Environment Canada Environnement Canada

Canada

The CMC Monthly Forecasting System

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RPN seminar

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Acknowledgements

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Outlines

- Predictability

  --skill beyond 10 days?
- MJO contribution
- Current operational monthly system
- Proposed monthly system
- Skill comparison
- Computational cost
- Future

  coupled GEM, seamless forecasts

Predictability and Prediction

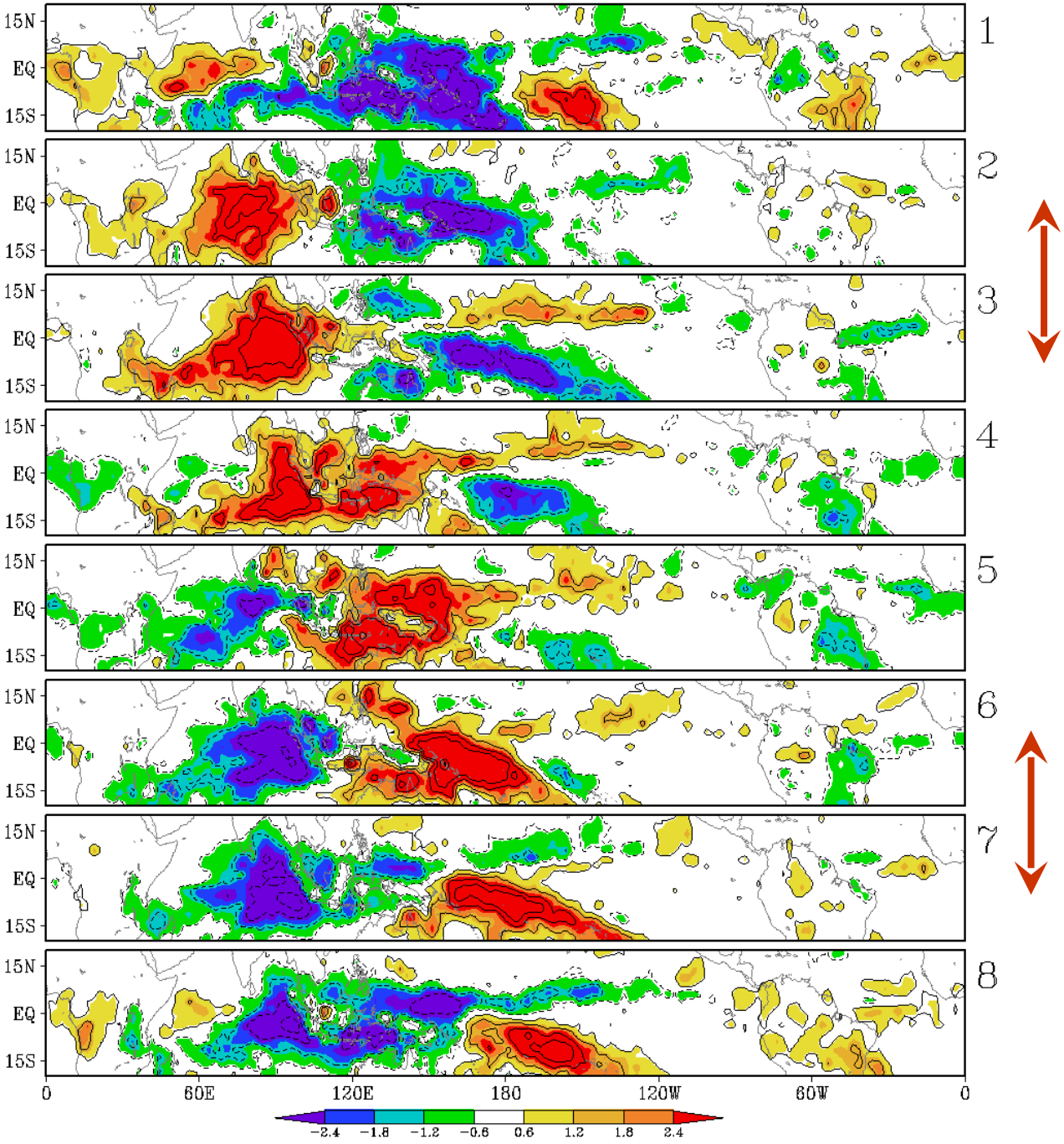
- Short-range weather forecasting (<10 days)
  - initial condition
- Seasonal prediction - lower boundary forcing
  - SST anomaly, e.g, El Nino
  - sea ice
  - land processes (soil moisture, snow cover, etc)
- Intraseasonal (10-30 days)
  - initial condition vs boundary forcing
  - MJO

MJO contribution

Composites of tropical

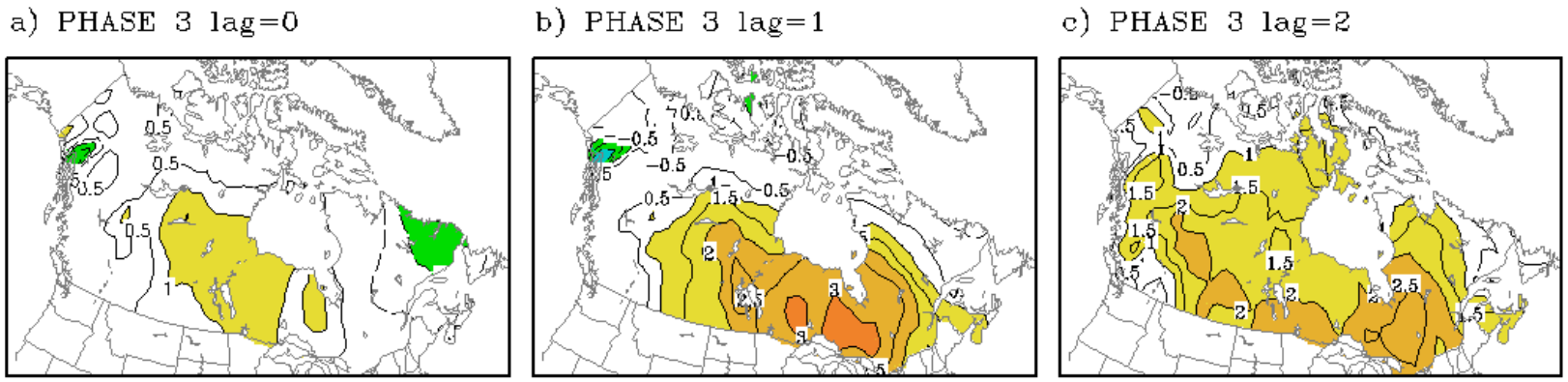
Precipitation rate for 8 MJO phases.

Xie and Arkin pentad data, 1979-2003



Impact on Canadian surface air temperature

Lagged winter SAT anomaly in Canada pentad averaged anomaly

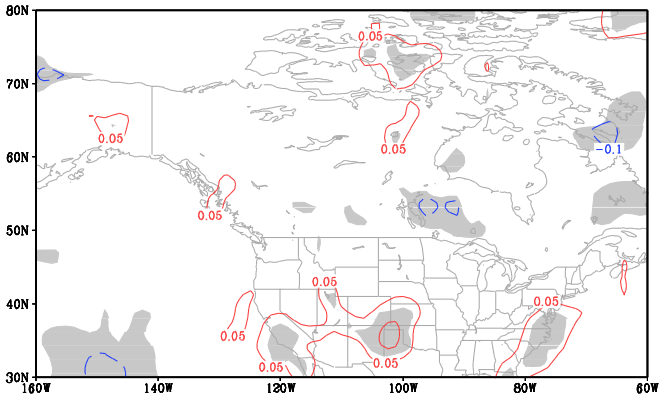


(Lin et al. MWR, 2009)

