Integrated non-CO_2 Greenhouse gas Observing System

InGOS and the future for non-CO_2 greenhouse gas observations

Alex Vermeulen, Arjan Hensen, Sylvia Walter, Peter Bergamaschi, Simon O'Doherty, Lynn Hazan, Ingeborg Levin, Ivan Mammarella, Eiko Nemitz, Euan Nisbet, Stefan Reimann, Thomas Röckmann, Martina Schmidt, Thorsten Warneke

European Commission

SEVENTH FRAMEWORK PROGRAMME

ECN

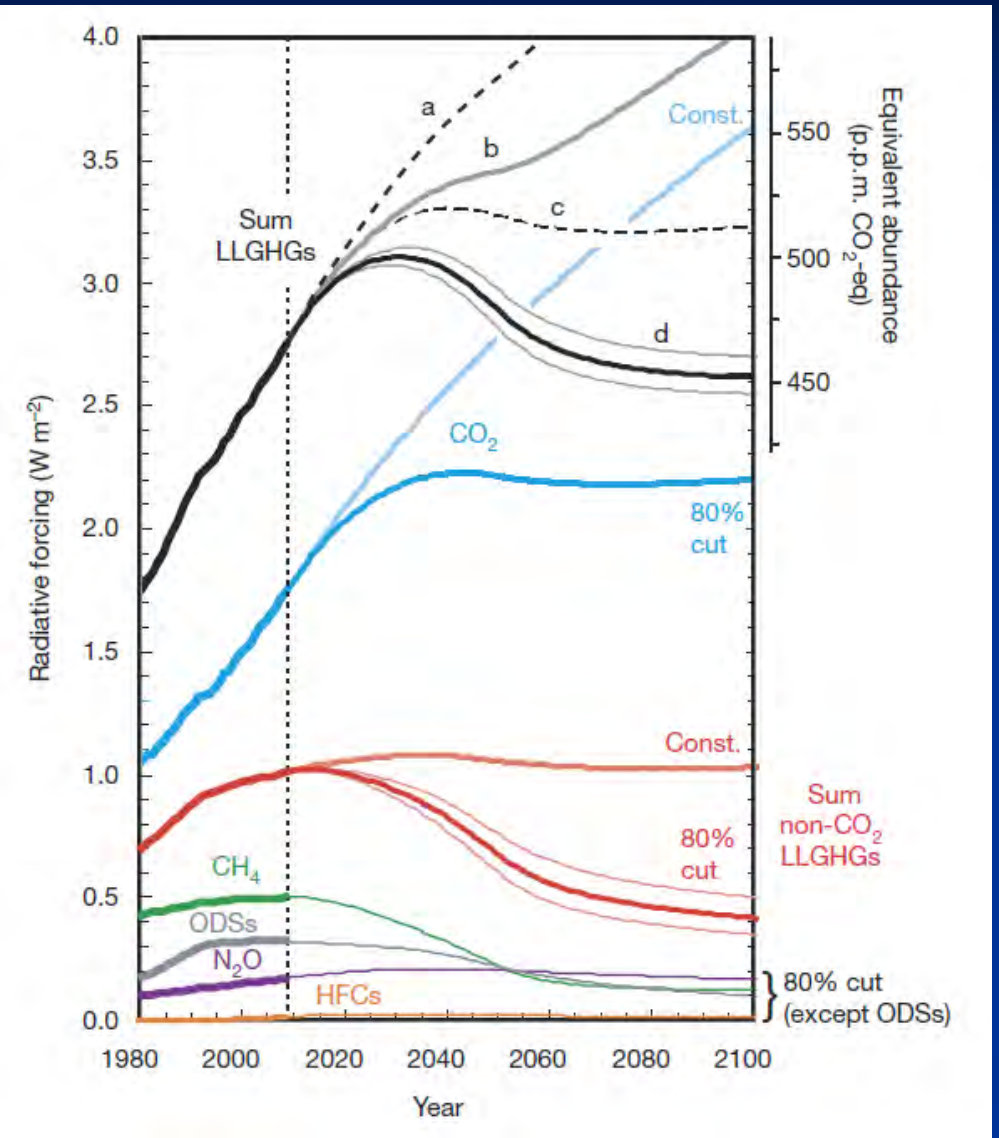
InGOS overview

Improving and extending European observation capacity for non-CO_2 greenhouse gases

- **Infrastructure project: Integrating Activities**
- **Budget 11 M€, EU 8 M€**
- **34 (36) partners, 14 (15) countries, 24 (28) observing stations**
- **1 October 2011 – 1 October 2015**
- **Will improve non-CO_2 observations and integrate them in ICOS**
- **Builds on: CHIOTTO, SOGE, CarboEurope, GHGEurope, IMECC etc.**
- **Coordination: ECN, NL**
  - http://www.ingos-infrastructure.eu

InGOS
Integrated non-CO_2 Greenhouse gas Observing System

Non-CO_2 reductions will be needed (too)!



