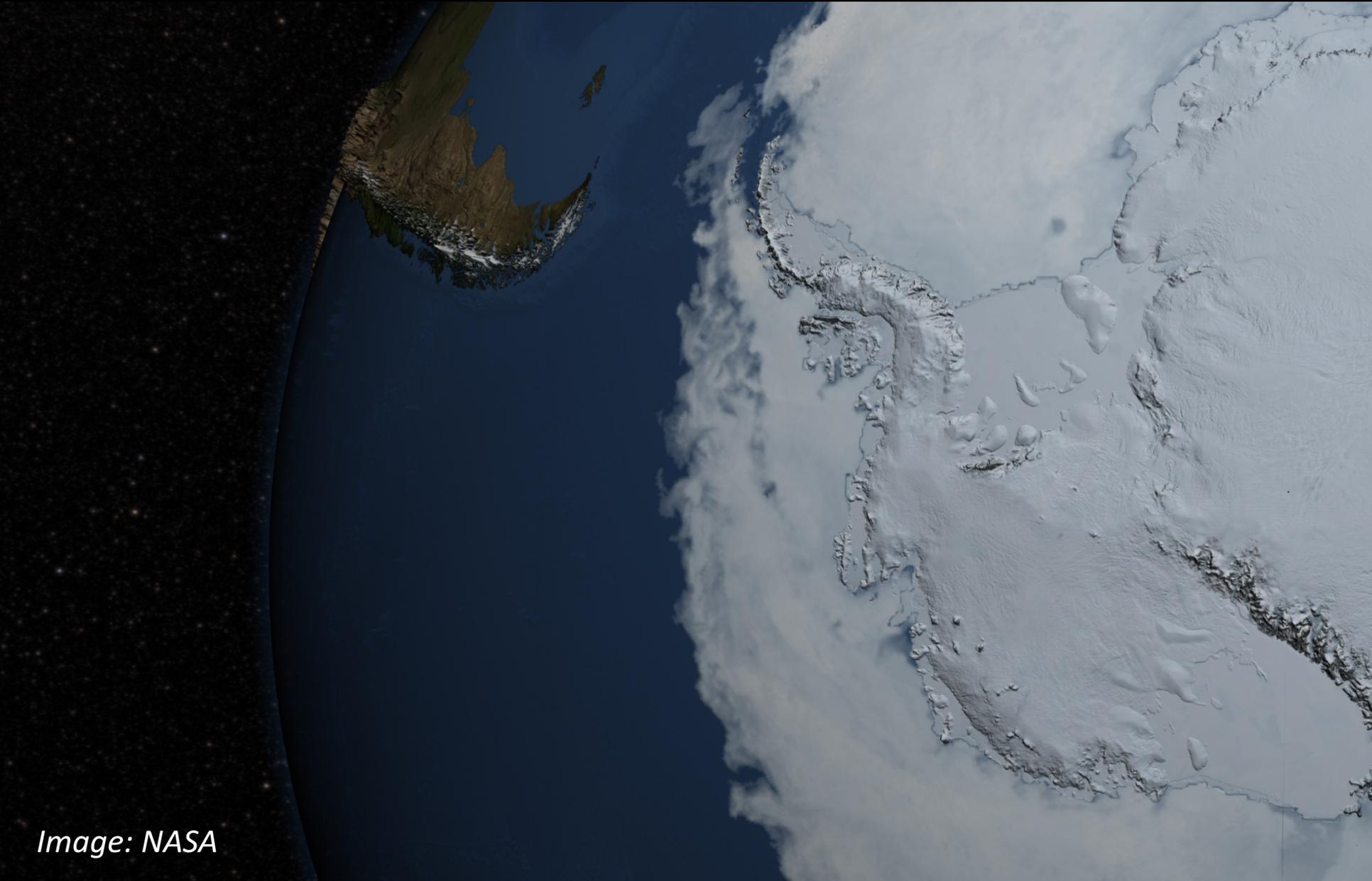


# Reconstructing 250 years of snow accumulation over West Antarctica

Brooke Medley<sup>1</sup>, Liz Thomas<sup>2</sup>  
<sup>1</sup>NASA GSFC, <sup>2</sup>BAS



*Image: NASA*

# A key component

Ice sheet mass *GAIN*

– *Present? Past or future?*

Surface elevation change

– *Direct & indirect (firn compaction)*

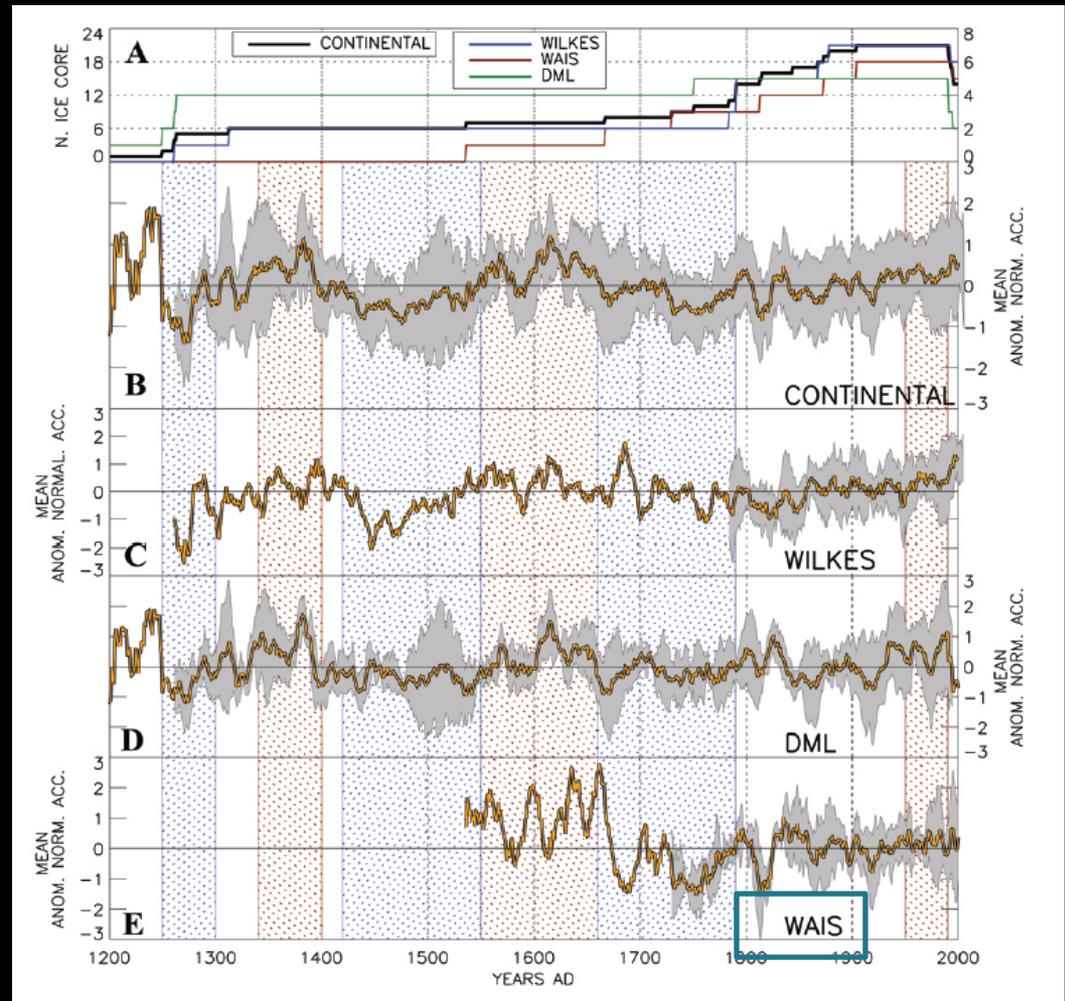
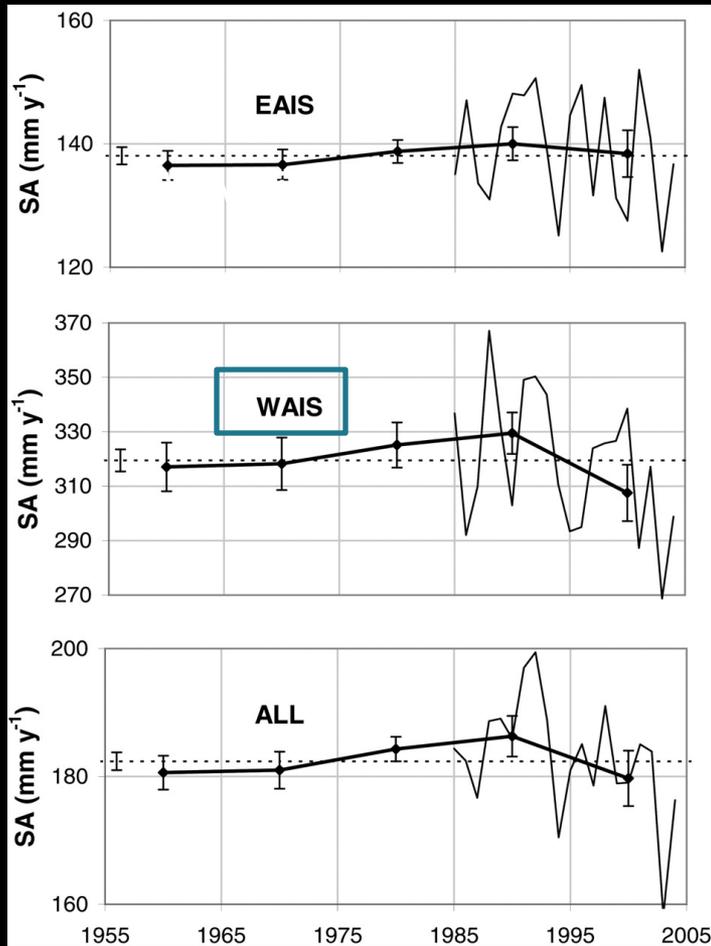
Constrain ice dynamics

