Bye-bye, two degree target?

Recent development in observed CO_2 and CH_4: Do we see any signs of reductions?

Cathrine Lund Myhre

NILU - Norsk institutt for luftforskning

Norwegian Institute for Air Research

Contributions from

Ove Hermansen & Ann Mari Fjæraa (NILU)

H.C. Hansson and B. Noone (University of Stockholm)

Gunnar Myhre (Cicero)

NILU

nature International weekly journal of science

Search Go

Advanced search

Home | News & Comment | Research | Careers & Jobs | Current Issue | Archive | Audio & Video | For Authors

Archive > Volume 497 > Issue 7447 > News > Article

NATURE | NEWS

Global carbon dioxide levels r milestone

Concentrations of greenhouse gas will soon surpas spot.

Richard Monastersky

30 April 2013

Continuing reliance on coal, which fuels this power plant in in the atmosphere ever higher.

RENE CLEMENT/POLARIS/EYEVINE

Near the moonscape summit of the Mauna Loa volca Hawaii, an infrared analyser will soon make history. S the next month, it is expected to record a daily conce carbon dioxide in the atmosphere of more than 400 p million (p.p.m.), a value not reached at this key surve

INTERNATIONAL | POLITIQUE | SOCIÉTÉ | ÉCO | CULTURE | IDÉES | PLANÈTE | SPORT | SCIENCES | TECHN

M Planète

PLANÈTE | Climat | Énergies | Ressources nat

Le taux de CO2 haut depuis plu d'années

LE MONDE | 08.05.2013 à 11h11

Par Stéphane Foucart

Abonnez-vous à partir de 1 €

Réagir | Classer

Recommander | Envoyer | 1 791

Un cap symbolique est en passe que l'homme est apparu sur Ter d'années... Le seuil de 400 part (CO2) atmosphérique devrait êtr historique de la station de Maur l'ère moderne ont été menées, Keeling.

La concentration de CO2 dans l'hémisphère Nord, ne franchira plusieurs années.

A Mauna Loa, la concentration ppm. La veille, l'Organisation m public son bilan climatologique de phénomènes extrêmes : séch

2012 AU NEUVIÈME RANG DE

"La variabilité naturelle du clima les caractéristiques physiques d climatiques résultent de plus en

Michel Jarraud, secrétaire génér

Celle-ci place l'année 2012 au observées depuis la fin du XIXe CO2 n'excédait pas alors les 30 au cours du dernier million d'an

Accélération brutale

ÉVOLUTION DE LA CONCENTRATION EN DIO

... DEPUIS 2 ANS (moyenne hebdomadaire

... DEPUIS 800 000 ans

400

theguardian

News | Sport | Comment | Culture | Business

Environment > Climate change

Global ca passes mi

Climate warmin the first time in

Damian Carrington

The Guardian, Frida

Jump to comme

Hawaii's Mauna Loa documented. Photo

For the first time carbon dioxide in parts per million (ppm). The last time so much gre

Observed concentration Atmosphere Watch stati

Observed concentrations parts per million (ppm) thr Atmosphere Watch netwo greenhouse gas, which is activities and is the main thousands of years, trapp life on earth.

On May 9, 2013, the daily Hawaii, recorded a readin Administration. Mauna Lo and so is widely regarded

Several other Global Atm the 400 ppm threshold du spring before vegetation g

The threshold was first cr was registered at Barrow, Canada (82.5N). From the in Ny-Ålesund, Norway, (a crossed at stations closer exceeding 400 ppm at the carrying out measuremen

The Global Atmosphere W methane and nitrous oxid

NRK | Nyheter | TV | Radio | Snarveier

Nordnytt | Forsiden

Aldri før har målestasjonen på Zeppelin-fjellet på Svalbard målt så høy CO2-konsentrasjon i lufta som i mars i år.

Rekordmye CO2 målt i lufta på Svalbar

Norske målinger viser rekordstor konsentrasjon av CO2 i lufta på Svalbard i mars. – Terskelen vi tid er nådd, sier luftforsker.

Publisert 26.07.2012, kl. 12.57

AV

Siden i fjor høst har Norge ved Norsk institutt for luftforskning (NILU) gjort egne målinger av CO2-konsentrasjonen i lufta på Svalbard.

CO2-konsentrasjon i luft måles i såkalte ppm, eller parts per million. Resultatene fra målestasjonen Zeppelin ved Ny-Ålesund i mars 2012 overgikk gamle rekorder.

– For første gang i historien har vi målt en månedsmiddelverdi her på over 400 ppm, sier seniorforsker ved NILU Cathrine Lund Myhre.

- **LES OGSÅ:** Fant tropisk plankton i arktisk hav
- **LES OGSÅ:** Faretruende issmelting på Grønland
- **LES OGSÅ:** Grønlands isbreer smeltet raskt også på 1930-tallet

Ikke overraskende

Det er et internasjonalt mål om at den globale oppvarmingen skal holdes under 2 grader i gjennomsnittstemperatur sammenlignet med før industrialiseringen startet på slutten av 1700-tallet.

– Da er det en vitenskapelig forståelse om at CO2-konsentrasjonen i lufta må holdes under 400 ppm, sier Lund Myhre som forteller at konsentrasjonen har økt jevnt siden målingene tok til internasjonalt på 1950-tallet.

– Vi vet det at det har vært en økning på rundt to ppm i året siden den tid, så jeg er ikke overrasket over resultatene fra Svalbard.

NILU

An recognized goal: limit the manmade global warming to 2º corresponding to ca 400 ppm CO_2

Scientific community -> IPCC -> EU -> Norway with government and authorities

In 1996 the EU adopted a target of a maximum 2°C rise in global mean temperature, compared to pre-industrial levels.

18 December 2009: the 15th session of the Conference of Parties (COP 15) to the United Nations Framework Convention on Climate Change:

- To prevent dangerous anthropogenic interference with the climate system, recognizes "the scientific view that the increase in global temperature should be below 2 degrees Celsius", in a context of sustainable development, to combat climate change.

IPCC AR4 has indicated that achieving the 2 ºC target with “reasonable probability” will mean stabilising greenhouse gas (GHG) concentrations in the atmosphere at about 445 to 490 ppm CO2-equivalents (WG3)

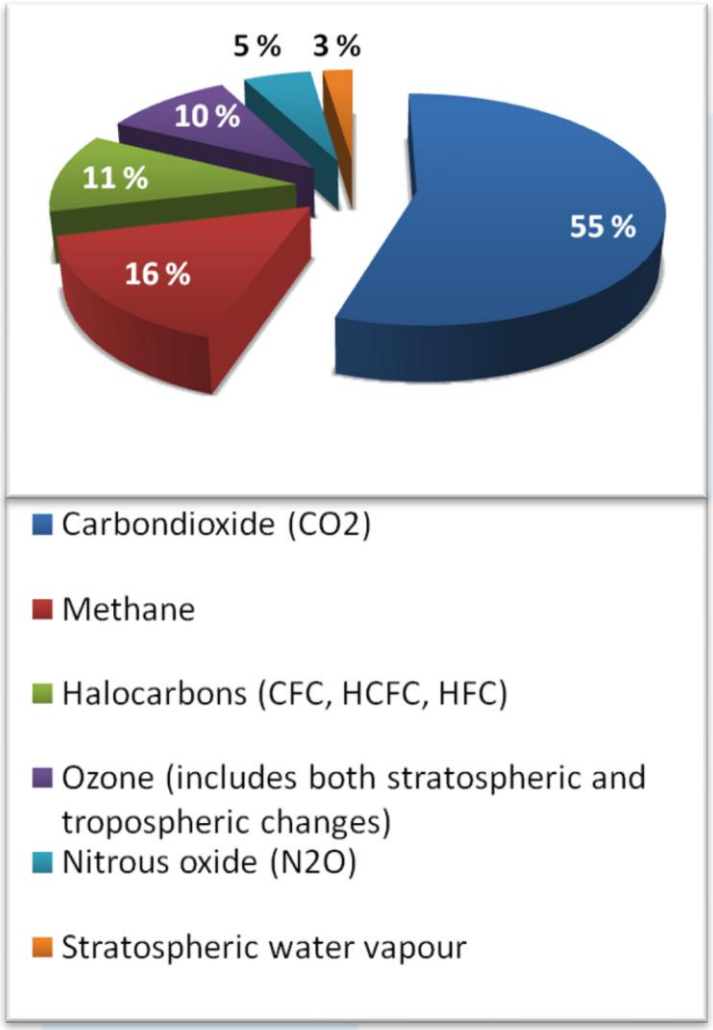
NILU

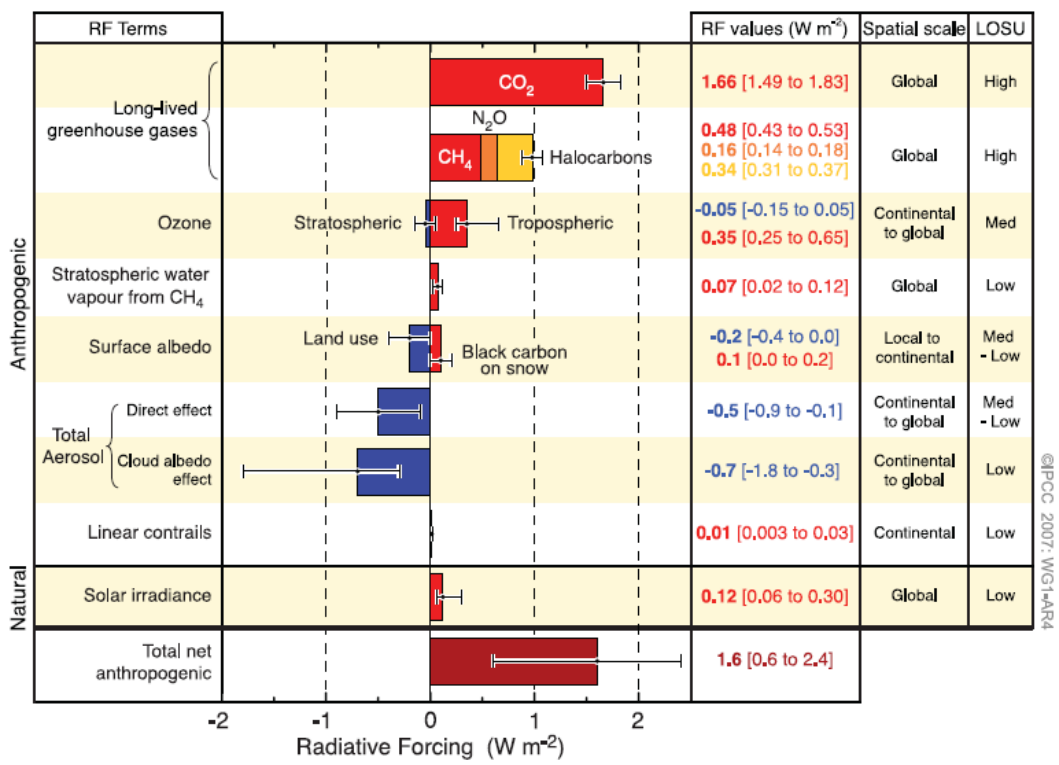
Outline

- Development of CO_2 and CH_4 in a historical perspective
- Interpretation of observations
  - The importance of adequate measurements networks
- The most important greenhouse gases and their recent development and trends
- What about the relationship 2°C and 400 ppm ?
  - CO_2 equivalents
  - Climate sensitivity
  - Other important factors

