MJO Research at Environment Canada

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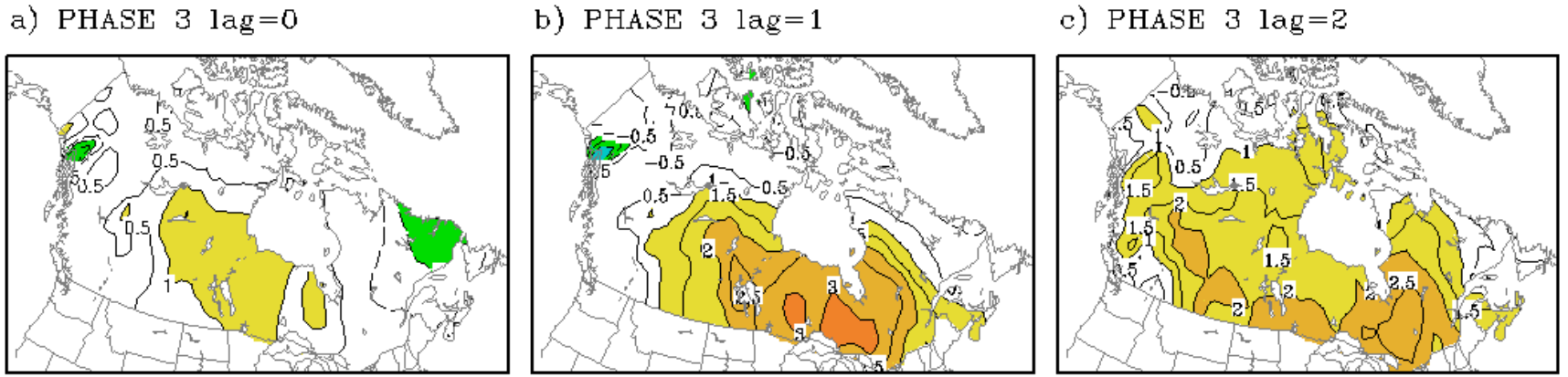
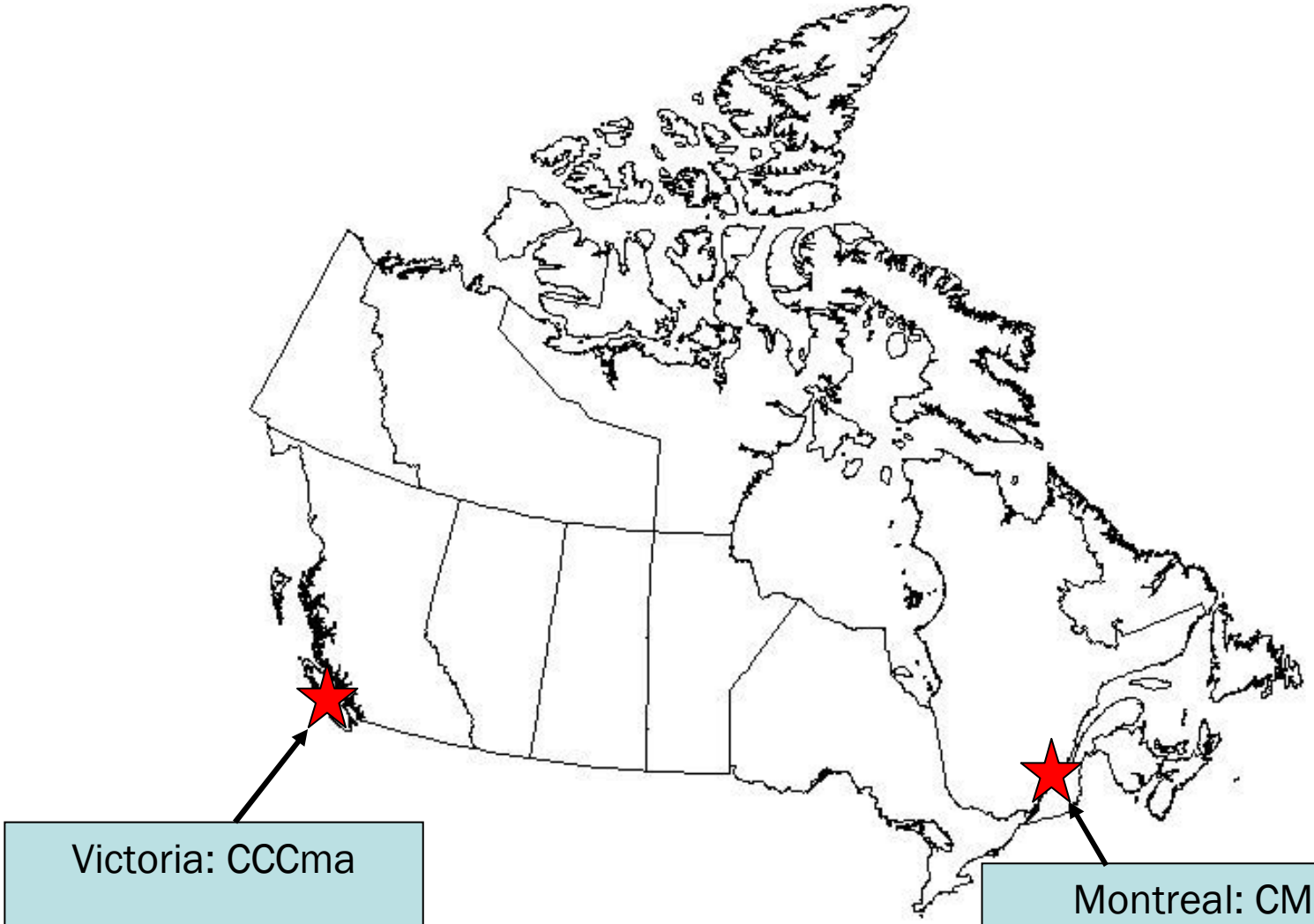
Why MJO in Canada?

Lagged winter SAT anomaly in Canada



Composites of pentad SAT data for 201 stations over Canada from 1979-2007
WH2004 defined MJO index



