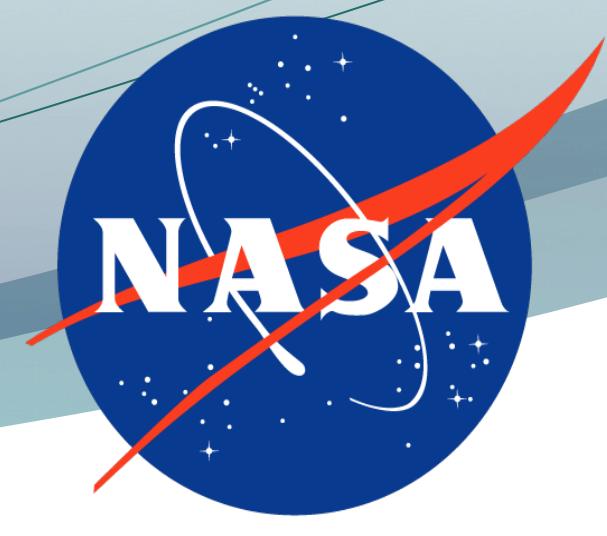


# Exploring Spatial and Temporal Variations of Arctic Circulation Using Oxygen Isotopes of Seawater



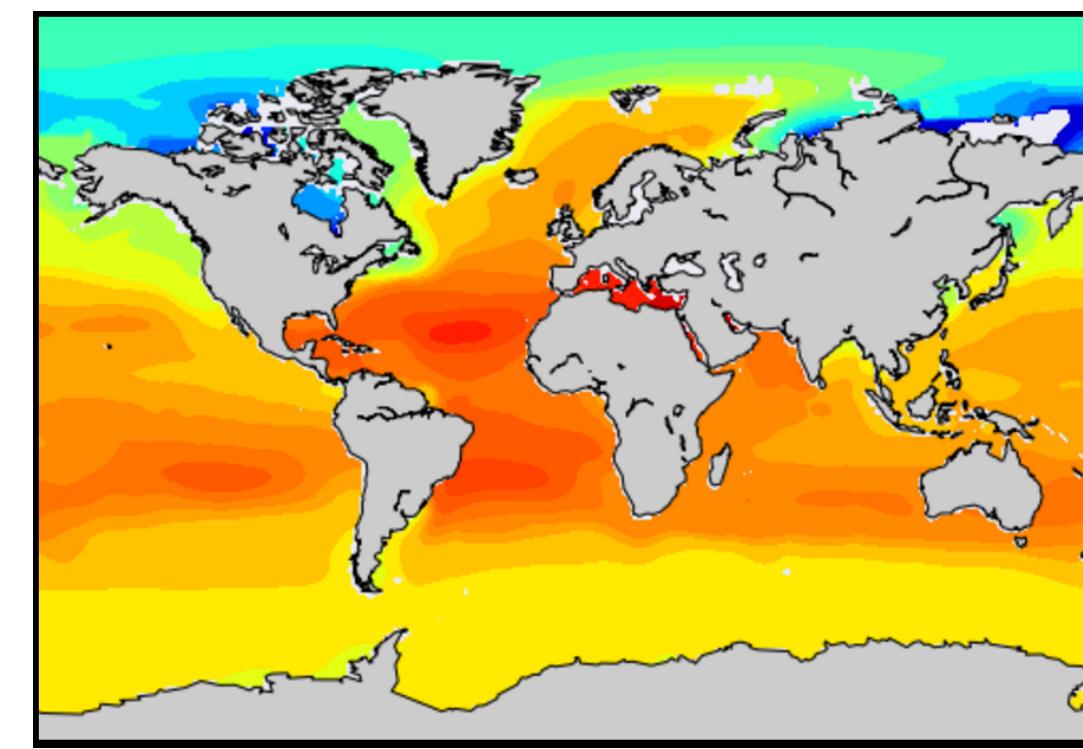
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## Introduction

Observations from the past sixty years of seawater  $\delta^{18}\text{O}$  and salinity were compiled into a database by Schmidt et al. (1999) and used to calculate a three-dimensional  $1^\circ \times 1^\circ$   $\delta^{18}\text{O}$  global gridded dataset by LeGrande and Schmidt (2006; LS06) (fig 1.1).

