Environment and Climate Change Canada | Environnement et Changement climatique Canada

Canada

Activities of the World Climate Research Programme Working Group on Subseasonal to Interdecadal Prediction (WGSIP)

Bill Merryfield and Doug Smith

WGSIP co-chairs

WMO OCP-2, 30 May-1 June 2018, Barcelona

WCRP Working Groups

Working Group on Numerical Experimentation (WGNE)

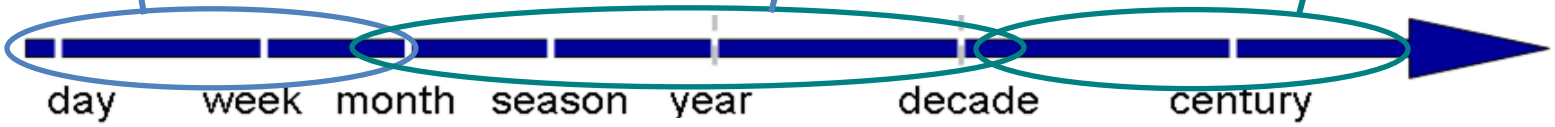
MJO Task Force…

Working Group on Sub-seasonal to Interdecadal Prediction (WGSIP)

CHFP, DCPP…

Working Group on Coupled Modelling (WGCM)

CMIP…



Weather predictions

Subseasonal to decadal predictions

Long term climate change projections

Overview of WGSIP

WGSIP seeks to facilitate and coordinate research on

- sources of predictability in the climate system
- ability of dynamical models to exploit predictability
- most effective practices for initializing climate predictions
- methods for extracting and communicating climate prediction information

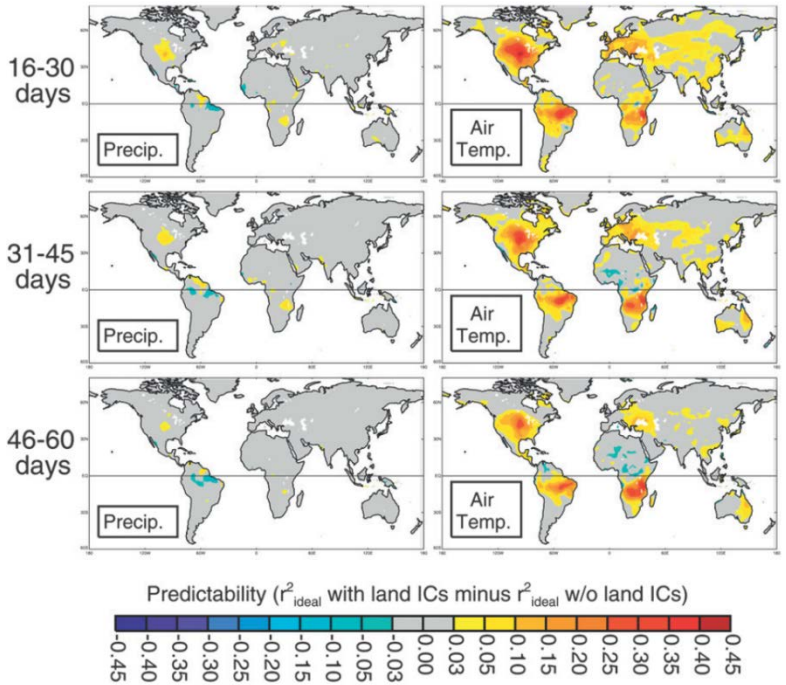
WGSIP approaches these aims through

- targeted community research projects
- enabling access to hindcasts from many climate prediction systems
- organizing scientific meetings
- facilitating coordination between organizations representing different aspects of climate prediction research and operations

Previous WGSIP Projects

GLACE-2

- Joint between WGSIP, GEWEX
- Hindcasts with realistic vs randomized IC
- Land influence on predictability, skill



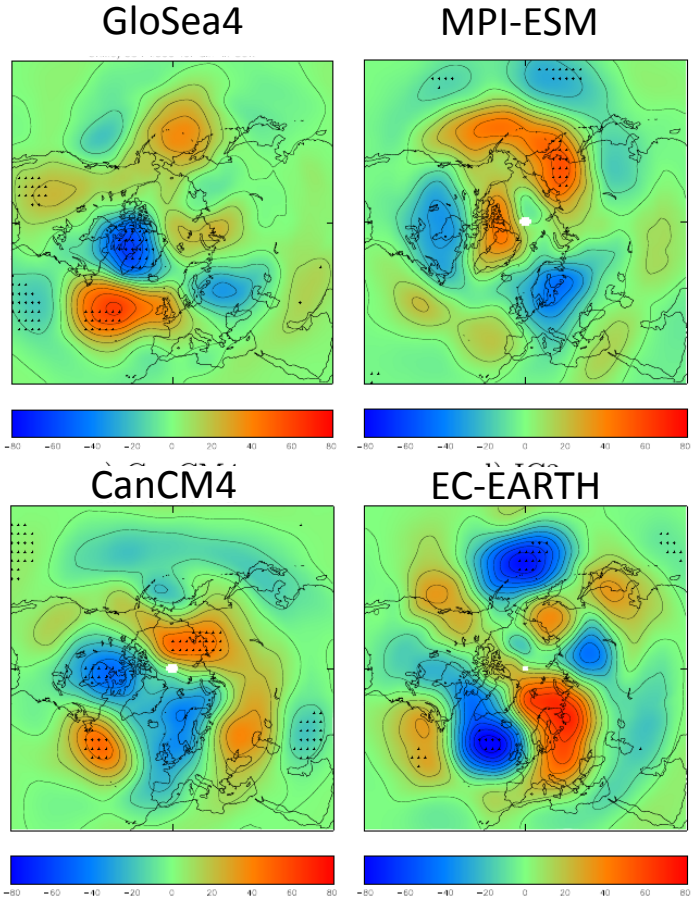
Precipitation and temperature predictability attributable to land initialization (Koster et al., 2011)

StratHFP

- Quantify forecast improvements from initializing and resolving the stratosphere
- Hi-top vs lo-top hindcasts

IceHFP

- Influence of sea ice on circulation
- Realistic vs climatological ice init
- High vs low ice years

