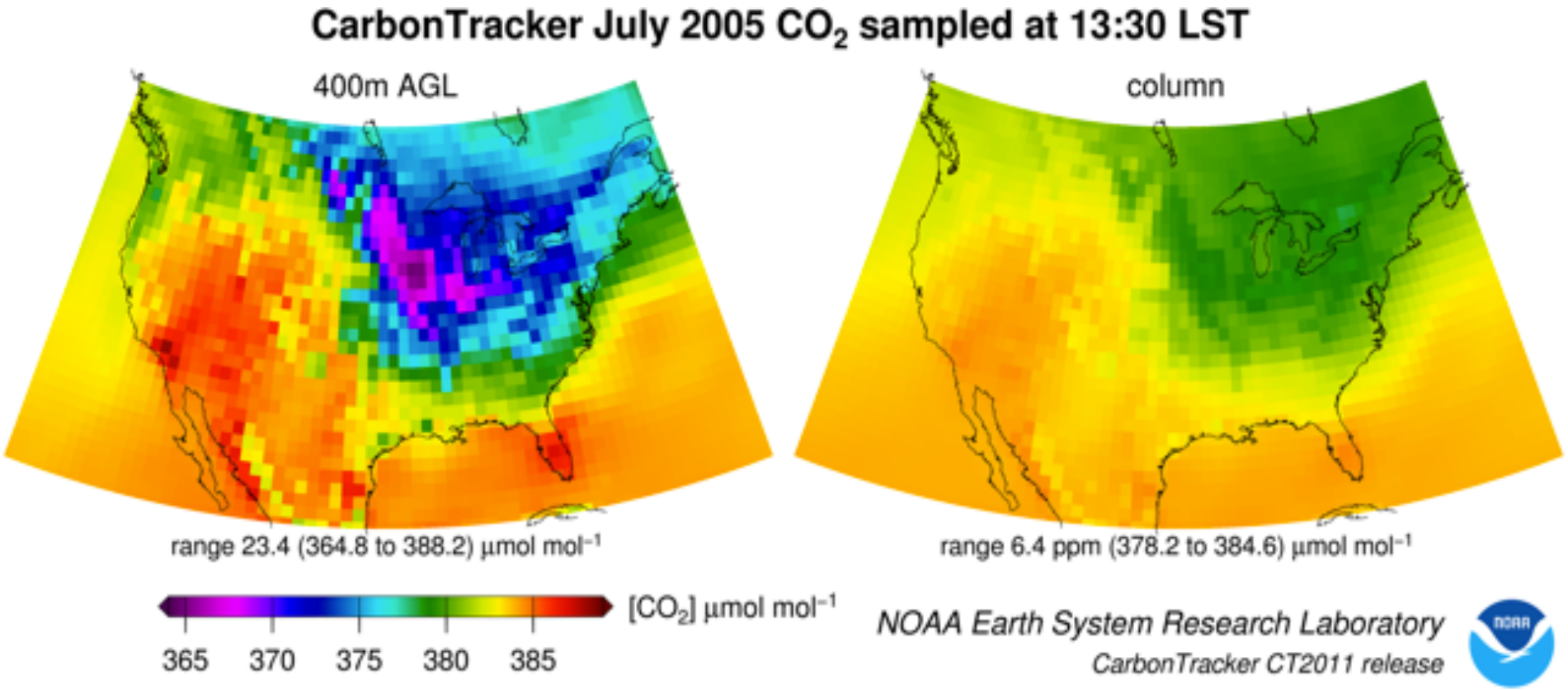
A few illustrative slides on

Greenhouse Gas Measurement Challenges

Pieter Tans and Arlyn Andrews

19 September 2014

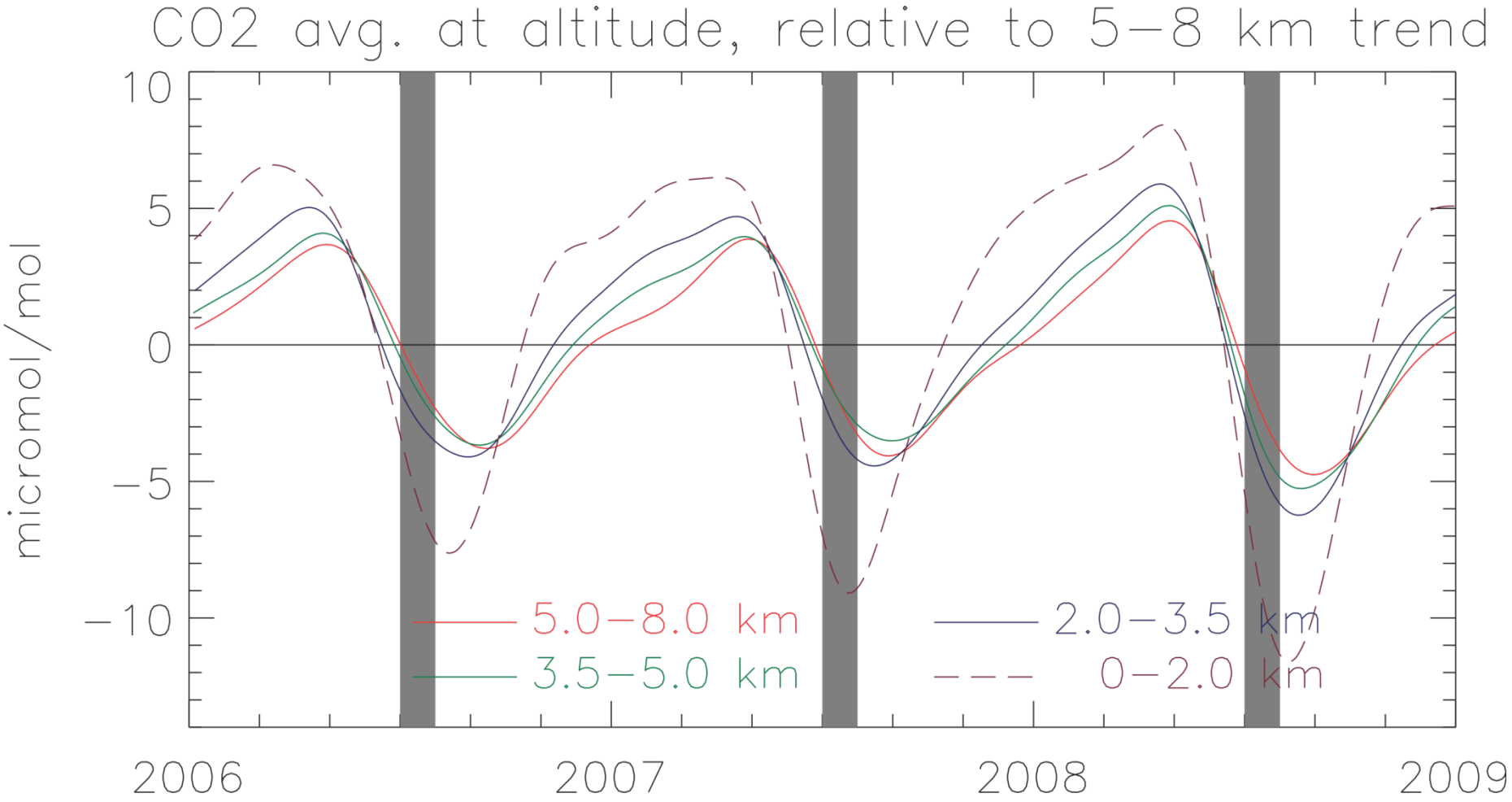


Regional scale sources/sinks are visible as mole fraction enhancements/depletions in the boundary layer

At mid- and high latitudes, total column as well as mid-troposphere averages show primarily what is happening in the entire latitude band ~30-60 North.

