Global scale *in situ* measurements provide essential linkage: *"Ecosystem Change" linked to Climate, Weather, Air Quality.*

Steven C. Wofsy

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- **Ecosystem Change.**
- **Extending and Improving Weather and Air Quality Forecasts.**
- **Reducing Climate Uncertainty and Informing Societal Response.**

}

E2a (MI). Quantify the global fluxes of CO_2 and CH_4 at spatial scales of 100 – 500 km and monthly temporal resolution with uncertainty of < 25% between land ecosystems and the atmosphere, and between ocean ecosystems and the atmosphere.

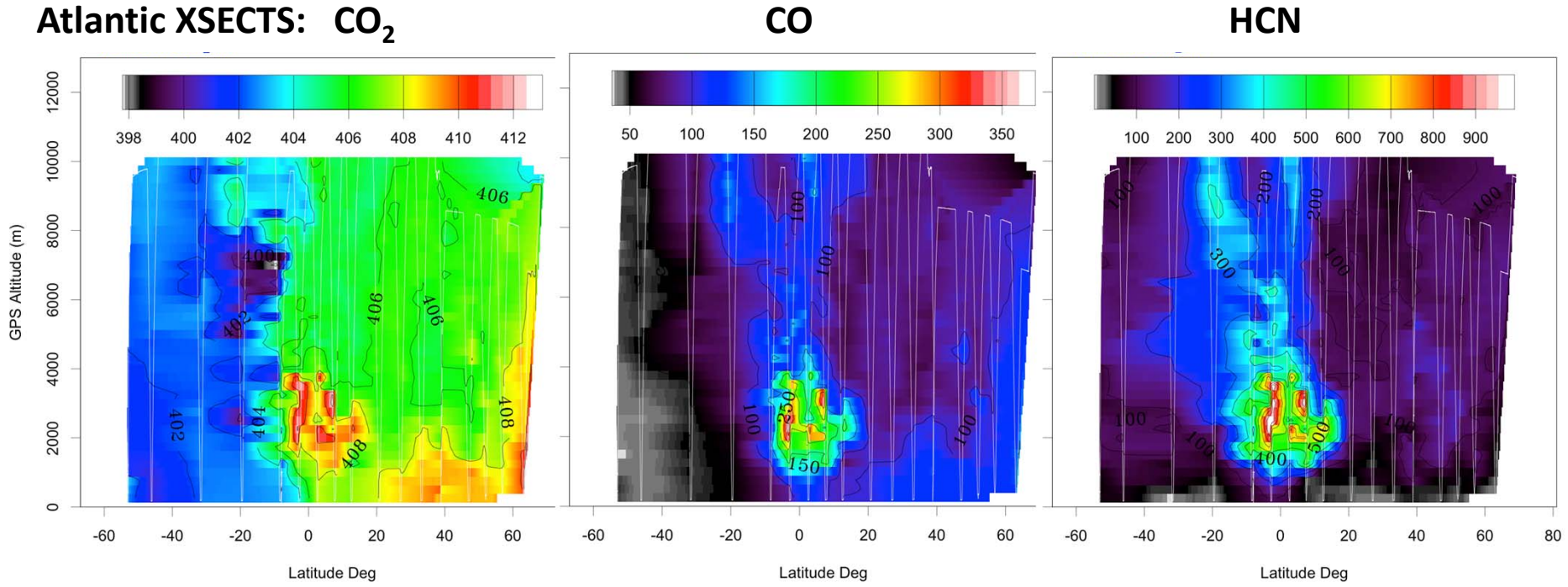
Missing concepts:

i. The large anthropogenic fluxes of CO_2 and CH_4 must be determined in order to measure the ecosystem fluxes.

ii. Emissions (biogenic and anthropogenic) and are inextricably mixed up with pollutants and aerosols.

Airborne – *in situ* – remote sensing connections:

- Tell us what is “inside the box” ;
- Diagnose underlying processes ;
- Confront global models with coordinated suites of data to test model transport, identify sources.



ATom: NASA DC-8: tracking biomass burning contributions to CO_2 ecosystem fluxes (Feb 2017)

Comparing two global missions:

HIPPO: 88 N – 67 S, Pacific only

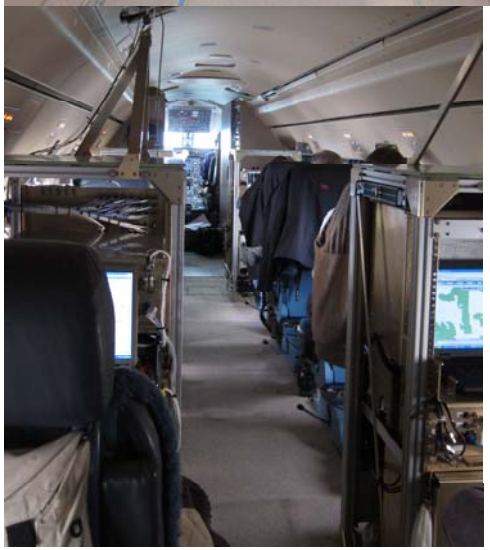
7 Major instruments
Carbon cycle, tracers, halocarbons
Total crew: 10;
Science Crew: 5

GV

ATom: 88 N – 87 S, Pacific, Atlantic, Arctic, S. Ocean, Antarctic

25 Major instruments
Carbon gases, tracers, halocarbons, reactive gases, full aerosol suite ; *freight…*
Total crew: 42; Science Crew: 25

DC-8



Width
7.5 / 5.5’

Payload
5600 lbs

Width
11’

Payload
30000
lbs

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Range, duration, payload | **1 DC-8 = 4.5 Gulfstream -V**

Unique worldwide

CO_2, CH_4 ⇔ <u>air quality, climate change</u> via atmospheric chemistry and aerosol payloads.