– *Uncertainty propagates*

# What do we know?

Frezzotti et al., *Cryosphere*, 2013

Monaghan et al., *Science*, 2006



# Firn has a memory ☹️

Height change derived using the IMAU-FDM early 2000 years, enforced by the firn

It is important that we understand recent surface changes, so we understand the limitations our techniques!



# Monaghan *et al.* (2006) technique

Create a gridded accumulation product through combination of firn core records & atmospheric fields

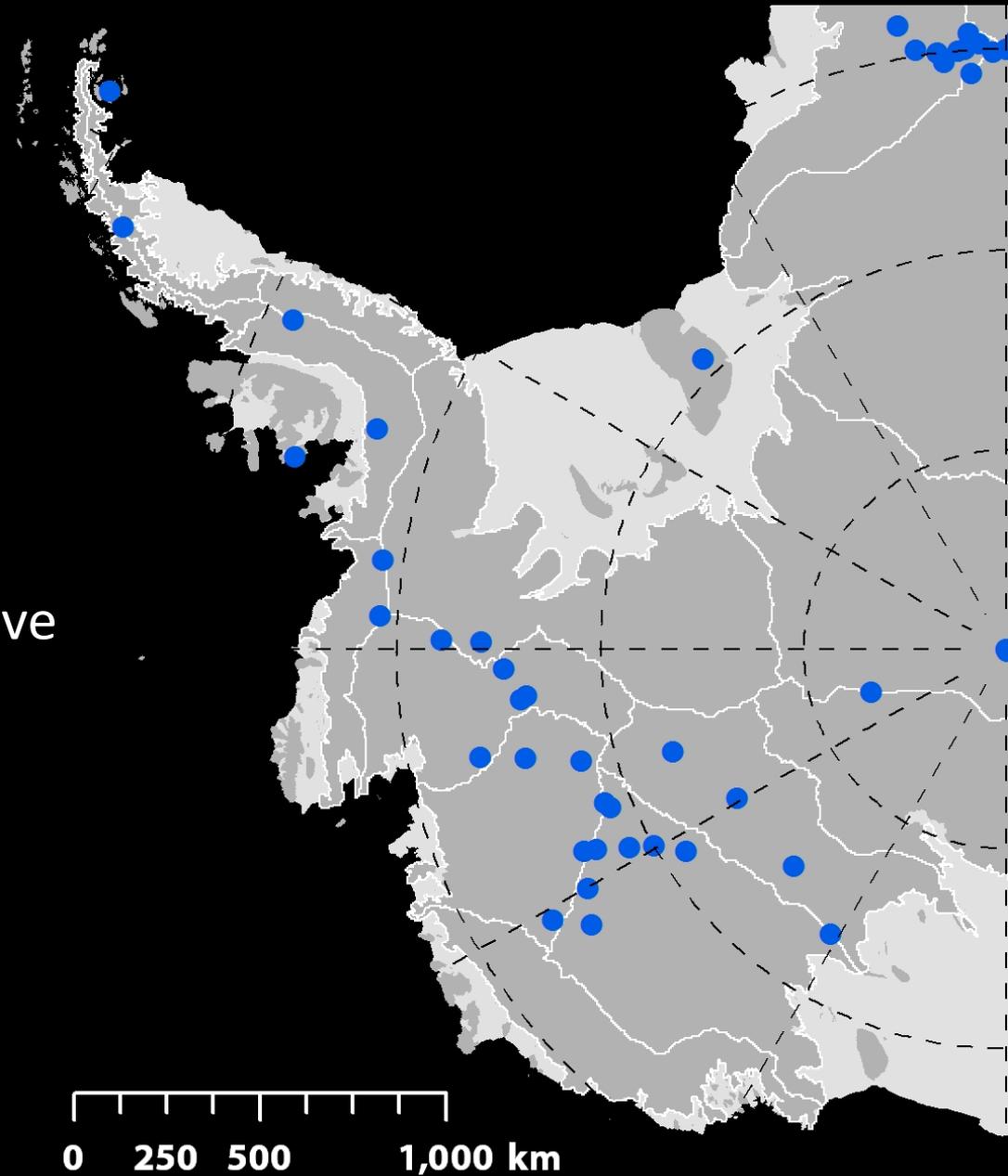
Time → cores

Space → atmospheric grids

The result: Annual grids of accumulation since 1750

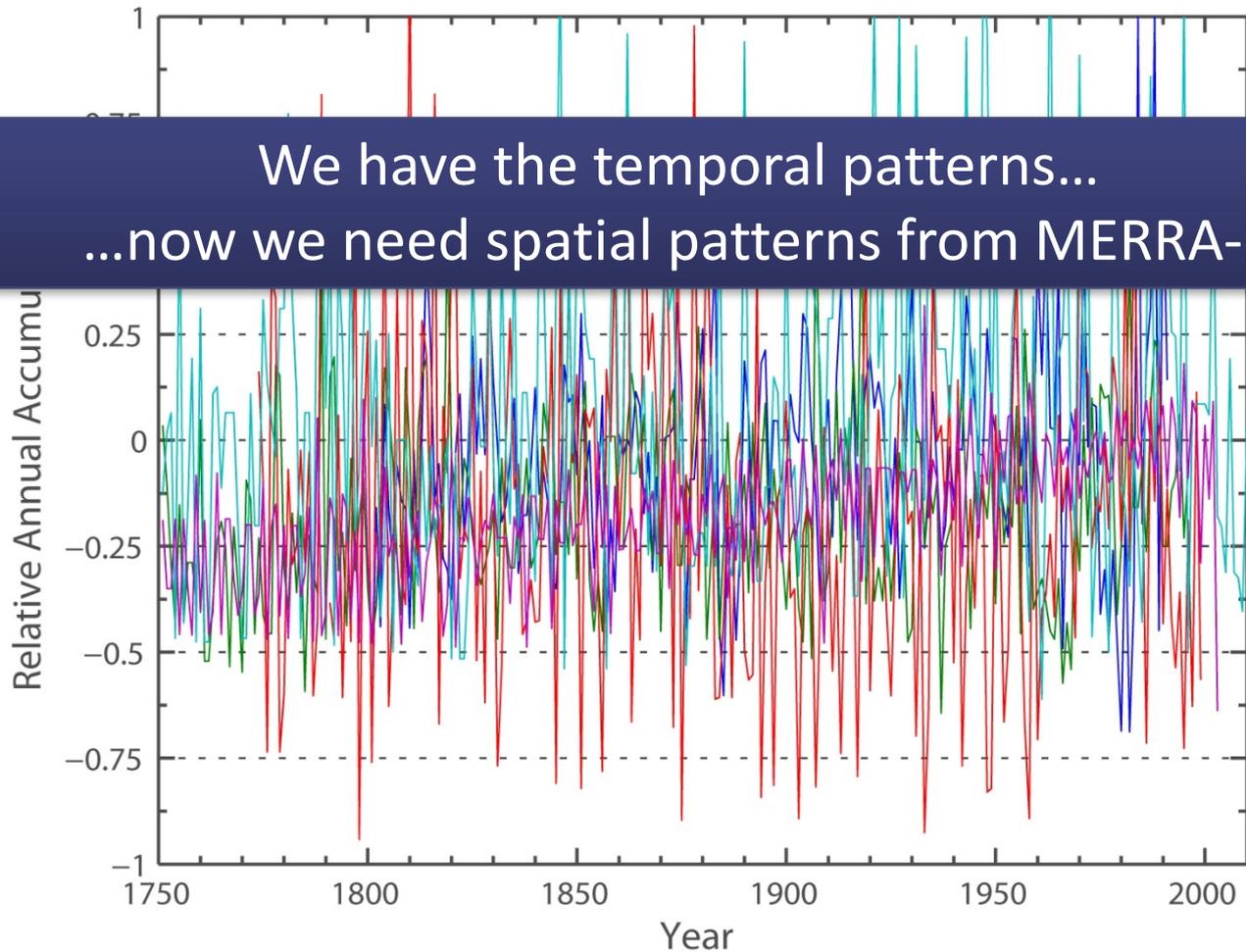
# Core Data Set

- 81 annually resolved records (WAIS, EAIS, AP)
  - ~30 from WAIS
- Normalized records relative to the 1980-1989 avg