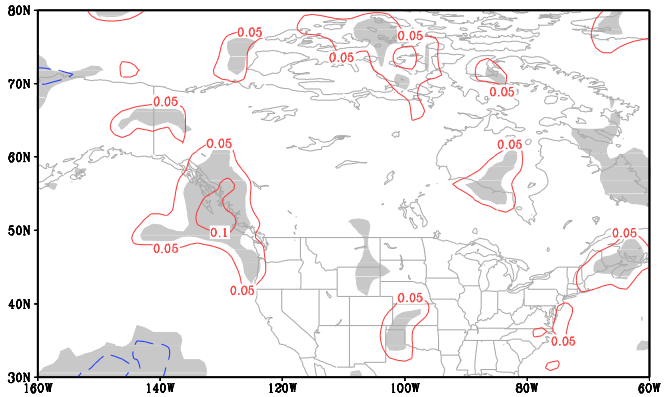
Precipitation

Pentad averaged anomaly

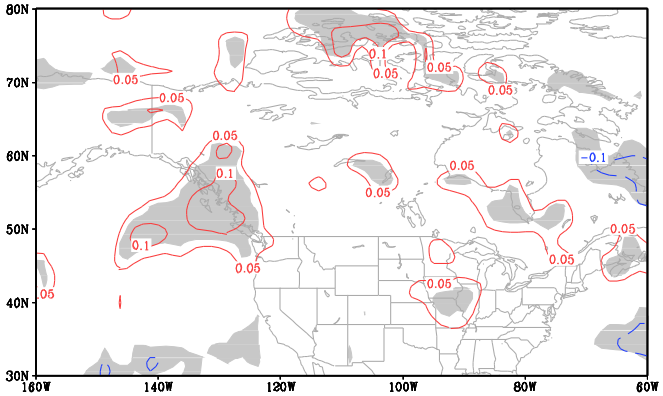
a) lag=0



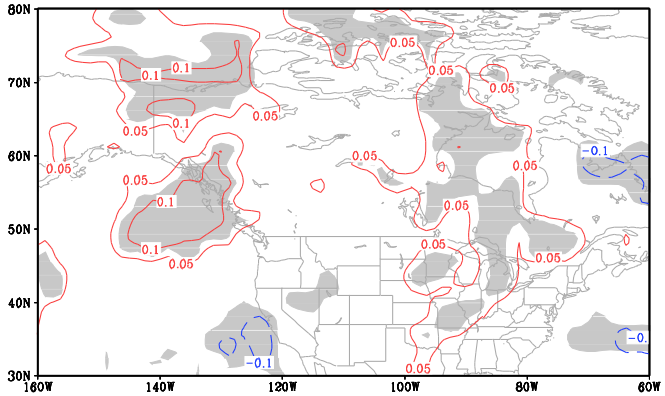
b) lag=1



c) lag=2

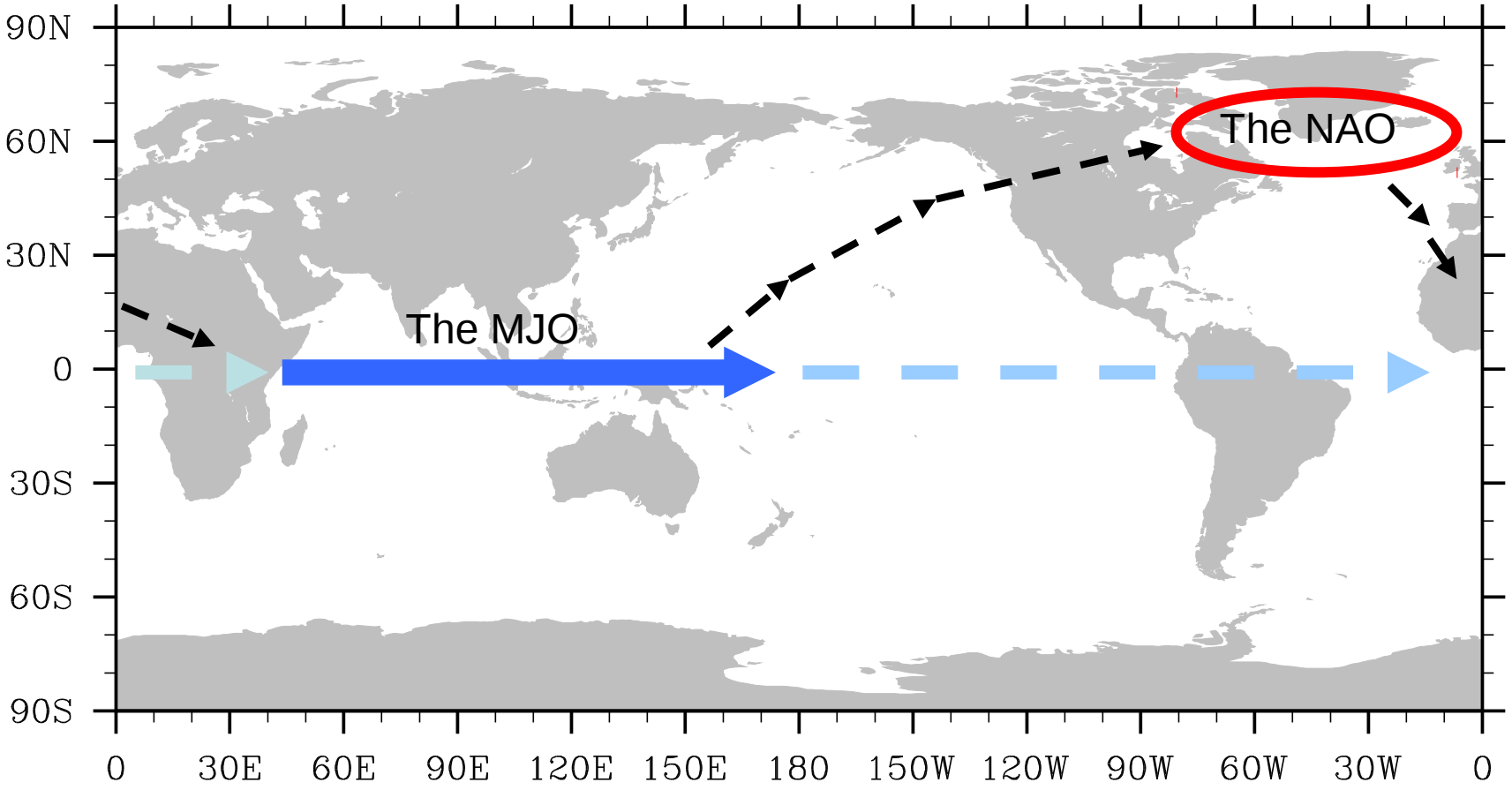


d) lag=3



Normalized Precip Rate regression to PC2

Two-way MJO – NAO interaction



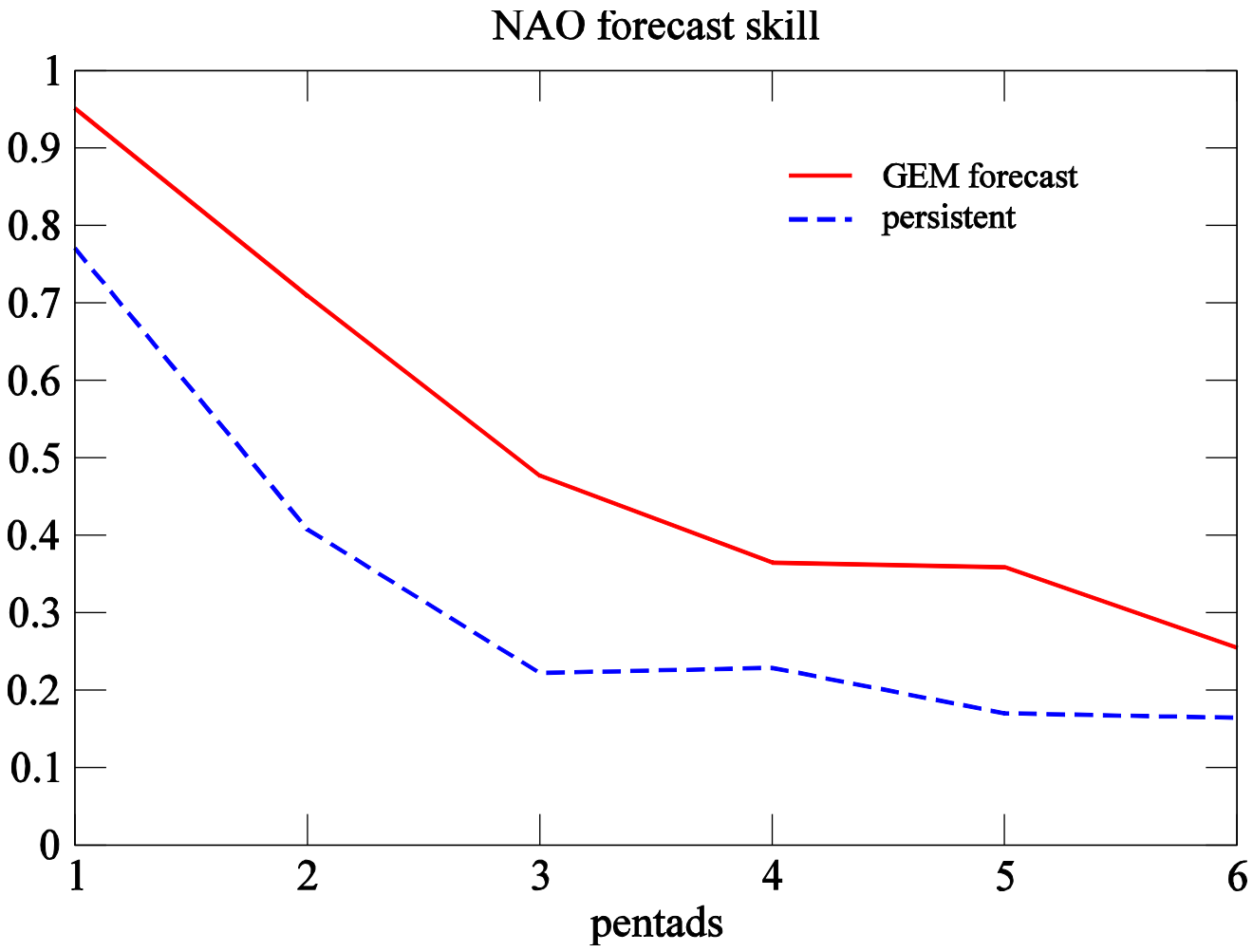
ISO hindscast with GEM

- GEMCLIM 3.2.2, 50 vertical levels and 2^{o} of horizontal resolution
- 1985-2008
- 3 times a month (1^{st}, 11^{th} and 21^{st})
- 10-member ensemble (balanced perturbation to NCEP reanalysis)
- NCEP SST, SMIP and CMC Sea ice, Snow cover: Dewey-Heim (Steve Lambert) and CMC
- 45-day integrations

