Forecasting Marine Heatwaves over the Global Ocean

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NOAA Southwest Fisheries Science Center
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With lots of help from
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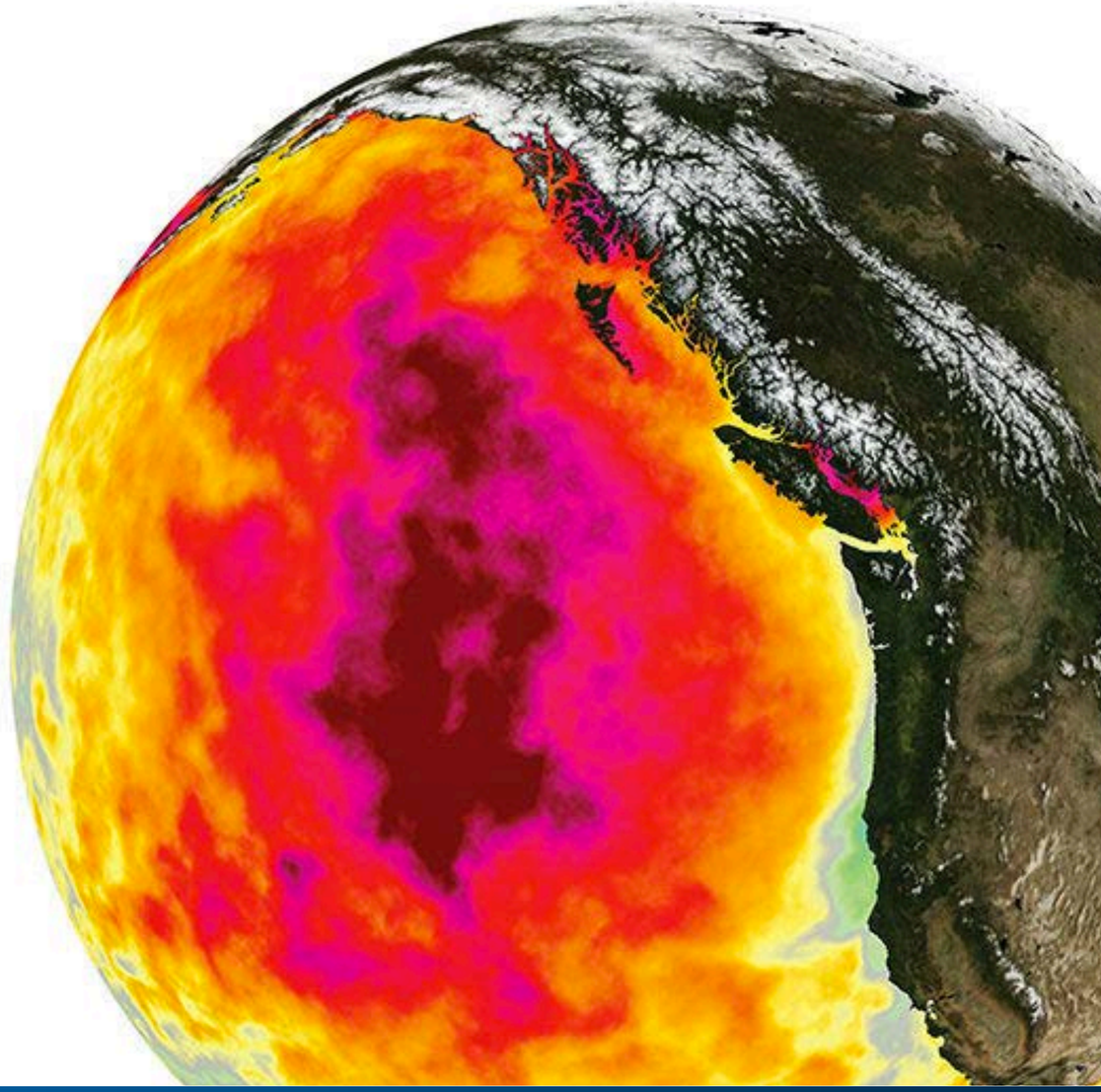
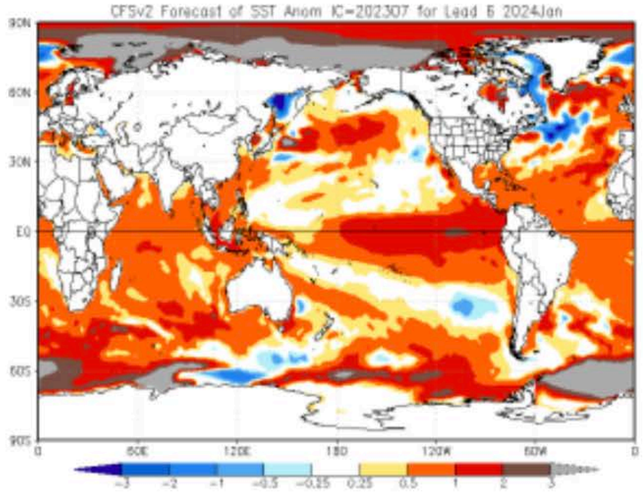
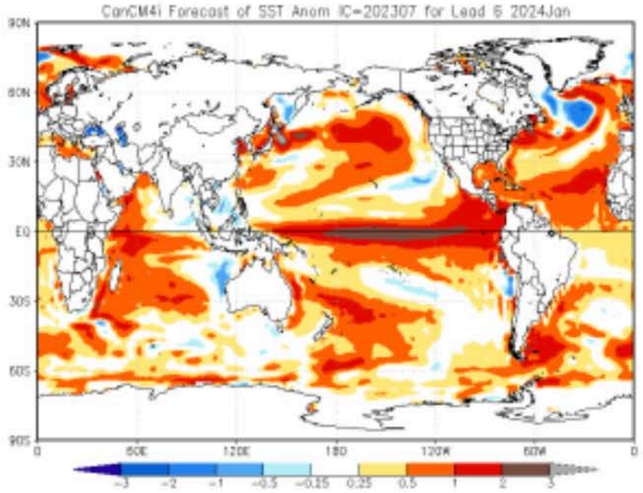


Leveraging forecasts in the North American Multimodel Ensemble…

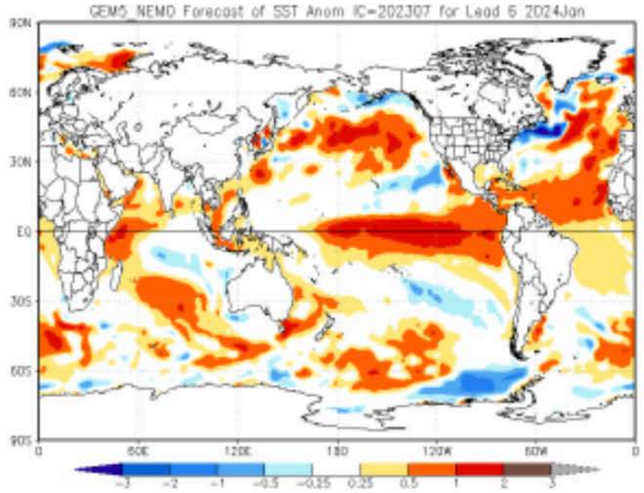
NCEP_CFSv2



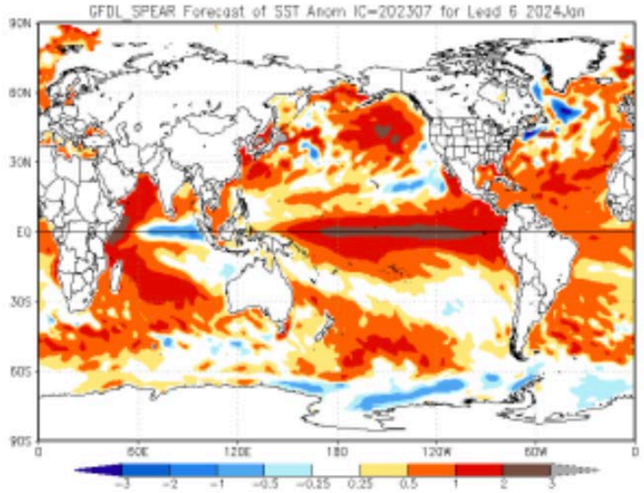
CanCM4i



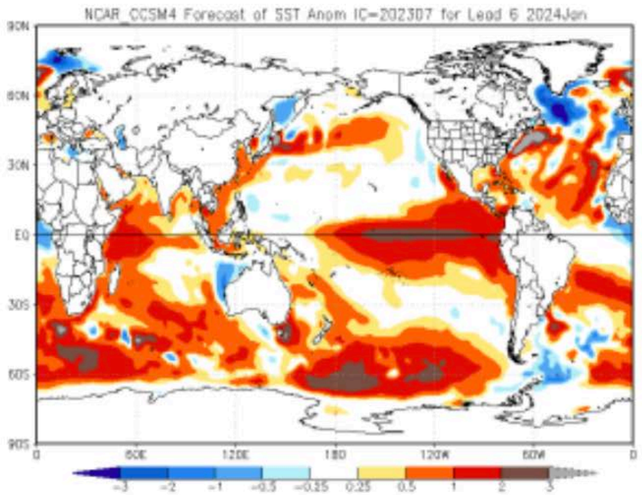
GEM5_NEMO



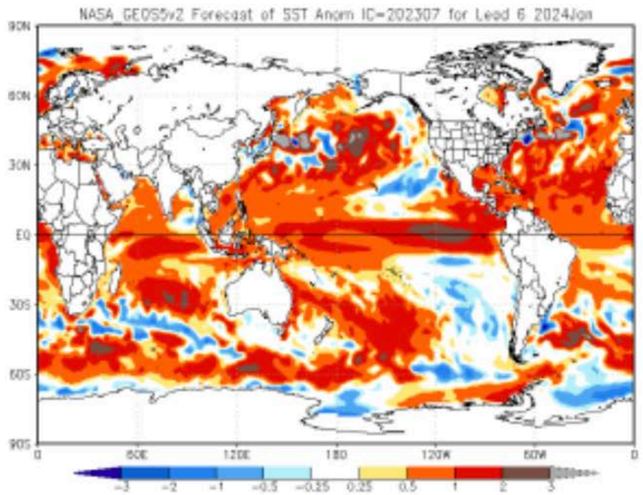
GFDL_SPEAR



NCAR_CCSM4



NASA_GEOS5v2



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

...to create seasonal marine heatwave forecasts

Seasonal SST forecasts (1991-2020)

↓

Remove lead- and initialization-dependent model mean climatology from each ensemble member to get SSTa

↓

(Detrend SSTa)

↓

Calculate lead-dependent MHW thresholds
(90th percentile of forecast SSTa from all ensemble members)

↓

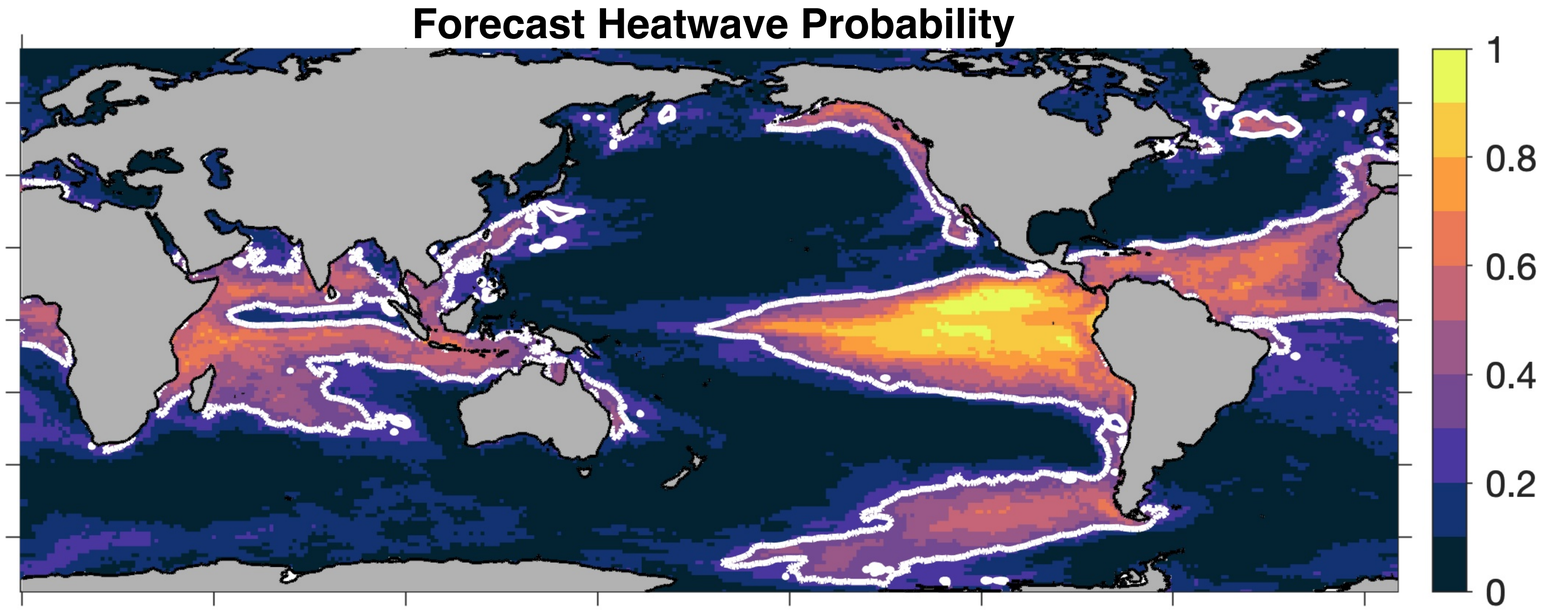
Identify forecast MHWs

Repeat for each of six models → ~70 member monthly MHW forecast

Evaluate with OISSTv2.1 SST
(same methodology to identify MHWs)

