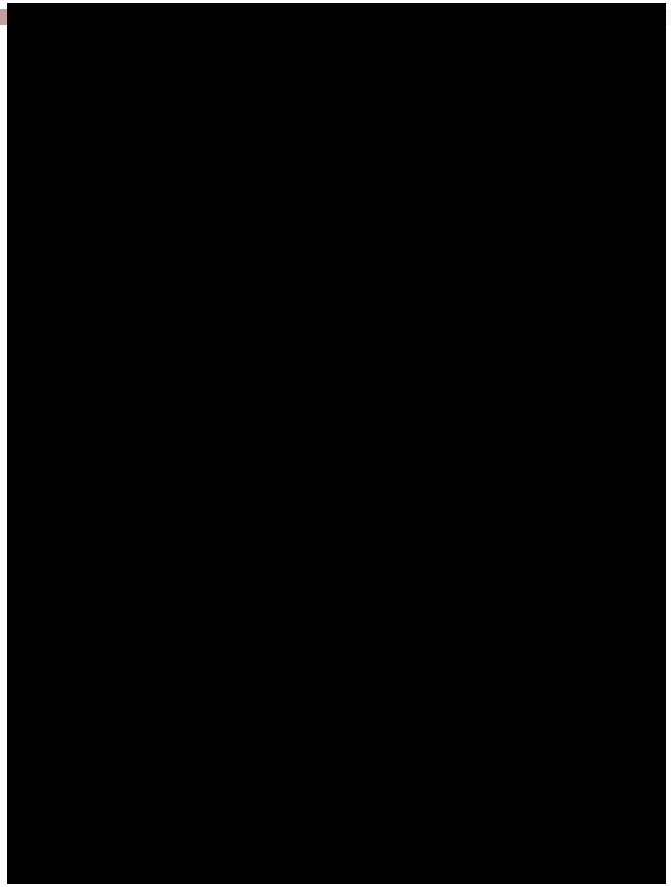
Toward the understanding of Trends in hail and thunderstorm in China over the past 50 years

Qinghong Zhang[1,2],
Xiaofei Li, Mingxin Li [1,2]

Fuqing Zhang[2] , Xiang Ni [1]

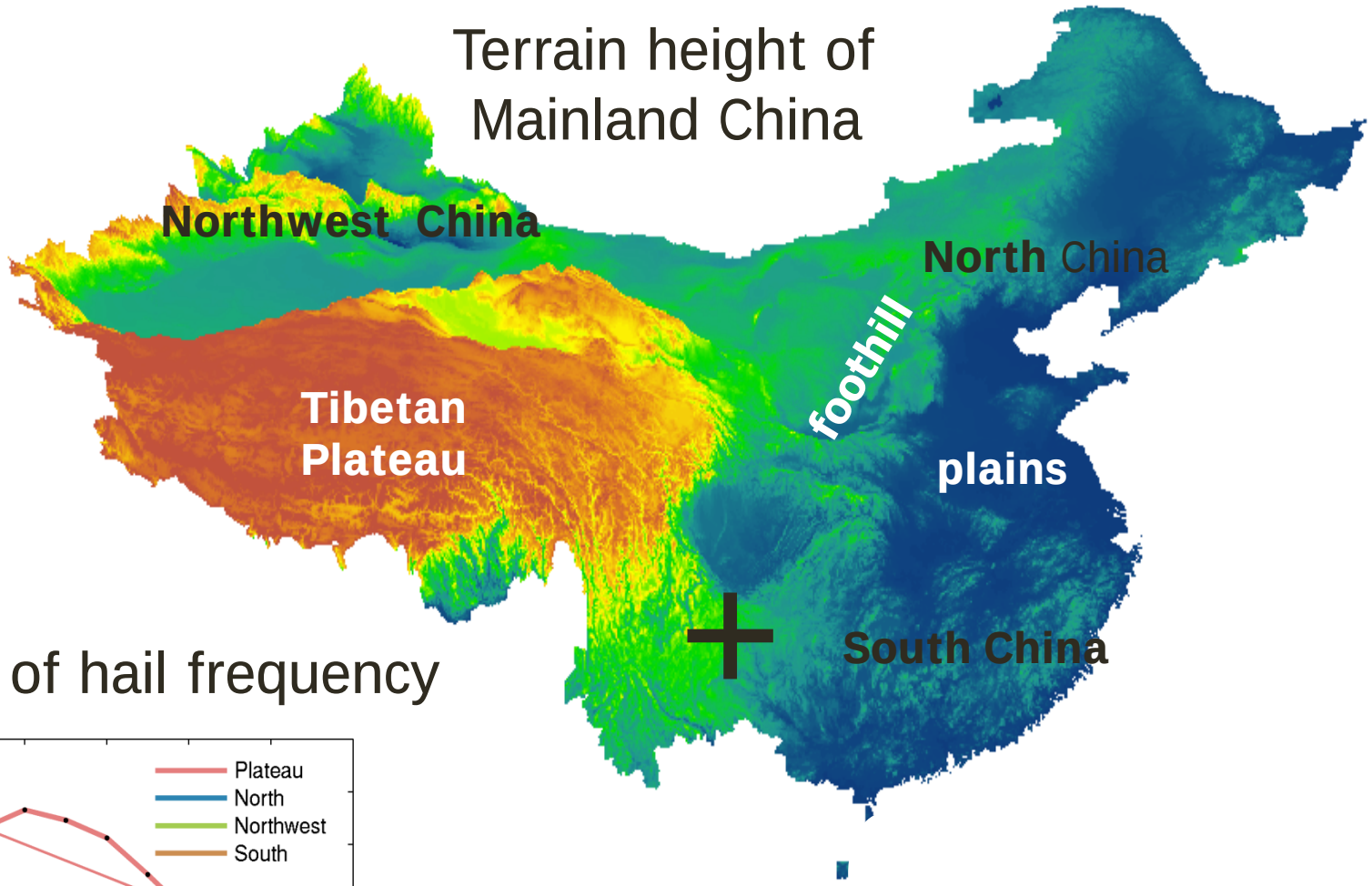
[1] Department of Atmospheric and Oceanic Sciences, Peking University, Beijing 100871, China

2 Department of Meteorology, The Pennsylvania State University, University Park, Pennsylvania

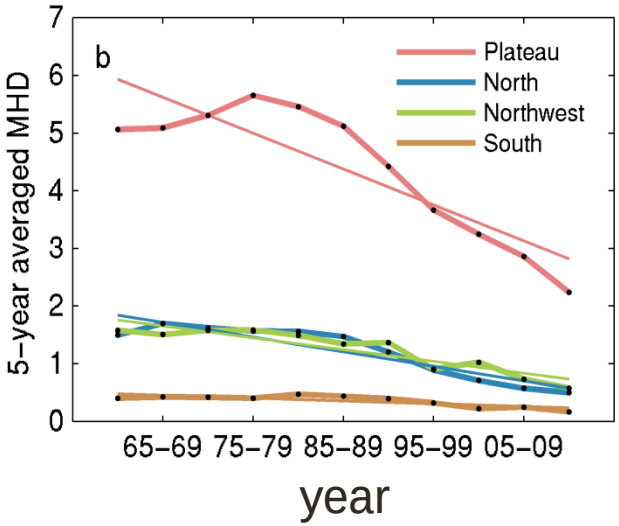


2nd European Hail Workshop, Bern Switzerland April 19 2017

Terrain height of Mainland China



Variation of hail frequency



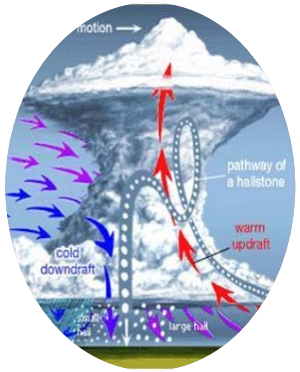
the maximum hail diameter (MHD) equaling to or exceeding 2 mm (China Meteorological Press, 2007)

Possible bridge between hail and climate change?

