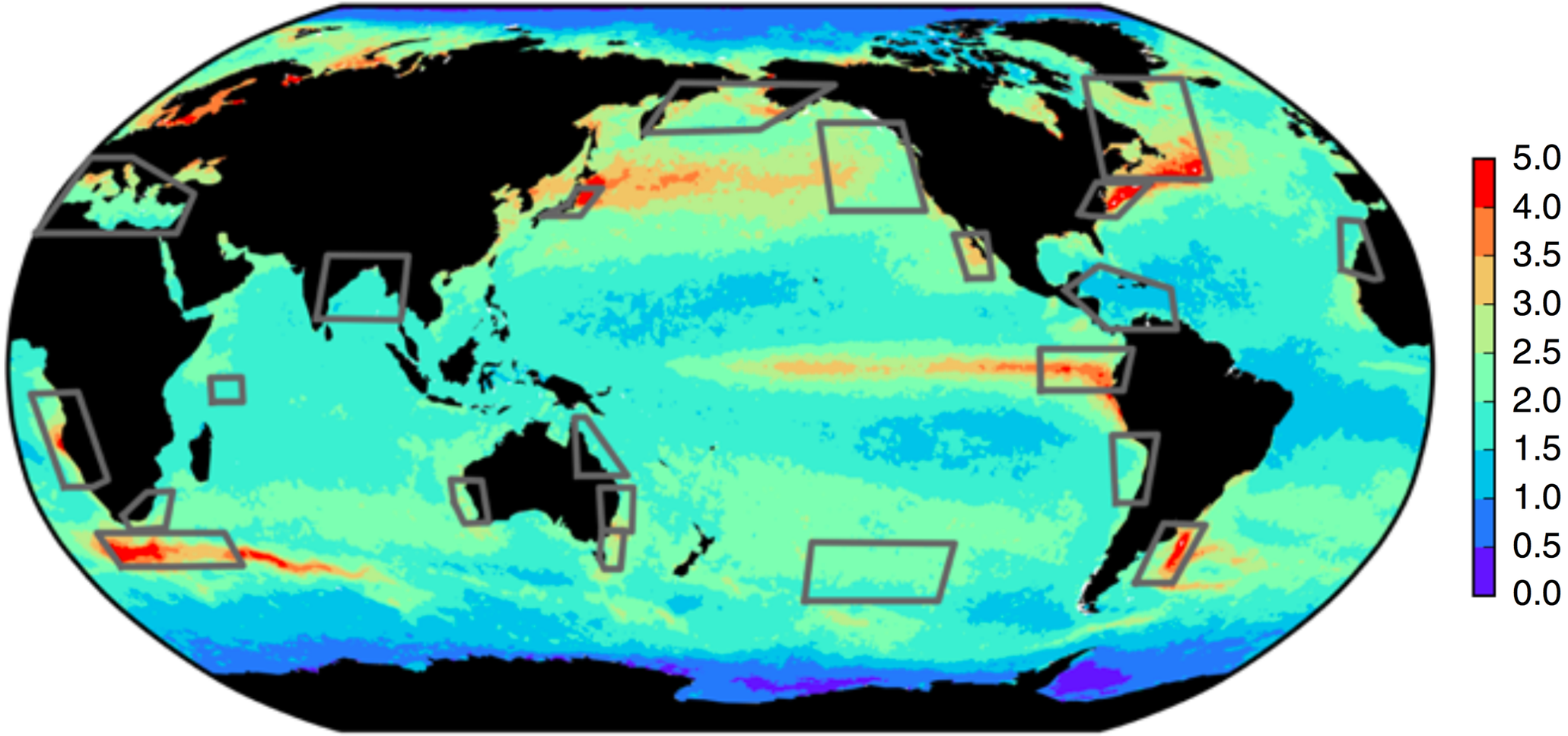
Predictability of Marine Heatwaves

Mike Jacox
NOAA Southwest Fisheries Science Center
NOAA Earth System Research Laboratory

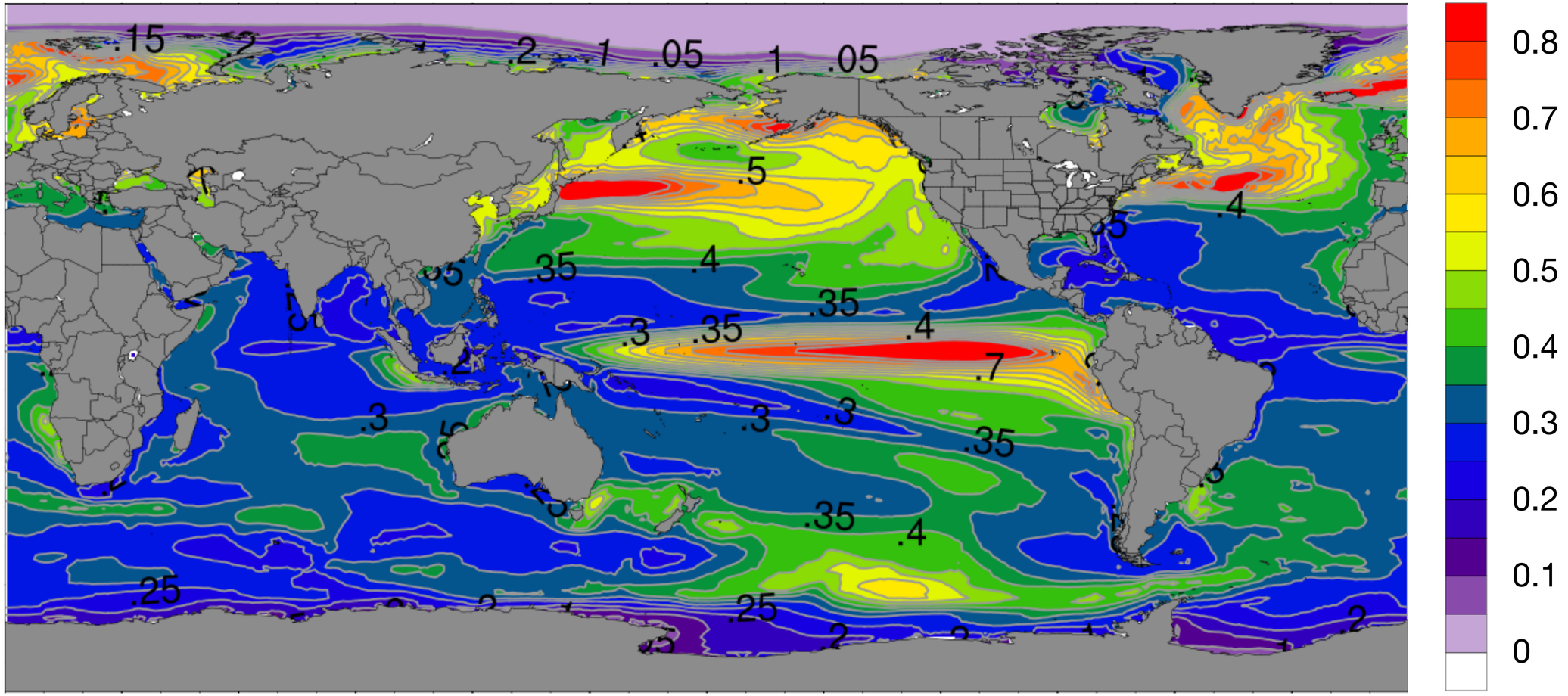
Annual ESSM Community Workshop
November 19, 2019

Marine Heatwave Intensity (˚C)

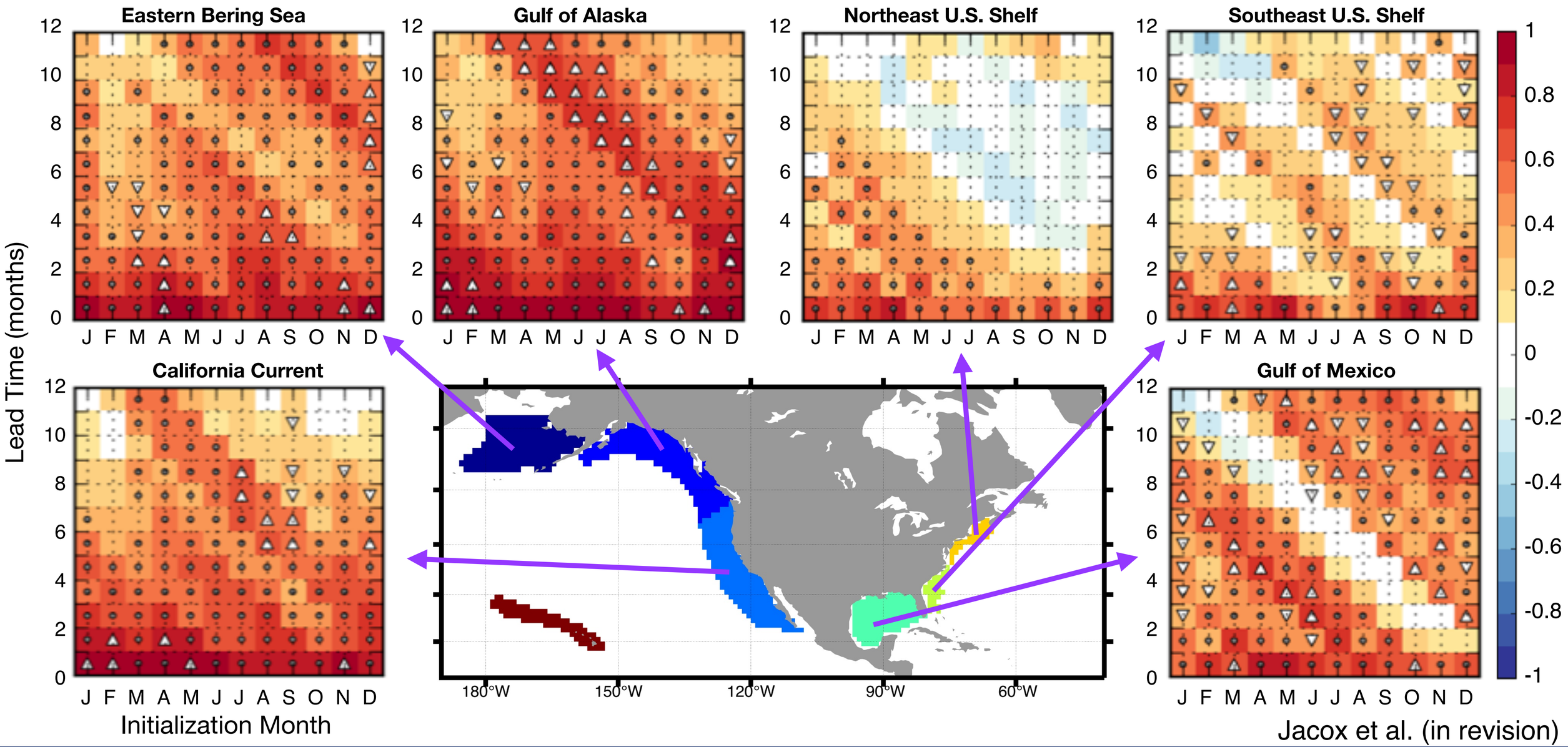


Holbrook et al. (2019)

SST Variance (˚C)



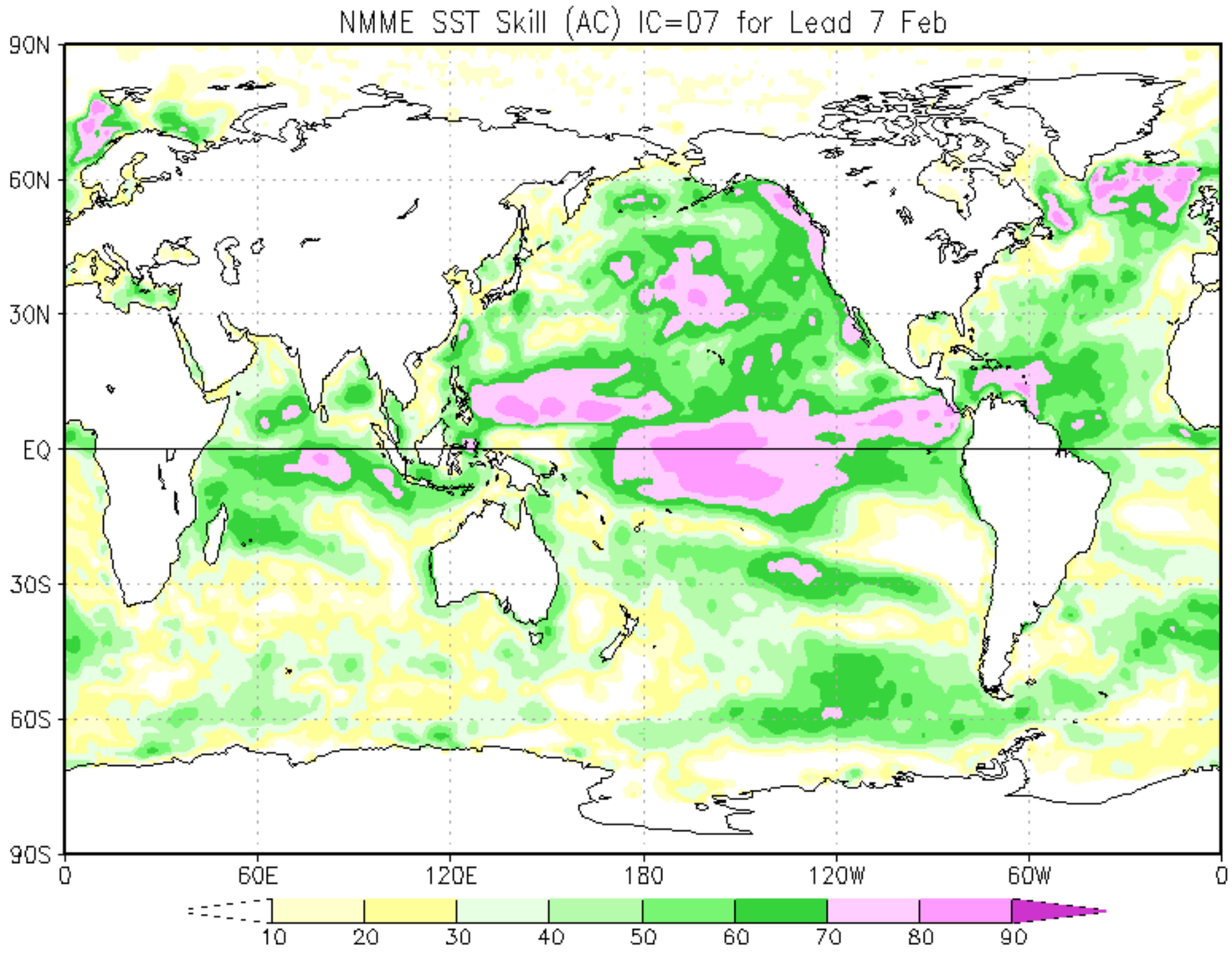
https://www.esrl.noaa.gov/psd/ipcc/



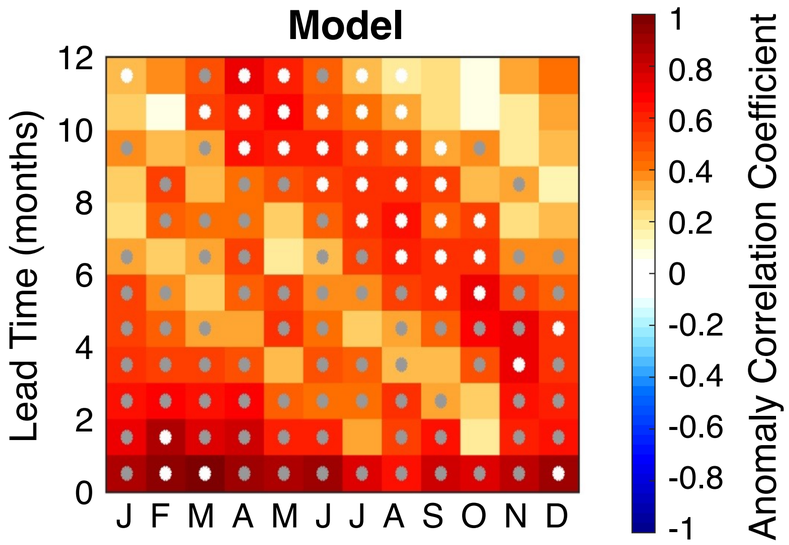
Jacox et al. (in revision)

