

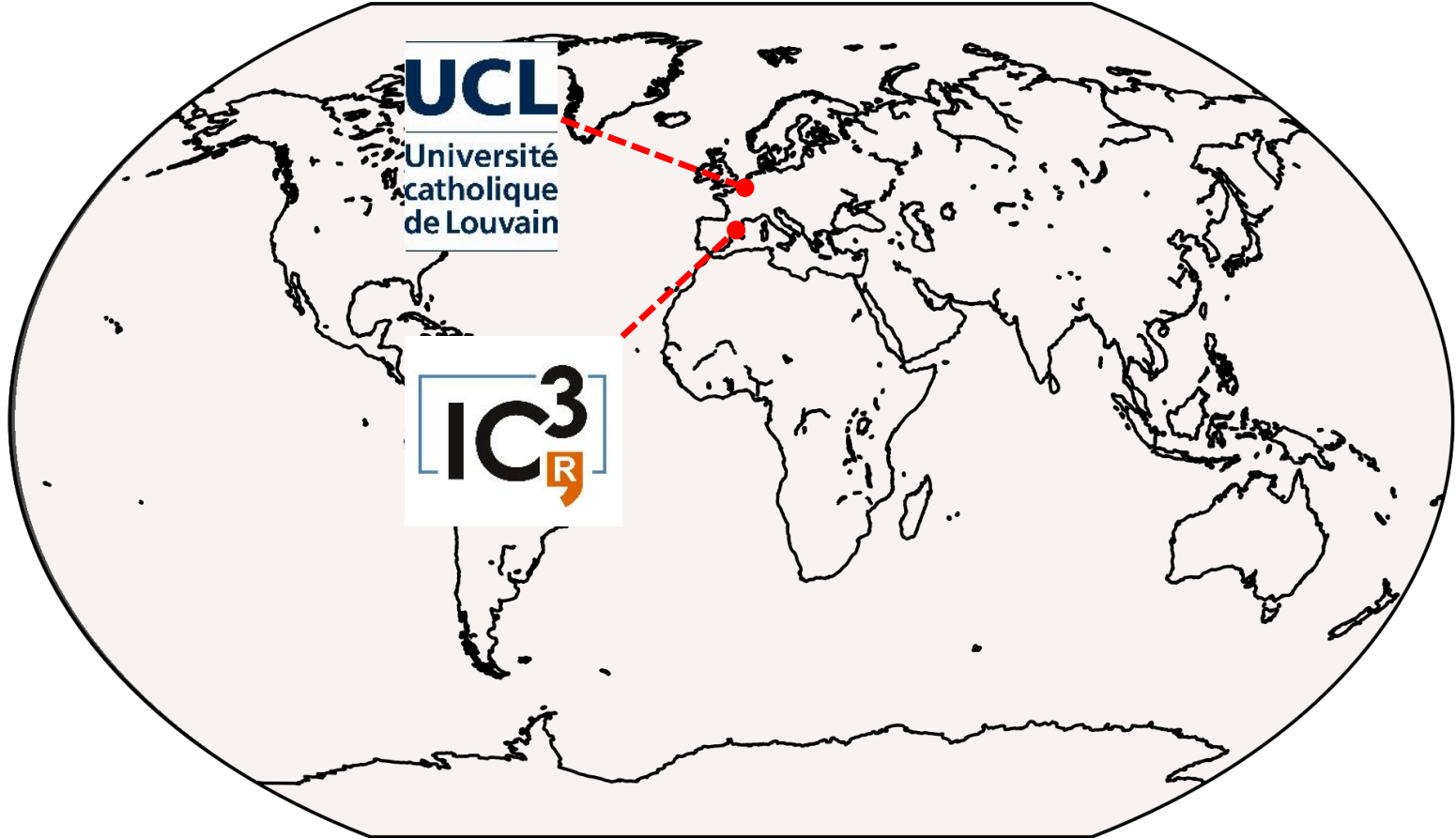
Polar Predictability Workshop
Reading, 8-10th April 2015

The 2014 all-time record of Antarctic sea ice extent

François Massonnet

V. Guemas, N. S. Fučkar, F. J. Doblas-Reyes





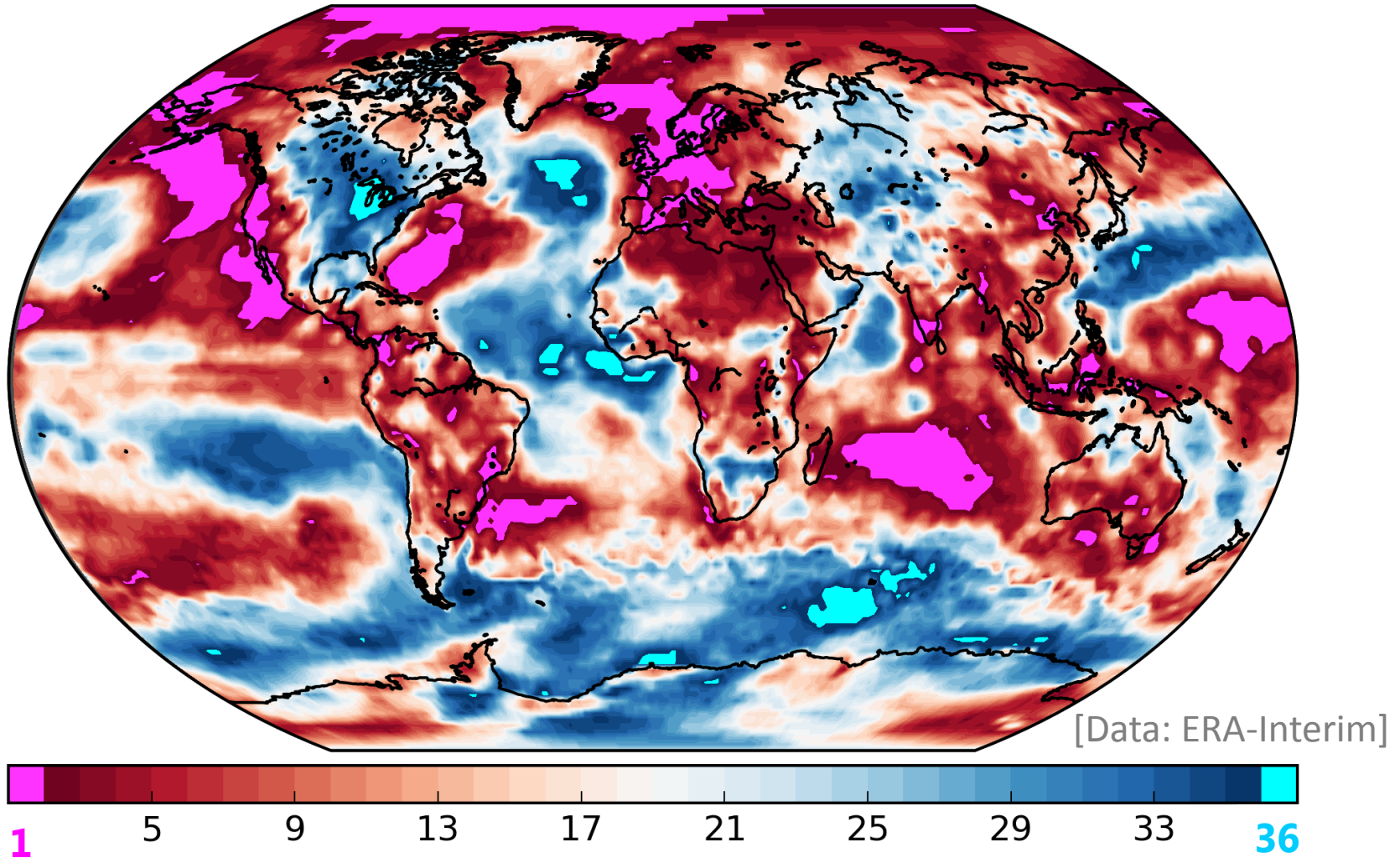
UCL

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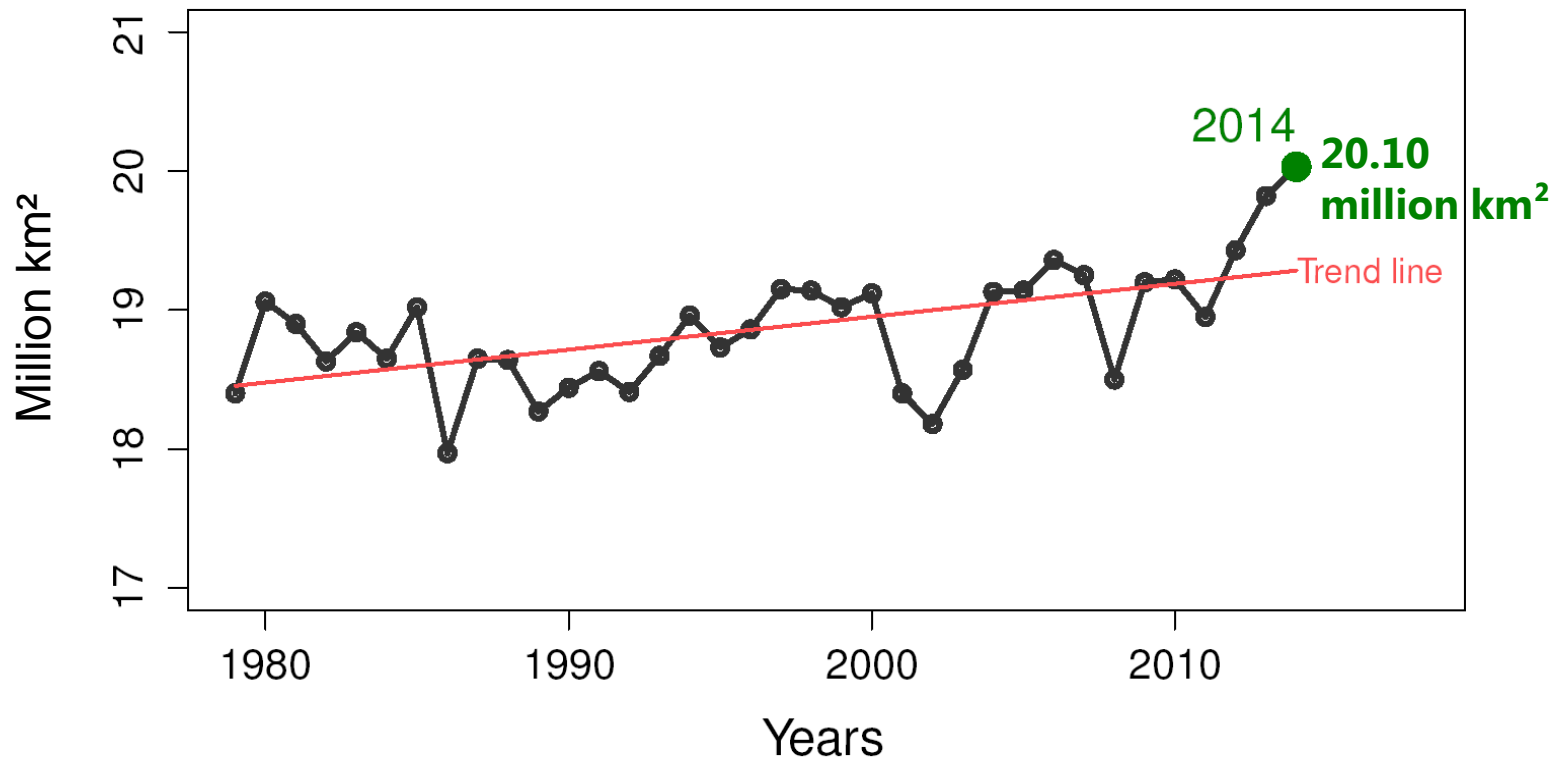
2014, a year of extremes

Rank of 2014 annual mean temperature among the last 36 years



2012, 2013, **2014**: third record in a row for Antarctic sea ice extent

September Antarctic sea ice extent



[Data: NSIDC sea ice index]

