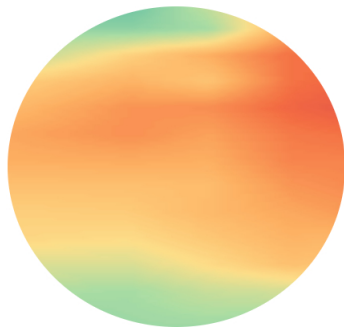
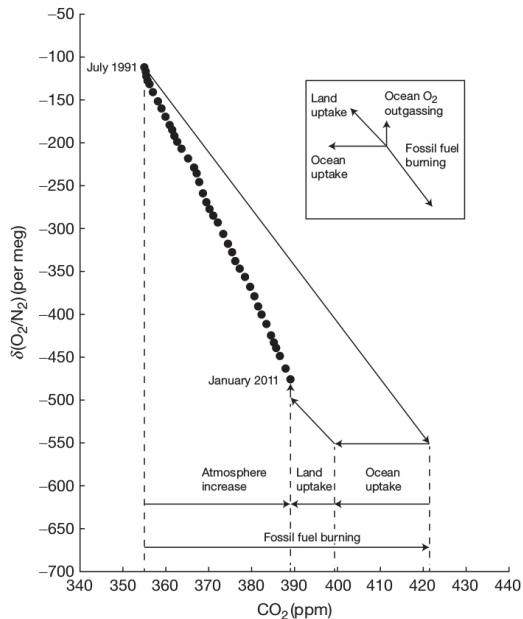


Atmospheric Gradients of O₂ and CO₂ During ORCAS



O₂ and CO₂



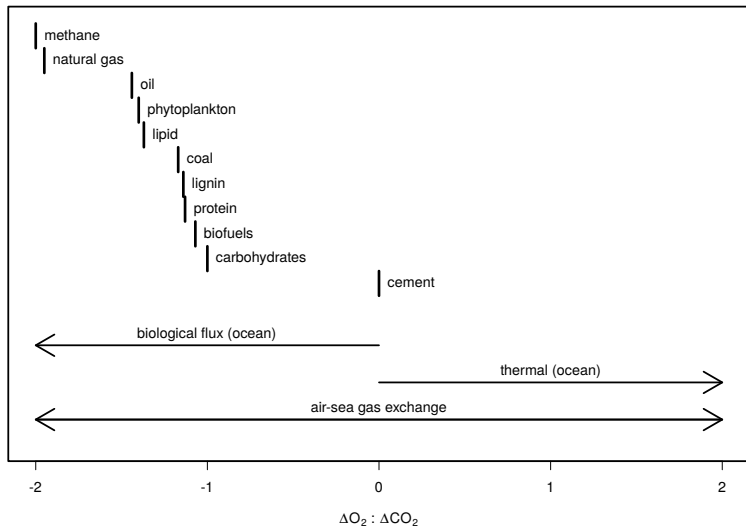
- Variations of atmospheric O₂ and CO₂ are coupled on global to local scales
- Atmospheric observations of both species yield top-down constraints on surface fluxes

$$\Delta O_2 : \Delta CO_2$$

- Oxidative Ratio (OR): moles of O_2 produced or consumed divided by the moles of CO_2 produced or consumed during respiration, photosynthesis, or combustion
- α_B : the global apparent terrestrial OR, or the net land biospheric O_2 flux divided by the net land biospheric CO_2 flux
- Photosynthetic Quotient (PQ): ratio of O_2 production to CO_2 consumption/organic carbon production during photosynthesis
- Molar Exchange Ratio (MER): ratio of the flux densities of O_2 and CO_2
- Concentration Gradient Ratio (CGR): ratio of the concentration gradient between a region impacted by flux and background

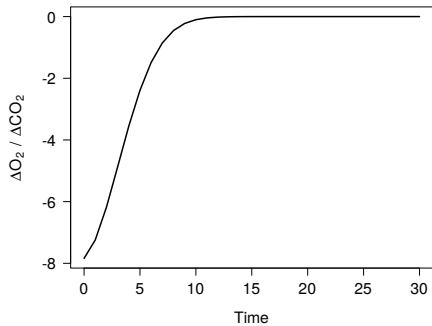
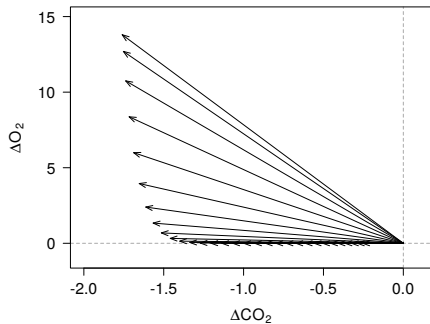
All expressed on a molar basis (e.g., mol mol⁻¹ or ppm eq. ppm⁻¹)

Definitions and Caveats



From/after: Keeling, 1988; Masiello, et. al., 2008; Randerson, et al., 2006; Steinbach, et al., 2011

Definitions and Caveats



Observed $\Delta O_2 / \Delta CO_2$ vary with time due to differences in equilibration times.

