Answers to the anonymous reviewer #2

The reviewer's comments are shaded in grey. Text passages that will be transferred to our revised manuscript are written in italic.

My largest scientific questions arise from potential scale-dependencies of the results. A recent manuscript by Zhao and Liu (http://onlinelibrary.wiley.com/doi/10.1111/gcb.12496/abstract), admittedly from a slightly different topic although likewise related to carbon dynamics, highlights some important scaling issues. Is 500 x 500 m enough to capture methane emissions? I'm working with colleagues on an interesting permafrost collapse system where anything coarser than 20 x 20 m simply will not do for understanding methane flux. There are surface features with 2 orders of magnitude more methane emissions than anything else on the landscape, and the characteristic dimensions of these things is on the order of tens of meters, not hundreds. That being said, it is exceedingly difficult to upscale methane dynamics of natural ecosystems using typical remote sensing platforms like Landsat. A critical discussion of scale dependencies, potentially as a subsection under section 3.3, would emphasize important avenues of future research without distracting from the rigor of the analysis as presented. Figure 4 does present some important insights into scaling issues, as do the maps with the EDGAR comparisons, although embedded within the scaling uncertainties are multiple important differences in accounting methodology.

We will add the following paragraph as a new subsection to section 3.3 to address the scale dependency:

3.3.3 Scale dependency

When processing a spatially explicit inventory, a spatial resolution needs to be defined. For practical reasons it was decided to use a resolution of 500 m x 500 m, which is considerably better than the resolutions of a few kilometers typically used in regional-scale inverse modeling. Note that the input data were usually available at a higher resolution of 100 m x 100 m, and estimates were first obtained for this higher resolution and then averaged to the 500 m x 500 m grid.

In many cases, the specific choice of spatial scale does not affect the total emissions estimated for a country. This is true for example for ruminant emissions where the total only depends on the number of ruminants but not on the granularity of their distribution within the country. Emissions from ecosystems such as wetlands, however, may critically depend on the chosen scale, in particular if they are estimated with an ecosystem model where the fluxes depend non-linearly on the spatial resolution of the input data. This was shown for example by Zhu et al. (2013) who found 42% higher wetland CH_4 emissions when running their biogeochemistry model at 5 km x 5 km resolution as compared to a simulation at 100 km x 100 km resolution. They explained the difference by subgrid-scale variations of the water table which are smoothed out at lower spatial resolution. In our case, we do not rely on a biogeochemistry model but on estimates of emission fluxes determined for specific wetland ecosystems, multiplied by the areas covered by these ecosystems in each grid cell. Nevertheless, these estimates may be biased if they are based on non-representative emission fluxes. Determining representative fluxes is particularly difficult for ecosystems, where the fluxes may vary on very small spatial scales.

For example, DelSontro (2011) observed CH_4 flux variations across Lake Wohlen covering more than two orders of magnitude in CH_4 flux within a few tens of meters. It is therefore of great importance to combine individual flux measurements into values that are representative for the whole ecosystem (in this case a lake) before using them in an inventory.

When finally building a gridded inventory, methods should be avoided that introduce artificial scale dependencies. Such problems are generated for instance when grid cells are assigned to a single land-use type, as shown e.g. by Zhao and Liu (2013), but can be avoided using for example a mosaic approach which divides each cell into fractional contributions of all land-use classes (Mahrt and Sun (1995), Avissar and Pielke, 1989). We largely avoided such scale dependencies by first determining land-use coverage of individual ecosystems based on high resolution (100 m x 100 m or better) data sets before distributing the corresponding fluxes over the grid cells of the inventory.

The information in the top of 15187, that about 90% of methane fluxes are being investigated here, should be highlighted elsewhere like the abstract to make the reader aware of potential biases in the product.

We will change the first sentence of the abstract (p. 15183 l. 2ff) to:

We present the first high-resolution (500 m × 500 m) gridded methane (CH_4) emission inventory for Switzerland, which integrates 90% of the national emission totals reported to the United Nations Framework Convention on Climate Change (UNFCCC) and recent CH_4 flux studies conducted by research groups across Switzerland.

The introduction is two pages long, the methods about 14 pages, and the combined results and discussion section is about 6 pages. This doesn't leave much room for discussion, in a relative sense. But the measurement, modeling and inventory communities want to know something more about how they can improve understanding of methane flux at the national scale. What sorts of recommendations will be the most fruitful for building realistic national inventories, and what information did you wish that you had when creating this product?

The new paragraph on scale issues now extends our Results and Discussion section, and we will add the following additional Section 3.3.4 “Needs for building more realistic regional and national inventories” in our revised manuscript:

3.3.4 Needs for building more realistic regional and national inventories

Regional and national inventories rely on spatial and temporal integration of local fluxes. Many studies are performed at a local scale to investigate the driving processes and often only cover short time periods of a few weeks or are only made in specific seasons. To obtain more representative results, we strongly recommend to extend such measurements to complete years or even multiple years to include intra and inter annual variations. Even though fluxes deviating from the mean are more interesting to understand the underlying processes, information on representative fluxes for given ecosystems is more valuable to build realistic inventories. The development of process based models that result in spatially resolved flux estimates may also contribute to better inventories At the same time, measurements integrating CH_4 fluxes over larger areas approximating the spatial resolution *of the inventory are preferred to derive emission factors. These recommendations are not limited to natural fluxes. Emission factors to estimate anthropogenic methane fluxes rely in the majority of cases on laboratory measurements. The total methane emissions of e.g. a plant are rarely measured directly. Such direct measurements are especially desirable to reveal the true emission of sectors where different emission estimates result in large differences. Knowing the true total emissions would also help to investigate the efficiency of mitigation measures as certain pathways might be missed when only investigating the known individual methane producing processes.*

(please note minor usage issues like page 15204 ’cattle is moved’)

We will check minor language usage issues (cattle are plural as this reviewer correctly notes) and rely on the copyediting of Biogeosciences which according to our experience does a good job in sorting out such minor language issues in the production process.

Additional references:

Avissar, R., and Pielke R. A.: A Parameterization of Heterogeneous Land Surfaces for Atmospheric Numerical Models and Its Impact on Regional Meteorology. Mon. Wea. Rev., 117, 2113–2136, 1989.

Mahrt, L., and Sun, J.: Dependence of exchange coefficients on averaging scale or grid size. Quart. J. Roy. Met. Soc., 121 (528), 1835-1852, 1995.

Zhao S., and Liu S.: Scale criticality in estimating ecosystem carbon dynamics, Glob. Change Biol., doi:10.1111/gcb.12496, 2013.

Zhu X. Zhuang Y., Lu X., and Song L.: Spatial scale-dependent land-atmospheric methane exchange in the northern high latitudes from 1993 to 2004, Biogeosciences Discuss., 10, 18455-18478, doi:10.5194/bgd-10-18455-2013, 2013.