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Study of Characteristics of Haze and Dust Storm over Northwest China

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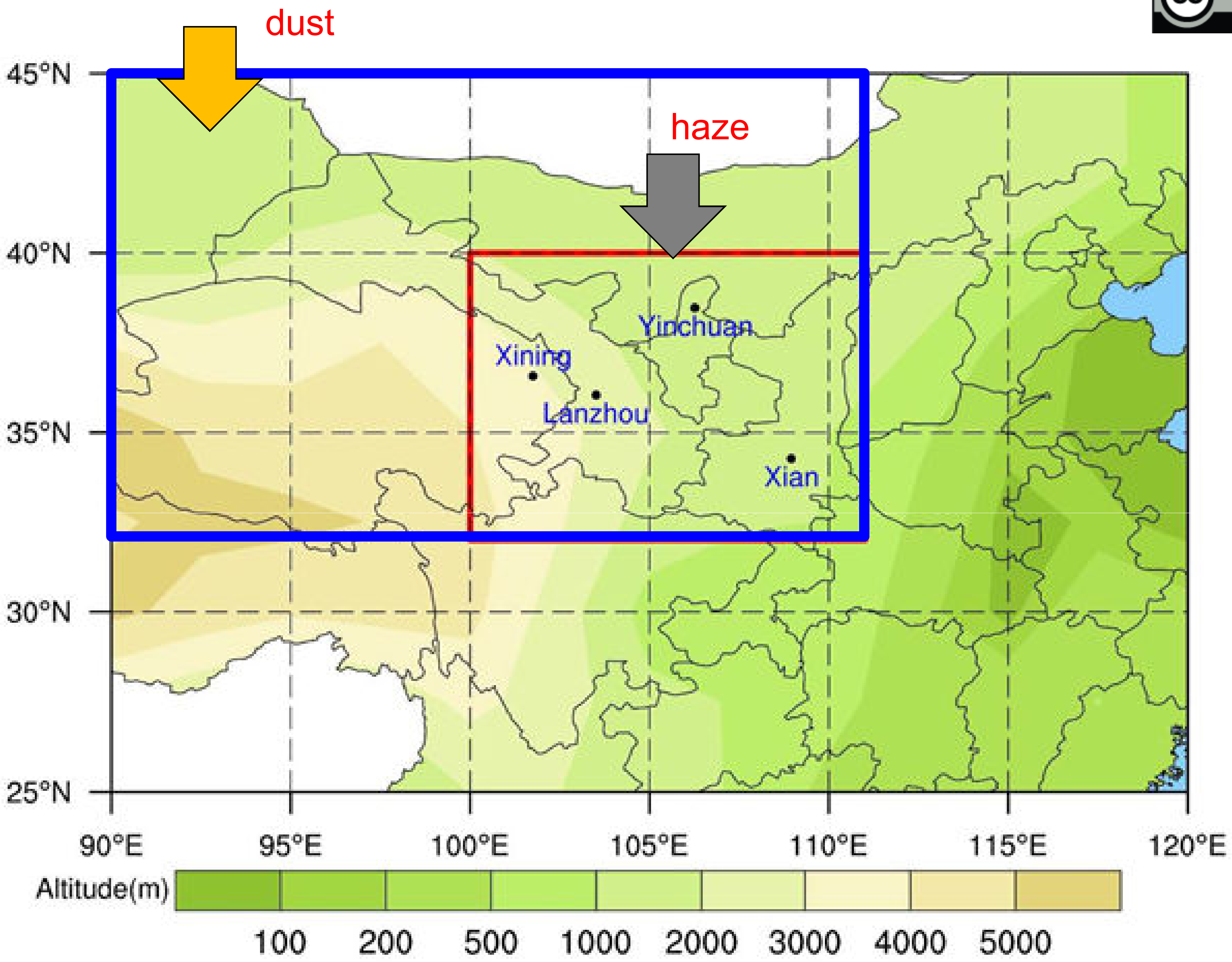
Outline

- Motivation
- Haze and Dust Events in China
  - **Haze**
  - **Duststorm**
- Conclusions



Area for study (Bule: dust, Red: haze)

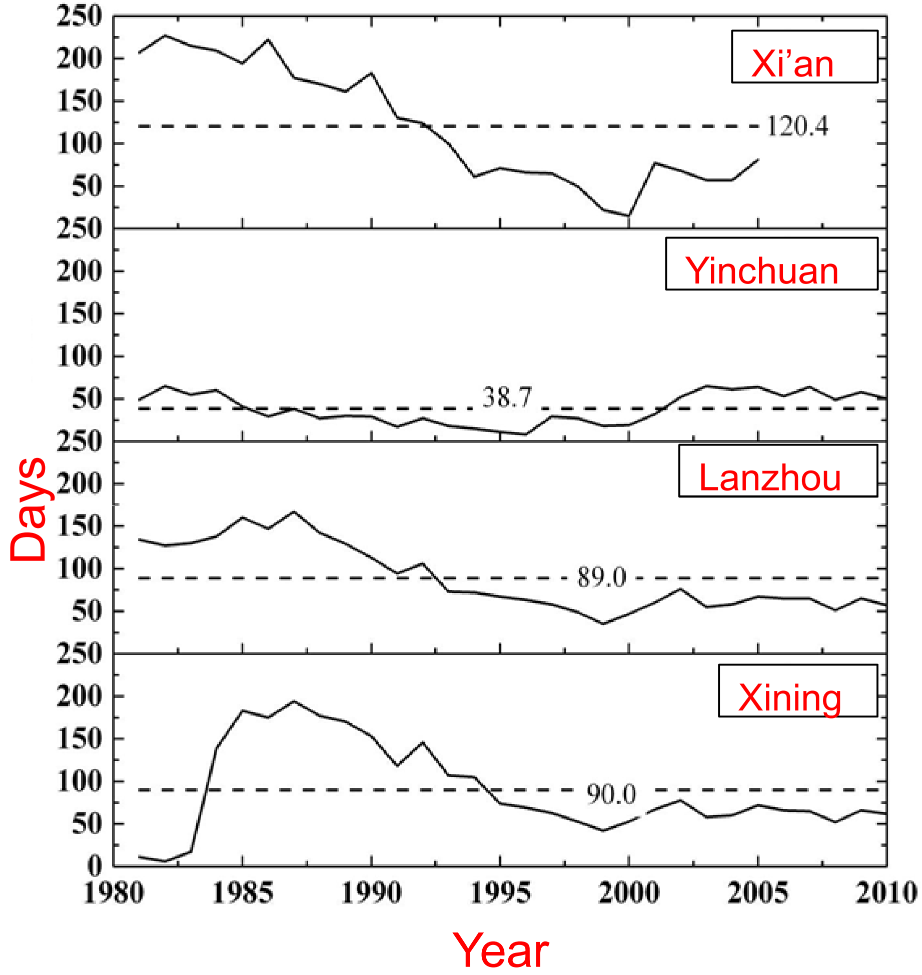
Motivation

- More than ever before, the public is paying attention to haze occurred in China, which is closely related to the air quality and human health.
- Duststorm is one of the disasters in spring in north China and it may cause heavy air pollutions.
- Based on satellite remote sensing data of CALIOP/CALIPSO and ground-based observations, characteristics of the haze and dust storm occurred in the Northwest China (NC) were analyzed.
- The vertical distribution of particle shape and size, weather situation and features of meteorological elements were investigated, during the haze events occurred in March 2013 and dust storms in spring from 2009 to 2011 in northwest China.

