

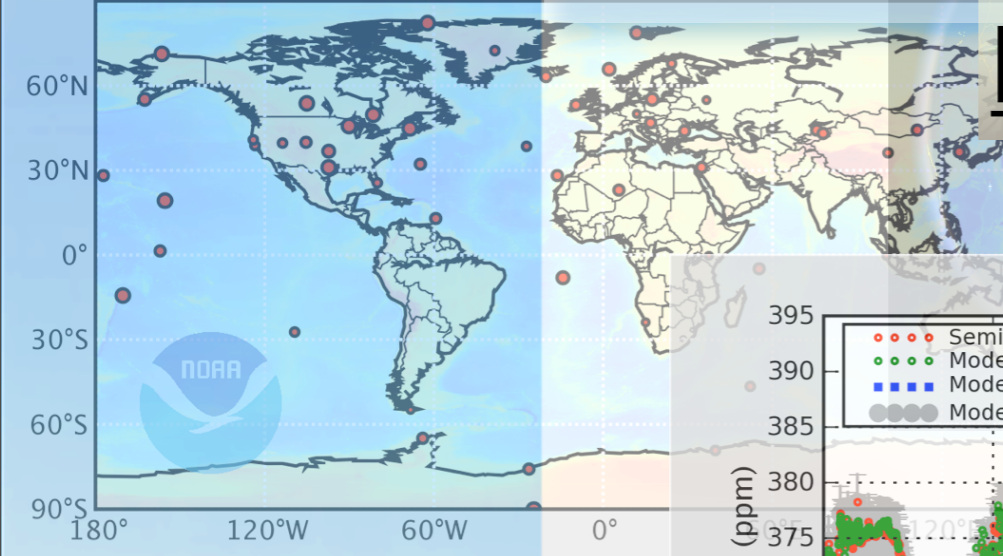


CarbonTracker

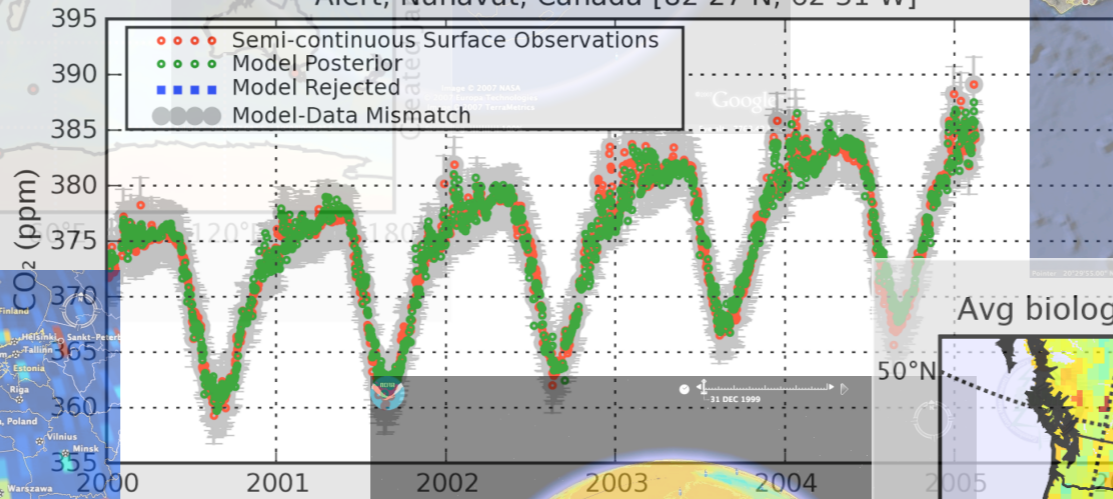
Wouter Peters, Andy Jacobson, Ken Masarie, Pieter Tans, Colm Sweeney, Arlyn Andrews, Lori Bruhwiler, John Miller, Gaby Petron, Adam Hirsch, Tom Conway, Maarten Krol, Guido van der Werf, Jim Randerson, Paul Wennberg

<http://carbontracker.noaa.gov>

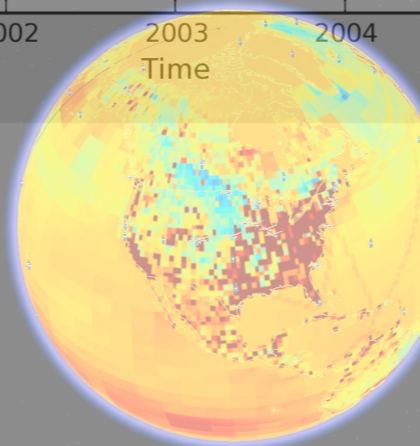
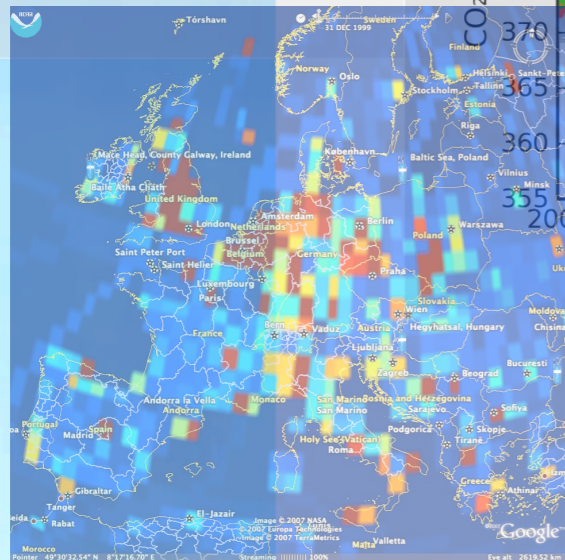
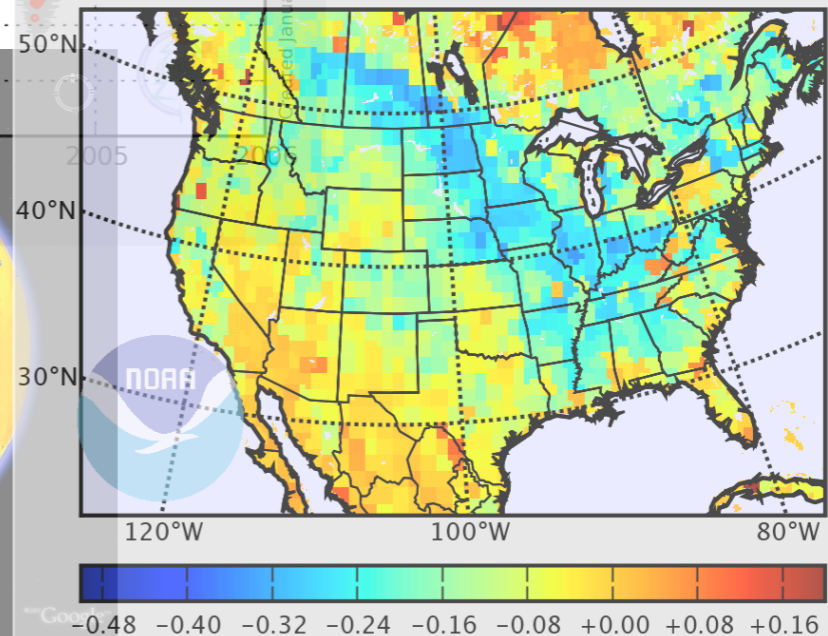
Observation sites used in CarbonTracker



Alert, Nunavut, Canada [82 27'N, 62 31'W]



Avg biological flux [$\mu\text{mol}/\text{m}^2/\text{s}$] for 2001-2005



Created January-19-2007, v1.0





Website

U.S. Department of Commerce | National Oceanic & Atmospheric Administration | NOAA Research

Earth System Research Laboratory
Global Monitoring Division

Global Monitoring Division About Research Outreach Media Center

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CarbonTracker

What is CarbonTracker?

