Applications of regional biophysical model simulations for the Bering Sea:

Forecasting ecosystem indicators & fish habitat

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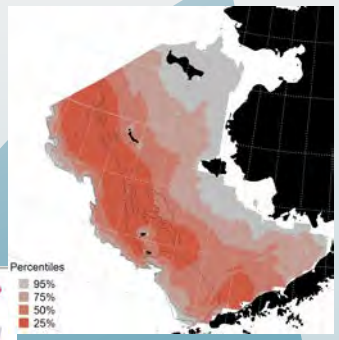
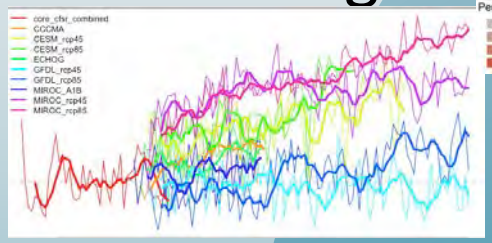
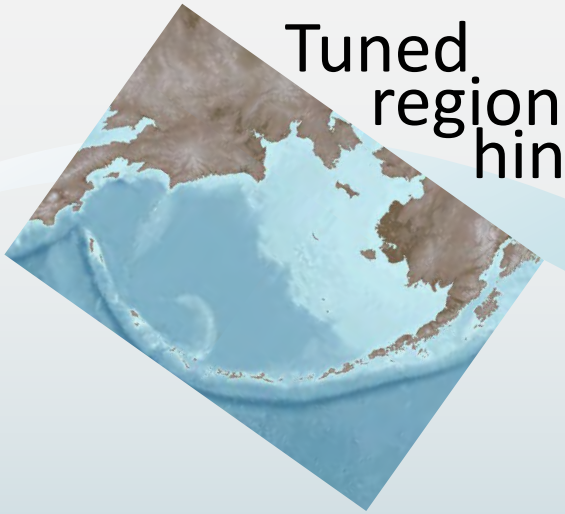
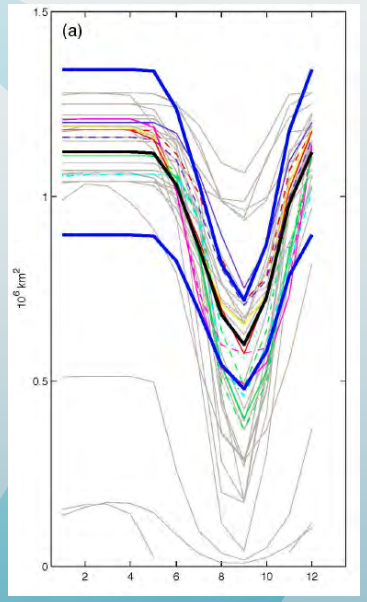
Inform management/ develop products: time series, spatially explicit environmental data, ensemble averages





