The distinguish influence of equatorial subsurface winter Ocean initial conditions in 1979 and 1997 on tropical summer SST in CFSv2 Seasonal Reforecasts

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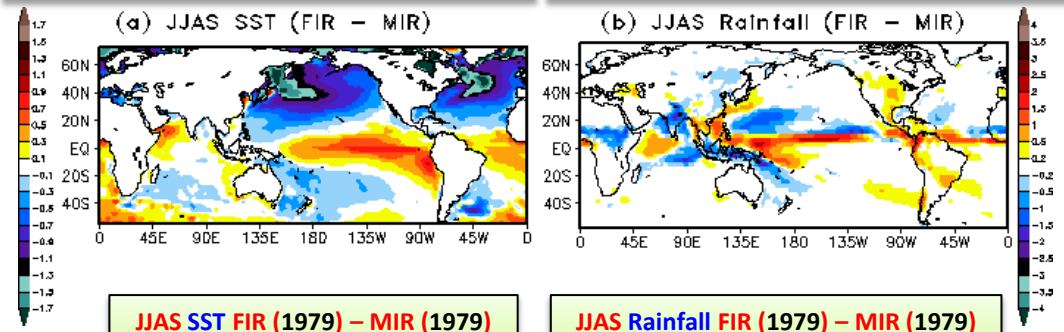
Model and Experimental Design:

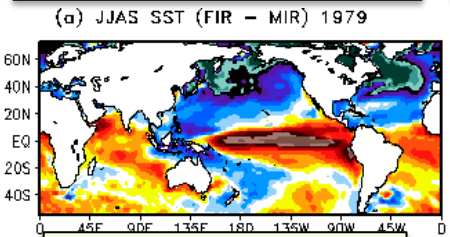
- **Model: National Centers for Environmental Prediction (NCEP) Coupled Forecast System version-2 (CFSv2)**
- **February initialized reforecasts (FIR) and May initialized reforecasts (MIR) for period 1979-2008**
- **Ocean initial conditions (OICs)**:Climate Forecast System Reanalysis **(CFSR)**, Global Ocean Data Assimilation System **(GODAS)**, European Centre for Medium-Range Weather Forecasts (ECMWF) Ocean Reanalysis System 3 **(ORA-S3)**, and ECMWF Comprehensive Modelling of the Earth System for Better Climate Prediction and Projection **(COMBINE-NV).**
- **The land, atmosphere, and sea ice ICs**: Climate Forecast System Reanalysis (CFSR) for **1979-2008**
- **The number of ensemble members** for each initial month is **16** in the seasonal reforecasts.
- **Please see references for details of experiments (**Shukla, et. al. 2017, Climate Dynamics. https://doi.org/10.1007/s00382-017-3594-0 and Shukla, et. al. 2019, International Journal of Climatology. https://doi.org/10.1002/joc.6029)
- **SST =** sea surface Temperature; **JJAS =** mean of June to September; **AS =** mean of August to September

JJAS SST FIR (1979-2008) – MIR (1979-2008)

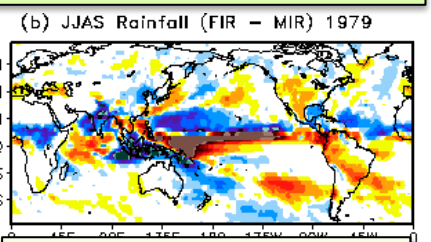


JJAS Rainfall FIR (1979-2008) – MIR (1979-2008)

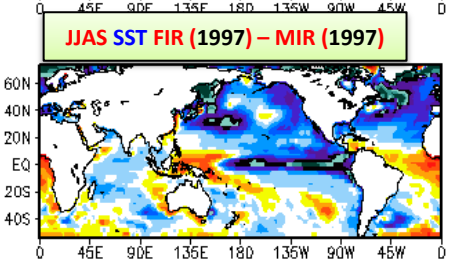
JJAS SST FIR (1979) – MIR (1979)



