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Attibution of the Tibetan Plateau to Northern Drought

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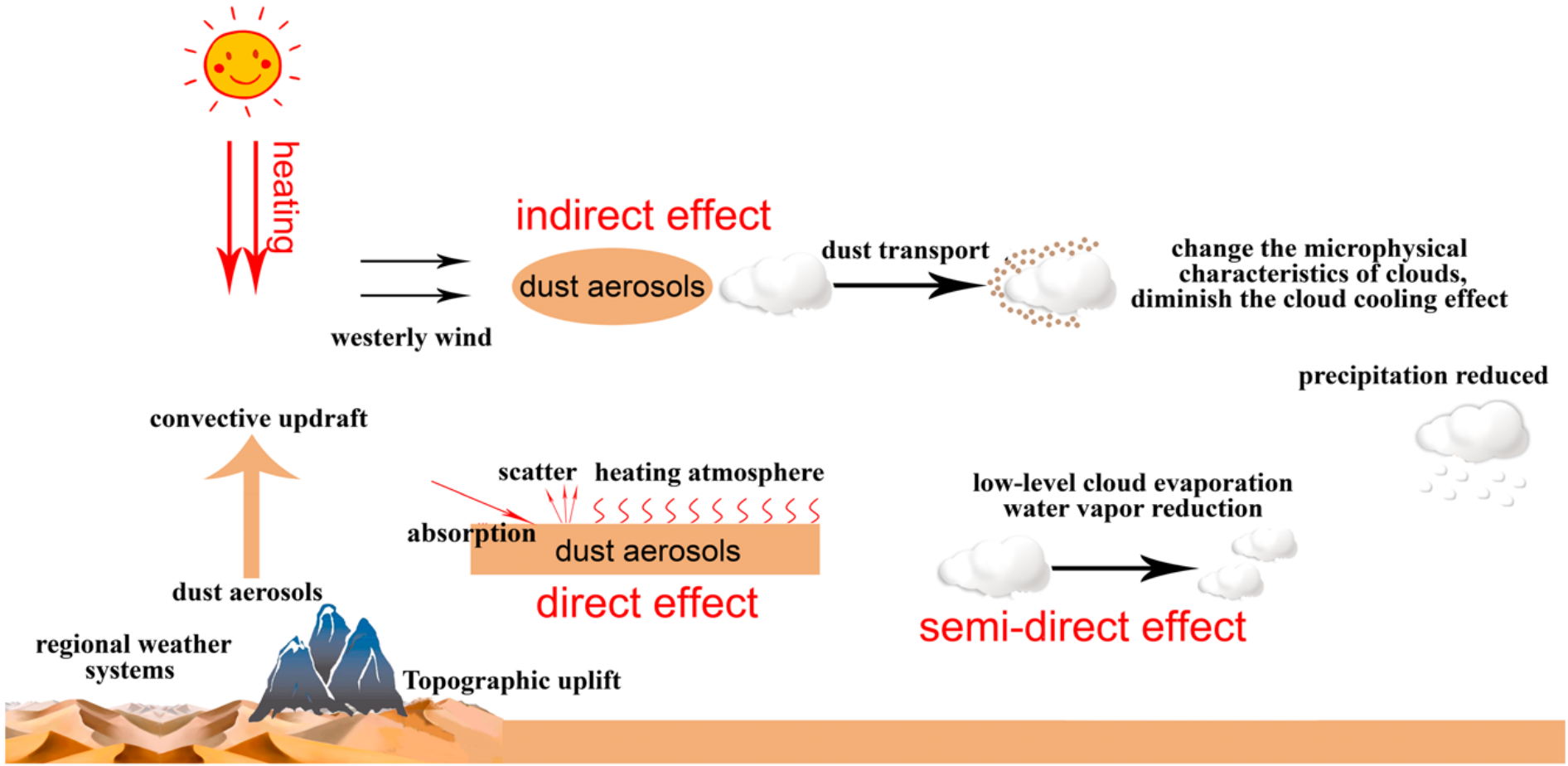
Outline

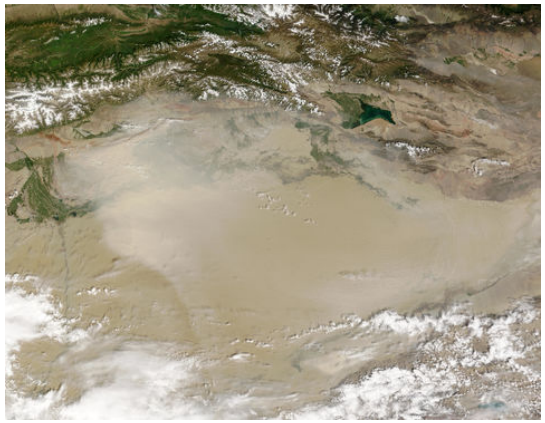
1. Motivation
2. Results and discussion
3. Conclusion

