

# A comparison of estimations of net community production in the Amundsen Sea polynya, Antarctica

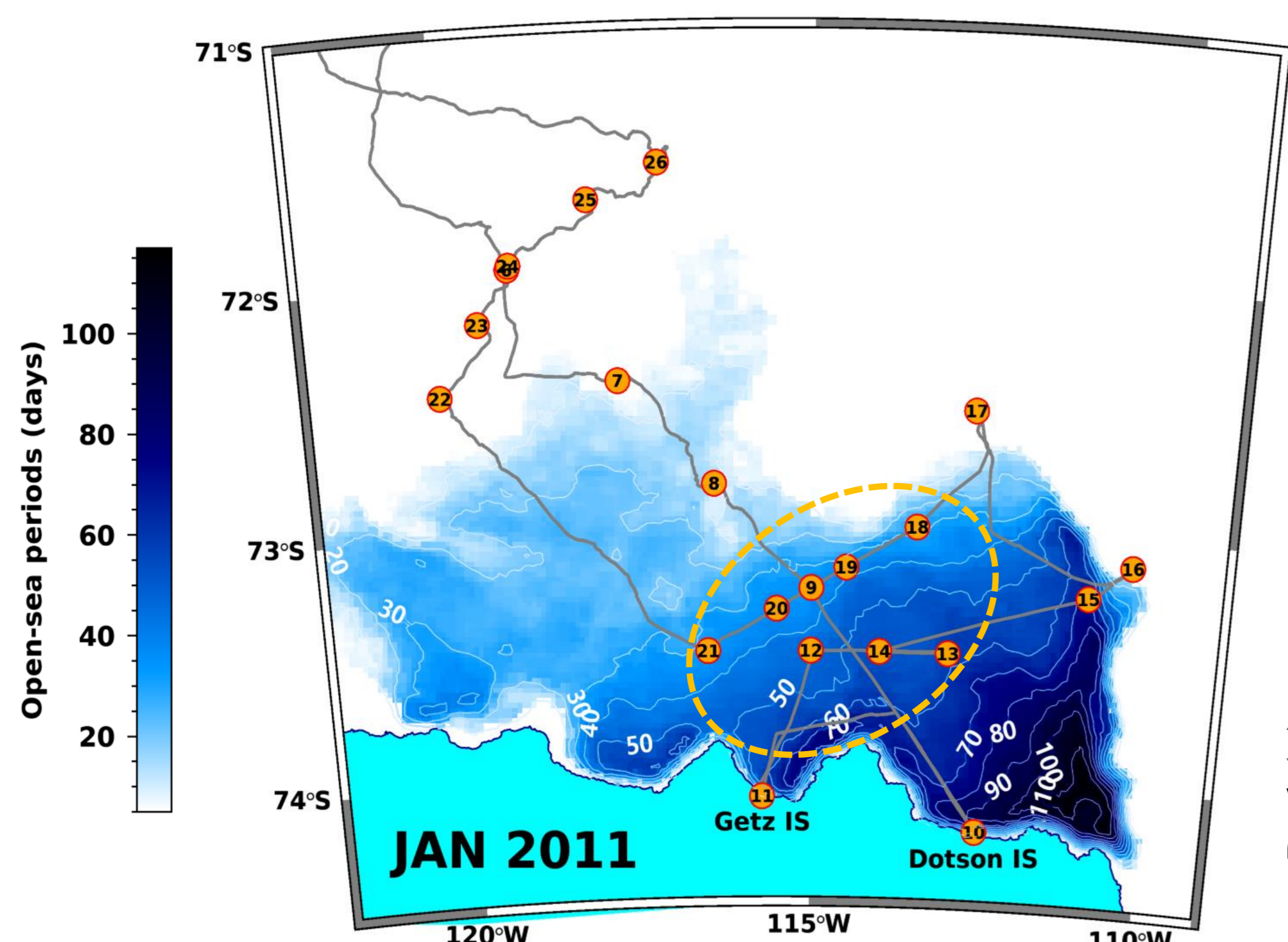
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## Sampling and Methods

### 1. Sampling



- The open-sea periods (days) were calculated by counting the number of days in the grids defined by EMSR-E where sea-ice concentration is lower than 15%. The cruise track of R/V Araon is indicated by gray line.
- The red circles represent the sampling stations. The approximate Amundsen Sea Polynya (ASP) is designated by yellow dotted circle.