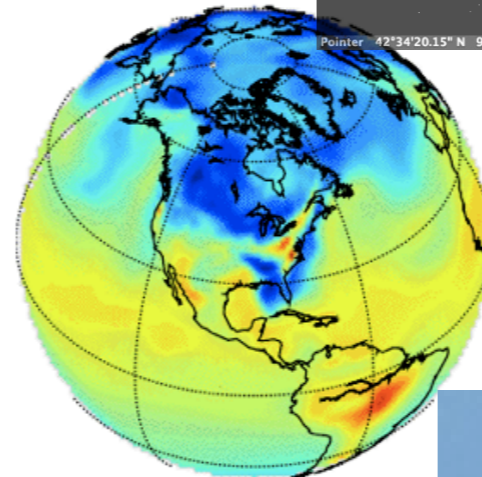
A system to keep track of carbon dioxide uptake and release at the Earth's surface over time. [\[read more\]](#)

Who needs CarbonTracker?

Policy makers, industry, scientists, and the public need CarbonTracker information to make informed decisions to limit greenhouse gas levels in the atmosphere. [\[read more\]](#)

What does CarbonTracker tell us?

North America is a source of CO₂ to the atmosphere. The natural uptake of CO₂ that occurs mostly East of the Rocky Mountains removes only ~30% of the CO₂ released by the use of fossil fuels. [\[read more\]](#)



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Image © 2007 NASA
© 2007 Europa Technologies
Image © 2007 TerraMetrics

Google™

Pointer: 42°34'20.15" N 96°51'38.19" W
Streaming: 100%
Eye alt: 10350.34 km

FTP

fluxes

molefractions

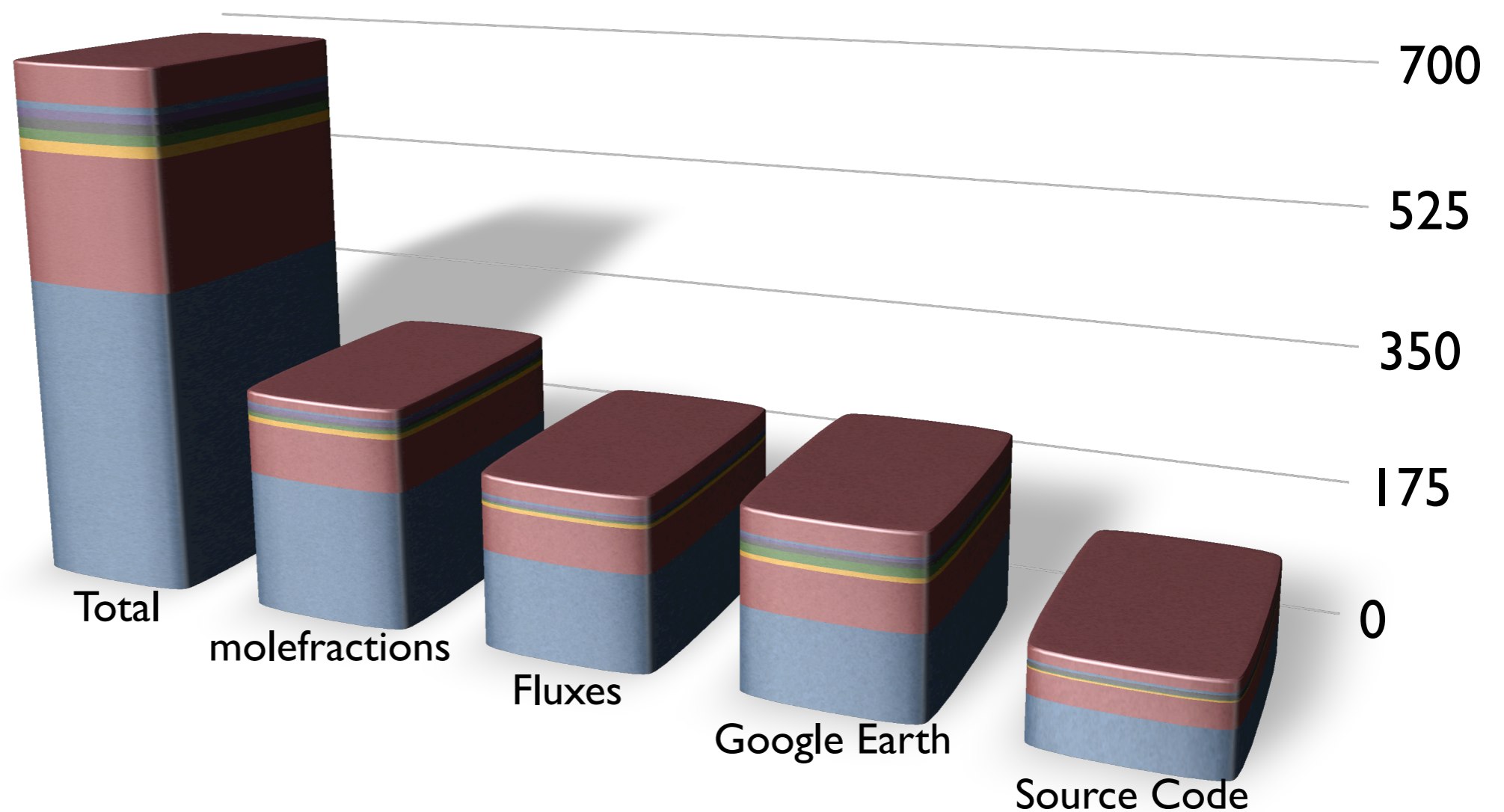




Appears to serve a need

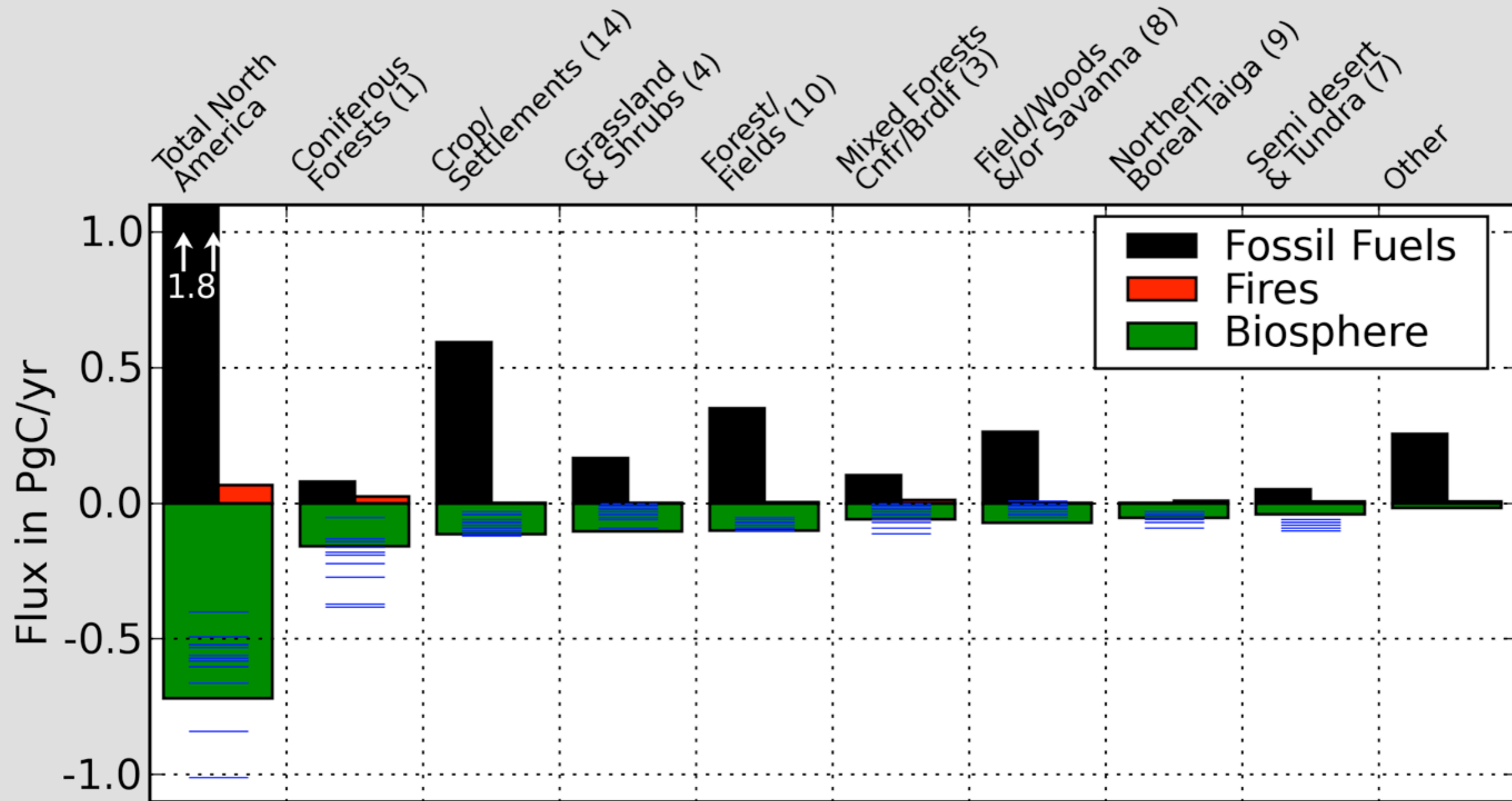
CarbonTracker FTP server downloads since March 23rd 2007

