Atmospheric measurements for emission estimation:
Real-world Emission Verification of Halogenated Greenhouse Gases

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overview

1. **The basis: global measurement data from AGAGE and NOAA**

2. **Measurements in support of MRV (Measurement, Reporting and Verification)**
   a) world-wide emissions (1-box model)
   b) country-level emissions (meteorological transport models)

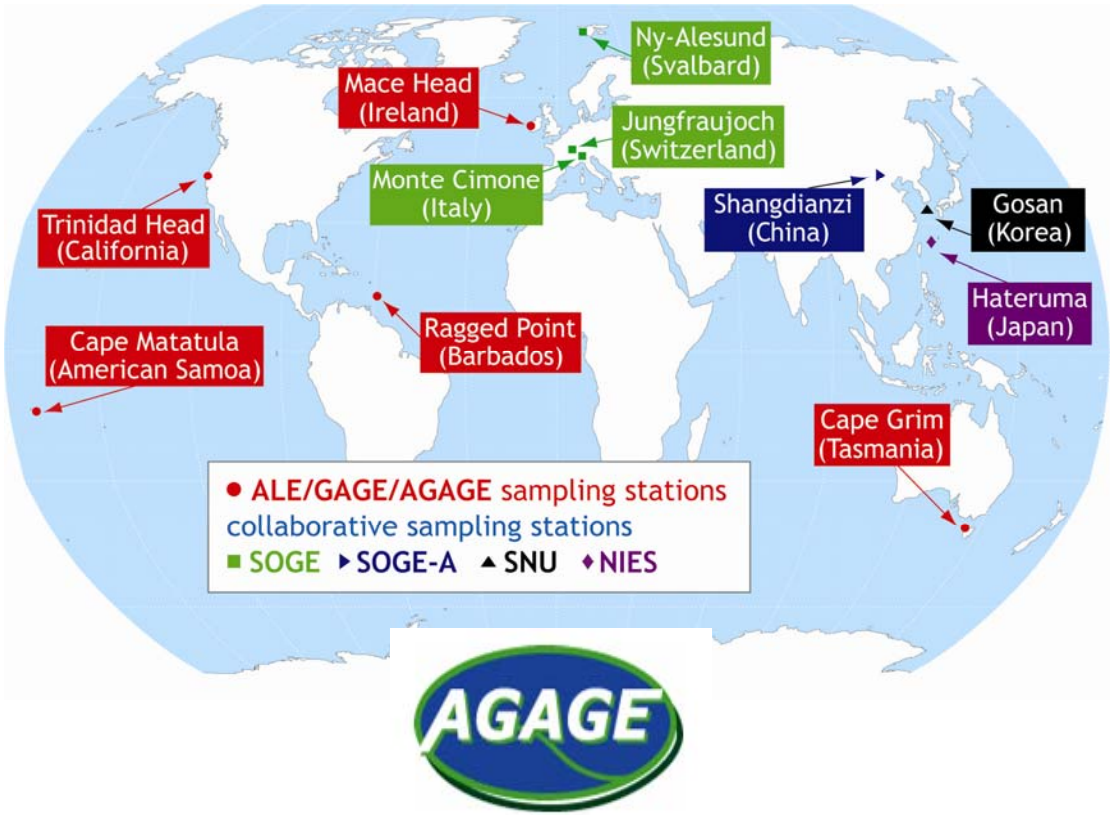
3. **Examples of MRV:**

- HFCs from inventories vs. measurements
  -  Switzerland
  -  United Kingdom
  -  Australia