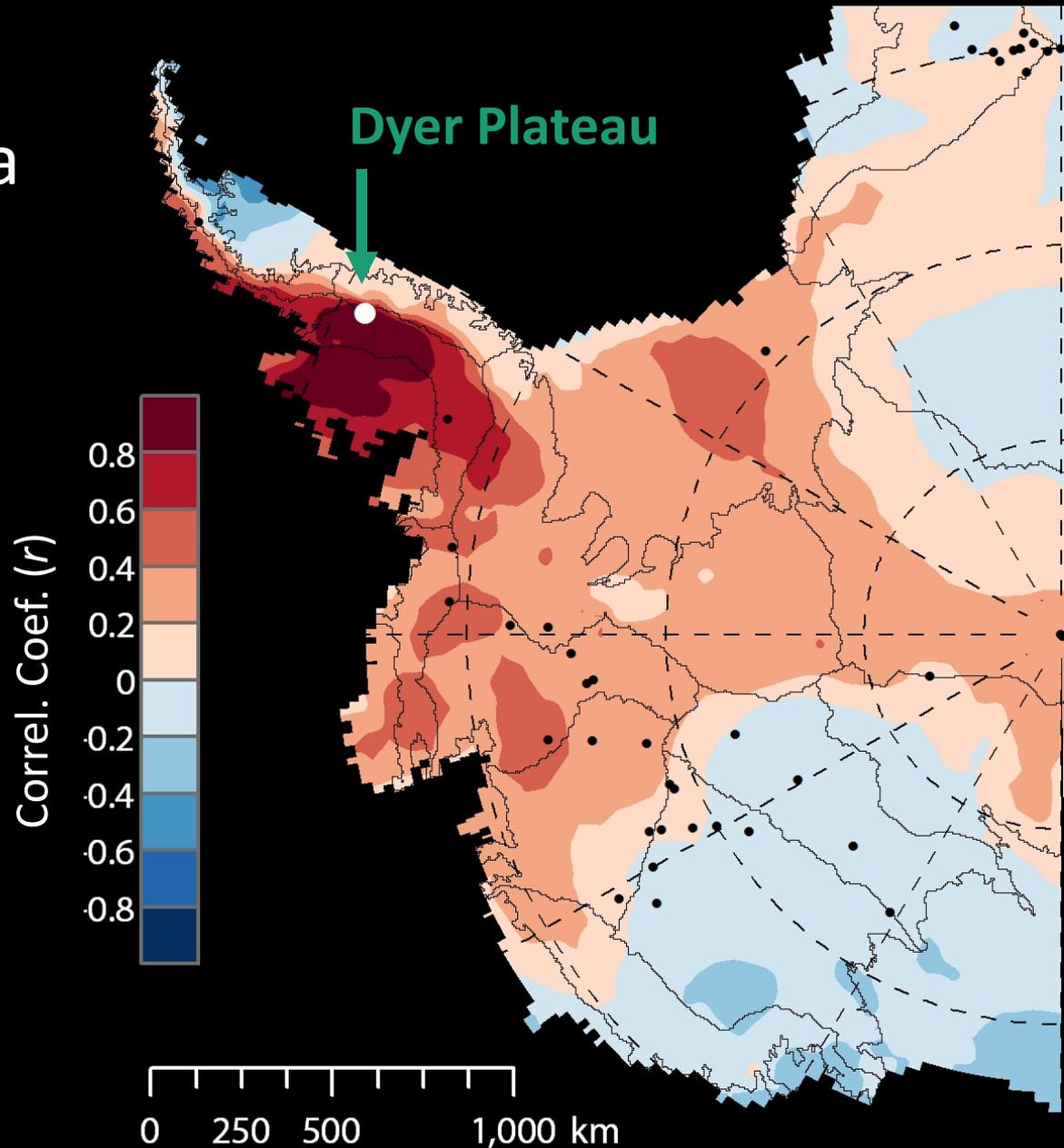
# Five sample core records

We have the temporal patterns...  
...now we need spatial patterns from MERRA-2



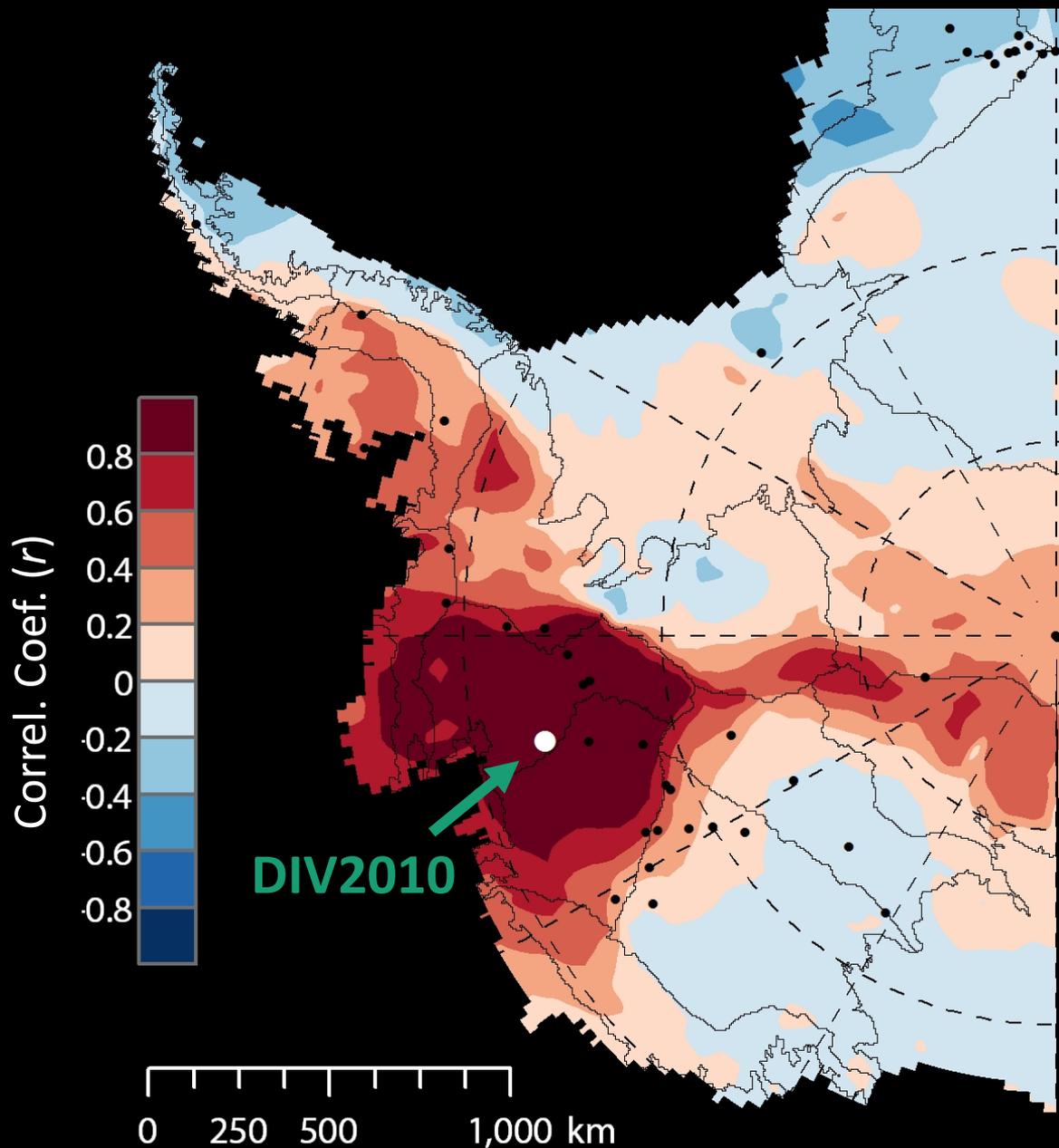
# Correlation Map: Antarctic Peninsula

- Derive a correlation map for each core
- Used to take a weighted average of all records for each cell



