The Short-Term Climate Prediction System FIO-CPS v2.0 and its Prediction Skill in ENSO

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Summary

The First Institute of Oceanography-Climate Prediction System (FIO-CPS), built on a climate model with the oceanic observation initialization, has been updated from version 1.0 to 2.0, with a finer resolution and more reasonable physical processes. Hindcast experiments were conducted using FIO-CPS v1.0 and v2.0, and their prediction abilities based on 27 years (1993 to 2019) experiment data were analyzed. The results show that the sea surface temperature (SST) biases over the eastern Pacific and the Southern Ocean are improved in the initial condition of FIO-CPS v2.0. Moreover, this new system has a higher skill for predicting El Niño-Southern Oscillation (ENSO). The improvement in the annual mean SST prediction over the Equatorial Pacific mainly contributes to the enhanced ENSO prediction skill in FIO-CPS v2.0. It indicates that a state-of-the-art climate model with a well-simulated mean state is critical in improving the prediction skill on the seasonal time scale.

Model and experiments

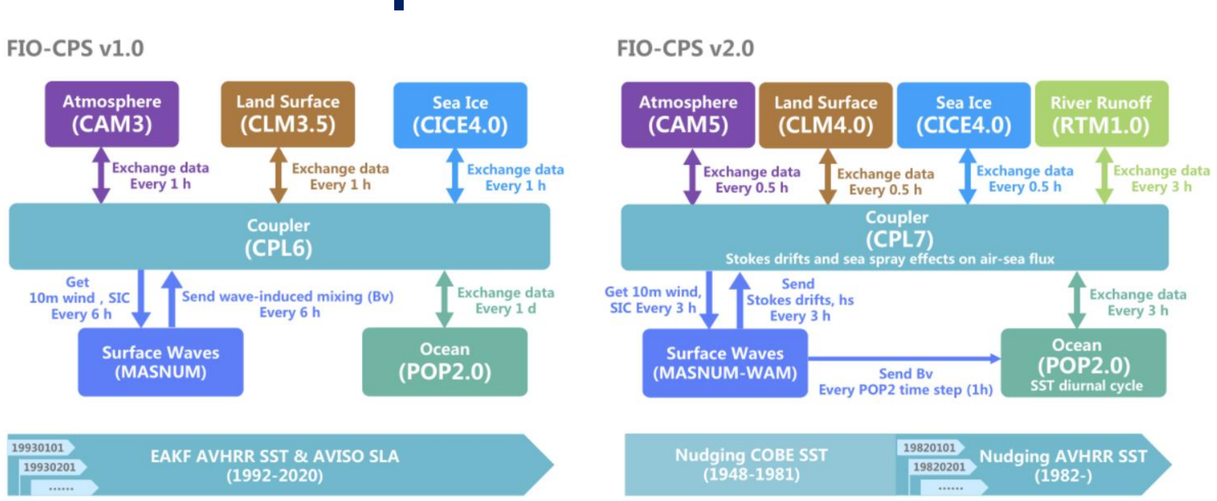

FIGURE 1 | Flowcharts for FIO-CPS v1.0 and FIO-CPS v2.0

The FIO-CPS has been updated from version 1.0 to 2.0, accompanied by fines in the horizontal-vertical resolution and improved physical processes. Three other distinctive physical processes related to air-sea interactions, including the effect of the Stokes drift, the sea spray, and the SST diurnal cycle, were included in FIO-ESM v2.0. FIO-CPS v1.0 uses the ensemble adjustment Kalman filter (EAKF) method to assimilate the daily SST and sea level anomaly for the initialization. In FIO-CPS v2.0, the assimilation experiment was started from 1948 to acquire more stable results. With one ensemble simulation, the nudging approach was utilized to consider the ocean satellite observations in the initial conditions.

