# Understanding and Quantifying CO_2 and CH_4 Greenhouse Gas Fluxes on the Regional Scale: The Project CarboCount CH

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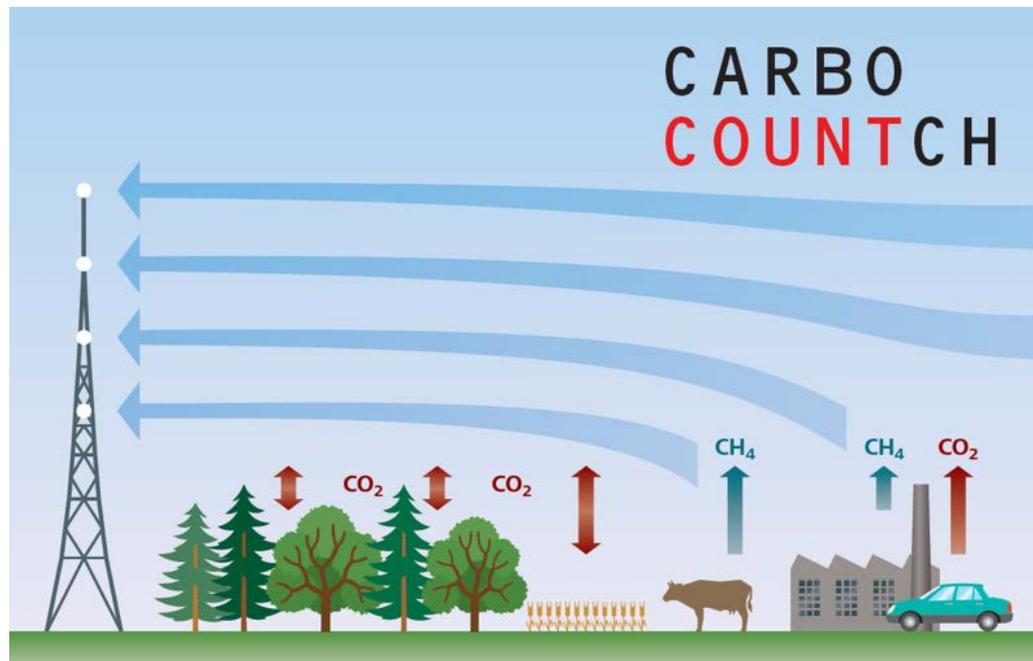
CarboCount CH

Goals

- Improved understanding of CO_2 fluxes in Europe and their sensitivity to climate variations

- Develop prototype of a modeling and observation system of CO_2 and CH_4 fluxes in Switzerland

Approach

- Simulations of biosphere-atmosphere exchange of CO_2 in Europe over past 33 years (1979-2012)

- Setup of CarboCount-CH GHG observation network in CH

- Estimation of CO_2 and CH_4 fluxes in CH through combination of **top-down** & **bottom-up** methods:

  - Top-down: Two independent inversion systems
  - Bottom up 1: Hi-res inventories of CO_2 und CH_4 emissions
  - Bottom up 2: Biogeochemistry model to simulate exchange of CO_2 between biosphere and atmosphere

