Variability of the number of the 'Asian Dust' events during XX century in the South Korea as a result of changes in atmospheric circulation over the Northern Hemisphere.

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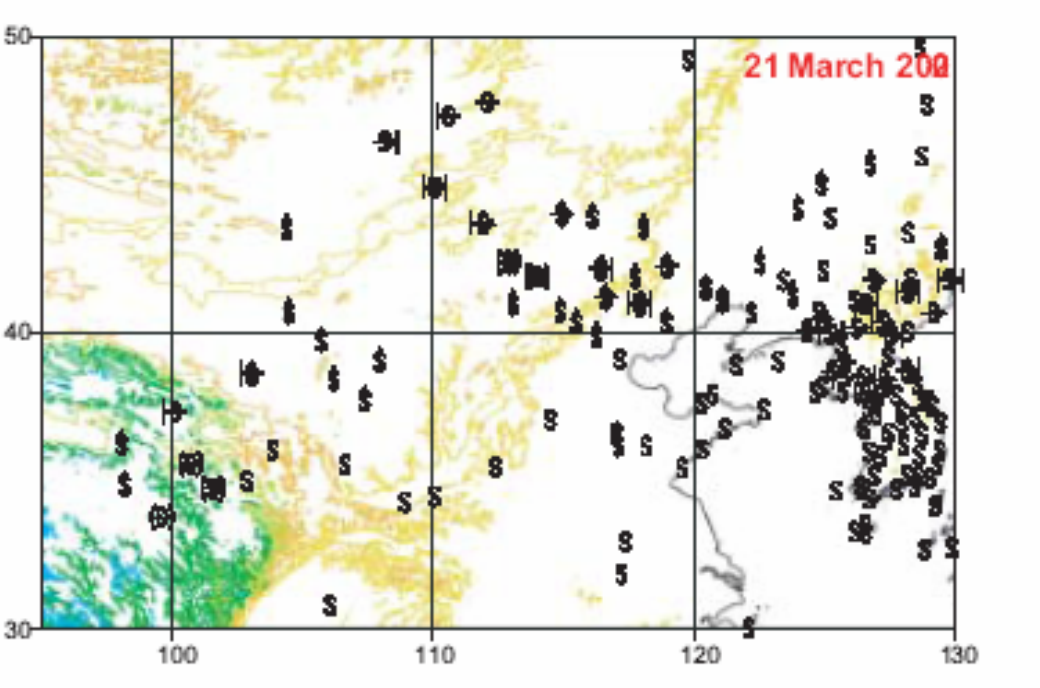
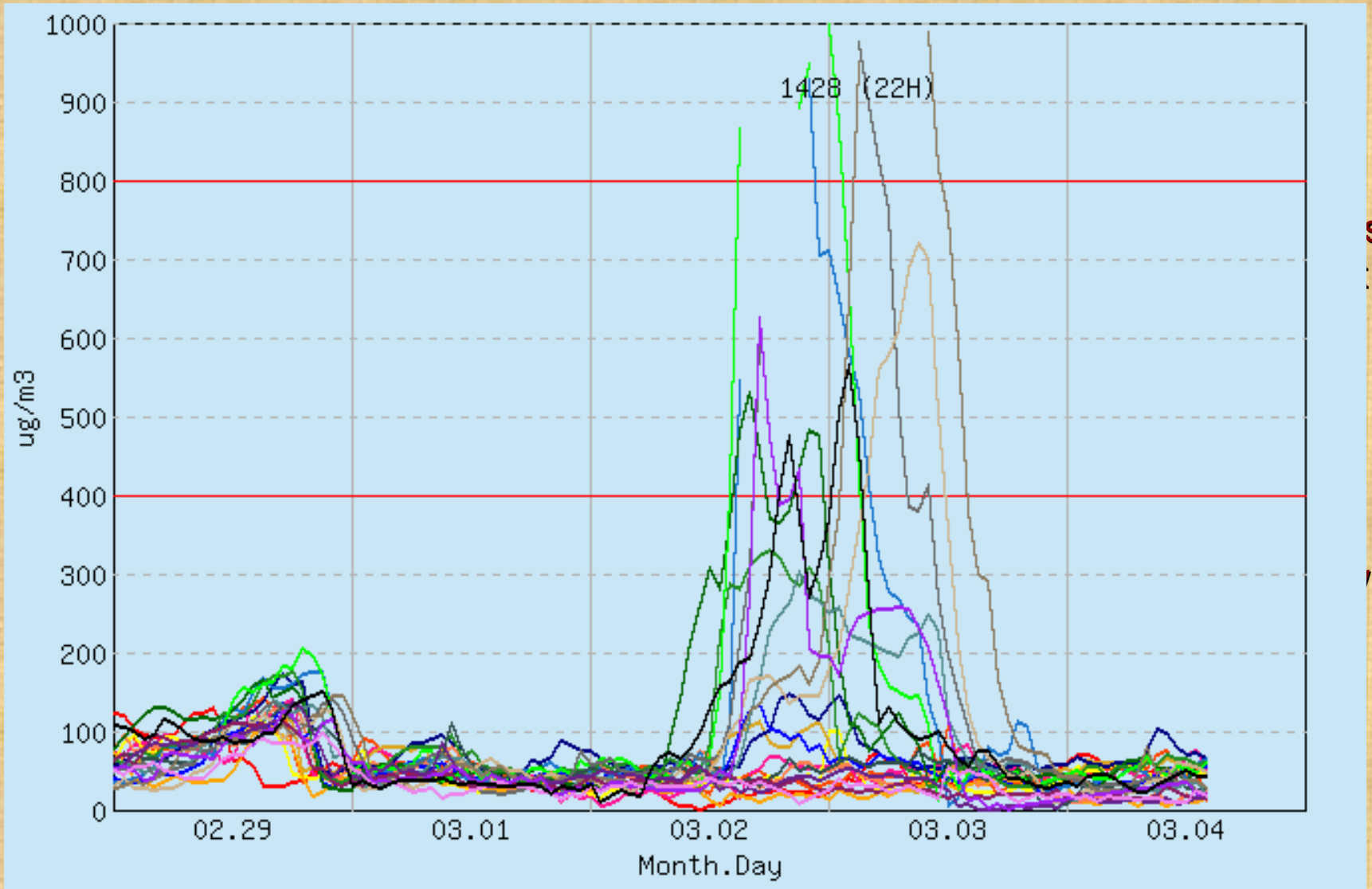
Ukrainian Hydrometeorological Institute, Kiev, Ukraine

Soo Il Park
Research Centre of Asian Dust and long-range Transboundary Air Pollutants, Seoul, South Korea

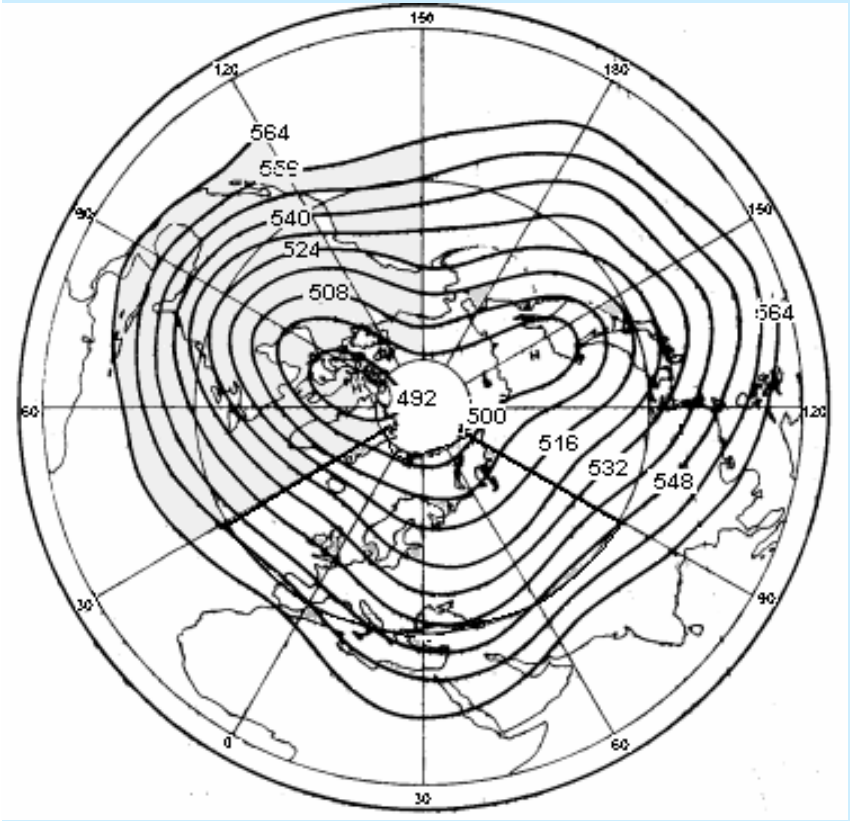


Introduction



The planetary atmospheric circulation of troposphere in the Northern hemisphere

Mean field 500hPa for period 1967-1982 (Zverev N.I.,1987)



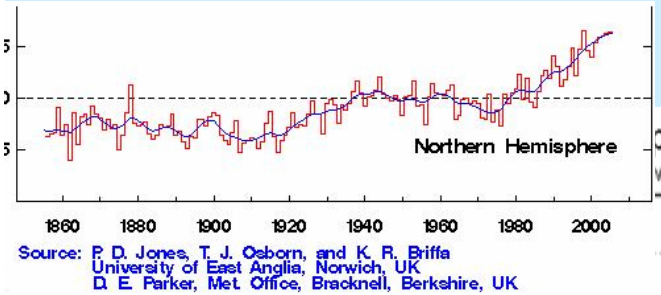
A planetary atmospheric circulation of troposphere in the Northern Hemisphere is the three-vortex system.

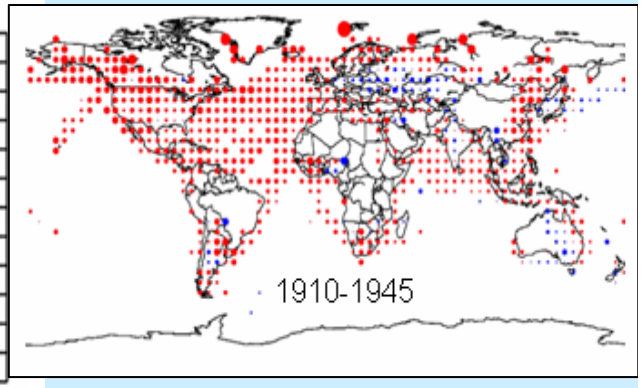
This system consists of three ridges in the winter: North Atlantic, Siberian (in the summer, it is thermal) and Canadian maximums of pressure. The European , Aleutian and Iceland minimums are placed between maximums.

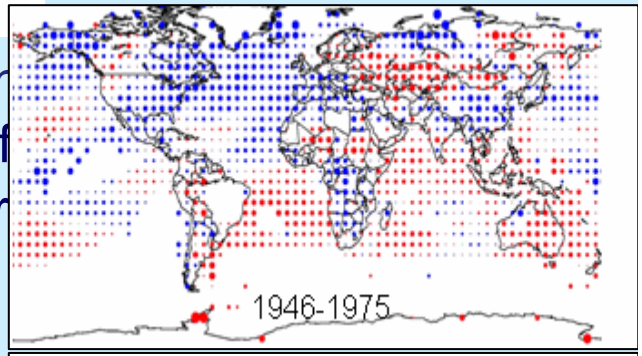
As a rule, all changes of one pair of minimum and maximum of pressure are connected with the changes of the other.