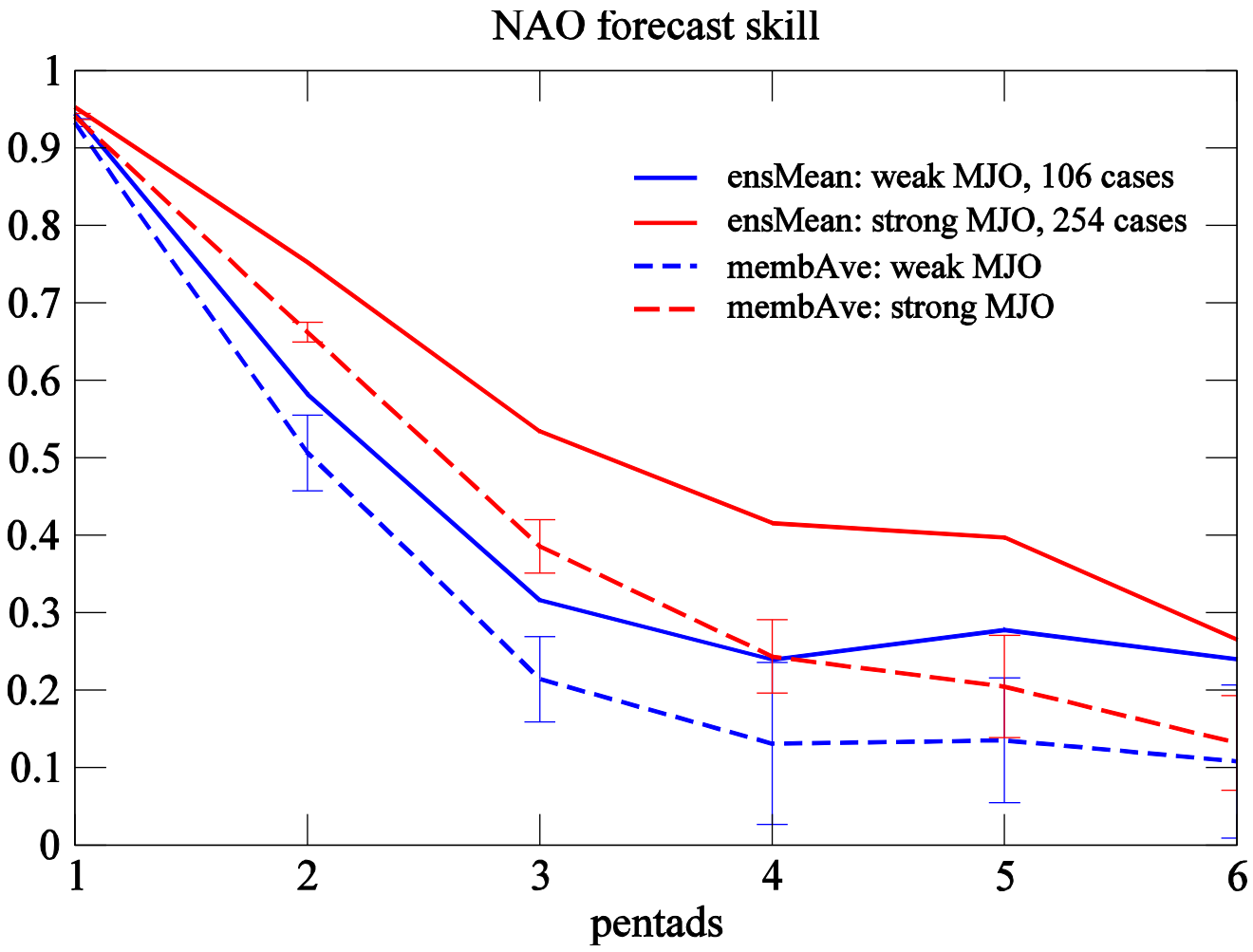
NAO forecast skill
extended winter – Nov – March
MJO influence

A simple measure of skill:

temporal correlation between forecast and observations



(Lin et al. GRL, 2010)



(Lin et al. GRL, 2010)

Current operational monthly system

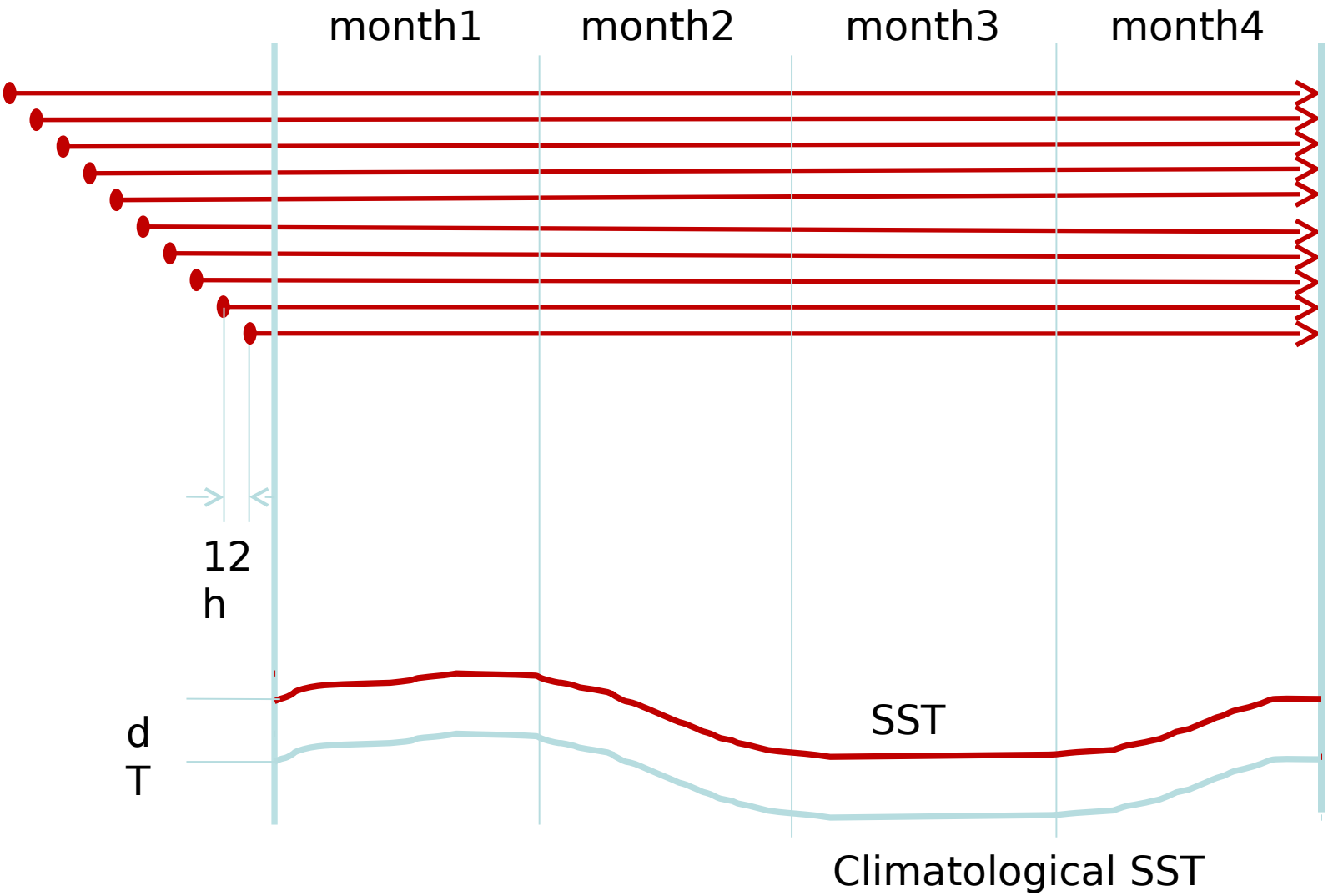
- 4 global-model 2-tier Seasonal Forecasting System

