MJO-NAO connection and its implication to subseasonal prediction

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Recherche en Prévision Numérique, Environment Canada

ECMWF S2S workshop

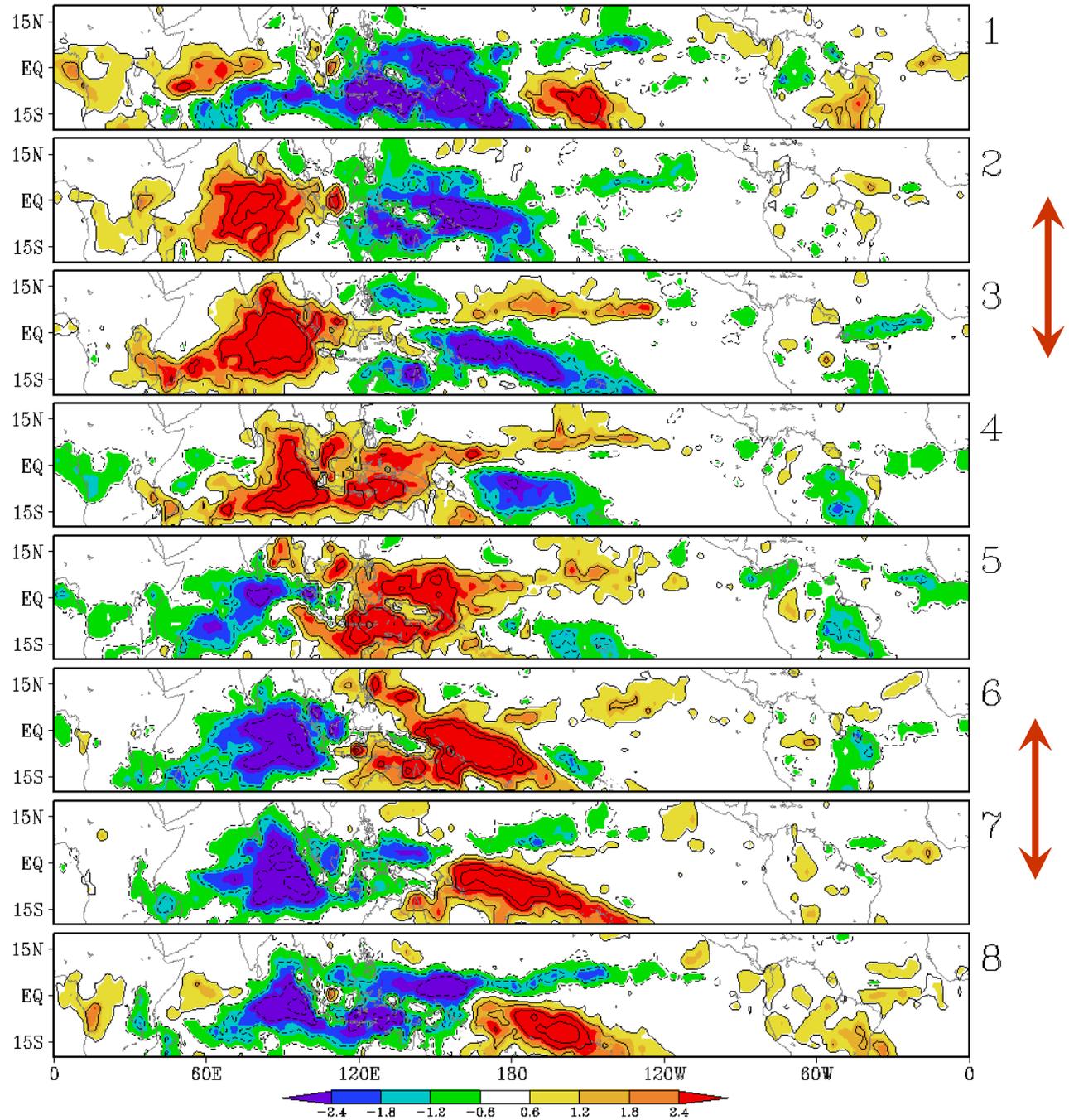# Outlines

- Connection between the MJO and the NAO
- MJO influence on North American surface air temperature
- Subseasonal prediction of the MJO and NAO

Composites of tropical

Precipitation rate for 8 MJO phases, according to Wheeler and Hendon index.

Xie and Arkin pentad data, 1979-2003

Connection between the MJO and NAO

Data

NAO index: pentad average

MJO RMMs: pentad average

Period: 1979-2003

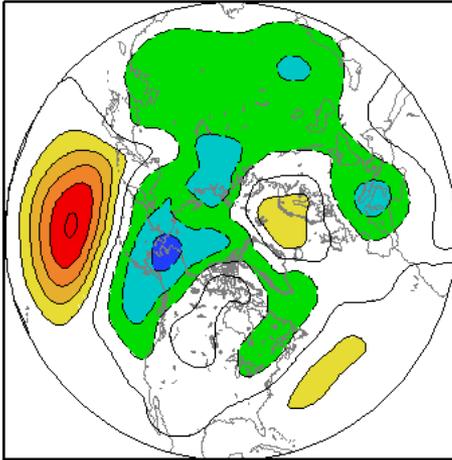Extended winter, November to April (36 pentads each winter)

Lagged probability of the NAO index

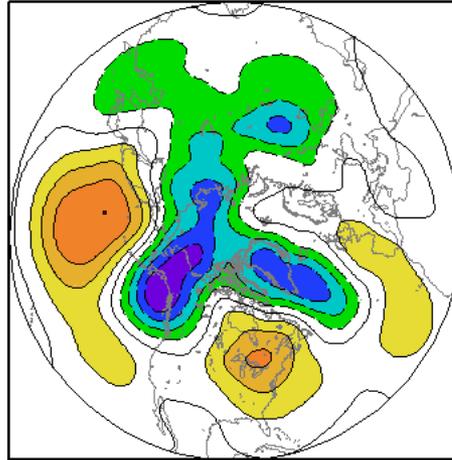**Positive: upper tercile**; Negative: low tercile

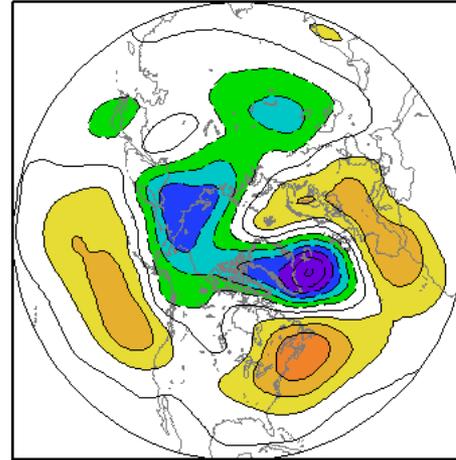| Phase	1	2	3	4	5	6	7	8
Lag −5		−35%	−40%			+49%	+49%	
Lag −4						+52%	+46%	
Lag −3		−40%					+46%	
Lag −2						+50%		
Lag −1								
Lag 0				+45%				−42%
Lag +1			+47%	+45%				−46%
Lag +2		+47%	+50%	+42%		−41%	−41%	−42%
Lag +3		+48%				−41%	−48%	
Lag +4						−39%	−48%	
Lag +5				−41%				

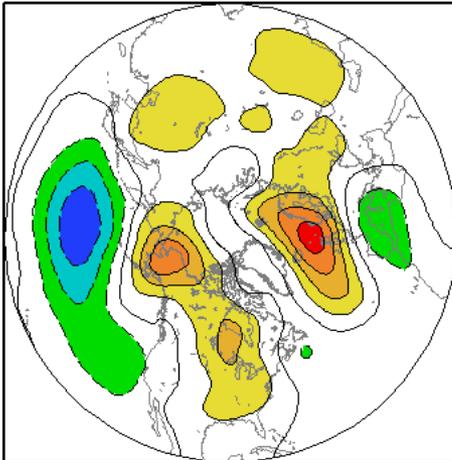(Lin et al. JCLIM, 2009)

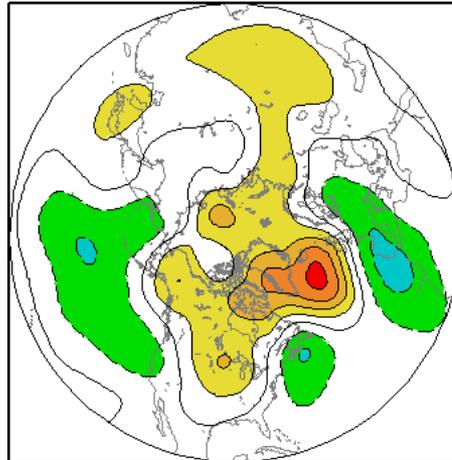# Tropical influence
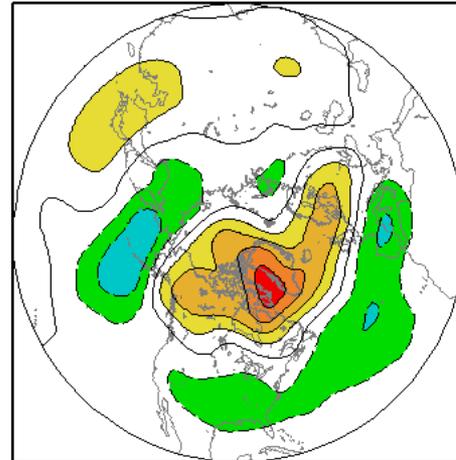

