

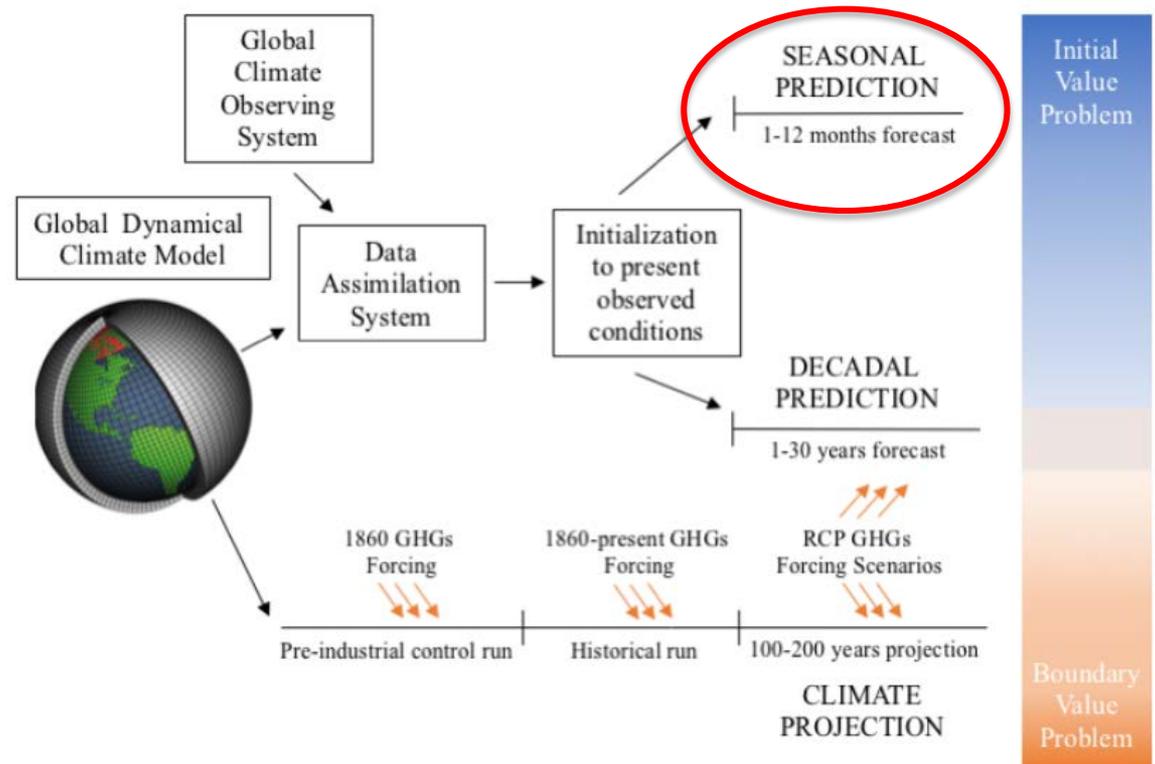
# The Skill of North American Multi-Model Ensemble (NMME) SST forecasts for US coastal ecosystems

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# Global Climate Models (GCMs)

- Developed to study Climate variability and change
- GCM Forecast system developed – mainly to predict ENSO
- Now being used to make seasonal to decadal forecasts of global SSTs and other climate variables