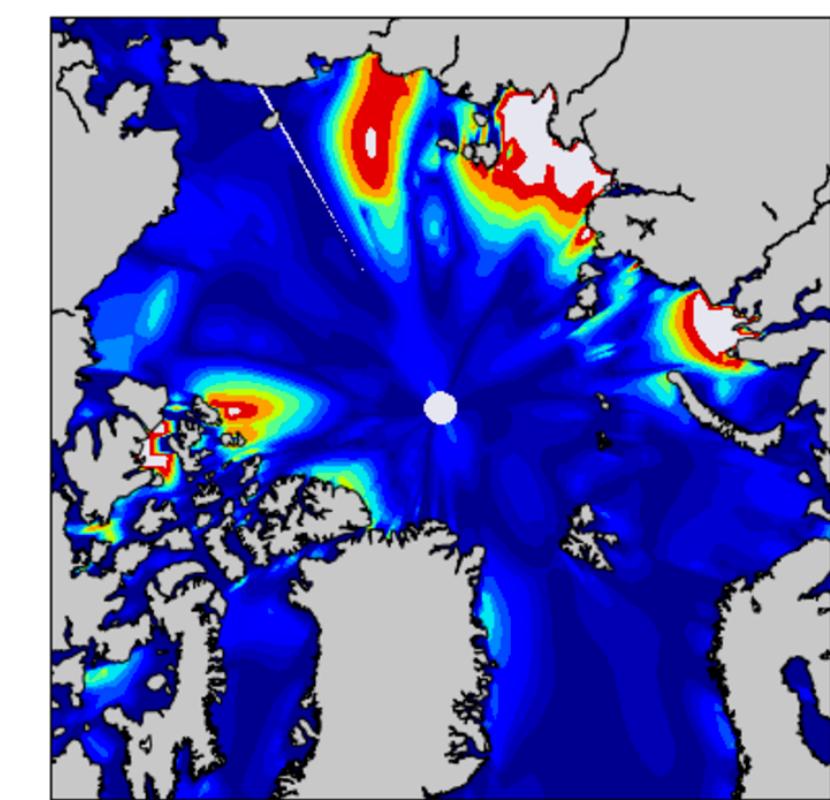
**Fig 1.1** LS06 v1.18 Global  $\delta^{18}\text{O}$