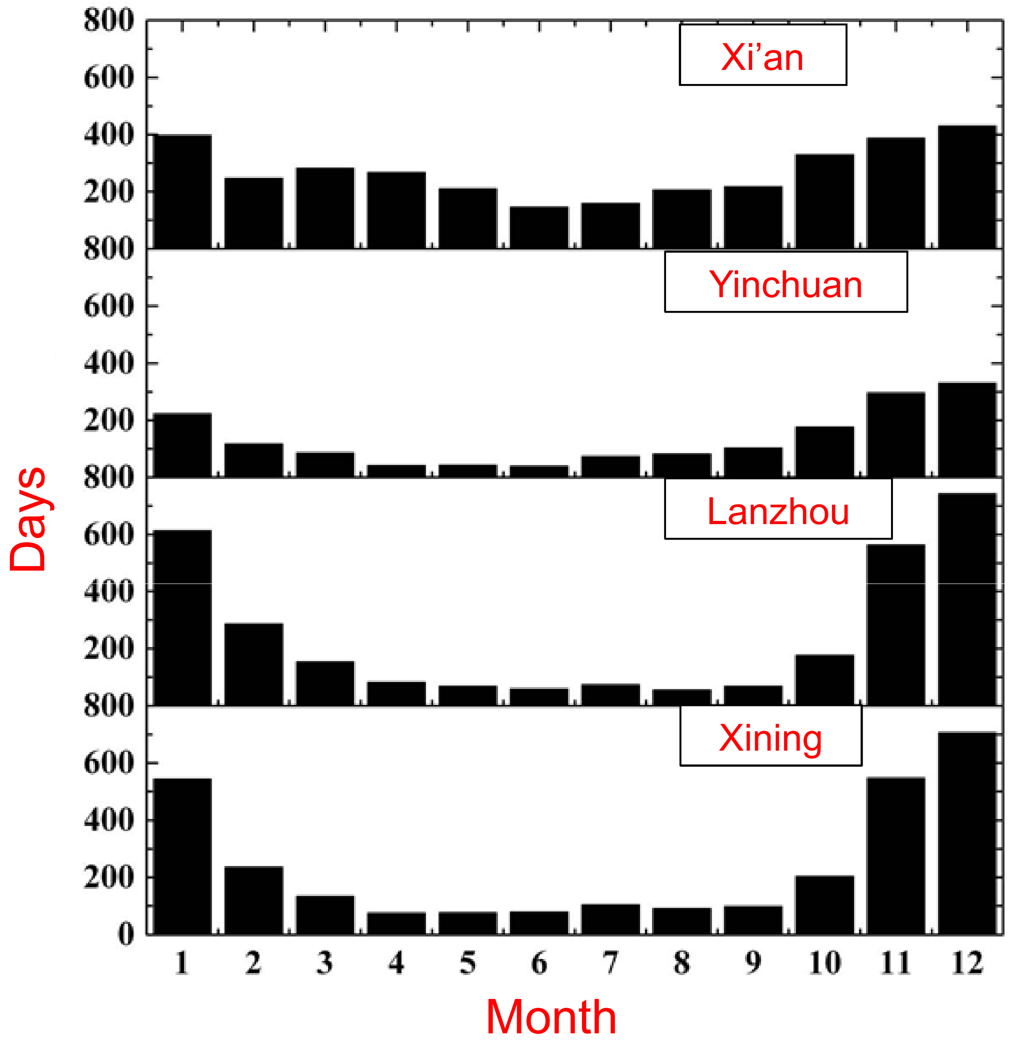
Study of Haze events in East part of Northwest China

●Annual and Interannual variation of haze days

The frequency of haze events in east part of northwest China was decreased from 1980s to the end of the 20th century and then increased from the beginning of 21st century.



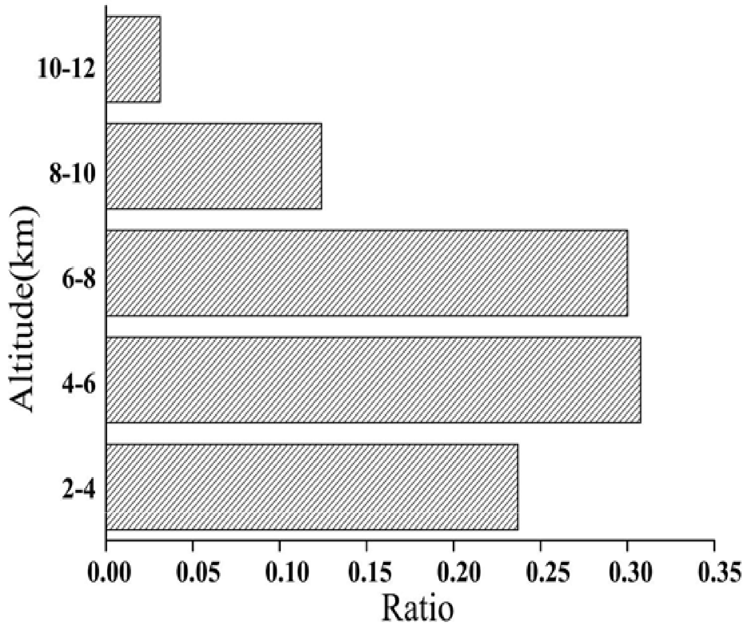
Annual variation of haze days from 1981 to 2010



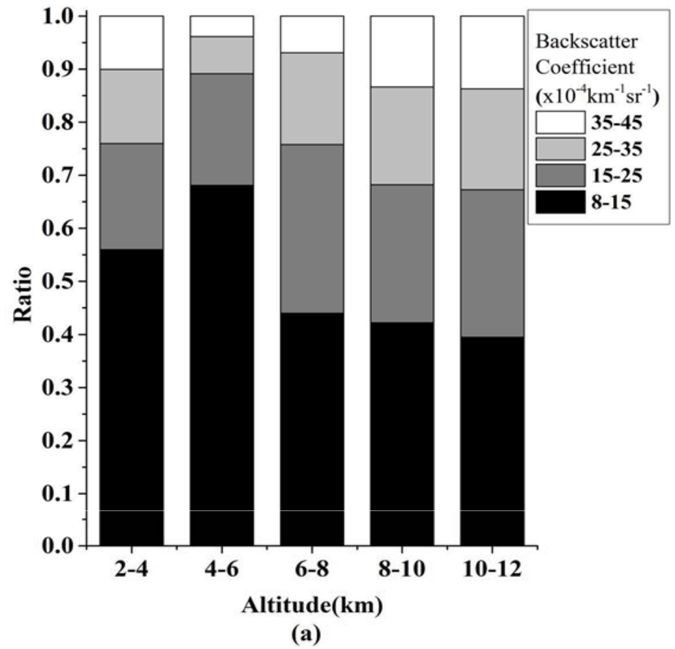
Interannual variation of haze from 1981 to 2010

Most of haze events occurred in winter (mainly contributed by coal burnning in heating period) and spring (inversion layer and suspending fine particles induced by dust storm or emission of …).

●Vertical distribution of aerosol 2010.1—2013.4 ,Calipso

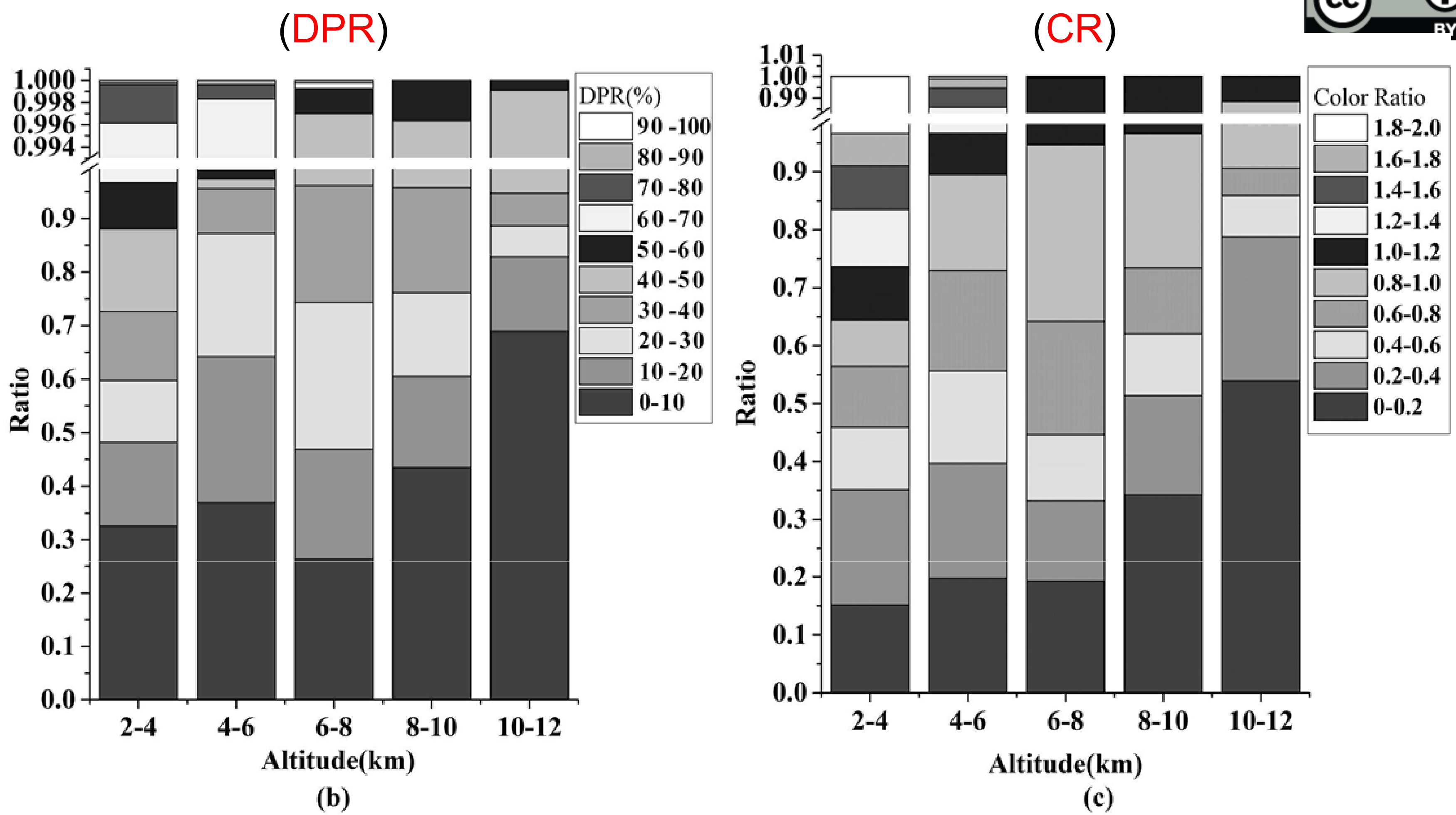


Vertical distribution of aerosol backscattering coefficients at 532nm



Frequency distribution on different height levels of aerosol backscatter coefficients

The majority in the troposphere during the haze events were the particles with backscattering coefficients ranged from 0.0008 to 0.0025 /km.sr, and the backscattering coefficients of particles at 532nm increased with altitude from 4 to 10 km.