The 2014 all-time record of Antarctic sea ice extent

1. Observations/reanalyses

Winds and sea ice anomalies are **linked** to each other

2. Model experiments

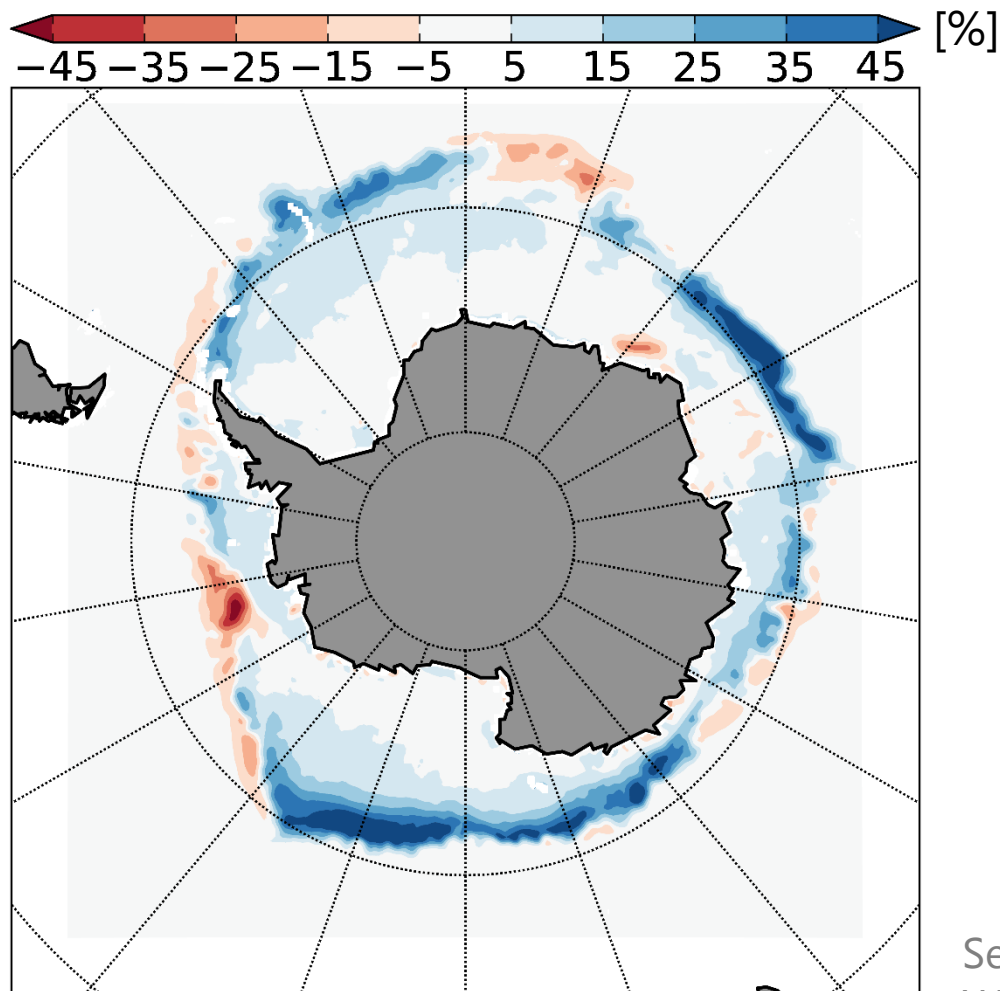
Winds and sea ice anomalies are **not linked** to each other

3. Origins of the 2014 record

Distinguishing between actual and possible mechanisms

2014 winter sea ice conditions were representative of long-term trends

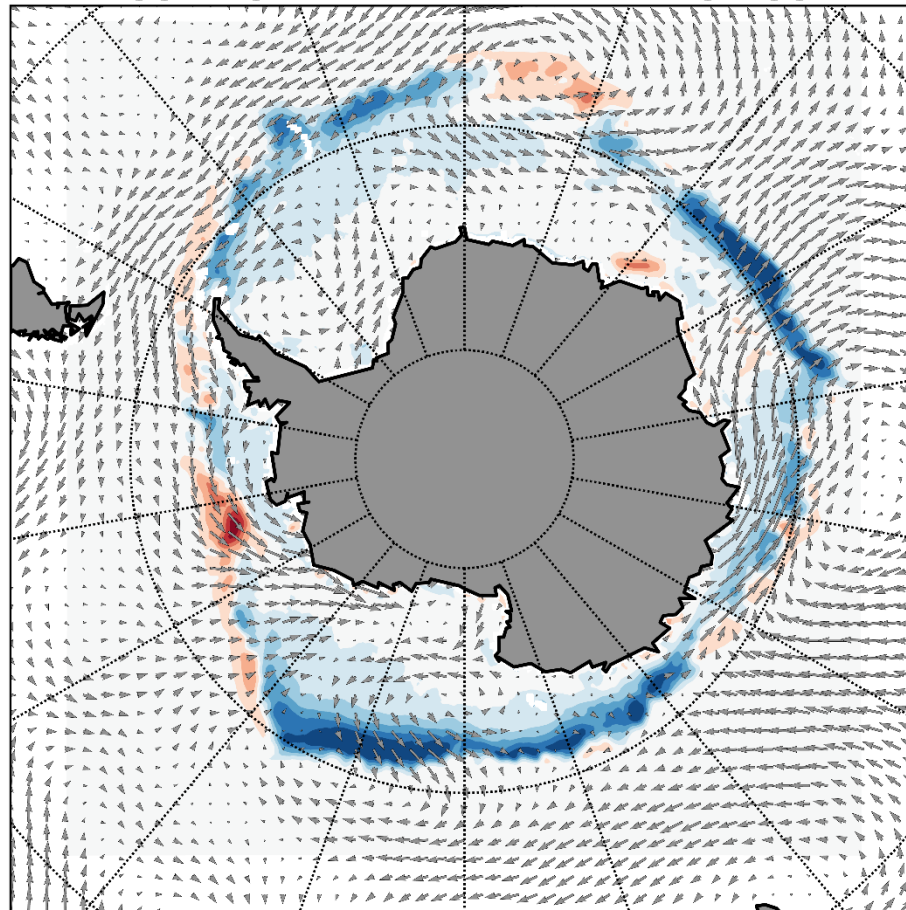
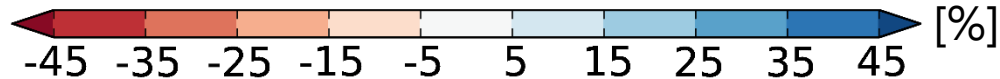
September 2014 sea ice concentration anomalies (ref. 1979-2013)



Sea ice data: OSI-SAF
Wind data: ERA-Interim

2014 winter sea ice anomalies were associated to wind anomalies

2014 sea ice concentration anomalies (ref. 1979-2013)



Jul-Aug-Sep
Wind anomalies
→ 4 m/s

Sea ice data: OSI-SAF
Wind data: ERA-Interim

The 2014 all-time record of Antarctic sea ice extent

1. Observations/reanalyses

Winds and sea ice anomalies are **linked** to each other

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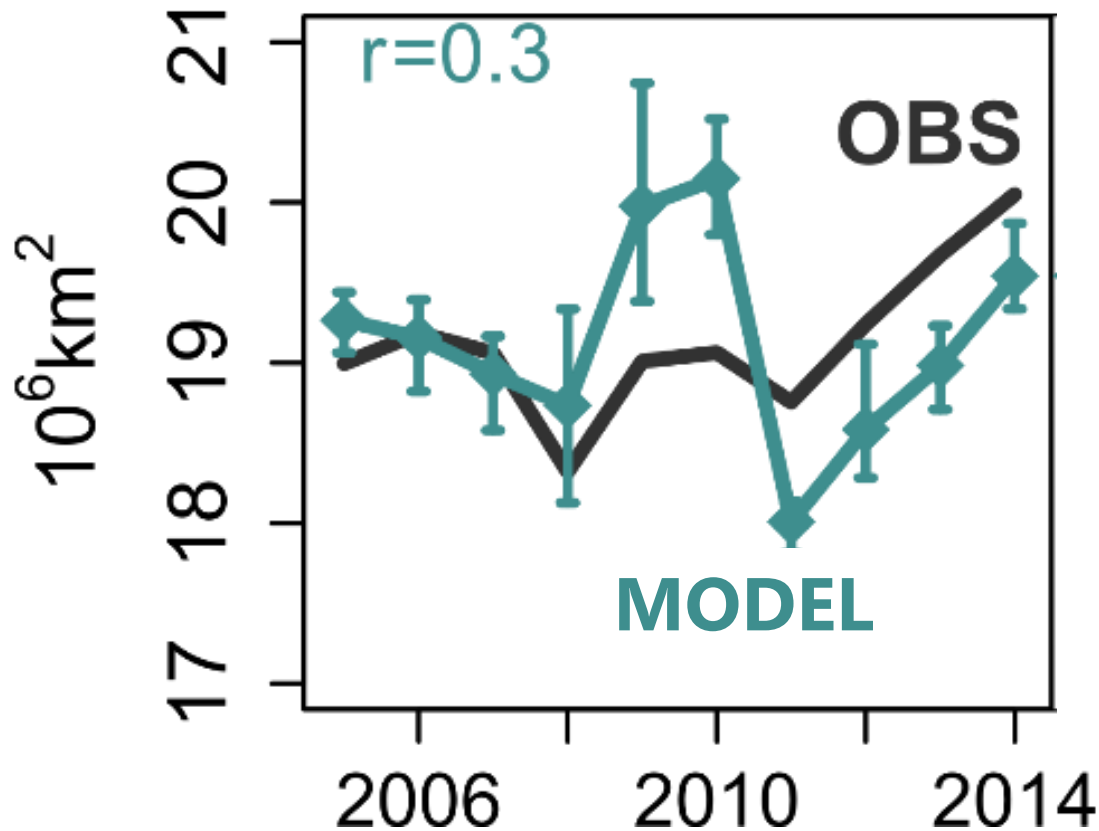
Winds and sea ice anomalies are **not linked** to each other

