Integrated Global GHG Information System (iG³IS):
(Systematic Services)
You can manage what you measure

11th GEOSS Asia Pacific Symposium

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Sigma Space
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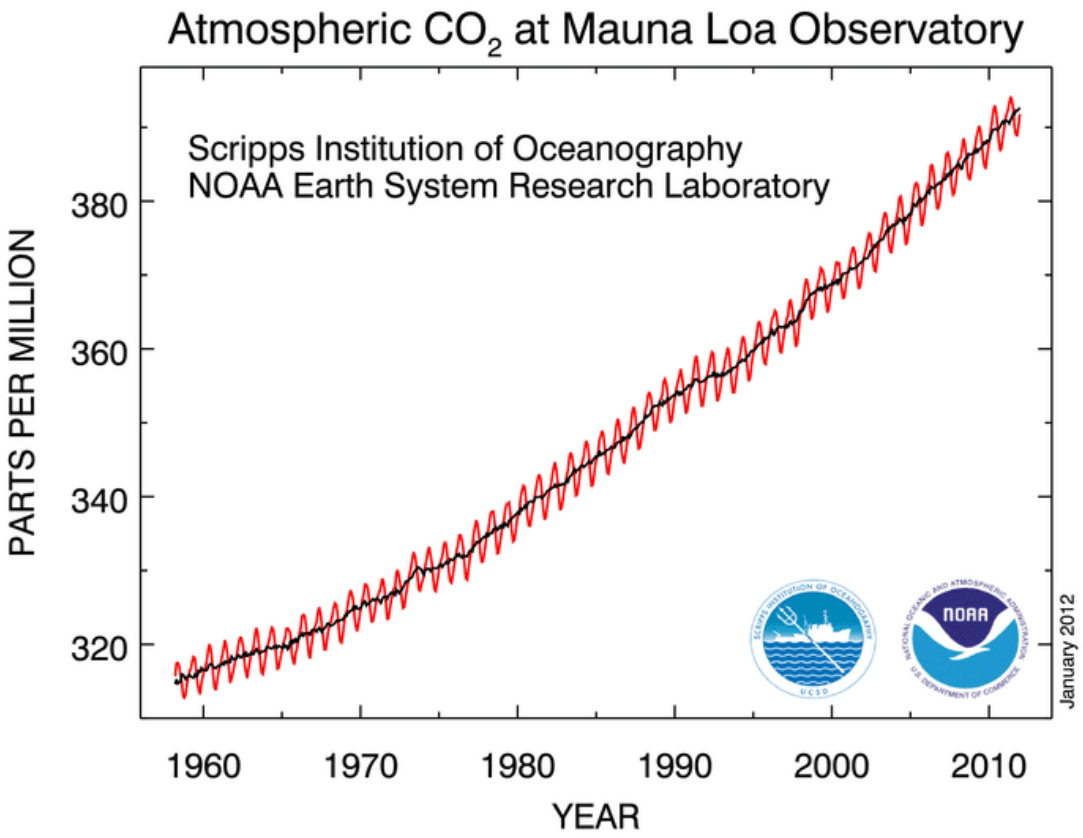
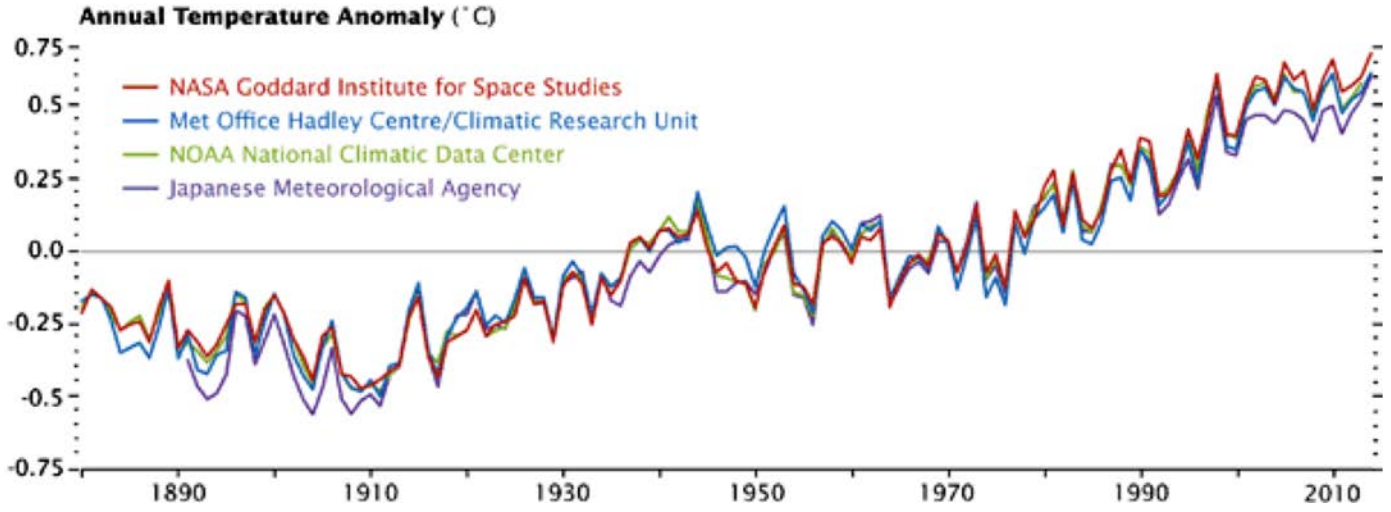
IG³IS Science Team

Kevin Gurney, ASU Daniel Zavala, EDF Jocelyn Turnbull, GNS NZ

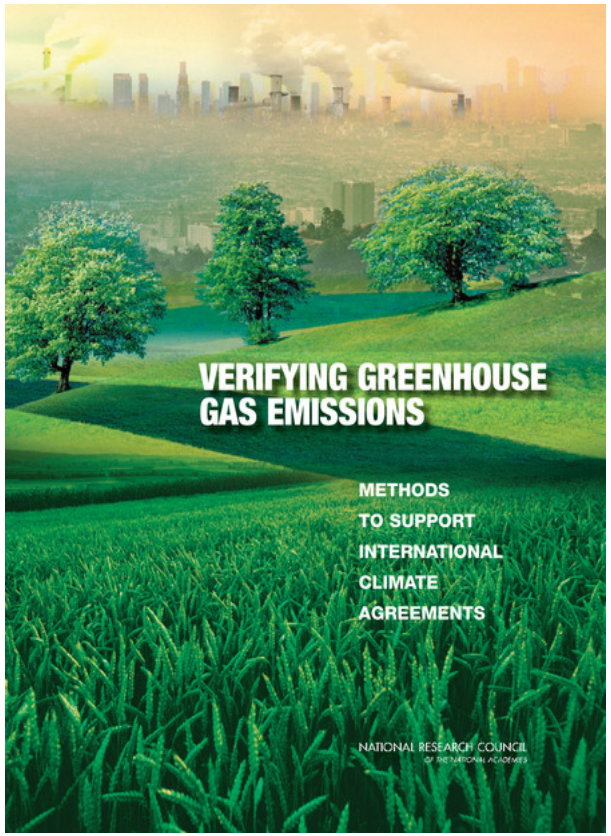
The bedrock of the UNFCCC process are the high-precision, long-term, science-based (or evidence-based) info; data records like the "Keeling curve" and the global average temperature records

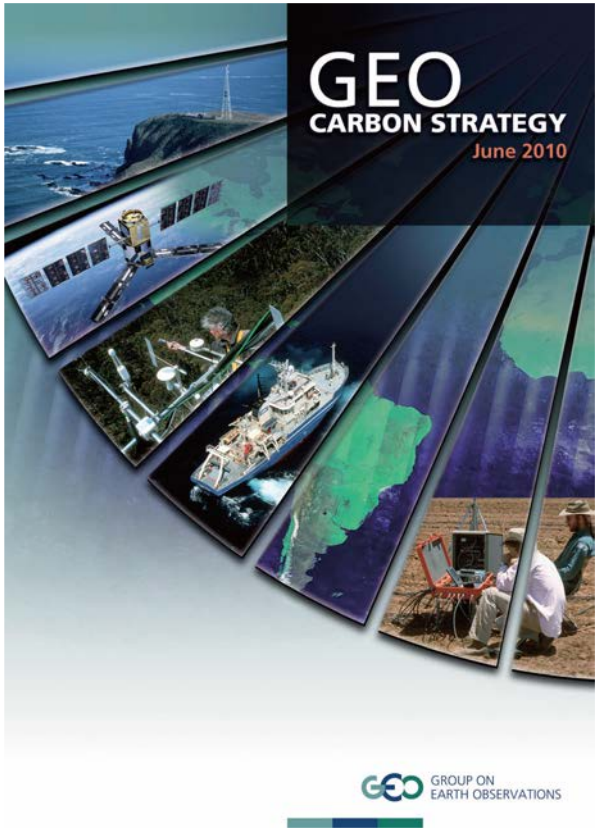


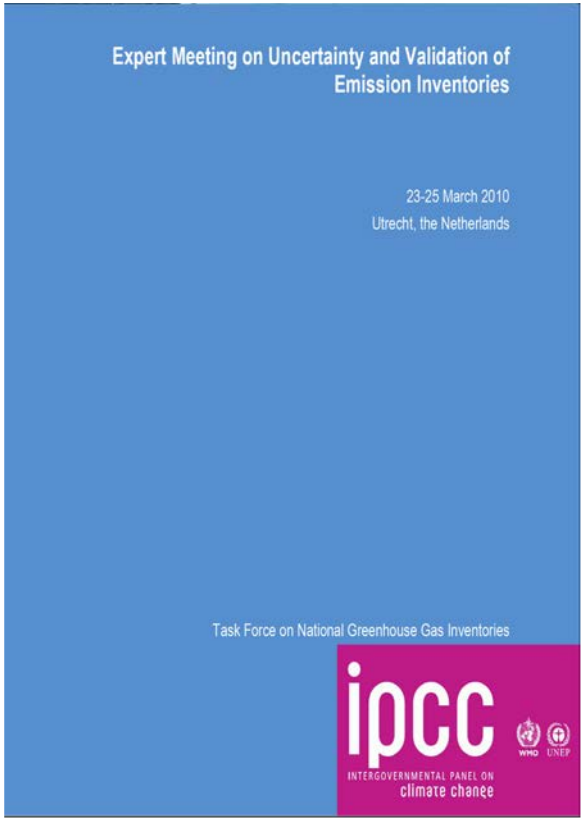


GHG monitoring and reporting in 2010: atmospheric "top-down" versus inventory "bottom-up"

Can atmospheric measurements and models "verify" inventories?







