A Spring View of ENSO Diversity

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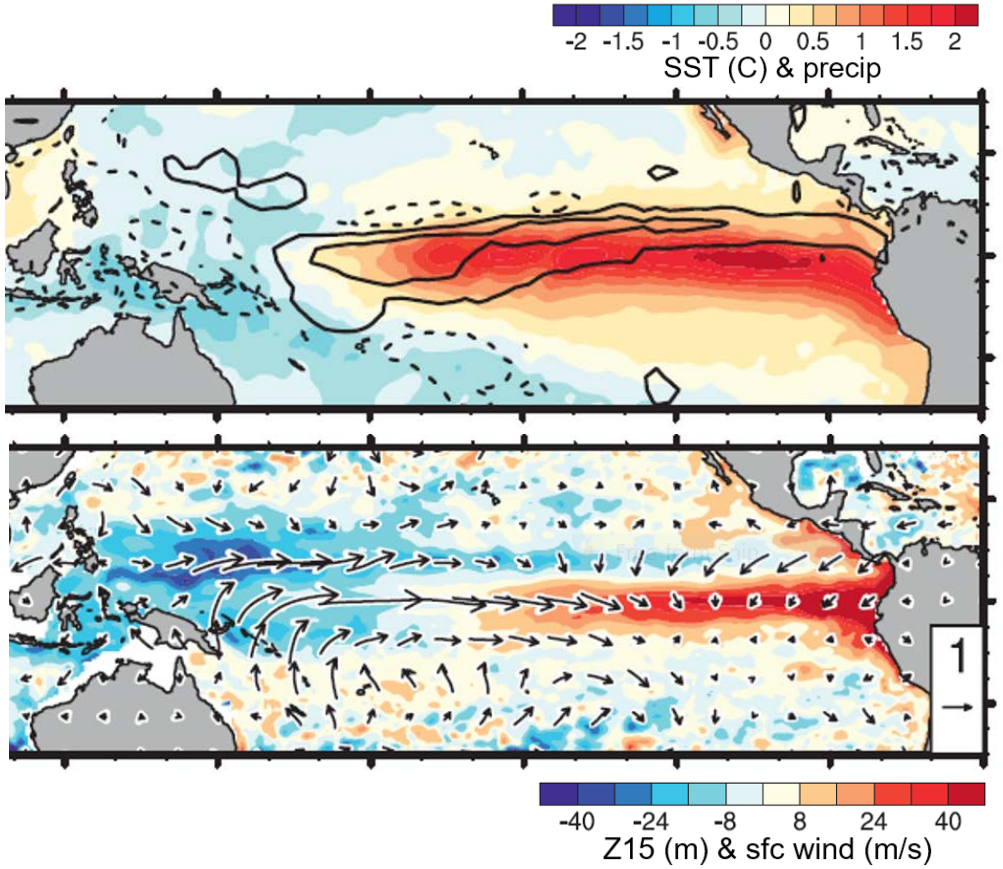
Anza-Borrego Desert State Park, CA
March 2017

El Nino composite (1958-2007) (Deser et al. 2012, JC)