3. Origins of the 2014 record

Distinguishing between actual and possible mechanisms

2005-2014 simulations of Antarctic sea ice, **controlled atmosphere**

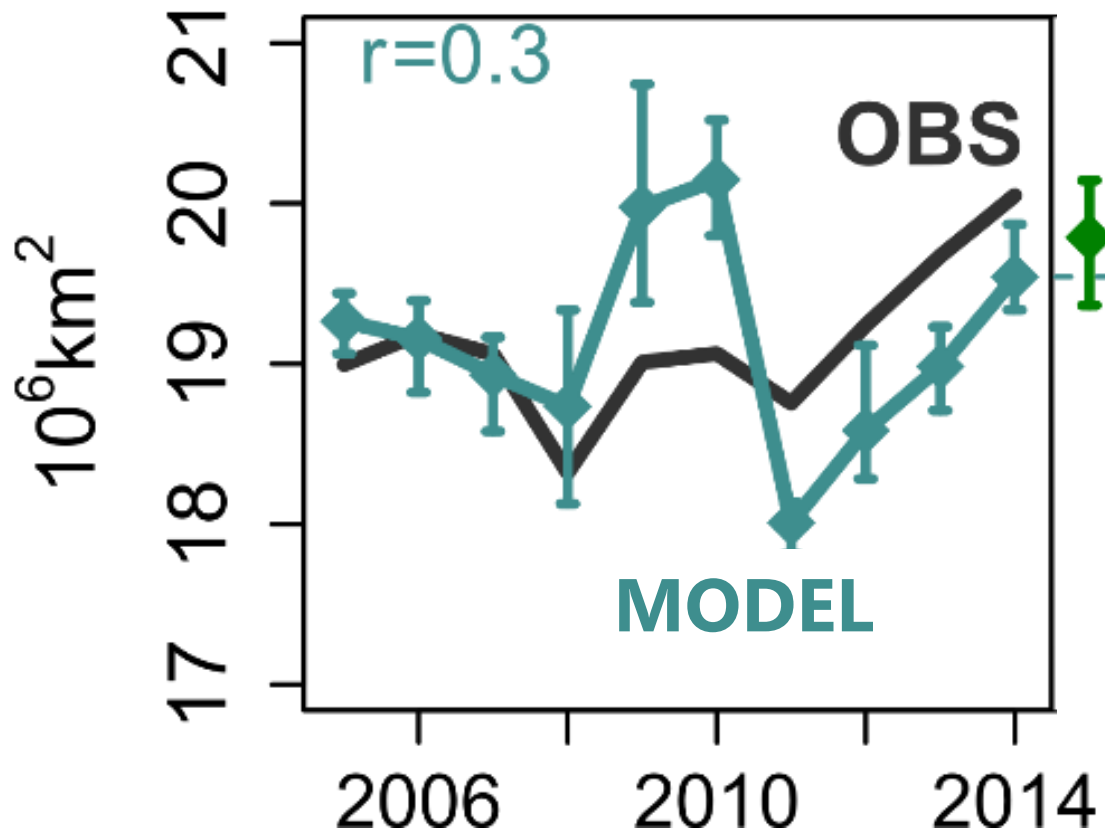
September Antarctic sea ice extent



Ocean-sea ice model: NEMO-LIM3
Atmospheric forcing: ERA-Interim
Obs: OSI-SAF

2014 winds did not have a major *dynamical* impact on sea ice

September Antarctic
sea ice extent

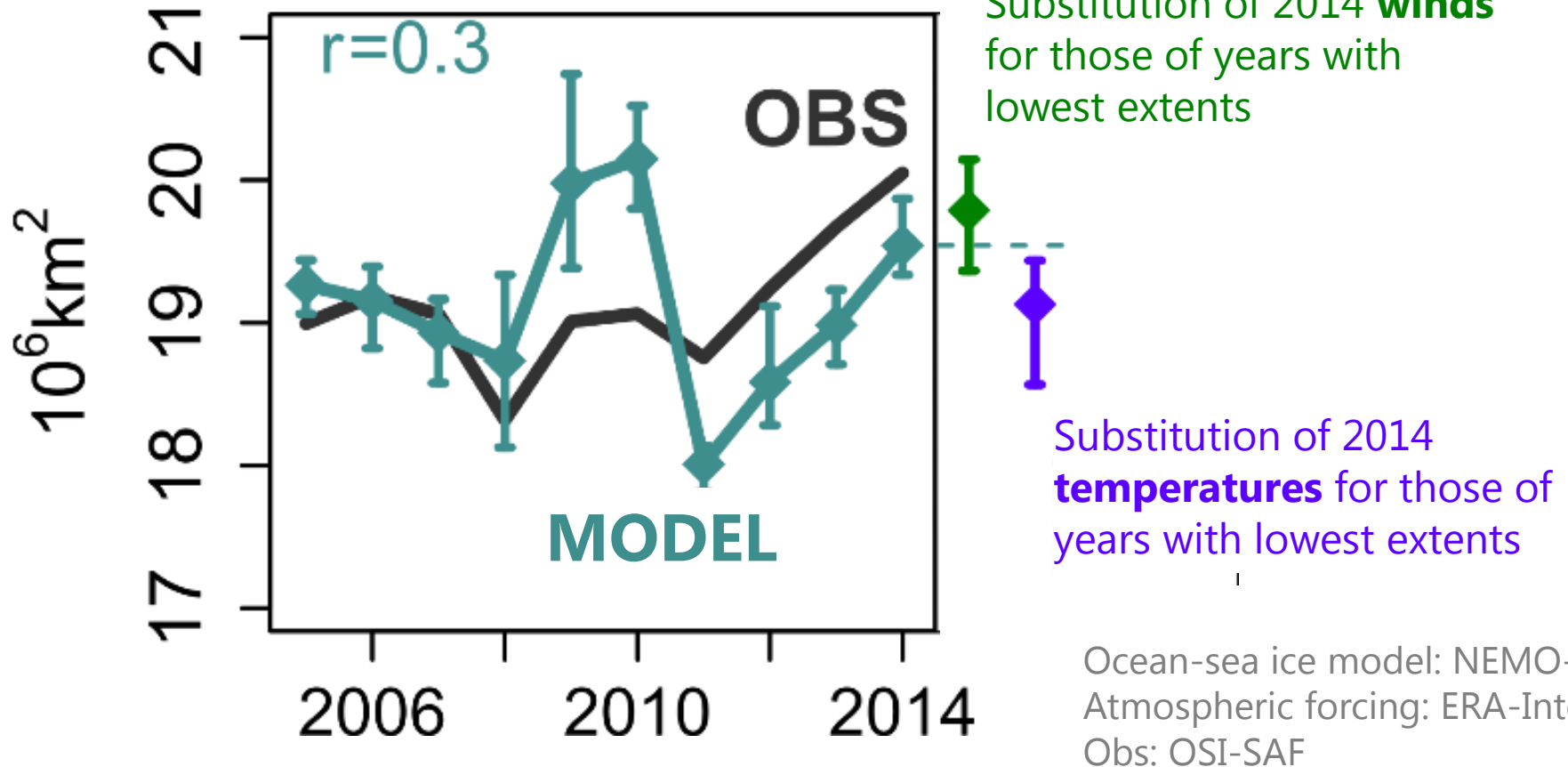


Substitution of 2014 **winds**
for those of years with
lowest extents

Ocean-sea ice model: NEMO-LIM3
Atmospheric forcing: ERA-Interim
Obs: OSI-SAF

2014 surface temperatures had a significant impact on sea ice

September Antarctic sea ice extent



The 2014 all-time record of Antarctic sea ice extent

1. Observations/reanalyses

Winds and sea ice anomalies are **linked** to each other

2. Model experiments

Winds and sea ice anomalies are **not linked** to each other

3. Origins of the 2014 record

Distinguishing between actual and possible mechanisms

Winds and sea ice
anomalies are linked

(OBS)

Winds and sea ice
anomalies are linked
(OBS)

but

winds do not have a
dynamical impact on sea ice
(MODEL)

Winds and sea ice
anomalies are linked
(OBS)

but

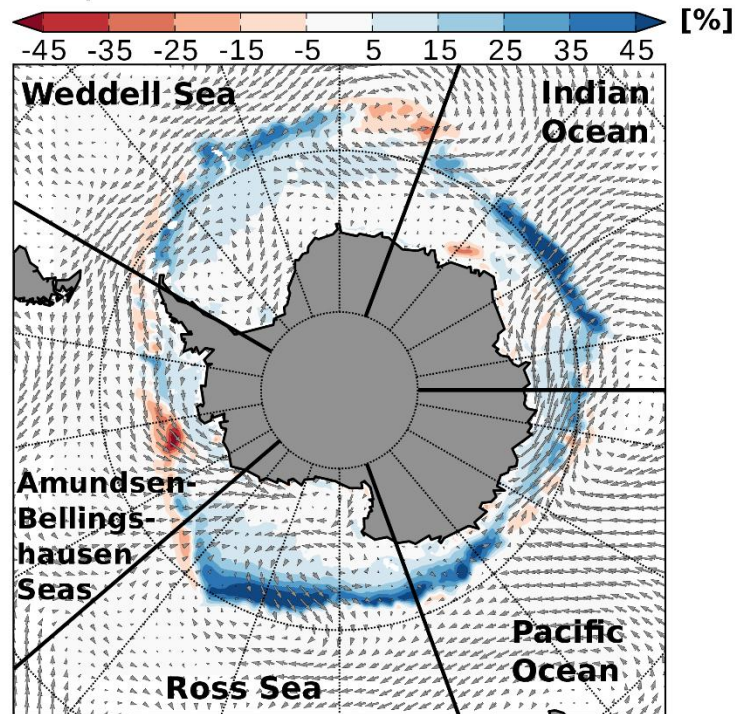
winds do not have a
dynamical impact on sea ice
(MODEL)

while

surface temperatures have a
significant impact on sea ice
(MOD)

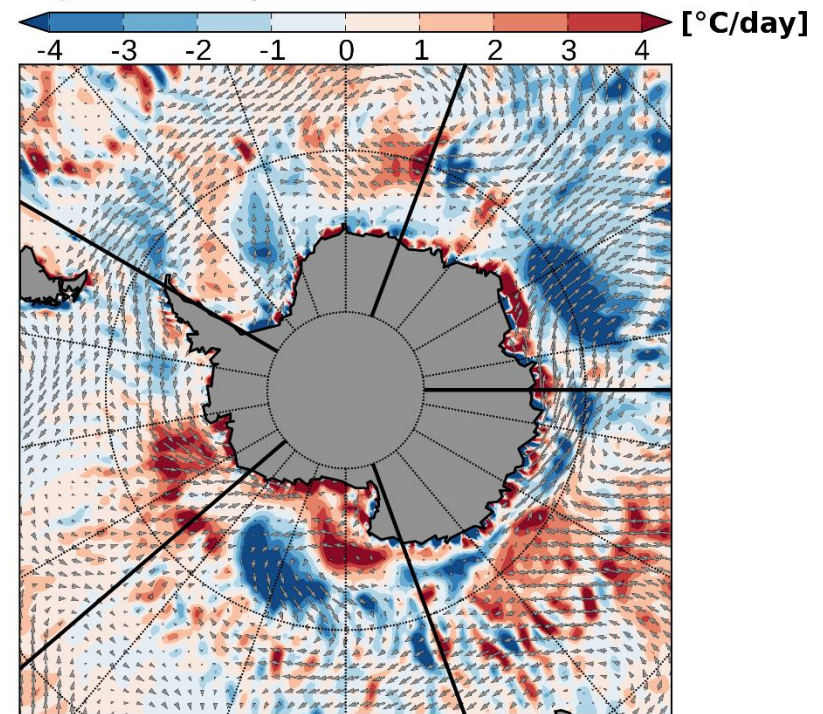
The sea ice record was chiefly due to anomalous advection enhancing ice production offshore

Sea ice conc. & wind anomalies



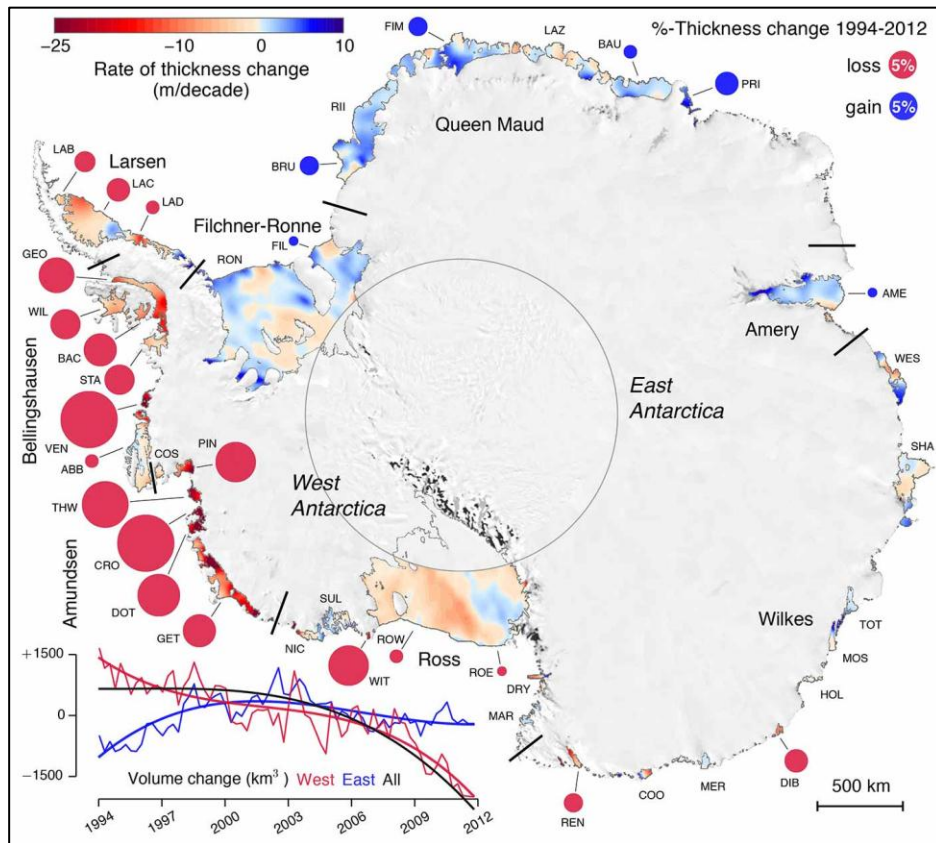
4 m/s — (JAS 2014 wind anomaly)

