Liquid-State Water Bimorphism in Cold Atmospheric Clouds

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ABSTRACT

In this chapter the results of recent research of properties and physicochemical nature of liquid water contained in droplets of subzero temperature clouds are stated. The study was initiated by hardly explainable anomalies connected with the liquid disperse phase in phase-mixed clouds. The work is based on the analysis of various experimental materials including author's unique data on the phase-disperse composition of cold atmospheric clouds, interpreted from fundamentals of the structure physical chemistry. It was found that the liquid disperse phase is a stable component of ice-containing clouds, which essentially differs in most properties from ordinary water constituting purely liquid-water clouds. Namely, it steadily keeps at temperatures below –40^{o}C and is in condensation equilibrium with ice; its droplets consisting of H_2O substance have a density as high as 2.1 g·cm^{-3}, and so on. The typical presence of this water form in cold clouds is confirmed by the natural glory phenomenon. It is thoroughly proved that this specific form named A-water has a non-hydrogen-bonded intermolecular structure and belongs to the amorphous water heretofore known only as a laboratory low-temperature solid condensate, being its melt. The field measurements have not only discovered the natural existence of the amorphous water, but also specified its most important properties, inaccessible in laboratory conditions. As a part of the consideration of the nature of both metastable forms, supercooled ordinary liquid water and A-water, some important peculiarities of their internal freezing process are deduced based on their internal structure, affecting in-cloud microphysical processes. The origin of both water forms and subsequent transformation of phase-disperse types of cold clouds are discussed. The conceptions evolved provide a comprehensive explanation of every obscure peculiarity of cold cloud composition, evolution processes and accompanying phenomena.