

# Performance of the RPN GEM in seasonal forecasting

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McGill University (McGill)

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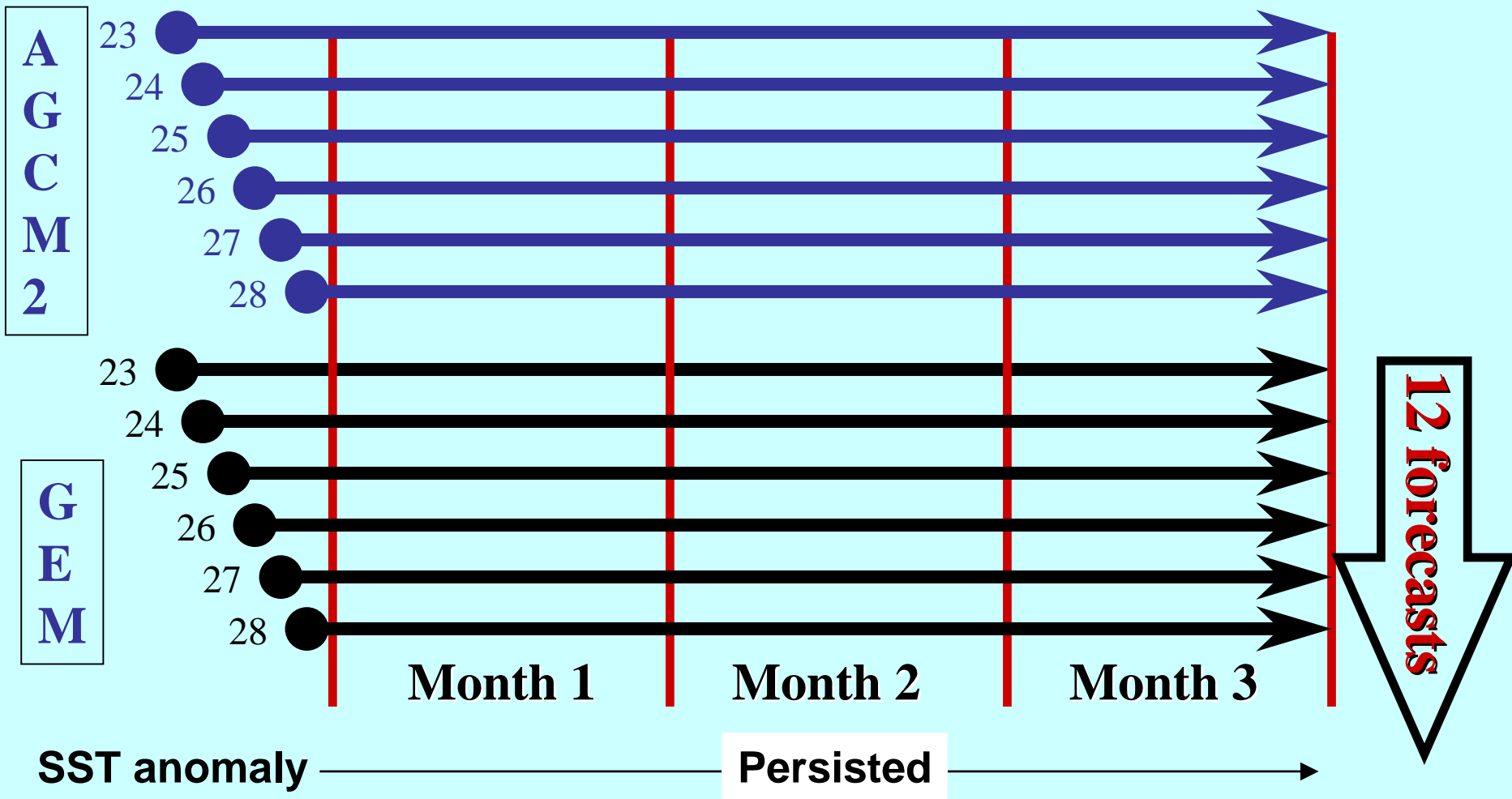
# OUTLINE

- CMC's operational seasonal forecasting system using dynamical global models
- Performance of the RPN GEM model
  - Zero and one-month lead time
  - 6 members vs 10 members
  - GEM vs GEM + AGCM2 vs GEM + AGCM2 + SEF
- Current and future Canadian contributions to APCN

# CMC current operational seasonal forecasting system

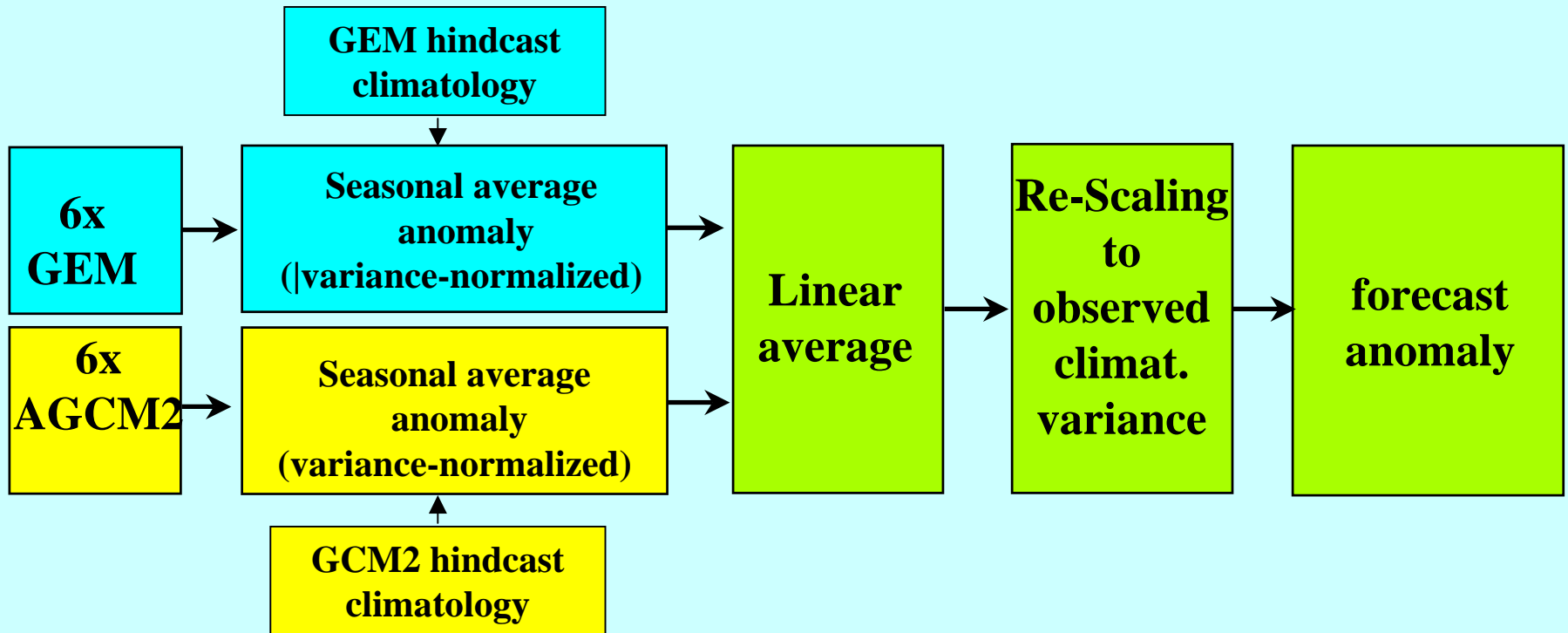
- **Multi-Model Ensemble Methodology**
  - CCCma AGCM2 (Spectral T32 L10) (Climate simulation model)
  - RPN GEM (Grid-point 1.875° L50) (NWP model)
- **Based on Historical Forecast Project (HFP)**
  - 26 years of hindcasts (1969-1994) done in operational-like conditions (no information from the future were used, i.e. **follows SMIP2 / HFP protocol**)
  - Provides model climatology needed for characterizing the real-time forecasts
  - Provides expected skills
- **Three-month seasonal forecast issued every month (12 per year)**
- ***Zero-month lead time***

