Climate Drift in CCSM4 Decadal Prediction Experiments

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CCSM4 Decadal Prediction Experiments

		Hindcast	DART
IC	atm/lnd	20thC, rcp4.5	AMIP
	ocn	Hindcast	DART
	ice	Hindcast (4-yr salinity restoring)	Hindcast (3-mon salinity restoring)
start years		61,66,71,76,81,86,91,96 00,01,02,03,04,05,06 (15 total)	75,80,85,90,95 00,01,02,03,04,05,06 (12 total)
ensemble#		10	
length		10/30 years	

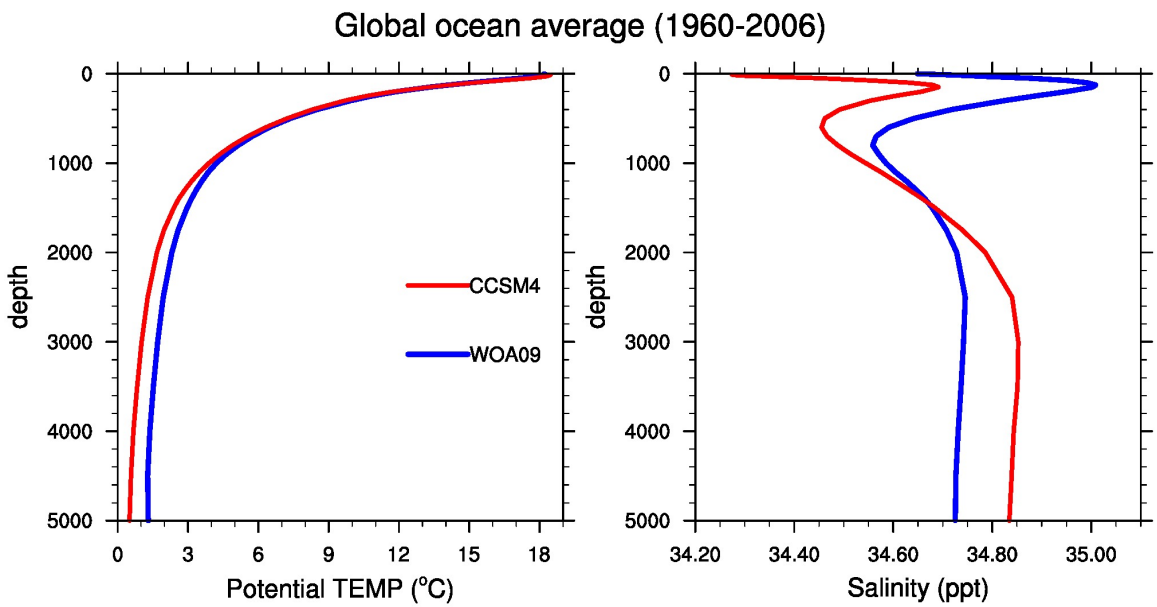
Free runs: 20thC+RCP4.5, 6 members

last 700 yrs of the 1300-yr preindustrial control

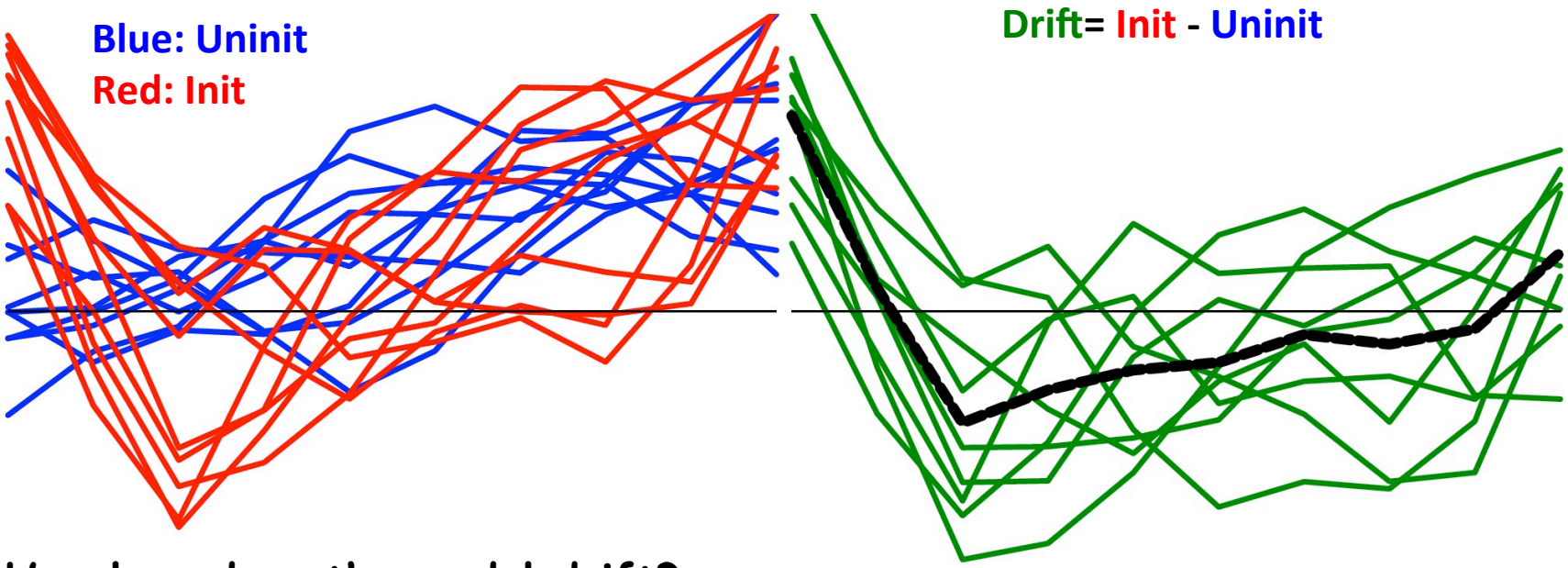
Definition of drift:

Initialized decadal prediction minus the **uninit**ialized (20thC +RCP4.5)

Drift from a particular start year is caused by model climatological bias and initial anomalies