Paris Agreement and GHG Monitoring: Evolving from "Top-Down versus Bottom-Up" Paradigm

Then COP15 (2009)

Binding Multi-national Treaty Commitments

"we will verify your reported emissions"

A grand top-down GHG Information System

Advocates: Science Community!!!

Now COP23 (2017)

Nationally Determined Contributions

"we will help you improve your data"

Federation of focused monitoring systems

Advocates: WMO (191 countries),UNEP, Cities (eg, C40), NGOs, Industry (eg, Oil Companies)

Some of the IG³IS Principles

- Combine (unified approach) atmospheric measurements with socioeconomic inventory data to *better quantify and attribute greenhouse gas emissions.*
- *Stakeholders are entrained from the beginning* to ensure that information products meet user priorities and deliver on the foreseen value proposition.
- IG³IS will serve as an international coordinating mechanism and establish and propagate *consistent methods and standards* (**BIPM/GAW** partnership).
- Success-criteria are that the information *guides additional and valuable emission-reduction actions*.
- IG³IS must mature *in concert with evolution of policy and technology.*

IG³IS Implementation: Products and Objectives

Products

- ***Pilot projects*** **to build user-base and improve skill,**
- ***Document good-practice*** **implementation guidelines**

Objectives

- ***Improved national inventory reporting*** by making use of atmospheric measurements for all countries
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Crosscutting Activities

- **Stimulate high-priority *Research and Development***
- **Inverse Modeling *benchmarking, testbed and intercomparison***

WMO OMM

World Meteorological Organization
Organisation météorologique mondiale
Organización Meteorológica Mundial
Всемирная метеорологическая организация
المنظمة العالمية للأرصاد الجوية
世界气象组织

UN environment

United Nations
Environment Programme

Executive Office

Reference: Science/Executive/2017/JMcG/VF/yo

2 March 2017

Dear Sir/Madam,

The Intergovernmental Panel on Climate Change concluded in its Fifth Assessment Report that anthropogenic greenhouse gas emissions are extremely likely being the dominant cause of the recent climate change. Long-term observations drove this conclusion and led the Parties to the United Nations Framework Convention on Climate Change to focus on mitigating and adapting to climate change.

The implementation of the Paris Agreement requires governments to limit atmospheric concentrations of greenhouse gases. The agreement calls for transparency mechanisms to be established. The ability to implement policies that limit greenhouse gas concentrations in the atmosphere would be greatly enhanced by an Integrated Global Greenhouse Gas Information System, jointly implemented by the World Meteorological Organization and the United Nations Environment Programme. Such a system will use atmospheric observations, relevant socio-economic data and modelling to provide information about sources and sinks of greenhouse gases at policy-relevant temporal and spatial scales.

The implementation of this system requires much deeper collaboration between meteorological and environmental communities and allocation of considerable amount of resources by Members. Such collaboration was promoted by Decision 20 taken by the sixty-eighth session of the World Meteorological Organization Executive Council. Strengthened cooperation with the Intergovernmental Panel on Climate Change will also be key. Only through joint efforts will it be possible to fully realize the potential of such an information system in guiding additional mitigation options, reducing uncertainties in national emission inventories and raising situational awareness on the progress toward national emission reduction commitments. We therefore encourage you to establish such collaboration within your country, and would be pleased to provide further information and advice if needed on this matter.

We would like to express our appreciation for your continued support in promoting joint activities of the World Meteorological Organization and the UN Environment. We look forward to working together.

Yours sincerely,

Petteri Taalas
Secretary-General
World Meteorological Organization

Erik Solheim
Executive Director
UN Environment

To: Permanent Representatives of Members of WMO (PR-0000)
Committee of Permanent Representatives to UNEP

Annex 3

Under the

Framework Memorandum of Understanding between

the secretariat of the United Nations Framework Convention on Climate Change, the Kyoto Protocol and the Paris Agreement and the

World Meteorological Organization

1. Memorandum of Understanding

This document, when duly signed, forms a part of the Framework Memorandum of Understanding (the MoU) concluded between the secretariat of the United Nations Framework Convention on Climate Change, the Kyoto Protocol and the Paris Agreement (the UN Climate Change secretariat) and the World Meteorological Organization (the WMO), collectively referred to as the Parties, on 6 November 2017. Obligations set out in the MoU apply to this specific Collaboration Project. Terms used but not defined in this Collaboration Project have the meaning given to them in the MoU.

2. Basic Collaboration Project Information

Project name:	Observations-based tools for improved national greenhouse gas emission estimates
Project duration:	4 years
Start date:	January 2018
Target deadline for completion:	December 2021
Geographical scope (if applicable):	Global
Substantive scope:	Development and use of observation-based tools for improved national greenhouse gas emission estimates

3. Objective

In recognition of the progress that has been made in atmospheric research, measurement and modelling, WMO has initiated the development of an Integrated Global Greenhouse Gas Information System (IG^3IS). The IG^3IS serves as an international coordinating mechanism under the auspice of WMO to establish and propagate globally consistent methods and standards to help assess emission reduction actions. It promotes use of atmospheric observations and inverse modelling techniques and, by combining them spatially and temporally with socioeconomic emission inventory data, it improves information and management of emission reduction policies and measures.

Under the UNFCCC, developed countries provide annual national GHG inventories covering emissions and removals of direct GHG emissions from the energy sector, industrial processes, solvents, agriculture, the waste sector, and land use, land use change, and forestry (LULUCF), and for all years from the base year or period to the most recent year.

IG^{3}IS early achievements

- IPCC TFI guidelines/guidance provide broad international calculation methods (2006):
  - Inventory protocols for transparent, documented, consistent over time, complete, comparable, assessed for uncertainties, subject to quality control and quality assurance, and efficient in the use of resources

- IPCC TFI 2019 Refinement to 2006 Guidelines– will improve guidance to countries
  - ***Will include assessment of methods for using atmospheric measurements & analyses to improve inventory estimates and certainties.***
  - Establish link with WMO/IG^{3}IS effort to propagate methods and standards to both developed and developing countries.

United Nations

Framework Convention on Climate Change

FCCC/SBSTA/2017/L.21

Distr.: Limited
12 November 2017

Original: English

Subsidiary Body for Scientific and Technological Advice
Forty-seventh session
Bonn, 6–15 November 2017

Agenda item 8
Research and systematic observation

Research and systematic observation

12. The SBSTA noted the increasing capability to systematically monitor greenhouse gas concentrations and emissions, through in situ as well as satellite observations, and its relevance in support of the Paris Agreement.[18]

[18] See the section titled "Decision 51 - IG3IS Implementation Plan" in the WMO submission, referred to in paragraph 4(a) above, and the summary report on the Earth Information Day, paragraphs 30 and 31 and 73–86, referred to in paragraph 3 above.

GLOBAL
ATMOSPHERE
WATCH

Integrated
Global Greenhouse Gas
Information System

IG³IS Implementation: Products and Objectives

Products

- ***Pilot projects*** **to build user-base and improve skill,**
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Objectives

