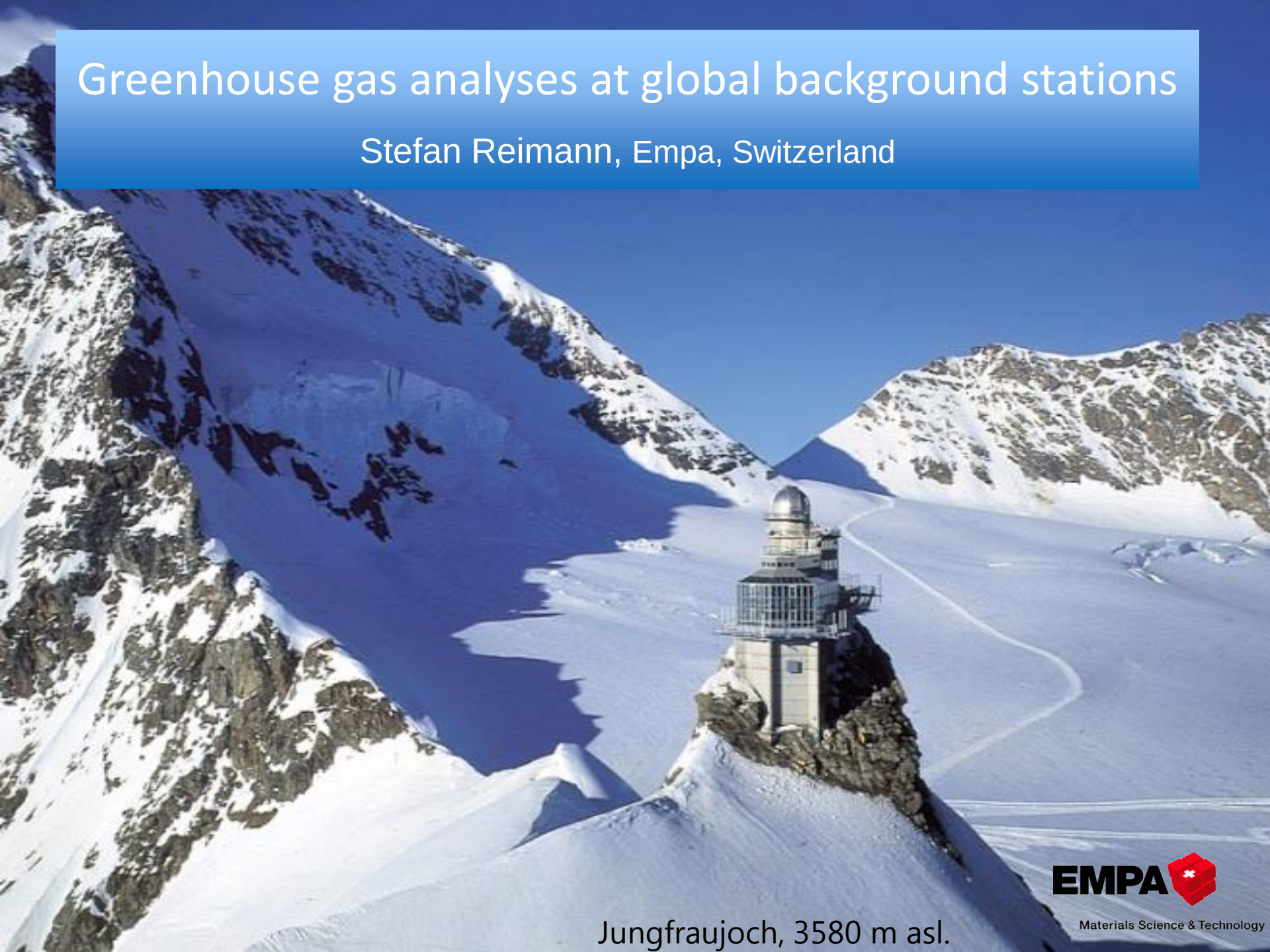
Greenhouse gas analyses at global background stations

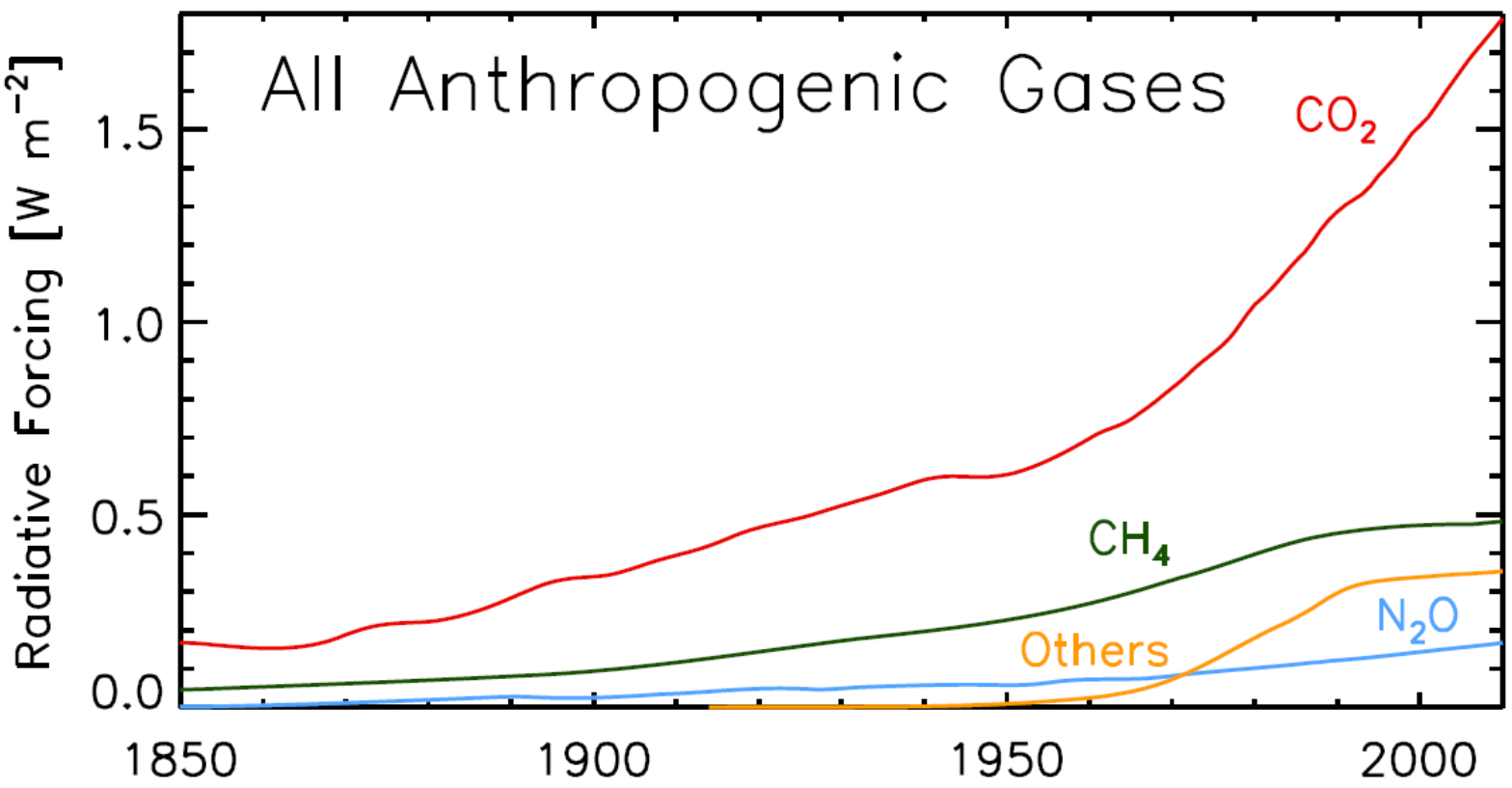
Stefan Reimann, Empa, Switzerland



Jungfraujoch, 3580 m asl.