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Measurement network

- **4 new sites** for CO_2, CH_4 and CO dry VMR
- regular ^{14}C samples at Beromünster
- 3 NABEL sites with CO and CO_2 + 2 sites with CO and CH_4
- 4 FLUXNET sites
- Central calibration lab at Empa (GAW World Calibration Center)
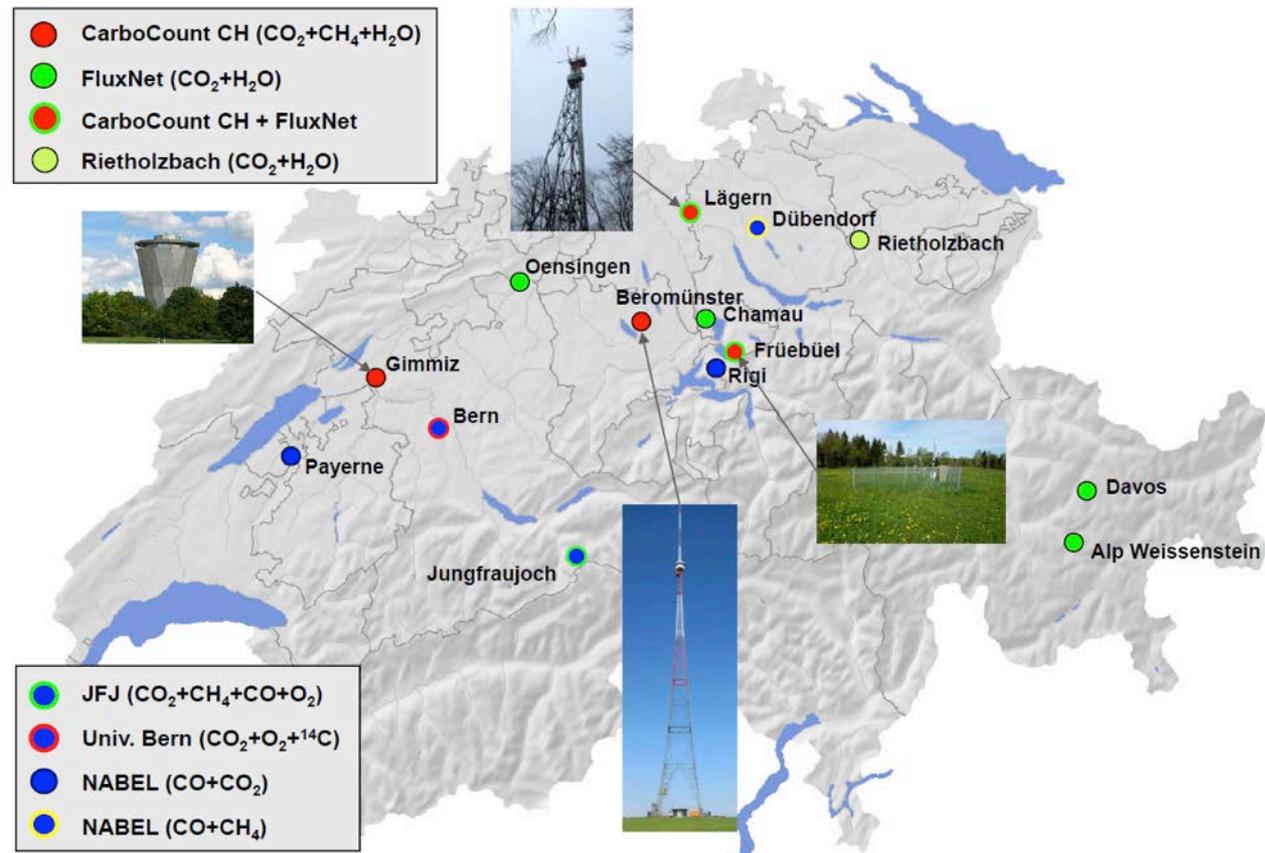
Tall tower site Beromünster

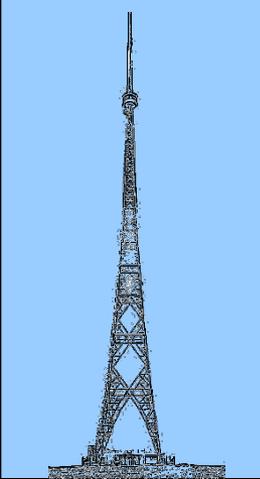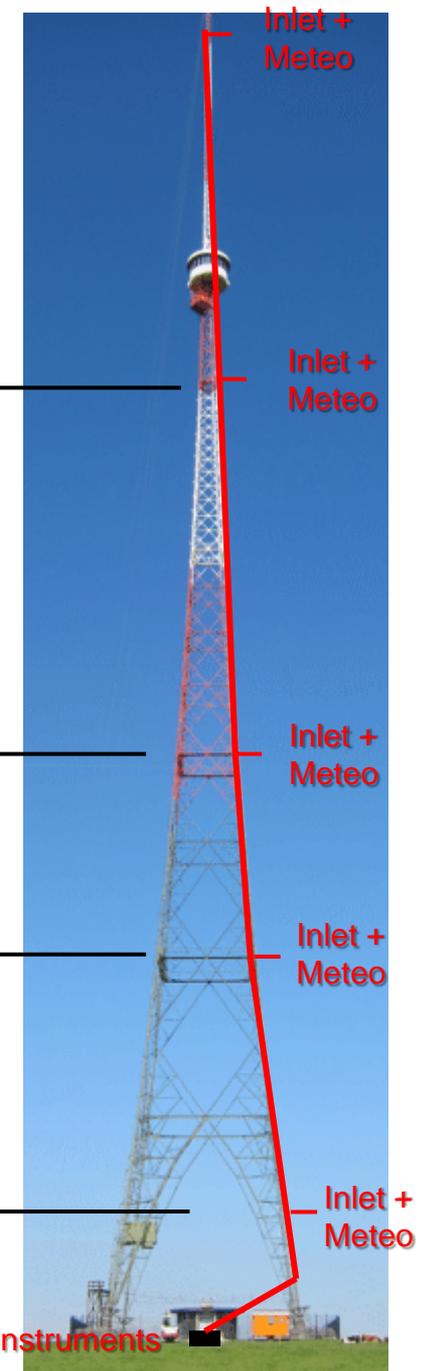**building hosting instruments**

