Geophysical Research Abstracts
Vol. 17, EGU2015-4441, 2015
EGU General Assembly 2015


# Climatological analysis of hail occurrence in China mainland using a Poisson regression model

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Understanding the variability of hail events in the context of global climate change is a challenge for researchers. Previous studies found significant decrease in annual hail occurrence since 1980 in China, especially in the northern China. These changes are linked to the variations in large-scale environmental conditions. This study explores the possible connection between hail activities with some environmental parameters using a Poisson regression model, and constructs a hail index to depict its climatology during the period 1960-2012 over mainland China. The hail index takes the form of$\mu = \exp(\mathrm{b} \cdot \mathrm{x} + \log(n \cdot \cos(\varphi))$, in which $n$ is the total number of stations in a grid cell and $\varphi$ is its associated latitude of the grid cell.$\mathrm{x}$ are the predictors and $\mathrm{b}$ are the coefficients from the regression model. We use hail observations from 535 stations in China during the period and the NCEP monthly reanalysis in our regression model. We calculate 25 large scale atmospheric parameters from the reanalysis data as the predictors, and fit the monthly hail day count data. We perform the regression for three regions: Tibet Plateau (Tibet), northern China (North), and southern China (South), and show different seasonal variability of hail occurrence over these regions. We found that the surface equivalent potential temperature (Surfte), Total Totals (TT), and K index (K) are the best combination of predictors to formulate the hail index. This index could capture the main climatological spatial distribution, seasonal variation of hail day. The year-to-year variability fitting of observation and model results is significant when annual values of hail day and predictors are applied in this index. Based on a one-dimension hail growth model, surface water vapor content and temperature profile in the lower troposphere are confirmed to have impact on hail diameter at freezing level, which supports the use of surface equivalent potential temperature as a predictor. Total Totals and K index are both related to the lapse rate in lower troposphere, which contains information about the increase in temperature below freezing level that promotes hail melting during descent.