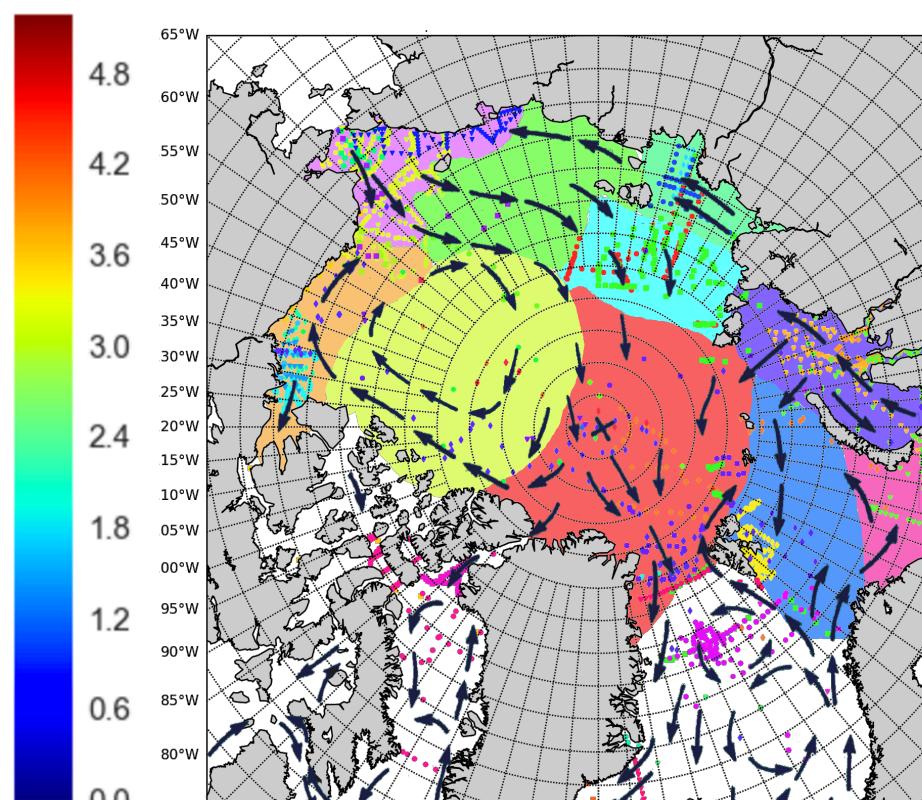
$\delta^{18}\text{O}$

Because freshwater processes impact the isotopic composition of seawater as they impact salinity, regional linear regressions (Craig and Gordon, 1965) can be leveraged to trace hydrology. This study updates the Schmidt et al. (1999) database, examines discrepancies between estimated and calculated  $\delta^{18}\text{O}$  using the Arctic Ocean as a case study (fig 1.2.), and recalculates LS06.

**Fig 1.2** Arctic  $\delta^{18}\text{O}$  Discrep.



**Fig 1.3** 10 Arctic Regions



The Arctic Ocean is parsed, QC'd and analyzed according to geography, surface currents (fig 1.3) and seasonality (fig 2.1a,b).

## Methods

- Added 3k (10% increase) to Schmidt et al. (1999) database.
- LS06 method to update global gridded dataset (fig 1.1).
- Measured Arctic discrepancies (estimated-calculated  $\delta^{18}\text{O}$ ) from 0-10m integrated above 66 N (fig 1.2)  $\sim 2992 \delta^{18}\text{O}$ .
- Explored 10 regions of the Arctic Ocean parsed by geography and surface currents (Brown 2001, fig 1.3) for root cause of discrepancies.
- Jackknife slope analysis to QC each region (fig 2.6).
- Linear regression to find regions of unique  $\delta^{18}\text{O}$ -sal relationships under two temporal regimes—frozen (4 regions in JFMAOND) and melt (10 regions in MJJAS).
- Regions consolidated using similar  $\delta^{18}\text{O}$ -Sal relationships.
- Recalculated global gridded dataset (LS06) and analyzed discrepancies for each regime.

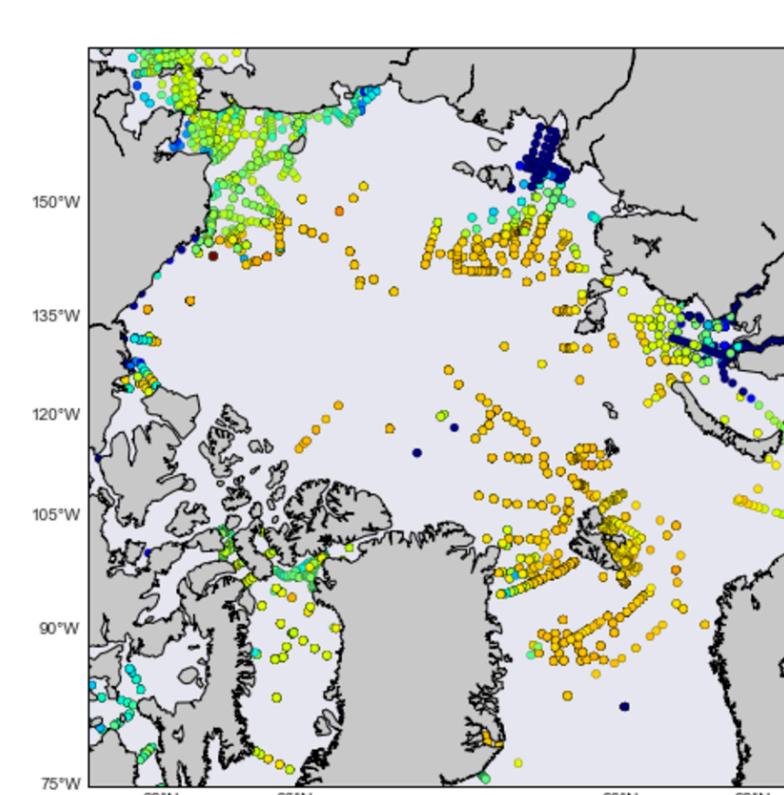
## Future Work

Use Jackknife to QC globally and along isopycnals.  
How does sea ice dampen the relationship?  
How will these trends change as Arctic warms?