Jacox et al. (2022)

Example forecasts

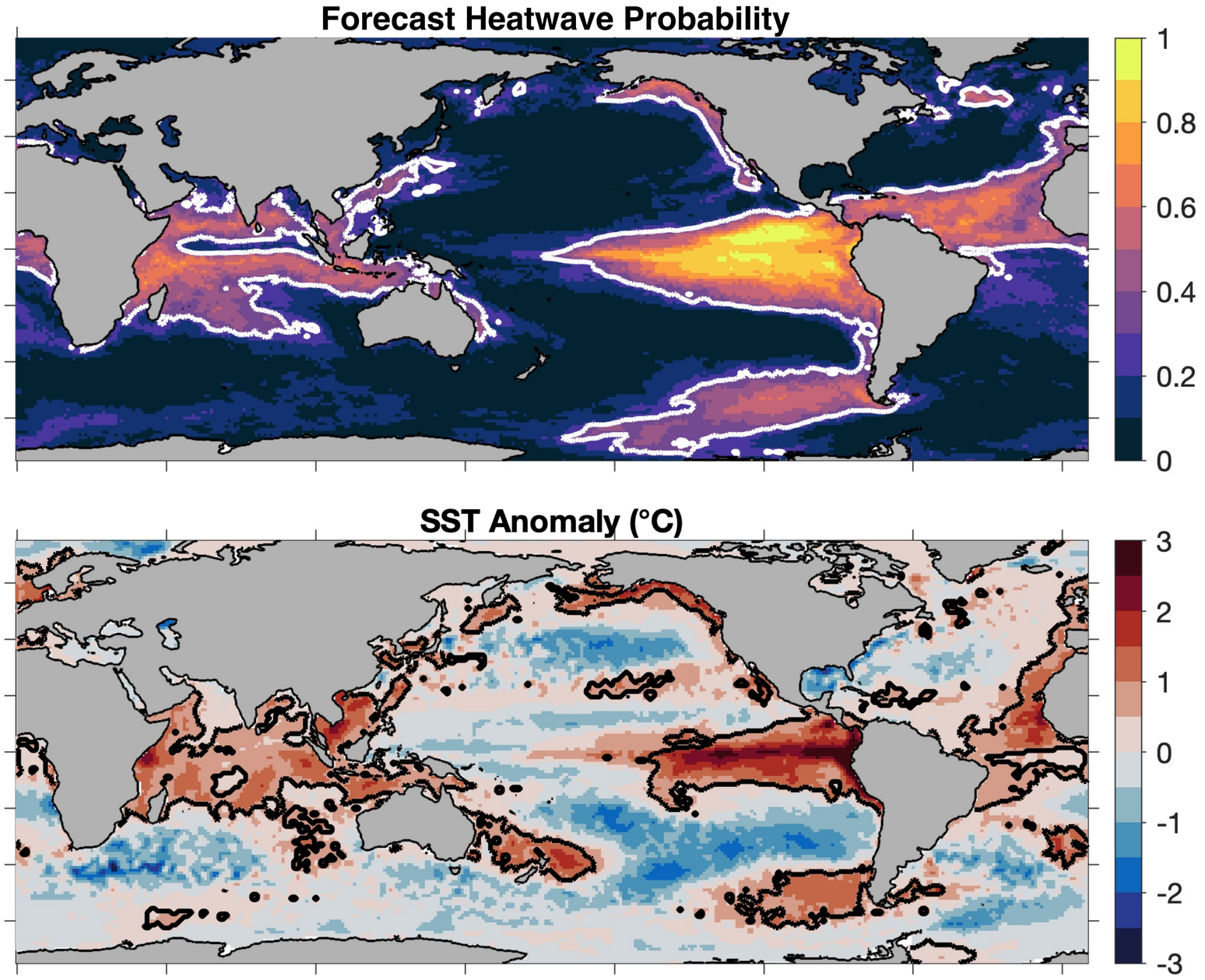


July 1997 forecast

8.5 month lead time

March 1998 heatwaves

Example forecasts



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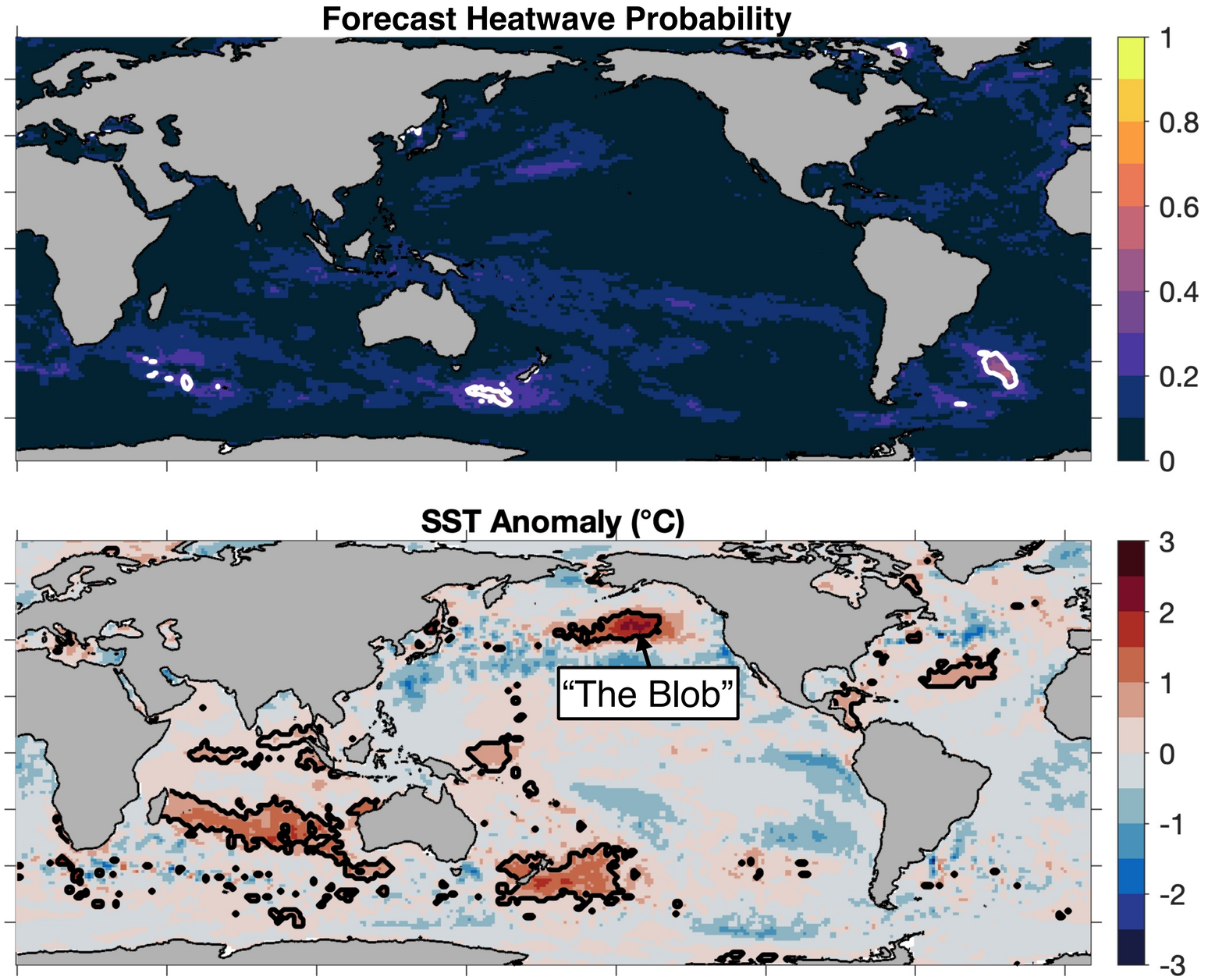
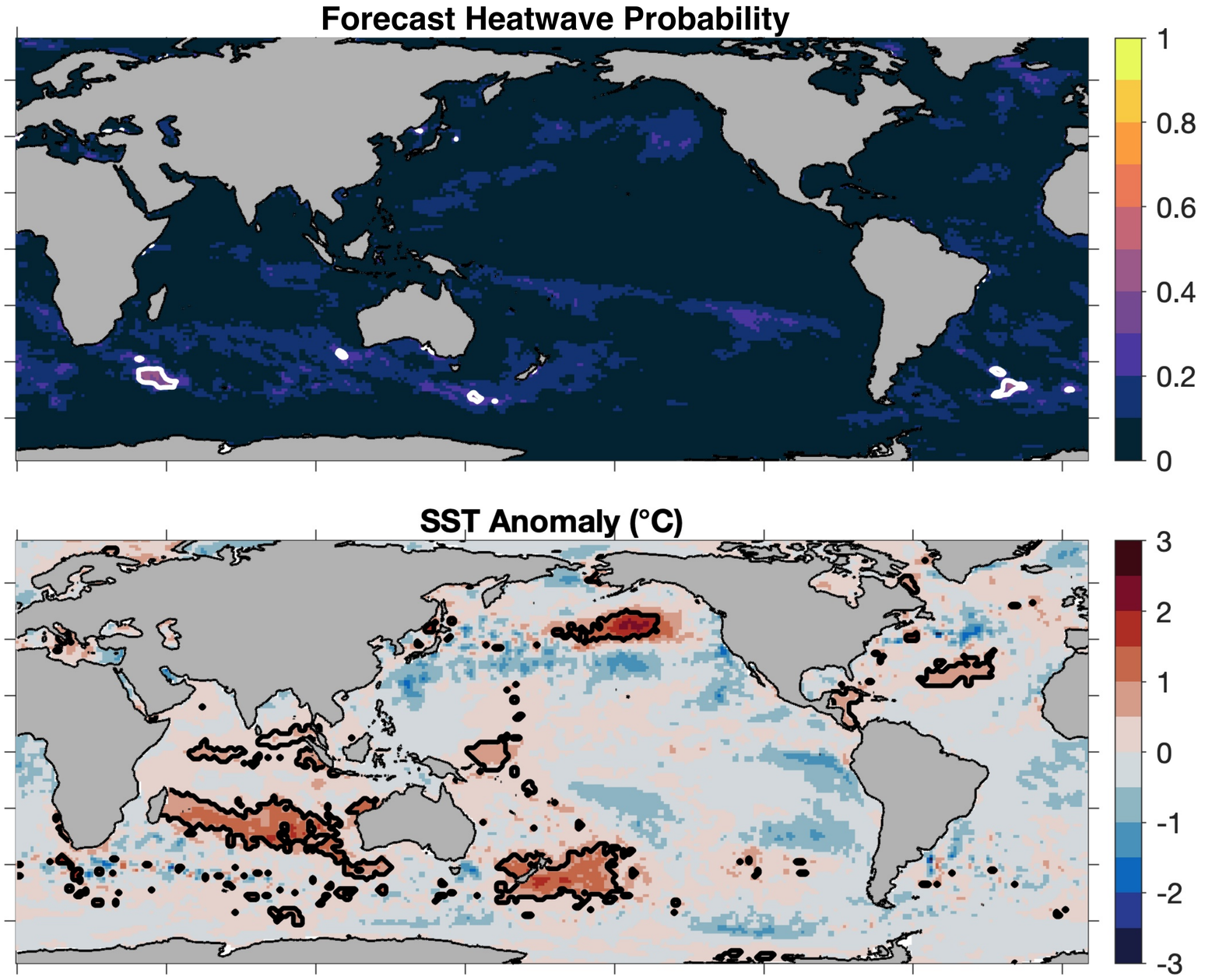