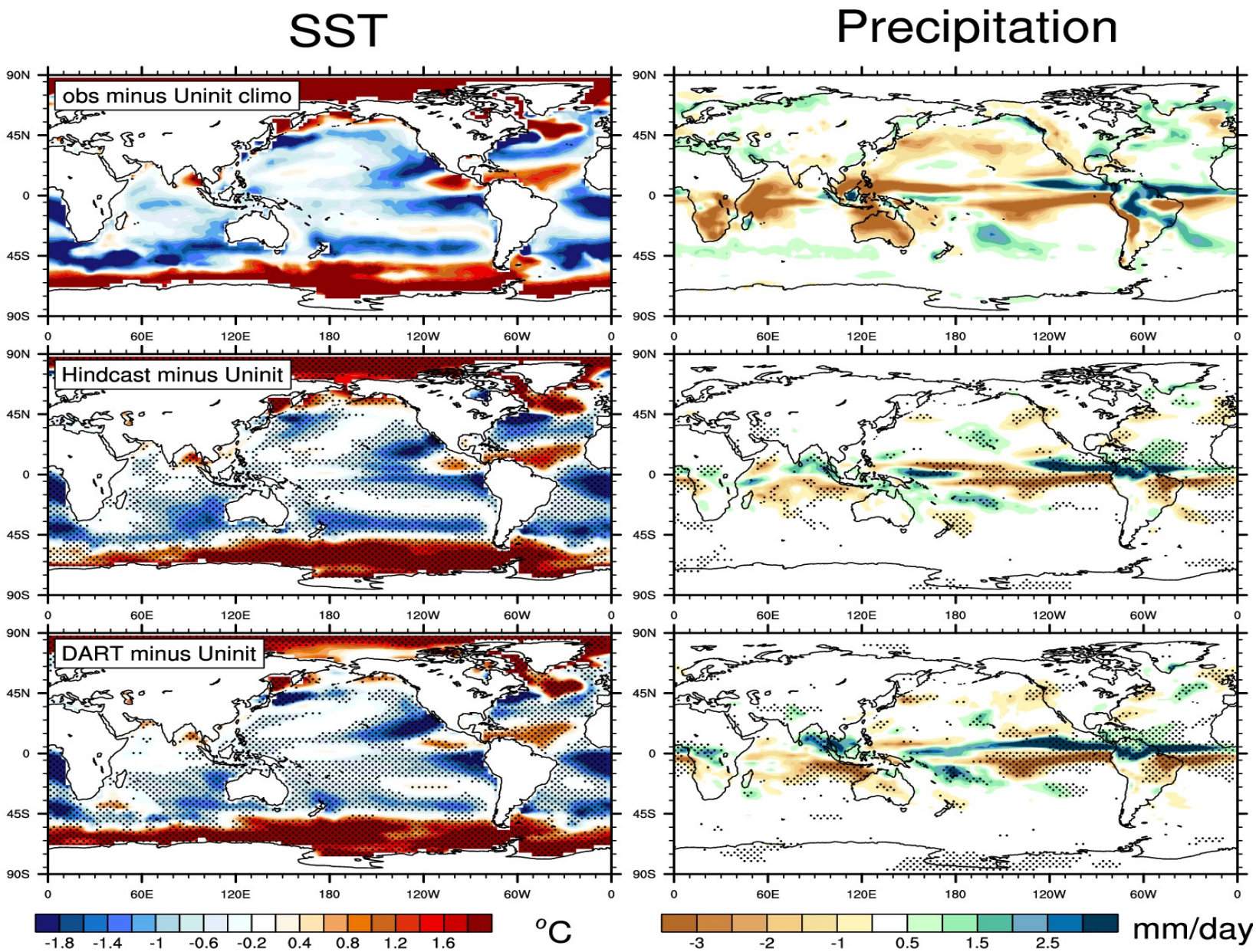


Motivation



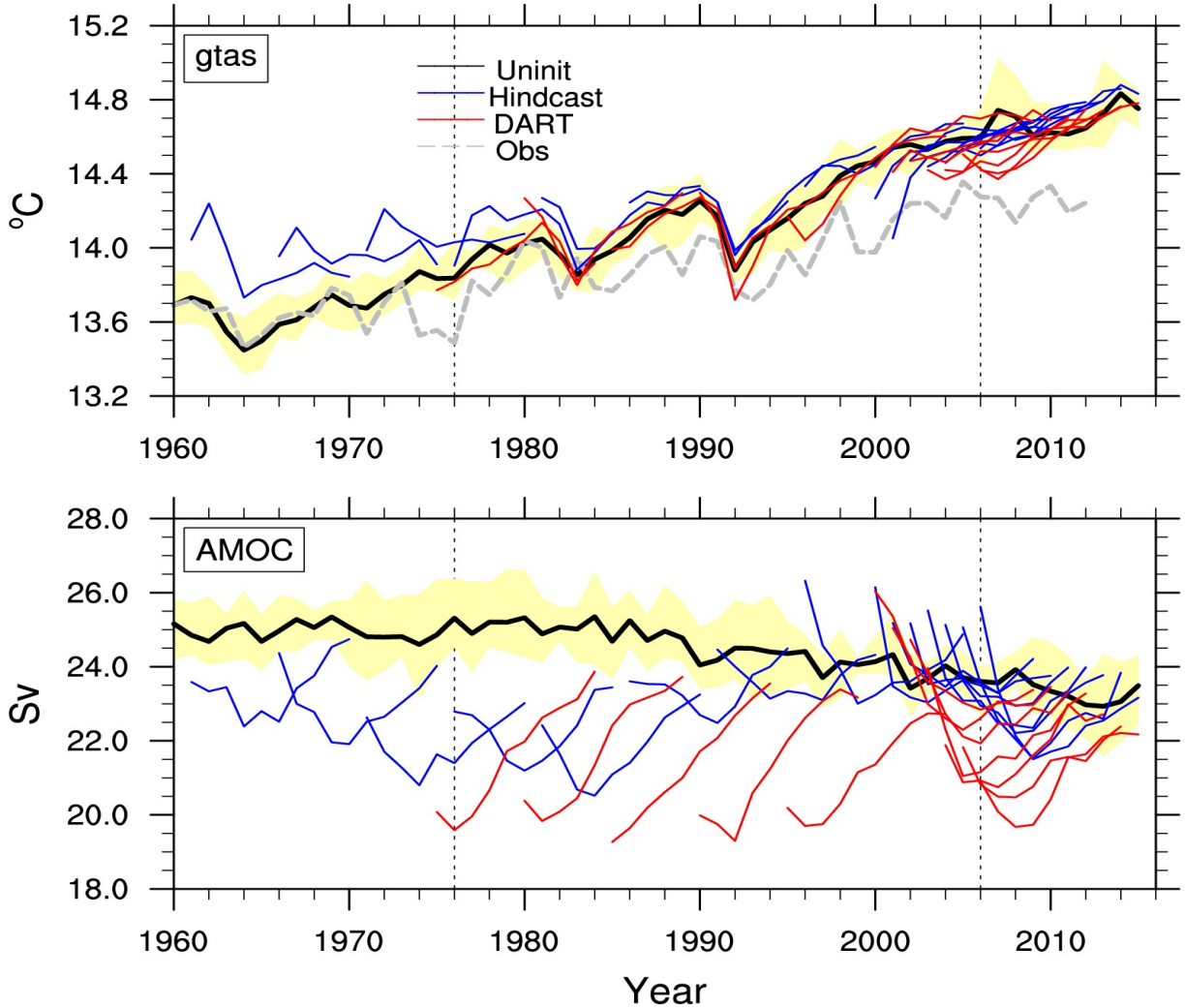
How long does the model drift?
=> how long impact from initialization can last

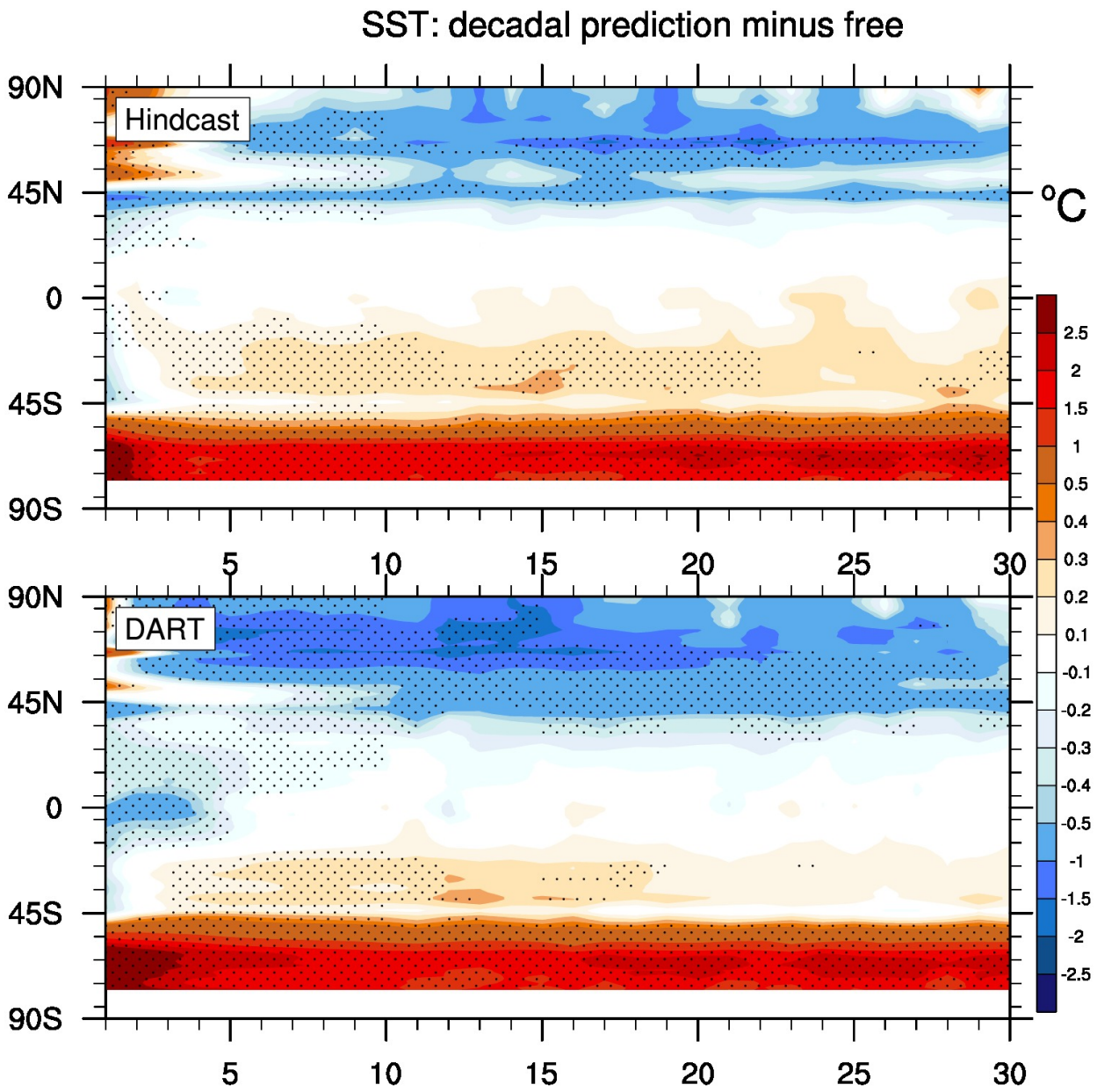
What cause the drift?