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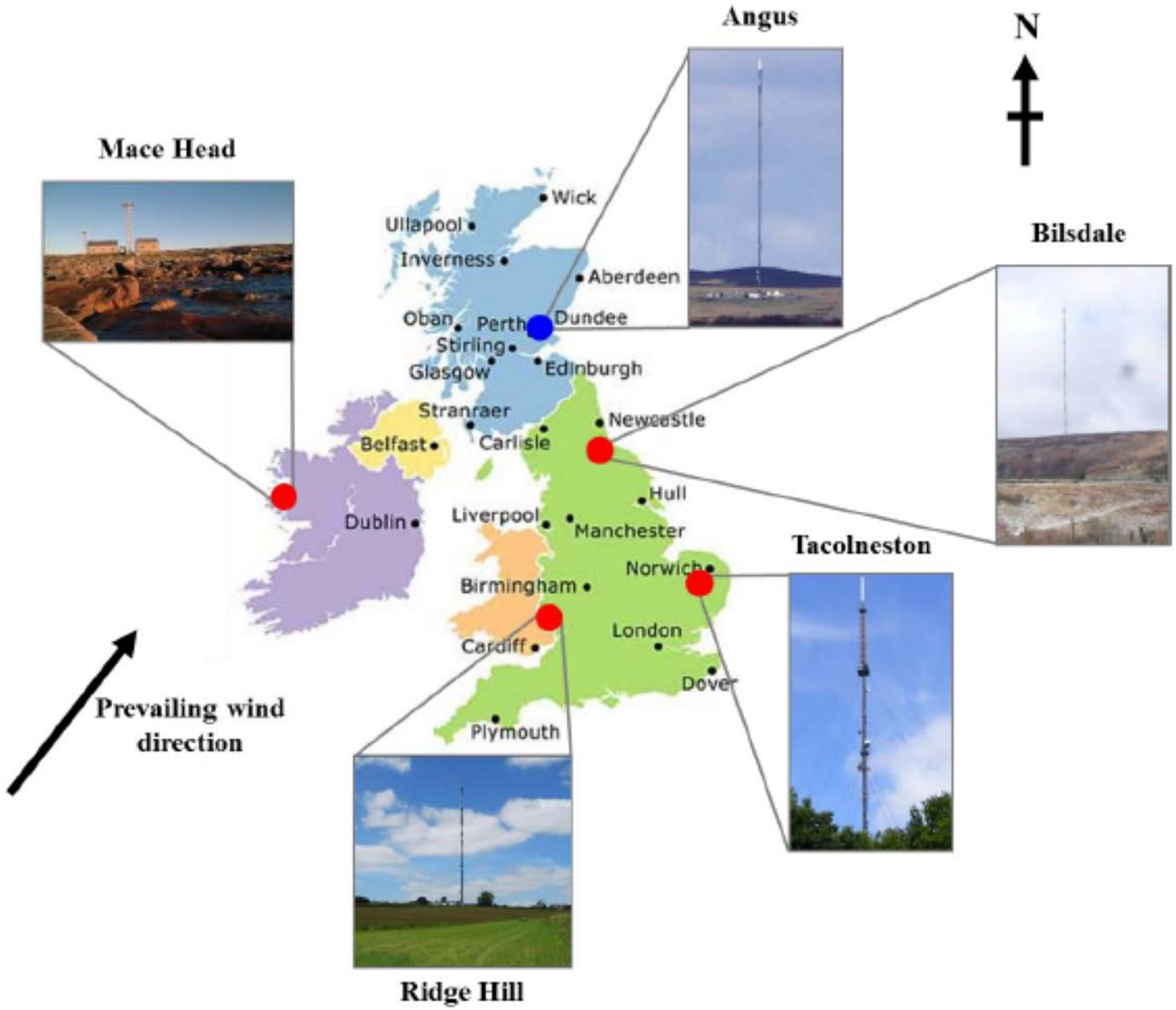
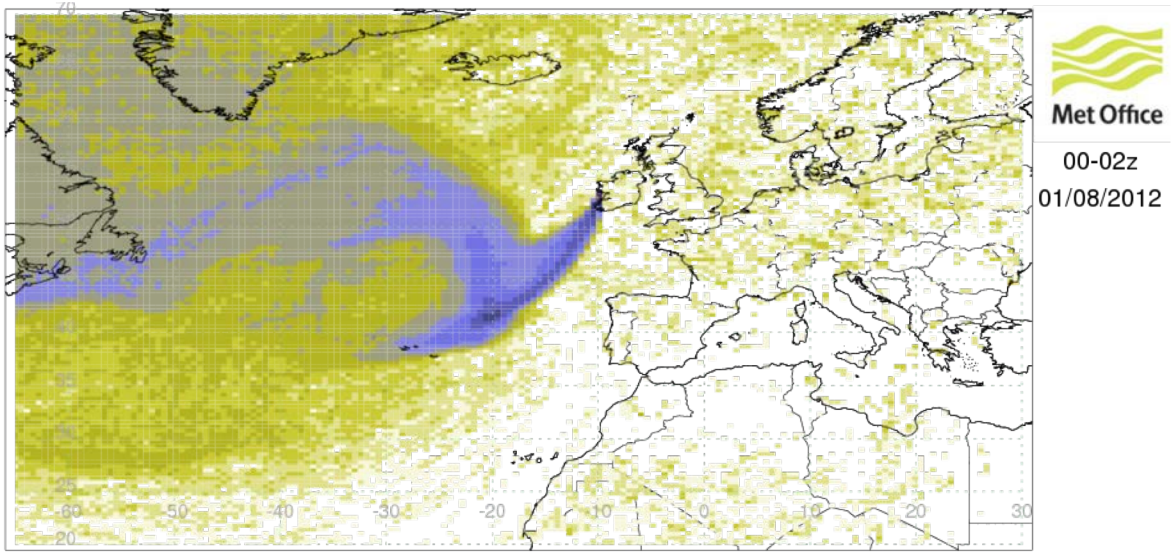
UK Measurement Network in support of national inventory reporting



UK Met Office Modelling and Analysis

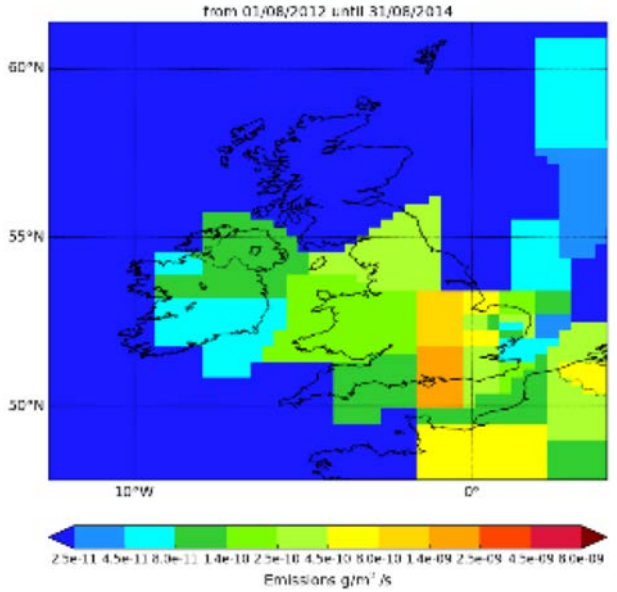


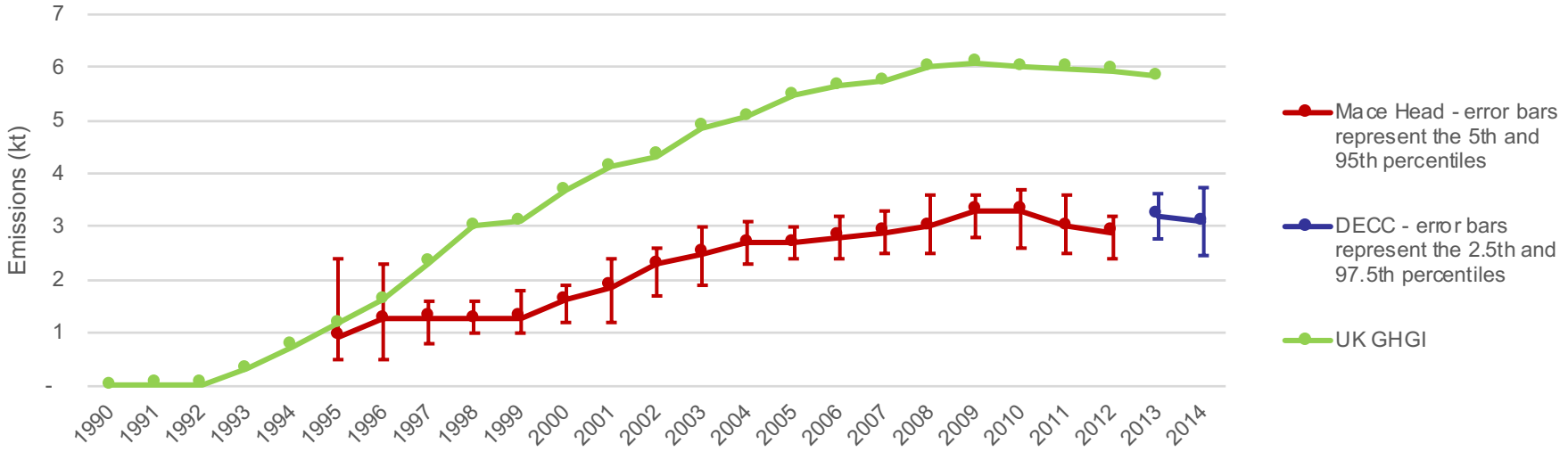
Mace Head air history maps are generated for each 2-hour period between 1989 and 2015

