Supplemental Material

The double peaked El Niño and its physical processes

(Supplementary Figures)

Na-Yeon Shin[1], Jong-Seong Kug[1], F. S. McCormack[2] and Neil J. Holbrook[3]

[1]Division of Environmental Science and Engineering, Pohang university of Science and Technology (POSTECH), Pohang, Korea

[2]School of Earth, Atmosphere & Environment, Monash University, Clayton, Victoria 3168, Australia

[3]Institute for Marine and Antarctic Studies and ARC Centre of Excellence for Climate Extremes, University of Tasmania, Hobart, Tasmania 7001, Australia

J. Climate (Revised version submitted)

Sep, 2020

Correspondence: Prof. Jong-Seong Kug, Division of Environment Science and Engineering, Pohang University of Science and Technology (POSTECH), Pohang 37673, South Korea.

jskug1@gmail.com

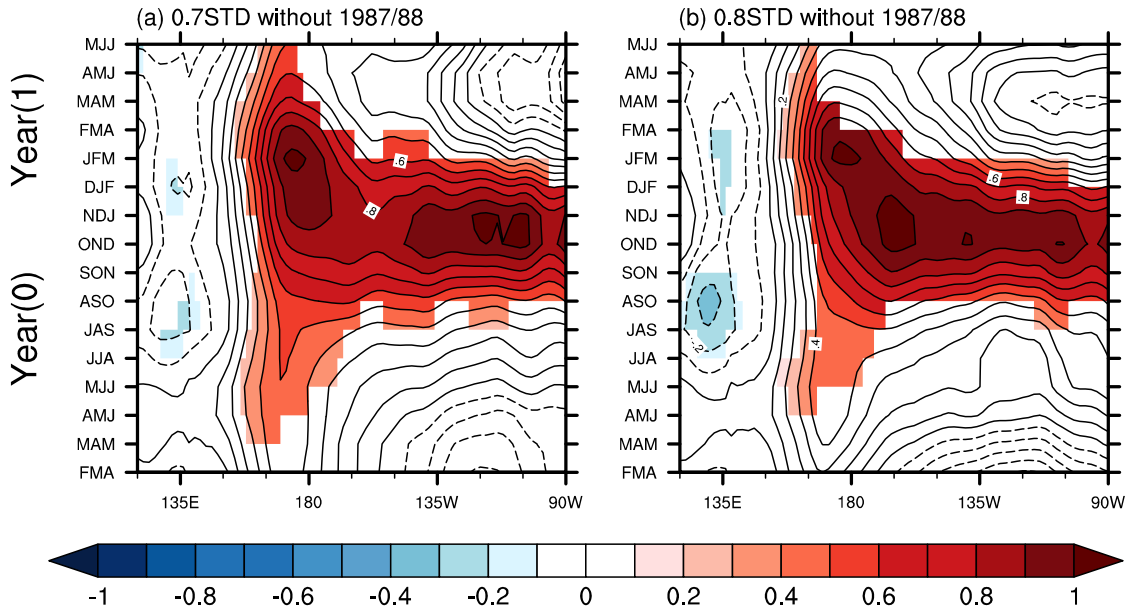

Fig S1. Composite evolution of the DP El Niño with the criteria of (a) 0.7 standard deviation and (b) 0.8 standard deviation except for 1987/88 El Niño case. The SSTA are normalized by the NDJ SSTA index of each year. X-axis is longitude and Y-axis is months of the year of El Niño type evolution. Shadings indicate the 90% confidence level. Unitless for all.