- U.S.
- Unknown
- Germany
- France
- Netherlands
- Canada
- Australia
- Others





What does it tell us?



North American Flux by ecosystem

CT: 0.65 PgC/yr (range: -0.4 to -1.01 PgC/yr)

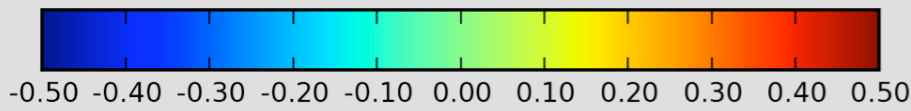
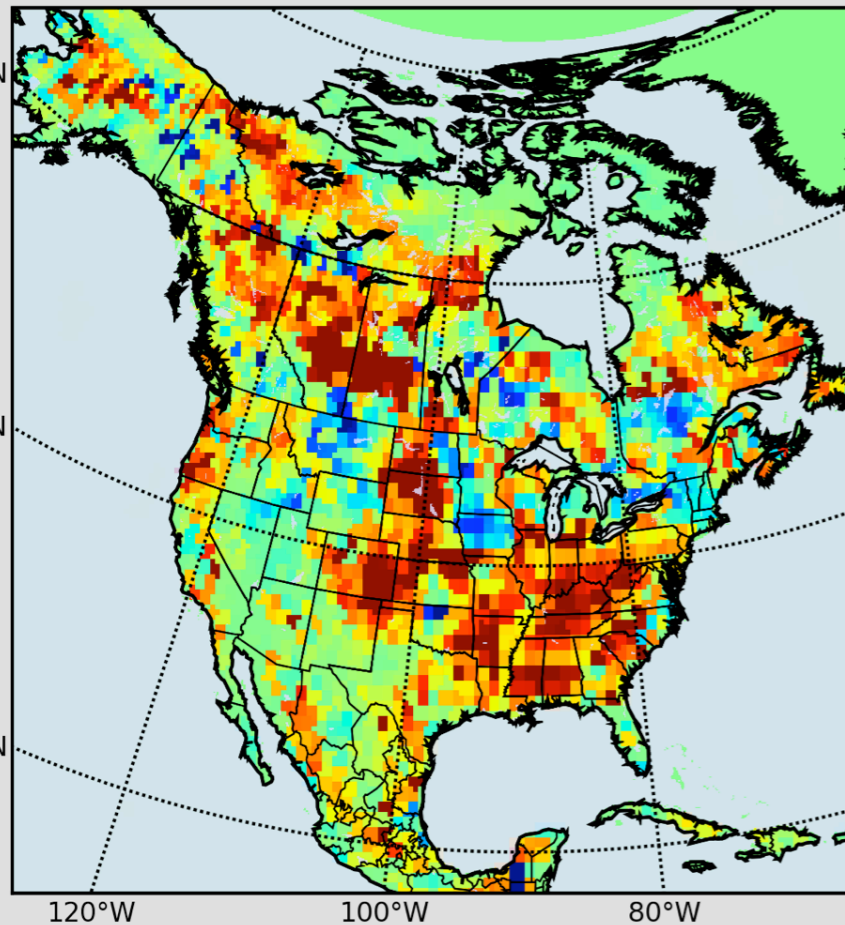
SOCCR: 0.68 PgC/yr (range: +/- 50%)



What does it tell us?

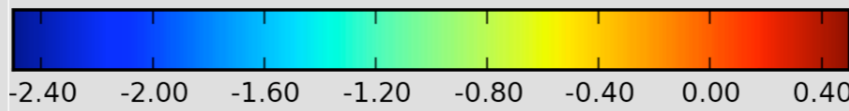
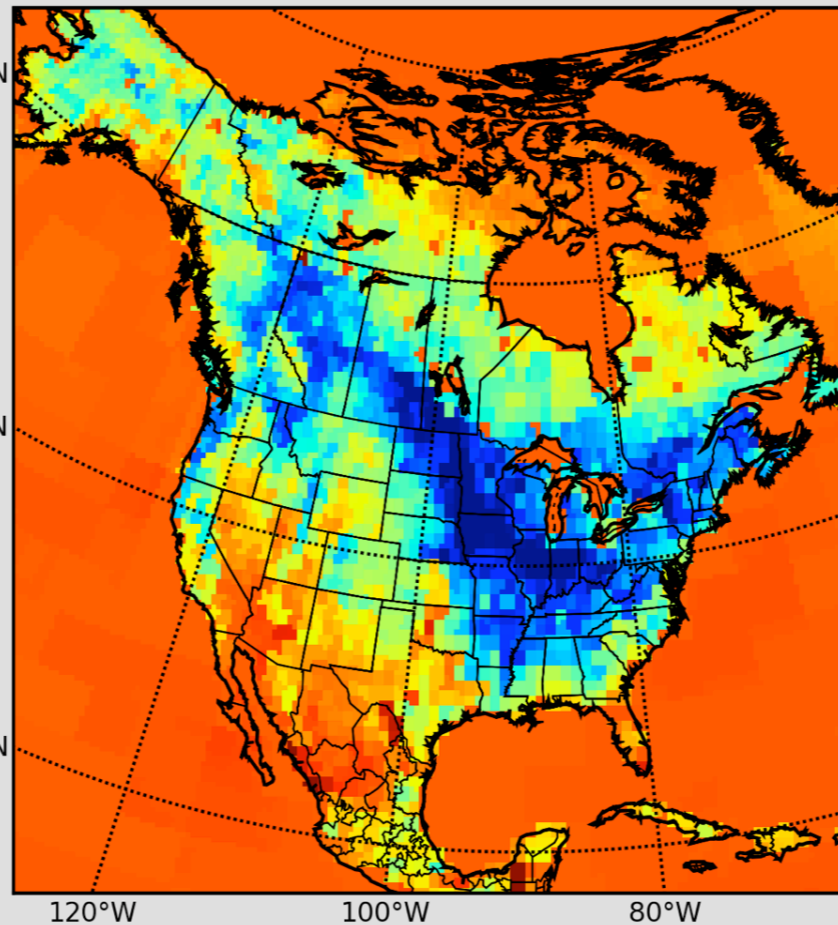
- 2002 lowest uptake (-0.32 PgC/yr): half of 2001-2005 mean
- 2004 highest uptake (-0.82 PgC/yr)

