Hitatregðan á heimskautaslóðum

SUMAR OG HAUST

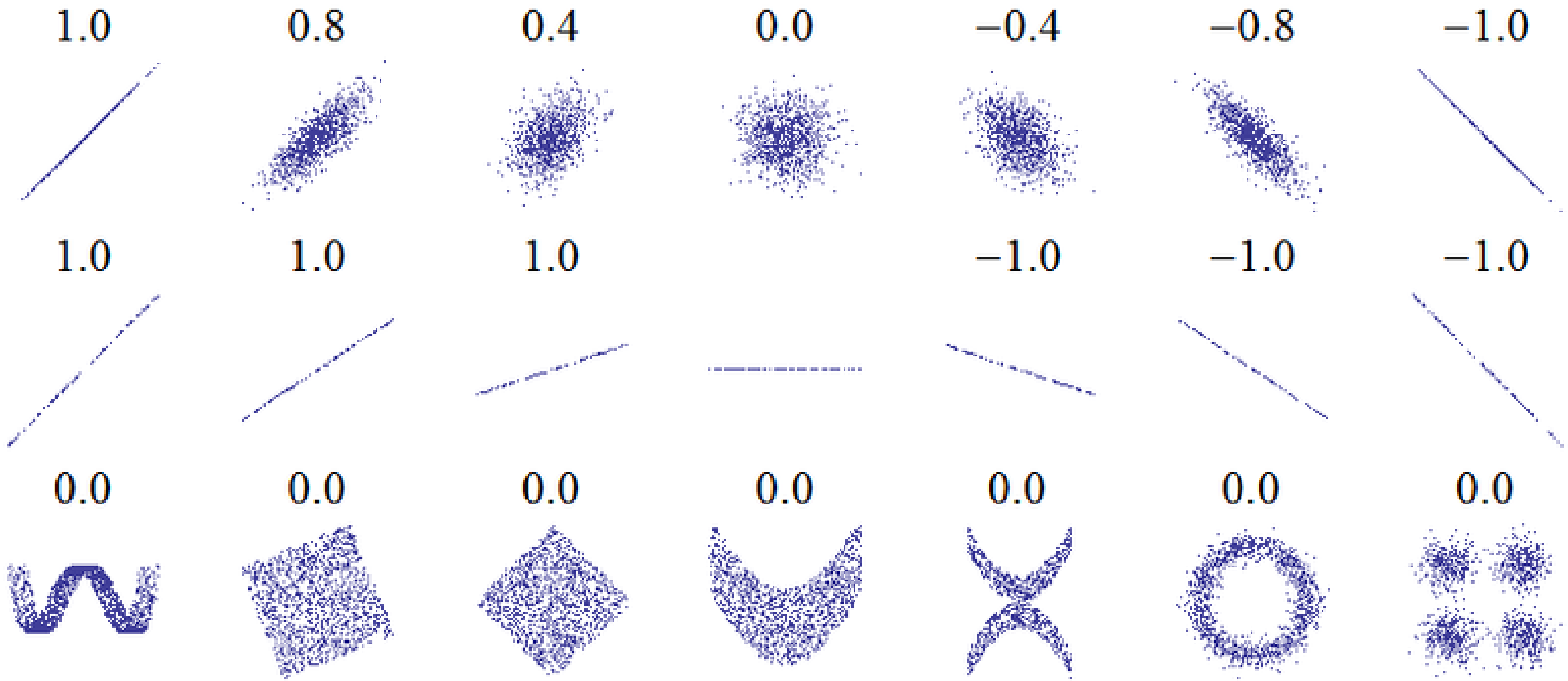
Negar Ekrami
Haraldur Ólafsson

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

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



RMetS
Royal Meteorological Society

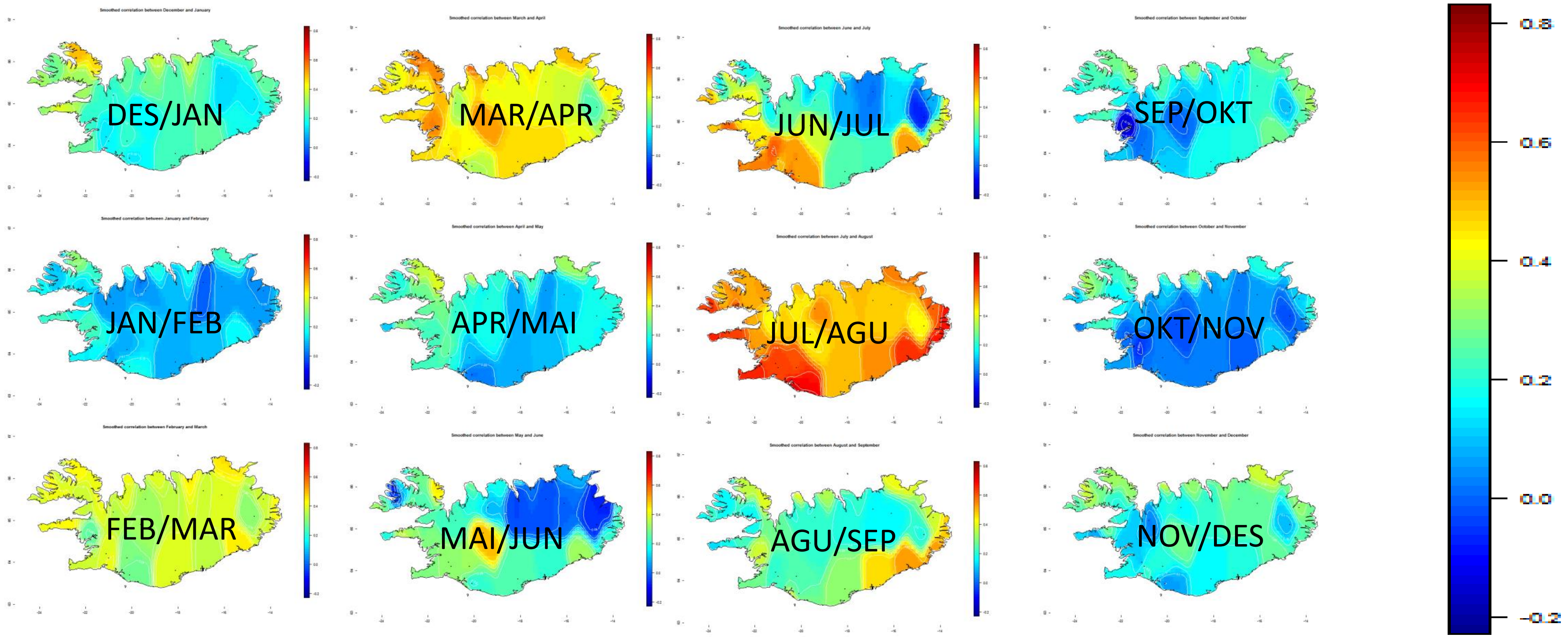
International Journal of Climatology

RESEARCH ARTICLE

Persistence of observed air temperatures in Iceland

Lisa Degenhardt, Haraldur Ólafsson,

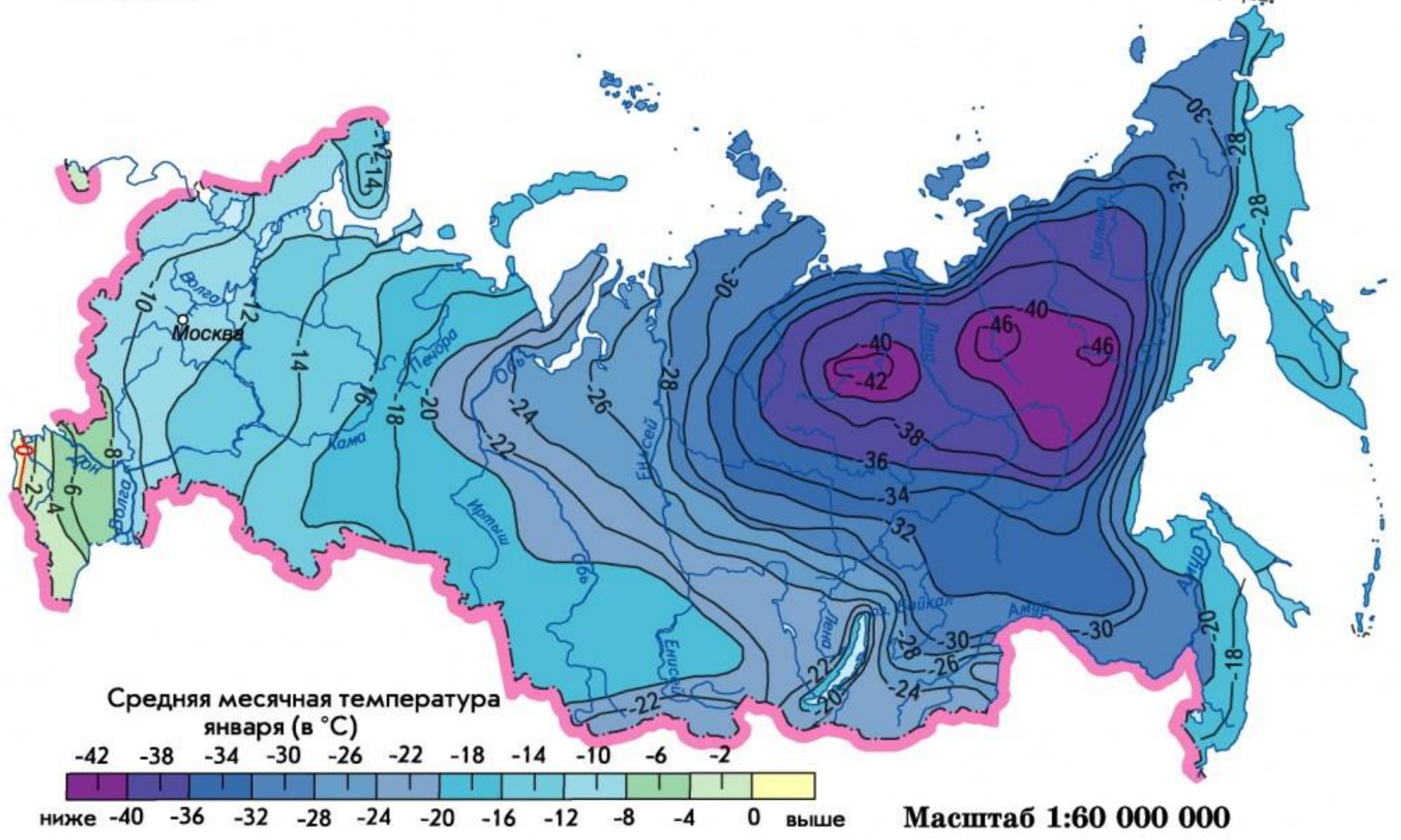
Meðalhitafylgni milli aðliggjandi mánaða



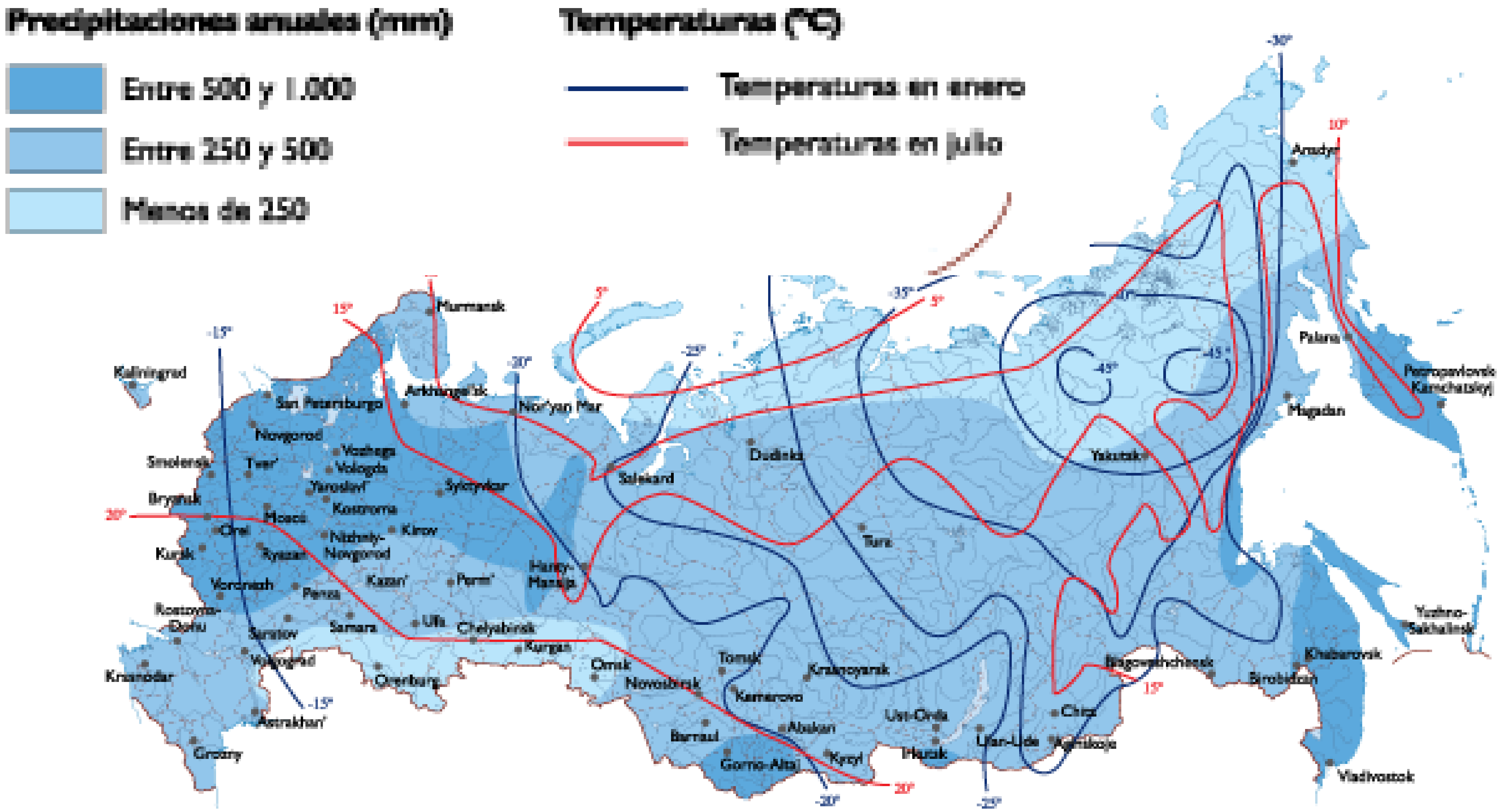
Negar Ekrami

Hitatregðan á heimskautaslóðum, SUMAR OG HAUST

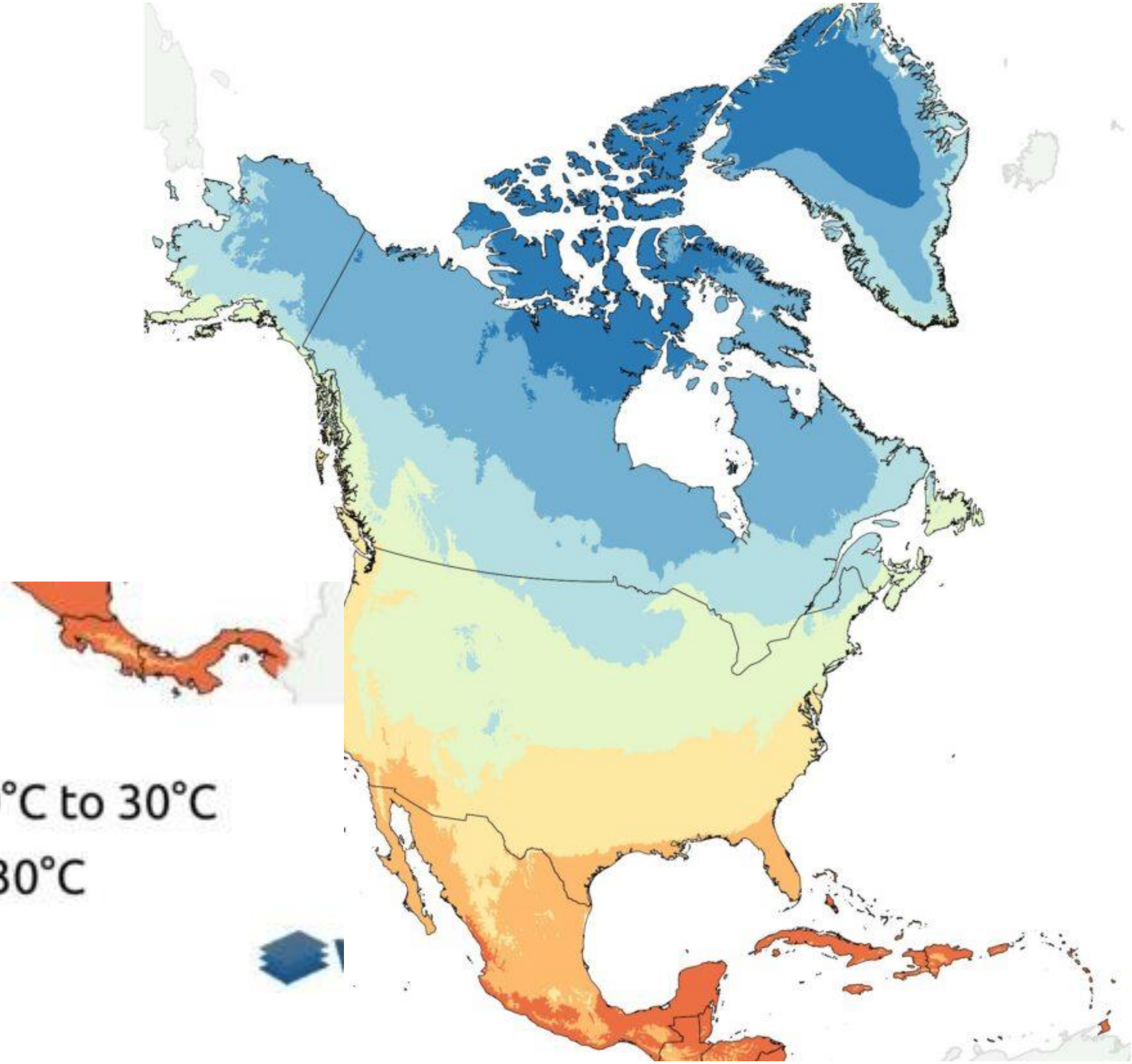
ЯНВАРЬ



Масштаб 1:60 000 000

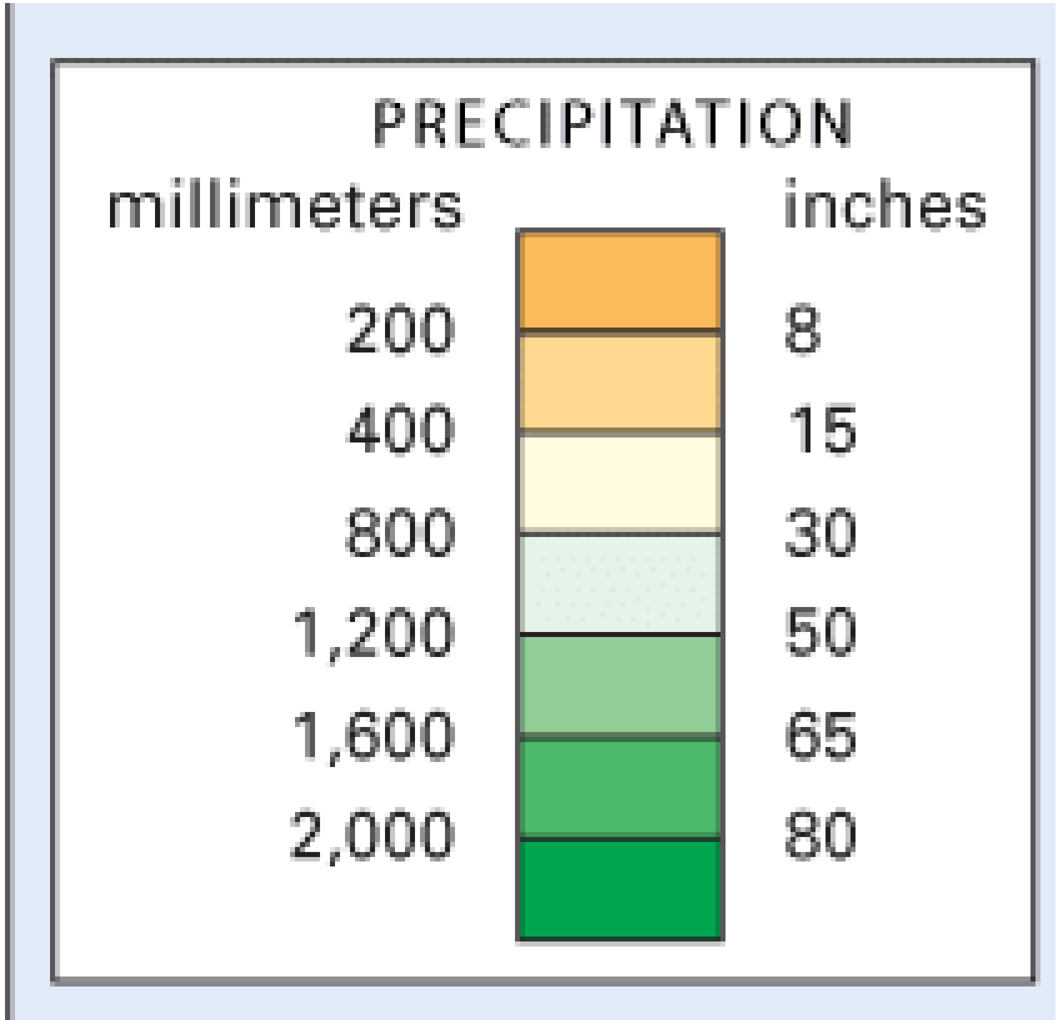

Precipitaciones anuales (mm)
Entre 500 y 1.000
Entre 250 y 500
Menos de 250
Temperaturas (°C)
Temperaturas en enero
Temperaturas en julio
Kaliningrad
San Petersburgo
Novgorod
Smolensk
Tver'
Bryansk
Orel
Kursk
Voronezh
Rostov-na-Donu
Krasnodar
Groznyy
Astrakhan'
Volgograd
Saratov
Penza
Ryazan'
Moscú
Vozhega
Vologda
Yaroslavl'
Kostroma
Nizhniy-Novgorod
Kirov
Kazan'
Samara
Ufa
Perm'
Chelyabinsk
Kurgan
Orenburg
Murmansk
Arkhangel'sk
Nar'yan Mar
Syktyvkar
Hanty-Mansijsk
Salekhard
Dudinka
Tura
Omsk
Novosibirsk
Tomsk
Kemerovo
Barnaul
Gorno-Altaj
Abakan
Kyzyl
Krasnoyarsk
Ust-Orda
Irkutsk
Ulan-Ude
Chita
Aginskoje
Blagoveshchensk
Birobidzhan
Khabarovsk
Vladivostok
Yuzhno-Sakhalinsk
Yakutsk
Magadan
Palana
Petropavlovsk Kamchatskiy
Anadyr'
-15°
-20°
-25°
-30°
-35°
-40°
-45°
5°
10°
15°
20°

Average temperature in January (between 1970 and 2000)

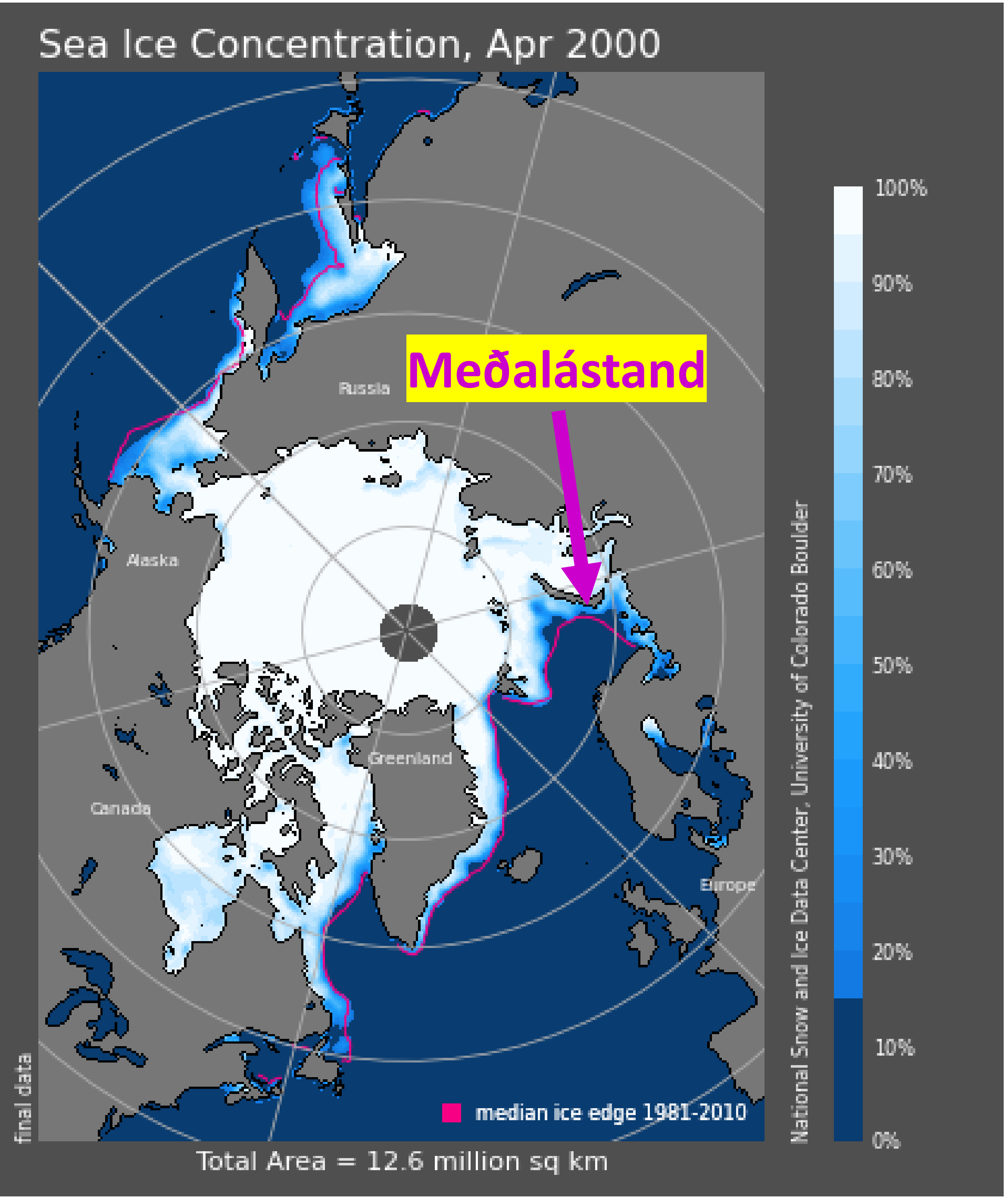


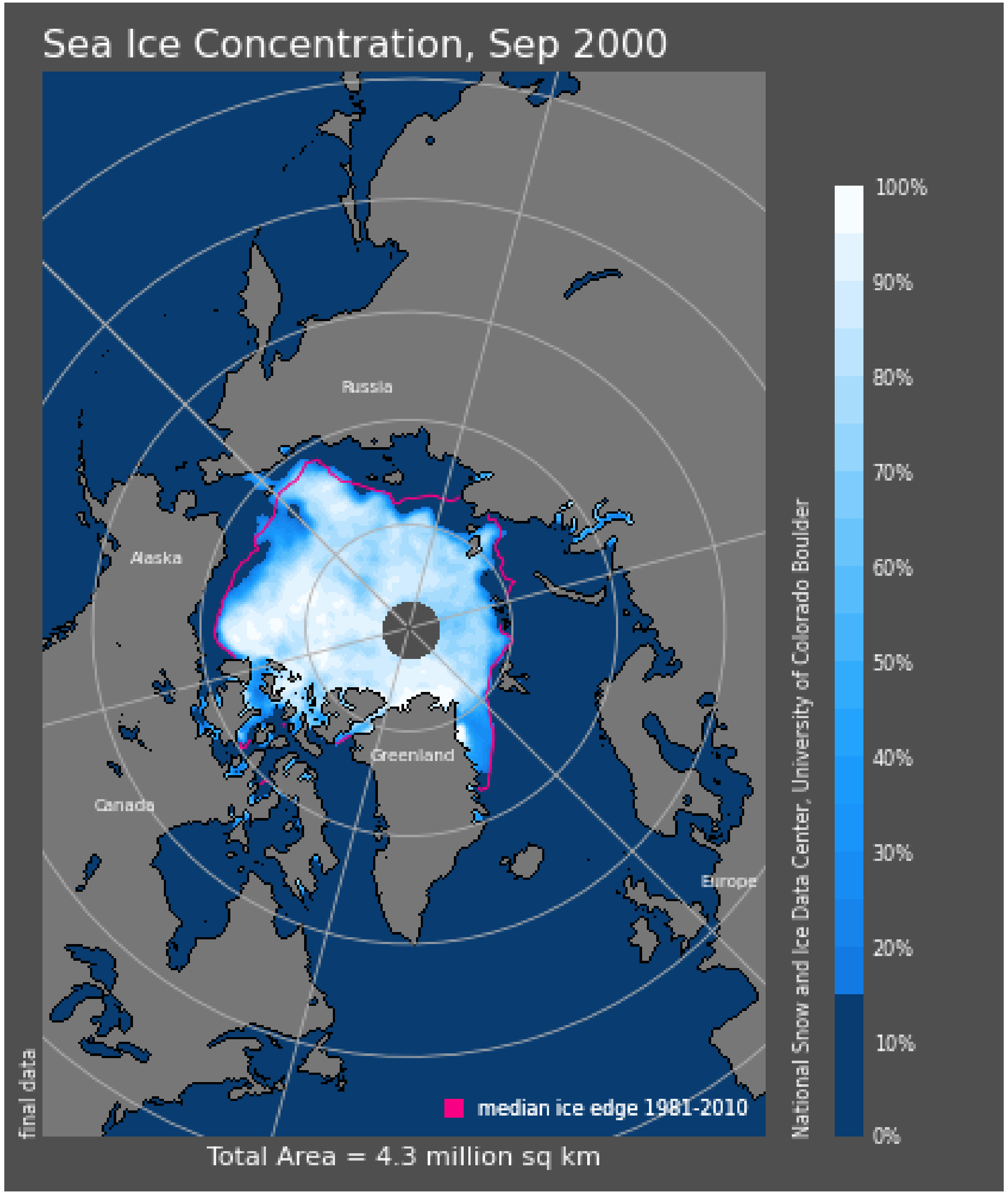
■	<= -30°C	■	-10°C to 0°C	■	20°C to 30°C
■	-30°C to -20°C	■	0°C to 10°C	■	> 30°C
■	-20°C to -10°C	■	10°C to 20°C		

