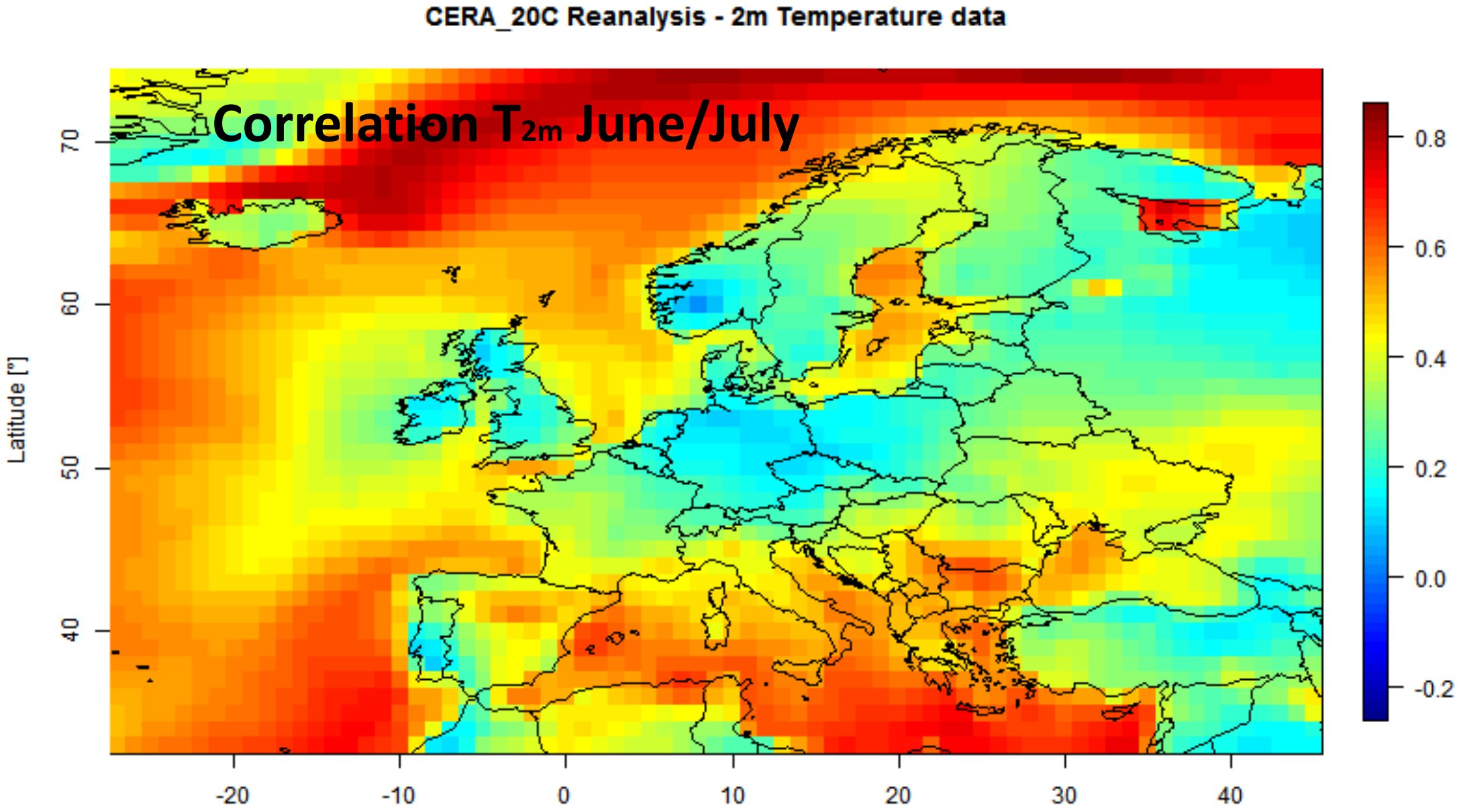


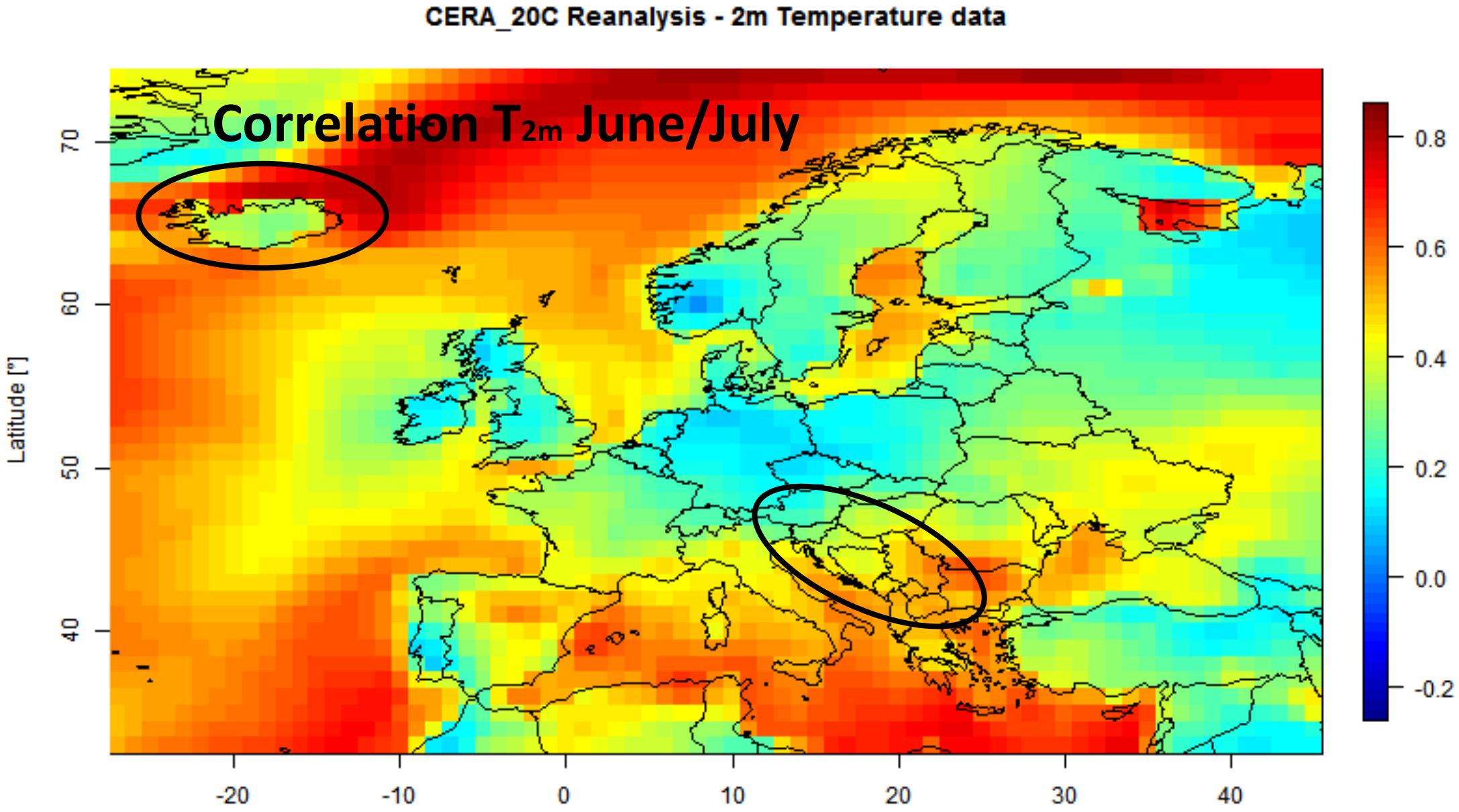

Type here to search

08:49
12.10.2023

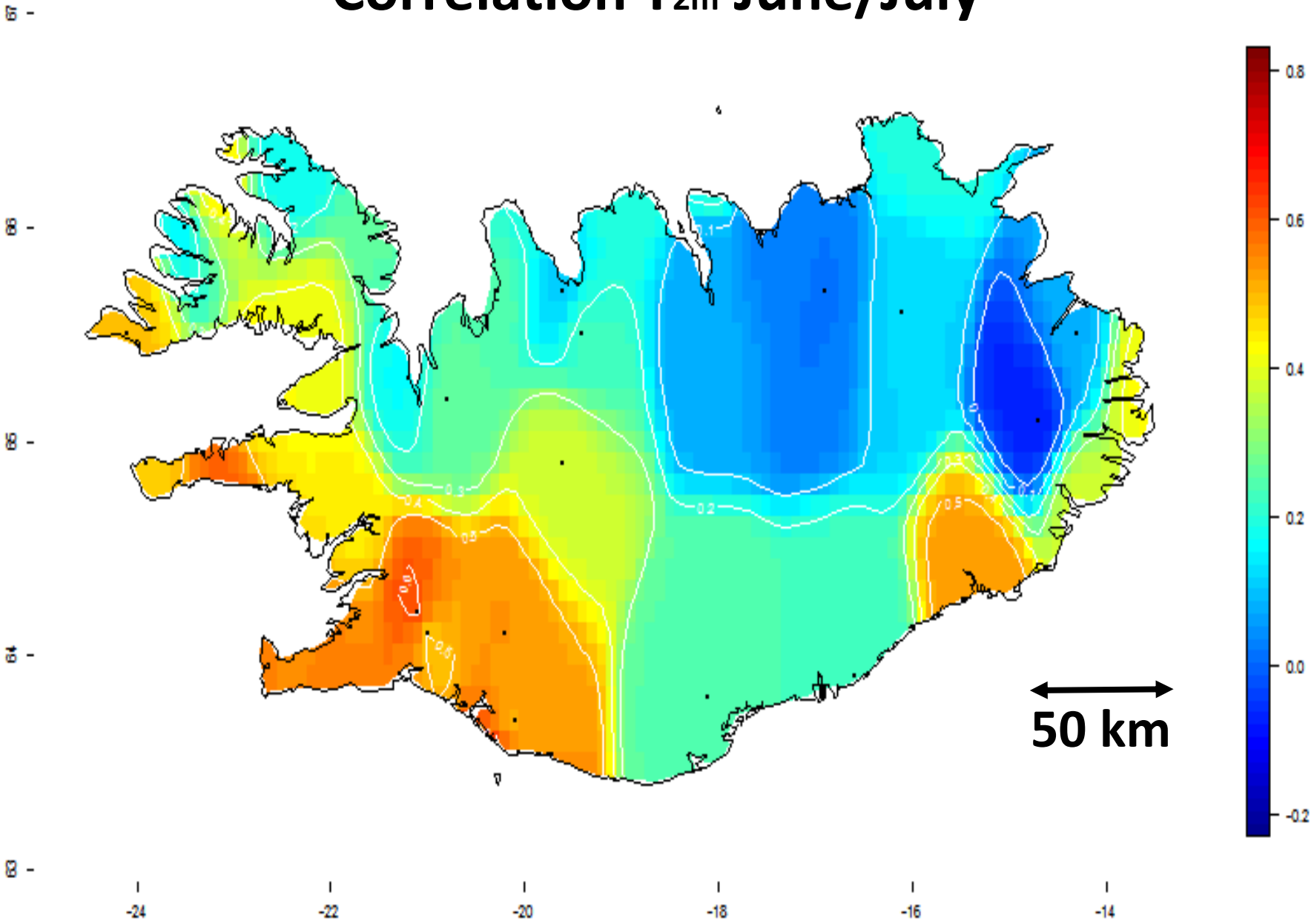
# Monthly Snow Cover Extent - December 2011



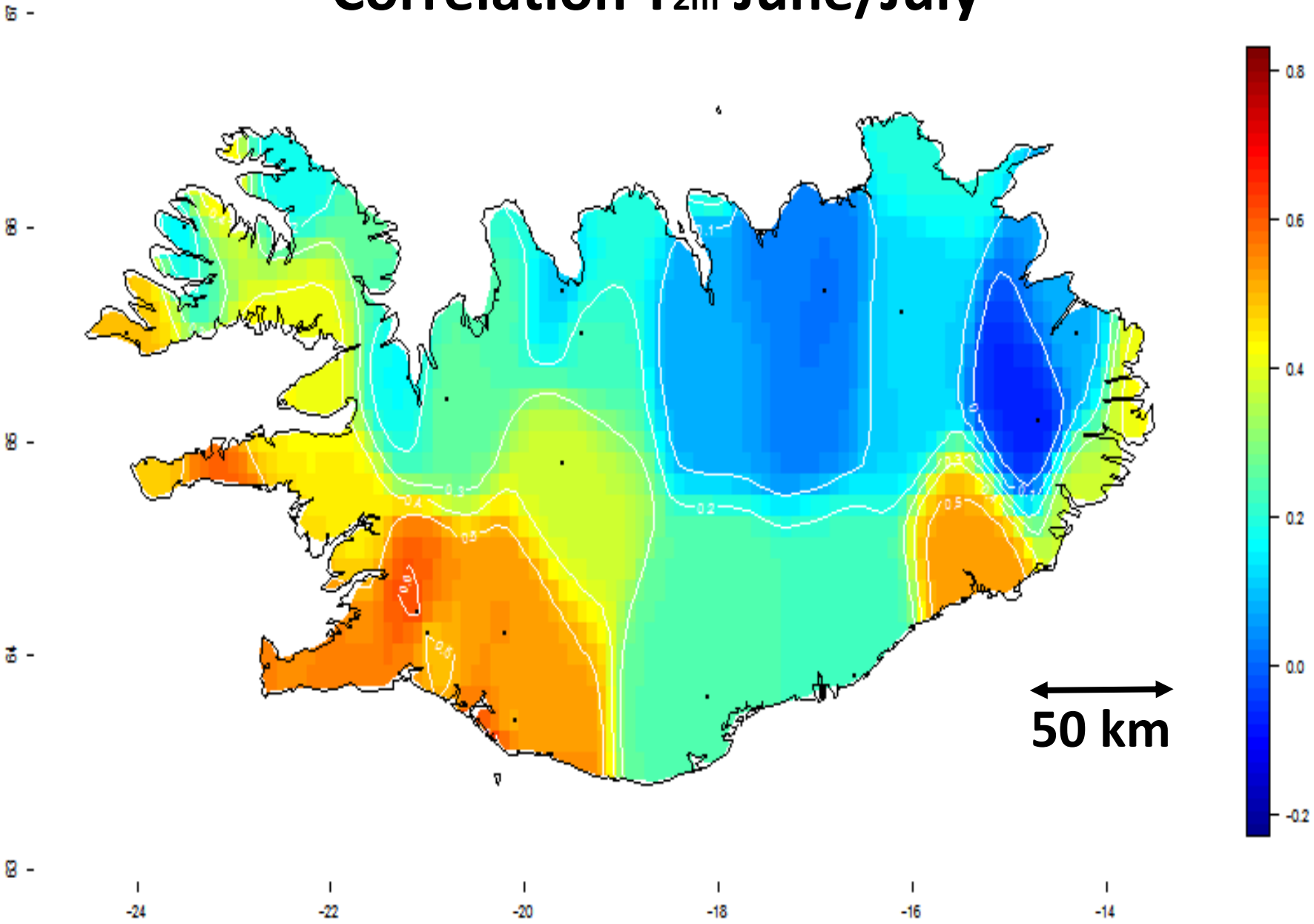

CERA_20C Reanalysis - 2m Temperature data
Correlation T2m June/July
Latitude [°]
70
60
50
40
-20
-10
0
10
20
30
40
0.8
0.6
0.4
0.2
0.0
-0.2


