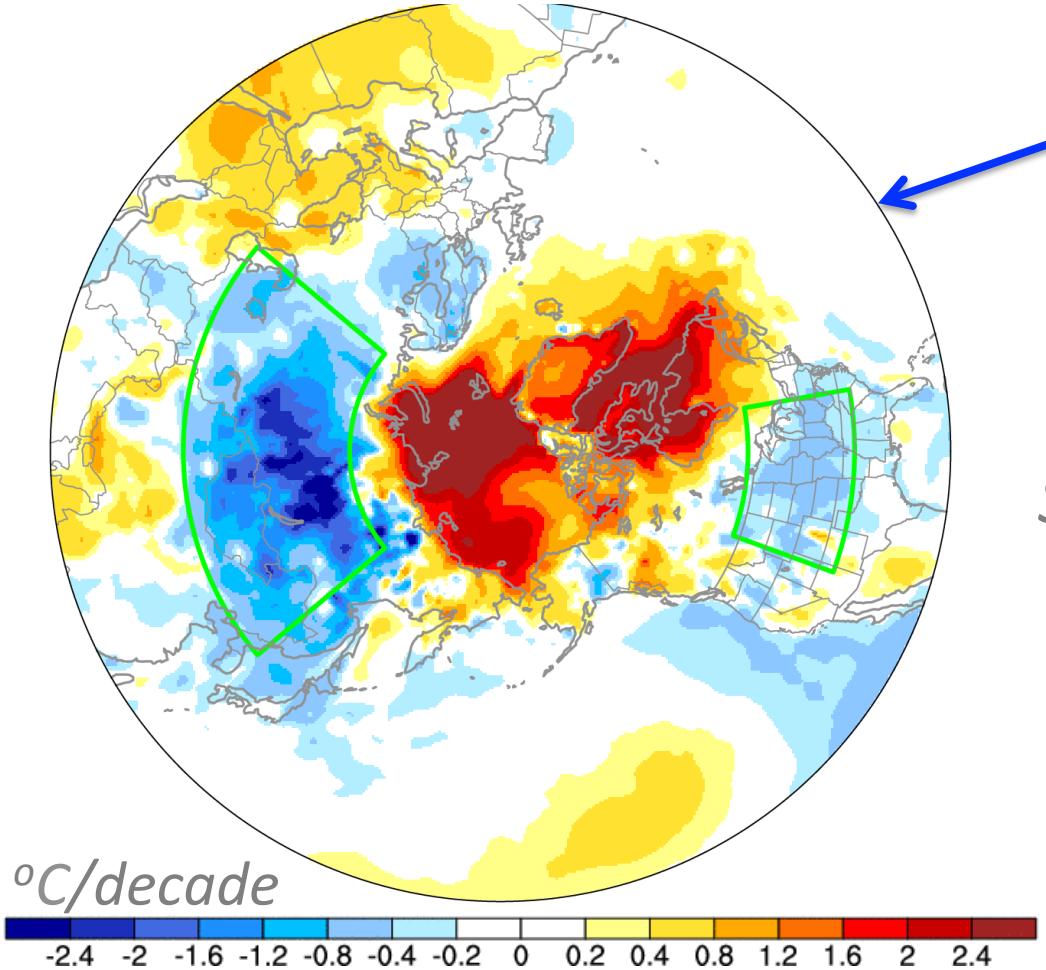
What Caused the Recent "Warm Arctic, Cold Continents" Trend Pattern in Winter Temperatures?



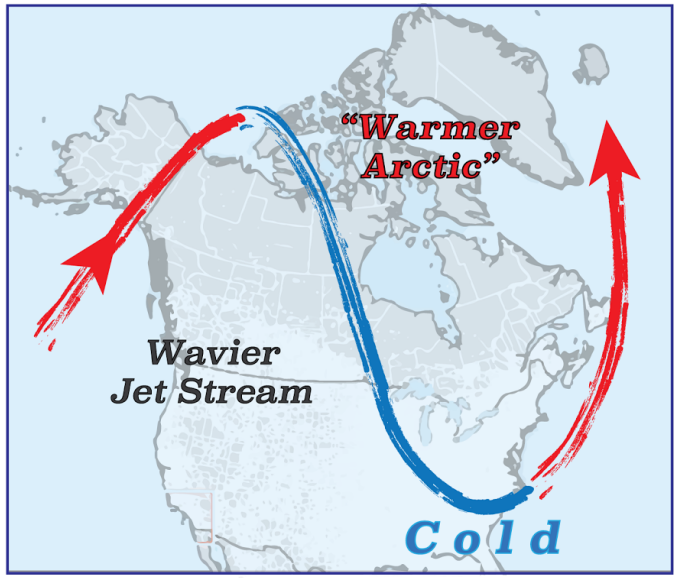
ERA-Interim
1990/91-2013/14
winter 2m-T trend

Sun, Perlwitz and Hoerling 2016, GRL, Submitted

Lantao Sun, Judith Perlwitz and Martin Hoerling

IASOA transport WG meeting, April 13, 2016

Does recent Arctic change significantly affect the jet stream?



Francis and Vavrus (2012; 2015); Cohen et al. (2013); Honda et al. (2009); Overland et al. (2011; 2015); Liu et al. (2012); Tang et al. (2013); Overland and Wang, 2015; Kim et al. (2014); Mori et al. (2014); Nakamura et al. (2015); Kug et al. (2015) and others

Review paper: Cohen et al. (2014)

Barnes (2013); Screen and Simmonds (2013); Screen et al. (2013); Screen (2014); Barnes et al. (2014); Gerber et al. (2014); Sorokina et al. (2015); Hassanzadeh and Kuang (2014; 2015); Perlwitz et al. (2015); Li et al. (2015); McCusker et al. (2016) and others

