Roles of Wind Shear at Different Vertical Levels in Cloud System Organization and Properties

ARM CLIMATE RESEARCH FACILITY

Research Highlight

Complex systems of thunderstorms, called mesoscale convective systems (MCSs), occur frequently across the globe and contribute greatly to the hydrologic cycle and atmospheric energy budget. Organized MCSs, like squall lines that form ahead of a cold front, tend to produce severe weather and heavy rains. One important factor in determining the development of an MCS is vertical wind shear.

A team of U.S. Department of Energy scientists at Pacific Northwest National Laboratory–in collaboration with Nanjing University of Information Science and Technology in China–investigated how wind shear produces effects at different vertical levels on the organization and properties of convective systems using the Weather Research and Forecasting model. Conducting real-case simulations of an MCS with a detailed bin cloud microphysical scheme under different wind shear conditions, the team found that increasing wind shear in the lower troposphere leads to a more organized quasi-line convective system. Strong wind shear in the middle troposphere tends to produce isolated storms with supercell characteristics, while in the upper troposphere, the convective intensity is weakened. The team found that evident changes of cloud macrophysical and microphysical properties in the strong wind shear cases mainly result from large changes in convective organization and water vapor. The insights gained from this study will help researchers better understand the following factors that contributing to convective organization and cloud properties.

• Strong winds at lower/middle levels lead to line/mesocyclone systems.

• Strong winds at upper levels increase high cloudiness and weaken convection.

• Evident change of cloudmacrophysical/microphysical properties induced by wind shear.

Reference(s)

Chen Q, J Fan, S Hagos, W Gustafson, and L Berg. 2015. "Roles of wind shear at different vertical levels, Part I: Cloud system organization and properties." Journal of Geophysical Research – Atmospheres, 120(13), 10.1002/2015JD023253.

Contributors

Jiwen Fan, *Pacific Northwest National Laboratory*

Working Group(s)

Cloud-Aerosol-Precipitation Interactions

U.S. DEPARTMENT OF ENERGY | Office of Science