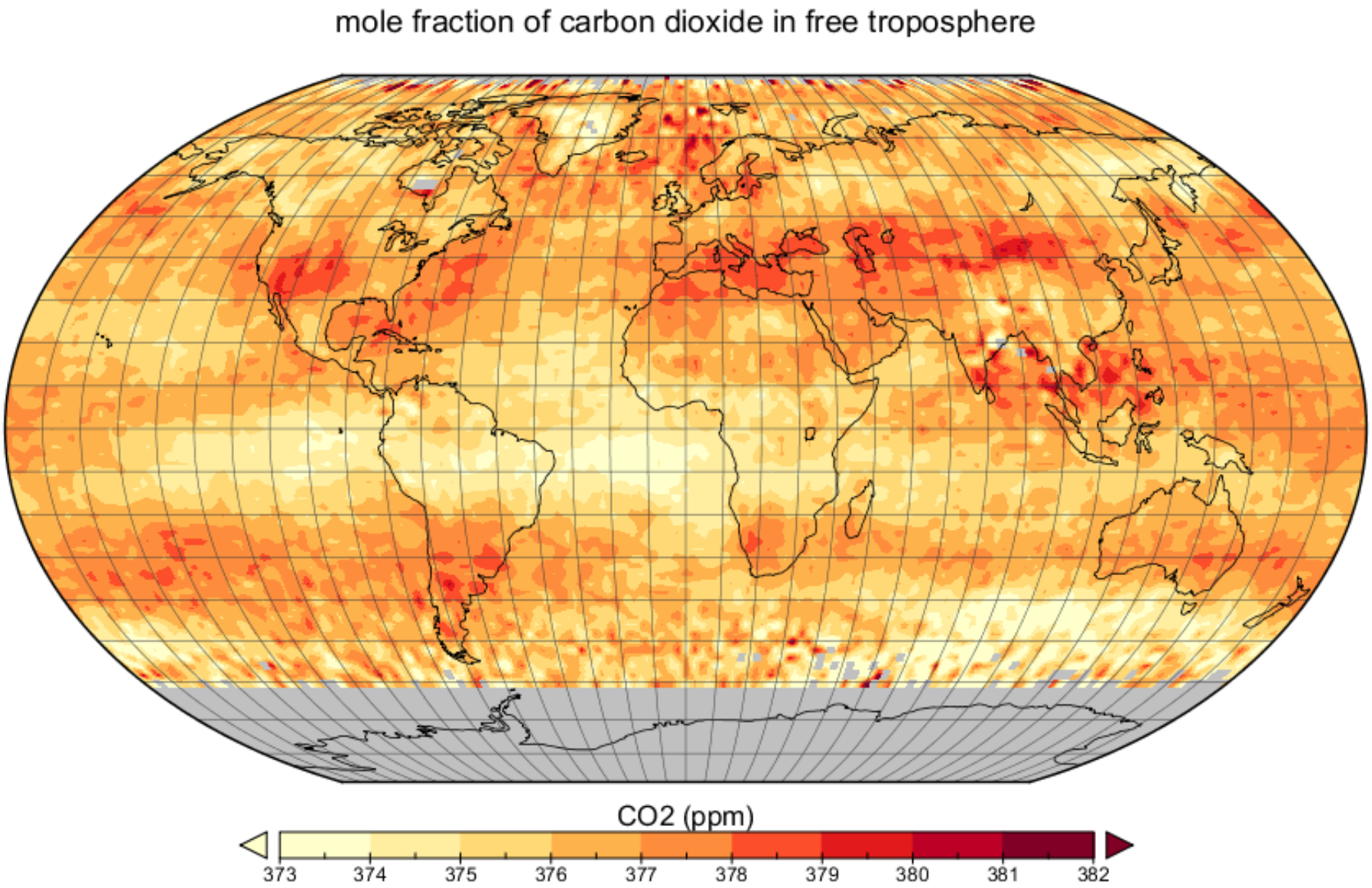
Mass balance estimate: 1 PgC/year source of CO_2 in the USA causes the total column average to increase by ~0.5 ppm. We would like to quantify such emissions to ~10-20%

Coupling between different altitudes as observed, on average, in aircraft samples over the U.S. between the atmospheric boundary layer and higher altitudes.

