AN ICEBERG DRIFT MODEL FOR THE BARENTS SEA

LOM

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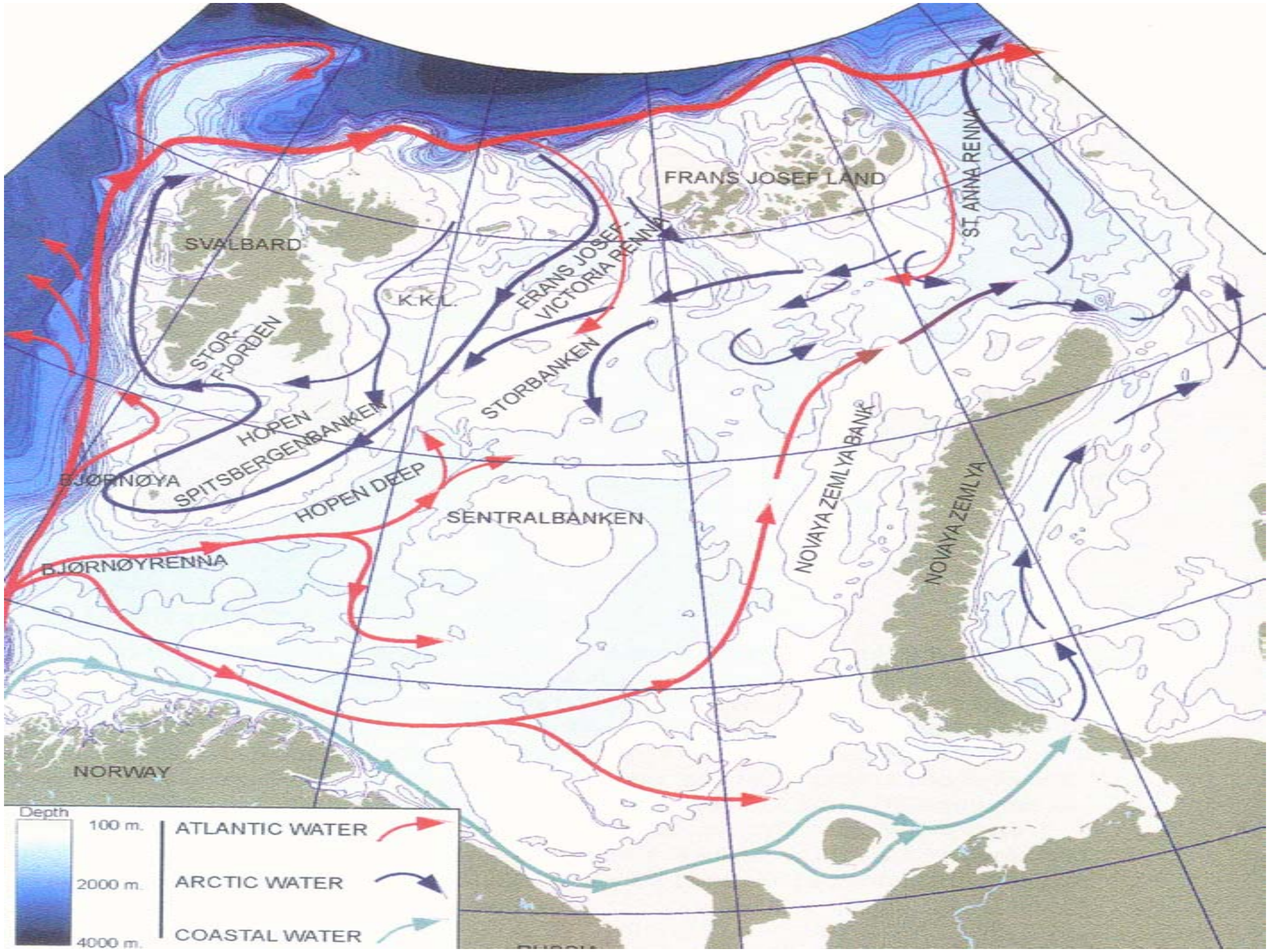
Outline

- Circulation in the Barents Sea
- Sources of icebergs
- Iceberg model equation
- Validation against data from Russian buoy deployment in 1989
- Conclusion & future work