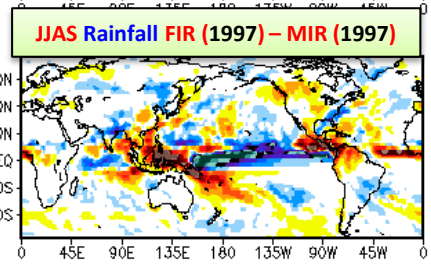
JJAS Rainfall FIR (1979) – MIR (1979)



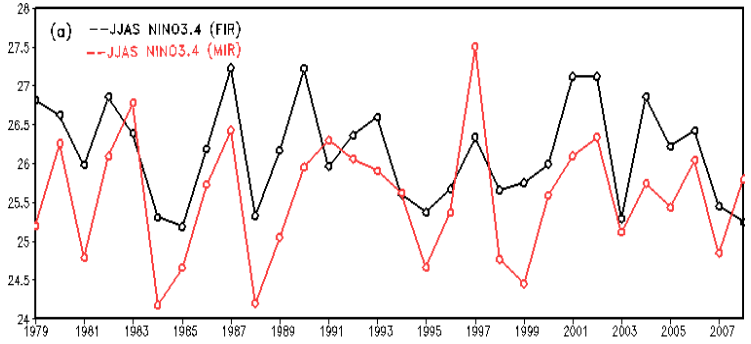
JJAS SST FIR (1997) – MIR (1997)



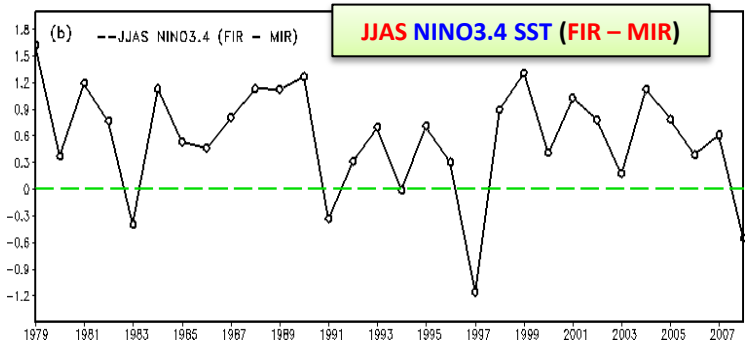
JJAS Rainfall FIR (1997) – MIR (1997)



Year-to-year variation of season mean JJAS NINO3.4 SST index in FIR (black line) and MIR (red line) for period 1979-2008

