

# Variability of Arctic Sea Ice Export and Deformation through Nares Strait

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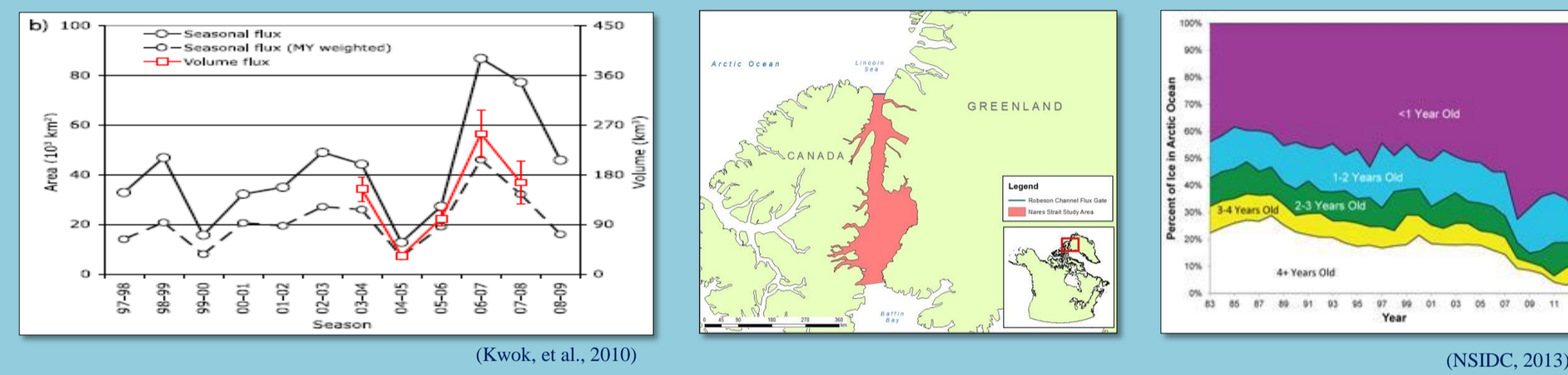
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**NSTP** **PFSN**  
Northern Scientific  
Training Program Programme de formation  
scientifique dans le Nord

## Introduction

Nares Strait is a major conduit for sea-ice export from the Arctic Ocean and thus affecting climate and human activities further south. Due to the large role that Nares Strait plays in the Arctic sea-ice regime, the conditions and dynamics of this region could further contribute to overall depletion of ice formation and thickness – the Arctic sea ice mass balance.

The research design drawn upon Kwok's study "Variability of Nares Strait" (2005) and "Large Sea Ice Outflow into Nares Strait in 2007" (2010). The main focus of this study is to extend the time series from 2009-2013 and to investigate the atmospheric influence on the sea ice regime within the strait.



## Research Questions

**What is the flux of sea ice exporting through Nares Strait over the years of 1997-2013?**

What is the percentage of the total Arctic sea ice budget is incorporated in this flux?

**How has the changes to wind strength and speed affected the dynamics through the strait?**

What are the observed changes to the wind dynamics within the study area over time?

**How well does the CIS-ASITS model ice motion within a high latitude narrow channel?**

How do the model results compare to the observed buoy trajectories?

## Objectives

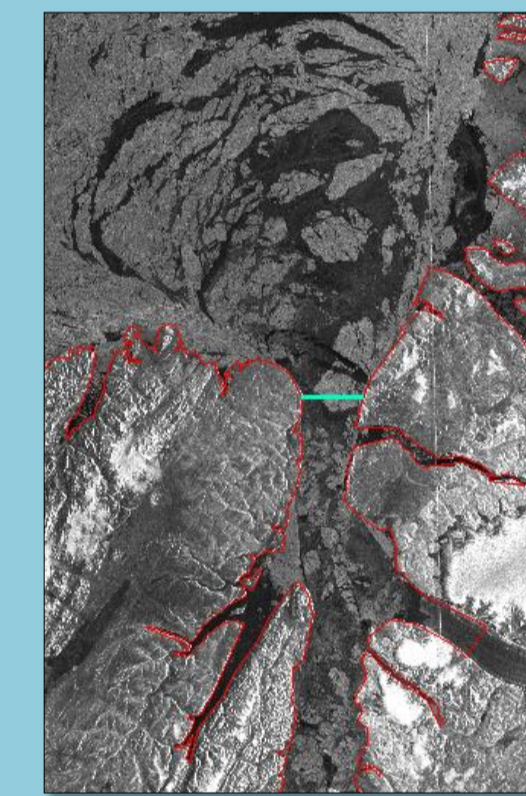
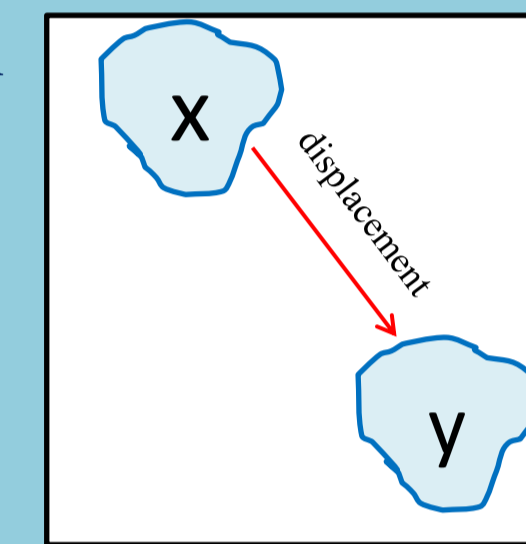
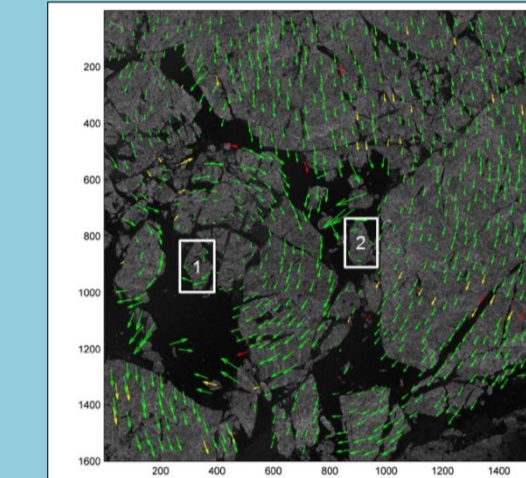
1. Process buoy data from Nares Strait and use the results to study ice drift variability
2. To retrieve ice motion from RADARSAT imagery and to calculate sea ice area flux through Nares Strait from 1997-2013
3. To validate satellite data used to measure ice drift.



