Implementation of the Integrated Global Greenhouse Gas Information System (IG^3IS)

O.Tarasova* and BIG IG^3IS Science Team

*WMO Research Department

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

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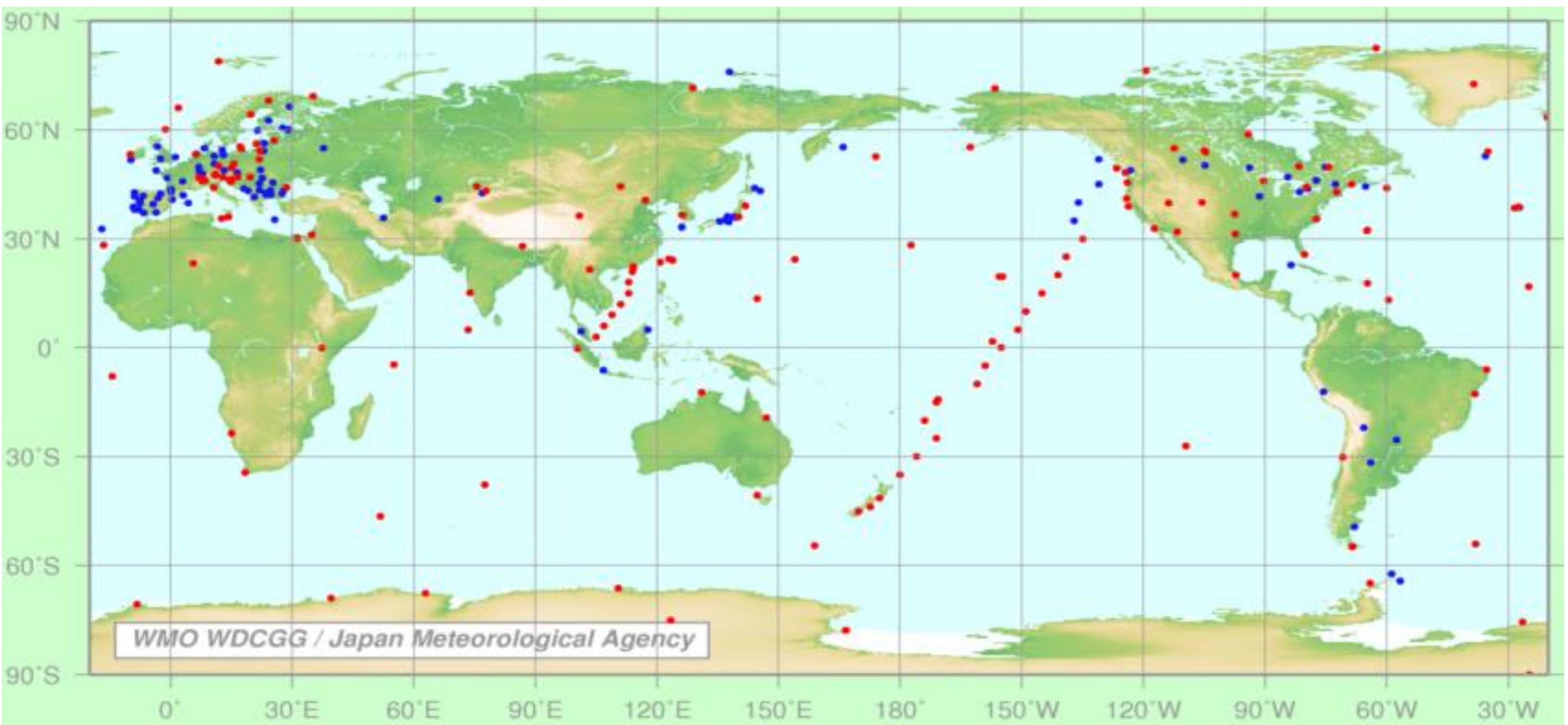
World Meteorological Organization
Organisation météorologique mondiale

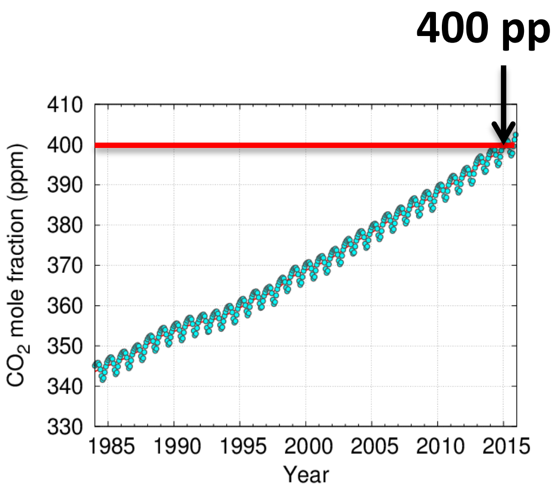
WMO Role in GHG Information and IG³IS

The Role of the World Meteorological Organization (WMO)

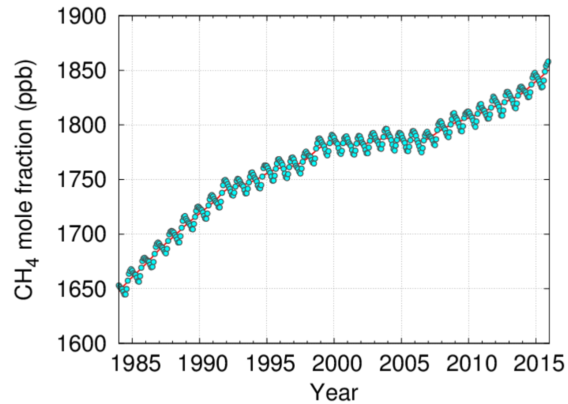
- Ensure high quality, consistent, continuous GHG and other observations of atmospheric composition
- Develop high quality atmospheric transport and data inversion models
- Coordinate global atmospheric measurements; improve models and analysis
- Leverage capabilities across programs and nations
- Build capacity in developing nations



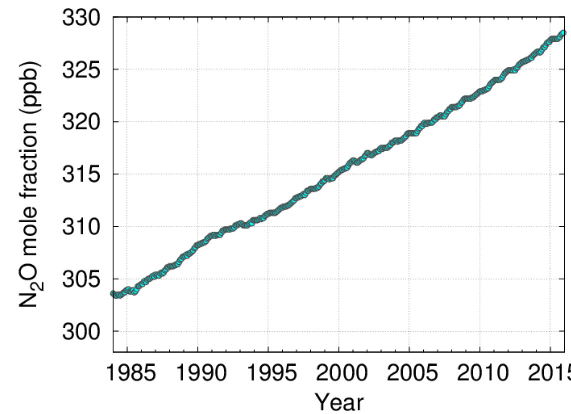
Evolution of GHGs 1985-2015



Carbon dioxide (CO_2)

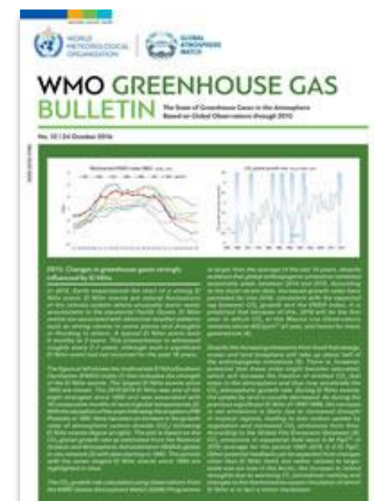


Methane (CH_4)



Nitrous oxide (N_2O)

Globally averaged mole fraction of CO_2 in the atmosphere reached the milestone of 400 parts per million for the first time in 2015 and surged again to new records in 2016 on the back of the very powerful El Niño event



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Key features of the Paris agreement

- **New legal agreement** for the post-2020 climate regime under the UNFCCC
- Addresses **mitigation, adaptation and minimizing loss and damage**
- Ambition to limit warming **to well below 2 °C above pre-industrial levels** while **pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels**
- Addresses the means of implementation: finance, technology and capacity building
- Builds on **Nationally Determined Contributions** (NDCs) from Parties to the UNFCCC, a crucial step towards common objective
- Countries invited to update emission targets by 2020 and every five years
- **Transparency** and reporting on national progress