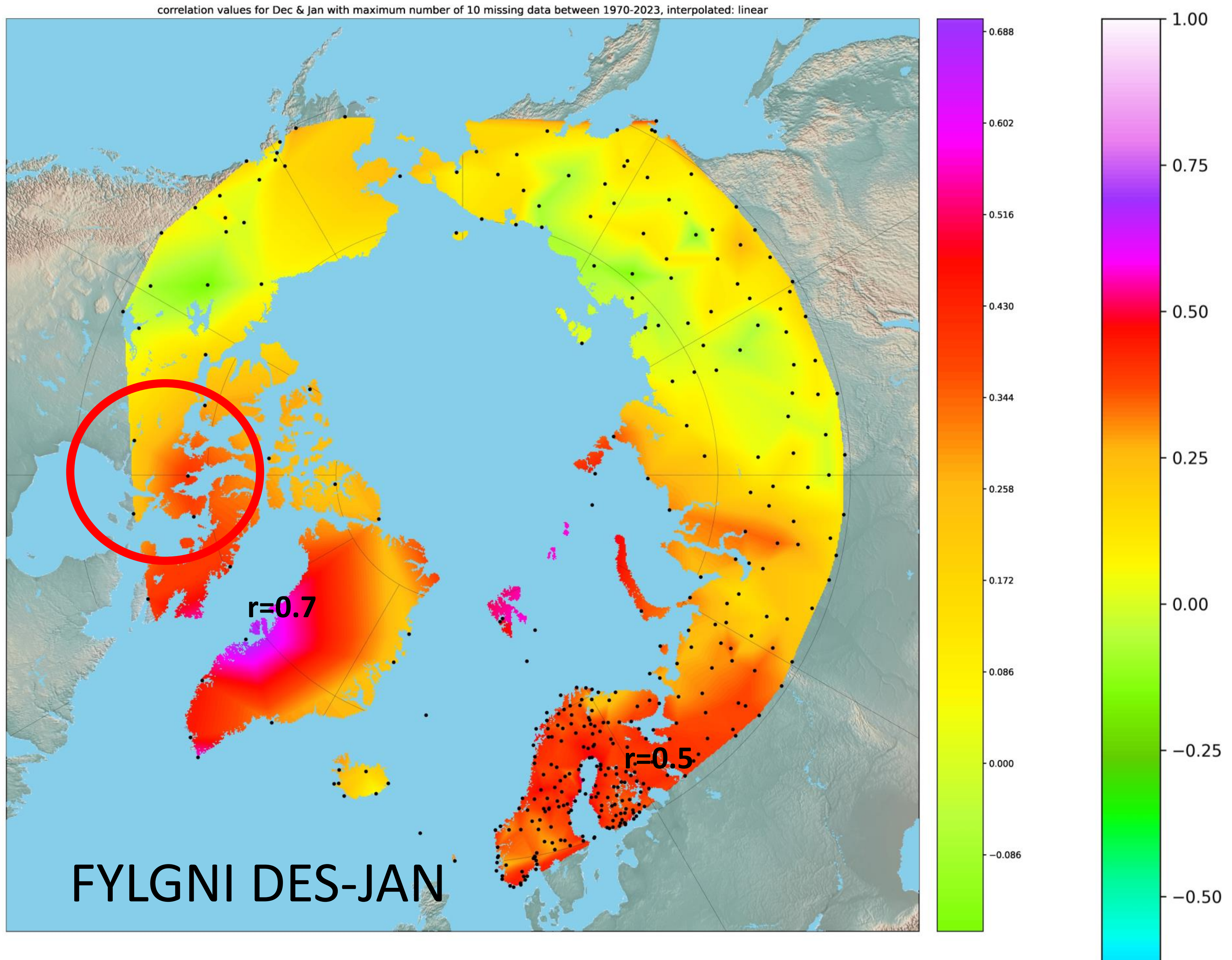
Ársúrkoma


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

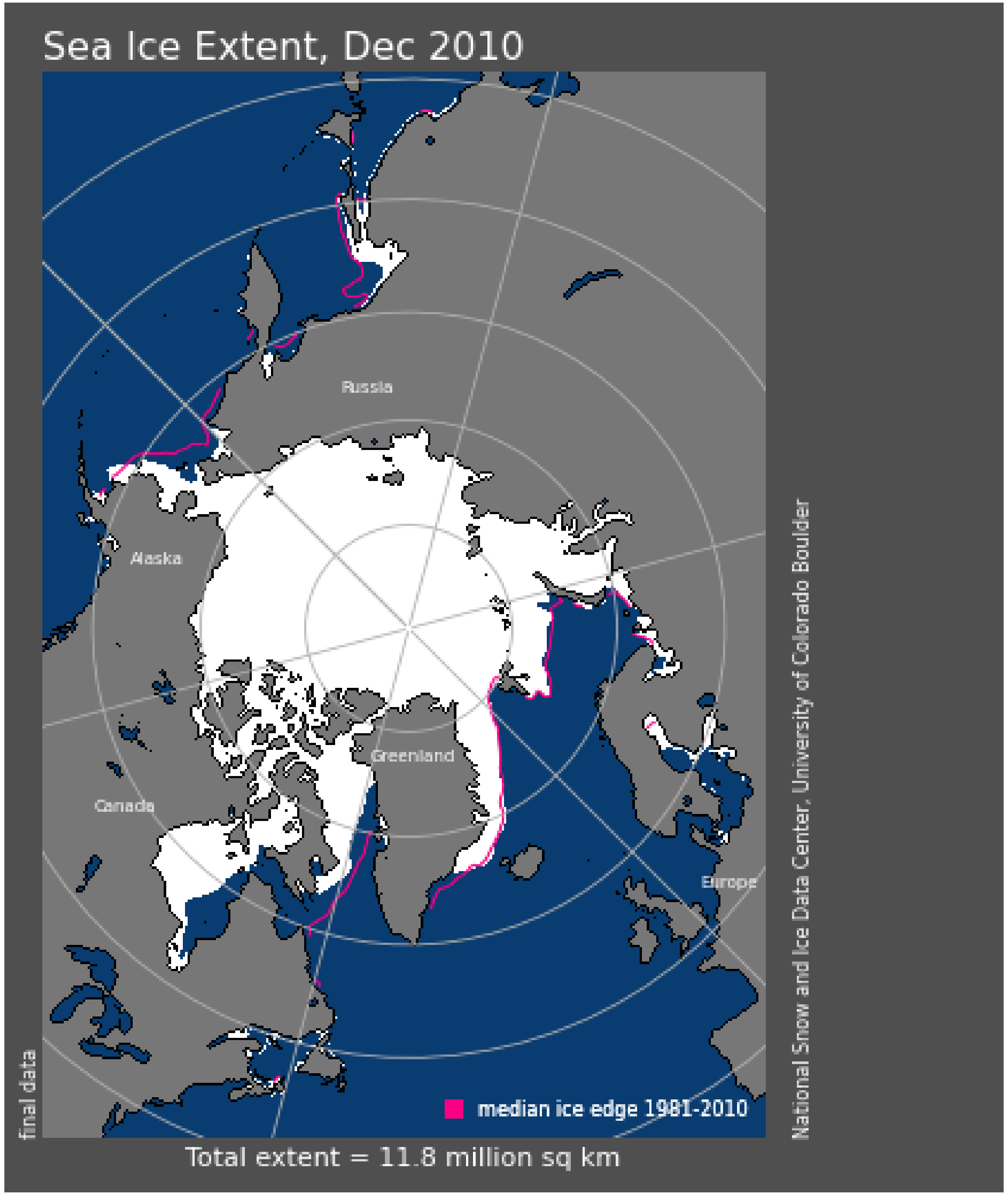

Anchorage
Godthåb
Seattle
Winnipeg
Montreal
New York
Chicago
Washington, D.C.
Denver
Los Angeles
Dallas
Atlanta
Miami
Havana
Kingston
Santo Domingo
Mexico City
Guatemala City
Panama City
PRECIPITATION
millimeters
inches
200
8
400
15
800
30
1,200
50
1,600
65
2,000
80
0
100
1,000 mi
0
500
1,000
1,500 km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

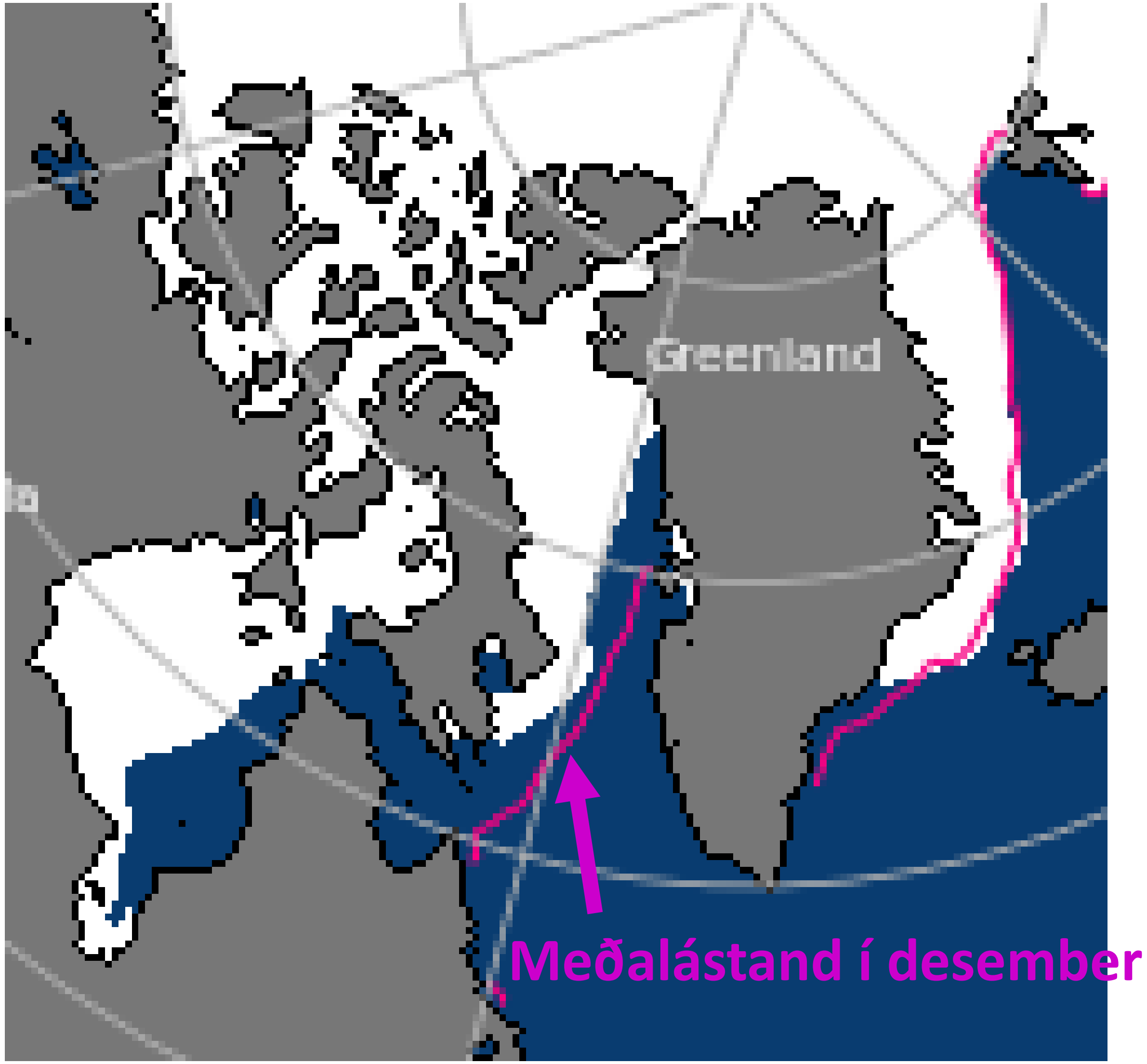

Sea Ice Concentration, Apr 2000
Meðalástand
Russia
Alaska
Greenland
Canada
Europe
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
National Snow and Ice Data Center, University of Colorado Boulder
final data
median ice edge 1981-2010
Total Area = 12.6 million sq km

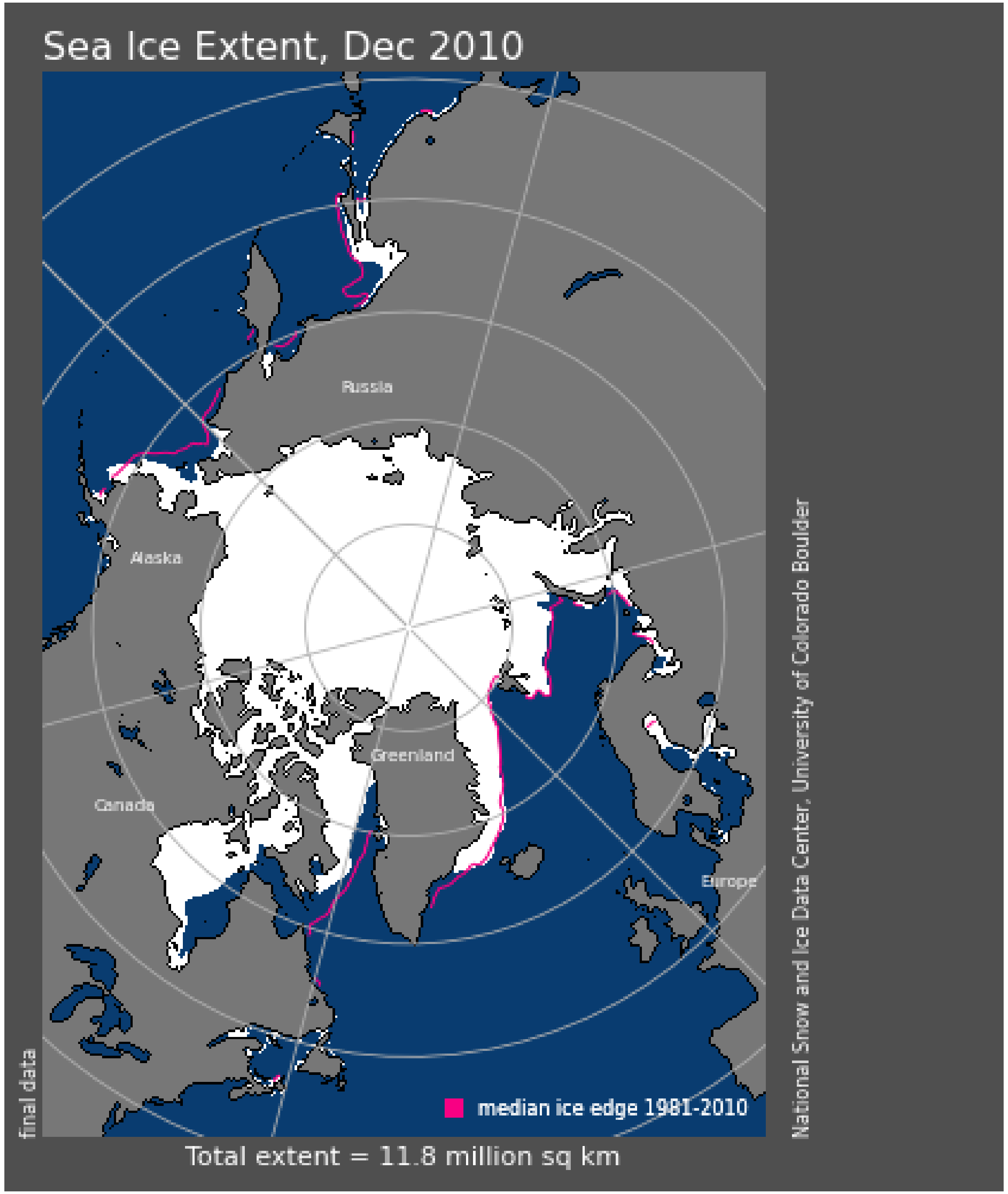

Sea Ice Concentration, Sep 2000
Russia
Alaska
Greenland
Canada
Europe
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
National Snow and Ice Data Center, University of Colorado Boulder
final data
median ice edge 1981-2010
Total Area = 4.3 million sq km

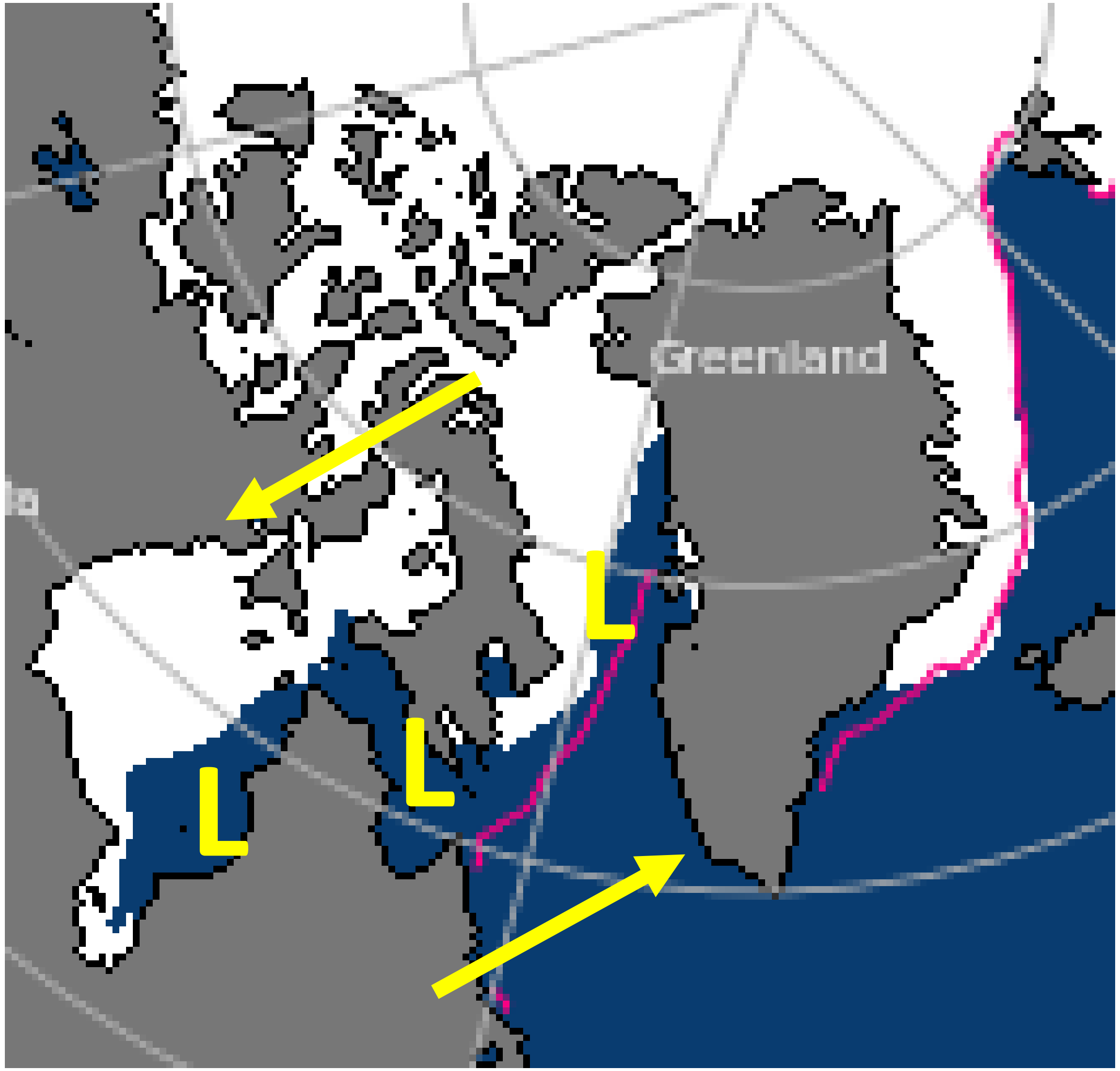


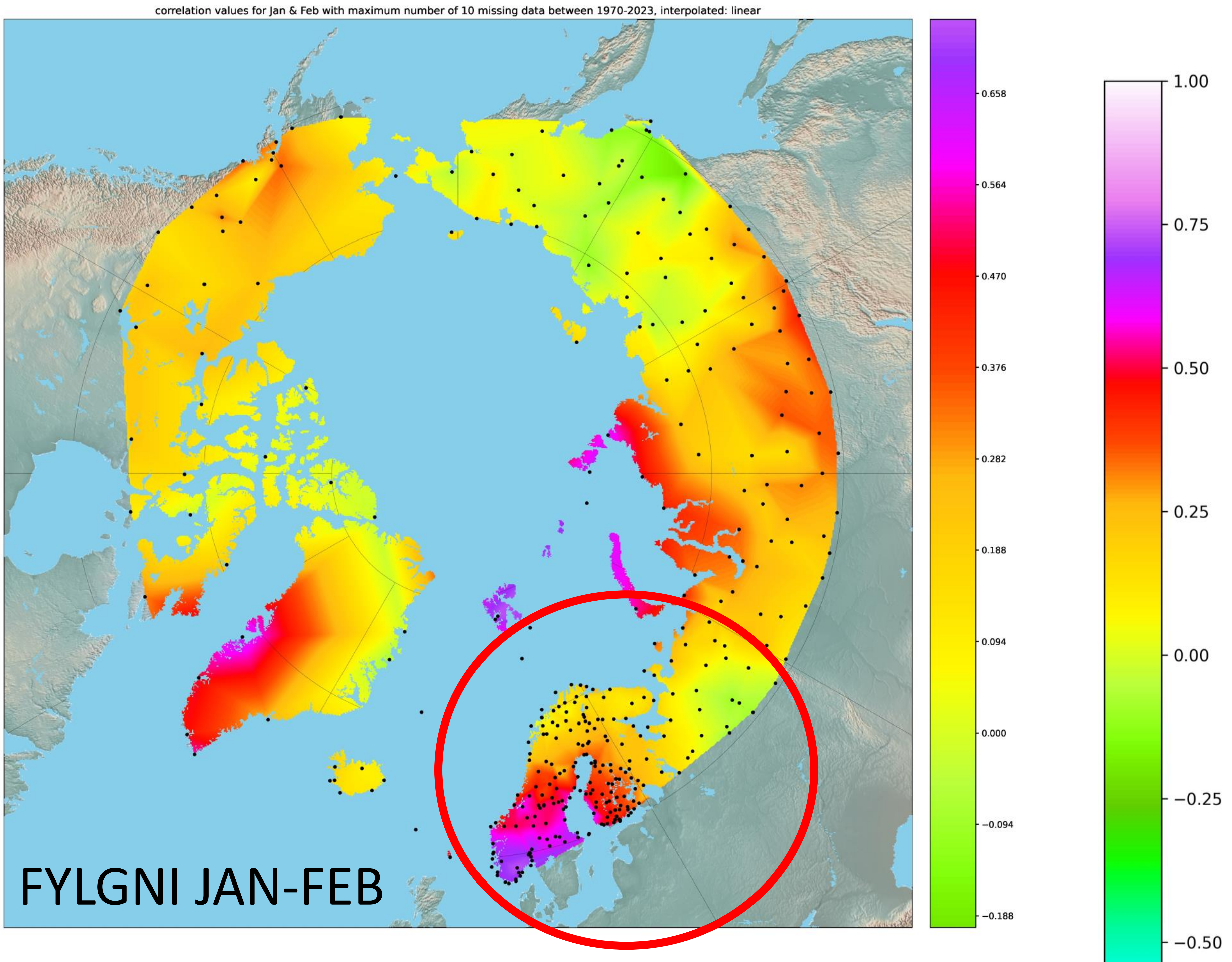
Gögn: mælingar í punktunum

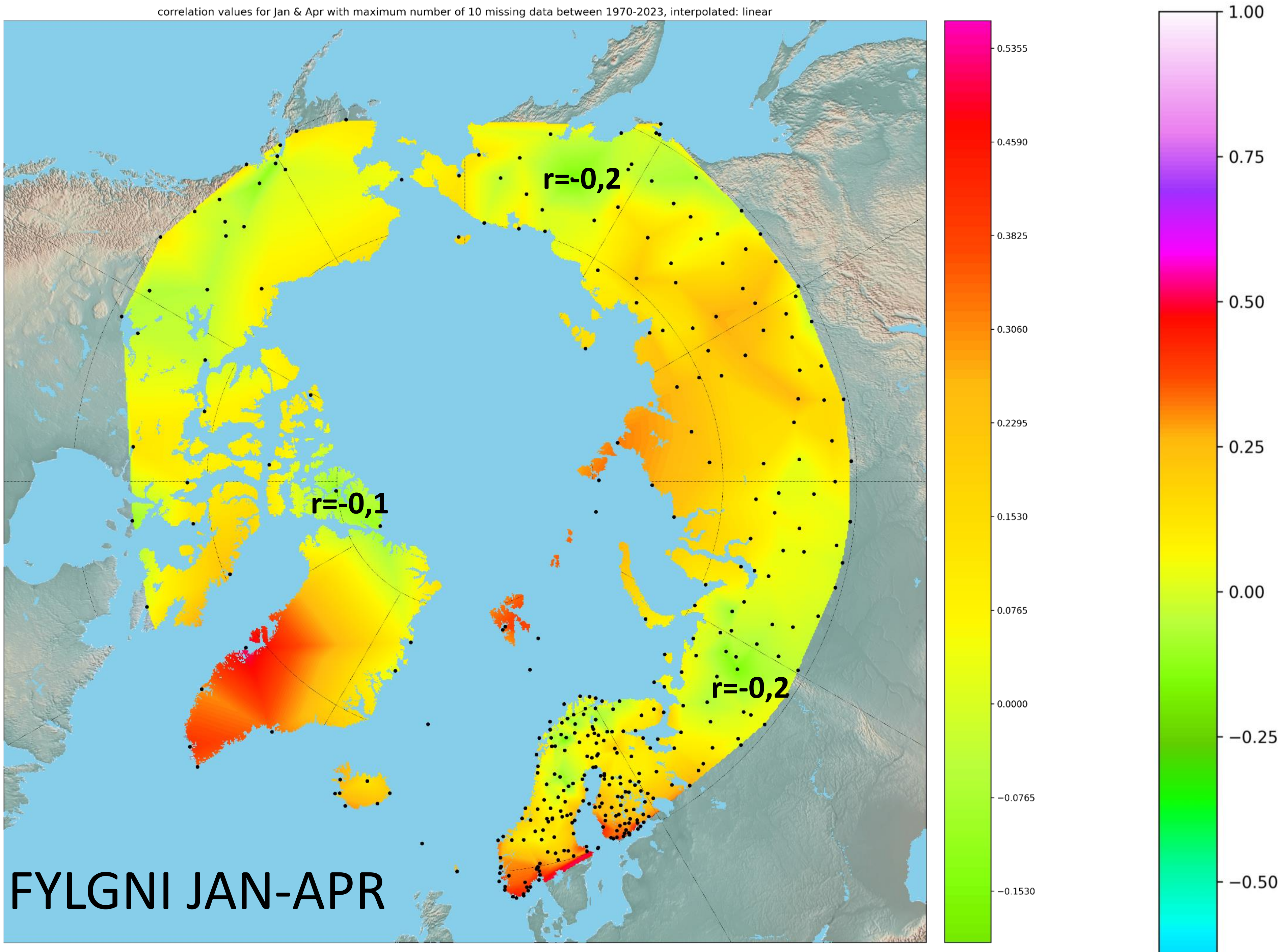

Sea Ice Extent, Dec 2010
Russia
Alaska
Greenland
Canada
Europe
median ice edge 1981-2010
Total extent = 11.8 million sq km
final data
National Snow and Ice Data Center, University of Colorado Boulder


Greenland
Meðalástand í desember

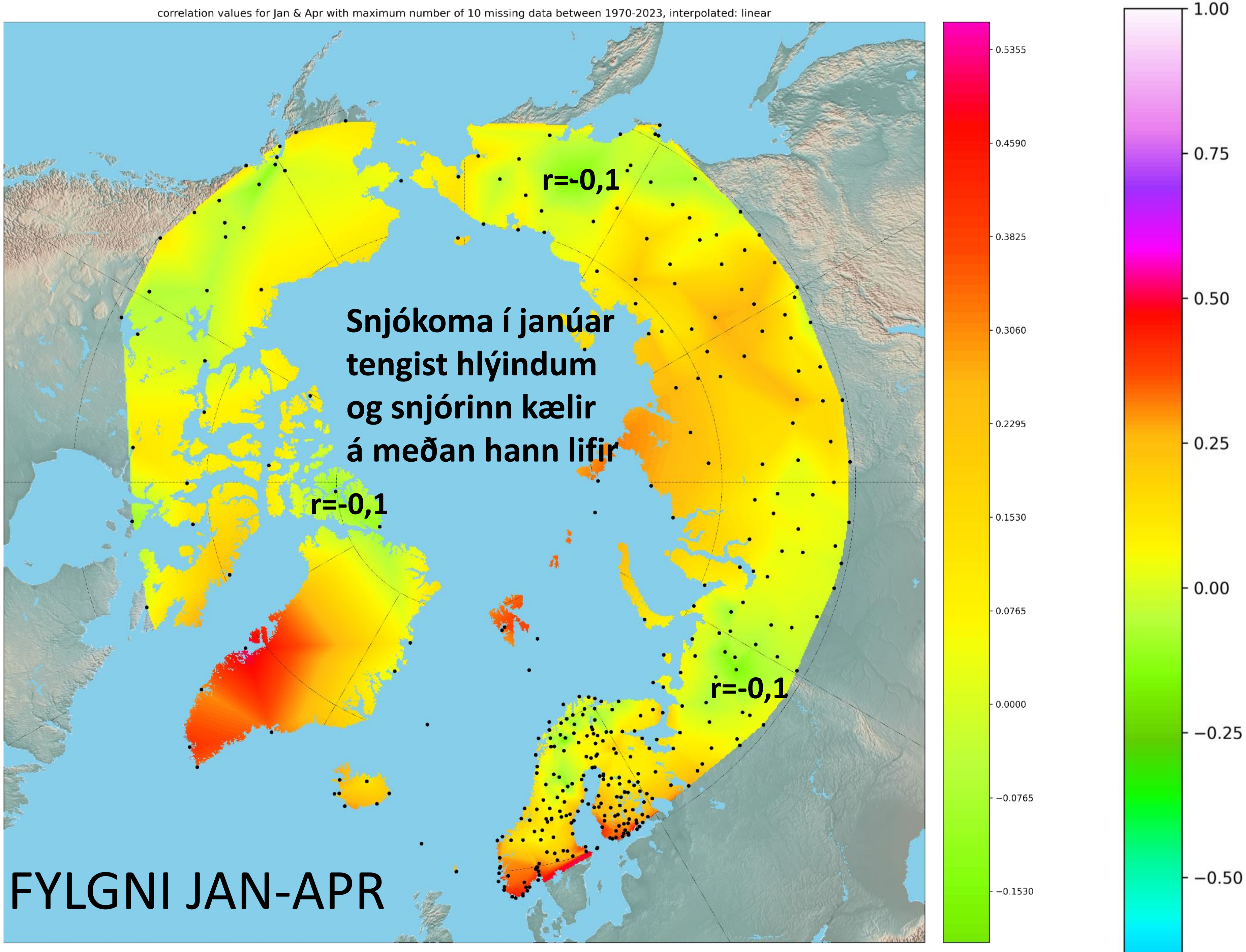

Sea Ice Extent, Dec 2010
Russia
Alaska
Greenland
Canada
Europe
median ice edge 1981-2010
Total extent = 11.8 million sq km
final data
National Snow and Ice Data Center, University of Colorado Boulder

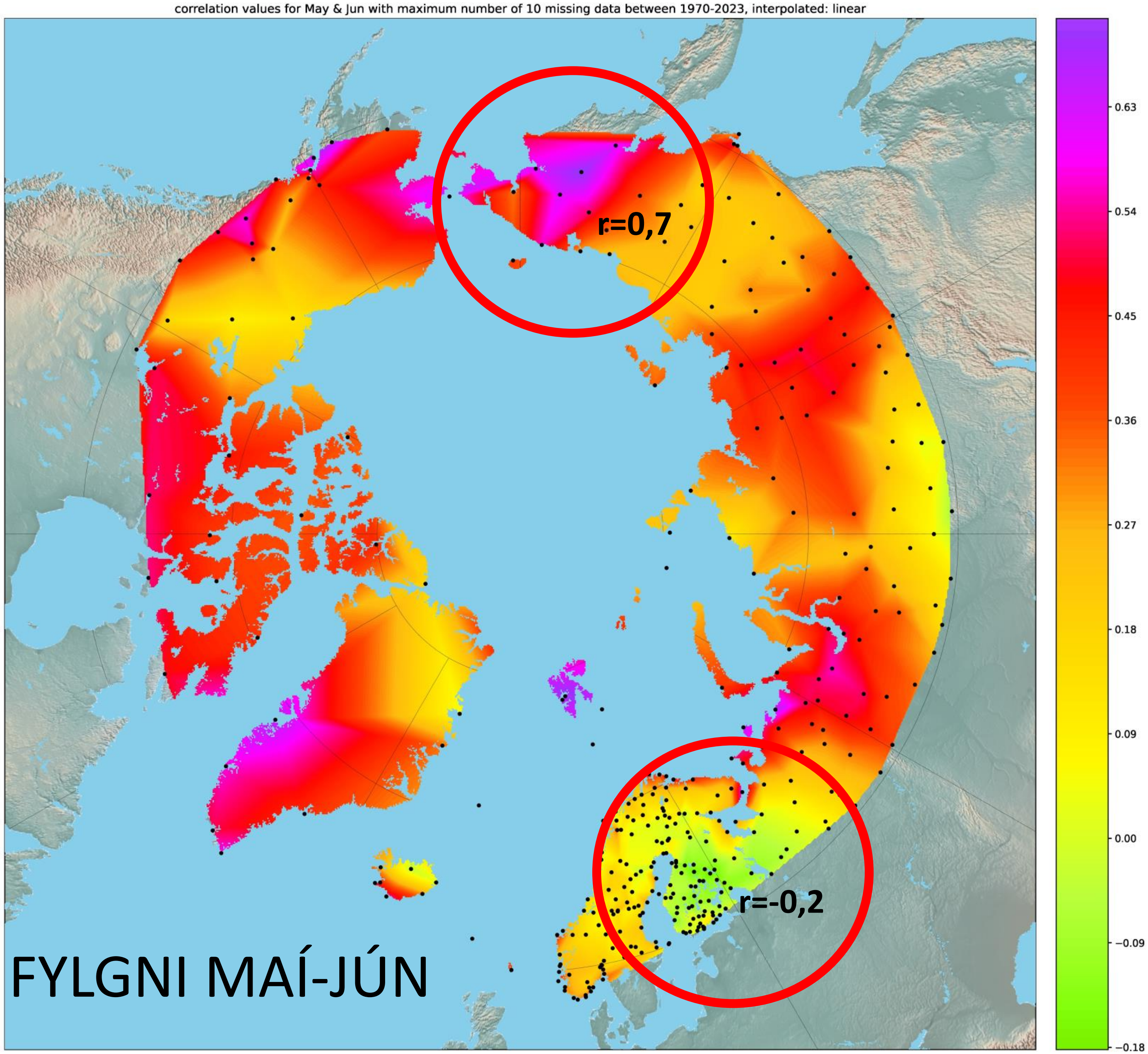

Greenland
L
L
L

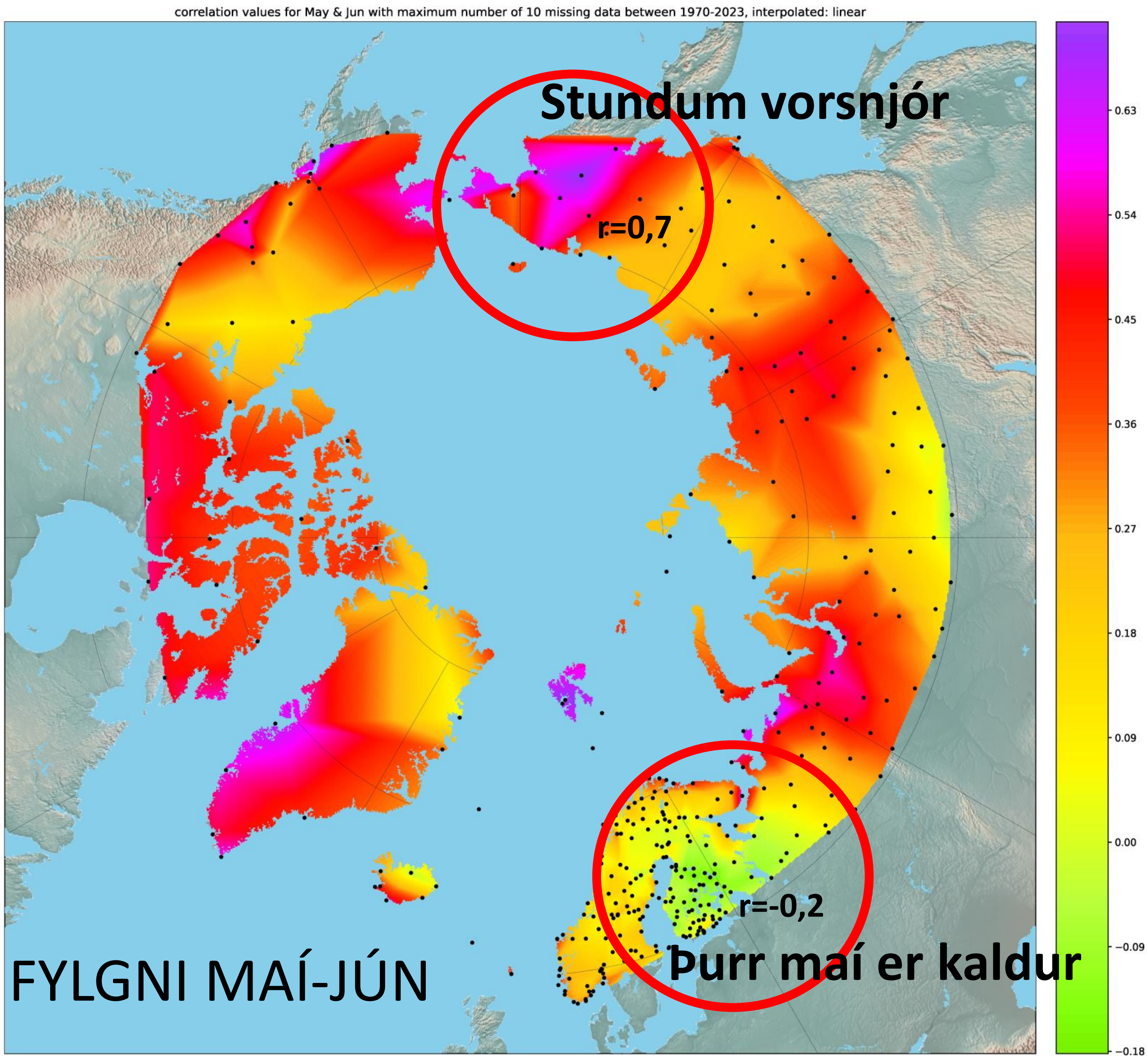

correlation values for Jan & Feb with maximum number of 10 missing data between 1970-2023, interpolated: linear
0.658
0.564
0.470
0.376
0.282
0.188
0.094
0.000
−0.094
−0.188
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
FYLGNI JAN-FEB