Sept-Nov

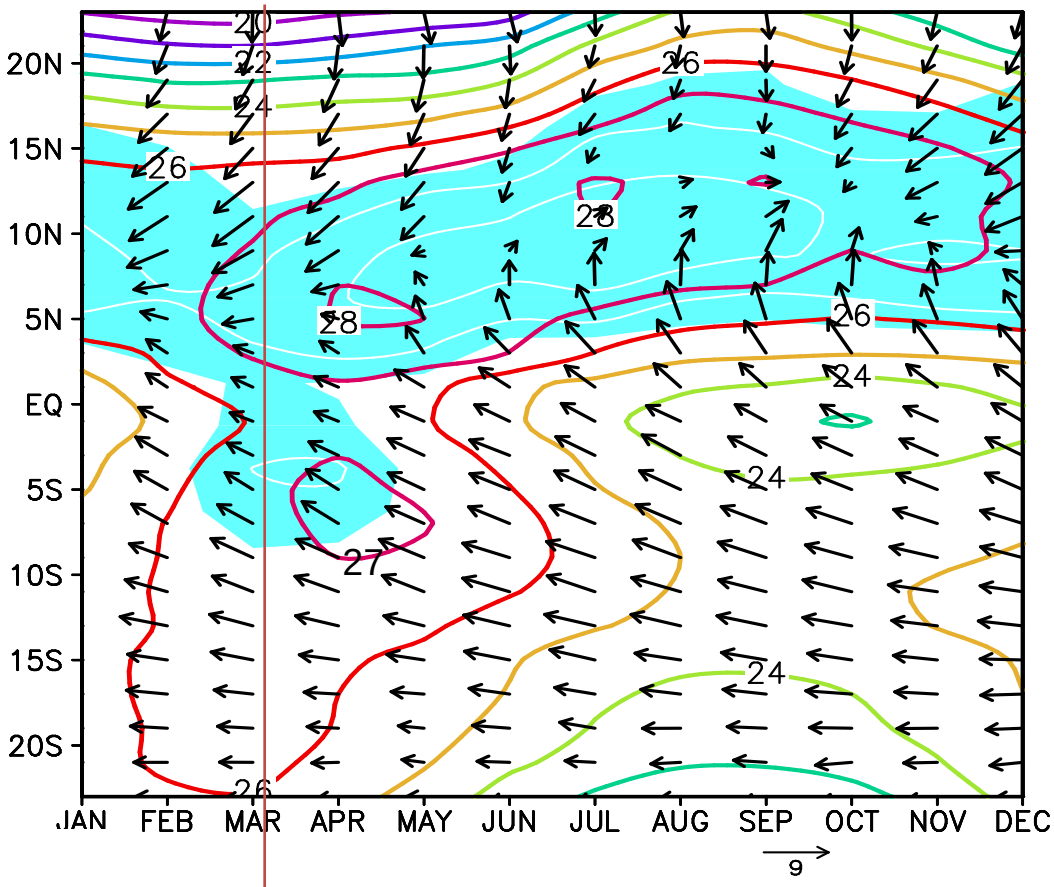


Bjerknes feedback

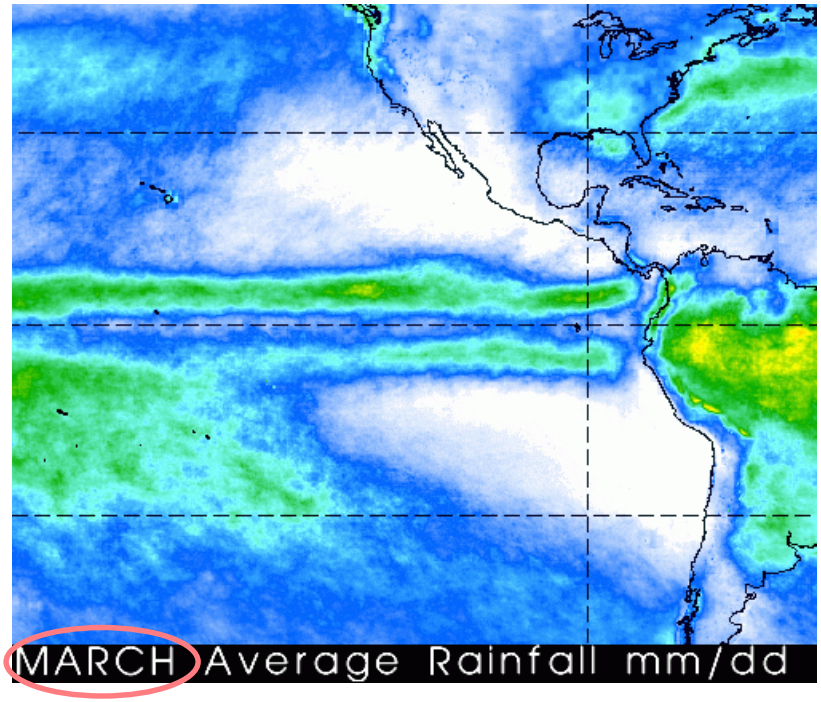
- Westerly wind anomalies in the western basin
- Maximum warming in the eastern basin ← Eq. wave adjustment.
- Weak precip response over the cold tongue ← cool mean SST

