Advancing Operational Infrastructure

Arun Kumar

Principal Scientist, Climate Prediction Center

Chair, WMO IPET-OPSLS*

arun.kumar@noaa.gov

*WMO Expert Team on Operational Predictions from Sub-seasonal to Longer Time-Scales

WMO Expert Team on Operational Predictions from Sub-Seasonal to Longer Time Scales (ET-OPSLS)

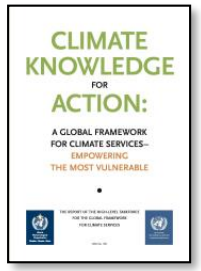
- Provides oversight for coordinating the operational infrastructure and data exchange between different centers engaged in long-range forecasting (sub-seasonal, seasonal, decadal);
- Develops data exchange requirements based on evolving user needs and technological advancements;
- Collaborates with various WMO research bodies (e.g., WWRP, WCRP) on research needs to advance operational infrastructure for initialized predictions.

Standards for the operational LRF infrastructure have been codified in WMO technical regulation documents.

Outline

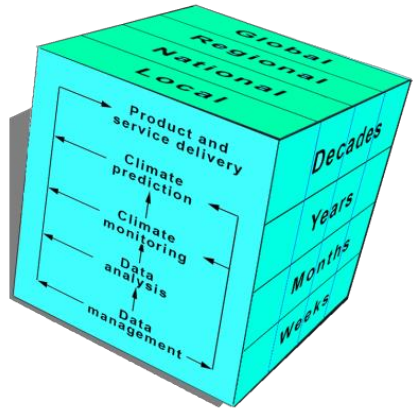
- The current WMO operational infrastructure for Sub-seasonal to Decadal (S2D) predictions.
- Operational issues and research requirements.
- Advancing operational infrastructure.

GFCS GLOBAL FRAMEWORK FOR CLIMATE SERVICES



Current status of operational S2D infrastructure within WMO

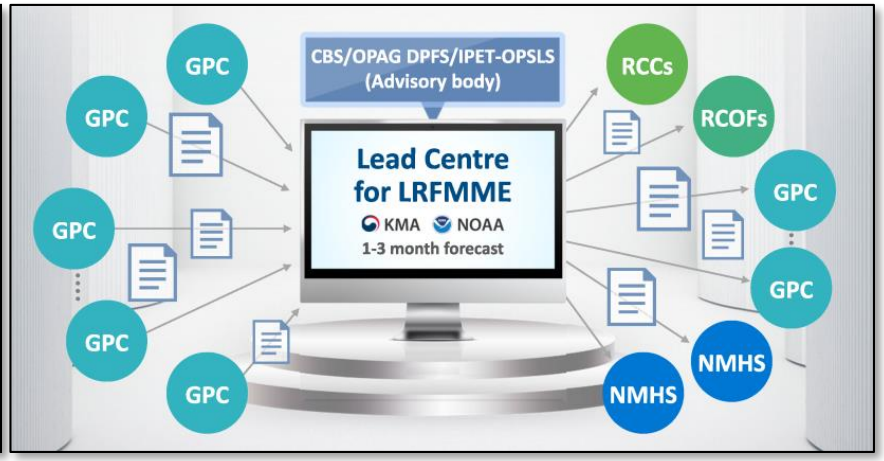
- Global Producing Centers for Long-Range Forecasts (GPC-LRFs) – Seasonal.
- Global Producing Centers for Annual to Decadal Climate Predictions (GPC-ADCPs).
- Regional Climate Centers (RCCs).
- Regional Climate Outlook Forums (RCOFs).



- These “operational” entities provide support for the infrastructure for various components of WMO’s Climate Services.