NILU

The main greenhouse gases and their contribution to change in radiative balance from 1750-2005

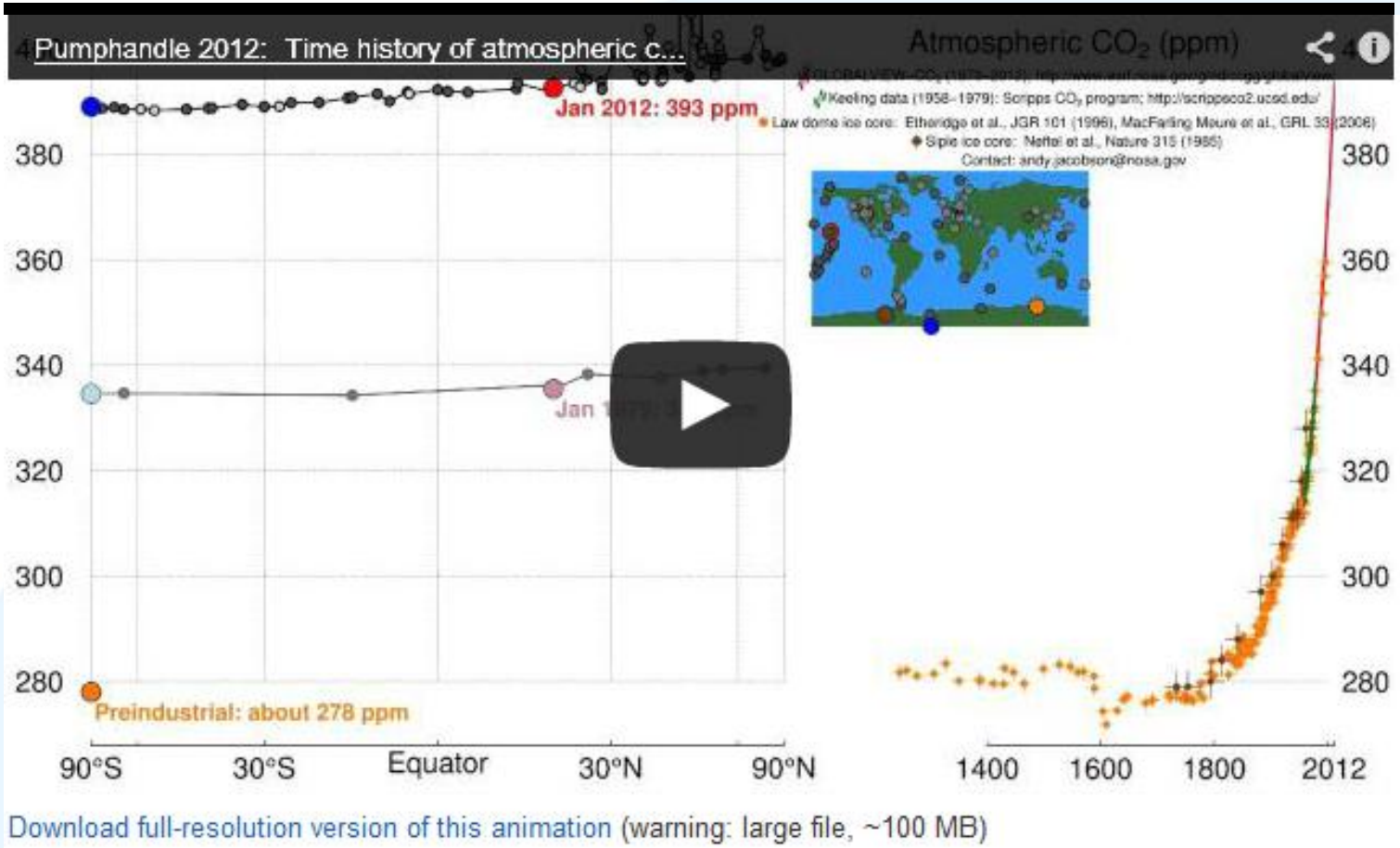




->ΔT = ca + 0.8 °C since 1750

NILU

Time history of atmospheric carbon dioxide from 800,000 years ago until January, 2012.

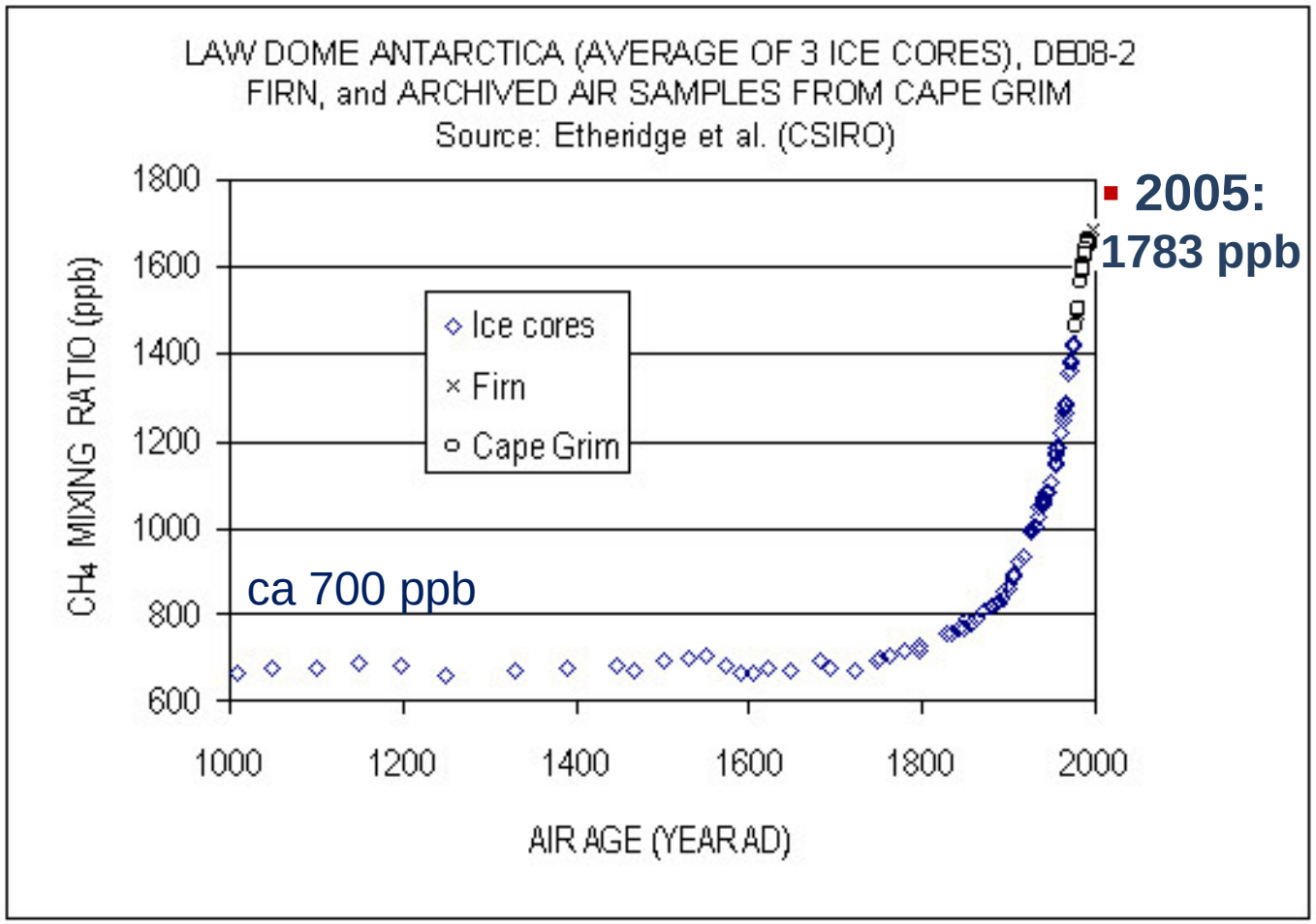


Download full-resolution version of this animation (warning: large file, ~100 MB)

Provided by
National Oceanic & Atmospheric Administration- NOAA Research
http://www.esrl.noaa.gov/gmd/ccgg/trends/history.html

