SHORT-TERM VARIATION OF ATMOSPHERIC CARBON DIOXIDE AT MT. WALIGUAN: IMPLICATION FOR SOURCE, SINK AND LONG-RANGE TRANSPORT

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ABSTRACT
This presentation describes in-situ atmospheric CO_2 measurements at Waliguan Observatory (WLG, 36°17'N, 100°54'E, 3816m asl) since 1994, together with 5-day isobaric back trajectory analysis. We also use the Hybrid Single-Particle Lagrangian Integrated Trajectory (Hysplit-4) transport/diffusion model to simulate the CO_2 variation at WLG in January 1999 and compared with observations. A case study for polluted air mass transport event with a short-term elevated CO_2 has been conducted to further investigate the impact of source, sink and long-range transport of atmospheric CO_2.

INTRODUCTION
CO_2 is a significant greenhouse gas. At present, the fraction of anthropogenically emitted CO_2 remaining in the atmosphere has been relatively steady at 50-55% of the fossil fuel CO_2 emission. Continuous measurements of atmospheric CO_2 mixing ratio at a specific site can provide great detail for the study of CO_2 variability and on its sources and sinks. WLG, located at the remote area of western China, is one of the 23 baseline stations in the WMO-GAW network. Funded by the United Nations and the Chinese Government, the WLG was officially opened in 1994 and is situated in an important geographical region providing important information from the Eurasia continent.

SITE AND EXPERIMENT
WLG is a remote site away from major anthropogenic sources. The general area is covered in sparse vegetation. The immediate surroundings are grassy with no tree growth. The meteorological data indicate a typical continental plateau climate. It is relatively windy and dry with a yearly precipitation of 300mm. Predominant wind directions have a significant seasonal change, from WSW in winter (D, J, F) to ESE-ENE in summer (J, J, A). Atmospheric CO_2 mixing ratio was measured using a Licor6251 NDIR analyzer. The system began in 1994 with an ambient analysis frequency of one per minute, and an estimated overall precisions below 0.02% (～365ppm standard gas repeatedly injection).

Lagrangian isobaric back trajectories were calculated back for 5 days for air parcels reaching WLG every 6 hours (00, 06, 12, 18 UTC) at endpoint heights corresponding to 600mb levels. The 600mb trajectories constituted the main data set used in this study because they were considered to be the most representative of the air being sampled at WLG at a sampling height (3816+80) m. Influence of air mass long-range transport to the CO_2 variation at WLG was discussed using trajectory cluster-CO_2 concentration analysis. Hysplit-4 transport/diffusion model simulation for the January 1999 was calculated, to estimate natural and anthropogenic sources/sinks contributed by local and surrounding areas to the CO_2 short-term variations at WLG in winter. A case study for the polluted air mass transport event with short-term elevated CO_2 mixing ratios in winter time, were performed to further investigate the impact of source, sink and long-range transport of atmospheric CO_2.

RESULTS ANG DISCUSSION
CO_2 trajectory cluster concentrations at WLG showed close correlation to the source/sink conditions of air parcel origination and transport route. Air mass from NE-ENE-E (inhabited areas with enhanced vegetation) in all seasons appends N direction (more vegetation) in summer caused considerable short-term variation in the WLG CO_2 records.

Hysplit-4 model simulation suggests quantitative contribution of natural and anthropogenic sources/sinks by local and surrounding areas to the CO_2 short-term variations at WLG in winter. Fig. 1 shows observed and simulated atmospheric CO_2 mixing ratio at WLG for January 1999. Fig. 2 shows 5-day back trajectory route arriving at WLG for 7 and 9 January 1999. The case study suggested CO_2 short-term elevation on 9 January is mainly attributed to the prevailing surface wind and the long-rang transport from source areas of east, northeast or northwest areas carrying contaminative air parcels.

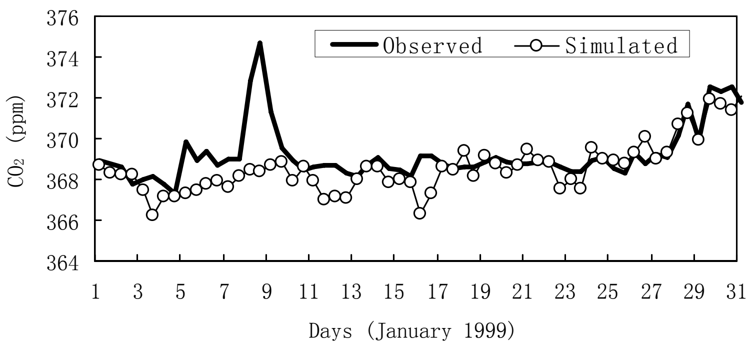

Fig. 1. Observed and simulated atmospheric CO_2 mixing ratio at WLG for January 1999

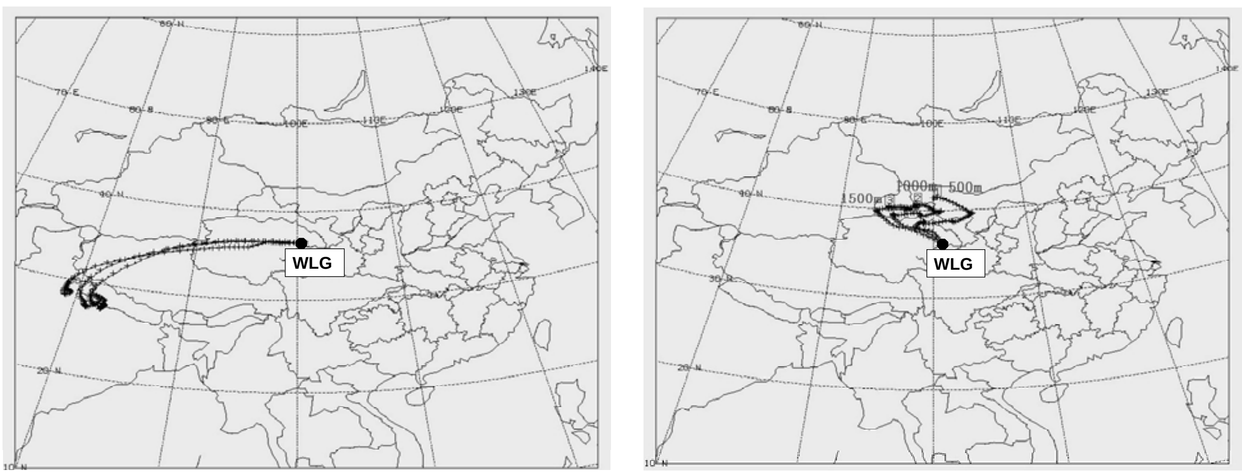

Fig. 2. 5-day back trajectory route arriving at WLG (Left 7 January 1999, right 9 January 1999)

By combination of prevailing surface wind and long-range transport in different seasons, impact of anthropogenic sources of Mainland China contributed much more in summer than in winter to the CO_2 short-term variations at WLG, contrarily by surrounding countries. In the simulated region, with prevailing surface wind/long-range transport westerly in winter, sources by countries outside western border of China counted up to 30% of the total contribution, sources by Chinese Provinces Qinghai, Sichuan, Chongqin and Gansu afforded 70% of contribution by mainland China. With prevailing surface winds/long-range transport from east/northeastern areas in summer, sources by Mainland China provided more than 90% of the total contribution, therein, 70% from Qinghai and Gansu Province.

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