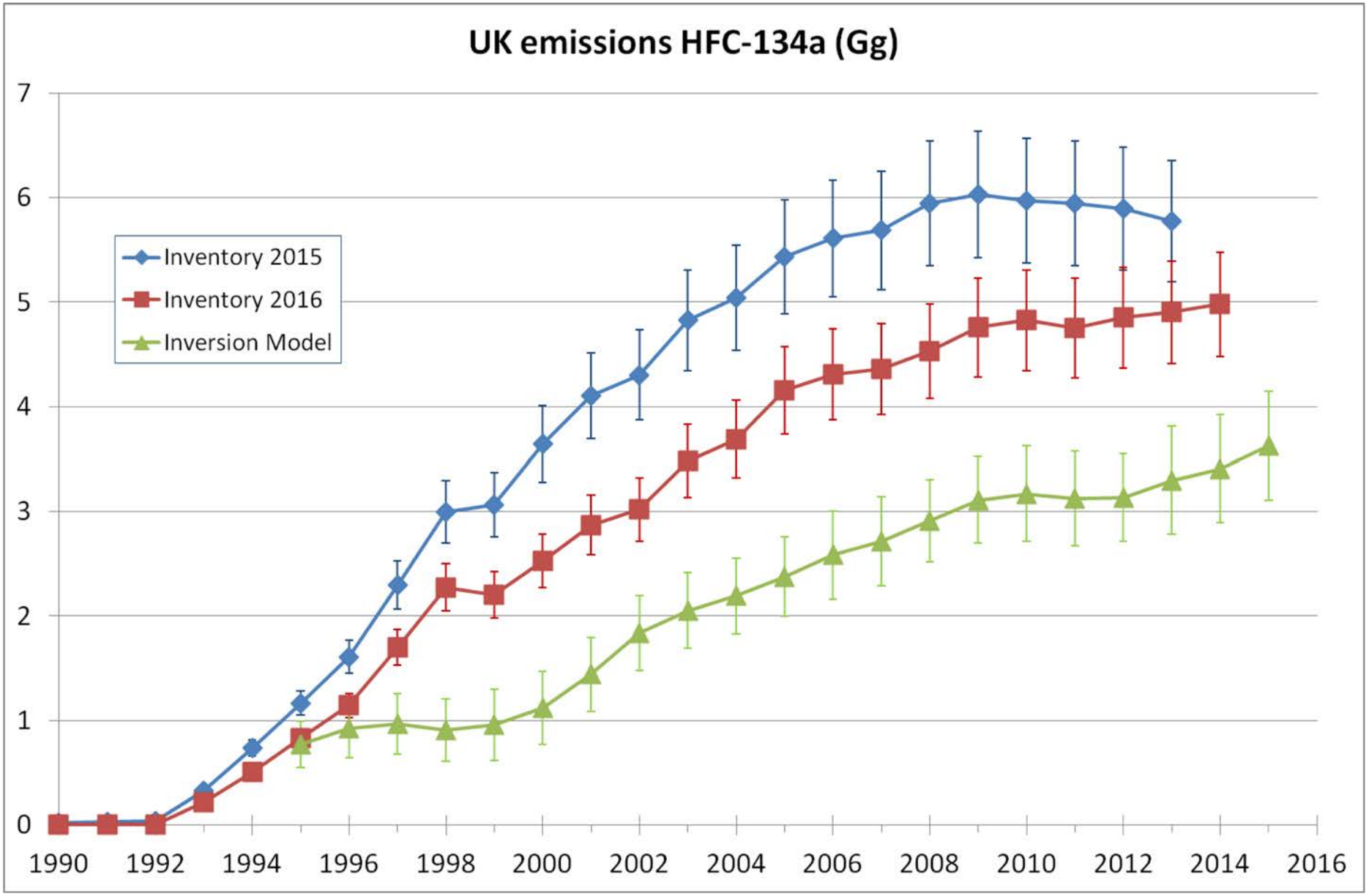
- **Use the NAME transport model driven by 3-D meteorology to understand the recent (3-4 weeks) history of the air arriving at measurement stations**
- **Two stage process:**
  - **Estimate long-term Northern Hemisphere baseline concentrations using Mace Head observations.**
  - **Estimate regional emissions through inversion modelling (InTEM).**

Example from UK report to UNFCCC: HFC-134a

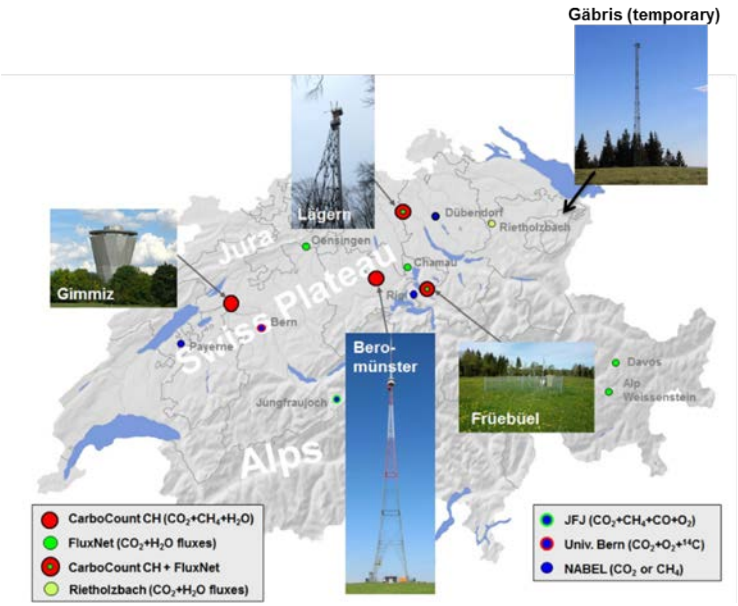
- **Significant mismatch throughout the entire time-series of emissions, approximately inversion is 50% lower than inventory.**
- **Investigated the refrigeration model used by inventory compilers, key variables to be re-considered by BEIS (formerly DECC):**
  - **Refill rate**
  - **Uptake rate**






UK emissions HFC-134a (Gg)
Inventory 2015
Inventory 2016
Inversion Model
0
1
2
3
4
5
6
7
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

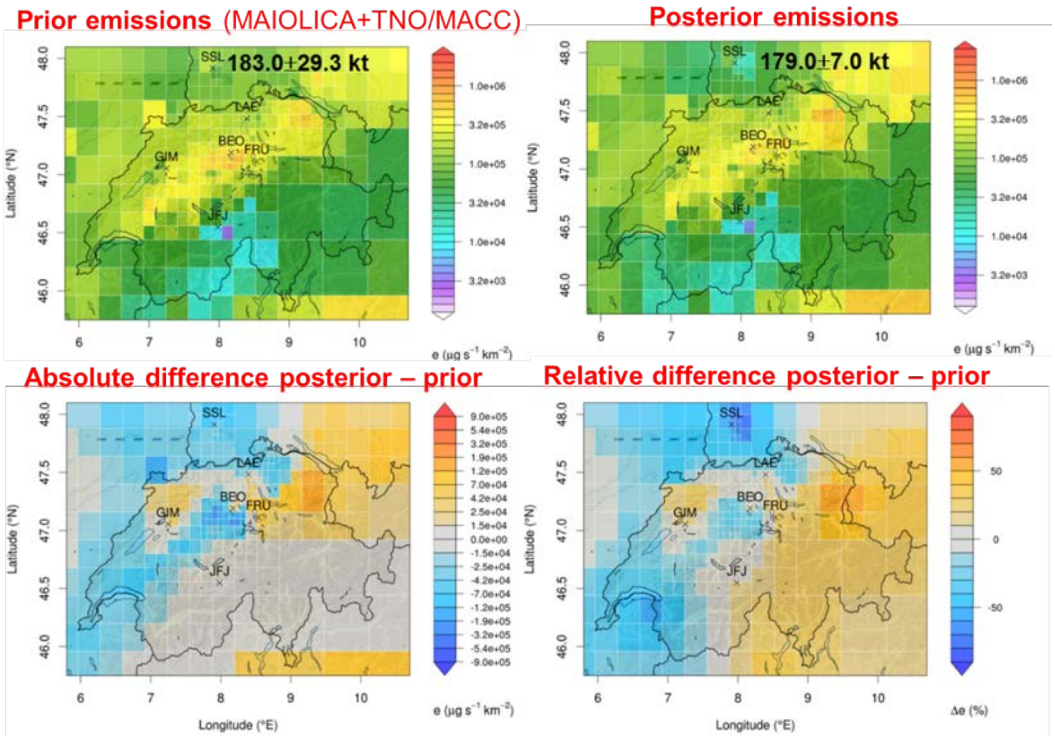
IG³IS good practice example from Switzerland



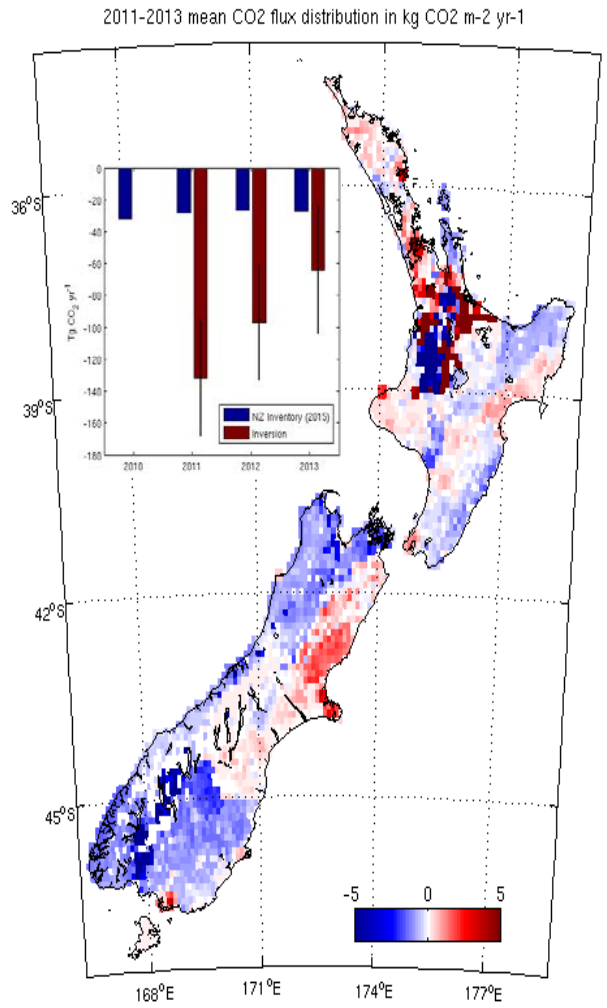
New GHG measurement network established (project CarboCount-CH)

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/



CO_2 inversion for NZ indicates larger land carbon uptake than expected



- Initial inversion using two observation sites indicates larger uptake than prior model or bottom up accounting, particularly in forested regions
- Ongoing work 5 national sites
  - Targeted studies of natural forest, plantation forest, pasture and urban landscapes
  - Detailed bottom-up modelling and atmospheric inversions at national and regional scales
  - Feedback between atmospheric observations and bottom-up information to refine both and provide best estimates of land carbon exchange

Jocelyn Turnbull, GNS Science New Zealand

Atmospheric CO2 observations and models suggest strong carbon uptake by forests in New Zealand
Steinkamp et al, Atmos. Chem. Phys., 17, 47–76, 2017, doi:10.5194/acp-17-47-2017

