

Long-time changes of the summer atmospheric circulation over East Asia and variation moisture content in the Selenga River basin



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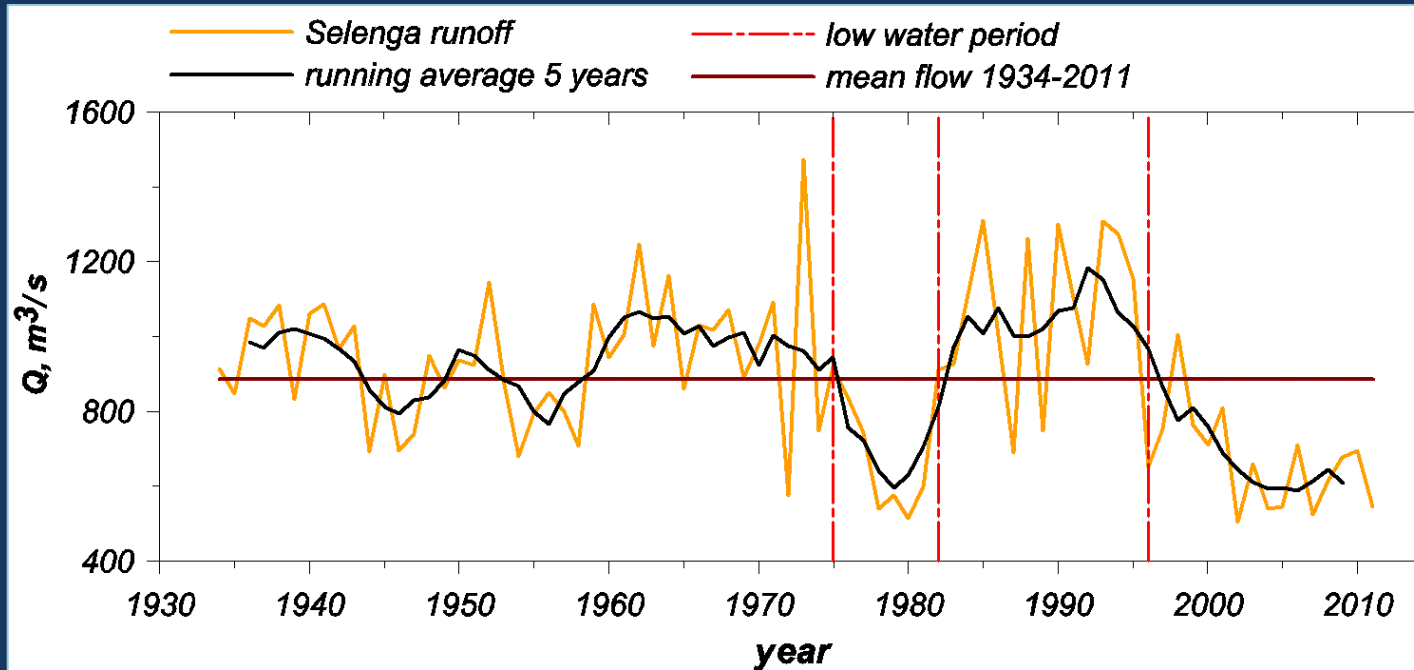
1. Study Motivation

The most part of the Selenga River basin (63%) are in Mongolia and remaining 27% are in Russia. The Selenga River and its confluents are the main water supply source for Mongolia. The water inflow of the Selenga River forms about half of the Baikal Lake's inflow. The low inflow is threat of hydropower potential in Angara HPPs cascade.

The basin is located in the north of the arid zone of the Asian continent. Despite of this fact, the most part of basin receives a significant amount of rainfall. Most of it falls in a short period in summer, while June-August months contain 60% of total annual rainfall. It could be 90-100 mm of rainfall in each of these months.

Rainfall has significant interannual variability in this location. Droughts can follow by abnormally high rainfall and vice versa.





Pic. 1. Change of the Selenga River runoff (June-august) recording station Mostovoi)

Since 1996 there are a decrease of water content of the Selenga River. It has been suggested that the observed reduction in runoff is regular low-water period replacing the period of high water content. Alternating periods of high and low water content is typical for the this basin in the past. According to forecasts, this low-water period have to finish in 2001-2003. However, the reduction in runoff is observed for 16 years.

Besides this low-water period another important feature of investigated time interval is significantly broken runoff homogeneity in 70s. After 1970s the Selenga's runoff variations is characterized by more high variability.

