Detection of Kamchatka blocking and its winter circulation pattern

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Kamchatka blocking in newspaper

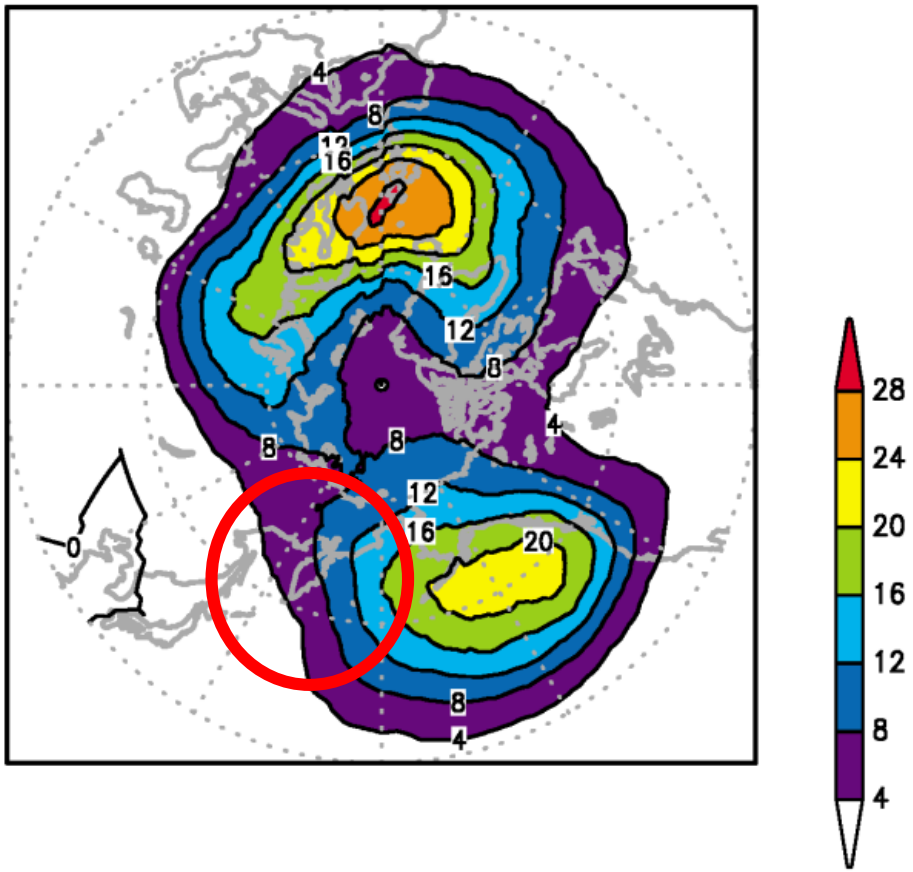
Cold weather in April, Why?

서울 지역 기온 변화 예상 단위:도 최저—0/0—최고 자료:기상청

10일(수)	11(목)	12(금)	13(토)	14(일)	15(월)	16(화)	4월 중순 평년기온
1/9	2/10	2/12	5/18	8/17	4/10	2/10	7.8/18

But, Kamchatka is not a central location of blocking activity

[JRA55] 1991-2006



Blocking frequency for winter obtained by hybrid blocking detection algorithm based on Dunn-Siguouin et al. (2013)

