Barrier Layers and tropical Atlantic SST biases in coupled GCMs.

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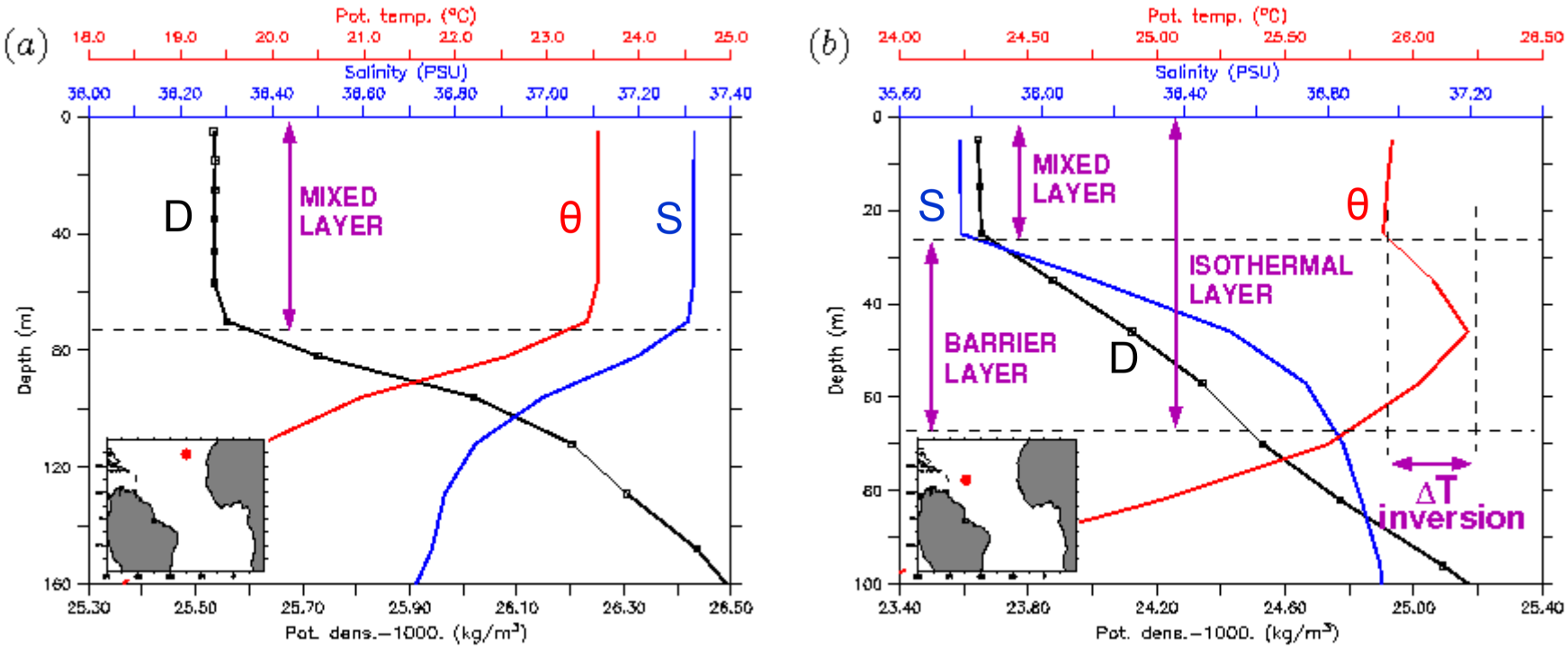
Examples of Ocean Stratification (Jan 1978, SODA)



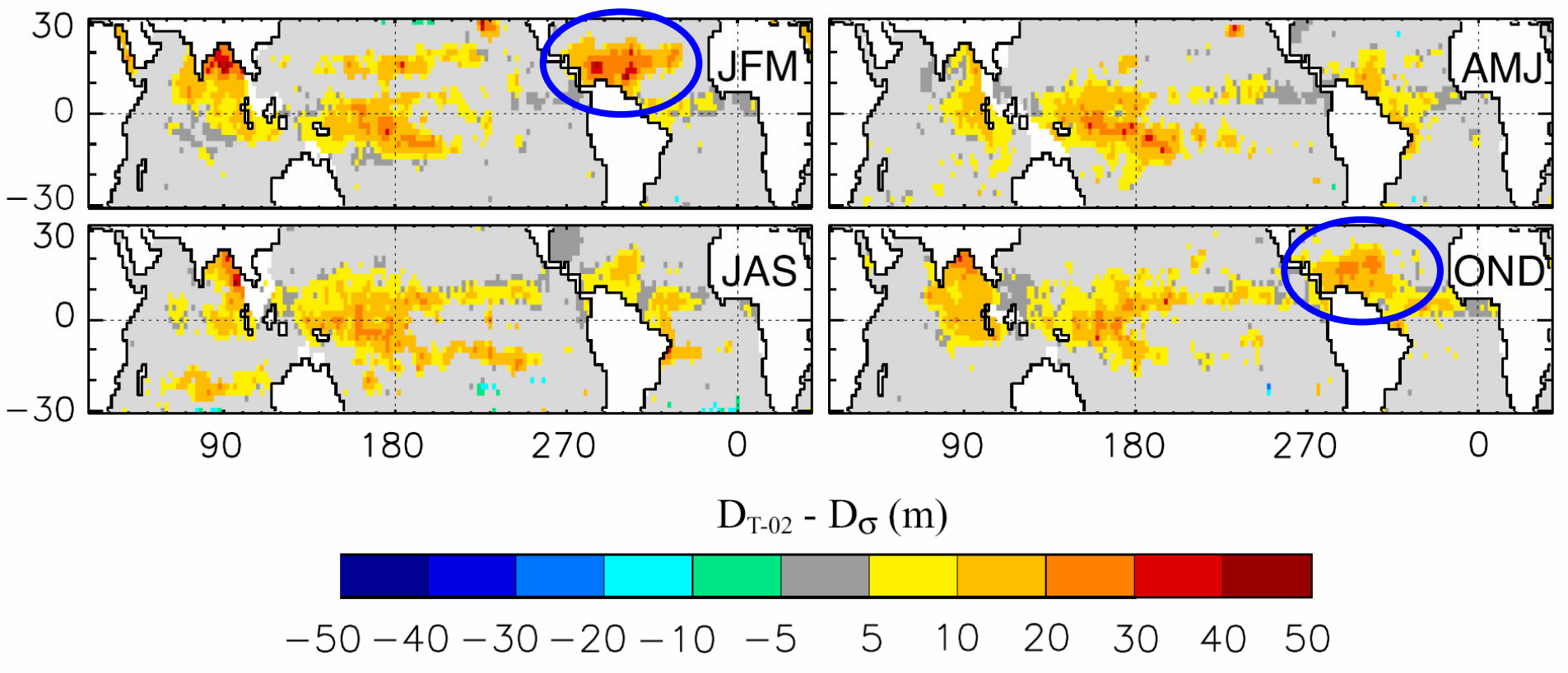
definitions: **[Juliette Mignot et al. (2007)]**