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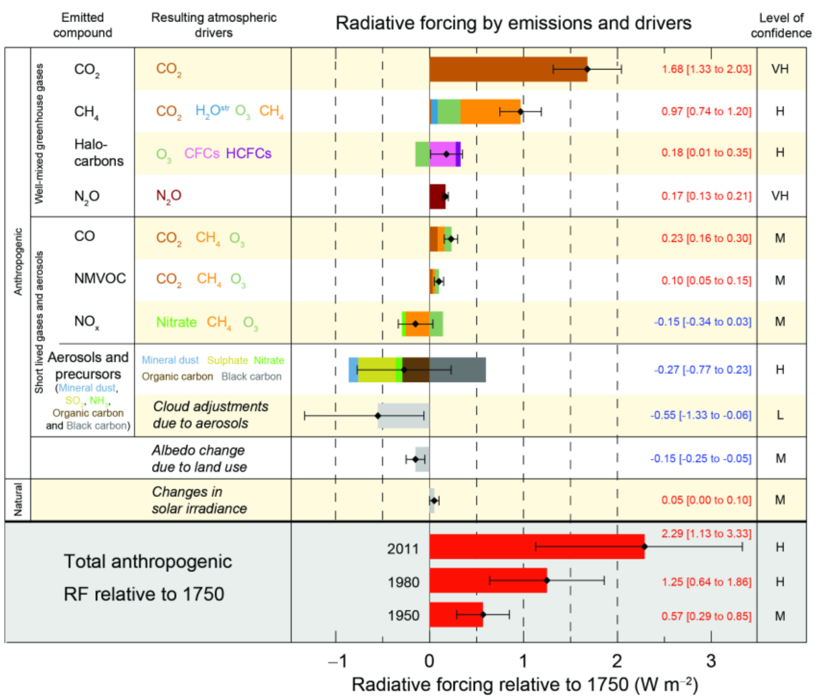
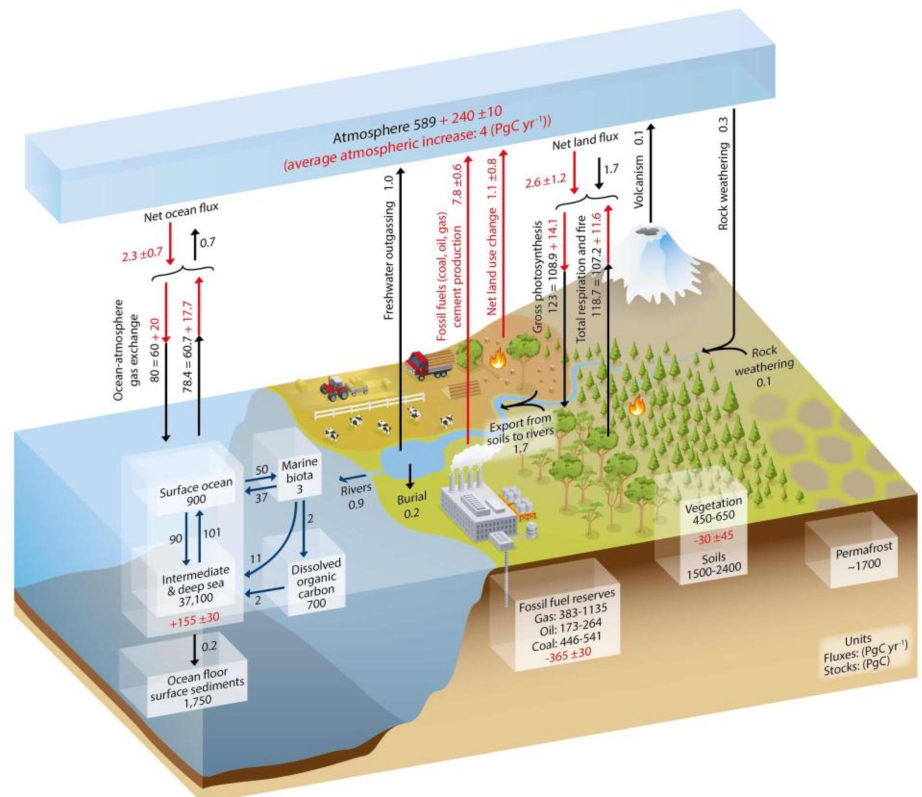
COP21 · CMP11
PARIS 2015
UN CLIMATE CHANGE CONFERENCE

Paris Agreement – limit the warming below 2C (by limiting emissions)

Fundamental problem – it is what you **HAVE** in the atmosphere, not what you **PUT** in the atmosphere, that controls the temperature





Calculations are for year in 2011

Human (9GtC in) – ocean (2.3GtC out) – biosphere(2.6GtC out)

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How to get emissions?

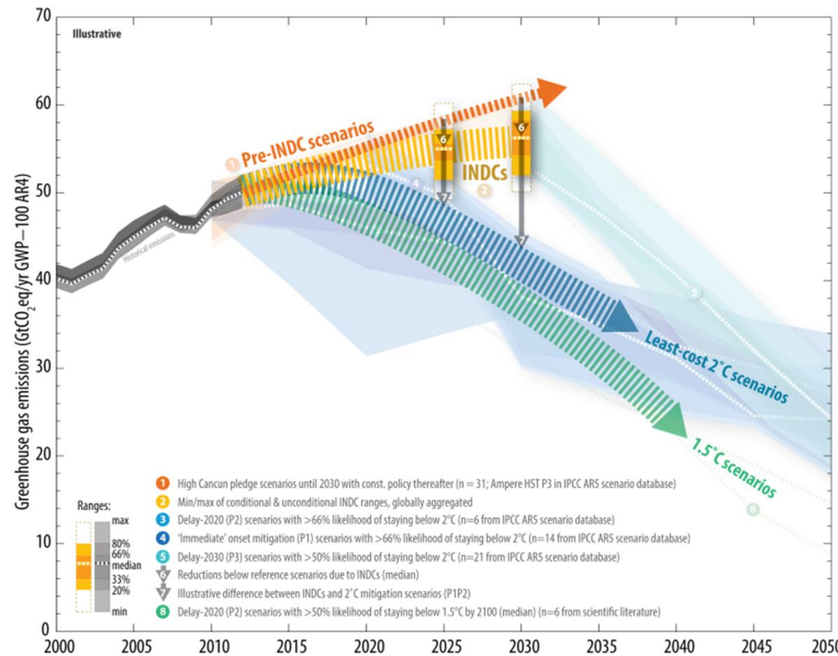
- “Bottom-up” measurements (IPCC reporting)
  - Emissions reporting
  - Reported and “verified” offsets
  - Site-specific measurements

- **“Top-down” measurements**
  - Comprehensive atmospheric observation system
  - Ecosystem and ocean observations
  - Inverse modelling

- Combination of above

NDCs

Assuming that we know ocean and biospheric uptake



IPCC Special Report

NDC are evaluated every 5 years -> are we on the right track?
Where can we cut more?
Are oceans and biosphere are working as expected?

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The Integrated Global Greenhouse Gas Information System (IG^3IS)

Goal: Support the success of post-COP21 actions of nations, sub-national governments, and the private sector to reduce climate-disrupting GHG emissions through a sound-scientific, measurement-based approach that:

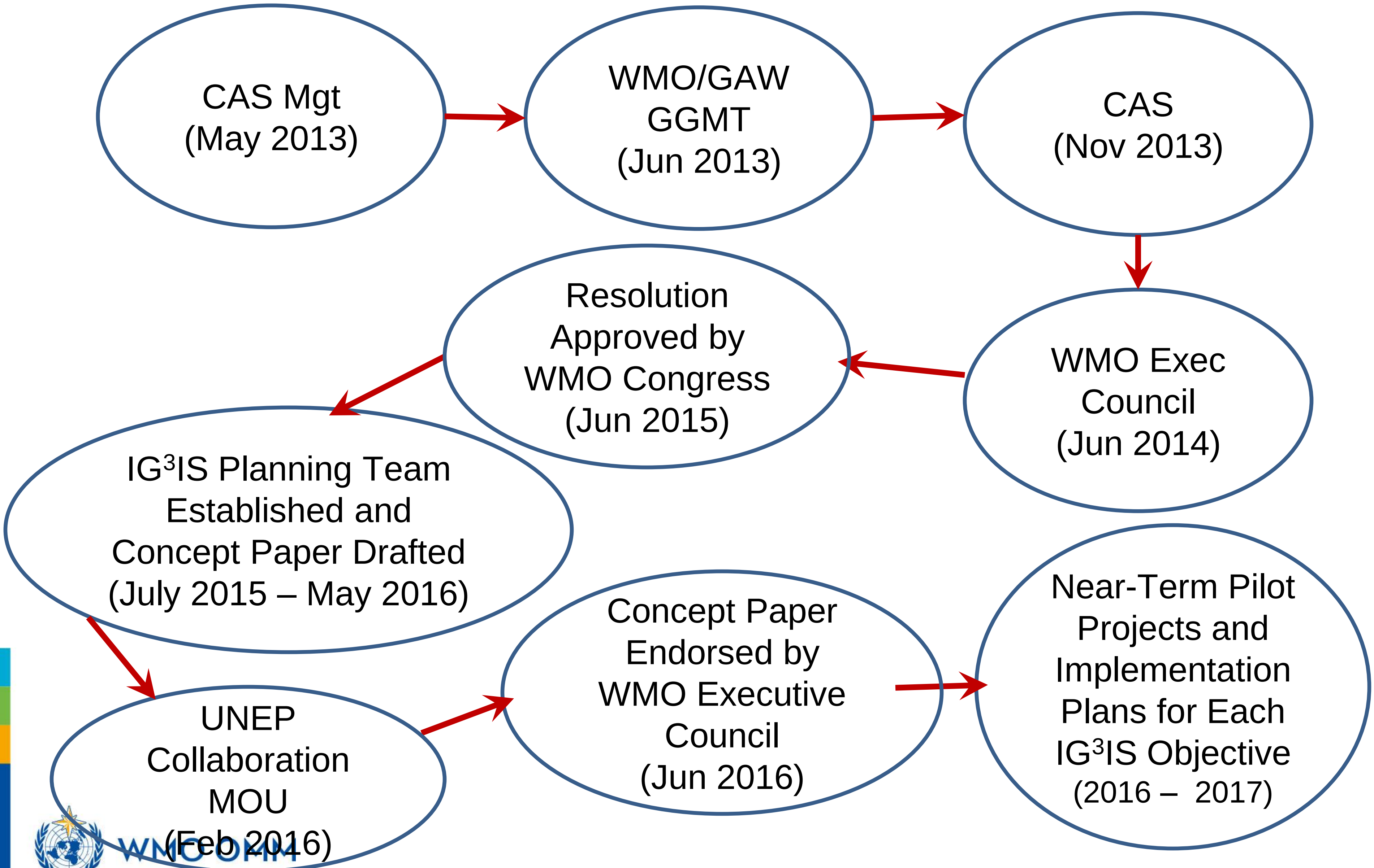
- **reduces uncertainty of national emission inventory reporting**,
- **identifies large and additional emission reduction opportunities**, and
- **provides nations with timely and quantified guidance on progress towards their emission reduction strategies and pledges (e.g., NDCs)**