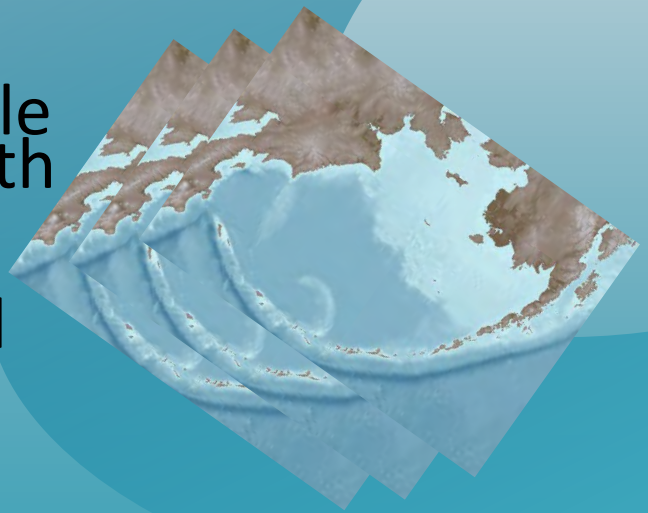
Tuned regional hindcast





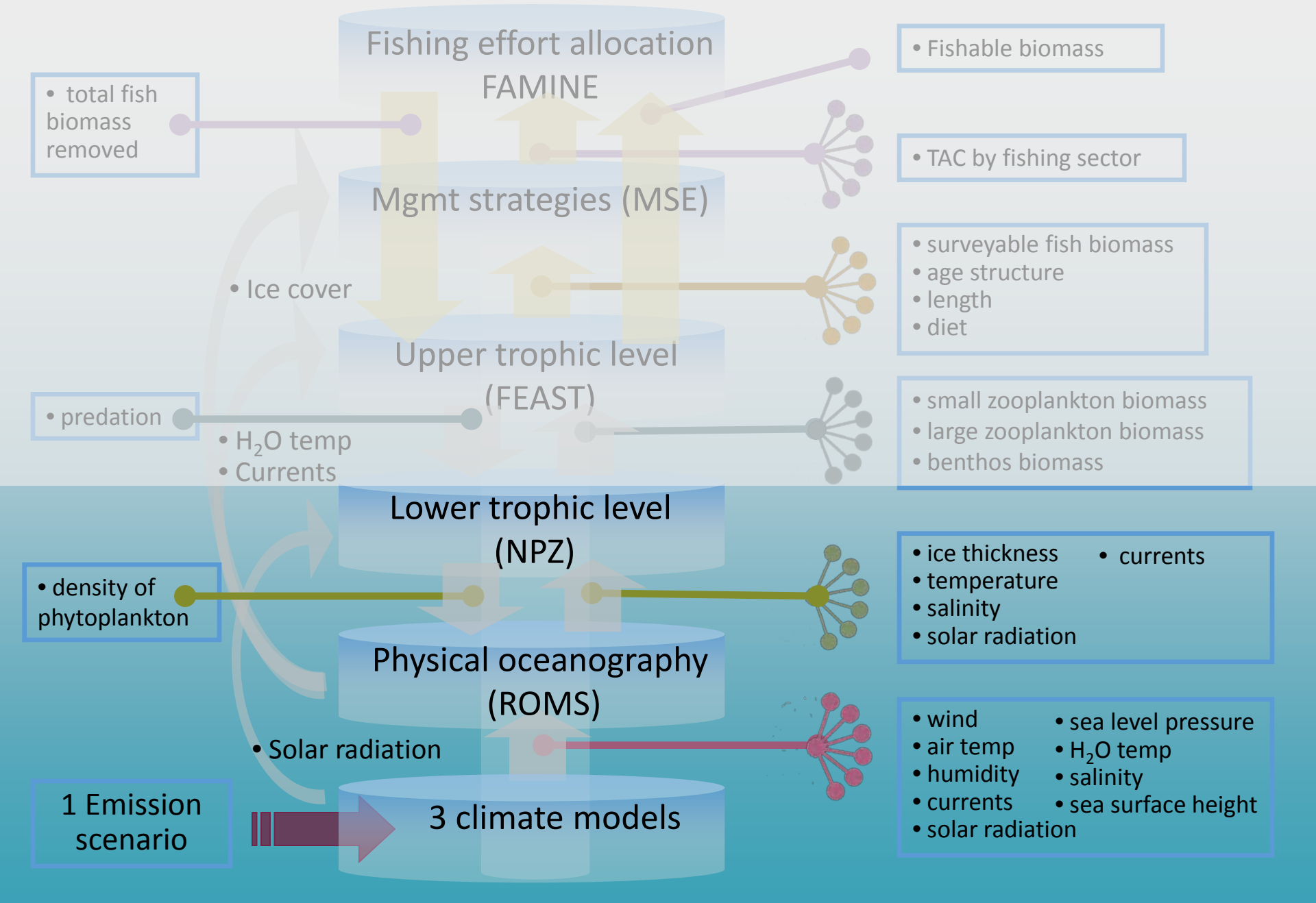
Define GCM performance criteria

Downscale GCMs with regional model and build forecasts library

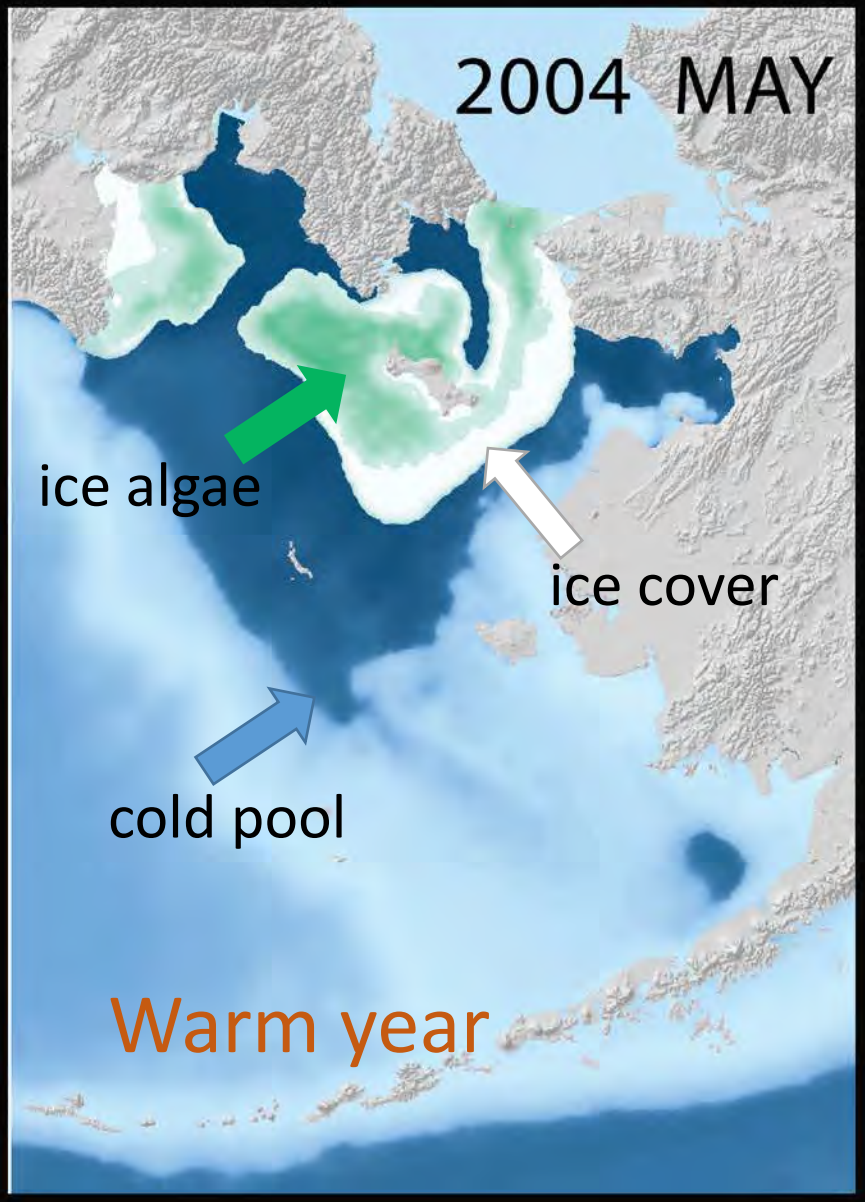


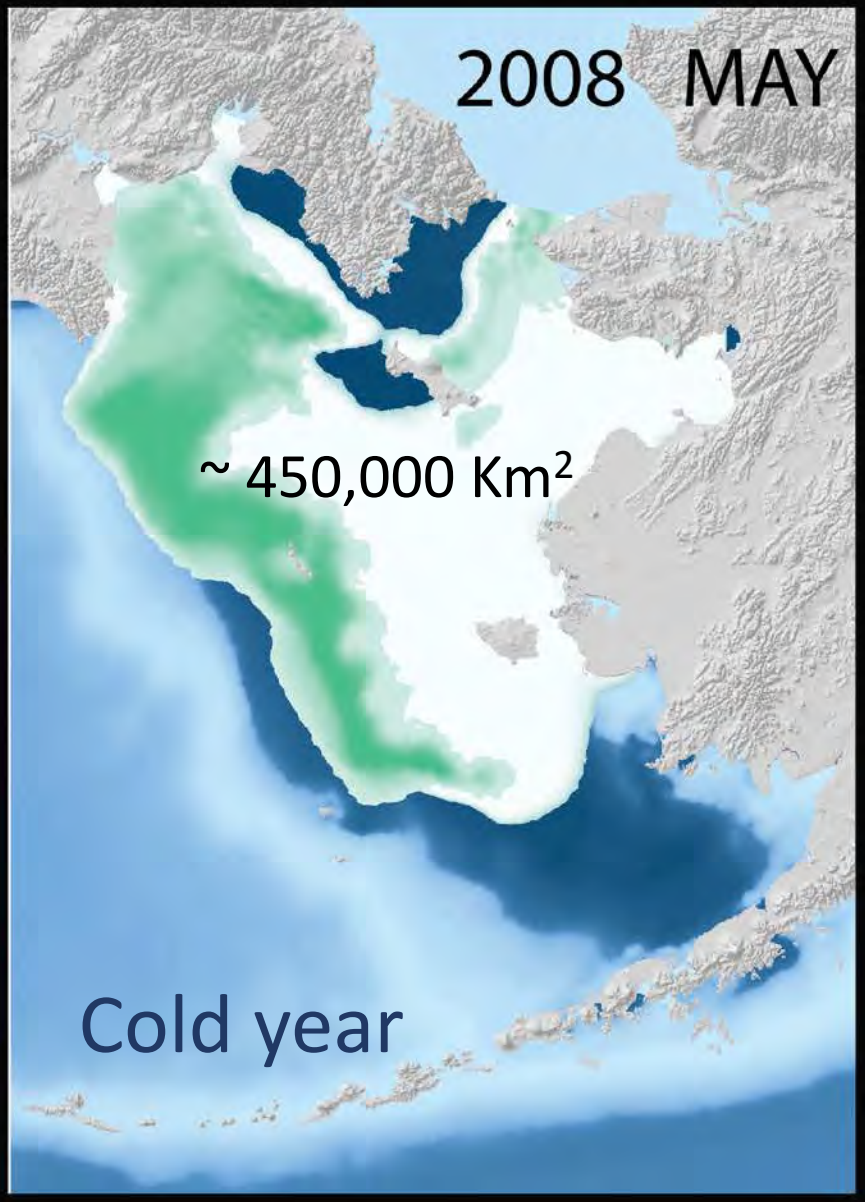
Select GCMs, RCP