Victoria: CCCma

Climate research

Montreal: CMC & RPN

Operational &

Meteorological research

Environment Canada Environnement Canada

Canada

Canadian models

- CCCma: GCM2, GCM3, CGCM

  for climate modeling studies

- RPN: SEF, GEM, CGEM

  used by CMC for operational forecasts

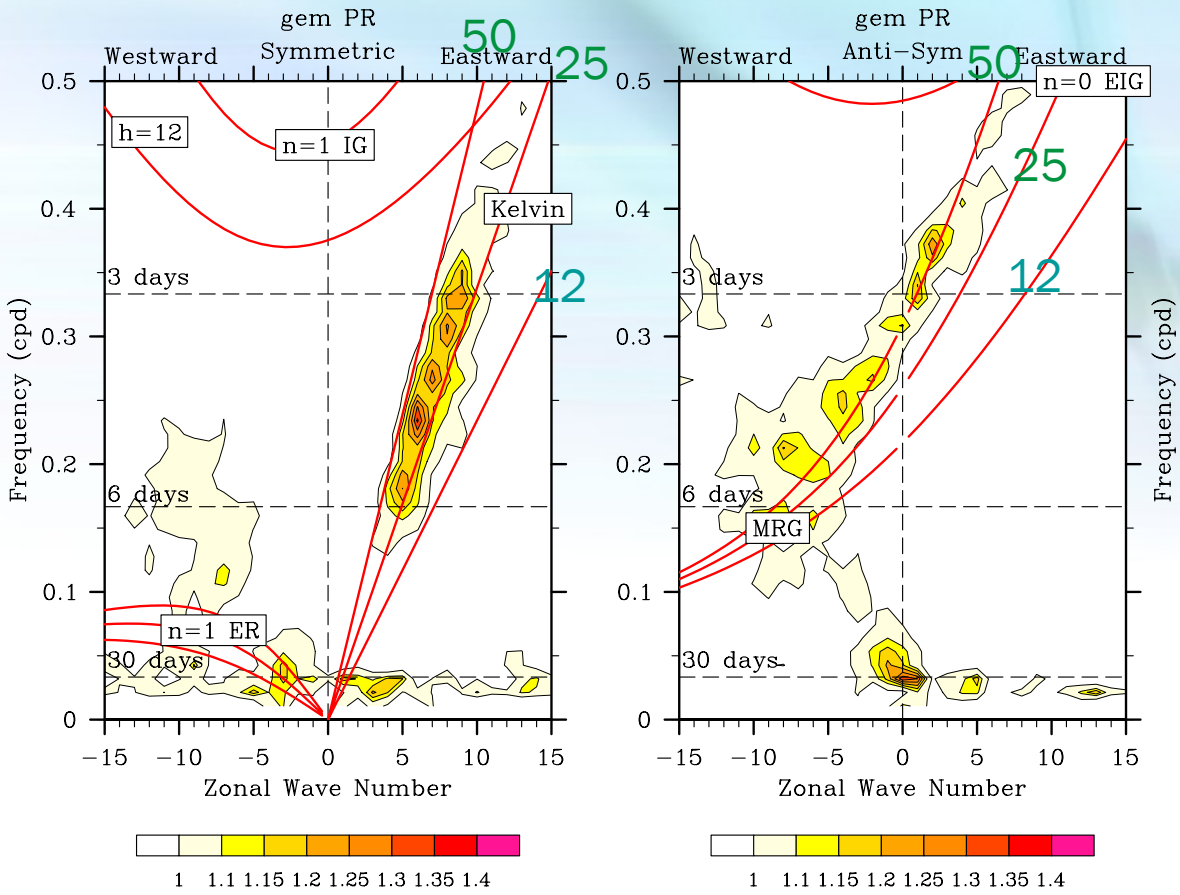
- Current seasonal forecast system (4 models)

  (two-tier seasonal forecast system)

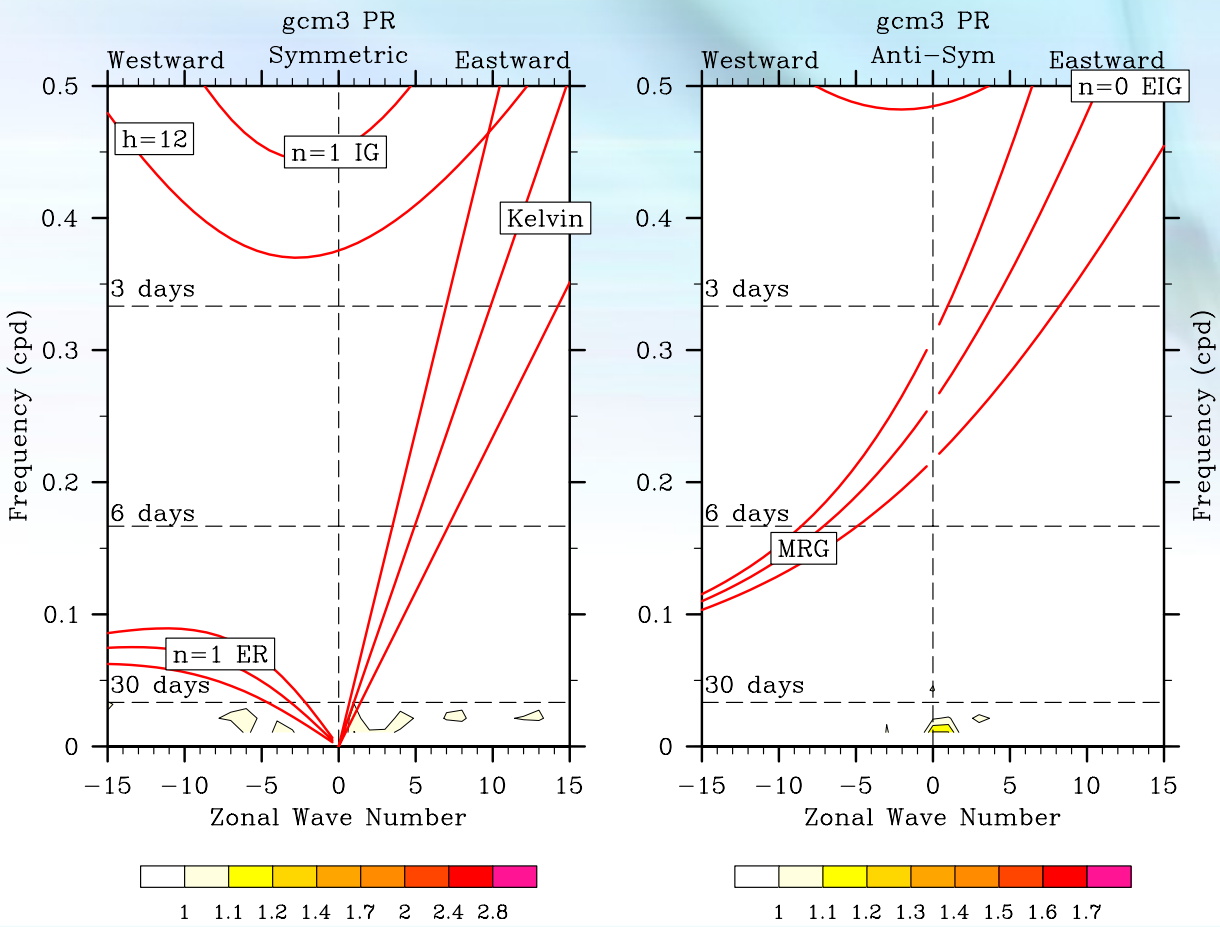
MJO forecast skill in GEM and GCM3

- HPF2 output of GEM and GCM3
  (Hindcast of seasonal forecast system)
- GEM: global 2°x2°, 50 levels
- GCM3: T63, 32 levels
- 4-month integrations, every month, 1969-2002
- Lin et al. (2008) - MWR

