

WMO Infrastructure for Operational Long-Range Forecasts

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Sub-seasonal to Longer Time-Scales

World Meteorological Organization (WMO)

- WMO is an intergovernmental organization with a membership of 192 Member States.
- As a specialized agency of the United Nations, WMO is dedicated to international cooperation and coordination on monitoring and predicting the state of the Earth's System.
- Some key WMO functions:
 - Creation of standards for observations and monitoring;
 - Creation of standards for data exchange and infrastructure;
 - Facilitates coordination across meteorological and hydrological services.



World Meteorological Organization (WMO)

- Various technical and expert teams (within the WMO structure) develop standards for operational infrastructure and dissemination of services.
- Infrastructure standards are codified in the Global Data-Processing and Forecast System (GDPFS) Manual (which contains technical regulations).



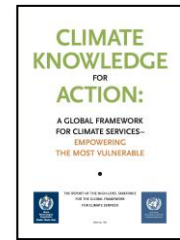
Expert Team on Operational Predictions from Sub-Seasonal to Longer Time Scales (ET-OPSLS)

- 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 the GDPFS Manual.

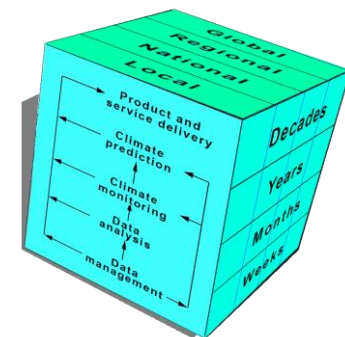
Outline

- The current WMO operational infrastructure for Sub-seasonal to Decadal (S2D) predictions.
- Operational issues and research requirements.
- Connecting operations with the research component.



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;

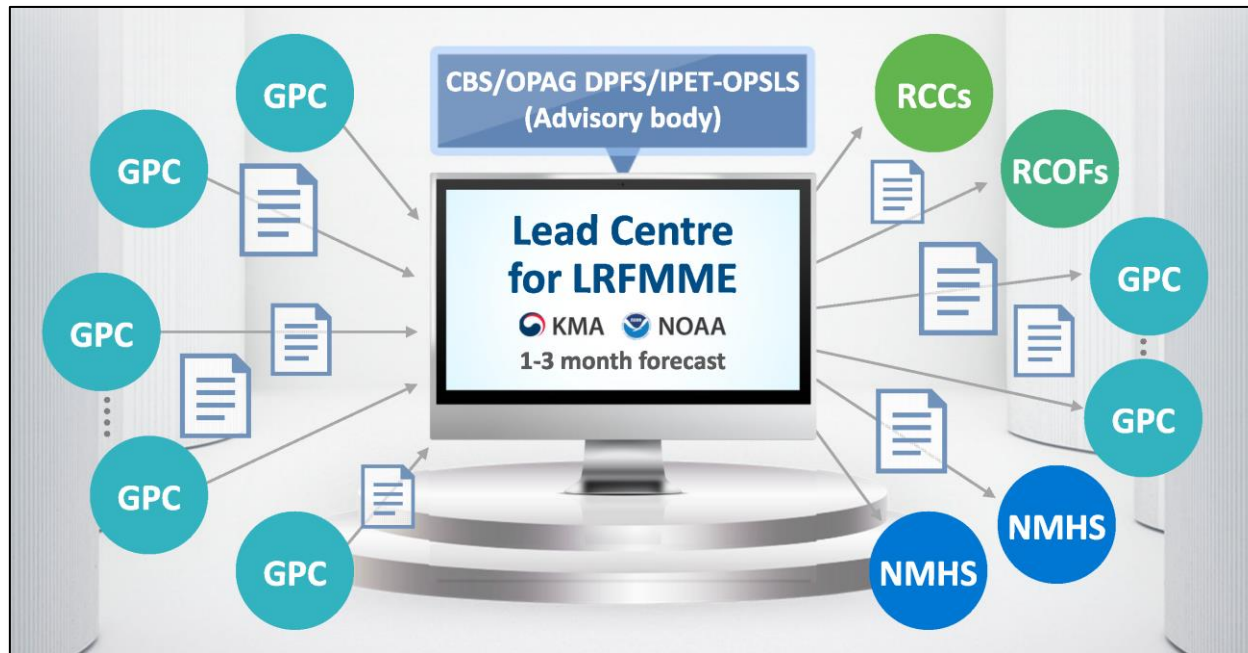


- On a monthly basis, seasonal forecast data is provided to the WMO Lead Center for Long-Range Forecast Multi Model-Ensembles (LC-LRFMME) hosted by the Korean Meteorological Administration (KMA);