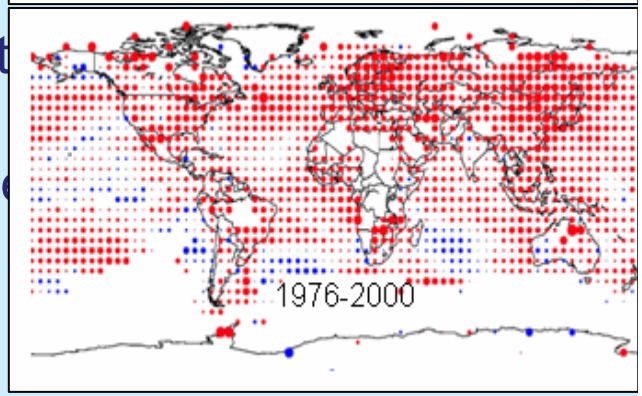
Regional circulation has to research on area equal on extent from the west to the east 120 degrees.

THE GLOBAL TEMPERATURE DURING XXth CENTURY







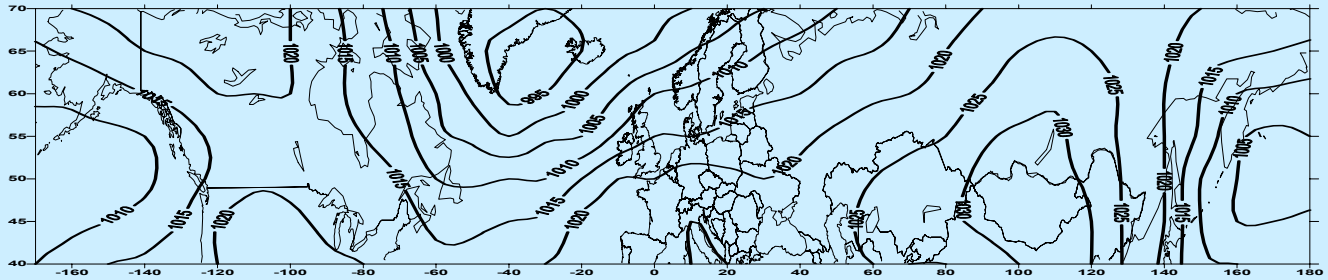


Global warming was register from beginning of 20th century to the present tense. For our study of change sea-level pressure fields during XXth centur we mark three periods in global temperature trend :

- **first warming** is within period of 1911-1944
- **second warming** is since the end of the 1970s unt now
- **period of the** near stable temperature between th

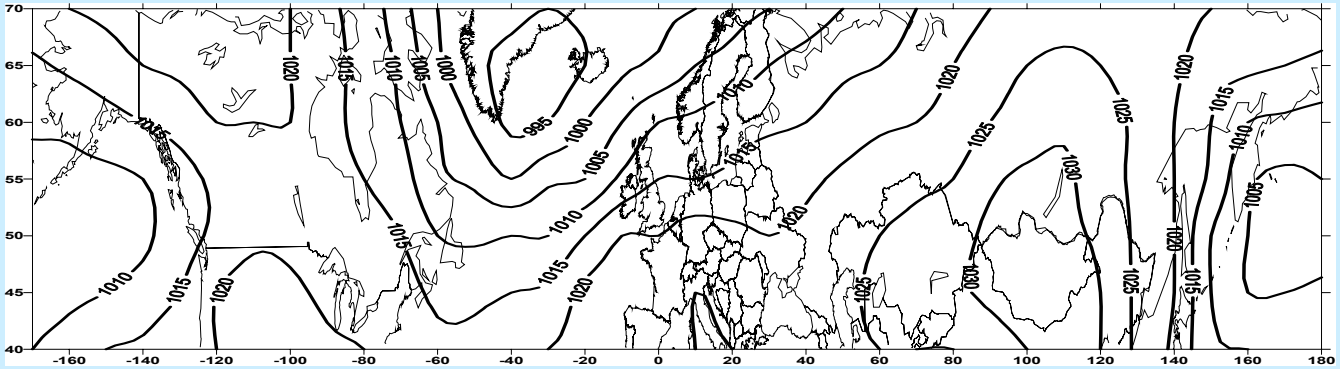
Each period is about 30 years.