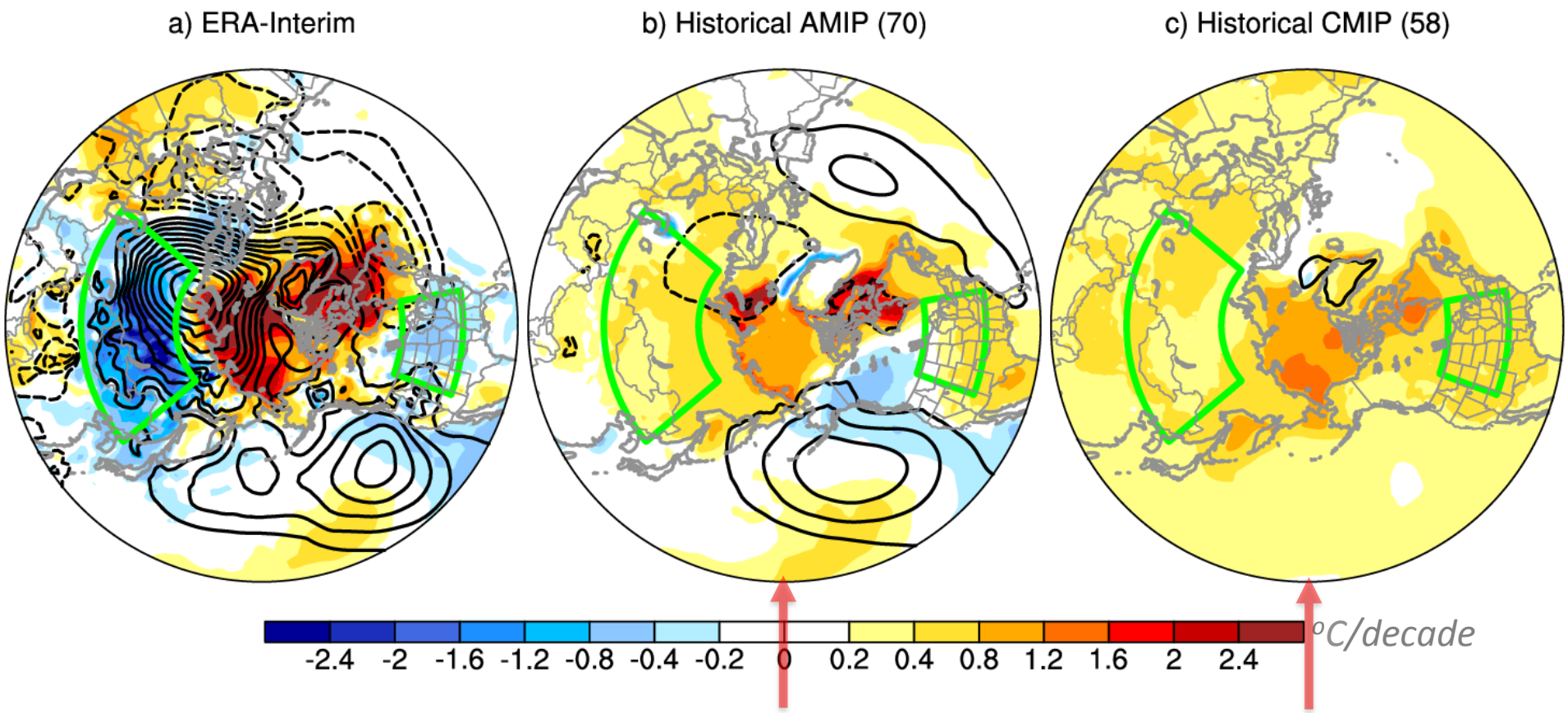
Review paper: Barnes and Screen (2015)

Climate Model Simulations

- Historical AMIP (70): atmosphere model simulation forced by observed radiative forcings, SSTs and sea ice concentrations.
- Historical CMIP (58): atmosphere-ocean coupled model simulation forced by observed radiative forcings.

✧ *1990/91-2013/14 winter trends in sea-level pressure (SLP) and 2m-temperature*

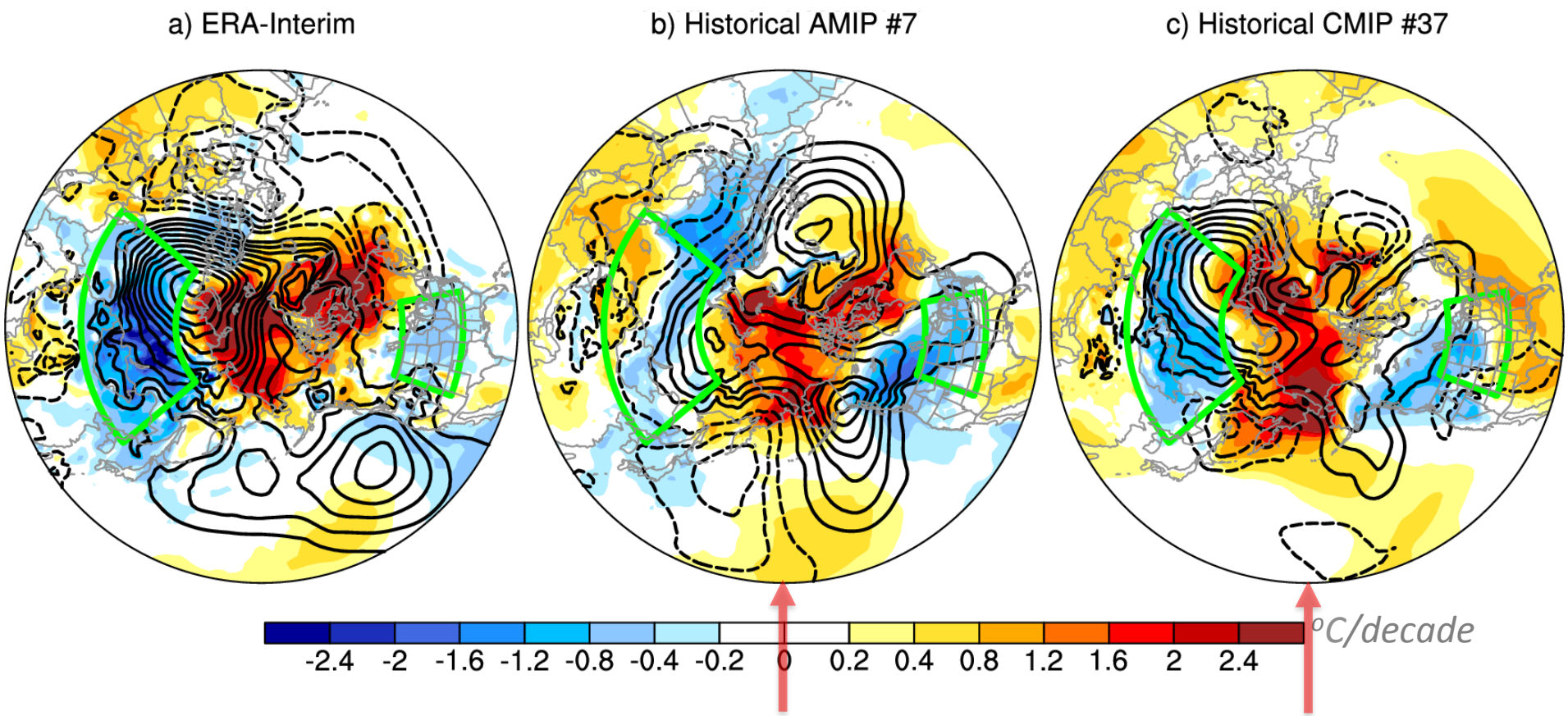
1990/91-2013/14 DJF 2m-T/SLP trend (CI: 0.5 hPa decade^{-1})



Model ensemble-mean

- Recent mid-latitude cooling trend is not a *forced* response, either to GHG forcing, or the additive effects by SSTs and sea ice concentrations.