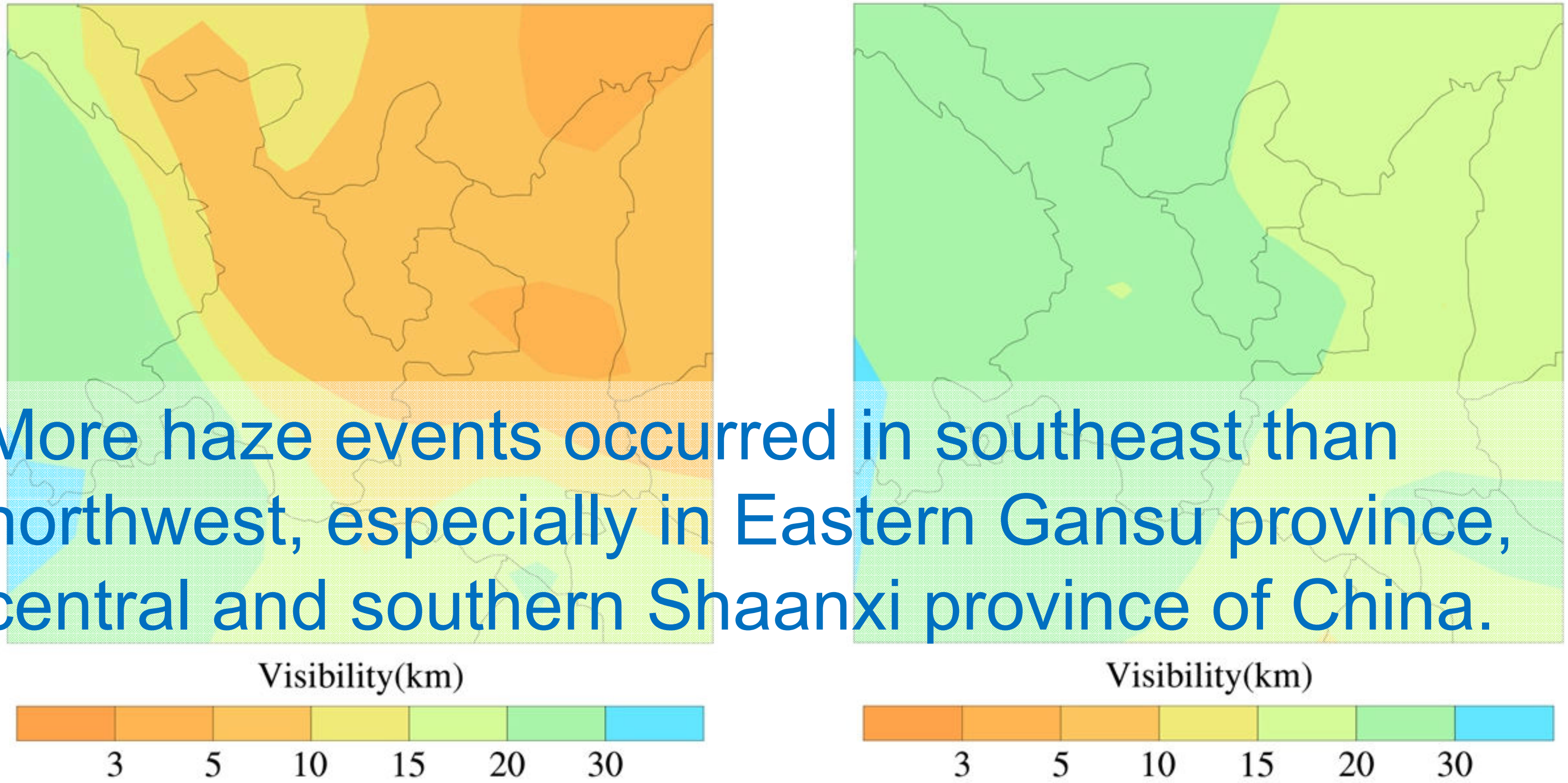


(b) Aerosols volume DePolarization Ratio (DPR) was mostly less than 20% above 6 km and the mean irregularities of aerosols were weakened with height.

(c)The Color Ratio was below 0.8 during haze events and centered at 0.0-0.4.

●Case study (in spring)

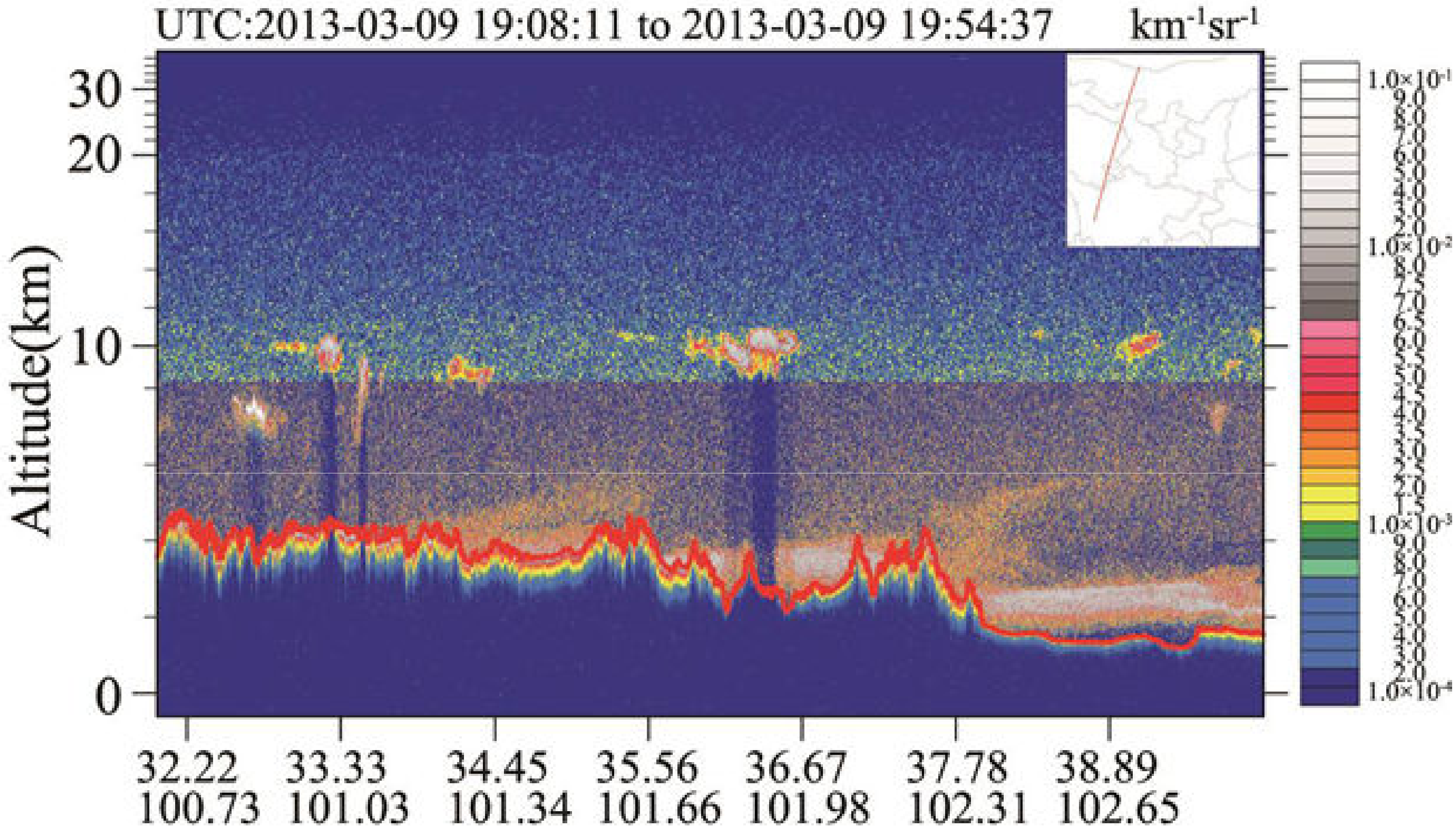
More haze events occurred in southeast than northwest, especially in Eastern Gansu province, central and southern Shaanxi province of China.



