A new ocean model configuration for management of central North Pacific Marine Resources (MOM6-COBALT-HIC6kv1.0)

Gabriela Negrete García[1], Dax Matthews[2,3], Charles A. Stock[1], Brian Powell[2], Ryan R. Rykaczewski[3], Kisei Tanaka[3], Hannah Barkley[3], Tobias Friedrich[2], Jessica Y. Luo[1], Andrew C. Ross[1], Yi-Cheng Teng[1]

[1]NOAA/OAR/GFDL, 201 Forrestal Rd, Princeton, NJ 08540
[2]Department of Oceanography, University of Hawai`i at Manoa, 1000 Pope Road, Marine Sciences Building, Honolulu, HI 96822
[3] Pacific Islands Fisheries Science Center, 1845 Wasp Boulevard Building 176, Honolulu HI 96818

Correspondence to: Gabriela Negrete García (Gabriela.Negrete@noaa.gov)

Supplementary Figures

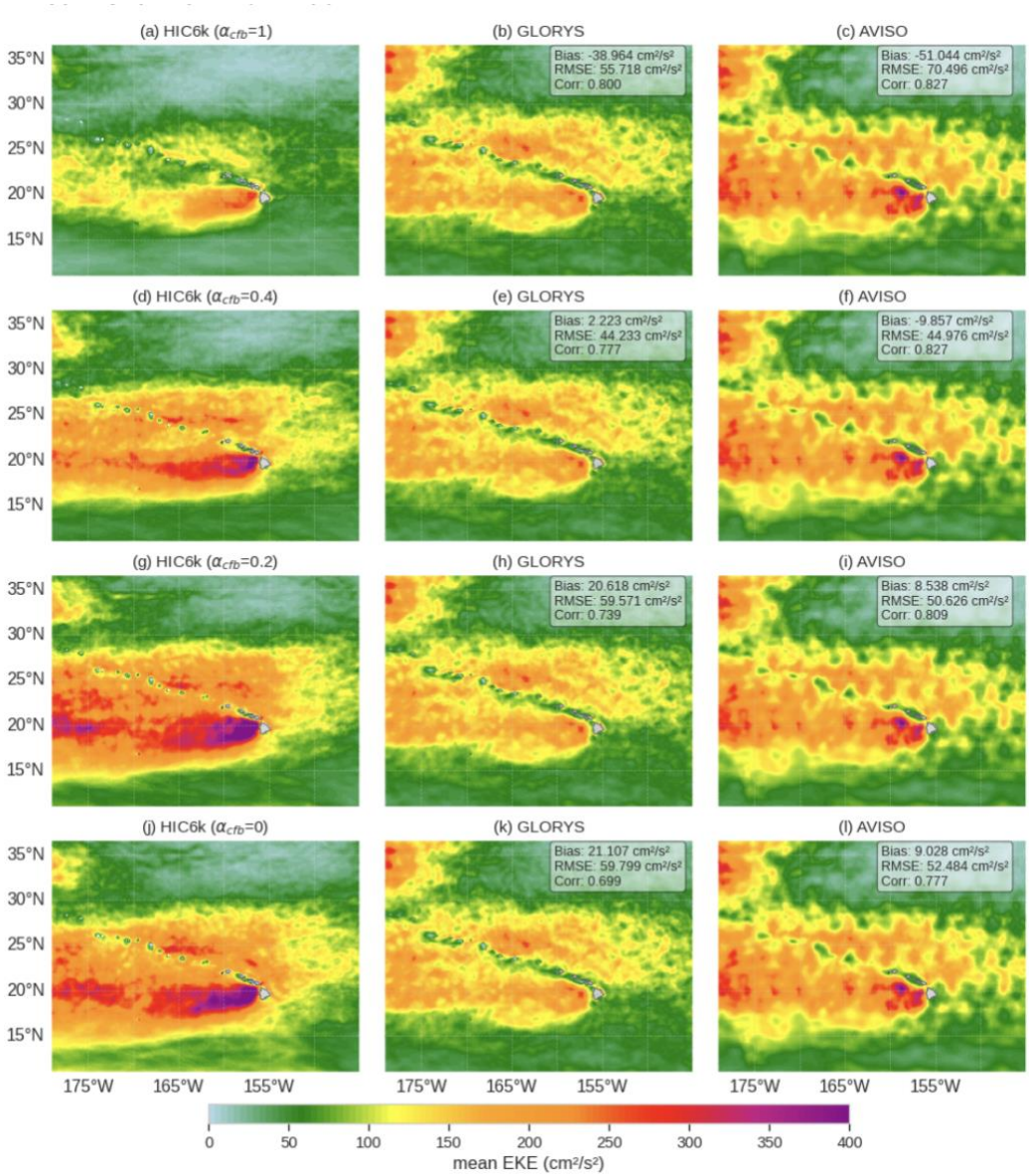

Figure S1. Mean eddy kinetic energy (EKE; cm²/s²) derived from geostrophic velocities averaged over 1993-2000, comparing four HIC6k model configurations against GLORYS12 reanalysis and AVISO altimetry observations. Rows correspond to model simulations with decreasing current strength (a-c) αcfb=1 (full current feedback), (d-f) αcfb=0.4, (g-i) αcfb=0.2, and (g-i) αcfb=0 (no current feedback). For each row the left column shows the model, the center panel shows GLORYS, and the right panel shows AVISO, with the bias, RMSE, and spatial correlation of the model relative to each observational product annotated in the upper right.