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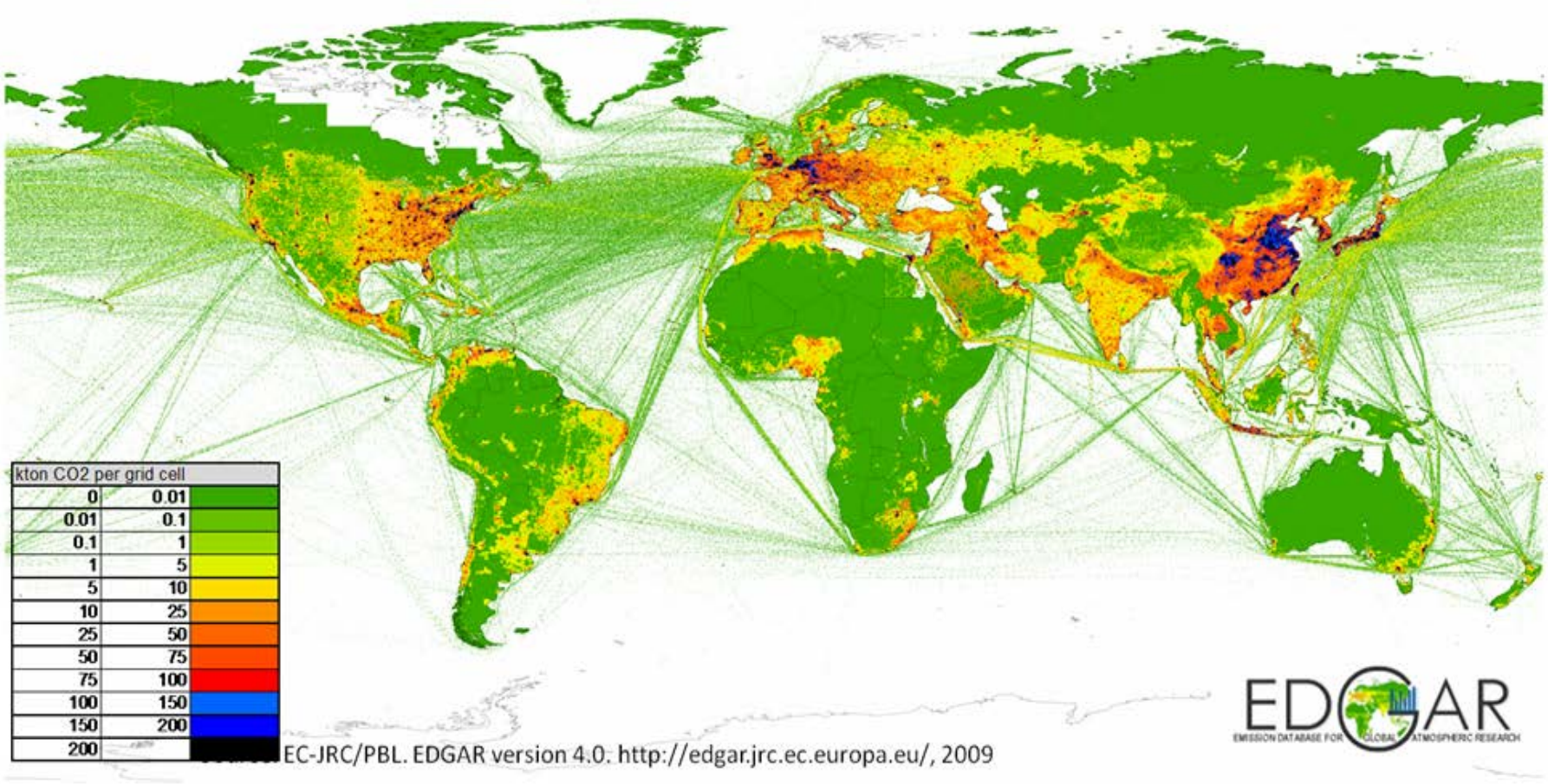
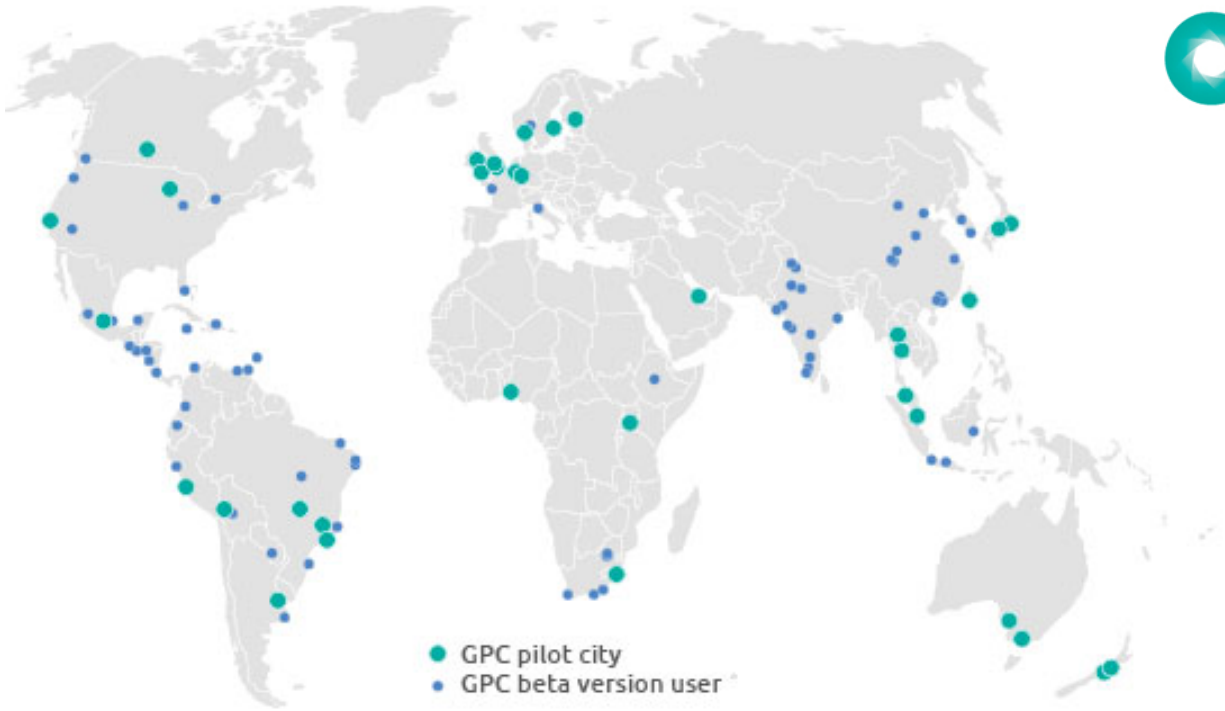
Relevance: cities matter

Cities account for roughly two-thirds of energy-related greenhouse gas (GHG) emissions

The Lima–Paris Action Agenda of the Paris Agreement has formalized a role for "non-state actors" including cities



Why care about GHGs in cities?



Cities are active stakeholders and have ambitious reduction targets and mitigation efforts

GREENHOUSE GAS PROTOCOL

UNDER 2°

SECRETARIAT THE CLIMATE GROUP

THE WORLD BANK

eit Climate-KIC

ICLEI Local Governments for Sustainability

C40 CITIES CLIMATE LEADERSHIP GROUP

PIONEERED BY THE ROCKEFELLER FOUNDATION 100 RESILIENT CITIES

GLOBAL COVENANT of MAYORS for CLIMATE & ENERGY

THE WORLD'S LARGEST COALITION OF CITIES FIGHTING CLIMATE CHANGE

COMPACT of MAYORS

Covenant of Mayors for Climate & Energy

Urgency: cities are changing rapidly

http://*www.c40cities.org*

- Both with **Stabilization**
  - Green LA Plan (2007)
    - 35% (vs 1990) by 2030
  - Paris Climate Plan (2007)
    - 25% (vs 2004) by 2020