(a) 9-March-2009 (b) 19-March-2009

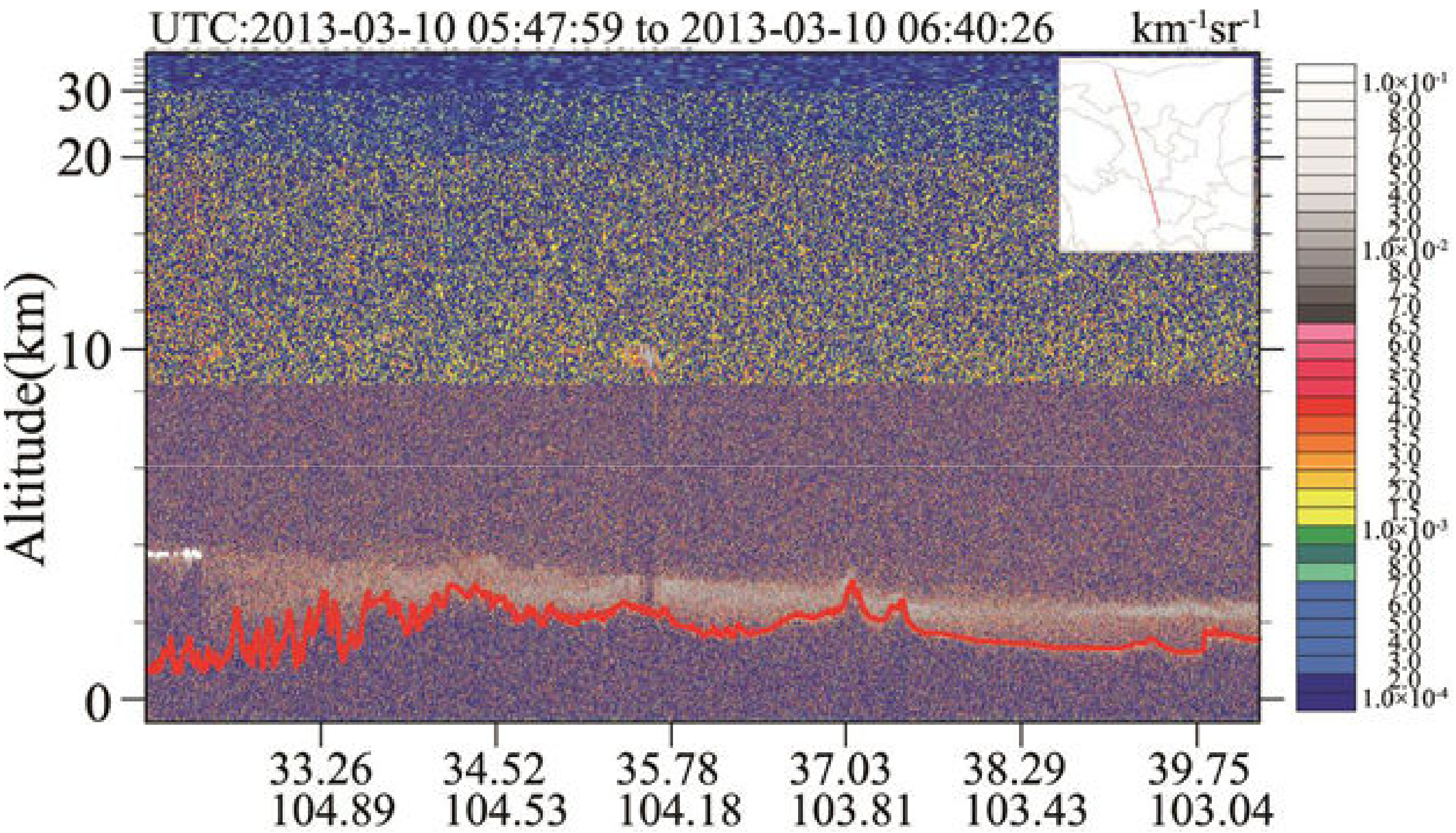
Spatial distribution of visibility(km) over the distribution of the eastern part of northwestern China on March 9th (a) and 19th (b), 2013

●Case study (in spring)



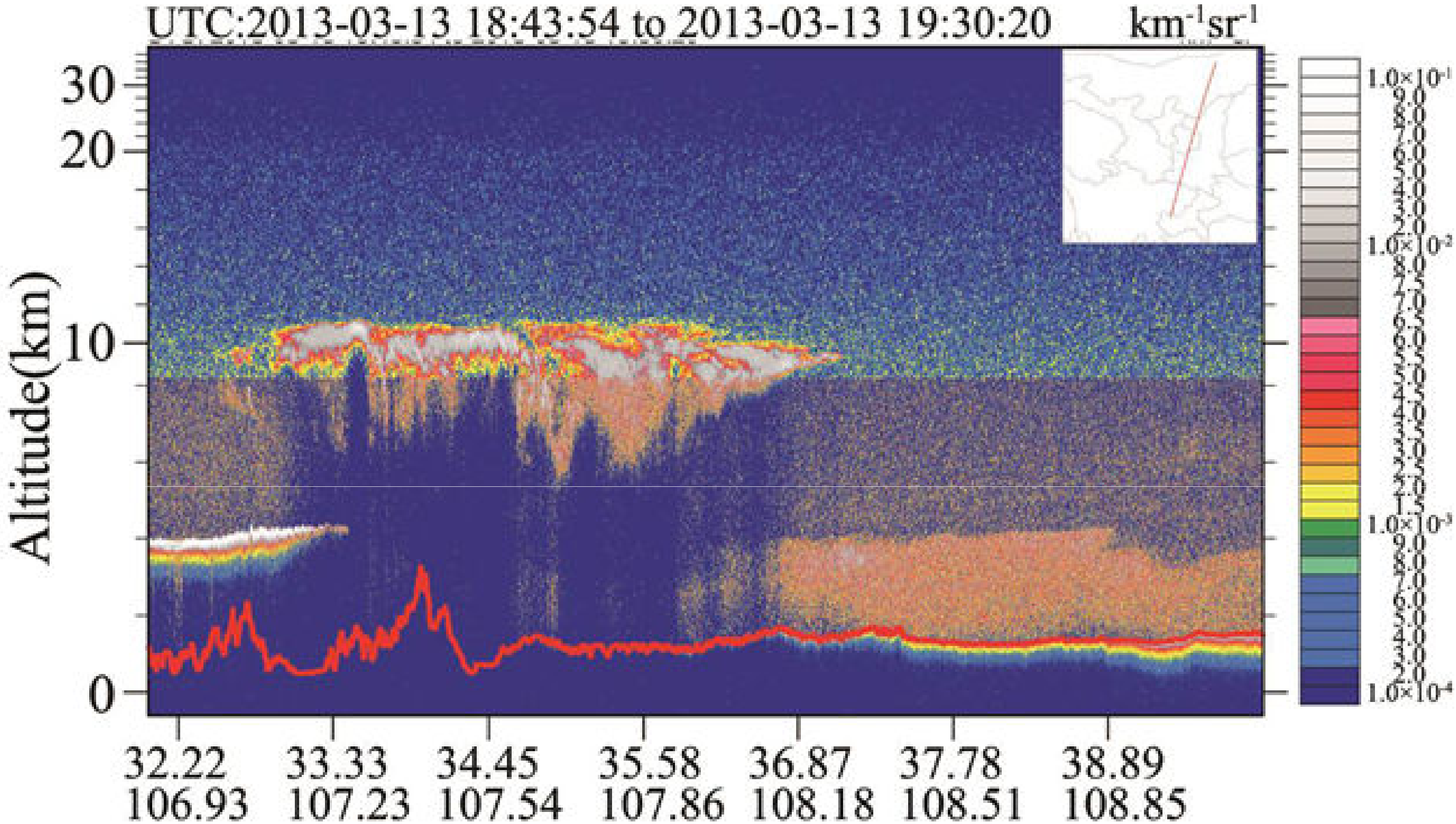
Vertical cross section of backscattering coefficient at 532nm during March 9th,2013 (CALIPSO,Redline: topography)

●Case study (in spring)