valve switch box

212 m

132 m — Inlet + Meteo

Inlet + Meteo

72 m — Inlet + Meteo

45 m — Inlet + Meteo

12 m — Inlet + Meteo

Instruments

Model System

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Coupled system COSMO-CLM^2

COSMO mesoscale NWP model

- model of a consortium of weather services in Europe (Germany, Switzerland, Italy, Poland, Greece, Rumania, Russia)
- COSMO-CLM: Climate version of COSMO

Davin et al., COSMO-CLM^2: A new version of the COSMO-CLM model coupled to the Community Land Model, Clim. Dyn., 2011.

Community Land Model CLM 4.0
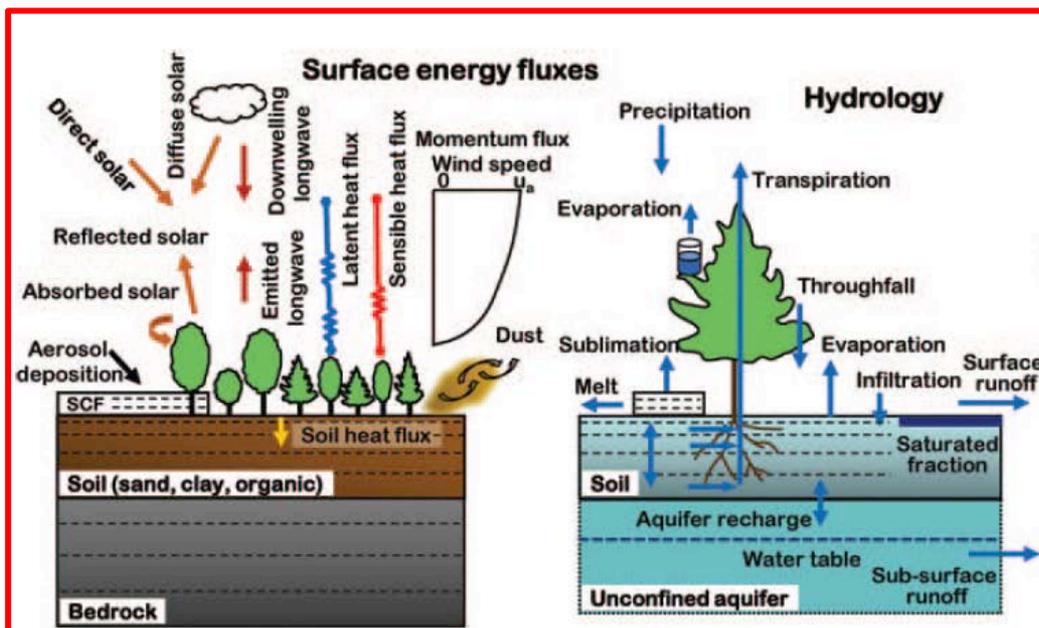
Lawrence et al. (2011)

Two inversion systems

Goal:

- Inverse estimation of CO_2 and CH_4 fluxes from observations
- Optimal integration of measurements, model, and a priori knowledge

Lagrangian

- FLEXPART-COSMO

- 4 day backward simulations

- nested simulations at 2 km and 7 km resolution

- footprints (residence time maps) provide source sensitivies

- Bayesian inversion or Kalman filter *Brunner et al. (2012)*

Eulerian

- COSMO-CLM^2 + tracers

- O(100) ensemble simulations, varying CO_2 fluxes from PFT

- nested simulations

- source sensitivites approx. with Ensemble Kalman Filter

- CarbonTracker inversion *Peters et al. (2007)*

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Collection of high-resolution input data

