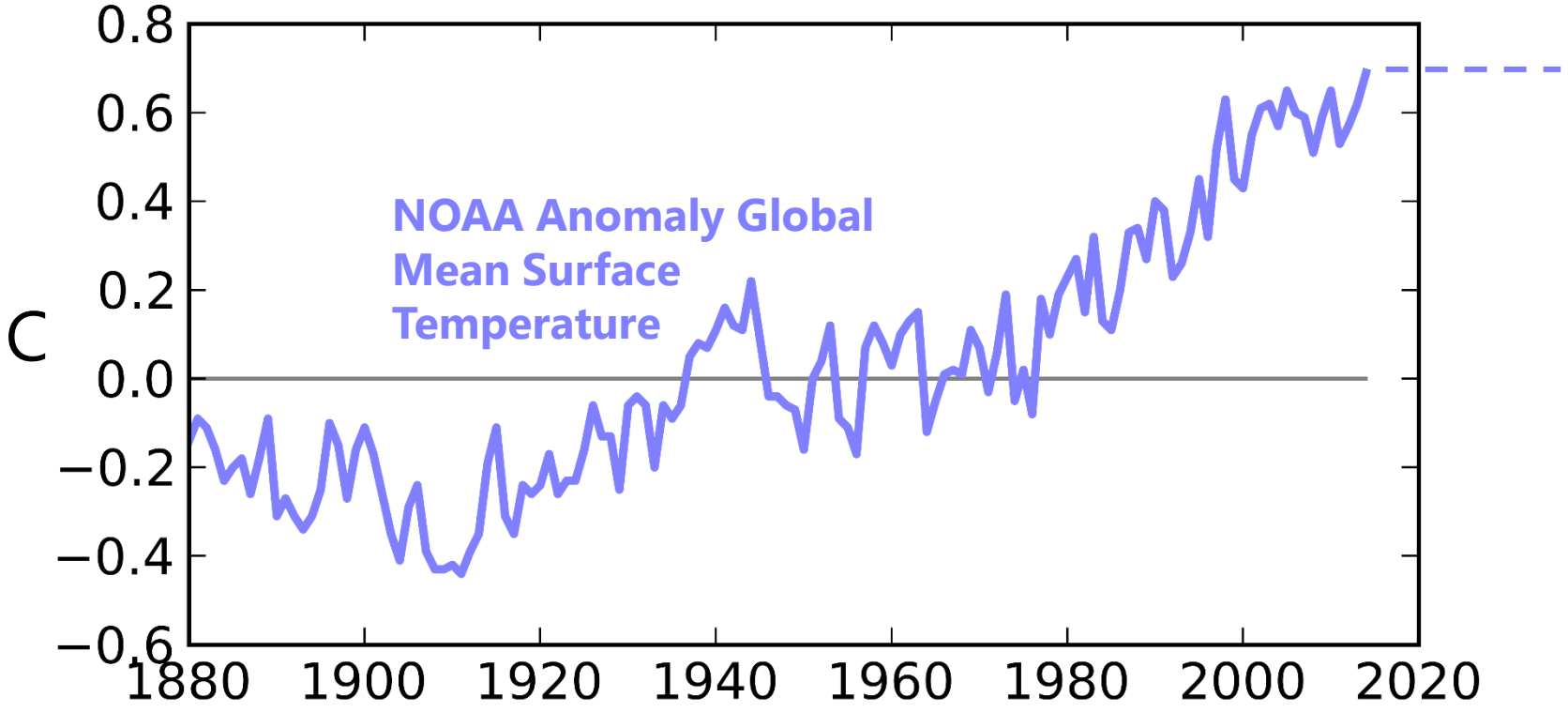
IC3, 9th of March 2015
François Massonnet

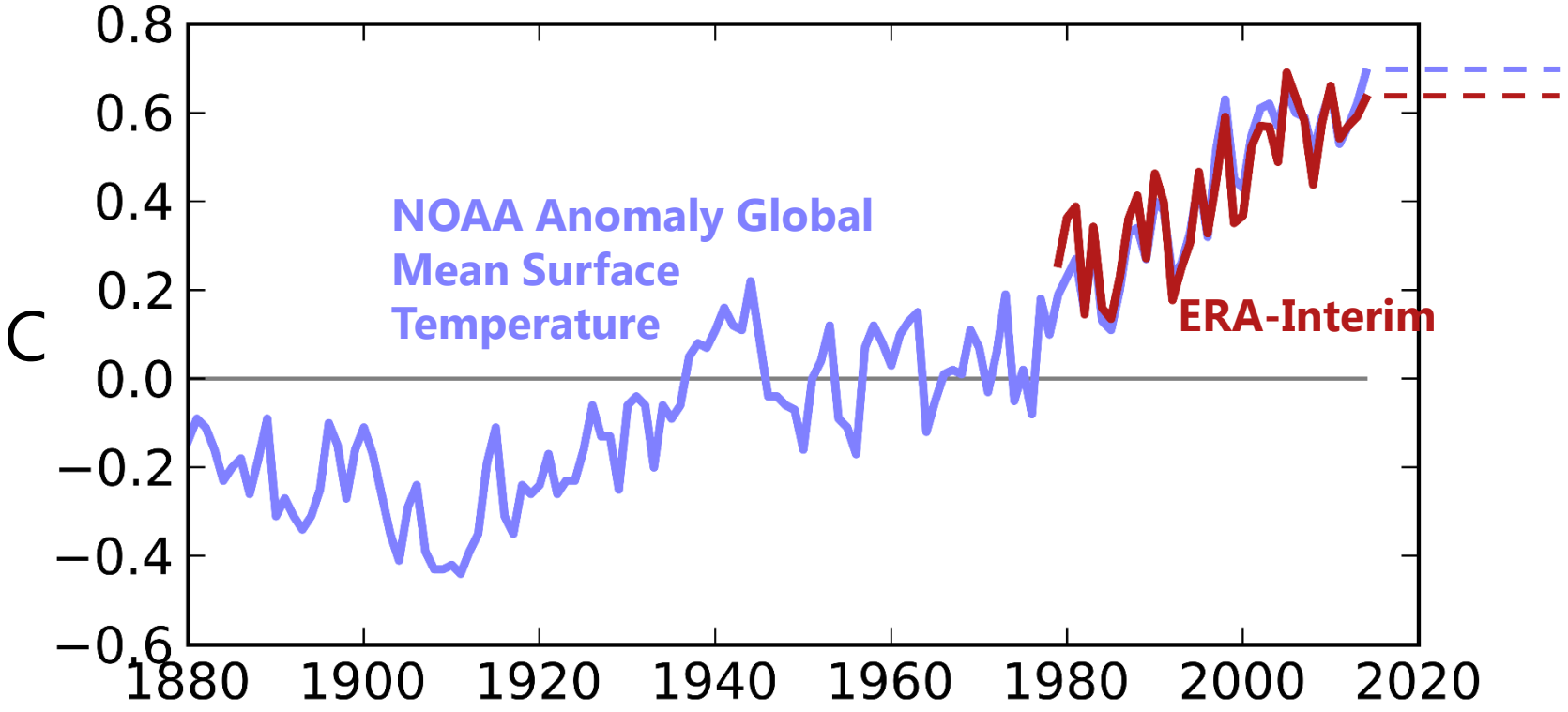
2014, year of extremes



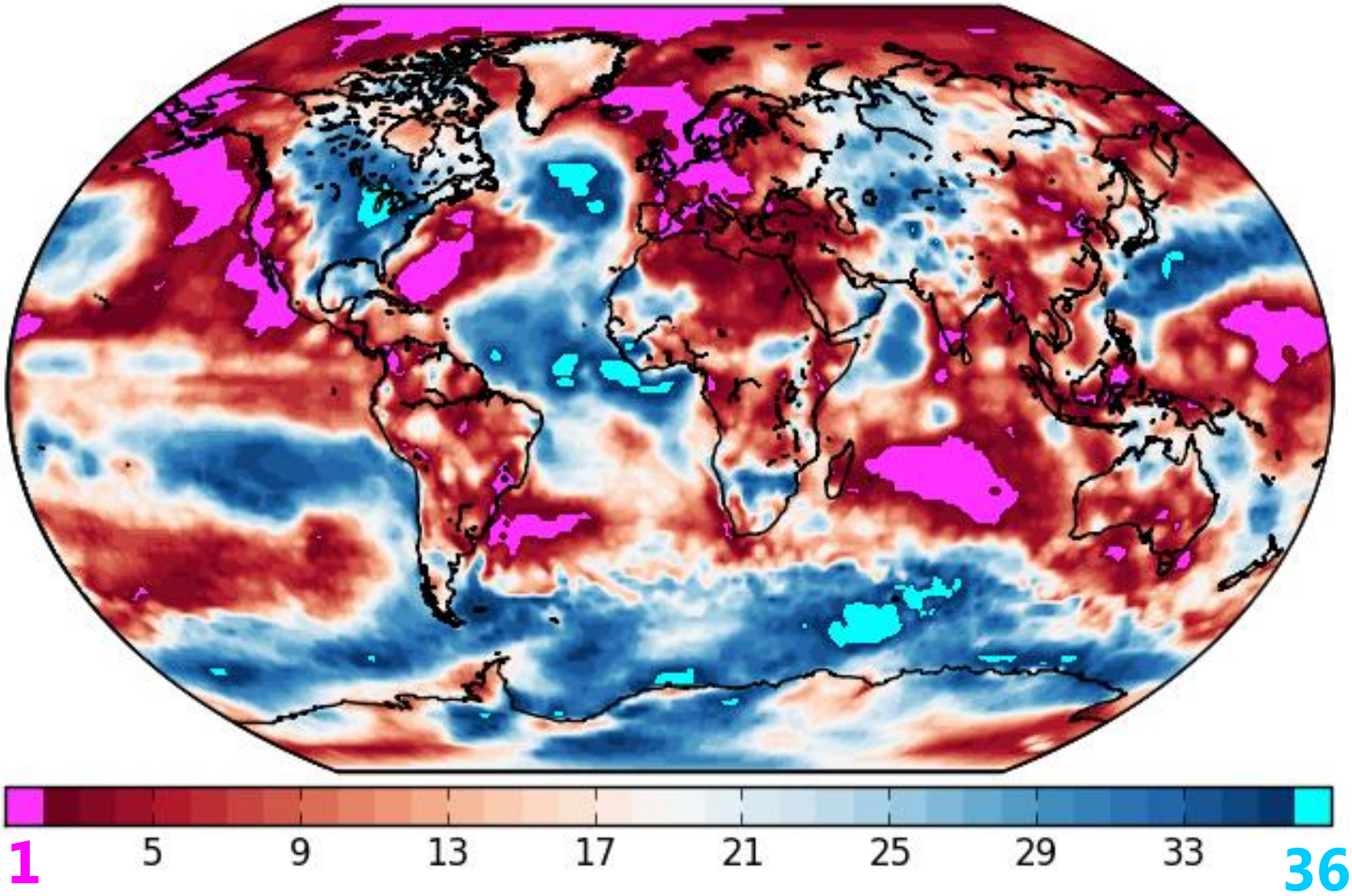
IC3, 9th of March 2015
François Massonnet

2014, year of extremes

or warm year in a changing climate?

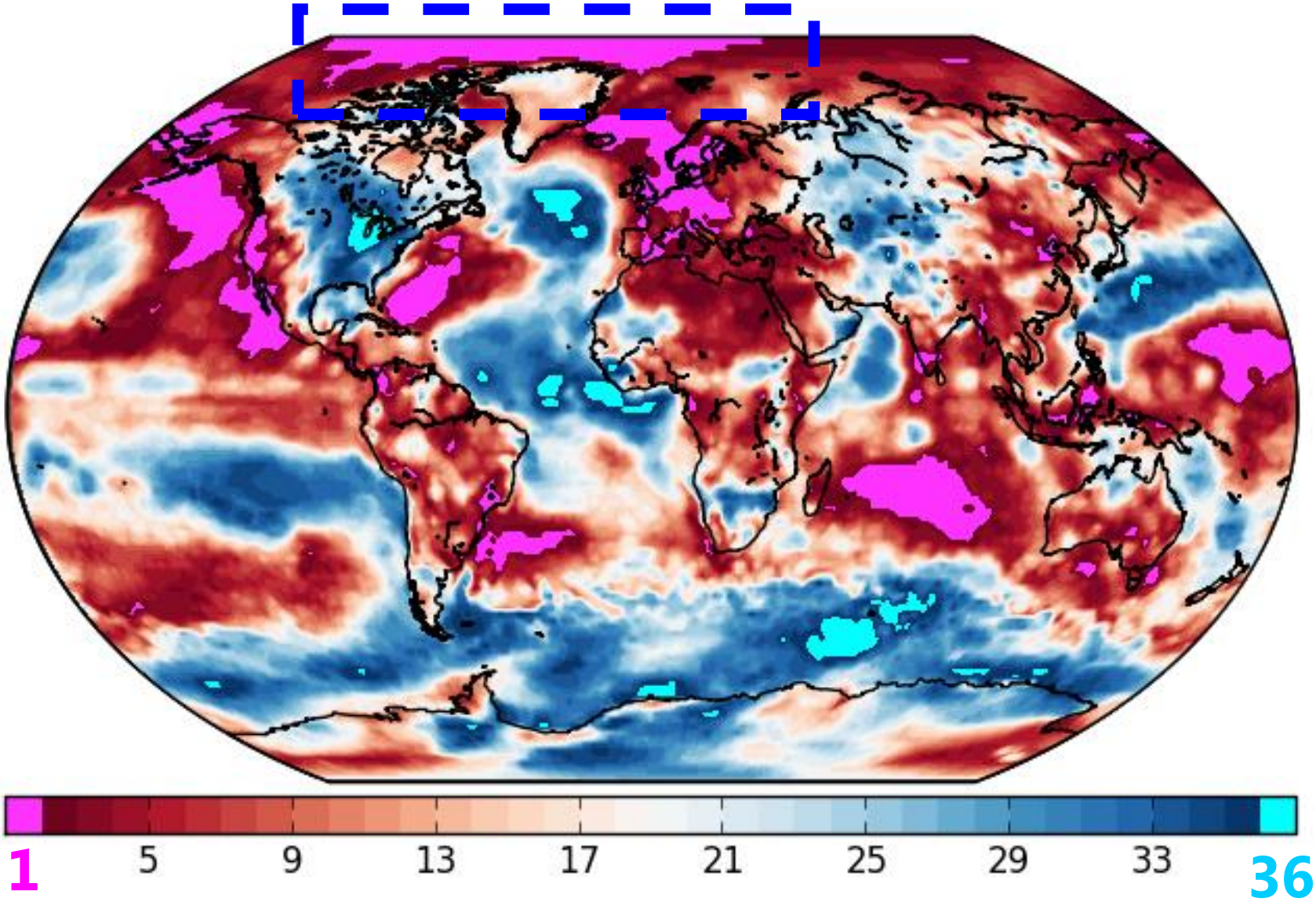


Rank of 2014 annual mean temperature over the last 36 years



(7.4% of the surface)

Rank of 2014 annual mean temperature over the last 36 years



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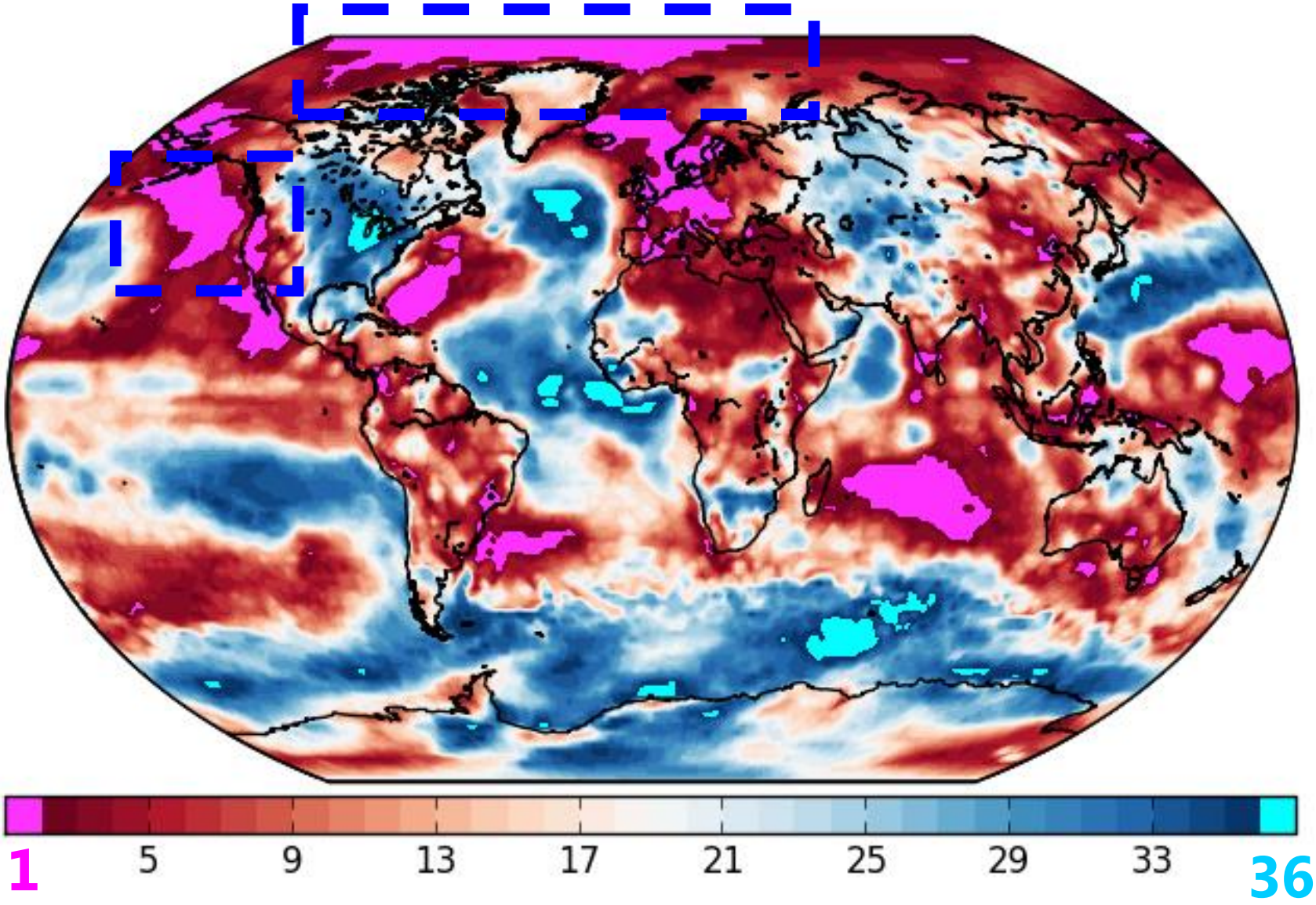

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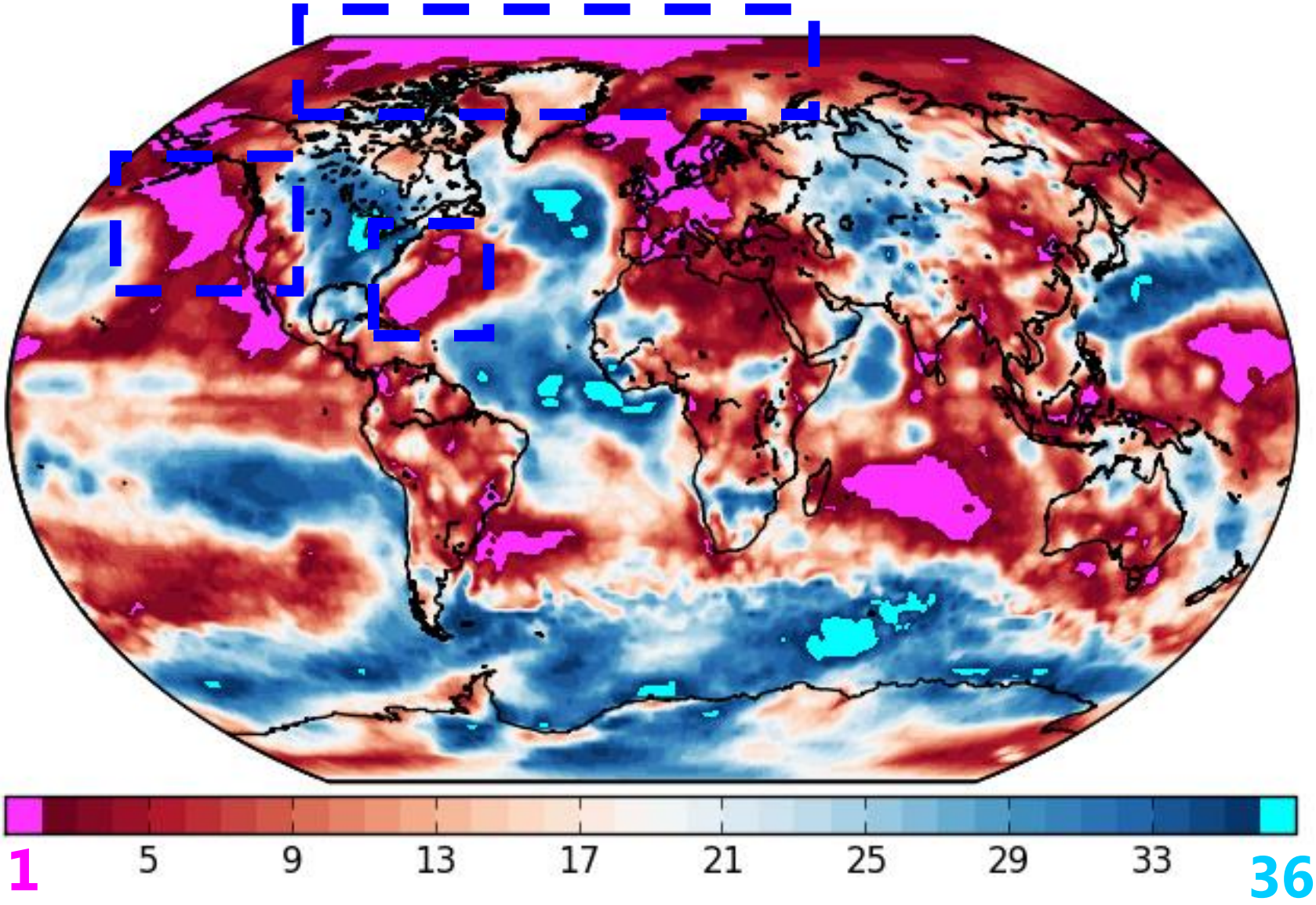

