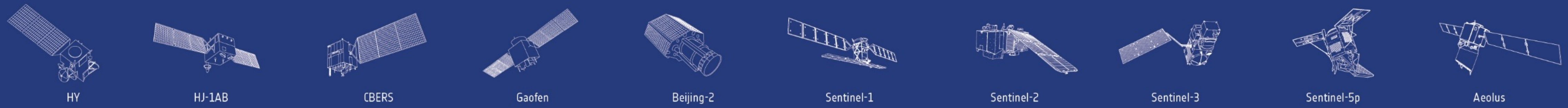


2023 DRAGON 5 SYMPOSIUM

3rd YEAR RESULTS REPORTING

11-15 SEPTEMBER 2023

[PROJECT ID. 59055]

[MONITORING EXTREME WEATHER AND CLIMATE EVENTS OVER CHINA AND EUROPE USING NEWLY DEVELOPED CHINESE AND EUROPEAN REMOTE SENSING DATA]

TITLE OF THE PROJECT:

MONITORING EXTREME WEATHER AND CLIMATE EVENTS OVER CHINA AND EUROPE USING NEWLY DEVELOPED CHINESE AND EUROPEAN REMOTE SENSING DATA

PRINCIPAL INVESTIGATORS:

CHINESE: FUXIANG HUANG

EUROPEAN: ABHAY DEVASTHALE

TEAM MEMBER:

RUIXIA LIU; BO YU; SANG LI; SONG LIU; JINGNING LUO; SONG GAO

PRESENTED BY: FUXIANG HUANG

Objectives of the project:

- What weather and climate patterns drive extreme events?
- Using satellite data combined with surface observations, reanalysis data to investigate co-variability of weather and climate patterns with temperature over China and Europe during extreme events.
- Modeling co-variability of extreme weather and climate events.
- Interdisciplinary collaboration and young scientist training.

Chinese Young scientists contributions in Dragon 5

Name	Institution	Poster title or paper title	Contribution including period of research
XI Chen	National Satellite Meteorological Center,	Cross-tropopause transport of surface pollutants during the Beijing 21 July Deep Convection event, Published on Journal of the Atmospheric Sciences, 79(5):1349-1362. Doi:10.1175/JAS-D-21-0115.1.	Data analysis 2021-2022
Shiya Sun	National Satellite Meteorological Center,	Forward Simulation of solar backscattered ultraviolet radiation for satellite over the Tibetan Plateau, Published on Optics and Precision Engineering, 2022, 30(3):256-263. (in Chinese)	Data analysis 2021-2022
Qian Chen	National Satellite Meteorological Center, School of Environmental Science and Engineering, Sun Yat-Sen University		Data analysis 2022-now

Published papers and young scientists training in 3 years

- Chinese young scientists training:
  - 3 young scientists got their master degree in last 3 years.

- Peer reviewed Publications by Chinese team:
  - 4 papers were published in last 3 years.

List of Peer reviewed publications by Chinese team

Name	Title of the journal	Title of the paper
X. Chen, B Zhong, F. Huang, X Wang, S.Sarkar, S. J, X.Deng,et al.	Journal of the Atmospheric Sciences, 79(5):1349-1362. Doi:10.1175/JAS-D-21-0115.1.	Cross-tropopause transport of surface pollutants during the Beijing 21 July Deep Convection event,
Shiya Sun, Fuxiang Huang, Xueqi Xia	Optics and Precision Engineering, 2022, 30(3):256-263. (in Chinese)	Forward Simulation of solar backscattered ultraviolet radiation for satellite over the Tibetan Plateau,
X. Chen, L. Wu, X.Chen, Y.Zhang, J.Guo, S.Safieddine, F. Huang, X.Wang	Atmospheric Environment, 220(1): 1-11. doi.org/10.1016/j.atmosenv. 2019.117060.	The role of natural factors in constraining long-term tropospheric ozone trends over Southern China,
J.Luo, F.Huang, S.Gao, S.Liu, R.Liu, Abhay Devasthale	Atmosphere, 2022, 13, 157, https://doi.org/10.3390/atmos13020157.	Satellite monitoring of the dust storm over China on 15 March 2021

Two results after 3 years of activity:

- **Satellite monitoring of the dust storm over northern China on 15 March 2021.**
- **A new mechanism of forming ozone mini high/holes over North China Plain (NCP) in winter.**

1. Satellite monitoring of the dust storm over northern China on 15 March 2021

- Introduction
- Data and methodology
- Results and analysis
- conclusions

Introduction

Northern China was hit by a severe dust storm on 15 March 2021, (the “3.15” dust storm thereafter) covering a large area and bring impact to a degree that was unprecedented in more than 20 years in east Asia. In the study, we carried out a day-and-nigh continuous monitoring to the path of dust moving, using multi-spectral data from the Chinese FY-4A satellite combined with the Japanese Himawary-8 from visible, near-infrared, mid-infrared, thermal-infrared bands.

Data and Methodology

- The FY-4A AGRI and Himawari-8 AHI data.
- Surface observation data in north China.

Dust monitoring algorithms:

- daytime dust identification
- daytime intensity calculation
- nighttime dust identification.

Channel	FY-4A AGRI		Himawari-8 AHI	
	Wave Length (μm)	Resolution (km)	Wave Length (μm)	Resolution (km)
Visible light	0.470	1	0.470	1
			0.510	1
	0.650	0.5	0.639	0.5
	0.825	1	0.856	1
Near-infrared	1.375	2		
	1.610	2	1.61	2
	2.250	2–4	2.25	2
Short wave infrared	3.75	2	3.88	2
	3.75	4		
Infrared	6.25	4	6.24	2
			6.94	2
	7.10	4	7.35	2
	8.50	4	8.59	2
	10.70	4	10.4	2
			11.2	2
	12.00	4	12.4	2
	13.50	4	13.3	2

Results and analysis

Fig. 1 shows the initial stage of the dust storm in northwest Mongolia.

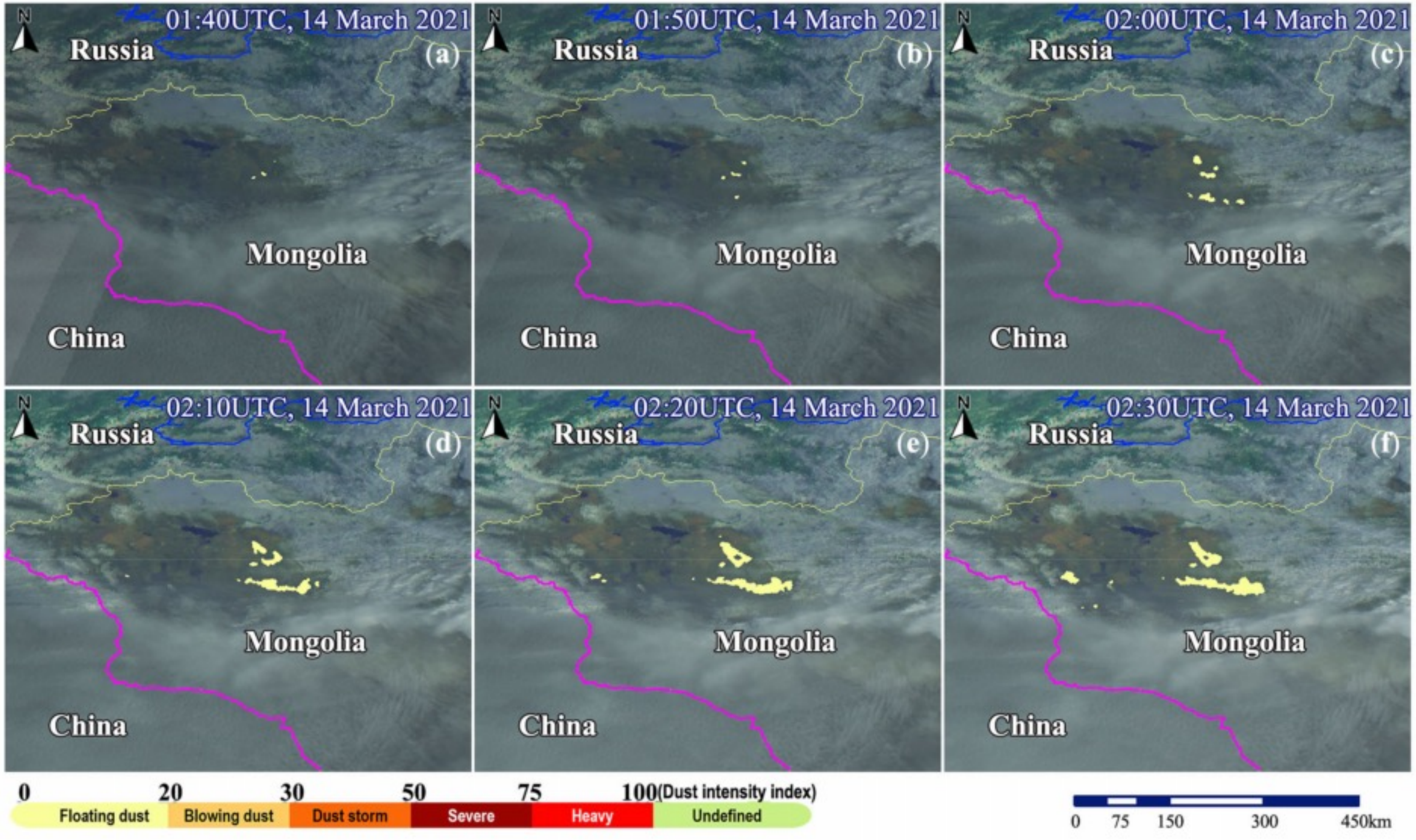


Fig. 2 shows the forming of dust storm in the west of Ulaanbaatar in Mongolia, causing people death and property damage.