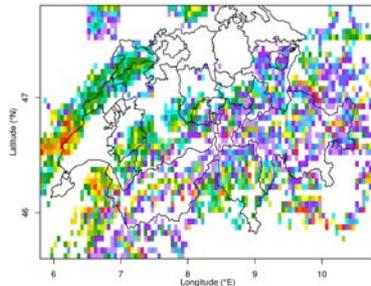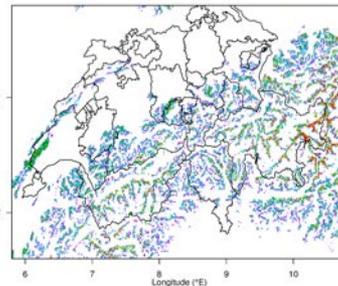## Community Land Model 4.0

- 1 hydrology parameter
- 4 land cover parameters
- 4 soil parameters
- 7 vegetation parameters

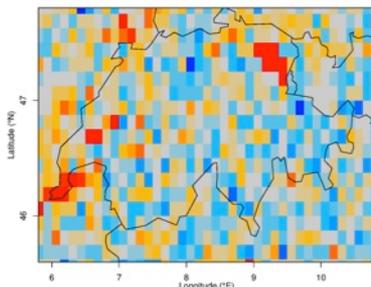### Evergreen Needleleaf Boreal Forest
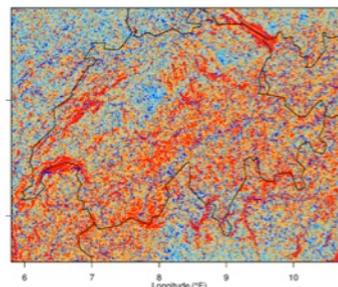
NCAR 0.05°   CarboCount 0.01°

FMAX

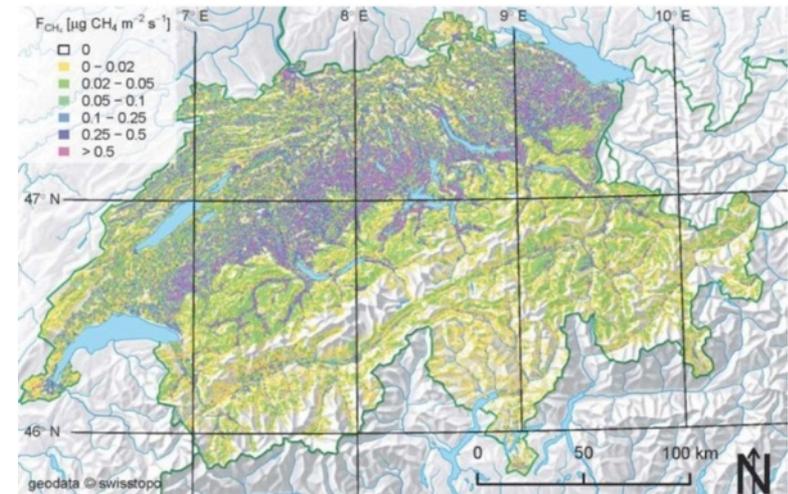NCAR 0.1°   CarboCount 0.01°

Emission Inventories

Switzerland
- CarboCount CO_2, 500 m x 500 m
- MAIOLICA CH_4, 500 m x 500 m

Europe
- EDGAR v4.2: CO_2, CH_4, 0.1°x0.1°

MAIOLICA CH_4 inventory

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First results – Simulations for Beromünster

FLEXPART-COSMO simulations fo CO_2, CO and CH_4

Footprints

X

Emissions
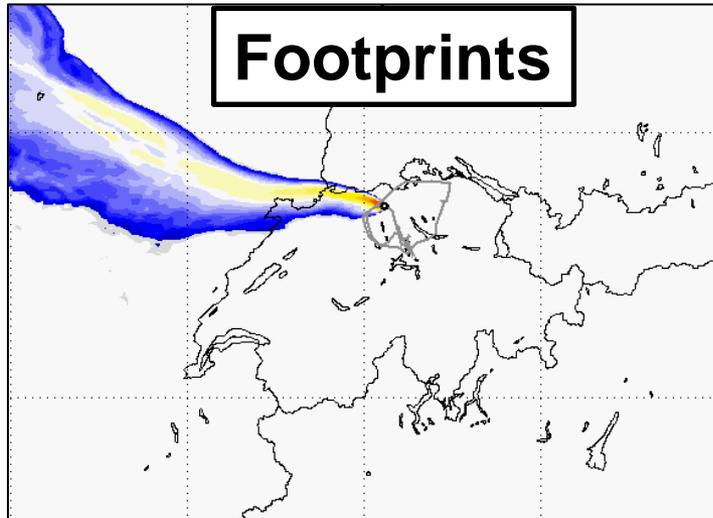
= concentration time series

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First results – Simulations for Beromünster

