Toward the Atmospheric Greenhouse Gas Observing System We Need

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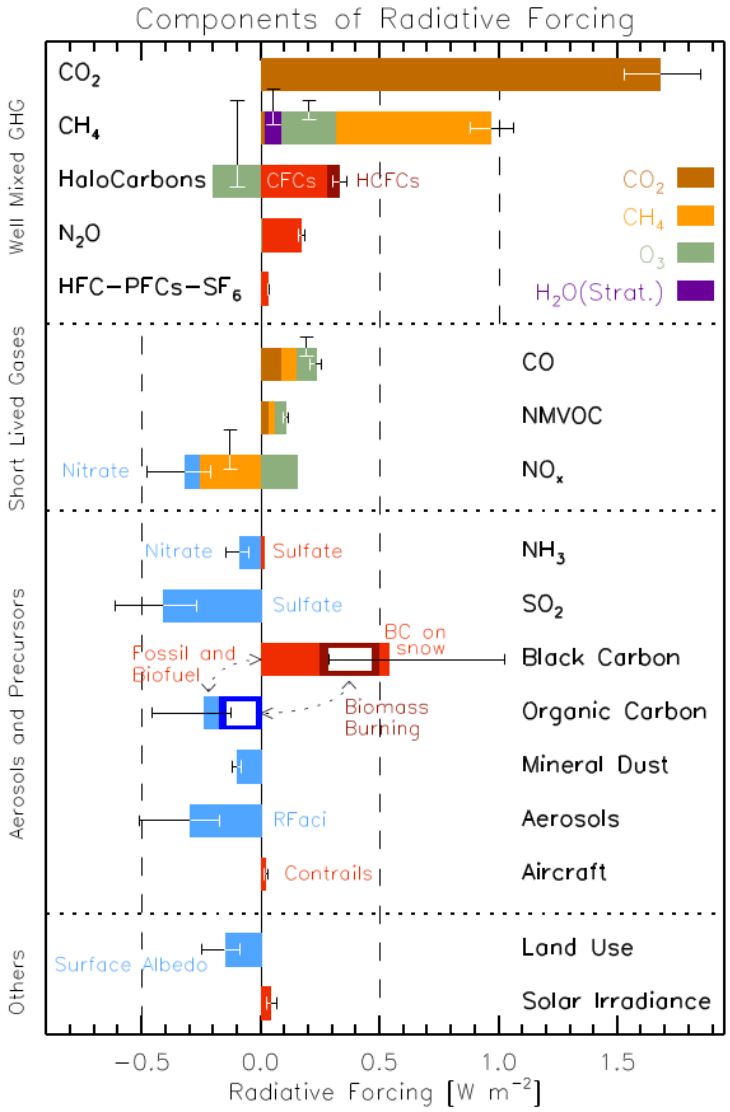
(Substituting for Pieter Tans)

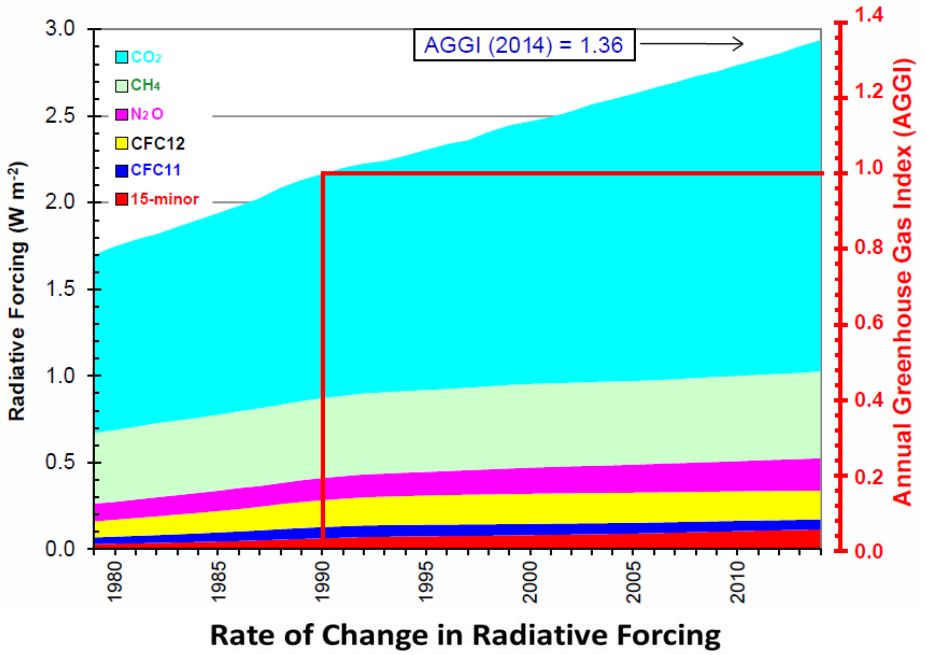
43rd Global Monitoring Annual Conference
19 May 2015

The Problem

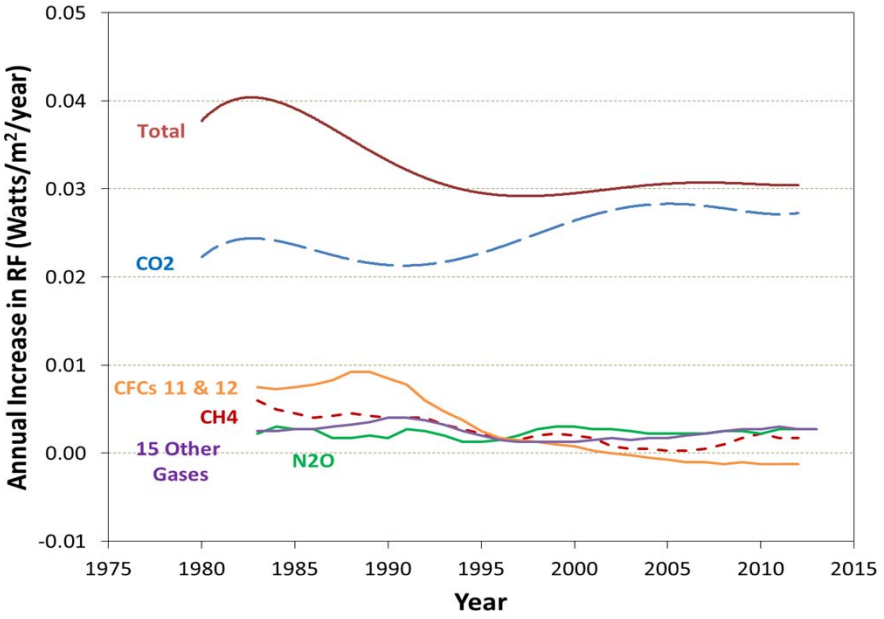
Radiative Forcing – Why we have climate change