4. **Outlook: Measurements in support of MRV**

World-wide networks for Non-CO_2 greenhouse gas observations

Examples: Advanced Global Atmospheric Gases Experiment, NOAA, WMO



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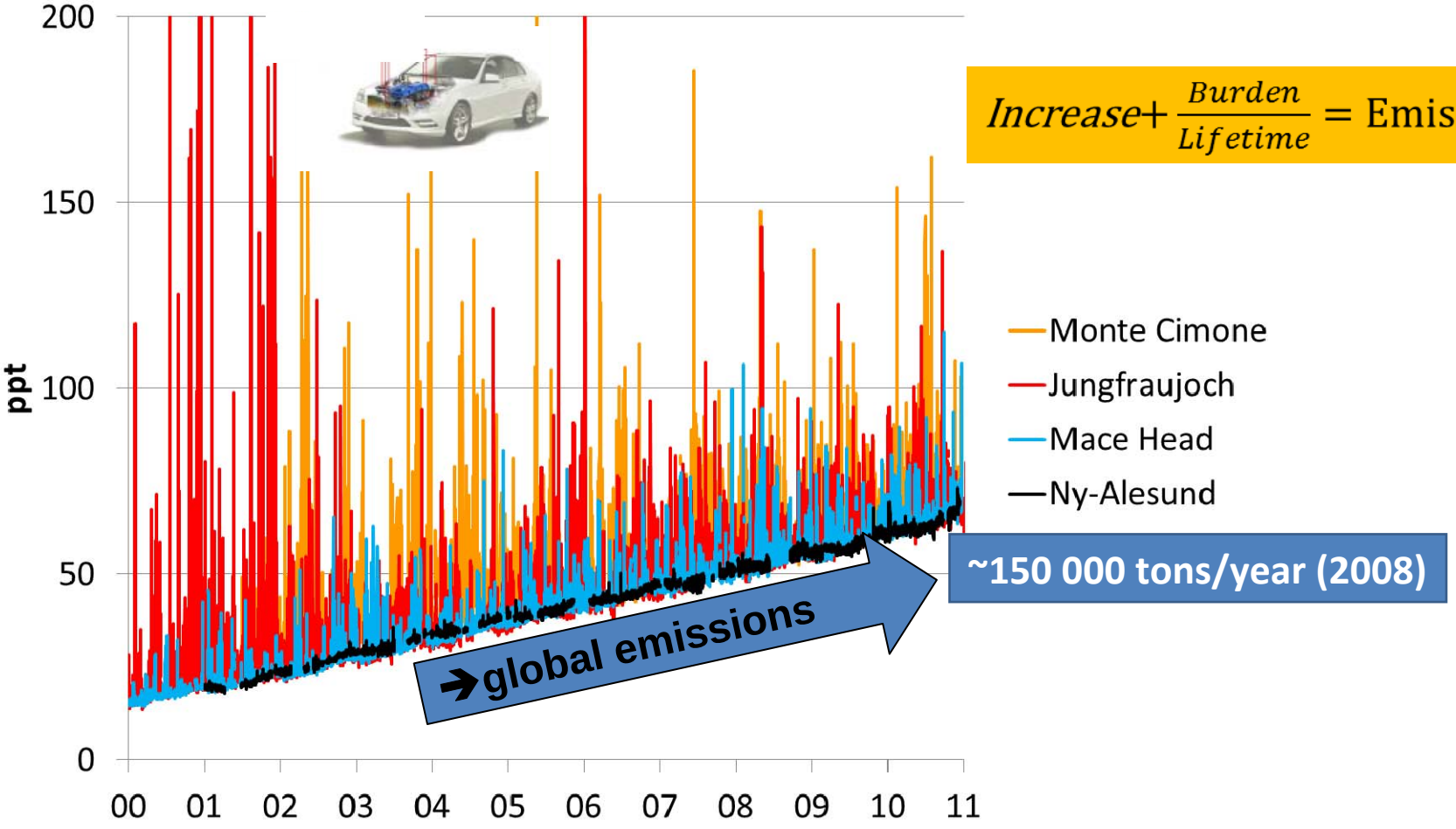
International collaboration is required

Global emissions from a 1-box model: HFC-134a (e.g. from mobile air conditioners)

