Research Needs for Advancing Operational S2D Forecasting Infrastructure

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Outline

- The current operational infrastructure for Sub-seasonal to Decadal (S2D) predictions;

- Operational issues and research requirements (some specific examples);

- Enabling mechanisms for improving operations and research collaboration.
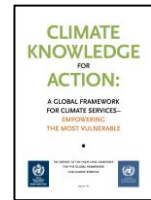
Current status of operational S2D infrastructure within WMO

- 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 WMO's Climate Services Information System (CSIS).
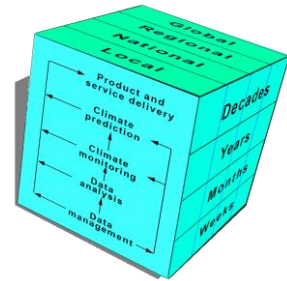
The mandate of the ET-OPSLS is to…

- Provide oversight for coordinating the operational infrastructure and data exchange between different centers;

- Support evolution of the Climate Services Information System (CSIS);

- Develop operational requirements based on evolving user needs;

- In collaboration with WCRP (e.g., WGSIP), promote international cooperation and research on initialized operational S2D predictions.
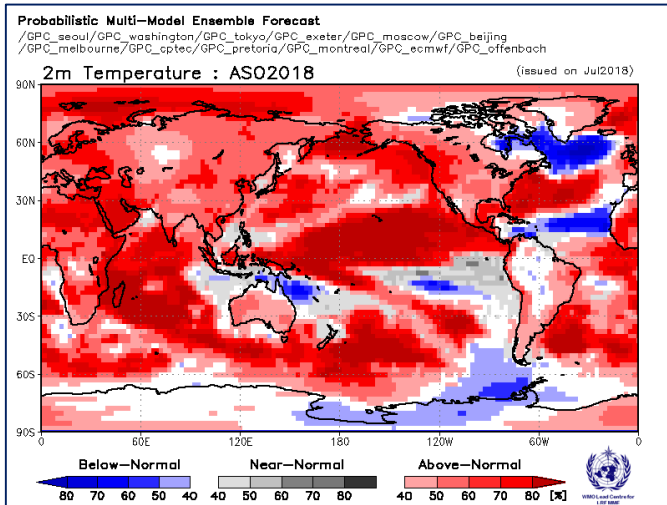
Operational infrastructure for seasonal forecasts

- 13 Global Producing Centers for Long-Range Forecasts (GPC-LRFs);

- 11 seasonal forecast systems are based on coupled models;

- 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).
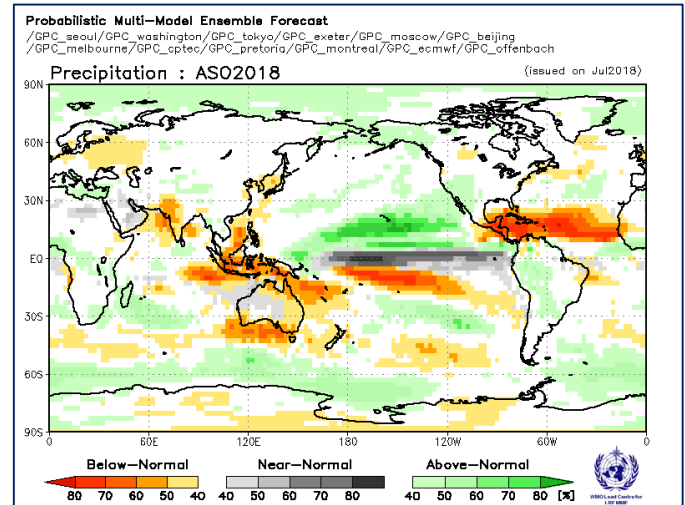
- https://www.wmolc.org/

WMO Global Producing Centres

Products from LC-LRFMME

Probabilistic Multi−Model Ensemble Forecast
/GPC_seoul/GPC_washington/GPC_tokyo/GPC_exeter/GPC_moscow/GPC_beijing
/GPC_melbourne/GPC_cptec/GPC_pretoria/GPC_montreal/GPC_ecmwf/GPC_offenbach