Long lived Gases



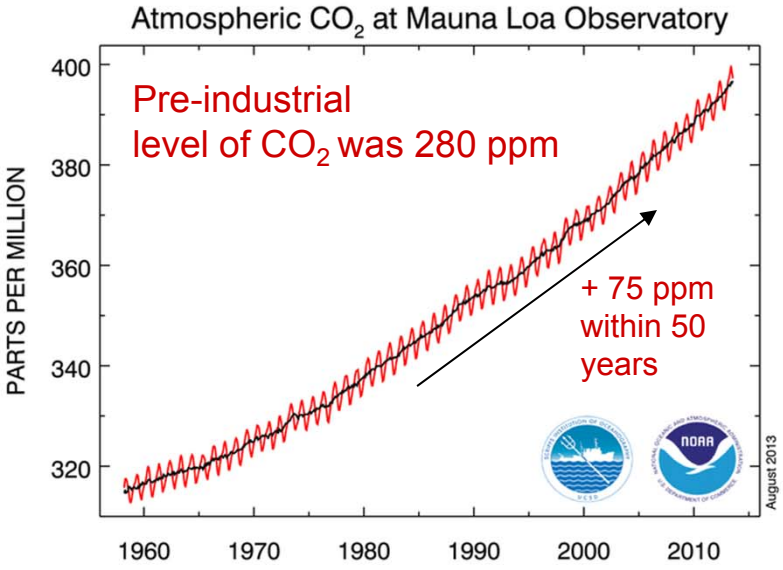
Rate of Change in Radiative Forcing

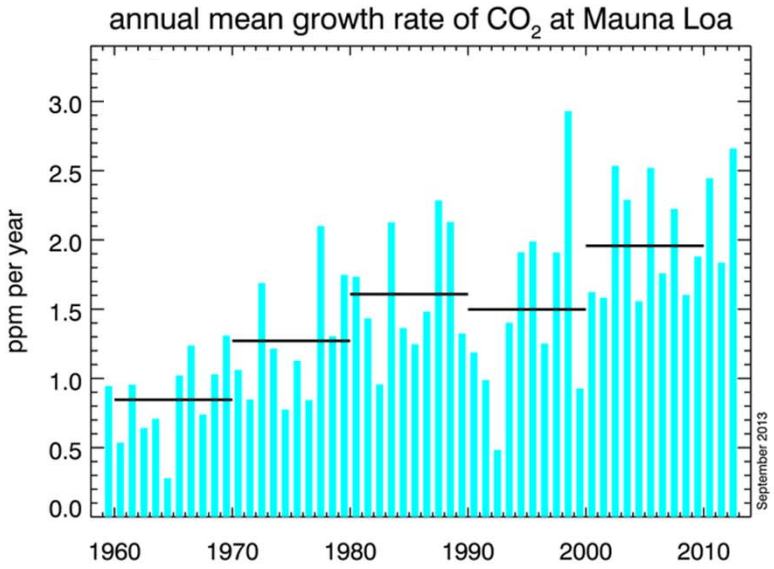


et al.

Atmospheric CO_2 - The Primary Driver of Climate Change

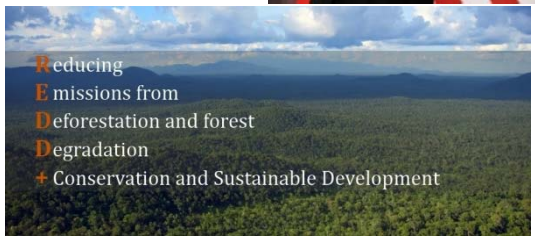
- Atmospheric CO_2 continues to increase every year
  - The trend is largely driven by fossil fuel emissions
- The growth rate increases decadally
  - Variability is largely driven by the Earth System
- The Earth System continues to capture 50% of emissions
  - Despite the increase in emissions
  - Do we understand carbon cycle?



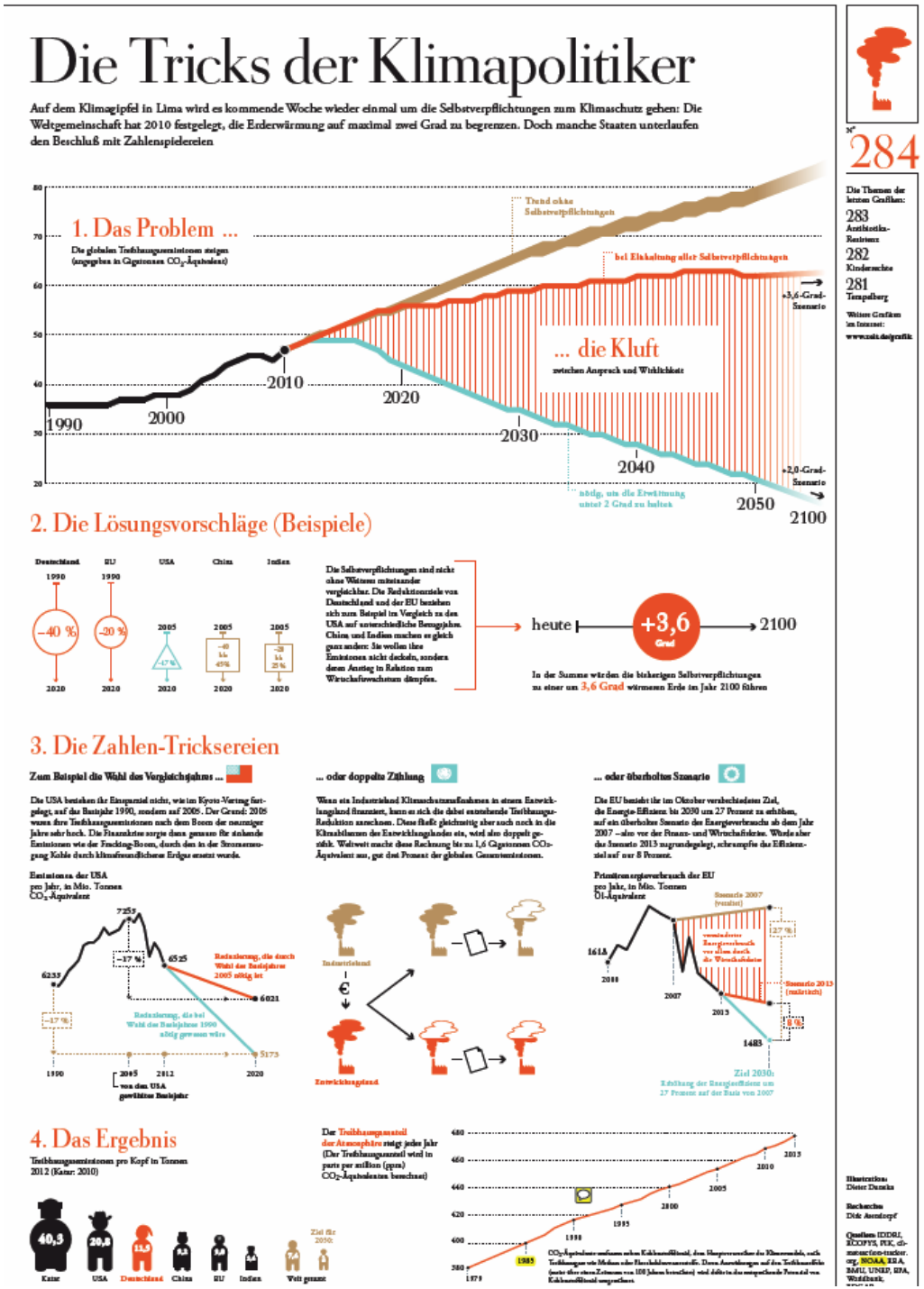


Proposed Solutions

Recent Happenings re: GHGs



- IPCC AR5 reinforces conclusions of AR4
  - Climate is changing
  - GHGs are causing it
  - Increasing atmospheric CO_2 is causing ocean acidification
  - RF keeps going up, driven mainly by increasing CO_2
- Emission reduction commitments still being made
  - Europe doubling down by 2030
  - US-China agreement
  - States, regions, and businesses making commitments
  - Enabling programs appearing



7. NOVEMBER 2014 DIE ZEIT N°49

41 GRAFIK | Thema: Klimakonferenz

Die Tricks der Klimapolitiker

Auf dem Klimagipfel in Lima wird es kommende Woche wieder einmal um die Selbstverpflichtungen zum Klimaschutz gehen: Die Weltgemeinschaft hat 2010 festgelegt, die Erderwärmung auf maximal zwei Grad zu begrenzen. Doch manche Staaten unterlaufen den Beschluß mit Zahlenspielereien