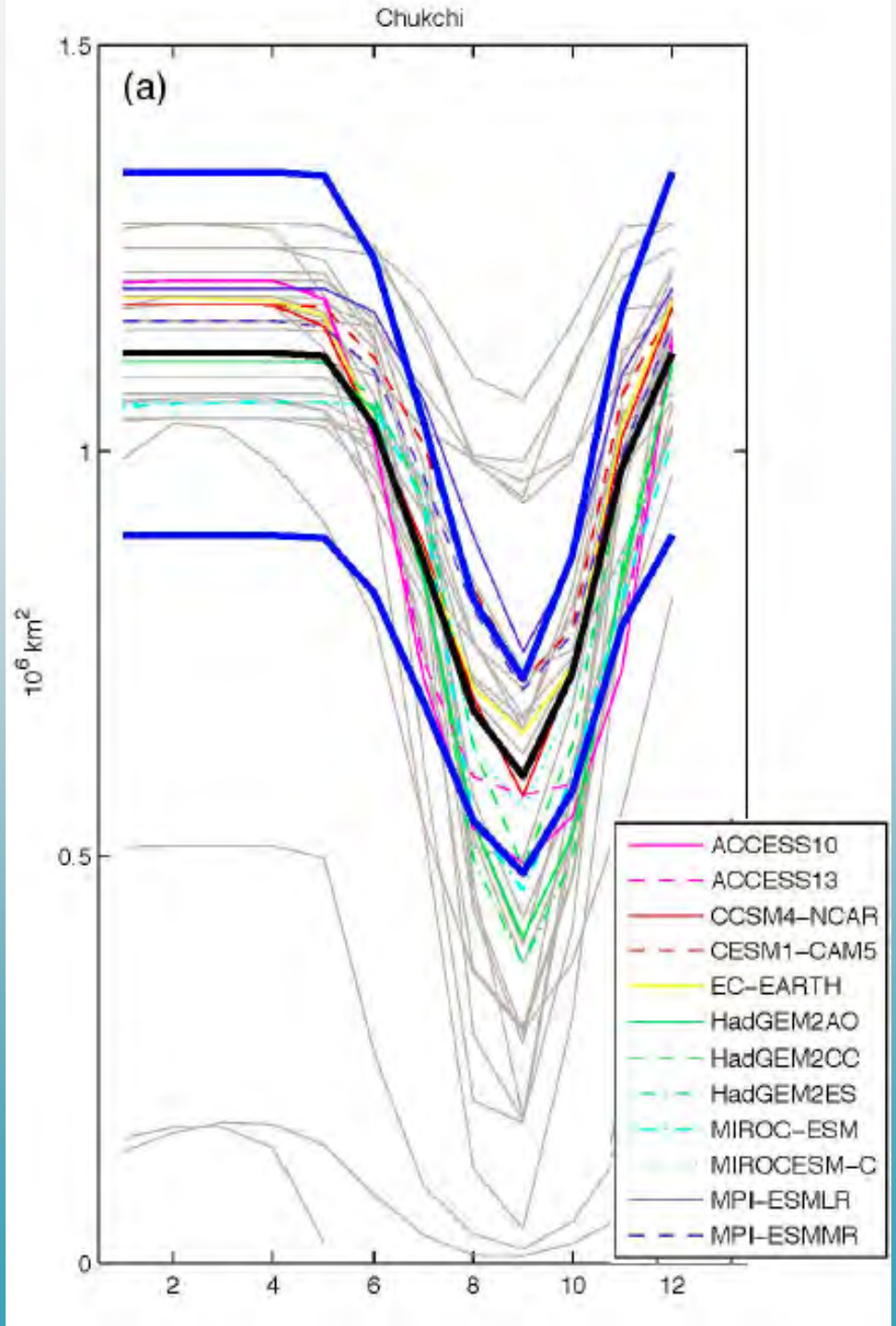
Bering10K-ROMS-BESTNPZ-FEAST-FAMINE



Bering10K-ROMS-BESTNPZ-HINDCAST





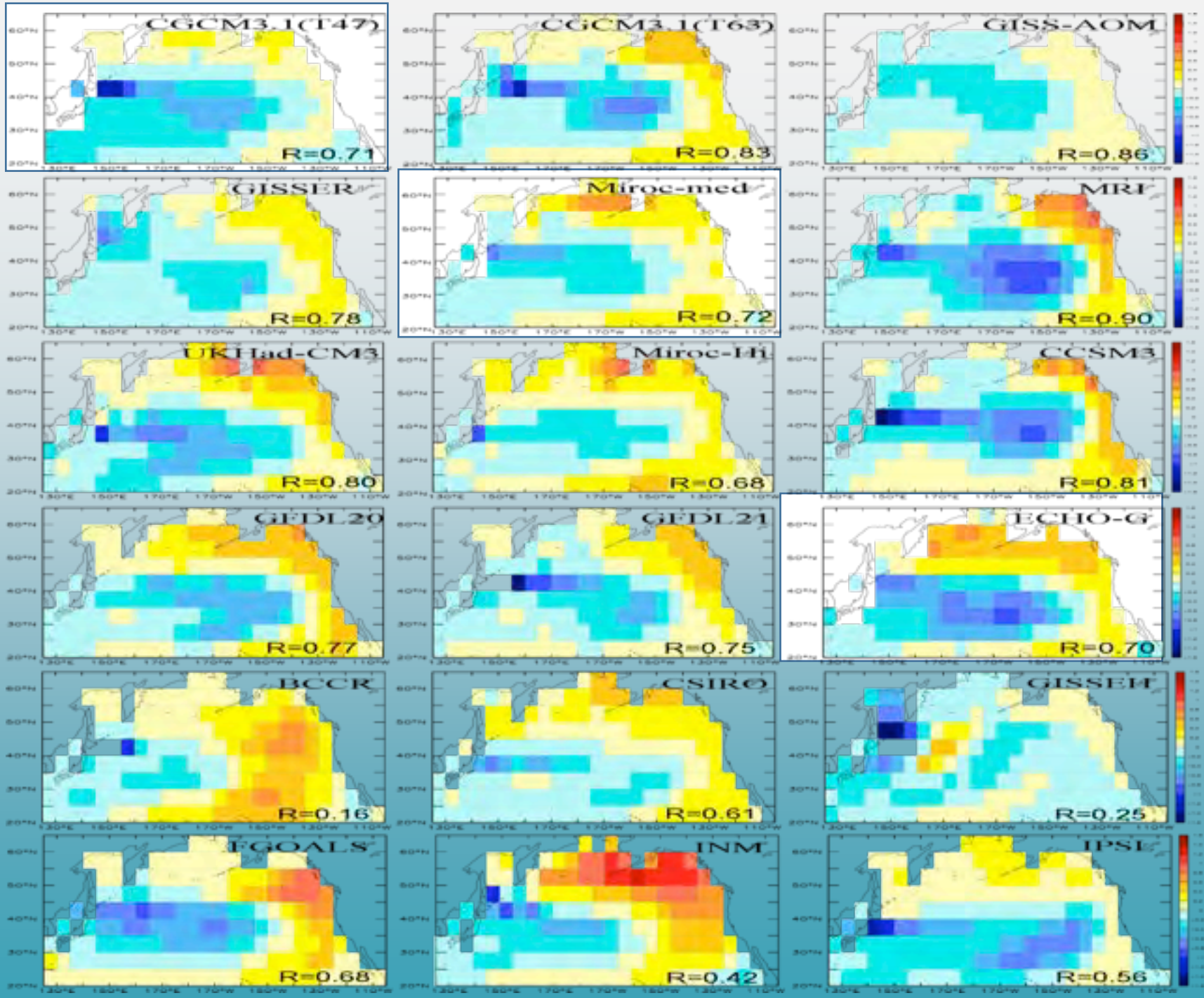


GCM model evaluation

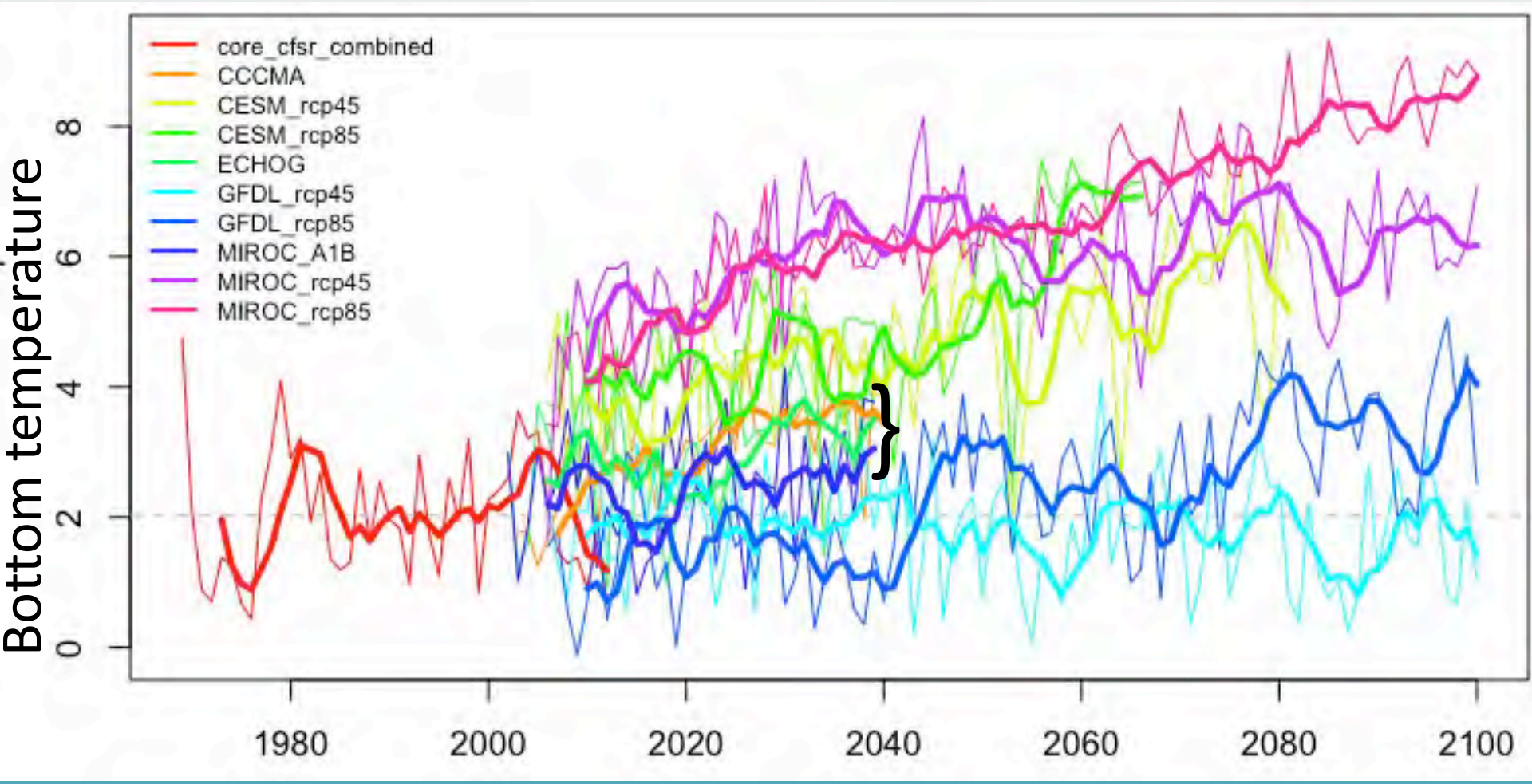
Criteria: capture key processes

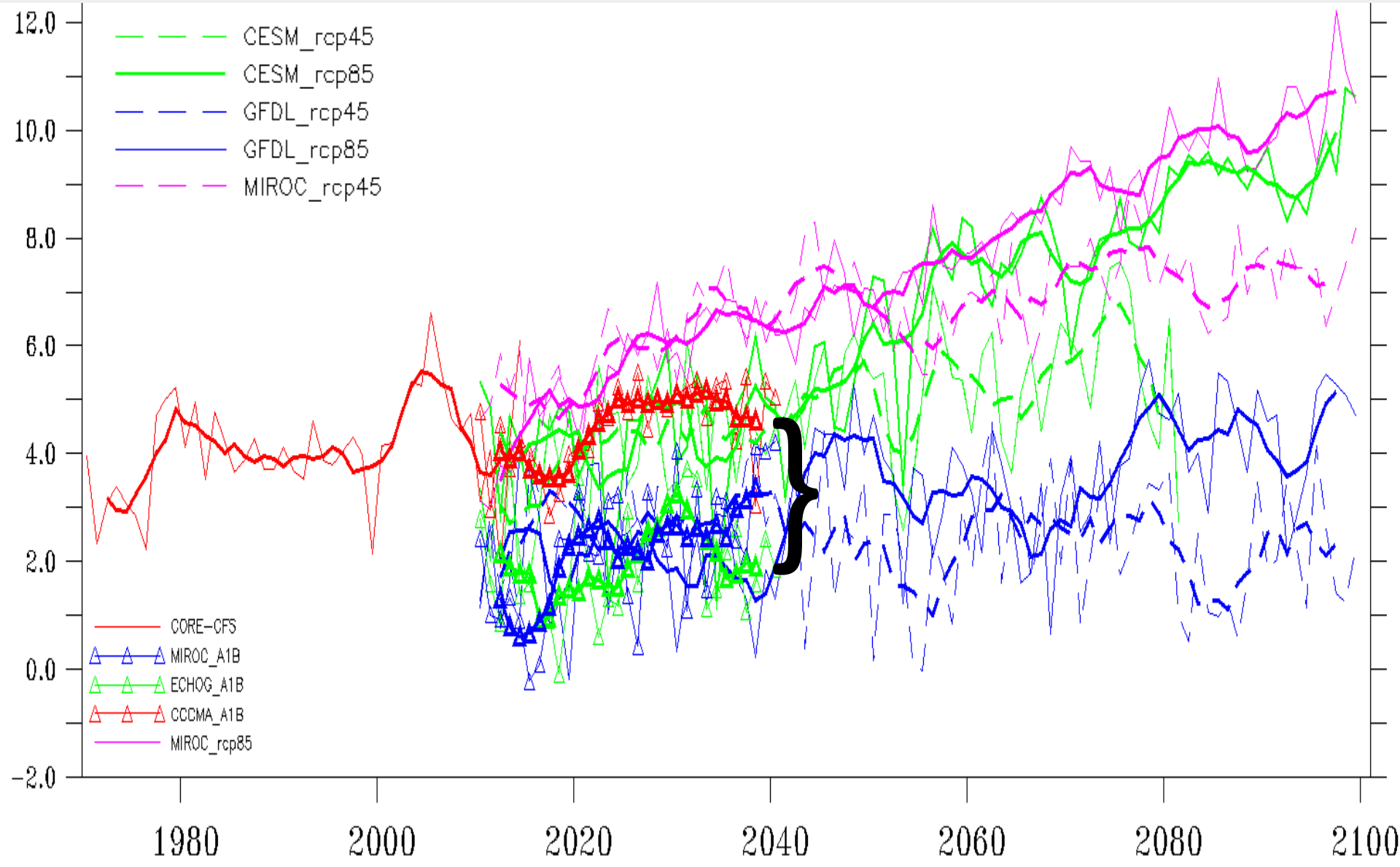