# Multi-Model Ensemble Methodology



# Multi-Model Ensemble Methodology

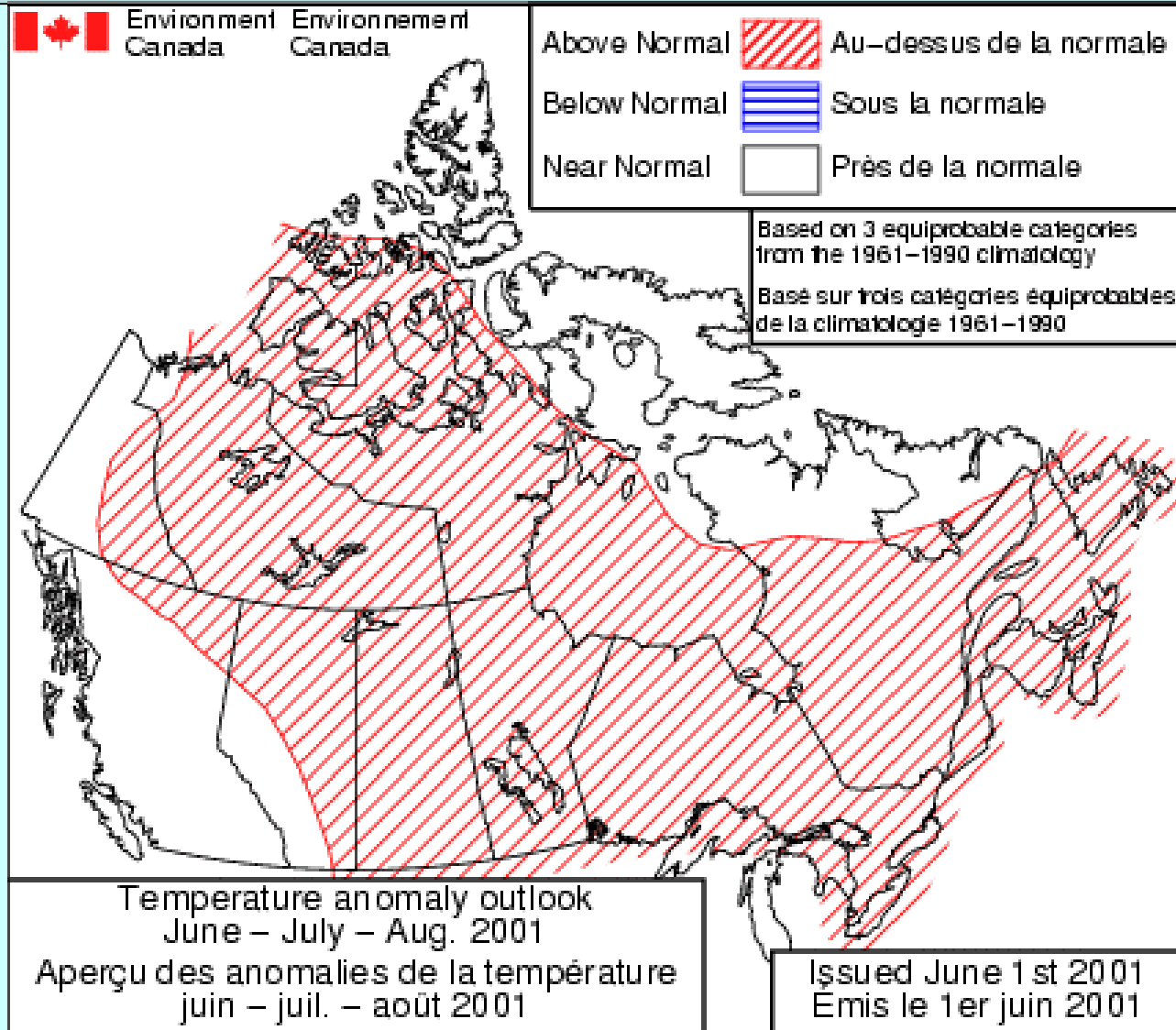
## Forecasts combination



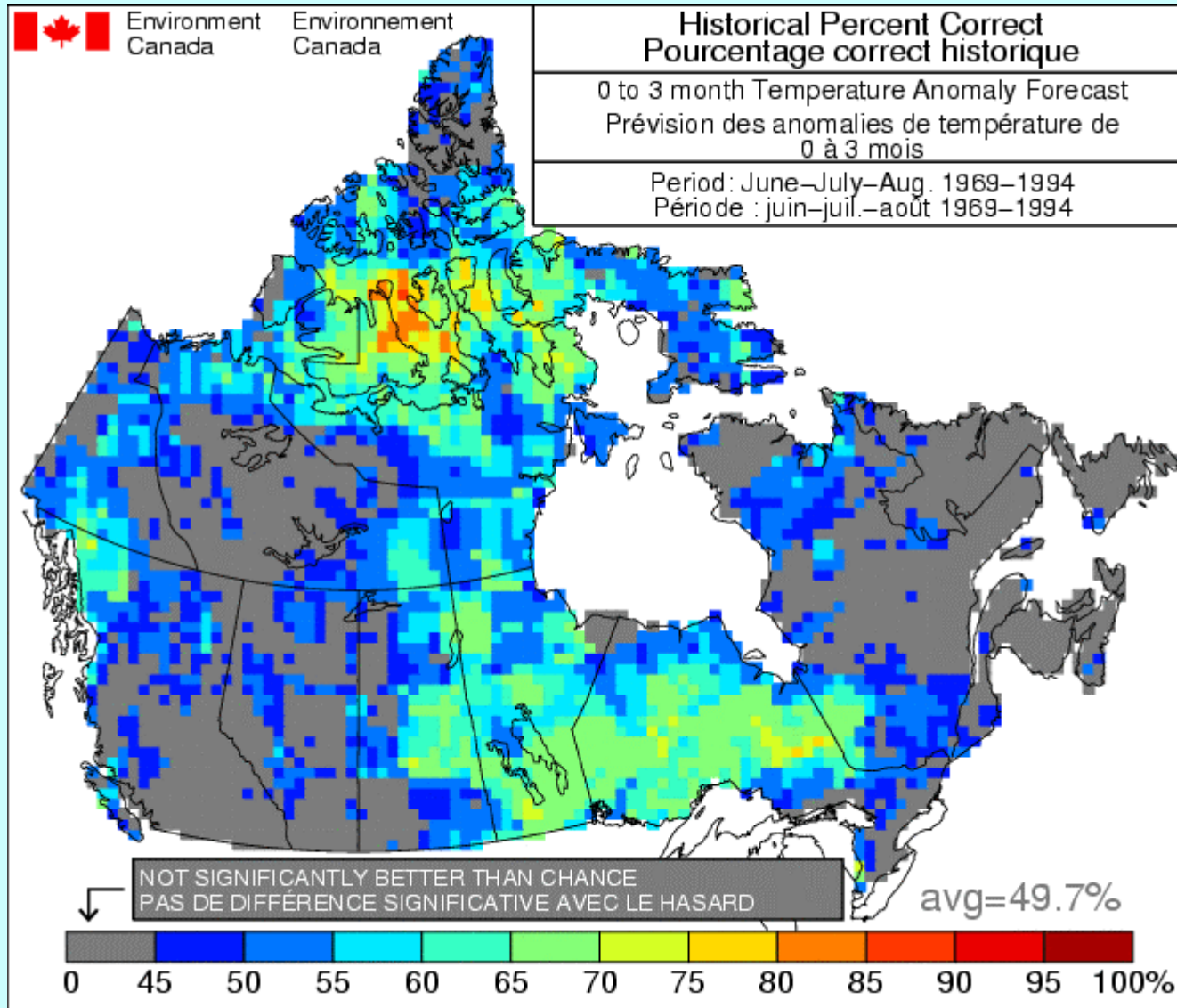
- Anomalies classified into three equi-probable categories using  $0.43 \sigma$  as threshold
- Identical approach for temperature and precipitation