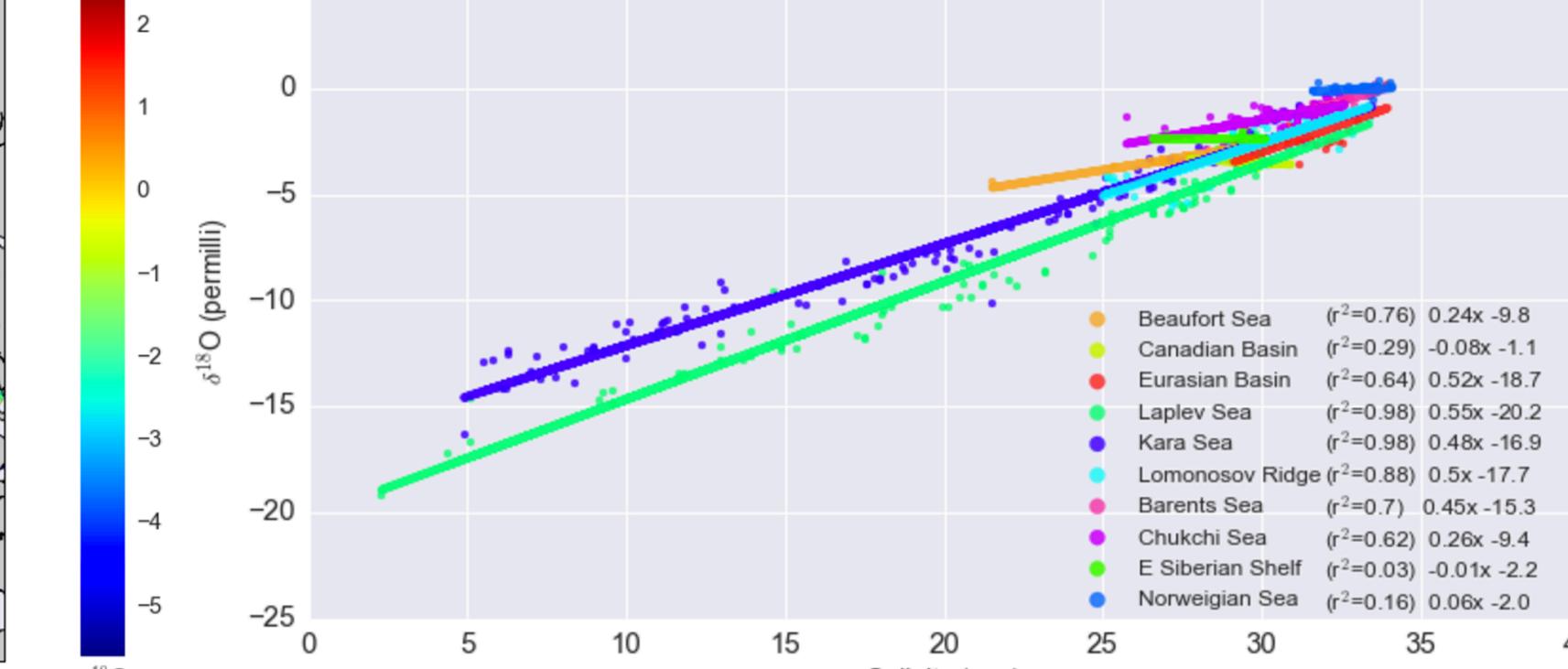
## Quality Checks and Water Mass Consolidation

