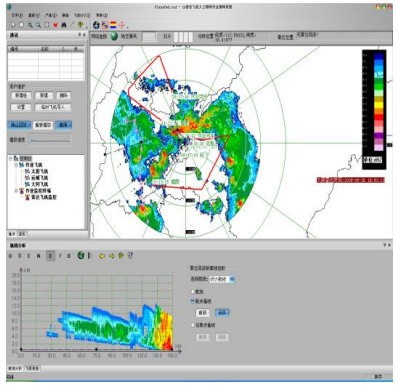
Weather Modification and its development in Xinjiang





Caixia Cui, Xinjiang Meteorological Bureau

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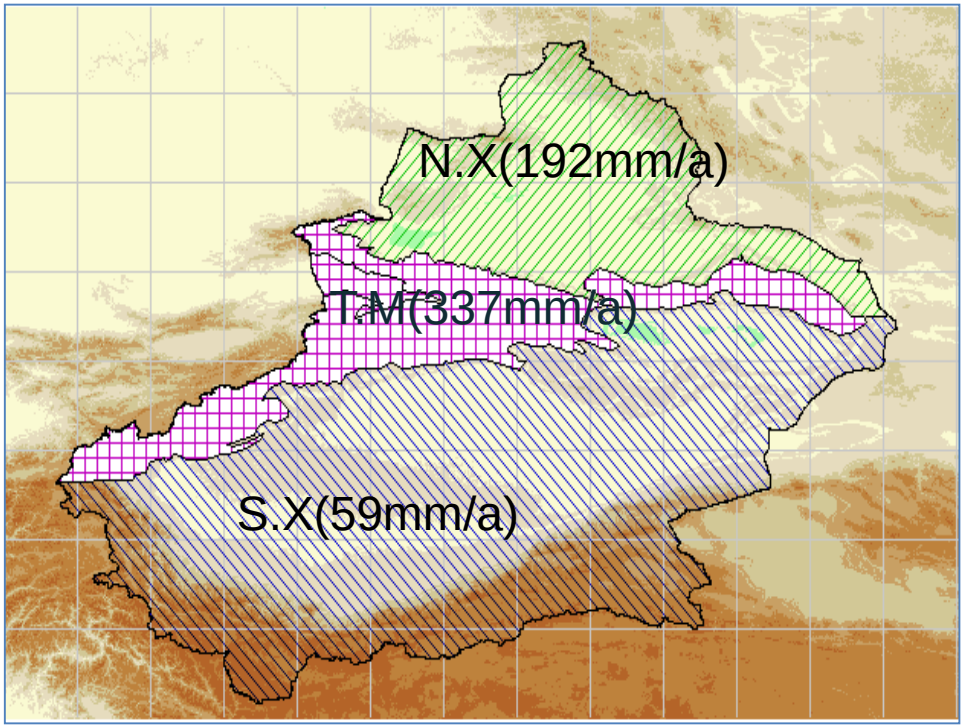
Outline