NILU

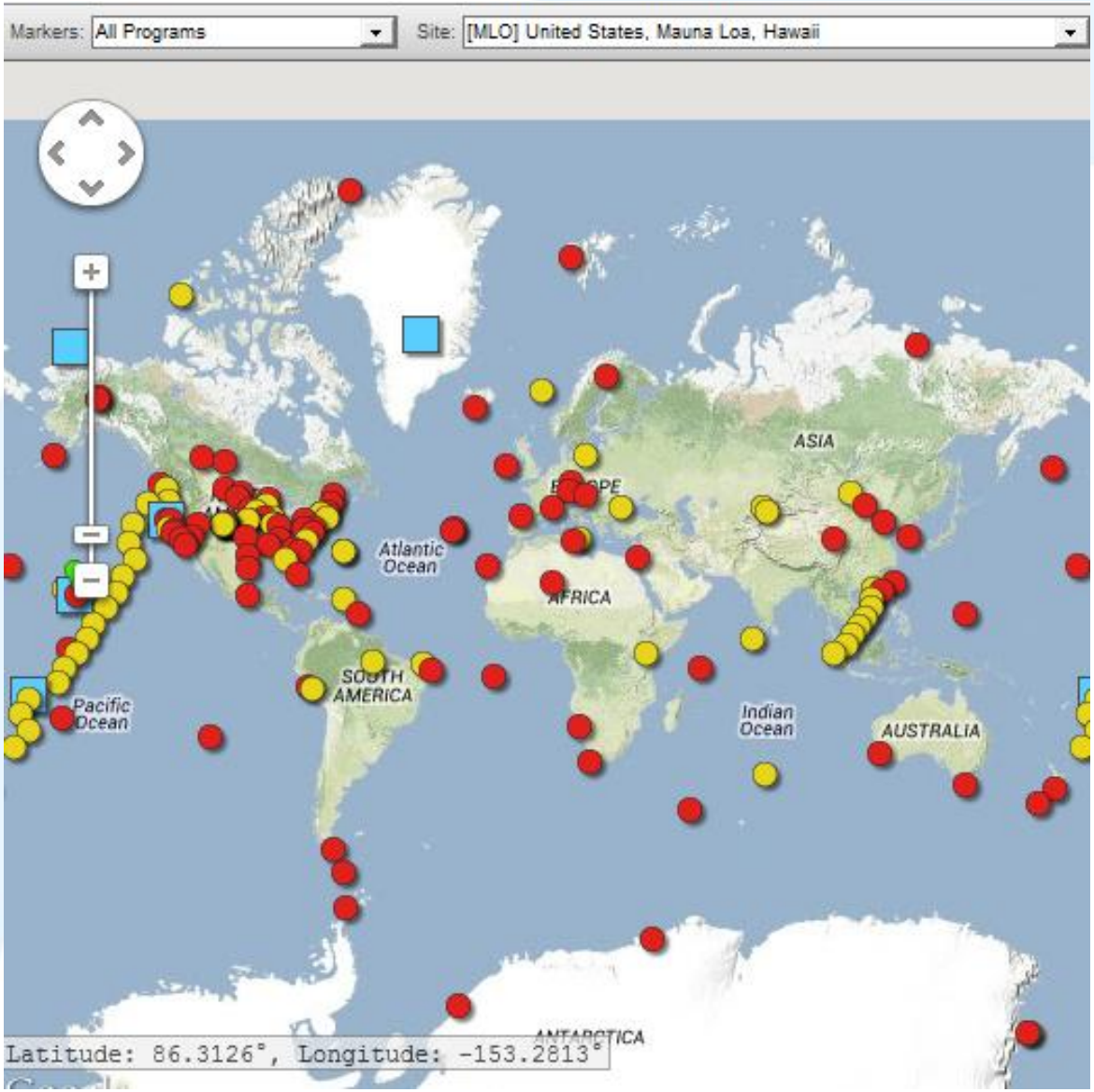
Time history of atmospheric CH_4 from the year 1000 until, 2005



http://gcmd.nasa.gov/KeywordSearch/Metadata.do?Portal=amd&KeywordPath=Parameters%7CPALEOCLIMATE%7CICE+CORE+RECORDS%7CMETHANE&EntryId=CDIAC_CH4_LAWDOME&MetadataView=Full&MetadataType=0&lbnode=mdlb3

NILU

The importance of sites, networks, location



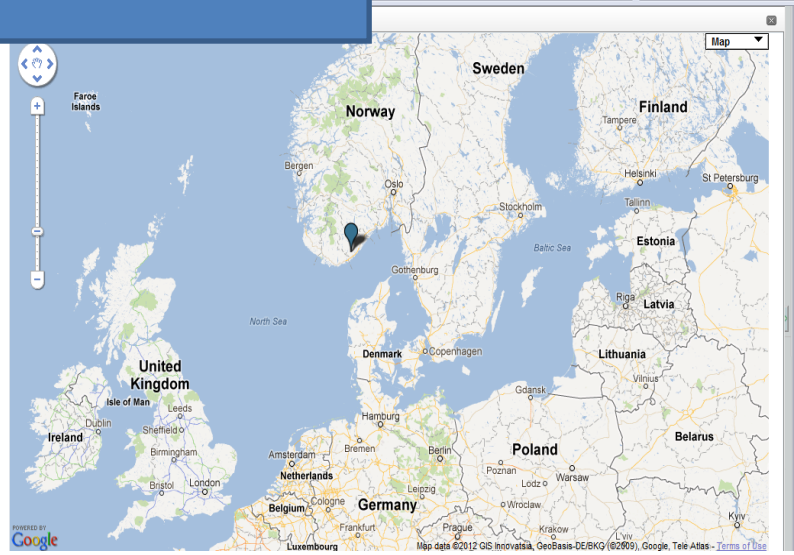
NILU

The importance of sites, networks, location

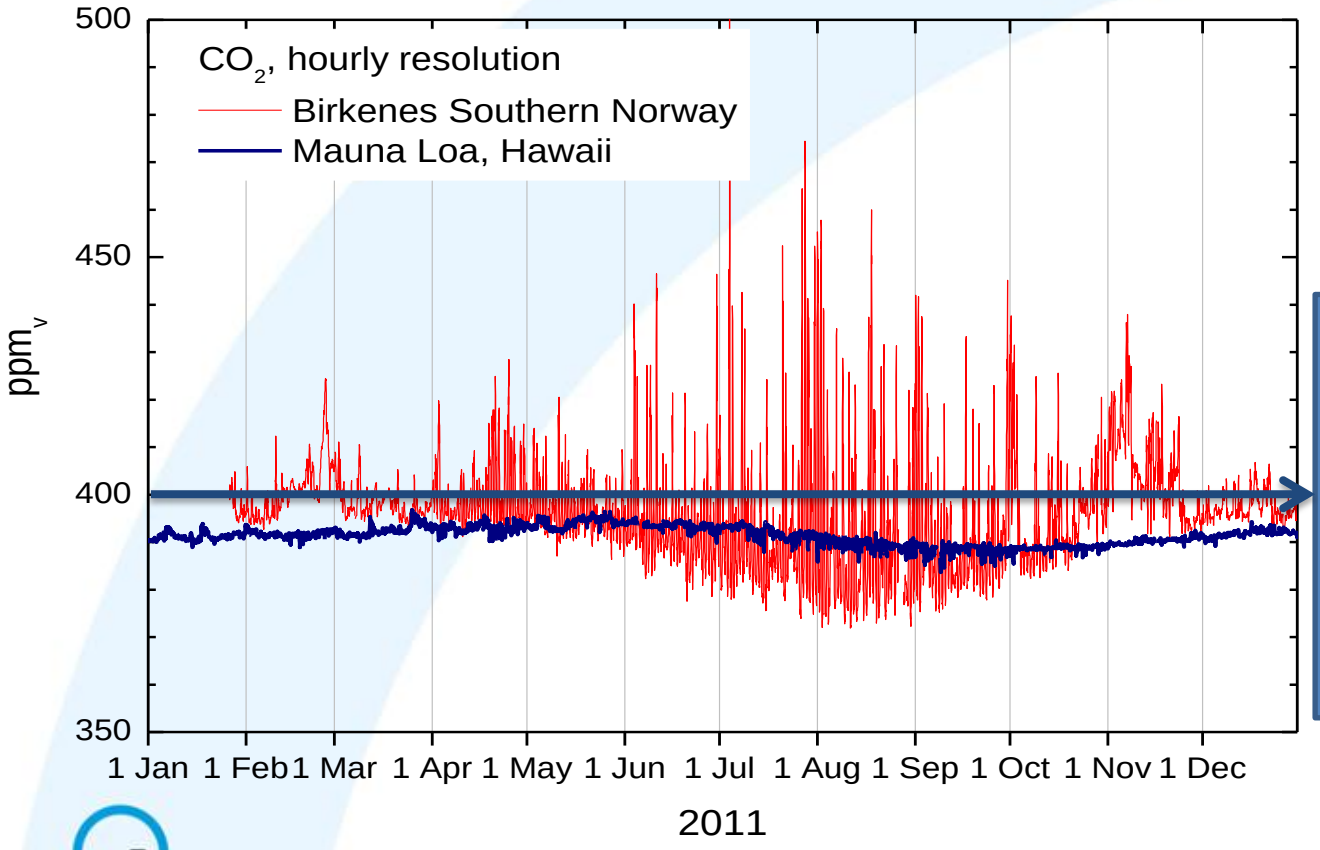
Mauna Loa (NOAA)

- **Both sites:**
- No/Little influence by local pollution
- ”Free sight”
- Regional background conditions at Birkenes
- Regional background /Hemispheric background at Mauna Loa

Birkenes (NILU)



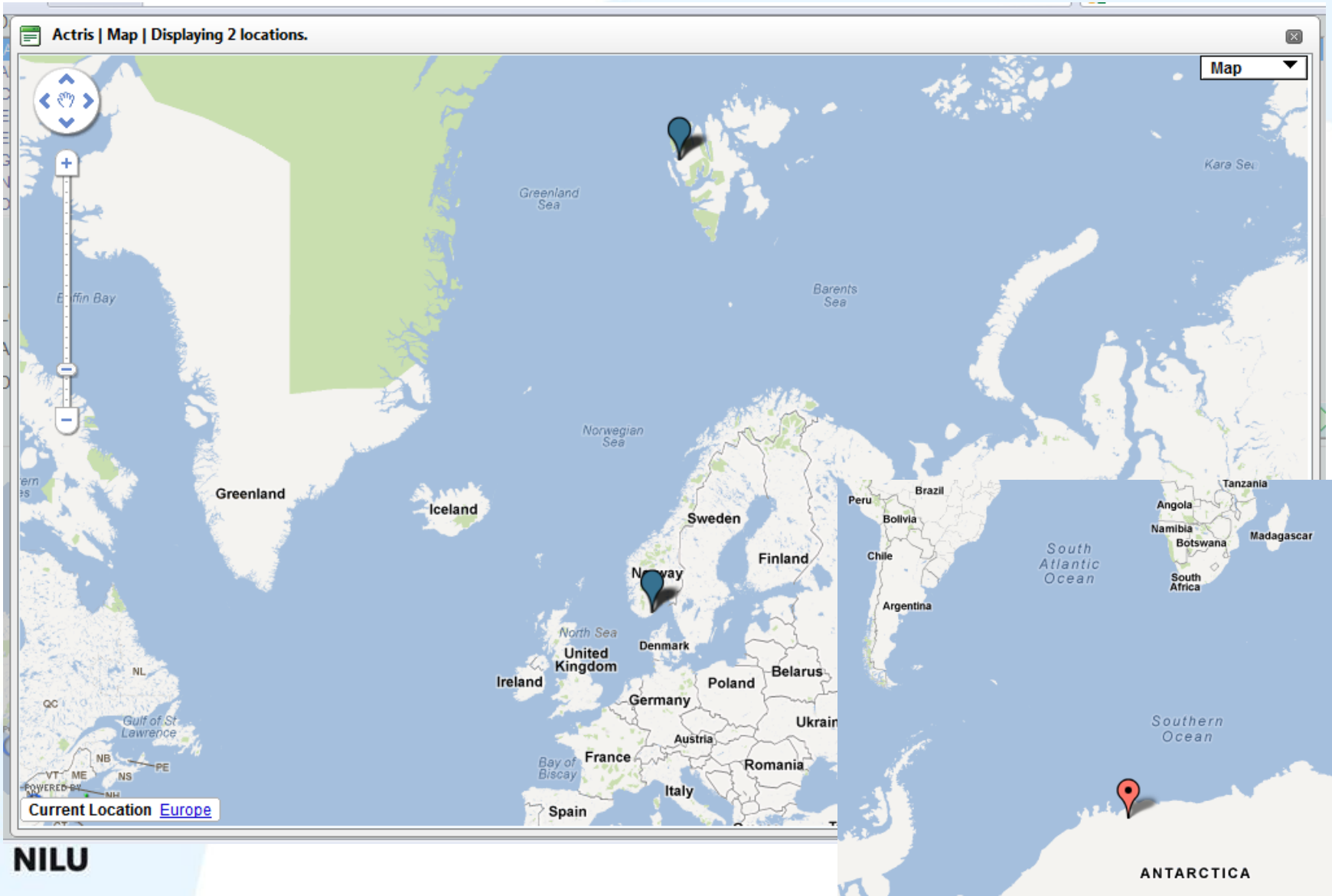
CO_2: One year at Birkenes and Maona Loa