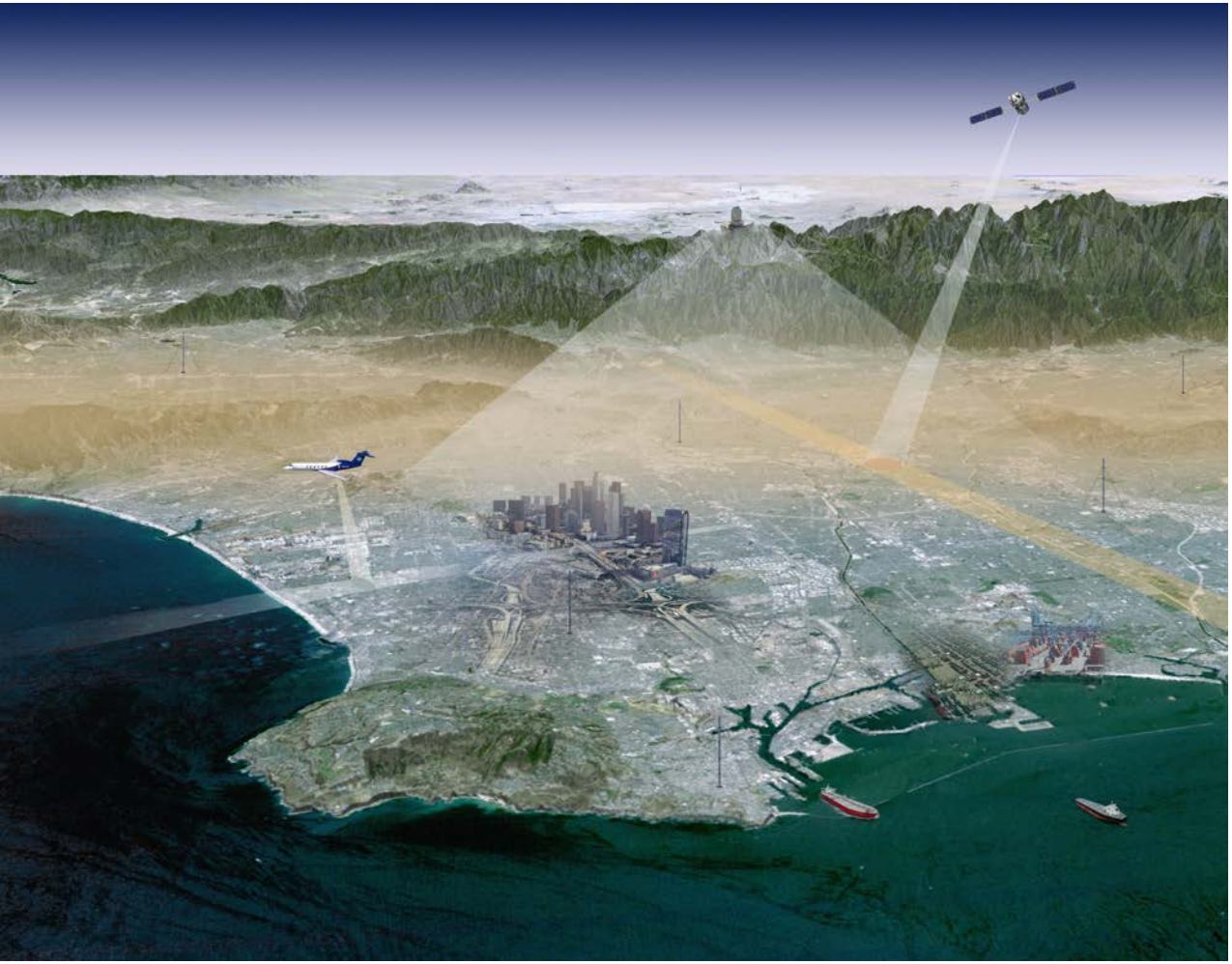
and **Growth**

- Global urbanization will ***double*** by 2050
- Explosive growth in developing megacities

  population >4%/year

  emissions >10%/year

IG^{3}IS City-Scale Objective

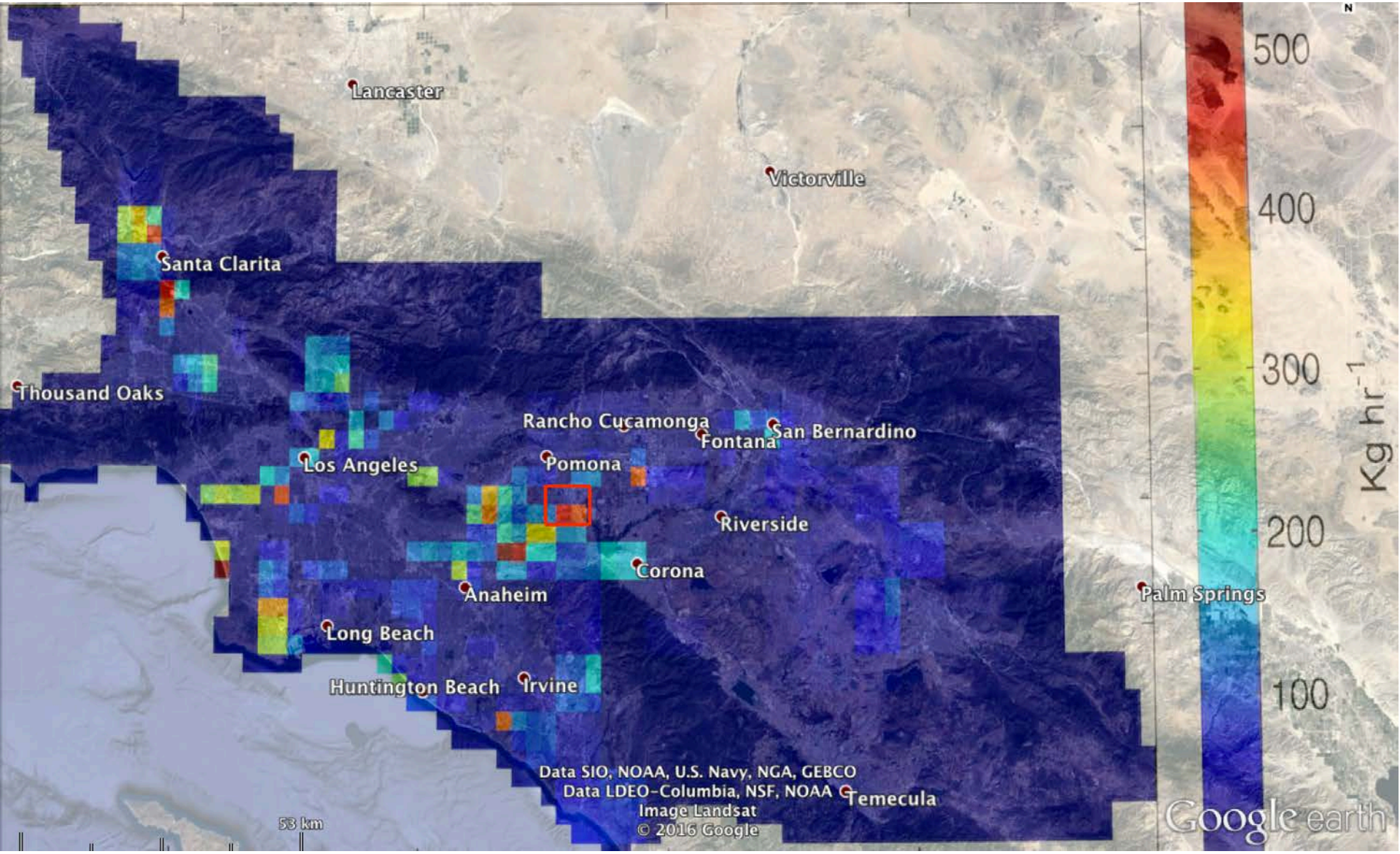


Carbon emissions from cities and their support systems represent the single largest human contribution to climate change.

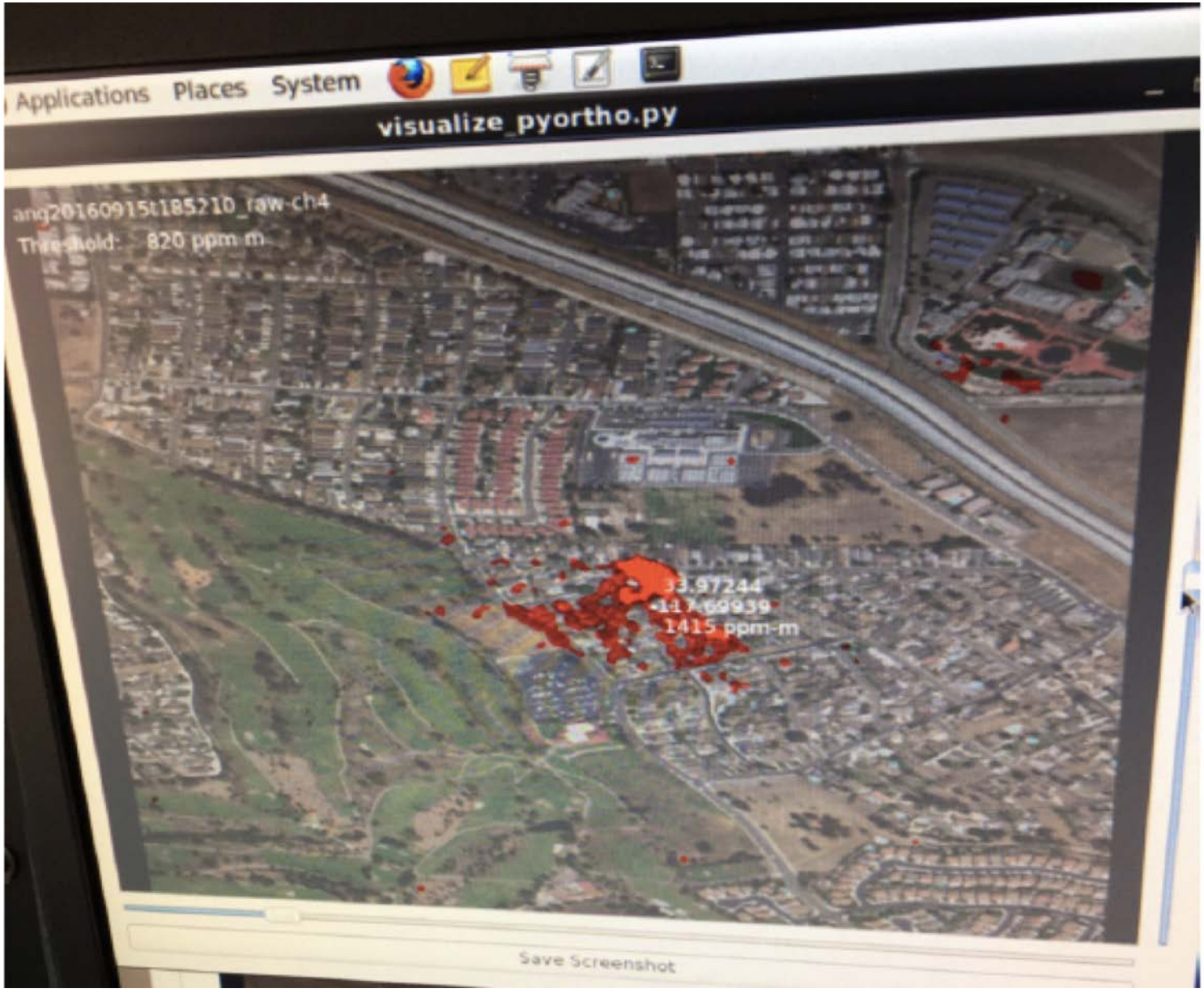
IG^{3}IS city-scale objective provides a strategy, methodology and roadmap for an international framework to assess directly the carbon emission trends of the world's cities.

http://megacities.jpl.nasa.gov

Los Angeles inverse model of 12 tower measurements shows methane hot spots at known & a large unknown source



Airborne imaging spectrometer sees methane plume confirming large leak from distribution system