March 2013 forecast

8.5 month lead time

November 2013 heatwaves

Example forecasts

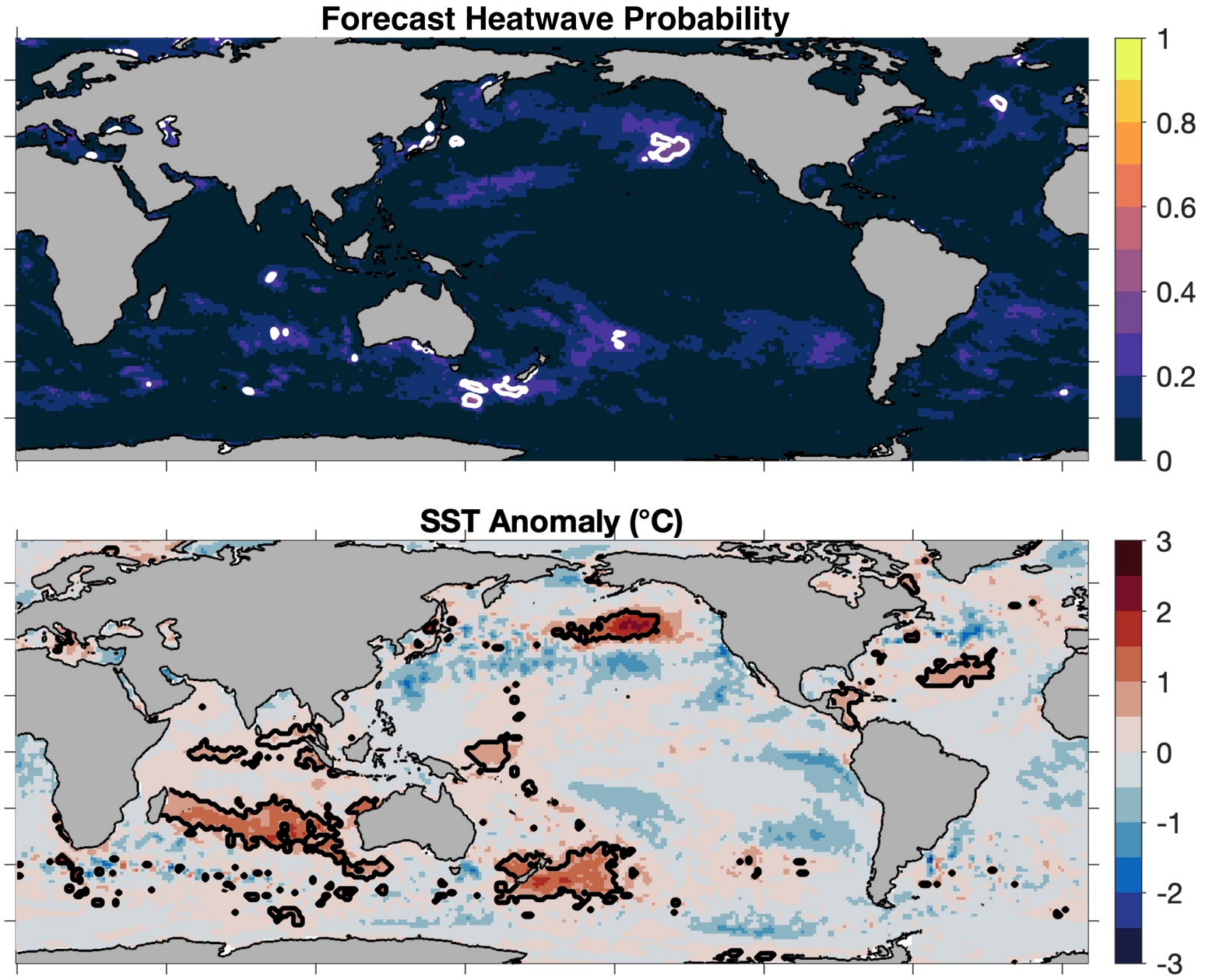


July 2013 forecast

4.5 month lead time

November 2013 heatwaves

Example forecasts

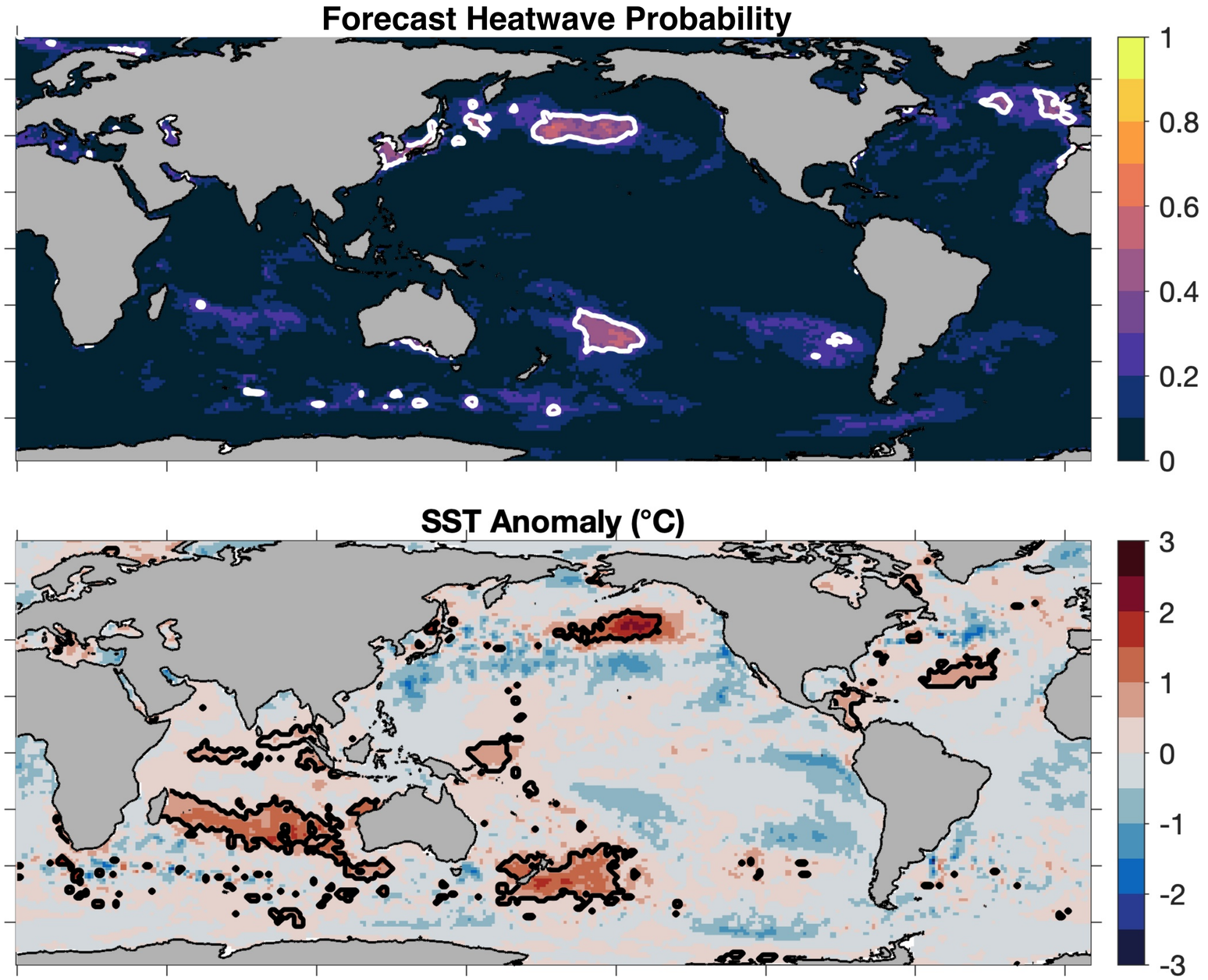


September 2013 forecast

2.5 month lead time

November 2013 heatwaves

Example forecasts

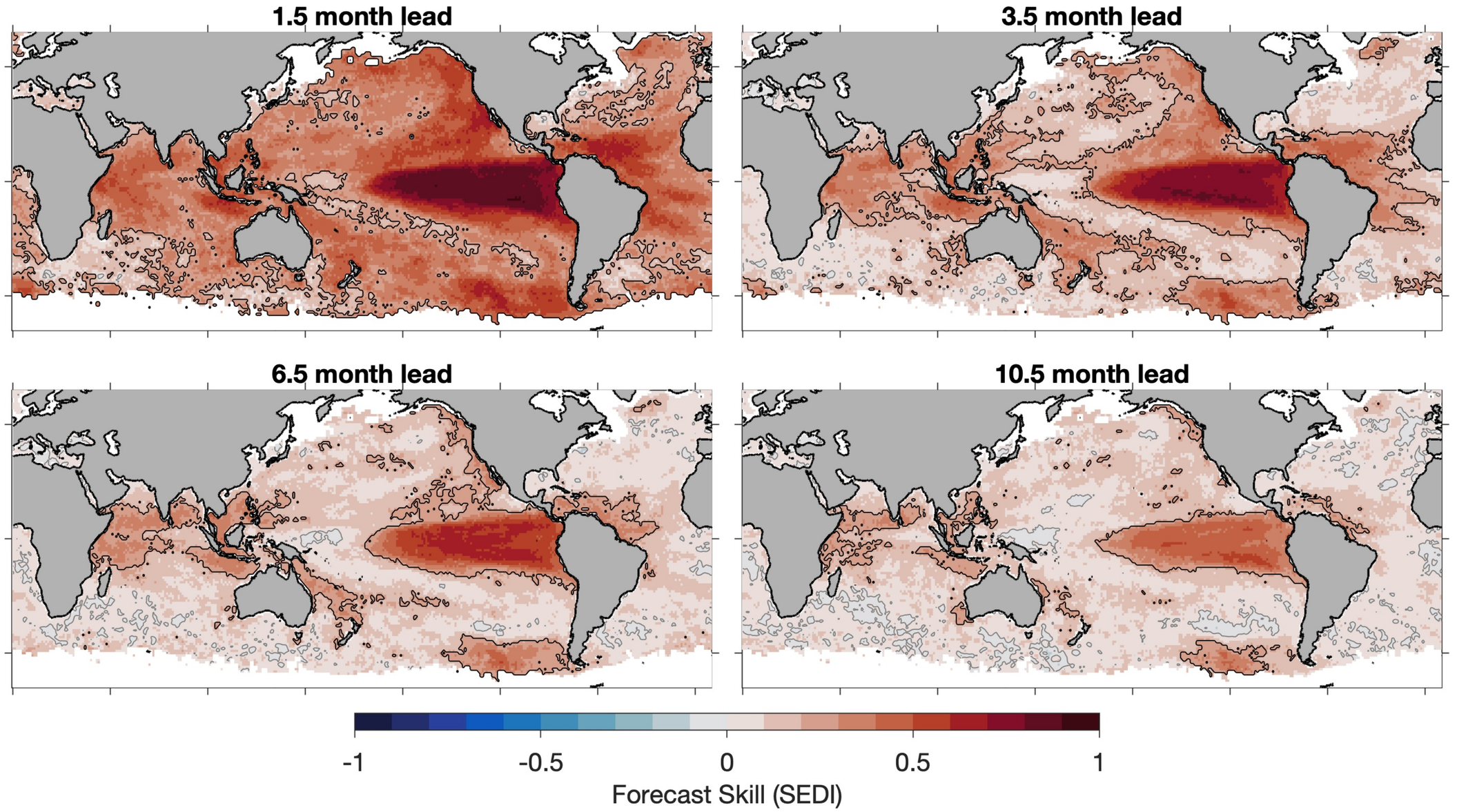


October 2013 forecast

1.5 month lead time

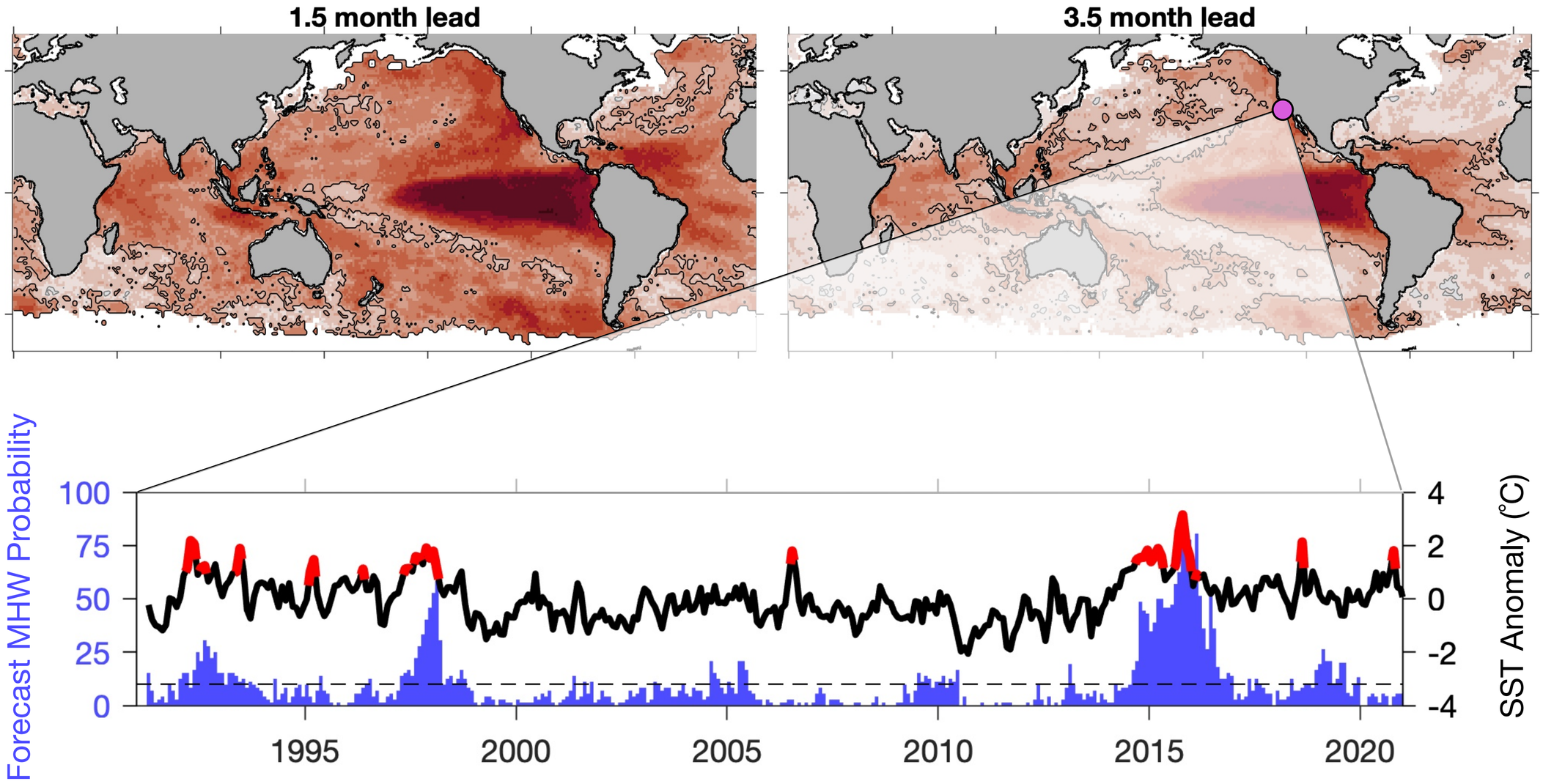
November 2013 heatwaves

Marine heatwave forecast skill



