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RELATIONSHIP BETWEEN WARM WATER VOLUME AND EL NIÑO SOUTHERN OSCILLATION : PHYSICAL INTERPRETATION AND ASYMMETRY

par Yann PLANTON

LOCEAN, Paris

en salle Joël Noilhan

Résumé :

El Niño–Southern Oscillation (ENSO) is the dominant mode of interannual climate variability, with large environmental impacts at the global scale. With anomalous warming of up to 4°C in the eastern equatorial Pacific, extreme El Niño, such as in late 1982, 1997 and 2015, involve a complete re-organization of tropical convection
with outsized societal impacts relative to moderate El Niño. Despite an improved understanding of ENSO dynamics over the past decades, predicting ENSO's amplitude remains a challenge, especially at long lead-times. The recharge oscillator theory highlighted the role of the oceanic heat content averaged over the equatorial Pacific as a robust precursor of ENSO several seasons ahead, providingsome hope to improve long-lead time ENSO forecasts.
The water warmer volume (WWV), proxy of the equatorial Pacific heat content, is the
most widely used precursor of ENSO. The standard interpretation of this lead relation in the context of the recharge oscillator theory is that anomalous easterlies during a La Niña, favour a slow recharge of the equatorial Pacific that will later favour a transition to El Niño. Using idealised experiments with a linear continuously stratified (LCS) ocean model, we demonstrate that WWV in spring mostly reflects the fast Kelvin wave response to wind anomalies during the early months of the year. It is hence not an appropriate index of the slow recharge invoked in the recharge oscillator. The evolution of the heat content over the western equatorial Pacific (WWVW) is dominated by the forced Rossby wave response to wind anomalies over the previous 10 months. WWVW hence involves a longer-term recharge than WWV, thus we recommend using WWVW rather than WWV as an index for the slow recharge before the spring predictability barrier. The recharge oscillatortheoryis however essentially linear and does not account for the potential asymmetries existing between El Niño and La Niña events. Yet, observations suggest that the ocean preconditioningis a more efficient predictor for La Niña than for El Niño events. Because of large uncertainties related to the short observational record, we analyse this asymmetry in a set of pre-industrial control experimentsfrom eleven coupled models, selected for their capability to simulate observed ENSO variability. As suggested by observations, the discharge one year before ENSO peak in these models is a significantly better precursor of La Niña occurrence and amplitude than the recharge for El Niño. This asymmetry likely arises from (1) the asymmetry of the ocean preconditioning that promotes a larger influence on La Niña (larger discharge) than on El Niño (weaker recharge) and from (2) a nonlinear Bjerknes feedback that promotes the growth of El Niño rather than La Niña.

Pour tout renseignement, contacter Y. Poirier (05 61 07 96 55) ou J.L. Sportouch (05 61 07 93 63)
Centre National de Recherches Météorologiques
42, Avenue G. Coriolis - 31057 Toulouse Cedex