ML depth: $\sigma_{z=-\mathrm{mld}} = \sigma(s_{10\mathrm{m}}, \theta_{10\mathrm{m}} - 0.2)$ **BL thickness:** $d_{\mathrm{ild}} - d_{\mathrm{mld}}$

Isothermal layer depth: $\theta_{z=-\mathrm{ild}} = \theta_{10\mathrm{m}} - 0.2$

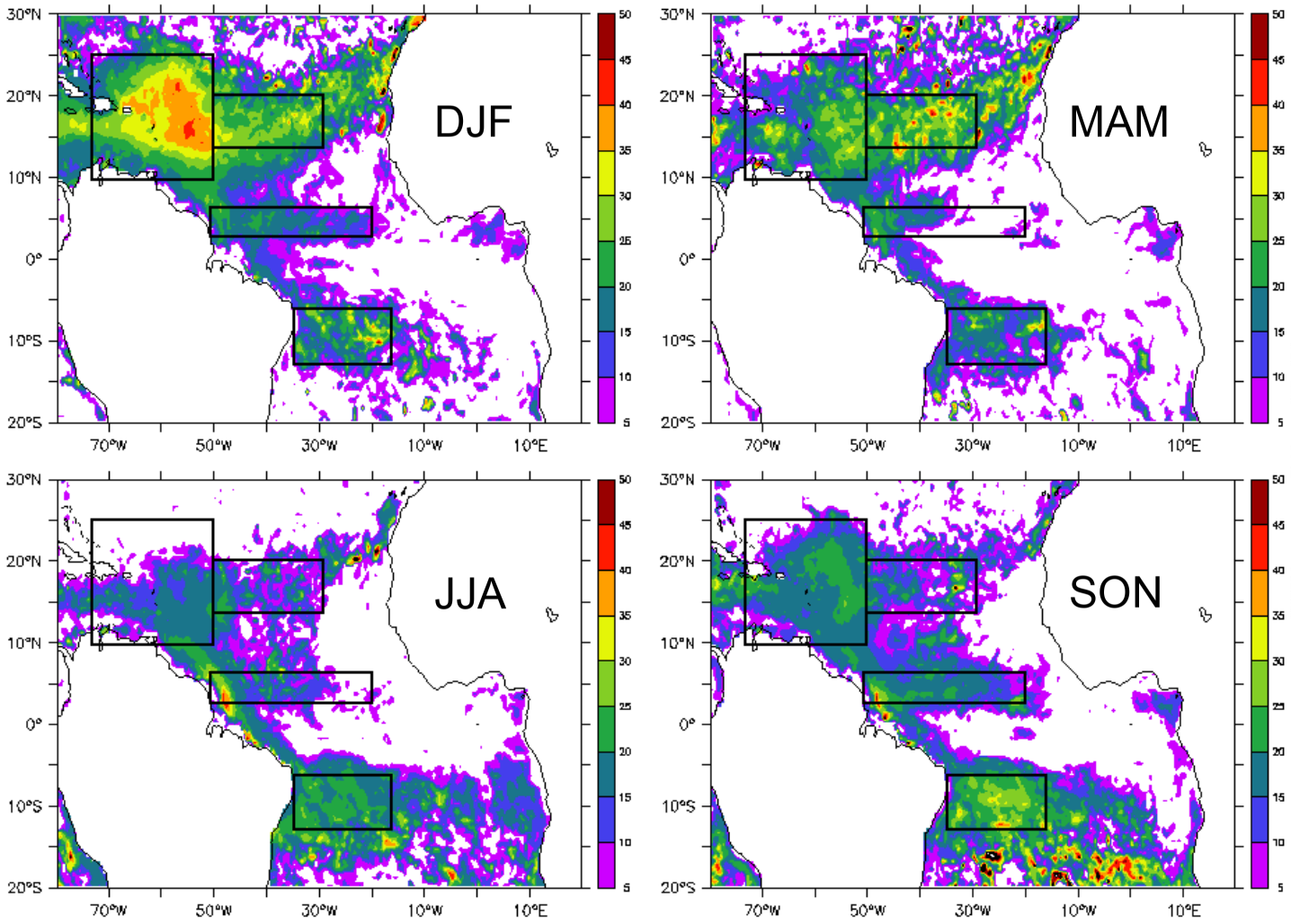
Observed seasonal variation of BL thickness (in m).

(Based on NODC, WOCE and ARGO database from 1967-2006.)



