4.059 Persistent La Niña-like climate in 2010s reduced export from China and suppressed ozone trend in the lower troposphere over Japan.

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Abstract:

Large increase in the springtime free tropospheric ozone over the western and eastern North Pacific has been linked to the increase in anthropogenic emissions in China. In the 2000s, a rapid increase of tropospheric ozone was observed at Mt. Happo, Japan. However, the increasing trend at Mt. Happo has been unexpectedly suppressed by 5–10 ppbv since 2008 before the reduction of Chinese emissions. After 2012, ozone levels were sustained at about 60 ppbv. In this study, we analyze the tropospheric ozone records at Mt. Happo, along with the decadal changes in climate and anthropogenic emissions. We find that persistent La Niña-like climate pattern during 2008–2013 has reduced continental outflow from China to the western Pacific via weakened westerly wind, even though Chinese emissions continued to increase until 2012. On the other hand, an El Niño-like climate pattern during 1992–1996 has enhanced continental outflow export from China via strengthened westerly wind, contributing to the accelerated ozone trends. In addition, enhanced storm track activity around Japan during 2000–2006 has also contributed to the ozone increase. These results indicate that the tropical forcing by El Niño and La Niña affected the long-term trend of springtime free tropospheric ozone in Japan. Without this climatic effect driven by persistent La Niña, the ozone trend would have been further upward over the western Pacific and possibly over the western North America in late 2000s to early 2010s. At Mt. Happo, the mean springtime ozone level might have exceeded 70 ppbv by the early 2010s.