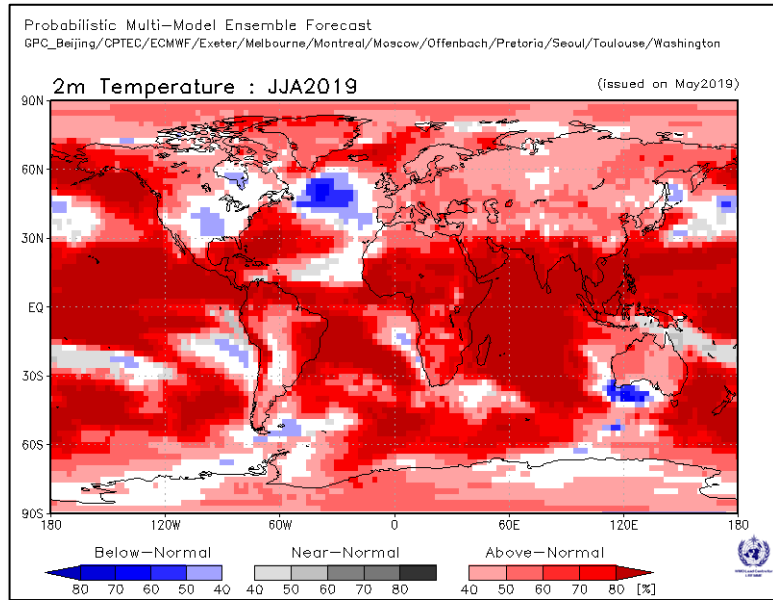
Lead Center for Long-Range Forecast Multi Model Ensembles (LC-LRFMME)

<https://www.wmolc.org/>

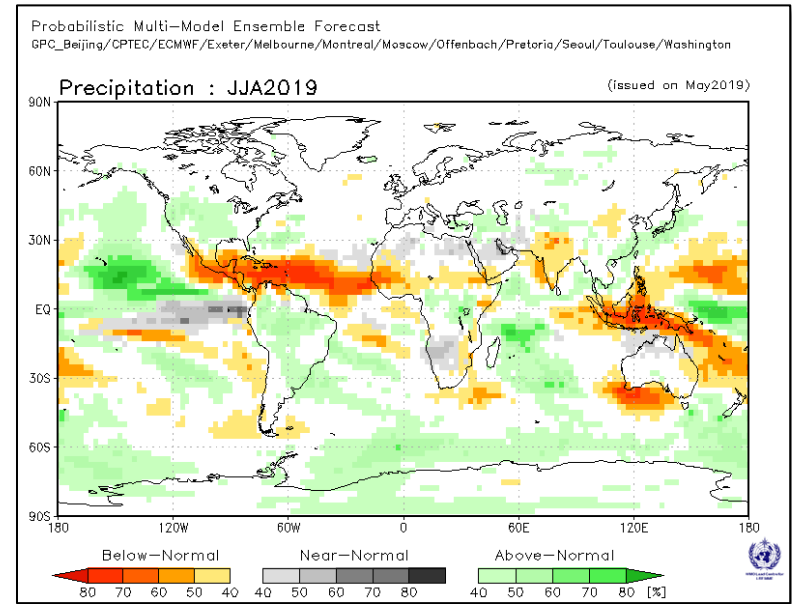
- LC-LRFMME provides a conduit between GPCs-LRF and NMHSs, RCCs etc.



