Measuring clear-air vertical velocity profiles with IASI

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ABSTRACT

Measuring vertical velocity in the atmosphere has long been a challenge due to its small magnitude. Taking advantage of the modulation of free tropospheric relative humidity by vertical motions, we derived analytical relationships that allow us to retrieve vertical velocities in clear air from successive measurements of brightness temperature in the infrared absorption band of water vapour. This methodology has been successfully applied to high-rate geostationary satellite data and provides measurements of mid-tropospheric vertical motion with a resolution of 1 hour and 2 km in time and space, respectively. It has also been validated against numerical simulations and in situ observations (Poujol and Bony, submitted).

Here, we show that such observations can also be produced with IASI, using the successive passage of the Metop-A and Metop-B satellites, despite significant challenges due to the different orbits of the two satellites and the high sensitivity to instrumental noise. While the single broad band channel of geostationary satellites only provides an estimate of mid-tropospheric vertical motion, we use a selection of IASI channels in the water vapour absorption band to retrieve vertical profiles of vertical velocity in the mid-to-upper troposphere, at IASI native horizontal resolution, and with an effective vertical resolution of about 100-200 hPa.

First observations reveal strong subsidence occurring around organized convective systems. This subsidence seems to peak in the middle or lower troposphere, unlike the top-heavy mass flux usually reported within convective updrafts. Moreover, the combination of these vertical velocity measurements with IASI temperature and humidity retrievals illuminates our understanding of the influence of the cloud-induced circulations on the surrounding clear-air. At the date of the conference, these results may be evaluated against in situ observations from the MAESTRO field campaign to take place in summer 2024.

Finally, we provide some perspectives on the advent of geostationary infrared sounders, which should enable reliable measurements of clear-air vertical velocity with a high horizontal, vertical and temporal resolution, over a full geostationary disk.