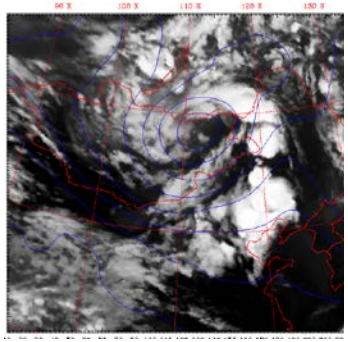
Large scale circulation change

severe storm

FLH
VWS



CAPE
PW
triger
mechanism



Climate change

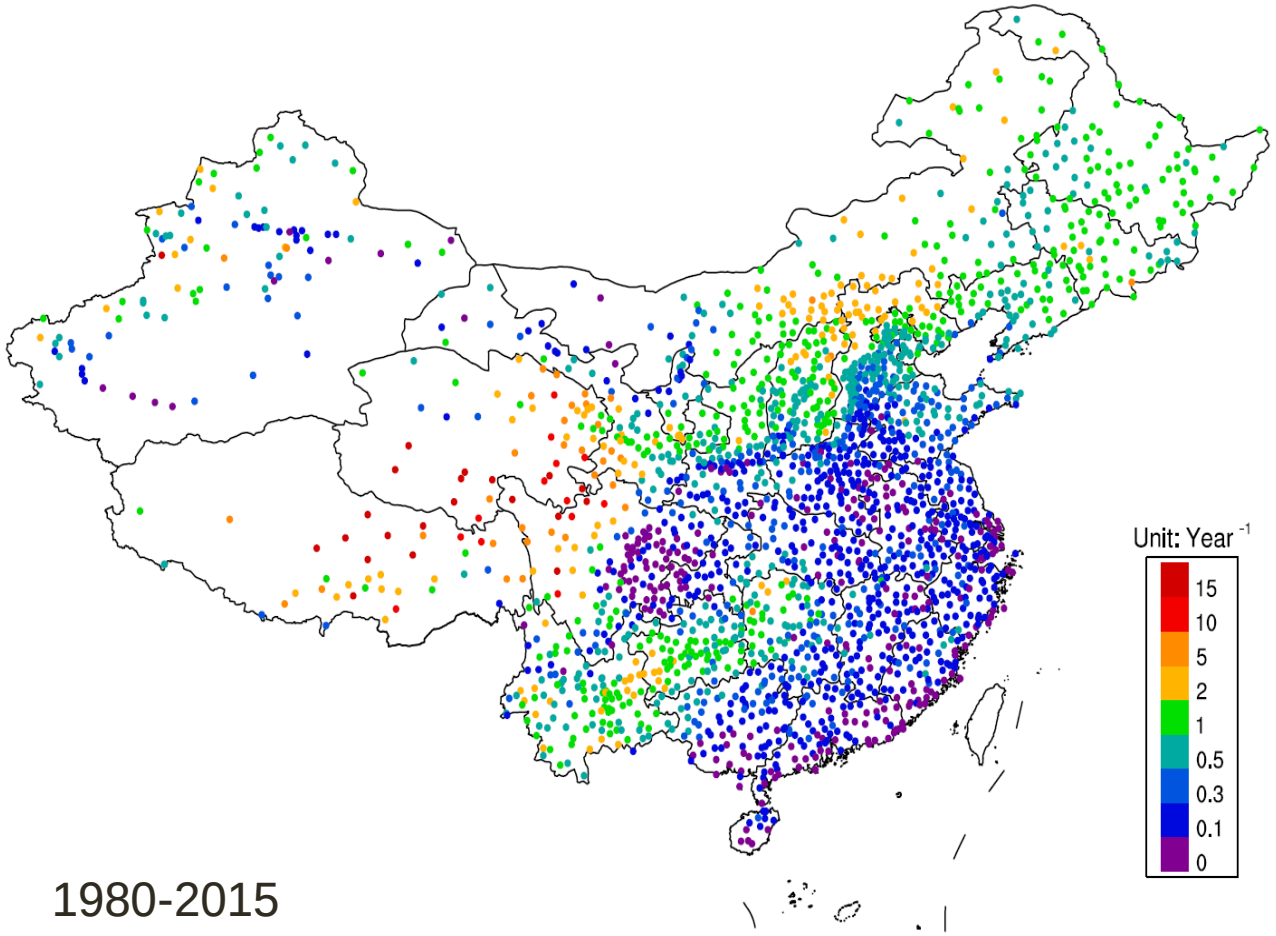
Objective

- Did severe storm changed in number?
- If the changes of large scale circulation associated with the changes of severe storm and hail occurrence in China?

Data

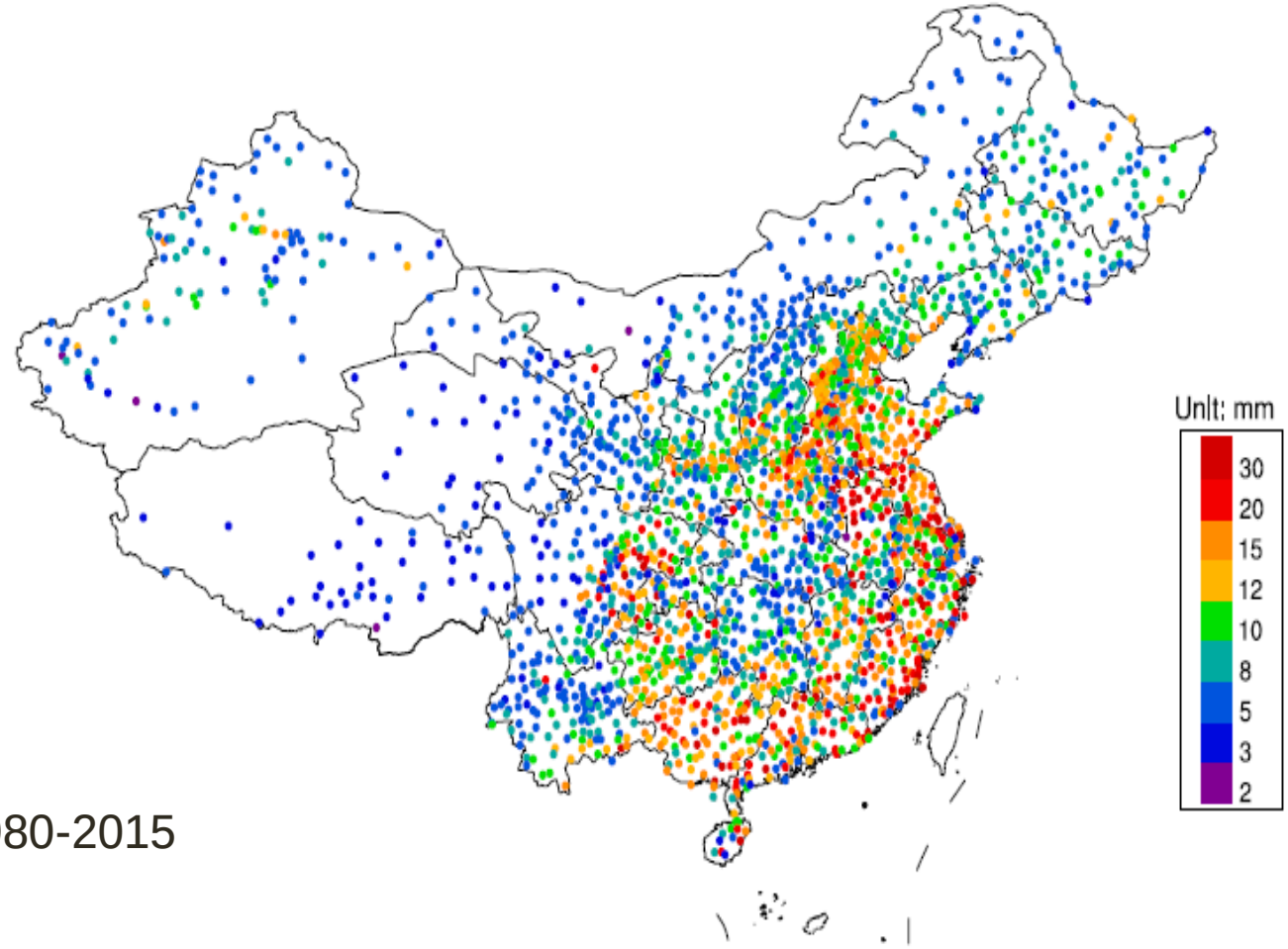
- Datasets 1951-2015 from information center of CMA
  - 983 surface station observation (weather phenomenon)
  - 2477 surface station
    - ✓ thunder storm (starting and ending time)
    - ✓ hail (starting and ending time)
    - ✓ lightning
    - ✓ high wind
    - ✓ heavy precipitation
    - ✓ the maximum diameter of hailstone (start early 1980s with 80% coverage with hail record)
- ✓ NCEP/NCAR reanalysis (1961 to 2011)