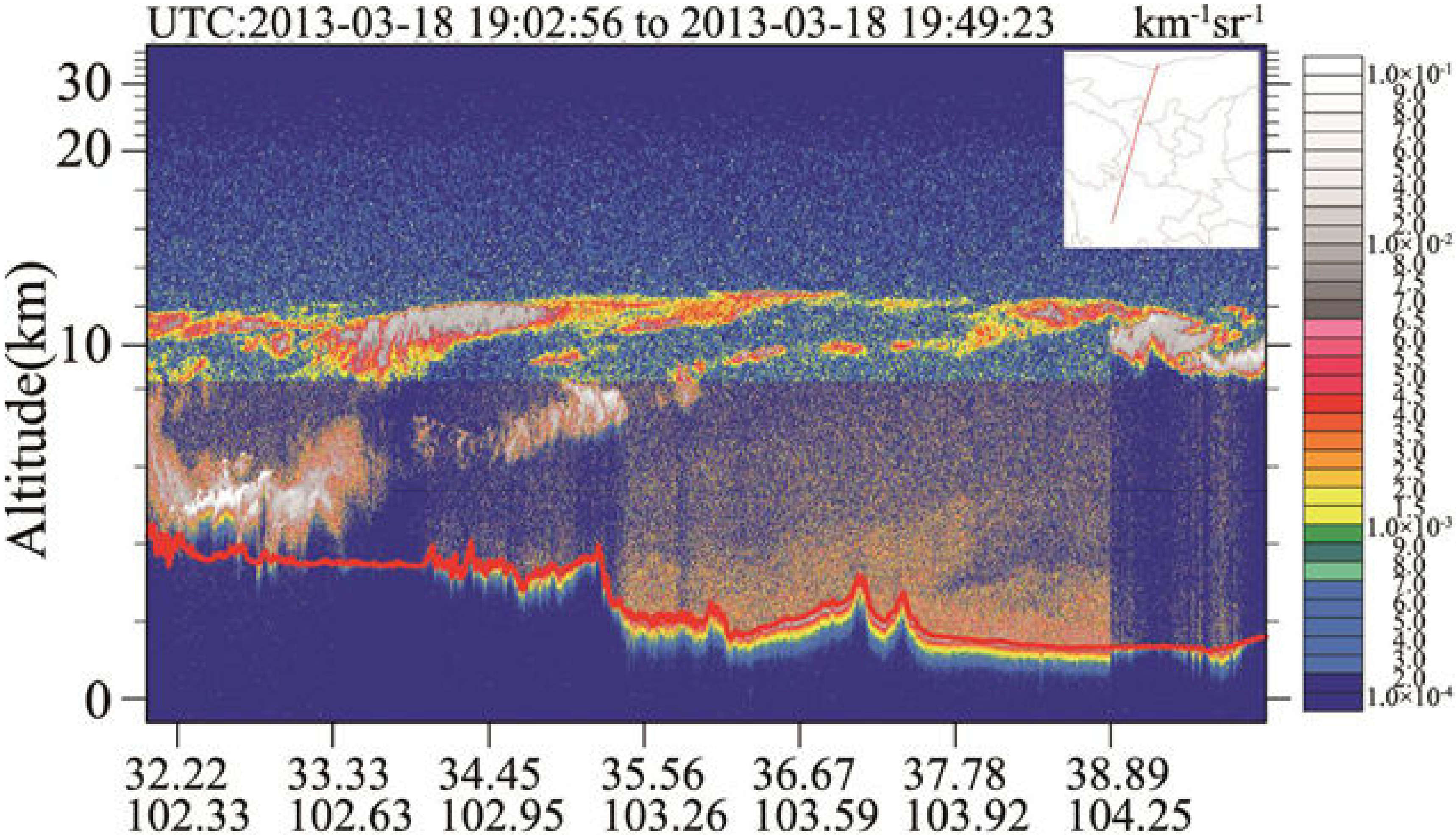
Vertical cross section of backscattering coefficient at 532nm during March 10th,2013 (CALIPSO,Redline: topography)

●Case study (in spring)



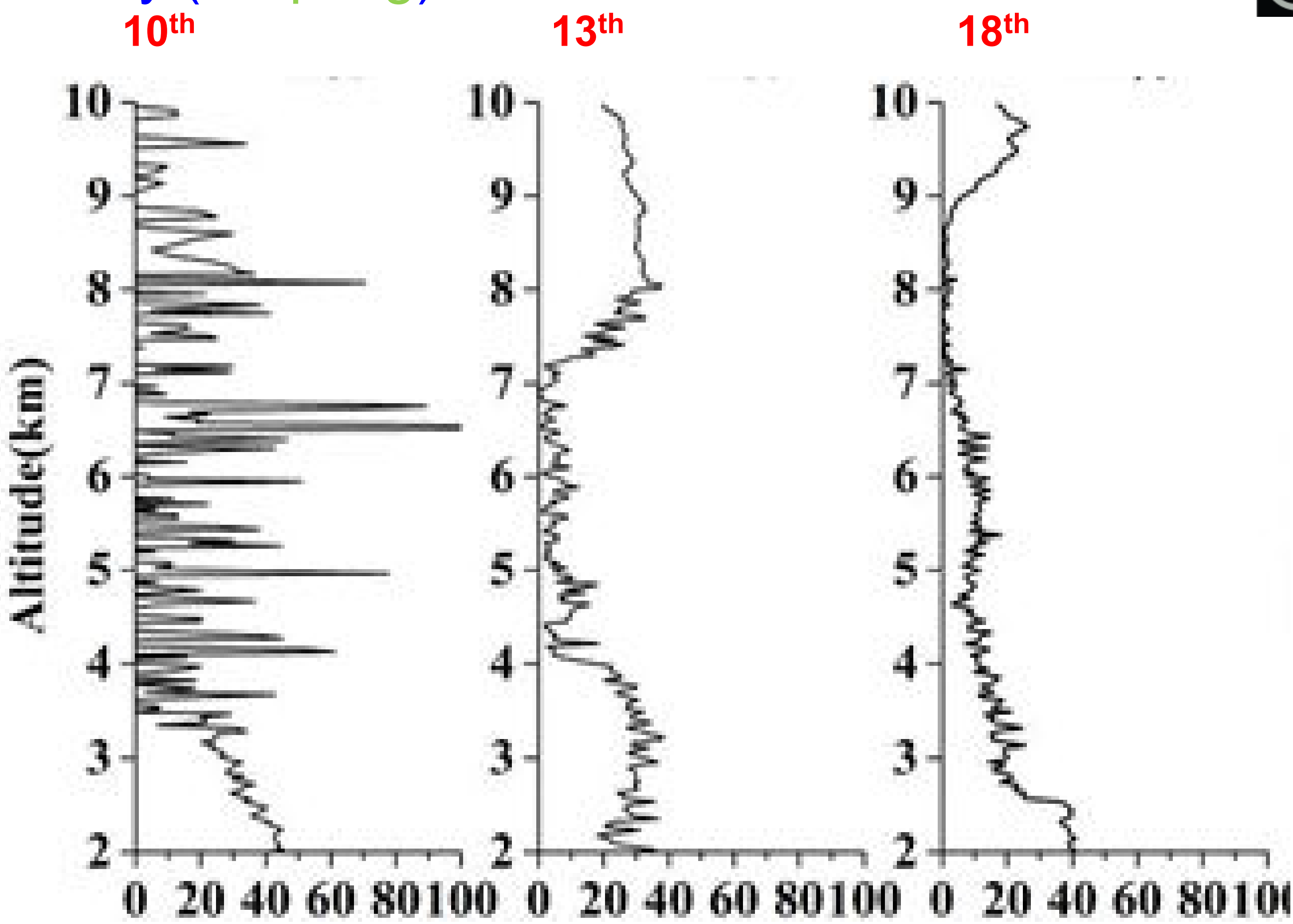
Vertical cross section of backscattering coefficient at 532nm during March 13th,2013 (CALIPSO,Redline: topography)

●Case study (in spring)



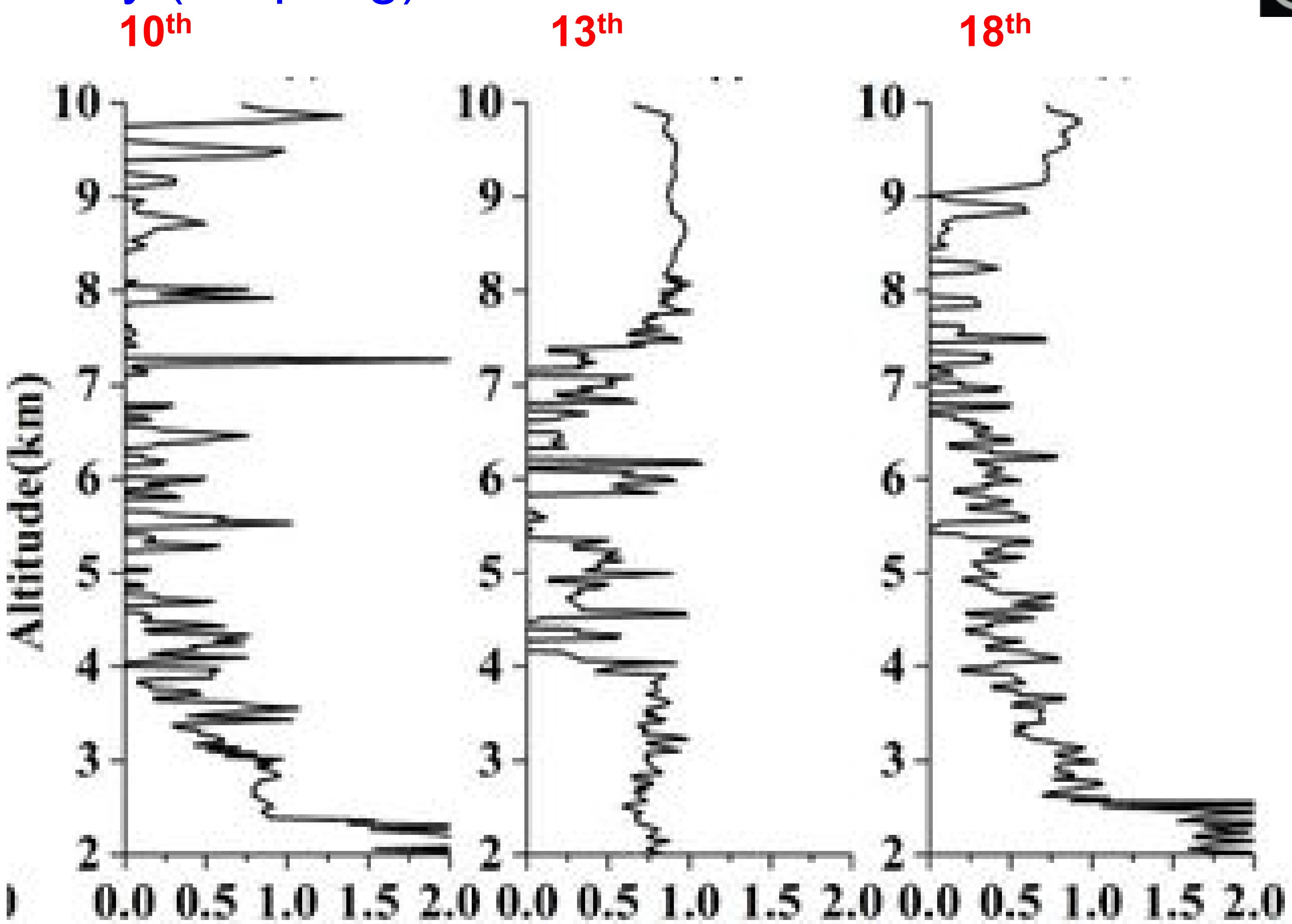
Vertical cross section of backscattering coefficient at 532nm during March 18th,2013 (CALIPSO,Redline: topography)