Global deep soundings of *in situ* measurements, the only way to deal with:

Biases: Wring out biases in global satellite data (land-sea, latitude, hemisphere, season), which lead to unacceptable biases in "global fluxes of CO_2 and CH_4 at spatial scales of 100 – 500 km with monthly resolution". See TCCON, GoSAT, OCO-2 v. 7, 8, 9.

Vertical distributions: Find algorithm issues ; what is inside the box.

Fluxes: Separate anthropogenic and ecosystem fluxes via chemical suite.

Climate interactions: Aerosols, CH_4 lifetimes, ….

<u>**Unbiased ensemble sampling** can make these data globally representative.</u>

Long range, heavy lift → Key to enable space observations to answer the most important global questions

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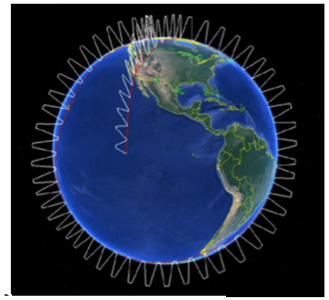
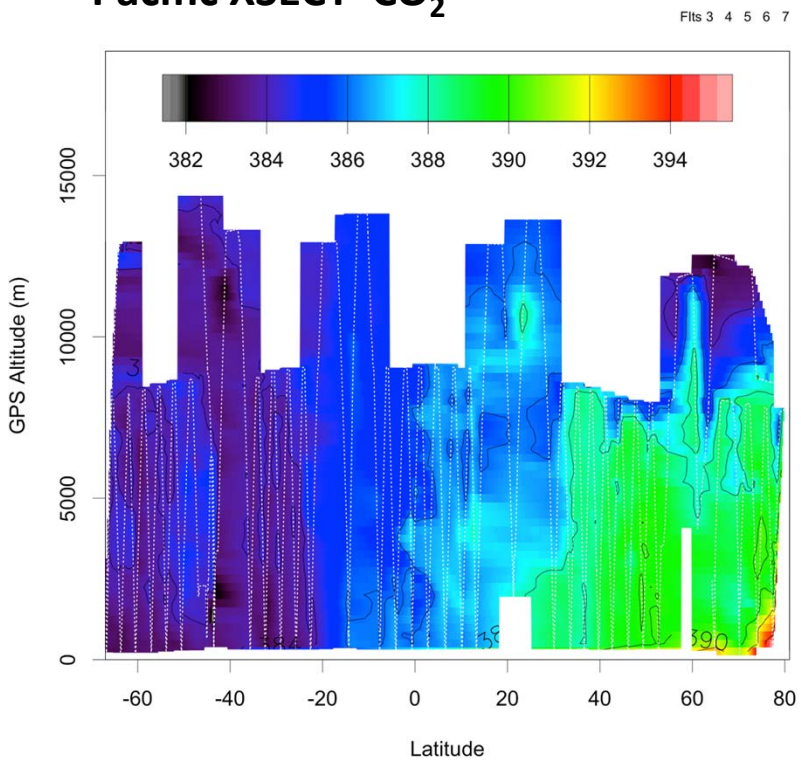
Airborne – *in situ* – remote sensing connections:

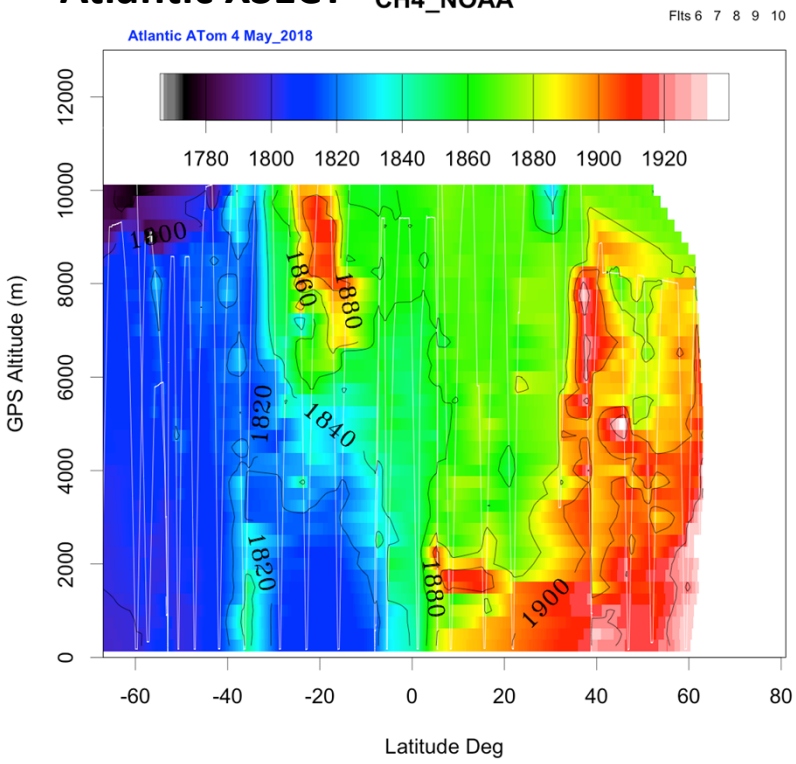
- Tell us what is “inside the box” ;
- Diagnose underlying processes ;
- Confront global models with data.



Pacific XSECT CO_2



Atlantic XSECT CH4_NOAA



HIPPO: NSF GV (2009 – 2011)

ATom: NASA DC-8 (2016 – 2018)