Concept paper approved by EC-68

IG³IS Principles

- IG³IS will serve as an international coordinating mechanism and establish and propagate consistent methods and standards.
- Diverse measurement and analysis approaches will fit within a common framework.
- Stakeholders are entrained from the beginning to ensure that information products meet **user priorities** and deliver on the foreseen value proposition.
- Success-criteria are that the information guides additional and valuable **emission-reduction actions**.
- IG³IS must mature in concert with evolution of technology and user-needs / policy.

IG^{3}IS programmatic evolution within WMO



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Near-term IG^{3}IS Objectives (3-5 year horizon)

1. Reduce uncertainty of national emission inventory reporting to UNFCCC;
2. Locate and quantify previously unknown emission reduction opportunities such as fugitive methane emissions from industrial sources; and,
3. Provide subnational entities such as large urban source regions (megacities) with timely and quantified information on the amounts, trends and attribution by sector of their GHG emissions to evaluate and guide progress towards emission reduction goals.
4. Support of global stock taking

Cross-cutting activity on development of inverse modelling techniques

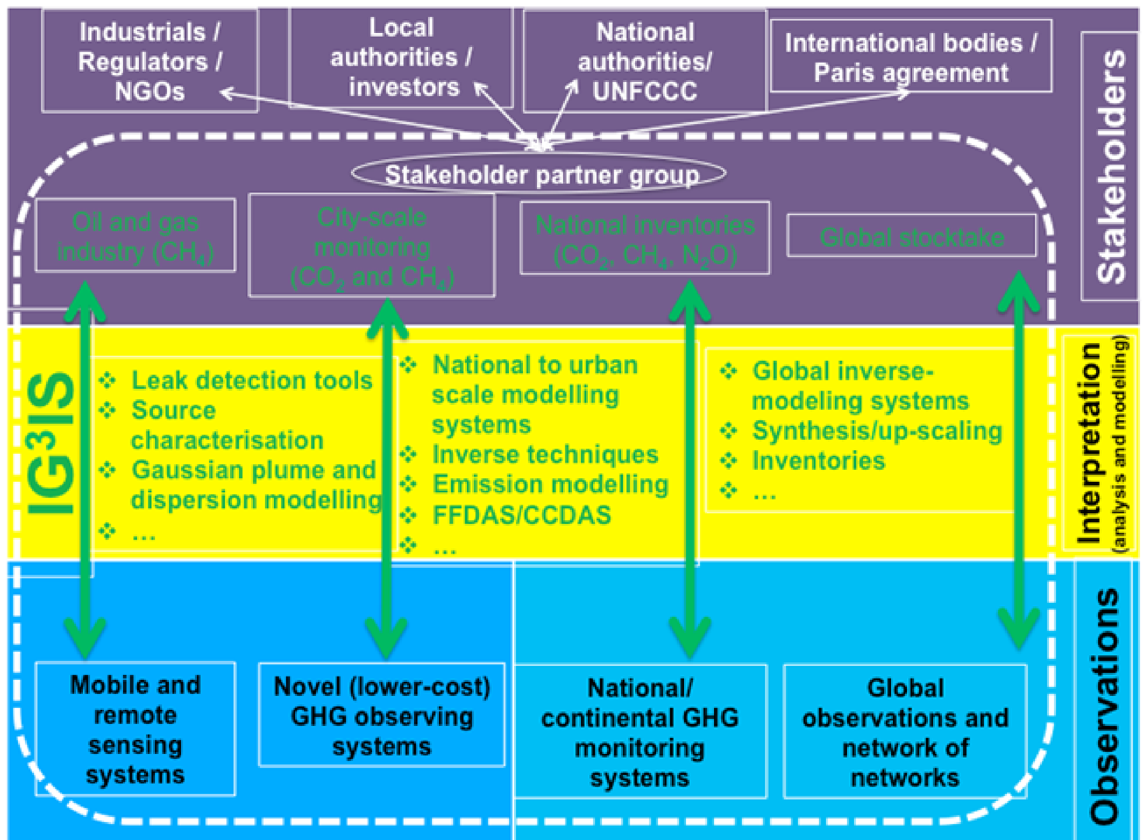
Annotated outline of the IG^{3}IS Implementation Plan was presented at EC-69

IG³IS Implementation

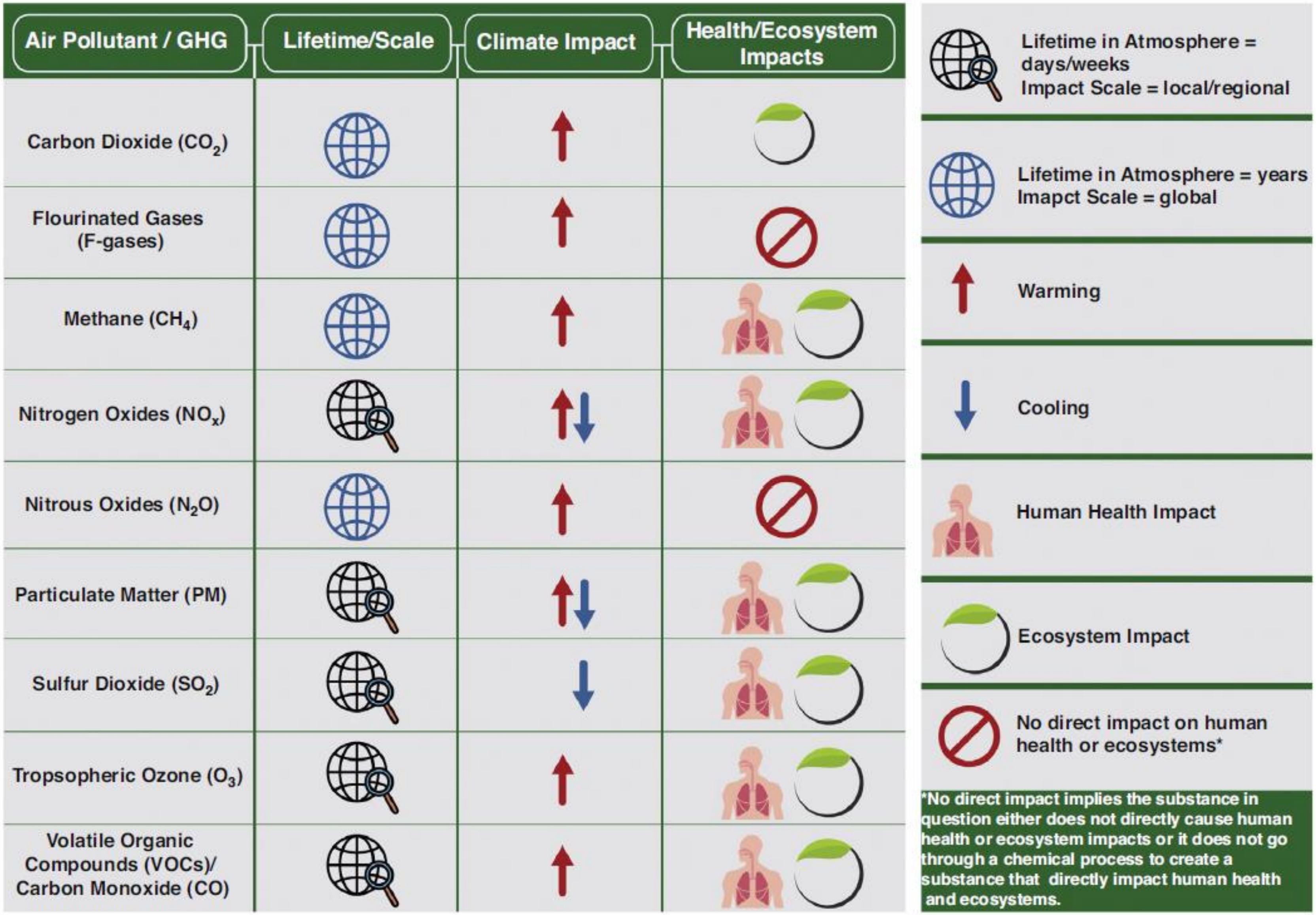
IG³IS implementation is proceeding along two lines of activity:

1. The preparation of methodological guidelines that describe "good practice" use of atmospheric measurements for implementation under each objective area, and

2. The initiation of new projects and demonstrations that propagate and advance these good practice capabilities and build confidence in the value of IG³IS information with stakeholders.



Co-benefits of combined climate and air quality policies



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(from Melamed et al., 2017)

What sectors can be supported by IG^3IS?

Mitigations	Main observations	Observations needed for sector attribution	Additional benefits
Transport and energy	CO_2	^{14}C in CO_2 CO, NOx	Air quality and health through co-emitted
Oil and gas emissions/ waste management	CH_4	CH_4 isotopic composition Volatile Organic Compounds (VOC)	Regional air quality (agricultural production loss due to O_3)
Agriculture/ land use	CH_4, N_2O	CH_4 isotopic composition Volatile Organic Compounds (VOC) NOx	The same as above plus water quality

Adaptation measures:

- Sustainable agricultural practices (with optimal use of fertilizers)
- Food security and development and development of pollution sustainable crops
- Minimization of impacts on human health

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Objective 1: IG^{3}IS in Support of National Inventory Preparation

(lead authors Alistair Manning and Dominik Brunner)

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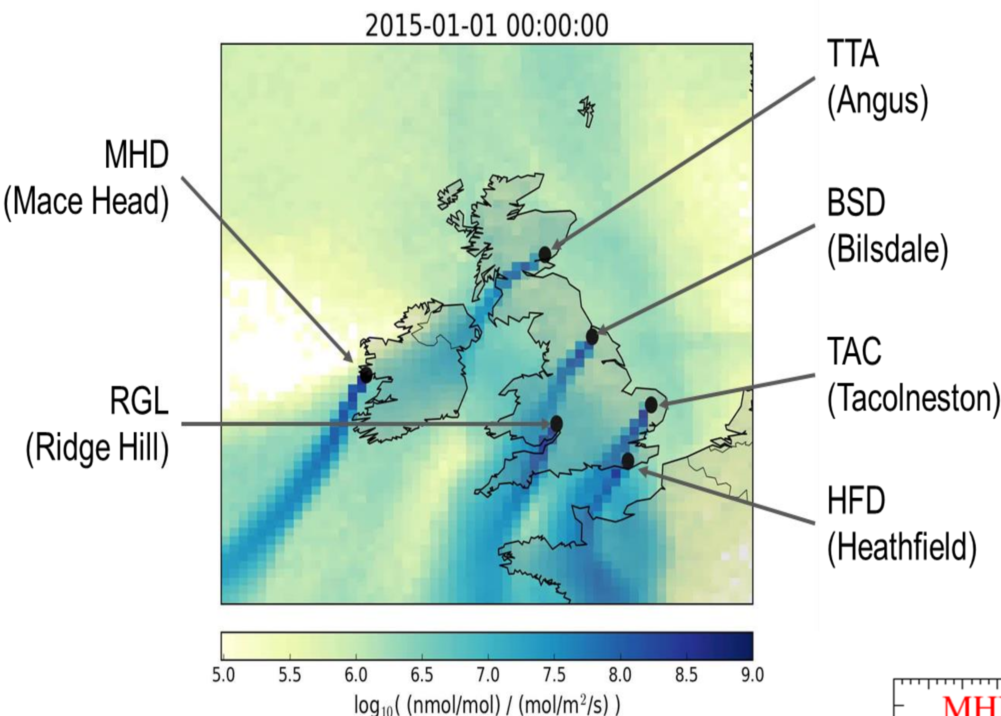
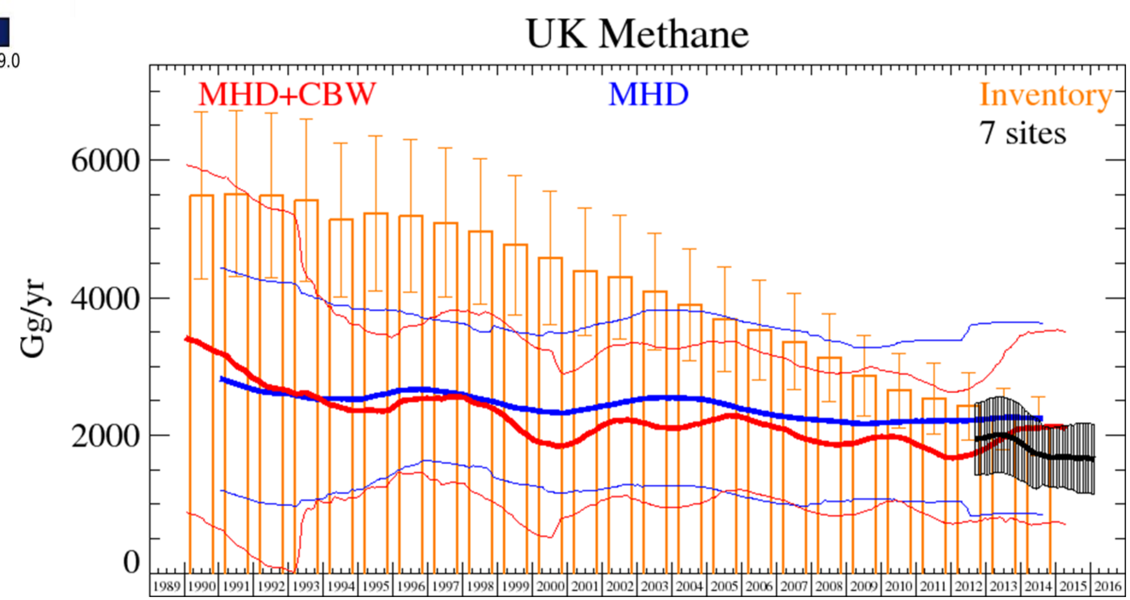
IG³IS best practice from UK



The GAUGE project

Time resolution of emission estimates was improved, while uncertainty is still substantial (Lagrangian approach used)

Sations footprint modelled using NAME model (Cortesy of Alistair Manning Met Office, UK)



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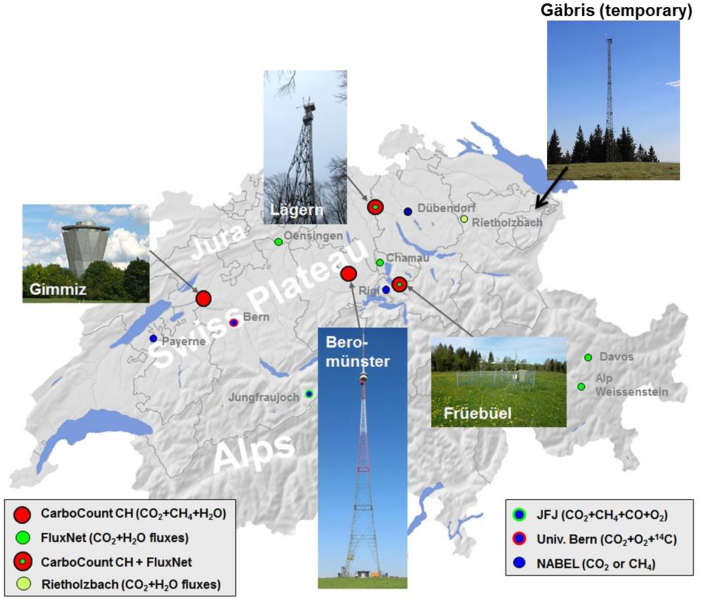
IG³IS best practice from Switzerland