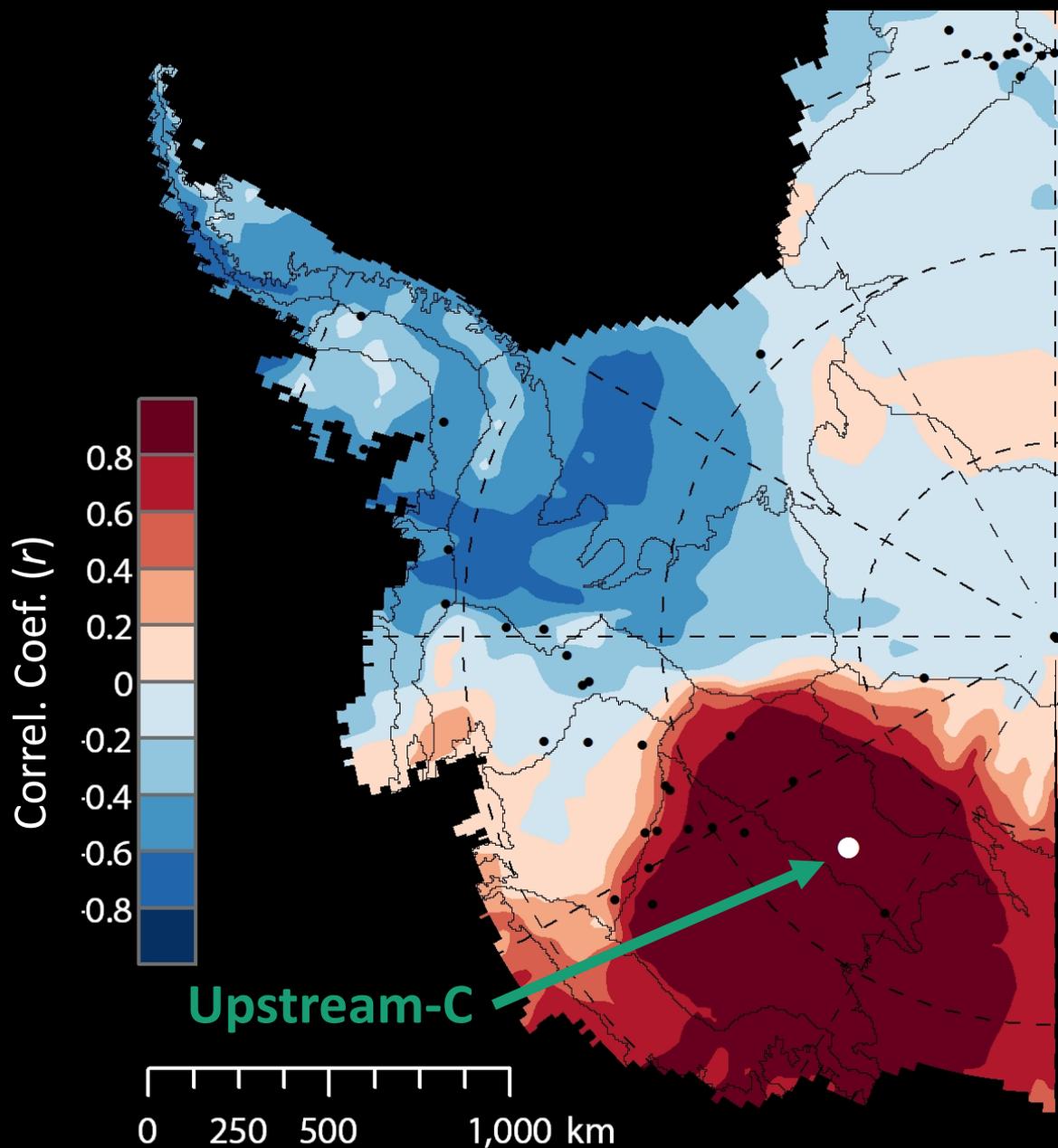
# Correlation Map: Central WAIS

- Strongly related to drainage divides
- Connection to South Pole



# Correlation Map: Western WAIS

- Seesaw pattern with Eastern WAIS and AP



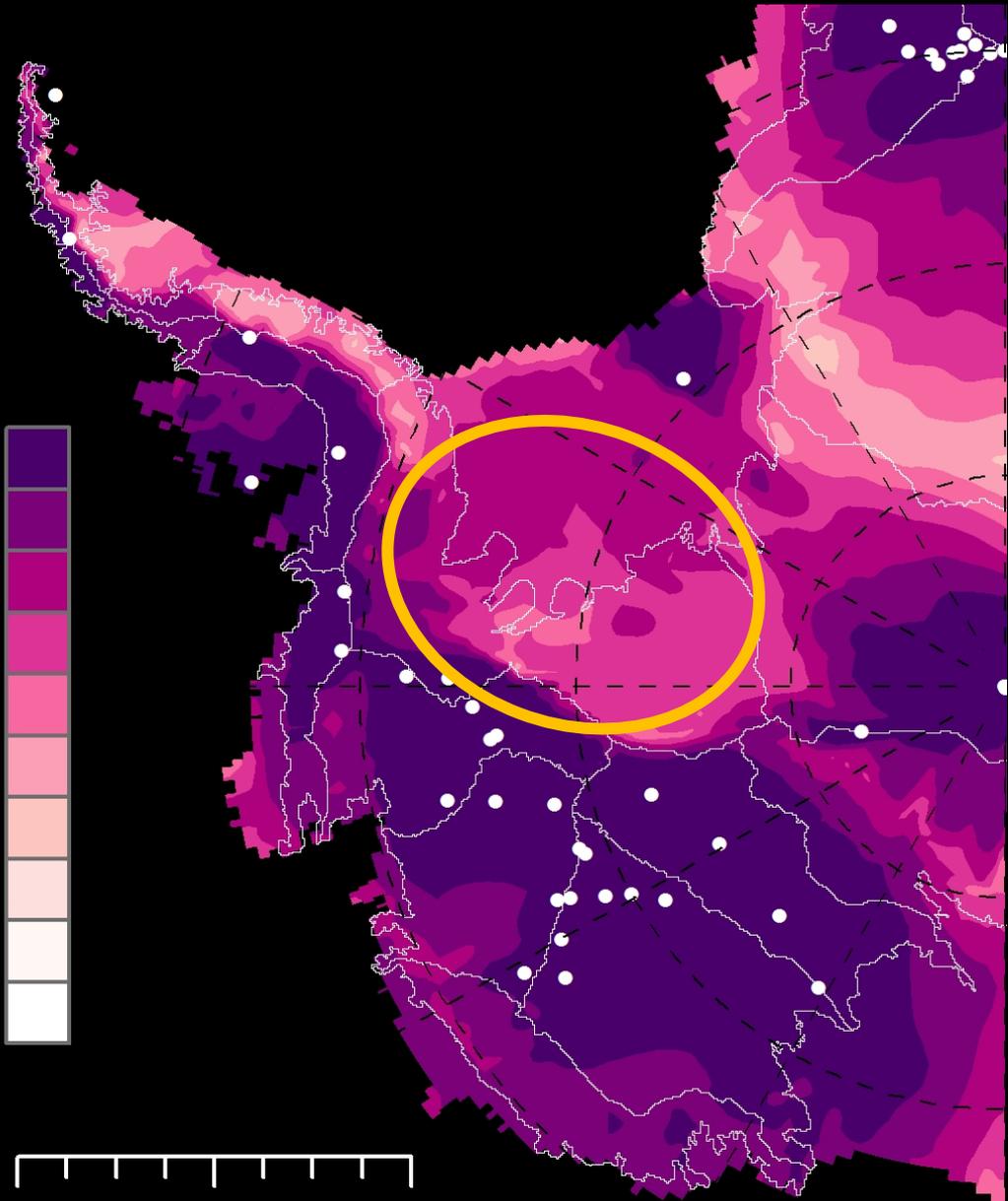
# Maximum Correlation

- Max correlation with one of the cores
- Do our core records cover most of WAIS?
  - Yes!
- Need some cores?  
Or we're missing some!

