

# 'FROM FRESH- TO MARINE WATERS: THE FATE OF DISSOLVED ORGANIC MATTER IN THE LENA DELTA REGION, SIBERIA'

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Global Biogeochemical Cycles

AN AGU JOURNAL

# OUTLINE

- Organic matter
- Classification of Dissolved organic matter (DOM)
- Motivation: DOM in the Lena River Delta
- Objectives
- Results & Discussion
- Summary
- Outlook

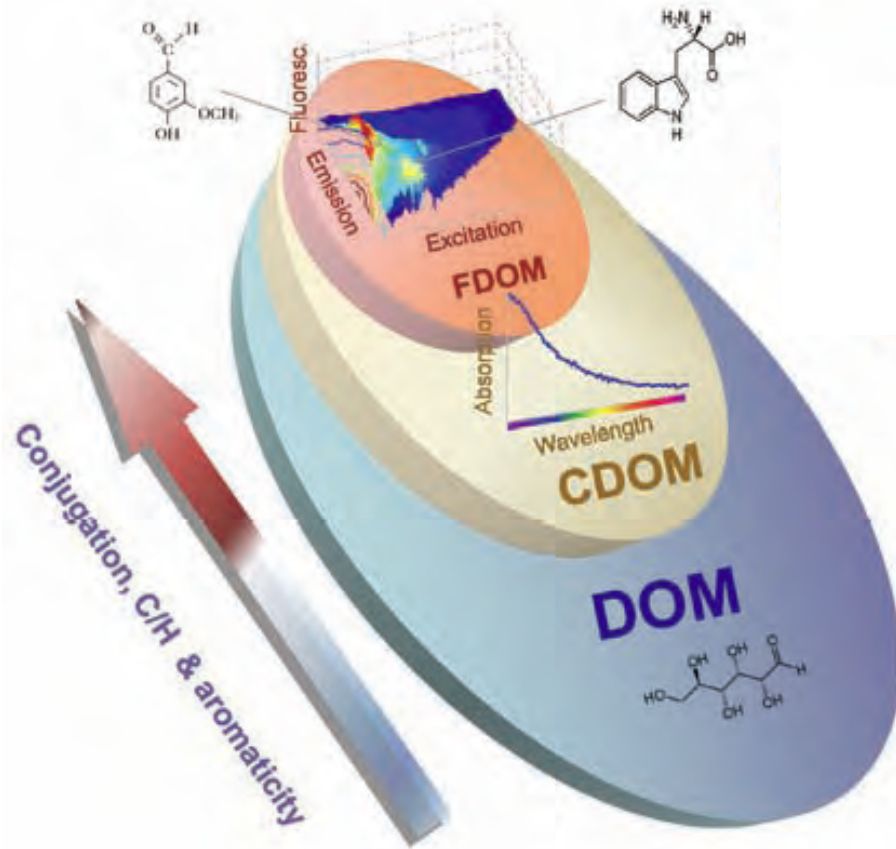
# DISSOLVED ORGANIC MATTER

**It is a matter composed of organic compounds that has come from the remains of organisms such as plants and animals and their waste products in**

**the environment**

- **Dissolved:** size  $< 0.2\mu\text{m}$
- **Particulate:** size  $> 0.2\mu\text{m}$

# DISSOLVED ORGANIC MATTER



Stedmon & Álvarez-Salgado, 2011

Coble (2007)

- Humic acids
- Fulvic acids
- Degraded protein
- others
- Autochthonous
- Allochthonous

- Chromophoric DOM (CDOM)
- Fluorescent DOM (FDOM)

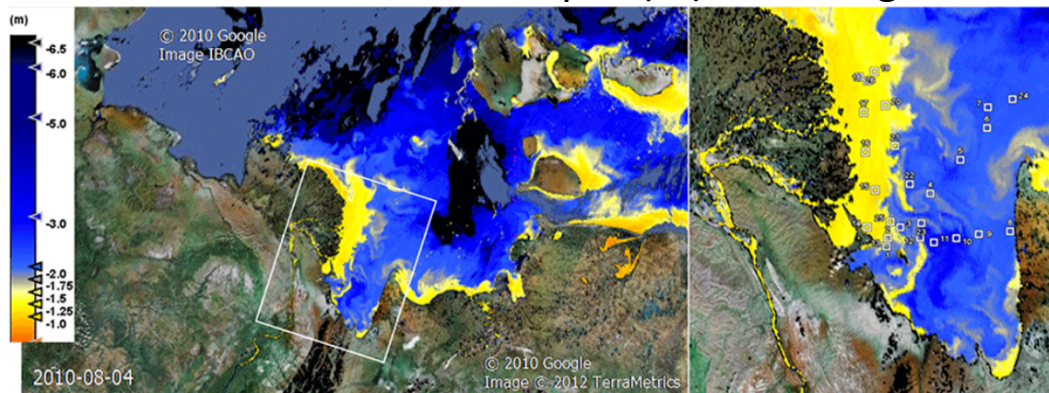
## WHY TO STUDY THE DOM??

