

Changes in Antarctic surface mass balance since 1979

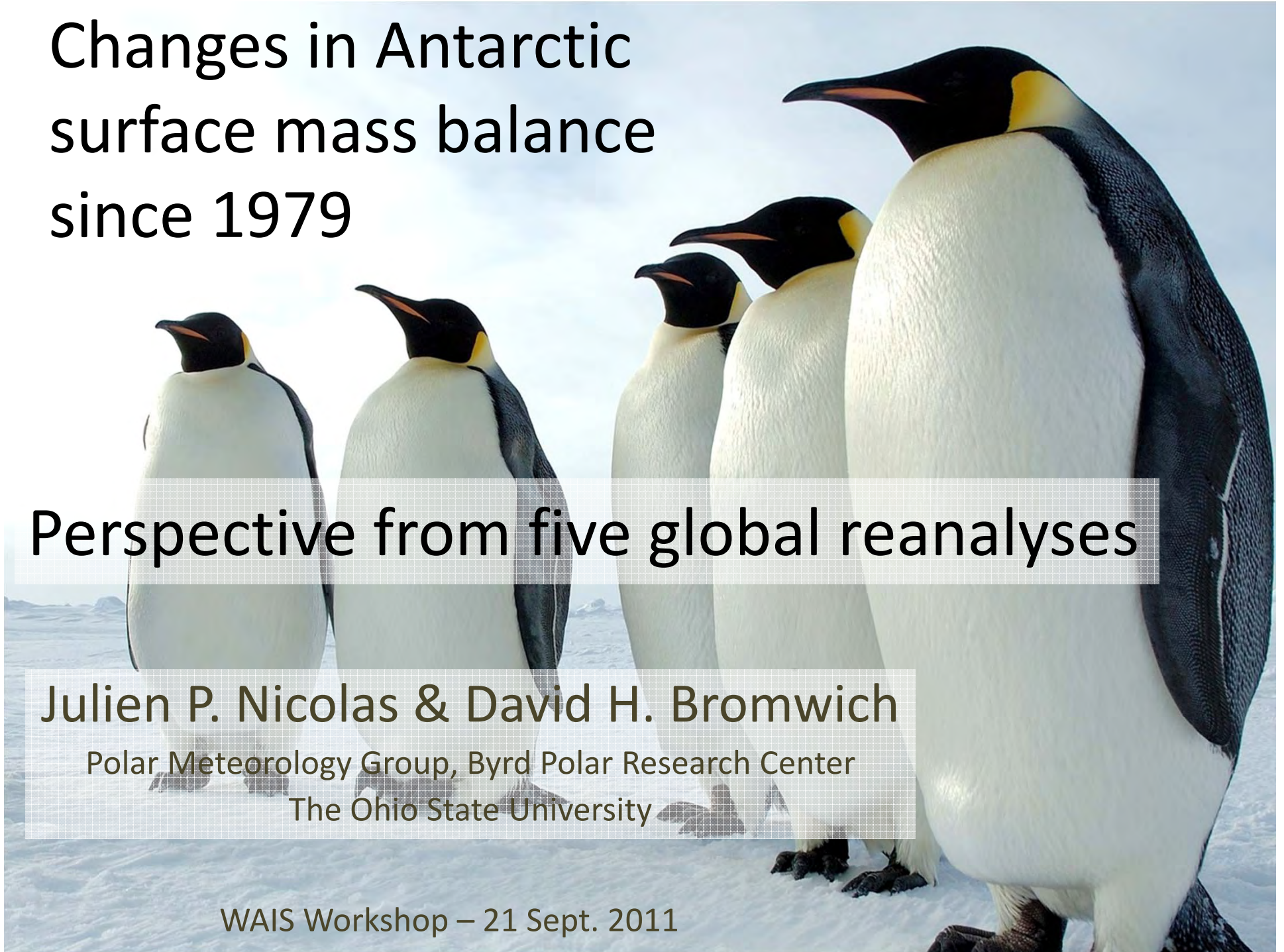
Perspective from five global reanalyses

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Polar Meteorology Group, Byrd Polar Research Center

The Ohio State University

WAIS Workshop – 21 Sept. 2011



Background & Motivations



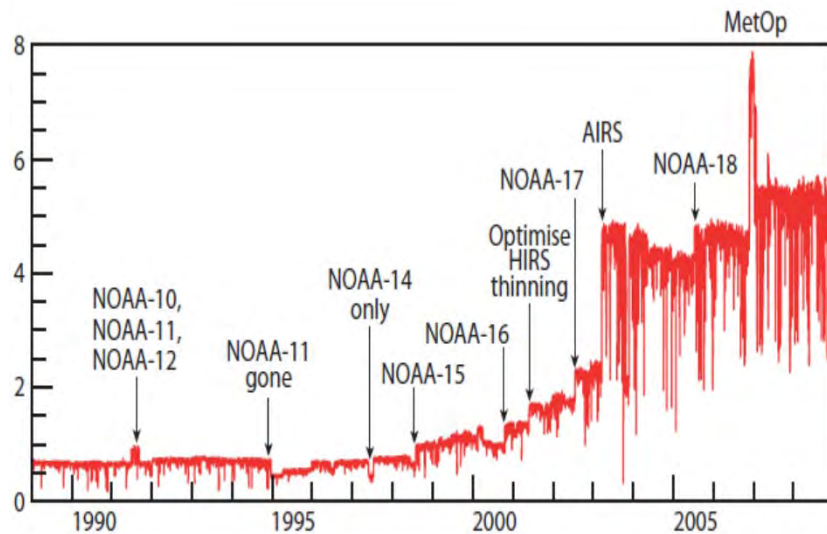
- Reanalyses known to contain spurious trends caused by changes in the observing system.

What's the status of the recent reanalyses?

Background & Motivations

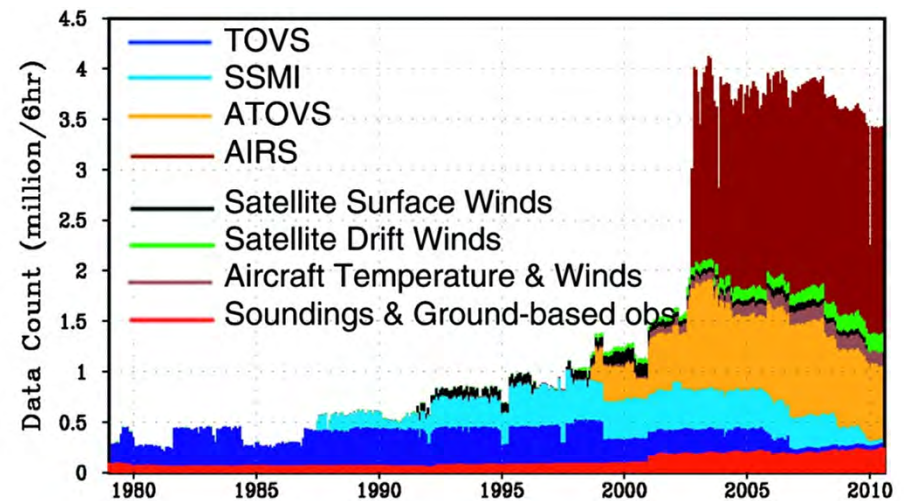
- Dramatic increase in the number of observations assimilated into the reanalyses

ERA-Interim



[Dee et al., 2009, *ECMWF Newsllett.*]

MERRA



[Rienecker et al., 2011, *J. Climate*]

Background & Motivations



- Reanalyses known to contain spurious trends caused by changes in the observing system.

What's the status of the recent reanalyses?

Background & Motivations



- Reanalyses known to contain spurious trends caused by changes in the observing system.

What's the status of the recent reanalyses?

- Assessment of precipitation and atmospheric circulation in global reanalyses in high southern latitudes during 1989-2009 (*J. Climate*)

Here, analysis extended back to 1979

Method



- Comparison of the time series & trends in:
 - Precipitation (P)
 - Precipitation-minus-Evaporation (P-E)
 - 2-m Temperature (T2m)

Datasets

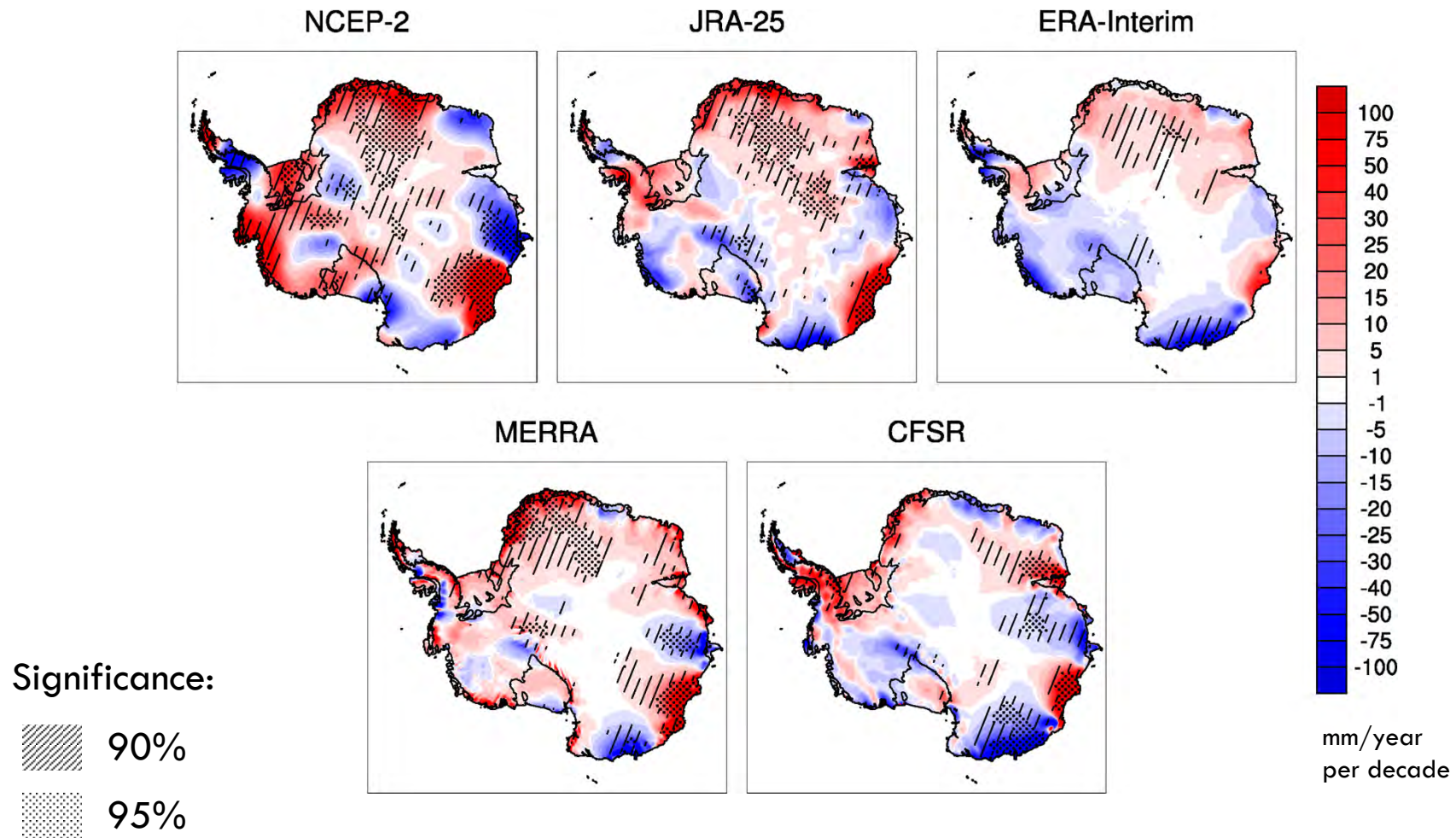


- **NCEP2** (NCEP/DOE)
- **JRA-25** (Japan Meteorological Agency)
- **ERA-Interim** (ECMWF)
- **MERRA** (NASA)
- **CFSR** (NCEP)