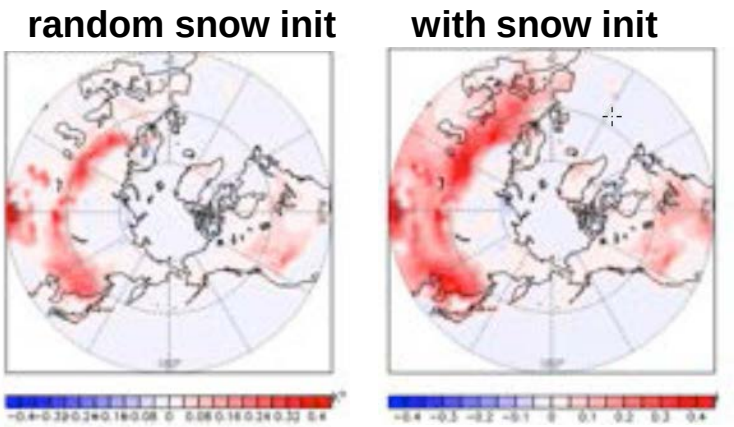


SON circulation anomaly, low minus high (2007 – 1996) ice years (D. Peterson)

Current WGSIP Projects

SNOWGLACE

- impact of snow initialization on sub-seasonal to seasonal forecasts
- 8 centres participating

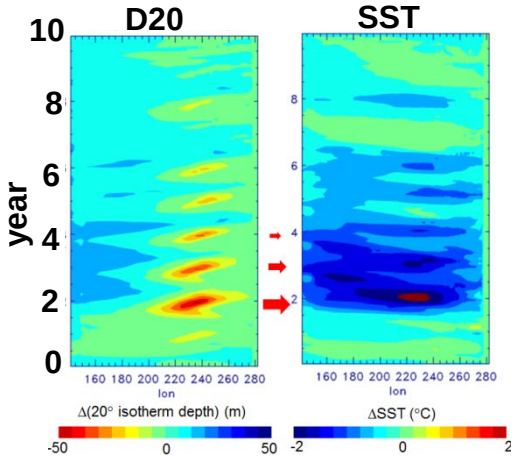


Potential predictability of April temperature in days 1-15 of forecast with randomized (left) and realistic (right) snow initialization (J.-H. Jeong)

Long-Range Forecast Transient Intercomparion Project (LRFTIP)

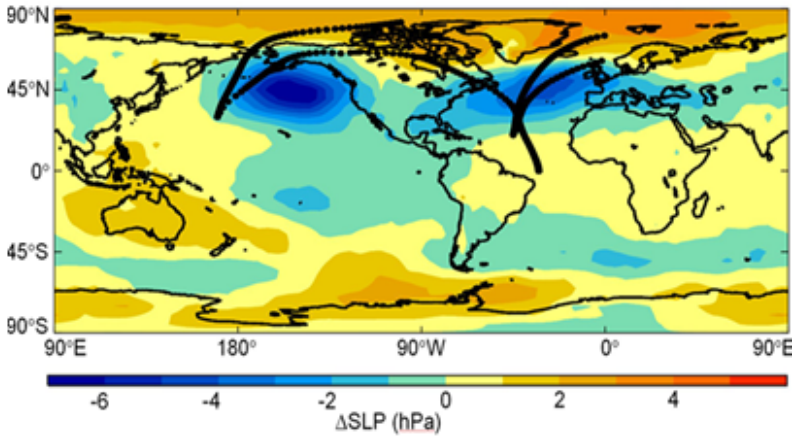
- shock/drift in climate forecasts
- hindcast climatologies for ~40 sub-seasonal/seasonal/decadal models

Transient equatorial Pacific 20°C isotherm depth (left) and SST (right) differences in CanCM4 decadal hindcasts with and without subsurface ocean initialization (W. Merryfield) →



Teleconnections

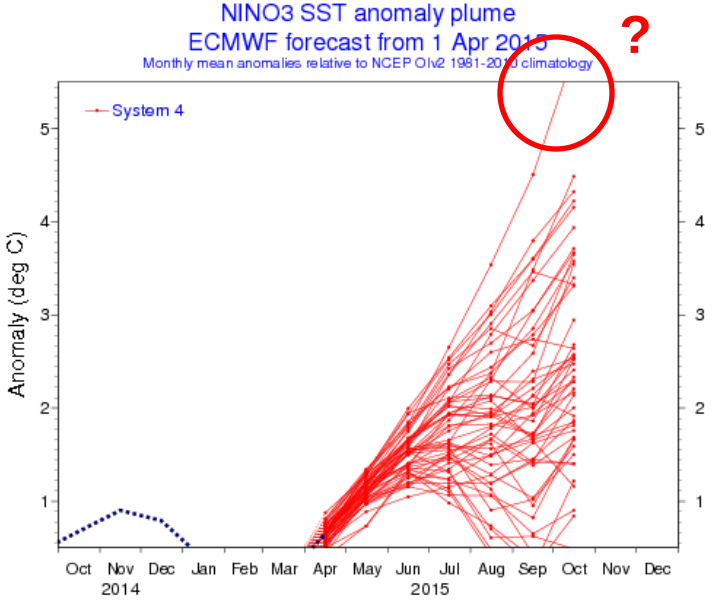
- role of tropical rainfall anomalies in driving teleconnections to extratropics
- multi-model skill in predicting seasonal tropical rainfall

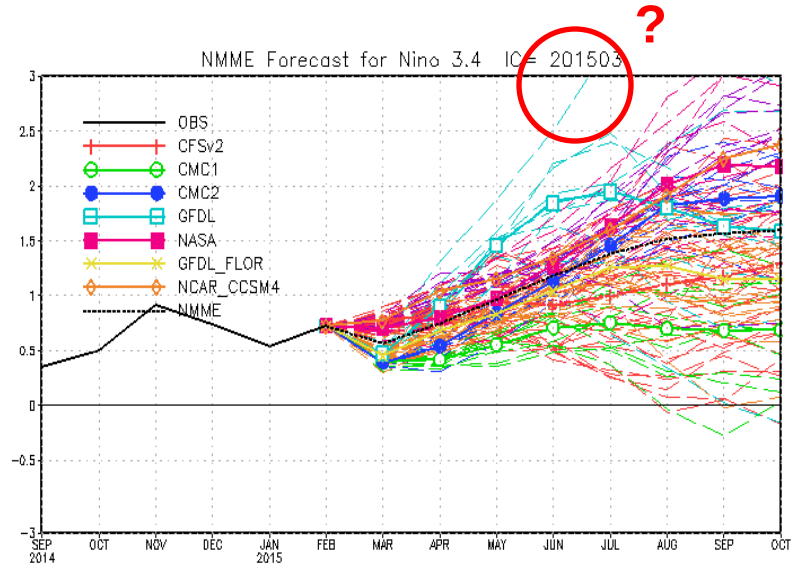


SLP anomalies and Rossby wave paths in DJF associated with El Niño events (A. Scaife)

