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Not biomass burning but stratospheric intrusion dominating tropospheric ozone over the Tibetan Plateau

Junhua Yang[a], Kun Wang[a,1], Mang Lin[b,c], Xiufeng Yin[a], and Shichang Kang[a,c]

Using in situ aircraft measurements of ozone and precursor source tracers over remote marine regions from the NASA Atmospheric Tomography (ATom) mission, Bourgeois et al. (1) report the large contribution of biomass burning emissions to ozone throughout the global remote troposphere. Although the broad point is robust, the conclusion by Bourgeois et al. (1) may not be sufficiently solid over climatically important remote inland regions that are not investigated by the ATom mission. Indeed, influences of biomass burning on the tropospheric ozone level over the Tibetan Plateau, the world's highest and largest plateau, might not be as vital as the stratospheric intrusion.

There are very few biomass burning emissions over the Tibetan Plateau itself. Being adjacent to South Asia where biomass burning is especially important, the Tibetan Plateau is arguable influenced by air pollution from South Asia (2). However, by conducting a regional climate chemistry transport model Weather Research and Forecasting model coupled with Chemistry based on the modeling setup adopted in Yang et al. (3), we found that the contribution of biomass burning from South Asia to surface ozone over the Tibetan Plateau was negligible (less than 1%) in 2012 (Fig. 1*A*). Alternatively, the Community Atmosphere Model with Chemistry simulation revealed that more than 80% of surface ozone can be owing to the stratospheric ozone intrusion in the inland Tibetan Plateau during the peak episodes (4).

Fig. 1*B* quantitatively shows enhanced contributions of stratospheric ozone to the troposphere during 2012 nonmonsoon seasons (January to May) over the Tibetan Plateau corroborated by the European Centre for Medium-Range Weather Forecasts Atmospheric Composition Reanalysis 4. Other evidence of stratospheric influences comes from measurements of cosmogenic radiosulfur (^{35}S), a radionuclide predominately produced in the stratosphere. It is demonstrated that enrichments of stratospherically sourced ^{35}S in ground-level aerosols are a unique chemical signature of downward transport of stratospheric air to the troposphere (5). Based on ^{35}S measurements at various midlatitude sites (the Tibetan Plateau, East China, the western United States), Lin et al. (6) found high ^{35}S concentrations over the Tibetan Plateau (at least twice those of East China and the western United States), indicating that the Tibetan Plateau is more affected by stratospheric air than other regions. To further elucidate, we collected direct field-based measurements of ^{35}S in atmospheric sulfate aerosol in the inland Tibetan Plateau during 2012 (7). As shown in Fig. 1*B*, significant enrichments of ^{35}S in the nonmonsoon season are in agreement with the downward transport of stratospheric ozone at the same season.

Author affiliations: [a]State Key Laboratory of Cryospheric Sciences, Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences, Lanzhou 730000, China; [b]State Key Laboratory of Isotope Geochemistry and Chinese Academy of Sciences Center for Excellence in Deep Earth Science, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou 510640, China; and [c]University of Chinese Academy of Sciences, Beijing 100049, China

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[1]To whom correspondence may be addressed. Email: wangkun@lzb.ac.cn.

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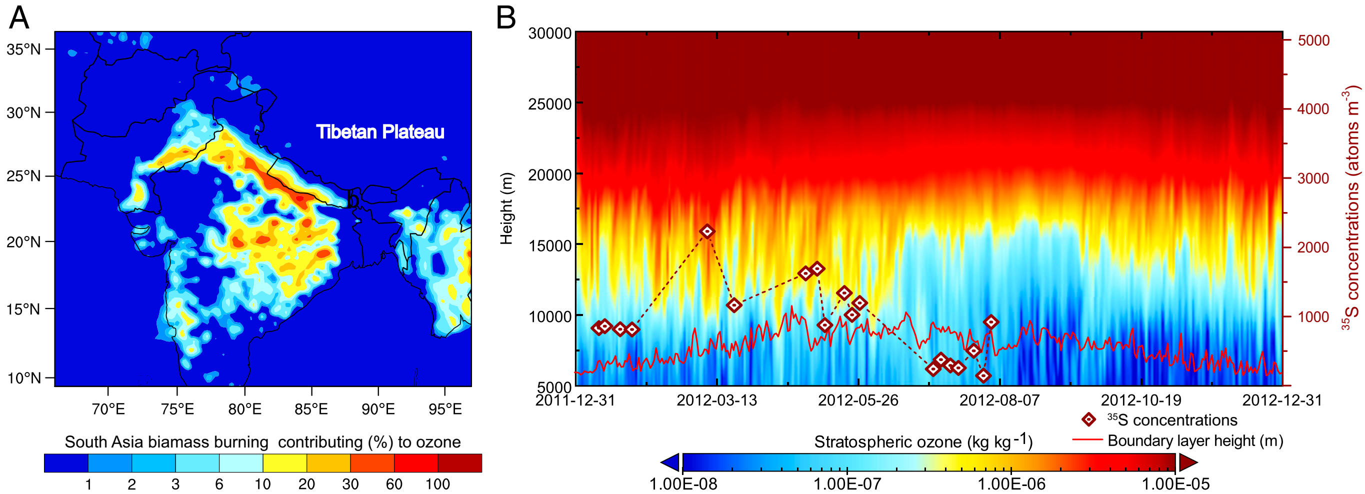

Fig. 1. Effects of biomass burning and stratospheric intrusion on ozone over the Tibetan Plateau. (*A*) The contribution ratio (percentage) of biomass burning to ozone over the Tibetan Plateau and South Asia. (*B*) Stratospheric ozone tracer and boundary-layer height over the Tibetan Plateau as well as ^{35}S concentrations in the inland Tibetan Plateau.

To conclude, based on an integrative analysis with isotopes observations and reanalysis data as well as numerical simulations, we suggest that not biomass burning but stratospheric intrusion dominates the tropospheric ozone level over the Tibetan Plateau. Therefore, besides in situ photochemical production in the troposphere from biomass burning, accurately accounting for the intrusion of ozone-laden stratospheric air is required to understand the impacts of ozone on atmospheric chemistry and climate over the Tibetan Plateau and potentially, other high-elevation remote regions worldwide. Cautions should be taken when extrapolating the marine measurement-based results of Bourgeois et al. (1) to inland remote regions, such as the Tibetan Plateau.

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