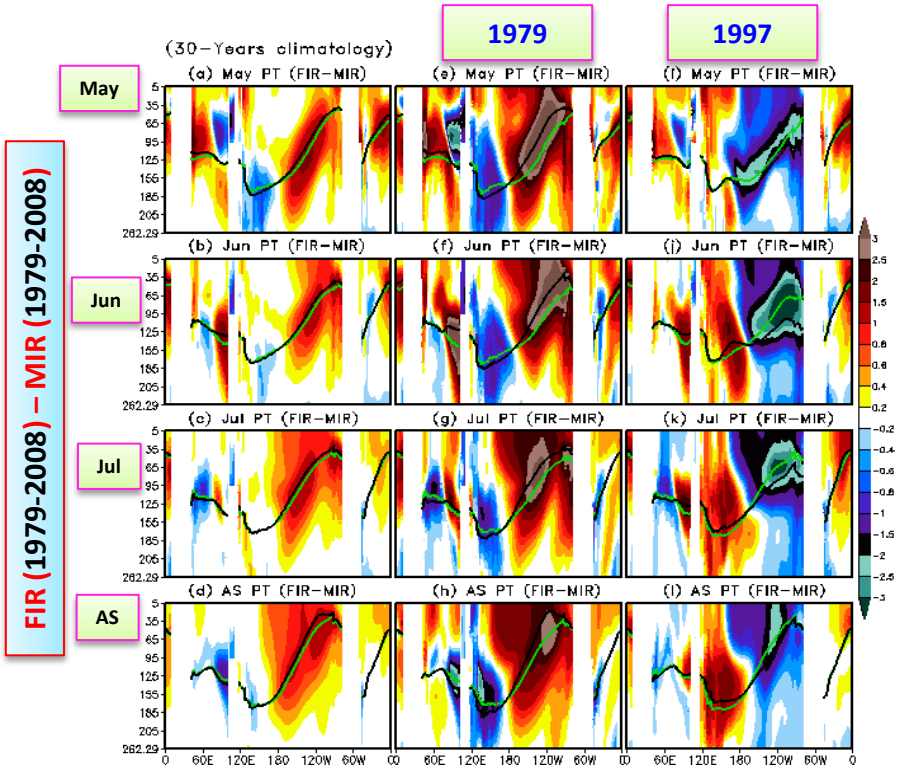


JJAS NINO3.4 SST (FIR – MIR)

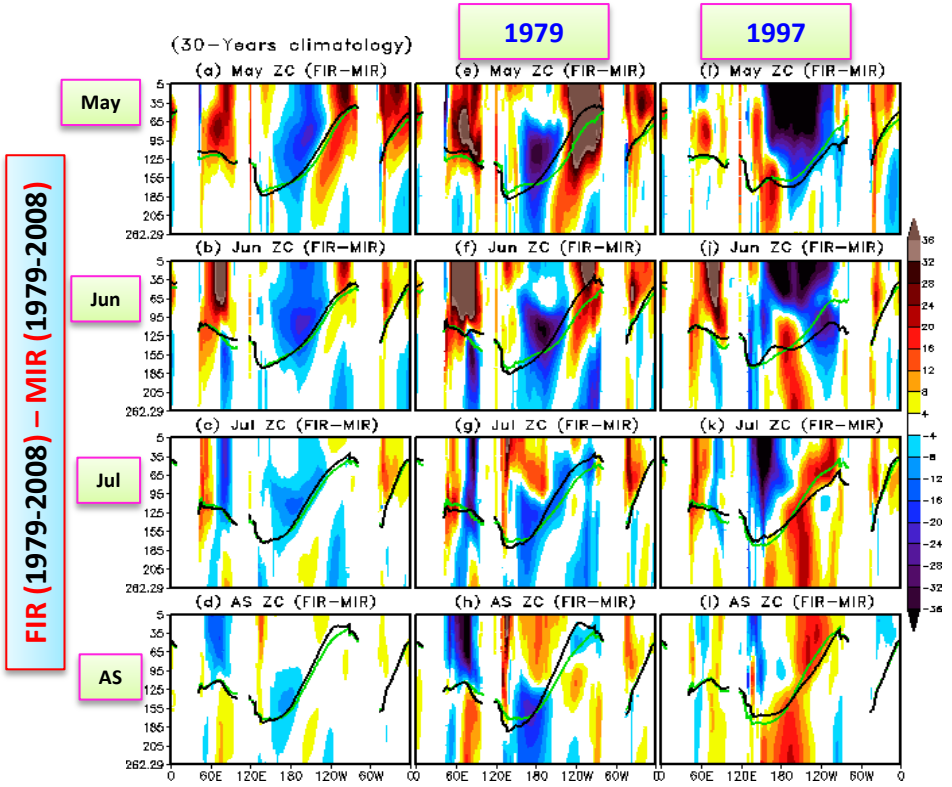


Longitude-depth section (latitude averaged from 1°S to 1°N) of difference of potential temperature (PT), and zonal current (ZC; cm/s) between FIR and MIR for mean of 1979-2008, 1979 and 1997