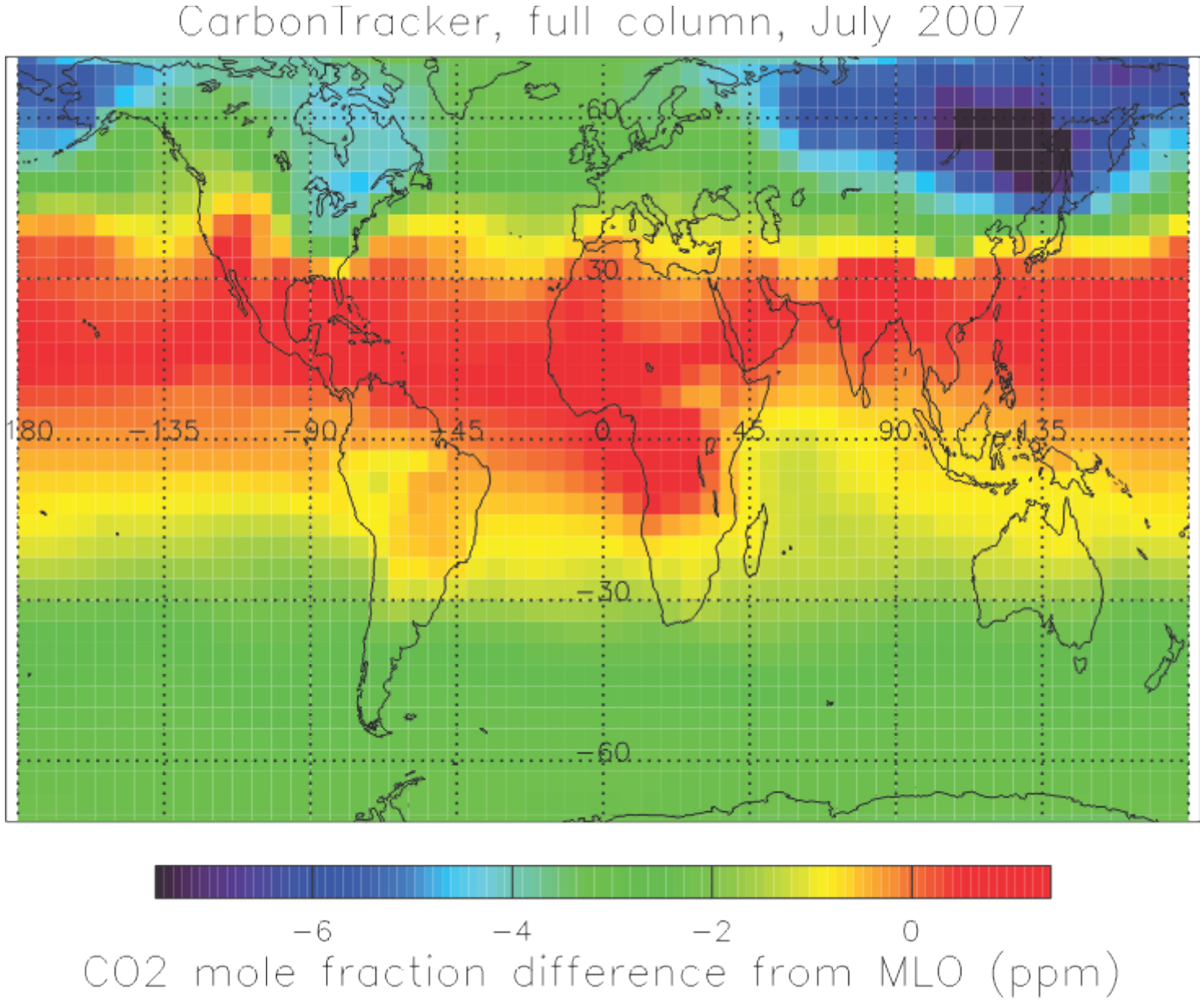


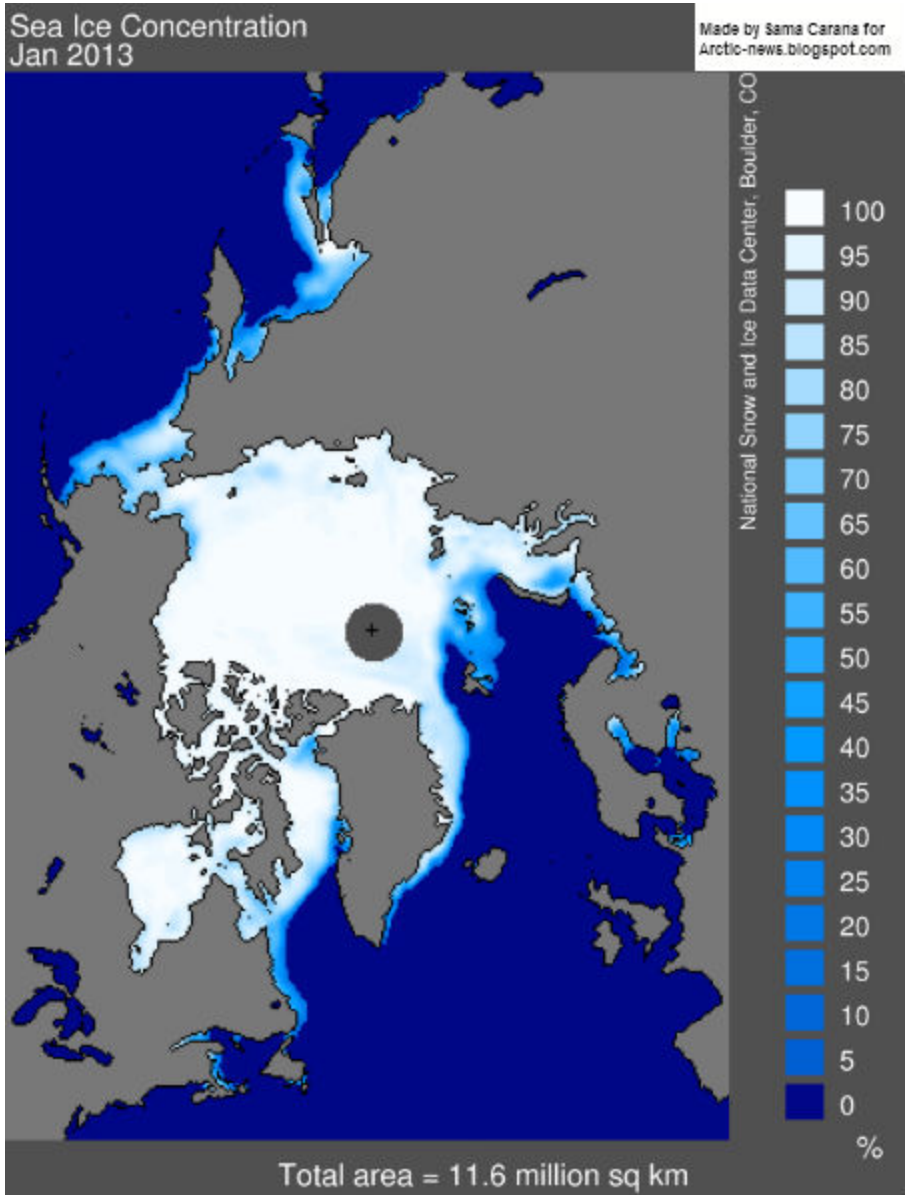
Note: the month of July is highlighted, because next 2 maps show July averages.