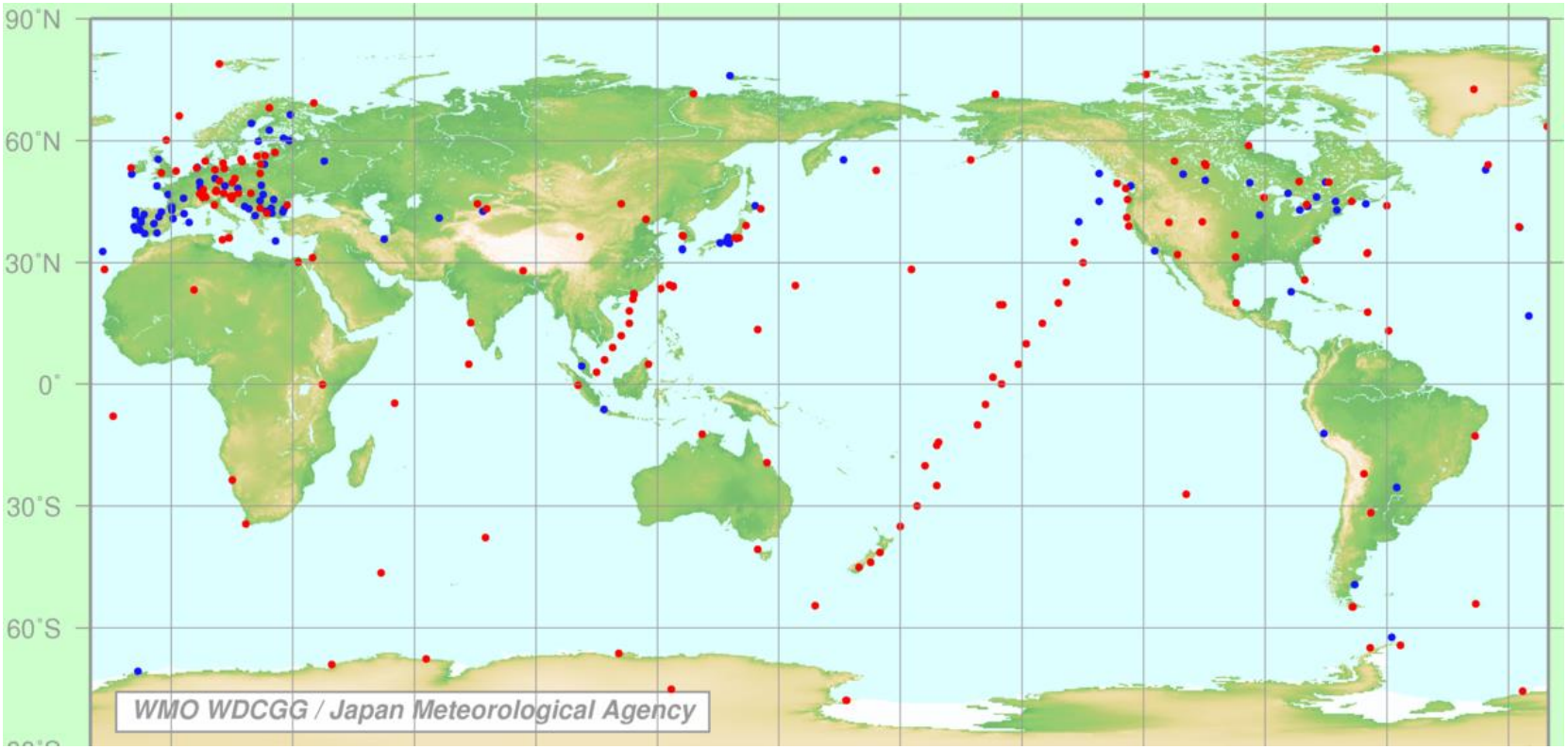
EMPA
Materials Science & Technology

The major anthropogenic greenhouse gases



IPCC AR5

in-situ observations of CO_2/CH_4/N_2O submitted to WDCGG of GAW/WMO



As of April 2014, the WMO/GAW global atmospheric monitoring network consisted of 141, 123 and 49 fixed stations on the ground for CO_2, CH_4 and N_2O respectively. About 13%, 13% and 18% of the stations perform both flask sampling and continuous measurements of CO_2, CH_4 and N_2O, respectively.

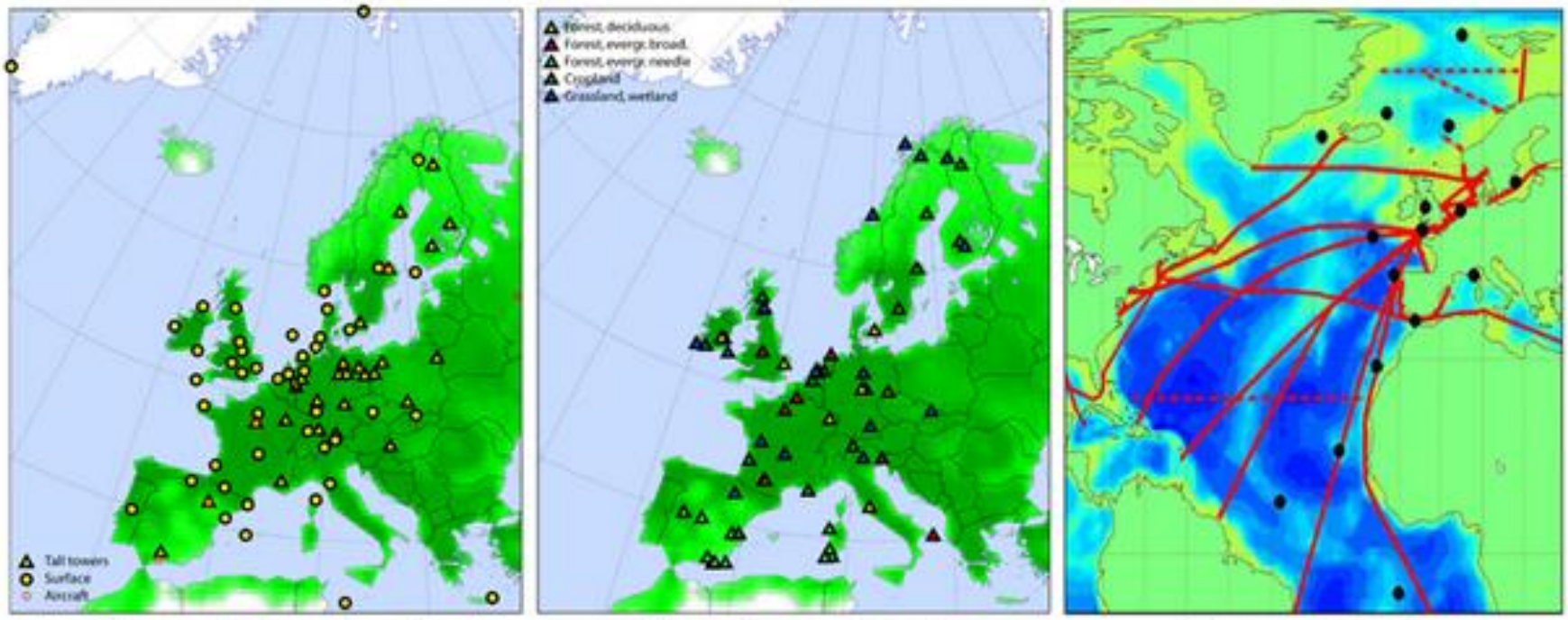
NOAA shipboard transects over the Pacific are planned to be re-established in 2014 or 2015

Source: O. Tarasova, WMO

Global CO_2 measurements by NOAA

Surface Flasks Airborne Flasks In Situ Tall Tower In Situ Observatory

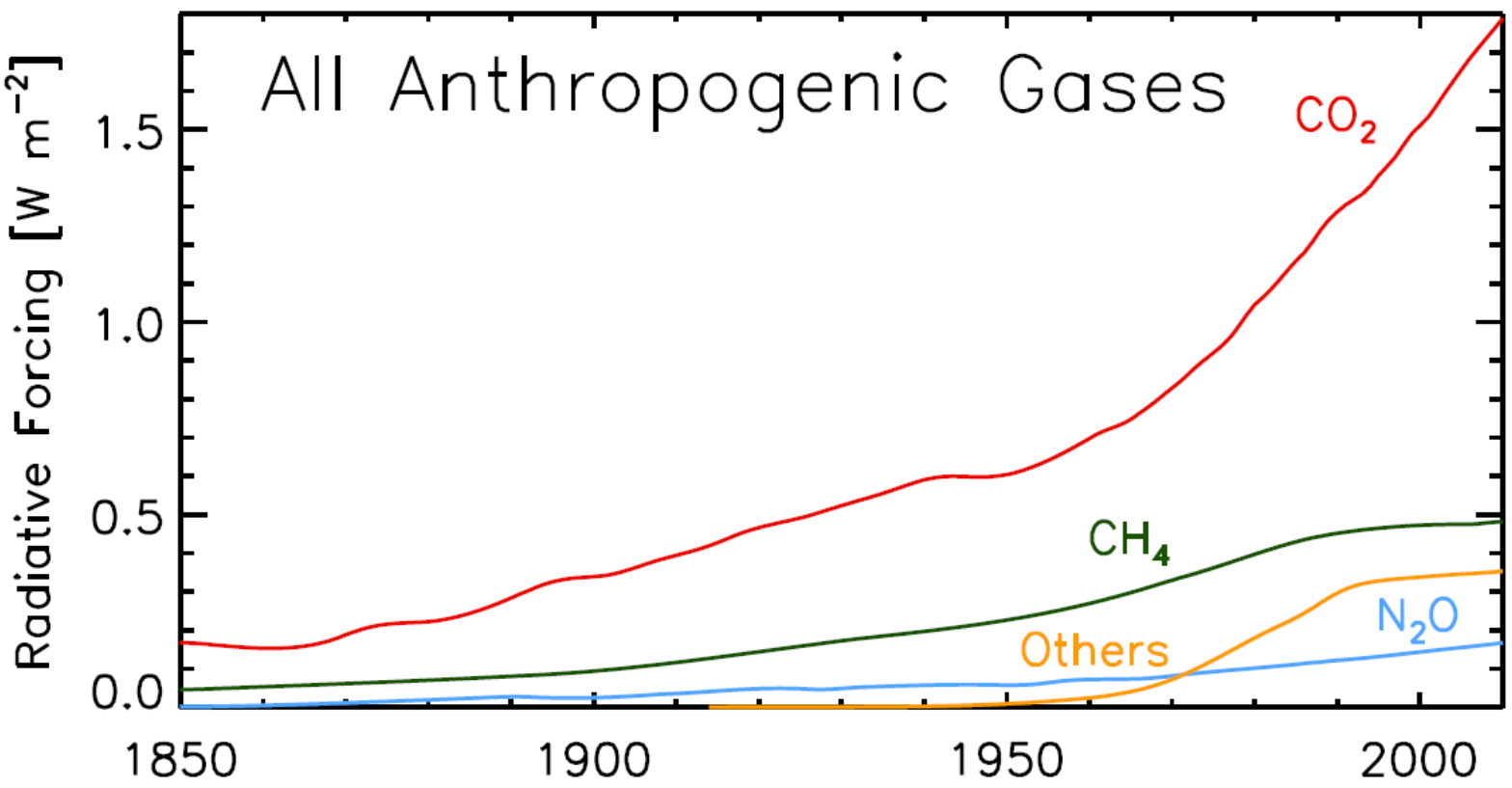
Regional networks
The envisaged ICOS network



