Abnormal late season cold surges during Asian winter monsoon 2005

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Joint Meeting for Seasonal Prediction of the East Asian Winter Monsoon 2004/2005

KMA Temperature Forecast

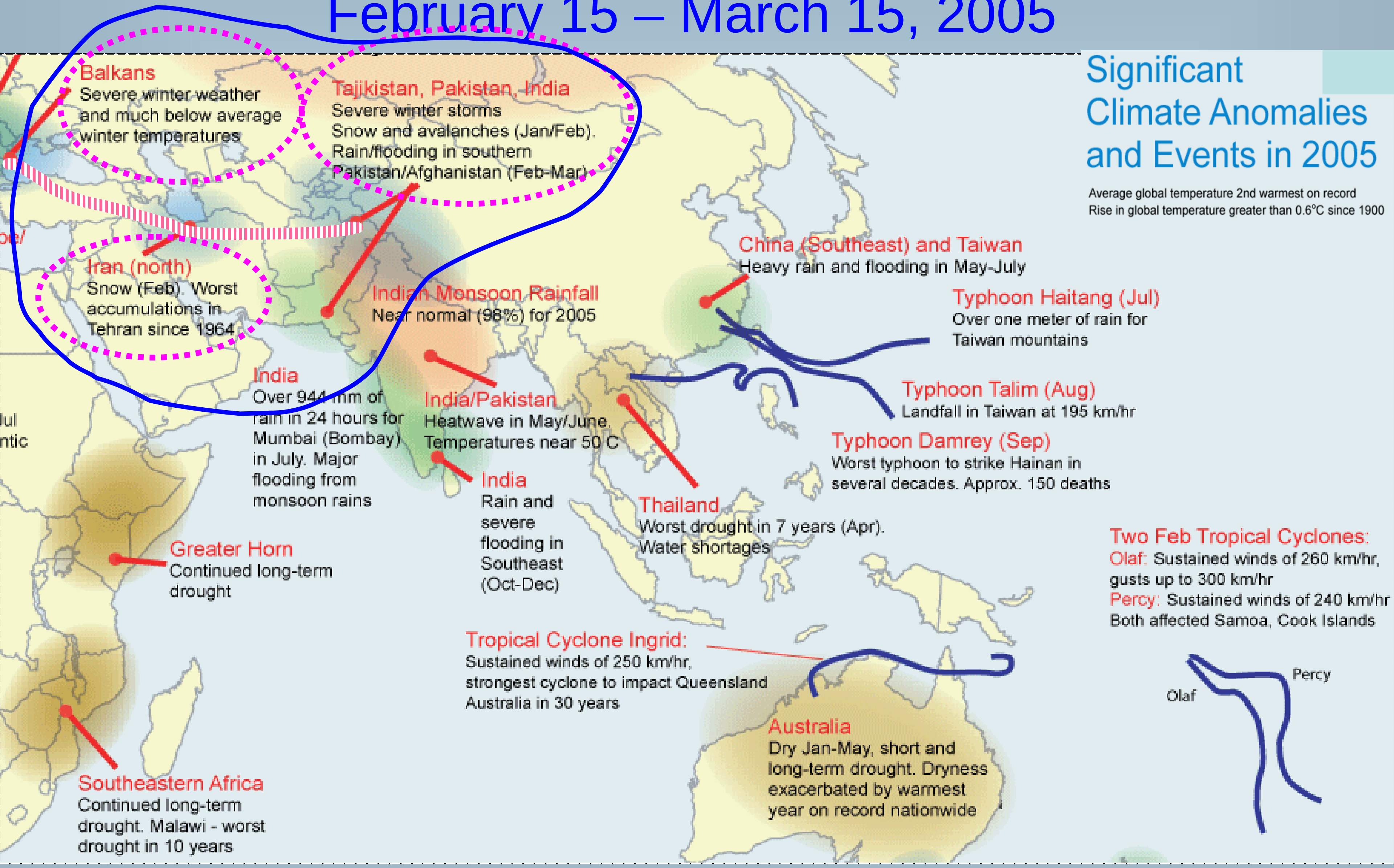
Based on the weak El Nino year's circulation pattern, warmer and normal temperature in Korea is possible

- **Above normal : Korea, southern and central part of China, southern and central part of Japan**
- **Near normal : northern part of China and Japan**
- **Totally warmer than normal over the East Asia**
  But, frequent cold spells expected, particularly, in the northern part of East Asia

Same conclusions (warm winter) by CMA and JMA

Significant Climate Events during the Late Winter

February 15 – March 15, 2005



NCDC: Climate of 2005 - in Historical Perspective: Annual Report
(http://www.ncdc.noaa.gov/img/climate/research/2005/ann/significant-extremes2005.gif)

February 2005

In the Kashmir region along the India/Pakistan border, snowfall described as the worst in two decades affected parts of the Himalayan region during February 16-20. In India, at least 230 people were killed due to the extreme winter weather (OCHA/Reuters). Snowfall accumulations reached 2 meters (6.6 feet) in some parts of Jammu and Kashmir states in India.

March 2005

Above average snow cover occurred throughout much of Europe and Asia during the early part of March, as unusually cold and snowy conditions throughout the boreal winter season persisted through the 9th. Across Serbia and Montenegro, snow depths exceeding 2 meters (6.5 feet) were reported in some areas, cutting off some residents (IFRC).

Xinjiang Hit by Snowmelt Flood

At least 110,000 residents have been affected by snowmelt flooding in Ili Kazak Autonomous Prefecture, northwest China's Xinjiang Uygur Autonomous Region, the prefectural bureau of civil affairs said on Tuesday.

According to the bureau, the floods had hit eight counties and two cities as of Tuesday, destroying 12,000 rooms and 3,267 hectares of arable land and killing 3,736 head of livestock. Another 796 hectares of crops were affected in the flooding.

Heavy snowfall and extremely cold weather during the winter led to unusually deep snow accumulation in the Ili River Valley, north of the Tianshan Mountains.

Temperatures rose quickly in early March, causing the snow to melt faster than usual and leading to flooding and landslides. The situation was exacerbated by consecutive days of rain in the middle of the month.

The local government has implemented flood-control measures and has been organizing a relief operation in Ili. Cash and materials have been distributed to flood-stricken areas of the prefecture.

(Xinhua News Agency March 23, 2005)

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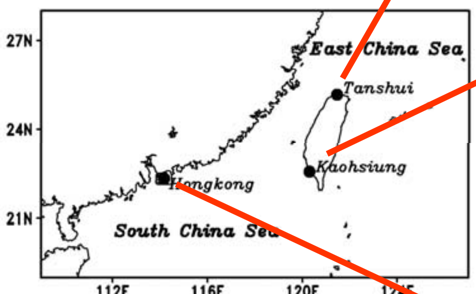
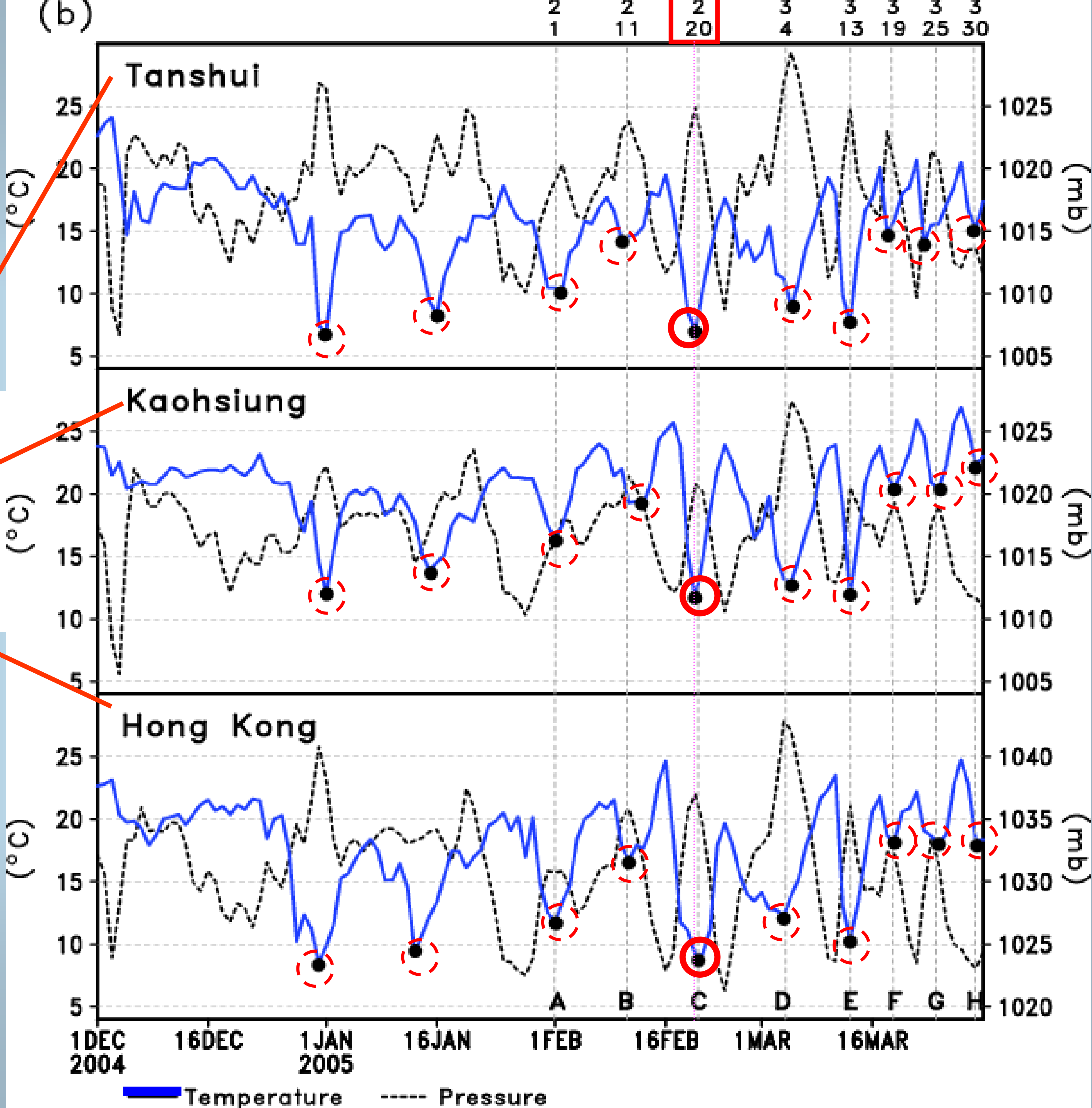
Related Stories

