

Oral Presentation

Theme 1.1: The Contemporary Carbon Cycle - Trends, Variability and Time of Emergence of Human Impacts
 Keywords: atmosphere, CO₂, CO₂ isotopes, westerly duct

Intermittent behaviour in the seasonal inter-hemispheric exchange of 12CO₂ and 13CO₂

Francey, Roger James (1); Frederiksen, Jorgen (1); Loh, Zoe* (1); Trudinger, Cathy (1); Allison, Colin (1); Krummel, Paul (1); Langenfelds, Ray (1); Law, Rachel (1); Haverd, Vanessa (2)

1: CSIRO, Oceans and Atmosphere, Aspendale, Australia; 2: CSIRO, Oceans and Atmosphere, Yarralumla, Australia

Recent changes in the annual average CO₂ inter-hemispheric difference frequently coincide with decreased winds in the westerly duct[1], a region above ~6 km over the equatorial Pacific. This is caused by winds impinging the Himalayas that episodically penetrate equatorial tropical convection. The coincidence of an 'open duct' (with associated increased turbulent kinetic energy) and near-maximum interhemispheric CO₂ difference in the boreal winter expedites CO₂ exchange[2]. Intermittently through previous decades, the westerly winds have been abnormally low or missing during the boreal winter. These occasions coincide with anomalies in CO₂ measured in baseline conditions at Mauna Loa and Cape Grim and the interhemispheric difference using 25-year CSIRO GASLAB data (with the extreme cases visible throughout most of the iconic Keeling 5-decade Mauna Loa-South Pole CO₂ records[3]). When the duct is open, the strength of westerly winds exhibits an anti-correlation with the Pacific Decadal Oscillation that is reflected in Mauna Loa CO₂ seasonality. Isotopic signals in the interhemispheric difference and seasonal behaviour imply that a significant terrestrial contribution to the Southern Hemisphere CO₂ seasonality is Northern Hemisphere CO₂ transferred rapidly in brief periods around February each year. Atmospheric CO₂ inversions without the duct do not allow for this this CO₂ exchange process, instead generally attributing spatial changes to terrestrial source/sinks.

[1] Webster, P. J., and Holton, J. R. Cross-equatorial response to mid-latitude forcing in a zonally varying basic state. *J. Atmos. Sci.* **39**, 722-733 (1982) [2] Francey, R. J. and Frederiksen, J. S. The 2009–2010 step in atmospheric CO₂ interhemispheric difference. *Biogeosciences* **13**, 873- 885 (2016) [3] Keeling, R. F., Piper, S. C., Bollenbacher, A. F., and Walker, J. S. Atmospheric CO₂ records from sites in the SIO air sampling network. In *Trends: A Compendium of Data on Global Change*. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., USA (2009)

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