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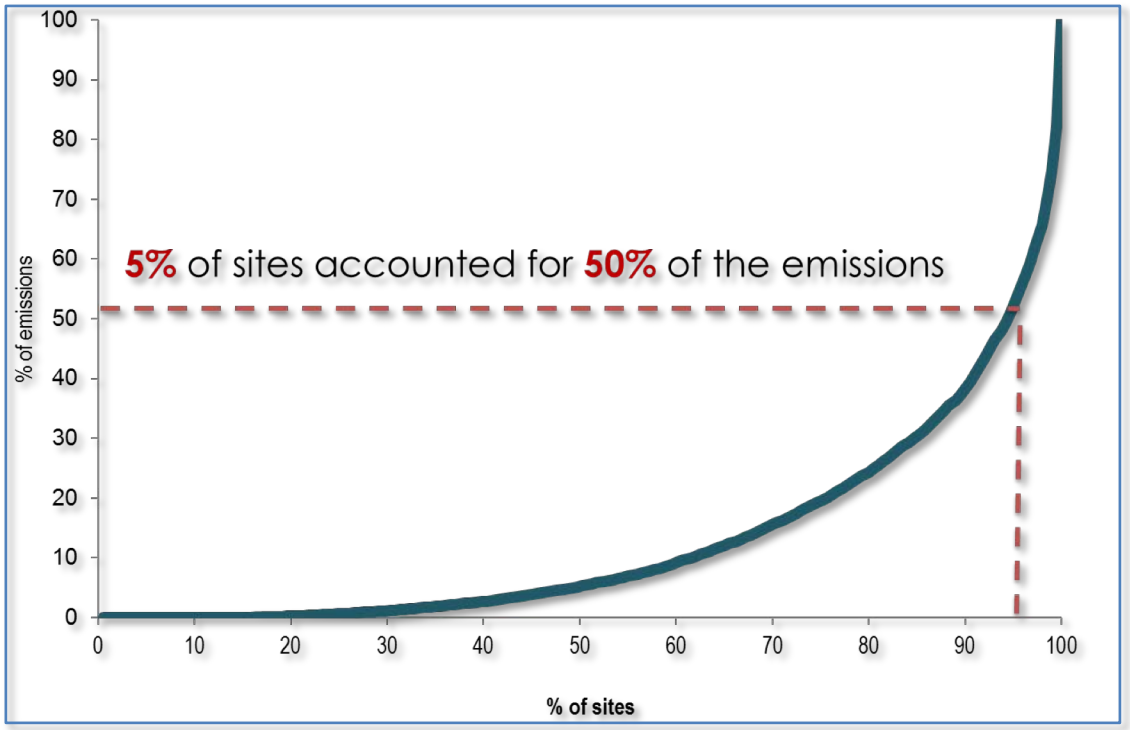
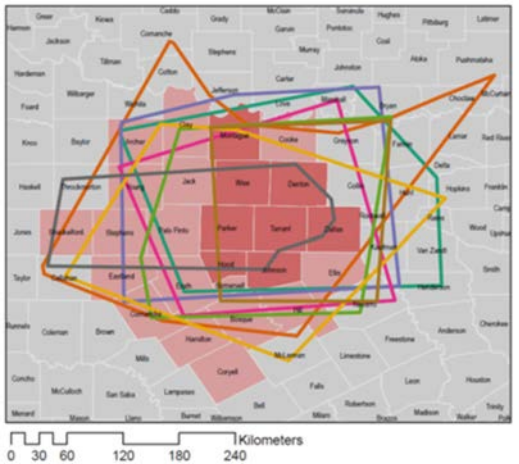
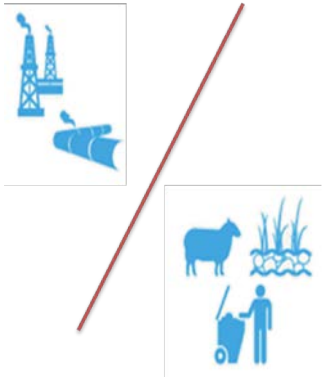
Objective 3: Detect and Quantify Industrial and Agricultural Methane Emissions





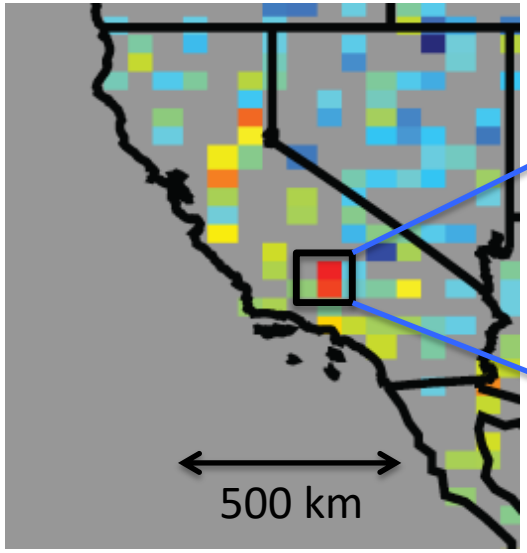
Multiple flights



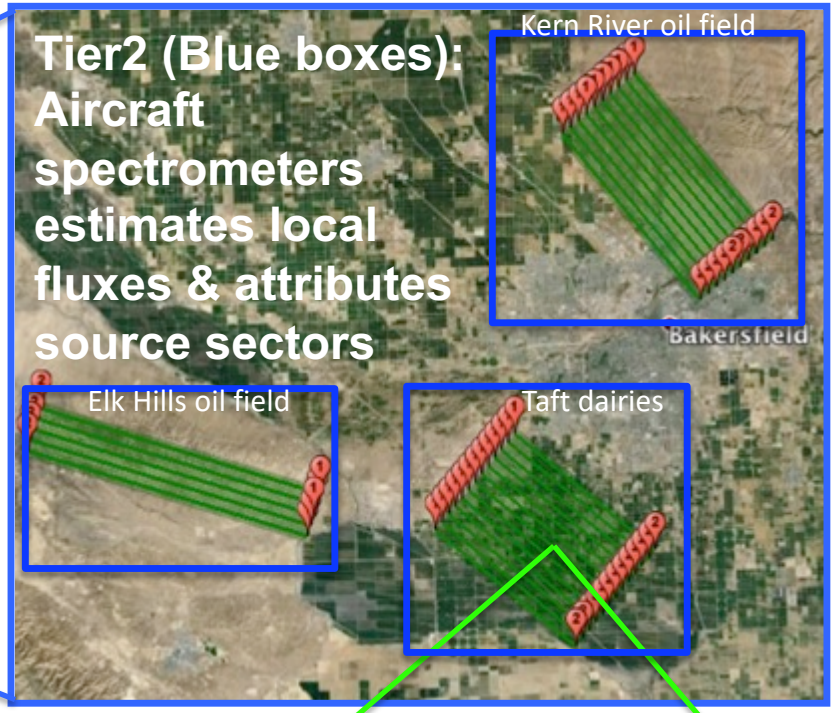
Attribution techniques

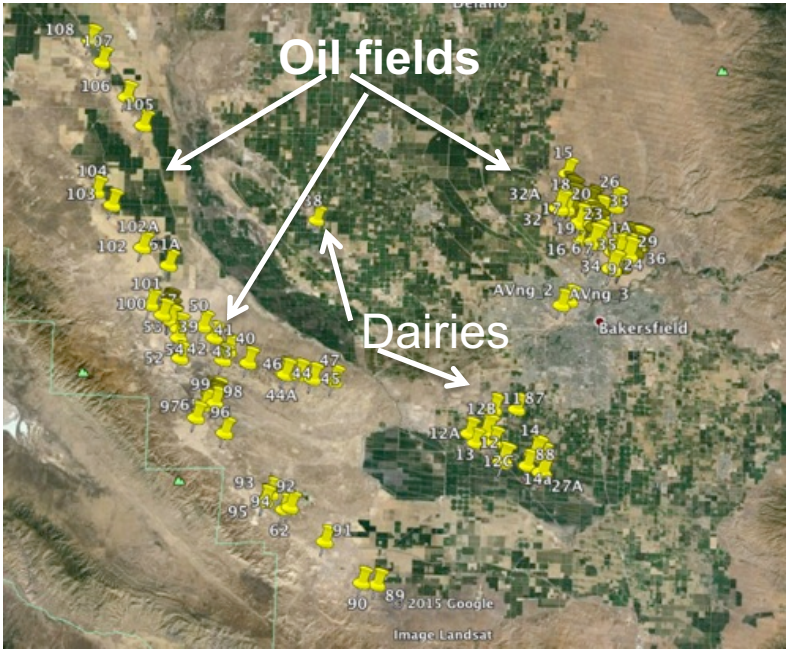
Tiered strategy for monitoring methane leaks in the US

