# Interannual variability of dissolved organic carbon

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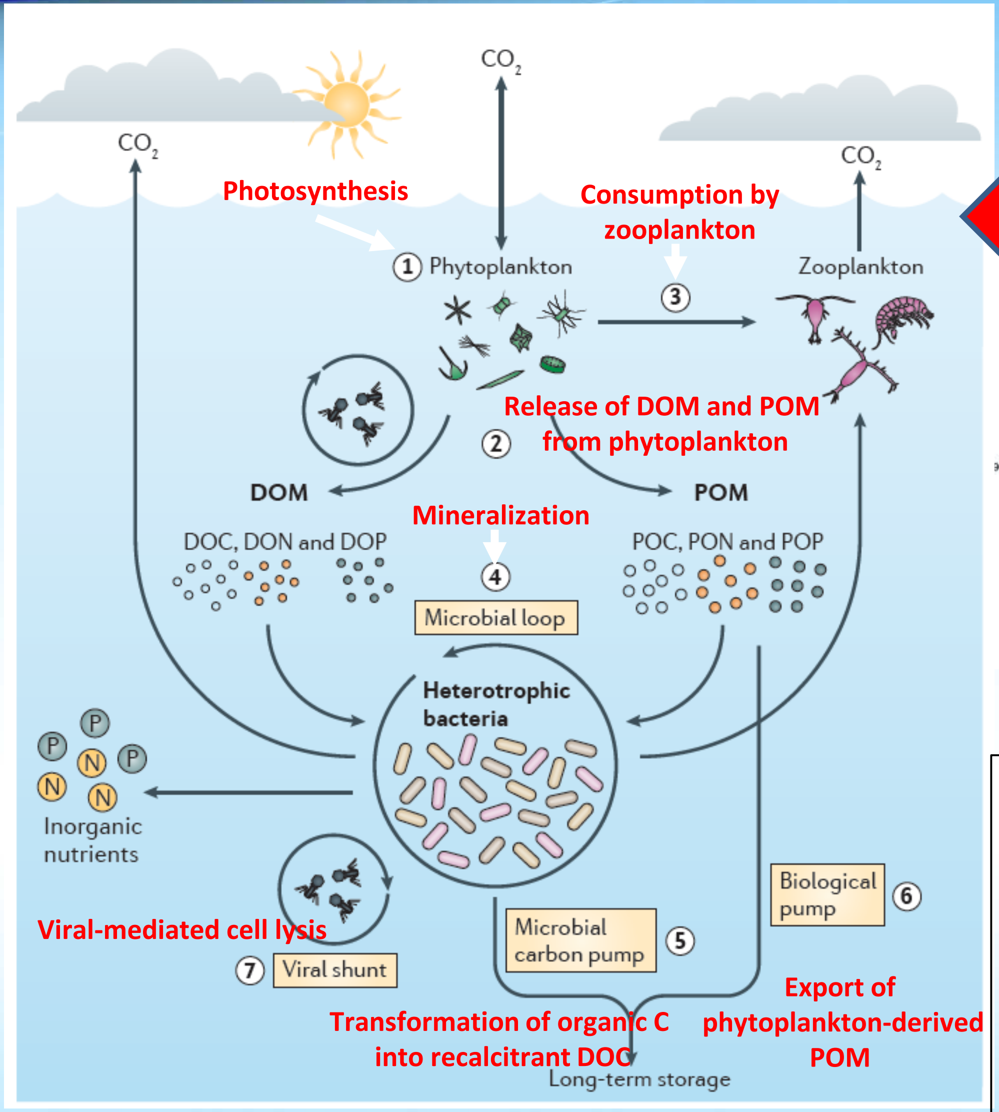
# Why dissolved organic carbon?




(Buchan et al., 2014)

**Terrigenous organic carbon input by discharge of arctic rivers**


(Holmes et al., 2012)

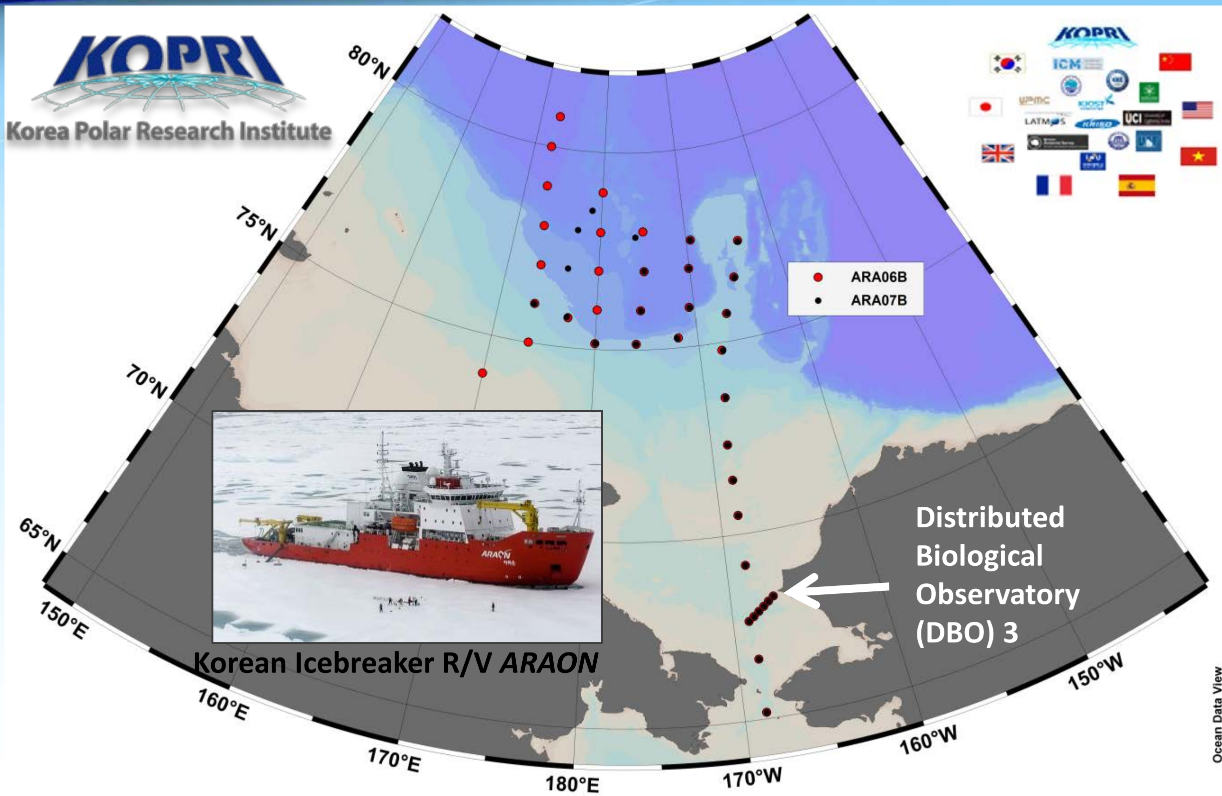
DOC discharge fluxes in arctic rivers

- Mackenzie: 1.4 Tg C $yr^{-1}$
- Yukon: 1.5 Tg C $yr^{-1}$
- Ob: 3.05–4.2 Tg C $yr^{-1}$
- Yenisei: 4.69 Tg C $yr^{-1}$
- Lena: 5.6–5.8 Tg C $yr^{-1}$
- Kolyma: 0.46–0.82 Tg C $yr^{-1}$