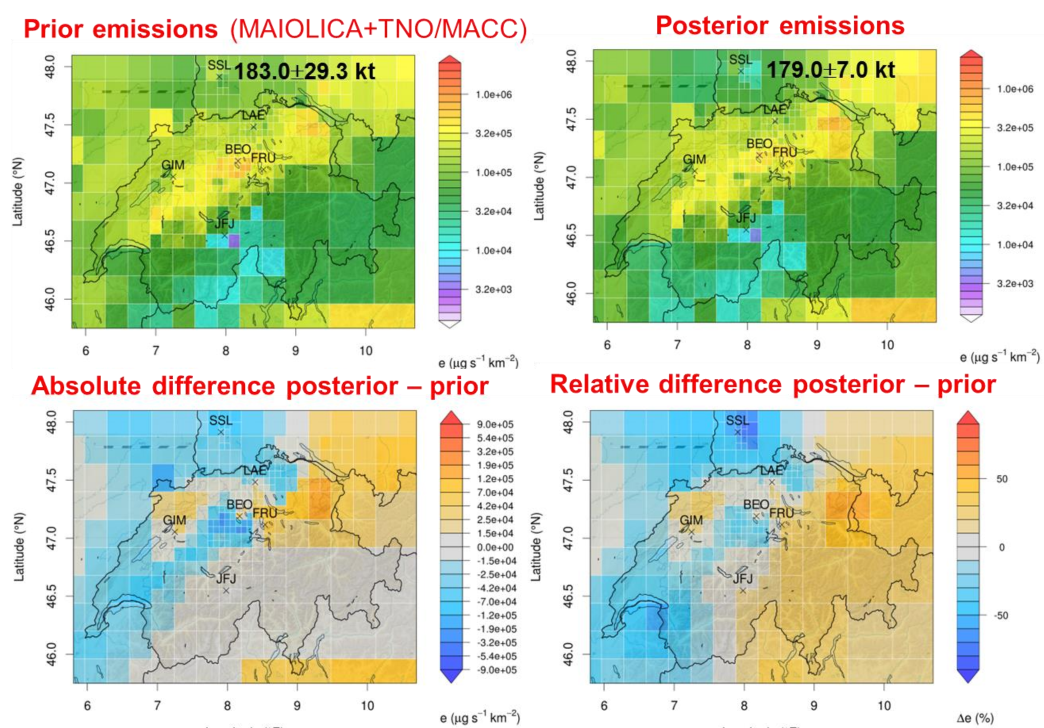


CH_4 emissions in Switzerland 2013

Henne, S.,D Brunner et al.,2016 : Validation of the Swiss methane emission inventory by atmospheric observations and inverse modelling, Atmos. Chem. Phys., 16, 3683–3710, www.atmos-chem-phys.net/16/3683/2016/

New GHG measurement network established (project CarboCount-CH)

FLEXPART-COSMO (Empa, MeteoSwiss) – Largangian model with Bayesian inversion



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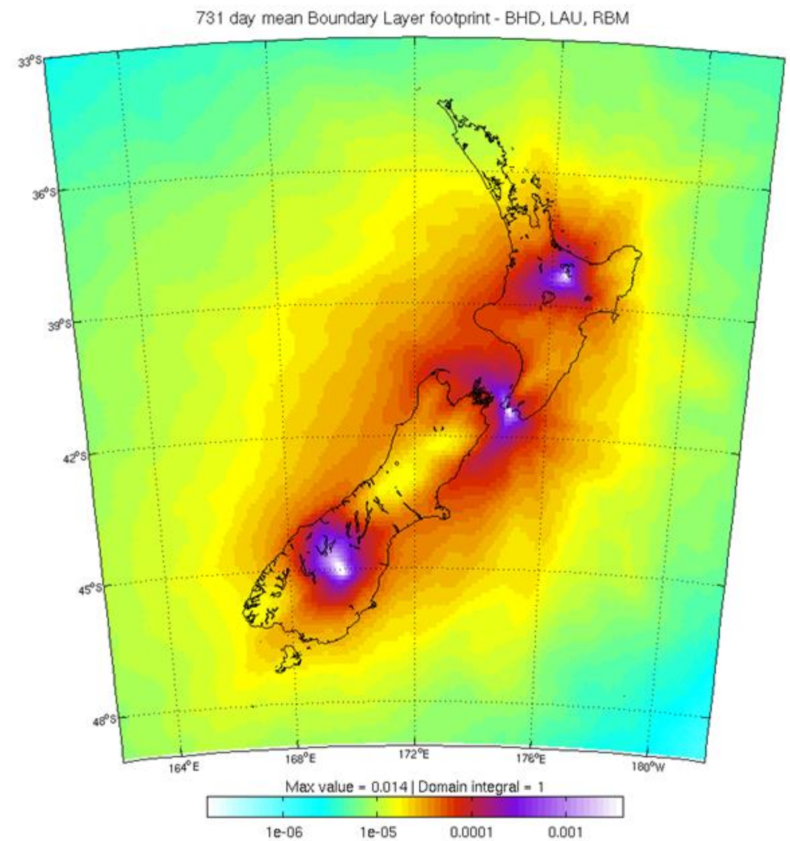
New Zealand "top-down" regional carbon programme

- NAME is used for the inverse modelling.
- Currently 3 observation sites contribute CO_2 data to the inverse model.
- Use ^{14}C for sector attribution
- NIES Transfuture 5 observations are included when it is within the domain.
- Adding 2 new sites this year



Slide: courtesy of Brailsford Gordon, NIWA

(Steinkamp etal, 2017)

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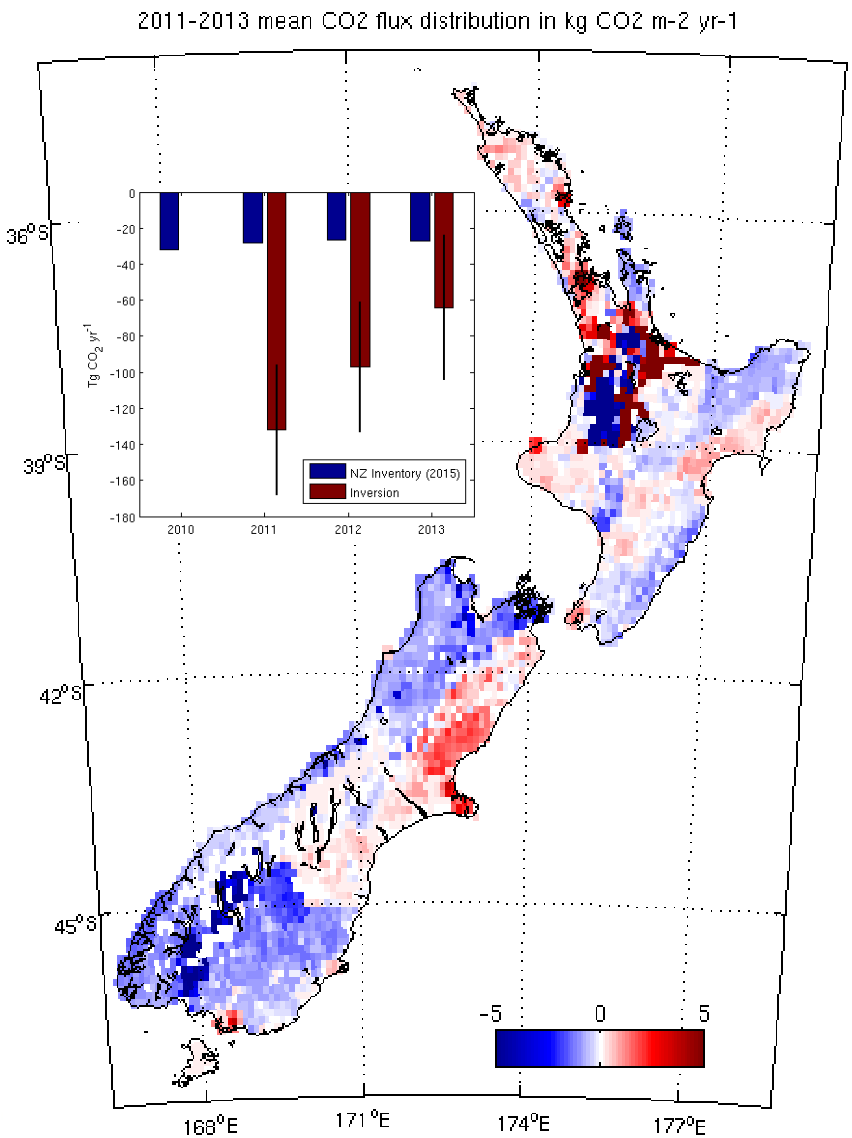

Geographic Distribution of Inverse Flux Estimates

- Larger uptake than prior model or bottom up accounting, particularly in forested regions
- Differences to bottom up accounting partly due to differences between LULUCF and what the atmosphere 'sees'. These issues are still being resolved.