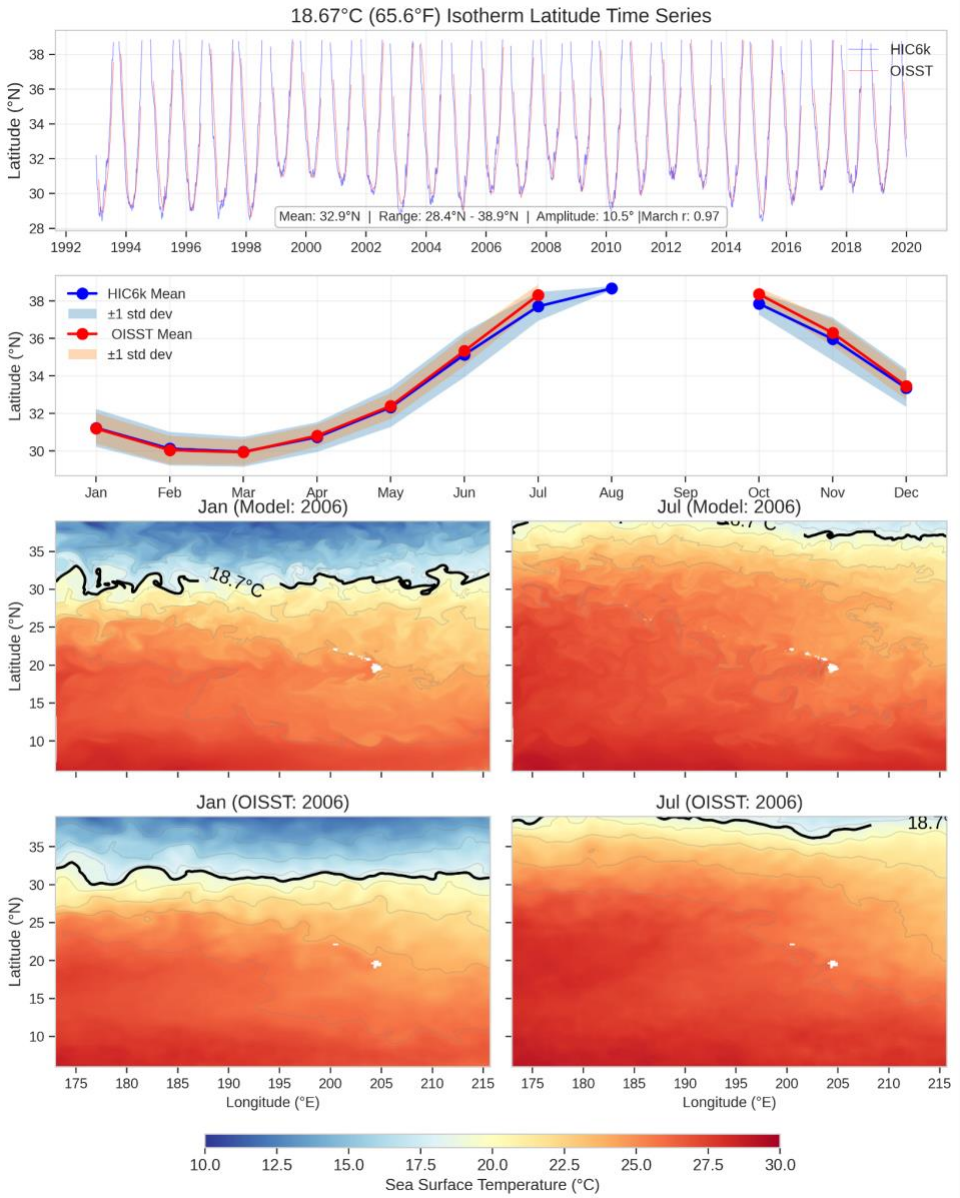

Figure S2. Comparison of the 18.67°C (65.6°F) sea surface temperature isotherm latitude between the HIC6k regional ocean model and OISST satellite observations. (Top) Time series of the daily latitudinal position of the 18.67°C isotherm from 1992–2020, with HIC6k (blue) and OISST (orange) showing strong agreement (March r = 0.97) and a mean isotherm latitude of 32.9°N, ranging from 28.4°N to 38.9°N with a seasonal amplitude of 10.5°. (Middle) Mean seasonal cycle of isotherm latitude for HIC6k (blue, ±1 std dev shading) and OISST (red, ±1 std dev shading), with the isotherm reaching its southernmost extent in February–March (~30°N) and northernmost extent in August (~38°N). (Bottom) Spatial maps of SST with the 18.67°C isotherm (bold black contour) shown for January and July of 2006 for HIC6k (middle row) and OISST (bottom row), illustrating the seasonal meridional migration of the isotherm across the central North Pacific. Shared colorbar indicates SST in °C.