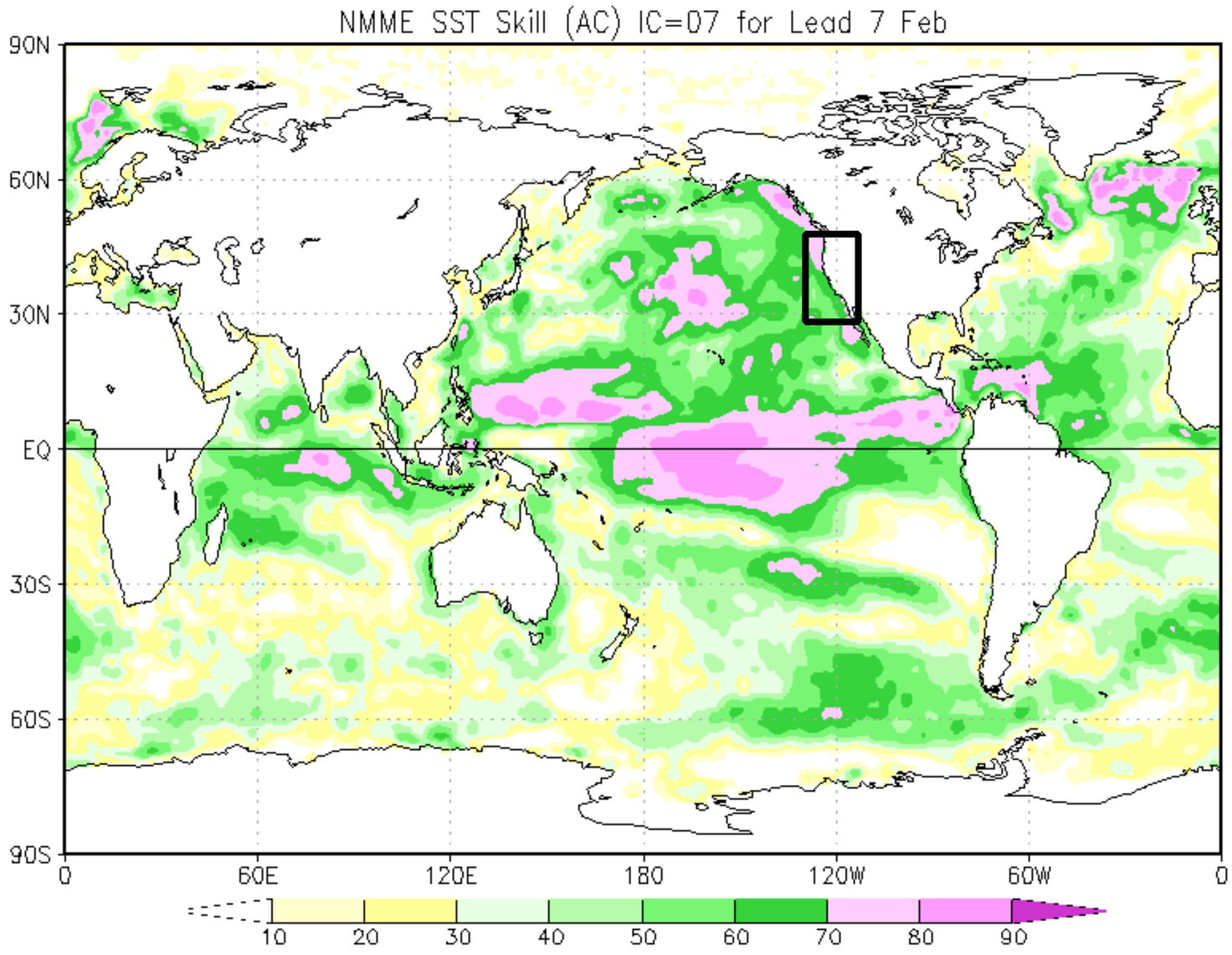
North American Multi-Model Ensemble (NMME)

July Forecast of February SST (7-month lead)

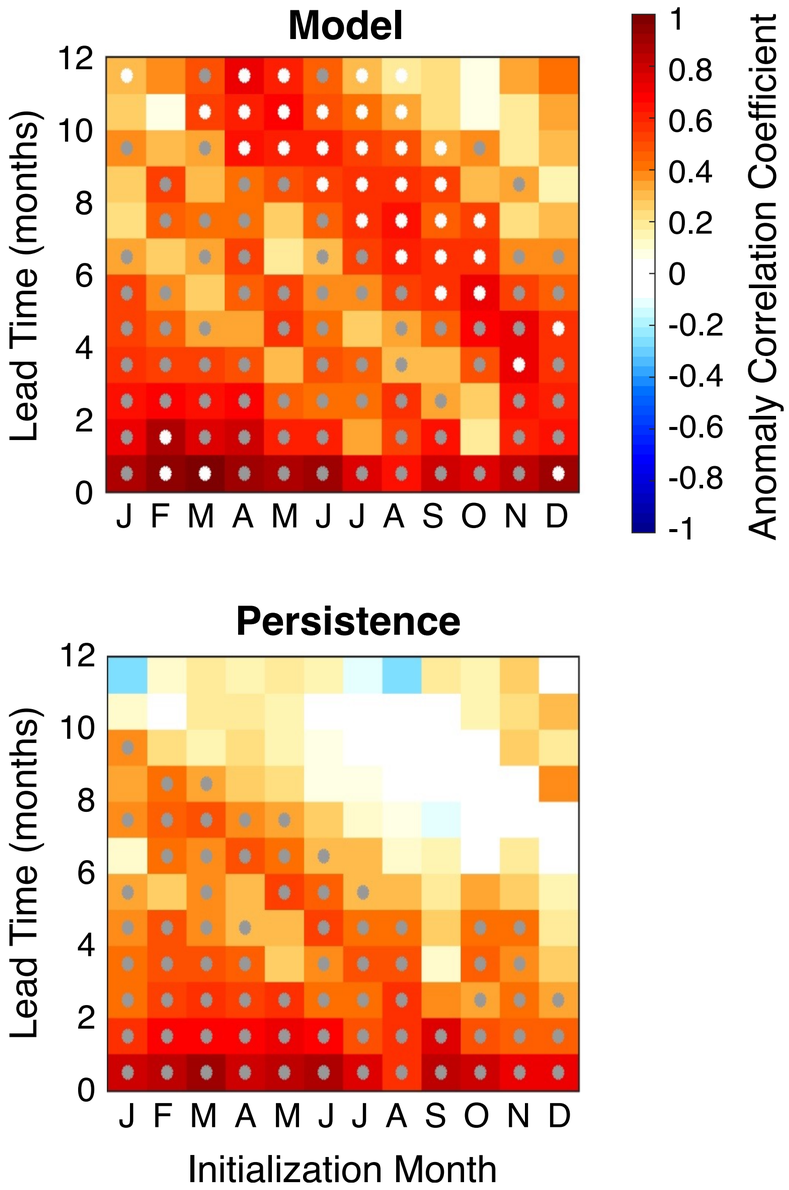


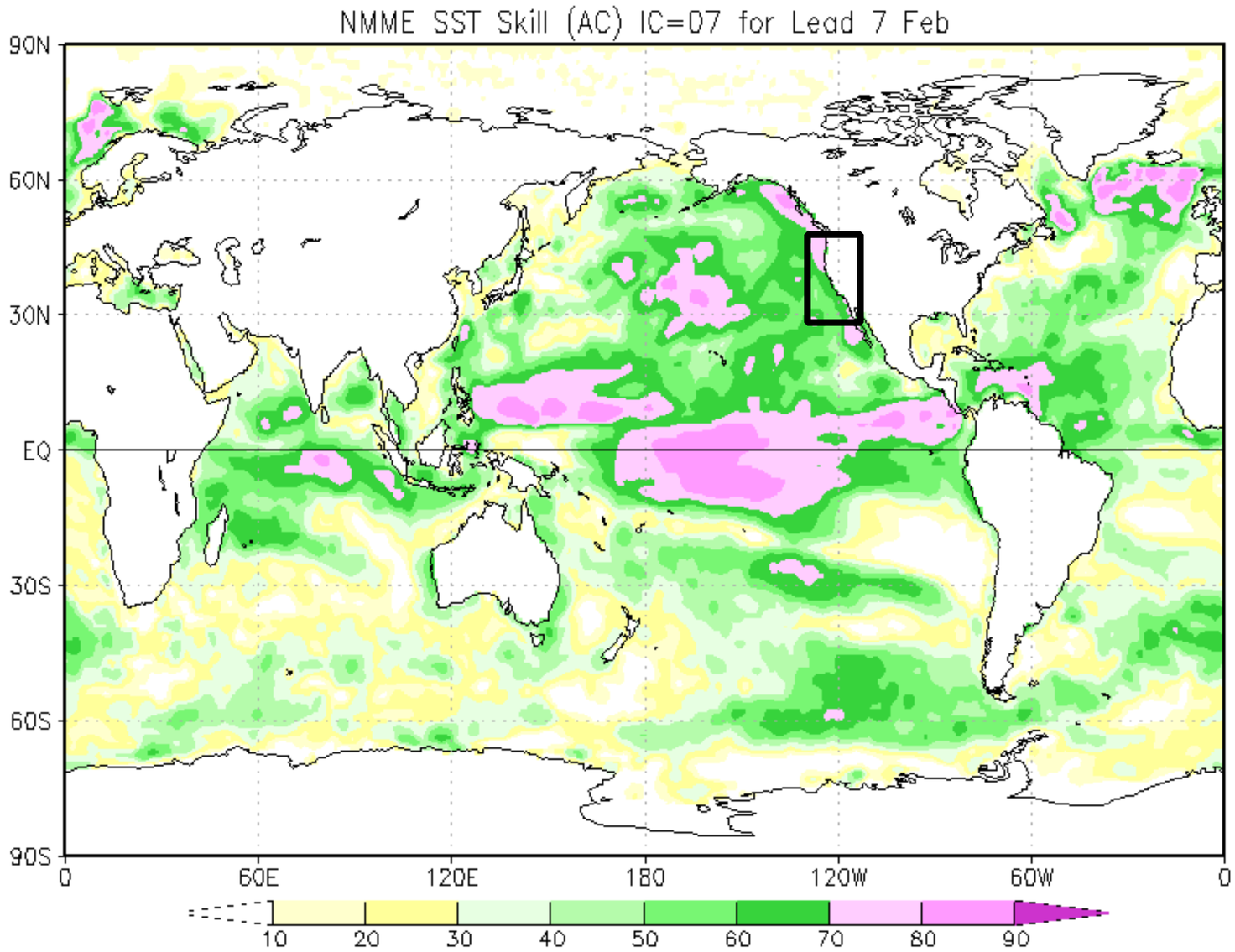
https://www.cpc.ncep.noaa.gov/products/NMME/





Jacox et al., Climate Dynamics (2017)





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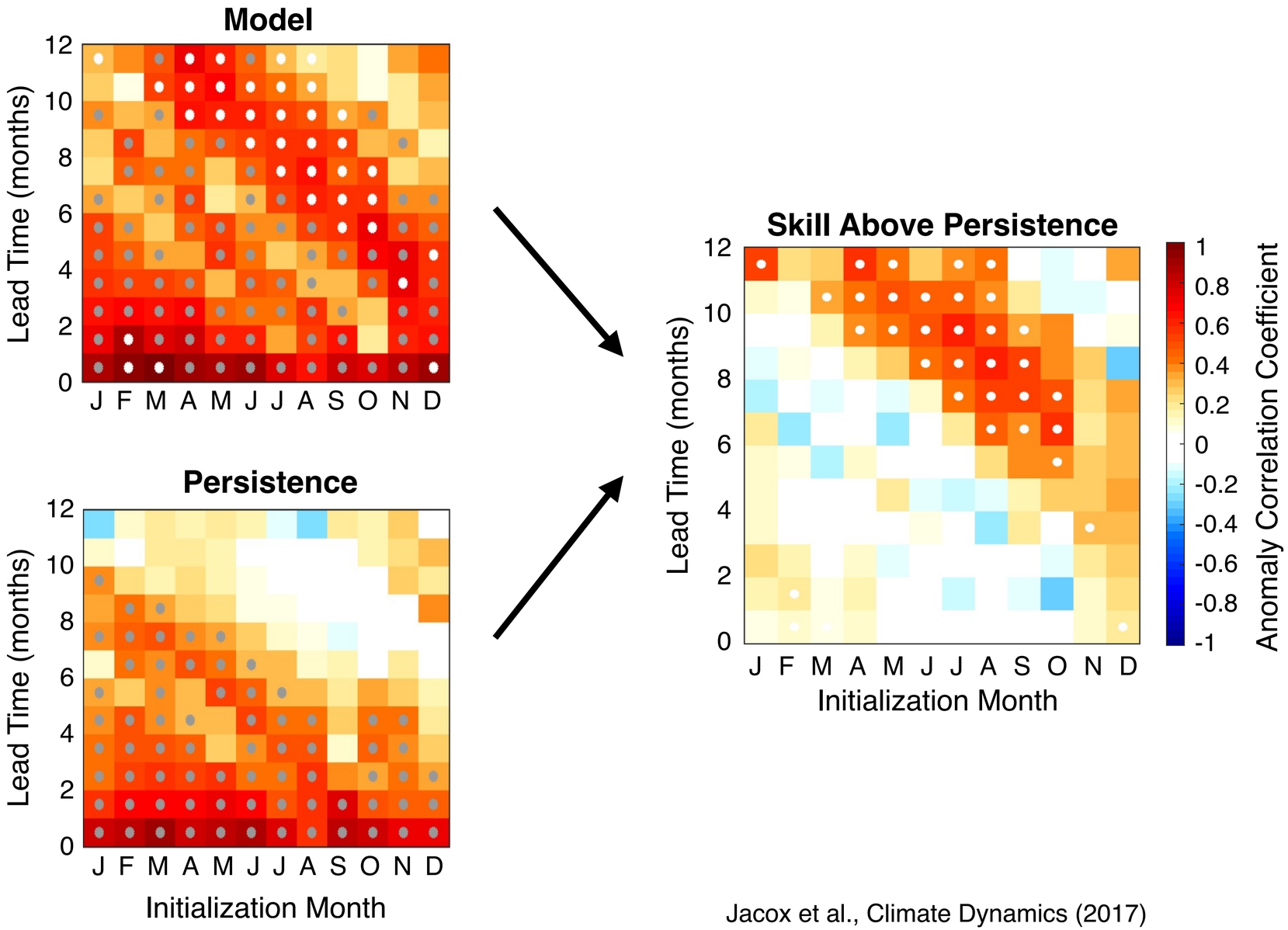

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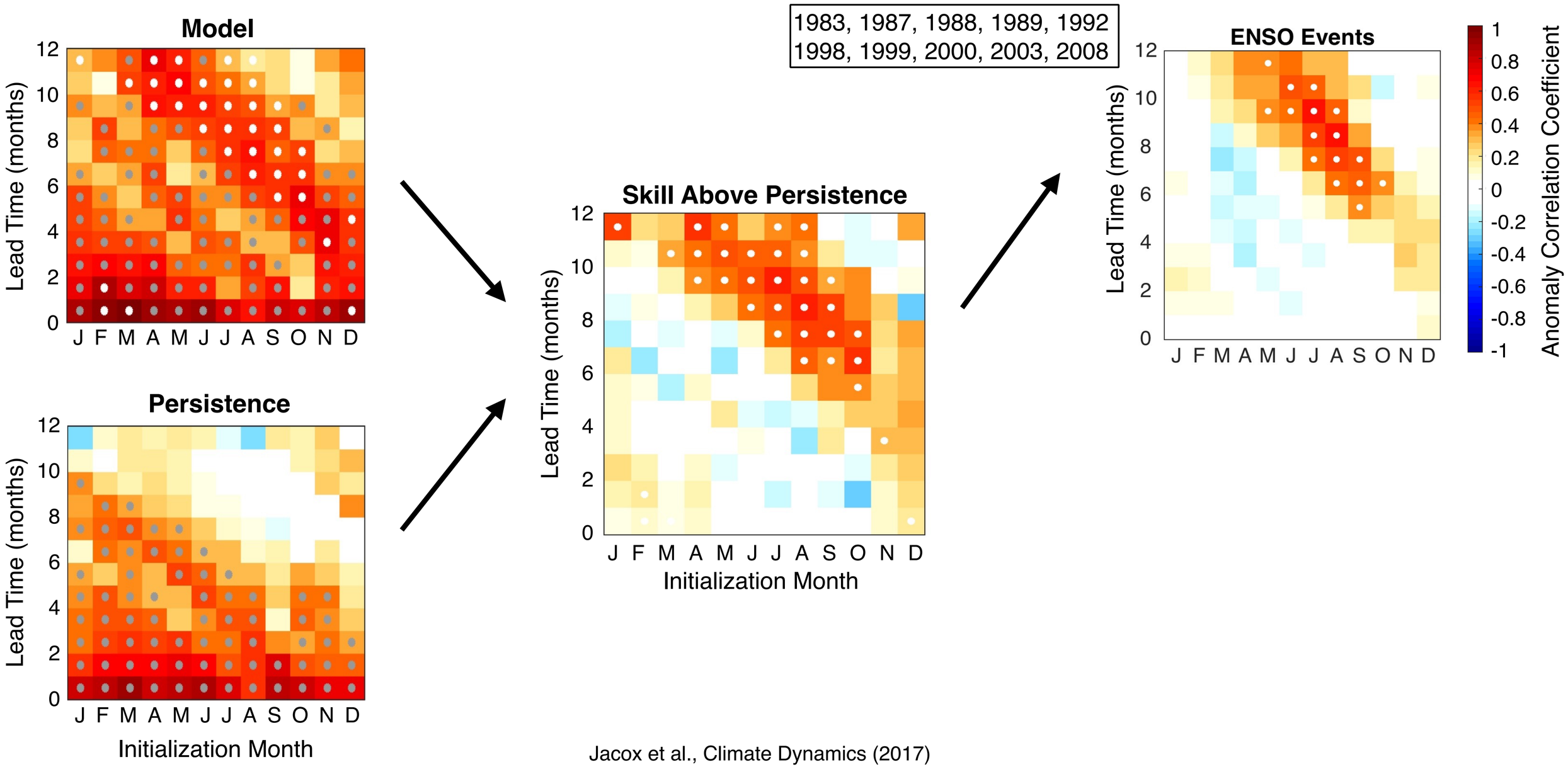