Atmospheric Lifetime: **13.4 years**

Increase: **+11%/year**



$$Increase + \frac{Burden}{Lifetime} = \text{Emission}$$

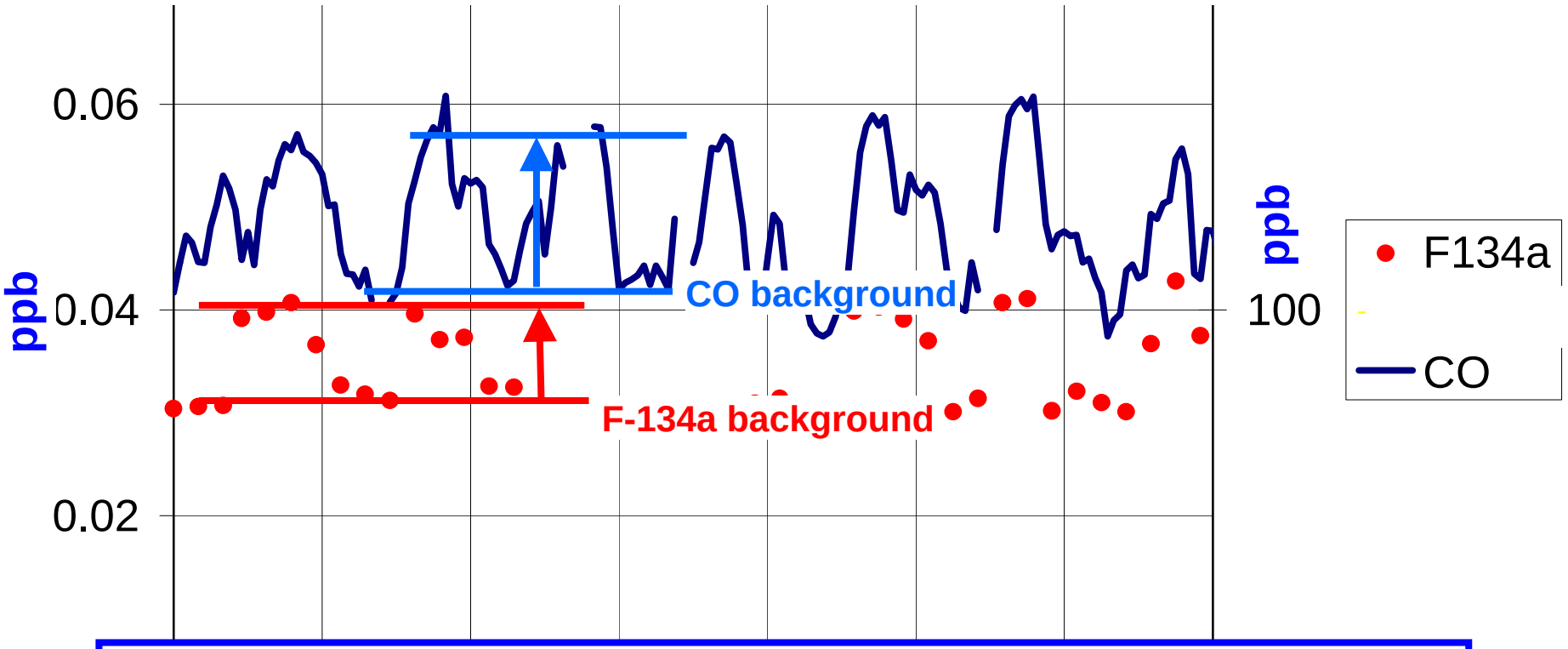
~150 000 tons/year (2008)

Methods using measurements in support of MRV (Measurement, Reporting and Verification)