- ✓ Early reports suggested that terrigenous DOC from arctic rivers was refractory and that it may not be important for the biogeochemistry of the Arctic Ocean.
- ✓ However, recent studies have shown terrigenous DOC removal to be active but slow process (Hansell et al., 2004; Cooper et al., 2005; Holmes et al., 2008; Letscher et al., 2011).

**If DOC from arctic rivers is indeed more labile than previous thoughts, continuous monitoring of organic carbon in the Arctic Ocean is required.**

# Research stations surveyed in 2015 and 2016





**ARA06B cruise: August 1–21, 2015 (39 stations)**
**ARA07B cruise: August 6–19, 2016 (31 stations)**

CTD rosette system

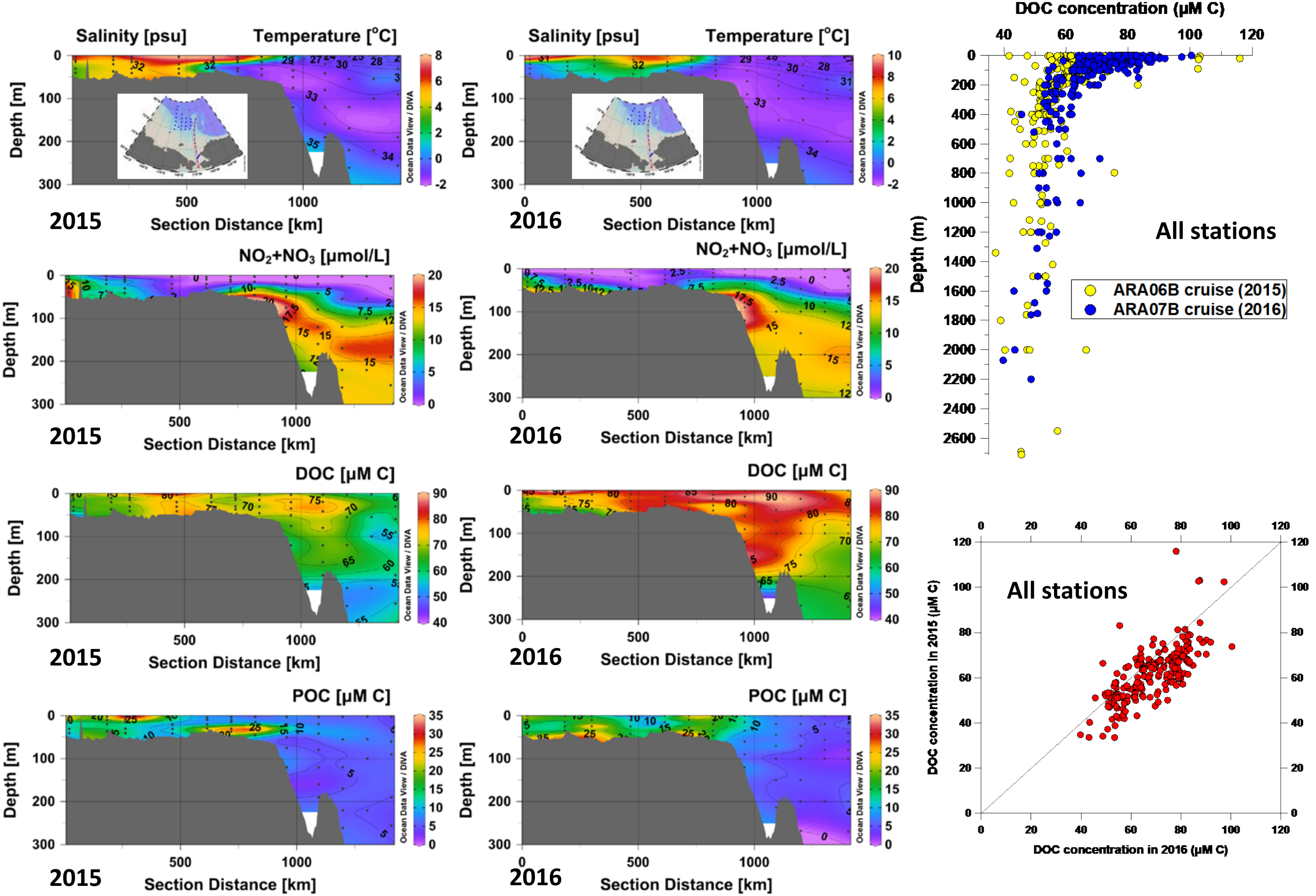
**The objectives of this study**

(1) Investigate the distributions of dissolved organic carbon in the Chukchi Sea

(2) Estimate the contribution of terrigenous dissolved organic carbon to the observed dissolved organic carbon

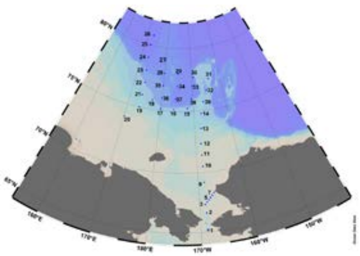
(3) Understand dynamics of dissolved organic carbon in the Chukchi Sea

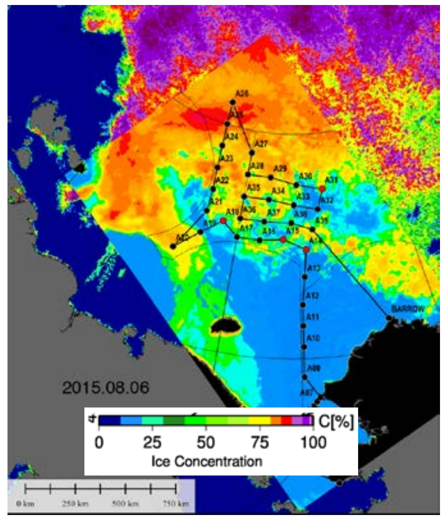
# Distributions of DOC and POC in 2015 and 2016