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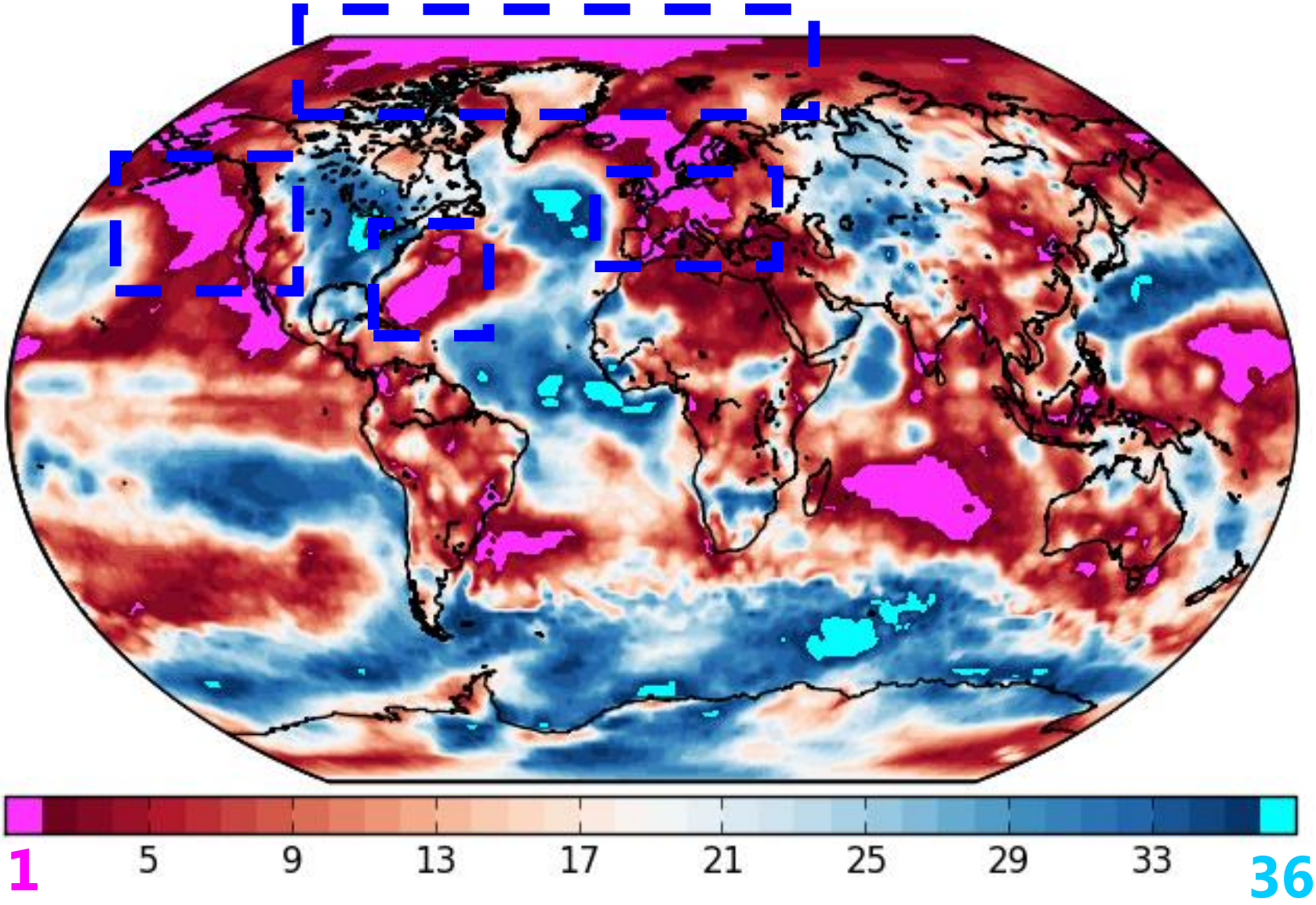

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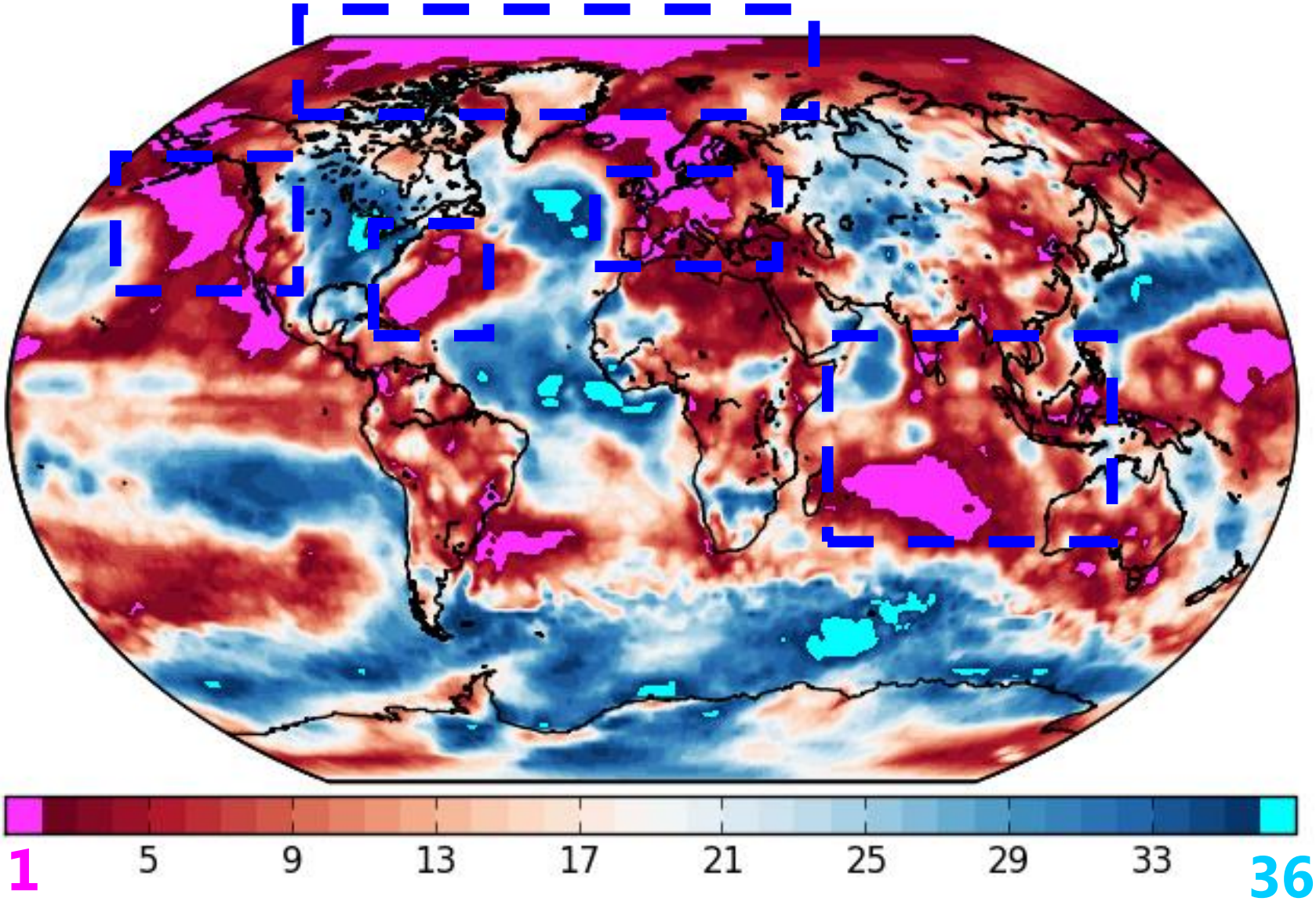

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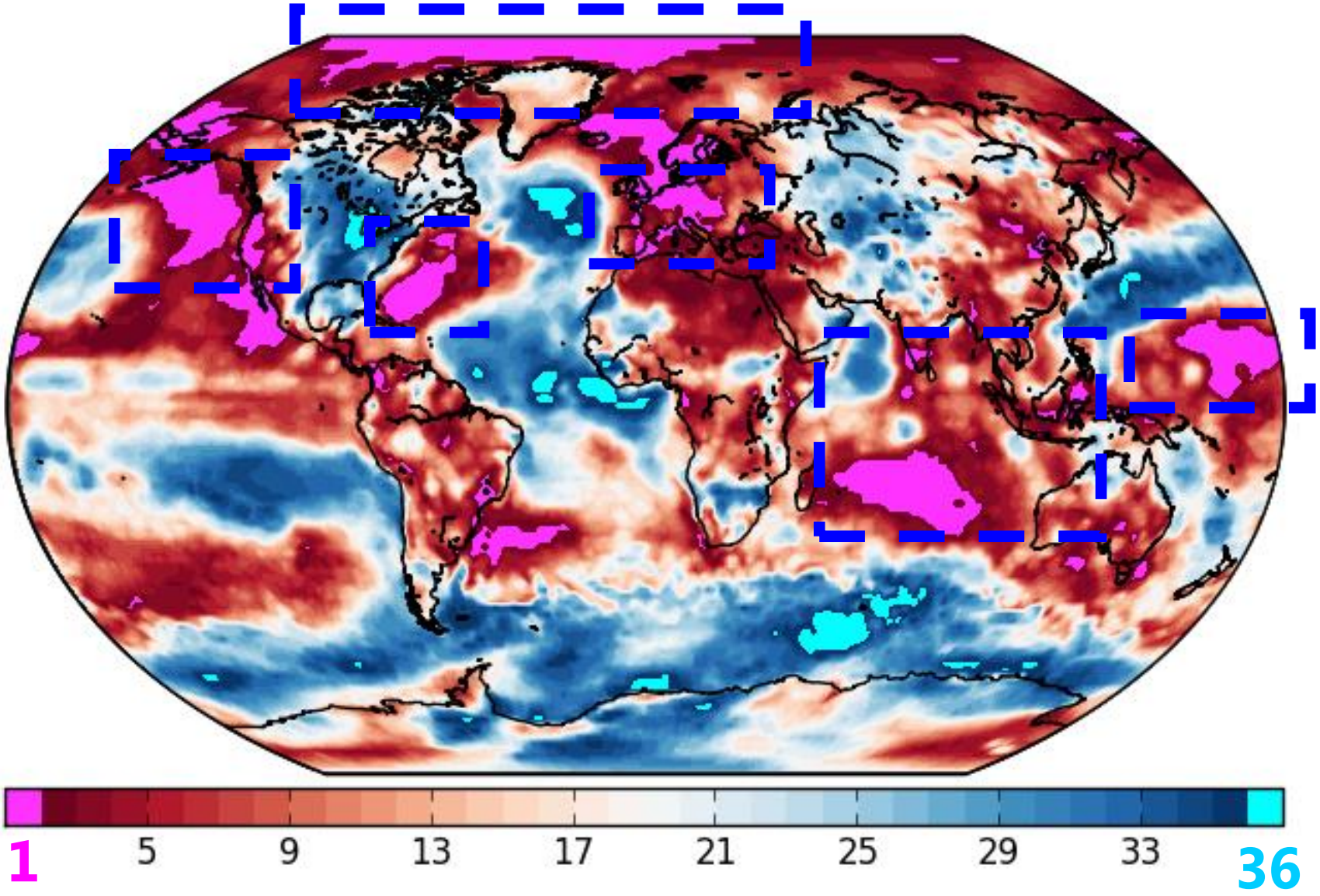

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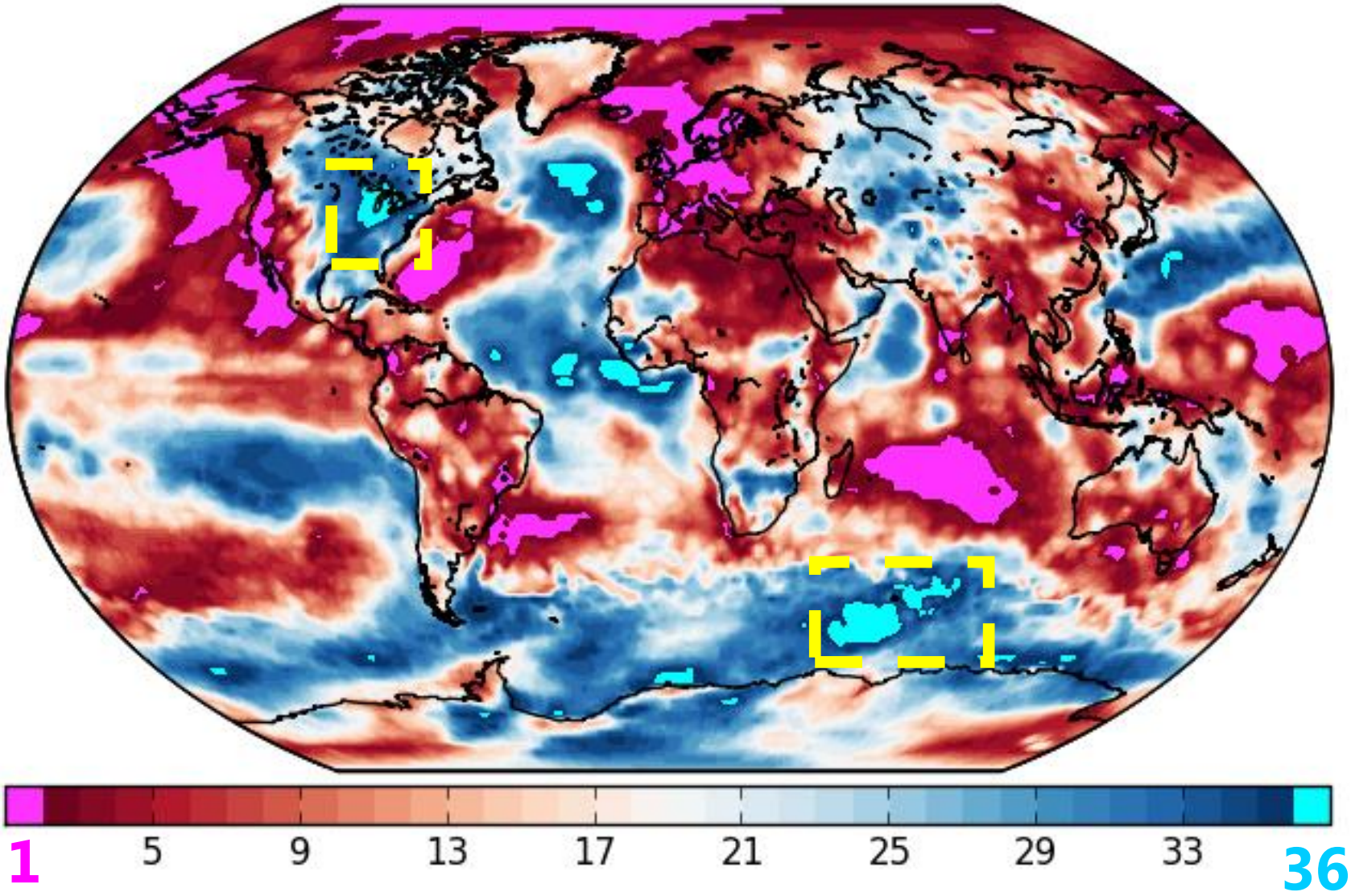
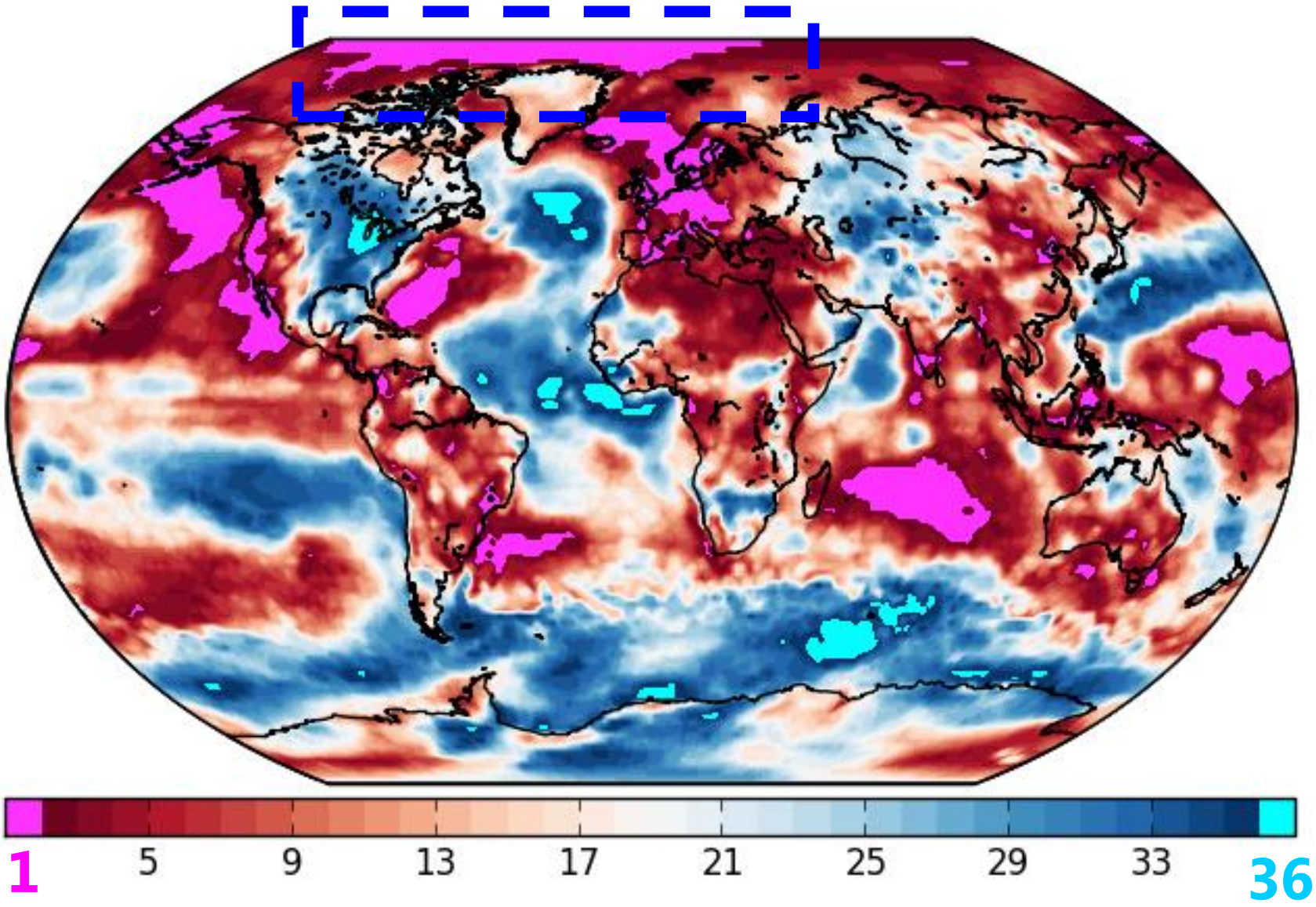


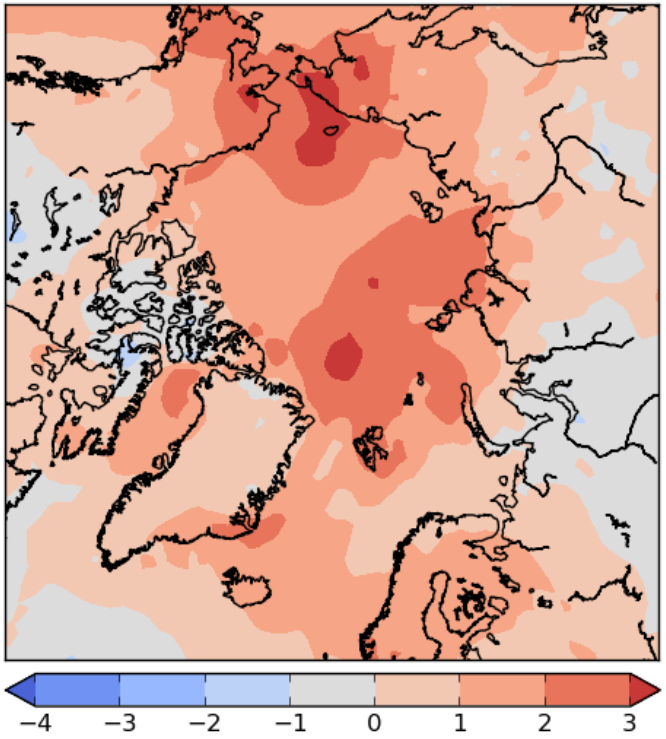
Cold extremes are just *less* likely in a warming climate

Rank of 2014 annual mean temperatures over the last 36 years



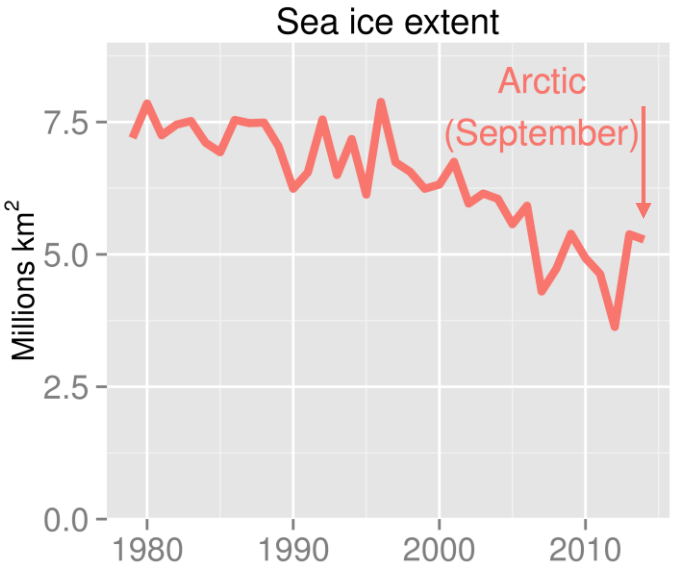
Arctic: 2014 temperatures and sea ice follow strong, long-term trend

Anomaly of annual mean 2014 near-surface air temperature (ref: 1979-2014)



[C]