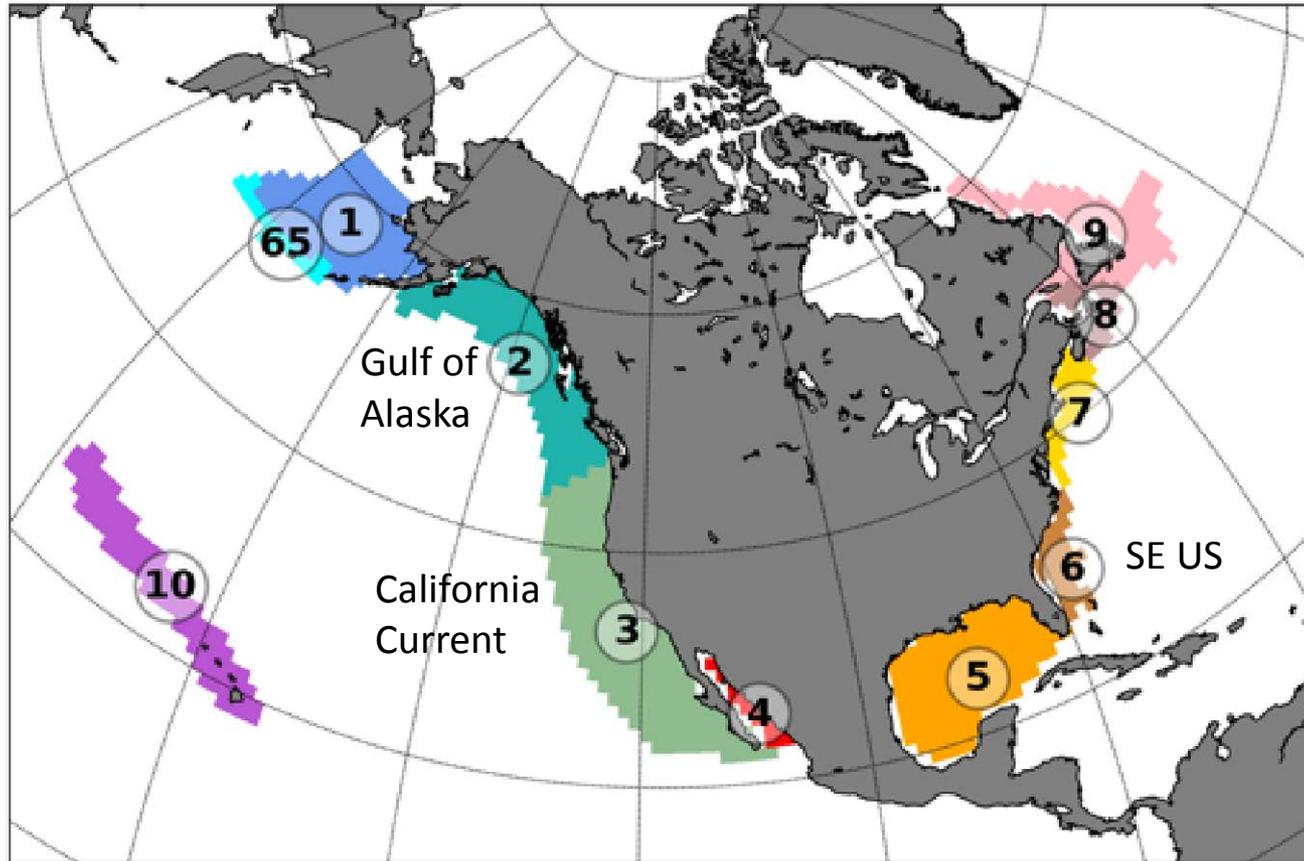


Here we evaluate SST forecast skill of GCMS for Large Marine Ecosystems (LMEs) in US waters