New York City Research Initiative

**Fig 2.1a** Melt Season (MJJASO)  $\delta^{18}\text{O}$  Dist.



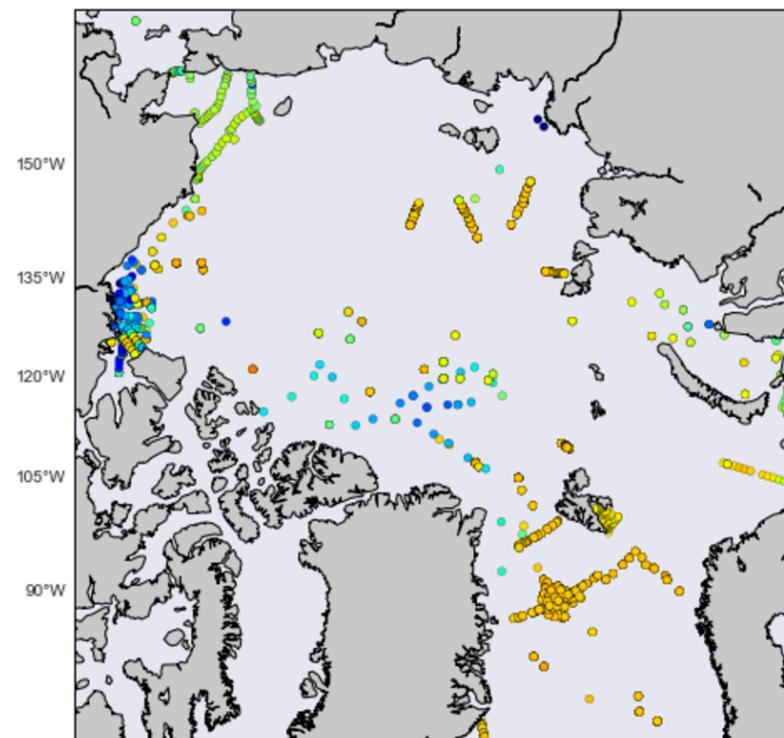
**Fig 2.2a** Melt Season  $\delta^{18}\text{O}$ -Sal Relationship of 10 Regions



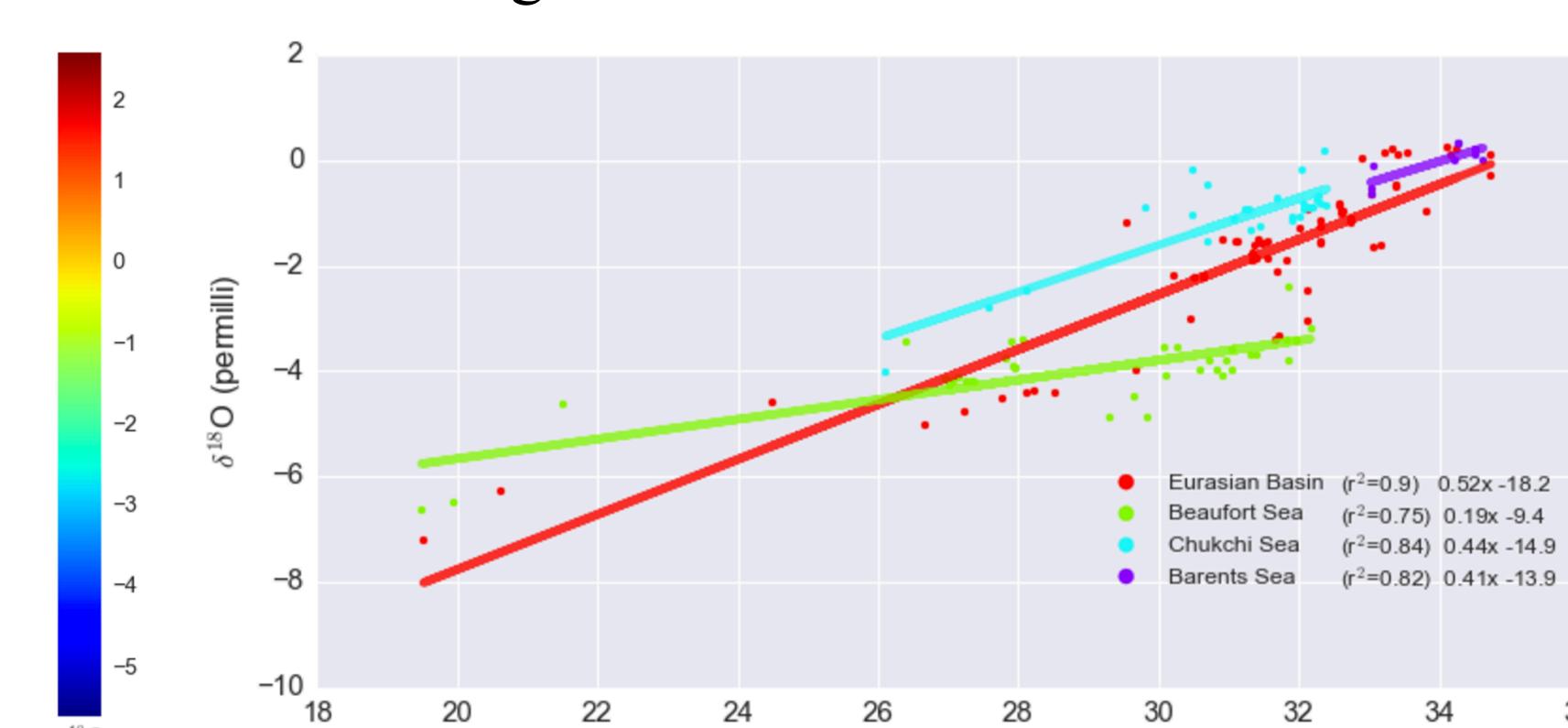
Strong spatial distribution and freshwater gradients from coastal meteoric sources to open ocean.

