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A Brief Overview of the MAMM, GAUGE and related studies at the University of Manchester.

Work Conducted by colleagues at the University of Manchester and Partner Institutes.

- I started working on these projects 1.5 weeks ago.
- Graphics, photos, figures, text and information courtesy of G. Allen and team at the University of Manchester.

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MAMM
Methane in the Arctic: Measurement and Modelling

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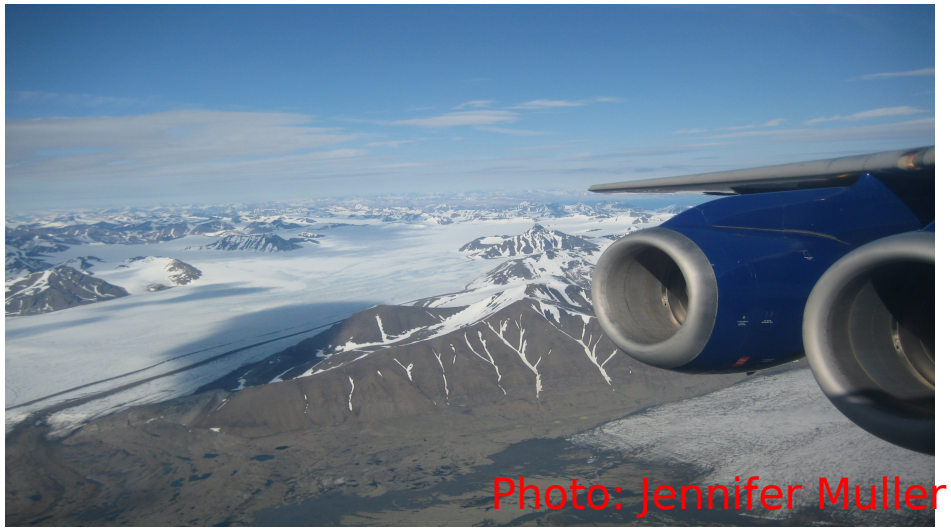
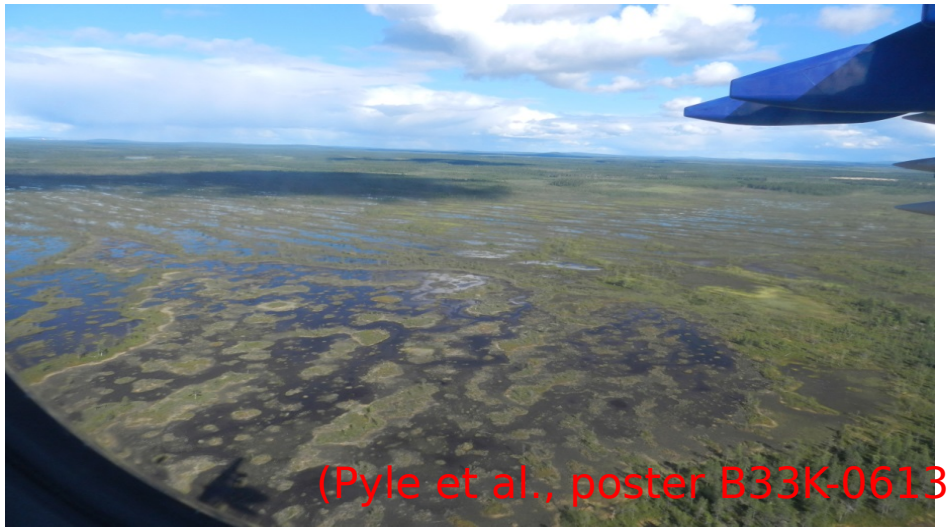
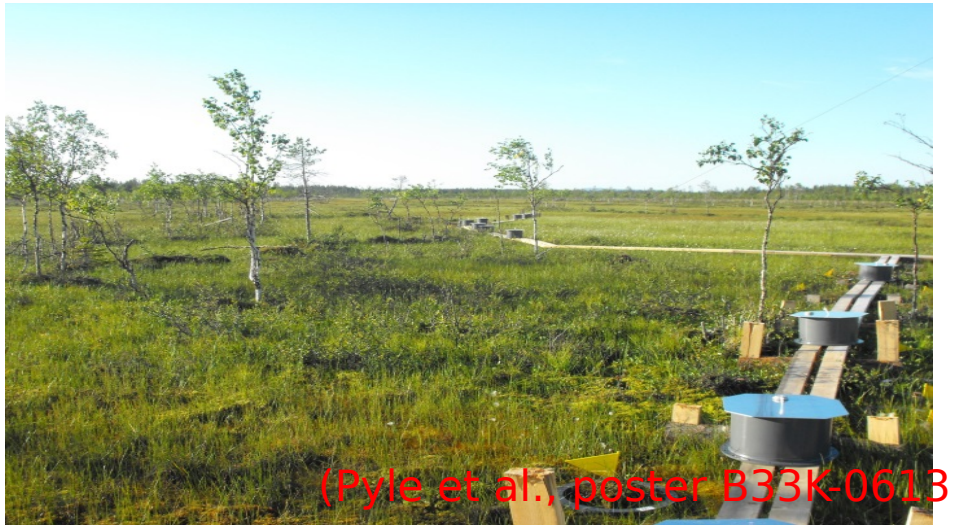


Photo: Jennifer Muller


(Pyle et al., poster B33K-0613)


(Pyle et al., poster B33K-0613)


(Pyle et al., poster B33K-0613)

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FAAM. UK Facility for Airborne Atmospheric Measurements

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FAAM. UK Facility for Airborne Atmospheric Measurements

- CH4, CO2 (Los Gatos Research, Fast Greenhouse Gas Analyser)
- N2O (Aerodyne QCL)
- δ13C-CH4 (Fisher et al., France et al.,)
- CO (Aerolaser VUV spectrometry)
- HCN, Organic acids (CIMS)
- Black Carbon (SP2)
- Remote sensing (Illingworth et al.,)
- Meteorological variables