Atmospheric network | Ecosystem network | Marine network

Envisionned ICOS networks

The major anthropogenic greenhouse gases



IPCC AR5

DQOs for GHG

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SF_6	± 0.02 ppt	± 0.05 ppt	6 – 10 ppt	1.1 – 9.8 ppt
H_2	± 2 ppb	± 5 ppb	450 – 600 ppb	140 −1200 ppb
$\delta^{13}C\text{-}CO_2$	± 0.01‰	± 0.1‰	-7.5 to -9‰ vs. VPDB	
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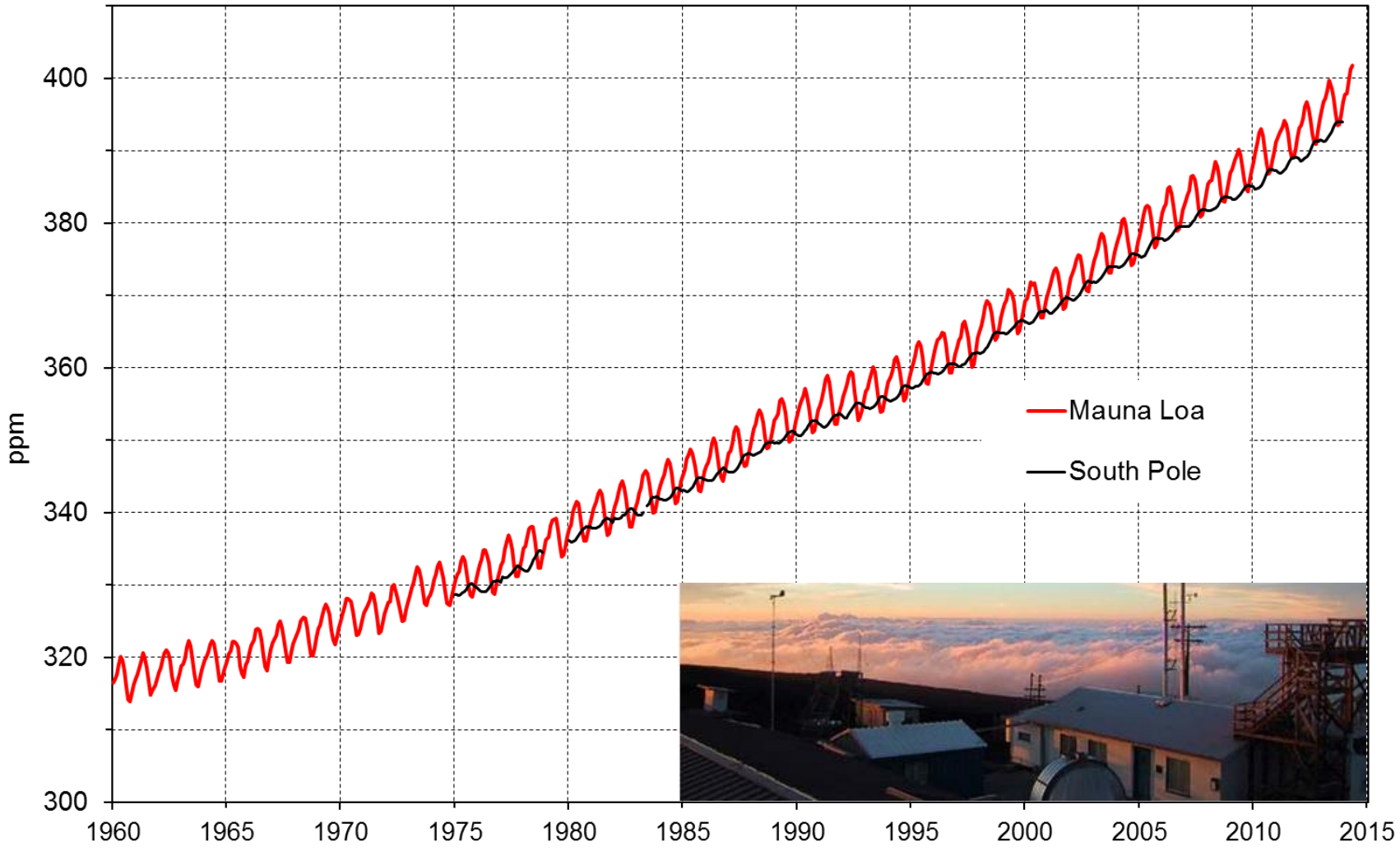
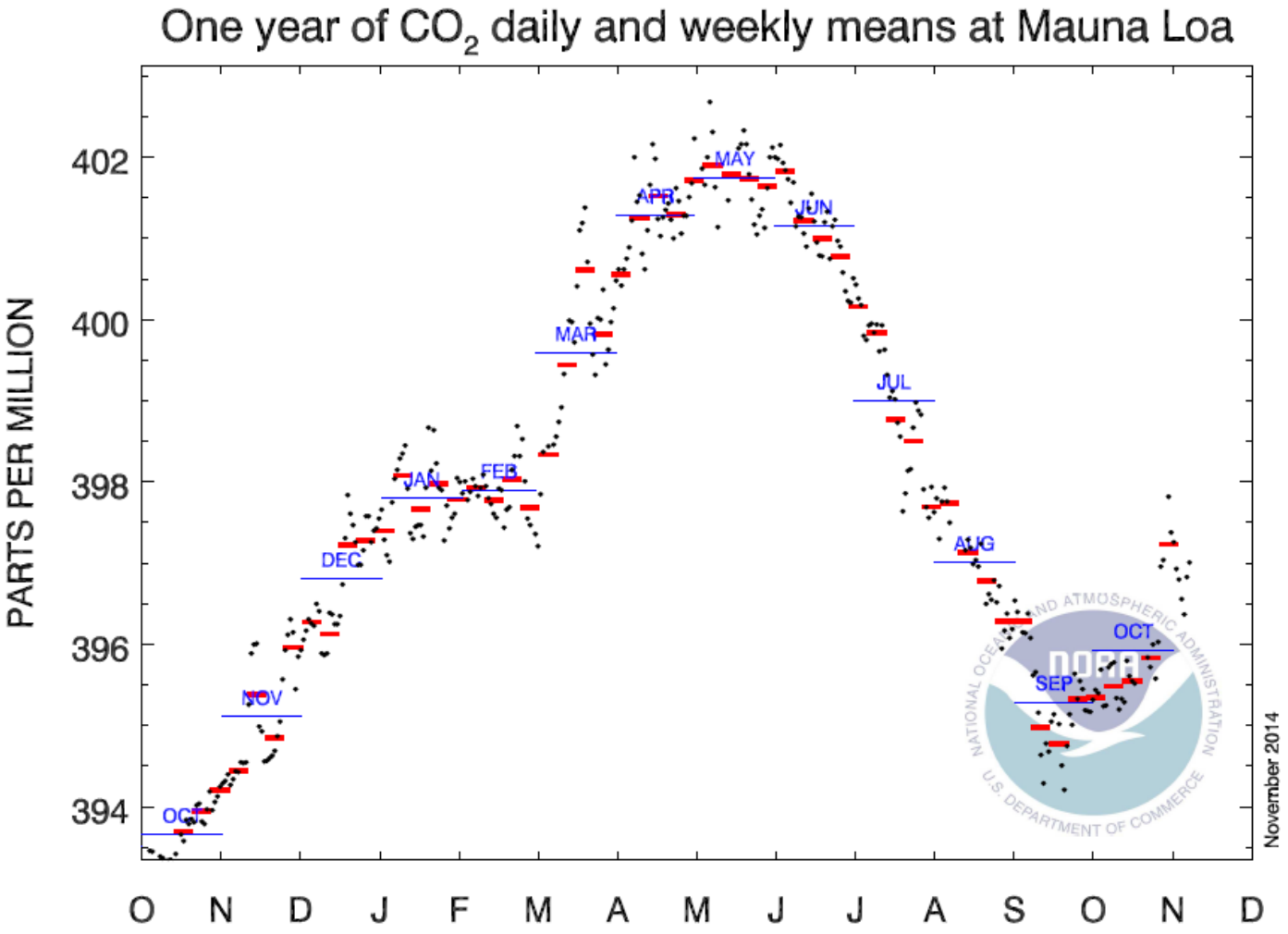
O_2/N_2	± 2 per meg	± 10 per meg	-250 to -800 per meg (vs. SIO scale)	

Mauna Loa: the most famous CO_2 record in the world



http://www.esrl.noaa.gov

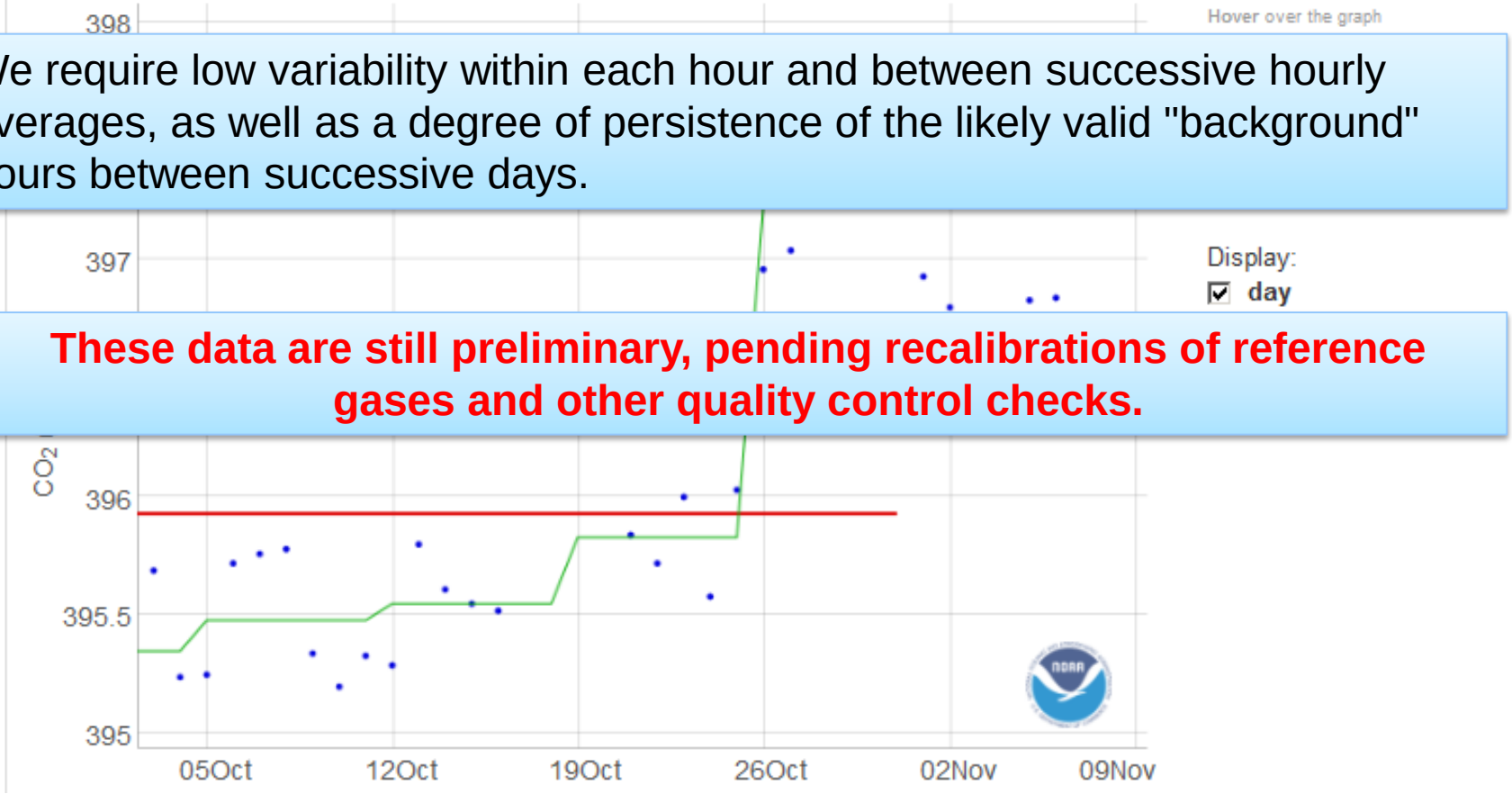
Mauna Loa
Different levels of integration



