Tropical Pacific Decadal Variability: Oceanic Processes and Inter-Basin Interactions
Terms of reference

Tentative member list:

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Potential members external to the panel: M. Balmaseda, J. Emile-Geay, R. Farneti, N. Holbrook, F. Kucharski, B. Qiu, A. Santoso, J. Sprintall, C. Ummenhofer

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Motivation

Tropical Pacific Decadal Variability (TPDV, defined here as the naturally-occurring variations at timescales from 8 to 40 years) plays an important role in the global climate as evident from its influence on the recent slowdown of the global surface temperature trend. These internal decadal variations also confound the detection of the climate change signal in the tropical Pacific, and modulate the tropical Pacific background conditions, which affect the amplitude, frequency and spatial pattern of ENSO events on interannual timescales. Understanding the nature and predictability of TPDV, its representation in climate models, and its projected changes is therefore of great value. While a significant fraction of TPDV may result as ENSO residual, we know that there are other processes that can give rise to decadal variations in the tropical Pacific. An example of such processes involves the upper-ocean meridional overturning circulation in both Hemispheres, known as Subtropical-Tropical Cells (STCs) as well as oceanic Rossby waves, which mediate the STC adjustment and the evolution and structure of tropical Pacific heat content. While the connection between STC strength and equatorial SSTs has been shown in observational and modelling studies, several questions remain open:

a) Variability in the interior pycnocline transport (i.e., away from the western boundary) appears to be anti-correlated with the transport in the Low Latitude Western Boundary Currents (LLWBC); the relative influence of these two components of the transport on the equatorial upper-ocean heat content is not clear. In particular, it is not clear which fraction of the boundary transports enters the equatorial thermocline relative to the fraction that exits the Pacific through the Indonesian Throughflow (ITF), and the extent to which this partition is controlled by the Indian Ocean conditions;
b) The location of the winds that are most effective in forcing the STCs and their origin. In particular, do these wind variations arise as a response to equatorial SST anomalies, or are they purely stochastic? Are they controlled by extra-tropical influences in the Pacific sector, or are they related to influences from the Atlantic and Indian Oceans through atmospheric teleconnections? The answers to these questions are key for understanding the predictability of STC variability and TPDV.
c) While the STCs have been related to TPDV via circulation changes, the role of advection of temperature (or spiciness) anomalies by the mean circulation may also play a role. The feasibility for spiciness anomalies to reach the equator has been demonstrated in some modelling studies, but the influence of these subsurface anomalies on equatorial SSTs needs to be understood.
d) Available instrumental records are relatively short to robustly characterize TPDV and constrain its representation in models. Paleo-climate information could help extend

the observational record further back in time, but the suitability of proxy data for characterizing STC variability and its drivers needs to be assessed.

e) STC variability and TPDV can be expected to change in a warming world, but the nature of these changes has not yet been investigated.

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This working group intends to:

1. Review the existing literature on the characteristics of the STCs, and their linkages with equatorial SST anomalies in both observations and modelling studies. Identify the elements that are robust and consistent among modelling studies vs. those that are less certain and in need of further exploration. In particular, assess how model-dependent results are.
2. Review the current state of understanding of the interactions between Low Latitude Western Boundary Currents (LLWBC) and tropical Pacific heat content and upwelling in observations, reanalysis products, and General Circulation Models (oceanic and coupled).
3. Review current understanding of how the state of the Indian Ocean can influence the tropical Pacific Ocean heat discharge through its control on the ITF at decadal timescales (in analogy to what proposed for ENSO) and whether it can affect the contribution of the LLWBC to the tropical Pacific equatorial thermocline heat content. This may include liaising with the Indian Ocean Regional Panel.
4. Review current state of knowledge on the influence of the Indian and Atlantic regions on the Pacific basin via atmospheric teleconnections - including liaising with the Pan-tropical Interactions Focus group to assess the role played by inter-basin interactions on TPDV.
5. Review studies that assess the fidelity of state-of-the-art climate models in reproducing the key processes described above and identify aspects in need of further examination.
6. Explore how paleo-climate data and paleo simulations can deepen our understanding of TPDV by extending the instrumental record.
7. Examine which changes may occur to TPDV under different warming scenarios, what causes them, and how robustly they are represented in models.
8. Summarize the findings of the working group in one or more papers, including one review paper, and possibly other papers presenting new research resulting from collaborations among WG members, e.g., the examination of the STCs in ocean model simulations forced with the same atmospheric forcing protocol, like the OMIP simulations recently completed as part of the CMIP6 project, to assess the role of the forcing vs. models' specific structure in the representation of the STCs
9. Organize one or more conference sessions to stimulate discussions on TPDV and promote further research on the remaining open questions.

Work in this WG will be primarily conducted virtually through email exchanges and monthly conference calls. In-person meetings during conferences will also be organized whenever in-person conferences will resume and WG members can participate either in person or virtually.