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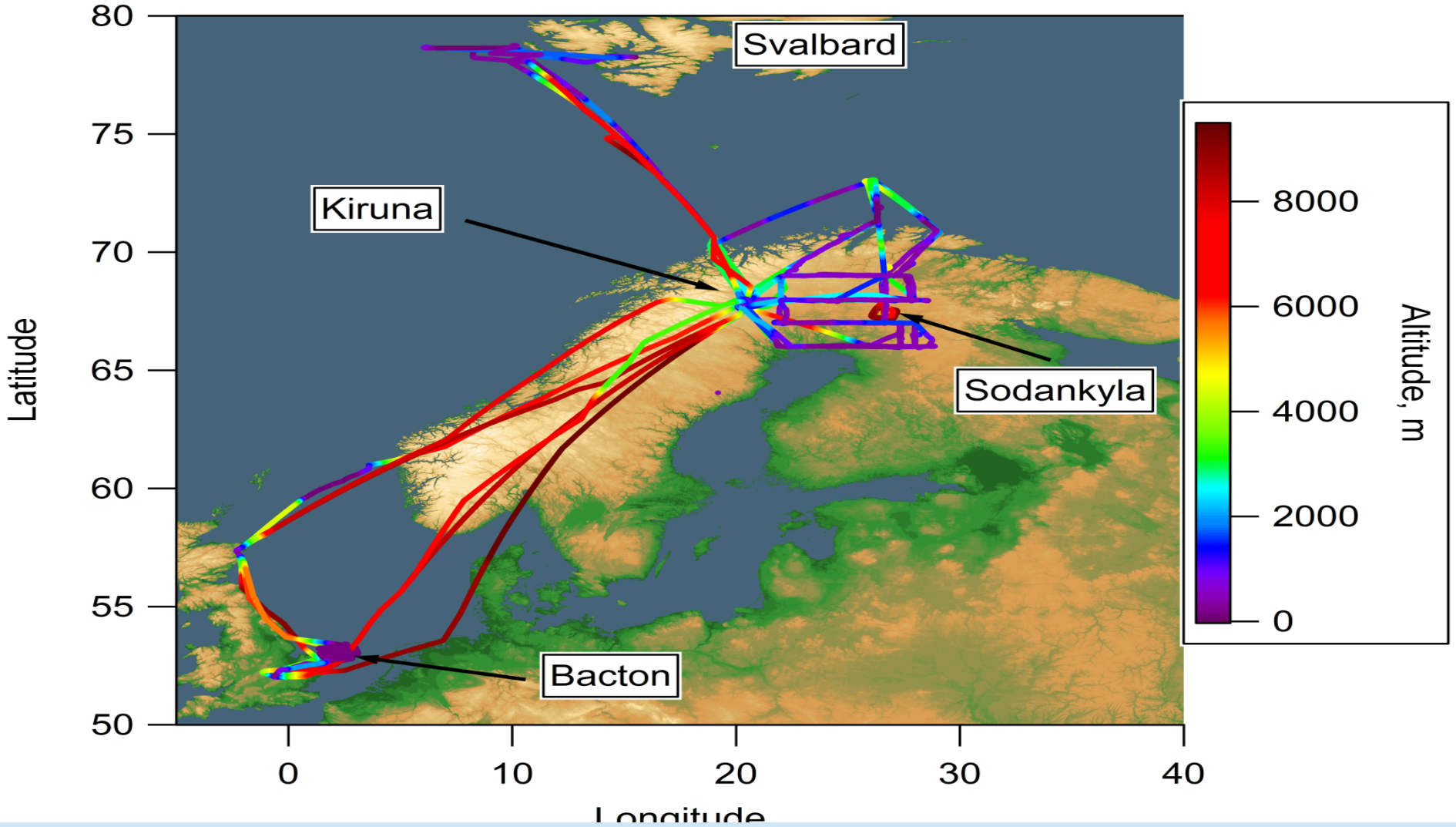
Arctic Airborne Measurement



July 2012	August 2013	September 2013
6 flights	9 flights	7 flights

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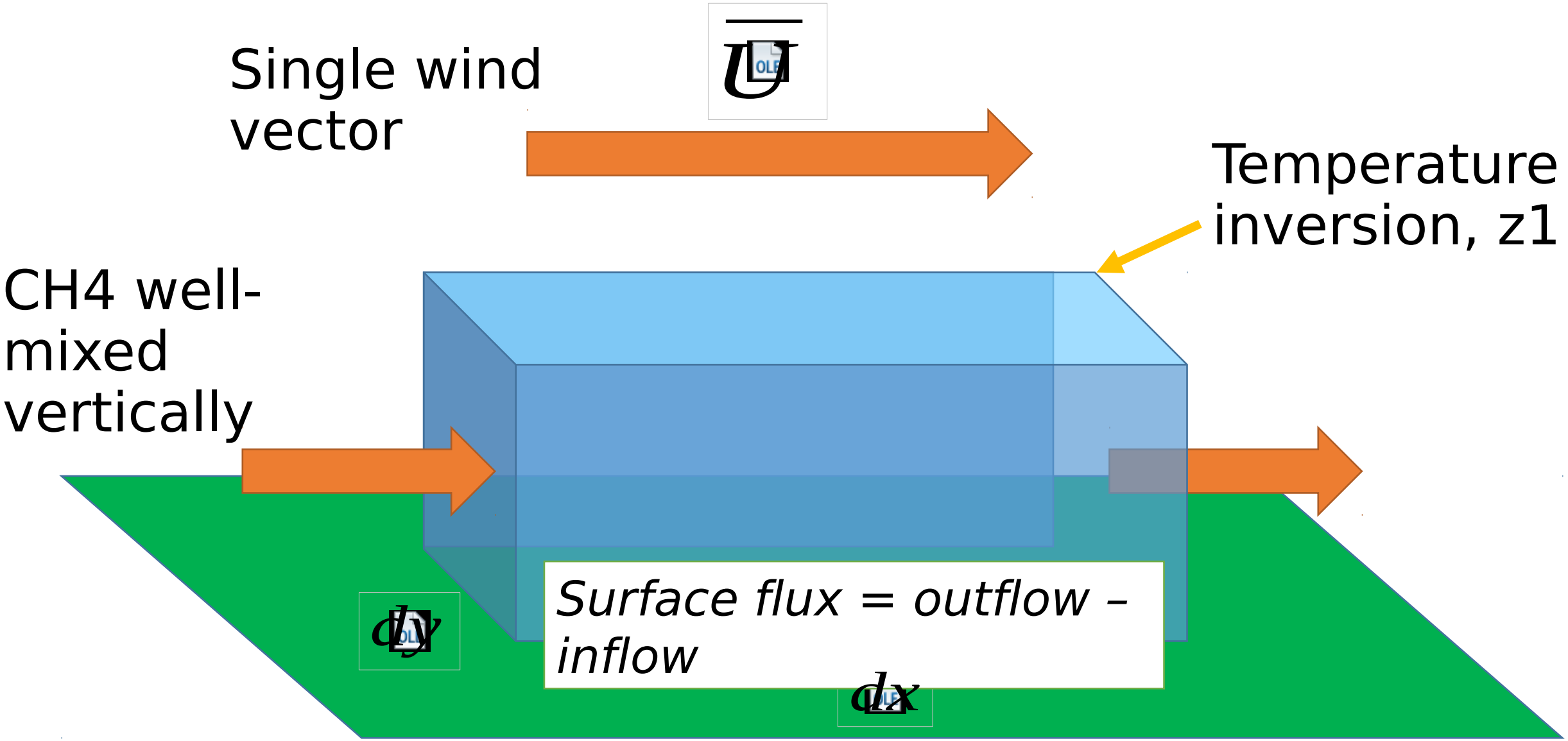
Boundary layer mass balance



