WMO WGSIP INITIATIVE:

Concept Note: Climate forecast information for decision making (I4D)

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Additional participants: WGSIP members, and colleagues at IRI, CCCma and other institutes if interested

Context – Main goals

The generation, translation, implementation and use of climate predictions at sub-seasonal, seasonal and other time scales opens new perspectives for the use and uptake by potential decision makers. Yet, predictions at theses ranges suffer from systematic errors, drift and possible initialization shocks which make proper evaluation, post-processing and calibration compulsory to inform decisions.

This WGSIP project on climate forecast information for decision making offers to tackle several research-to-operations issues faced by the climate prediction community:
1) Assessment and improvement of calibration and ensemble techniques: how can imperfect model forecasts be translated into useful, reliable and comprehensive products?
2) Combination of forecasts across time scales: how can subseasonal and seasonal predictions be efficiently combined to better predict events?
3) Capacity building and guidance to the operational community

In doing so, the project is aligned with the WCRP Strategic Plan objective 4.2 “Engaging with society”.

Components and research scope

1) *Calibration and multi-model ensemble techniques (CEIP: Calibration and Ensemble Intercomparison Project)*

Several recent works (e.g., Doss-Gollin et al., 2018, using the S2S database; Manzanas et al. 2019 using the C3S database; and many others) have compared different bias adjustment and calibration techniques for seasonal hindcasts. Additional evaluation of calibration techniques for multiple time scales, different variables and percentiles of the probability distribution, also involving a comparison between gridbox-by-gridbox and pattern-based approaches, is still widely needed by the community. This component aims at coordinating efforts to evaluate these and other calibration-related research-to-operation questions.

Furthermore, there are several ways to build ensembles using multi-model output, one of the key questions being how to optimally weight each model or realization, or if weights are actually needed after using certain types of calibration, and the advantages and disadvantages of simple counting versus parametric and non-parametric approaches.

Together, the calibration and ensemble techniques can also contribute to present probabilistic forecasts using the entire probability density function, rather than just the traditional tercile-based forecasts.

Also, input from project participants on the optimal combination for lagged ensemble forecasts (ensemble size vs. too large lags) would be appreciated by potential users, particularly for the S2S scale for which a variety of initialization and ensemble generation strategies exist.

The project will take advantage of the different initiatives and research work already in place in different institutes and other projects (like the S2S Prediction Project), and will provide a set of recommendations and software including standard approaches. A first version of a Python-based set of tools is already available on GitHub (https://github.com/agmunozs/PyCPT/) and is expected to be expanded during the project.

2) *Combined forecasts across time scales*

This component will explore ways to take advantage of a combination of seasonal and subseasonal forecasts to increase predictive skill and provide complementary information, for example how subseasonal information can be used to update or adjust seasonal forecasts initialized slightly earlier (similar to the Ready-Set-Go approach; Goddard et al., 2014). Some recent work (Muñoz et al., 2018; Muñoz et al., *in prep.*) using weather regimes in the context of onset/demise and rainfall characteristics has shown there are important advantages in combining these two timescales.

A related topic to be addressed by this component is how to optimally perform seamless verification across time scales. Recent work (e.g., Ford et al., 2018; Dirmeyer et al, *sub-judice*) has been already exploring this issue.

Other research questions to be considered are related to the relative merits of burst initialization vs. lagged approaches, and comparing the relative importance of large ensemble size, long hindcast periods, and higher initialization frequencies in the different time scales.

3) *Capacity building and guidance for the operational community*

Organization of training schools/workshops. The IRI and ICTP will help organize schools regarding components (1) and (2) mentioned above.

Guidance for the operational community regarding (1) and (2) will be provided in a concise document.

Expected outcomes

Deliverables would include the communication of results in workshops and scientific meetings; could be one or two synthesis papers on recommendations on components (1) and (2). The team will also help organize at least one training school on these topics.

- ➔ assessment of calibration methods and impacts on both deterministic and probabilistic skill metrics
- ➔ assessment of cross-timescale forecast combination methodologies
- ➔ development or enhancement of standardized community tools for components (1) and (2), e.g., PyCPT (https://github.com/agmunozs/PyCPT/) for calibration procedures.

- ➔ journal publications and meeting presentations communicating improved knowledge on this topic; could be one or two synthesis papers on recommendations on components (1) and (2).
- ➔ At least one training school on these topics.

Participants per component

Additional WGSIP members and others in the scientific community as interested.

Initial actions

- Sep 2019-Dec 2019: further develop PyCPT to include both deterministic and probabilistic skill assessment metrics. Initial testing with EOF-based calibration methods.
- Jan 2020-Apr 2020: include non-EOF based calibration methods in PyCPT (e.g., ELR, and those discussed by Manzanas et al 2019, among others); initial exploration of lagged ensemble versus ensemble size over illustrative case studies (e.g., precipitation over mid-latitudes).
- May-Jul 2020: call for participation in CEIP, offering the possibility of using and supporting PyCPT, but open to use any language and software.
- Jul 2020 forward: initial exploration of cross-timescale forecast combination.

Related initiatives and contact points

- IPET-OPSLS: Caio?
- S2S ensemble sub-project: Yuhei (confirmed)
- S2S R2O: Ángel (and Caio?)
- Copernicus/seasonal models/data services: Carlo Buontempo and Anca?
- NMME, SubX: Emily Becker, Kathy Pegion (confirmed)
- S2S Real Time Pilot and potentially SERA: Joanne?
- S2S: Paul Dirmeyer (confirmed)
- Data services: Ramiro Saurral and Andy Robertson (confirmed)

References

Dirmeyer, P. A., and T. W. Ford, 2019: A technique for seamless forecast validation from weather to monthly time scales. *Mon. Wea. Rev.*, (sub-judice).

Doss-Gollin, J. *et al.* (2018) 'Heavy Rainfall in Paraguay during the 2015/16 Austral Summer: Causes and Subseasonal-to-Seasonal Predictive Skill', *Journal of Climate*, 31(17), pp. 6669–6685. doi: 10.1175/JCLI-D-17-0805.1.

Ford, T. W., Dirmeyer, P. A. and Benson, D. O. (2018) 'Evaluation of heat wave forecasts seamlessly across subseasonal timescales', *npj Climate and Atmospheric Science*. Springer Science and Business Media LLC, 1(1). doi: 10.1038/s41612-018-0027-7.

Goddard, L. *et al.* (2014) 'The International Research Institute for Climate & Society: why, what and how', *Earth Perspectives*. Springer, 1(1), p. 10. doi: 10.1186/2194-6434-1-10.

Manzanas, R. *et al.* (2018) 'Can bias correction and statistical downscaling methods improve the skill of seasonal precipitation forecasts?', *Climate Dynamics*. Springer Berlin Heidelberg, 50(3–4), pp. 1161–1176. doi: 10.1007/s00382-017-3668-z.

Muñoz, Á.G., G.A. Vecchi, L. Carvalho (2018) ‘Onset and demise of the (North and South) American Monsoon System: a unifying view via cross-equatorial fluxes’. Memories of the WCRP Grand Challenge on Clouds, Circulation and Climate Sensitivity: 2nd Meeting on Monsoons and Tropical Rain Belts. ICTP, Trieste. July 2018.