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

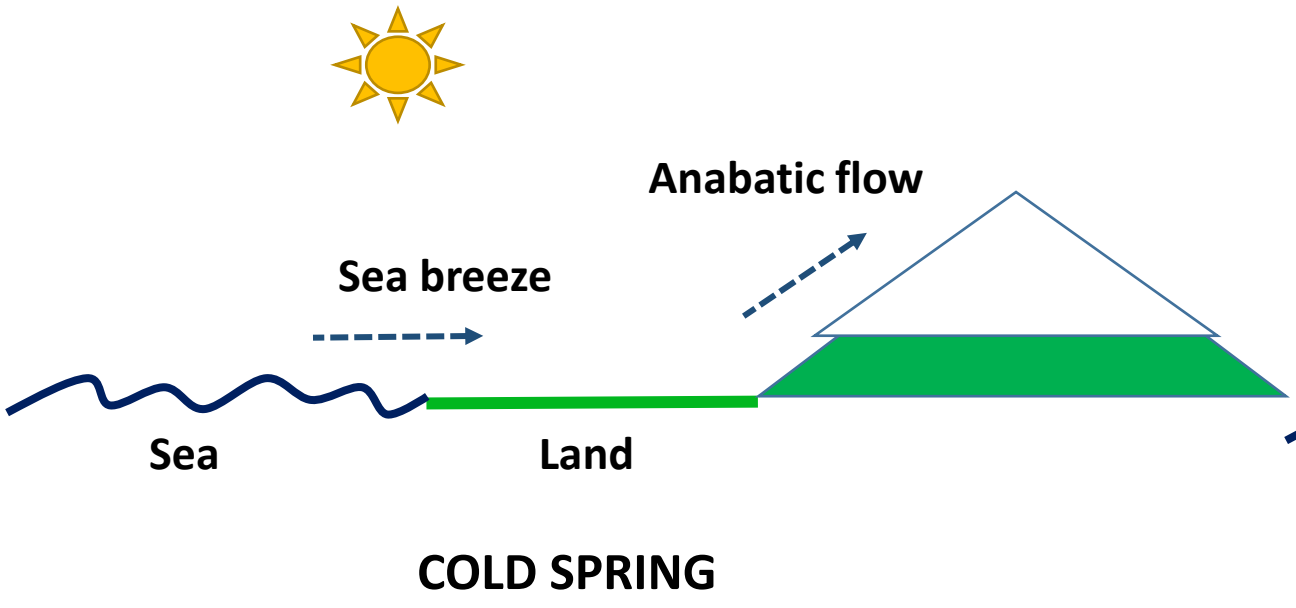


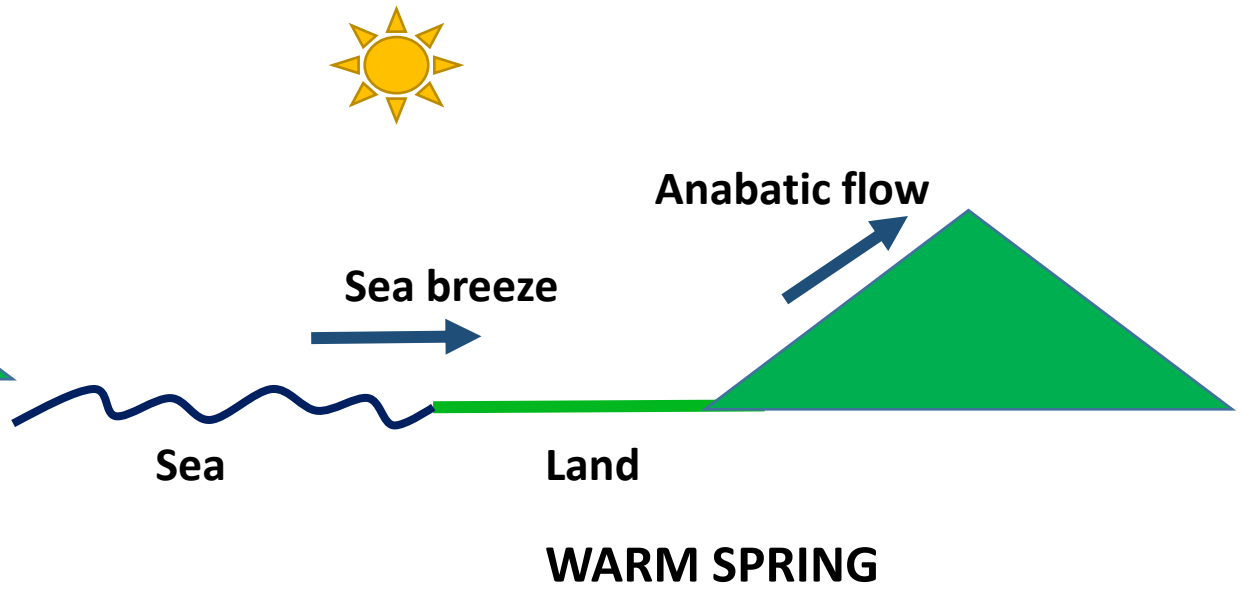
# Correlation $T_{2m}$ June/July



# The mesoscale circulation negative feedback

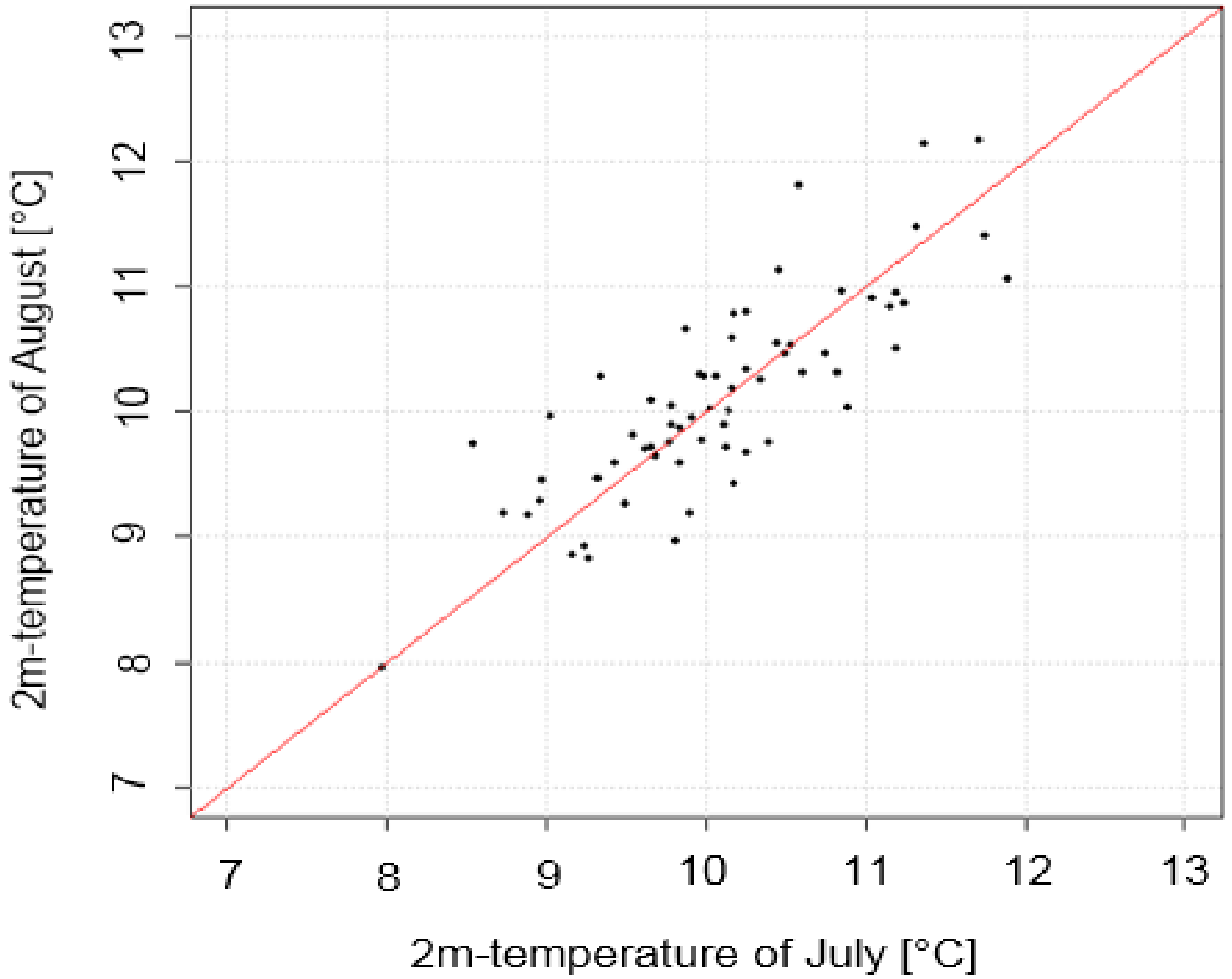
How can a cold June give a warm July?




