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Seven years of recent European net terrestrial carbon dioxide exchange constrained by atmospheric observations

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Abstract

We present an estimate of net ecosystem exchange (NEE) of CO_2 in Europe for the years 2001–2007. It is derived with a data assimilation that uses a large set of atmospheric CO_2 mole fraction observations ($\sim$ 70 000) to guide relatively simple descriptions of terrestrial and oceanic net exchange, while fossil fuel and fire emissions are prescribed. Weekly terrestrial sources and sinks are optimized (i.e., a flux inversion) for a set of 18 large ecosystems across Europe in which prescribed climate, weather, and surface characteristics introduce finer scale gradients. We find that the terrestrial biosphere in Europe absorbed a net average of $-165\,\mathrm{Tg\,C\,yr^{-1}}$ over the period considered. This uptake is predominantly in non-EU countries, and is found in the northern coniferous ($-94\,\mathrm{Tg\,C\,yr^{-1}}$) and mixed forests ($-30\,\mathrm{Tg\,C\,yr^{-1}}$) as well as the forest/field complexes of eastern Europe ($-85\,\mathrm{Tg\,C\,yr^{-1}}$). An optimistic uncertainty estimate derived using three biosphere models suggests the uptake to be in a range of -122 to $-258\,\mathrm{Tg\,C\,yr^{-1}}$, while a more conservative estimate derived from the a-posteriori covariance estimates is $-165 \pm 437\,\mathrm{Tg\,C\,yr^{-1}}$. Note, however, that uncertainties are hard to estimate given the nature of the system and are likely to be significantly larger than this. Interannual variability in NEE includes a reduction in uptake due to the 2003 drought followed by 3 years

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of more than average uptake. The largest anomaly of NEE occurred in 2005 concurrent with increased seasonal cycles of observed CO_2. We speculate these changes to result from the strong negative phase of the North Atlantic Oscillation in 2005 that lead to favorable summer growth conditions, and altered horizontal and vertical mixing in the atmosphere. All our results are available through http://www.carbontracker.eu

Keywords: atmospheric CO_2, carbon exchange, data assimilation

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