Compatible mixing gradients (slope) and freshwater end-members (y-int) marked with solid ticks (right) and merged (fig 2.3a). Poorly sampled regions with low  $R^2$  denoted with a dashed tick and aggregated with nearest neighboring region.

**Fig 2.1b** Frozen Season (JFMAOND)  $\delta^{18}\text{O}$  Dist.



**Fig 2.2b** Frozen Season  $\delta^{18}\text{O}$ -Sal Relationship of 4 Regions



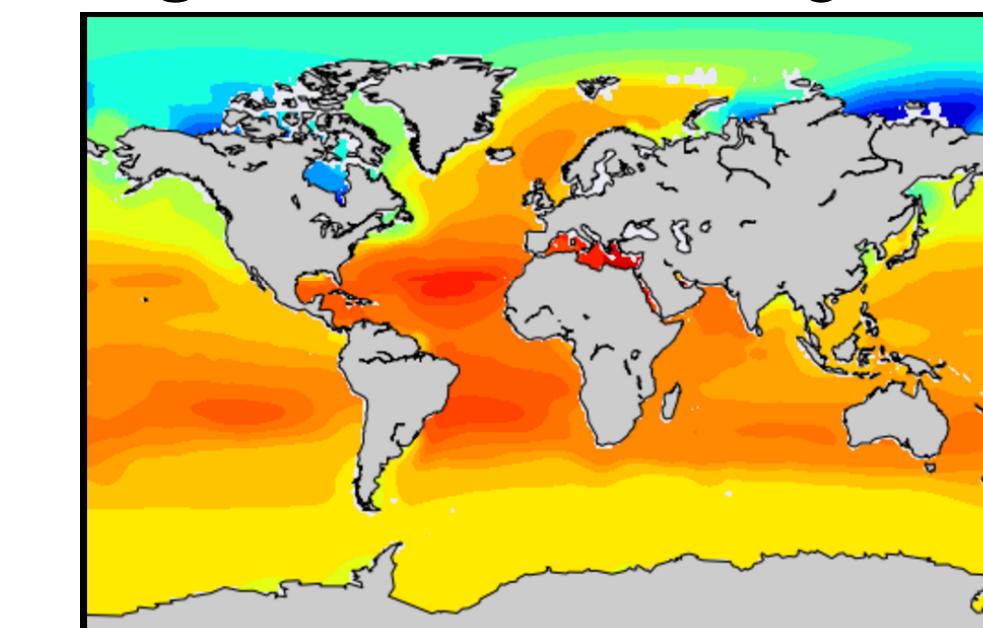
Sea ice limits regions to: Chukchi, Beaufort, Barents and Eurasian Basin. Gradients weaker.

Less dynamic hydrology when freshwater flux is low from 3 freshwater sources in fig 2.3a and sample distribution is poor.

## Conclusion

The Arctic is a small land-enclosed body of water with complex circulation and diverse inputs. Transient meteoric water from river discharge leaves a lasting imprint. To reflect this, LS06 is calculated using 3 regions in Melt season (right) and 2 regions in Frozen season (not pictured). Despite the variable hydrology in the Beaufort Gyre, discrepancies are. Due to poor spatial distribution of Frozen season, calculated  $\delta^{18}\text{O}$  is disproportionately shaped by few measurements.

