GLOBAL MONTHLY CO_2 FLUX INVERSION WITH REGULARIZATION USING REMOTE SENSING-BASED SURFACE FLUX FIELDS

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ABSTRACT
An inverse modeling system has been developed based on the Bayesian principle for estimating the carbon fluxes of the 48 regions globally and 28 regions over North America in monthly steps for 2003 using CO_2 concentration measurements at 95 atmospheric baseline stations and with regularization using remote sensing-based surface flux field. Preliminary inversion results of global carbon flux and a carbon flux field over North America have been obtained.

INTRODUCTION
Various inverse modeling techniques (Enting, 2002) are currently available for estimating regional carbon fluxes using atmospheric CO_2 concentration observations. However, the number of currently available observation stations is still sparse relative to the size of the global surface, and this essentially limits the number of regions that can be reliably inverted globally without using additional information as constraints to the inversion. In this study, we attempt to develop a technique to use remote sensing-based surface flux estimates as constraints to monthly global inversion. A nested framework of 48 regions of the globe with a relatively fine variable grid of 28 regions (Fig. 1) over North America is formulated for the inversion for one year in 2003.

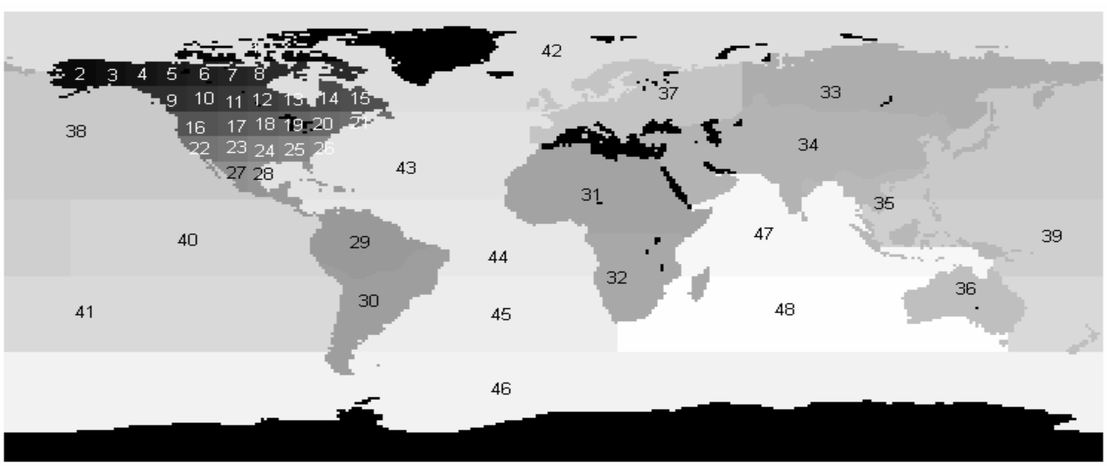

Fig. 1. 48 regions with nested 28 regions over North America for inverse modeling

TRANSPORT MODELING
Two sets of transport matrixes, describing the response of each station to fluxes from each region at monthly time steps, have been produced using the NIES model (Maksyutov, 2000), a global atmospheric transport model developed by the National Institute of Environmental Studies in Japan, with horizontal resolution of 2.5 by 2.5 degree and 15 sigma vertical level, separately coupled with Biome-BGC and the Boreal Ecosystem Productivity Simulator (BEPS) (Liu et al, 1999), BEPS estimates carbon fluxes using

remote sensing inputs of land cover and leaf area index in addition to other spatial datasets. Three years of forward transport modeling based on NCEP wind field has been done.

INVERSION METHOD

A Bayesian synthesis inversion technique with a Tikhonov regularization parameter (Hansen, 1998) is used to estimate monthly net CO_2 fluxes from these 48 regions with a regularization of surface fluxes of these regions modeled by BEPS. A CO_2 concentration error matrix is similar to that used by TRANSCOM (Gurney et al, 2000, 2002), but we use an *a priori* flux covariance matrix with each element as a function of regional area and the *a priori* flux.

INVERSION RESULTS

A series of inversion results have been obtained for each month of 2003. The posterior carbon flux with model-uncertainty for 48 regions of January and July are selected to show in Figs. 2(a) and 2(b), respectively. The chi-square test showed that the inversion results are statistically reliable, but much more work is still needed to ensure the spatial and temporal patterns of carbon fluxes are correctly inverted. .

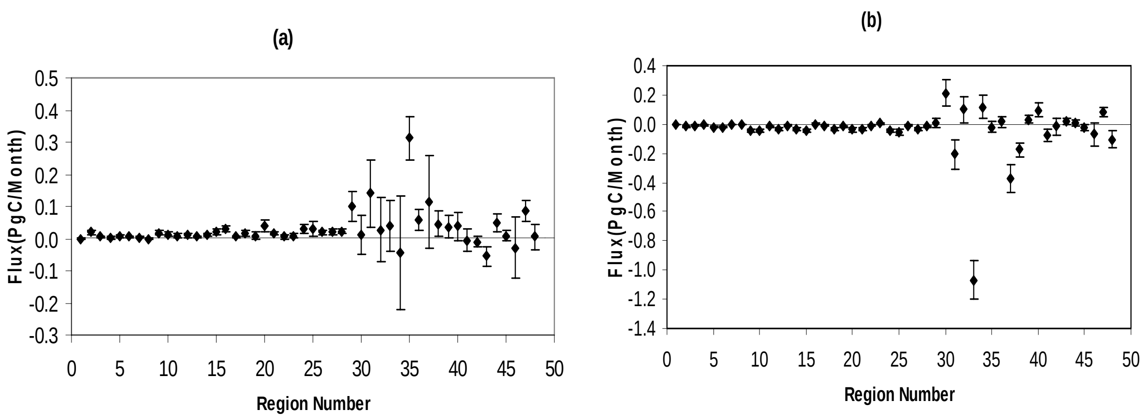

Fig. 2. Posterior carbon fluxes with uncertainty for 48 regions in January (a) and July (b) 2003

ON-GOING WORK

With the two sets of transport response matrixes, one produced with and one without using remote sensing information, we will explore the information content of surface remote sensing variables for inverse modeling. By comparing the inverse results based on different ecosystem models, we will also find clues to mechanisms of terrestrial ecosystem functioning and allow us to optimize ecosystem models.

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