NCAR scientists investigate the processes that cause severe weather using a variety of methods, including: 1) special observational field programs; 2) numerical simulations with advanced computer models developed and maintained at NCAR; and 3) theoretical studies on fluid dynamics.

Results from these studies have many applications affecting safety, commerce, and everyday life, including benefits to real-time forecast systems and civil engineering.

Observational Field Projects

NCAR scientists organize and participate in special field projects that collect observational data near and within severe storms. Recent storm projects have focused on heavy precipitation, severe convective wind gusts, and tornadoes, including MPEX (2013), DC3 (2012), and VORTEX2 (2009-2010). (See http://catalog.eol.ucar.edu/ for a longer list.)

Studies leveraging field project data are conducted by NCAR scientists along with colleagues at universities and private companies. Much of this research uses software developed at NCAR.

To gain a deeper understanding of severe weather events, NCAR researchers use computer models that can simulate severe convective storms. Also known as numerical simulations, these computer models are developed and maintained at NCAR and can run on various computing systems, from a laptop computer to state-of-the-art supercomputers.

Some models, like the widely used Weather Research and Forecasting (WRF) Model (http://wrf-model.org/), are designed primarily for forecasting and simulating actual severe weather events. Others, like Cloud Model 1 (CM1), are designed for theoretical studies of small-scale processes like supercells (rotating thunderstorms) and tornadoes.

Unique data collected in a squall line during the VORTEX2 field project in 2009. Radar reflectivity is indicated by the color scale and the tracks of weather balloons (called rawindsondes) are indicated by red lines.
The primary advantage of computer simulations is that they provide complete data at all points in space and time, and thus can be used to supplement what can be learned from limited observations. As an example, theories for tornadogenesis (the processes that cause tornadoes) within supercells are currently being evaluated using computer models developed at NCAR.

Theoretical Studies of Fluid Mechanics

To develop a thorough understanding of severe storms, NCAR scientists study the dynamics, or fluid mechanics, of atmospheric flows. Recent projects include studies of how tornadoes interact with the ground, and how cold air “gravity currents” that spread along the ground can create severe surface wind gusts in derechos (long-lived, nonrotating storms). Results from these studies are disseminated to the wider community through articles in peer-reviewed journals such as Journal of the Atmospheric Sciences and Journal of Fluid Mechanics.

Applications

Findings from these studies are transferred to operations at meteorological services around the world via improvements to computer models such as the widely used WRF Model. These improvements lead to better forecasts of severe weather events.

Funding

Primary sponsor is the National Science Foundation (NSF).

Seeking funds to extend fundamental research on tornadoes and severe convective windstorms (derechos), and to transfer results to computer models such as the widely used WRF Model.

Research Partners

NOAA’s National Severe Storms Laboratory

Contact

George Bryan, PhD, Scientist, NCAR Mesoscale & Microscale Meteorology
303.497.8989, gbryan@ucar.edu

Scott Rayder, UCAR Senior Advisor for Development and Partnerships
303-497-1673, rayder@ucar.edu