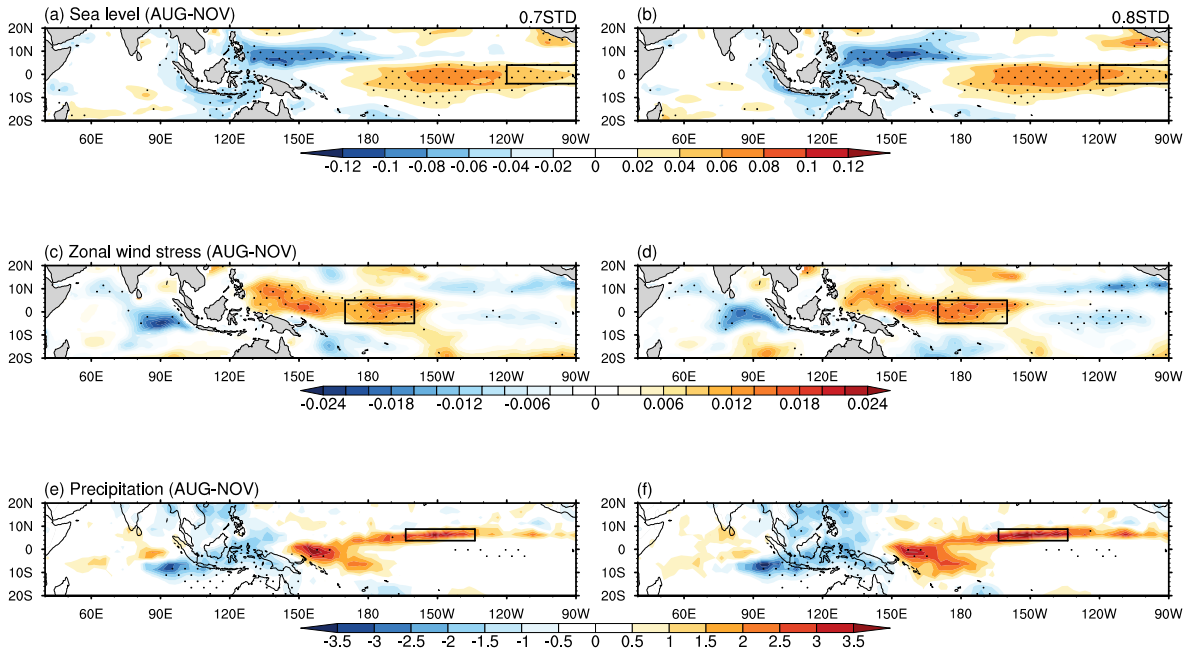

Fig S2. Composite of the (a), (b) sea level anomalies, (c), (d) zonal wind stress anomalies, and (e), (f) precipitation anomalies of the DP El Niños for the development period. All variables are normalized same as Figure 3. Left column is with the criteria of 0.7 standard deviation and right column is with the 0.8 standard deviation. The stippling (dots) indicates regions where values are significant at the 90% confidence level. Black boxes represent the area where the difference appears. The units are (m $^{\circ}C^{-1}$) for (a), (N m^{-2} $^{\circ}C^{-1}$) for (b), and (mm day^{-1} $^{\circ}C^{-1}$) for (c).

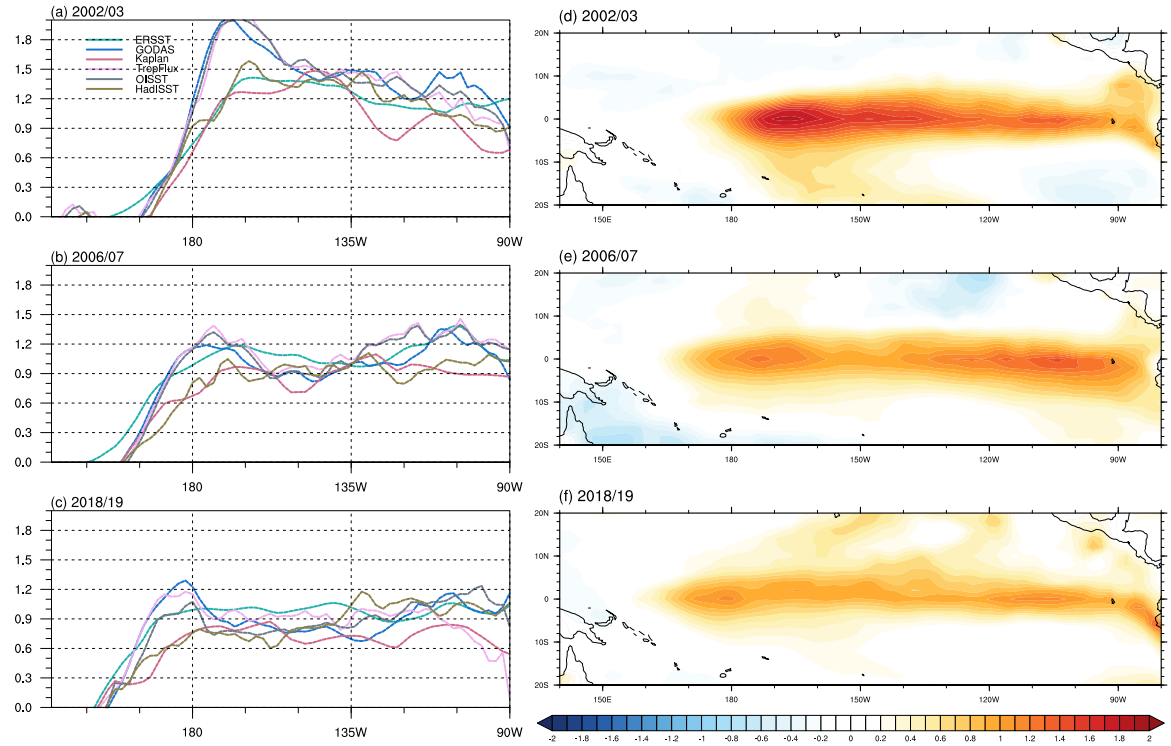

Fig S3. To check the data dependence of SST, we use the Optimum Interpolation SST (OISST), the Hadley Centre SST (HadISST), Kaplan SST and TropFlux SST (Reynolds et al. 2002; Kaplan et al. 1998; Rayner et al. 2006; Kumar et al. 2012) as well as ERSST and GODAS. Latitude (2S-2N) averaged individual SSTA (℃) of NDJ for (a) 2002/03, (b) 2006/07 and (c) 2018/19. (d), (e) and (f) are the composite of SSTA except for HadISST dataset.

References

Kaplan, A., M. A. Cane, Y. Kushnir, A. C. Clement, M. B. Blumenthal, and B. Rajagopalan, 1998: Analyses of global sea surface temperature 1856–1991. *J Geophys Res Oceans*, **103**, 18567–18589, https://doi.org/10.1029/97jc01736.

Kumar, B. P., J. Vialard, M. Lengaigne, V. S. N. Murty, and M. J. McPhaden, 2012: TropFlux: air-sea fluxes for the global tropical oceans—description and evaluation. *Clim Dynam*, **38**, 1521–1543, https://doi.org/10.1007/s00382-011-1115-0.

Rayner, N. A., P. Brohan, D. E. Parker, C. K. Folland, J. J. Kennedy, M. Vanicek, T. J. Ansell, and S. F. B. Tett, 2006: Improved Analyses of Changes and Uncertainties in Sea Surface Temperature Measured In Situ since the Mid-Nineteenth Century: The HadSST2 Dataset. *J Climate*, **19**, 446–469, https://doi.org/10.1175/jcli3637.1.

Reynolds, R. W., N. A. Rayner, T. M. Smith, D. C. Stokes, and W. Wang, 2002: An Improved In Situ and Satellite SST Analysis for Climate. *J Climate*, **15**, 1609–1625, https://doi.org/10.1175/1520-0442(2002)015<1609:aiisas>2.0.co;2.