

Feasibility study of IR ozone and temperature limb sounder for small satellites

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For the studies of dynamics and chemistry, observations of vertical profiles of temperature and O₃ are essential. Multiband IR limb sounder, Nimbus-7/LIMS and TIMED/SABER have shown that the IR limb sounding can show 1) vertical resolution 1-2 km (better than scale height ~3 km), 2) temperature and accuracy 1-2%, and 3) ozone accuracy 2-5%. Other measurement techniques, solar occultation, mm/sub-mm limb sounder, FTS limb sounder have some disadvantages compared to the multiband IR limb sounder such as TIMED/SABER.

Solar occultation technique can measure only at the terminator region during the satellite orbiting which also limits the observations only 28-30 times a day. Limb emission techniques (IR or mm/sub-mm) can measure more 1000 points a day. Compared to multiband IR limb sounder, FTS IR limb sounder generally require bigger instrument and larger data rate, and mm/sub-mm limb sounder requires large antenna (1 m) to achieve required vertical resolution 3 km. FTS IR and mm/sub-mm limb sounders can have measurement capability for many minor components, but these two techniques require longer observation interval (which is less spatial sampling). In this study, we report a feasibility study of multiband IR limb sounder to measure temperature and O₃ for a small satellite with SMILES follow-on, a mm/sub-mm limb sounder, as the core instrument.

TIMED/SABER is a successor of the first generation multiband IR limb sounder (LIMS), which has 10 bands (CO₂N 14.888-15.520, CO₂W 13.347-16.941, 13.347-16.941, O₃ 9.057-9.729, H₂O 6.510-7.120, NO 5.257-5.566, and three SWIR channels (OH 1.952-2.189, OH 1.562-1.698, O₂ 1.262-1.285)). It uses a 77 K pulse tube cooler, and total instrument is 55W and 58.5 kg. Tsao et al (Tsao et al. 2000) have proposed an IR limb sounder (temperature and O₃), 20 kg and 20 W, using uncooled micro-bolometer array detector. The IR limb sounder using uncooled detector, MCS (Mars Climate Sounder), 10 kg and 15 W, has already demonstrated the excellent performance of uncooled IR limb sounder for the Mars observation, where the low weight and low power are strongly favorable. In Japan, uncooled IR imager have been developed for the Venus Climate Orbiter/Akatsuki (Fukuhara et al 2011) and for the small satellites (Fukuhara et al, this session). We will conduct further feasibility studies of both 80 K cooled and uncooled multiband IR limb sounder, whether they meets the 1) weight and power limitation (cooled instrument), and 2) sensitivity at mesosphere (uncooled instrument).

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