2. Why the runoff is reduced?

The reason for reducing the runoff of the Selenga River is a significant decrease in rainfall in the northern part of East Asia in the summer.

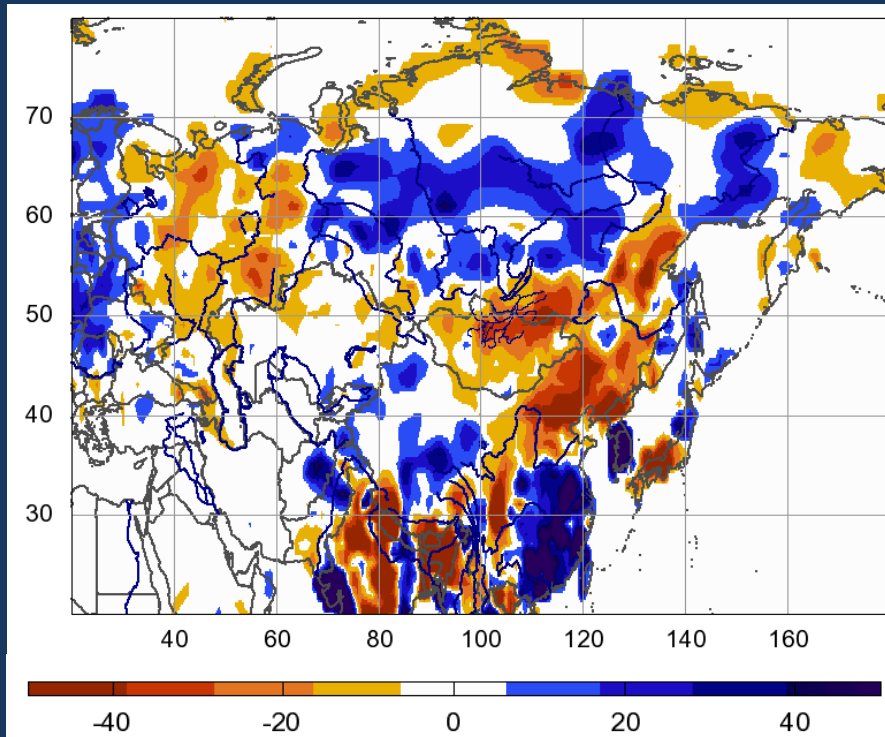


Fig. 2. Precipitation anomaly for summer (June-august) 1996-2011 in mm/month. Deviation from normal 1950-1990. (based on the GPCC data – Global Precipitation Climatology Centre)