Correl. Coef. ( $r$ )

0.9  
0.8  
0.7  
0.6  
0.5  
0.4  
0.3  
0.2  
0.1

0 250 500 1,000 km



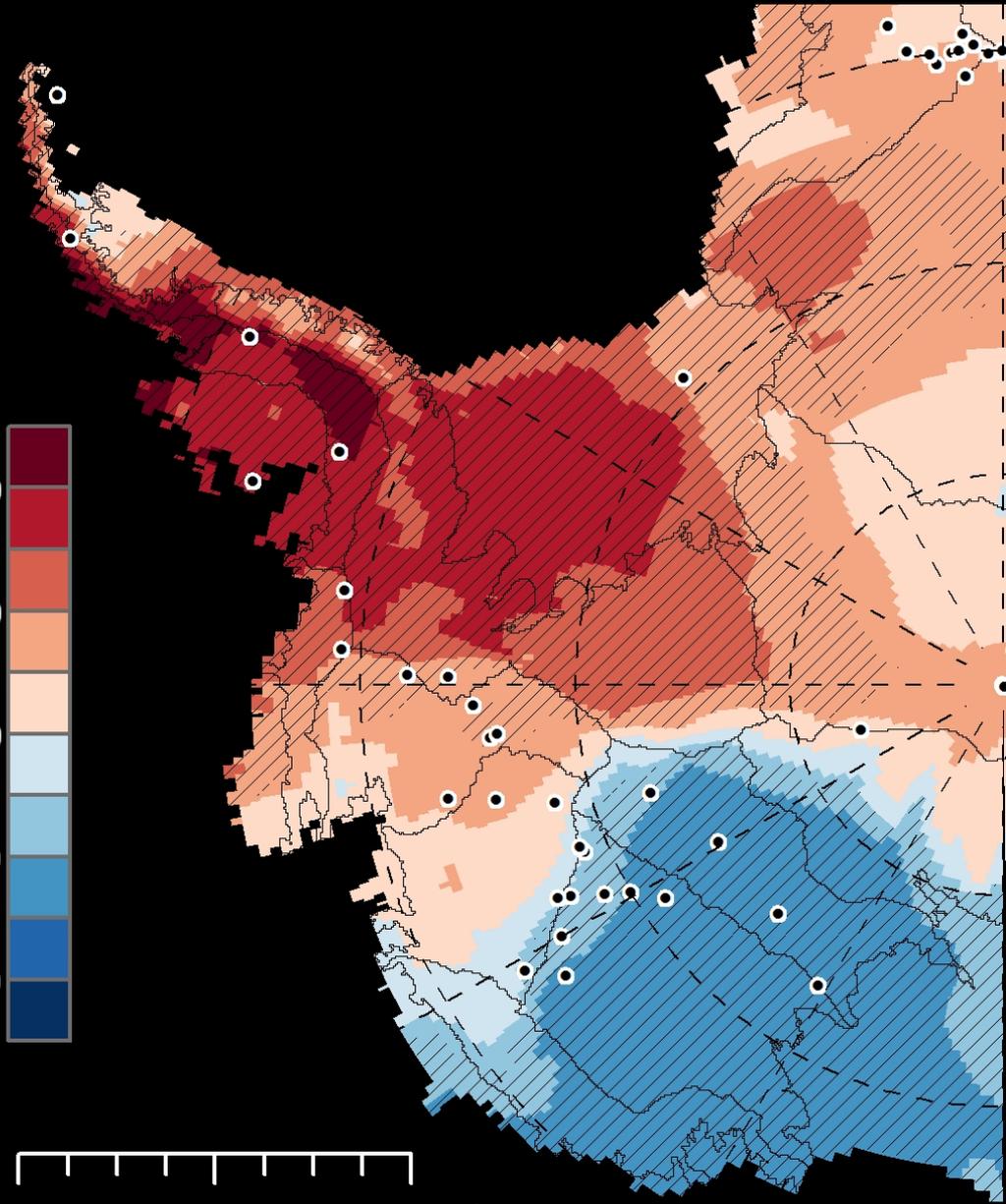
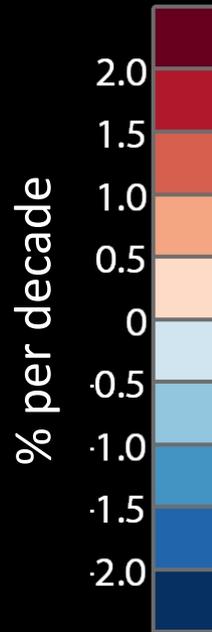
- For each grid cell, weight *ALL* the core records by their  $r^2$  values
- Creates 250-year time series for each grid cell!
  - Let's start with trends over the 20<sup>th</sup> century -

# Century Trend: 1901-2000

Hatching: p-value < 0.01

Strong opposing trends  
between Eastern and  
Western WAIS

Not much change in  
central WAIS



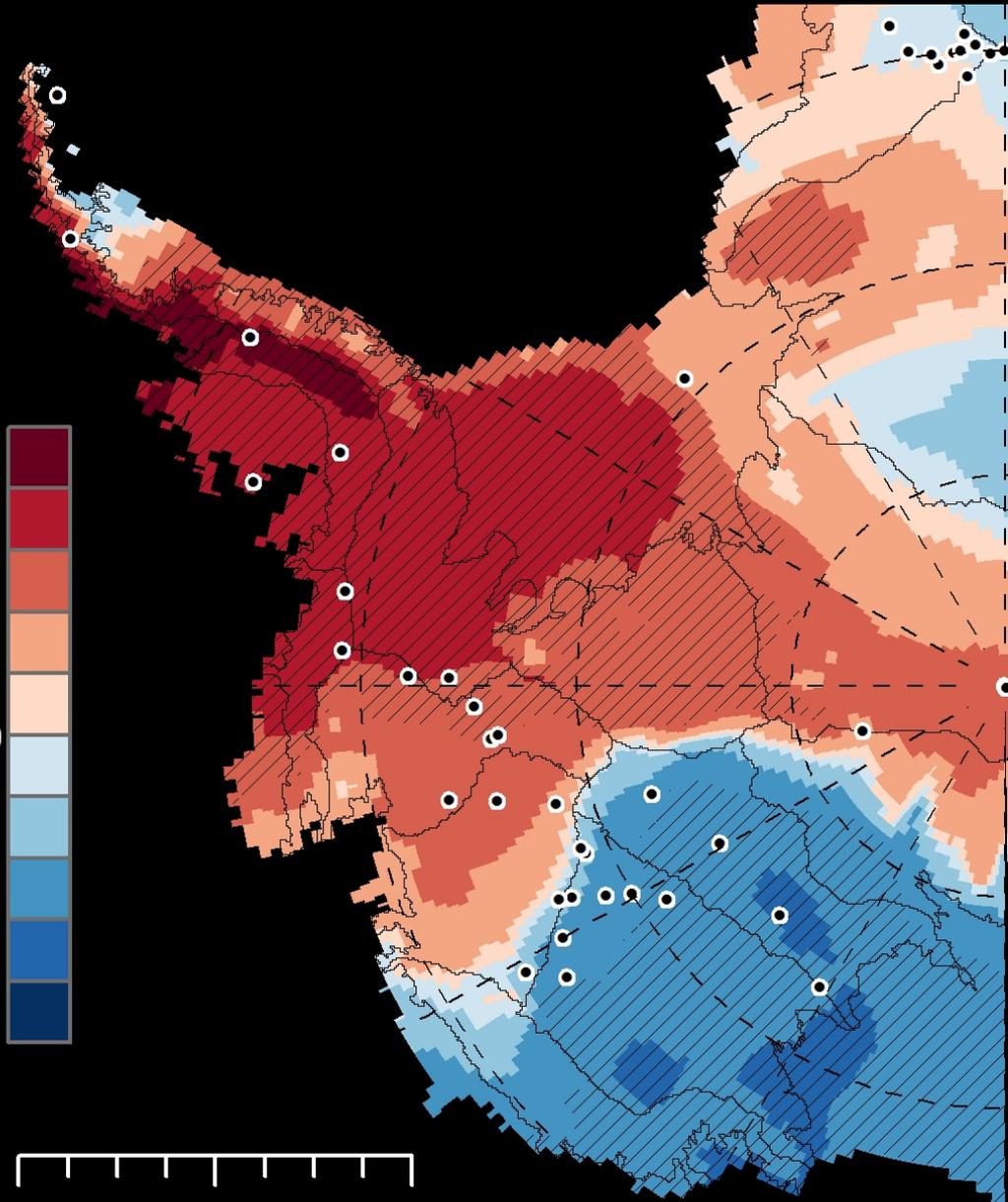
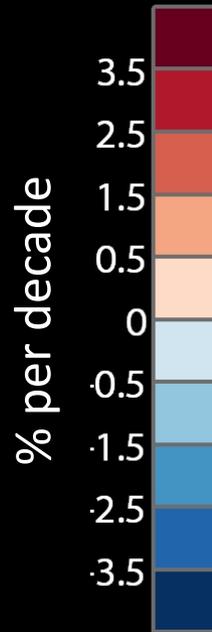
# Mid-Century Trend: 1951-2000

Hatching: p-value < 0.01

Note scale change!