- Sea ice monthly climatology
  - within +/- 20%
- Select GCM models, RCPs, geochemical, nutrients…
- Downscale with regional model Bering10K-ROMS-BESTNPZ and build forecast library.

Wang and Overland et al., 2015, Projected future duration of the sea-ice-free season in the Alaskan Arctic. Prog. Oceanogr. 136: 50-59.

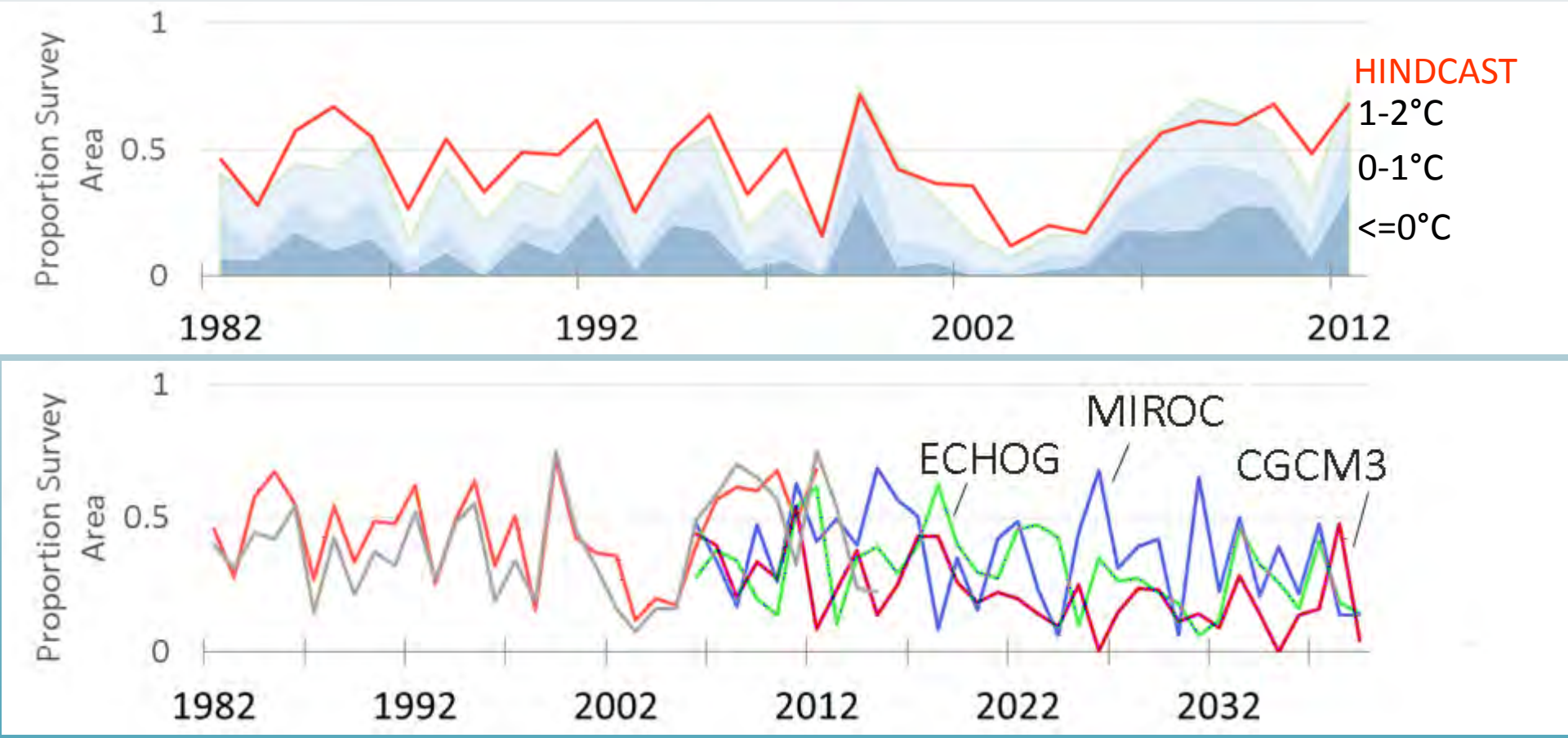

CGCM3.1(T47)
R=0.71
CGCM3.1(T63)
R=0.83
GISS-AOM
R=0.86
GISSER
R=0.78
Miroc-med
R=0.72
MRI
R=0.90
UKHad-CM3
R=0.80
Miroc-Hi
R=0.68
CCSM3
R=0.81
GFDL20
R=0.77
GFDL21
R=0.75
ECHO-G
R=0.70
BCCR
R=0.16
CSIRO
R=0.61
GISSEH
R=0.25
FGOALS
R=0.68
INM
R=0.42
IPSL
R=0.56