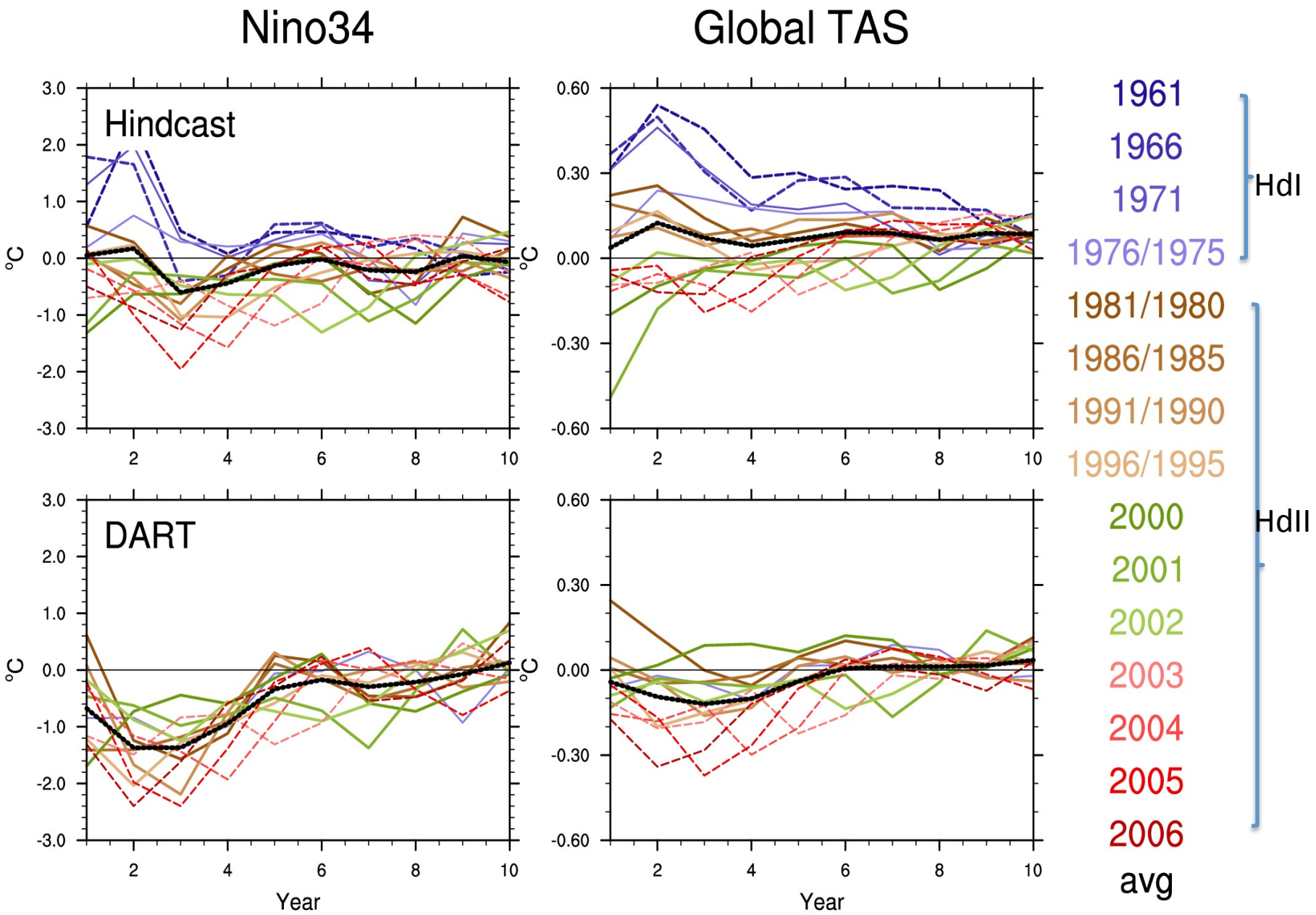


For more info on CCSM4, see Gent et al. 2012, Danabasoglu et al. 2012

Drift in global avg TAS and AMOC

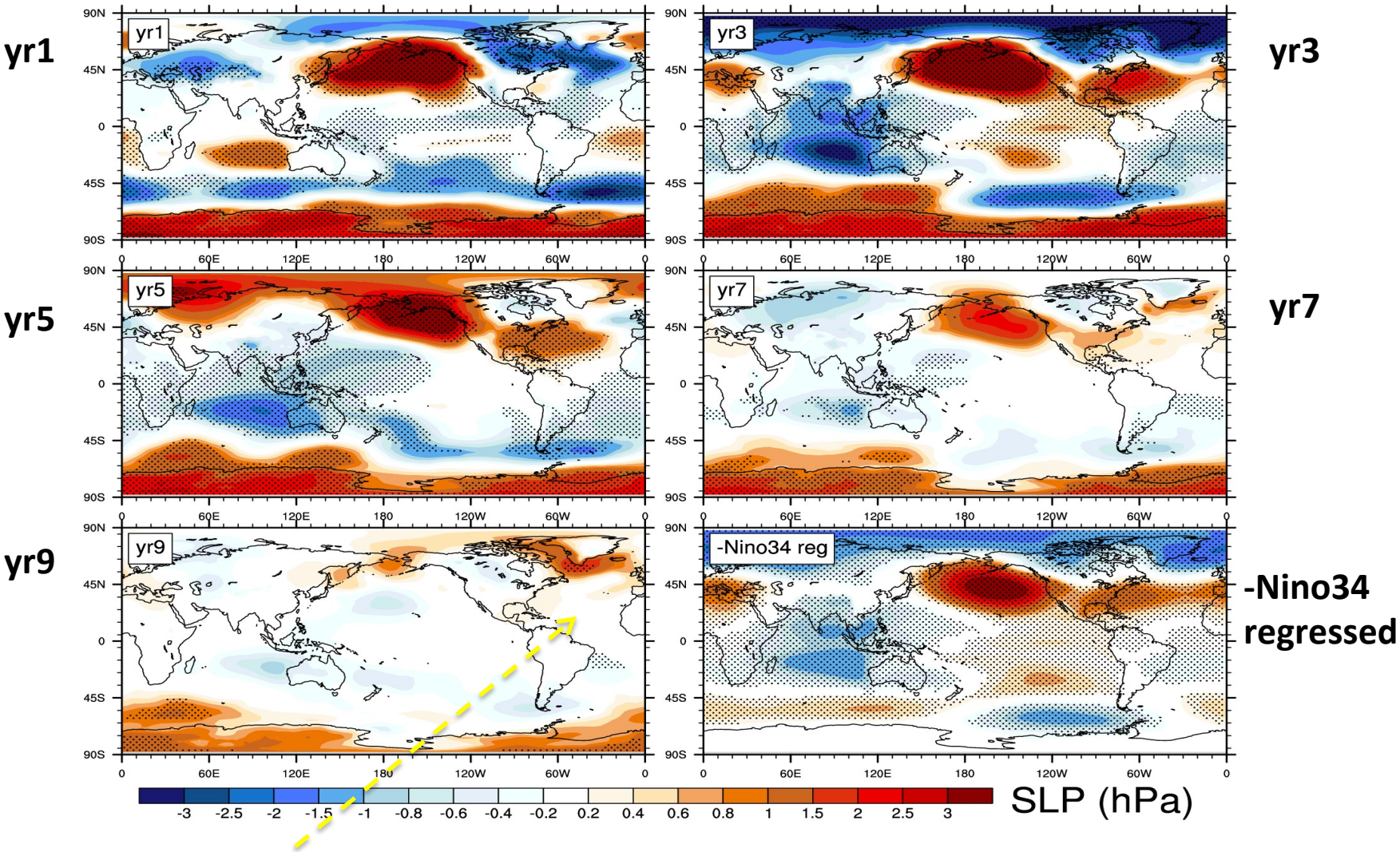



SST: decadal prediction minus free
Hindcast
DART
90N
45N
0
45S
90S
5
10
15
20
25
30
°C
2.5
2
1.5
1
0.5
0.4
0.3
0.2
0.1
-0.1
-0.2
-0.3
-0.4
-0.5
-1
-1.5
-2
-2.5