LC-LRFMME – Probabilistic Forecasts

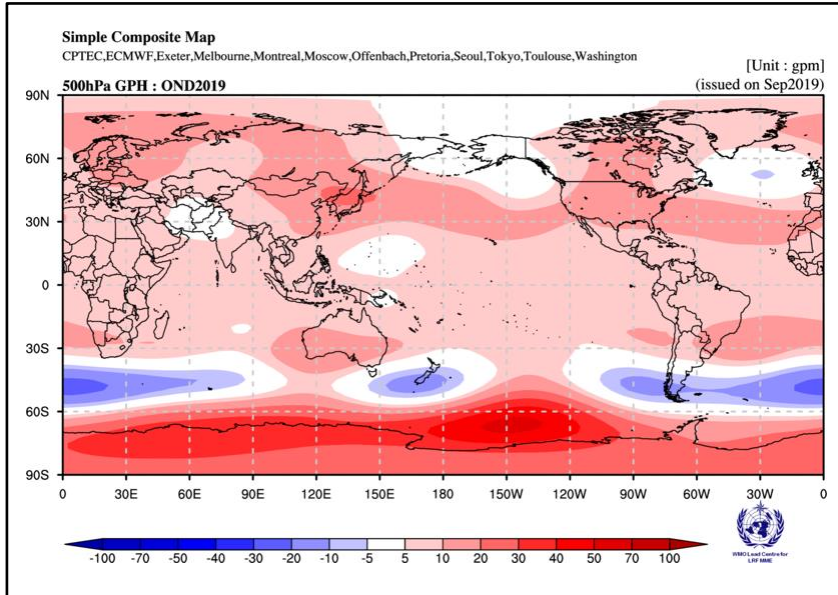


Temperature

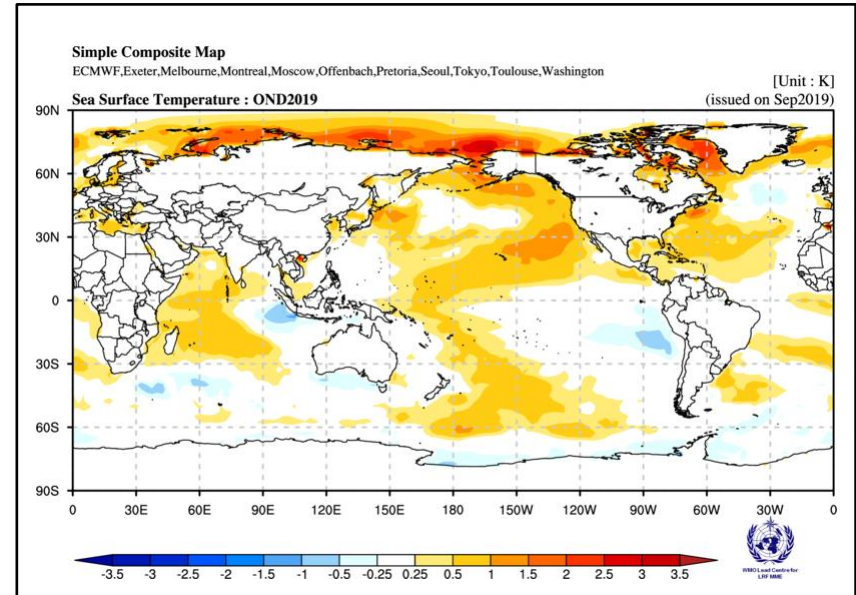


Precipitation

LC-LRFMME – Deterministic Forecasts



500-mb Height

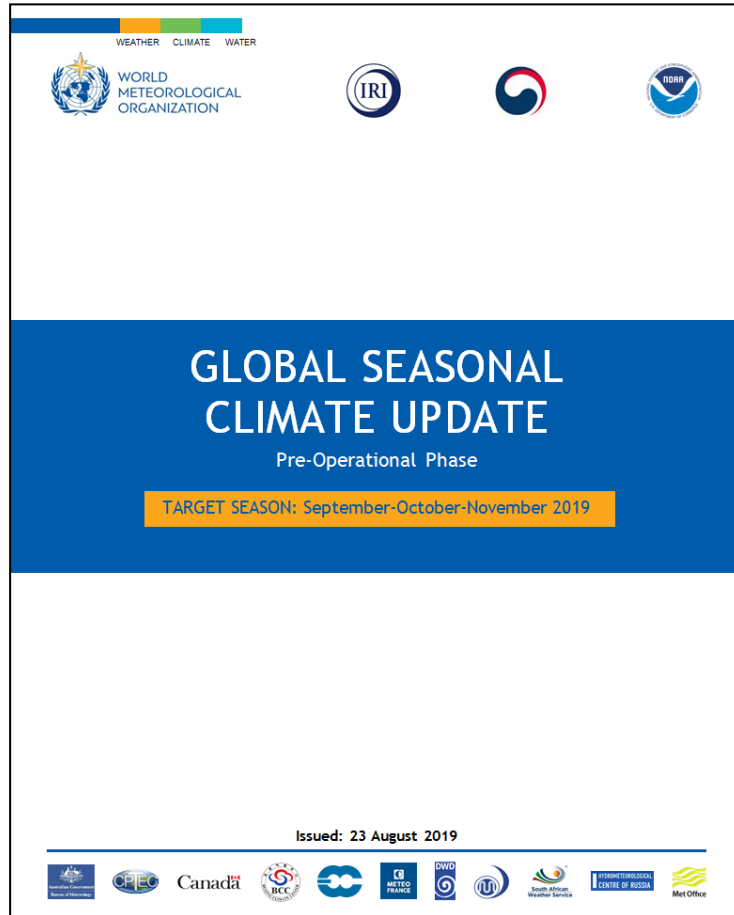


Sea Surface Temperature

Global Seasonal Climate Update (GSCU)

- Intends to provide an update for the observed climate anomalies (surface temperature and precipitation, drivers of climate variability) for the previous season and the outlook for the next season.
- Released four times a year.
- GSCU parallels a similar WMO effort on providing regular ENSO updates.
- Forecasts from the LC-LRFMME provide the basis for the outlook component of the GSCU.
- <http://www.wmo.int/pages/prog/wcp/wcasp/LC-LRFMME/index.php>

Global Seasonal Climate Update (GSCU)



The latest version can be downloaded from:

<https://ftp.cpc.ncep.noaa.gov/mingyue/GSCUWMO/Supplementary/>

Global Seasonal Climate Update (GSCU)

- Contents

- Summary

- 1. Observations

- 1.1 Large-scale sea surface (SST) Indices
- Observed temperature
- Observed Precipitation

- Potential evolution of the state of the climate over the next three months

- 2.1 Large-scale sea surface (SST) Indices
- Predicted temperature
- Predicted precipitation