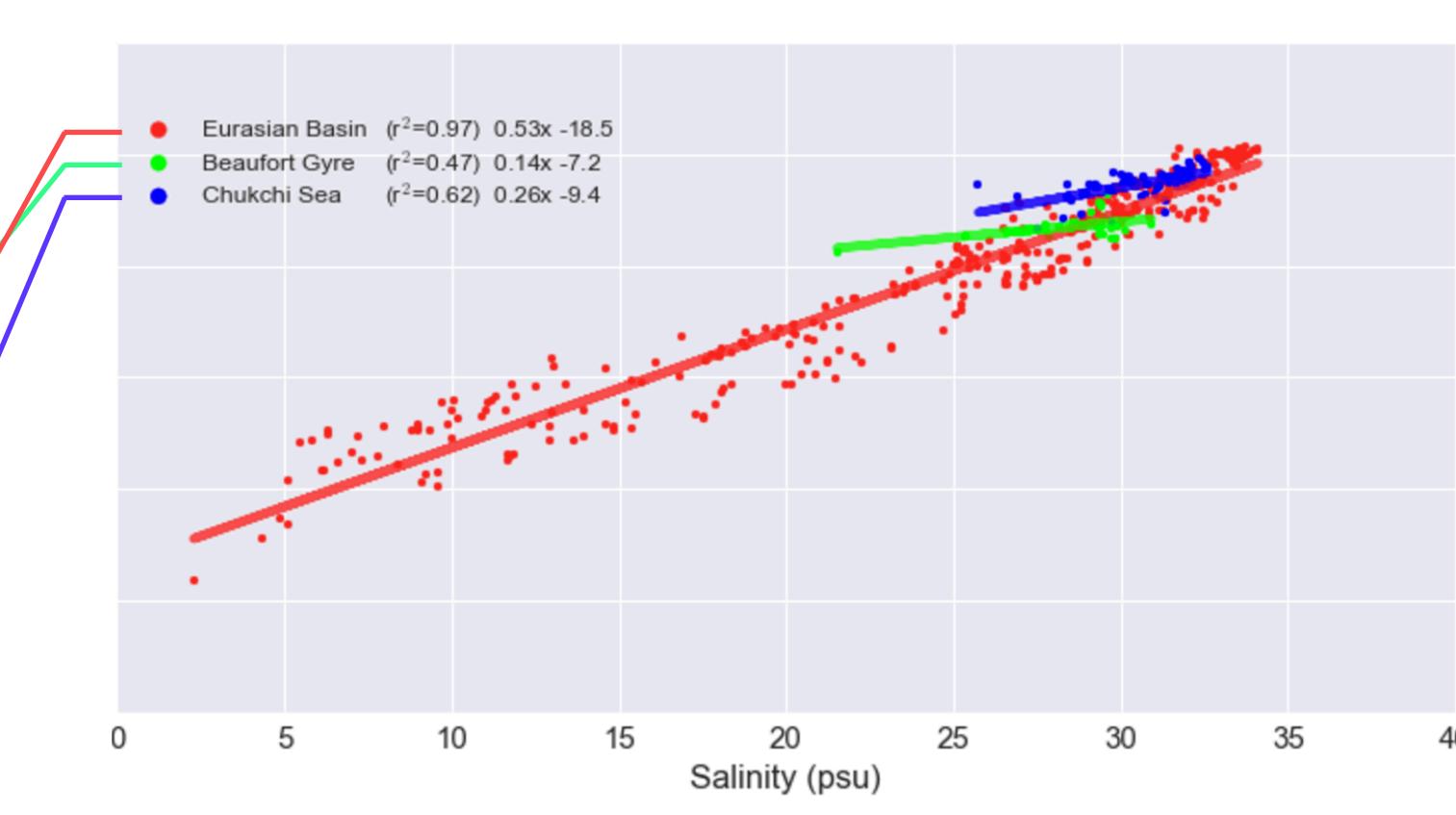
**Fig 3.1** LS06 Melt 3 Regions



## Acknowledgements

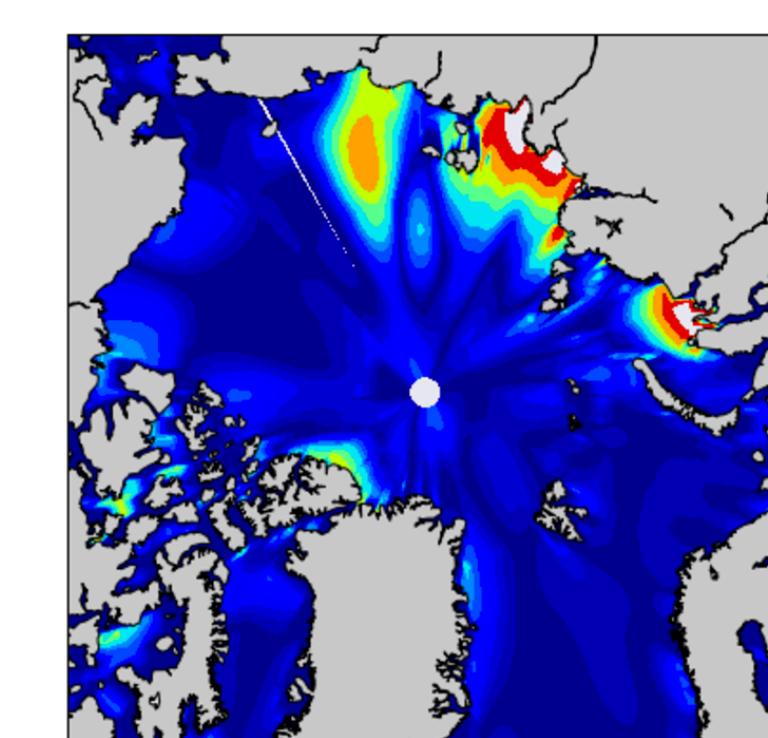
We would like to thank NYCRI education director Matthew Pearce, our mentor Dr. Allegra LeGrande and Dr. Leon Johnson for supporting us with NSF award number AGS-359293.

**Fig 2.3a** Melt Season  $\delta^{18}\text{O}$ -Sal Relationship of 3 Regions



Unique  $\delta^{18}\text{O}$ -Sal relationships represent three Arctic freshwater sources visible in fig 2.1a gradients—Bering Strait (purple) and Russian (red) and Canadian (green).