- 2 ºC limit in 2100 hard to reach
- CO_2 –eq=2 ºC -> 450 ppm

- a = 2010 (non-)CO_2 emissions
- b = 80% reduct. non-CO_2
- c = 80% reduct. CO_2
- d = 80% reduct. CO_2+non-CO_2

Montzka et al, Nature, 2011

N_2O is currently biggest ODS (Ravishankara et al, 2009)

Emission reductions >80%: verification!

non-CO_2 GHG emissions uncertain

- Global antrop. emissions from network badly constrained
- Anthropogenis emissions bottom-up on country basis:
  - CO_2 emission annually per country -> 10% or more different (EEA, 2012)
  - CH_4: 30%
  - N_2O: 50 .. 200%
  - SF_6: 50%
  - Halocarbons: 50%
- Development of inverse transport models
- Verification by more and better observations is needed
- We can't go back later to measure todays baseline
- Capture suprise emissions (natural (CC) or human)

InGOS activities

- Networking activities:
  - Improve historic datasets CH_4, N_2O, SF_6, H_2, CO
  - Good practice development for all gas, isotope and flux observations
  - Near real-time provision of tracer data and
  - Provision of QA'ed new observational data
- Trans National Access:
  - 18 stations
  - Provision of
    - lab calibration standards
    - Gases for comparisons
- Service activities: databases (linked/shared with ICOS/AGAGE/WMO etc)
- Research activities
  - Testing and (co-)developing new sensors/instruments/methods
  - Integration of measurements and (inverse) modelling, network optimisation.
  - Link with remote sensing (TCCON)
  - Development of new observations (halocarbons, isotopes)
  - Integration of flux and concentration measurements at tall tower sites