$-\vec{u} \cdot \nabla T$ anomalies



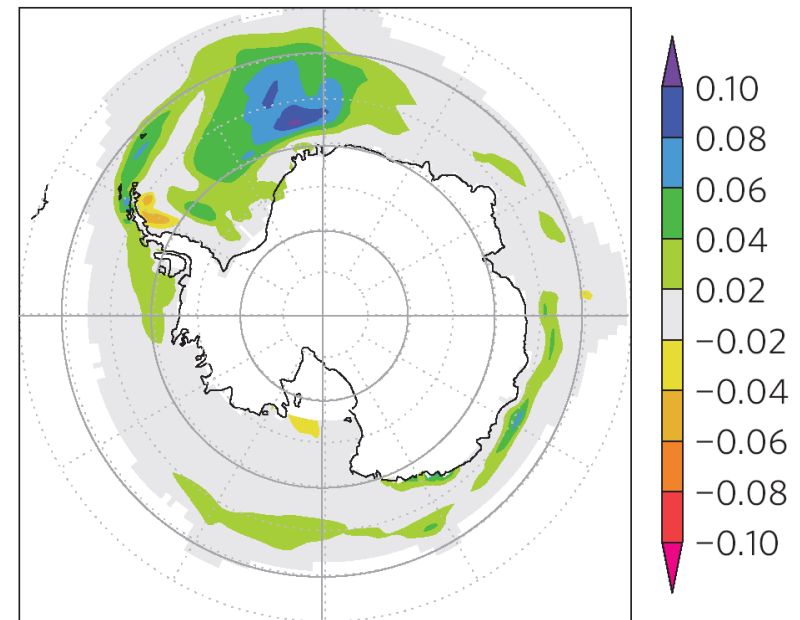
4 m/s — (JAS 2014 wind anomaly)

Accelerating ice shelf melt promotes sea ice expansion: a *possible* mechanism



[Paolo et al., Science, 2015]

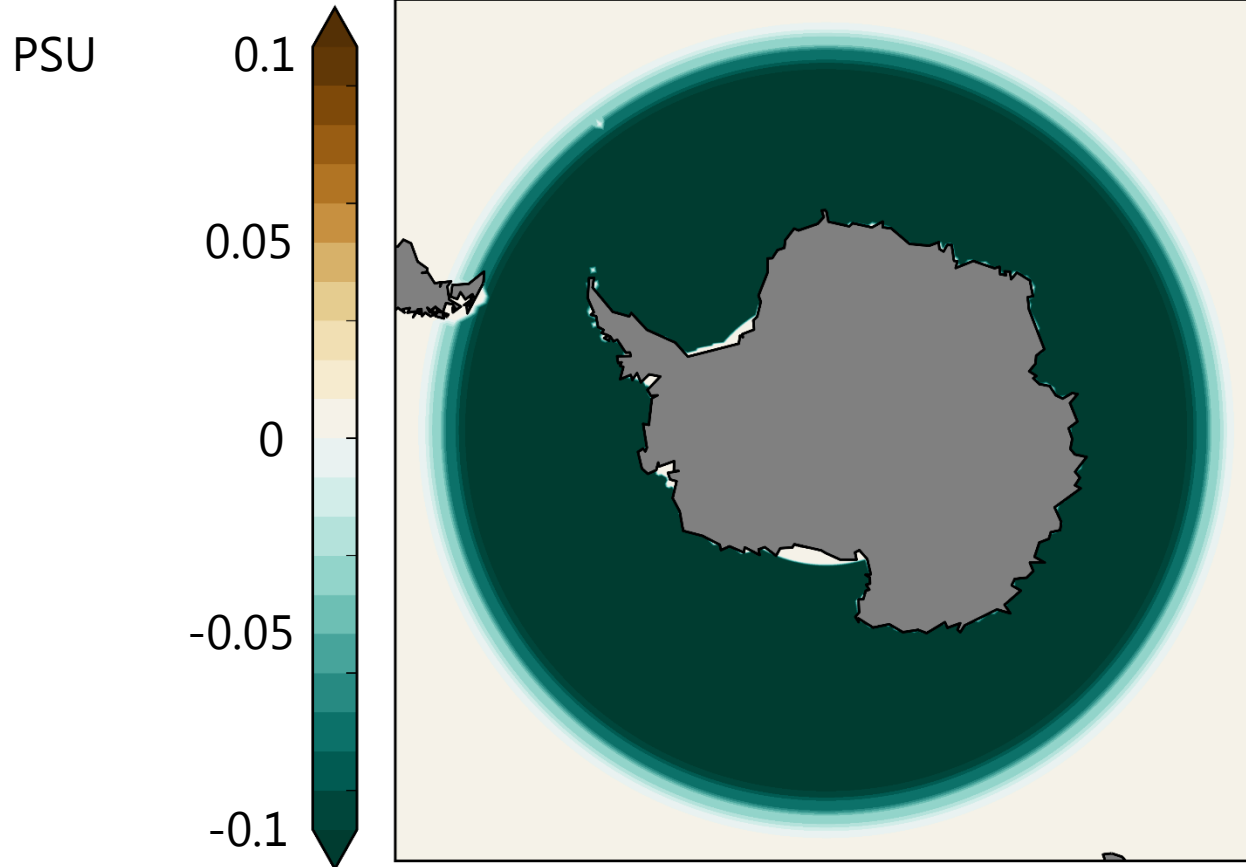
Fall/Winter sea ice concentration changes after a +250 Gt/yr freshwater input



[Bintanja et al., Nat. Geosci., 2013]

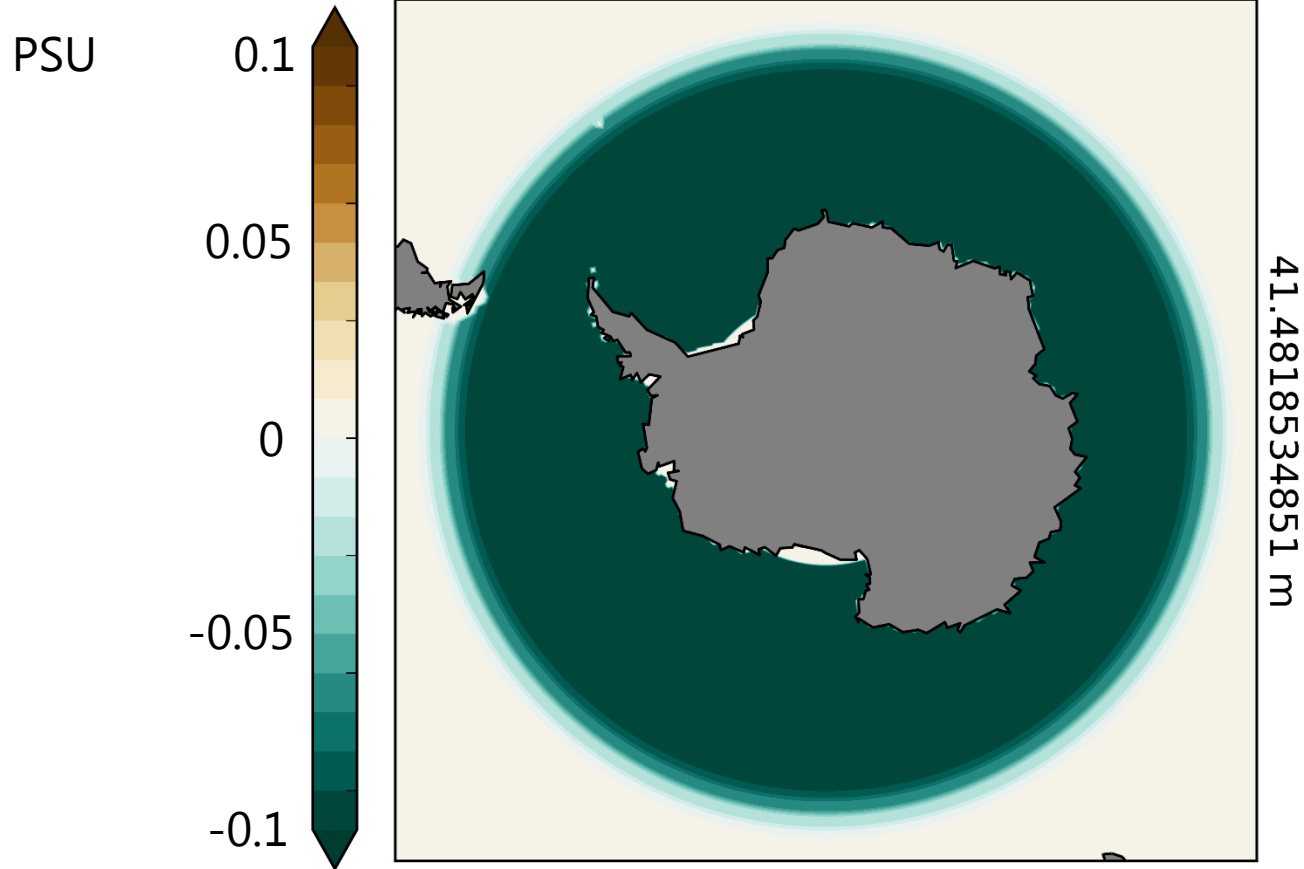
Prescribed salinity anomaly in March 2014

0-37 m



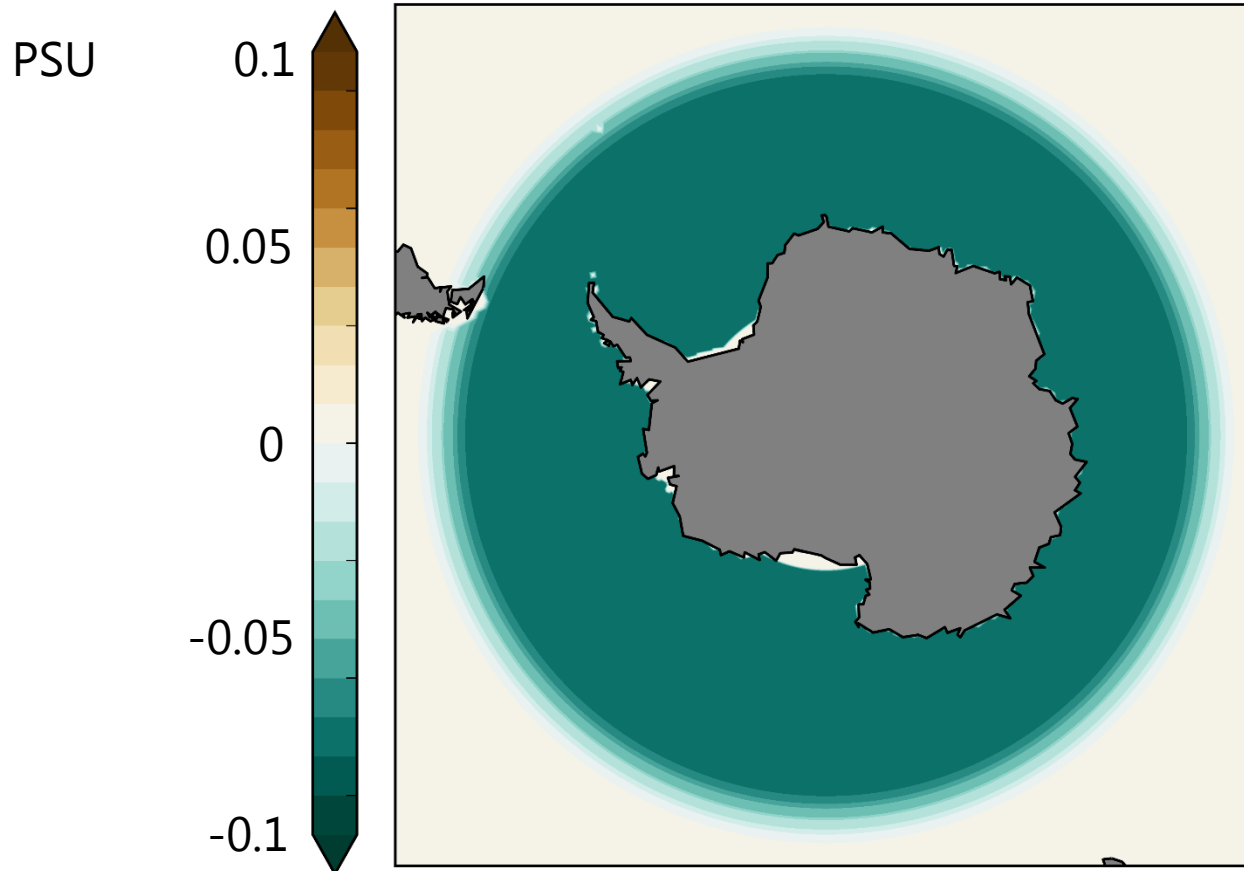
Prescribed salinity anomaly in March 2014