Robustness of approach: CMIP 3 vs CMIP5

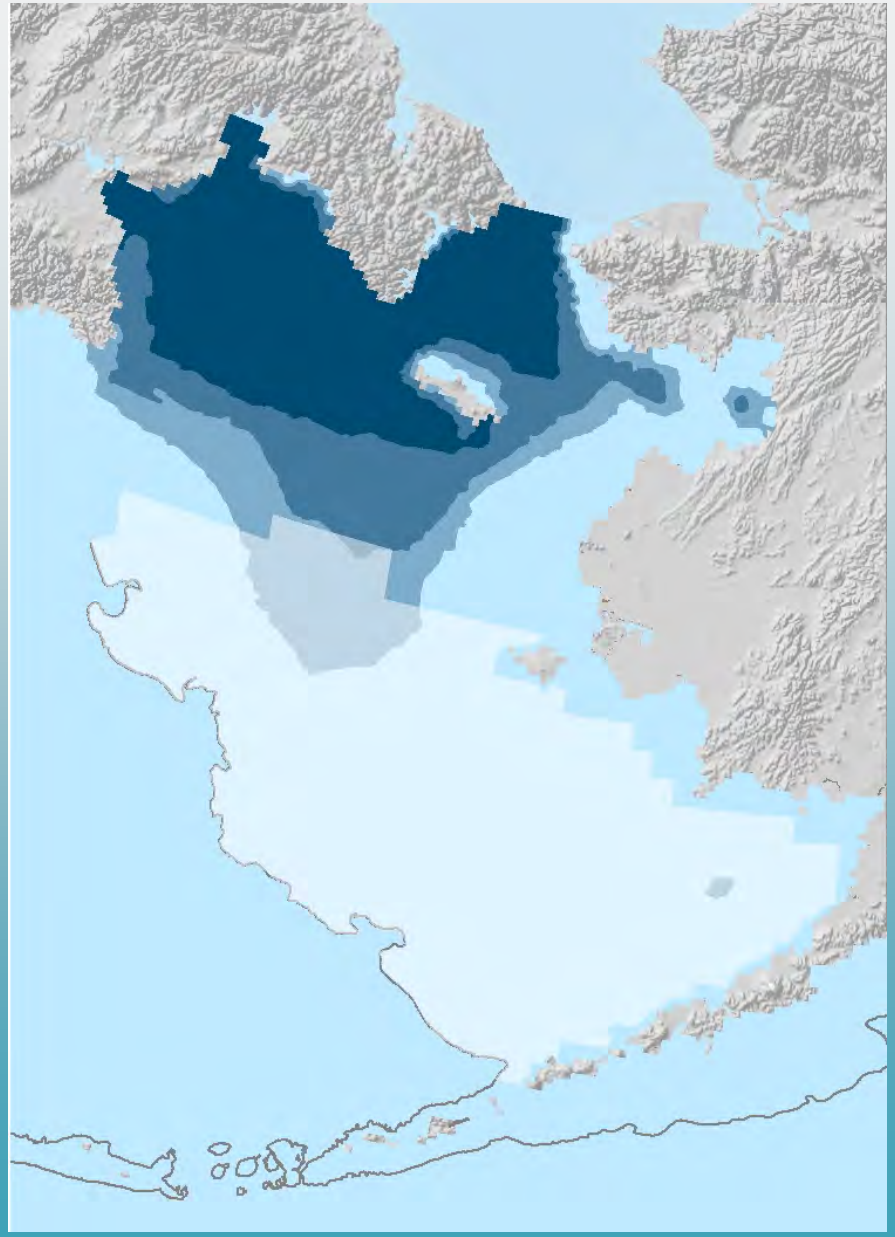



CESM_rcp45
CESM_rcp85
GFDL_rcp45
GFDL_rcp85
MIROC_rcp45
CORE-CFS
MIROC_A1B
ECHOG_A1B
CCCMA_A1B
MIROC_rcp85
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
1980
2000
2020
2040
2060
2080
2100

Downscaled forecast product:
Indicator: cold pool, area where T<2°C, CMIP3 A1B



Cold pool T< 2, 1, 0, °C



Days past Mar-15 when sea ice cover > 10% in box

Conclusions

- Robust ensemble approach (with vetted models)
- Spatial reference is key factor for indicator
- Indicator needs to be robust to climate change trends, irrespective of magnitude or rate of change

Downscaled forecast product:
Essential Fish Habitat in Alaska under future climate

Essential Fish Habitat in Alaska

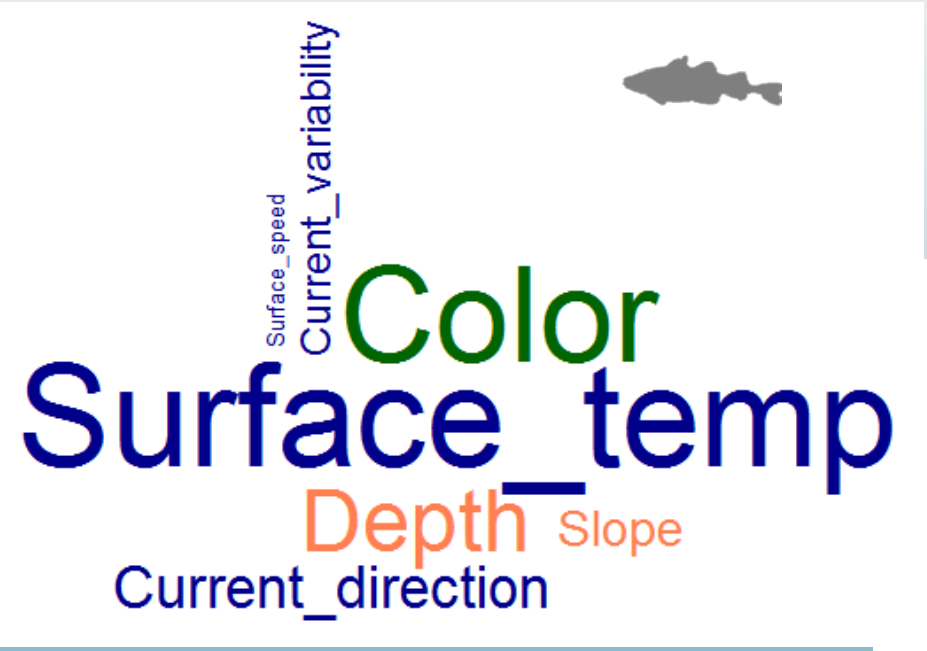
- EFH can trigger management actions
- Distribution models developed to improve EFH Descriptions from Tier 0 (no information) and Tier 1 (presence information) to Tier 1 & Tier 2 (density information by habitat)
- Standardized and repeatable method
- Use GAMS and forecasts to evaluate future EFH for 21 species