The large-scale sea level pressure (SLP) fields during last 100 years



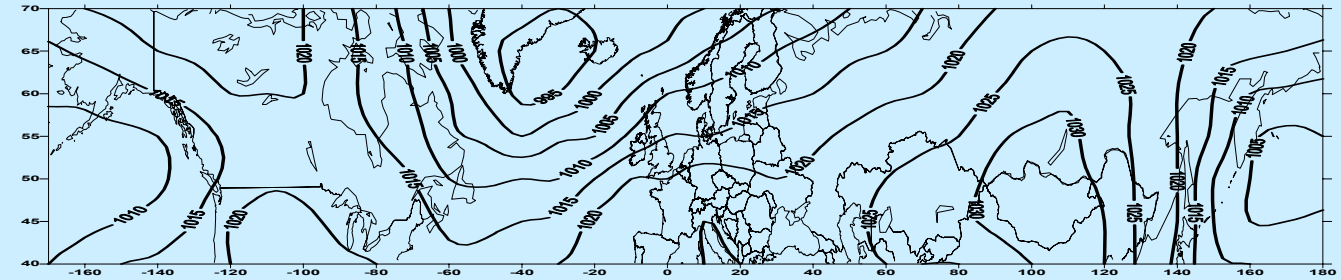
Period of the first warming

1901-910



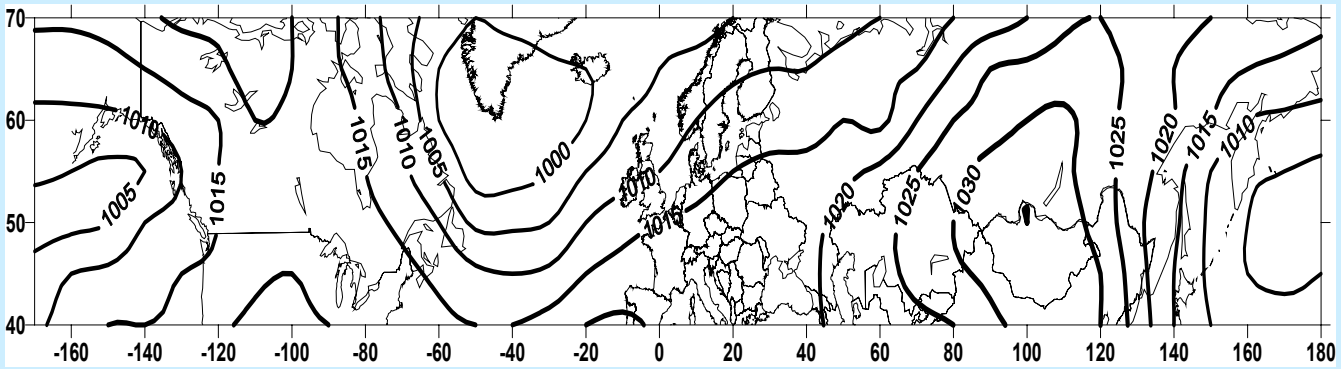
1901-1910

The large-scale sea level pressure (SLP) fields during last 100 years



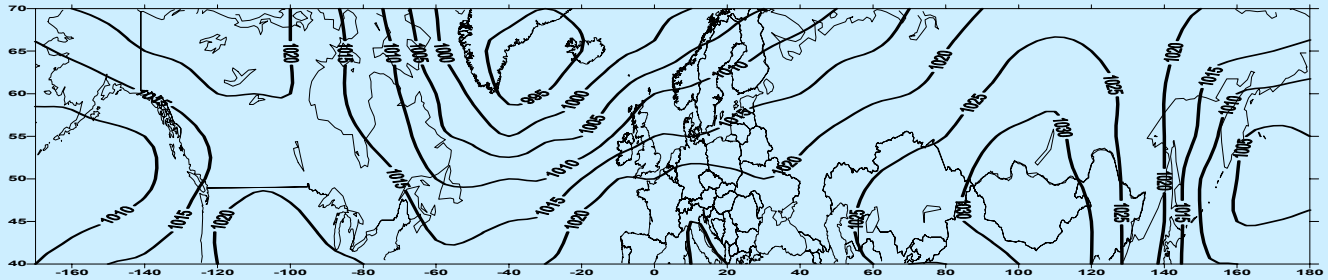
Period of the first warming

1901-910



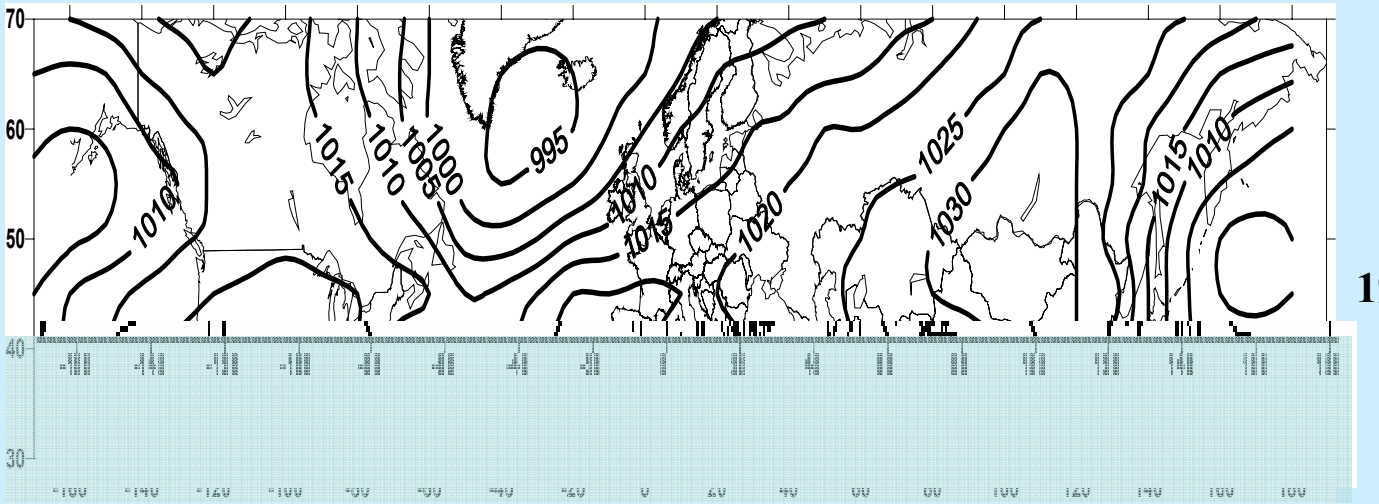
1911-1920

The large-scale sea level pressure (SLP) fields during last 100 years



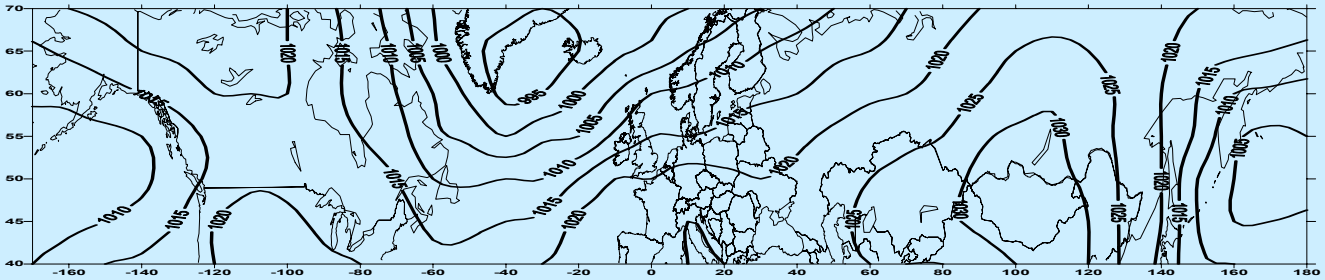
Period of the first warming

1901-910



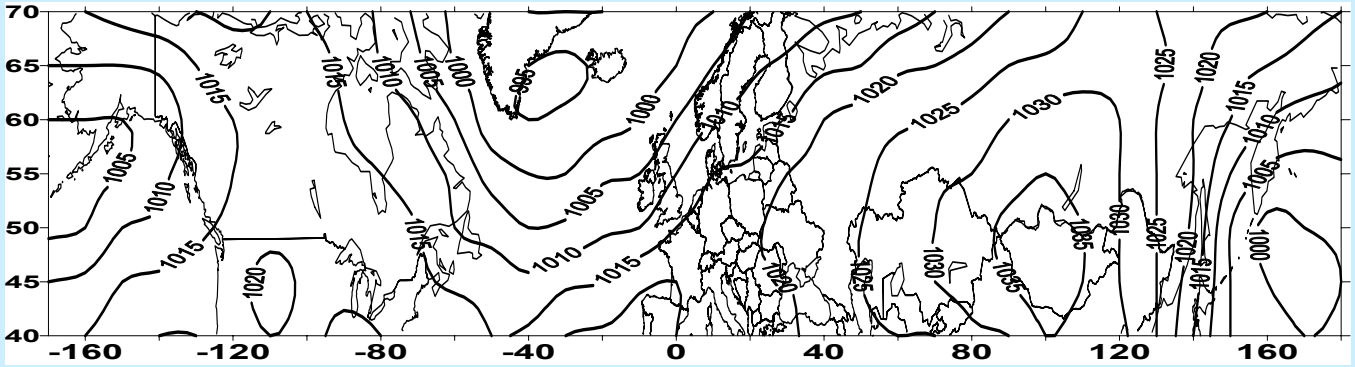
1921-1930

The large-scale sea level pressure (SLP) fields during last 100 years



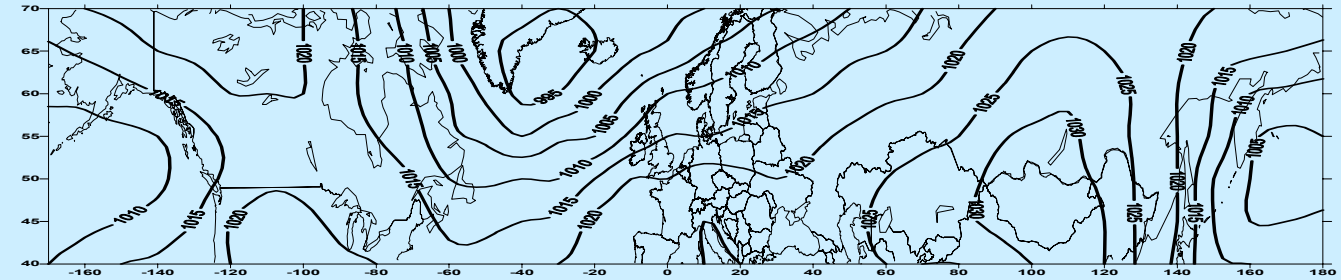
Period of the first warming

1901-910



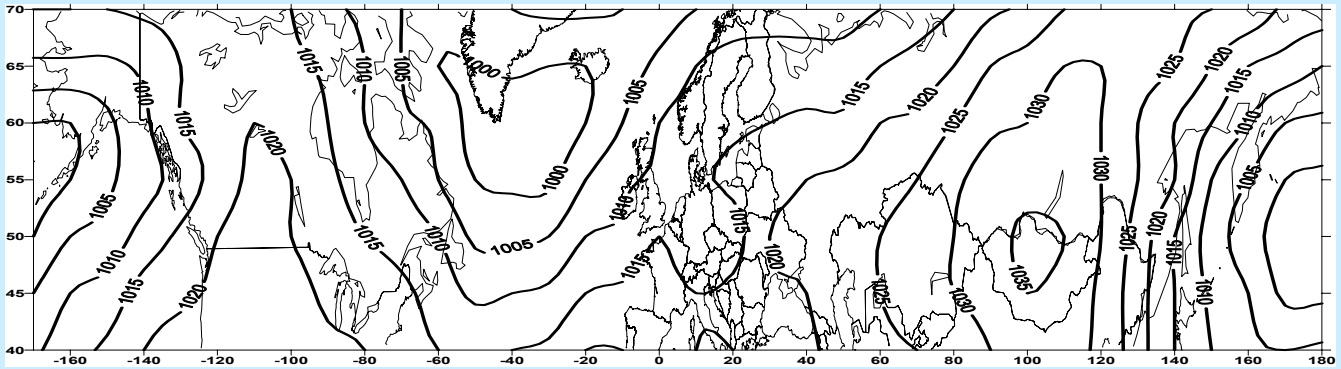
1931-1940

The large-scale sea level pressure (SLP) fields during last 100 years



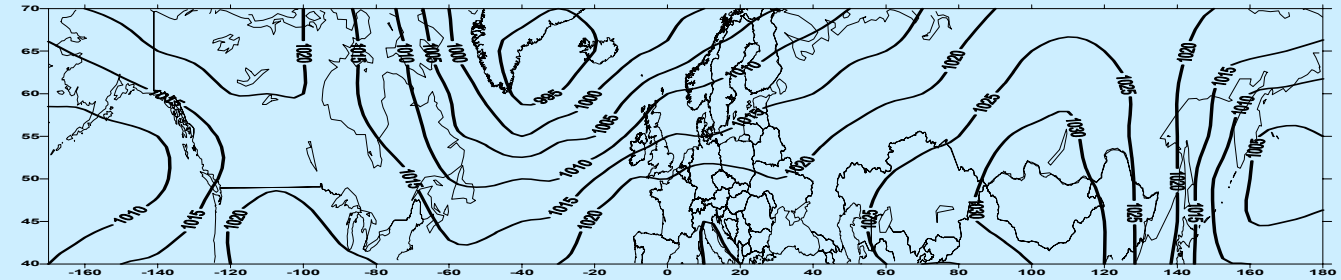
Period of the near stable global temperature

1901-910



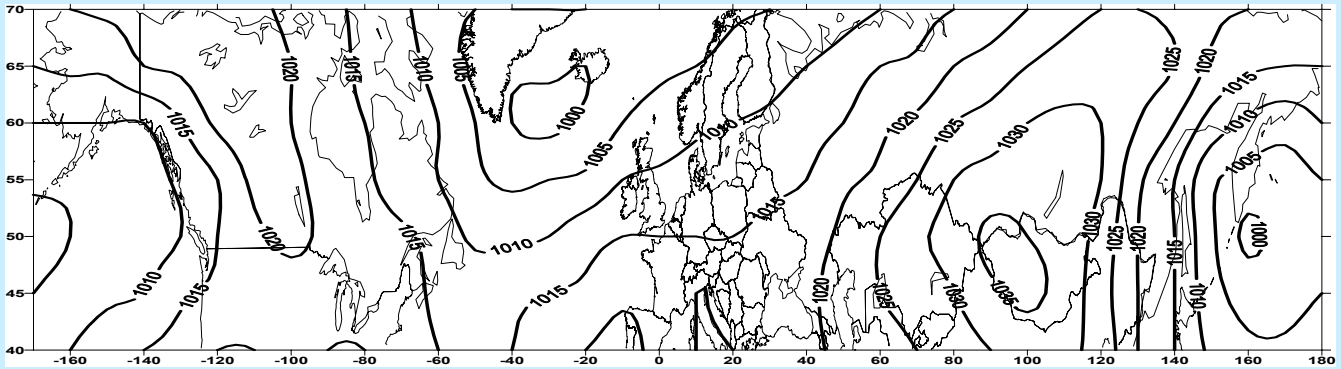
1941-1950

The large-scale sea level pressure (SLP) fields during last 100 years



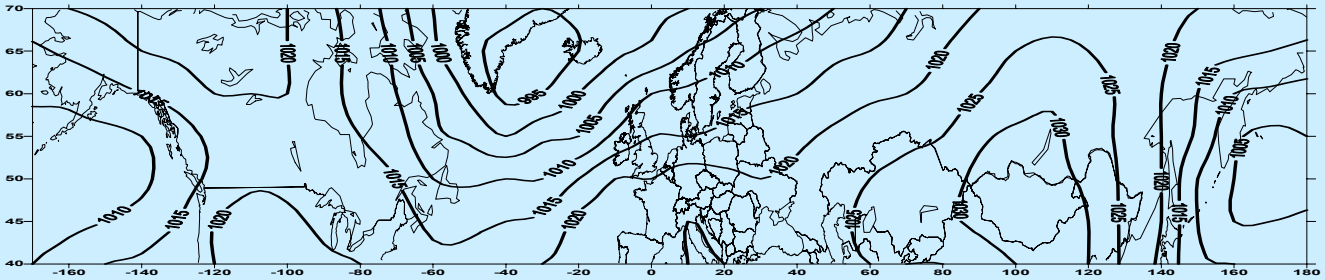
Period of the near stable global temperature

1901-910



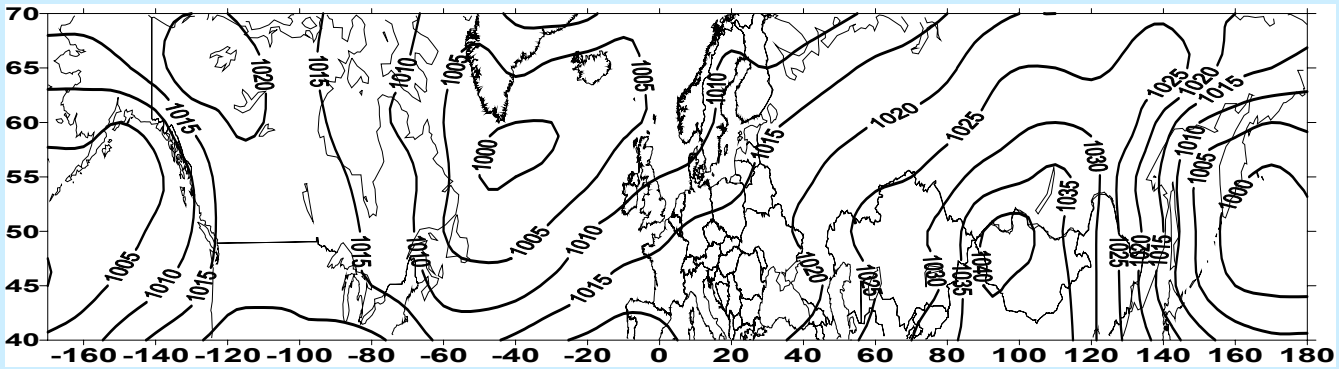
1951-1960

The large-scale sea level pressure (SLP) fields during last 100 years



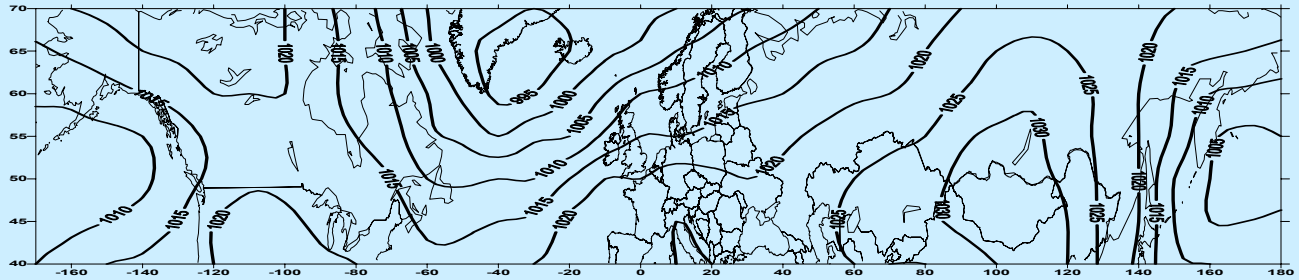
Period of the near stable global temperature