Annual mean Hail Frequency



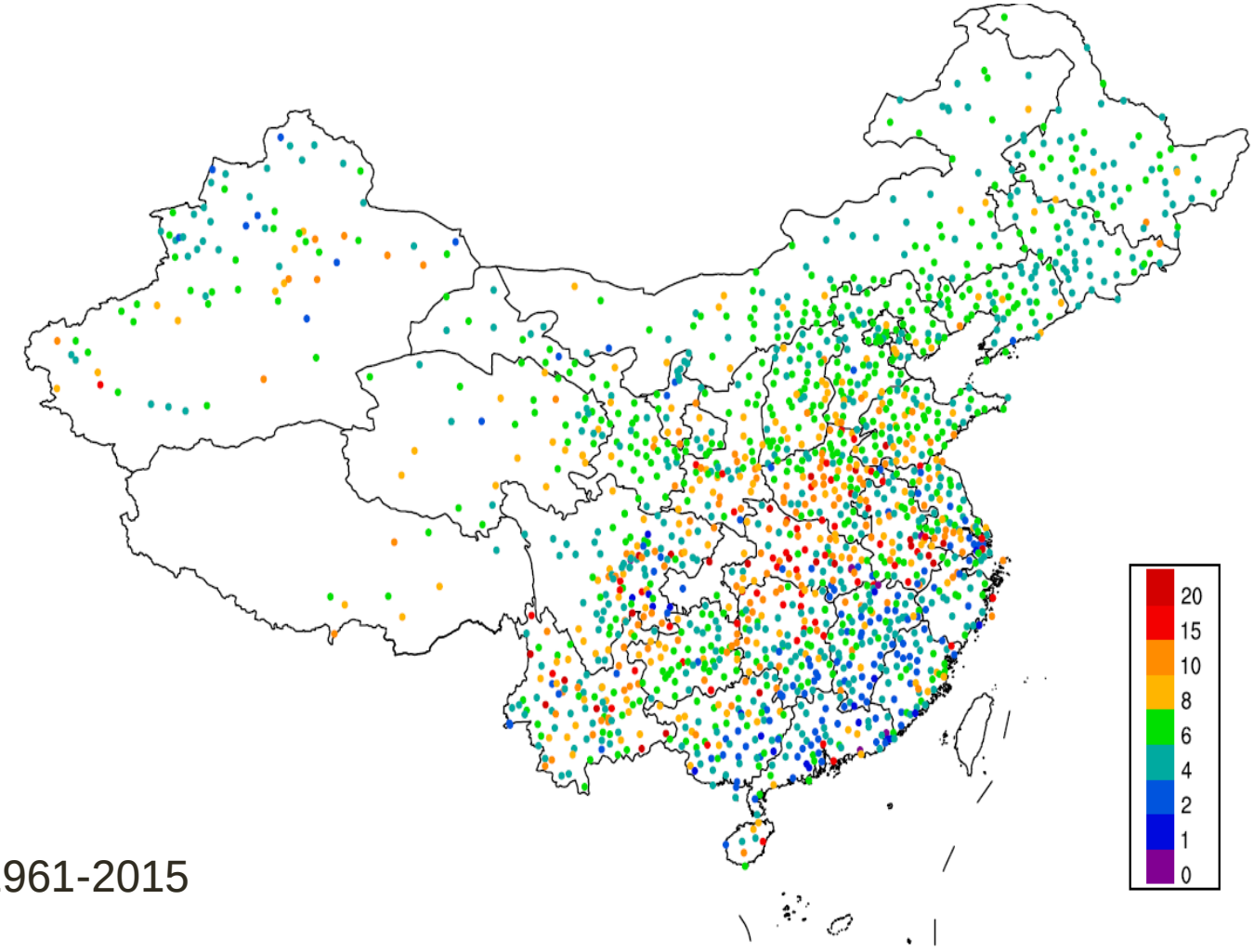
1980-2015
2454 stations

Annual mean Hail size



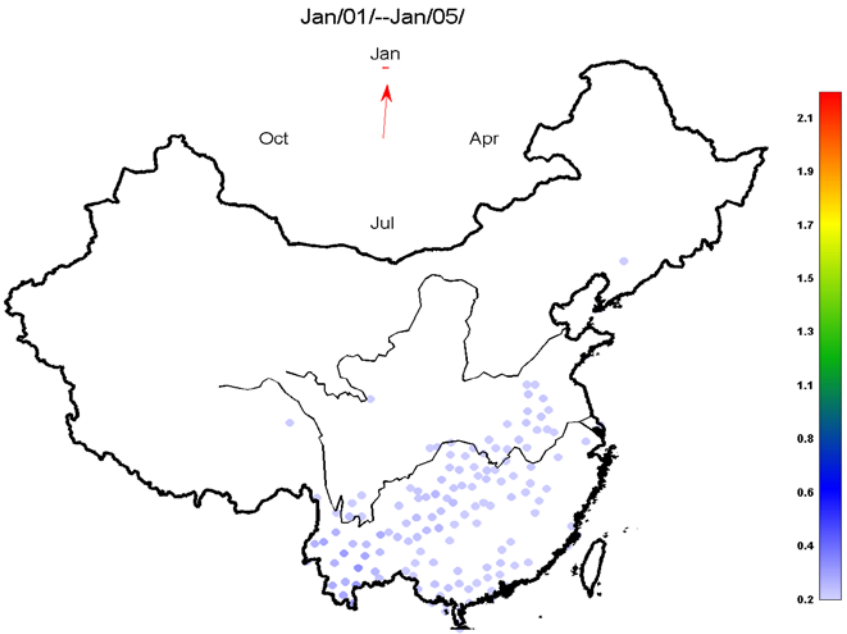
1980-2015

Station mean hail duration



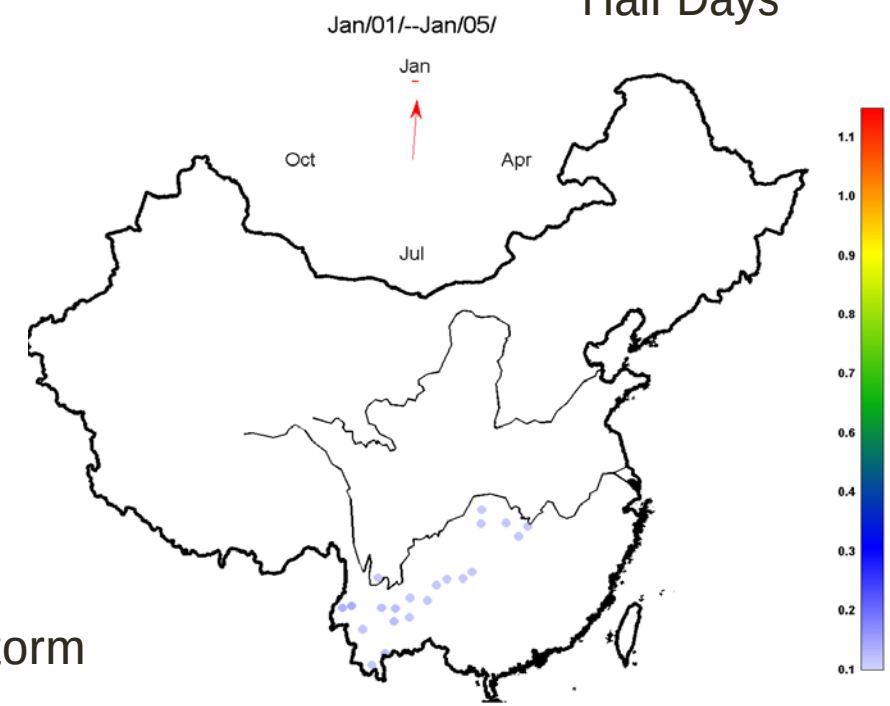
1961-2015

Seasonal variation of 5-day annual mean thunderstorm and hail day in China 1961-2012