Note: 4oo ppm global annual mean! Not hourly, monthly mean

NILU

Main Norwegian Observatories

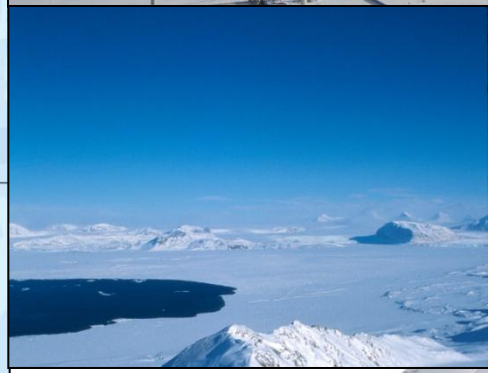


NILU

The Zeppelin Observatory

Zeppelin, an atmospheric supersite

- 78° 54'N, 11° 53'E,
- 475 m.a.s.l. Ny-Ålesund, Svalbard
- **Unique location in atmospheric monitoring**
  - **Global/hemispheric change**
    - Tropospheric ozone since 1989
    - more than **40 greenhouse gases** including CH_4, ozone, CFCer, HCFCer, HFCer, halons, others since 2001/2010 (GC)
    - Other trace gases: VOCs, CO, H_2 , SO_2, HNO_3 since 2001
    - **N_2O** since 2009
    - **CO_2** since in 2012, NILU
      - University of Stockholm since 1989
    - Various aerosol properties mostly performed by University in Stockholm
    - POPs, Hg, etc



