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Asian chemical outflow to the Pacific in late spring observed during the PEACE-B aircraft mission

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The Pacific Exploration of Asian Continental Emission phase B (PEACE-B) aircraft mission was conducted over the western Pacific during April-May 2002. During several flights, large enhancements of CO greater than 200 ppbv were observed at altitudes between 5 and 10 km. In this study, we focused on vertical transport mechanisms over East Asia that were responsible for these enhancements, using the European Centre for Medium-Range Weather Forecasts (ECMWF) meteorological data and infrared cloud data obtained by the Geostationary Meteorological Satellite (GMS)-5. A case study for the highest CO event shows that it was likely due to vertical transport of pollutants caused by deep cumulus convection along a quasi-stationary frontal zone, which was formed over central China. In the mean meteorological field during the PEACE-B period, the warm, moist low-level southerlies converged into the frontal zone, sustaining cross-frontal temperature and moisture contrasts. Along the frontal zone, the mean vertical motion was distinctively upward, and a subtropical jet aloft was found to transport uplifted air parcels efficiently into the western Pacific. In this study, criteria to identify deep convection are defined using both the ECMWF and GMS data. The results show that convective activity, which was generally high below the subtropical jet, played an important role in producing updrafts over central China. The convective transport resulted mainly from a limited number of episodes each of which followed the development of a weak cyclonic disturbance. Back trajectories of air parcels sampled at altitudes between 4 and 13 km onboard the aircraft during PEACE-B show that among air parcels originating from the 800-hPa level or below,

69% were likely to undergo convective uplifting. In addition to convection, sloping isentropes often observed along the quasi-stationary jet axis yielded persistent slow quasi-adiabatic uplifting of air over the Far East, which was occasionally intensified with a classical warm conveyor belt (WCB) airstream on the passage of migratory cyclonic disturbances. Meteorological conditions during PEACE-B were thus favorable for the uplifting of boundary layer air influenced by anthropogenic emissions over central China. These results are consistent with the relatively high levels of Halon 1211, a good tracer of Chinese anthropogenic emissions, observed in the air parcels that were likely uplifted in the frontal zone.