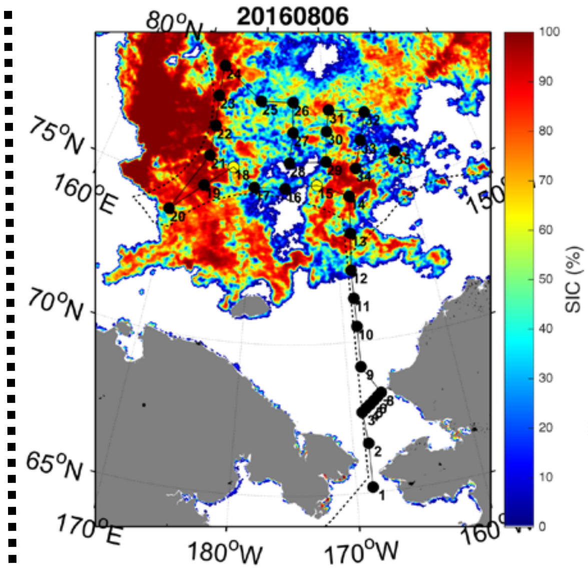


# Comparison of surface water characteristics between 2015 and 2016

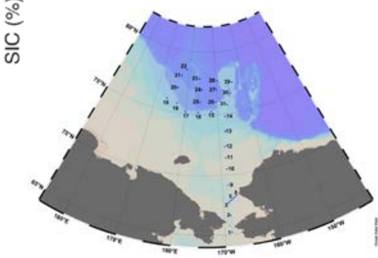
**2015**
**ARA06B**
**(August 1-21, 39 stations)**