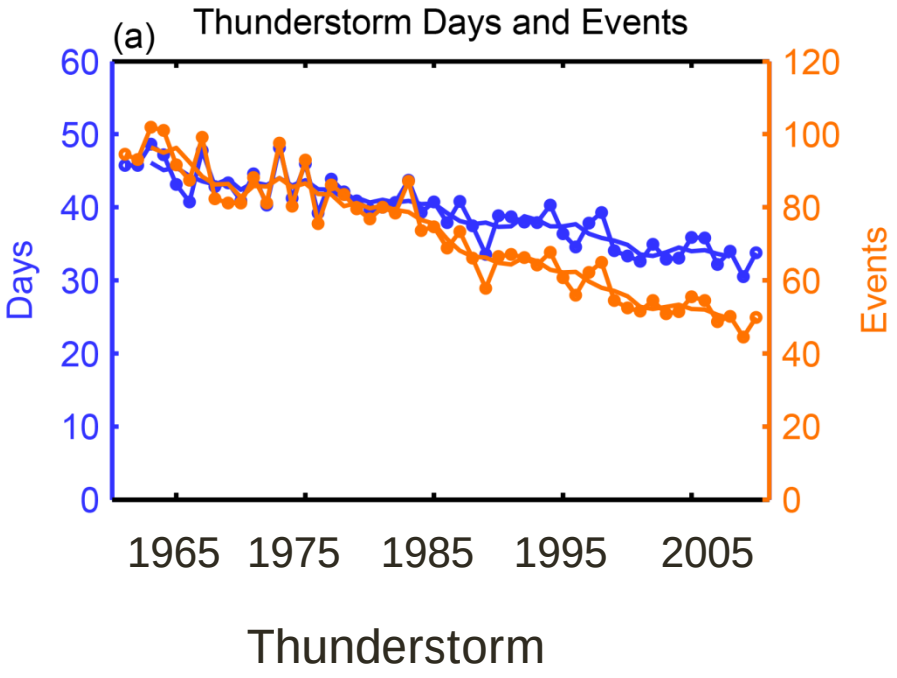
Thunder storm Days

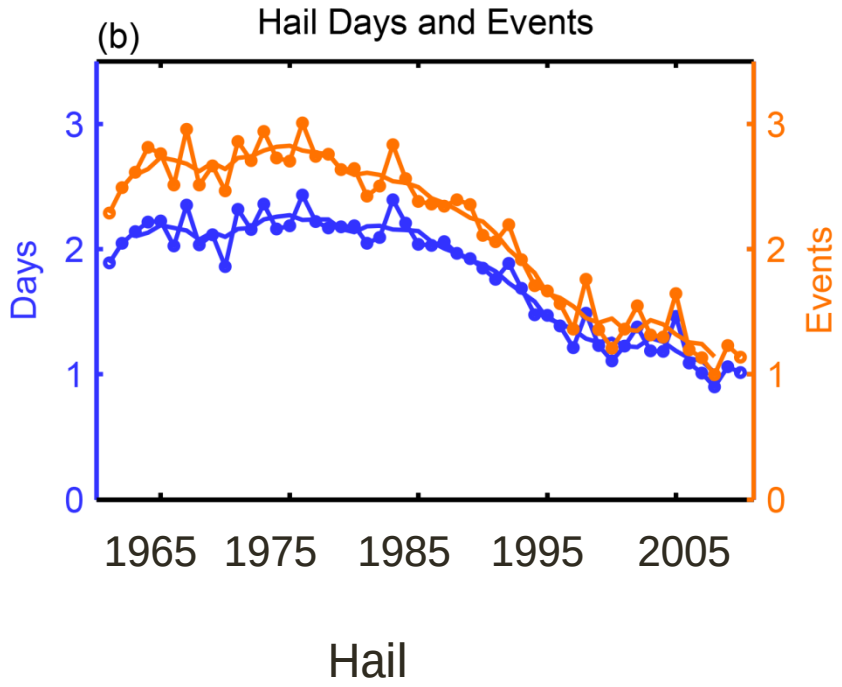
Hail Days



The seasonal variationun of both thunderstorm and hail are associated with the onset of summer monsoon

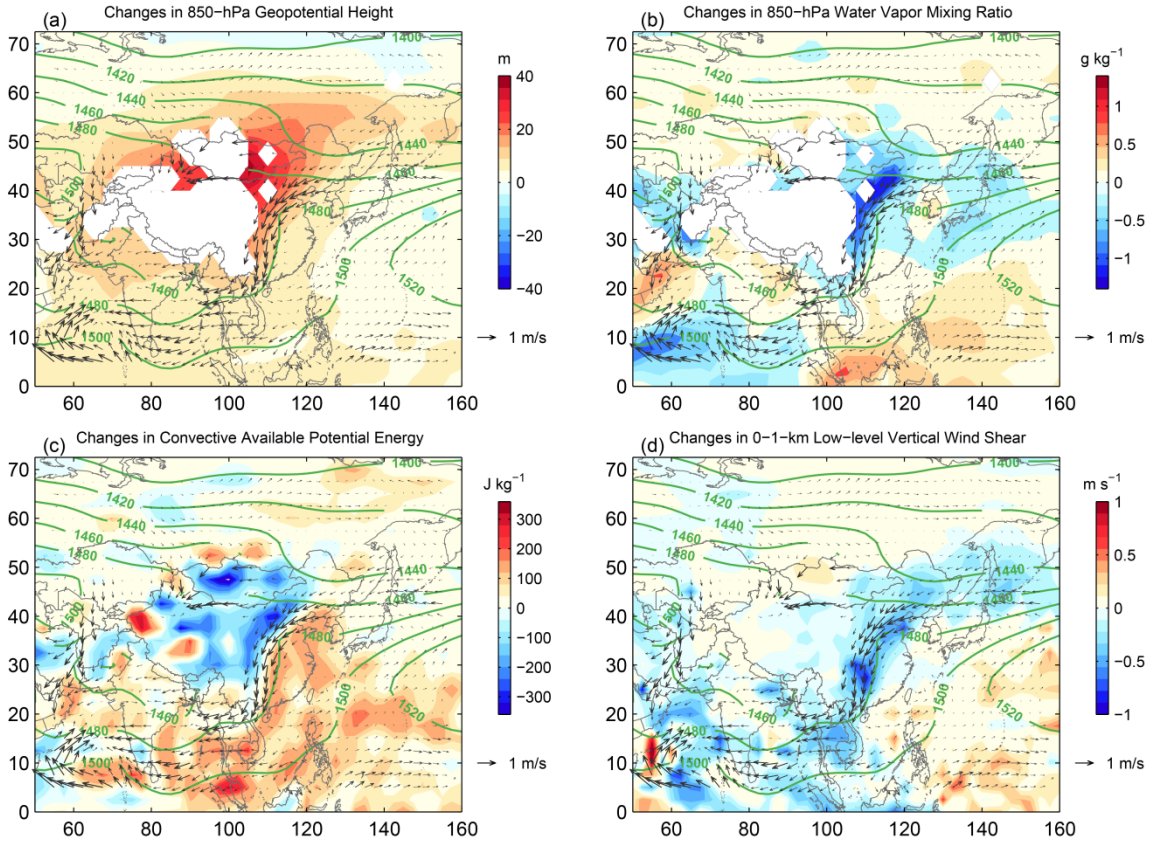
Trend of station mean thunderstorm (hail) frequency and Days from 1961 to 2011





Trend of **large-scale atmospheric environmental conditions** in warm season 1961 to 2011

850 hPa GPH



850 hPa Qv

CAPE

VWS

Vector : difference in the 850-hPa wind vectors between the two periods
Shading: differences of the second 25-year average (1986–2010) and the first 25 year (1961–1985)
lines: the 25-year average of the 850-hPa geopotential heights during 1986–2010

Summary

Less moisture
Weaker dynamic forcing

Weaker summer Monsoon

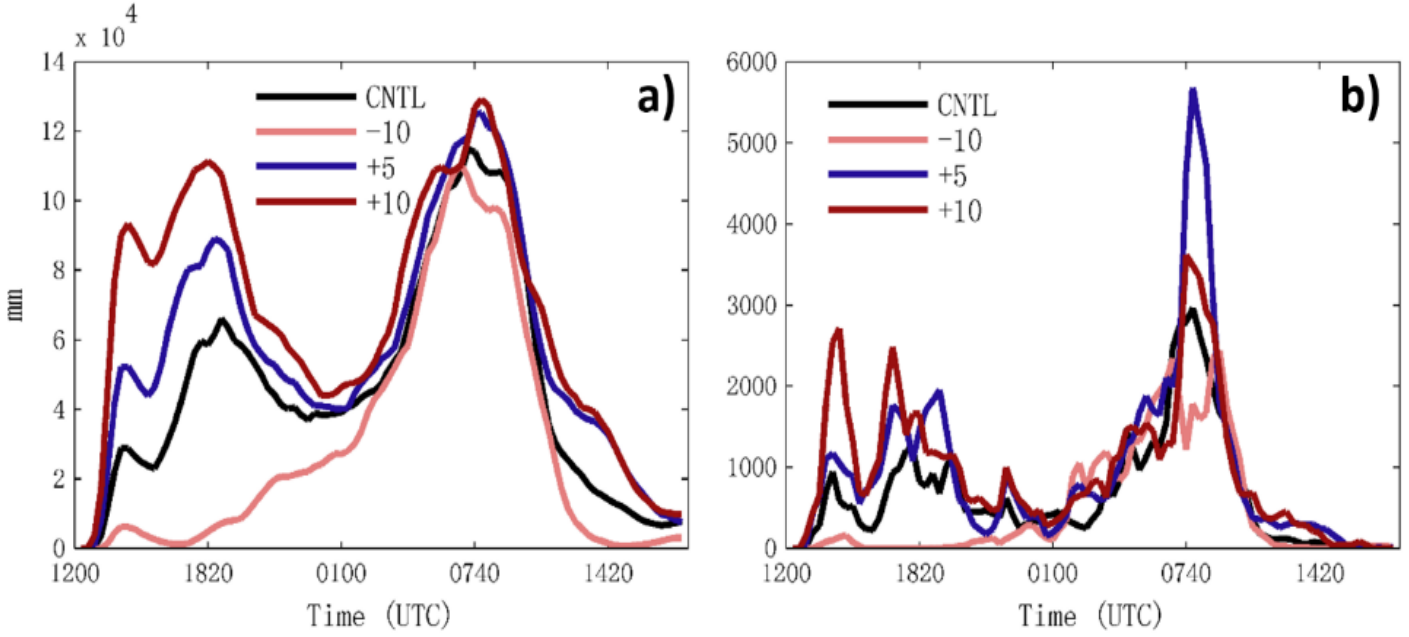
Large scale circulation

VWS
FLH

severe thunderstorm

Weakening of East Asian summer monsoon which is the primary source of moisture and dynamic forcing conducive for warm-season severe weather over China.