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

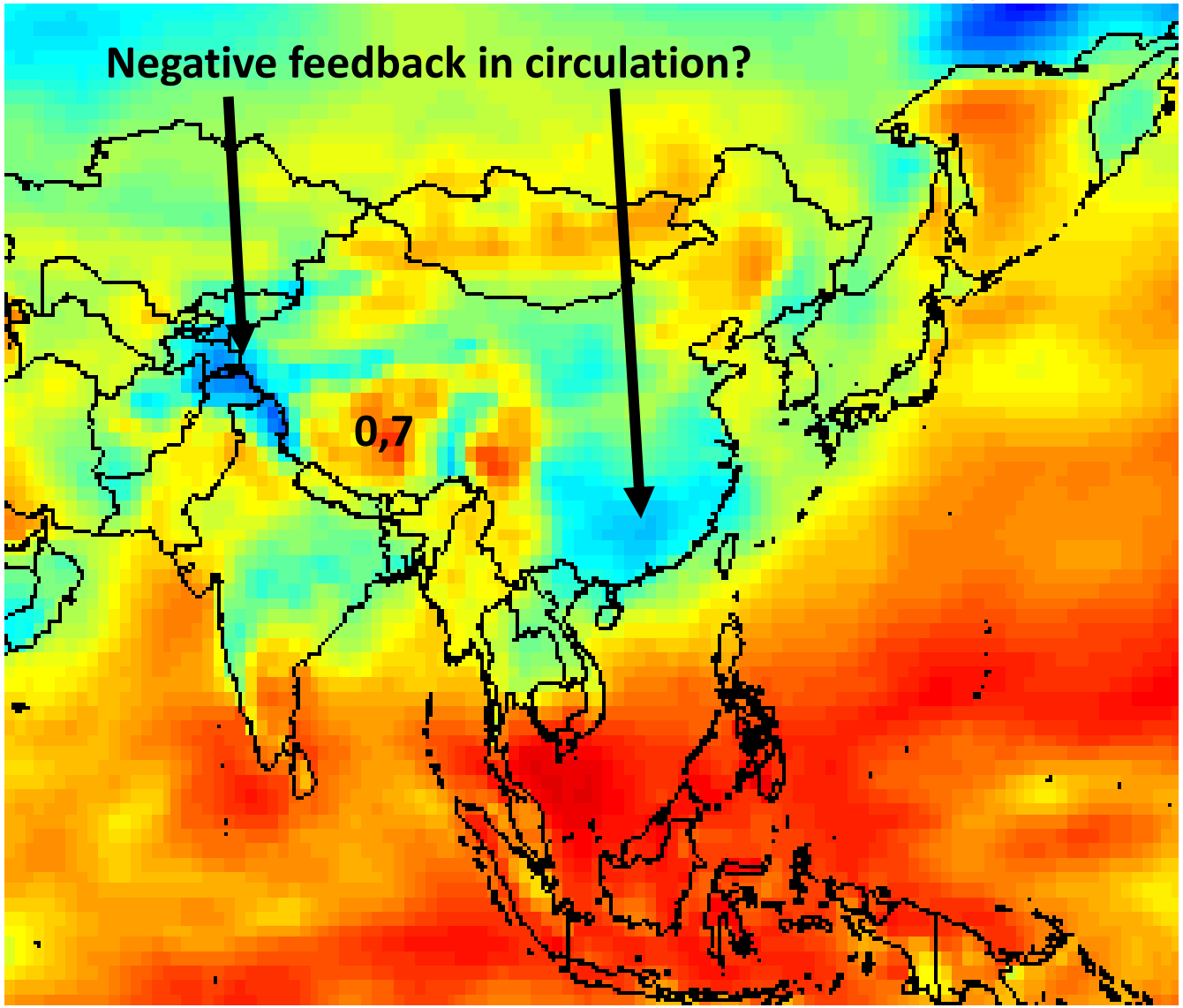
c) Vestmannaeyjar




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!**

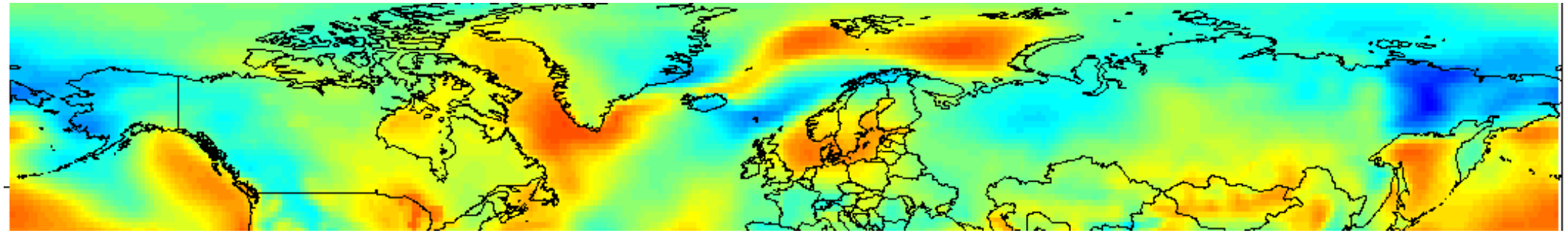
# Correlation $T_{2m}$ January/February

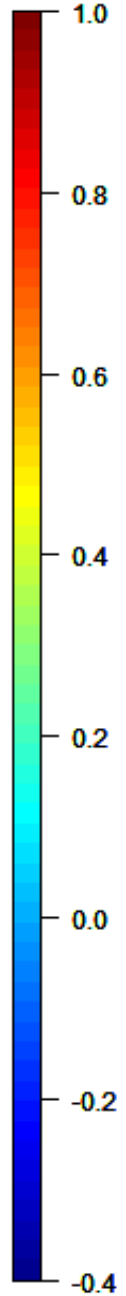



# Correlation $T_{2m}$ January/February

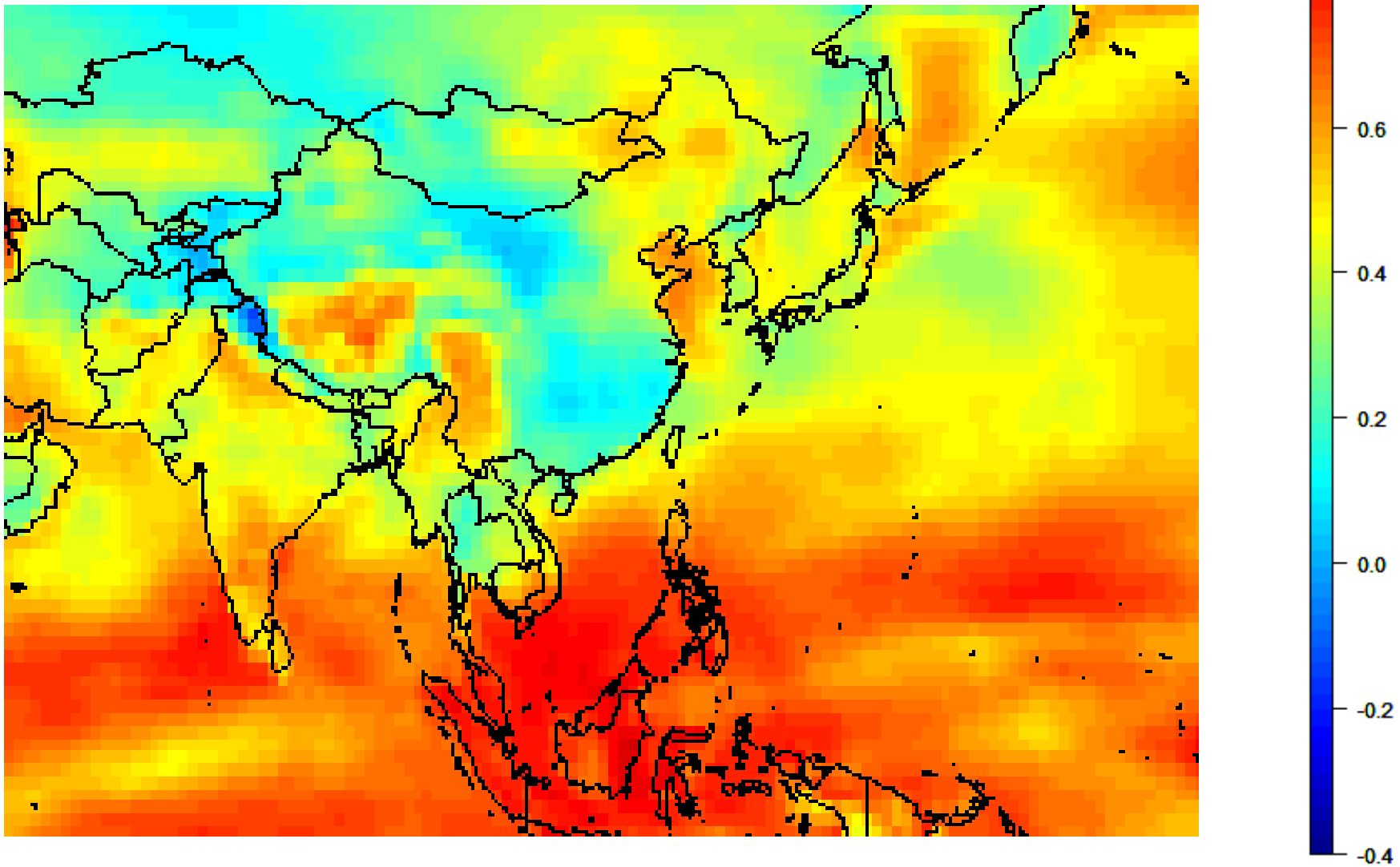