Effects of dust aerosols on the cloud

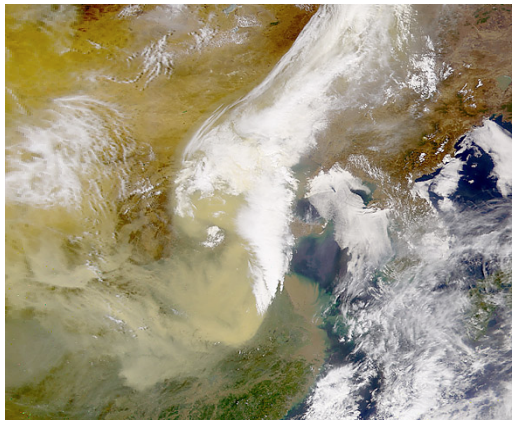


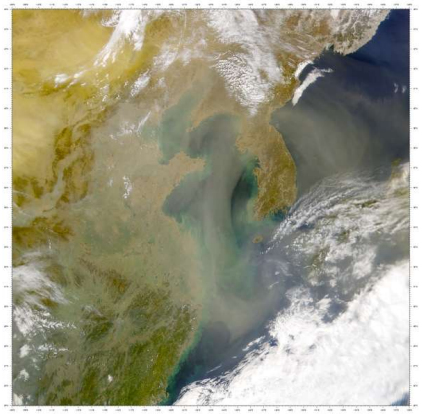
Dusty-cloud

Asia



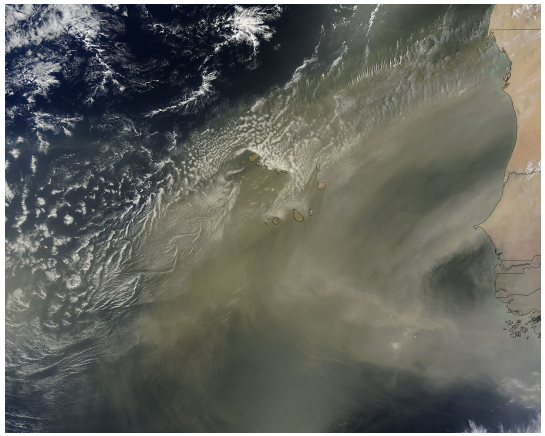
Taklimakan Desert

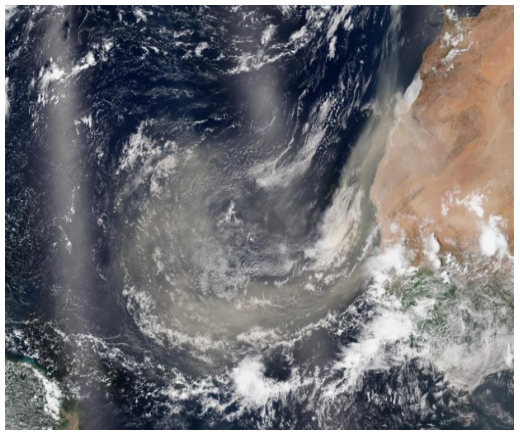


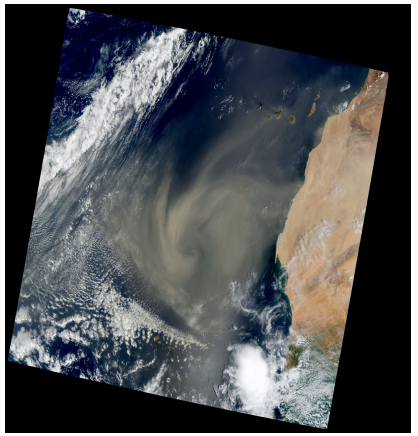


China, Japan and Korea

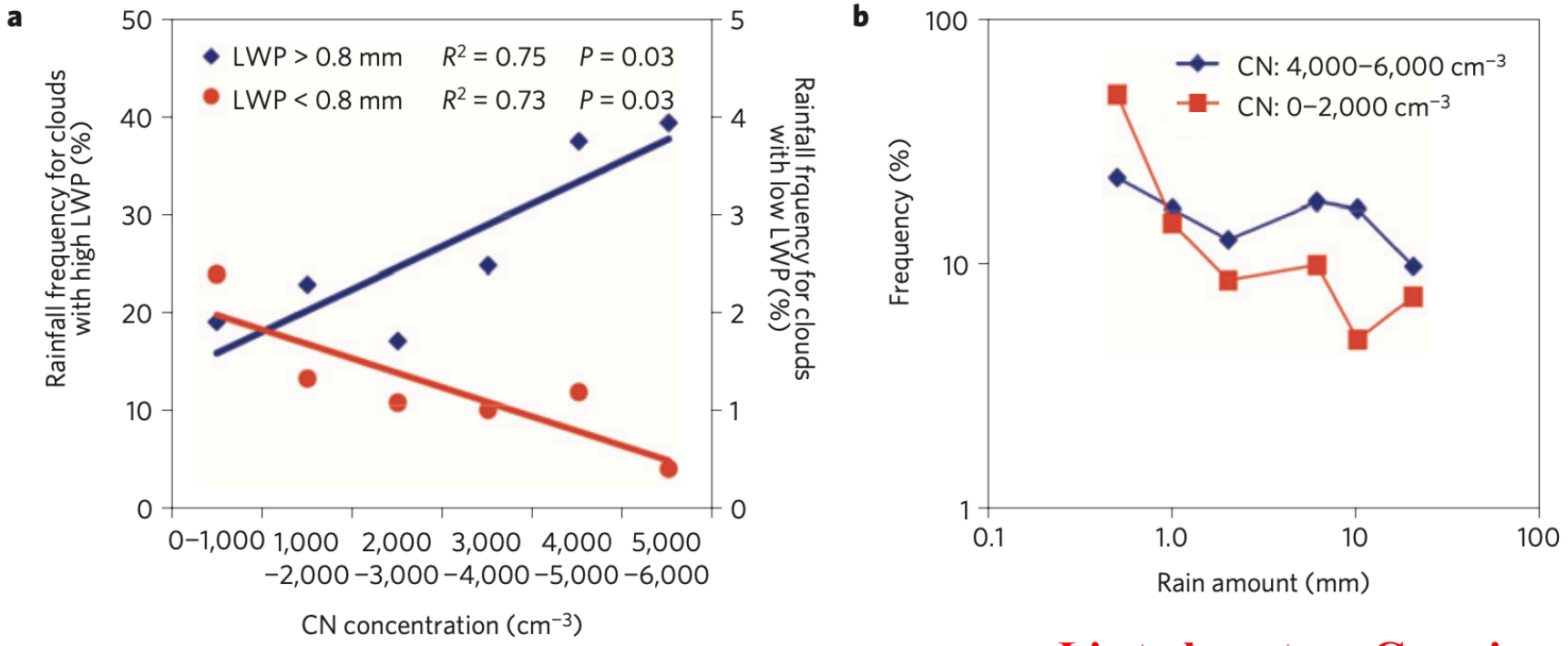
Sahara







Changes in rainfall frequency and rain rate distribution with concentration of condensation nuclei (CN)



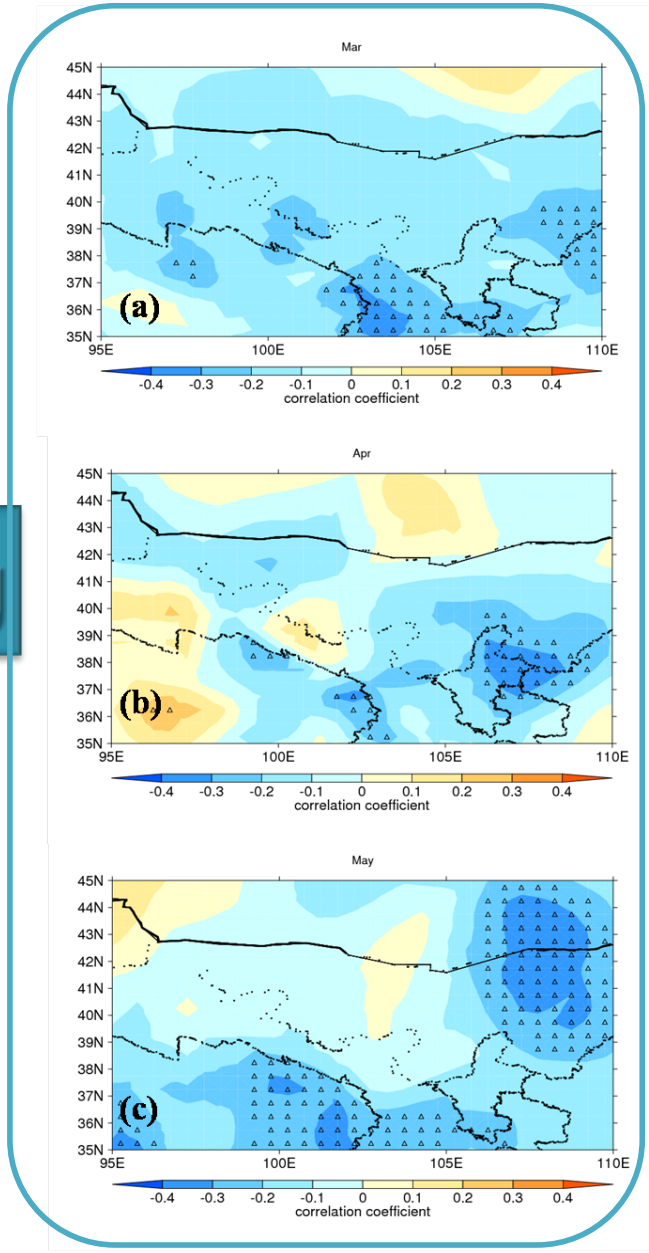
Li et al., nature Geoscience, 2011

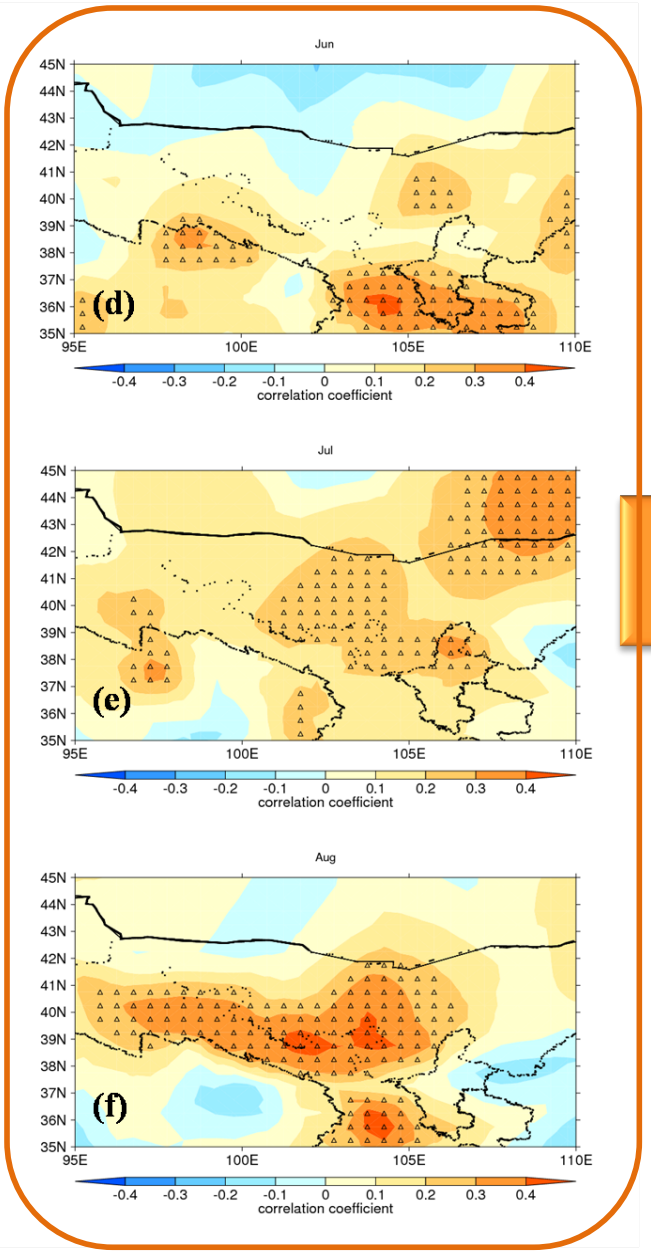
1. Rain increases with aerosol concentration in deep clouds that have a high liquid-water content but declines in clouds that have a low liquid-water content.

2.Increase in aerosol could enhance drought in dryland and dry season.

3.Declining in aerosol could enhance flooding in humid region and season.