Data: ERA-Interim

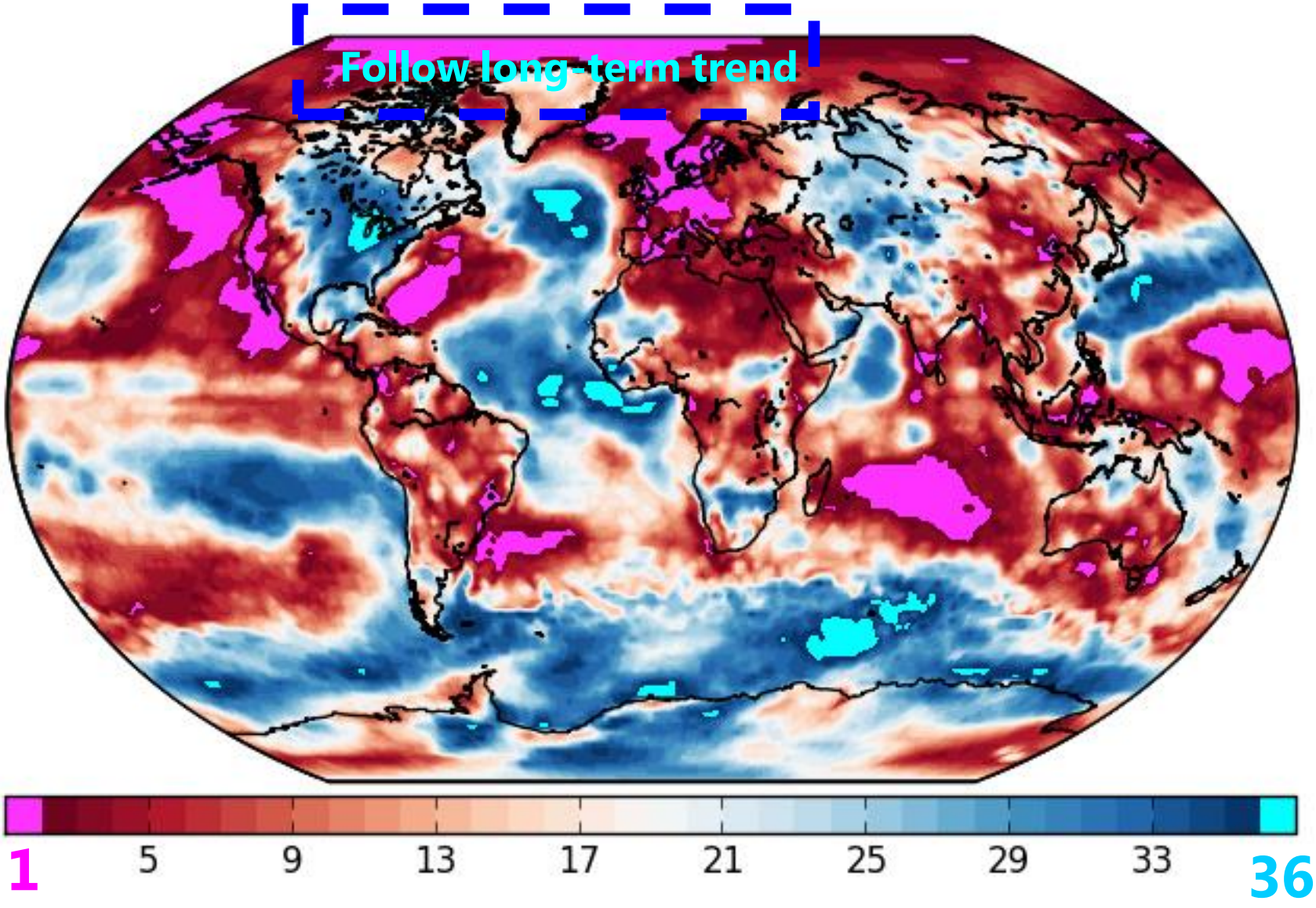


Data: NSIDC

Sea ice
September 2014

http://youtu.be/FDRnH48LvhQ

Rank of 2014 annual mean temperatures over the last 36 years



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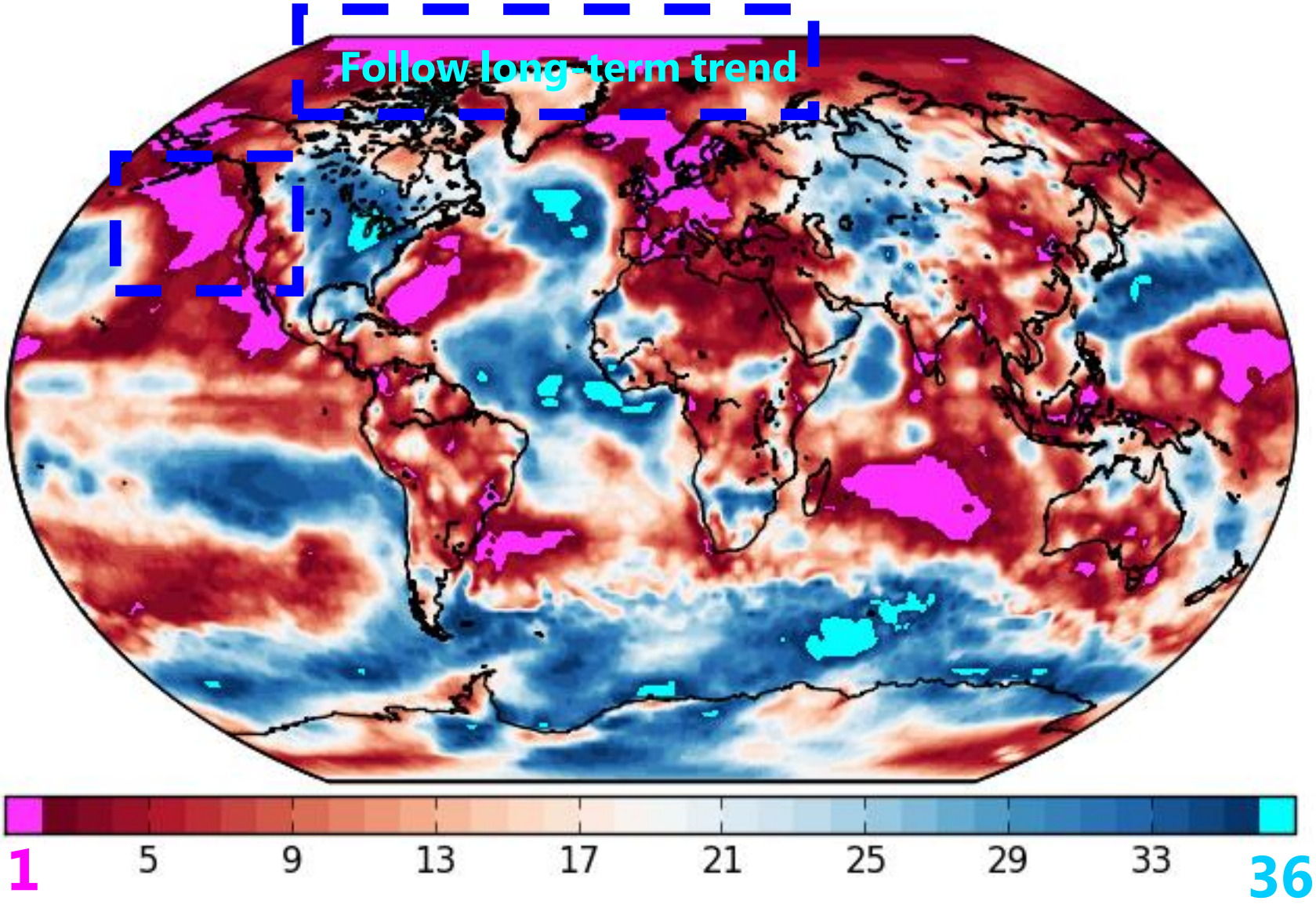
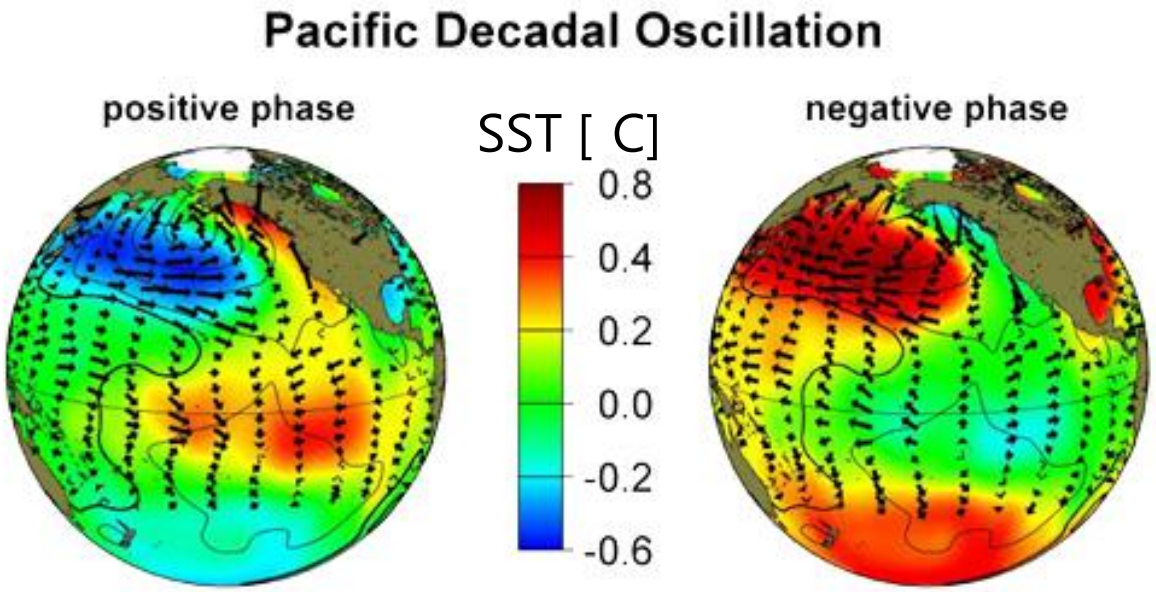


The Pacific Decadal Oscillation is the leading mode of SST variability in the North Pacific



http://ffden-2.phys.uaf.edu/645fall2003_web.dir/Jason_Amundson/enso.htm

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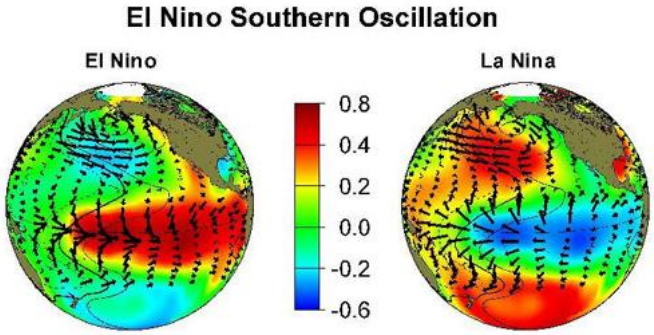
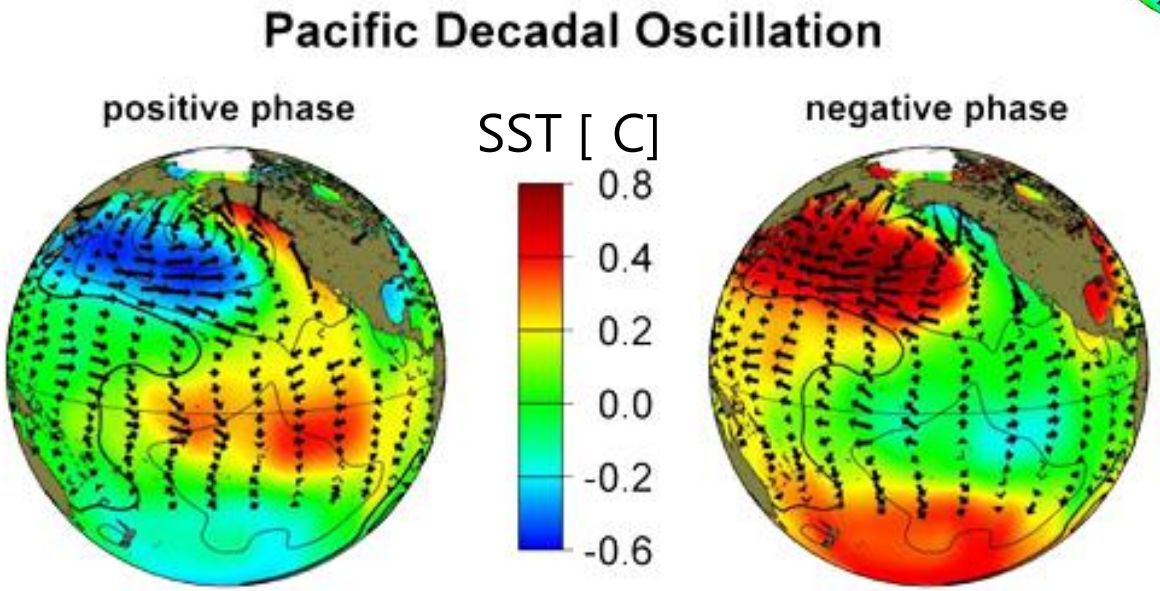
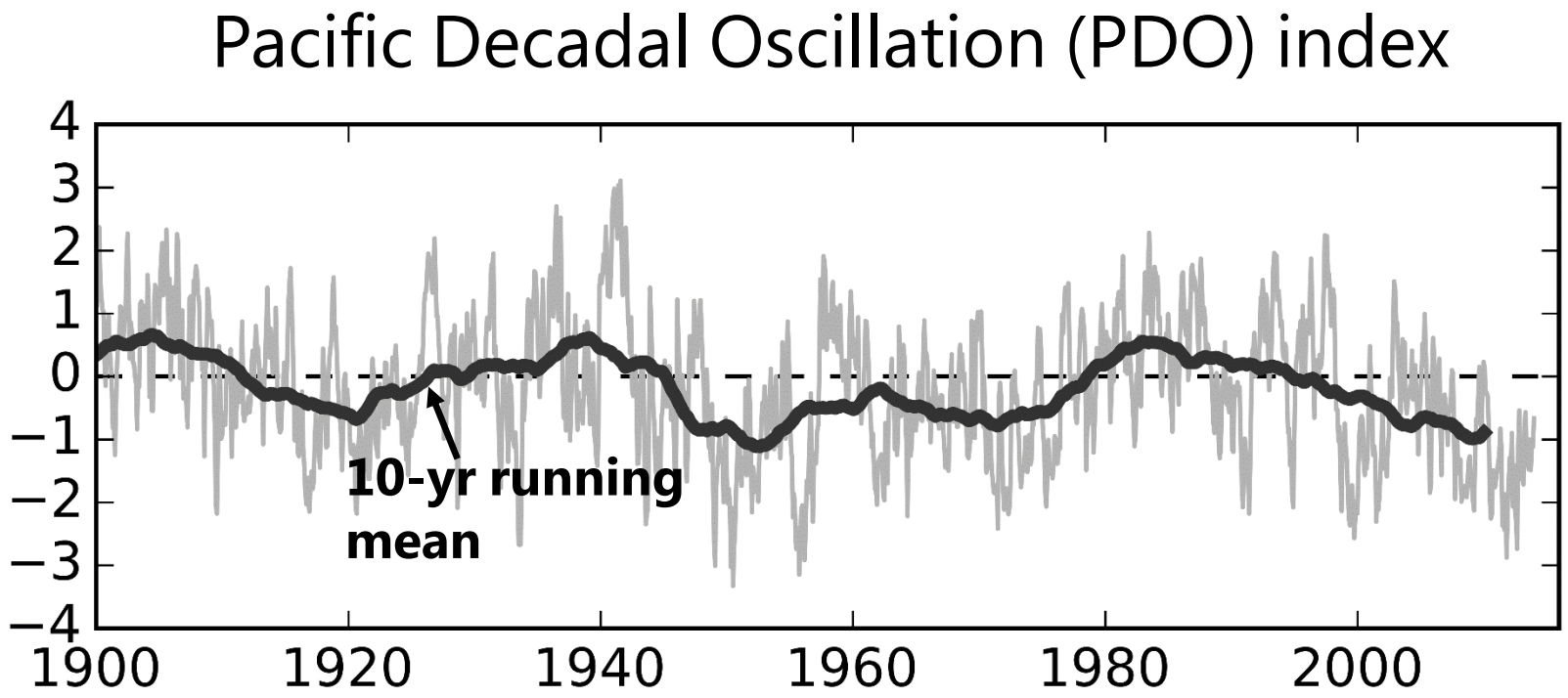




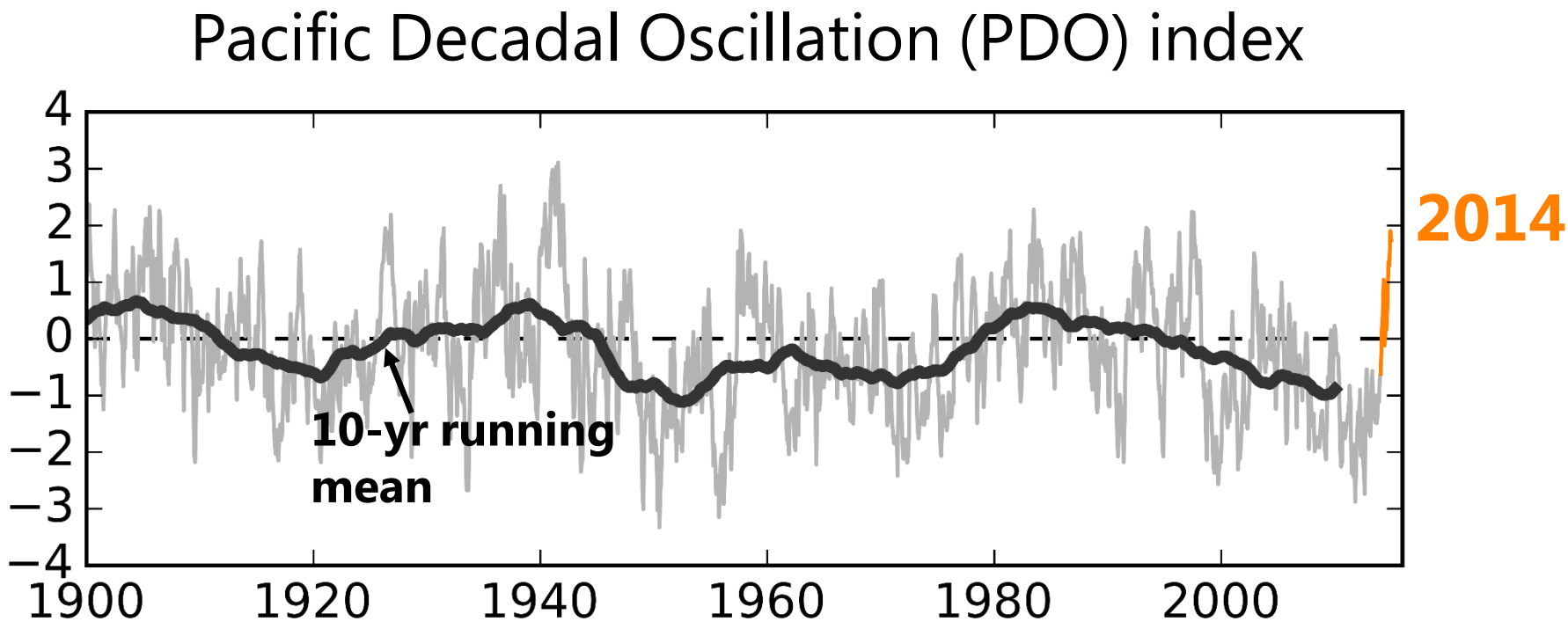
http://ffden-2.phys.uaf.edu/645fall2003_web.dir/Jason_Amundson/enso.htm

The Pacific Decadal Oscillation was in its negative phase up to recently



Data: http://www.ncdc.noaa.gov/teleconnections/pdo/

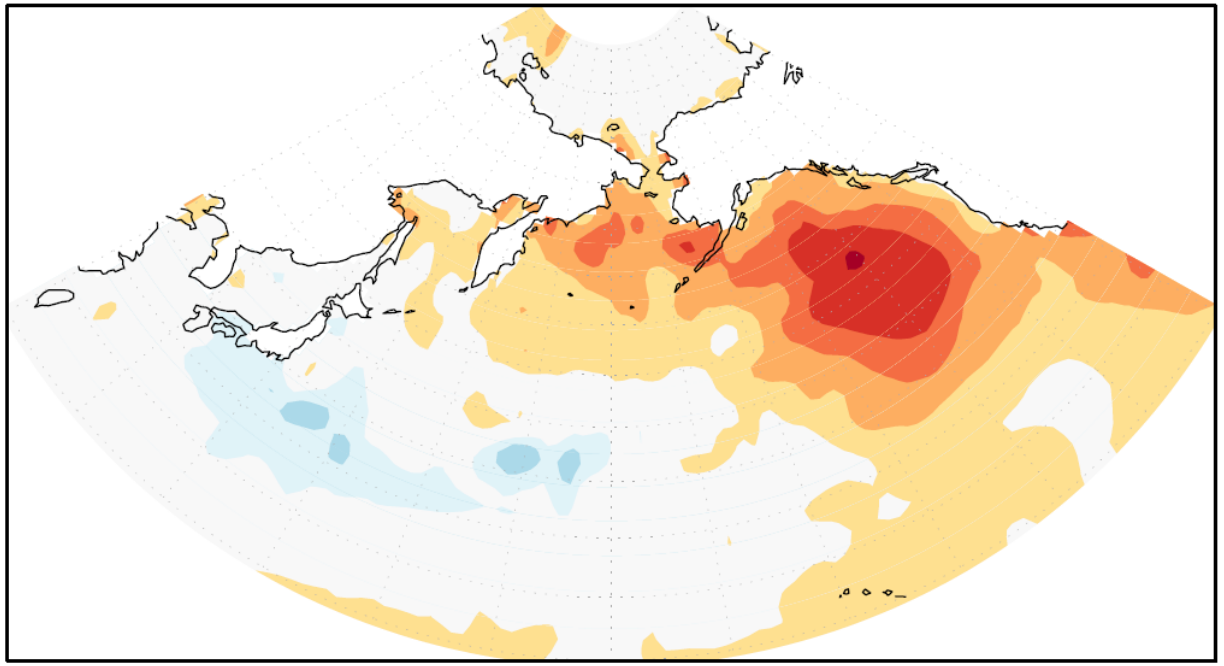
The Pacific Decadal Oscillation switched to positive phase in 2014

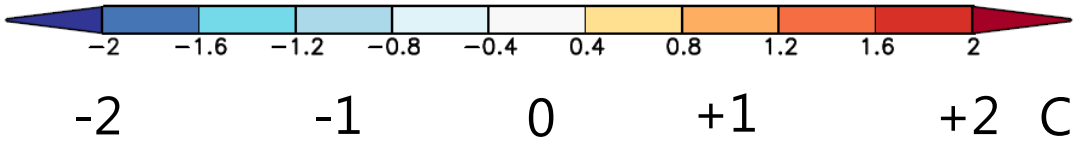


Data: http://www.ncdc.noaa.gov/teleconnections/pdo/

The Pacific Decadal Oscillation switched to positive phase in 2014

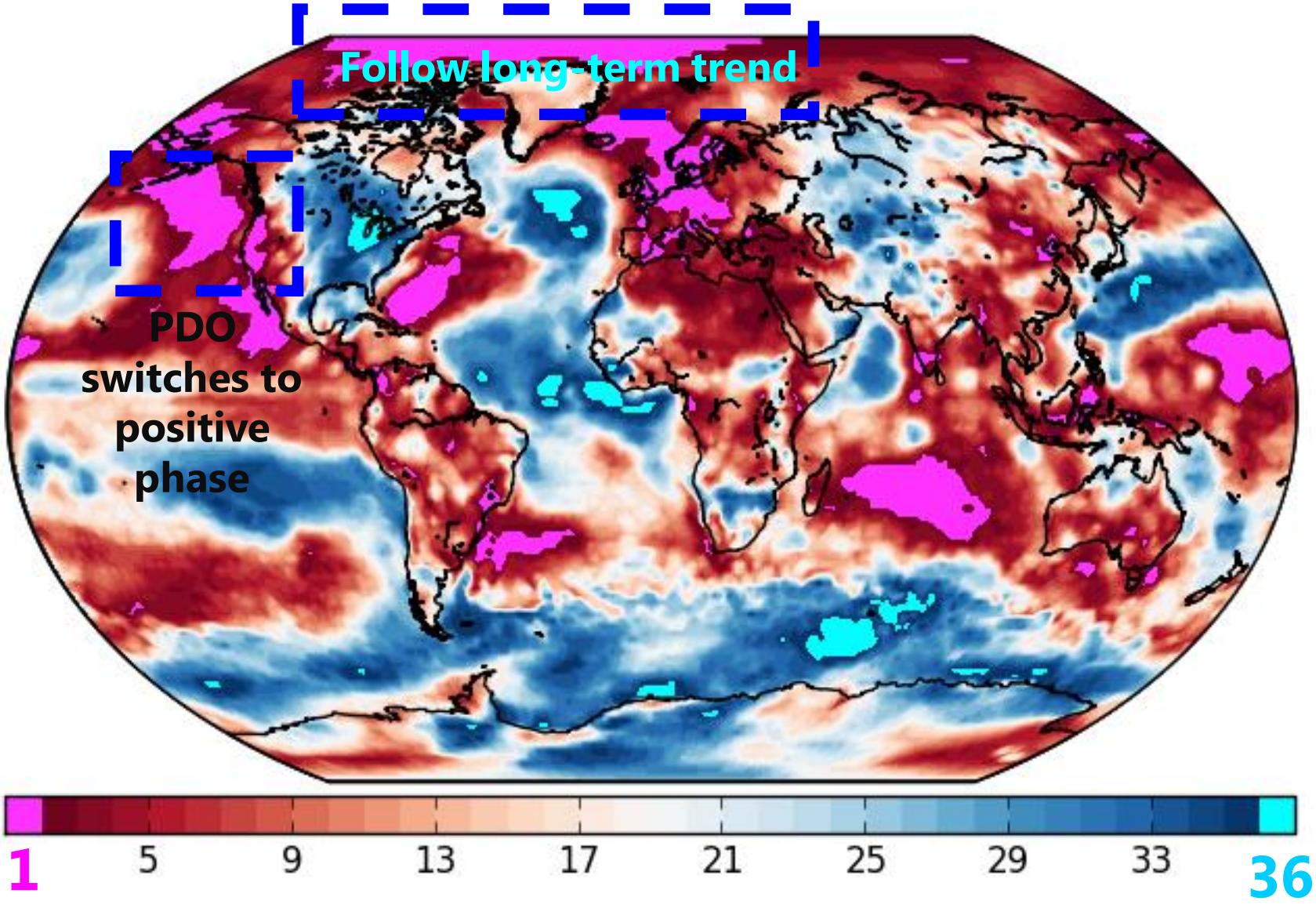
2014 Anomalies of Sea Surface Temperature (ref: 1981-2000)