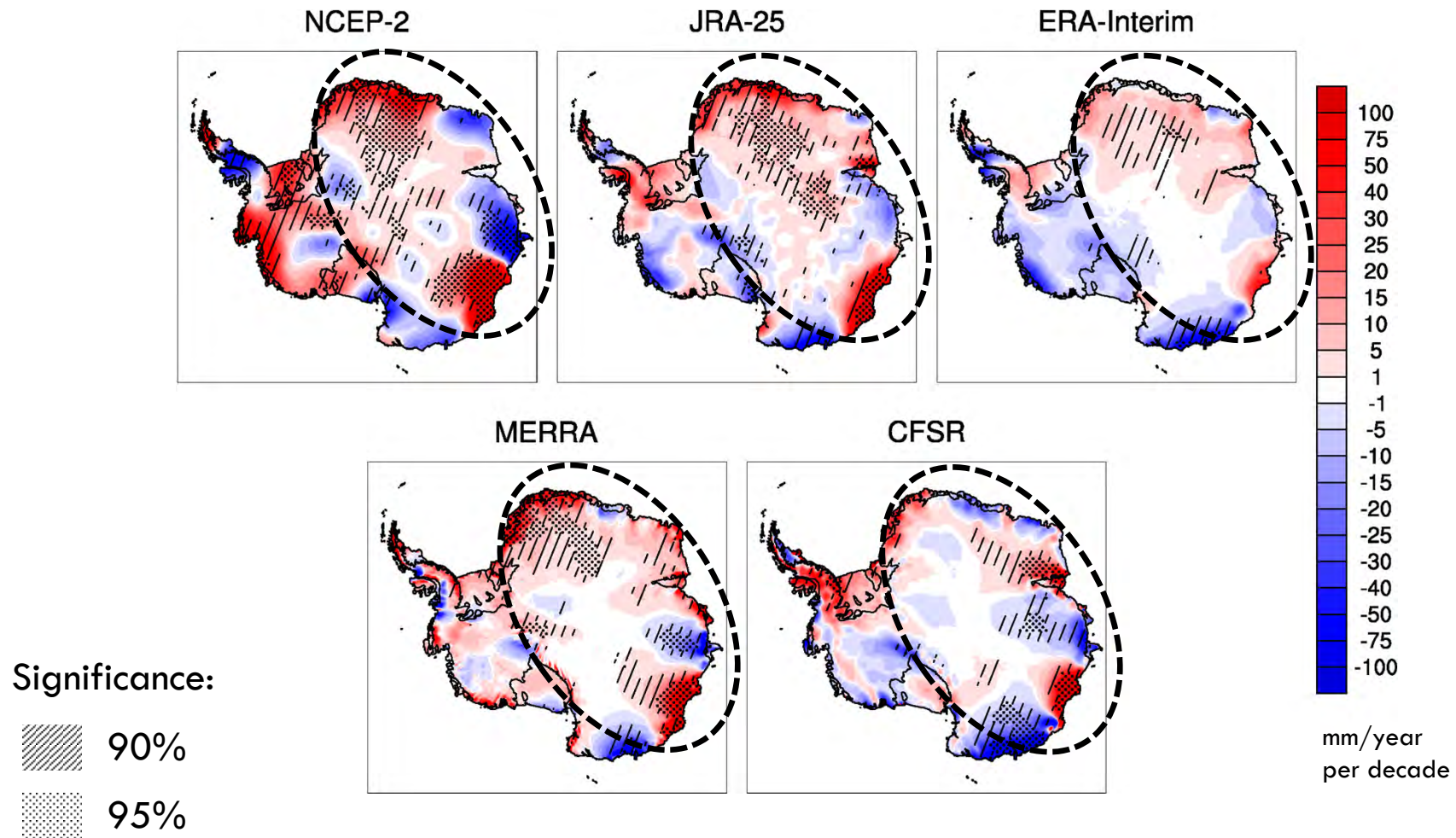
Precipitation & P-E



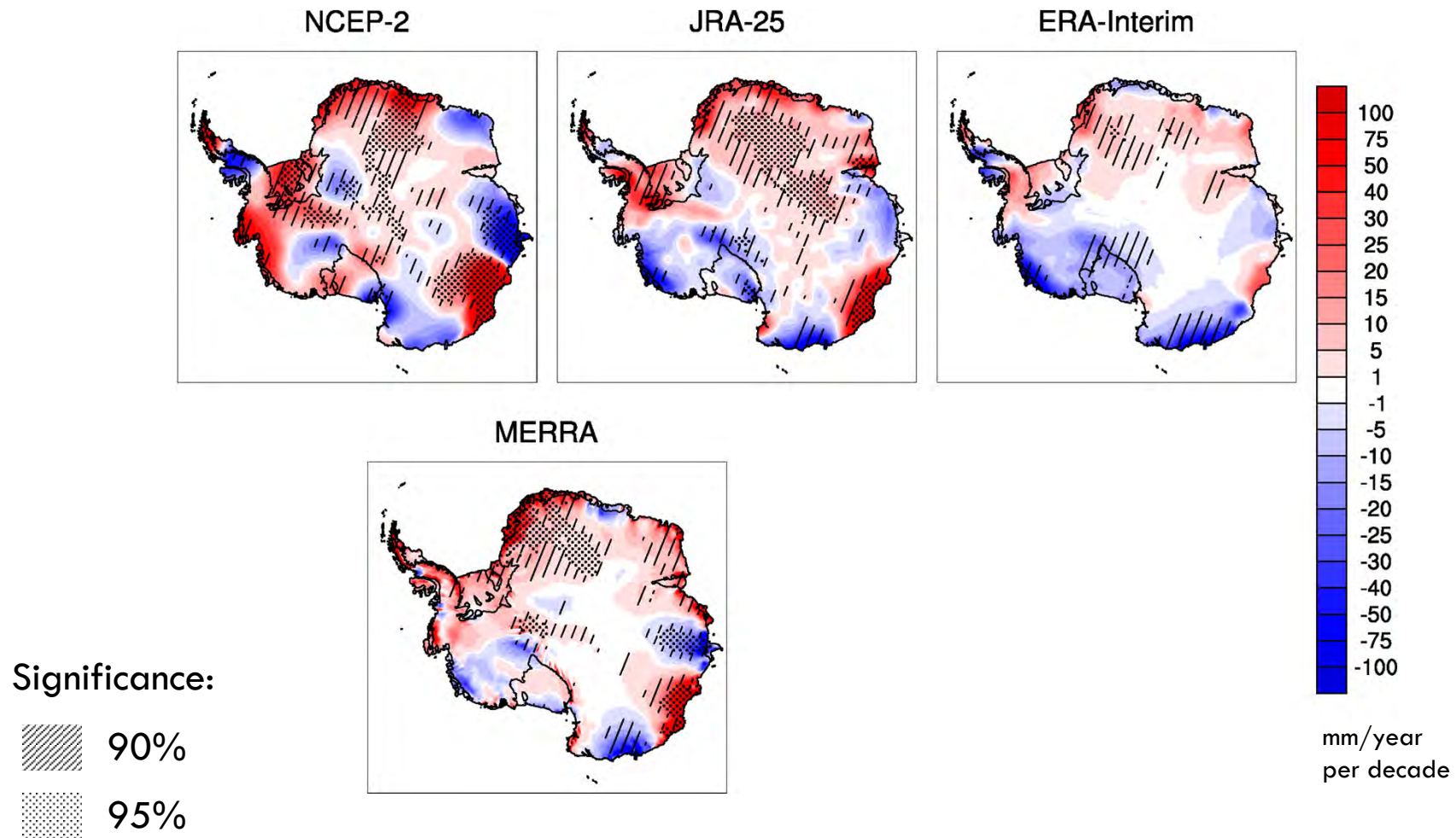
Trends in annual P-E (1979-2009)



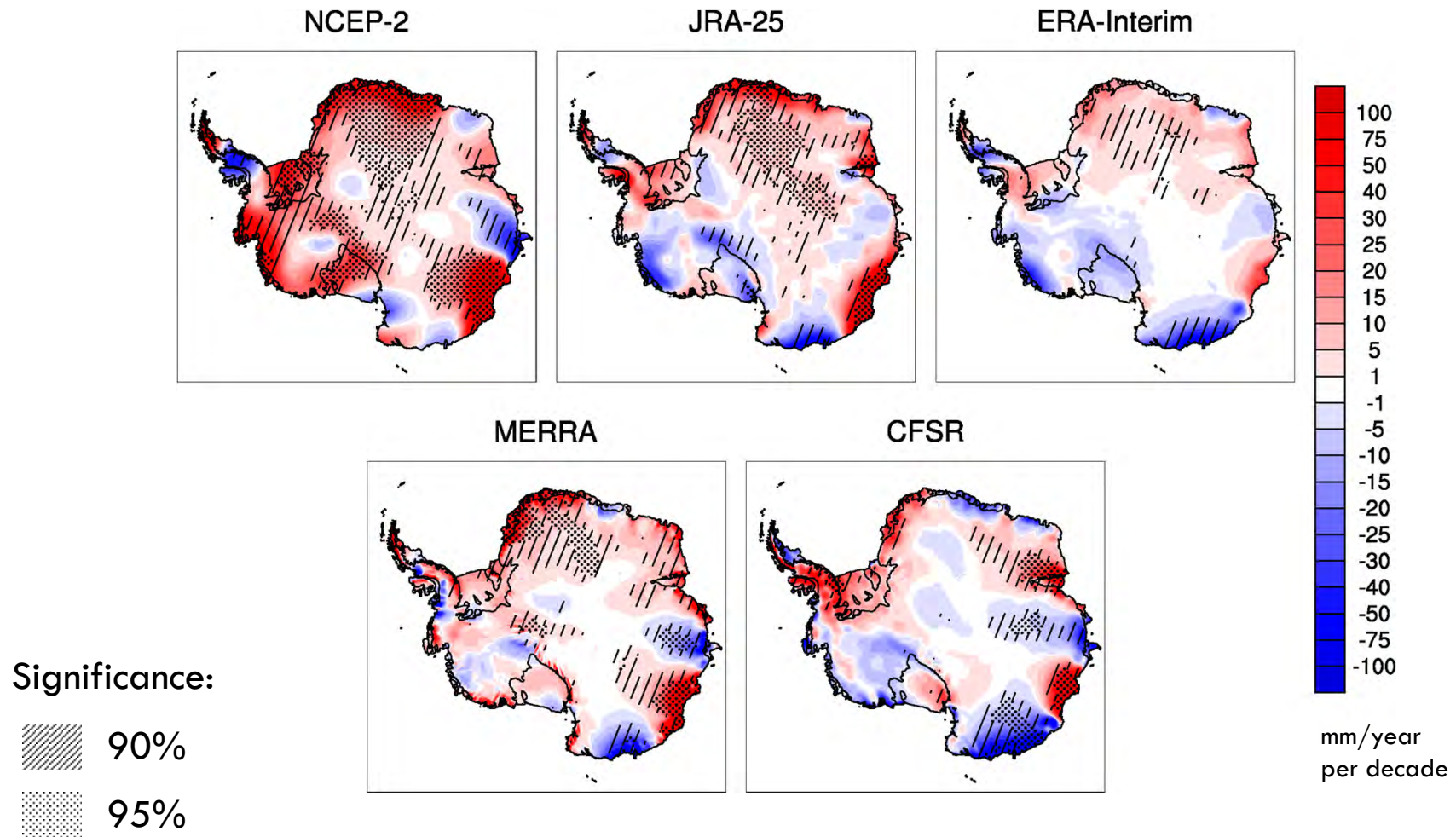
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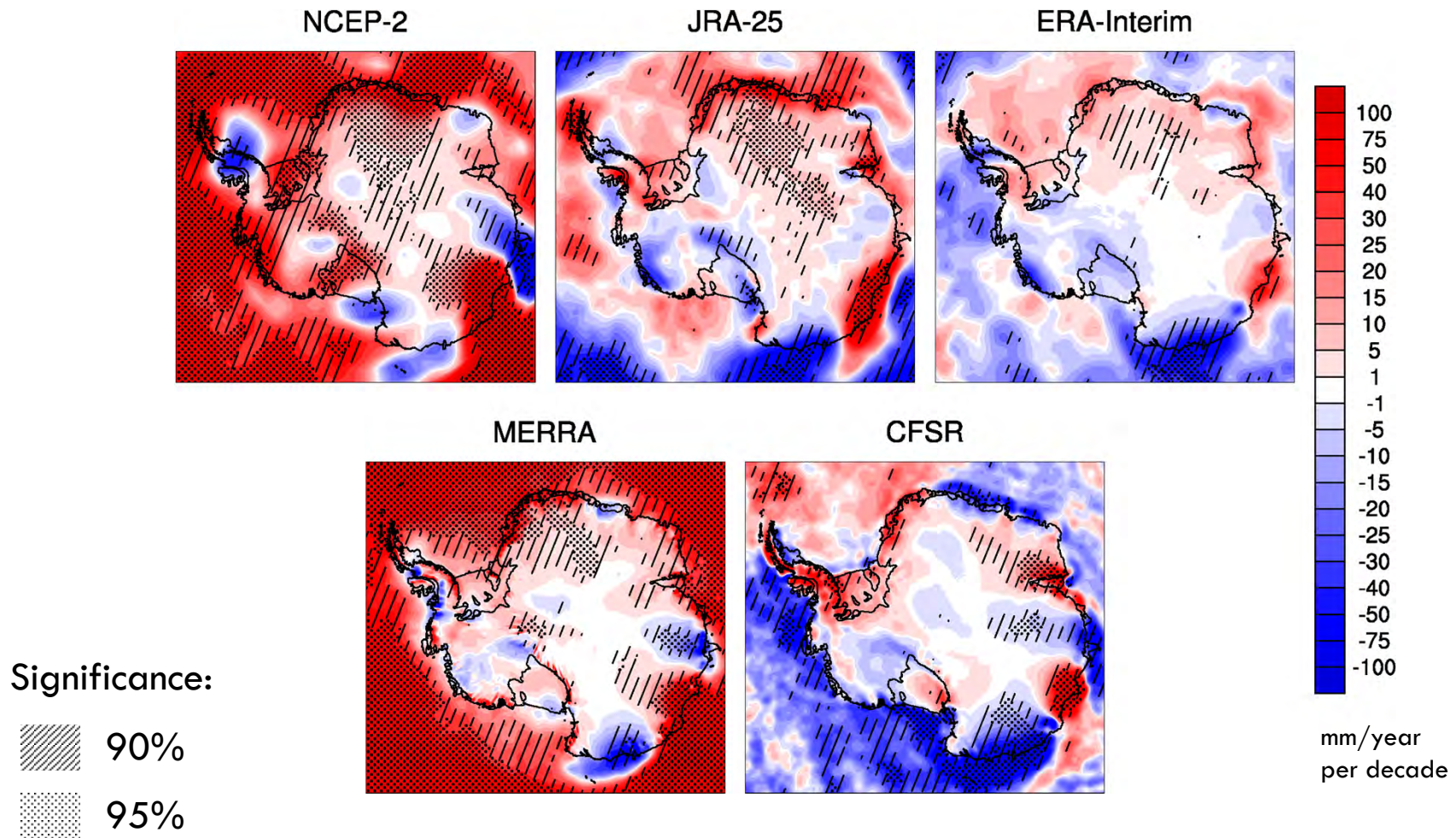
Trends in annual P-E (1979-2010)