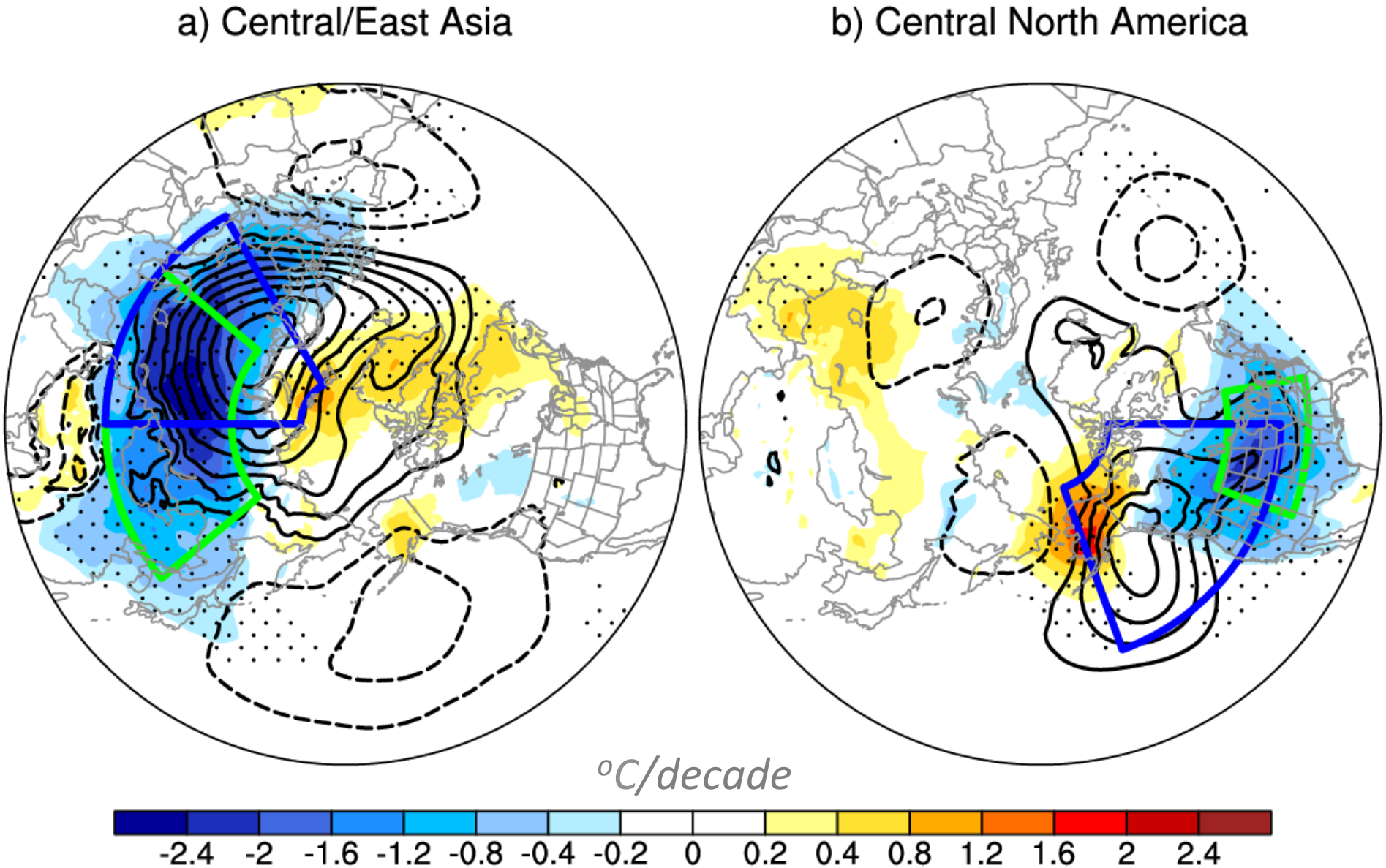
1990/91-2013/14 DJF 2m-T/SLP trend (CI: 0.5 hPa decade^{-1})



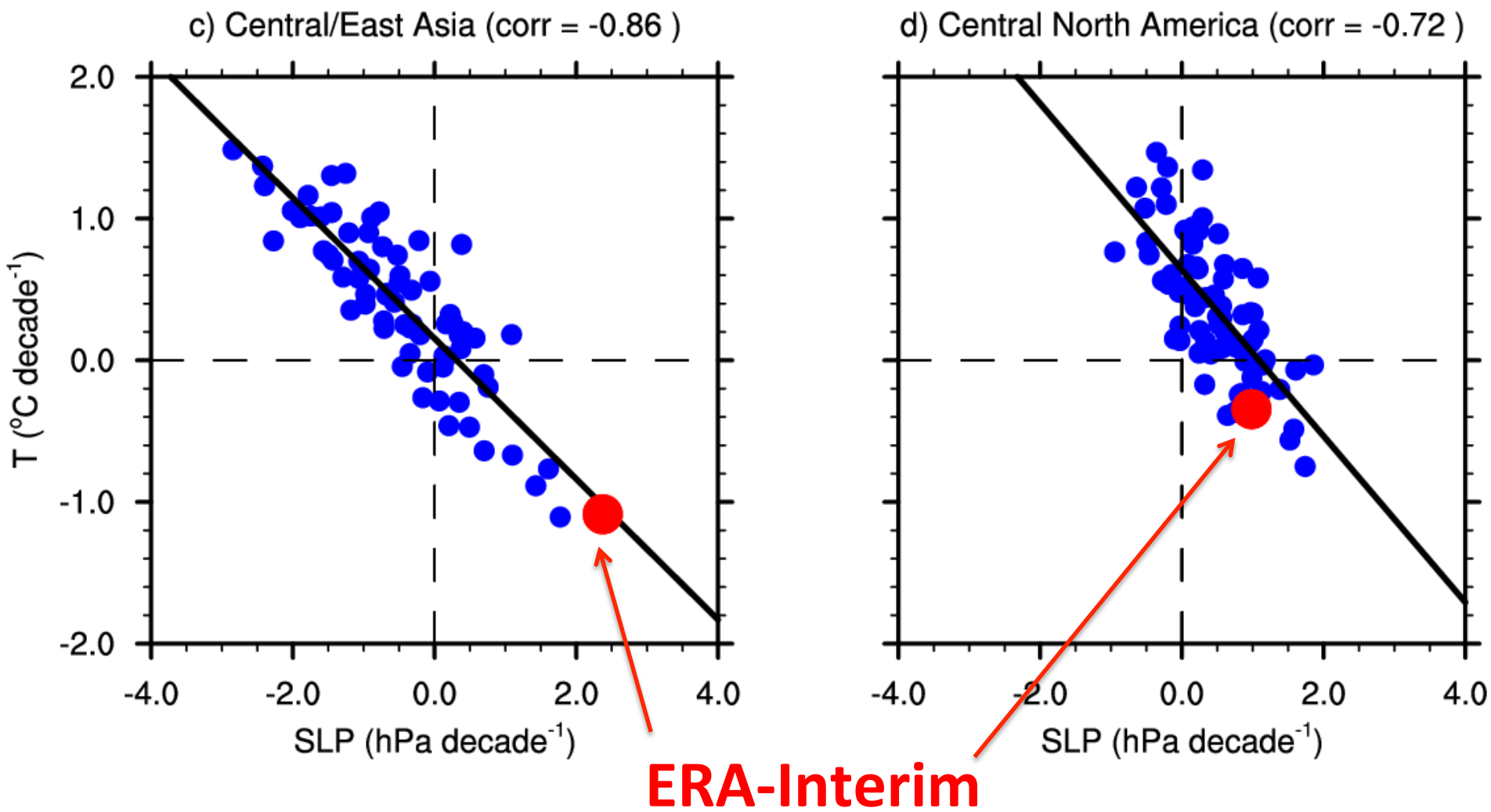
Individual ensembles

- Rather, the observed cooling trend more likely reflects the atmospheric internal variability.