GCM – ocean, atmosphere, land, and sea ice

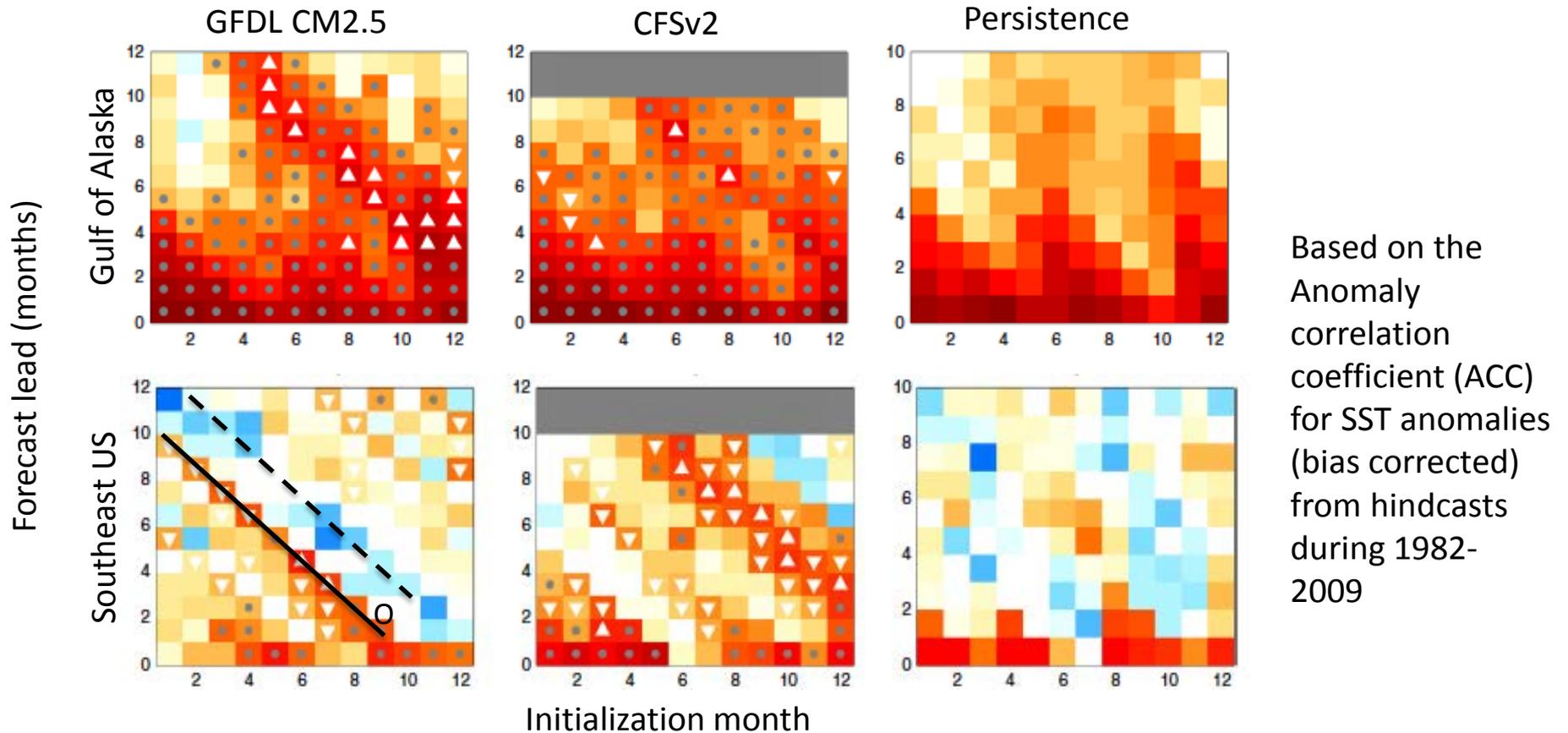
Figure courtesy of D. Tommasi

# Large Marine Ecosystems (LMEs)

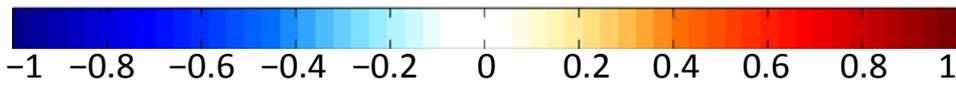


LMEs 1: East Bering Sea (EBS), 2: Gulf of Alaska (GoA), 3: California Current (CC), 5: Gulf of Mexico (GoM), 6: Southeast U.S. Continental Shelf (SEUS), 7: Northeast U.S. Continental Shelf (NEUS), 8: Scotian Shelf (SS), 9: Newfoundland-Labrador Shelf (NL), 10: Insular Pacific Hawaiian (IPH), 65: Aleutian Islands

# Monthly SST Anomaly Forecast Skill in LMEs



Based on the Anomaly correlation coefficient (ACC) for SST anomalies (bias corrected) from hindcasts during 1982-2009



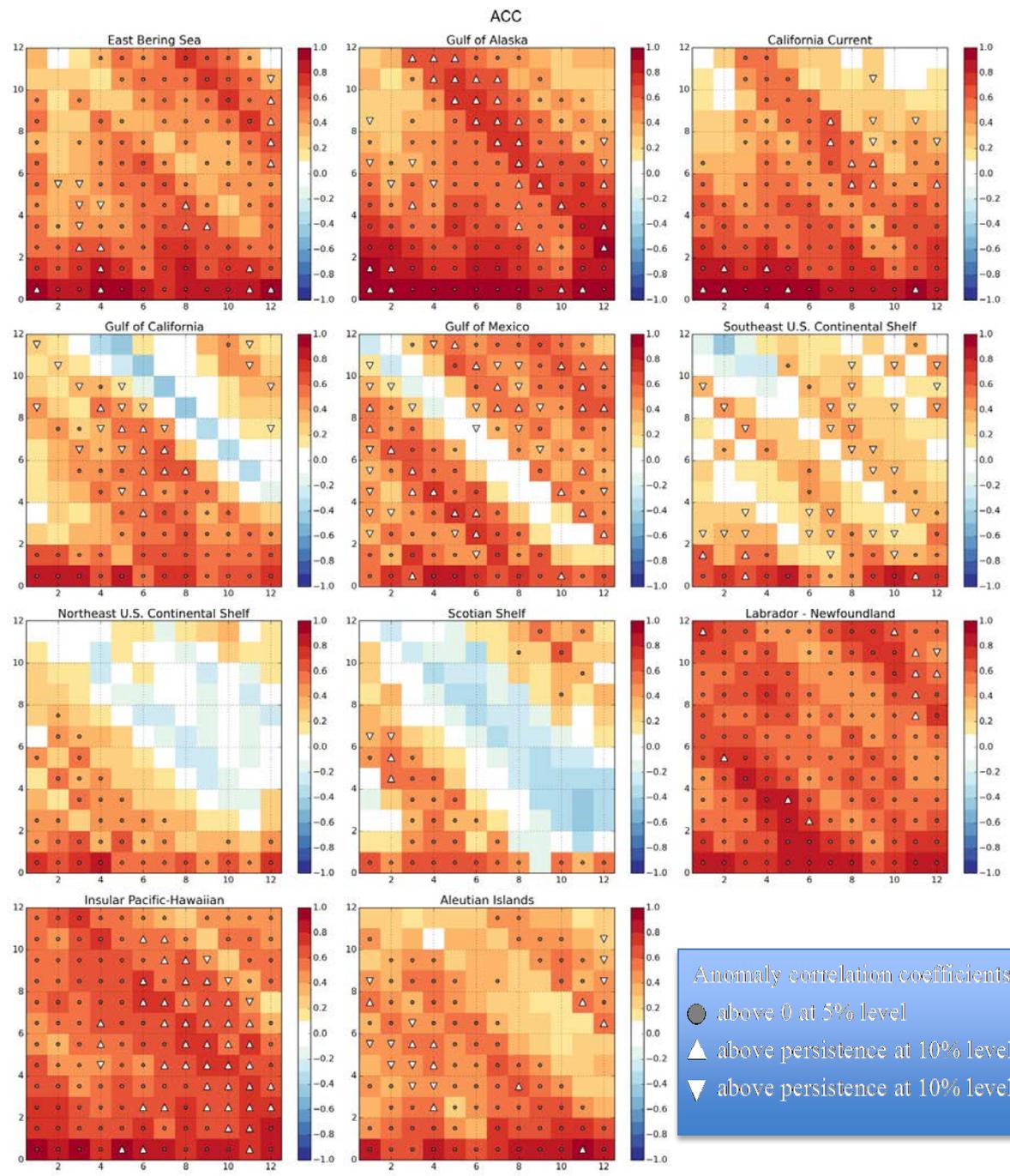
- Anomaly correlation coefficients:
- above 0 at 5% level
  - ▲ above persistence at 10% level with ACC > 0.5
  - ▼ above persistence at 10% level with ACC < 0.5.