Circulation



Sources of icebergs

Average 300 000 tons (90 x 60 x 15m) **(Ice Data Acquisition Project, IDAP, 1994)**

Max. observed 6.2 mill. tons (320 x 270 x 40m) **(IDAP)**

Average speed 0.5 knots, maximum 2 knots. Mostly follow southerly current 40E **(IDAP)**

Iceberg drift model equation (Lichey 2001)

$$M * \frac{d\vec{u}}{dt} = \vec{F}_A + \vec{F}_W + \vec{F}_C + \vec{F}_{SS} + \vec{F}_{SI}$$

M: Mass
F_A: Atmospheric drag
F_w: Ocean drag
F_c: Coriolis force
F_{ss}: Force due to the sea surface slope
F_{si}: Force due to sea ice

Iceberg drift model
Ocean(W) and Air(A) drag components

Smith and Banke,1983 relationship:

$$\vec{F}_x = (\frac{1}{2} * \rho_x * c_x * A_{vx} + \rho_x * c_{dx} * A_{hx}) * |\vec{v}_x - \vec{u}| * (\vec{v}_x - \vec{u})$$

$_x$: refers to air(A) and water(W)

ρ_x: medium density

c_x: dimensionless coeff of resistance

c_{dx}: dimensionless drag coeff for very smooth surface

A_{vx}: area of iceberg wall in contact with the wind /oceanic flow

A_{hx}: horizontal area of iceberg in contact with the wind (top)/ocean (base) current

V_x: wind/ocean current velocity

u: iceberg velocity

Iceberg drift model
Coriolis and Sea surface slope components

$$\vec{F}_C = 2 * M * \Omega * \sin\phi * \vec{k} \times \vec{u},$$

$$\vec{F}_{SS} = -M\vec{g} * \sin\alpha$$

Ω: rotation of the Earth

k: unit vector perpendicular to the Earth

g: acceleration due to the gravity

α: tilt of the sea surface estimated from the barotropic part of the modeled ocean velocity

Iceberg drift model

Sea Ice Forces

$$\vec{F}_{SI} = \begin{cases} 0 & : \quad A \leq 15\% \\ \frac{1}{2} * \rho_{SI} * c_{SI} * A_{SI} |\vec{v}_{SI} - \vec{u}| (\vec{v}_{SI} - \vec{u}) & : \quad 15\% < A < 90\% \\ -(\vec{F}_A + \vec{F}_W + \vec{F}_C + \vec{F}_{SS}) & : \quad A \geq 90\% \text{ and } P \geq P_s \end{cases}$$

$$P = P^* * h * \exp\{-20(1 - A)\}$$

A: sea ice concentration

ρ_{si}: sea ice density

C_{si}: sea ice coefficient of resistance

A_{si}: product of sea ice thickness and iceberg width

V_{si}: sea ice velocity

P: sea ice strength parameter (resistance of sea ice)

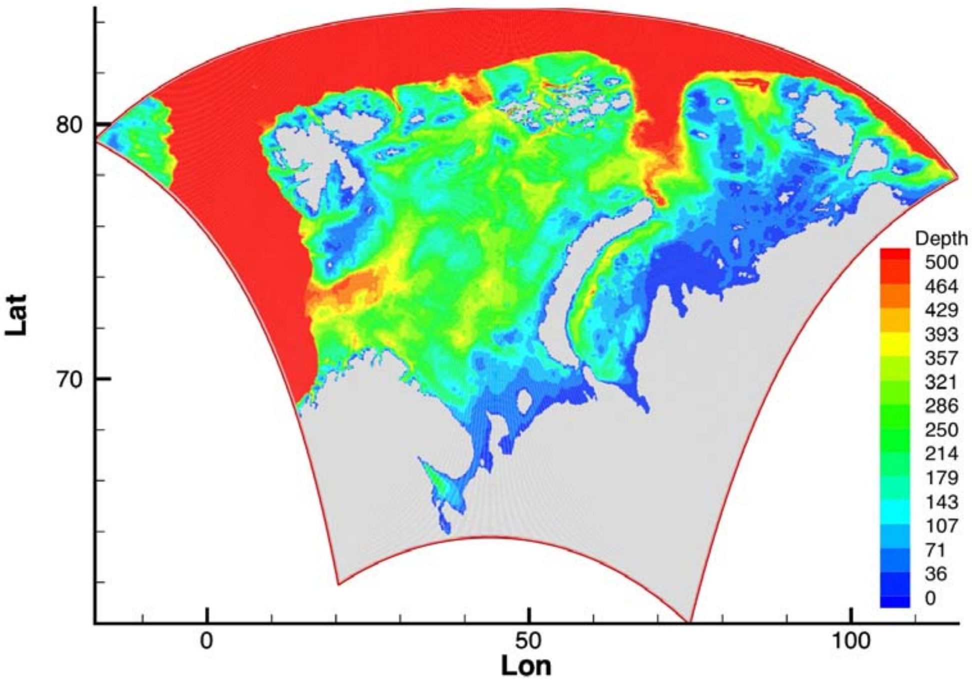
P_s and P^*: threshold value and empirical coefficient

