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Observations of phase transitions in mixed phase cloud during CLACE

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During the winter of 2004 the CLoud Aerosol Characterisation Experiment 3 (CLACE-3) was performed at the Sphinx Jungfraujoch high alpine research station (3580m above sea level, Switzerland) to investigate the microphysics and cloud aerosol interactions of mixed phase clouds. High frequency cloud microphysics measurements were made from a raised platform and tower mounted rotating cross arm so that the cloud probes could be pointed into wind allowing for optimal measurement. A Spec Inc Cloud Particle Imager (CPI) was used to look at the habit and size distribution of ice particles. Cloud droplet size distributions and liquid water content were measured using a PMT Forward Scattering Spectrometer Probe (FSSP-100) upgraded with DMT SPP-100 rev-1 electronics. Separately a Gerber PVM was used to measure liquid water content. A TSI Airborne Droplet Analyser also measured cloud droplet size distributions using a Phase Doppler Particle Analysis (PDPA) technique. Analysis of the microphysics data yielded the liquid and ice water content of cloud and the size distribution of the liquid and ice phases. From this the cloud Ice Mass Fraction (IMF) was calculated which when averaged over the data set (approximately 16000 minutes of in-cloud data) demonstrates a bi-stability where clouds prefer to be of either low or high Ice Mass Fraction. The majority of the cloud was highly to fully glaciated (IMF$>$70%, total duration 7056 minutes). Truly mixed phase cloud was observed during the experiment but it occurred less frequently (30%$<$IMF$<$70%, total duration 3840 minutes) than the fully glaciated and partially glaciated cases (IMF$<$30%, to-

tal duration 5100 minutes). The pure liquid phase was rarely observed. Both droplet number concentration and Liquid Water Content were found to decrease linearly with increasing Ice Mass Fraction while ice crystal number concentration increases in the general case. For many clouds periods of alternating rapid phase transitions from supercooled droplets to ice were observed. Fully glaciated periods persisted for tens of seconds to several minutes spanning distances ranging from 50m to lengths approaching 1km respectively. For these fully glaciated periods it is suggested that the Bergeron-Findeisen process has gone to or is near completion in the measured volume given that there are no or very few small droplets present as the bulk have been lost by vapour diffusion to the ice phase by the Bergeron-Findeisen process. Estimates of the time and length scale of the phase transitions will be presented.