- Latest updates for monitoring and prediction information

- How to use the Global Seasonal Climate Update


The screenshot shows the WMO website's 'Latest Global Seasonal Forecasts' page. The page features a navigation menu on the left with links for 'Planning & Monitoring', 'PROGRAMMES', 'GFS', 'ANCOMET', 'Publications', 'Library', 'Learning', 'Language resources', and 'Youth'. A search bar is located below the menu. The main content area is titled 'Latest Global Seasonal Forecasts' and includes a paragraph explaining the WMO Lead Centre for Long-Range Forecast Multi-Model Ensemble (LC-LRFMME) and its role in providing forecast data from 13 WMO accredited Global Producing Centres of Long Range Forecasts (GPCs-LRF). Below the text are two maps: 'Seasonal mean surface air temperature forecast' and 'Seasonal mean precipitation forecast'. An interpretation text at the bottom explains the spatial pattern of seasonal mean surface air temperature forecast probabilities, noting that probabilities are calculated for the average temperature for the season being in the highest third (above-normal or warm), middle third (normal) or lowest third (below-normal or cold) ranges of the baseline record (1993-2009) at each location. Colour code is indicated only for the category that has the highest probability.


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>

WMO Lead Centre for Annual-to-Decadal Climate Prediction

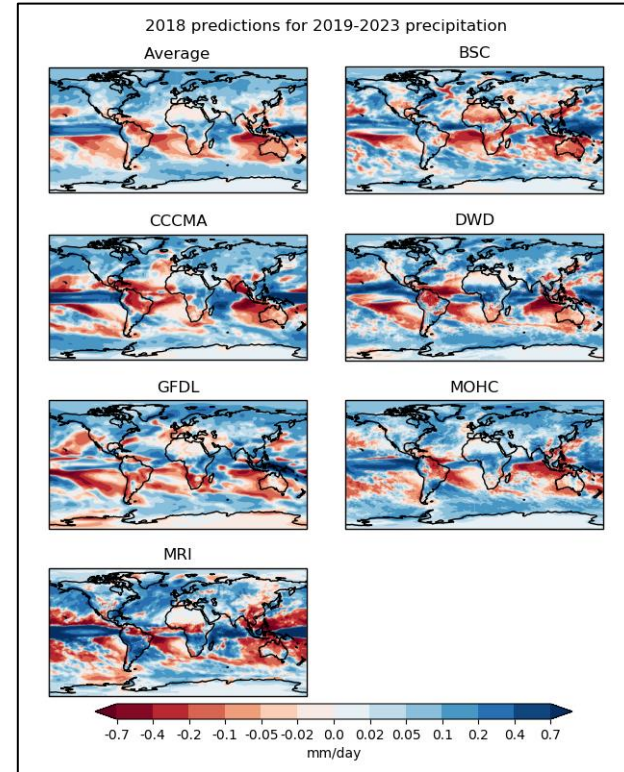
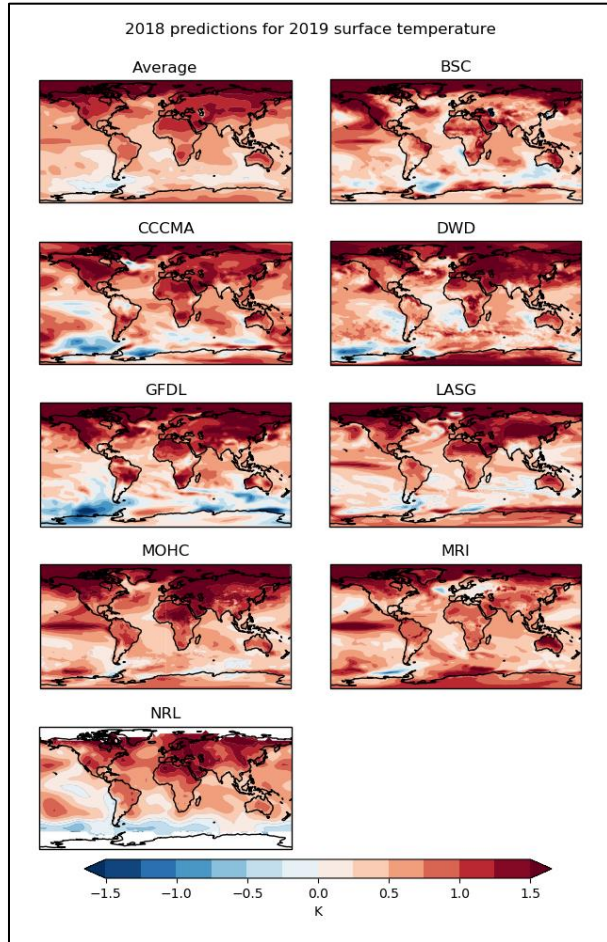
The Met Office is a designated Lead Centre for Annual-to-Decadal Climate Prediction (LC-ADCP). The LC-ADCP collects and provides hindcasts, forecasts and verification data from a number contributing centres worldwide.