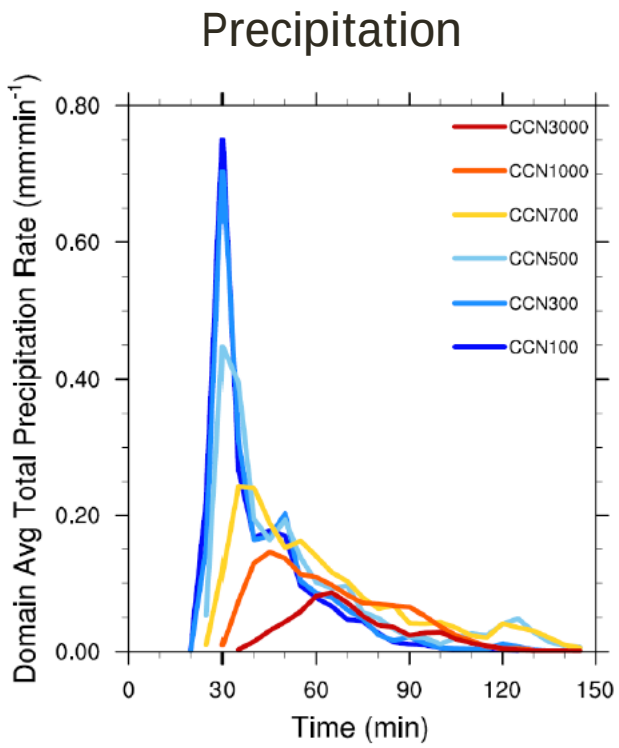
Response of hail precipitation to initial moisture

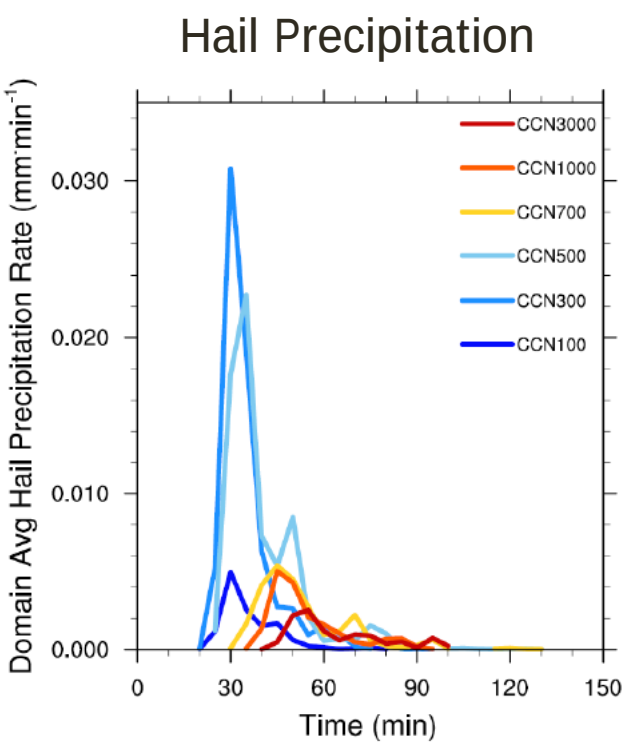


The total precipitation rate response to increasing water vapor content was linear, while the response of hail for this first episode was linear for the firs episoldt; however, for the event's second episode, remains mostly linear.

Mingxin Li
Poster

Hail precipitation response to initial CCN





Xiaofei Li
Poster

The initial CCN concentration (CCNC) had obvious non-monotonic effects on the mixing ratio, number concentrations, and radius of hail, both in clouds and at the surface, with a CCNC threshold between 300 and 500 mg^{-1}. An increasing CCNC is conducive (suppressive) to the amount of surface hail precipitation below (above) the CCNC threshold.

We don't know what we know

Zhang, Q. Xiang Ni. Fuqing Zhang, 2017: Decreasing trend in severe weather occurrence over China during the past 50 years. *Sci. Rep*, **doi: 10.1038/srep42310.**

Li, Mingxin ;Zhang, Qinghong ;Zhang, Fuqing, 2016: Hail Day Frequency Trends and Associated Atmospheric Circulation Patterns over China during 1960-2012，Journal of Climate. **29(19)**：7027~7044.

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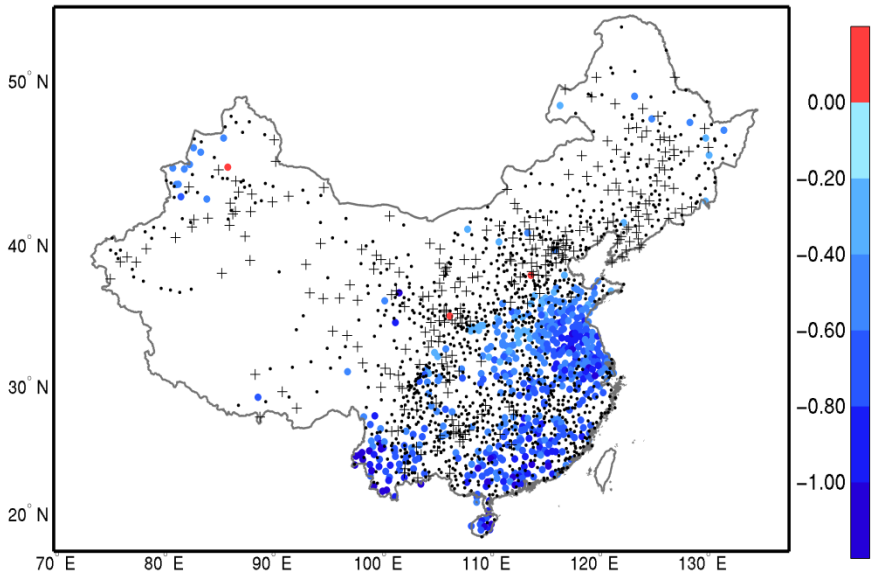
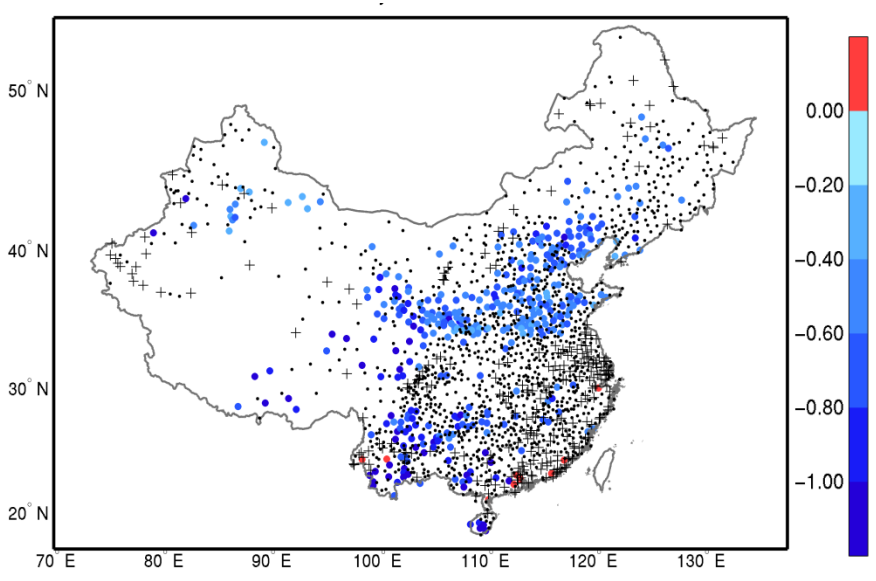
Thanks

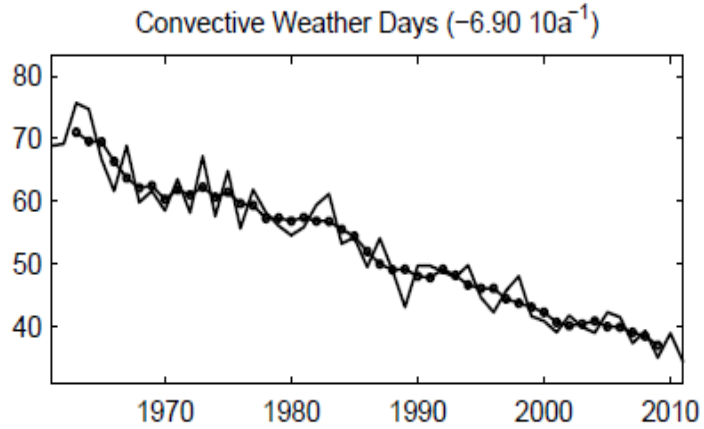
Trends in the number of thunderstorm day