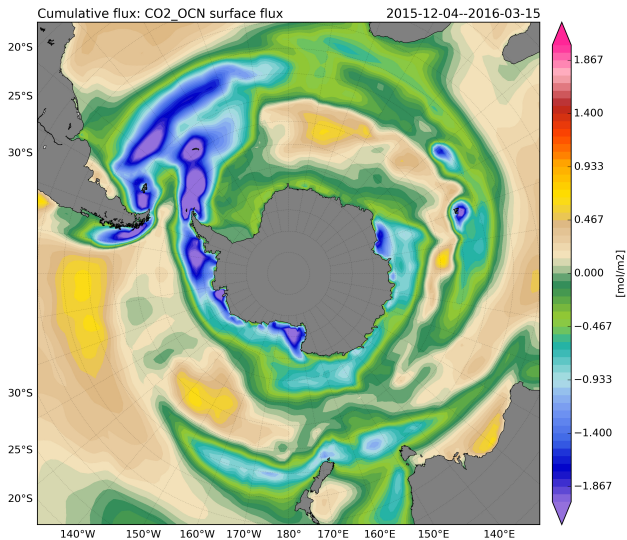


Figure courtesy of Matt Long (NCAR)

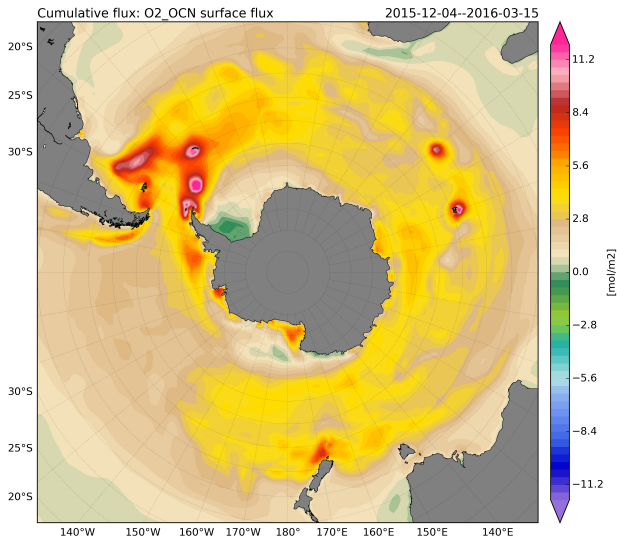


Figure courtesy of Matt Long (NCAR)

Cumulative Molar Exchange Ratios of O₂:CO₂ in the Southern Ocean

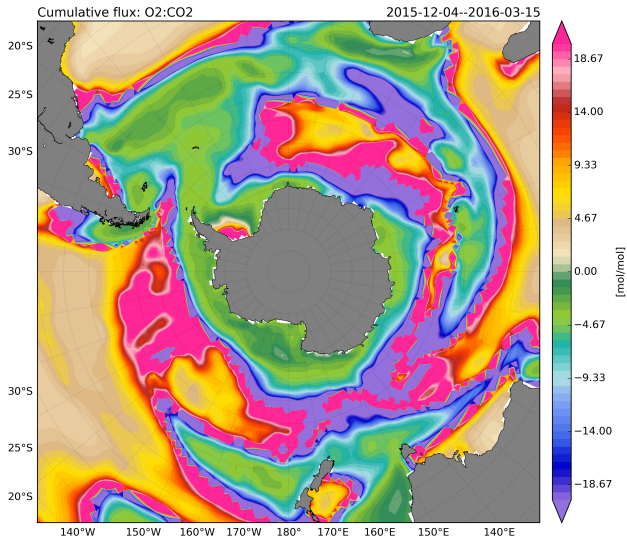
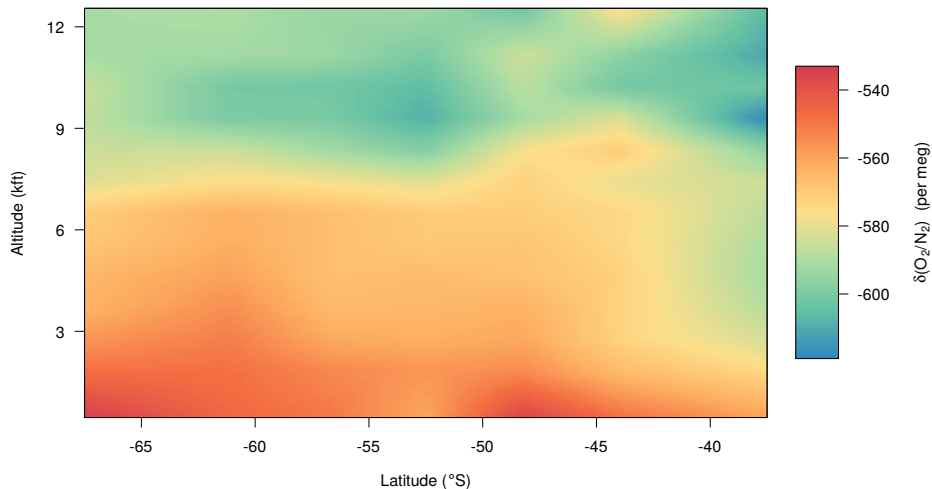