Data: Reynods v2 SST
Figure: Climate Explorer, KNMI

Rank of 2014 annual mean temperatures over the last 36 years



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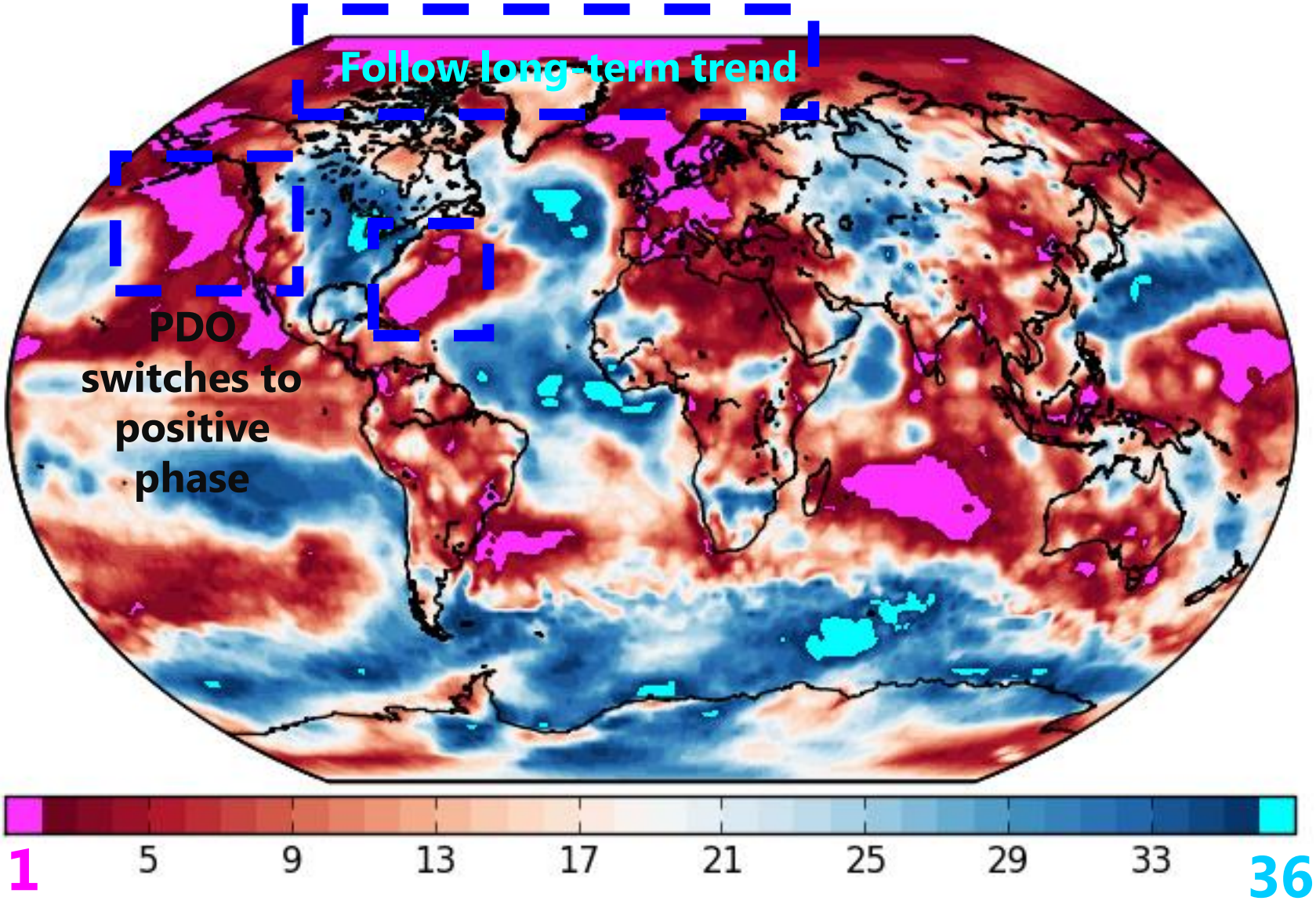
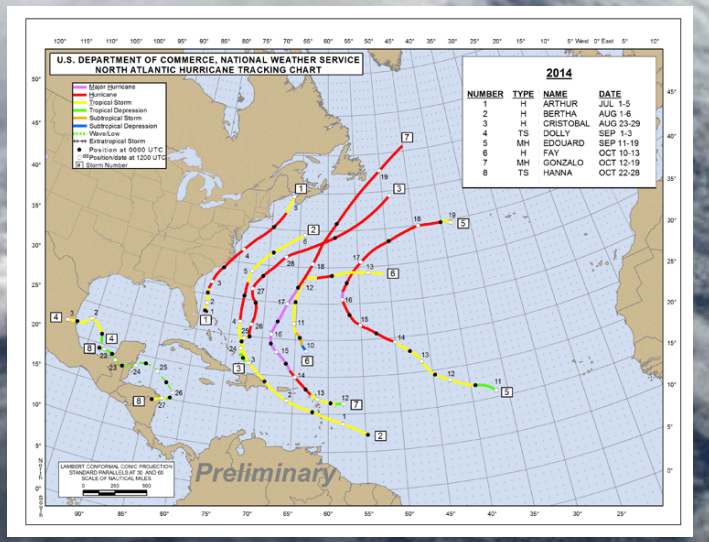


Hurricane Gonzalo



Data: http://www.wunderground.com/blog/JeffMasters/comment.html?entrynum=2870

The 2014 Atlantic hurricane activity was below average, and well predicted…

	1981-2010 Average	2014	Predicted (NOAA)
Named storms	12	8	10.5
Hurricanes	6	6	4.5
Major Hurricanes	3	2	1.5
Accumulated Cyclone Energy Index	1.0	0.63	0.7

The 2014 Atlantic hurricane activity was below average, and well predicted… but maybe not for good reasons!

"

NOAA Pre-season announcement

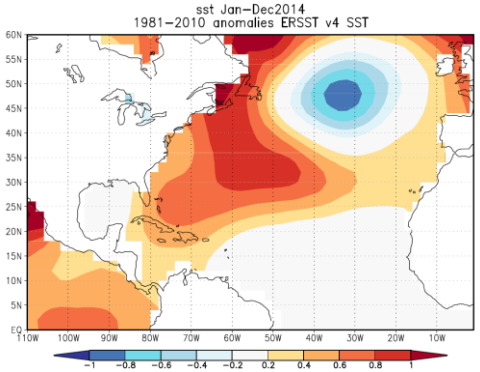
NOAA cites three key factors influencing their forecast for a below-normal to near-normal hurricane season:

1) **An El Niño event is predicted** for the summer and fall, which is expected to bring strong wind shear-inducing […]

2) Sea Surface Temperatures (SSTs) are near average in the MDR. Many long-range dynamical computer forecast models are **predicting that SSTs in the MDR will remain near- or below-average** throughout the hurricane season.

3) We are in an active hurricane period that began in 1995, and this positive phase of the Atlantic Multi-decadal Oscillation (AMO) may act to keep hurricane activity higher than it would otherwise be.

2014 SST anomaly



"

http://www.wunderground.com/blog/JeffMasters/comment.html?entrynum=2688

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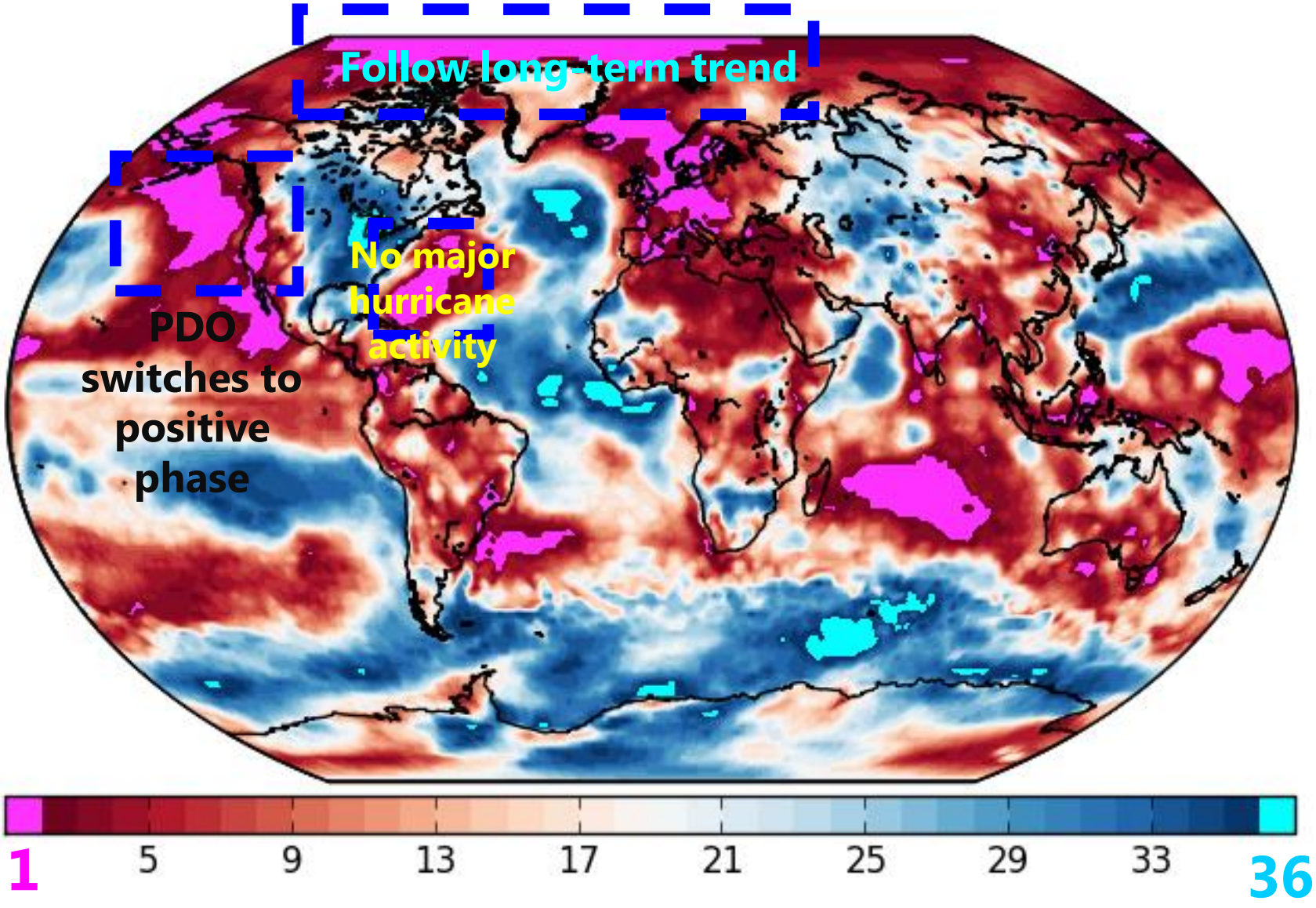

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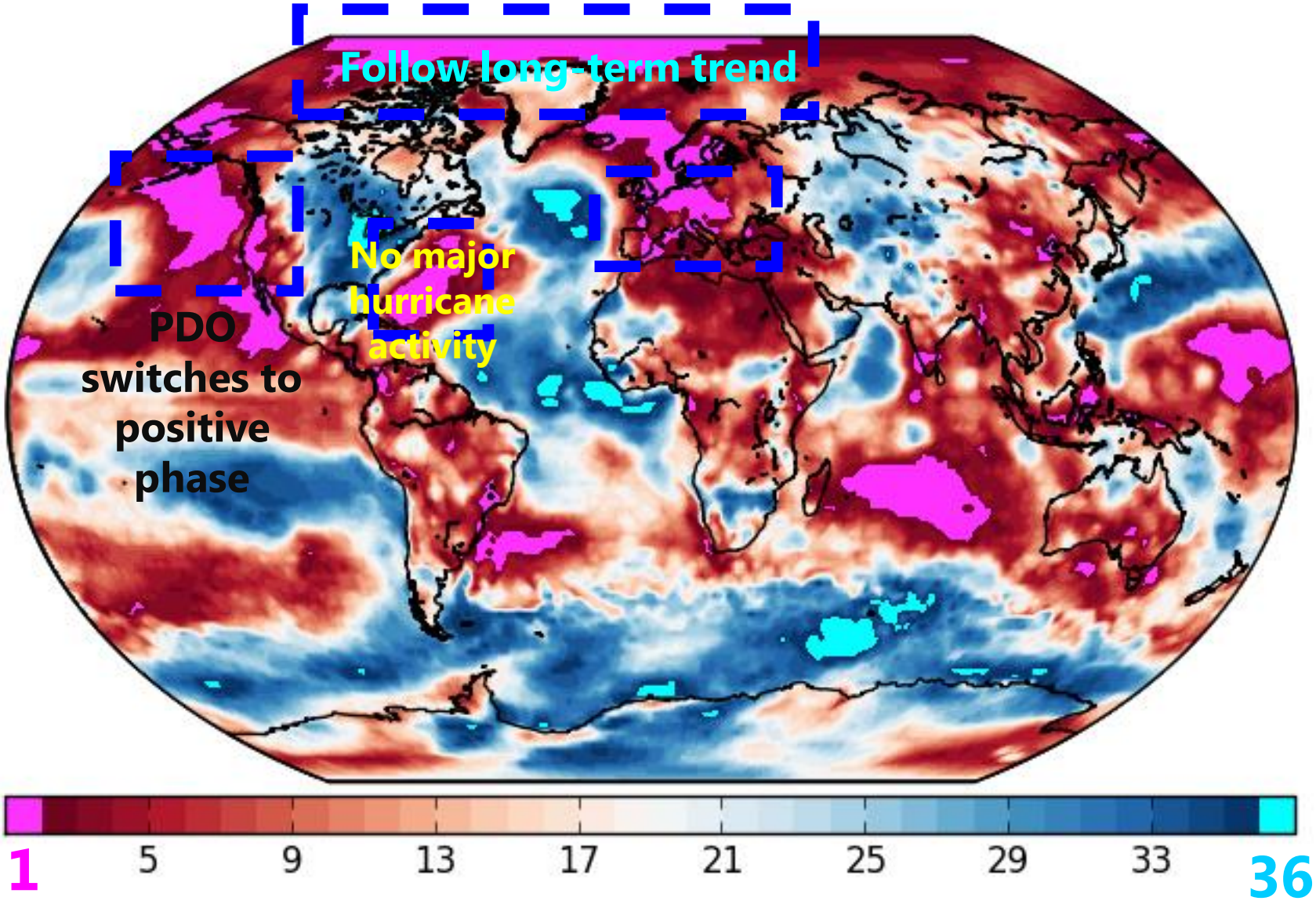
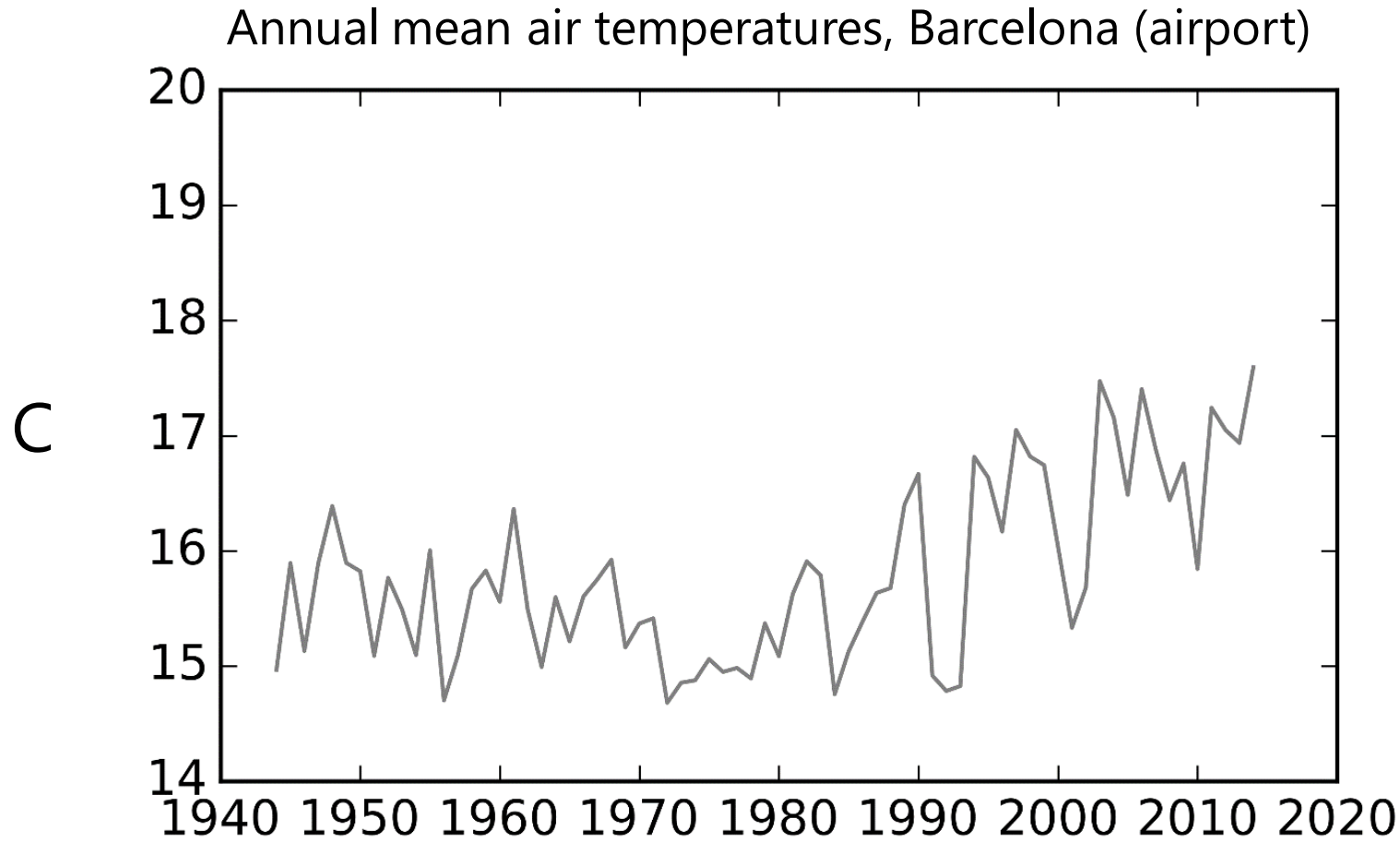
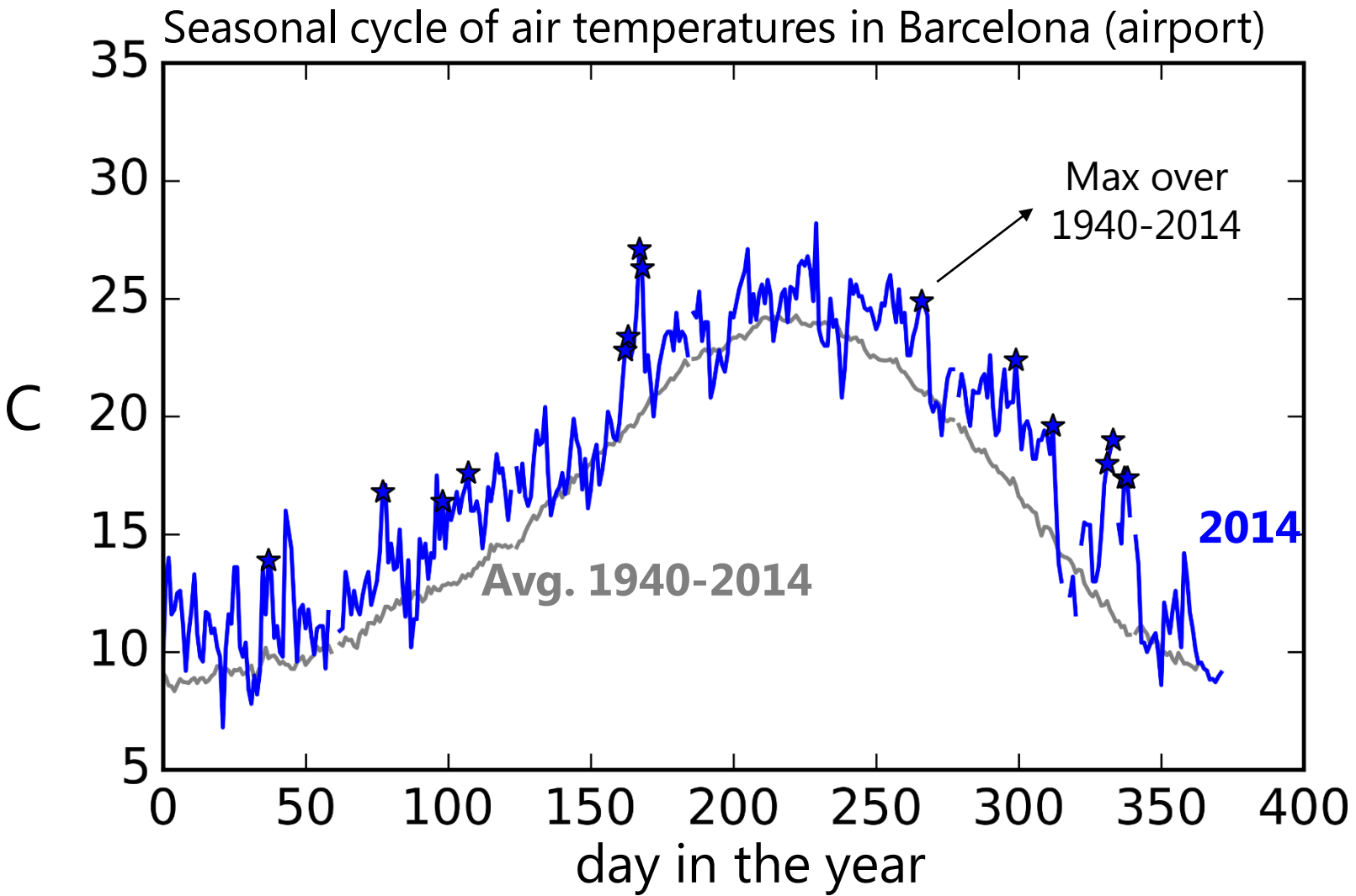


Air temperatures were the warmest in 2014. Did you feel it?