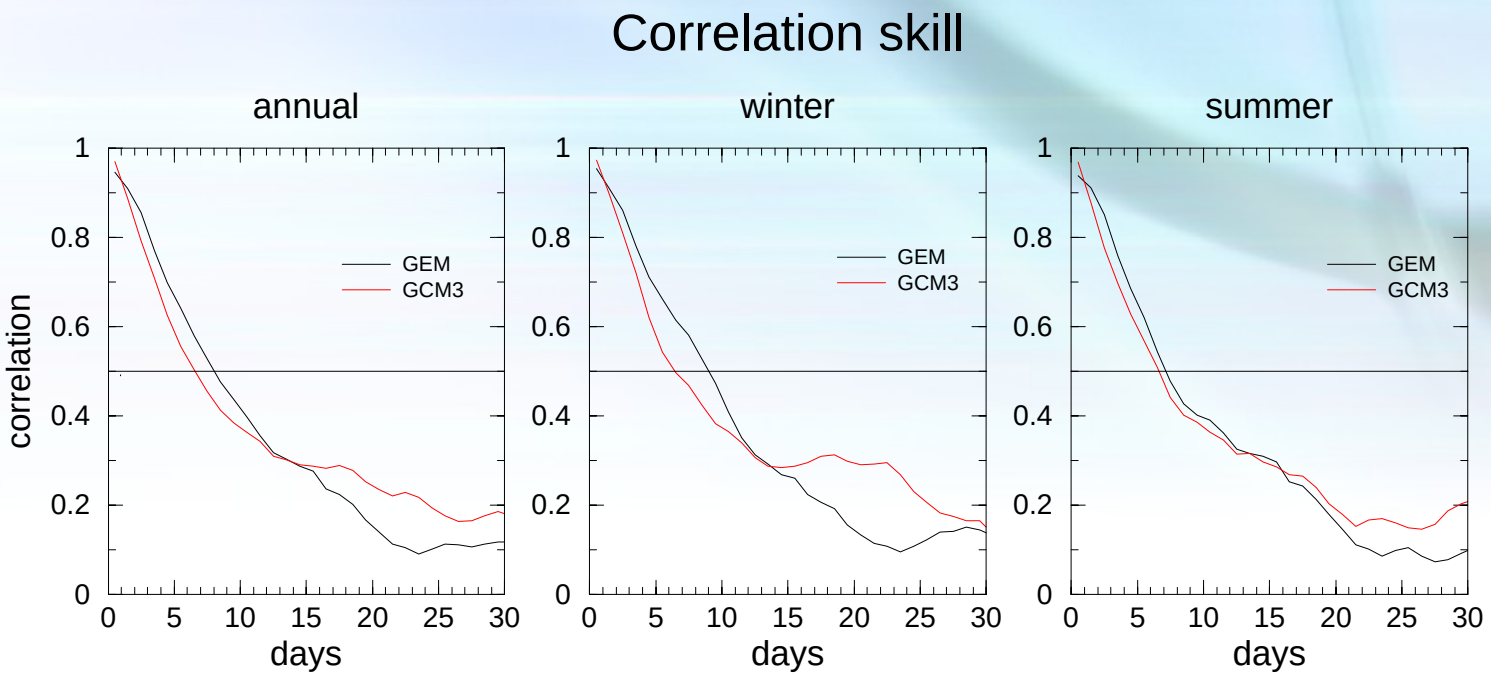
GEM


gem PR
Symmetric
Westward
Eastward
50
25
12
h=12
n=1 IG
Kelvin
3 days
6 days
n=1 ER
30 days
Frequency (cpd)
Zonal Wave Number
1 1.1 1.15 1.2 1.25 1.3 1.35 1.4
gem PR
Anti−Sym
Westward
Eastward
50
25
12
n=0 EIG
3 days
6 days
MRG
30 days
Frequency (cpd)
Zonal Wave Number
1 1.1 1.15 1.2 1.25 1.3 1.35 1.4

GCM3

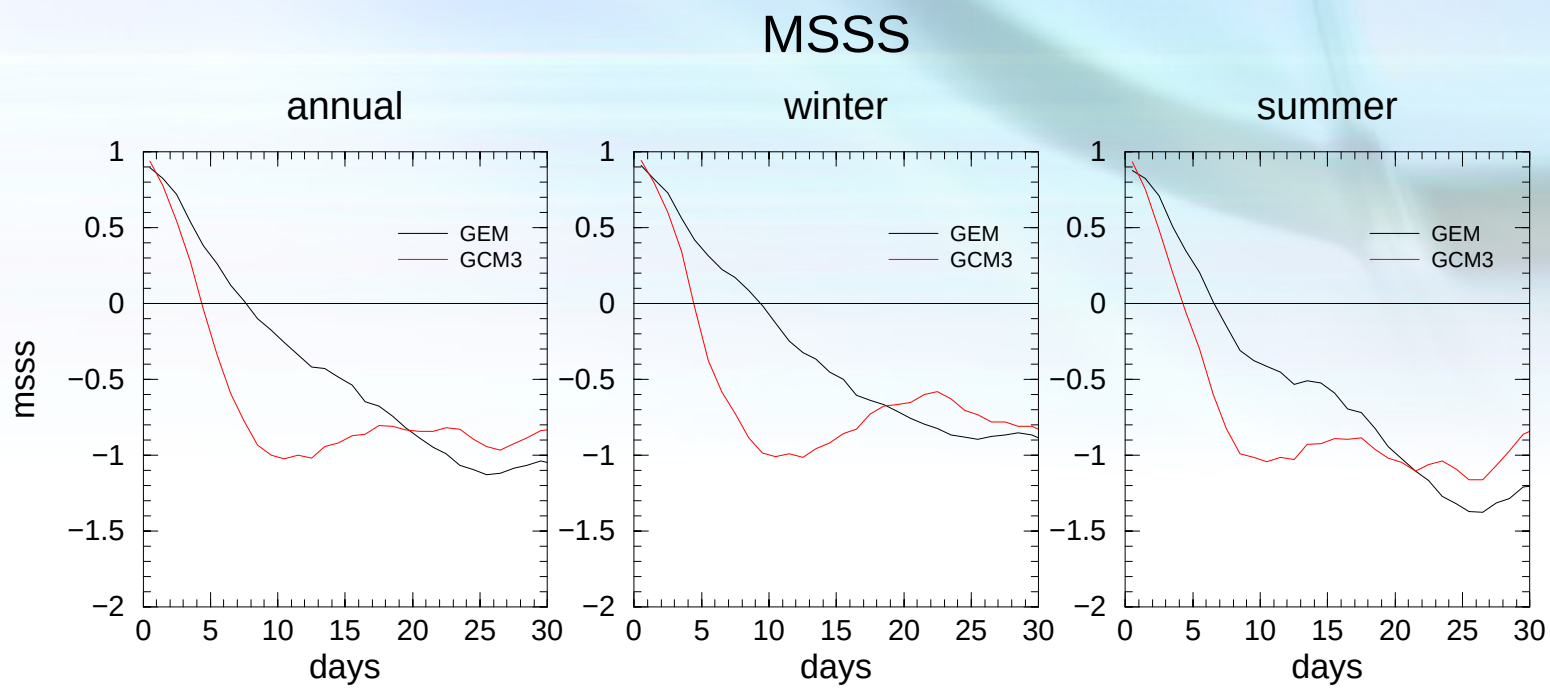

gcm3 PR
Symmetric
Westward
Eastward
h=12
n=1 IG
Kelvin
3 days
6 days
30 days
n=1 ER
Frequency (cpd)
Zonal Wave Number
1 1.1 1.2 1.4 1.7 2 2.4 2.8
gcm3 PR
Anti−Sym
Westward
Eastward
n=0 EIG
MRG
3 days
6 days
30 days
Frequency (cpd)
Zonal Wave Number
1 1.1 1.2 1.3 1.4 1.5 1.6 1.7

