Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AAS021-P07 Room:Convention Hall Time:May 23 16:15-18:45

Comparison of 2 versions of a global atmospheric transport model (NIES99 TM and NIES08 TM) using APO observations

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We show comparisons of two versions of an atmospheric global transport model, NIES99 and NIES08, and observations using Atmospheric Potential Oxygen (APO = O_2 + 1.1 CO_2). APO is defined so that it is invariable with the terrestrial biotic exchanges and it is not as sensitive to fossil fuel burning activities as CO_2 or O_2 is. Thus, the main variation is caused by air-sea exchanges of O_2. Therefore, APO has a unique flux distribution and is able to provide a good test to the transport models from different perspectives.

National Institute for Environmental Studies (NIES) has been making observations of CO_2 and O_2 on cargo ships which have been repeating round-trip cruises between Japan and Canada/the United States and between Japan and Australia/New Zealand since December 2001. With this valuable data set, we compare the observations and model results including annual mean distributions and seasonal amplitudes.

For the NIES99 TM and NIES08 TM, the same flux set was used to make transport difference clearly. We used oceanic fluxes of O_2, N_2 and CO_2 , and fossil fuel burning anthropogenic fluxes of CO_2 and O_2. As for the oceanic O_2 and N_2 fluxes, climatological monthly anomalies of Garcia and Keeling [2001] and annual mean oceanic O_2 and N_2 fluxes from the annual-mean ocean inversion studies of Gruber et al. [2001] and Gloor et al. [2001], respectively, are used. As for the oceanic CO_2 fluxes, we use two sets of monthly sea surface CO_2 flux climatology of Takahashi et al. [2002] and Takahashi et al. [2009]. For the anthropogenic CO_2 flux, global fossil fuel CO_2 emission with spatial resolution of 1 deg. x 1 deg. for the year 2006 from CDIAC database is repeatedly used every year in this simulation. The O_2 consumptions associated with the fossil fuel burning is calculated from the fossil fuel CO_2 fluxes and the -O_2:C exchange ratios for the burnings.

In general, NIES99 TM reproduces the seasonal amplitudes, the annual mean values and rectifier effect at northern North Pacific better than NIES08 TM does. NIES08 TM represents APO in the Southern Hemisphere more smoothly because of more balanced tracer transport due to strong mass conservation. We will show the comparisons more in details in this presentation.

Keywords: atmospheric O2, atmospheric potential oxygen (APO), seasonal cycle, global atmospheric transport model