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Wintertime Methane Emission From the Barents and Kara Seas and Sea of Okhotsk: Satellite Evidence.

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Existence of strong seabed sources of methane, including gas hydrates, in the Arctic and sub-Arctic seas with proven oil/gas deposits is well documented. Enhanced concentrations of dissolved methane in deep layers are widely observed. Many of marine sources are highly sensitive to climate change; however, the Arctic methane sea-to-air flux remains poorly understood: harsh natural conditions prevent in-situ measurements during winter. Satellite remote sensing, based on terrestrial outgoing Thermal IR radiation measurements, provides a novel alternative to those efforts. We present year-round methane data from 3 orbital sounders since 2002. Those data confirm that negligible amounts of methane are fluxed from the seabed to the atmosphere during summer. In summer, the water column is strongly stratified from sea-ice melt and solar warming. As a result, ~90% of dissolved methane is oxidized by bacteria. Conversely, some marine areas are characterized by positive atmospheric methane anomalies that begin in November. During winter, ocean stratification weakens, convection and winter storms mix the water column efficiently. We also find that the amplitudes of the seasonal cycles over Kara and Okhotsk Seas have increased during last 18 years due to winter concentration growth. There may be several factors responsible for sea-air flux: growing emission from clathrates due to warming, changes in methane transport from the seabed to the surface, changes in microbial oxidation, ice cover, etc. Finally, methane remote sensing results are compared to available observations of temperature in deep ocean layers, estimates of Mixed Layer Depth, and satellite microwave sea-ice cover measurements.