Scientific Ballooning: Recent Developments in Technology and Instrumentation (PSB1)

EXPERIMENTAL STUDY FOR THE DETERMINATION OF THE TURBULENCE ONSET IN NATURAL CONVECTION ON INCLINED PLATES

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In June, 8th, 2009 the balloon-borne solar telescope SUNRISE was launched from the Swedish Space Corporation balloon facility Esrange. A telescope with a mirror of 1 m in diameter observed the Sun during six days until the mission was terminated in Canada. The design process of SUNRISE and of any optical telescope requires the analysis of the effect of surrounding air on the quality of images. The turbulence encountered in the local telescope environment degrades its optical performance. This phenomenon called 'seeing' consists of optical aberrations produced by density non-homogeneities in the air along the optical path. The refraction index of air changes due to thermal non-uniformities so that the wavefront incident on the mirror is randomly distorted, and therefore, images are altered. When telescope mirrors are heated, as it happens in solar telescopes, and therefore they are at a temperature different from the environment's, natural convection occurs. It is then crucial to know whether the flow in front of the mirror is laminar or turbulent. After reviewing the literature, it was found that the scattering of results about the onset of the transition gives only rough orders of magnitude of the values of the critical Grashof numbers. Aiming to obtain more information about it, the problem of determination of the turbulence onset in natural convection on heated inclined plates in air environment was experimentally revisited. The transition has been determined from hot wire velocity measurements. The onset of turbulence has been considered to take place where velocity perturbations start to grow. Experiments have shown that the onset depends not only on the Grashof number, but also on other parameters as the temperature difference between the heated plate and the surrounding air. A correlation between dimensionless Grashof and Reynolds numbers has been obtained, fitting extraordinarily well the experimental data. The results are obtained in terms of non-dimensional numbers, this way they apply to any air pressure and therefore to any floating altitude.