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DKRZ Computing Resources Proposal – Part 1: Abstract

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Abstract

Anthropogenic activities are changing the atmospheric composition to an extent that the stability of our climate system is at high risk. However, in order to reduce human impacts on the climate system, one has to determine the origins of involved atmospheric species. These species must be monitored continuously to ensure an actual reduction in greenhouse gases (GHGs).

Our group has built up various automated sensor networks in the city of Munich to measure GHGs and air pollutants: **MUCCnet** (5 high-precision EM27/SUN spectrometers), **Air Quality Network** (50 street-level in-situ air quality sensors), **Low-Cost Network** (100 street-level in-situ CO2 sensors), and **Mid-Cost Network** (20 roof-level in-situ CO2 sensors).

We focus our efforts on urban GHG emissions, as human activities are increasingly concentrated around cities and because urban areas have many overlapping emission sources. Since we cannot directly measure surface fluxes but only concentrations, most of our work is dedicated to atmospheric transport and inverse modeling:

1. Transport Modeling: We use coarse models on a large boundary region and high-resolution models in the inner modeling domain. Models we use are WRF, GRAMM/GRAL, PALM-4U, OpenFOAM, WRF-CHEM, ICON-ART, HYSPLIT, and STILT.

2. Inverse Modeling: To cope with the countless number of time-variable emitters, we use novel inverse modeling methods to reconstruct high-dimension emission fields from sparse measurements.

3. Observing System Simulation Experiments: Using synthetic measurements, we can test the robustness and accuracy of our inverse modeling approaches and measurement networks.

4. Upscaling: To scale up our approaches, we are considering existing proxies in combination with satellite data to model GHG fluxes in areas with little or no measurement infrastructure.

The described modeling approaches can be applied to any GHG species or air pollutants subject to atmospheric transport. Even if we can reduce anthropogenic carbon emissions significantly within the next 50 years, we will always have to monitor anthropogenic GHG fluxes. Air pollutants or GHGs overlooked by previous policies (F-Gases) can be modeled using the same methodology.

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