2m Temperature : ASO2018   (issued on Jul2018)

Probabilistic Multi−Model Ensemble Forecast
/GPC_seoul/GPC_washington/GPC_tokyo/GPC_exeter/GPC_moscow/GPC_beijing
/GPC_melbourne/GPC_cptec/GPC_pretoria/GPC_montreal/GPC_ecmwf/GPC_offenbach

Precipitation : ASO2018   (issued on Jul2018)

2-m Temperature

Precipitation

https://www.wmolc.org/

Infrastructure for Annual to Decadal Climate Predictions (ADCP)

- An effort led by UK Met Office;

- WCRP Grand Challenge on Near-Term Climate Predictions (NTCP).

- https://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/long-range/wmolc-adcp

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.

BCCR		GFDL		MOHC		NRL
BSC		IPSL		MPI		Reading
CCMA		LASG		MRI		SMHI
CERFACS		MIROC		NCAR		

15 Centers

Products from ADCP
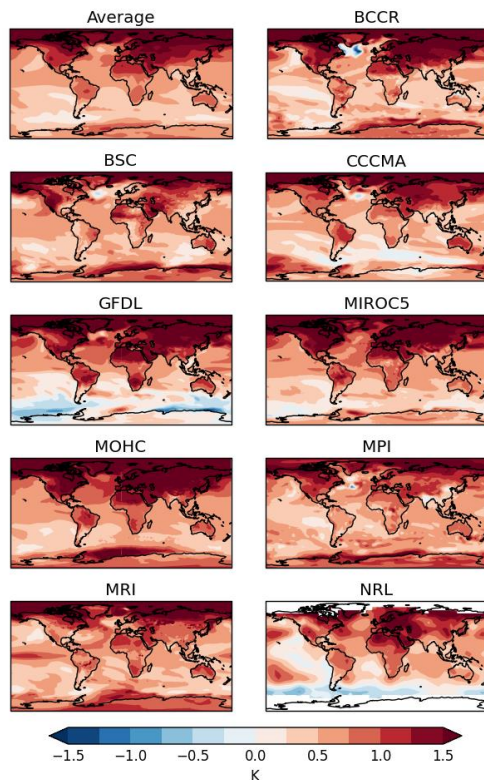
2018-2022 Average

2-m Temperature
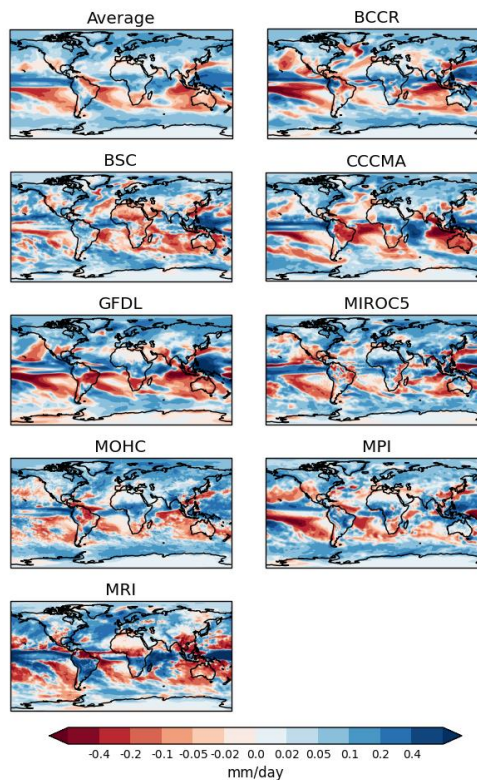
Precipitation

Sub-Seasonal to Seasonal (S2S) Project

- Currently a joint WWRP/WCRP <u>research</u> 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/

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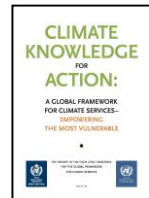
Operational issues

