Pacific climate variability

SIOC 209 (1 unit), Spring 2018

Time: Monday 930-1030am; **place**: Spiess Hall 330
Instructor: Shang-Ping Xie, Tel: 822-0053; sxie@ucsd.edu;
Class website: http://ted.ucsd.edu

La Nina condition persists in the tropical Pacific, steering winter storms away from California and driving the state back to drought. The Godzilla El Nino two winters ago failed to bring highly anticipated storms and rains to California. In the following winter with the tropical Pacific in a weak La Nina state, rain storms battered California staging a spectacular decadal bloom. The 2015-16 El Nino was successfully forecast but the same models sounded a false alarm and predicted a strong warm event to take place in late 2014. What about the Big Blob? Did it affect California climate?

The Pacific is home to El Nino/the Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO). What triggers ENSO, what makes each El Nino different from the others, and what is the role of atmospheric noise such as the Madden-Julian Oscillation and North Pacific Oscillation? What determines ocean-atmospheric teleconnections from the tropical Pacific to remote regions in North America and Asia? What causes the seasonal phase-locking of the variability? What are the new advances and outstanding issues in ENSO prediction? What drives extratropical ocean variability, and how is it fundamentally different from that in the tropics?

The seminar takes a deep look into these questions by discussing key papers in the literature. At the first meeting on April 2, the instructor will give a lecture overviewing the broad theme of the seminar. A list of possible topics is provided below. Each registered student is expected to present a main paper for discussion. Everyone in the group will read the main paper before the seminar. The presenter or the instructor may follow with a mini-review to discuss related aspects of the research. The choices by the registered students and other volunteer participants will shape up the final lineup of topics (diagnostic vs. theoretical, atmosphere vs. ocean).

Learning objectives: to gain an understanding of ocean-atmospheric dynamics giving rise to rich variability in the Pacific Ocean, including the role of tropical-extratropical interactions and possible changes in such variability under greenhouse warming.

Topics. The following list includes 20 topics, each with one or more suggested papers. Please choose a main paper and email the instructor your choice by April 4 (W). Suggestions for other topics/papers are welcome.

Equatorial ocean heat budget and coupled instability

Jin, F.-F., S. T. Kim, and L. Bejarano (2006), A coupled-stability index for ENSO, *Geophys. Res. Lett.*, 33, L23708, doi:10.1029/2006GL027221.

Observations of recharge

Meinen, C.S. and M.J. McPhaden, 2000: Observations of Warm Water Volume Changes in the Equatorial Pacific and Their Relationship to El Niño and La Niña. *J. Climate,* **13**, 3551–3559, https://doi.org/10.1175/1520-0442(2000)013<3551:OOWWVC>2.0.CO;2

Ishida, A., Y. Kashino, S. Hosoda, and K. Ando (2008), North-south asymmetry of warm water volume transport related with El Niño variability, *Geophys. Res. Lett.*, 35, L18612, doi:10.1029/2008GL034858.

ENSO phase lock

Vecchi, G.A. and D.E. Harrison, 2006: The Termination of the 1997–98 El Niño. Part I: Mechanisms of Oceanic Change. *J. Climate,* **19**, 2633–2646, https://doi.org/10.1175/JCLI3776.1

ENSO diversity

Lengaigne, M. and Vecchi, G. A., 2010: Contrasting the termination of moderate and extreme El Nino events in coupled general circulation models. *Clim. Dyn.* 35, 299-313.

Capotondi, A., and Coauthors, 2015: Understanding ENSO diversity. *Bull. Amer. Meteor. Soc.*, **96,** 921-938, https://doi.org/10.1175/Bams-D-13-00117.1

Wind burst effect

Levine, A. F. Z., McPhaden, M. J., 2016: How the July 2014 easterly wind burst gave the 2015-2016 El Nino a head start. *Geophys. Res. Lett.*, 43, 6503-6510.

Hu, S., Fedorov, A. V., 2016: Exceptionally strong easterly wind burst stalling El Nino of 2014. *PNAS* 113, 2005-2010.

Pacific meridional mode

Vimont, D. J., Alexander, M., Fontaine, A. 2009: Midlatitude Excitation of Tropical Variability in the Pacific: The Role of Thermodynamic Coupling and Seasonality. *J. Climate*, 22, 518-534.

Larson, S. M.; Kirtman, B. P., 2014: The Pacific Meridional Mode as an ENSO Precursor and Predictor in the North American Multimodel Ensemble. *J. Climate*, 27, 7018-7032.

ENSO variance cycle

Wittenberg, A.T., A. Rosati, T.L. Delworth, G.A. Vecchi, and F. Zeng, 2014: ENSO Modulation: Is It Decadally Predictable?. *J. Climate*, **27**, 2667–2681, https://doi.org/10.1175/JCLI-D-13-00577.1

ENSO asymmetry

An, S. and F. Jin, 2004: Nonlinearity and Asymmetry of ENSO. *J. Climate*, **17**, 2399–2412, https://doi.org/10.1175/1520-0442(2004)017<2399:NAAOE>2.0.CO;2

Takahashi K, Karamperidou C, Dewitte B (2018) A theoretical model of strong and moderate El Niño regimes. *Clim Dyn*. https://doi.org/10.1007/s00382-018-4100-z

ENSO effect on tropical cyclones

Camargo, S.J., A.W. Robertson, S.J. Gaffney, P. Smyth, and M. Ghil, 2007: Cluster Analysis of Typhoon Tracks. Part II: Large-Scale Circulation and ENSO. *J. Climate*, **20**, 3654–3676, https://doi.org/10.1175/JCLI4203.1

ENSO effect on extratropical storms and atmospheric rivers

Shapiro, M. A., et al. (2001), The influence of the 1997–99 El Niño Southern Oscillation on extratropical baroclinic life cycles over the eastern North Pacific. *QJ Royal Met. Soc.*, 127: 331–342.