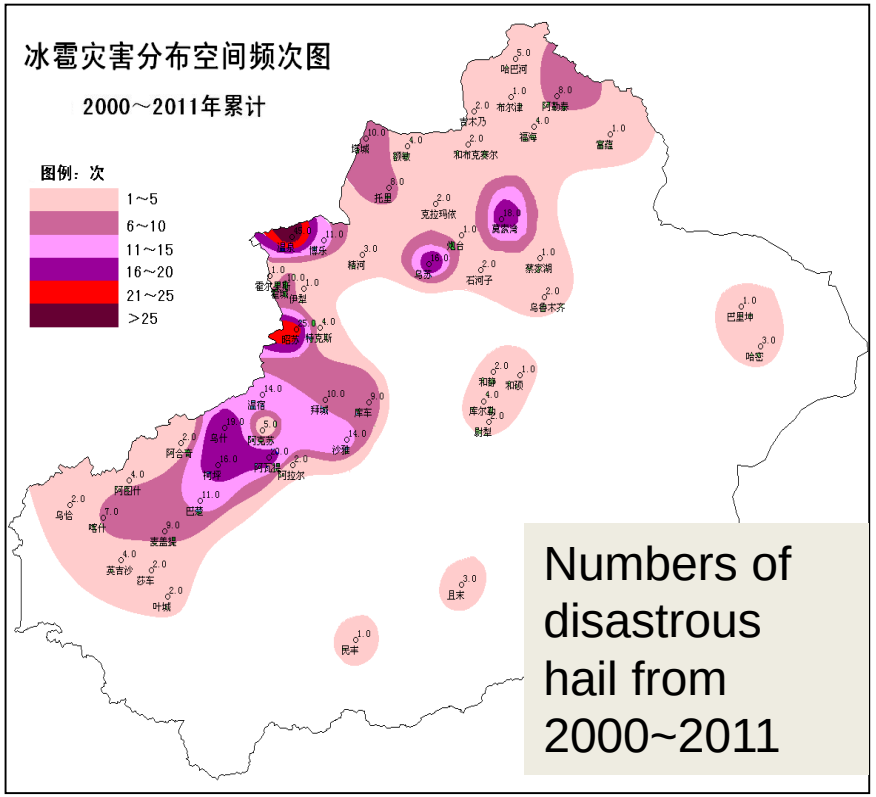
- Operational activities and research in weather modification
- Legislation and policies
- Limitation and problems
- What should we do in the future

Difficulties providing convincing scientific evidence of success led to the moderation of weather modification by the late 1970s worldwide. But in China, especially in Xinjiang ,an arid and semi-arid region, it just began then. Severely short of water resource and loss of property due to hail required that we look for ways to solve these problems.