Inversion-Method 1:
ISC: Inter-Species Correlation

Inversion-Method 2:
ATM: Atmospheric Transport Models

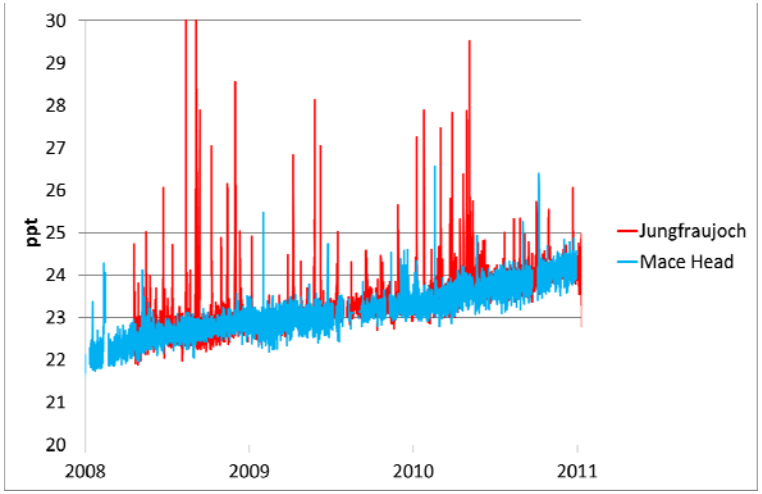
Inversion-Method 1
ISC: Inter-Species Correlation

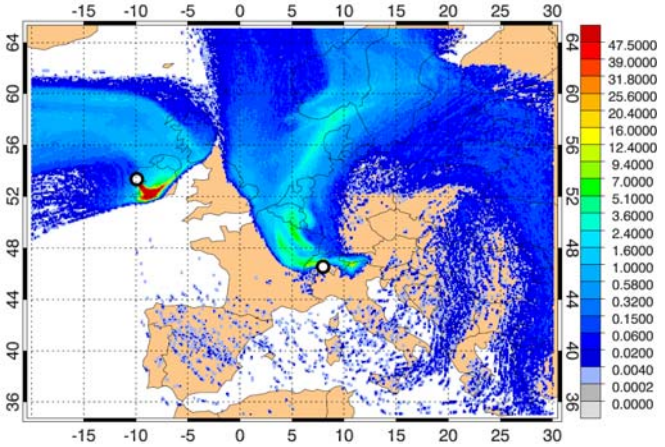


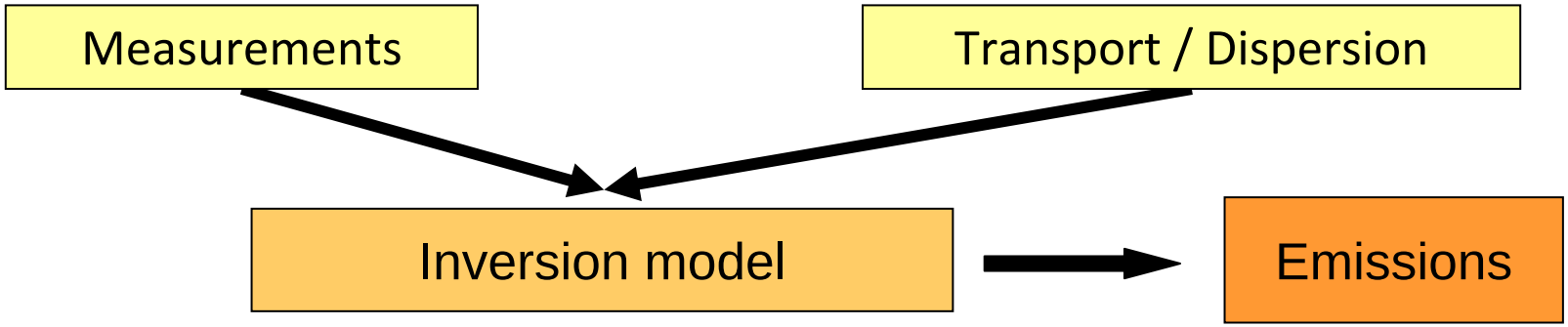
$$\frac{\text{Emission CO}}{\text{CO over background}} = \frac{\text{Emission F-134a}}{\text{F-134a over background}}$$

Combine continuous measurements of a tracer with known emissions with those of a substance of unknown emissions