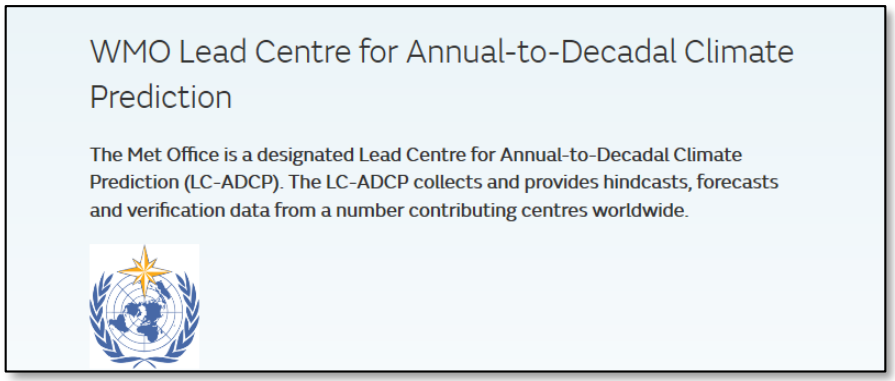
Operational infrastructure for seasonal forecasts

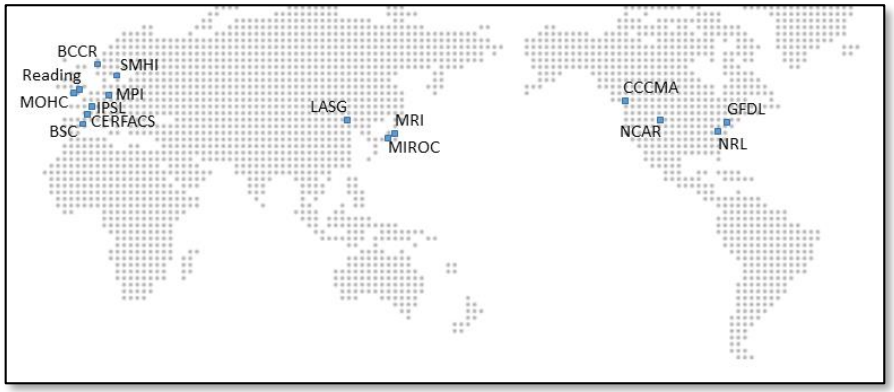
- 13 Global Producing Centers for Long-Range Forecasts (GPC-LRFs).
- GPCs-LRF are required to fulfill a set of mandatory functions.
- On a monthly basis, seasonal forecasts are provided to the WMO Lead Center for Long-Range Forecast Multi-Model Ensembles (LC-LRFMME).



Infrastructure for Annual to Decadal Climate Predictions (ADCP)

- An effort led by the UK Met Office;
- Outlooks updated once a year;
- Outlooks for year 1 and years 2-5 average;
- Plans to release "Global Annual to Decadal Climate Update (GA2DCU)."
- https://www.wmolc-adcp.org