http://www.esrl.noaa.gov

Mauna Loa
Different levels of integration

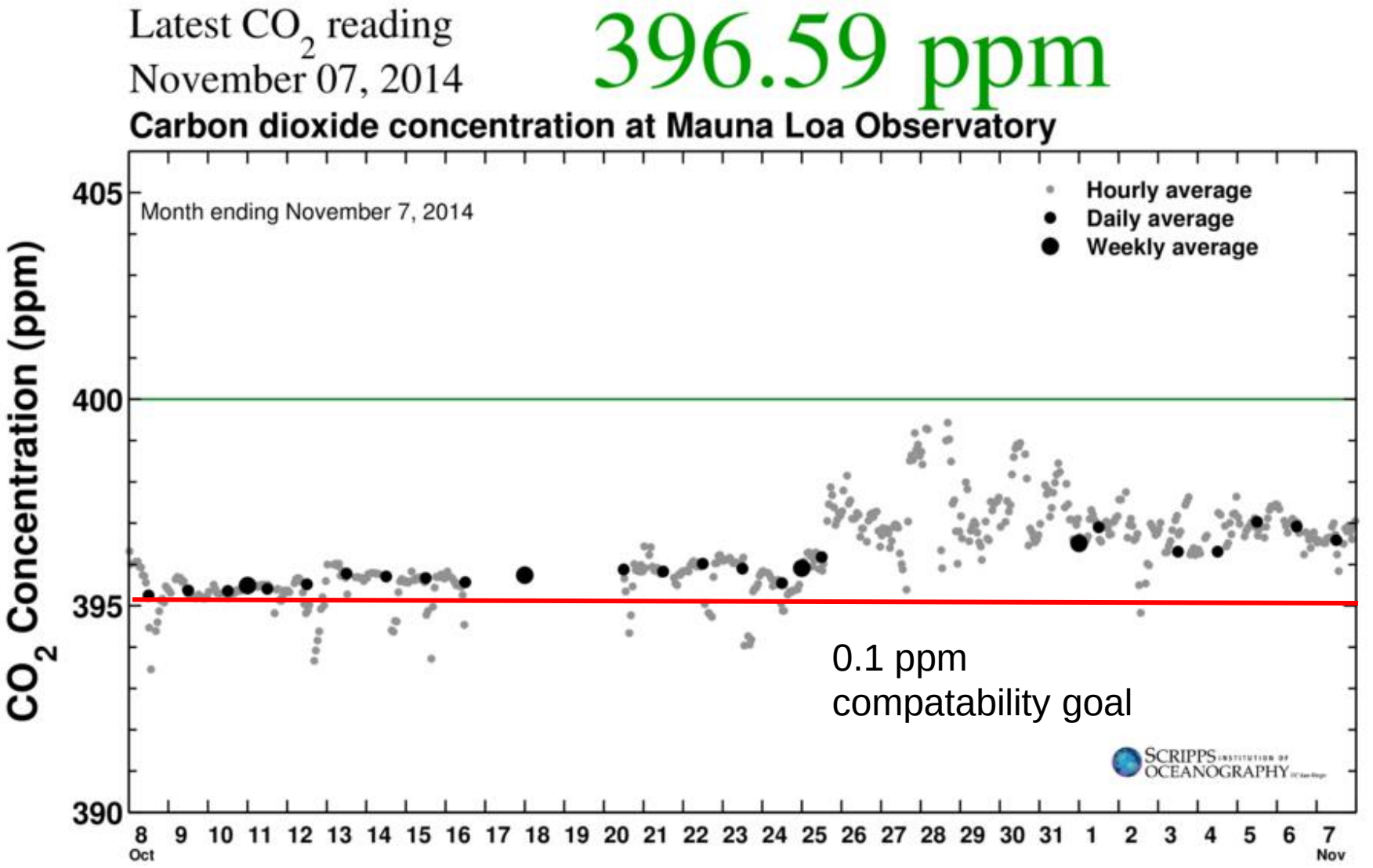
We require low variability within each hour and between successive hourly averages, as well as a degree of persistence of the likely valid "background" hours between successive days.



These data are still preliminary, pending recalibrations of reference gases and other quality control checks.

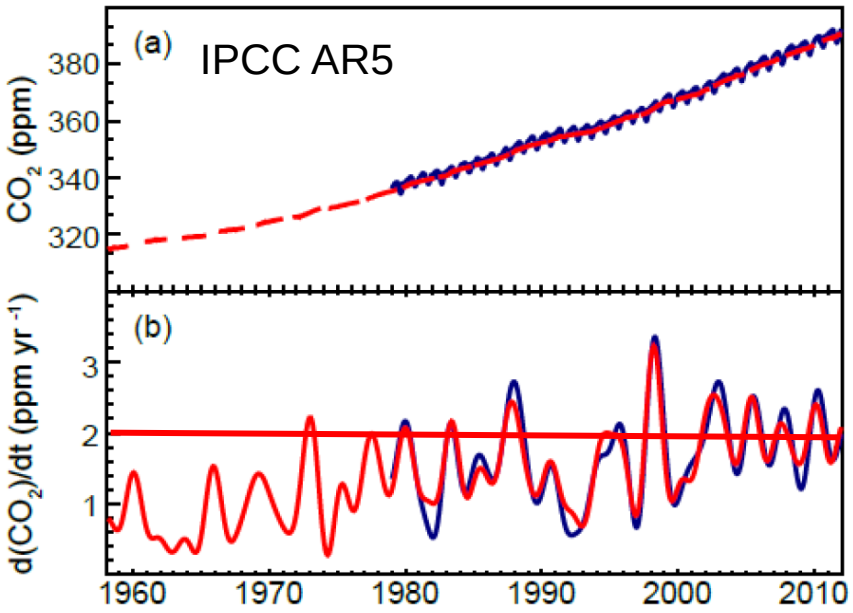
The daily means are based on hours during which CO2 was likely representative of “background” conditions, defined as times when the measurement is representative of air at mid-altitudes over the Pacific Ocean.

Mauna Loa (SIO data record)
The use of parallel measurements



https://scripps.ucsd.edu/programs/keelingcurve/

Yearly increases of CO_2: Global average



~300 Gt of CO_2

~75% of French CO_2 emissions in 2014

0.1 ppm

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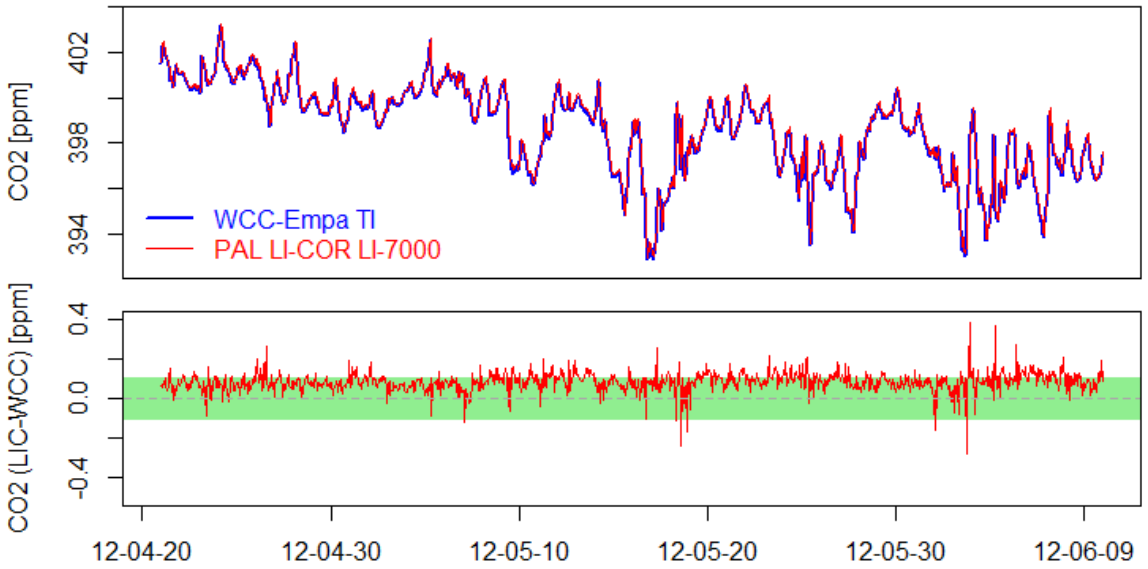
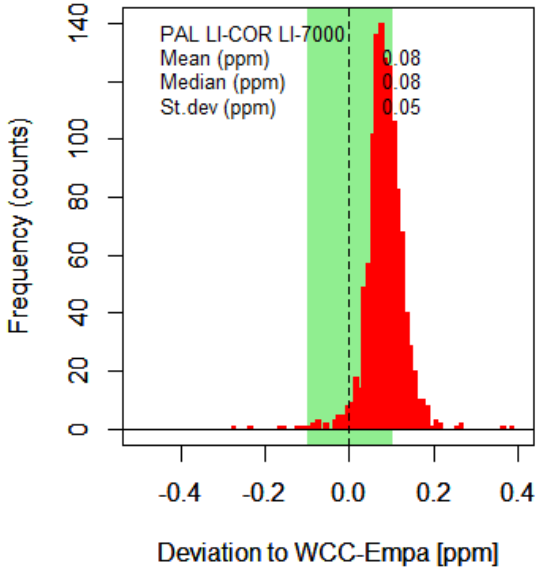
Results from WCC station audits