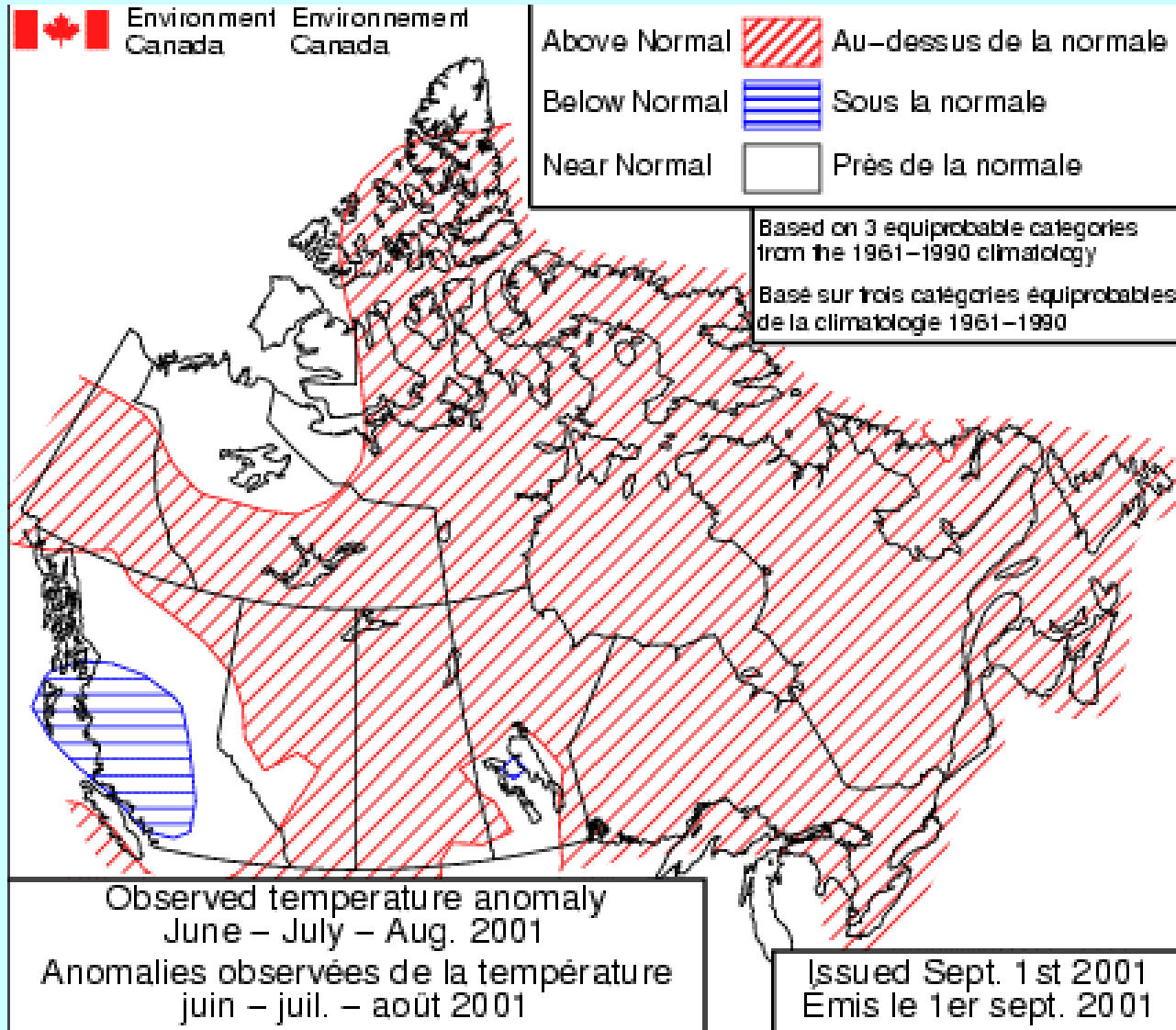
# Categorical temperature forecast for J-J-A 2001



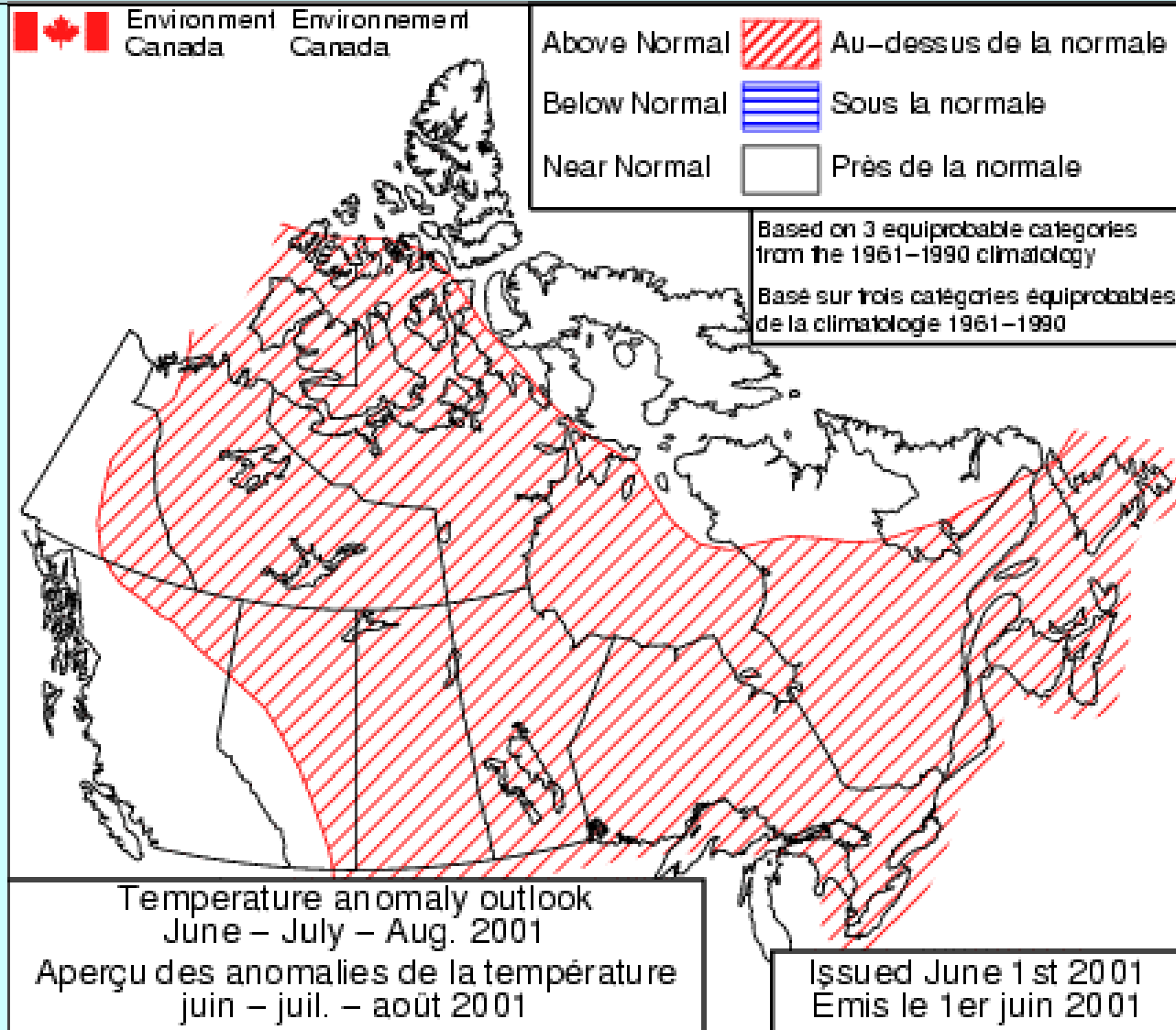
# Skill map associated with the forecast map



# Observed temperature category for summer 2001



# Categorical temperature forecast for J-J-A 2001

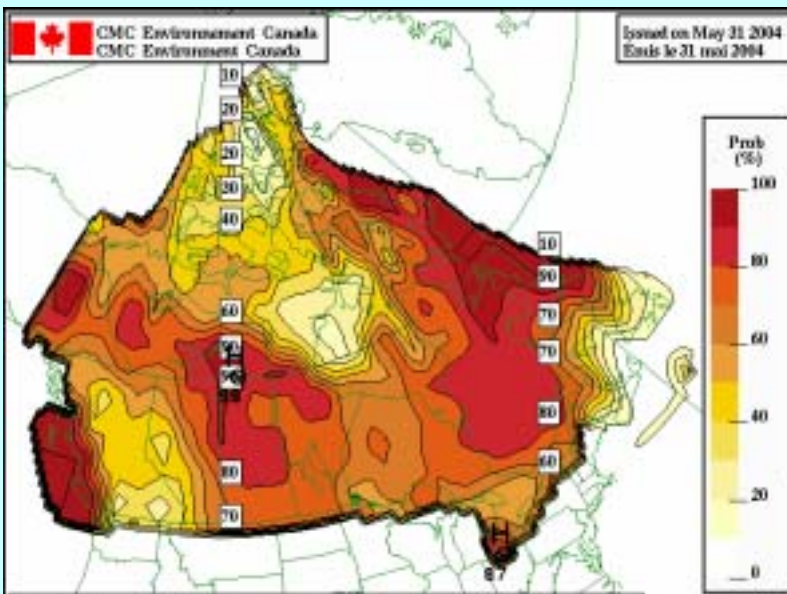


# Probabilistic approach

Number of member	Probability	Bin
0	0%	0-9%
1	8.33%	0-9%
2	16.67%	10-19%
3	25%	20-29%
4	33.33%	30-39%
5	41.67%	40-49%
6	50%	50-59%
7	58.33%	50-59%
8	66.67%	60-69%
9	75%	70-79%
10	83.33%	80-89%
11	91.67%	90-100%
12	100%	90-100%