- Design of the configuration of operational S2D prediction system (and the science that provides the rationale);

- Development of products and communication of probabilistic forecasts;

- Verification of forecasts.
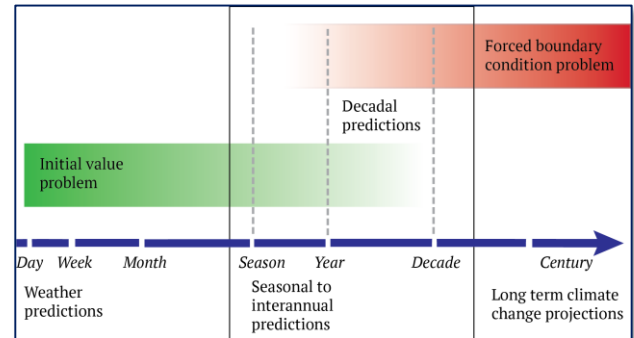
A (partial) summary of the current configuration of some operational seasonal forecast systems

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 natural constraint for operational centers to follow similar configurations.

- Why it is so?

Why so much diversity in operational forecast systems?
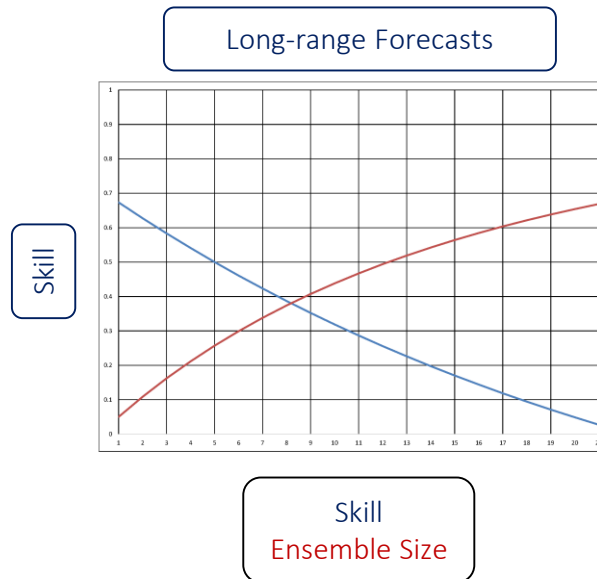

Weather Forecasts
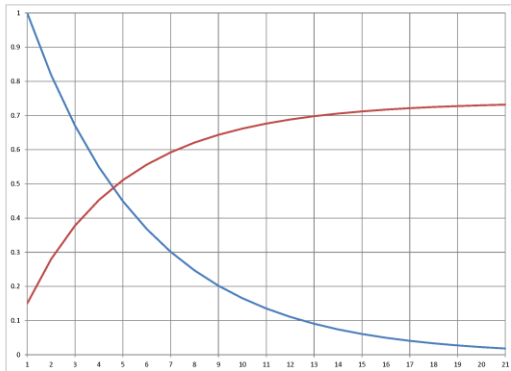
Skill

Skill
Ensemble Size

- Initial decay in skill with lead-time is steep.

- Lagged ensemble is not an option.

- A large compromise in skill if the data assimilation system and forecast models are not the same.
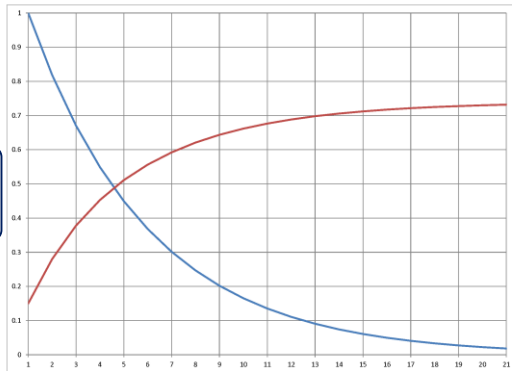
- And hence, …

Why so much diversity in operational forecast systems?

- Initial decay in skill is slow.

- Lagged ensembles have the potential for improving skill.