Precipitation enhancement and storm damage mitigation

- Xinjiang is located in a dry region where the average rainfall is 158mm/a and disastrous hail is common .





Precipitation enhancement and storm damage mitigation

- The ratio of maximum precipitation to minimum in Xinjiang is 2.09, two times than global mean ratio(1.05) .This means some years this region becomes even more drier.

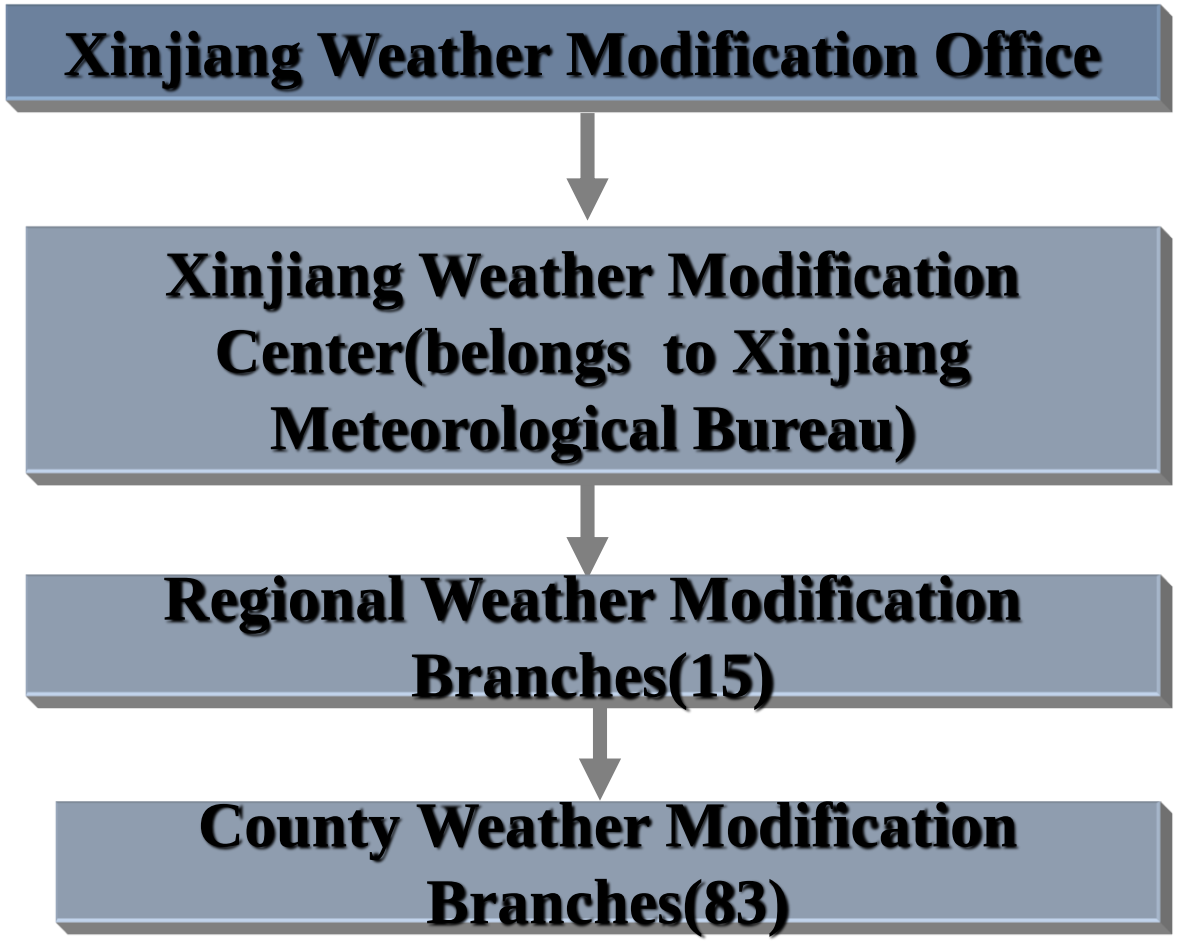
Annual mean precipitation and max/min in different areas

