Forecasting strong precipitation—the potential of potential deformation

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Vorticity, divergence and deformation are the three basic characteristics of wind fields. While many previous studies have revealed and confirmed the close relationship between both vorticity and divergence and the occurrence of precipitation, few have focused on the deformation of the precipitating atmosphere. In fact, deformation is closely related to the occurrence and distribution of strong precipitation—a relationship explored in a recent study published in *Advances in Atmospheric Sciences*, which aimed to involve deformation in the diagnosis of precipitation.

In the study, a new parameter called potential deformation (PD) has been derived by scientists from the Institute of Atmospheric Physics, Chinese Academy of Sciences. PD is composed of potential stretching deformation and potential shearing deformation, which are constructed based on the concept of potential vorticity, and PD does not change with coordinate rotation. PD is then used in a simulated mesoscale convective system (MCS) to examine its performance in precipitation diagnosis.

"We find that PD performs well in indicating the heavy precipitation area within the MCS," says LI Na, the first author of the study. During the two band-shaped and cluster-shaped stages of the MCS, large-value areas of PD also present corresponding bands and clusters.

"An analysis of the physical basis for the close correlation between the PD and precipitation shows that PD can reflect the precipitation area because it contains the typical processes for the production of MCS

precipitation: warm and moist inflow, a rear inflow jet, cold and dry downward flow, and a surface cold pool," LI says. "And all these processes are contained in PD by the three-dimensional gradient of the generalized potential temperature (or moisture), the vertical wind shear and deformation, and thus PD correlates closely with precipitation." According to the study, the correlation coefficient can reach up to 0.7. This implies great potential for using PD in precipitation detection and forecasting.

At present, numerical models represent one of the main ways for predicting precipitation. However, precipitation in numerical models is mainly obtained by parameterization schemes (microphysical parameterization and cumulus parameterization), which contain strong uncertainties. To improve the prediction skill of precipitation by numerical modeling, a number of extended methods have been developed based on the numerical results as a complement to the numerical predictions.

"The usefulness of PD lies in that it can also be calculated from numerical prediction results and used as an interpretation technique to indicate precipitation," says Dr. RAN Lingkun, the corresponding author of the study. "The application of the parameter in forecasting precipitation and its comparison to numerical precipitation is a possible avenue of research for our group in the future."

More information: Na Li et al, Potential deformation and its application to the diagnosis of heavy precipitation in mesoscale convective systems, *Advances in Atmospheric Sciences* (2017). DOI: 10.1007/s00376-017-6282-4

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