- Xinjiang Floods Break 100 Bridges
- Snow and Ice Cause Damage Across China
- Earthquake Destroys 900 Homes in Xinjiang

Web Links

Temp and P_{sfc} for 1 Dec 2004 - 20 Mar 2005.

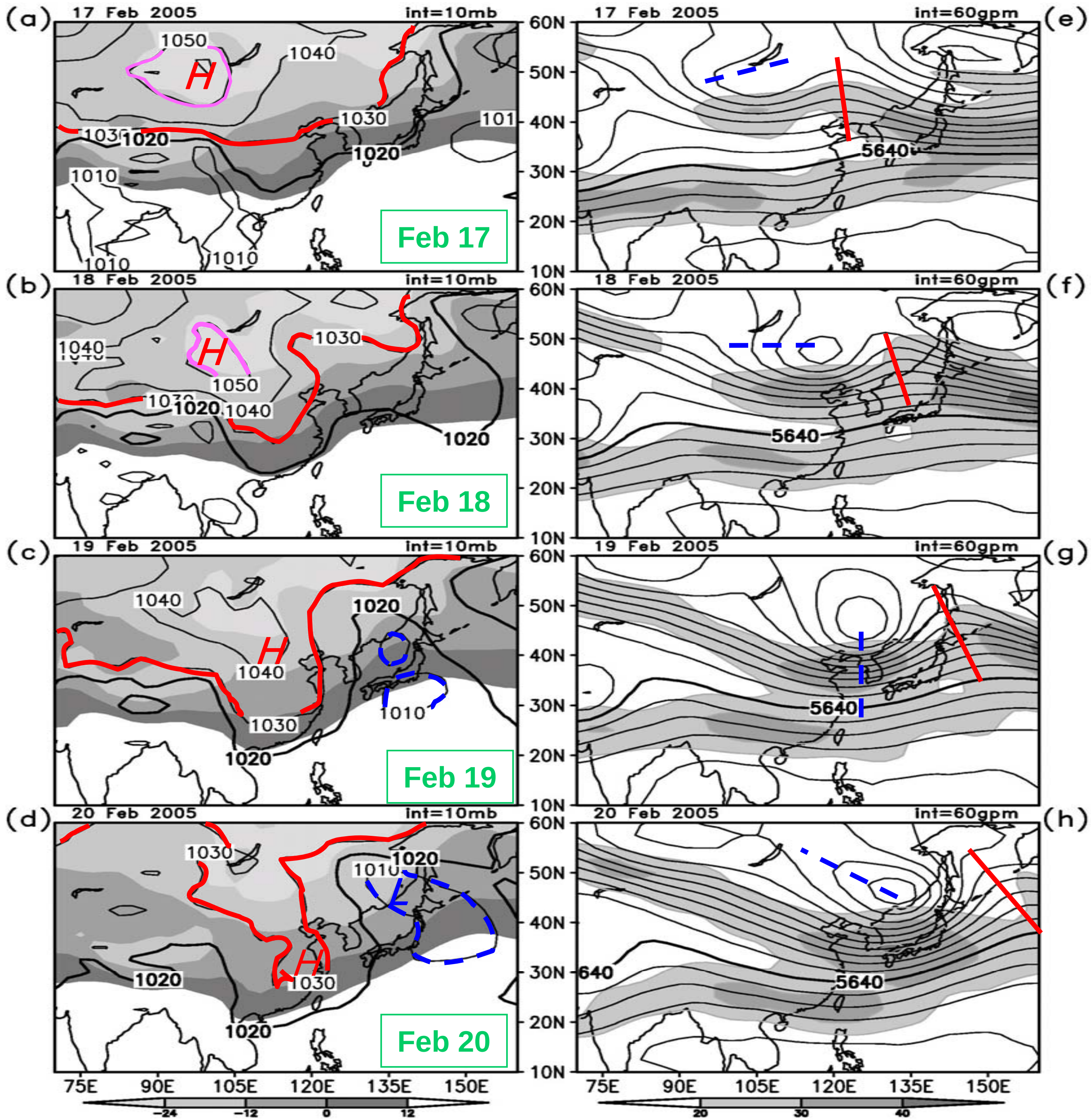


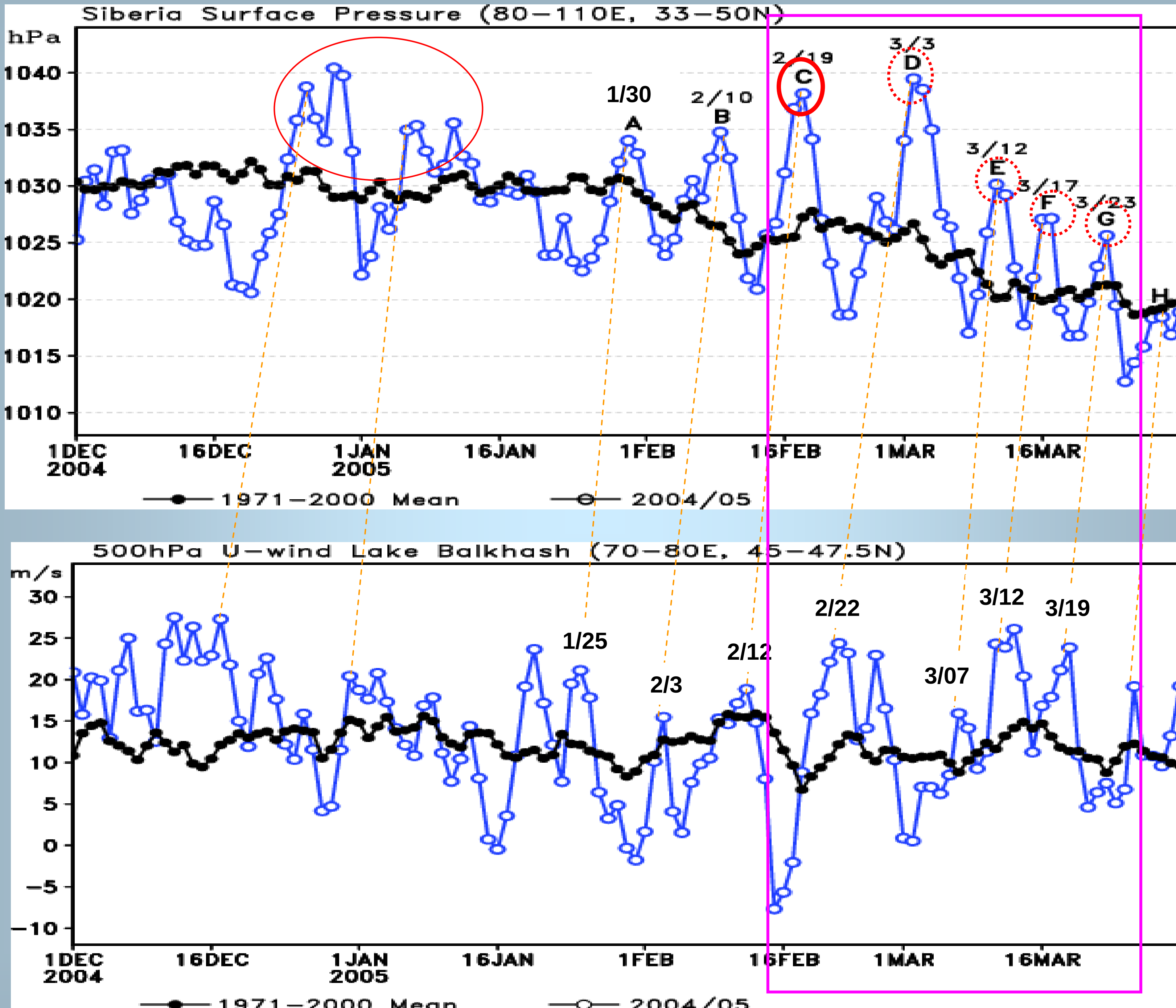


8 cold episodes (Mini Temp within a 5-day period).