(Juliette Mignot et al., 2007)

Seasonal variation of BL thickness (in m) based on SODA reanalysis (1958-2001)



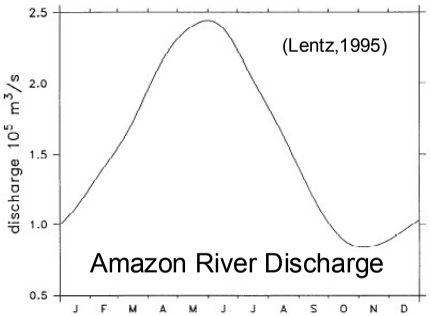
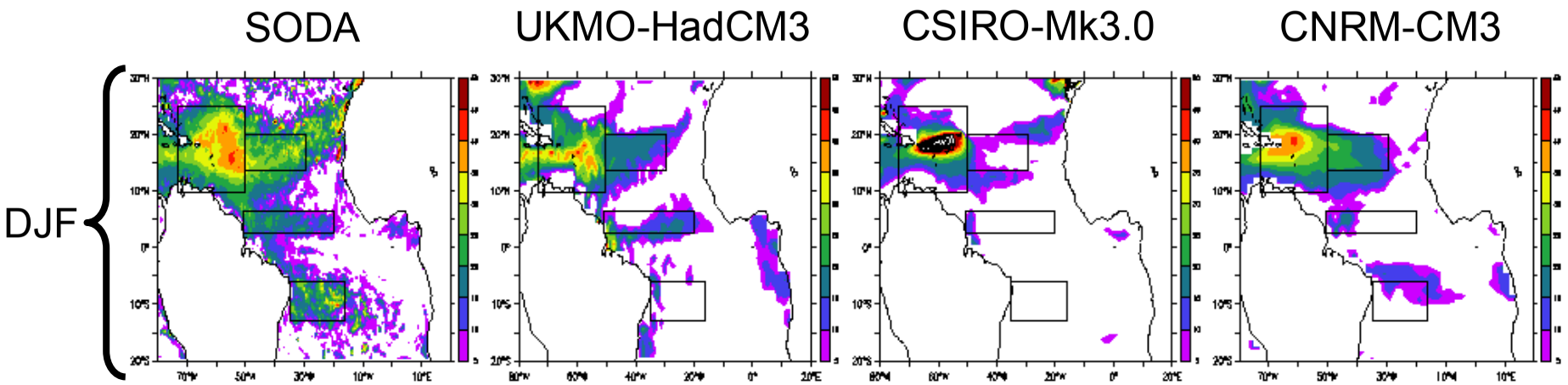
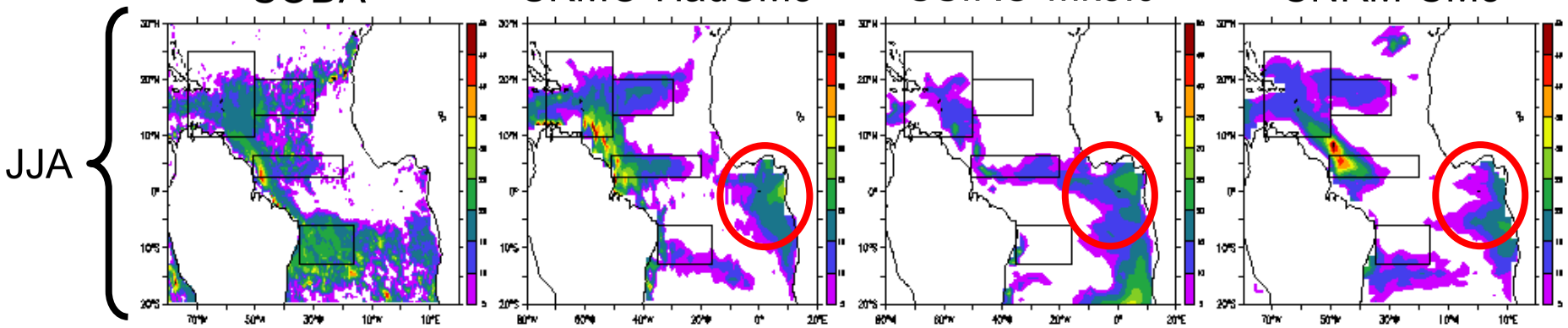


Figure 2. Time series of the monthly averaged Amazon River discharge from *Oltman* [1968]. Discharge is based on Obidos stage data for the period 1928–1946.

Seasonal variation of BL thickness (in m) in coupled GCMs.