Potential Temperature



Zonal current



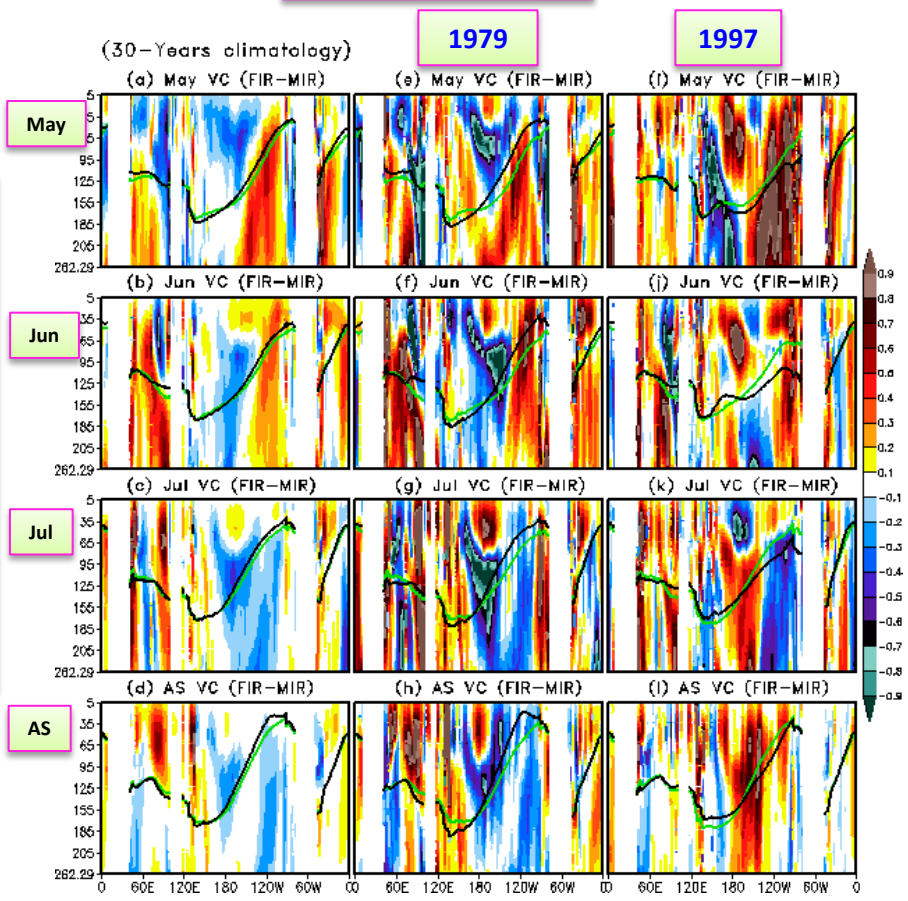
The green line (black line) indicates 20°C isotherm (Z20) in FIR (MIR).

For 1979: Due to (i) the deeper 20°C isotherms (Z20) in FIR during May 1979, (ii) stronger equatorial undercurrent (EUC) and vertical current in the central and eastern Pacific Ocean from May to June in FIR, and (iii) a weaker upwelling around 90°-85° W from May to June in FIR for 1979 in comparison to MIR, the deep ocean water upwelled to the surface through the EUC was usually warm in the eastern Pacific in June.

For 1997: Due to (i) the deeper Z20 in MIR during May 1997, (ii) stronger EUC in the central and eastern Pacific Ocean from May to June in MIR, (iii) a weaker upwelling of deep ocean waters around 90°-85° W from May to June in MIR, and (iv) stronger upwelling in the equatorial Pacific Ocean in May 1997 of FIR, the difference between FIR and MIR in June and July 1997 depicts below-normal potential temperature in the equatorial eastern Pacific.

Longitude-depth section (latitude averaged from 1°S to 1°N) of difference of vertical current (VC; meter/day) between FIR and MIR for mean of 1979-2008, 1979 and 1997

