WMO WGSIP INITIATIVE:

Representation of temperature trends in seasonal hindcasts
(A component of the WGSIP Prediction Capability Project)

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Additional participants: WGSIP members and others as interested, colleagues at CCCma

Context – Main goals

The initial conditions of climate forecasts and hindcasts should accurately represent the long-term warming of the atmosphere, ocean and land to the extent that those trends are accurately encoded in the input observations and by the initialization method employed. This is important because long-term changes over the hindcast period can be appreciable in relation to interannual variability, and therefore will contribute non-negligibly to skill if the trends are represented accurately in forecasts. For this to occur also requires that changes in radiative forcing driving the trends be accurately represented, that the model components realistically respond to those changes, and that artificial departures from the observed trends are not induced by transient behavior of the model following initialization.

There have thus far been only a few examinations of these issues. Doblas Reyes et al (2006) and Liniger et al. (2007) established that realistic initial conditions are not sufficient to imprint observed temperature trends in seasonal forecasts especially if increasing greenhouse gas radiative forcing is not represented, and that forecast quality is degraded when temperature trends are unrealistic. Boer (2009) and Cai et al. (2009) reinforced these conclusions, whereas Jia and Lin (2013) and Kharin et al. (2012) showed conversely that skill of seasonal and decadal forecasts can be improved by post hoc adjustment of temperature trends to observed values. There have been very few efforts to ascertain reasons for mispreresented trends beyond deficiencies in radiative forcing. Notably, Luo et al. (2012) found that SST-nudging ocean initialization caused spurious subsurface ocean cooling, which in turn led to weak and even negative surface temperature trends at long lead times. In terms of multi-system investigations, Krakauer (2017) showed there is a tendency for nine models contributing to the North American Multi-Model Ensemble (NMME) to underestimate long-term warming over land, whereas a similar tendency exists over ocean according to an unpublished study by van den Dool.

Research Plan

Given the demonstrated impacts of temperature trends on forecast quality, the known deficiencies of some systems in representing such trends, and the paucity of related investigations particularly in recent years, a knowledge gap clearly exists for this important topic. This project will address the gap by systematically examining the ability of many seasonal prediction systems to represent observed long term temperature trends as functions of lead time, season and region, and will attempt to relate performance to the radiative forcing and initialization methodologies employed. Hindcast datasets employed will include those from WGSIP's Climate System Historical Forecast Project (CHFP), the NMME, and Copernicus. Although seasonal predictions will initially be targeted, findings from this project may be applicable to S2S and decadal predictions as well, and extension to those time scales is a possibility.

Expected outcomes

→ assessment of long-term global and regional temperature trends as a function of lead time in hindcasts from many seasonal prediction systems
→ assessment of extent to which deficiencies in representing long-term temperature trends impact temperature prediction skill
→ development of standard diagnostics for temperature trends in hindcasts
→ journal publications and meeting presentations communicating improved knowledge on this topic

Participation

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

Initial actions

- Sep 2019-Dec 2019: acquire monthly 2m temperature hindcast data from CHFP, NMME, Copernicus, and possibly elsewhere, plus uninitialized historical simulations for same models where available
- Jan 2020-Jun 2020: analyse data and relate results to radiative forcing and initialization methods employed; perform ancillary analyses for other variables e.g. subsurface ocean temperature if helpful for assessing causes of misrepresented trends

Related initiatives and contact points

None initially

References

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