Forecaster vs. Meteorologist

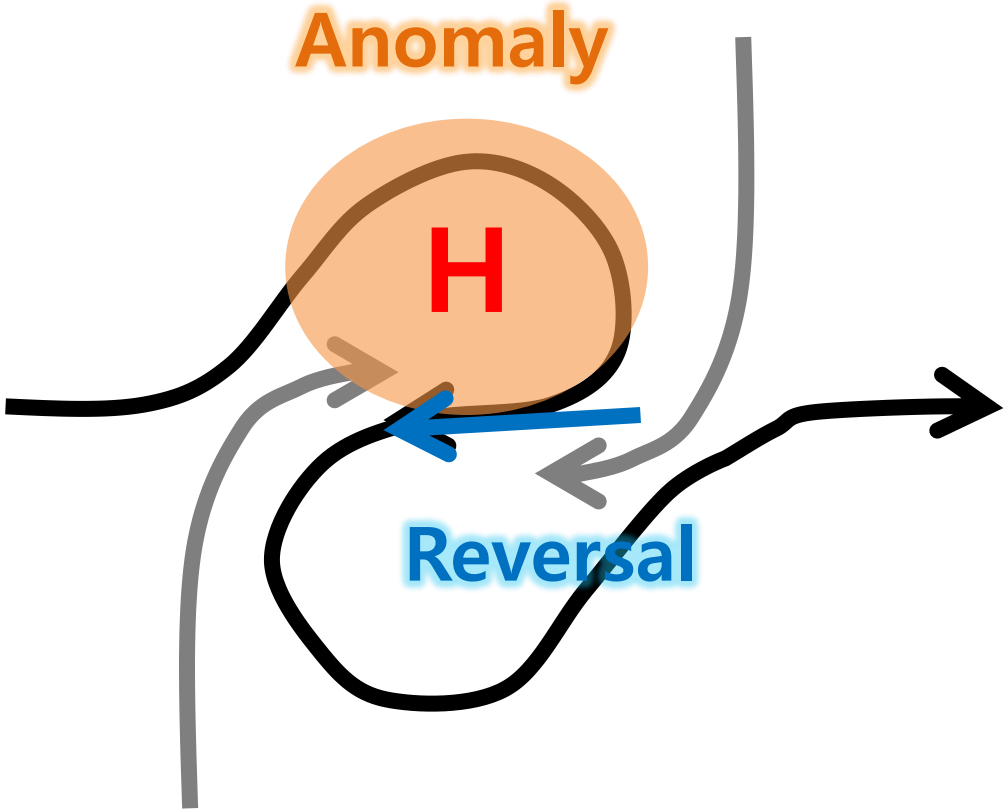
Kamchatka Blocking, is it real?

Definition of Blocking

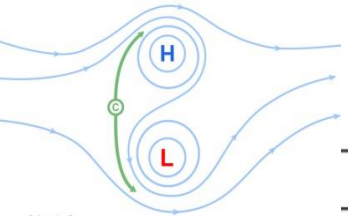
Normal

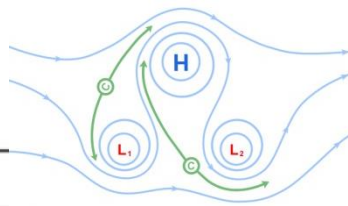
Block

Quasi-stationary high-pressure system that interrupts the eastward propagation of synoptic disturbances by reversing the zonal flow.



Detection algorithms (History)





