

## Abstract

We present here a dynamical method for modelling temporal and geographical variations in ammonia emissions in regional scale Chemistry Transport Models (CTMs) and Chemistry Climate Models (CCMs) is presented. The method is based on the meteorology in

the models and gridded inventories. We use the dynamical method to investigate the spatio-temporal variability of the ammonia emissions across part of Europe and study how these emissions are related to geographical and year-to-year variations in atmospheric temperature alone. For simplicity we focus on the emission from a storage related to a Danish standard pig stable with 1000 animals and display how the emission from this source category would vary geographically throughout central and northern Europe and from year to year. In view of future climate changes we also evaluate the potential future changes in the emission by including temperature projections from an ensemble of climate models. The results points towards four overall issues: (1) Emissions can easily vary with 20% by changing geographical location within a country due to overall variations in climate. Largest uncertainties are seen for large countries like UK, Germany and France. (2) Annual variations in overall climate can at specific locations cause uncertainties in the range of 20 %. (3) Climate change will in general may increase the emissions with 0–40 %, in central to northern Europe. (4) Gradients in existing emission inventories that are seen along country borders (e.g. between UK and France) don't share a border!, can be reduced by using a dynamical methodology for calculating emissions.

Acting together these four issues can cause substantial uncertainties in emission. Emissions are generally considered among the largest uncertainties in the model calculations

with CTM and CCM models. Efforts to reduce uncertainties are therefore highly relevant. It is therefore recommended that both CCMs and CTMs implement a dynamical methodology for simulating ammonia emissions in a similar way as for biogenic volatile organic compound (BVOCs) a method that has been used for more than a decade in CTMs.

- add one line on possible impact of such methodologies for European policies like NEC and IPPC directives

- check if after discussion concerning ranges in table 1 the numbers in the abstract are still correct

Formatted: Highlight

Formatted: Space After: 0 pt, Line spacing: single, Don't adjust space between Latin and Asian text, Don't adjust space between Asian text and numbers