Data: European Climate Assessment & Data set

Air temperatures were the warmest in 2014, because of high temperatures throughout the year



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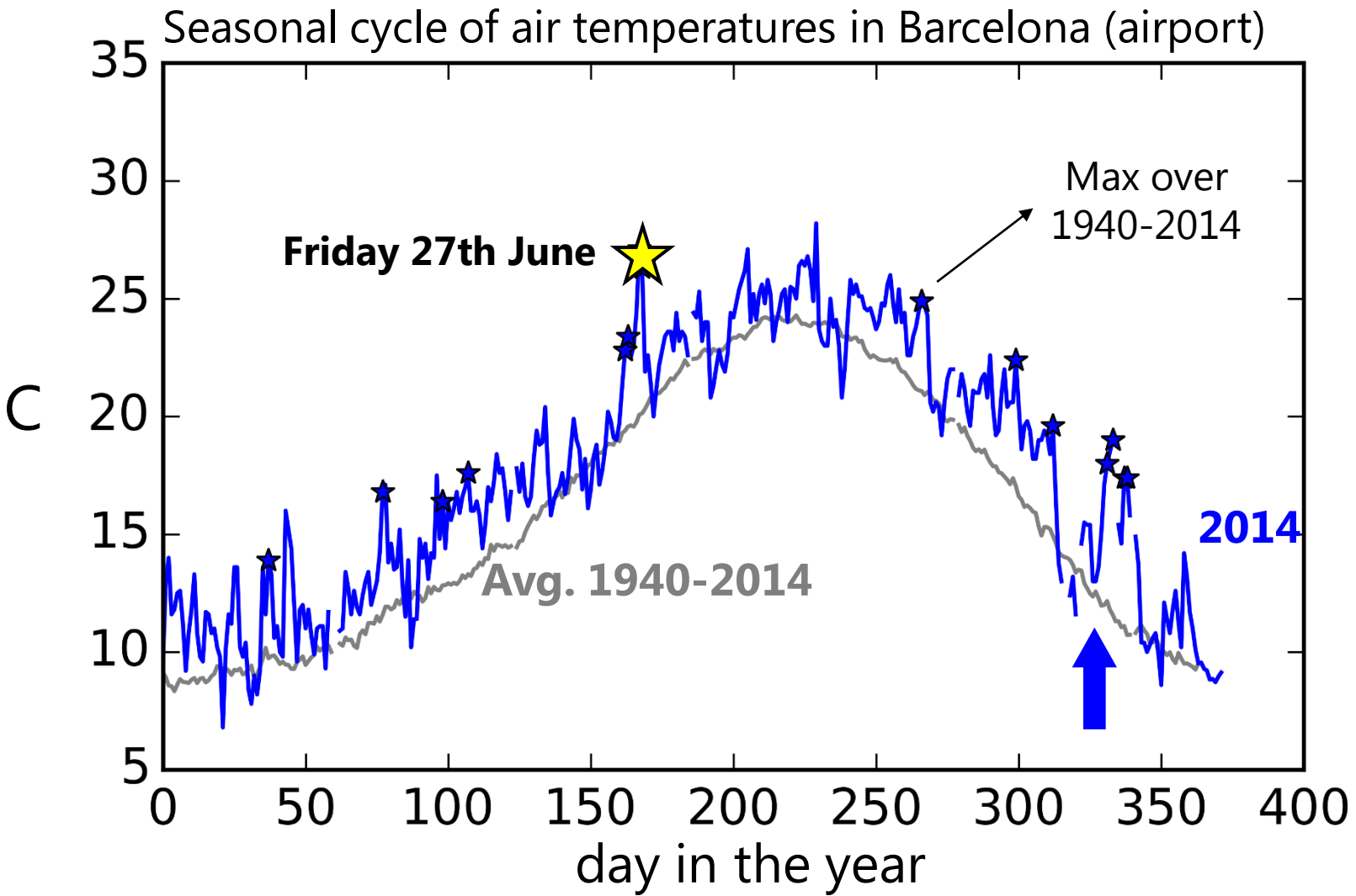

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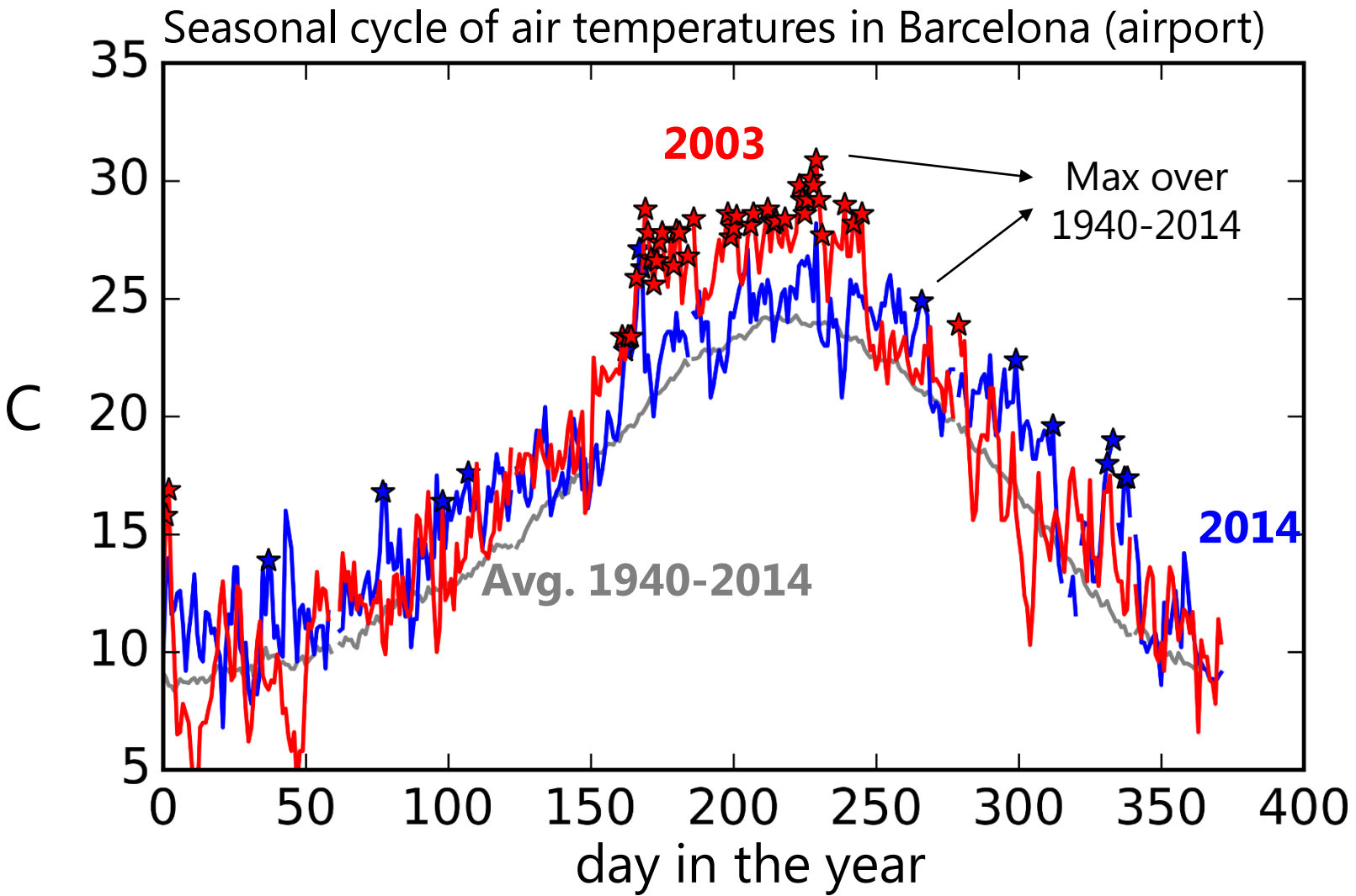

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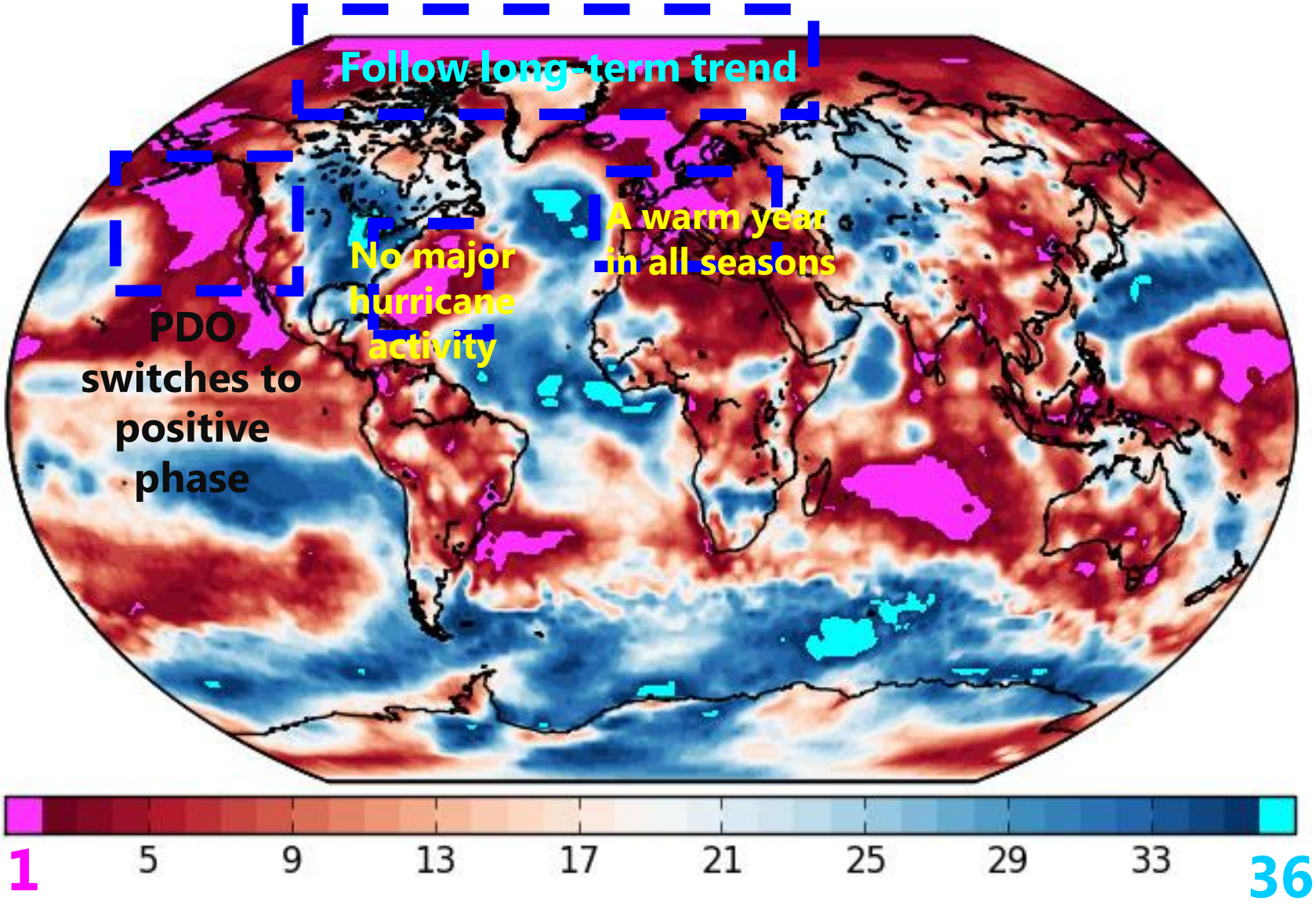

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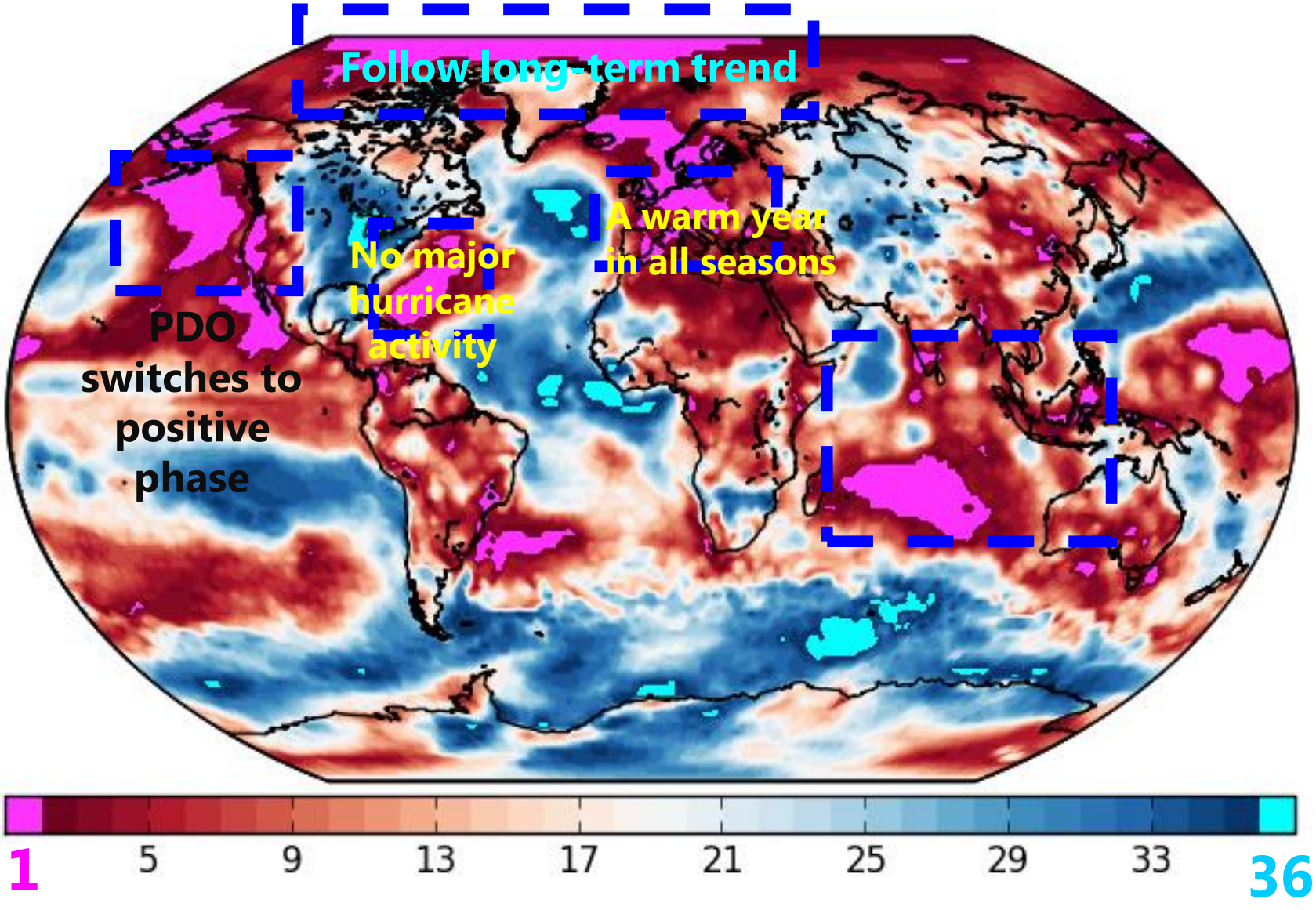
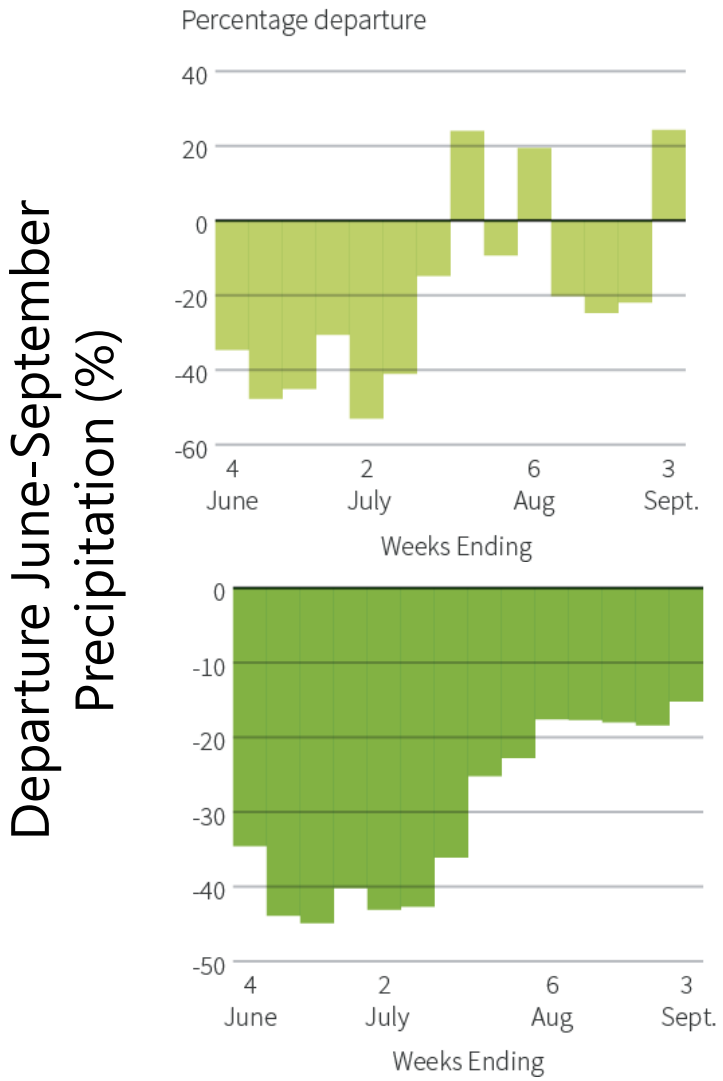


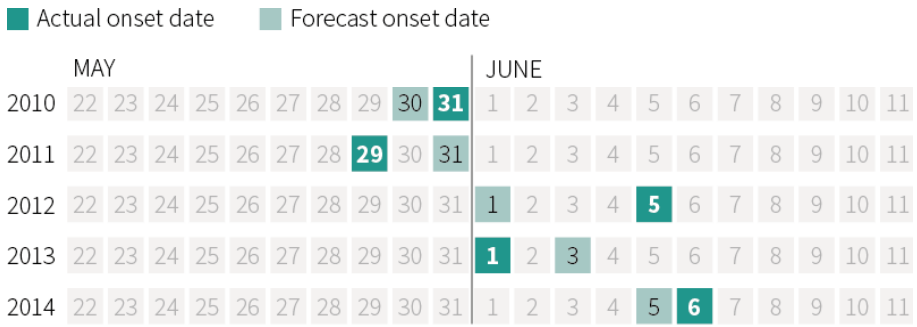
A below-average monsoon was forecasted for 2014

Rainfall Category	July		August	
	Range (% of LPA)	Forecast Probability (%)	Range (% of LPA)	Forecast Probability (%)
Below Normal	<94	**53**	<94	**43**
Normal	94 -106	**35**	94 -106	**35**
Above Normal	>106	**12**	>106	**22**

Indian Meteorological Department
http://www.imd.gov.in/section/nhac/dynamic/2lrf_eng14.pdf

Monsoon activity in 2014 was indeed below average, and onset correctly predicted





http://graphics.thomsonreuters.com/14/india_monsoon/index.html

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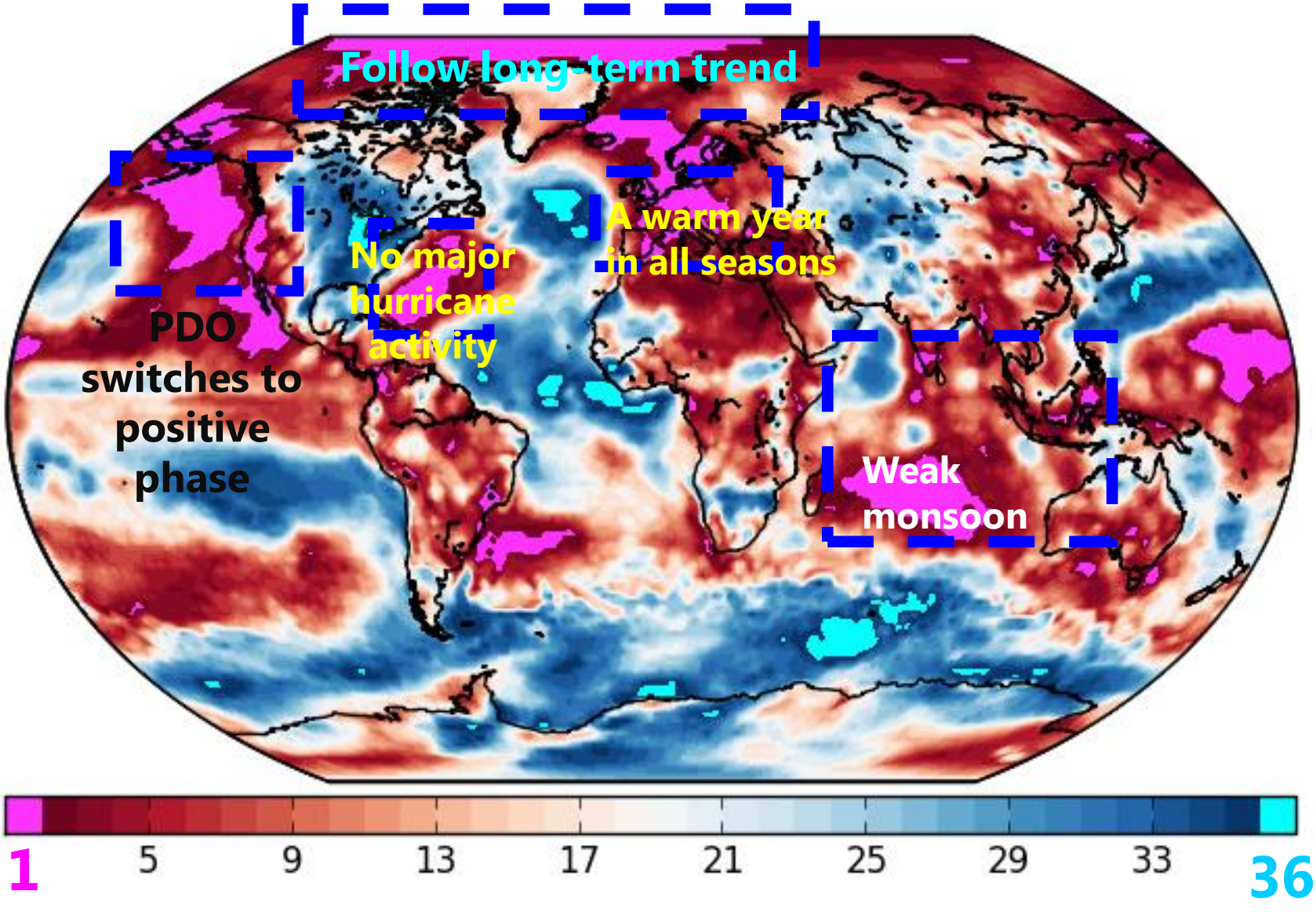