area	Annual mean precipitation(mm)	max/min
North Xinjiang	192.1	2.33
Tianshan mountain	337.1	1.91
South Xinjiang	59.1	4.22
Whole Xinjiang	158.1	2.09

Based on 1971~2000 surface rainfall observation in Xinjiang

So despite lack of scientific proof, operational weather modification activities are supported by central and local government based on cost versus probabilistic benefit analyses.

organization structure



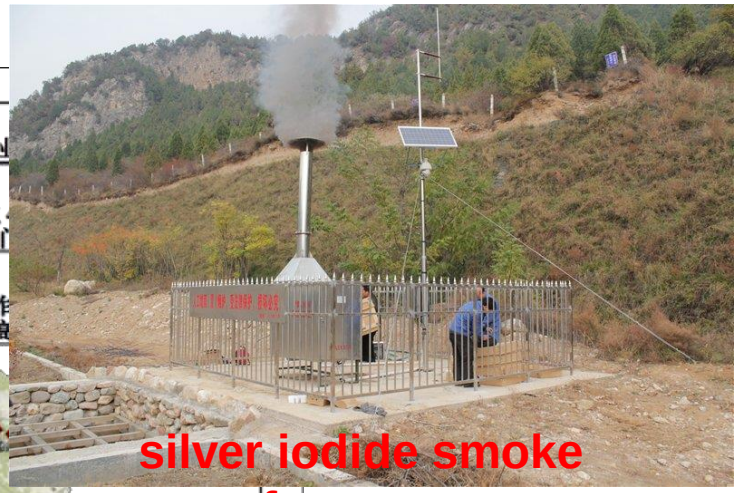
Morn then 3000 employees

The scale of weather modification in Xinjiang

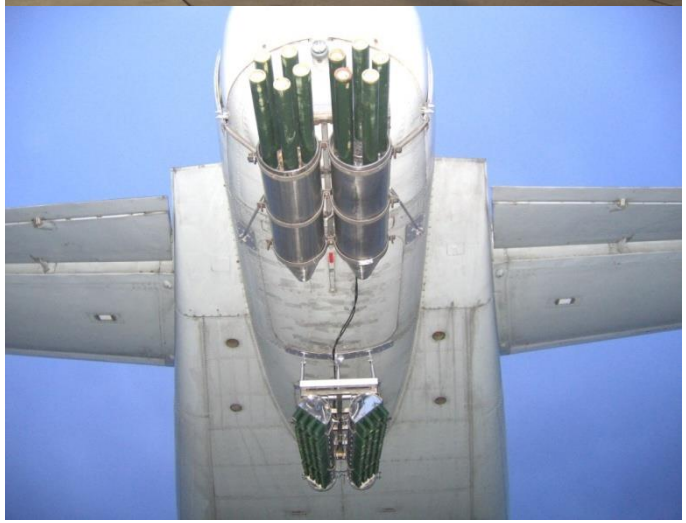
In 2015, we use 2 airplanes fly along mountainous areas in winter to enhance snowfall. 196 anti-aircraft guns or 716 rocket launchers equipped in 1297 fixed operational spots, set 78 silver iodide smoke furnaces to enhance summer precipitation and suppress hail fall.

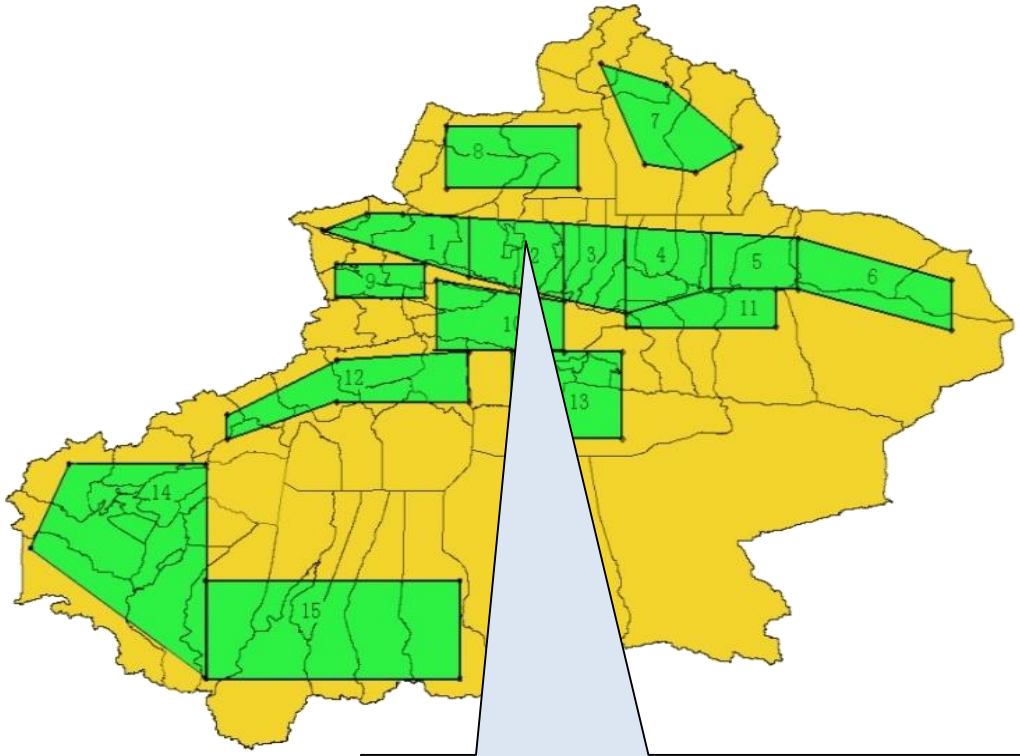
There are satellite dada, 11 doppler weather radars to be used directing actions. This year 20,000 rocket projectile and 100,000 shells were consumed.