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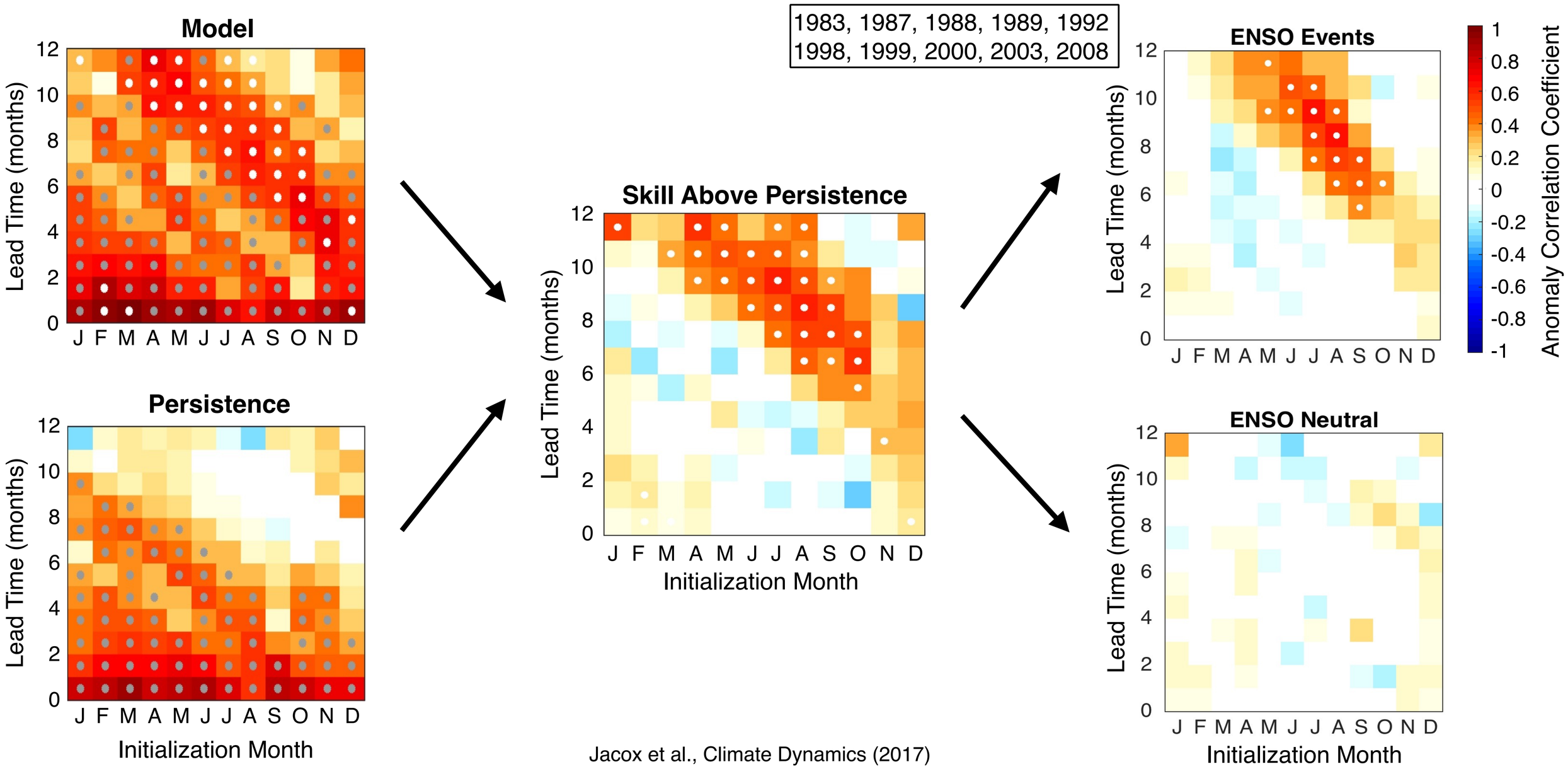

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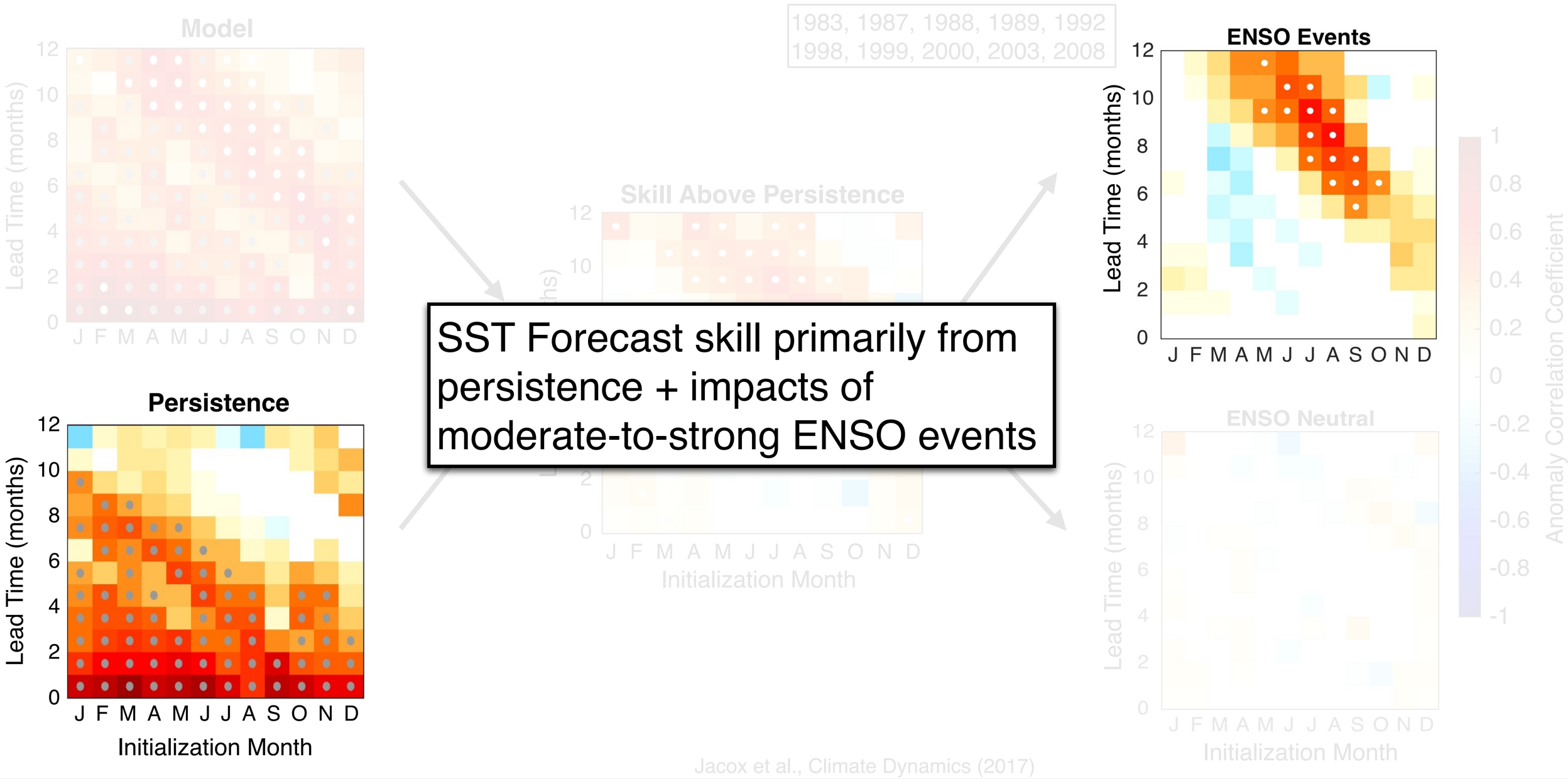
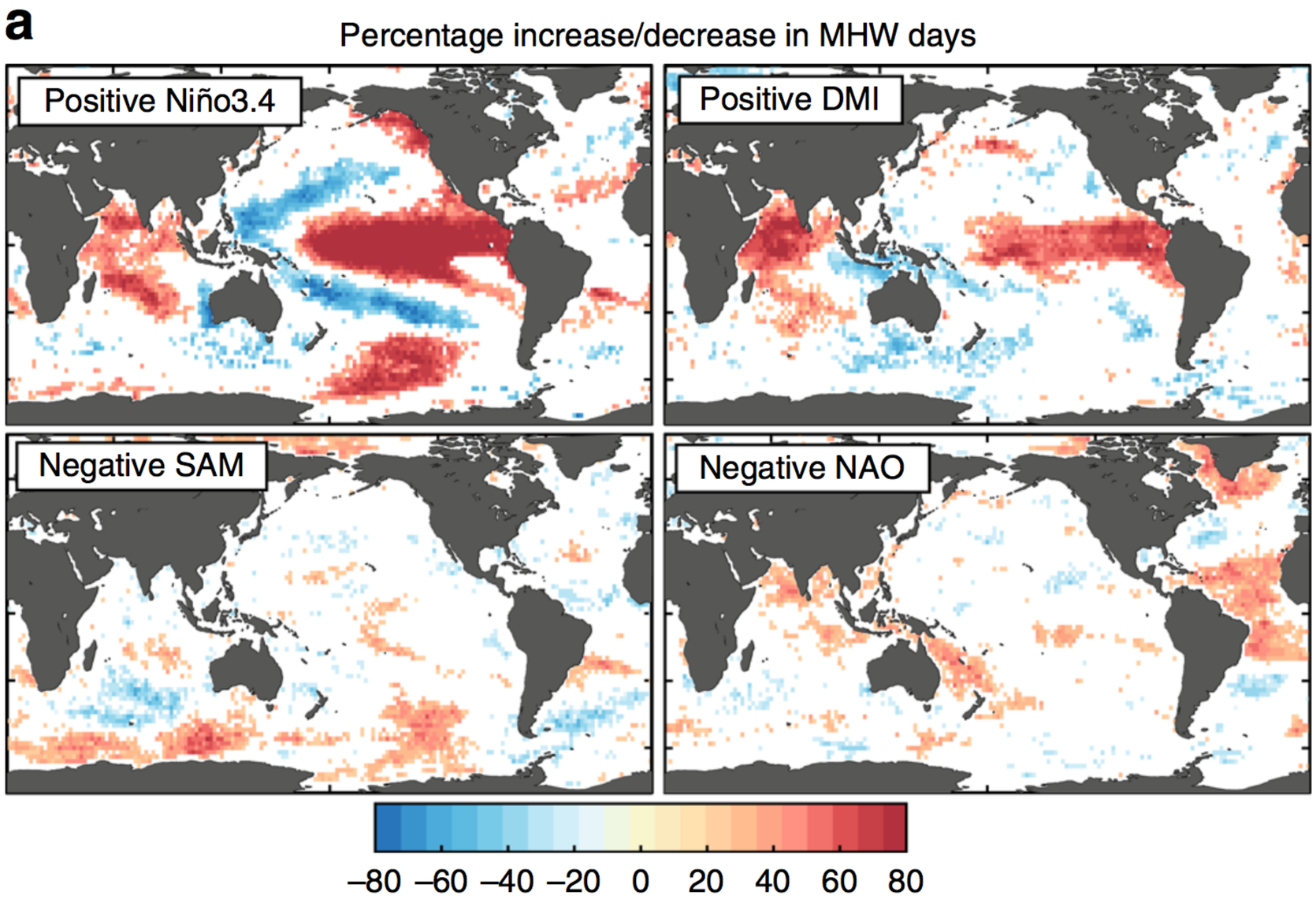


SST Forecast skill primarily from persistence + impacts of moderate-to-strong ENSO events

Jacox et al., Climate Dynamics (2017)