Slide: courtesy of Brailsford Gordon, NIWA

INTERGOVERNMENTAL PANEL ON climate change

Our ref.: 5207-16/IPCC/P-44

To the Executive Heads
of International and other Organizations

Geneva, 16 August 2016

Sir/Madam,

I am writing on behalf of the Chair of the Intergovernmental Panel on Climate Change (IPCC) on the subject of the Forty-Fourth Session of the IPCC (IPCC-44) scheduled to take place at the United Nations Conference Centre, United Nations ESCAP, Rajdamnern Nok Avenue, Bangkok 10200, Thailand, from 17 to 20 October 2016.................

The **main agenda items** of the Forty-Fourth Session of the IPCC will be to consider the outline for the IPCC **Special Report** on the impacts of **global warming of 1.5 ºC above pre-industrial levels** and related global greenhouse gas emission pathways, and **to consider the outline of the Methodology Report(s) to refine the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.** The Panel will also address other items that require consideration and decision by the Panel.

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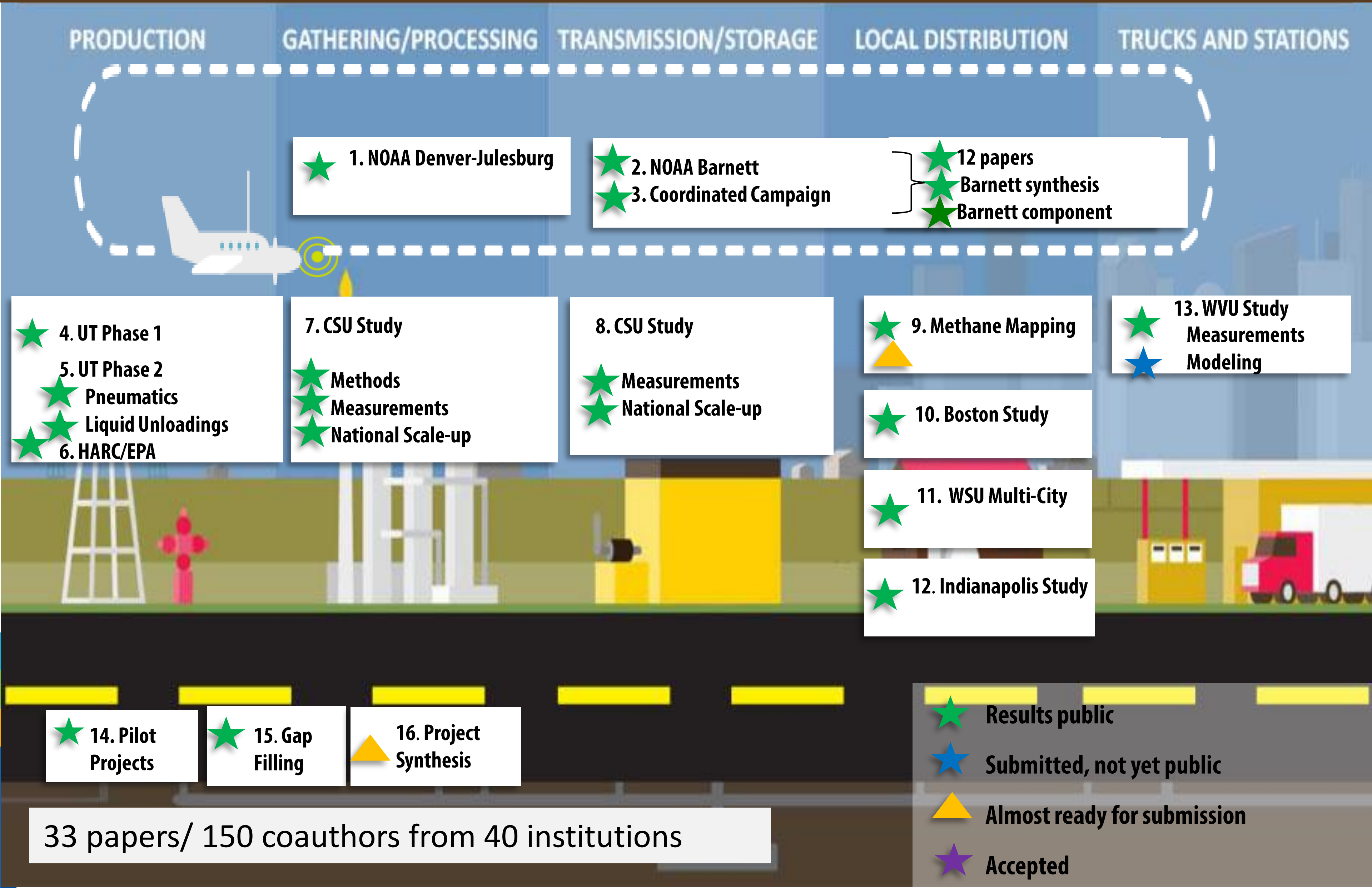
Objective 2: Detect and Quantify Anthropogenic Methane Emissions

(*lead authors Daniel Zavala-Araiza, Gabrielle Petron, Rod Robinson*)

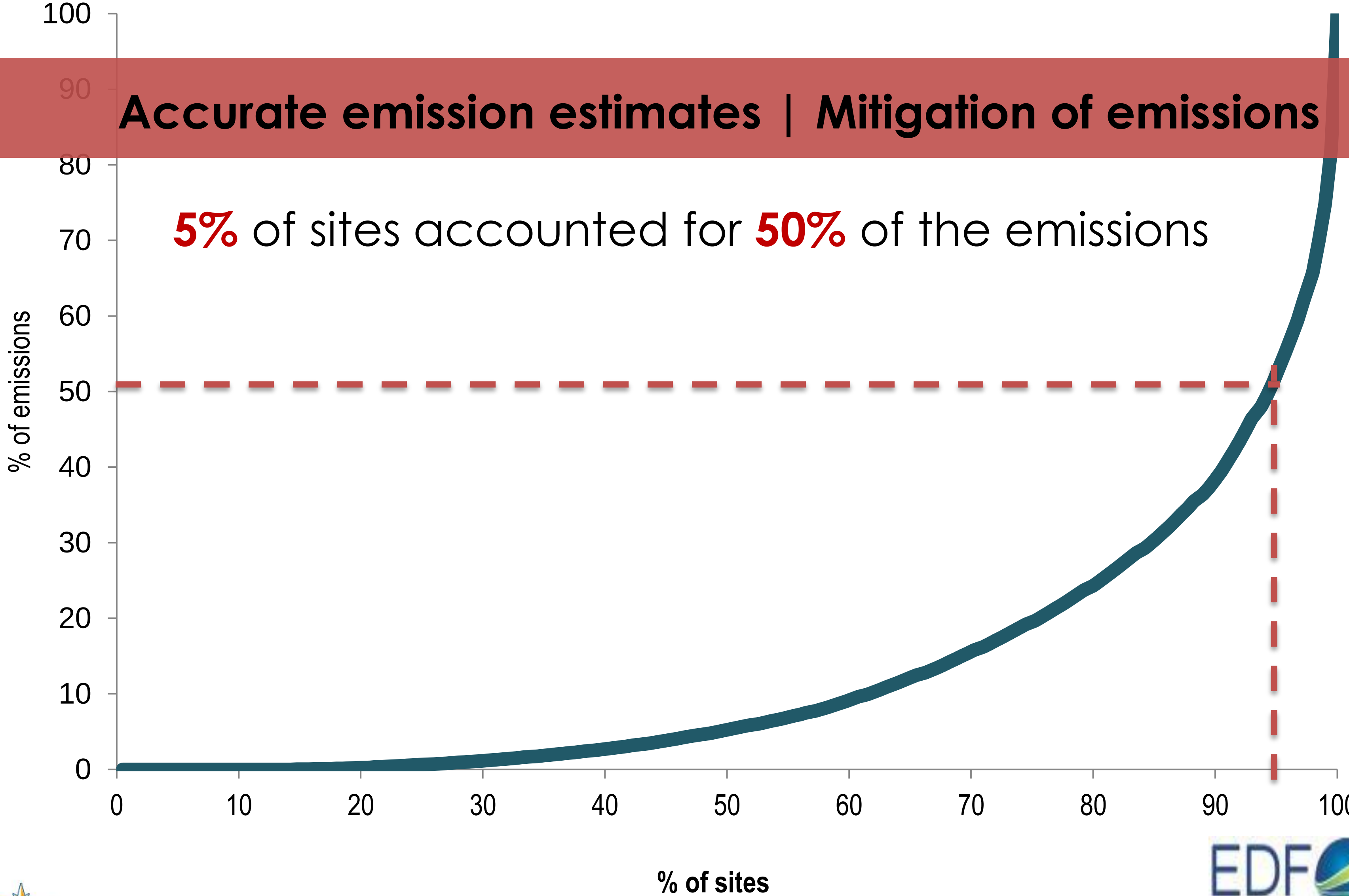
EDF Coordinated Studies
US Natural Gas Supply Chain Methane Emissions