Obs. Precip., SST & wind

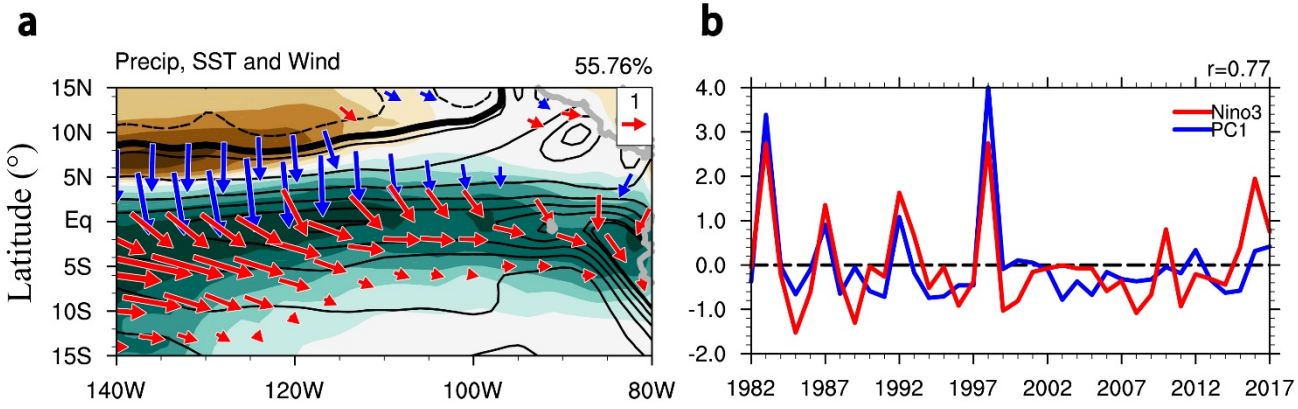
120-115ºW



FMA: Double ITCZ & weak southerlies



EOF of FMA rainfall



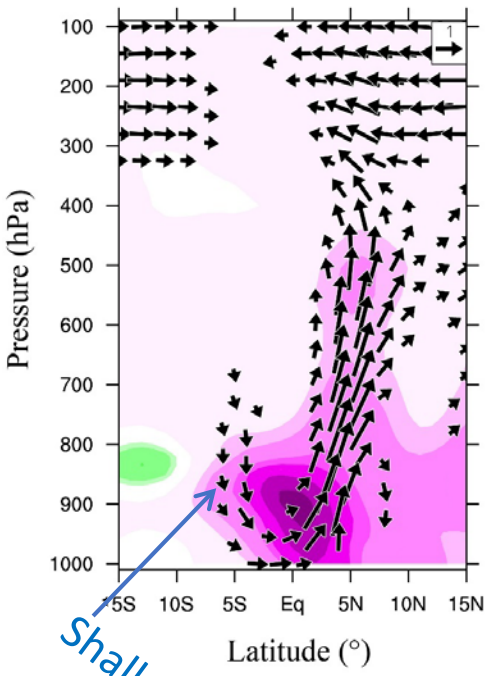
EOF1

→ Extreme El Nino

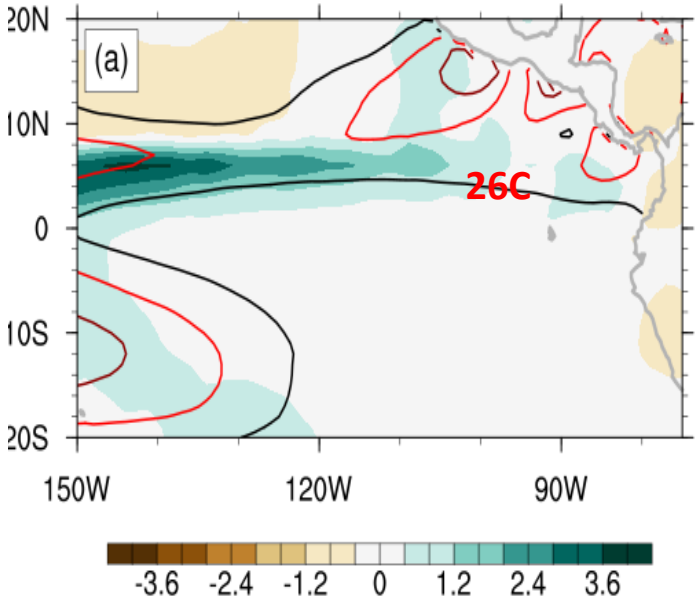
No La Nina

ENSO evolution: NDJ

