University of Colorado Boulder

The Divorce of the North Atlantic Ocean and Atmosphere Attributed to Human Affairs

Jeremy Klavans, Mark Cane, Amy Clement, Lisa Murphy, Chengfei He, Pedro DiNezio

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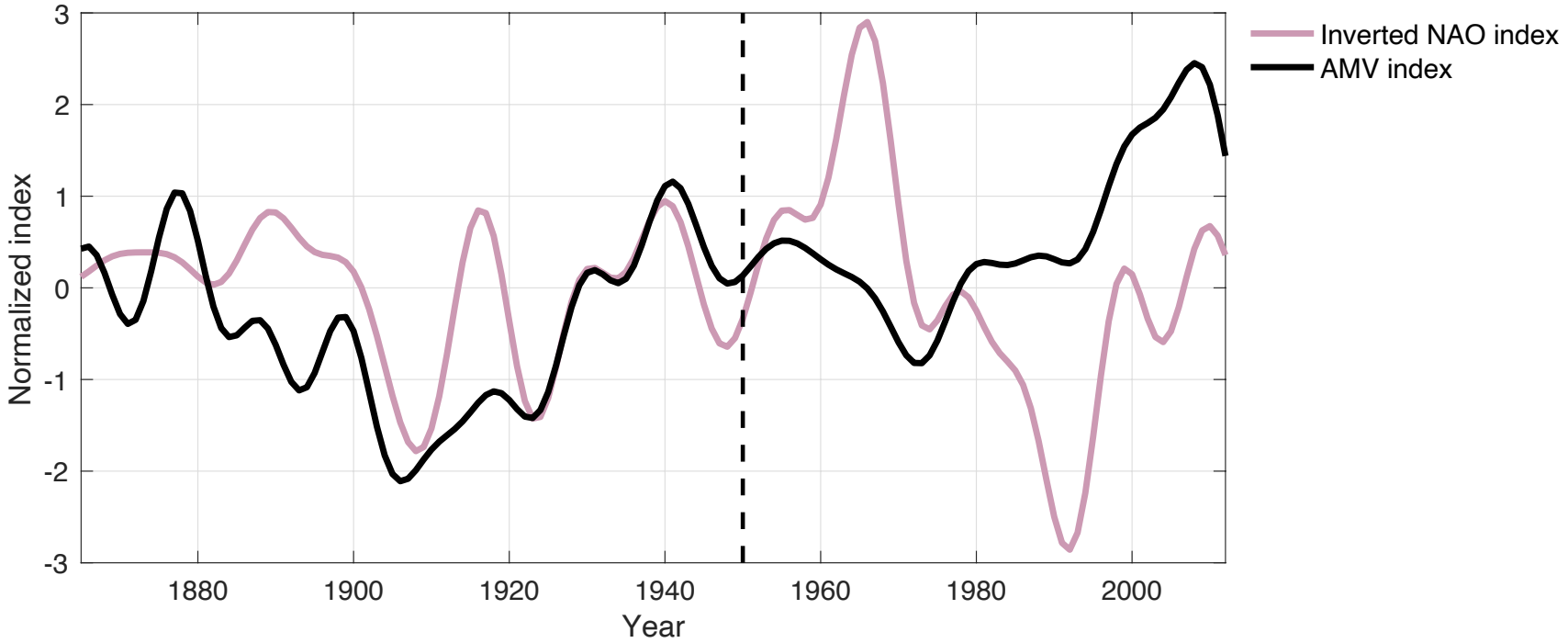
jeremy.klavans@colorado.edu