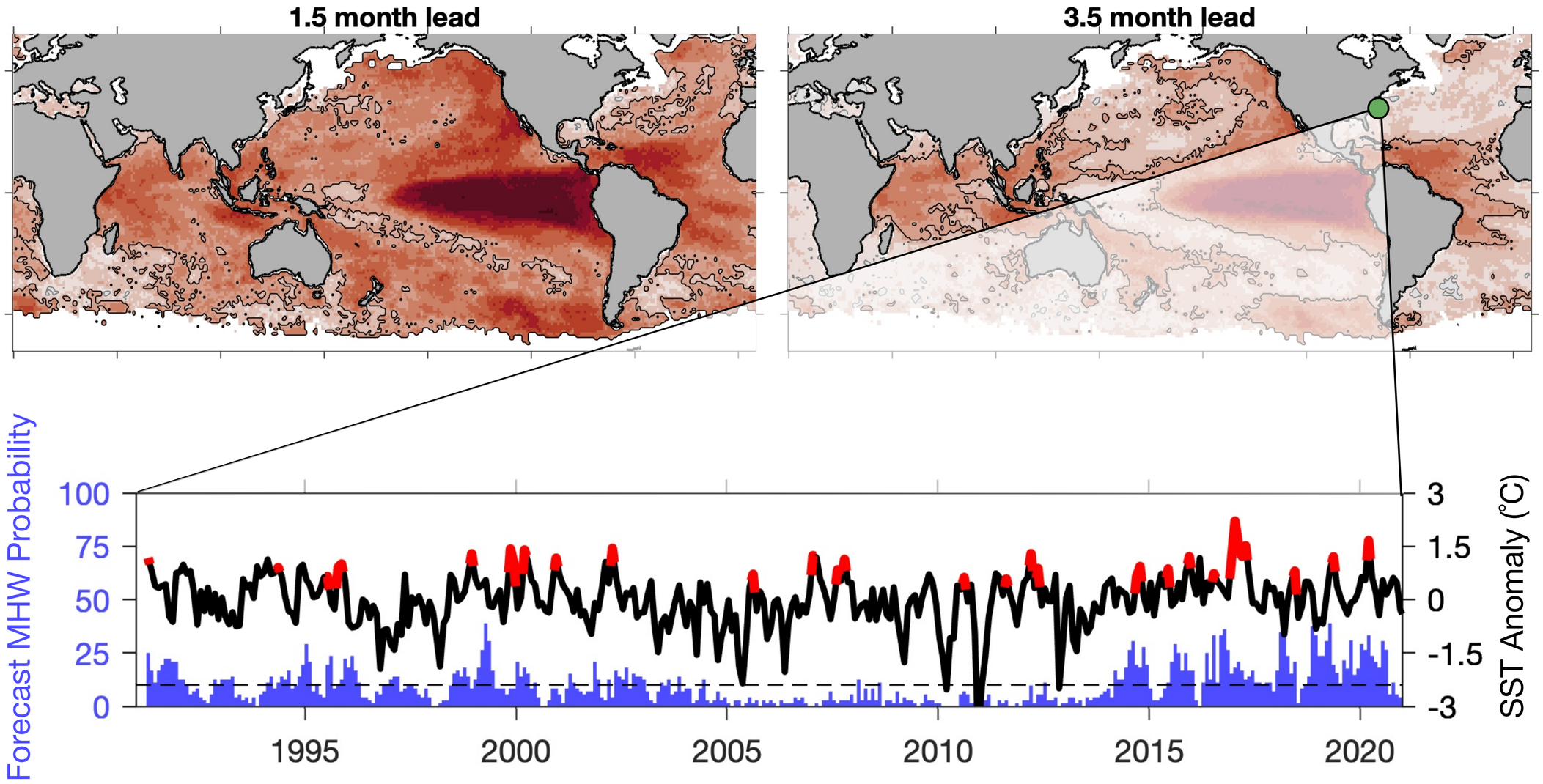
Jacox et al. (2022)

Marine heatwave forecast skill



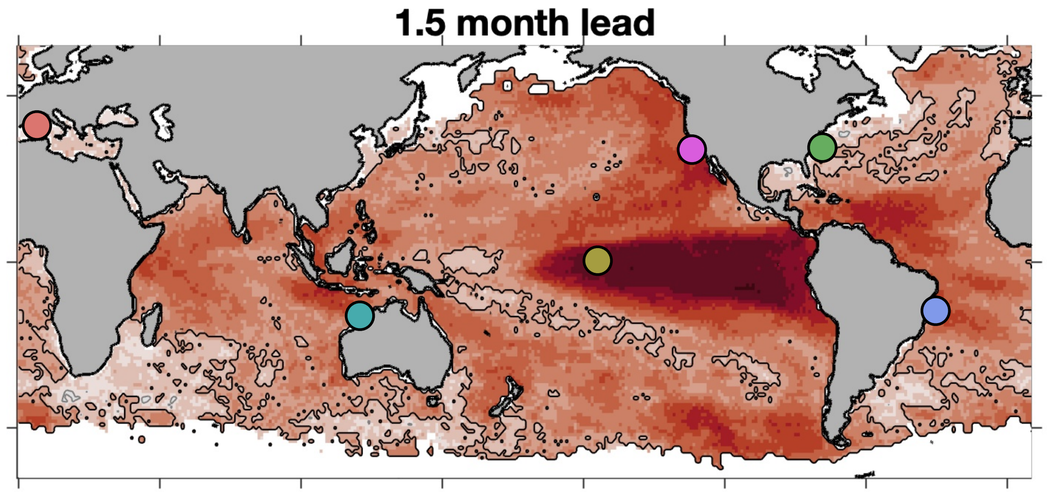
Jacox et al. (2022)

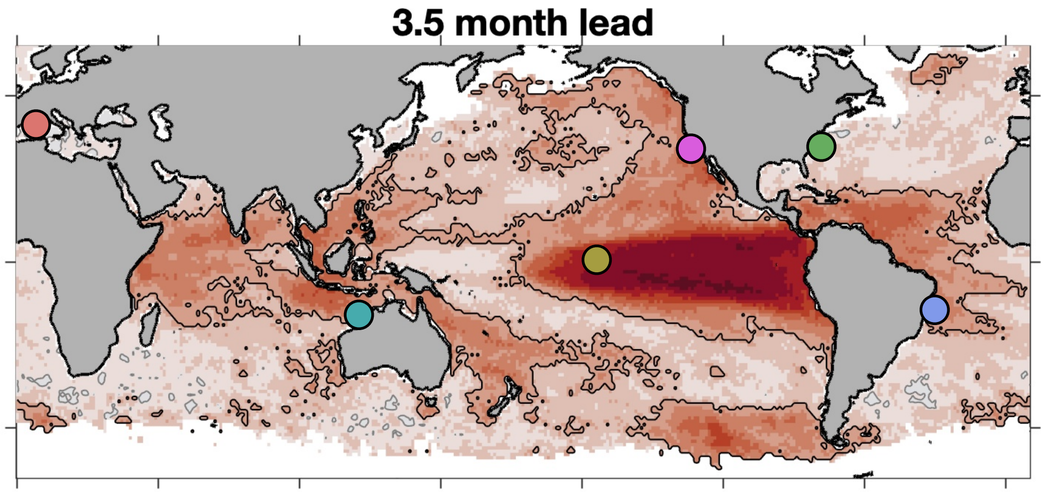
Marine heatwave forecast skill

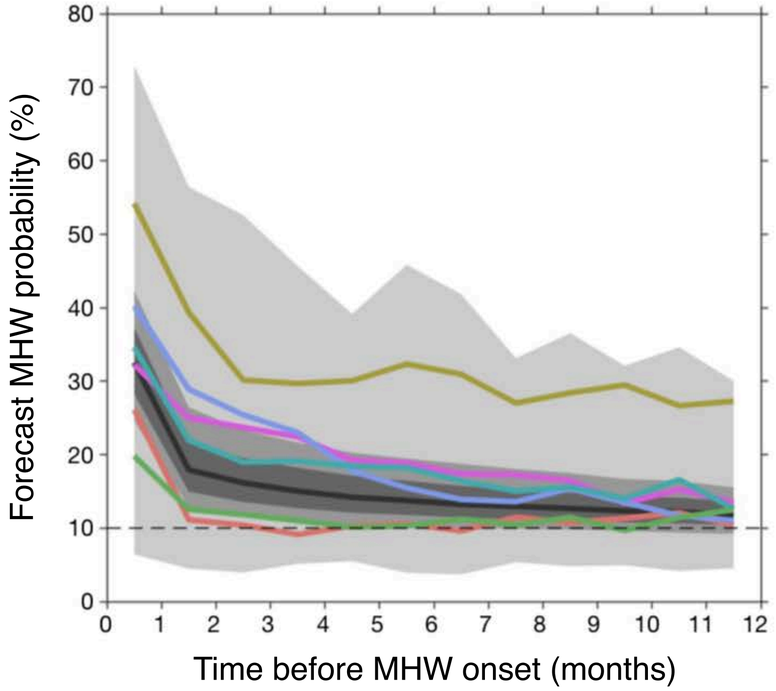


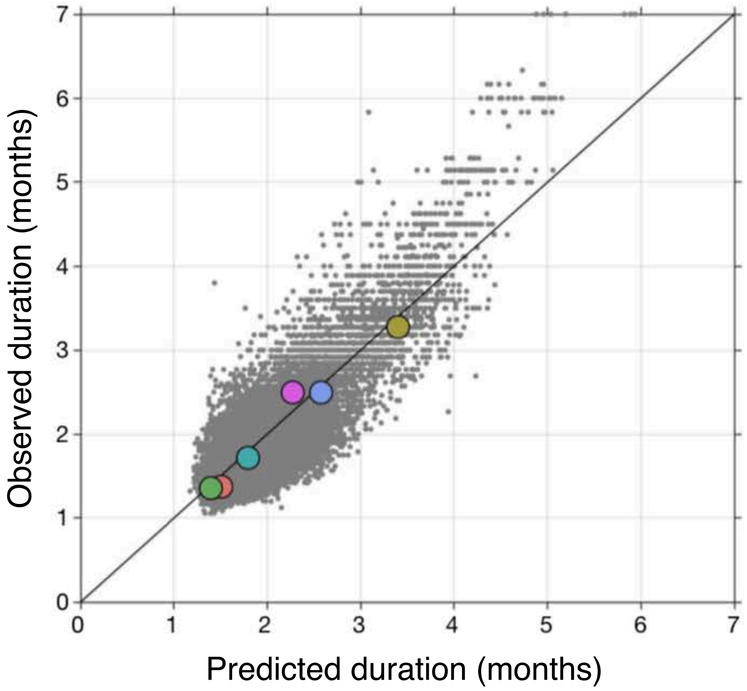
Jacox et al. (2022)

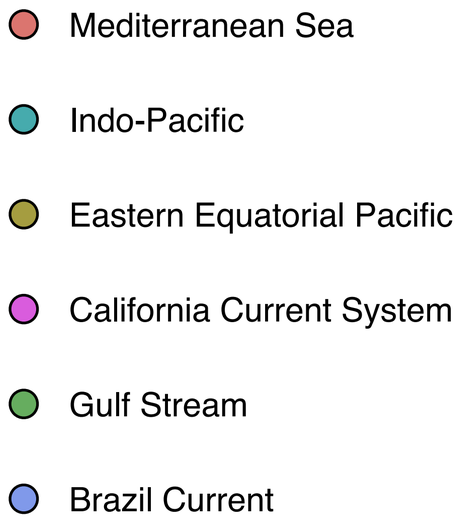
Marine heatwave forecast skill (onset and duration)





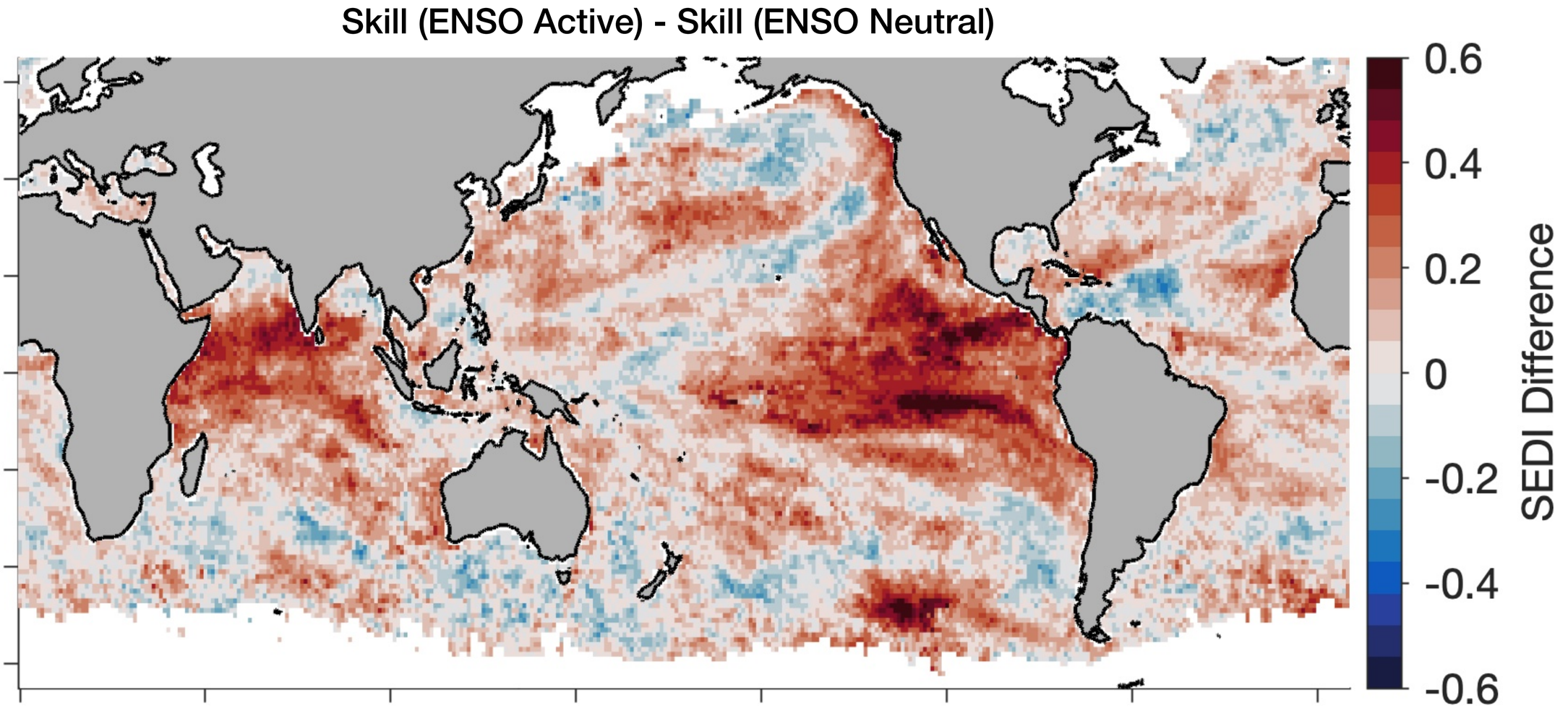






Jacox et al. (2022)