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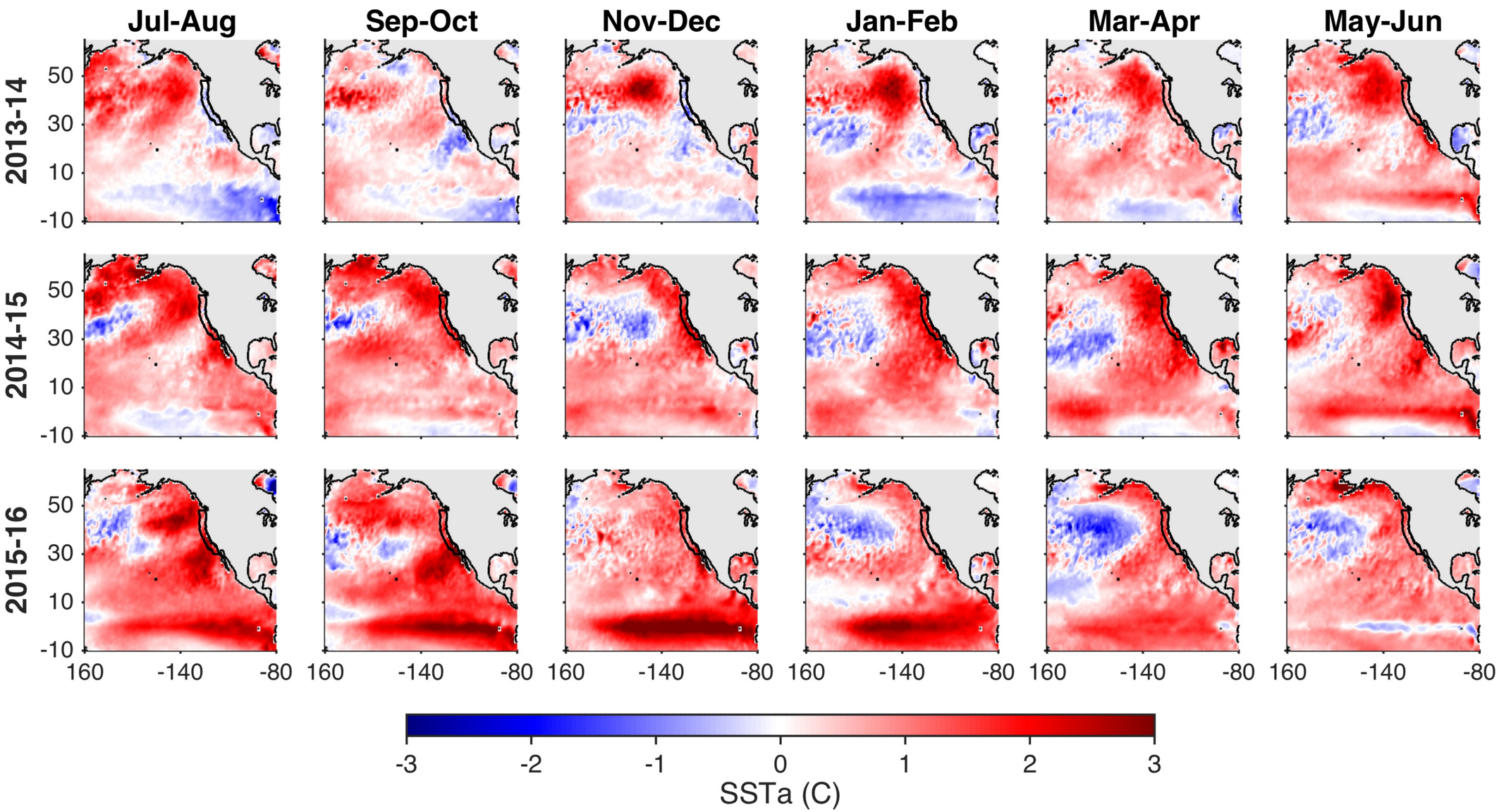
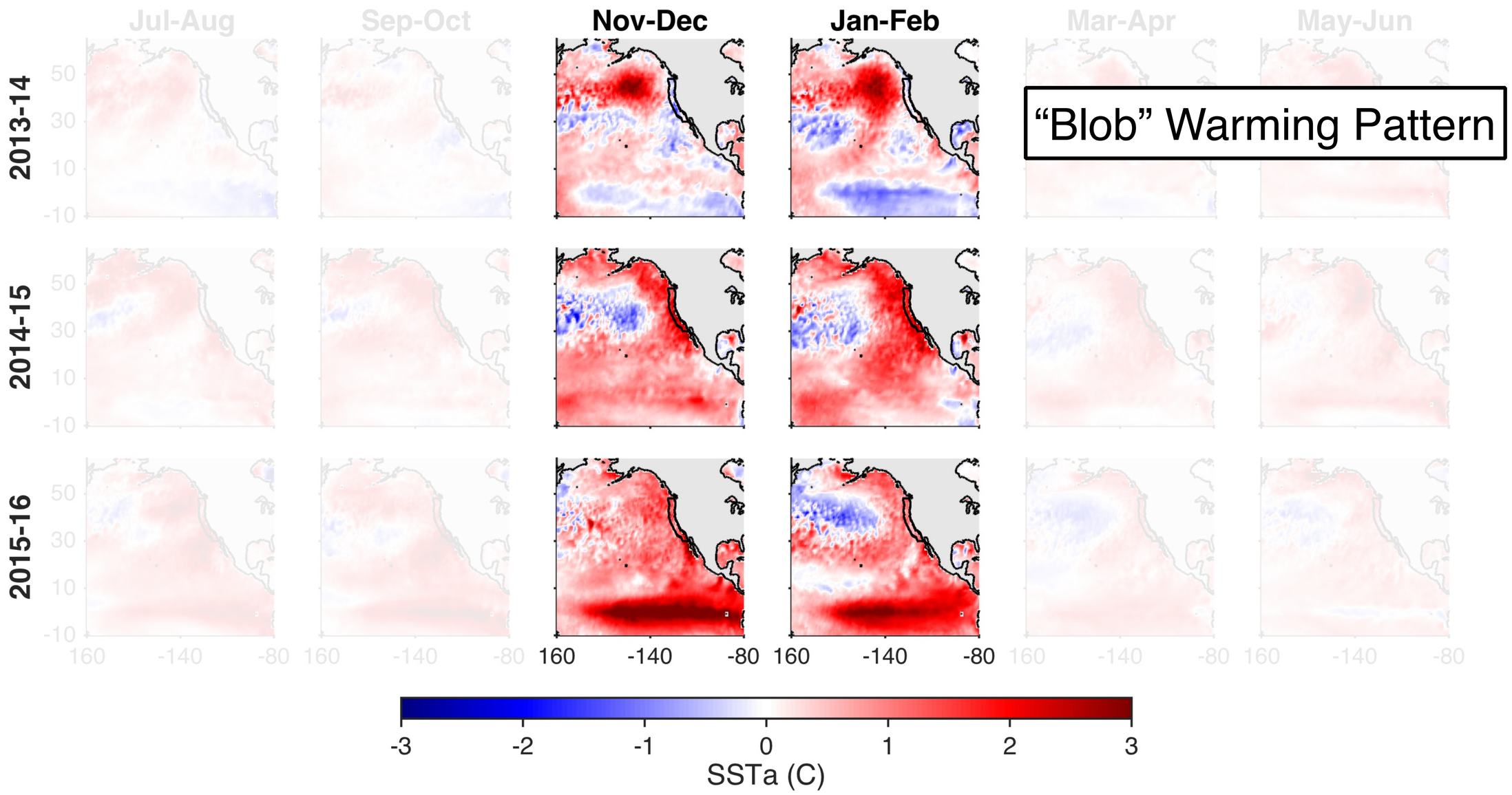
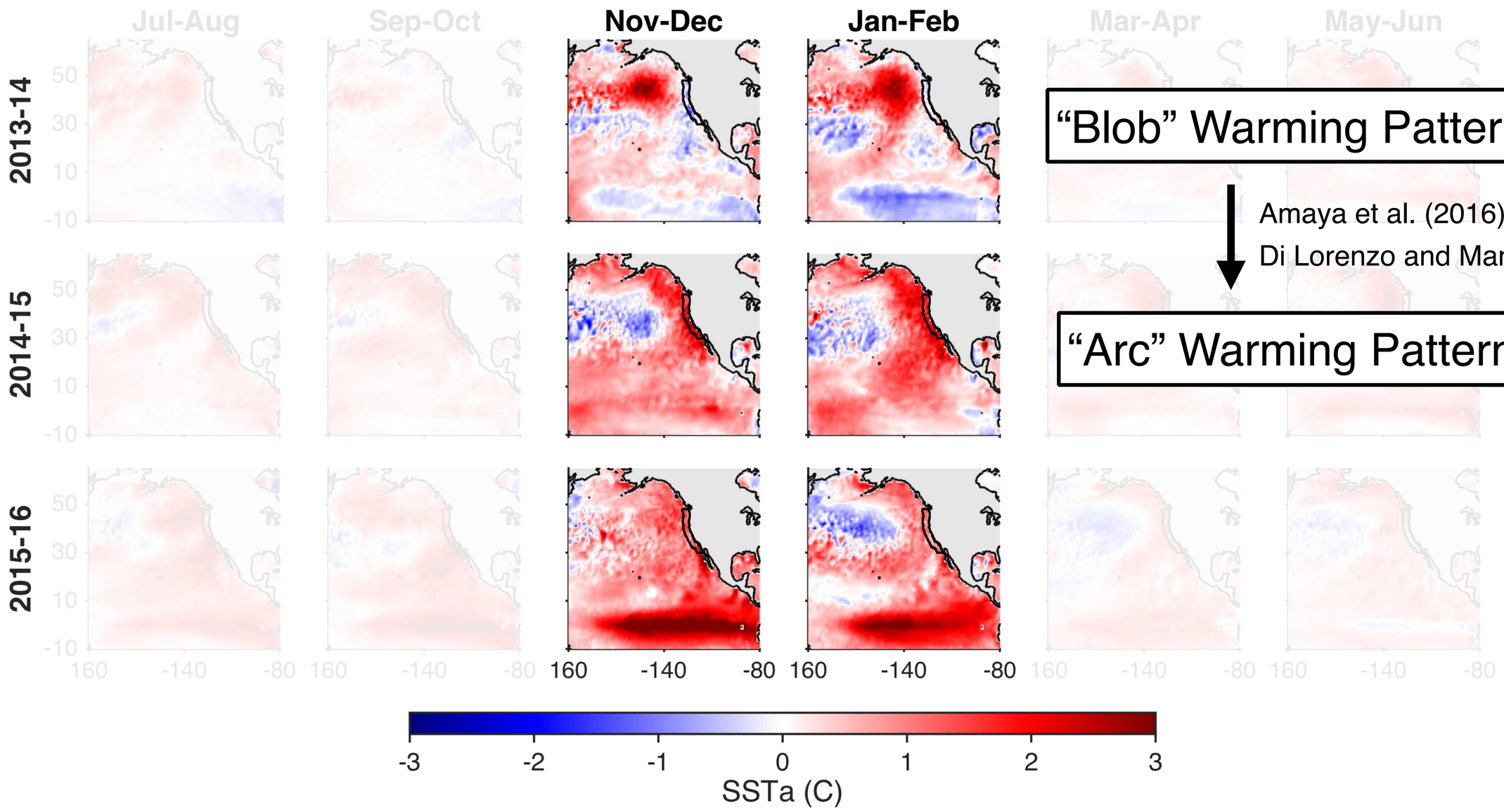

Jul-Aug
Sep-Oct
Nov-Dec
Jan-Feb
Mar-Apr
May-Jun
2013-14
2014-15
2015-16
50
30
10
-10
160
-140
-80
-3
-2
-1
0
1
2
3
SSTa (C)



"Blob" Warming Pattern



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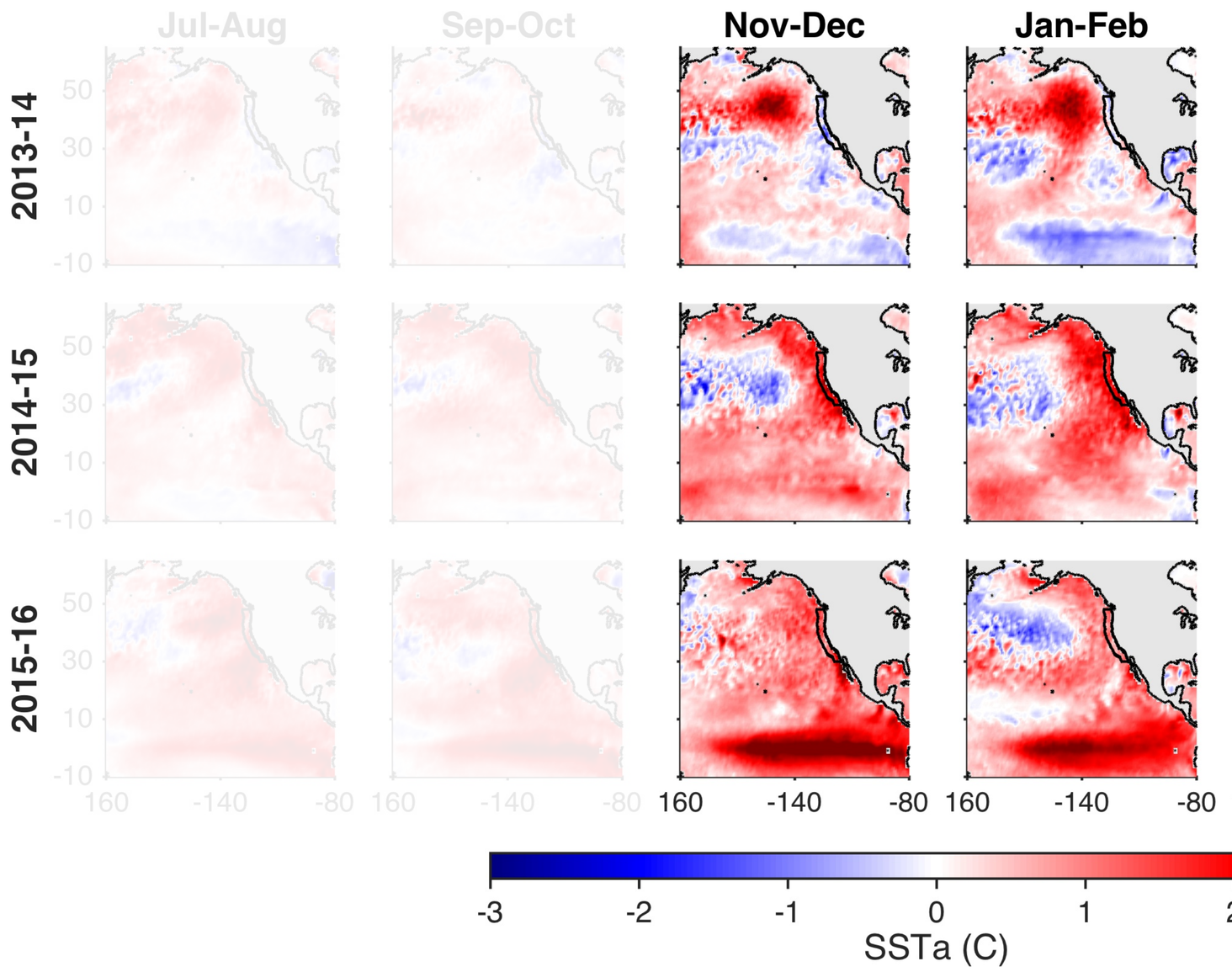
Amaya et al. (2016)

Di Lorenzo and Mantua (2016)

“Arc” Warming Pattern



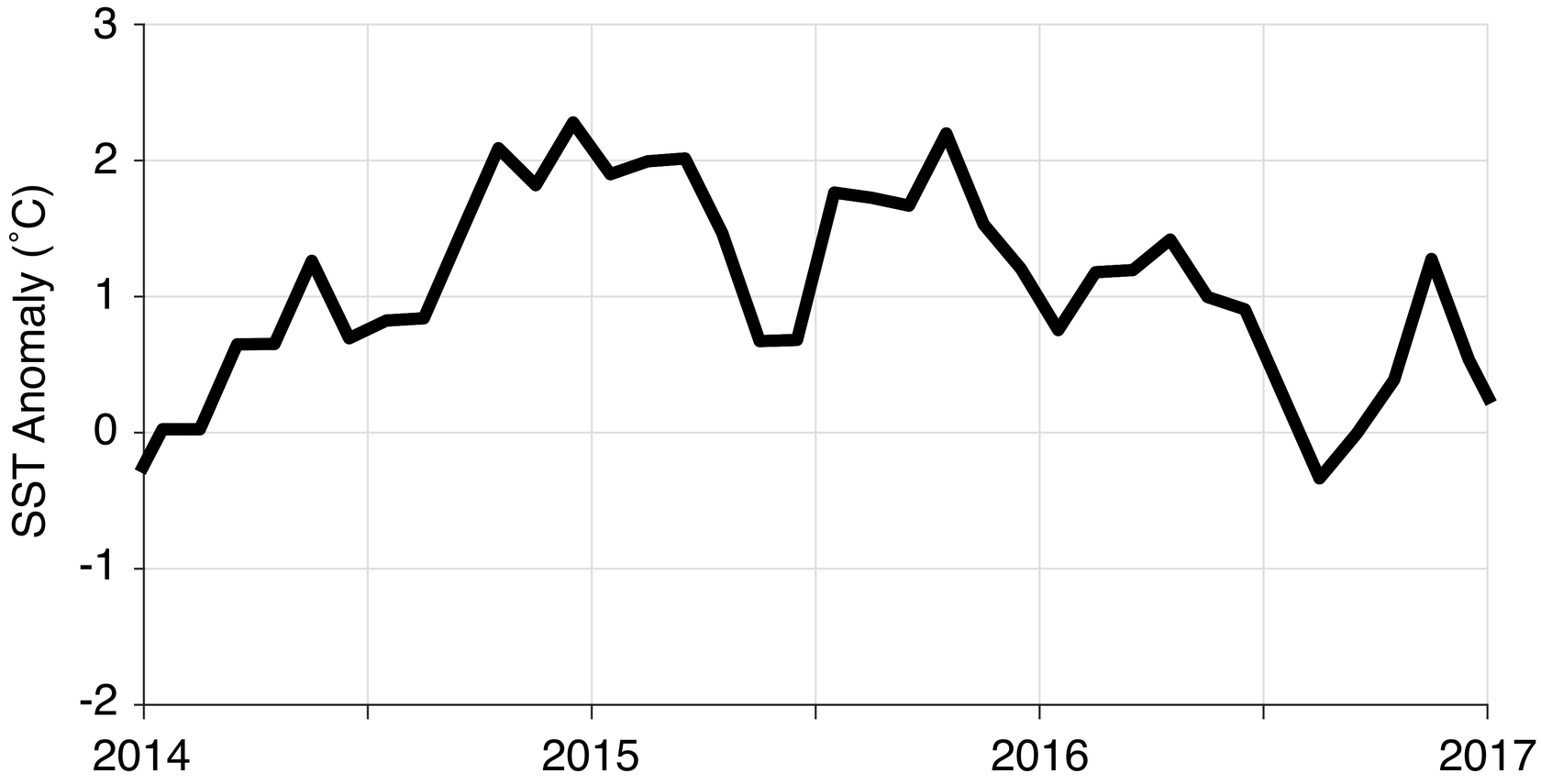
“Blob” Warming Pattern

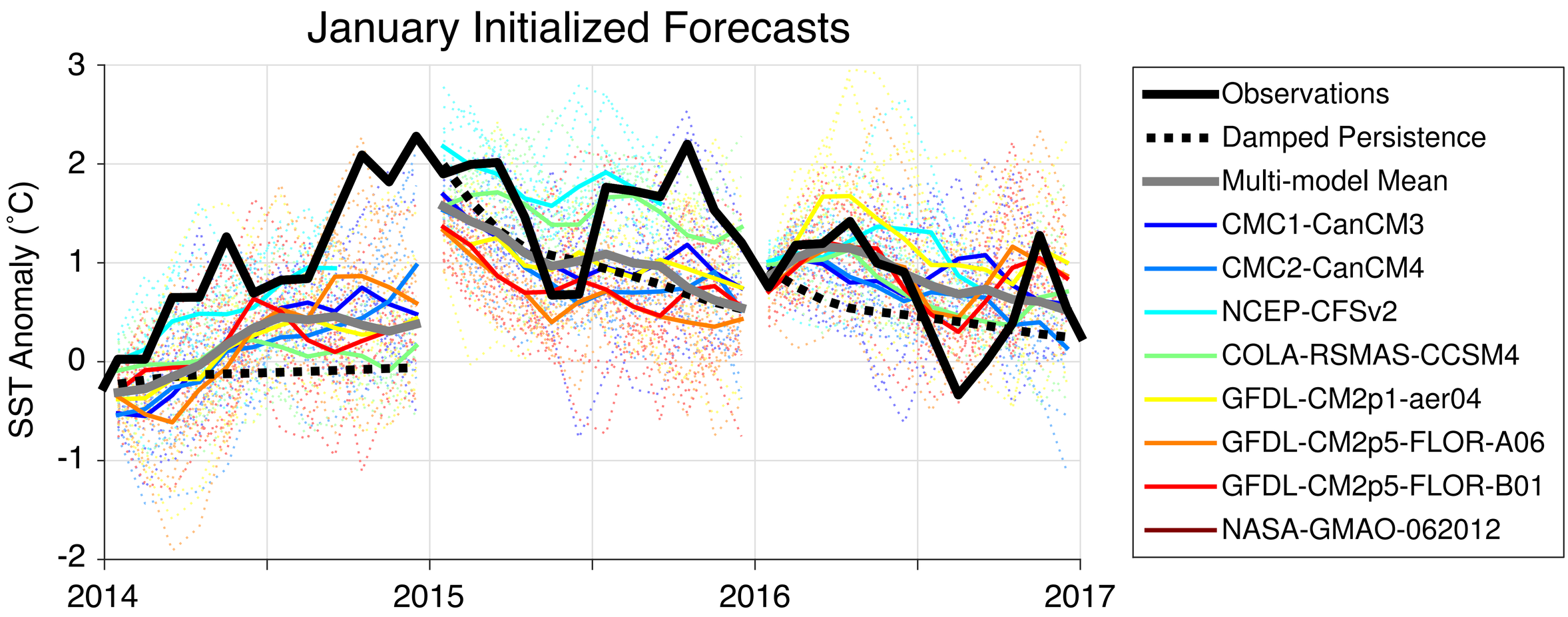
Amaya et al. (2016)
Di Lorenzo and Mantua (2016)