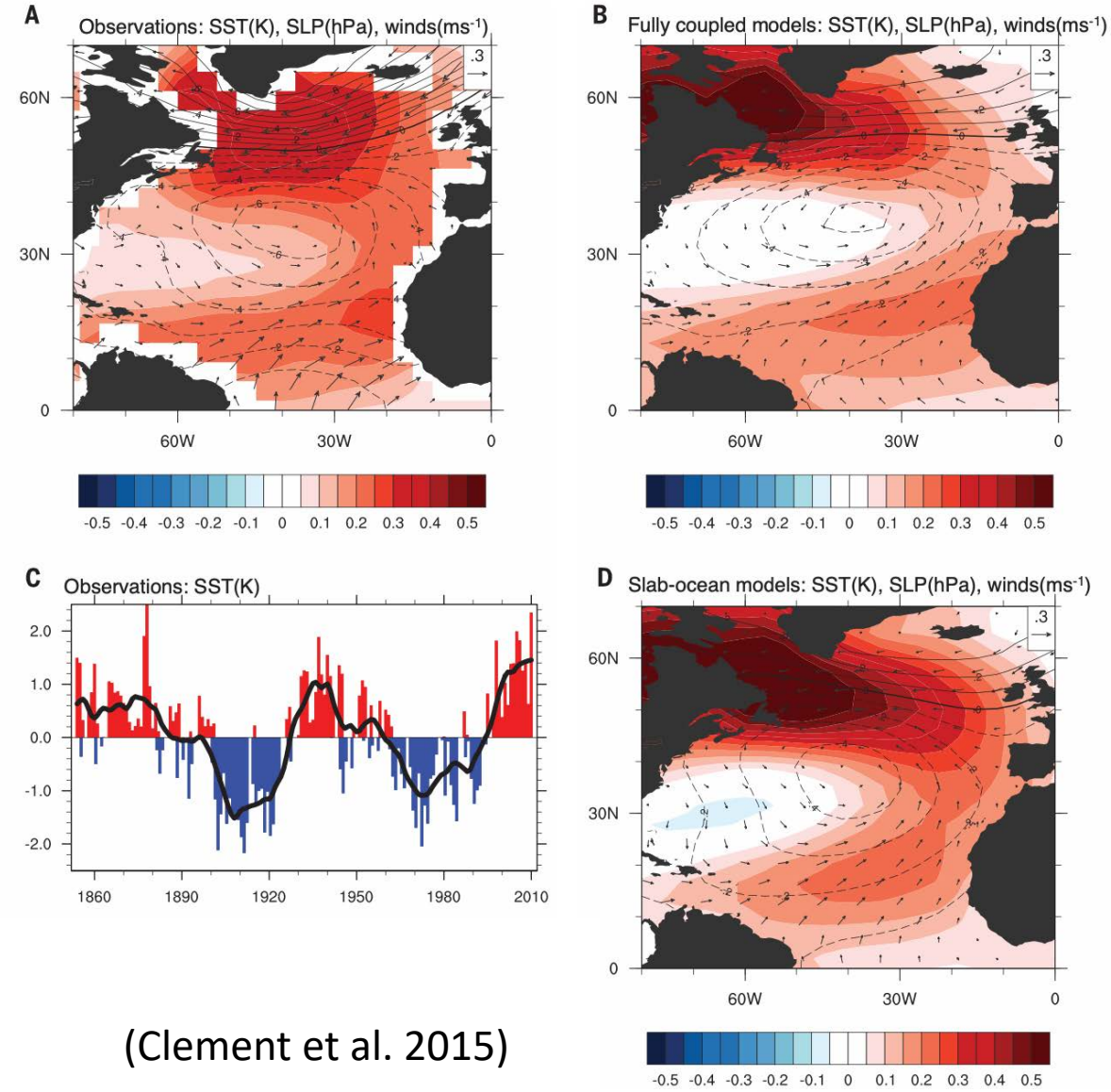
Introduction: the divorce



- The NAO and AMV are happily married until about 1950 (r = -0.62)
- After 1950, they split up (r = 0.06)
- We hypothesize that the divorce signifies a change in primary mechanisms for the AMV

Introduction: AMV potential mechanisms

- Potential mechanisms for multidecadal SST variability in the North Atlantic:
  1. Atmosphere (NAO)
  2. Ocean (AMOC)
  3. External forcing (aerosols, GHGs)



(Clement et al. 2015)