Absolute fields

Departure fields

Weather types

Flow reversal

Anomaly

Eddies

Subjective

Objective

Rex 1950a
Austin 1980
Treidl et al. 1981
Knox & Hay 1984

Lupo & Smith 1995
Wiedenmann et al 2002

Vautard 1990
Michelangeli et al. 1995
Verdecchia et al. 1996

Lejenäs & Økland 1983
Tibaldi & Molteni 1990

Elliot & Smith 1949
Charney et al. 1981
Liu 1994

Hartmann & Ghan 1980
Mullen 1986

Barriopedro et al. 2006
Diao et al. 2006

Dole & Gordon 1983
Shukla & Mo 1983
Knox and Hay 1985
Sausen et al. 1995

Mullen 1989
Kaas & Branstator 1993
Cash & Lee 2000

Pelly and Hoskins 2003

Schwierz et al. 2004

Barriopedro et al 2010

Dunn-siguoin et al 2013

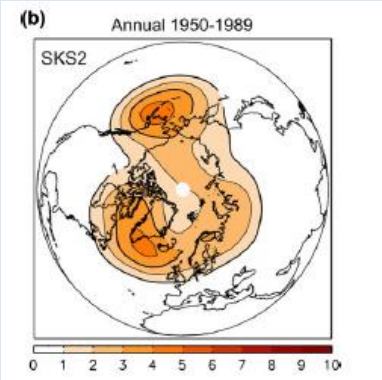
Davini et al. 2012

Masato et al. 2013

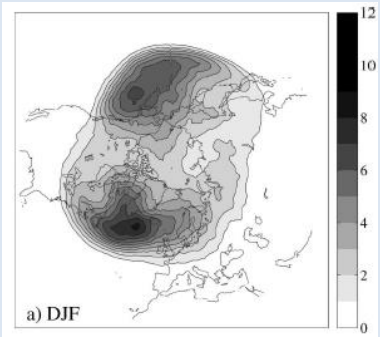
Different blocking identifications
produce different climatology distributions

Anomaly method

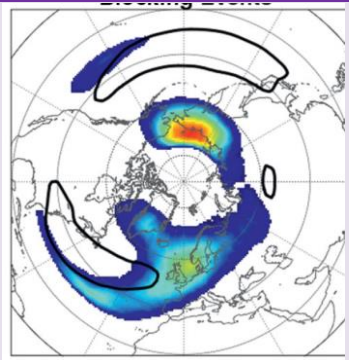
SKS et al 1995
Z500 anomalies
NCEP annual
1950-1989



Croci-Maspoli et al 2007
Negative PV anomalies
ERA40 DJF
1957-2002

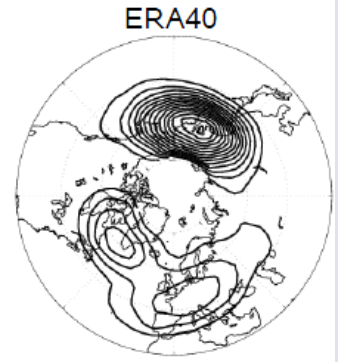


Reversal method



Local reversal index

Davini et al 2012
dZ500/dy
NCEP DJF
1951-2010

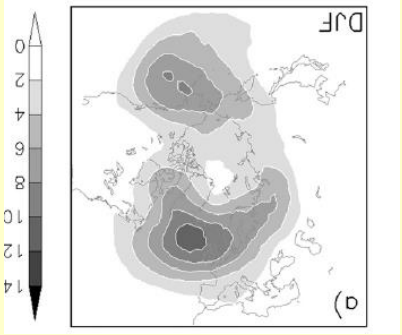


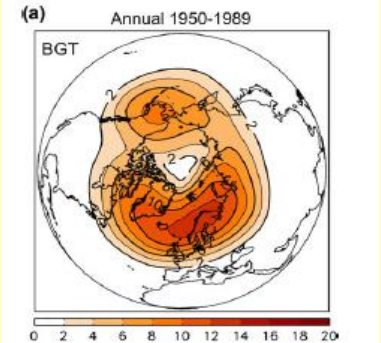
Large-scale reversal index

Masato et al 2013
~Pelly & Hoskins 2003
dΘ/dy at 2pvu
ERA40 DJF
1958-2001
CI 0.05%