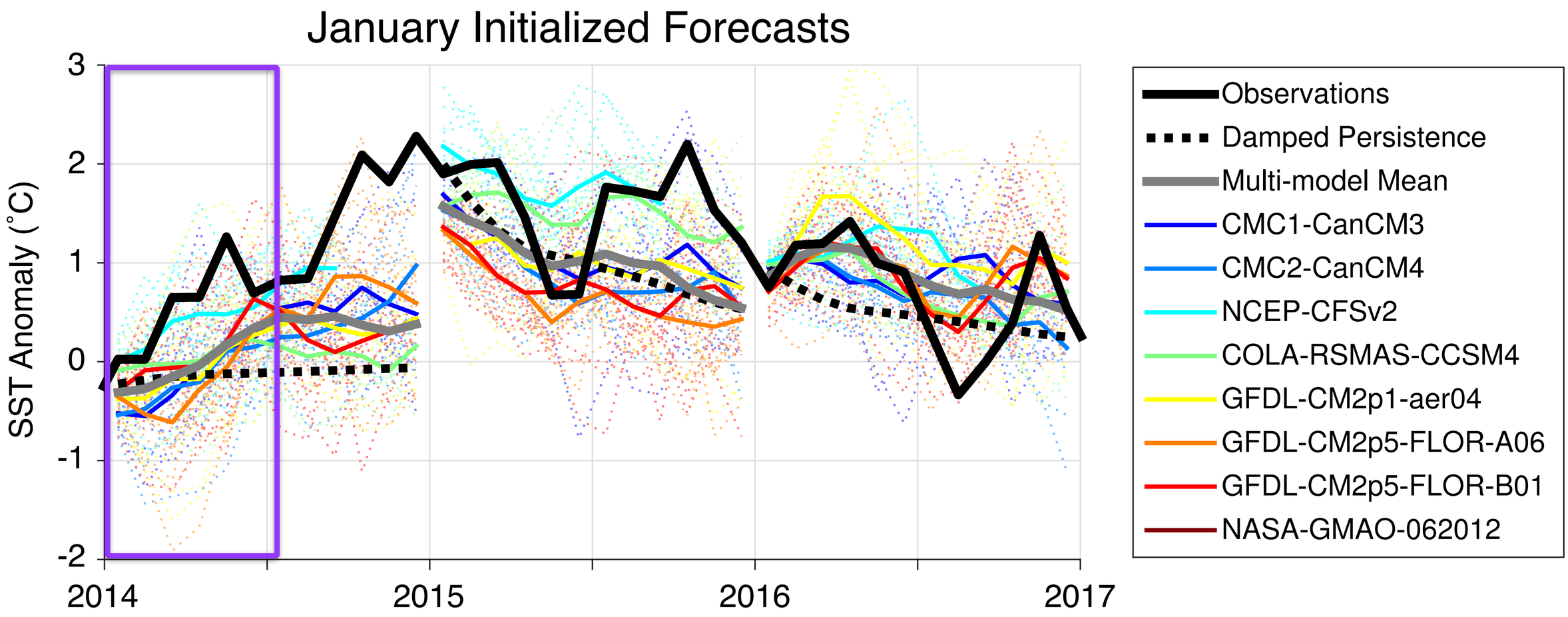
“Arc” Warming Pattern

Jacox et al. (2016)
Frischknecht et al. (2017)

El Niño Warming Pattern


SST Anomaly (°C)
3
2
1
0
-1
-2
2014
2015
2016
2017


January Initialized Forecasts
SST Anomaly (˚C)
3
2
1
0
-1
-2
2014
2015
2016
2017
Observations
Damped Persistence
Multi-model Mean
CMC1-CanCM3
CMC2-CanCM4
NCEP-CFSv2
COLA-RSMAS-CCSM4
GFDL-CM2p1-aer04
GFDL-CM2p5-FLOR-A06
GFDL-CM2p5-FLOR-B01
NASA-GMAO-062012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SST Anomaly (°C)
3
2
1
0
-1
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2014
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2016
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Damped Persistence
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GFDL-CM2p1-aer04
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GFDL-CM2p5-FLOR-B01
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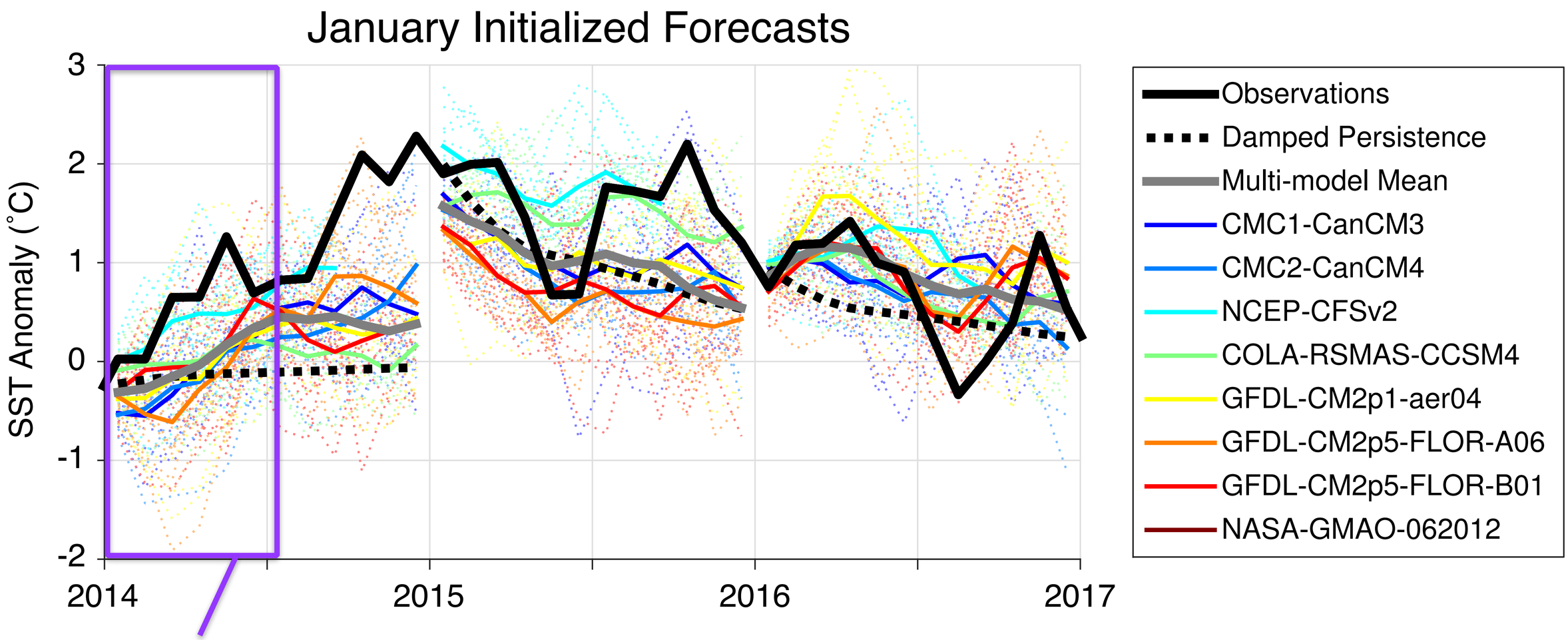
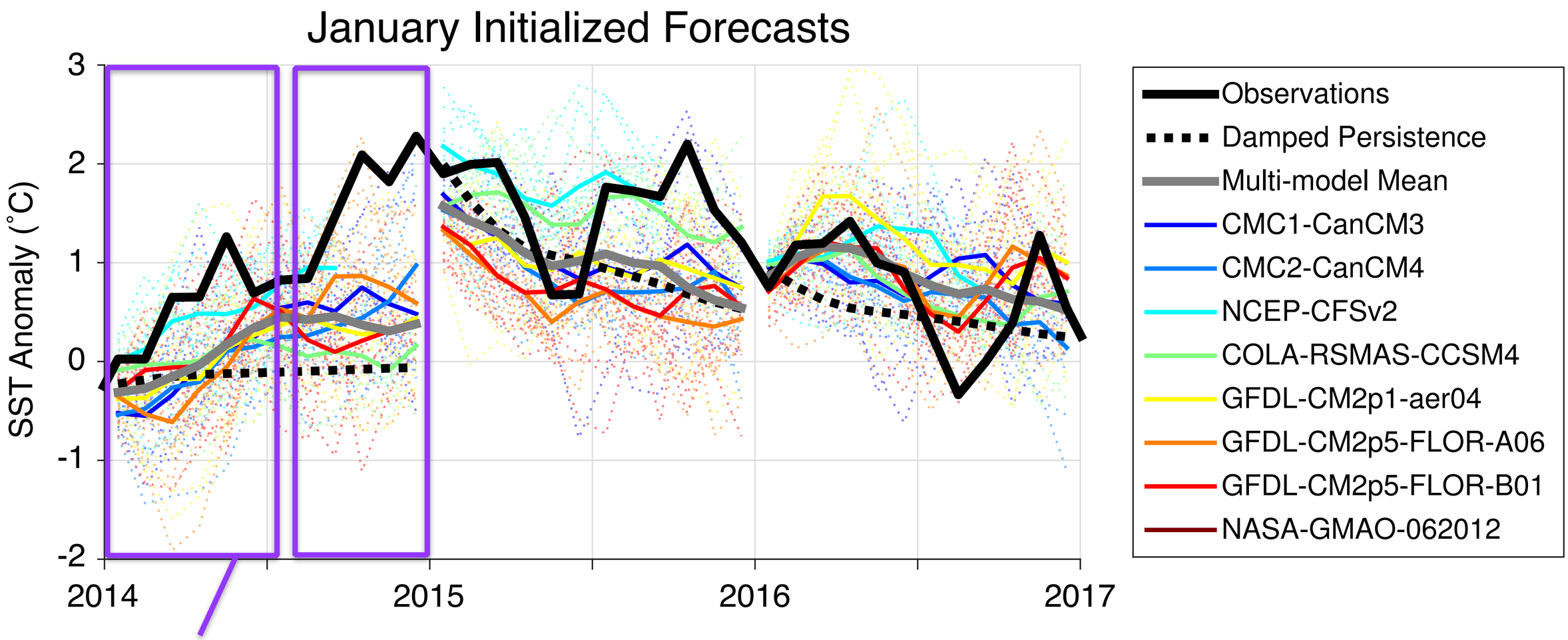


Lateral/surface heat flux from offshore SST anomalies (Predictable)



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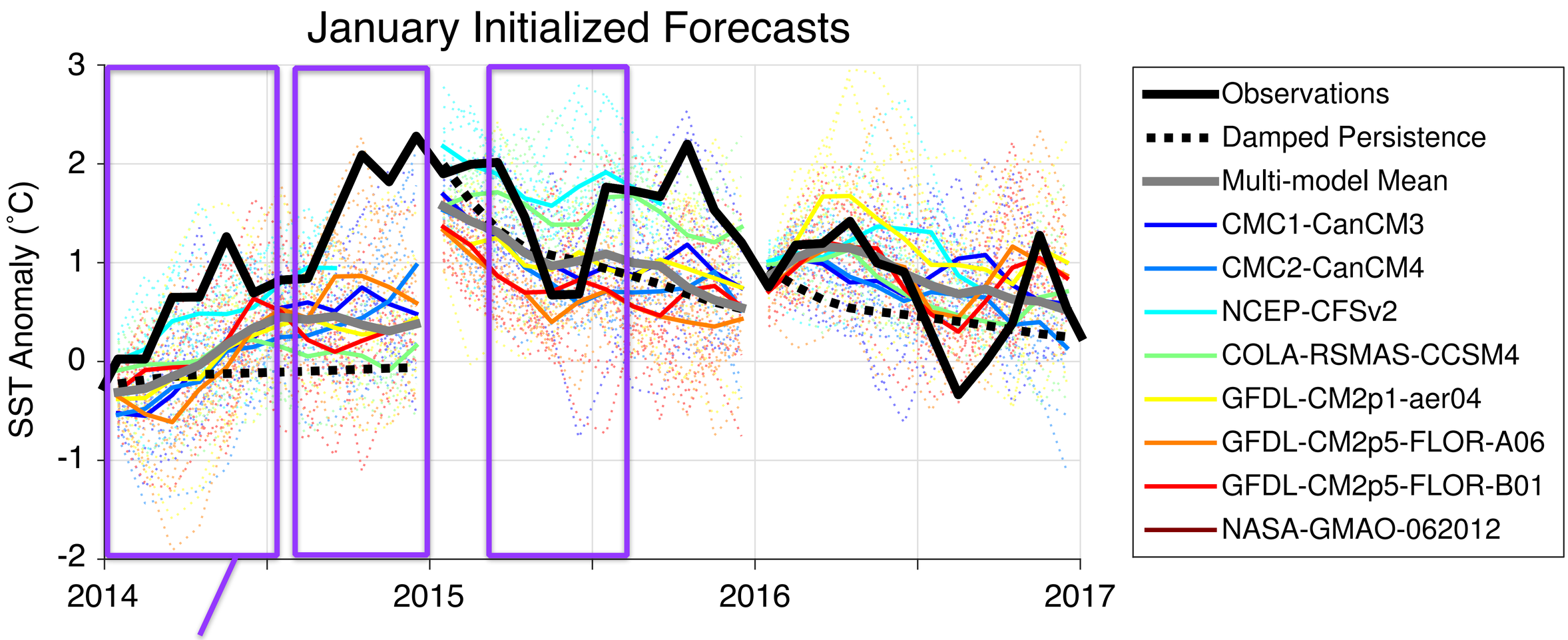
(Predictable)



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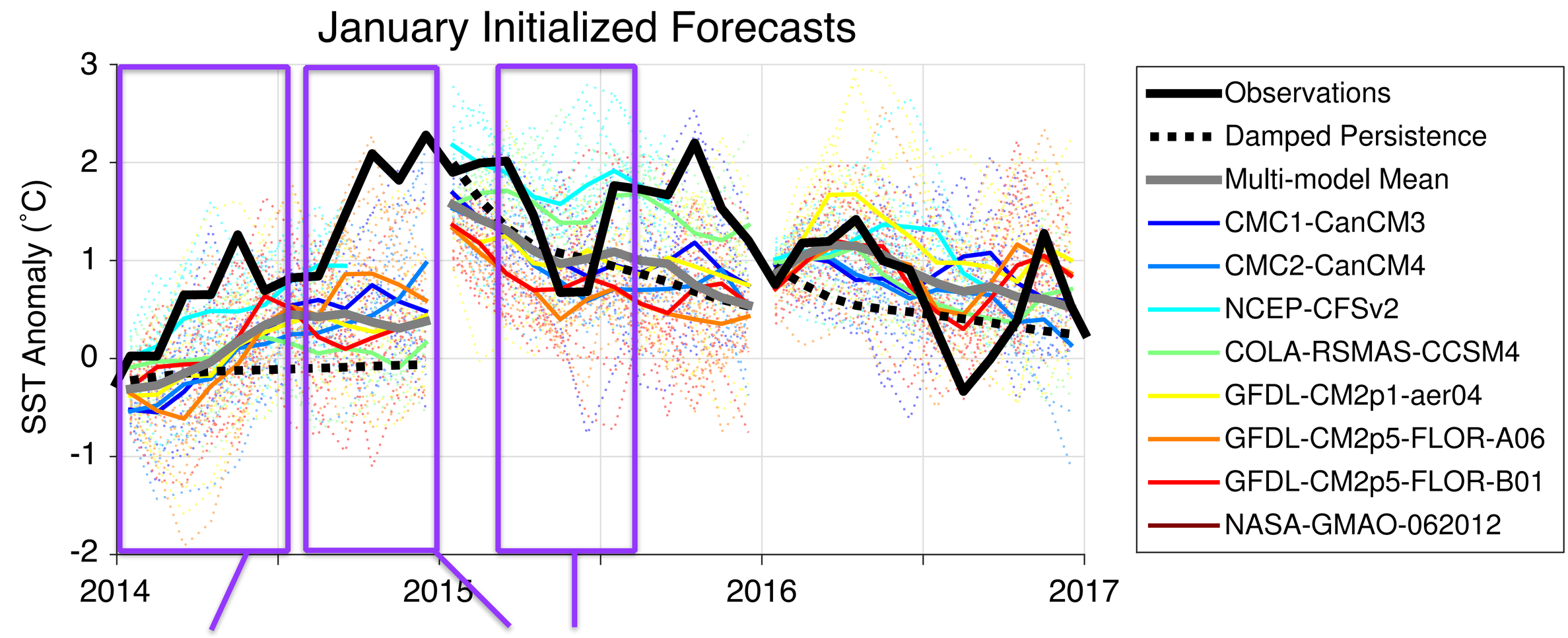
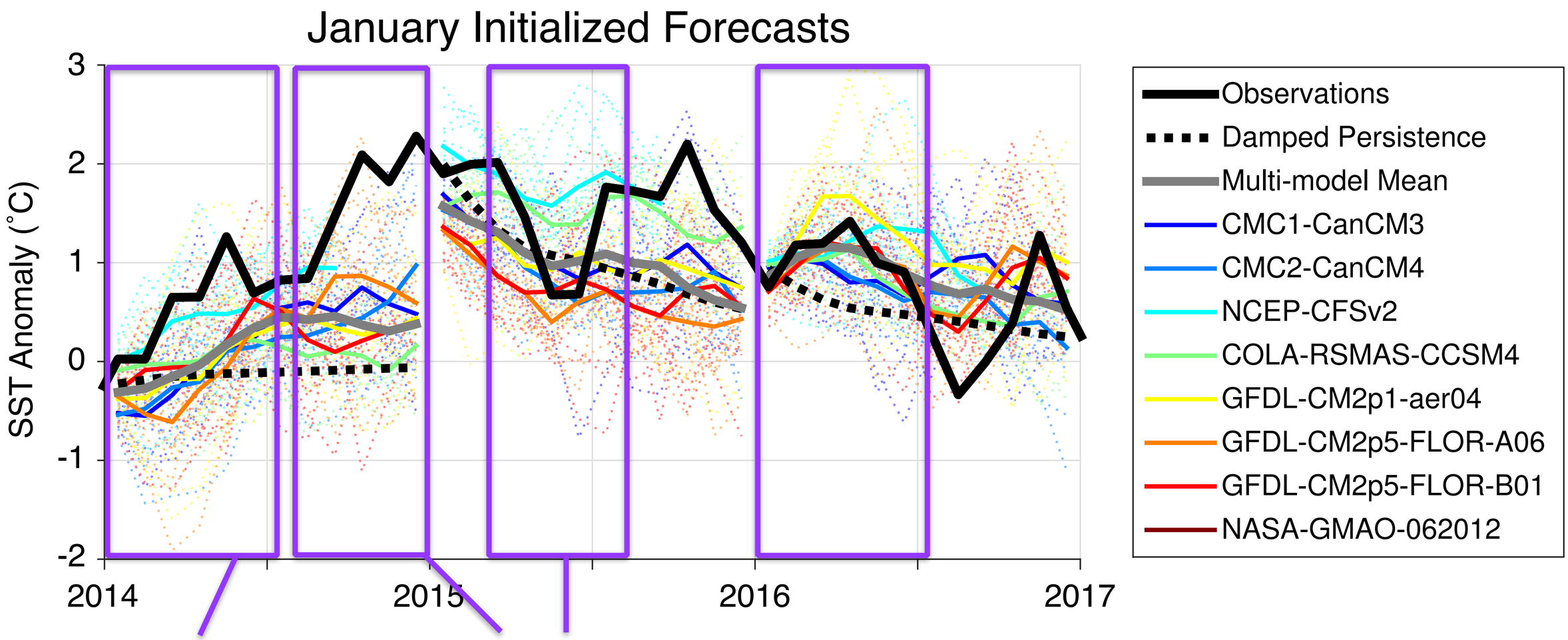