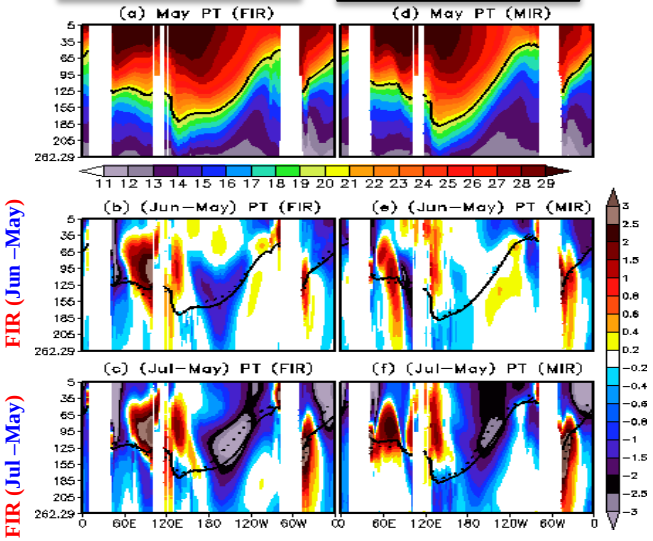
Vertical current



The green line (black line) indicates 20°C isotherm (Z20) in FIR (MIR).

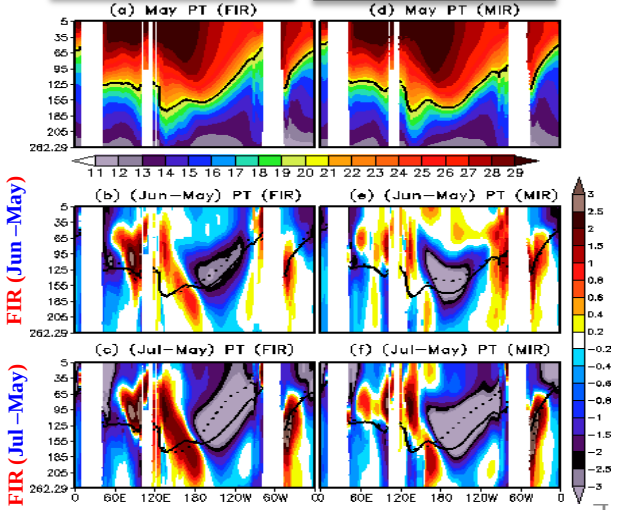
Longitude-depth section (latitude averaged from 1°S to 1°N) of potential temperature (PT) and change of PT with respect to May in FIR and MIR during 1979

PT May (FIR) 1979 | PT May (MIR) 1979



Longitude-depth section (latitude averaged from 1°S to 1°N) of potential temperature (PT) and change of PT with respect to May in FIR and MIR during 1997

PT May (FIR) 1997 | PT May (MIR) 1997



Conclusion:

- The difference between February initialized reforecasts (FIR) and May initialized reforecasts (MIR) depicts warmer (cooler) SST over equatorial central Pacific during summer 1979 (1997).
- The difference between FIR and MIR during 1979 depicts warmer potential temperature over the equatorial central-eastern Pacific mainly between 150°W-110°W at depth from 155m to 65m in May. The 20°C isotherms (Z20) is deeper in the central and eastern Pacific in May 1979 of FIR than MIR.
- FIR depicts a stronger magnitude of equatorial undercurrent (EUC) and vertical current in eastern Pacific, and a weaker upwelling around 90°-85° W from May to June 1979 than MIR, therefore, a center of warm potential gradually moves upward in the eastern Pacific during summer, resulting in warmer SST in eastern Pacific during summer 1979 in FIR than MIR.
- The magnitude of equatorial potential temperature and EUC in May 1997 of MIR is larger than FIR in equatorial central-eastern Pacific. The Z20 of May 1997 in MIR is deeper in the central and eastern Pacific in comparison to FIR.
- Due to stronger vertical current in May 1997 of FIR in eastern Pacific, cool deep water drawn to the surface maybe larger in June. The 20°C isotherms of MIR in summer tends to be deeper in equatorial eastern Pacific than FIR in 1997, resulting in cooler SST in eastern Pacific during summer 1997 in difference between FIR and MIR.
- The impact of equatorial OICs during 1979 and 1997 in North Atlantic is almost the same, resulting in warmer summer SST over equatorial North Atlantic in FIR than MIR.