1901-910



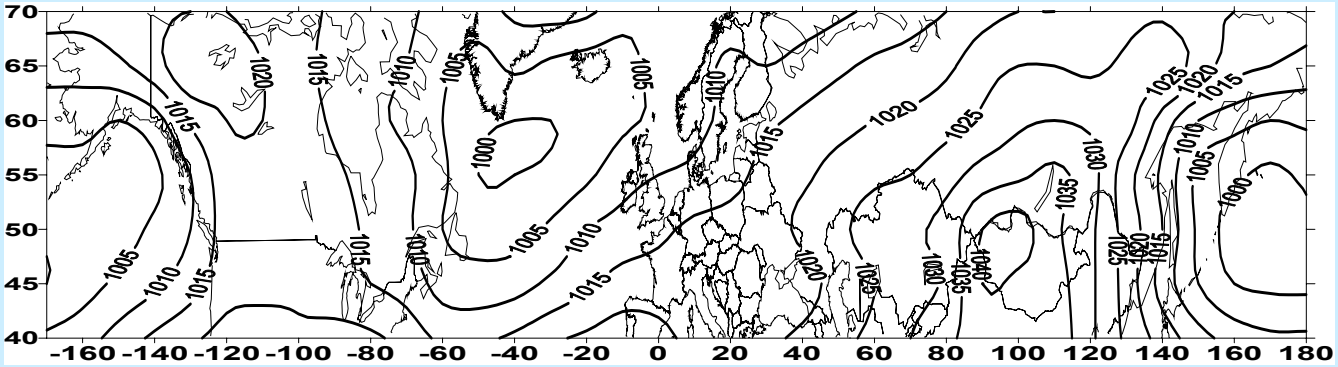
1961-1970

The large-scale sea level pressure (SLP) fields during last 100 years



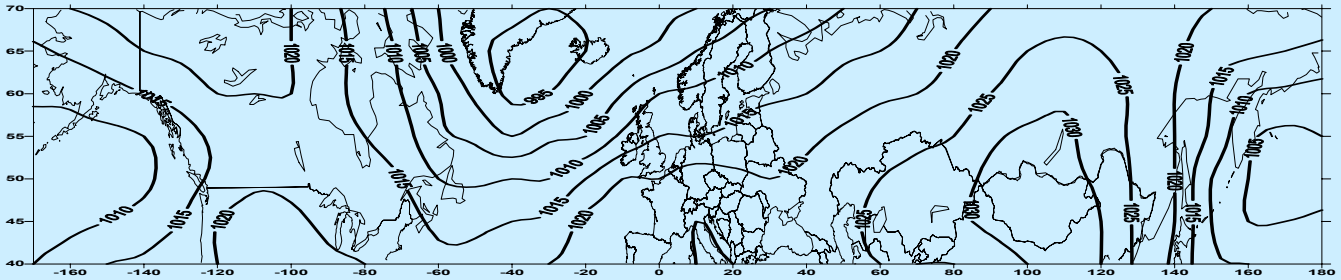
Period of the second warming

1901-910



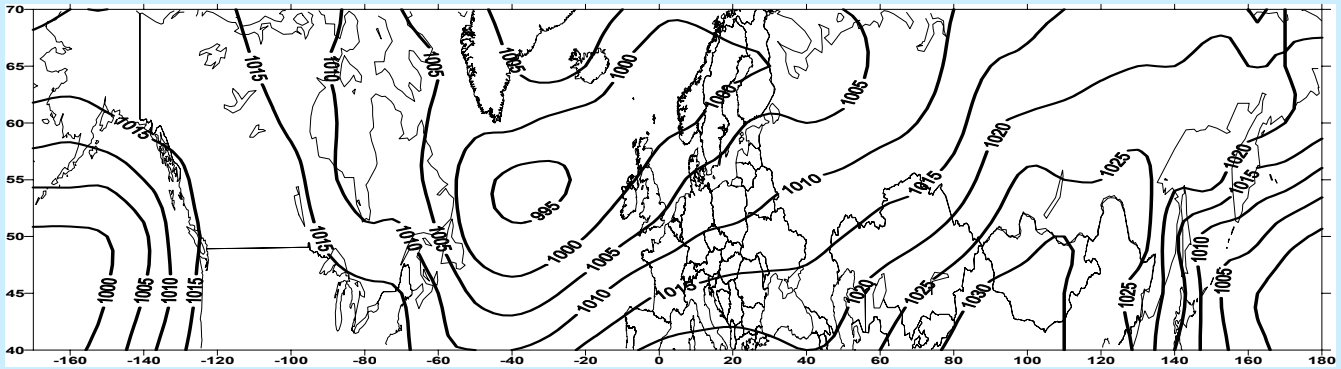
1971-1980

The large-scale sea level pressure (SLP) fields during last 100 years



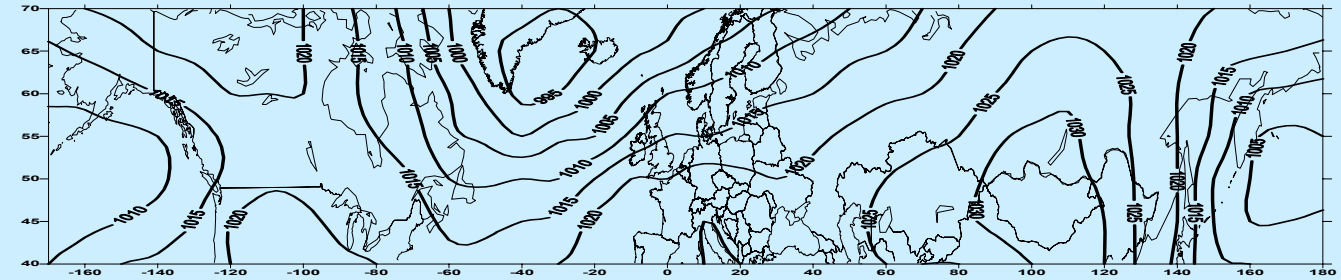
Period of the second warming

1901-910



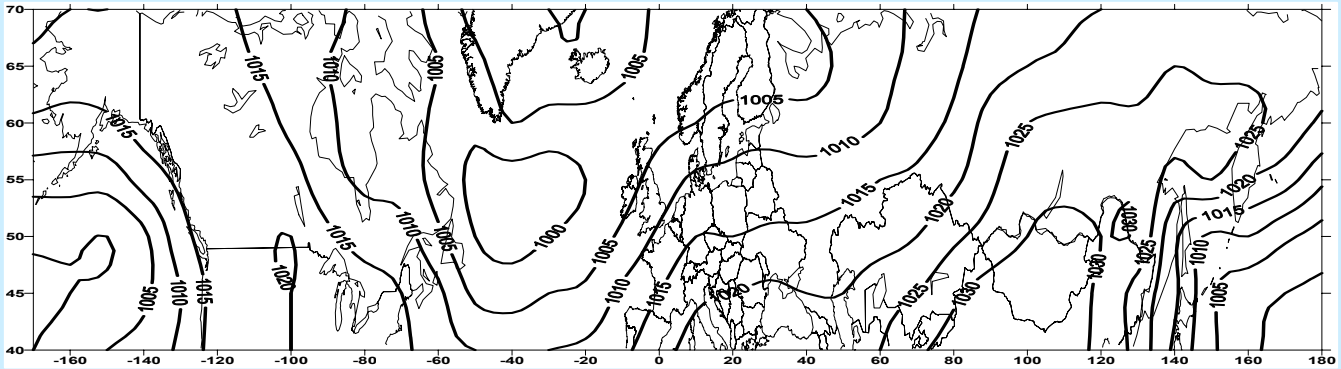
1981-1990

The large-scale sea level pressure (SLP) fields during last 100 years



Period of the second warming

1901-910

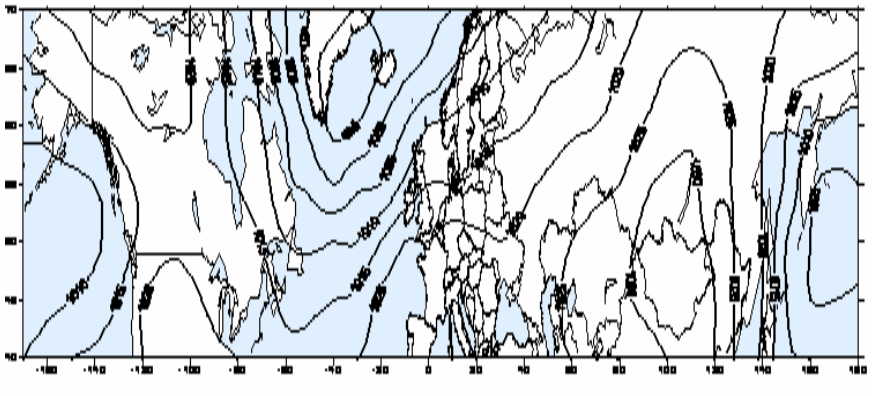


1991-2000

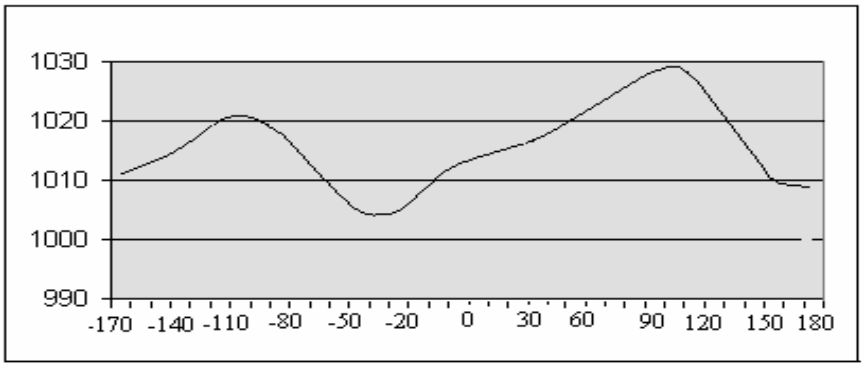
The latitudinal average sea-level pressure fields ($\overline{P}$)