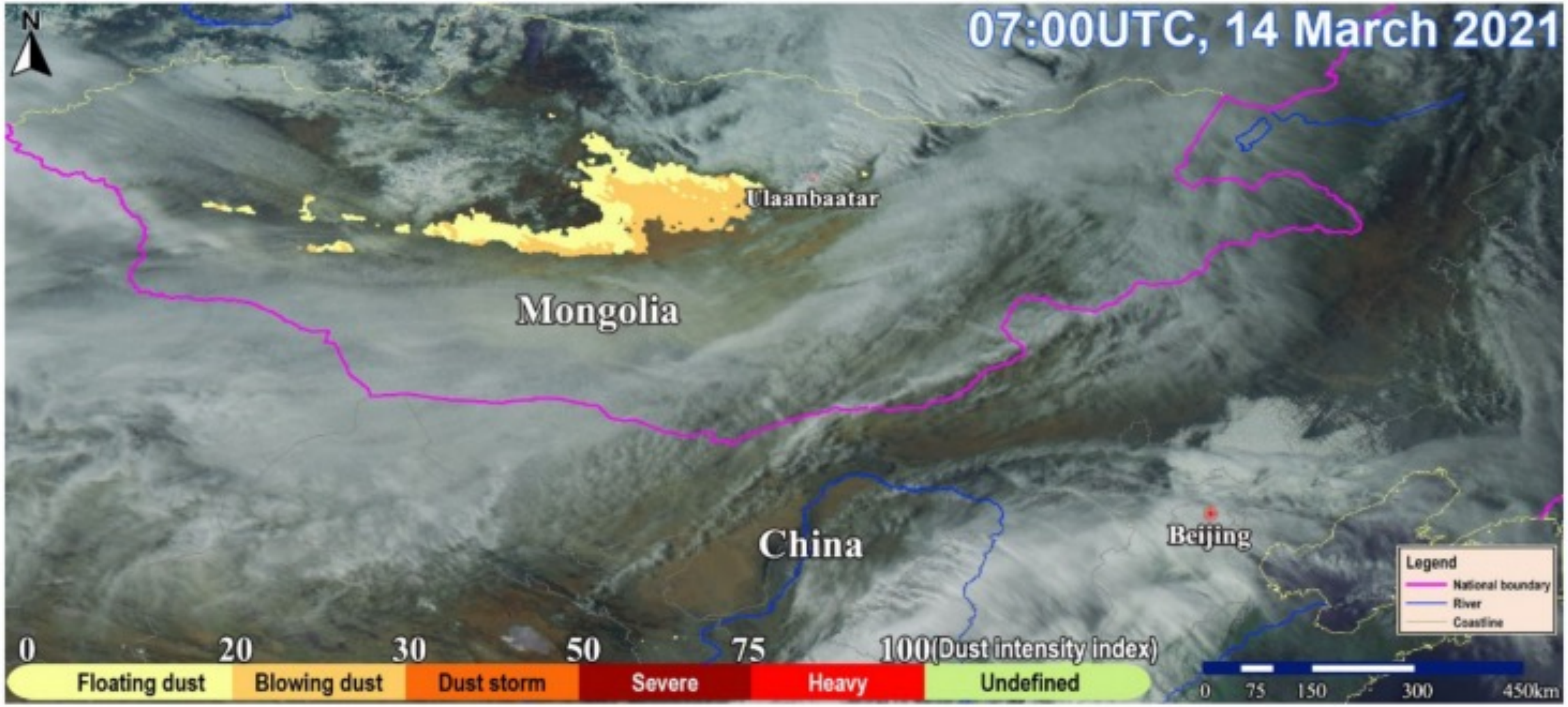


Fig. 3 shows after 7:00 14 March, the floating dust changed its moving direction from west to east towards China and crossed the China-Mongolia border from Erenhot at about 13:00 14 March.

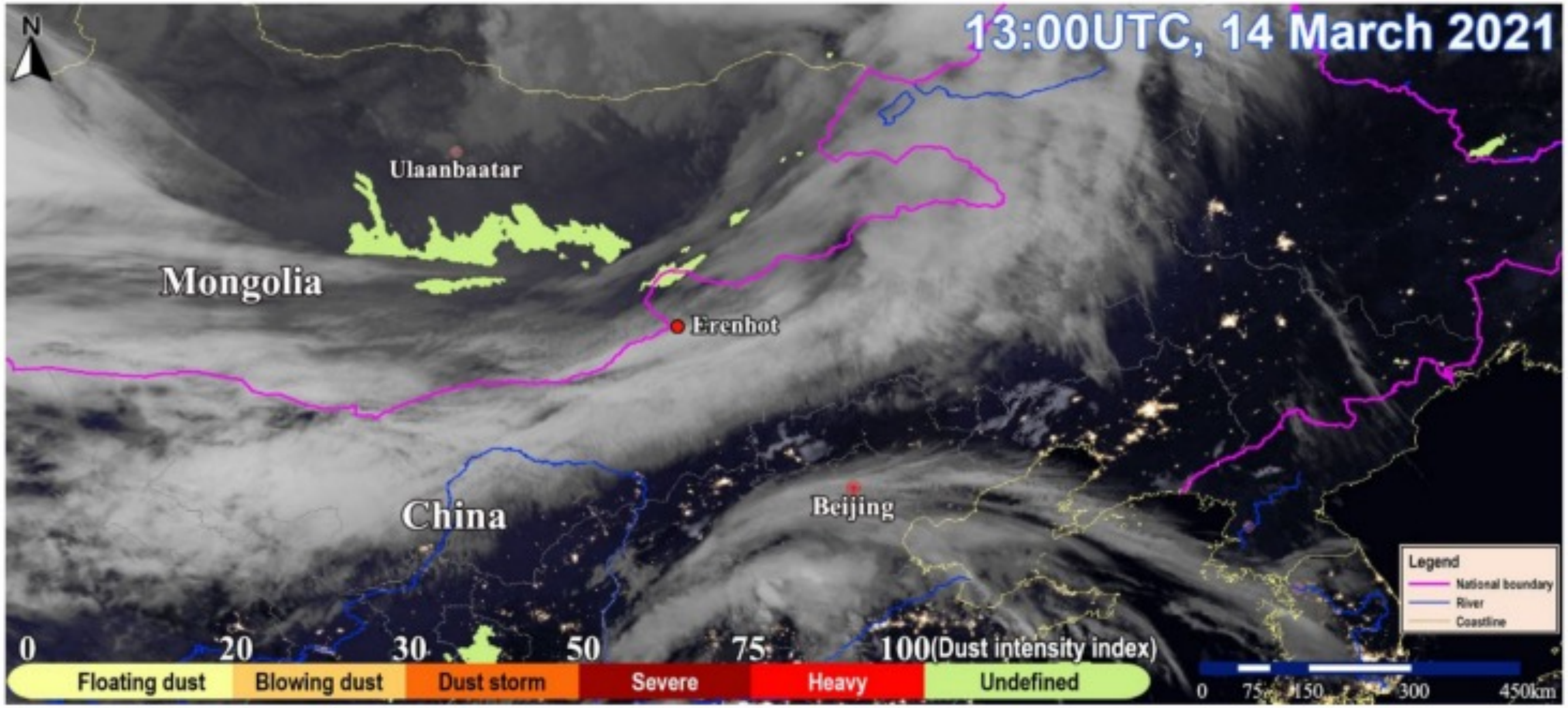


Fig. 4 shows after crossing the China-Mongolia border, the floating dust continued to move southward during 13:00 t 18:00 14March.