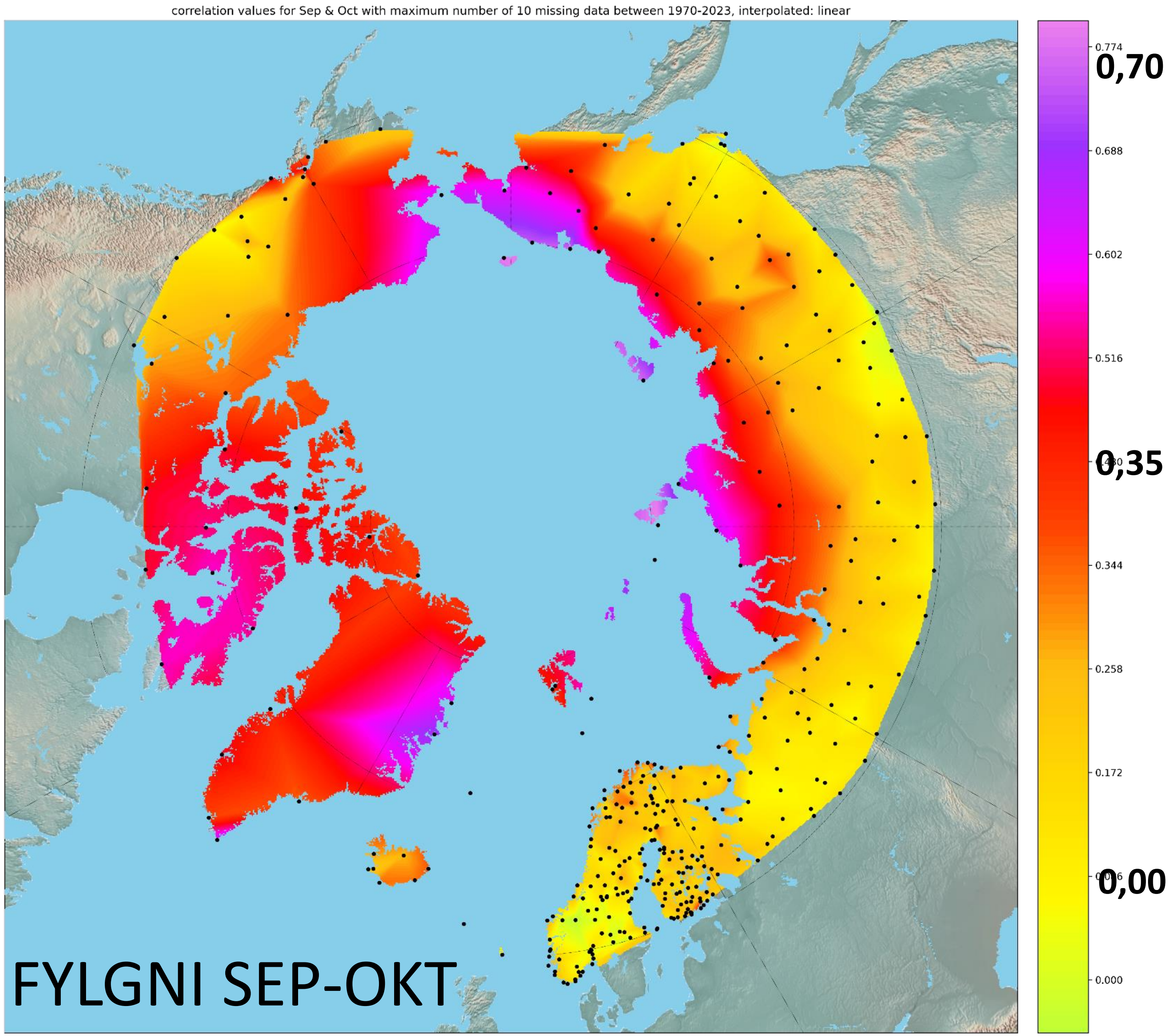
correlation values for Jan & Apr with maximum number of 10 missing data between 1970-2023, interpolated: linear
r=-0,2
r=-0,1
r=-0,2
FYLGNI JAN-APR
0.5355
0.4590
0.3825
0.3060
0.2295
0.1530
0.0765
0.0000
−0.0765
−0.1530
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50


correlation values for Jan & Apr with maximum number of 10 missing data between 1970-2023, interpolated: linear
Snjókoma í janúar
tengist hlýindum
og snjórinn kælir
á meðan hann lifir
r=-0,1
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

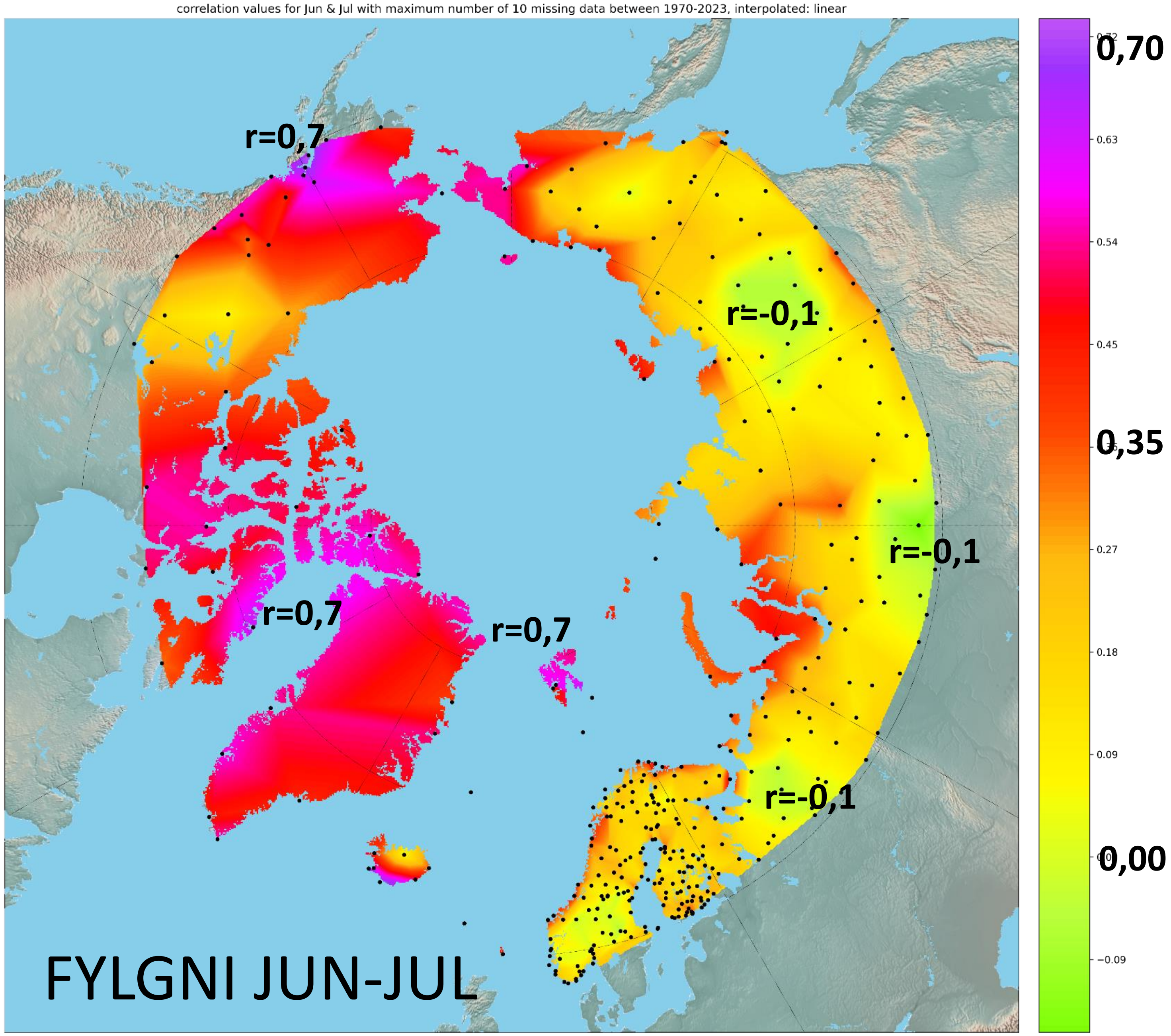

correlation values for May & Jun with maximum number of 10 missing data between 1970-2023, interpolated: linear
r=0,7
r=-0,2
FYLGNI MAÍ-JÚN
0.63
0.54
0.45
0.36
0.27
0.18
0.09
0.00
−0.09
−0.18


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

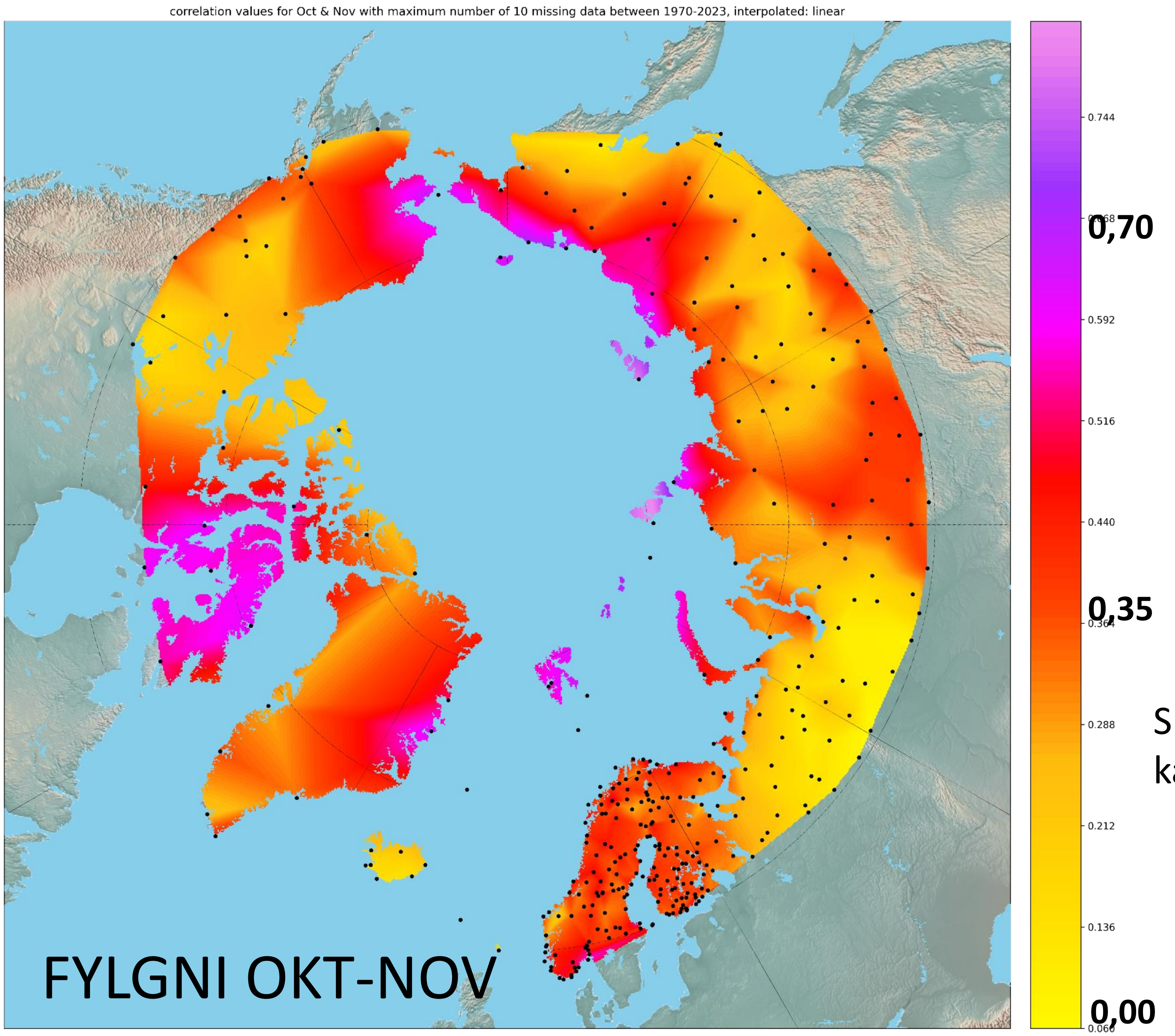
Sumar og haust


correlation values for Sep & Oct with maximum number of 10 missing data between 1970-2023, interpolated: linear
0.774
0,70
0.688
0.602
0.516
0,35
0.344
0.258
0.172
0,00
0.000
FYLGNI SEP-OKT

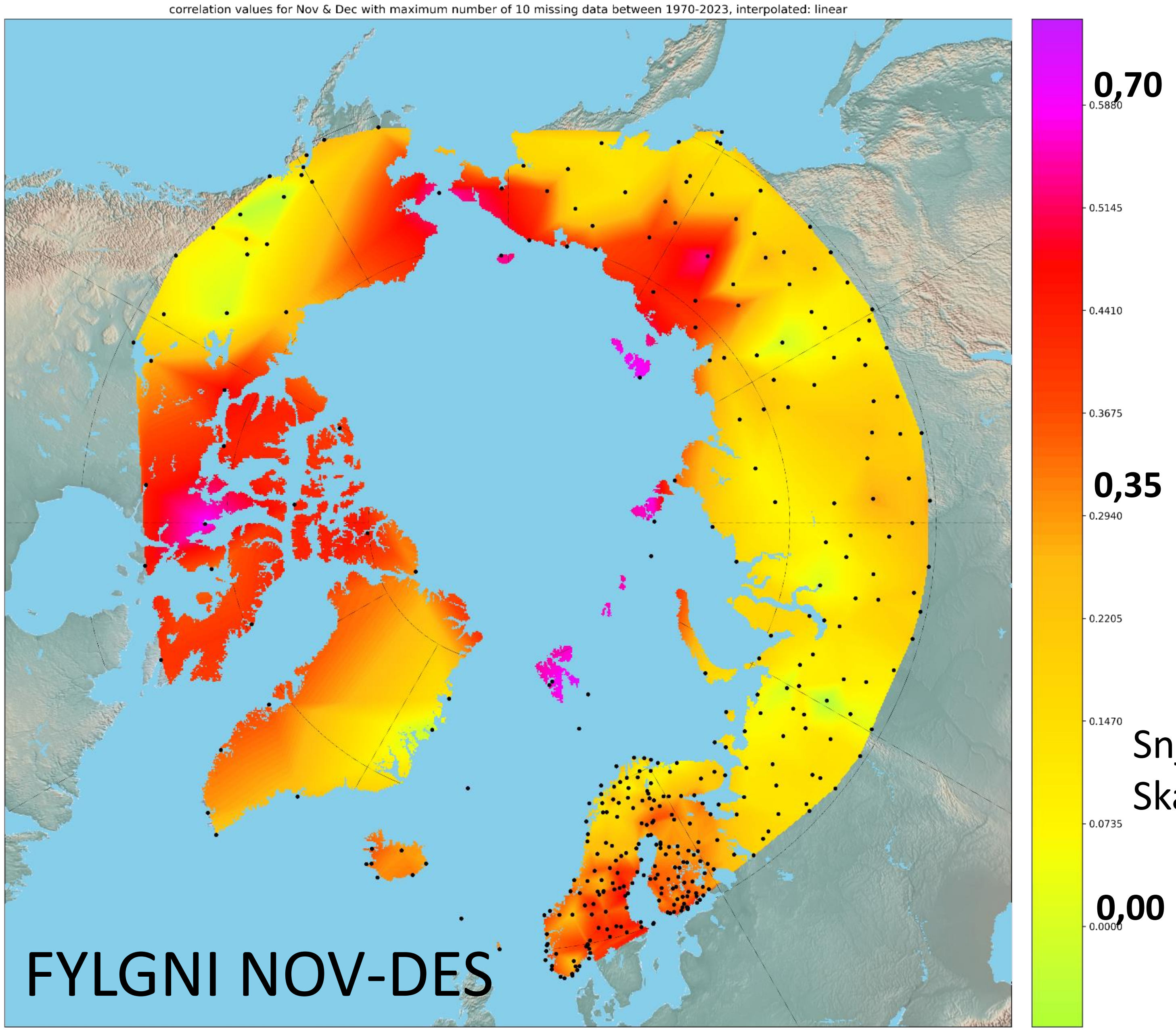
SKÓLABÓKIN



correlation values for Jun & Jul with maximum number of 10 missing data between 1970-2023, interpolated: linear
r=0,7
r=-0,1
r=-0,1
r=0,7
r=0,7
r=-0,1
FYLGNI JUN-JUL
0,70
0,35
0,00
0.63
0.54
0.45
0.27
0.18
0.09
−0.09

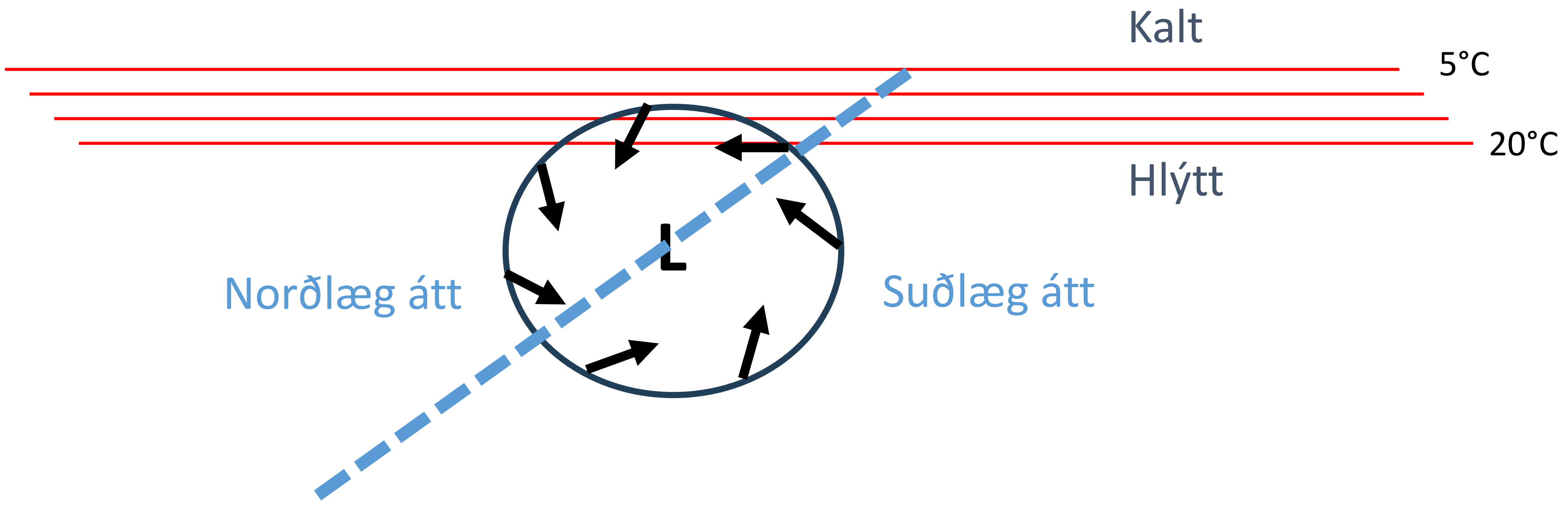


Snjóþungur október í Skandinavíu er kaldur



Snjóþungur nóvember um miðbik Skandinavíu er kaldur

Aðstæður þar sem aðstreymi gæti spillt fyrir hitafylgni



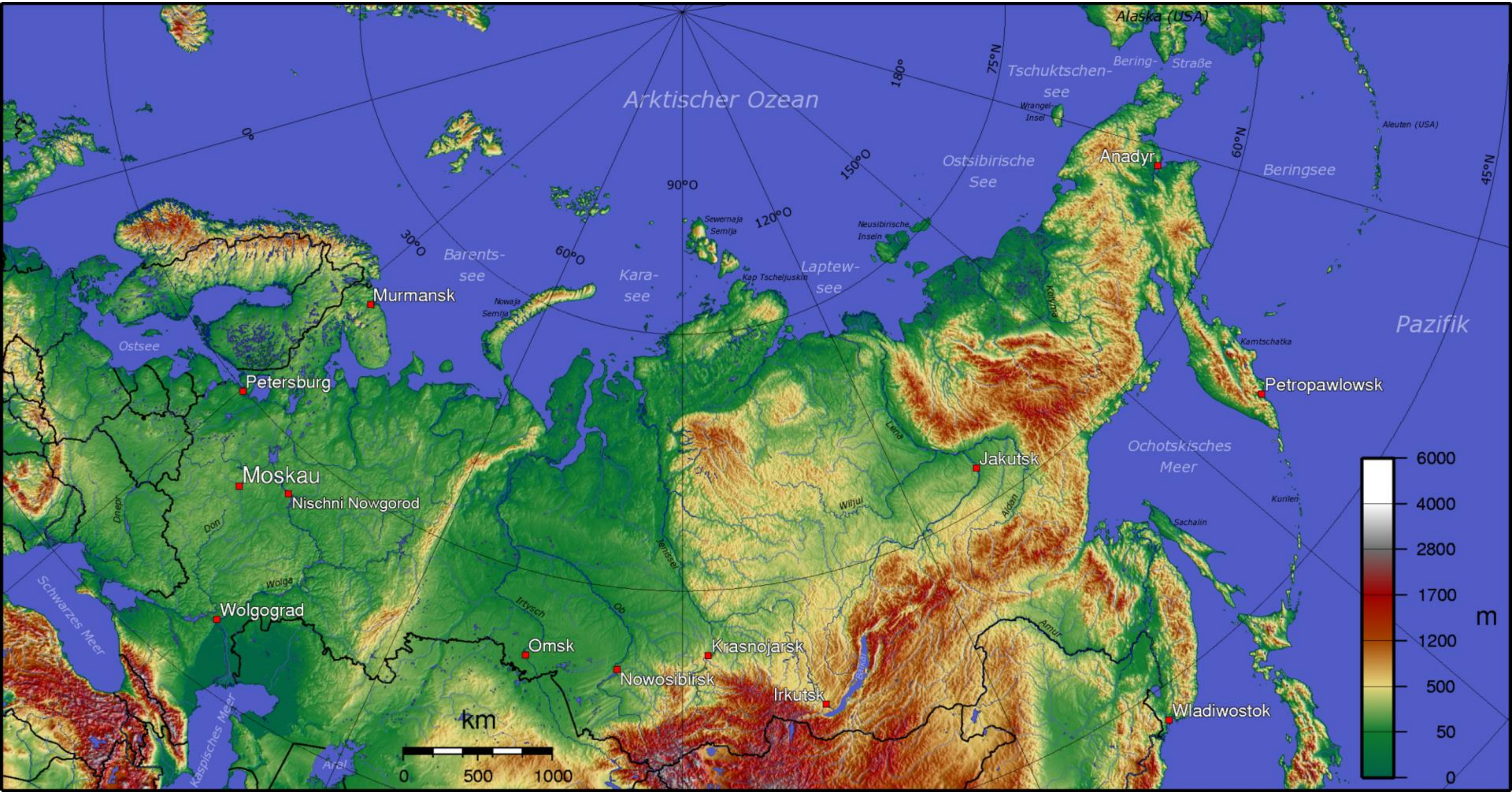
Það bara kalt aðstreymi niðri við jörð

Sá hluti vindasviðs sem er afleiðing af hitalægð hefur kælandi áhrif

Hitatregða á norðurslóðum

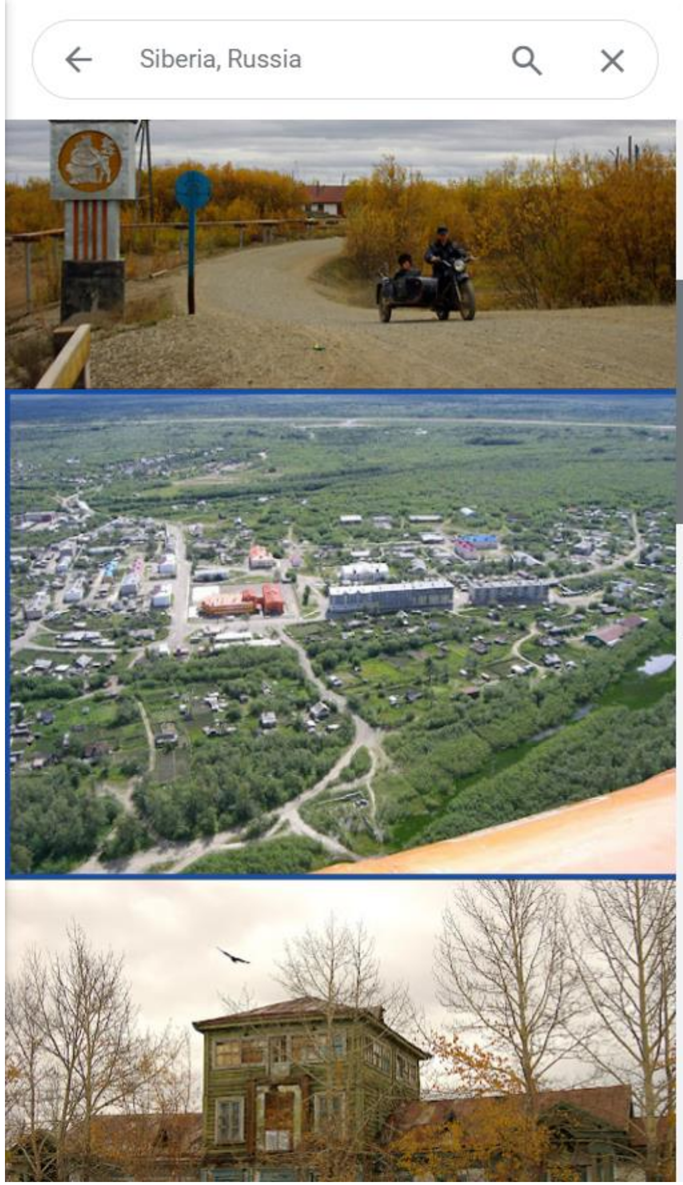
- Áhrif hafíss sterk og skýr – víða mjög mikil fylgni við hafísrönd
- Óljós áhrif tengd jarðvegsraka á sumrin
- Hlýindi tengd snjókomu að vetrarlagi virðast skila sér með köldu fráviki á vorin
- Vindar tengdir hafísfráviki virðast hafa áhrif í báðar áttir
- Vindar tengdir hitafráviki yfir landi hafa líklega neikvæð áhrif á fylgnina


Þökk fyrir áheyrnina



Arktischer Ozean
Alaska (USA)
Bering- Straße
Tschuktschen-see
Wrangel-Insel
Aleuten (USA)
Beringsee
Anadyr
Ostsibirische See
Neusibirische Inseln
Laptew-see
Kap Tscheljuskin
Sewernaja Semlja
Kara-see
Barents-see
Nowaja Semlja
Murmansk
Ostsee
Petersburg
Moskau
Nischni Nowgorod
Wolgograd
Schwarzes Meer
Kaspisches Meer
Aral
Omsk
Nowosibirsk
Krasnojarsk
Irkutsk
Baikal
Jakutsk
Ochotskisches Meer
Kamtschatka
Petropawlowsk
Pazifik
Kurilen
Sachalin
Wladiwostok
Amur
Aldan
Lena
Kolyma
Wiljui
Jenissei
Ob
Irtysch
Wolga
Don
Dnepr
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

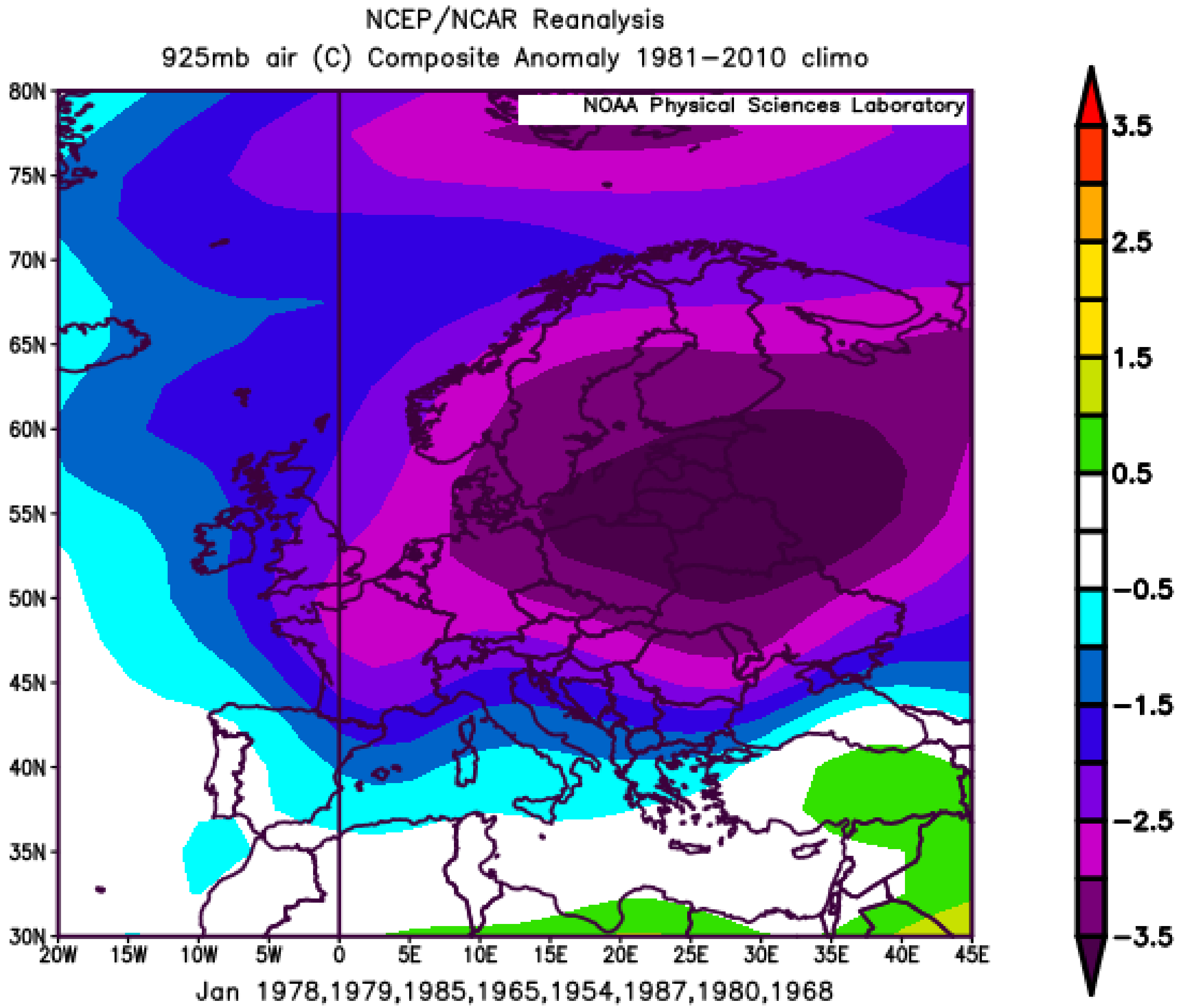


Hitatregðan

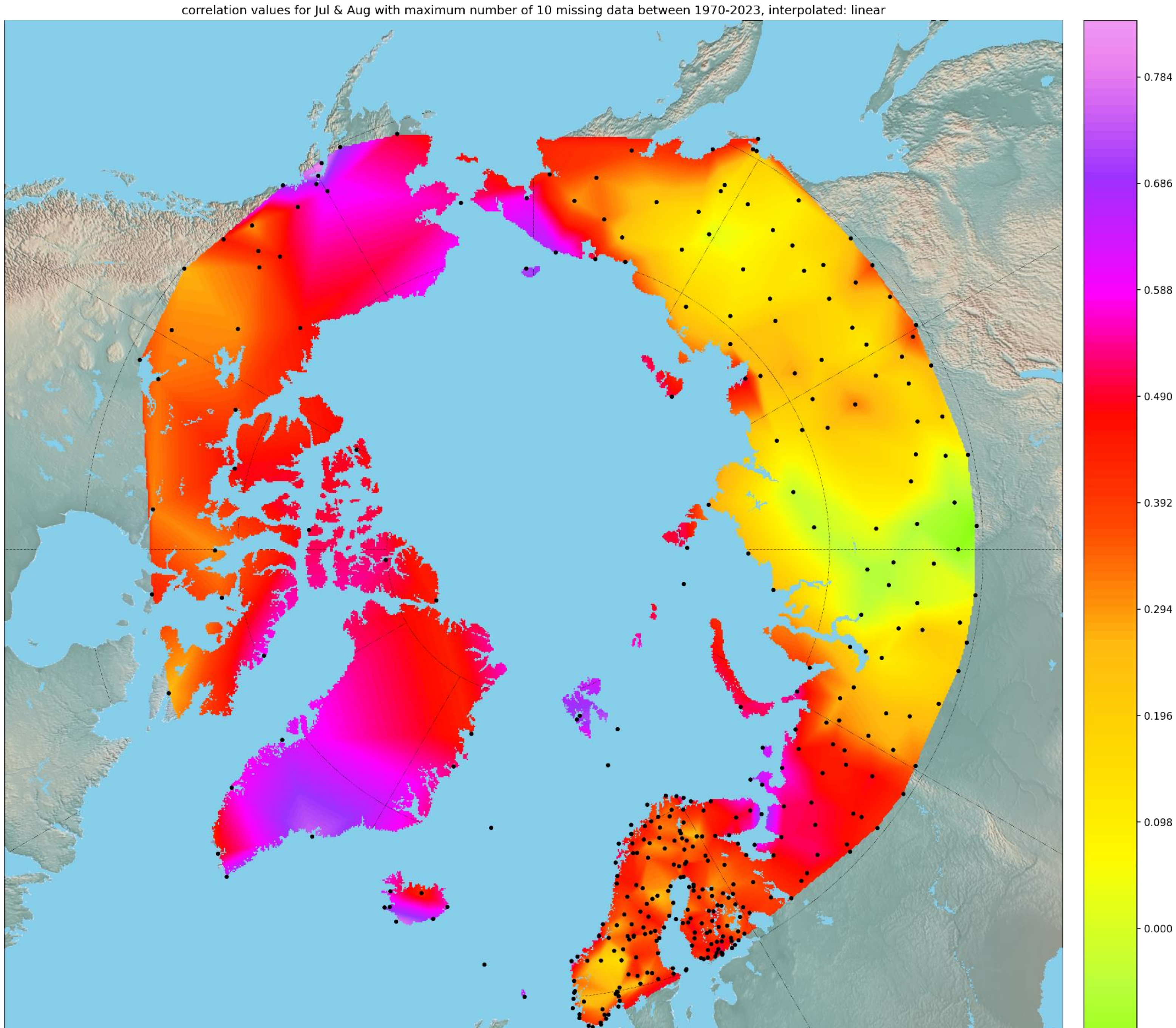
Salomé Avrillaud (Frakklandi)