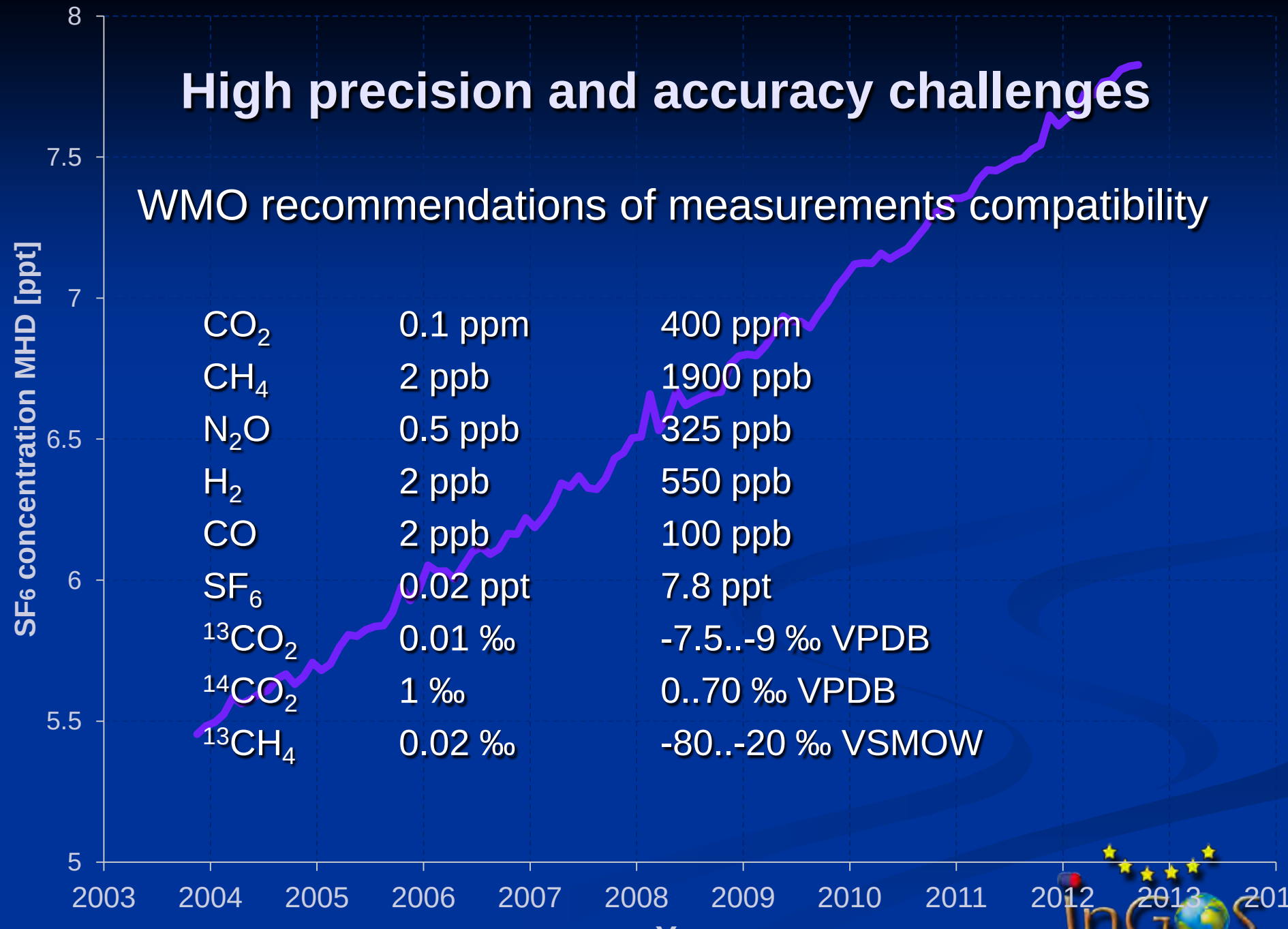
Integration of models and observations

- High resolution ^{222}Rn emission maps for model validation (connects with Transcom-BLH)
- Forward and inverse modelling by 7 independent global and/or regional models
- CH_4+N_2O:
  - Network sensitivity for
    - current network (22)
    - ICOS (34),
    - ICOS future (50)
  - Special EDGAR 4.2FT for prior emission estimates
- $^{13}CH_4$ tracer modelling
- Halocarbon inversions

High precision and accuracy challenges

WMO recommendations of measurements compatibility

CO_2	0.1 ppm	400 ppm
CH_4	2 ppb	1900 ppb
N_2O	0.5 ppb	325 ppb
H_2	2 ppb	550 ppb
CO	2 ppb	100 ppb
SF_6	0.02 ppt	7.8 ppt
$^{13}CO_2$	0.01 ‰	-7.5..-9 ‰ VPDB
$^{14}CO_2$	1 ‰	0..70 ‰ VPDB
$^{13}CH_4$	0.02 ‰	-80..-20 ‰ VSMOW



InGOS
Integrated non-CO_2 Greenhouse gas Observing System

Less GC's, let's go optical

New instrumentation: CRDS, OA-ICOS, QCL…

Wollongong FTIR (Griffith et al, 2011)

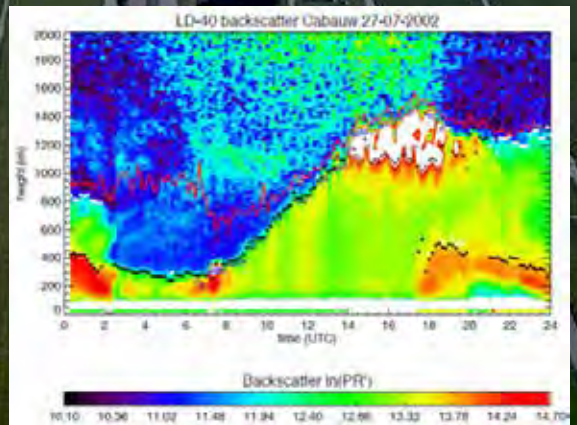
- Full IR spectra - wavenumber 1000-5000 cm^{-1}
- Travelling standard for ICOS

Precision:

- CO_2: 0.05 ppm
- $^{13}CO_2$: <0.08 ‰
- CH_4: 0.2 ppb
- N_2O: 0.03 ppb
- CO: 0.2 ppb
- HDO: 1 ‰
- $H_2{}^{18}O$: 0.2 ‰