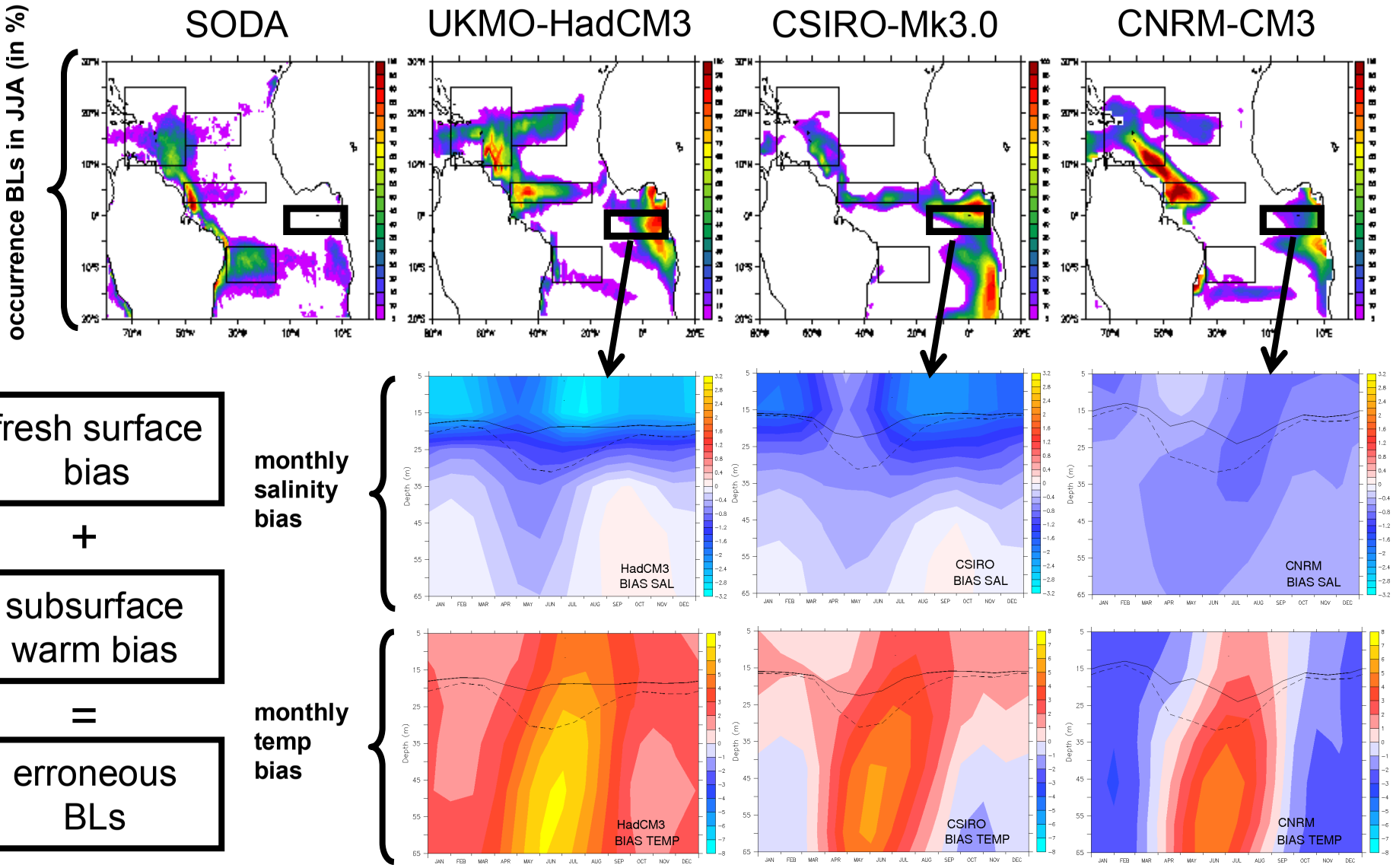


Generally less thick BLs over Northwestern tropical Atlantic in DJF.

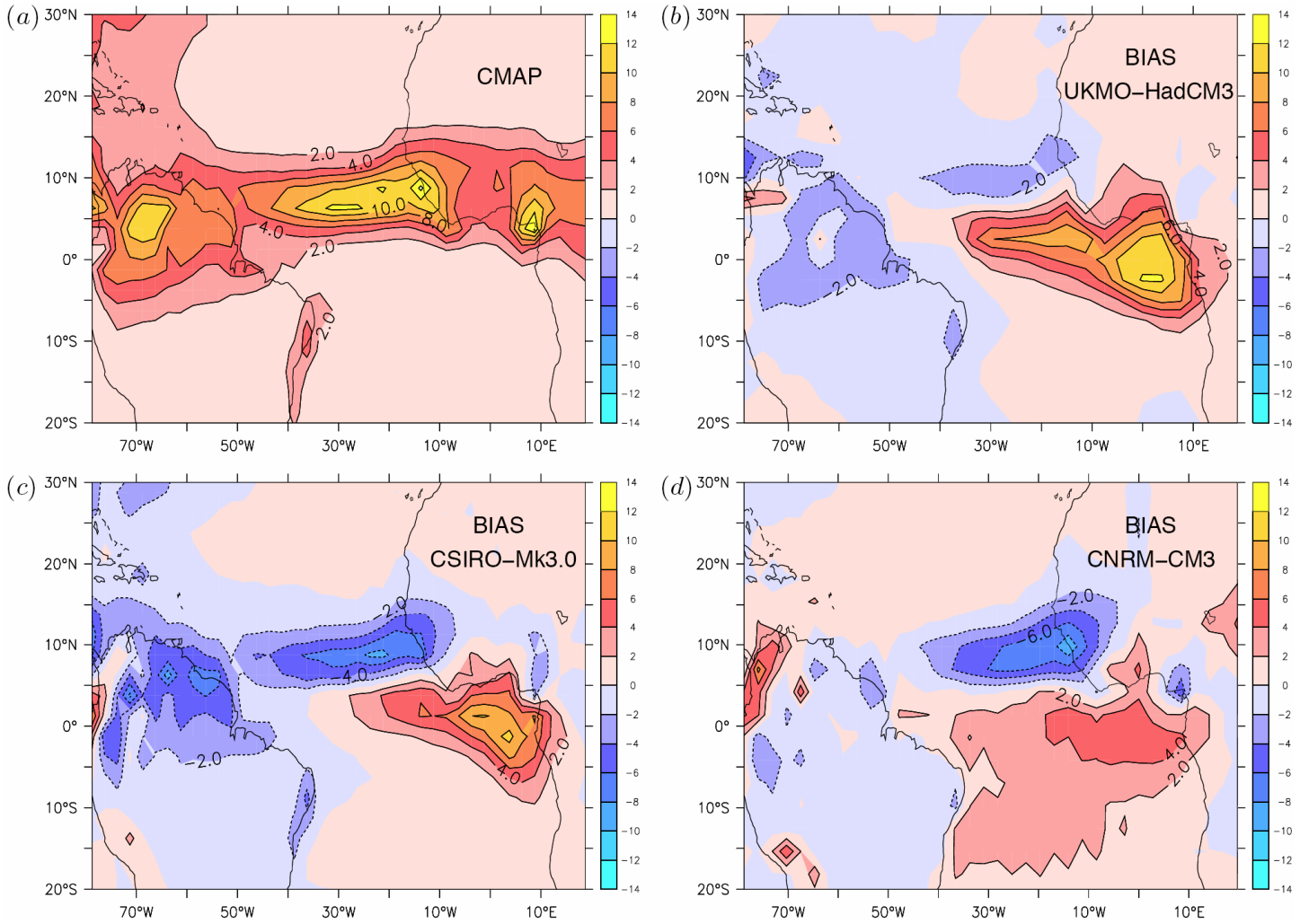


Erroneous presence of BLs over Southeastern equatorial Atlantic in JJA.