- DOM is an important fraction of carbon in the oceans → CARBON CYCLE
- CDOM absorbs light in the UV range → NATURAL BIOTA SHIELD

# THE LENA RIVER AND DELTA REGION

- **One of the largest rivers in the world**
  - ~20% total fresh water in the Arctic Ocean (Cauwet & Sidorov, 1996)
  - The greatest discharge of organic matter in the Arctic
    - Stedmon et al. (2011)
  - Under climate changing pressure (Yang et al., 2002)
    - Permafrost thaw → river discharge (Lyon & Destouni, 2010)

MERIS First attenuation depth (m) – 04. Aug. 2010



Heim et al. (2014)

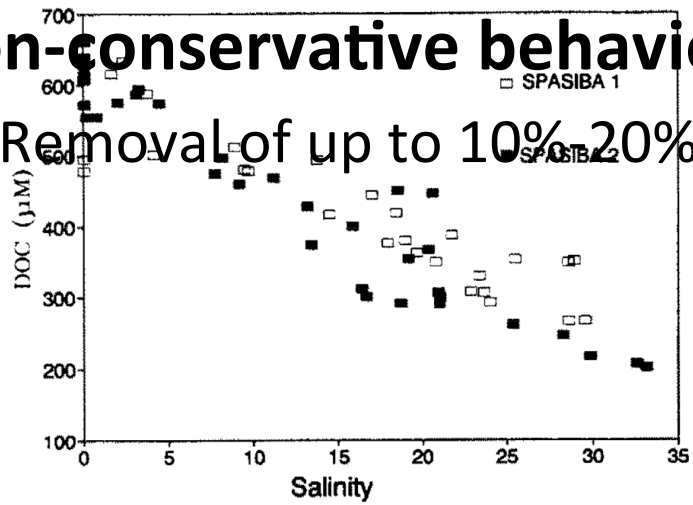
# MOTIVATION

## DOM IN THE LENA DELTA REGION

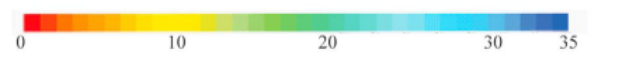
- Conservative mixing of DOM

- Non-conservative behavior (Alling et al., 2010)

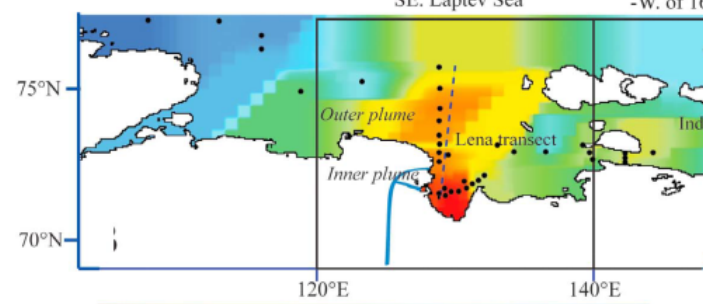
– Removal of up to 10%, 20%



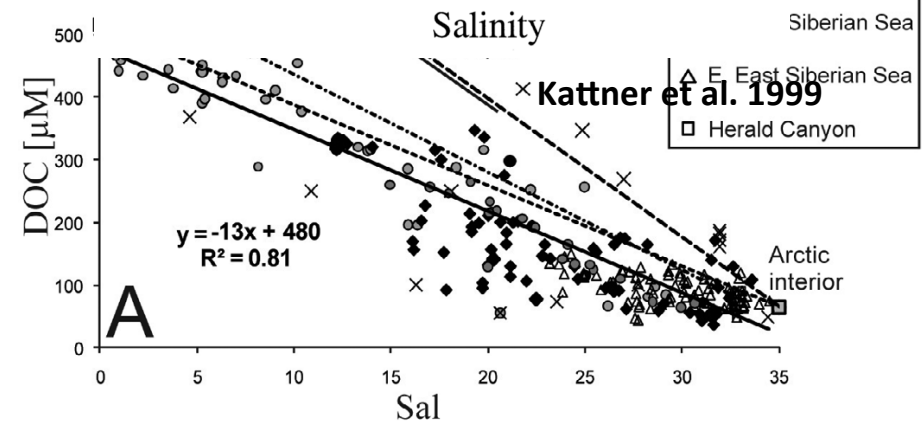
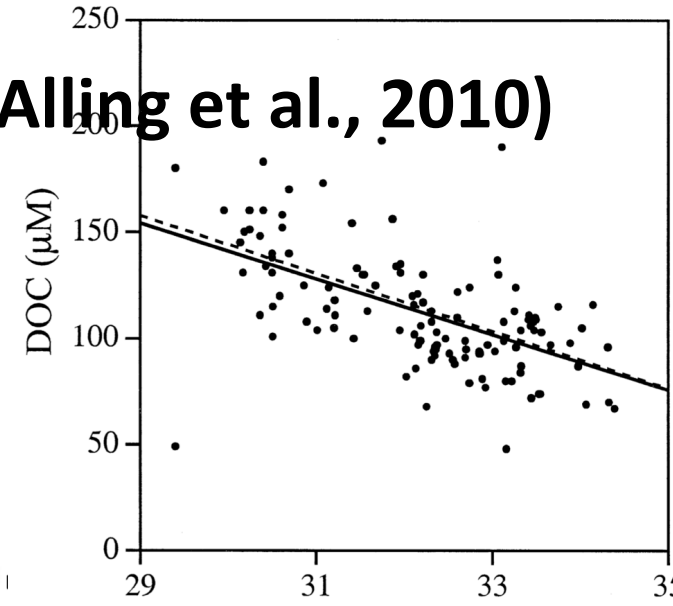
Cauwet & Sidorov, 1996