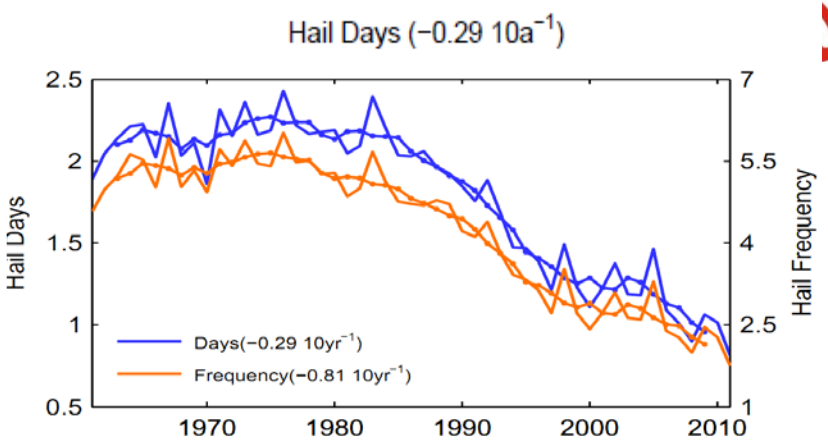
1961-1989

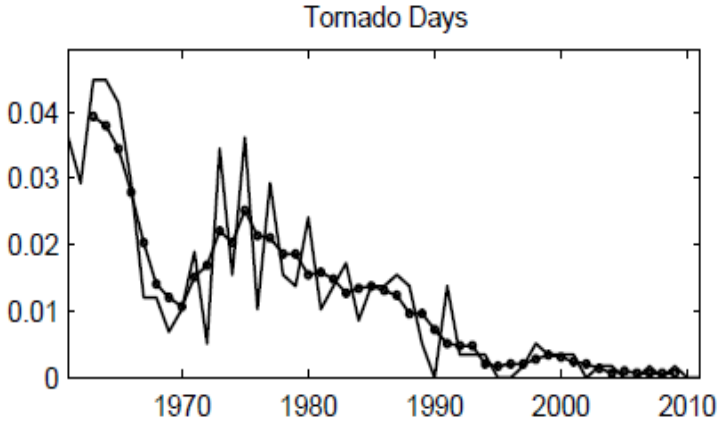


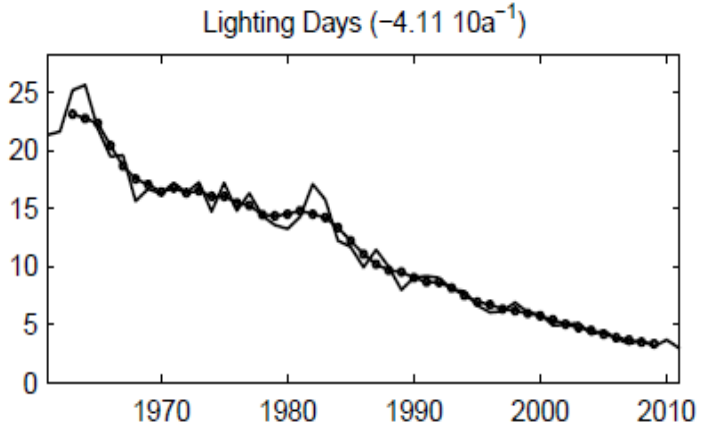
1990-2013

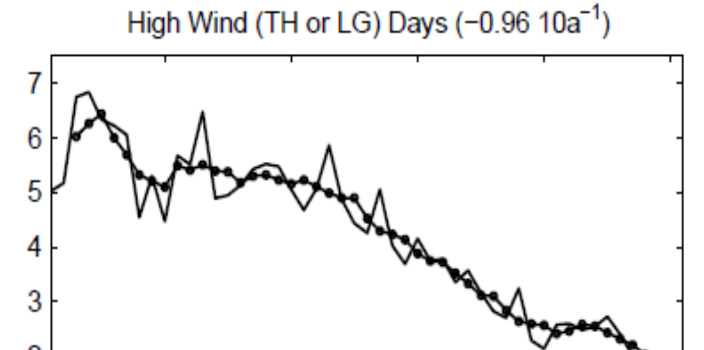


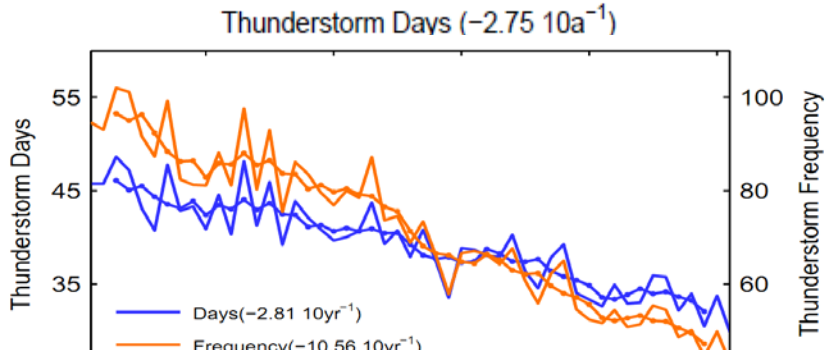

Convective Weather Days (−6.90 10a^{-1})
80
70
60
50
40
1970
1980
1990
2000
2010


Hail Days (−0.29 10a^{-1})
Hail Days
Hail Frequency
2.5
2
1.5
1
0.5
7
5.5
4
2.5
1
Days(−0.29 10yr^{-1})
Frequency(−0.81 10yr^{-1})
1970
1980
1990
2000
2010

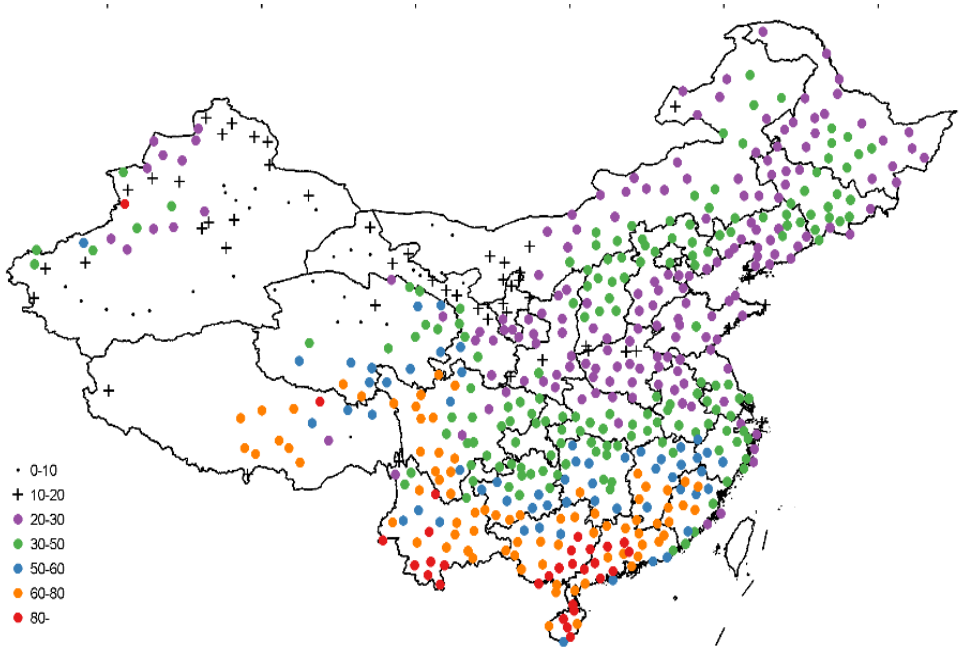

Tornado Days
0.04
0.03
0.02
0.01
0
1970
1980
1990
2000
2010


Lighting Days (−4.11 10a^{-1})
25
20
15
10
5
0
1970
1980
1990
2000
2010


High Wind (TH or LG) Days (−0.96 10a^{-1})
7
6
5
4
3

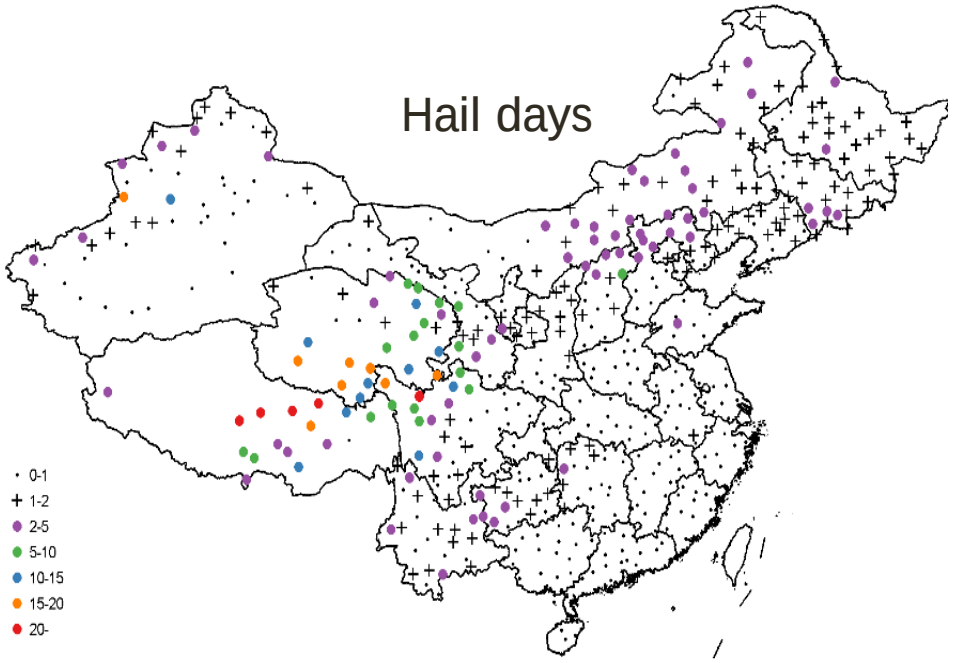

Thunderstorm Days (−2.75 10a^{-1})
Thunderstorm Days
Thunderstorm Frequency
55
45
35
100
80
60
Days(−2.81 10yr^{-1})