Lessons learned: **Super-emitters**

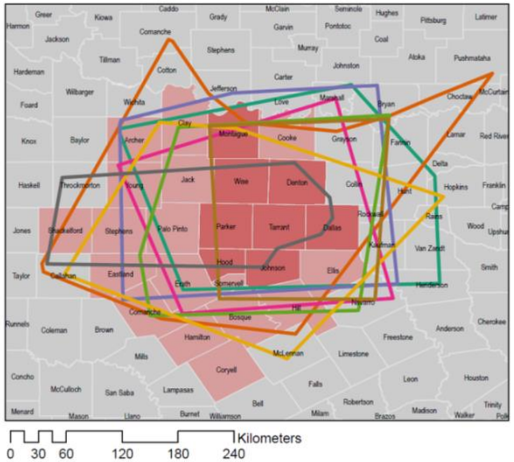
Accurate emission estimates | Mitigation of emissions

5% of sites accounted for **50%** of the emissions



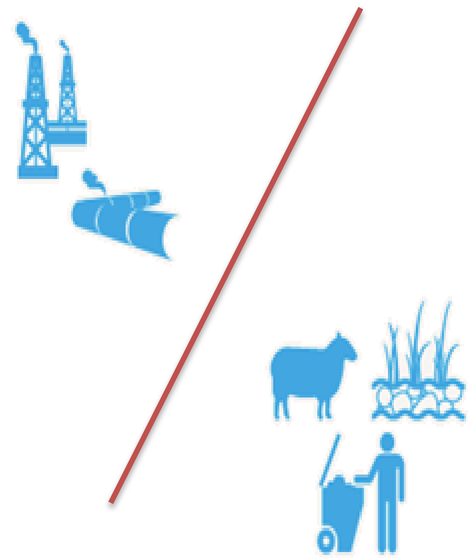
(courtesy D. Zavala)