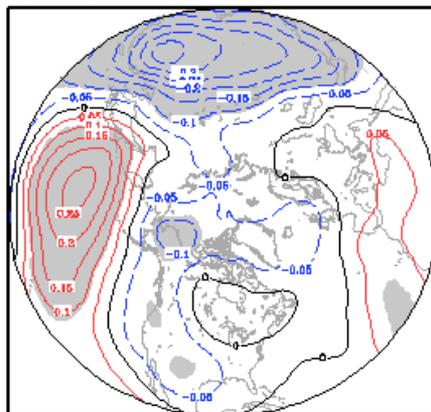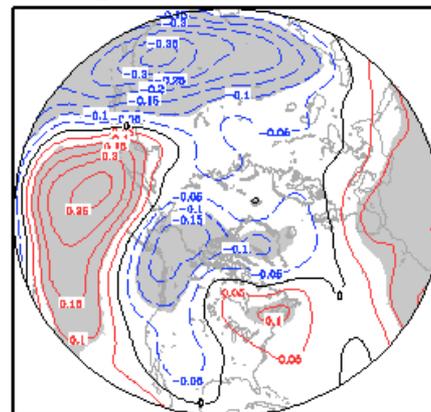a) PHASE 3 lag=0   b) PHASE 3 lag=1   c) PHASE 3 lag=2
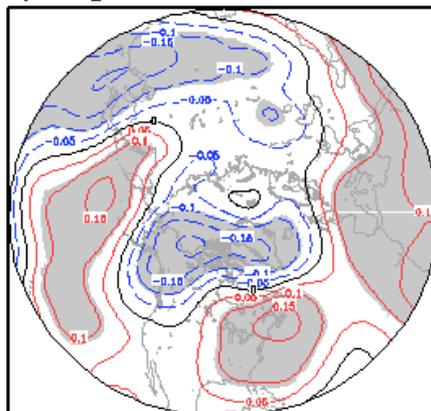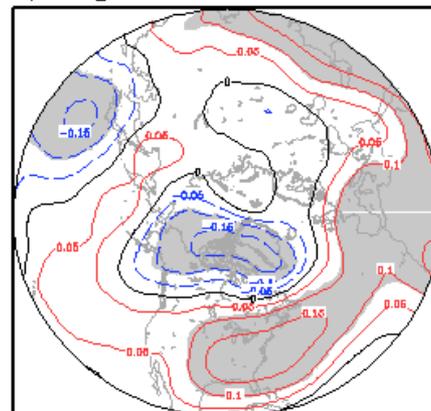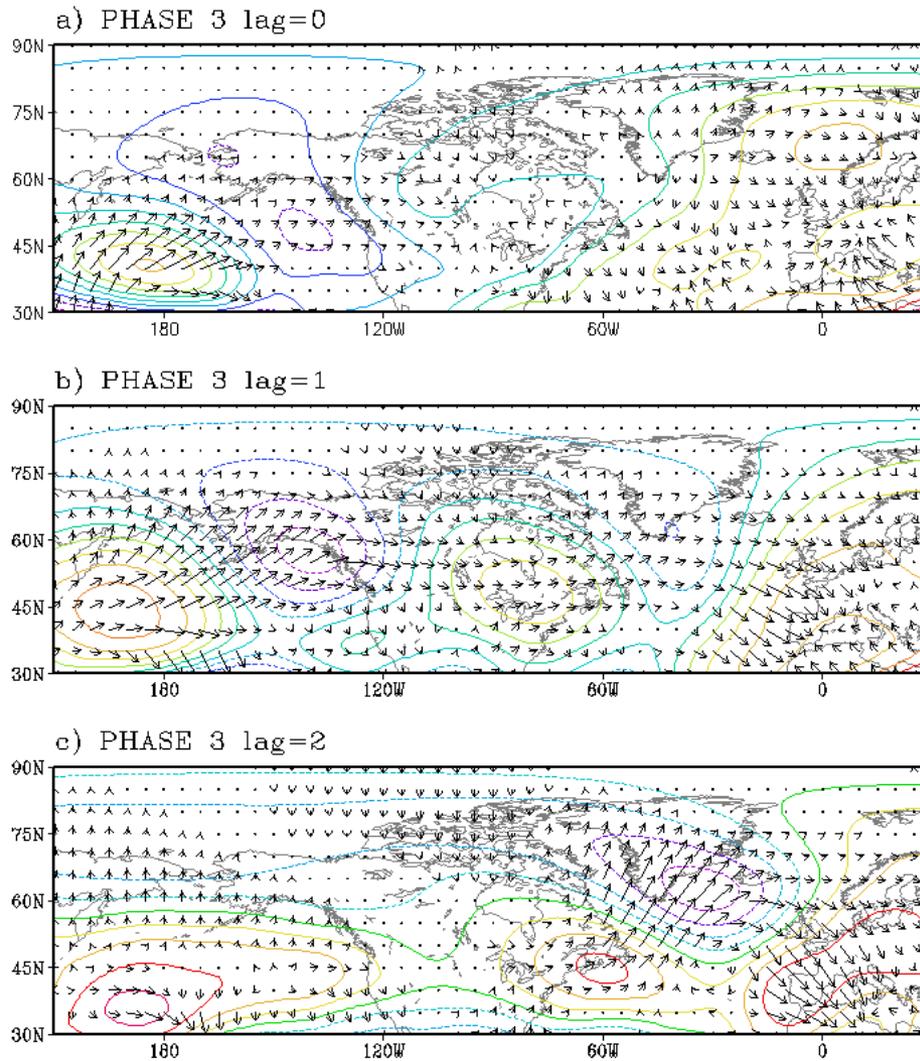
d) PHASE 7 lag=0   e) PHASE 7 lag=1   f) PHASE 7 lag=2