ENSO is a dominant driver of forecast skill



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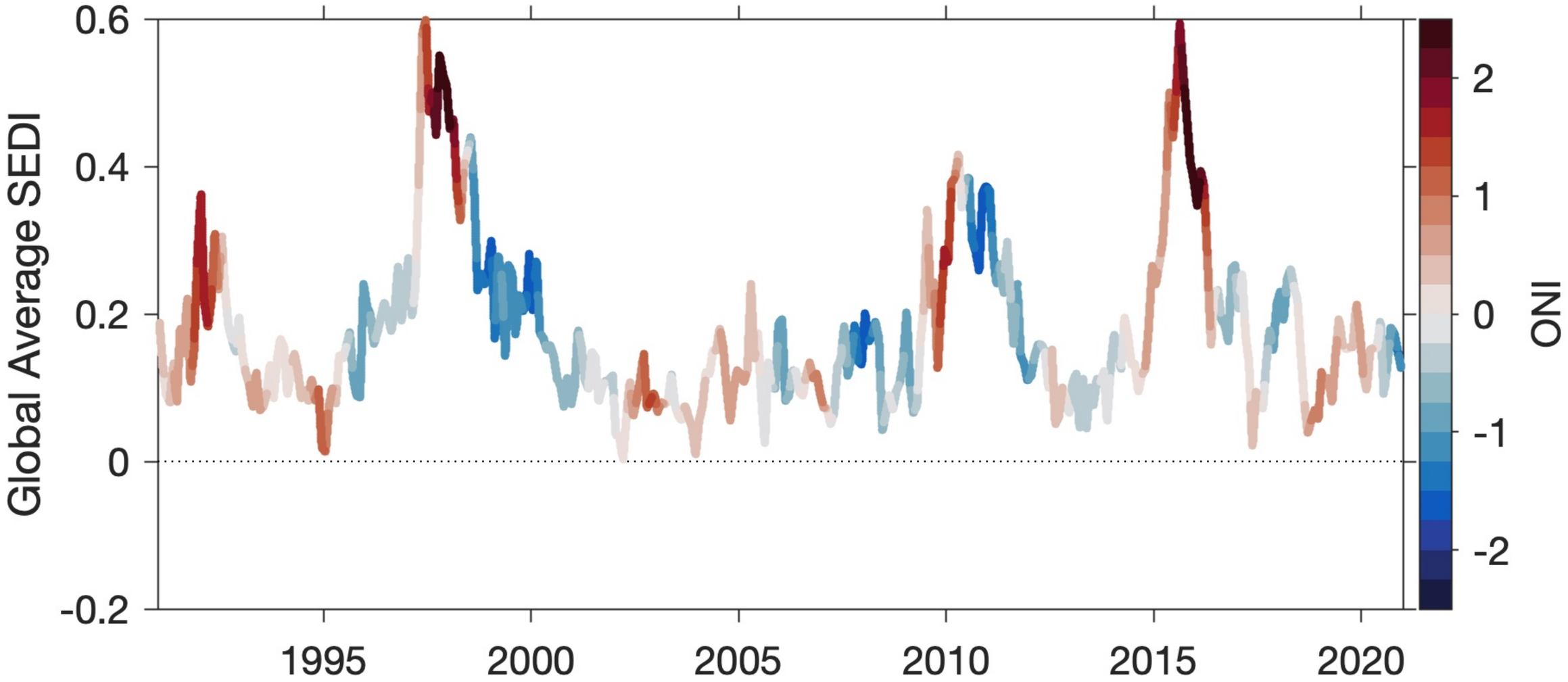
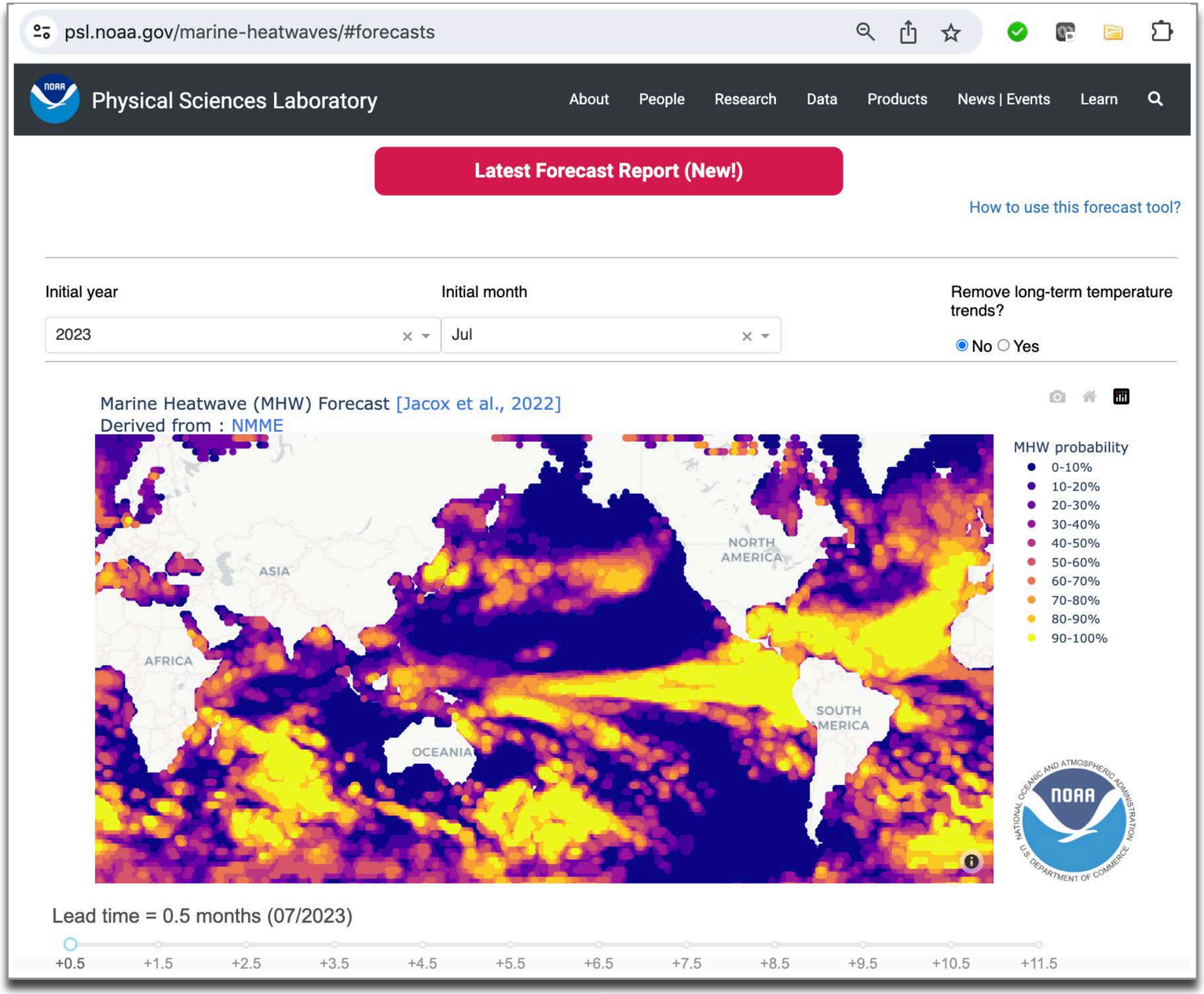


Jacox et al. (2022)