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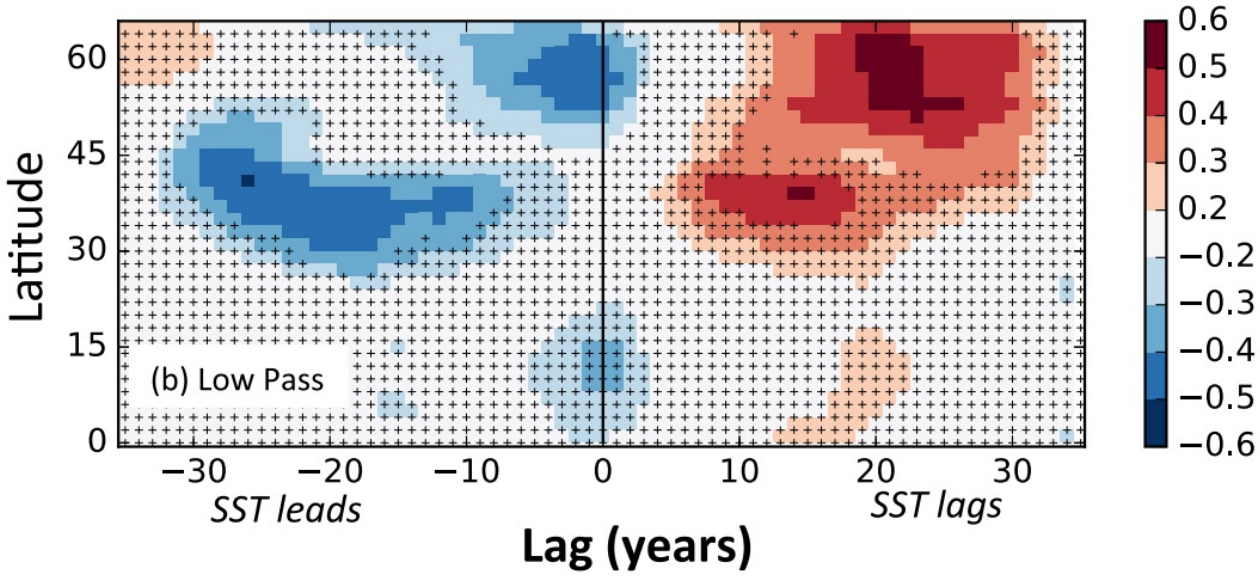

(Delworth et al. 2017)

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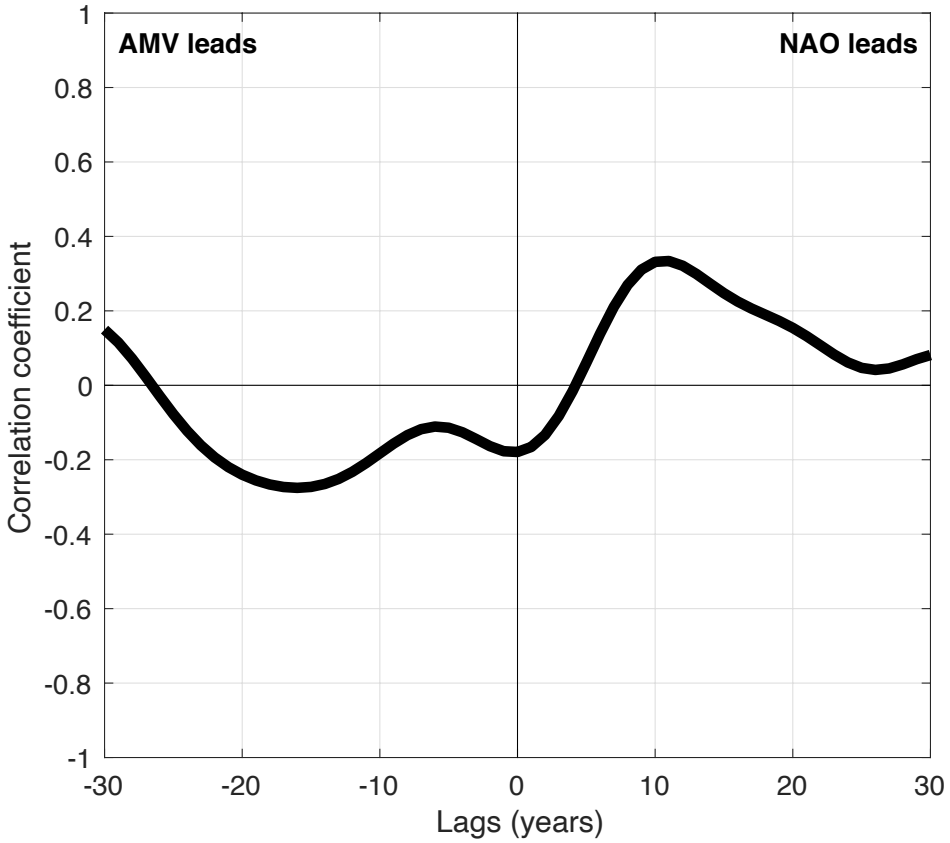