Lisa Degenhardt (Íslandi)

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

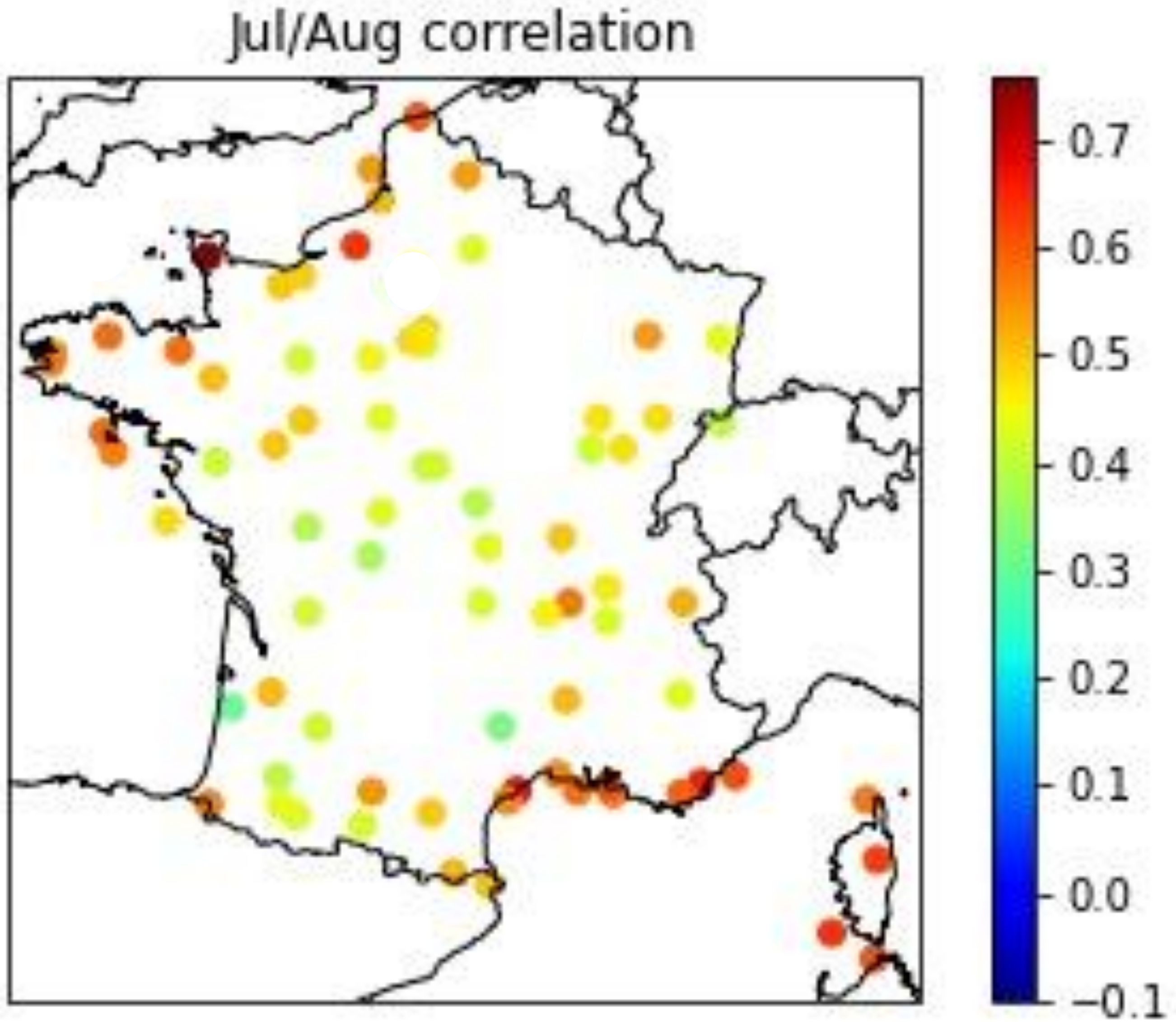



Töluverð tregða er í kuldafrávikum í A-Evrópu
Kuldaköst í Frakklandi leitast við að spilla sér
H

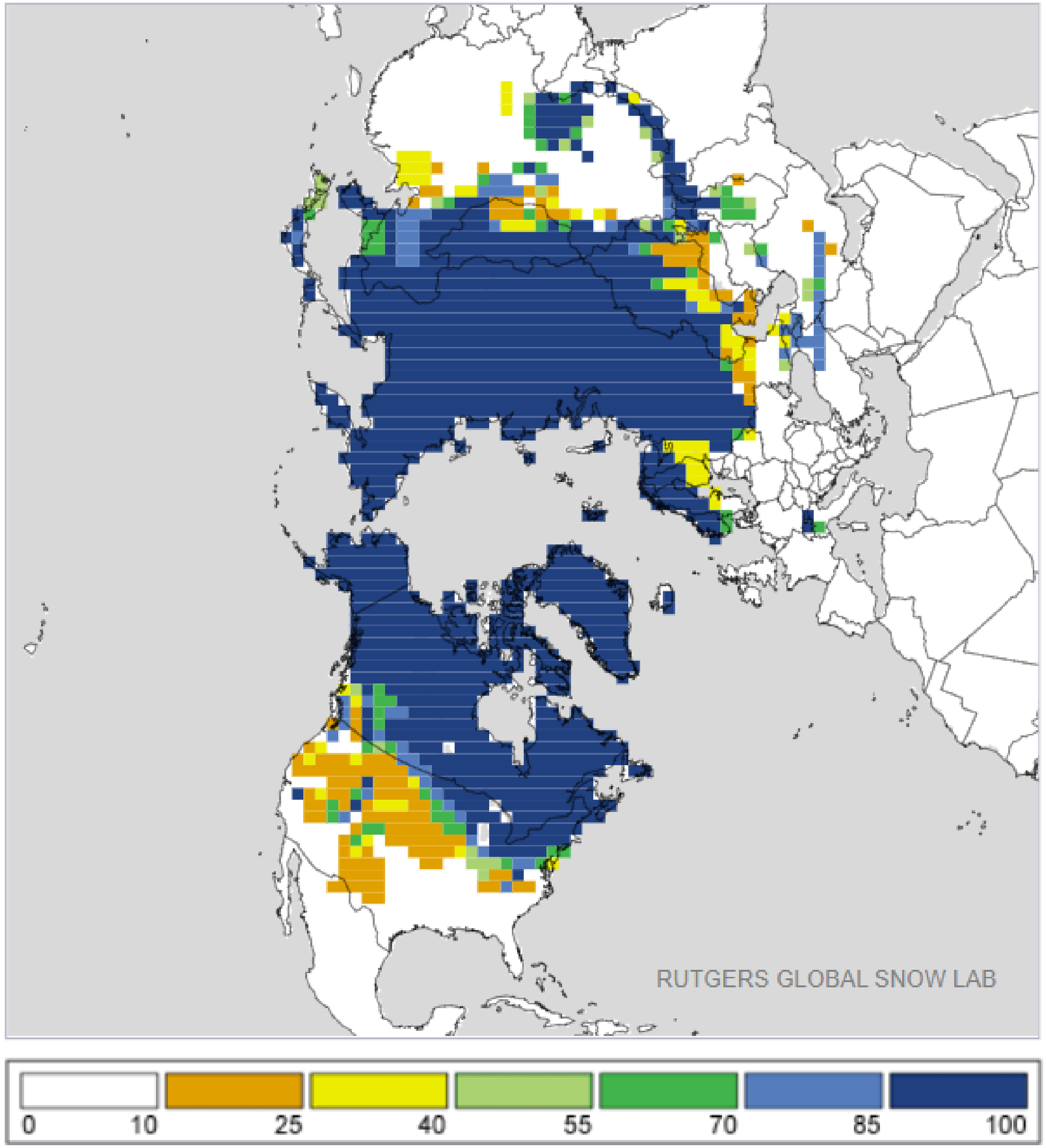

correlation values for Jul & Aug with maximum number of 10 missing data between 1970-2023, interpolated: linear
0.784
0.686
0.588
0.490
0.392
0.294
0.196
0.098
0.000

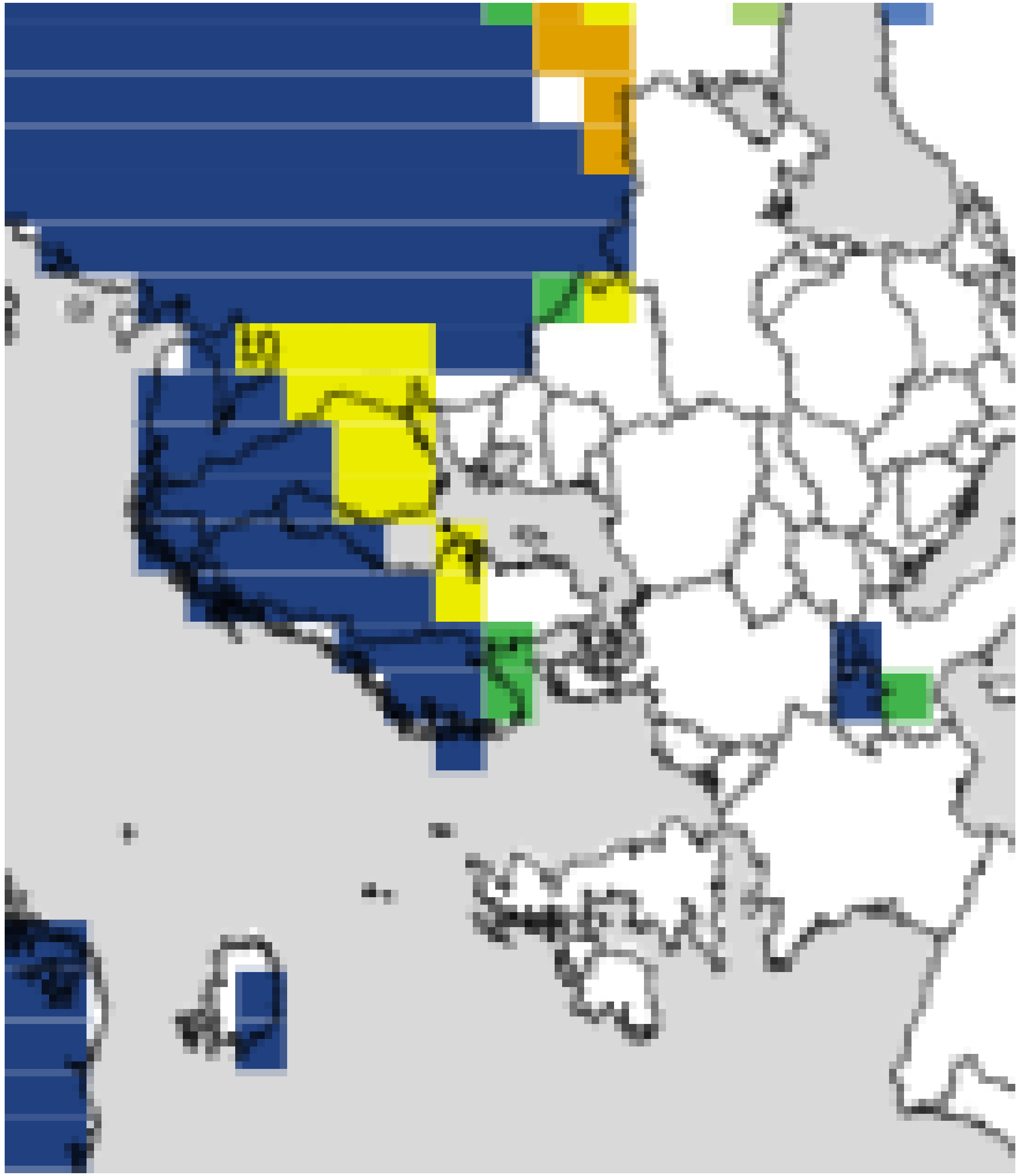
- Síbería

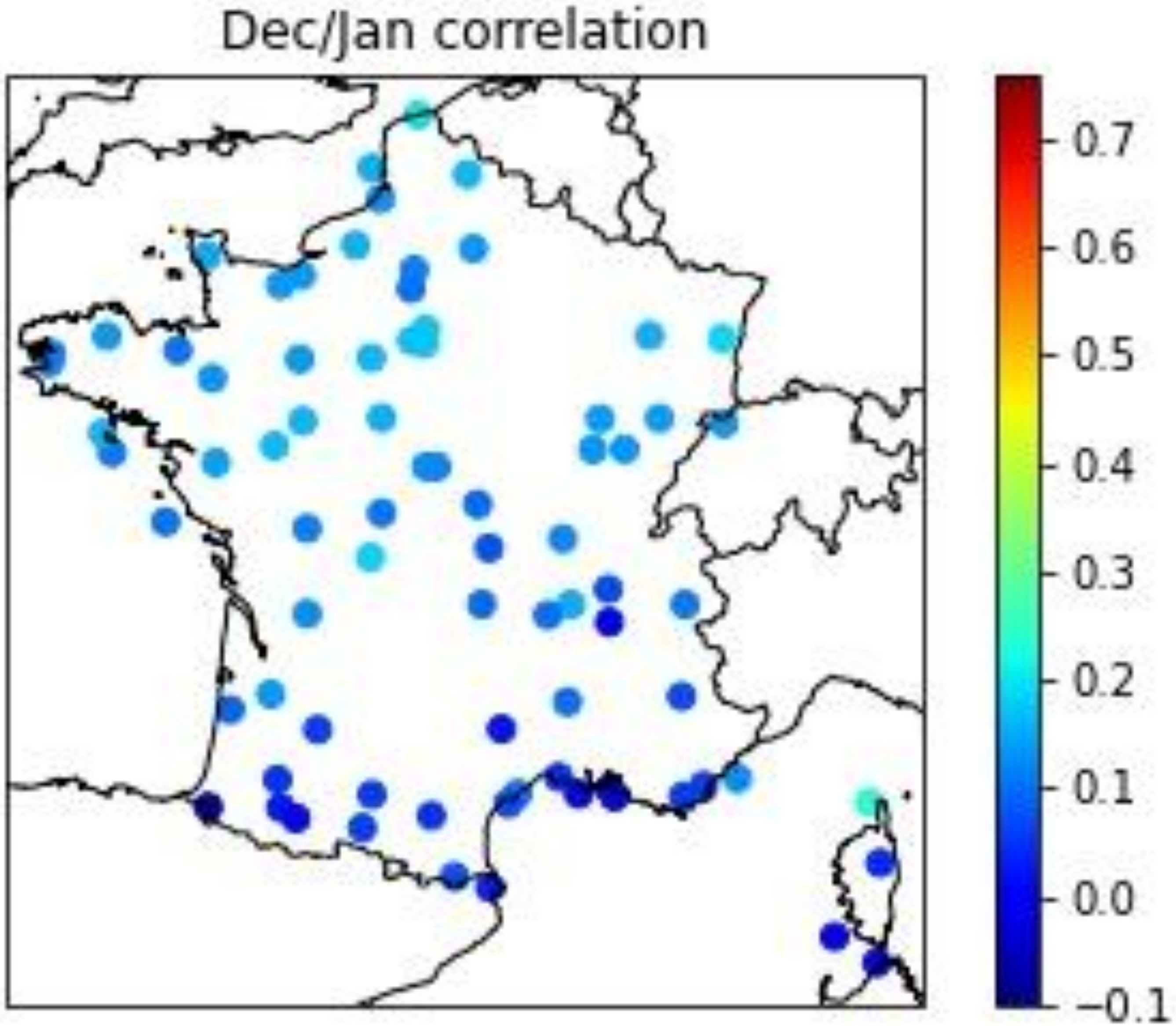
Síbería


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

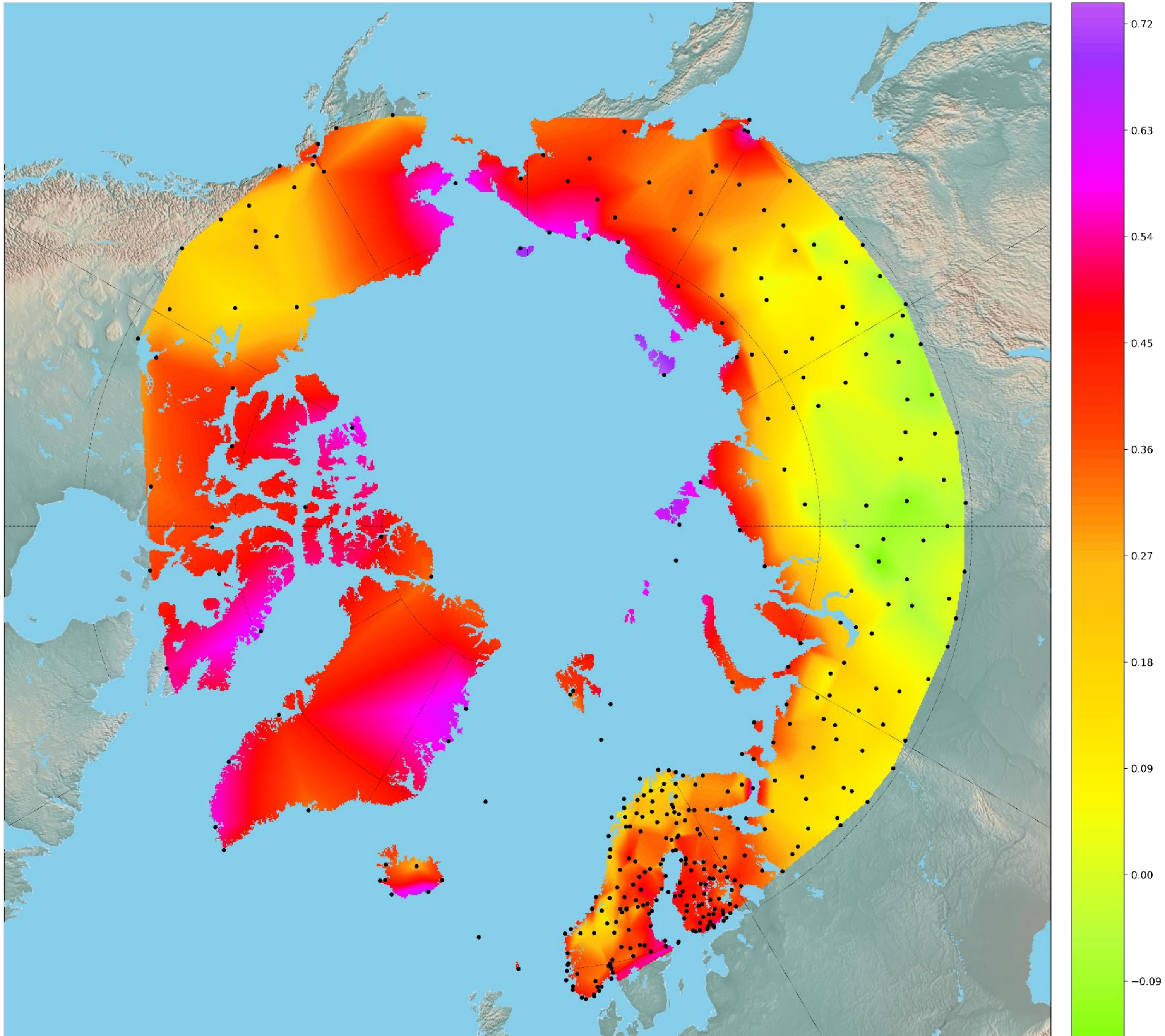
Monthly Snow Cover Extent - January 1981



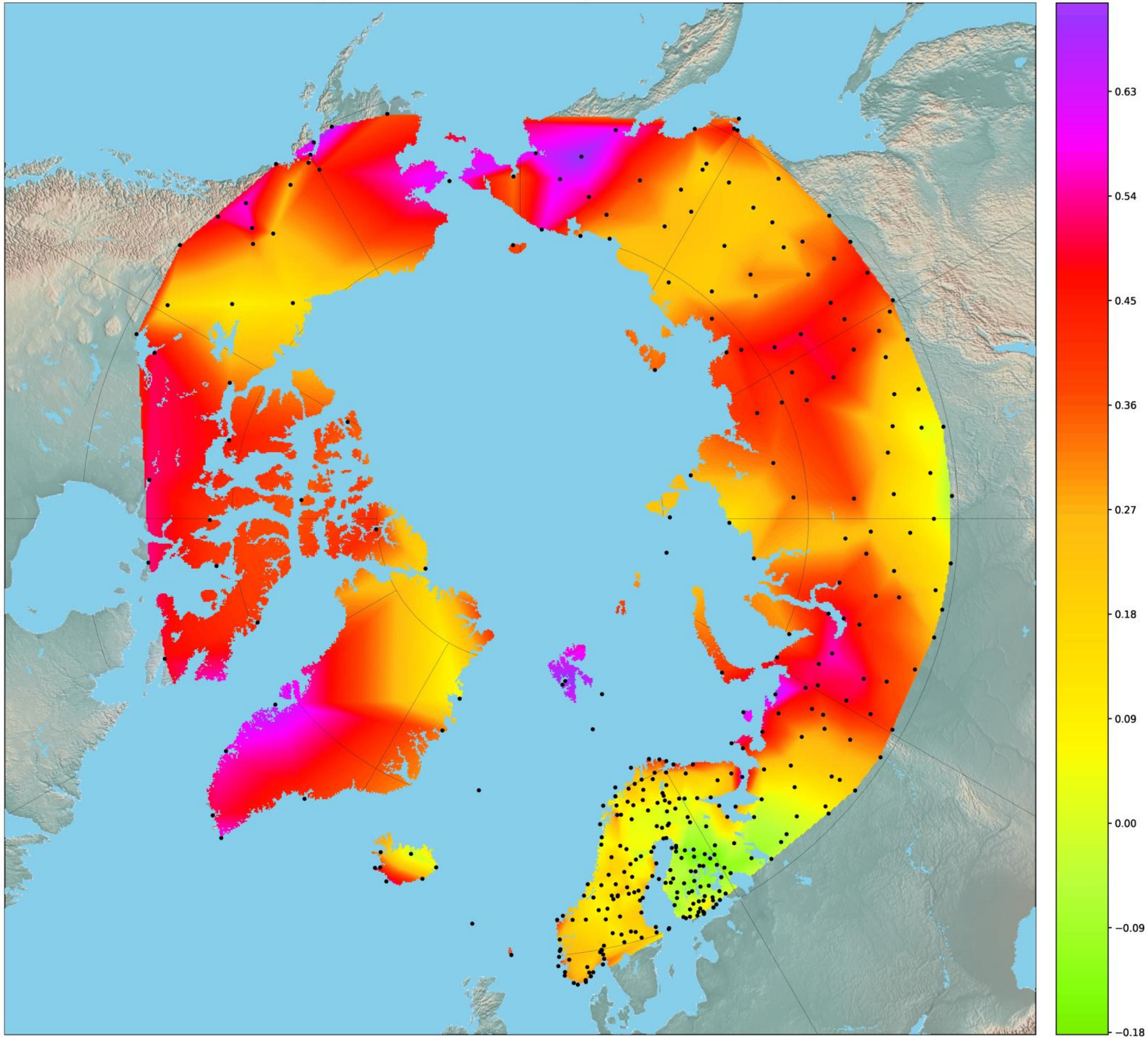



Dec/Jan correlation
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
−0.1

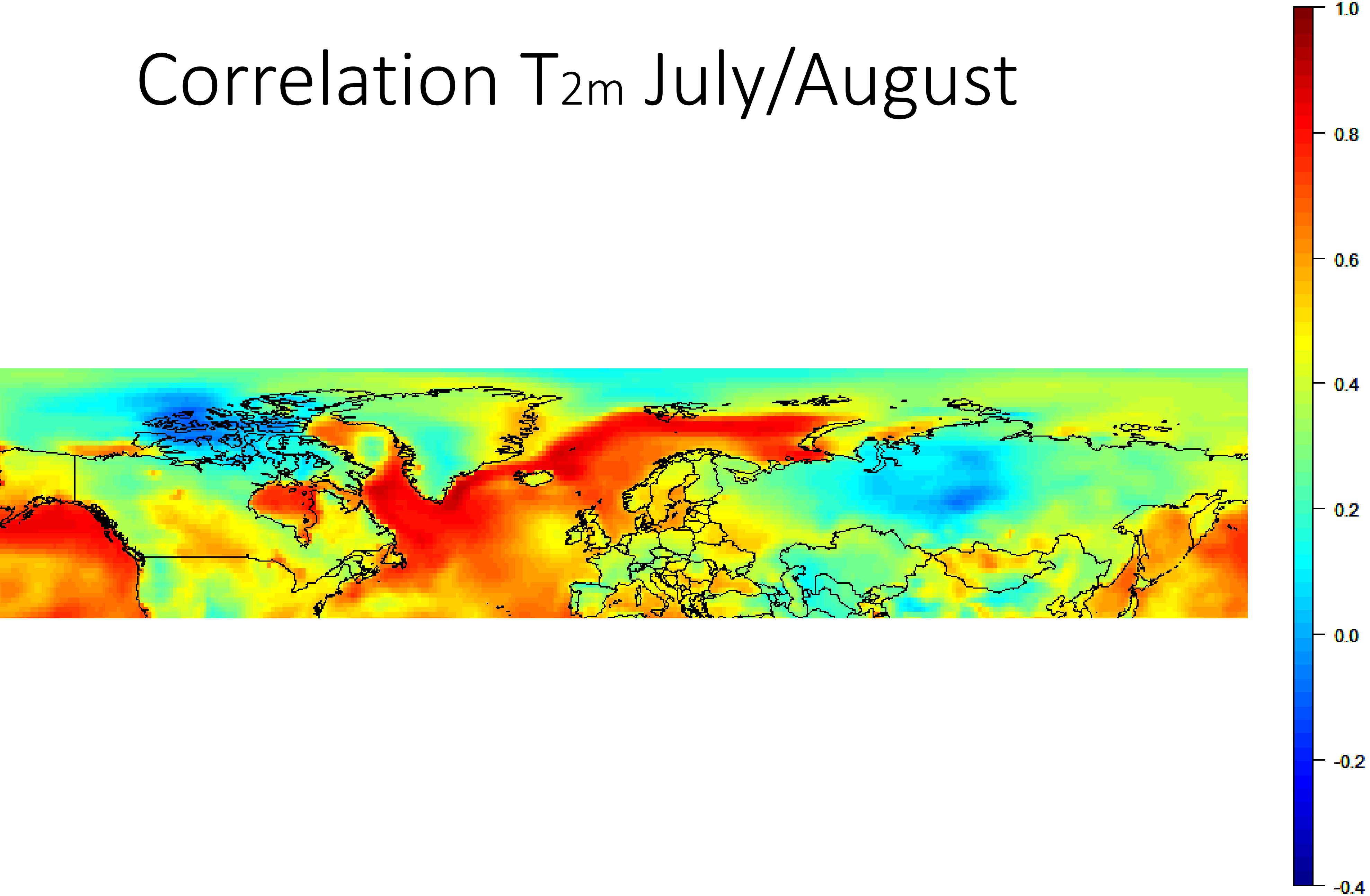
correlation values for Aug & Sep with maximum number of 10 missing data between 1970-2023, interpolated: linear



