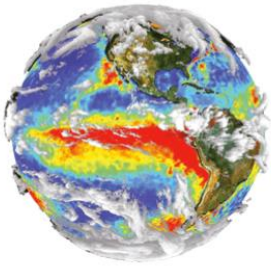

Research Focus on ENSO in a Changing Climate

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Panel/RF overview

The **Research Focus on ENSO in a Changing Climate** targets the following key goals:
1) In the context of a changing climate, improve understanding of the processes in nature and in models that control ENSO's behavior, including its inter-decadal variation and inter-event diversity.
2) Synthesize existing ENSO evaluation methods in CGCMs, promote best practices, and propose a standard ENSO evaluation protocol as a resource for model developers, impacts studies, and coordinated analysis of CMIP models.
3) Identify new observations needed to better constrain ENSO processes, both for the current climate and for past climates. This includes helping to guide the redesign of the tropical Pacific observing system (TPOS).
4) Understand how ENSO may change in the coming decades, due to anthropogenic forcings as well as intrinsically-generated variability.

Working towards these goals requires a synthesis of existing ENSO evaluation methods for CGCMs, and a hierarchy of evaluation methods and ENSO models. Gaps and duplication in these methods must be identified, and observations must be prioritized and assessed for how they can be better used. Paleo records, in particular, have significant untapped potential.

Achievements for 2016-17

- **Goal 1 & 4**: Organization of numerous ENSO sessions at international conferences. Organisation of 5th ENSO CLIVAR workshop in Busan (South Korea) in Oct 2017. Initial organization of IV International Conference on ENSO: ENSO in a warmer climate in Guayaquil (Ecuador) in Oct 2018. ENSO RF group telecons (Sept. 2017) and in person meeting in Busan. Several new publications listed below.
- **Goal 2**: Current work involves multi-model evaluation to document ENSO performance of existing models and contributing to the Metrics Panel set up under WGCM guidance. A first subset of the metrics used by Bellenger et al. (2014) for ENSO analysis in CMIP5 is being integrated into 3 evaluations systems currently developed in the community: ESMValTool (IS-ENES2 european effort), metrics package at PCMDI and CLIMAF (French community effort). A standard interface (API) is being developed to ease separation of concerns, science provenance documentation and proper governance.

- **Goal3**: Publication of TPOS first report (Cravatte et al. 2016). Participation in TPOS Backbone Task Team, TPOS Model and Data Assimilation Task Team, and NOAA's TPOS Implementation Strategy Team.

Plans for 2018 and beyond

- Goals 1 & 4: update on ENSO in a changing climate during 5th CLIVAR ENSO workshop in 2017. Write a review paper on ENSO complexity. Seek to organise an ENSO summer school.
- Goal 2: devise science provenance interface for ENSO metrics, propose a "CLIVAR ENSO Metric 2018" package addressing a number of science questions and organise community governance. Promote approach to other areas.
- Goal 3: RF group to continue provide input to TPOS w.r.t to modelling needs.

Articles published in 2016/17 as part of panel/RF activities (if any)

Atwood, A. R., D. S. Battisti, A. T. Wittenberg, W. G. H. Roberts, and D. J. Vimont, 2017: Characterizing unforced multi-decadal variability of ENSO: A case study with the GFDL CM2.1 coupled GCM. Climate Dyn., 49 (7-8), 2845-2862. doi: 10.1007/s00382-016-3477-9.

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Cravatte, S., B. Kessler, N. Smith, S. Wijffels, K. Ando, M. Cronin, T. Farrar, E. Guilyardi, A. Kumar, T. Lee, D. Roemmich, Y. Serra, J. Sprintall, P. Strutton, A. Sutton, K. Takahashi, and A. T. Wittenberg, 2016: First Report of TPOS 2020. GOOS-215, 200 pp. [Available online at http://tpos2020.org/first-report.] doi: 10.13140/RG.2.2.28674.07363.

Graham, F. S., A. T. Wittenberg, J. N. Brown, S. J. Marsland, and N. J. Holbrook, 2017: Understanding the double peaked El Niño in coupled GCMs. Climate Dyn., 48 (5), 2045-2063. doi: 10.1007/s00382-016-3189-1.

Khodri M, T. Izumo , J. Vialard , S. Janicot , C. Cassou , M. Lengaigne , J. Mignot , G. Gastineau , E. Guilyardi , N. Lebas , A. Robock , M. McPhaden (2017). Tropical explosive volcanic eruptions can trigger El Niño by cooling tropical Africa. Nature Communications, in press

Krishnamurthy, L., G. A. Vecchi, R. Msadek, H. Murakami, A. Wittenberg, and F. Zeng, 2016: Impact of strong ENSO on regional tropical cyclone activity in a high-resolution climate model in the North Pacific and North Atlantic. J. Climate, 29, 2375-2394. doi: 10.1175/JCLI-D-0468.1.