Forecast skill of MJO index

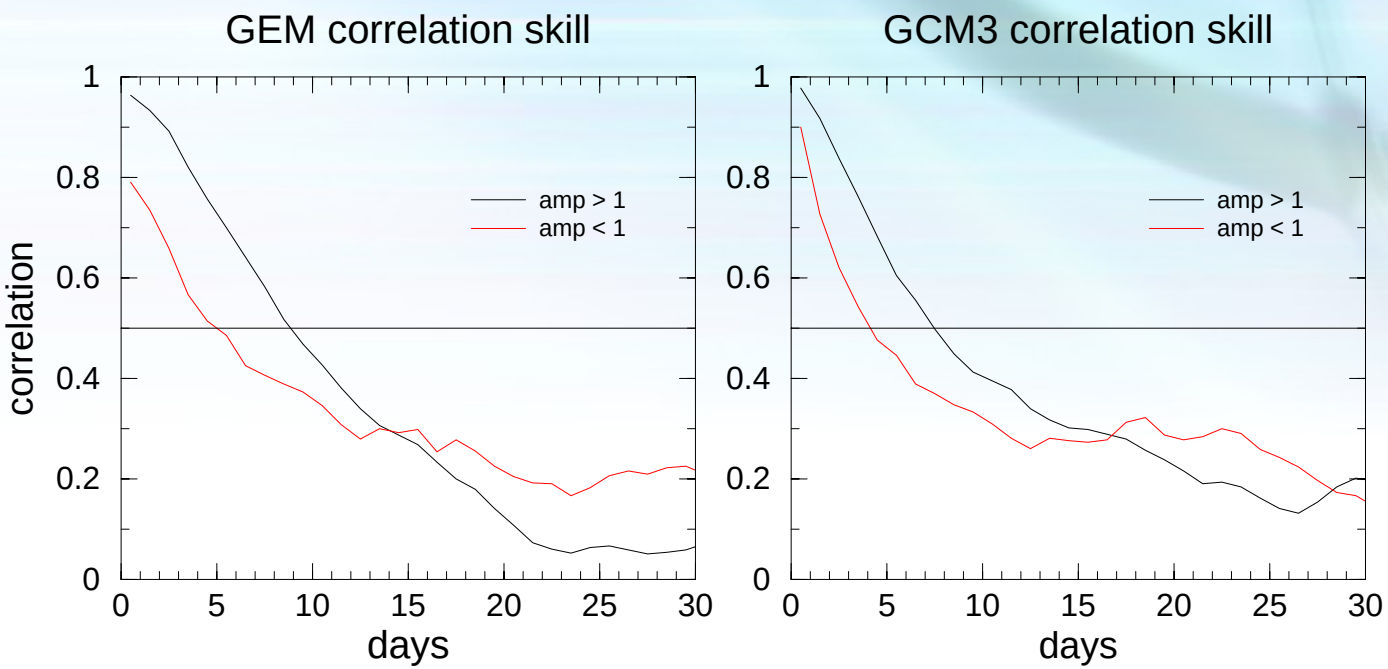


Forecast skill of MJO index

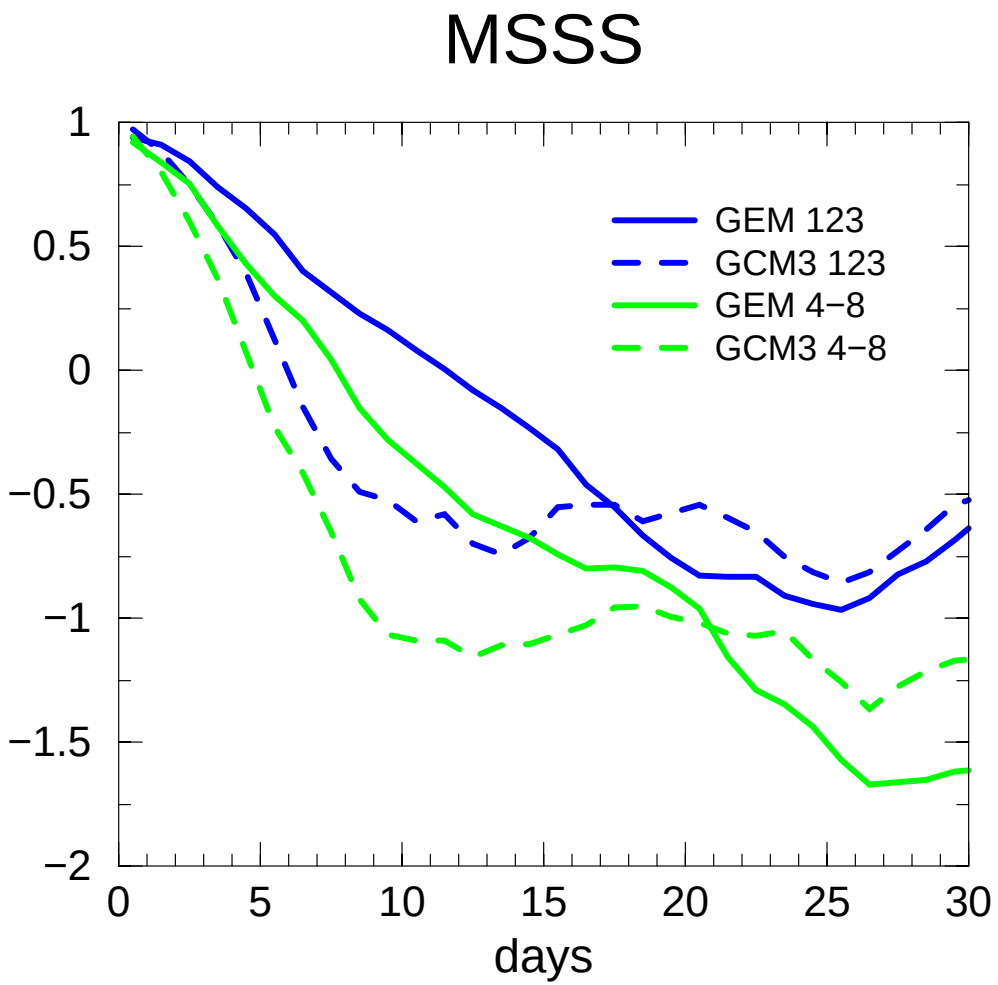
$$Msss = 1 - MSE_f / MSE_c$$



Forecast skill stratified by MJO amplitude



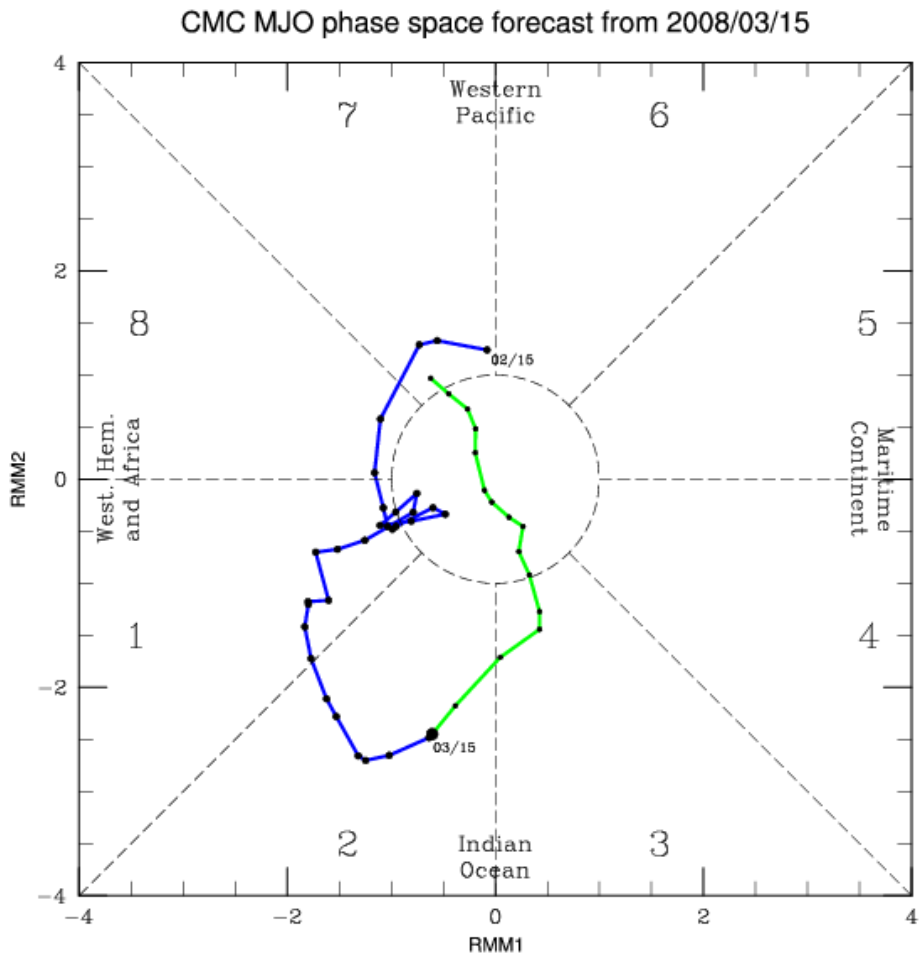
Forecast skill stratified by MJO phase



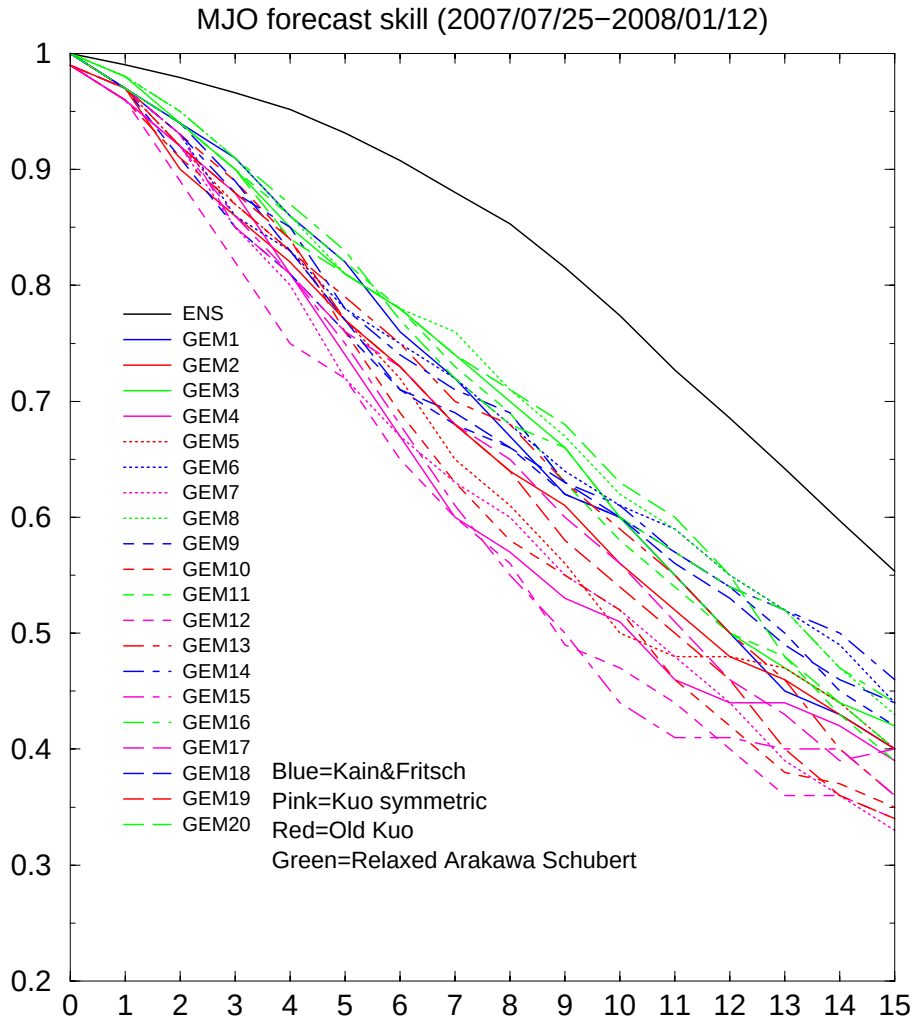
CMC ensemble prediction system

- GEM model 400x200x28 (0.9°)
- 20 members, Kalman filter
- Perturbed physics (4 different convection schemes)