37-47 m



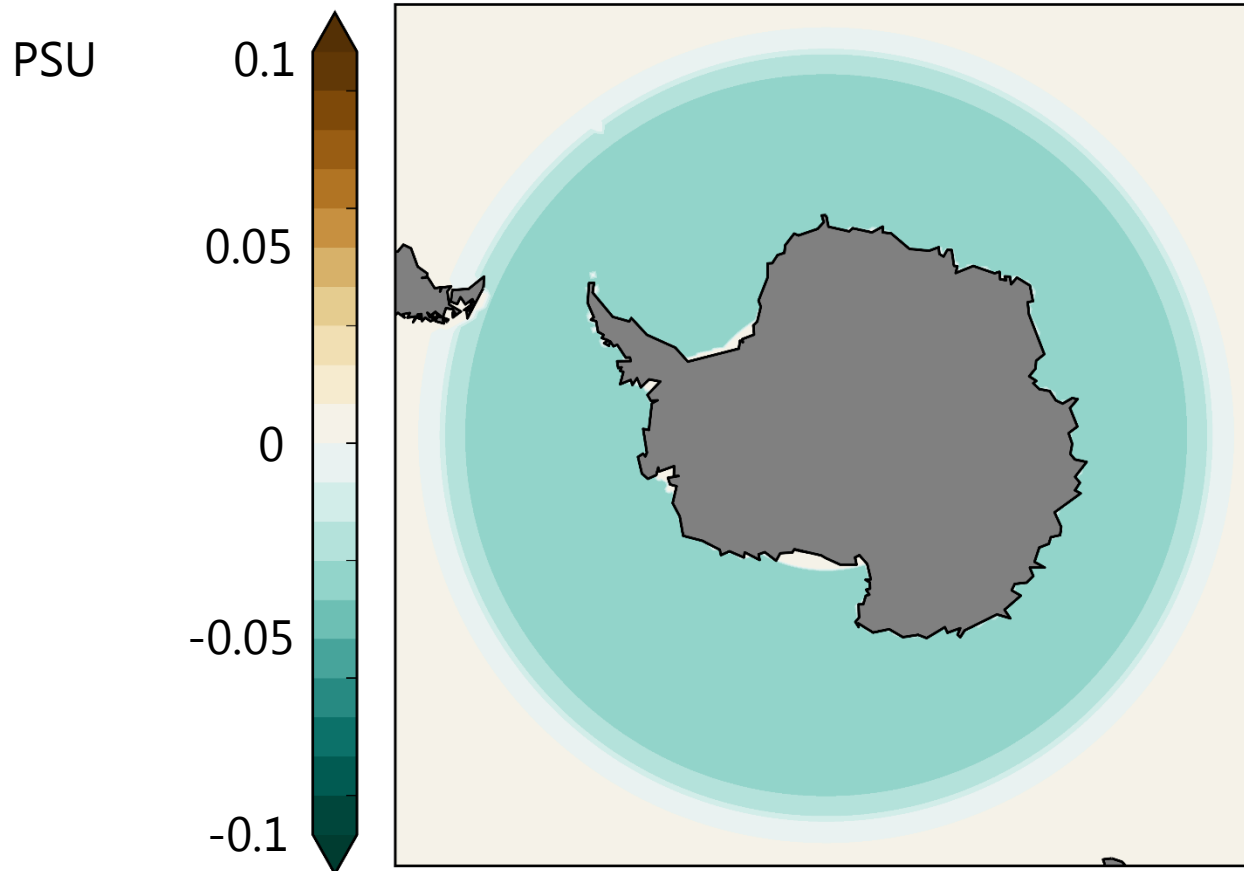
Prescribed salinity anomaly in March 2014

47-58 m



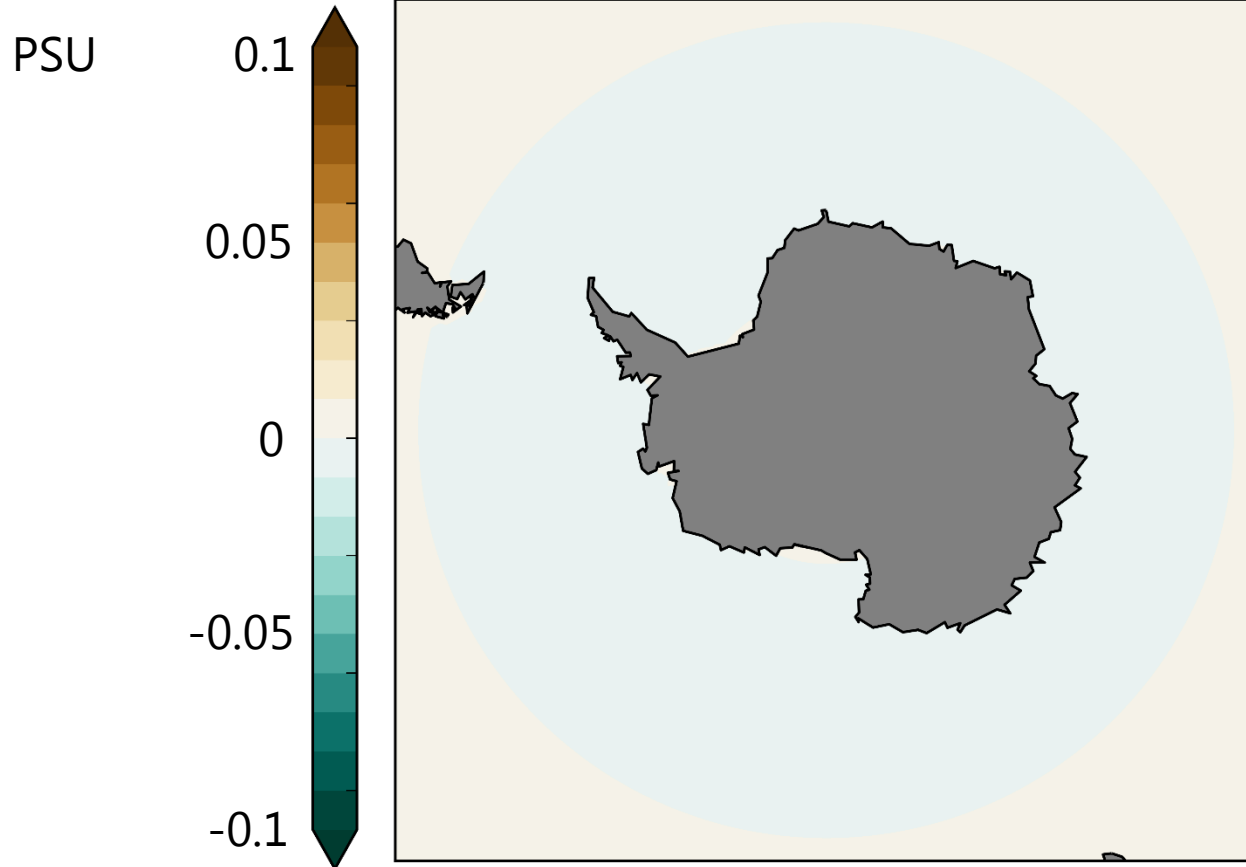
Prescribed salinity anomaly in March 2014

58-71 m



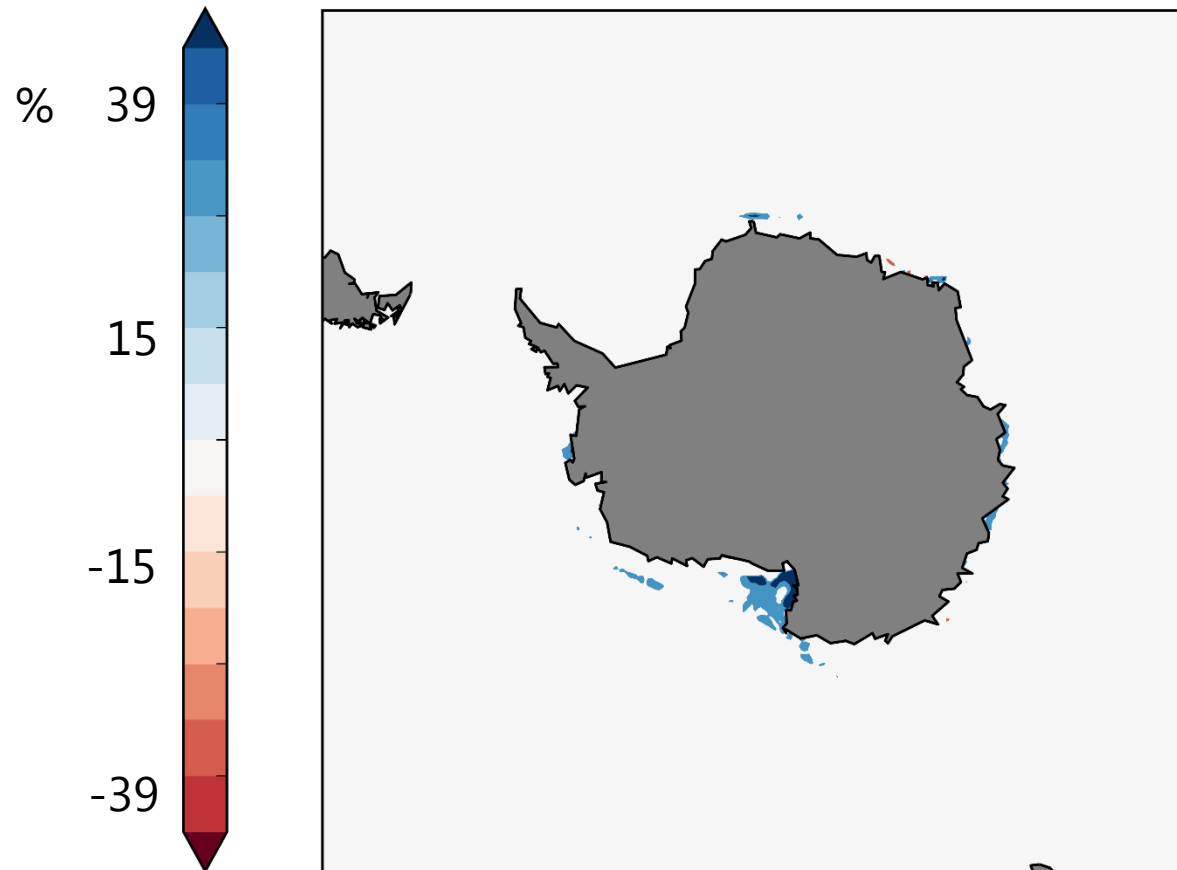
Prescribed salinity anomaly in March 2014