  GEM: 2°x2°, 50 levels

  AGCM2: 625 km (T32), 10 levels

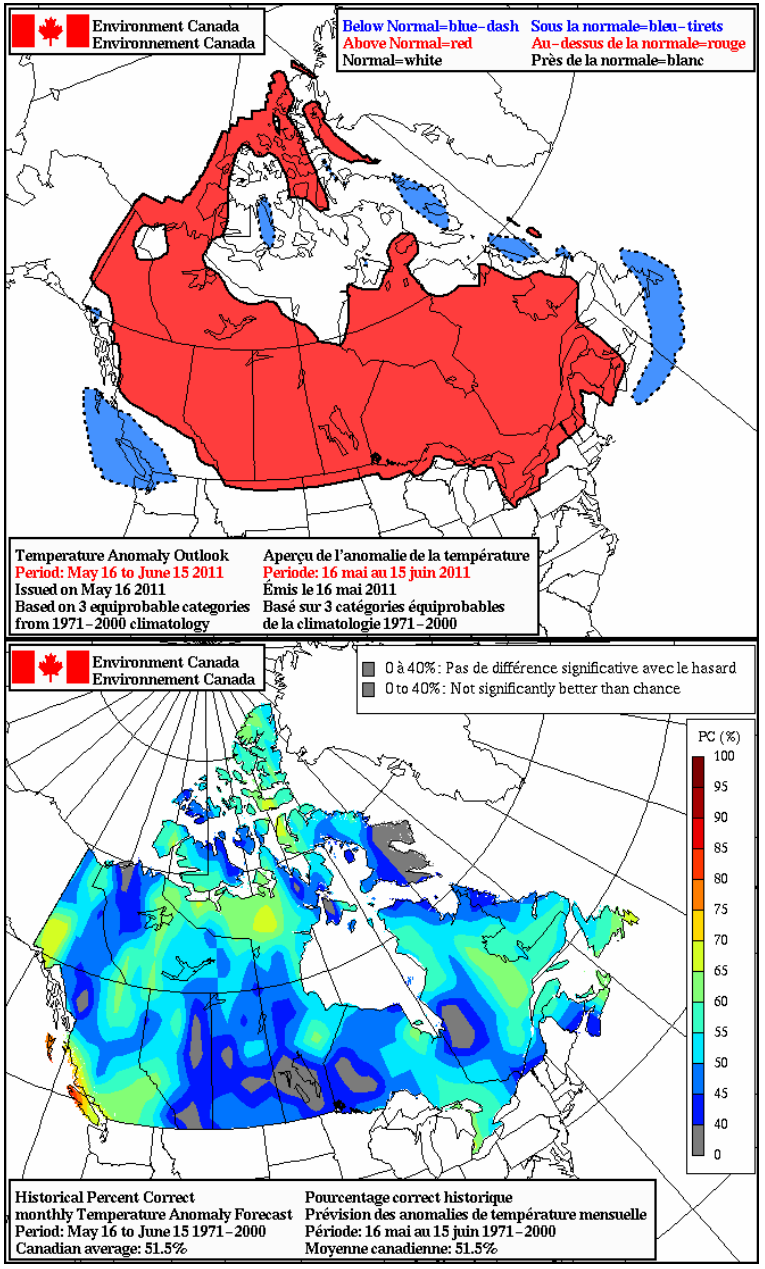
  AGCM3: 315 km (T63), 32 levels

  SEF: 210 km (T95), 27 levels
- Once a month (beginning of each month)
- 4-month integrations
- 10 members each model
- Persistent SST anomaly
- Sea ice and snow cover anomalies relaxed to climatology


month1
month2
month3
month4
12
h
d
T
SST
Climatological SST

Current operational monthly system products

- Twice a month: 1st and 16th
- 30-day mean temperature anomaly



http://weatheroffice.gc.ca/saisons/image_e.html?img=mfe1t_s&title=forecasts

Shortcomings with the current system

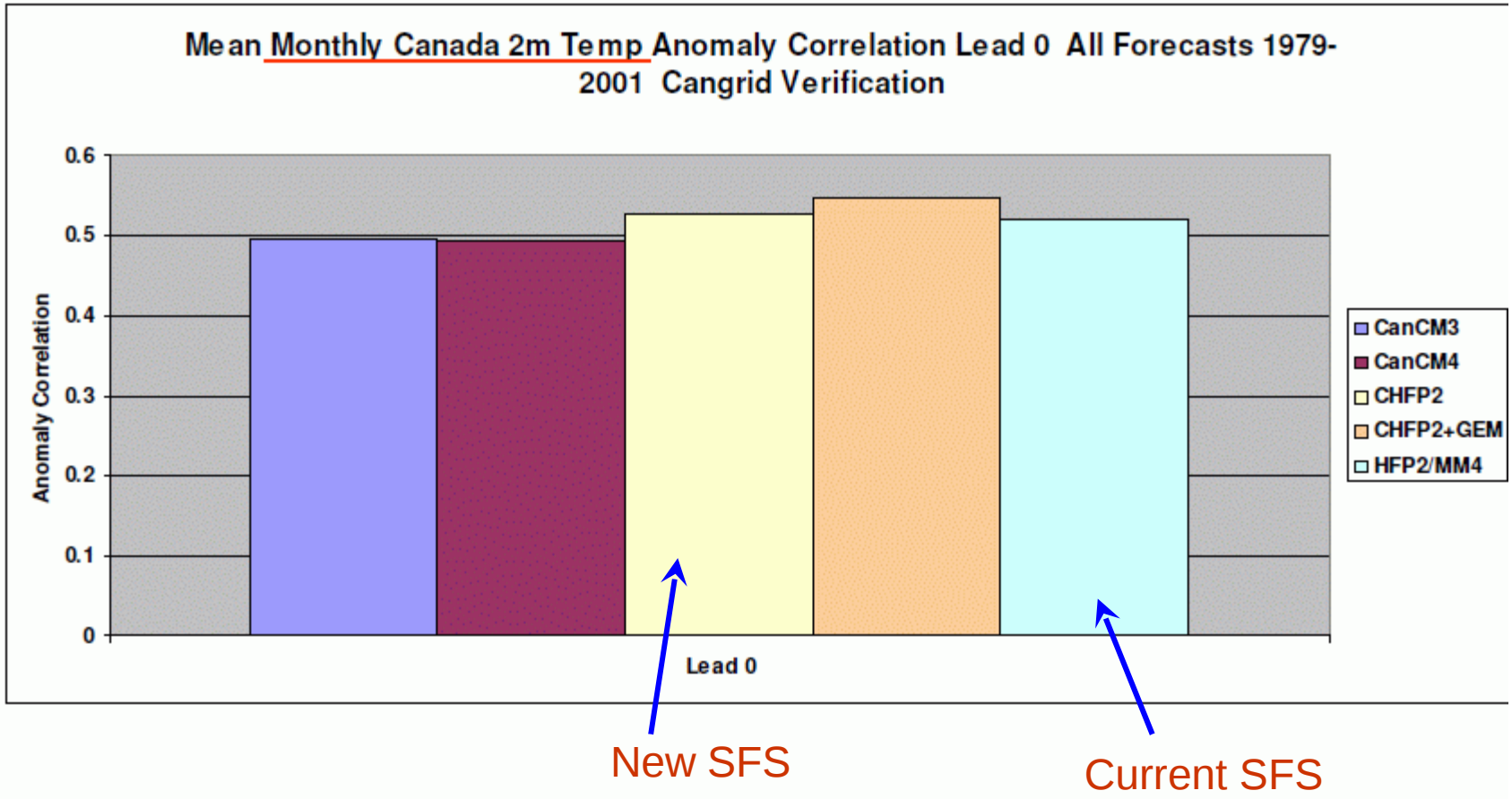
- Designed for seasonal forecasts
- Poor initial conditions: 12-hour lagged initial conditions
- Low resolution
- Low forecast skill

How about the new Seasonal System?