Hybrid method

Dunn-siguon et al 2013
SKS+TM
NCEP DJF
1960-2010





Barriopedro et al 2010
TM+SKS
NCEP annual
1950-1989

Reversal method

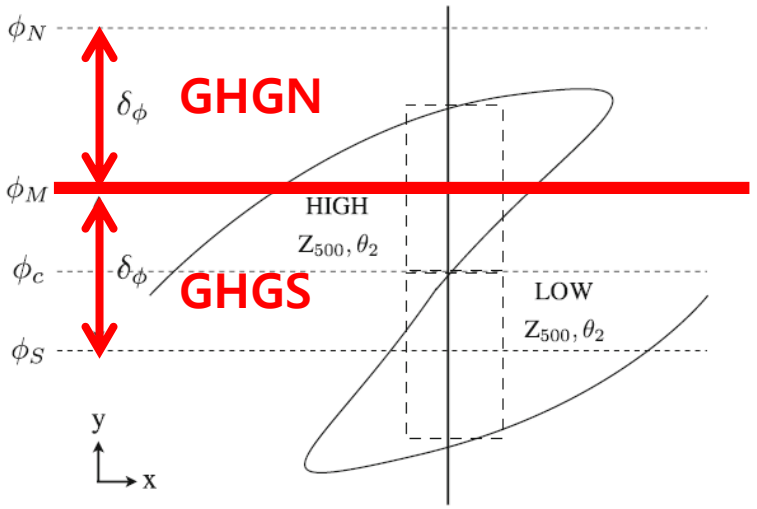
1D

Local Reversal Index

Tibaldi & Molteni 1990 (Z, ϕ_M fixed at 50N)

$$\mathrm{GHGS} = \frac{\Delta Z(\phi_M, \phi_S)}{(\phi_M - \phi_S)} = \frac{Z(\phi_M) - Z(\phi_S)}{(\phi_M - \phi_S)},$$

$$\mathrm{GHGN} = \frac{\Delta Z(\phi_N, \phi_M)}{(\phi_N - \phi_M)} = \frac{Z(\phi_N) - Z(\phi_M)}{(\phi_N - \phi_M)},$$



2D

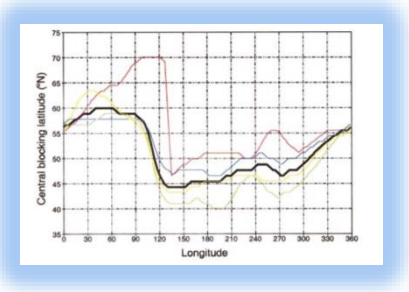
≈ Davini et al 2012 (Z, ϕ_M varies 30~75N)

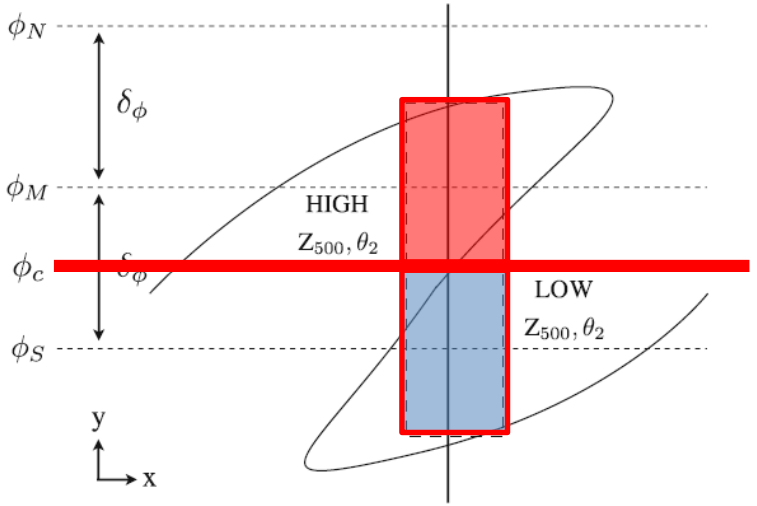
1D

Large-scale Reversal Index

Pelly & Hoskins 2003 (θ, ϕ_c is max of TEKE)

$$\beta = \frac{1}{\delta_\phi} \int_{\phi_c}^{\phi_c + \delta_\phi} \theta \, d\phi - \frac{1}{\delta_\phi} \int_{\phi_c - \delta_\phi}^{\phi_c} \theta \, d\phi,$$





2D

≈ Masato et al 2013 (θ, ϕ_c varies 40~70N)