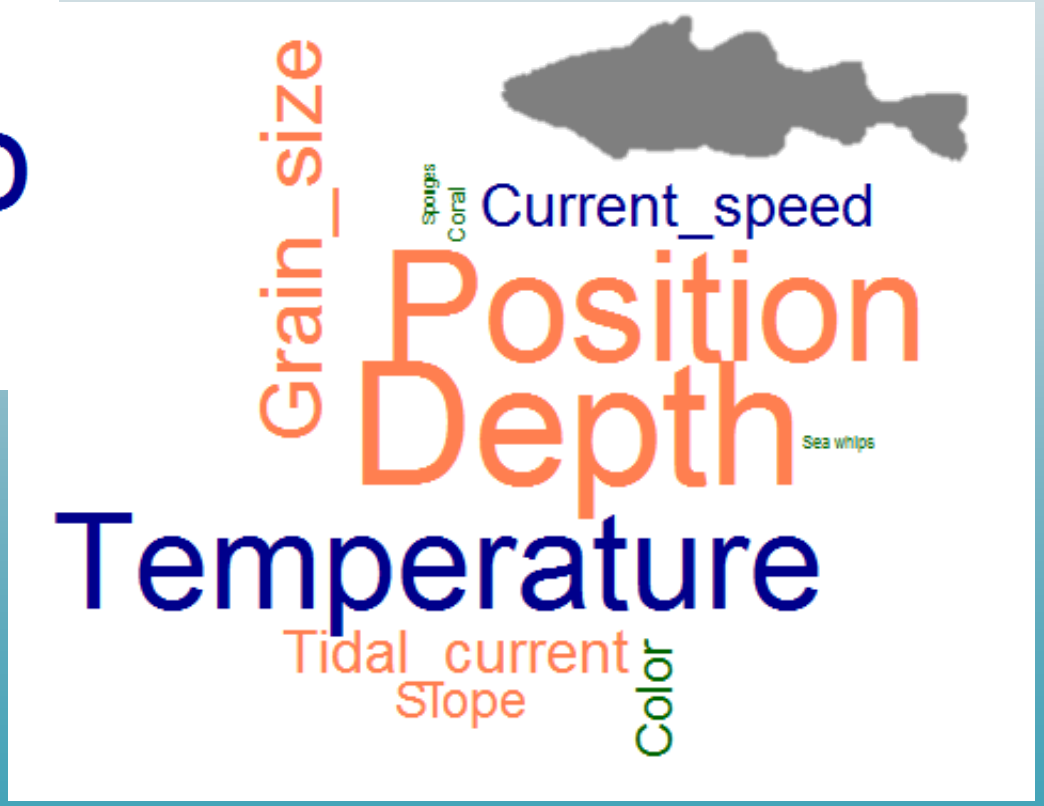
Generalized Additive Model

- latitude X longitude
- slope
- sediment grain size
- bathymetry
- tidal current maximum
- bottom temperature
- surface temperature
- bottom current speed
- surface current speed
- current direction
- current variability
- ocean color (satellite chl-a conc.)
- coral presence-absence
- sponge presence-absence
- sea whip & sea pen presence-absence

- Static features
- Dynamic physical ocean
- Dynamic biological

Quantitatively ranked factors for juv. & adults

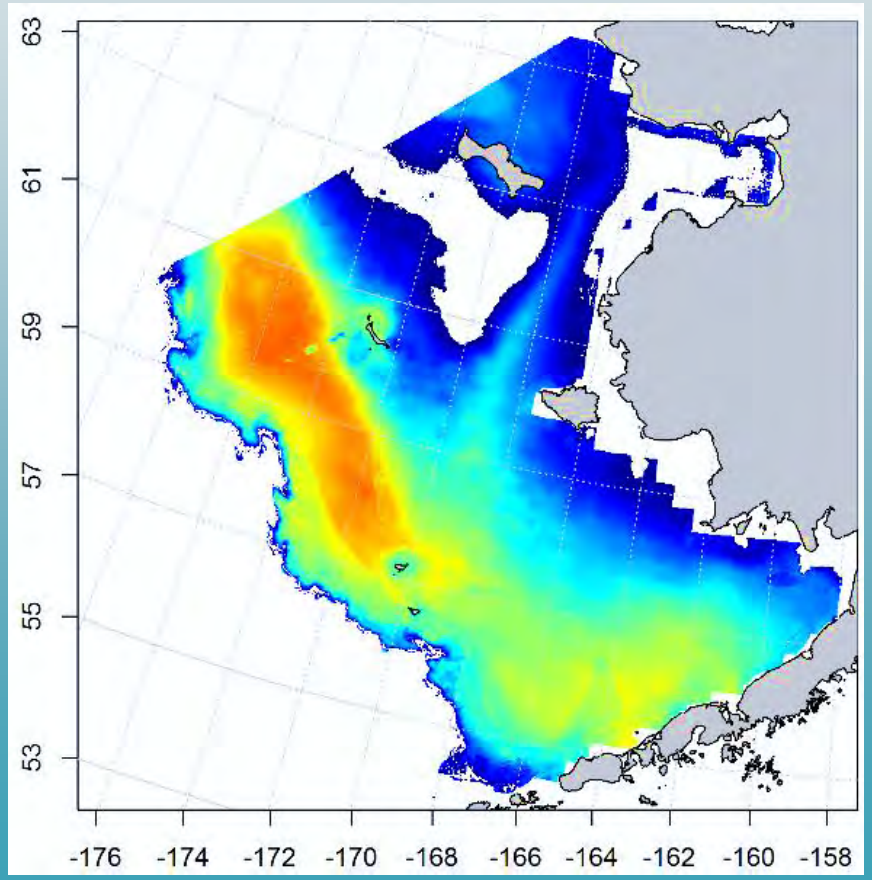




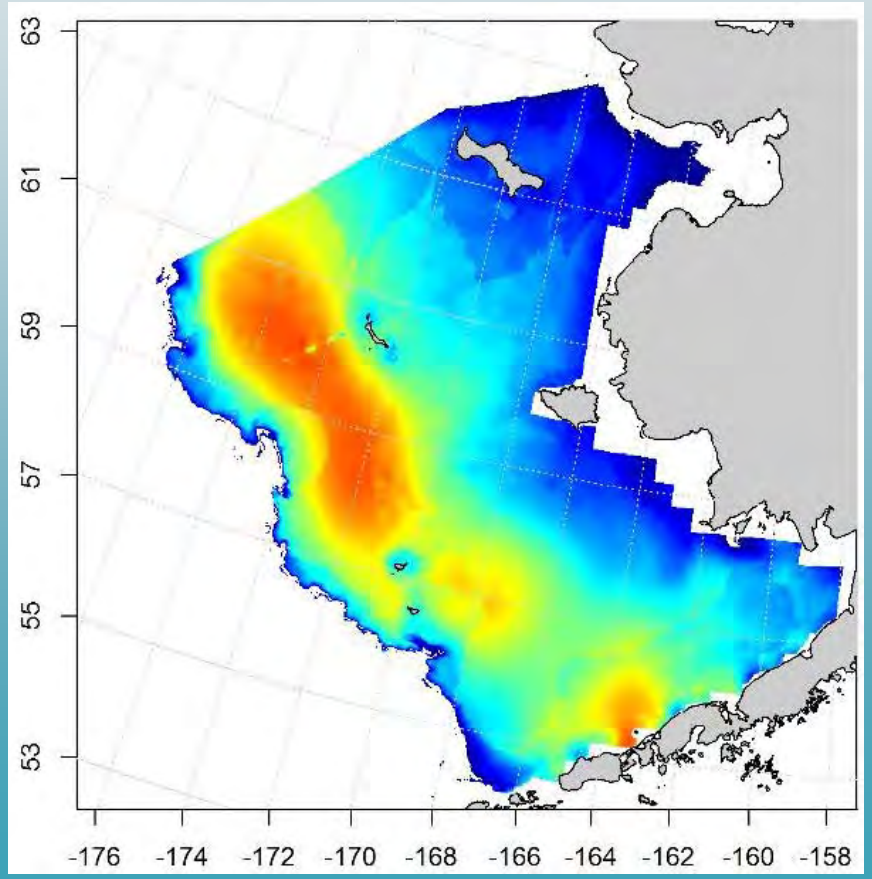
Run GAM with forecasted variables for future EFH