AMIP SLP trend pattern associated with mid-latitude cooling

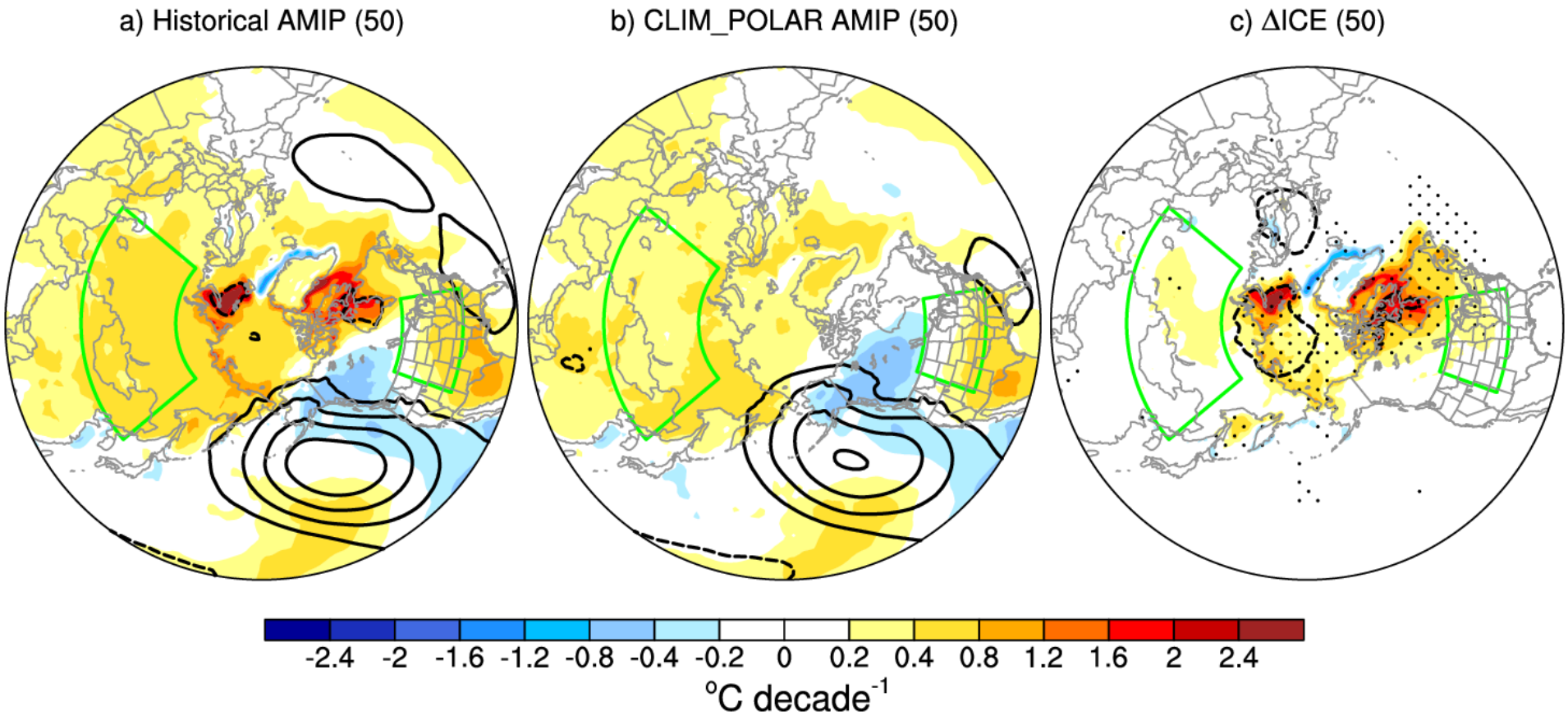


2m-T/SLP trend for individual ensembles

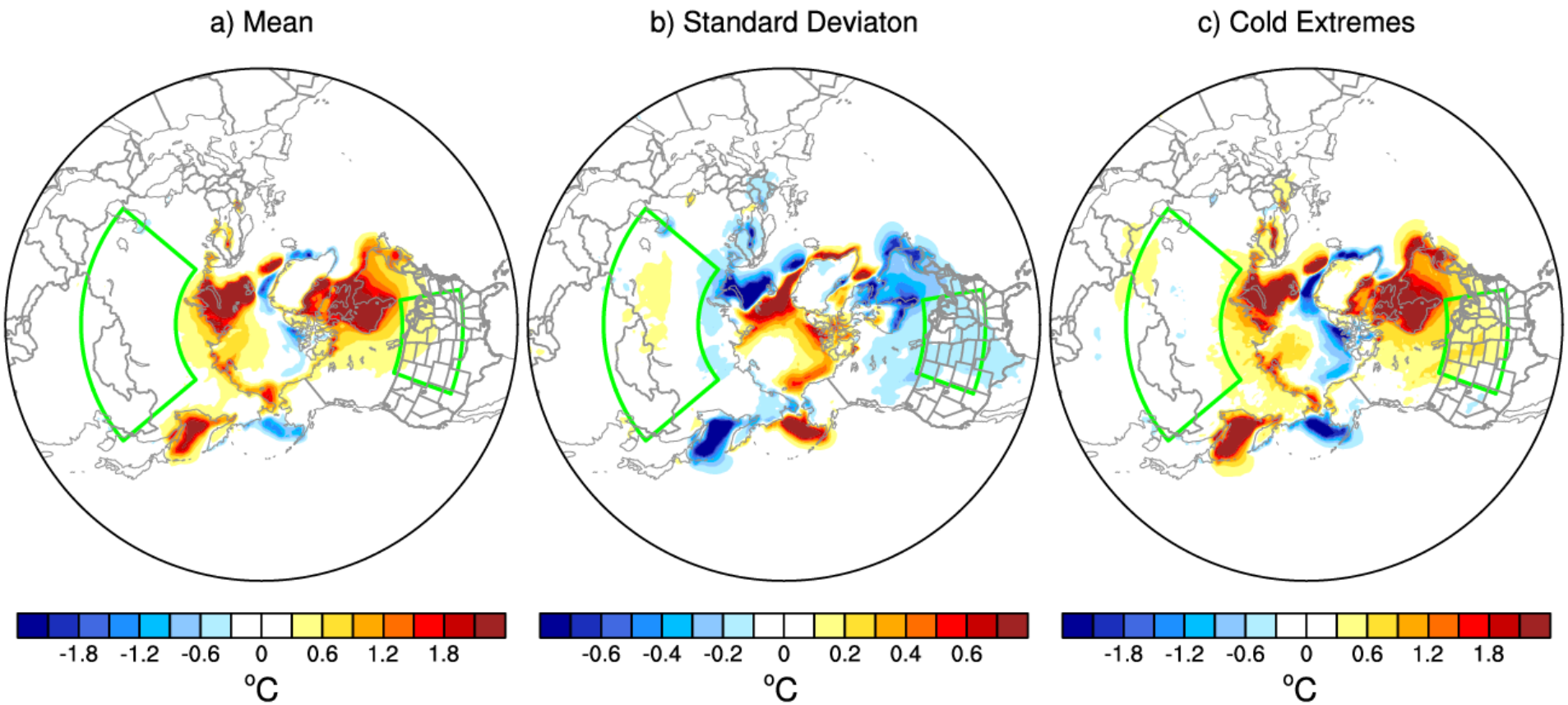


1990/91-2013/14 DJF 2m-T/SLP trend (CI: 0.5 hPa decade^{-1})