- Don't quite know how much skill is compromised if assimilation systems (for component models) are not consistent with the forecast model.

- And hence, …

Long-range Forecasts

Skill

Skill
Ensemble Size

Why so much diversity in operational forecast systems?
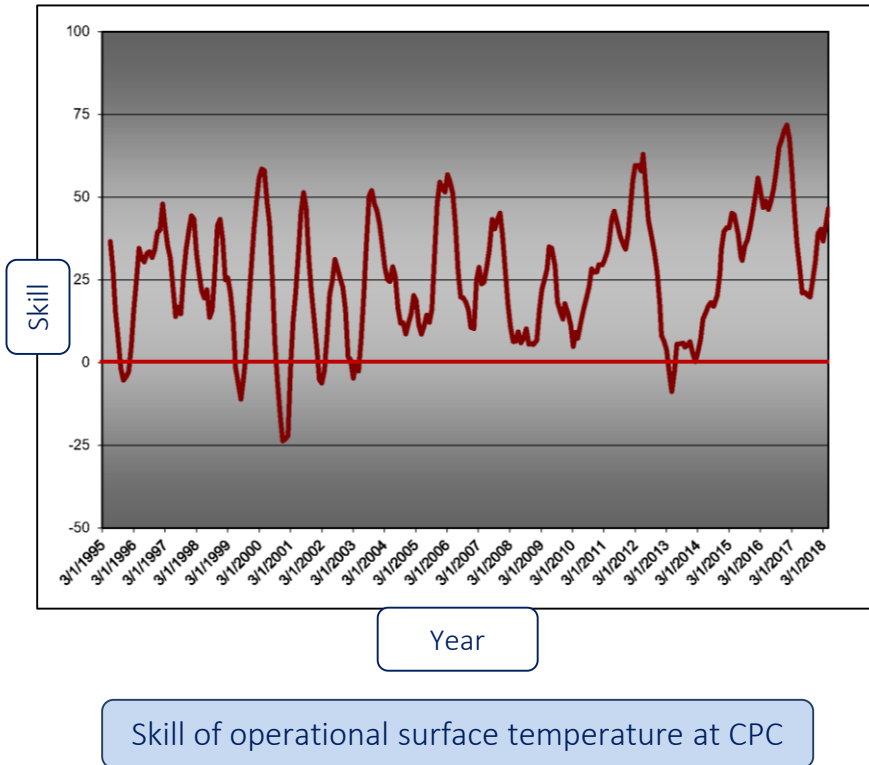
Questions:

- What factors compromise realization of skill, and how much?

- Lagged vs. burst?

- What is the optimal lagged ensembles?

- How much consistency for initial condition matters?

- With trends in climate, what hindcast to use for base climate?

Weather Forecasts

Long-range Forecasts

Skill

Skill
Ensemble Size

Understanding variations in prediction skill


Skill of operational surface temperature at CPC

- Large variations in skill over time.
- Forecasting tools (models) have evolved over 23-year period.

Questions:

- What are the reasons for variations in skill (ENSO; trends; …)?
- What is the influence of improvements in models, assimilation and the observing system on skill?

Variations in skill of ENSO and the ocean observing system

of ocean observations in Eq. Pacific
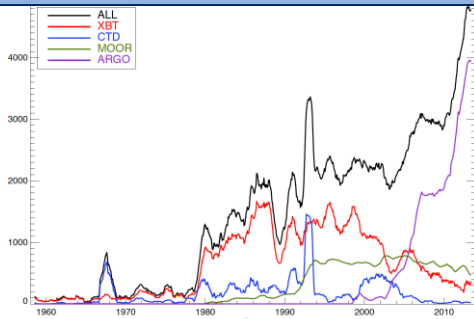
- Hard to see a relationship between the evolution of the observing system and ENSO prediction skill.

- Why? Model errors (and inability to effectively ingest observational data) or fundamental ENSO dynamics?