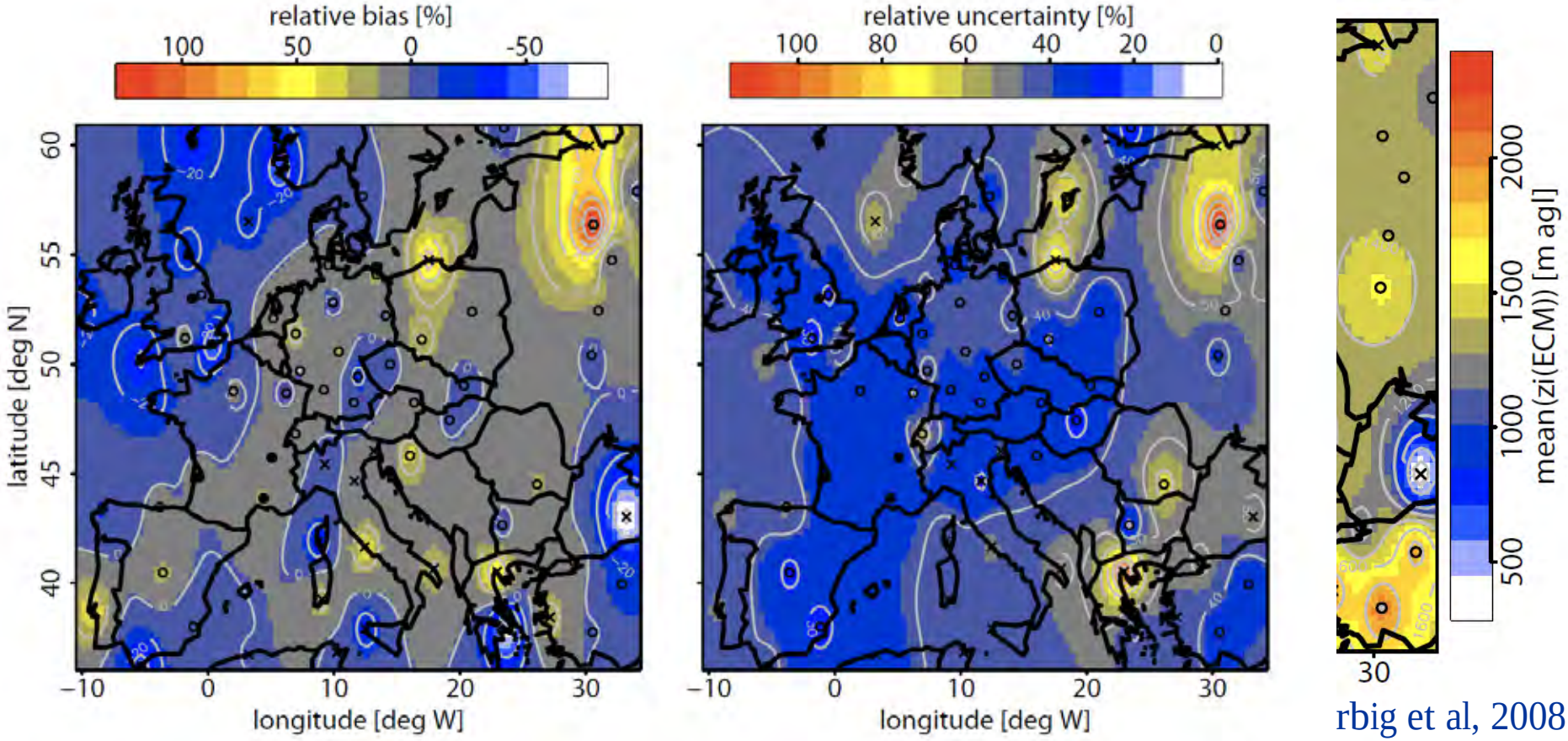
Links with air quality/ atm. composition change research

- Almost same anthropogenic sources, same atmosphere!
- GHG's are ~passive tracers: ultimate test
  - Can be measured very precise, less uncertainties (deposition, reactions, sampling artefacts)
  - Test for minimising transport errors in atmospheric transport models
  - Very sensitive to vertical mixing processes
- Ideal case for setup of multi tracer constrained inversions
- Improvement of GHG emissions by verification-> improvement of other emissions as well (time and place)!
- Baseline monitoring infrastructure should be shared, almost same demands