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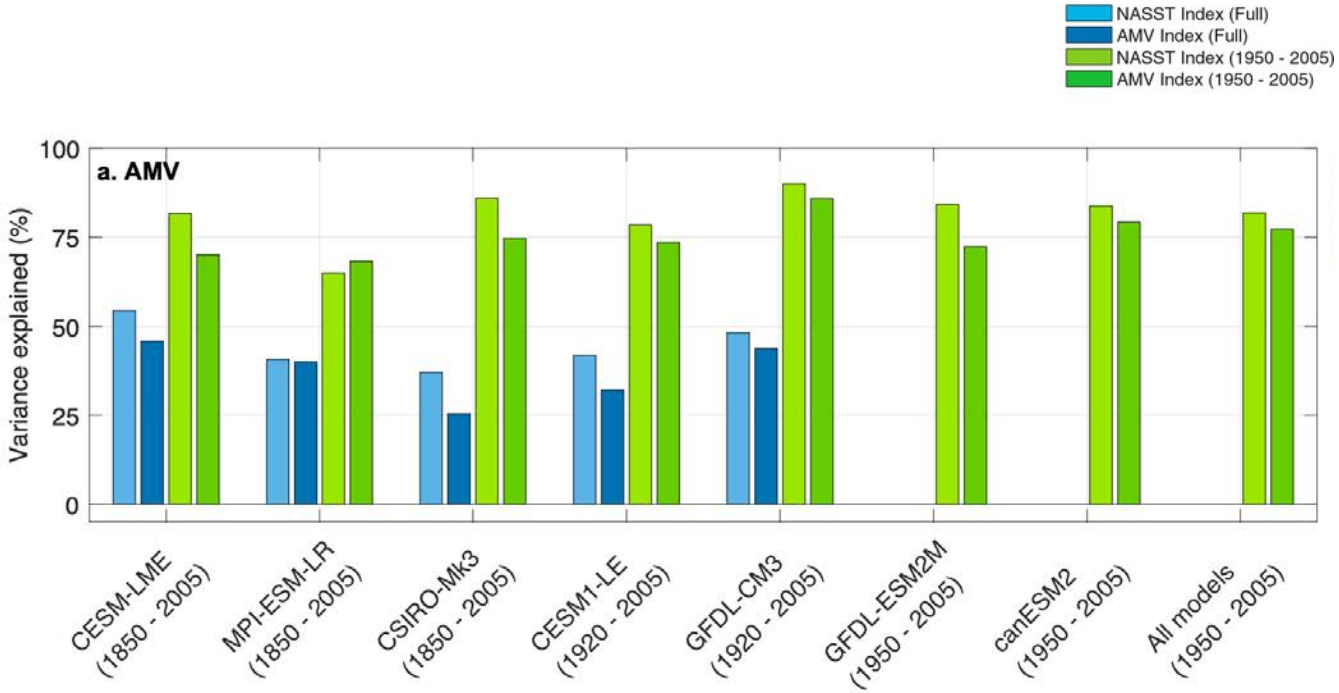


(Klavans et al. 2022)

Methods: Simple SST model

- Force a simple linear model for SST with each of these three terms:

$$\frac{dAMV}{dt} = -\alpha AMV - \beta_1 NAO + \beta_2 AMOC + \beta_3 Forcing + \beta_4 \varepsilon$$

- Damping coefficient and weights on forcings are determined by linear regression on the observed AMV tendency
- Integrate the model with those weights to get a predicted SST timeseries
- Compare with observations
- Test different combinations of forcing terms, different time periods