Example of products from ADCP



2019 Average

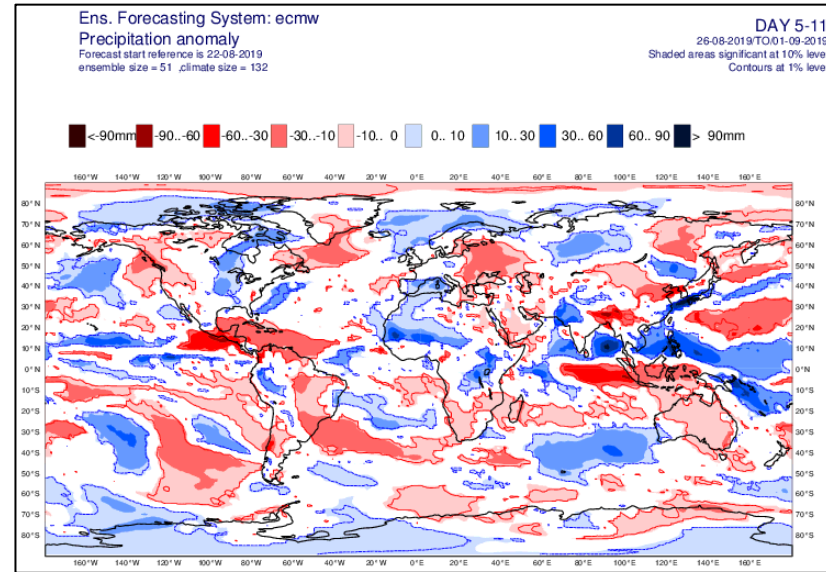
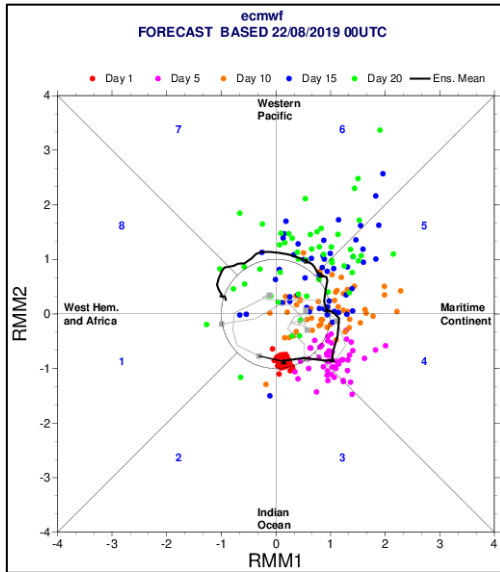
2019-2023
Average

Sub-Seasonal to Seasonal (S2S) Project

- Currently a joint WWRP/WCRP research project;
- Collects hindcast and (delayed) real-time sub-seasonal forecast data;
- Efforts are under way to develop a formal operational infrastructure (similar to LRF and ADCP) within WMO.
- <http://s2sprediction.net/>



S2S Products – ECMWF (3-week delay)

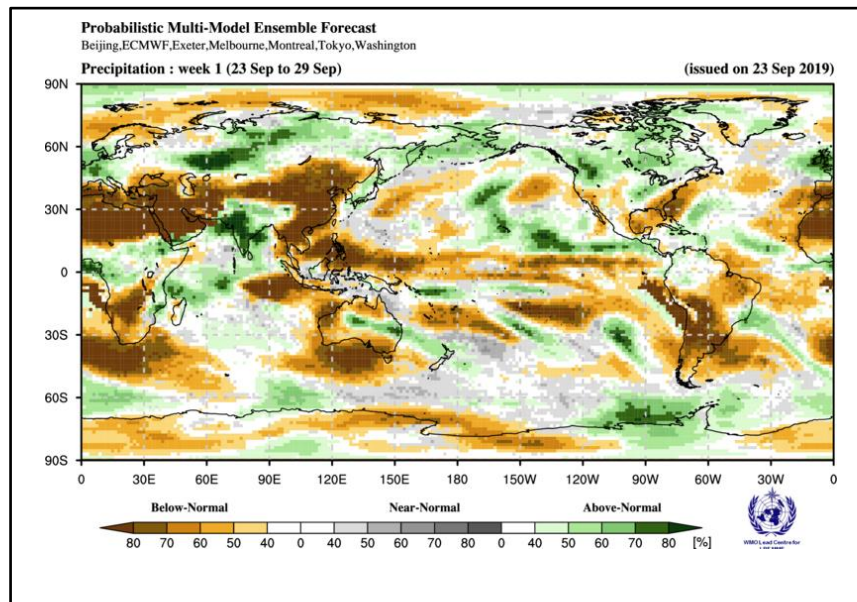
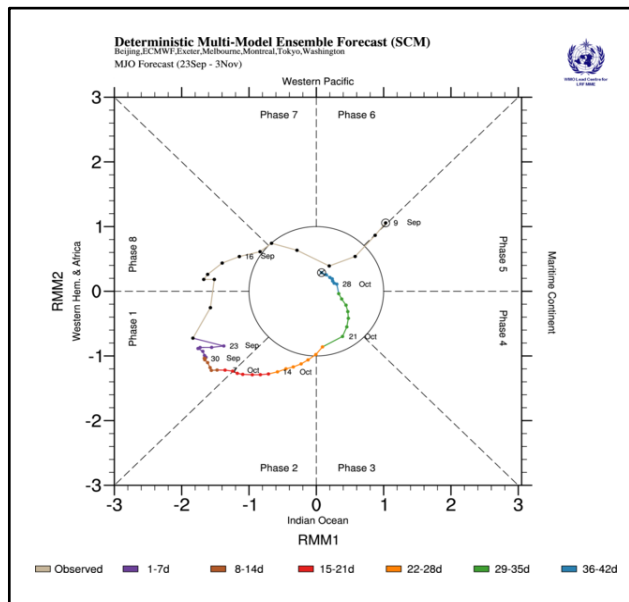