Mid- to high tropospheric CO2 July 2004 from AIRS-AMSU

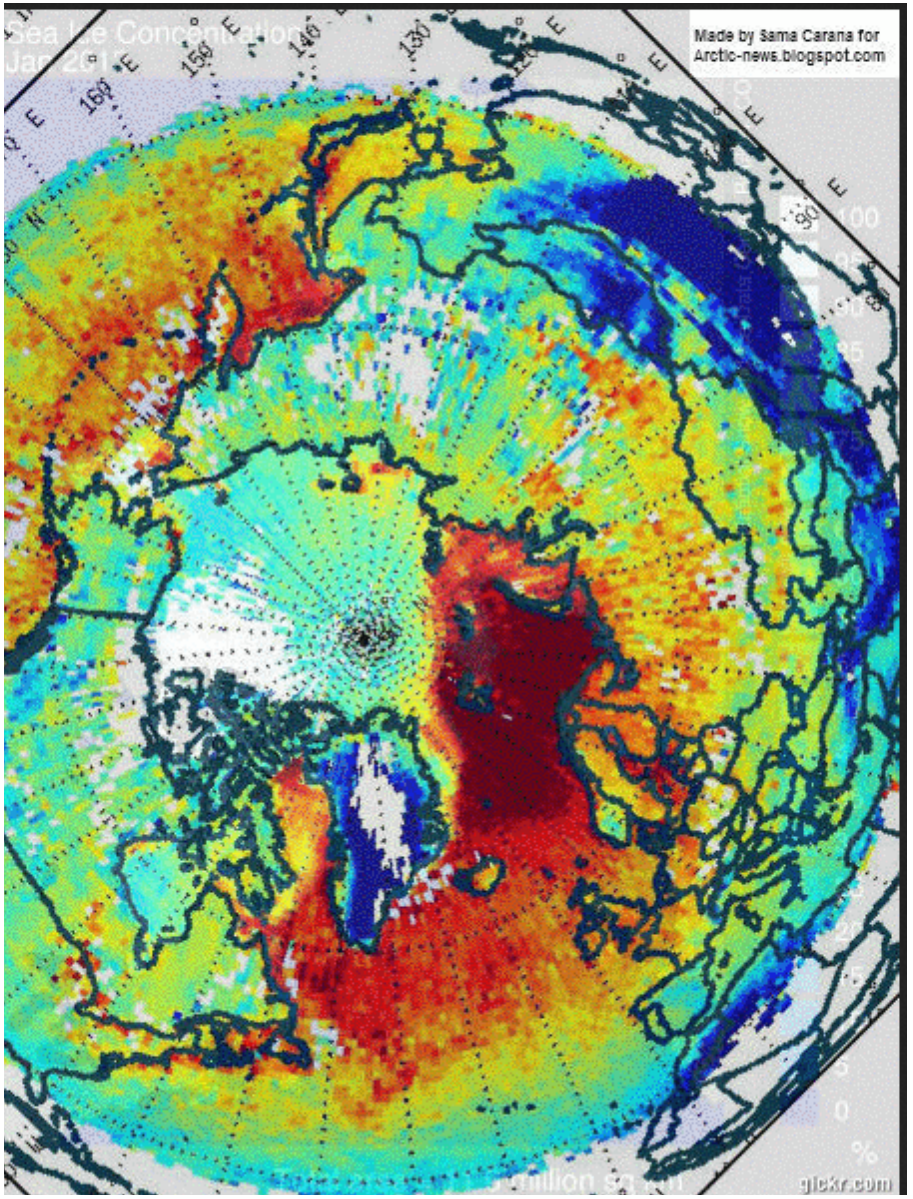


AIRS3C2M


CarbonTracker, full column, July 2007
60
30
-180
-135
-90
-45
0
45
90
135
-30
-60
-6
-4
-2
0
CO2 mole fraction difference from MLO (ppm)



NSIDC: Sea Ice Loss (%)