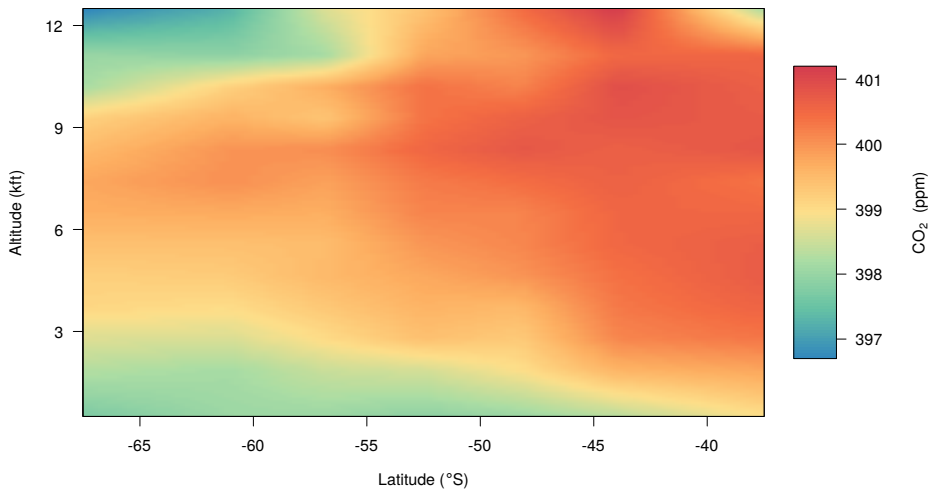
Figure courtesy of Matt Long (NCAR)

The $\delta(\text{O}_2/\text{N}_2)$ Curtain Average



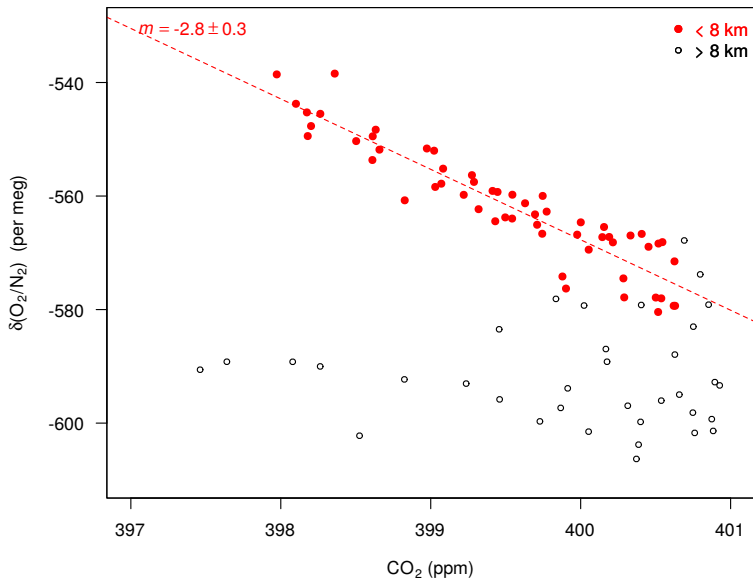
Throughout the campaign, large-scale enhancement of oxygen was seen in the lower troposphere.