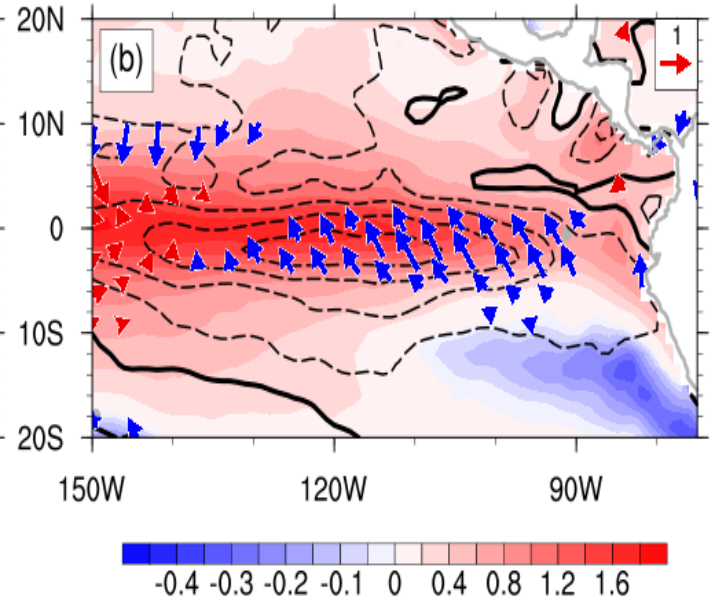
Humidity & circulation



Shallow circulation



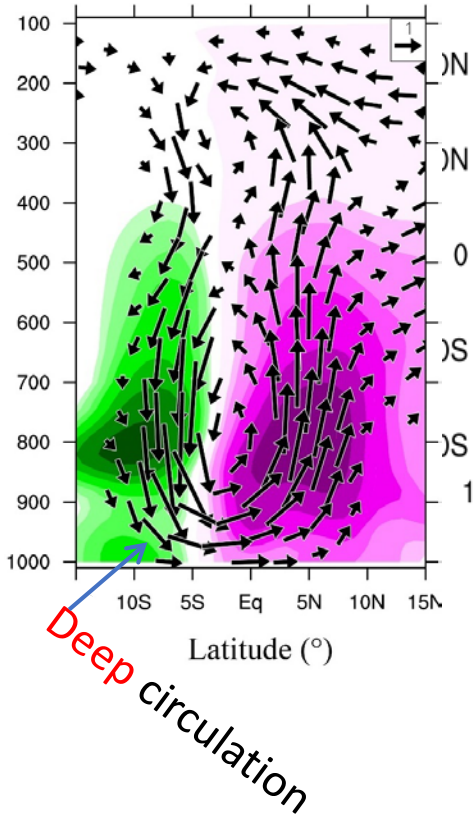
Precip (shaded) & mean SST (contours)



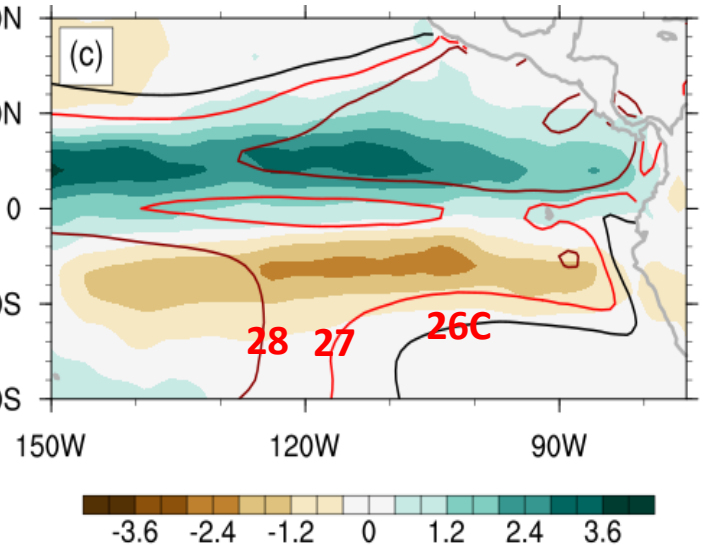
SST (shaded), latent heat flux (contours) & sfc wind vectors