Erroneous BLs in Southeastern Equatorial Atlantic during JJA



Precipitation biases in JJA.

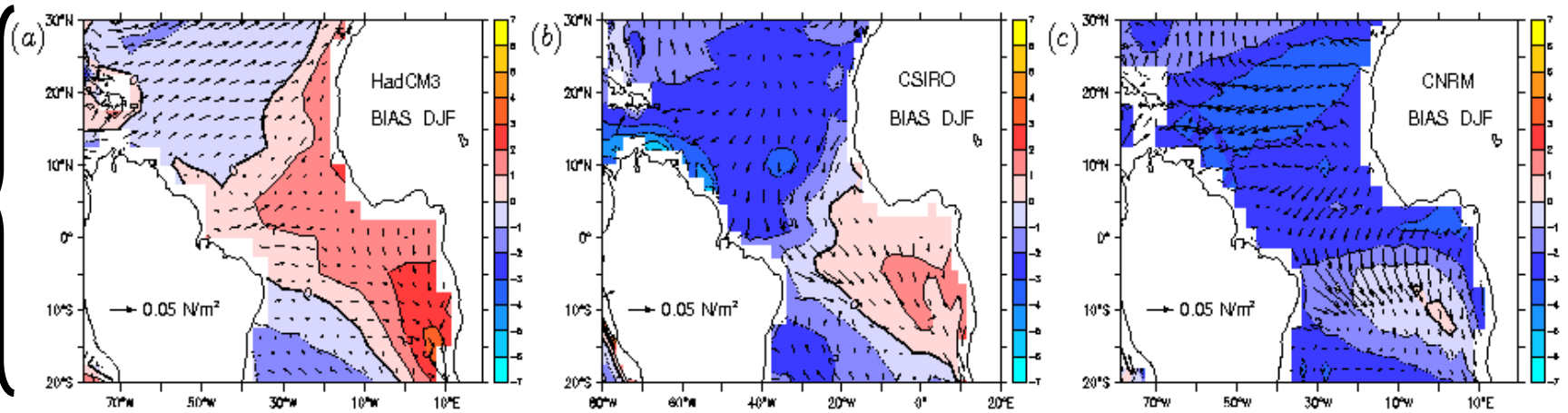


Fresh surface bias in southeastern eq. Atlantic related to precipitation bias.

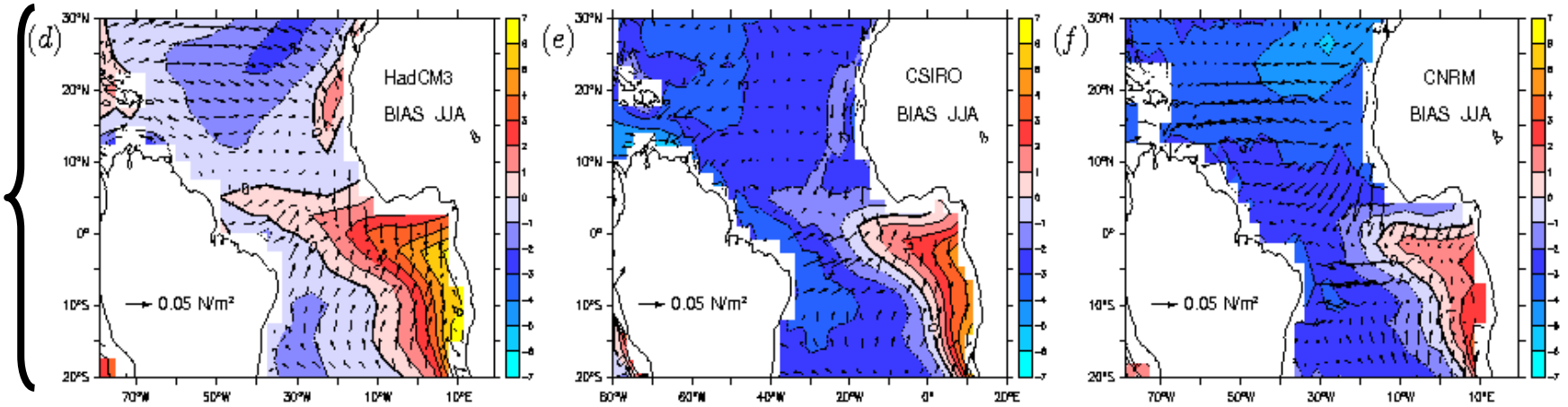
SST biases in coupled GCMs.

UKMO-HadCM3 | CSIRO-Mk3.0 | CNRM-CM3

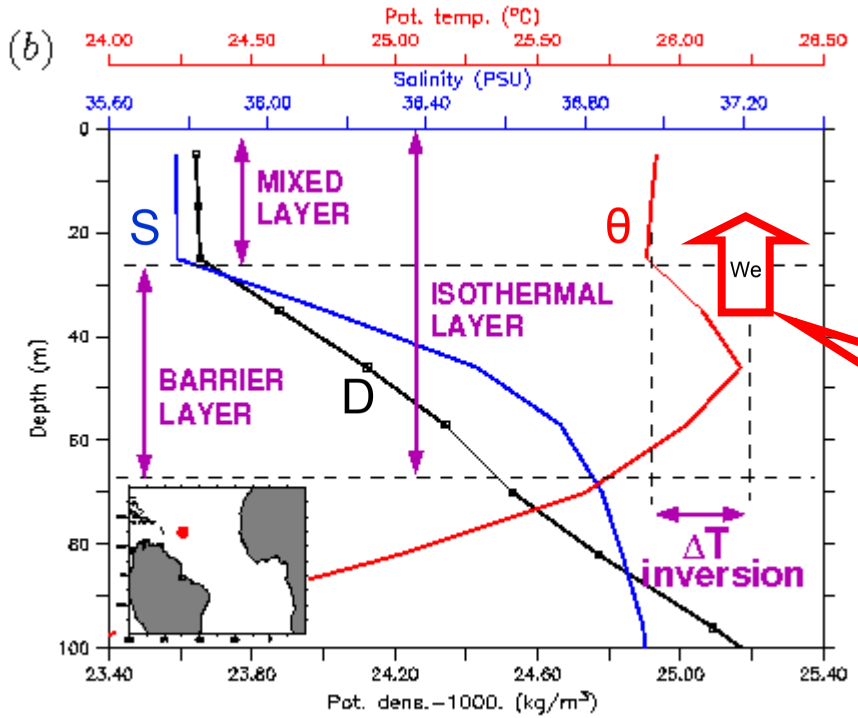
DJF



JJA



Influence BLs on SST.