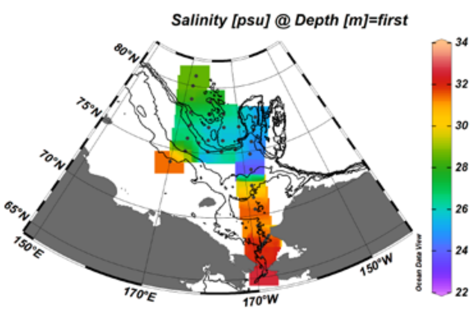


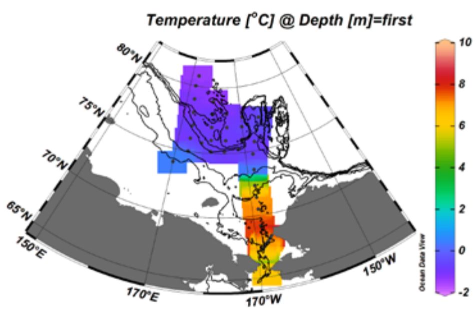


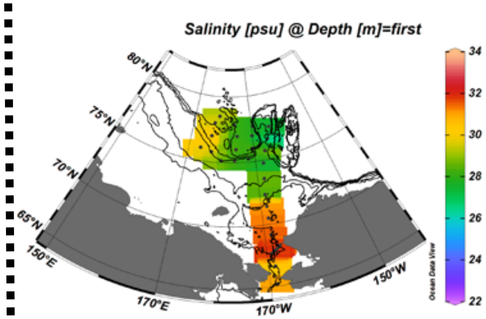

**2016**
**ARA07B**
**(August 6-19, 31 stations)**

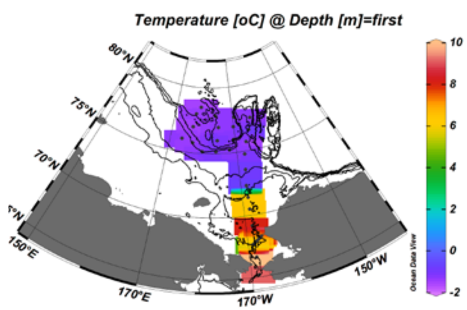




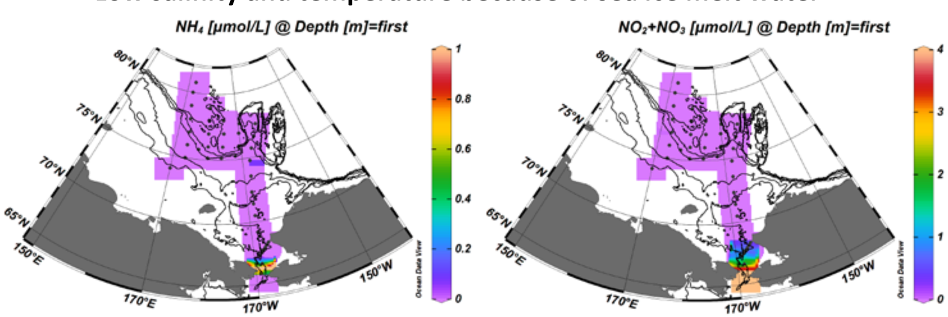




**Low salinity and temperature because of sea ice melt water**

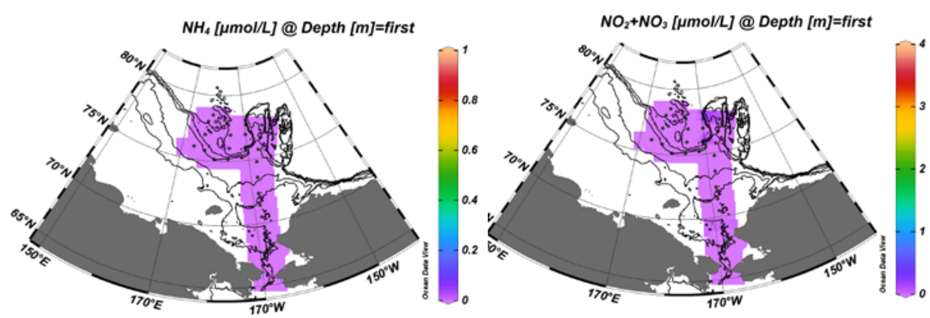



**Relatively high salinity was observed in the western sites**




**Nitrogen species were depleted in surface water**




**Nitrogen species were depleted in surface water**

# Comparison of surface water characteristics between 2015 and 2016

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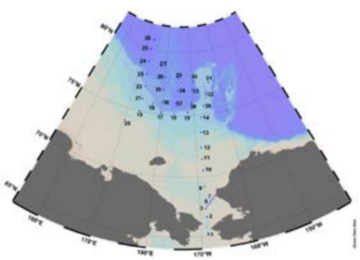
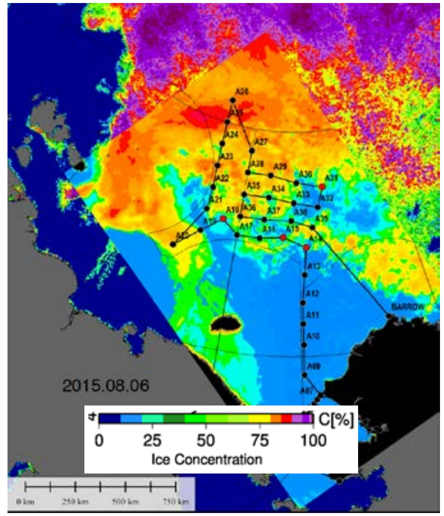
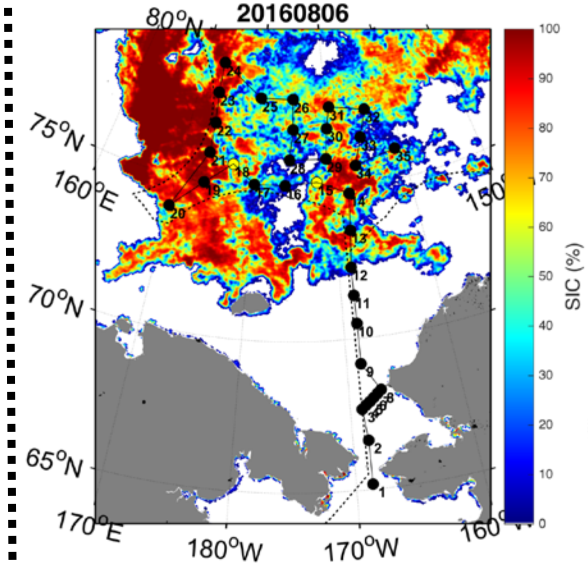
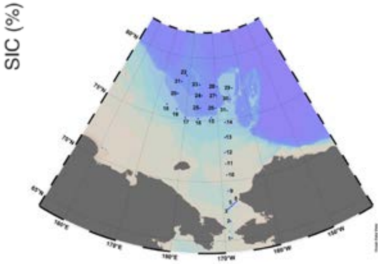
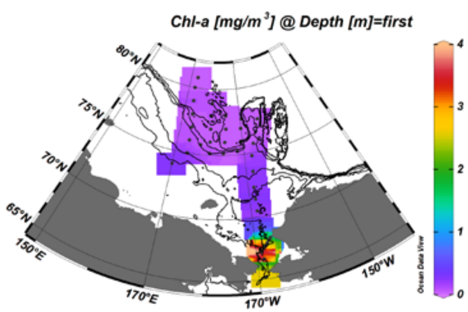


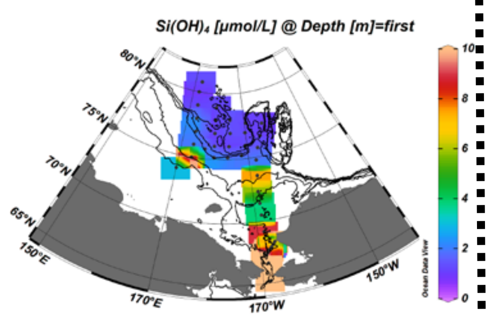


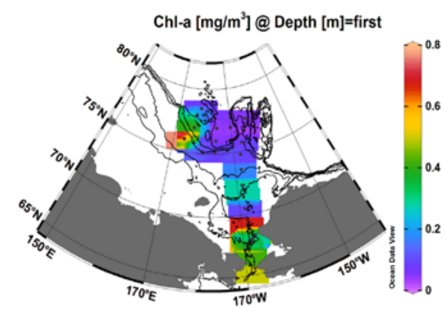

**2016**
**ARA07B**
**(August 6-19, 31 stations)**

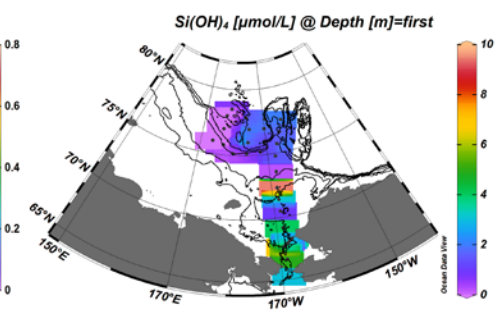




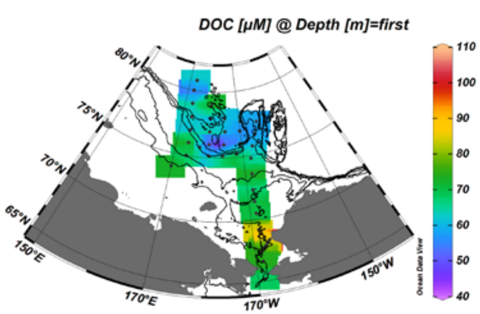



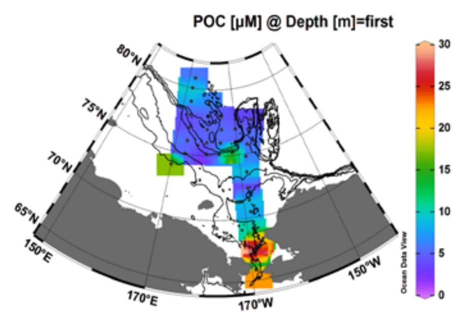

**Chl-a concentrations were extremely low because of stratification**



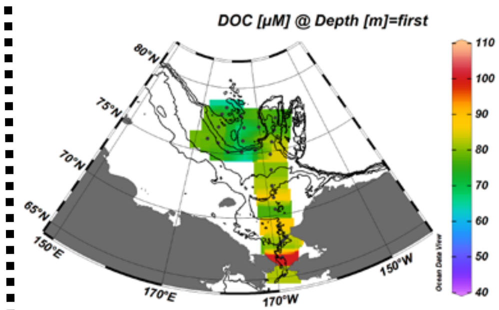



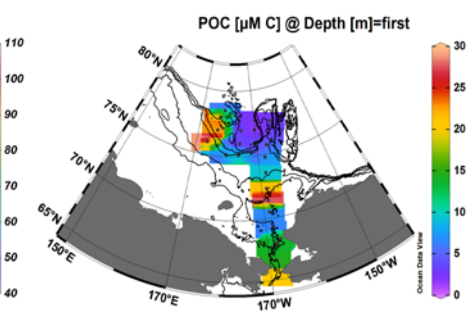

**Silicic acid was depleted in the western stations: diatom bloom**




**DOC concentrations were lower in the low sea ice concentration regions**




**DOC concentrations were lower in the low sea ice concentration regions**

# Freshwater tracer

**To distinguish freshwater sources, $\delta^{18}O$ was used.**

$$1 = f_{river} + f_{sea\ ice\ melt} + f_{seawater}$$

$$\delta^{18}O = f_{river} \times \delta^{18}O_{river} + f_{sea\ ice\ melt} \times \delta^{18}O_{sea\ ice\ melt} + f_{seawater} \times \delta^{18}O_{seawater}$$

$$Salinity = f_{river} \times S_{river} + f_{sea\ ice\ melt} \times S_{sea\ ice\ melt} + f_{seawater} \times S_{seawater}$$