### 2. Analytical Method

#### 2.1 Analyses

Dissolved Inorganic Carbon (DIC) and Total Alkalinity (TA)

: a Versatile Instrument for Determination of Titration Alkalinity (VINDTA 3C)

Nutrients  
: a 4-channel continuous Auto-Analyzer (QuAatro, Seal Analytical).

#### 2.2 NCP calculation from DIC

seasonal NCP (mmol C m<sup>-2</sup>)

$$= \int_0^x (DIC_x - DIC_{observed}) dz + Gas\ exchange$$

NCP (mmol C m<sup>-2</sup> d<sup>-1</sup>)

$$= seasonal\ NCP \div Number\ of\ open\ water\ days$$

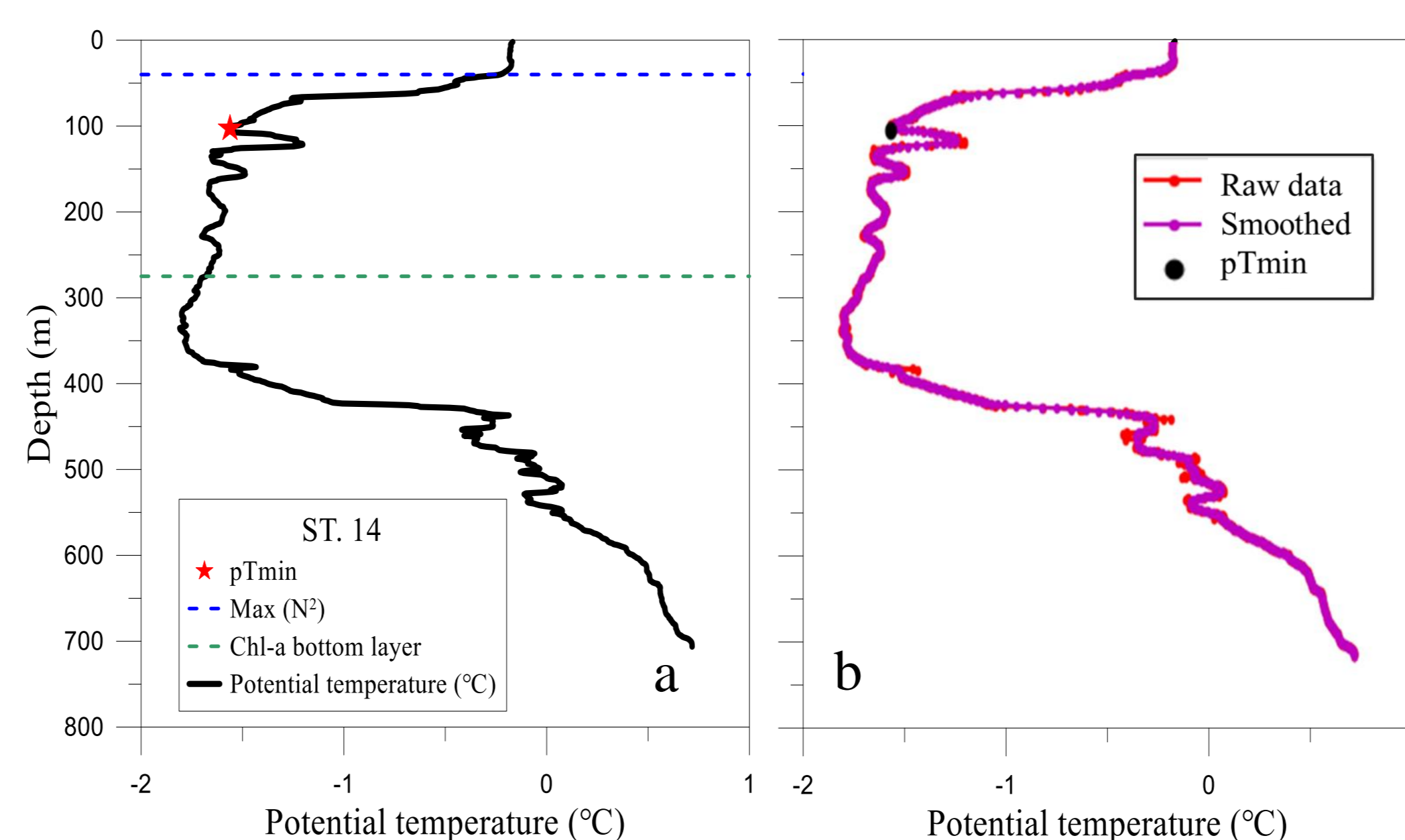
- Gas exchange did not include here, but will be considered later.  
- The number of open water days (35 ± 16 days) were estimated from the date of ≤ 15% average ice concentration in the polynya area to the date of sampling.