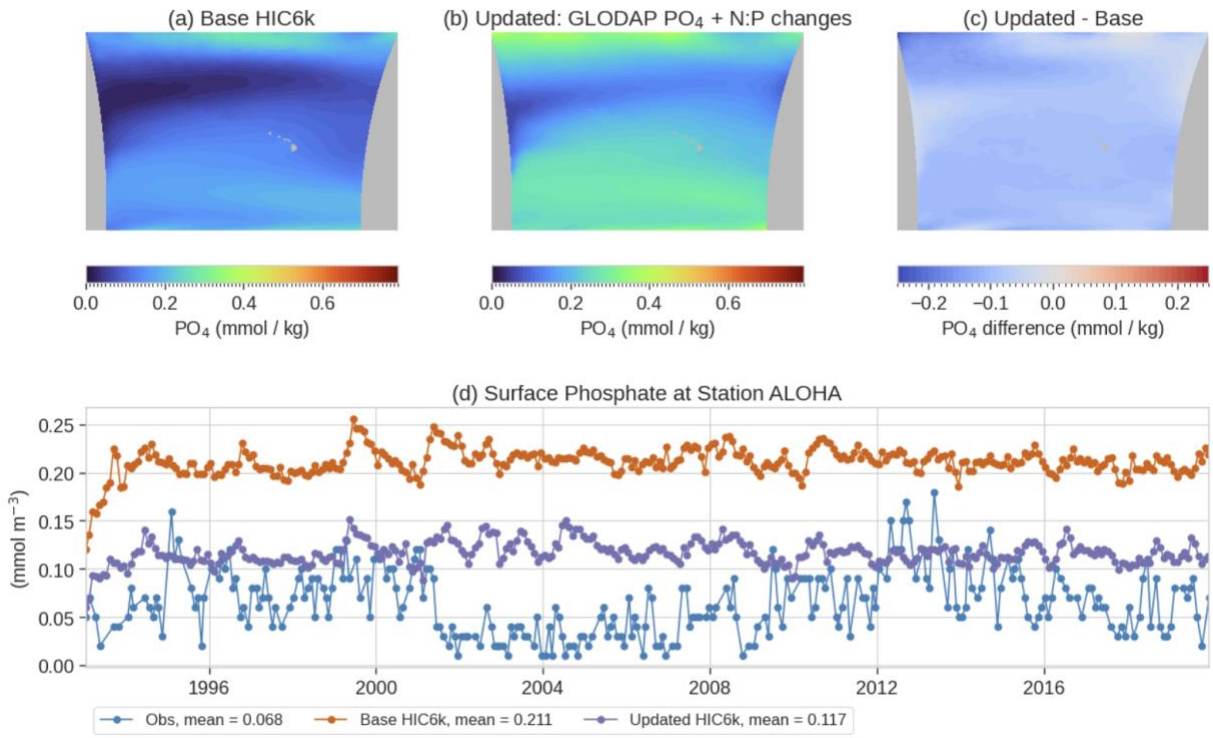

Figure S3. Impact of updated boundary conditions and N:P ratios on surface phosphate. Annual-mean surface PO_4 (mmol kg^{-1}) from (a) the Base HIC6k simulation and (b) the updated HIC6k simulation incorporating GLODAP-derived boundary conditions and adjusted N:P ratios. (c) Difference in annual-mean surface PO_4 between the updated and base simulations (Updated – Base). (d) Monthly surface PO_4 at Station ALOHA from observations (blue), the Base HIC6k simulation (orange), and the updated HIC6k simulation (purple) over the full model period. Mean values across the record are indicated in the legend.