Strong(er) opposing  
trends between Eastern  
and Western WAIS

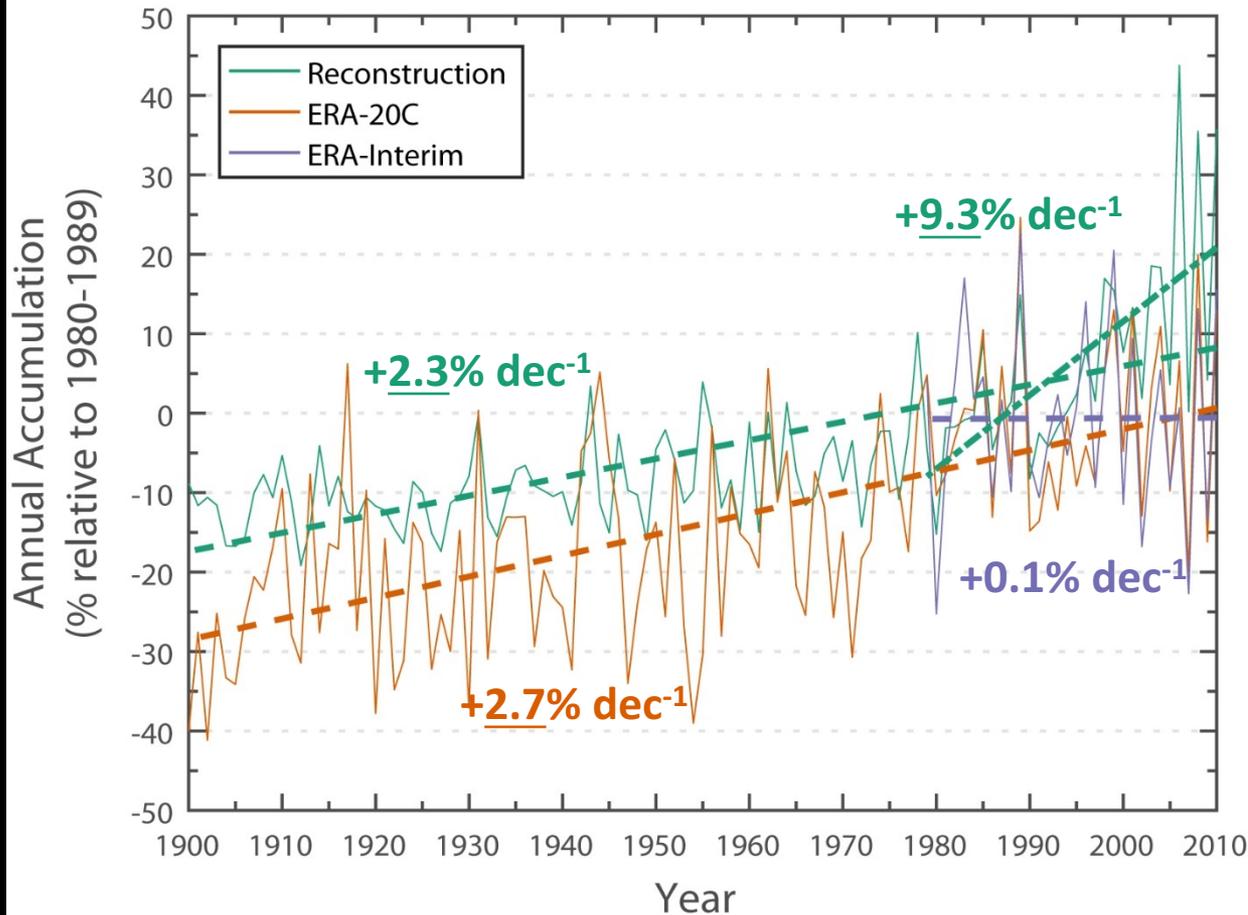
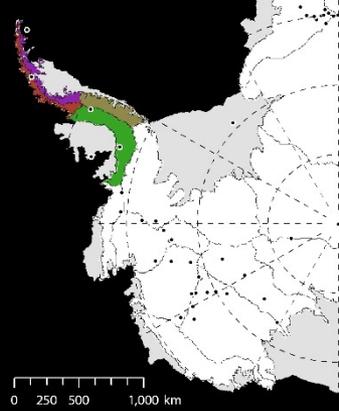
No significant change in  
central WAIS



## Comparisons with ECMWF products:

1. ERA-Interim reanalysis (1979-2015)
2. ERA-20C reanalysis (1900-2010)
  - Assimilated observations: surface pressure, winds (no satellite/upper-air data)

# Antarctic Peninsula



Correlation Coef ( $r$ )

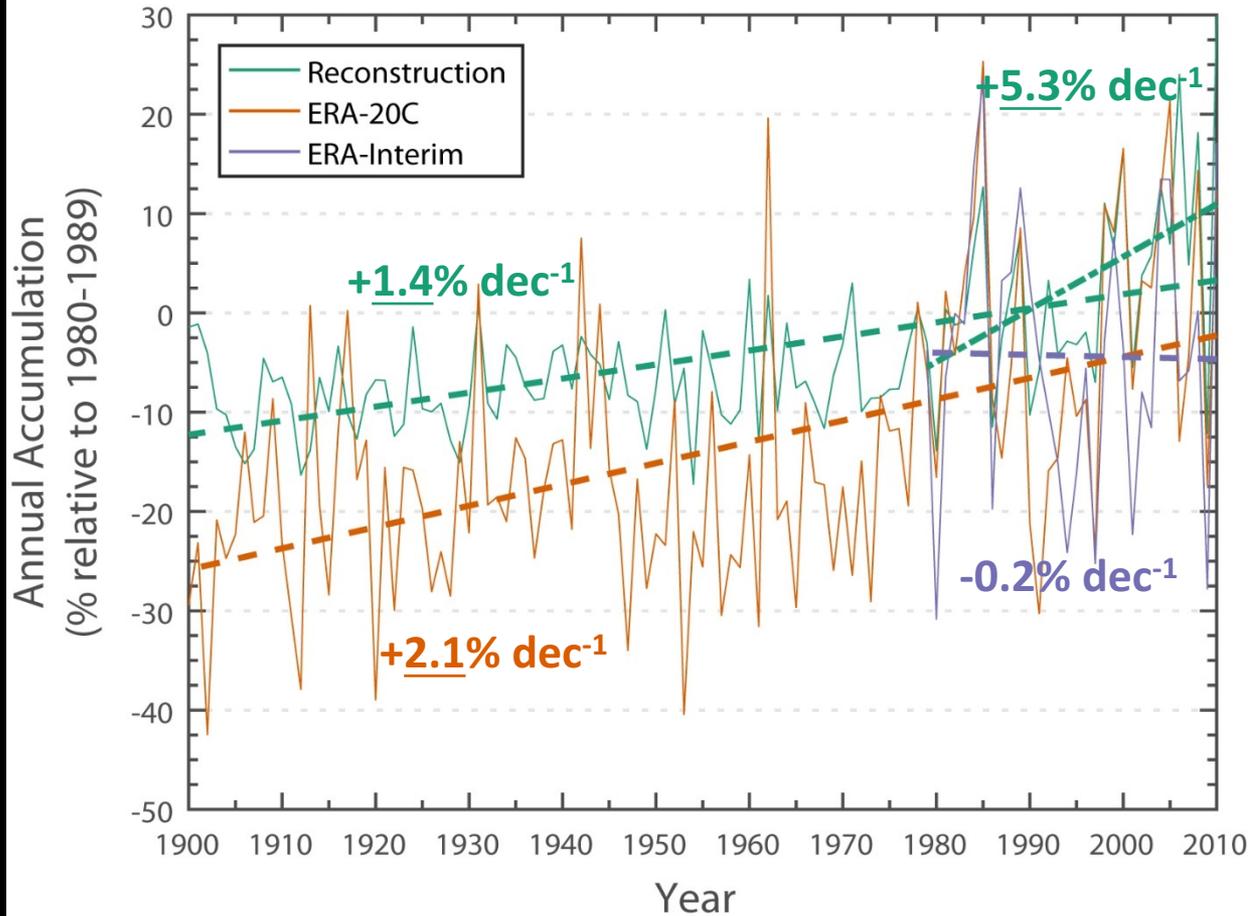
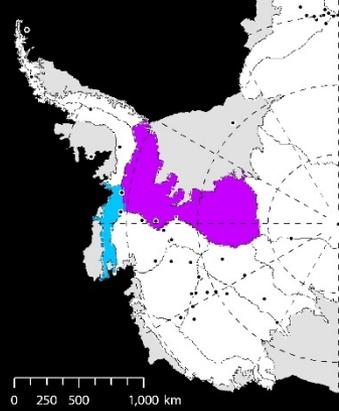
1900 – 2010:  
0.44,  $p \ll 0.01$

1979 – 2010:  
0.68,  $p \ll 0.01$

*Based off of  
detrended time  
series*

Underline:  $p < 0.01$

# Eastern WAIS



Correlation Coef ( $r$ )