If the pressure fields written as a matrix P with elements which correspond to values of pressure in the point ***j*** and ***i*** of a regular grid of field of our archive for every decade, then $\overline{p_j} = \frac{1}{n}\sum_{i=1}^{N} p_{ij}$

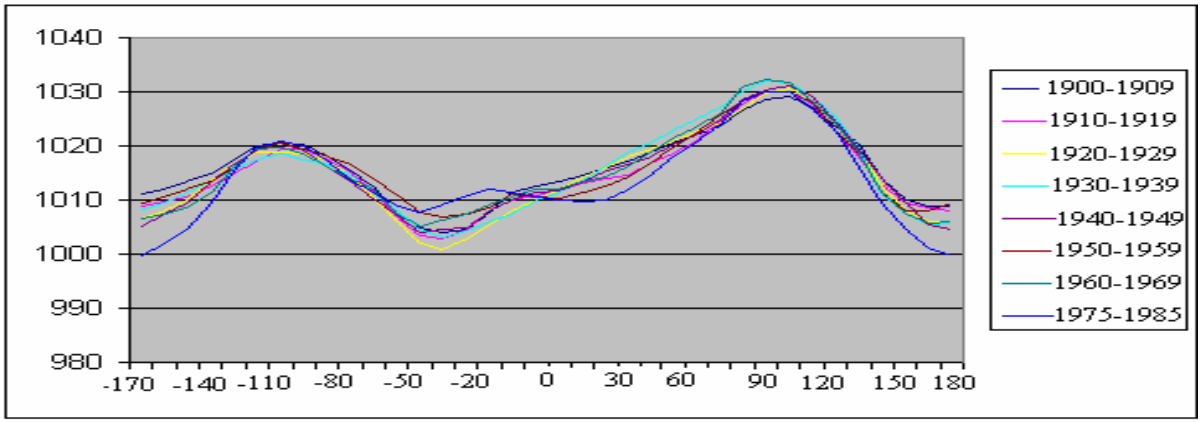
$\overline{P}=\left(\overline{p}_1 \quad \overline{p}_2 \quad \cdots \quad \overline{p}_j \quad \cdots \quad \overline{p}_{n-1} \quad \overline{p}_n\right)$ is latitudinal average sea-level pressure field.



The field of pressure 1900-1909



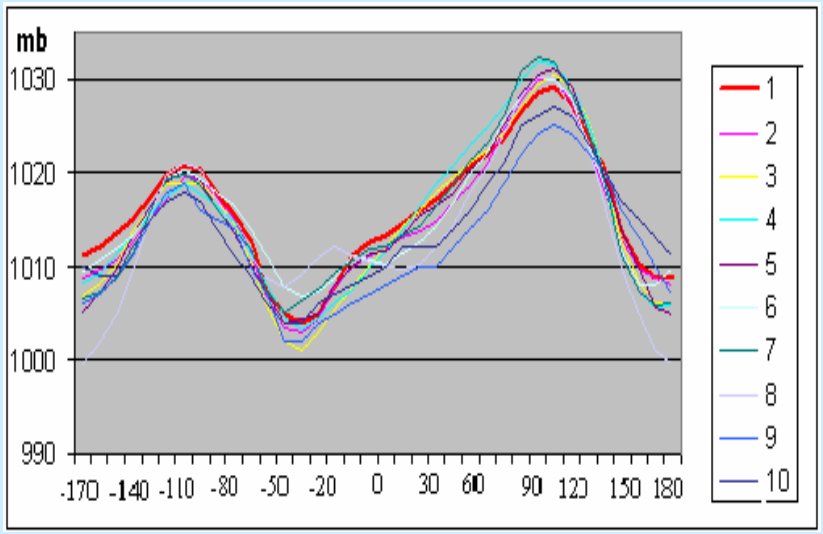
$\overline{P}_1$ **1900-1909**



The latitudinal average of field of pressure XX century

The latitudinal average sea-level pressure fields ($\overline{P}$) from decade to decade in the XX century

The latitudinal average of sea-level of pressure field, XX century

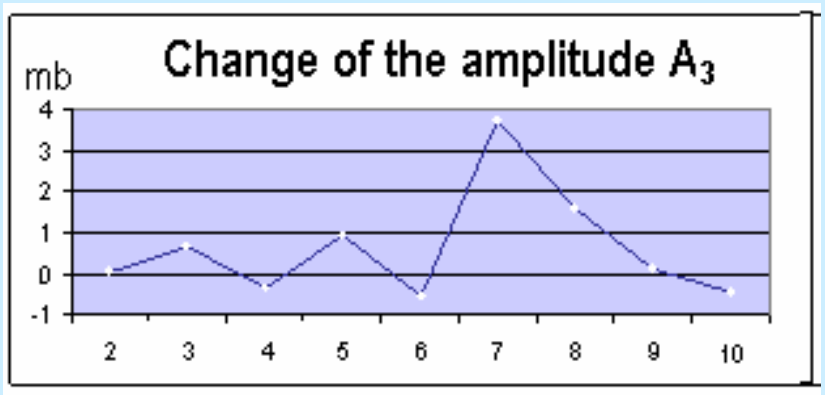


$$\overline{P}=\left(\overline{p}_1 \quad \overline{p}_2 \quad \dots \quad \overline{p}_j \quad \dots \quad \overline{p}_{n-1} \quad \overline{p}_n\right)$$

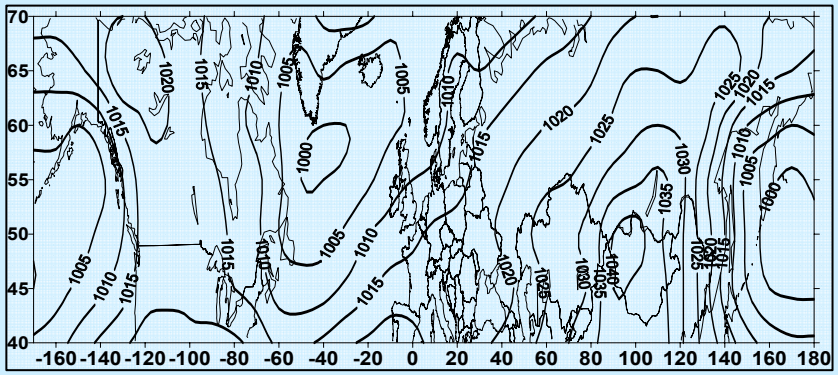
$$\overline{p}(j)=\overline{p}+\sum_{m=1}^{n/2}\left(a_m \cos\frac{2\pi m}{n} j + b_m \sin\frac{2\pi m}{n} j\right)$$

$$\Phi_m = arctg\frac{b_m}{a_m}$$

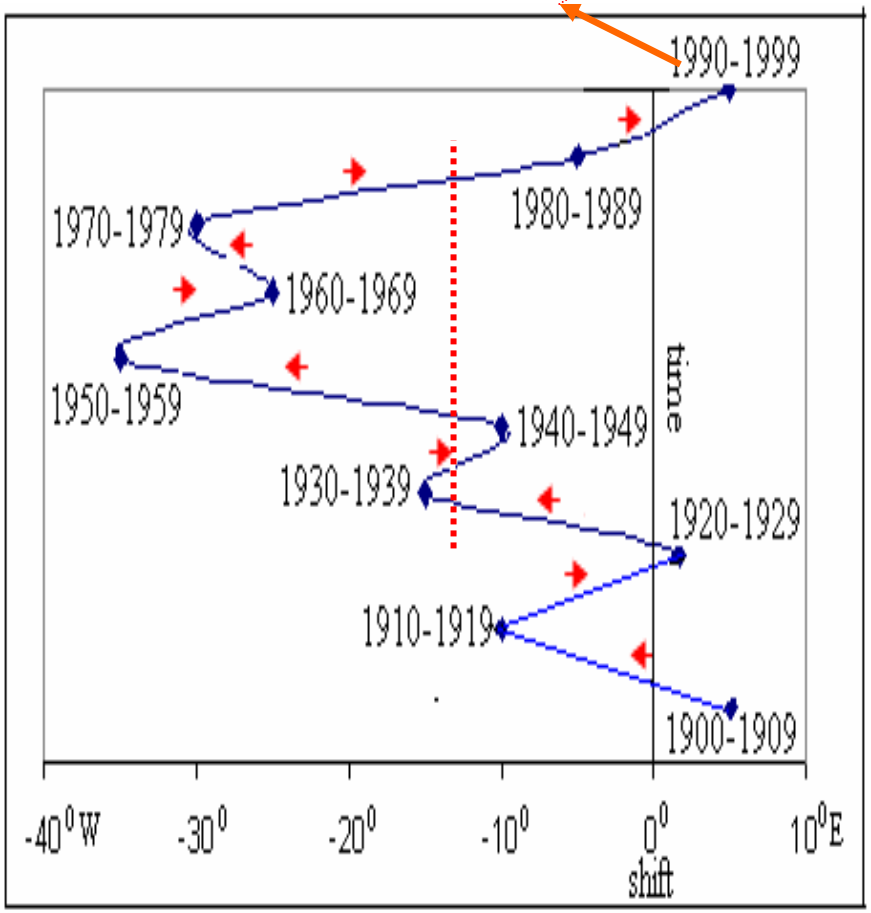
$$\Delta\Phi_m = \Phi_{km} - \Phi_{(k-1)m},$$

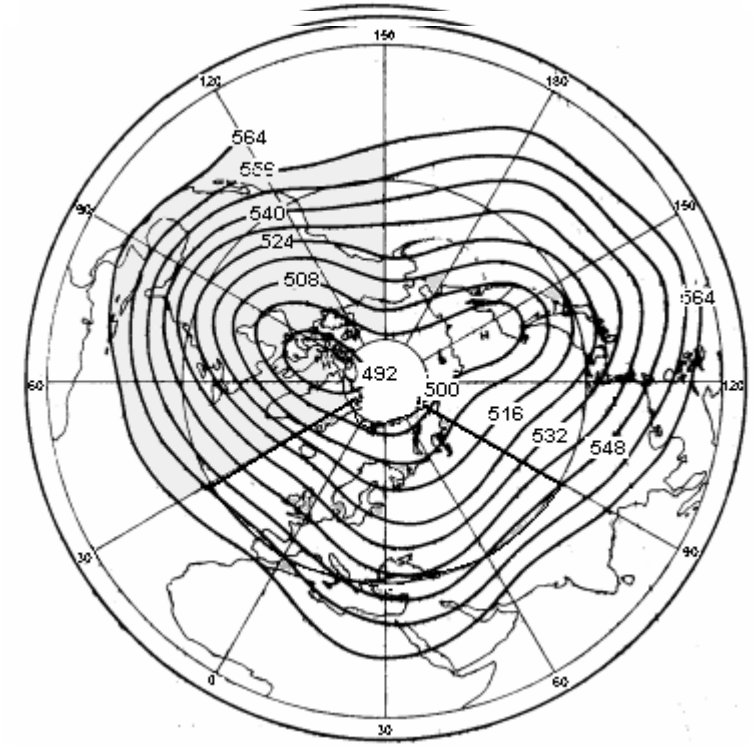


1961-1970



Displacement of the large-scale atmospheric circulation from decade to decade of the XX century over North Hemisphere.