Next WGSIP Projects

- Current projects to wind down after next WGSIP meeting (June 2019, Moscow)
- New set of projects will be considered, as motivated by members' interests and community inputs—ideas welcome
- Idea: nature, realizability and likelihood of **unprecedented extreme**s in ensemble forecast members, e.g. "monster" El Niño:





- Idea (from ET): experimentation to improve understanding of the impact of different observation platforms and types on the skill of climate predictions

Ongoing WGSIP Project

- Hindcast data from > 20 seasonal forecasting systems
- Served at CIMA in Argentina
- ~200 registered users
- ~10^5 files downloaded in 2017
- CF-compliant NetCDF4
- Featured in a Nov 2017 BAMS article→

The Climate-System Historical Forecast Project

Providing Open Access to Seasonal Forecast Ensembles from Centers around the Globe

Adrian M. Tompkins, María Inés Ortiz De Zárate, Ramiro I. Saurral, Carolina Vera, Celeste Saulo, William J. Merryfield, Michael Sigmond, Woo-Sung Lee, Johanna Baehr, Alain Braun, Amy Butler, Michel Déqué, Francisco J. Doblas-Reyes, Margaret Gordon, Adam A. Scaife, Yukiko Imada, Masayoshi Ishii, Tomoaki Ose, Ben Kirtman, Arun Kumar, Wolfgang A. Müller, Anna Pirani, Tim Stockdale, Michel Rixen, and Tamaki Yasuda

UNCERTAINTY IN SEASONAL FORECASTING. Any prediction of the future evolution of the Earth system requires an associated assessment of its uncertainty. This is true whether the forecast is for the days ahead or is a longer-term prediction for the following months and seasons.

For seasonal forecasts, the uncertainty associated with inexact initial conditions, which can grow rapidly in time, is usually addressed by running multiple forecasts with perturbations applied to the initial state of the ocean and atmosphere (Arribas et al. 2011; Stockdale et al. 2011). The idea is that the perturbed initial conditions are of a suitable magnitude to represent the uncertainty in the observational measurements and the analysis tools that are used to process them. As the forecast evolves, the differences between the forecasts, known as the ensemble "spread," should therefore reflect the typical forecast error, or "uncertainty"; in other words, the eventual real-world evolution should be contained within the cluster of this forecast ensemble. In tandem, uncertainty in forecasts is also contributed to by our inexact representations of the Earth system physics. This contribution to uncertainty is sampled by employing different Earth system models (Yun et al. 2005; Weisheimer et al. 2009; Smith et al. 2013), the so-called multimodel approach, which is often supplemented by the use of perturbations to physical processes, known as stochastic physics schemes, to further account for structural errors in a particular

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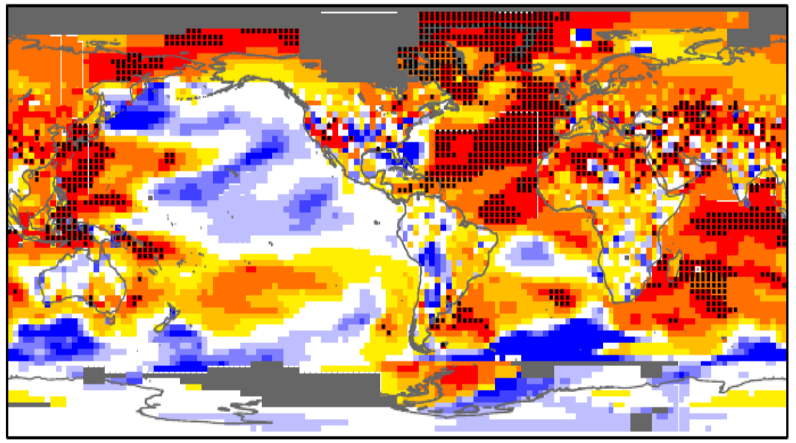
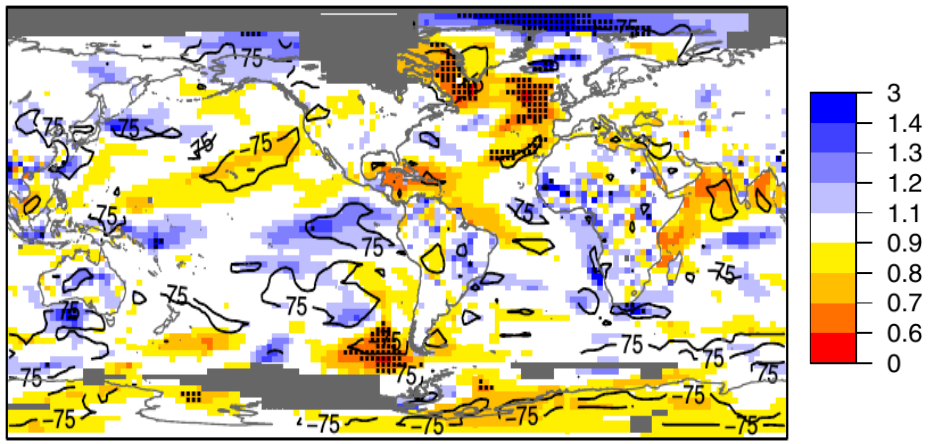
Decadal Climate Prediction Project (DCPP)

- ~20 modelling centres preparing for CMIP6 decadal prediction experiments, to include
  - **ensemble hindcasts** 1961-present
  - ongoing **near-real time** forecasts
  - experiments elucidating **influences of PDV, AMV, volcanoes**
- Response plan for **updated decadal forecasts in the event of a large volcanic eruption**, using observation-based stratospheric sulfur aerosol forcings from SPARC/SSiRC
- Exciting prospects for CMIP6 to build on accomplishments of CMIP5:

T2m RMS skill score×100, years 2-5 (6 systems)



RMSE(initialized) / RMSE(unitialized)



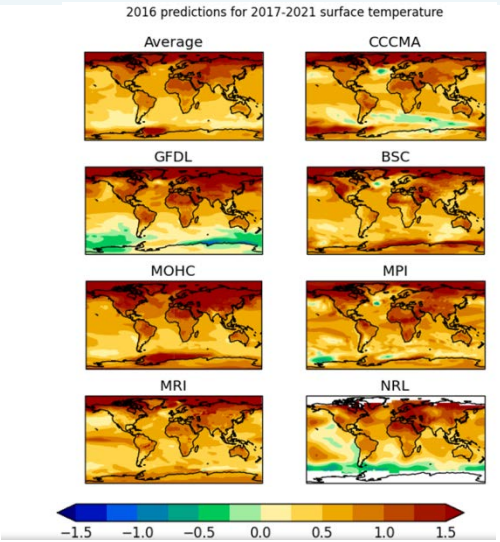
Doblas-Reyes et al., Nat. Comm. (2013)