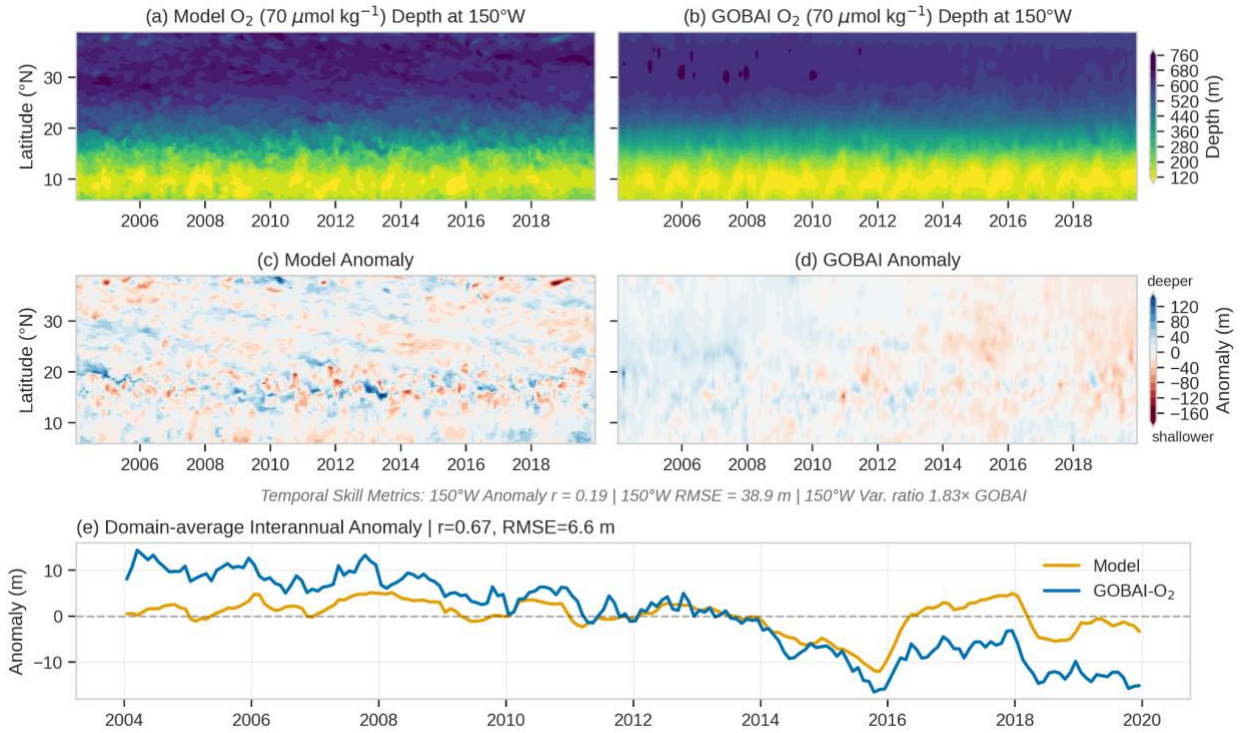

Figure S4. Hovmöller diagrams and domain-average time series of oxycline depth (70 µmol kg⁻¹ O_2 isoline) along 150°W for 2004–2019. (a-b) Oxycline depth for the model and GOBAI-O_2, respectively, (c–d) Interannual anomalies relative to the monthly climatology for the model and GOBAI-O_2, with positive (blue) values indicating a deeper-than-normal oxycline and negative (red) values indicating a shallower-than-normal oxycline. Temporal skill metrics at 150°W: anomaly correlation r = 0.19, RMSE = 38.9 m, and model variability 1.83× GOBAI-O_2. (e) Domain-average interannual anomaly time series after removal of the monthly seasonal cycle, showing the model (yellow) and GOBAI-O_2 (blue); domain-average correlation r = 0.67 and RMSE = 6.6 m.

Parameter	Name	Units	Value	Default
P:N minimum ratios				
p_2_n_min_Sm	minimum small phytoplankton P:N ratio	mol P mol N^{-1}	0.04 (1/25)	0.032 (1/31)
p_2_n_min_Md	minimum medium phytoplankton P:N ratio	mol P mol N^{-1}	0.05 (1/20)	0.032 (1/31)