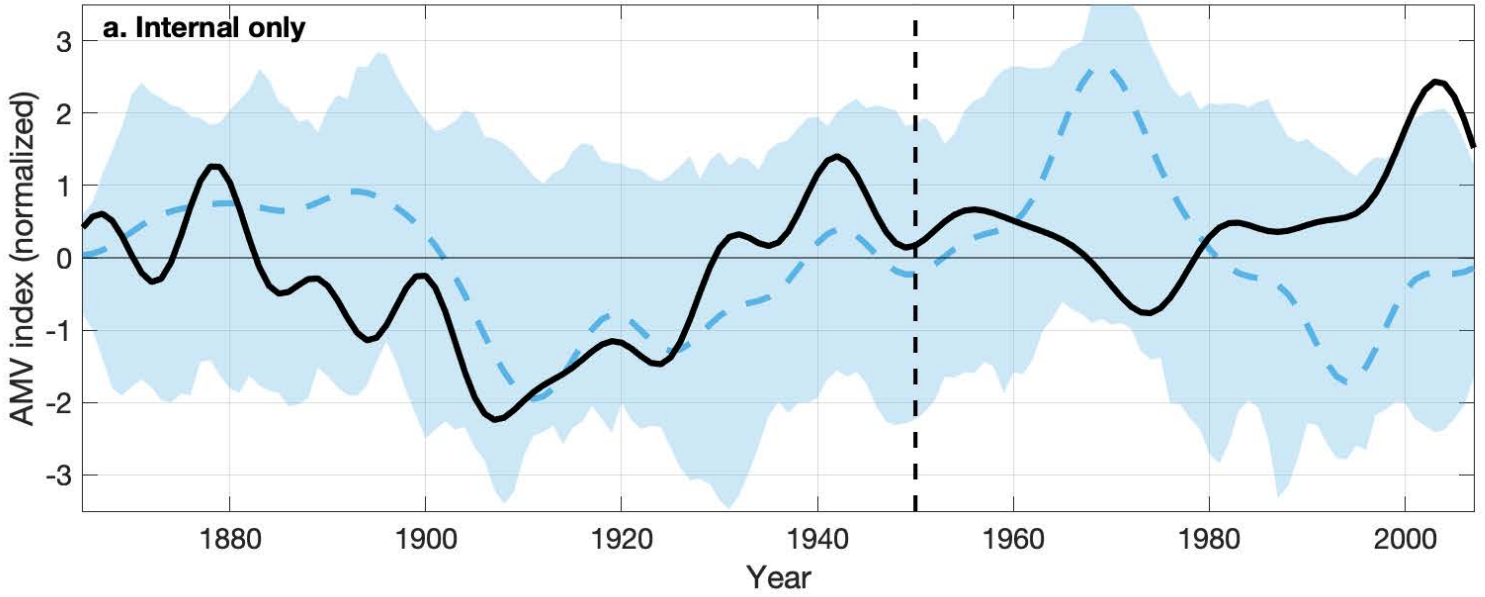
Methods: Data and coefficients

- Observational data
  - SST: **HadISST**, ERSSTv5
  - NAO: **station-based**, EOF
  - AMOC: **EN4 reconstruction (Fraiser and Cunningham 2021),** Giese et al. 2016
  - Forcing: **CMIP5 (Miller et al. 2014)**
- Note: global forcing, all timeseries normalized

	1865 - 2007	
	(a)	(b)
NAO	-0.06	-0.07
AMOC	0.01	0.02
Forcing	-	0.23
R^2 (T)	0.64	0.68

Results: AMV timeseries

- (a) Internal-only model captures variability between 1900 - 1950 (r^2 = 84%) but less from 1951 - 2007 (r^2 = 28%)
- (b) Including external forcing improves simulation of 1951 - 2007 period (r^2 = 65%)
- Improve explained variance by training on different periods