Surface flux = outflow – inflow

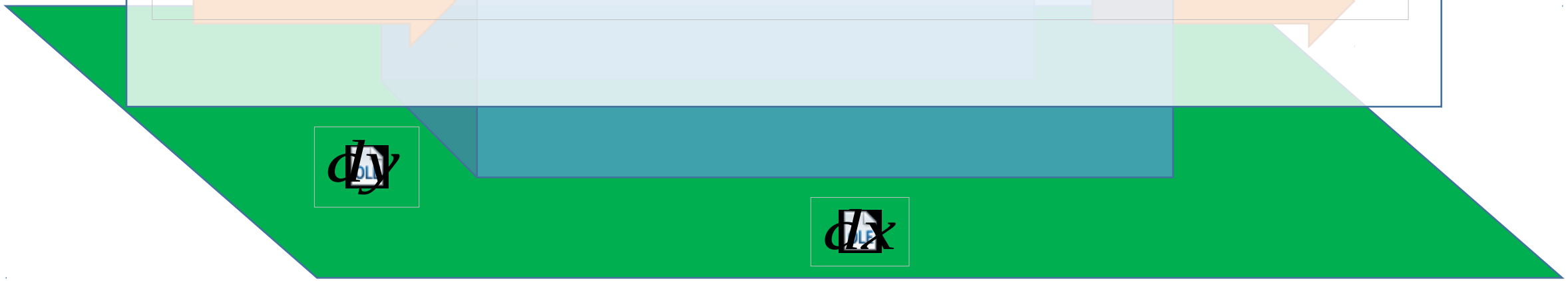
Single wind vector

$\overline{U}$

Temperature inversion, z1

CH4 well-mixed vertically

$$flux = \overline{U} \cdot \frac{dCH_4}{dx} \cdot \int_0^{z_1} n dz$$



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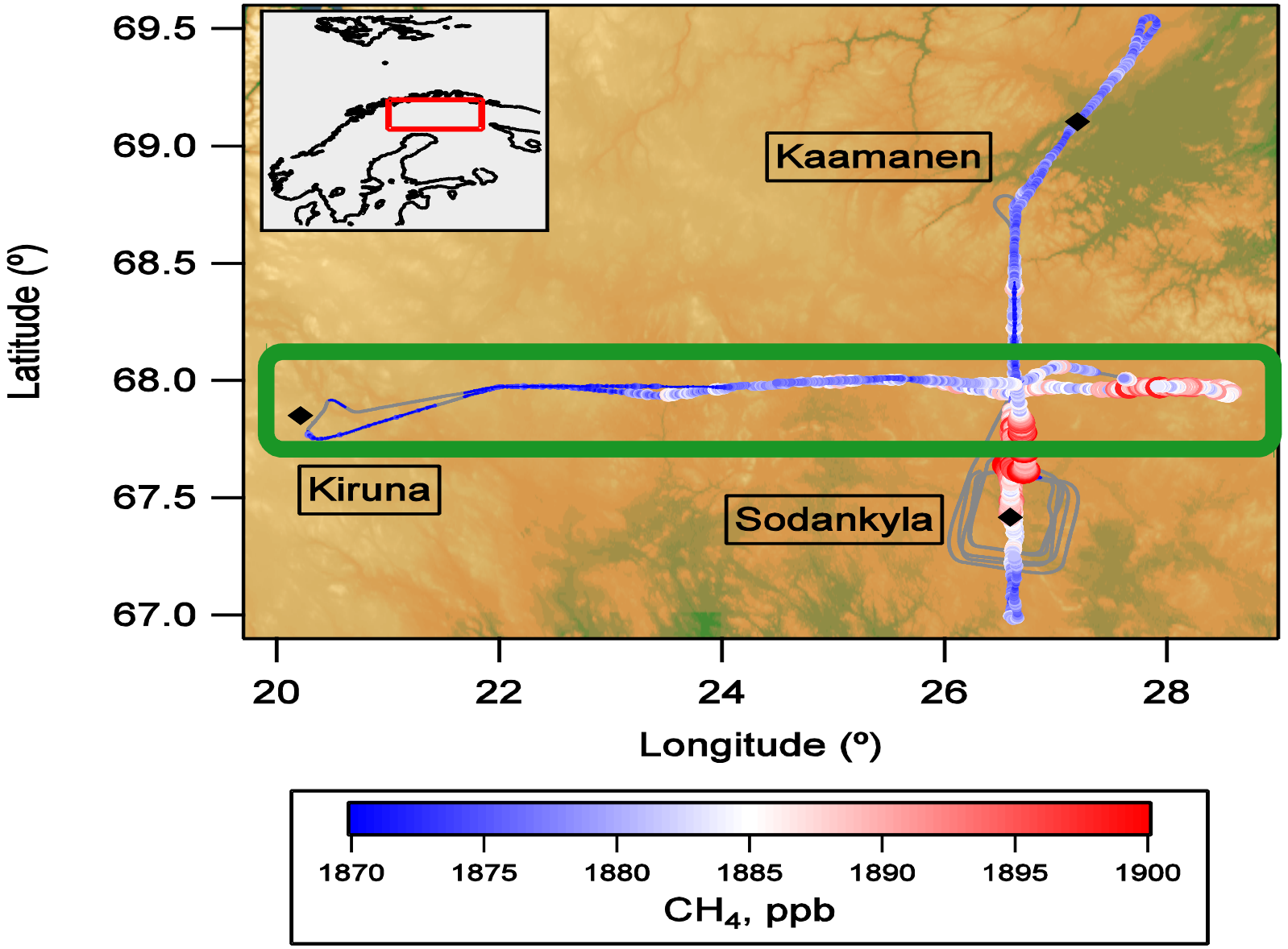
Wetland Survey