Trends in annual P (1979-2009)



Trends in annual P (1979-2009)

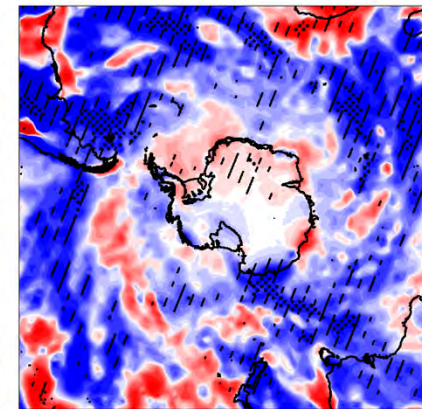
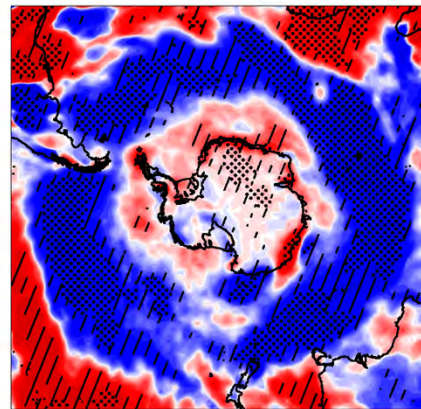
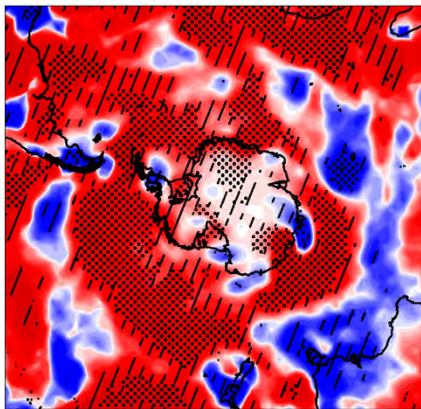


Trends in annual P (1979-2009)

NCEP-2

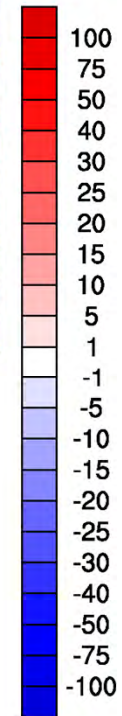
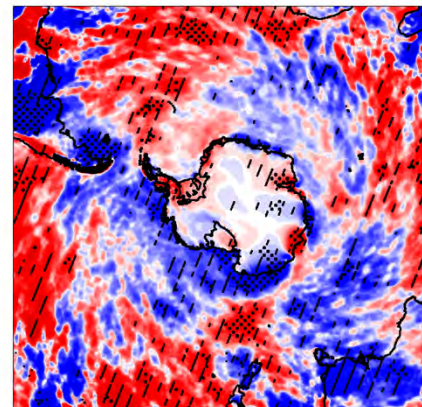
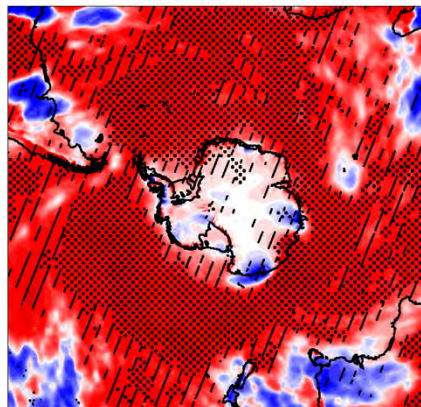
JRA-25

ERA-Interim



MERRA

CFSR



mm/year
per decade

Significance:

 90%

 95%

Trends in annual P (1979-2009)

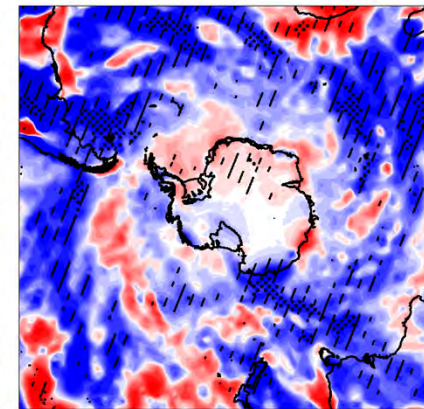
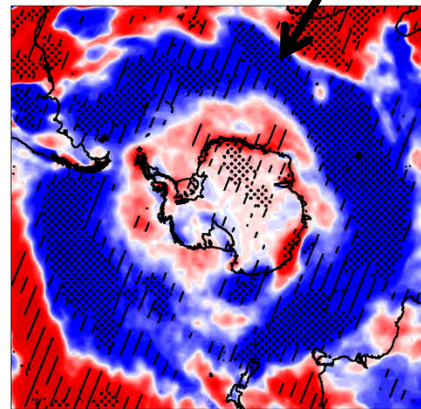
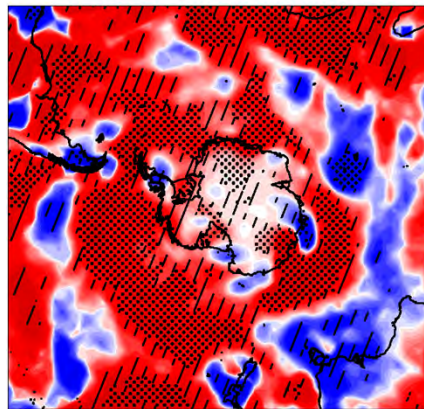


SSM/I
(1987)

NCEP-2

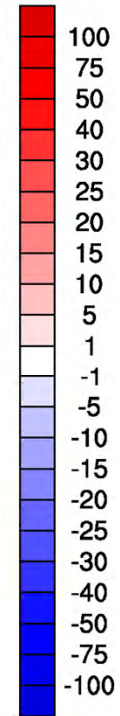
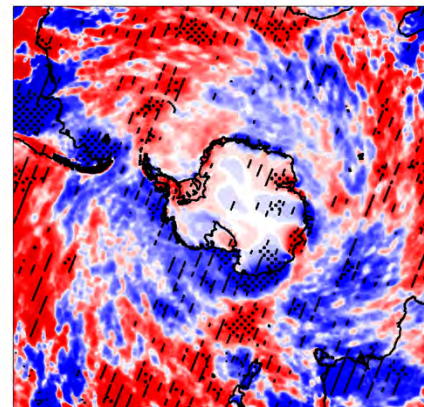
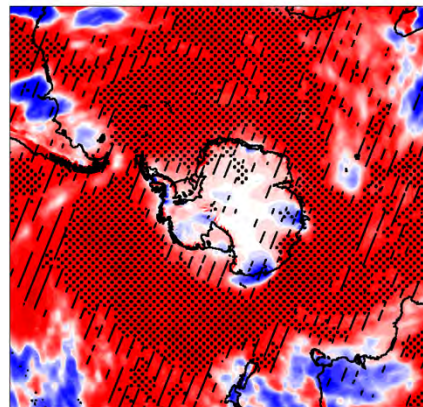
JRA-25

ERA-Interim



MERRA

CFSR



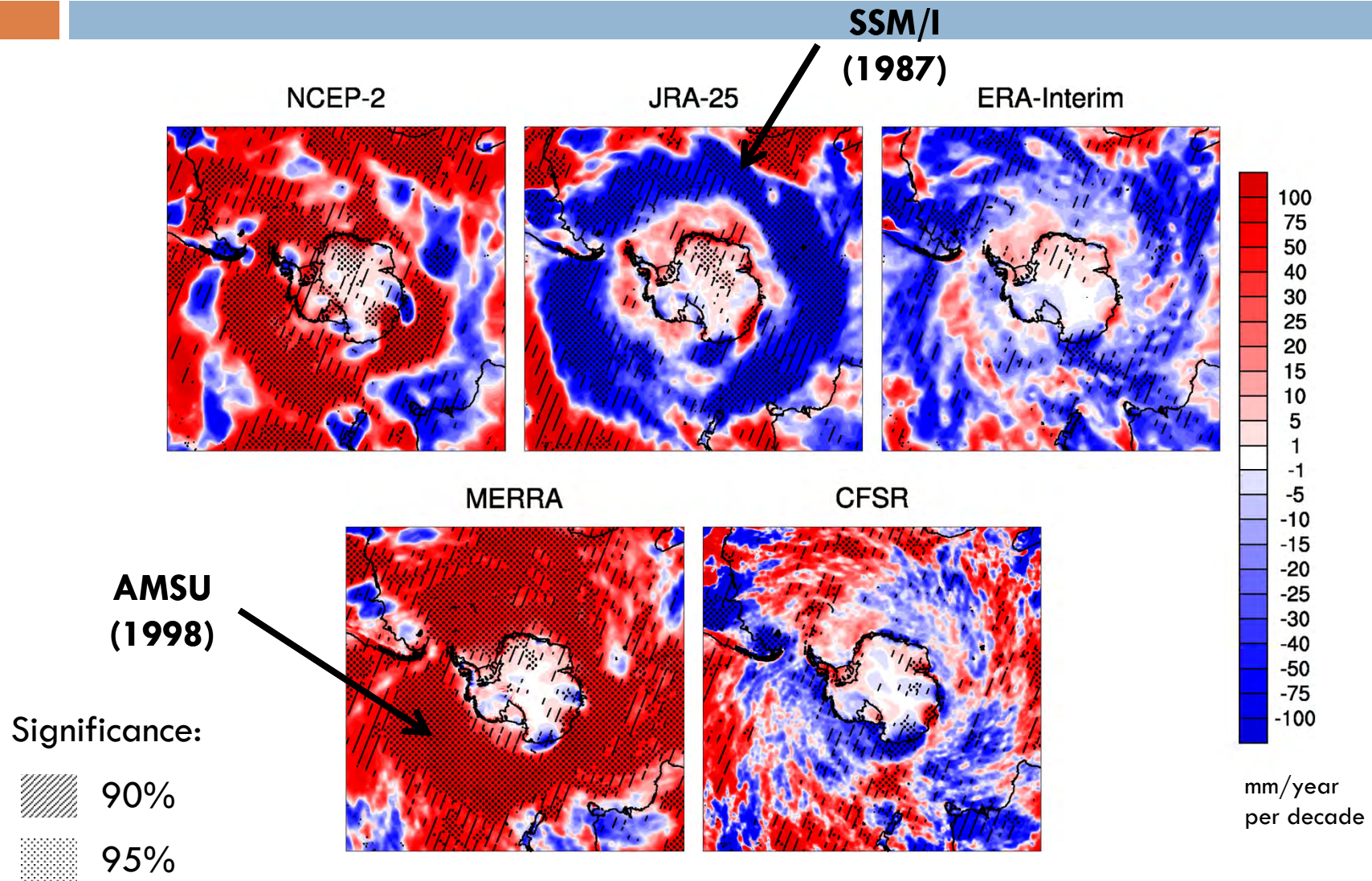
mm/year
per decade

Significance:

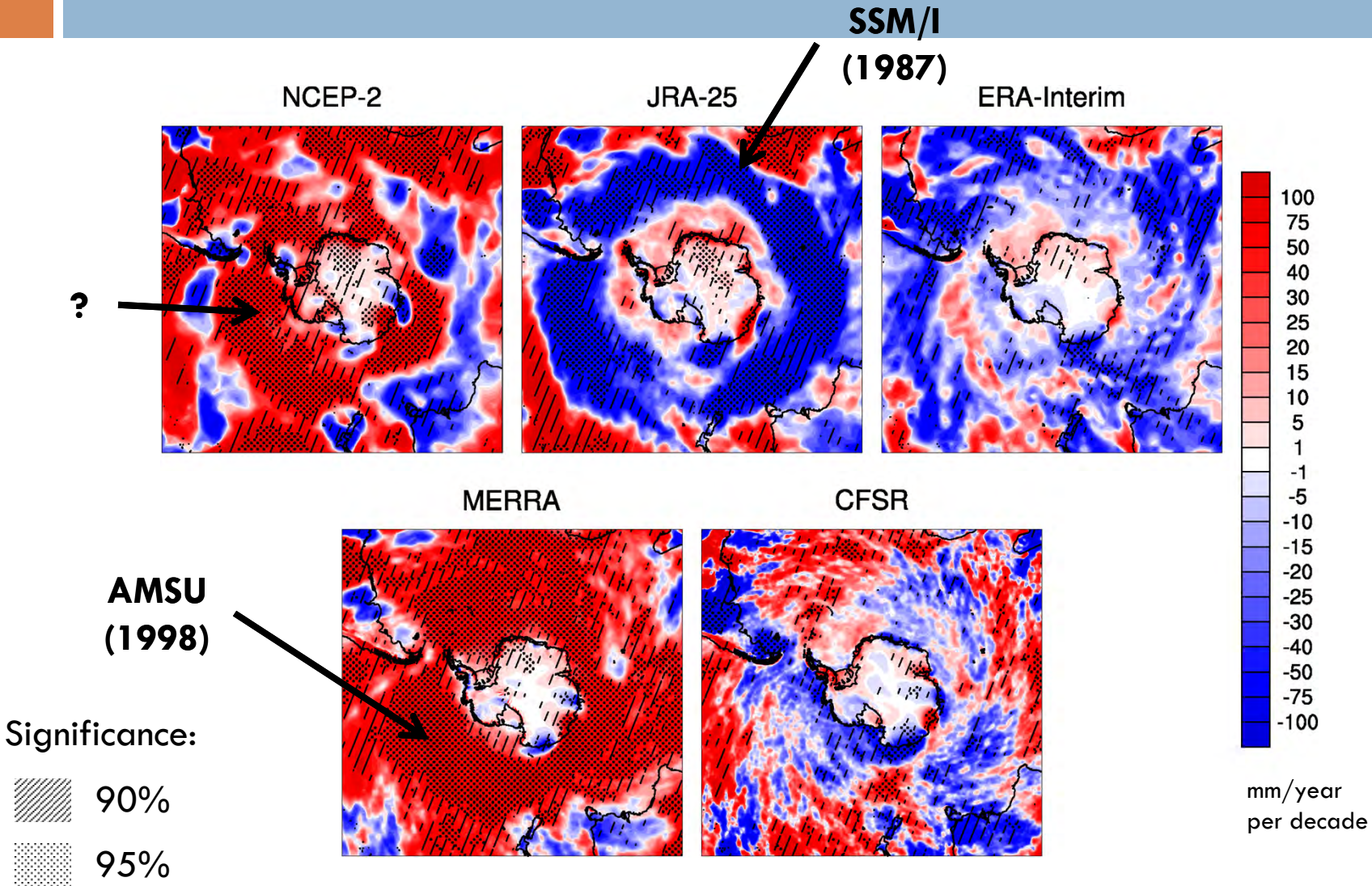
 90%

 95%

Trends in annual P (1979-2009)

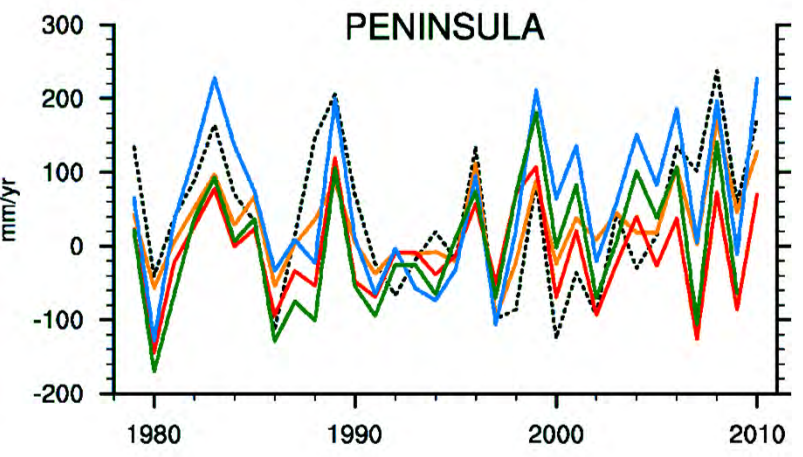
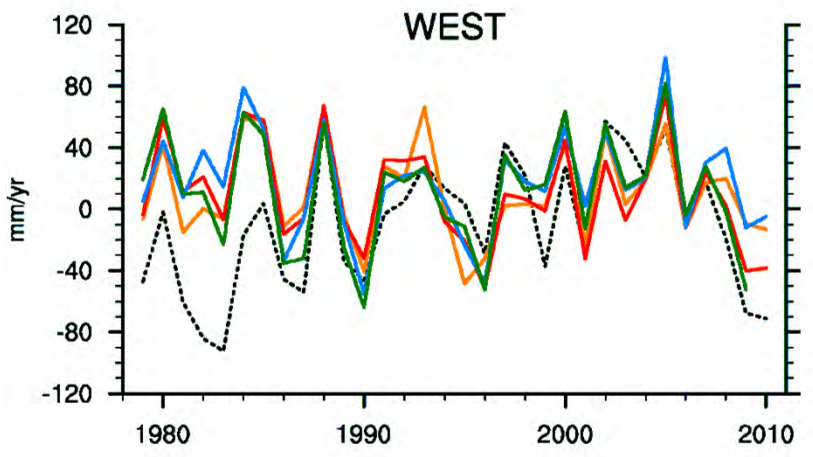
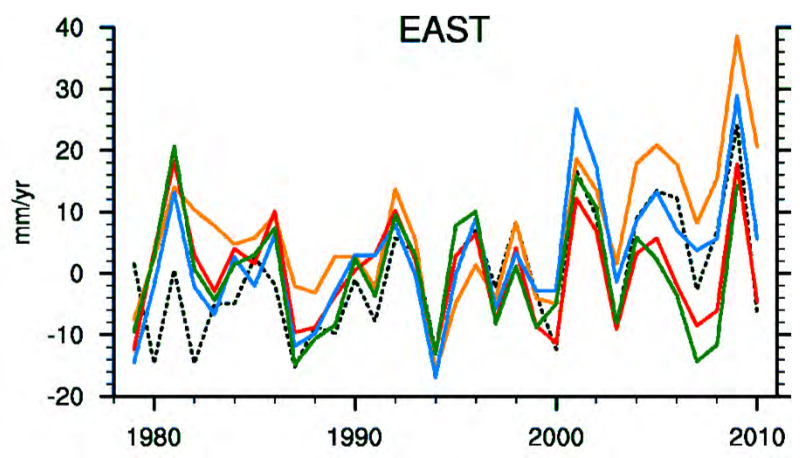
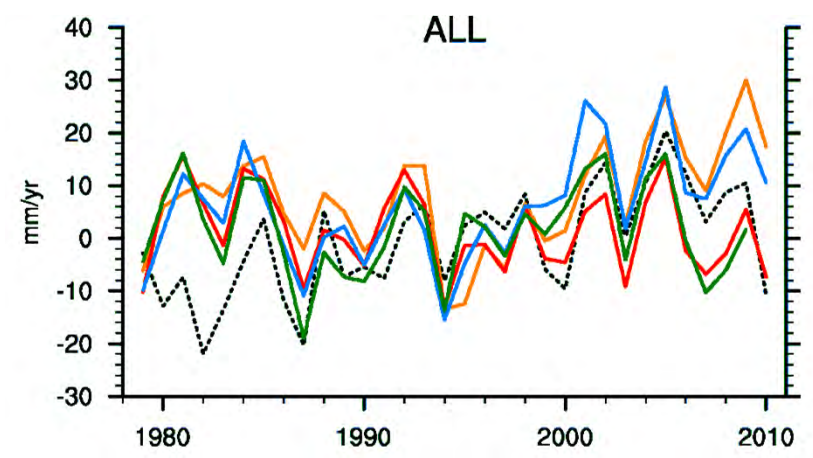


Trends in annual P (1979-2009)