- 16 day integration

CMC ensemble prediction system



CMC ensemble prediction system



Tropical-extratropical interaction

- MJO and the NAO – observational study

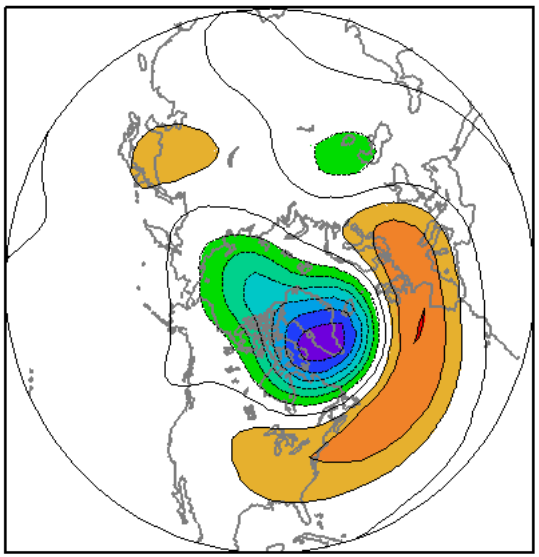
  Lin et al (2008)- JCLI

- ISO in a dry GCM

  Lin et al. (2007) - JAS

The North Atlantic Oscillation

Definition of the NAO: 2nd REOF of monthly Z500



NAO index: projection of pentad Z500 anomaly onto this pattern

Period: 1979-2003

Extended winter, November to April (36 pentads)