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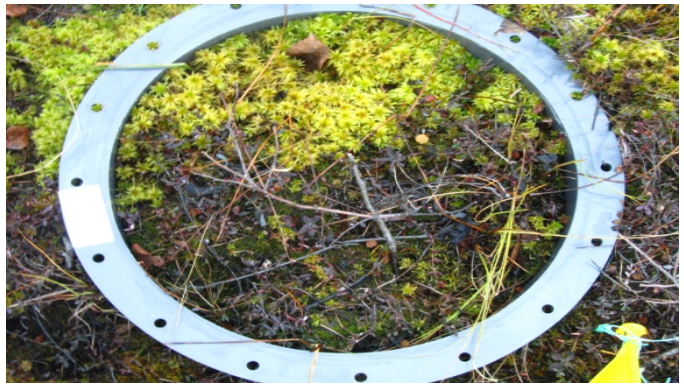
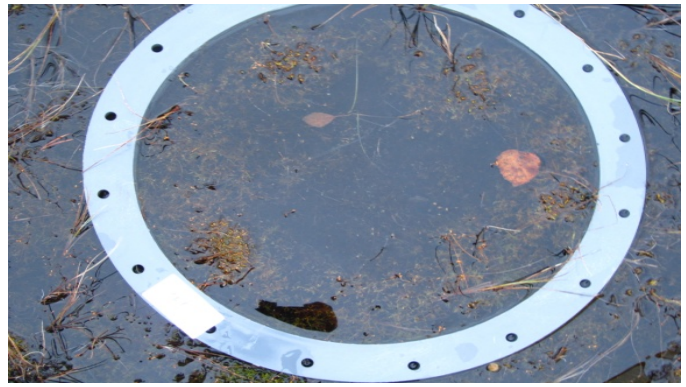
Sodankyla chamber fluxes

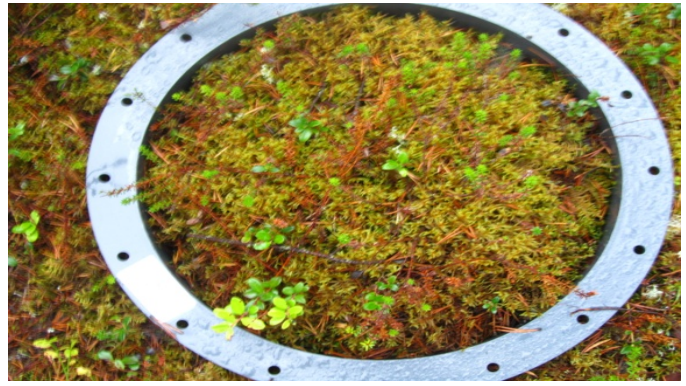
39 chambers in the wetland





21 chambers in the forest





Photos: Kerry Dinsmore

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MAMM Summary

- Regional fluxes determined using an airborne mass balance approach.
- Further studies planned using dispersion models (e.g. NAME).
- Important constraint for regional process models (e.g. the JULES model)

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GAUGE
Greenhouse gAs Uk and Global Emissions

ECMWF

DEPARTMENT OF ENERGY & CLIMATE CHANGE

NPL
National Physical Laboratory

THE UNIVERSITY OF EDINBURGH

VT·VETAM HABEANT

UNIVERSITY OF LEEDS

defra
Department for Environment Food and Rural Affairs

CEH

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

NERC
SCIENCE OF THE ENVIRONMENT

UNIVERSITY OF CAMBRIDGE

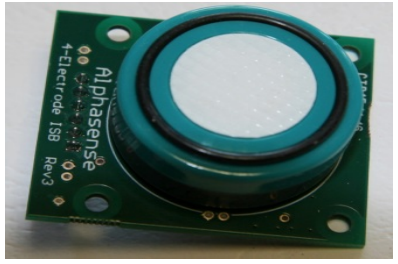
Met Office

DFDS SEAWAYS

Quantifying UK anthropogenic GHG emissions

DFDS ferry:
CO2, CH4, N2O*

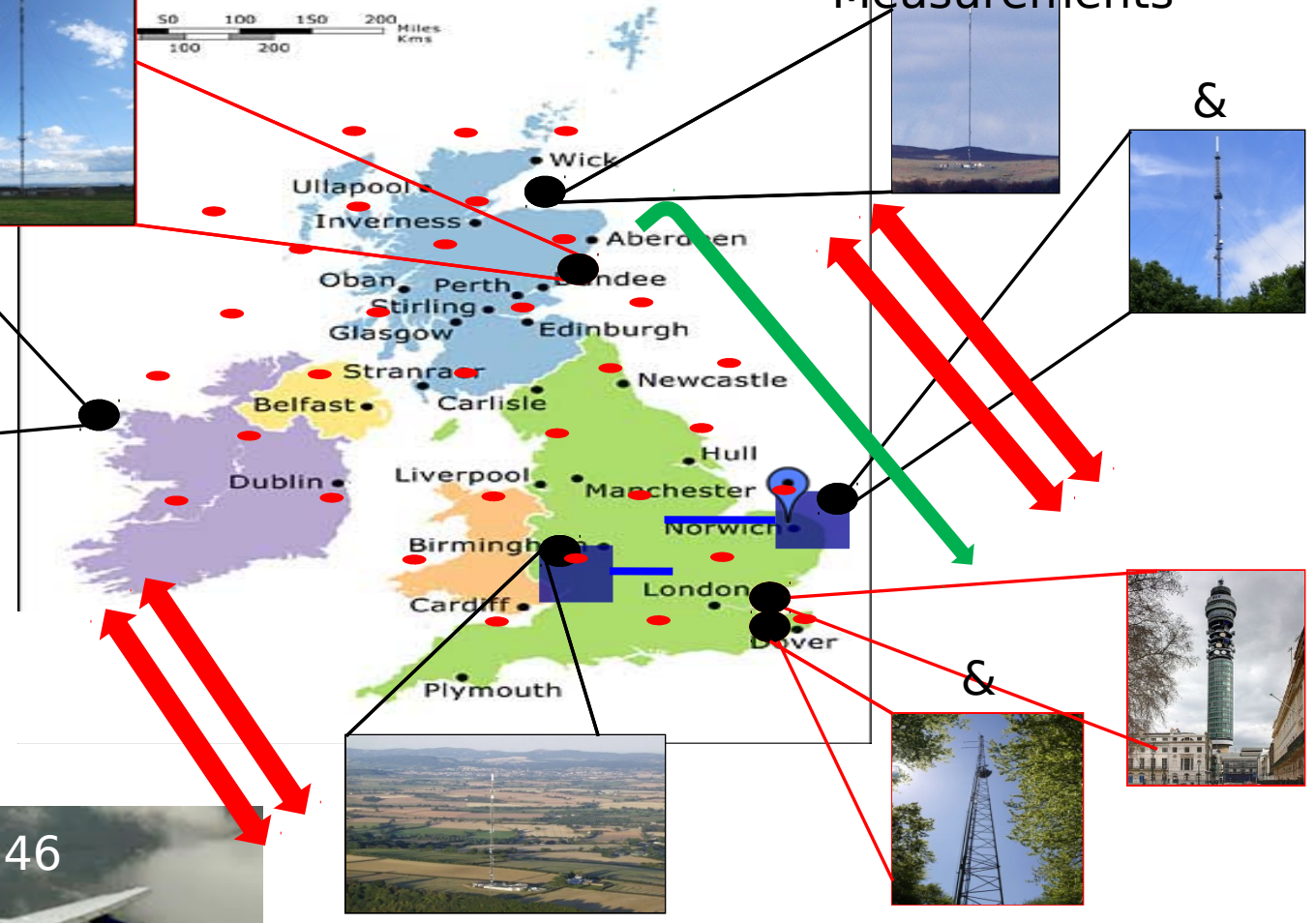
IASI, GOSAT, OCO-2
et al



New
technology

BAe 146

Tower
Measurements



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GE: Quantifying UK anthropogenic GHG emissions