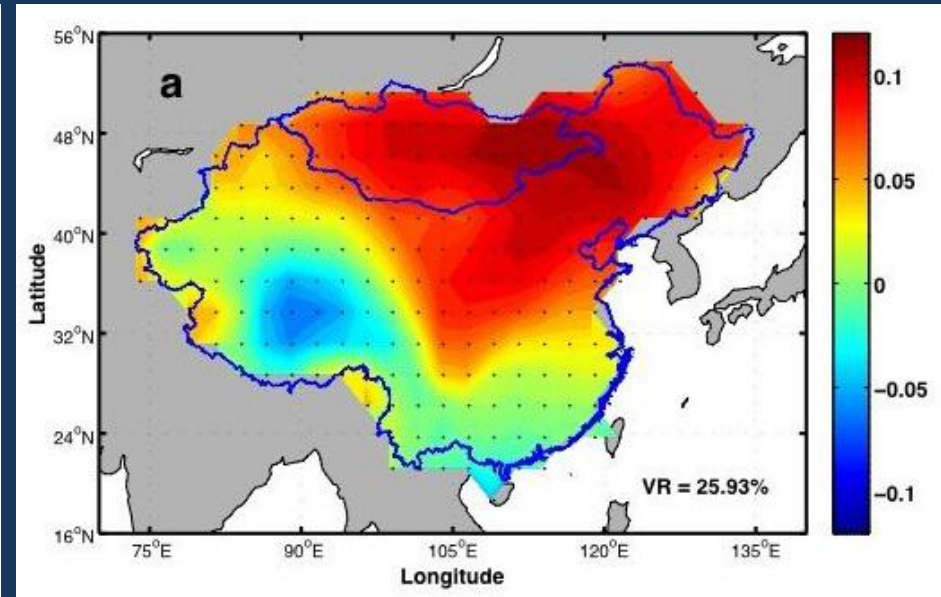
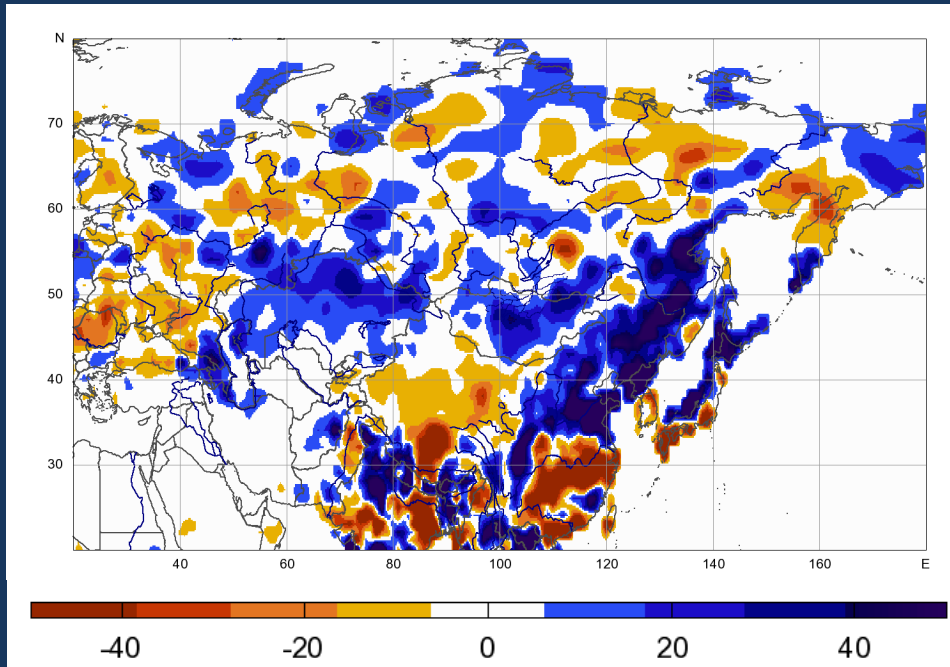


Fig. 3. Spatial pattern of the leading EOF of summer PDSI over China/Mongolia (Li et. al., 2009)

**Spatial distribution of rainfall in
1996-2011 in East Asia
«Dry in North – Wet in South»**

Spatial pattern of rainfall in summer over Asia in high water period of the Selenga River runoff



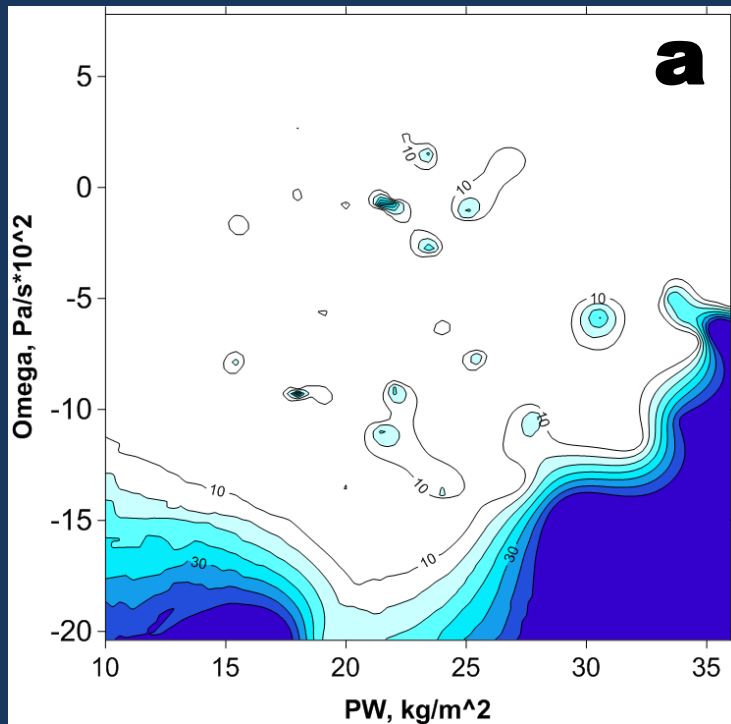
The structure of rainfall distribution «wet-in-north/dry-in-south» comparable with contemporary one in intensity, but opposite in type was observed in 50-60s of last century.

