Geophysical Research Abstracts, Vol. 9, 04670, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-04670

Seasonal CO_2 rectifier effect and the large-scale extratropical atmospheric transport

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The annual mean CO_2 distribution typically shows a north-south gradient with higher CO_2 concentration near the North Pole and gradually decreasing to zero near the equator. This mean annual CO_2 distribution is generally referred to as the rectifier effect (Denning). The physical mechanism of the rectifier effect is generally attributed to the covariance of the biospheric fluxes and the vertical variation of the planetary boundary layer (PBL). Thus, photosynthetic signal in the summer must pass through a deeper summertime PBL while respiration signal in the winter must pass through a shallow winterime PBL. However, there may be other physical mechanisms involved in forming the annual north-south distribution of CO_2. In this study, we use an atmospheric transport model to study the effect of large-scale horizontal transport has on the zonal distribution of annual mean CO_2. We find that the horizontal transport contributes about 70% to the seasonal rectifier effect, while the remaining 30% is attributable to variation in the PBL depth.