Annual to decadal prediction system

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Introduction:

Decadal climate prediction is a relatively new line of research, getting momentum within the climate community, as well as in the climate services arena (e.g., Bojovic et al., 2019).

The ability to provide meaningful decadal predictions using dynamical models has yet to be firmly established, but pioneering efforts at initialized coupled ocean-atmosphere 10-yr predictions have begun (Meehl et al., 2009, Smith et al. 2007; Keenlyside et al. 2008; Pohlmann et al. 2009).

Focusing on the climate conditions over the next 10 to 30 years decadal prediction bridges the gap between seasonal/interannual and long-term climate projections (Meehl et al., 2009).

Initializing Climate models offers the potential to predict internal variability in addition to externally forced climate change on decadal time scales and is thought to be at the heart of the decadal prediction problem. However, providing skilful decadal predictions using coupled models, especially for the TIO and adjacent regions is of great importance but is a grey area and need special attention.

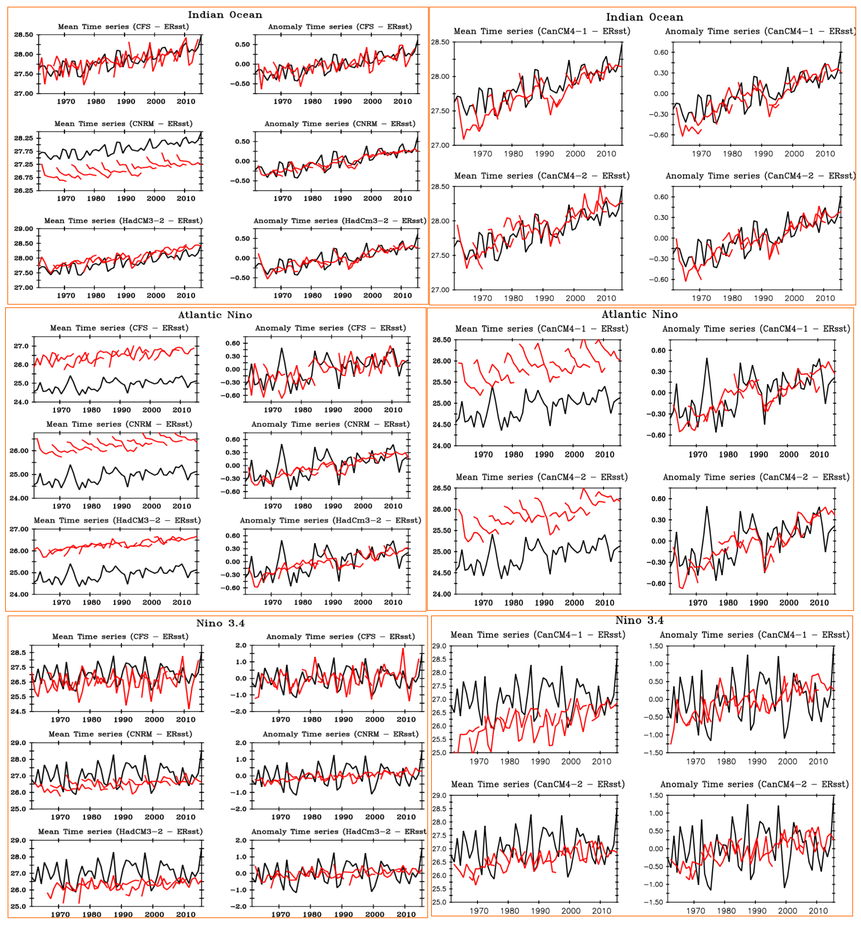
Objectives:

Study the skill of SST and SLA decadal prediction from the CMIP5 and CFS models over the global ocean with special emphasis to Tropical Indian Ocean.