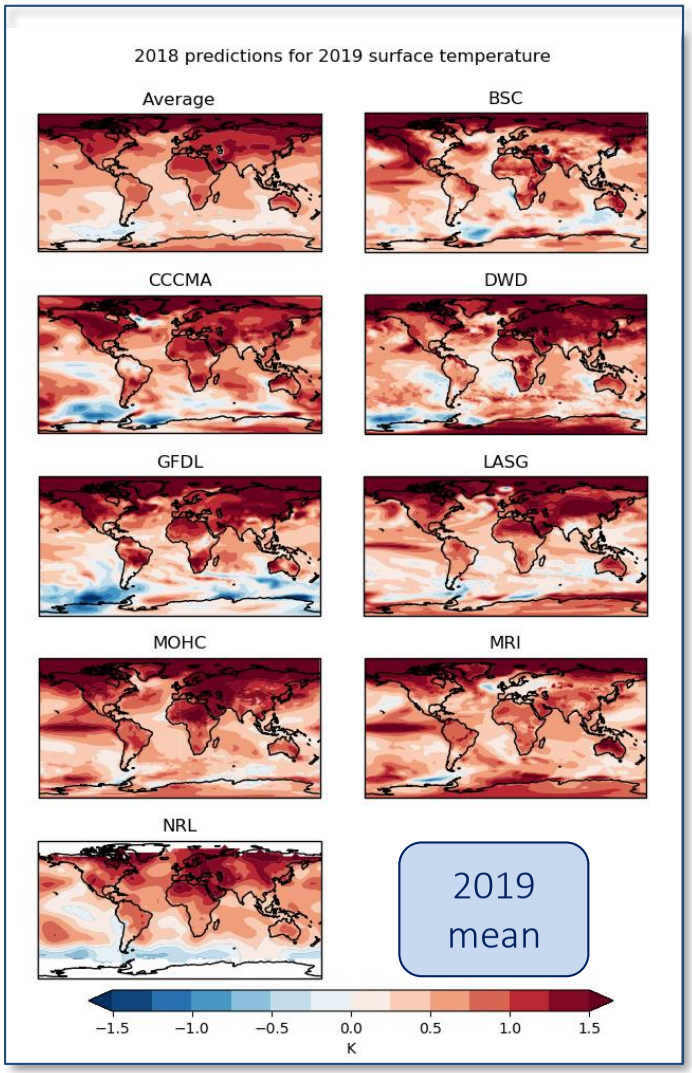




BSC | CCCMA | DWD | MOHC

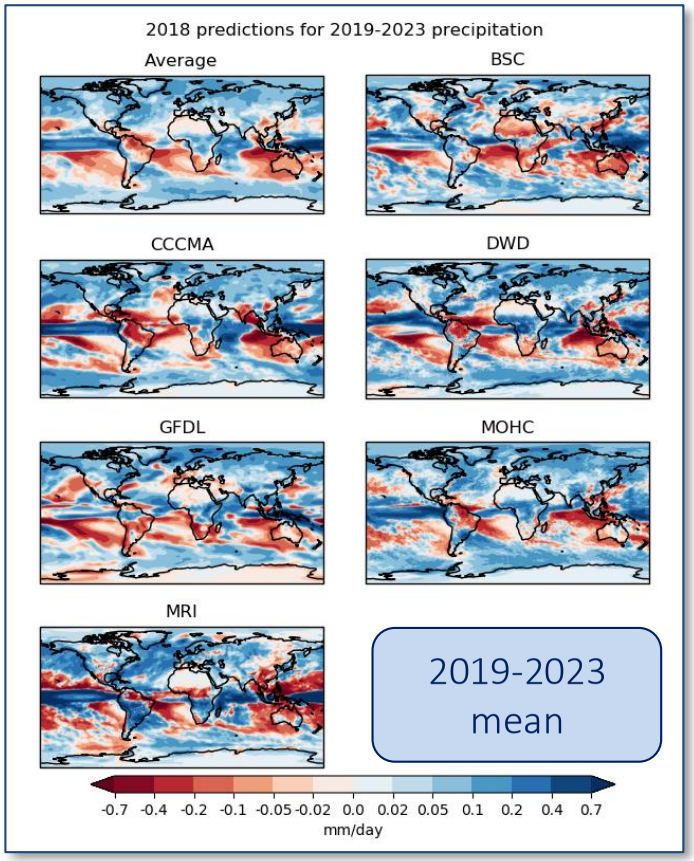
BCCR | IPSL | MPI | NRL
CERFACS | LASG | MRI | Reading
GFDL | MIROC | NCAR | SMHI