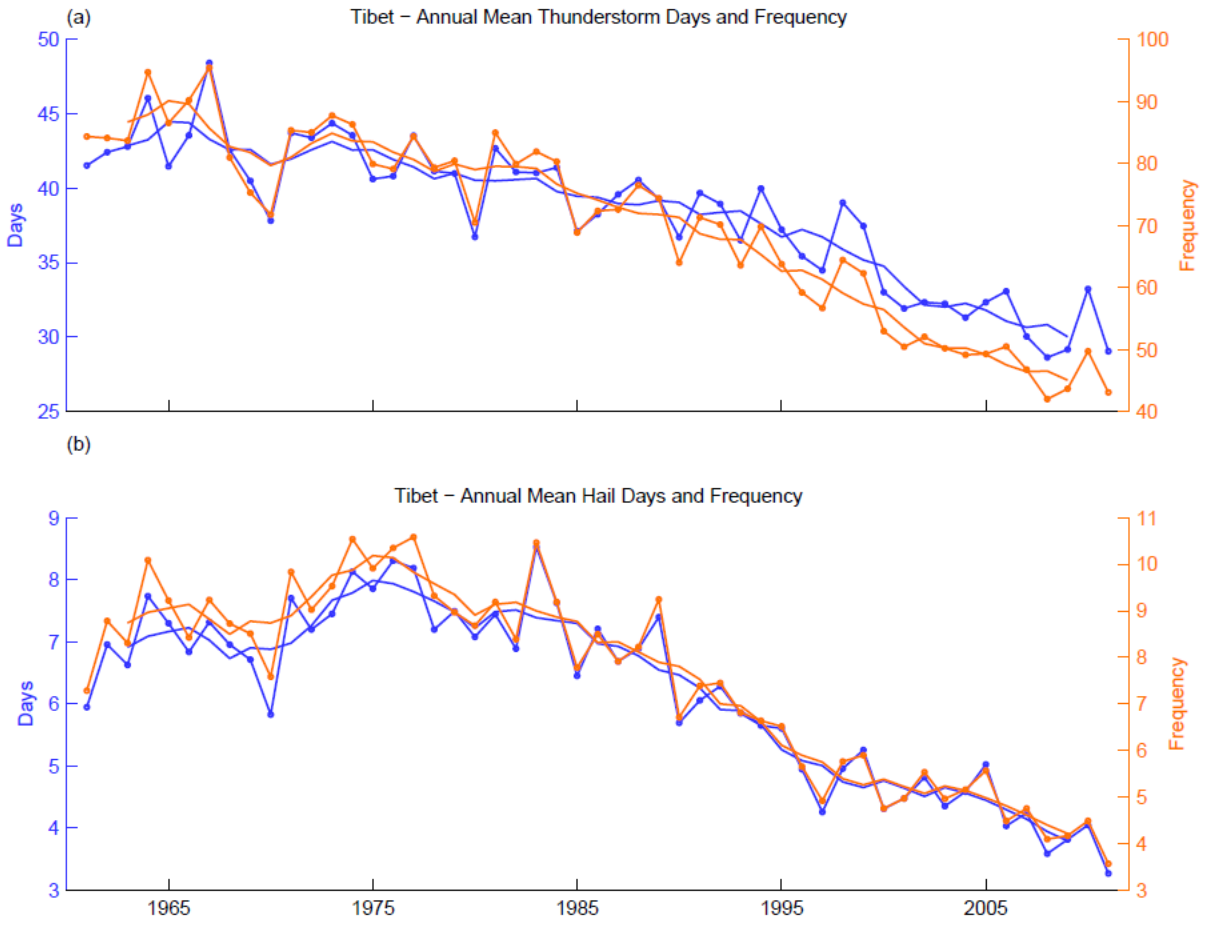
Spatial distribution of annual thunderstorm and hail days