Inversion-Method 2
ATM: Atmospheric Transport Models



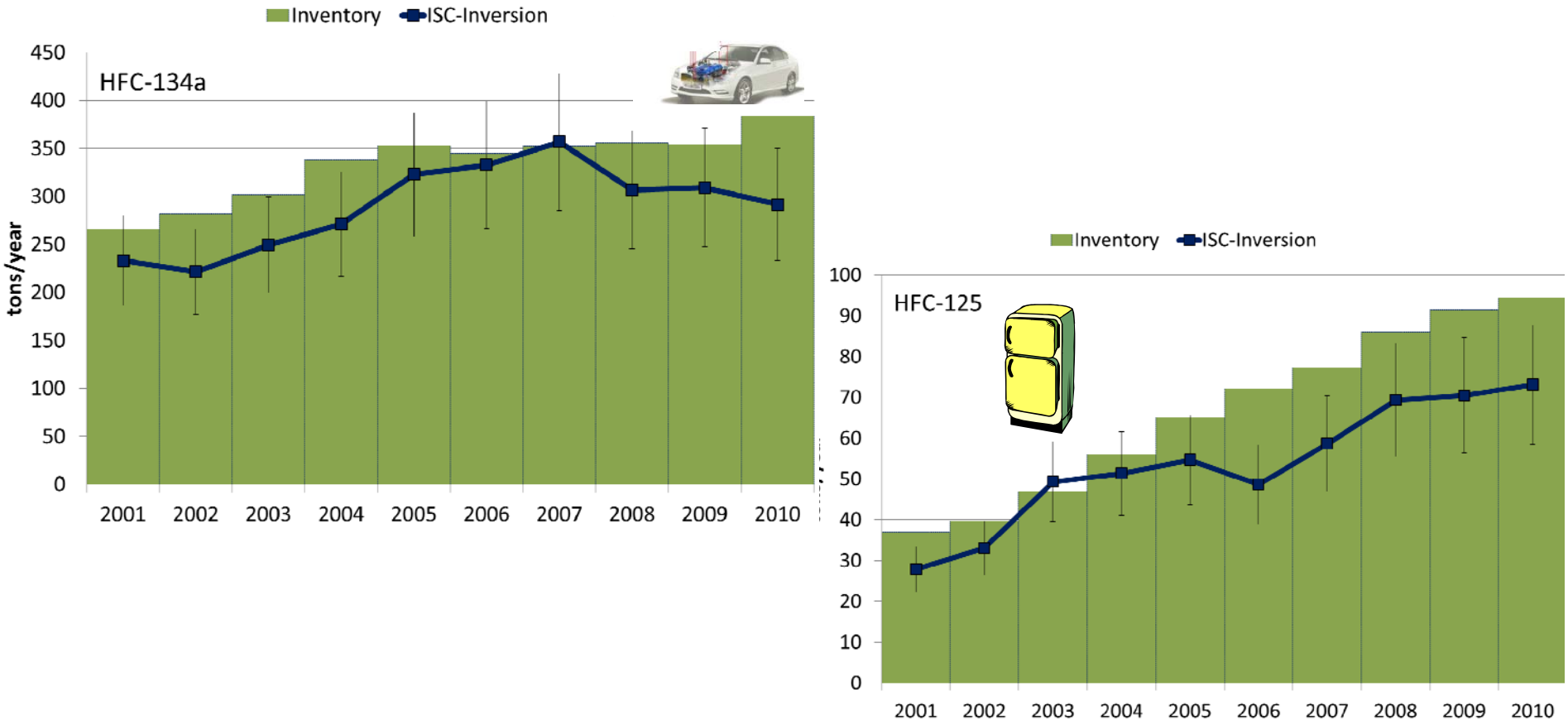




Combine continuous measurements with dispersion modeling results to estimate regional emissions

Inventories vs. measurement-based emissions: HFC-134a and HFC-125 from Switzerland