# Multi-Model Forecasts

- Many studies have found that forecasts from multiple models are better than those from any single model
- Here we examine the skill of SST hindcasts from the North American Multi-Model Ensemble (NMME), phase 1
  - *Kirtman et al. 2014, BAMS*
- Monthly Hindcasts during 1982-2002 from 14 models
  - All output on a 1° lat x 1° lon grid
- Skill estimated by:
  - First average ensembles from individual models
  - Average models to create a multi-model mean hindcast
  - Bias correct hindcasts by removing drift (initialization month, lead)
  - Skill of SST hindcasts evaluated relative to ¼° Reynolds OI SST data set

# Anomaly Correlation Coefficients (ACC) for Ensemble mean SST NMME Forecasts for US LME regions

(all NMME models averaged together)

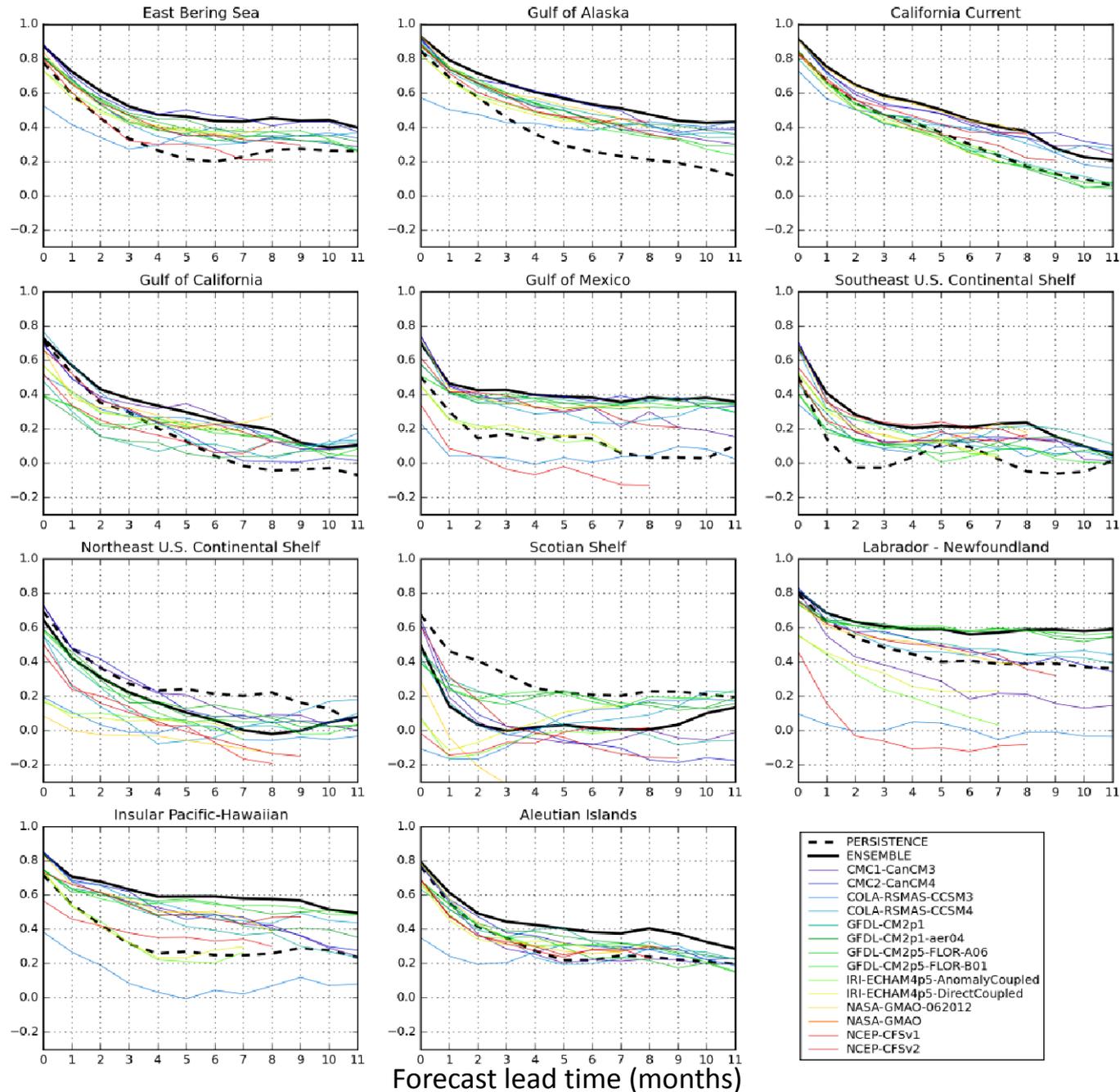


Anomaly correlation coefficients:

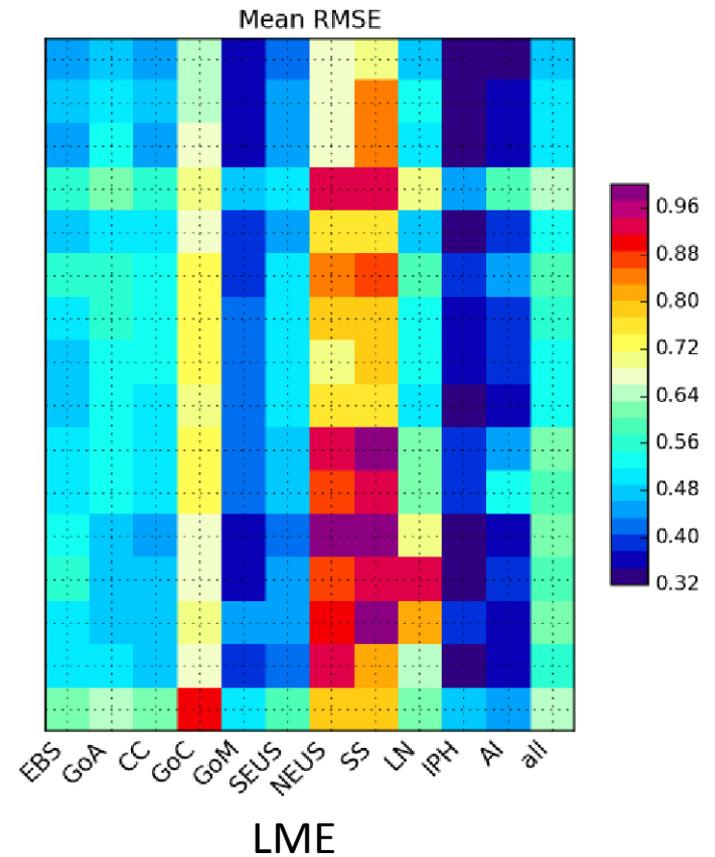
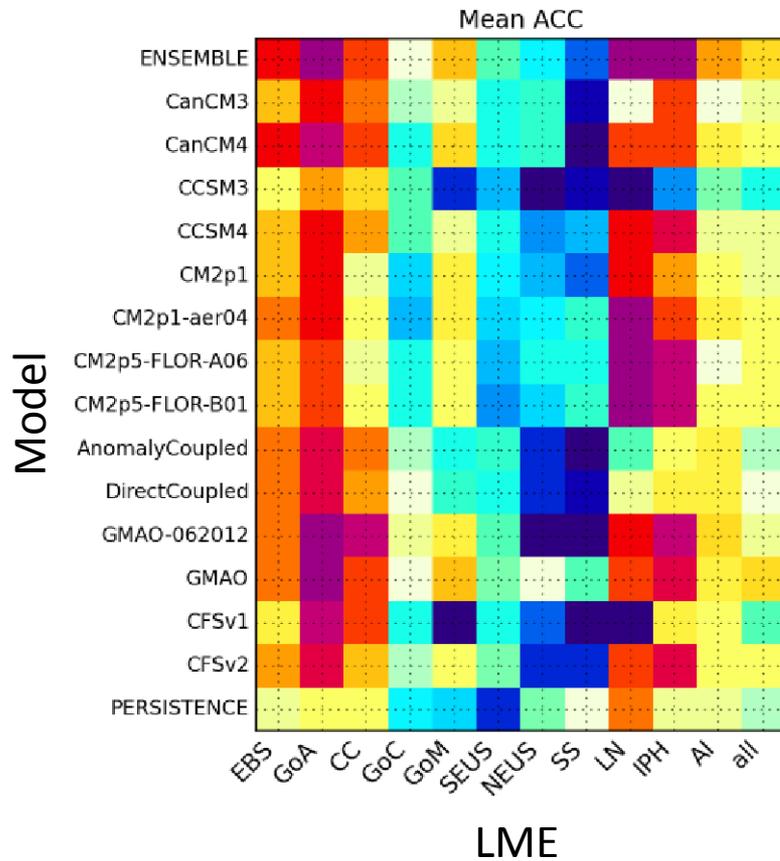
- above 0 at 5% level
- ▲ above persistence at 10% level with ACC > 0.5
- ▼ above persistence at 10% level with ACC < 0.5.