h: ice thickness

Forcing computation

Daily averages forcing

- 10m wind field from ERA40 with 1.125⌖resolution
- Sea Ice data from a nested configuration of HYCOM. TOPAZ gives boundary conditions to a Barents Sea model of 9-12 km resolution
- Ocean velocities interpolated over the iceberg draft from HYCOM Barents Sea model of 9-12 km resolution
- Tides are not included

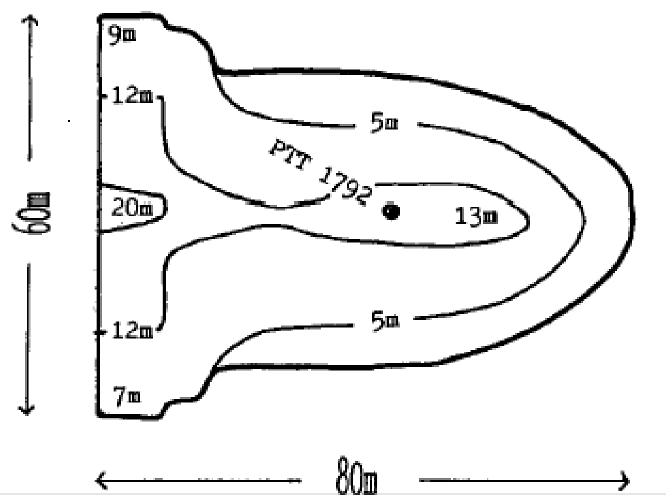


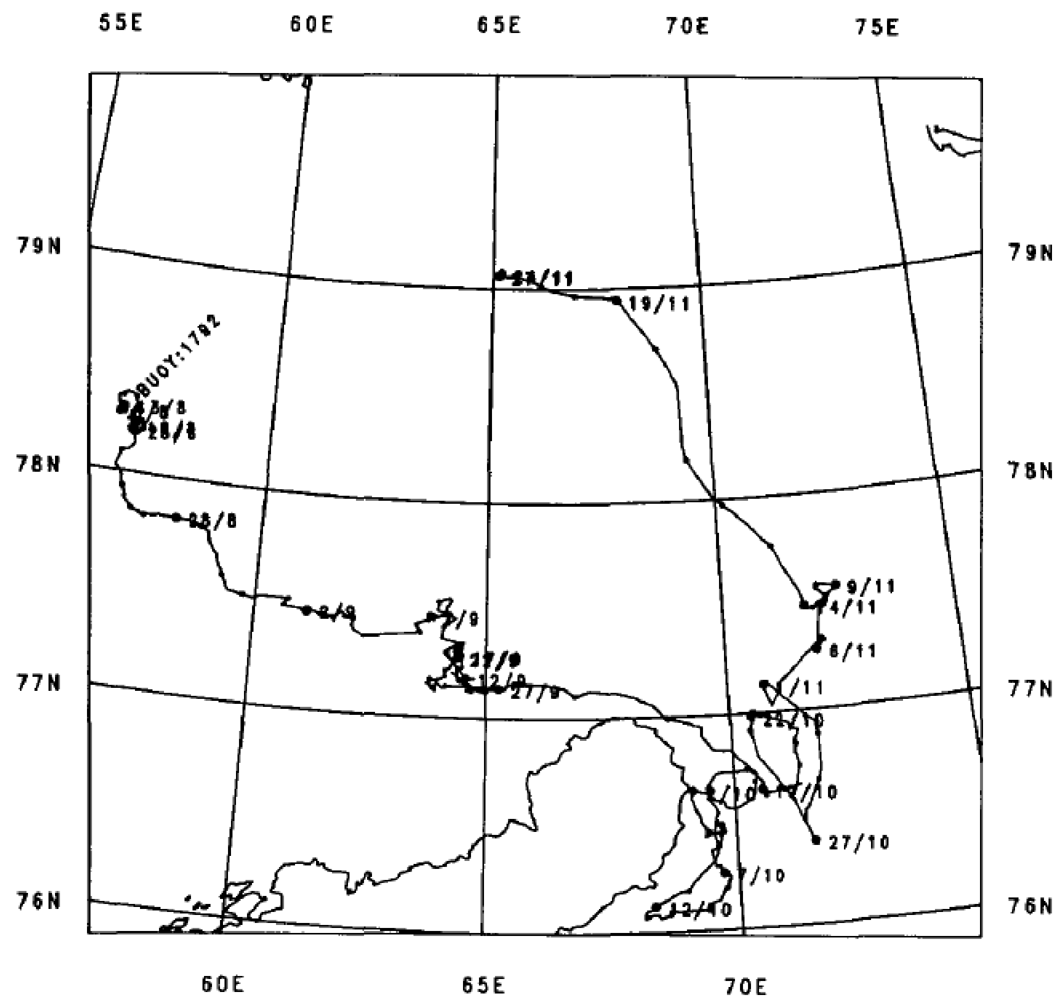
Data: iceberg #1792 (IDAPreport89)