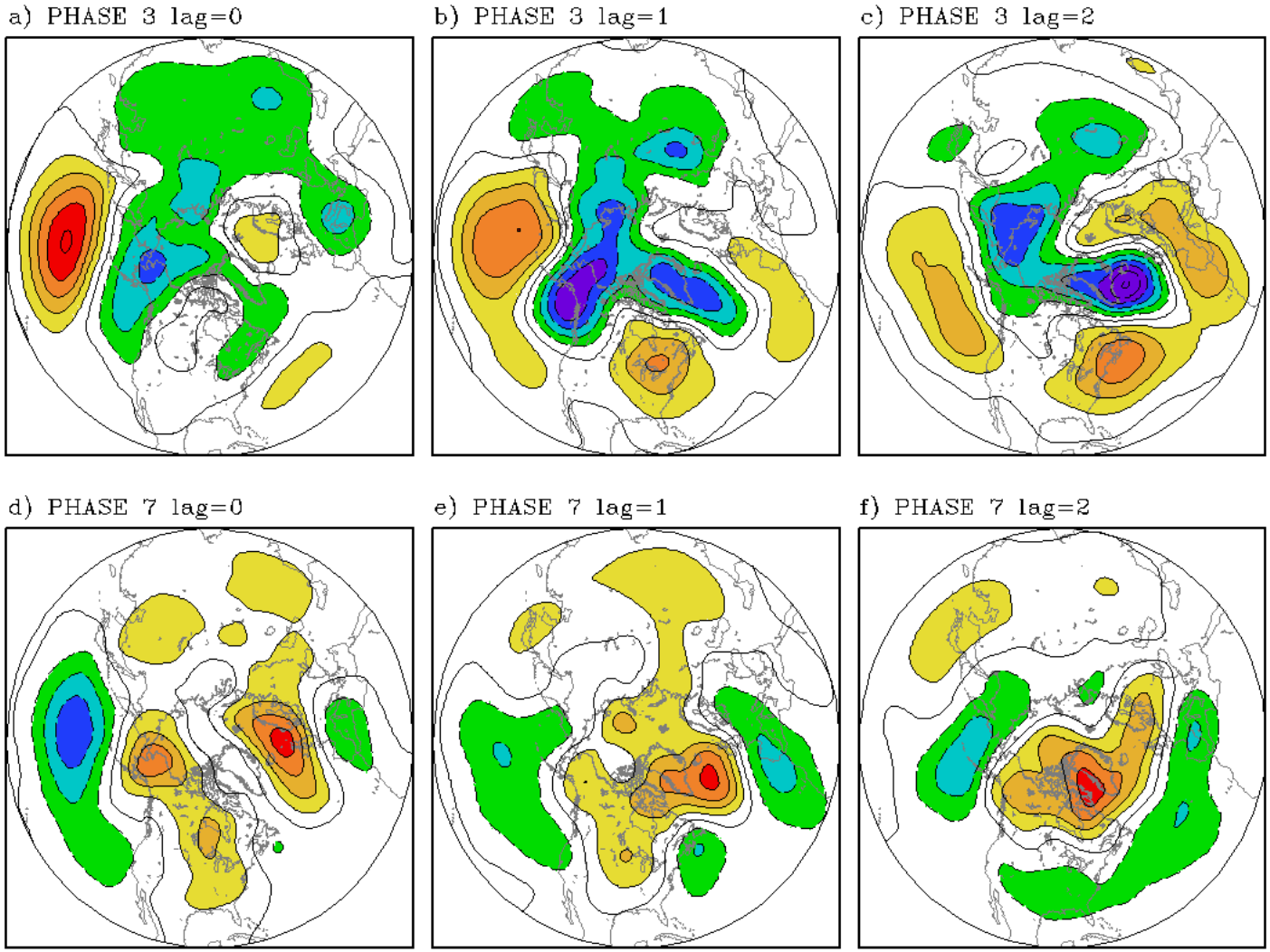
Lagged composites of the NAO index in different MJO Phases

Phase	1	2	3	4	5	6	7	8
Lag −5			−0.39				0.28	
Lag −4		−0.26				0.28		
Lag −3		−0.29						
Lag −2						0.26		
Lag −1								
Lag 0								−0.41
Lag +1		0.26	0.27	0.26			−0.25	−0.35
Lag +2		0.34	0.36			−0.31	−0.33	−0.29
Lag +3		0.35				−0.35	−0.41	
Lag +4						−0.35	−0.31	
Lag +5				−0.27				

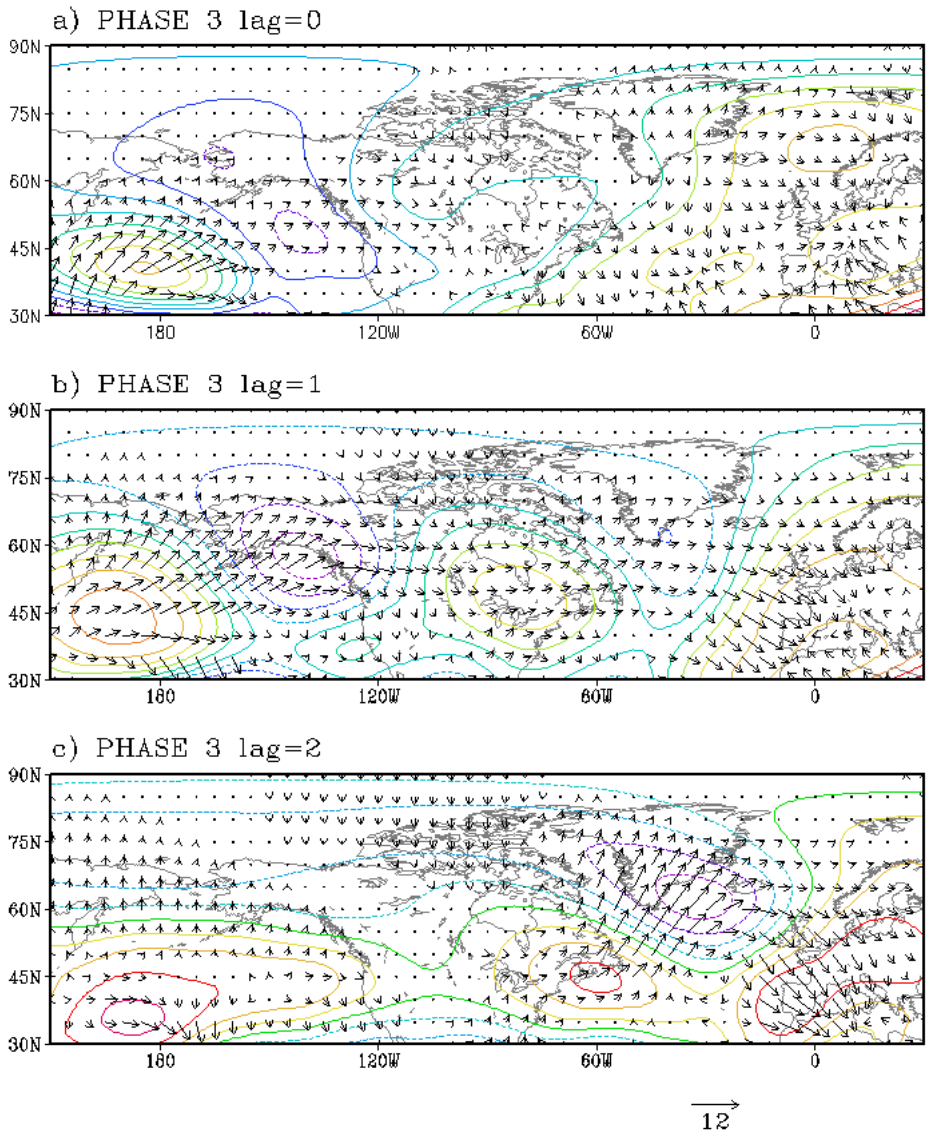
Numbers are significant at 0.05 level
Signal about 35% of NAO standard deviation