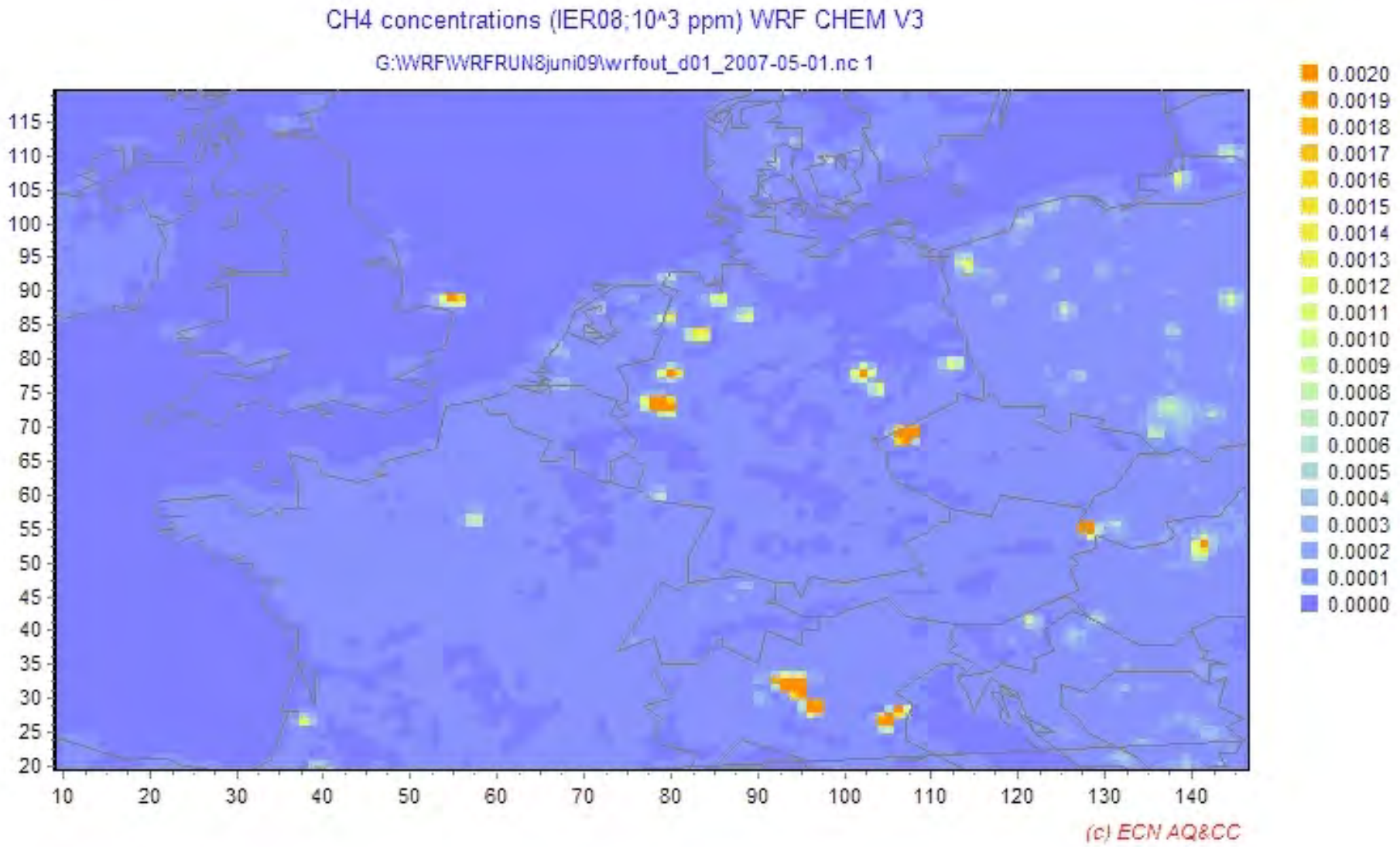
Link climate with air quality: inventories uncertainty, transport (vertical mixing)

- PBL height systematic uncertainty: 30% or more
- Systematic errors in concentration and derived fluxes
- Large potential for improvement: assimilating ceilometer network