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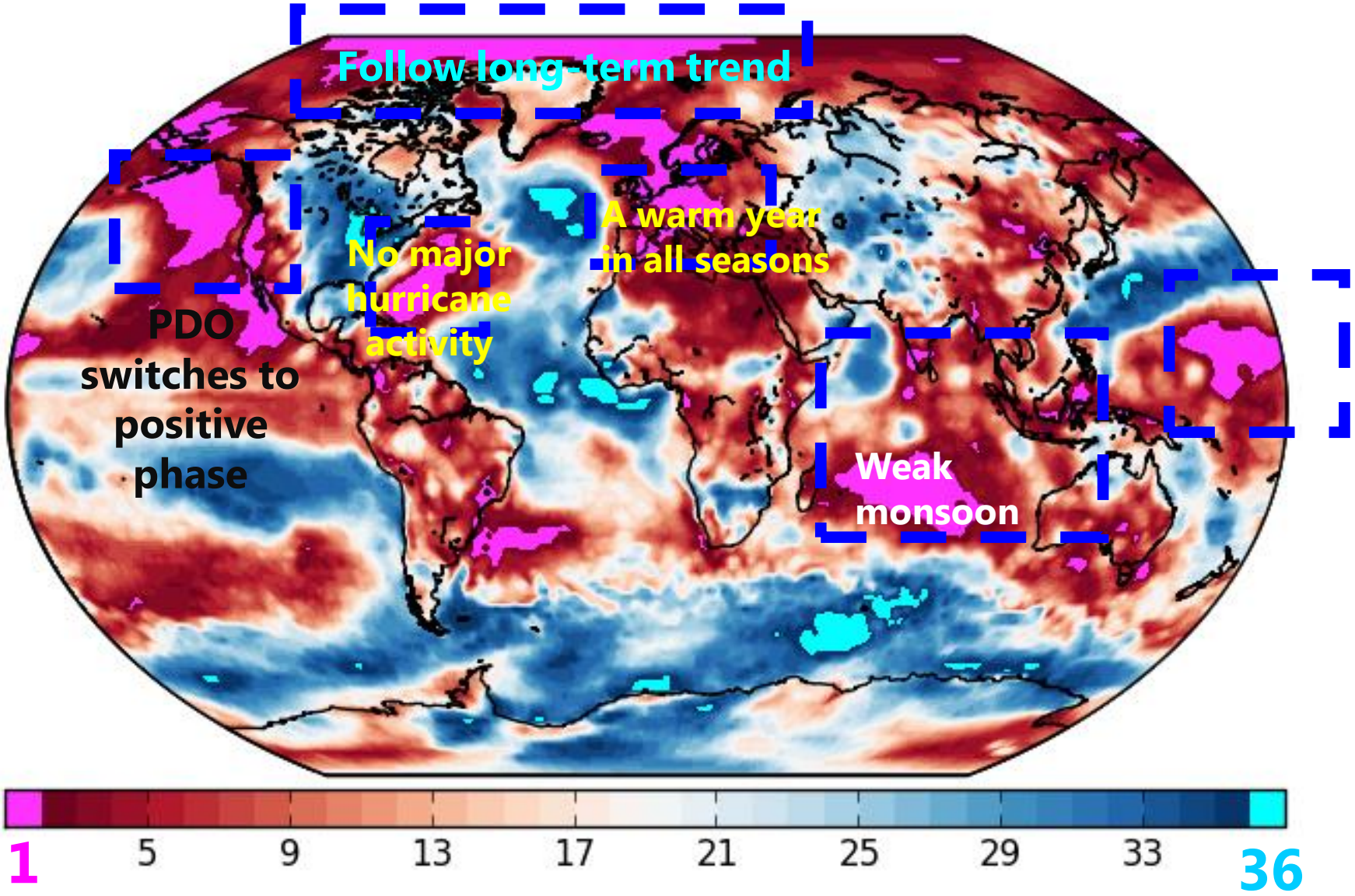
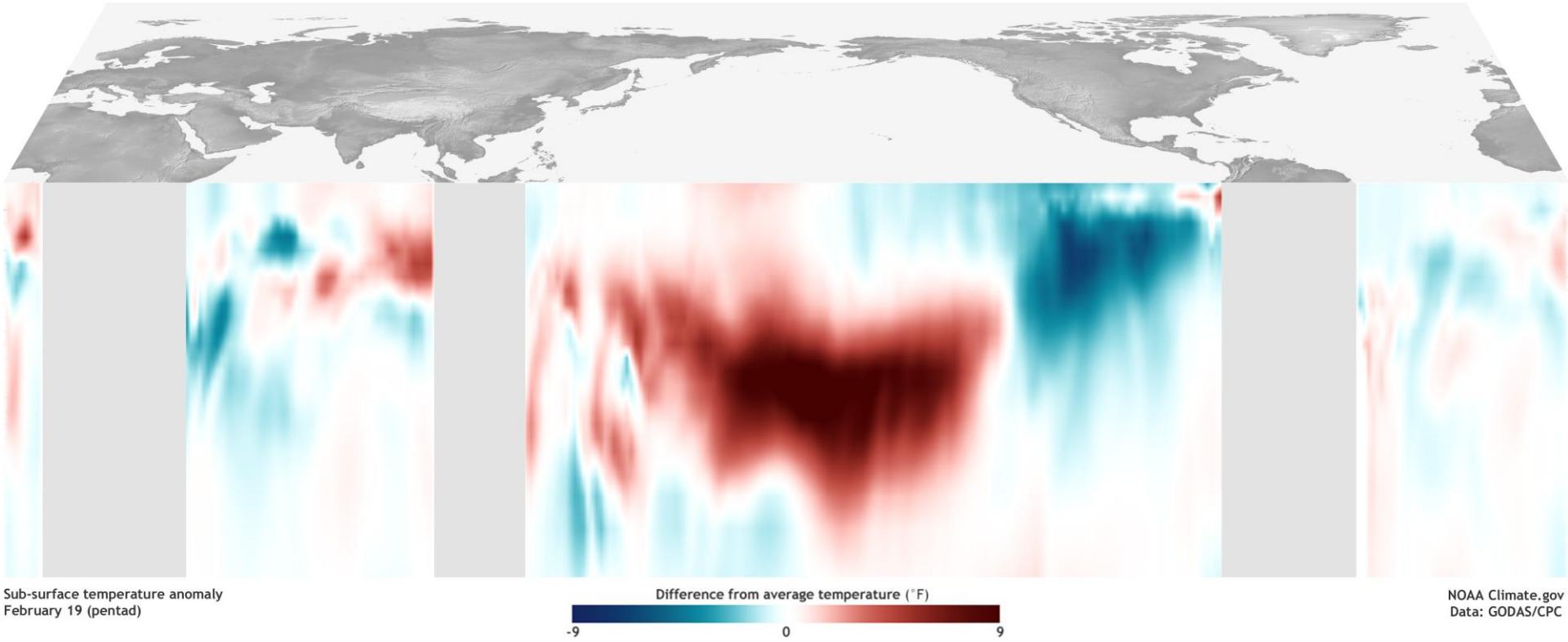


May 2014

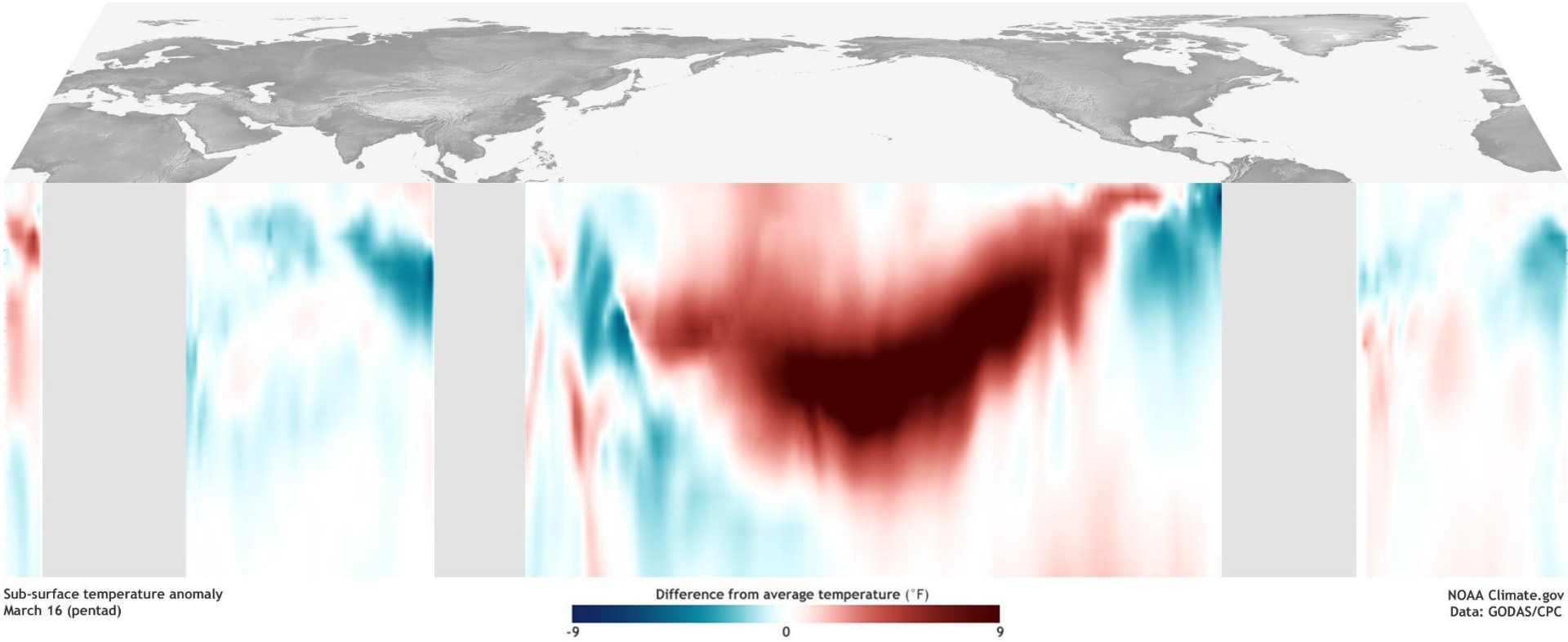
http://climatecrocks.com/2014/04/28/kevin-trenberth-on-el-nino-the-only-question-is-how-big/

February 2014



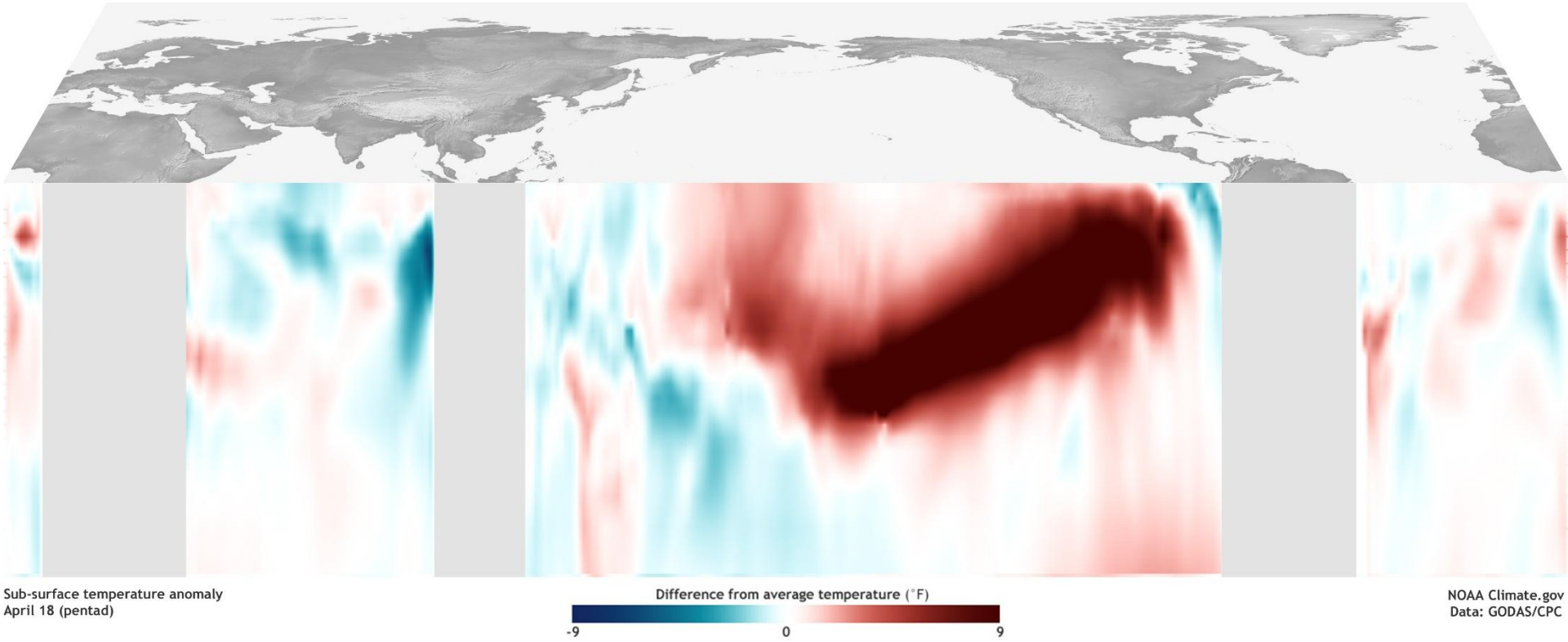
http://www.climate.gov/news-features/featured-images/slow-slosh-warm-water-across-pacific-hints-el-ni%C3%B1o-brewing

March 2014



http://www.climate.gov/news-features/featured-images/slow-slosh-warm-water-across-pacific-hints-el-ni%C3%B1o-brewing

April 2014



http://www.climate.gov/news-features/featured-images/slow-slosh-warm-water-across-pacific-hints-el-ni%C3%B1o-brewing

Very weak El Niño : no response from atmosphere,
no strong SST gradient

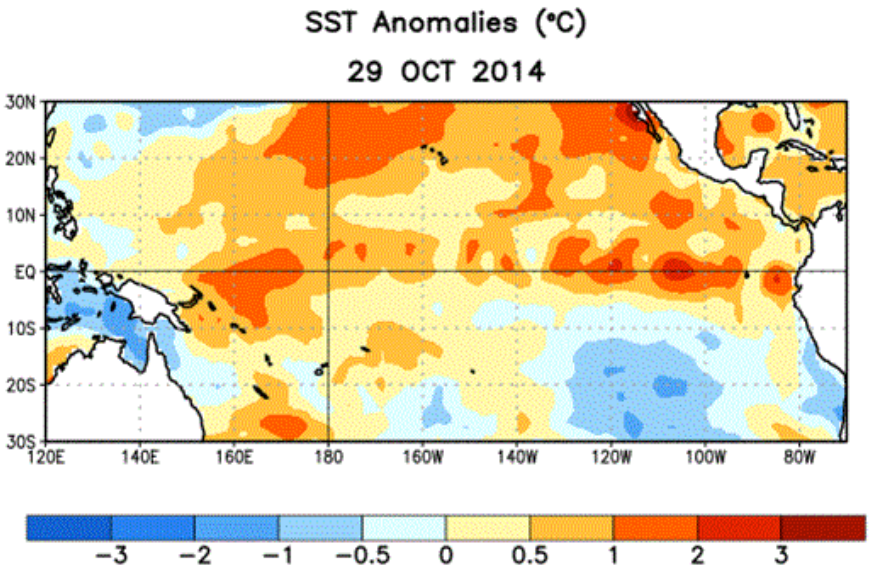
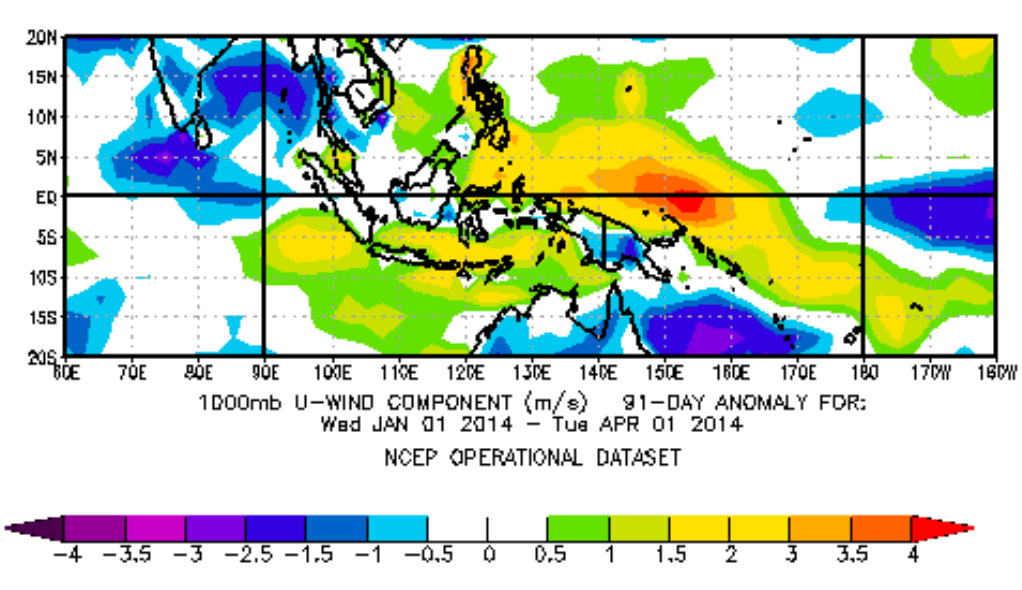
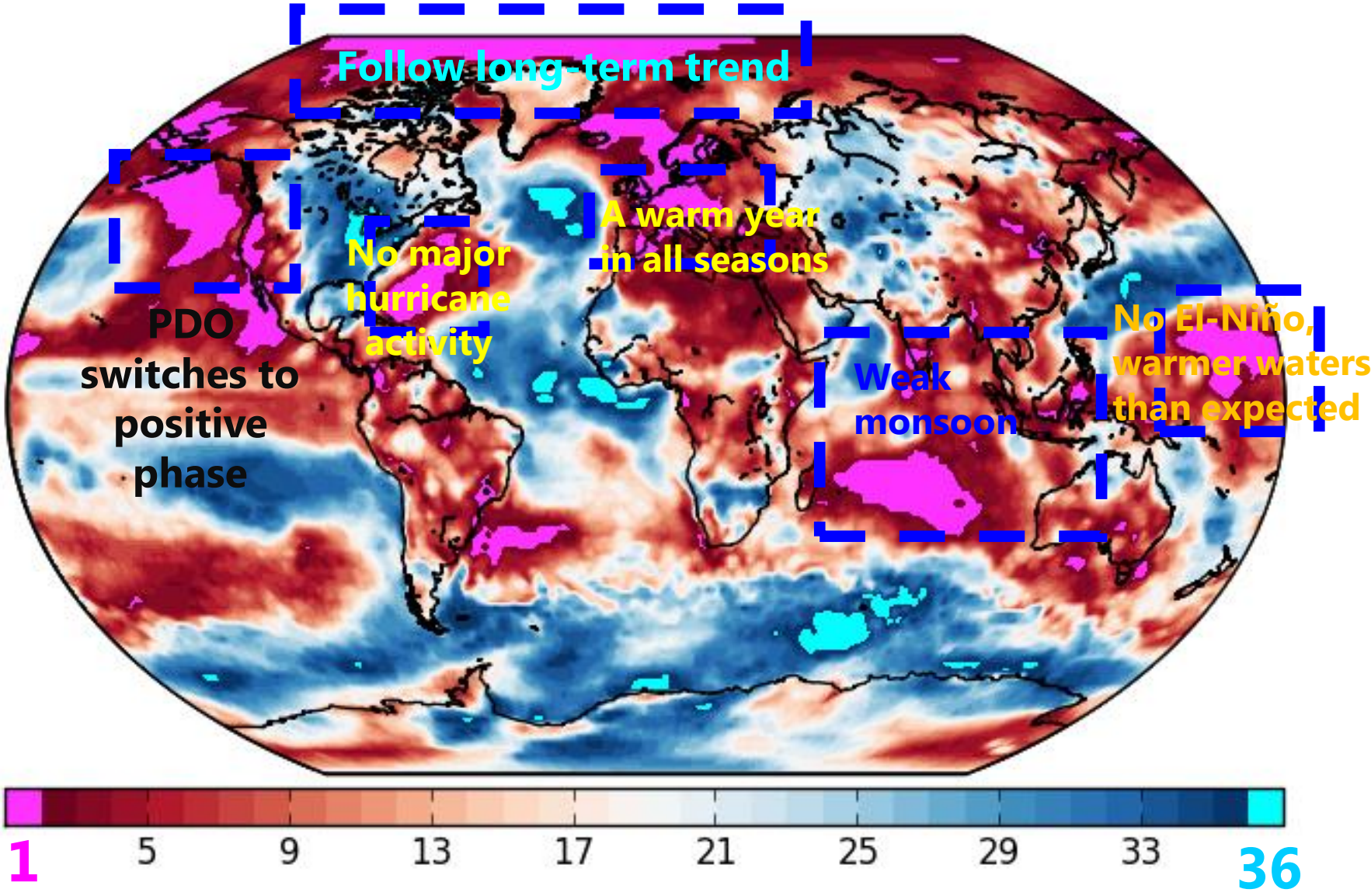


Figure 1. Average sea surface temperature (SST) anomalies (°C) for the week centered on 29 October 2014. Anomalies are computed with respect to the 1981-2010 base period weekly means.