ENSO evolution: FMA

Humidity & circulation



Deep circulation



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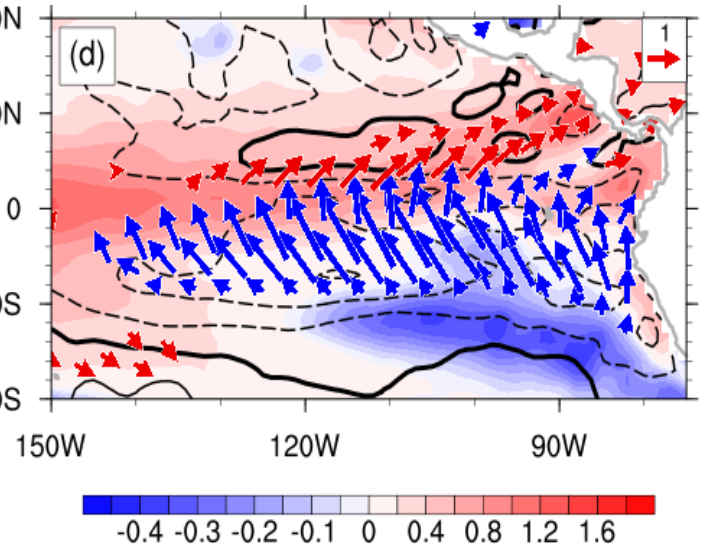
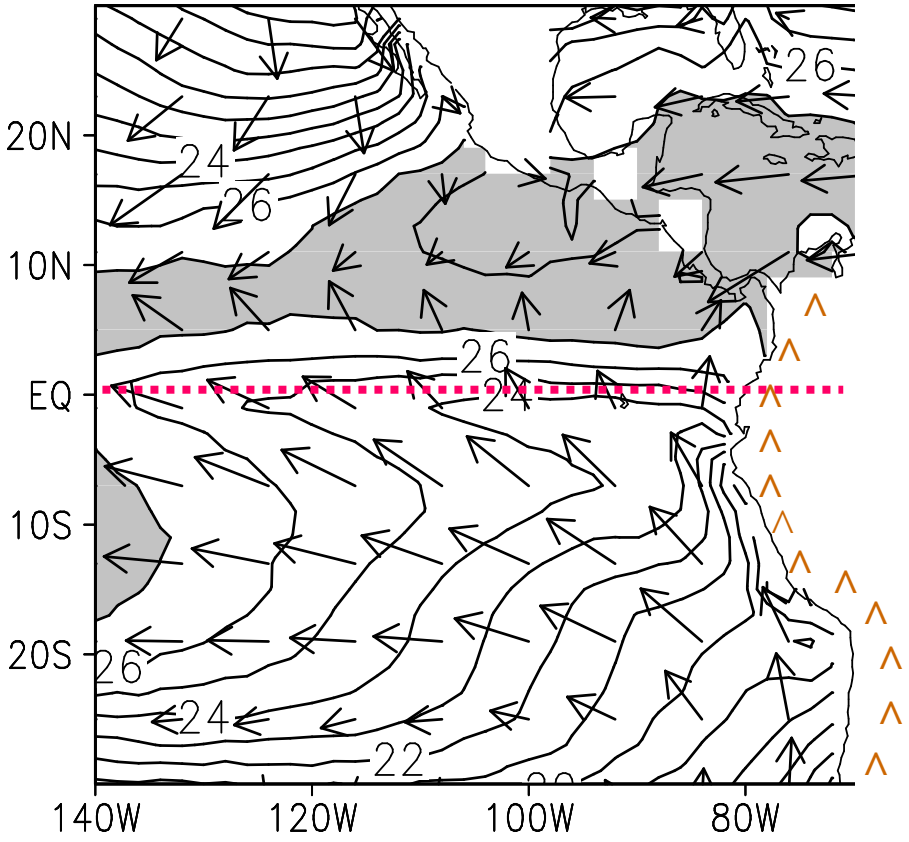
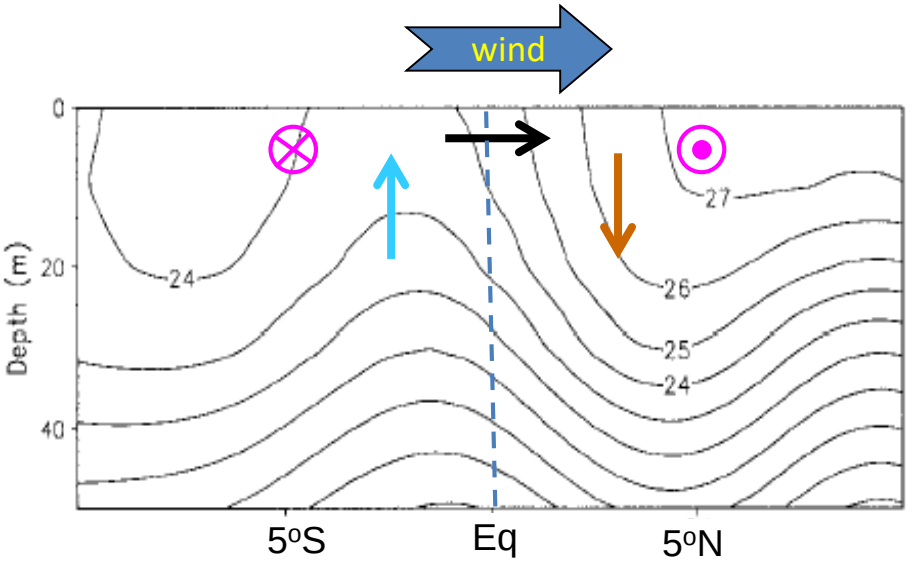