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



Correlation T_{2m} July/August



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

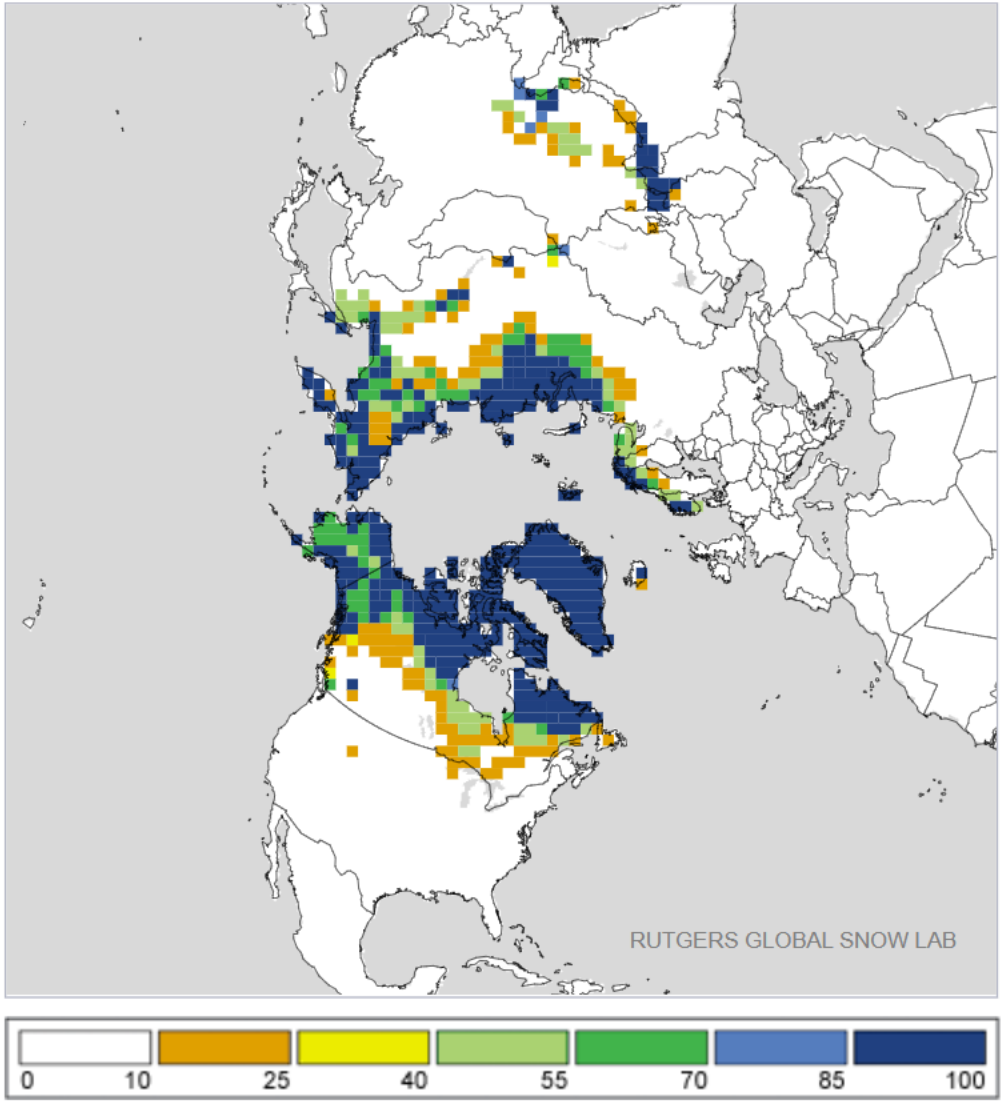
North America:
9.02 million sq. km

<< < YEAR > >>

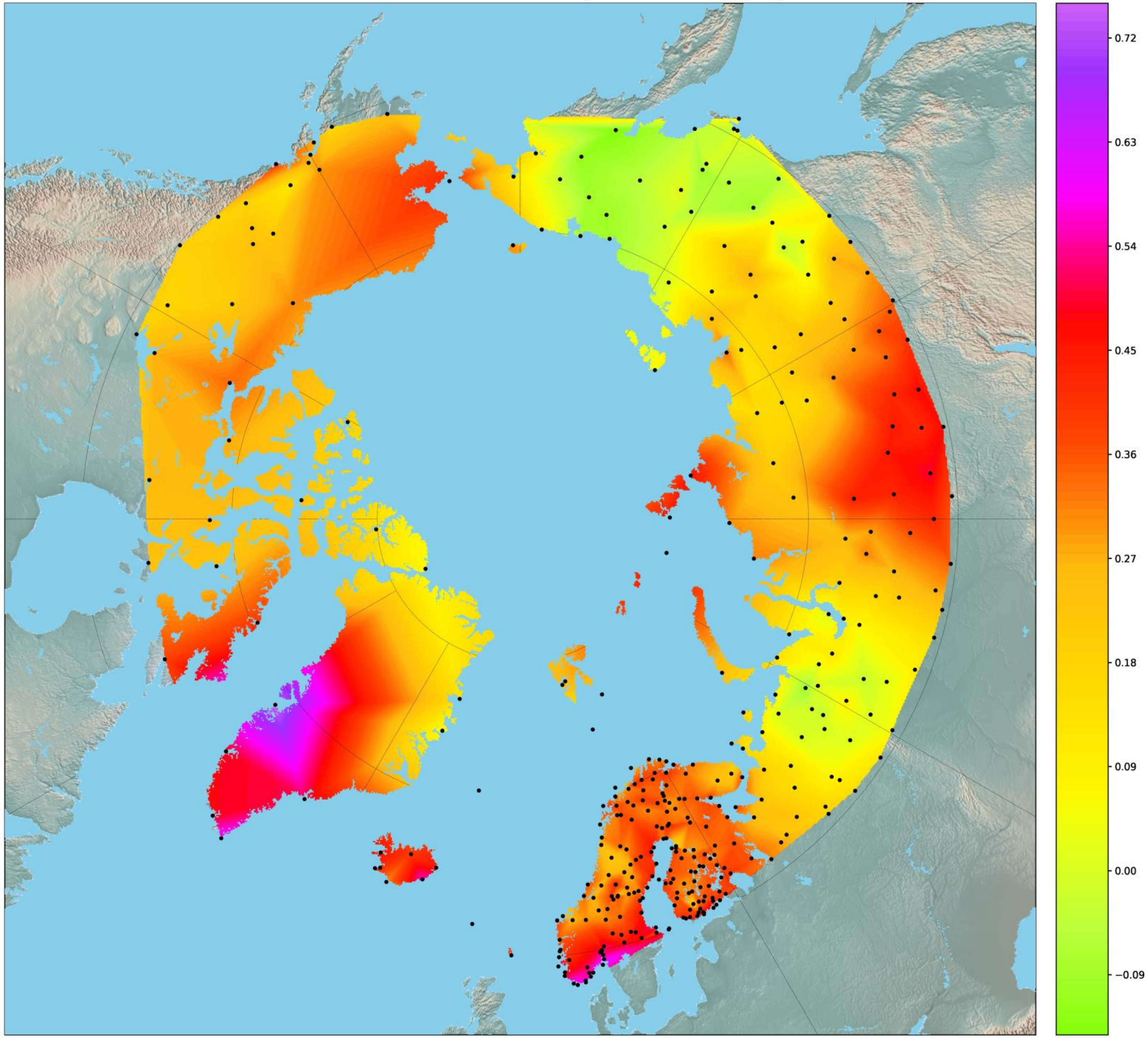
< MONTH >

See Departure

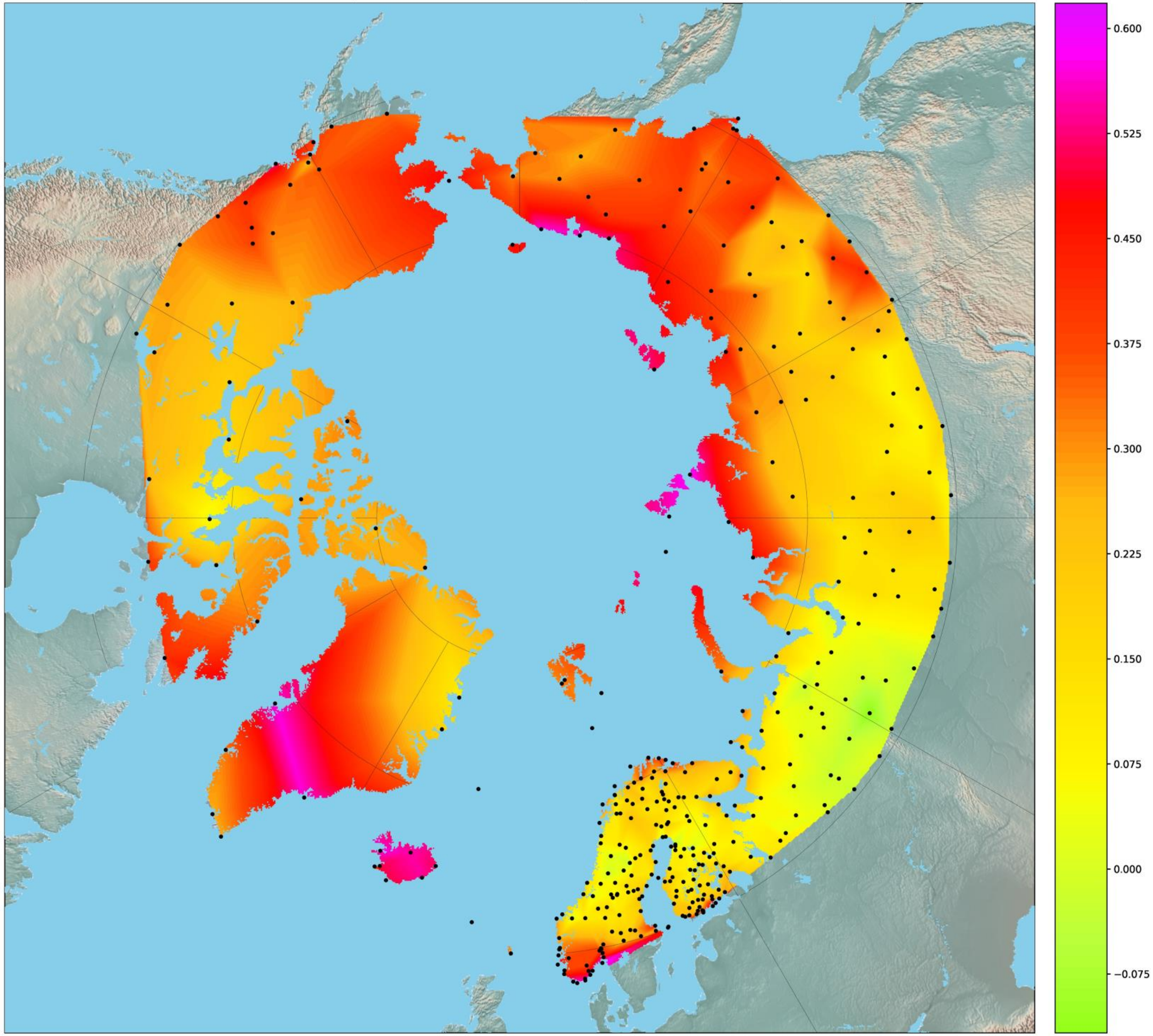
Monthly Snow Cover Extent - May 2013

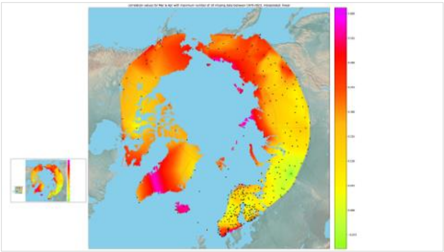


correlation values for Feb & Mar with maximum number of 10 missing data between 1970-2023, interpolated: linear

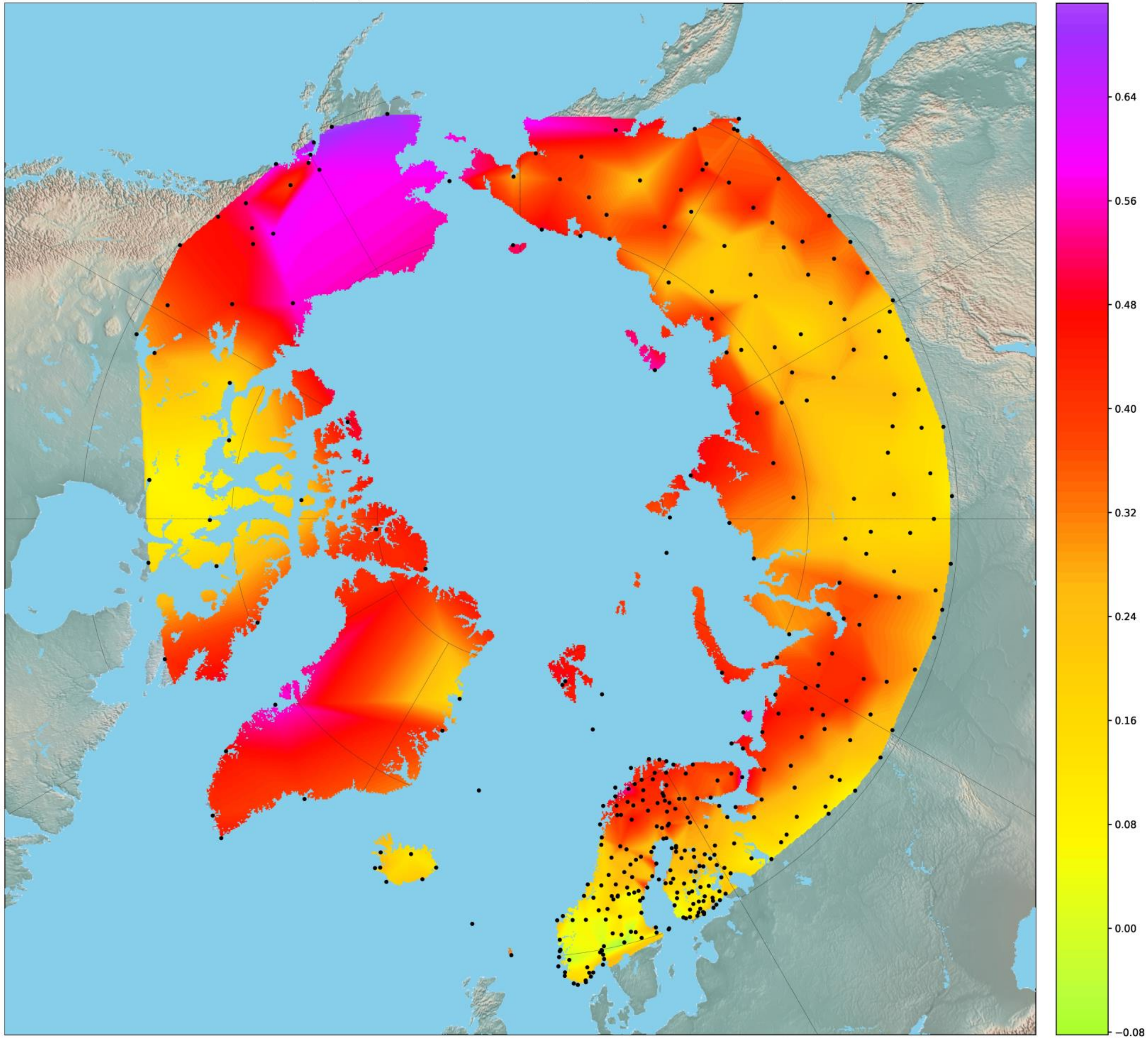


correlation values for Mar & Apr with maximum number of 10 missing data between 1970-2023, interpolated: linear

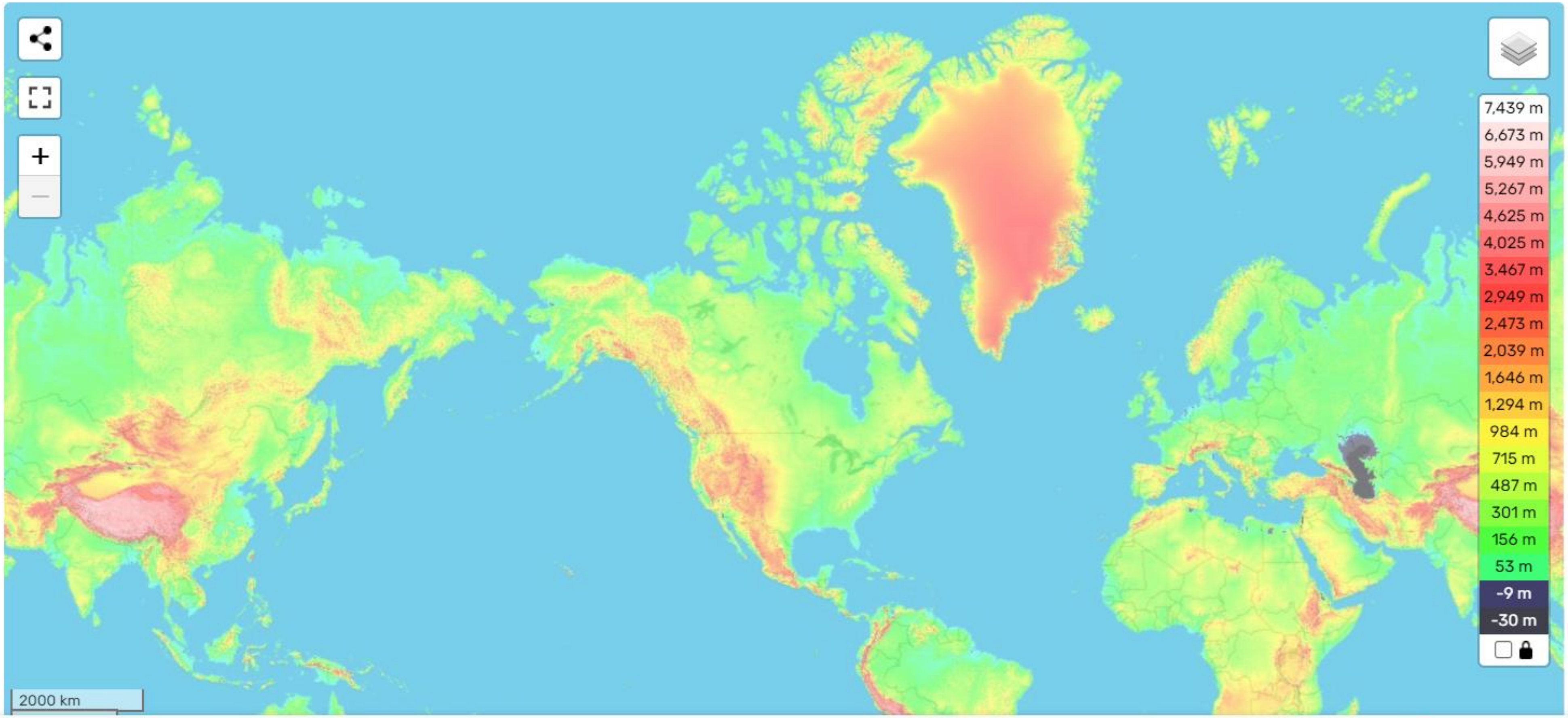




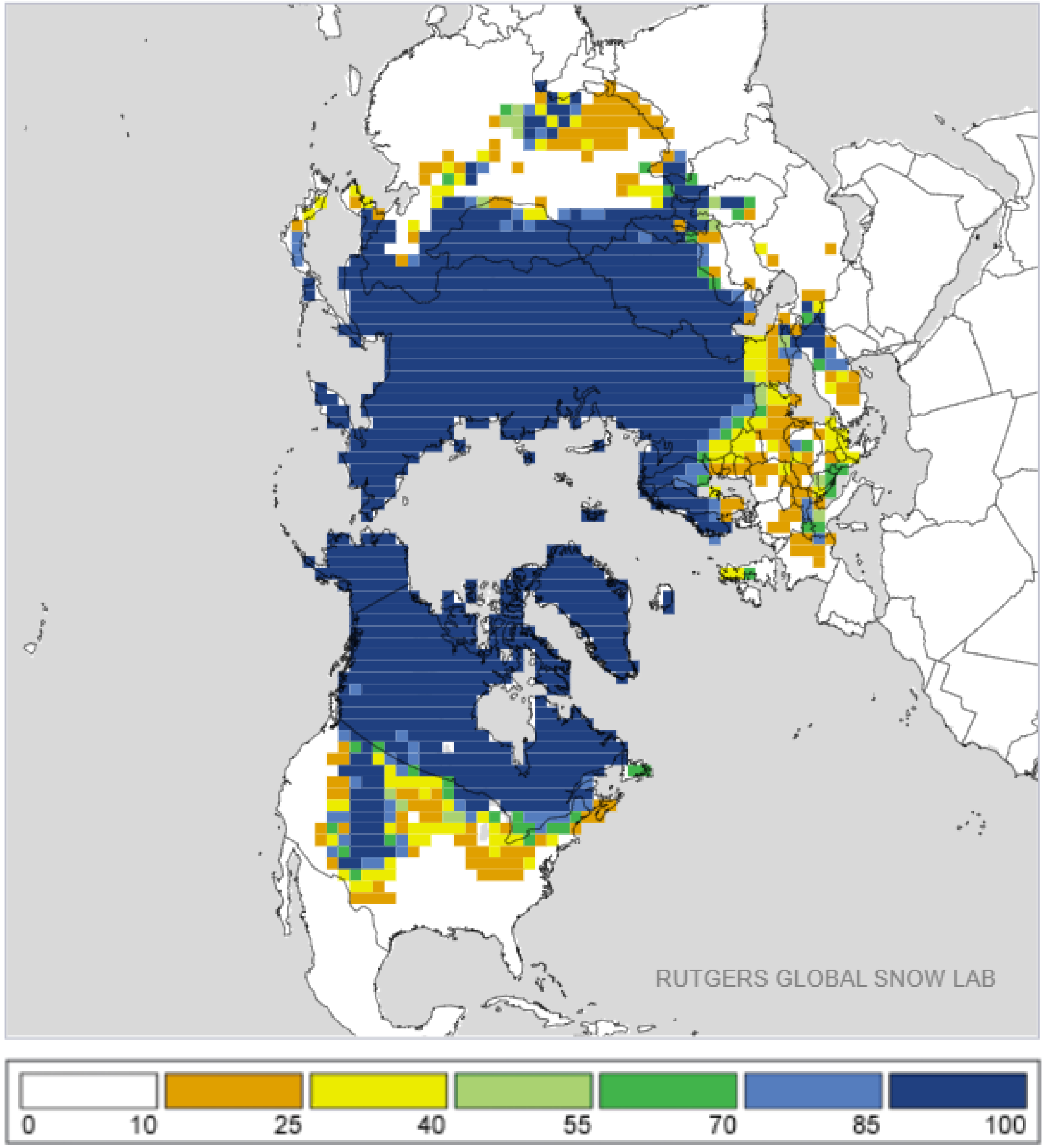
correlation values for Apr & May with maximum number of 10 missing data between 1970-2023, interpolated: linear

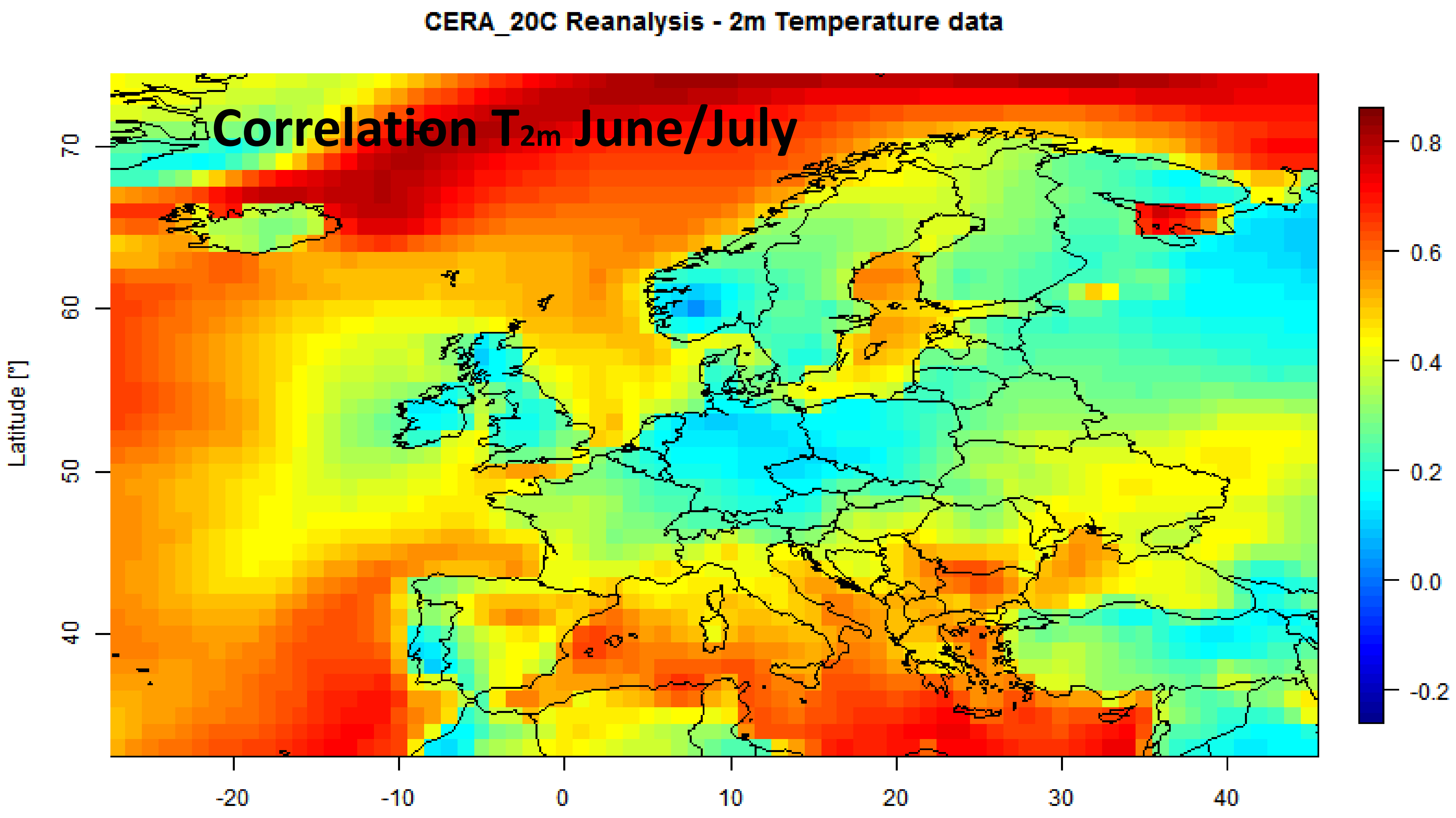


Click on the **map** to display **elevation**.

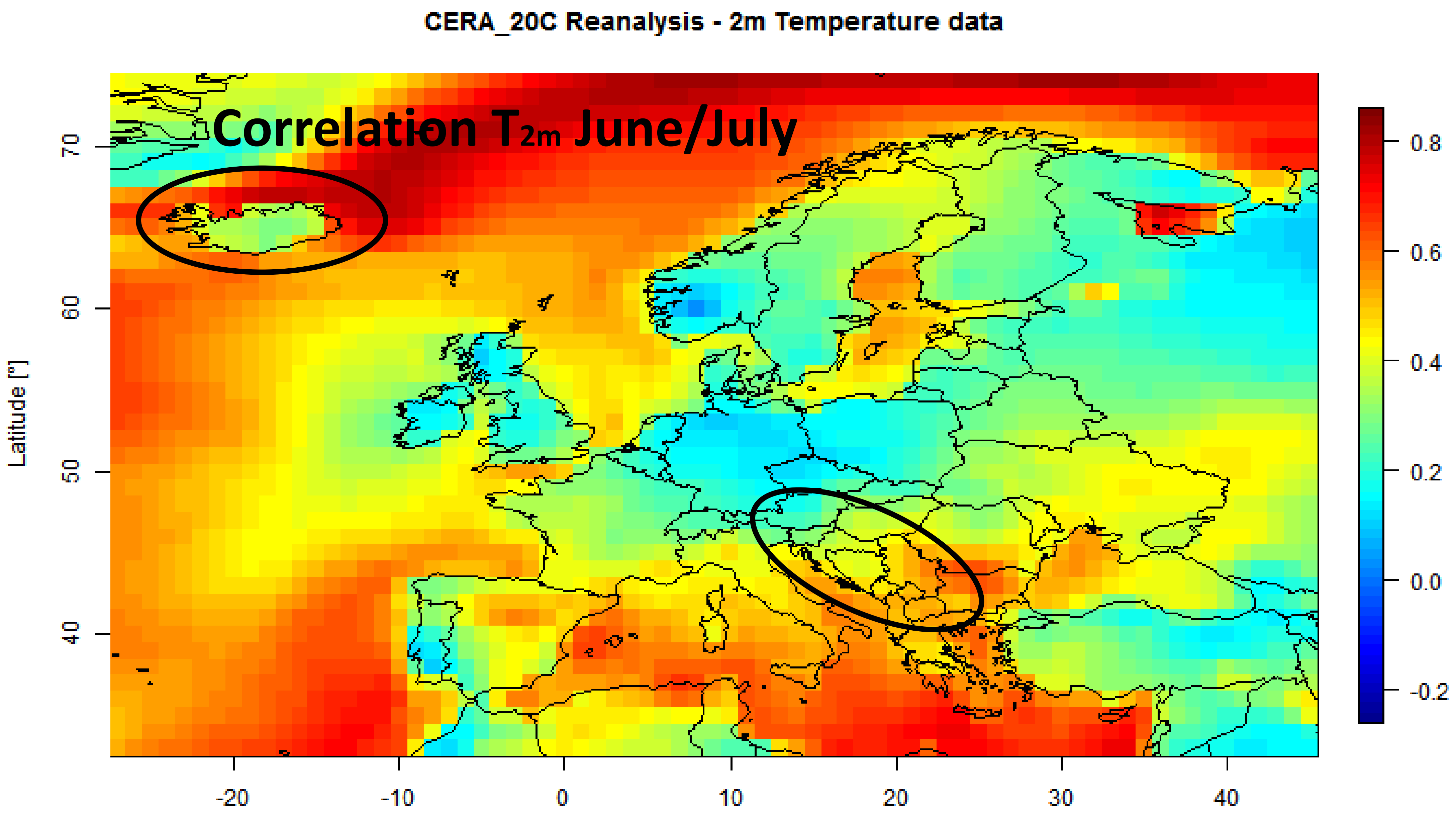


Monthly Snow Cover Extent - December 2011





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



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70
60
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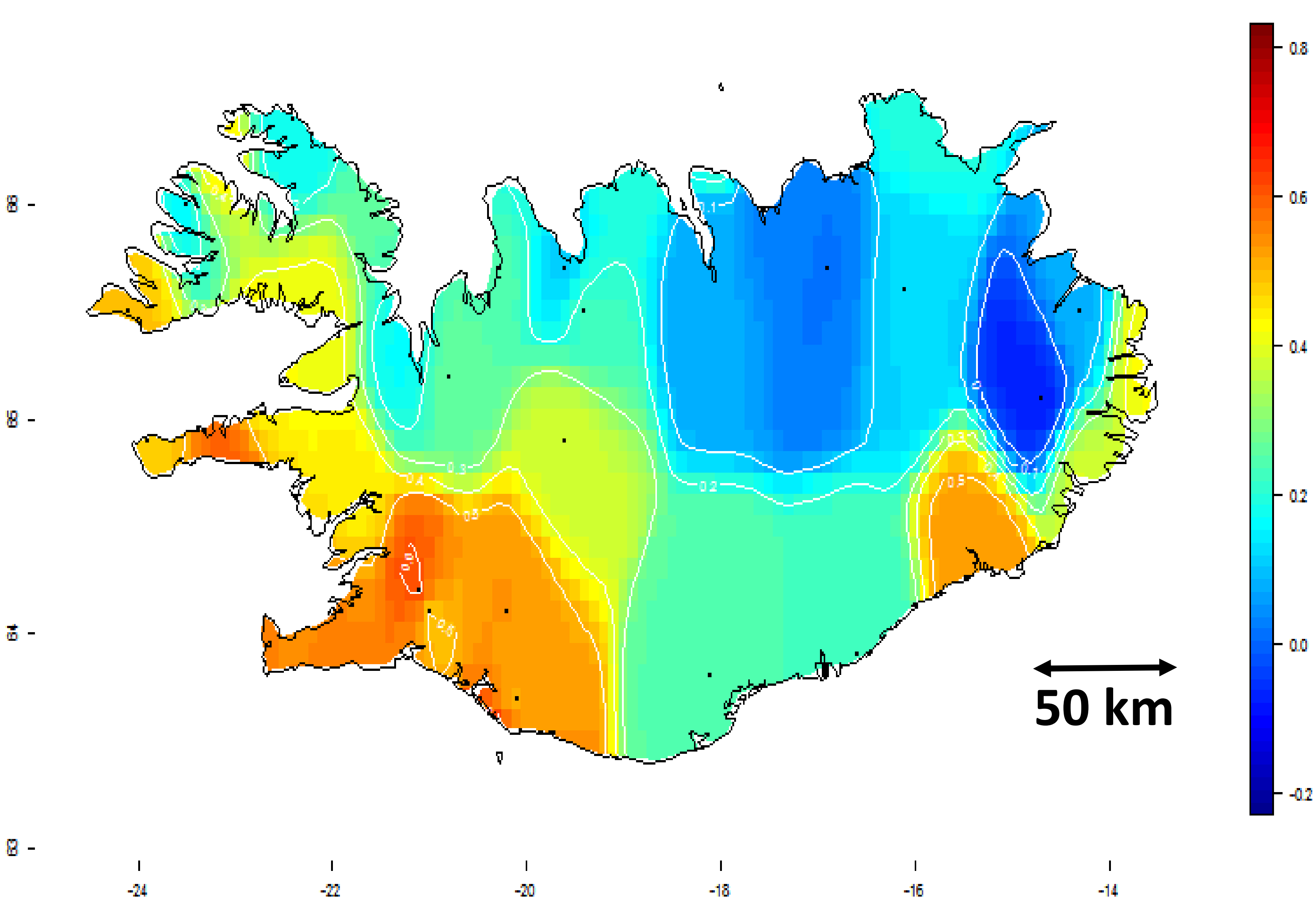
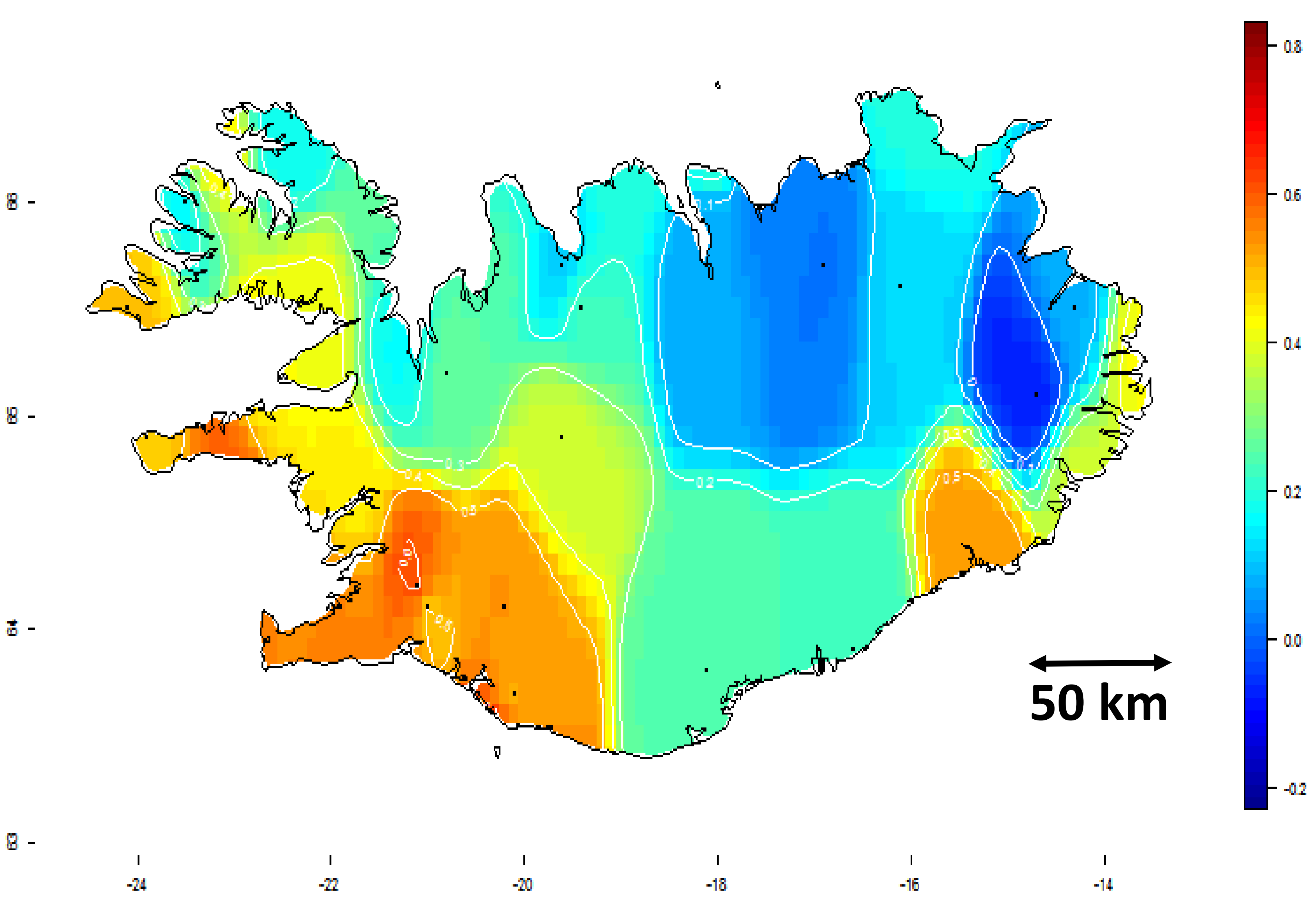
0.8
0.6
0.4
0.2
0.0
-0.2