- Answers have important implications for the investments in the sustained ocean observing system for ENSO prediction.
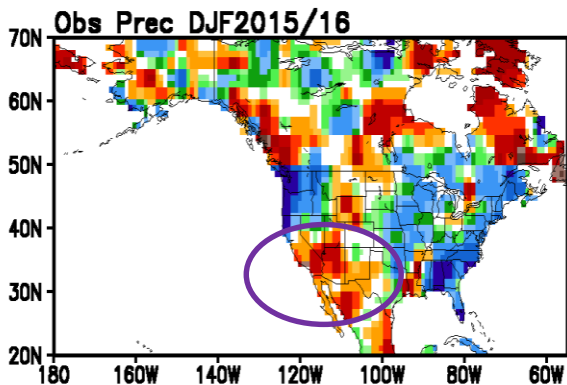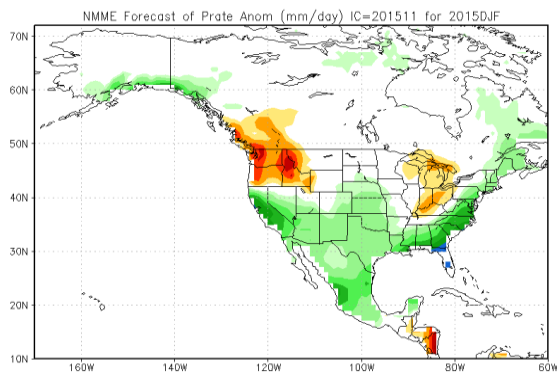
(b) 3-mon-lead
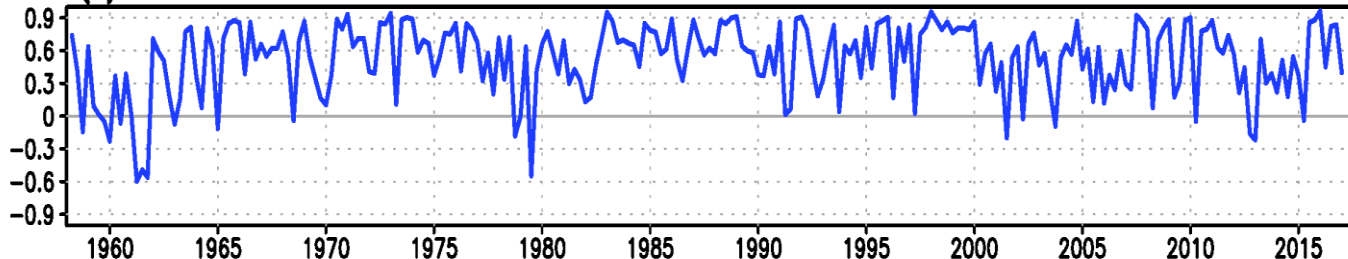
Niño3.4 Anomaly Correlation

Drs. Bohua Huang; Chul-Su Shin; COLA

# 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...

- Scientific studies to date (~ 15) have not been able to settle the reasons.
- Observed anomalies may have been within the envelope of possible outcomes.
- Communication to decision makers remains a challenge.

Estimates of Seasonal Predictability
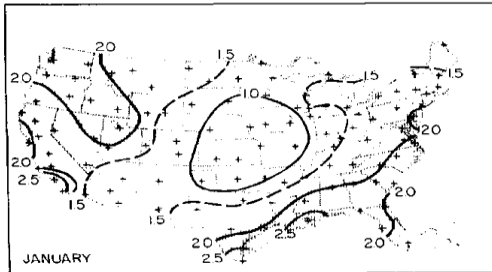
Madden, 1976
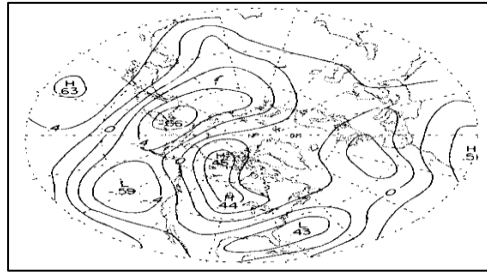
Horel and Wallace, 1982
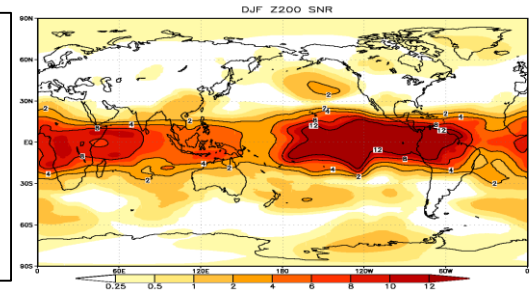
Kumar et al., 2015

