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PATTERNS AND TRENDS IN ATMOSPHERIC METHANE OVER THE ARCTIC OCEAN: THERMAL IR SATELLITE OBSERVATIONS

Abstract

According to surface and satellite data, global atmospheric methane concentrations are increasing. Supposedly this growth is driven in part by warming Arctic sources, including methane release from under permafrost due to integrity loss, from hydrates due to destabilization, and from microbial reduction of organic material in shallow sediments. Satellites provide critical coverage to track changes on basin-scale, but Short Wave IR (SWIR) observations are problematic, requiring surface-reflected solar radiation, absent through the long polar nights. Long atmospheric path length and low reflectivity of snow, ice, and water surfaces further constrain SWIR passive spectrometers (SCIAMACHY, TANSO/SWIR, etc.) Arctic observations. Thermal IR (TIR) nadir-viewing spectrometers (AIRS, IASI, TANSO/TIR, CrIS, etc.) measure the Earth's surface and atmospheric radiance day and night (for cloud free skies). Optimal conditions for TIR CH4 retrievals are when the surface is warmer than the atmosphere and low atmospheric humidity. Thus, TIR sounder-retrieved CH4 can provide important synoptic high latitude data over open water; year-round conditions in the Western Arctic.

Both AIRS and IASI CH4 lower atmospheric data (averaged over 0-4 km altitude) clearly document strongly enhanced CH4 concentrations over the Barents and Norwegian Seas with a maximum in January-March, as well as over the Kara, Laptev, and Chukchi Seas for September-November, i.e. the period of minimum Arctic ice cover. To validate these retrievals, surface greenhouse gas data were collected on the Russian Research Vessel Akademik Fedorov from Norway to the Laptev Sea and back. Numerous small spatial scale CH4 anomalies of 30 to 100 ppb were observed above the Barents and Laptev Seas, particularly for waters depths at the edge of the hydrate stability field. Preliminary comparison of surface and sounder-retrieved CH4 showed very good agreement, generally within 20 ppb or better. Good long-term agreement in amplitude and seasonal phase also was found between TIR satellite data and in situ CH4 at the Zeppelin observatory (Svalbard). Preliminary long-term analysis of the TIR data (available since 2002) confirms the global trend of increasing CH4 since 2007. To date, indications of overall accelerated growth in Arctic CH4 emissions in the satellite data remains unclear. Our findings highlight the potential and value of Arctic satellite CH4 data and the importance of validation.