Dissolved methane distribution in surface seawater and its controlling factors in mid- and high-latitudes in the Southern Ocean

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Methane (CH_4) is a potent greenhouse gas that has contributed approximately 20% to the Earth's warming since pre-industrial times. The world's oceans could be an important source for atmospheric methane, comprising 1-4% of annual global emissions. But despite its global significance, oceanic methane production is still poorly understood [e.g., Karl et al., 2008]. The subsurface layer of the ocean is often supersaturated relative to atmospheric equilibrium [e.g., Sasakawa et al., 2008]. Recently, the scientists have implemented surveys especially in the polar regions where the climate change is believed to be important in the world ocean. We participated in one of the research cruises operated in the Southern Ocean in austral summer time (from late November 2012 to mid-February 2013). We continuously measured CH_4 and carbon dioxide (CO_2) by using a cutting-edge system consisting of a cavity ring-down spectroscopy (CRDS) and an equilibrator to obtain high-resolution distribution of CH_4 and CO_2 in seawater. Aside from figuring out oceanic methane distribution in ocean surface, we have found generally good correlation of dissolved CH_4 concentrations that have been measured using the CRDS and gas chromatography (GC) techniques. A reduced major axis (RMA) technique shows a regression line, and the slope and intercept of the regression line were 1.11±0.03 and 0.24±0.30, respectively. This result obviously indicates that the CRDS-based measurement system allows us to obtain high-resolution CH_4 concentration continuously.

The high-resolution results from the measurements enable us to research deeper characteristics of methane in ocean surface. We collected dataset of mixing ratios/concentrations of CH_4 and CO_2 in the air and the surface ocean. Beside this, physicochemical quantities such as ambient pressure, salinity, temperature were also collected to investigate the controlling factors of the distribution of methane. The dataset from observation showed us a new highly resolved picture about the horizontal oceanic methane distribution in ocean surface in the Southern Ocean (Figure 1).

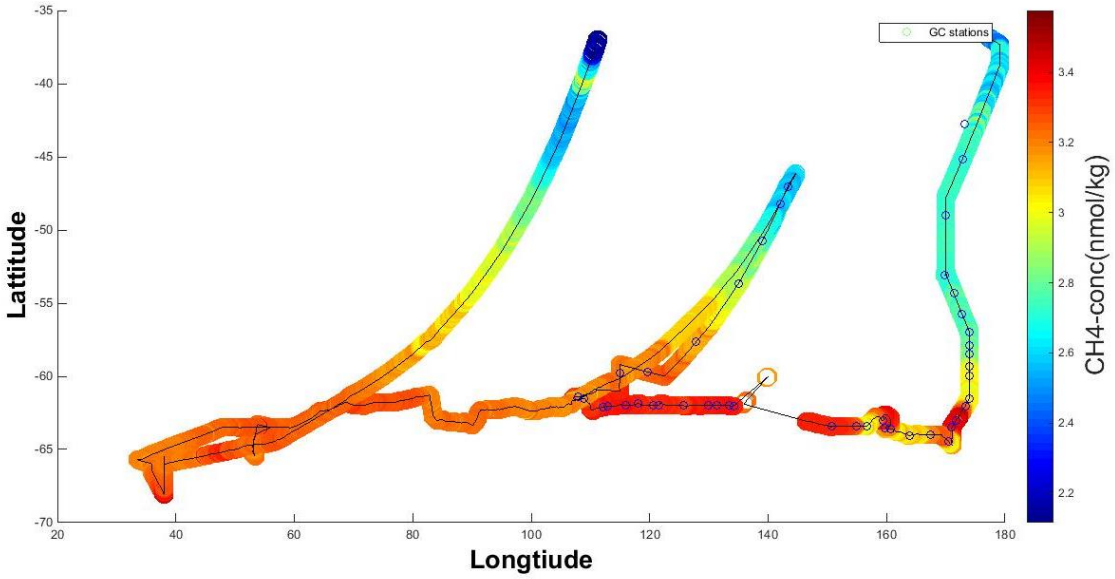

Figure 1. Spatial map of the track cruise and distribution of dissolved methane concentration.
(blue circles on the black line were stations for taking samples for GC measurements)

From Figure 1, we can see that dissolved methane concentration is generally low in mid-latitudes (from about 35°S to 48°S). In contrast, it is higher in high latitudes (from 48°S to 68°S) than that in low latitude. Mean concentration of oceanic methane in overall region is 3.1 nmol/kg.

Moreover, we will present the controlling factors to represent the horizontal distribution of CH_4 in surface water using some biogeochemical parameters such as CH_4 isotopic composition ($\delta^{13}C$) and concentration of nitrous oxide (N_2O) and its isotopic composition ($\delta^{15}N$ and $\delta^{18}O$), because the isotopic composition is known as a tracer for identifying the source of excess CH_4 in subsurface seawater [e.g., Sasakawa et al., 2008].

References

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