Result

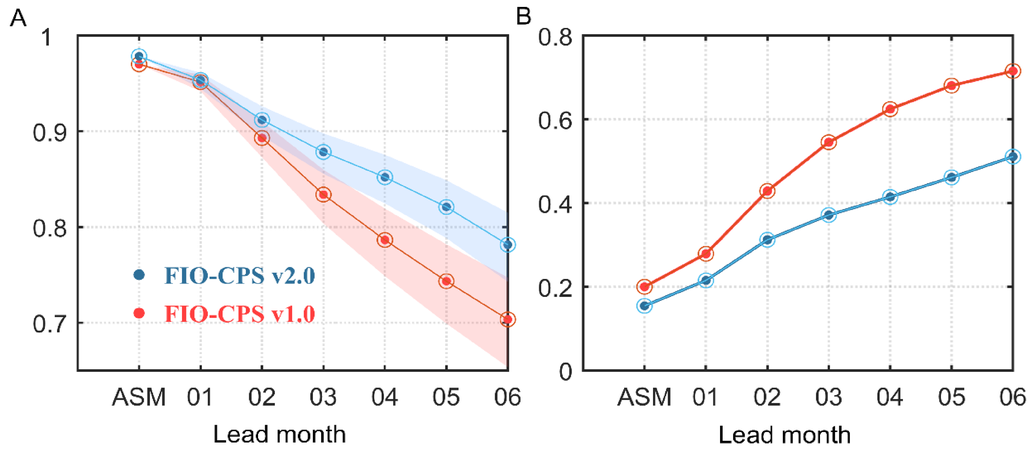

FIGURE 2 | (A) ACC and (B) RMSE of the Niño 3.4 index between the OISST v2.1 and the simulation for 1993–2019. The red and blue lines represent the assimilated and predicted results of FIO-CPS v1.0 and FIO-CPS v2.0 for 1-month to 6-month lead times, and the shaded area in (A) indicates the 95% confidence interval.

The prediction skill represented by the anomaly correlation coefficient (ACC) of the Niño3.4 index is greater than 0.78 at the 6-month lead time, which increases by 11.09% compared to the value of 0.70 in FIO-CPS v1.0. The root mean square error (RMSE) decreases by 0.20, which accounts for 28.59% of the FIO-CPS v1.0 result. Furthermore, the improvement of the prediction skill changes seasonally, featured by the ACC significantly increasing in the boreal winter and early spring.

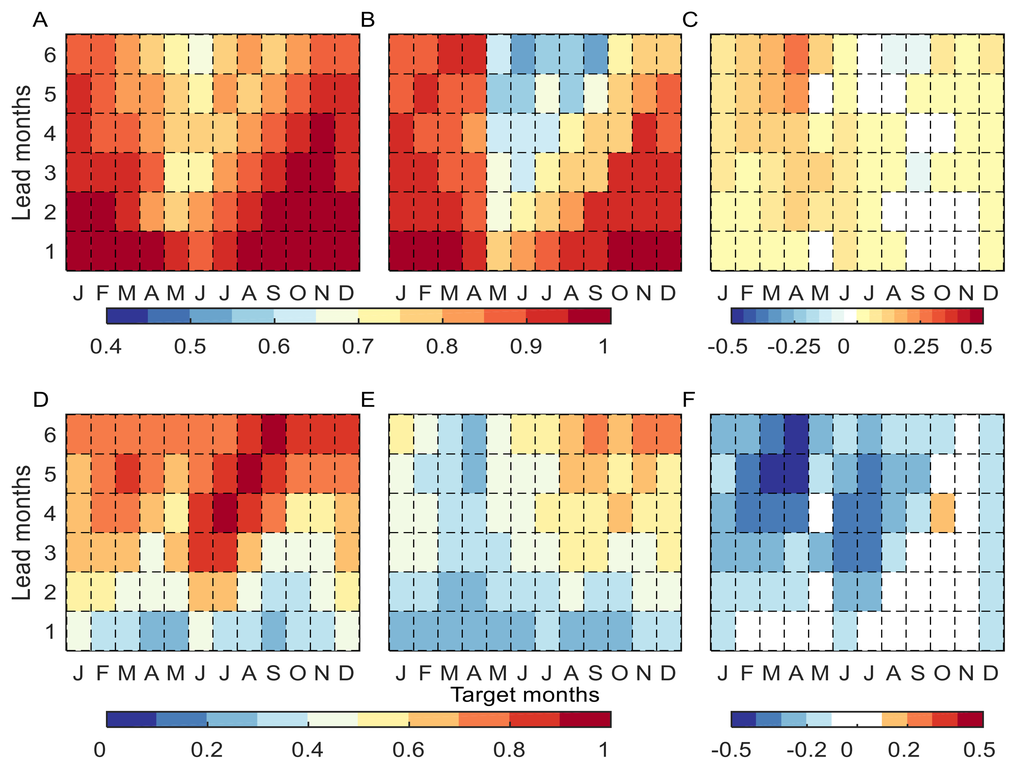

FIGURE 3 | ACC and RMSE of the Niño 3.4 SSTA as a function of the target month and lead month obtained using the (A, D) FIO-CPS v1.0; (B, E) FIO-CPS v2.0; (C, F) the differences between FIO-CPS v2.0 and FIO-CPS v1.0.

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