MJO Index

Can be reached from:
<http://s2sprediction.net/>
(Click on “Products” menu)

Rainfall

S2S Products – Lead Center (real-time; password protected)



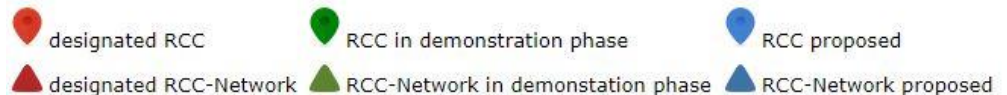
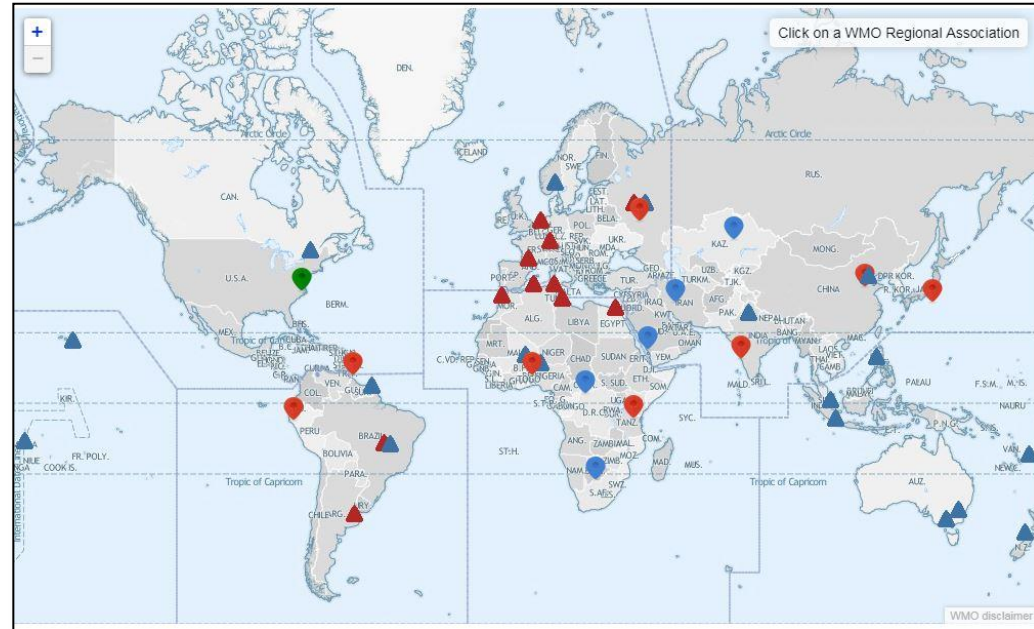
MJO Index

Password protected;
NMHSs can request access
from the Lead Center

Rainfall

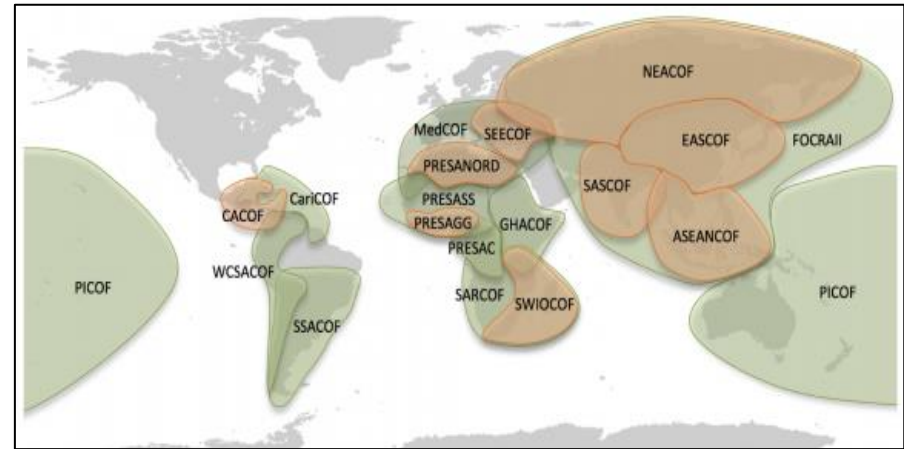
WMO Regional Climate Centers (RCCs)

- RCCs provide regional climate products in support of regional and national activities.
- Similar to GPCs-LRFs, RCCs need to fulfill a set of mandatory functions (listed in the GDPFS Manual).
- Outlooks from LC-LRFMME.