●Case study (in spring)



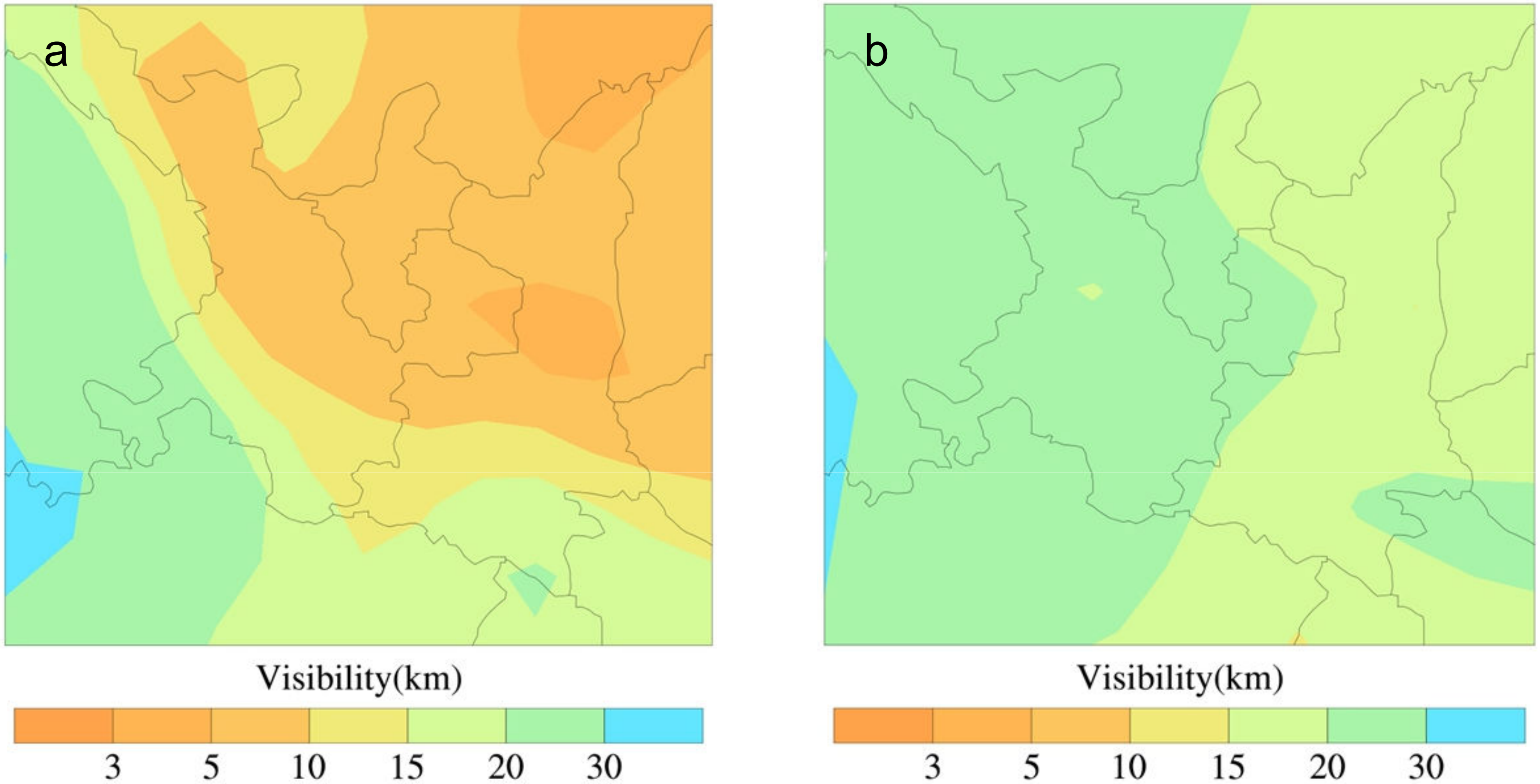
The vertical profile of volume Depolarization Ratio through the appropriate sections of the satellite on March 10th, 13th and 18th 2013

●Case study (in spring)



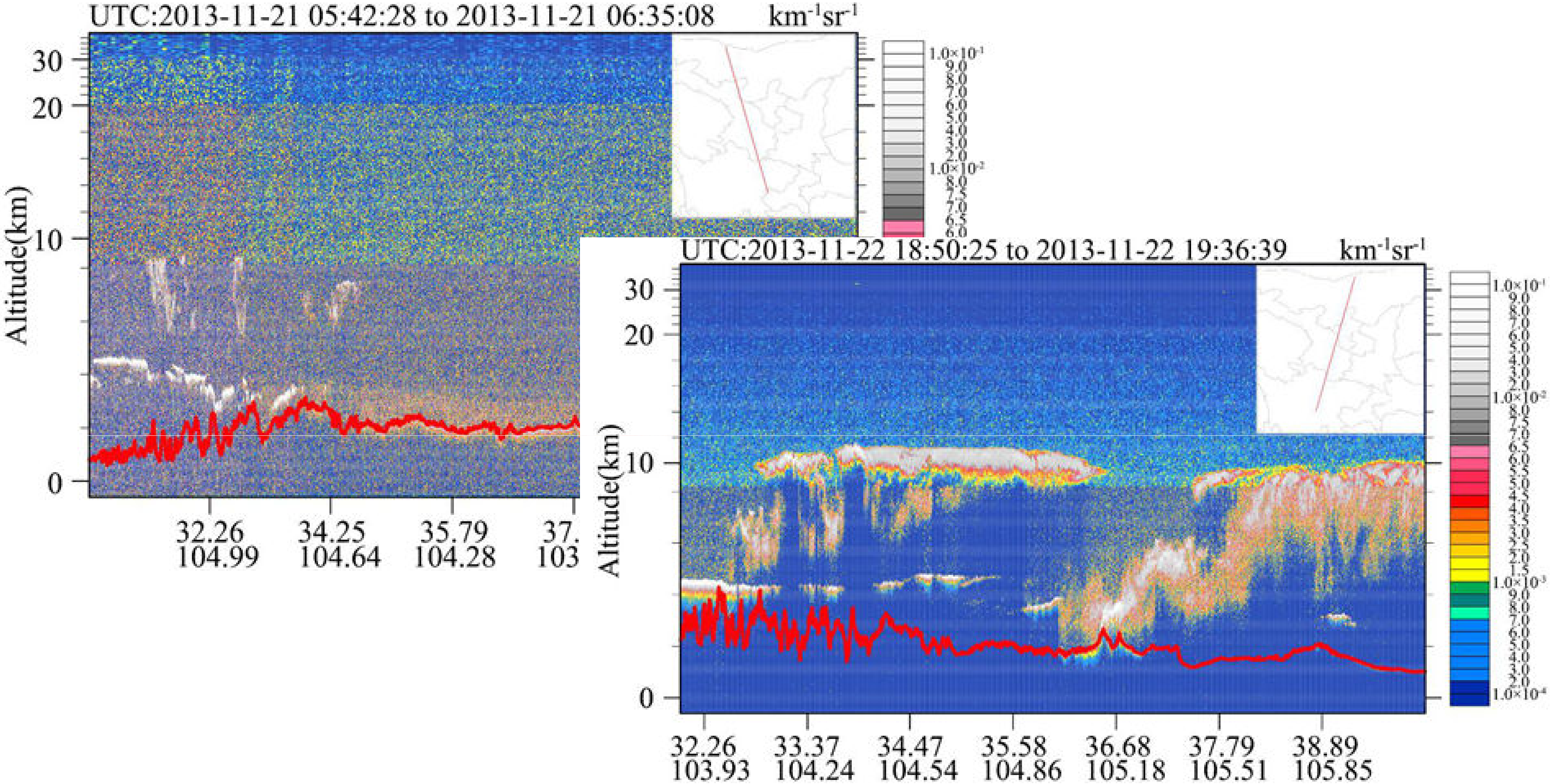
The vertical profile of Color Ratio through the appropriate sections of the satellite on March 10th, 13th and 18th 2013