WGSIP role in decadal prediction

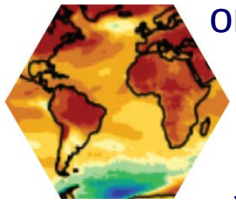
Met Office

SPECS
Seasonal-to-decadal climate Prediction for the improvement of European Climate Services

Multi-model decadal forecast exchange



WCRP Grand Challenge on Near-Term Climate Prediction



science + technical standards for LC + Annual to Decadal Climate Update

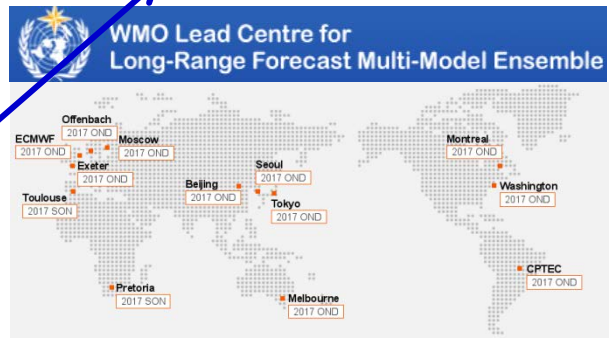
WGSIP

high level coordination

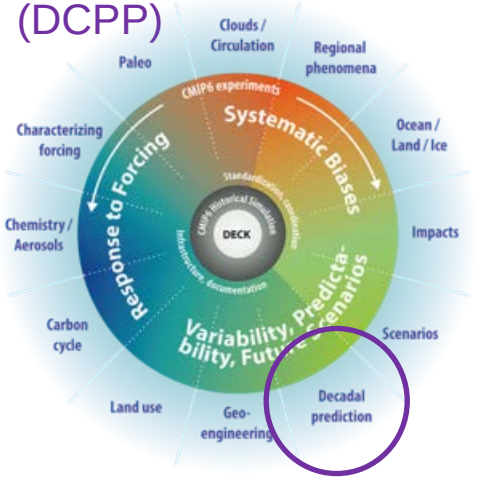
IPET-OPSLS

WMO Lead Centre for Annual to Decadal Climate Prediction (LC-ADCP)

operational multi-model forecasts for WMO services



Decadal Climate Prediction Project (DCPP)



research-driven hindcast experiments + ongoing ~real-time predictions

Second International Conference on Subseasonal to Seasonal Prediction (S2S) and Second International Conference on Seasonal to Decadal Prediction (S2D)

- Largest climate prediction conferences since first S2D in 2013, S2S in 2014
- > 400 abstracts submitted
- 3 days of parallel conferences, 1.5 days of cross-cutting plenary sessions
- WGSIP members comprise 3 of 4 S2S/S2D co-chairs, 5 S2D SOC members
- *Opportunity to synthesize current state of climate prediction research to guide R2O, encourage O2R*

Coordination with WMO Operations

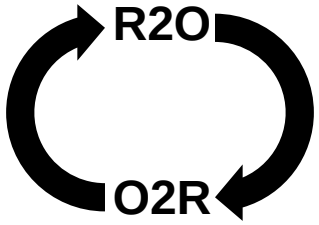
- WGSIP + ET working to establish closer cooperation/collaboration on enhancing Research-to-Operations (**R2O**) and Operations-to-Research (**O2R**) transfer of knowledge & expertise

- Facilitated so far through
  - WGSIP co-chair participation in ET meeting (2016 Beijing)
  - session with ET co-chairs at WGSIP 19 (2017 Exeter)
  - this meeting
  - ET participation in organization of S2S/S2D conferences (Sep 2018 Boulder)

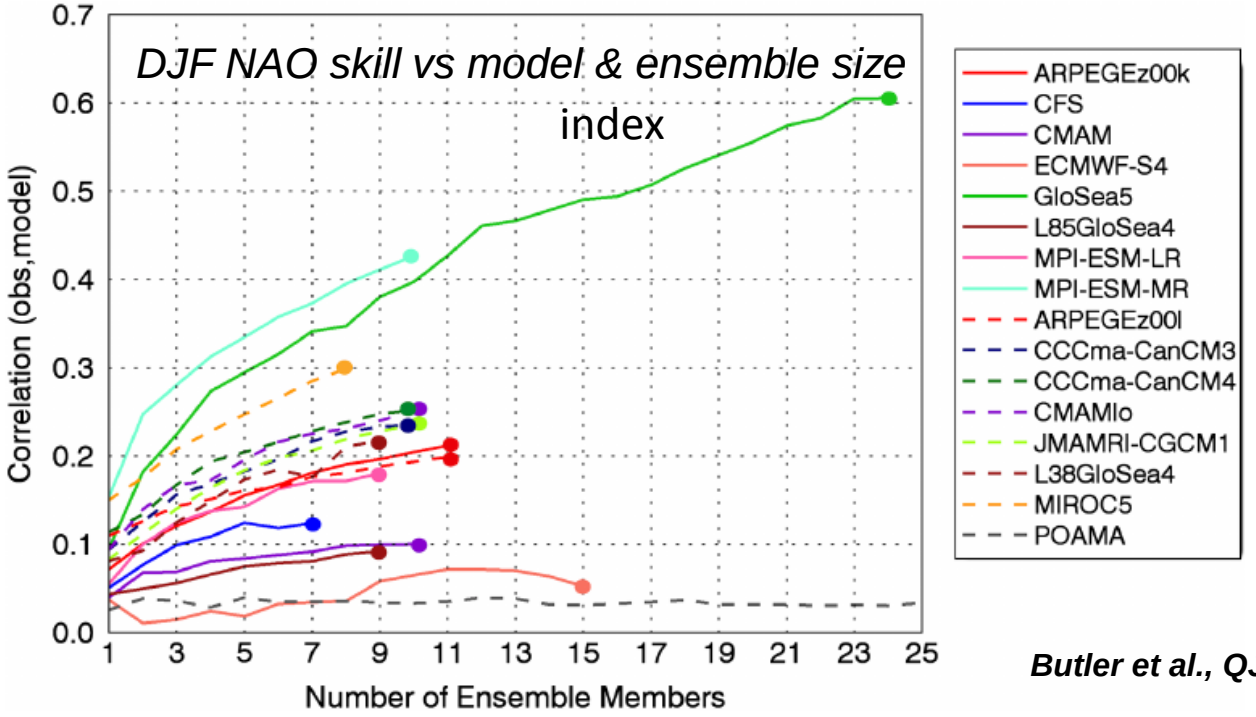
- WGSIP + ET co-chairs have agreed to form a **joint task group** on closing the gap between research and operations
  - title, membership and remit to be finalized
  - joint **R2O/O2R mechanisms** that have been discussed include
    - ≥1 review paper(s)
    - WGSIP reporting on research outcomes that could enhance products/services
    - operational community input into WGSIP projects