Lateral/surface heat flux from offshore SST anomalies (Predictable)

Wind forcing (Not Predictable)



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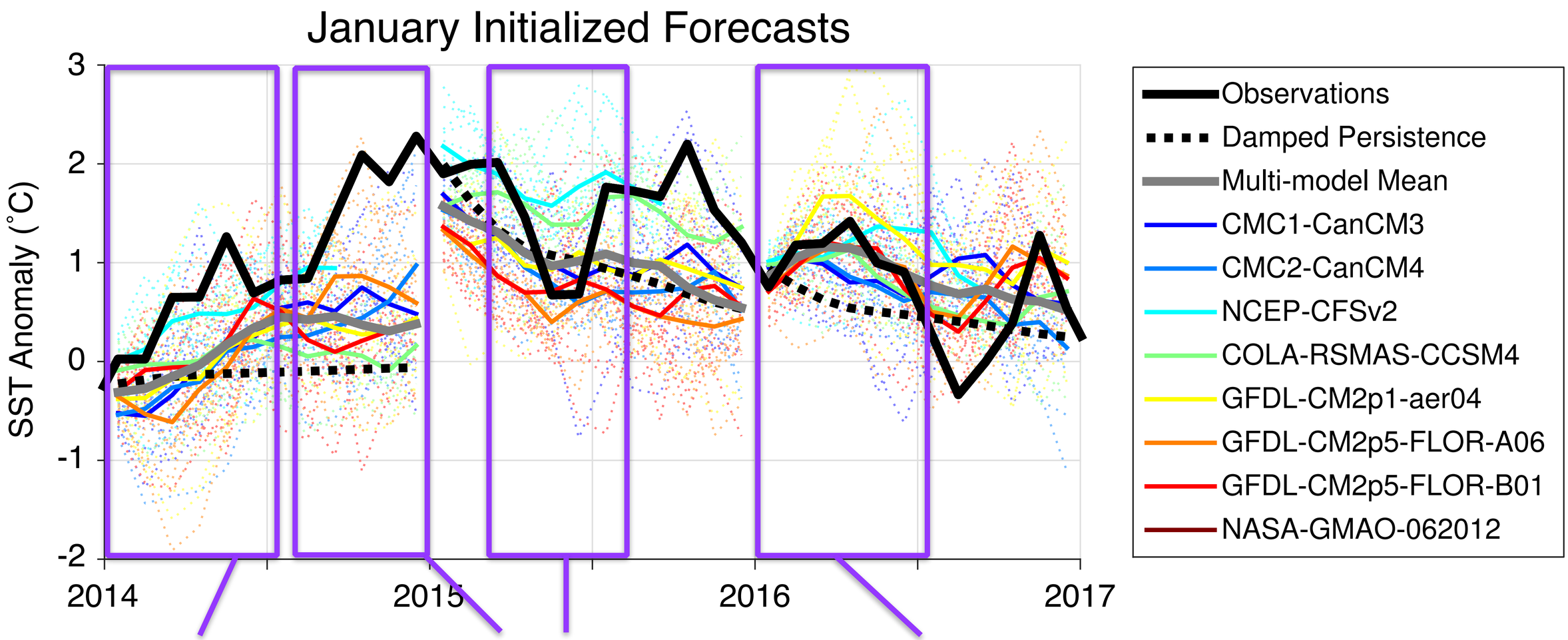
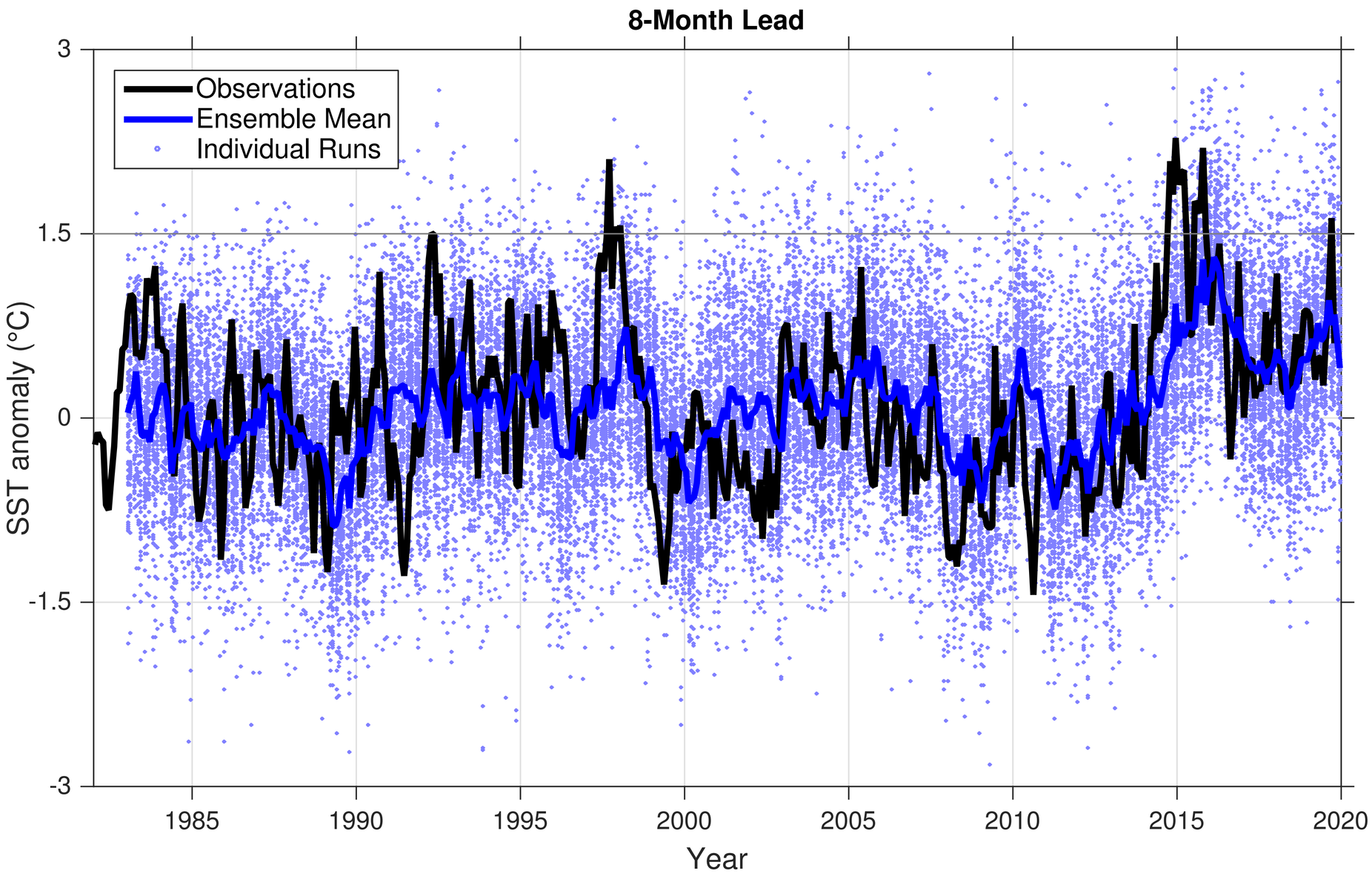


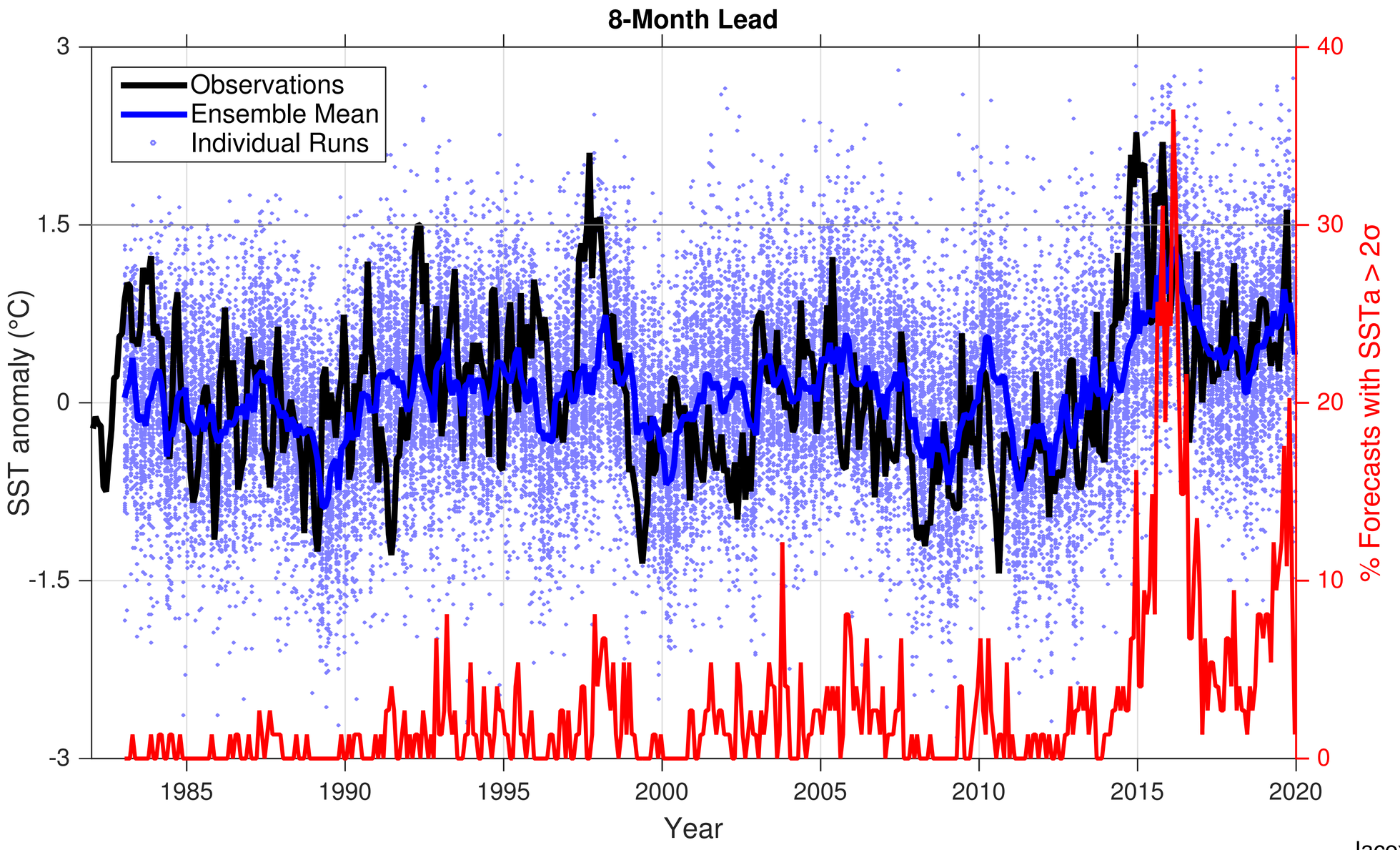
Lateral/surface heat flux from offshore SST anomalies
(Predictable)

Wind forcing
(Not Predictable)

El Niño forcing from South via coastal trapped waves / advection
(Predictable)



Jacox et al., FiMS (2019)



Jacox et al., FiMS (2019)

Is ‘The Blob’ back? New marine heat wave threatens Pacific

By Warren Cornwall | Sep. 17, 2019 , 4:15 PM

Return of warm water 'blob' in the Pacific threatens marine life

ENVIRONMENT 9 October 2019

By Adam Vaughan

Marine Heat Wave Reminiscent of 'the Blob' Lingers off U.S. West Coast

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Tuesday, October 8, 2019

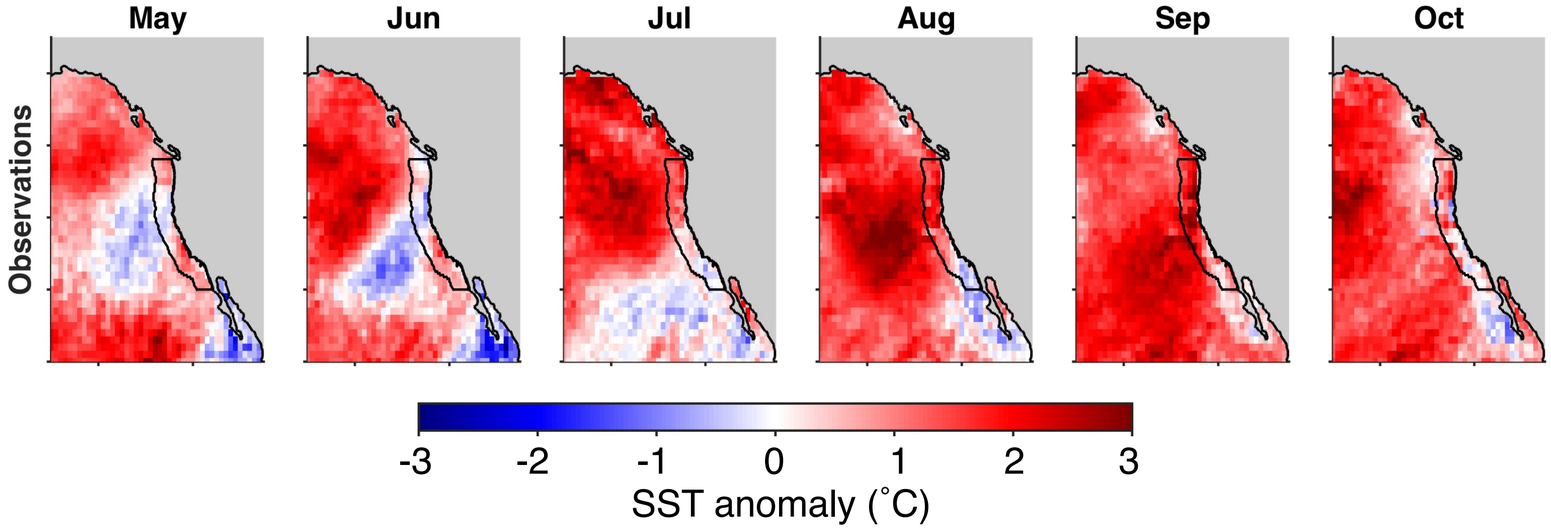
A new, big warm Blob is back in the north Pacific Ocean