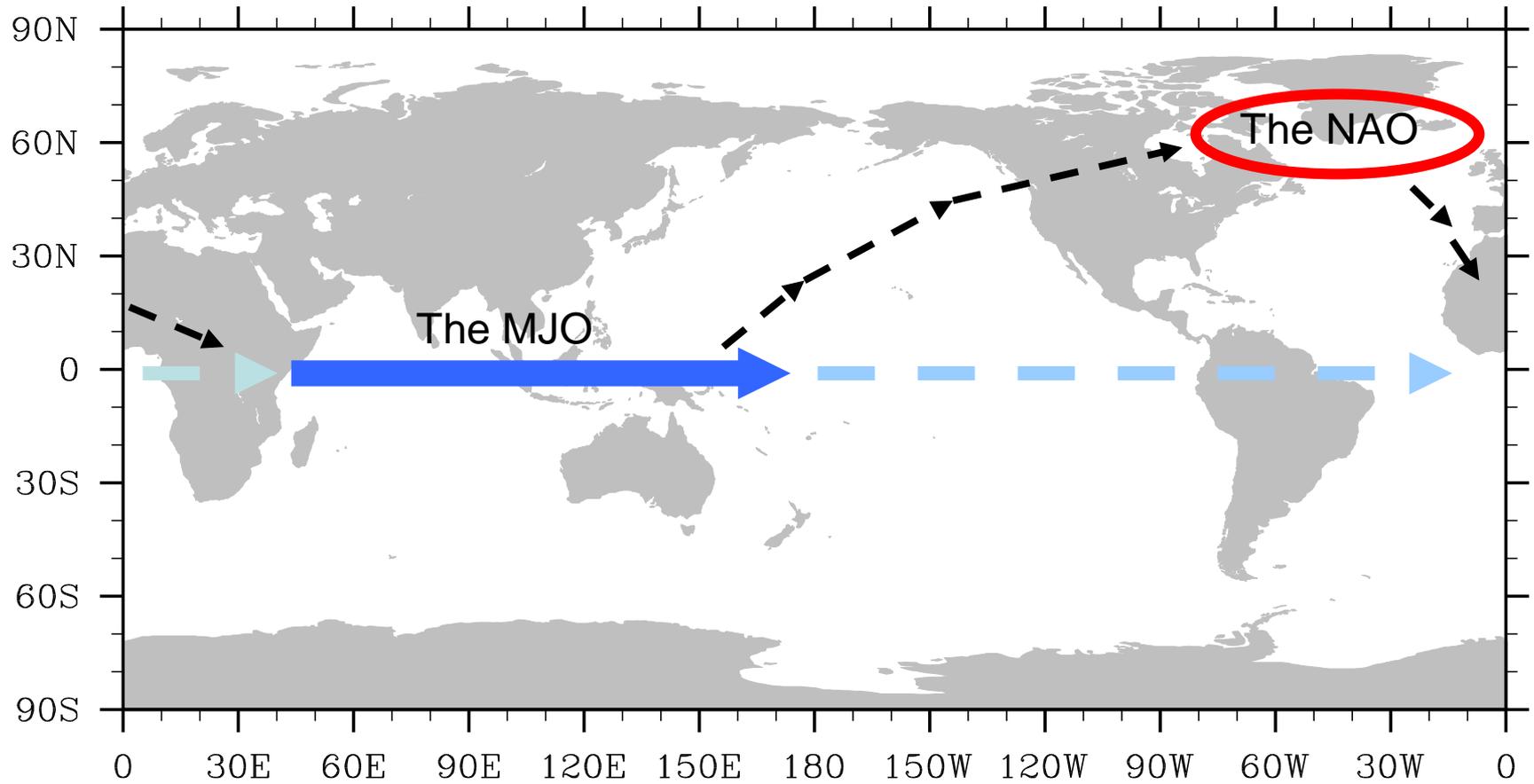Normalized Z500 regression to PC2

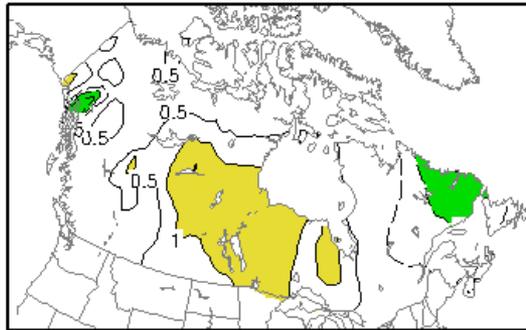# Wave activity flux and 200mb streamfunction anomaly
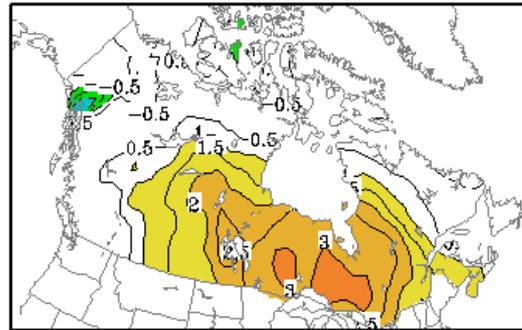
Two-way MJO – NAO interaction

The MJO

The NAO

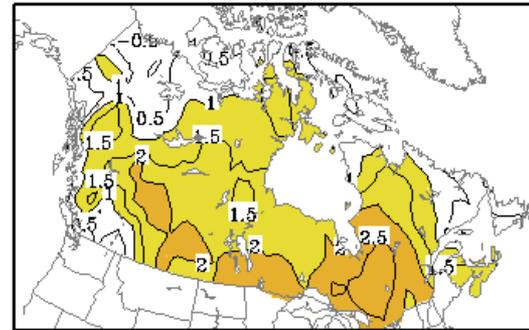# Impact on Canadian surface air temperature

Lagged winter SAT anomaly in Canada

a) PHASE 3 lag=0 b) PHASE 3 lag=1 c) PHASE 3 lag=2

(Lin et al. MWR, 2009)
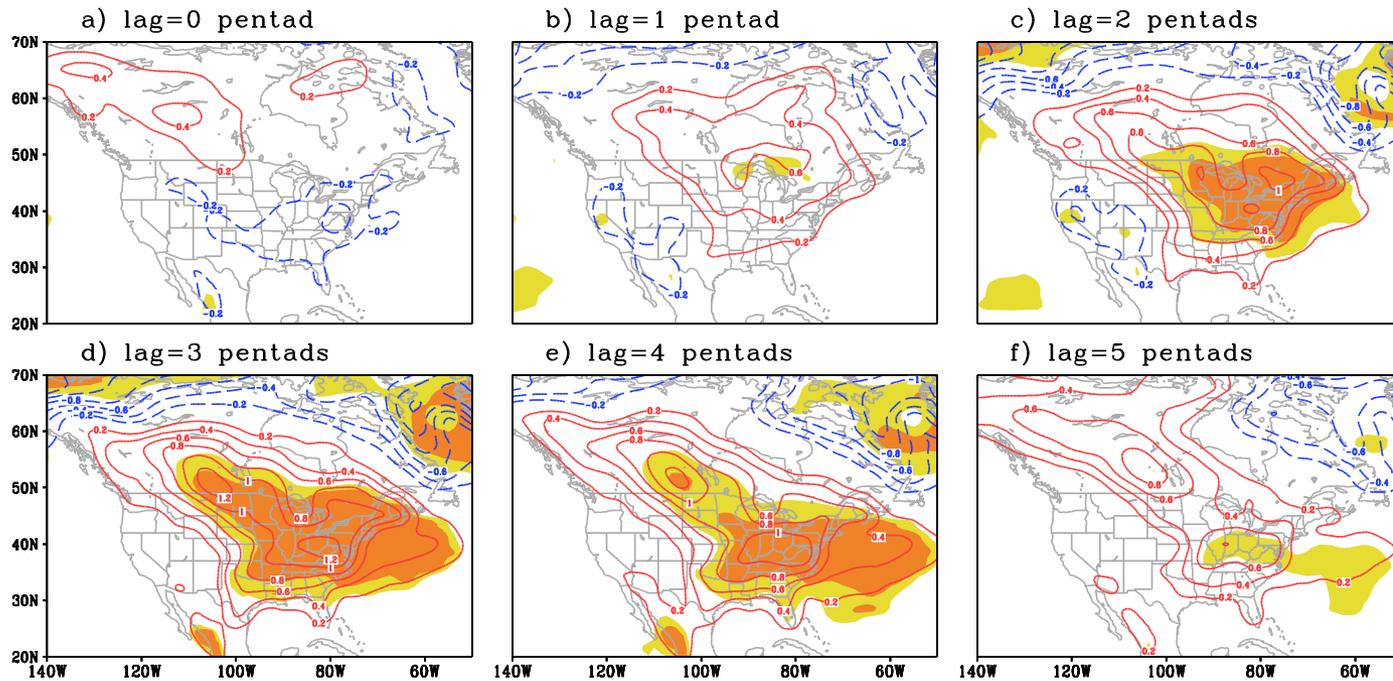
Impact on North American surface air temperature

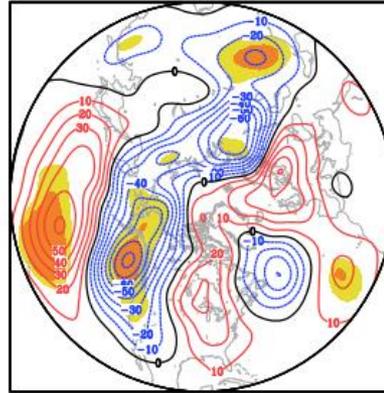Lagged regression of SAT with −RMM2

The Canadian monthly forecast system

- GEPS4.0.0 800x400 ~50 km resolution L40(forecast) L74(analysis

- Extend Global EPS forecast from 16 days to 32 days once a week (Thursday 00 UTC)

- Persistent SST anomaly (2-tier system)

- 20+1 members

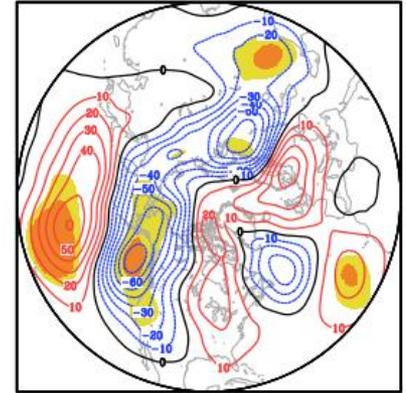- Hindcast 'on-the-fly', 4 members 18 years