Lee, S.-K., A. T. Wittenberg, D. B. Enfield, S. J. Weaver, C. Wang, and R. M. Atlas, 2016: U.S. regional tornado outbreaks and their links to spring ENSO phases and North Atlantic SST variability. Environ. Res. Lett., 11 (4), 044008. doi: 10.1088/1748-9326/11/4/044008.

L'Heureux, M. L., K. Takahashi, A. B. Watkins, A. G. Barnston, E. J. Becker, T. E. Di Liberto, F. Gamble, J. Gottschalck, M. S. Halpert, B. Huang, K. Mosquera-Vásquez, and A. T.

Wittenberg, 2017: Observing and predicting the 2015/16 El Niño. Bull. Amer. Meteor. Soc., 98 (7), 1363-1382. doi: 10.1175/BAMS-D-16-0009.1.

Kam, J., T. R. Knutson, F. Zeng, and A. T. Wittenberg, 2016: Multi-model assessment of anthropogenic influence on record global and regional warmth during 2015. Section 2 of: "Explaining extreme events of 2015 from a climate perspective." Bull. Amer. Meteor. Soc., 97 (12), S4-S8. doi: 10.1175/BAMS-D-16-0138.1

Newman, M., A. T. Wittenberg, L. Cheng, G. P. Compo, and C. A. Smith, 2017: The extreme 2015/16 El Niño in the context of historical climate variability and change. Bull. Amer. Meteor. Soc., accepted, September 2017.

Predybaylo, E., G. Stenchikov, A. T. Wittenberg, and F. Zeng, 2017: Impacts of a Pinatubo-scale volcanic eruption on ENSO. J. Geophys. Res. Atmos., 122, 925-947. doi: 10.1002/2016JD025796

Puy M., J. Vialard, M. Lengaigne, E. Guilyardi, P. N. Di Nezio, A. Voldoire, M. Balmaseda, G. Madec, C. Menkes and M. J. McPhaden (2017). Influence of Westerly Wind Events stochasticity on El Niño amplitude: the case of 2014 vs. 2015. Clim. Dyn., in press

Stuecker, M. F., A. Timmermann, F.-F. Jin, Y. Chikamoto, W. Zhang, A. T. Wittenberg, E. Widiasih, and S. Zhao, 2017: Revisiting ENSO/Indian Ocean Dipole phase relationships. Geophys. Res. Lett., 44 (5), 2481-2492. doi:10.1002/2016GL072308.

Zhang, W., F.-F. Jin, M. F. Stuecker, A. T. Wittenberg, A. Timmermann, H.-L. Ren, J.-S. Kug, W. Cai, and M. Cane, 2016: Unraveling El Niño's impact on the East Asian monsoon and Yangtze River summer flooding. Geophys. Res. Lett., 43 (21), 11375-11382. doi: 10.1002/2016GL071190

Zhang, W., G. A. Vecchi, H. Murakami, T. Delworth, A. T. Wittenberg, A. Rosati, S. Underwood, W. Anderson, L. Harris, R. Gudgel, S.-J. Lin, G. Villarini, and J.-H. Chen, 2016: Improved simulation of tropical cyclone responses to ENSO in the western north Pacific in the high-resolution GFDL HiFLOR coupled climate model. J. Climate, 29, 1391-1415. doi: 10.1175/JCLI-D-15-0475.1.

Budget and other needs for 2018

(Please keep in mind the overall budget of CLIVAR is ~60,000 CHF for 2017 and this needs to be distributed between all activities and cover the SSG meeting.

Possibly 10k Euro for ENSO summer school in 2018 (tbc)

Aim for a total length of ~2 pages, more is fine, but not necessary

Annex A

Proforma for CLIVAR Panel requests for SSG approval for meetings

1. **Panel or Working Group:** ENSO RF
2. **Title of meeting or workshop:** 2nd session of the CLIVAR ENSO RF meeting
3. **Proposed venue:** Guayaquil, Equator
4. **Proposed dates:** 19-20 October 2018
5. **Proposed attendees, including likely number:** ENSO RF members + invitees (~12 people)
6. **Rationale, motivation and justification, including: relevance to CLIVAR science & WCRP Grand Challenges, and any cross-panel/research foci links and interactions involved:**

   Some of the ENSO RF members are involved in the SOC of the ENSO symposium. It is an opportunity to have the group meeting back to back with the ENSO international conference to review the ENSO metrics work and discuss the issues arising from the symposium.
7. **Specific objectives and key agenda items:** ENSO metrics and other issues from the symposium.
8. **Anticipated outcomes (deliverables):**
9. **Format:**
10. **Science Organizing Committee (if relevant)**
11. **Local Organizing Committee (if relevant)**
12. **Proposed funding sources and anticipated funding requested from WCRP:** USD 10k