Posted Oct 11, 2019

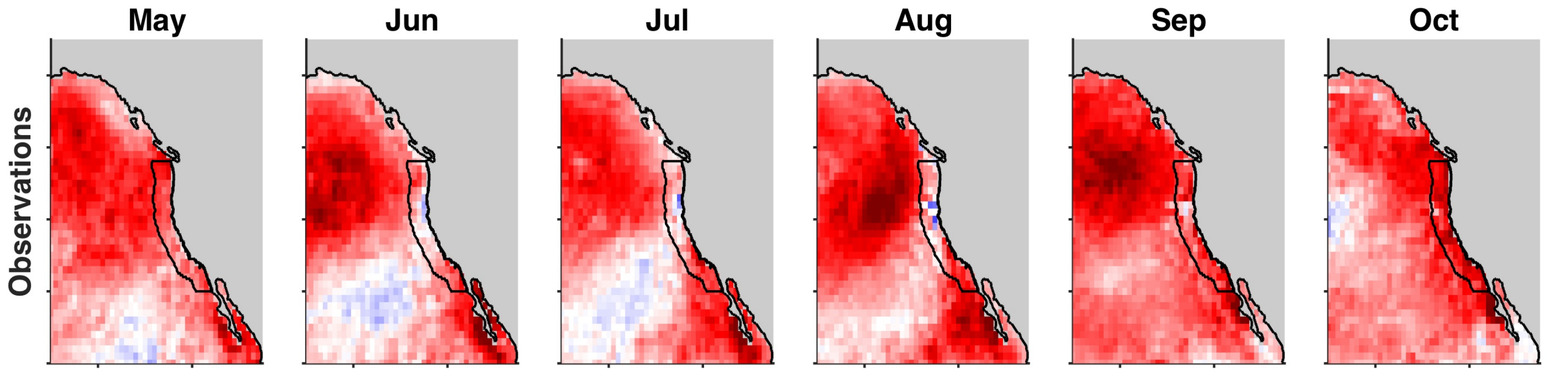
57 1.3k shares

By Mark Torregrossa | mtorregr@mlive.com

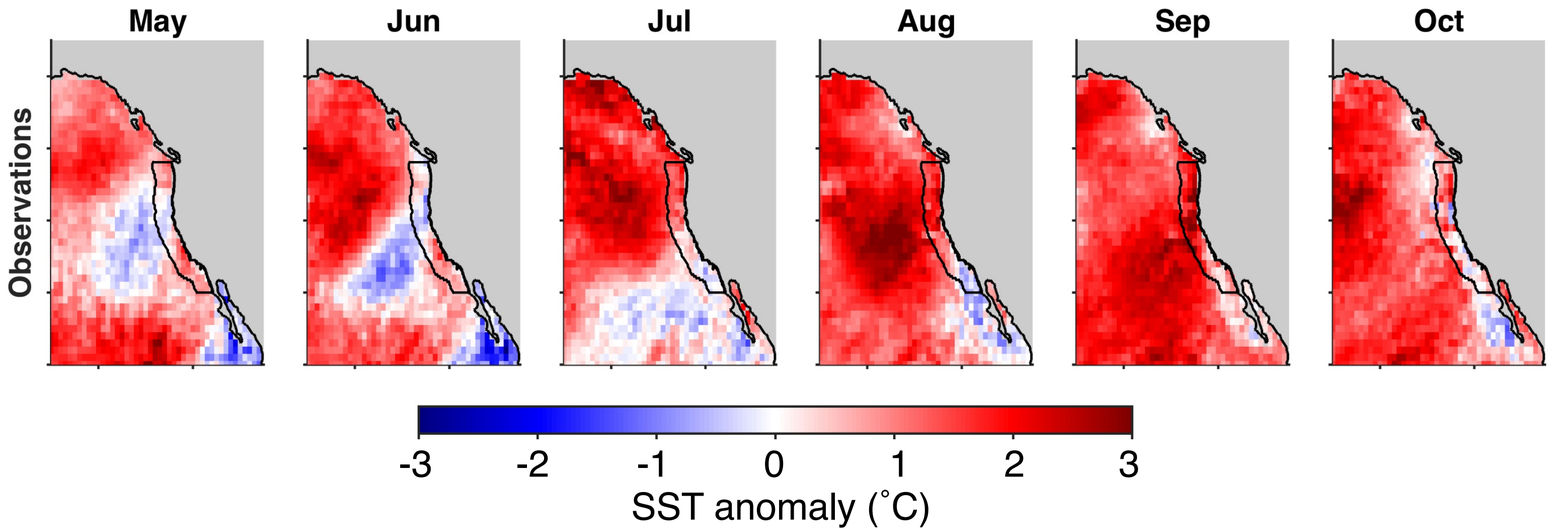
2019



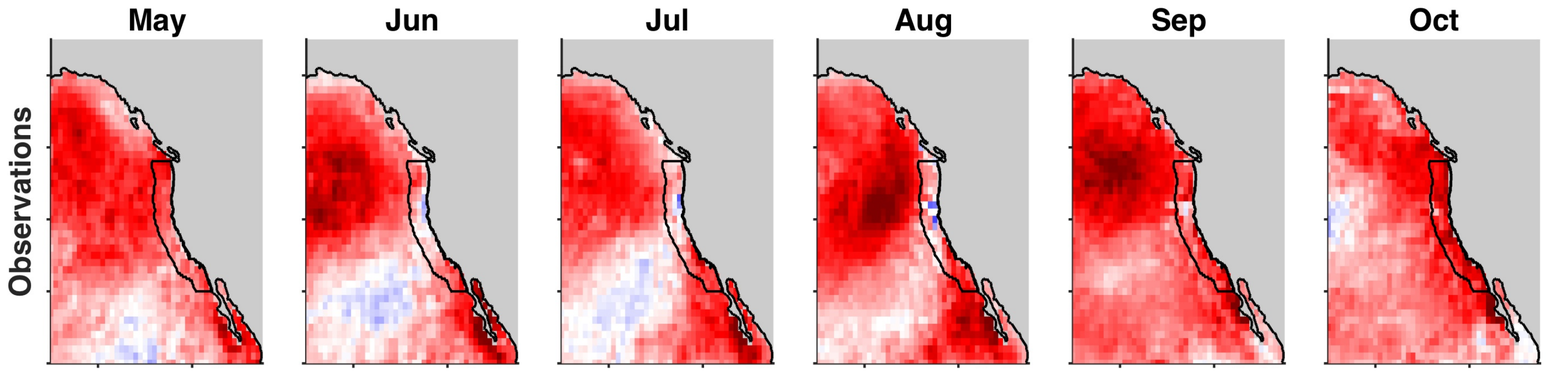
2014


May
Jun
Jul
Aug
Sep
Oct
Observations

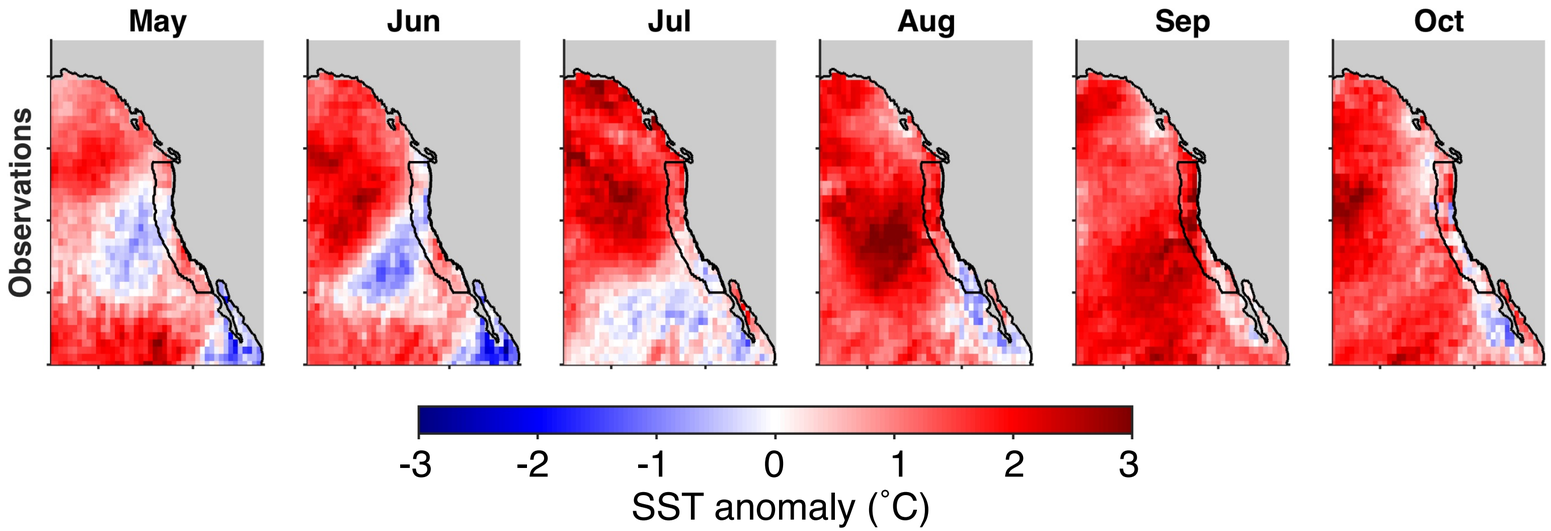
2019

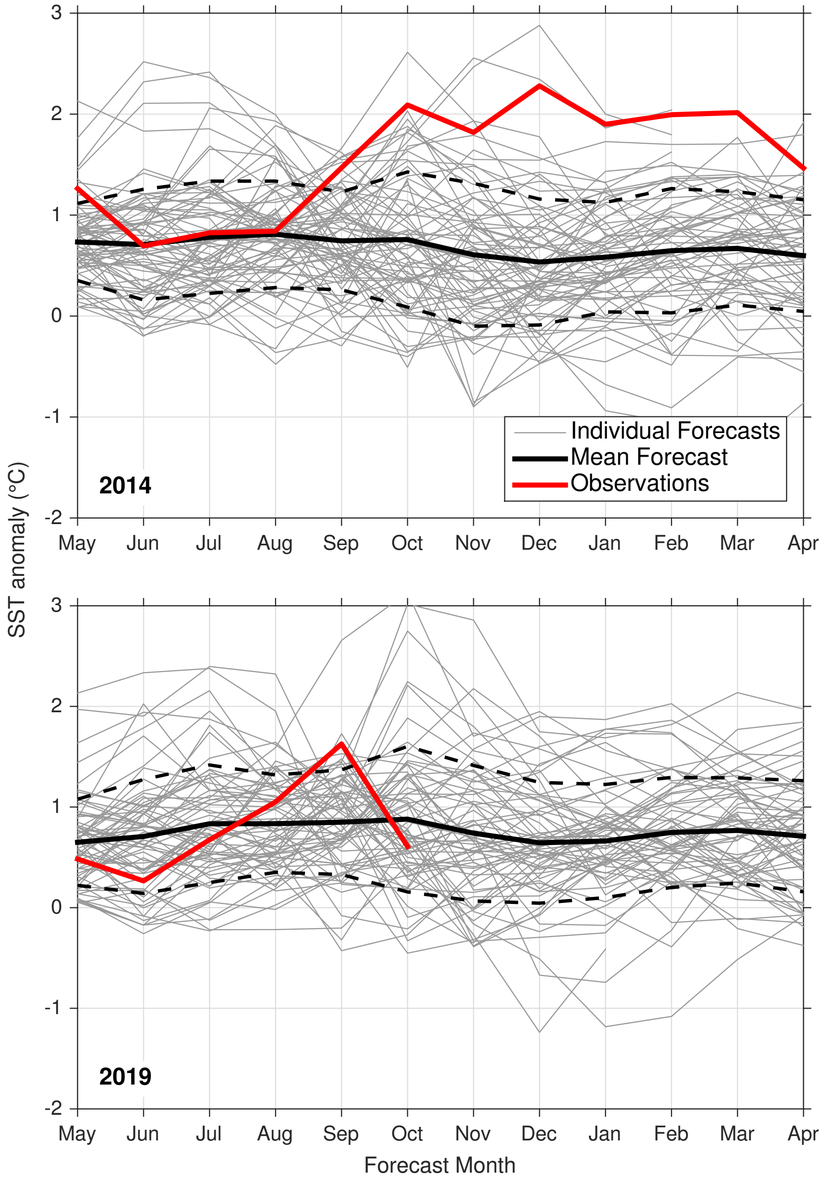

May
Jun
Jul
Aug
Sep
Oct
Observations
-3
-2
-1
0
1
2
3
SST anomaly (˚C)