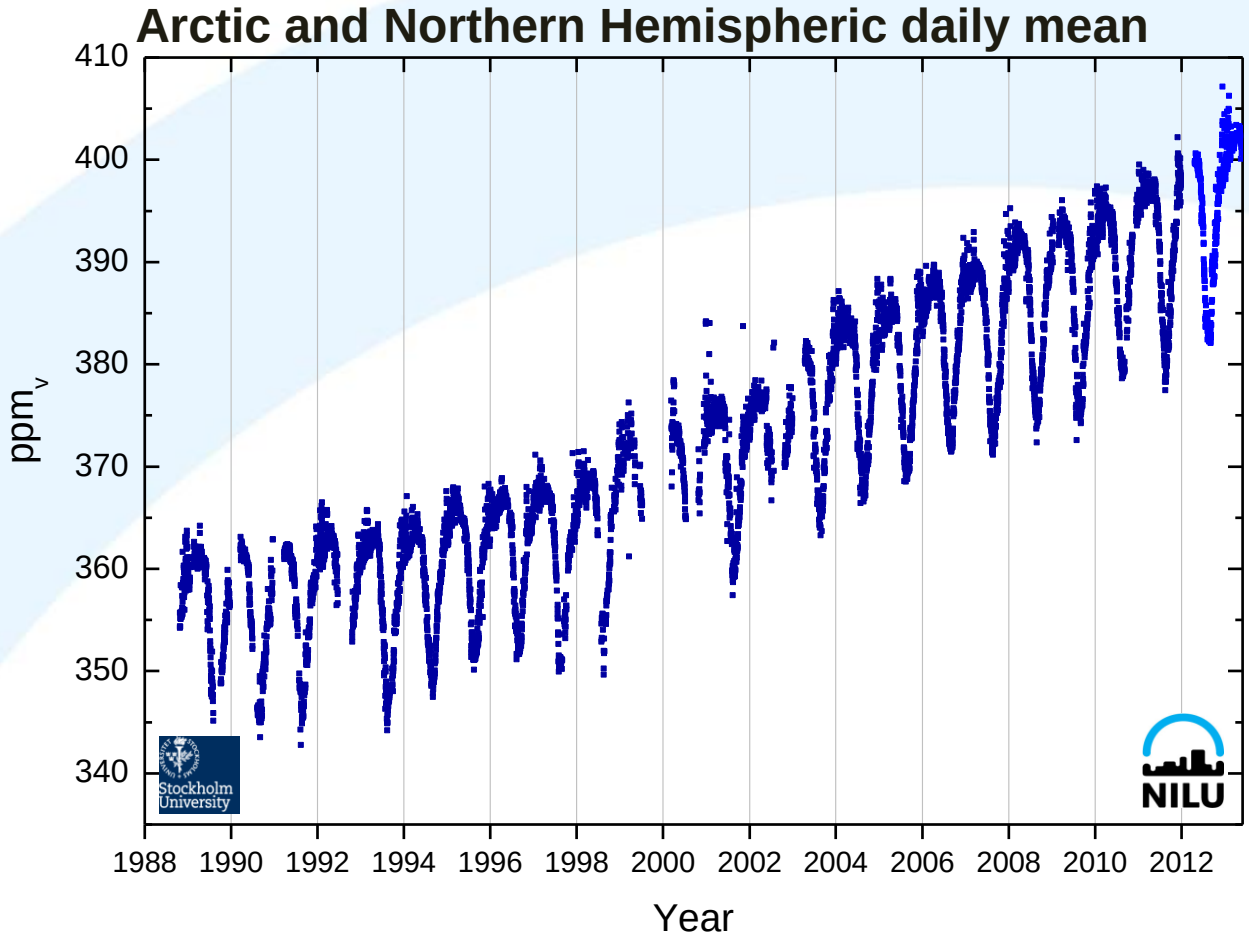
Recent observations at Zeppelin

CO_2 1988-2011

SU maintains a continuous infrared CO_2 instrument: 1988-2011

NILU: New CO/CO_2 Picarro instrument since spring 2012 in parallel

Weekly flask sampling programme lead by NOAA CMDL



NILU

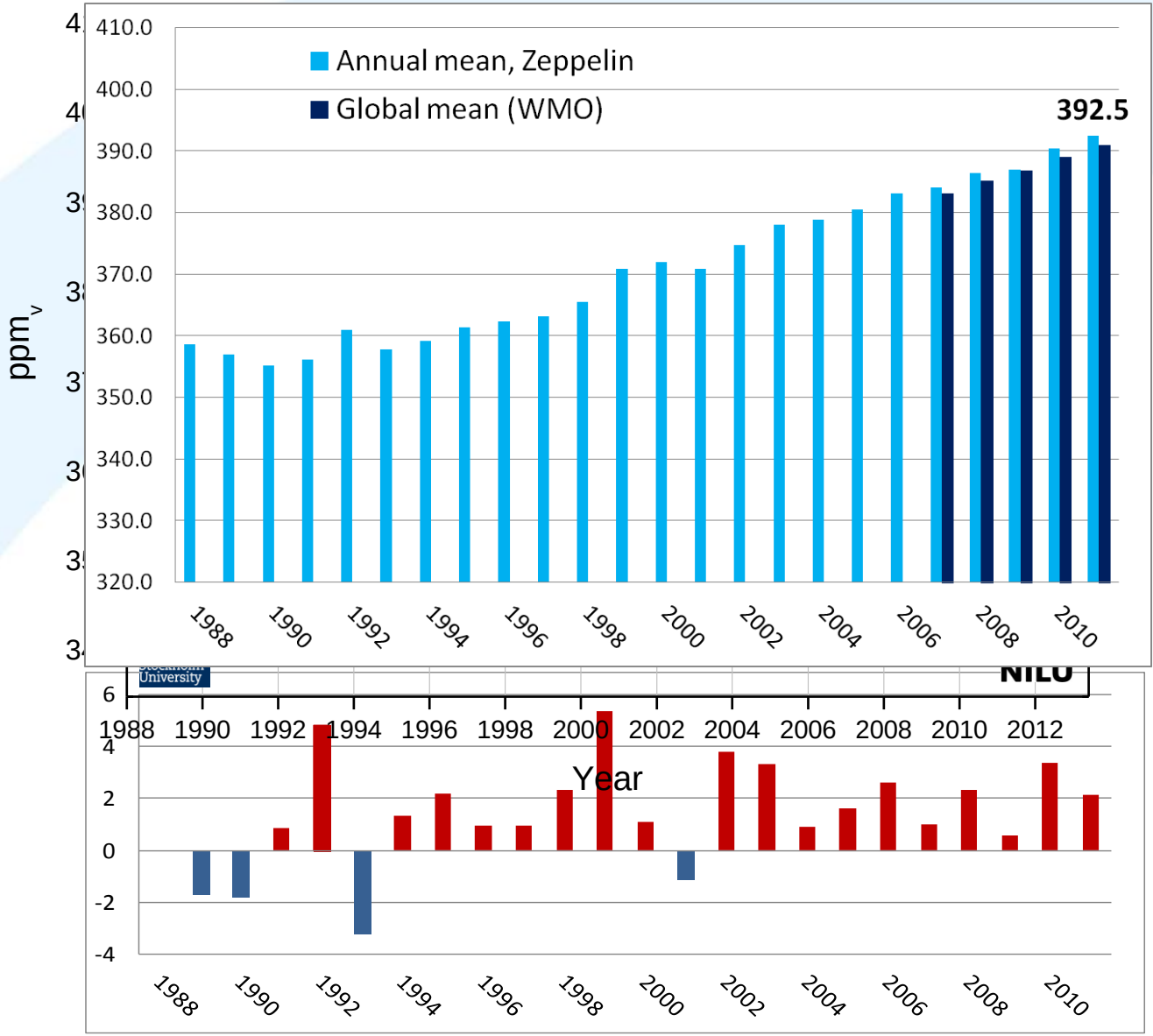
Recent observations at Zeppelin

CO_2 1988-2011

SU maintains a continuous infrared CO_2 instrument: 1988-2011

NILU: New CO/CO_2 Picarro instrument since spring 2012 in parallel

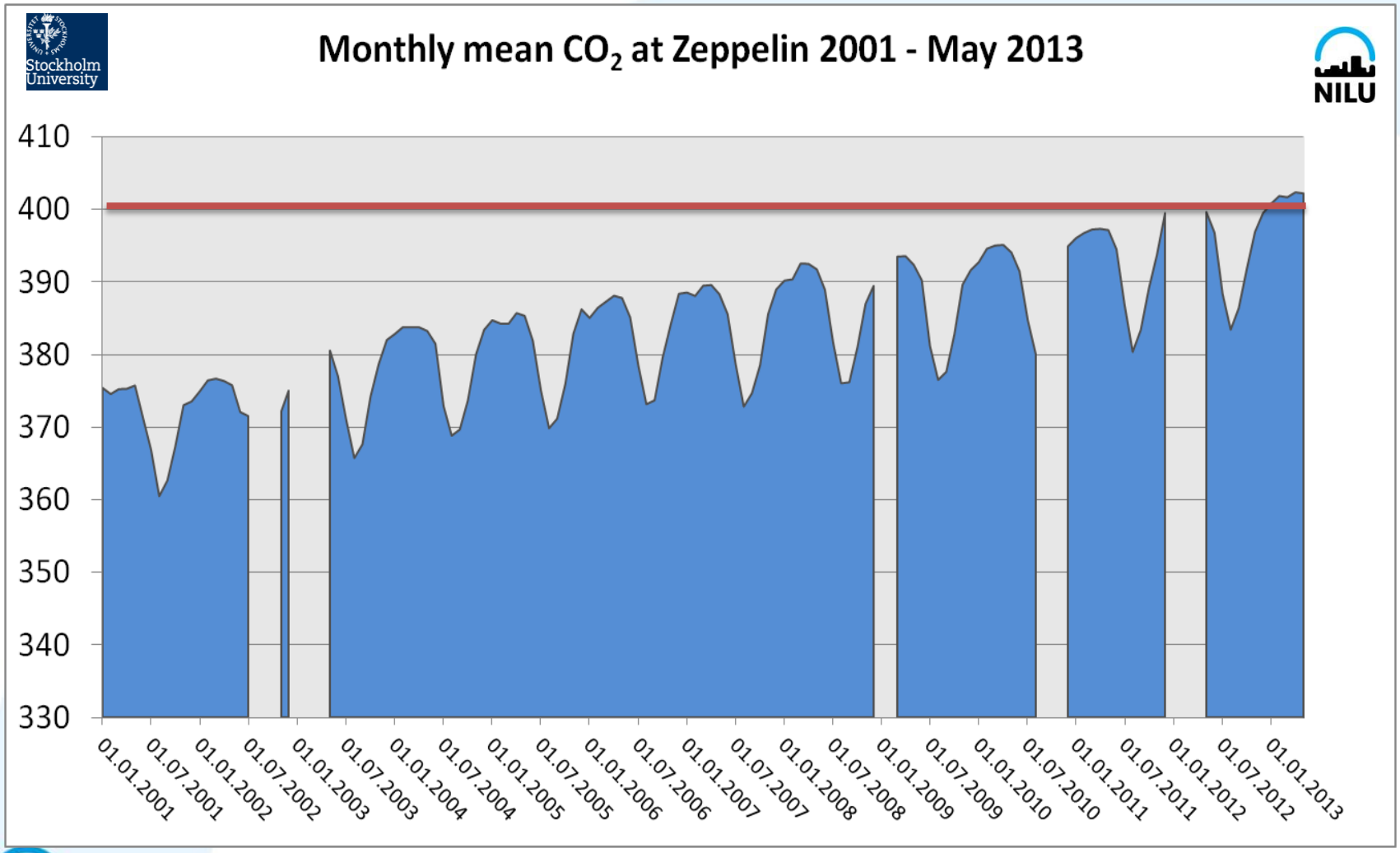
Weekly flask sampling programme lead by NOAA CMDL



