Notes on possible new WGSIP projects

+ Notes on possible workshop topics at the end

(to inform further discussion and decision making at WGSIP 21)

1) Possible CHFP-based projects

(a)

Yuhei 11 Apr 2019:
I would like to hear your thoughts on an activity on the Asian summer (and winter) monsoon seasonal prediction that I would like to propose. I am interested in assessing this aspect using CHFP. (I have no plan to coordinate additional experiments.) Our knowledge on the Asian summer monsoon has been advanced in the last 10 years. So, I feel that it would be worth revisiting this theme and to document advances of the Asian prediction. The CHFP data archive is a perfect asset for doing this.

I understand the WGSIP does not want to have too many projects because the person power is limited. This activity could be a part of a large project of assessing the predictive capability of seasonal prediction systems. If you or your colleagues are interested, I would like to collaborate with you on this topic. I will prepare a short document and slides for the next meeting.

(b)

Bill: global/regional temperature trends in seasonal forecast models have been found to be problematic (mostly too low, as in NMME), but issue has not been systematically explored in a large set of models

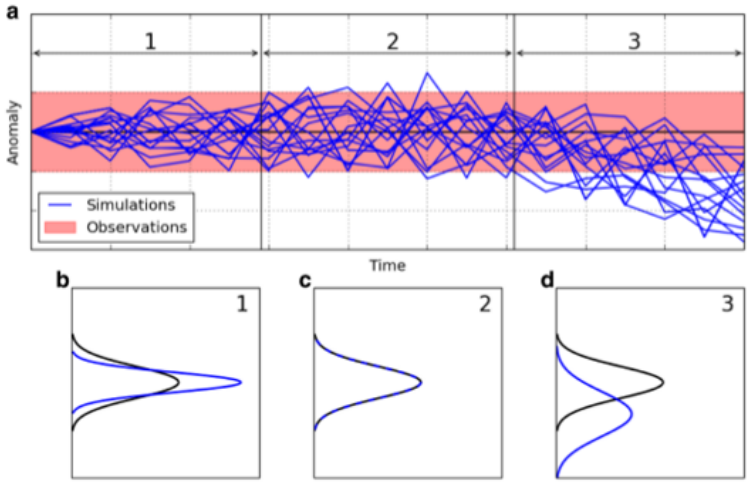
2) Additional project ideas emanating from WGSIP

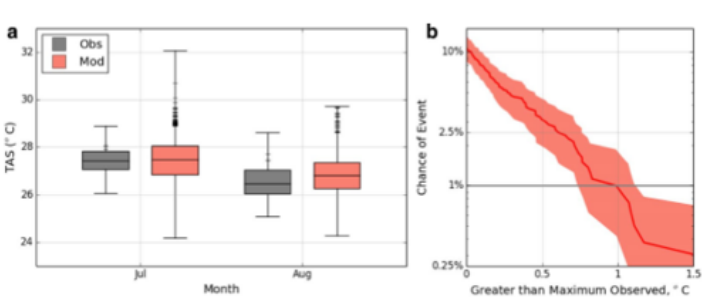
Bill 15 Apr 2019:
A few preliminary ideas to stimulate thought and discussion:

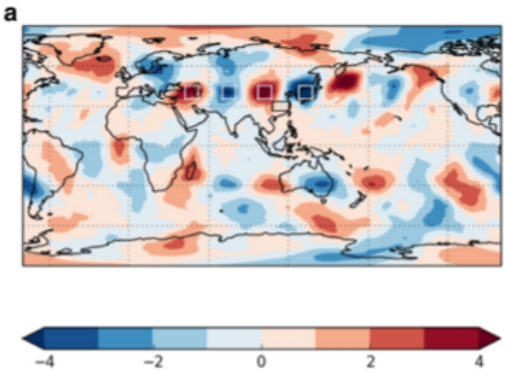
(a)

1) Unprecedented extremes – given that ensemble hindcasts provide *many* possible realizations of (simulated) reality, mine ensemble members of CHFP, etc. hindcasts to identify outlier climate events representing extreme ENSOs or other climate variations that lie outside what has been experienced in the historical record. Examine their nature and assess likelihood that such events could occur in the real world.

