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Atmospheric Measurement Techniques Discussions

Interactive comment on “Fallspeed measurement and high-resolution multi-angle photography of hydrometeors in freefall” *by* T. J. Garrett et al.

Anonymous Referee #1

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General comments

Paper describes an instrument for automated and high-resolution multi-angle photography of hydrometeors in freefall, named Multi-Angle-Snowflake Camera (MASC). Construction of instrument is based mainly on three cameras and additional system of near-infrared emitter-detector pairs arranged in two arrays separated vertically by some known distance. This system of infrared motion sensor is used for triggering cameras and measuring fallspeed of hydrometeors. MASC functioning is controlled by internal microprocessor and software developed for data acquisition of images, fallspeeds and timestamps. Stereoscopic images of hydrometeors are analyzed using MATLAB image processing toolbox for a range of properties including: the average maximum

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Interactive Discussion

Discussion Paper

dimension along the major axis, the aspect ratio relative to the minimum dimension along the minor axis, the angle from the horizontal to the major axis, the hydrometeor cross-section and perimeter, and a dimensionless expression of the hydrometeor complexity.

MASC performance is presented on the example of winter filed campaign between February and April 2012, at an altitude of 2600 m, in the Wasatch Front near Salt Lake City, UT. In addition, results of discrete dipole approximation computations of the microwave scattering phase function for hydrometeors (four individual snowflakes) identified by MASC are presented at the manuscript final part.

In general the manuscript is well constructed and clearly written. The goal of instrument development is clear and reasonable. It is to help improve representations of frozen hydrometeors in weather and remote sensing models. Description of MAST construction and image analysis procedures is precise.

Specific comments

In fact MASC development was not based on discovery of completely new hydrometeors measuring/sensing technique. The novelty of device arises rather from the combination of some already well known measuring and image analysis techniques. Among of combined technologies, digital photography plays the key role for the MASC functioning. Having this in mind it is worth to mention some previous scientific communications describing successful implementation of digital cameras for hydrometeors fall velocity or diameter measurements, see e.g. Licznar et al. 2007 (Microprocessor Field Impactometer Calibration: Do We Measure Drops' Momentum or Their Kinetic Energy? J. Atmos. Oceanic Technol.,vol 25) and references herein. Presenting the current state of art of hydrometeors recording by automated ground-based disdrometers it is also necessary to mention about 2D-VIDEO-DISTROMETER (see http://www.distrometer.at/). MASC and 2D-VIDEO-DISTROMETER operational basics seem to be at least partly similar. Similarities and differences of both devices should be discussed and explained.

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In Sect. 3 the conservative rejection conditions are outlined. Is it possible to estimate some ratio of rejected hydrometeors versus recorded by MASC hydrometeors (that passed a focus threshold)? Is it possible to record the whole hydrometeor size distribution of natural precipitation by MASC and compare it with DSD spectrum recorded by some disdrometers? Finally is it possible to compare at least roughly mass of hydrometeors recorded by MASC with precipitation mass measured by some weighing gauge?

The title of paper suggests that MASC is suitable for measurement of hydrometeors in general, whereas the measurements of frozen hydrometeors only are discusses in manuscript. Is MASC designed also for liquid hydrometeors measurements?

Page 4835(16): "In all regards, the range of possible characteristics is broad. The atmosphere seems to allow for most possibilities." These statements are insufficient as the discussion of a wide results dataset (approximately ten thousand images). The range of measured parameters values should be clearly reported. It is also possible to check for the existence of some relations between measured parameters (e.g. fall velocity versus maximum hydrometeor dimension, reported for instance at the book of Pruppacher and Klett "Microphysics of Clouds and Precipitation").

Fig. 3 suggests appearance of some rare hydrometeors with high fall velocity of about 8-10 m/s. These are values exceeding rainfall terminal fall velocities. In addition, as claimed by author: "what was measured was not necessarily the hydrometeor terminal velocity, but rather a hydrometeor settling speed representing a convolution of the terminal velocity within a turbulent wind field" Were also negative fall velocities recorded during field campaign caused by snowflakes updraft? Is MASC suitable to record hydrometeors with negative fall velocities?

Page 4836(24): "However, this might easily require over 50GB of shared computer memory." Please explain how was this necessary DDSCAT calculations computer memory estimated?

Technical corrections

Page 4829(13): “where |n| is the refractive index” precisely: “where |n| is the complex refractive index”

Fig. 3. Description and scale for vertical axes should be added.

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 4827, 2012.