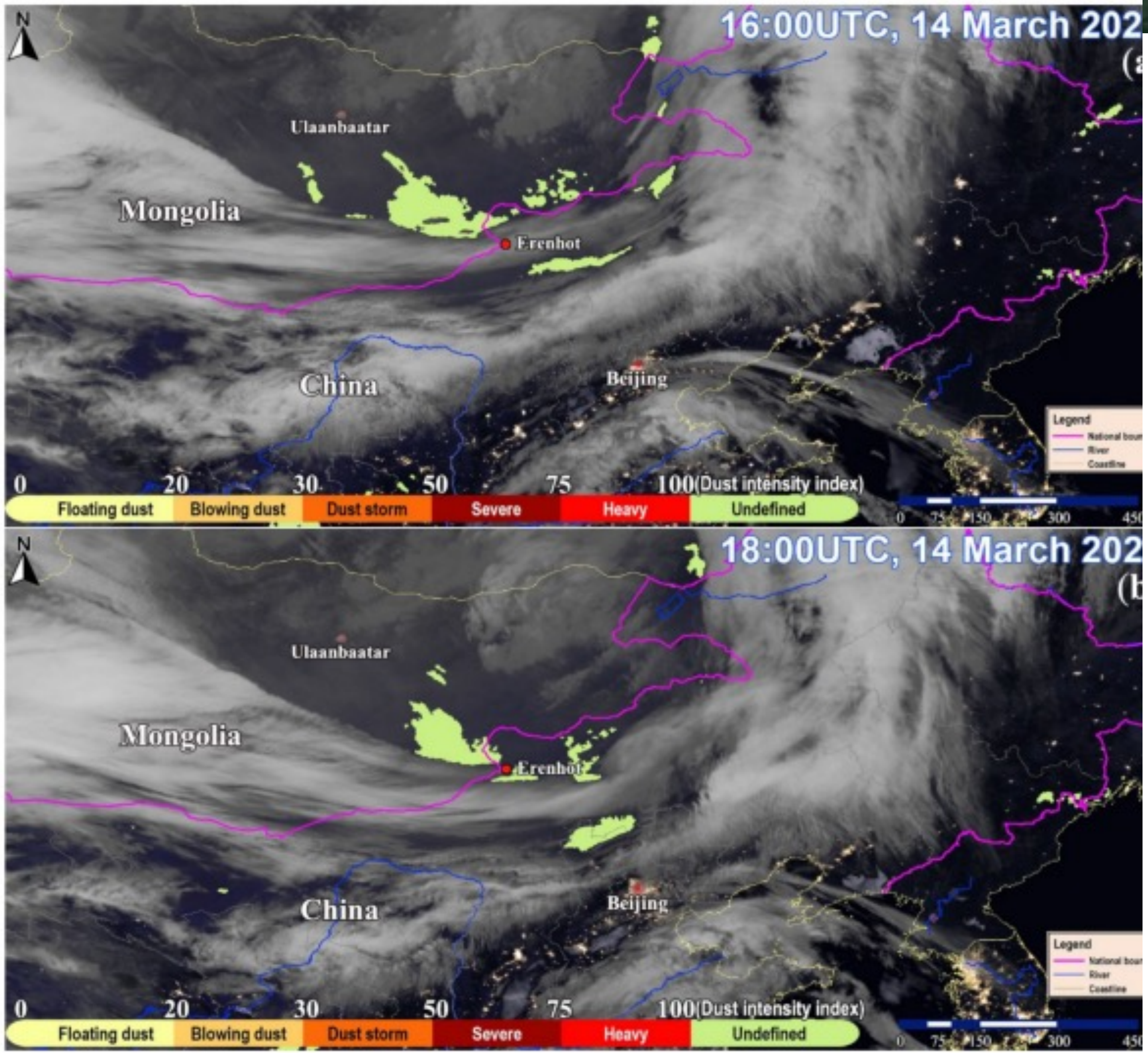
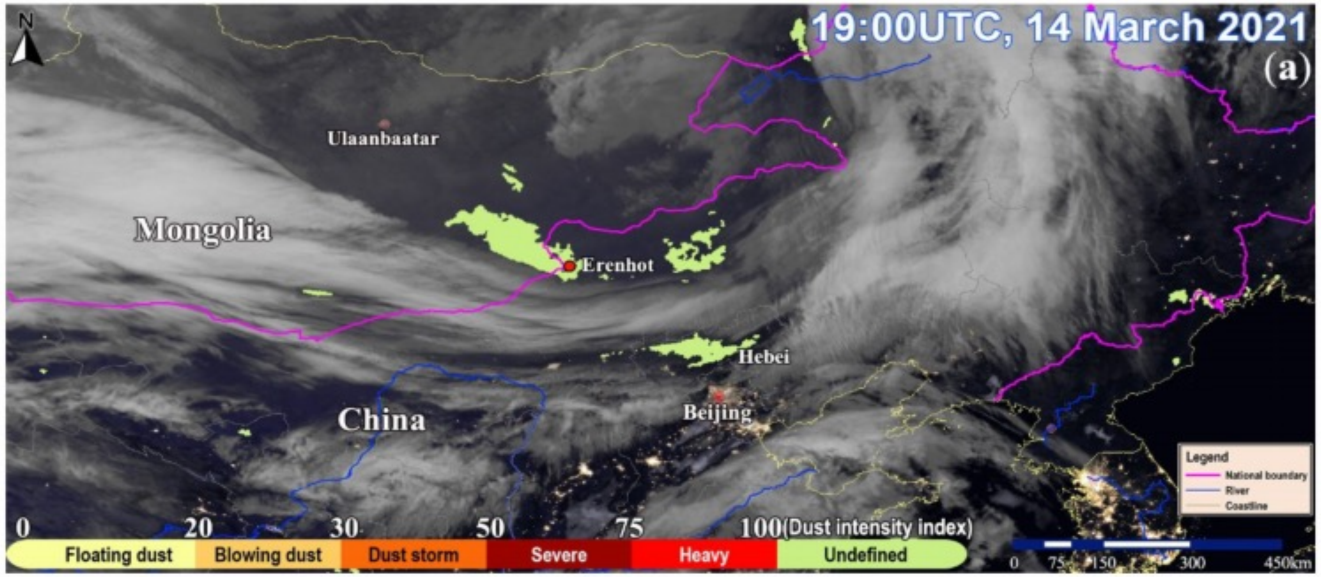


Fig. 5 shows the floating dust arrived in Beijing at around 21:00 on 14 March.



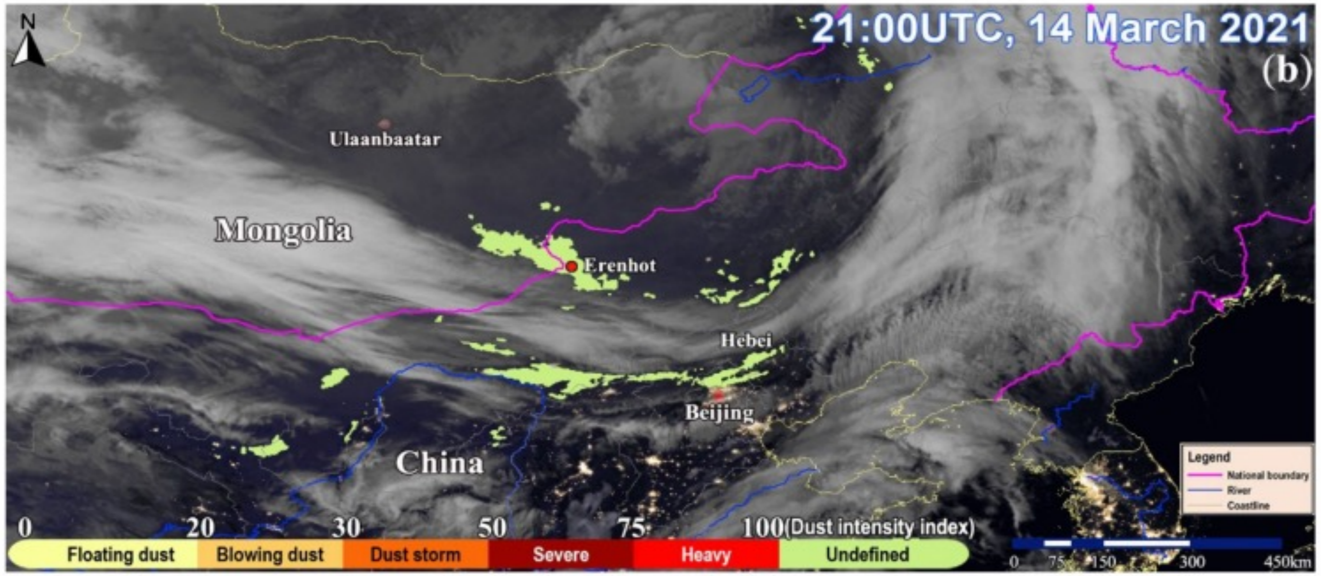
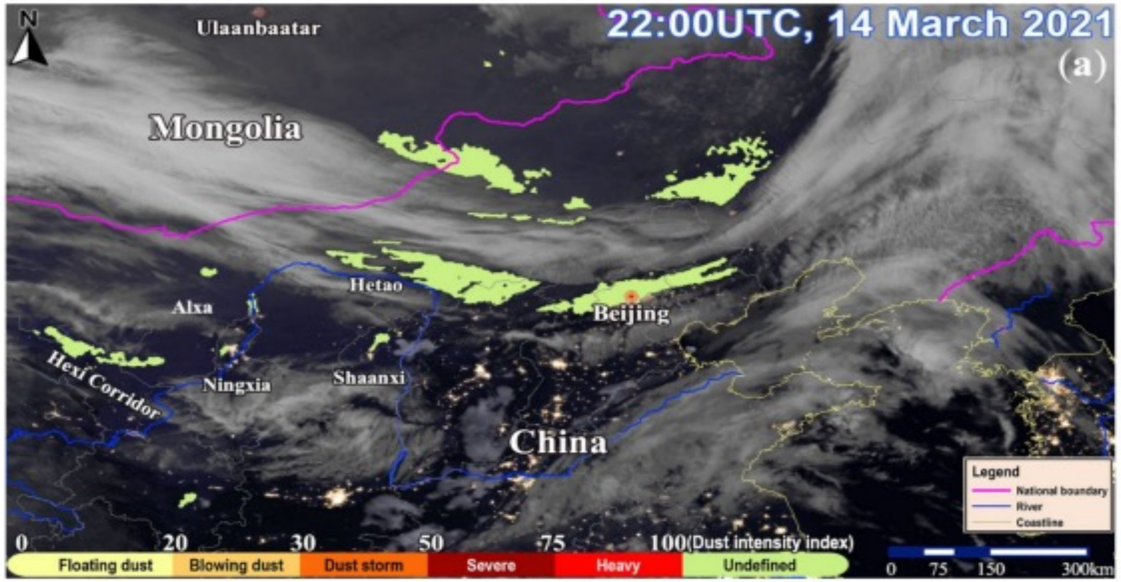


Fig. 6 almost at the same time, dust emission occurred in Hexi Corridor-Hetao, west China and was moving toward east.