Example of products from ADCP



2019 mean

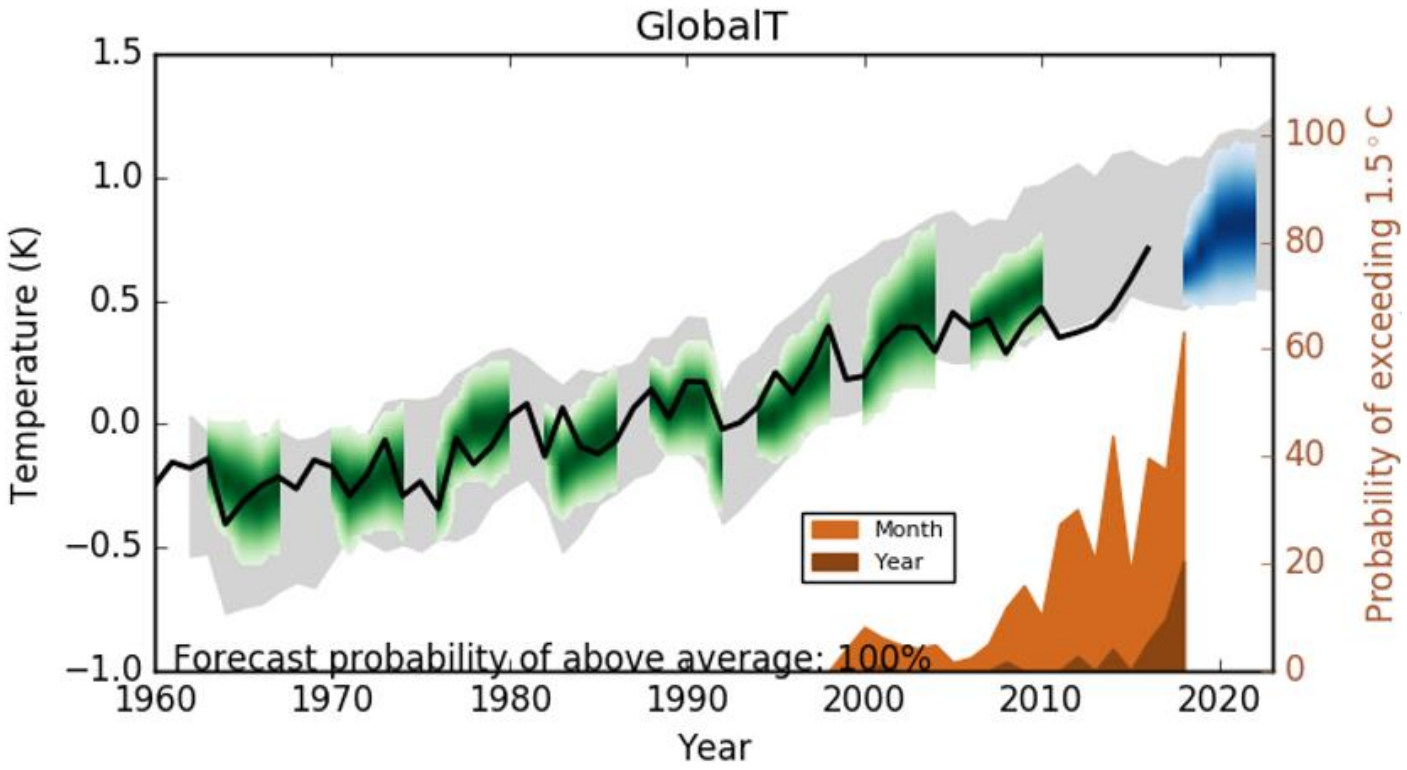
Temperature



2019-2023 mean

Precipitation

Predicted chance of temporarily exceeding 1.5 degrees



Doug Smith
UKMO

- Multi-model decadal forecasts for the period 2018 to 2022
- 63% chance of at least one month exceeding 1.5 degrees above pre-industrial
- 20% chance of at least one year exceeding 1.5 degrees above pre-industrial

(updated from Smith et al. 2018, Predicted chance that global warming will temporarily exceed 1.5 C. *Geophys. Res. Letts*., 10.1029/2018GL079362)

Plans for the Global Annual to Decadal Climate Update (GA2DCU)

- Will mimic similar WMO updates for ENSO, the state of Global Seasonal Climate Update (GSCU) and its outlook.
- Will be released once a year.
- Planned layout:
  - Executive Summary;
  - Current state of climate, including of the potential drivers of low-frequency climate variability (PDV, AMO…);
  - Multi-model based annual-to-decadal outlooks.

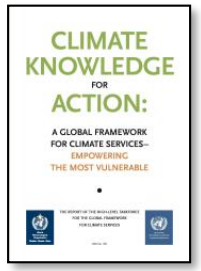
And so…

- Advances have been made in establishing an operational infrastructure in seasonal and annual to decadal predictions, but…
- There is still a long way to go. A goal to strive for is to aim for a level of coordination and delivery of services that is in place for the operational weather prediction community. But to reach there…
- …there are research needs for clarifying issues that are hindering necessary advancements in operational infrastructure.

Outline

- The current WMO operational infrastructure for Sub-seasonal to Decadal (S2D) predictions.
- Operational issues and research requirements.
- Advancing operational infrastructure.