●Case study (in winter)



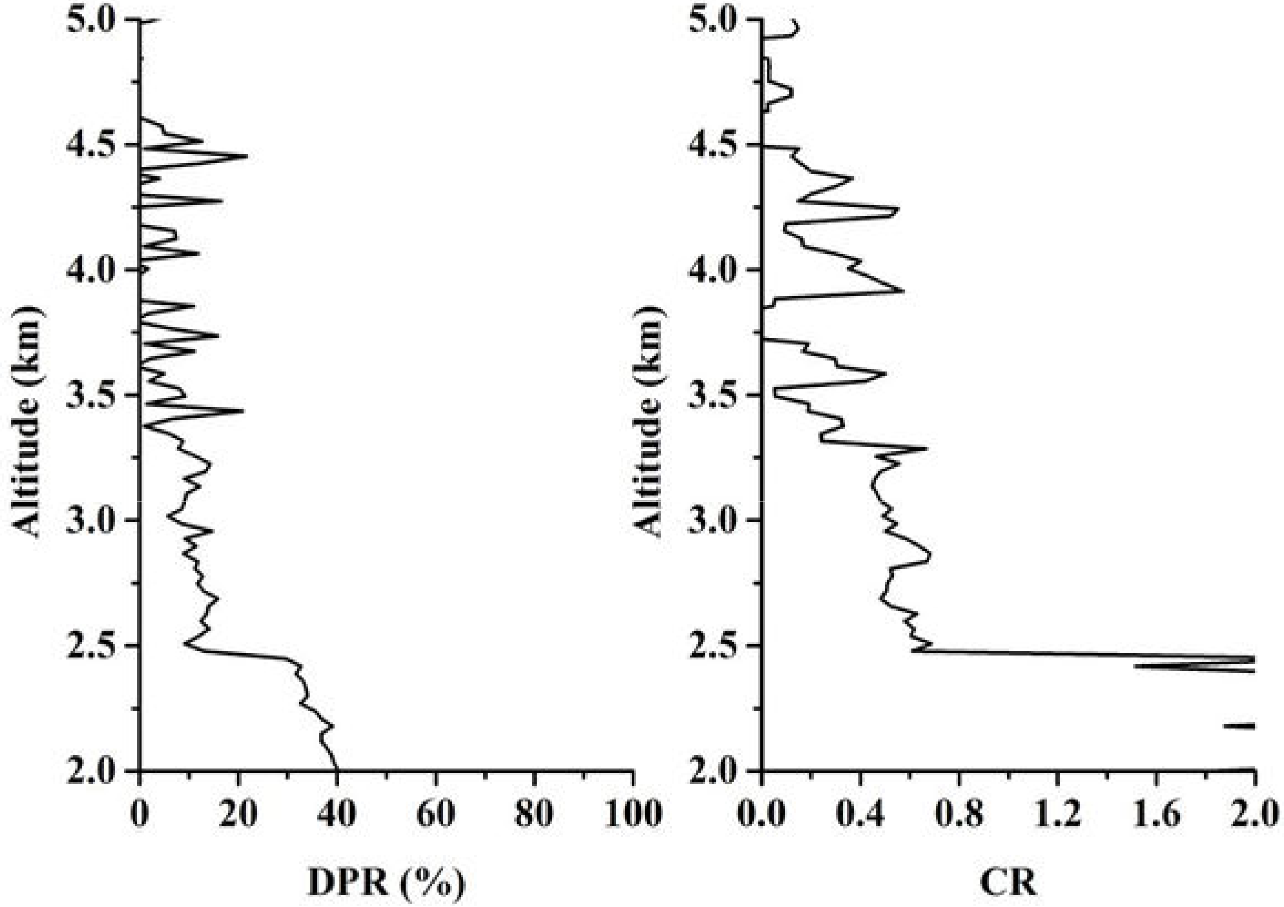
Spatial distribution of visibility(km) over the distribution of the eastern part of northwestern China on November 18th (a) and 22th (b), 2013

●Case study (in winter)



Vertical cross section of the 532nm backscattering coefficient from the CALIPSO during November 21 th and 22th,2013

●Case study (in winter)

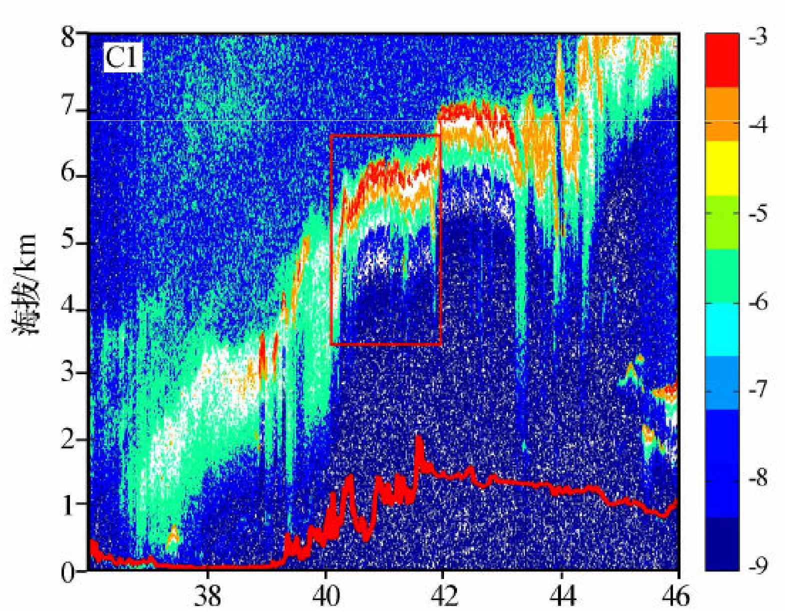


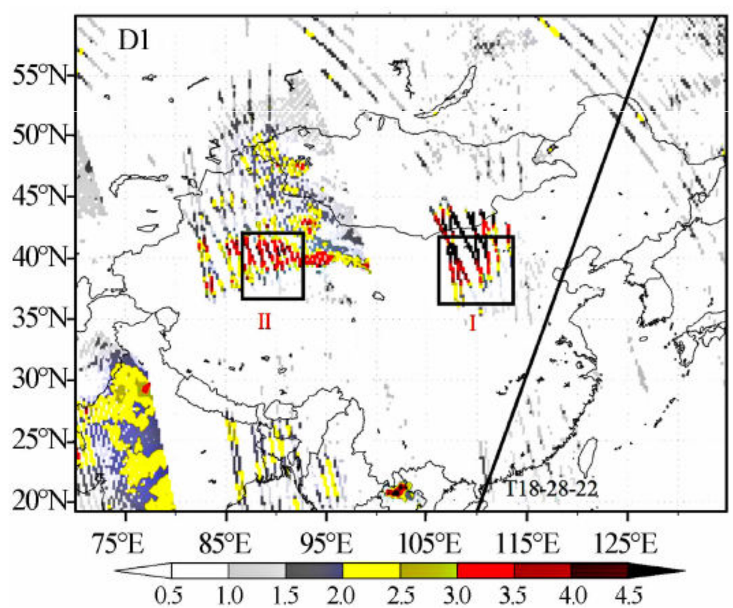
The vertical profile of volume depolarization ratio and color ratio through the appropriate sections of the satellite on November 21th 2013