SST (shaded), latent heat flux (contours) & sfc wind vectors



Effect of cross-equatorial wind

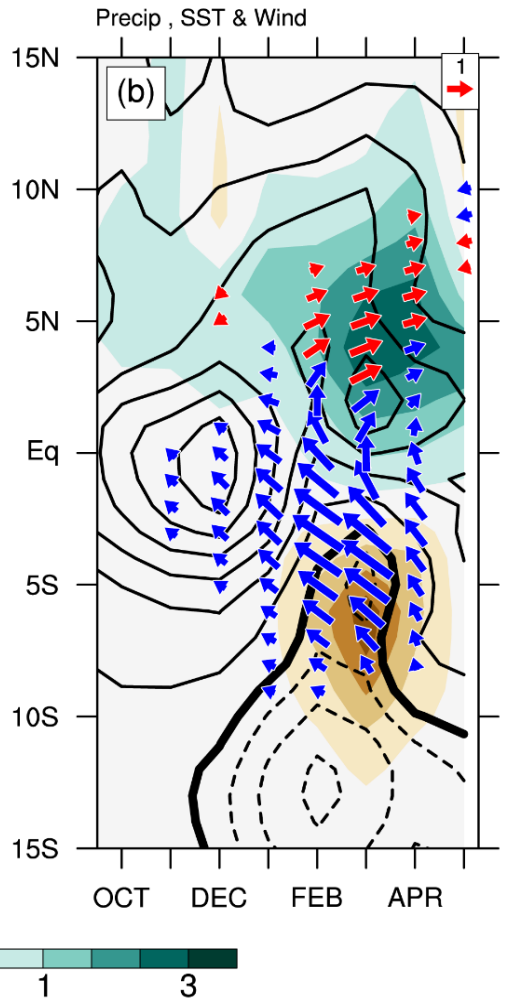
Philander & Pacanowski (1981, Tellus); Xie (1998, JC)



Ocean temp at 90W

In the far eastern Pacific, the zonal wind vanishes and it is the southerlies that maintain the upwelling cooling, slightly south of the equator (centered at 1-2S) in the open ocean, and along the coast.