http://www.climate.gov/news-features/blogs/enso/what%E2%80%99s-hold-el-ni%C3%B1o

Rank of 2014 annual mean temperatures over the last 36 years



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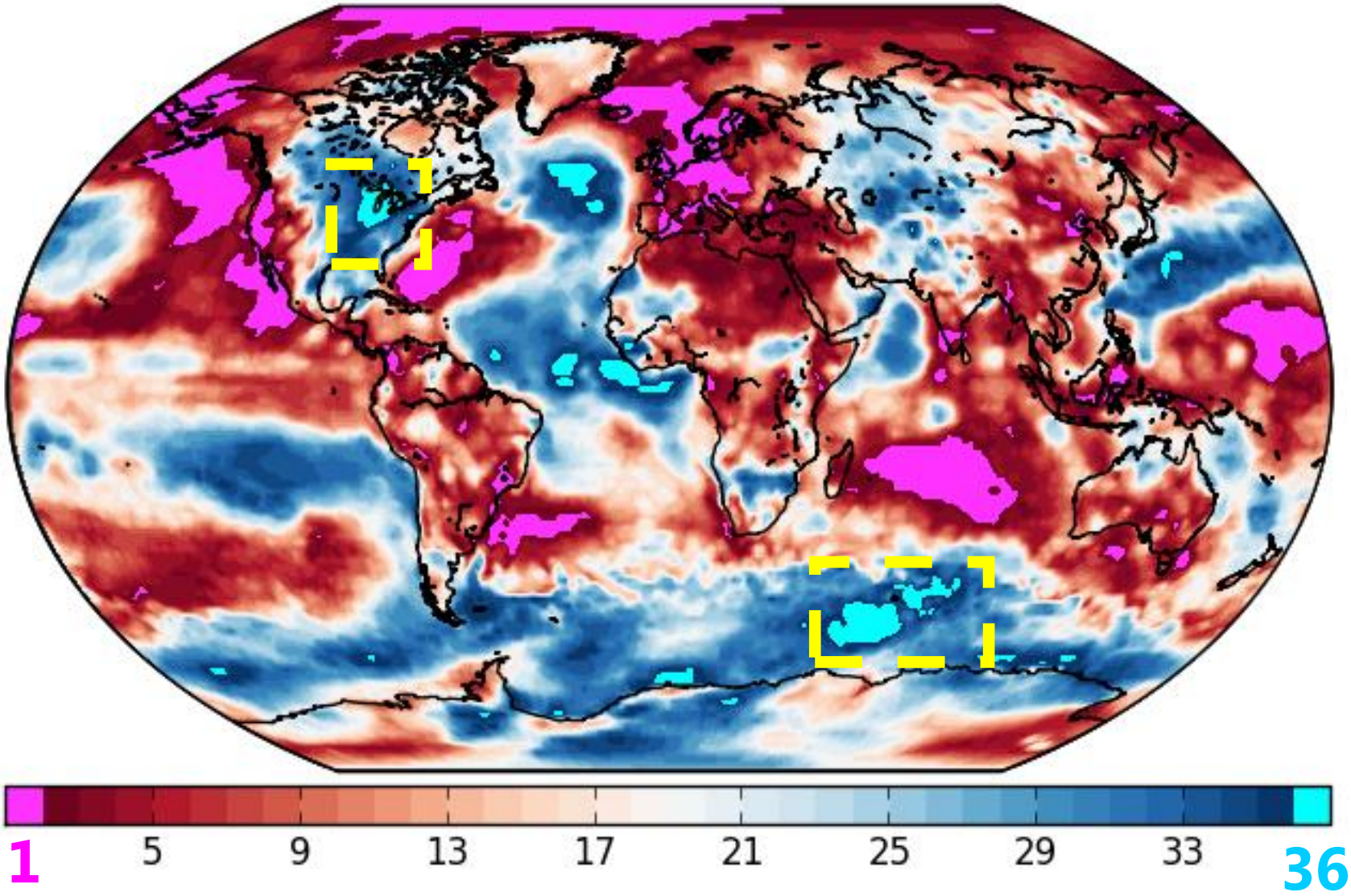
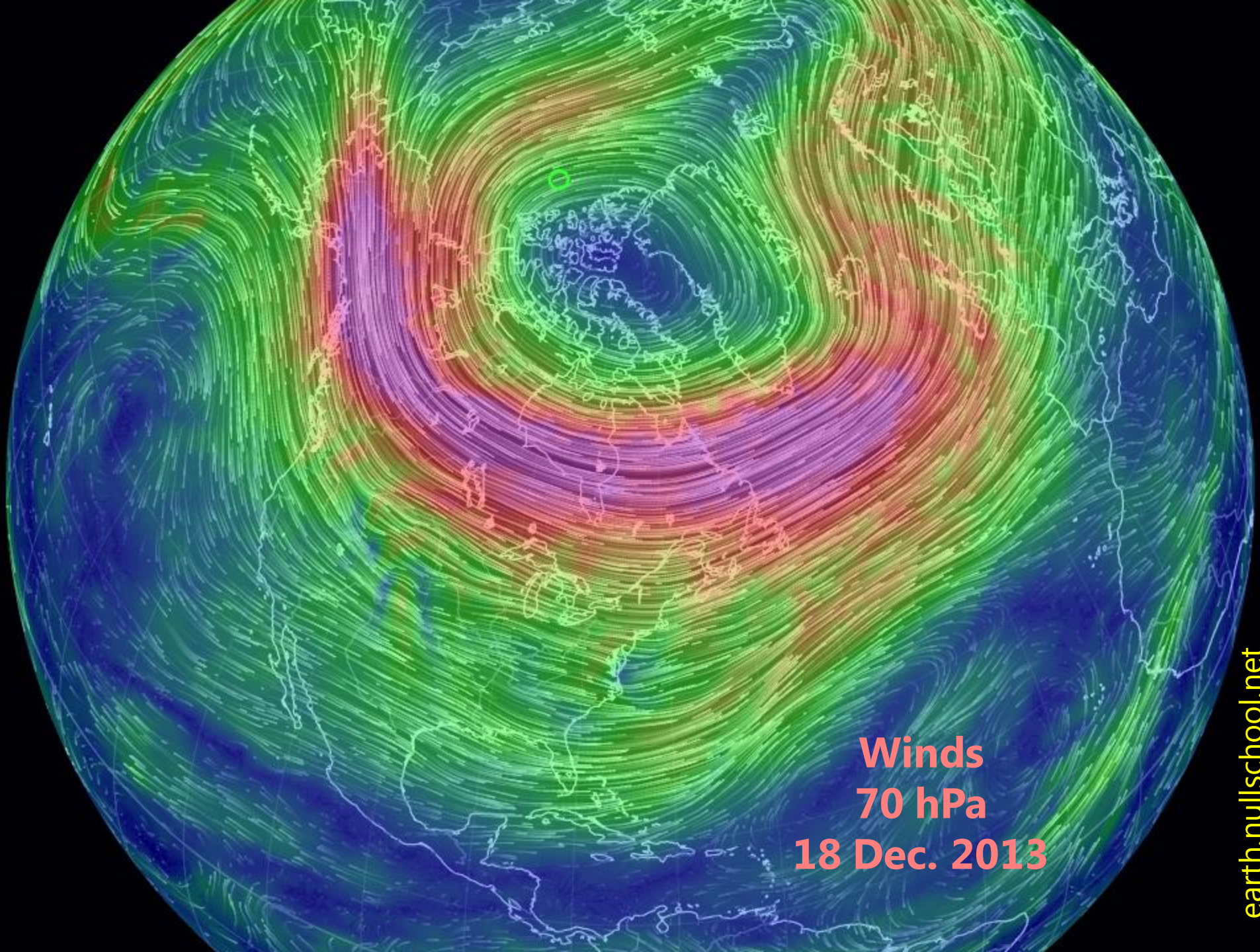
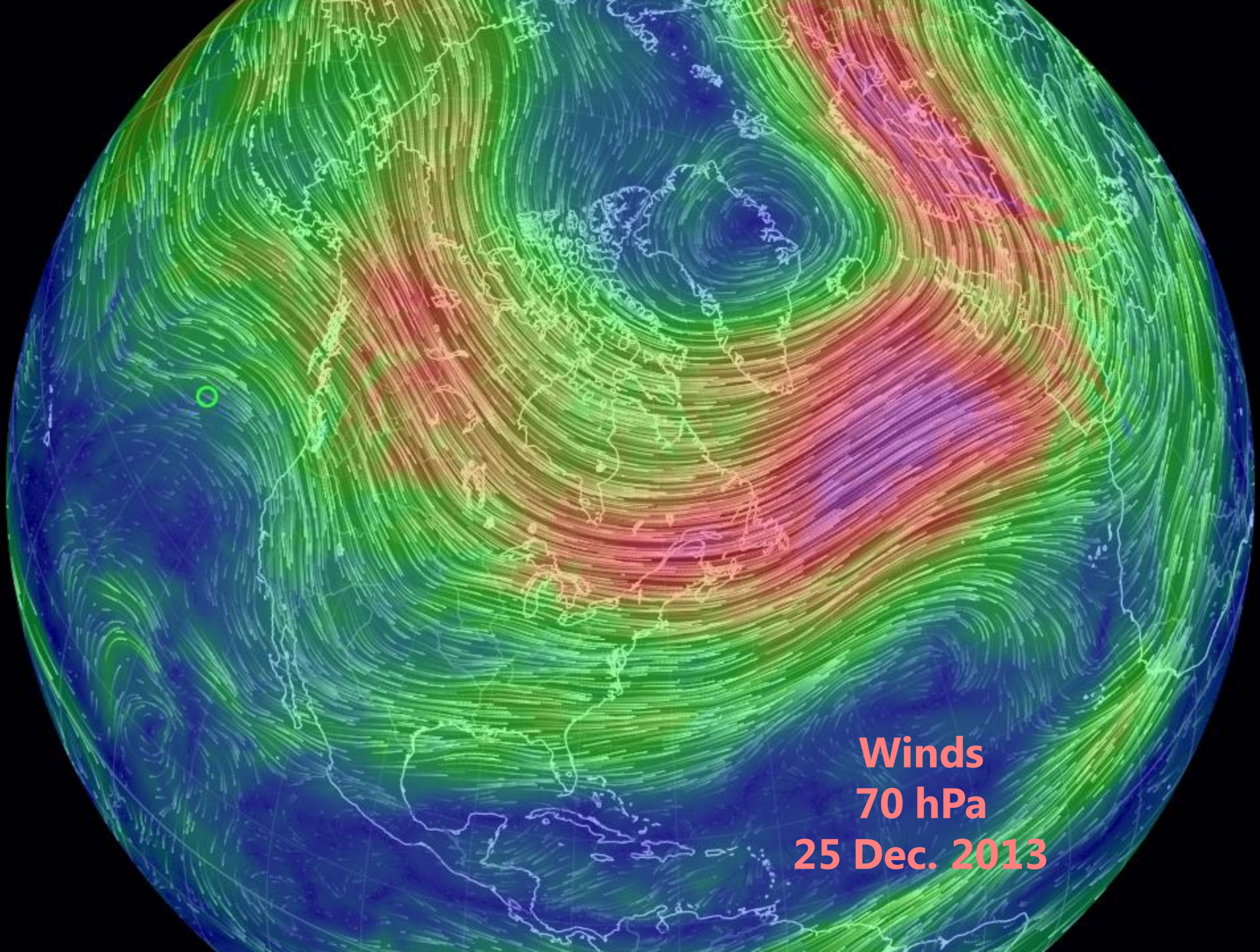
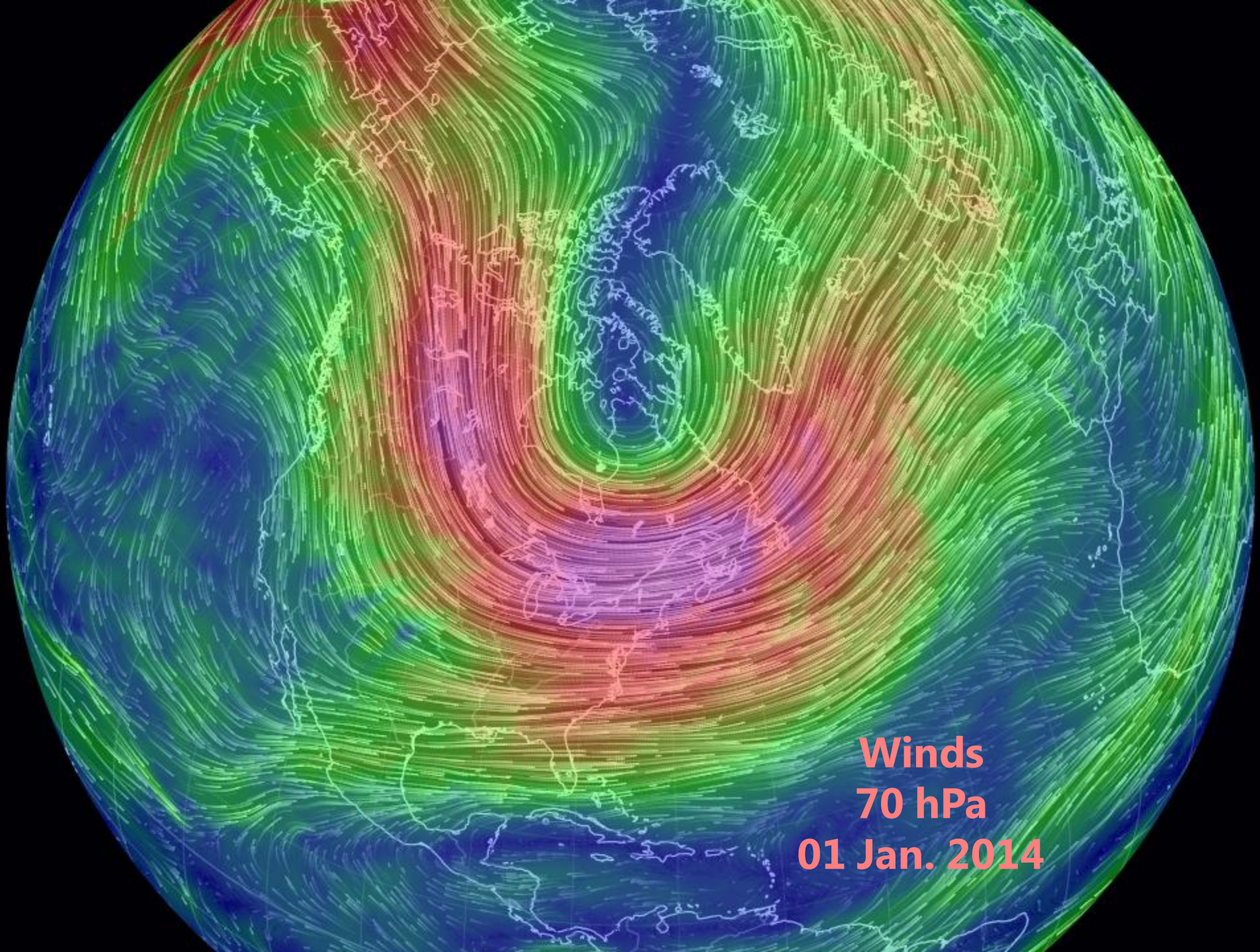
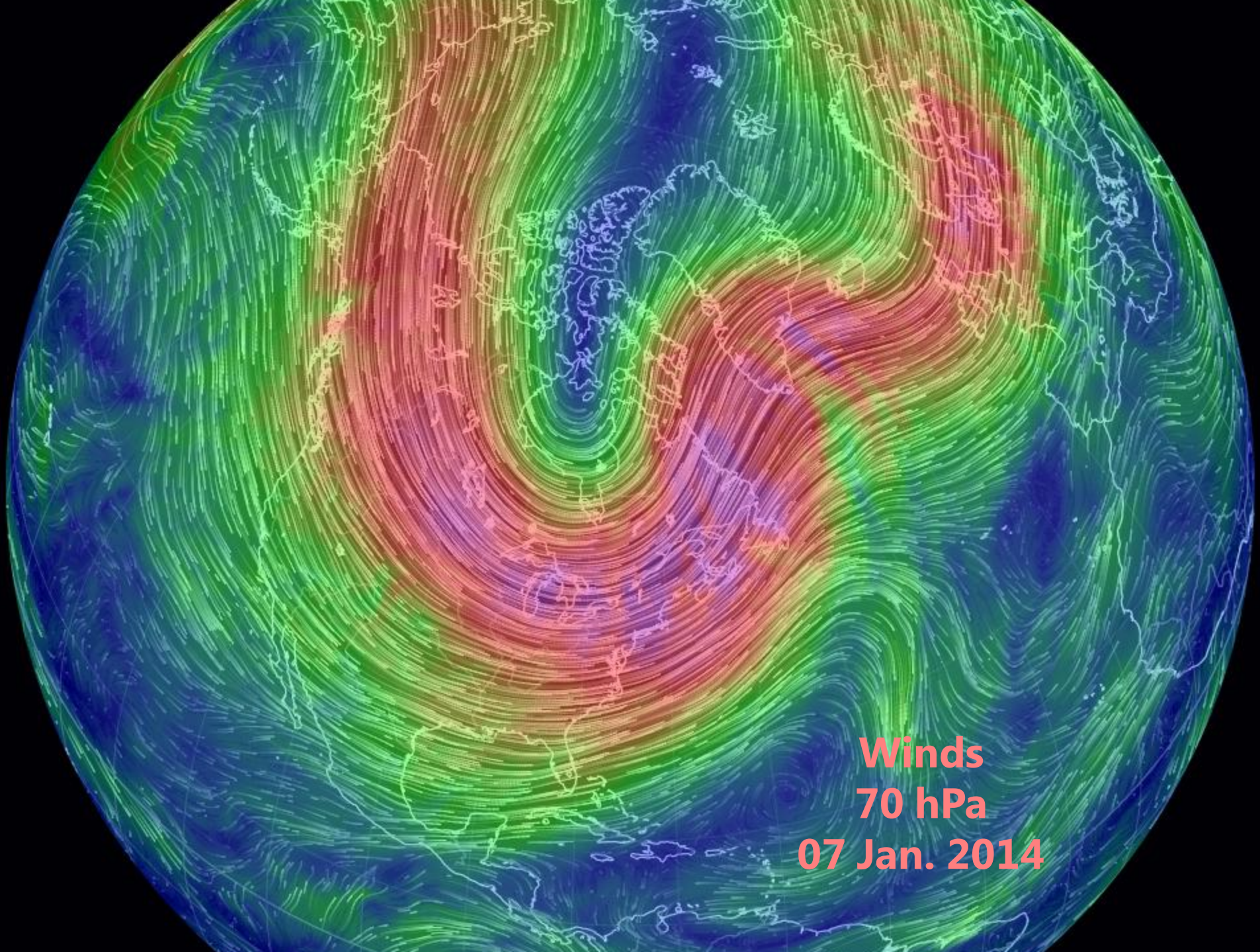
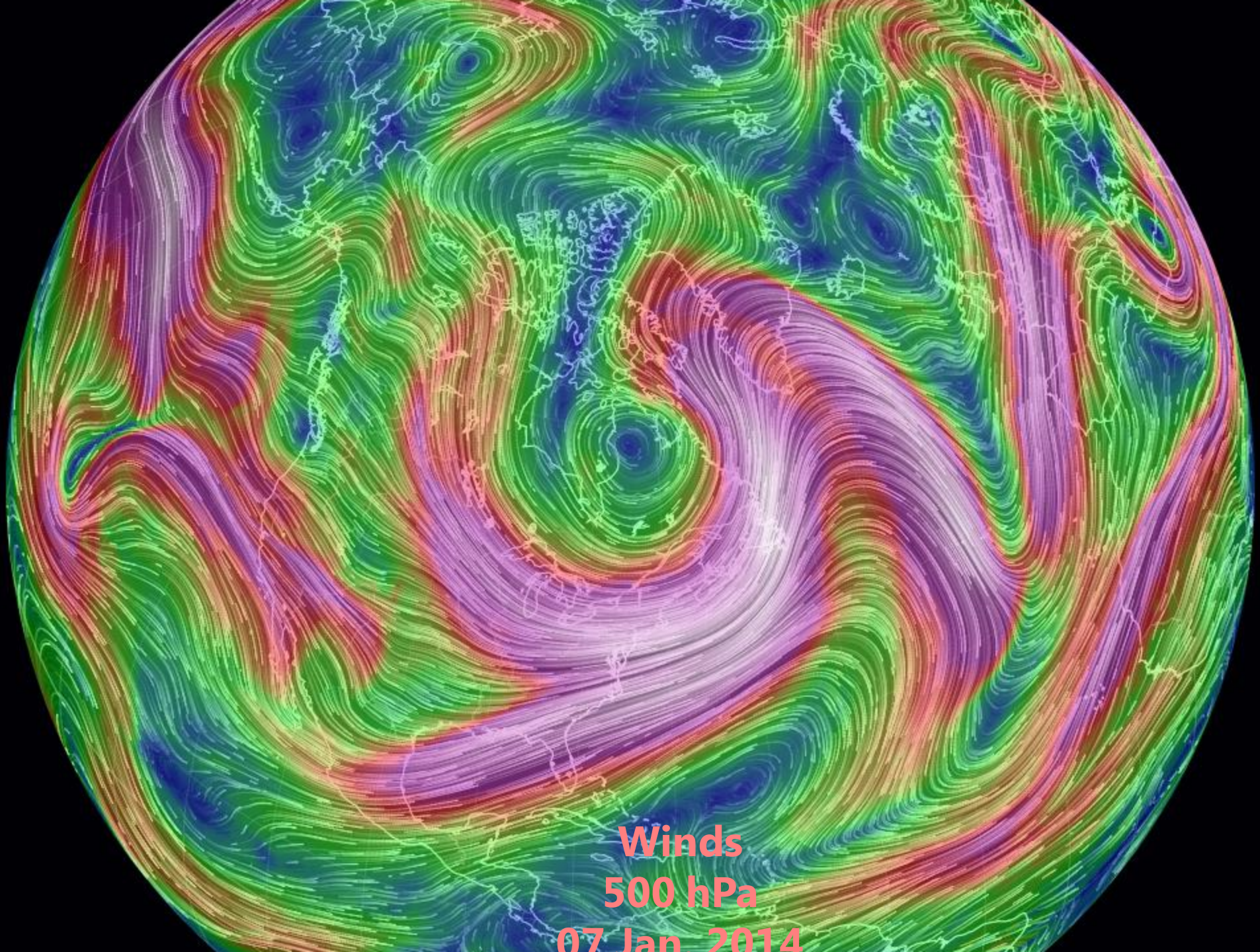



Winds
70 hPa
18 Dec. 2013
earth.nullschool.net

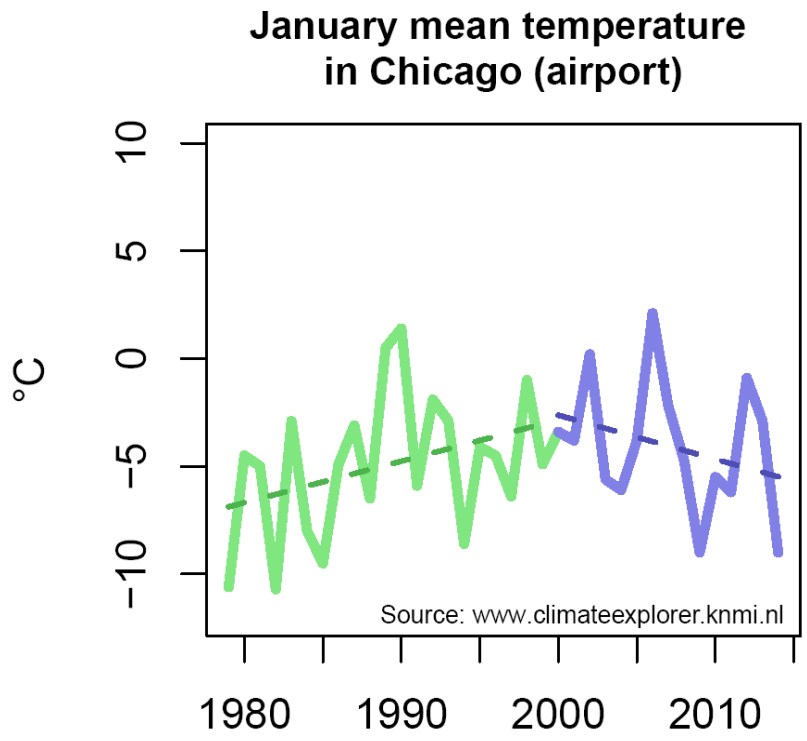

Winds
70 hPa
25 Dec. 2013

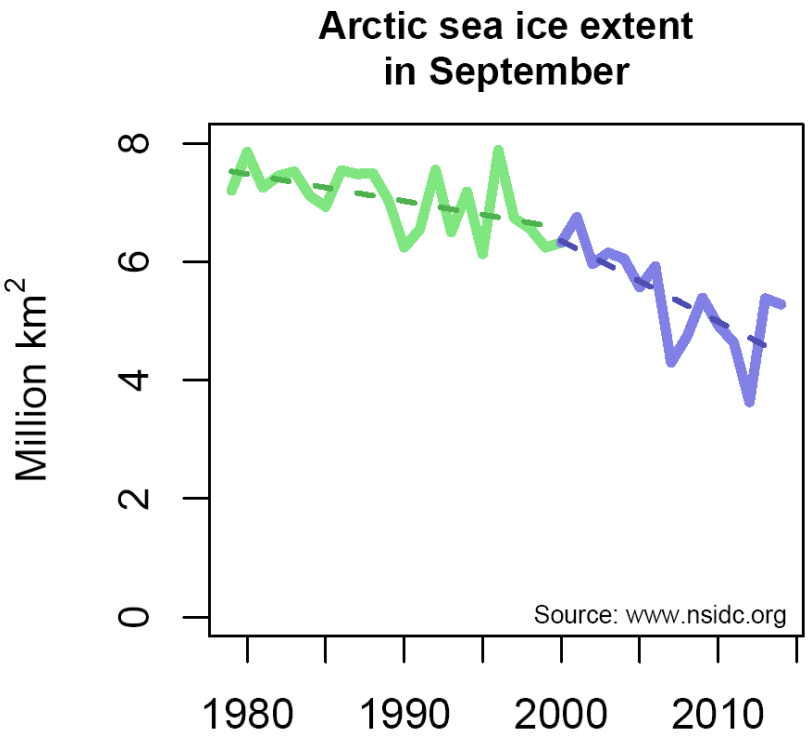

Winds
70 hPa
01 Jan. 2014


Winds
70 hPa
07 Jan. 2014

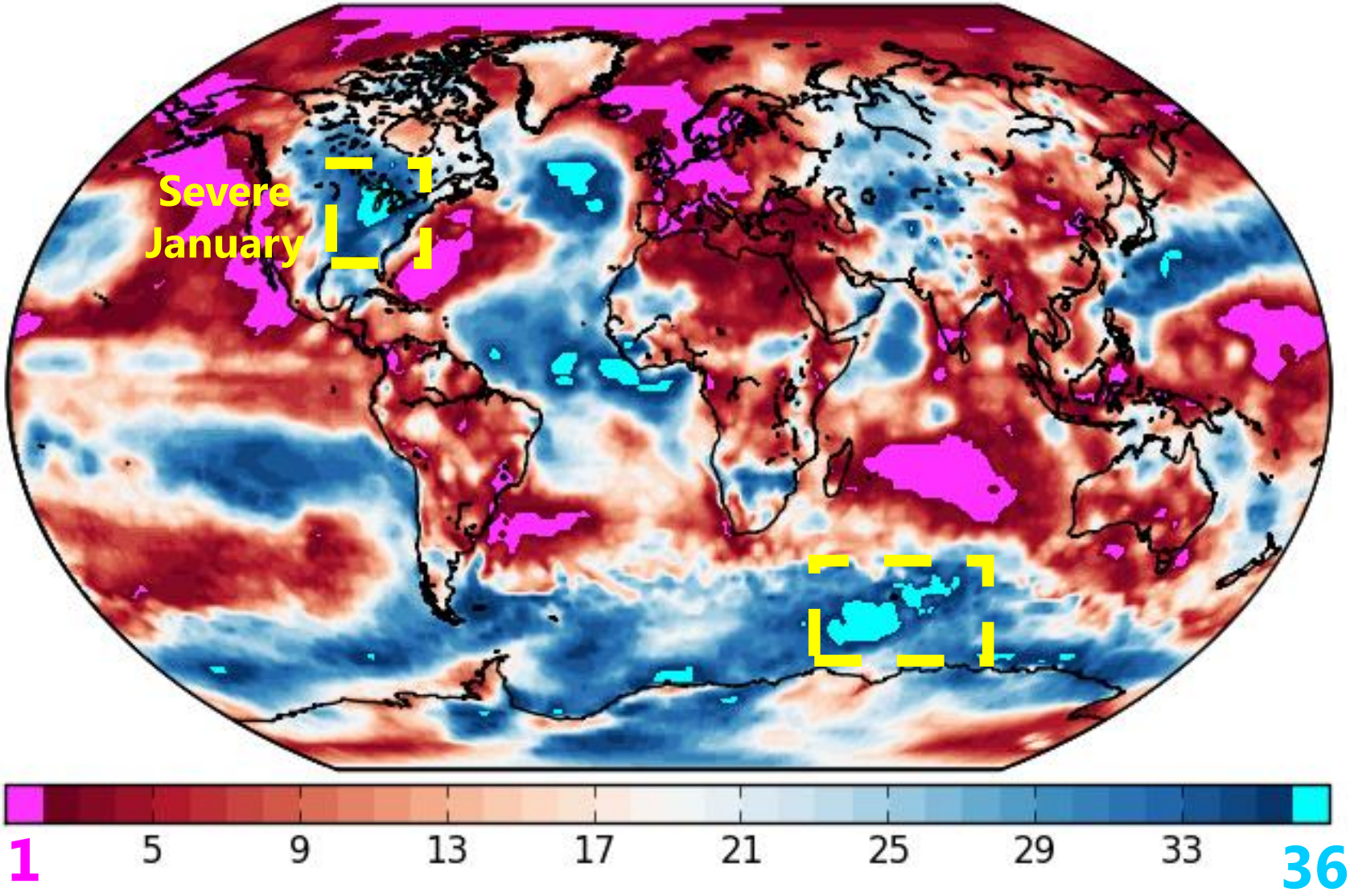

Winds
500 hPa
07 Jan 2014

Cold waves may be linked to Arctic sea ice decline, but strong evidence is not yet on the table