Development of in-house decadal prediction system based on CFS modelling system

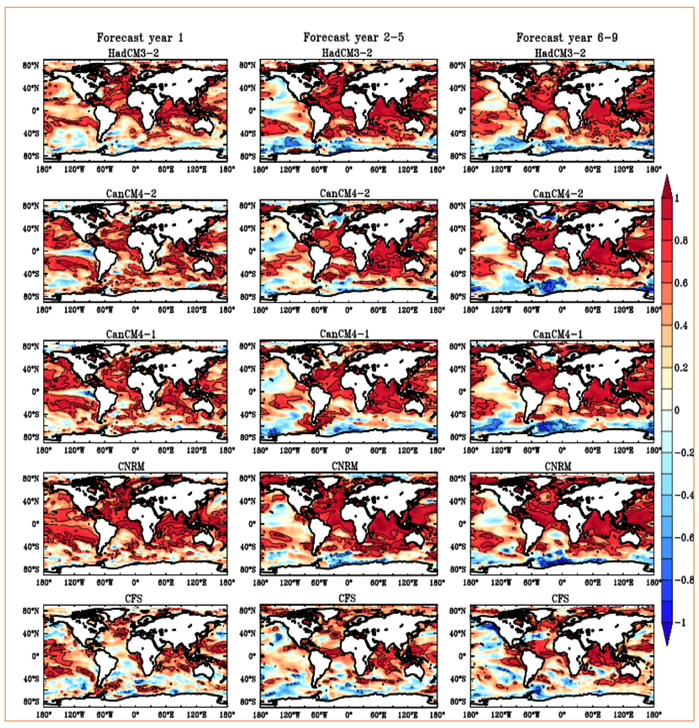
Data Used : ERSST Observational data, ORAS4 Sea level data, CMIP5 model (CFS ,CNRM,CanCM4-1,2,HadCM3-2) decadal prediction, CFS reanalysis to initialise decadal prediction system.

Time series of predicted and observed SST and SST anomaly from CMIP5 models



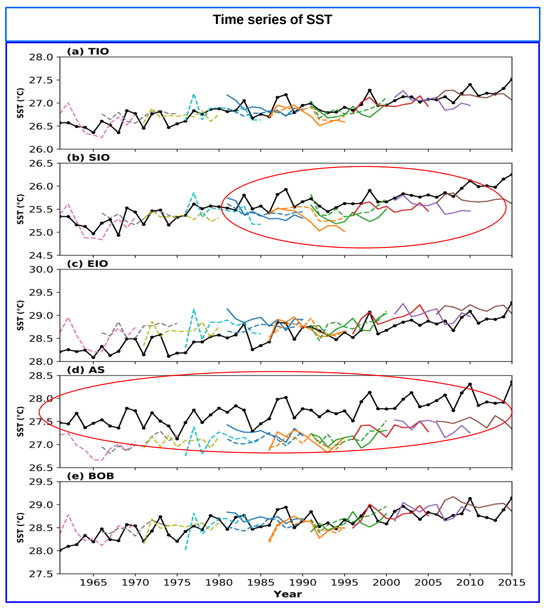
- From the time-series it is found that almost every models are able to capture the trend, but underestimates the variability in different regions.
- CFS outstands out as the best model by capturing the trend and fluctuations efficiently.
- Models (except CFS) in general failed to capture the High variability in NINO3.4 region, but still succeeds in capturing the strong warming/cooling events.

Anomaly Correlation for different models at different leads



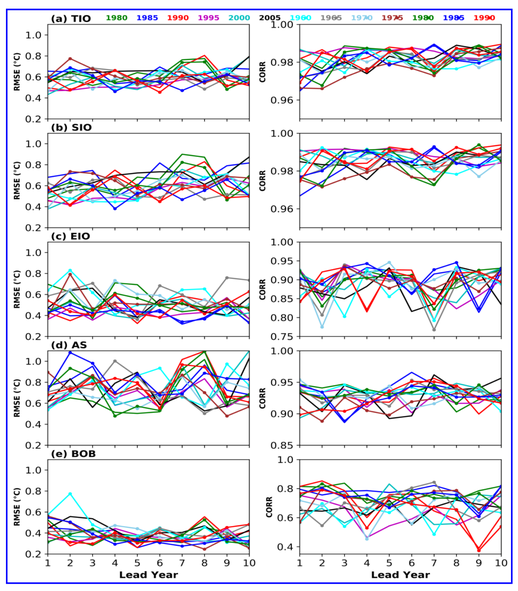
- Anomaly correlation analysis reveals that models showed consistent predictive skills for TIO at different forecast years.
- It is found that tropical regions show high predictability skill for SST as compared to extra-tropical region except for eastern equatorial Pacific.

