Drop size ambiguities in the retrieval of rain rates
from the GPM core measurements

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The Tropical Rainfall Measuring experience has confirmed that one of the main difficulties surrounding the retrieval of rain profiles from spaceborne radar reflectivity measurements is the unknown Drop Size Distribution. In the case of TRMM, this retrieval algorithms constrainted the DSD using an independent estimate of the vertically integrated attenuation, as well as the passive radiances the passive radiances measured independently (albeit within the radiometers's larger field-of-view).

The dual-frequency radar which the GPM core satellite will carry should prove a much more effective tool in sorting out at least part of this DSD-induced ambiguity. Indeed, with two radar reflectivity profiles, one would expect to be able to retrieve not just a single rain rate profile, but also at least one additional "first order" DSD profile, such as a profile of the (mass-weighted) mean drop diameter D*. Unfortunately, this expectation may turn out to be difficult to fulfill, because the reflectivity profiles at the two radar frequencies are far from independent. Indeed, lighter rain is largerly made up of small drops, and the backscattering cross-section of small drops is not significantly different at 14 and 35 GHz, the GPM radars' frequencies, so that one would not expect large differences in the assocated radar reflectivity factors. While the difference in the extinction cross-section is more significant for small drops, its magnitude is too small to be exploitable for light precipitation. At the other extreme, for heavy precipitation, the attenuation can be quite large, so much so that it is expected to drive the back-scattered signal at 35 GHz below the sensitivity of that channel. In brief, the reflectivity profiles at the two frequencies are not expected to be significantly different at low rain rates, and they will in effect reduce to a single frequency at high rain rates, leaving a rather narrow range over which the two frequencies can be realistically expected to resolve, to first order, the DSD-induced ambiguity problem.

Starting with several different DSD models (two exponential and two gamma parametrizations, and two EOF models), we have tried to retrieve the rain rate and D* profiles associated with the dual-frequency reflectivity profiles measured by JPL's airborne PR-2 radar over hurricanes Humberto and Gabrielle during the CAMEX-4 experiment in August 2001. While the general structure, and especially the vertical behaviour, of the retrieved D* profiles does not depend drastically on the DSD model assumed, the estimates themselves, of the rain rate as well as the mean drop size, do depend very significantly on the DSD model assumed. The natural conclusion is that, in spite of the dual-frequency radar that GPM will carry, the careful a-priori modeling of the DSD, at scales commensurate with the GPM radars' resolution, will be crucial to the success of the GPM core retrieval algorithm. We offer a new, robust method to quantify the characteristics of the DSD at these scales using dual-frequency wind profiler data.