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The vertical structure of ozone and water vapor profiles in Lhasa within Asia summer monsoon anticyclone during the stratospheric intrusion

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A stratospheric intrusion process occurred over the southeastern side of the Asia summer monsoon (ASM) region is investigated using the balloon-borne measurements of ozone and water vapor during 18−20 August 2013. Data from Lhasa (29.66° N, 91.14° E, above sea level (asl.) 3,650 m) show that the positive relative change of the ozone mixing ratios in the tropopause layer attained to 90 % on 19 and 20 August. The backward trajectory calculation from CLaMS model and the satellite data from the ozone monitoring instrument (OMI) and the atmospheric infrared sounder (AIRS) indicate that the (stratospheric) air parcels intruded (originated) from the Northeast Asia to the southeastern edge of the ASM anticyclone. Meanwhile, typhoon Utor occurred over the sourtheastern edge of the ASM and lasted from 8 to 18 August 2013. The convection associated with Utor uplifted air with low ozone from the Western Pacific to the middle/upper troposphere. Air parcels with high ozone from the high latitude and with low ozone from the Western Pacific met at the sourtheastern side of the ASM and then transported westward to Lhasa over long-distances (∼2,000 km). In addition, the laminated identification method is used to identify the laminae structure of the ozone and water vapor profiles from the middle troposphere to the lower stratosphere in Lhasa, confirming the role of the dynamic disturbance (e.g., Rossby and gravity wave)