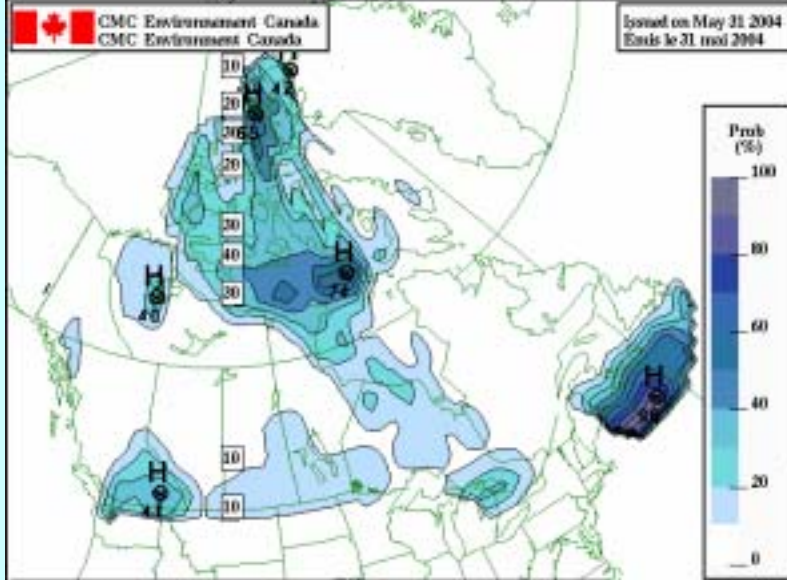


A  
b  
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Forecast probability of above normal temperature (no calibration)  
**Period: June - July - August 2004**  
Based on 3 equiprobable categories from 1961 - 1990 climatology

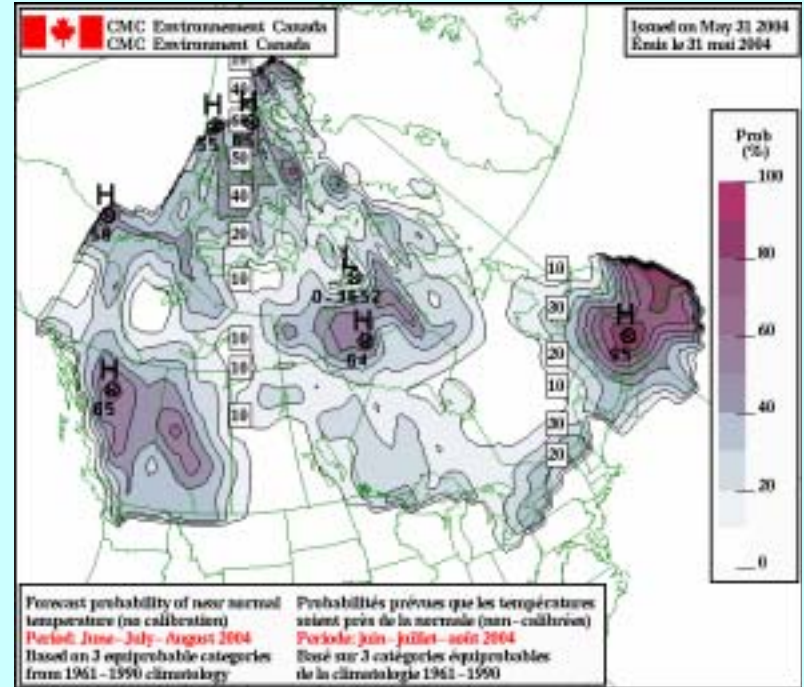
Probabilités prévues que les températures soient au-dessus de la normale (non-calibrées)  
**Période: juin - juillet - août 2004**  
Basé sur 3 catégories équiprobables de la climatologie 1961 - 1990



Forecast probability of below normal temperature (no calibration)  
**Period: June - July - August 2004**  
Based on 3 equiprobable categories from 1961 - 1990 climatology

Probabilités prévues que les températures soient sous la normale (non-calibrées)  
**Période: juin - juillet - août 2004**  
Basé sur 3 catégories équiprobables de la climatologie 1961 - 1990

# Temperature forecast J-J-A 2004



Forecast probability of near normal temperature (no calibration)  
**Period: June - July - August 2004**  
Based on 3 equiprobable categories from 1961 - 1990 climatology

Probabilités prévues que les températures soient près de la normale (non-calibrées)  
**Période: juin - juillet - août 2004**  
Basé sur 3 catégories équiprobables de la climatologie 1961 - 1990

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# RPN GEM Performance

- Global Environmental Multi-Scale (GEM)
  - Multi-purpose operational CMC NWP model
    - Short-term (48 h - 15 km )
    - Medium-term (120 h - 100 km)
    - Seasonal (4 months – 200 km )
- New HFP
  - 32 years (1969-2000)
  - 4-month forecast
    - Seasonal forecasts with zero *and* one-month lead time
  - 10 members instead of 6

# Experiments:

(Boreal summer – 26 years)

- GEM: One-month lead time vs zero-month lead time
- GEM: 6 members vs 10 members
- GEM vs GEM+AGCM2 vs GEM+AGCM2+SEF

# Experiments:

(Boreal summer – 26 years)

- GEM: One-month lead time vs zero-month lead time
- GEM: 6 members vs 10 members
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## Verification used:

Variable :

Seasonal mean of surface air temperature (SAT)

Skill measurements:

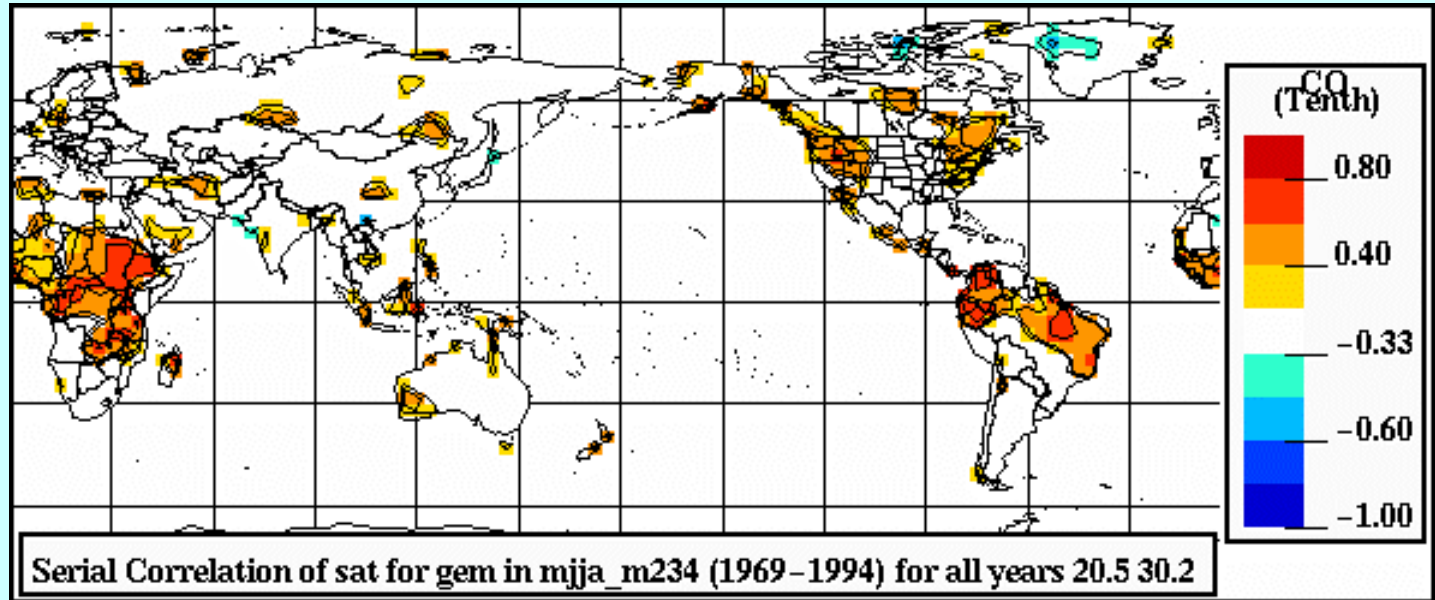
Serial correlation between forecast and obs. (CRU)