Summer Flux Anomaly [$\mu\text{mol}/\text{m}^2/\text{s}$]
for 2002



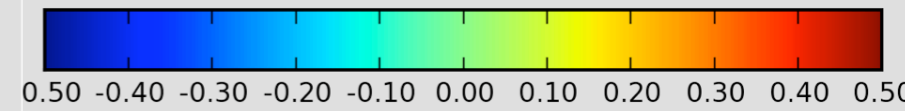
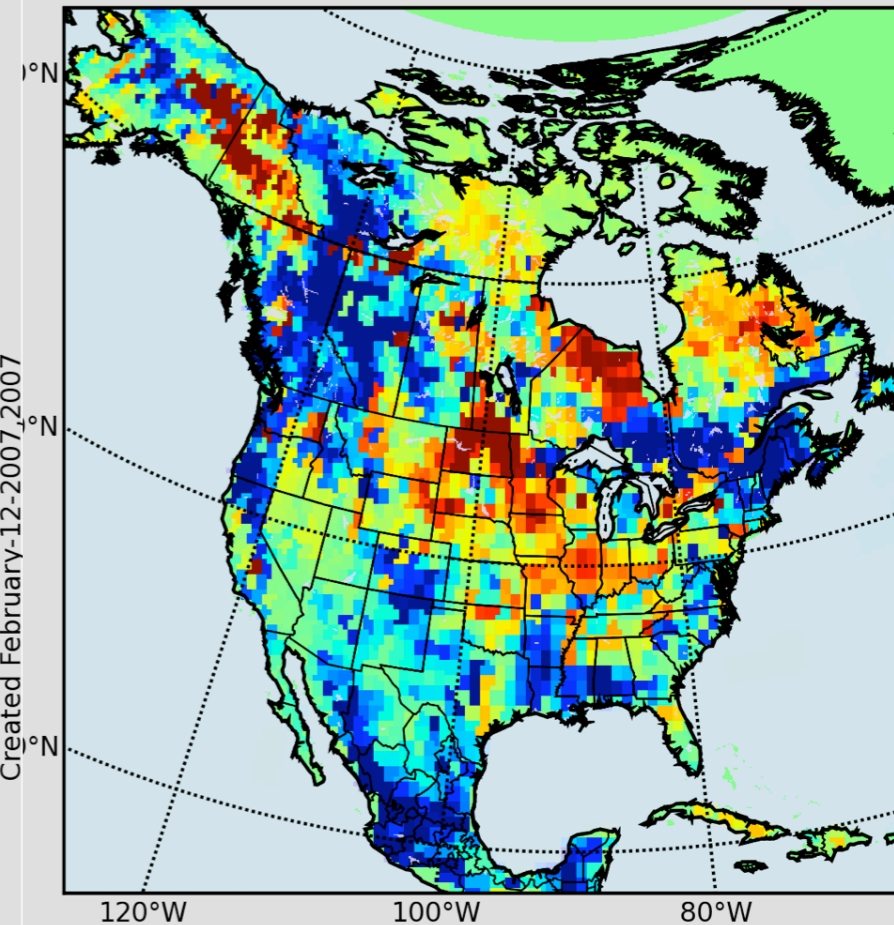
**2002 Summer
Natural Flux**

Summer Mean Flux [$\mu\text{mol}/\text{m}^2/\text{s}$]
for 2001-2005



**Mean Summer
Natural Flux**

Summer Flux Anomaly [$\mu\text{mol}/\text{m}^2/\text{s}$]
for 2004



**2004 Summer
Natural Flux**



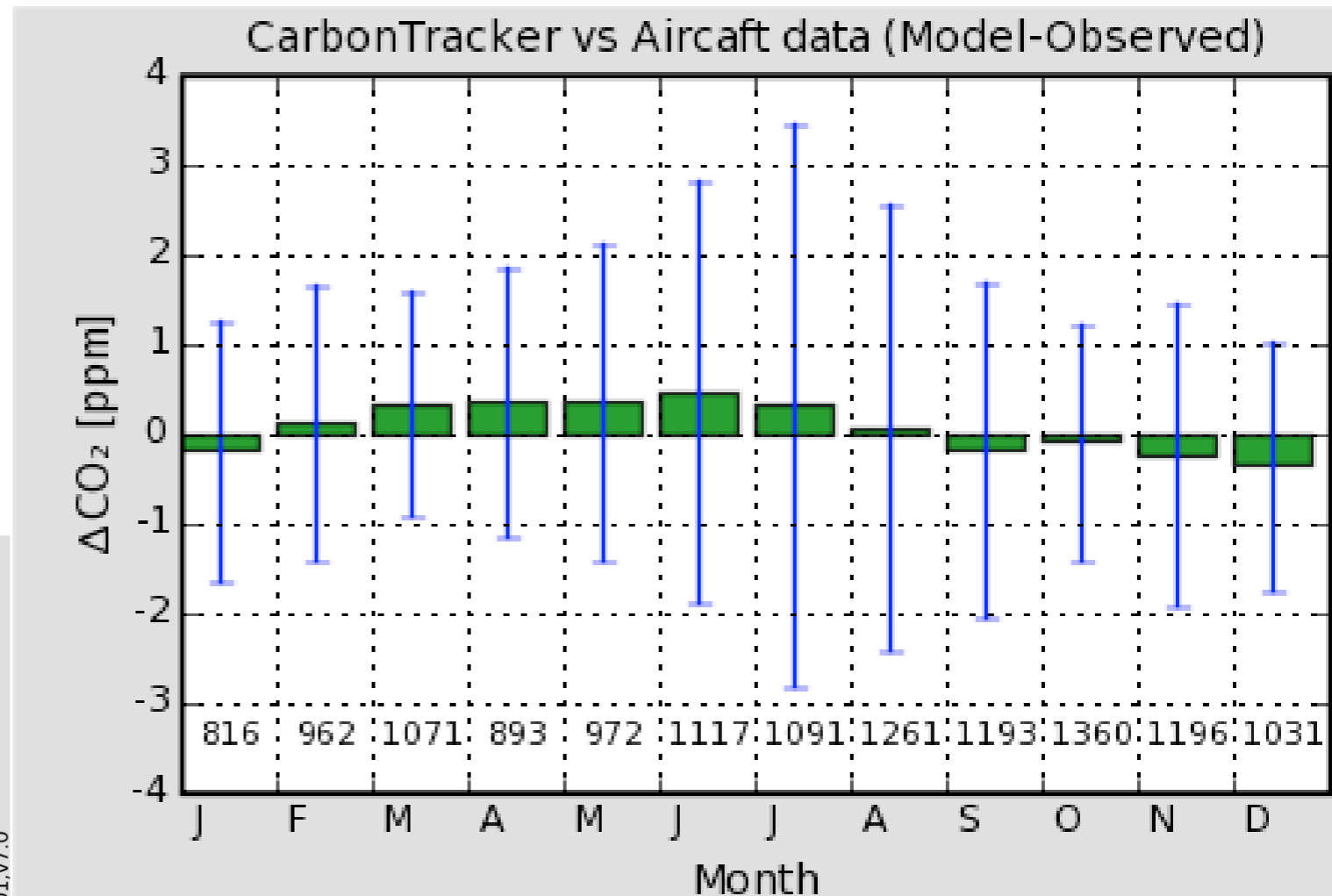
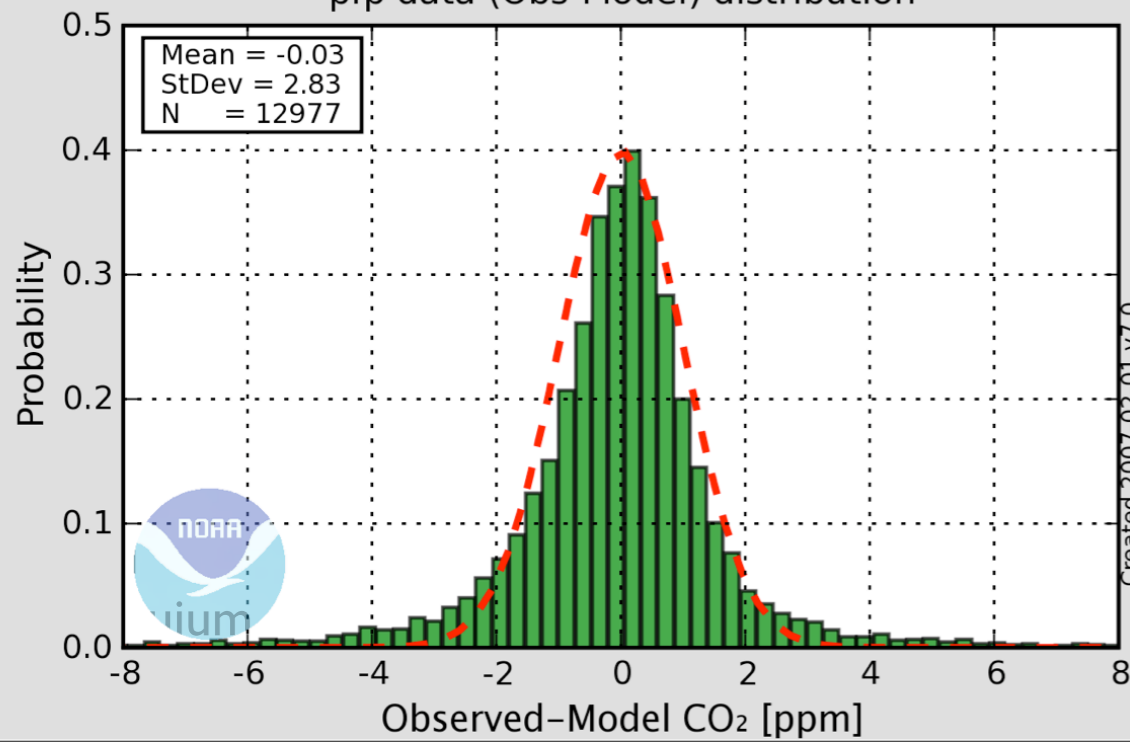
How good is it?