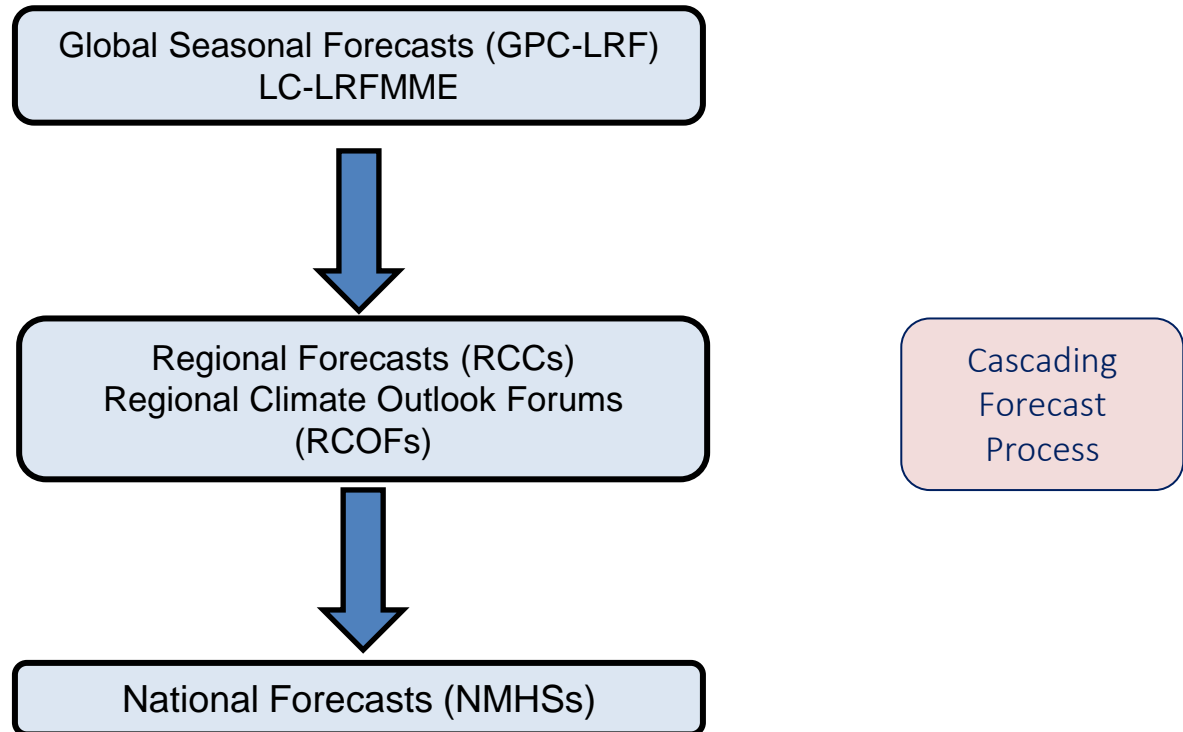
WMO Regional Climate Outlook Forums (RCOFs)

- A mechanism for developing and disseminating *regional* climate outlooks.
- Most RCOFs currently utilize a consensus based subjective approach for seasonal outlooks, and are being encouraged to move towards objective methodologies (traceable, reproducible, verifiable and well documented).



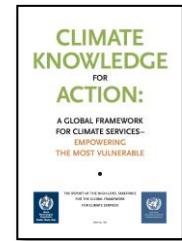
WMO Infrastructure for LRF

- All in all, WMO infrastructure for LRF has a tiered concept



Outline

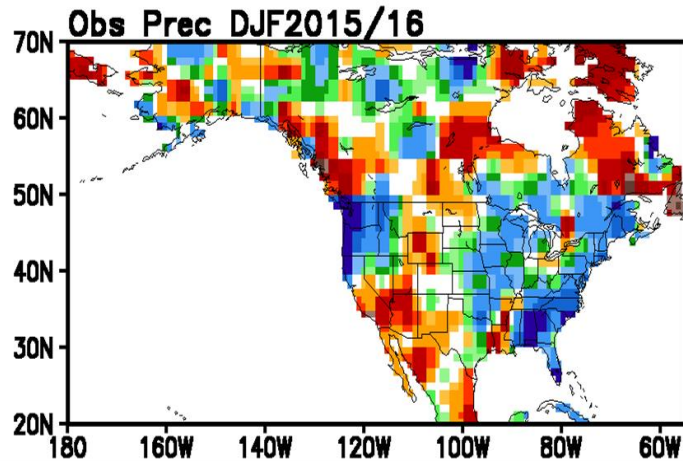
- The current operational infrastructure for Sub-seasonal to Decadal (S2D) predictions.
- Operational issues and research requirements.
- Connecting operations with the research component.



