WGSIP/DCPP Report
(draft 1)

1. Highlights for JSC

- A comprehensive synthesis of "Current and emerging developments in subseasonal to decadal prediction", informed by the recent International Conferences on Subseasonal to Decadal Prediction, was published in BAMS.
- **A new cycle of WGSIP projects** aligned with the WCRP's Strategic Plan was initiated at WGSIP's 21st session in Moscow in May 2019. These include:
  Prediction capability, which aims to fill knowledge gaps relating to key Earth system prediction capabilities, using existing hindcast datasets including WGSIP's Climate-system Historical Forecasting Project (CHFP). Three initial foci are *Monsoon prediction*, seeking to better understand processes and mechanisms responsible for seasonal predictability of the Asian and global monsoons and to develop new diagnostics to describe monsoon forecast performance; *Ocean prediction,* assessing capabilities for predicting sea surface height (relevant to coastal flooding) and mixed-layer depth (relevant to ocean ecosystems); *Temperature trends,* assessing accuracy of temperature trends in climate forecasts and impacts of temperature trend errors on operational predictions.
  Extremes, which aims to assess the predictability of extreme events, and to better quantify the risks of extremes (including unprecedented events) in the current climate by using large ensembles of initialised climate model hindcasts. A WGSIP-organized WCRP Workshop on Extremes in Climate Prediction Ensembles scheduled to be held in Busan, South Korea in October 2020 will serve as a focal point for community research efforts in this area and involve scientists from developing Asian countries through pending support from the Asia-Pacific Network for Global Change Research.
  Information for decision making (I4D), which is reviewing and intercomparing methods for calibration and combination of forecasts across time scales, and contributing capacity building and guidance to the operational community.
- **Ongoing WGSIP projects:** CHFP continues to add prediction systems to its hindcast database at CIMA in Argentina, and to inform WGSIP and community investigations, leading e.g. to papers on seasonal prediction of tropical, Indian Summer Monsoon and Central African rainfall. In addition, projects examining impacts of snow initialization and initial shock and drift continue to be active.
- **DCPP CMIP6 simulations**: DCPP hindcasts and targeted predictability, mechanism and case study simulations have been completed by numerous modelling groups, and DCPP-led initial papers on robust skill of decadal predictions and teleconnections from Atlantic multidecadal variability published.
- **Capacity building:** WGSIP co-organized and gave lectures and lab sessions for the International Young Scientists School and Conference on Computational Information Technologies for Environmental Sciences ("CITES-2019", Moscow May-June 2019).

2. Primary science issues (looking ahead, 3 to 5 years)

- Atmospheric circulation has been viewed as a major source of irreducible uncertainty in climate predictions and projections. However, recent studies show that climate

models severely underestimate atmospheric circulation predictability, especially in the north Atlantic. On decadal timescales the predictable signal is ~10 times too small in models, requiring 100 times more ensemble members to extract it, and additional post processing to overcome underestimated teleconnections. There is evidence that multi-decadal responses to external drivers are also underestimated, in which case this issue affects understanding of past climate change as well as predictions and projections.

- Understanding the relative roles on internal variability and external forcing is crucial for attribution, prediction and projection. Analysis of decadal predictions suggests that external factors dominate and are able to produce decadal variability in addition to long-term trends. Hence an important issue is to better understand how the climate system responds to external forcing including solar, volcanoes, aerosols and ozone.
- Extending subseasonal to decadal prediction capabilities across Earth system components motivates understanding and quantifying their predictability, and requires novel approaches for initialization and verification of less well-observed variables.
- Development of regional and local forecast information, emphasizing probabilities of weather and climate extremes, that is seamless across time scales.

3. Issues and challenges

- Within WCRP, WGSIP/DCPP maintains cross-membership with GC-NTCP and S2S, and reviewed the GC's Annual-to-Decadal Climate Update while co-organizing its planned 2020 workshop with S2S and GC-Extremes. WGSIP's Monsoon project is collaborating with the CLIVAR/GEWEX Monsoons Panel. WGSIP's Ocean Prediction project has discussed data standards and is exploring synergies with related S2S and C3S initiatives, and will do so with CLIVAR's Ocean Model Development and Global Synthesis and Observations Panels (OMDP and GSOP).
- An important WGSIP partner outside of WCRP is WMO's Expert Team on Operational Predictions from Sub-seasonal to Longer-time Scales (IPET-OPSLS). The WGSIP and ET co-chairs currently operate as an informal task team to address R2O and O2R issues, and have discussed formalizing this arrangement with JSC approval. An important step is agreement to create a data "pipeline" to incorporate hindcasts from past, present and future WMO Global Producing Centre seasonal forecasting systems in the CHFP archive. Besides enhancing CHFP-enabled research opportunities, this will enable tracking of changes in seasonal forecast system performance over time as requested to WGSIP by TPOS2020 and recommended in its Second Report.
- The near future is likely to bring increasing emphasis on developing and improving seamless climate information for regions, as well as broadened Earth system prediction capabilities requiring increased communication and coordination with the observational, data assimilation and reanalysis communities. Application of machine learning to postprocessing of climate forecasts is likely to be a further growth area.
- WGSIP seeks for its membership to optimally represent regions, key operational and research centres, prediction time scales, and related groups and initiatives (through cross membership). This has become increasingly challenging as climate prediction activities worldwide have broadened and matured, and WGSIP would thus benefit from increasing its current membership of 13 (11 in 2020) by 1 or 2, and/or including ex-officio members representing related WCRP and WMO groups.
- Much could be achieved through a joint working meeting involving WGSIP, DCPP, GC-NCTP, S2S, IPET-OPSLS and core project representatives in 2021 or 2022. Objectives would include sharing approaches and results of interrelated research initiatives and formulating strategies for research and climate services development.
- Much potential added value of model outputs is being lost due to fragmentation of community research initiatives having differing experimental protocols and data standards. Going forward, this issue coud be addressed by leveraging CMIP

protocols and ESGF data access for climate prediction experiments, using DCPP protocols as a starting point. Such a relatively small perturbation to CMIP/ESGF would yield great benefits for climate prediction research.