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A new fast aircraft thermometer for temperature measurements in clouds

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One of the fastest available aircraft thermometers suitable for measurements in clouds is Ultrafast Aircraft Thermometer UFT, designed and manufactured at Warsaw University in various versions. It is a thermoresistant unit working at constant voltage. In its UFT-F version the sensing element is a 5 mm long platinum-coated tungsten wire 2.5 μm thick (resistance ca 50 Ω), protected against impact of cloud droplets by suitably shaped protective rod located 6.5 mm in the front of the wire, with suction system which removes water collecting on the rod and damps eddies shedded from it. With time constant of order 10^{-4} s it permits, at 100 m/s airspeed, good resolution of features of few centimeter size, but for deeper studies of mixing processes in clouds still better resolution is desirable. Unfortunately this cannot be achieved by going down with thickness of the sensing wire, since already the present one is mechanically very weak and seldom survives more than few hours of flight. A solution proposed in this paper is replacing the 2.5 μm sensing wire in UFT-F with one 5 μm thick, heating it electrically, and measuring power needed for keeping its temperature constant. Such system is typical for thermoanemometers and King LWC-meter and similar electronics can be used for temperature stabilization. If heated to temperature only few kelvins above the expected ambient value, the sensor reacts much stronger to fluctuations of temperature than to expected fluctuations of airspeed (the latter introducing errors of about 0.1K, i.e. within the limits of usual noise of UFT). Its speed of reaction depends not only upon the thermal properties of the wire but on electronics as well and by suitable adjustment of the latter time constant of order 10^{-5}s can be achieved. An automatic electronic switch switches the temperature of the wire in about 4K steps, keeping it about 4K above the highest value encountered in the ambient air over last

15s of flight. Alternative solution is a slow, averaging, cloud-water-protected termoresistant thermometer included into the stabilizing bridge so as to keep the temperature of the sensing wire about 4K above the ambient air average.

The proposed solution has the advantage of being mechanically much stronger than UFT-F and permitting resolution of features of few millimeters size, (i.e. comparable with the length of the wire and thus the maximal available with this kind of instrument). Its disadvantage is dependence of its sensitivity on temperature, pressure and airspeed, which in practice may be difficult to calculate. Thus a simple procedure of frequent in-flight recalibration is provided.