Fig. 4. Precipitation anomaly for summer (June-august) 1955-1965 in mm/month. Deviation from normals 1950-1990. (based on the GPCC data)

Reference

- Qian W., Q. Hu, Y. Zhu, D.-K. Lee *Centennial-scale dry-wet variations in East Asia // Climate Dynamics, 2003, Vol. 21, pp. 77-89*
- Shen C., Wang W.-C., Peng Y., Xu Y., Zheng J. *Variability of summer precipitation over Eastern China during the last millennium // Clim. Past, 2009, vol. 5, 129-141*
- Li et al., *Summer monsoon moisture variability over China and Mongolia during the past four centuries, Geophys. Res. Lett., 2009, Vol. 36*

3. Conditions of rainfall productions in the Selenga River basin

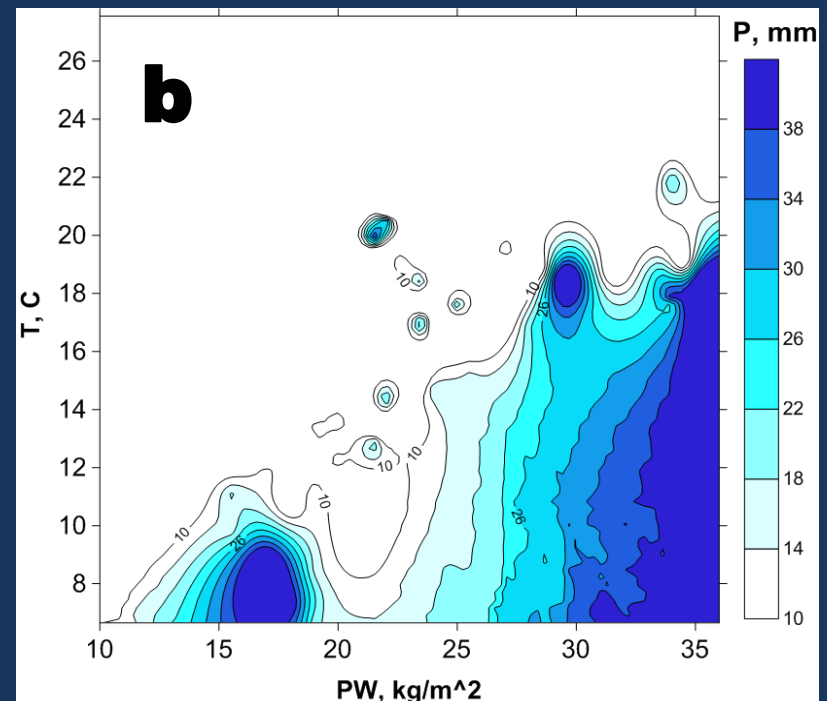


Rainfall of summertime

Early and late summer - low precipitable water

Midsummer - high precipitable water

Fig. 5. Distribution of summer rainfall production (based on the measurements station Kyakhta and Ulan-Ude) depending on the combination of precipitable water and vertical velocity (a); precipitable water and surface temperature (b)