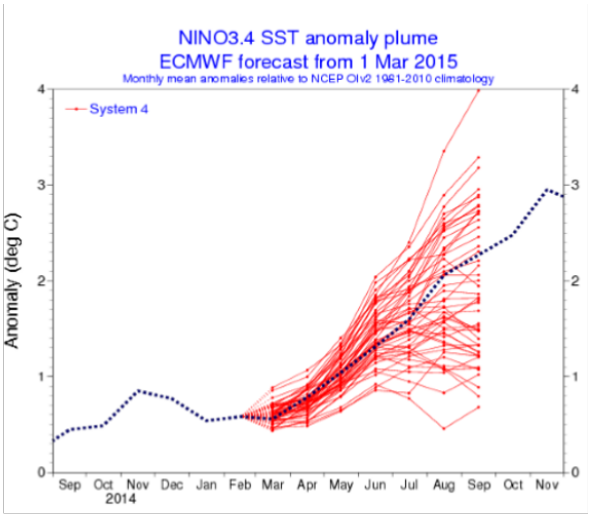
- UNSEEN methodology?

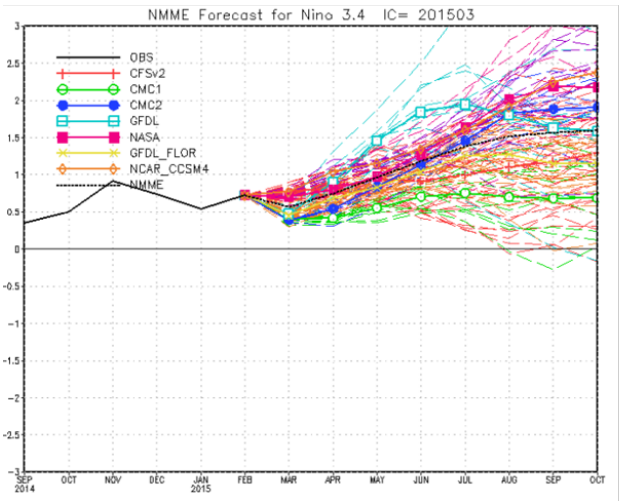


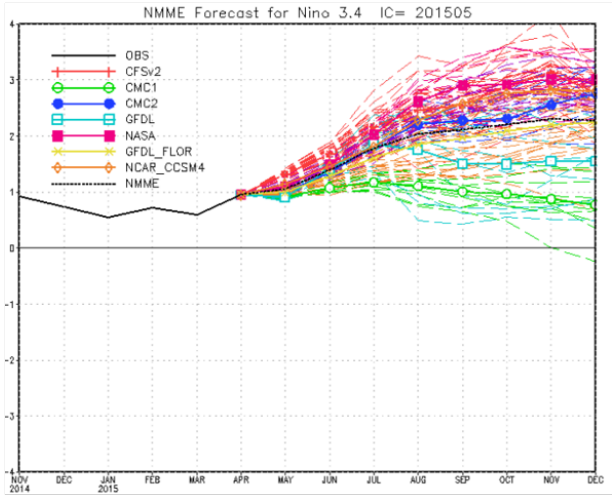




- Outlier El Ninos, etc.?







(b)

2) Ocean Climate Forecasting Project – comprehensively survey ability of current subseasonal, seasonal and/or decadal systems to predict ocean attributes beyond SST, assess suitability of various ocean reanalyses and other datasets and combinations thereof for verification, interfacing with WCRP groups including S2S, DCPP, and Clivar panels, OMDP, GSOP, ocean panels. Assess potential contribution to ocean science and climate services applications.

M Balmaseda feedback:

very timely prompt. Here we are discussing which ocean output we can provide from seasonal forecasts, and how to verify it.

At the moment there is little ocean output aside from SST and sea-ice. We are working with C3S to propose a list of user relevant/verifiable ocean variables. SSH, SST, SSS are possible ones. Mixed layer depth you have to provide an exact definition. There are many. We have also talked about some isotherm depths (D20, D28,D26), or the heat in upper ocean (above mixed

layer, above a given isotherm). I would not go to upwelling. It is too noisy and not verifiable. Perhaps surface currents. To start simple, one possibility is to use the subset used in S2S project. Regarding verification data sets, one can use altimeter. For subsurface either the in-situ reconstructions (like EN4, good for monthly means). Or the ensemble of ocean renalyses.

J. Baehr feedback:
The different variables you outlined seem an attractive mix of basics and upcoming (SSH, ML, marine heat waves) variables. Would we have the observations to quantify? Maybe only do one very focused project on one but very sensitive variable - how about mixed layer? And then think about the best verification?

(c)
Doug 16 April 2019:
A few ideas to address the WCRP objectives.