- **Historical AMIP**: observed GHGs, SST and sea ice conditions.
- **CLIM_POLAR AMIP**: observed SST, GHGs and sea ice 1979-1989 climatology
- **ΔICE = Historical AMIP – CLIM_POLAR AMIP**



DJF 2m-T Response to Arctic sea ice loss: 2004/05-2013/14 average

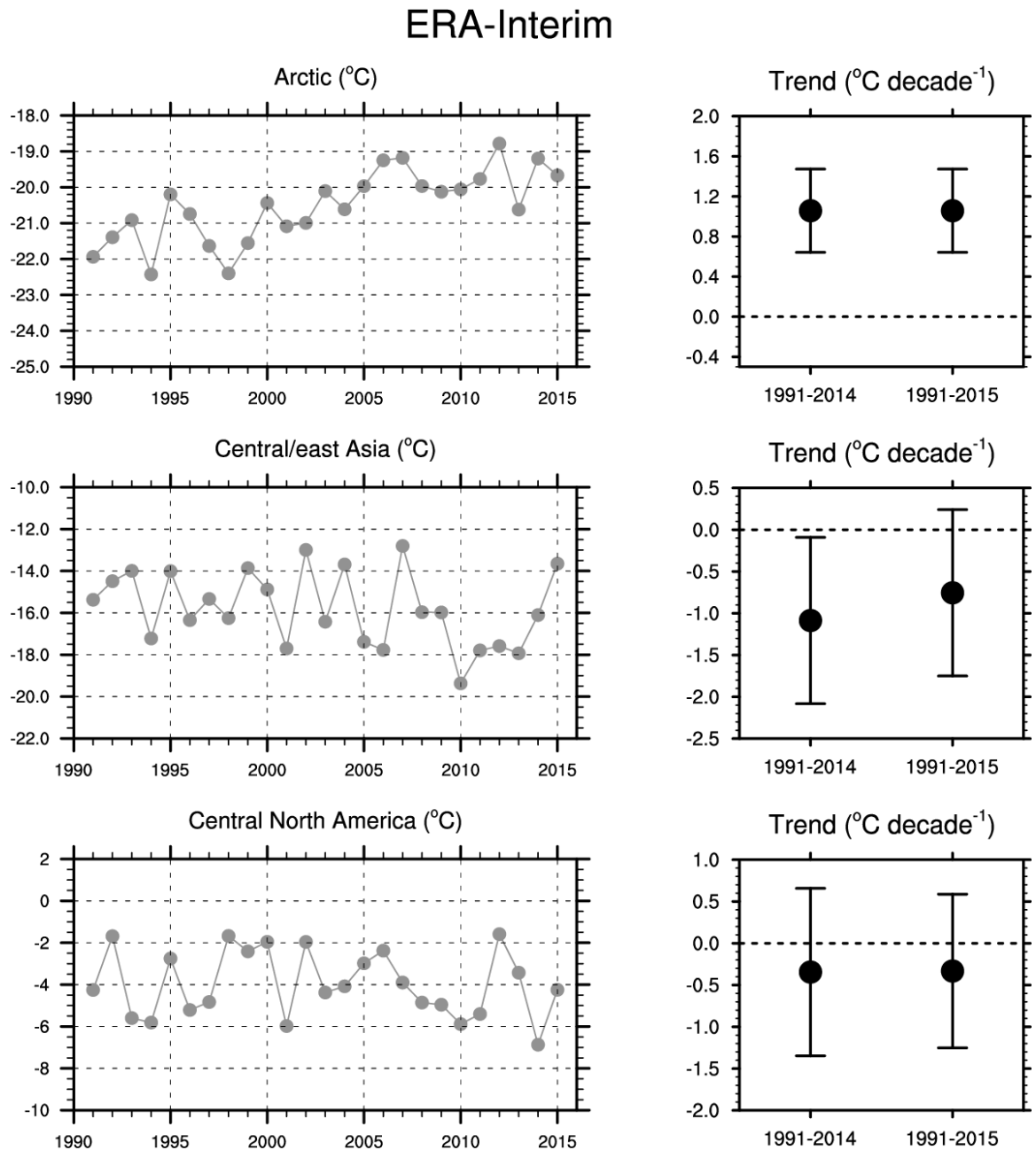


Arctic sea ice loss reduces daily temperature variability and reduces cold extremes.

