Scientists track individual raindrops inside clouds

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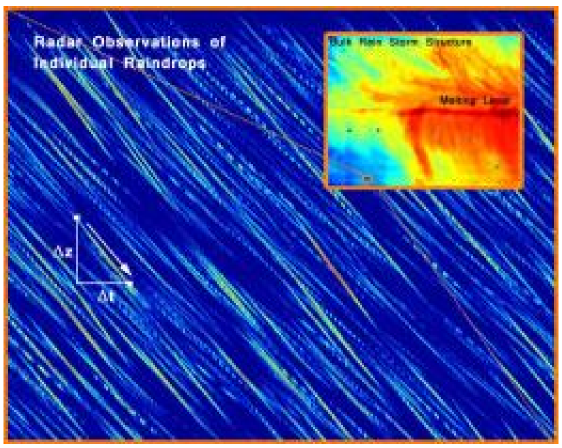

The image was obtained as a deep convective cloud system passed over the vertically pointed radar on August 27, 2010. The image displays a time-height plot of both the bulk radar structure obtained from the MCR's lower resolution (37m range resolution) waveform (inset) as well as the peculiar, nearly linear sloping radar reflectivity features (or "streaks") determined to have been generated by individual raindrops as they traversed the higher resolution (0.5m range resolution) radar beam. The bulk radar structure revealed in the inset shows that the higher reflectivity values (warmer colors) resulted from a high concentration of larger ice particles generated aloft (top of the image) which then settled through the melting layer and contributed to the population of individual raindrops observed in the lower portion of the cloud by the MCR's high-resolution waveform. The location of the higher-resolution radar streak observations is denoted by the small orange box depicted in the lower-left portion of the inset. The small colored circles within the inset show the locations of the research aircraft while it was obtaining in situ cloud measurements over the radar just below the melting level. The left-to-right downward sloping streaks evident in the outer image indicate the movement of particles toward the earth's surface. The along-streak reflectivity values, measured Doppler phase shift, and slope can be exploited to determine the concentration, size, velocity (or other properties) of the individual cloud particles, as depicted graphically for an isolated streak with the labeled white lines. Note that the vertical scale of the inset (ordinate) represents a range of approximately 5.5 km while that of the streak image is 63m. The time scale of the inset (abscissa) represents approximately 21 minutes of elapsed time while that of the streak image is roughly 25 seconds. This image was created from the raw MCR data by Dr. Jerome Schmidt and placed in final form using Adobe Photoshop with the assistance of Ms. Cynthia Karengin (NRL).

(Phys.org) -- Naval Research Laboratory (NRL) scientists are leading a multi-agency study which reveals that a very high-resolution Doppler radar has the unique capacity to detect individual cloud hydrometeors in the free atmosphere. This study will improve scientists' understanding of the dynamics and structure of cloud systems.

This Doppler radar was previously used to track small debris shed from the NASA space shuttle missions during launch. Similar to the traces left behind on film by sub-atomic particles, researchers observed larger cloud particles leaving well-defined, nearly linear, radar reflectivity â€œstreaksâ€ which could be analyzed to infer their underlying properties. Scientists could detect the individual particles because of a combination of the radar's 3MW power, narrow 0.22 degree beamwidth, and an unprecedented range resolution as fine as 0.5m. This combination of radar attributes allows researchers to sample a volume of cloud about the size of a small bus (roughly 14 m^3) when operating at a range of 2 km. With such small pulse volumes, it becomes possible to measure the properties of individual raindrops greater than 0.5mm in diameter due to the low concentration of such drops in naturally occurring cloud systems and the overwhelming dominance such drops have on the measured radar reflectivity when present in a field comprised of smaller particles.

The study was carried out as a multi-agency effort with scientists from NRL's Marine Meteorology Division, located in Monterey, California, as well as the Scripps Institution of Oceanography, the Naval Surface Warfare Center Dahlgren Division, the Johns Hopkins University Applied Physics Laboratory, L-3 Interstate Electronics Corp, Radar Technology Specialists Corp., Weather Modification, Inc., and students as far away as the Institute of Geophysics located at the University of Warsaw. This team of specialists, spanning an area of expertise from cloud physics and dynamics to radar theory, design, and applications, assembled to conduct a series of weather experiments held in coordination with the Naval Ordinance Test Unit, the Federal Aviation Administration, Cape Canaveral Air Force Station Facility, and NASA between 2008 and 2010.

The purpose of these experiments was to study the properties of various cloud systems as well as to evaluate the ability of the U.S. Navy's Mid-Course Radar (MCR) to retrieve information on the cloud's internal flow and precipitation structure. Toward this end, the team conducted field projects during the height of the Florida summer convective season in order to collect radar data, launch weather balloons, obtain in situ cloud data using an instrumented research aircraft, and to document other features of the local cloud systems using a variety of complimentary surfaced-based sensors such as an upward looking lidar and all-sky camera. These additional instruments were used to continuously monitor the sky conditions as well as to help guide the precise placement of the aircraft and the high-resolution MCR radar beam during the numerous case events documented during the course of the experiment.

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In addition to Dr. Schmidt, the NRL research team members include Dr. Paul Harasti and Dr. Piotr Flatau, who is an on-site faculty member from Scripps Institute of Oceanography. The finding is published in the June 12, 2012 issue of the *Proceedings of the National Academy of Sciences* where the list of remaining authors and their contributions to the study may be found.

Provided by Naval Research Laboratory

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