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| **WORLD METEOROLOGICAL ORGANIZATION**COMMISSION FOR BASIC SYSTEMSOPAG on DPFS**MEETING OF THE CBS (DPFS) EXPERT TEAM ON OPERATIONAL PREDICTIONS FORM SUB-SEASONAL TO LONGER-TIME SCALES (ET-OPSLS)**BARCELONA, SPAIN, 2 AND 4 TO 6 JUNE 2018 |  | DPFS/ET-OPSLS/Doc. 7.4 (v2)(5.VI.2018)\_\_\_\_\_\_\_Agenda item : 7.4ENGLISH ONLY |

**Position paper on operational climate prediction**

*(Submitted by Caio Coelho, Francisco Doblas-Reyes, Arun Kumar and
 Rupa Kumar Kolli)*

##### Summary and purpose of document

This document summarizes the initial discussion on the elaboration of a position paper on operation climate prediction from the sub-seasonal to the decadal time scale.

##### Action Proposed

The meeting is invited to review its content and provide comments/suggestions.

**Annex(es):** Annex A - “R2O opportunities: Thoughts on how can WGSIP contribute to enhancing GPC & LC forecast products and services and in the development of the operational forecasting infrastructure?”

# Position paper on operational climate prediction

The position paper, as one of the outcomes from the 2nd WMO workshop on Operational Climate Prediction (OCP-2), is expected to summarise operations to research (O2R) main requirements and developments that could be relevant from research to operations (R2O), as well as provide a description of the mechanism/enablers for this communication to take place efficiently. It can be seen as a way to put together the R2O and O2R ideas that are circulating often in an informal manner but that are hardly documented. The position paper should be written in an inspiring way so that both young researches and operational forecasters can use it as a guide for their future developments. It is envisaged that the position paper be developed with the intent to publish it as a peer-reviewed article in a reputed scientific journal, such as the Bulletin of the American Meteorological Society (BAMS).

Annex A contains a document prepared by Arun Kumar and Caio Coelho for the interaction with WGSIP that might be a key contribution to this position paper.

Arun Kumar expects this paper a) to summarize impediments (real or perceived) in the utilization of extended-range forecasts, and b) proposing mechanisms/enablers that can lead to improved interactions between the operational and research community. Operational needs could be related to (a) providing guidance on the design of forecast systems, (b) developing methods (e.g. initialization strategies) to maximize realization of predictability as prediction skill, and (c) research needs that would facilitate to overcome (or clarify) the impediments in the uptake of the forecasts by the user and the application community.

Caio Coelho sees the position paper with a much broader view. For Caio Coelho, it should summarize the current status and challenges of operational climate prediction (from the sub-seasonal to the decadal time scale), including relevant technical, scientific, communication, infrastructure, services and training aspects and, therefore, more aligned with the Global Framework for Climate Services (GFCS) concept. In this way, it would be used as an update of the [WCRP Position Paper on Seasonal Prediction](https://journals.ametsoc.org/doi/abs/10.1175/2008BAMS2707.1). He considers that the additional paper suggested by Francisco Doblas-Reyes could be based on a selection of topics from the exhaustive list in Annex A, more focused on specific technical and scientific aspects to highlight a few open challenges for stimulating the scientific community to address them. As an alternative, one could select the most burning challenges from Annex A to be discussed in more detail in the context of the broader position paper if this is what is expected as the major outcome of OCP-2. This approach would then consist in the preparation of two different documents.

Francisco Doblas-Reyes, following what Caio Coelho says, sees two options (non exclusive): a) a summary of OCP-2, which could be an update of the WCRP seasonal prediction position paper, based on the workshop summary that WMO has to write and more along the lines of the GFCS concept, as suggested by Caio Coelho, and b) a more targeted document with a selection of topics, the ones the workshop consider as top priority and that the research community should address with urgency. The position paper could be any of these two, with the OCP-2 summary being a generic, extended document and the second document could be a short paper to be published in the Bulletin of the American Meteorological Society, Nature Climate Change, Climate Services or a similar journal. A quick consultation at OCP-2 suggested that the best option might be going for the two documents.

Based on the discussion above, an initial suggestion for the outline of the long position paper on operational climate prediction (from the sub-seasonal to the decadal time scale), to be further discussed and detailed/elaborated, is:

**1. Brief historical introduction** (including the current infrastructure for operational climate prediction and the research initiatives; overview of societal needs for climate prediction information).

**2.State of the Art in the science of climate prediction** (including the latest advances in our understanding of the processes and drivers with potential contributions to the predictability of the climate from sub-seasonal to decadal time scales and global to local space scales; advances in computational and communication technologies, etc.)

**3. Current status/practices of operational climate prediction** **across different time and space scales** (including technical aspects such as forecast quality methods and levels, production methods, data and exchange standards, challenges and impediments for the uptake of forecasts by the user and applications communities, communication of forecast uncertainty, capacity development/training aspects, and also highlighting the need for improving the current practices).

**4. Gaps between scientific and operational capabilities** (including needs that can be met by the currently available research achievements).

**5. Priority areas in need of research developments for improving provision of operational climate services** (including discussions on unmet needs and a selection of the most burning topics that will come out from OCP-2, most likely already included in the exhaustive list of Annex A and how the research community can benefit from addressing those topics).

**6. Mechanisms/enablers for improving interaction between the operational and research communities to address key issues and gaps for advancing operational climate prediction** (including the examples of good practice, achievements, and proposition of new mechanisms to facilitate and improve the transition of research findings to operations and feedback from operations to research).

**7. Operations to Operations (O2O) interactions** (including the cascading aspects of global-regional-national-local climate prediction enterprise and the need to adopt standards and protocols as well as exchange of knowledge, data and information and capacity development).