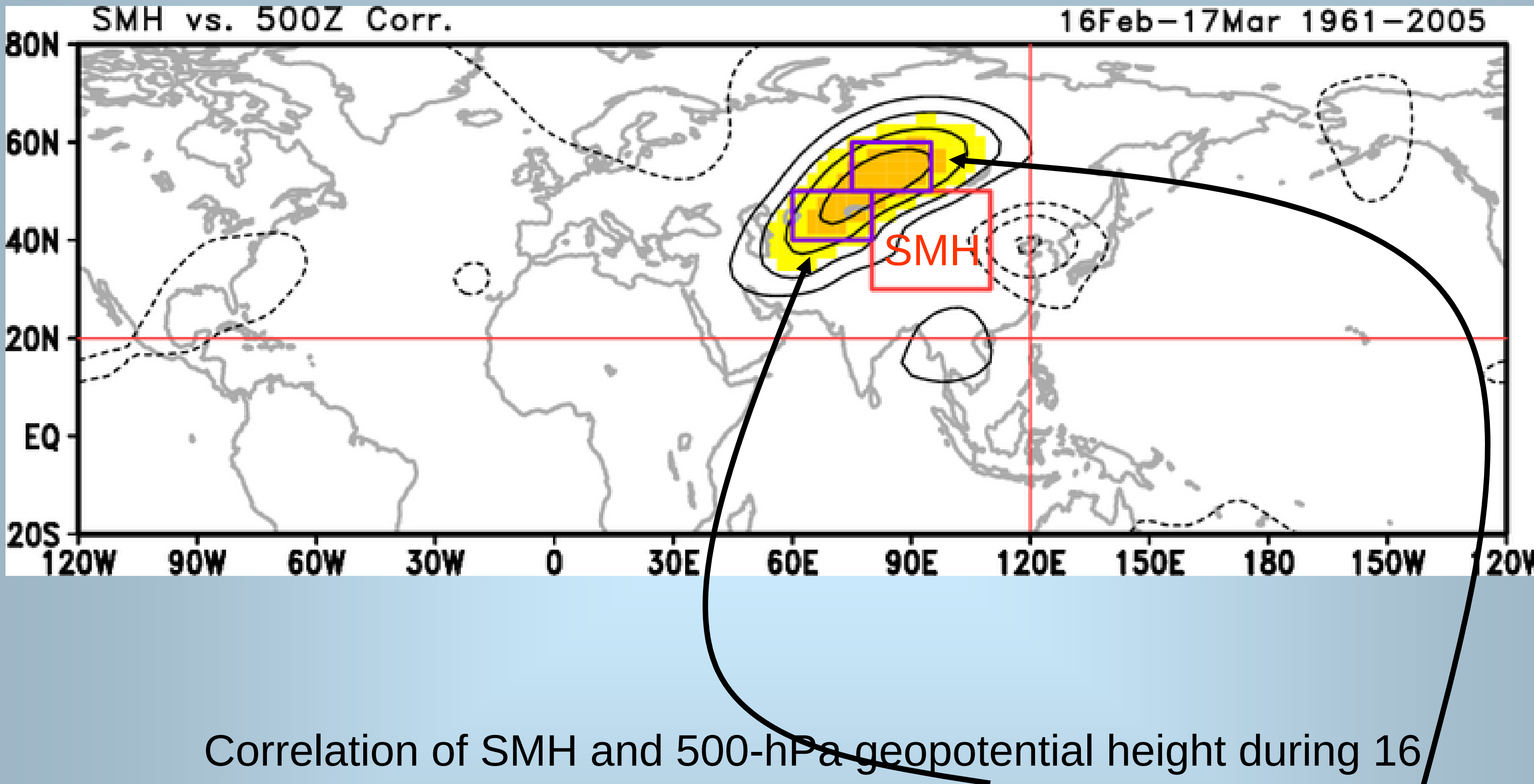
SLP & Sfc. Temp

500 hPa GPH & U





Siberia Surface Pressure (80–110E, 33–50N)
hPa
1040
1035
1030
1025
1020
1015
1010
1/30
A
2/10
B
2/19
C
3/3
D
3/12
E
3/17
F
3/23
G
H
1DEC 2004
16DEC
1JAN 2005
16JAN
1FEB
16FEB
1MAR
16MAR
1971–2000 Mean
2004/05
500hPa U–wind Lake Balkhash (70–80E, 45–47.5N)
m/s
30
25
20
15
10
5
0
–5
–10
1/25
2/3
2/12
2/22
3/07
3/12
3/19
1DEC 2004
16DEC
1JAN 2005
16JAN
1FEB
16FEB
1MAR
16MAR
1971–2000 Mean
2004/05



Correlation of SMH and 500-hPa geopotential height during 16 Feb – 17 Mar, 1961-2005. Two boxes (Central Asia and West Siberian) are selected to test the sensitivity of the 500-hPa height to the perturbations in other regions.

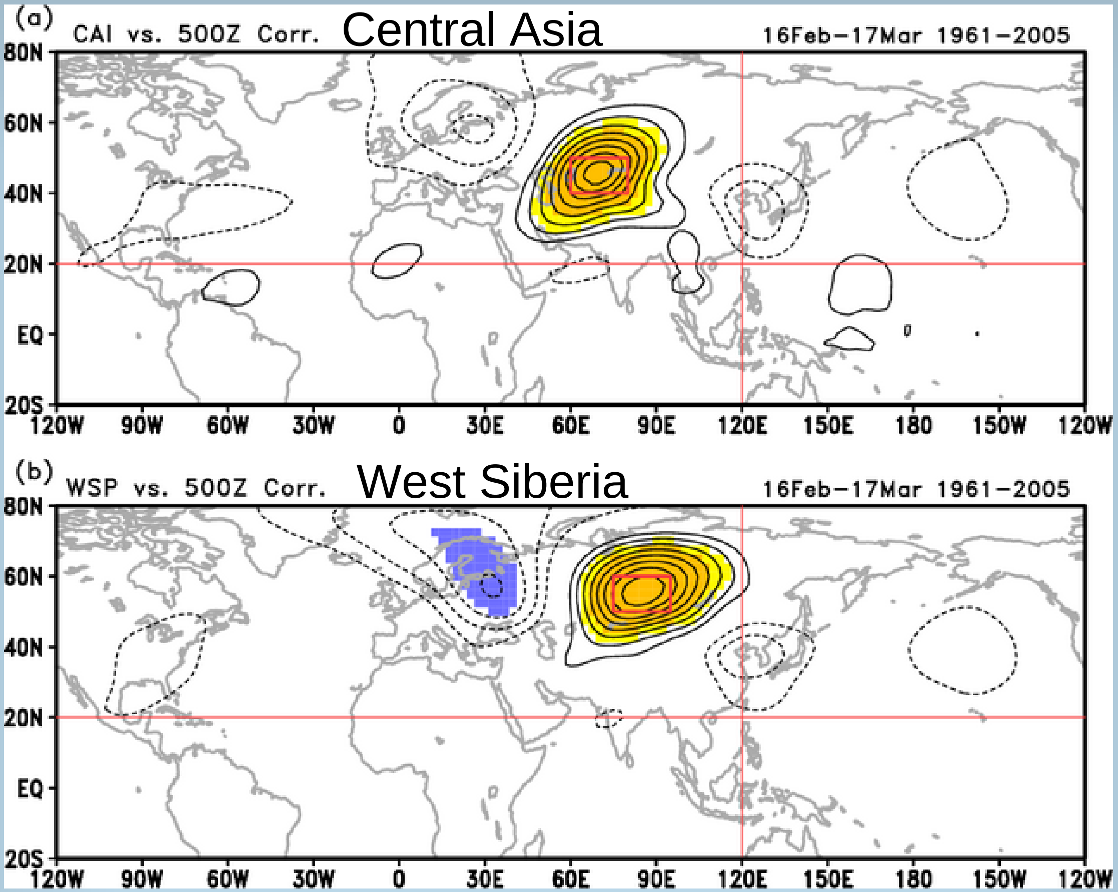


Fig. 5. The late winter 500-hPa geopotential height correlation during 16 Feb – 17 Mar, Reference point: (a) Central Asia at 60E-80E, 40N-50N, (b) West Siberia at 75E-95E, 50N-60N. Shaded: confidence 95%.