Nino34
Global TAS
Hindcast
DART
°C
Year
1961
1966
1971
1976/1975
1981/1980
1986/1985
1991/1990
1996/1995
2000
2001
2002
2003
2004
2005
2006
avg
HdI
HdII

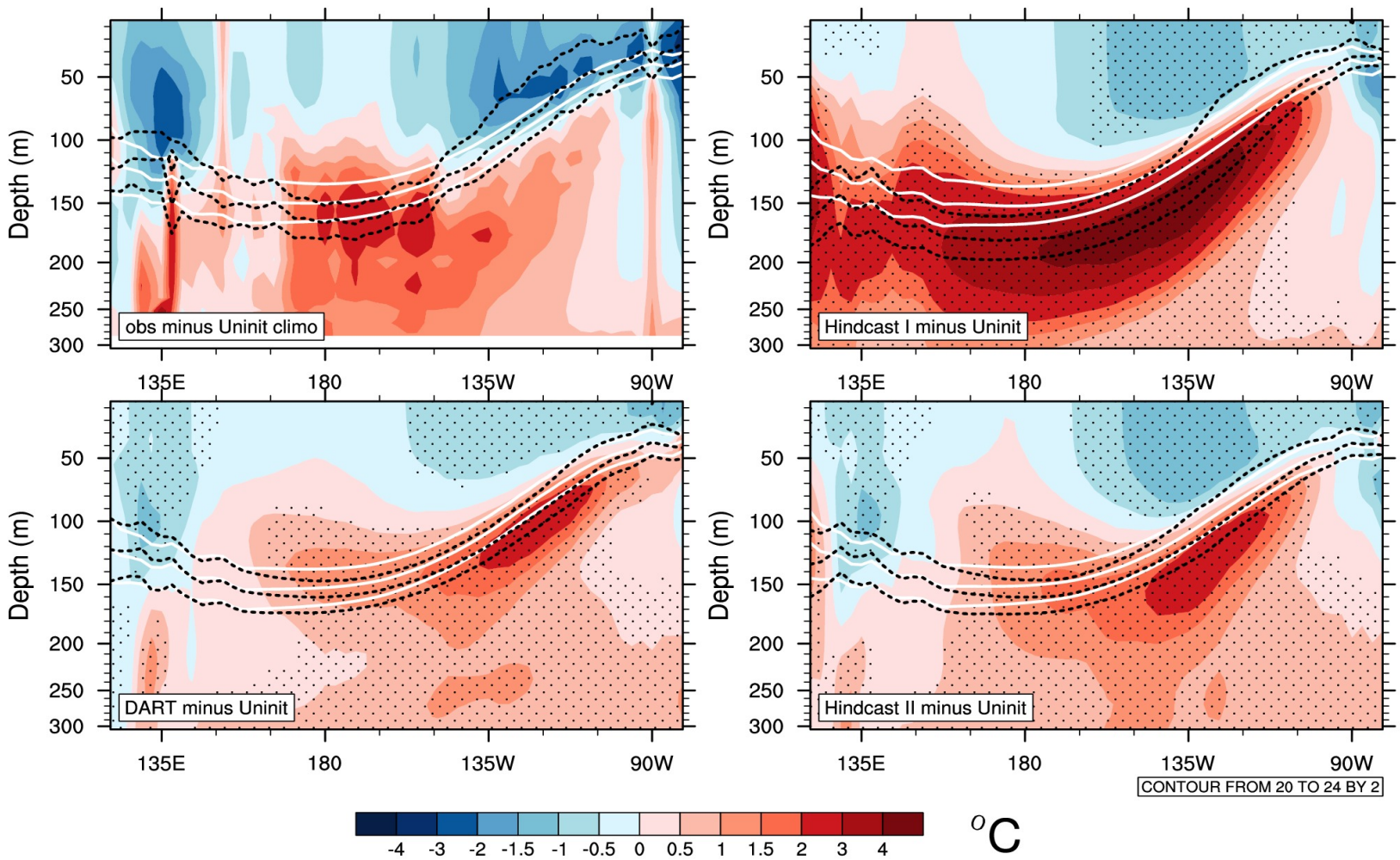
Drift in DART DJF SLP

Highly connected to drift in eq. Pacific SST

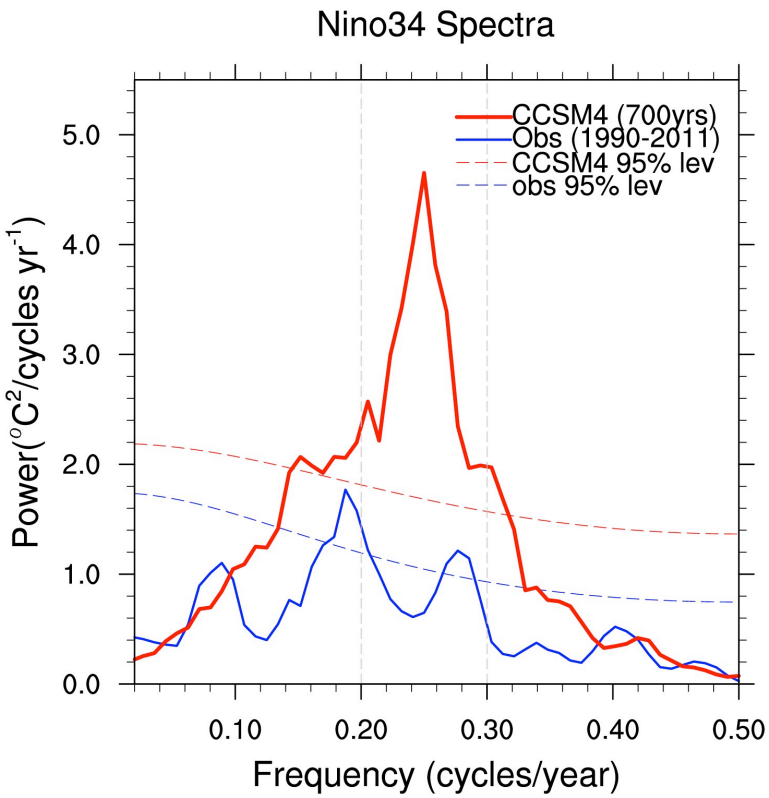


AMOC is still drifting