(SODA, Jan 1978)

$w_e = \partial h/\partial t + \partial uh/\partial x + \partial vh/\partial y$

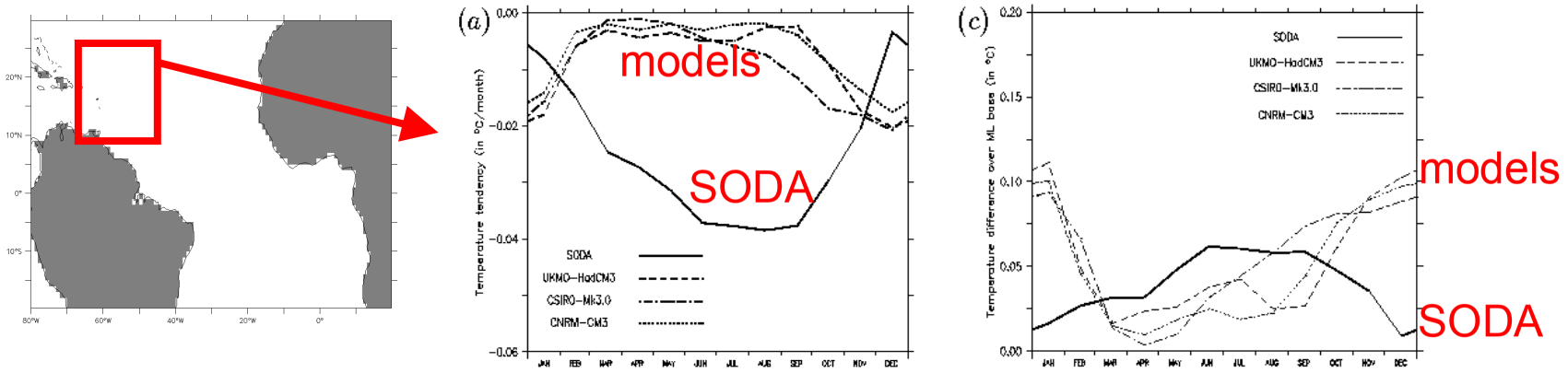
$EHF = - w_e(T - T_{-h})/h \quad (w_e>0)$

h = mixed-layer depth
T_{-h} = temp entrained water

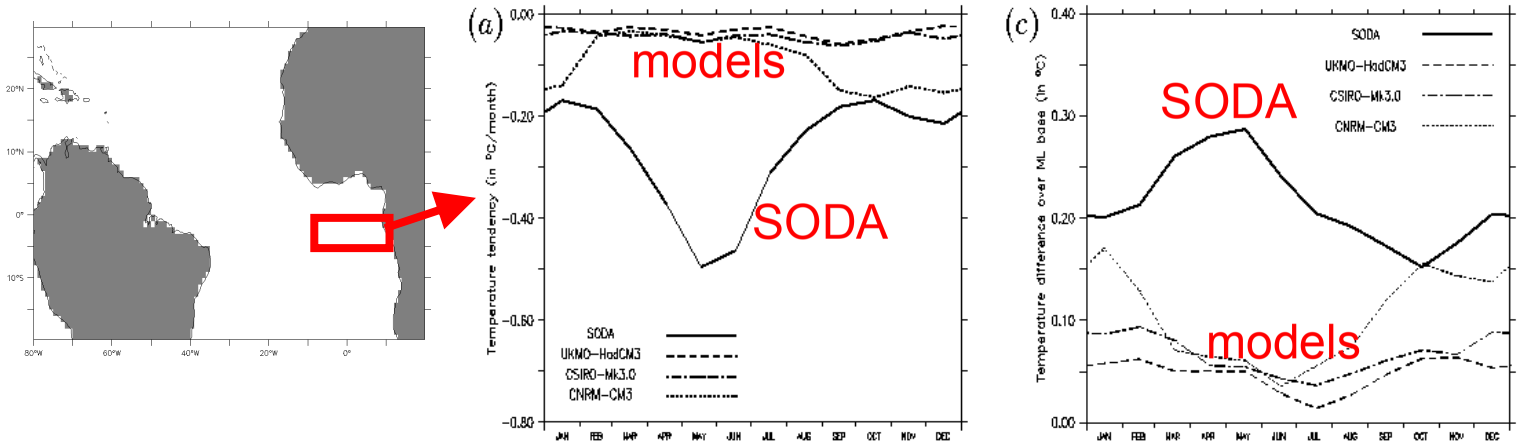
Barrier layer plays a role in maintaining the warm sea surface temperature by suppressing entrainment of cold thermocline water into mixed layer.

Biases in entrainment heat flux.