p_2_n_min_Lg	minimum large phytoplankton P:N ratio	mol P mol N^{-1}	0.0625 (1/16)	0.032 (1/31)
P:N maximum ratios				
p_2_n_max_Sm	maximum small phytoplankton P:N ratio	mol P mol N^{-1}	0.0625 (1/16)	0.05 (1/20)
p_2_n_max_Md	maximum medium phytoplankton P:N ratio	mol P mol N^{-1}	0.0714 (1/14)	0.0625 (1/16)
p_2_n_max_Lg	maximum large phytoplankton P:N ratio	mol P mol N^{-1}	0.0833 (1/12)	0.0714 (1/14)
p_2_n_max_Di	maximum diazotroph P:N ratio	mol P mol N^{-1}	0.05 (1/20)	0.025 (1/40)
P:N Slope Parameters				
p_2_n_slope_Sm	increase in small phytoplankton P:N ratio per unit phosphate concentration	mol P mol N^{-1}	4.60E+04	4.80E+04
p_2_n_slope_Md	increase in medium phytoplankton P:N ratio per unit phosphate concentration	mol P mol N^{-1}	4.60E+04	4.80E+04
p_2_n_slope_Lg	increase in large phytoplankton P:N ratio per unit phosphate concentration	mol P mol N^{-1}	4.60E+04	4.80E+04
p_2_n_slope_Di	increase in diazotroph phytoplankton P:N ratio per unit phosphate concentration	mol P mol N^{-1}	4.60E+04	0

Table S1. COBALTv3 Parameter Adjustments for HIC6k Simulation.