Spring

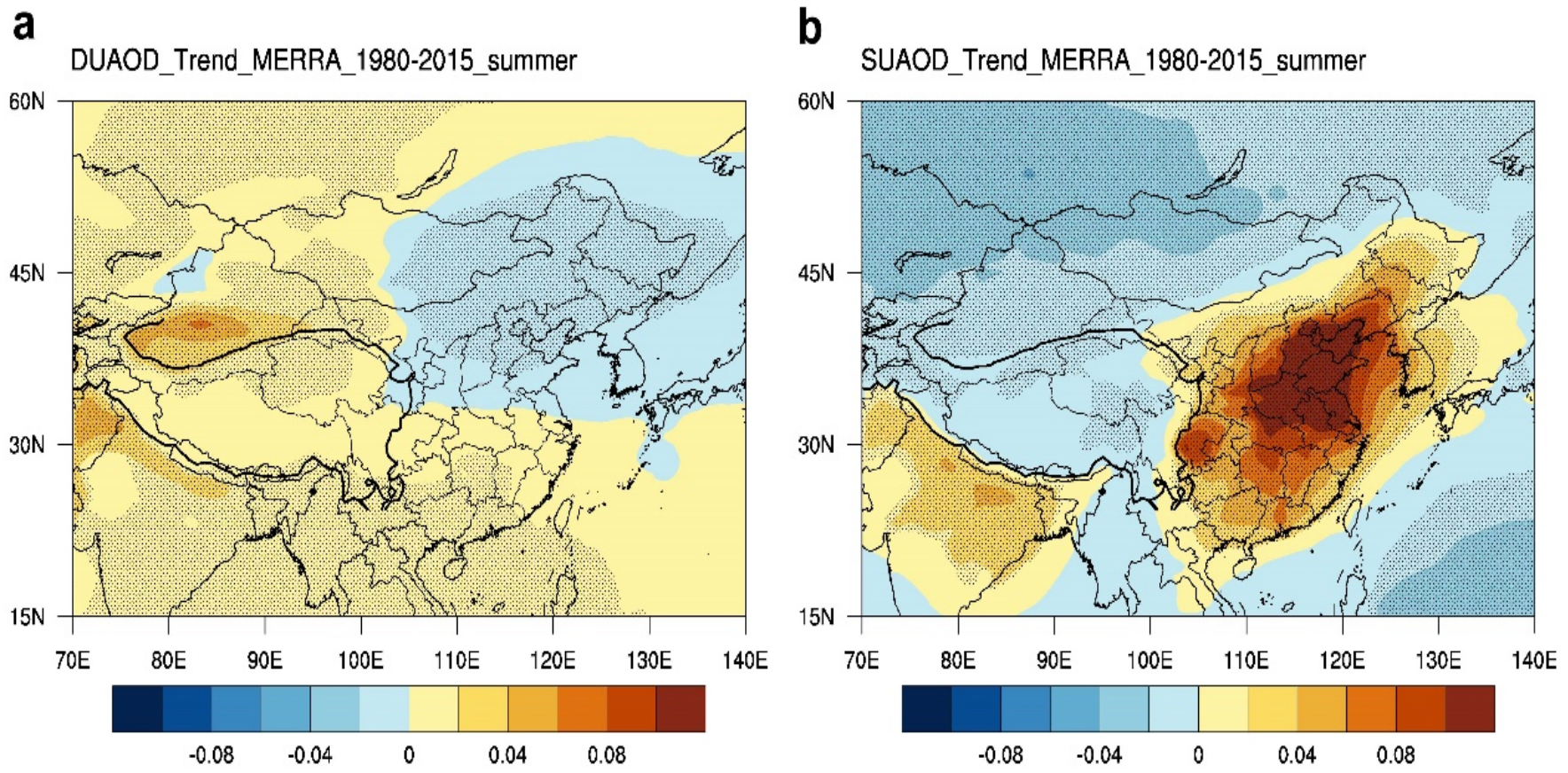




Summer

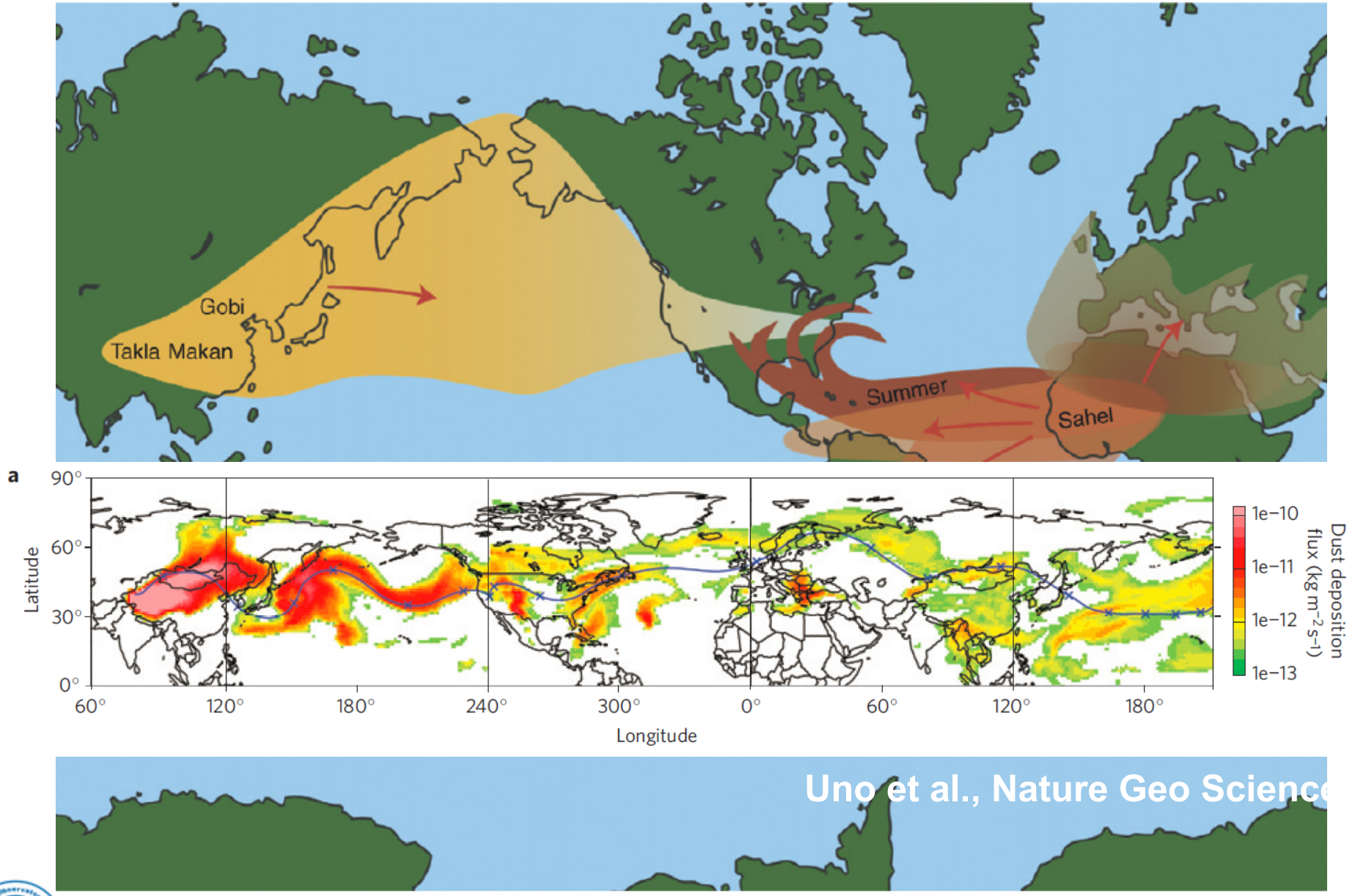
Correlation between Taklimakan dust index with the precipitation

