Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

AAS23-P07 Room:Convention Hall Time:May 22 17:15-18:30

Inpact of tropical instability waves on ENSO characteristics

IMADA, Yukiko[1*], Masahide Kimoto[2]

[1]Graduate School of Information Science and Engineering, Tokyo Institute of Technology, [2]Atmosphere and Ocean Research Institute, University of Tokyo

In this study, the impact of TIWs in the Pacific Ocean on El Nino/Southen Oscillation (ENSO) is investigated by introducing a new scheme of TIWs into our AOGCM MIROC with medium resolution.

Tropical instability waves (TIWs) are equatorial sub-synoptic-scale eddies observed both in the Pacific and Atlantic Oceans as cusp-shaped frontal waves propagating westward during the second half of the year, and are an important mechanism for distributing heat in the meridional direction. Recently, Yu and Liu (2003) showed that TIW intensity increases during La Nina years and is reduced during El Nino years with a linear relationship, which is related to the mechanism generating baroclinic instability. Furthermore, An (2008) suggested that TIWs could play an important role in producing the asymmetry between El Nino and La Nina. It is suggested that asymmetric heat transport associated with TIWs which are active (inactive) during La Nino (El Nino) gives an significant asymmetric negative feedback to ENSO, and explain the observed asymmetric feature of stronger-amplitude El Nino and weaker-amplitude La Nina asymmetry. However, there are several potential nonlinear processes causing the asymmetric behavior of ENSO in the tropical air-sea coupled system. The ENSO model presented by An (2008) is too simple to confirm the TIW contribution in the presence of other potential processes causing ENSO asymmetry. In this study, we investigated the impact of TIWs on ENSO characteristics in the mixture of nonlinear processes using an atmosphere and ocean general circulation model (AOGCM) MIROC. 100-year integrations were performed with and without the TIW parameterization which was the first attempt to represent the TIW-induced baroclinic eddy heat transport (Imada and Kimoto 2012).

A comparison between two experiments figured out important roles of baroclinic eddies in ENSO characteristic. One is the responsibility of TIWs for ENSO asymmetry. The GCM run with the TIW scheme showed larger skewness of sea surface temperature (SST) anomalies in the ENSO active region, which supports An (2008). Its effect was dominant compared with the other asymmetric sources such as nonlinear dynamical heating of ENSO (An and Jin 2004).The other role of baroclinic eddies is to change the mechanism of ENSO phase transition from a SST mode (Neelin et al,. 1998 ;Guilyardi, 2006) to a thermocline mode (Guilyardi, 2006) due to the stratification modified by the eddy heat transport around the off-equatorial thermocline. It also promotes the lower frequency of ENSO.

The resulting changes in ENSO characteristics are consistent with the observed ENSO modulation including increase of period, asymmetry, and shift from SST to thermocline mode, concurrent with the observed 1970's climate shift. The result of ocean assimilation conducted by high-resolution AOGCM also shows the increasing TIW activity through the increasing meridional density gradient in the eastern tropical Pacific associated with the climate shift. Therefore, this numerical approach provided a new suggestion that TIWs have an important role in the interaction between the Pacific decadal variability and ENSO, and have possibility to contribute to the understanding of them.

Keywords: El Nino/Southern Oscillation, Tropical instability waves, Atmosphere and Ocean General Circulation Model, parameterization