### 3 Depth Definition

#### 3.1 Physical Mixed Layer Depth (MLD)

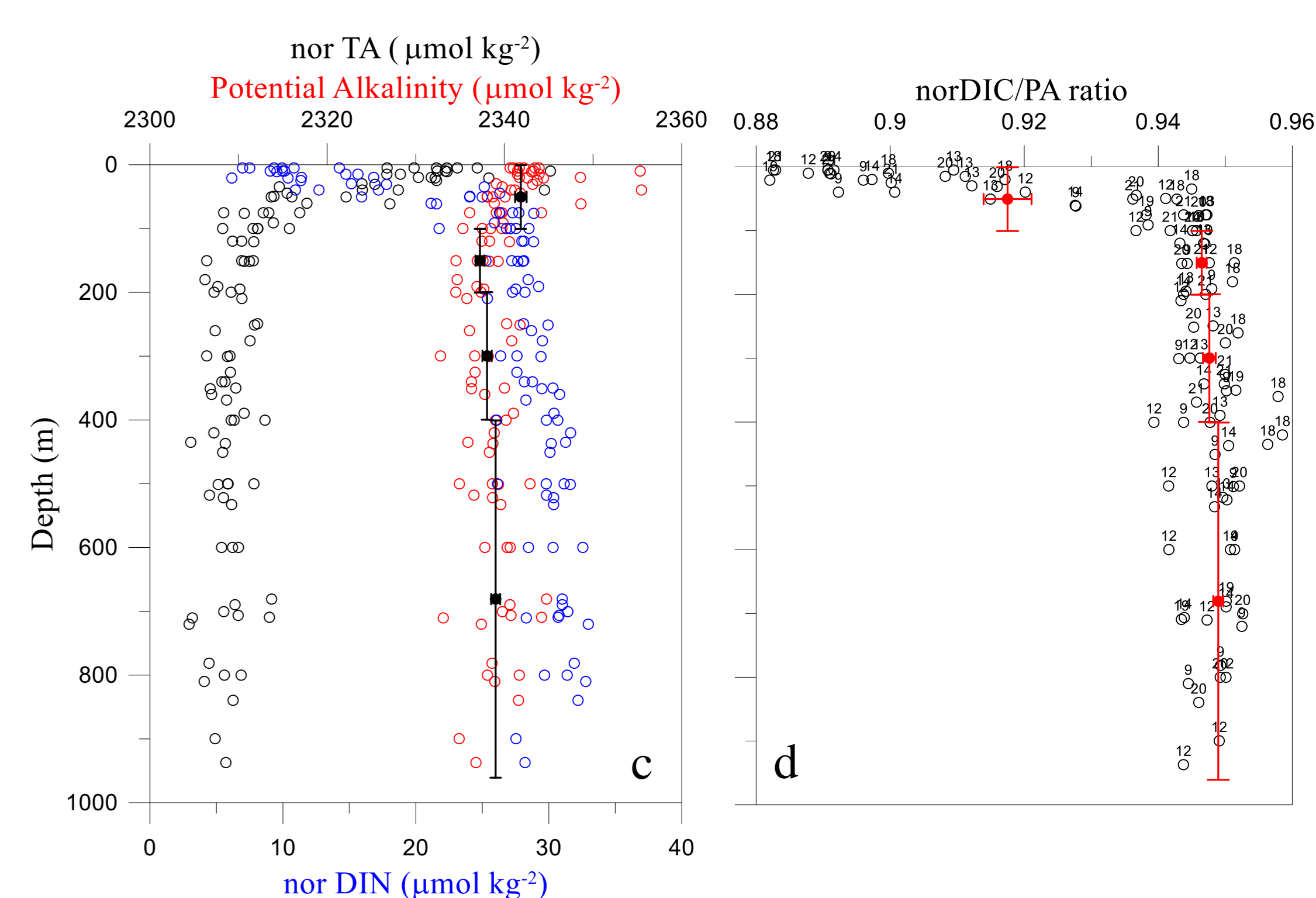
Author	MLD Threshold Criterion
Fragoso and Smith (2012)	$\Delta\sigma_\theta = 0.01\ kg\ m^{-3}$
Sallée et al. (2010)	$\Delta\sigma_\theta = 0.03\ kg\ m^{-3}$
Rintoul and Trull (2001)	$\Delta\sigma_\theta = 0.05\ kg\ m^{-3}$
Kuska et al. (2015)	$\Delta\sigma_\theta = 0.125\ kg\ m^{-3}$
Schofield et al. (2015)	Max(N <sup>2</sup> )

