Variation of CO_2 Mole Fraction in the Lower Free Troposphere, in the Boundary Layer and at the Surface

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Eight years of occasional flask air sampling and 3 years of frequent *in situ* measurements of carbon dioxide (CO_2) vertical profiles on board of a small aircraft, over a tall tower greenhouse gases monitoring site in Hungary, are used for the analysis of the variations of vertical profile of CO_2 mole fraction. Using the airborne vertical profiles and the measurements along the 115 m tall tower it is shown that the measurements at the top of the tower estimate the mean boundary layer CO_2 mole fraction during the mid-afternoon fairly well, with an underestimation of 0.27 - 0.85 µmol mol^{-1} in summer, and an overestimation of 0.66 - 1.83 µmol mol^{-1} in winter. The seasonal cycle of CO_2 mole fraction is damped with elevation. While the amplitude of the seasonal cycle is 28.5 µmol mol^{-1} at 10 m above the ground, it is only 10.7 µmol mol^{-1} in the layer of 2500 - 3000 m corresponding to the lower free atmosphere above the well-mixed boundary layer. The maximum mole fraction in the layer of 2500 - 3000 m can be observed around 25 March on average, two weeks ahead of that of the marine boundary layer reference (GLOBALVIEW). By contrast, close to the ground, the maximum CO_2 mole fraction is observed late December, early January. The specific seasonal behavior is attributed to the climatology of vertical mixing of the atmosphere in the Carpathian Basin.

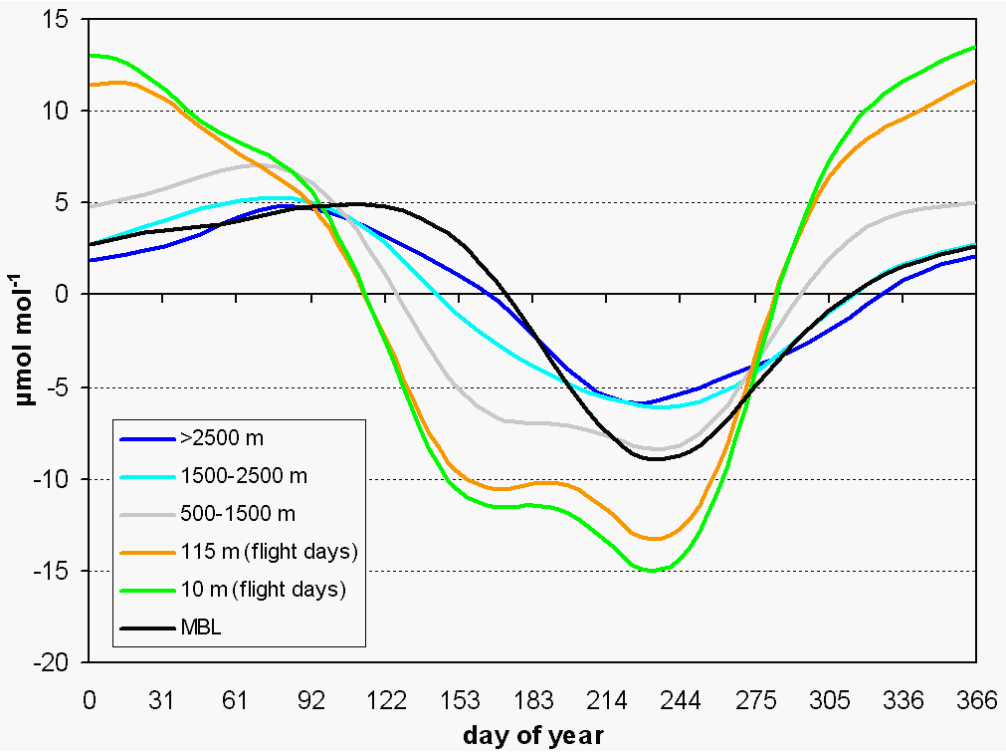

Figure 1. Mean seasonal cycle of atmospheric carbon dioxide mole fraction (relative to the corresponding annual average) at different elevations above the ground (aircraft and tower) and in the modeled marine boundary layer (MBL – GLOBALVIEW-CO_2).