HIWC-RADAR II Particle Size Distributions and Mass Size Distributions

Particle and mass size distribution data from the HIWC-RADAR-II campaign (2018) have been processed and archived by the National Center for Atmospheric Research (NCAR). Previous PSD/MSD datasets from the HAIC (2014/2015) and HIWC-RADAR-I (2015) were processed by the Centre National de la Recherche Scientifique Laboratoire de Météorologie Physique (CNRS). The data produced for this archive have followed the processing techniques and file formats that were used in previous datasets as closely as possible to maintain consistency across projects. See Leroy et al. (2016, 2017) for further details on the processing techniques.

Probe specifications:

This archive consists of data collected from two instruments that operated on the NASA DC-8 aircraft, the DMT Precipitation Imaging Probe (PIP), and the SPEC Two-Dimensional Stereo probe (2D-S). Both instruments are two-dimensional optical array probes which record images of particles that travel through their sampling area. The recorded images are then analyzed to produce particle size distributions and mass distributions from 10 microns to 7mm in diameter.

2D-S: Two 128-element diode arrays, 10 microns per pixel, arm width of 6.3 cm.
PIP: 64-element diode array, 100 microns per pixel, arm width of 22.2 cm

The 2D-S records particles from two separate arrays, one with a vertical (top view) orientation, and one with a horizontal (side view) orientation. The vertical array is used in this dataset. The PIP was oriented vertically for all flights. The 2D-S was installed in the inboard canister on the right wing of the DC-8, and the PIP was installed on the outboard canister of the right wing.

Processing details:

Particle size determination
Particle size and mass distributions are given in terms of equivalent-area particle diameter (D_{eq}), which is defined as the diameter of a circle with the same area (A) as the particle image:

$$D_{eq} = \sqrt{4/\pi\ A}$$

The final D_{eq} value has been adjusted to account for optical diffraction (Korolev 2007) and for partially imaged particles, where the portion of the particle outside of the array is estimated and A is adjusted accordingly. A "center-in" technique has been applied so that particles determined to have their center outside of the image array are rejected (Heymsfield and Parrish, 1978).

Instrument Corrections
Particle shattering corrections have been applied to the 2D-S following Field et. al (2006). Both the 2D-S and PIP have probe tips designed to minimize the amount of shattering. Optical depth

of field for the PIP follows the manufacturer's specifications. Depth of field for the 2D-S follows Lawson et al. (2006).

When multiple particles are imaged in a single PIP frame, only the largest particle is measured and accepted. Multiple images in 2D-S frames are treated as a single particle.

Both instruments record the time of arrival of each individual particle, and missing data is either flagged or can be determined by a particle counter. This information is used to compute the overload time when a probe is temporarily not recording data.

The PIP experienced poor image quality on alternating diodes throughout the project. The data from these diodes are not used, and the neighboring (good) diodes are copied in their place.

Binning
The 2D-S is used for all size bins smaller than 800 microns. The PIP is used for all size bins larger than 1200 microns. A blend between the 2D-S and PIP is used in the overlap range between 800-1200 microns, as described in Leroy et. al (2016). The final archived distributions have been interpolated to bins in 10 micron intervals.

Mass computation
Mass distributions are computed from the particle size distributions using a power-law relationship of the form $M = \alpha D^{\beta}$ (cgs units). The β exponent is fixed at a value of 2.51. The α coefficient is adjusted dynamically to fit the value reported by the Isokinetic Total Water Content Evaporator Probe (IKP2). When adjustment of α is not possible, a default value of 0.023 has been applied.

File descriptions:

Composite particle size distributions and mass distributions are given in bins ranging from 15 microns to 6995 microns in 10-micron increments. The bin center-points are listed in the first line of the file. In following lines, the starting time of each interval is given (UTC seconds from midnight), followed by the particle size distribution or mass distribution for that time interval. Particle size distribution units are **#/L/micron**. Mass distribution units are **g/m^3/micron**.   Poor or missing data are flagged with a value of -999.

A housekeeping file is available for each flight containing bulk parameters derived from the distribution data, including total number concentration (#/m^3), ice water content (g/m^3), and median mass diameter (microns). The α and β coefficients used to calculate the mass distribution are listed. Finally, a data quality flag, overload time, and end diode voltages are given for the 2D-S and the PIP.

Selected particle images from the 2D-S and PIP are available as a series of PNG image files. Each file represents one minute of flight time, and the 60 panels in the image show the first

particle buffer available per second. Many more images are not shown but are available by request.

References:

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