Correlation T_{2m} June/July

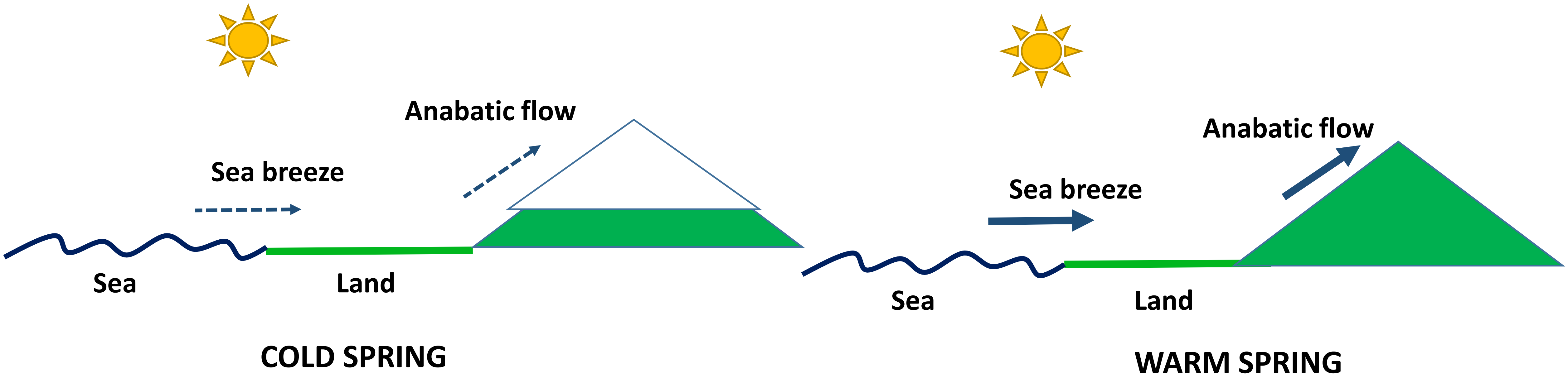


Correlation T_{2m} June/July

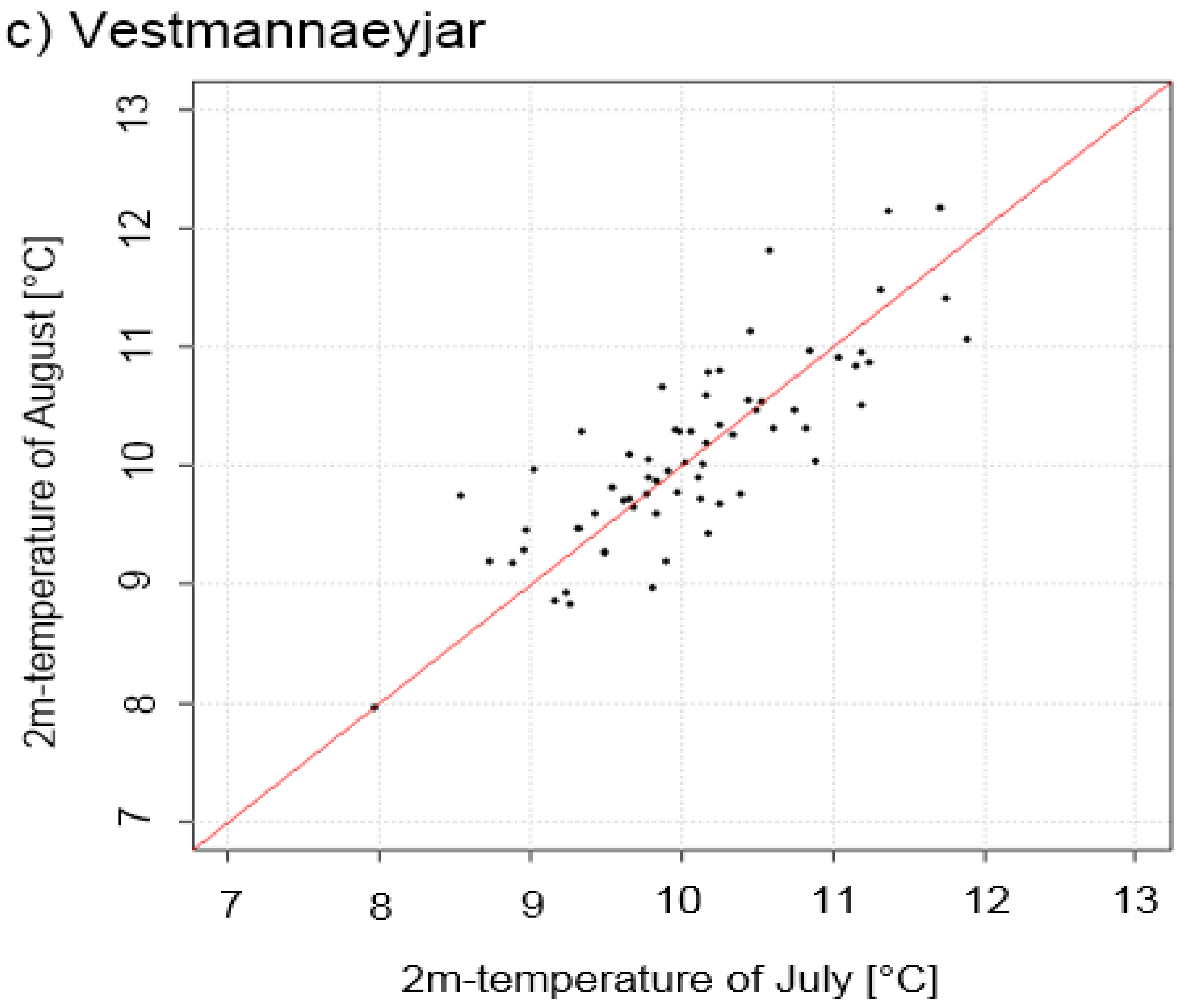


The mesoscale circulation negative feedback

How can a cold June give a warm July?



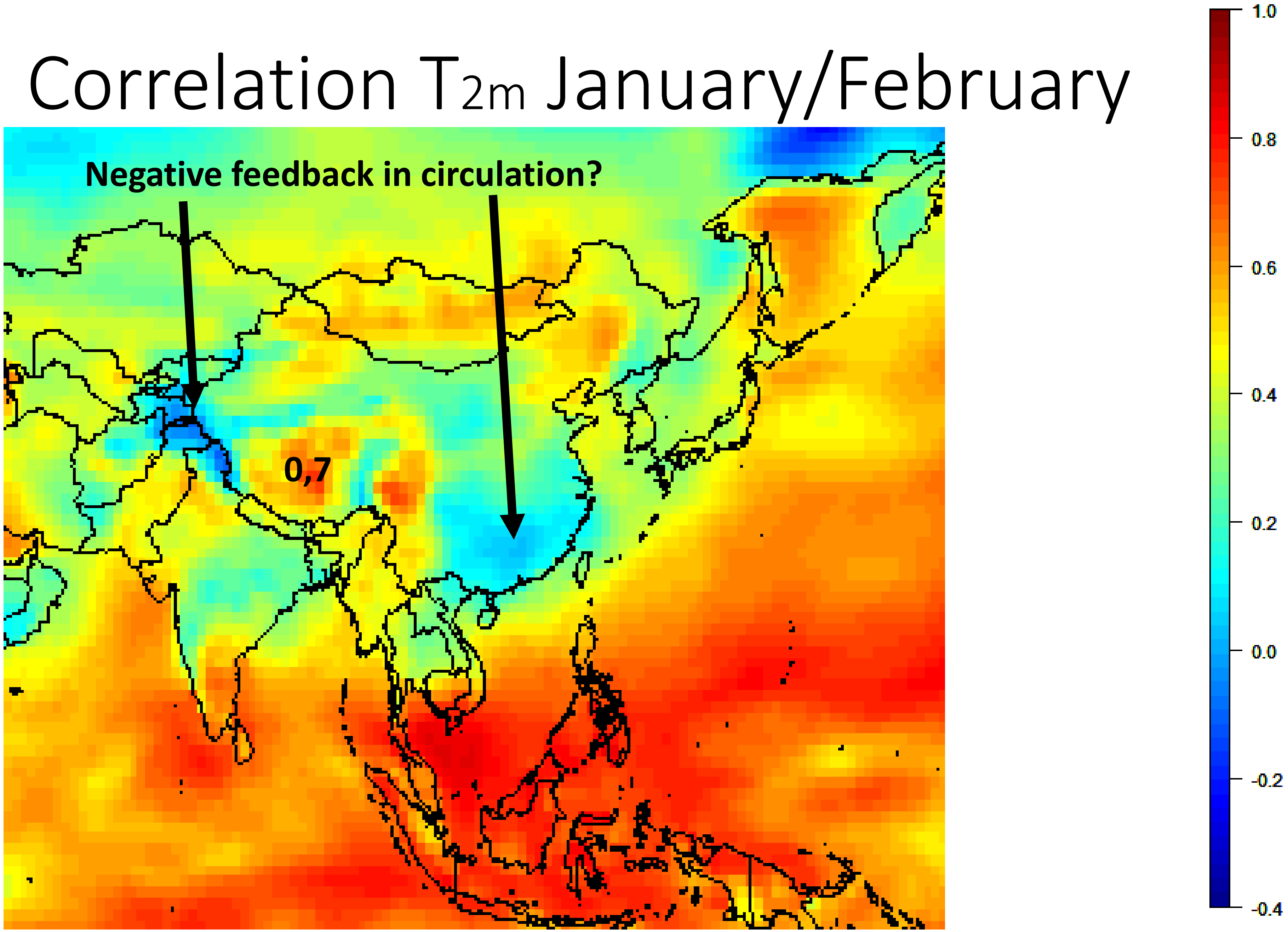
A cold spring gives much snow in the mountains, leading to weaker sea breeze and anabatic winds



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!

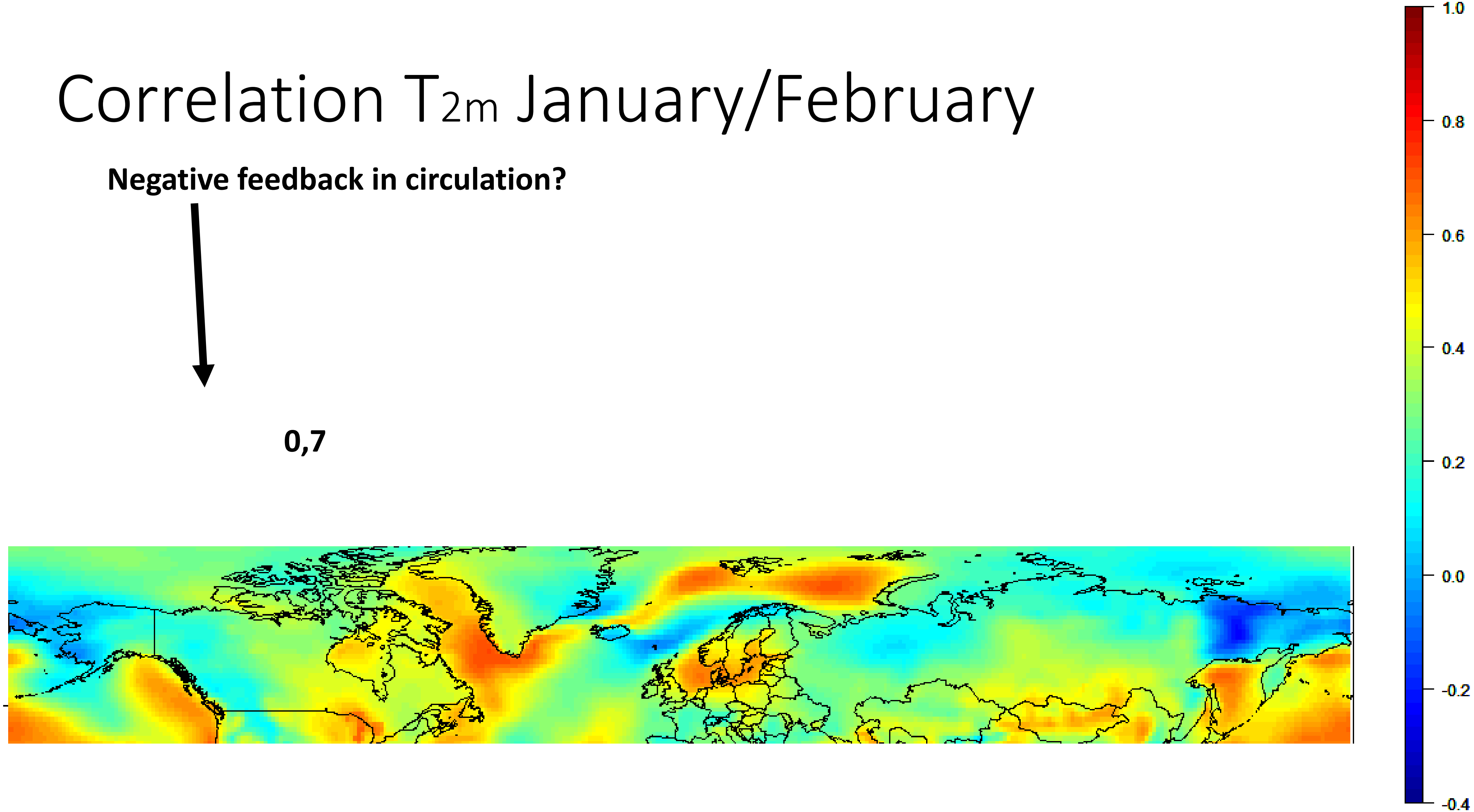
Correlation T_{2m} January/February



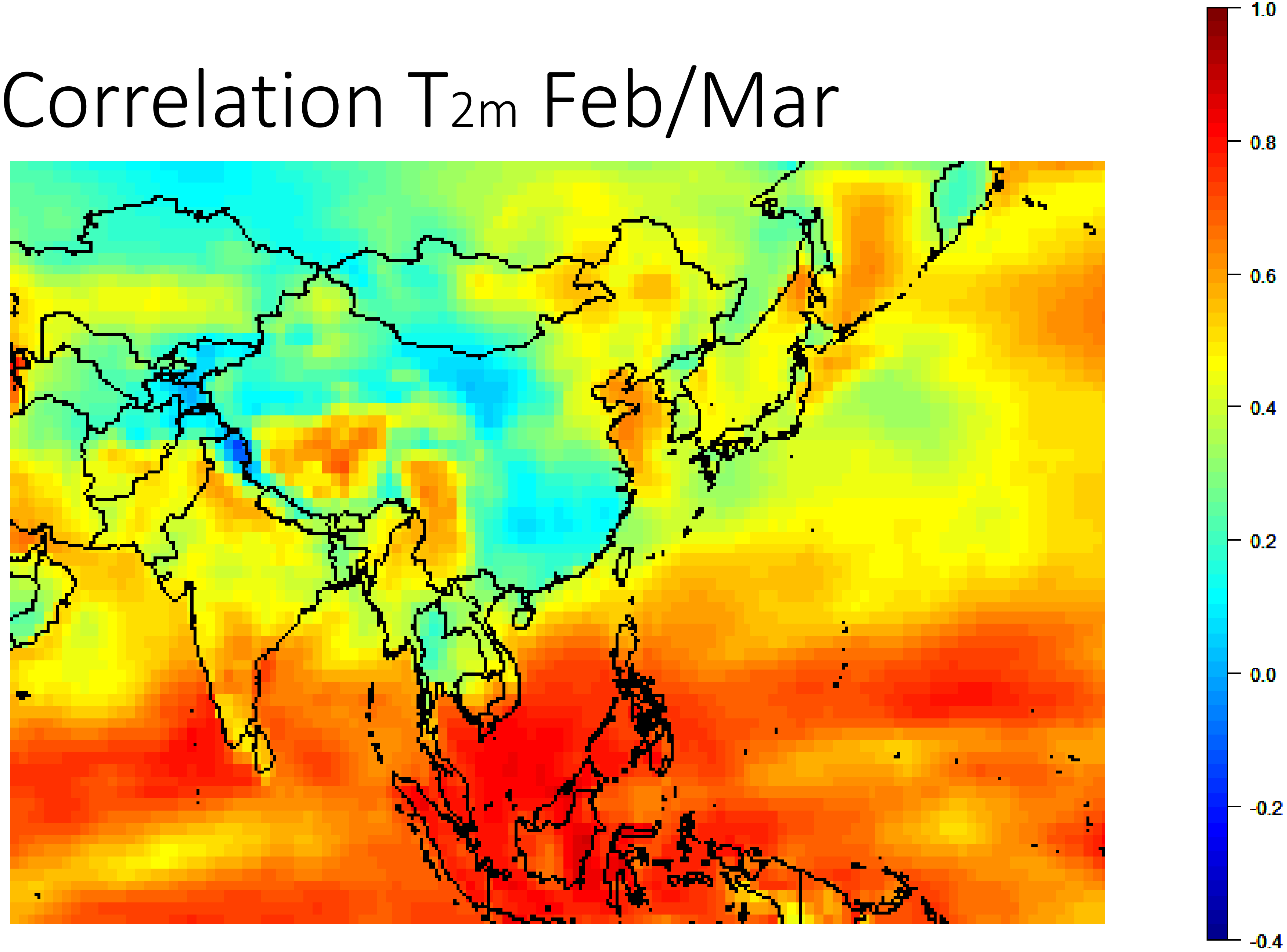
Correlation T_{2m} January/February

Negative feedback in circulation?