**Negative feedback in circulation?**

**0,7**

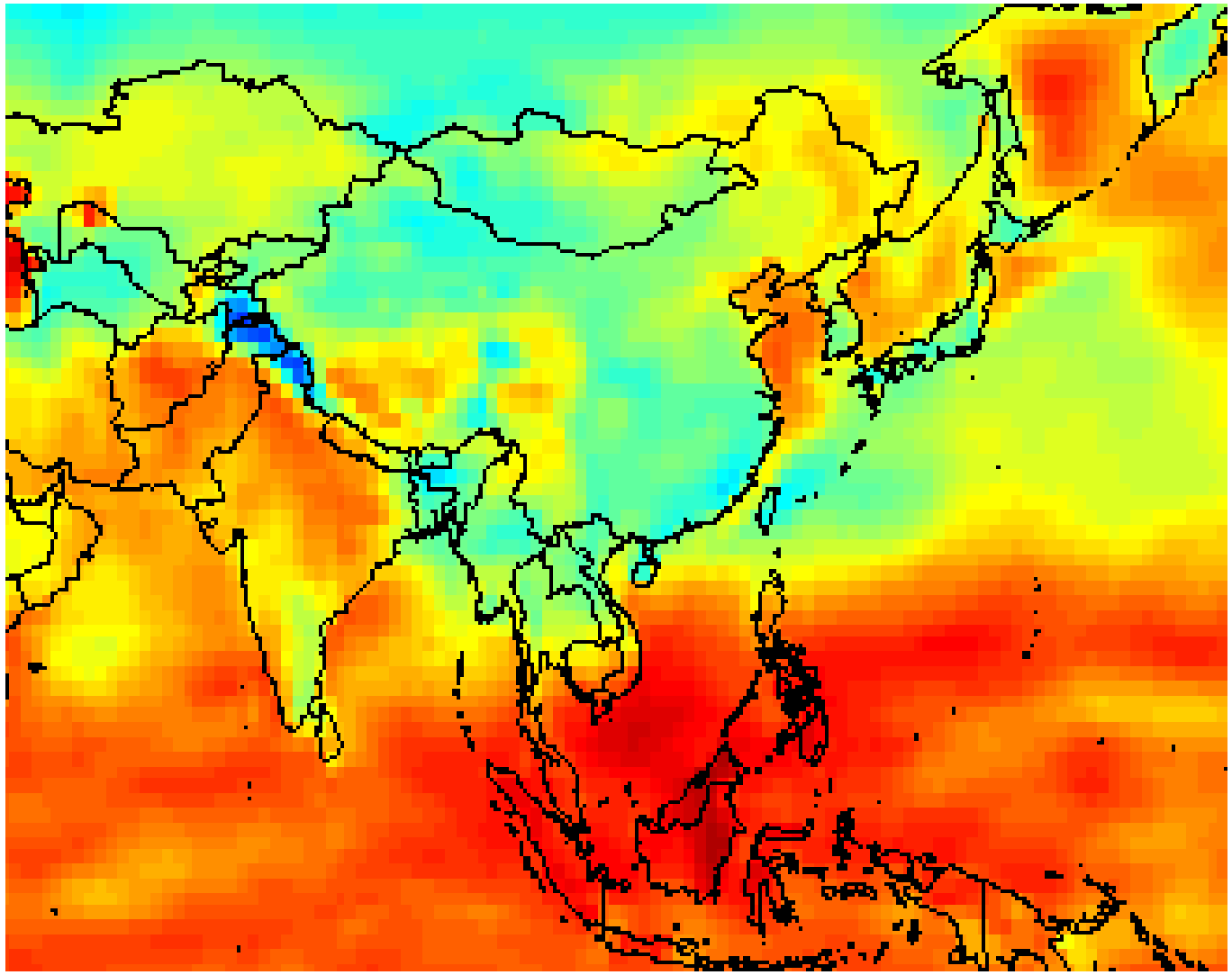




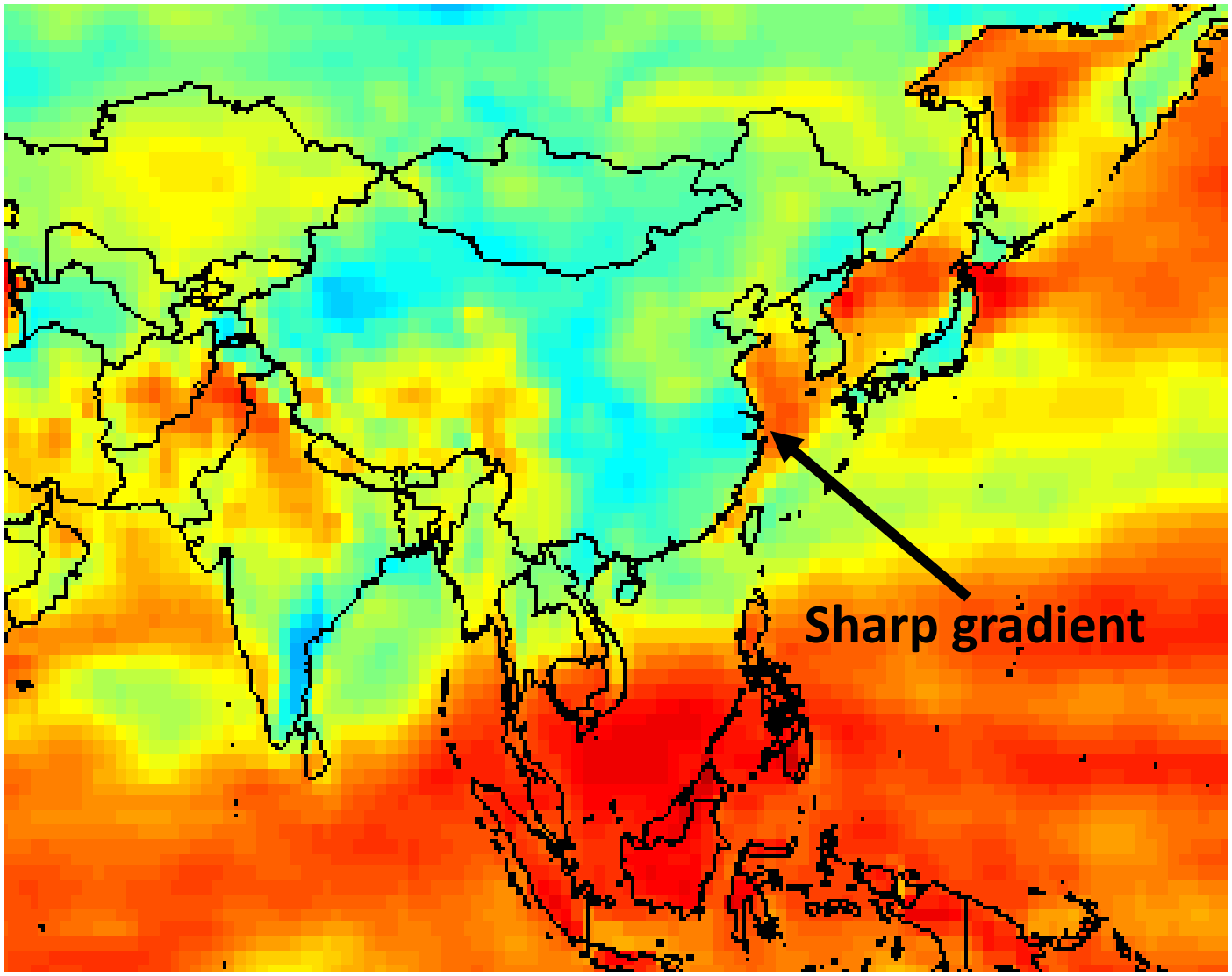
# Correlation $T_{2m}$ Feb/Mar



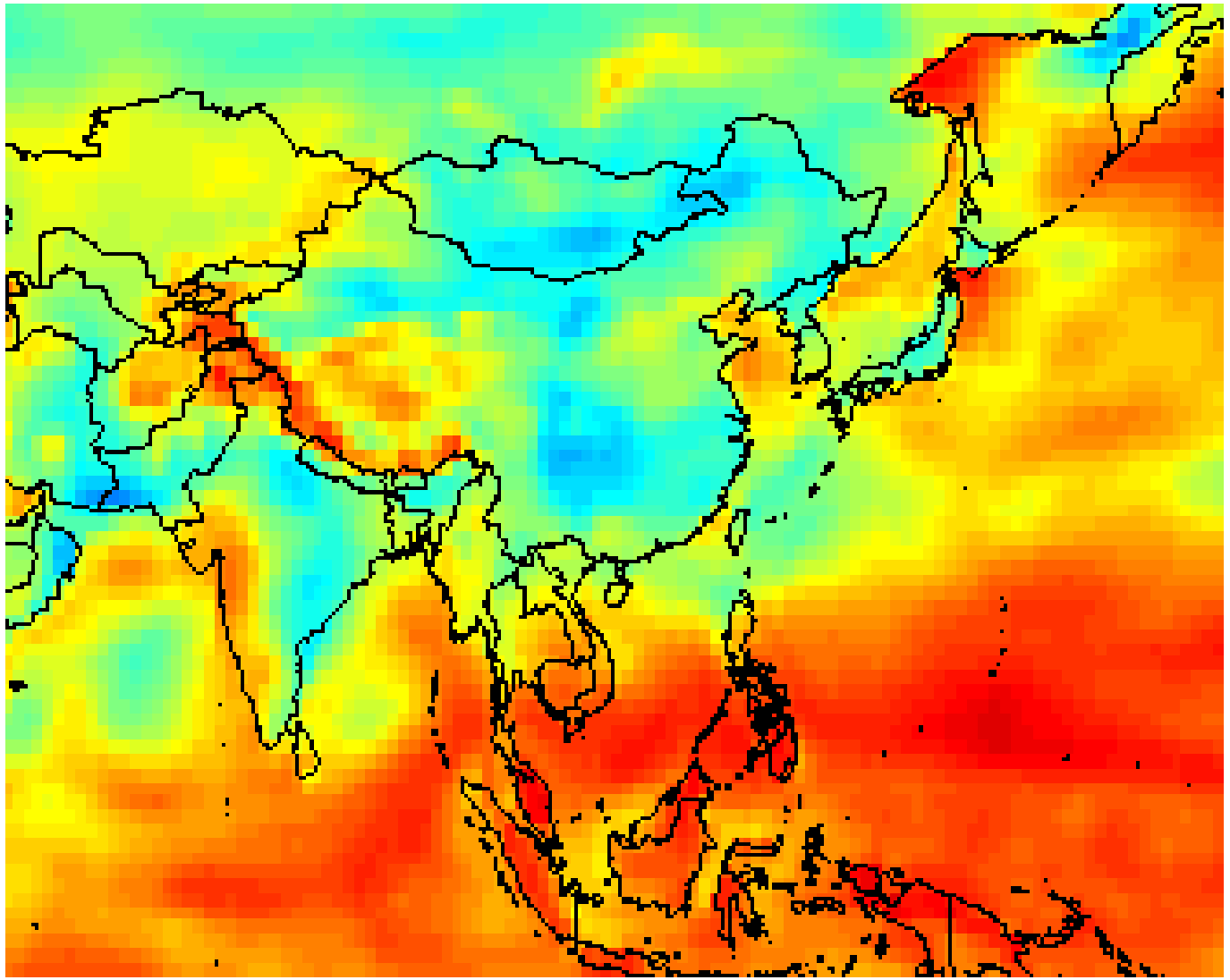
# Correlation $T_{2m}$ Mar/Apr

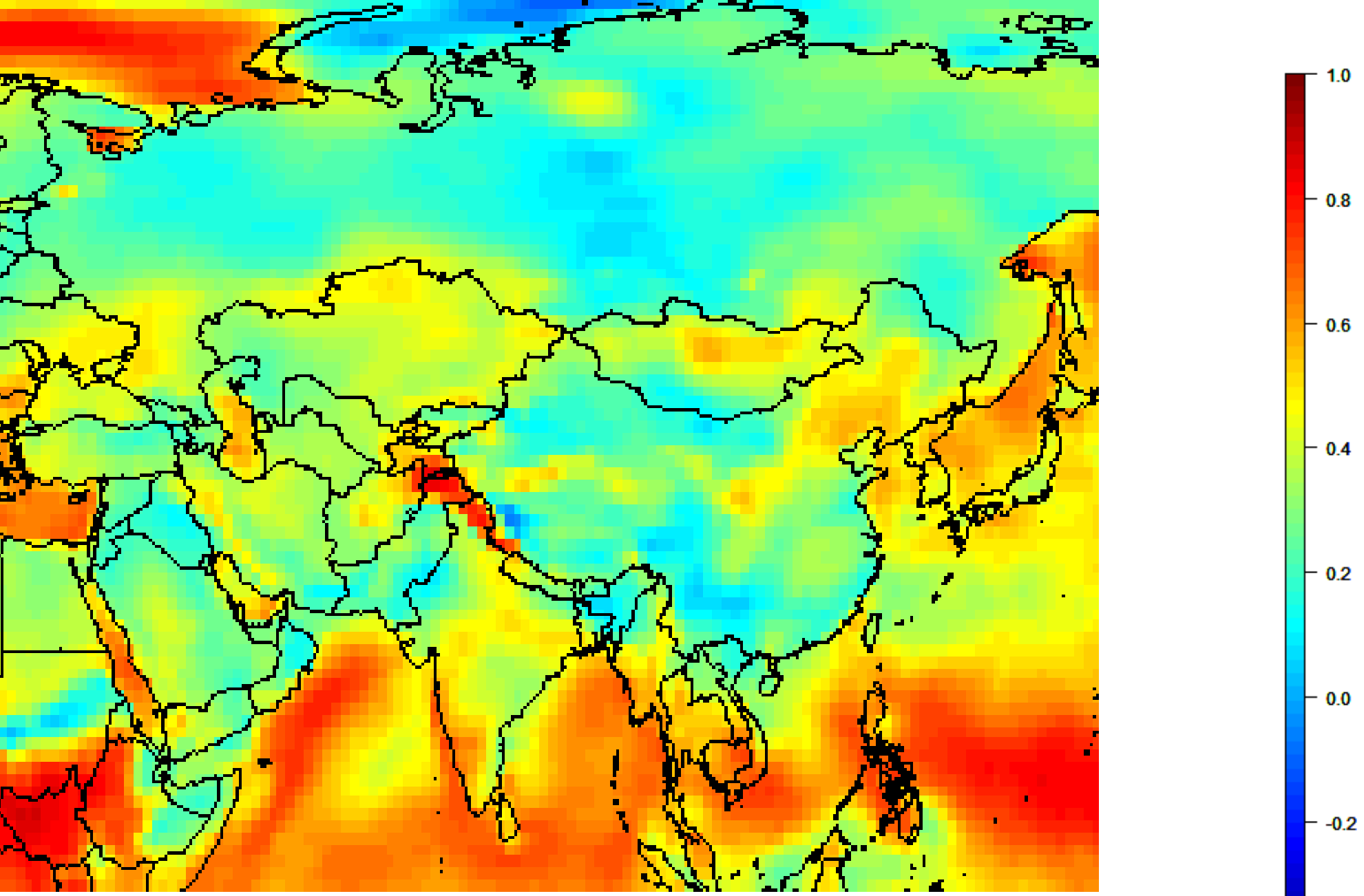


# Correlation $T_{2m}$ Apr/May

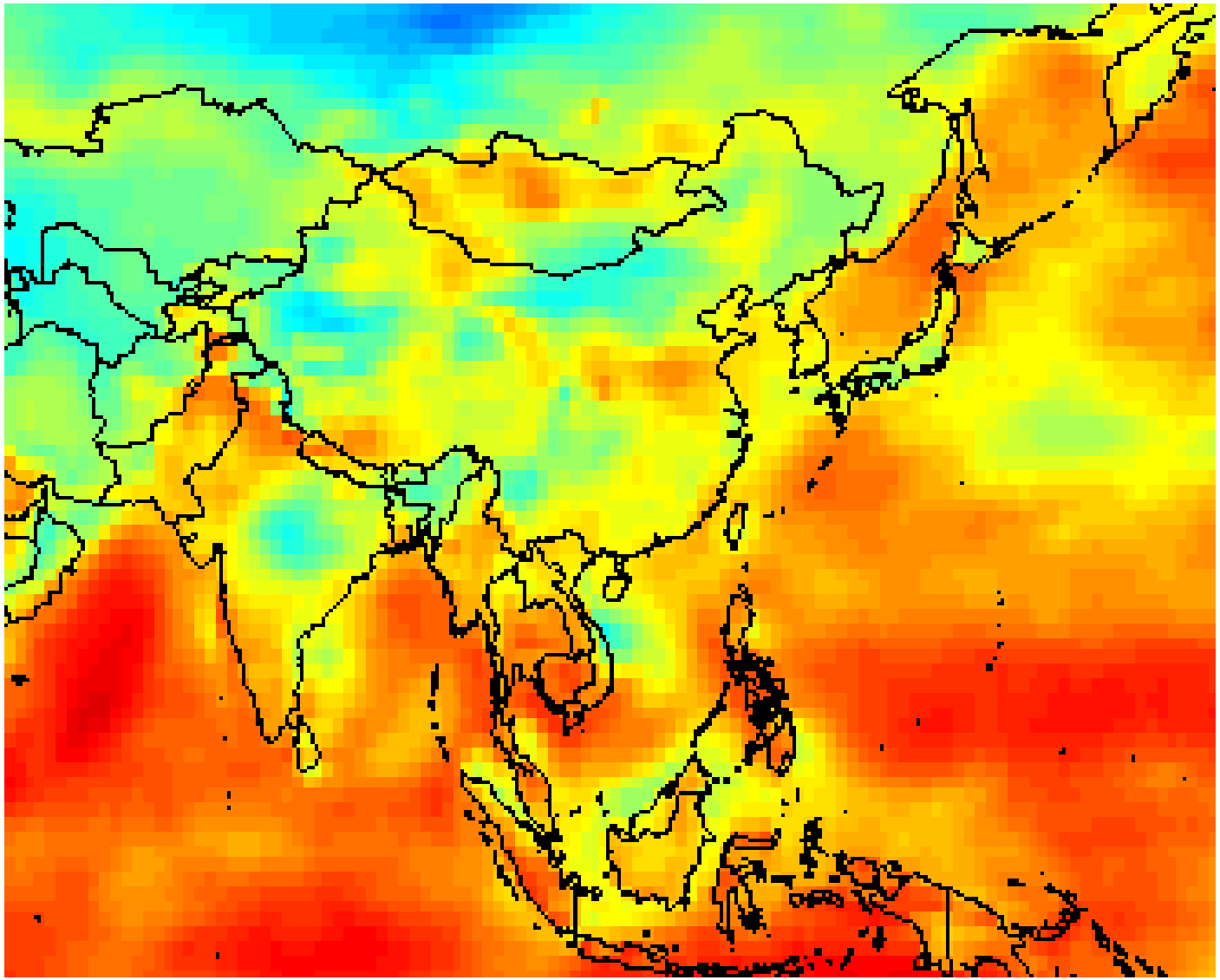



# Correlation $T_{2m}$ May/June

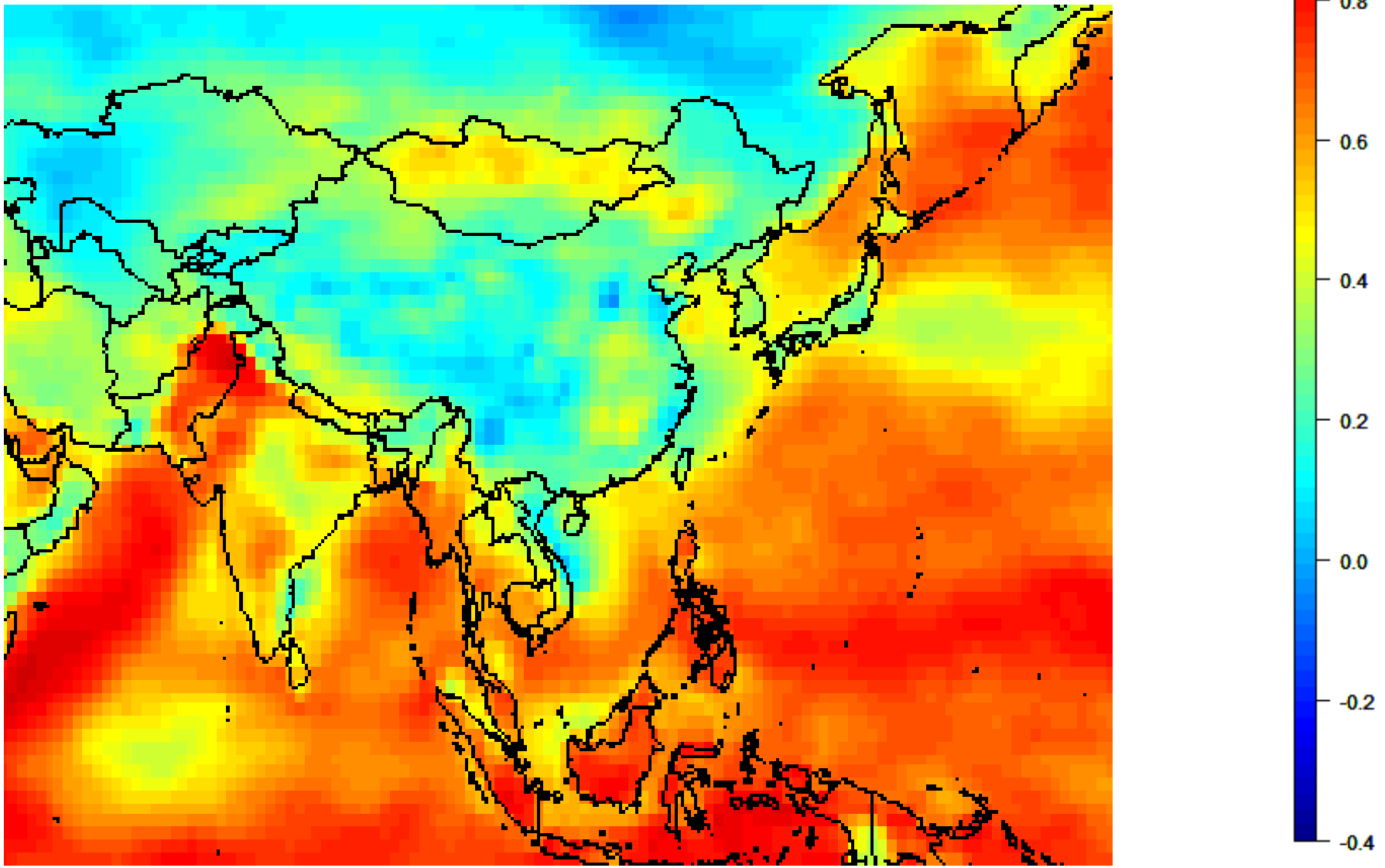



1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4