4. Interannual variation of precipitation in June

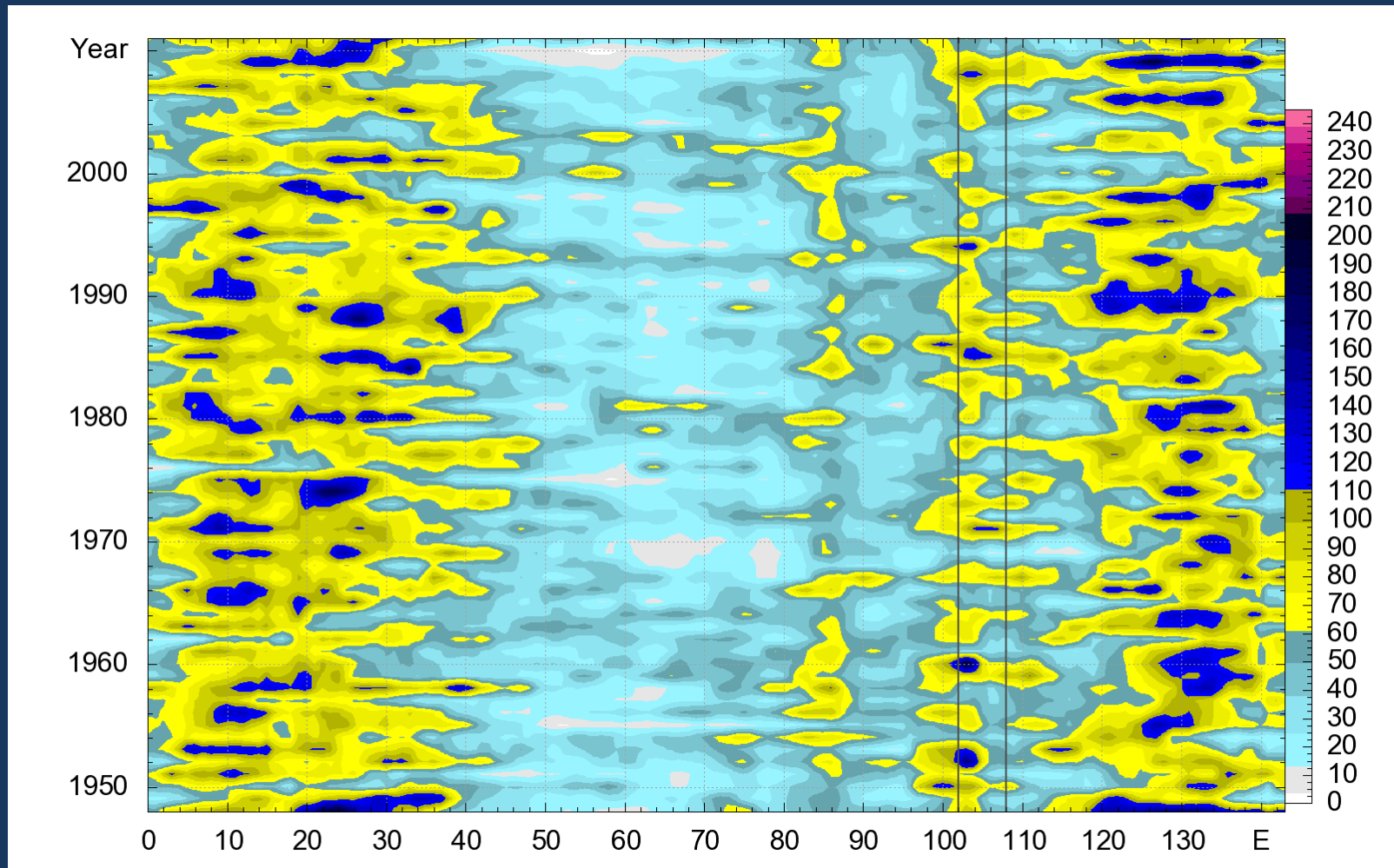


Fig. 6. Time-longitude cross-section of changes (mm) in June total precipitation averaged in latitude area 40 –50 N for 1948–2011.