The fixed operational spots



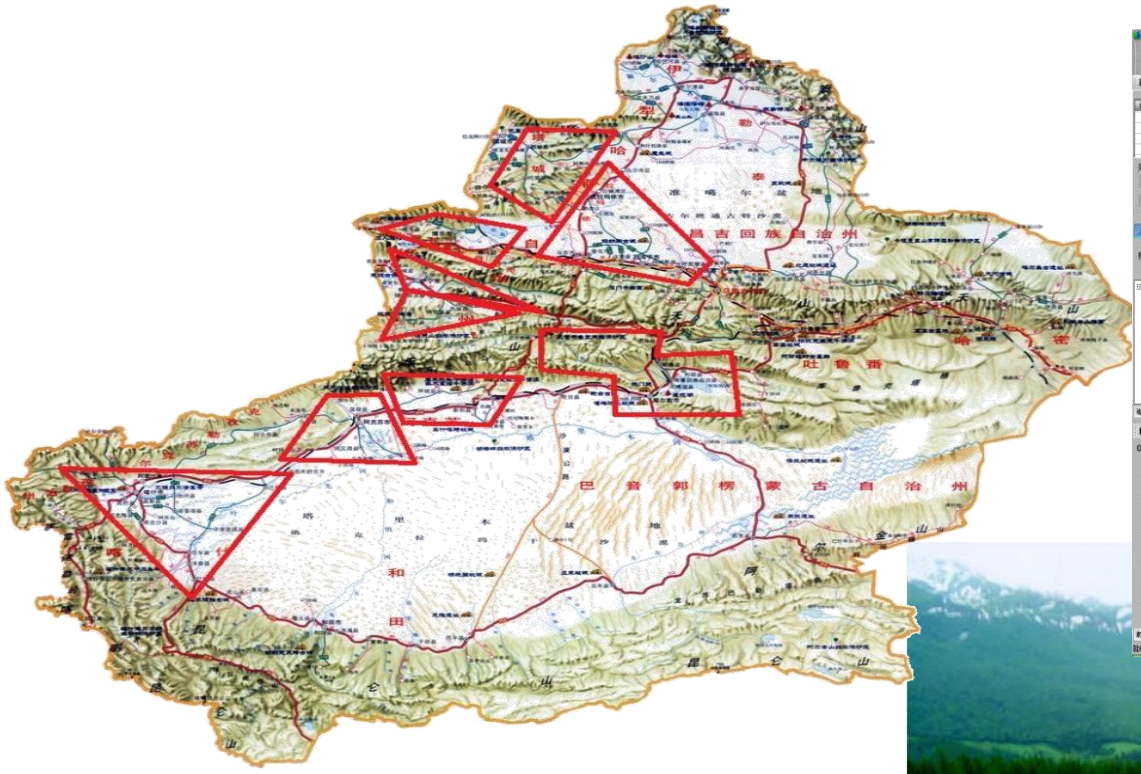
Utilize 2 airplanes for cloud seeding in winter orographic systems over mountainous regions