NILU

Recent observations at Zeppelin

Arctic and Northern hemispheric CO_2



NILU

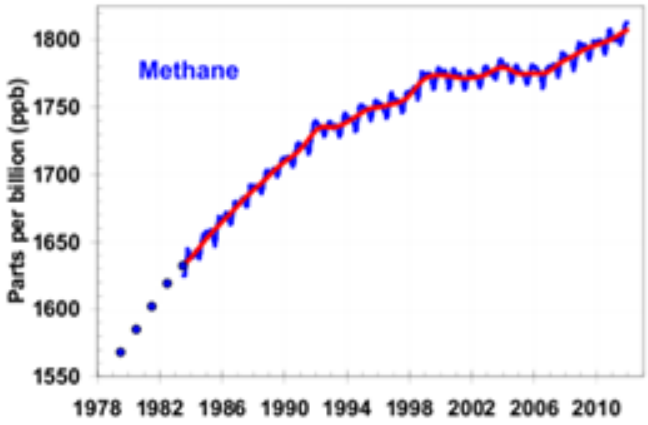
Recent observations at Zeppelin

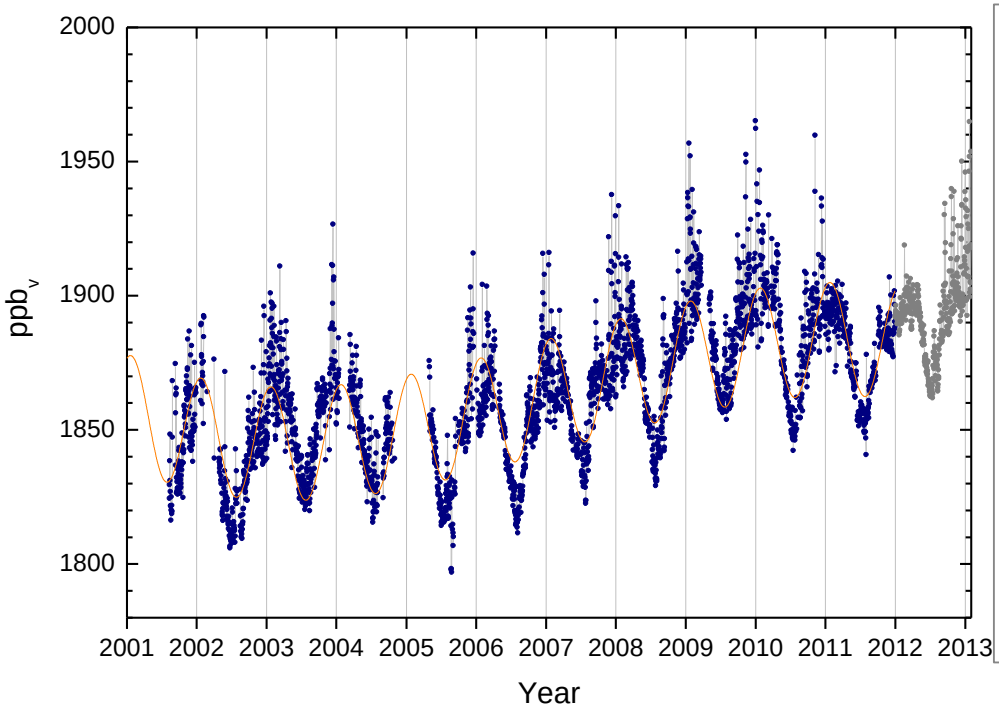
Arctic CH_4

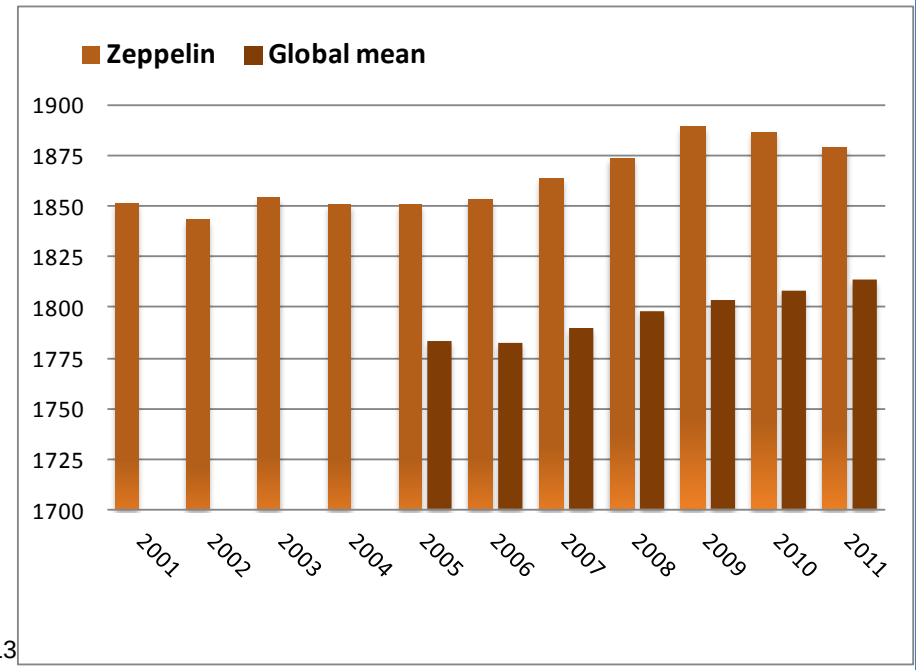
Lifetime ca 10 years

GWP= 25

Trend 2001-2011: +4.3 ppb year $^{-1}$







Other greenhouse gases at Zeppelin Observatory

Halocarbons

CFC-11

Lifetime: 45 years

GWP = 4660

CFC-12

Lifetime: 100 years

GWP = 10 200

CFC-113

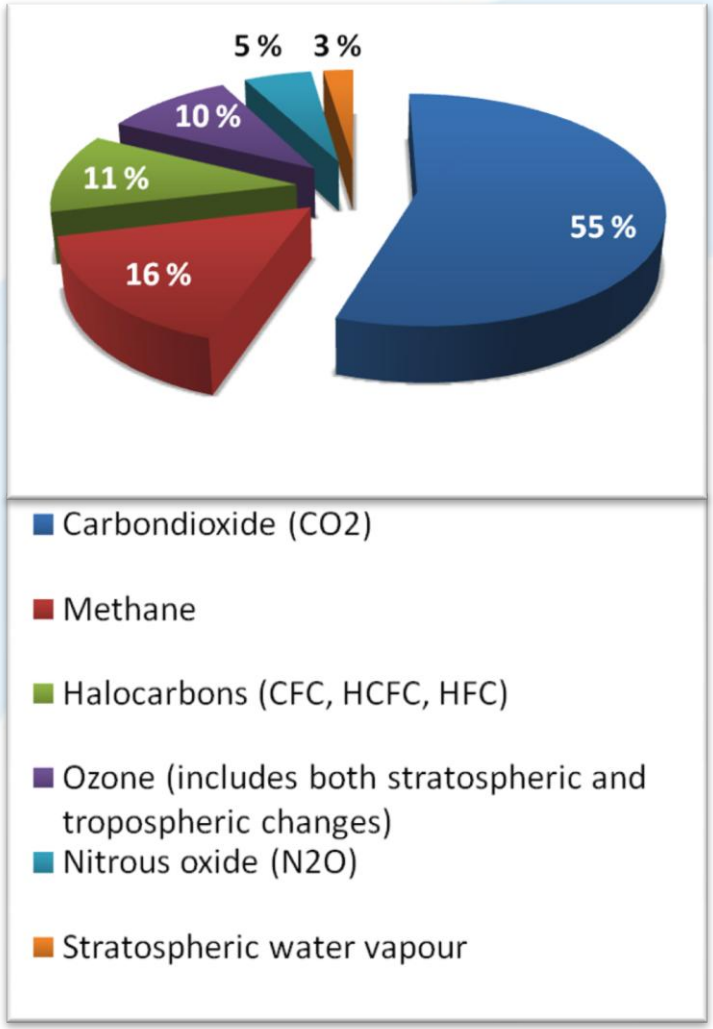
Lifetime: 85 years

GWP = 5 820

CFC-115

Lifetime: 1020 years

GWP = 7670



GWP: Hodnebrog, et al., 2013

Other greenhouse gases at Zeppelin Observatory

Halocarbons

Montreal protocol signed in 1987 works!
Direct results of science policy interaction
Excellent!
Also to the benefit for climate

GWP: Hodnebrog, et al., 2013

Other greenhouse gases at Zeppelin Observatory

Halocarbons

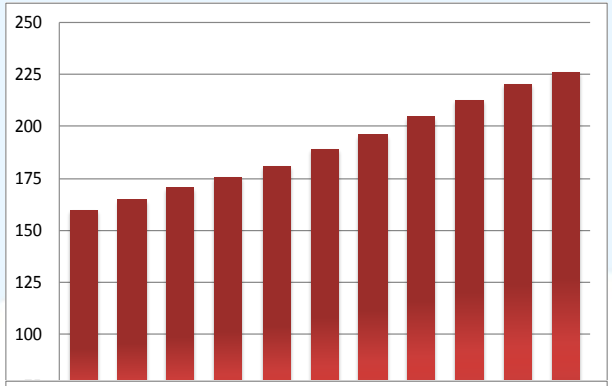
HCFC-22

Lifetime: 11.9 years

GWP is 1760

+6.9 ppt/yr

42% increase since 2001



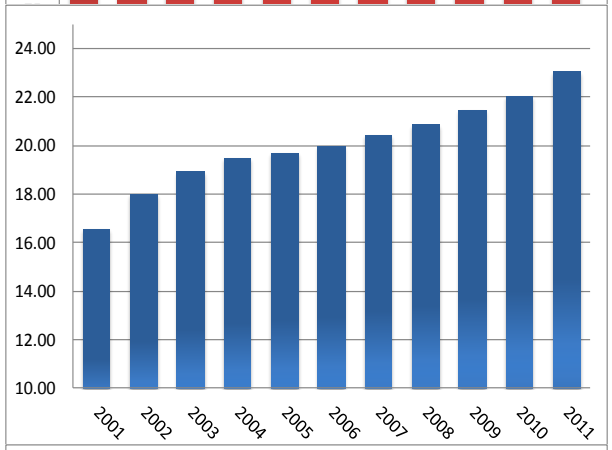
HCFC-141b

Lifetime: 9.2 years

GWP is 782

+0.55 ppt/yr

39% increase since 2001



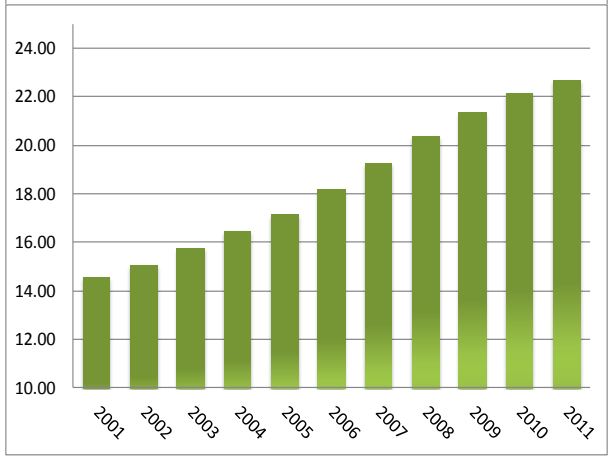
HCFC-142b:

Lifetime: 17.2 years

GWP is 1980

+0.87 ppt/yr

56% increase since 2001



NILU

Other greenhouse gases at Zeppelin Observatory

Halocarbons

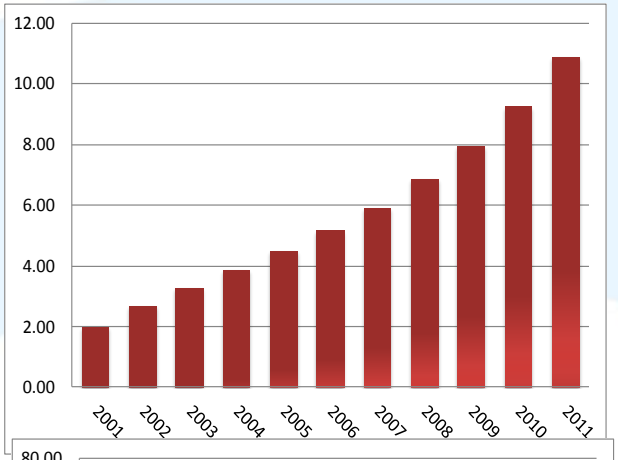
HFC-125

Lifetime: 28.2 years

GWP is 3170

+0.84 ppt/yr

446% increase since 2001



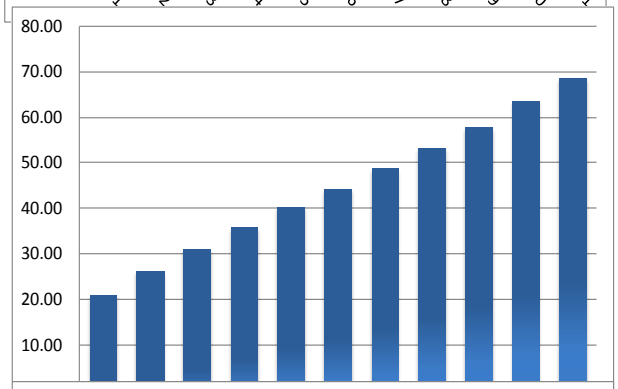
HFC-134a

Lifetime: 13.4 years

GWP is 1300

+ 4.7 ppt/yr

230% increase since 2001



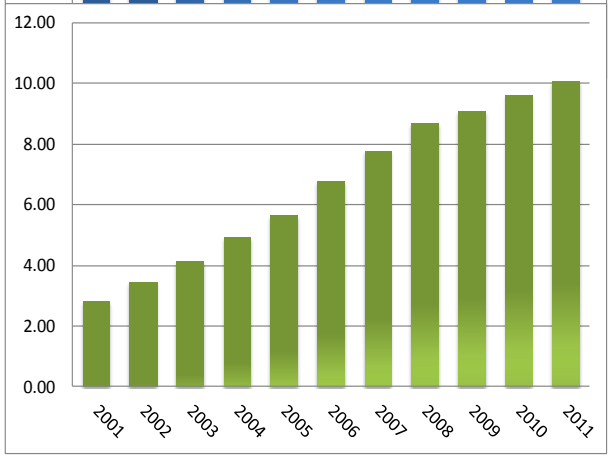
HFC-152a:

Lifetime: 1.5 years

GWP is 138

+0.77 ppt/yr

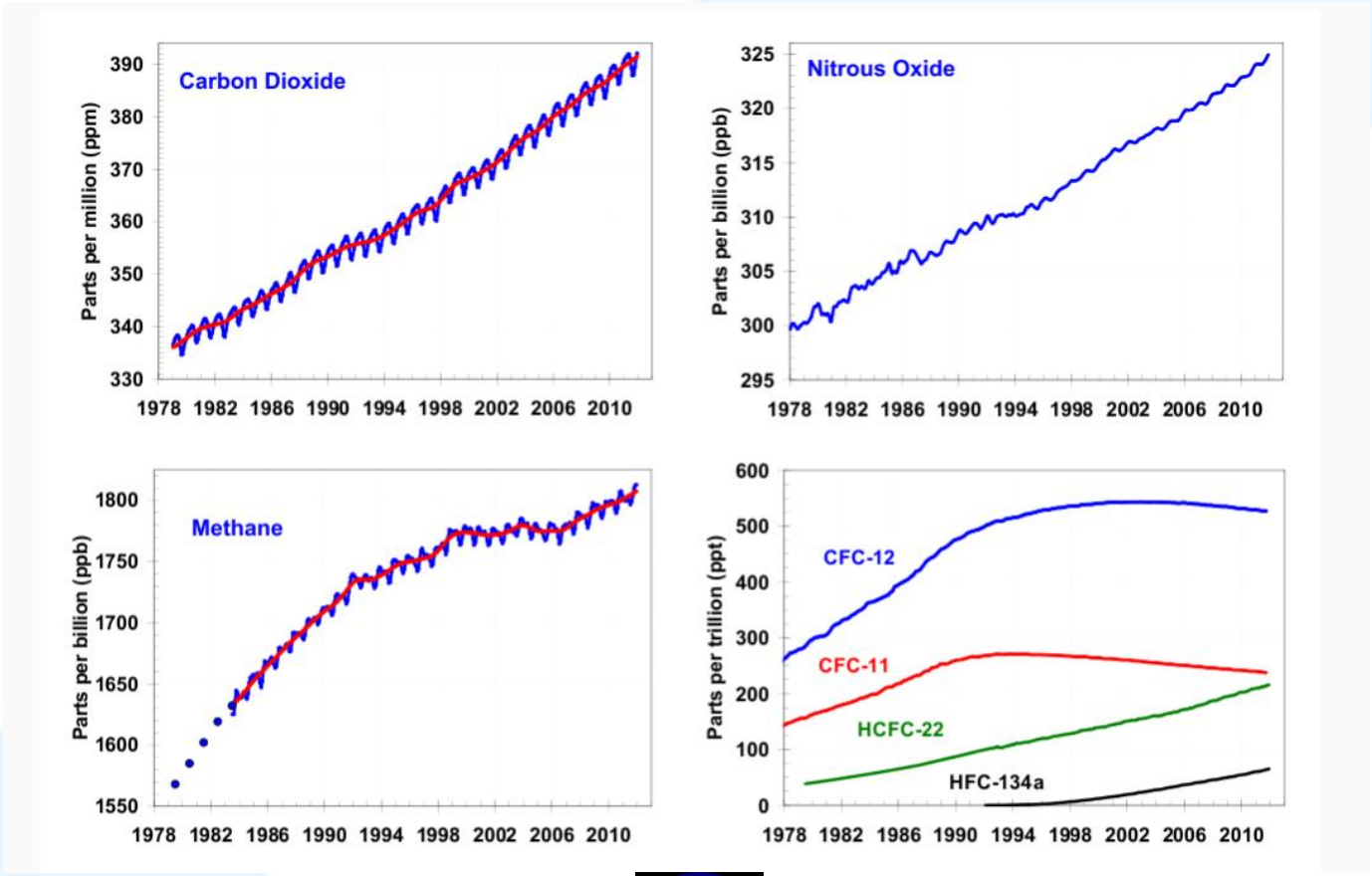
256% increase since 2001



NILU

Recent observations

Global mean for the main gases



NOAA

NILU

http://www.esrl.noaa.gov/gmd/aggi/


So far not looking good…
Some other aspects to think of.

What about the relationship 2°C and 400 ppm ?

Scientific studies on the **risk of reaching 2 degree warming, under various assumption -> Based on many assumptions and factors**

The concept of CO_2 eq:

- Metric converting the forcing from other gases to CO_2 equivalent forcing.
  - Today's atmosphere: other GHG corresponds to ca ca 80 ppm CO_2
- For future predictions, assumptions about emissions relevant

What is the temperature response to increase in CO_2?

- climate sensitivity: the equilibrium global mean surface temperature change following a doubling of atmospheric CO_2 concentration

  Various approaches to assess this

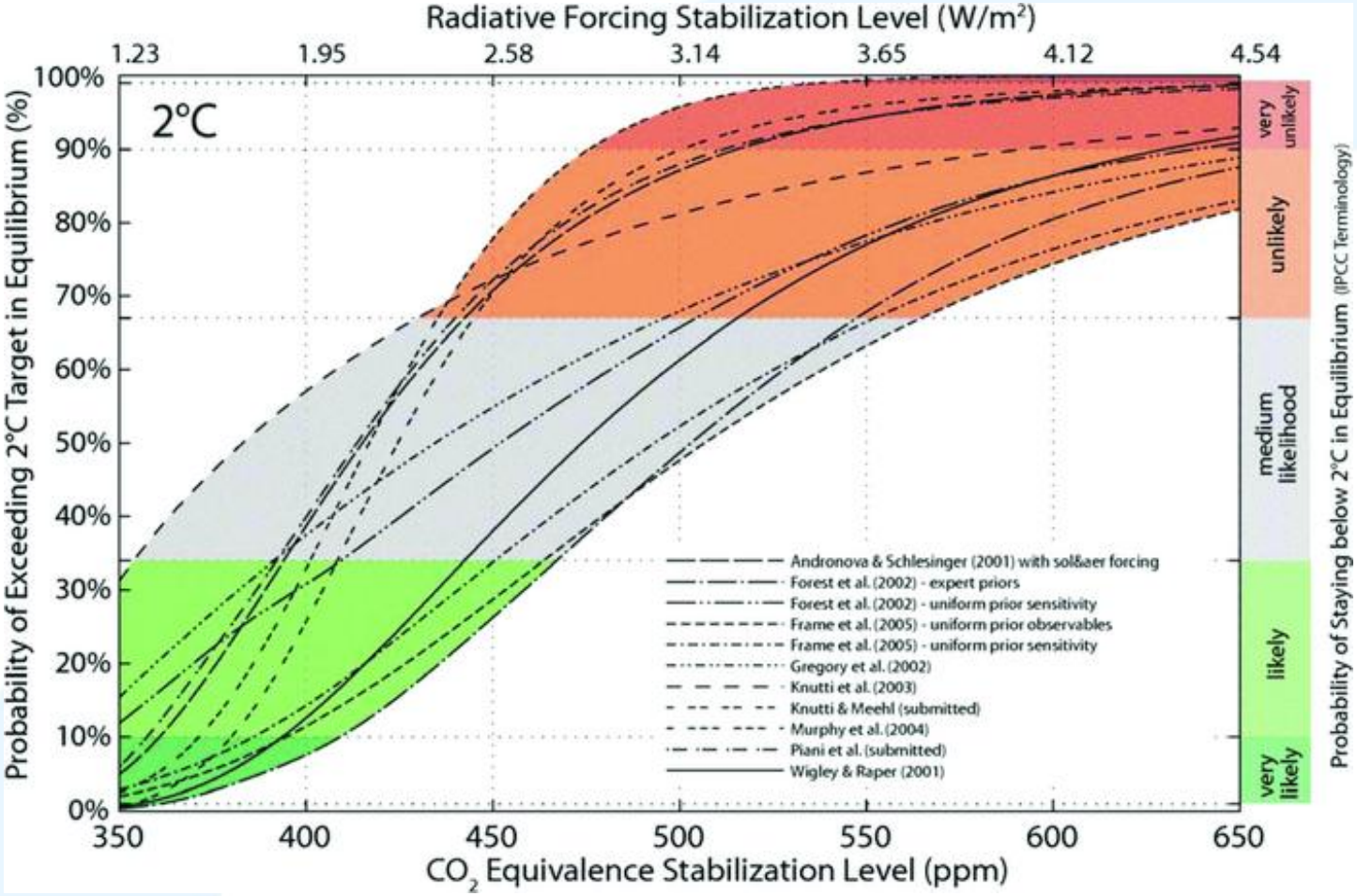
  I. Detailed knowledge of aerosols and other component over time, since 1750
  II. Temperature change and the driving forcing in paleoclimate perspectives
  III. Understanding of feedback processes in climate models

Timing of emissions

not only total emission but also distribution of emission strength over years

NILU

Two degree target possible with reasonable probablity?



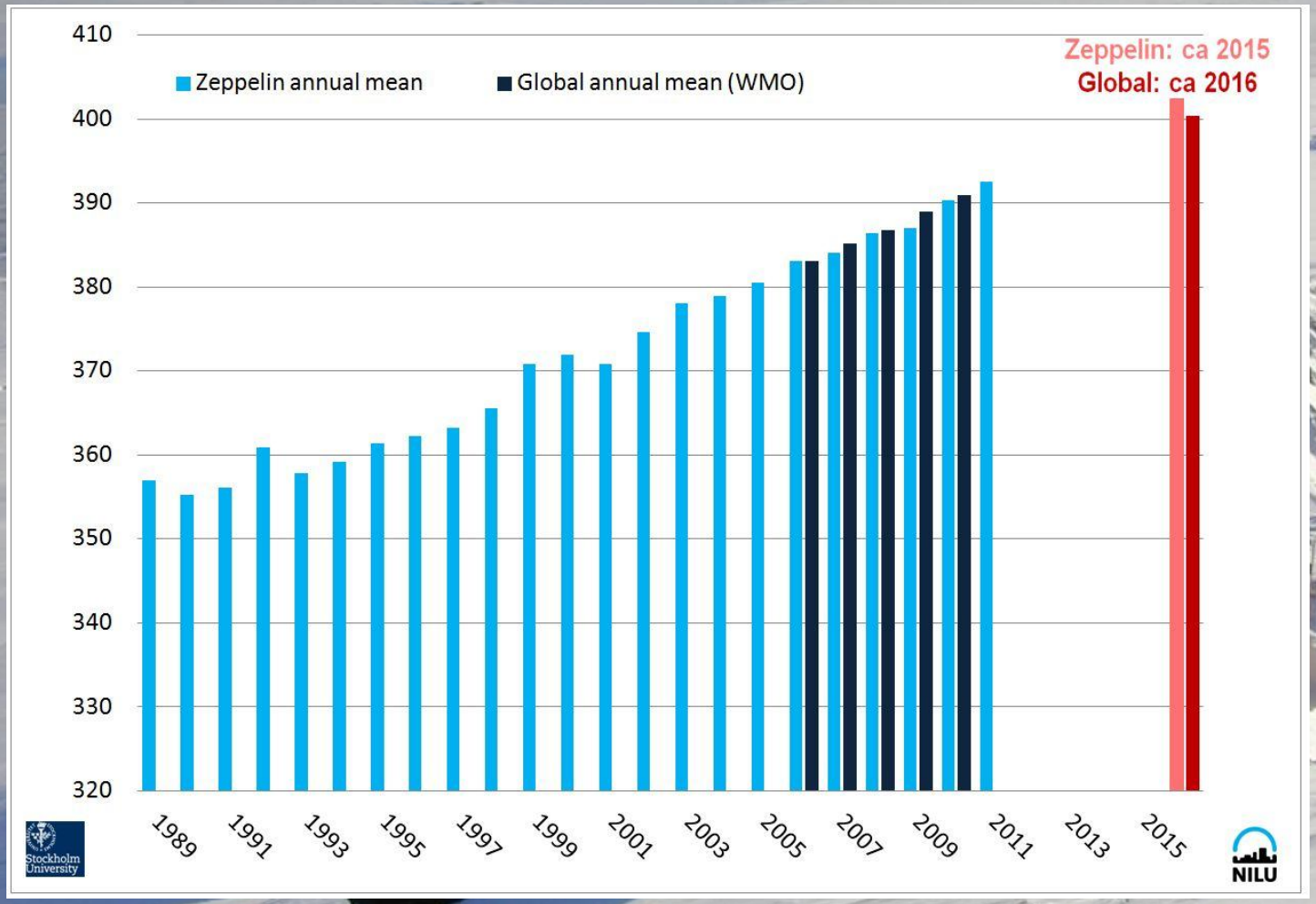
Source:
IPCC WGII, section 19.4.2 (citing Hare and Meinshausen 2005).

NILU

When will the level reach 400 ppm?