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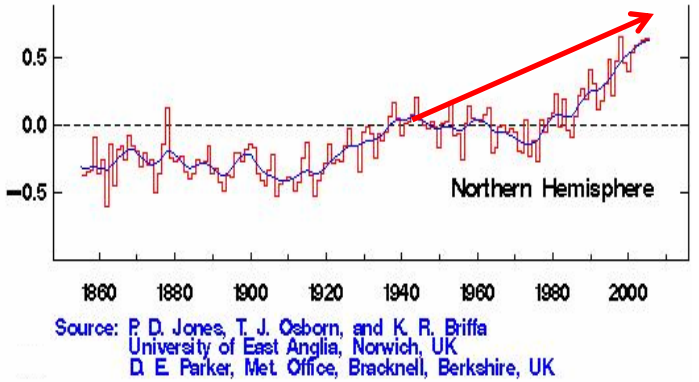
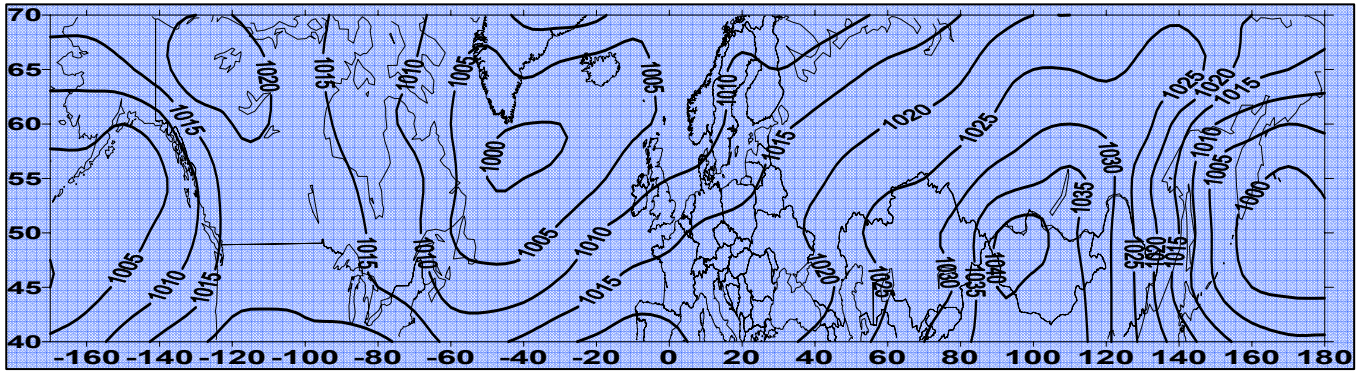
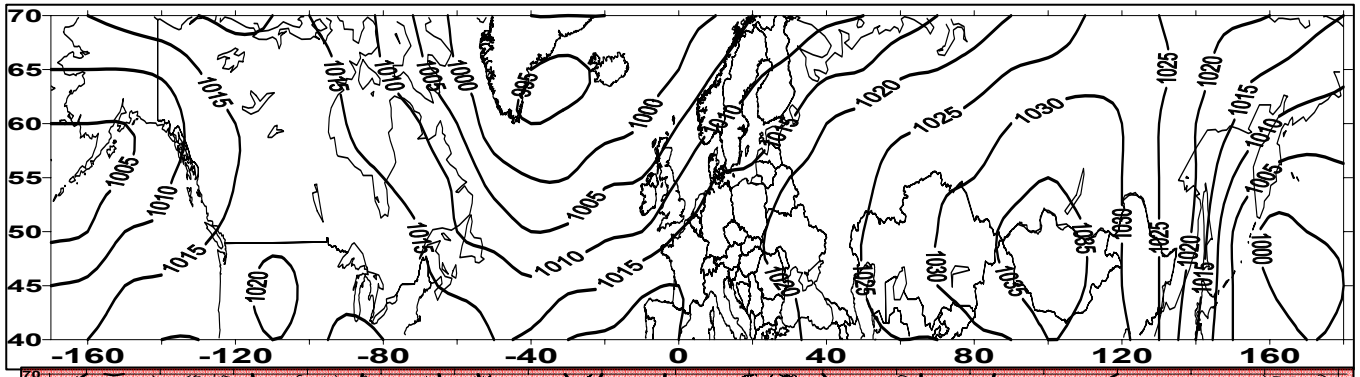
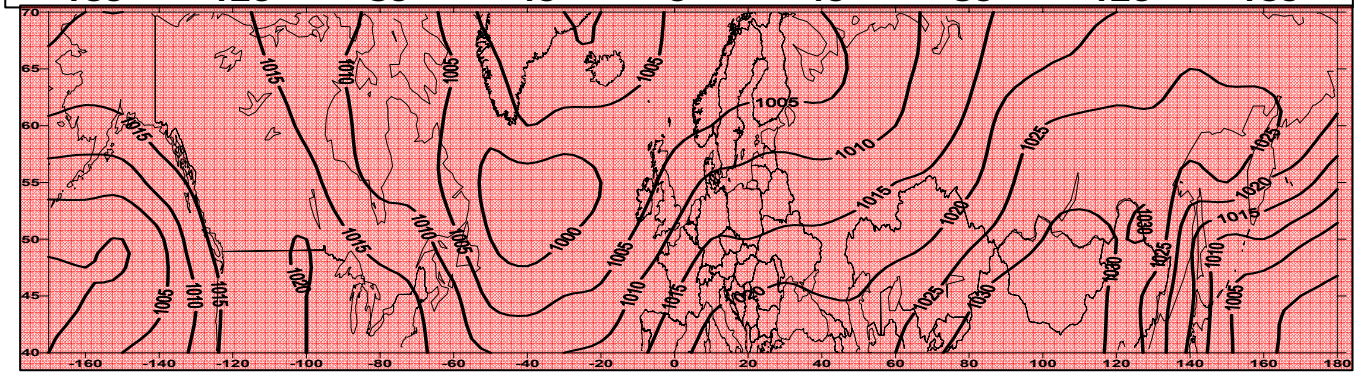




1961-1970
20 град. к западу



1931-1940



1991-2000
20 град. к востоку

2nd Workshop on Mineral Dust, 10-12 Sep. 2003, Paris

Historical Records of Asian Dust Events in Korea

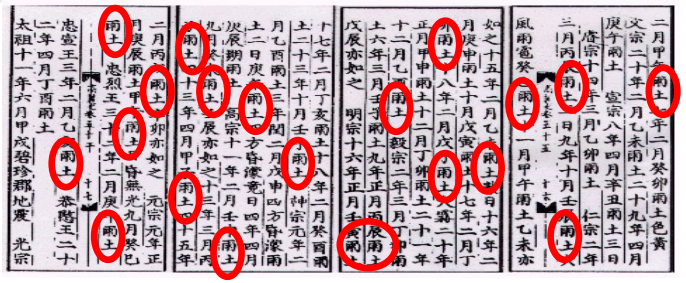
Youngsin Chun
Meteorological Research Institute, Seoul, KOREA

For the understanding of dust phenomena over Korea, climatological dust records were analyzed and compiled. Statements regarding dust events were extracted from ancient books and thoroughly examined to collect as much reliable data as possible.

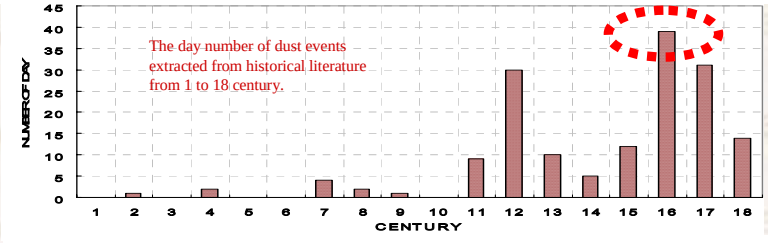
http://yellow.metri.re.kr

Period of the Three Kingdoms (BC 57 - AD 938)

YEAR	MONTH (Lunar)	KINGDOM	ORIGINAL RECORD	MEANING
174	1	Silla	**雨土**	Dust fell like rain.
299	10	Goguryeo	**黃霧四塞**	Yellow fog in all directions
379	4	Baekje	**雨土竟日**	Dust fell all day.
389	2	Silla	**雨土**	Dust fell like rain.
500	4	Silla	京都 **黃霧四塞**	There was yellow fog in all directions in Gyungju, Silla's capital.
606	3	Baekje	王都**雨土晝暗**	The sky of Baekje's capital was darkened like night by dustfall.
627	3	Silla	大風**雨土**過五日	Dust storm lingered over five days.
644	10	Goguryeo	平壤 雪 色赤	Snow tinged with red in Pyungyang.
770	3	Unified Silla	**雨土**	Dust fell like rain.
780	1	Unified Silla	**黃霧**	Yellow fog
780	2	Unified Silla	**雨土**	Dust fell like rain.
850	1	Unified Silla	京都**雨土**	Dust fell in Gyungju, Silla's capital.

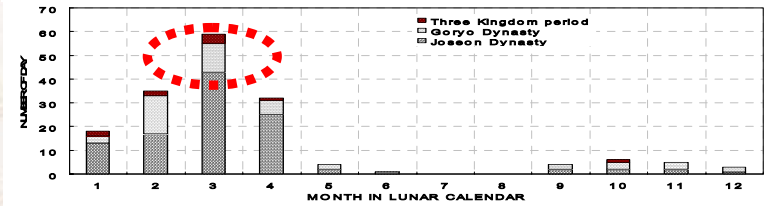


"Woo-Tou" are recorded in Goryeo sa.
At this time, almost all events were observed in the capital.
Out of these records, 50 were about a dust event during from AD 918 to 1392.



During the 16th century, the largest number of dust events was recorded.
However, no record was found for 43 years before and after the war between Korea and Japan in 1592.

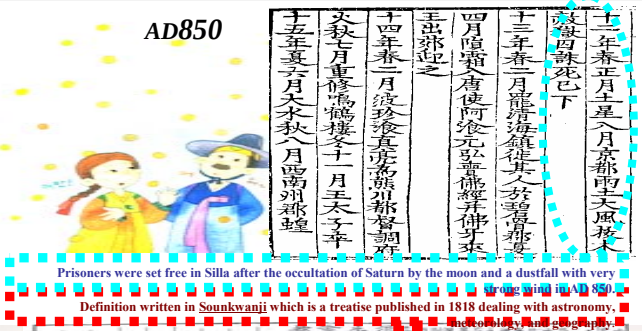
The last historical event was documented in 1784.



The occurrence of dust events mostly concentrated in springtime. March in lunar calendar is almost corresponding to April of solar one.

Even in winter Asian dust events are observed occasionally.

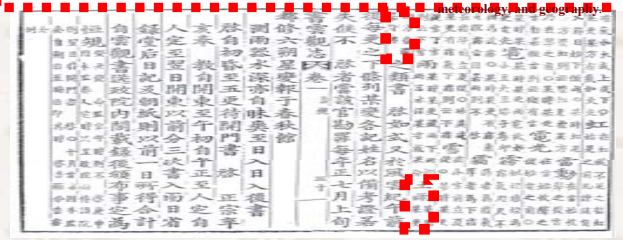
AD850



Prisoners were set free in Silla after the occultation of Saturn by the moon and a dustfall with very strong wind in AD 850.

AD1818

Definition written in Sounkwanji which is a treatise published in 1818 dealing with astronomy, meteorology and geography.