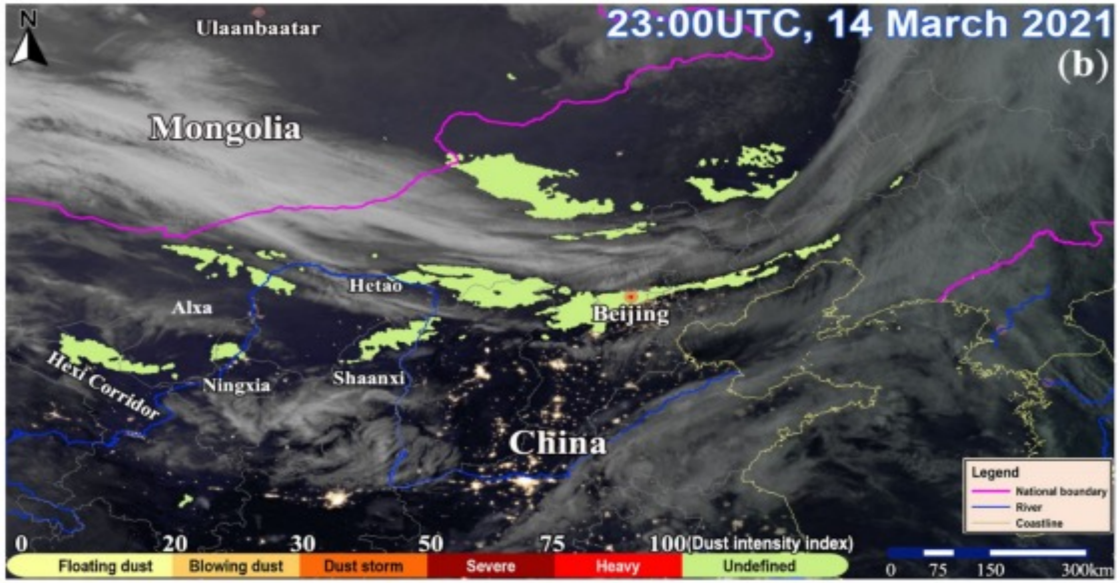
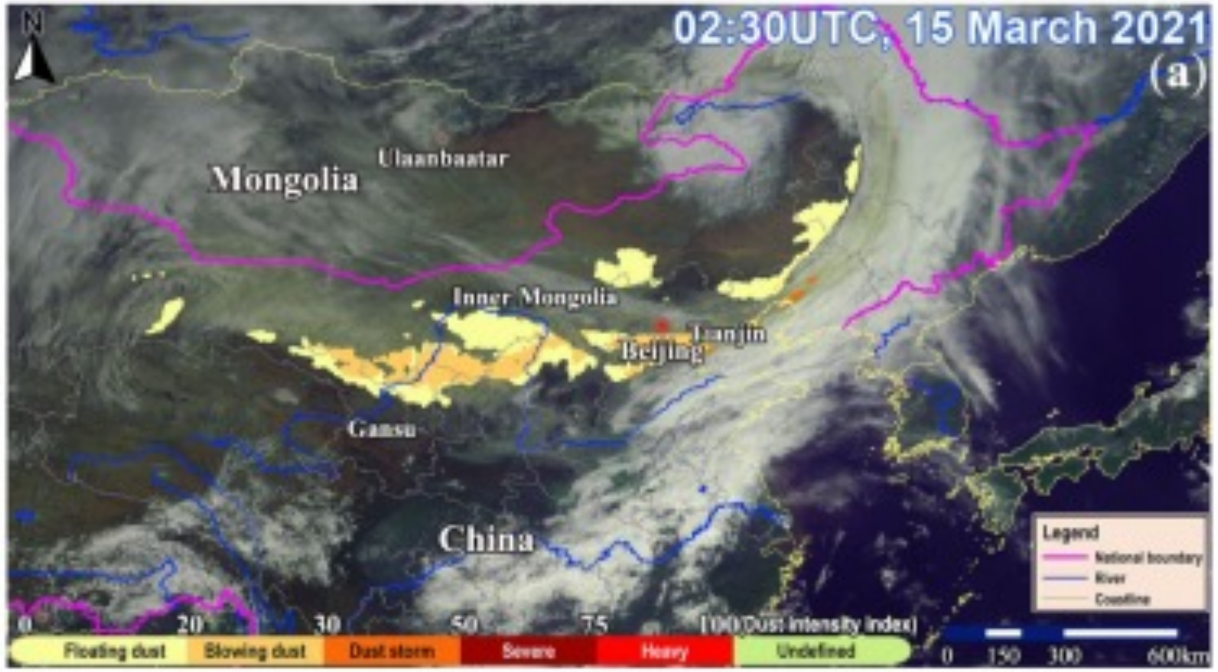
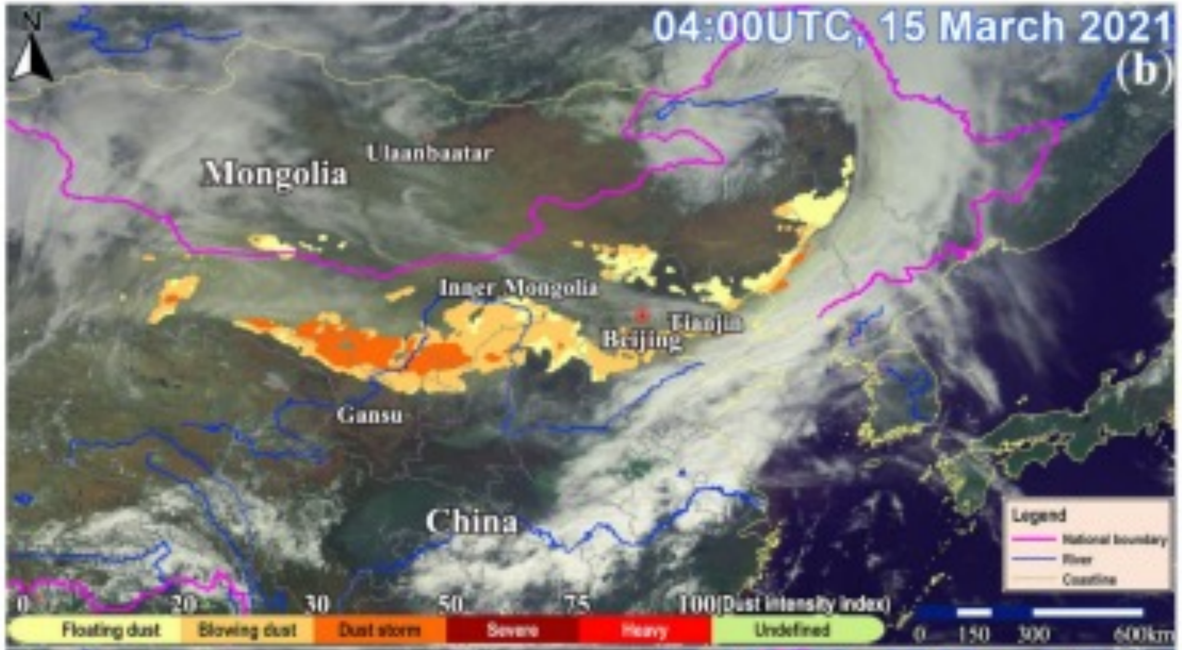


Fig. 7 shows the processes of floating dust developed into dust storm in north China.