Tropical influence

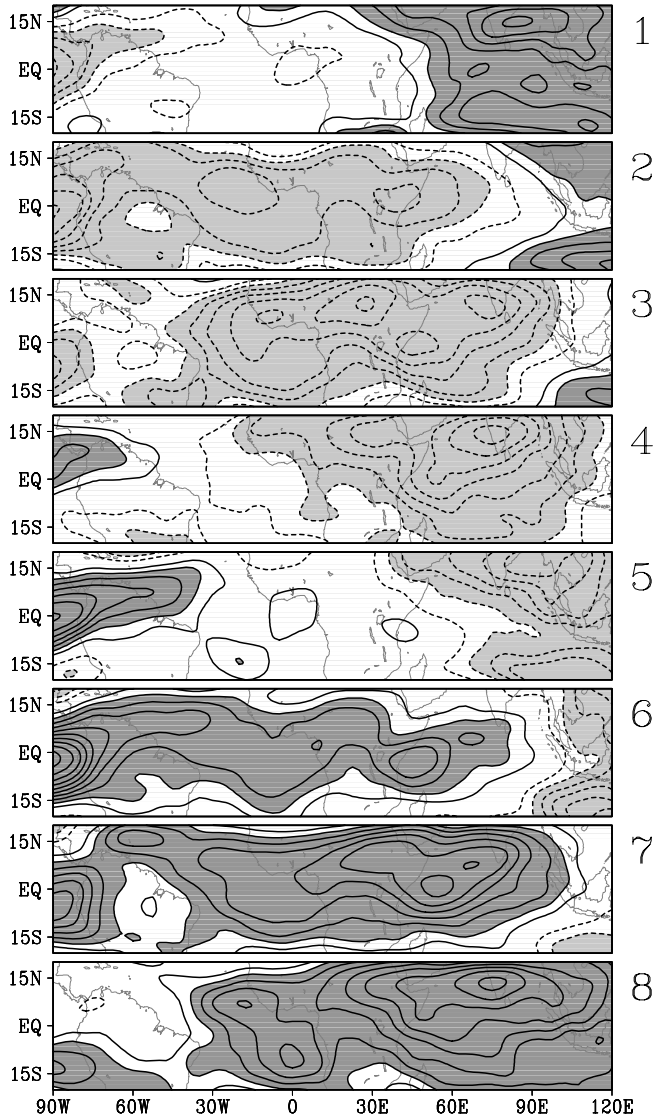
Z500 composites



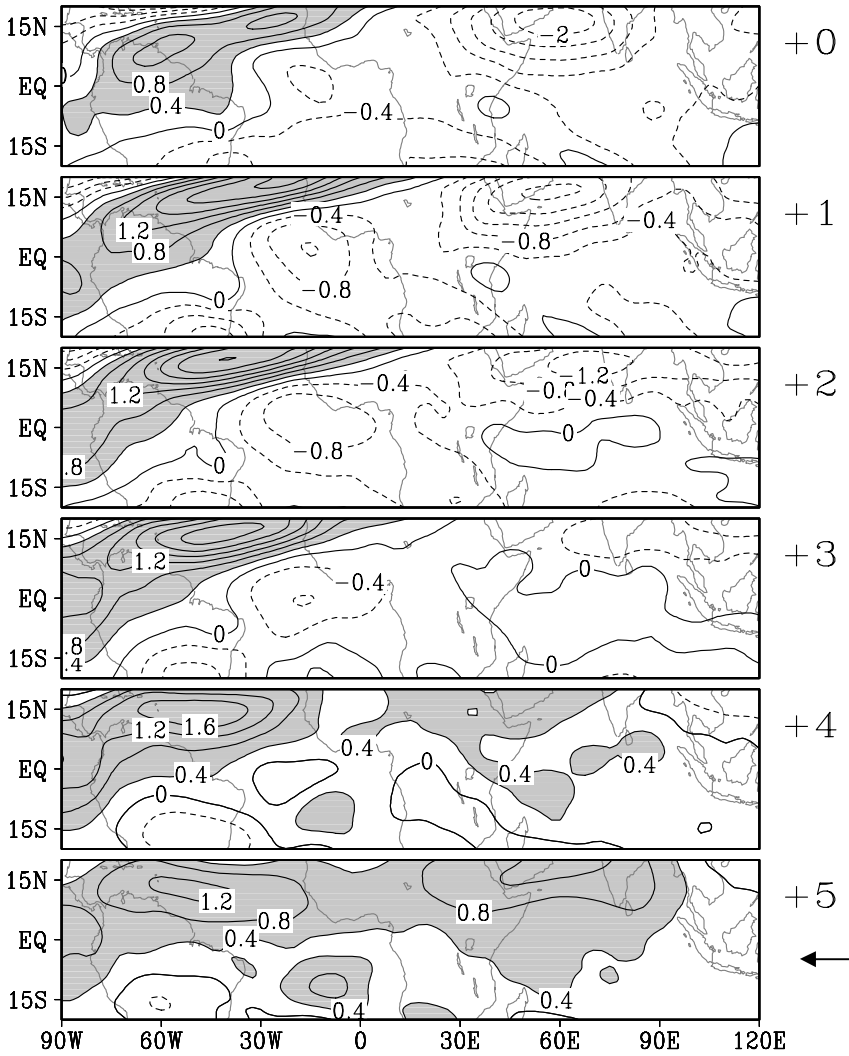
Wave activity flux and 200mb streamfunction anomaly



200mb U composite in different MJO Phases



Extratropical influence



← Similar to MJO Phases 6-7

Lagged regression of 200mb U to NAO index

MJO and NAO

- Increase of NAO amplitude 10~15 days after the MJO-related convection anomaly reaches western Pacific
- The development of NAO is associated with a Rossby wave train
- A strong NAO is followed by a change of tropical Atlantic upper zonal wind, which could trigger a tropical ISO.

ISO in a dry model

- Primitive equation AGCM (Hall 2000) – similar approach for forcing as the Marshall-Molteni model, but not Q-G.
- T31, 10 levels
- Time-independent forcing to maintain the winter climate (1969/70-98/99) → all variability come from internal dynamics
- No moisture equation, no interactive convection
- 3660 days of integration