Annual P-E time series

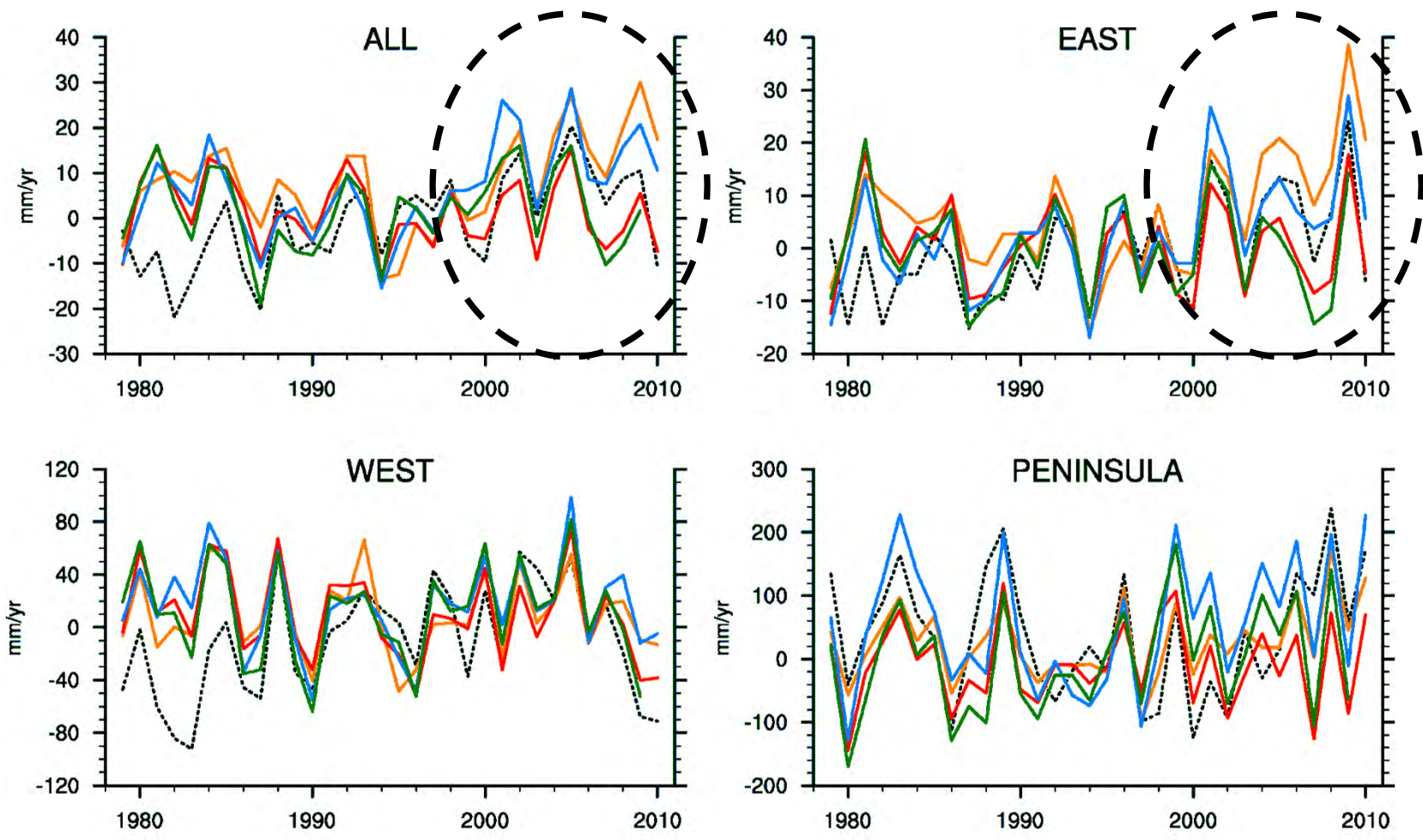
- NCEP-2
- JRA-25
- ERA-Interim
- MERRA
- CFSR



Anomalies with respect to the 1990-1999 mean

Annual P-E time series

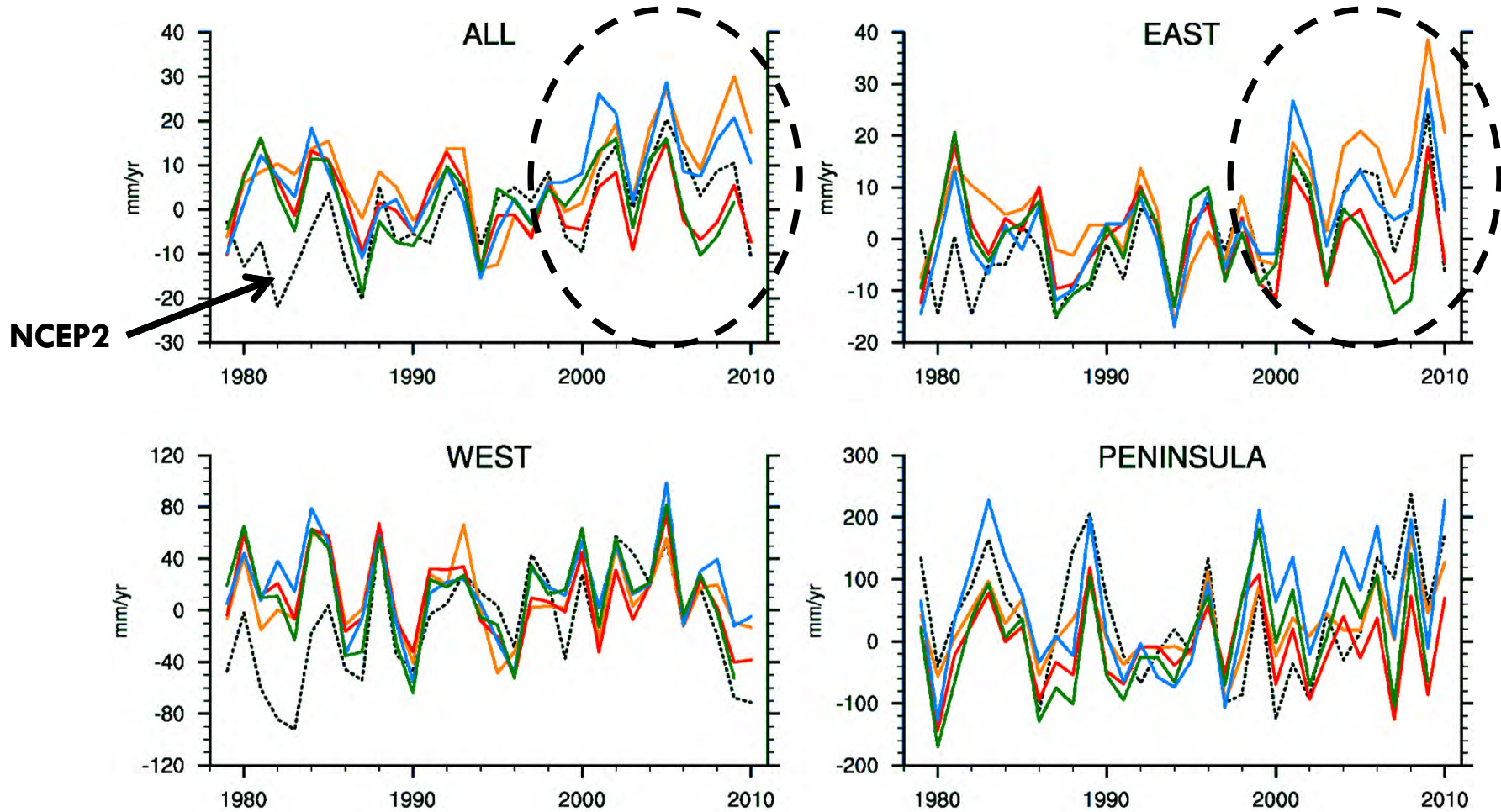
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Anomalies with respect to the 1990-1999 mean

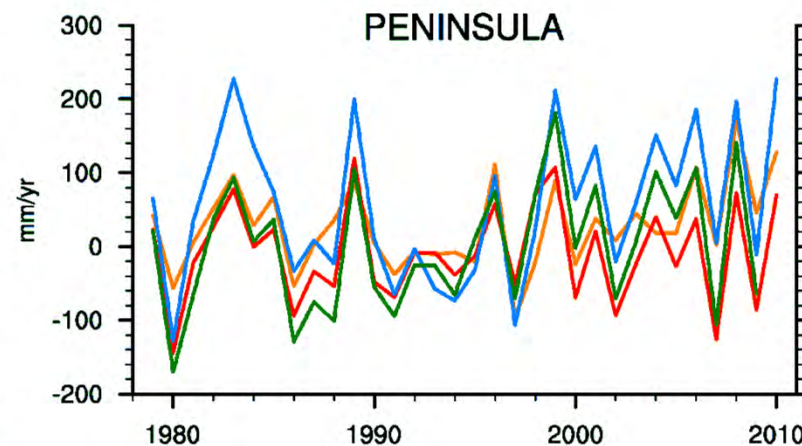
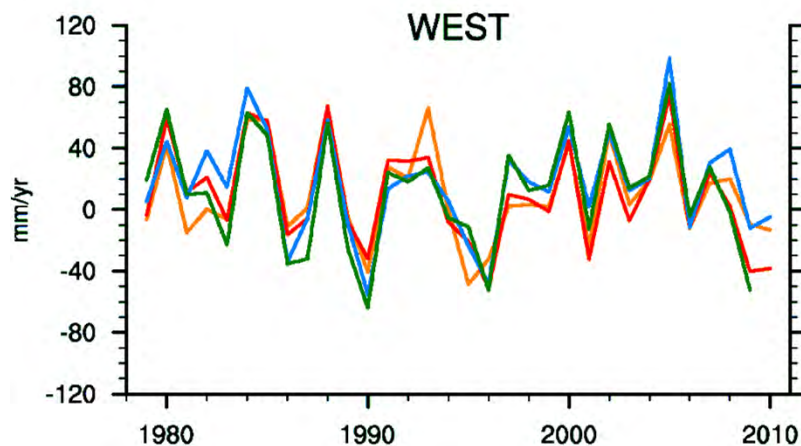
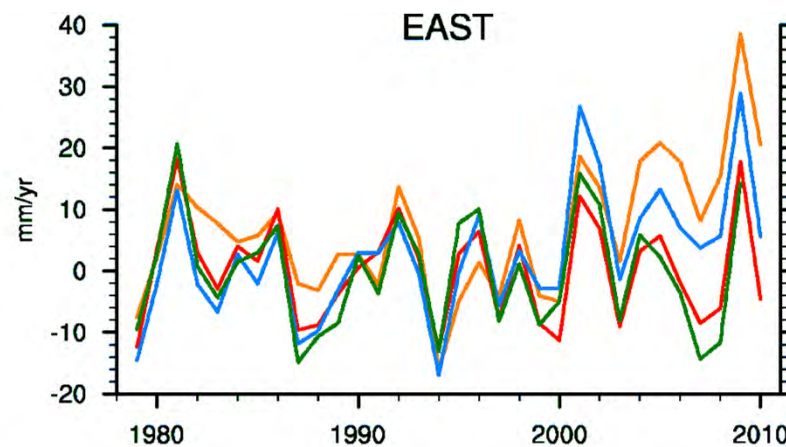
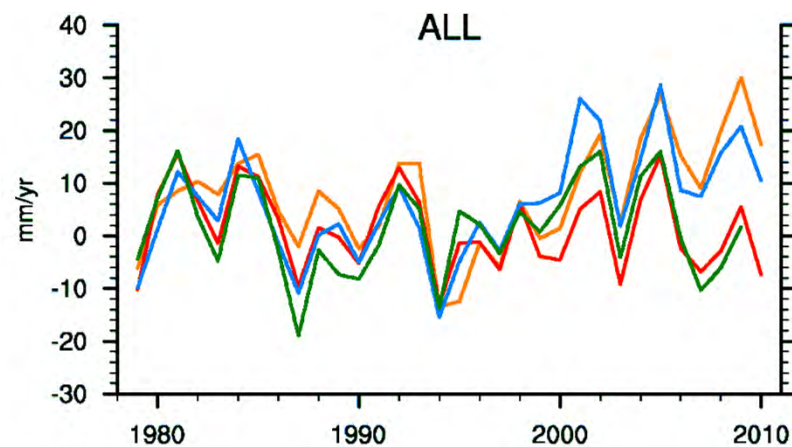
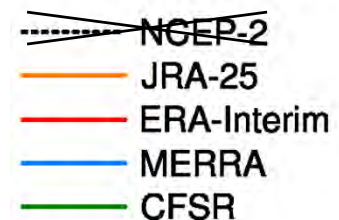
Annual P-E time series