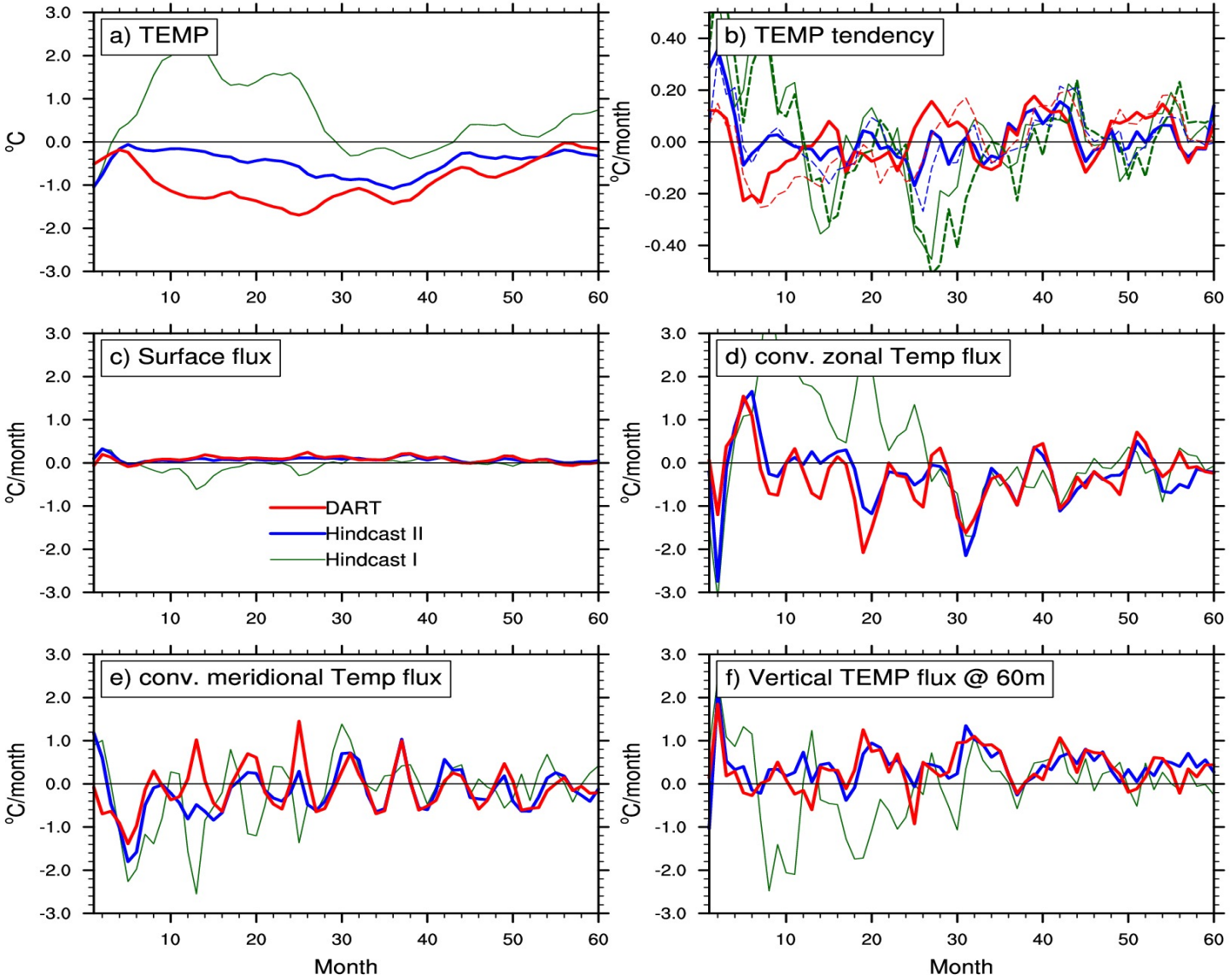
Eq. Pacific TEMP Diffs in month 1

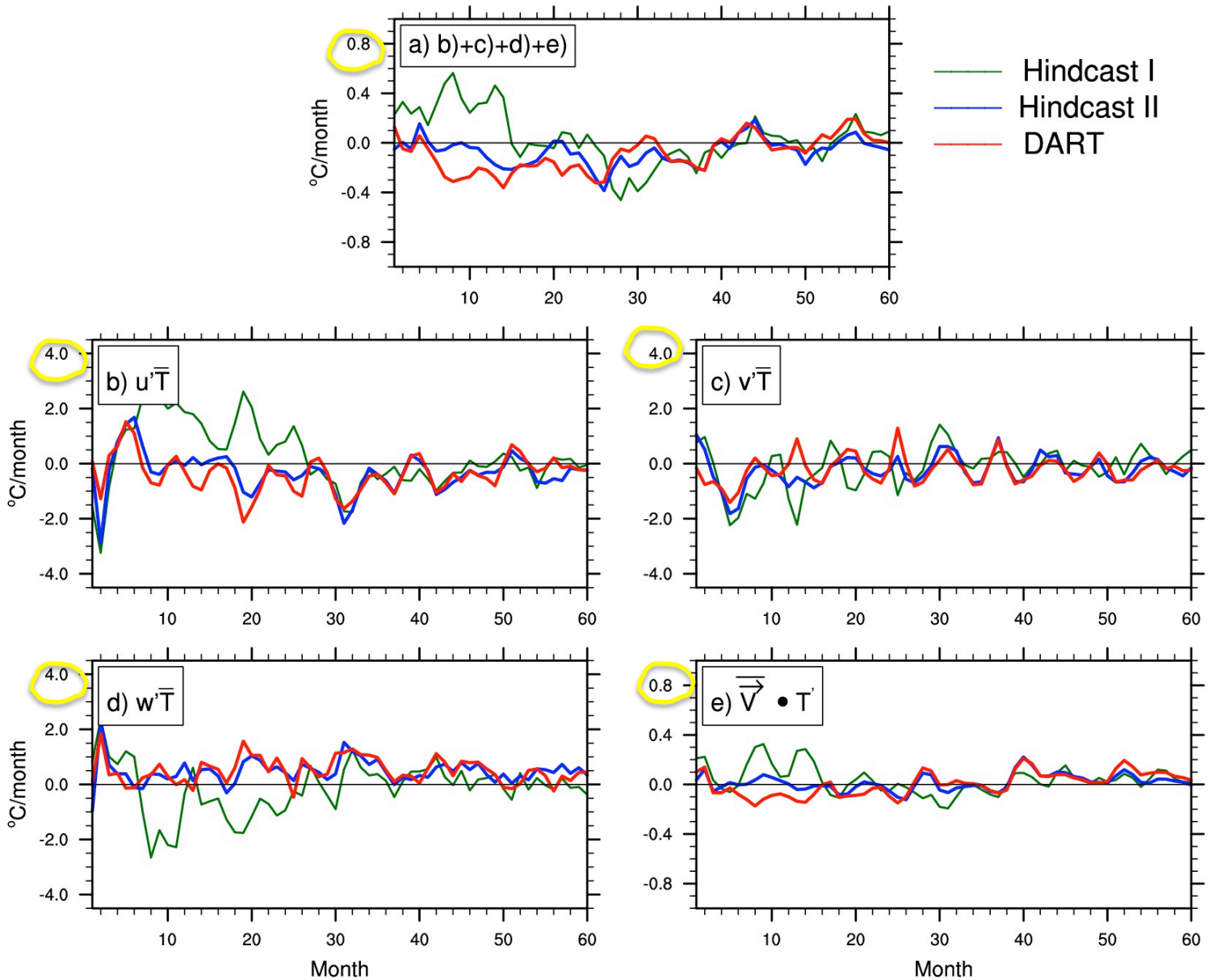


What caused the drift?



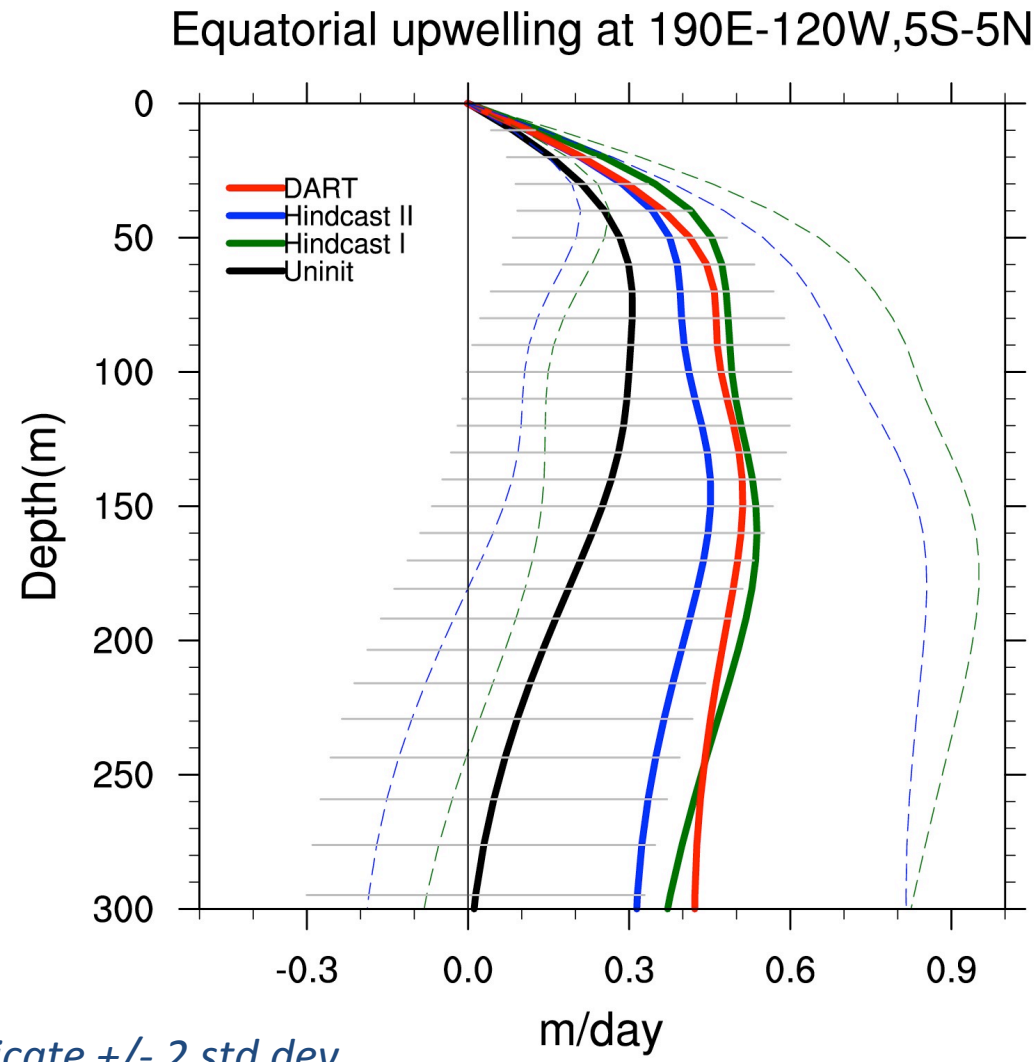
Nino34 region (60m) heat budget




a) b)+c)+d)+e)
Hindcast I
Hindcast II
DART
°C/month
b) u'T̄
c) v'T̄
d) w'T̄
e) V̄ • T'
Month
Month

