Modelling the variability of atmospheric CH4 and δ13C-CH4 over Europe

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Within InGOS our task is to assess the potential benefits of an extension of the European measurement network with high frequency measurements of δ13C-CH4. Now that analytical techniques approach a stage at which such an extension is becoming feasible from a measurement point of view, the question arises what it would bring us.

In theory, observations of atmospheric δ13C-CH4 provide insights in the source mixture of atmospheric CH4, which is crucial to answer questions such as, for example, the contribution of natural variability of wetland sources or of changing agricultural practices, to the recent trends in the CH4 growth-rate.
In practice, uncertainties in the source signatures of CH4 emissions, on atmospheric transport, the CH4 oxidation rate and on the δ13C-CH4 observation themselves, limit the amount of useful information that can be obtained from observations of atmospheric δ13C-CH4. In this study we investigate the balance between the information that is gained and the additional uncertainty that is introduced when using high frequency isotope measurements.

We first make an attempt to determine the conditions required for δ13C-CH4 observations to provide exploitable constraints on European CH4 sources, in a hypothetical inverse modelling framework. We use the TM5 transport model to propagate uncertainties in CH4 emissions and source signatures to the δ13C ratio of methane in the surface layer of the atmosphere. At locations where uncertainties in CH4 emissions lead to the largest perturbations of the surface δ13C-CH4, observations of the δ13C of atmospheric methane should provide exploitable insights in CH4 emissions.
We then estimate, for existing CH4 observation sites, the scientific potential of deploying δ13C-CH4 measurement instruments.

At a few sites, selected for their potential interest, we perform more detailed analysis of the modelled CH4 and δ13C-CH4. We look in particular at the interest of high-frequency versus daily observations, and at the impact of local CH4 emissions on the observations.