- NCEP-2
- JRA-25
- ERA-Interim
- MERRA
- CFSR



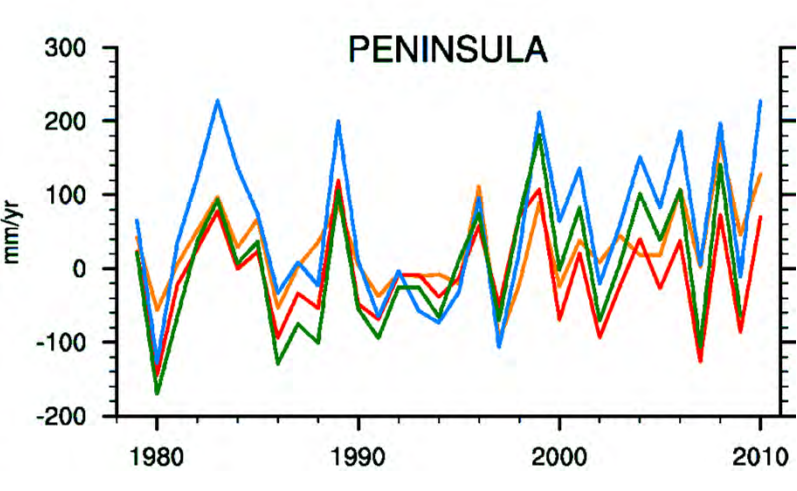
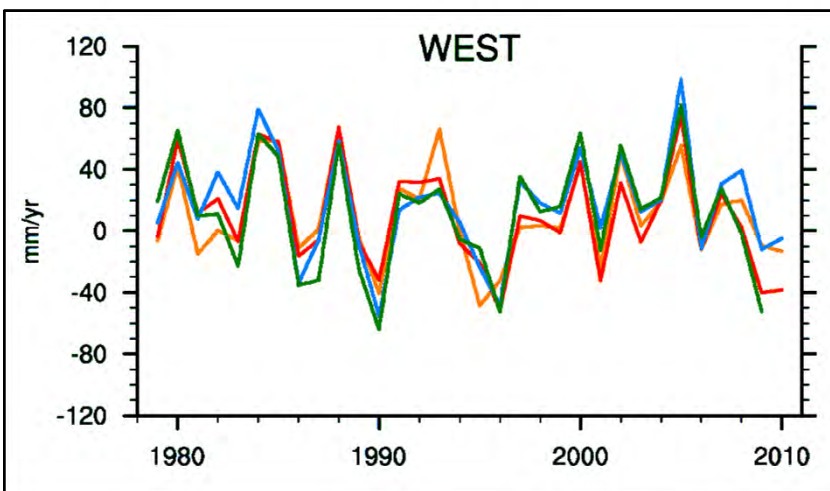
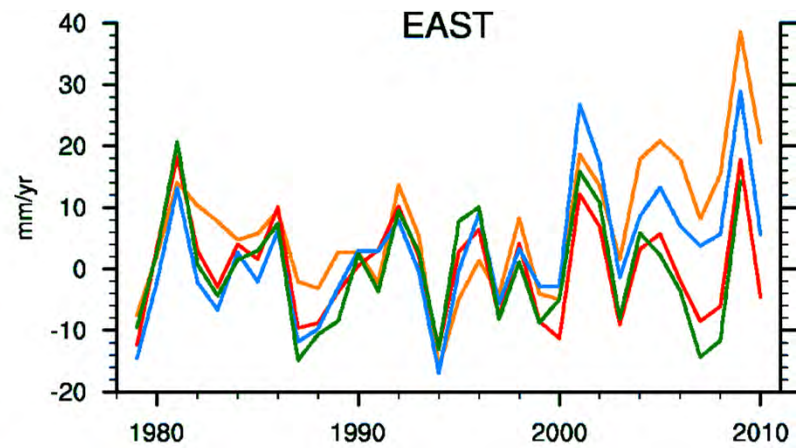
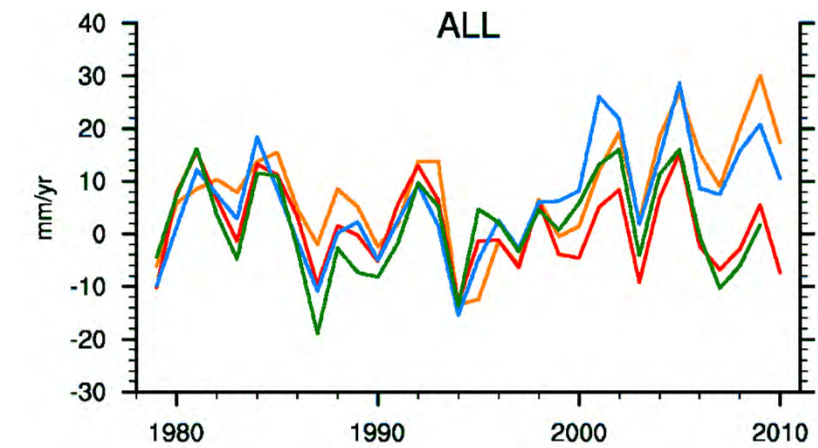
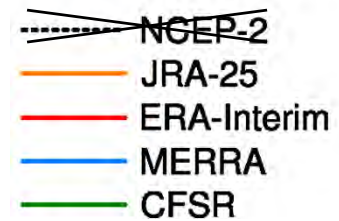
Anomalies with respect to the 1990-1999 mean

Annual P-E time series



Anomalies with respect to the 1990-1999 mean

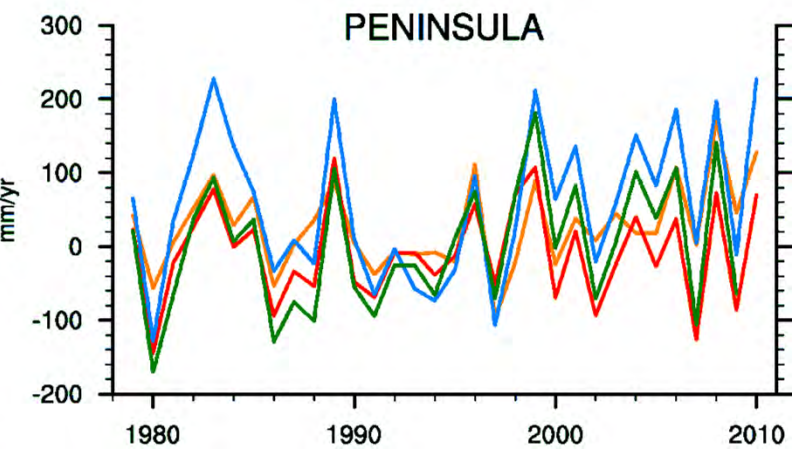
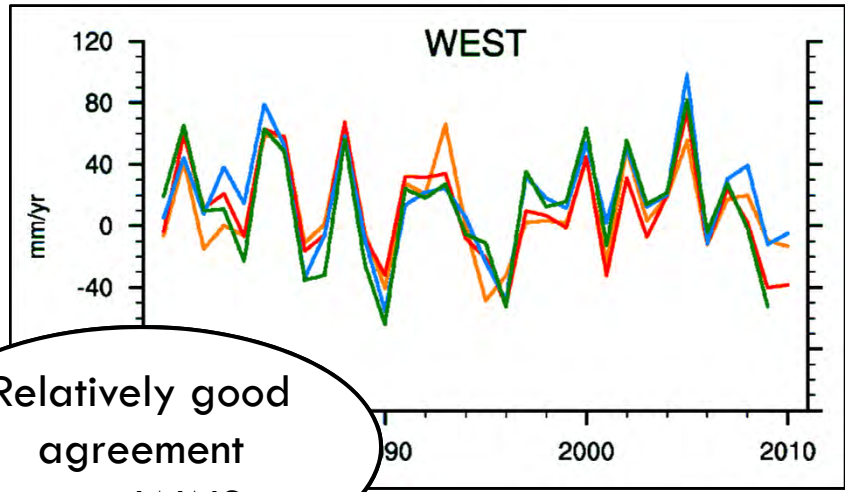
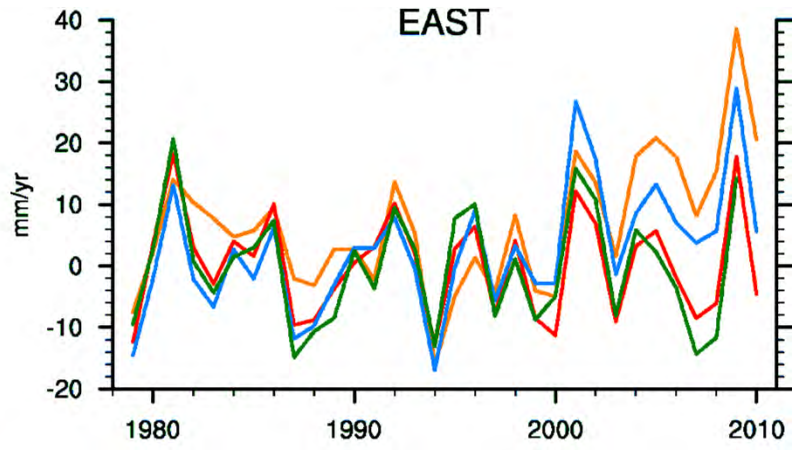
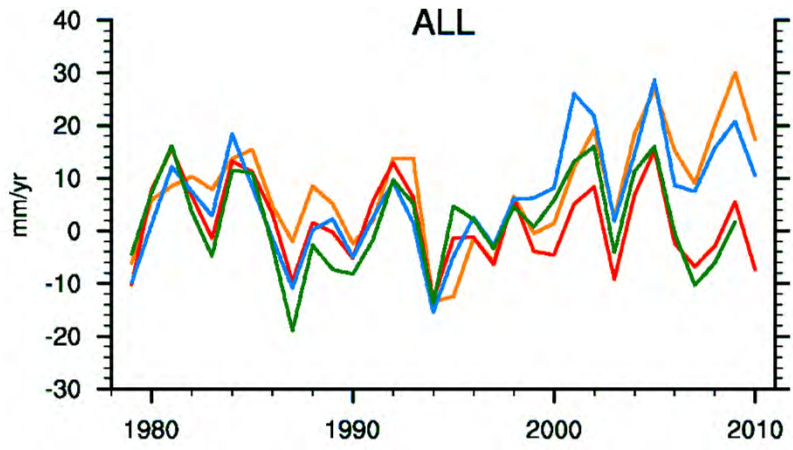
Annual P-E time series



Anomalies with respect to the 1990-1999 mean

Annual P-E time series

- NCEP-2
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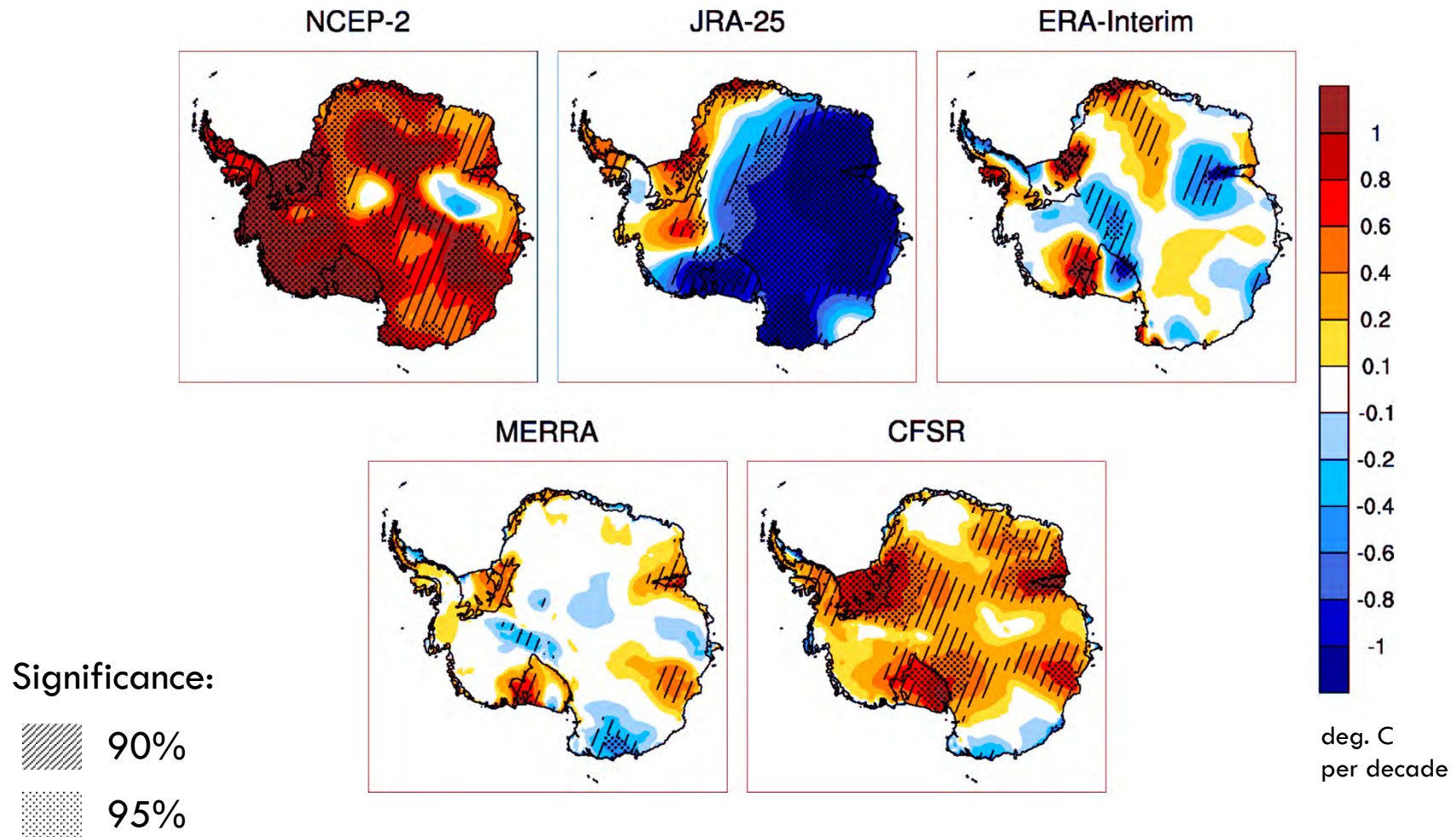
Relatively good agreement over WAIS