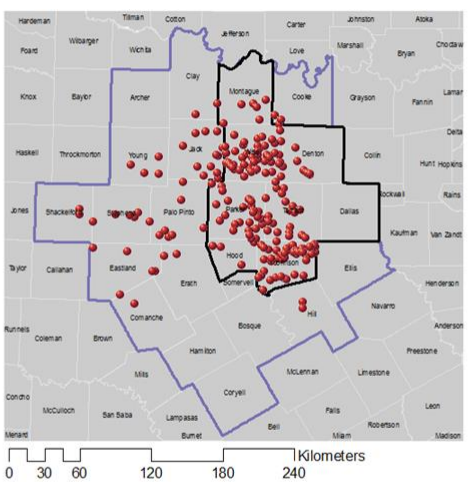
Additional Lessons learned



Multiple flights

Attribution techniques





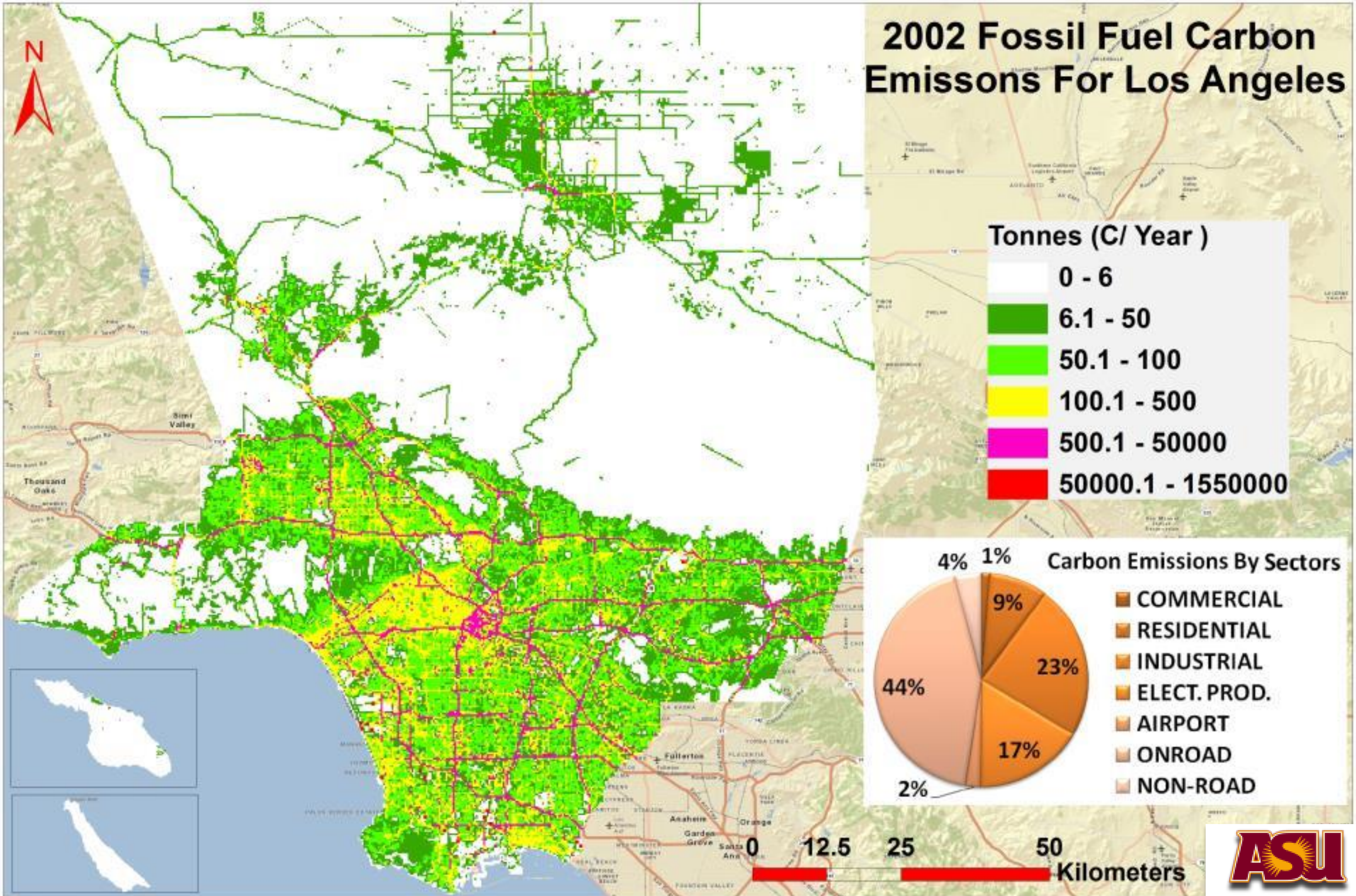
Accurate facility counts

Objective 3: IG^{3}IS in Support of City-Scale Mitigation Efforts

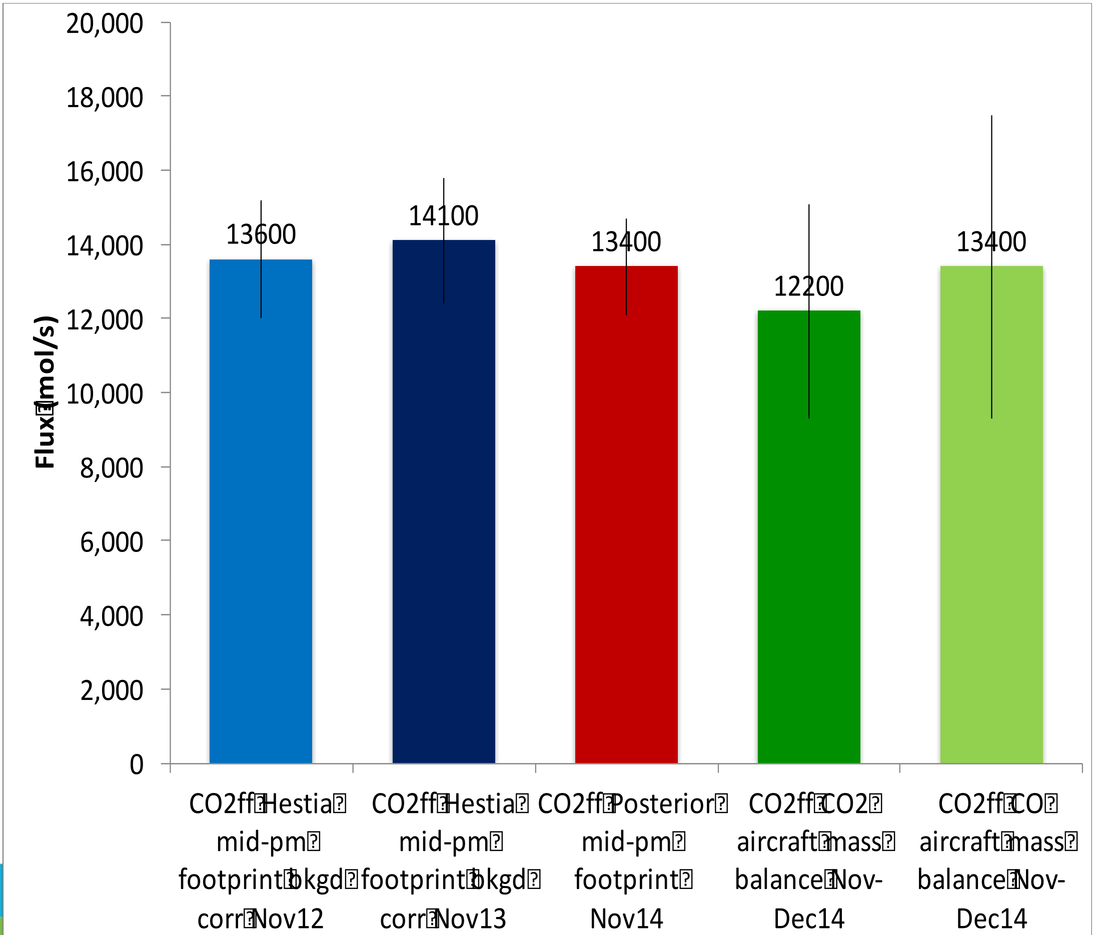
(lead authors Felix Vogel, Jocelyn Turnbull)

The Hestia Project:

Quantifies all fossil fuel CO_2 emissions at building and street scale



Indianapolis CO_2ff flux comparison



Turnbull et al, ICDC10 presentation

Comparison of whole city, winter, fossil fuel CO_2 flux

- Hestia high resolution bottom-up data product
- Atmospheric inversion based on in situ tower CO_2 data and WRF/LPDM
- Mass balance using downwind aircraft measurements

- ➢ Flask measurements used to convert total CO_2 or CO to CO_{2ff} for aircraft and inversion
- ➢ Matched times and footprint
- ➢ Corrected to the same background

Excellent agreement across top-down and bottom-up methods

13,300 mols/s ± 6%

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Level of sophistication of urban stakeholder needs →

Complexity of solution ↓

Identify major emitters and anomaly detection	Quantification of total GHG emissions	Assessment of GHG emissions per sector	Tracking annual and long-term emission changes	Understand short-term emission changes and spatial patterns	Process understanding of emissions and tracking of mitigation impacts
Inventory validation (A1)	Inventory or emission model (A2)	Sector-specific inventory or emission model (A3)	Continuously updated inventory or emission model (A4)	Temporally and spatially disaggregated inventory or emission model (A5)	Process-based emission model using real-time emission data
Mobile surveys (B1)	Mass-balance (B2) Radon tracer method (B3)	Multi-tracer ratio observations (B4)	Radon tracer method (B5) Multi-tracer observations (B6)	Mobile surveys (B7) Repeated mass-balance	Dedicated field campaigns (
Remote sensing (C1)	DAS using short-term observations (C2)	*DAS using dense observations(C3)* *DAS using multi-species data*	DAS using long-term observations (C4)	*DAS using dense observations (C5)*	FFDAS DAS using multi-species

Demonstrated skills

Theoretically tested skills

Future potential skills

DAS = data assimilation system

(courtesy F. Vogel)

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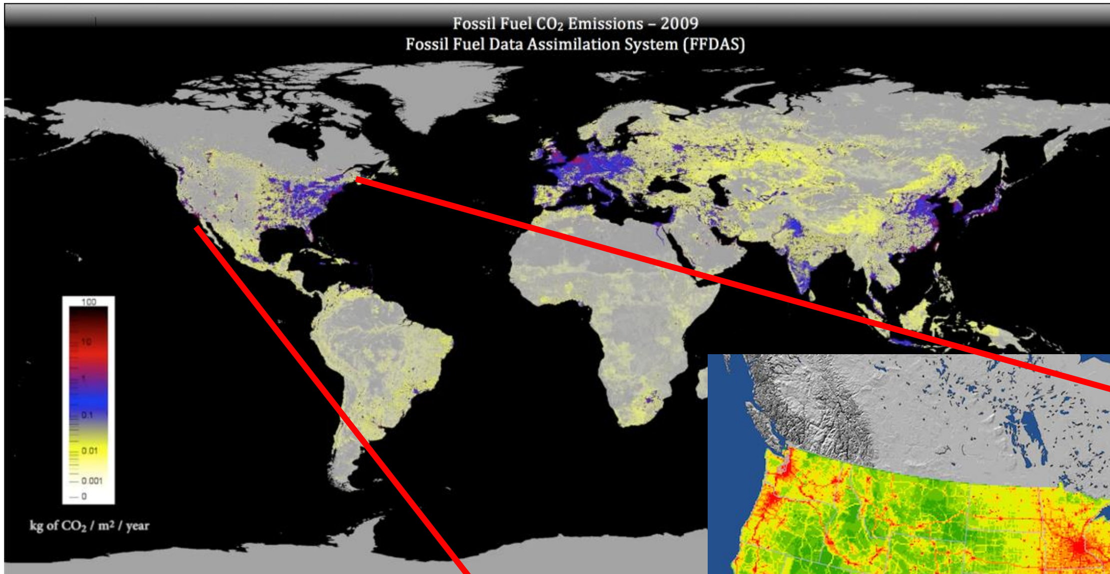
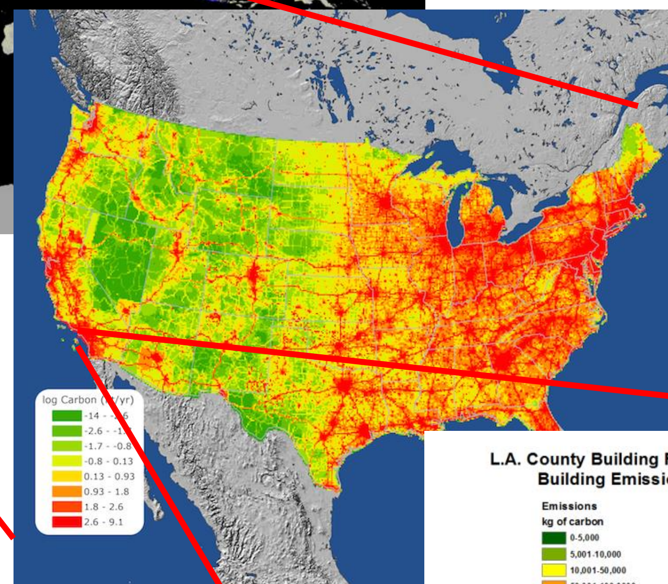
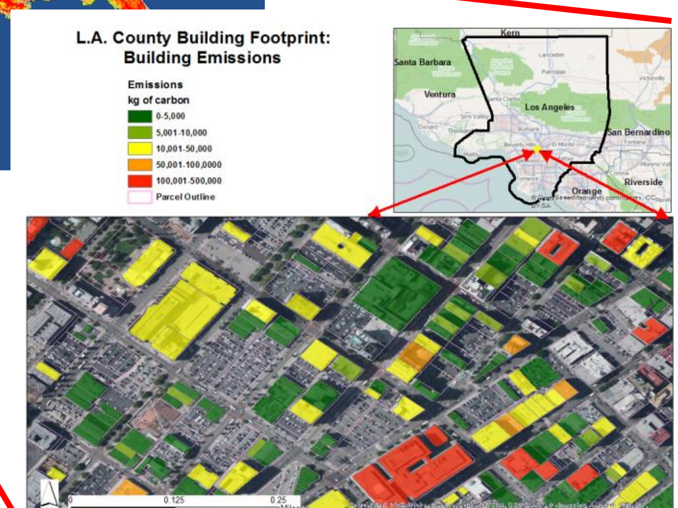
"Nesting" – from the planet to a building







- Global consistency
- Consistency across scales
- standardization

Instead of conclusions

- IG^{3}IS is a community initiative, hence all contributions (documentation of working methods) are welcome
- IG^{3}IS Implementation Plan will be a living document
- More pilot and demonstration projects following the same guiding principles are needed to demonstrate the full potential of the system

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Thank you
Merci

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