N° 284

Die Themen der letzten Grafiken:
283 Antibiotika-Resistenz
282 Kinderarmut
281 Tarifpaket

Weitere Grafiken im Internet: www.zeit.de/grafik

1. Das Problem ...

Die globalen Treibhausgasemissionen steigen (angegeben in Gigatonnen CO_2-Äquivalent)

Trend ohne Selbstverpflichtungen

bei Einhaltung aller Selbstverpflichtungen

... die Kluft

zwischen Anspruch und Wirklichkeit

+3,6-Grad-Szenario

+2,0-Grad-Szenario

nötig, um die Erwärmung unter 2 Grad zu halten

1990 2000 2010 2020 2030 2040 2050 2100

2. Die Lösungsvorschläge (Beispiele)

Deutschland 1990 −40 % 2020

EU 1990 −20 % 2020

USA 2005 −17 % 2020

China 2005 −40 bis 45 % 2020

Indien 2005 −20 bis 25 % 2020

Die Selbstverpflichtungen sind nicht ohne Weiteres miteinander vergleichbar. Die Reduktionsziele von Deutschland und der EU beziehen sich zum Beispiel im Vergleich zu den USA auf unterschiedliche Bezugsjahre. China und Indien machen es gleich ganz anders: Sie wollen ihre Emissionen nicht deckeln, sondern deren Anstieg in Relation zum Wirtschaftswachstum dämpfen.

heute +3,6 Grad 2100

In der Summe würden die bisherigen Selbstverpflichtungen zu einer um 3,6 Grad wärmeren Erde im Jahr 2100 führen

3. Die Zahlen-Tricksereien

Zum Beispiel die Wahl des Vergleichsjahrs ...

Die USA bestehen ihr Einsparziel nicht, wie im Kyoto-Vertrag festgelegt, auf das Basisjahr 1990, sondern auf 2005. Der Grund: 2005 waren ihre Treibhausgasemissionen nach dem Boom der neunziger Jahre sehr hoch. Die Finanzkrise sorgte dann genauso für sinkende Emissionen wie der Fracking-Boom, durch den in der Stromerzeugung Kohle durch klimafreundlicheres Erdgas ersetzt wurde.

Emissionen der USA pro Jahr, in Mio. Tonnen CO_2-Äquivalent

7253 6525 6021 5173 −17 % −17 % 1990 2005 2012 2020

Reduzierung, die durch Wahl des Basisjahres 2005 nötig ist

Reduzierung, die bei Wahl des Basisjahres 1990 nötig gewesen wäre

... oder doppelte Zählung

Wenn ein Industrieland Klimaschutzmaßnahmen in einem Entwicklungsland finanziert, kann es sich die dabei entstehende Treibhausgas-Reduktion anrechnen. Diese fließt gleichzeitig aber auch noch in die Klimabilanzen der Entwicklungsländer ein, wird also doppelt gezählt. Weltweit macht diese Rechnung bis zu 1,6 Gigatonnen CO_2-Äquivalent aus, gut drei Prozent der globalen Gesamtemissionen.

Industrieland € Entwicklungsland

... oder überholtes Szenario

Die EU bezieht ihr im Oktober verabschiedetes Ziel, die Energie-Effizienz bis 2030 um 27 Prozent zu erhöhen, auf ein überholtes Szenario der Energieverbrauchs ab dem Jahr 2007 – also vor der Finanz- und Wirtschaftskrise. Würde aber das Szenario 2013 zugrundegelegt, schrumpfte das Effizienzziel auf nur 8 Prozent.

Primärenergieverbrauch der EU pro Jahr, in Mio. Tonnen Öl-Äquivalent

Szenario 2007 (veraltet) 1618 2007 2013 1483 −27 % −8 % Szenario 2013 (realistisch)

Ziel 2030: Erhöhung der Energieeffizienz um 27 Prozent auf der Basis von 2007

4. Das Ergebnis

Treibhausgasemissionen pro Kopf in Tonnen 2012 (Katar: 2010)

40,3 Katar 20,0 USA 11,6 Deutschland 7,6 China 7,1 EU 1,7 Indien 4,4 Ziel für 2050: 1,4 Welt gesamt

Der Treibhausgasanteil der Atmosphäre steigt jedes Jahr (Der Treibhausgasanteil wird in parts per million (ppm) CO_2-Äquivalenten berechnet)

480 460 440 420 400 380 1978 1985 1990 1995 2000 2005 2010 2013

Illustration: Dieter Dansks

Recherche: Dirk Asendorpf

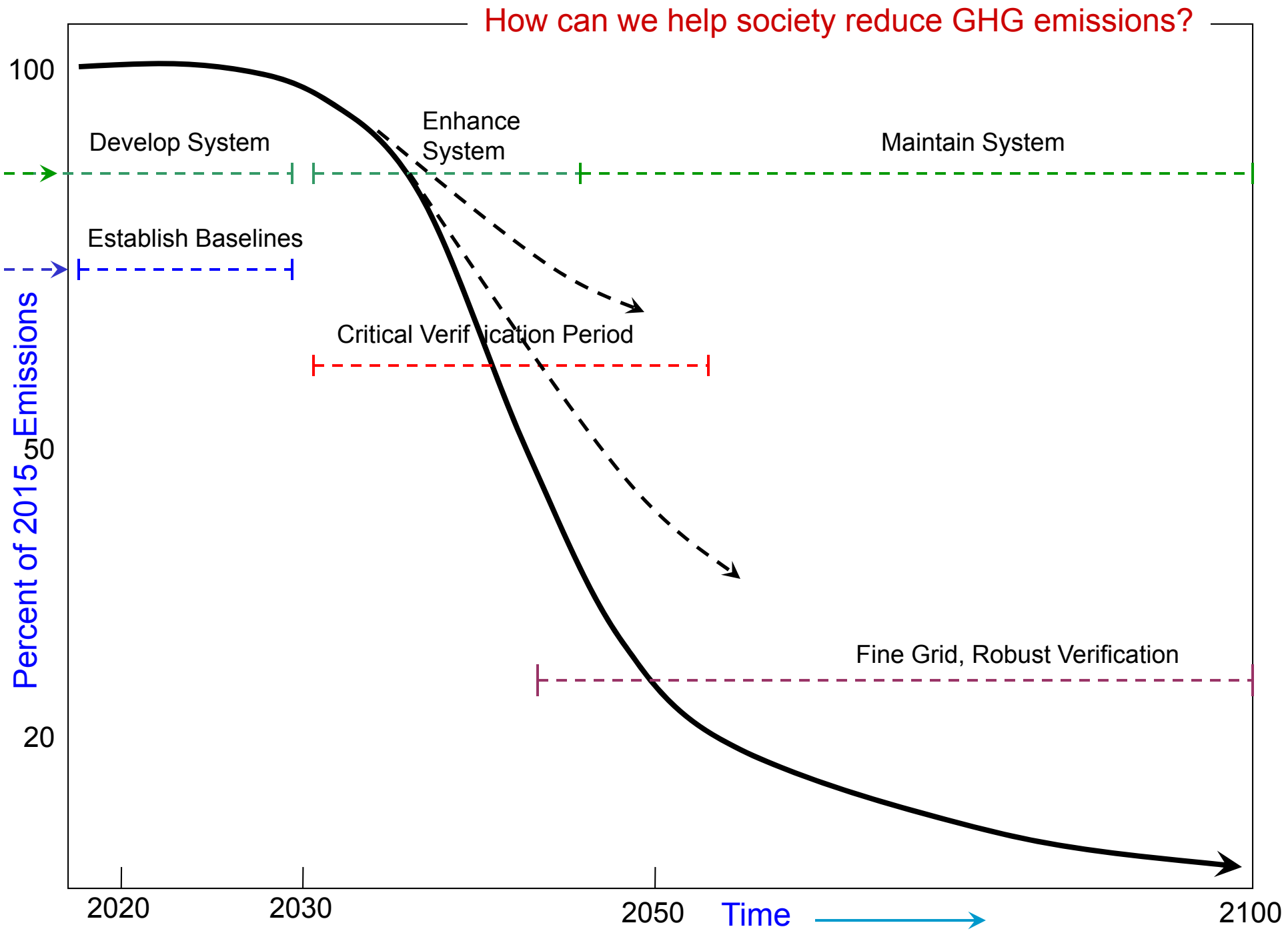
Quellen: IDDRI, ECOFYS, PIK, climateactiontracker.org, NOAA, IEA, BMU, UNEP, EPA, Weltbank, ...

