The Evolution of CarbonTracker

• What is CarbonTracker (CT)? A CO2 data assimilation project that uses atmospheric measurements from the Global Greenhouse Gas Reference Network (Figure 3) and partnership measurement programs to infer the fluxes of carbon dioxide at the Earth’s surface using models of atmospheric transport and terrestrial/oceanic exchange processes.

• What’s the purpose? CT fluxes are an end-to-end atmospheric loading. Changes from year to year, and predict future conditions.

• What are the CT products? Fluxes (Figure 1) and 4-dimensional mole fraction fields (Figure 2) are data derived products that are made freely available to the public.

• Who are our customers? Optimized CO2 fluxes are intended to be used in policy making decisions. The 4-dimensional mole fraction fields are data assimilated for CT2011.

CarbonTracker Observation Sites

Figure 1: CT2011 CO2 fluxes over North America

Figure 2: Global 3x2o/ North America 1x1o CO2 mole fraction field.

Methodology

CarbonTracker optimized fits use ensemble Kalman filtering (EnKF) to calculate scaling factors that are used to multiply initial flux estimates to better match the data.

• CT solves for 240 regions and ecosystems which individually solve for photosynthesis and respiration fluxes.

• CT fluxes are net ecosystem exchange (NEE). The current model design does not include the data.

• CT solves for 240 regions and ecosystems which are then aggregated to 11 TRANSCOM regions, 19 ecosystems, and 30 ocean regions.

• Only terrestrial and ocean fluxes are optimized. Fossil fuel and fire emissions are assumed to be known.

• 1 week of data is assimilated at a time in a 5 week moving window.

Current Activities and Future Plans

Figure 6: Cloud-free CO2 measurement map from the GOSAT satellite. Data assimilations are being tested that use upper air data from the GOSAT satellite, TCCON network, and aircraft. Until now, CarbonTracker has used surface measurements almost exclusively for data assimilation.

Figure 7: The hexagonal horizontal grid of NOAA GSD’s Finite Icosahedral Model (FIM). The CT modeling group is working with GSD to do high resolution CO2 forecast simulations with FIM in conjunction with near-real time forecasts with TM5. The forecast product is intended to be released more frequently than the annual CarbonTracker optimized flux product and more responsive to user requests.

Figure 8: CarbonTracker-Lagrange uses Lagrangian Particle Dispersion Modeling (LPDM) to compute footprints of CO2 surface sensitivity for individual measurements. Inversion methods such as Bayesian and Geostatistical techniques are under development to use these footprints to optimize the inferred fluxes using an ecosystem scaling approach similar to CarbonTracker–CO2. Different LPDMs (e.g. HYSPLIT and STILT) and meteorological drivers will also be used to investigate the sensitivity of derived flux estimates to errors in simulated transport.

CarbonTracker Methane

The NOAA CarbonTracker–CH4 data assimilation product is also under development as a companion to NOAA’s CarbonTracker–CO2, with the goal of producing quantitative estimates of emissions of methane to the atmosphere from natural and anthropogenic sources for North America and the rest of the world.

Figure 9: Estimated winter-time fossil fuel emissions from North America. Recent CarbonTracker–CH4 research sees an increase in the methane contribution from the fossil fuel sector, likely due to increased natural gas production.

International Collaborations

CarbonTracker Asia – Contact: Chun-Ho Cho (http://www.nimr.go.kr/2/carbontracker/)
CarbonTracker China – Contact: Lingxi Zhou, Xingqin An
CarbonTracker Europe – Contact: Wouter Peters (http://www.carbontracker.eu)
CarbonTracker Australasia – Contact: Sara Mikaloff-Fletcher
CarbonTracker Brazil – Contact: Luciana Vanni Gatti

Academic Partnerships

NCAR – Contact: Britt Stephens
University of Wisconsin – Contact: Bjorn Brooks
Colorado State University – Contact: David Baker, Scott Denning
Oregon State University – Dave Turner
Jet Propulsion Laboratory – Susan Kulawik

Figure 5: CT fit to Mauna Loa data

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