My interests are in numerical simulation, experiments and theory of dilute aerosols. I think there has been much progress in the last 15 years. Here's what I consider the outstanding issues

- Development of LES for dilute aerosols. This should be considered broadly (from light to heavy particles, all size ranges, etc.). It is clear that future calculations will increasingly rely on LES (over RANS) as computers become faster. Getting the physics right in LES models (with Lagrangian descriptions of the particles) is still an open area.

- Physics of particle clustering. Particle clustering dramatically affects a number of aerosol processes (gravitational settling, collision, turbulence modulation, evaporation/condensation, etc.). Understanding the scaling with all parameters (including the Reynolds number) remains an open question.

- Experimental diagnostics. The ability to obtain 3D information, including tracking has exploded in the past 5 years. Experiments are poised to rival DNS with precision (but with no limitation on the Reynolds number). This is an exciting growth area. Examples include the recent measurement of particle accelerations in turbulence (e.g., see LaPort et al., Nature 409:1017-19, 2001, Voth et al., J. Fluid Mech. 469:121, 2002).