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Methane emissions from the Baltic Sea nine days after the Nord Stream explosions

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The sabotage of the Nord Stream pipelines on 26 September 2022 led to the largest event of methane venting to the atmosphere on record. The pipelines contained about 300 000 tonnes of methane, and an estimate based on Europe's ICOS network quantified the emissions to the atmosphere at 90 000-300 000 tonnes of methane in the first days of the event (Ramonet et al., 2022). The vast majority of methane that vented from the pipelines into the water likely escaped to the atmosphere near-instantly via bubble transport, which had largely ceased by 1 October 2022. However, a fraction dissolved into the water. To investigate the possibility of a "long tail" of release of this dissolved methane to the atmosphere, we conducted airborne surveys of the leak area on 5 October 2022. Methane data were recorded with a Picarro G2401m onboard the HELiPOD platform, a drag probe attached to a helicopter with a rope, down to 30 m above sea level. We observed methane enhancements of up to 300 ppb above atmospheric background, in an area about 30 km both up- and downwind of the leak locations. Using an inverse model of atmospheric transport, we show that the atmospheric data can be explained by an area source and estimate a source strength on the order of tens of tonnes of methane per hour on the day of observations. To better understand the spatial distribution of the emissions, especially emissions upwind of the leak locations, we further run a model of oceanic transport for tracers released at the leak locations and couple it to a Wanninkhof-model of diffusive emissions. The areal emission distribution we find with this model has some similarities to the emission pattern retrieved using the airborne measurements. We conclude that a significant amount of methane was dissolved in the Baltic Sea during the outgassing event following the Nord Stream explosions. Methane that was initially dissolved in the surface layer still escaped to the atmosphere days after the initial outgassing event.