- Estimates highly consistent with independent aircraft data
- Shows no large tropics-to-mid latitudes flux

	NH Land	Tropical Land
CT	-1.80	+0.09
T3L2	-2.58	+1.86
Baker	-2.42	+1.80
Jacobson	-2.88	+4.18
Stephens*	-1.5	+0.1

* Accepted for Science

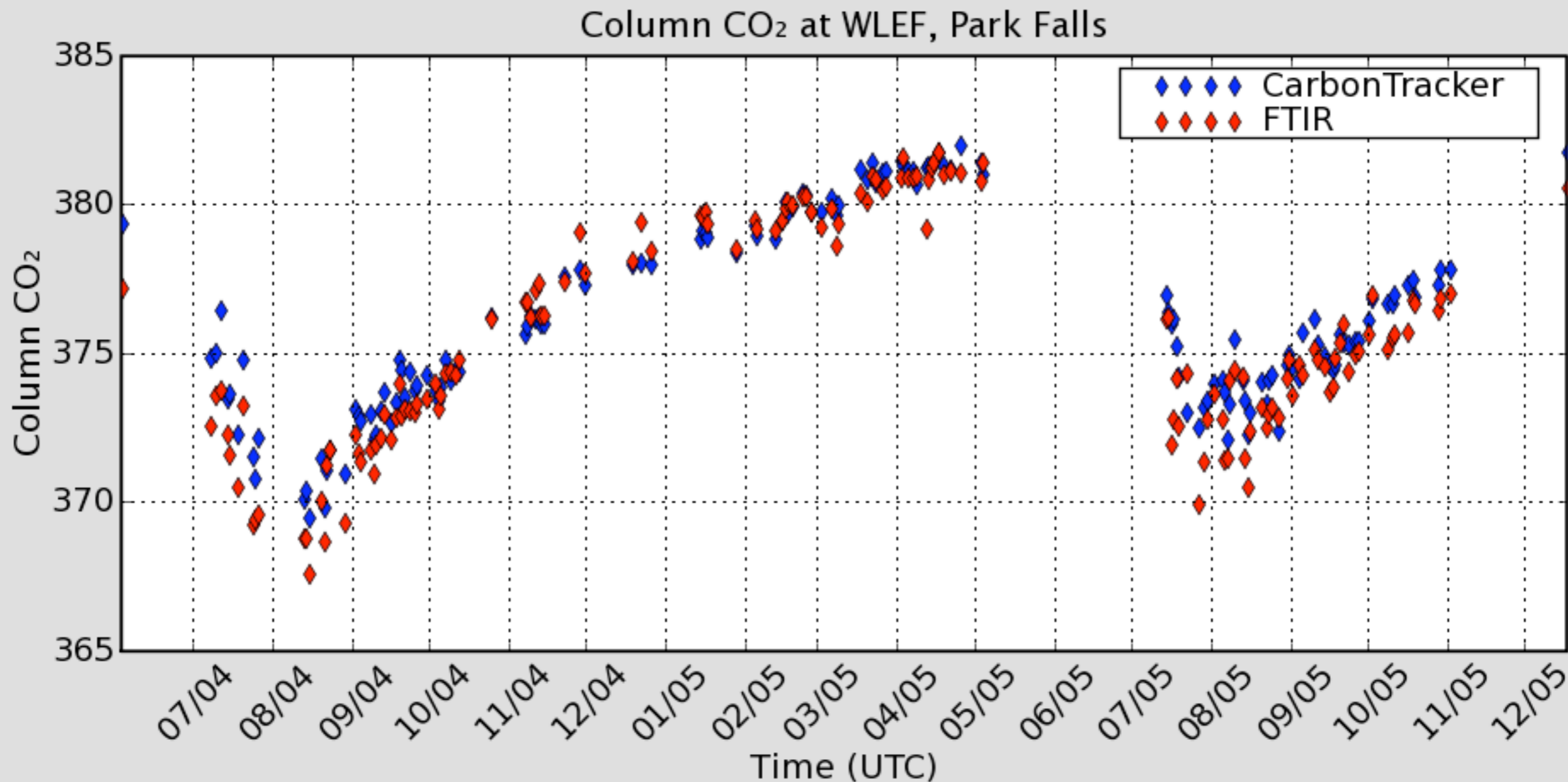
pdf data (Obs-Model) distribution





How good is it?