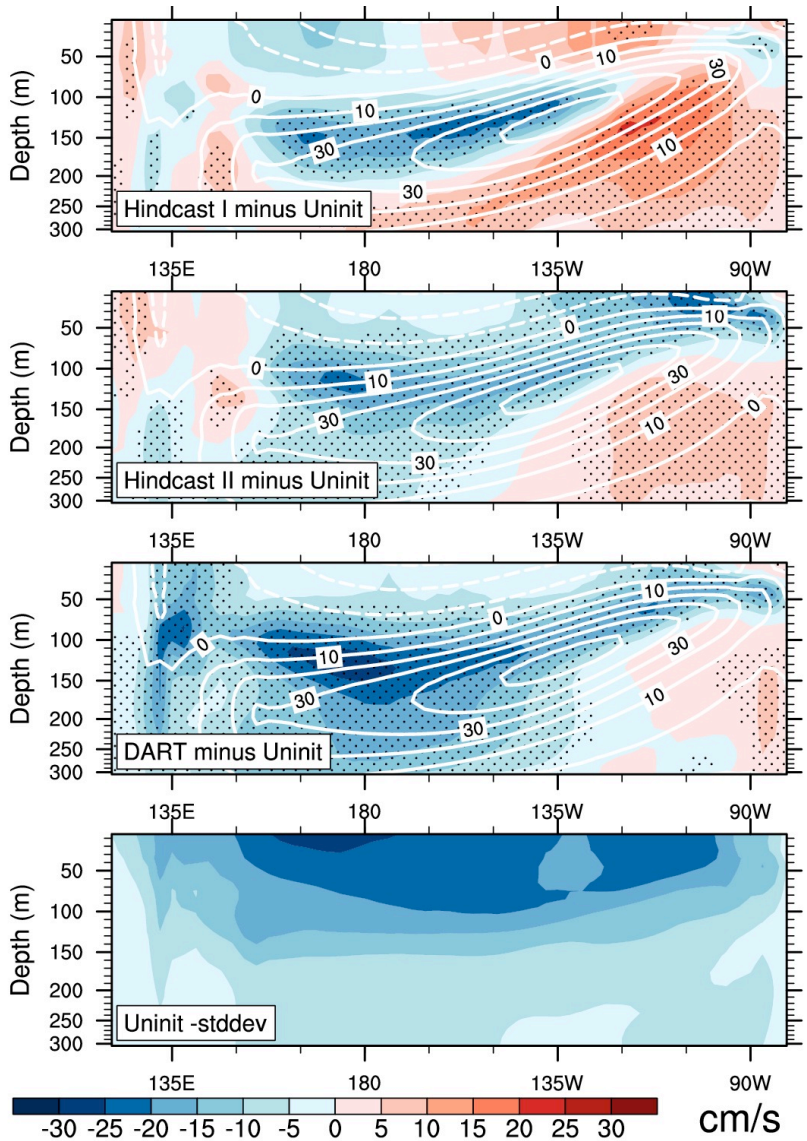
Unusual initial conditions

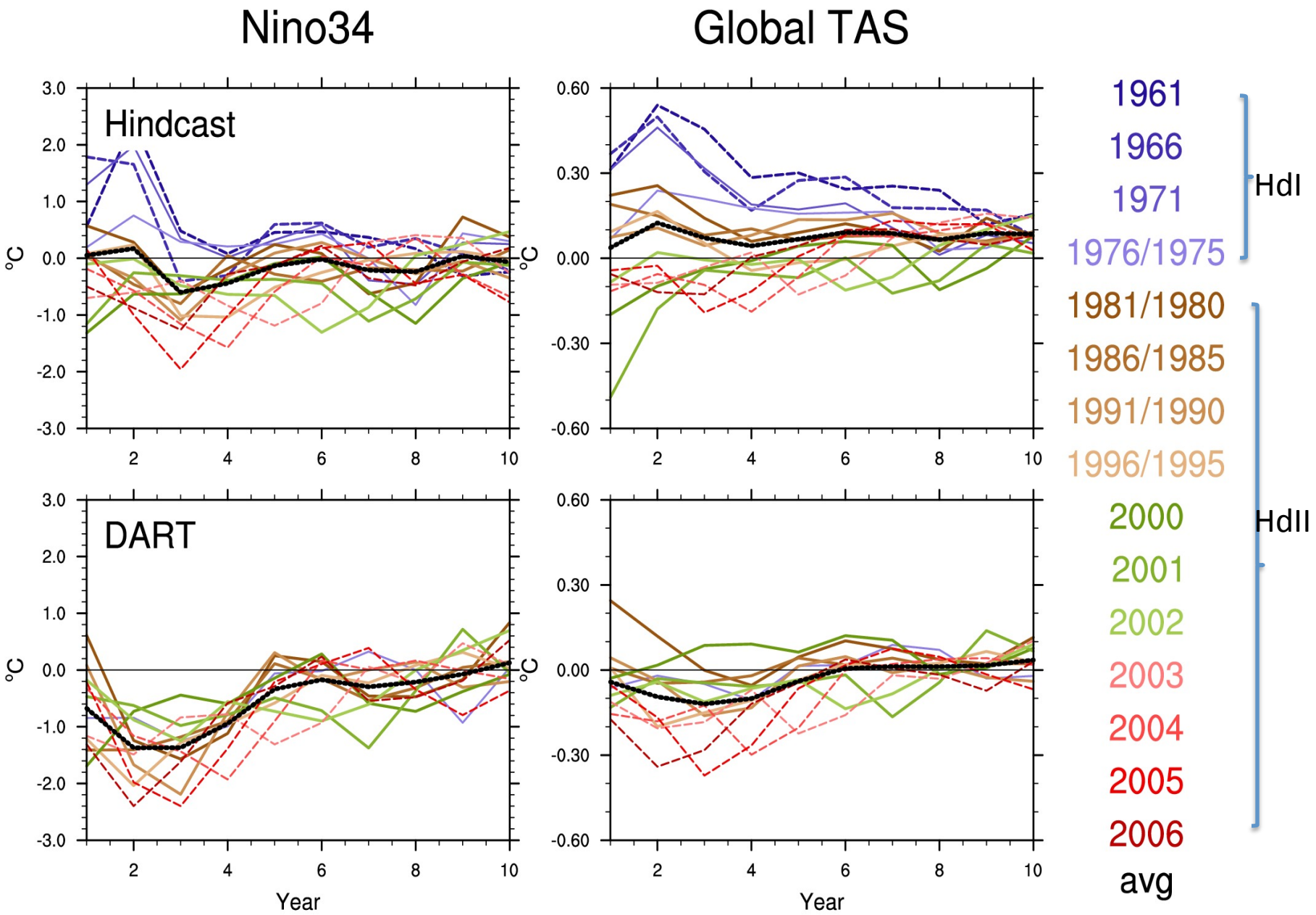
can cause the extended cold drift



Grey lines indicate +/- 2 std dev

Zonal current (2.5S-2.5N)




Nino34
Global TAS
Hindcast
DART
°C
Year
1961
1966
1971
1976/1975
1981/1980
1986/1985
1991/1990
1996/1995
2000
2001
2002
2003
2004
2005
2006
avg
HdI
HdII