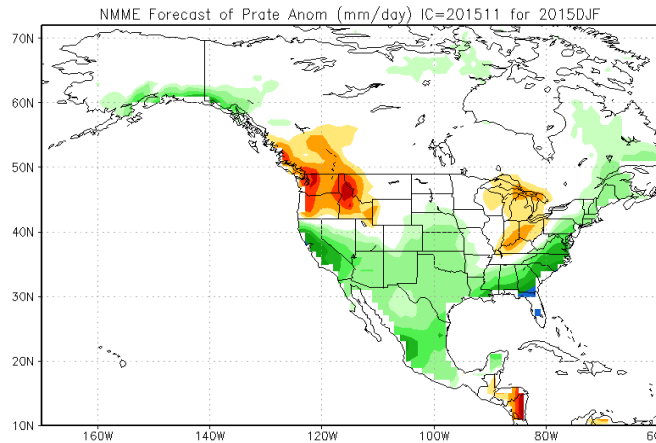
Operational issues

- 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...

Communicating LRF Outlooks: DJF 2015/16 California Rainfall



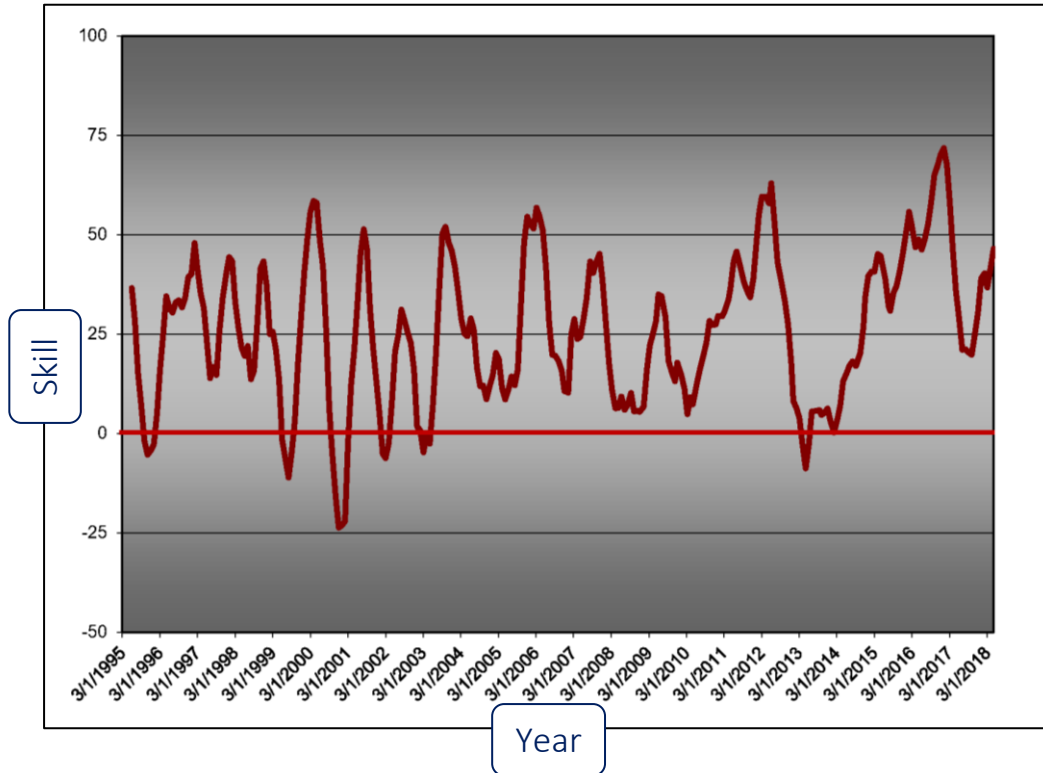
Observed



Models (NMME)

- One of largest El Niño events in recent record.
- Seasonal forecast for wet anomalies generated lots of expectations; but...
- ...it did not happen
- Communication of probabilistic forecasts (and expectations for skill) to decision makers remains a challenge.

Understanding variations in prediction skill

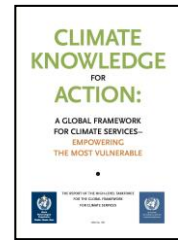


Skill of operational surface temperature at CPC

- Large variations in skill over time; why?
- What is the influence of improvements in models, assimilation and the observing system on skill?
- Conditional skill vs. unconditional skill
- Hierarchy of skill measures – user friendly, relevant to model developers, statisticians

Outline

- The current WMO operational infrastructure for Sub-seasonal to Decadal (S2D) predictions.
- Operational issues and research requirements (some specific examples).
- Connecting operations with the research component.



WMO Research Components

- World Weather Research Programme (WWRP)
 - Data assimilation and observing strategies
 - Predictability, Dynamics and Ensemble Forecasting (PDEF)
 - Verifications
 - Working Group on Numerical Experimentation (WGNE)
 - Sub-seasonal to Seasonal Predictions
- World Climate Research Programme (WCRP)
 - Predictability and its sources
 - Climate Variability (CLIVAR)
 - Working Group on Sub-seasonal to Decadal Prediction (WGSIP)

Summary

- Impressive advances have been made in developing operational infrastructure for long-range outlooks in support of climate services, but...
- We are not there yet. Our benchmark should be the level of coordination that happens in the operational weather prediction community.
- Further research efforts will be required to provide guidance on some high priority issues in advancing operational infrastructure, product development and communication of information.

Questions?