Scandinavian Peninsula

/Barents Sea

Central Asia

Greenland

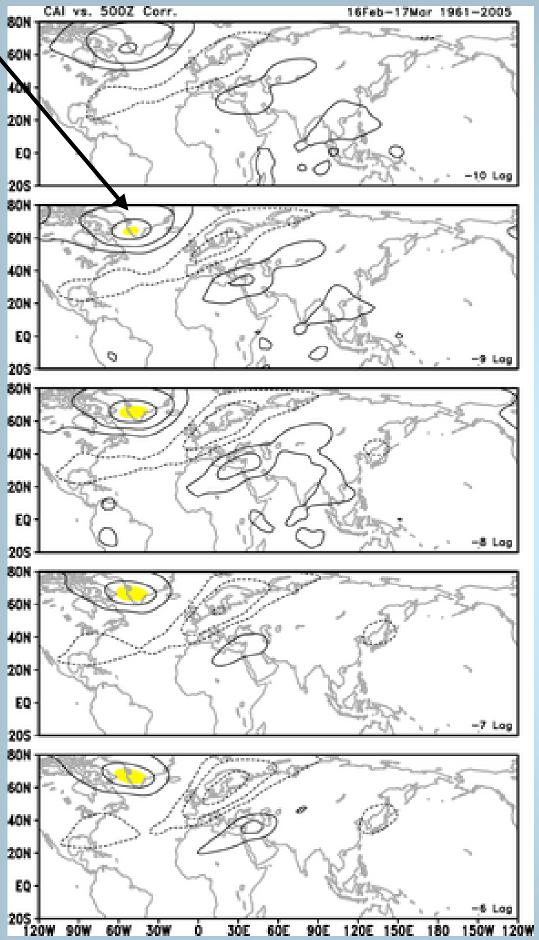
-10 days

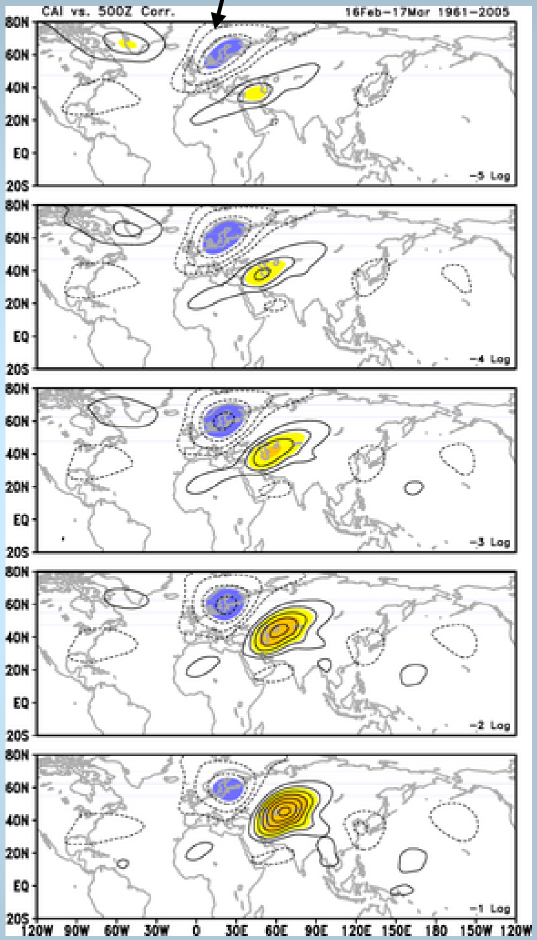
-9 days

-8 days

-7 days

-6 days





-5 days

-4 days

-3 days

-2 days

-1 day

500-hPa geopotential height lag correlation maps (interval 0.1).
Light shading 90%; Dark shading 95%.