- Estimates of predictability are critical for managing user expectations.
- Over a 40-year span, predictability estimates have remained fairly constant.
- Inadequacies of models (that are used to estimate predictability) are often blamed.

Questions:

- How should we ascertain the "goodness of forecast systems?" What metrics to use?
- What is predictability conditional to specific predictors, e.g., for weak vs. strong El Niño?
- Is there a spread-skill relationship?

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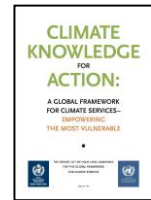
Enabling mechanisms: Communication

- WMO Operational Climate Prediction (OCP) Workshop series
    - OCP-1 : 2015; Pune/India;
    - OCP-2 : Barcelona/Spain;
    - Develop a summary paper on operational issues (to encourage further research).
- RCCs and RCOFs;

- Develop mechanisms for communicating operational issues to WGSIP and develop joint targeted projects.

Enabling mechanisms: Providing forecast data

- THORPEX Interactive Grand Global Ensemble (TIGGE): Collection of real-time forecast data from operational ensemble forecast systems; ~ 2008; operational data released after two day delay;

- The Climate-System Historical Forecast Project (CHFP): Hindcast data from seasonal forecast system;

- S2S Project: Hindcast and real-time forecasts from operational sub-seasonal forecast system; real-time data delayed by three weeks;

- Seasonal forecast data from the WMO LC-LRFMME: Not available yet, but discussions are under way to open up the hindcast and real-time forecasts.

Thanks!

Model Predictions of ENSO from Aug 2018

IRI/CPC
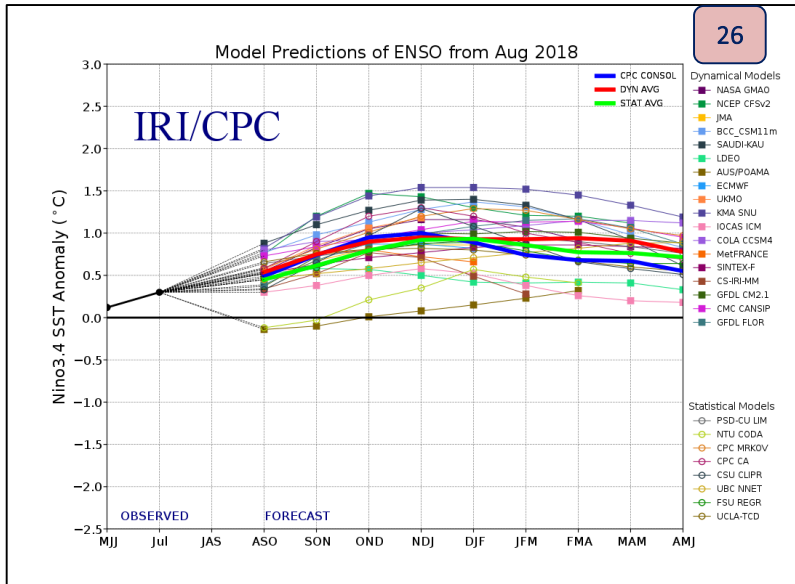
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- Number of forecast systems increases for longer range.
- 18-Dynamical + 8 statistical models
- Prediction systems utilize variety of initial condition information (observations), initial perturbation techniques; and yet
- Skill levels among different prediction systems are not markedly different

- What does it tell us about the system being predicted; about observational requirements etc.?

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