Environment Canada   Environnement Canada

Canada

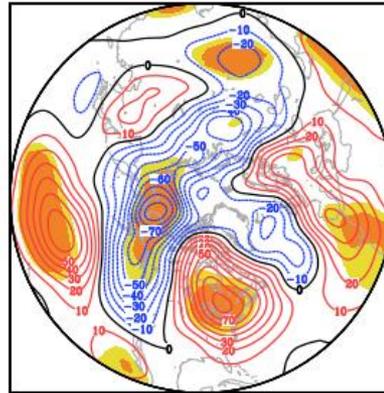Z500 anomaly composite
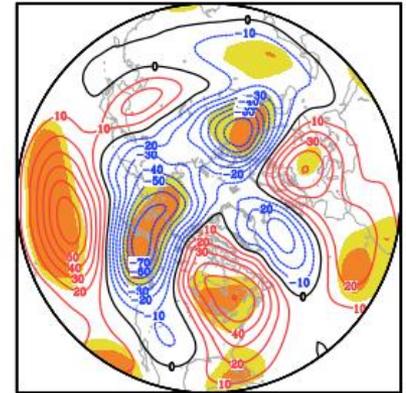After MJO phase 3

a) OBS pentad 1   b) FCT pentad 1
c) OBS pentad 2   d) FCT pentad 2
e) OBS pentad 3   f) FCT pentad 3

Environment   Environnement
Canada   Canada

Z500 anomaly composite
After MJO phase 3

a) OBS pentad 4

b) FCT pentad 4
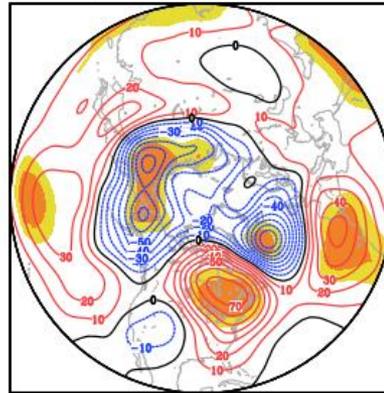
c) OBS pentad 5

d) FCT pentad 5

e) OBS pentad 6

f) FCT pentad 6

Environment   Environnement
Canada   Canada

T2m anomaly composite
After MJO phase 3

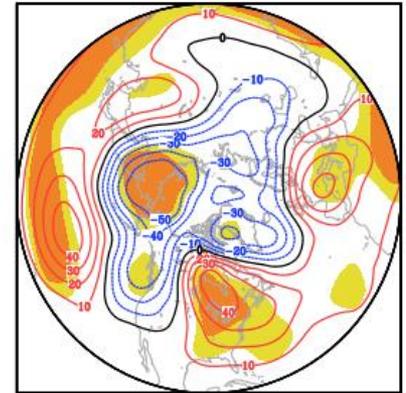a) OBS pentad 1   b) FCT pentad 1
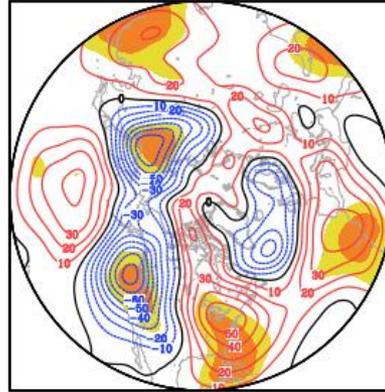
c) OBS pentad 2   d) FCT pentad 2
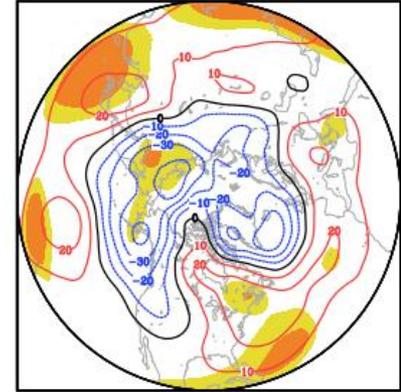
e) OBS pentad 3   f) FCT pentad 3

Environment Environnement
Canada   Canada

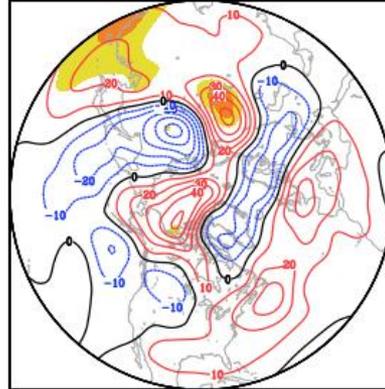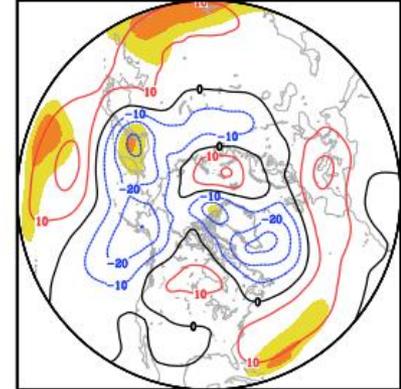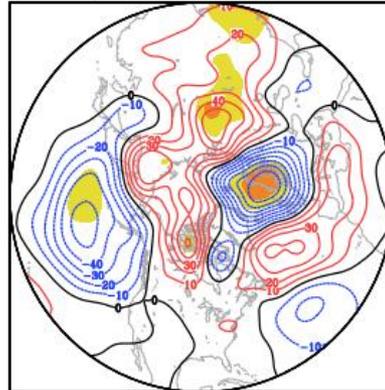T2m anomaly composite
After MJO phase 3
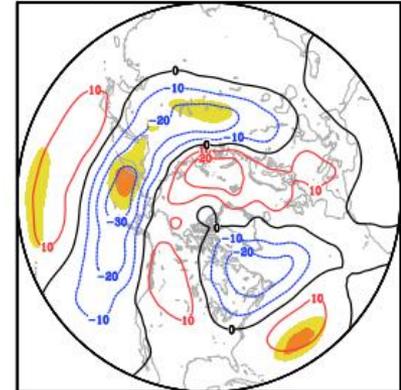

a) OBS pentad 4

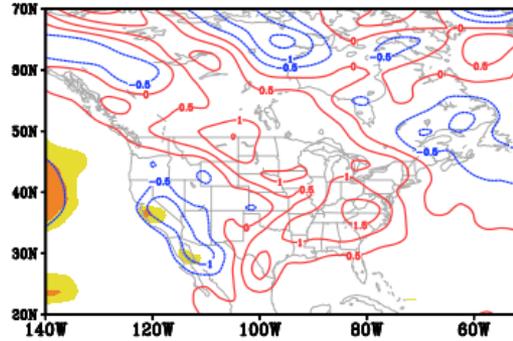b) FCT pentad 4

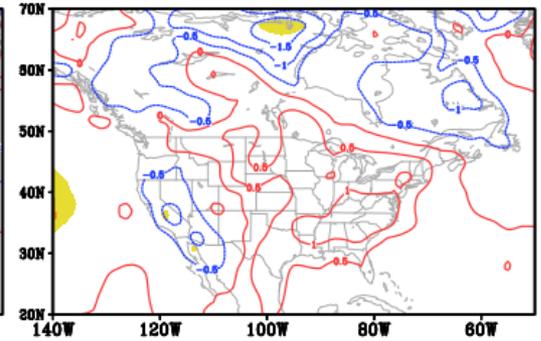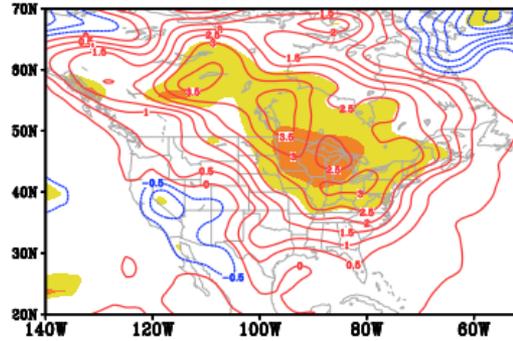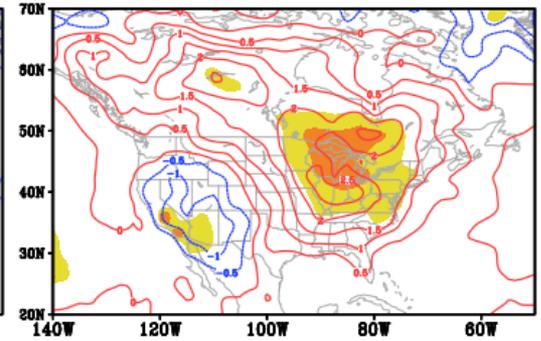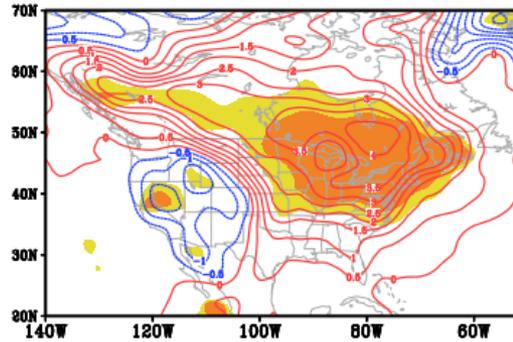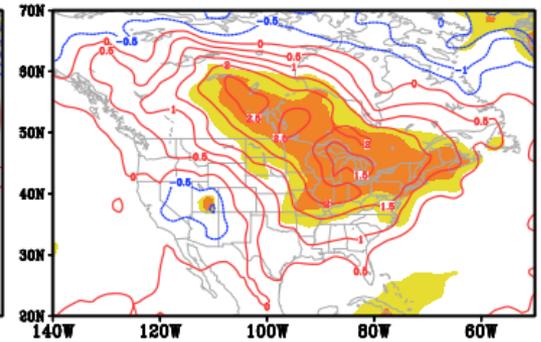c) OBS pentad 5