Records of Asian dust events were extracted from the historical chronicles of Korea: Samguk sagi (BC 57 - AD 938), Goryeo sa (918-1392), and Joseon wangjo sillok (1392-1853) and Munhuenbigo (~ 1776). 160 records were retrieved for the period encompassed by the above literature since the first record made in AD 174. Dust events were most frequently called "Woo-Tou" written in Chinese letters. The records show that Asian dust events took place most often during springtime and there was no occurrence during summertime. It is found that this pattern is similar to that of the past century.

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2nd Workshop on Mineral Dust, 10-12 Sep. 2003, Paris

Asian Dust Events in Korea for Recent 100 Years

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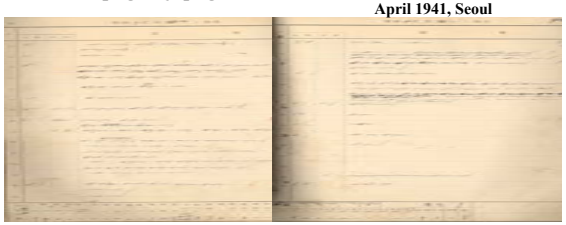
Meteorological Research Institute, Seoul, KOREA

1. Introduction

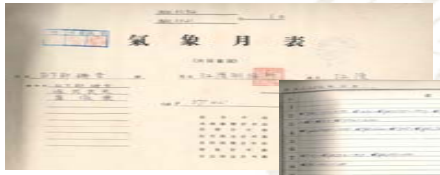
Asian dust days in Korea since 1915 up to 2002 were investigated based on official records of the Asian Dust events.

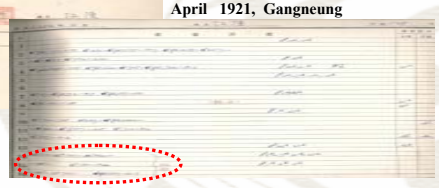
2. Data and analysis method

Monthly report of weather phenomenon was searched page by page to find Asian Dust event.



April 1941, Seoul

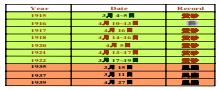




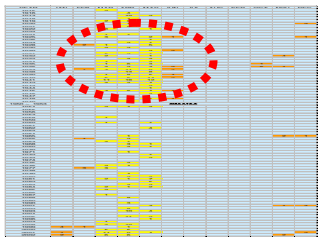
April 1921, Gangneung

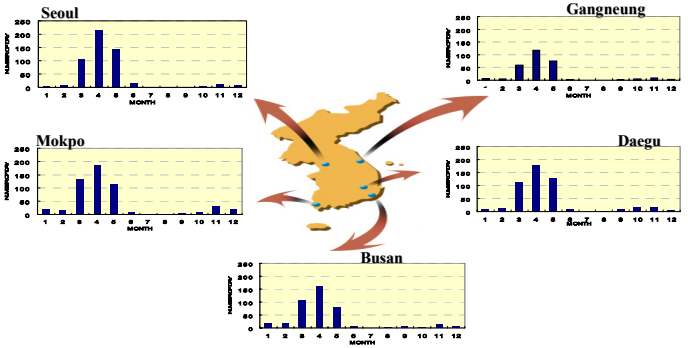
3. Results

Asian Dust code change



1915年 → 1922年 → 1956年 → present





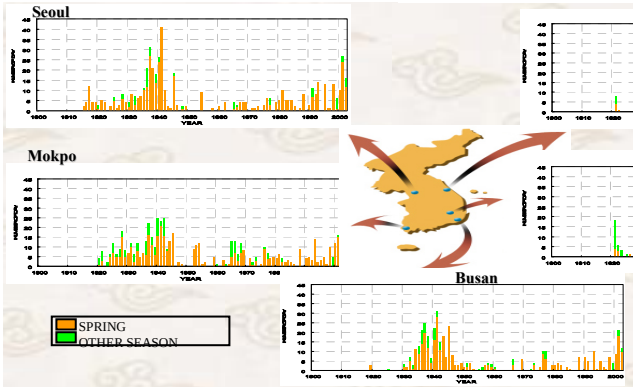
Three different ways recording the Asian Dust events were found ; Chinese character in 1915, code which looks like infinitive with underbar(e.g., ∞) from 1922 to 1955, and c within a box (e.g.,) after 1956 until now. Based on these three dust codes, recent 100 year's Asian Dust days were analyzed.

The occurrence frequency of Asian Dust days

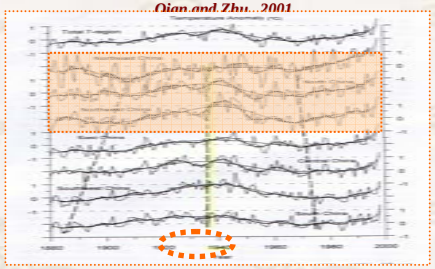
unit: %

Station \ Month	1	2	3	4	5	6	7	8	9	10	11	12
Seoul	1.3	4.5	20.6	40.8	27.7	3.0	0	0	0	1.3	1.9	1.7
Mokpo	3.6	2.9	24.2	33.3	20.6	1.6	0	0.7	1.3	1.6	6.1	4.0
Busan	3.8	4.5	26.0	38.2	19.3	1.7	0	0.2	1.2	0.2	3.3	1.7
Daegu	2.0	2.8	22.5	35.7	25.9	1.6	0	0.6	1.4	3	3.4	1.0
Gangneung	2.4	1.4	20.6	40.6	26.2	1.0	0	0	1	1.7	3.1	1.3
Mean	**2.6**	**2.7**	**22.8**	**37.8**	**23.9**	**1.8**	**0**	**0.3**	**1**	**1.6**	**3.6**	**1.9**

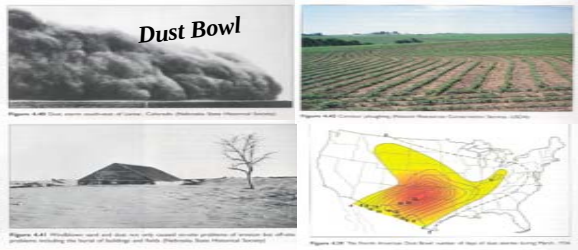
The occurrence of dust events mostly concentrated in springtime showing 85% frequency during recent 100 years. April is the best season to observe Asian Dust events. Even in winter months from November to February, Asian Dust events are observed occasionally.



There is two pecks in late 1930's and recent year.
These characteristics are shown at 5 stations.



There was a distinct warm period of northern China in 1930's and 1940's.



Furthermore dust storm occurred in America many times during 1930's because of the severe drought and desertification(UNEP, 1997).

4. Summary

a. The large number of Asian Dust days appeared mainly from 1930's to early 1940's.
(Severe dust year : 1941 (41 days) in Seoul, 1940 & 1942 (21 days) in Mokpo,
1941 (31 days) in Busan, 1936 (33 days) in Daegu, 1936 (24 days) in Gangneung.)
b. Average number of Asian Dust days were 5.8 in Seoul, 6.1 in Mokpo, 4.2 in Busan,
5.2 in Daegu and 3.3 in Gangneung a year.
c. Occurrence frequency in springtime : 89.1% in Seoul, 78.1% in Mokpo,

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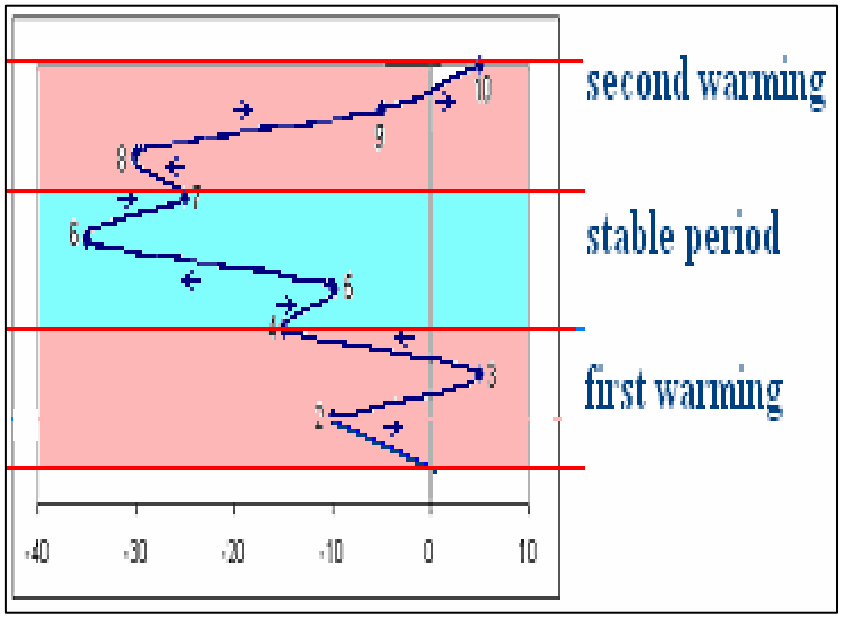


Fig. 13.
Displacement of the large-scale atmospheric circulation from decade to decade of the XX century over North Hemisphere.

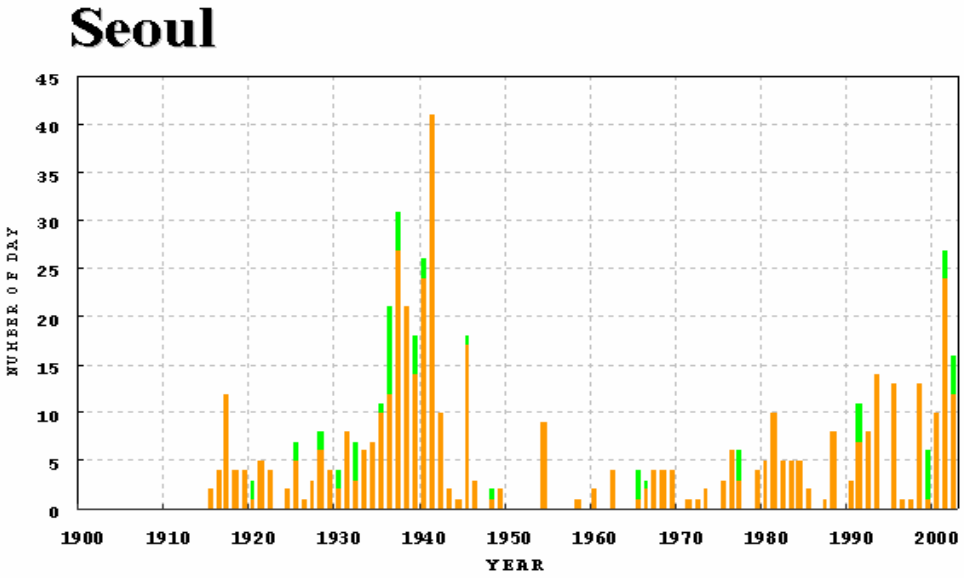
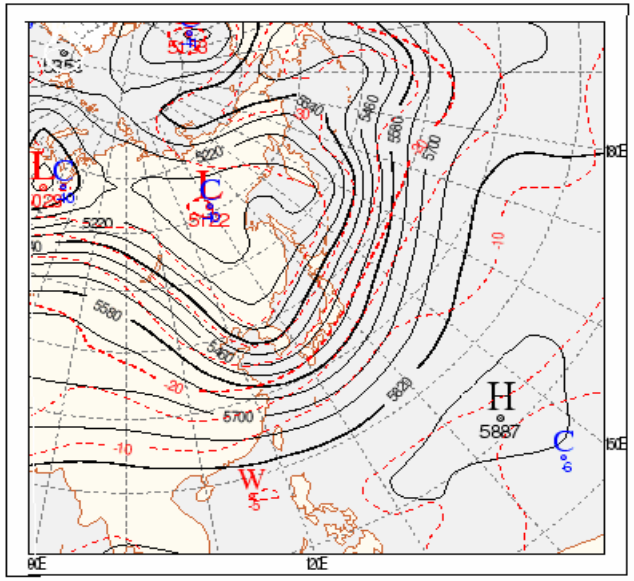


