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An Analysis of Spatiotemporal Characteristics and Trends of Global Atmospheric Energy

Kaiqi Chen, Jianping Li, Tiejun Xie, Qiuyun Wang, and Lanning Wang
Beijing Normal University, College of Global Change and Earth System Science, Beijing, China (kyle1023@163.com)

Atmospheric energetics is an important part of atmospheric science. Understanding the spatiotemporal characteristics of atmospheric energy can provide new ideas and methods for atmospheric research, especially climate change. On the basis of NCEP monthly reanalysis data from 1948 to 2016, this paper explains the whole feature of global atmospheric energy changes from the distribution, trends and dominant modes change of total energy, internal energy, potential energy, latent heat energy and kinetic energy. The main conclusions can be drawn as follows: (1) apart from high altitude areas, total energy decreases from the equator to the poles, and most parts of the world are increased. The distribution and variation of internal energy and potential energy are closely related to the total energy. The maximum area and significant change zones of latent heat energy are located in the equator and low latitudes. The maximum area of kinetic energy locates in long-wave trough of middle latitudes and outlet zone of westerly jets. In addition, the variations in kinetic energy located in double westerly jets in the southern hemisphere is most obvious. (2) The total energy shows the characteristic of discontinuous periodical leap growth. The total energy of the northern hemisphere is more than that in the southern hemisphere, but the speed-up of the northern hemisphere is slower than the southern hemisphere. That is, the energy between the northern and southern hemispheres tends to be homoplasy. The total energy above the ocean is more than that of the land, and that gap has widened. Volcanic eruptions may have an important effect on the interannual reduction of atmospheric energy. (3) Spatial characteristics of the first leading mode of each components of atmospheric energy are coincided with their distribution of trends, and they had occurred decadal catastrophe around 1975. As a whole, the second leading mode of the total energy, internal energy and potential energy of atmosphere reflect that the north and south pole change in a reversed way to other regions. Latent heat energy in some lower-latitude areas shows an opposite change tendency to the rest of the world. The kinetic energy mainly shows the meridional wave train distribution from the tropical Pacific to the north and south poles. Time series of the second leading mode possess the characteristics of multi-decadal variations, and they may relate to the internal variability of the climate system.