Moderate El Niño

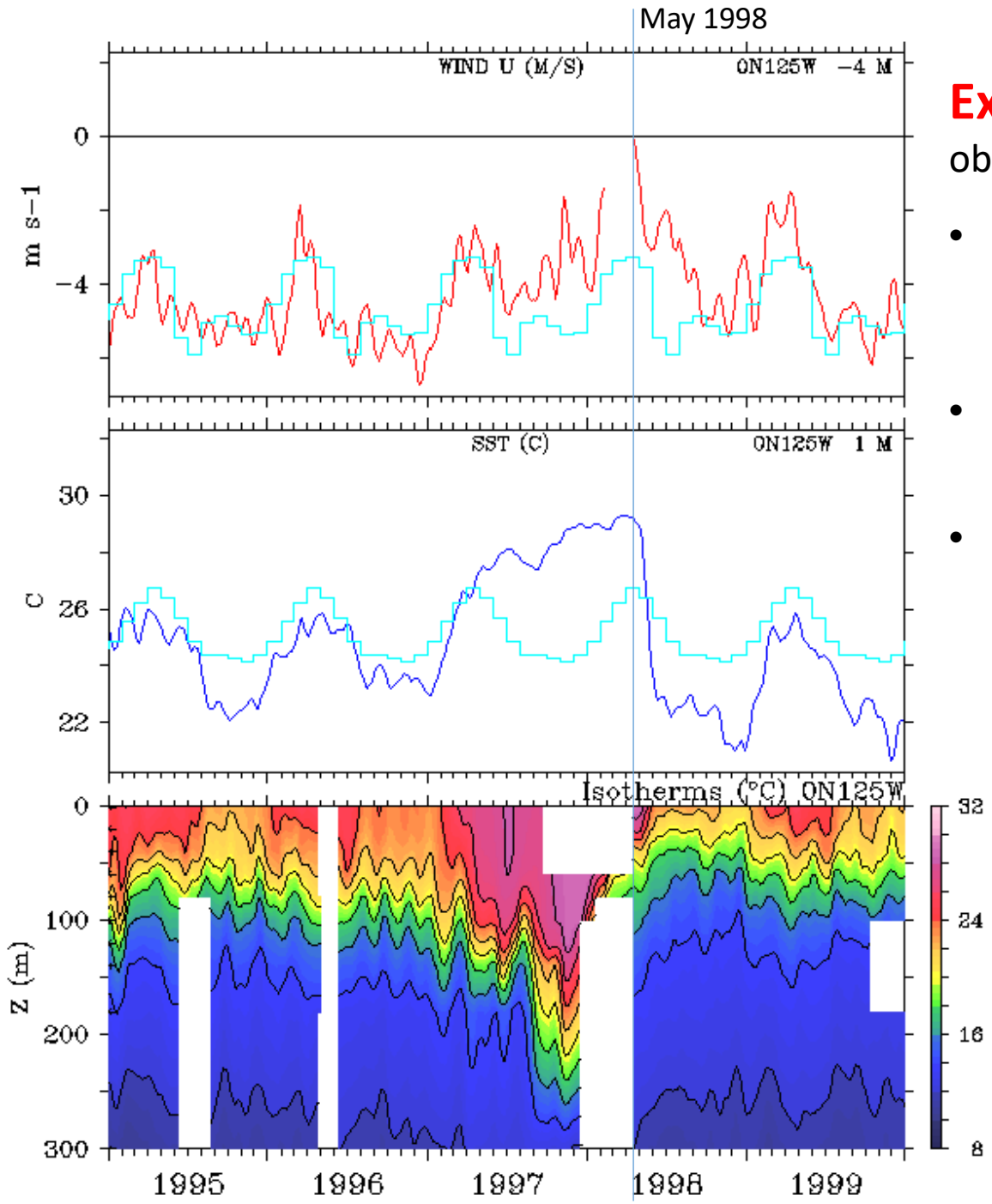


EPID

Upwelling south of equator

Rapid decay

Anomalies of : precipitation (color shading), SST (contours) and wind (vectors)



Extreme El Nino of 1997-98 as observed by 125°W, Eq. buoy

- Diminishing easterlies in early '98→ intrusion of wind anomalies.
- By April '98, thermocline depth has returned to normal.
- SST did not decrease until the easterly trades returned → importance of local wind anomalies

cf. McPhaden (1999, *Science*)