➢ Effect of aerosols on the precipitation

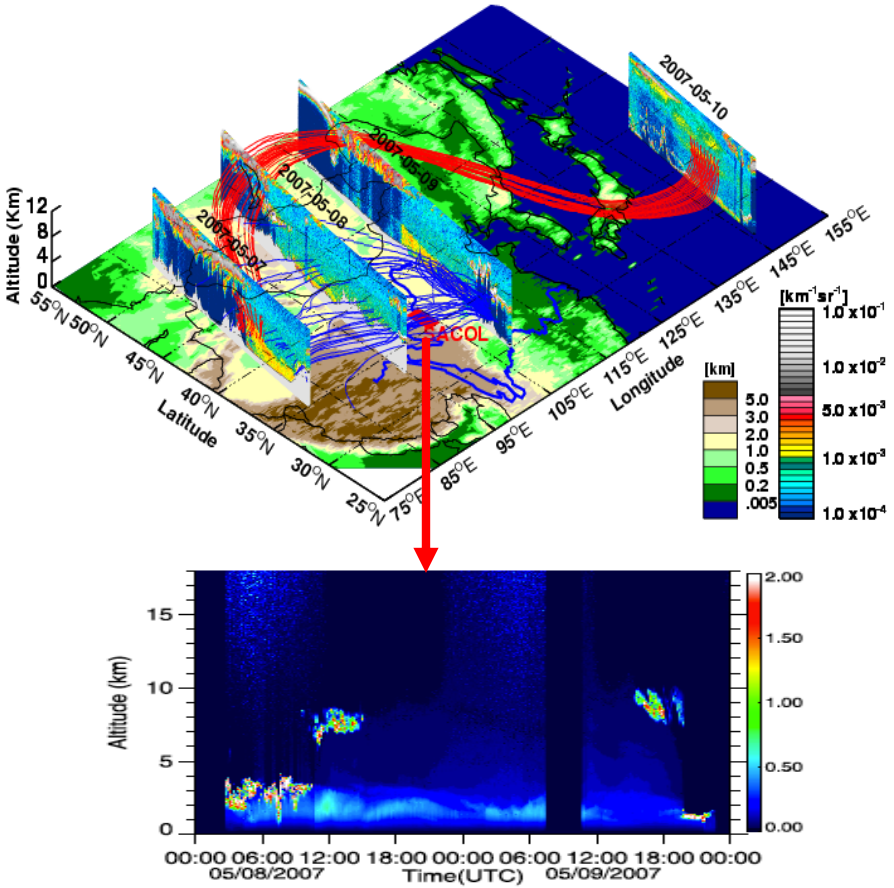


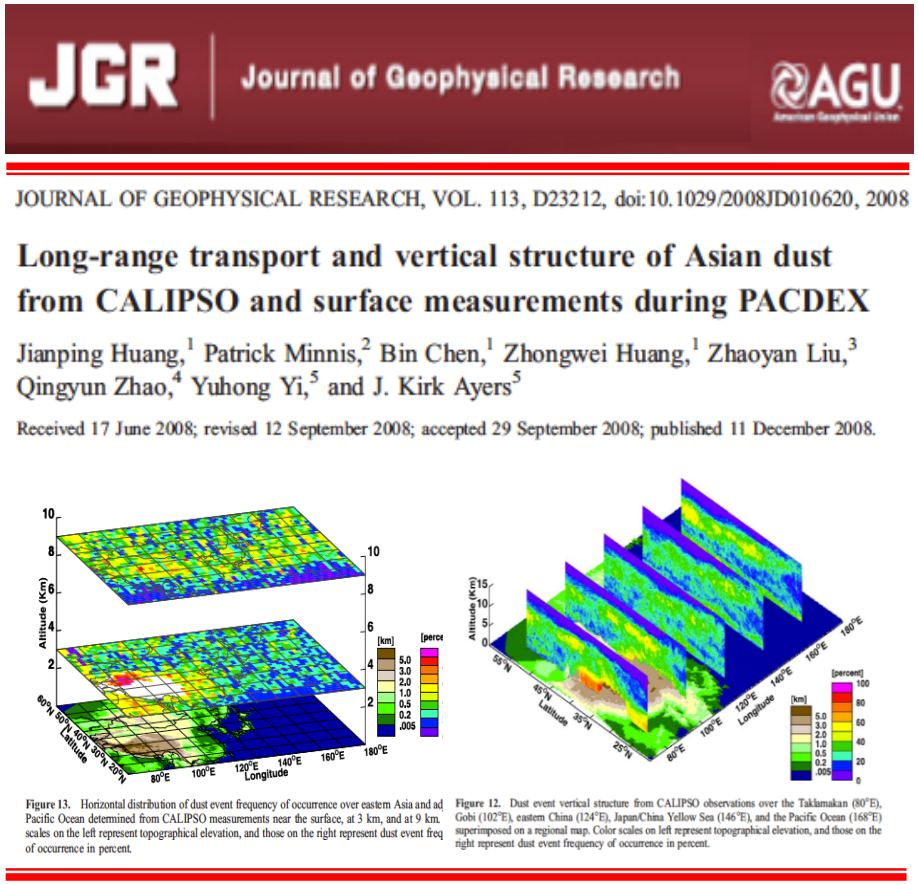
Since 1980, it indicates decreased dust but increased sulfate aerosols over northern China, resulting in a reduction of ice nucleus. It is not beneficial to rain over there.

Global dust transport



➢ The long-range transport and vertical distribution of East Asian dust aerosols are revealed.





JGR | Journal of Geophysical Research | AGU

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Long-range transport and vertical structure of Asian dust from CALIPSO and surface measurements during PACDEX

Jianping Huang,[1] Patrick Minnis,[2] Bin Chen,[1] Zhongwei Huang,[1] Zhaoyan Liu,[3] Qingyun Zhao,[4] Yuhong Yi,[5] and J. Kirk Ayers[5]

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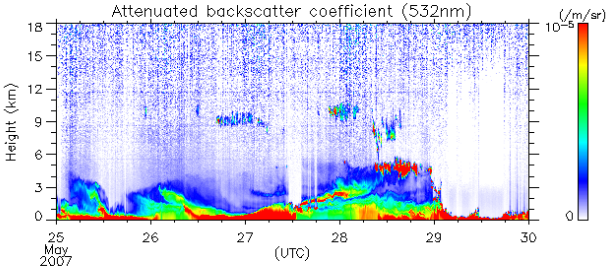
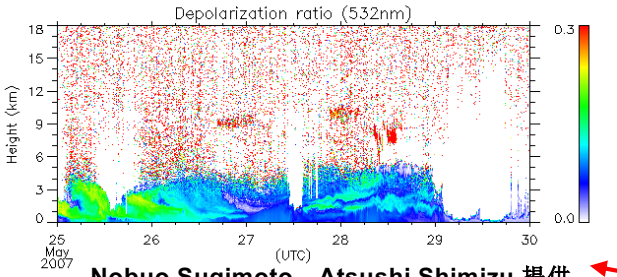
Figure 13. Horizontal distribution of dust event frequency of occurrence over eastern Asia and ad Pacific Ocean determined from CALIPSO measurements near the surface, at 3 km, and at 9 km. scales on the left represent topographical elevation, and those on the right represent dust event freq of occurrence in percent.

Figure 12. Dust event vertical structure from CALIPSO observations over the Taklamakan (80°E), Gobi (102°E), eastern China (124°E), Japan/China Yellow Sea (146°E), and the Pacific Ocean (168°E) superimposed on a regional map. Color scales on left represent topographical elevation, and those on the right represent dust event frequency of occurrence in percent.

Asia dust can be lifted to altitude of 9 km and transported eastward by the jet stream to North America across the North Pacific Ocean