71-86 m



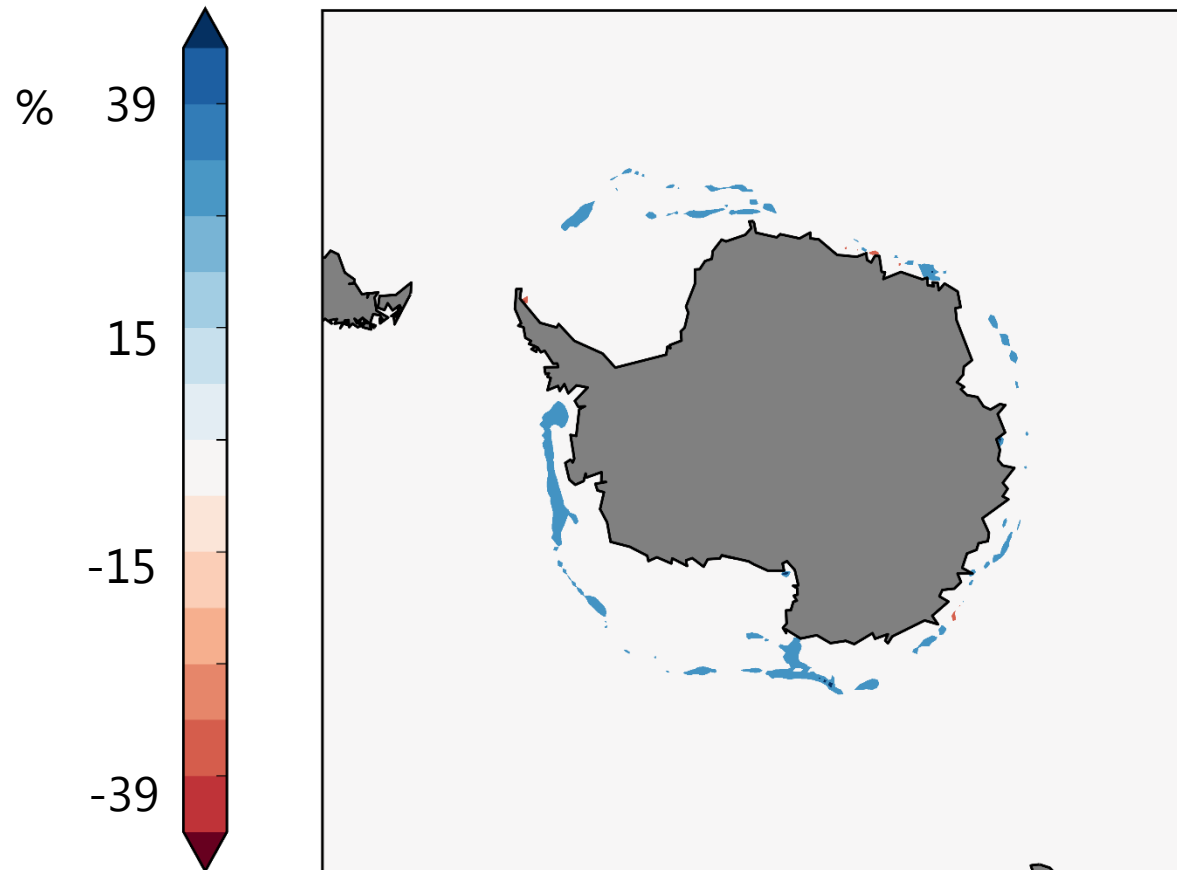
Sea ice concentration response
after -0.1 PSU in March

March 2014



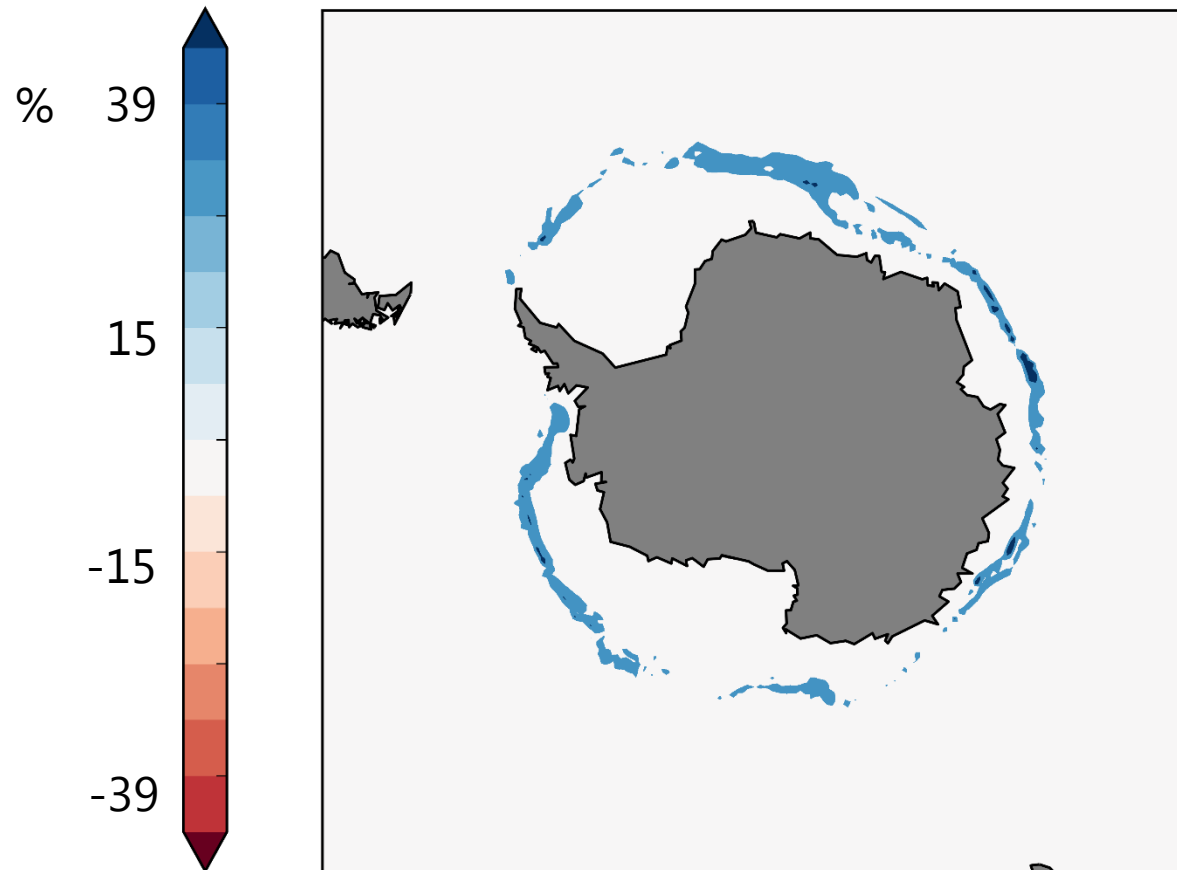
Sea ice concentration response
after -0.1 PSU in March

April 2014



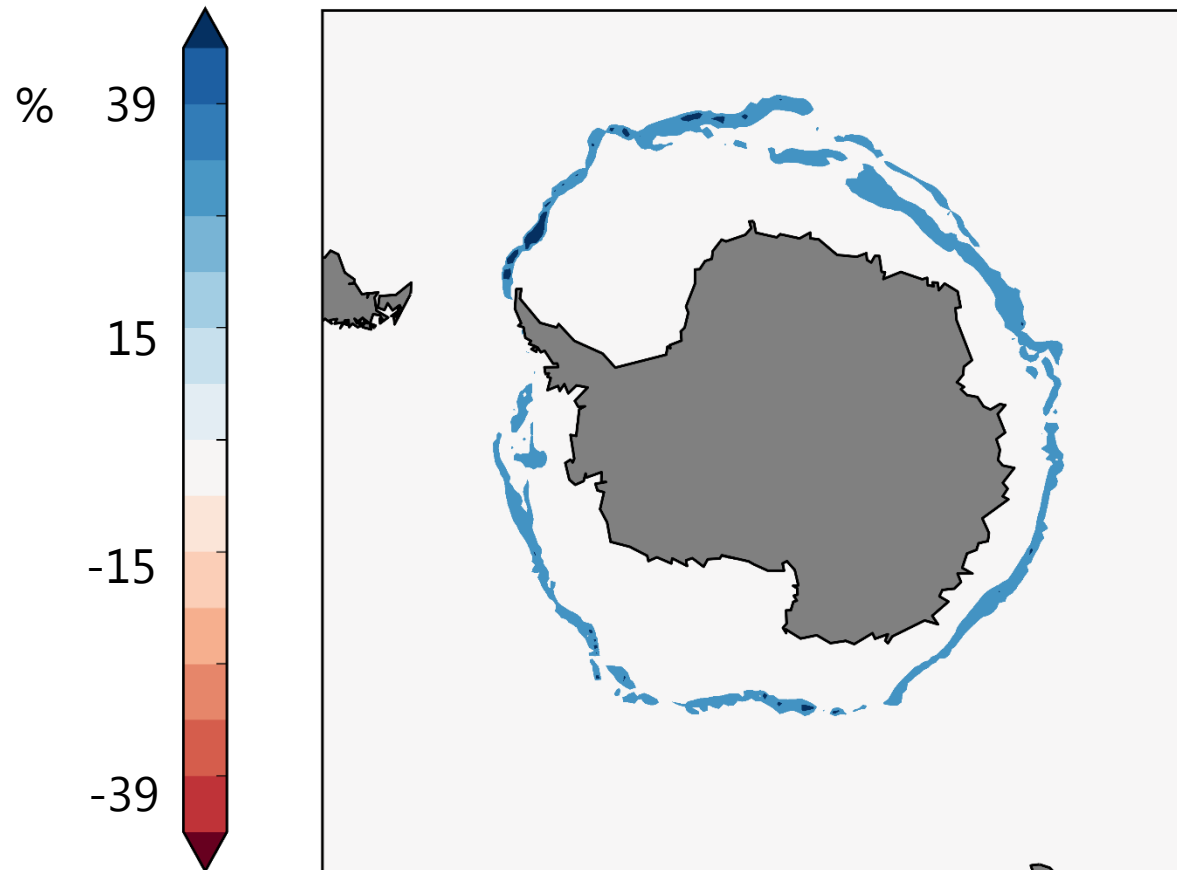
Sea ice concentration response
after -0.1 PSU in March

