Until recently, airborne in situ measurements of cirrus microphysical properties have generally been unreliable (particularly for small (<50 μm) ice crystals) because of the potential presence of shattering artifacts and the inability of older optical array probes to image small particles. The 2010 DOE Small Particles In Cirrus (SPartICus) provided an extensive dataset of midlatitude cirrus clouds with new instrumentation designed to minimize shattering artifacts and with sufficient time response to image particles as small as 10–15 μm. In addition, post-processing analysis techniques have been developed that can reliably identify and remove the artifacts. The April, 2011 NASA Midlatitude Cirrus Experiment (MACPEX) should provide additional measurements of cirrus properties with the new instrumentation. We will first present statistics of midlatitude cirrus ice concentrations and size distributions. Next, we will compare the measured cirrus microphysical property statistics with results from ensembles of detailed process-model simulations. Sensitivity studies will be used to evaluate the relative importance of different modes of ice nucleation (heterogeneous and homogeneous) and other cloud processes (e.g., aggregation, sedimentation) in controlling the ice concentrations and sizes.