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Rethinking the role of the Bjerknes feedback in the equatorial Atlantic

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The Bjerknes feedback is considered to play a central role in the El Niño-Southern Oscillation (ENSO) phenomenon, which dominates interannual variability in the equatorial Pacific. The underlying feedback mechanism consists of three components: 1) a weakening of the equatorial trades (westerly wind anomalies) in the western basin deepens the thermocline in the east; 2) the deepened thermocline reduces upwelling efficiency and warms sea-surface temperature (SST) in the east; 3) warm SSTs further weaken the equatorial trades. Various studies have suggested that a similar feedback mechanism operates in the equatorial Atlantic. The current study, on the other hand, presents evidence that the role of the Bjerknes feedback is much weaker than previously thought. This is due to the weakness of components 2) and 3) of the feedback mechanism.

The weakness of component 2) is related to off-equatorial influences on the equatorial Atlantic. Both observations and model simulations suggest that wind stress curl north of the equator generates subsurface warming that is transported to the equator where it can initiate a warm event. The relevant wind stress curl pattern features easterly anomalies on the equator, which, by themselves, would act to shoal the thermocline and cool SSTs. The off-equatorial influence counteracts this cooling and thus weakens component 2) of the Bjerknes feedback.

General circulation model (GCM) experiments indicate that equatorial Atlantic surface wind variability reduces by only about 20% when climatological SSTs are prescribed, compared to the fully coupled simulation. This suggests that SST anomalies have only limited influence on equatorial Atlantic surface winds, which undermines component 3) of the Bjerknes feedback.

These findings have important implications for seasonal prediction of the equatorial Atlantic. Particularly the large internal atmospheric component of surface wind variability (∼80%) diminishes prospects of skillful long-lead predictions. Off-equatorial influences further complicate the task. Potential implications for equatorial Pacific variability will be discussed.