Summary

FMA mean state:
Double ITCZ & seasonal eq. warming

↓

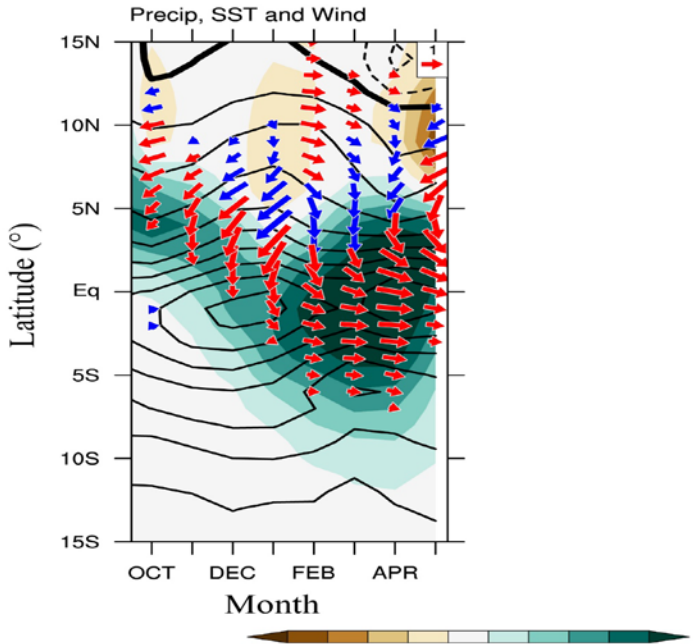
Extreme El Nino

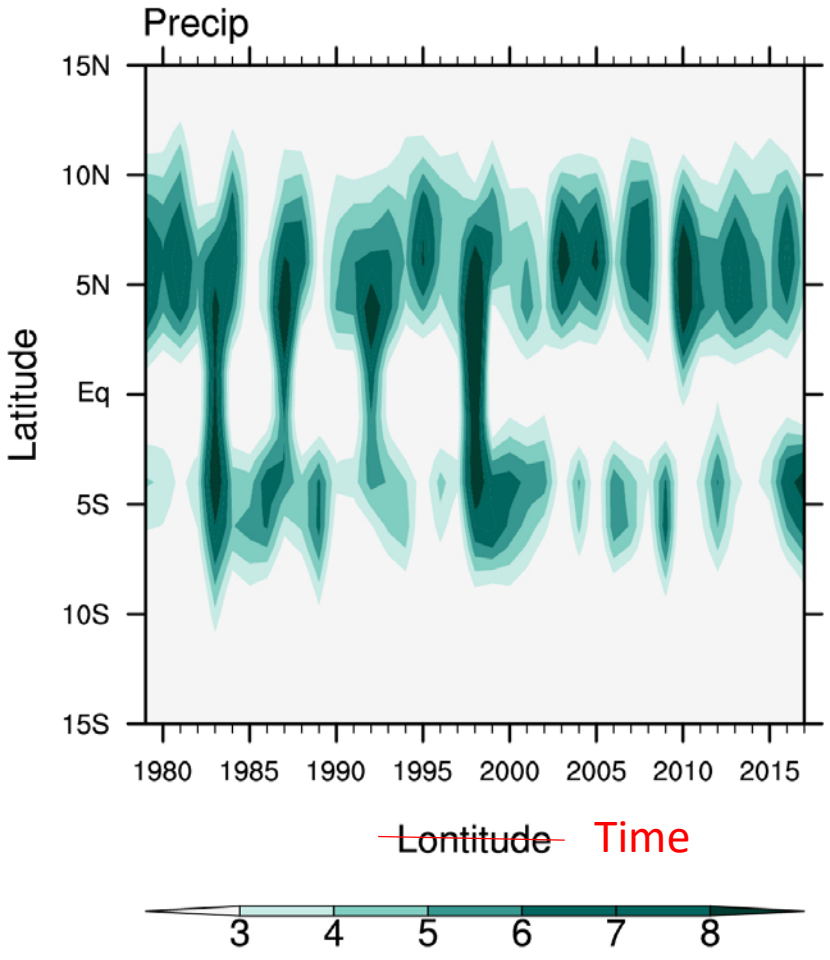
↓

Enhanced eq. convect.
EP Bjerknes

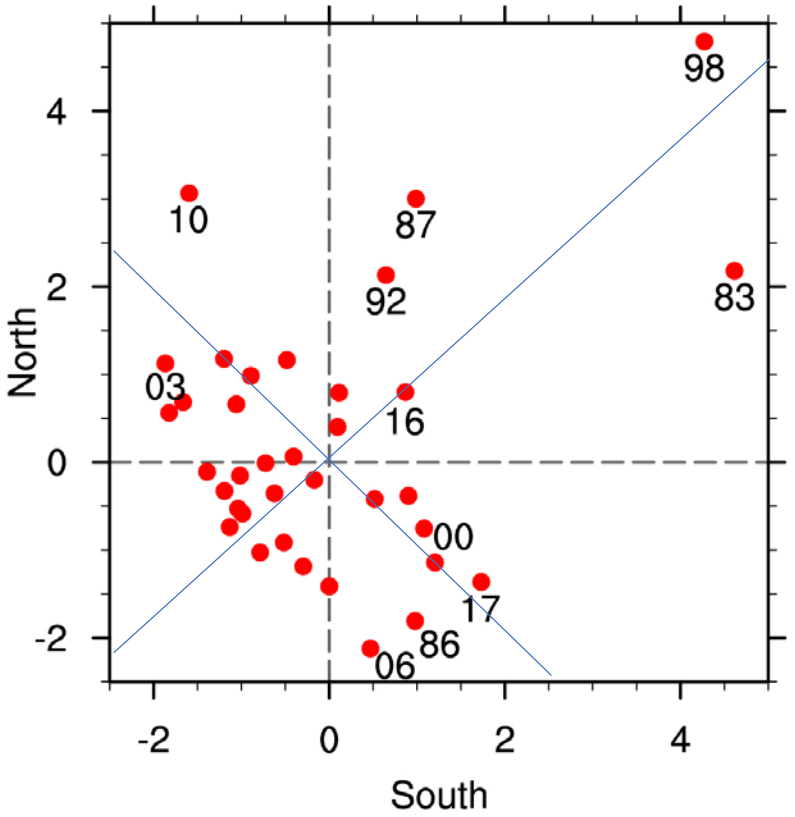
↓

Suppressed eq. upwelling
Slow decay





83, 87, 92 & 98 in different color



Conclusions

- Eastern Pacific ITCZ dipole (EPID): a WES mode in FMA when the mean state is symmetric (and atmospheric feedback is strongest).
- Represents interannual variability in relative intensity of the double ITCZ.
- EPIC is preceded by moderate ENSO and causes the rapid termination of moderate ENSO.
- Extreme El Nino decays slowly because of local Bjerkness feedback in the eastern Pacific, by causing deep convection there.

EOF modes of FMA rainfall variability in CESM (dx=1 deg)