D) Lena River plume - SE. Laptev Sea E) East Sibe - W. of 140°E



CITES - 29.06.2015



# OBJECTIVE AND HYPOTHESIS

- **OBJECTIVE**

- to investigate the processes modulating the DOM mixing within the Lena delta region

- Carbon pathways in the Arctic

- **HYPOTHESIS**

- Dilution/Mixing

- Photobleaching

- Sorption/Flocculation

- Biological degradation

- Production of DOM from phytoplankton

Removal

Release

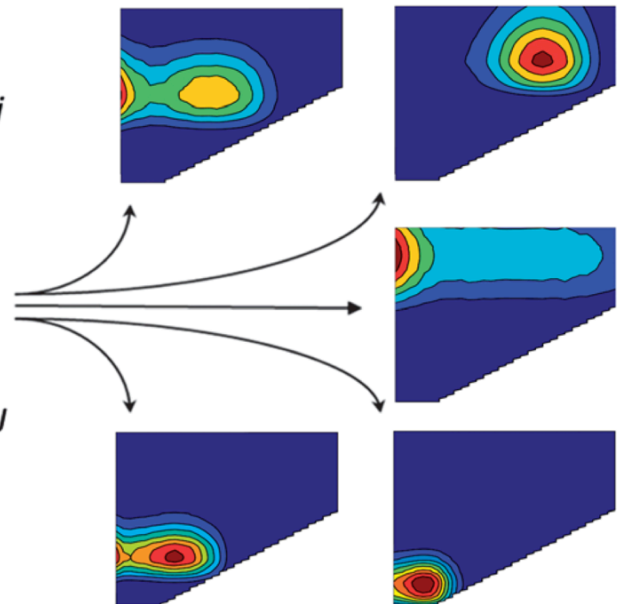
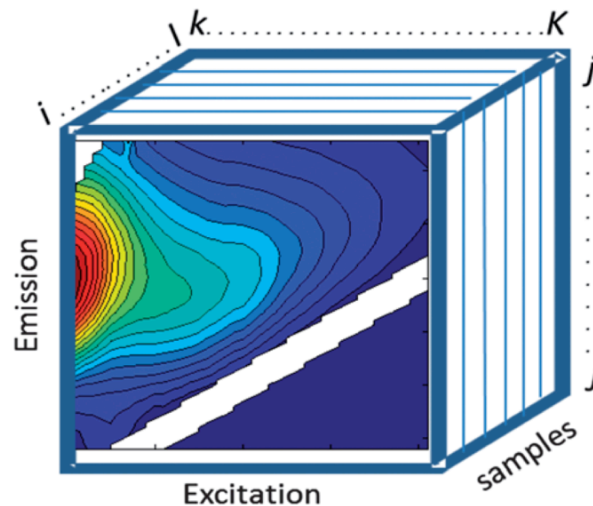
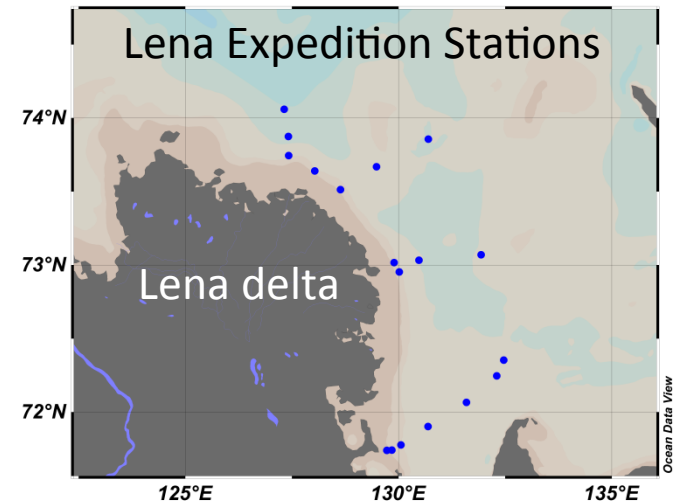
# MATERIAL AND METHODS

- **LENA DELTA EXPEDITION**

- 1-7 September 2013
- R/V “Dalniye Zelentsy” - MMBI

- **DATA SET**

- 4 transects → 18 Stn → 60 Samples
- CTD → UMLD, w
- DOC
- Aqualog Fluorescence
  - CDOM absorptio
  - Excitation-Emiss
- PARAFAC model
  - Stedmon & Bro, 20