CarboCount

- Project goals
- Network
- Model system
- input data

First results

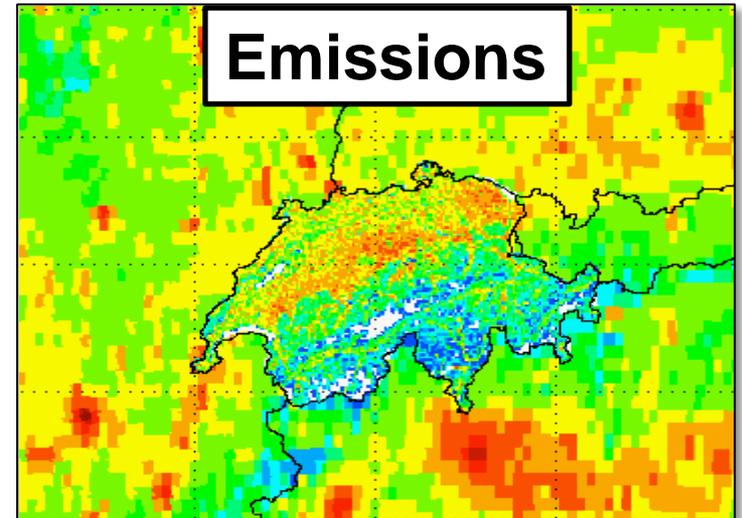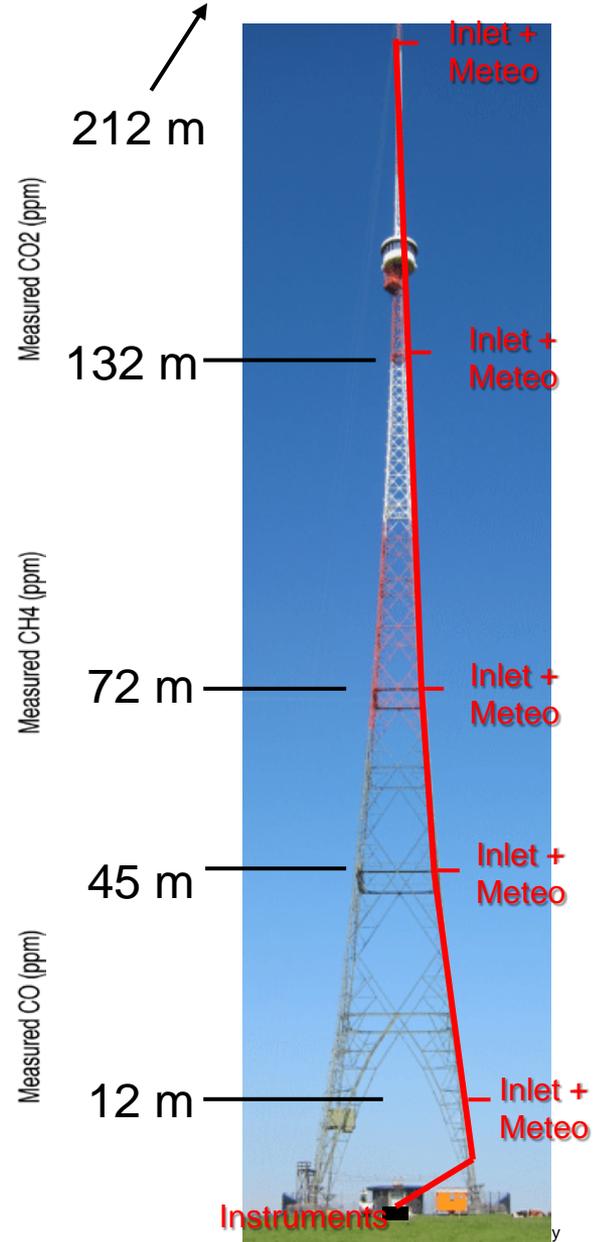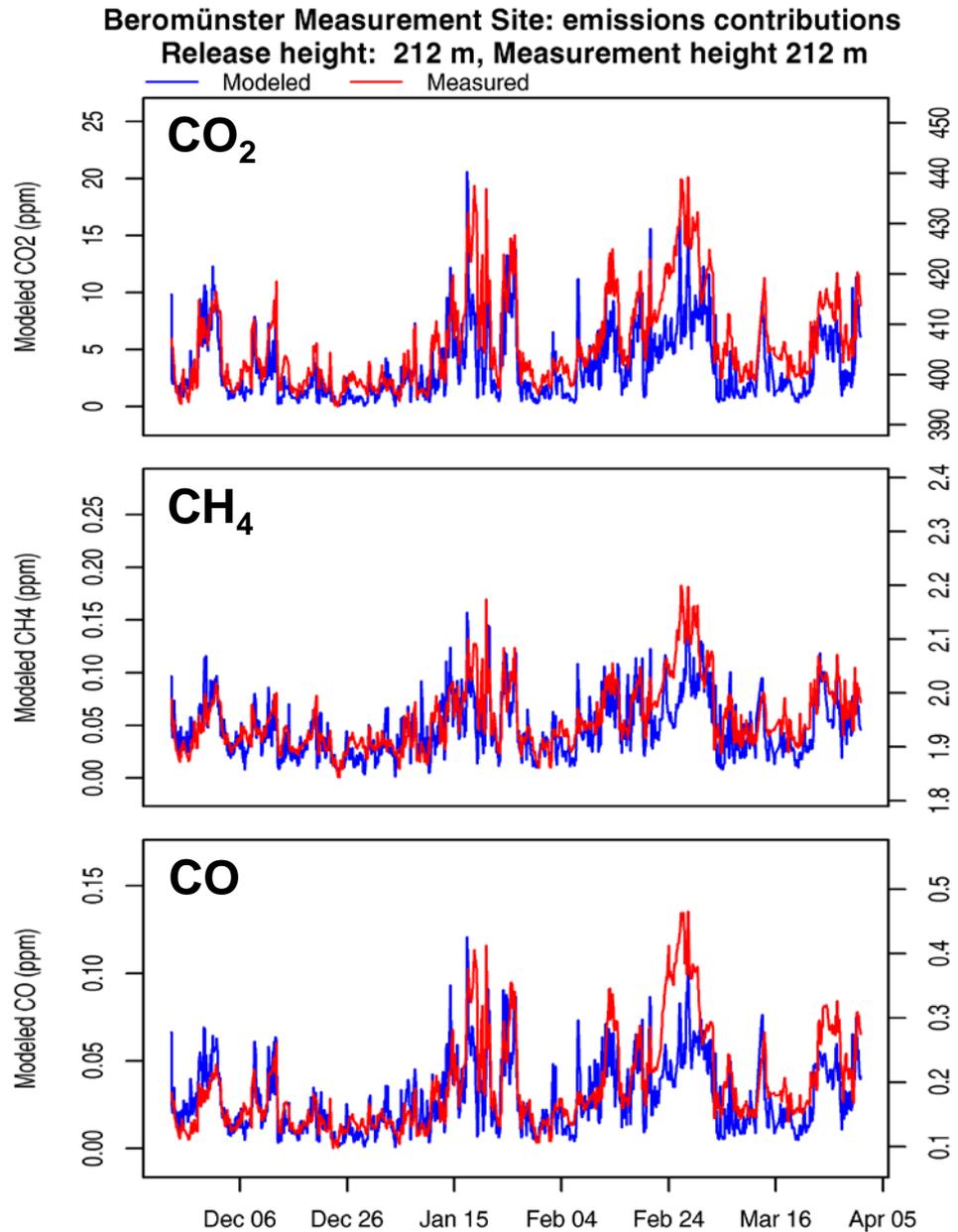- FLEXPART simulations

Conclusions

Beromünster Measurement Site: emissions contributions
Release height: 212 m, Measurement height 212 m
Modeled — Measured

CO_2

CH_4

CO

212 m — Inlet + Meteo

132 m — Inlet + Meteo

72 m — Inlet + Meteo

45 m — Inlet + Meteo

12 m — Inlet + Meteo

Instruments

First results – CO and CO$_2$ at Beromünster

Beromünster Tower: 2012-11-23 to 2013-04-11

CO2 (ppm) — — — CO (ppm)

212 m.a.g.l

132 m.a.g.l

72 m.a.g.l

45 m.a.g.l

12 m.a.g.l

Date

Outlook and conclusions

Next steps:

- further processing of measurement data

- integrate new input data sets into CLM4.0

- complete setup of COSMO-CLM^2 and perform 30-yr simulations of CO_2 fluxes over Europe

- Setup CarbonTracker inversion system and test with idealized tracers

- Setup and test FLEXPART-based inversion system

Conclusions:

- Goal of CarboCount CH is to quantify CO_2 and CH_4 fluxes at regional scale and to understand feedbacks with climate

- Measurement network complete

- Model system still under construction

- First results for Beromünster (and Lägern) demonstrate high quality of transport simulations based on COSMO meteorology

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