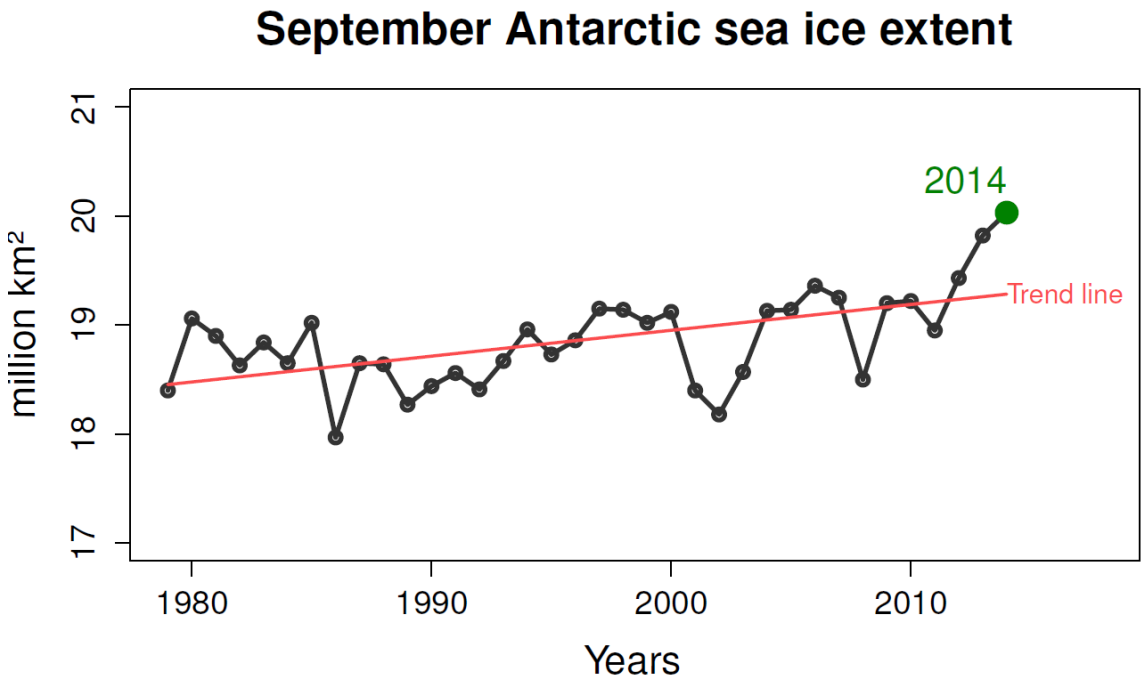




Rank of 2014 annual mean temperatures over the last 36 years

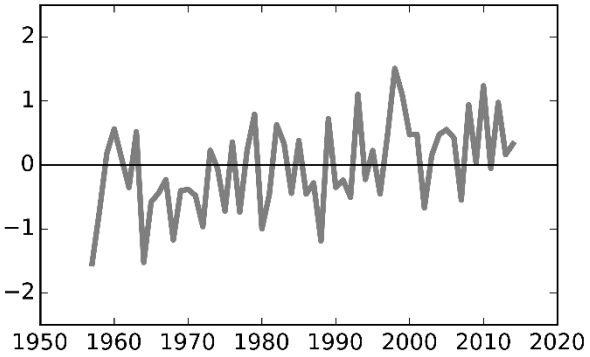


Antarctic sea ice keeps puzzling scientists in 2014



Data: NSIDC

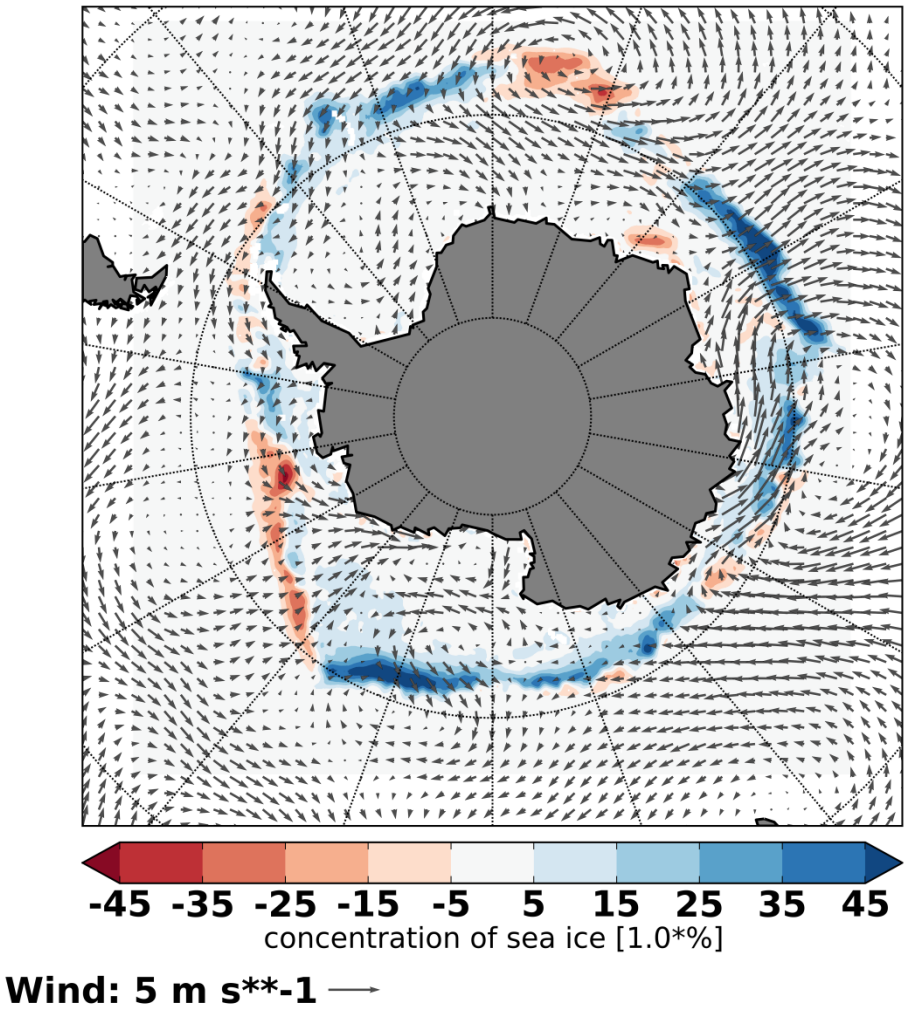
Southern Annular Mode Index



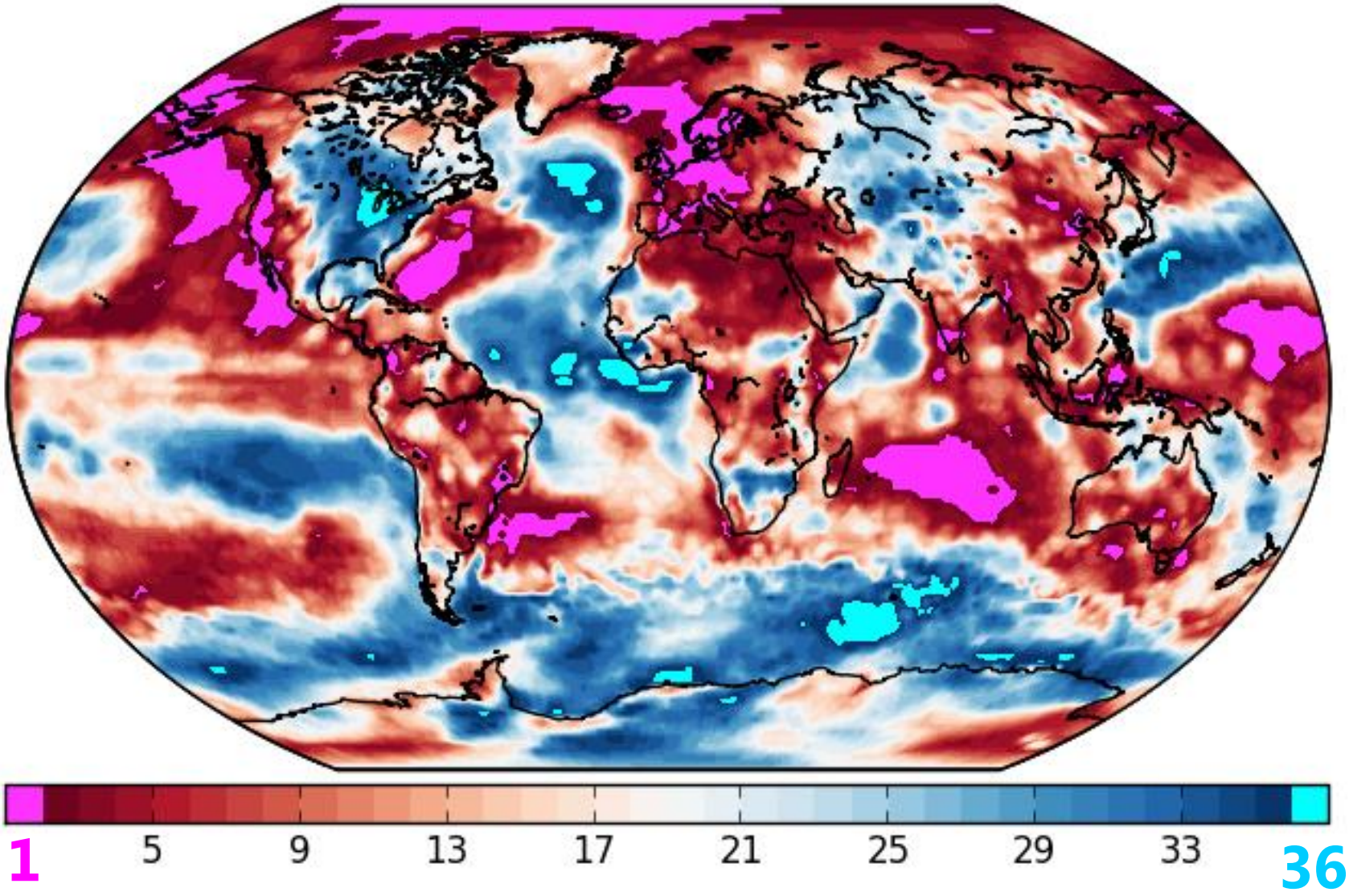
Data: http://www.nerc-bas.ac.uk/public/icd/gjma/newsam.1957.2007.txt

The 2014 all-time record is in part due to anomalous winds

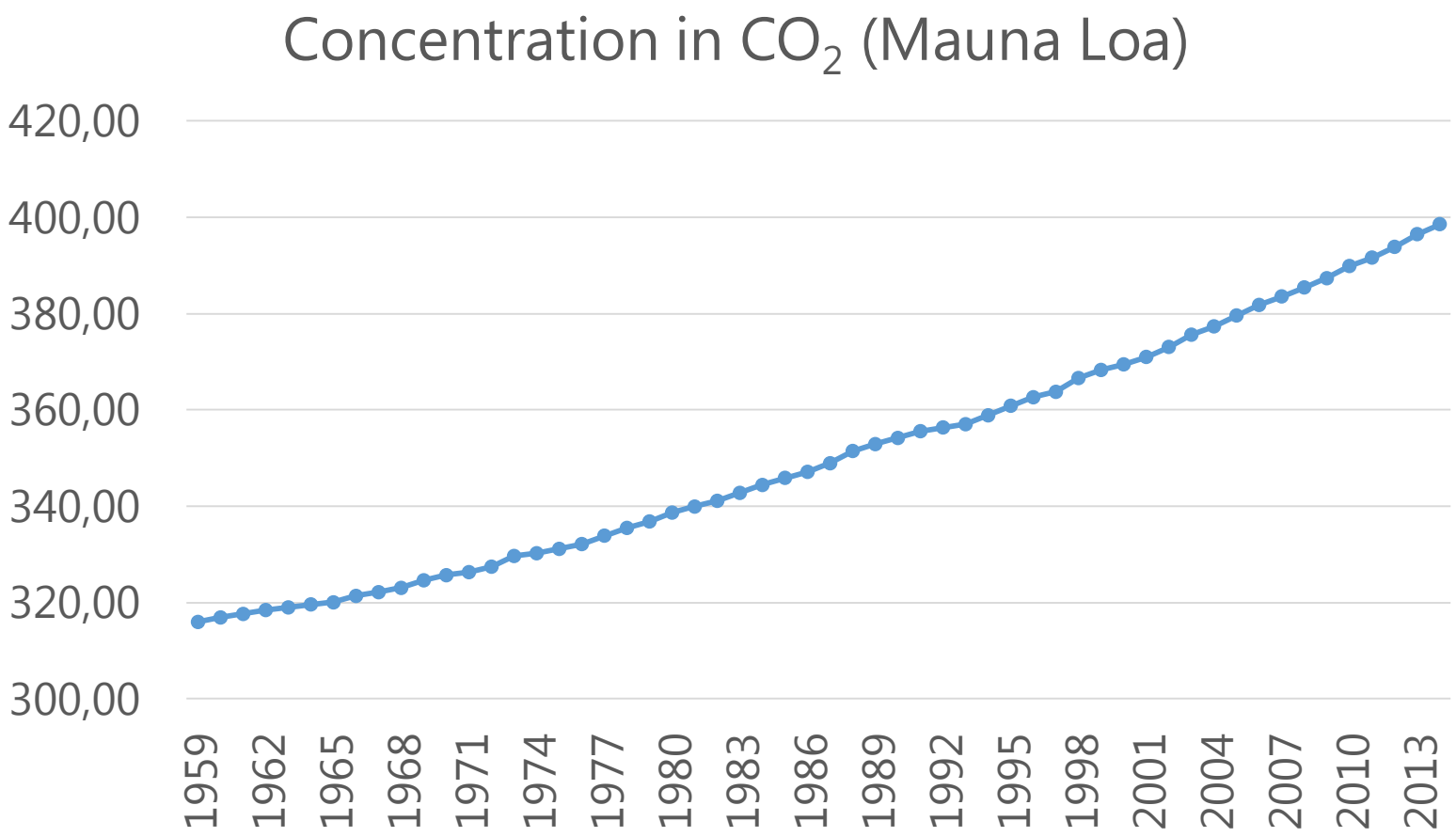
Anomalies sea ice concentration and winds



Rank of 2014 annual mean temperatures over the last 36 years

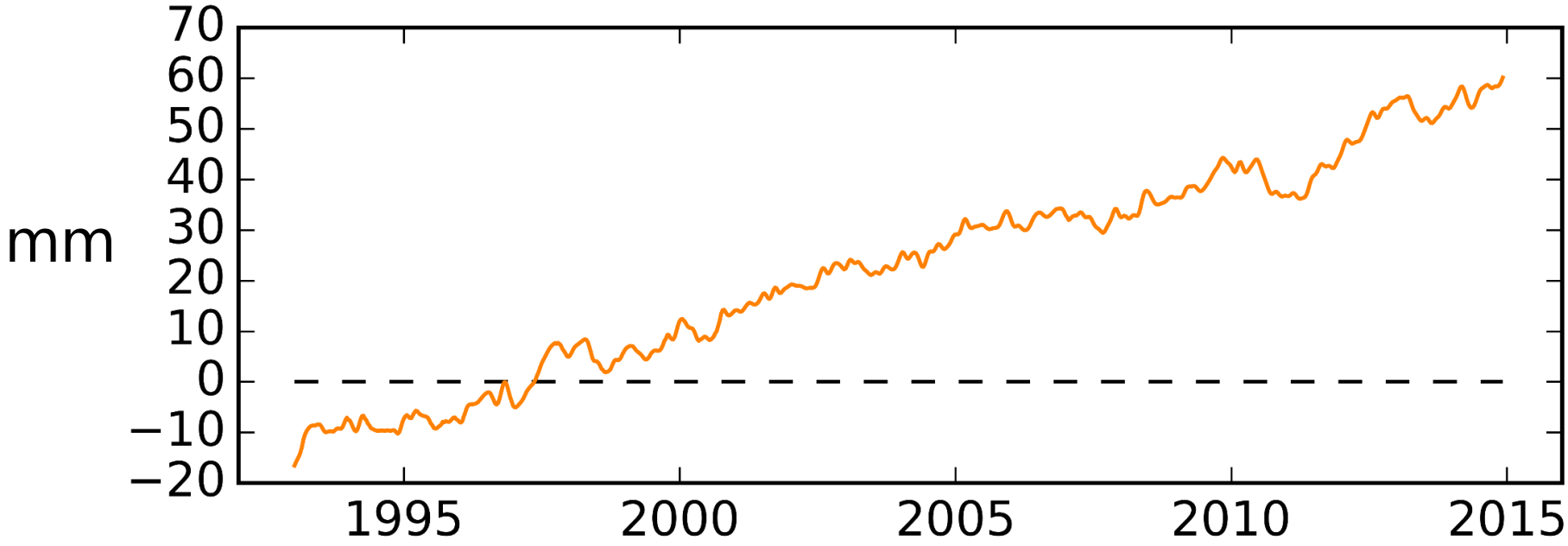


Enough extremes?
Here are three more:



Global Sea Level Rise

http://climate.nasa.gov/vital-signs/sea-level/



Total Solar Irradiance

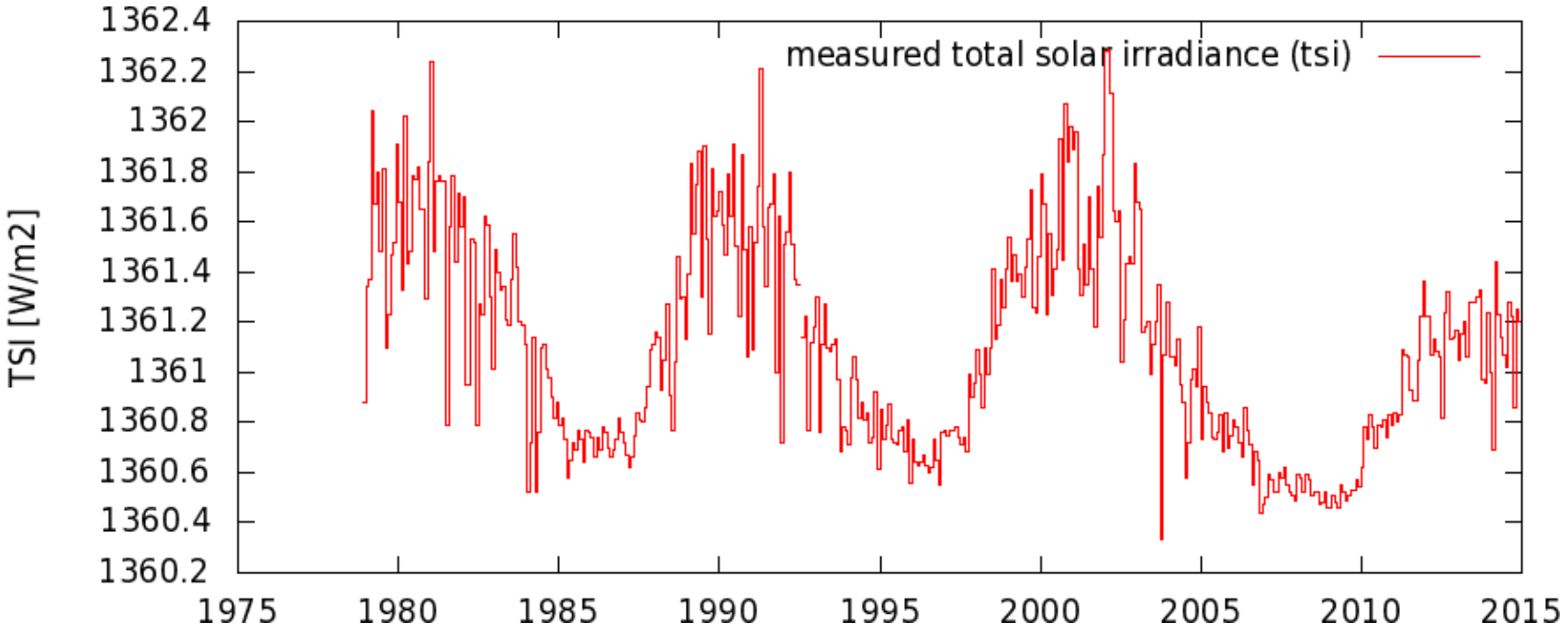


Figure: Climate Explorer, KNMI

Take home messages

- Was 2014 an extreme year?
  - Warm extremes: yes.
  - Cold extremes: very localized signals, except in Antarctica where sea ice keeps expanding.

- Why was 2014 extreme?
  - Mostly the trend contributes to produce the extreme
  - Near absence of El Niño did not push temperatures far above the trend

Outlook for 2015

- PDO switched to positive phase in 2014, and 2015 may be the beginning of a new cycle
- Montreal had the coldest month in February; « America split in two parts » may repeat
- MetOffice predicts warmer 2015 than 2014 on a global mean basis

http://www.metoffice.gov.uk/news/releases/archive/2014/2015-global-temp-forecast

Thank you!

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Sources

Interpretation, discussion:

http://www.knmi.nl/klimatologie/annual_overview_world_weather/

http://climate.nasa.gov/news/2221/

http://www.nnvl.noaa.gov/MediaDetail2.php?MediaID=1673&MediaTypeID=1

http://nsidc.org/arcticseaicenews/2015/01/december-ends/

Data, plots:

ERA-Interim Reanalyses

Climate Explorer (KNMI)