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

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Terrain height of Mainland China

Variation of hail frequency

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

The seasonal variation 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

Vector: difference in the 850-hPa wind vectors between the two periods
lines: the 25-year average of the 850-hPa geopotential heights during 1986–2010
Summary

Weakening of East Asian summer monsoon which is the primary source of moisture and dynamic forcing conducive for warm-season severe weather over China.
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 first episode; however, for the event’s second episode, remains mostly linear.
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


Thanks
Trends in the number of thunderstorm day

1961-1989

1990-2013
Spatial distribution of annual thunderstorm and hail days
Station mean annual thunderstorm Frequency

Seasonal and diurnal Variation

warm season: MJJAS