## Methodology

### Part I: Remote Sensing Analysis

- 16 years – 1997-2013
- CIS-ASITS
- RADARSAT 1 and 2
- Based on Kwok 2005 & Kwok, et al., 2010
- Ice Motion (km/d)
- Can calculate MYI fraction from concentration and flux



#### Estimating Ice Flux <sup>1</sup>

$$F = \sum c_i u_i \Delta x$$

**c** = ice concentration  
= from CISDA – Regional Ice Charts  
**u** = ice motion normal to the flux gate  
= model products  
**Δx** = spacing along the gate  
= 5km

- Regression analysis to compare Ice flux yearly
- Use ArcGIS – Python to analyze vectors to perform this calculation for each image pair (can average for monthly and yearly flux after in Excel)
- Sea ice area flux = km<sup>2</sup>/d

#### Estimating Uncertainty of Flux <sup>1,3</sup>

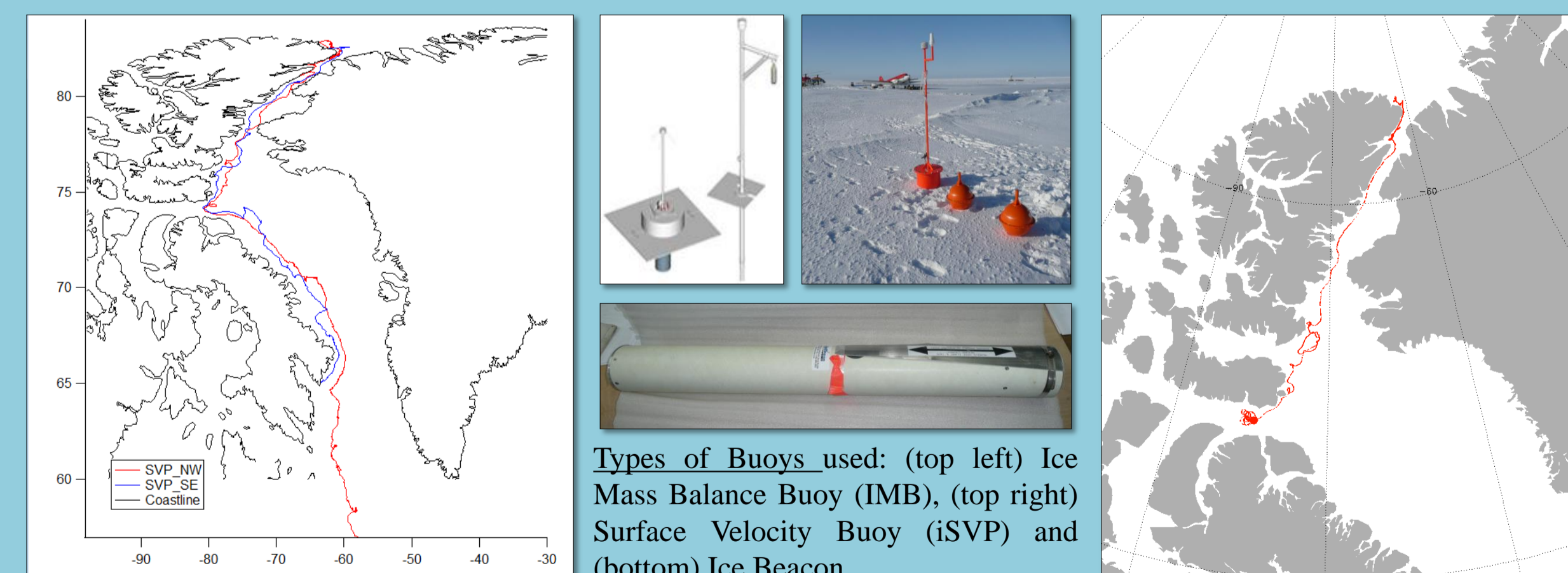
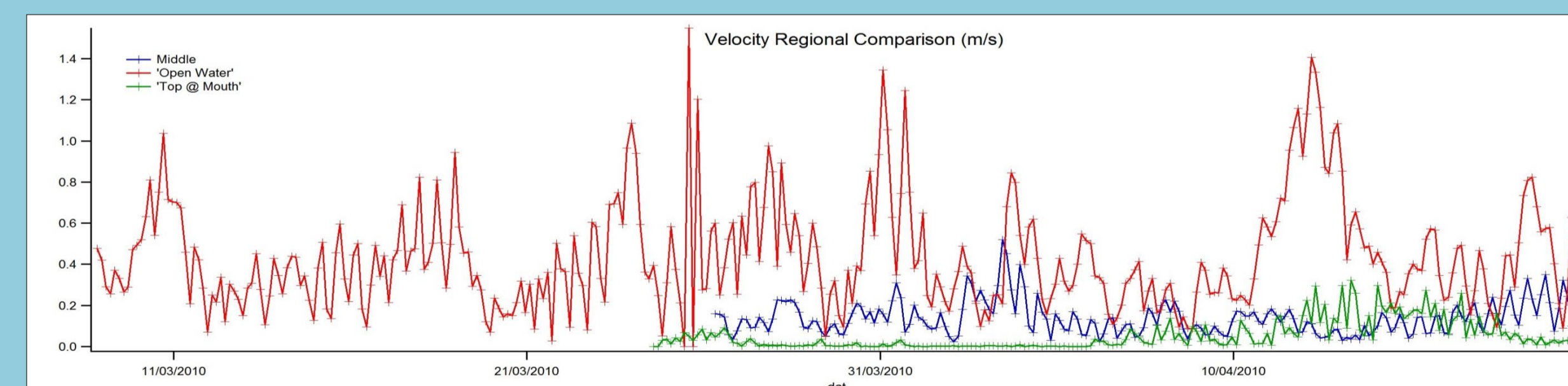
$$\sigma_f = \sigma_c L / \sqrt{N_s}$$

**σ<sub>c</sub>** = error in SAR derived ice velocities  
= -0.43 km/d (Komarov & Barber, 2013)  
**L** = width of flux gate  
= 40km  
**N<sub>s</sub>** = # of samples along the gate  
= (40km/5 = 8)

- Will provide a "source of error" for the specific flux gate – how much can the estimate vary by?

### Part II: Buoy Analysis

- Variables Collected: GPS, Barometric Pressure, Temperature, IMB information
- Ice Motion found by calculating displacement
- Validate model data



Types of Buoys used: (top left) Ice Mass Balance Buoy (IMB), (top right) Surface Velocity Buoy (iSVP) and (bottom) Ice Beacon

### Part III: Meteorological Analysis

- Still to be investigated further