Methods

- **Data**

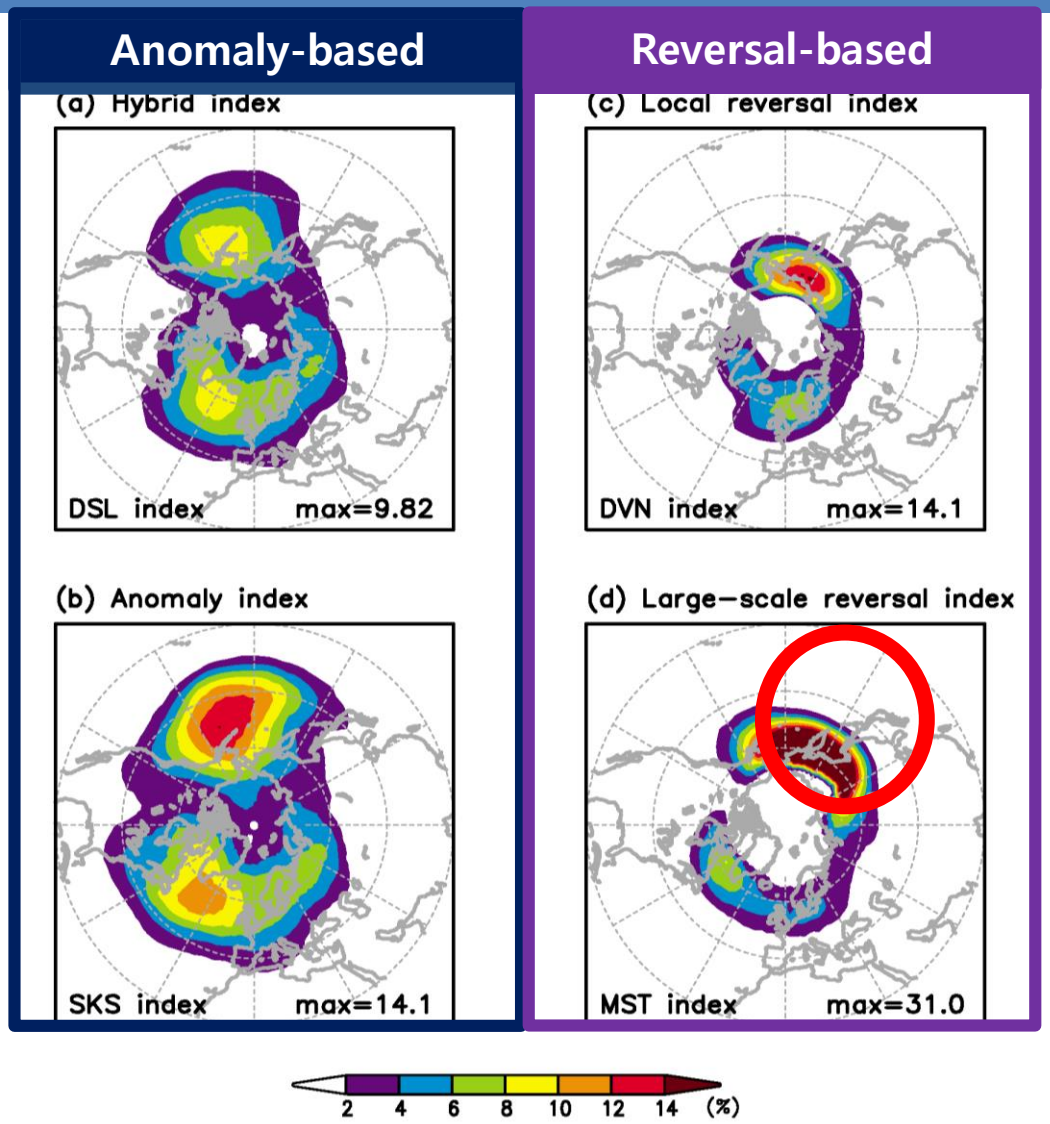
  NCEP Reanalysis Z500 daily data (DJF, 1950~1989)