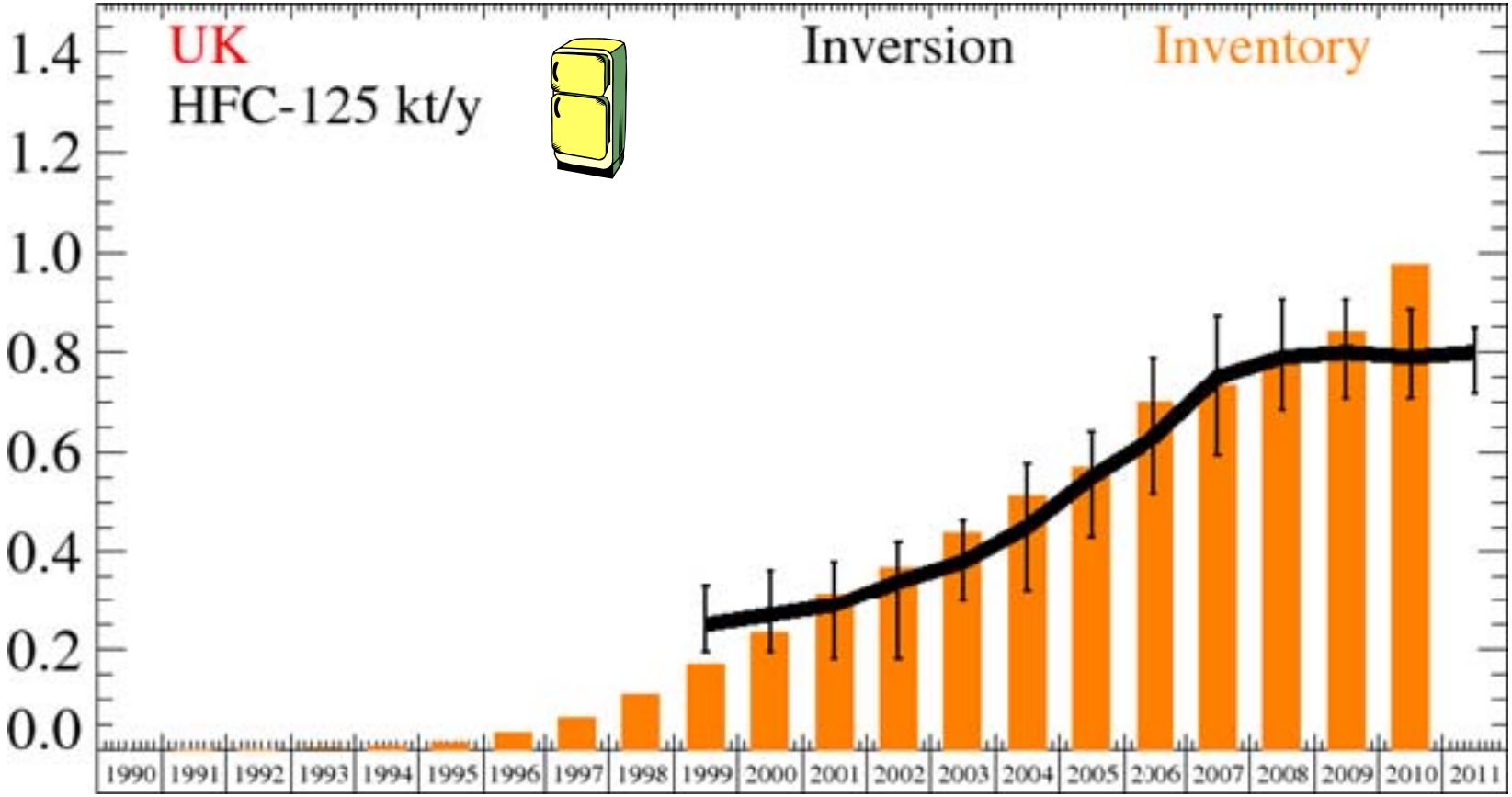
Switzerland: ISC-based inversion



Source: Empa 2012
National Swiss Inventory Report, submission: 2012

Inventories vs. measurement-based emissions: HFC-125 from United Kingdom