West Siberia

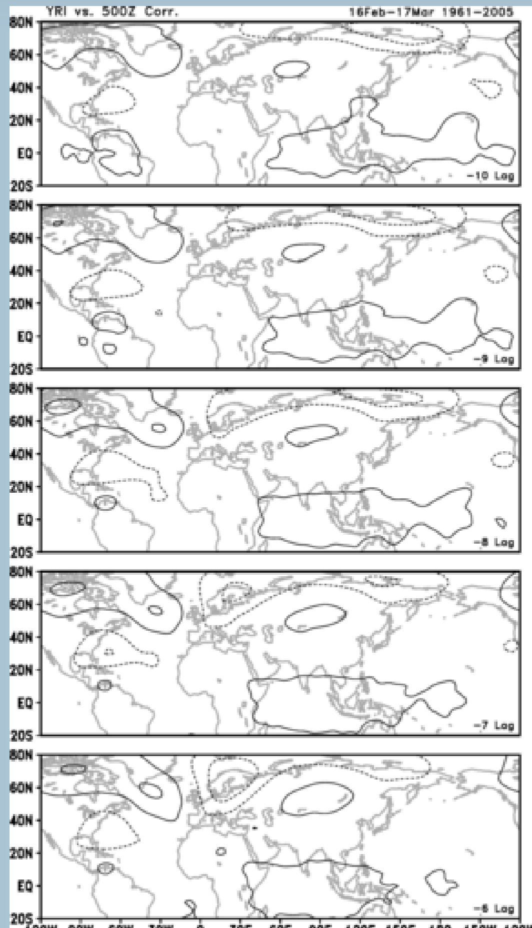
-10 days

-9 days

-8 days

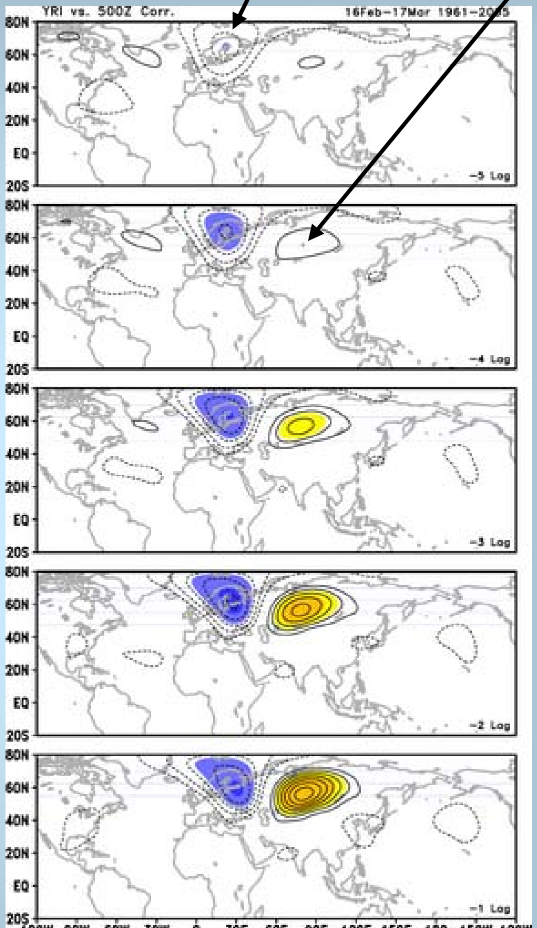
-7 days

-6 days



Barents Sea

Lake Baikal



-5 days

-4 days

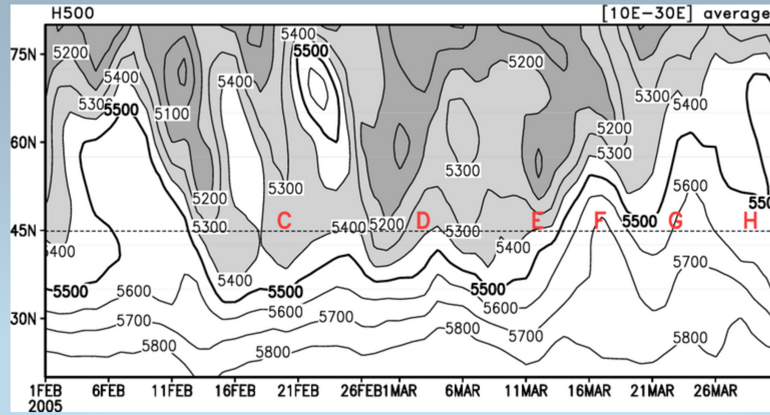
-3 days

-2 days

-1 day

Scandinavian Peninsula

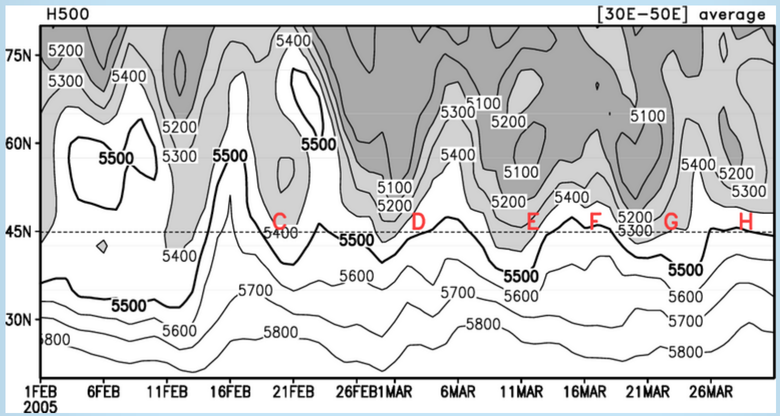
10°E-30°E



Time-latitude cross-section of 500-hPa height

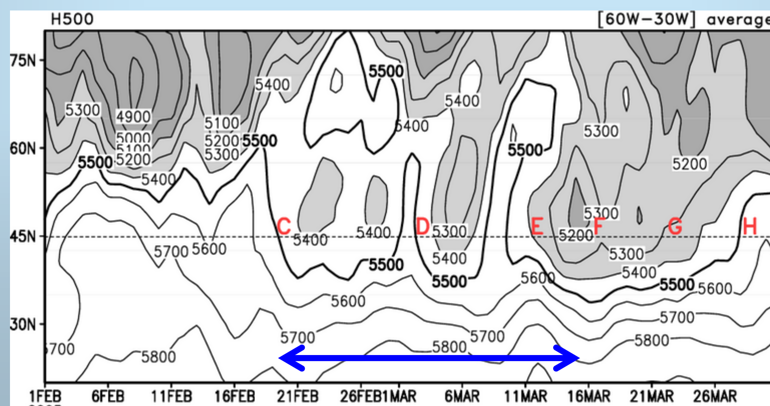
Barents Sea

30°E-50°E



Greenland

60°W-30°W

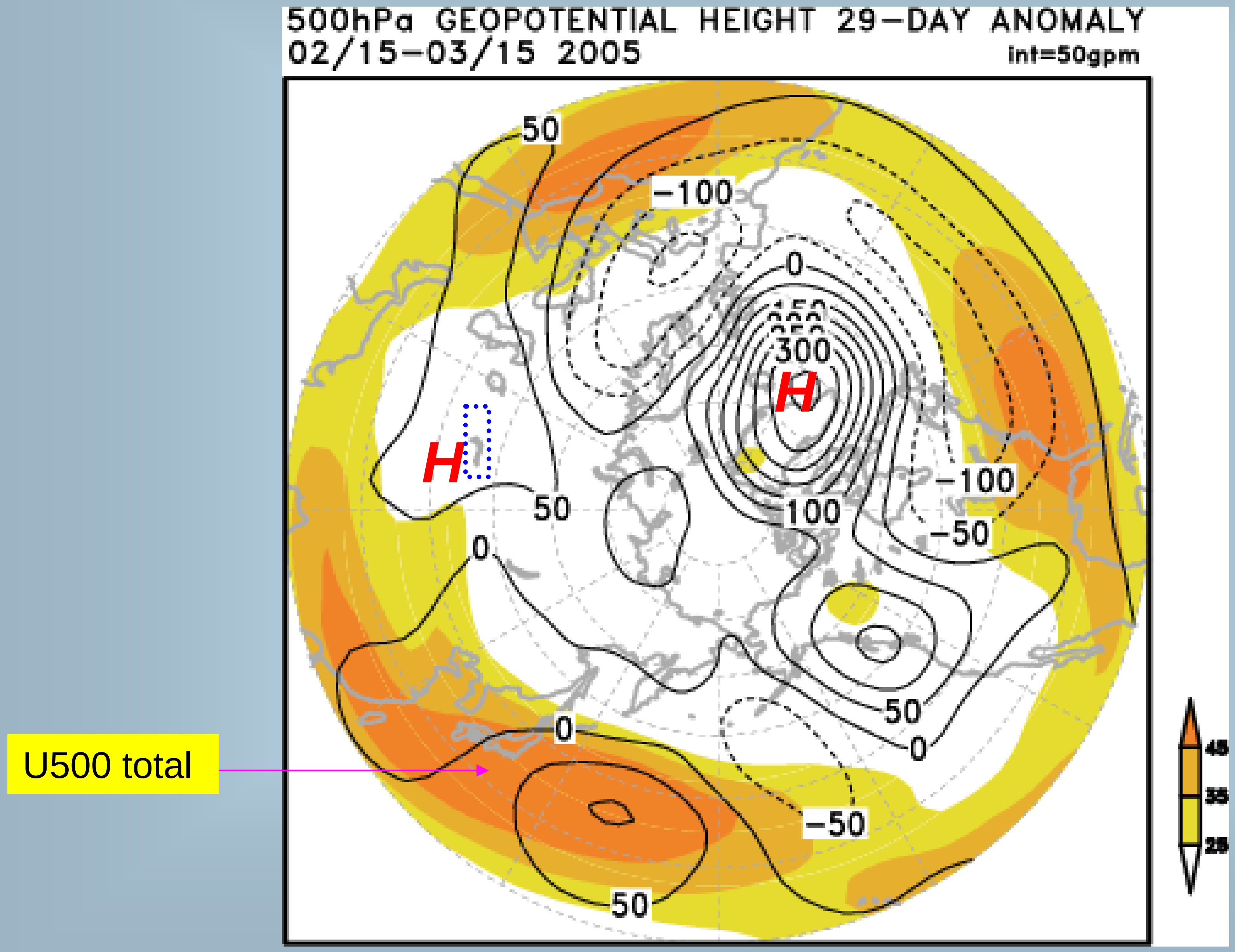


Atlantic Blocking

Shaded: < 5400m,
Dark Shaded: < 5200m.
Thick Line: 5500m.

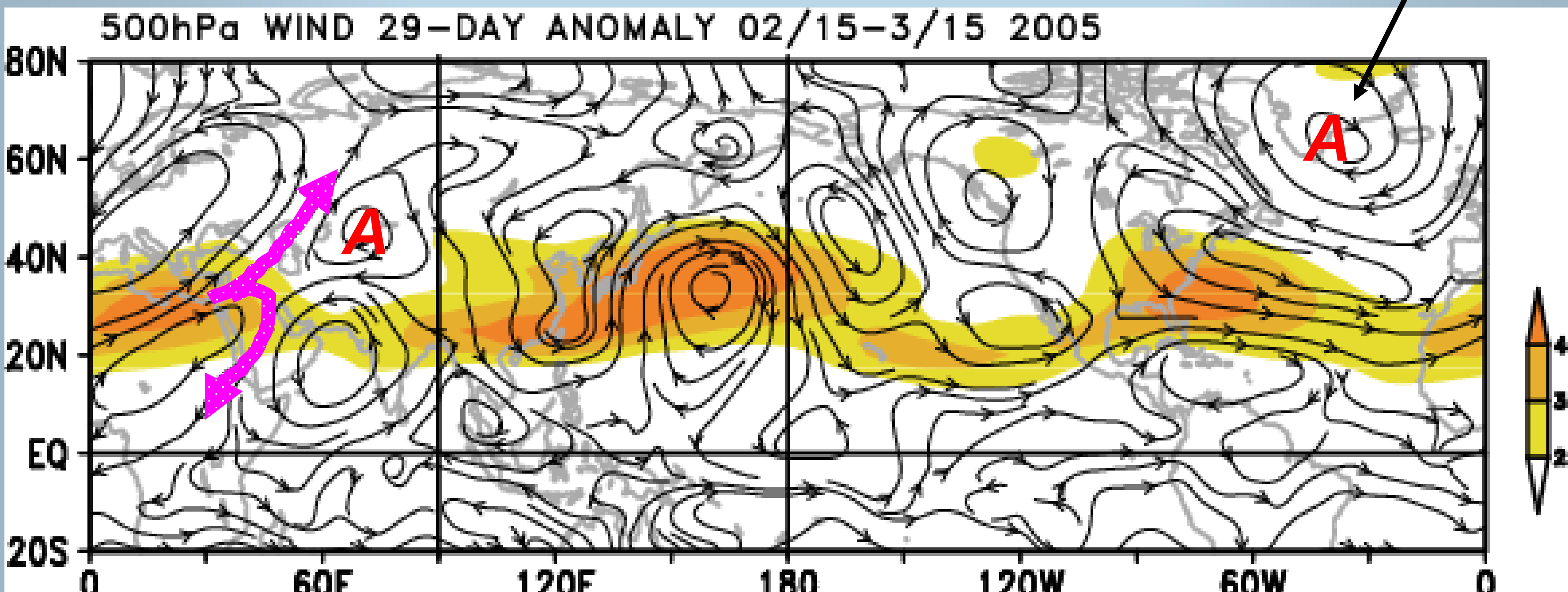
(interval 100m).