Web-based marine heatwave forecasts



Built on output from the North American Multi-model Ensemble

>70-member ensemble, using six global climate models

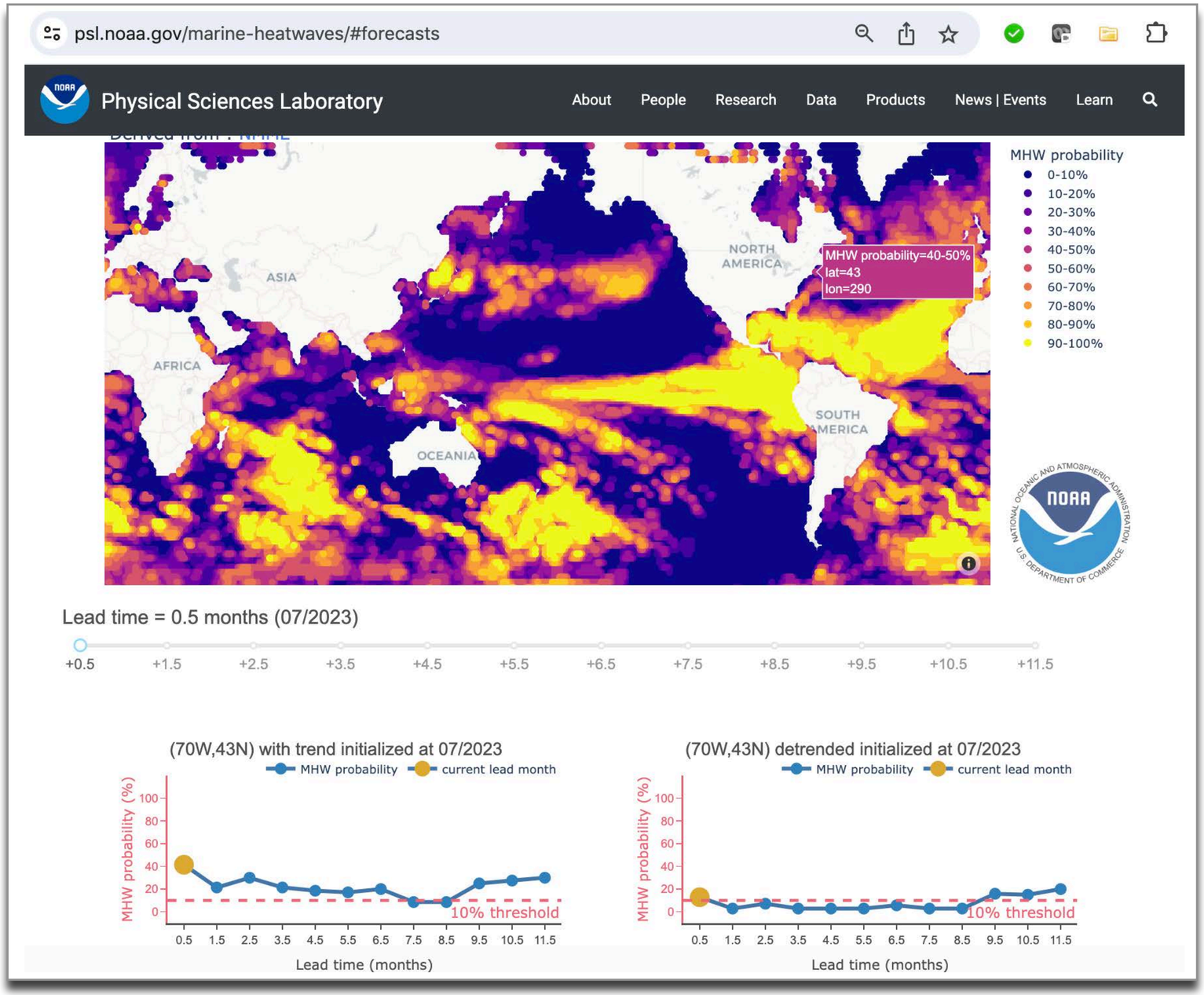
Forecasts issued monthly

Lead times up to one year

Current and past forecasts online

https://psl.noaa.gov/marine-heatwaves

Web-based marine heatwave forecasts



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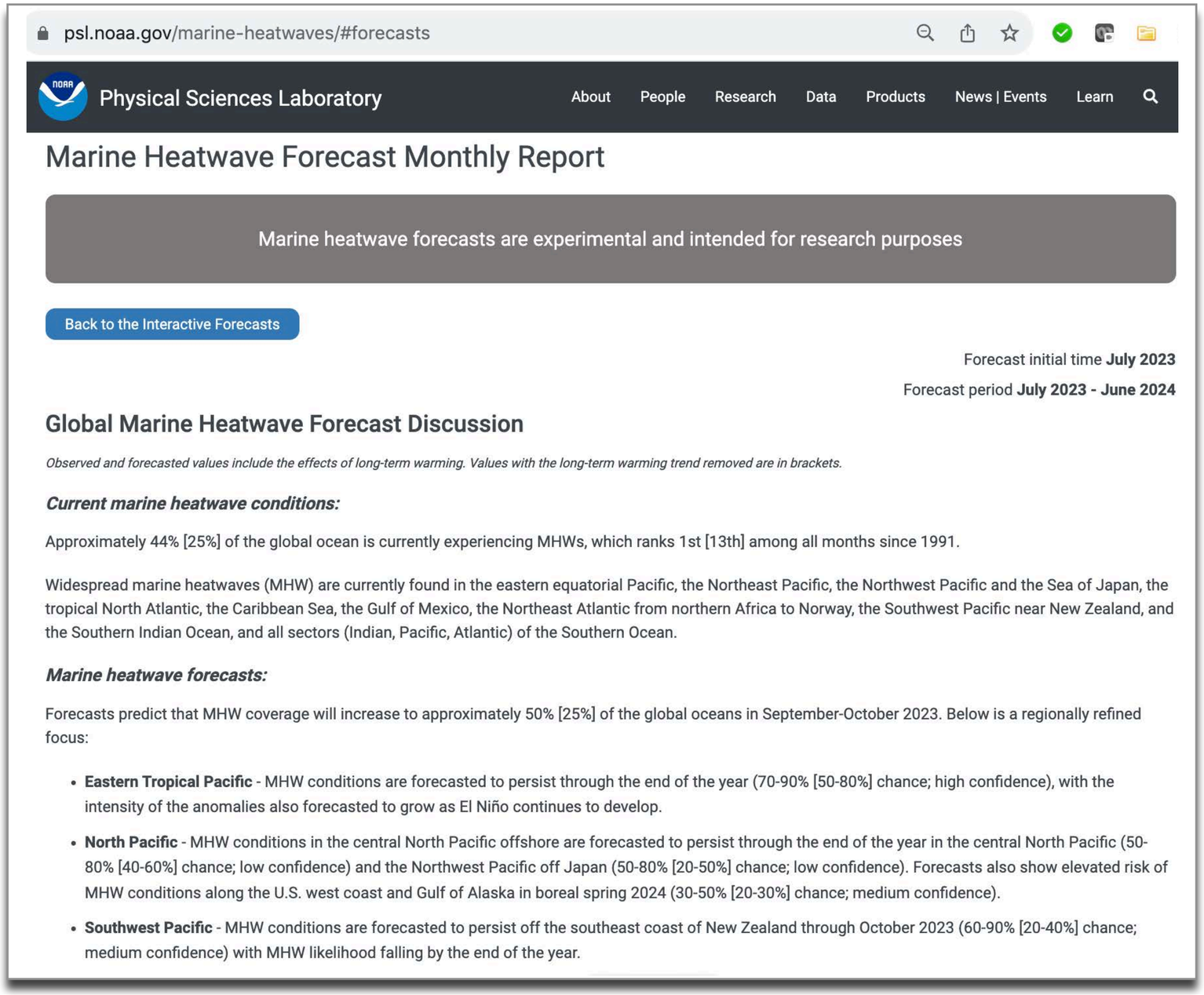

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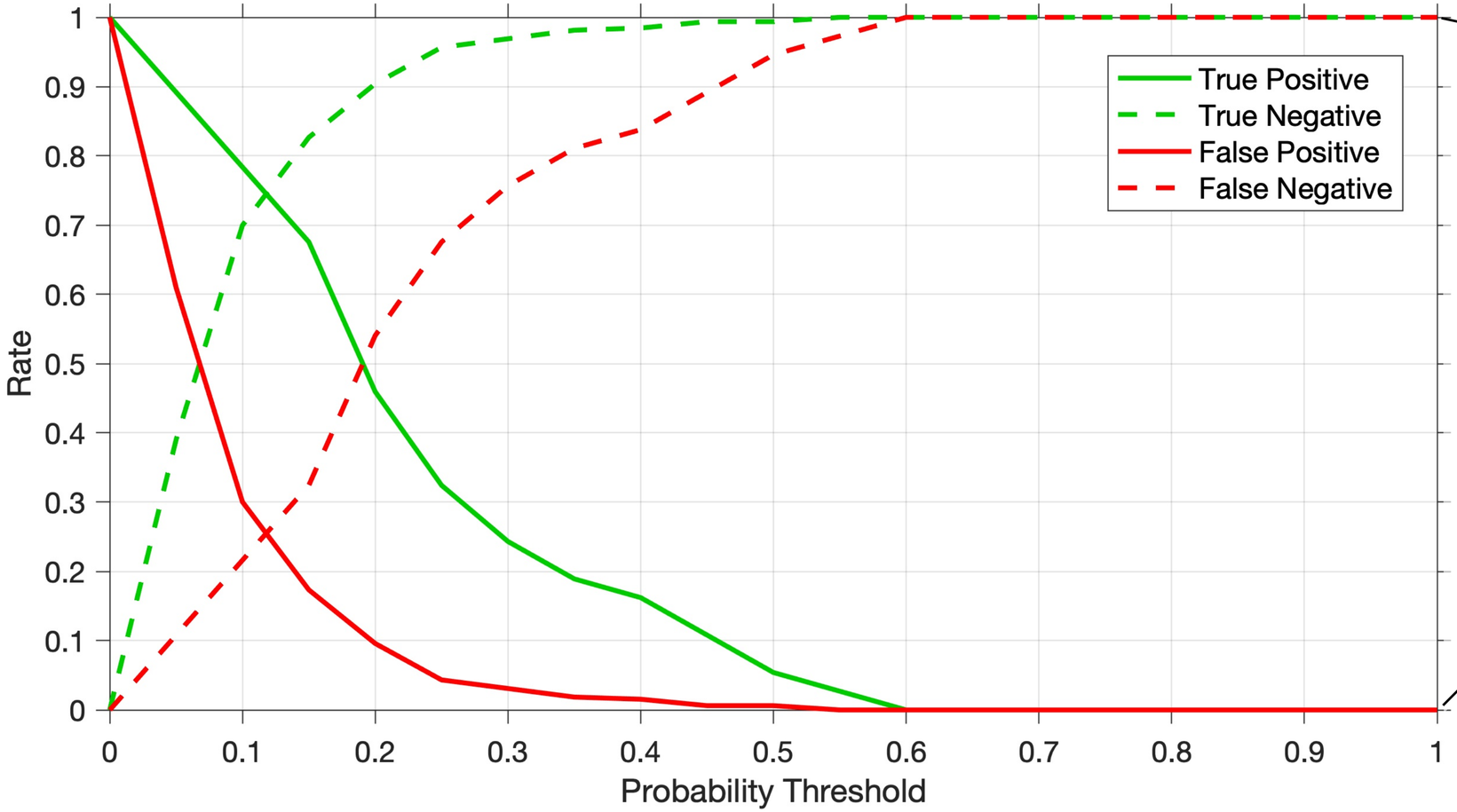
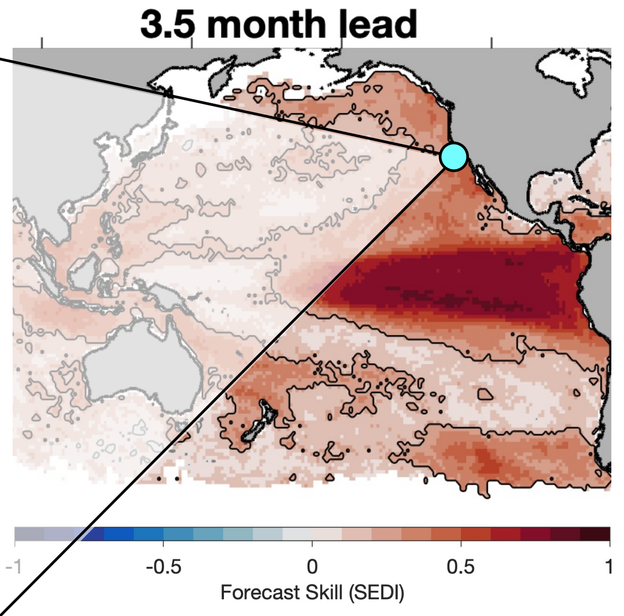
Turning probability forecasts into decision thresholds





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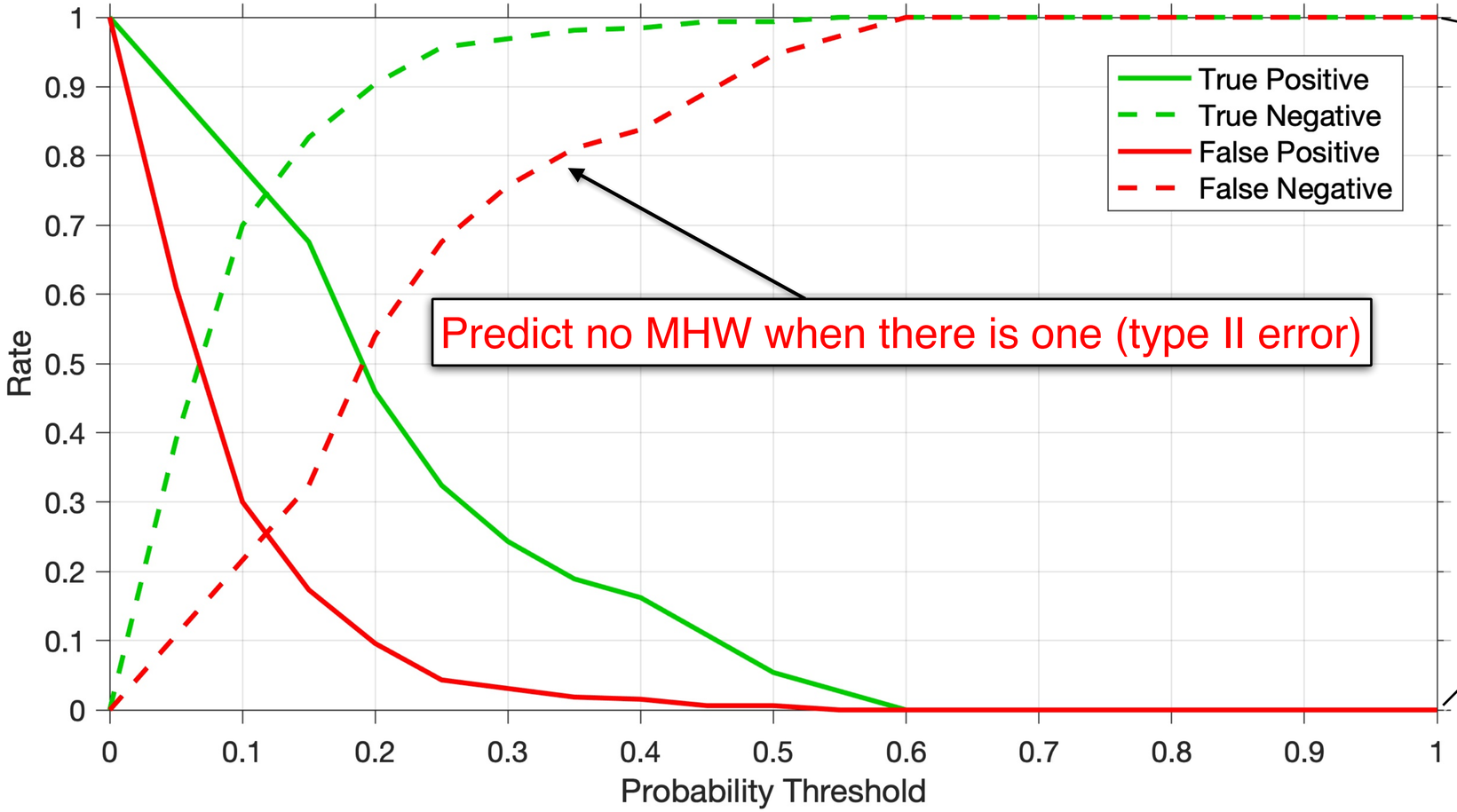
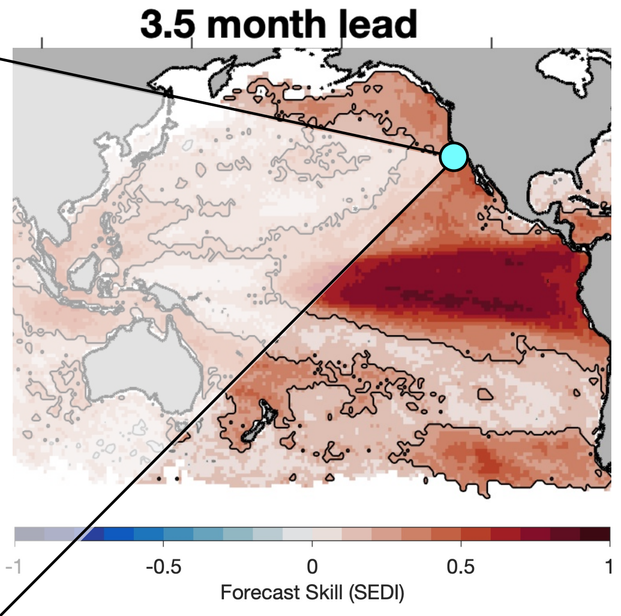
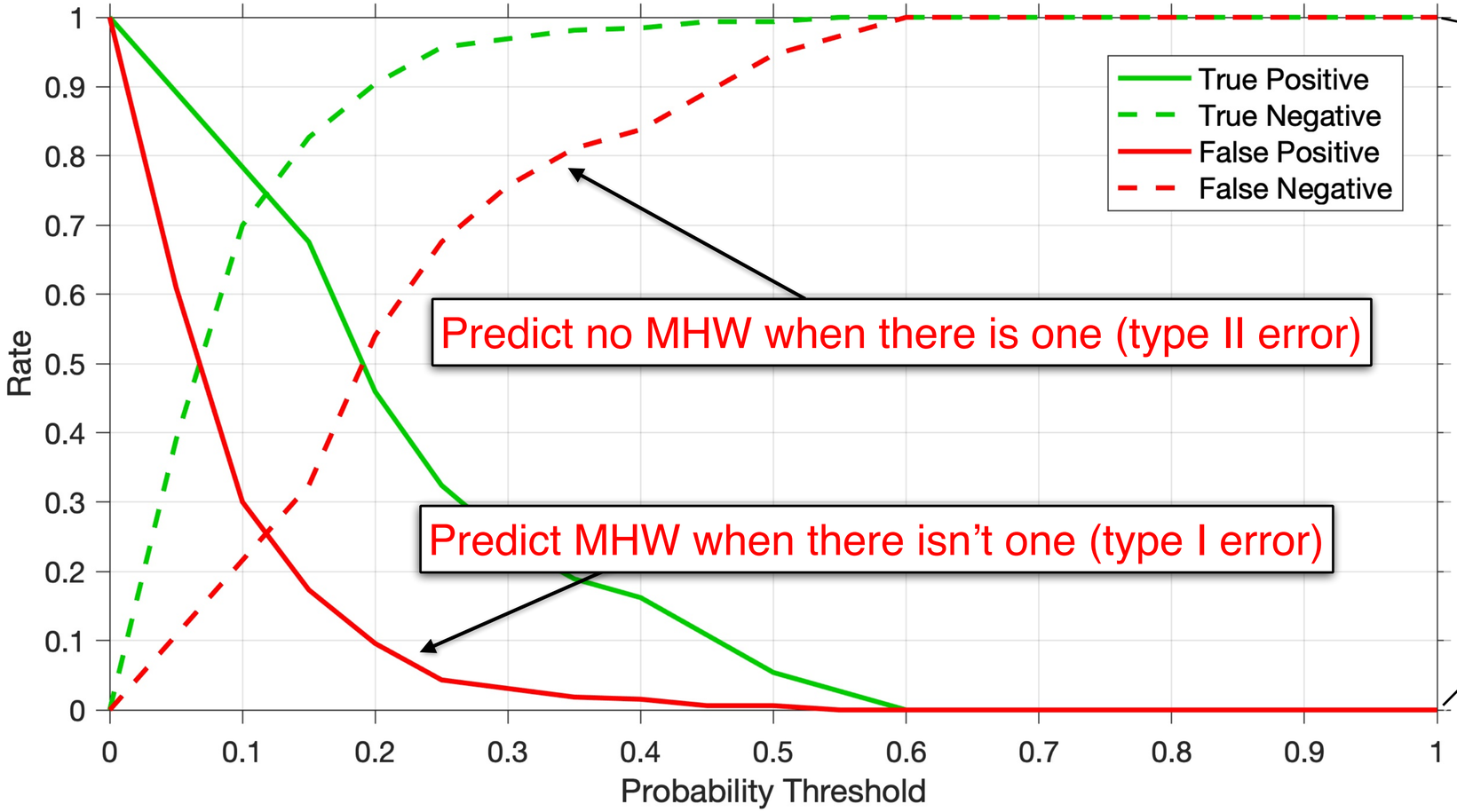
Turning probability forecasts into decision thresholds