- Two-coupled-model 1-tier system to be in operation by the end of this year
- CanCM3 = AGCM3 + OGCM4 (10 forecasts)

  CanCM4 = AGCM4 + OGCM4 (10 forecasts)
- Multi-seasonal (12 months)
- No improvement in first month forecasts

First month



From: Bill Merryfield

Proposed Monthly System

- EPS based
- Two components

  1) Real time forecasting system

  2) Hindcast (model statistics)

Real time forecasting system

- Extend EPS to 32 days once a week (00Z Thursday) (35 days if we choose Monday)
- Upgraded with EPS system (see Peter Houtekamer's last talk)
- Kalman filter, 20 members
- GEM 4.x.y with time-evolving SST (Michel Desgagné)

Hindcasts

- To generate EPS climate statistics, in order to calibrate real time forecasts (model drift, spread change)
- For the same date, past 12 years
- 5 members each year, total of 60 members

Years 1, 5, 9: configs 1-5

Years 2, 6,10: configs: 6-10

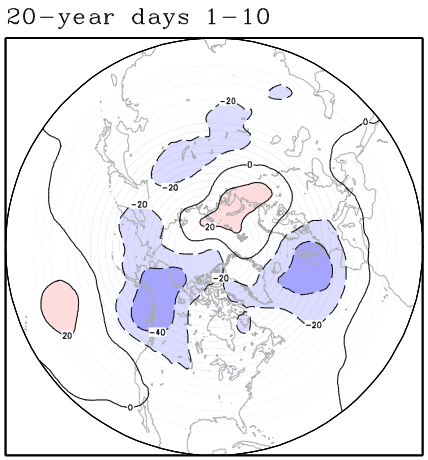
Years 3, 7,11: configs: 11-15

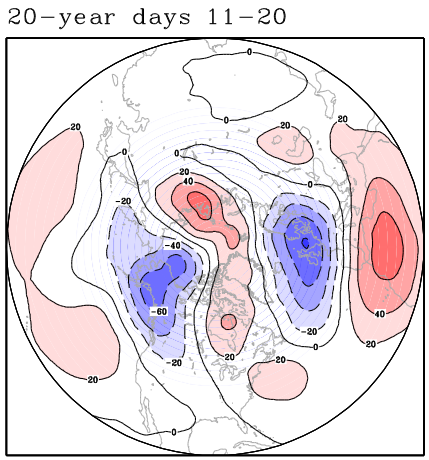
Years 4, 8,12: cinfigs: 16-20

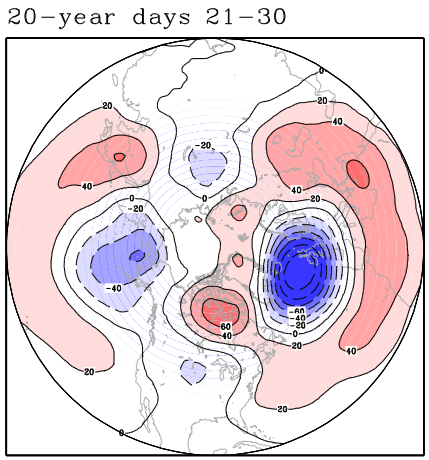
• Can be done any time before the real time forecasting, when the computer is available

Hindcasts: 20 years or 12 years

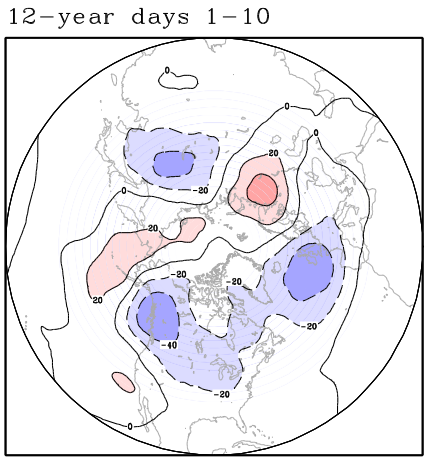
20 years

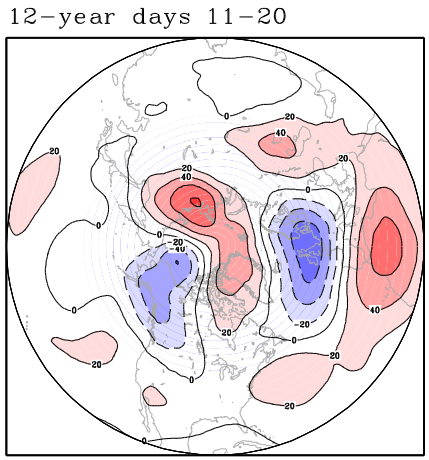


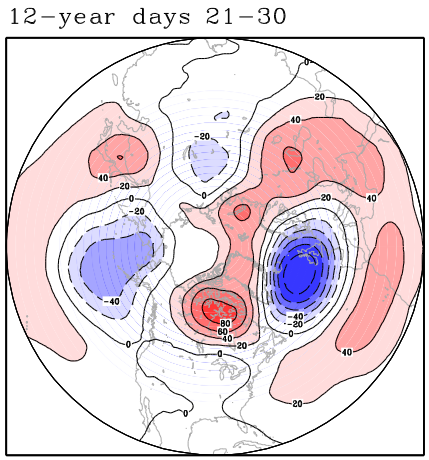




12 years







EPS Z500 bias for January 1 forecasts

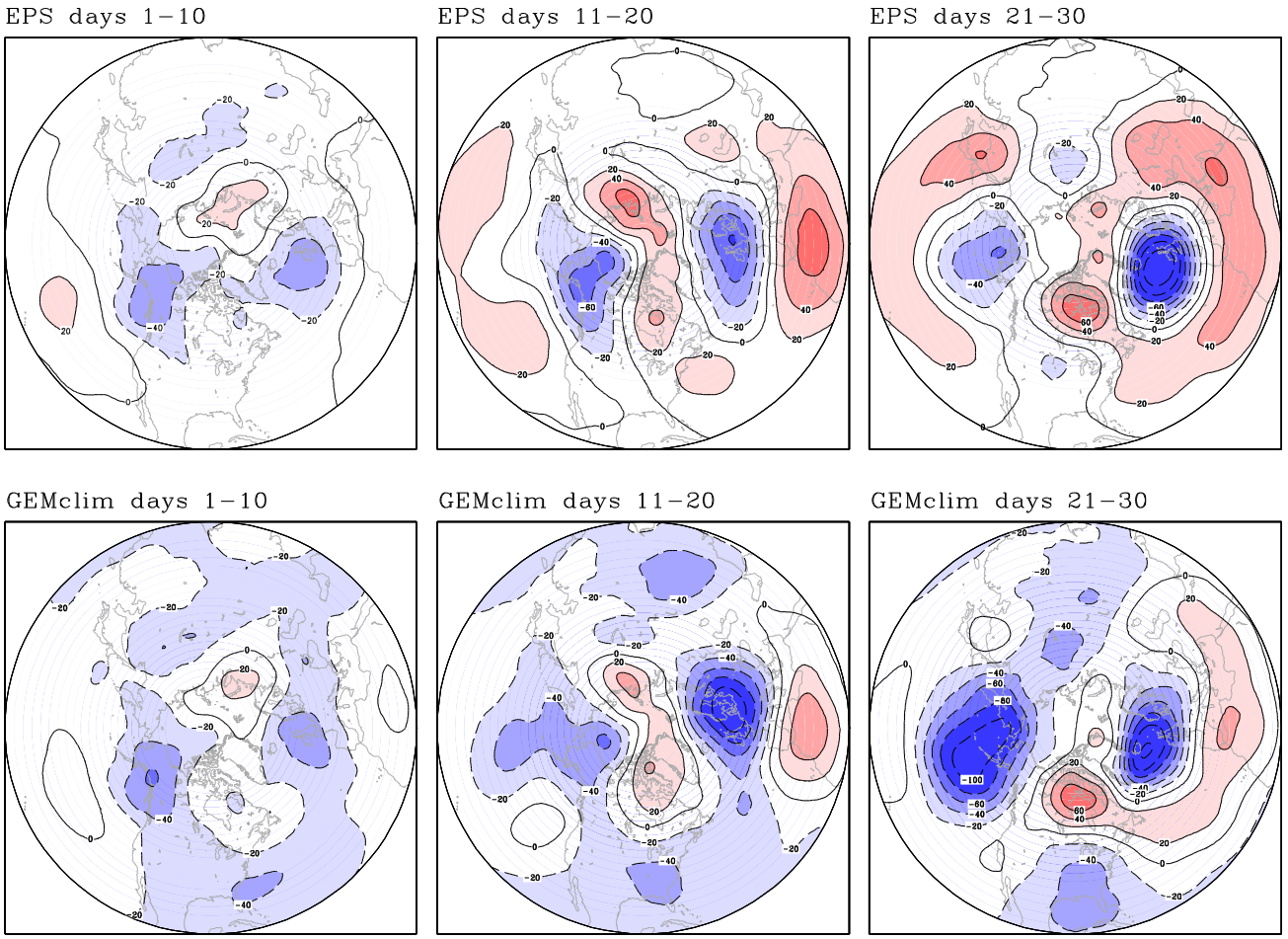
Hindcasts: Can we use the low resolution GEM?