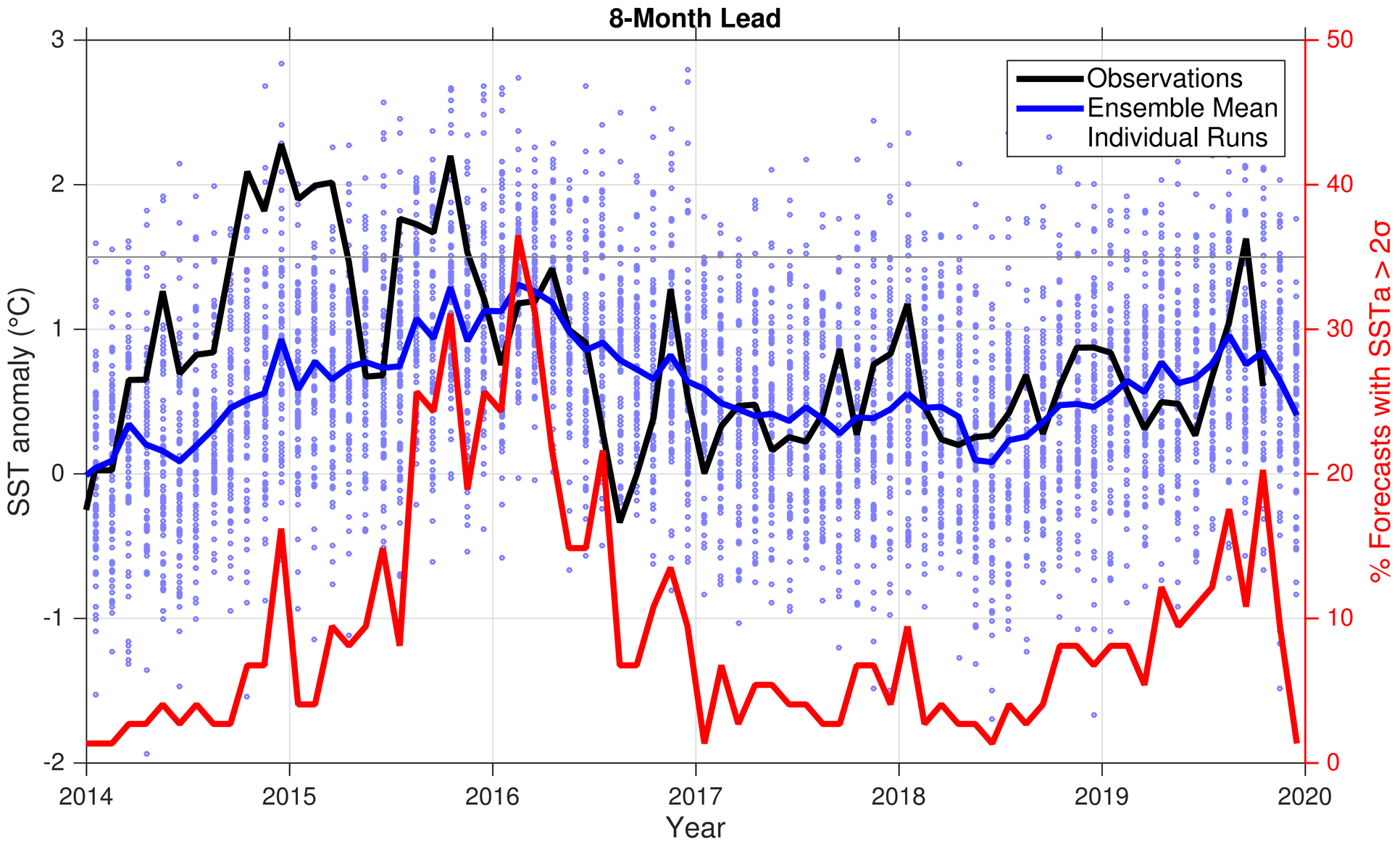
2014


May
Jun
Jul
Aug
Sep
Oct
Observations

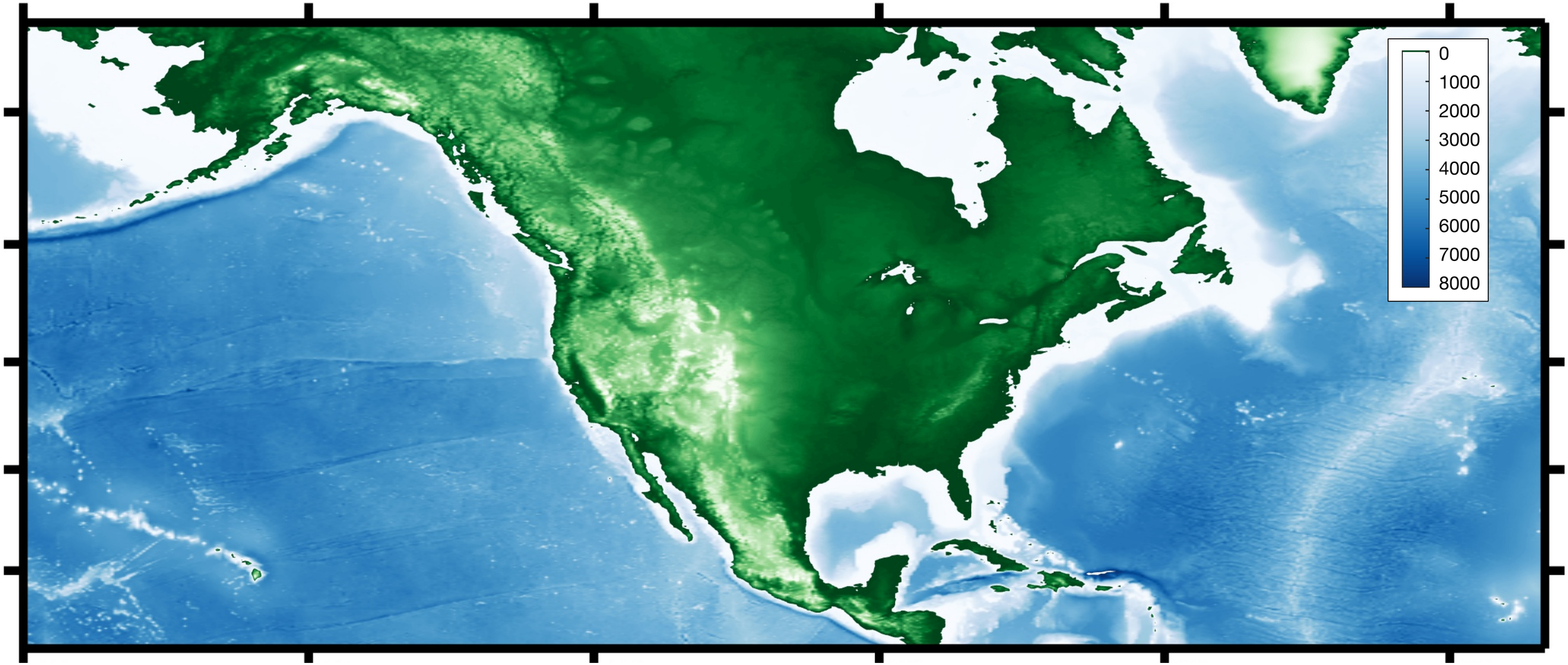
2019


May
Jun
Jul
Aug
Sep
Oct
Observations
-3
-2
-1
0
1
2
3
SST anomaly (˚C)


SST anomaly (°C)
Individual Forecasts
Mean Forecast
Observations
2014
2019
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
Forecast Month


8-Month Lead
Observations
Ensemble Mean
Individual Runs
SST anomaly (°C)
% Forecasts with SSTa > 2σ
Year
3
2
1
0
-1
-2
50
40
30
20
10
0
2014
2015
2016
2017
2018
2019
2020

NOAA's **Marine Prediction Task Force** coordinates activities to explore seasonal prediction of **coastal high water levels** and changing **living marine resources**"



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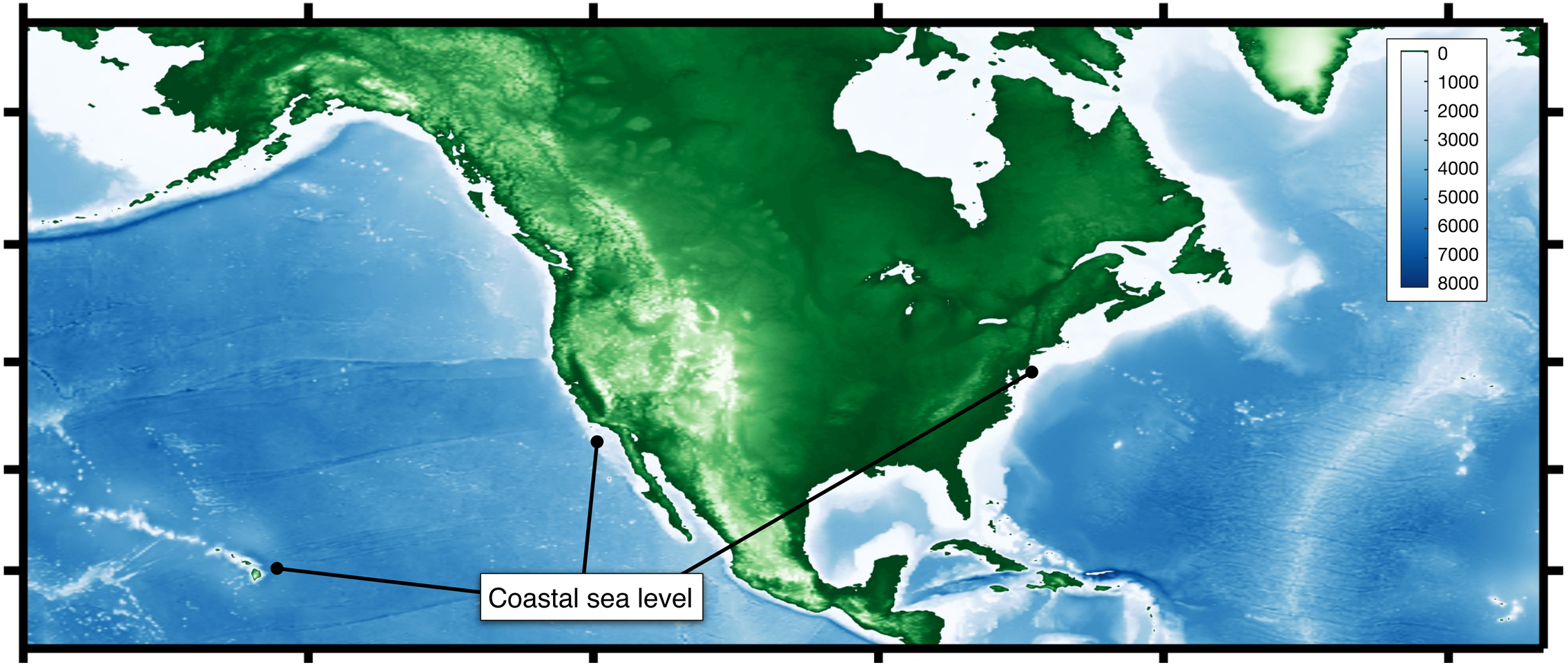

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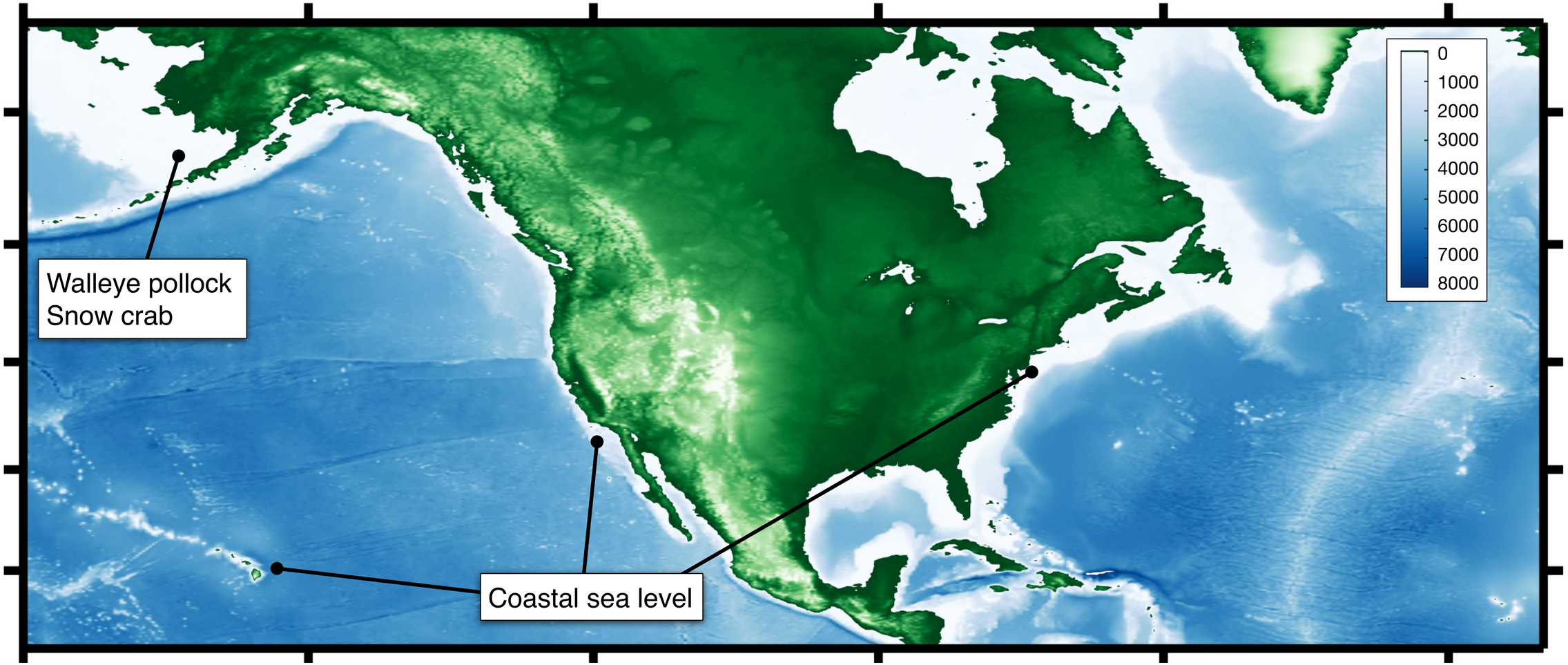

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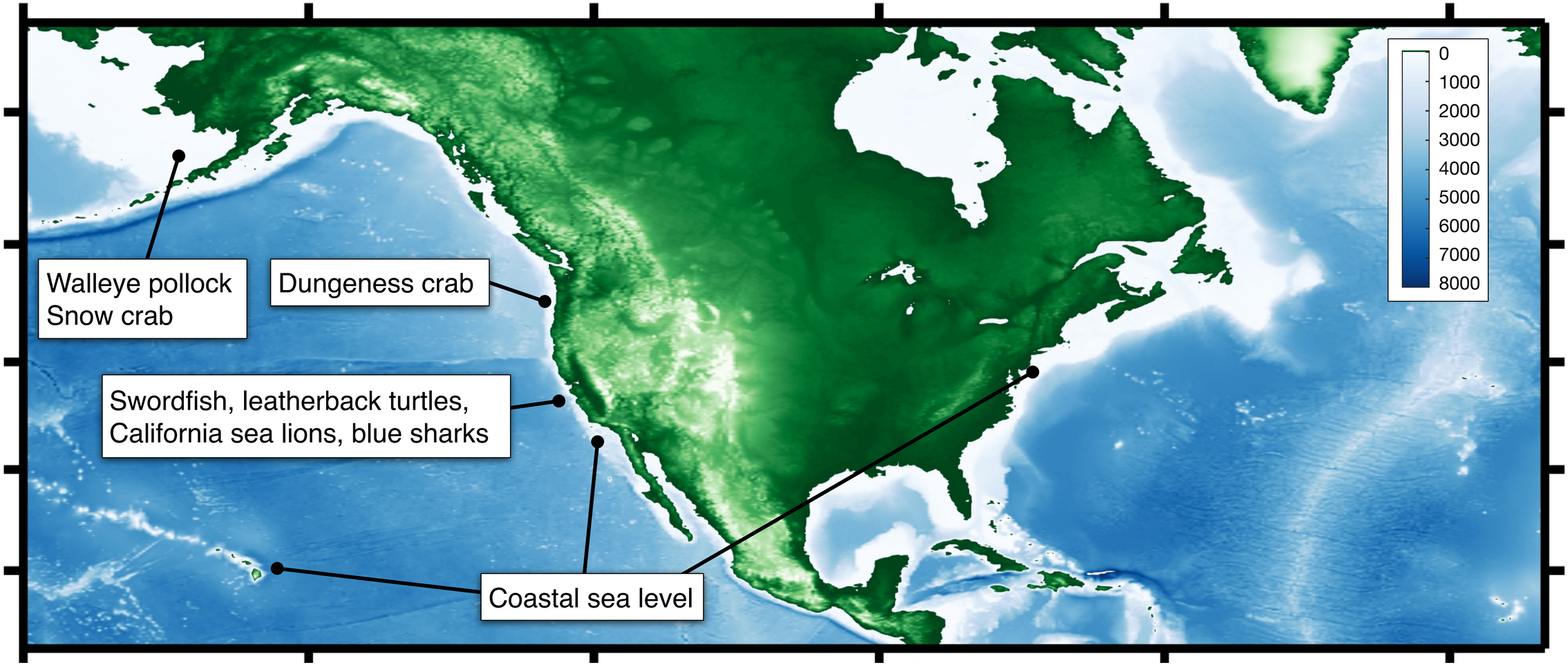

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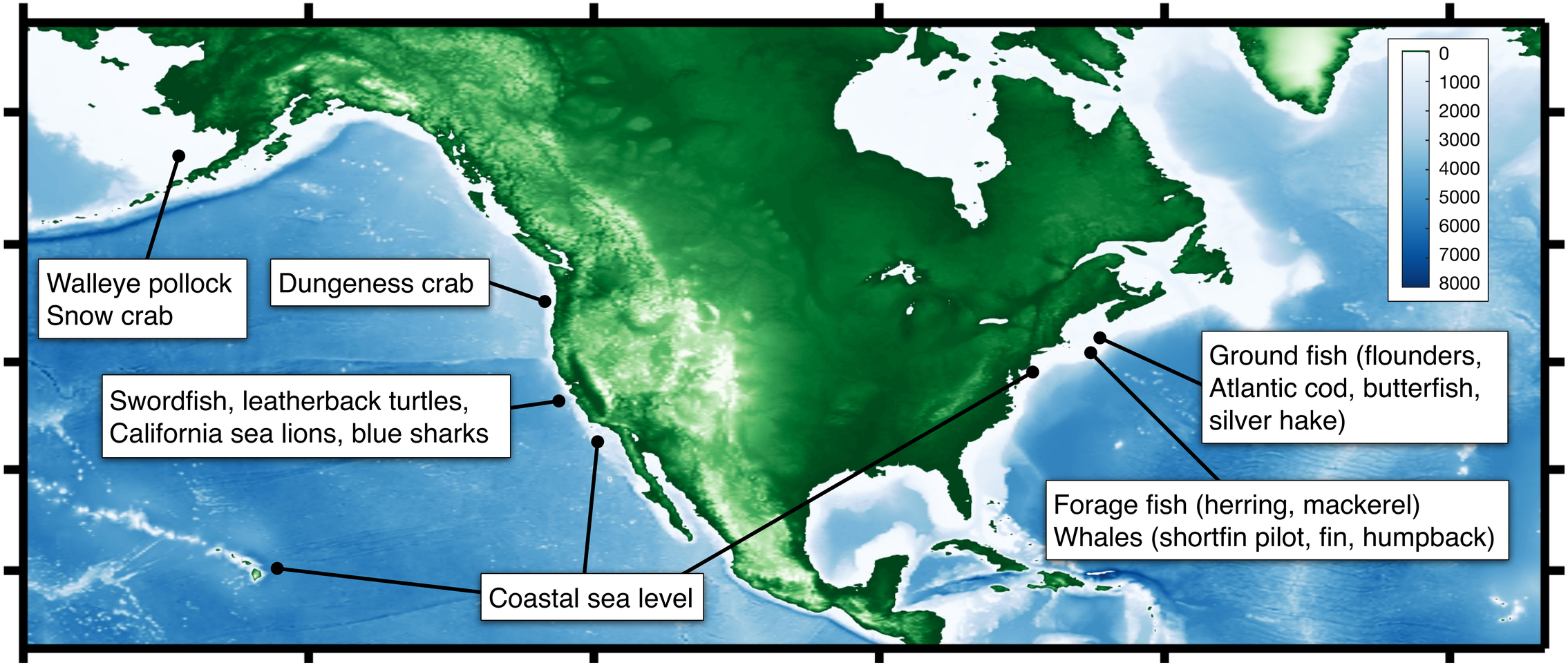

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Mechanism	Timescales of predictability
Physical predictability	
Persistence	1 – 10 months
Re-emergence	6 – 12 months
Coastal waves	1 – 3 months
Baroclinic Rossby waves	1 month – 2+ years
Advection	1 – 2+ years
Tropical – extra-tropical connections	1 month – 2 years
Sea-ice processes	1 – 12 months
Biogeochemical and ecological predictability	
Biogeochemical response to physical forcing	Consistent with physical predictability
Species response to environmental change	Consistent with environmental
Species life history	1 – 2+ years

Jacox et al. (in revision)

Some Key Questions for Marine Heatwave Prediction

What is the predictability and what are the mechanisms?

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How well are they represented in models?

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What would be done with MHW forecasts?