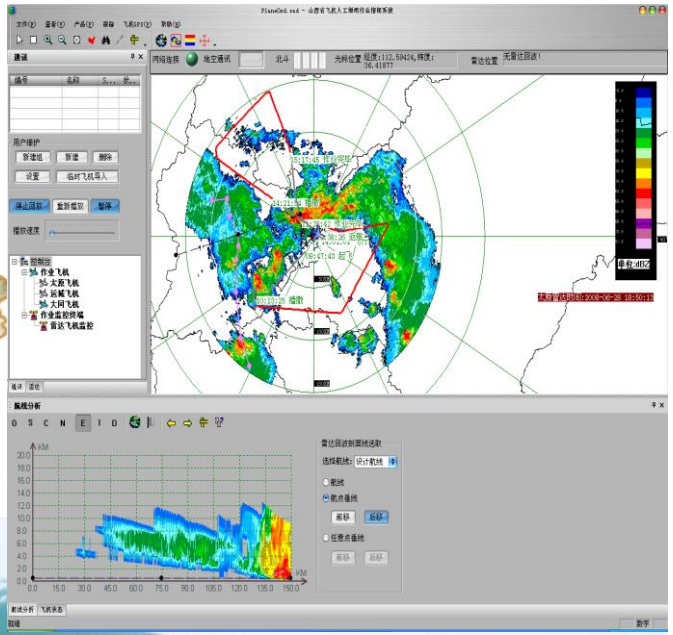


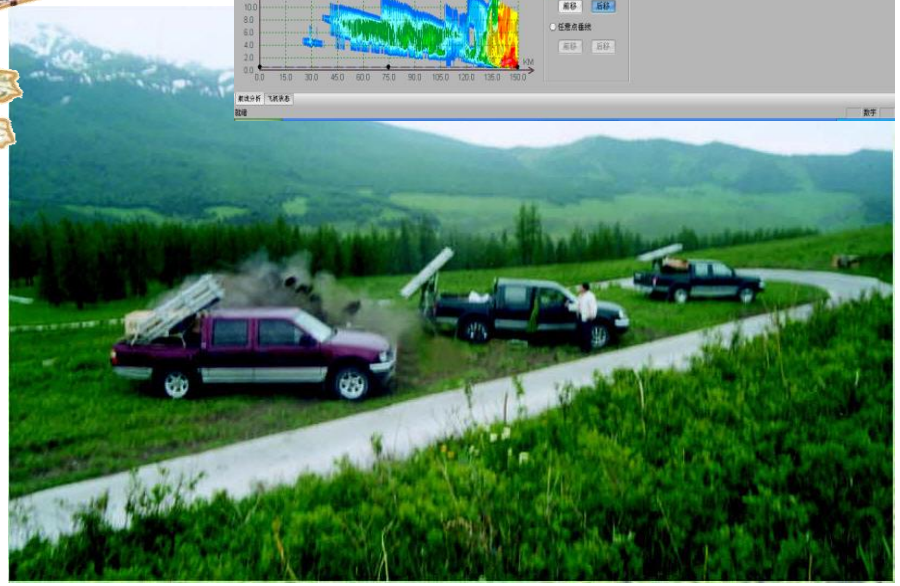


15 practice areas near mountain

Hail prevention based on radar monitoring







research in weather modification

- Atmospheric water resource evaluation using both in situ and remote observational data.
- Orographic cloud seeding experiment in the northern Tianshan moutainous areas.
- Studies on hail moving paths to chose fixed operational spots.
- computational systems for planning weather modification operation.

research in weather modification

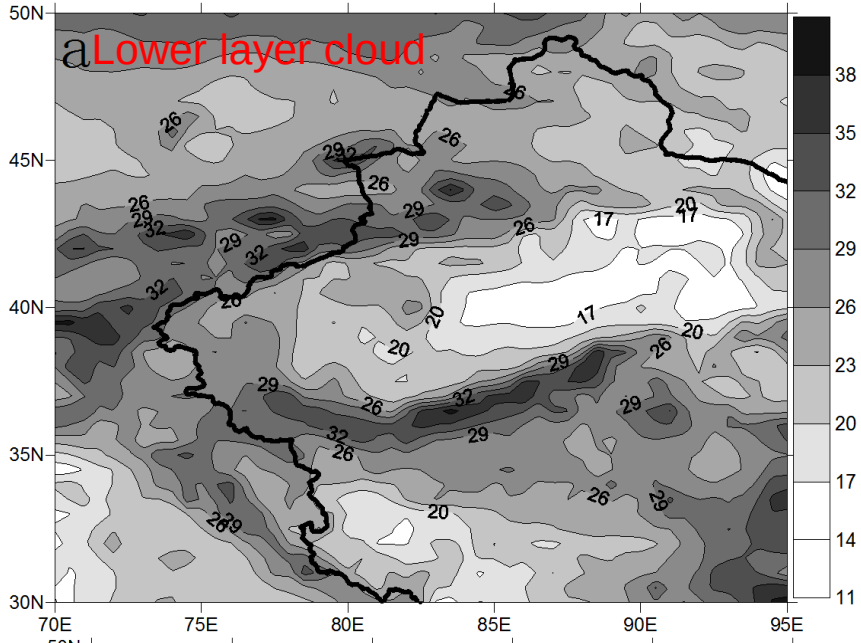
Characteristics of spatial and temporal distribution of low layer cloud in Xinjiang mountain regions.