Drifted from August 8 to November 27th 1989

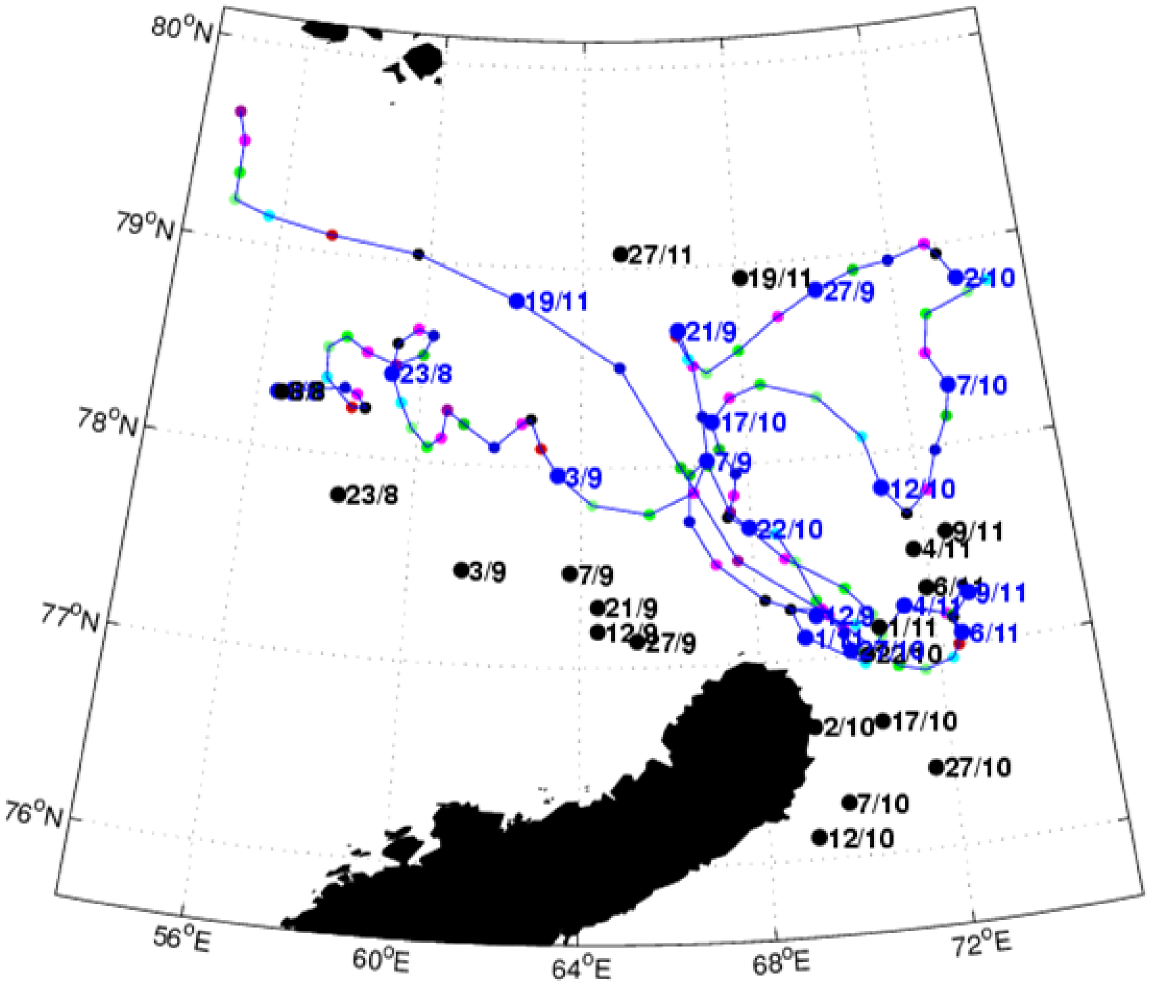