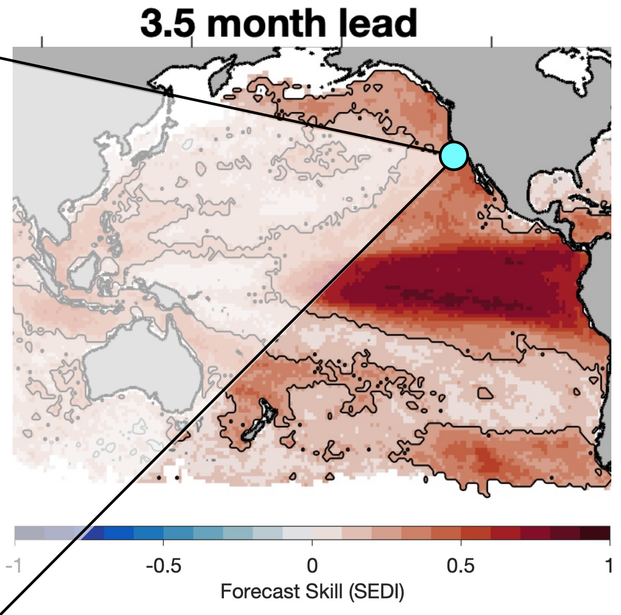




Jacox et al. (2022)

Turning probability forecasts into decision thresholds

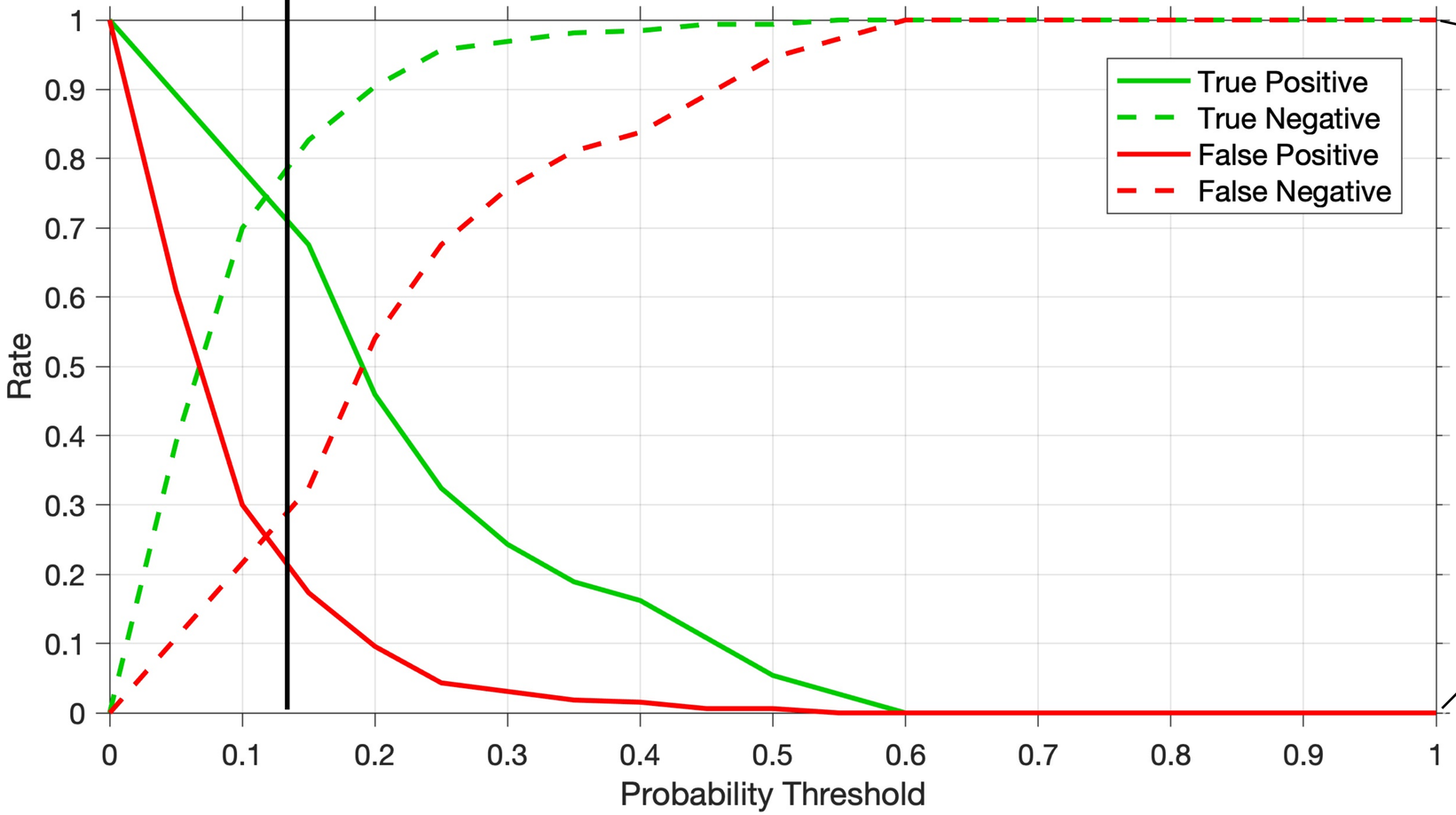


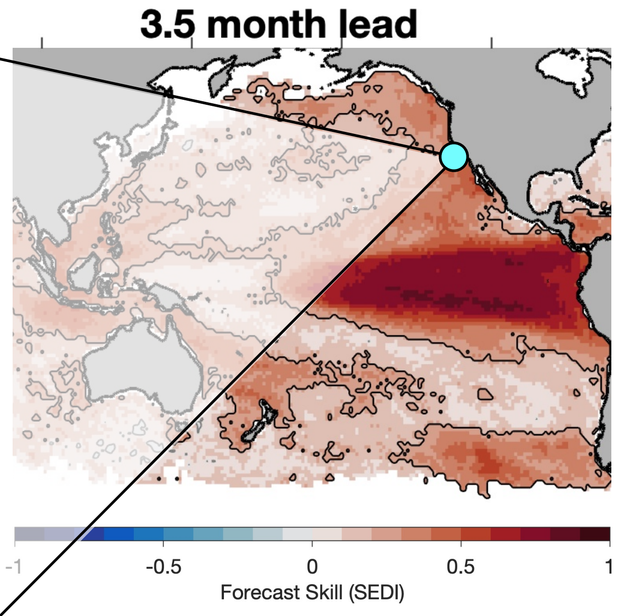


Jacox et al. (2022)

Turning probability forecasts into decision thresholds

Low Risk Tolerance
Minimize false negatives
Avoid inaction when MHW occurs
Concerned with all MHWs



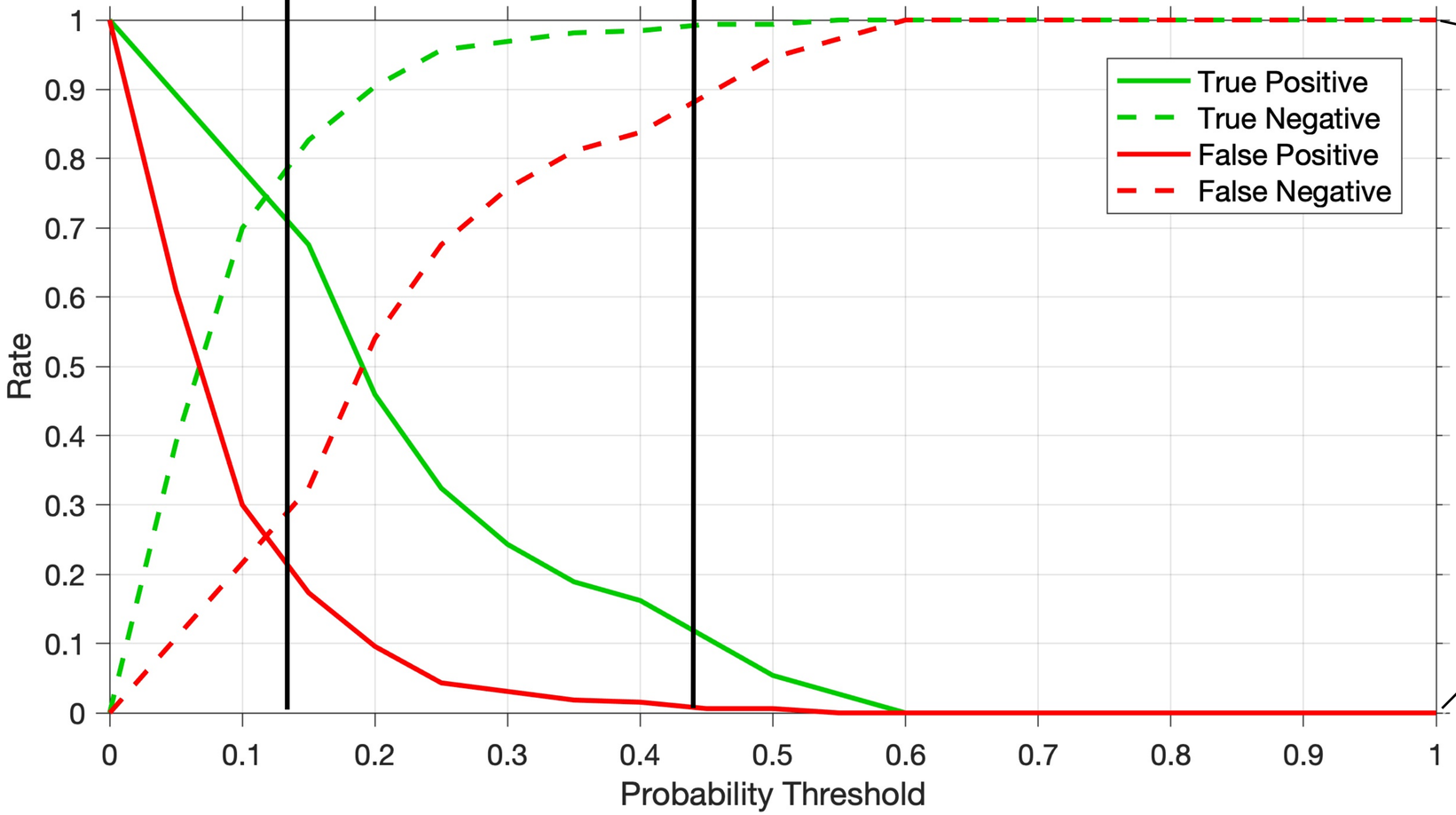


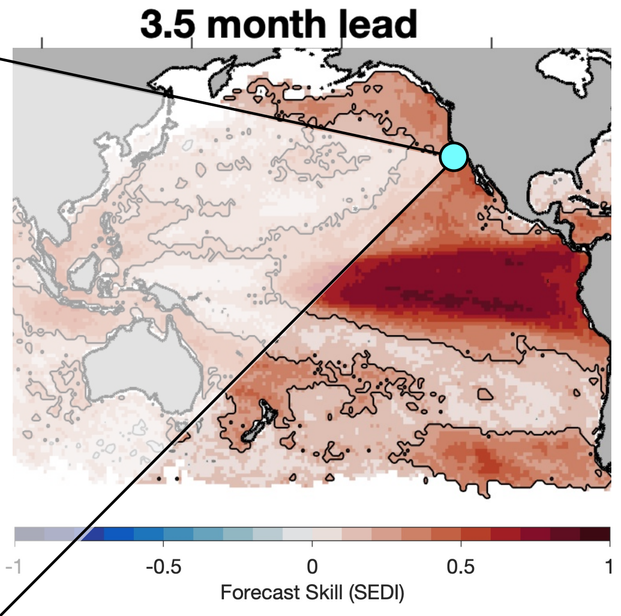
Jacox et al. (2022)