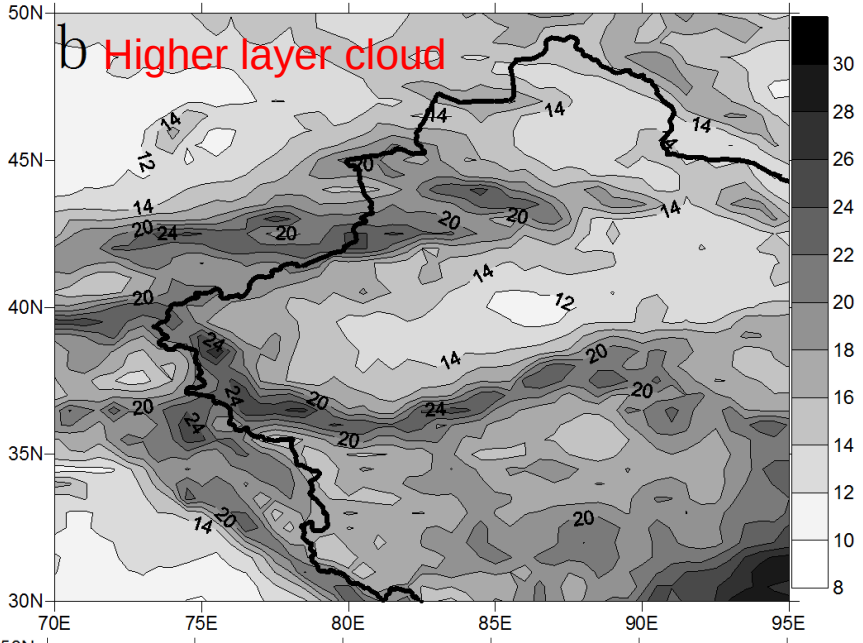
The multi-year spatial distribution and seasonal variations of cloud coverage and liquid water path of low layer clouds over Mountainous in Xinjiang are analyzed by using the CERES(Clouds and the Earths Radiant Energy System) SSF (Single Satellite Footprint) Aqua MODIS cloud data product from 2003 to 2007.