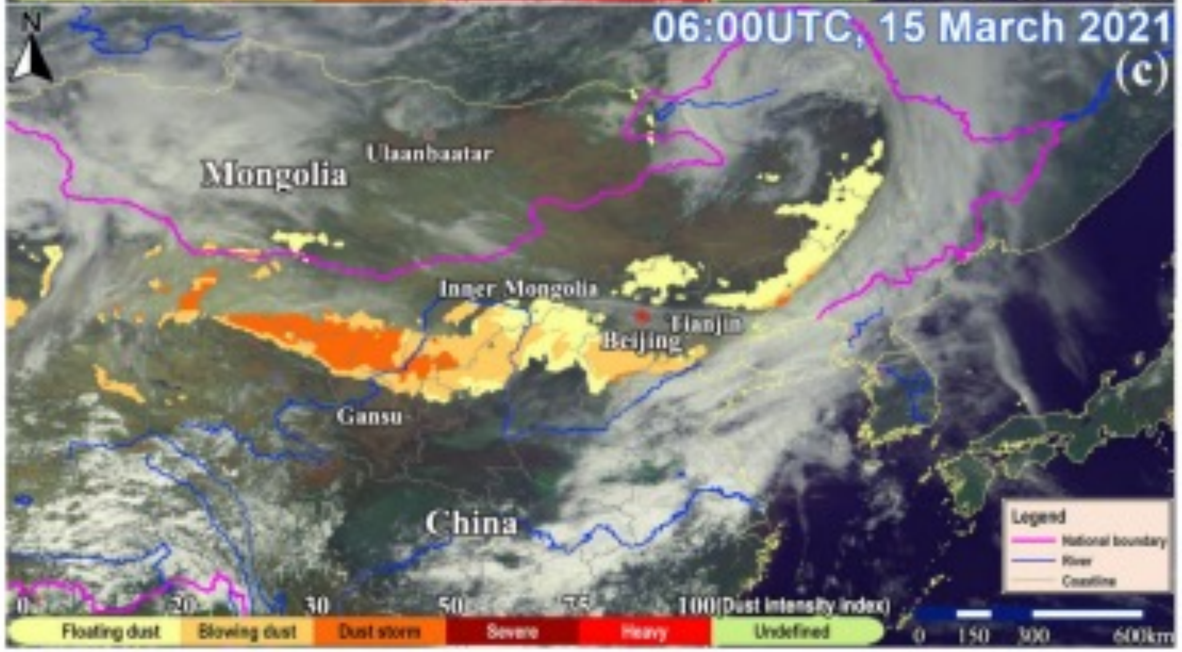
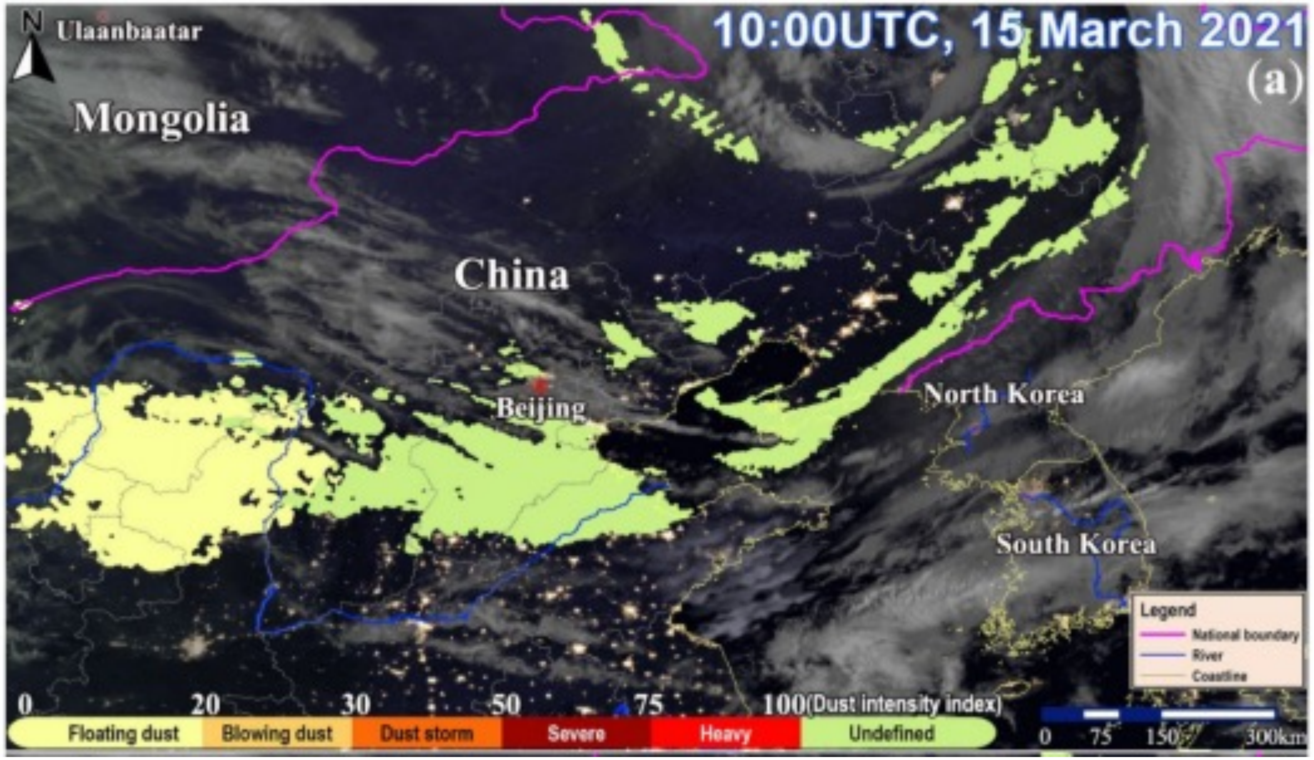


Fig. 8 shows the processes of the dust storm gradually dissipated.



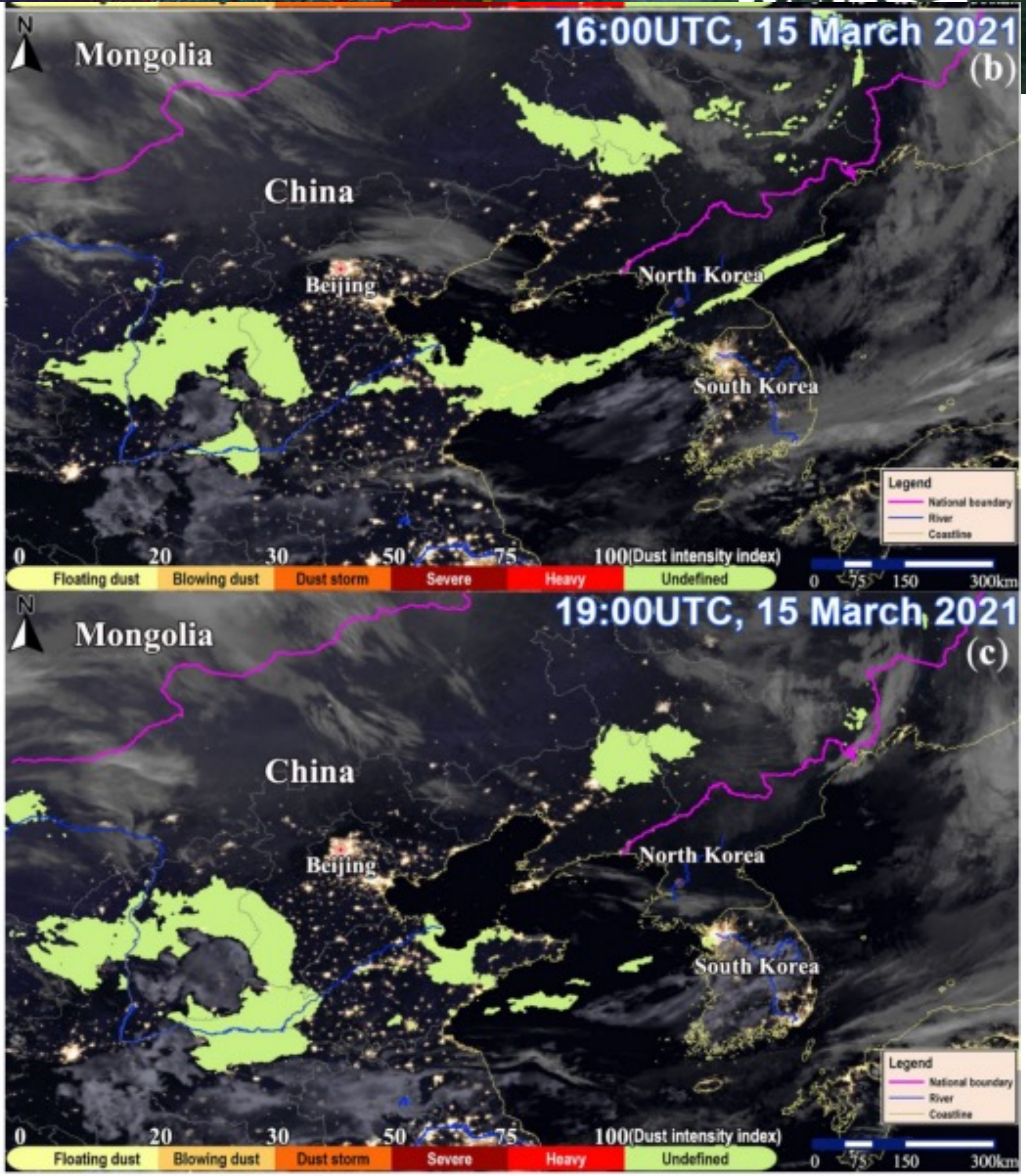


Fig. 9 shows the distribution of PM10 surface observation stations over north China.