- WGSIP is very encouraged by the opened access to LC-LRFMME graphical products and possibility of same for hindcasts

Advantages of open data



- Can facilitate a “virtuous circle” with operational needs and outputs informing research, which in turn informs operations
- Opening LC-LRFMME hindcasts and ideally forecasts (delayed if necessary) to the research community would be a key step
- Availability from CHFP or ESGF (in NetCDF) would enable LC to inform studies like this:



Butler et al., QJRMS (2016)

Figure 4. Skill of model forecasts of the DJF NAO index (here calculated as the SLP difference between the Icelandic low and Azores high-pressure centres) versus the number of ensemble members. Here the correlations are calculated by randomly selecting ensemble members 100 times, averaging them together if the number of ensemble members is greater than 1, and then correlating the ensemble-mean with the observed DJF NAO index using ERA-Interim reanalysis.

Opportunities for product development

- **Untapped potential** exists e.g. for
  - prediction of a **wider range of earth system variables** (land, ocean, sea ice, ecosystems)
  - prediction of **evolving risks of weather and climate extremes**, including unprecedented extremes
  - **event timings** (e.g. monsoon onset/cessation, sea ice advance/retreat)
  - **tailored forecast information** for decision making

- Usefulness needs to be established by research outcomes, but this is happening

- **Verification** can be an issue, however evidence that
  - **climate forecasts** can point to **quality** of observational datasets
  - **multi-dataset averaging** may enhance quality for less well-detemined variables

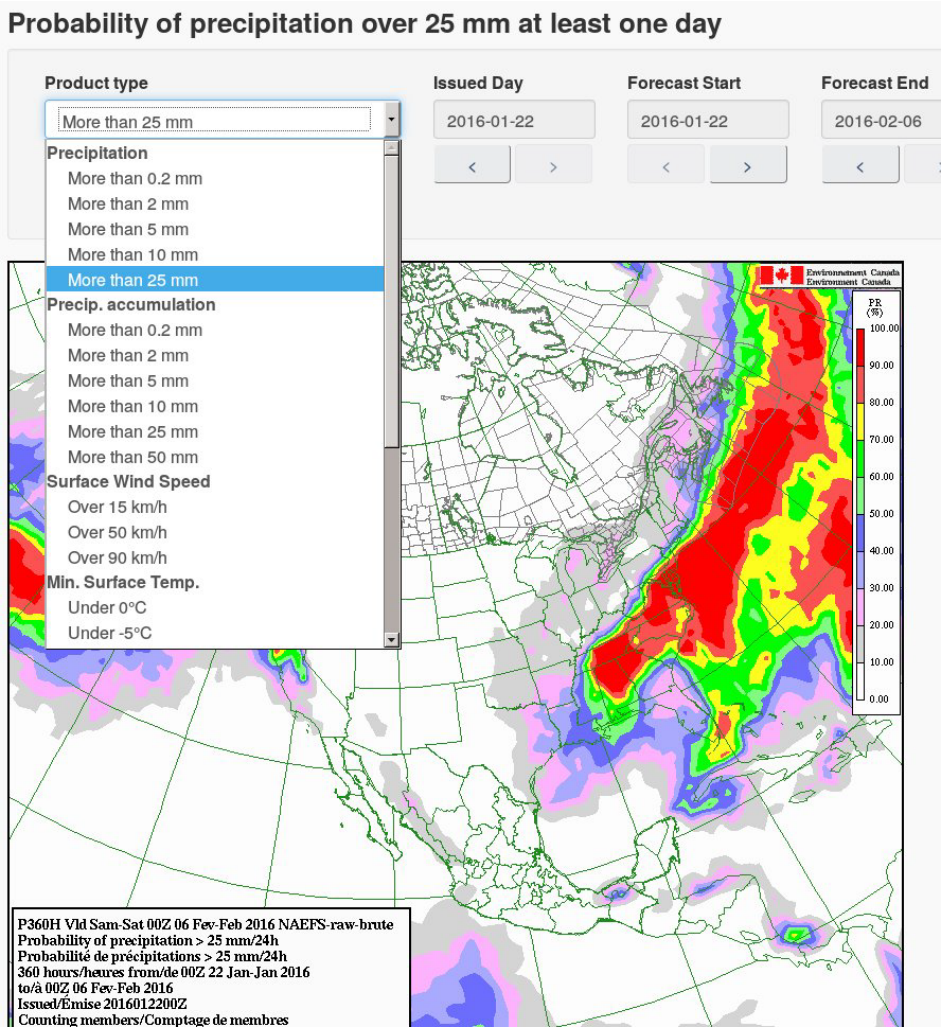
- Implications for GPCs/LCs: **more variables, daily data** (like C3S, S2S, NMME)