Number Games . . .

- Everyone makes a commitment
- They are using different baselines
- They are using different approaches
- Exports and imports come into play
- Offsets and tradeoffs are engaged

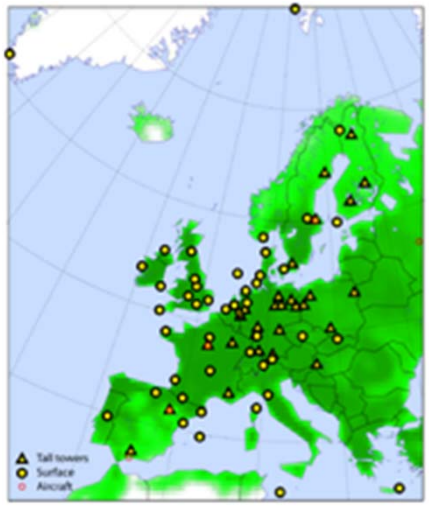
(Page is translated and presented as Poster P-53 at this meeting.)

GHGs, Butler et al.

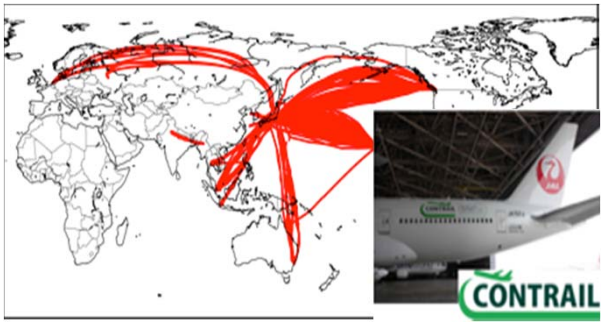

How can we help society reduce GHG emissions?
100
50
20
Percent of 2015 Emissions
Develop System
Enhance System
Maintain System
Establish Baselines
Critical Verification Period
Fine Grid, Robust Verification
2020
2030
2050
Time
2100

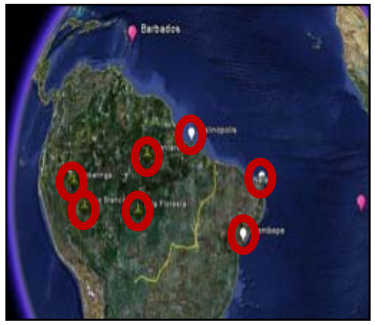
So, how are we improving observations to provide information?

Global *in situ* networks

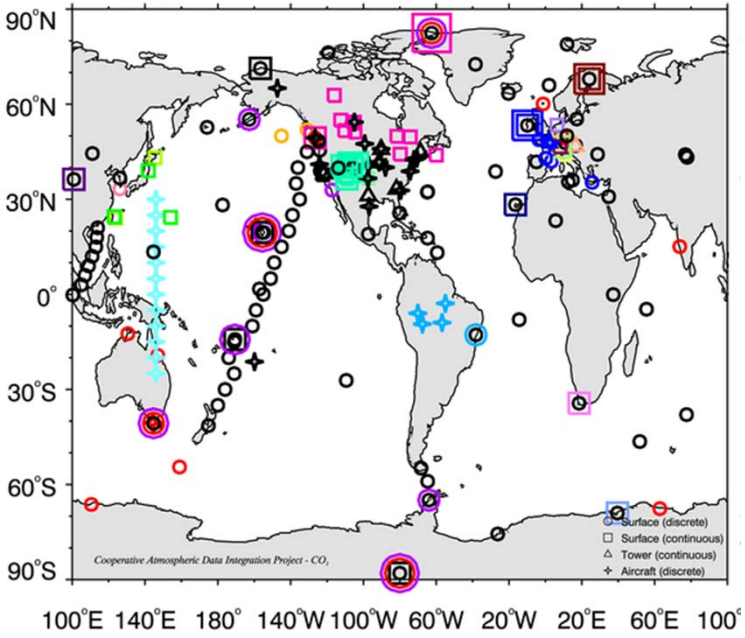


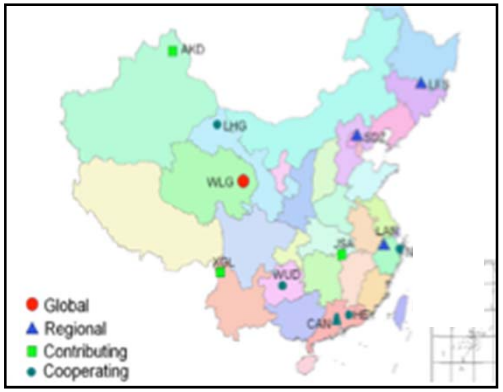
Atmospheric network

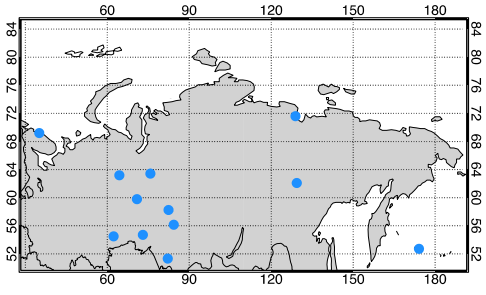




GLOBALVIEW-CO2





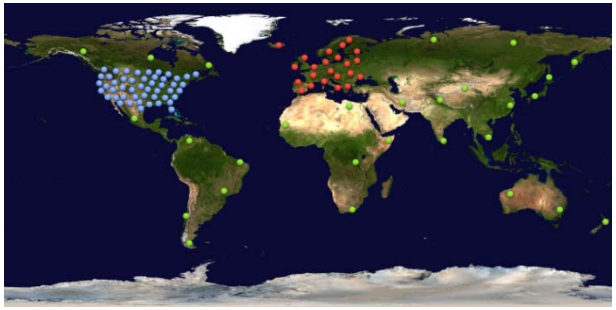


GHGs, Butler et al.