Example: CO_2, LI-COR LI7000 @ Pallas

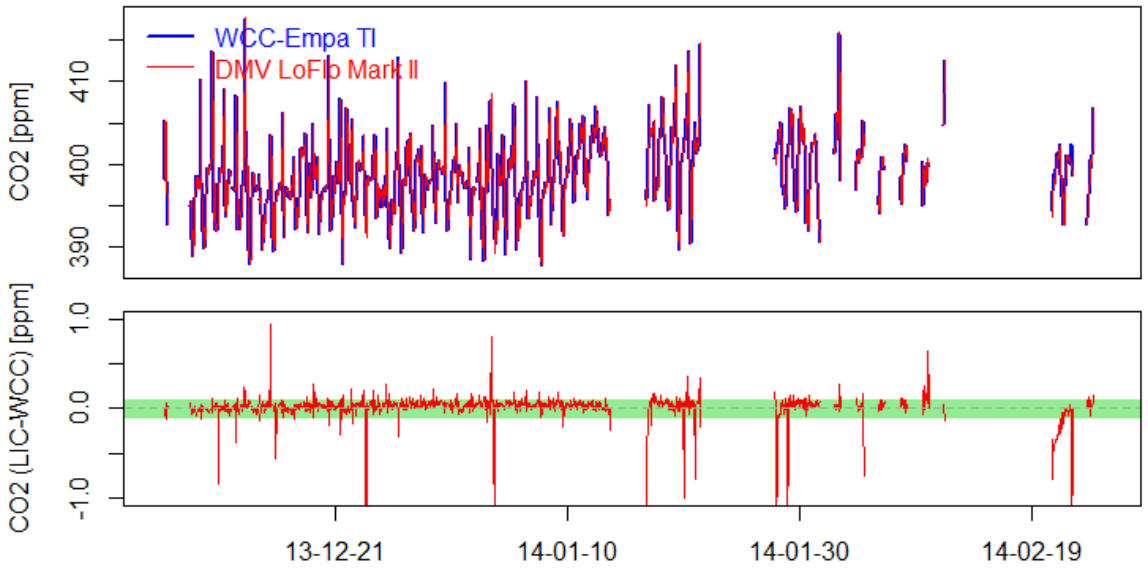


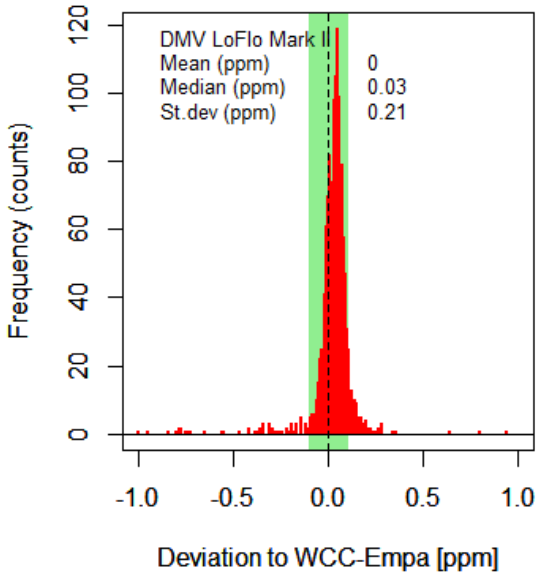


C. Zellweger, Empa

Results from WCC station audits

Example: CO_2, LoFlo Mark II @ Danum Valley





C. Zellweger, Empa

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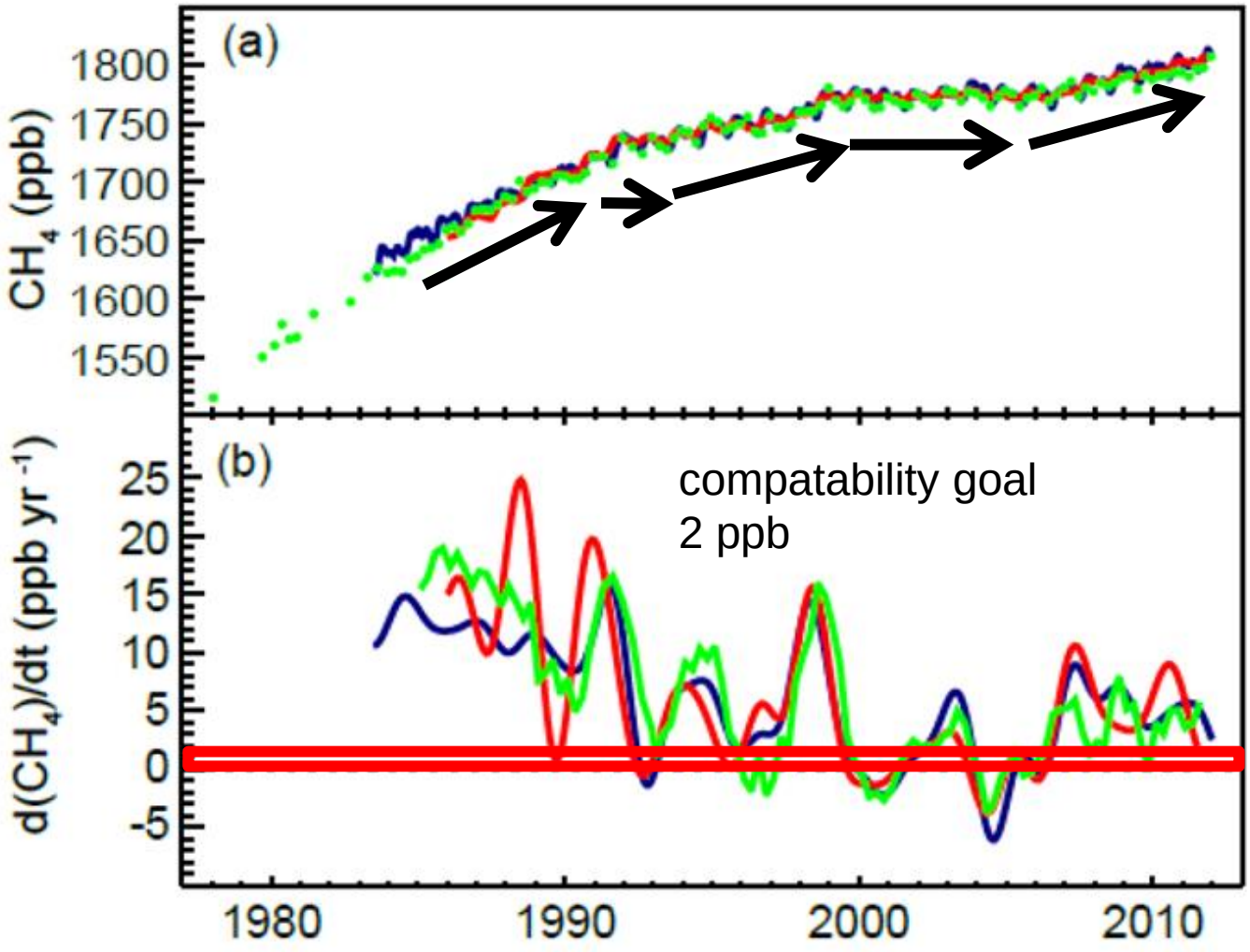
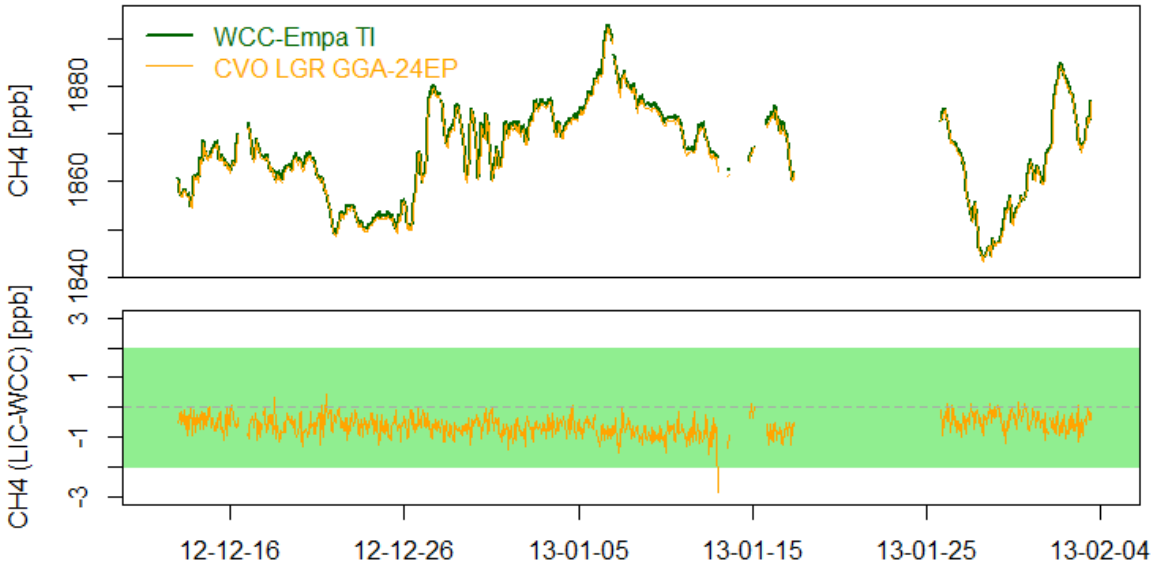
Methane (CH_4) from global networks