GFCS GLOBAL FRAMEWORK FOR CLIMATE SERVICES



Issues related to advancing operational infrastructure

- Design of the configuration of operational prediction system (and the science that provides the rationale for their design decisions): hindcast period, ensemble size, consistency of analysis across reforecasts & real-time forecasts; perturbation generation…
- Development of products and communication of probabilistic outlooks: bias correction, calibration, multi-model construction, communicating probability and reliability…
- Verification of forecasts: Small sample size, intuitive vs. rigorous scores, conditional vs. unconditional skill, understanding past variations in skill…

Diversity in the configuration of seasonal forecast systems

13 GPCs-LRF for seasonal predictions

Center	Real-time forecast frequency	Ensemble size
NCEP	Daily	4
ECMWF	Once a month	51
UKMO	Daily	2
BoM	Twice per week	33
JMA	Every 5 days	51
DWD	Once a month	30
ECCC	Once a month	20

- Substantial diversity among the configuration of operational systems.
- Makes analysis of construction of multi-model ensemble an extremely difficult task.
- Most centers also don't maintain a consistency between analysis and forecast model.
- For weather forecasting, whatever degrades skill is not done, and provides a strong constraint for operational centers to follow similar configurations.
- Why it is so?

Why such a diversity in the configuration of long-range operational forecast systems?

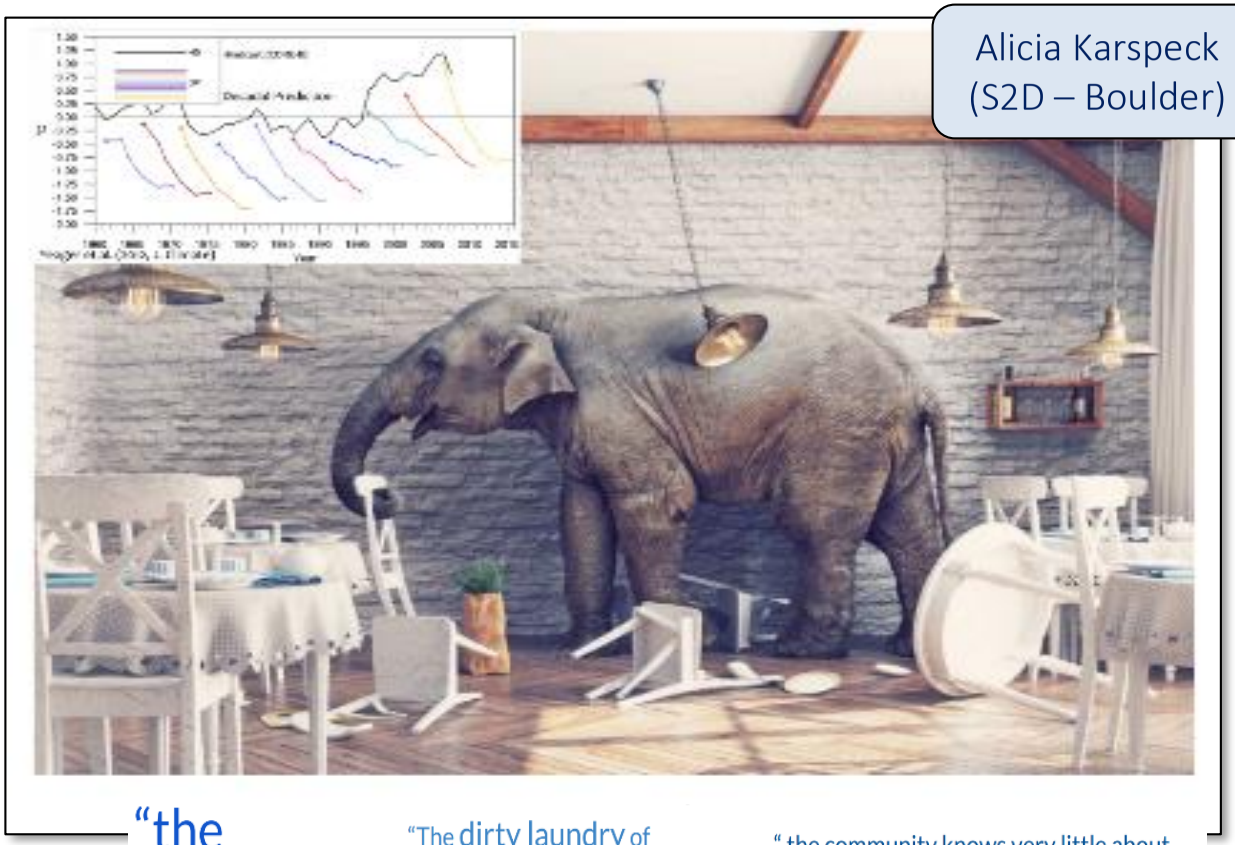
- For weather prediction we know what constrains and influences prediction skill – specification of the state of the atmosphere. Errors in the quality of initial conditions have punishable consequences on skill.
- For seasonal predictions, although the main driver is the initial state of the sub-surface ocean in the equatorial tropical Pacific, the essential requirements on spatial and temporal sampling are less clear.
- For near-term climate prediction, what information in the specification of the initial state matters is even less clear…
- As a consequence…

