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Potential of in-service aircraft based greenhouse gas observations within IAGOS for constraining regional carbon budgets.

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The spatial and temporal variations of atmospheric CO_2 contain information about carbon sources and sinks and the characteristics of the CO_2 exchange processes between the atmosphere and the surface of the earth. Within the recently established European Research Infrastructure IAGOS (In-service Aircraft for a Global Observing System), highly accurate and precise in-situ observation of greenhouse gases is foreseen in the near future. The objective of this study is to quantify the reduction in uncertainty in estimates of carbon sources, sinks, and exchange processes brought about by the use of this newly developed data stream. Anticipating the deployment of five GHG observing systems within IAGOS, the flight tracks from five in-service aircraft within MOZAIC (Measurement of OZone and water vapour by AIrbus in-service airCraft), a predecessor of IAGOS, are used in an inversion system to assess the constraint on the carbon budget and quantify the potential for reduction in posterior CO_2 flux uncertainties. These measurement locations are used to evaluate the impact of data from aircraft on the reduction of flux uncertainties compared to that based on the existing global observation network, and furthermore to identify areas where the addition of these measurements would be of greatest impact. We use the Jena Inversion System that employs the Global Atmospheric Tracer Model TM3 for atmospheric transport, focussing on the period 1996-2004. The vertical aircraft profiles are input into the inversion as two partial-column averages instead of point measurements, the lower partial column completely containing (and exceeding) the boundary layer. Thus the error due to imperfect model representation of the boundary layer height and hence the vertical tracer transport near the surface can be diminished, and results in the reduction of the overall model-data mismatch error. The experimental design is such that in each simulation the existing measurement network is augmented by pseudo-observations from up to five simulated IAGOS aircraft. Uncertainty reduction from each of these simulations is compared to the uncertainty reduction from simulations employing only IAGOS or only the existing observation network. Additional constraint on regional carbon budgets is expected from the reduced model-data mismatch error when using vertical profiles as compared to using point measurements within the atmospheric boundary layer only.