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Atmospheric Measurement Techniques Discussions

Interactive comment on "Fast-response high-resolution temperature sonde aimed at contamination-free profile observations" *by* K. Shimizu and F. Hasebe

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Your first comment is that the amplitude of the pendulum motion appears huge. We agree to you in that the horizontal displacement of 40 m that we got from 4D-GPS is large, but it was confirmed by the sonde movement speed obtained by GPS raw data. In view of the general consensus that GPS could provide the movement speed in every second with the accuracy of 0.2 m/s (Section 5.2.1 of Misra and Enge, 2001), there will be no reason to doubt this value.

The GPS-based wind measurement system on radiosondes relies on the speed and direction of the instrument resulting from both the atmospheric and the pendulum motions of sondes. During this processing, we can estimate the magnitude and phase of the pendulum motion quite accurately. Our experience even in the calm condition shows that the GPS speed often exceeds 10 m/s for the soundings with the suspension line of 30 m. Unfortunately, our flight with the suspension line of 120 m, was not equipped with an additional GPS at the neck of the balloon. Therefore, we cannot apply differential method to derive the amplitude of the swing motion in this case. However, the magnitude of the pendulum motion could be roughly estimated from those taken from radiosonde by subtracting the slowly-varying atmospheric motion from the raw GPS data. The horizontal displacement thus estimated is about 40 m for the sonde with the suspension line of 120 m (similar to that of 30 m), indicating that the speed of the swing motion is much slower in the case of 120 m line than that of 30 m.

Reference: Misra, P. and P. Enge: Global Positioning System: Signals, Measurements, and Performance, Ganga-Jamuna Press, Lincoln, MA, USA, 2001.

Your second comment is that the amplitude of the (spurious) peaks shown on Figures 3, 4 and 6 also appears huge. The observed temperature perturbations are surely big, and actually they are bigger than we had expected. That is why we tried to measure the skin temperature of the balloon (Fig. 9). After a couple of experiments, however, we came to accept such large perturbations as a fact due to the strong illumination and inefficient heat removal by air flow in the stratosphere. It is only our impression, but the fact that the balloon surface temperature is 20 degrees higher than the environment may well explain the sonde body warmer than the environment by 6-8 K.

Before replying to your next comments on Figs. 4 and 6, let me confirm that the flight modules having been used to draw these figures are different. The former consists of one tungsten sonde only, while the latter is made up of a pair of tungsten sondes each of which is fixed on the opposite end of a plate with the sensor arms directed to the outer side (Fig. 5). In case of a single payload (Fig. 4), there is no synchronization between the sensor's encounter with the perturbed air and the swing motion, because

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the sonde ascent is accompanied by the spin as well as the pendulum motion. What we want to show here is that the perturbation does occur when the sonde is apparently out of the reach from the balloon contrail. On the other hand, the dual launch (Fig. 6) is designed to synchronize the encounter to the perturbed air with the swing direction. For example, Tungsten 1 (but not Tungsten 2) is affected by the foregoing flight module during the swing motion from A to B. The situation is the opposite during that from B to C.

Your idea of using the cape is interesting. However, we are anxious about some possible side effects resulting from its use. For example, your experience of reduced pendulum motion may mean that the balloon does not properly follow the atmospheric motion in the shear zone causing errors in wind measurements. We are also concerned about heat contamination created by the cape. The use of a vane is also interesting. Actually we tried to design it. However, we finally did not adopt it as the motion might not necessarily be constrained to what we intended to. At this moment, we think the use of a long suspension line will be enough to mostly eliminate the heat contamination. Please be aware, however, there remain small perturbations with the magnitude of about 0.4 K due probably to the variation of insolation associated with the solid angle change of the solar illumination against the sensor body (p.3302).

Your last comment is concerned with our suggestion of using the descent data. There are obviously disadvantages for using the descending data. However, there are definite advantages as well. We do not propose to use descending data for operational purpose. For some research purposes, however, we may want to put much weight on the advantages given by descending data. The shaky motion can be avoided by controlled slow descent that i made possible by using a valve that releases launching gas gradually. The reception range of the sonde signal depends on the meteorological conditions. Missing data could be made minimal by preparing a proper receiving system.

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