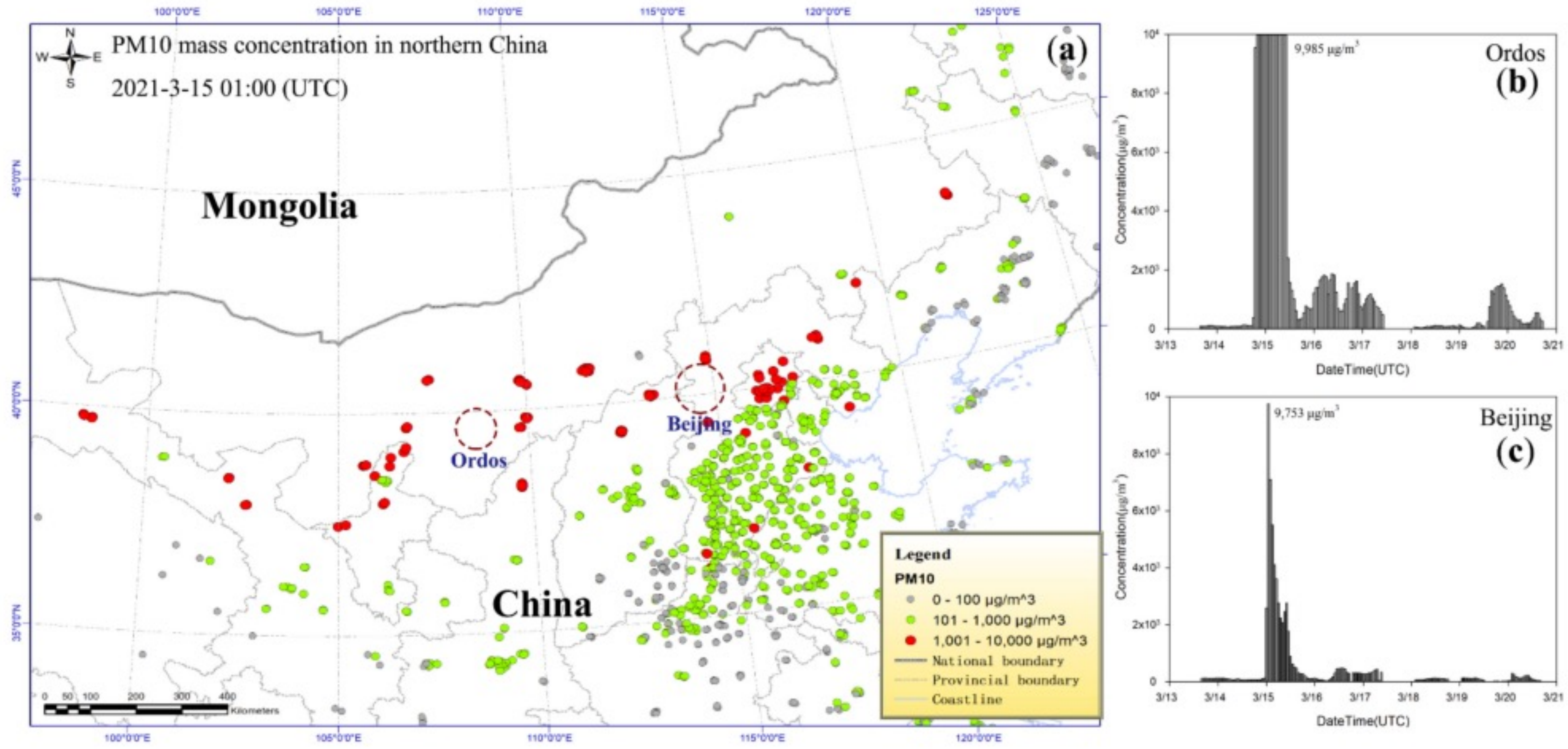


Fig. 10 48h HYSPLIT trajectory tracking analysis: north Beijing

The figure shows most dust in north Beijing come from northwest Mongolia.

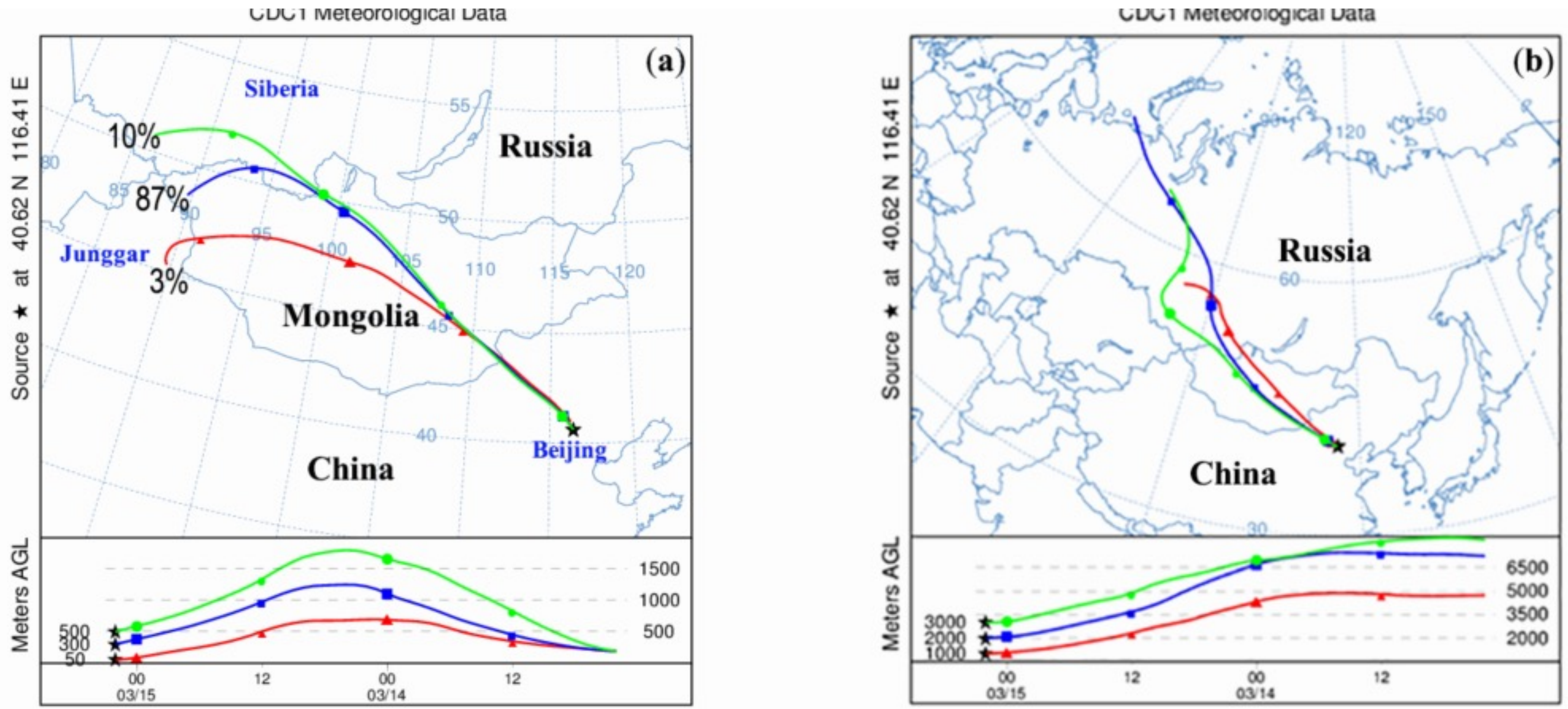
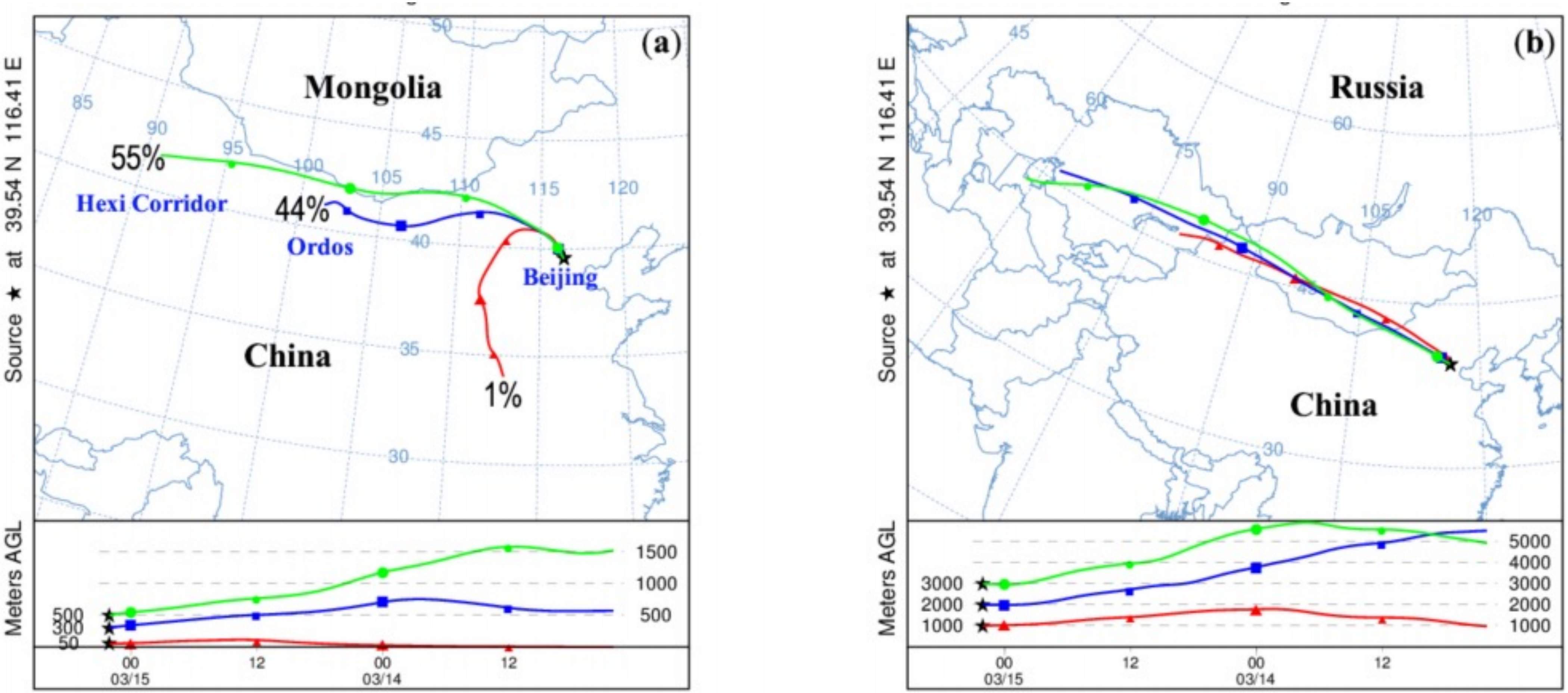


Fig. 11 48h HYSPLIT trajectory tracking analysis: south Beiing

The figure shows most dust in south Beijing come from west China.



Conclussons:

- The “3.15 dust storm” in north China lasted more than 40hours, with a transport distance over 3900km, causing severe consequence, was the most severe dust storm in last 20 years over east Asia.