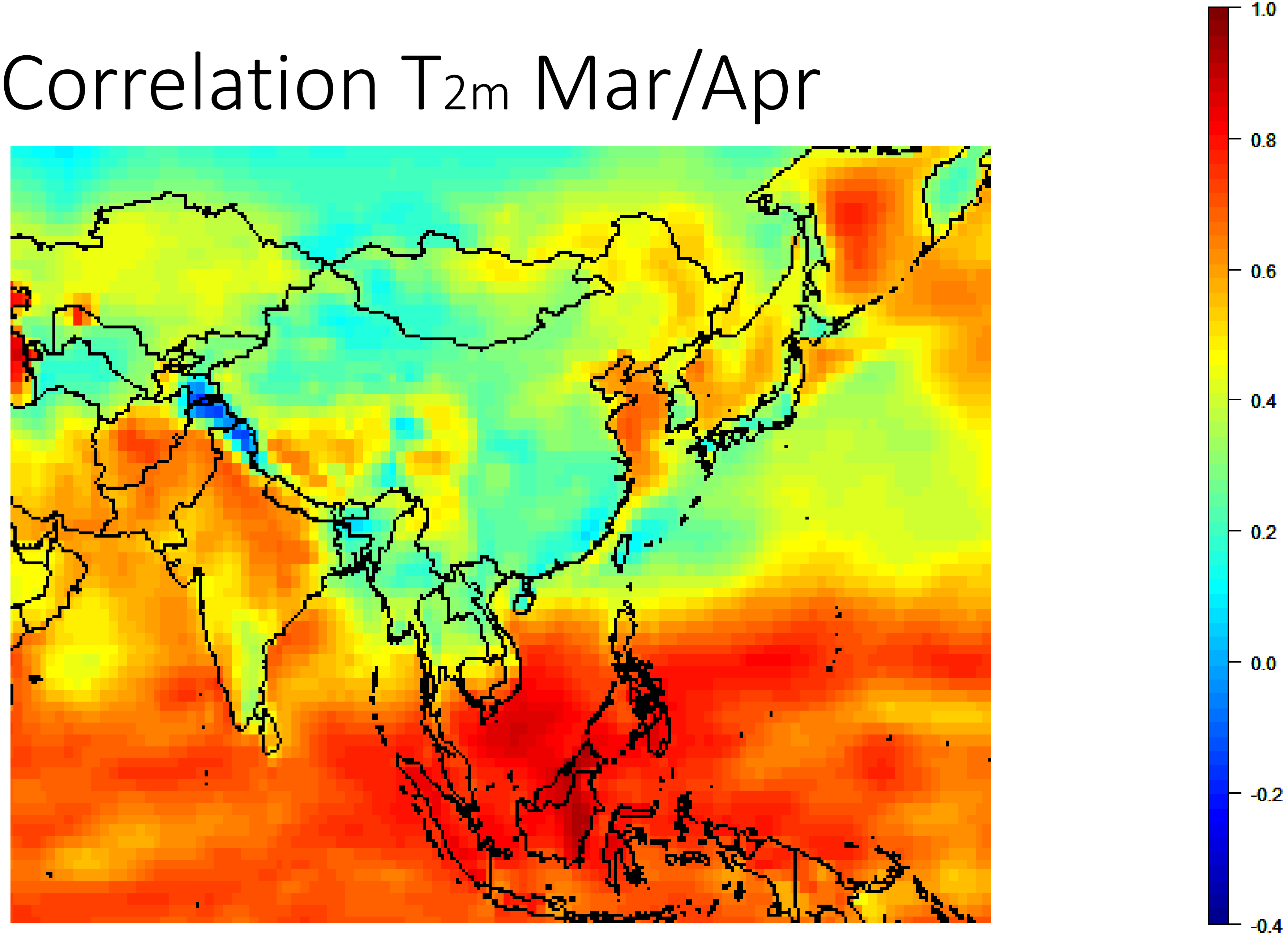
0,7



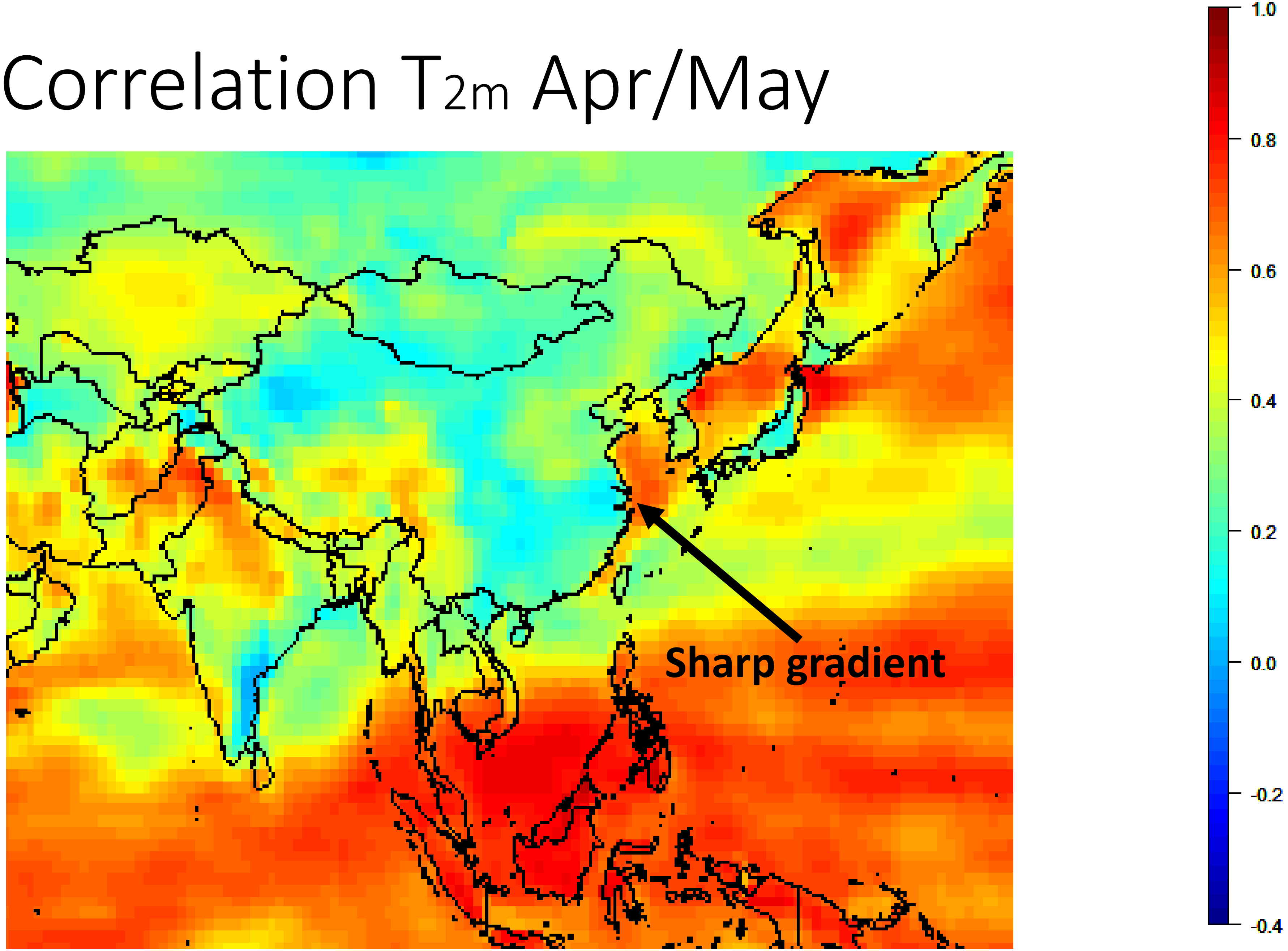
Correlation T_{2m} Feb/Mar



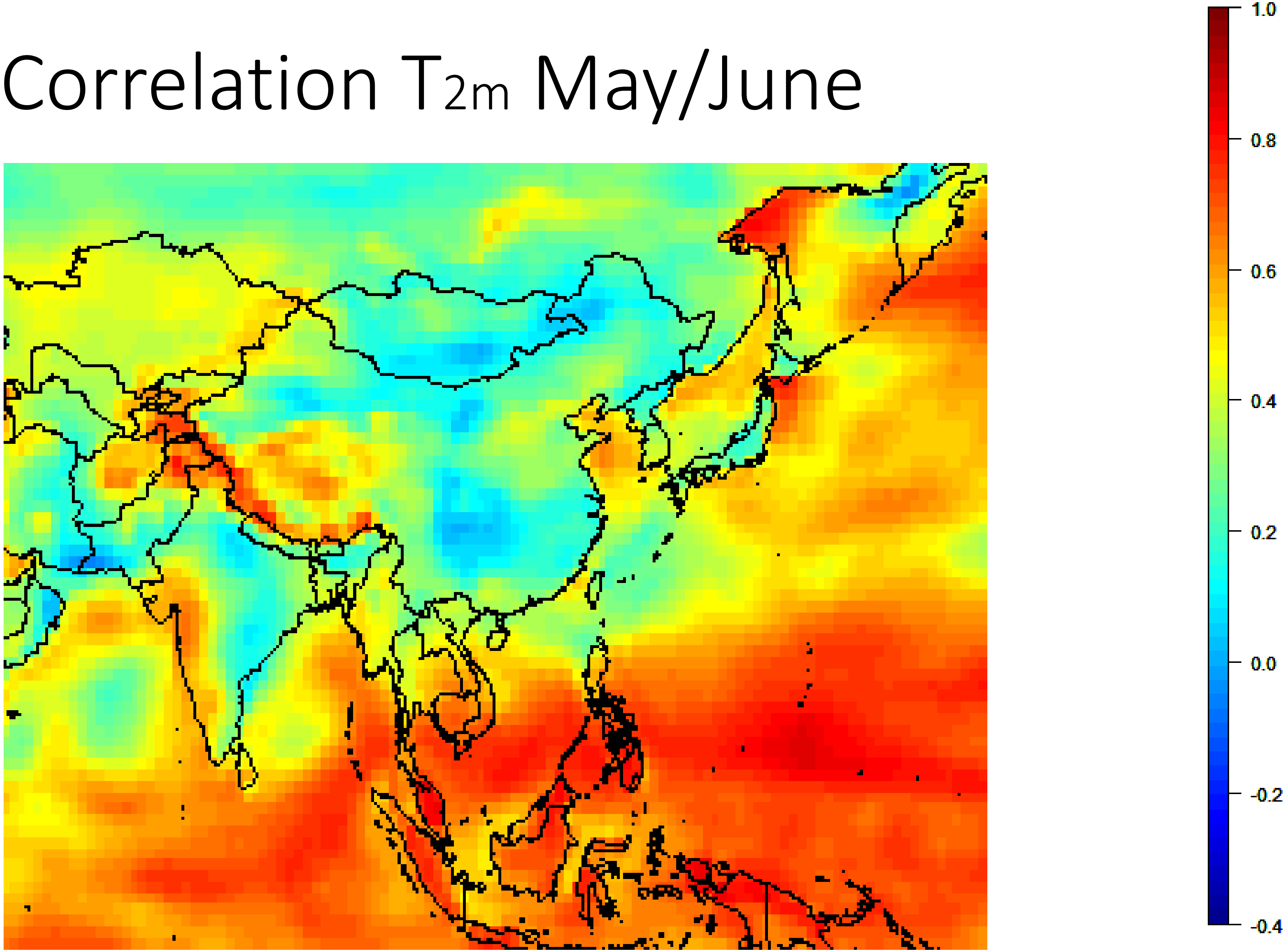
Correlation T_{2m} Mar/Apr

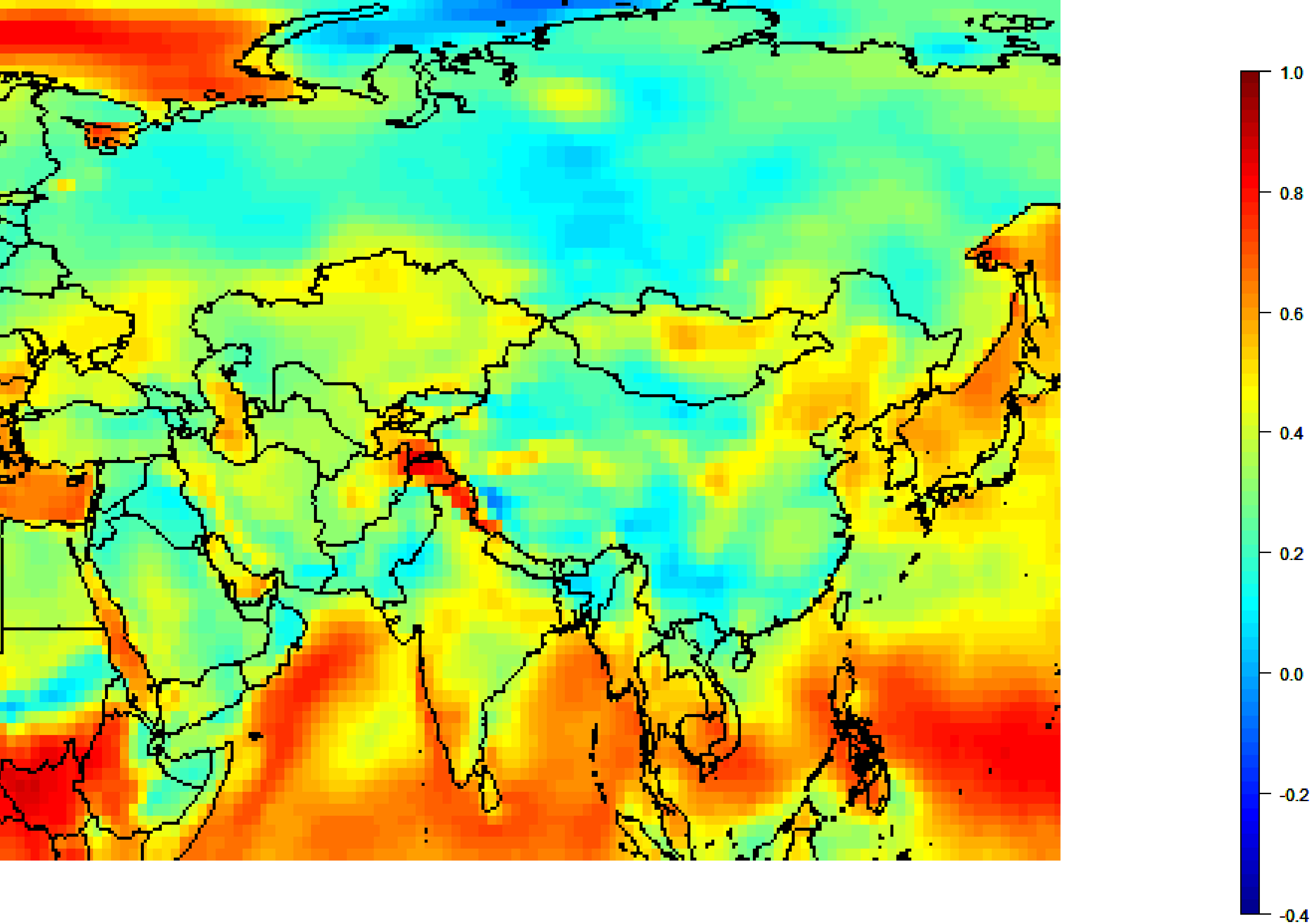


Correlation T_{2m} Apr/May



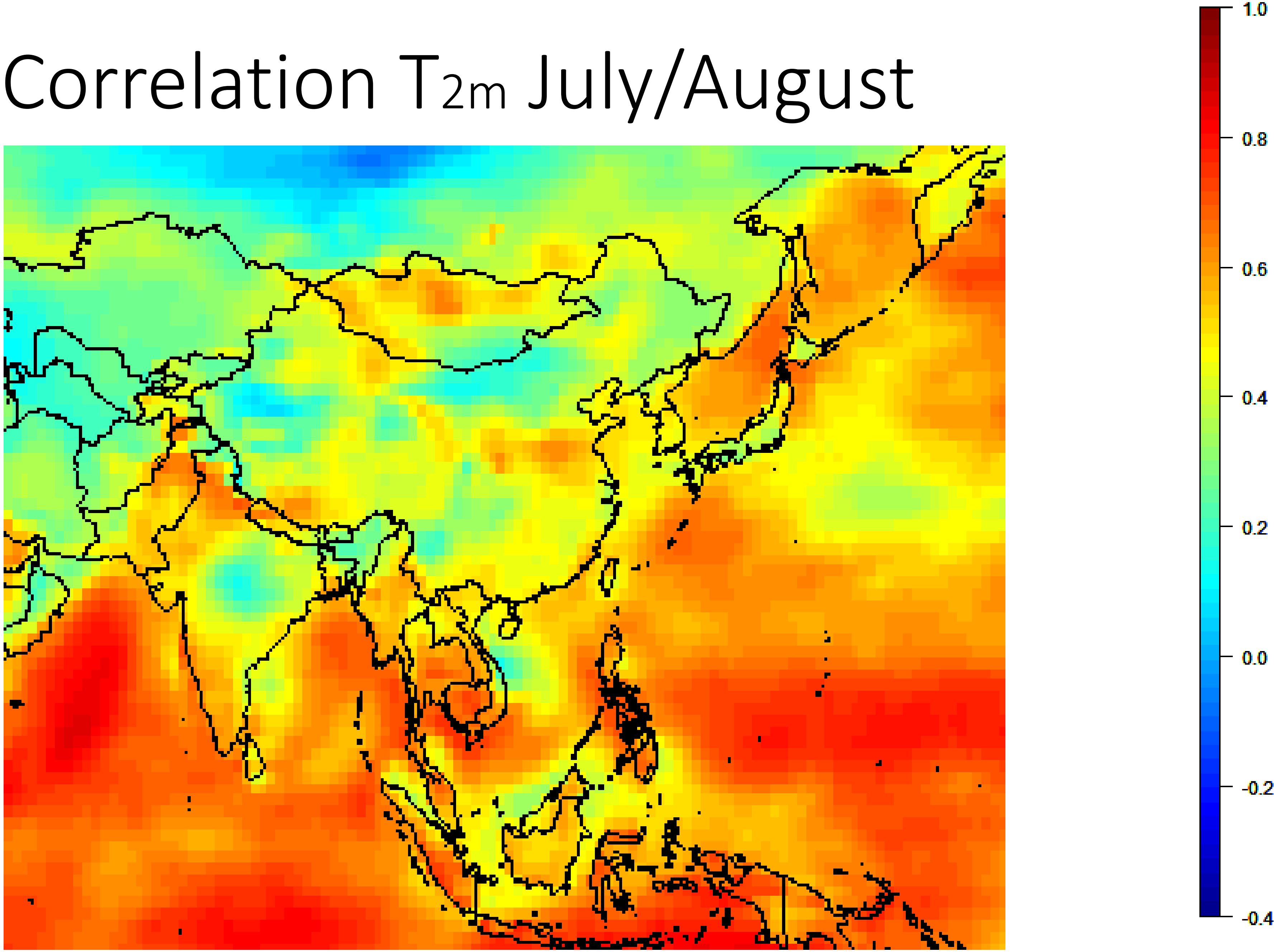
Correlation T_{2m} May/June



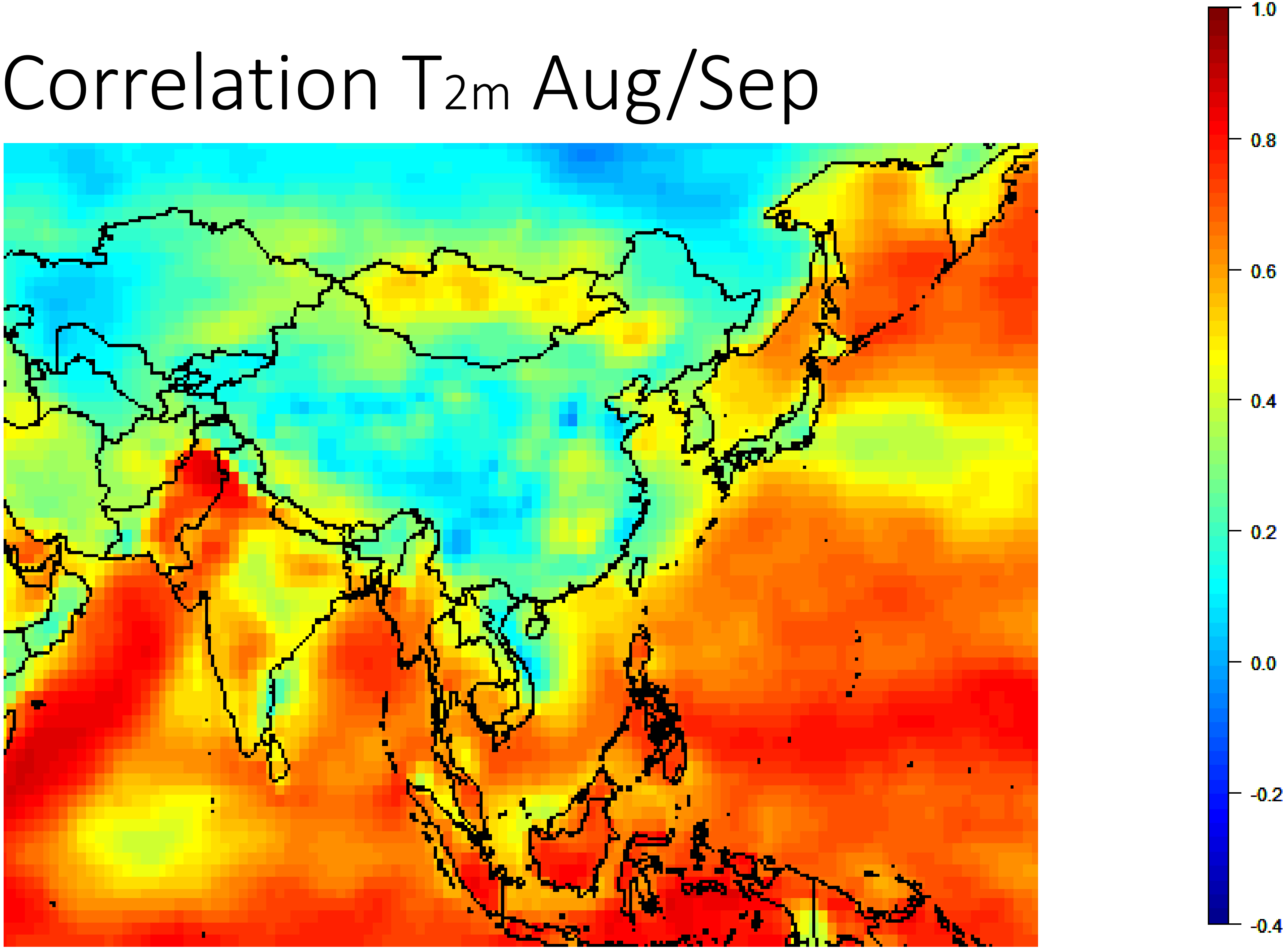


1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4

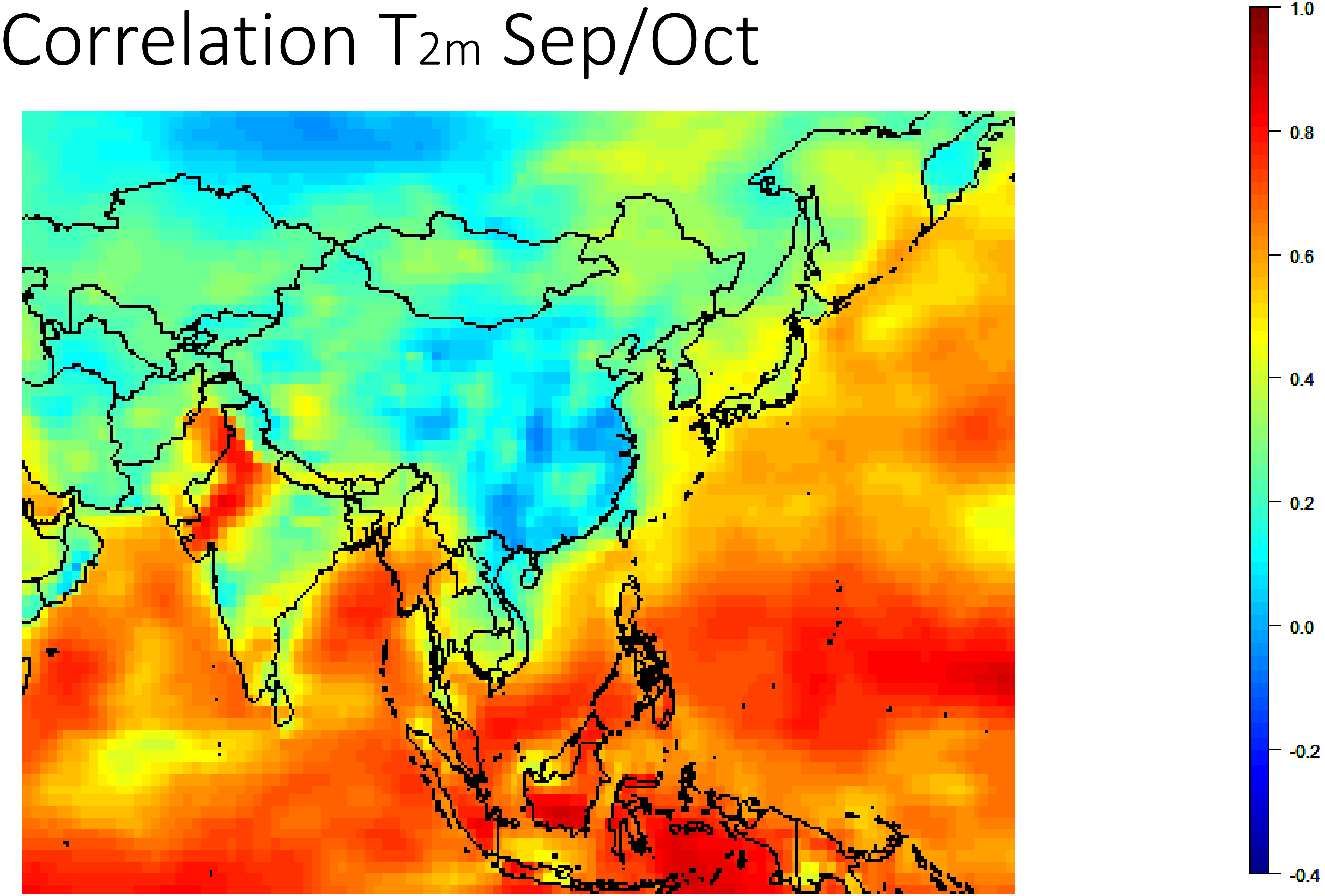
Correlation T_{2m} July/August



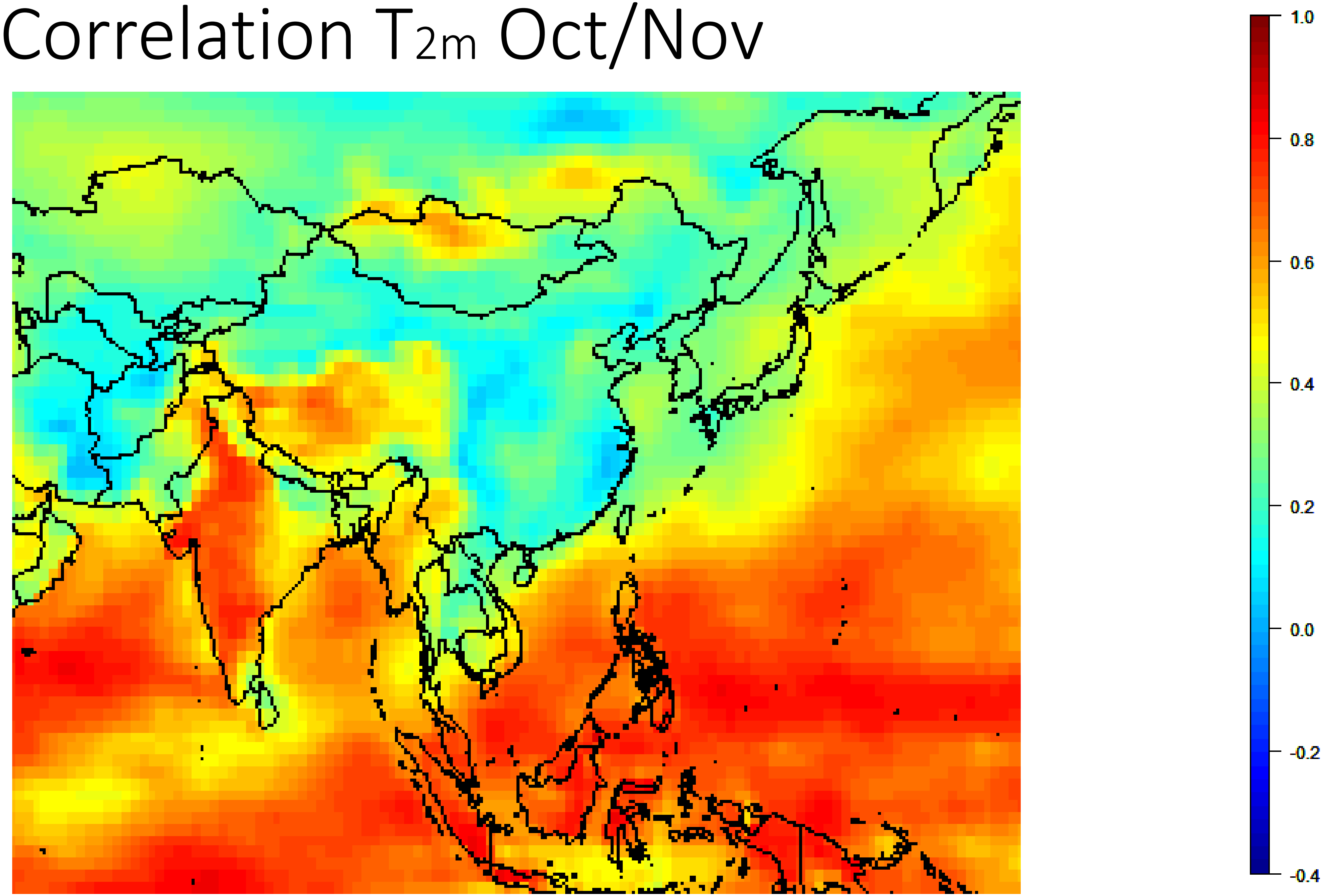
Correlation T_{2m} Aug/Sep



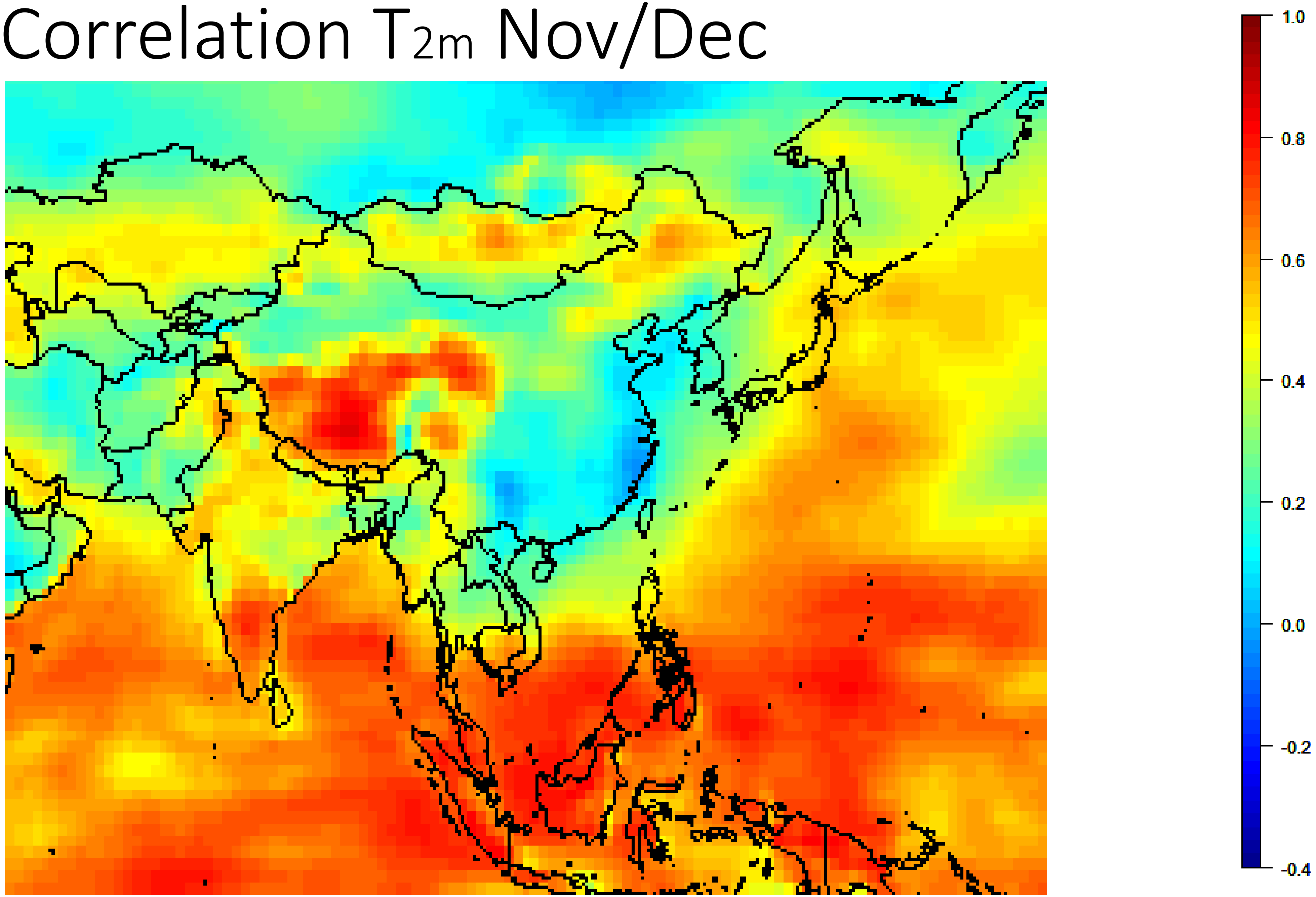
Correlation T_{2m} Sep/Oct



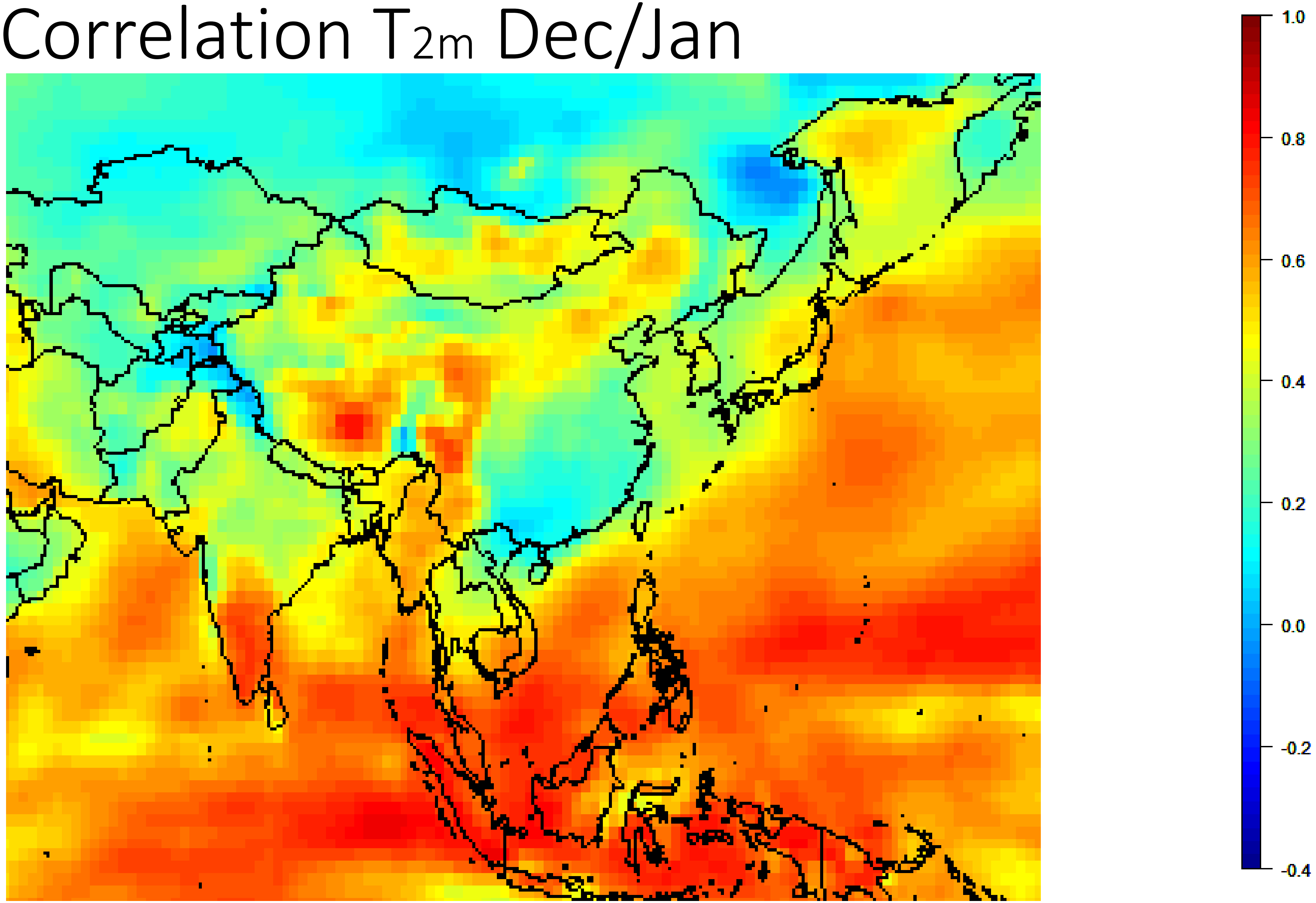
Correlation T_{2m} Oct/Nov



Correlation T_{2m} Nov/Dec

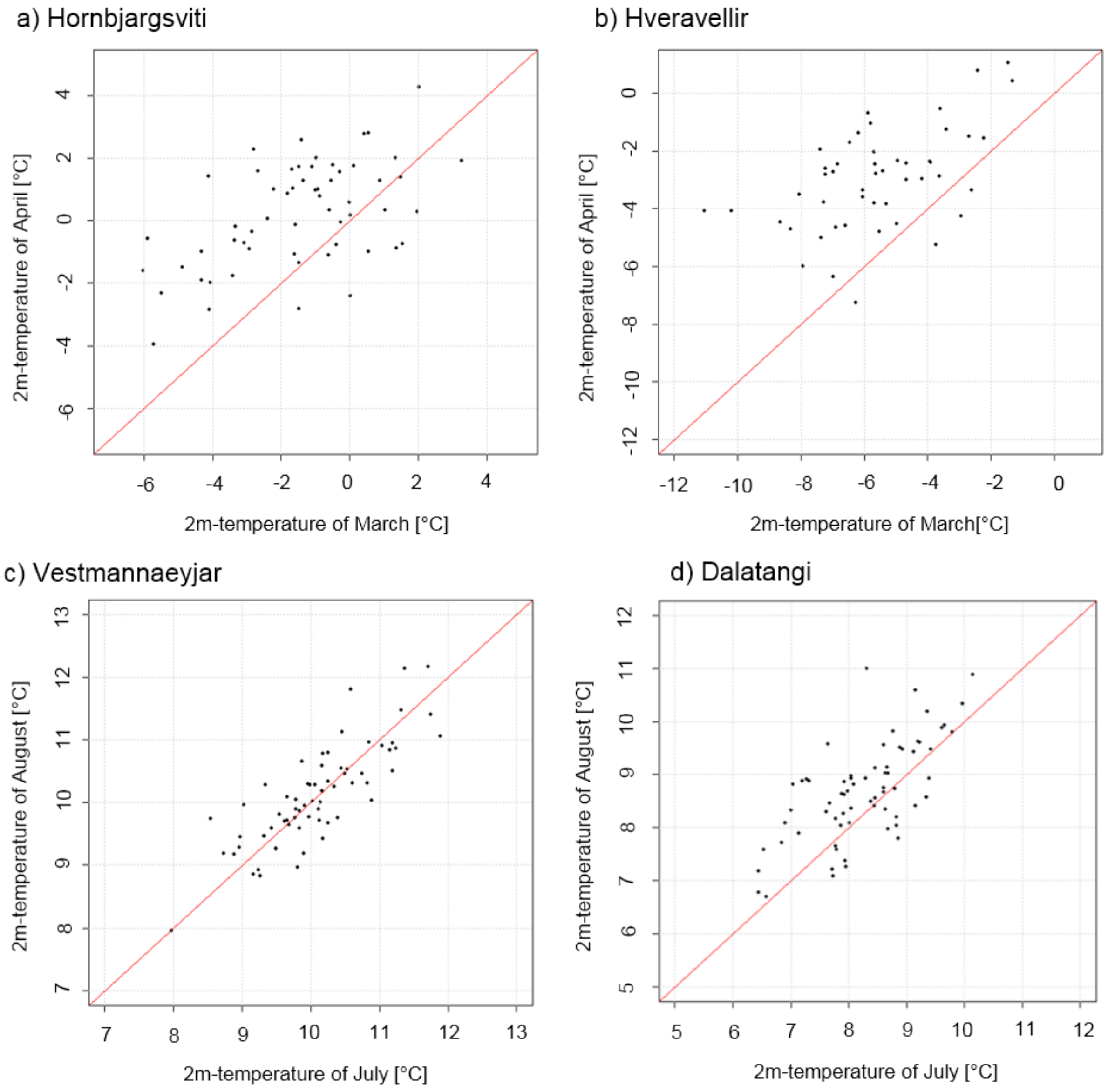


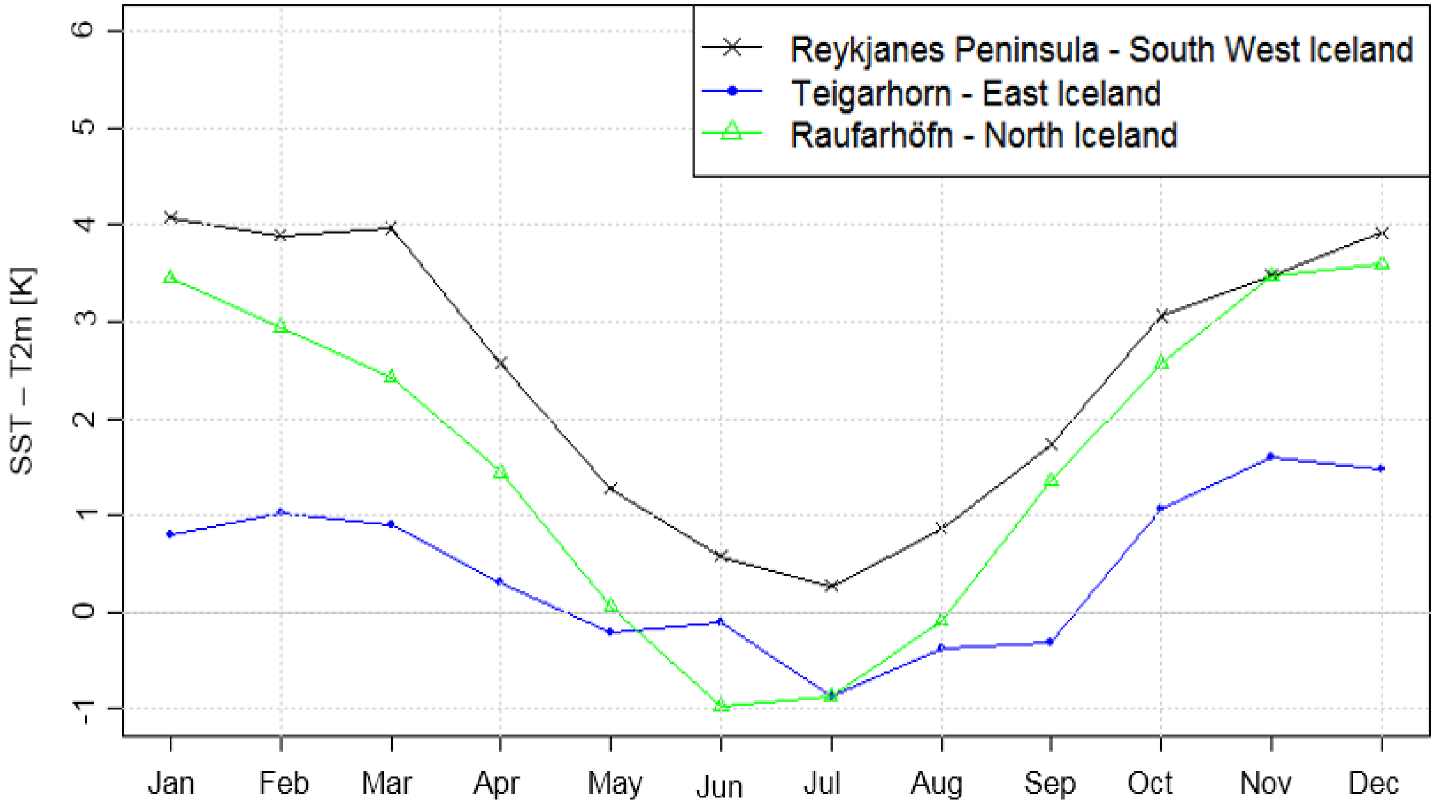
Correlation T_{2m} Dec/Jan



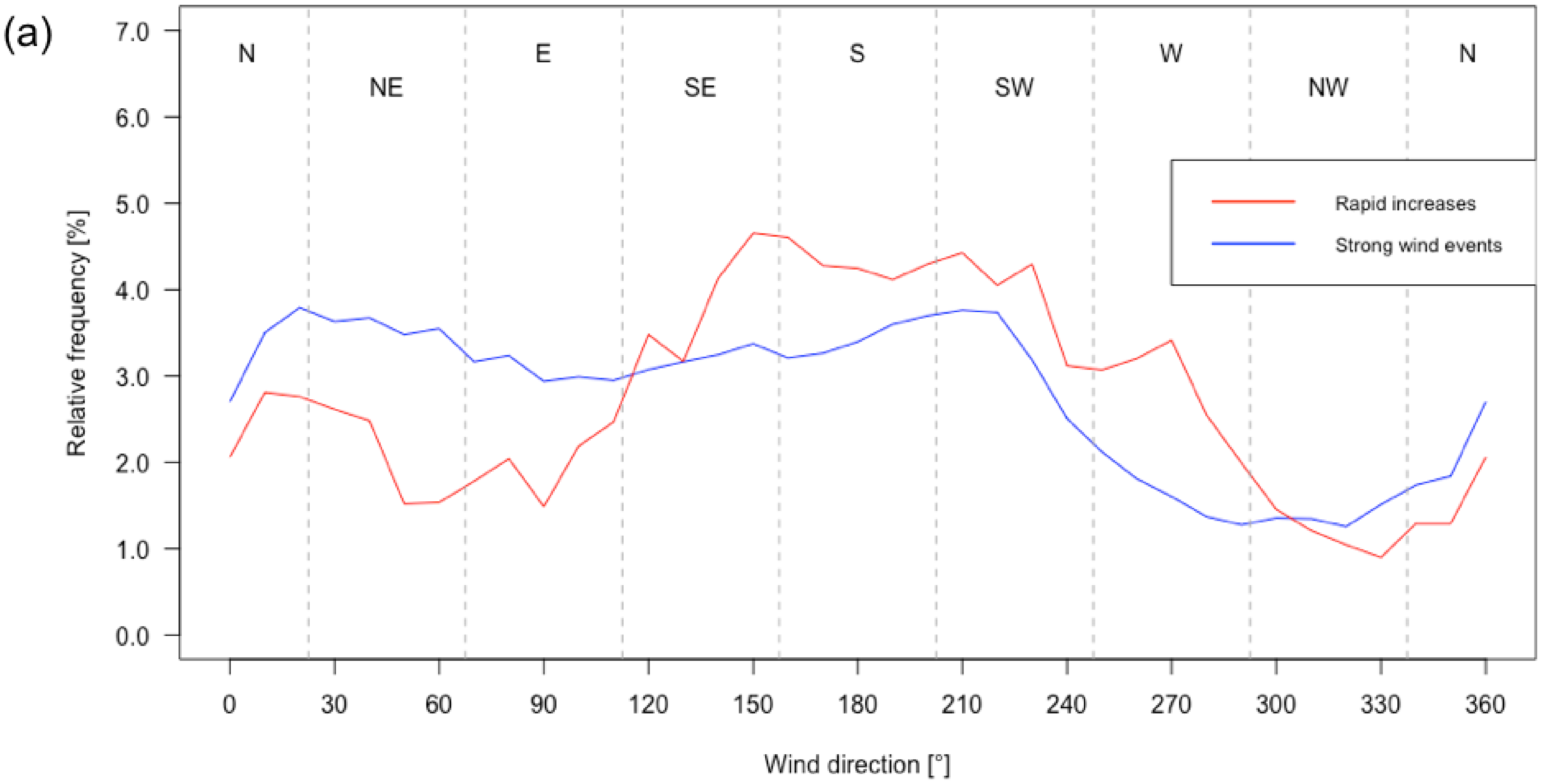
Some key points

- 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

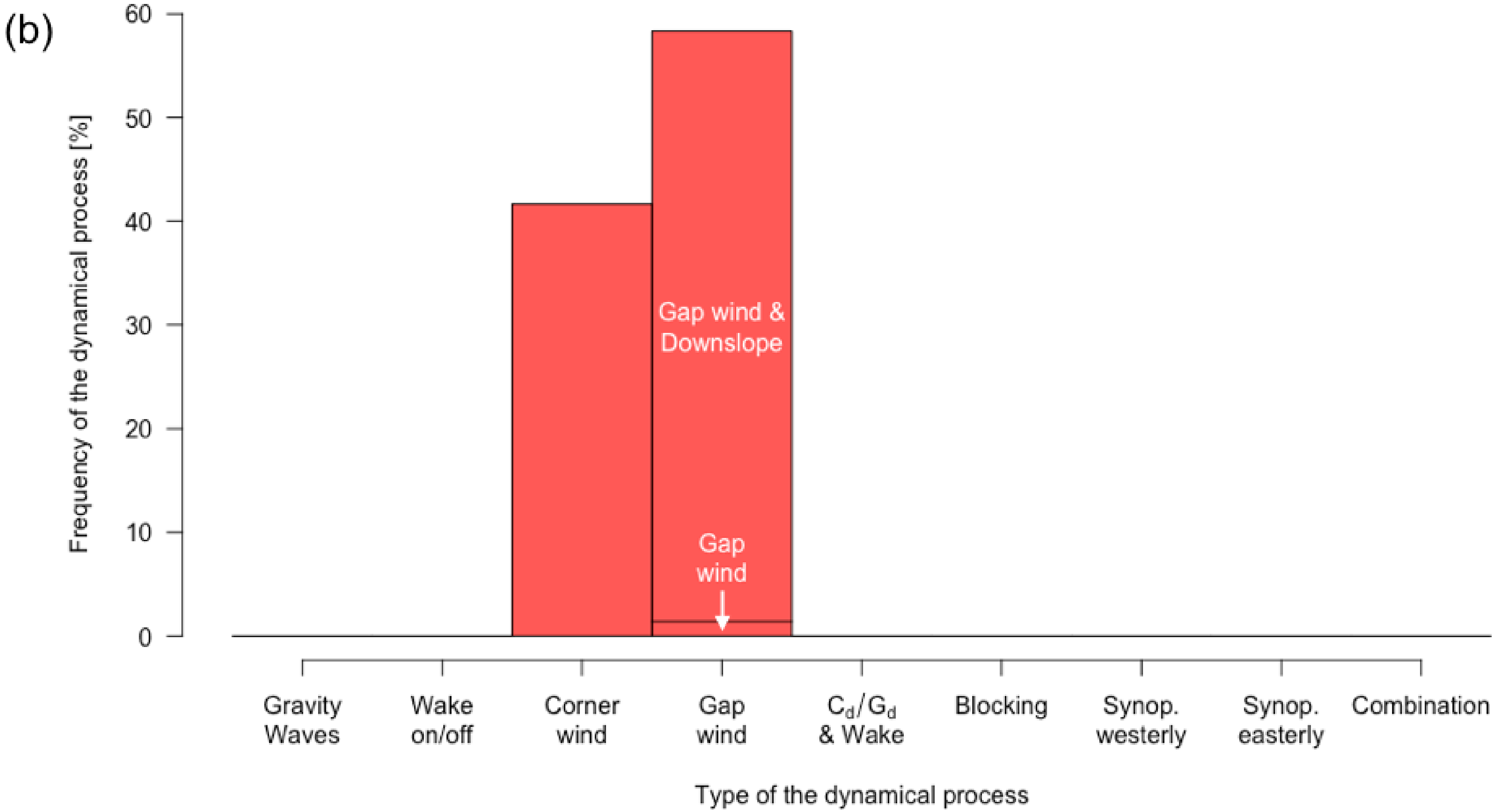

a) Hornbjargsviti
2m-temperature of April [°C]
2m-temperature of March [°C]
b) Hveravellir
2m-temperature of April [°C]
2m-temperature of March[°C]
c) Vestmannaeyjar
2m-temperature of August [°C]
2m-temperature of July [°C]
d) Dalatangi
2m-temperature of August [°C]
2m-temperature of July [°C]