- **End-member: river water (salinity = 0, $\delta^{18}O = -20.3$), sea ice melt (salinity = 4.5, $\delta^{18}O = -1.9$), seawater (salinity = 35, $\delta^{18}O = 0.3$) (Mathis et al., 2007).**

- **Marine DOC = Measured DOC – ($f_{river} \times DOC_{river} + f_{sea\ ice\ melt} \times DOC_{sea\ ice}$)**

- **$DOC_{river}$: 350 μM C and $DOC_{sea\ ice}$: 33.4 μM C**

# Differences of surface water characteristics between 2015 and 2016

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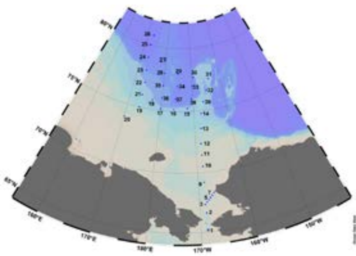

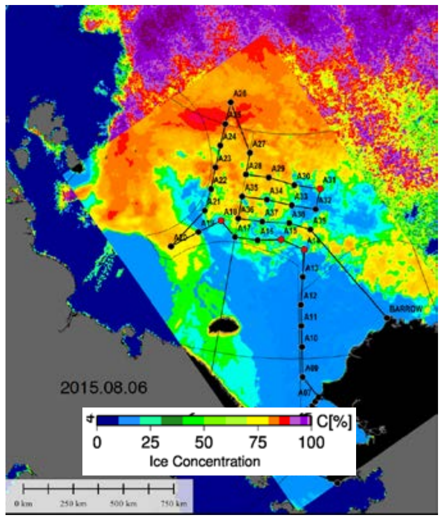


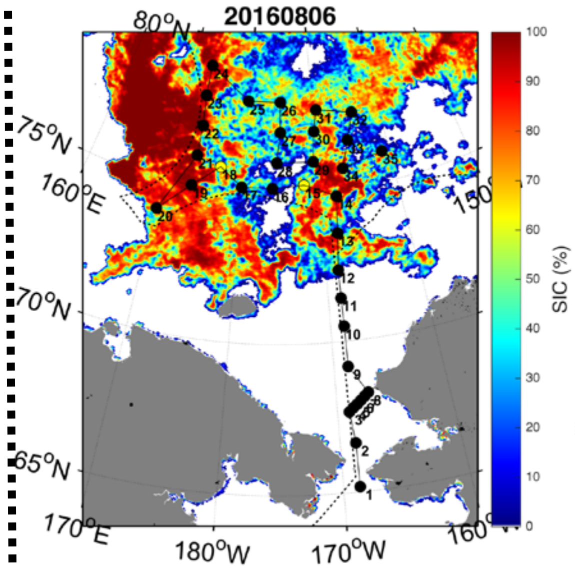


**2016**
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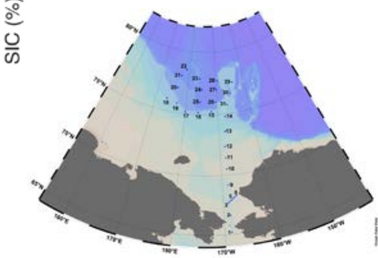
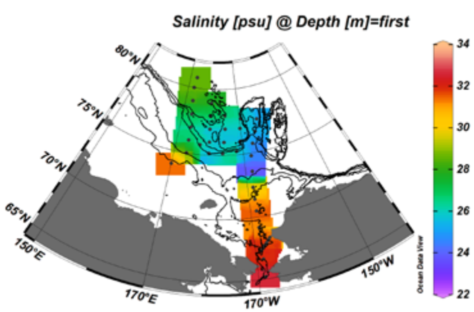
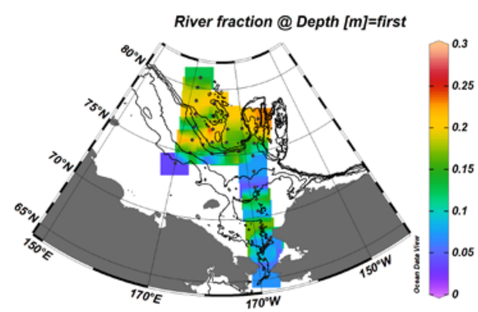
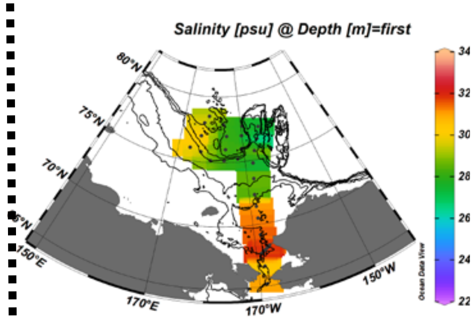
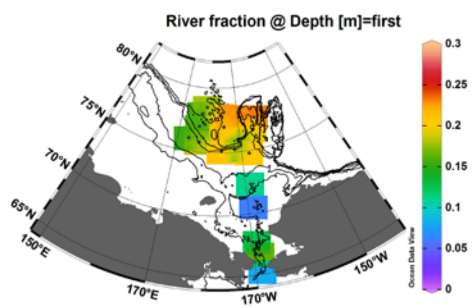
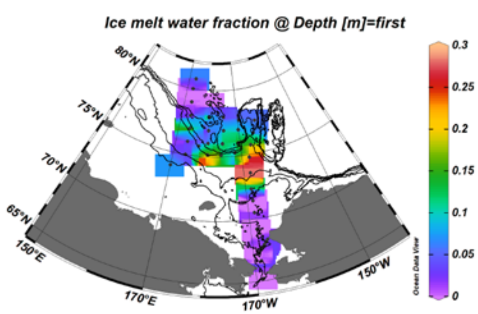