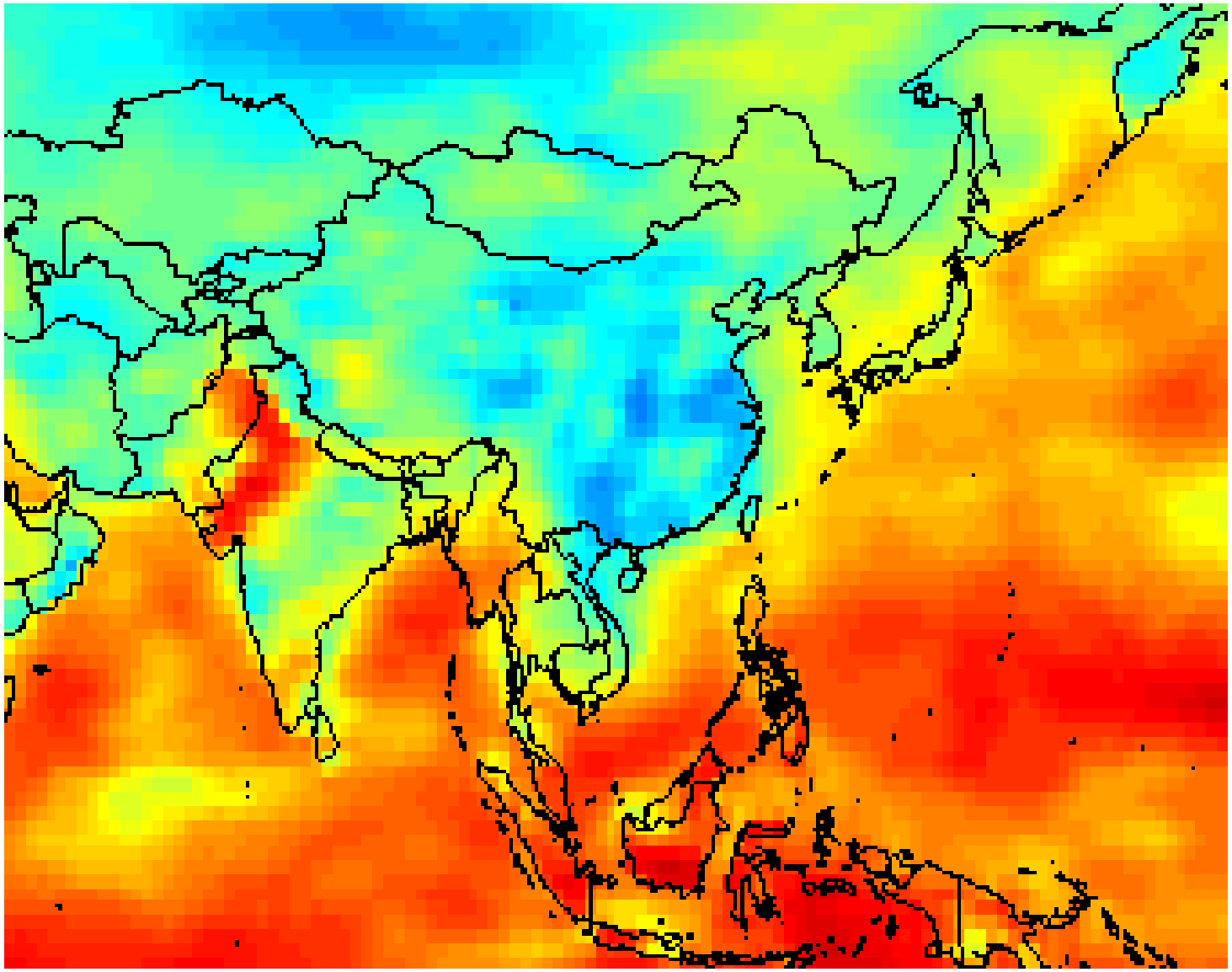
# Correlation $T_{2m}$ July/August



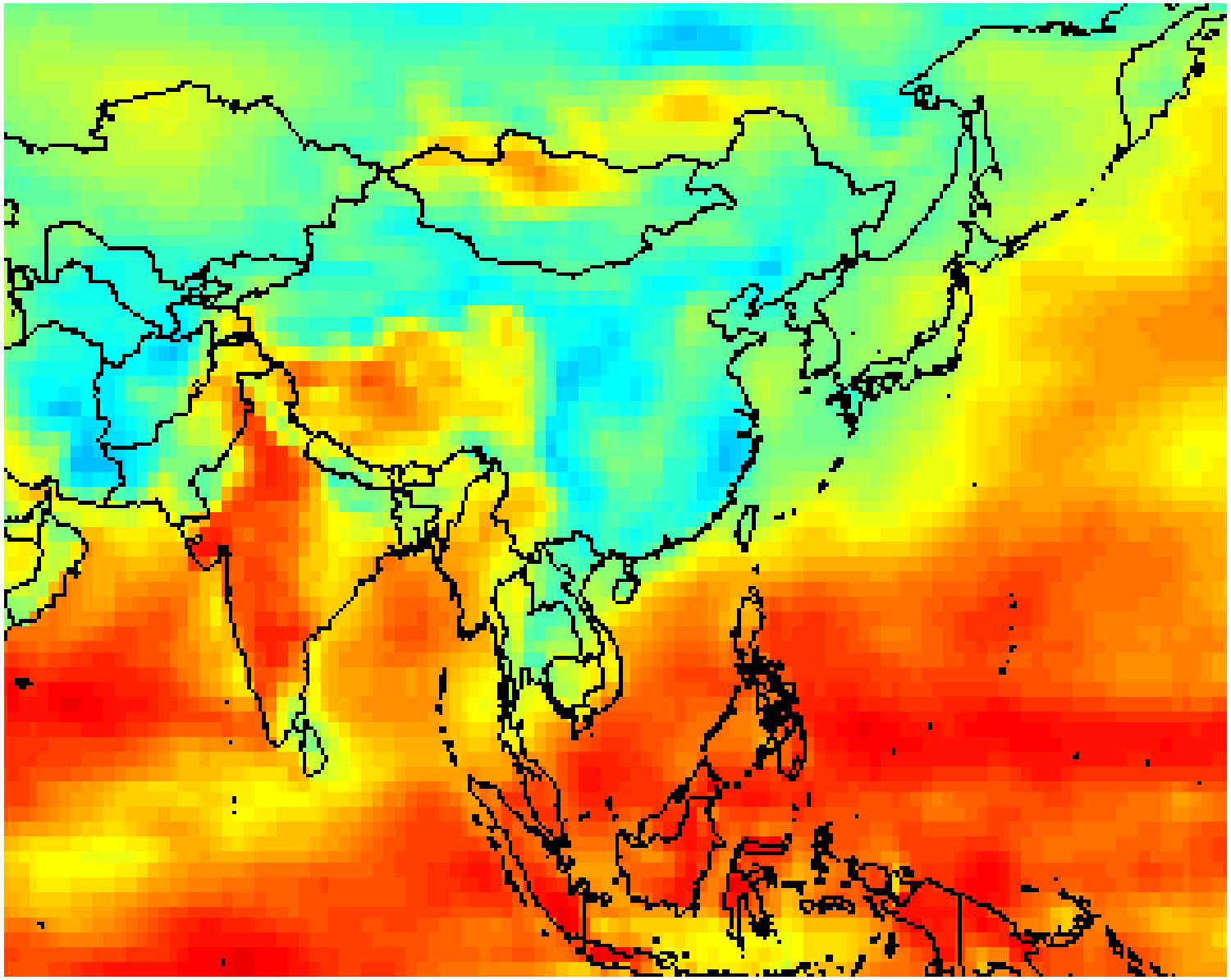
# Correlation $T_{2m}$ Aug/Sep



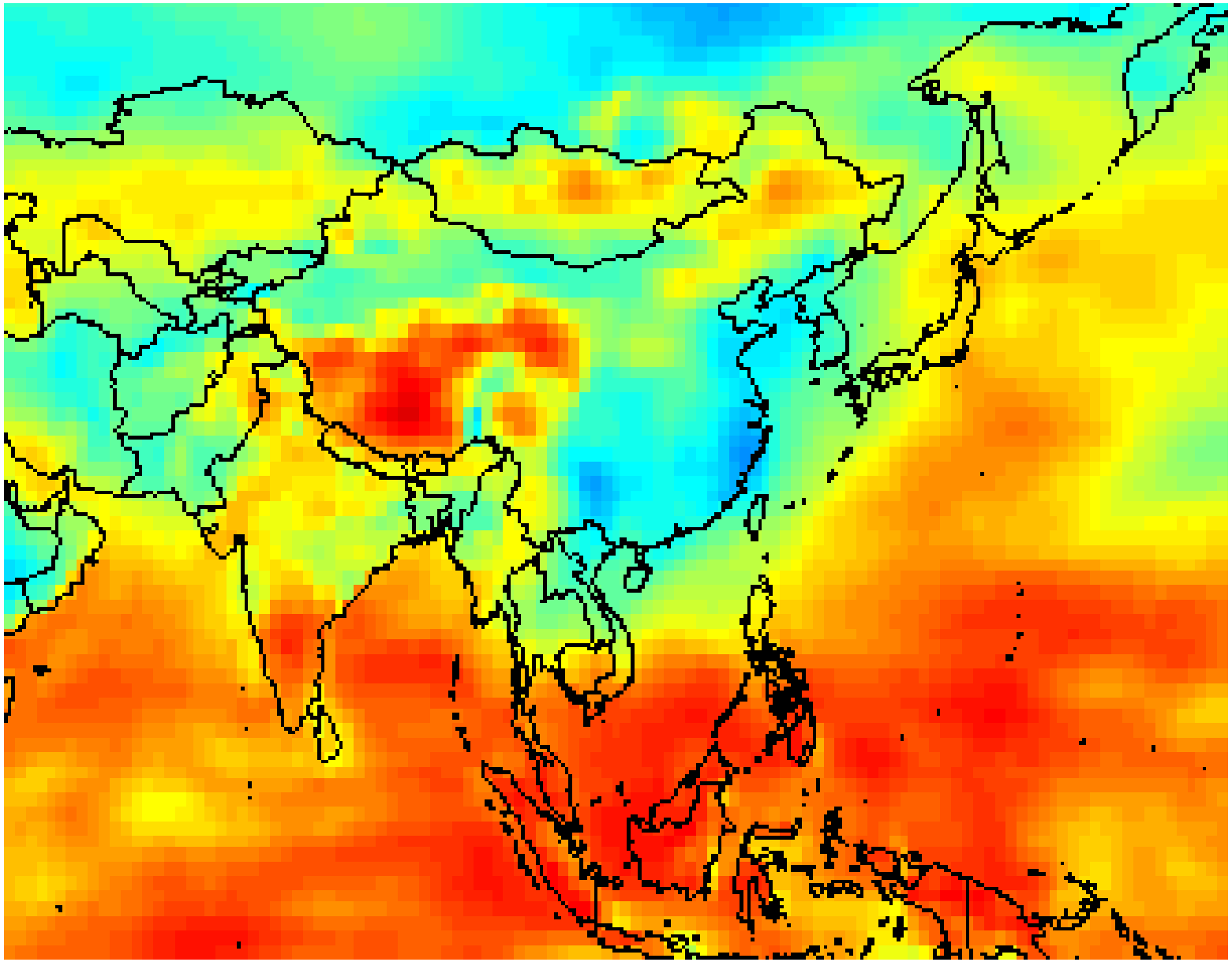
# Correlation $T_{2m}$ Sep/Oct



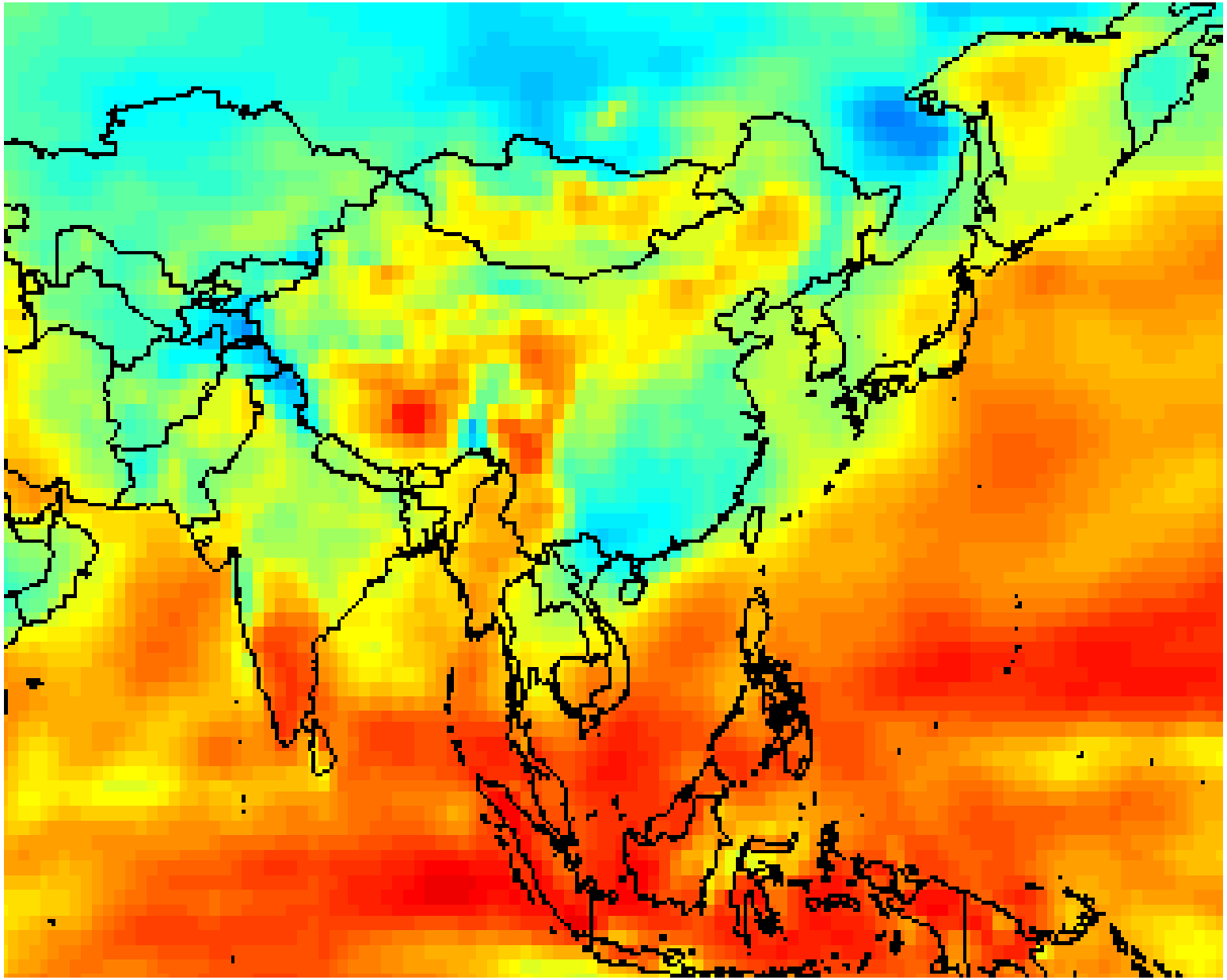
# Correlation $T_{2m}$ Oct/Nov



# Correlation $T_{2m}$ Nov/Dec

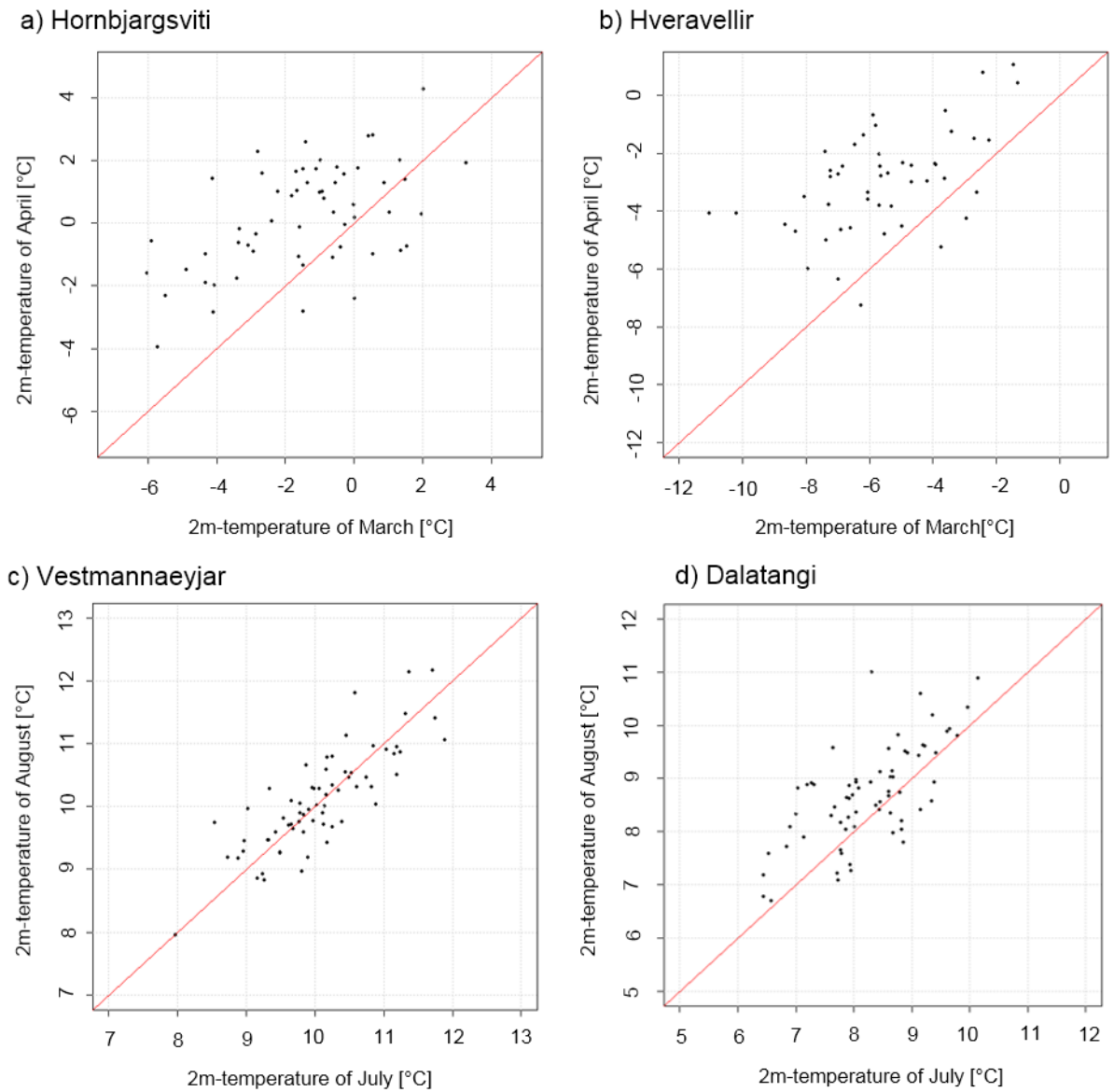


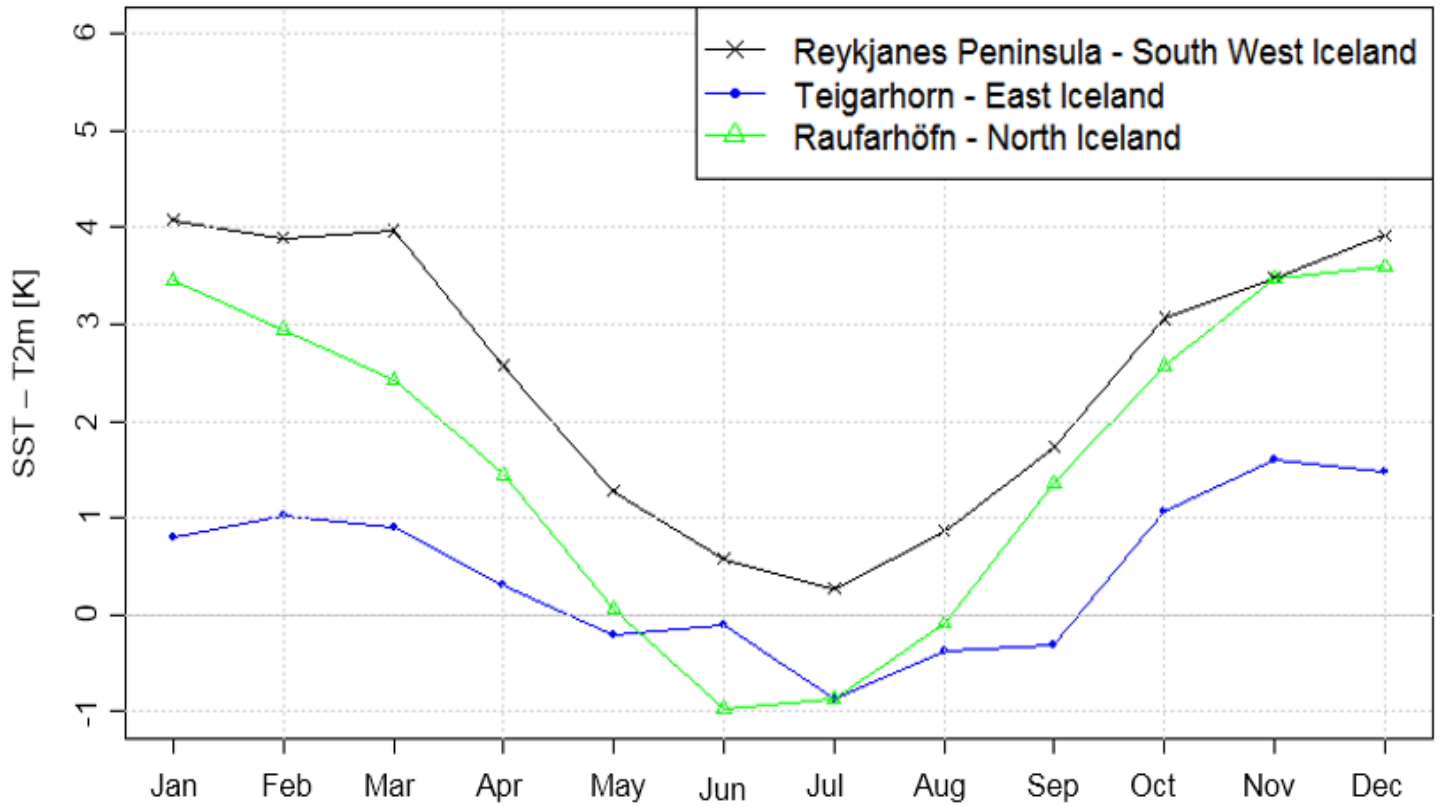