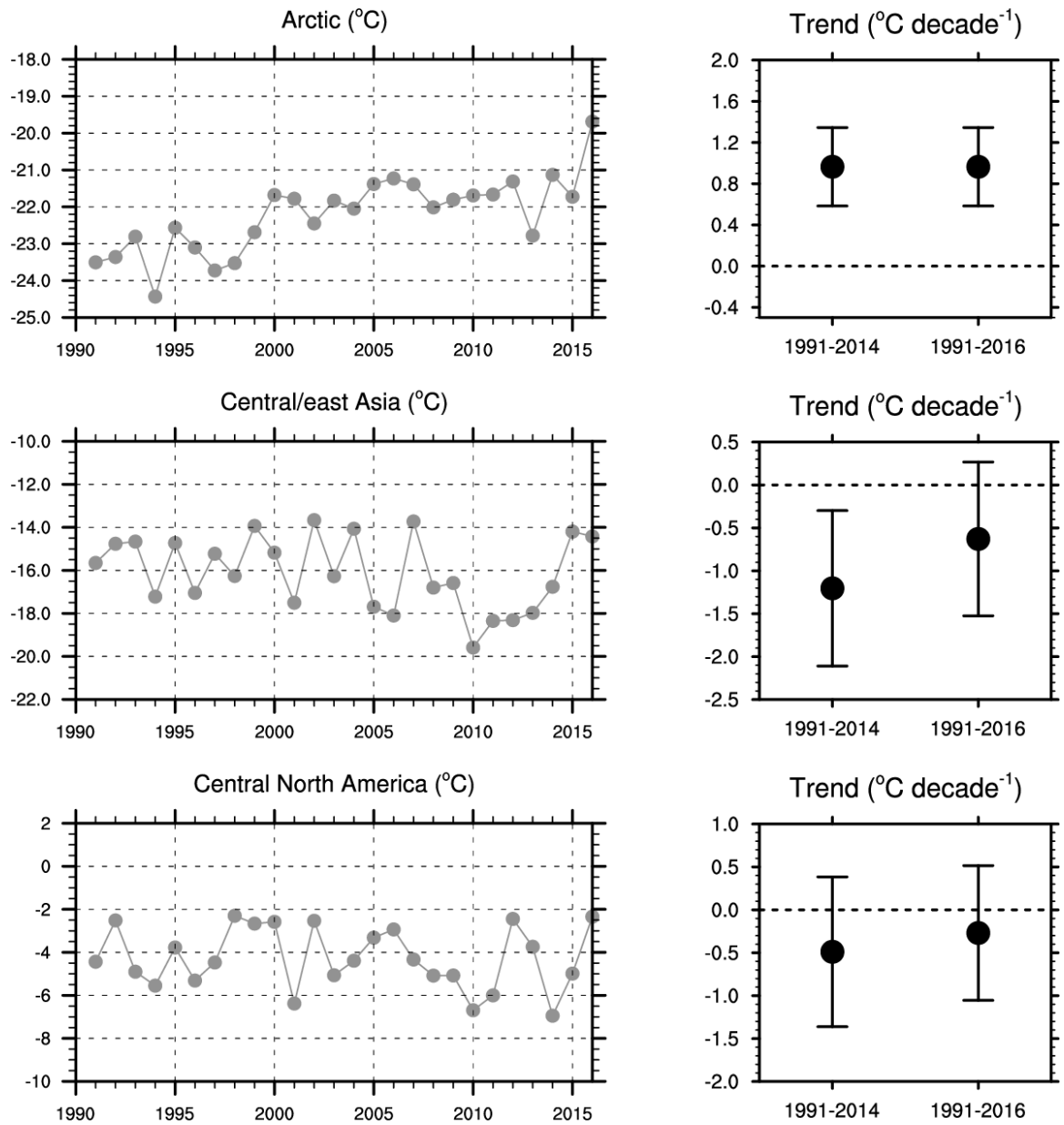
Summary

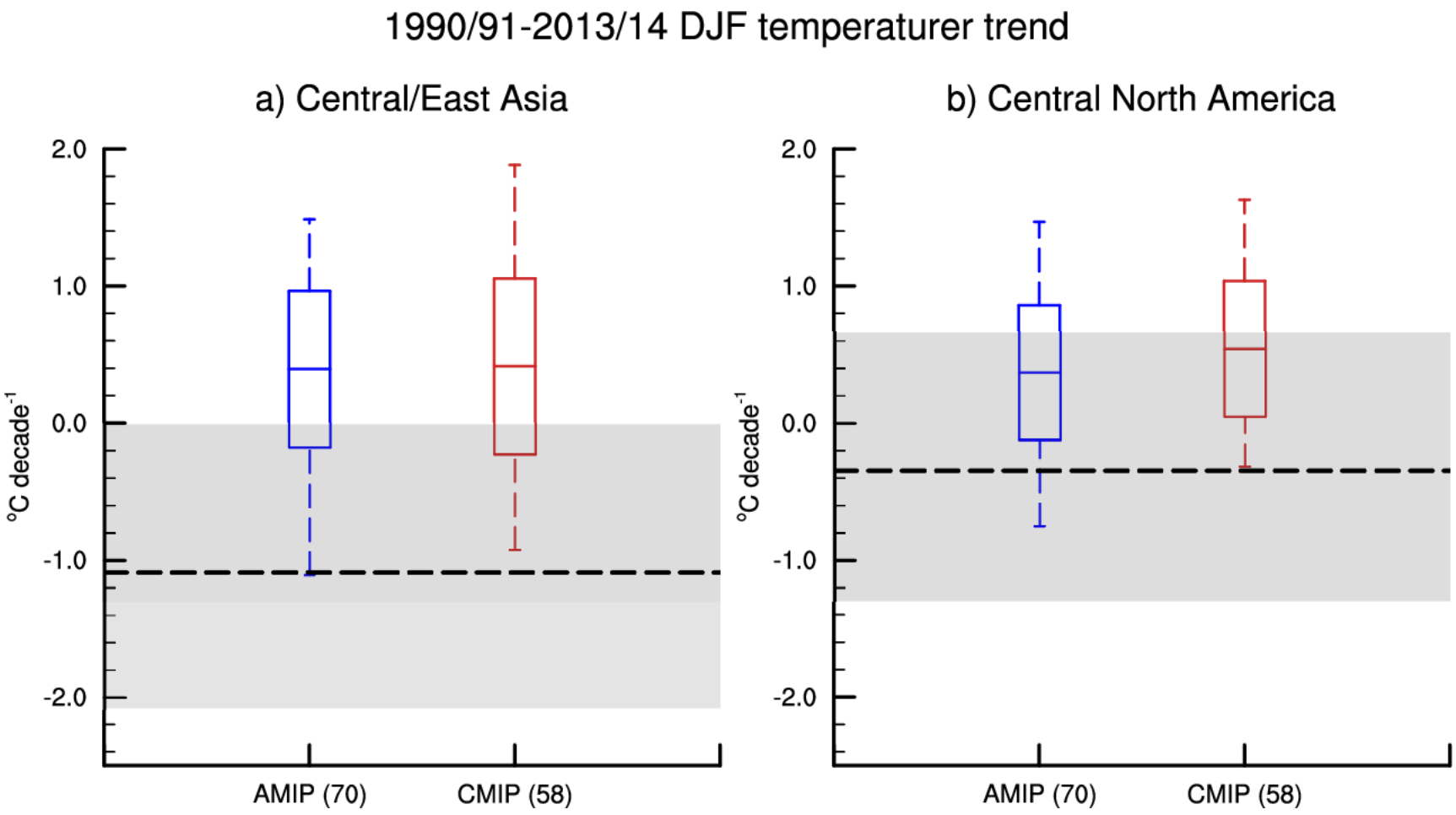
1. Observed recent cooling trend in central/east Asia and central North America is not a forced response.
2. Recent sea ice loss contribute to the warming in the Arctic, but not cooling over mid-latitude continents.
3. Arctic amplification *does* affect mid-latitude weather, however by *reducing* daily variability and *reducing* cold extremes.