May 2014



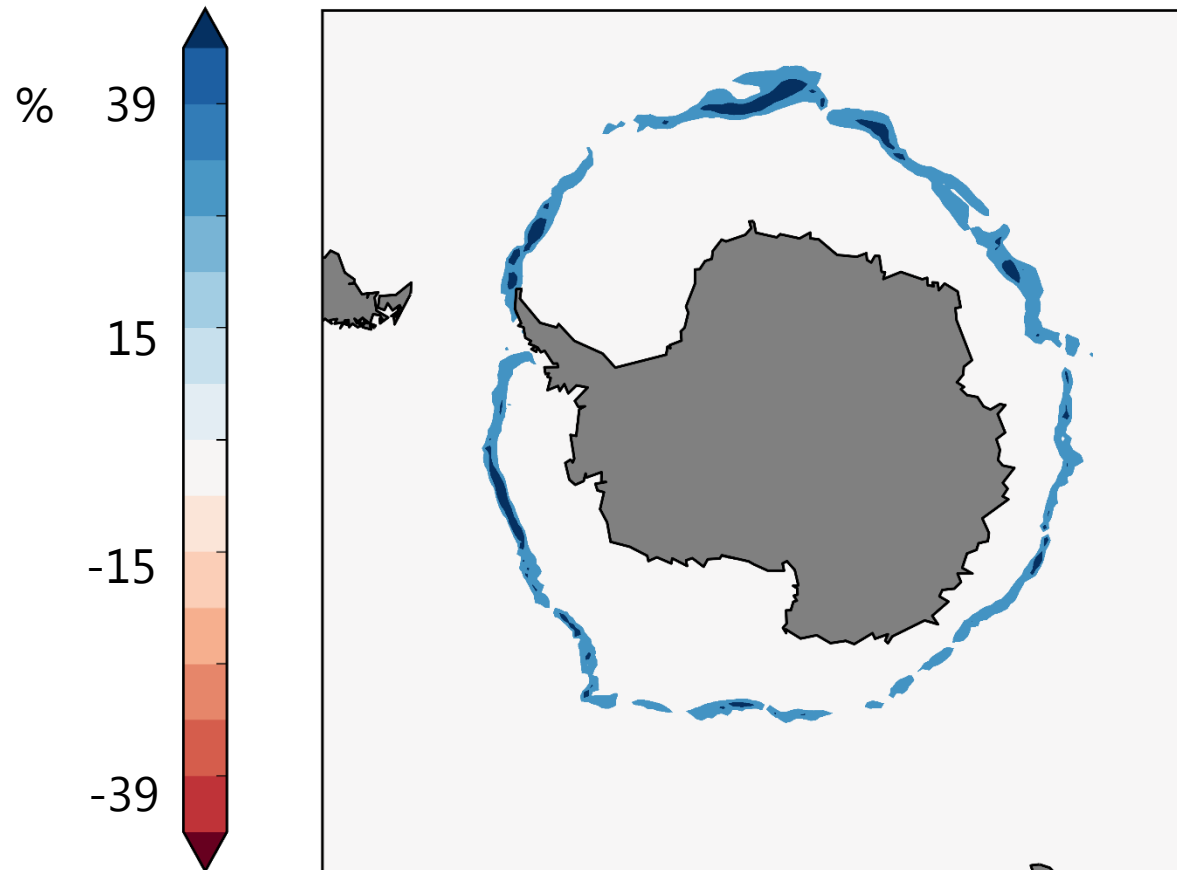
Sea ice concentration response
after -0.1 PSU in March

June 2014



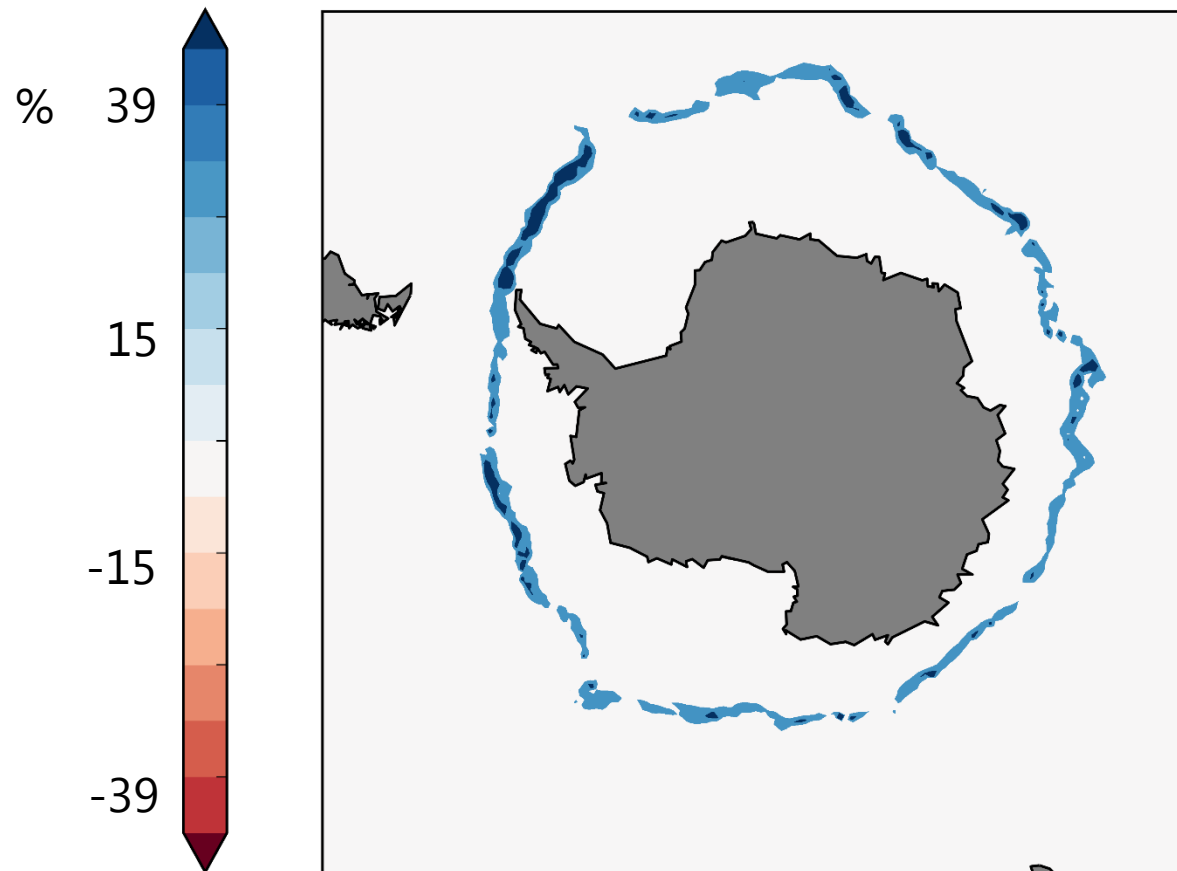
Sea ice concentration response
after -0.1 PSU in March

July 2014



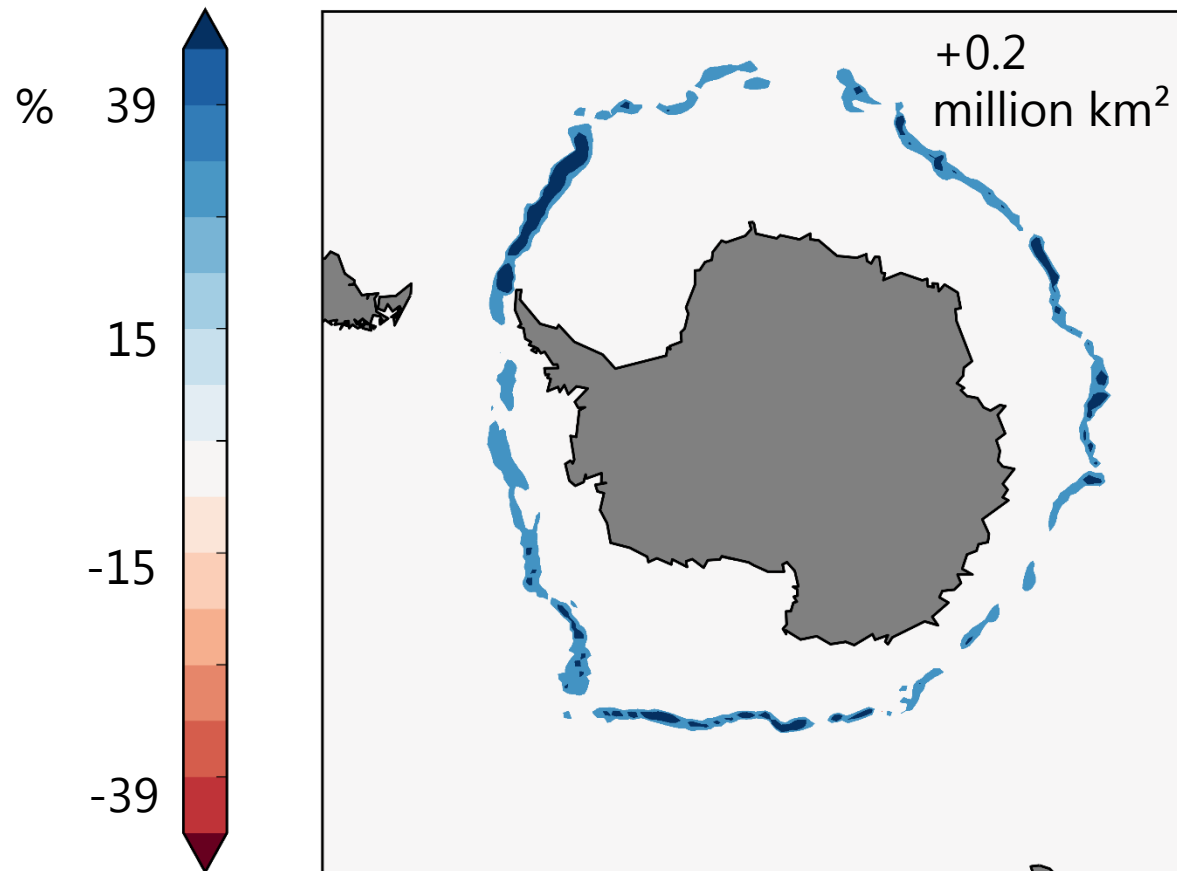
Sea ice concentration response
after -0.1 PSU in March

August 2014



Sea ice concentration response
after -0.1 PSU in March

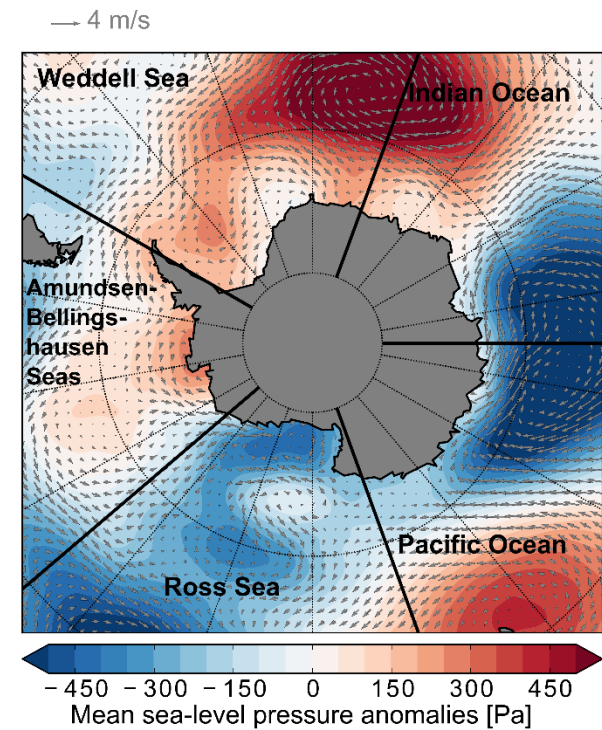
September 2014



Antarctic sea ice record

Lessons learned

Winds (following pressure distribution) have had a significant impact on temperature advection and sea ice production



Antarctic sea ice record

Lessons learned

Winds (following pressure distribution) have had a significant impact on temperature advection and sea ice production

Preconditioning could have played a secondary role, although uncertainties on the freshwater forcing remain