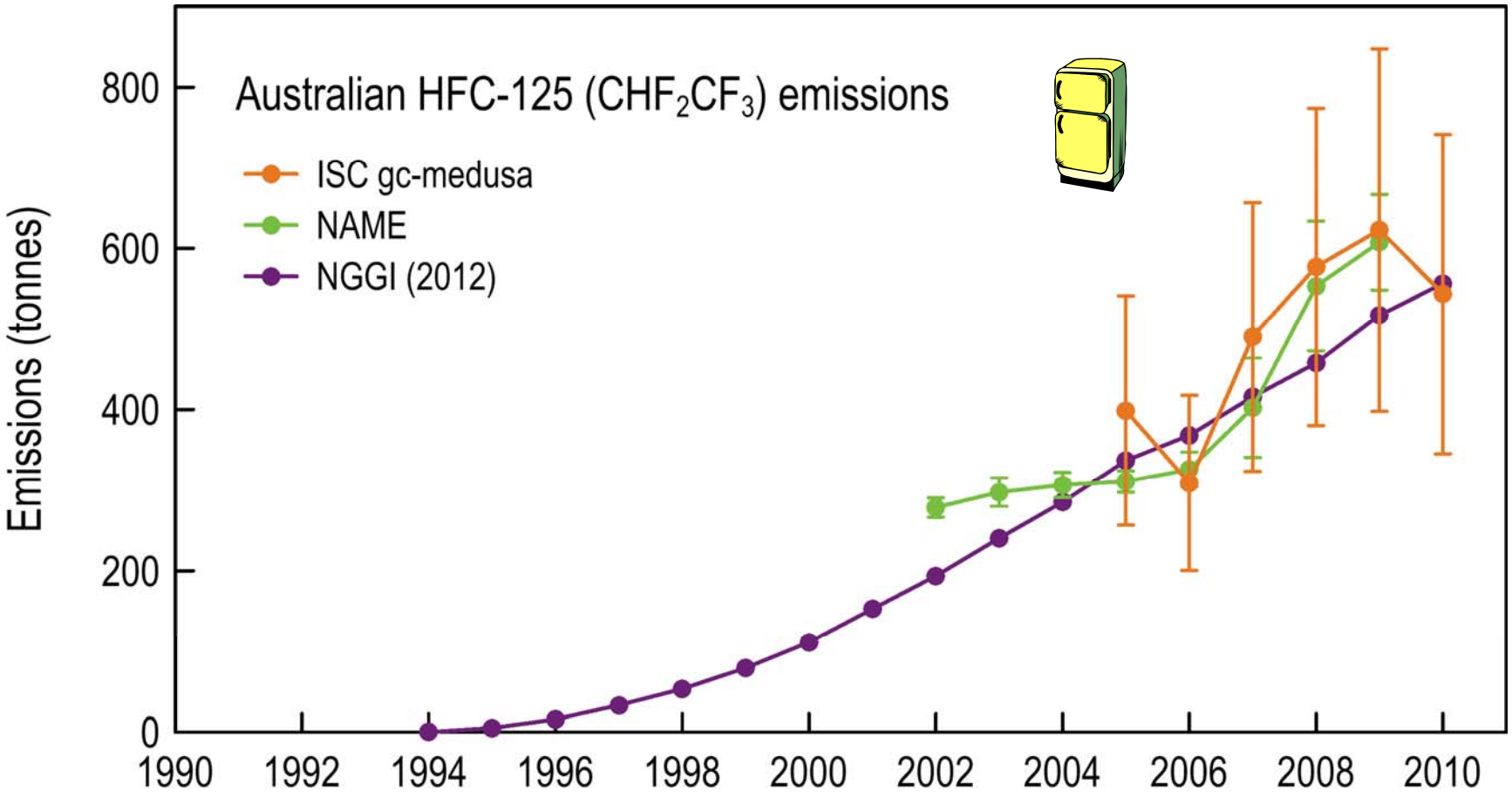
United Kingdom: ATM-based inversion



Source: UK MetOffice 2012
National Unitet Kingdom Inventory Report, submission: 2012