Observations SST Model

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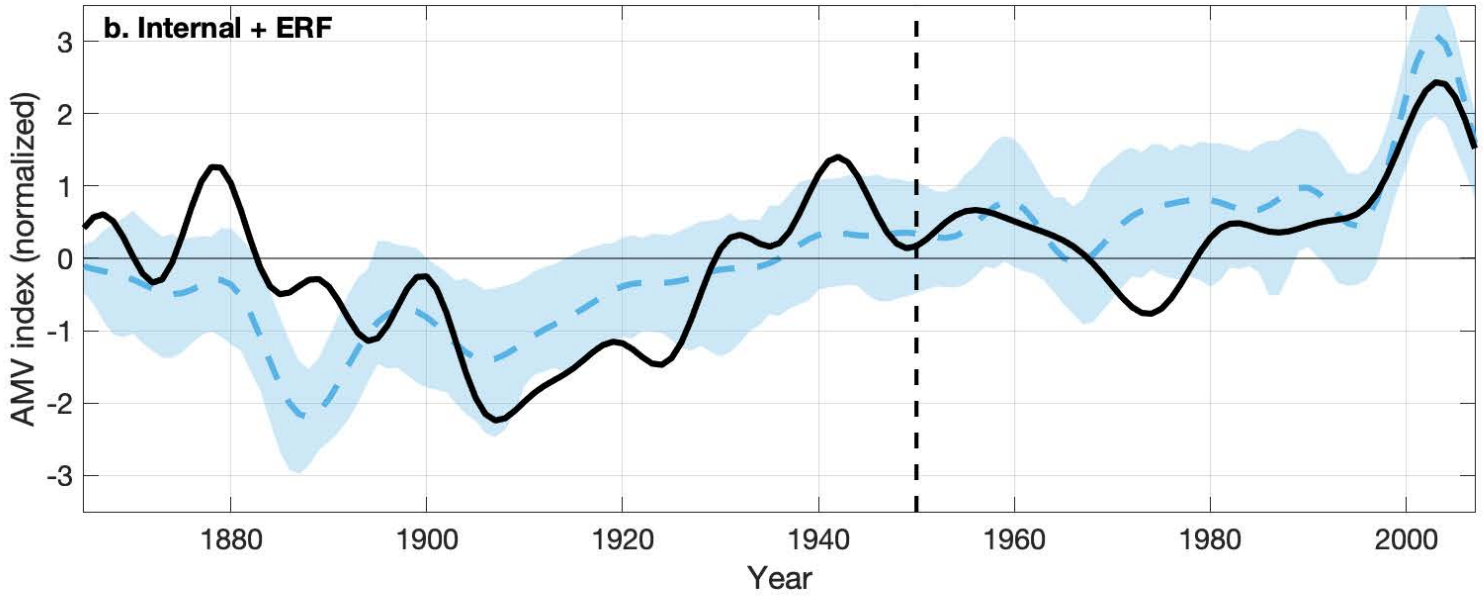
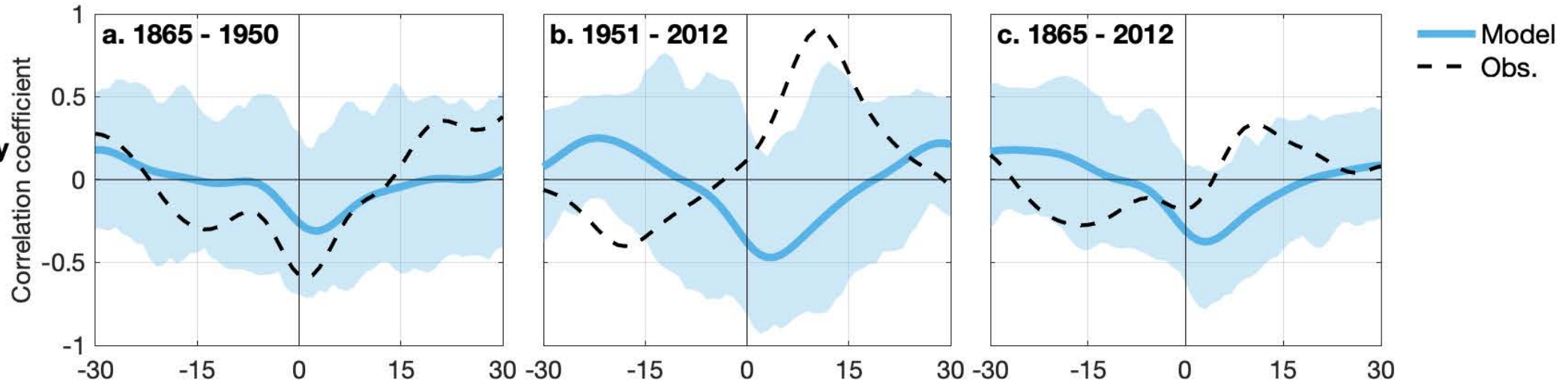