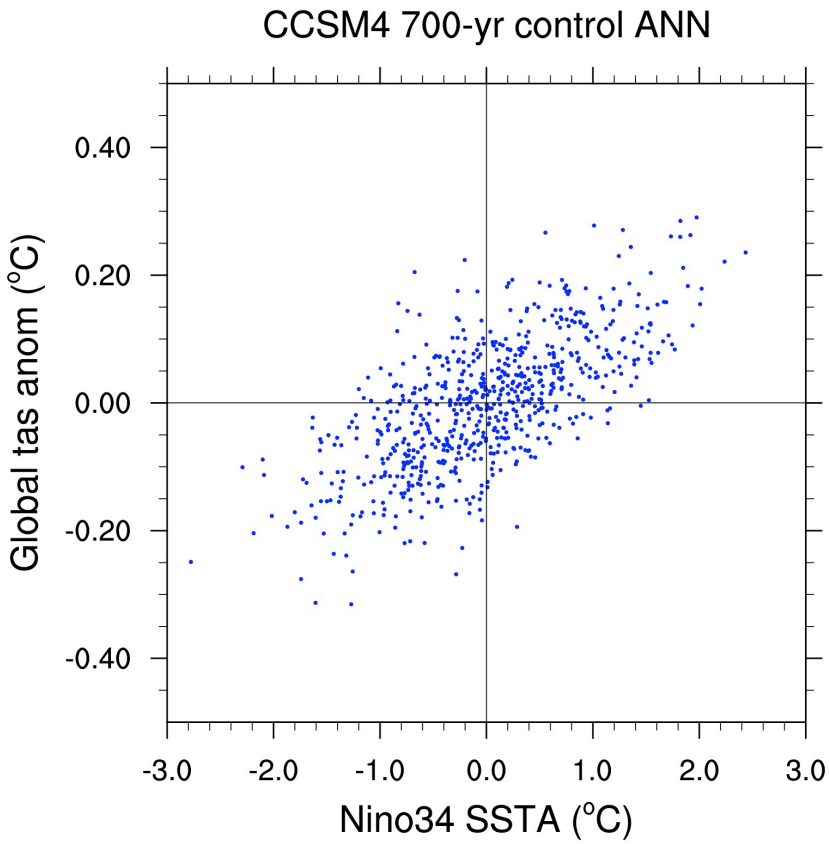
Summary

- The Hindcast initial conditions cause a warm drift from 1961, 1966, 1971, and 1976 start years, and the other Hindcast initial conditions as well as those from DART cause a cold drift in the equatorial Pacific SST in the first five prediction years.

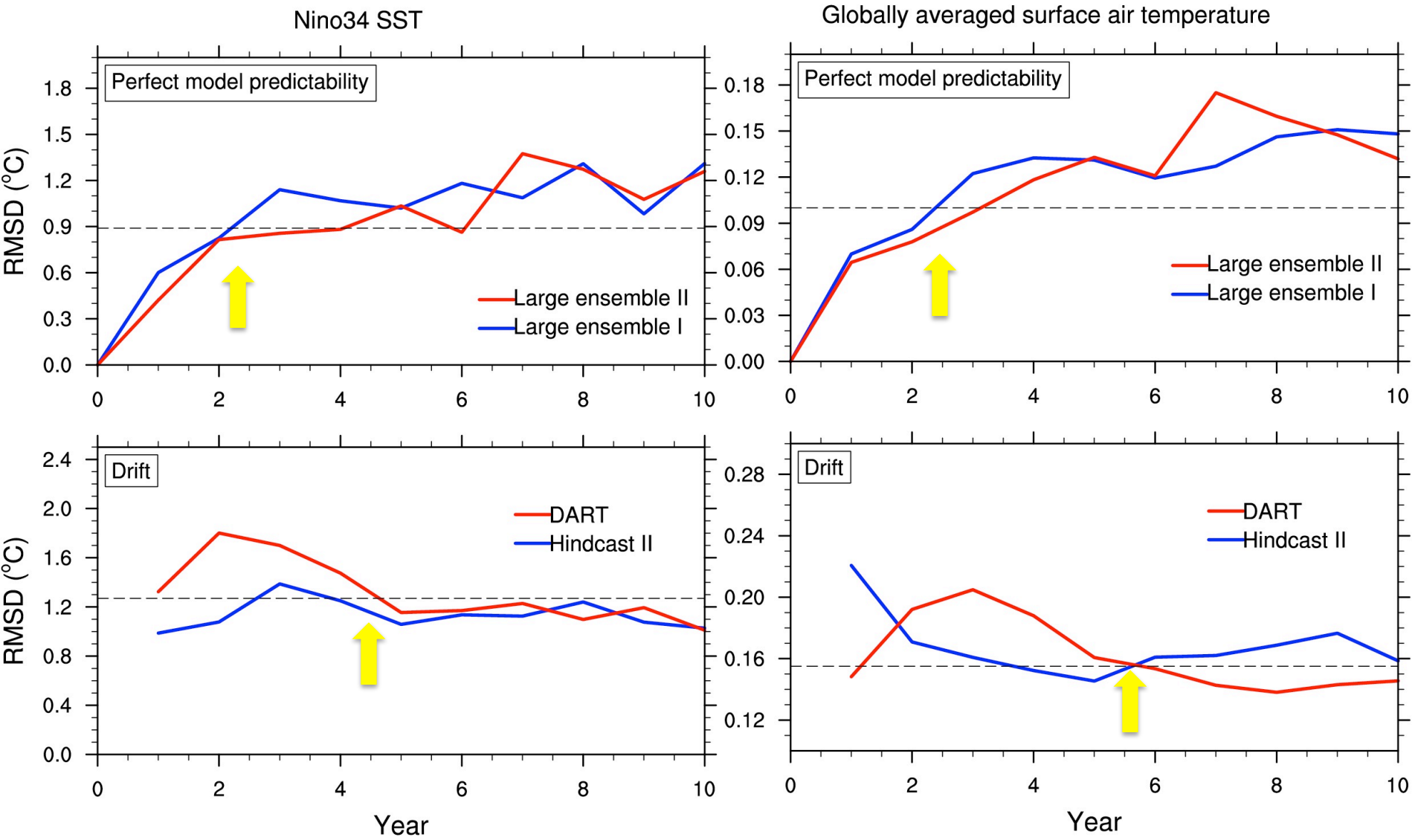
- The warm drift is mainly caused by large initial warm anomalies at thermocline and associated feedbacks, while the strong upwelling and zonal current anomalies are two major players for the extended equatorial cold drift.

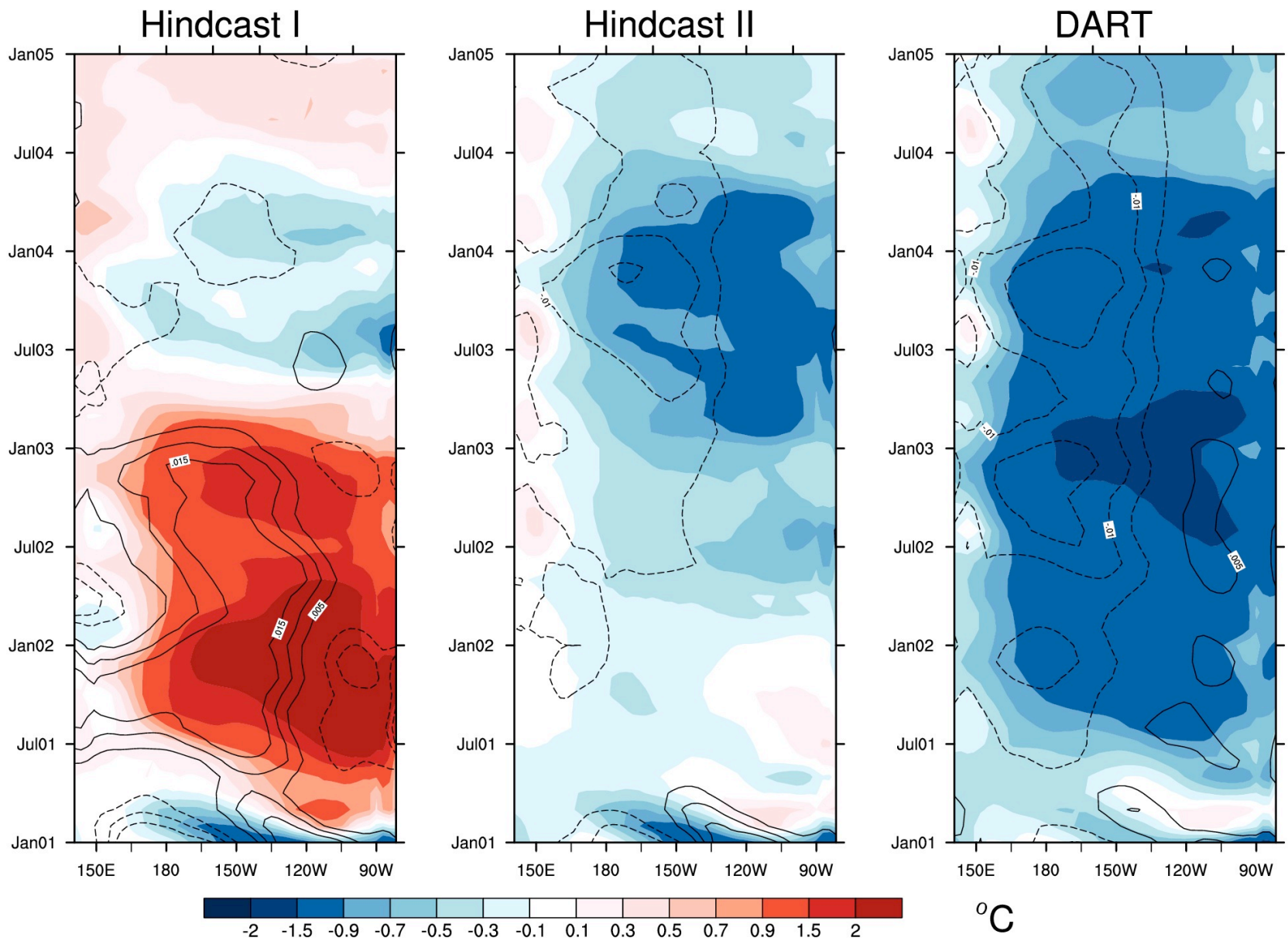
- The warm/cold drifts may contaminate the prediction anomalies (drift≠ monotonic decay), adding difficulty to interpret the prediction result.