“New” Players for Observations

- Commercial Air (IAGOS et al.)
  - Builds on efforts from MOSAIC (Euro airlines), CARIBIC (Lufthansa), and CONTRAIL (Japan Airlines)
  - Fourth package approved for CO_2 and CH_4 on commercial aircraft
    - Operational, but not much funding for instrument construction
  - Many airlines are interested in participating

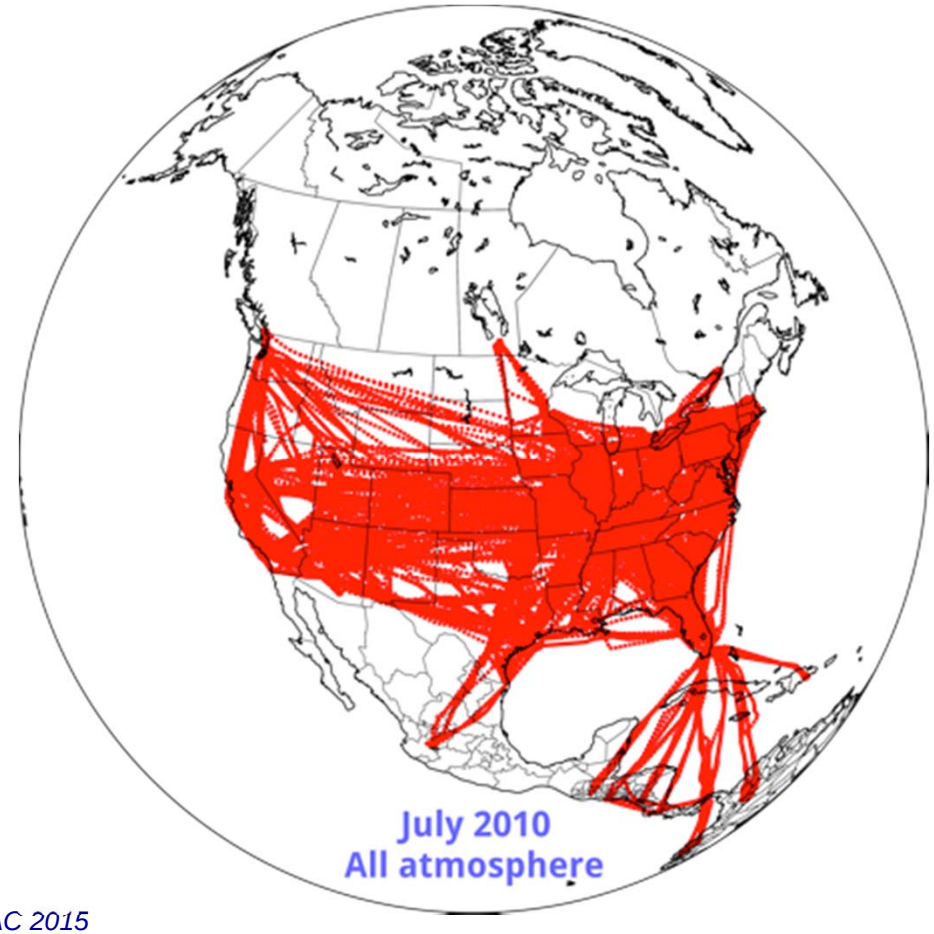
- Earth Networks
  - Investing $25M over 5 years to enhance global network with ~100 sites
    - Enhancement of ~40% over existing network
    - Committed to high quality positions



- Satellites (Existing and *Forthcoming)
  - AIRS/IASI (passive, mid-tropospheric sensors)
  - SCHIAMACHY (passive sensor)
  - GOSAT (passive sensor, large footprint)
  - OCO-2 (passive sensor, small footprint)
  - *ASCENDS (active laser)

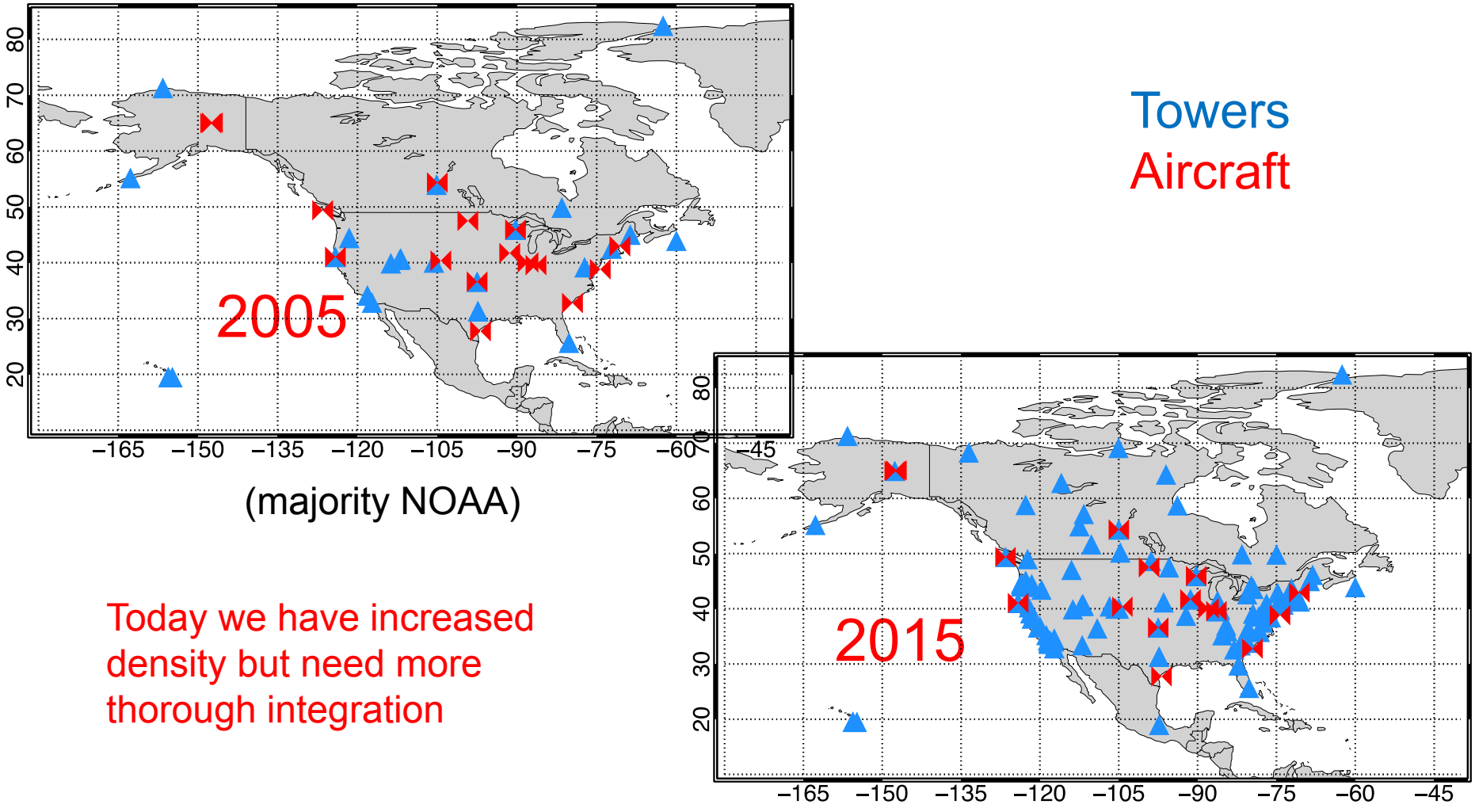
A potential new platform: U.S.-based commercial aircraft network.

(based on NOAA's existing
Airborne Water Vapor Sensing System)



- Similar (but smaller) systems exist in Japan and Europe
- Would provide 6-10 profiles/plane/day
- High altitude observations provide a link between satellites and surface in situ

North American CO_2 observations



(majority NOAA)

Today we have increased density but need more thorough integration

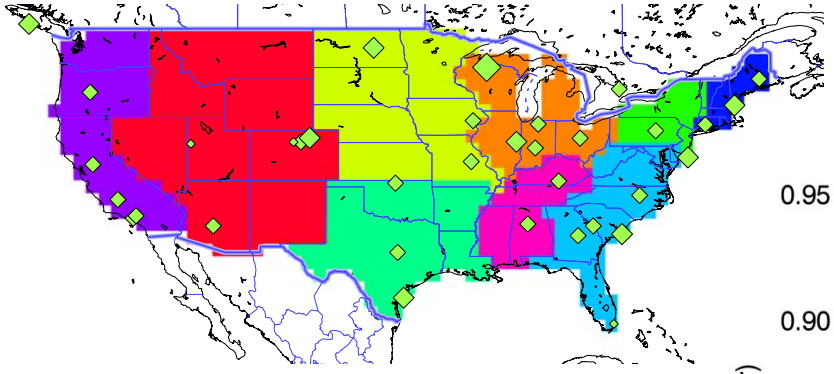
→ NEON will add to this.