The CO₂ Curtain Average

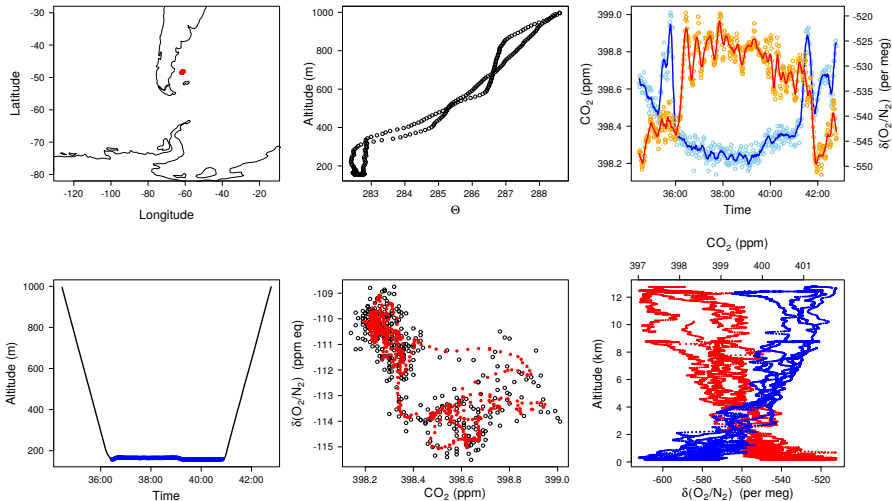


Conversely, large-scale drawdown of CO₂ is seen in the lower troposphere.

Mid-Troposphere-Surface Gradients

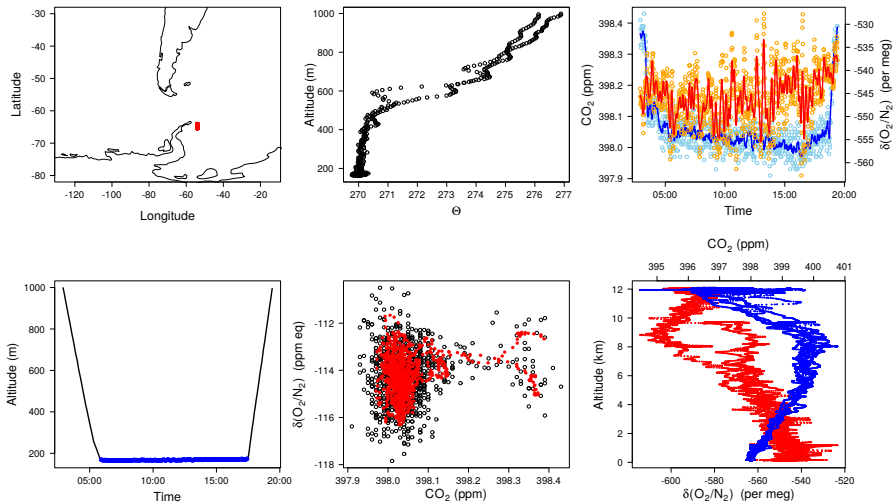


Example Dip (RF07)



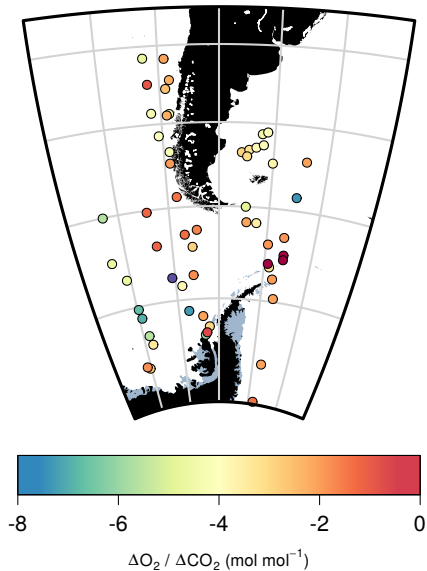
$$\Delta\text{O}_2 : \Delta\text{CO}_2 = -3.3 \pm 0.1$$

Example Dip (RF11)