Observations SST Model

Results: NAO-AMV lagged relationship

Internal only
1865 - 2012
coefficients



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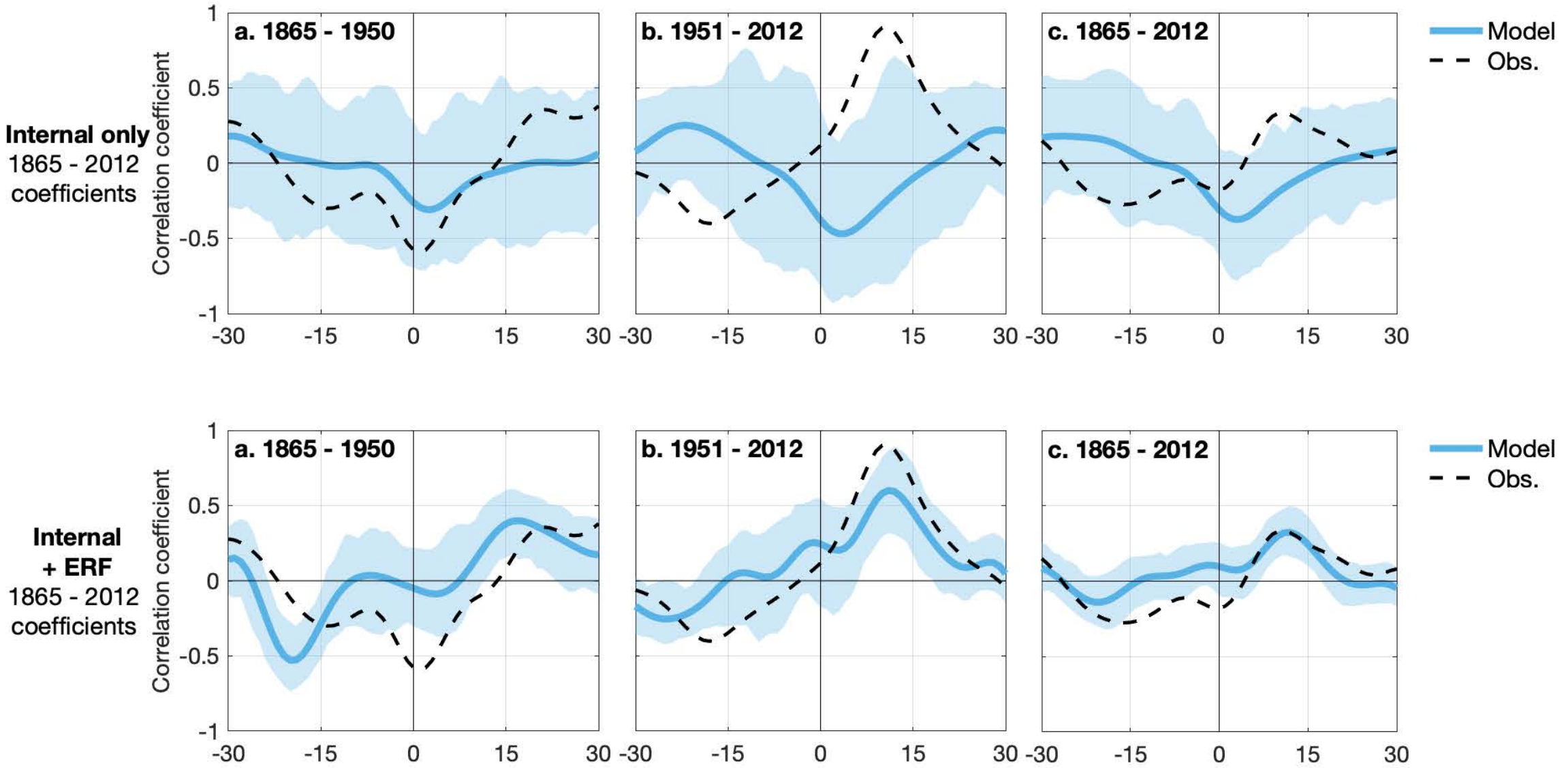

Discussion

- Forcing a simple SST model with observations of the NAO and AMOC reasonably recovers observed SST between 1865 – 1950
- Including external forcing significantly improves the simulation between 1951 – 2007
- Suggests a change in dominant mechanism before/after ~1950
- This change in mechanism creates the appearance of a lagged relationship between the NAO and AMV, which was previously attributed to AMOC
- That isn’t to say AMOC is not important, but rather we should be cautious when using SST as a proxy for AMOC during periods of large changes in forcing