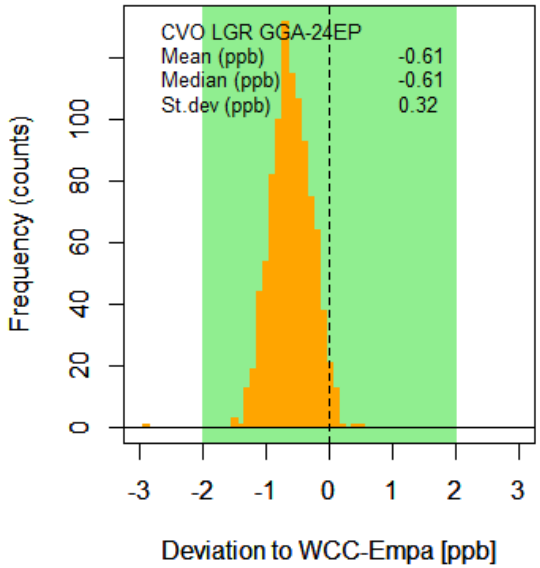


IPCC AR5

Results from WCC station audits

CH_4, LGR GGA-24EP @ Cape Verde

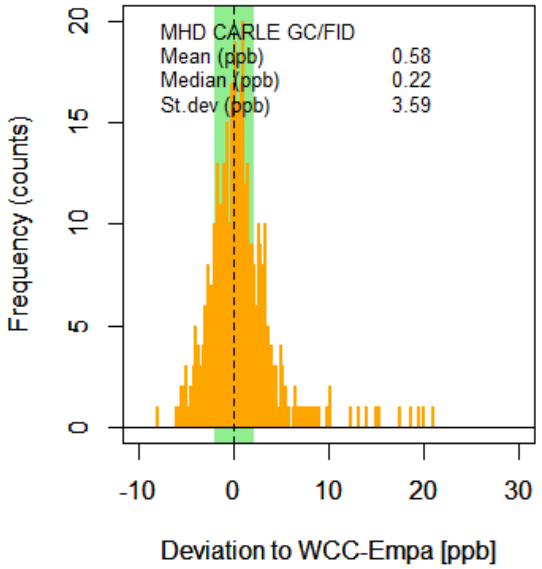




C. Zellweger, Empa

Results from WCC station audits

CH_4, GC/FID @ Mace Head



C. Zellweger, Empa

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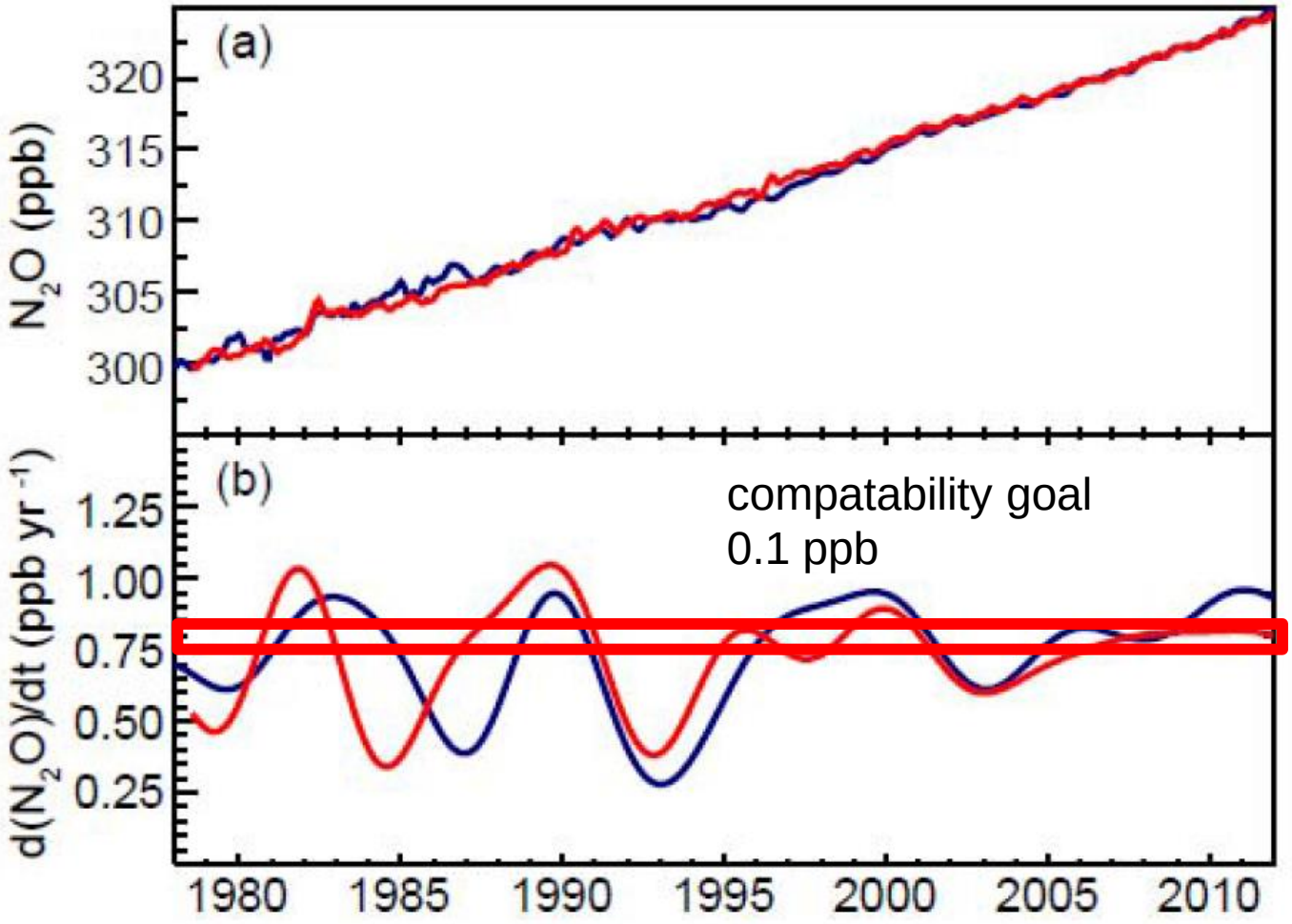
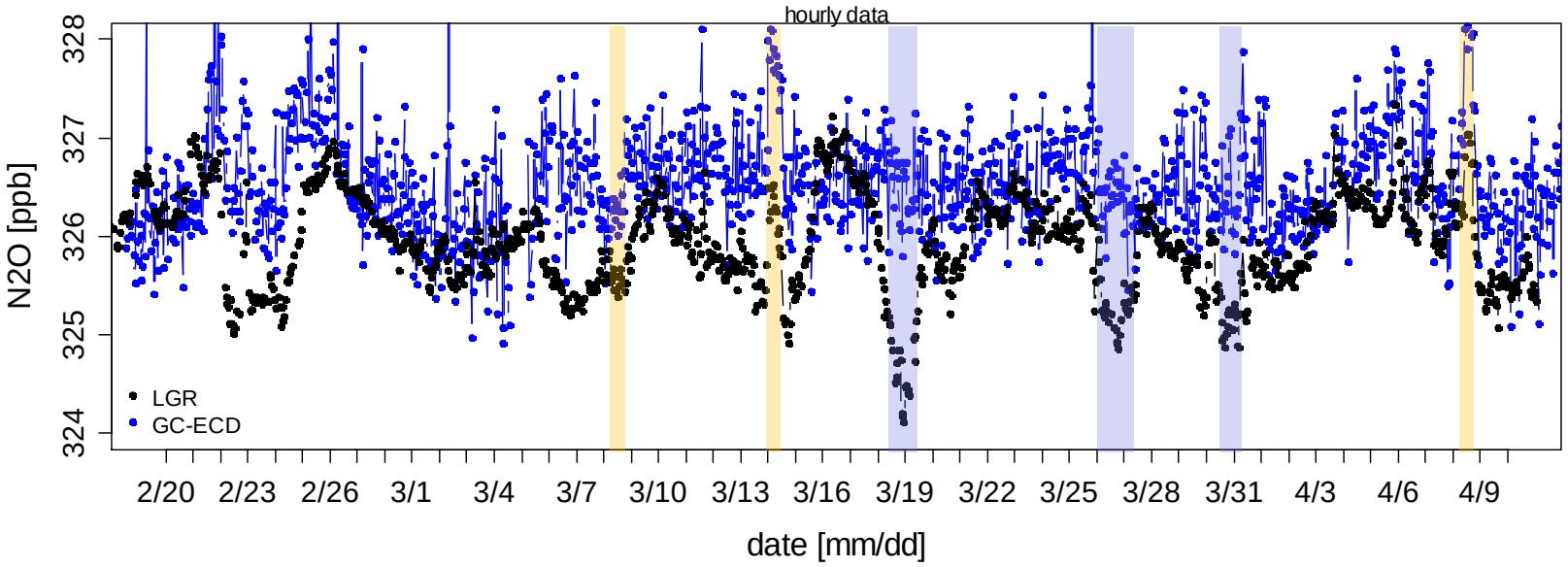
N2O from global networks



