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Estimation of Regional-Global Methane Emissions and Refinement of Its Estimate by GOSAT-2 and Surface Observations

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Methane (CH_4) is the second major anthropogenically produced greenhouse gas, after carbon dioxide. The objective of this study is to improve the accuracy of regional-global CH_4 emissions estimation through "top-down approach" using a chemical transport model, MIROC4-ACTM, and atmospheric observations. We retrieved CH_4 profiles from GOSAT, and estimated retrieval accuracy of 1% throughout the troposphere through comparisons with aircraft measurements and South Asian ground-based observations from our study. After validating the vertical and horizontal transport processes of MIROC4-ACTM through comparisons with aircraft and GOSAT measurements, we performed inversion analysis to estimate total CH_4 and nitrous oxide emissions. The inversion results are used in the IPCC 6th assessment report and could support the first global stocktake (GST). We also developed a LETKF data assimilation system for CH_4 flux estimation on model grid scale, and demonstrated that it was capable of reproducing known CH_4 flux patterns by assimilating pseudo-observations. We applied a two-box model simulation of carbon isotope of CH_4, $\delta^{13}C$-CH_4, for both hemispheres, and evaluated the consistency of global emission trends based on *a priori* and simulated *a posteriori* emissions with observed $\delta^{13}C$-CH_4 timeseries; the results suggested overestimation of CH_4 fugitive emissions in the EDGAR v4.3.2 inventory.

To better understand various types of regional CH_4 sources, particularly in South Asia, we have conducted long-term surface observations of CH_4, carbon monoxide (CO), and $\delta^{13}C$-CH_4 at Nainital, India and Comilla, Bangladesh. Simultaneous measurements of CH_4 atmospheric concentrations and fluxes from rice paddies in Tamil Nadu, India were also conducted. We evaluated the relationship between soil microbiology and greenhouse gases emissions quantitatively, and proposed a methodology for estimating global CH_4 emissions from rice paddies using information on soil microbial properties. The simultaneous measurements of concentrations and fluxes suggested that fluctuations in CH_4 emissions from rice paddies were an important factor in the seasonal variation of atmospheric CH_4 concentrations at the rice cultivation area. Diurnal variations in atmospheric CH_4 concentrations were less affected by CH_4 emissions from rice paddies than atmospheric transport in a one-dimensional advection model. Our trajectory analysis showed that most air masses with high CH_4 concentrations in northern India (Karnal and Sonepat) originated from the northwest, suggesting CH_4 sources in northwestern India. Analysis of the observed CH_4, CO, and $\delta^{13}C$-CH_4 timeseries at Comilla showed that 73% of CH_4 sources were of microbial origin and approximately 15% originated from biomass burning in autumn. The proportion of biomass burning sources increased to 32% in winter.

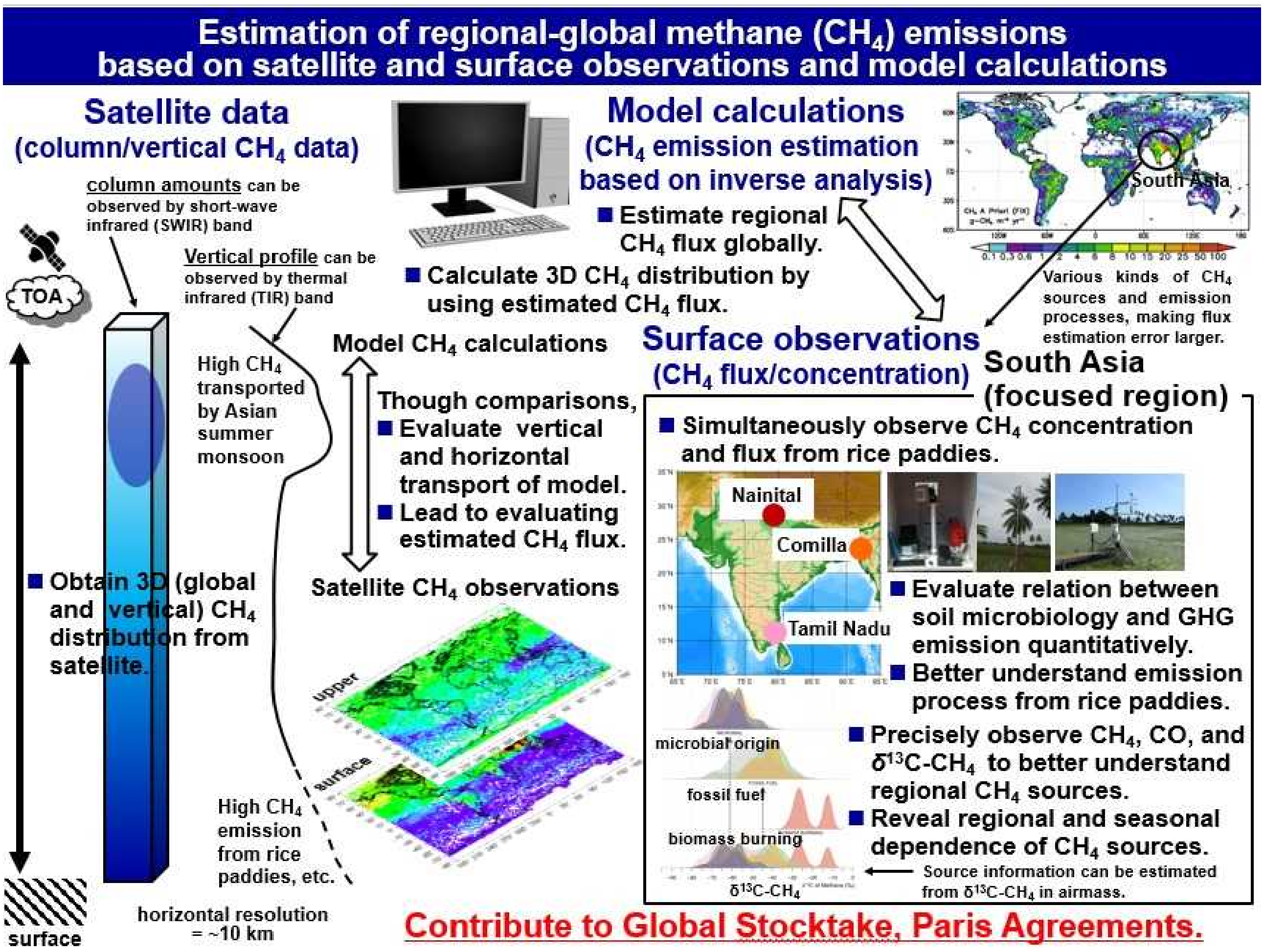

Fig. 1 Research goals and objectives of this study.

<Journal articles>

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