(Earth Networks, Environment Canada, NOAA and others)

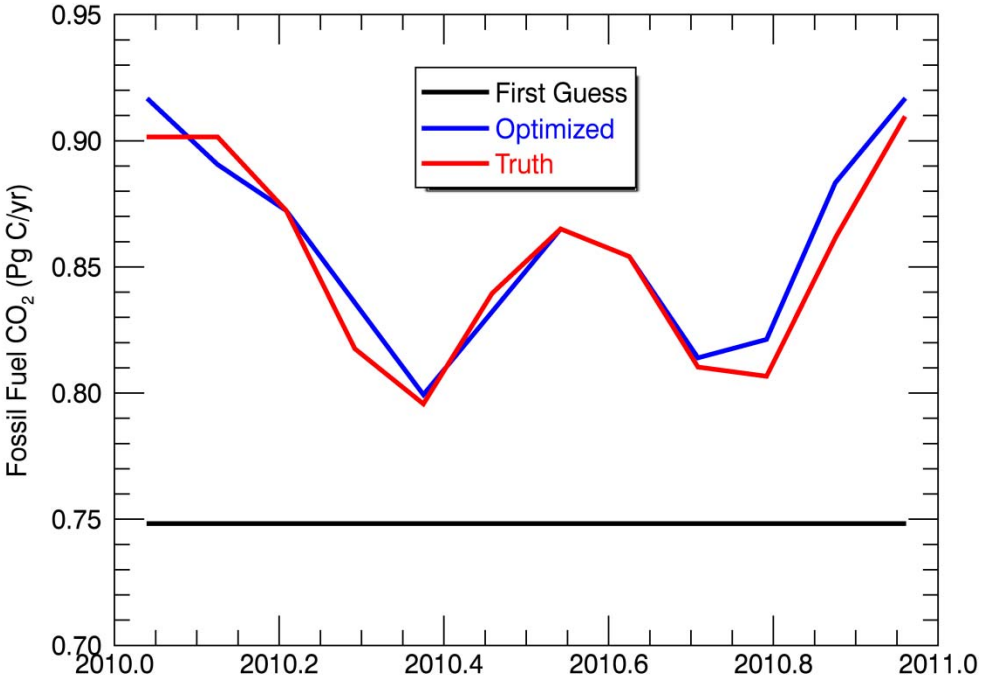
5000 Radiocarbon measurements allow "accurate" assessment of $FFCO_2$

→ ***Regional emission uncertainty of ~5-10%***

14CO2 OSSE network



US East Coast FFCO2 Emissions

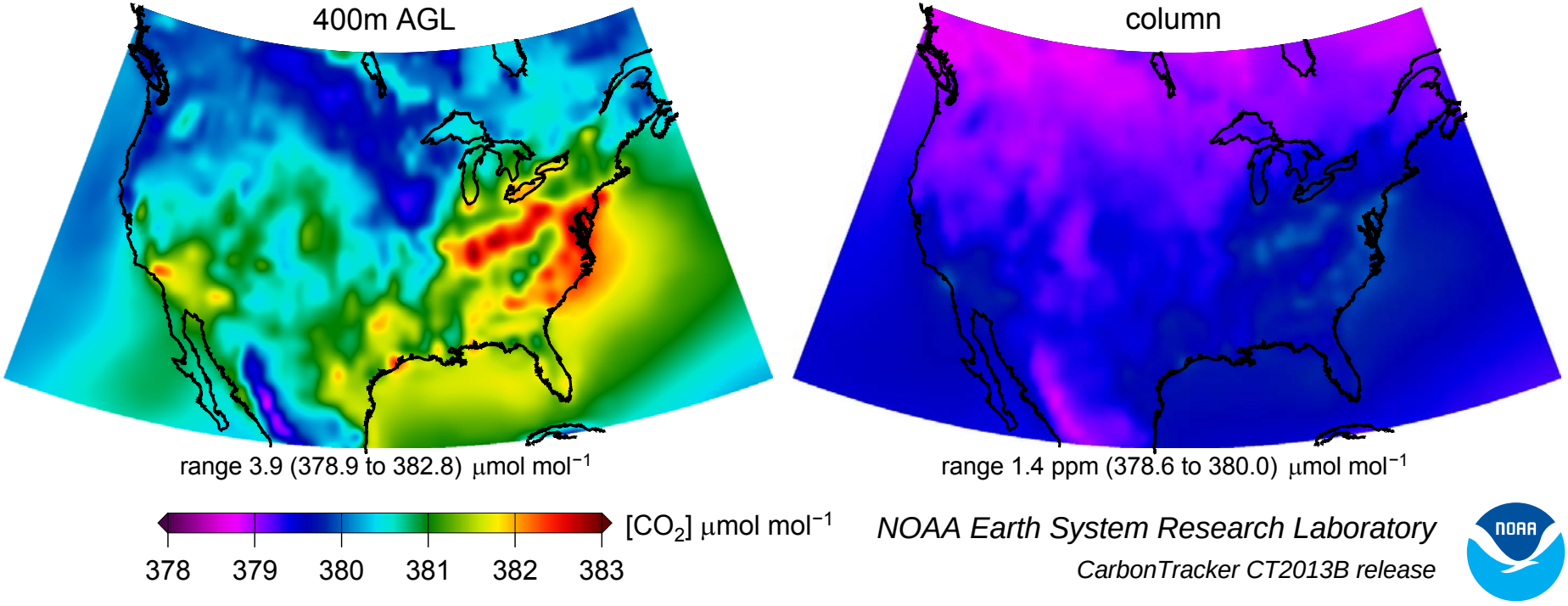


→ ***Follows National Research Council recommendation of large increase in $^{14}CO_2$ measurements to verify emissions***

Satellites

Small east-west differences (especially in the column) require high accuracy and precision

CarbonTracker 2005 CO_2 sampled at 13:30 LST

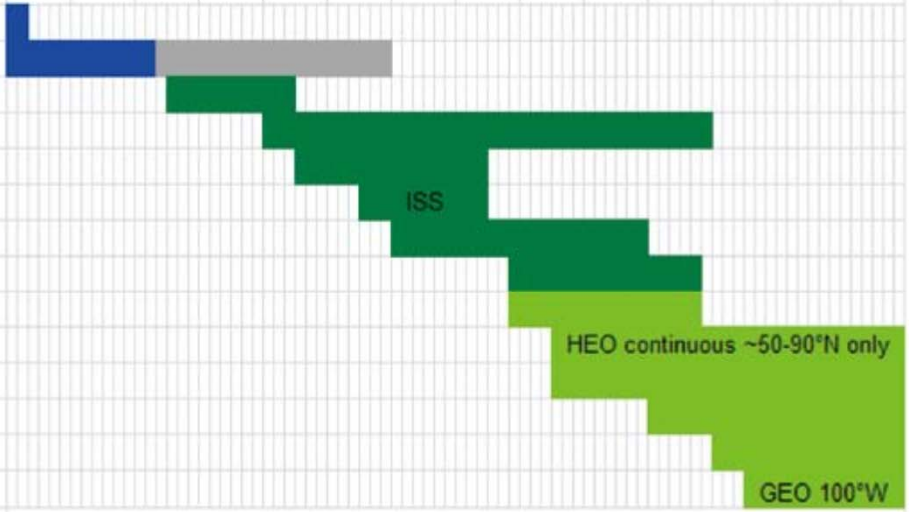


Expanded suite of satellites for the future

- Constellations of CO_2 satellites, including geo-stationary platforms (not considered below)