Mean length: 80m

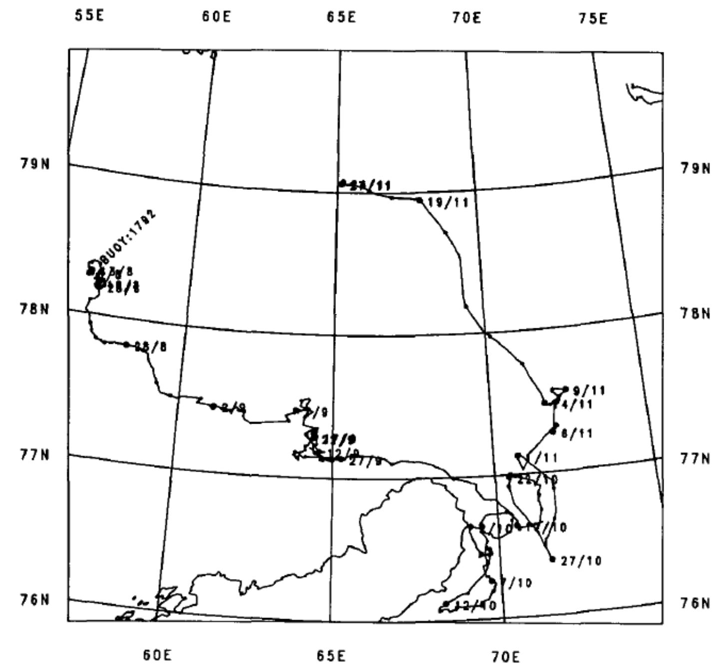
Mean width: 40m



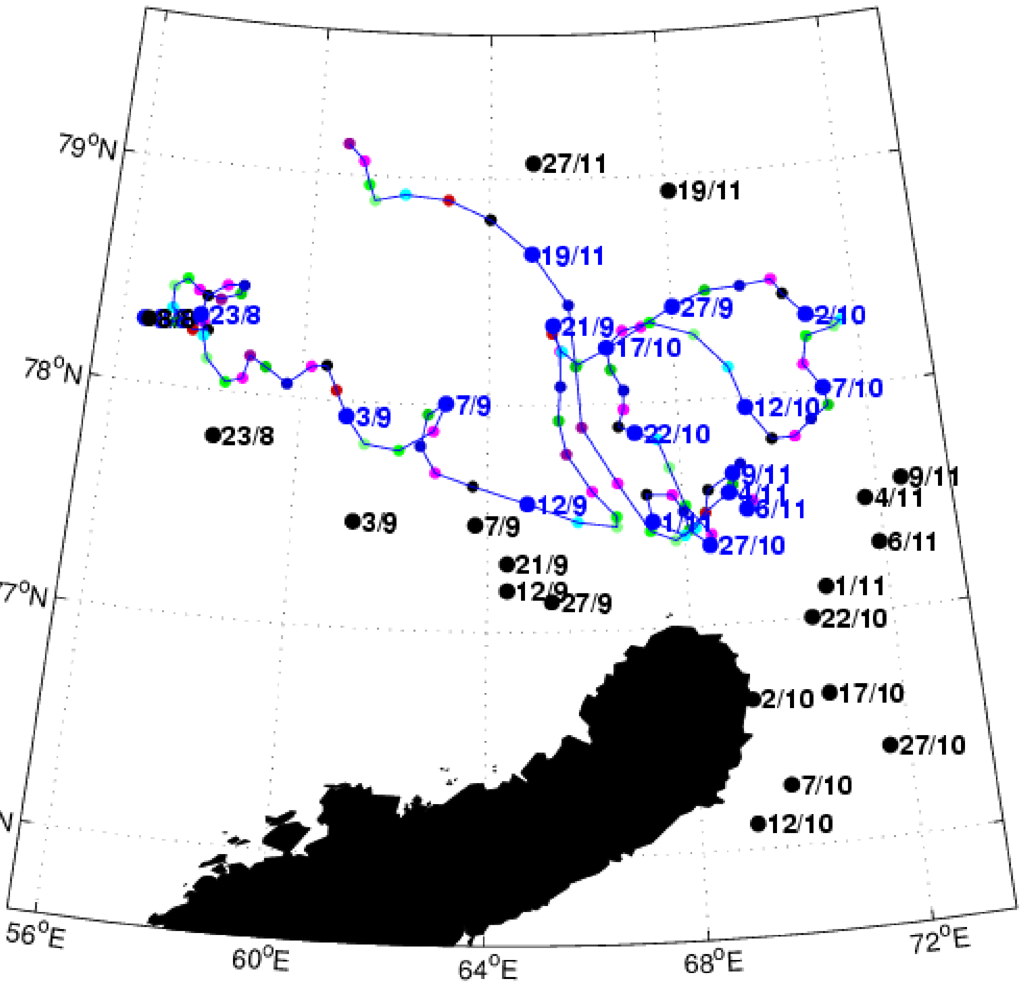