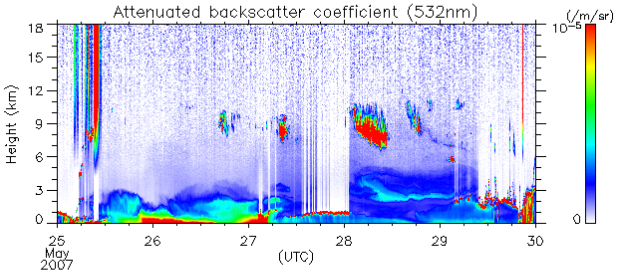
Lidar Observation in Seoul

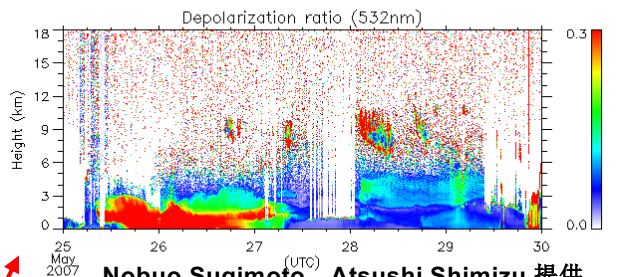




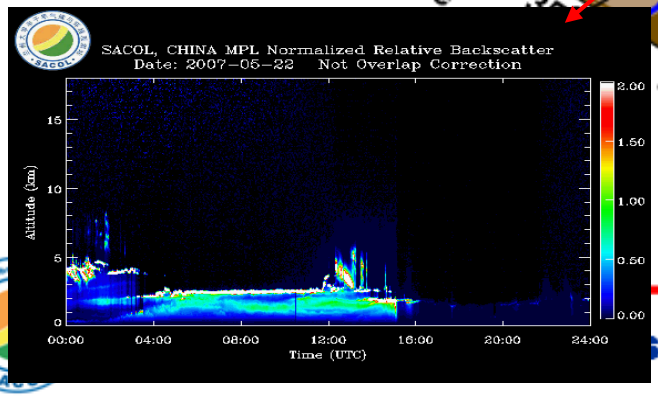
Nobuo Sugimoto，Atsushi Shimizu 提供

Lidar Observation in Matsue

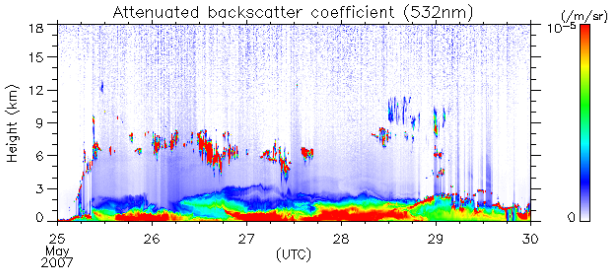


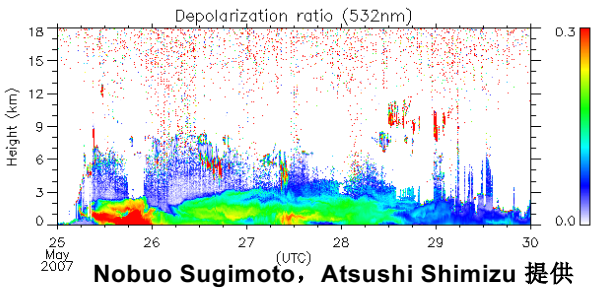


Nobuo Sugimoto，Atsushi Shimizu 提供



Lidar Observation in Nagasaki2





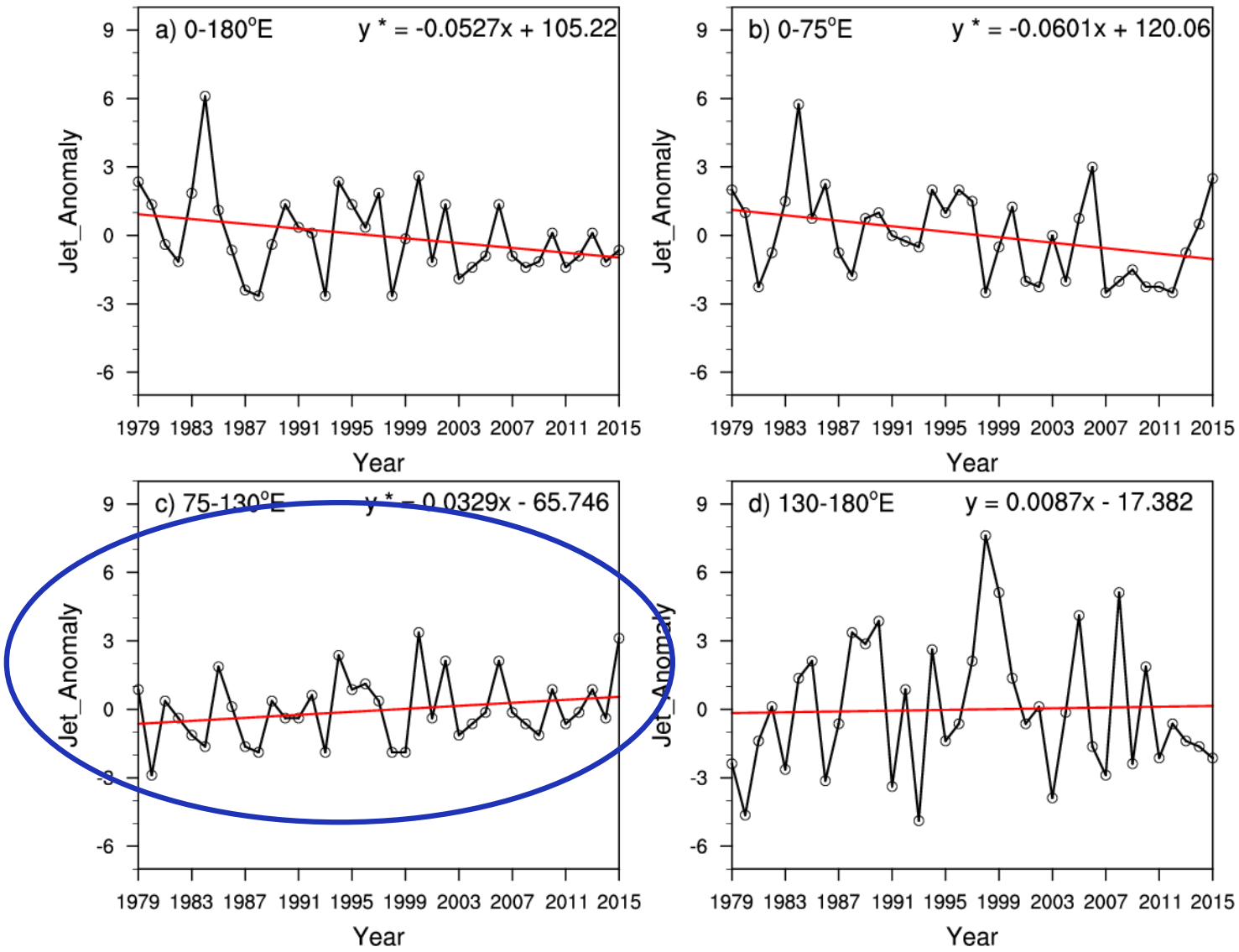
Nobuo Sugimoto，Atsushi Shimizu 提供

Huang et al., JGR, 2008b

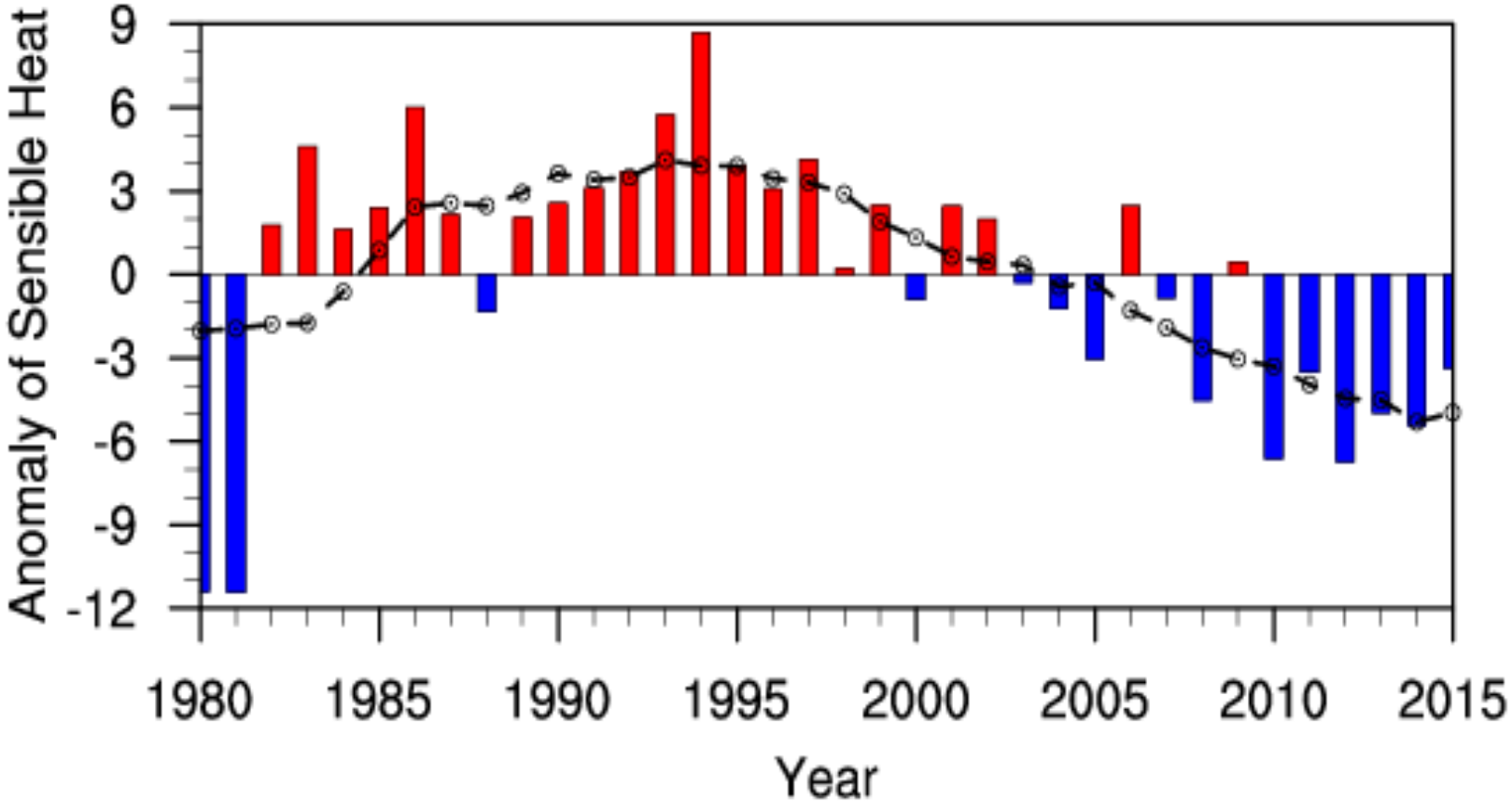
servatory & Laboratory (SA

Mechanism of precipitation reduction over northern area

- **SWJ center anomalies over different regions in the eastern part of Northern Hemisphere in July-August during 1979-2015**