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

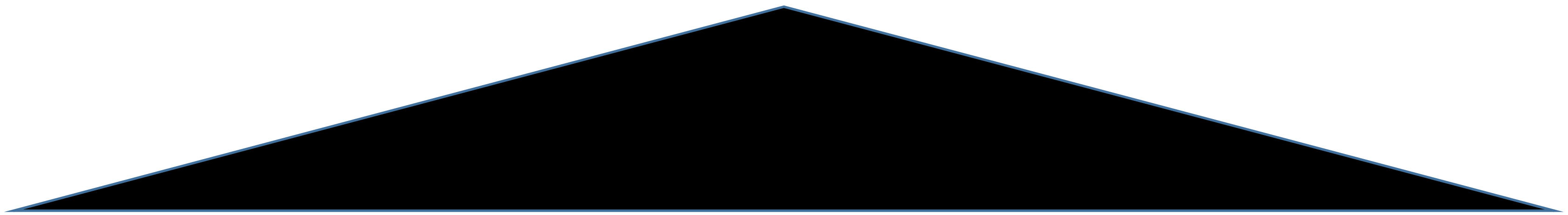

(a)
N
NE
E
SE
S
SW
W
NW
N
Rapid increases
Strong wind events
Relative frequency [%]
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
0
30
60
90
120
150
180
210
240
270
300
330
360
Wind direction [°]

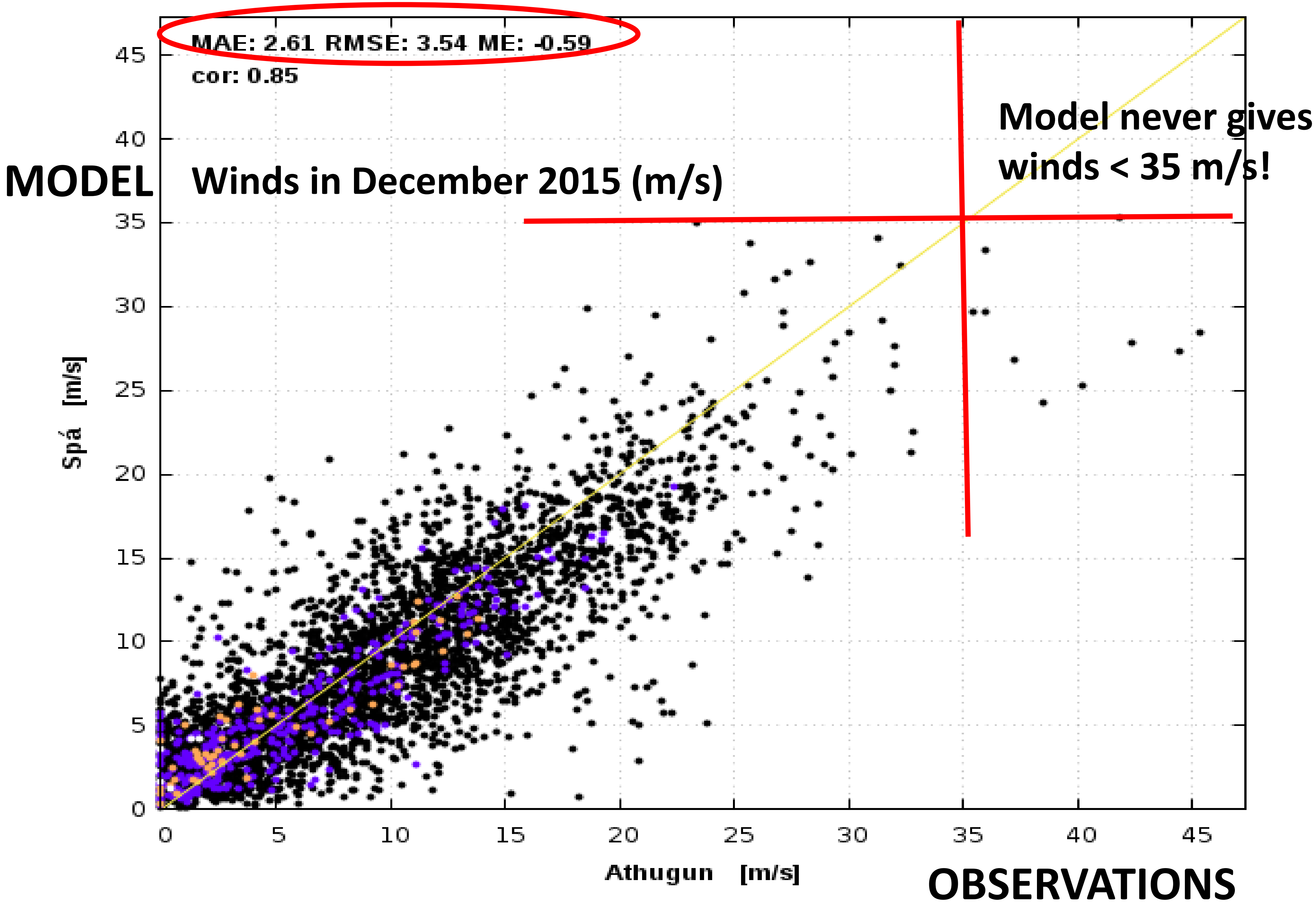
Type of the dynamical process

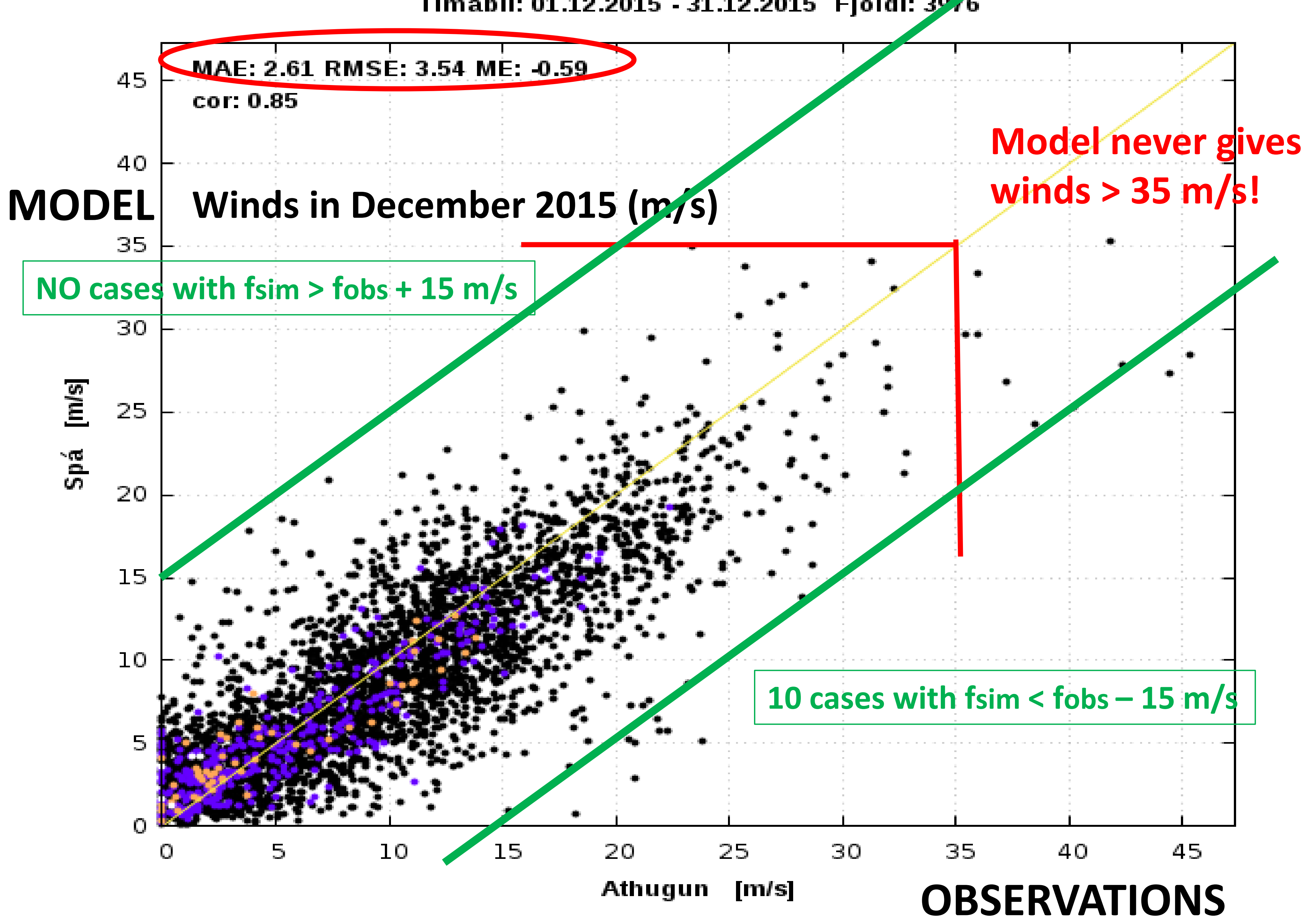


The mesoscale circulation negative feedback

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


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

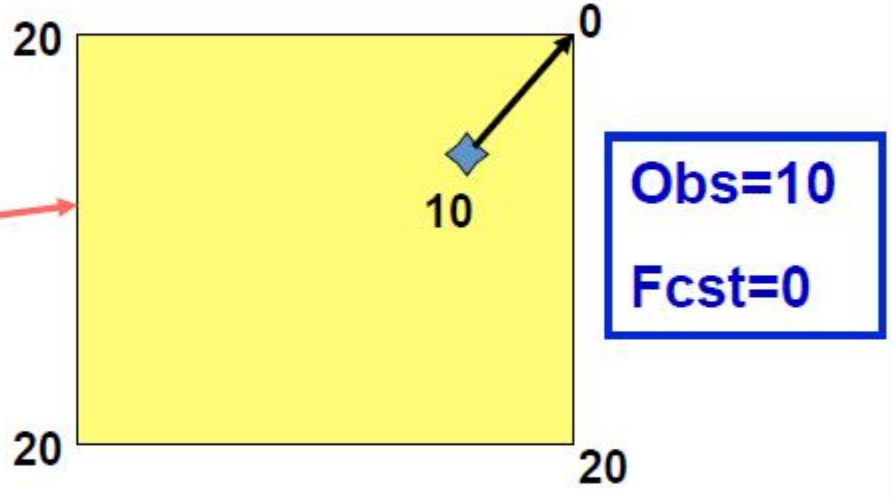
Matching forecasts and observations

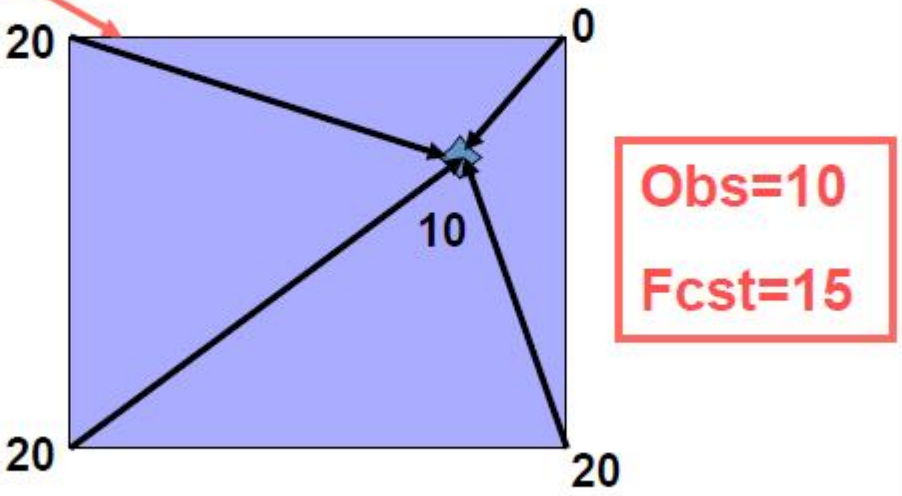
Example:

- 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

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

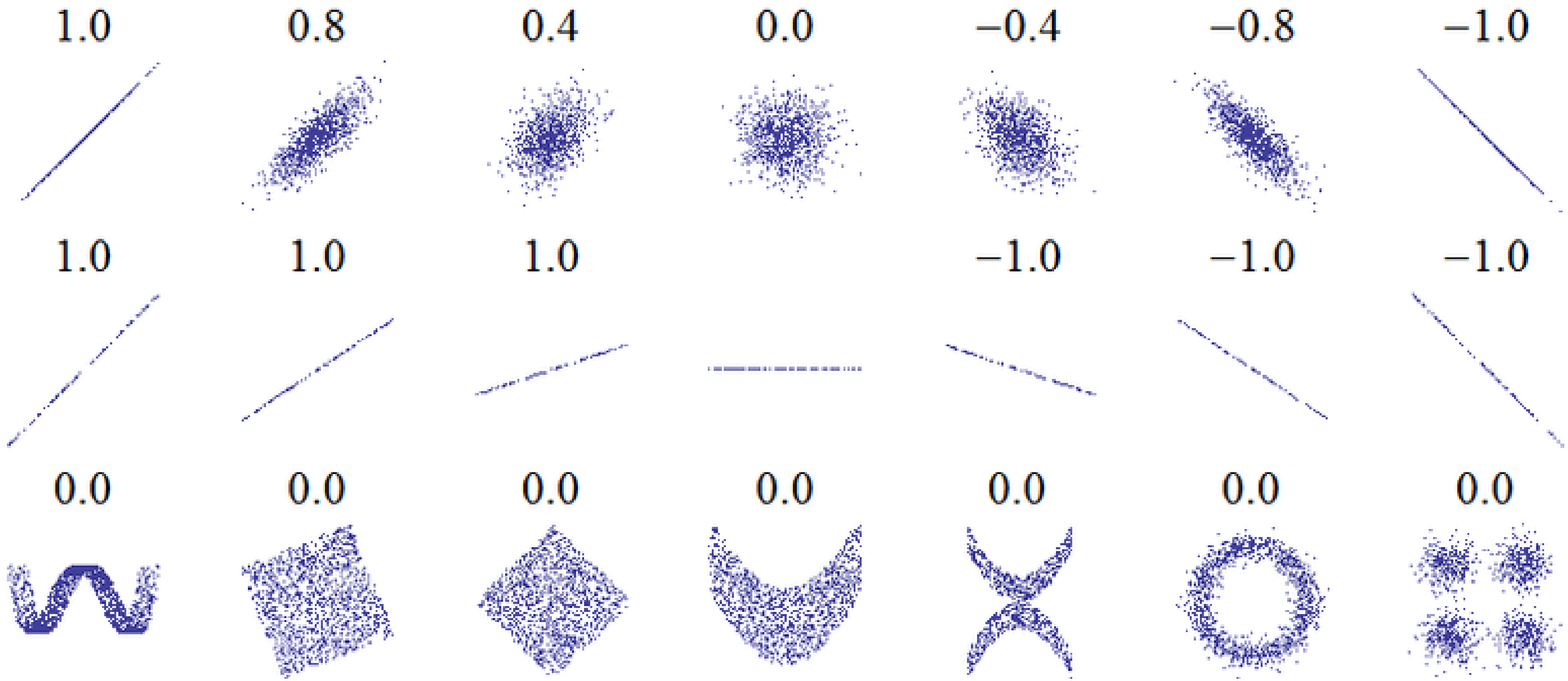
Bias

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

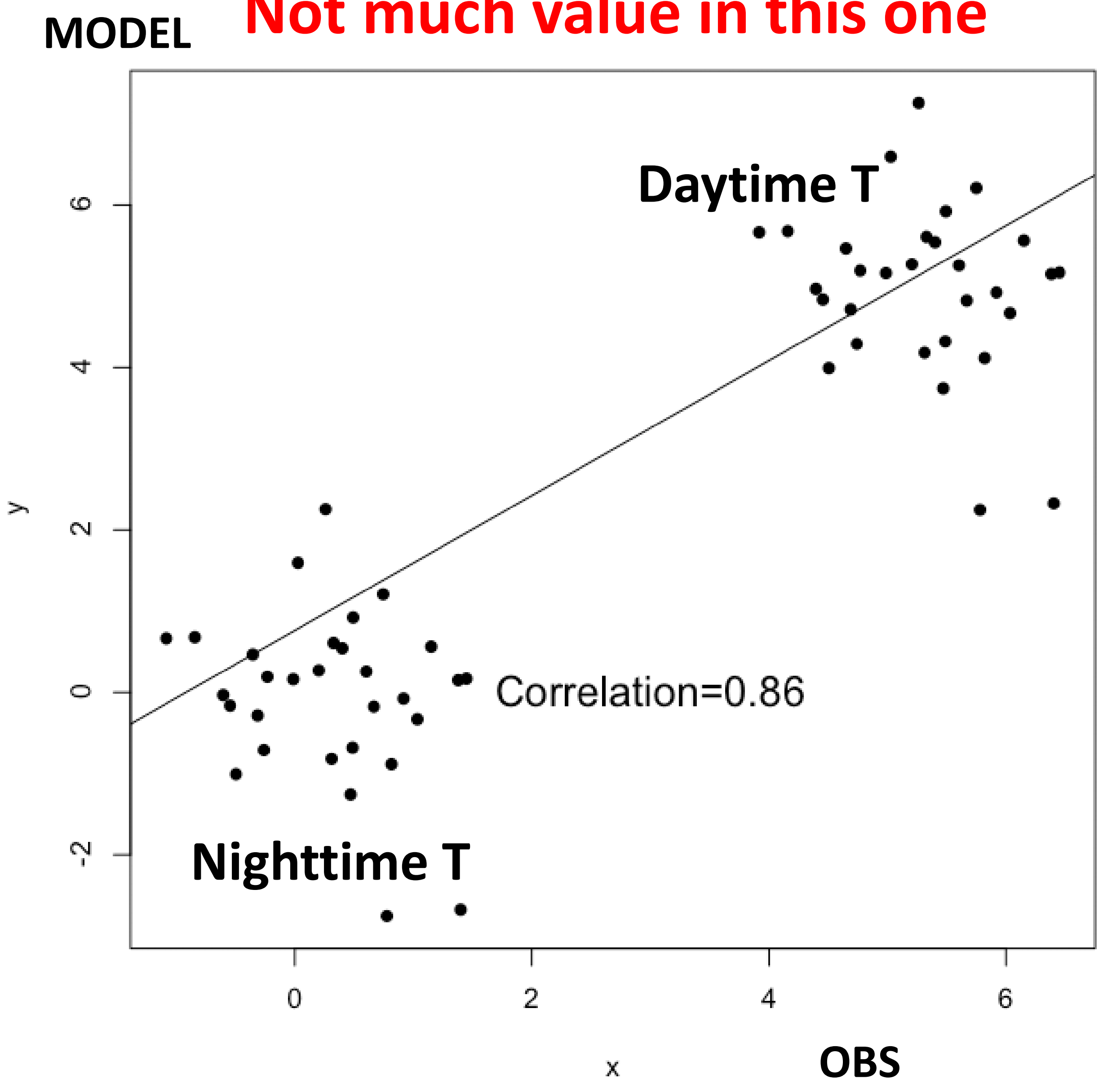
Brier score

Correlation coefficient

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



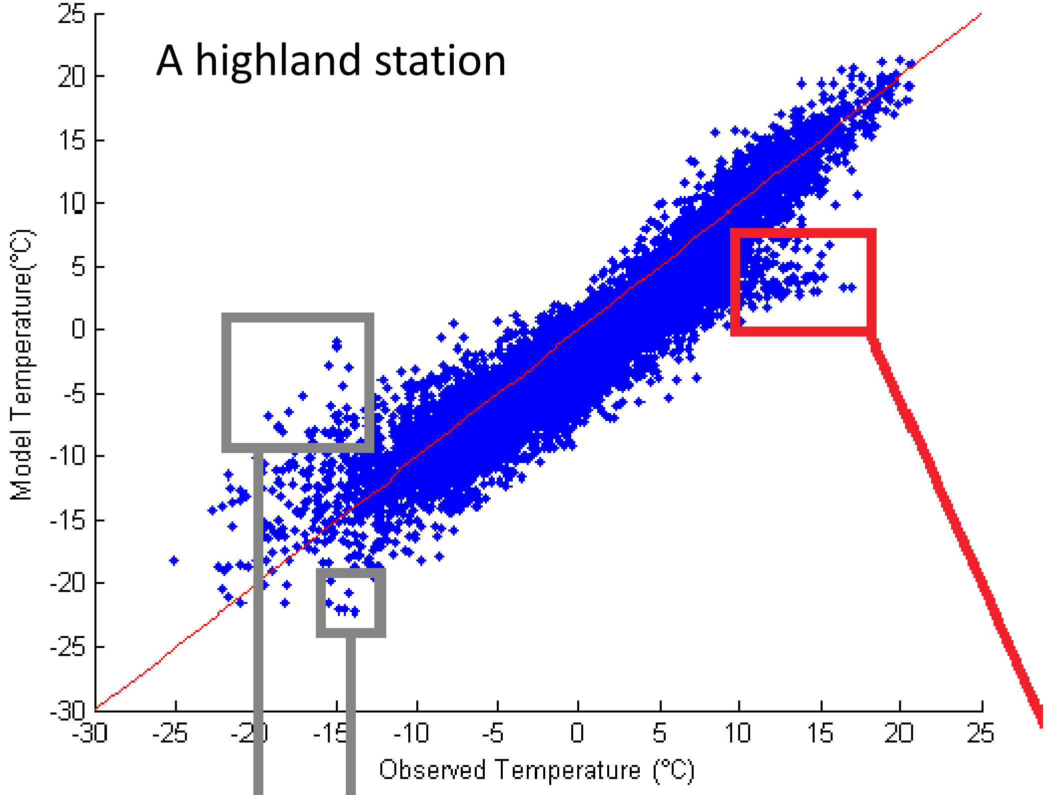
Not much value in this one



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

Isolate errors in time and space and weather parameter space

Simulated T

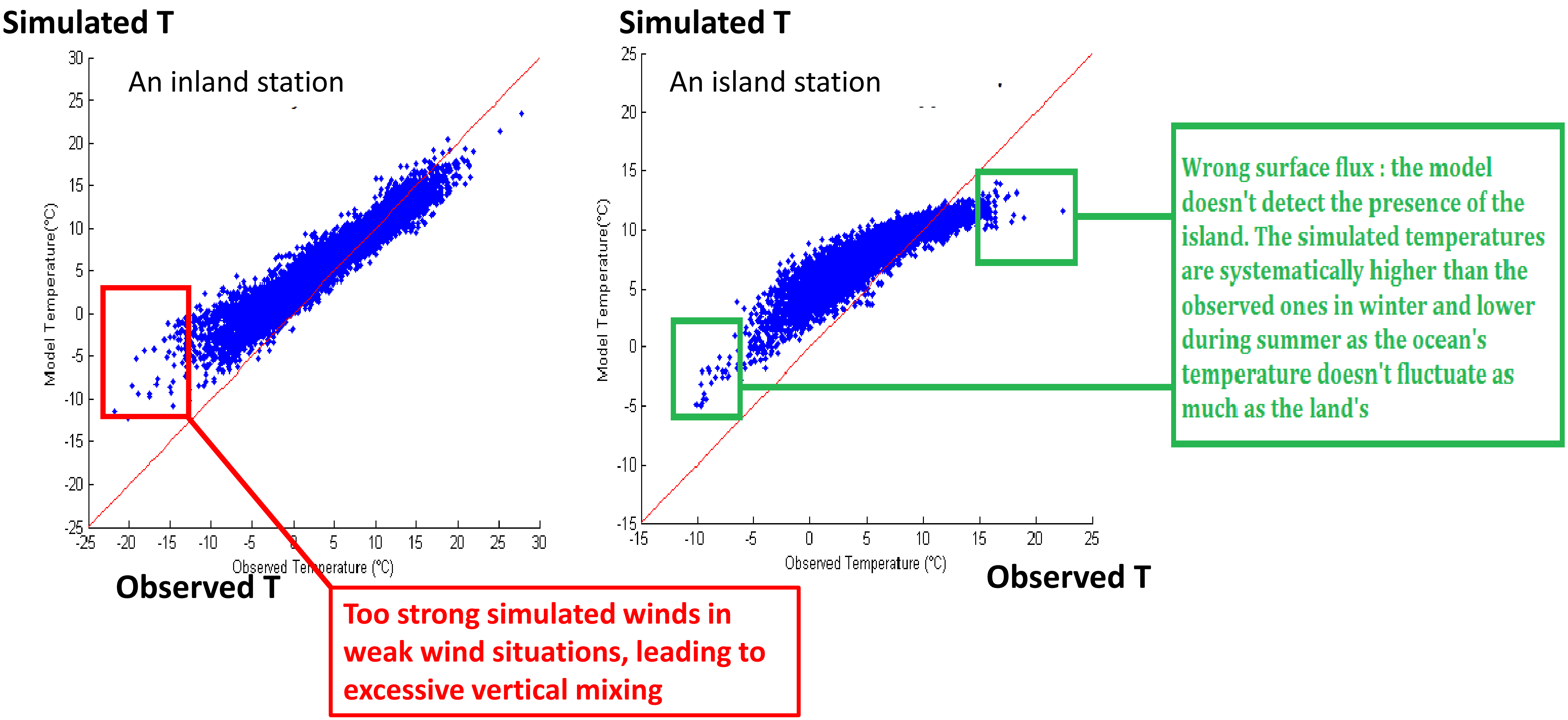


Observed T

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

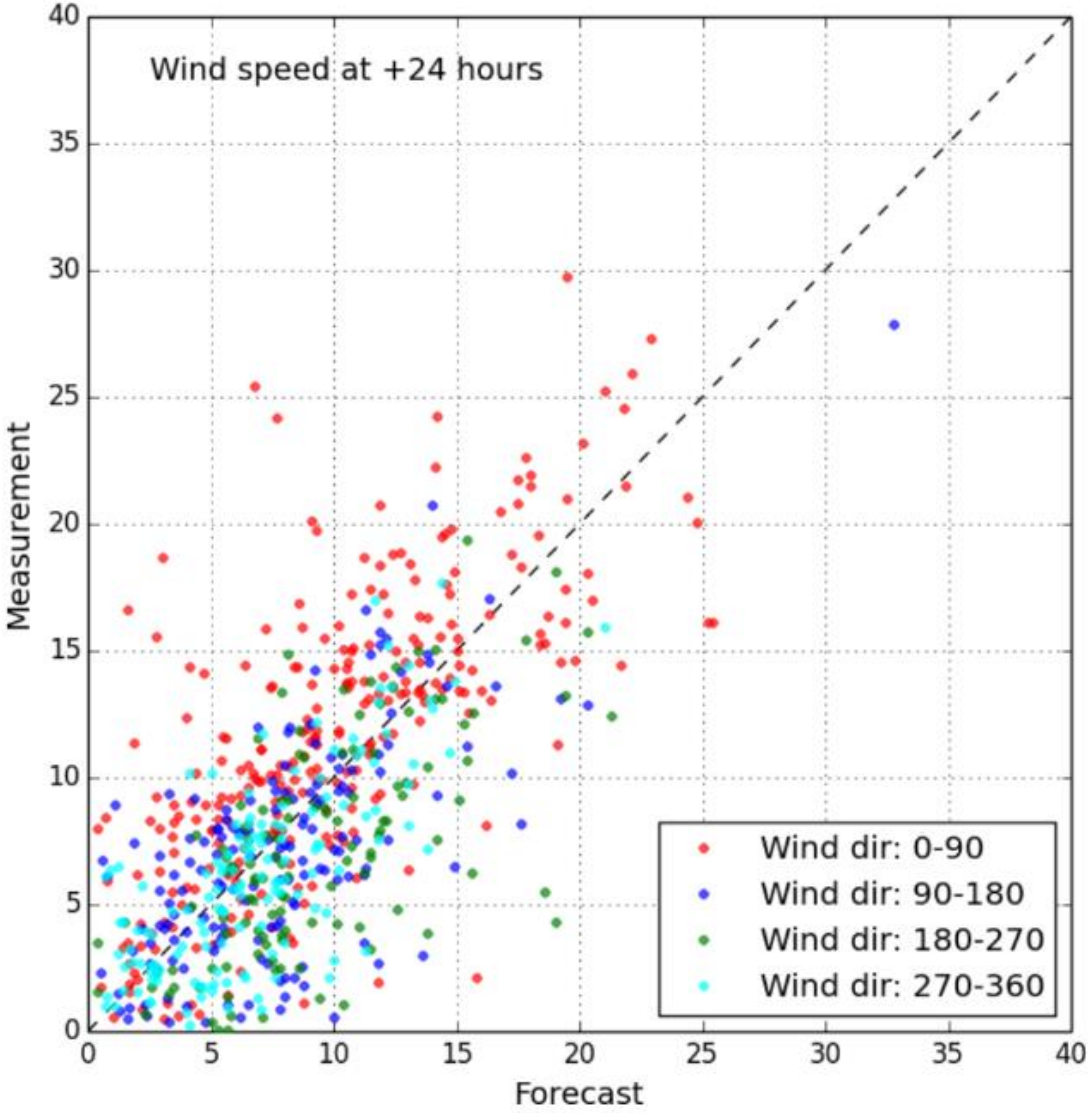
Wrong surface flux : in the highlands, the ice doesn't melt early enough in spring, implying lower simulated temperature than observations

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



Simulated T
An inland station
Model Temperature(°C)
Observed Temperature (°C)
Observed T
Too strong simulated winds in weak wind situations, leading to excessive vertical mixing
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

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



Classifying errors according to wind direction