1) Understanding. “Climate dynamics” could be linked to unprecedented extremes mentioned by Bill. “Reservoirs and flows” - annual to decadal forecasts of energy flows could be assessed?
2) Prediction. “Simulation capability” - an assessment of current capability, taking into account possible S/N issues. “Extreme events” - in addition to unprecedented extremes mentioned by Bill, we could focus on assessing the current levels of skill for predicting extreme events. Possible CMIP type exercise for 12 month forecasts to assess ongoing capabilities.
3) Future evolution. Perhaps a project to assess the role of external forcing (especially solar, volcanoes and anthropogenic aerosols) in decadal prediction.
4) Bridging climate science and society. A project focussing on “Research to operations”. Arun Kumar and Caio Coelho have drafted some ideas for this.

Mich:
- On the idea of unprecedented extremes: maybe an opportunity to team up with US CLIVAR work on “Large Ensembles”?
- Beyond temperature: focus on climate dynamics and precip?

3) Input from WMO

Bill: The following was discussed at the 2018 meeting of WMO ET-OPSLS:

WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR BASIC SYSTEMS
OPAG 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. 7.3

(15.V.2018)

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Agenda item : 7.3

ENGLISH ONLY

Collaboration with Working Group on Subseasonal to Interdecadal Prediction (WGSIP)

(Submitted by Arun Kumar)

Summary and purpose of document

This document describes research needs to advance operation seasonal forecast infrastructure and products. The document was submitted to the co-chairs of the Working Group on Subseasonal to Interdecadal Prediction (WGSIP).

Action Proposed

The meeting is invited to discuss the document and consider the recommendation for advancing potential strategies for collaboration between research and operations.

Annex(es): -

Reference(s): -

Research needs from operations to advance sub-seasonal to seasonal forecasting infrastructure and products

1. In September 2017, in attempts to enhance collaboration between operations and research, a list of potential research needs (Annex 1) was submitted from the Chair and Co-Chair of the IPET-OPSLS to the Co-Chairs of the Working Group on Subseasonal to Interdecadal Prediction (WGSIP). The document was discussed in the WGSIP session during the "Pan-WCRP Modelling Groups" meeting in October 2017, Exeter, UK.

2. Subsequently, the document (Annex 1) was also distributed to the IPET-OPSLS members and additional comments included:

- [Bertrand Denis] Forecast stability when the forecasts are produced on a daily basis: How can we explain that forecast instability phenomenon and can we reduce it, for example by increasing the number of ensemble members and/or models? How can a 30-day or 90-day average change so quickly from one run to the other? We have even seen periods of flip-flops.
- [Kristina Fröhlich] Questions related to the processes understanding. As Europe (and Eurasia as huge landmass) still suffer from very bad forecast skills, I would address urgent research needs to find out the relevant processes on the large time scale we are not yet able to describe with our coupled models. Or, from a model development perspective one could recommend to investigate topics such as
    - To find out the largest gaps in the land (and vegetation) modelling and their coupling to the atmosphere leading to huge errors on the long term,
    - The possible benefit of higher a resolved vertical structure of the troposphere and middle atmosphere to improve the vertical coupling of layers.
    - The possible benefit of wave models for the exchange between ocean and atmosphere.
    - The possible benefit of higher resolved near surface ocean layers by simultaneously avoiding conflicts with the sea-ice model.

3. Exploring pathways to develop collaborative partnerships for operational requirements to guide research are required. Few specific case studies can be selected to demonstrate the efficacy of the concepts.

4. It is recommended that IPET-OPSLS further consider the strategies to further interaction between operations and research, and if necessary, consider forming a task team to advance this concept in collaboration with the WGSIP.

Annex 1

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?

Arun Kumar & Caio Coelho
ET-OPSLS
29 September 2017

Below is a list of potential needs from the operational (GPCs and LC-LRFMME) to the research community[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

1. Relative merits of burst vs. lagged ensembles from the perspective of developing forecast products, e.g., capturing forecast uncertainty, capturing regime transitions etc.
2. 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?
3. Techniques for ensemble generation to better quantify forecast uncertainty.
4. 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.

5. 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).
6. 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.
7. 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

1. Guidance on the selection of optimal lagged ensemble.
2. 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.
3. Guidance for the development of complementary forecast products to the traditional tercile category probability summary commonly produced in RCOFs by RCCs and NMHSs.
4. Spread-skill relationship; what is the evidence, e.g., does spread has systematic variations on time-scales associated with S2S forecasts?
5. 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)
6. Relative merits for estimating forecast probabilities, e.g., between counting vs. parametric methods
7. 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

1. 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.]
2. 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
3. Contribute to defining uniqueness of verification standards for sub-seasonal forecasts

Comments:

1) 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.
2) 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
    a) 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
    b) 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?

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[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)