Percentage of land covered by significant correlation

# One-month vs zero-month lead time

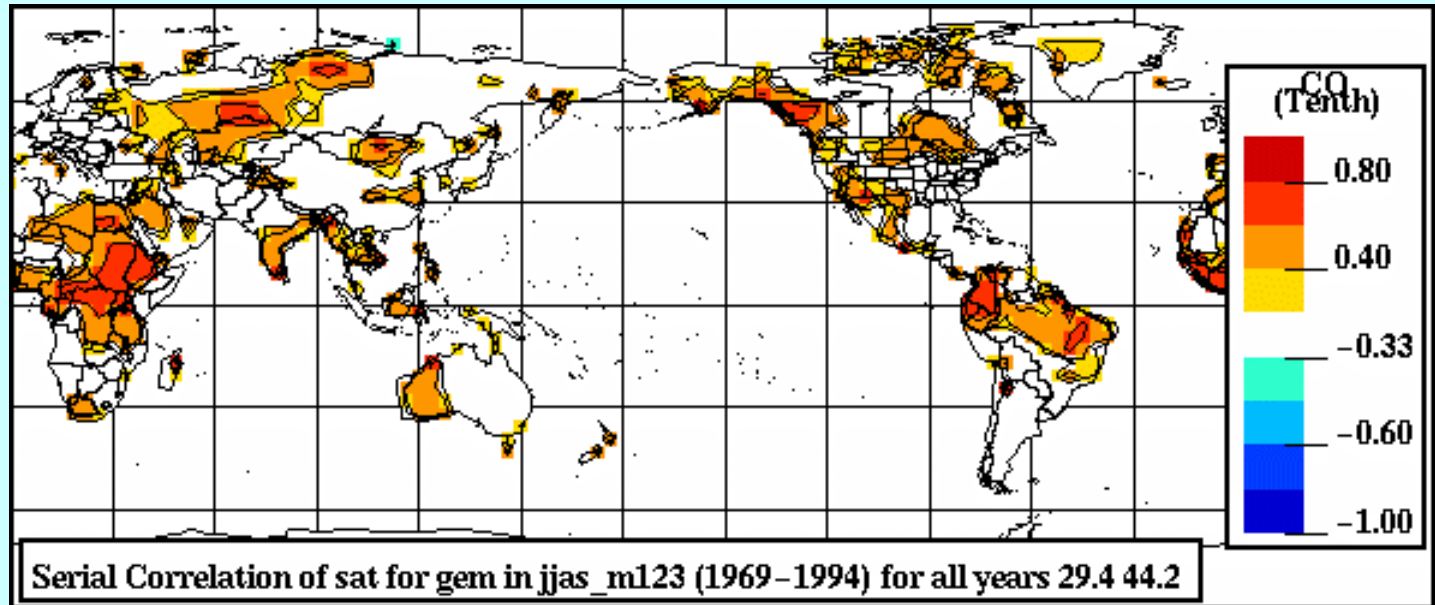
Boreal Summer

**One-month**  
Lead time  
(M)-J-J-A  
6 members



Serial cor= **20.5**  
Sig. land Area = **30.2**

**Zero-month**  
Lead time  
J-J-A  
6 members

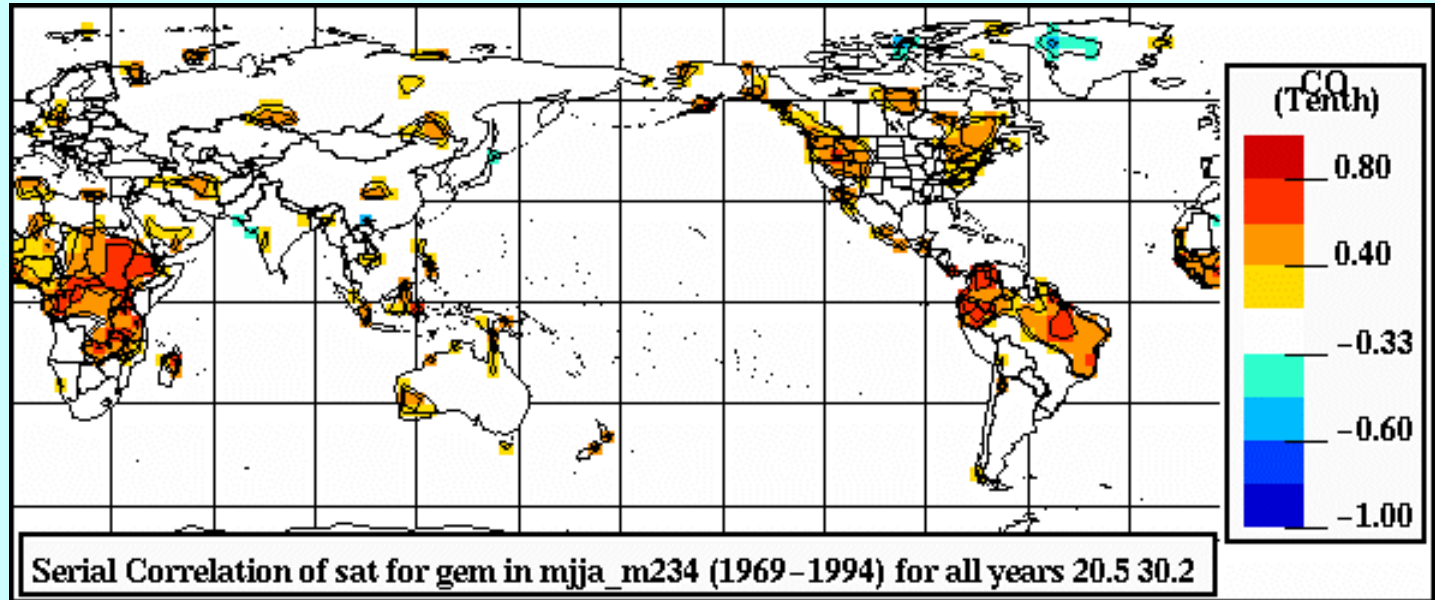


Serial cor= **29.4**  
Sig. land Area = **44.2**

Boreal Summer

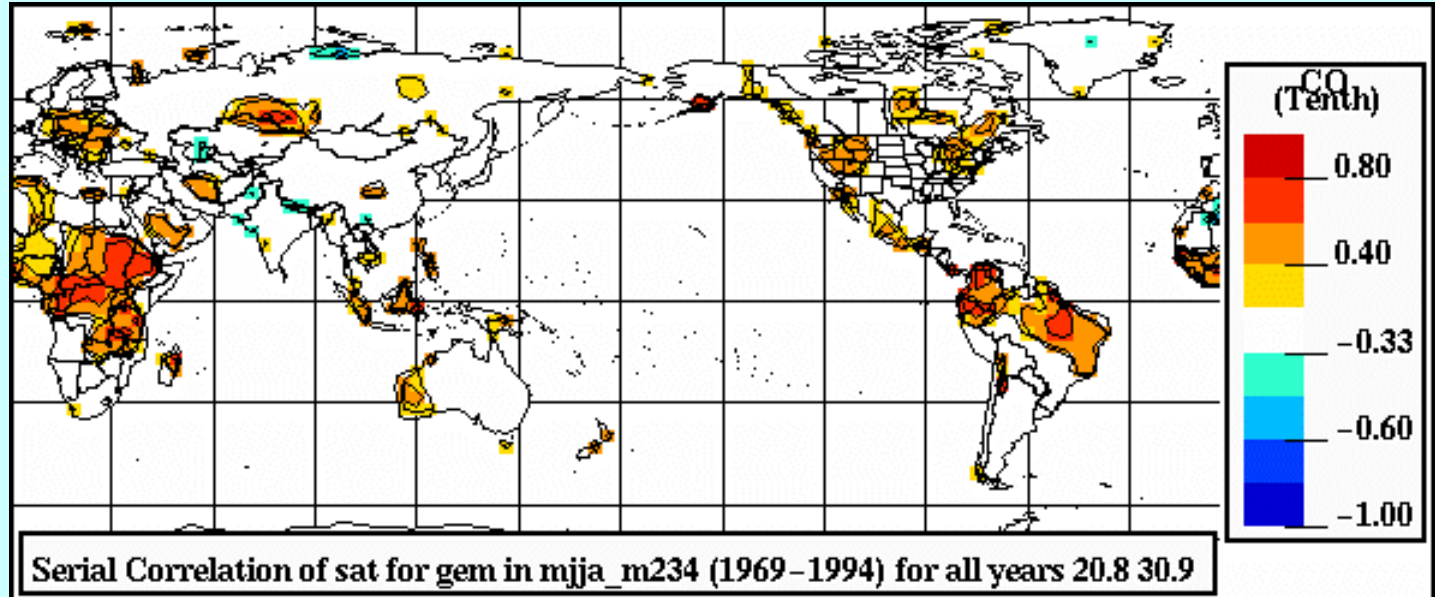