Zeppelin: 2 ppm yr-1 (2006-2011)

Global: 1.9 ppm yr-1 (2009-2011)



Acknowledgments

KLIF: Funding national monitoring of greenhouse gases

Swedish "Naturvårdsverket" and University of Stockholm (H.C. Hansson and B. Noone): CO_2 at Zeppelin since 1988

NFR : GHG-Nor: GreenHouse Gases in the North: from local to regional scale (SIS)

EU I3 projects:

InGOS: Integrated non-CO2 greenhouse gas observing system

ACTRIS-Aerosols, Clouds, and Trace gases Research InfraStructure Network

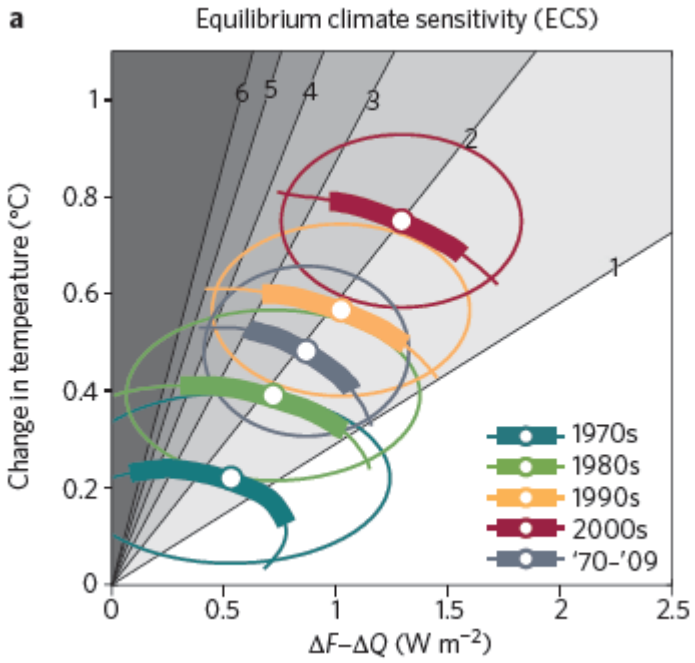
My colleagues:

Ove Hermansen, Chris Lunder, Terje Krognes: responsible for the daily operation of the GHG measurements at the Zeppelin and Birkenes Observatory

Ann Mari Fjæraa: Data management and analysis

All data are public and available through http://ebas.nilu.no

NILU Norsk institutt for luftforskning



Otto et al., 2013

NATURE GEOSCIENCE | ADVANCE ONLINE PUBLICATION |

The most likely value of equilibrium climate sensitivity based on the energy budget of the most recent decade is 2.0 °C, with a 5–95% confidence interval of 1.2–3.9 °C (dark red, Fig. 1a), compared with the 1970–2009 estimate of 1.9 °C (0.9–5.0 °C; grey, Fig. 1a).

Climate sensitivity – Temperature change for a doubling of CO_2 when the Earth has reach equilibrium

Making sense of palaeoclimate sensitivity

PALAEOSENS Project Members*

29 NOVEMBER 2012 | VOL 491 | NATURE | 683

"…. implies a warming of 2.2–4.8K per doubling of atmospheric CO_2, which agrees with IPCC estimates."

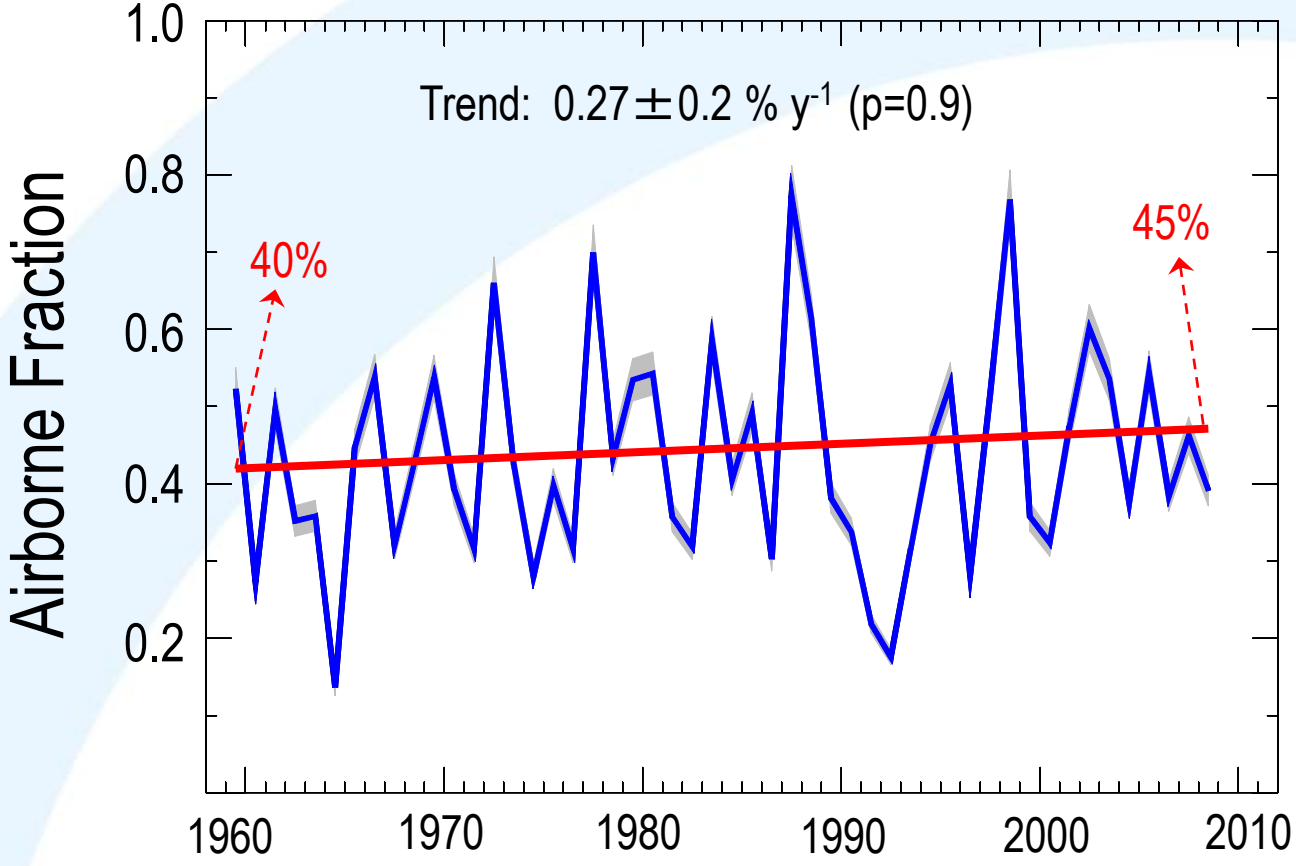
9 NOVEMBER 2012 VOL 338 SCIENCE

John T. Fasullo* and Kevin E. Trenberth

Many models, particularly those with low climate sensitivity, fail to adequately resolve these teleconnections and hence are identifiably biased.

NILU

Fraction of CO_2 emissions remaining in the atmosphere



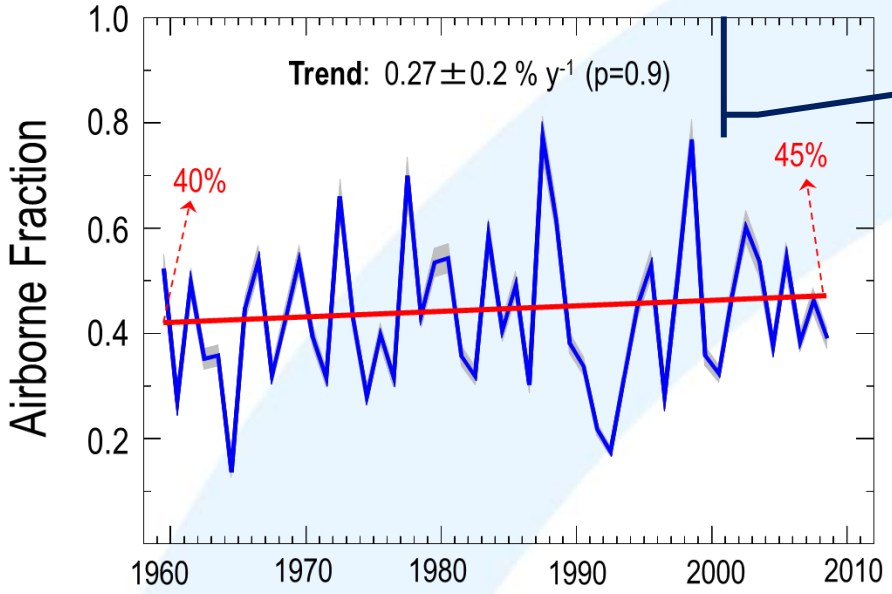
Le Quéré et al. 2009, Nature Geoscience; Canadell et al. 2007, PNAS; Raupach et al. 2008, Biogeosciences

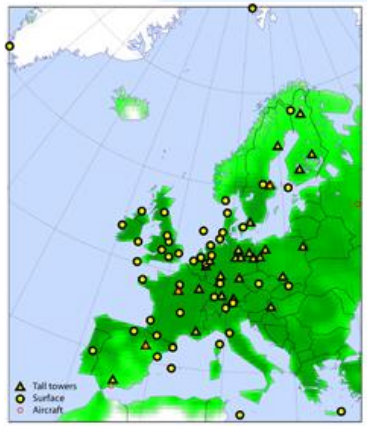
How was this result derived from ?

Long term record (50 years)

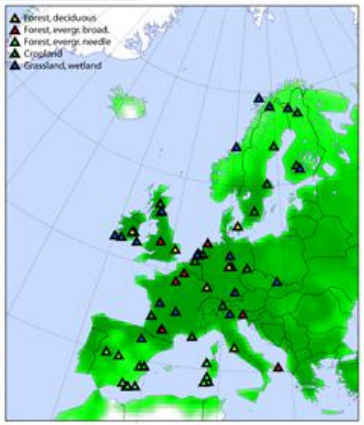
High precision measurements

Adequate station density (ICOS network)

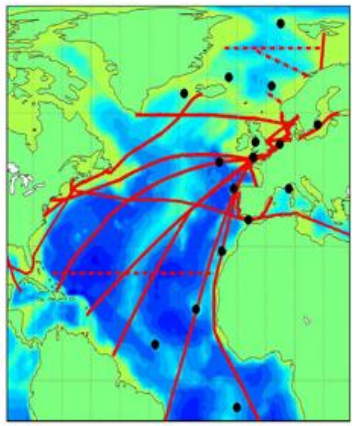




Atmospheric network



Ecosystem network



Marine network