4. Inerannual variation of precipitation in July

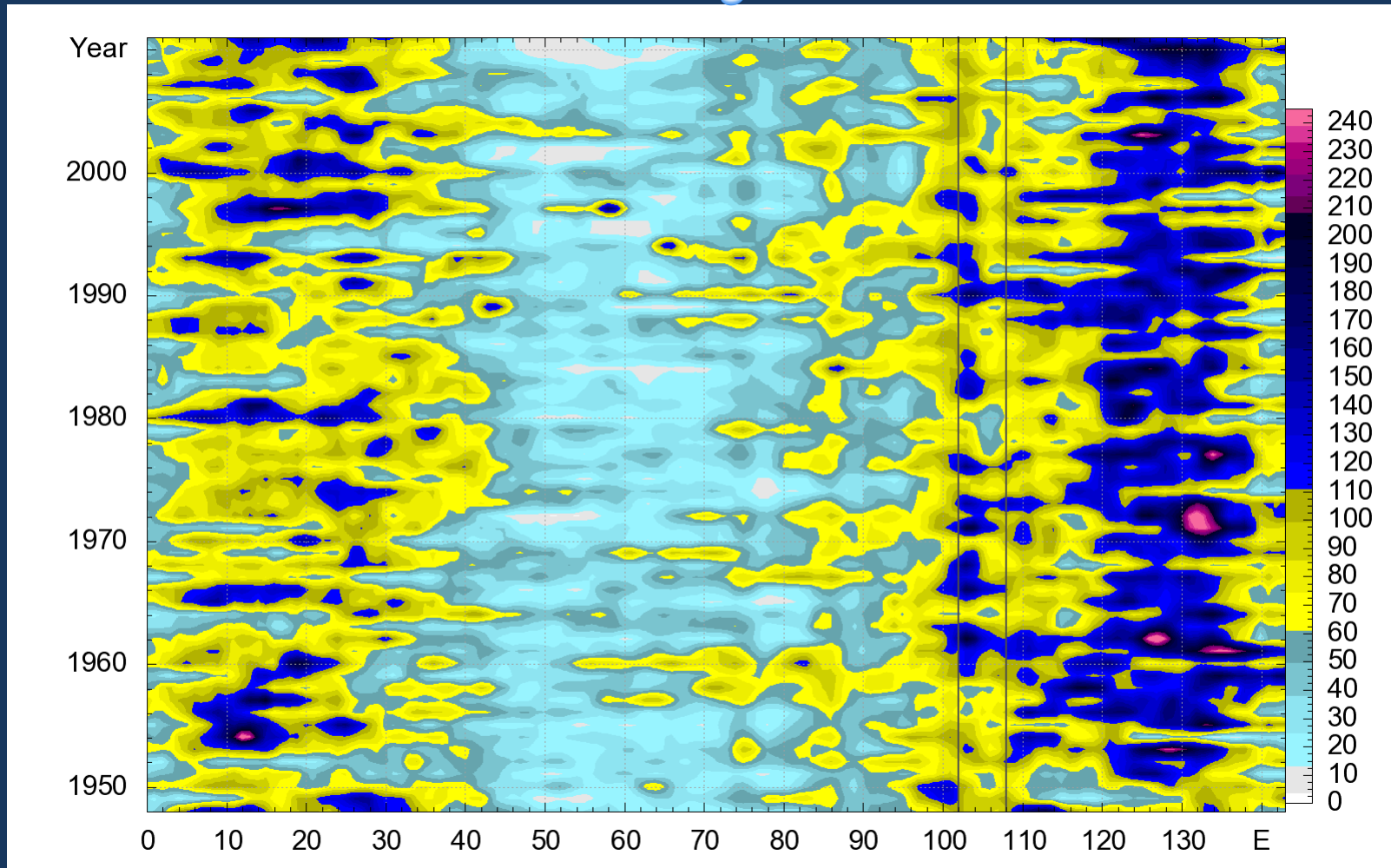


Fig. 7. Time-longitude cross-section of changes (mm) in July total precipitation averaged in latitude area 40 –50 N for 1948–2011.