#### 3.2 Potential Temperature Minimum Depth (pTmin)



- (a) Opposing to Carvalho et al., (2017), the bottom layer of chl-a fluorescence in the upper water column is not consistent with the maximum buoyancy, but locates deeper. We chose the bottom layer of the MLD for NCP at the depth where temperature gradient reversed to the gradient of 0.01°C m<sup>-1</sup> or minimum potential temperature whichever is shallower.
- (b) Used the Gaussian filter function (sigma = 3) provided by the Python library pandas. The pTmin depths were chosen as the pole of the first curve while the water temperature was less than -1°C.

#### 3.3 Biogeochemical MLD



- (c) All concentrations normalized to salinity 34.05 which is calculated by the freezing point in T-S diagram. Potential alkalinity (sum of normalized TA and DIN (Brewer and Goldman, 1978)) was calculated to correct for changes in the concentration of total alkalinity by photosynthesis.
- (d) The ratios of normalized DIC/PA (0 ~ 100 m; 0.91 ± 0.004, n = 49) were low by biological production in the surface layer. Below 100 m depth, the nDIC/PA ratios (< 100 m; 0.95 ± 0.001, n = 60) were almost constant.

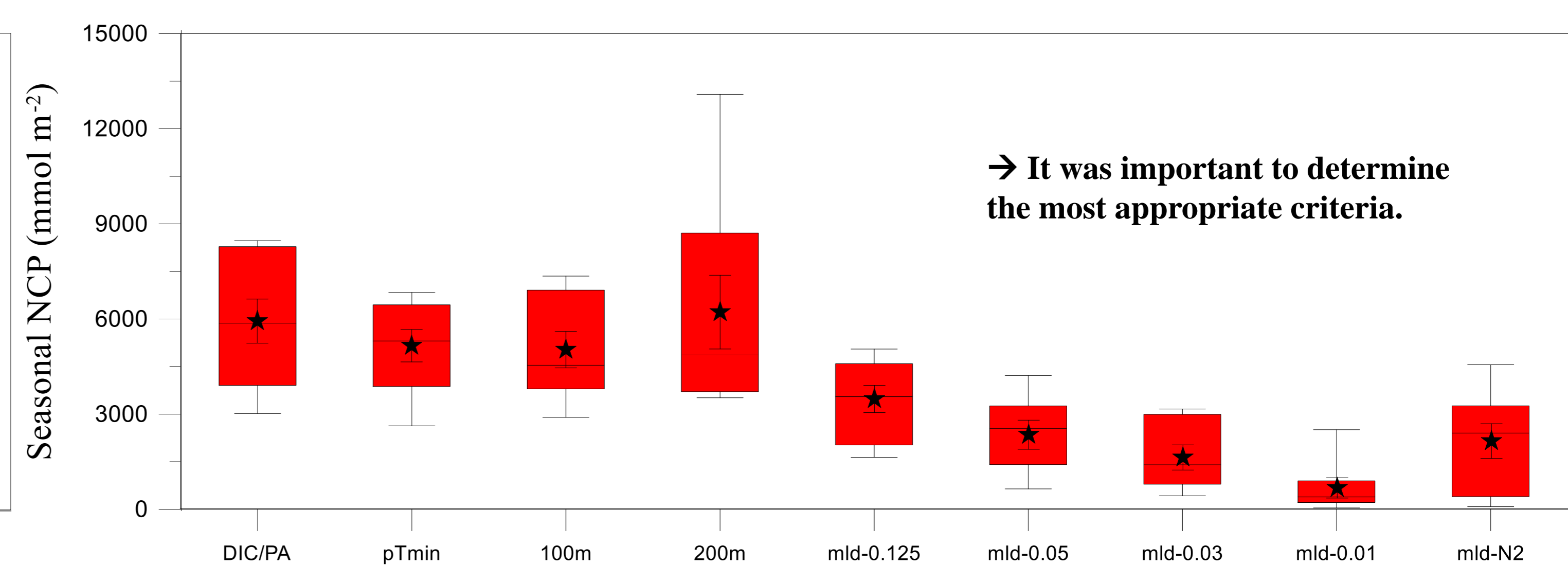
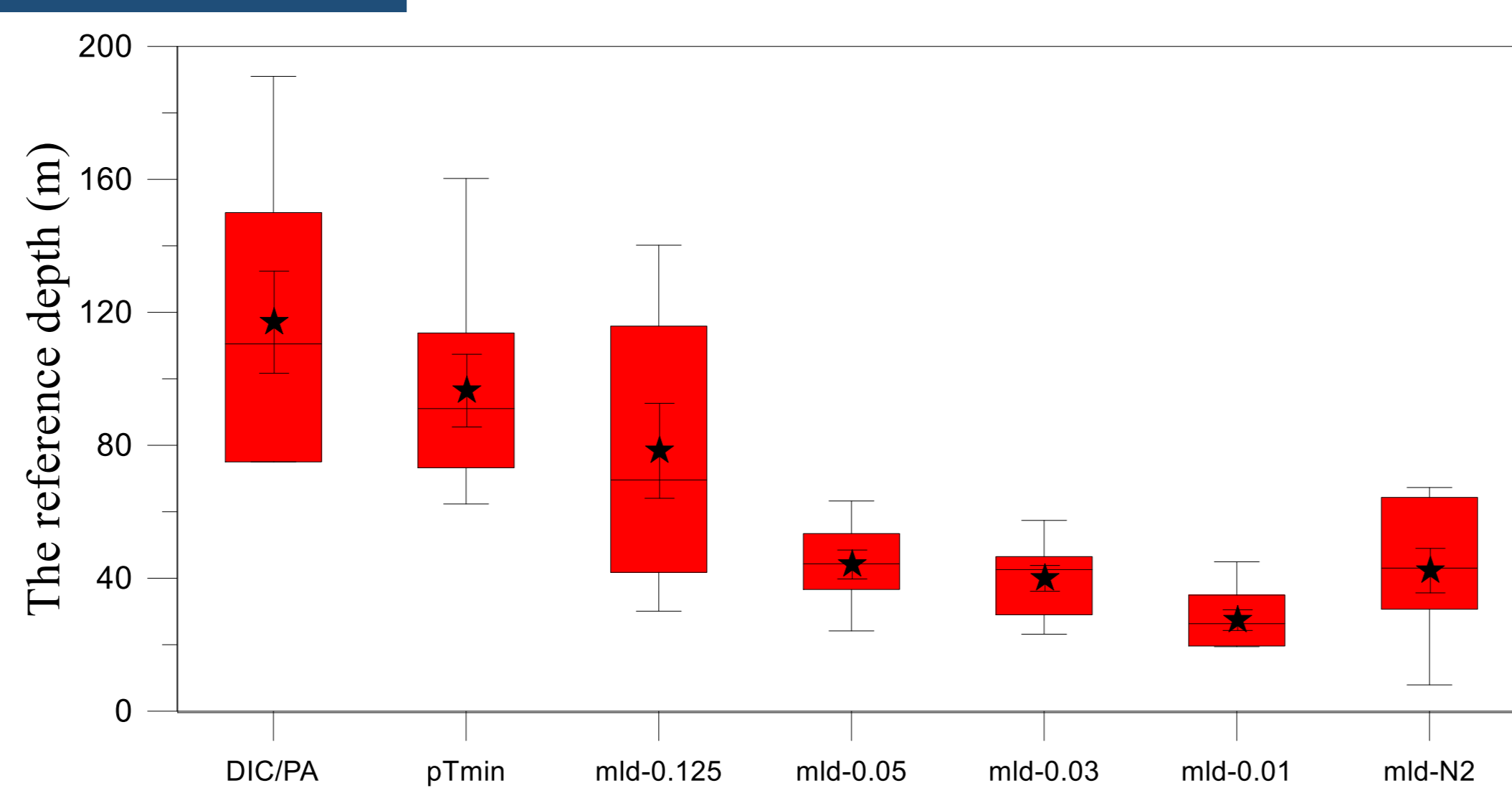
#### 3.4 The others

- 100 m and 200 m; the nearest two water depths were interpolated at the stations where the water depth samples were not collected.