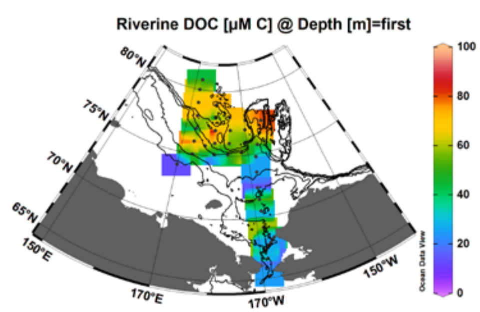


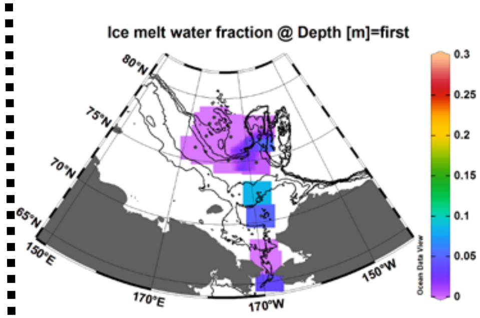



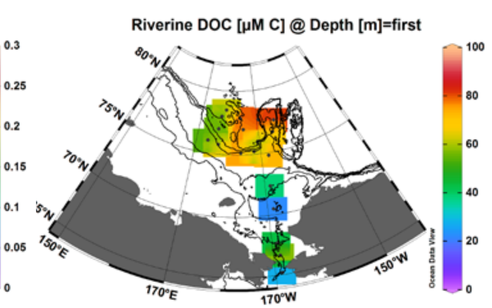



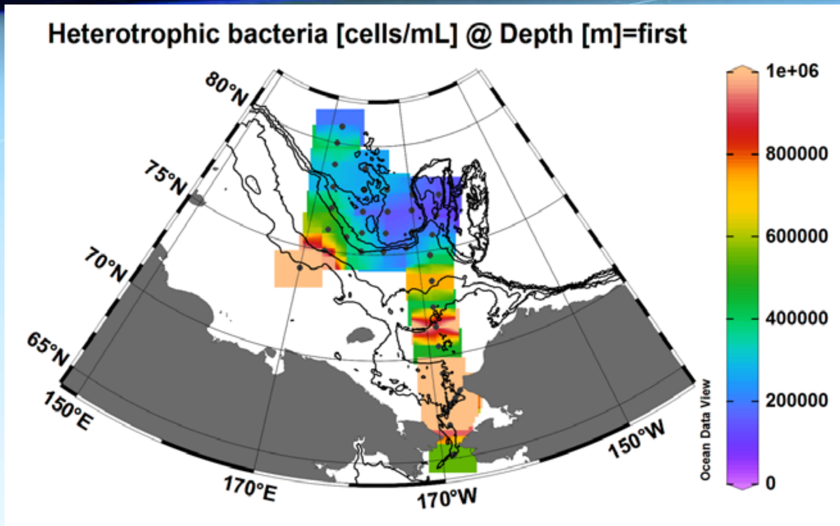



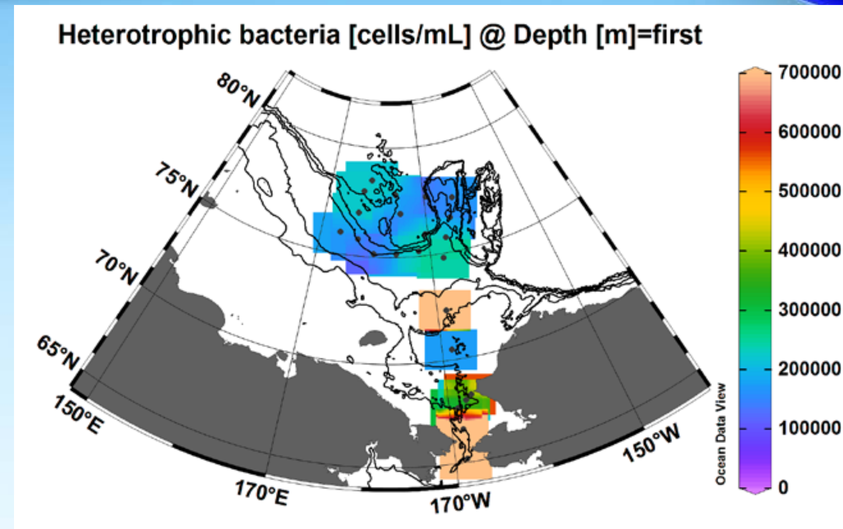



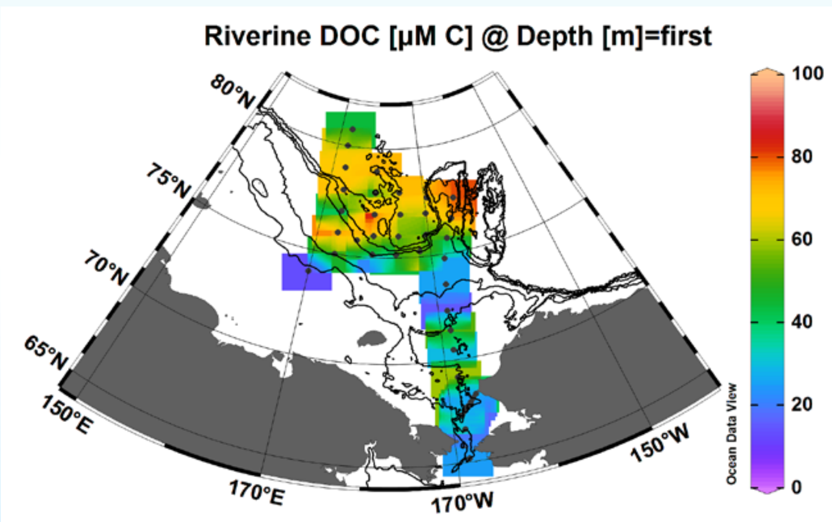
# Heterotrophic bacteria vs. riverine DOC