$E.H.F. = - w_e(T - T_{-h})/h$ $T- T_{-h}$



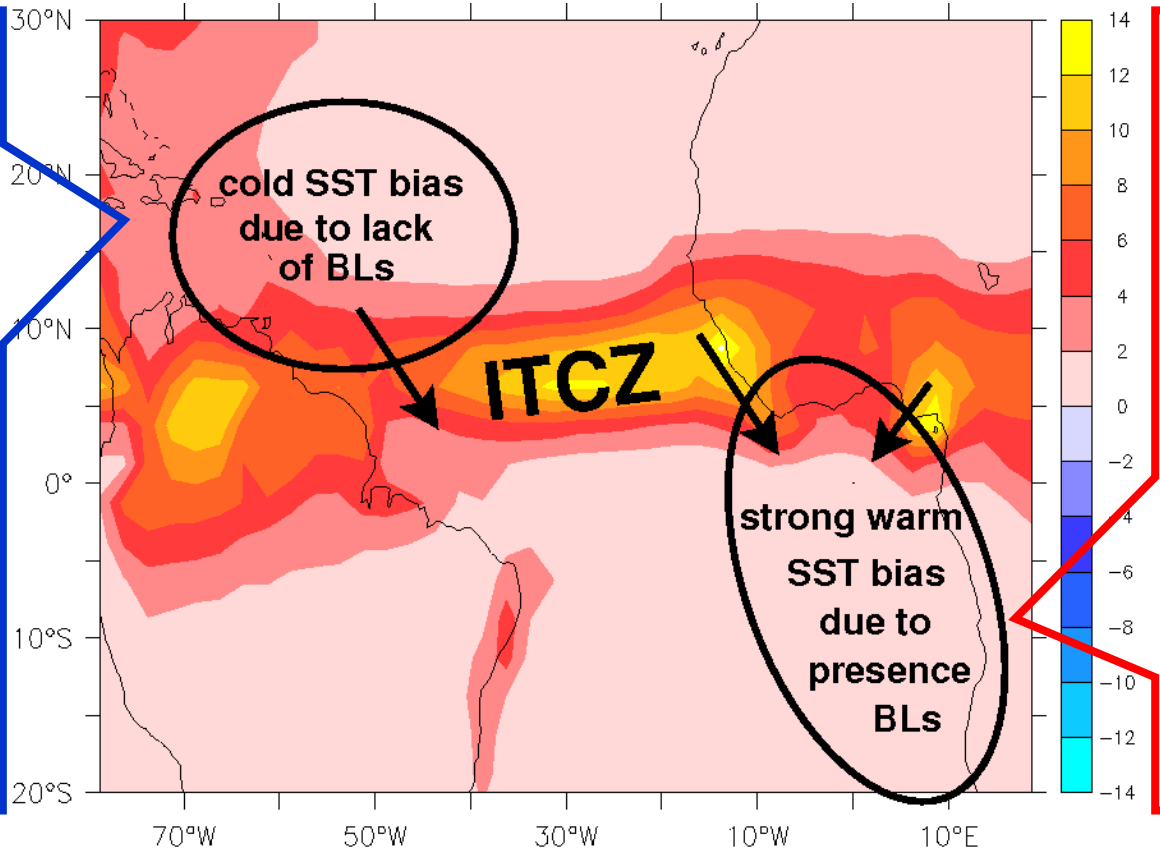
Entrainment cooling in NwTA overestimated by models during Nov-Jan.



Entrainment cooling in SeEA strongly underestimated by models.

Potential feedback mechanisms for tropical Atlantic SST biases related to BL dynamics.

1. Lack of BL causes entrainment cooling →
2. Cold SST bias →
3. Southeast shift of ITCZ →
4. Negative rainfall bias over western Atlantic warm pool →
5. Positive SSS bias preventing BL to form



1. Strong BL prevents entrainment cooling →
2. Warm SST bias →
3. ITCZ closer to the equator →
4. Positive rainfall bias over Atlantic cold tongue →
5. Negative SSS bias forming a stronger BL

Conclusions and discussion.

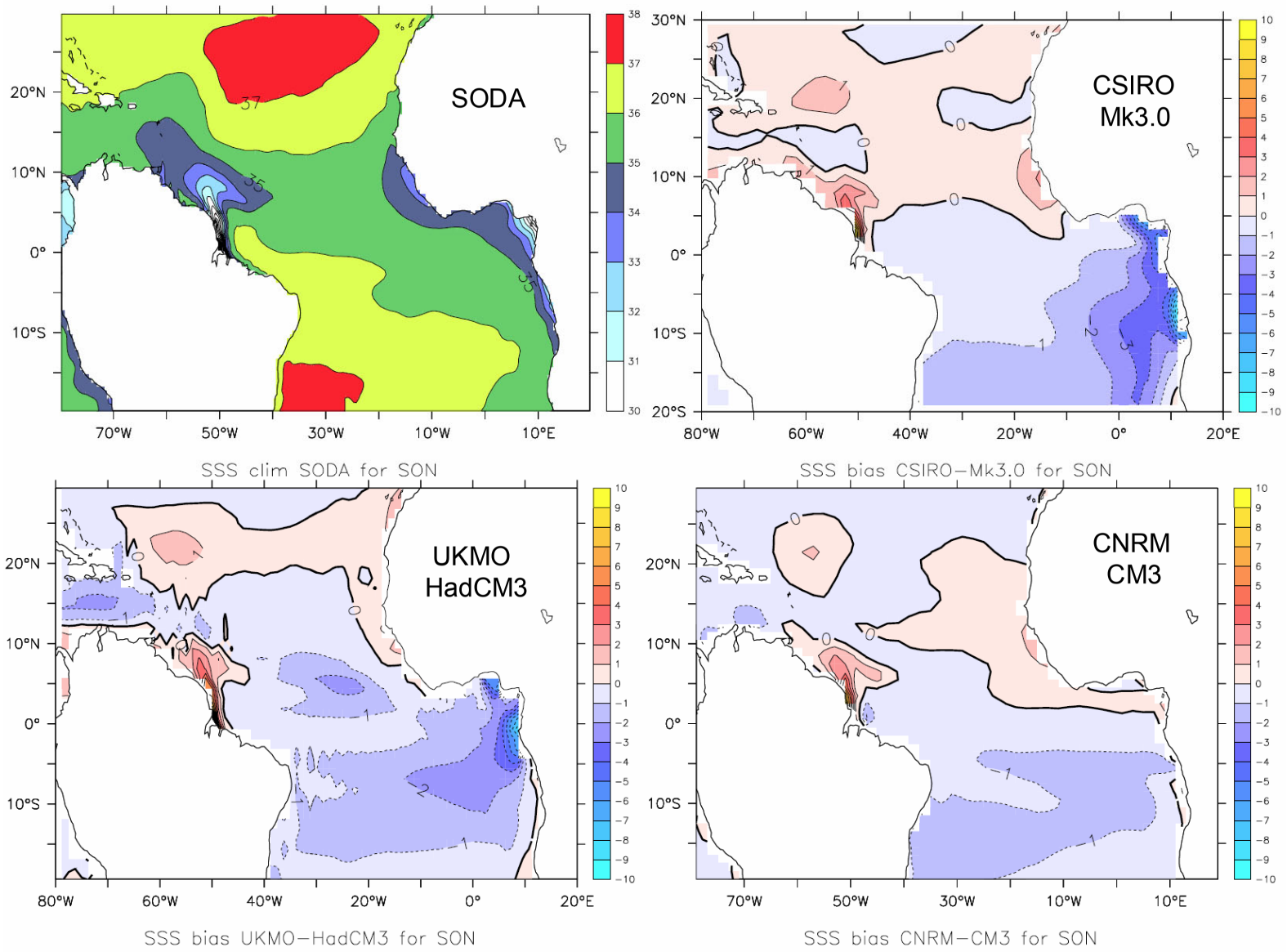
1. Consistent with recent studies, e.g., Foltz and McPhaden (2007), we found that the BL may play an important role in maintaining warm SST in the Atlantic warm pool region.