**8. Summary and recommendations**

The second, shorter, document could be a crisper, exciting and to the point piece of text along the lines of what was recently published in [Nature](https://www.nature.com/articles/d41586-017-08463-3) following the [2017 WMO Science Summit on Seamless Research for Weather, Climate, Water and Environment](https://public.wmo.int/en/events/meetings/science-summit-seamless-research-weather-climate-water-and-environment). This shorter document could be considered to be produced as a joint effort combining the outputs of OCP-2 (Barcelona, May 2018) and the WCRP/WWRP S2S2D conference (Boulder, September 2018).

A preliminary suggestion of contributing authors for the position paper (subject to revisions and/or additions) is the following: the co-chair of WMAC (Francisco Doblas-Reyes), the chair and co-chair of IPET-OPSLS (Arun Kumar and Caio Coelho), the co-chairs of WGSIP (Bill Merryfield and Doug Smith), the co-chairs of S2S (Andrew Robertson and Frederic Vitart) and WMO Secretariat (Rupa Kumar Kolli and Michel Rixen). Other members of the IPET-OPSLS are also welcome to contribute in the effort.

# Annex A: “R2O opportunities: Thoughts on how can WGSIP contribute to enhancing GPC & LC forecast products and services and in the development of the operational forecasting infrastructure?”

# Version 29 September 2017

Below there is a list of potential needs from the operational (GPCs and LC-LRFMME) to the research community[[1]](#footnote-1) . The list focuses on operational issues related to (a) configuration of S2S forecast systems, and development of S2S (b) forecast and (c) verification products.

## Configuration of S2S forecast systems

* Relative merits of burst vs. lagged ensembles from the perspective of developing forecast products, e.g., capturing forecast uncertainty, capturing regime transitions etc.
* Relative importance of various observations in influencing skill of S2S predictions? A related question is what details in initial conditions (in different components of the Earth System) are of importance for S2S predictions?
* Techniques for ensemble generation to better quantify forecast uncertainty.
* Given finite computing resources, which configuration aspects of forecasts systems will be more important to devote our resources on – hindcast length, ensemble size (during hindcasts); hindcast frequency; model resolution; initialization and assimilation etc.
* What level of consistency is required for the specification of initial condition between hindcasts and real-time forecasts, i.e., can one switch the source of initial conditions without compromising prediction skill? (note – the question, of course, depends on the component of Earth System but will be good to know for which components the tolerance is higher).
* Defining hindcast requirements and their influence on designing hindcast configuration, e.g., if hindcasts are required for bias correction/calibration vs. for skill assessment then the associated hindcast configurations may differ. Some guidance will be useful.
* Approaches for reducing initial shocks, e.g., reduction in model bias (an obvious one), coupled DA, anomaly initialization etc. Influence of initial shocks on compromising S2S prediction skill.

## Development of S2S forecast products

* Guidance on the selection of optimal lagged ensemble.
* Strategies for multi-model ensembles, e.g., equal vs. skill weighted (within the context of realistic length of hindcasts we currently have); guidance on objective procedures for consolidating forecast information from various models.
* Guidance for the development of complementary forecast products to the traditional tercile category probability summary commonly produced in RCOFs by RCCs and NMHSs.
* Spread-skill relationship; what is the evidence, e.g., does spread has systematic variations on time-scales associated with S2S forecasts?
* Guidance on fixed vs. “on the fly” hindcasts (from the perspective of interfacing with the user community and possibly providing hindcast data to force application models)
* Relative merits for estimating forecast probabilities, e.g., between counting vs. parametric methods
* Investigate the feasibility (e.g., establish a scientific basis) of producing long standing wish for products by various sectors based on daily forecast outputs (e.g. probabilistic forecasts of rainy season onset, wet/dry spells, heat/cold waves) together with the corresponding forecast verification products

## Development of S2S verification products

* Thoughts on how to quantify improvements in skill as more advanced prediction systems come online [something equivalent to the time history of 500-mb skill scores used on the weather prediction community but can overcome issues related to sampling, changes in hindcast period (as newer systems come online) etc.]
* Use of hindcast to address various question, e.g., regime dependence of forecast skill; conditional vs. unconditional estimate of skill; influence in the evolution of observing system in improving forecast skill
* Contribute to defining uniqueness of verification standards for sub-seasonal forecasts

## Comments

* The answer of some of the questions above may just be (a) we don’t know the answer OR (b) the question is not worth pursuing OR (c) the question is ill posed. A WGSIP perspective on above issues will be good to have in guiding the future evolution of the S2S operational forecasting infrastructure.
* Further, the answers to several questions could also be that “more is always better [e.g., larger hindcast period, larger ensembles, large ensemble run each day (which becomes equivalent to running a burst ensemble each day)]” or “everything is important” (e.g. we need consistency in initial conditions in components of the Earth System or saying that eventually everything will be part of coupled DA etc., so why bother]” but the reality is that
	+ We all have finite (human and computational) resources and would like to devote them on the issues that are likely to produce best return on investment, and
	+ For prediction on a particular time-scale, not everything is of same level of importance.

Given that, it will be good know (a) what is the current level of understanding or perspective on above questions maybe? and (b) whether a research agenda can be formulated to provide guidance to the development of operational forecast infrastructure?

1. This list does not include input from the entire membership of the Expert Team on Operational Predictions from Sub-Seasonal to Longer-Time Scales (ET-OPSLS) and is a preliminary list prepared by the Chair (Arun Kumar) and Co-Chair (Caio Coelho) [↑](#footnote-ref-1)