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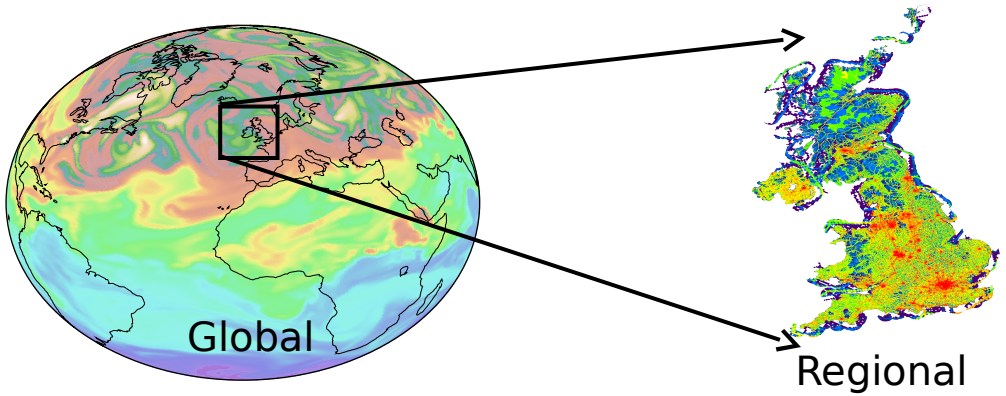
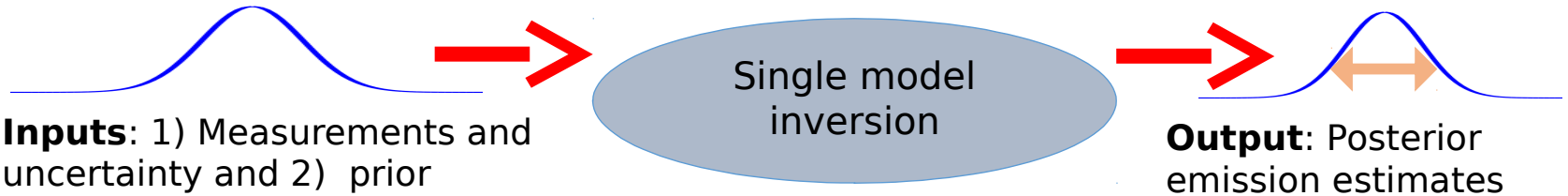
Cutting-edge models of atmospheric transport



Using the world-class meteorological analyses and the latest prior emission inventories

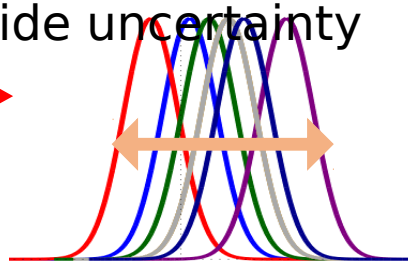
ting posterior emissions by combining measurements and models



Inputs: 1) Measurements and uncertainty and 2) prior emissions uncertainty

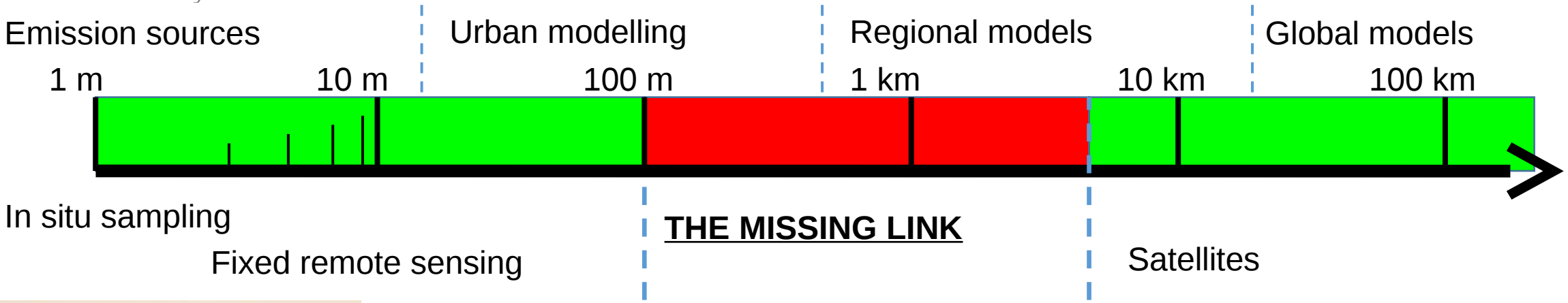
Output: Posterior emission estimates and uncertainty

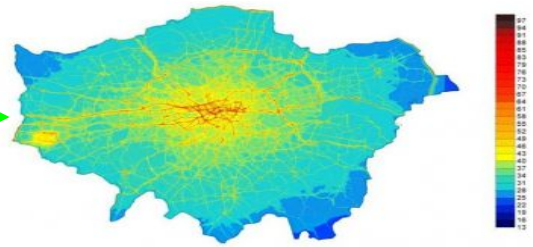
Facilitating better decisions: ensemble of emissions estimates provide uncertainty

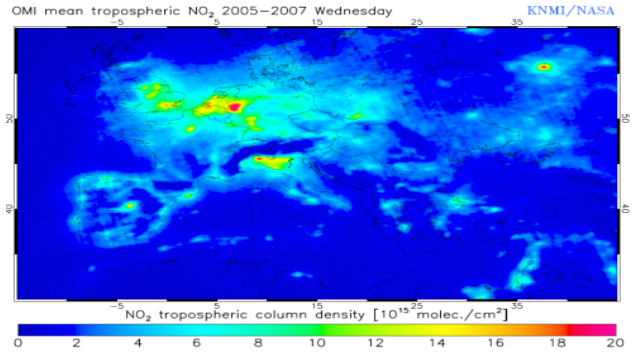


Modelling Aircraft measurements during London 2012: GHG fluxes sampled upwind and downwind

Emissions: The problem of scales







- **The Problem:** Processes/modelling/understanding at small (e.g. urban) scales not easily extrapolated to large (global) scales.