Inventories vs. measurement-based emissions: HFC-125 from Australia

Australia: ISC-and ATM-based inversion

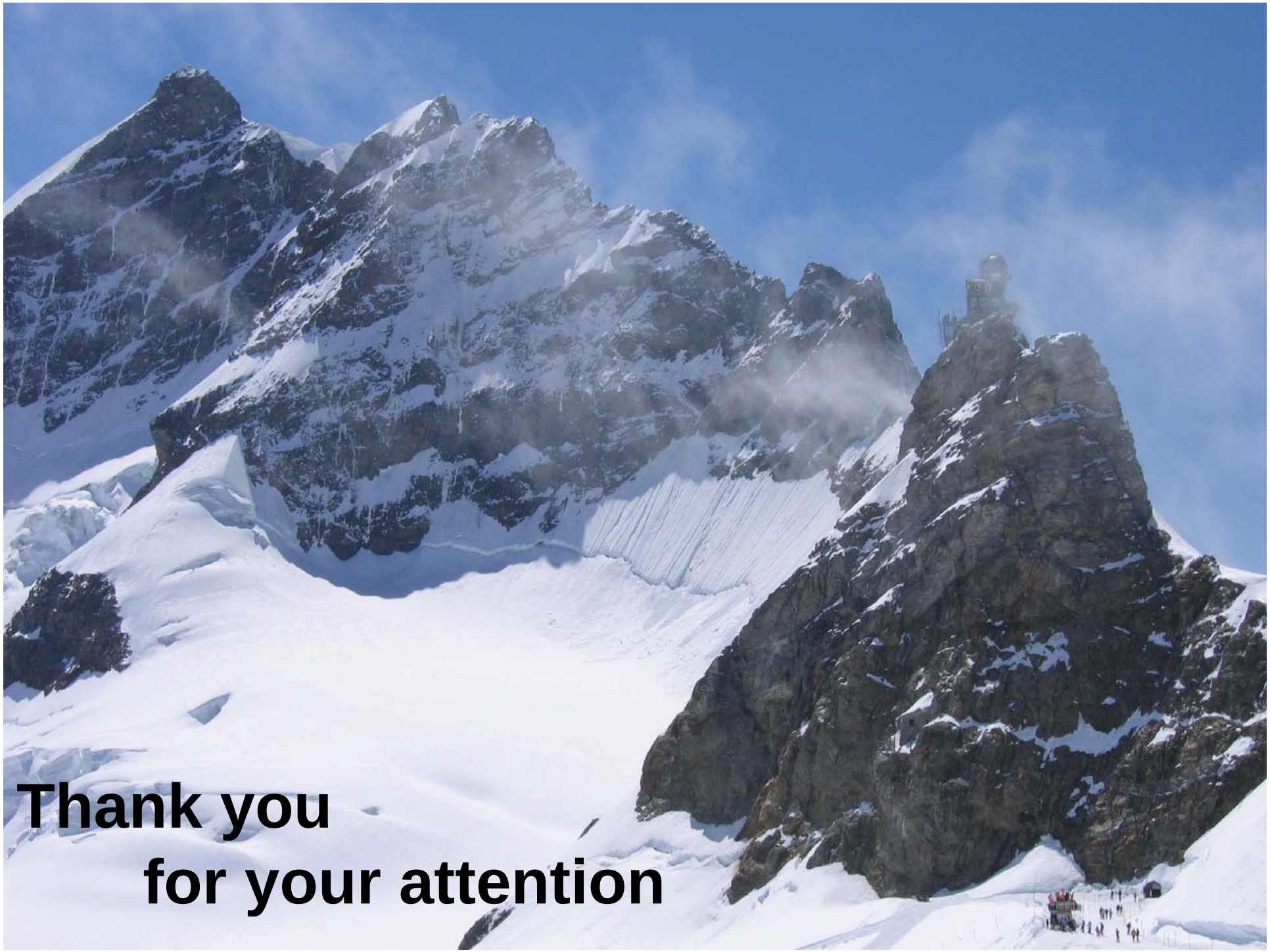


Source: CSIRO 2012
National Australian Inventory Report, submission: 2012

Conclusions

- This approach based on continuous measurements allows independently **validating inventories** down to the country level (incl. uncertainties).
- Emission estimations based on measurements provided **comparable information** across countries.
- Erroneously assigned emissions for halocarbons are detectable in Europe from continuous measurements.
- Emission estimations based on real-world observations offer an **independent tool** for the MRV (measurable, reportable and verifiable) approach for future protocols.

Requirements:
- **long-term comparable time-series**
- **strong international collaboration**


Thank you
for your attention