Antarctic sea ice record

Lessons learned

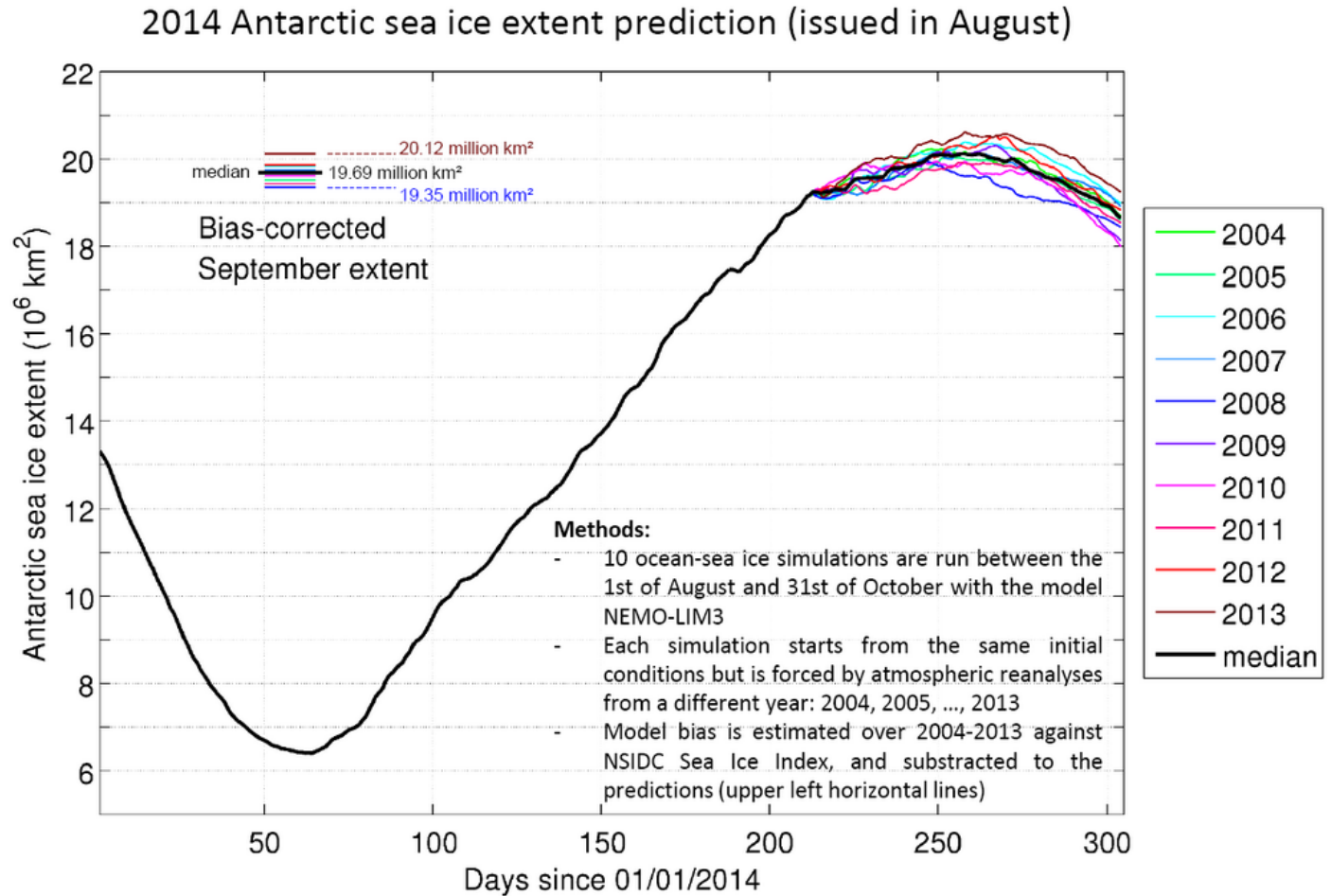
Winds (following pressure distribution) have had a significant impact on temperature advection and sea ice production

Preconditioning could have played a secondary role, although uncertainties on the freshwater forcing remain

Attribution of the maximum to ozone/greenhouse gas/temperature changes is not straightforward

Antarctic sea ice record

Lessons learned



Predictability: to be investigated

Thank you!

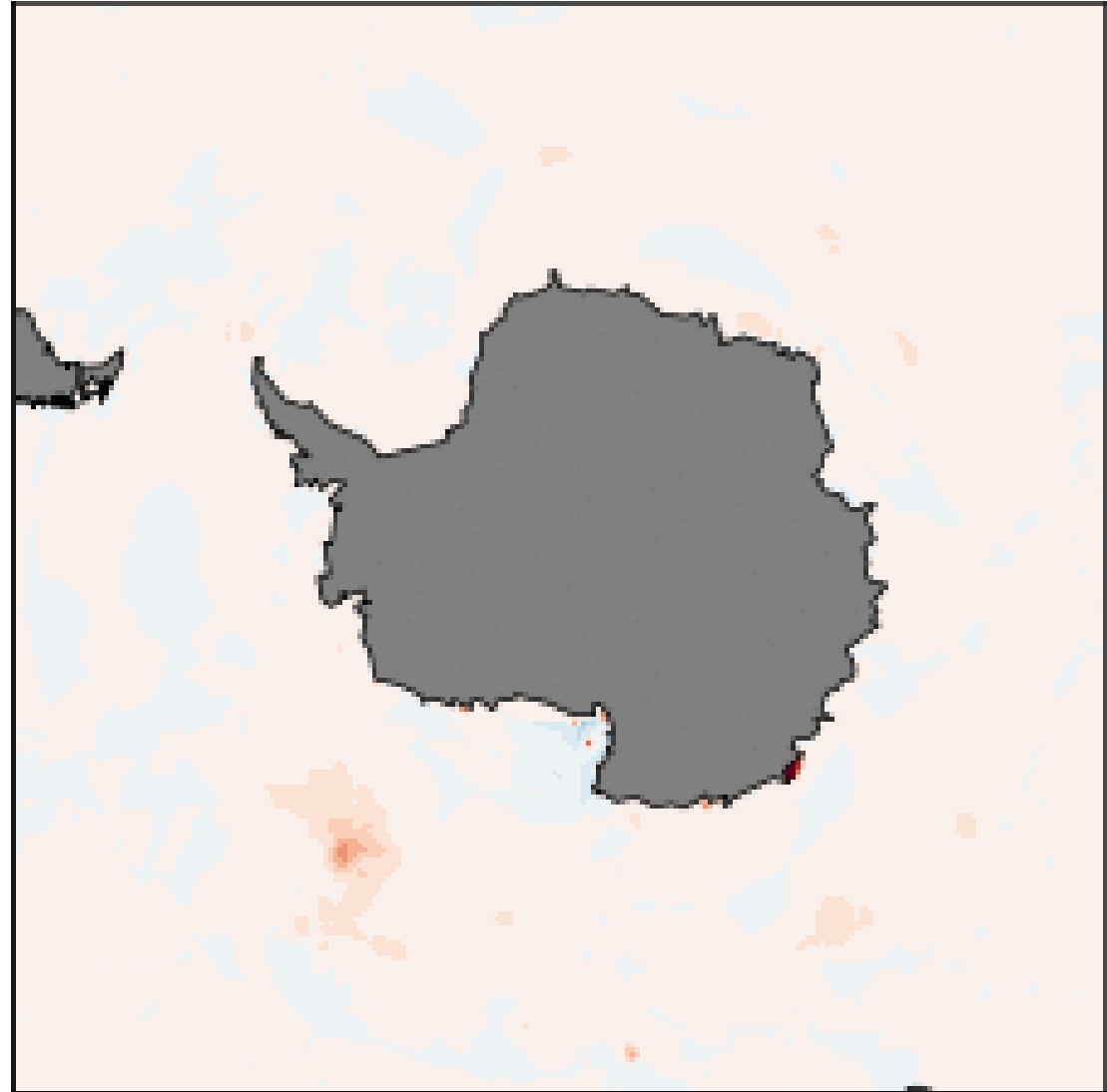
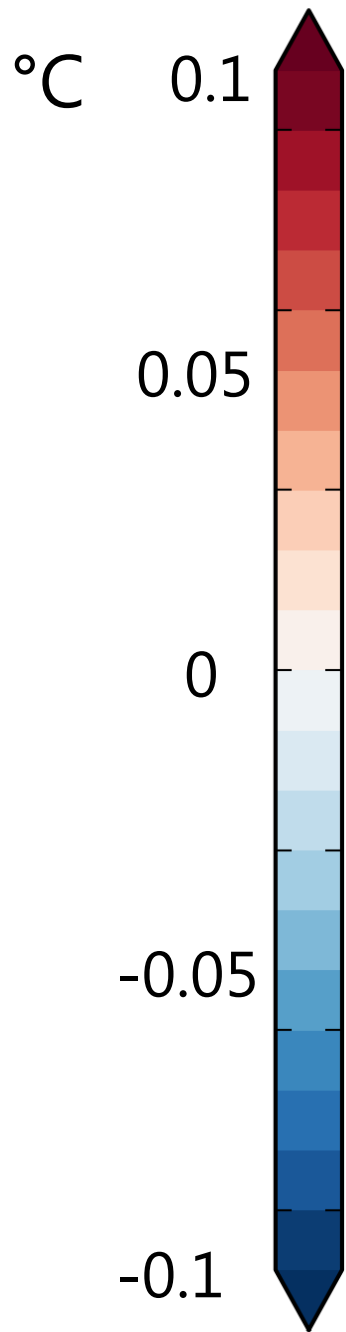
francois.massonnet@uclouvain.be

www.climate.be/u/fmasson

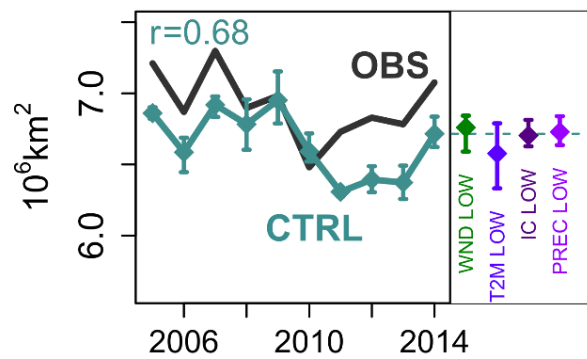


@FMassonnet

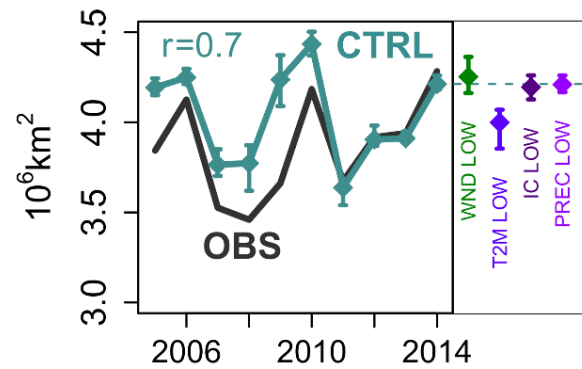
SST anomaly following -0.1 PSU initial condition



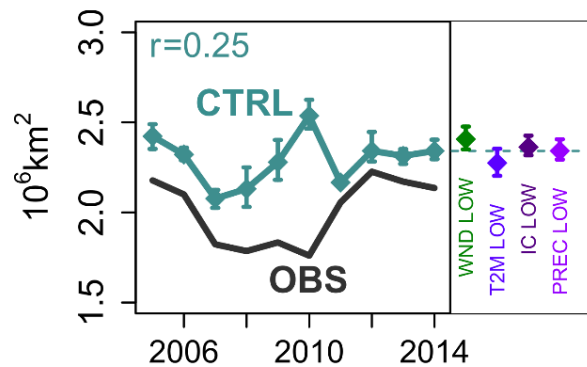
(a) Weddell Sea



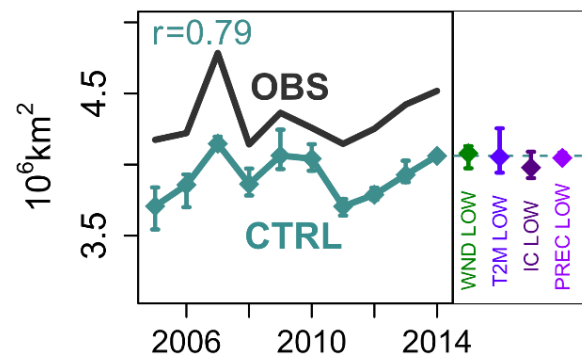
(b) Indian Ocean



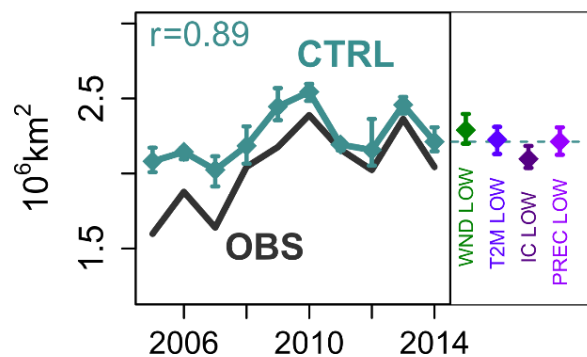
(c) Pacific Ocean



(d) Ross Sea



(e) Amund.-Bell. Seas



(f) Antarctica (total)