The 500-hPa Geopotential Height Anomaly

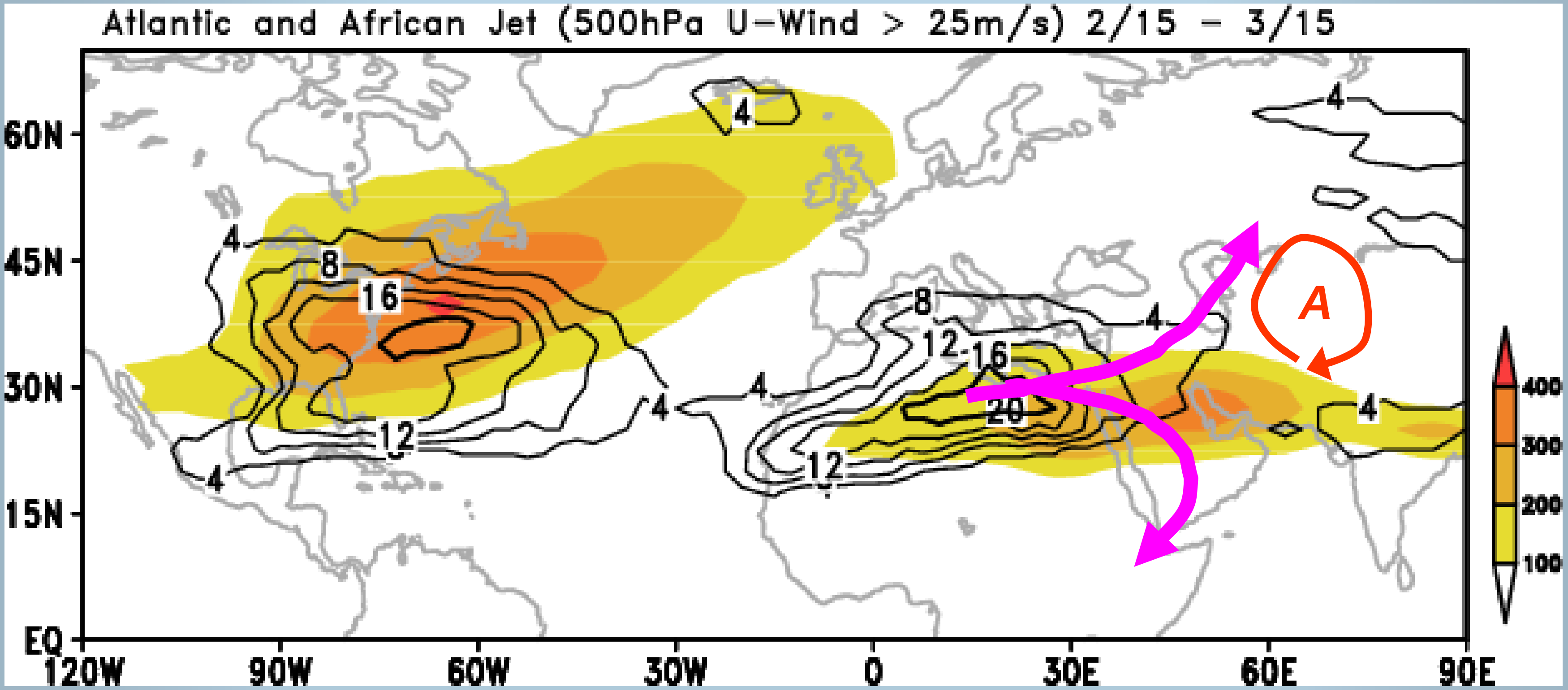


The 500-hPa Wind Anomaly

Atlantic Blocking



Central Asia Anticyclone



background colors: 1971-2000 climatology

contours: 2005

- Takaya and Nakamura (2005): Formation mechanisms of the blocking ridges to the east and west of the upper-level East Asian major trough are different.
  - To the west (West Siberia anticyclone): quasi-stationary Rossby wave train propagating across the Eurasian continent reinforced by the modest feedback forcing of transient eddies.
  - To the east: westward development of anticyclonic anomalies from the North Pacific reinforced by strong feedback forcing from the Pacific storm track.

Blocking Index GHGS:

$$GHGS = \left[\frac{Z(\phi_0) - Z(\phi_s)}{\phi_0 - \phi_s} \right],$$

$$GHGN = \left[\frac{Z(\phi_n) - Z(\phi_0)}{\phi_n - \phi_s} \right],$$

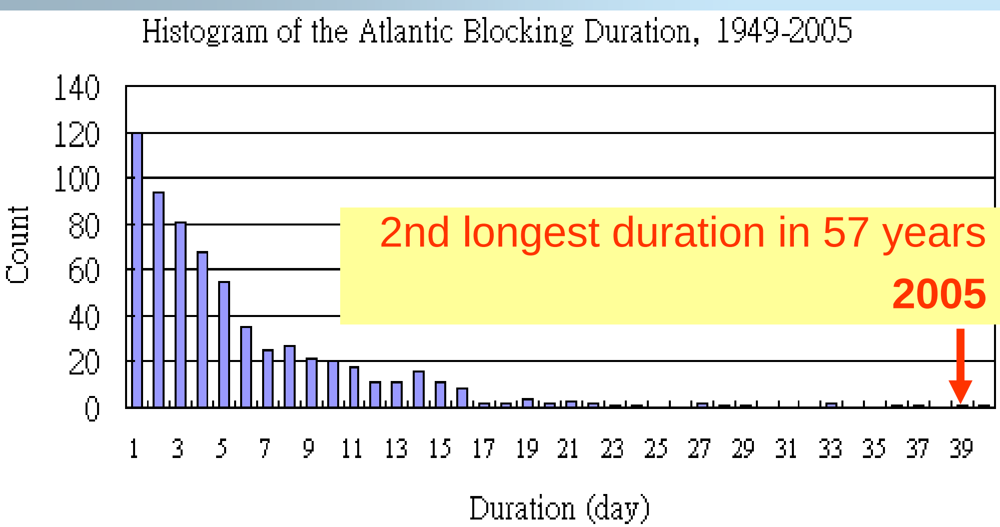
where

$$\phi_n = 80^o N + \delta, \phi_0 = 60^o N + \delta, \phi_s = 40^o N + \delta, \delta = -5^o, 0^o, 5^o.$$

A given longitude is determined as blocked at a given time if the following conditions are satisfied for at least one value of δ:

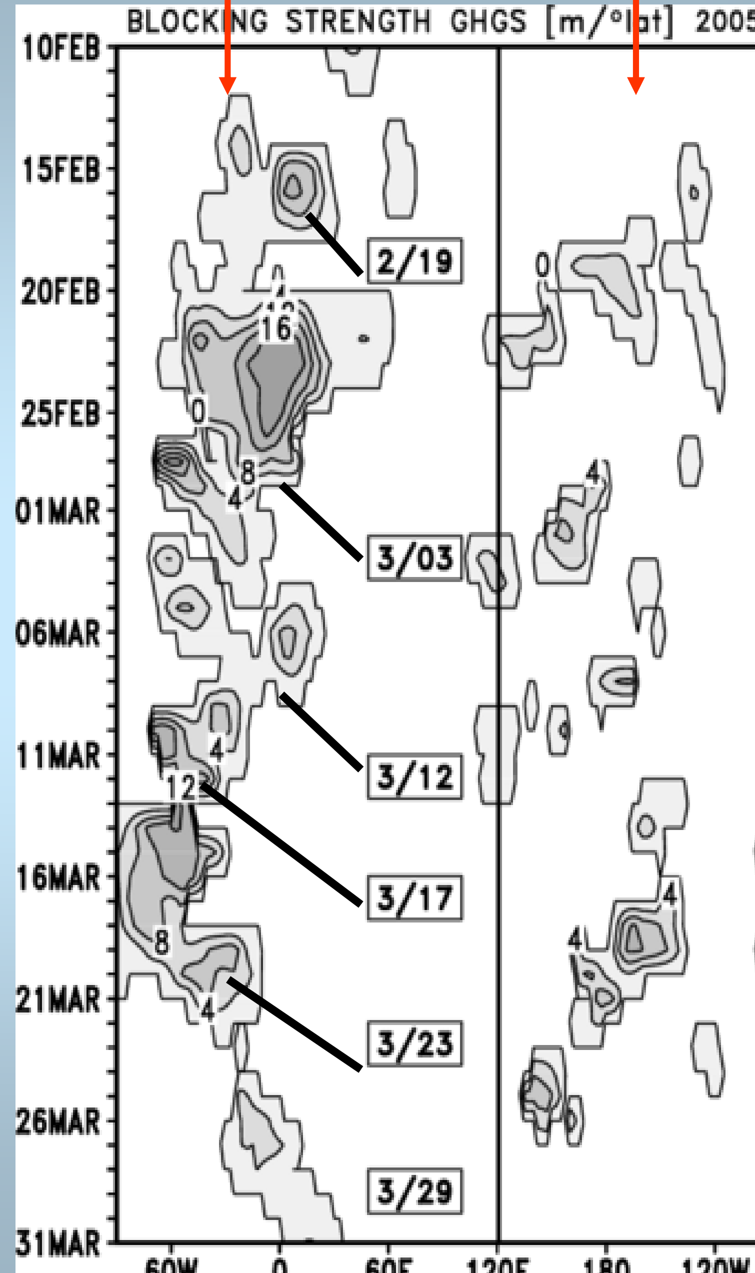
(1) GHGS＞0

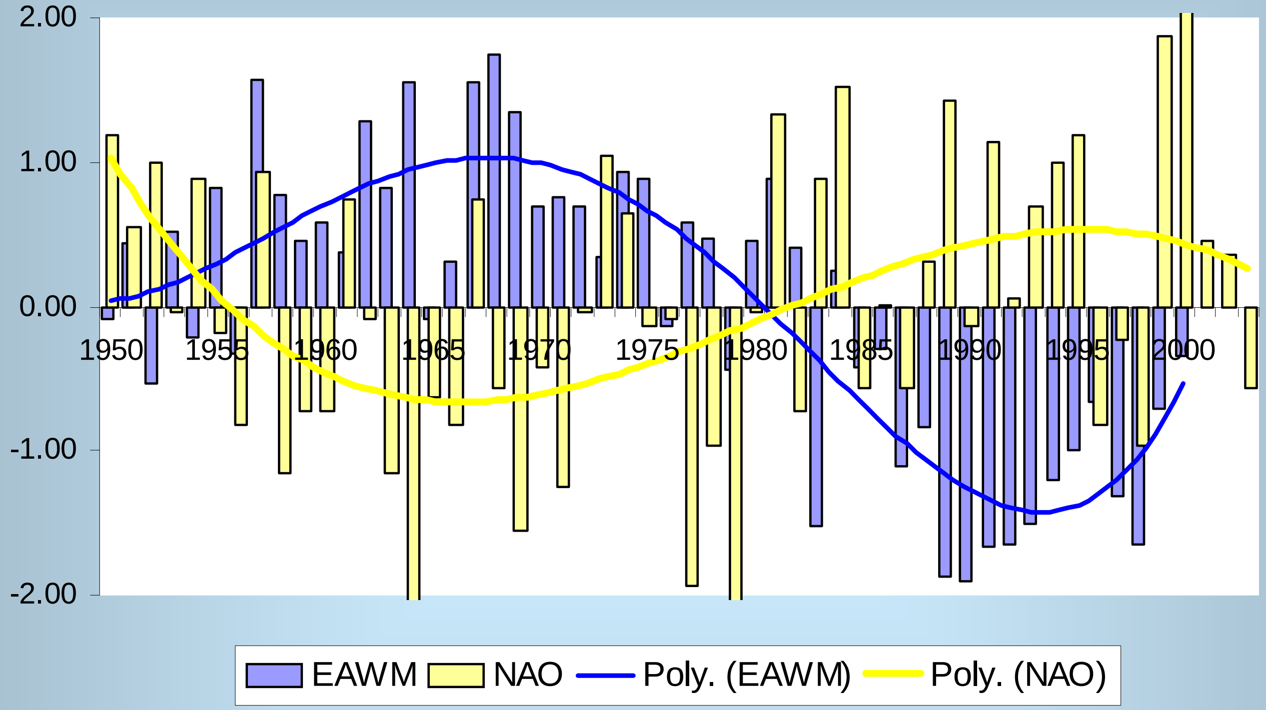
(2) GHGN＜-5 m/deg latitude.



The Atlantic Blocking

Pacific Blocking





Decadal variations. EAWM index = SLP (40°N-60°N, 70°E-120ºE)
Adapted from Gong et al. 2002, data curtsey of Qiyuan Guo. (Chang et al, 2006).

Atlantic Blocking Index (ABI)

standardized anomalies of the number of late-winter days with GHCS (60°W-0 °W) >0 and GHGN (60°W-0 °W) $<$ - 5 m/ °latitude.

Central Asian anticyclone Index (CAI)

H500 (60°E-80°E, 40°N-50°N) anomaly is positive and > 1*std

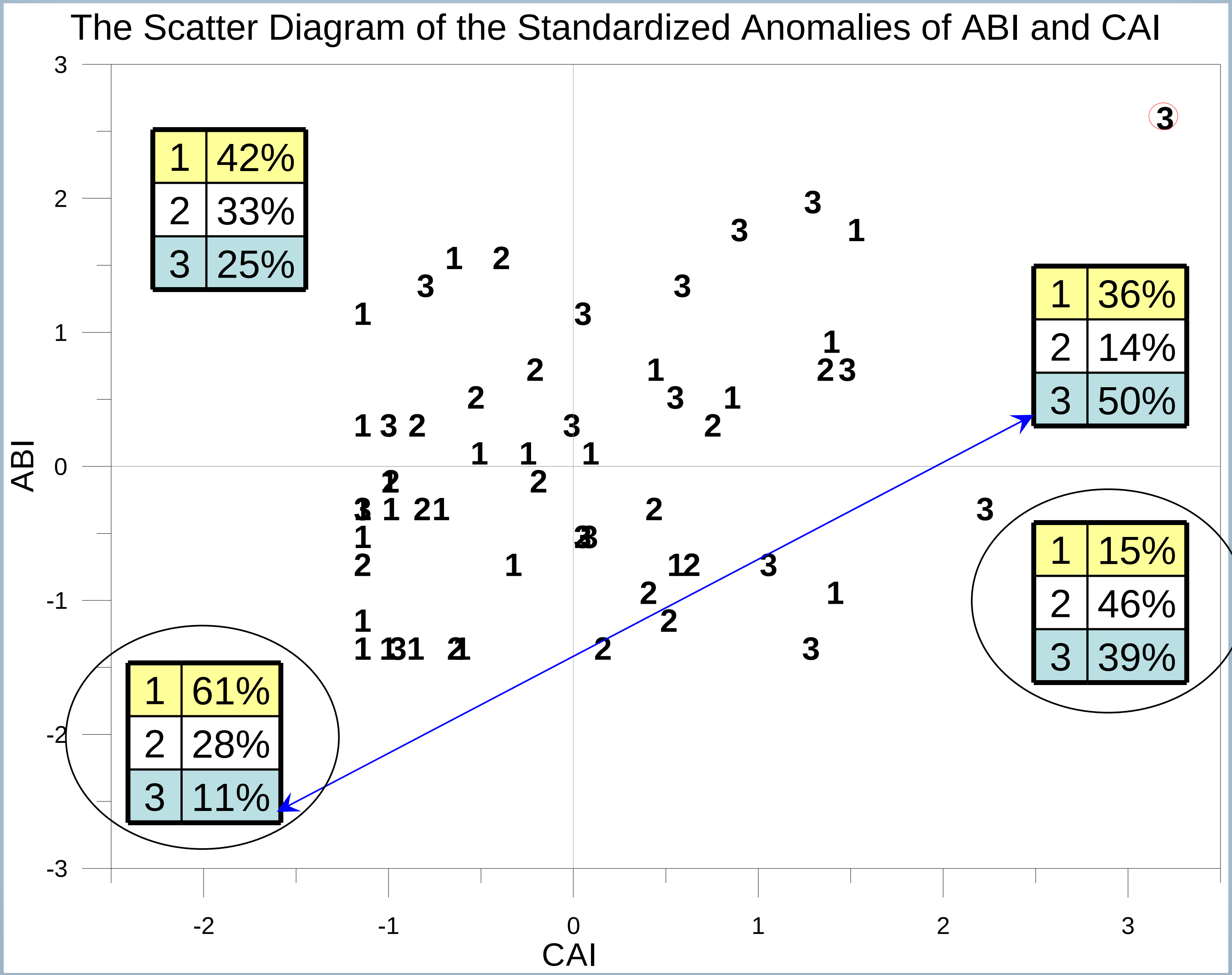
Siberia-Mongolia High Index (SMHI)

SLP (33°N-50°N, 80°E-110°E) anomaly > 1*std.

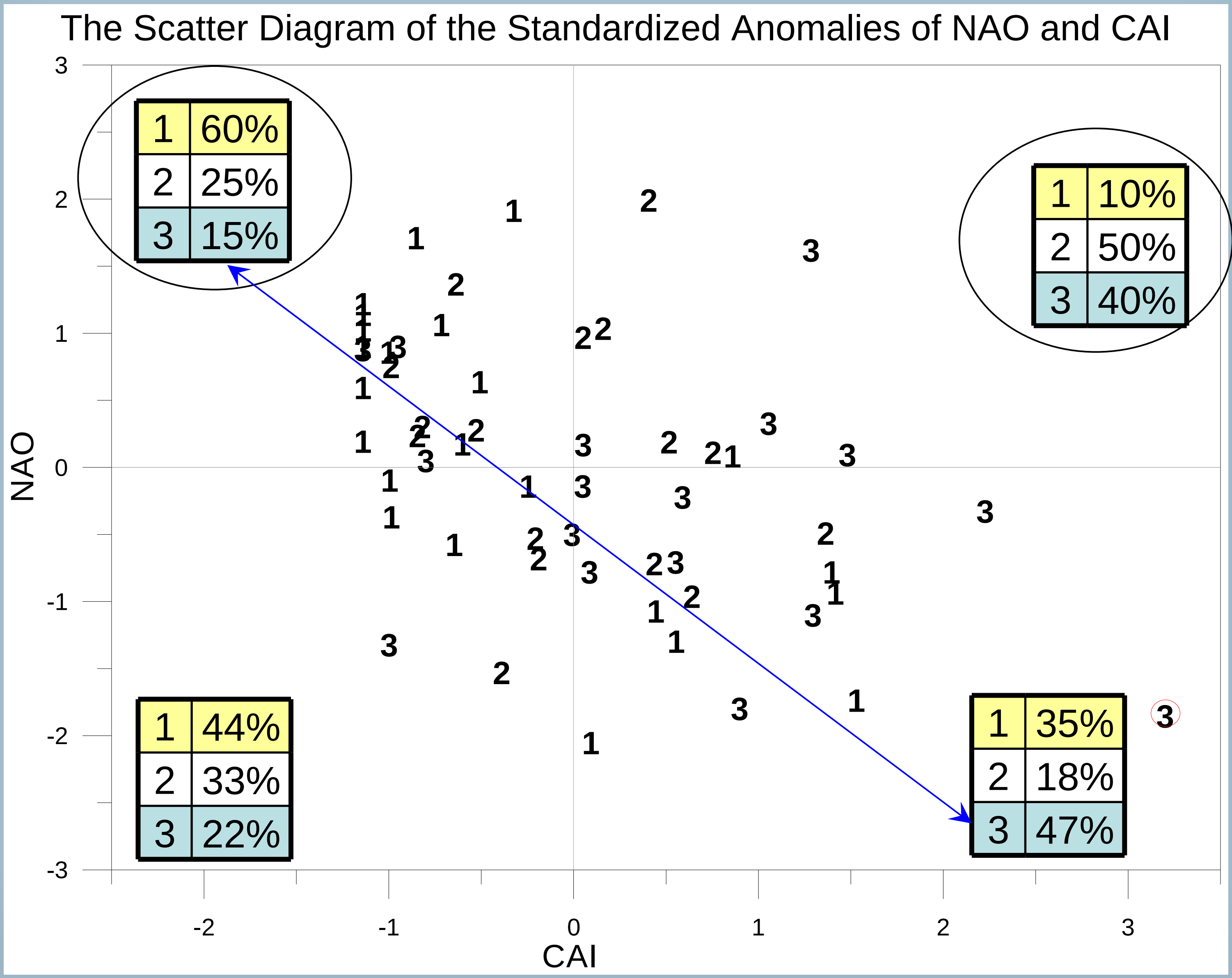
- ≥ 1 std **SMHI** = **3**
- 0.5 – 1 std, **SMHI** = **2**
- < 0.5std **SMHI** = **1**

