Observation of surface pressure variations beneath airplanes

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1.Introduction

There is a possibility that atmospheric motion excites continuously Earth's free oscillations (Kobayashi & Nishida, 1998). There are two candidates for the types of disturbances that excite the free oscillations. One is thermal convective motion, and the other is acoustic wave excites by the latent heating in cumulus clouds. We can judge the suitability of the choices by observing the time-space properties of surface pressure variations with high measurement accuracy (0.1 Pa and under) and high temporal (10 sec) and spatial (1 km) resolution. Conventional observation network does not provide such high resolution data. Therefore we are making a preliminary observation at Kyushu University using the PET bottle microbarometer (Umetani, 2003 Japan Earth and Planetary Science Joint Meeting) that is low cost and has high accuracy.

2.Surface pressure variations beneath airplanes

We often found pressure rises 1-5 Pa that continue for about 10 sec in our micro atmospheric pressure data (measurement accuracy 0.4 Pa, at 1-sec intervals).

Kyushu University is located near Fukuoka Airport, and airplanes fly at low altitude over the observation site. We compared visually identified timings of airplanes passages with pressure data, and confirmed that surface pressure rises when an airplane flying over Kyushu University.

3.Discussion

Flying airplane, pushed upward by the 'lifting force', pushes surrounding air downward by its wings. If we suppose that the downward force is projected on to the ground and causes the pressure rise over the circle whose radius is the same length as flight altitude, the amplitude of the pressure variation P' is given by

P' = mg/(pi h**2)

h : flight altitude
m : mass of an airplane
g : gravity acceleration

Substituting the value of h (about 200 m above Kyushu University) and m (about 300 t, Boeing 747-400) in above expression, we obtain P' about 20Pa. This value is larger than that of the observed pressure variations. But it is not inconsistent with our observation, if we consider that our observation site is offset from flight path by 200 m and the mass or altitude varies by airplanes.

Tahira et al. (2004 spring meeting of Meteorological Society of Japan) reported surface pressure variations related to airplanes in the micro pressure data observed at Aichi University of Education. Unlike our data, their data show pressure drop. The difference in the responses of barometers or in the flight altitudes may explain the contrasting signatures of pressure deviations, but we have not examined the details.

It is an evidence of the PET bottle microbarometer's accuracy that it can capture micro pressure variations related to airplanes.

But these variations are 'noises' for the original purpose which is to observe the surface pressure variation by atmospheric disturbances. We need to quantify these 'noises' and need to identify and remove them.