# Correlation $T_{2m}$ Dec/Jan

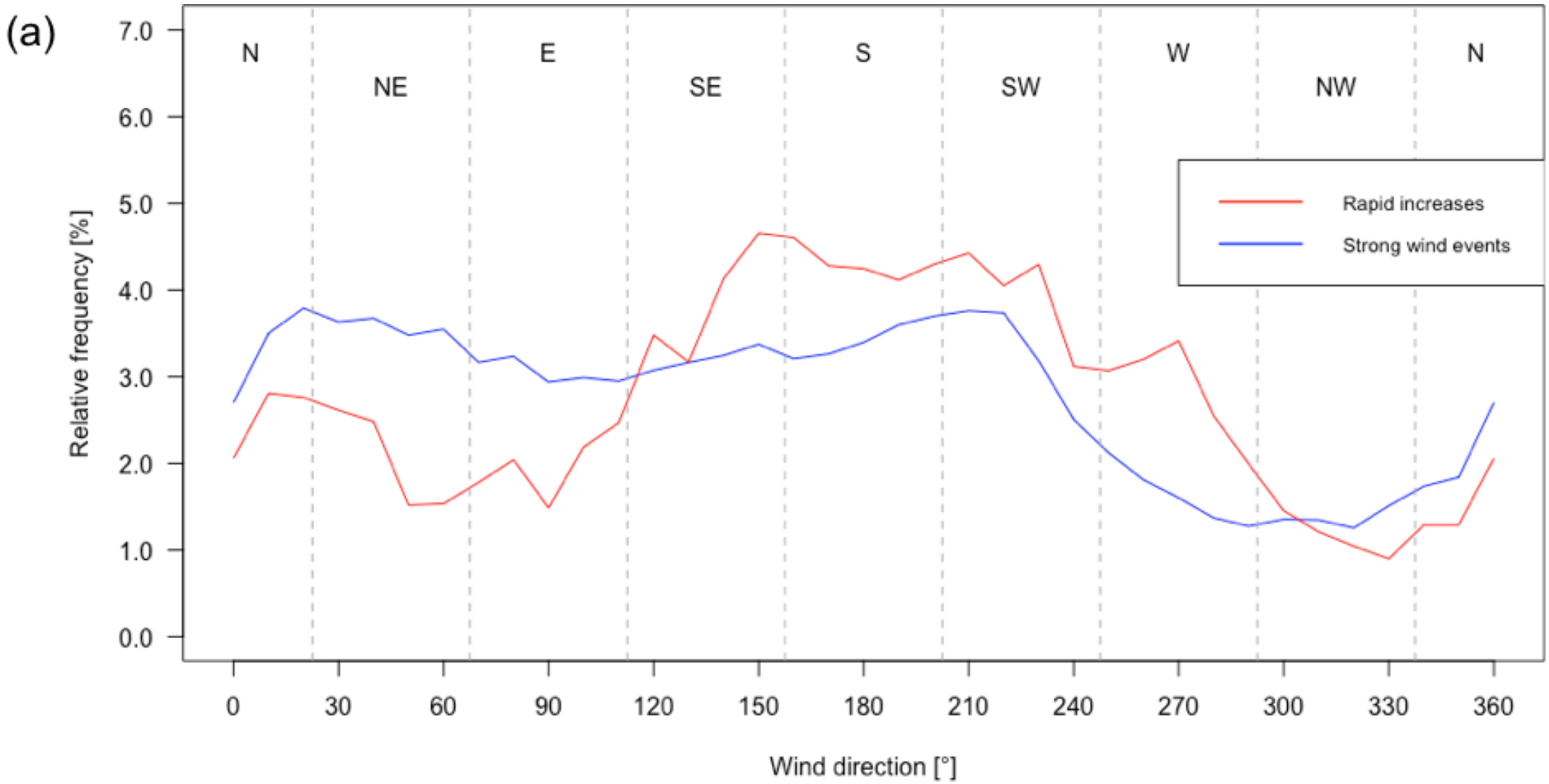


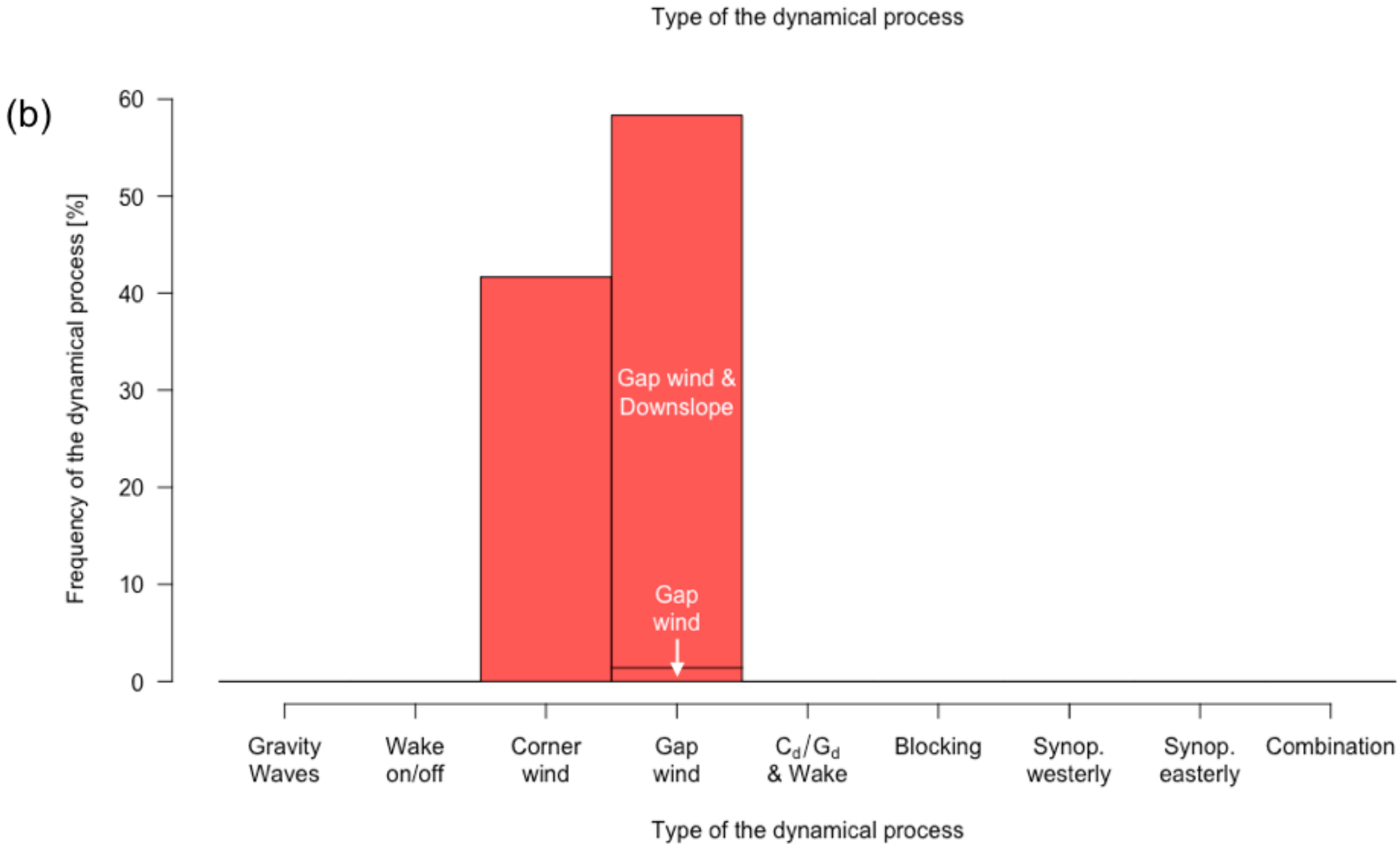
# Some key points

- 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]

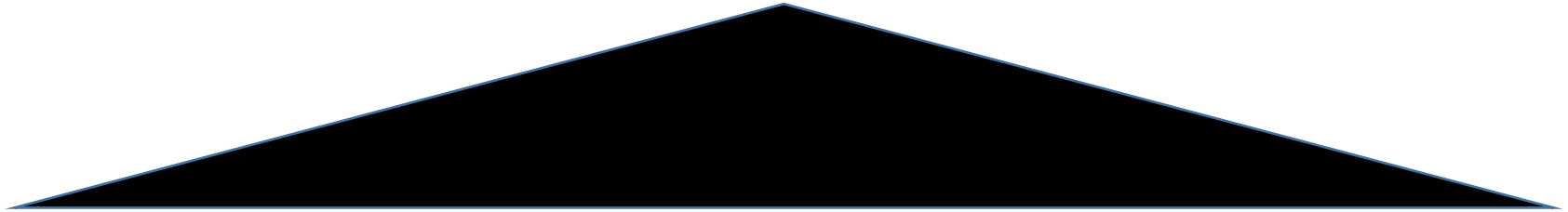

Reykjanes Peninsula - South West Iceland
Teigarhorn - East Iceland
Raufarhöfn - North Iceland
SST – T2m [K]
6
5
4
3
2
1
0
-1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