Tier 1: Satelite detects hotspot region



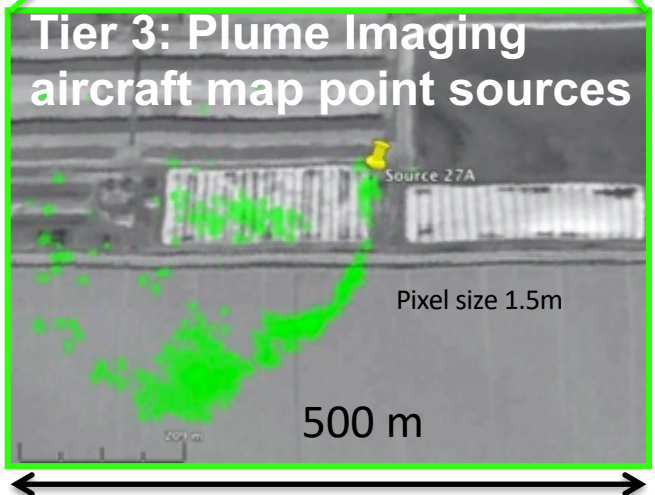
Turner et al 2015





Enhanced Activity Data

Tier 4 (not shown): Surface observations



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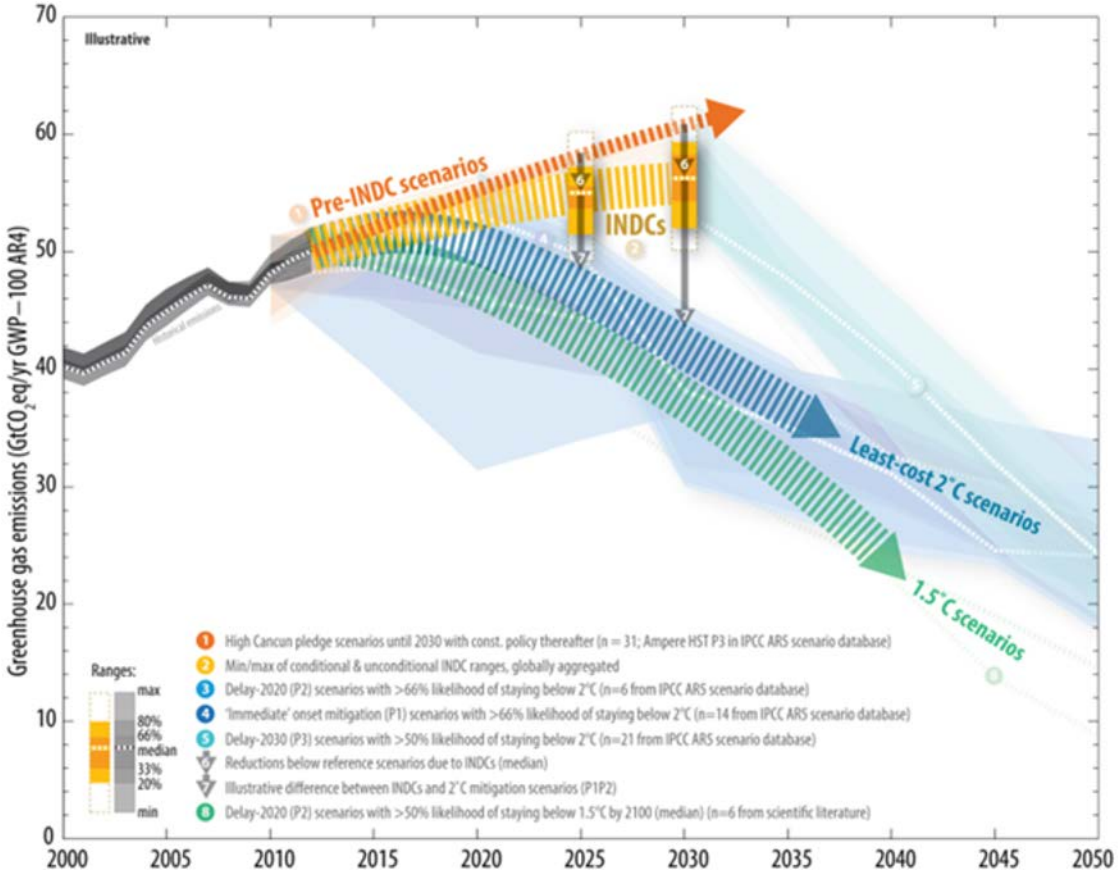
Objective 4: IG³IS in Support of the Global Stock Take



IPCC Special Report

Summary
"Translation Science"

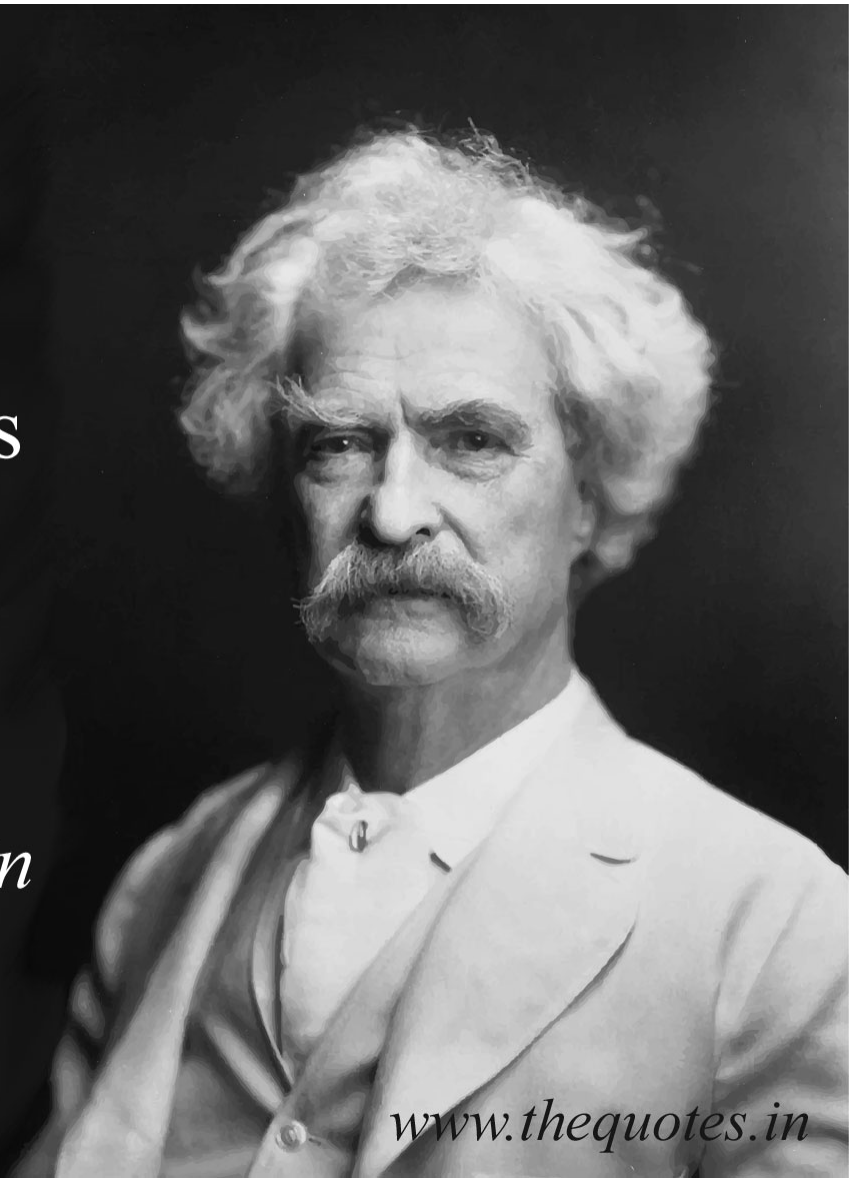
Promote and build confidence today that science-based information services need to be part of the solutions:

- Define the detailed good-practice guidelines for each objective area
- Develop near term pilot projects for each objective area

- Actively entrain users, partners and sponsors through all stages of development (GCF, GEF, WB, National and subnational governments, others)
- Coordinate with intergovernmental partners: UNFCCC, IPCC, GCOS, GFCS, GEO, WCRP, others

It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so.

Mark Twain



WORLD METEOROLOGICAL ORGANIZATION

An Integrated Global Greenhouse Gas Information System (IG^3IS) Science Implementation Plan

Version for EC-70

CONTENTS

WORLD METEOROLOGICAL ORGANIZATION

BULLETIN

Vol. 66 (1) - 2017

WEATHER CLIMATE WATER

An Integrated Global Greenhouse Gas Information System (IG^{3}IS)

by Phil DeCola[1] and WMO Secretariat[2]

Atmospheric composition measurements in the latter half of the twentieth century showed increasing global concentrations of greenhouse gases. These measurements were the initial cause of concern about global warming and climate change. Today, as nations make pledges to reduce their greenhouse gas (GHG) emissions, concentration measurements of carbon dioxide (CO_2) and other GHGs will unequivocally determine whether the actions taken are having the desired effect. Thus, WMO has initiated the development of an Integrated Global Greenhouse Gas Information System (IG^{3}IS) to help guide valuable GHG emission-reduction actions in response to climate change. This new System will establish and build confidence in the role of atmospheric composition measurements as an essential part of climate change mitigation efforts. This article discusses the need for and development of atmospheric composition measurements and the role of IG^{3}IS.

Climate change a global concern

In 1992, participants of the United Nations Conference on Environment and Development (the "Rio Earth Summit") adopted the United Nations Framework Convention on Climate Change (UNFCCC), an international treaty aimed at combatting climate change. The ultimate objective of the Convention is to stabilize greenhouse gas (GHG) concentrations "at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system." It further states "such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner." There are now 197 Parties to the Convention. But, what was the motivation and basis for this impressive global action?

The UNFCCC was established upon a bedrock of scientific evidence and understanding, consisting particularly of long-term observations of Earth's atmospheric chemical composition and its change over time. Consistent and accurate measurements show rapidly rising concentrations of GHGs, such as carbon dioxide. These measurements also unambiguously attribute the rise to human activities, and link the increasing GHG concentrations to global warming and negative climate impacts.[3]

Since the eighteenth century Industrial (or energy) Revolution, human activities have caused a steady increase in concentrations of GHGs such as CO_2, methane (CH_4) and nitrous oxide (N_2O), and mean global temperatures have been rising in response. Concentrations of CO_2 have risen by more than 40% from pre-industrial levels and continue to rise at an increasing rate. They are now higher than they have been in at least about four million years, when global average temperatures were 2 to 3 °C hotter than in the nineteenth century and sea levels were 7 to 25 metres higher than today.[4] Current levels of CH_4 are 2 ½ times

[1] Sigma Space Corporation and Department of Atmospheric and Oceanic Sciences, University of Maryland
[2] Oksana Tarasova, Chief, Atmospheric Environment Research Division

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