- We carried out a day-and-night continuous monitoring of the “3.15 dust storm” using multi-channel data from Geostationary satellites.

- Backward trajectory tracking showed that there are two sources of dust contributed the dust storm: one is from northwest Mongolia and the other is from west China.

2:A new mechanism of forming ozone mini high/holes over North China Plain (NCP) in Winter

- Introduction
- Mechanism A and B and its application in NCP
- A possible new mechanism in NCP

Introduction

Many papers focussed on mechanisms of forming mini ozone high/holes and the interrelation between ozone fluctuation and relating synoptic processes.

Although there exist some difference on the definition of ozone mini high/hole, and this difference leads to changes in frequency of events. In general, ozone mini high/hole events at mid-latitude exhibits more frequently in winter months.

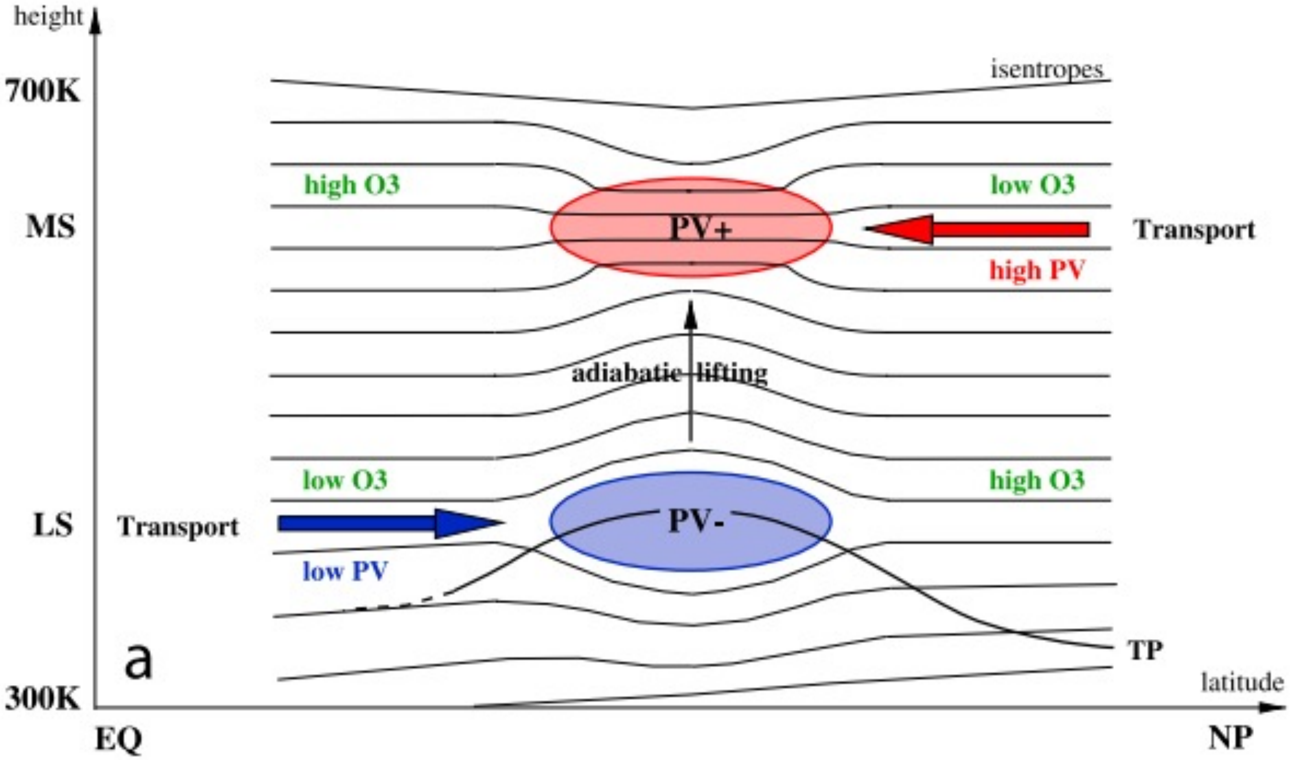
Forming Mechanism A and B

Up to now, it is generally believed that mechanism A and mechanism B are the main mechanisms responsible for the forming of ozone mini high/holes:

(A)far-range meridional transport of air masses from regions with different climatological ozone mixing ratios,

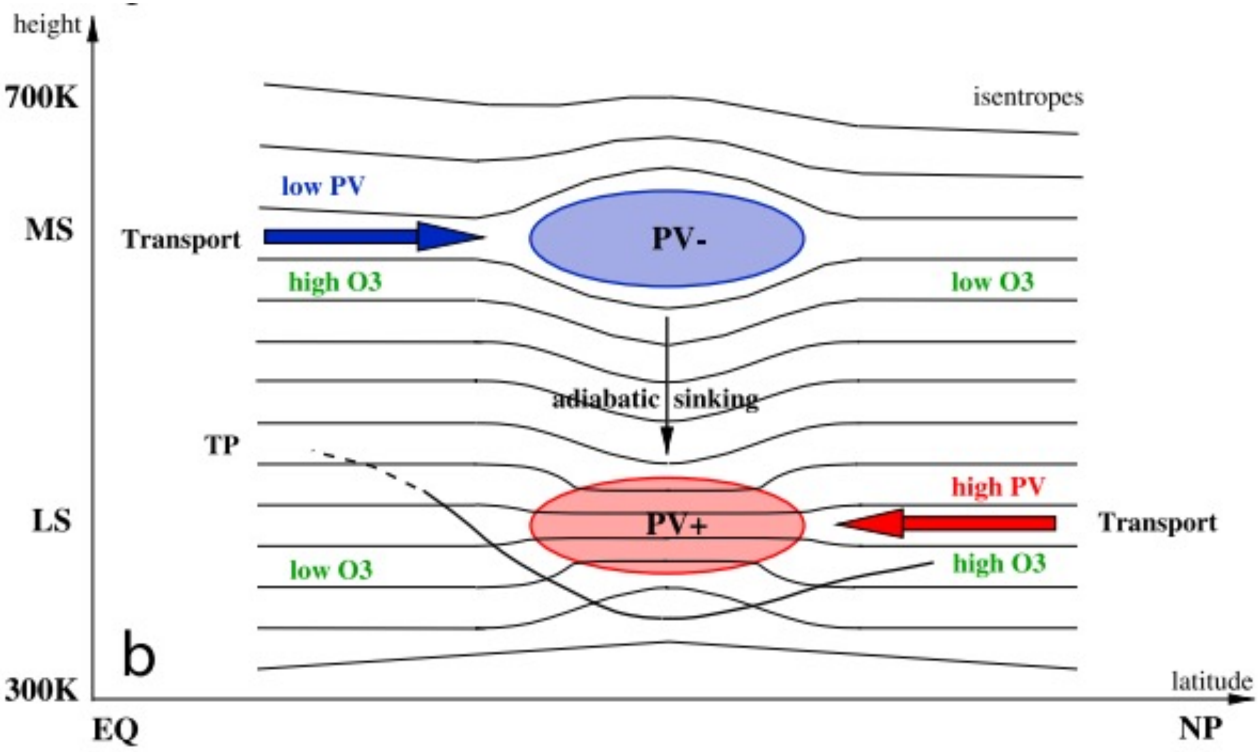
(B) (local) adiabatic vertical displacement of isentropes.

In general, these two mechanisms often work together, but mechanism A provides more important contribution than mechanism B.



From: Koch, et al., 2005, Geophys.Res.Lett., 32, L12810, doi:10.1029/2004GL 022062.

Conceptual model showing how ozone minihole is formed. The term low/high O3/PV refer to relatively low/high values on the respective isentrope. The thick black line (labelled TP) indicates the tropopause.



From: Koch, et al., 2005, Geophys.Res.Lett., 32, L12810, doi:10.1029/2004GL 022062.

Conceptual model shows how ozone minihigh is formed. The term low/high O3/PV refer to relatively low/high values on the respective isentrope. The thick black line (labelled TP) indicates the tropopause.

- The weather processes that accompanied with these ozone mini high/holes are also significantly different in winter months:
  - weather often accompanied with ozone mini highs is: extreme cold and dry
  - Weather accompanied with ozone mini holes is : extreme warm and wet