Why such a diversity in the configuration of long-range operational forecast systems?

- …there is a large diversity in the current configuration of operational systems for LRF across different centers
  - Operational schedule;
  - Length of hindcast;
  - Ensemble size;
  - Assimilation methods and initialization (e.g., full field or anomaly);
  - Perturbation strategies;
  - Consistency of analysis across hindcasts and real-time forecasts.
- There are clear research needs to establish “what matters?” for “realizing predictive skill” to guide the design of operational systems.

Bias correction, calibration and verification

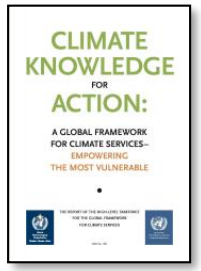
- The goal is to provide *reliable* predictions;
- Bias correction in a non-stationary climate (part of non-stationarity is the predictive signal);
- Small samples create serious issues with calibration and verification of LRF.



Outline

- The current WMO operational infrastructure for Sub-seasonal to Decadal (S2D) predictions.
- Operational issues and research requirements.
- Advancing operational infrastructure.

GFCS GLOBAL FRAMEWORK FOR CLIMATE SERVICES



Advancing operational infrastructure

- Operational systems are a tool for realizing predictability in the observed systems.
- For an operational systems targeting a particular time scale, questions along the lines of "what matters" are in a critical needs of some consensus:
  - What model resolution is required?
  - Which components of the Earth System are essential to include?
  - What observations are critical for forecast initialization?
- Bigger is better, but there is the practical question of ROI (while the initial infrastructure is being put together).
- The basic science question still is – "what are sources of predictability (that can be realized)?" and pursuing answers to this should continue.

Advancing operational infrastructure

- A multi-model approach with reliance on an international infrastructure is going to be absolutely essential.

- A mechanism for periodic assessment of progress in the operational prediction systems (sub-seasonal, seasonal, decadal), and improvements in prediction skill is also needed (along the lines of CMIP exercise for the climate projection class models).

Some thoughts for panel discussion

- Developing strategies for improving international collaboration across operational centers;
- Based on the current state of knowledge, a mechanism for developing recommendations for the design of operational systems;
- Understanding to what extent the current operational infrastructure is being utilized and what may be impediments in the utilization of information? Mechanisms for user feedback;
- Building and sustaining an observing system for the components that are key sources of predictability.
- How the services will be delivered?

Thanks!

Further information

- https://www.wmolc-adcp.org
- https://www.wmolc.org/ [seasonal predictions]
- https://www.wcrp-climate.org/images/WCRP_conferences/S2S_S2D_2018/pdf/Programme/orals/presentations/C1-01_Alicia-Karspeck.pdf [S2D presentation by Alicia Karspeck]
- https://www.wcrp-climate.org/images/WCRP_conferences/S2S_S2D_2018/pdf/Programme/orals/presentations/C3-Discussion_Danabasoglu.pdf [Closing summary of S2D conference]