Anomalies with respect to the 1990-1999 mean

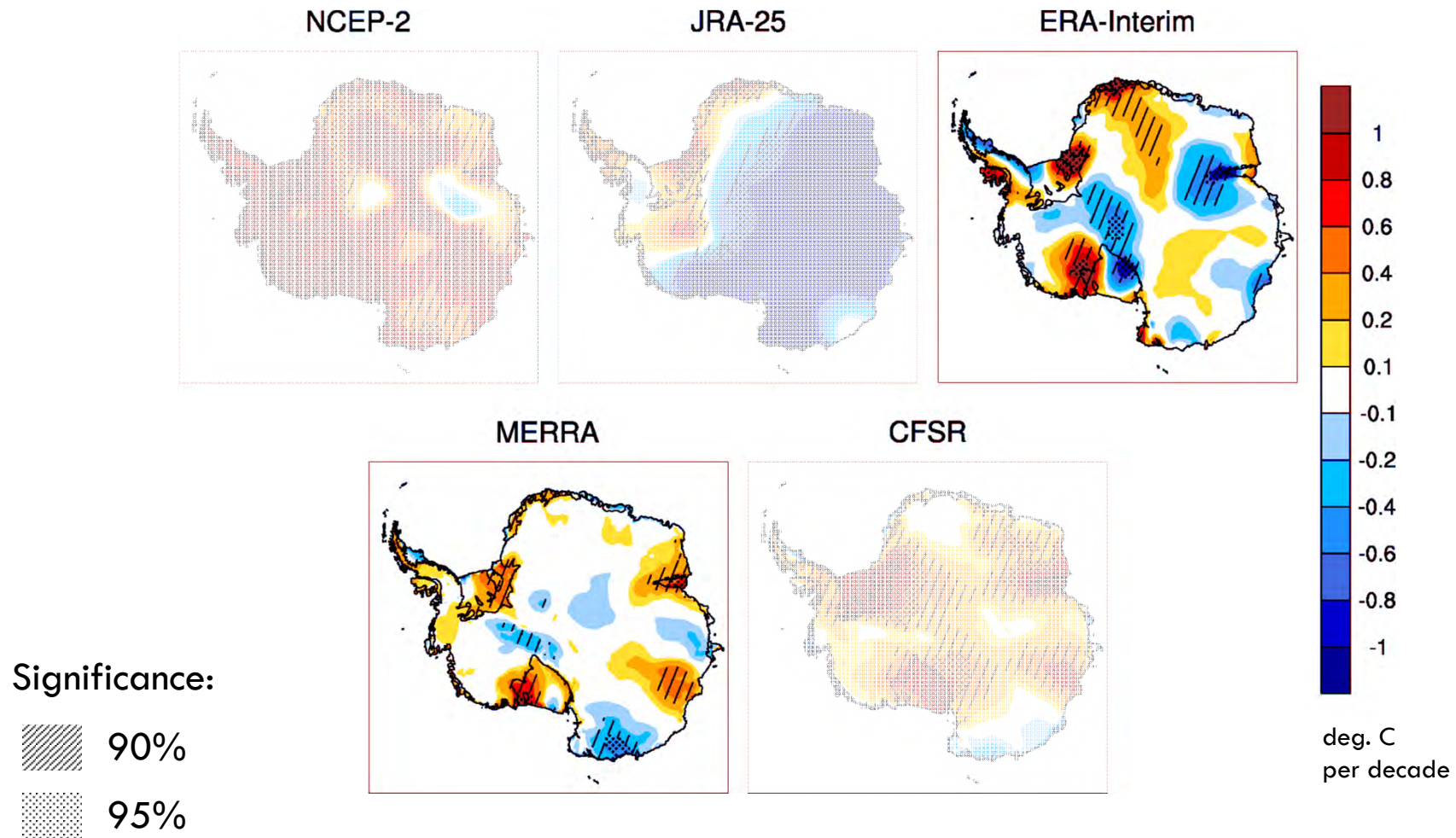
2-m temperature



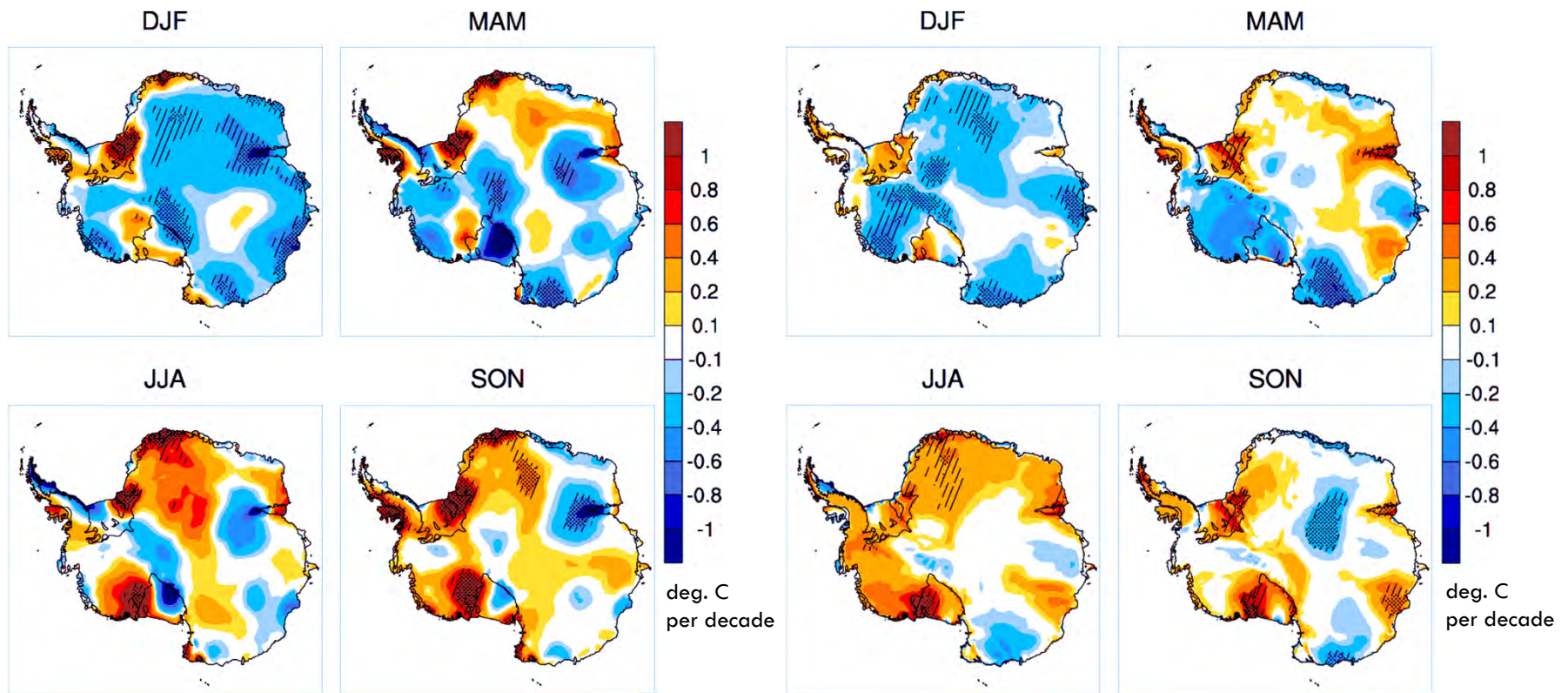
Trends in mean annual T2m (1979-2009)



Trends in mean annual T2m (1979-2009)



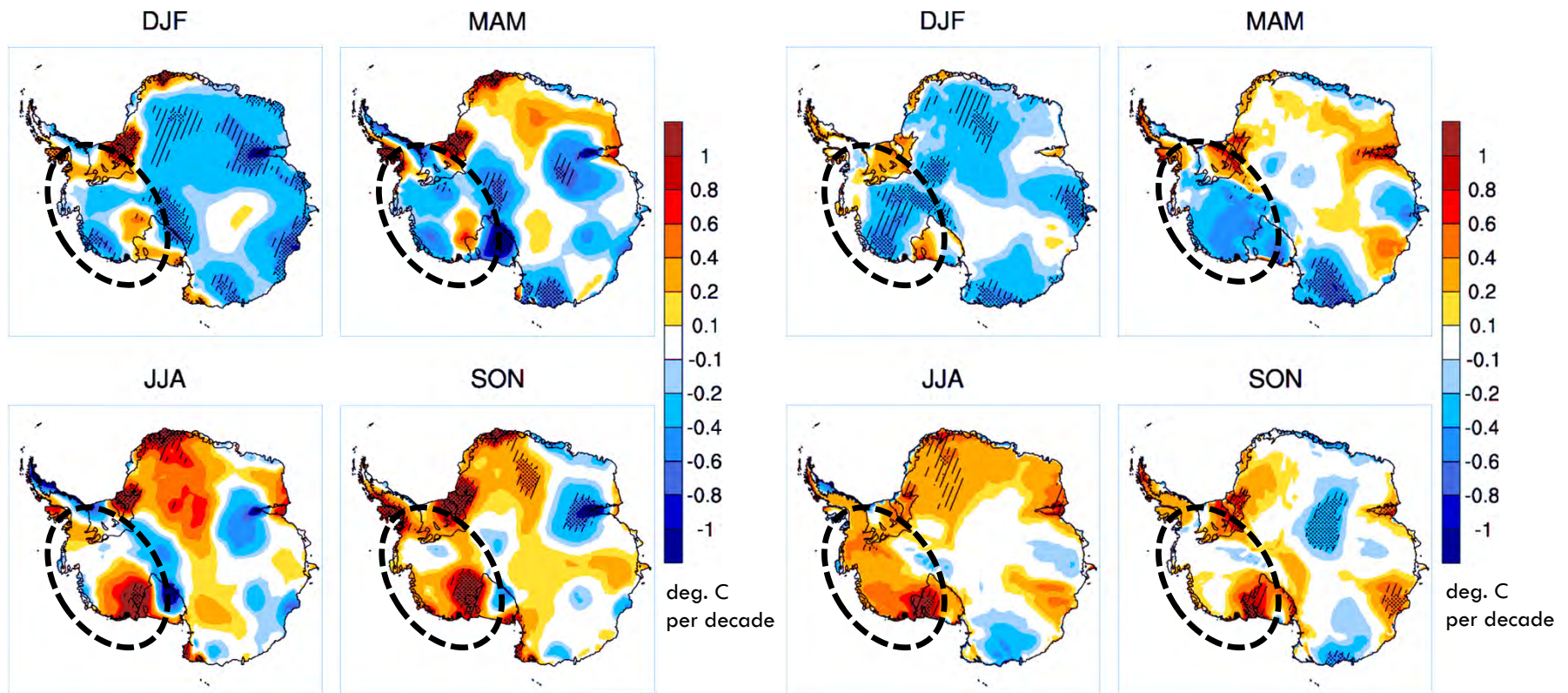
Trends in mean seasonal T2m (1979-2010)



ERA-Interim

MERRA

Trends in mean seasonal T2m (1979-2010)