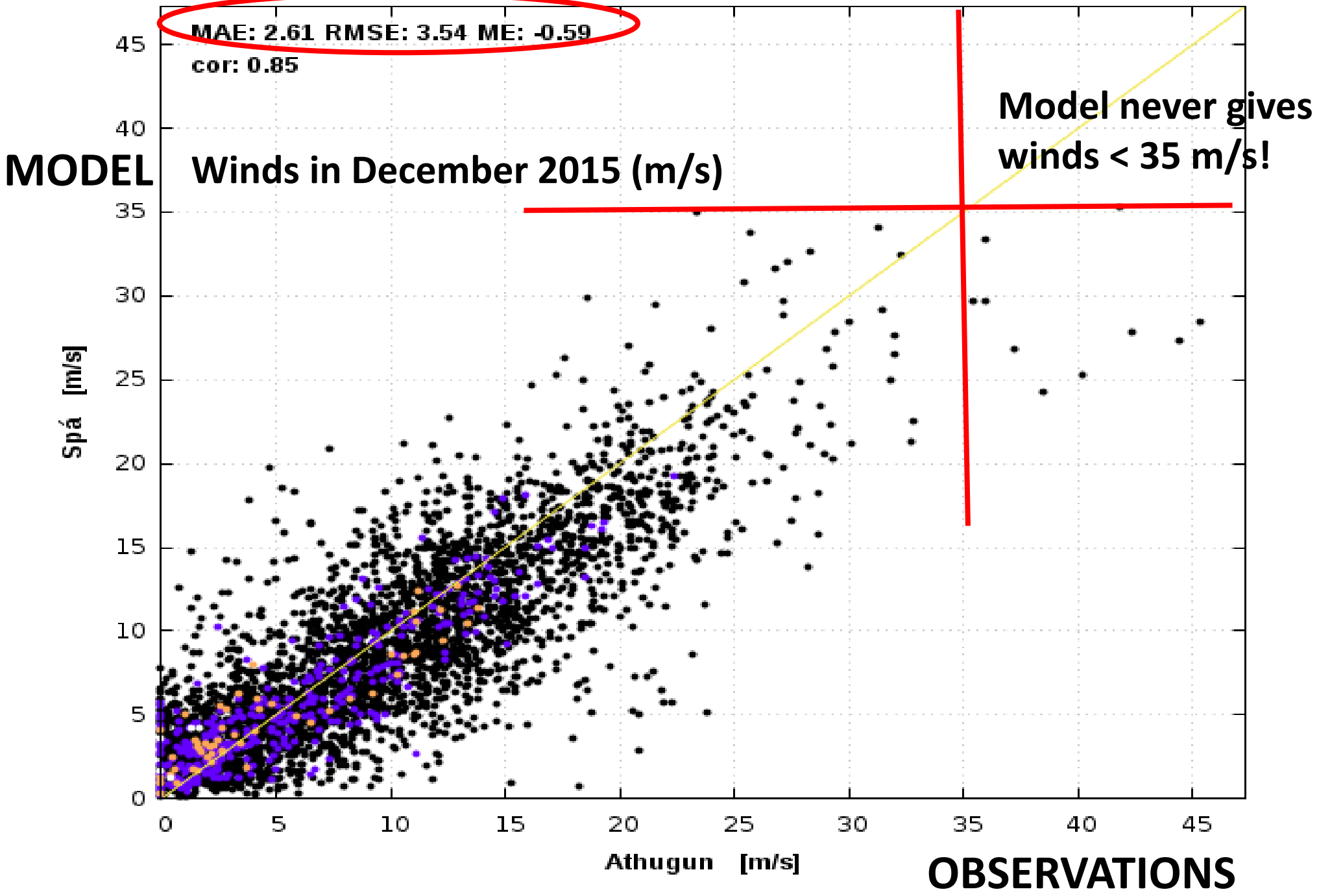

(a)
N
NE
E
SE
S
SW
W
NW
N
Rapid increases
Strong wind events
Relative frequency [%]
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
0
30
60
90
120
150
180
210
240
270
300
330
360
Wind direction [°]

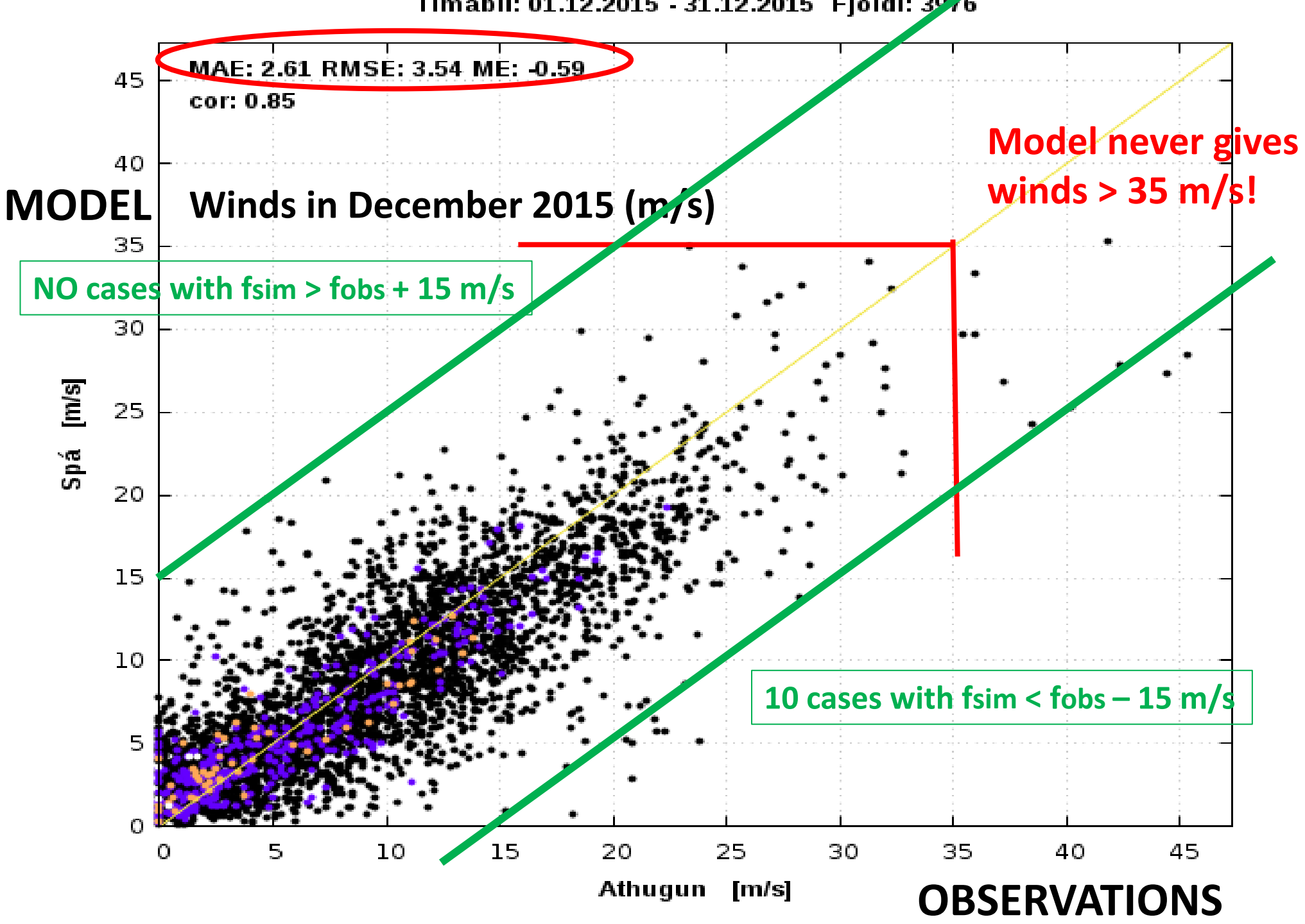

Type of the dynamical process
(b)
Frequency of the dynamical process [%]
60
50
40
30
20
10
0
Gap wind &
Downslope
Gap
wind
Gravity
Waves
Wake
on/off
Corner
wind
Gap
wind
$C_d/G_d$
& Wake
Blocking
Synop.
westerly
Synop.
easterly
Combination
Type of the dynamical process

# 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
Winds in December 2015 (m/s)
Model never gives winds < 35 m/s!
MODEL
OBSERVATIONS
Spá [m/s]
Athugun [m/s]
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
0
5
10
15
20
25
30
35
40
45