Time series of SST



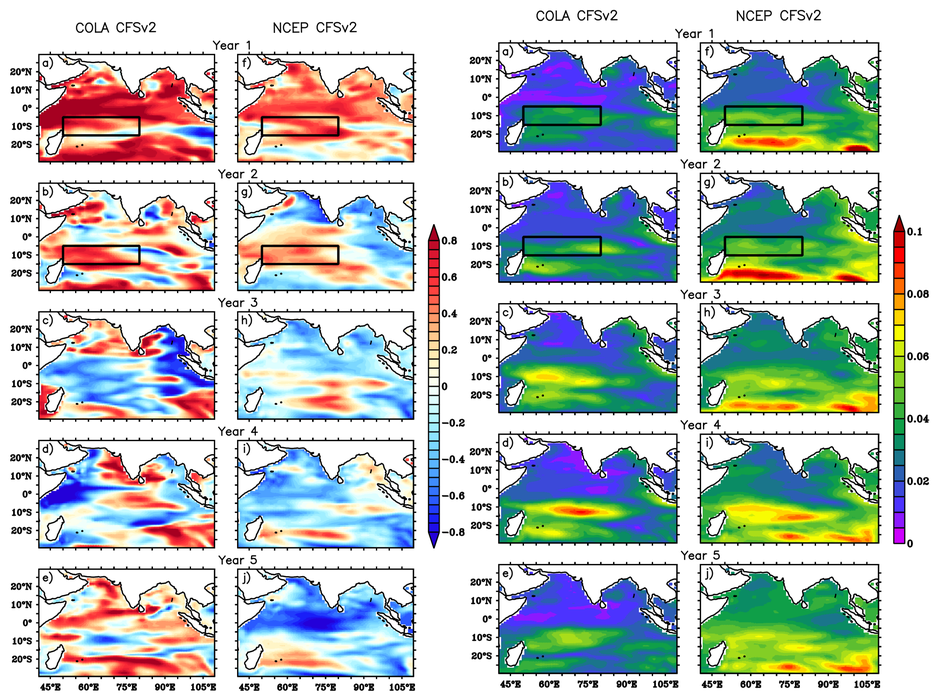
Basin averaged annual mean time series of ERSST and SST from CFSv2 decadal prediction run. Black solid line is ERSST; colored dashed line is CLA, colored solid line is NCEP SST.

Error Evolution

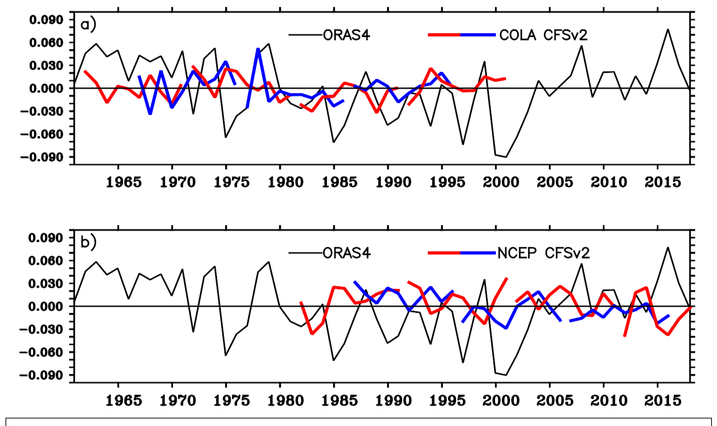


- **SST predictions are comparable with the observed trends in SST in all the study regions. But in the recent years trend in SIO SST is misrepresented by the models.**
- **SST is underestimated in SIO & AS and overestimated in EIO.**
- **RMSE ranges in 0.4°C – 0.8°C. But for AS it's higher (0.5°C – 1.1°C) and has oscillating nature.**
- **Pattern correlation is significant for the entire TIO, but is lower for BOB.**
- **Error and pattern correlation reveals that skill is varying from season to season as well as region to region. Performance is lower for summer and AS.**