## 6 members vs 10 members

One-month  
Lead time  
(M)-J-J-A  
**6 members**



Serial cor= **20.5**  
Sig. land Area = **30.2**

One-month  
Lead time  
(M)-J-J-A  
**10 members**



Serial cor= **20.8**  
Sig. land Area = **30.9**

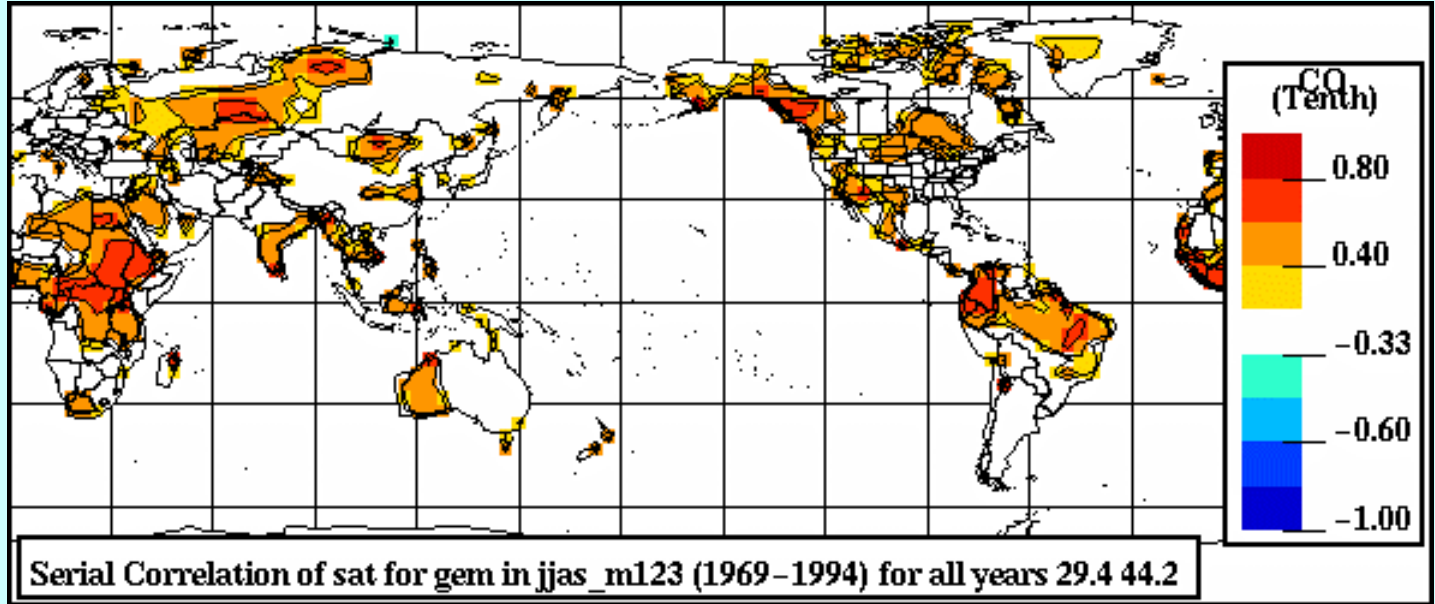
Boreal Summer

# GEM vs GEM + AGCM2

(zero-month lead time; 6 members each model)

## GEM

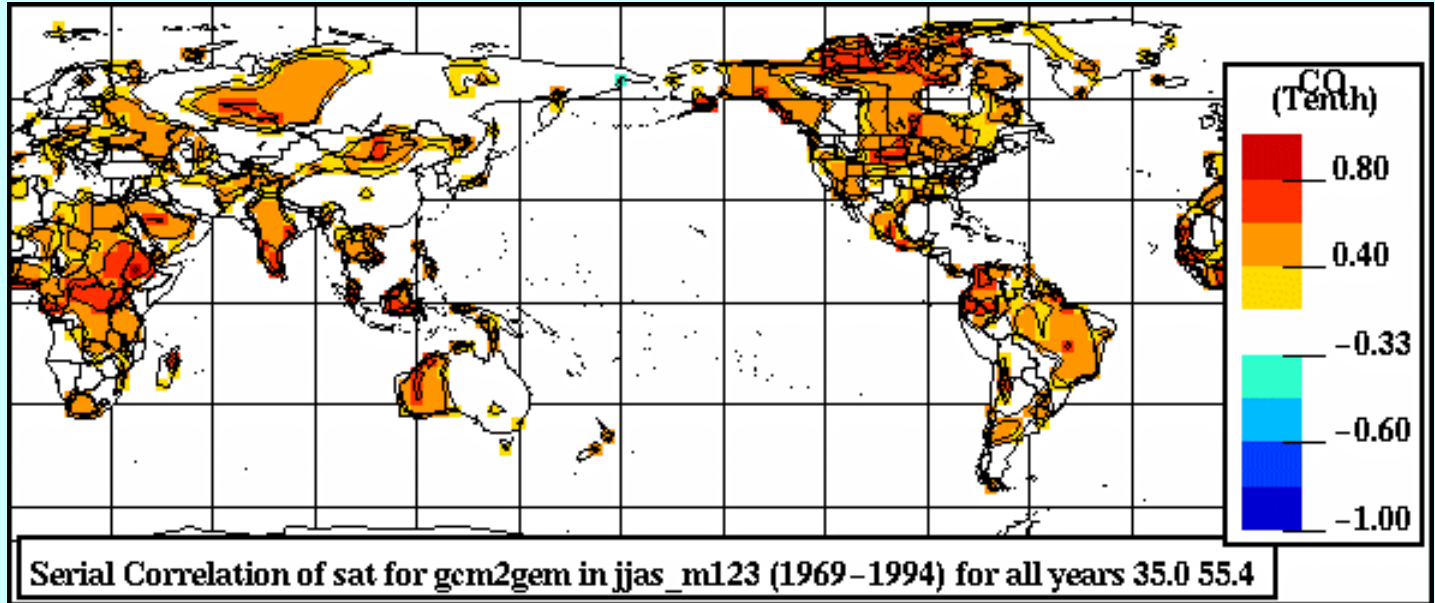
Zero-month  
Lead time  
J-J-A  
6 members