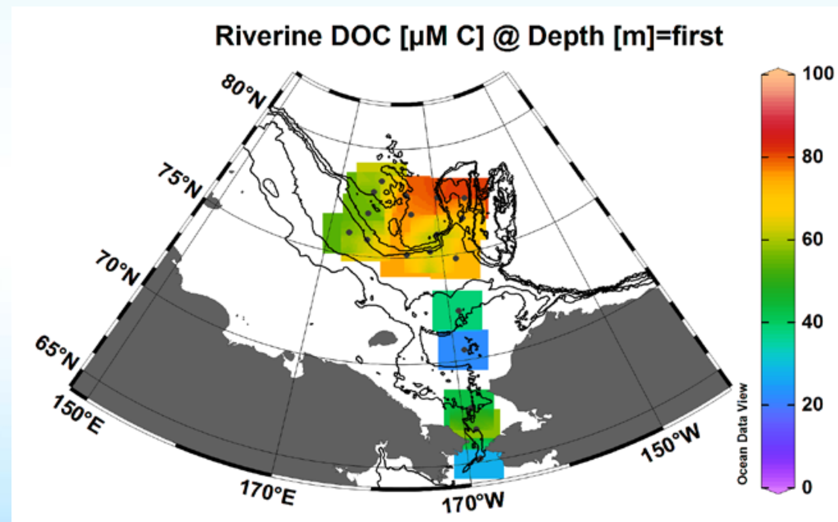



**2015**

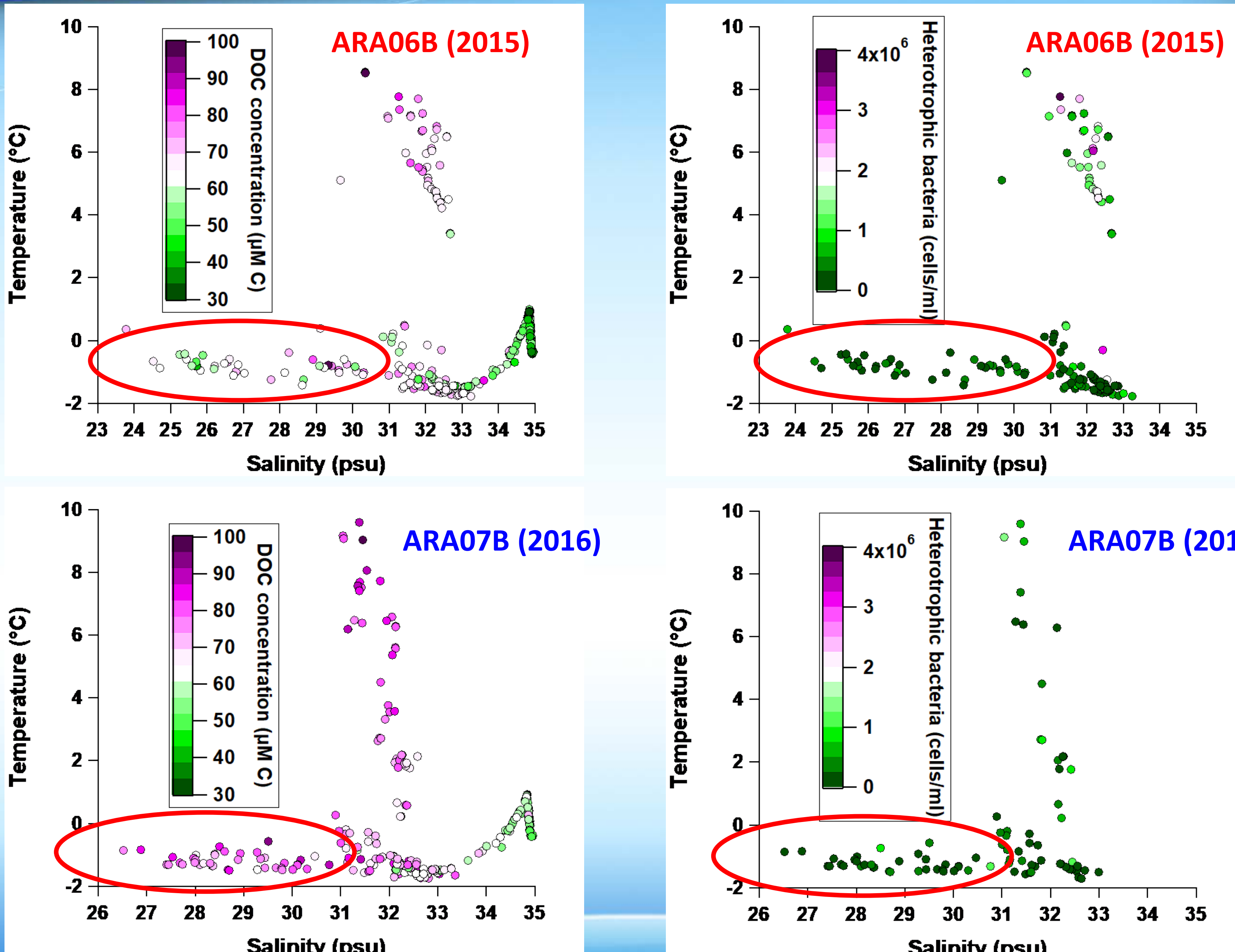
**2016**



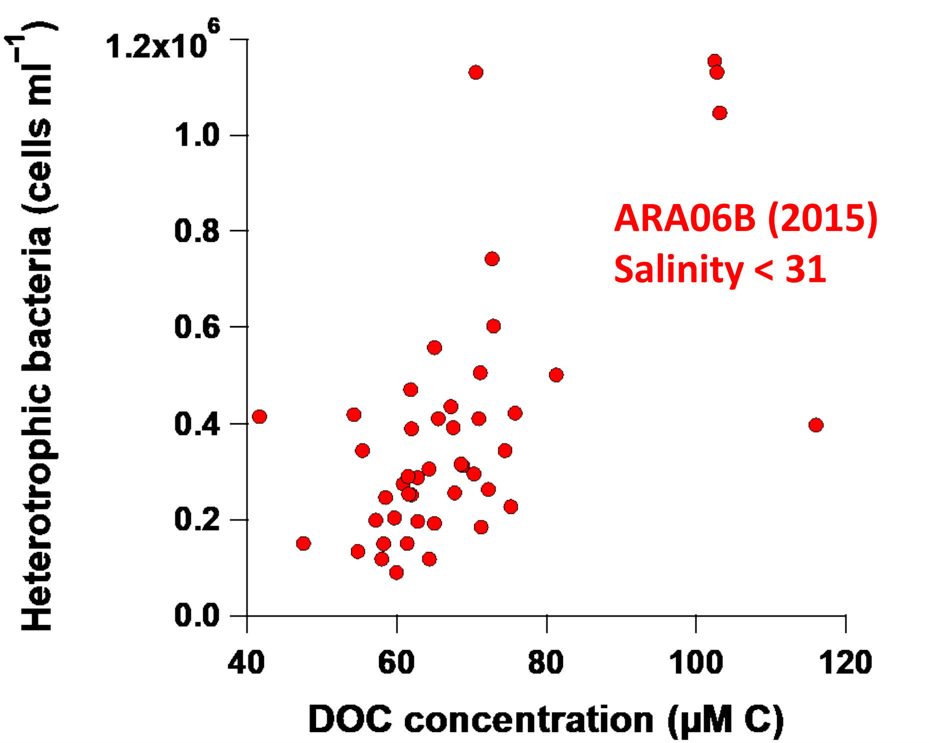



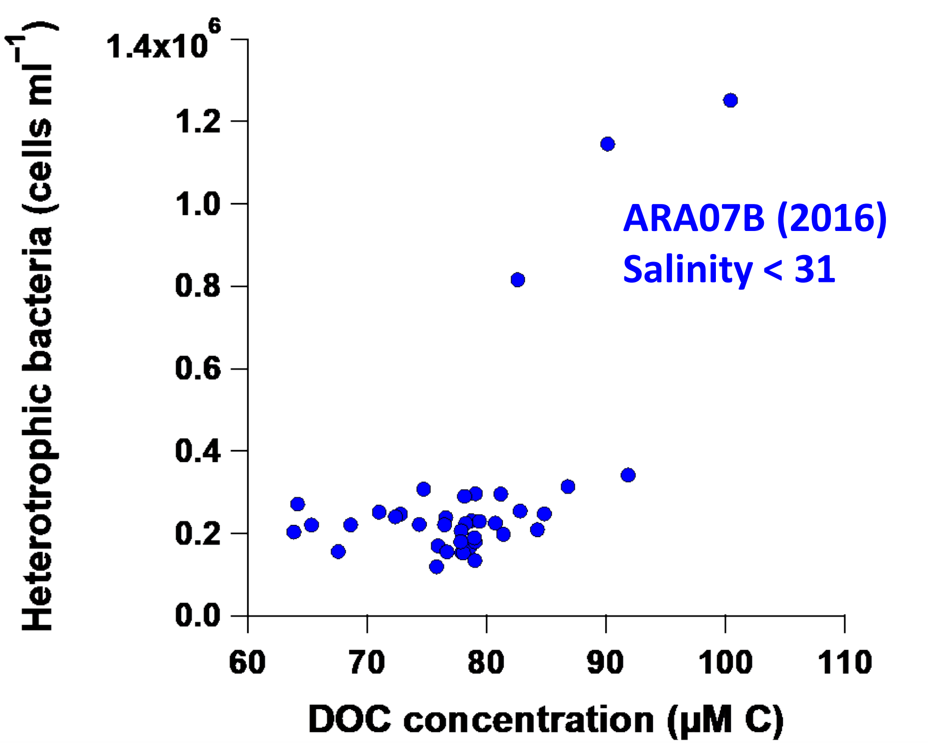

- **Heterotrophic bacterial abundance in surface water in 2015 was higher than that in 2016.**
- **Relatively low heterotrophic bacterial abundances were observed in the stations where riverine DOC concentrations were high.**

# Distributions of bacterial abundance and DOC



# Relationships between bacterial abundance and DOC

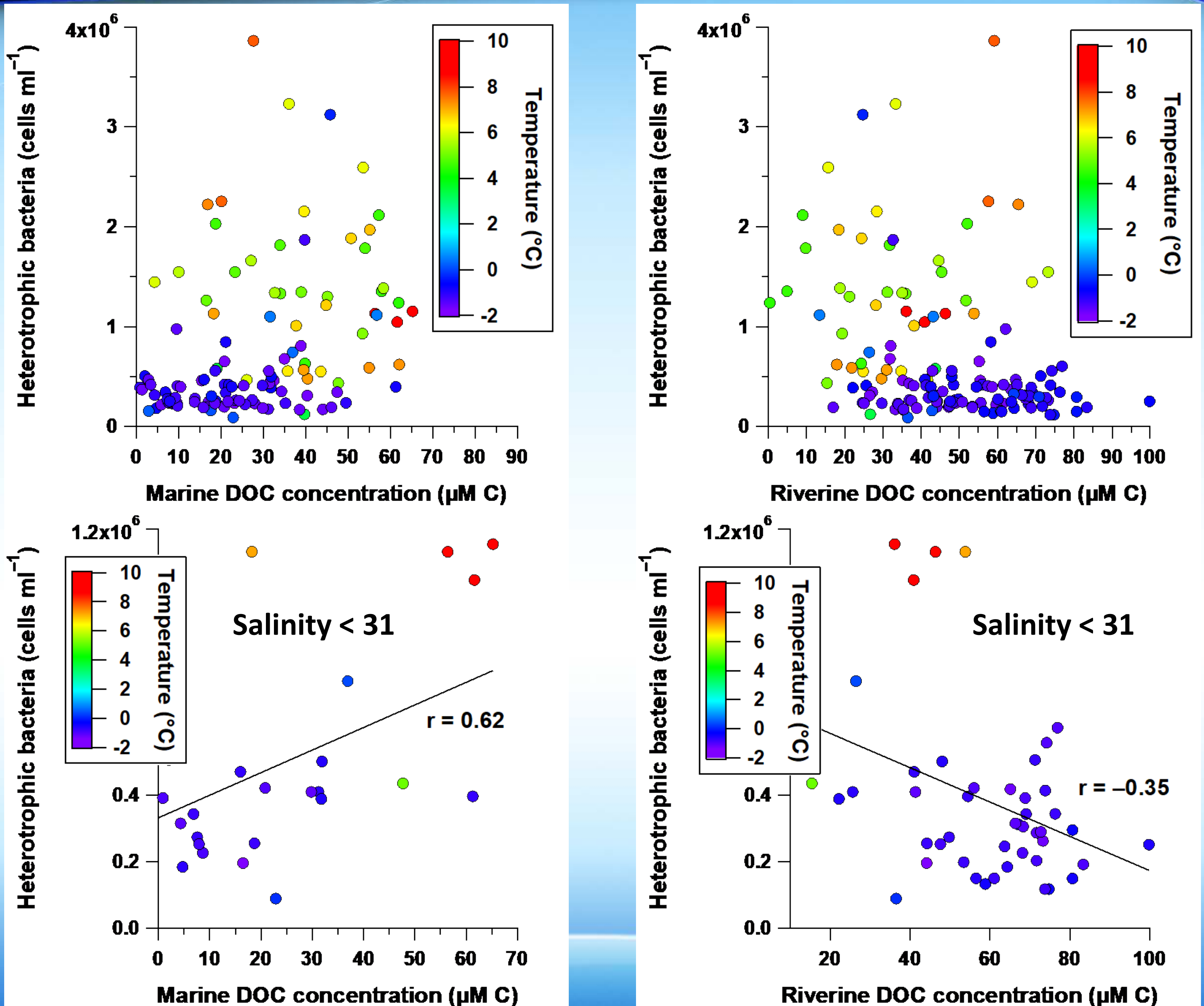



- **In 2015, DOC concentrations observed in the northern Chukchi Sea showed a positive relationship with bacterial abundance, suggesting that DOC was bioavailable and used by bacteria for their growth.**

- **In contrast, in 2016, bacterial abundances were lower than those in 2015 although there was a positive relationship between bacterial abundance and DOC concentrations, suggesting that DOC observed in 2016 was more refractory.**

# Bacterial abundance vs. marine and riverine DOC



# Future plan

- **Analysis of DOC samples collected in 2017**

- **Excitation emission matrix (EEM) spectroscopy analysis for the samples collected in 2015, 2016, and 2017 to estimate sources of DOC (e.g., protein-like, humic-like).**

**Excitation emission matrix (EEM) spectroscopy analysis**