EPS

(0.9°x 0.9°)

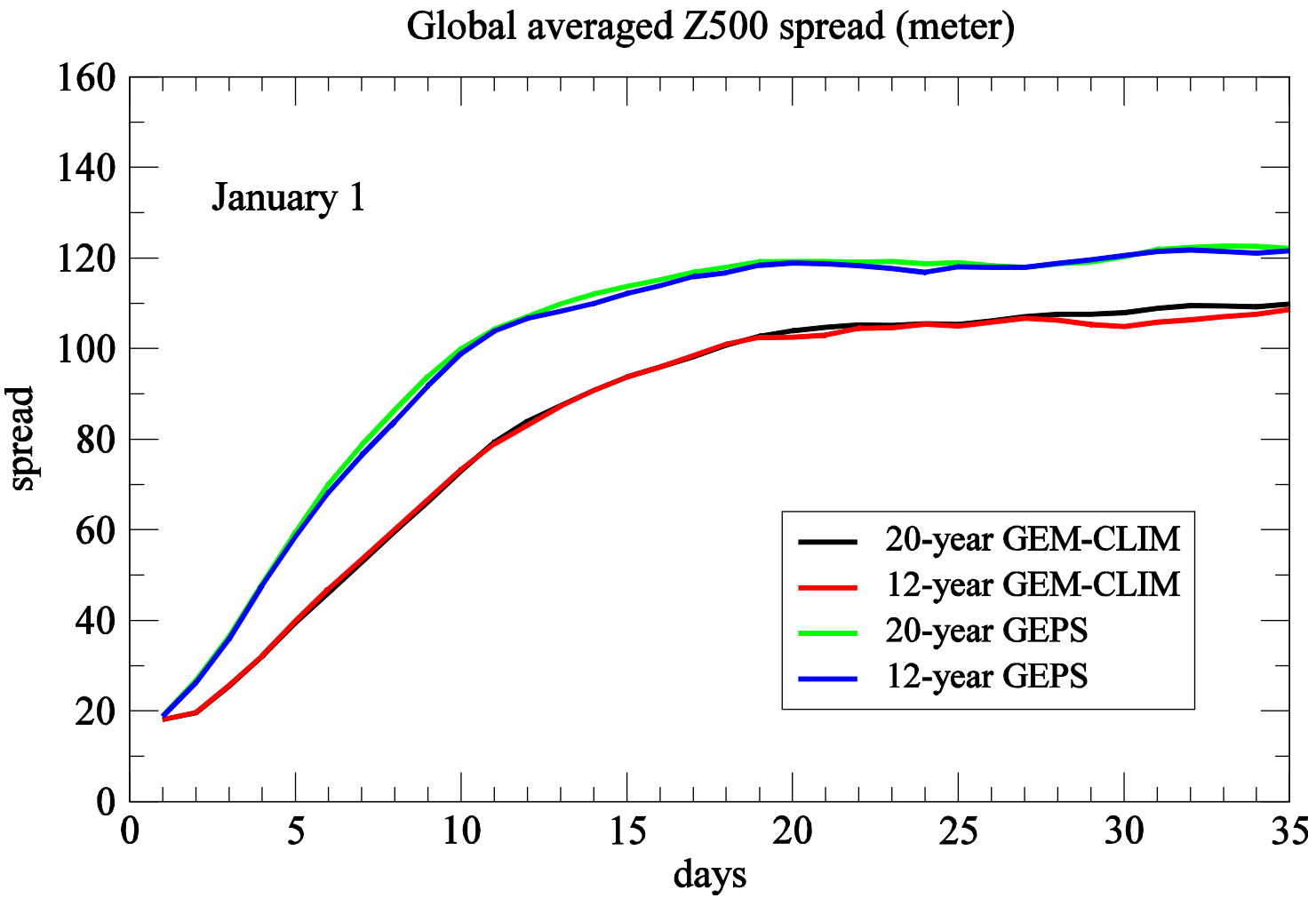
GEM-CLIM

(2° x 2°)



Z500 bias for January 1 forecasts

Hindcasts: resolution and length



Z500 spread among members

Note: GEM-CLIM runs: only one physics

Hindcasts: conclusion

- Cannot use low-resolution GEM → Have to use EPS
- 12 years is good enough

Proposed products

Forecast products of weekly average T2m and PR over Canada

Week 1: days 5-11; Week 2: days 12-18…

- Ensemble mean anomaly maps
- Probability maps for above, below and near normal

Cost of computation

- Real time forecasting: extend EPS from day 16 to day 32 once a week: 7% of EPS
- Hindcast of past 12 years. That represents a total of 60 members of 32 day runs. 43% of EPS
- Total: 50% of EPS

Note that for the hindcast, we can run the model any time before the real forecast date when the computer is available.

Evaluation

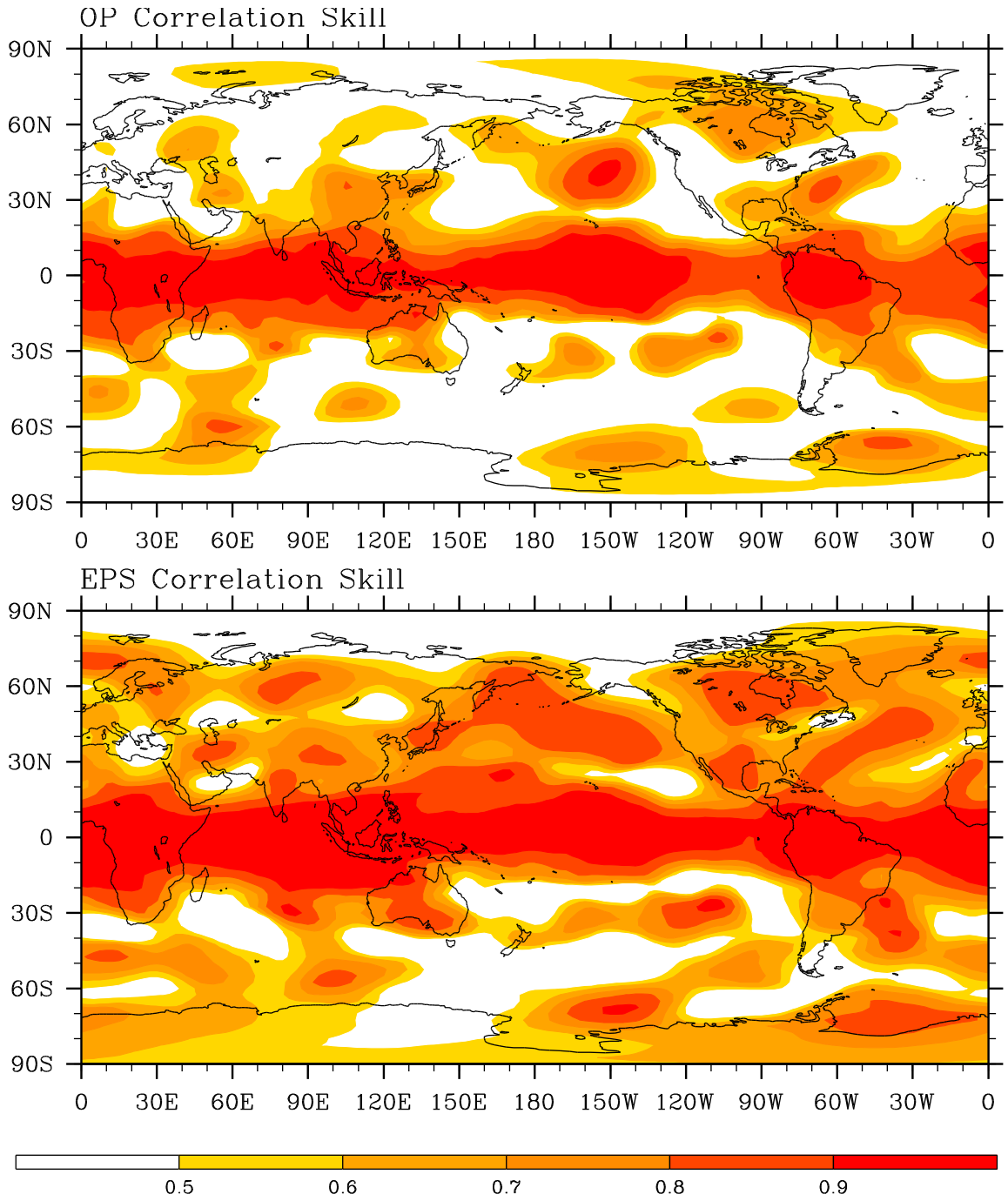
- Winter (January and February)
- Summer (July and August)
- Past three years (24 forecasts for each season)
- Correlation skill for ensemble mean 500 hPa geopotential height and T2m
- Categorical forecast score for T2m and PR

Evaluation

- The following results are based on the experimental forecasts using GEM 3.1.8 (very similar to the current EPS), 3 times a month