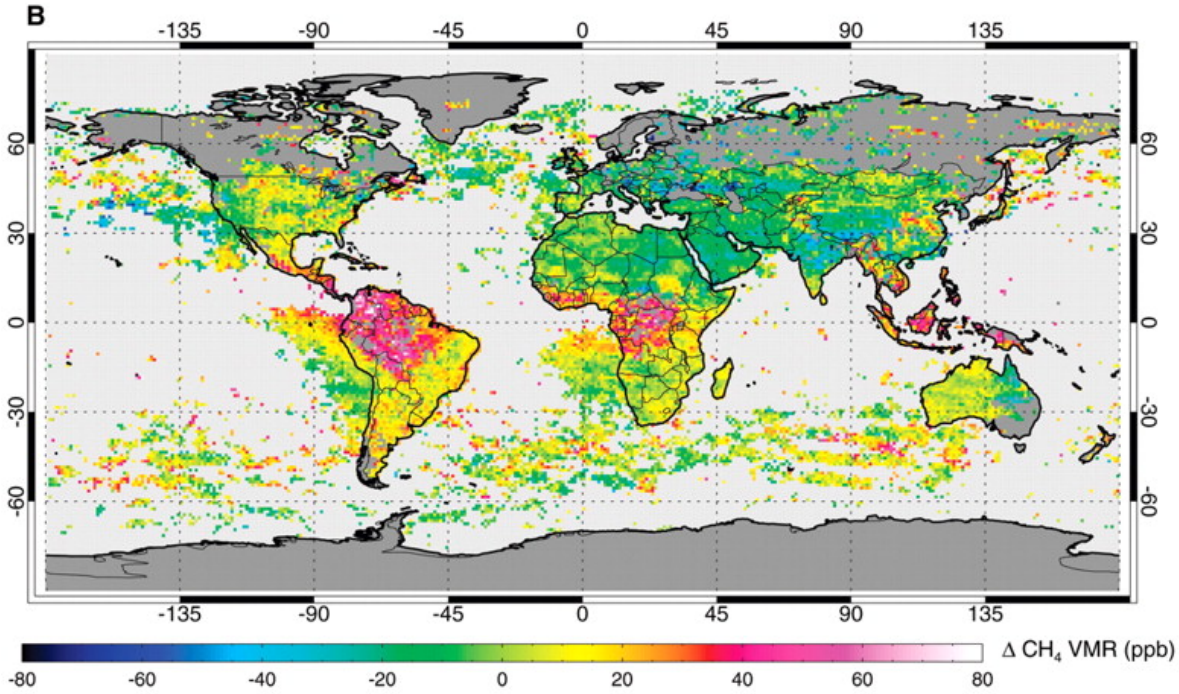
1780 1920

Retrieved CH_4: ppb

Slide from Ed Dlugokencky

CH4 map made by bloggers based on NOAA AIRS data

Difference between retrieved CH4 columns from SCIAMACHI and “known” CH4 sources modeled by TM5 transport model



Frankenberg et al., Science 306, 1010 (2005).

This was the discovery of a large and unexpected new CH4 source from vegetation in the Am azon….. Until it turned out to be due to an error in the spectroscopic parameters for water vapor.

It is entirely premature to rely on satellite retrievals of greenhouse gases to draw any conclusions about regional sources/sinks. The accuracy (freedom from bias) requirements are *more* then a factor of 10 beyond current instrument specs.

If one thinks to have made a discovery based on satellite retrievals, do not believe it unless there is enough evidence from calibrated in-situ measurements or in some cases ground based TCCON data. The latter also need validation from calibrated data.

We need to think differently about the role of satellite data in any GHG observing system. Very likely, for the next decade or longer the satellite retrievals will remain experimental, with biases down to very small levels still to be debugged with dense in-situ calibrated data. Without the latter we will never know all of the biases. It is imperative to design and fund a full observing system with all the required components, ongoing dense in-situ calibrated data on the ground and aircraft, including commercial aircraft platforms, AirCore, TCCON, and then also imbed satellites .

- Bayesian retrievals formally require an unbiased prior. To what extent is this the case?
- Is a quantitative uncertainty available for each scene? What about a measure of uncertainty reduction?
- Are radiances accessible so that researchers can develop alternative retrievals?
- Importance of determining what applications are appropriate for a CrIS GHG data products – instrument capabilities are not sufficient to enable reliable annual source/sink estimation via inverse modeling.
- What features of the data are attributable to the prior? e.g. does the N_2O prior include any trend?