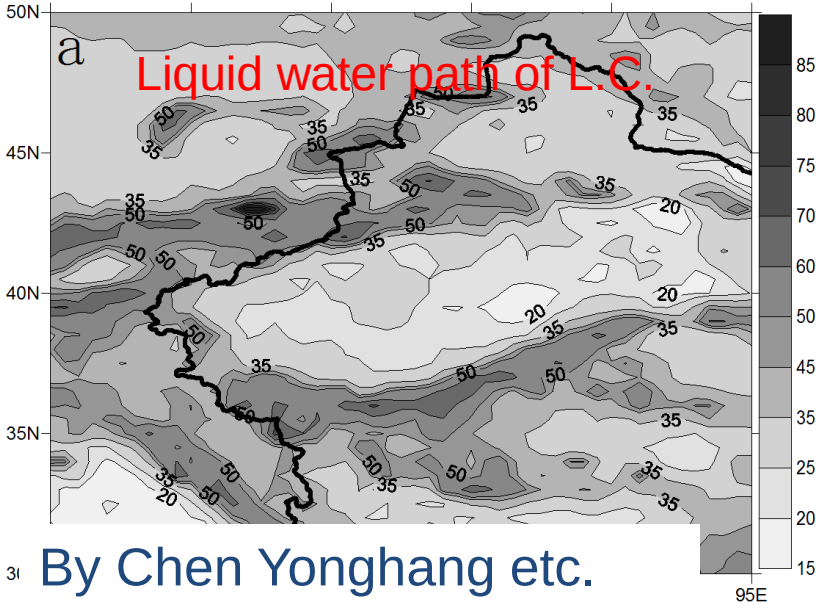
research in weather modification

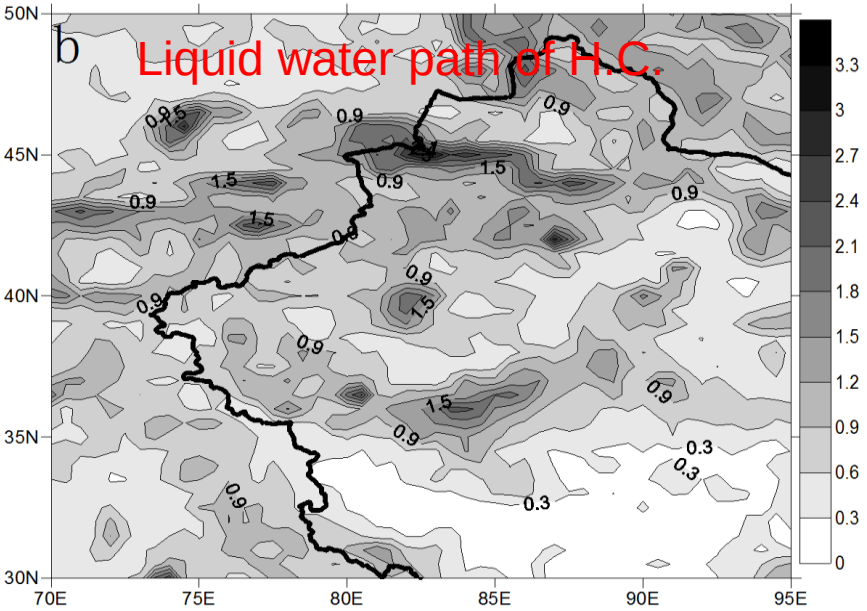
Cloud coverage and liquid water path of lower layer clouds in the three mountainous regions exhibit large seasonal variations. Cloud coverage in spring and summer is larger than that in autumn and winter. Cloud coverage in spring is the most abundant, while the most abundant season for the cloud liquid water path is in winter for the three mountain regions.

research in weather modification









By Chen Yonghang etc.

Vertical Distribution of Clouds over Xingjiang Mountainous areas

- Using 2B CLDCLASS data from January 2007 to December 2008 observed by the cloud profile radar (CPR) onboard the NASA's CloudSat satellite.
- Cloud top height and cloud base height were found to peak in summer and be lowest in winter. According to the analysis of occurrence, the cloud top height and cloud base height are mainly within 9~10 km over the Altay Mountains, 5~10km over the Tianshan Mountains, and 6~10 km over the Kunlun mountains.

Vertical Distribution of Clouds over Xingjiang Mountainous areas

- Cloud Water Resources of Mountain Ranges in Xinjiang based on CERES SSF Aqua MODIS Edition 1B/2B/2C cloud data.
- Multi-year average of the total cloud coverage of the Altay Mountains, Tianshan Mountains and Kunlun Mountains were 43.5%, 44.9% and 52.7%, indicating the cloud water resources had potential for artificial enhancing precipitation.

Legislations and policies of weather modification

- China encourages studies and operational activities of weather modification:
- National regulations: Artificial weather Management Ordinance(in 2002)
  - Xinjiang Uygur Autonomous Region: Weather Modification Administrative Rules(1998).
  - National standard: Safety Specification For Rocket Operation System In Precipitation Enhancement And Hail Suppression Activities(2008).
  - local standard: Construction Norms Of Ground-based Operating Station For Weather Modification(2011).

Legislations and policies of weather modification

In 2014, China published “National development plan of weather modification (2014~2020)”. In this plan, the development goals, overall layout, main tasks and implementation arrangements of the national artificial weather were determined. The organization and management system and operational mechanism of the weather were put forward.

Limitation and problems

Currently, we undertake operational activities without the guidance of careful scientific foundation, but the government is willing to spend funds to apply these unproven techniques. Central to this paradox is the failure of cloud seeding activities to provide an adequate verification

what should we do in the future

We will organize a coordinated program to conduct a sustained research project in the areas of cloud and precipitation microphysics, cloud dynamics, cloud modeling and cloud seeding. It should be implemented using a balanced approach of modeling, laboratory studies,and field measurement designed carefully to reduce the key uncertainties in the weather modification.

Thank you