2. In addition to errors in simulated surface winds and surface heat fluxes suggested by previous studies, coupled climate models' SST biases in the Atlantic warm pool and cold tongue regions may also be attributed to models' inability to simulate BL.

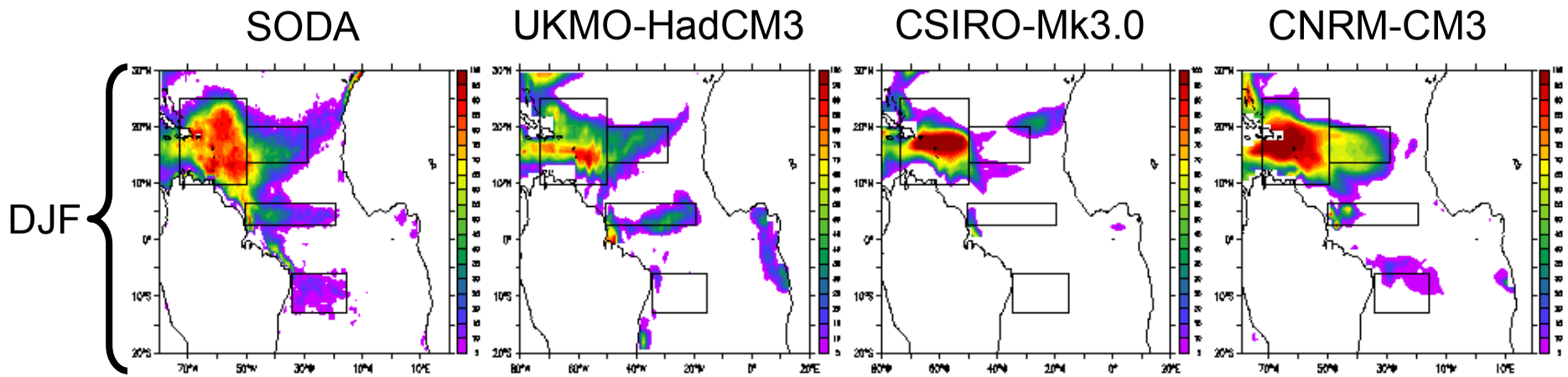
3. Formation of the BL in the tropical Atlantic potentially involves a positive ocean-atmosphere feedback. The extent to which this climate feedback is important in maintaining the mean climate state needs to be further explored.

- Implication: Coupled GCMs need to be improved for accurate simulation of salinity stratification.

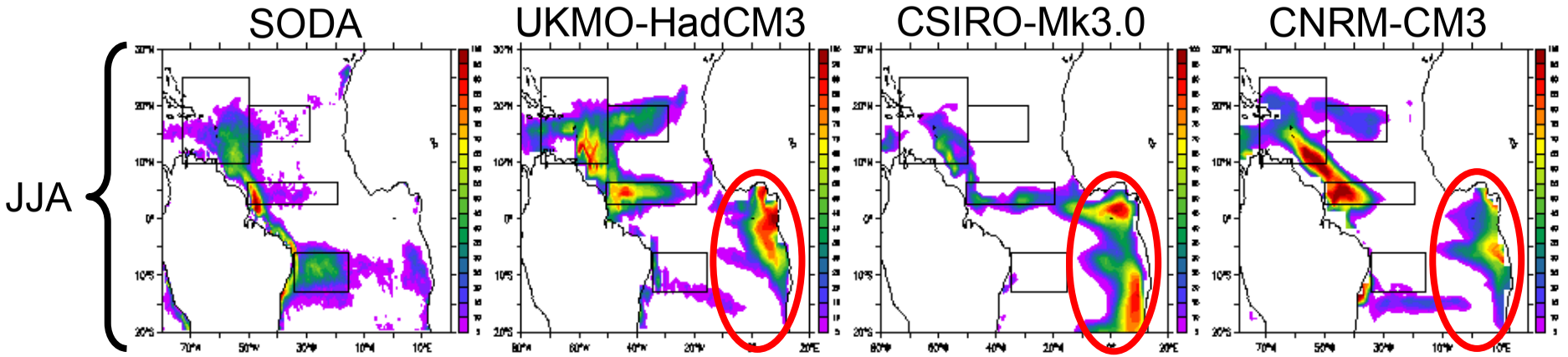
Sea surface salinity biases in SON.



Seasonal variation in BL occurrence (in %) in coupled GCMs.



Generally less frequent presence of BLs over Northwestern tropical Atlantic in DJF.



Erroneous presence of BLs over Southeastern equatorial Atlantic in JJA.