d) FCT pentad 5

e) OBS pentad 6

f) FCT pentad 6

Environment   Environnement
Canada   Canada
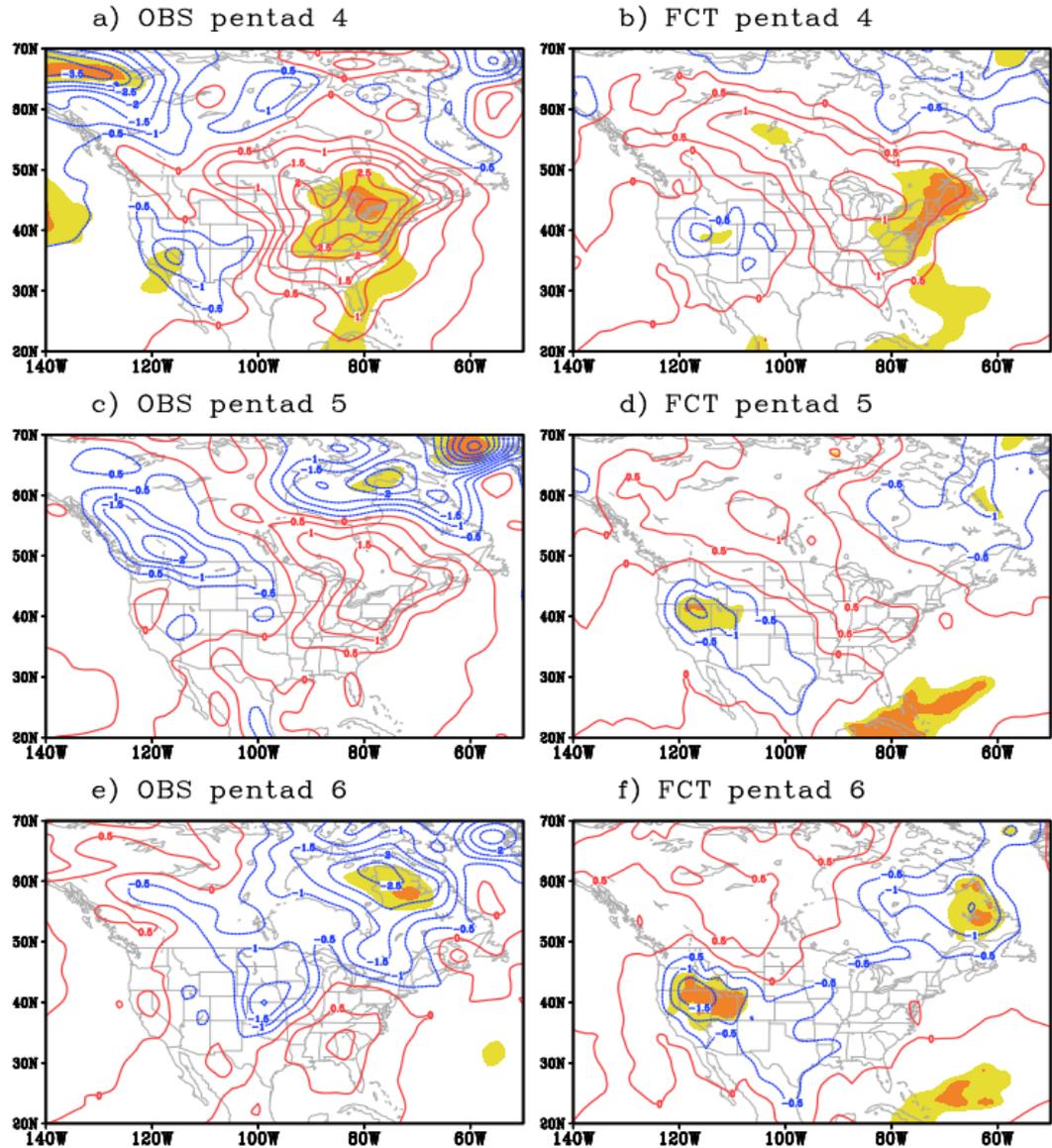
ISO hindscast with GEM

- GEM clim of Canadian Meteorological Centre (CMC)--

    GEMCLIM 3.2.2, 50 vertical levels and 2° of horizontal resolution

- 1985-2008

- 3 times a month (1st, 11th and 21st)

- 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

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Canada

NAO forecast skill
extended winter – Nov – March
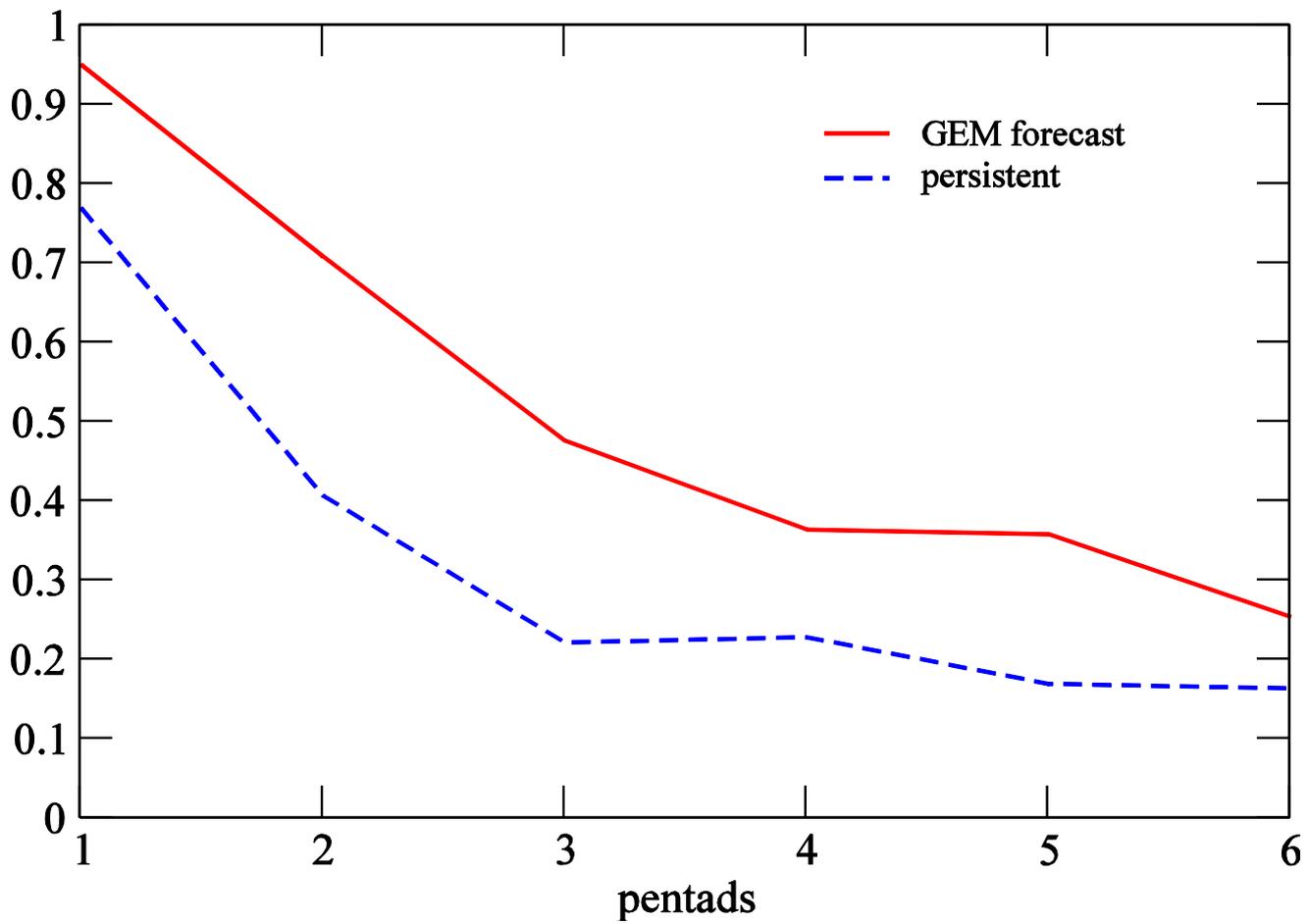# tropical influence