Serial cor= **29.4**  
Sig. land Area = **44.2**

## GEM+AGCM2

Zero-month  
Lead time  
J-J-A  
6 members



Serial cor= **35.0**  
Sig. land Area = **55.4**

Boreal Summer

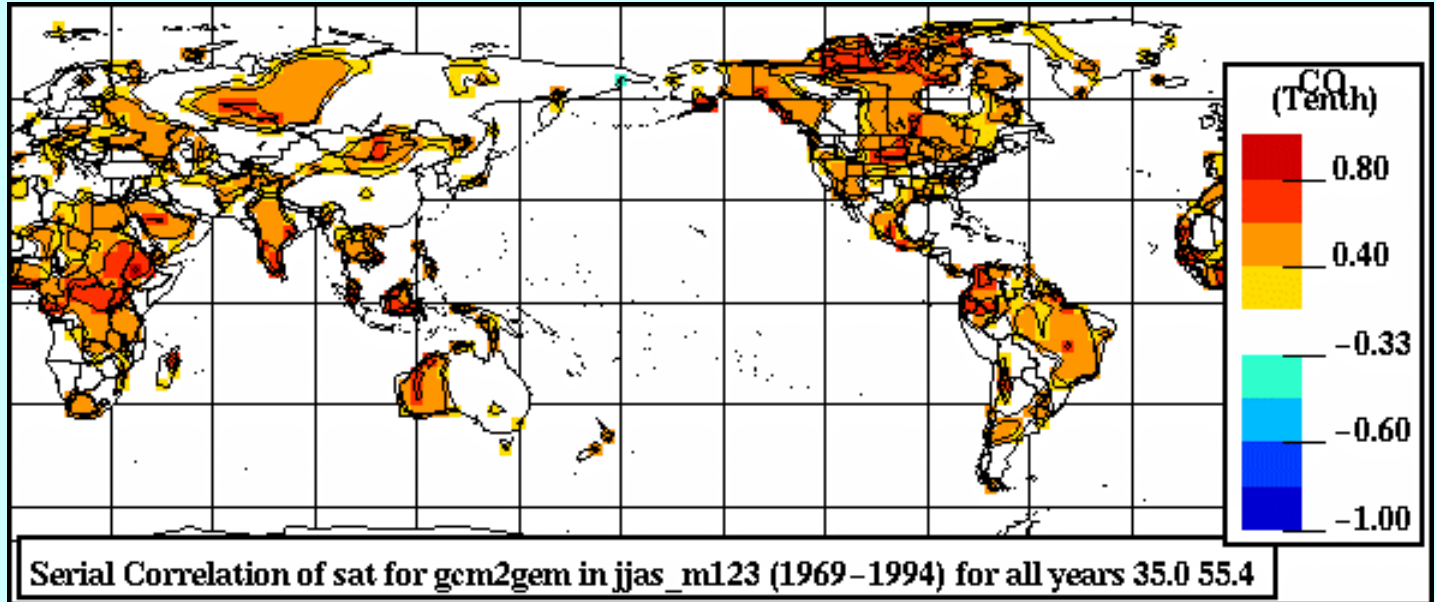
# GEM vs GEM + AGCM2 + SEF

(zero-month lead time; 6 members each model)

## GEM + AGCM2

Zero-month  
Lead time  
J-J-A  
6 members

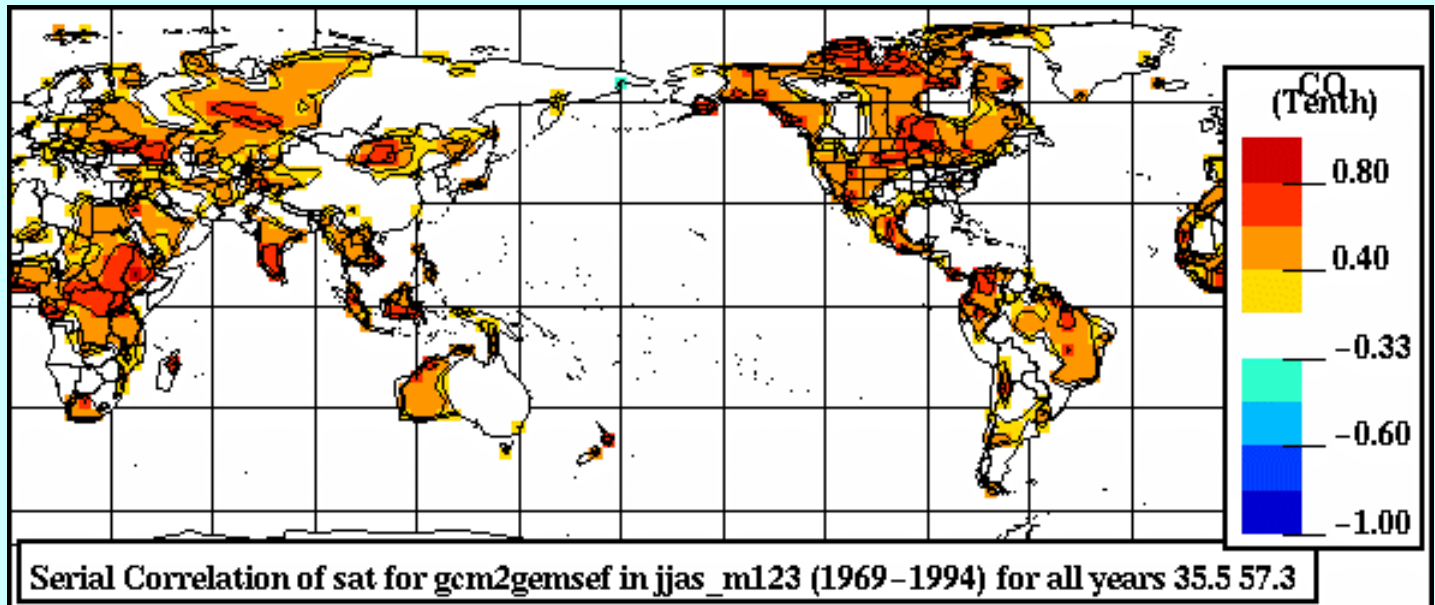
Serial cor= **35.0**  
Sig. land Area = **55.4**