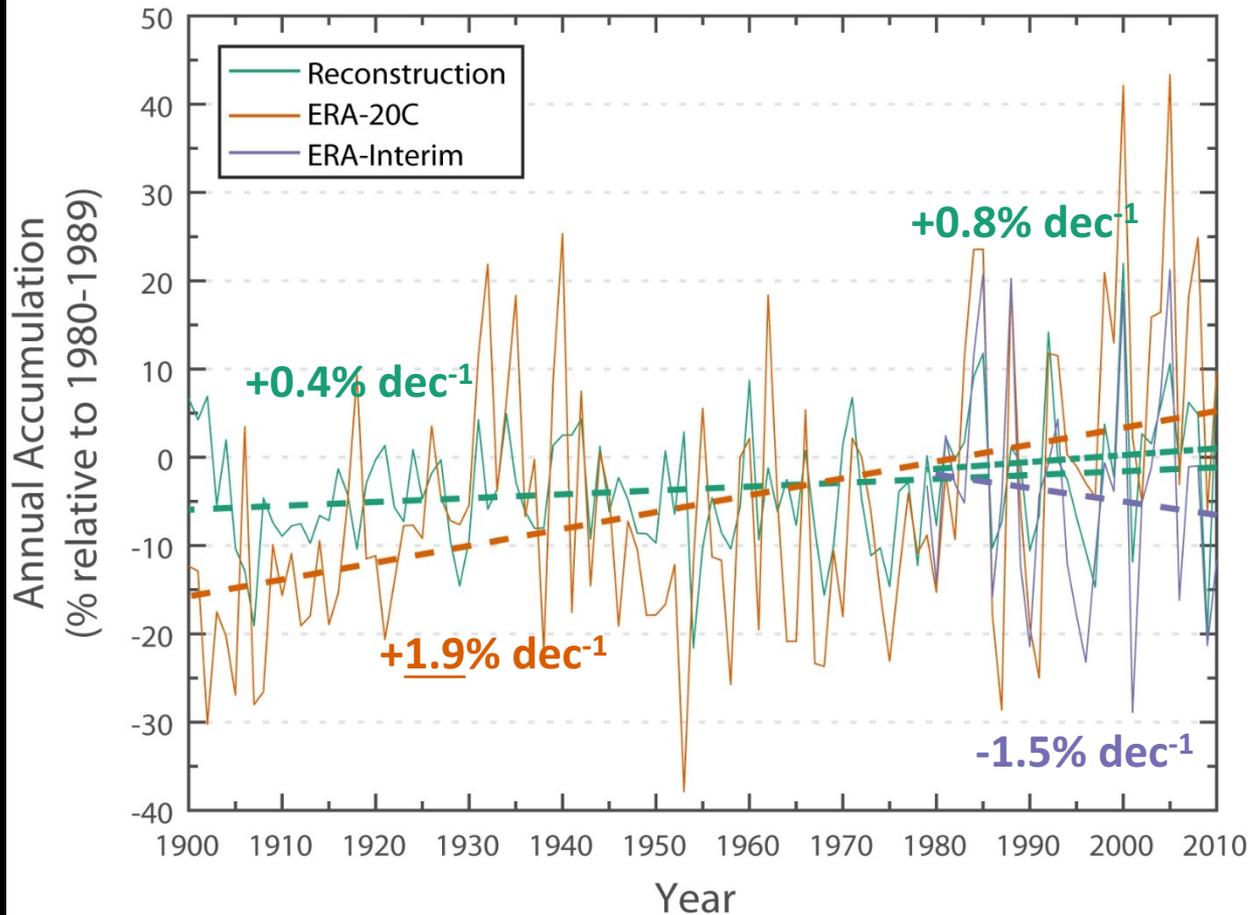
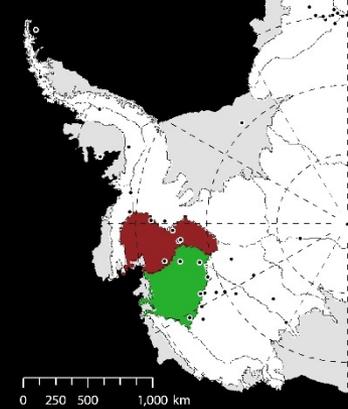
1900 – 2010:  
0.49,  $p \ll 0.01$

1979 – 2010:  
0.73,  $p \ll 0.01$

*Based off of  
detrended time  
series*

Underline:  $p < 0.01$

# Central WAIS



Correlation Coef ( $r$ )

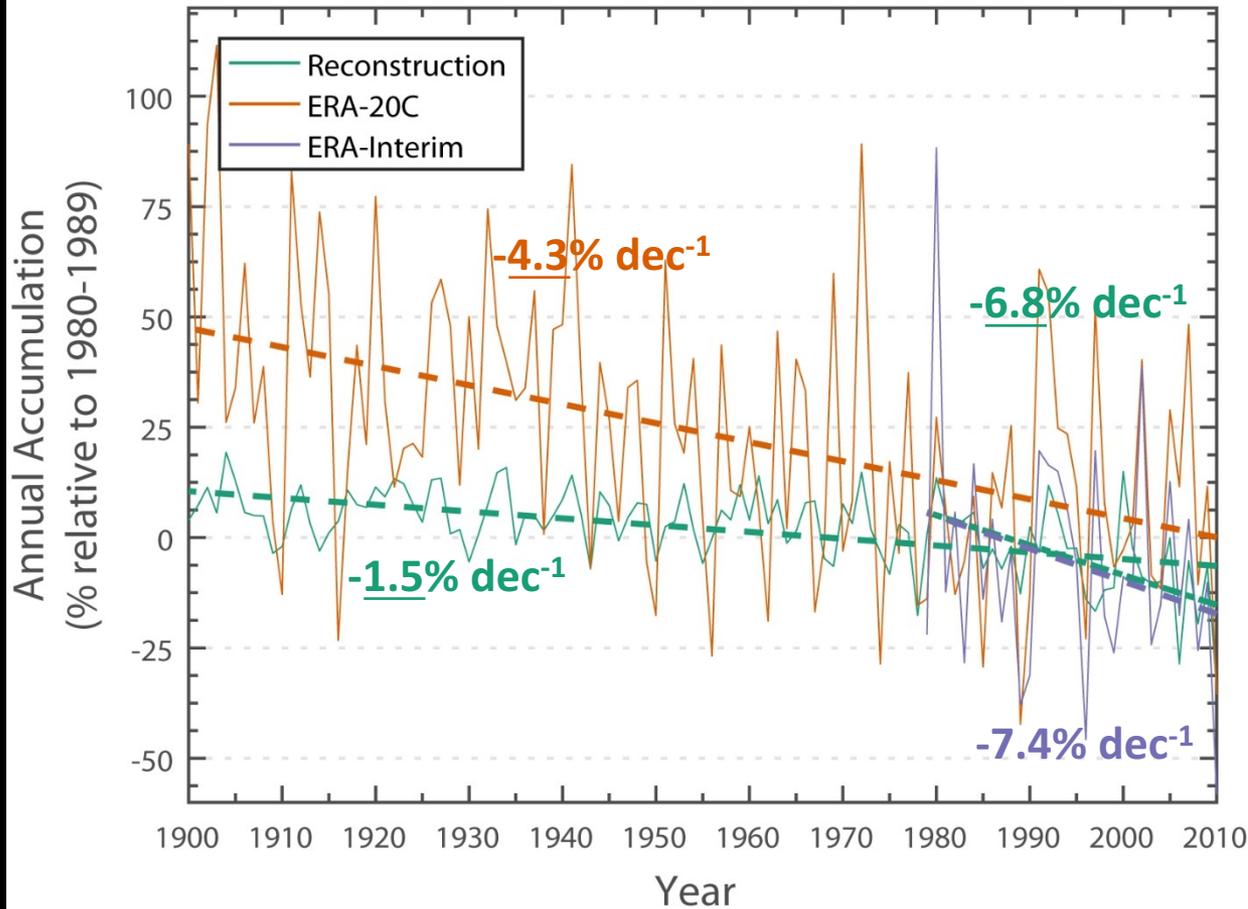
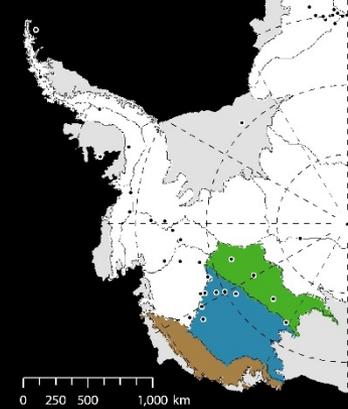
1900 – 2010:  
0.51,  $p \ll 0.01$

