

ENSO in a Changing Climate Research Foci

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RF overview

ENSO in a Changing Climate Research Foci started from 2015. During the past 3 years, the group has fulfilled majority of its goals, which include:

- **Goal 1: improve understanding** of the processes in nature and in models that control ENSO's behavior (decadal, diversity, climate change).
- **Goal 2: Synthesize existing ENSO evaluation methods** in CGCMs, promote best practices, and promote a standard ENSO evaluation protocol as a resource for model developers, impacts studies, and coordinated analysis of CMIP models.
- **Goal 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).
- **Goal 4: Understanding how ENSO may change** in the coming decades, due to anthropogenic forcing as well as intrinsically-generated variability.

The ENSO RF was instrumental in maintaining and developing international coordination of ENSO-related research. This was achieved by review publications, meetings, workshops and conference sessions and nurturing the next generation of ENSO researchers (invited contributions and organisation of a summer school in 2019 or 2020). A specific activity on model evaluation was launched (ENSO metrics, as presented during the Guayaquil ENSO conference in Oct 2018) and will be pursued within the Pacific Regional Panel.

The ENSO RF will end at the end of 2018. The outstanding works and partial expertise will be integrated within the CLIVAR Pacific Regional Panel. The ENSO RF co-chairs would like to thank the SSG for its support during the lifetime of the RF!

Achievements for 2017-18

Goals 1 & 4: Process Understanding:

- 4th CLIVAR ENSO Workshop on the evaluation of ENSO in Climate Models: ENSO in a changing climate (8 -10 July 2015, Paris, France), alongside with 'Our Common Future' COP21 Conference (Guilyardi et al. BAMS 2015);
- CLIVAR ENSO Workshop on ENSO Complexity (Oct. 2017, Busan, Republic of Korea);
- Joint Workshop with PRP on Decadal Variability of the Tropical Pacific (13-14 October 2018, Pedro de Manglaralto Ecuador);

- Publication of Cai et al (2015), Capotondi et al. (2015) and Timmerman et al. (2018) Reviews;
- Organization of numerous ENSO Sessions fuelled by the 2015-2016 extreme event;
- Contributed to IPCC reports and review (special report on ocean and cryosphere, scoping of IPCC AR6).

Goal 2: ENSO metrics: publication of Eyring et al. (2016) and Chen et al. (2016)

- Multi-model evaluation to document ENSO performance in CMIP;
- New set of metrics collections being integrated into a few evaluations systems: metrics package at PCMDI, ESMVal (IS-ENES3 effort).
- Pilot effort to help devise a standard way of providing model metrics that can be governed at the community level.

Goal 3 Identify new observations:

- Publication of Simmons et al. (2016), Cravatte et al. (2016);
- Contribute to the TPOS2020 effort, noted issues

The ENSO RF collaborated with PRP to lead the organisation of the IV International Conference on El Niño Southern Oscillation: ENSO in a warmer Climate, which was held on 16-18 October 2018 in Guayaquil, Ecuador. There were 6 sessions being organised during the conference, which have contributed to all the 4 goals of ENSO RF as mentioned above: 1) Ocean Observations; 2) ENSO Dynamics; 3) ENSO and Modes of Climate Variability; 4) ENSO Modeling and Prediction; 5) ENSO Impacts and Regional Process; 6) Climate Information and Sustainable Development. Five ENSO RF members were involved in the Scientific Committee of the Conference (<http://www.clivar.org/events/iv-international-conference-el-ni%C3%B1o-southern-oscillation-enso-warmer-climate>).

Plans for 2019 and beyond

Goals 1 & 4 Process Understanding:

- Organise next CLIVAR ENSO Workshop
- Organise an ENSO Summer School
- Propose new science topics (emergent constraints, simpler models, etc.)

Goal 2 ENSO metrics: publication of Eyring et al. (2016) and Chen et al. (2016)

- Finalise 3 ENSO metrics collections and publish results on CMIP5 vs. CMIP5 (summer 2019);

- Comparison of ENSO metrics implementations to devise technical standards and community governance – funded by IS-ENES3
- Contribute to launch a new potential ‘WCRP model evaluation panel’;

Goal 3 Identify new observations:

- Provide input to TPOS2020
- Identify ocean modellers for observation requirement definition

ENSO experts have identified the following goals for ENSO research to be integrated back into the CLIVAR Pacific Region Panel:

- Priority: keep the metrics activity very visible by creating a ENSO metrics task team (led by E. Guilyardi)
- Potential new science topics: 1) emergent Constraints; 2) simpler models
- Observation to serve ENSO research.
- It is proposed that A. Wittenberg joins the PRP as member.