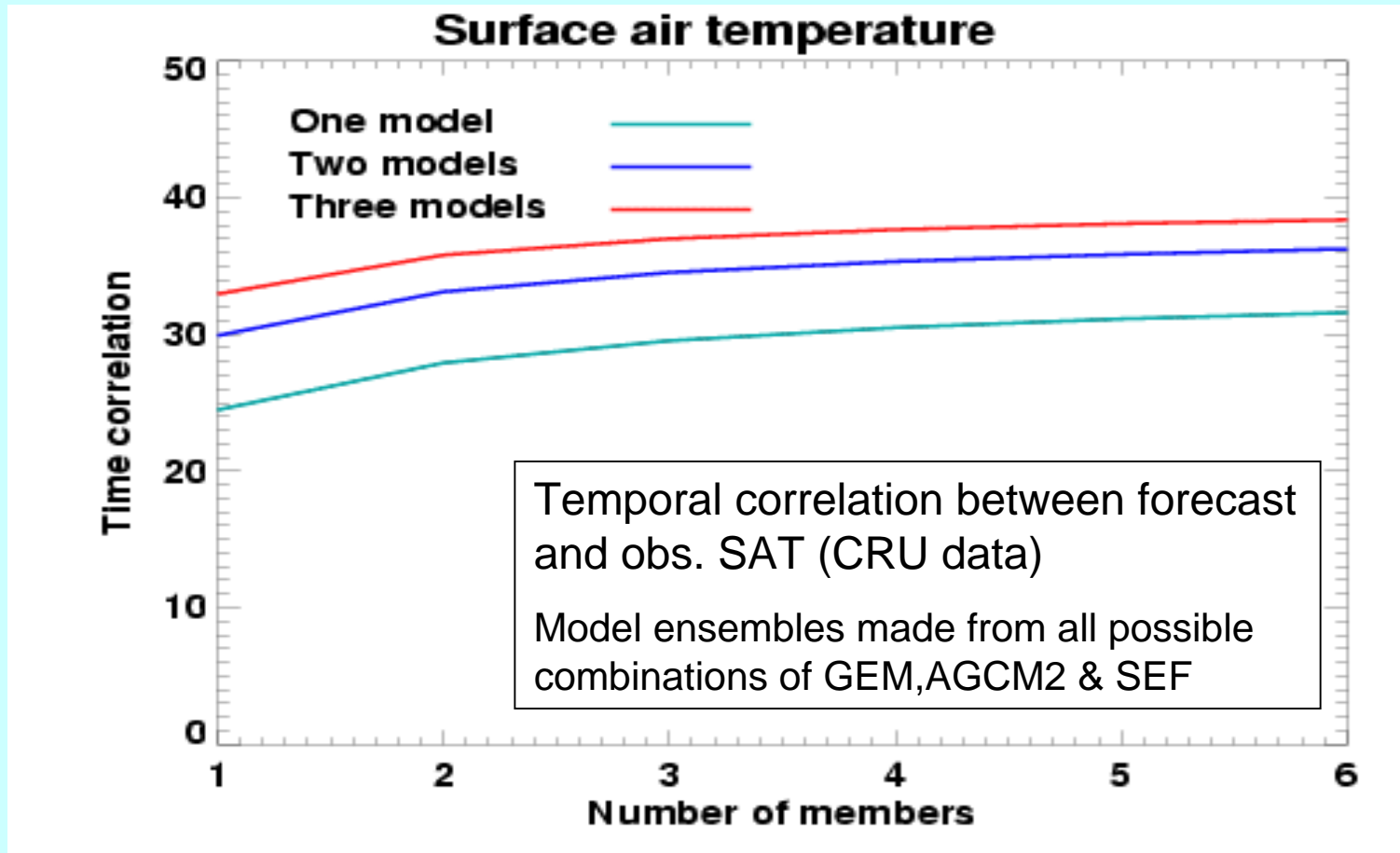
## GEM + AGCM2 + SEF

Zero-month  
Lead time  
J-J-A  
6 members

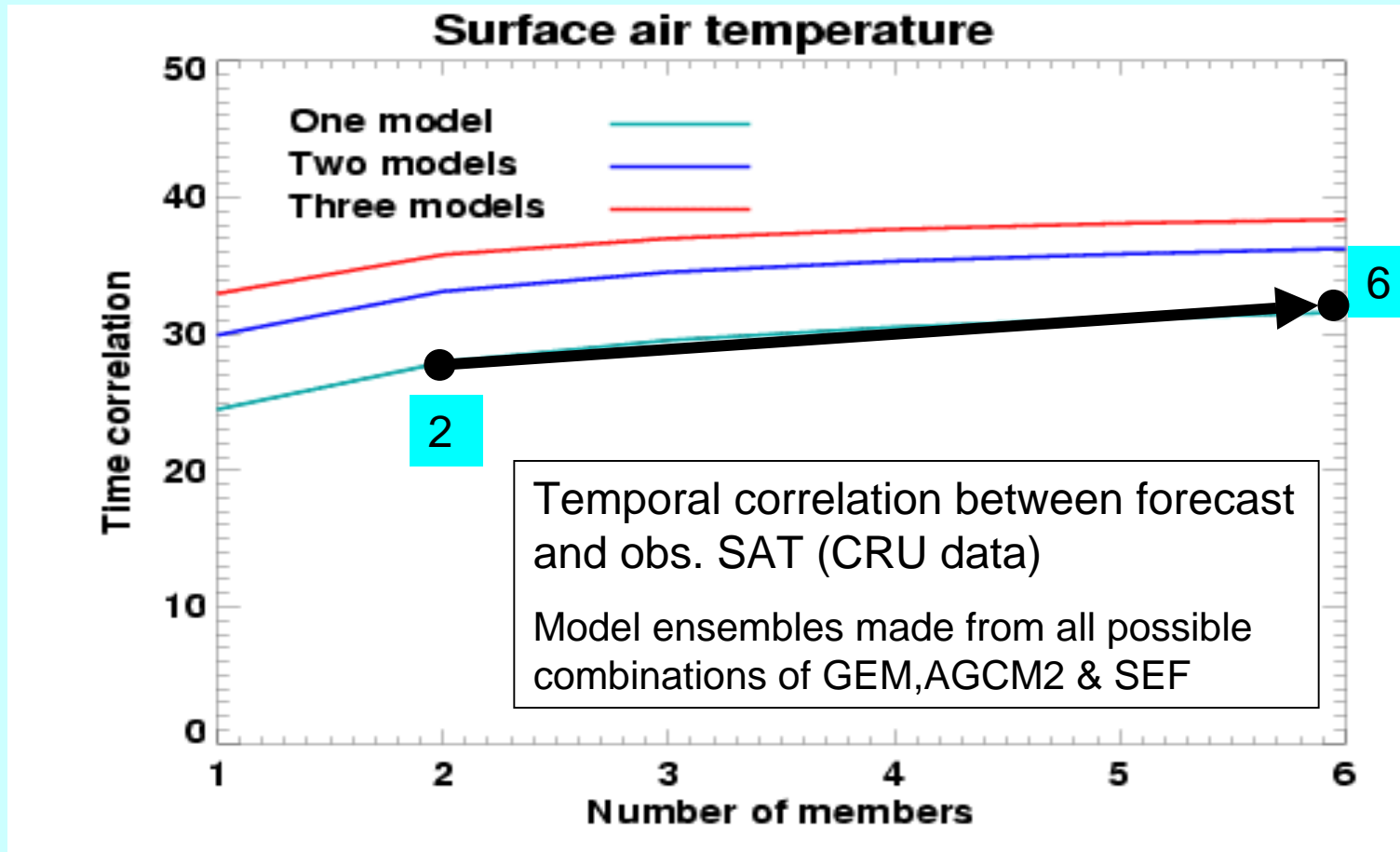
Serial cor= **35.5**  
Sig. land Area = **57.3**



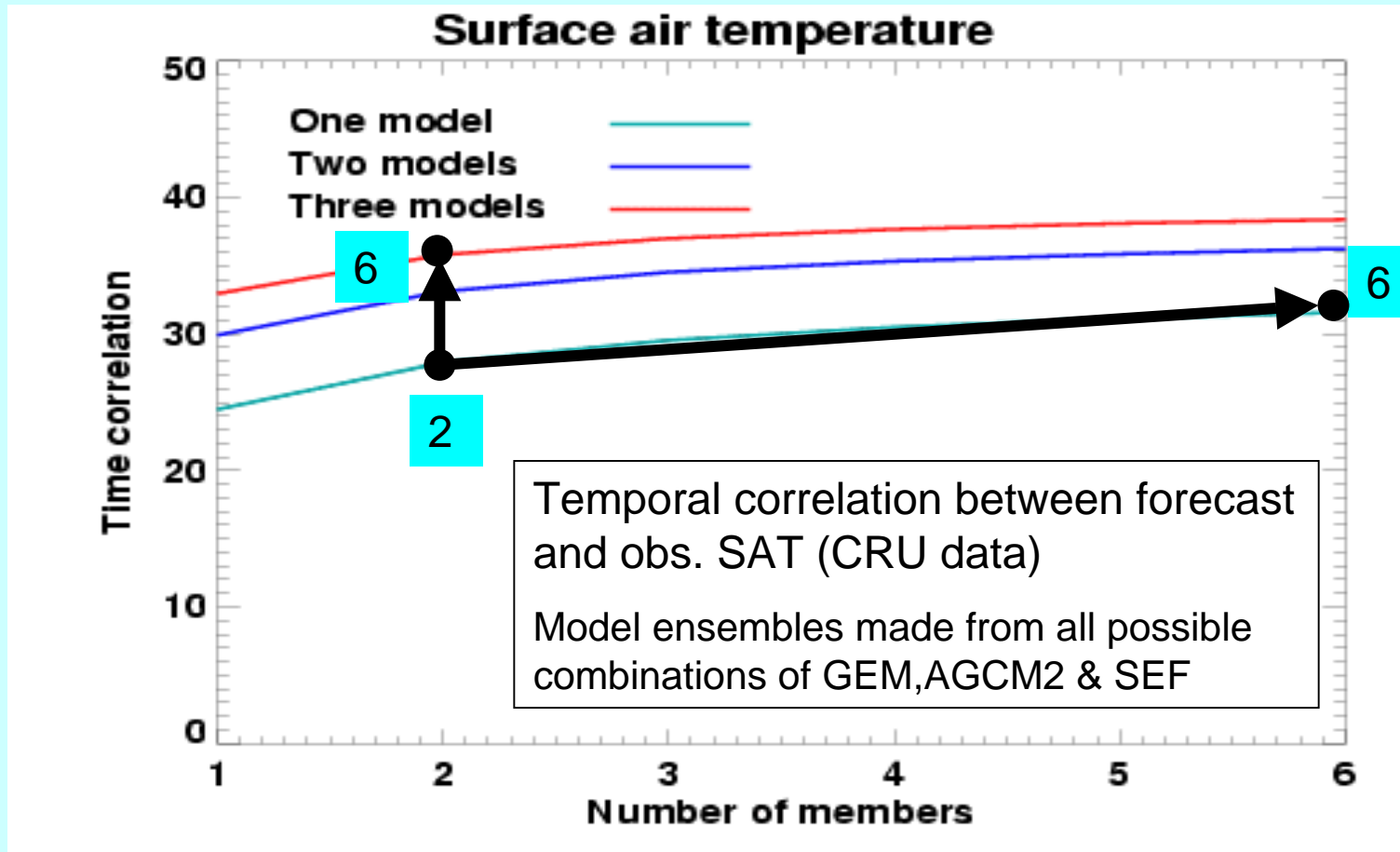
# Impact of increasing the number of members vs the number of models



# Impact of increasing the number of members vs the number of models



# Impact of increasing the number of members vs the number of models



# CMC next operational seasonal forecasting system

- **Multi-Model Ensemble Methodology: 2 more models**
  - AGCM2
  - GEM
  - AGCM3
  - SEF
- **Historical Forecast Project (HFP2)**
  - 32 years (instead of 26) of Hindcasts (1969-2000)
  - Extension from three to four-month hindcasts

# Current and Future Canadian contributions to APCN

- Current
  - Sent GEM 32-year HFP
  - Sent winter 2004-2005 GEM forecast with one-month lead time
- Future (2005)
  - Three more models (HFP & forecasts)
    - AGCM2 (CCCma)
    - AGCM3 (CCCma)
    - SEF (CMC)