EGU26-16089, updated on 08 Jun 2026
https://doi.org/10.5194/egusphere-egu26-16089
EGU General Assembly 2026

National-scale methane emissions in South Korea (2010–2021): insights from multiple inversion systems

Samuel Takele Kenea[1], Daegeun Shin[1], Wonick Seo[1], Sunran Lee[1], Fenjuan Wang[2], Shamil Maksyutov[2], Rajesh Janardanan[2], Soojeong Lee[1], Dmitry A. Belikov[3], Prabir K. Patra[4], Nicole Montenegro[5], Antoine Berchet[5], Marielle Saunois[5], Adrien Martinez[5], Ruosi Liang[6], Yuzhong Zhang[6], Ge Ren[7], Hong Lin[7], Sara Hyvärinen[8], Aki Tsuruta[8], and the Sangwon Joo, Sumin Kim[*]
[1]National Institute of Meteorological Sciences (NIMS), Jeju-do, Korea
[2]National Institute for Environmental Studies (NIES), Tsukuba, Japan
[3]Chiba University, Japan
[4]Japan Agency for Marine-Earth Science and Technology, Japan
[5]Laboratory for Climate and Environmental Sciences, France
[6]Westlake University, China
[7]National institute of metrology of China, China
[8]Finnish Meteorological Institute, Finland
[*]A full list of authors appears at the end of the abstract

Accurate estimation of methane (CH_4) emissions is essential for assessing mitigation progress, yet substantial uncertainties persist at the national scale. In South Korea, CH_4 emissions are predominantly anthropogenic, with the waste and agricultural sectors contributing approximately 82% of total national emissions. This study analyzes national-scale CH_4 emission estimates for South Korea during 2010–2021 using multiple atmospheric inversion systems participating in the Methane Inversion Inter-Comparison for Asia (MICA) project. Results from inversions using only in situ observations indicate that prior emissions over South Korea were likely overestimated. Prior estimates range from 1.5 to 1.7 Tg yr^{-1} for most years, whereas posterior emissions are, on average, about 15% lower than the prior estimates. A notable exception is the LMDZ inversion model, which yields posterior estimates that are 40 67% lower than prior values. This substantial reduction is primarily associated with the waste sector. Sectoral attribution reveals substantial inter-model differences. LMDZ shows a decreasing waste-sector emission trend in Exp. 1 but an increasing trend when only satellite observations are assimilated (Exp. 2), whereas the STILT-based inversion consistently indicates increasing waste-sector emissions. Given that the waste sector dominates national CH_4 emissions, these discrepancies strongly influence total emission estimates. The prior waste-sector emissions, derived from EDGAR v7, exceed those reported in South Korea's national greenhouse gas inventory (GIR), contributing to the observed overestimation. Additionally, the inversion-derived posterior estimates consistently indicate an overestimation of prior agricultural emissions during the summer months. Model performance evaluation over the region of interest indicates varying levels of agreement between simulated and observed

CH_4 mole fractions, with correlation coefficients ranging from 0.24 to 0.85 and posterior biases ranging from −65.6 to 0.34 ppb, highlighting the choice of transport model is important. Overall, this study highlights the value of multi-model inversion inter-comparisons for constraining national-scale CH_4 emissions, diagnosing sector-specific uncertainties, and identifying structural differences among inversion frameworks that can guide future improvements.

Sangwon Joo, Sumin Kim: National Institute of Meteorological Sciences (NIMS), Jeju-do, Korea