.

ABI


The Scatter Diagram of the Standardized Anomalies of ABI and CAI
ABI
CAI
1 42%
2 33%
3 25%
1 36%
2 14%
3 50%
1 15%
2 46%
3 39%
1 61%
2 28%
3 11%

NAO


The Scatter Diagram of the Standardized Anomalies of NAO and CAI
NAO
CAI
1 60%
2 25%
3 15%
1 10%
2 50%
3 40%
1 44%
2 33%
3 22%
1 35%
2 18%
3 47%

CAI Correlation

SMHI	**ABI**	**NAO**
1(23)	0.39	**-0.67**
2(16)	-0.08	-0.18
3(16)	0.33	-0.30
Total(55)	0.32	**-0.45**

SMHI Correlation

SMHI	**ABI**	**NAO**
Total(55)	0.18	-0.10

Conclusions

- Statistical and numerical models all forecasted a warm Asian winter monsoon for 2005. However, the highest frequency of late winter (mid-February to mid-March) cold surges occurred and coincided with the first break of 18 consecutive warm winters over China.
- The cold season is associated with the strong pulsation of the surface Siberian Mongolia high (SMH) which resulted from the confluence of several events.
- To the east a strong Pacific blocking with three pulses of westward extension intensified the stationary East Asian major trough to create favorable condition for cold surges.
- To the west a dominant Atlantic blocking and an anomalous deepened trough in the Scandinavian/Barents Sea region excited a succession of Rossby wave forcing for the downstream development (Lake Baikal, west Siberia).
- An upper level Central Asian anticyclone that is often associated with a stronger SMH was anomalously strong and provided additional forcing.
- The Atlantic blocking, AO and NAO are all somewhat correlated with the central Asian anticyclone only when SMH is weak (warm winters). In strong SMH cases (cold winters) the correlations diminish.
- During late winter 2005 the Central Asian anticyclone was strengthened by the Atlantic blocking through both the downstream wave activities and a circulation change that affected the Atlantic and West Asian jets. As a result, late winter 2005 stands out as a record-breaking season in the Asian winter monsoon.

CONCLUSIONS

- **A unusually persistent Atlantic blocking and an anomalous Central Asian anticyclone are identified as the main cause of the late winter Southeast Asian cold surges in 2005.**

- **The Atlantic blocking appears to influence the Southeast Asian cold surges through two effects.**

  - **It enhances the jet instability by aligning the Atlantic jet with the African jet through forcing the Atlantic jet to the south of its normal position.**

  - **It slows down the eastward propagation of the Rossby wave train over the Pacific and results in the Pacific jet and the associated eddies remain standing-like for almost one month.**

- **The Central Asian anticyclone can accelerate the upper-level westerly flow over Lake Balkhash, and subsequently intensify the surface pressure of the Siberia-Mongolia High, which is the origin of the cold air that moves to Southeast Asia.**

- **The late-winter subseasonal-sacle stronger than normal SMH is not likely to occur when Atlantic blocking and Central Asian anticyclone are weak.**

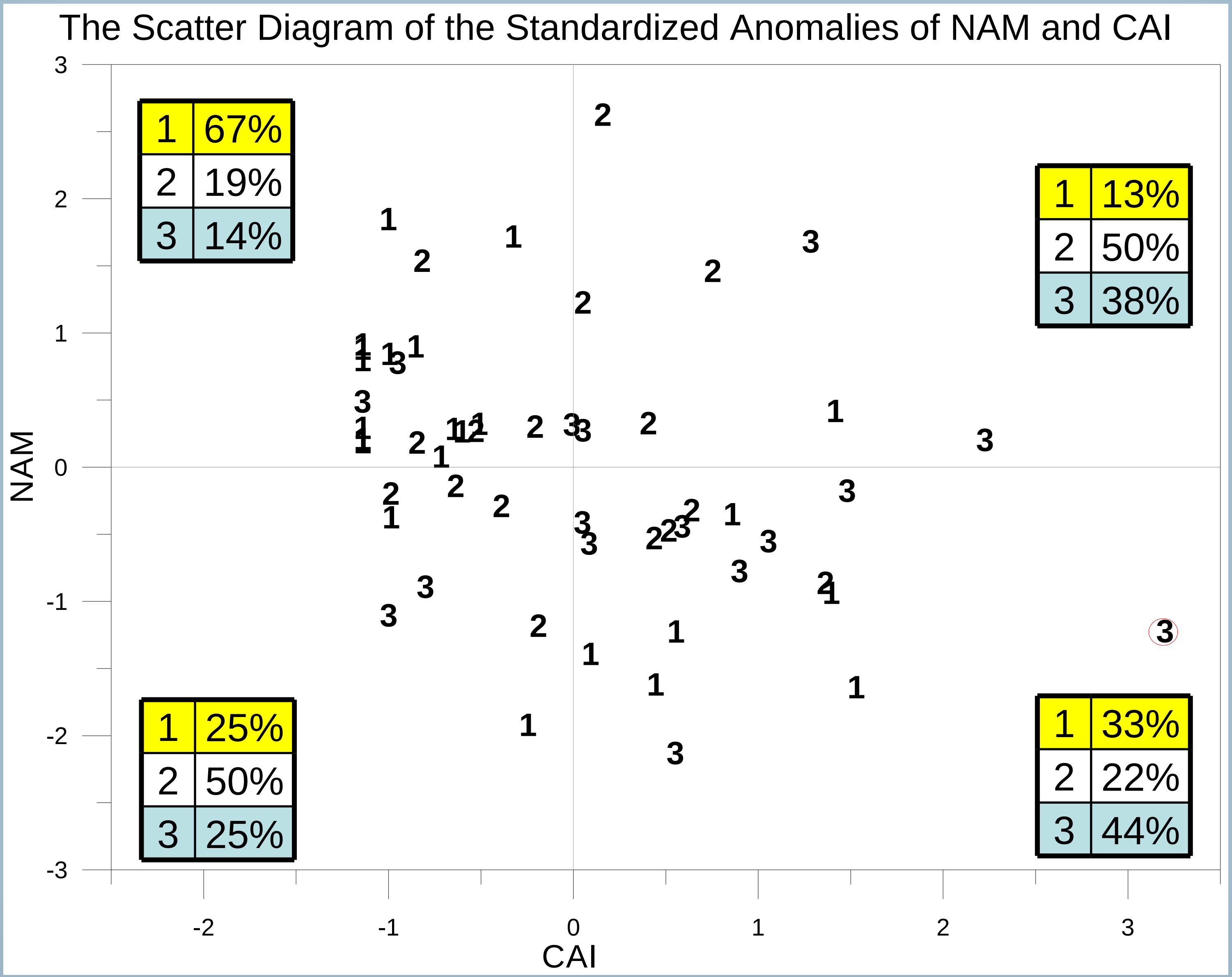
ABI & CAI

SMHI	**ABI>0**	**ABI<0**	**CAI>0**	**CAI<0**
1	10	13	7	16
2	6	10	8	8
3	9	7	11	5

NAO

SMHI	**NAO>0**	**NAO<0**
1	13	10
2	10	6
3	7	9

AO


The Scatter Diagram of the Standardized Anomalies of NAM and CAI
NAM
CAI
1 67%
2 19%
3 14%
1 13%
2 50%
3 38%
1 25%
2 50%
3 25%
1 33%
2 22%
3 44%