- **A solution**: Airborne in situ and aircraft remote sensing at intermediate scales: to test models with measurements that link these scales, e.g. Karion et al., Mays et al.

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The FAAM Aircraft

FAAM
Facility for Airborne Atmospheric Measurements

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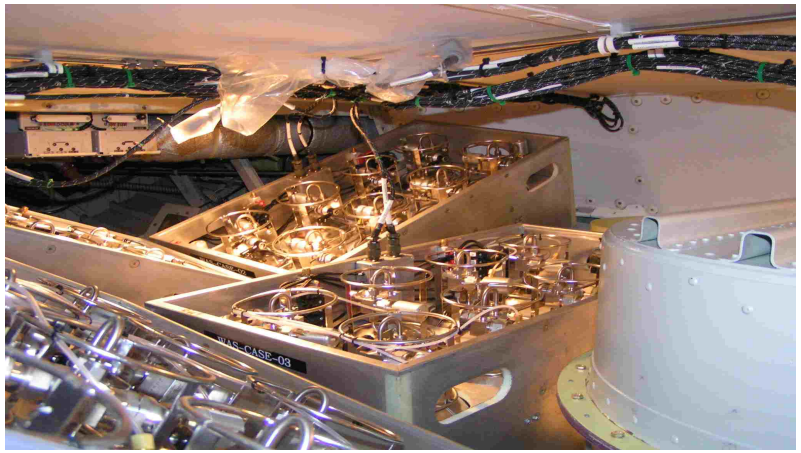
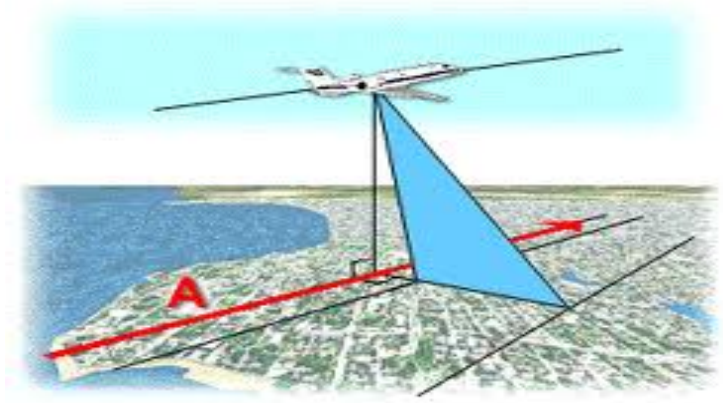
- In situ
  - CH4, CO2 , N2O
    - (Aerodyne QCL, LGR FGGA)
  - CO, O3, NOx
  - Dropsondes (T, p, q, winds)
- Whole Air Sample (WAS) system
  - 64 x 3 litre silico-steel canisters
  - GCxGC: C6-C13 NMHC, oxygenated VOCs
  - Continuous flow GC - Trace gases and CH4 δ13C
- Remote sensing
  - Nadir open-path FTIR (ARIES)
  - Vertical profiles of CH4, N2O etc
  - Cloud/Aerosol lidar