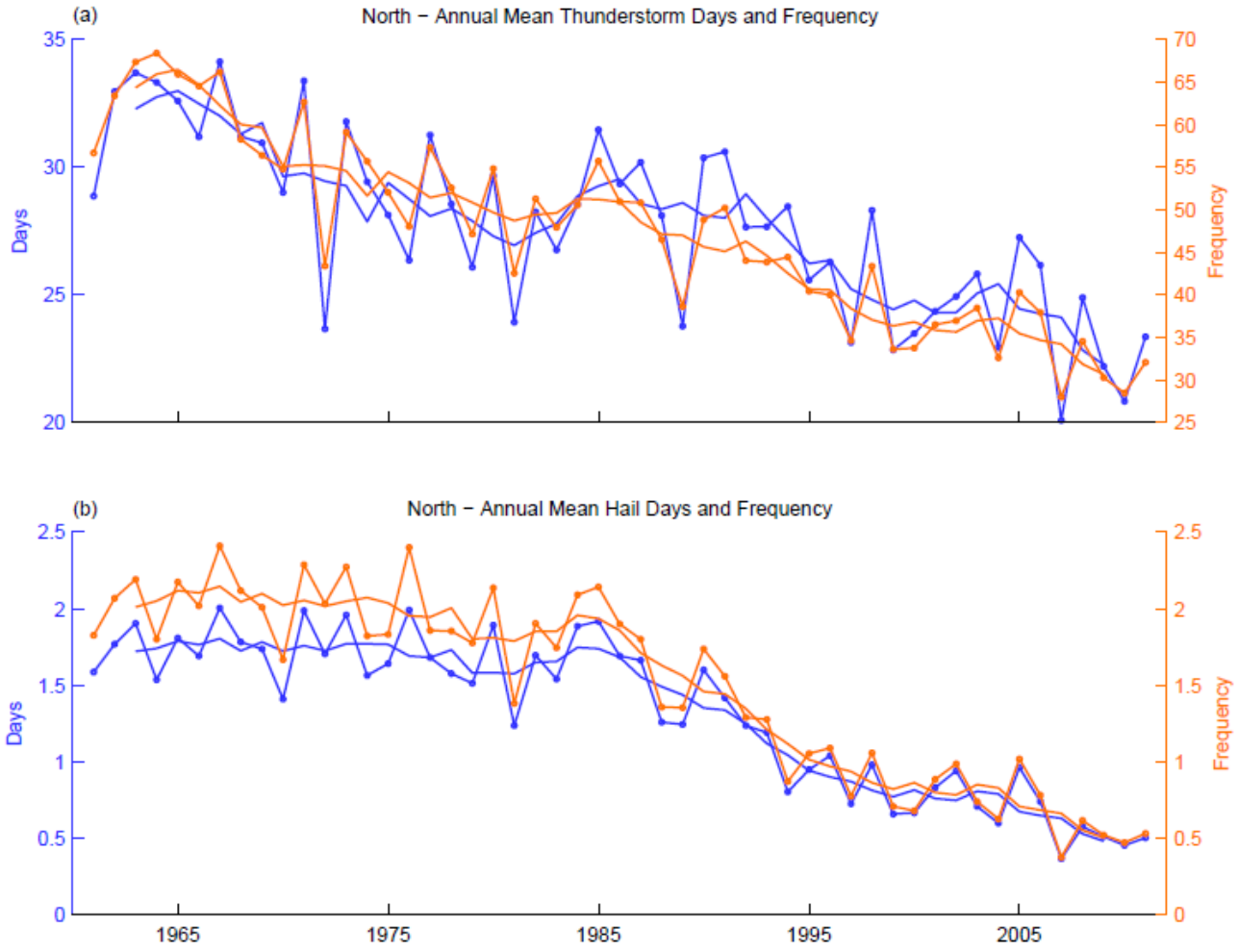


Thunderstorm Days

Hail days

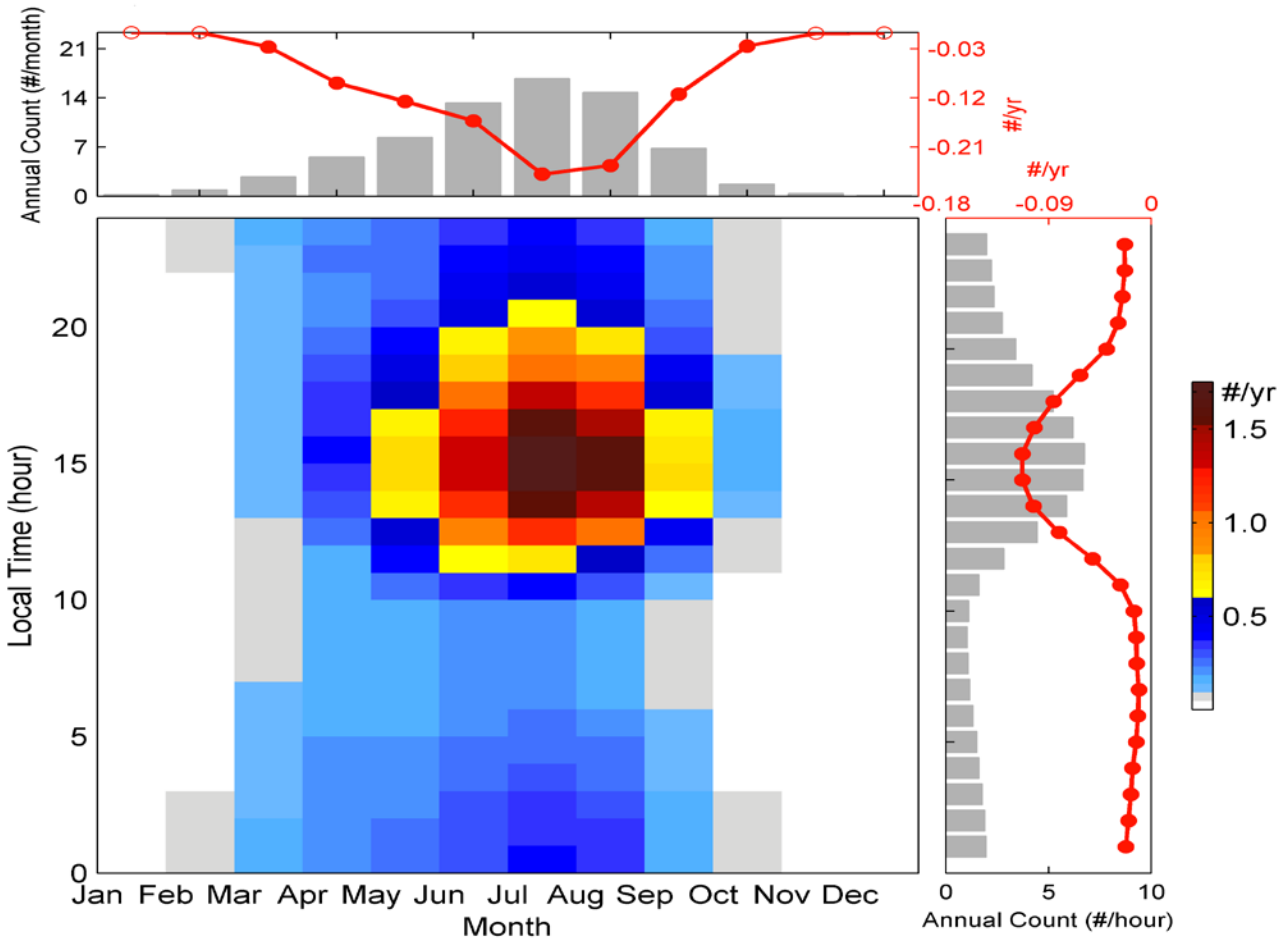



(a)
Tibet − Annual Mean Thunderstorm Days and Frequency
Days
Frequency
50
45
40
35
30
25
100
90
80
70
60
50
40
(b)
Tibet − Annual Mean Hail Days and Frequency
Days
Frequency
9
8
7
6
5
4
3
11
10
9
8
7
6
5
4
3
1965
1975
1985
1995
2005

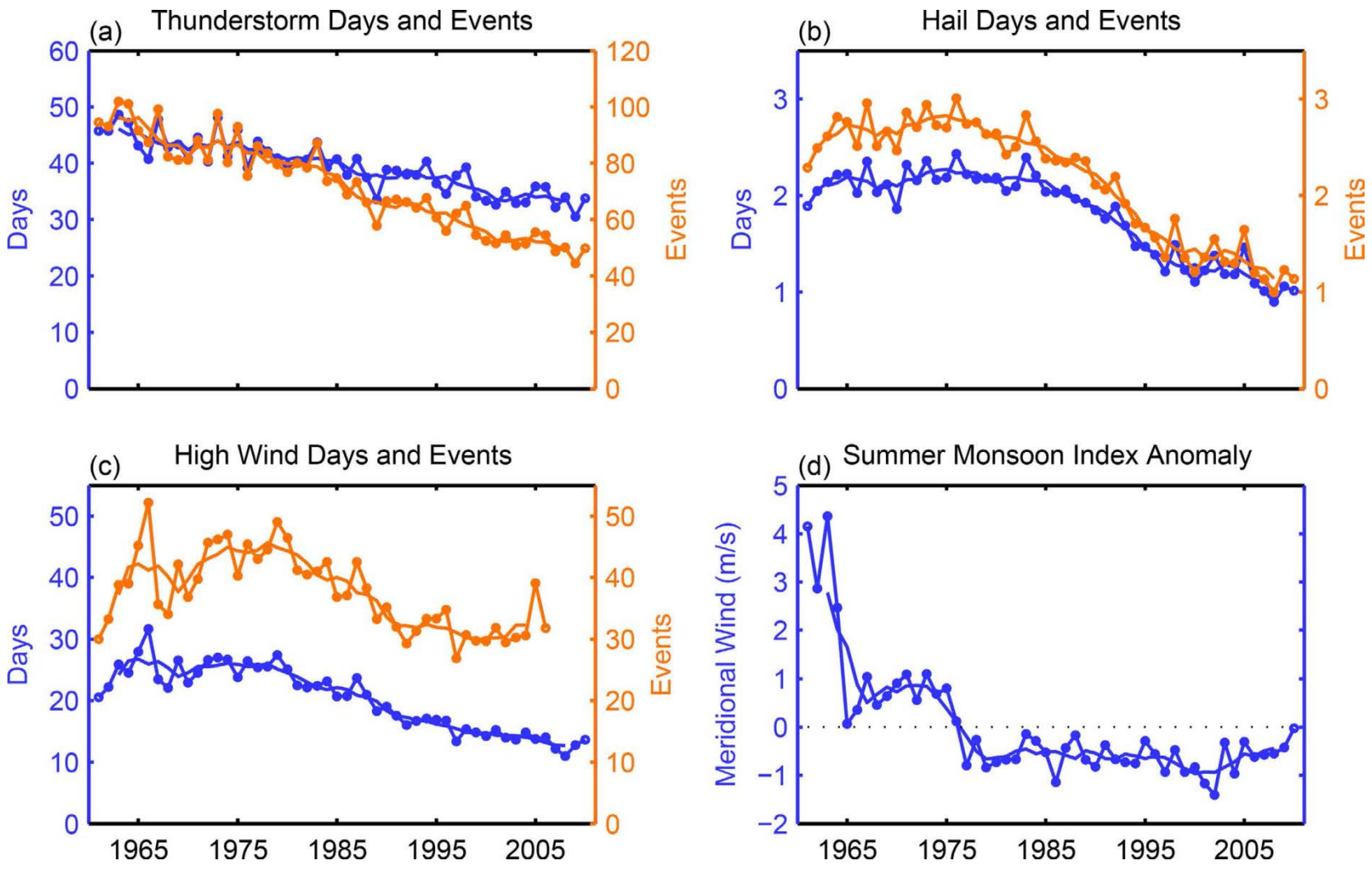

(a)
North − Annual Mean Thunderstorm Days and Frequency
Days
Frequency
35
30
25
20
70
65
60
55
50
45
40
35
30
25
(b)
North − Annual Mean Hail Days and Frequency
Days
Frequency
2.5
2
1.5
1
0.5
0
1965
1975
1985
1995
2005

Station mean annual thunderstorm Frequency

Seasonal and diurnal Variation



warm season： MJJAS


(a)
Thunderstorm Days and Events
Days
Events
(b)
Hail Days and Events
Days
Events
(c)
High Wind Days and Events
Days
Events
(d)
Summer Monsoon Index Anomaly
Meridional Wind (m/s)
1965
1975
1985
1995
2005