From “CEOS Strategy for Carbon Observations from Space’

Satellite, Instrument (Agencies)	CO_2	CH_4	FOV
ENVISAT SCIAMACHY (ESA)	•	•	30x60 km²
GOSAT TANSO-FTS (JAXA-NIES-MOE)	•	•	10.5 km (d)
OCO-2 (NASA)	•		1.29x2.25 km²
Sentinel-5P TROPOMI (ESA)		•	7x7 km²
TanSat (CAS-MOST-CMA)	•		1x2 km²
OCO-3 (NASA)	•		~4 km²
GOSAT-2 TANSO-FTS (JAXA-NIES-MOE)	•	•	10.5 km (d)
MERLIN (DLR-CNES)		•	0.135 km (w)
MicroCarb (CNES)	•		25 km²
PCW-PHEOS-FTS (CSA)	?	•	10x10 km²
MetOpSG Sentinel-5 (ESA-EUMETSAT)		•	7x7 km²
CarbonSat (ESA)	•	•	2x3 km²
ASCENDS (NASA)	•		0.100 km (w)
GEO-CAPE (NASA)		•	4x4 km²

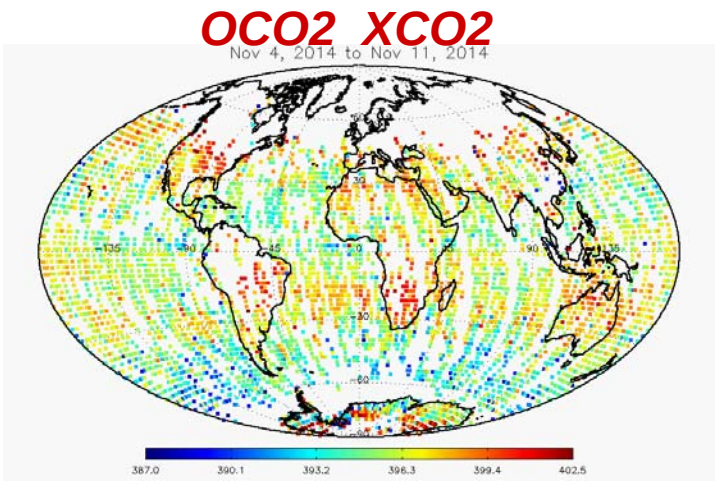


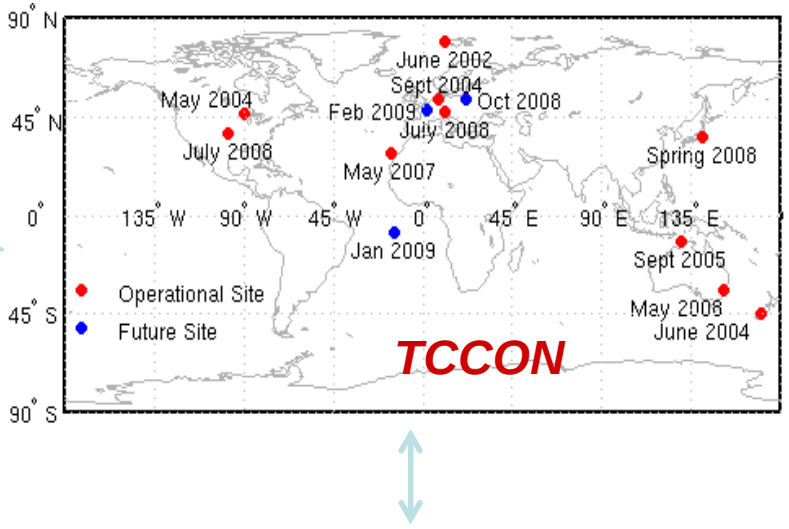
Based on information from various sources

d = diameter
w = width of a narrow strip along orbit track

Operating | Planned | Considered | Mission Extension

Improved satellite validation with expanded TCCON, Aircore and aircraft





Linkage to WMO CO_2 Calibration scale

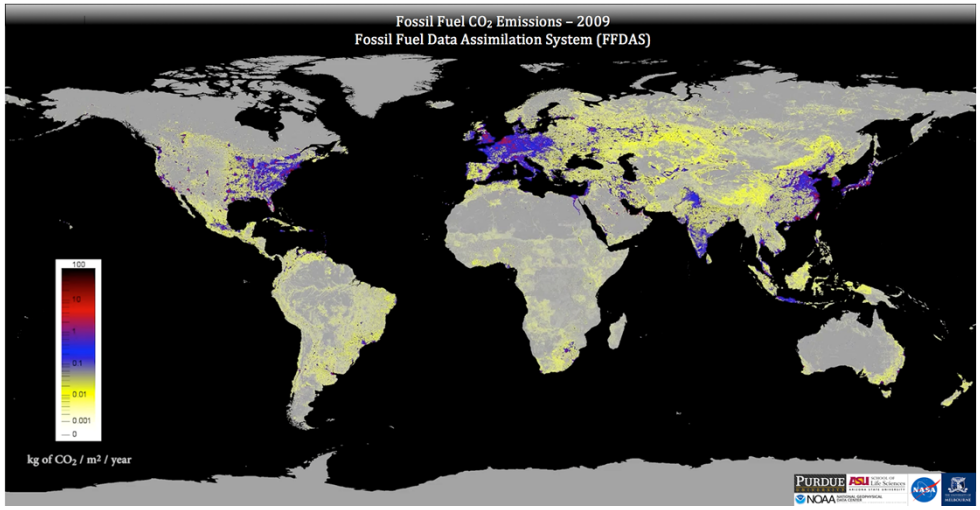
Aircore

Aircraft profiles

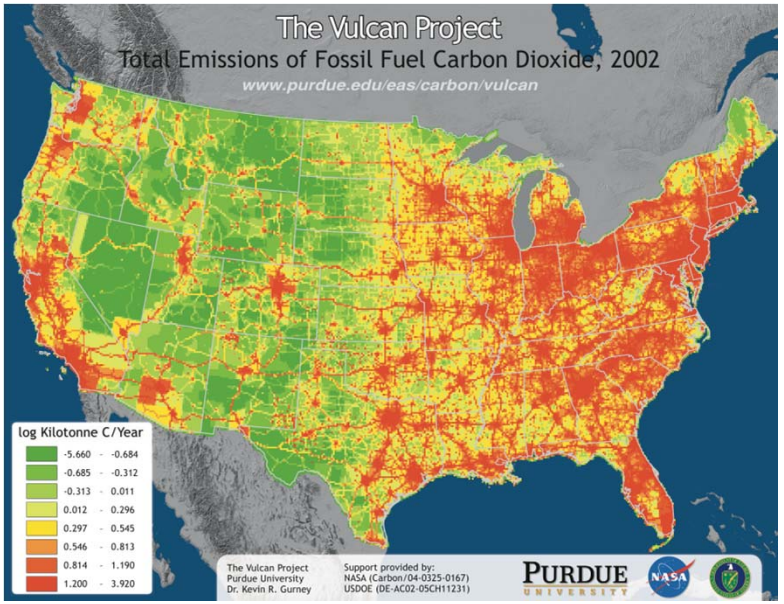
Providing Information . . .

Fossil Fuel Inventories

- Emissions are the “knobs” that need to be turned
- Currently lag real time by ~ 4 (1-10) years. This could be greatly improved.