Review articles published as part of RF activities

Cai, W., A. Santoso, G. Wang, S-W Yeh, S.-I. An, K. Cobb, M. Collins, E. Guilyardi, F-F Jin, J.-S. Kug, M. Lengaigne, M. J. McPhaden, K. Takahashi, A. Timmermann, G. Vecchi, M. Watanabe and L. Wu (2015). ENSO and greenhouse warming. *Nature Climate Change*, 5, 849–859, doi 10.1038/NCLIMATE2743

Capotondi, A., A. T. Wittenberg, M. Newman, E. Di Lorenzo, J. Y. Yu, P. Braconnot, J. Cole, B. Dewitte, B. Giese, E. Guilyardi, F.-F. Jin, K. Karneuskas, B. Kirtman, T. Lee, N. Schneider, Y. Xue, S.-W. Yeh (2015). Understanding ENSO diversity. *Bull. Amer. Met. Soc.*, 96, 921–938, doi: 10.1175/BAMS-D-13-00117.1

Eyring, V., Gleckler, P. J., Heinze, C., Stouffer, R. J., Taylor, K. E., Balaji, V., Guilyardi, E., Joussaume, S., Kindermann, S., Lawrence, B. N., Meehl, G. A., Righi, M., and Williams, D. N. (2016): Towards improved and more routine Earth system model evaluation in CMIP, *Earth Syst. Dynam. Discuss.*, doi:10.5194/esd-2016-26

Guilyardi E., A. Wittenberg, M. Balmesada, W. Cai, M. Collins, M. J. McPhaden, M. Watanabe, S-W Yeh (2016). ENSO in a Changing Climate - Meeting summary of the 4th CLIVAR Workshop on the Evaluation of ENSO Processes in Climate Models. *Bull. Amer. Met. Soc.* doi: 10.1175/BAMS-D-15-00287.1

Simmons A., J-L Fellous, V. Ramaswamy, K. Trenberth, G. Asrar, M. Balmaseda, J. P. Burrows, P. Ciais, M. Drinkwater, P. Friedlingstein, N. Gobron, E. Guilyardi, D. Halpern, M. Heimann, J. Johannessen, P. F. Levelt, E. Lopez-Baeza, J. Penner, R. Scholes, T. Shepherd (2016), Observation and integrated Earth-system science: A roadmap for 2016–2025, *Advances in Space Research*, Published online, doi:10.1016/j.asr.2016.03.008

Timmermann, A., An, S.-I., Kug, J.-S., Jin, F.-F., Cai, W., Capotondi, A., et al. (2018). El Niño–Southern Oscillation complexity. *Nature* 559, 535-545. <http://doi.org/10.1038/s41586-018-0252-6>

Other articles:

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.

Chen, C., M. A. Cane, A. T. Wittenberg, and D. Chen, 2017: ENSO in the CMIP5 simulations: Life cycles, diversity, and responses to climate change. *J. Climate*, 30 (2), 775-801. doi: 10.1175/JCLI-D-15-0901.1.

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.
- Planton Y., J. Vialard, E. Guilyardi, M. Lengaigne, T. Izumo (2018). Western Pacific oceanic heat content: a better predictor of La Niña than of El Niño. *Geophys. Res. Lett.* <https://doi.org/10.1029/2018gl079341>
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- 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
- Shonk J., E. Guilyardi, T. Toniazzo, S. J Woolnough and T. Stockdale (2017). Identifying Causes of Western Pacific ITCZ Drift in ECMWF System 4 Hindcasts. *Clim. Dyn.* , doi:10.1007/s00382-017-3650-9
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Budget and other needs for 2019

Please keep in mind that the overall budget of CLIVAR is limited and this needs to be distributed between all activities and the SSG meeting.

No.

Annex A

Proforma for CLIVAR Research Focus requests for SSG approval for meetings

- 1. Panel or Working Group:**
- 2. Title of meeting or workshop:**
- 3. Proposed venue:**
- 4. Proposed dates:**
- 5. Proposed attendees, including likely number:**
- 6. Rationale, motivation and justification, including: relevance to CLIVAR science & WCRP Grand Challenges, and any cross-panel/research foci links and interactions involved:**
- 7. Specific objectives and key agenda items:**
- 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:**