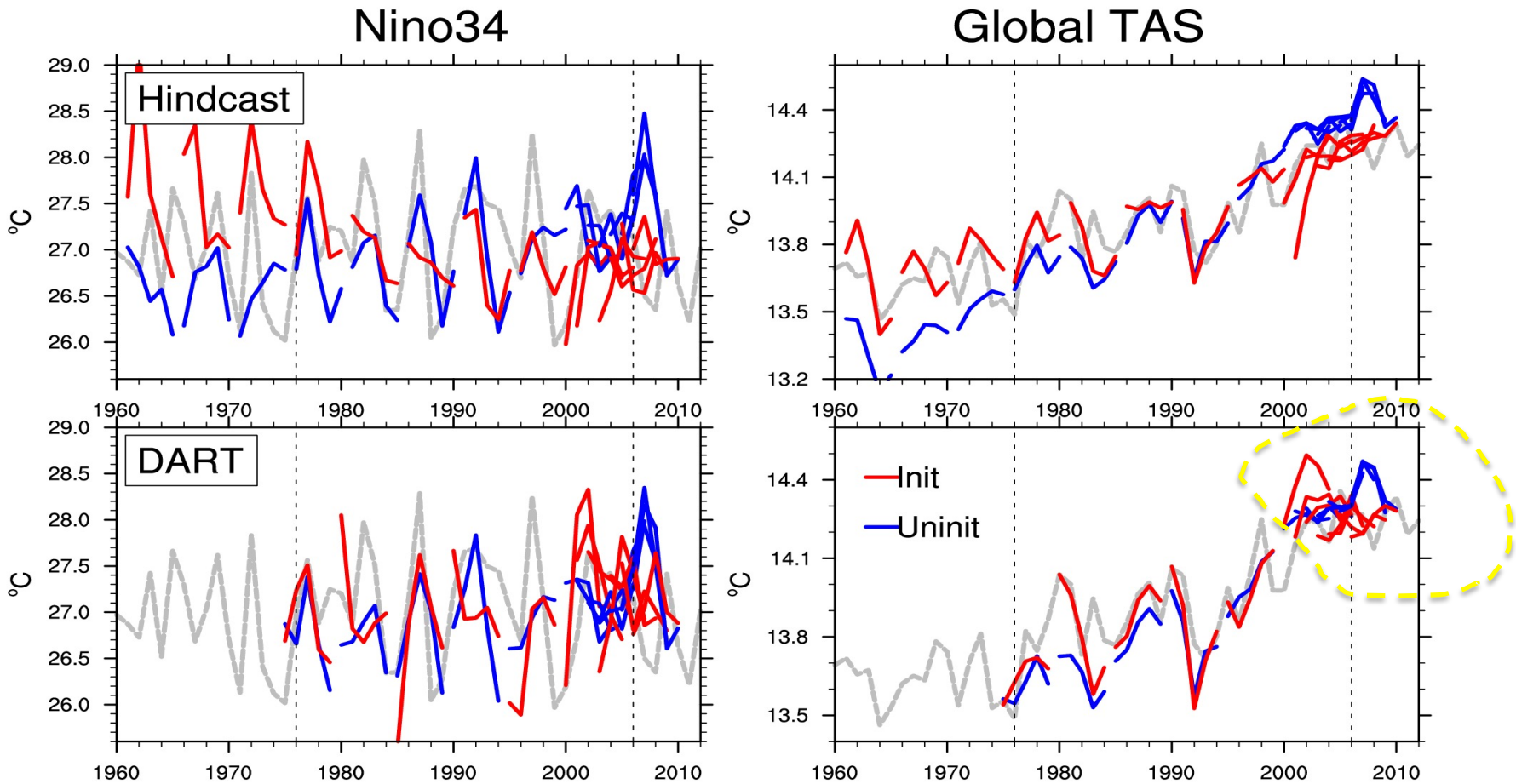
Implications for decadal prediction



Influence from initial information will last longer

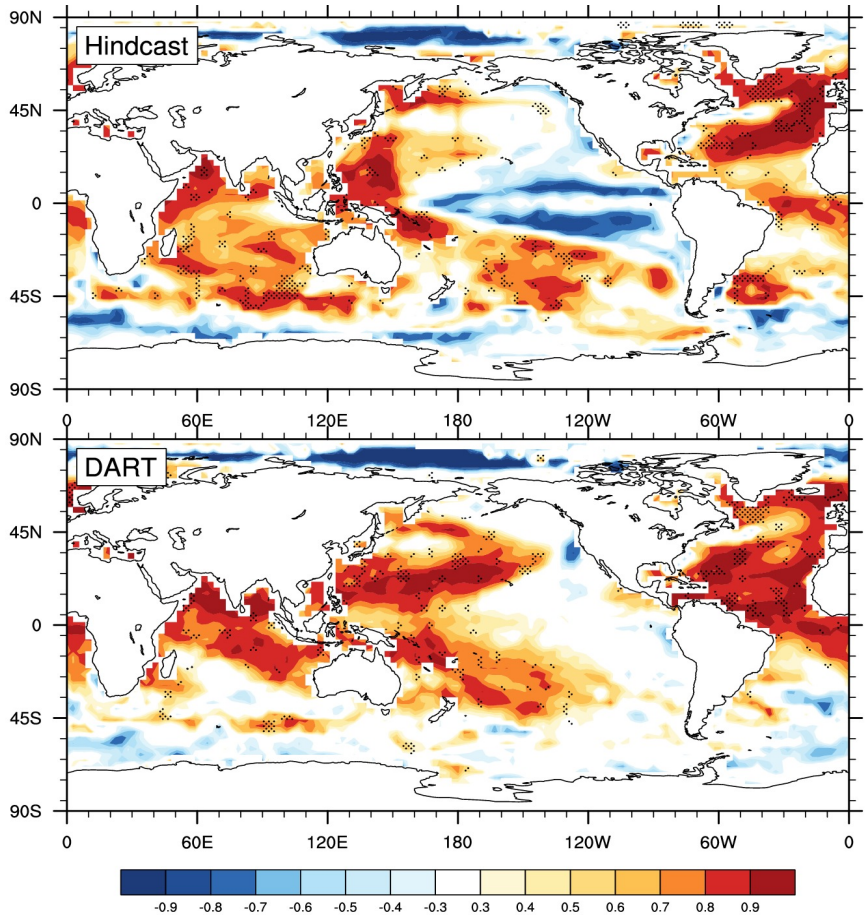



Hindcast I
Hindcast II
DART
Jan05
Jul04
Jan04
Jul03
Jan03
Jul02
Jan02
Jul01
Jan01
150E
180
150W
120W
90W
.015
.005
-.01
-2
-1.5
-0.9
-0.7
-0.5
-0.3
-0.1
0.1
0.3
0.5
0.7
0.9
1.5
2
°C



But why DART 2003-2006 initial conditions also produce colder anomalies than Uninit?

SST score (correlation)



Stippling represents 95% sig lev where Hindcast/DART score exceeds AR1 model (built with lag1 from the 700-yr control, trend from the uninit, and noise

- Score is low in the eq. Pacific due to dominance of ENSO (noise).

- The low score in the eq. Pacific does not exclude possibility that small components of the eq. Pacific SST (e.g. associated with IPO) may be more predictable…(same Idea as Branstator's AMOC talk).