FFDAS

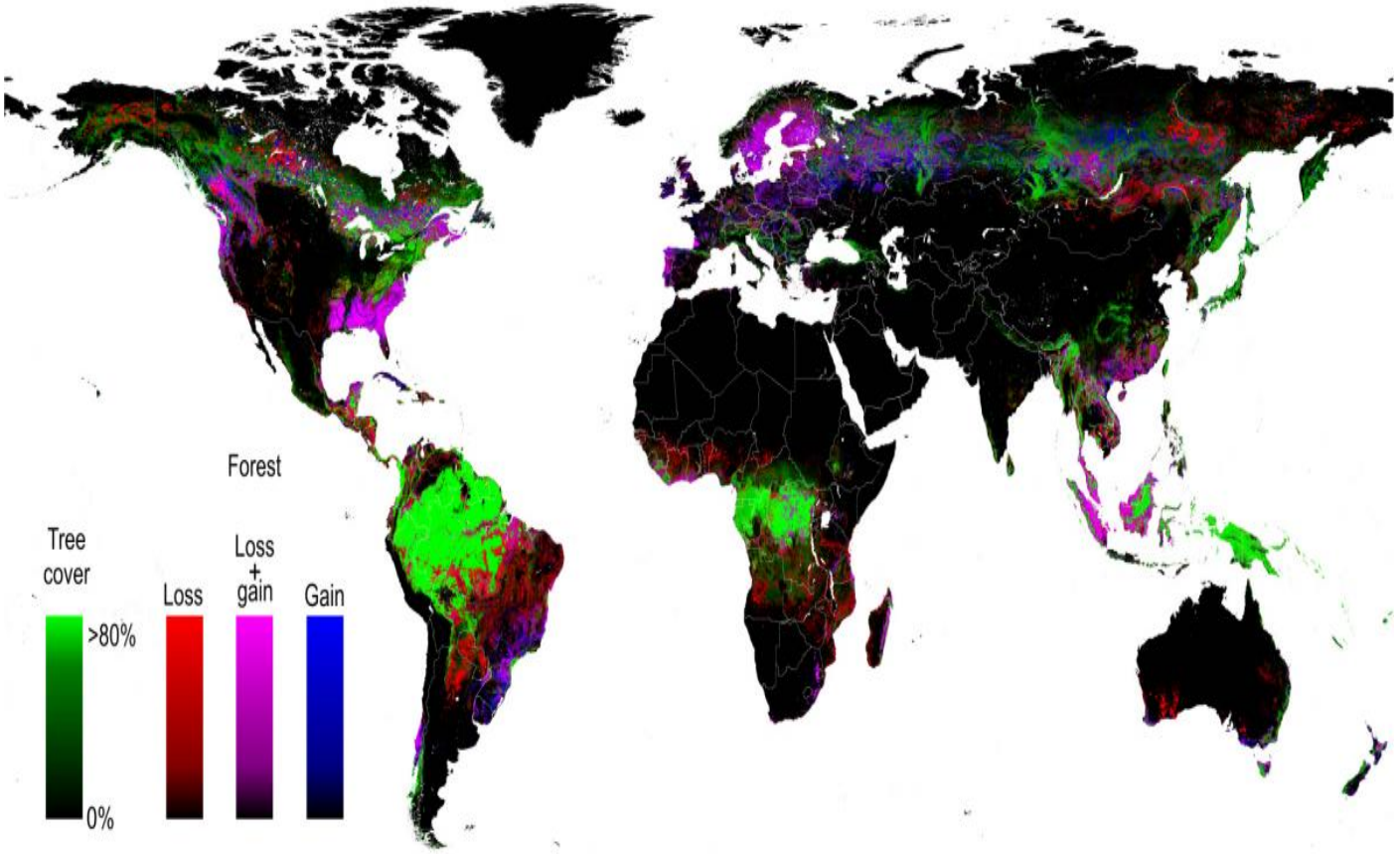


Vulcan

Land Disturbance

- Need to ensure continuity and improved resolution of remote sensing data sources

Global Forest Cover Change 2000-2012



GHGs, Butler et al.

"Information System" Goals

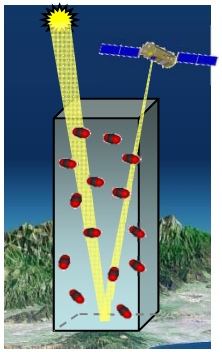
Direct improvements

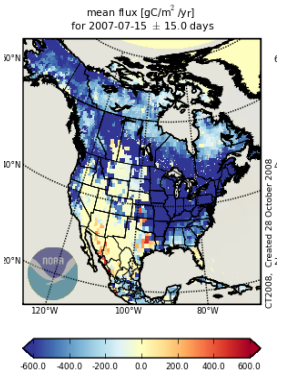
- More observations and improved data management
  - Isotopes and tracers
  - Vertical profiles
  - Compatibility
  - Near real-time data availability
- Higher resolution transport models
- Advanced data assimilation capabilities

Potential outcomes

- Better understanding of distribution and trends of GHGs
- Validation of emission reductions at subcontinental scales
- Separation of human and natural influences
- Separation of ocean and terrestrial influences
- Ultimately . . . . successful policy implementation

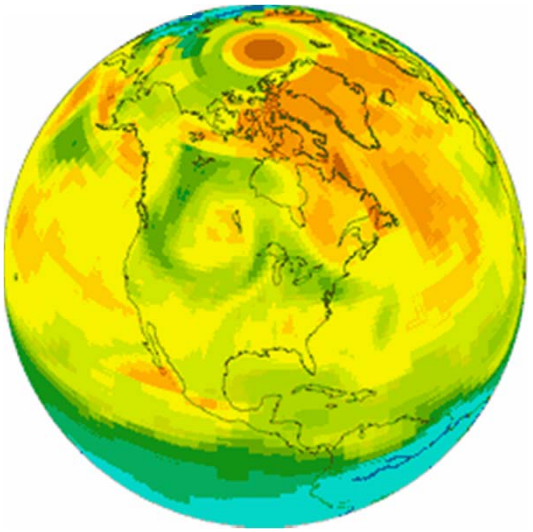
Satellites





China

“Carbon Weather”

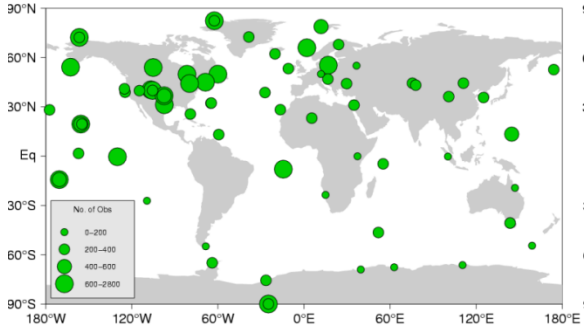


Questions?

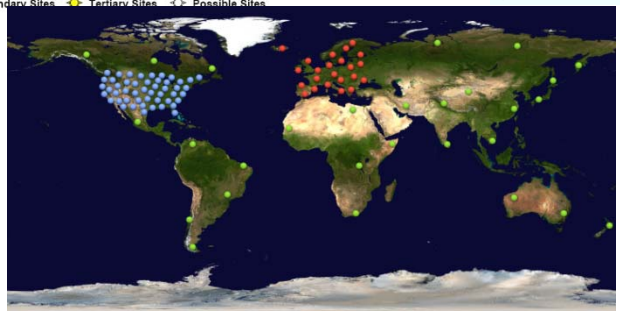
TCCON

SE Asia

Current Network



Earth Networks



Brazil