IPCC AR5

Ambient air data – N2O, hourly averages

i.e. average of 2 to 3 discrete injections (ECD) and full coverage hourly averages (LGR)



- small bias (cross-calibration of the calibration gases is still pending)
- short-term structure seen with LGR isn't always resolved with ECD

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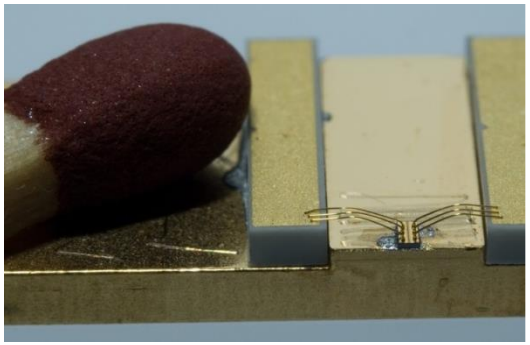
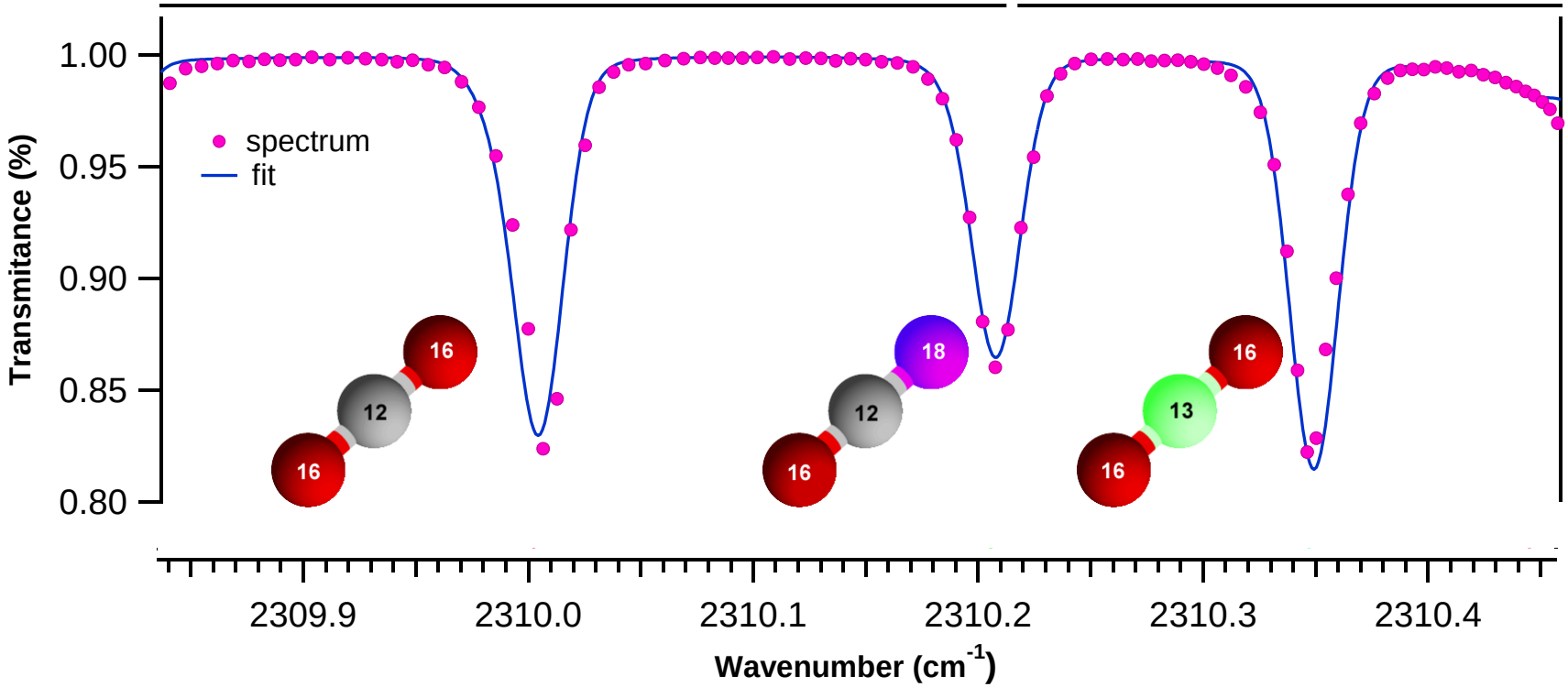
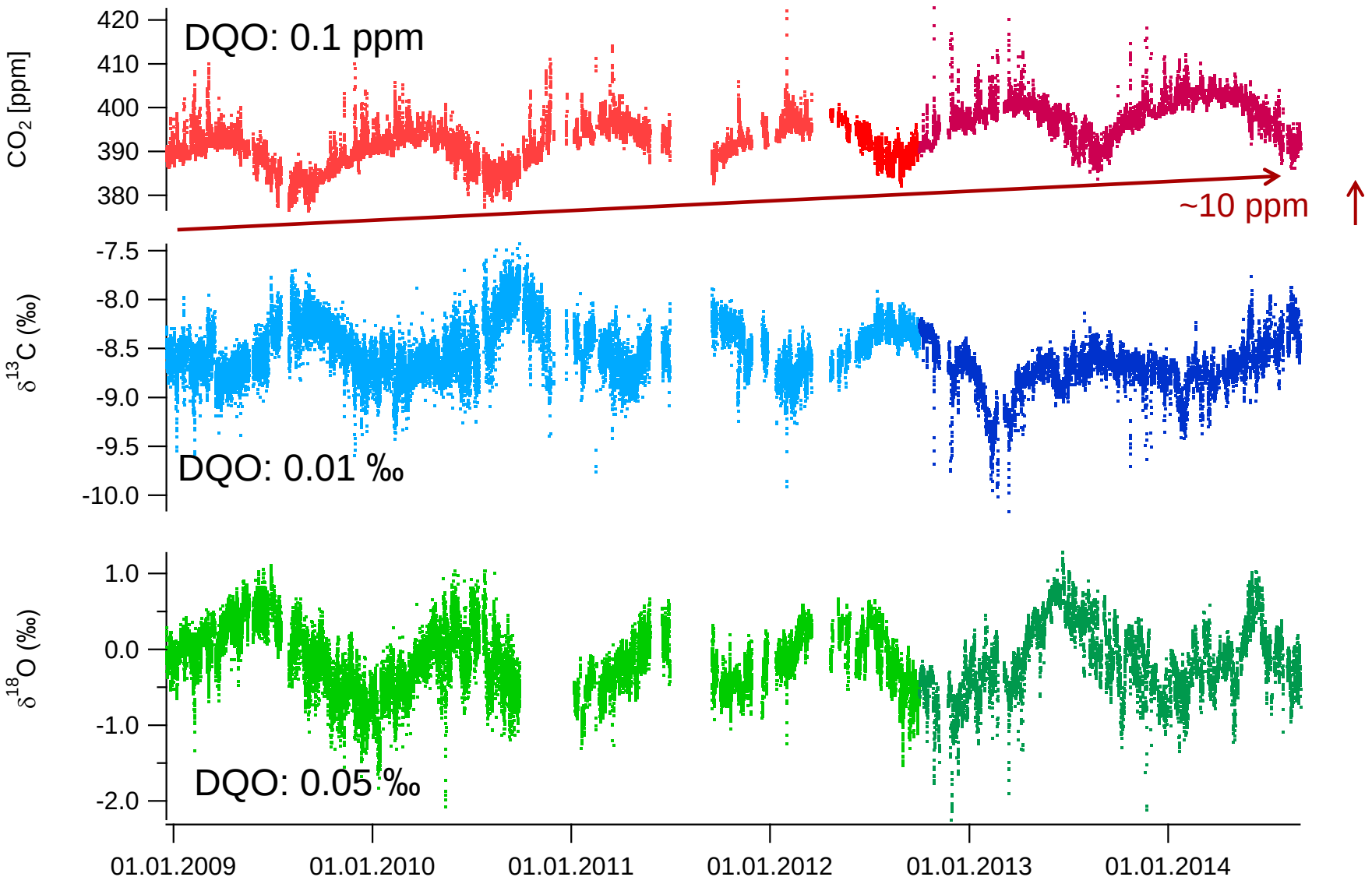
QCL Spectroscopy for Stable CO_2 Isotopes