Extra slides

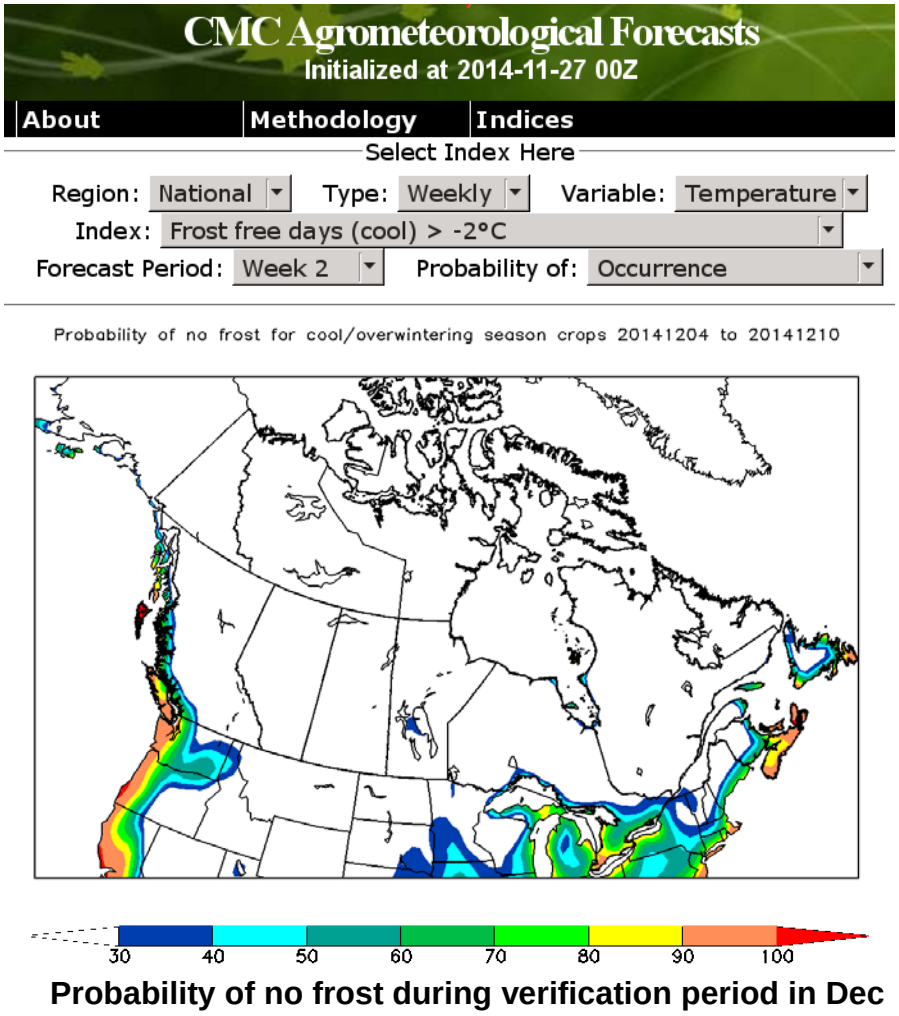
Potential applications of daily data (1)

- **Probabilities of events** including risks of extremes within verification period
- Examples from extended range:

NAEFS probabilities of exceedance



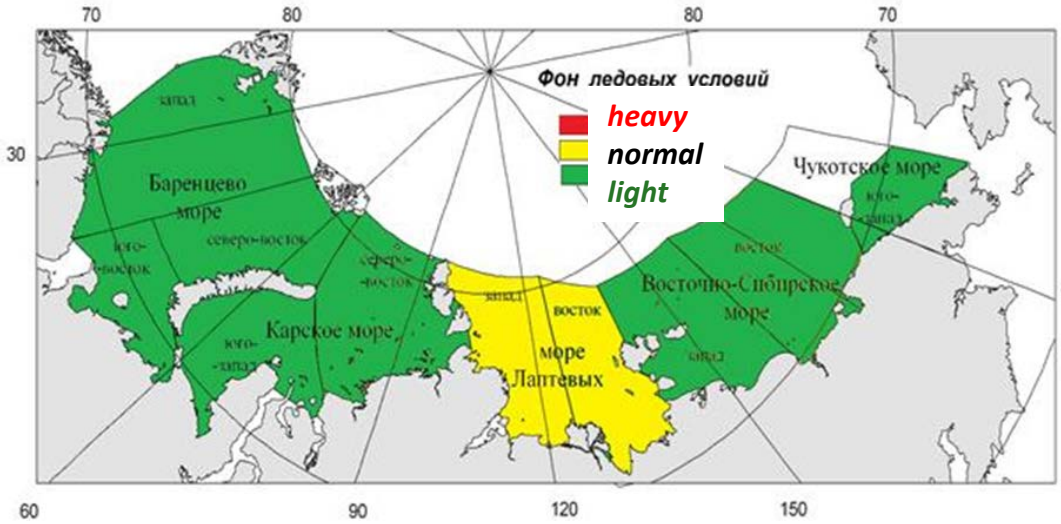
CMC experimental agromet event probabilities



Probability of no frost during verification period in Dec

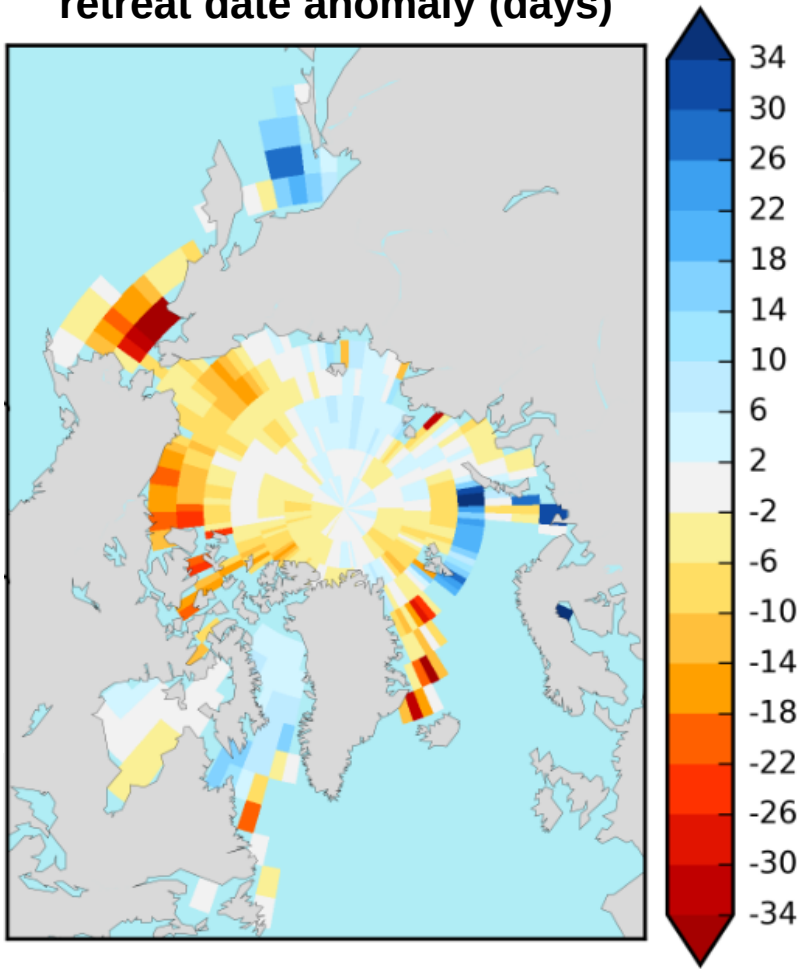
Potential applications of daily data (2)