# 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

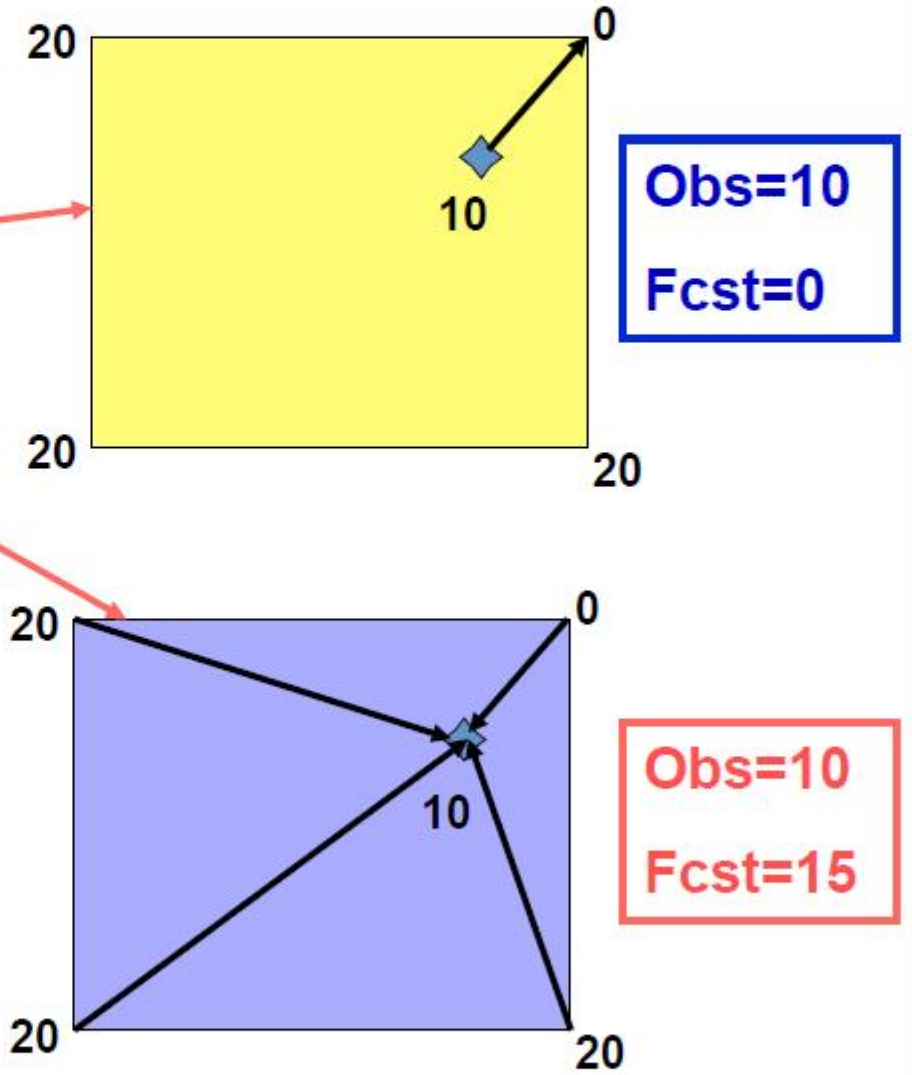
# Matching forecasts and observations

**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

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

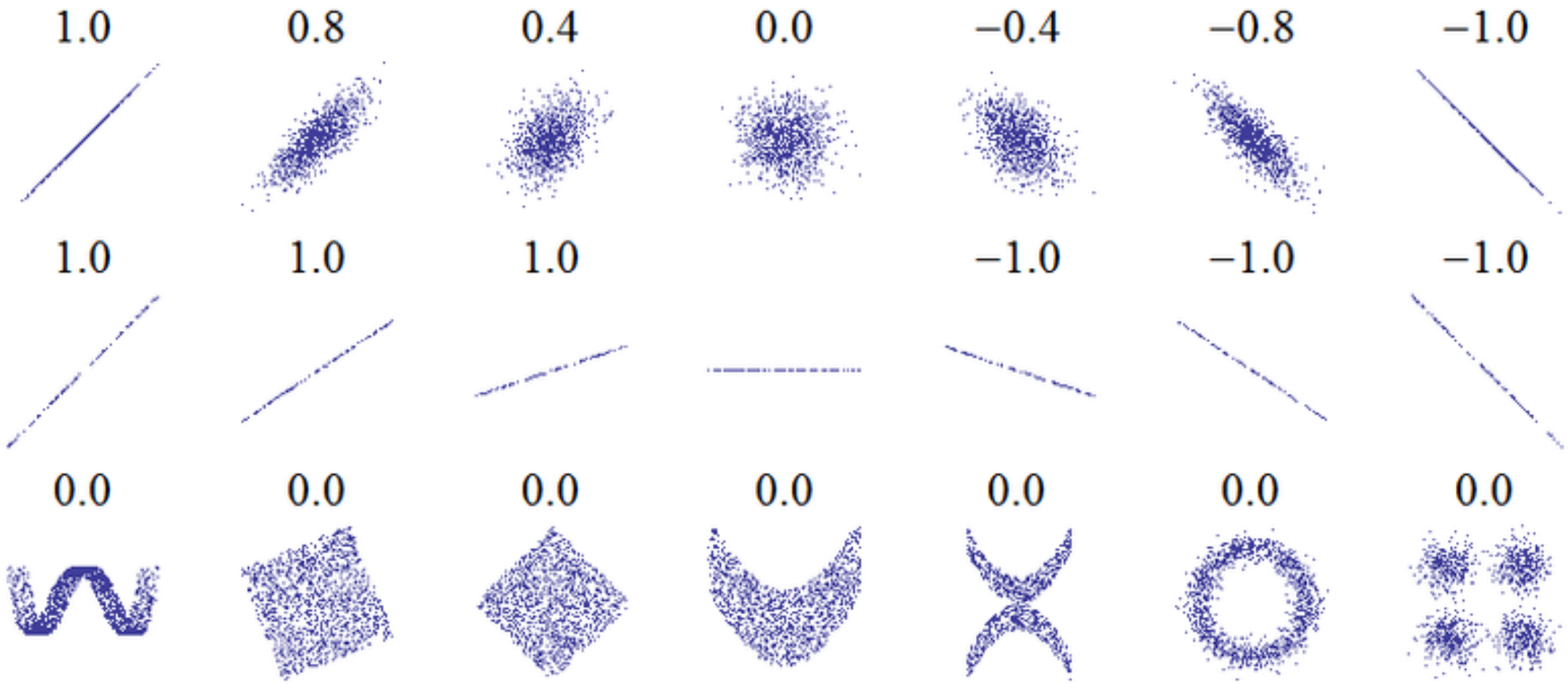
Bias

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

Brier score

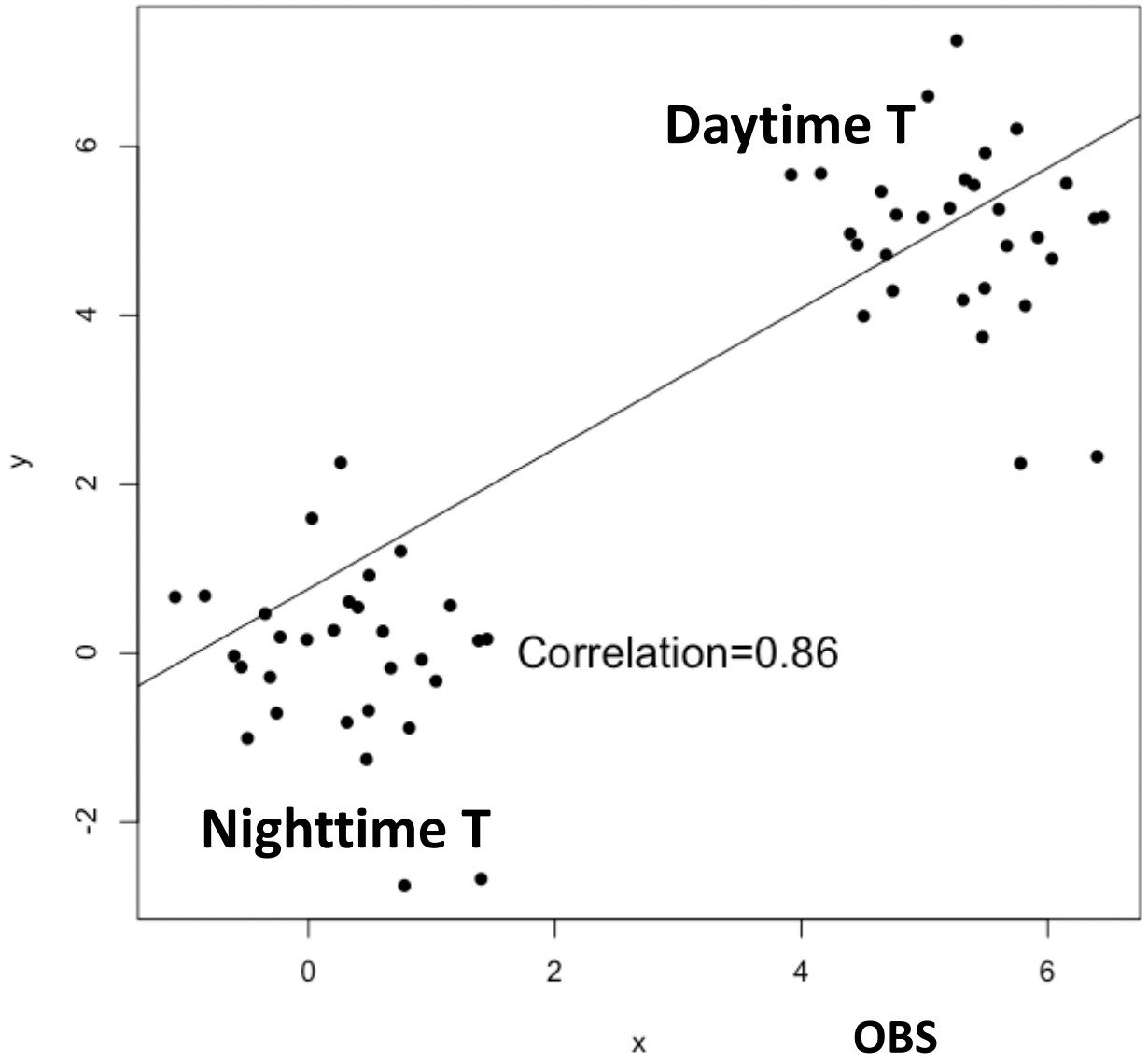
# Correlation coefficient

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



MODEL

**Not much value in this one**

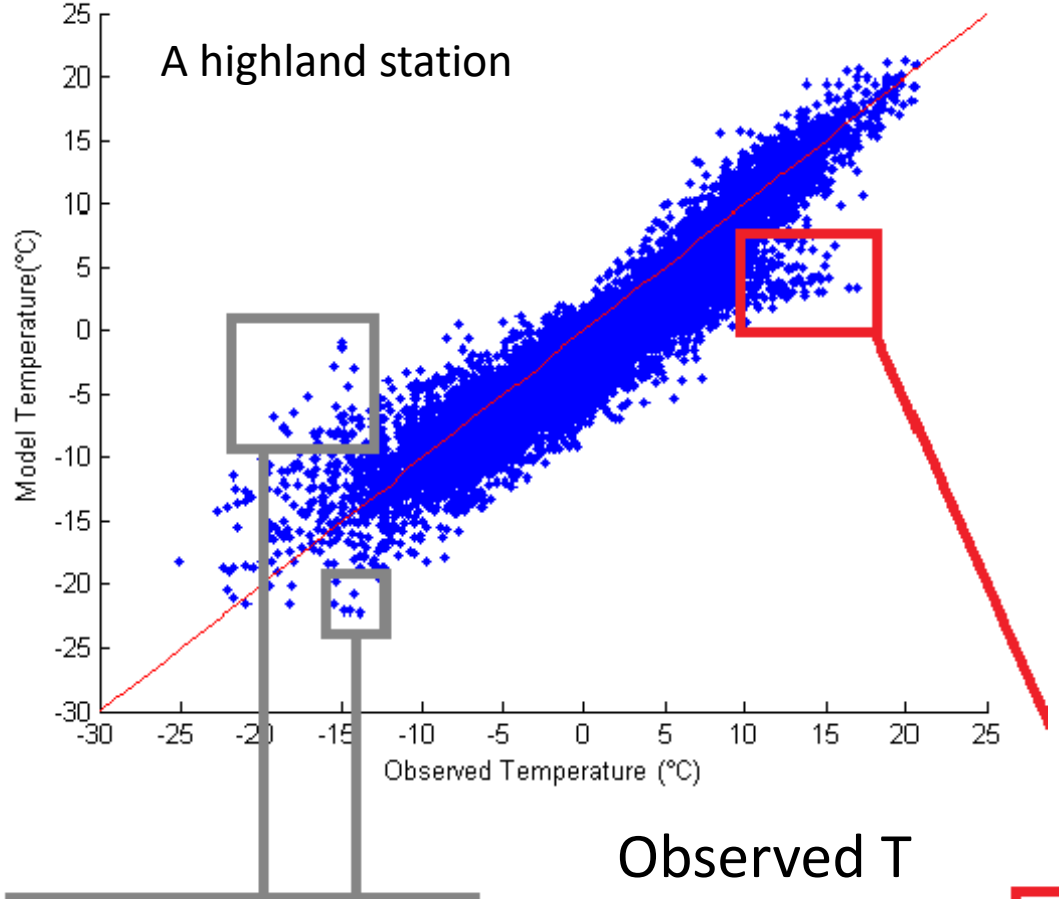



OBS

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

# Isolate errors in time and space and weather parameter space

Simulated T



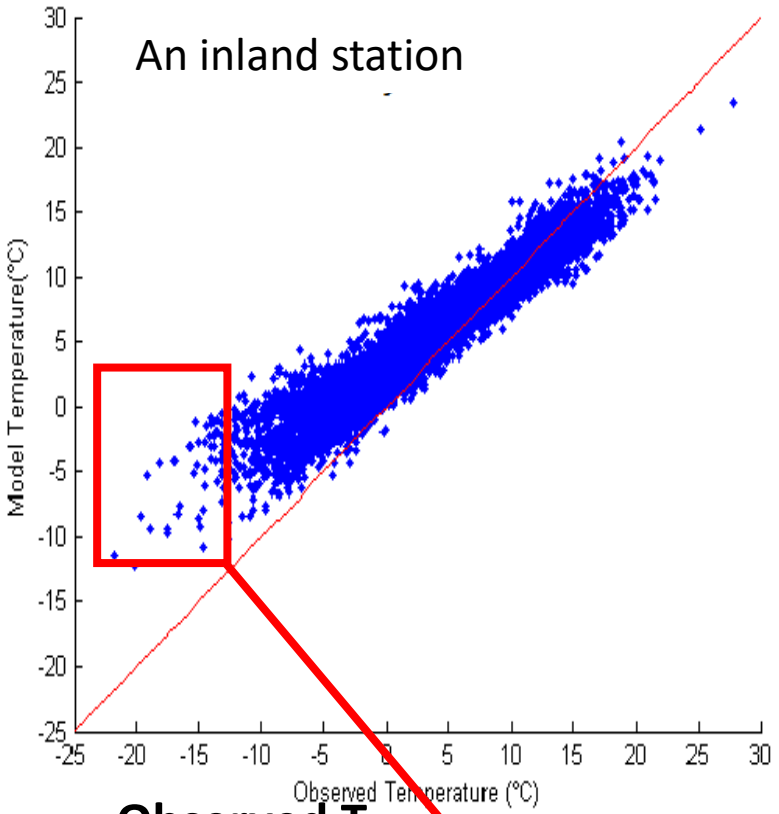

Observed T

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.)**

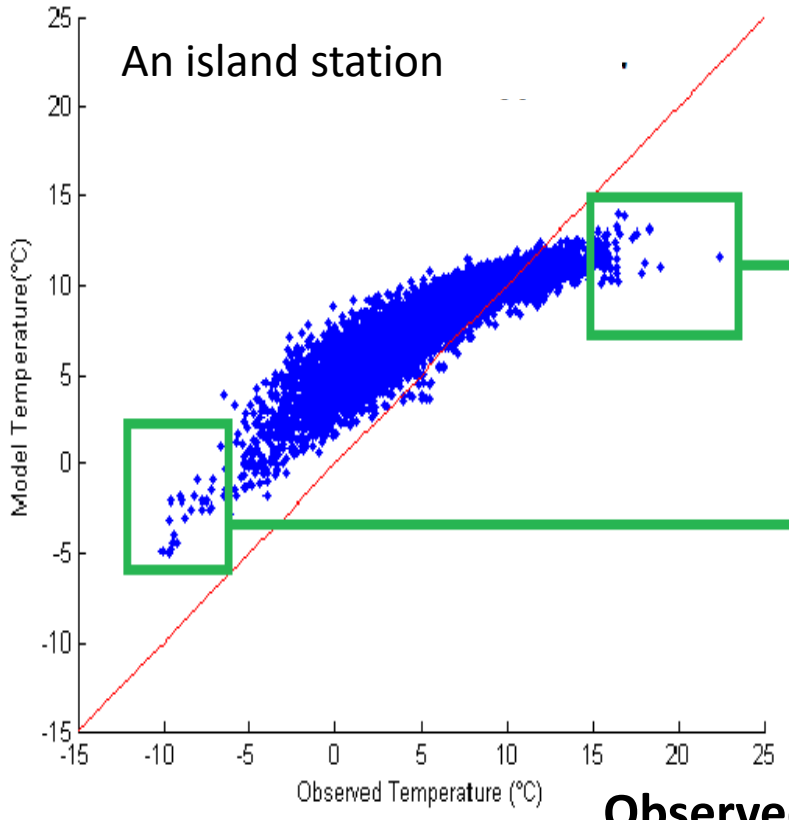
**Simulated T**




**Observed T**

**Too strong simulated winds in weak wind situations, leading to excessive vertical mixing**

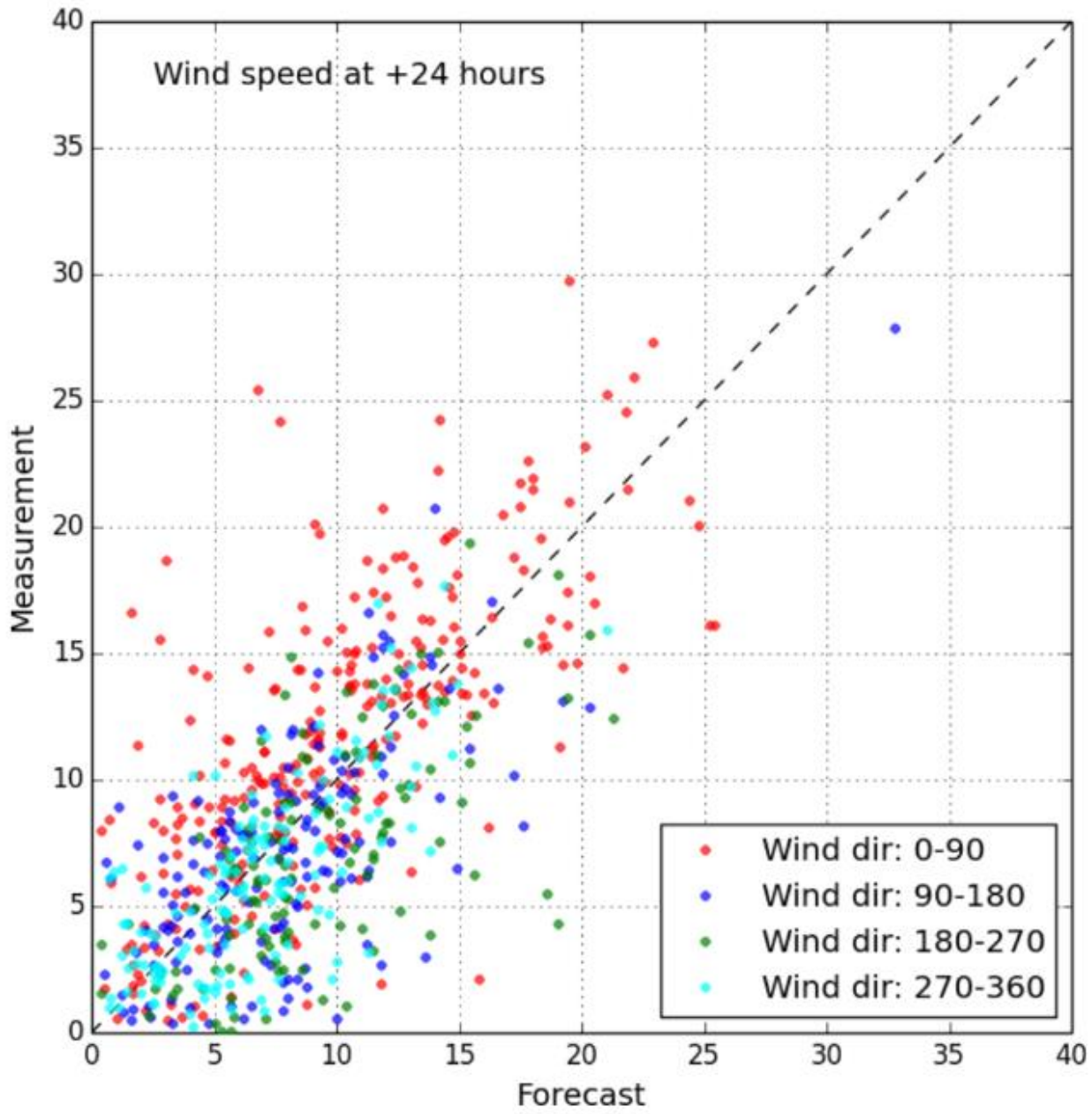
**Simulated T**




**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**

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




**Classifying errors according to wind direction**