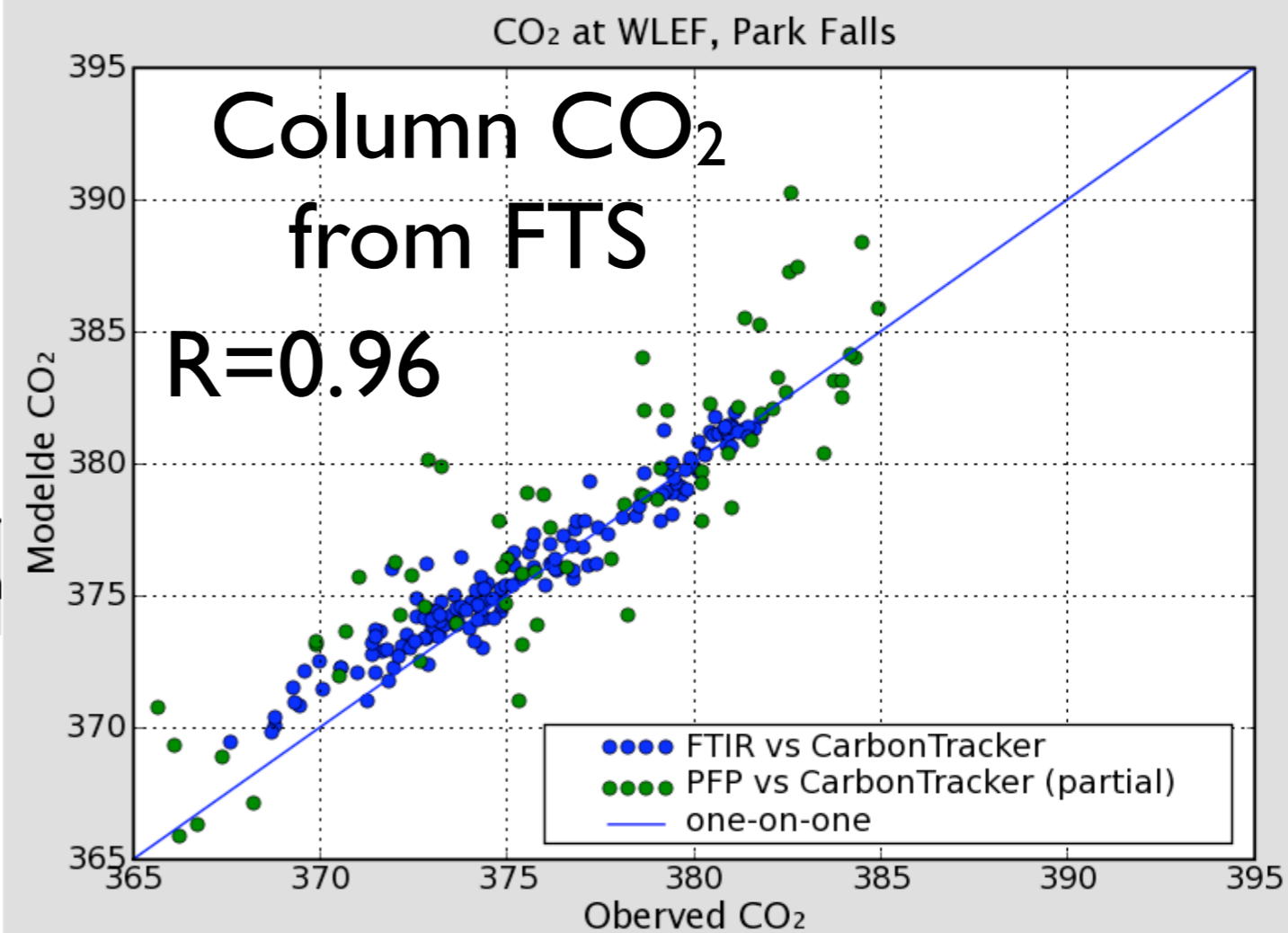
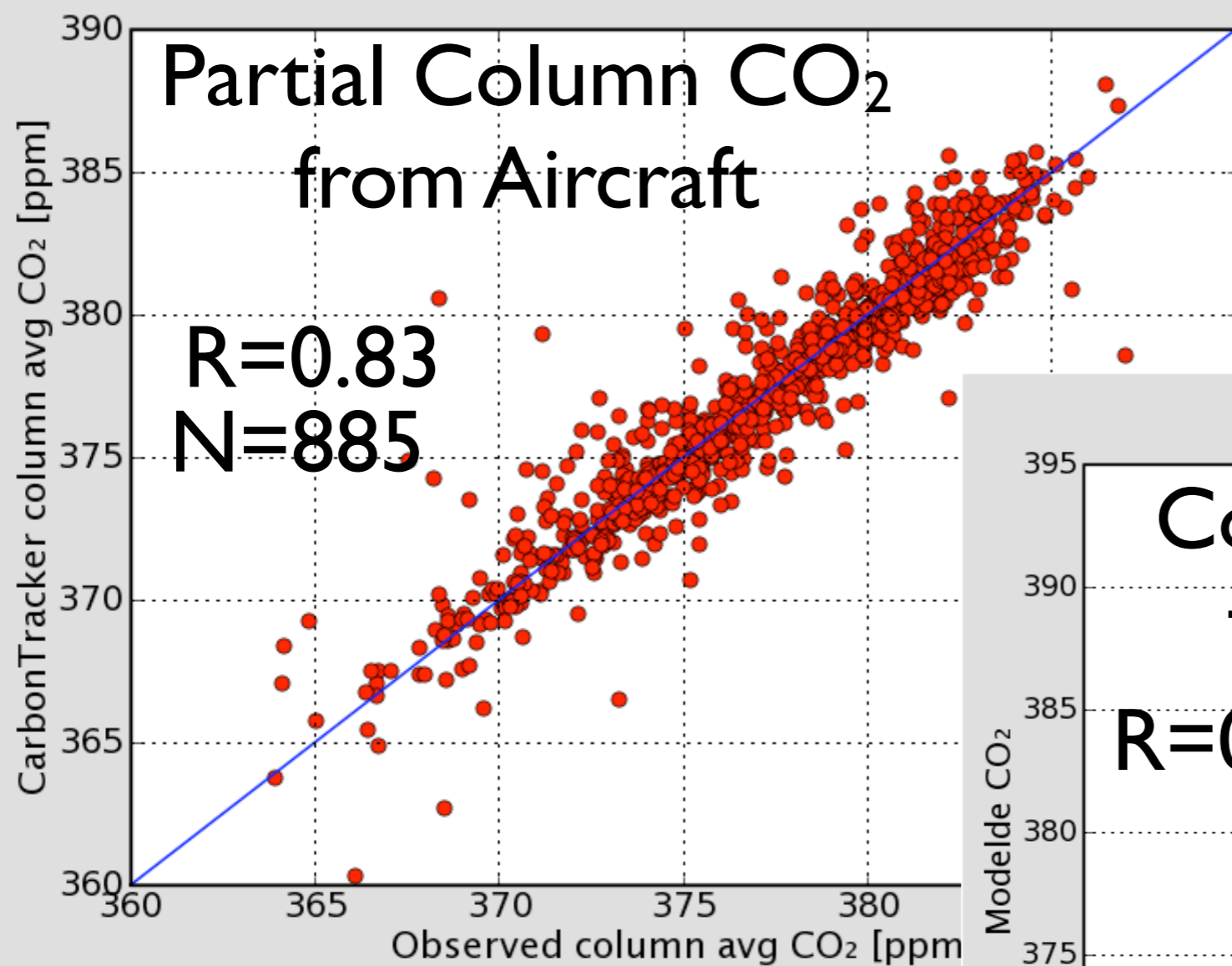
CarbonTracker column CO₂ against FTIR data
(Courtesy Paul Wennberg, Rebecca Washenfelder, Gretchen Keppel-Aleks)