Example: walleye pollock

Current EFH 1982-2012

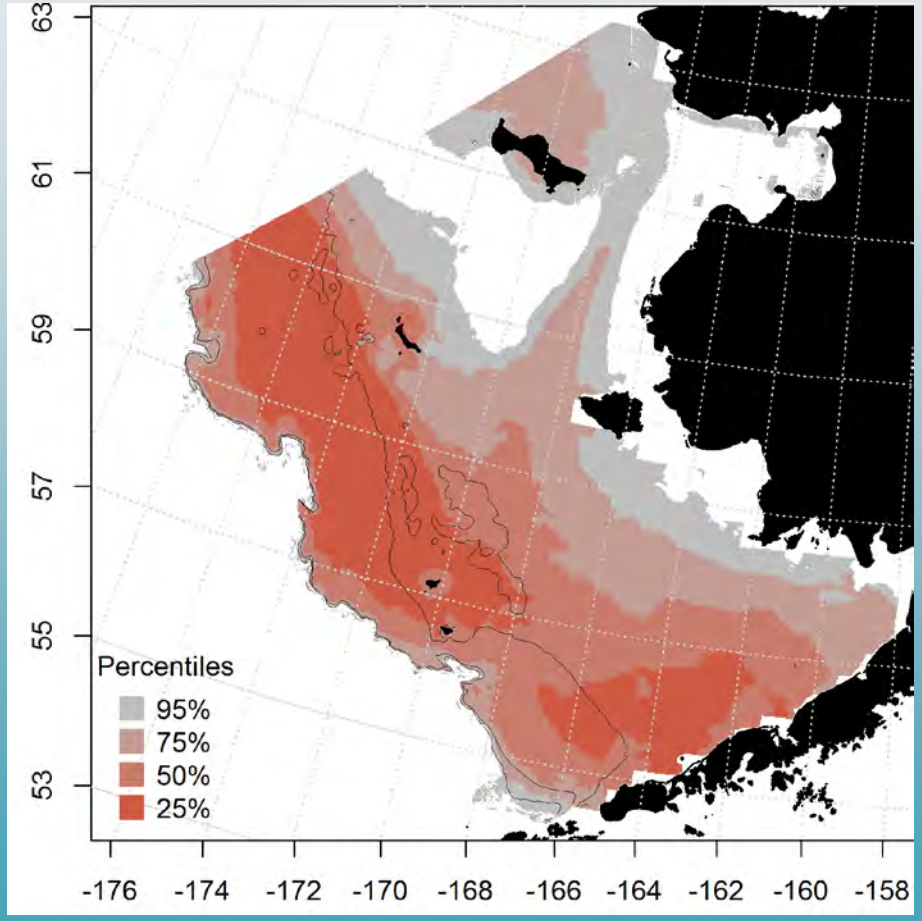


EFH 2039 CMIP3 (preliminary)

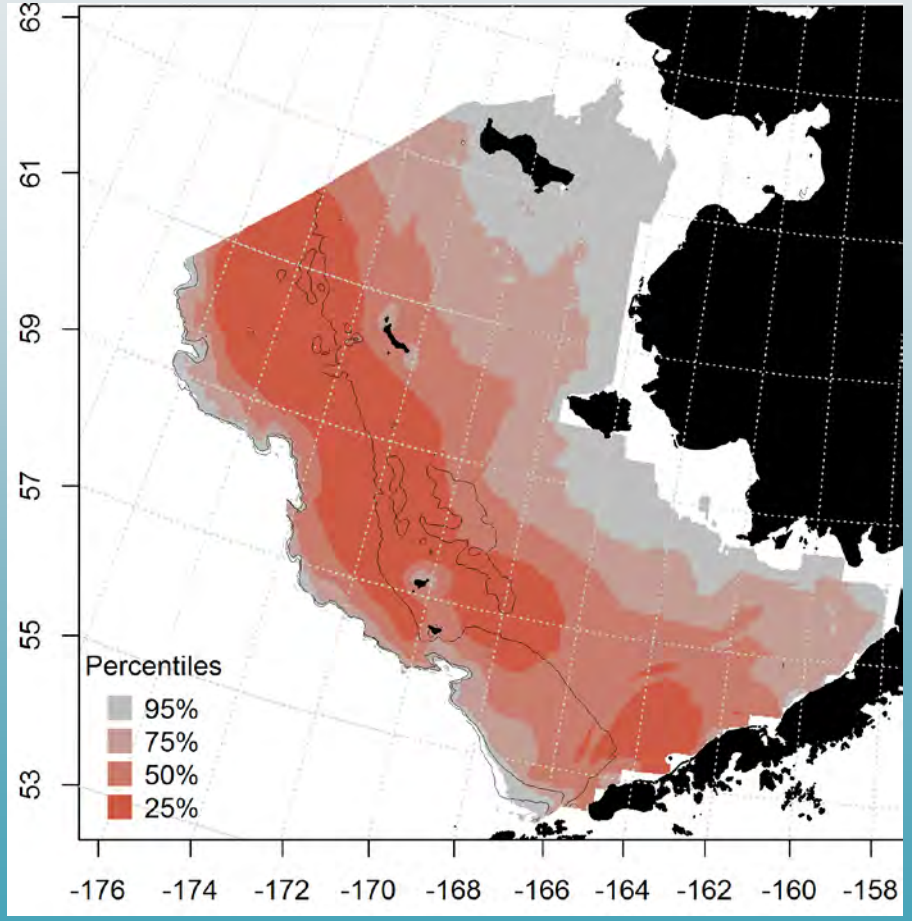


Run GAM with forecasted variables for future EFH

Example: walleye pollock



EFH 2030-40 CMIP3 (preliminary)



Conclusions

- Shifts retrospective EFH to cover potential future EFH
- Repeatable
- dynamic variables improve robustness against changing environmental landscape
- Test different periods to define EFH
- Programmatic use of models: expensive and timed, human factor limitation
- Policy use not the same as results from research

Next steps and applications

- Add CMIP5 (RCP 4.5, 8.5) forecasts to indicators and EFH
- Bias correction of forecasts
- 9 month predictions applications
- Part of upcoming Bering Sea Fisheries Ecosystem Plan
- Self-serve use of model output still challenging

Questions?

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