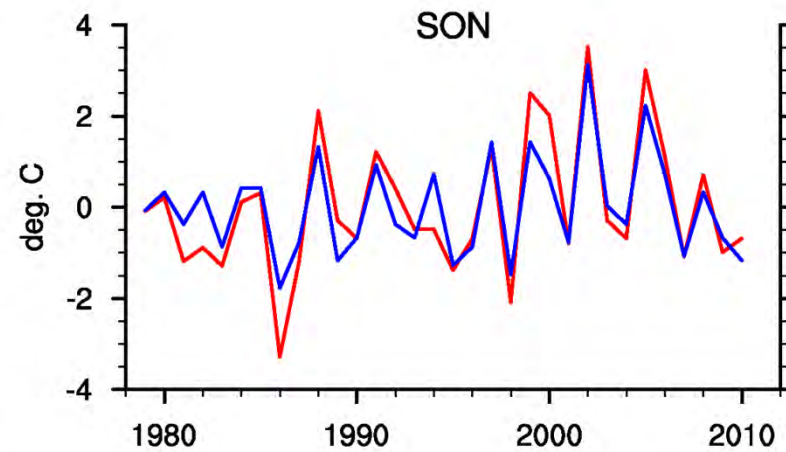
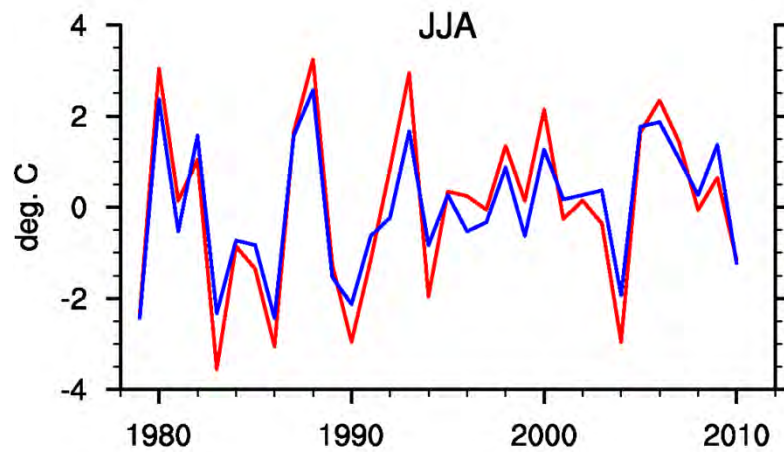
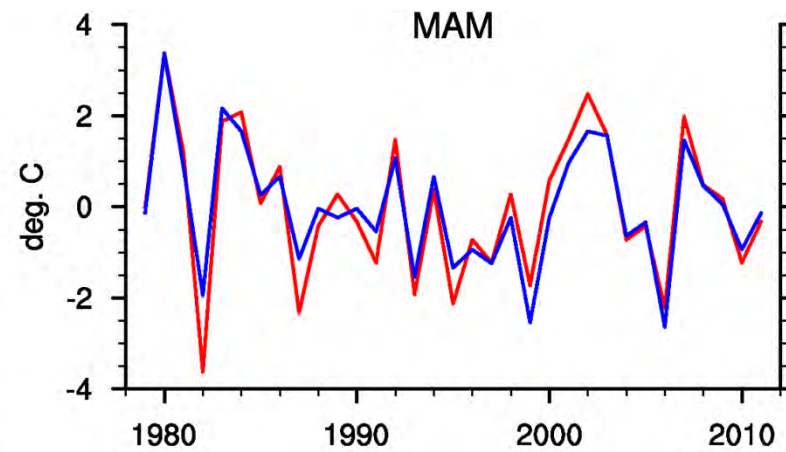
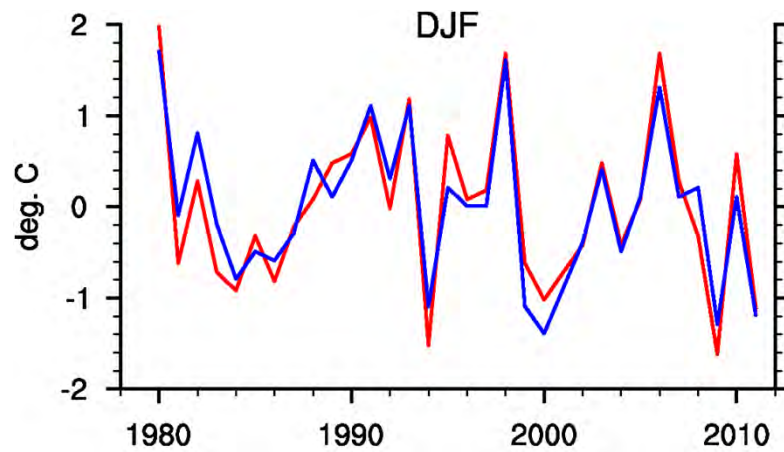


ERA-Interim

MERRA

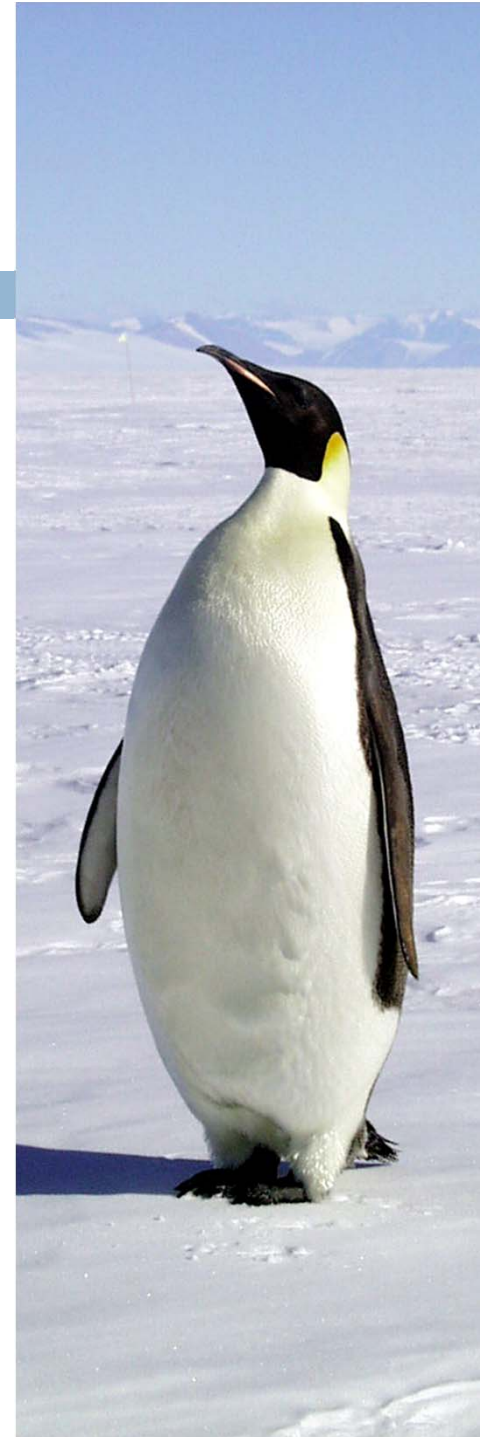
Seasonal T2m time series (WAIS only)

— ERA-Interim
— MERRA



Conclusions

- Cautious use of the global reanalyses for trend analysis
- ERA-Interim provides the most realistic trends in P-E and T2m for 1979-2010
- Results over WAIS:
 - ▣ Insignificant change in annual P and P-E
 - ▣ Trends in T2m generally not significant except over Siple Coast (warming) in winter and spring
- Paper: Bromwich et al., 2011: An assessment of precipitation changes over Antarctica and the Southern Ocean since 1989 in contemporary global reanalyses. *J. Climate*, 24, 4189–4209



Questions?



Photo by Glenn Grant

Additional figures

Reanalysis	Organization	Time coverage	Horizontal resolution	Vertical levels	Assimilation system	Satellite data used ^a
NCEP-2	NCEP/DOE	1979–present	T62, ~210 km	28	3DVAR	Retrievals
ERA-40	ECMWF	1957–Aug 2002	T159, ~125 km	60	3DVAR	Radiances
JRA-25	JMA/ CRIEPI	1979–present	T106, ~125 km	40	3DVAR	Radiances + VarBC ^b
ERA-Interim	ECMWF	1989–present	T255, ~80 km	60	4DVAR	Radiances + VarBC
MERRA	NASA GMAO	1979–present	$\frac{1}{2}^\circ \times \frac{2}{3}^\circ$, ~55 km ^c	72	3DVAR	Radiances + VarBC
CFSR	NCEP	1979–present	T382, ~38 km	64	3DVAR	Radiances + VarBC

^a VarBC: Variational bias correction of satellite radiances.

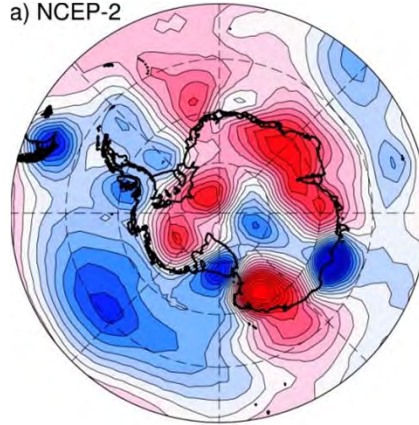
^b JRA-25 used VarBC with TOVS and static bias correction with ATOVS radiances (Onogi et al. 2007).

^c Resolution in latitude.

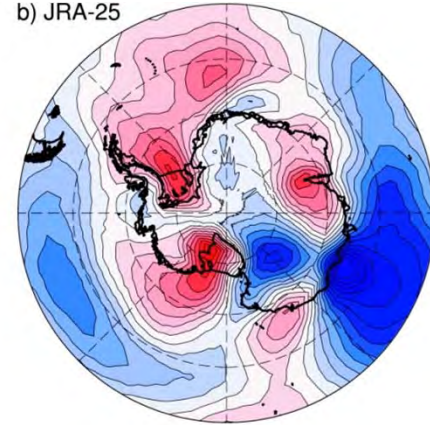
From Bromwich et al., 2011, *J. Climate*

1989–2009 trends in surface pressure (units: hPa per decade)

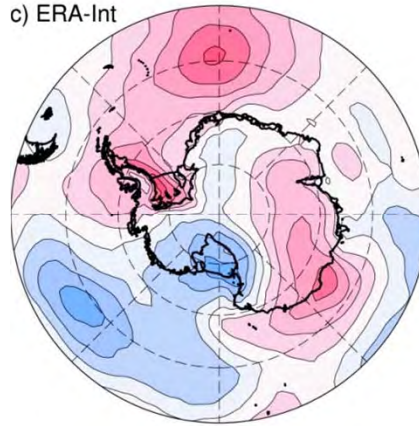
a) NCEP-2



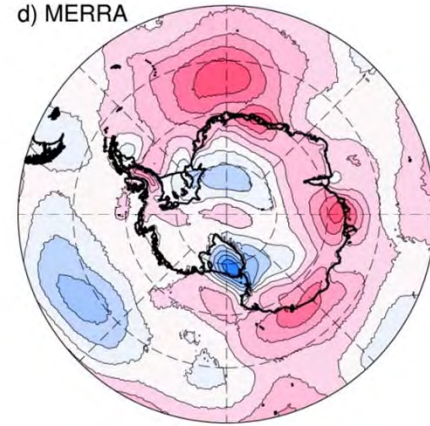
b) JRA-25



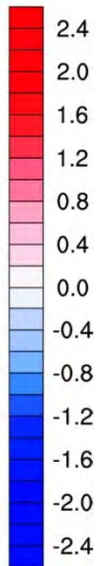
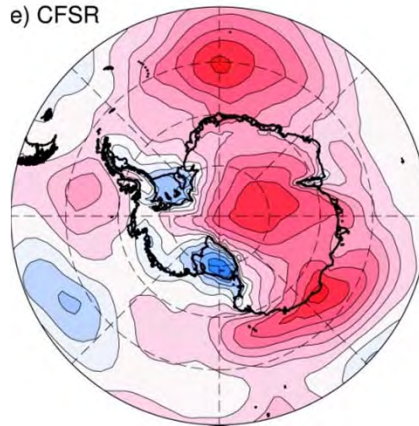
c) ERA-Int



d) MERRA



e) CFSR



From Bromwich et al., 2011, *J. Climate*