SUPPLEMENTARY FIGURES

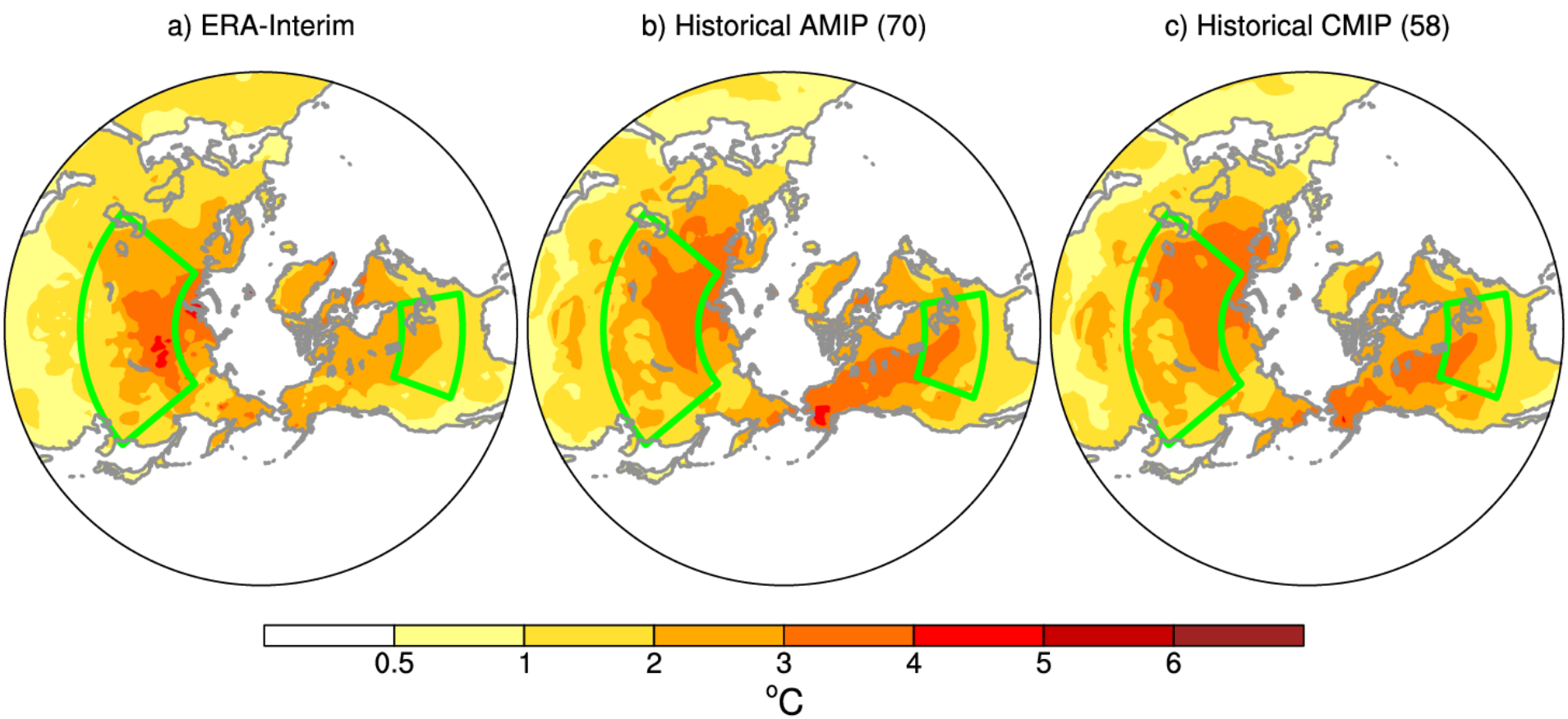

ERA-Interim
Arctic (°C)
Trend (°C decade-1)
Central/east Asia (°C)
Trend (°C decade-1)
Central North America (°C)
Trend (°C decade-1)
1990
1995
2000
2005
2010
2015
1991-2014
1991-2015

NCEP/NCAR Reanalysis

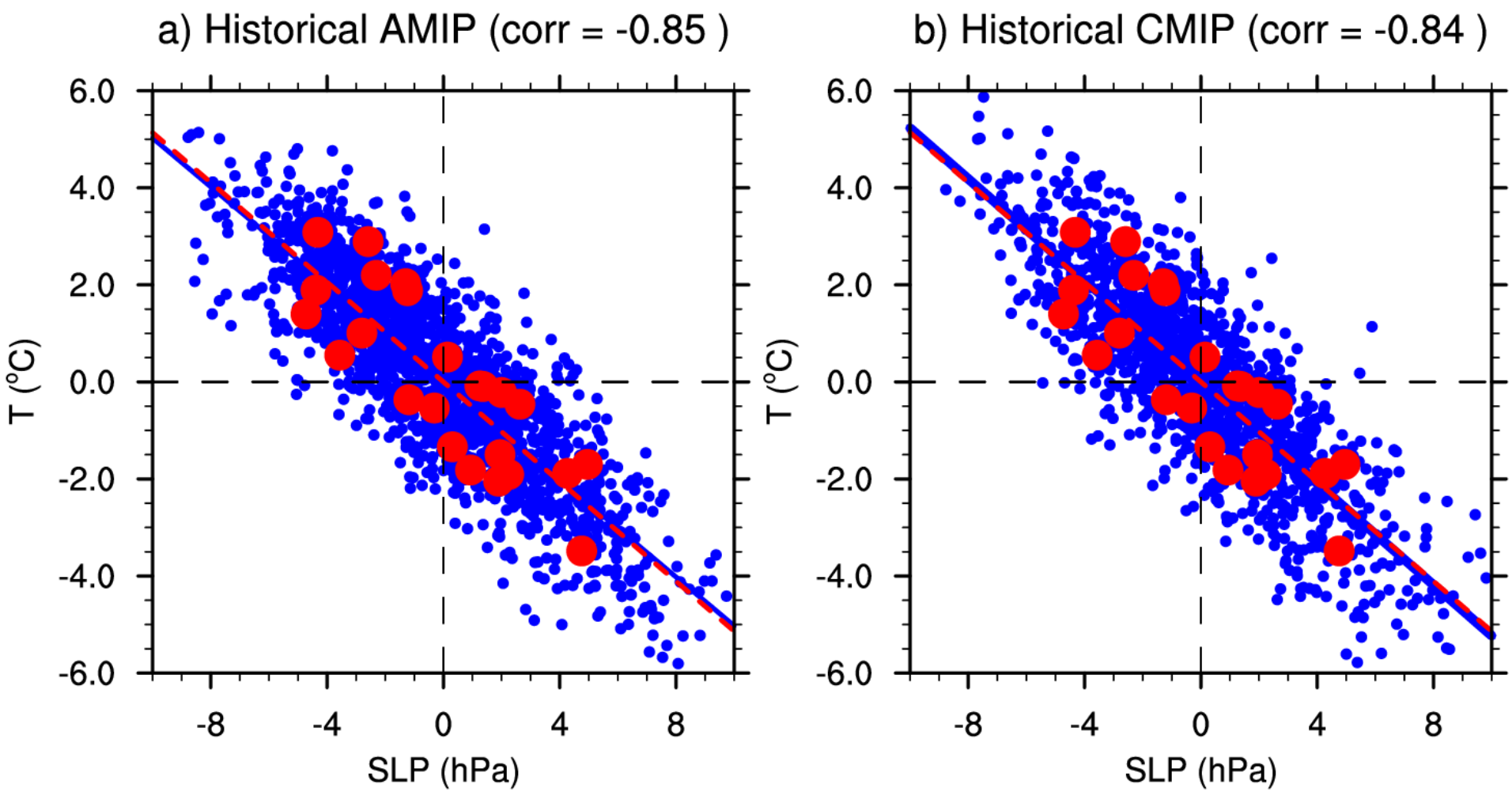



1990/91-2013/14 DJF temperaturer trend
a) Central/East Asia
b) Central North America
2.0
1.0
0.0
-1.0
-2.0
°C decade-1
AMIP (70)
CMIP (58)