ENSO effect on California beaches and fisheries

Barnard, P. L., et al. (2017). Extreme oceanographic forcing and coastal response due to the 2015–2016 El Niño. *Nature Communications*, *8*, 14365. http://doi.org/10.1038/ncomms14365

D. M. Checkley, R. G. Asch, and R. R. Rykaczewski, 2017: Climate**,** Anchovy, and Sardine. *Annual Rev. Marine Sci.* 9, 469-493, https://doi.org/10.1146/annurev-marine-122414-033819.

ENSO teleconnection

Trenberth, KE; et al., 1998: Progress during TOGA in understanding and modeling global teleconnections associated with tropical sea surface temperatures. *J. Geophys. Res.-Oceans*, 103, 14291-14324.

Branstator, G. W., 1990: Low-frequency patterns induced by stationary waves, *J. Atmos. Sci.*, 47, 629–648.

Seasonal prediction

Kirtman, Ben P.; Min, Dughong; Infanti, Johnna M.; et al., 2014: THE NORTH AMERICAN MULTIMODEL ENSEMBLE. *Bull. Amer. Meteor. Soc.*, 95, 585-601.

Larson, S. M.; Kirtman, B. P., 2017: Drivers of coupled model ENSO error dynamics and the spring predictability barrier. *Clim. Dyn.*, 48, 3631-3644.

Coupled modeling of ENSO

Bellenger, H.; Guilyardi, E.; Leloup, J.; et al., 2014: ENSO representation in climate models: from CMIP3 to CMIP5. *Clim. Dyn.* 42, 1999-2018.

Internal vs. forced atmospheric variability

Straus, D.M. and J. Shukla, 2002: Does ENSO Force the PNA?. *J. Climate*, **15**, 2340–2358, https://doi.org/10.1175/1520-0442(2002)015<2340:DEFTP>2.0.CO;2

Kumar, A. and M.P. Hoerling, 1995: Prospects and Limitations of Seasonal Atmospheric GCM Predictions. *Bull. Amer. Meteor. Soc.*, **76**, 335–345, https://doi.org/10.1175/1520-0477(1995)076<0335:PALOSA>2.0.CO;2

Linkin, M. E.; Nigam, S., 2008: The north pacific oscillation-west Pacific teleconnection pattern: Mature-phase structure and winter impacts. *J. Climate*, 21, 1979-1997.

Large-scale extratropical ocean-atmosphere interaction

Kwon, Y., et al., 2010: Role of the Gulf Stream and Kuroshio–Oyashio Systems in Large-Scale Atmosphere–Ocean Interaction: A Review. *J. Climate*, **23**, 3249–3281, https://doi.org/10.1175/2010JCLI3343.1

Newman, M., et al., 2016: The Pacific Decadal Oscillation, Revisited. *J. Climate*, **29**, 4399–4427, https://doi.org/10.1175/JCLI-D-15-0508.1

SST front-wind interaction

Ma, X. et al., 2016: Western boundary currents regulated by interaction between ocean eddies and the atmosphere. *Nature* 535, 533-537.

Bryan, F.O., et al., 2010: Frontal Scale Air–Sea Interaction in High-Resolution Coupled Climate Models. *J. Climate*, **23**, 6277–6291, https://doi.org/10.1175/2010JCLI3665.1

Pacific decadal oscillation

Chen, X., and J.M. Wallace, 2015: ENSO-like variability: 1900–2013. *J. Atmos. Sci.*, 28(24), 9623–9641, doi:10.1175/JCLI-D-15-0322.1.

Chen, X., and J.M. Wallace, 2016: Orthogonal PDO and ENSO indices. *J. Climate*, 29, 38833–3892, doi:0.1175/JCLI-D-15-0684.1.

Clement, A., P. Dinezio, and C. Deser, 2011: Rethinking the ocean's role in the Southern Oscillation. *J. Climate*, 24, 4056–4072, doi:10.1175/2011JCLI3973.1.

Kuroshio Extension variability

Qiu, B., S. Chen, N. Schneider, and B. Taguchi, 2014: A Coupled Decadal Prediction of the Dynamic State of the Kuroshio Extension System. *J. Climate*, **27**, 1751–1764, https://doi.org/10.1175/JCLI-D-13-00318.1

ENSO in warming climate

Power, S., F. Delage, C. Chung, G. Kociuba, and K. Keay, 2013: Robust twenty-first-century projections of El Niño and related precipitation variability. *Nature*, **502**, 541–545, doi:https://doi.org/10.1038/nature12580.

Cai, W., and Coauthors, 2014: Increasing frequency of extreme El Niño events due to greenhouse warming. *Nat. Climate Change*, 4, 111–116, doi:https://doi.org/10.1038/nclimate2100.