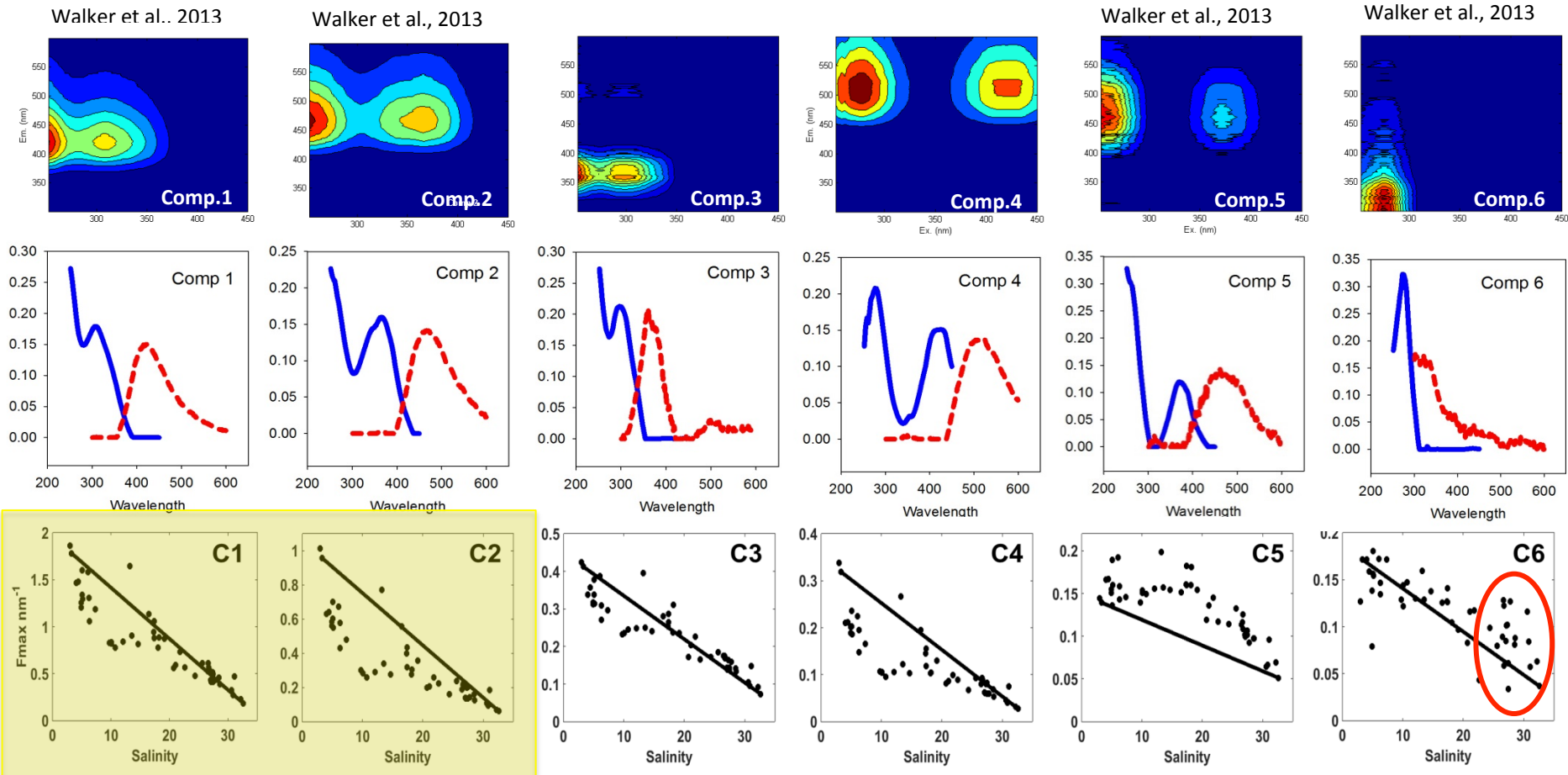
Murphy et al. 2013



# DOM COMPONENTS

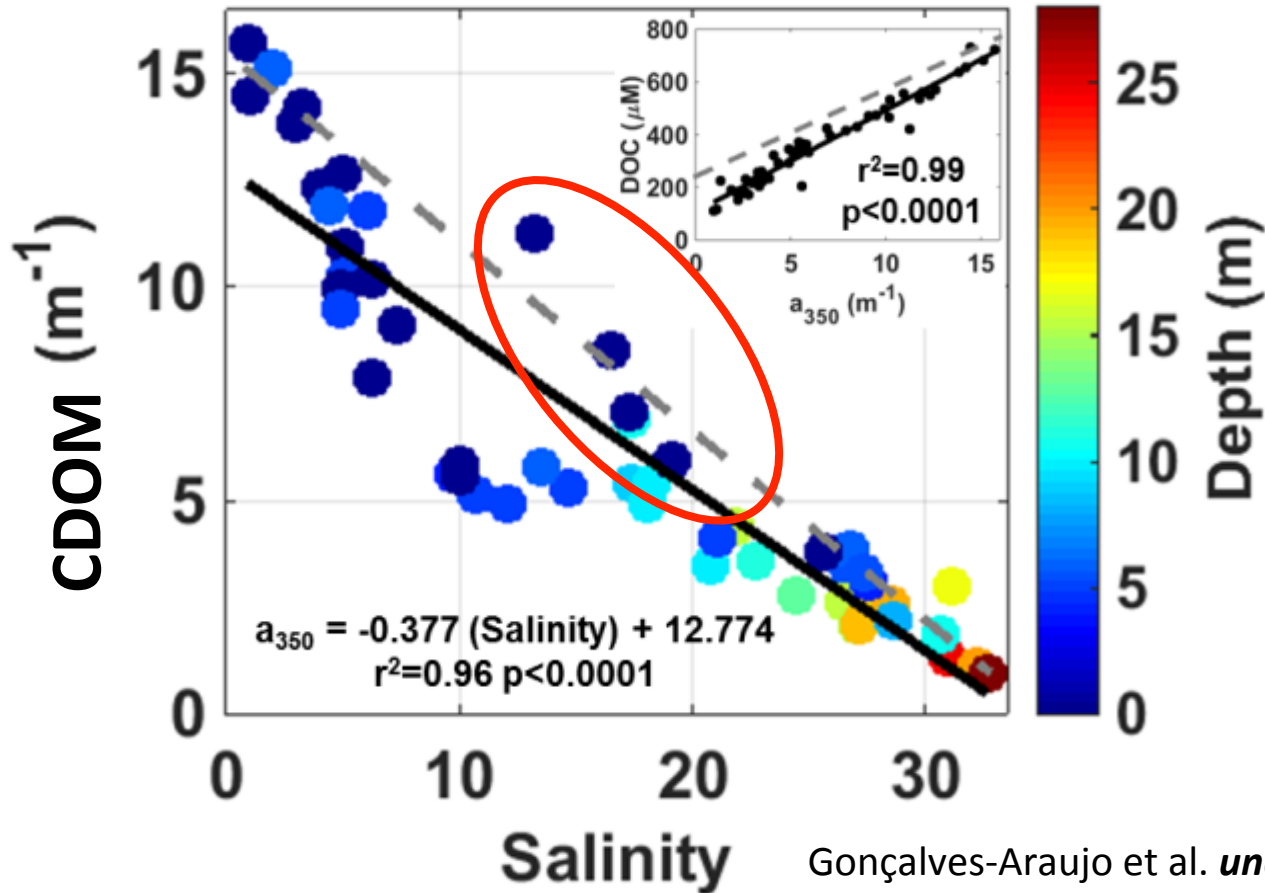
- PARAFAC model: 6 components validated
  - 4 humic-like (C1, C2, C4, C5)
  - 1 marine-humic-like (C3)
  - 1 protein-like (C6)

