Geophysical Research Abstracts, Vol. 9, 02094, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-02094

Bridging the scale gap: lidar estimation of small-scale rainfall

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One of the important scientific challenges for the hydrologic research community is to improve our understanding of the variability of rainfall at small scales (say, those below 10 km and 1 hour). Statistical scaling modeling provides a useful framework for linking observations with physics-based theories of rainfall behavior. The existing observational methods, while useful, contain many inadequacies. In-situ observations from rain gauges and disdrometers do not allow meaningful analysis of spatial scaling due to significant smoothing in variability by interpolation methods. Radar based estimates are subject to considerable uncertainties due to numerous, well-documented sources. Satellite based estimates do not have sufficient resolution at small scales. Also, there is a scale gap between point observations, which are useful for quantitative evaluation of the remote sensing rainfall products) and those provides by radar. Operational radars typically provide products at scale greater than 2 km. Research radar can provide smaller scale observation but those smaller than 0.25 km are often too noisy to be useful. The authors discus a novel application of an elastic scanning lidar to address this scale gap. Lidar can provide data with spatial resolution better then 5 m over a range up to 2 km. While lidar measurements of rainfall have been attempted in the past, the described study is perhaps the first motivated by hydrologic research needs. The authors conducted an experiment in which lidar beam was directed just over ($\sim$5 m) an optical disdrometer located some 400 m from the lidar. To obtain rainfall estimates from the lidar data the authors derived and solved a lidar equation using some simplifying assumptions about the drop size distribution (DSD). They used the disdrometer data in an independent way to derive high resolution (30 s) estimates of rain rate based on the measured DSD. Similar quantity derived from the lidar compares very well with the disdrometer data. The authors discuss a design of

an experimental setup for future research of lidar capability to provide high resolution rainfall estimates.