A simple measure of skill:

temporal correlation btw forecast and observations

NAO forecast skill

GEM forecast
persistent

pentads

(Lin et al. GRL, 2010a)

NAO forecast skill

- ensMean: weak MJO, 106 cases
- ensMean: strong MJO, 254 cases
- membAve: weak MJO
- membAve: strong MJO

pentads

(Lin et al. GRL, 2010a)

NAO forecast skill

phase8145, 119 cases
phase2367, 135 cases
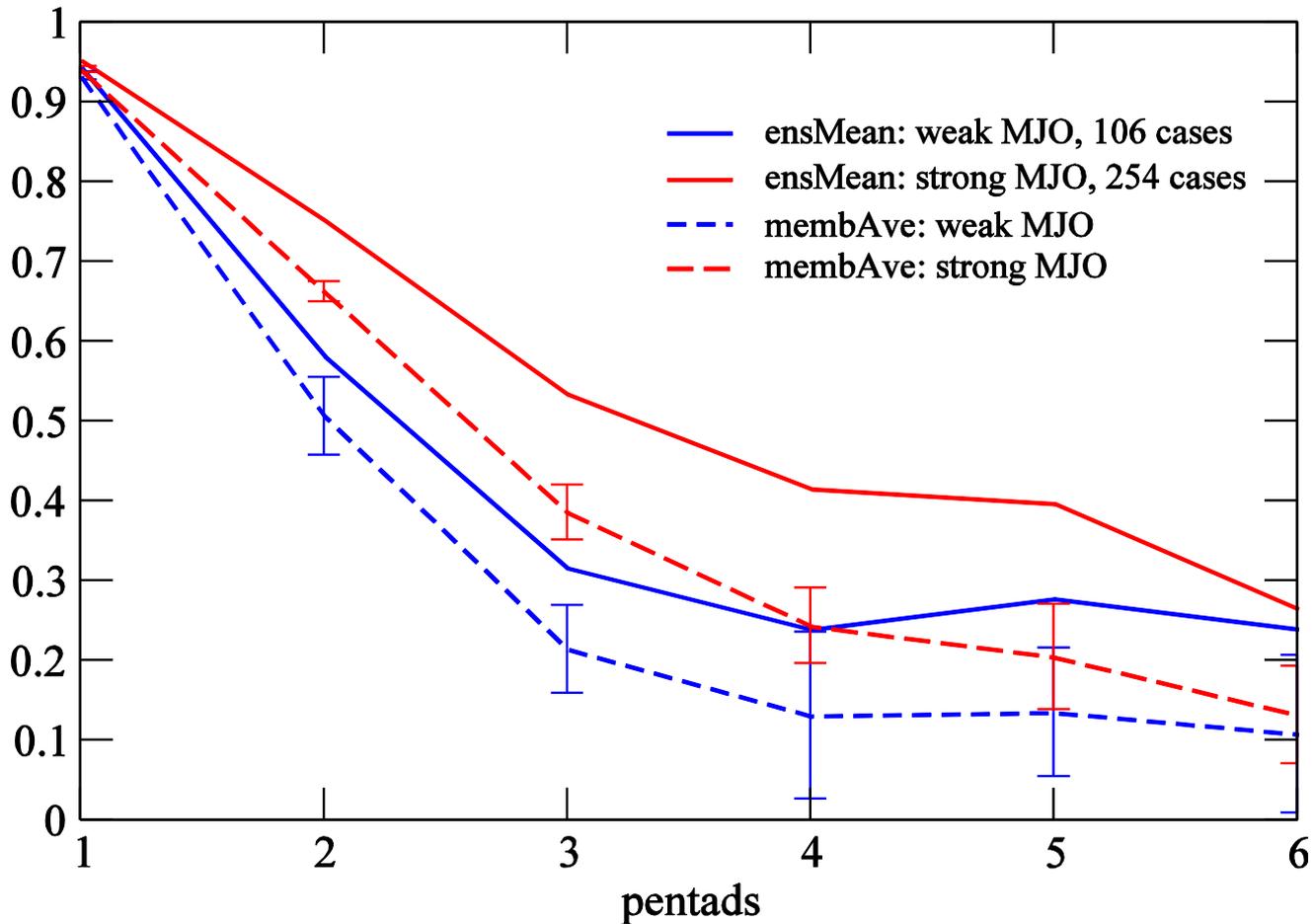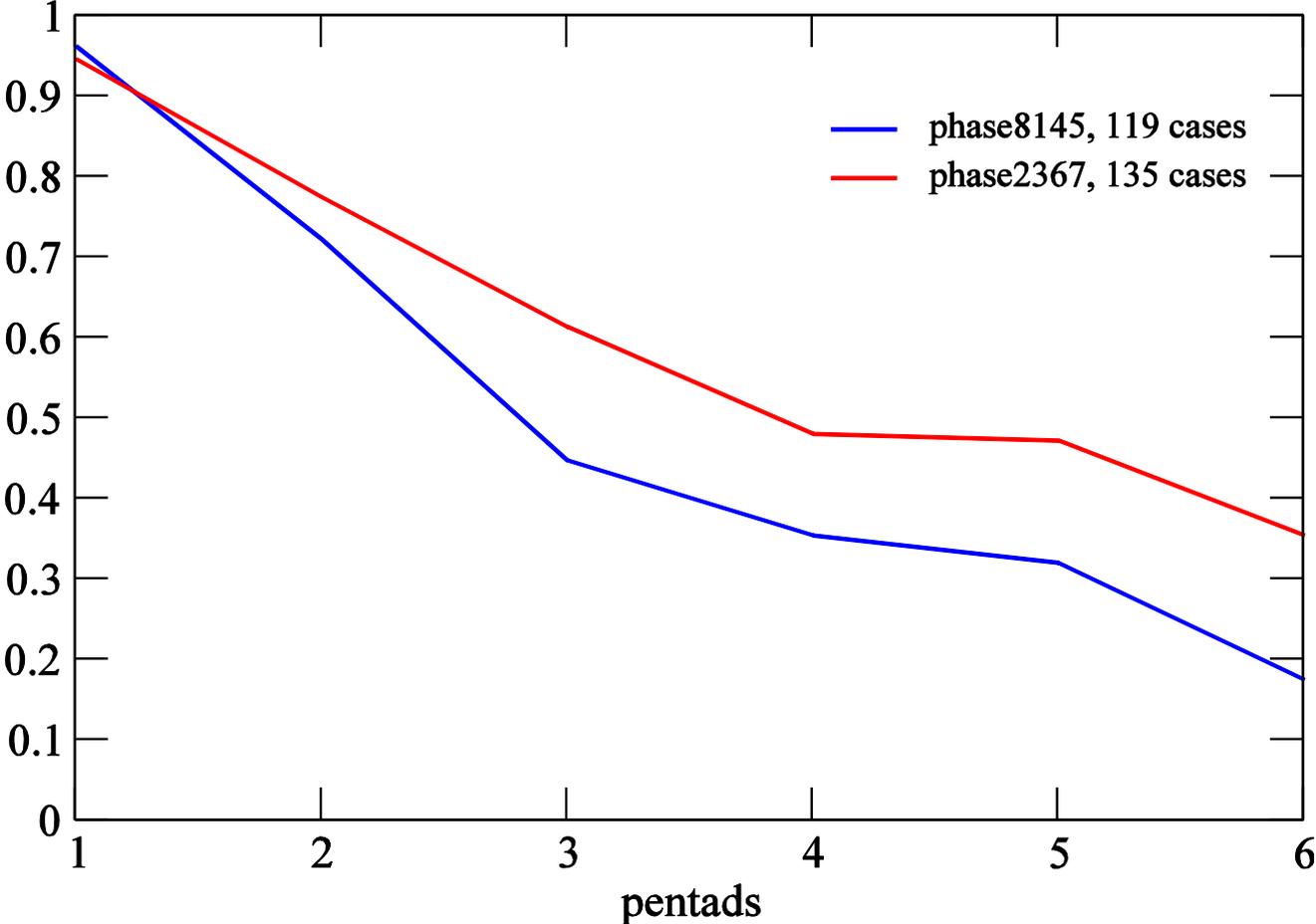
pentads

(Lin et al. GRL, 2010a)