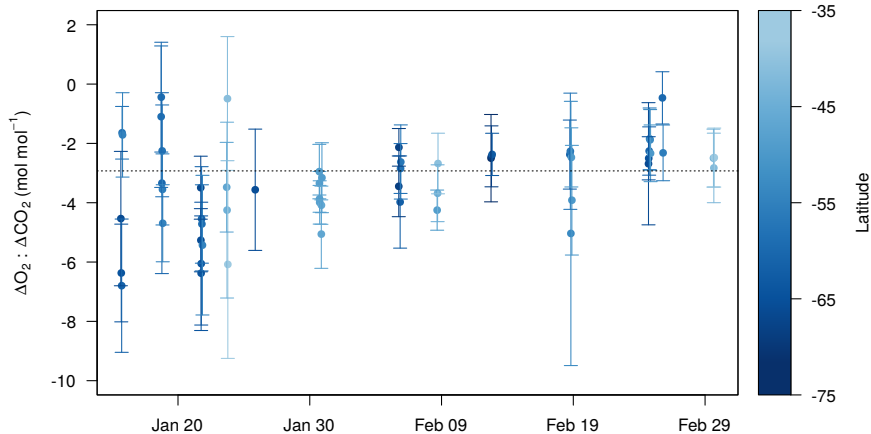


$$\Delta\text{O}_2 : \Delta\text{CO}_2 = -2.4 \pm 0.3$$

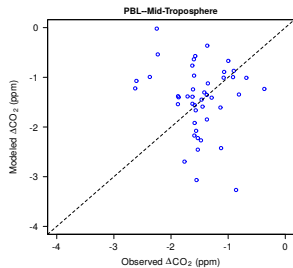
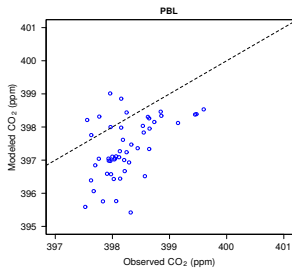
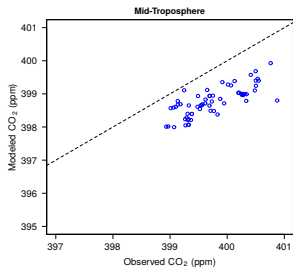
Mid-Troposphere–Surface Gradients (Ratios)



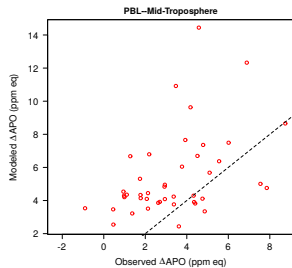
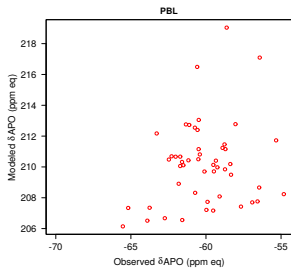
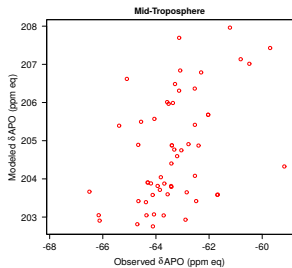
Mid-Troposphere–Surface Gradients (Ratios)



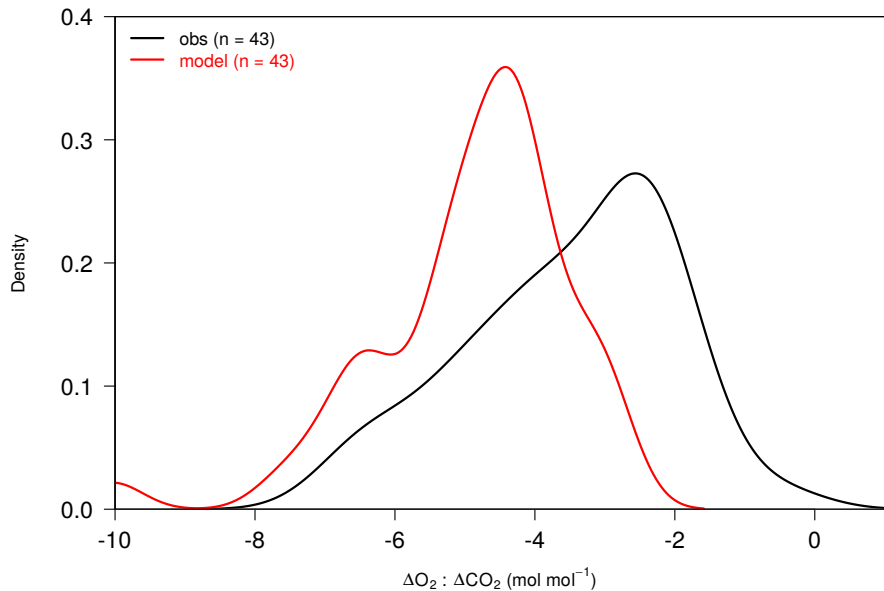
Mid-Troposphere–Surface Gradients (CO_2)



Mid-Troposphere–Surface Gradients (APO)



Mid-Troposphere–Surface Gradients (Ratios)



- Refine data selection
- Tropospheric–surface gradient without ocean fluxes
- Concentration gradients of other tracers
- Footprints/BTs
- M_θ