# Anomaly Correlation Coefficient (ACC)

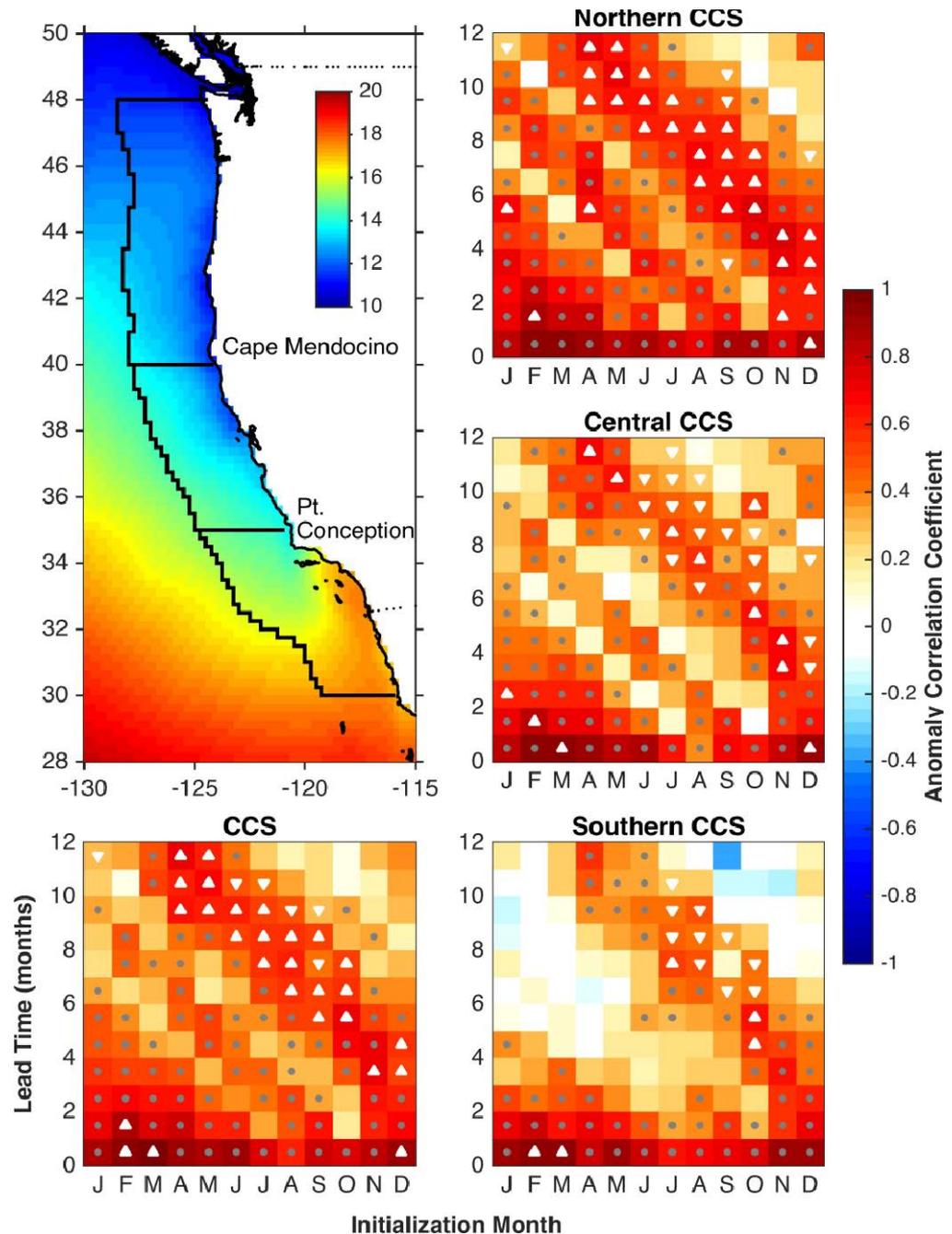
Average of ACCs over all initialized months as a function of forecast lead time for each model, persistence and the multi-model mean.