DOMINATED BY HUMIC-LIKE SIGNAL



# DOM MIXING

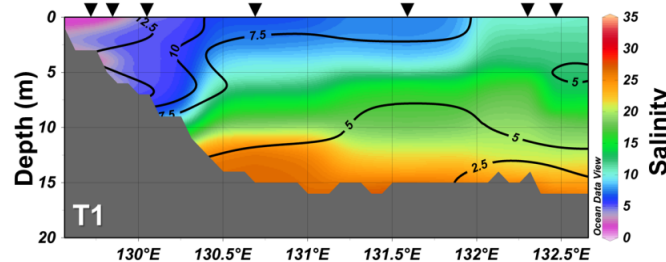
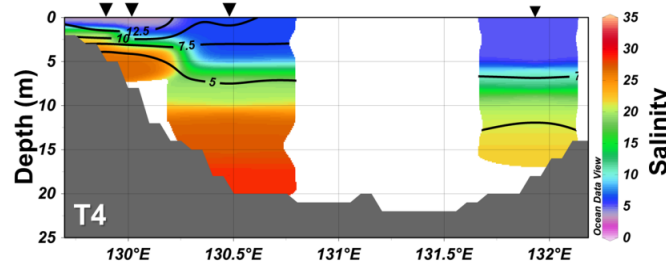
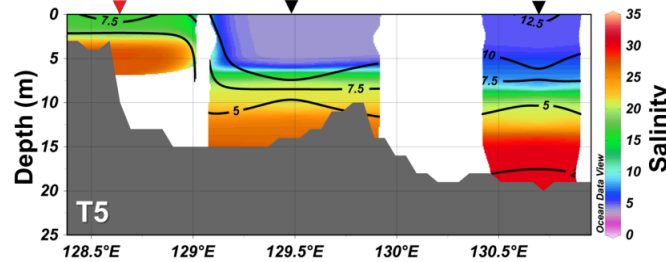
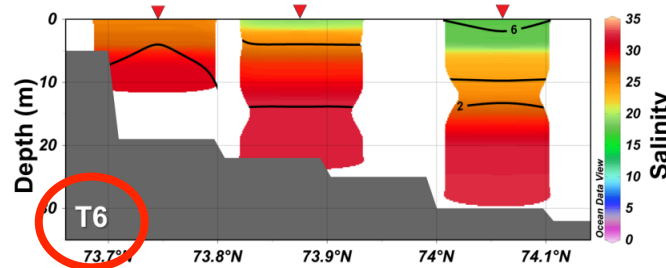
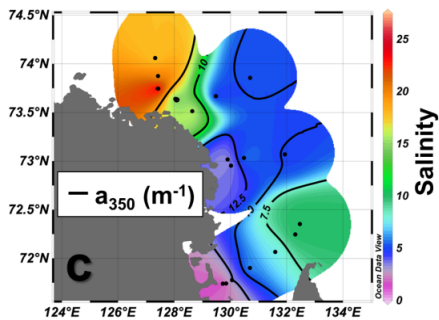
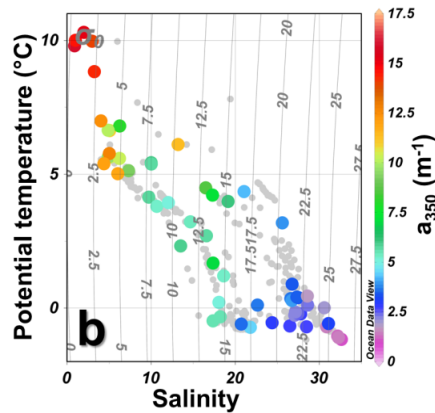
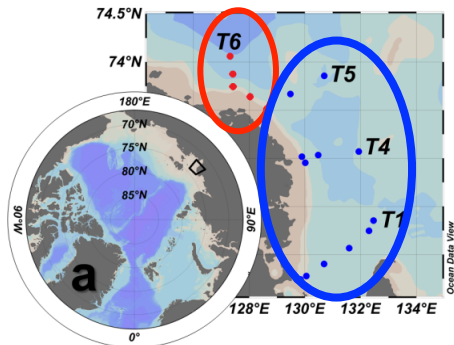
## WHAT DOES THAT MEAN?