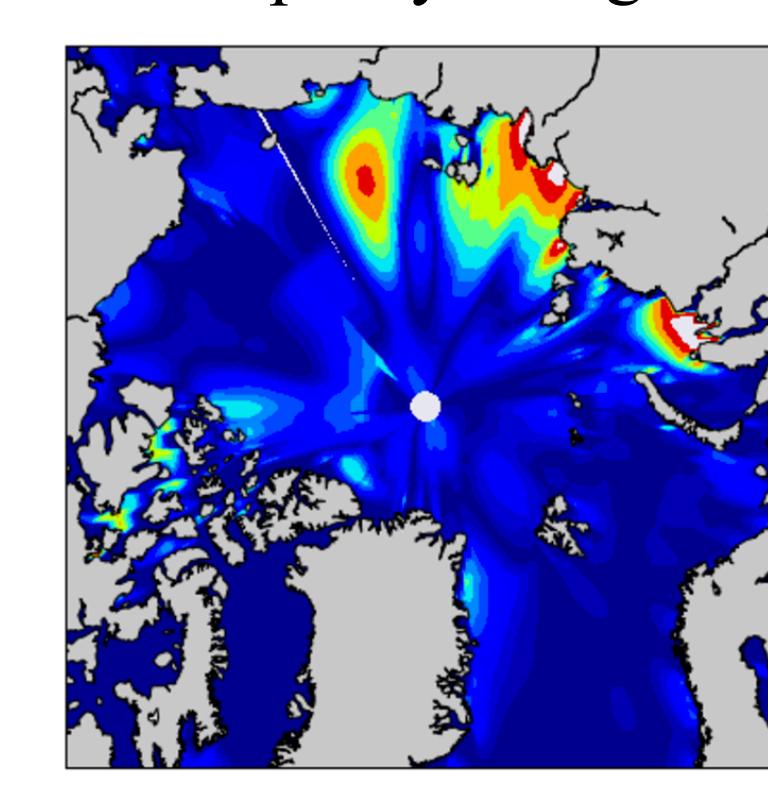
**Fig 2.4a** Melt Arctic Discrepancy 3 Regions



Discrepancy reduced by 700  $\delta^{18}\text{O}$  compared to fig 1.2.

Beaufort Gyre discrepancy eliminated. East Siberian Shelf more accurate despite lack of sampling coverage.

**Fig 2.4b** Frozen Arctic Discrepancy 2 Regions



Discrepancy reduced by 500  $\delta^{18}\text{O}$  compared to fig 1.2.

The Melt 3 WM is more accurate, calculate LS06

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