# Overall Skill Estimates of SST hindcasts

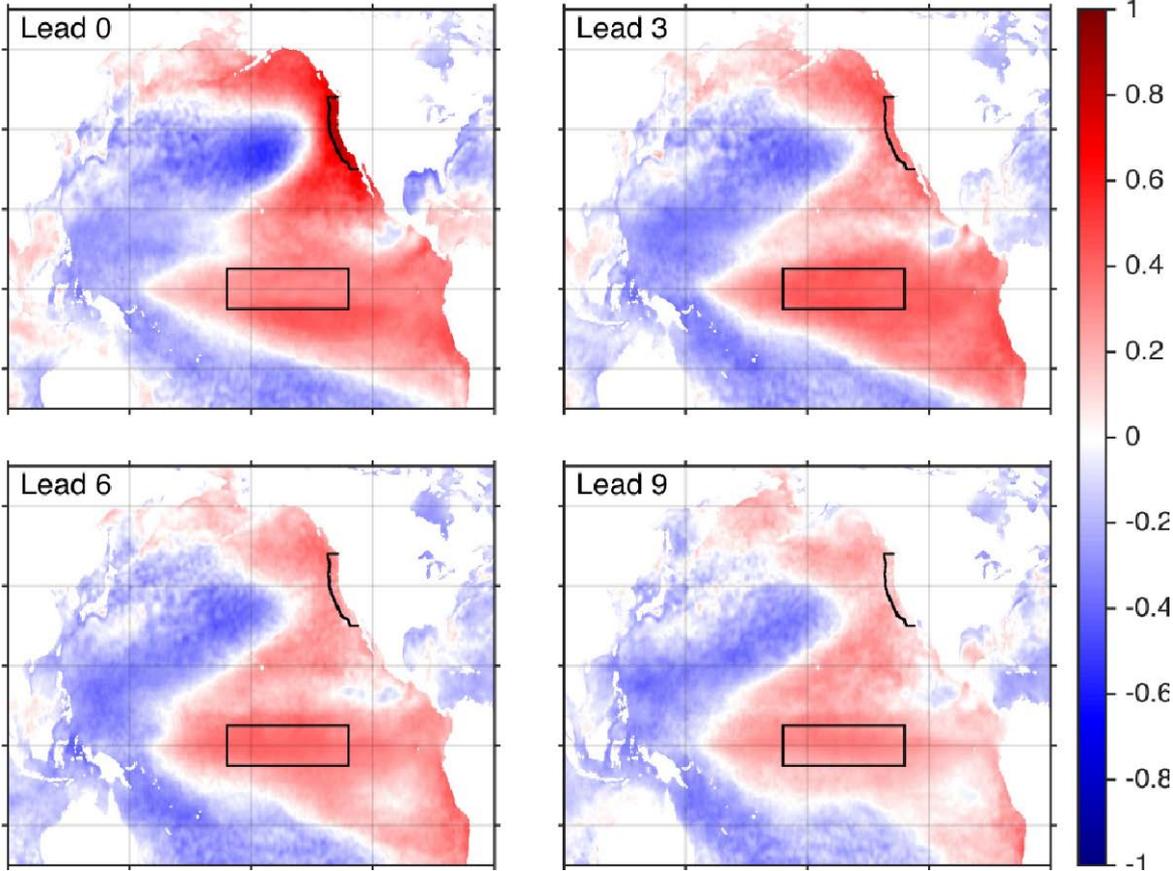


# Hindcast skill (ACC) for 3-sub regions in the California Current LME from CanCM4

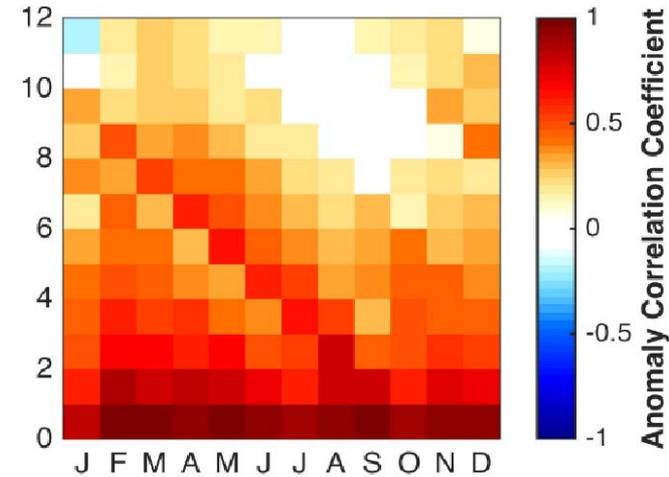


# Processes that influence predictability

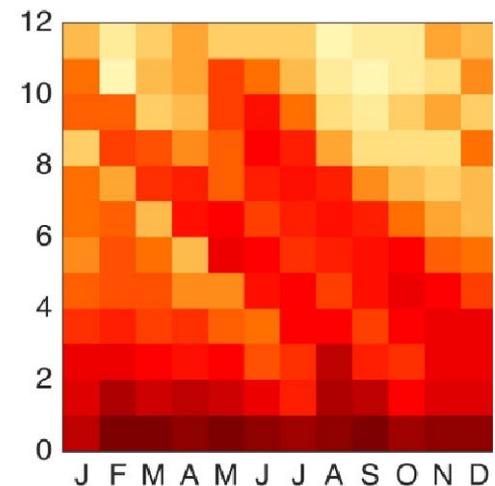
## ENSO



## Persistence



## ENSO + Persistence

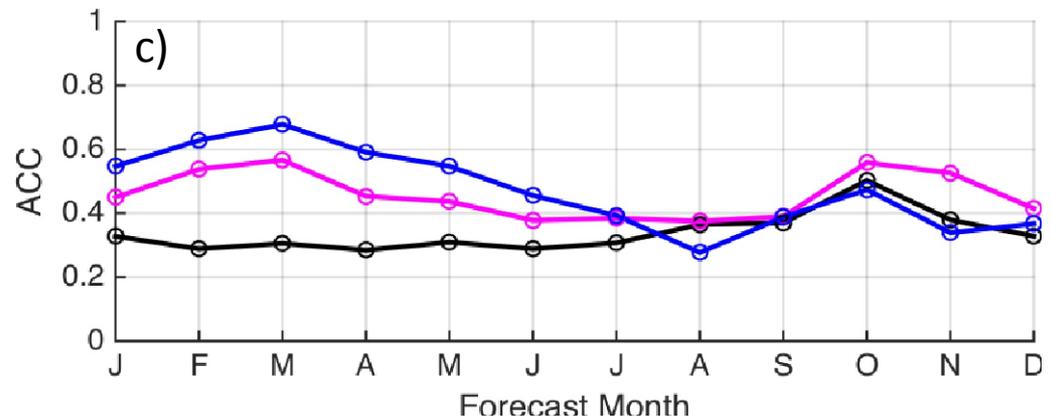
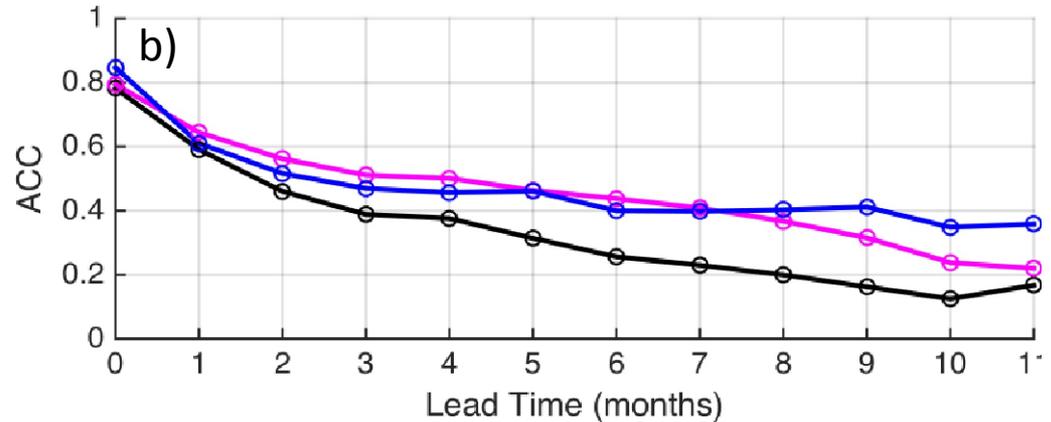
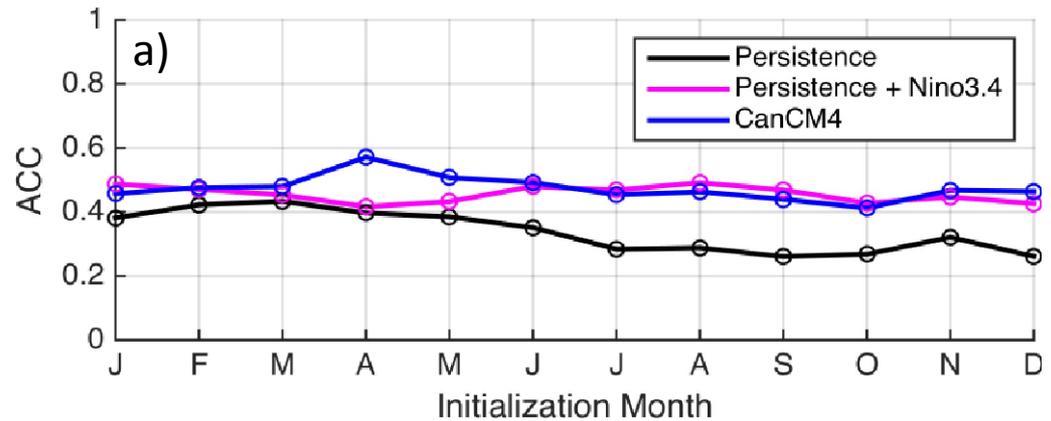