Gonçalves-Araujo et al. *under review GBC*

# HYDROGRAPHY

## Hydrography and water column structure – Lena 2013



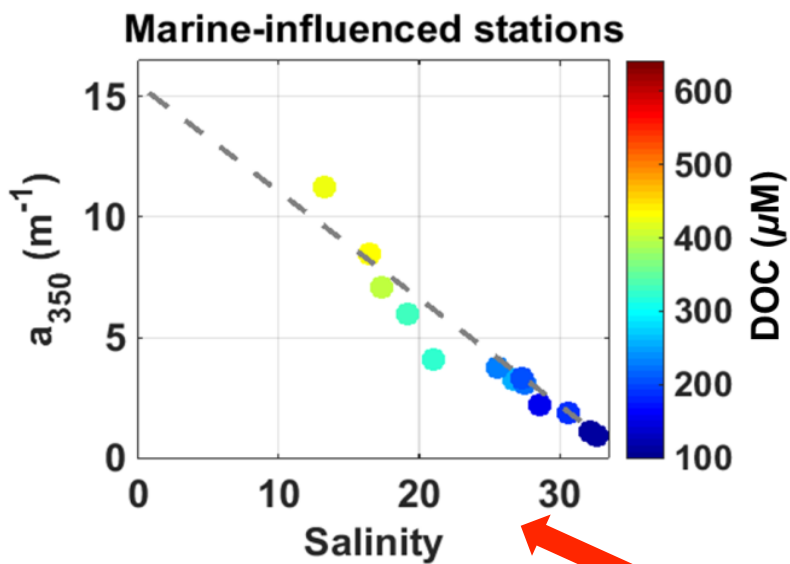
- Offshore wind event (Sep 99)
  - Bauch et al. (2009)

- **PLUME Stations** ●
  - Surface Sal < 10
  - Shallow low salinity layer
  - Strongly stratified

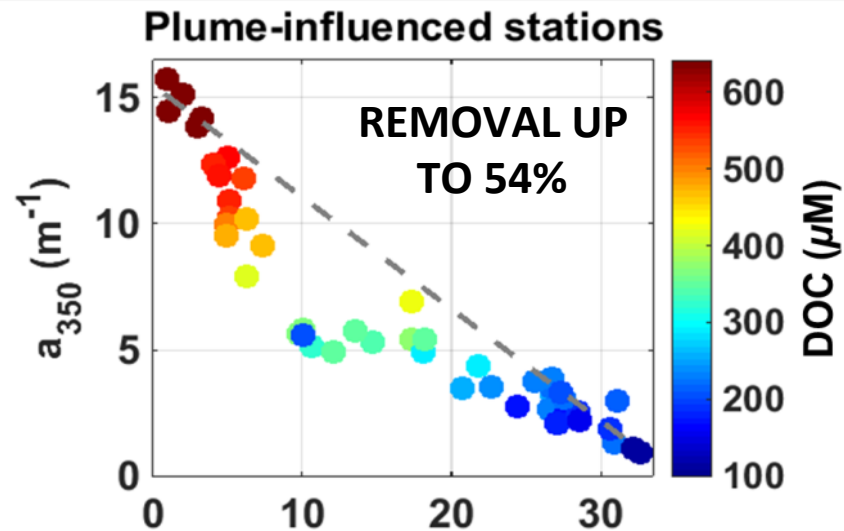
- **“Marine” Stations** ●
  - Surface sal > 10
  - Shallow UMLD (<8m)
  - Lower stratification
  - NW portion