- Possible use of NCEP/NARR data: wind, temperature
- Formulate atmospheric variable trends over the study period

## Expected Outcomes

- As sea ice becomes thinner, weaker and more deformed, wind forcing will have a greater impact on ice drift
- Sea ice area flux over time likely will show a positive, upward trend
- Positive correlations may be drawn between increasing sea ice area flux and positive climate perturbations within Nares Strait

## Relevance

There are a number of gaps this study will aim to meet:

- Sea ice export has not been quantified since 2009
- An in-depth study combining model results and buoy observations for the region has not been completed
- Focus of processes driving ice motion within the strait has largely been on the arching phenomenon
- Analysis of the fraction of MYI surging through Nares Strait has not been completed



## References

- <sup>1</sup> Howell, S., Wohleben, T., Dabboor, M., Derksen, C., Komarov, A., & Pizzolato, L. (2013). Recent changes in the exchange of sea ice between the Arctic Ocean and the Canadian Arctic Archipelago. *Journal of Geophysical Research*, 1-13.
- <sup>2</sup> Komarov, A., Barber, D. (2013) Sea Ice Motion Tracking From Sequential Dual-Polarization RADARSAT-2 Images. *IEEE Transactions on Geoscience and Remote Sensing*.
- <sup>3</sup> Kwok, R. (2005). Variability of Nares Strait ice flux. *Geophysical Research Letters*.
- <sup>4</sup> Kwok, R., Pedersen, L., Gudmandsen, P., & Pang, S. (2010). Large sea ice outflow into Nares Strait in 2007. *Geophysical Research Letters*.