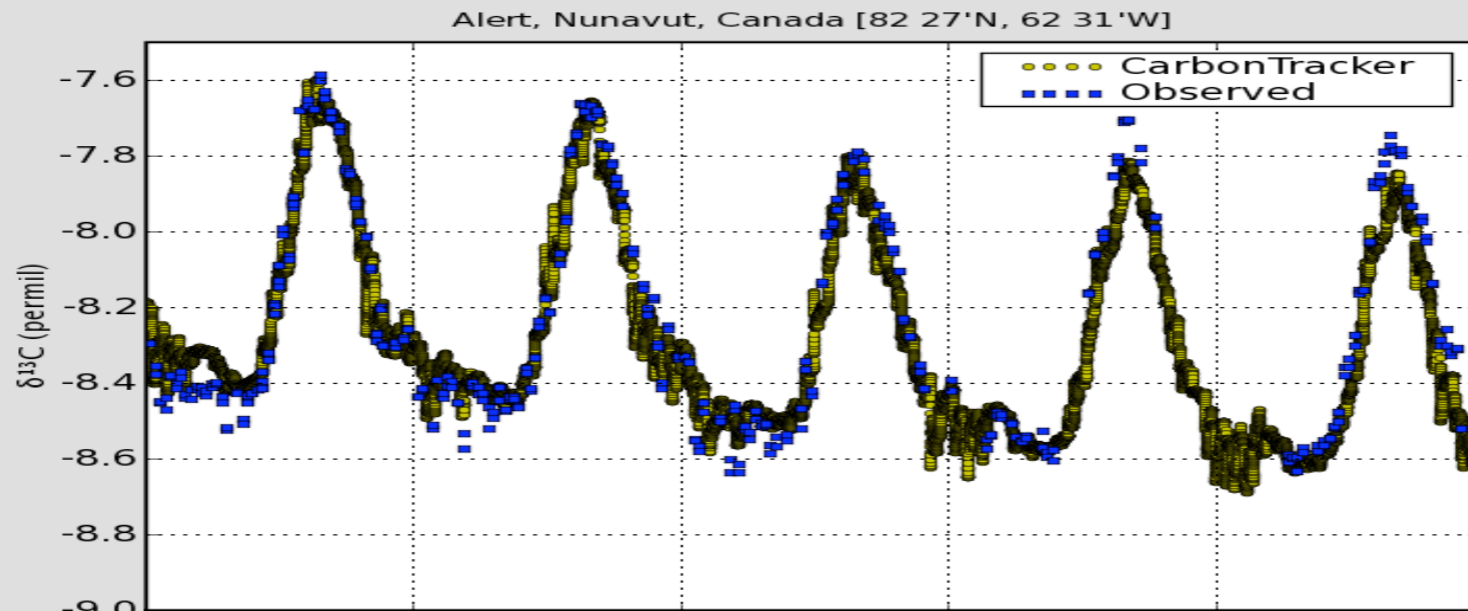


Created April-17-2007, FTIR Data Courtesy of P. Wennberg

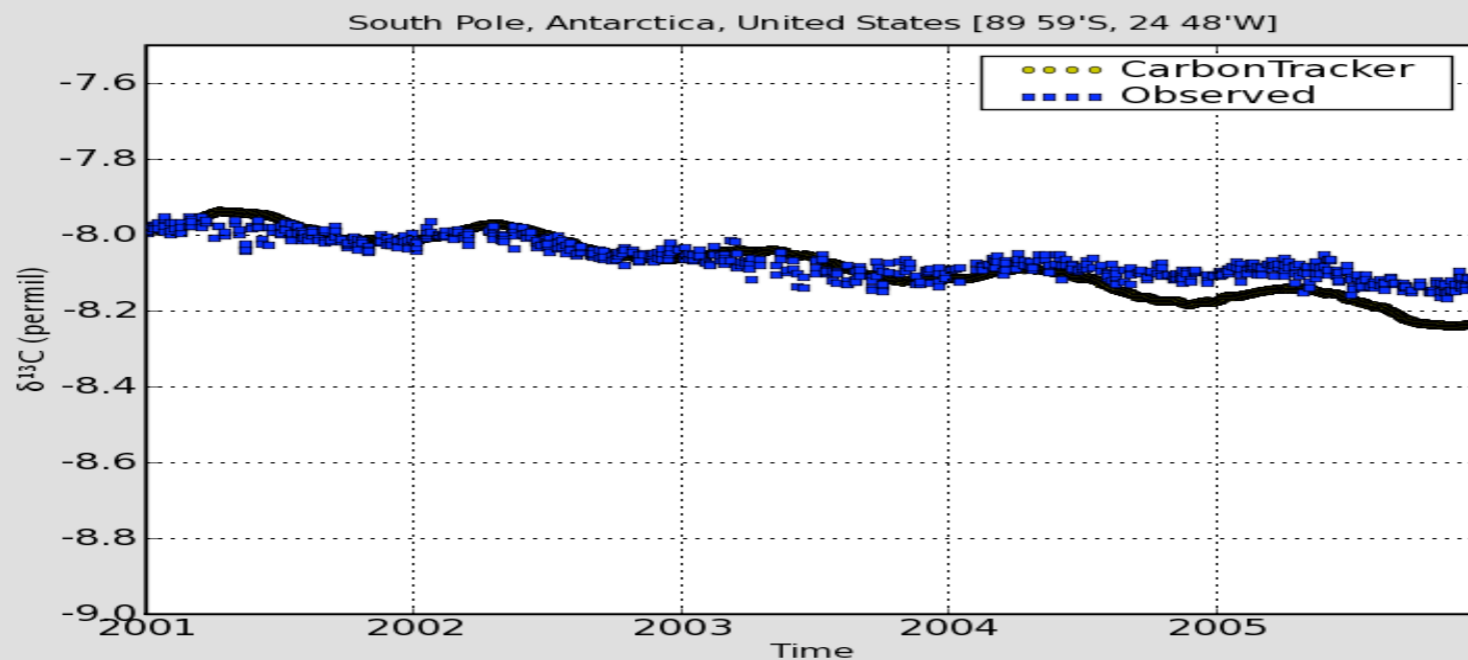


How good is it?

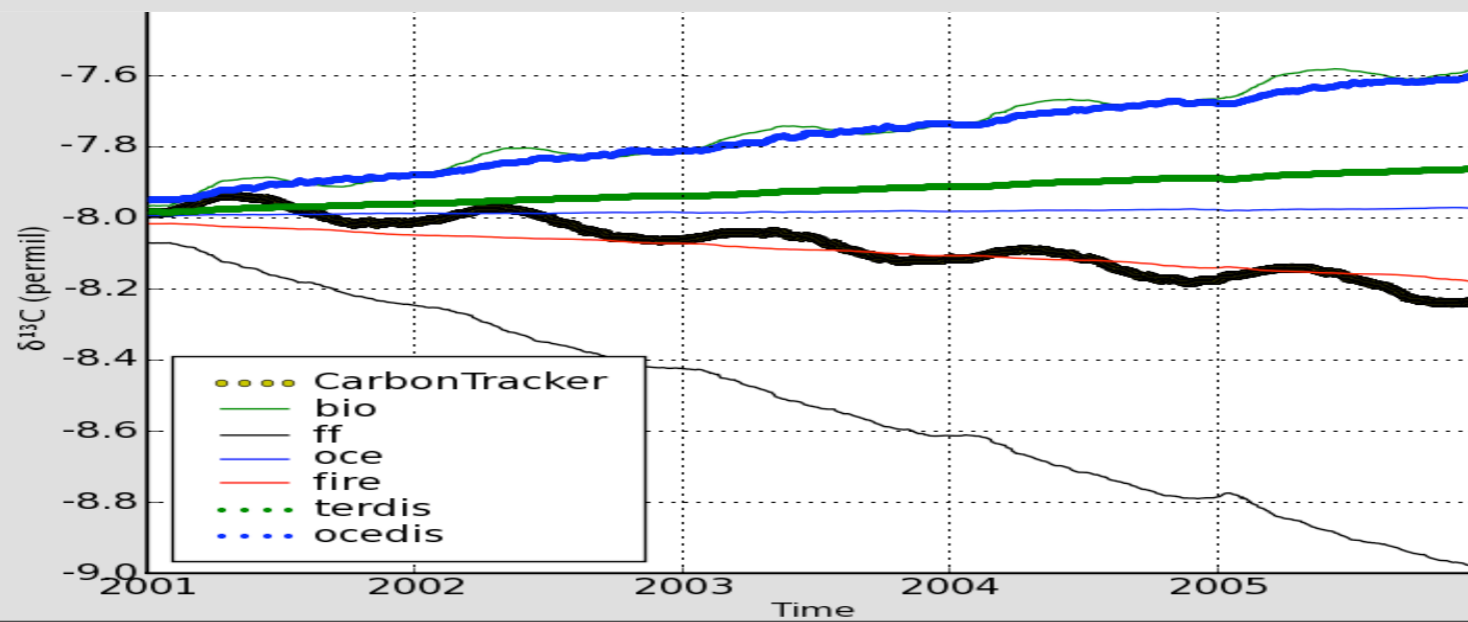




Alert



South Pole



South Pole
budget





CarbonTracker publication

- Peters, W., Jacobson, A., Sweeney, C., Andrews, A., Conway, T., Masarie, K., et al. (2007). An atmospheric perspective of North American carbon-dioxide exchange: CarbonTracker. *Proceedings of the National Academy of Sciences of the United States of America*, in review.