# DOM & HYDROGRAPHY

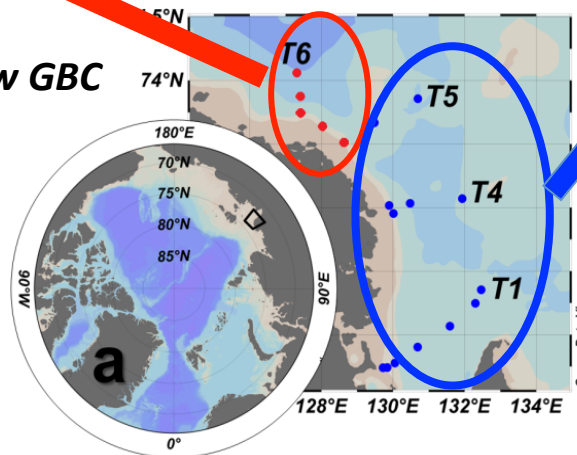
## CONSERVATIVE MIXING



## NON-CONSERVATIVE MIXING

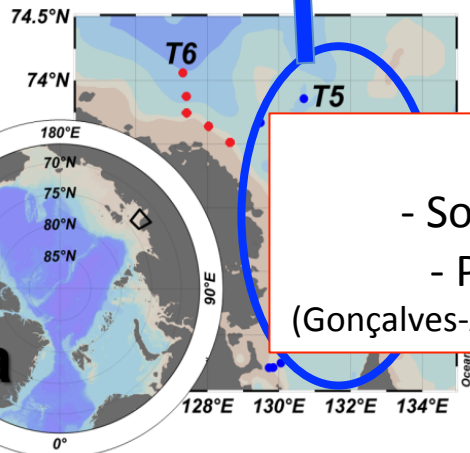
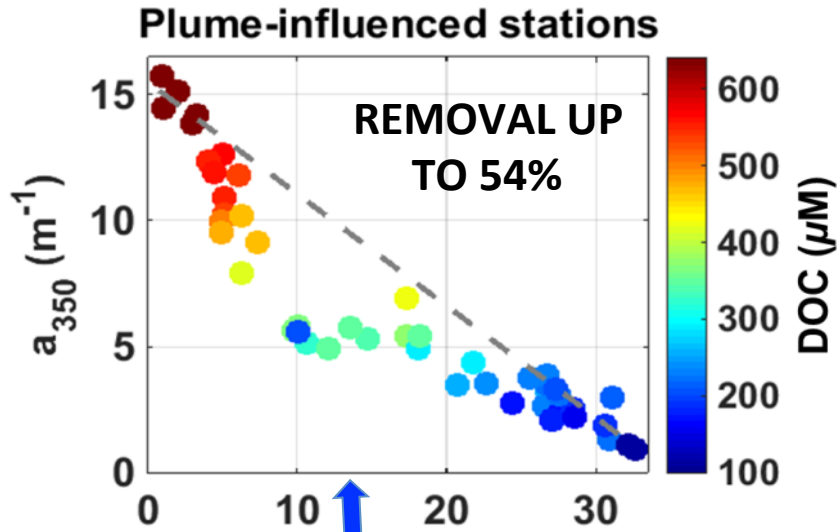


Gonçalves-Araujo et al. *under review* GBC



# DOM & HYDROGRAPHY

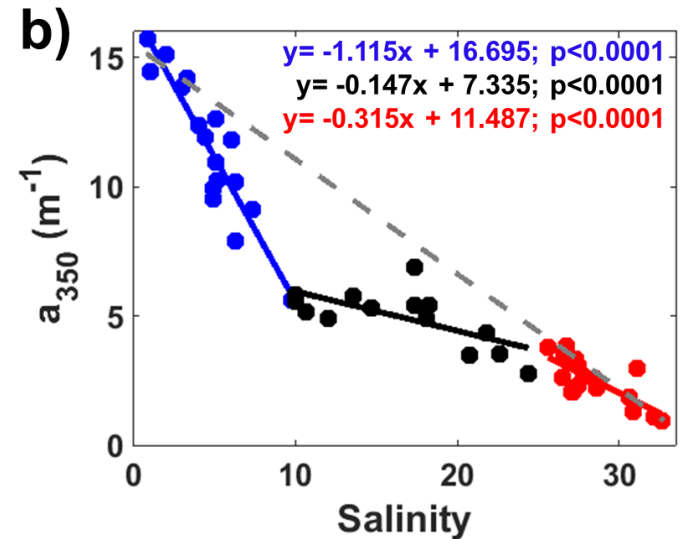
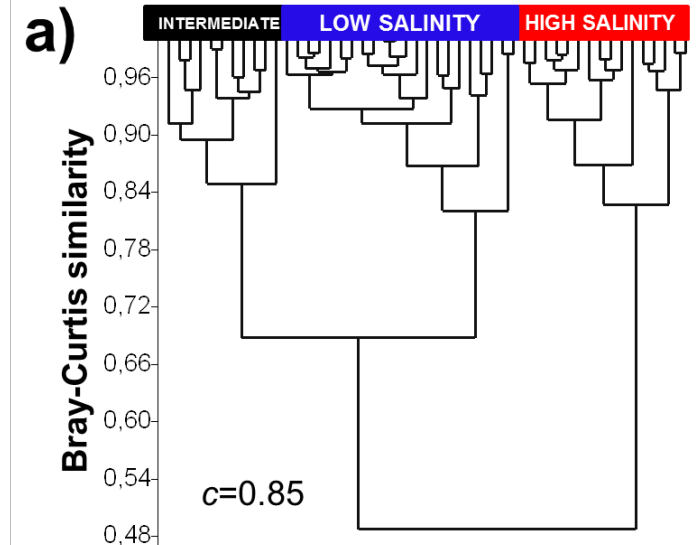
## NON-CONSERVATIVE MIXING



**REMOVAL:**

- Sorption/flocculation
- Photodegradation

(Gonçalves-Araujo et al. under review GBC)



Gonçalves-Araujo et al. *under review GBC*

# DOM MODIFICATION INDICES

## ABSORPTION Aromaticity Molec. weight

- **CDOM ABSORPTION SLOPE ( $S_{\text{CDOM}}$ )** – Helms et al. 2008
  - 275-295nm → degradation level
- **SPECIFIC UV ABSORBANCE (SUVA)** – Weishaar et al. 2003
  - Abs @ 254nm → aromaticity