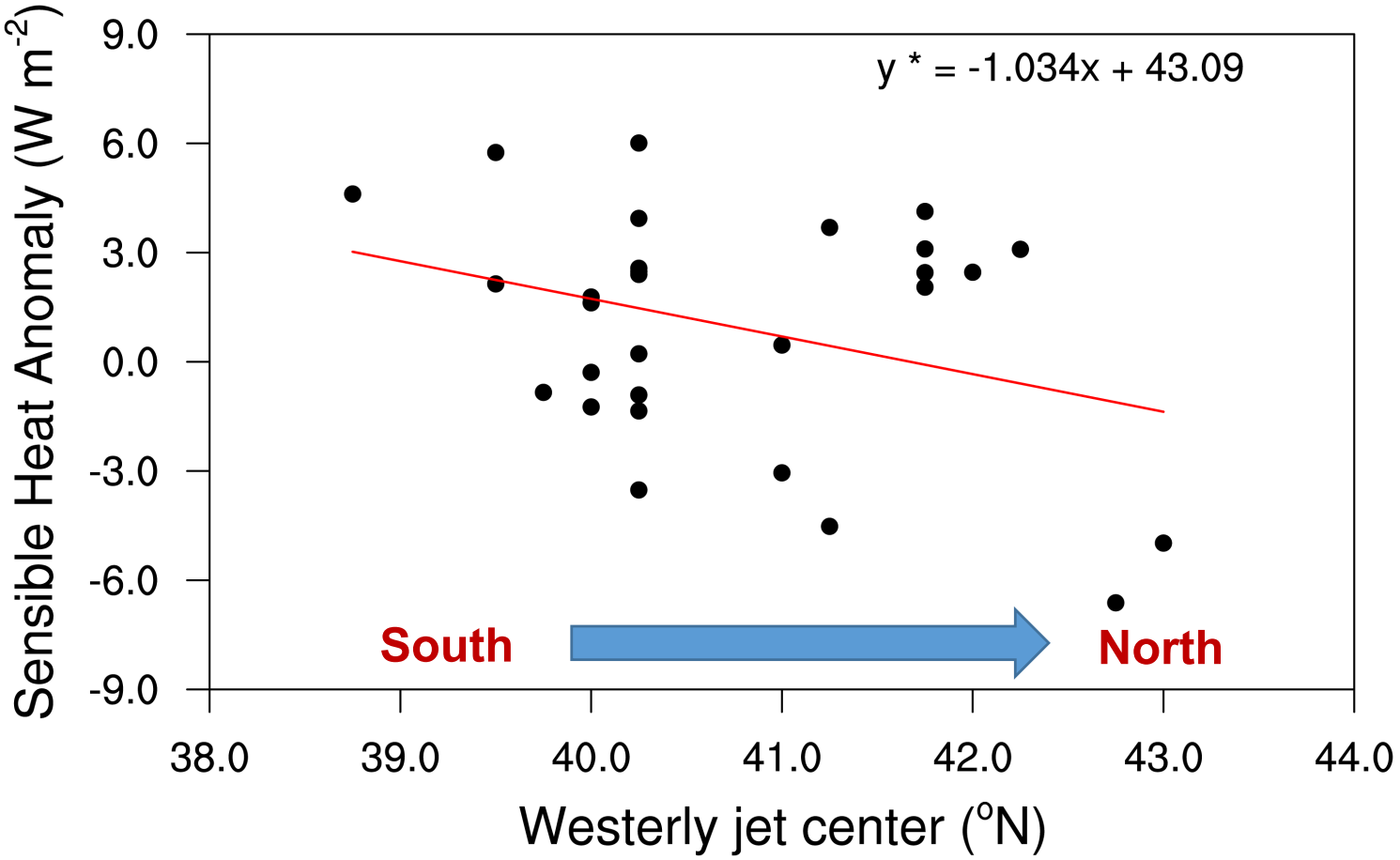


- **Sensible heat anomaly (W m^{-2}) over the TP in July-August during 1980-2015**



Sensible heat over the TP is gradually weakened in July-August during 1980-2015 （based onMERRA-2)

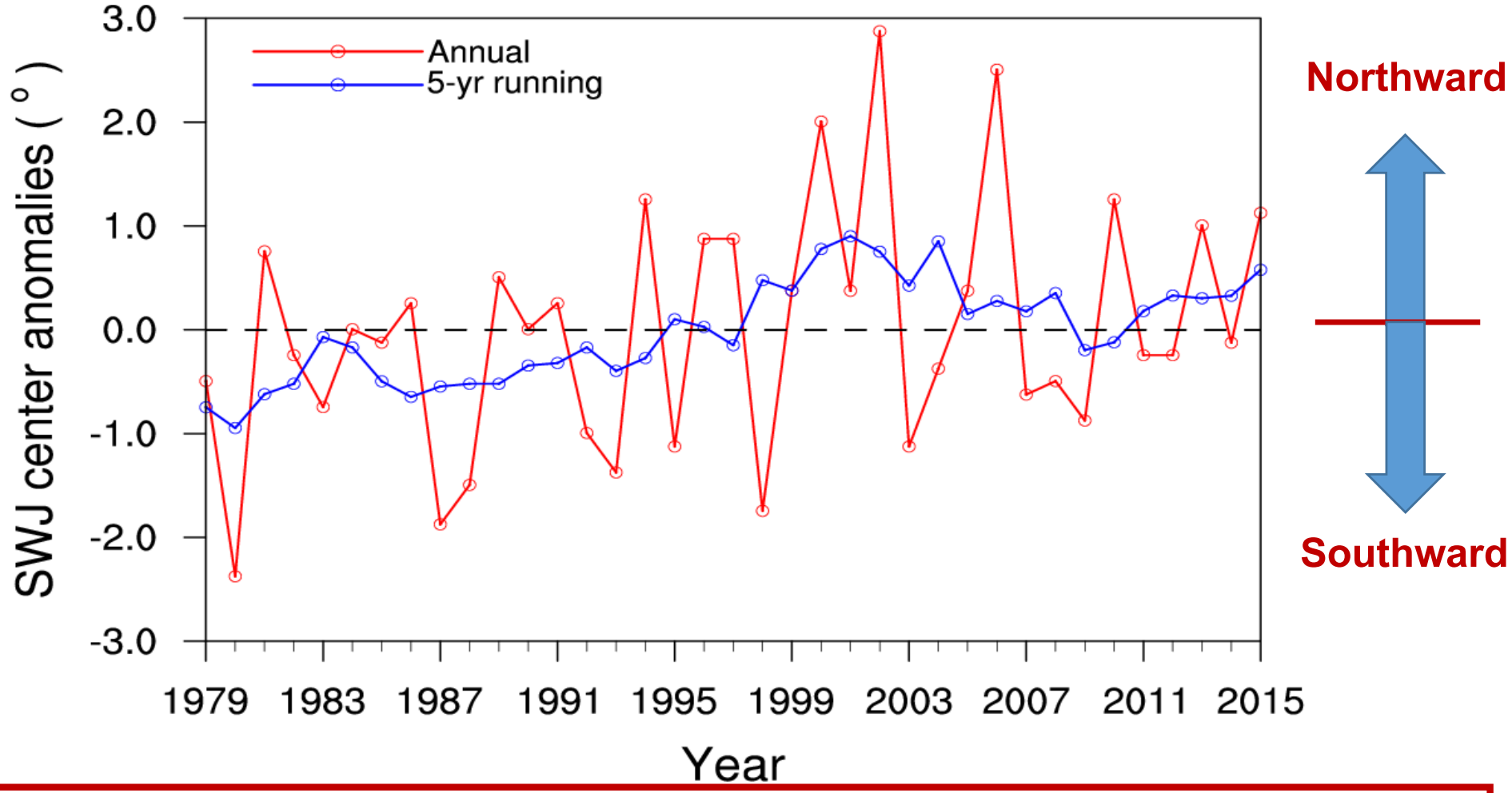
- **Correlation between the sensible heat anomaly and SWJ center over the region 30-60° N, 75-130° E in July-August during 1980-2015**



SH anomaly is positive, the SWJ center locates southward;

SH anomaly is negative, the SWJ center locates northward.

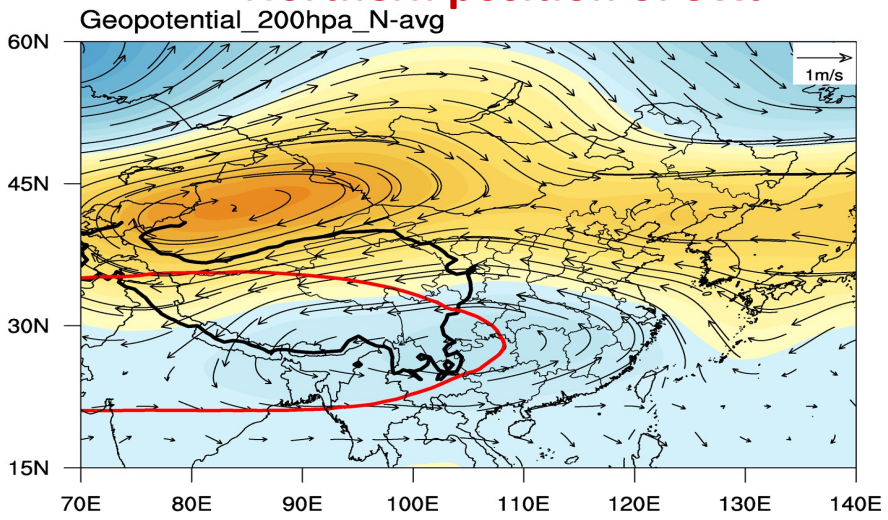
- **SWJ center anomalies over the region 30-60° N, 90-110° E**



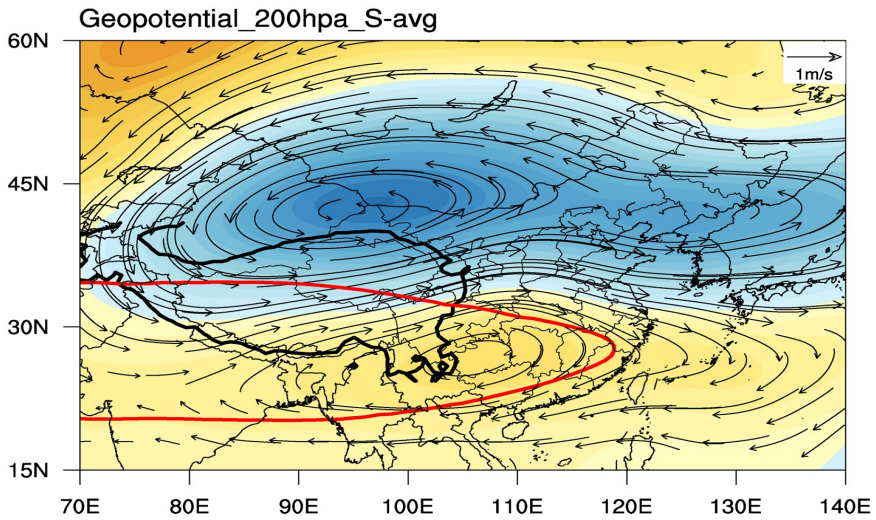
SWJ center over this region also indicates the trend of northward movement in July-August during 1979-2015

➢ Distribution of the horizontal wind field (arrows; m s^{-1}) and geopotentials (shading; gpm)