Correlation of Pacific basin wide SST with CCS regionally averaged SST 0, 3, 6, and 9 months prior

# Forecast Skill in the CC LME for:

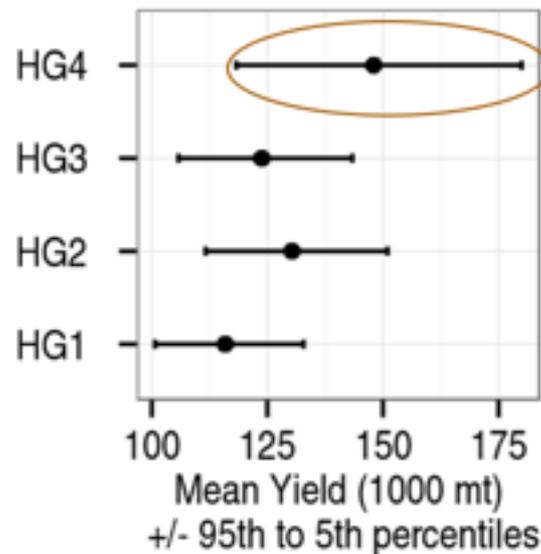
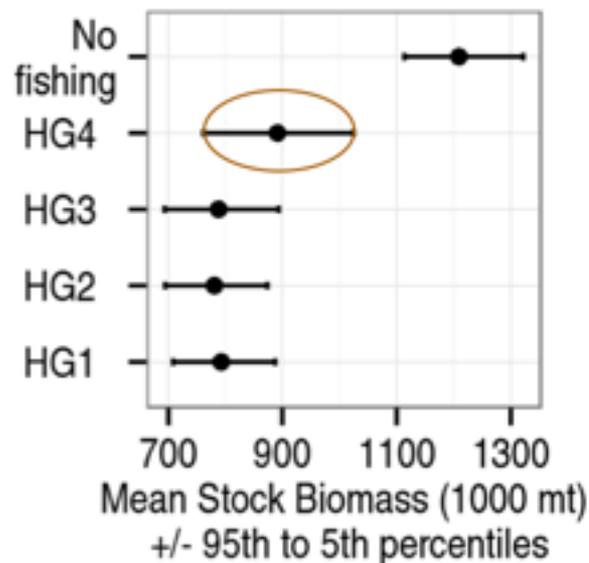
- a) initialization,
- b) lead time
- c) forecast month

Persistence + Nino3.4  
forecast a from a  
simple multiple linear  
regression model



# Application of SST forecasts to Pacific Sardines

- Sardine population simulated using an age-structured model
  - Recruitment dependent on parents biomass and SST
- Current harvest guideline (HG) dependent on previous year's SST and biomass in CC LME (HG2)
- Use late winter/early spring SST forecast from an NMME model
  - Use in Hg (controls fishing rate) to get predicted biomass (HG3)
- Use the predicted Biomass to inform the following years biomass (HG4)



HG1 = no SST  
HG2 = past SST  
HG3 = forecast SST  
for fishing rate  
HG4 = forecast SST for  
fishing rate and  
biomass forecast

# Summary

- GCMs have skill in predicting SSTs but varies widely by region, e.g.
  - Gulf of Alaska & California Current reasonably good
  - Southeast and northeast US not so much
- Skill in LME subregions
  - Decreases from north to south in the 3 California Current subregions
- Multi-model mean generally the best forecast though not necessarily for all regions at all time
  - Perhaps could be improved by weighting models by skill but non-trivial
  - Can use models to understand processes that contribute to predictability
  - Use this information to improve climate forecast systems (including statistical models)