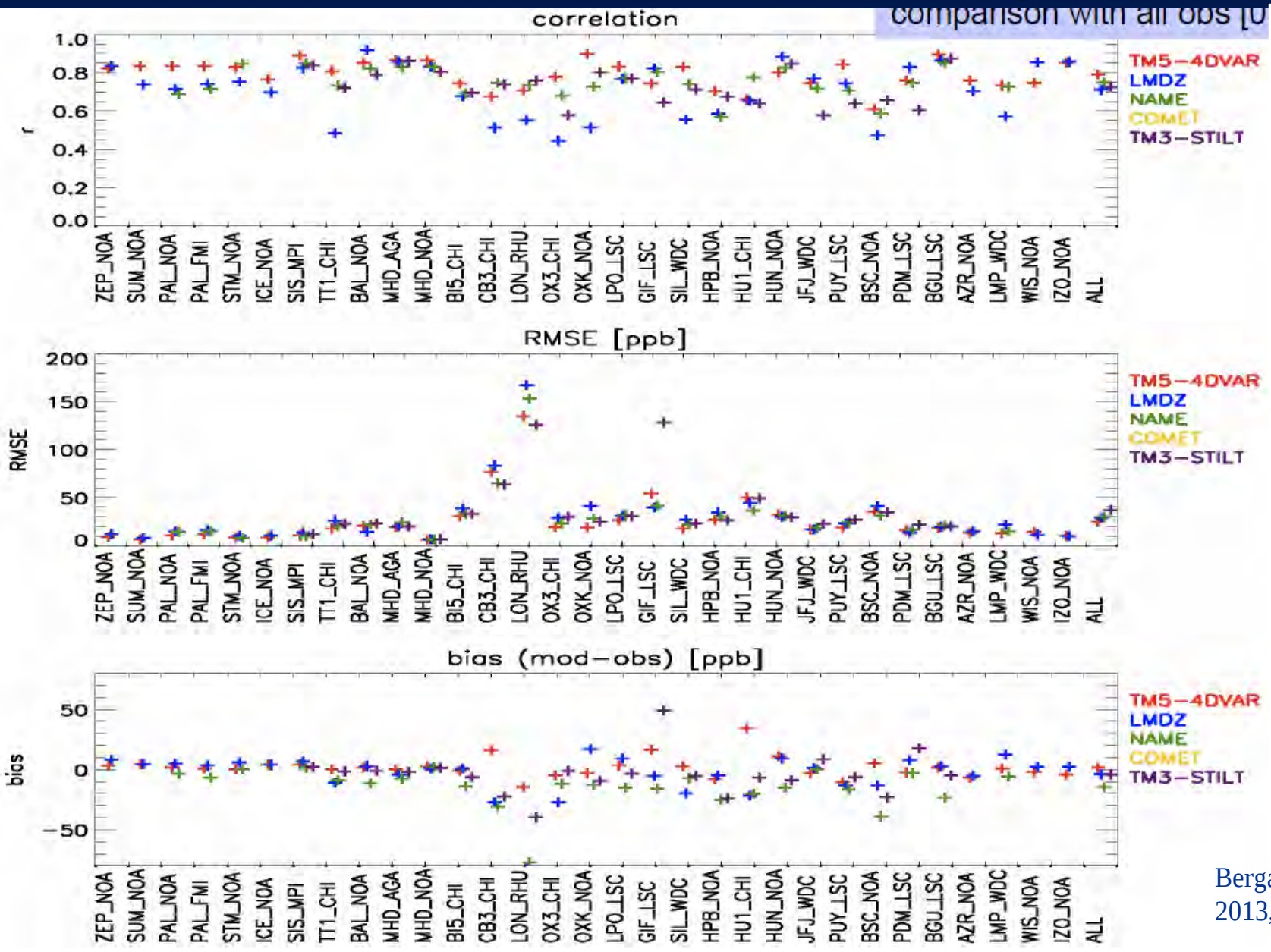


rbig et al, 2008

Shift to high resolution models (<5 km)



Models tested, correlations ok



Bergamaschi et al, 2013, in prep

InGOS now and in the future

- InGOS now well underway (~24 months) showing good progress
- InGOS integrates different communities (surface measurements, remote sensing and modelling)
- InGOS will provide
  - Harmonized historic datasets for continuous European obs. of CH_4, N_2O, SF_6, H_2, inclusive error analysis
  - Near realtime continuous data for CH_4, N_2O, SF_6, H_2, ^{222}Rn…
  - Improved regional emission estimates (bottom up+top down)
  - Network design for non-CO_2 monitoring
  - Improved measurement techniques and methods

InGOS beyond 2015

- Further expand, improve consistency and quality of network
- Test and deploy new (optical) techniques
- Increase links and synergy:
  - ICOS
  - ACTRIS
  - AQ networks
  - Urban networks: mobile platforms
  - Link to FP7 + Horizon 2020 projects
- Extend use of observations to full temporal resolution
- Additional isotopic ratio obs.: better source characterisation
- Deploy new remote sensing platforms, expand TCCON ground truthing (e.g. Tropomi) at co-located sites

Integrated non-CO_2 Greenhouse gas Observing System

THANK YOU!

The InGOS project receives funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 284274

Integrated non-CO_2 Greenhouse gas Observing System