Influence of a dispersed phase presented in external flow on heat exchange and erosion damage of surface of a hypersonic flight vehicle

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It is well known that our planetary atmosphere has a complex set of components, including water vapors, which tend to condense into a droplet phase particularly at altitudes of 2–13 km above the Earth's surface. Hence, a flight vehicle (FV) may fly in turbulent multiphase polydisperse nonequilibrium environment with high probability. In so doing the surface of hypersonic FVs is exposed to heavy thermal loads, even in free flow. The droplet phase presented in the flow can change the FV thermal conditions. The paper is devoted to passing of the droplet phase through the hypersonic FV bow shock wave. We consider splitting of droplets, when they pass through a shock wave and their evaporation in high-enthalpy flow over the FV.
We present a methodology for numerical simulation of the interaction of the dispersed flow with the supersonic FV. The methodology is based on Navier–Stokes equations that account for a Lagrange phase presented in flow. We make an assumption that particles and free flow may interface with each other. The particles can collide with one another and break up. We take into account the water evaporation from surface of particles which leads to increase in concentration of water vapor in an area adjacent to the FV. We made test runs using the described model. We made a conclusion on the influence of dropping liquid presented in flow on a flow pattern and heat exchange over the supersonic FV surface. We consider the possibility of erosion damage of the surface thermal protection effected by the dispersed phase.