Correlation skill: averaged for
pentads 3 and 4

a) weak MJO: T2m forecast skill

b) strong MJO: T2m forecast skill

c) difference
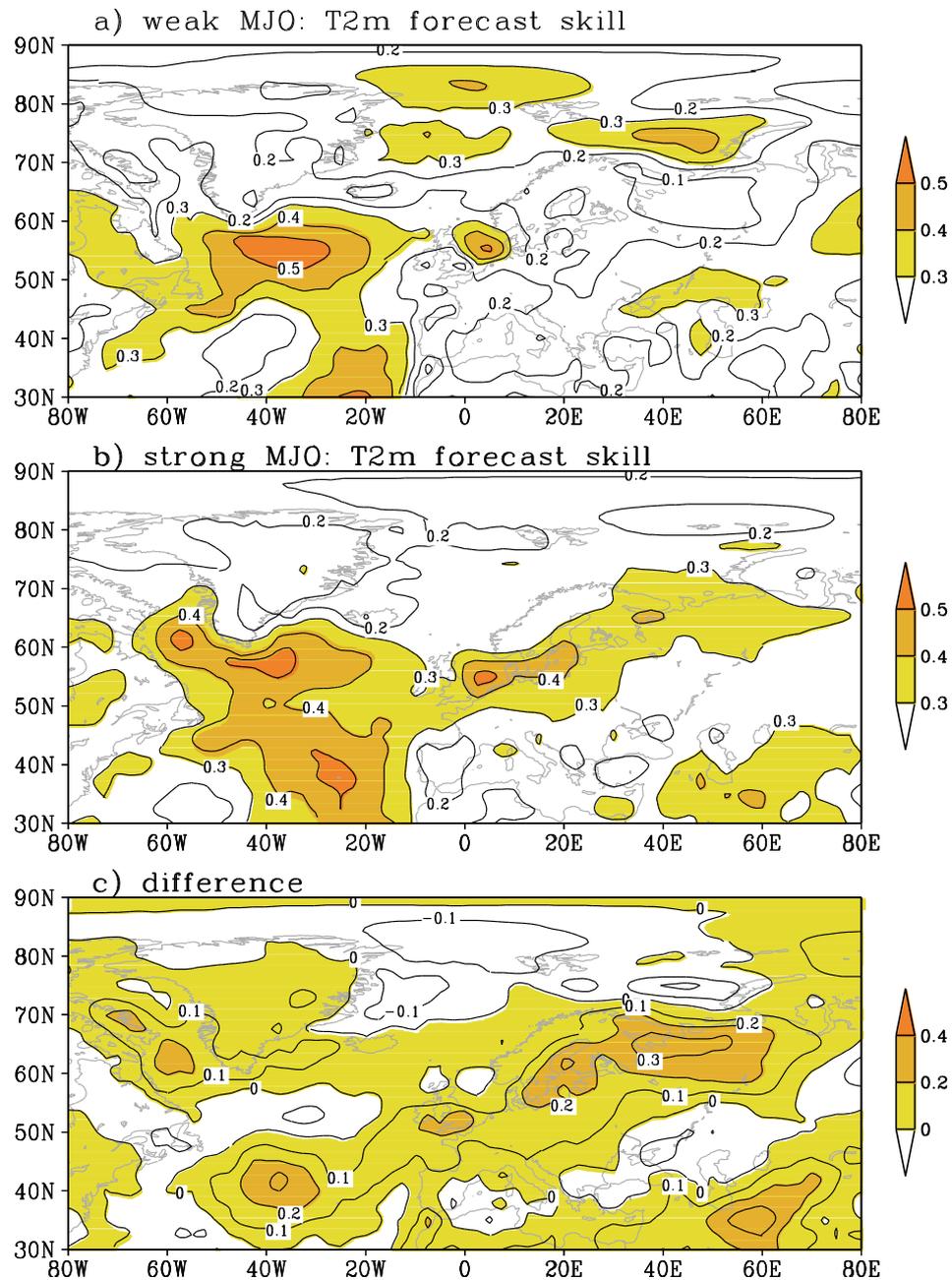
MJO forecast skill
---   impact of the NAO

Environment
Canada

Environnement
Canada

Canada

a) MJO forecast skill
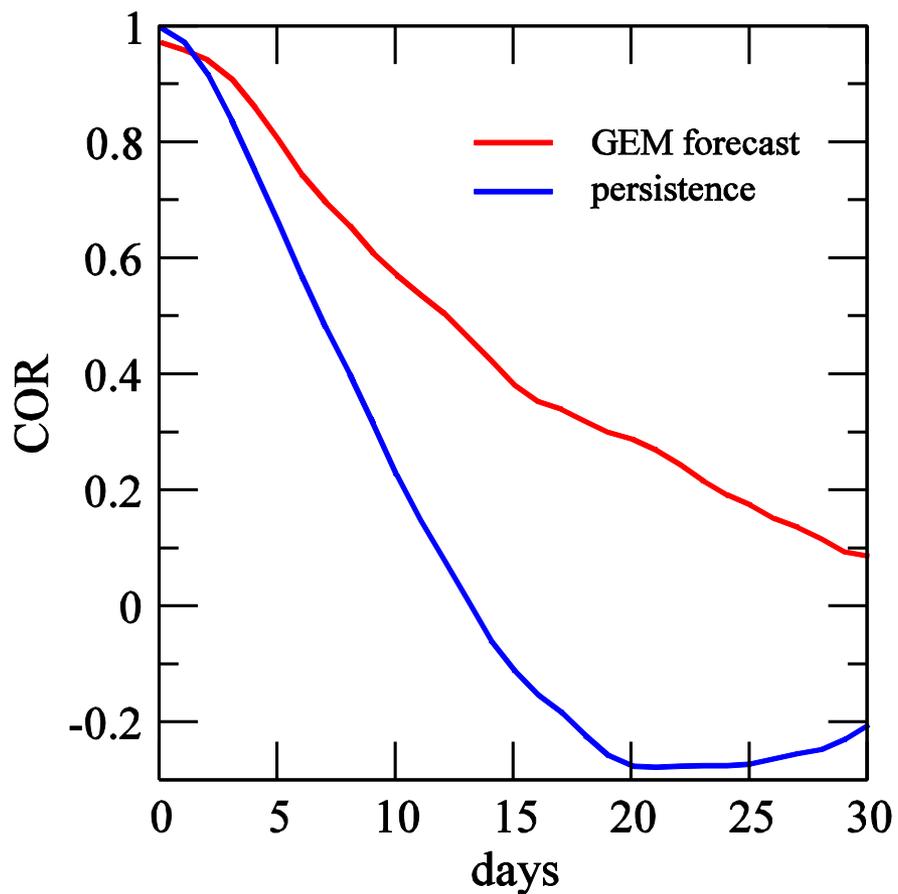
b) MJO skill by initial NAO amplitude

GEM forecast
persistence

weak NAO
strong NAO

(Lin et al. GRL, 2010b)

