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# A possible strategy to quantify sources of greenhouse gases over large regions.

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Inverse models use observations of the atmospheric mole fraction of trace gases, together with additional information, to infer patterns of sources (with either positive or negative sign) that are consistent with the observations. In order to establish a link between observations and sources, or source processes, a necessary component of the inverse models is that they simulate atmospheric transport and mixing processes while conserving mass. A majority of the observations take place at the surface, and increasingly at higher elevations in the atmosphere. Considerable uncertainty exists about the sources as well as about atmospheric mixing processes. Therefore, it is difficult to establish whether errors in one are not being translated into errors in the other. For example, an under-estimate of the mixing of air between the Planetary Boundary Layer (PBL) and the Free Troposphere (FT) would lead directly to an under-estimate of regional sources when only measurements in the PBL are available. The availability of frequent vertical profiles alleviates this problem, but still leaves uncertainties about transport in the FT. It is proposed that a vigorous program of frequent vertical profiles of high-precision 14CO2 measurements is likely to solve this problem. The emissions of CO2 from the burning of fossil fuels are more accurately known than from any other source, although the detailed emission patterns still need improvement. They are uniquely characterized by their zero 14C content. Observations of the patterns of the 14CO2 decrease can therefore help to pin down many crucial aspects of the transport models. Furthermore, a whole host of other trace gases can be linked to fossil CO2,

bringing additional diagnostics, as well as opportunities for improved simulations of atmospheric chemistry.