- **Event timings** within verification period
- **Example:** sea ice retreat date →
  - GPC Montreal w/ improved initialization
  - relative to 2009-2017
  - from 31 Mar 2018
  - deterministic (ideally probabilistic)
  - regional features correspond with other forecasts ↓



AARI forecast of ice conditions during June-August 2018 (from March)

retreat date anomaly (days)



Multi-model forecasts of this type are being developed for the Arctic Polar RCC

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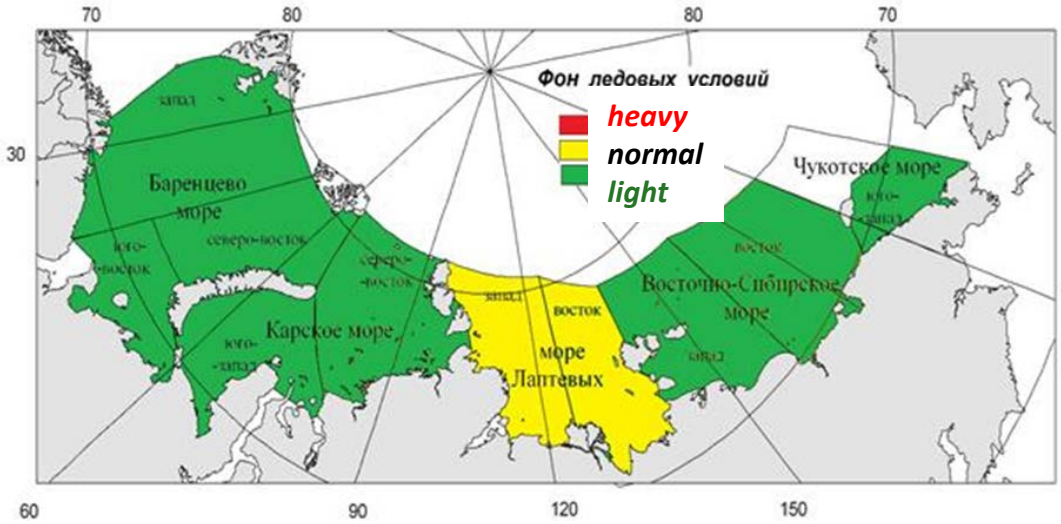

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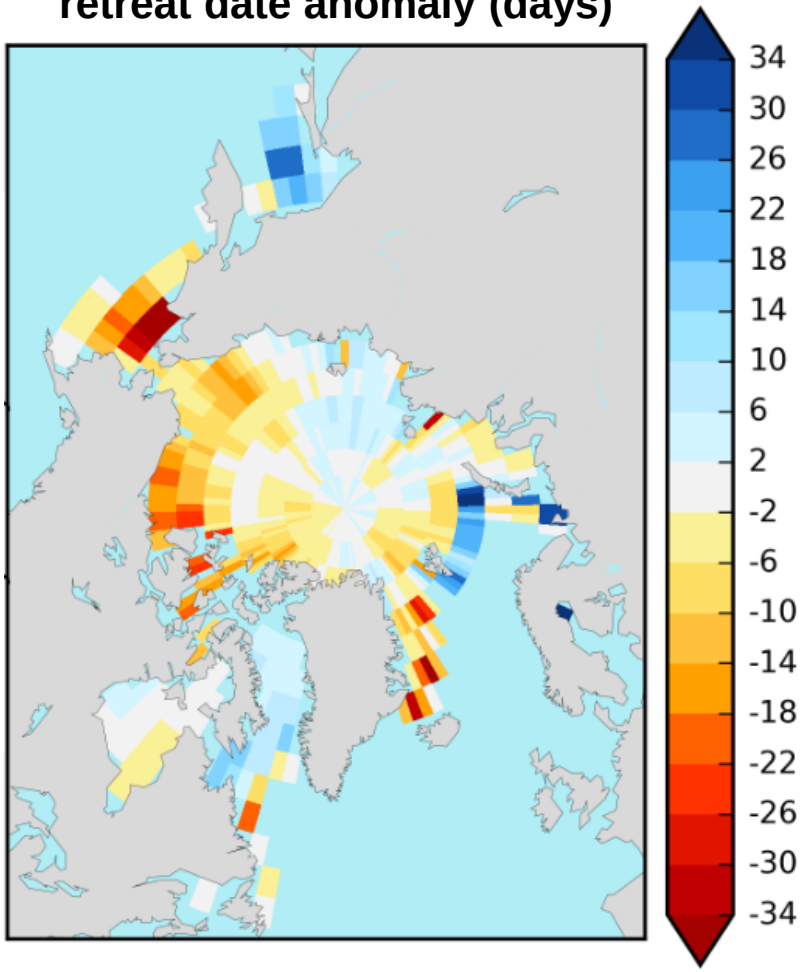