Study of Dust-storm In Northwest China

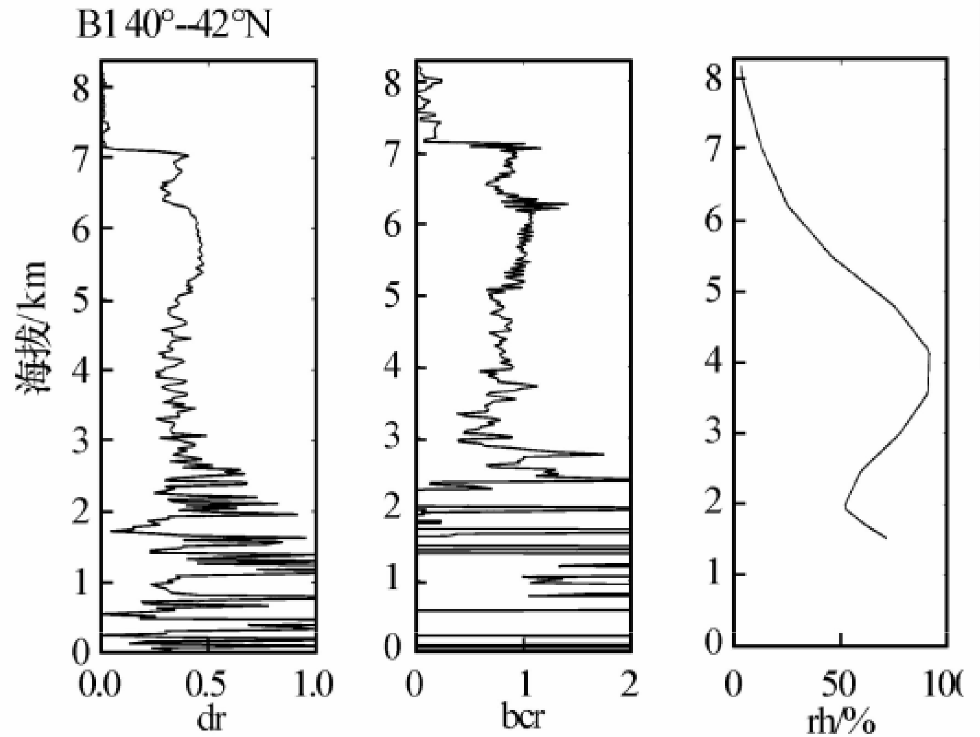
The vertical distribution of dust aerosol and transmission path of three cases of sandstorms in late April in 2009,2010 and 2011 were analyzed using a combination of satellite remote sensing data of CALIOP/CALIPSO and OMI/Aura, as well as a HYSPLIT trajectory model.

Case:2009.4.23

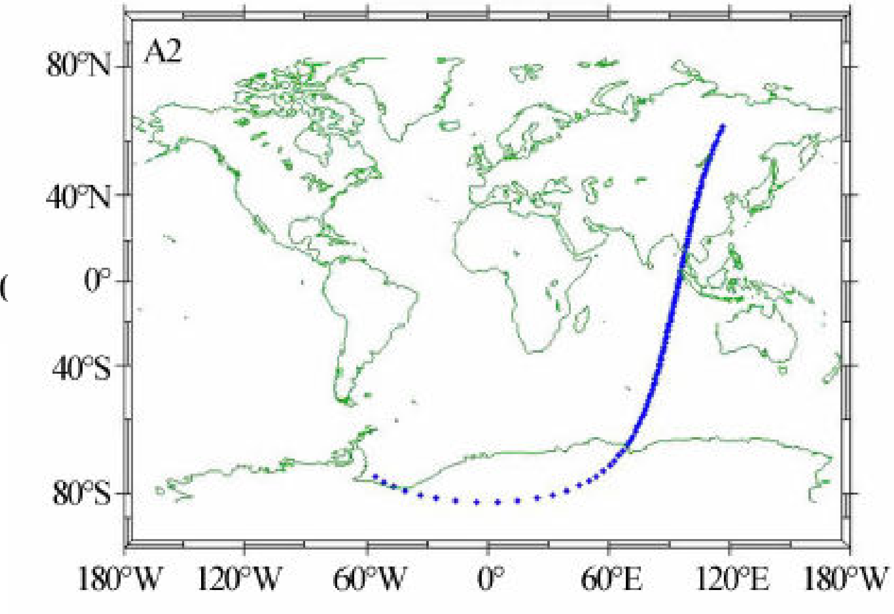




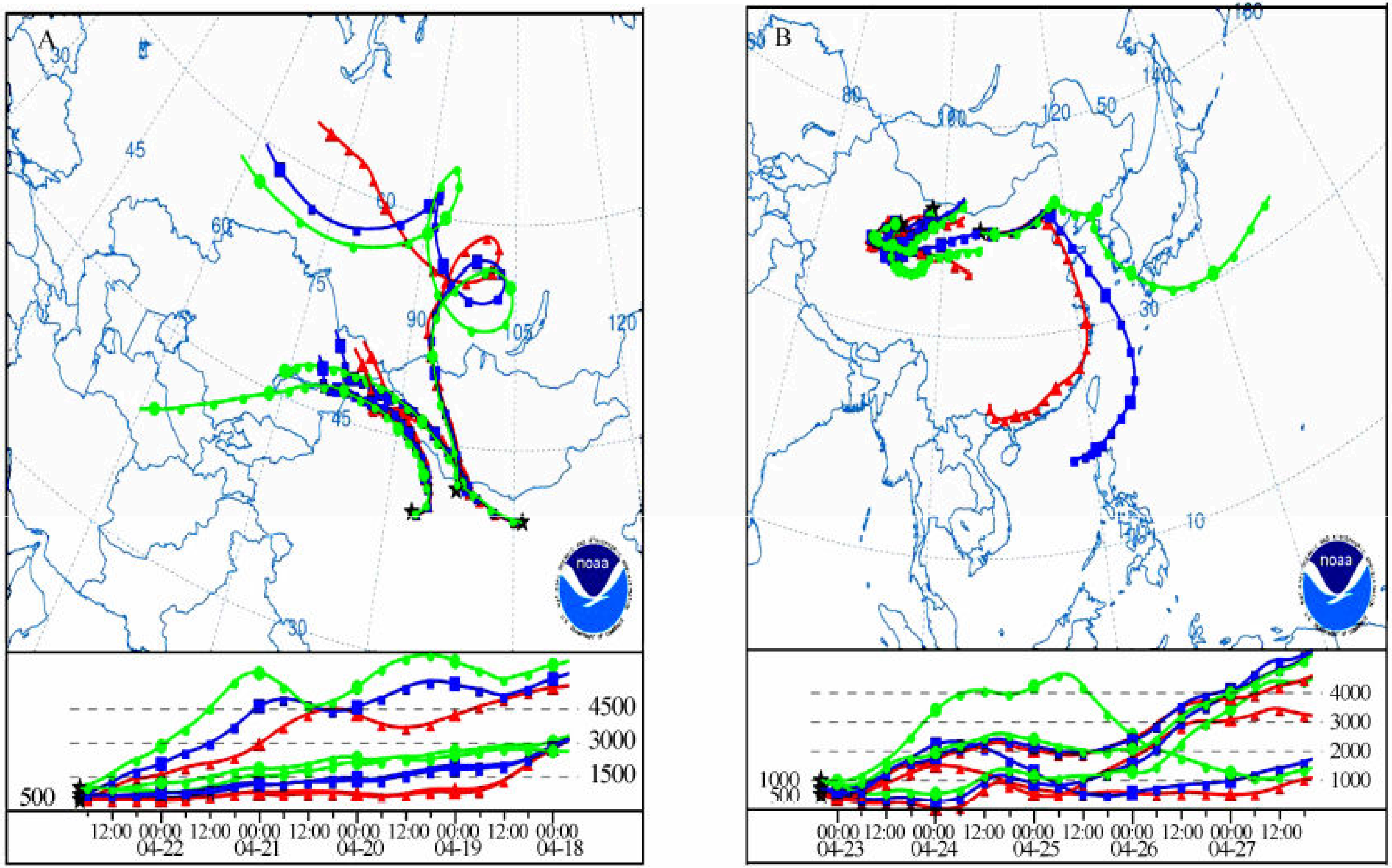
Right:The altitude-orbit cross-section of the total attenuated backscattering intensity at 532nm plotted in log scale at 18:00, April 23, 2009; (rectangular area of analysis section, Thick red line of surface elevation);
Left: The horizontal distribution of absorbing aerosol index (solid line-the satellite track cross-section, box for the high value area of aerosol index).



The vertical profiles of depolarization ratio (DPR) and backscatter color ratio (CR) and relative humidity (RH)



The CALIPSO satellite trajectory in the corresponding time period（blue line）



Transmission paths of backward trajectory (A) and forward trajectory (B) of sand-storm on April 23 of 2009 by HYSPLIT model

Comparison

Event	Vis	HR	DPR%	CR	Height
haze	2-5 km	25-80 %	<20	<0.8	0-6km
Dust	1 km	30-60%	>50	>1.0	0-3km

Conclusions

- The frequency of haze days are decreased from 1981 to 2000 firstly and then increased. Haze days occurred in winter most frequently.
- When haze occurred, the majority in the troposphere is the particles with backscatter coefficient ranged from 0.8×10^{-3}~2.5×10^{-3} $km^{-1}sr^{-1}$.
- Aerosols volume depolarization ratio was mostly less than 20%, the means aerosol irregularities were weaken with altitude.
- Color ratio was below 0.8 and for 8~12 km centered at 0.0~0.4, respectively.
- Haze easily occurs when the high-altitude and the surface are separately controlled by high-pressure system and uniform pressure, and there is temperature inversion near surface.

- There three paths of duststorm, north, northwest and west.
- In mixed weather system dust aerosol were mainly distributed in 0-7 km, and moved from west to east; in the pure cold front system they were mainly distributed in 0-4 km , moving from west to East South.
- The dust particles were located above 3 km with depolarization ratio about 0.5 and color ratio about 1.0 or higher in the most intense development of two weather systems (B&I);
- In the weakened period of sandstorm dust aerosols located in 0-2km, with depolarization ratio about 0.3,and color ratio about 0.8.

Thank you
for your attention

Danke.

Auf Wiedersehen