5. Interannual variation of factor influencing the formation rainfall in midsummer

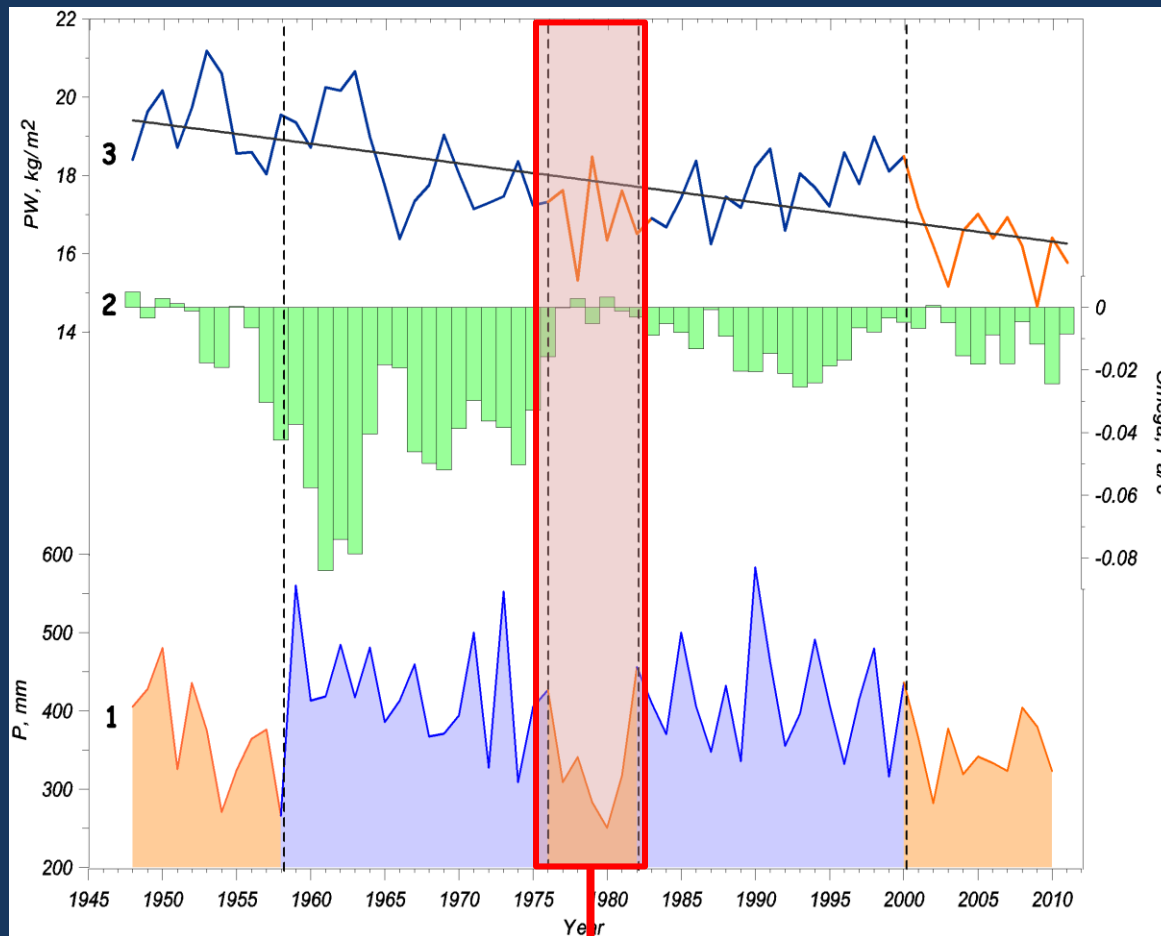


Fig. 8. Variation of 1948-2010 total precipitation (based on the GPCC data (1), average precipitable water (3) and average vertical velocity (2) based on the NCEP/NCAR Reanalysis 1 data (in the Selenga River basin from 20 June to 10 august)