Model Structure

- TM5 is now a subroutine of module main.F90 (similar to 4d-var project)
- TM5 is called twice:
 - once to 'forecast' CO₂ mixing ratios (5 weeks of transport)
 - once to run the background CO₂ (1 week of transport)
- a 'reset' is done in between

Time stepping

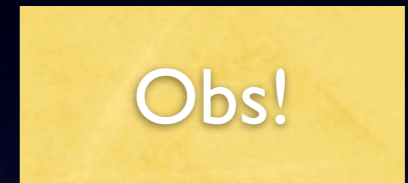
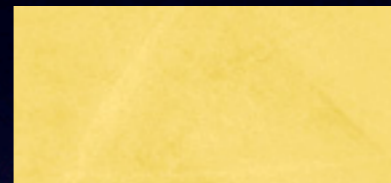
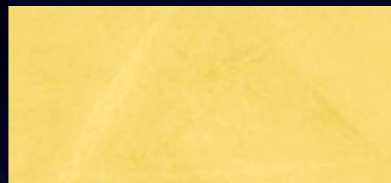
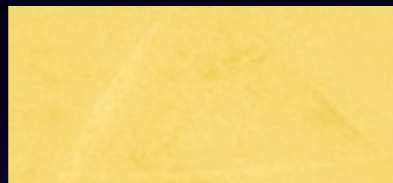
week 1

week 2

week 3

week 4

week 5



Obs!

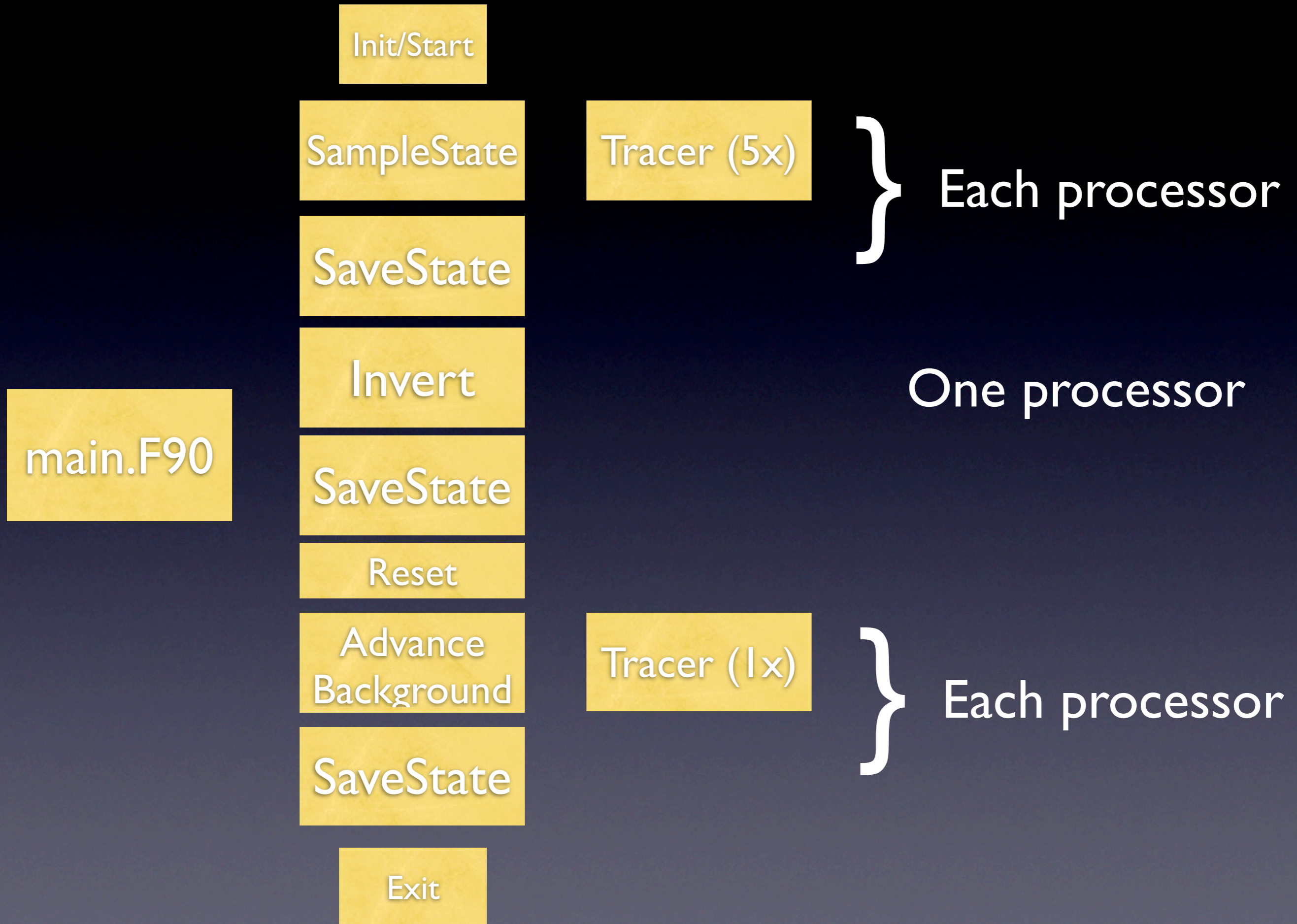
$t=t_i$

$t=t_{i+5}$

TM5 time
(save.hdf)

Time stepping





New Modules

- main.F90, enkf_tools.F90, enkf_common.F90, enkf_constants.F90, random.F90, emission_co2_*.F90, user_output_column.F90, user_output_column3d.F90, user_output_forecast.F90, user_output_eddyflux.F90
- Well documented (Protex), cycle 2 structure
- New RC-file items with defaults

Massive parallel

- 'Ensemble' approach means a tracer (CO_2) is represented N times, where $1 < N < 300$
- The N tracers are independent in TM5
- Each processor (10-50) handles their own tracers
- Communication only from main.F90, root does optimization
- tracer 1 is mean of ensemble, $2-N$ is the uncertainty
- Independent I/O was needed to limit communication

New output routines

- **user_output_column.F90**: hourly vertical profiles of tracers + meteorology at site locations (grd,slp,int)
- **user_output_column3d.F90**: 3D tracer distribution sampled at XX local time (satellite overpass)
- **user_output_eddyflux.F90**: hourly surface fluxes at site locations (grd,slp,int)
- **user_output_noaa.F90**: samples tracers for every NOAA event (flask filled), eventnumber allows comparison to observations

Conclusions (I)

- CarbonTracker structure builds strongly upon TM5 base
- Minimal changes to existing code base
- Main changes in I/O and tracer.F90 + initexit.F90
- New routines for general use being fed back to TM5 base
- New code (Andy!) user-friendly and adaptable to other trace gases