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Hydration of the lower stratosphere by ice crystal geysers over land convective systems

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Abstract. The possible impact of deep convective overshooting over land has been explored by six simultaneous soundings of water vapour, particles and ozone in the lower stratosphere next to Mesoscale Convective Systems (MCSs) during the monsoon season over West Africa in Niamey, Niger in August 2006. The water vapour measurements were carried out using a fast response FLASH-B Lyman-alpha hygrometer. The high vertical resolution observations of the instrument show the presence of accumulation of enhanced water vapour layers between the tropopause at 370 K and the 420 K level. Most of these moist layers are shown connected with overshooting events occurring upwind as identified from satellite IR images over which the air mass probed by the sondes passed during the three previous days. In the case of a local overshoot identified by echo top turrets above the tropopause by the MIT C-band radar also in Niamey, tight coincidence was found between enhanced water vapour, ice crystal and ozone dip layers indicative of fast uplift of tropospheric air across the tropopause. The water vapour mixing ratio in the enriched layers exceeds frequently by 1–3 ppmv the average 6 ppmv saturation ratio at the tropopause and by up to 7 ppmv in the extreme case of local storm in coincidence with the presence of ice crystals. The presence of such layers strongly suggests hydration of the lower stratosphere by geyser-like injection of ice particles over overshooting turrets. The pile-like increase of water vapour up to 19 km seen by the high-resolution hygrometer during the season of maximum temperature of the tropopause, suggests that the above hydration mechanism may contribute to the summer maximum moisture in the lower stratosphere. If this interpretation is correct, hydration by ice geysers across the tropopause might be an important contributor to the stratospheric water vapour budget.

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