Climatic shift in the late 70's

6. What is the reason for reducing the precipitable water in the Selenge River?

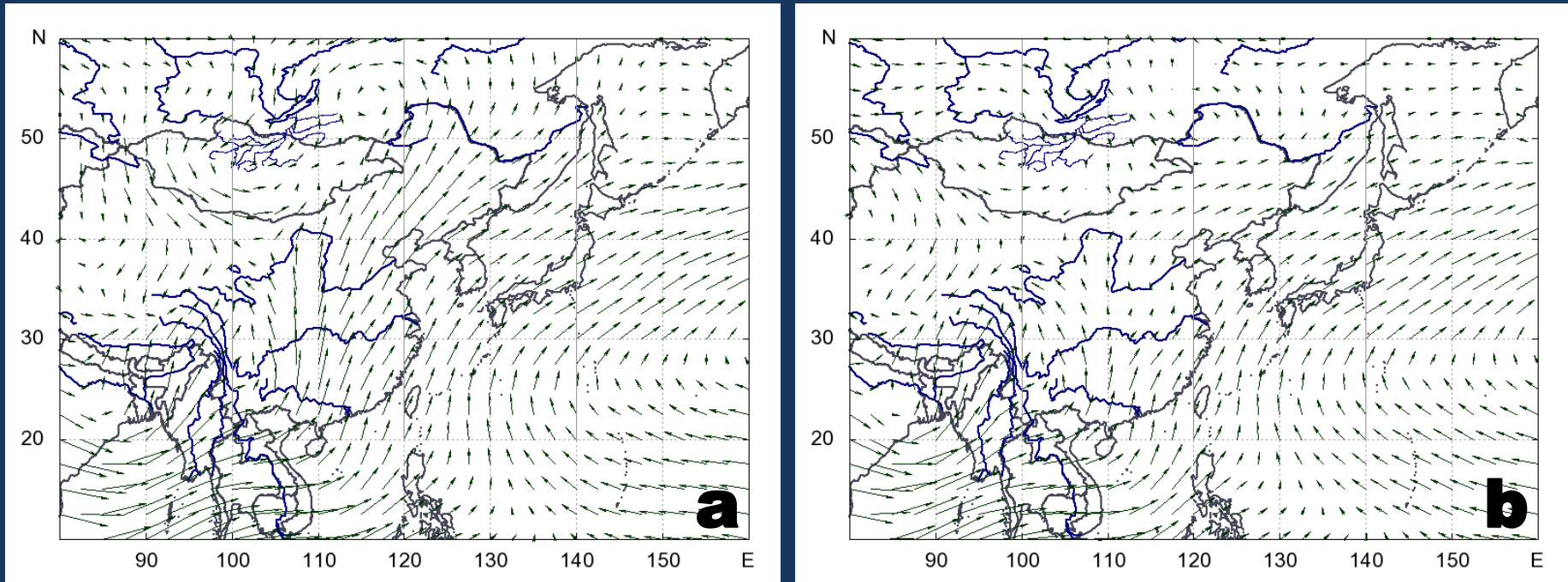
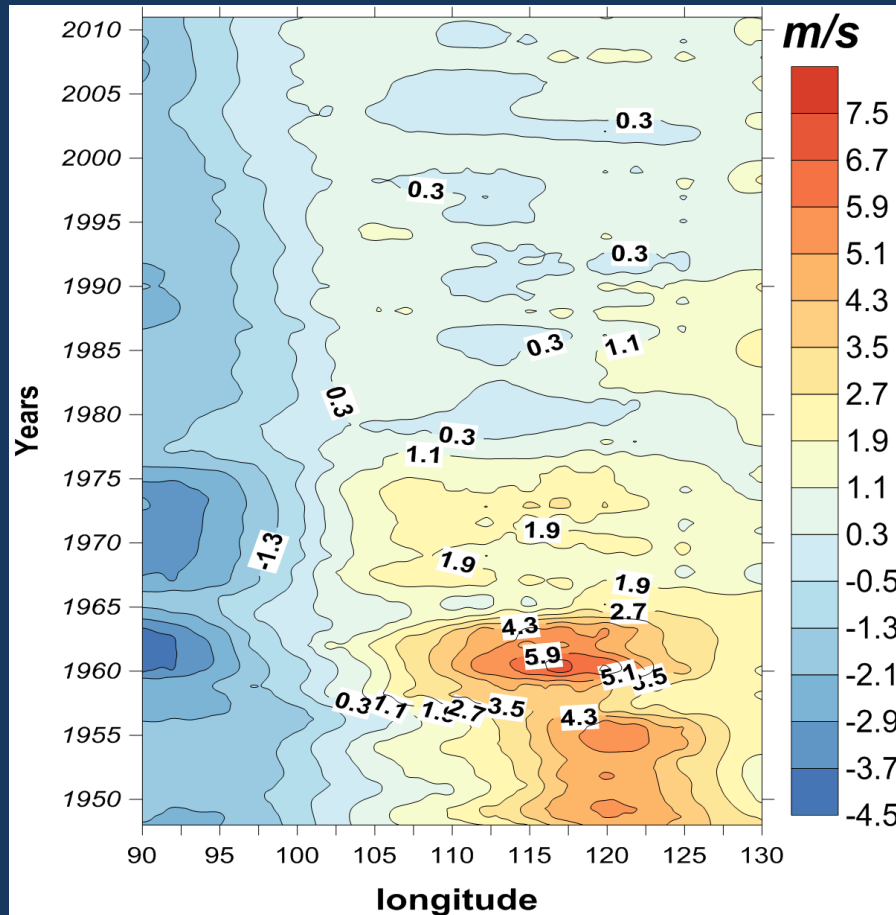


Fig. 9. Difference of summer 850hPa wind field (unit: m/s). (a) Composite distribution of 1948–1975; (b) Composite distribution of 1976–2011. NCEP/NCAR Reanalysis 1

The main reason is changes of the structure and intensity of velocity field

7. Long-term variability of atmospheric circulation over the north East Asia



Abrupt change of intensity meridional wind occurred in the 70s of the 20th century after 70s the weakening has been continued. After 1996 (the low-water period beginning) the circulation weakening is reached its maximum.

Fig. 10. Time-longitude cross-section of changes (m/s) in JJA winds at 850 hPa (meridional component) averaged in latitude area 35–50 N for 1948–2011. NCEP/NCAR Reanalysis 1

Conclusions

- The low-water period in the Selenga River basin observed since 1996 is result from the decrease of summer rainfall over north of East Asia.
- The most remarkable changes in summer rainfall take place in midsummer. Midsummer rainfall is connected with high precipitable water content.
- The rainfall change in the Selenga River basin is result of change of the wind field structure and intensity: weakening of moisture transport by East Asian monsoon and decrease of flow convergence over Northeast Asia.



*Thank you
for your
attention!*