- **Blocking Indices**
  - Hybrid index (Dunn-sigouin et al, 2013)
  - Anomaly index (Sausen et al, 1995)
  - Local reversal index (Davini et al, 2012)
  - Large-scale reversal index (Masato et al, 2013)

- **Common thresholds for Blocking detection**

- O(Overlapping)=50%, S(Min. Area)=2.5*$10^6$$km^2$, D(Duration)=5day

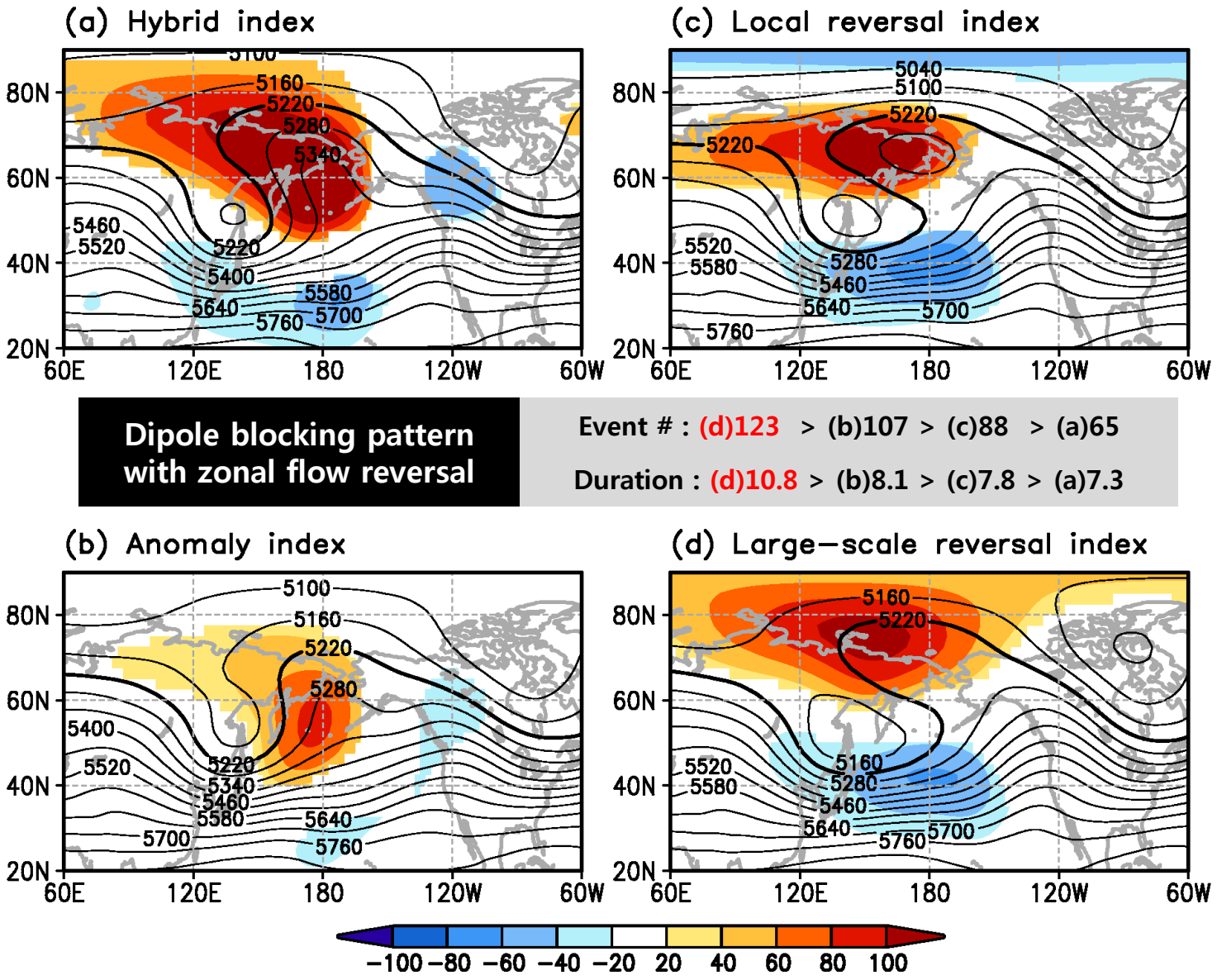
Blocking Frequency Climatology



Event # : (b)410 > (a)274 > (d)206 > (c)185

Duration : (d)8.8 > (b)8.4 > (a)8.0 > (c)7.3

Z500 (contour), Z500 anomaly (shading) composite during Kamchatka blocking [120E-180]