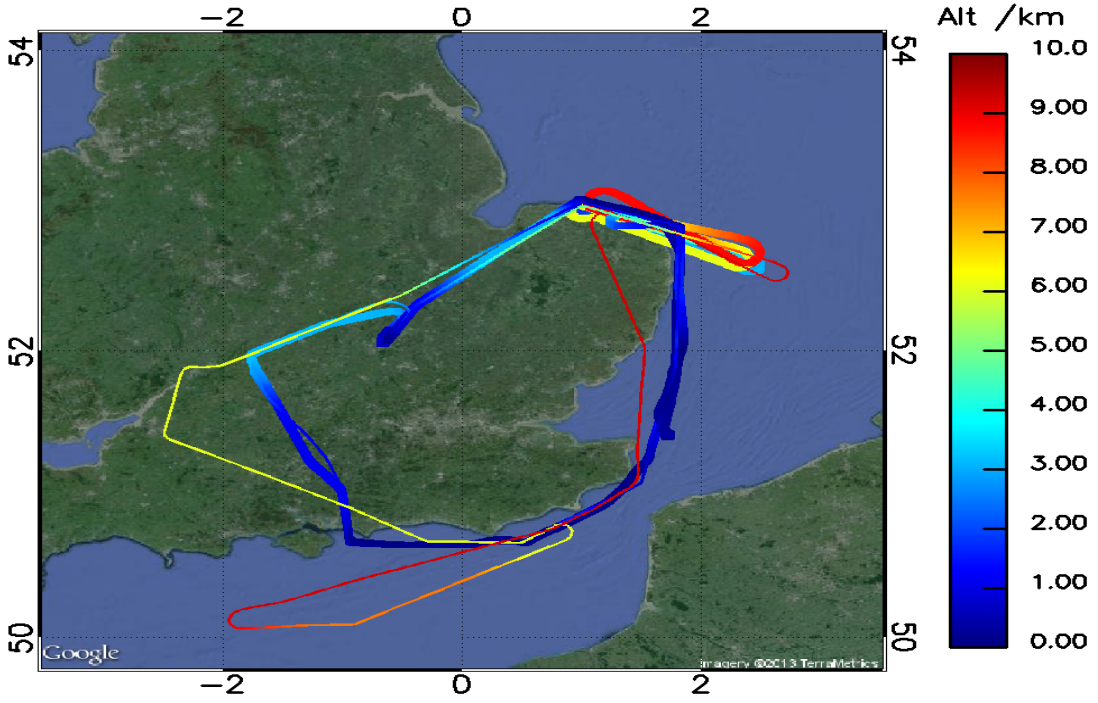


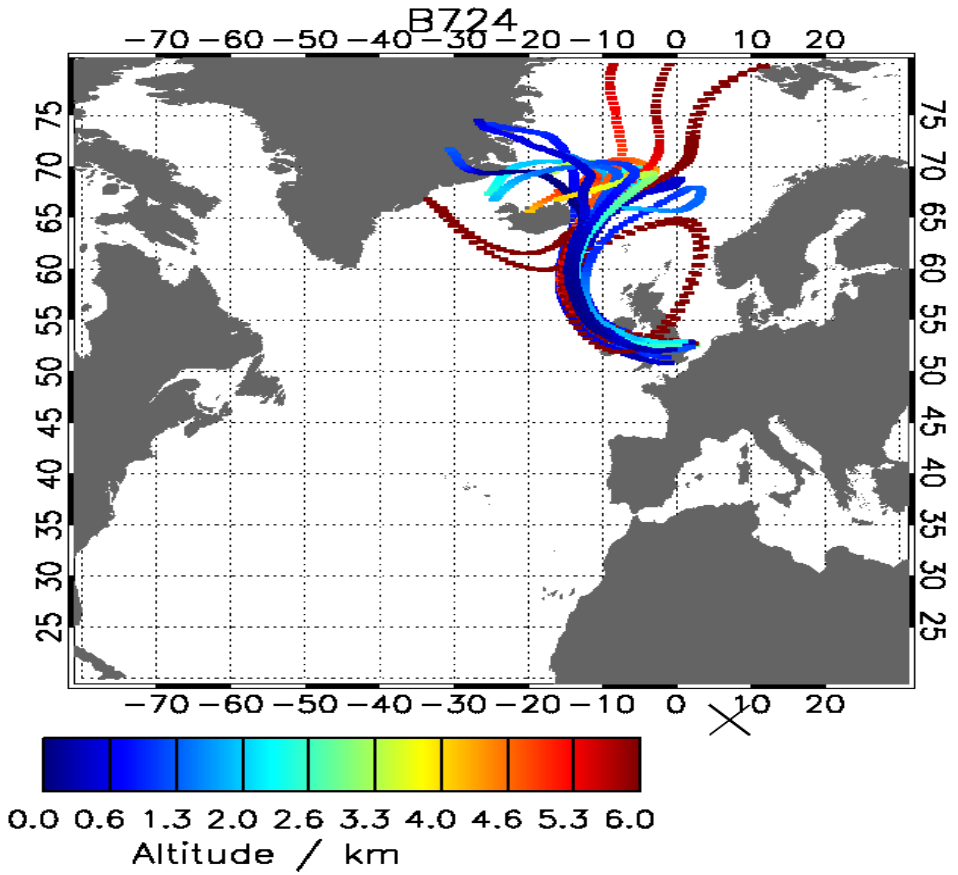
Flight B724 - 30 July 2012

London Case study during Olympics 2012

Complimentary to the ClearfLo campaign

Westerly winds from the Atlantic and Arctic





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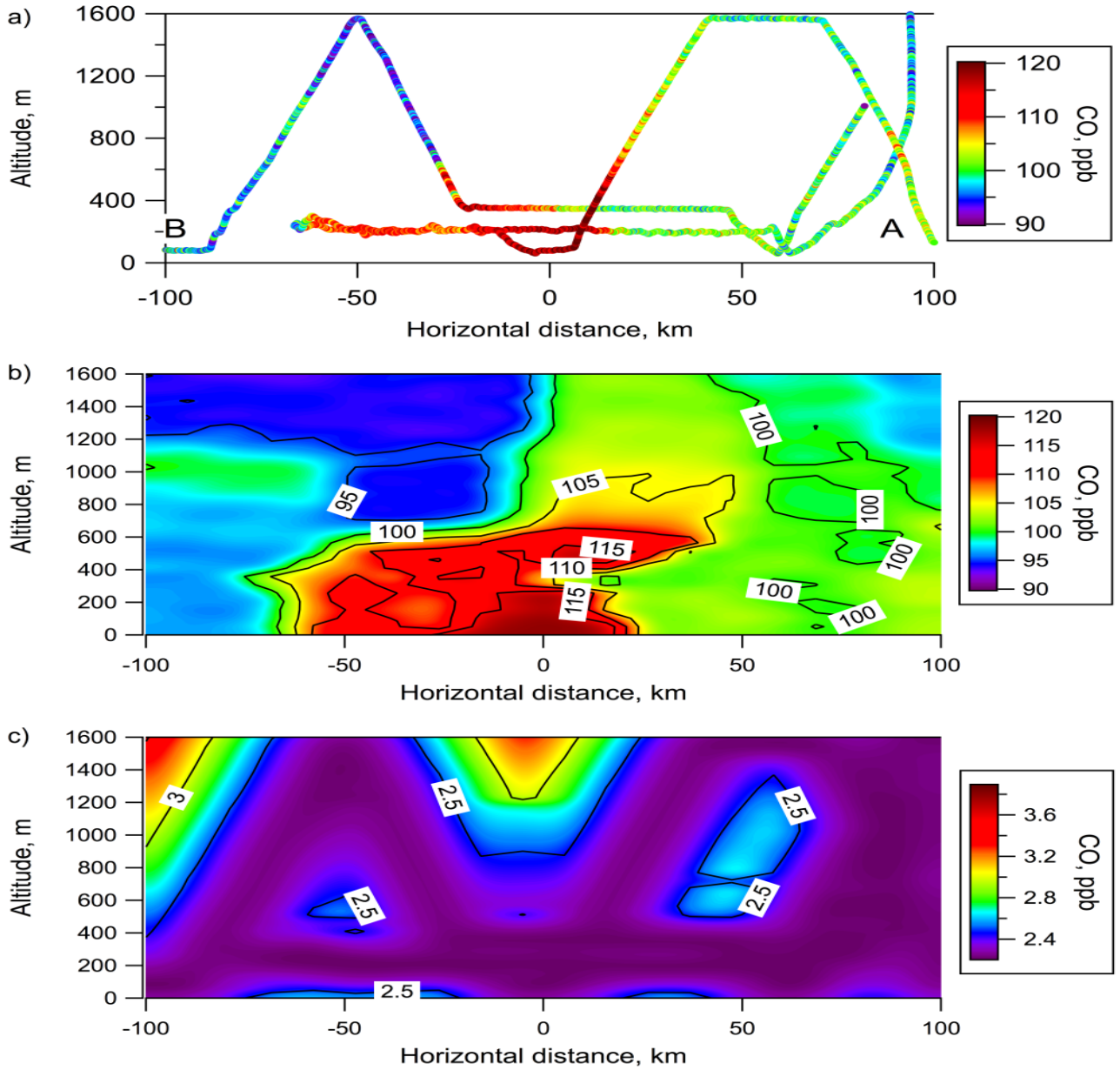
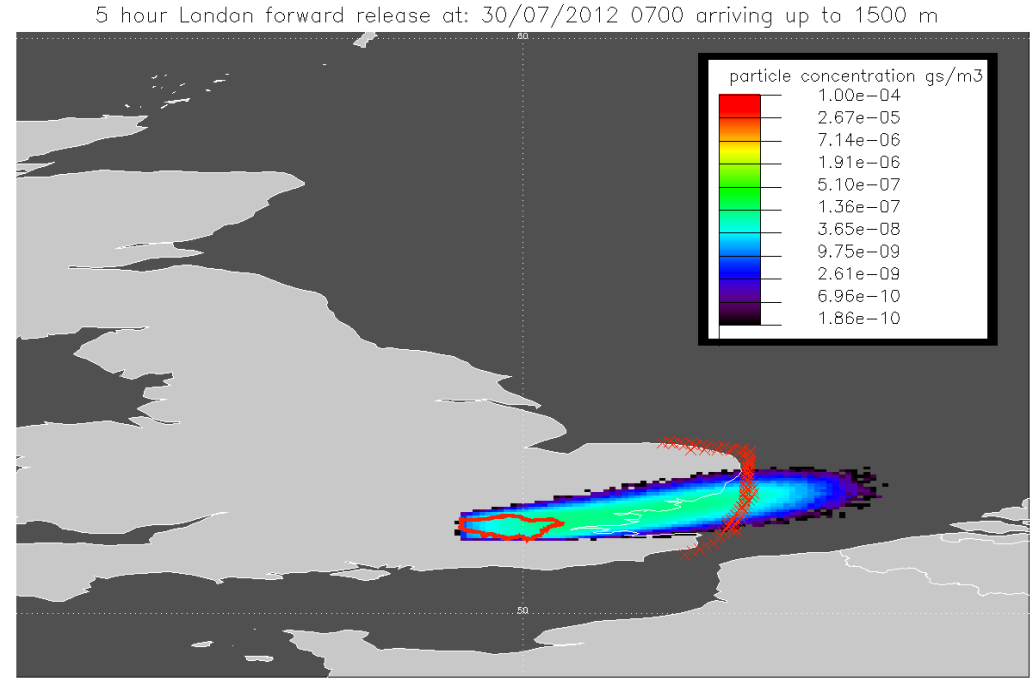
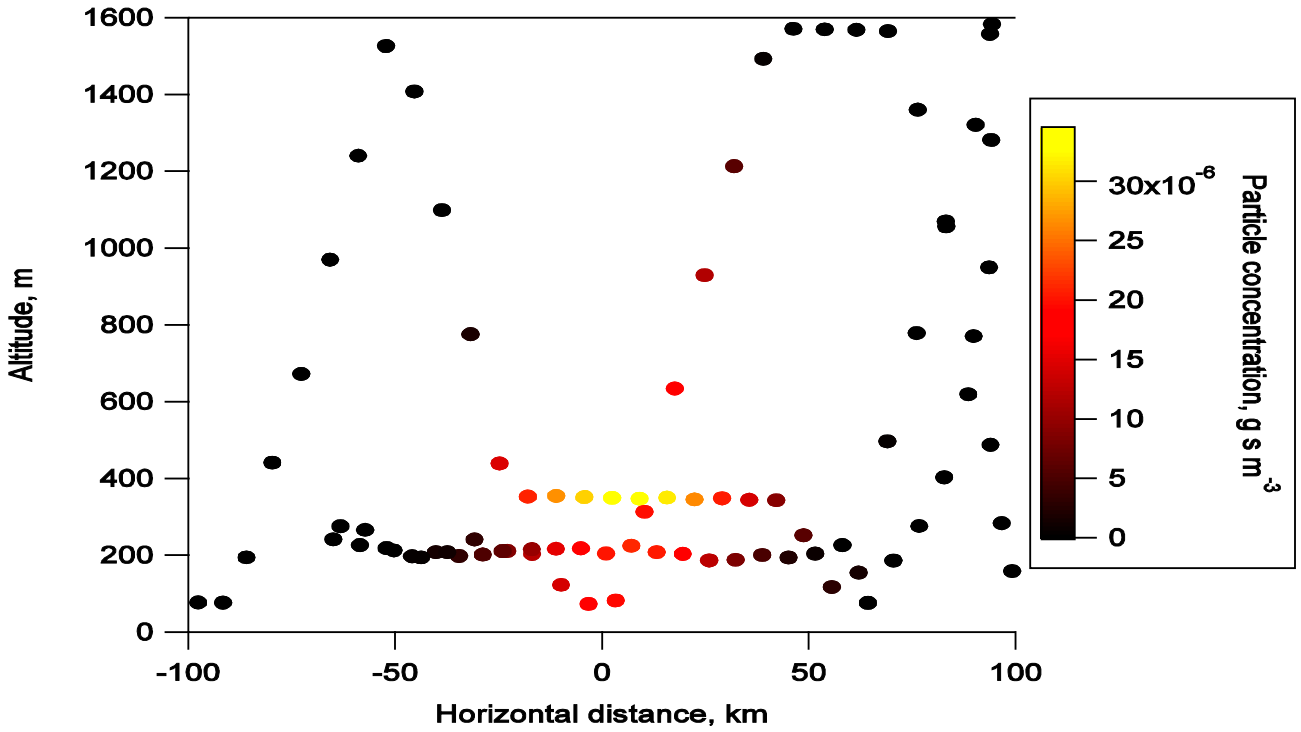
The London Plume



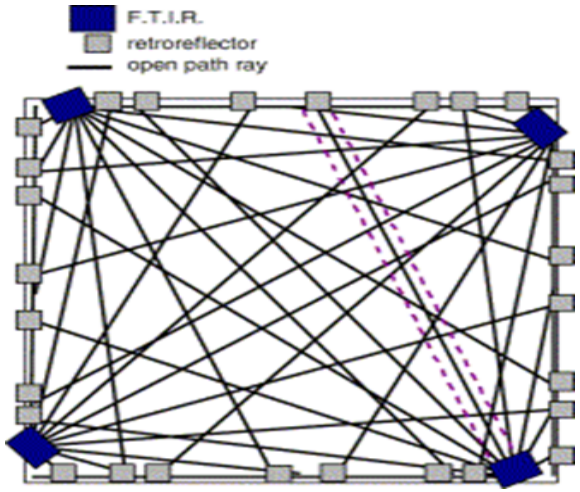
NAME dispersion modelling





- Influence of London emissions on air sampled by the aircraft along plane AB
- Determined using backwards NAME runs for 10000 particles released from the GPS of the aircraft.
- Warm colours show regions of greater airmass influence from London and vice versa for darker colours.

Fracking/landfill Flux Monitoring



$$-D_L\frac{\partial C}{\partial x} \qquad -D_L\left(\frac{\partial C}{\partial x}+\frac{\partial^2 C}{\partial x^2}dx\right)$$

$$vC \qquad v\left(C+\frac{\partial C}{\partial x}dx\right)$$

$$\frac{\partial C}{\partial t},\ \frac{\partial q}{\partial t}$$

$$dx \qquad dz$$