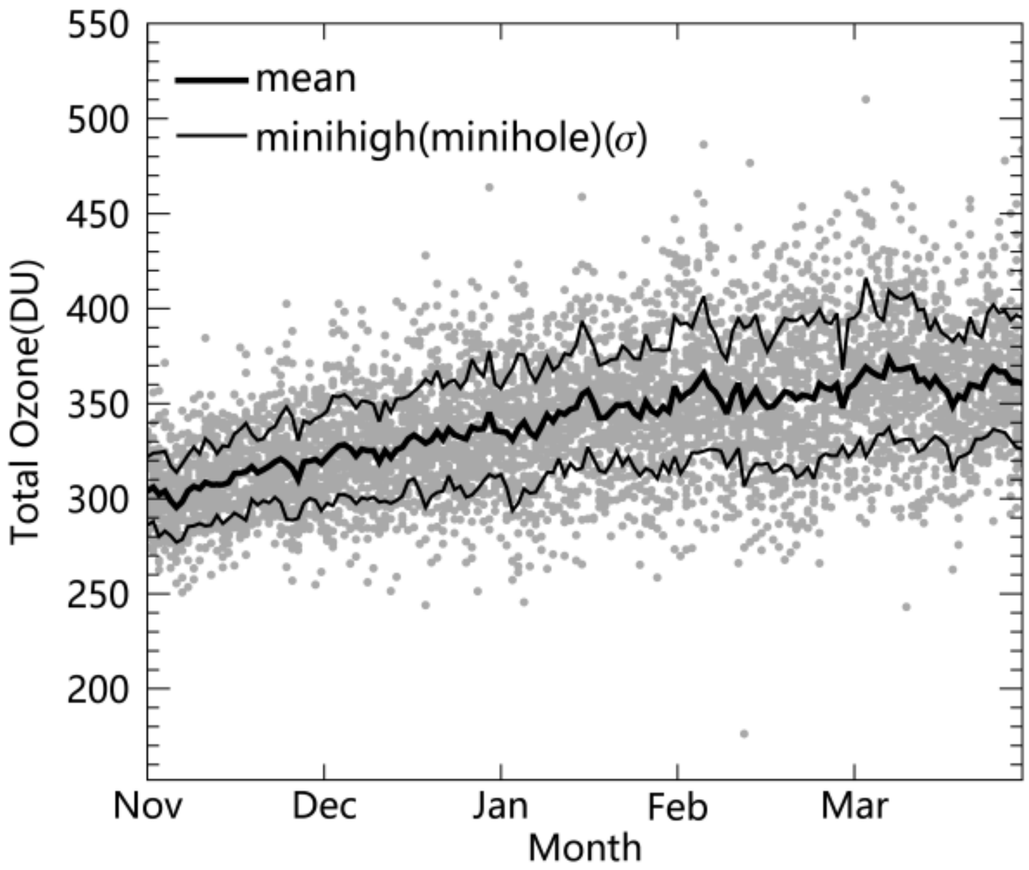
- These weather features are often closely related to mechanism A and B.

A possible new mechanism in NCP

The North China Plain (NCP) is surrounded by mountain ranges in the north, west and south, and borders the western Pacific Ocean to the east.

We investigated ozone mini high/holes over NCP in winter months during 1979-2019. Primary result shows, there may exists a new mechanism beyond mechanism A and B in NCP during winter months.

- Climatology of ozone mini high/holes in NCP in 5 months from Nov to Mar during 1979-2019. Data shown relative high frequency of ozone mini high/holes in winter.



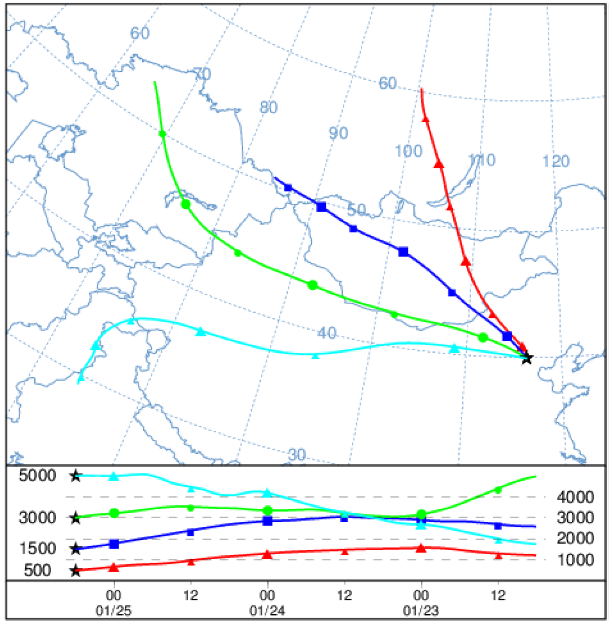
- Investigation shows that the formation of most ozone mini high/holes follows mechanisms A and B, as well as the accompanying laws of weather processes, ie. the rapid cooling and dry weather accompanied with ozone mini high events, and the rapid warming and wetting weather accompanied with ozone mini hole events.

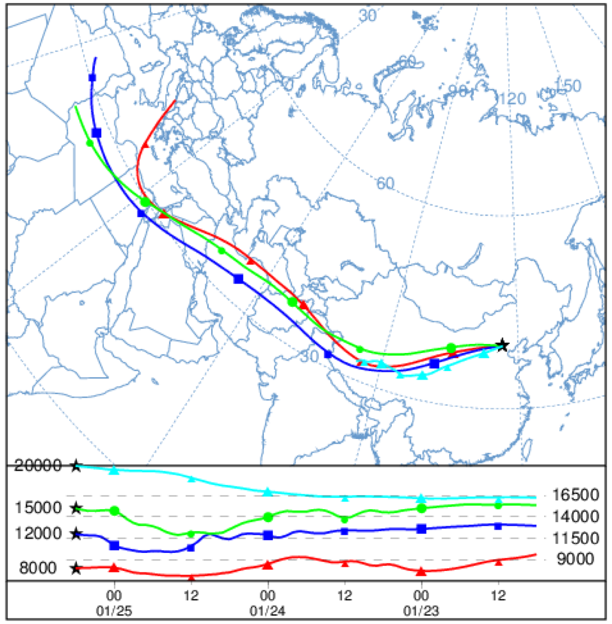
- However, there are also some abnormal cases in NCP. In these cases, the rapid and sharp cooling process is accompanied with ozone mini holes; while the rapid and sharp warming process is accompanied with ozone mini highs.

- An example of the former scenario occurred on January 25, 2018, and another example of the latter scenario occurred on January 29, 2014.

Analysis of the extreme ozone event on January 25, 2018.

3-day backward trajectories on 8 height levels from 20000 to 500 meters are used to determine the "origin" of the air masses. Figure below shows the air masses at lowest levels from 3000 to 500 meters come from high-latitude regions which results in rapid and sharp surface cooling weather during the process.

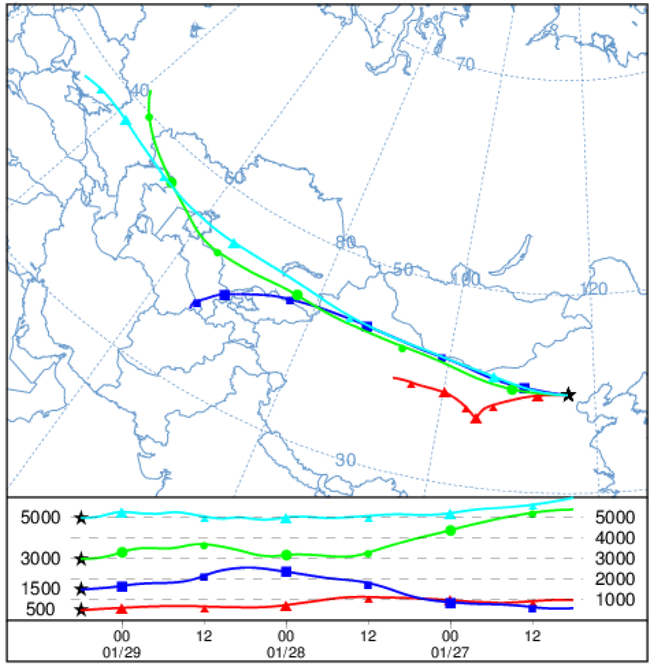


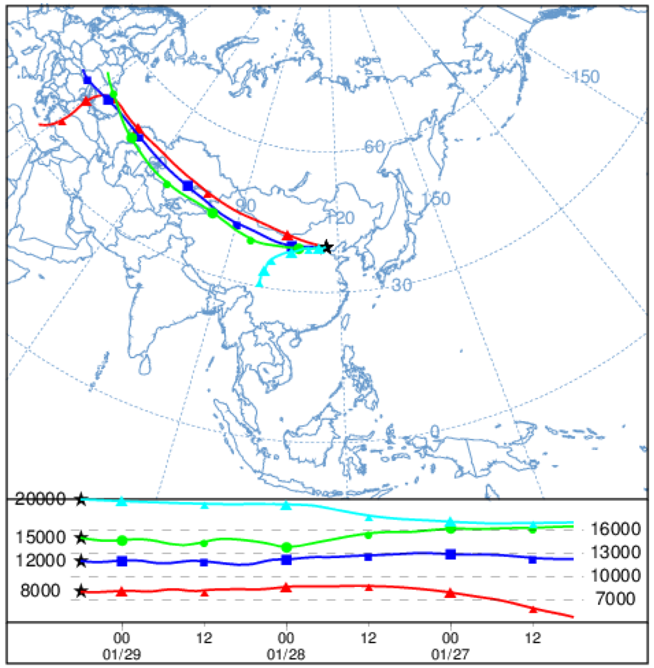


While the air masses at high levels from 20000 to 5000 meters come from regions almost at the same latitude in the west, with a remarkable vertical lifting process which results in forming of the ozone mini hole event.

- Analysis of the extreme ozone event on January 29, 2014.

3-day backward trajectories on 8 height levels from 20000 to 500 meters are also used to determine the "origin" of the air masses. Figure below shows the air masses at lowest levels from 3000 to 500 meters come from regions of almost the same latitude or lower latitude in the west which results in rapid and sharp surface warming weather during the process.





- While the air masses at high levels from 20000 to 5000 meters come from regions at high latitudes in the northwest, with a remarkable vertical sinking process which results in forming of the ozone mini high event.

- A possible new mechanism in NCP

In NCP, there may exist a new mechanism during winter months: the west/east-ward transport of air masses at the same latitudes plays a role in forming ozone mini high/holes, which is an additional but less important mechanism. And this new mechanism causes unnormal weather processes.

The formation of the new mechanism may be related to factors such as the terrain and topography of NCP, as well as its location of land and sea.

- We will carry out further investigation and alaysis.

Thank you for your attention!