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On the detection of long-term trends in carbon flux estimates using network observations and inverse modeling

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Estimates of CO_2 sources and sinks obtained with atmospheric inverse techniques at continental and ocean basin scales suggest considerable inter-annual variability in carbon fluxes, especially for the terrestrial biosphere. The inversions also imply small but interesting long-term trends for some regions such as the Southern Ocean, where inversions suggest that an additional uptake of about 0.5 GtC has occurred over the past two decades. This trend is not statistically significant in light of estimated flux uncertainties that are determined by the assumed prior flux uncertainties and the model-data mismatch errors. An additional complication in determining long-term trends from network observations and inverse models is that the density of sample locations has changed over time, often resulting in large re-allocation of fluxes between source regions. The aim of this study is firstly to examine how long-term features present in the network observations lead to trends in estimated fluxes and to what extent observed information about long-term changes is degraded by the inverse modeling process. Secondly, the issue of what it would take to determine long-term trends in estimated carbon fluxes is evaluated. Not surprisingly, higher sampling densities, as well as longer records and reduced uncertainties in transport are required to detect trends of the magnitude currently indicated by observations.