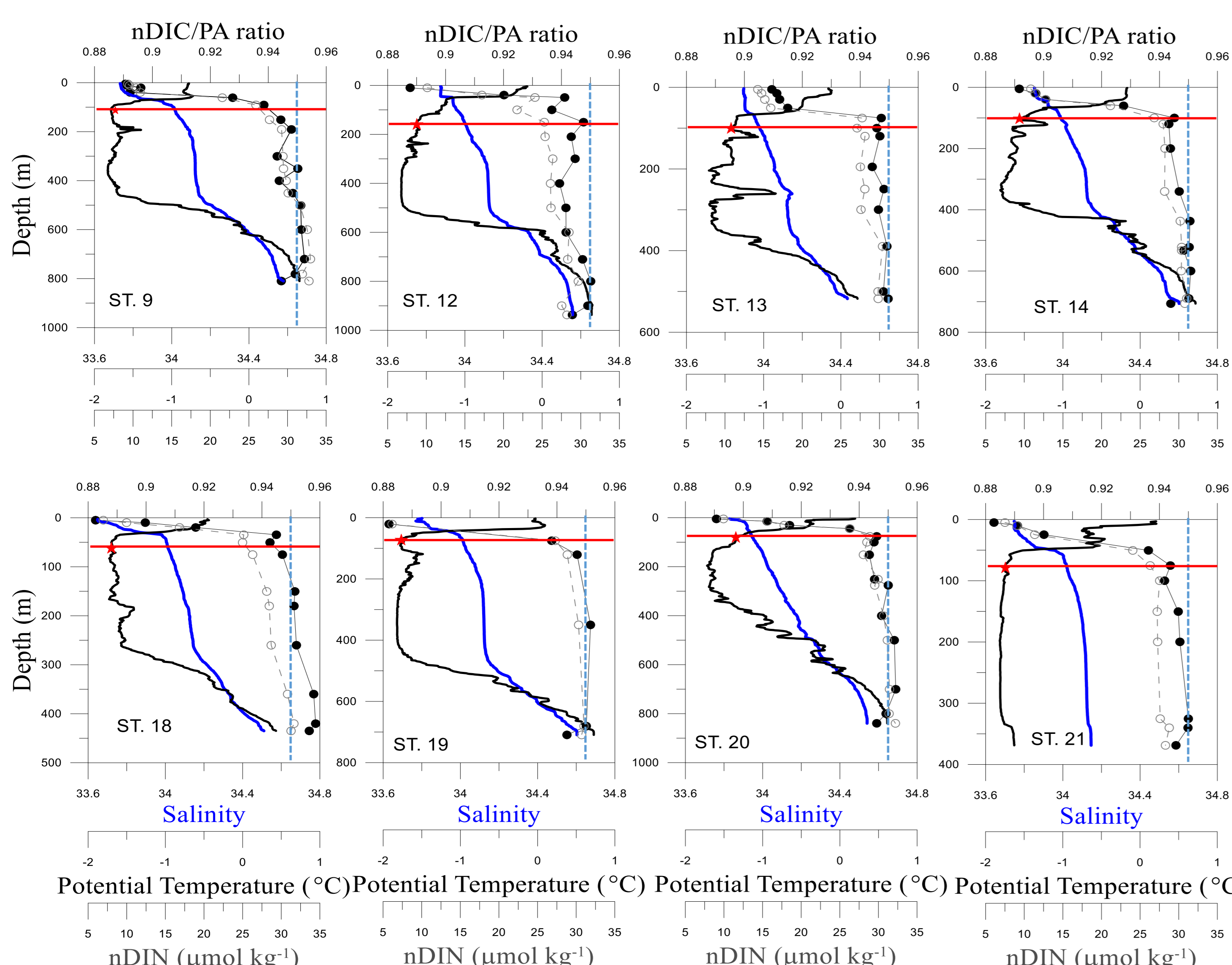
## Results and discussion

### 1. Seasonal NCP from drawdown of DIC

- The median values of the reference depth and the seasonal NCP were MLD < 100m ≡ pTmin ≡ nDIC/PA < 200 m.
- Estimated seasonal NCPs were highly dependent on what reference depths were used.



### 2. Estimating NCP



- Depending on where reference depths were located the C/N ratios were differ, suggesting all reference depths were affected by biological activity.
- The pTmin depth appears to indicate the top of Winter Water mass because it contains minimal interference driven by mixing with CDW. Thus, it could be used to calculate all biological production from the pre-bloom to the date of sampling.
- The pTmin depth can be used to estimate the seasonal NCP because it is consistent with the biogeochemical reference depth determined by nDIC/PA ratio at each station.
- The NCPs in February 2012 were about 20% of that in January 2011 (Hahm et al., 2014). We will investigate the temporal variation of the NCP using the proposed method.