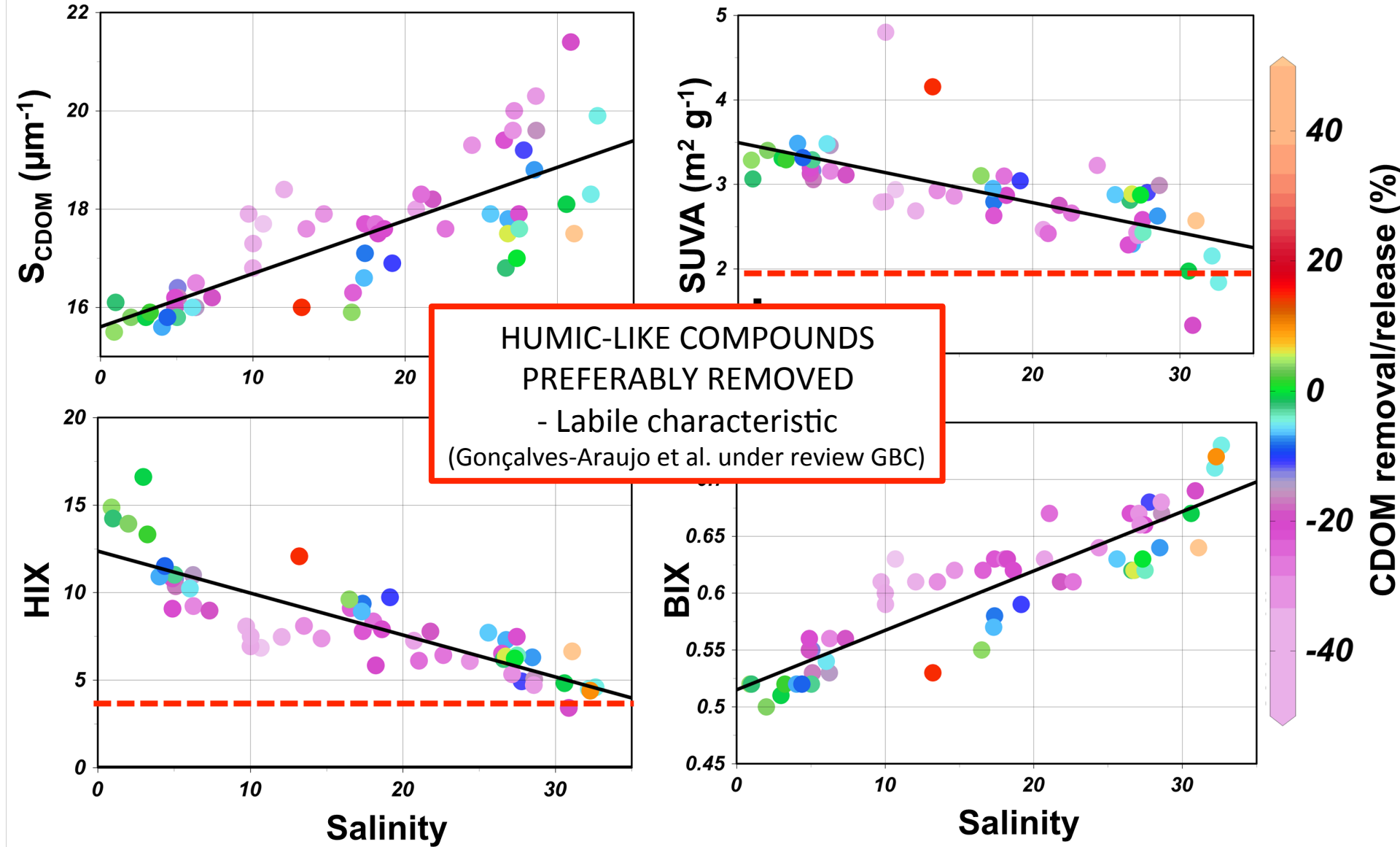
## FLUORESCENCE Humification

- **HUMIFICATION INDEX (HIX)** – Zsolnay et al. 1999
  - Humification degree

## FLUORESCENCE Biological activity

- **BIOLOGICAL INDEX (BIX)** – Huguet et al. 2009
  - $\beta$  fluorophore – Autochthonous DOM

# DOM MODIFICATION INDICES



# SUMMARY

- **6 fluorescent components characterized by PARAFAC model**
  - 4 humic-like
  - 1 marine-humic-like
  - 1 protein-like
- **Strongly humified region (>50% even @ high salinity)**
- **Reactivity/Complexity of DOM varies with salinity**
- **Conservative and non-conservative mixing of DOM**
  - Hydrography**
    - »PLUME SITES: non-conservative behavior (removal up to 54%) → mainly humic
      - Especially @ low salinity → FLOCCULATION AND/OR PHOTODEGRADATION
    - »MARINE SITES: conservative mixing



# MOVING FORWARD

- **What happens to DOM in its way from the river to the Atlantic basin, through the Arctic basin?**
  - Arctic expedition 2012 (central Arctic and Polar drift)
  - Fram Strait expedition 2014 (Arctic outflow)
- **Preliminary results – Fram Strait** (Gonçalves-Araujo et al. *in prep.*)
  - Lower DOM concentrations
  - Greater contribution of refractory compounds
    - Still dominated by Humic-like compounds
  - Photochemical reactions through the Arctic basin



# THANK YOU - спасибо



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