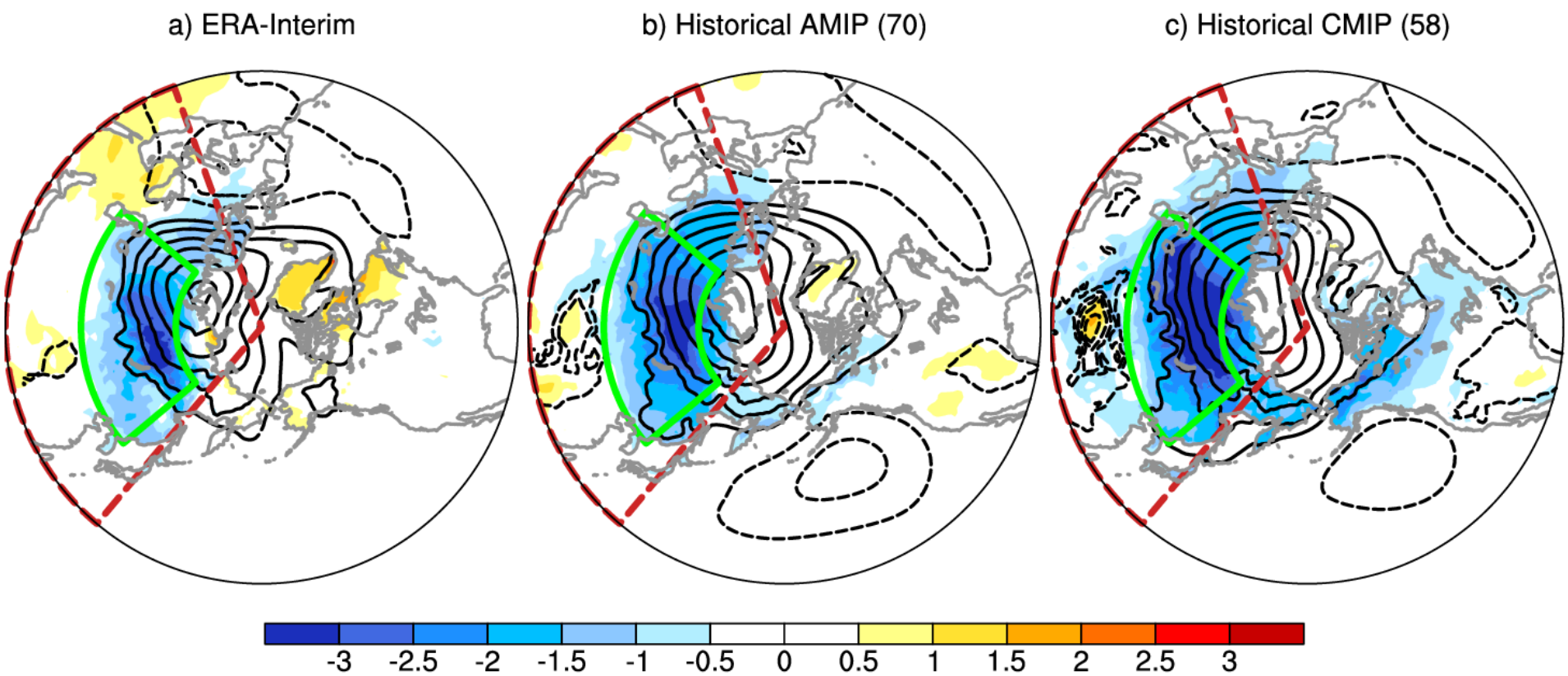
Winter temperature standard deviation

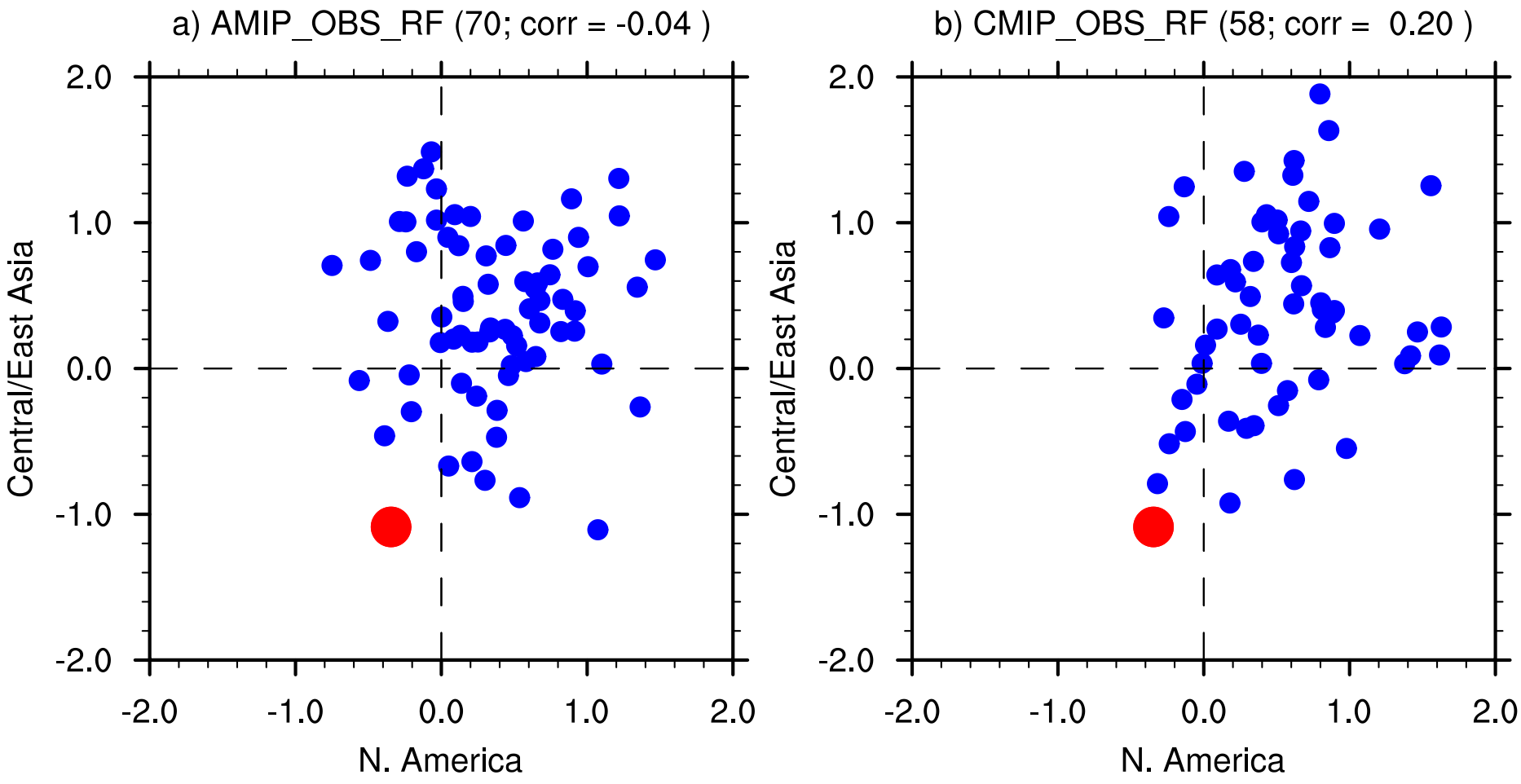


2m-T/SLP relationship at interannual timescale



Leading mode of the winter SLP at Eurasian sector and the corresponding temperature anomaly



Similar to Smoliak and Wallace (2015)

Temperature trend over N America and C/E Asia