- Comparison is made with the current operational monthly system

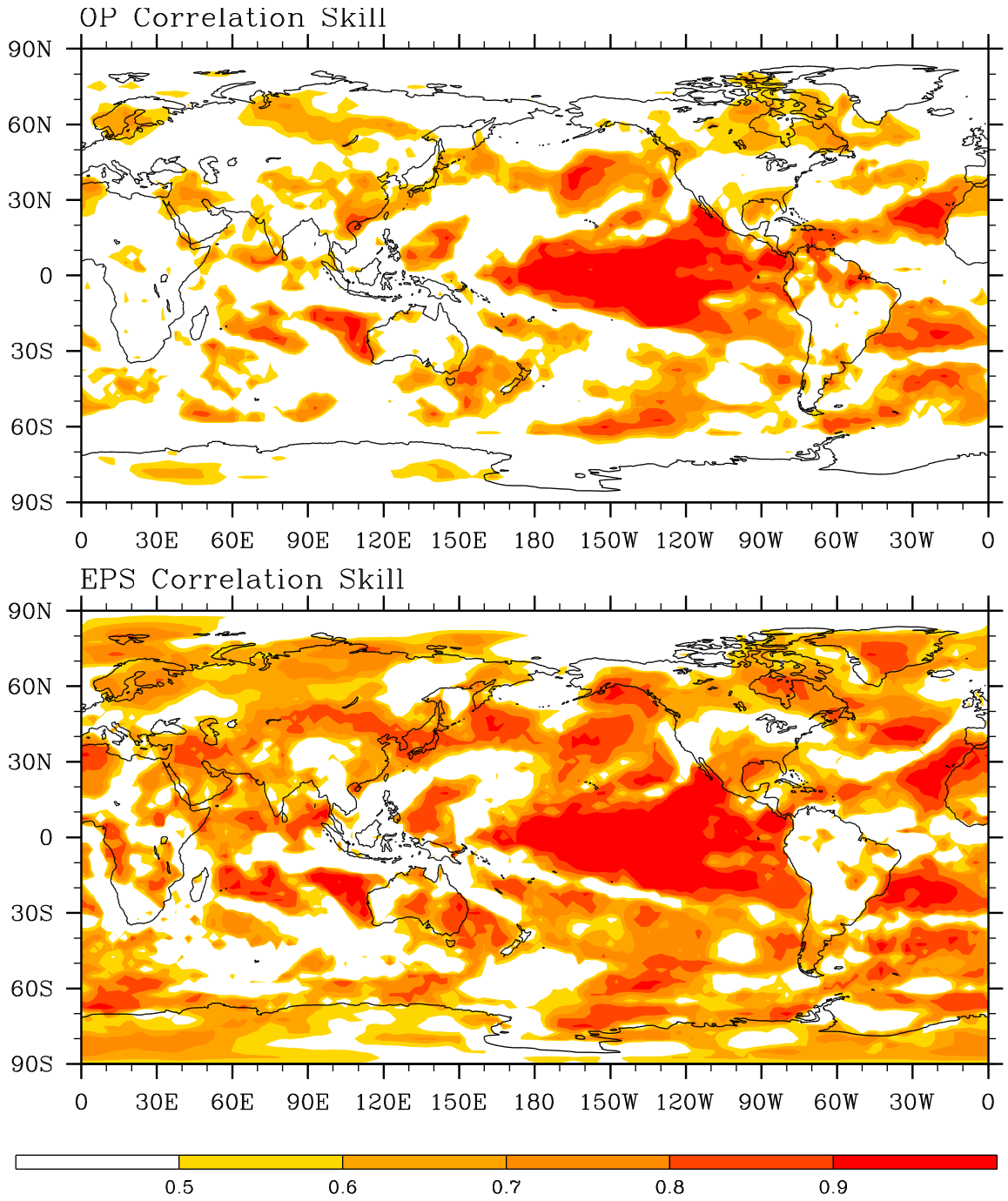
Correlation skill



Winter Z500

30-day average

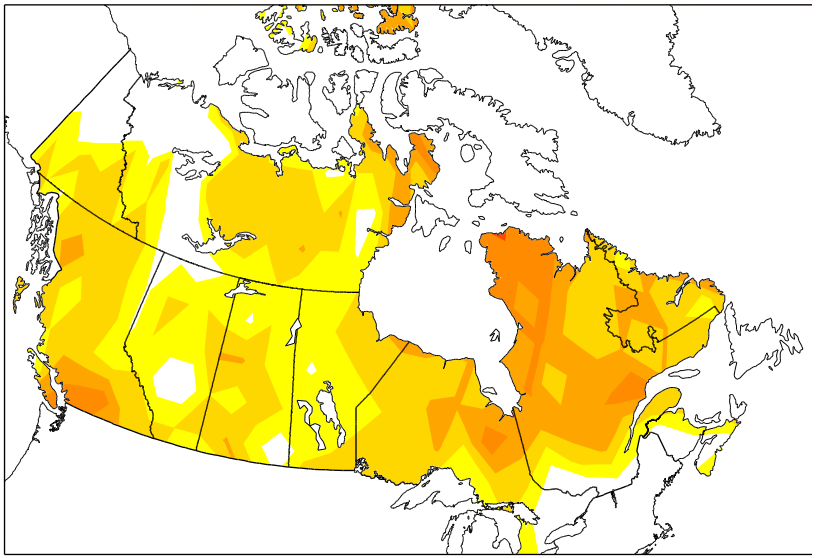
Correlation skill



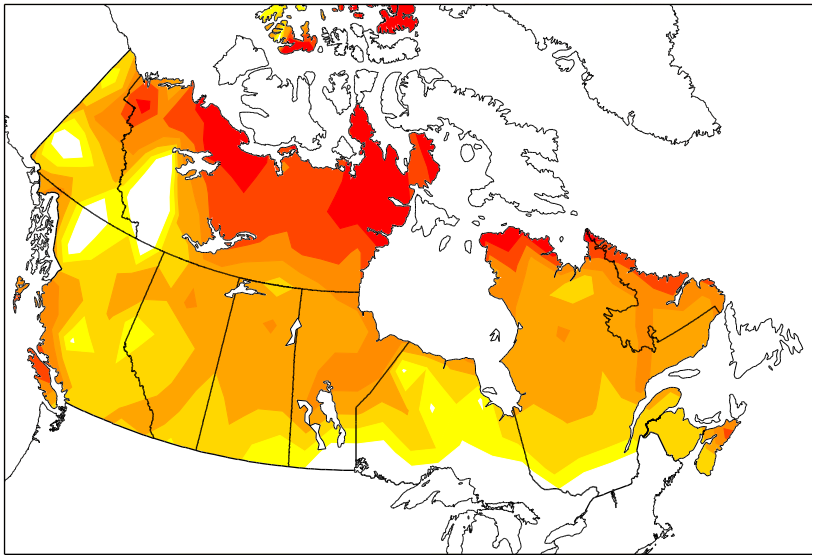
Winter T2m

30-day average

OP Percent Correct



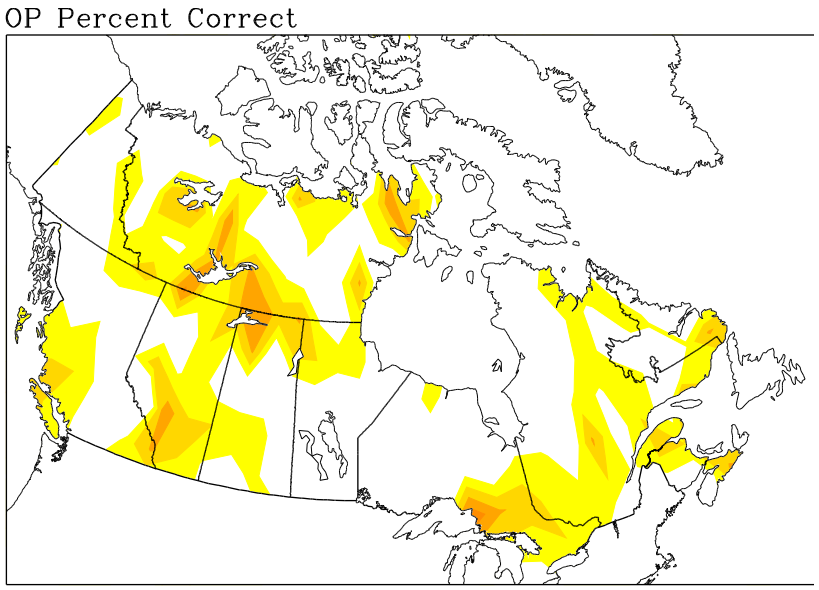
EPS Percent Correct

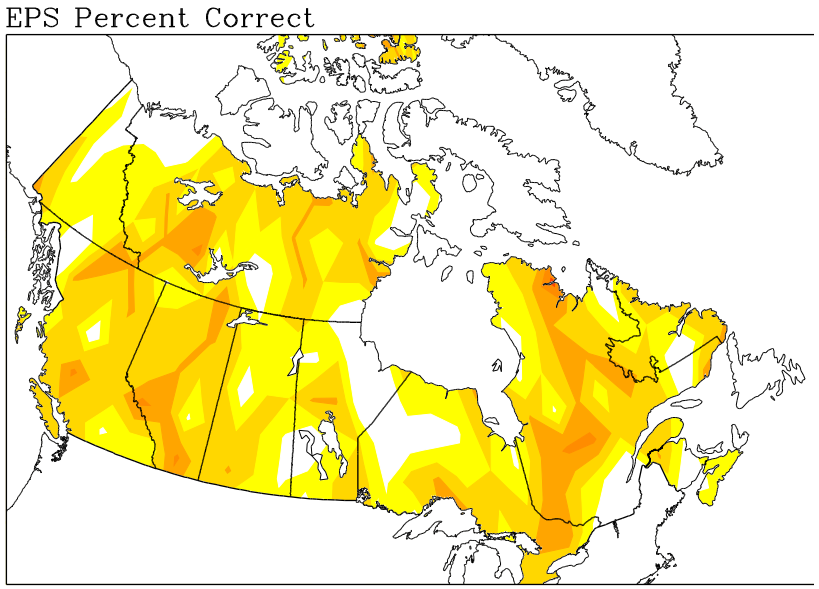


Percent Correct for categorical forecasts

Winter T2m

30-day average





Percent Correct for categorical forecasts

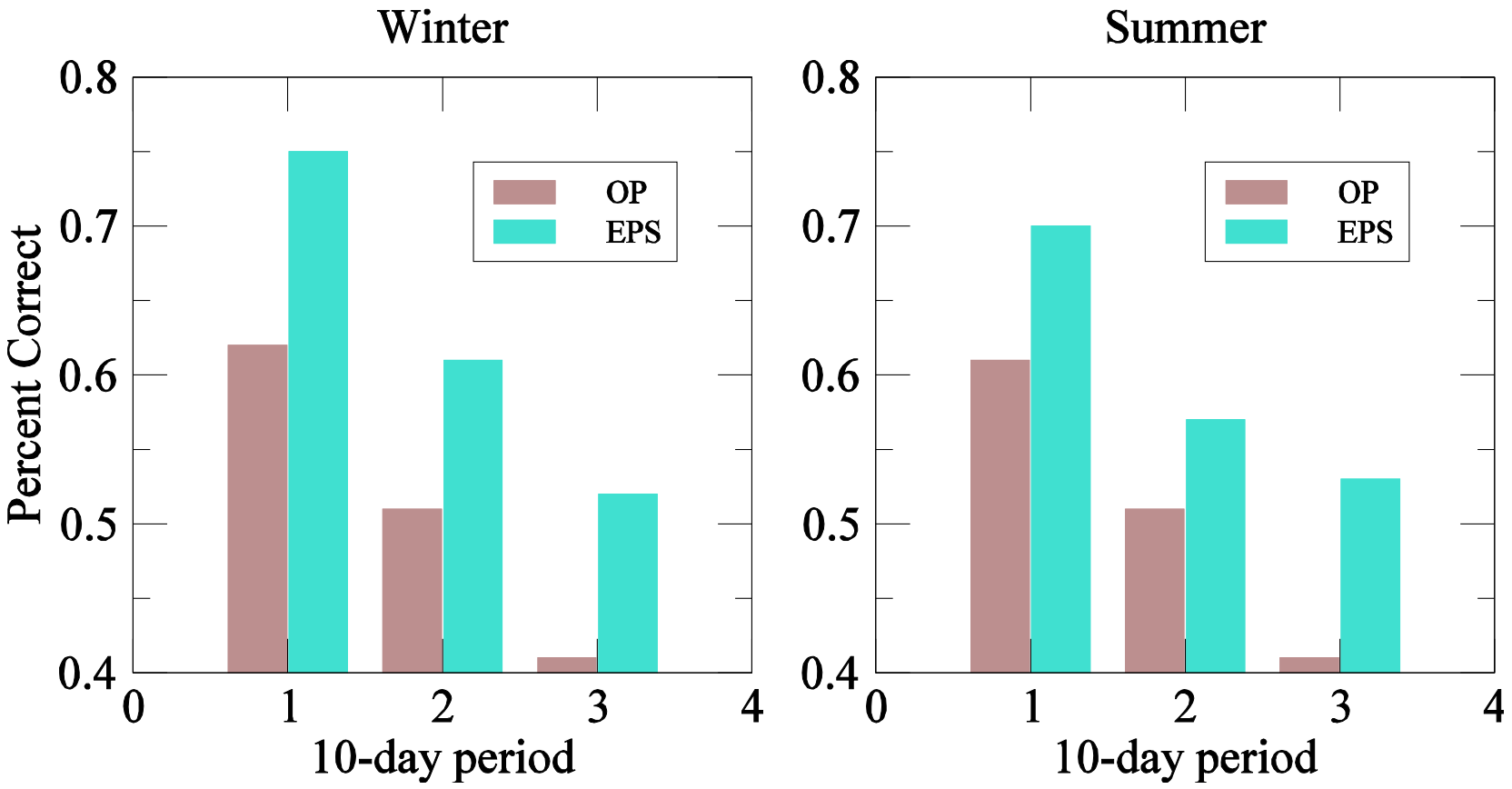
Winter PR

30-day average

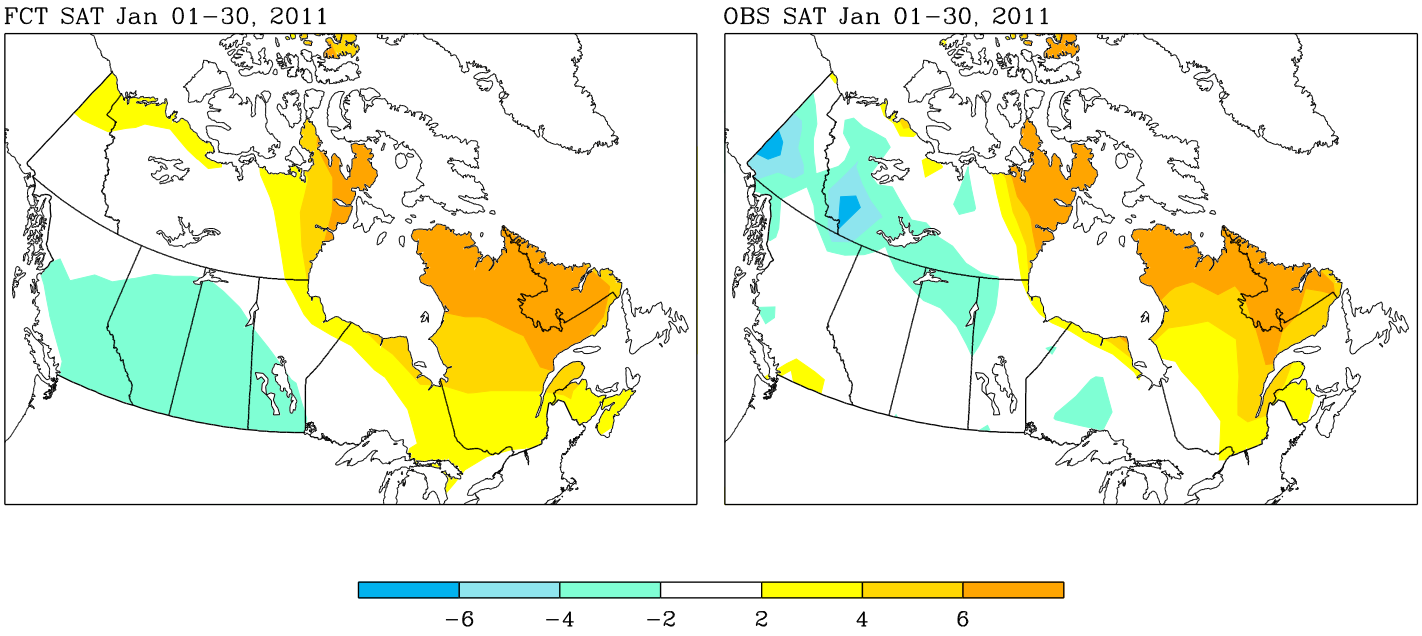
10-day average T2m

Over Canada

Percent Correct for categorical forecasts



An example



T2m ensemble mean anomaly

Next step

- CPOP approval
- Plan to implement operationally

Future for monthly system

- coupled GEM

  ocean-ice NEMO (Greg Smith, Jean-Marc Belanger)

  land surface assimilation system (Stephane Belair)

- Seamless forecasts

  coupled GEM joins seasonal system

  use of EPS initial condition in coupled GEM

Conclusion

- A new monthly forecast system is proposed, which consists of an EPS-based real-time forecasting system and a hindcast
- Aim to maximize signals from both initial and boundary conditions
- Performance assessment shows significantly better skill than the current operational monthly forecast system
- Ready to implement
- First step toward seamless forecasting

Thank you!