Model Result

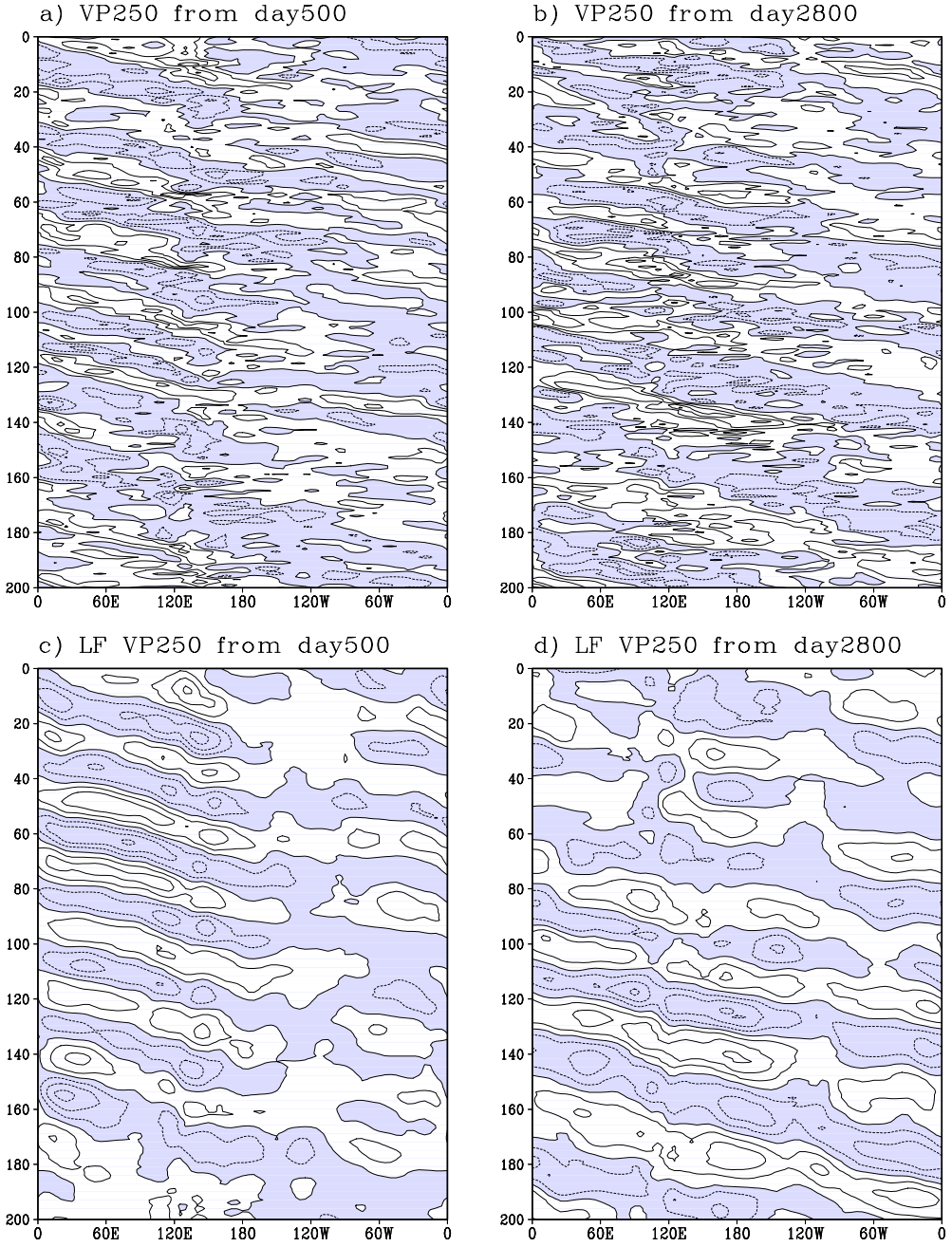
Zonal propagation

10S-10N

Unfiltered data

20-100 day band-pass

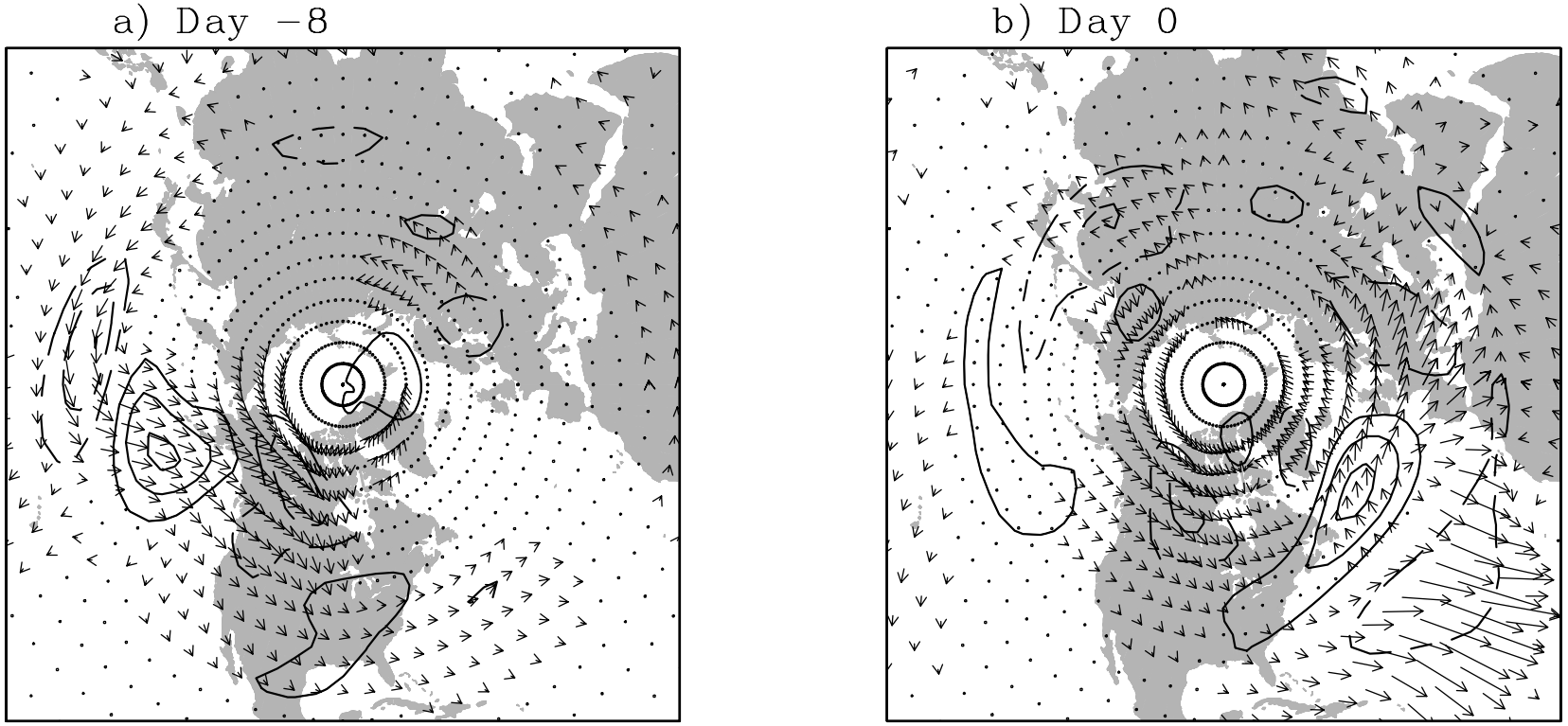
Stronger in eastern Hemisphere



ISO in a dry model

Global view

250 hPa PV' and wave activity flux



Linked to tropical eastward propagation in the eastern Hemisphere → Global propagation of low-frequency wave activity

ISO in a dry model

- Significant ISO generated in a dry GCM
- Tropics-extratropics interactions are likely responsible for generating the model tropical ISO
- A possible mechanism for the MJO

GOAPP research network

- Global Ocean-Atmosphere Prediction and Predictability (a five year project)
- Brings together ocean and atmospheric researchers from across Canada to improve forecasts of the ocean and atmosphere on time scales from days to decades and spatial scales of tens to tens of thousands of kms
- Development of CGCM and CGEM
- Enhanced ocean and coupled atmosphere-ocean modelling and data assimilation capabilities
- Includes improving understanding and representation of the MJO in coupled models
- Leads to next generation of seasonal and monthly forecast system in Canada

www.ec.gc.ca

Thank you!

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Canada