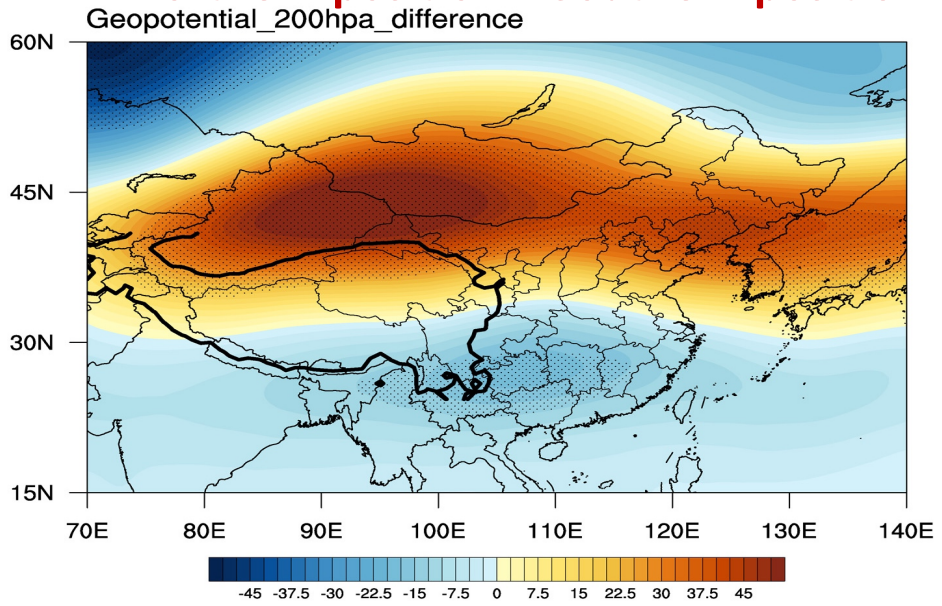
Northern position of SWJ



Southern position of SWJ

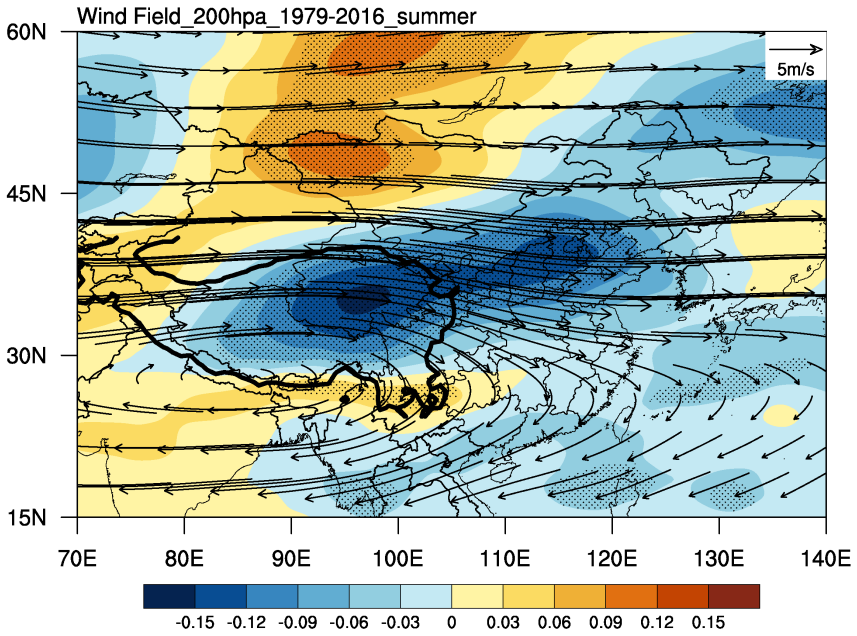


Northern position – Southern position

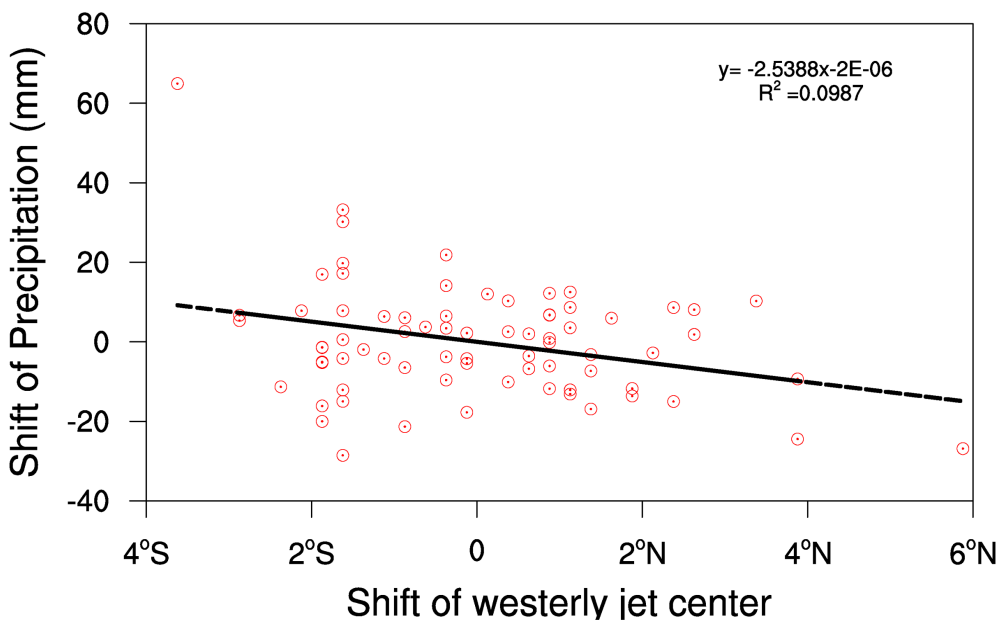


➢ Change of wind field at upper level and relation between the subtropical westerly jet center change and precipitation anomalies for the 1979–2016 period