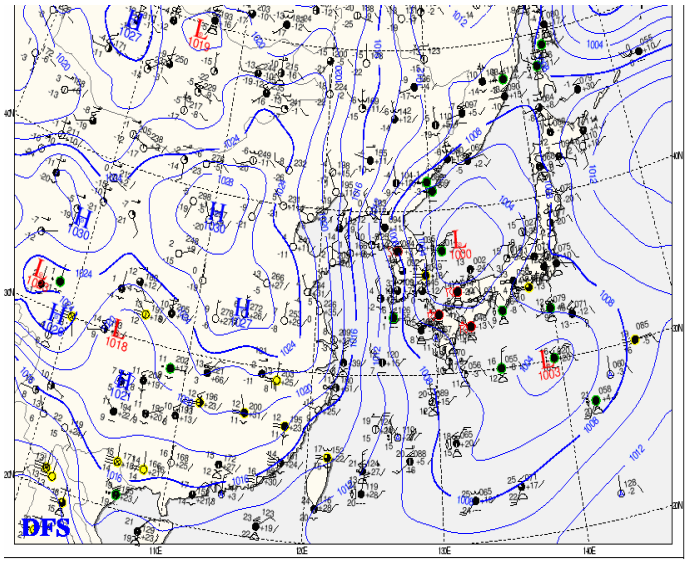
Fig. 14.
Number of the yellow sand during XX century (from the data KMA)

Etalons of fields of pressure and 500 hPa of the two most probable classes with “yellow sand” event over Korea.

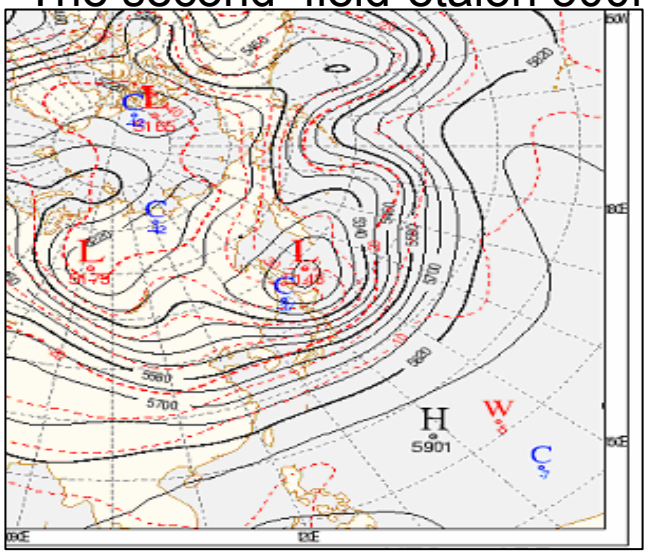
The first field-etalon 500hPa



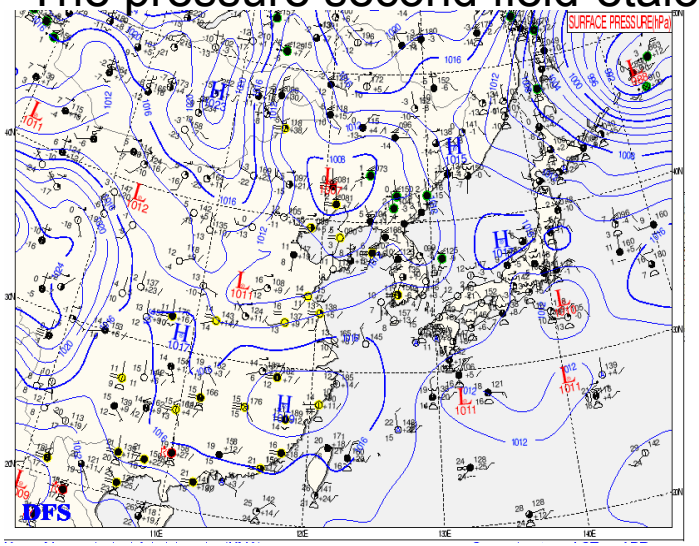
The pressure first field-etalon



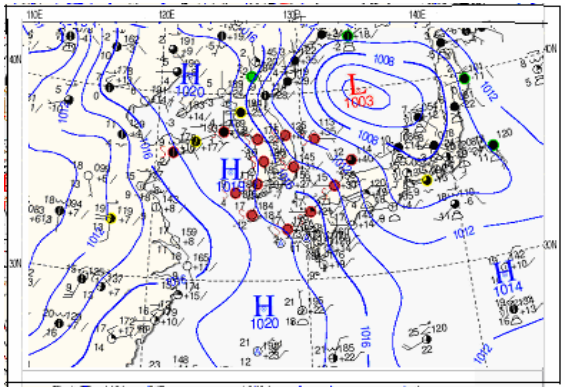
The second field-etalon 500hPa



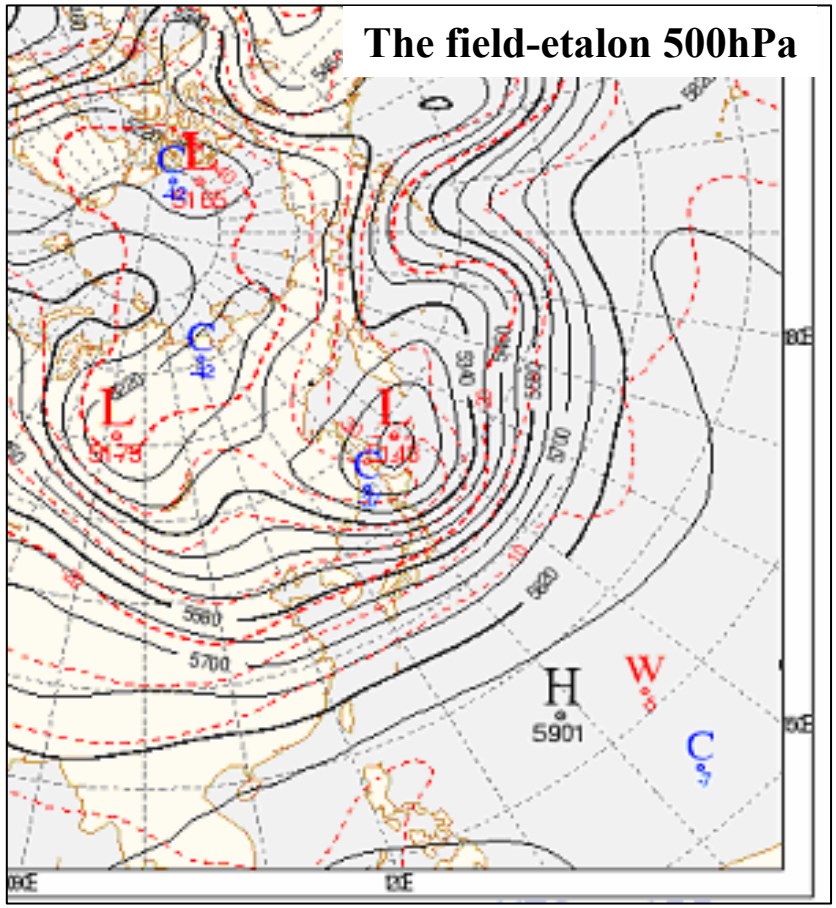
The pressure second field-etalon

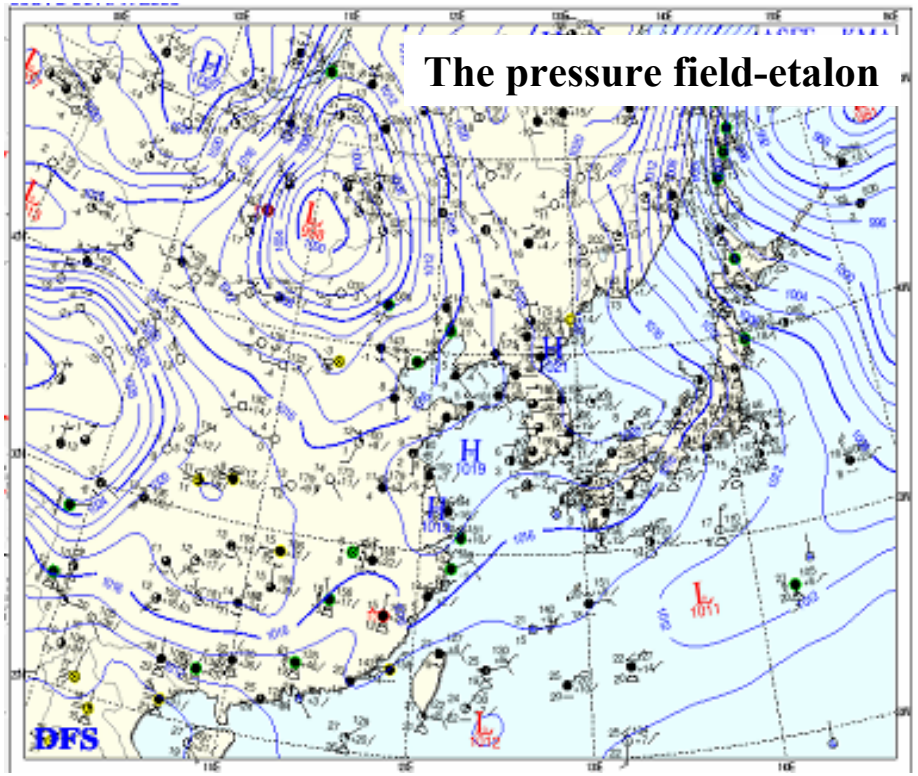


Etalon of class of synoptic situation for forecast of the “yellow sand” event in the next day in Korea



The synoptic situation of the “yellow sand” the next day





- **Conclusions:**

- **Displacement of large-scale atmospheric circulation to the west relative to its equilibrium position (1931-1940gg) at 20 degrees leads to a cooling of virtually all areas of the Northern Hemisphere.**

- **Displacement of large-scale atmospheric circulation to the east relative to its equilibrium position (1931-1940gg) at 20 degrees leads to a warming of virtually all areas of the Northern Hemisphere.**

- **Period of oscillation of large-scale atmospheric circulation is about 50-60 years and corresponds to a shift to the west-east ± 20 degrees.**

- **In the early twenty-first century, large-scale atmospheric circulation again shifted to the west to the equilibrium, as well as frosty winters, which have become manifest in recent years.**

  .

Conclusions:

1.The greatest number of cases of yellow sand have when you move the circulation from the east through the equilibrium position

2.The extreme shift of the atmospheric circulation to the west leads to a sharp decrease in the number of cases of yellow sand.

3.We must assume that the movement of circulation from the east to the equilibrium state will increase in the incidence of yellow sand in the coming decades.

4.This very important result gives the possibility of long-term benchmark of the nature of particulate air pollution over South Korea in the coming decade.