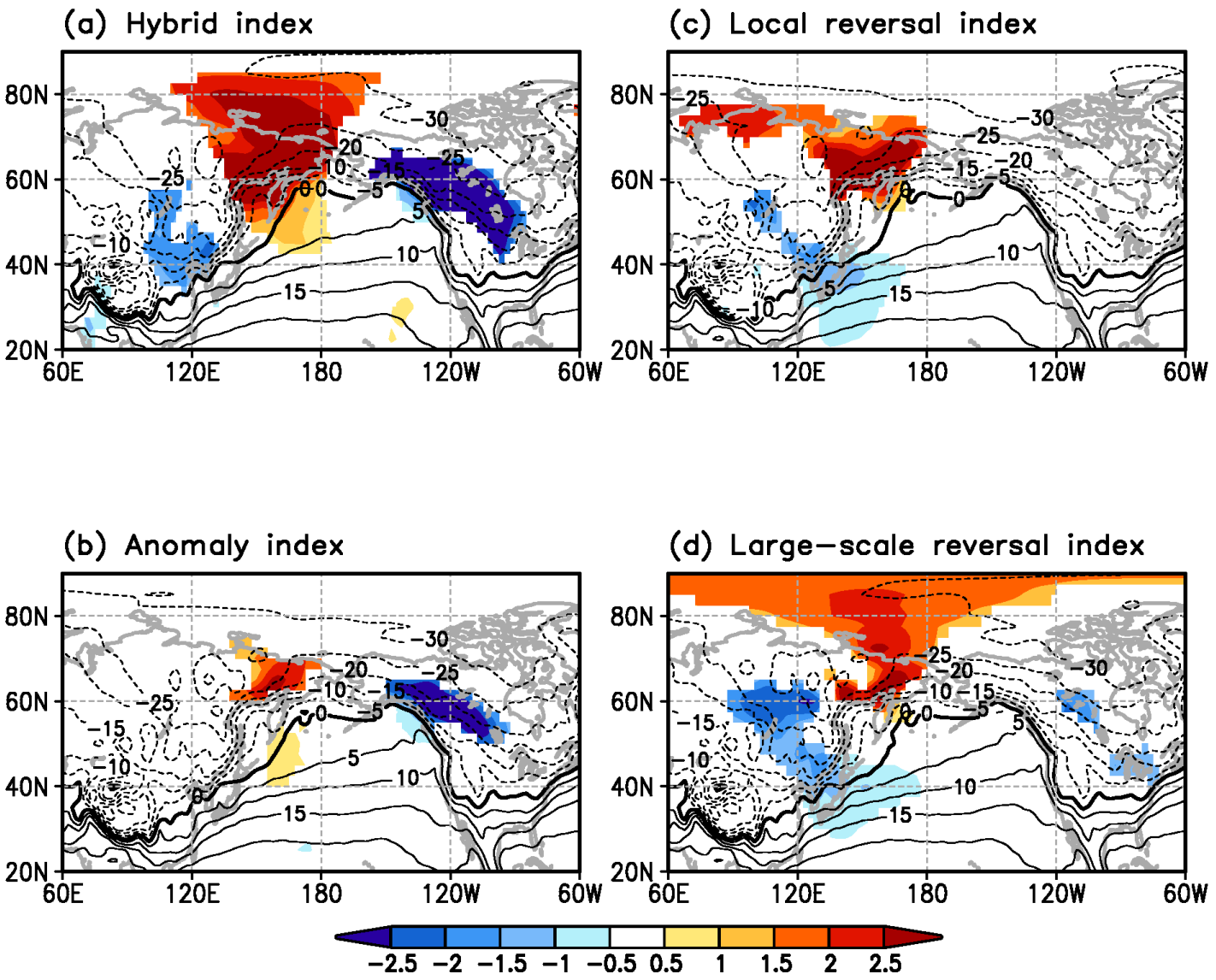


Dipole blocking pattern with zonal flow reversal

Event # : (d)123 > (b)107 > (c)88 > (a)65

Duration : (d)10.8 > (b)8.1 > (c)7.8 > (a)7.3

SAT (contour), SAT anomaly (shading) composite during Kamchatka blocking [120E-180]



Discussion

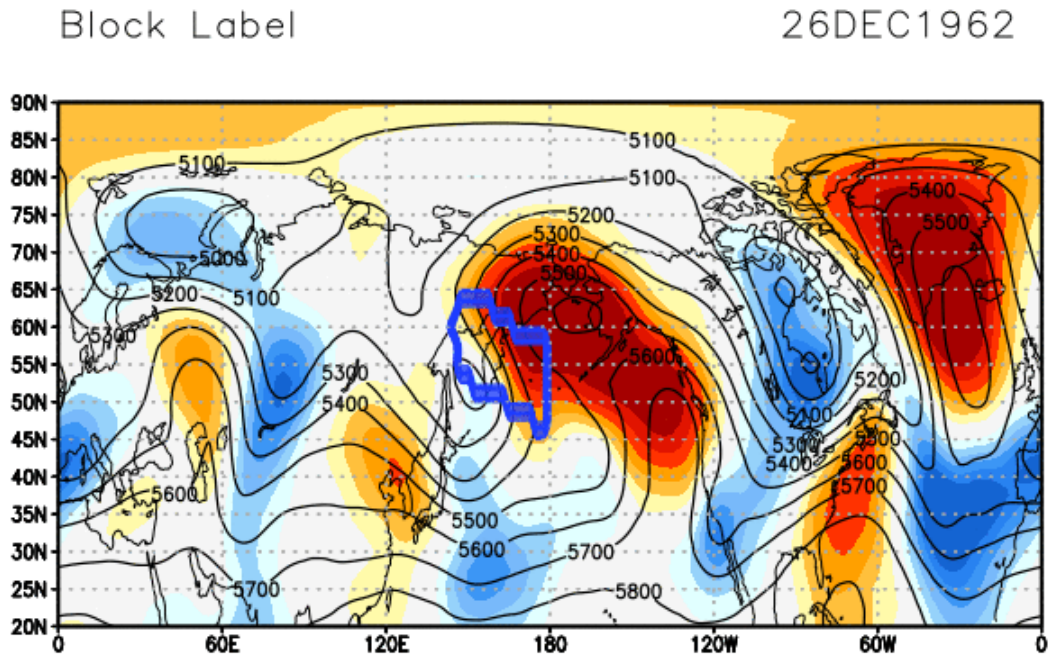
- Existing Blocking detection algorithms are so diverse and the resultant Blocking frequency maps are also very different with each others.

- Among the diverse detection algorithms, we find that large-scale reversal index only captures Blocking activity over Kamchatka region properly.

- Intrinsic wave breaking activity is well captured by the large-scale reversal index than others and this is the reason.

- Since Kamchatka blocking is related with extreme weathers such as cold surges in winter and heat waves in summer, we need much more efforts especially for understanding the initiation mechanism, its detailed evolution and characteristic changes in association with climate change.

THANK YOU



PH index(blue) Z500(black) Z500ano(shading)