a) U200 skill strong NAO

b) U200 skill weak NAO
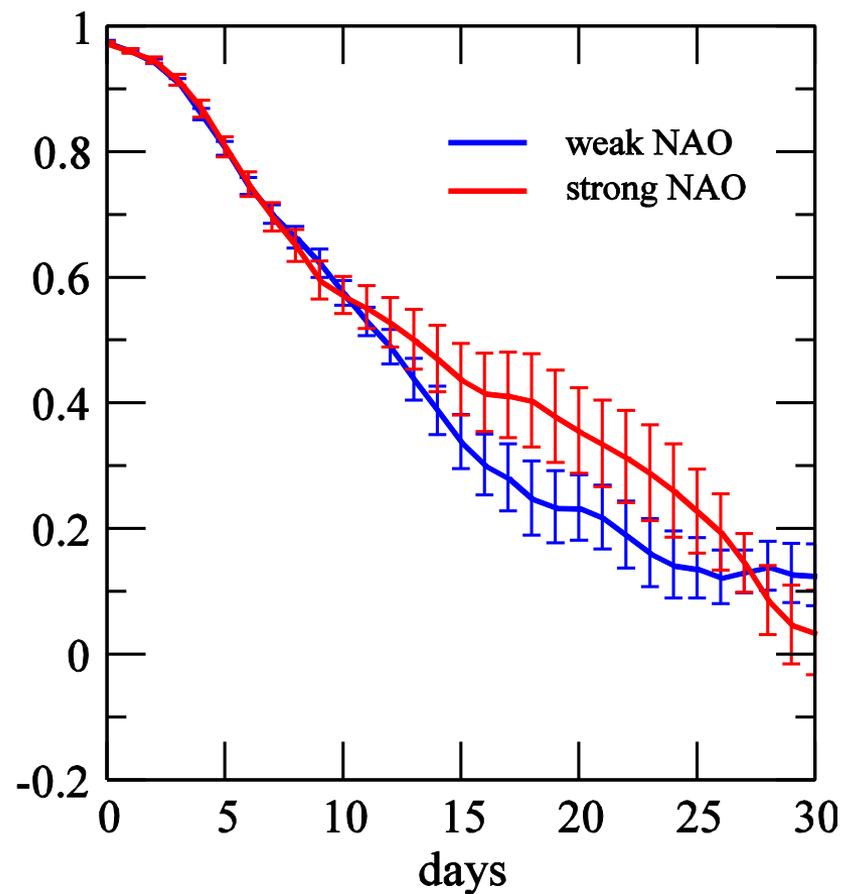
c) U200 skill strong−weak NAO
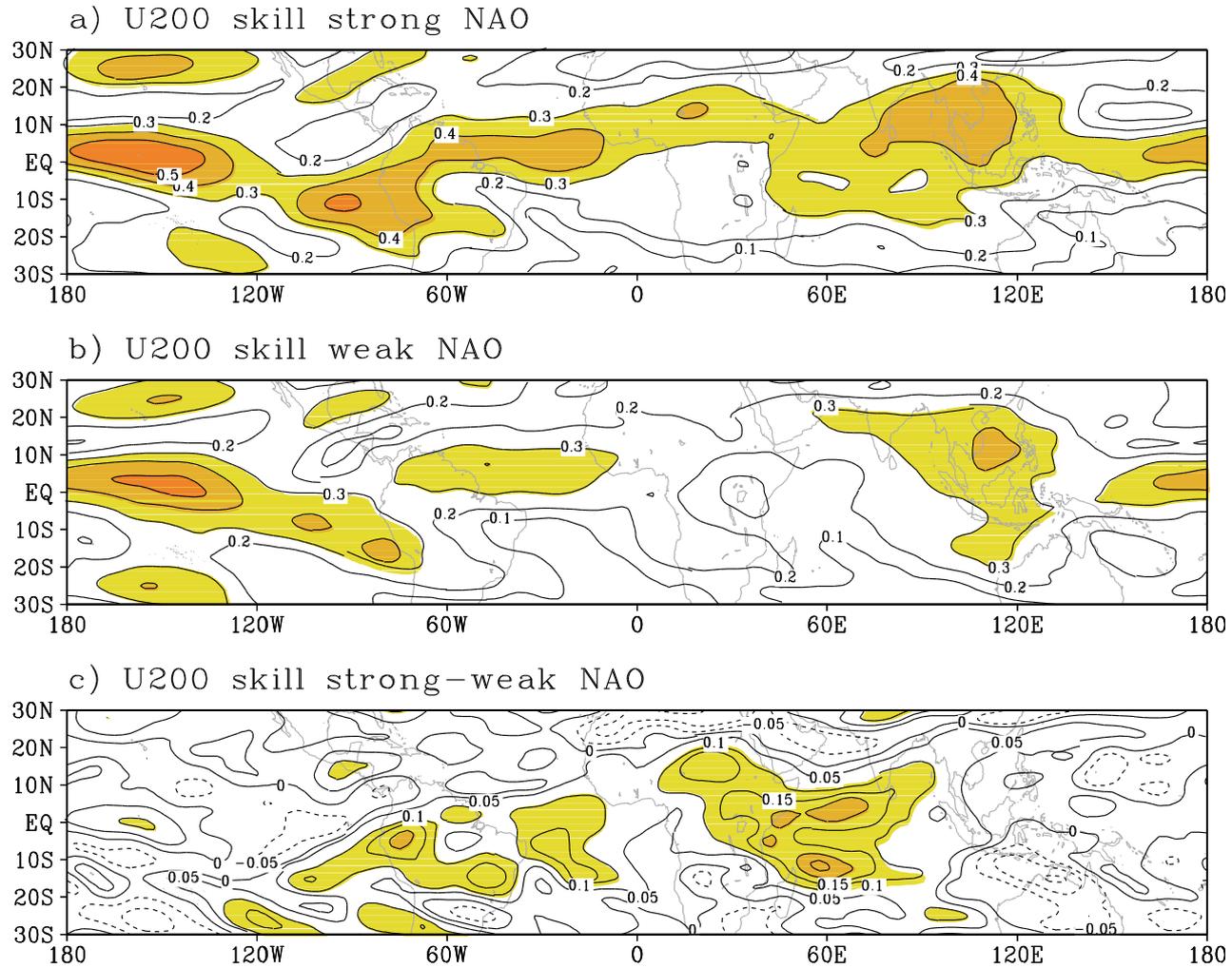
Skill averaged for days 15-25

a) U200 skill 0−90E
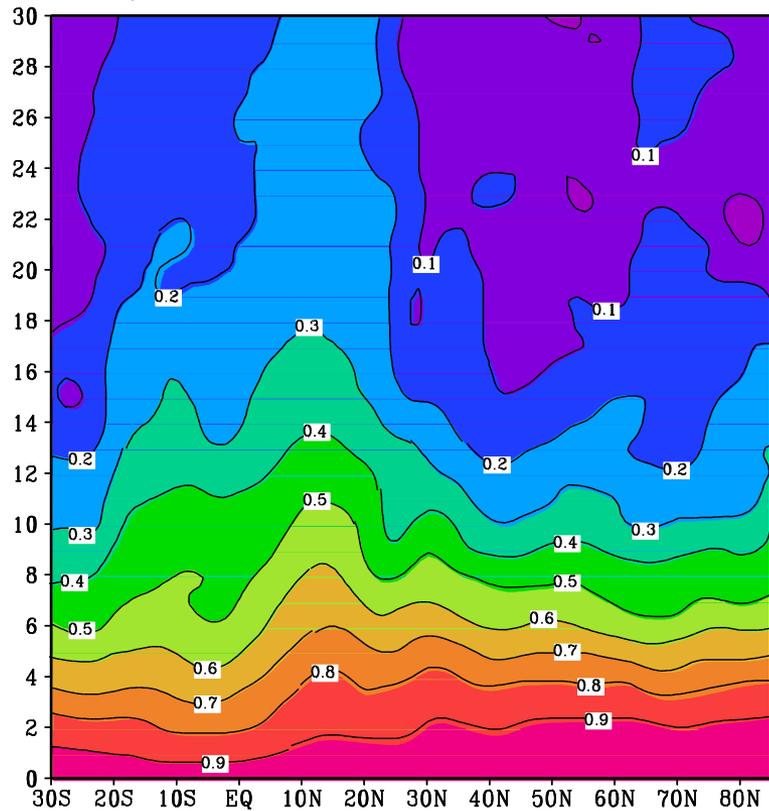
b) U200 skill strong−weak NAO

(Lin et al. GRL, 2010b)
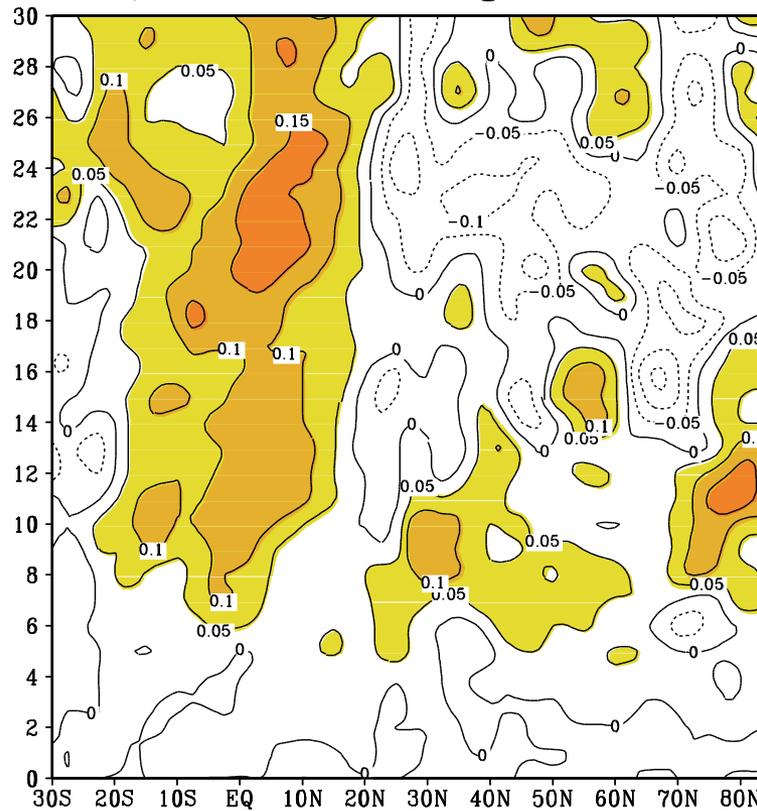
Summary

- Two-way interactions between the MJO and NAO
- Lagged association of North American SAT with MJO
- NAO intraseasonal forecast skill influenced by the MJO
- MJO forecast skill influenced by the NAO

Thank you!