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A new method to investigate regional scale carbon budgets from satellite measured carbon dioxide.

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The existing generation of satellite instruments (such as SCIAMACHY and AIRS) have allowed the retrieval of atmospheric mixing ratios of carbon dioxide. This data can be used to investigate carbon fluxes between the surface and the atmosphere. This information can compliment existing flux information from the high precision but low density network of surface and tower measurements, and could improve carbon cycle understanding in remote regions not covered by this network. This understanding will be further improved by the OCO and GOSAT missions, which are expected to be launched early in 2009.

A method has been developed to investigate regional scale carbon budgets, based on the UK met office Lagrangian trajectory model NAME (Numerical Atmospheric-dispersion Modelling Environment). The model provides information about where an air mass that has been sampled by the satellite instrument has come from. This provides both residence time information over various parts of the land surface, as well as information about where the air mass originated from.

The method can be used in forward mode, where we can use flux information from another source, for example carbon tracker data, and combine this with a background CO_2 mixing ratio to obtain an atmospheric concentration at the same place as the satellite measurement, allowing a comparison between the two.

Producing the background value (the initialisation) is the most challenging part of the method. Ideally, the background mixing ratio would also be obtained from the satellite instrument, from measurements over areas of negligible surface fluxes (background measurements over ocean, when investigating the land surface exchanges is not unreasonable).

The NAME model can provide information on where and when to take the background measurement. The air mass, from which the foreground measurement is made, is likely to have dispersed by the time the background measurement is made, which adds to this challenge.

The model can also be run in inverse mode, where the change in carbon mass between the foreground and background measurements, can be combined with the residence times from the NAME model. With the assumption that the region is made up of homogeneous flux ecoregions (sub-regions that are believed to have very similar flux behaviour, because they have similar weather), flux values can be assigned to the ecoregions which provide the best match with the observed mass exchange between foreground and background satellite measurements.

As a test case, we have demonstrated the method using the FSI-WFM-DOAS (University of Leicester) algorithm retrievals from SCIAMACHY over the North American region. This will provide the best place to compare our method with the wealth of other CO_2 mixing ratios and fluxes from top-down (Carbon Tracker) and bottom-up (Ameriflux) networks.