SLA ACC and RMSE at different leads



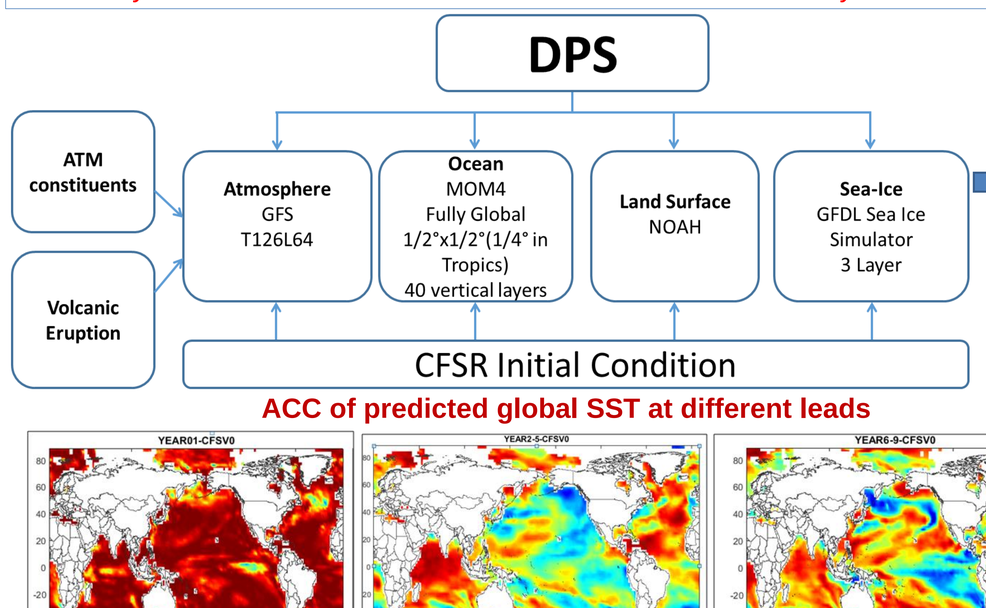
Time series of predicted and observed SLA over the TRIO

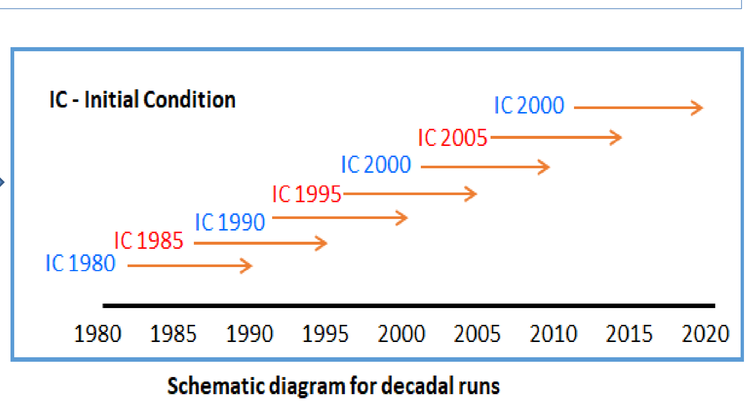


- Predictability of TRIO SLA in CFS is high for first and second year .
- COLA CFSv2 shows lower error for SLA in the SIO than NCEP CFSv2.
- TRIO SLA variability is underestimated in the models as compared to ORAS4.

In-house decadal prediction hind-cast runs and preliminary results

- Decadal runs are initialized from observed states in the month of November 1980, 1985, up to 2010 using CFSv2.
- CFSv2 is coupled Atmosphere-Ocean-Land-Ice Model. Atmospheric model is GFS (T126L64), Ocean model is MOM4 (0.5°×0.5°, 40 layer), Land surface model is NOAH (T126L4) and Ice model is 3 layered (Saha et al., 2014).
- Monthly SST from CFSv2 decadal forecast are used for the study.





Schematic diagram for decadal runs

ACC of predicted global SST at different leads

- **Preliminary analysis of decadal prediction of SST in CFS-V0 model shows good prediction skill over Indian Ocean and North Atlantic at different leads.**

Future plan: (a) Multiple member ensemble runs will be carried out for the robustness of system (b) Advanced version of IITM- CFS for further development and studies on decadal prediction

References:

Meehl, G.A., Goddard, L.,Murphy, J., Stouffer,R. J., Boer, G., Danabasoglu, G., . . . Stockdale, T. (2009). Decadal Prediction. BAMS, 90(10), 1467-1486. doi:10.1175/2009bams2278.1

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