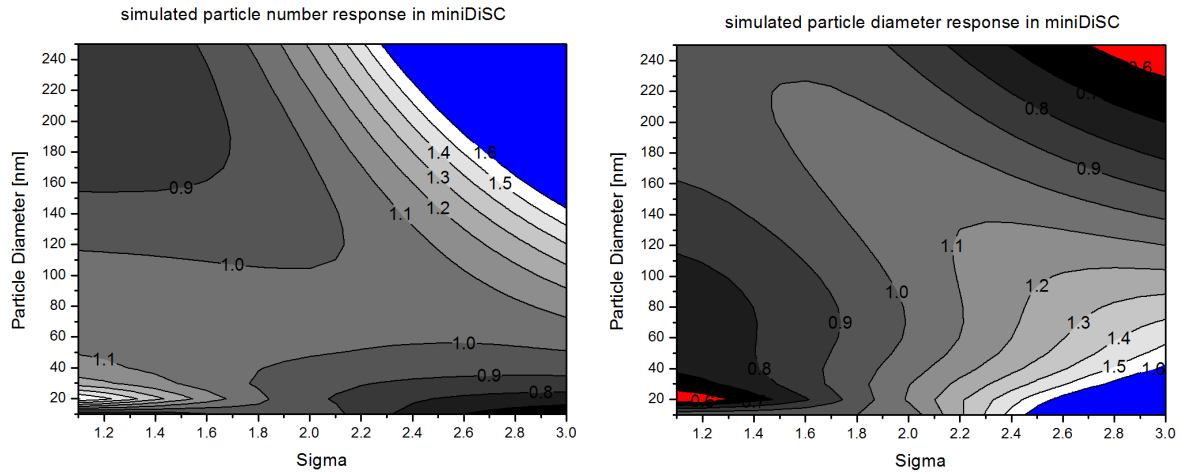
miniDiSC application note #11: Errors due to the size distribution shape

The miniDiSC is calibrated with monodisperse aerosol, and with the help of this calculation, the instrument response for polydisperse aerosols with a lognormal size distribution with a geometric standard deviation σ = 1.9 is calculated, and the corresponding calibration curve stored in the instrument. For aerosols that do not match this size distribution, an error occurs both in the number and diameter calculation. This is the main reason that we specify the accuracy of the miniDiSC to be ±30%. However, not all possible real aerosol size distributions affect the accuracy of the miniDiSC equally, and this application note tries to give a feeling for when you can trust the miniDiSC measurements, and when not.

Since there is an infinite number of possible size distributions, a general discussion of this effect is impossible. However, we can calculate what happens when the lognormal size distribution has a different σ than the one that was assumed. The result is shown in the two following graphs for lognormal size distributions with σ = 1.1 – 3.0 and geometric mean diameter of 10-250nm. Please note that these are just mathematical simulations for idealized size distributions – nevertheless they should give an idea of when to trust the miniDiSC and when not (or less) – if you know something about the size distribution you are trying to measure (or simply from looking at the diameters the miniDiSC is reporting).



Here's an example of how to read these graphs: Imagine that you are trying to measure a lognormal particle size distribution with a mean diameter of 80nm and σ = 1.9. Since this fulfils the assumption in the data inversion of the miniDiSC, we expect a good result. Indeed, if you look up this data point in the left-hand-graph, it is between the 1.0 and 1.1 contour, i.e. the number is slightly overestimated but by less than 10%. In the diameter plot, this point is very close to the 1.0 line, so there should be nearly no error there.

If you are trying to measure a monodisperse aerosol (σ = 1.1) with a diameter of 30nm, then you can see in the plot that it won't work too well – the particle diameter lies between the 0.6 and 0.7 contour, so the miniDiSC will report something like 0.65·30nm = 20nm. Also, the particle number will be overestimated by a factor of about 1.3.

In general, as you can see from these graphs, problems occur in the corners of these diagrams, whereas the more central parts of the diagrams are "safe" in the sense that the errors will be below 30%.