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Preliminary analysis of the development of the Carbon Tracker system in Latin America and the Caribbean

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RESUMEN

El sistema rastreador de carbono desempeñará un papel importante para mejorar la comprensión sobre las fuentes y sumideros de CO_2, el intercambio de gases entre la atmósfera y el océano, y las emisiones de gases provenientes de incendios forestales y combustibles fósiles en América Latina y el Caribe. El objetivo del presente estudio es analizar las tendencias de los flujos de carbono en la biosfera y el océano, así como las emisiones procedentes de incendios forestales y el uso de combustibles fósiles en dicha región, mediante el sistema rastreador de carbono. De 2000 a 2009 el flujo promedio de carbono para la biosfera, el uso de combustibles fósiles, los incendios y el océano en América Latina y el Caribe fue de –0.03, 0.41, 0.296 y –0.061 Pg C/yr, respectivamente, y en México fue de –0.02, 0.117, 0.013 y –0.003 Pg C/yr, respectivamente. El promedio del flujo neto de carbono en América Latina y el Caribe, por un lado, y México, por el otro, fue de 0.645 y 0.126 Pg C/yr, respectivamente. En América Latina y el Caribe, los sumideros terrestres de carbono se encuentran principalmente en las regiones boscosas y agrícolas, así como en los pastizales, zonas de arbustos y en la cordillera de los Andes. Los flujos netos entre la superficie y la atmósfera que incluyen al combustible fósil son predominantes en los alrededores de las grandes ciudades de México, Brasil y Chile, al igual que en las zonas de deforestación en el río Amazonas. Se ha comprobado que los incendios forestales son una importante fuente de CO_2 en América Latina y el Caribe. Por otra parte, podemos confirmar que la política de fomento al uso de etanol en vehículos livianos en Brasil ha contribuido a disminuir las emisiones de carbono generadas a partir de combustible fósiles, y suponer el efecto del programa Proárbol en México como resultado de la absorción de carbono proveniente de la biosfera y de incendios forestales. Este estudio confirma que el sistema rastreador de carbono puede cumplir un papel importante en Latinoamérica y el Caribe como herramienta científica para comprender mejor los procesos de absorción y liberación de carbono derivados de los ecosistemas terrestres, del uso de combustibles fósiles y del océano, además de permitir una vigilancia a largo plazo de las concentraciones de CO_2 en la atmósfera.

ABSTRACT

The Carbon Tracker system will play a major role in understanding CO_2 sinks and sources, gas exchange between the atmosphere and oceans, and gas emissions from forest fires and fossil fuels in Latin America and the Caribbean. This paper discusses the trends in carbon fluxes in the biosphere and ocean, as well as emissions from forest fires and fossil fuel use in the above-mentioned region, using the Carbon Tracker (CT) system. From 2000 to 2009, the mean carbon fluxes for the biosphere, fossil fuel use, wildfires and the ocean in Latin America and the Caribbean were –0.03, 0.41, 0.296, –0.061 Pg C/yr, respectively, and –0.02, 0.117, 0.013, –0.003 Pg C/yr, respectively, in Mexico. The mean net carbon flux for Latin America and the Caribbean was 0.645 Pg C/yr, and 0.126 Pg C/yr for Mexico. The terrestrial sinks in Latin America and the Caribbean are dominated by the forest, agricultural, grass and shrub regions, as well as the Andes mountain range and the net surface-atmosphere fluxes including fossil fuel are dominant in regions around large cities in Mexico, Brazil, Chile, and areas undergoing deforestation along the Amazon River. The results confirm that forest fires are an important source of CO_2 in Latin America and the Caribbean. In addition, we can confirm that policies encouraging the use of ethanol in light vehicles in Brazil have helped to decrease carbon emissions from fossil fuel, and assume the effects of the Proárbol program on carbon sinks from the biosphere and from fire emissions sources in Mexico. Based on this analysis, we are confident that the CT system will play a major role in Latin America and the Caribbean as a scientific tool to understand the uptake and release of CO_2 from terrestrial ecosystems, fossil fuel use and the oceans, and for long-term monitoring of atmospheric CO_2 concentrations.

Keywords: Carbon Tracker system, CO_2 sinks and sources, Latin America and the Caribbean, biosphere, fossil fuel, forest fires.

1. Introduction

Atmospheric measurements show that the global average of atmospheric carbon dioxide (CO_2) concentration is currently above 398 parts per million (ppm) and rising. Gaining a more accurate understanding of the CO_2 fluxes involved in the global carbon cycle will require a greenhouse gas monitoring system with adequate accuracy and precision to objectively quantify progress in reducing CO_2 emissions. The current sparse network of observation sites across North America and elsewhere is suitable for calculating annual continental fluxes of CO_2; but evaluating the success of mitigation measures requires fluxes to be resolved within much smaller regions. Current ground-based measurement technologies can provide the required precision, but the number of measurements is still insufficient. A powerful way to use these data is through a data assimilation system, which can utilize diverse types of data to develop a unified description of the modeled physical/biogeochemical system, consistent with the observations. The current grid scale for assimilation systems –such as the Carbon Tracker, the first data assimilation system to provide CO_2 flux estimates– is limited to a resolution of about 100 km or larger, primarily due to computer resource limitations (Marquis and Tans, 2008).

Knowledge of current carbon sources and sinks, their spatial distribution, and their variability in time is essential for predicting future atmospheric CO_2 concentrations, and therefore the anthropogenic perturbation of radiative forcing by CO_2 (Denman *et al.*, 2007; Hougton, 2007). To that end, we analyze a unique vertical profile sampling strategy using the Carbon Tracker (CT) 2011 system, which was implemented by the National Oceanic and Atmospheric Administration/Earth System Research Laboratory (NOAA/ESRL) to extract signatures of the exchange of CO_2 and trace gases at continental scales and their associated variability (Crevoisier *et al.*, 2010).

As a scientific tool, together with long-term monitoring of atmospheric CO_2 concentrations CT will help to improve our understanding of how carbon uptake and release from terrestrial and ocean ecosystems is responding to a changing climate, increasing atmospheric CO_2 and other environmental changes, including management strategies. CT will play a major role as a tool for monitoring, diagnosing, and possibly predicting the behavior of the global carbon cycle and the climate system. It can also monitor annual carbon fluxes at regional and global scales, even though its accuracy is lower than other methods, as shown in Table I (Hiroshi *et al.*, 2013).

CT can also become a policy support tool, since it can accurately quantify natural and anthropogenic CO_2 emissions and uptake at regional scales, which are currently limited by sparse observational networks. With adequate observations, CT can be used to track regional emissions over long time periods, including those from fossil fuel use; this will provide an independent control on emission amounts and estimates of fossil fuel use, based on economic inventories. With CT, responses to policies aimed at limiting greenhouse gases emissions can be evaluated. This independent measure of the effectiveness of policy choices can help improve mitigation strategies. CT is intended to be a tool for the community. Policy makers, industry, scientists, and the general public can use information from CT to make informed decisions on limiting greenhouse gases levels in the atmosphere.

Our ability to accurately track carbon with improved spatial and temporal resolution depends on our ability to analyze an appropriate number of samples in order to characterize atmospheric vari-