1979 – 2010:  
0.78,  $p \ll 0.01$

*Based off of  
detrended time  
series*

Underline:  $p < 0.01$

# Western WAIS



Correlation Coef ( $r$ )

1900 – 2010:  
0.24,  $p = 0.01$

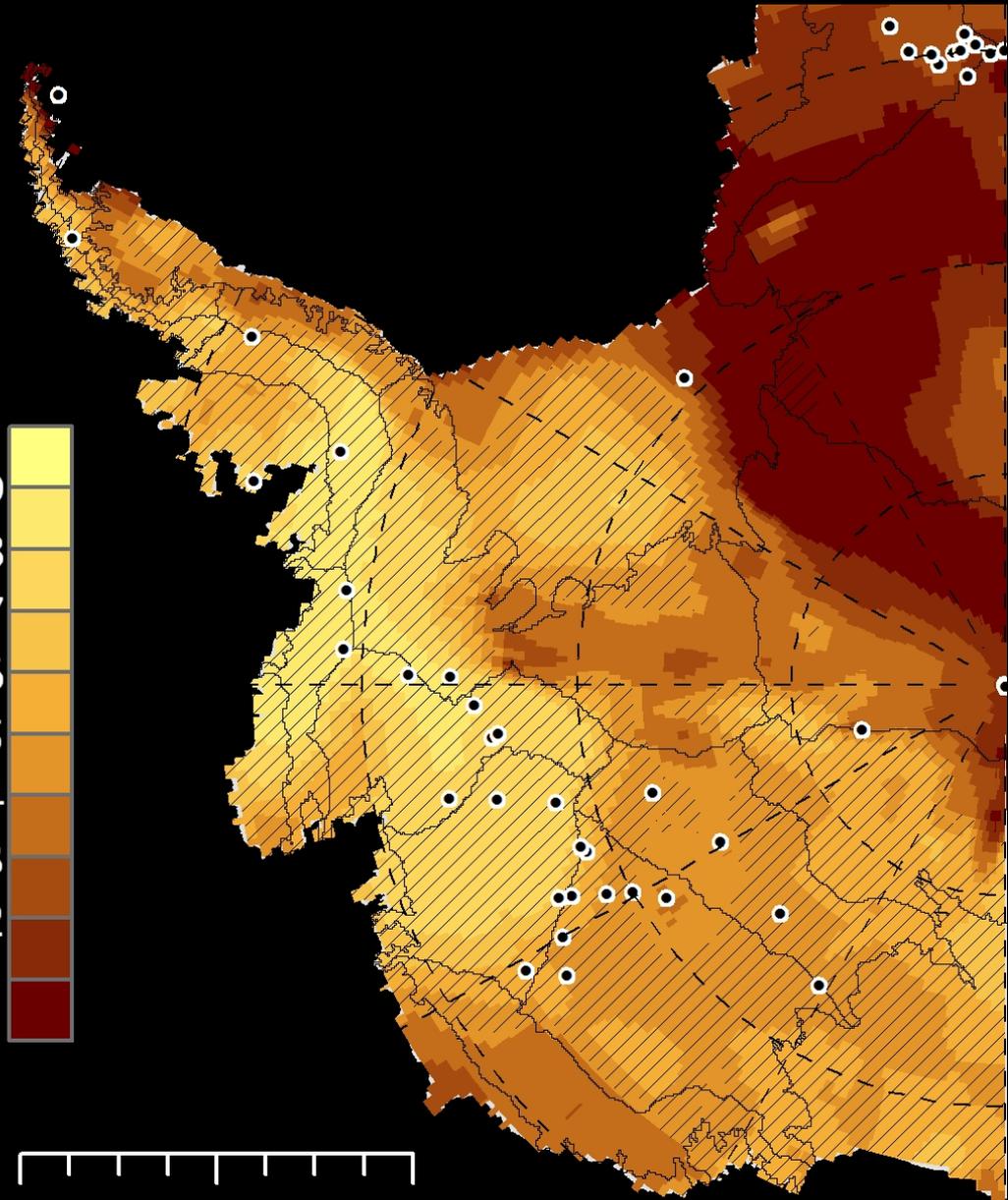
1979 – 2010:  
0.48,  $p < 0.01$

*Based off of  
detrended time  
series*

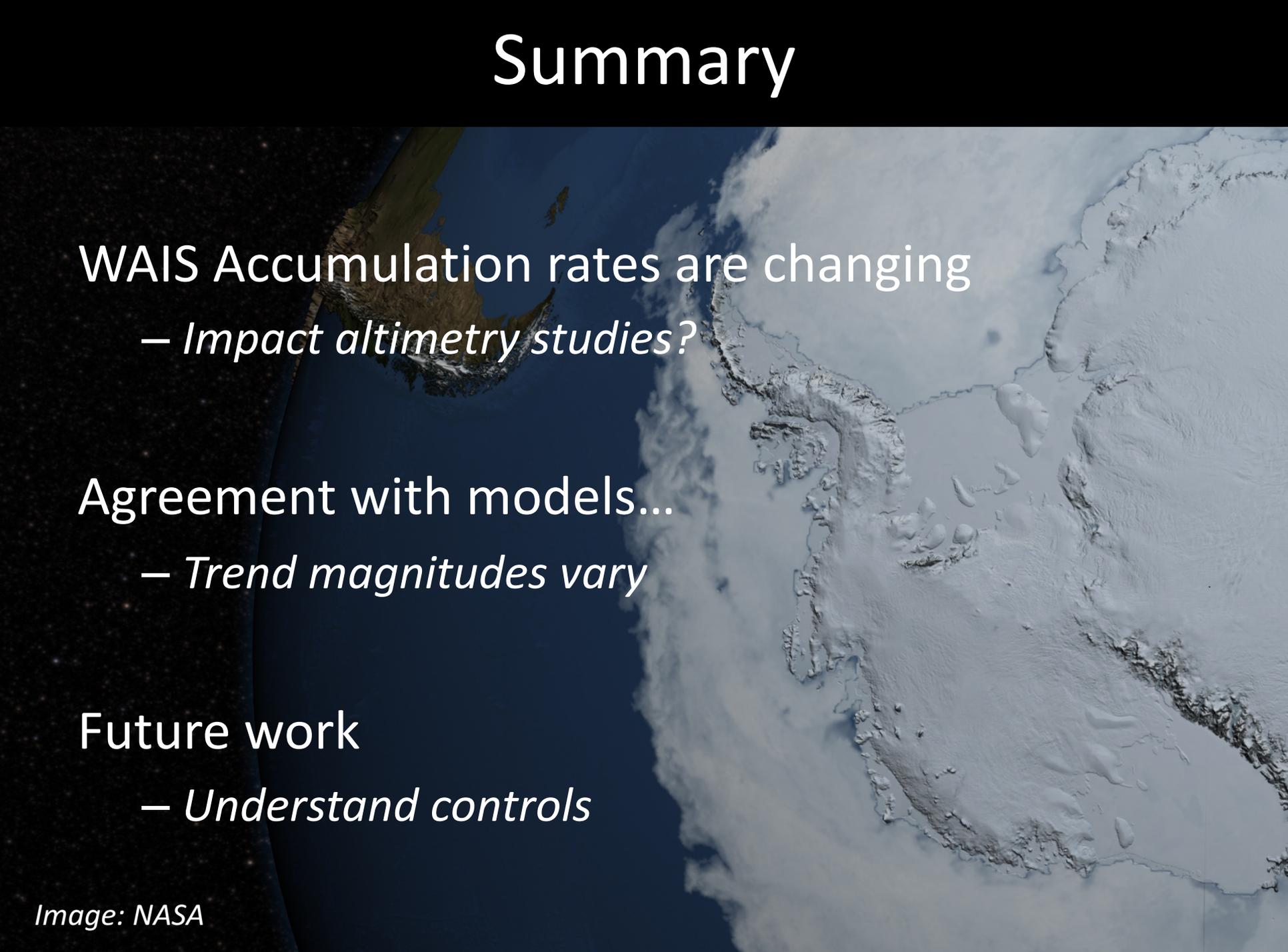
Underline:  $p < 0.01$

# Comparison with ERA-Interim

- Reconstruction is strongly correlated with ERA-Interim over most of WAIS
- Regions of low correlation are where cores are sparse
- Weaker correlation in W. WAIS is due to the lack of recent cores



# Summary



WAIS Accumulation rates are changing

– *Impact altimetry studies?*

Agreement with models...

– *Trend magnitudes vary*

Future work

– *Understand controls*

# Thanks!

The many hardworking field/lab teams that collected/analyzed the firn cores

Stefan Ligtenberg, IMAU

WAIS Workshop Organizing Committee

NASA/NSF Funding