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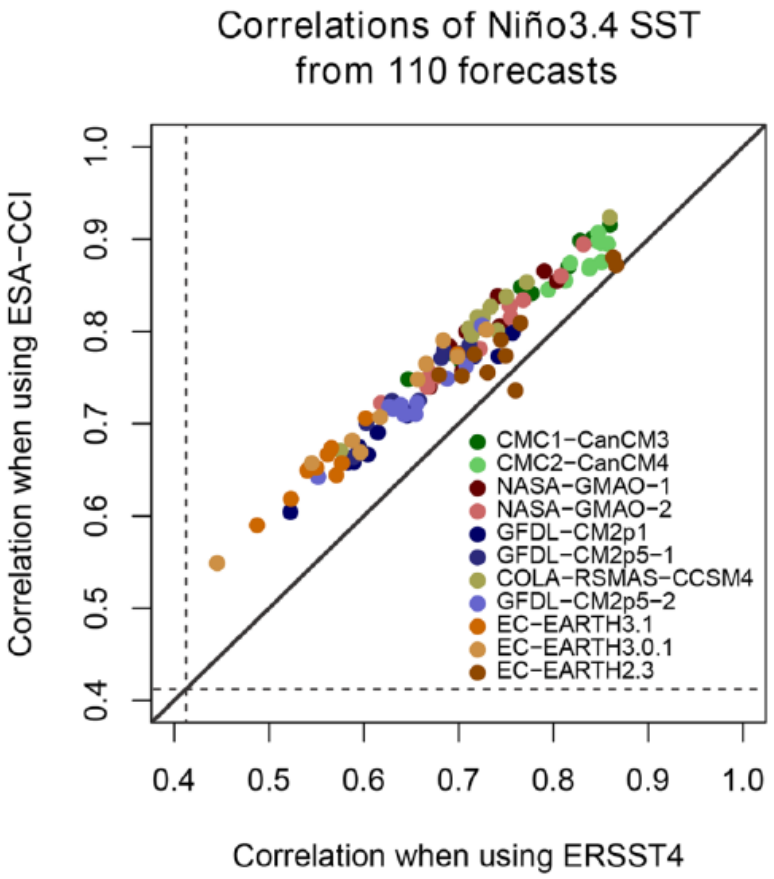
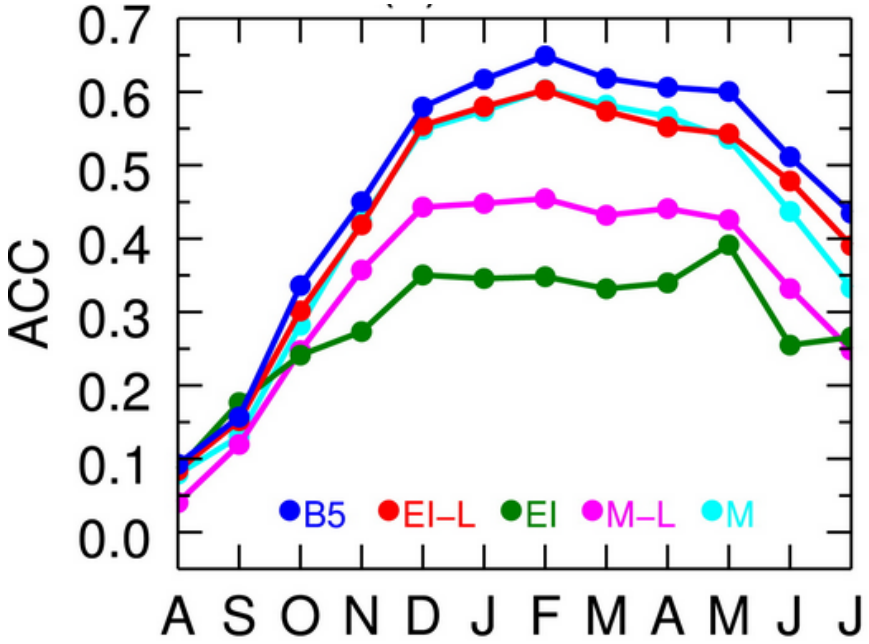
Verification aspects



SST skill is higher when verified using ESA-CCI than ERSST4 for ~all models, leads.
Massonnet et al., Science (2016)

Spatially-averaged skill in Northern Hemisphere (lead 0 months)

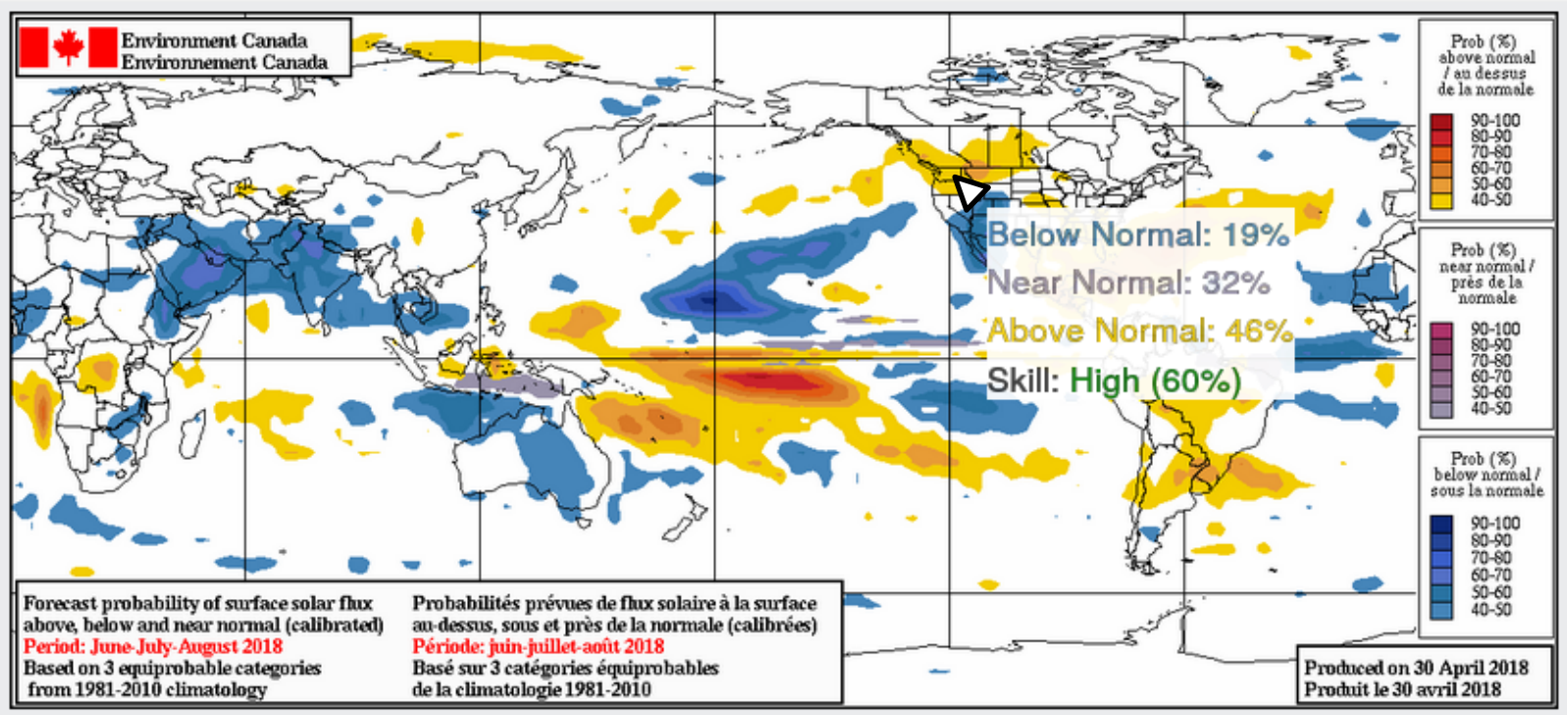


Snow water equivalent skill is higher when verified using blended dataset (B5) than individual datasets.
Sospedra-Alfonso et al., J. Hydromet. (2017)

Interactive forecast information for users

- **Example:** GPC-Montreal products at climate-scenarios.canada.ca

Downward solar radiation probabilistic forecast for JJA 2018



Skill map