Turning probability forecasts into decision thresholds

Low Risk Tolerance
Minimize false negatives
Avoid inaction when MHW occurs
Concerned with all MHWs

High Risk Tolerance
Minimize false positives
Avoid action when MHW does not occur
Concerned with most intense MHWs



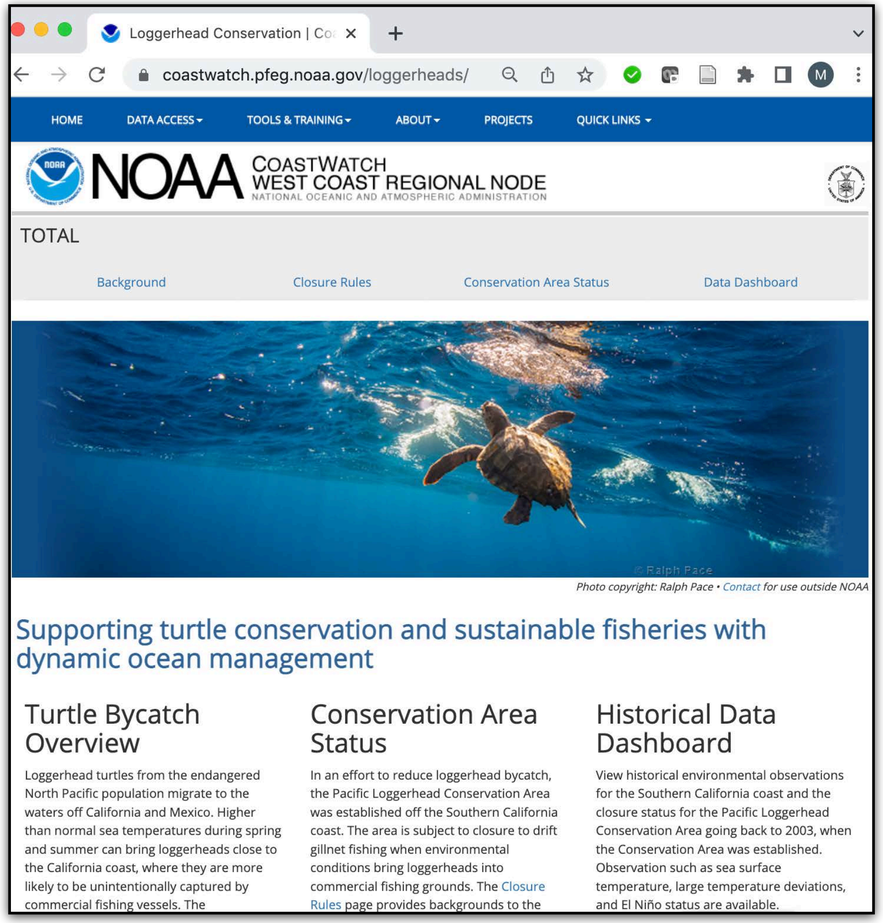


Jacox et al. (2022)

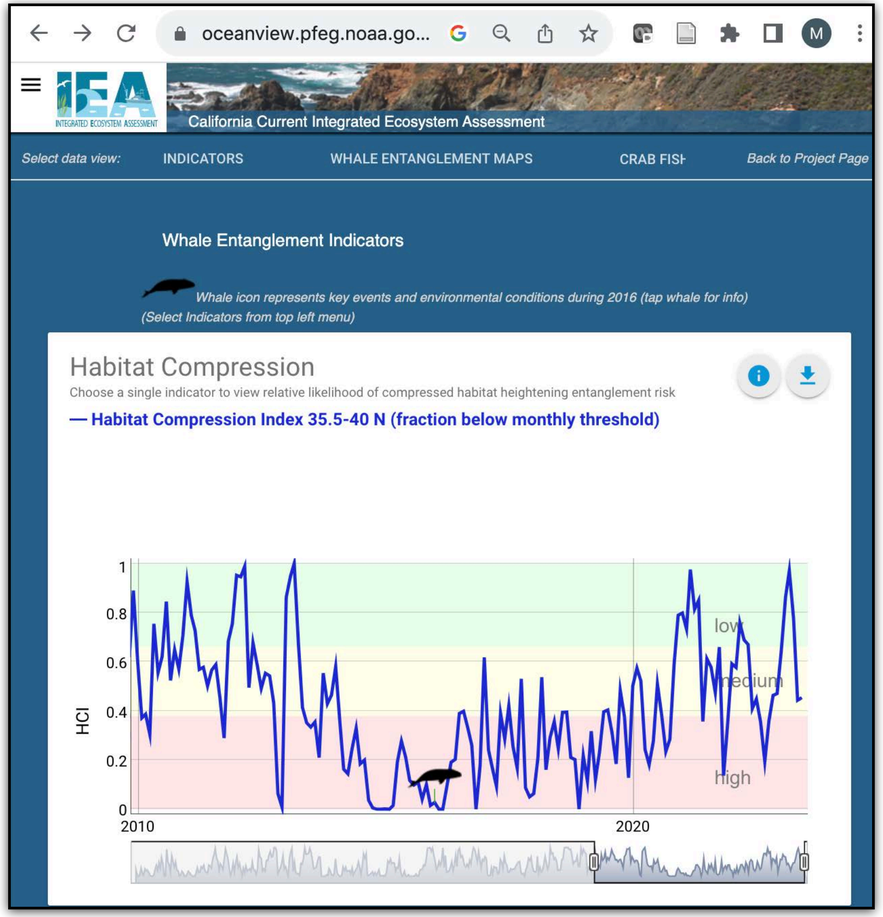
Tailoring forecasts for ecological thresholds

Marine Heatwaves

Loggerhead Turtle Bycatch

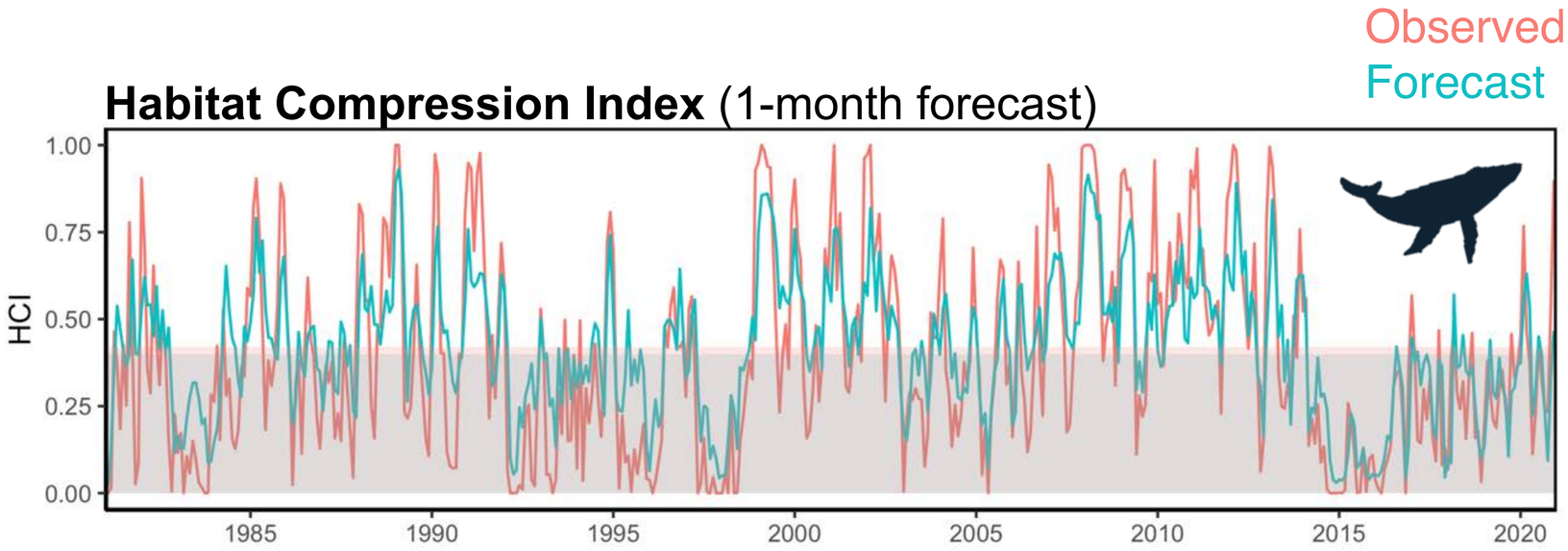


Habitat Compression (whale entanglement)



Brodie et al. (in review)

Tailoring forecasts for ecological thresholds



High compression in 2005 could have been predicted 1-2 months in advance.

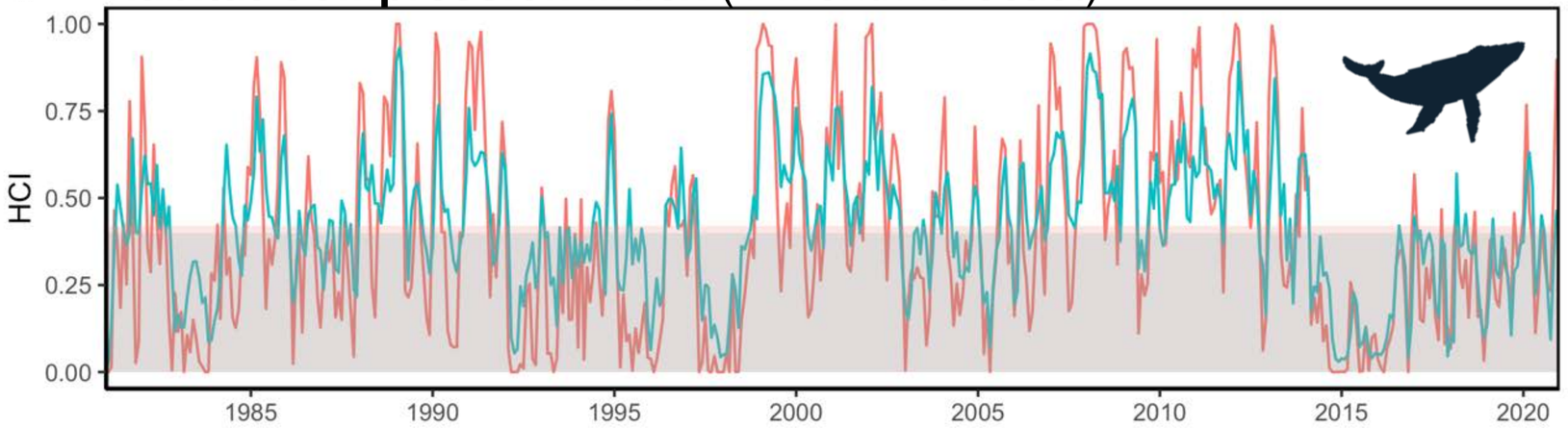
Persistent habitat compression 2014-2016 was predictable months in advance.

Brodie et al. (in review)

Tailoring forecasts for ecological thresholds

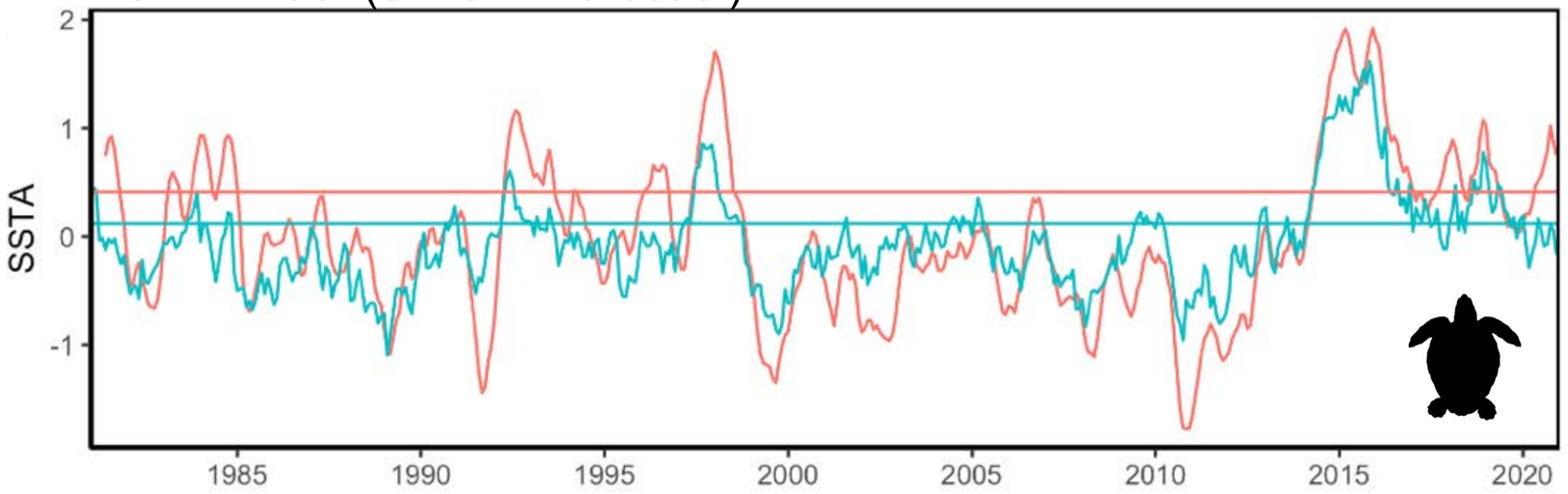
Observed
Forecast

Habitat Compression Index (1-month forecast)



Persistent habitat compression 2014-2016 was predictable months in advance.

TOTAL Tool (6-month forecast)



Fishery closures were enacted in the summers of 2015 and 2016.

These closures could have been predicted at least 6 months in advance.

Brodie et al. (in review)