B. Tuzson/J. Mohnen, Empa

Six year of measurements at Jungfraujoch

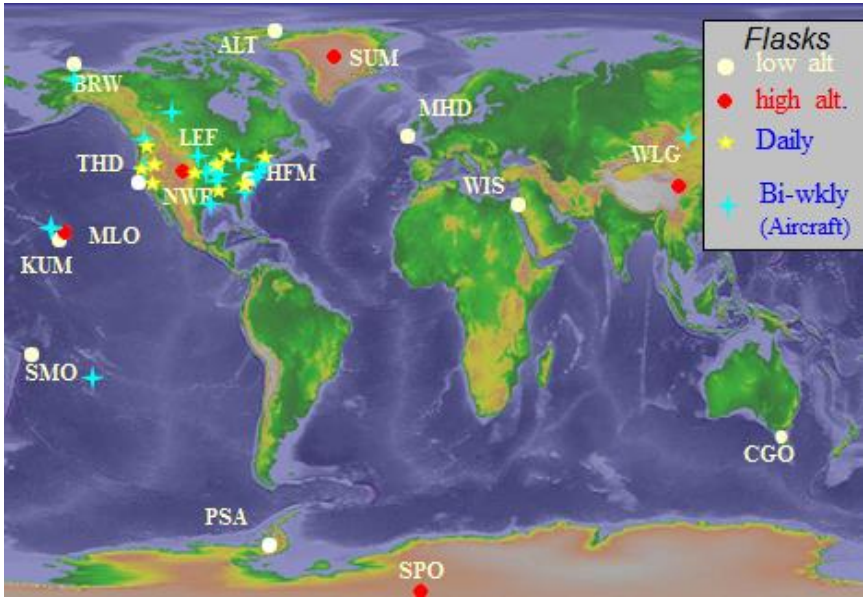


B. Tuzson/J. Mohnen, Empa

Halocarbons at global background sites

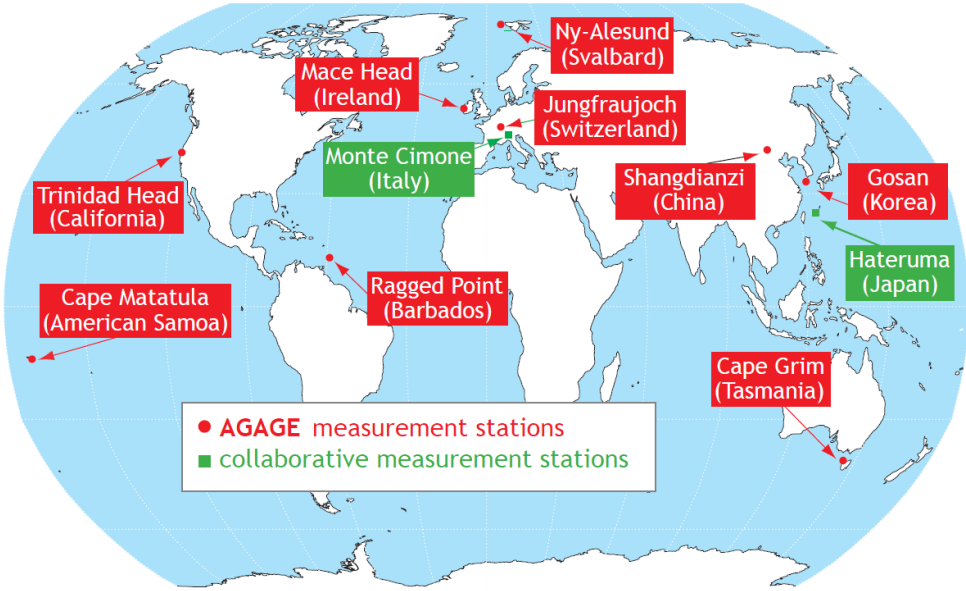
NOAA/ESRL

Halocarbon Surface and Aircraft Sampling Network



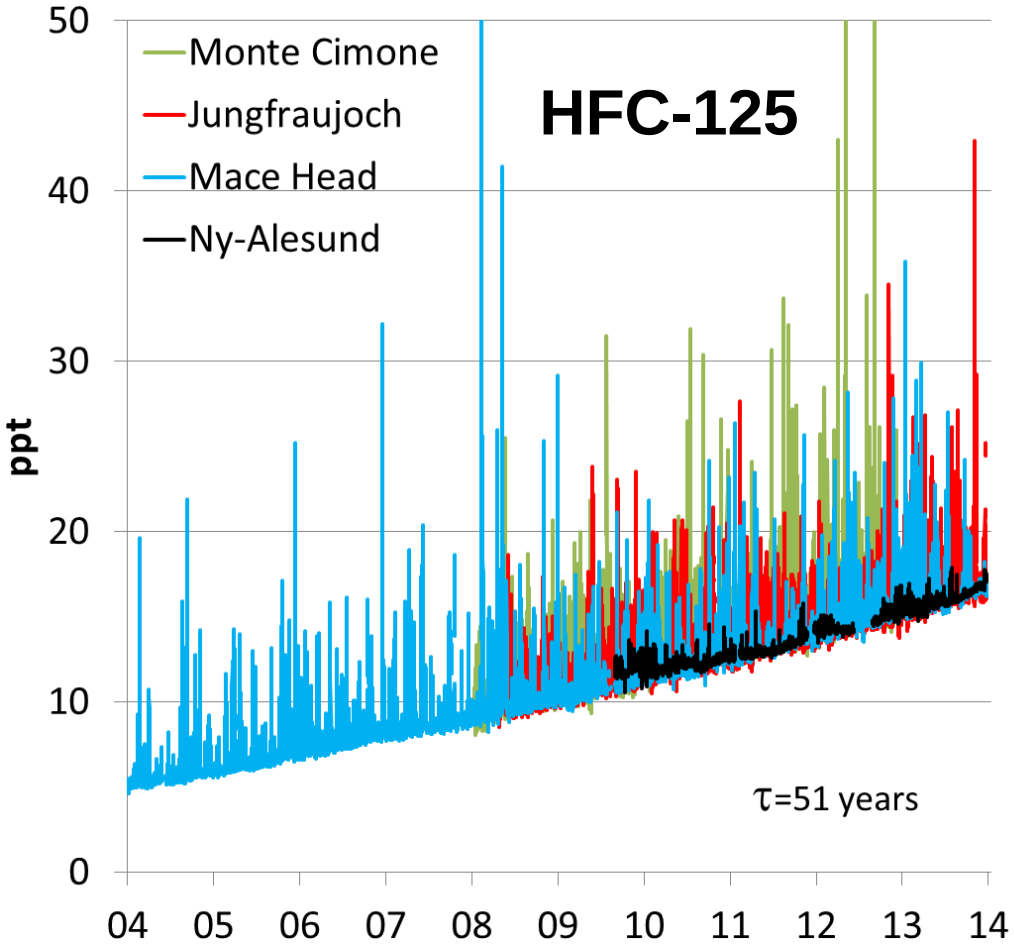
AGAGE

Continuous Halocarbon in-situ Sampling Network

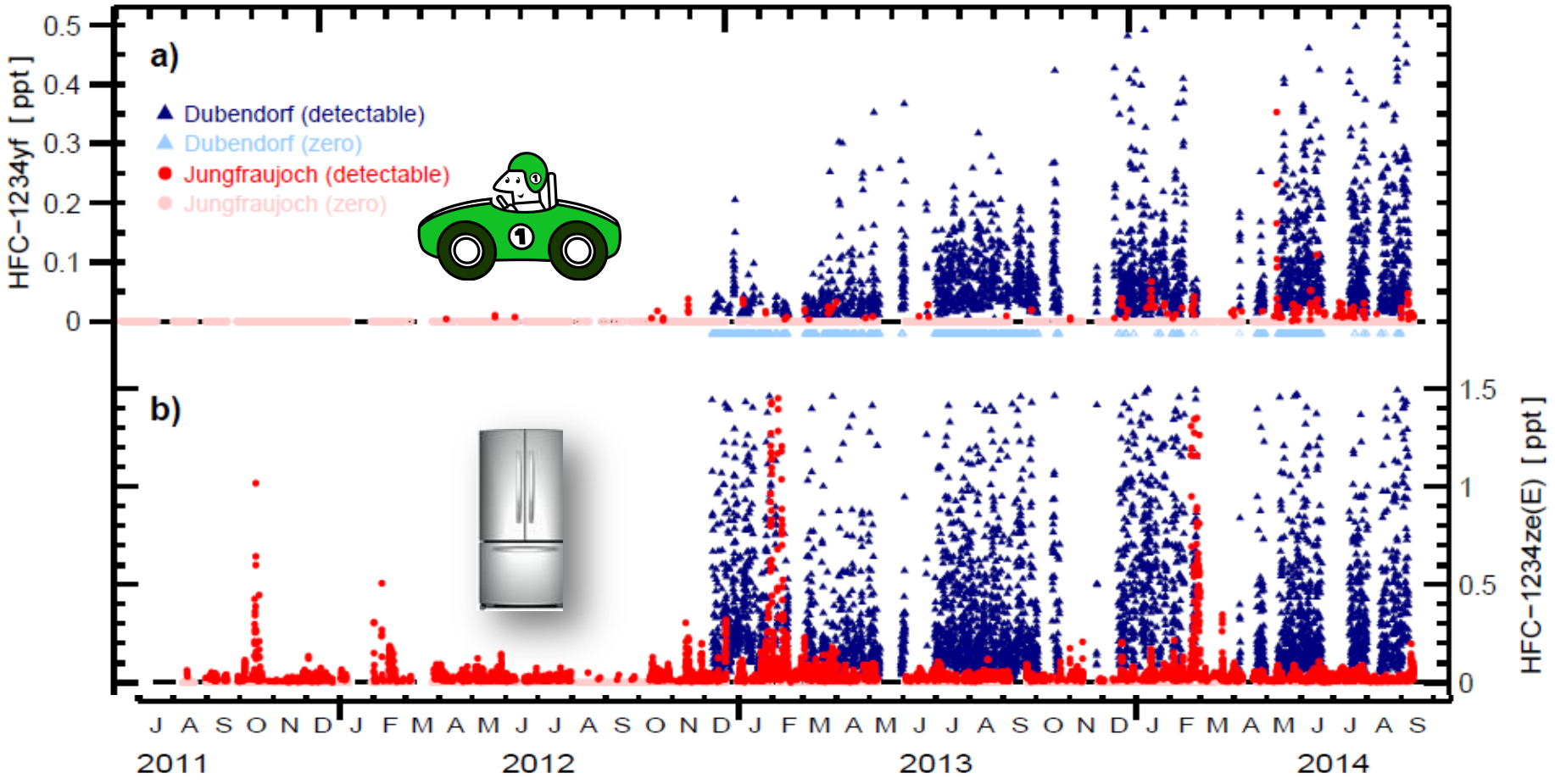


Halocarbons at global background sites

Fluorinated refrigerants



HFC-1234yf/HFC-1234ze(E): The "new kids on the block"



Vollmer et al., submitted

Conclusions

Continuous greenhouse gas measurements are essential for
- Trend analysis
- Emission estimation
- Verification of International treaties (e.g. Kyoto-Protocol)
- Use as early-warning tool

Data quality objectives DQOs have been defined for GAW/WMO related to scientific questions.

Common calibrations and standards should be used in global and regional networks to ensure compatability.

Acknowledgments

Empa
Christoph Zellweger
Martin Steinbacher
Joachim Mohn
Bela Tuzson
Lukas Emmenegger
Martin K. Vollmer

WMO
Oksana Tarasova

NOAA, AGAGE