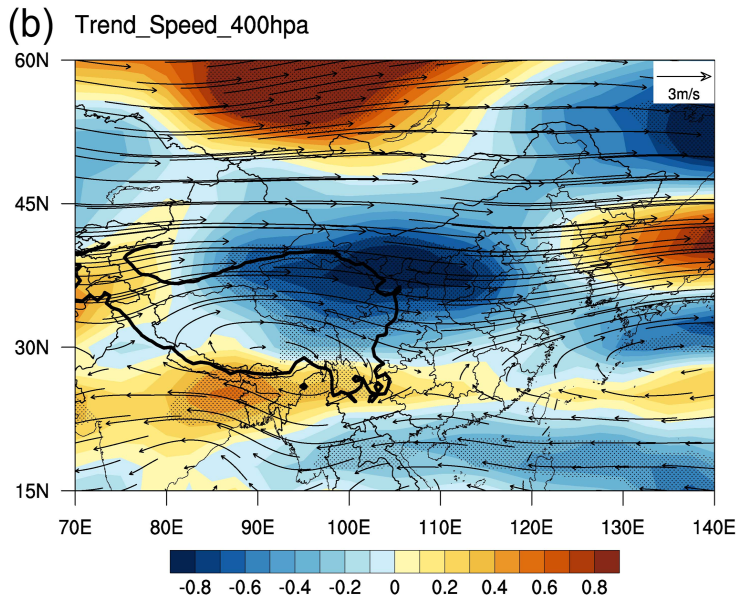
A

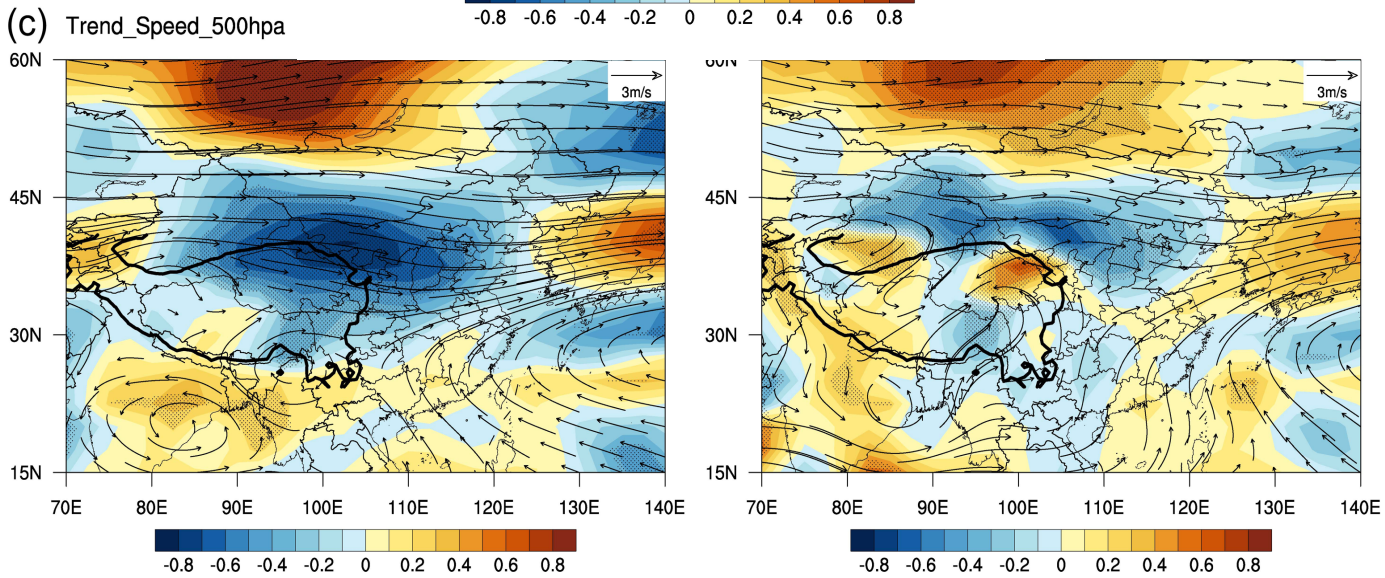


B



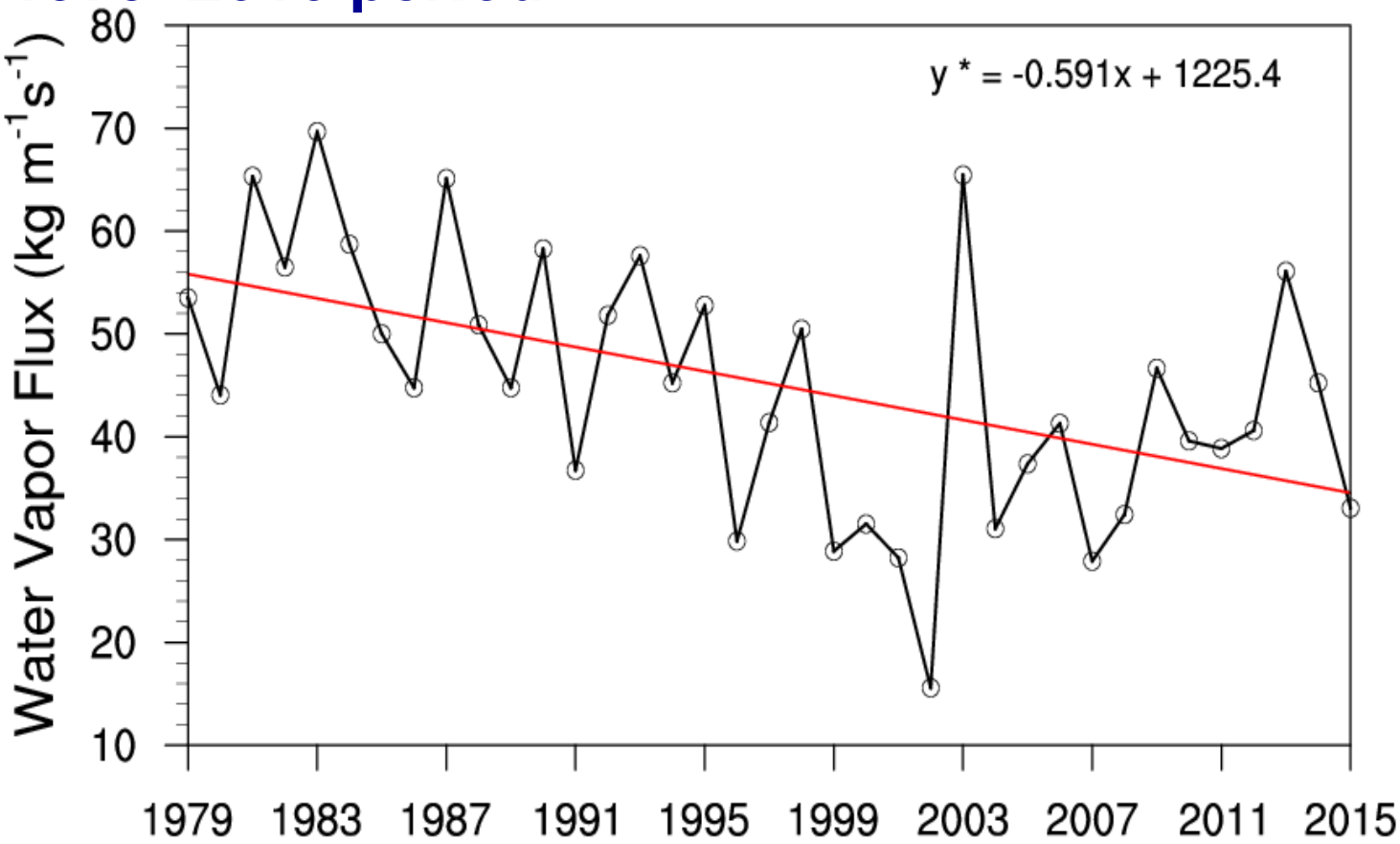
When the wind speed weakened due to the northward shift of westerly jet, the water vapor transportation from TP to the north of china is also decreasing, which could induce the drought of the north.





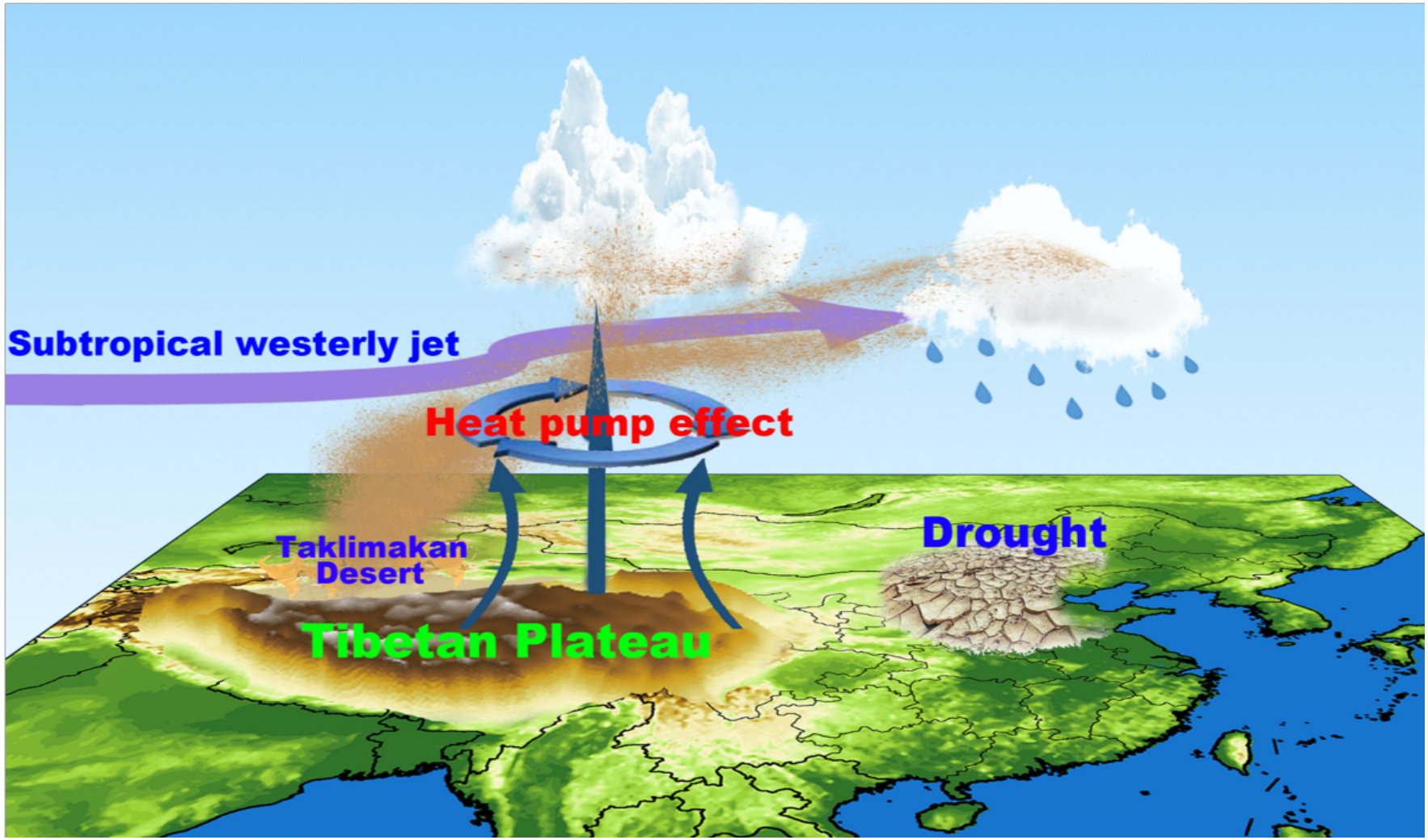
Due to northward moving of SWJ center, the wind speed in southern subtropics tends to decrease but increase in northern subtropics.

- **Water vapor flux at the eastern border of TP for the 1979–2016 period**



Water vapor flux at the eastern border of TP in July-August from 1979-2015 indicates significantly decreasing trend, showing a gradually declining of water vapor from the TP to north.

➢ A dynamic mechanism of northern drought attributable to TP



Conclusions

- Over the whole eastern part of the Northern Hemisphere, the position of SWJ center over the TP region shows more obvious southward moving since 1979
- When the SH over the TP was weak in July-August, the South Asian High (SAH) indicated a weaker strength and an abnormal high-pressure system in the upper-level atmosphere over the belt 30° N-50° N; correspondingly, the position of SWJ center over the region of 75° E-130° E in the Northern Hemisphere is crowed to northerly latitudes.
- When the SWJ shifts northward, the upper-level westerly wind is weakened; thus, the water vapor, clouds or dusty clouds over the TP are transported to north less often, reducing precipitation and causing more frequent droughts.

The Belt and Road Lidar Network

Thank you !