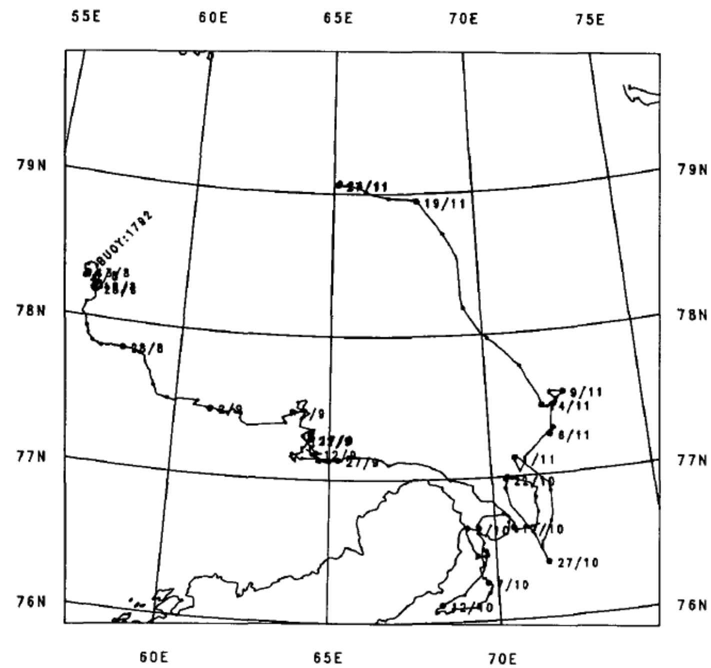
3 exp with 3 ≠ iceberg drafts 8m



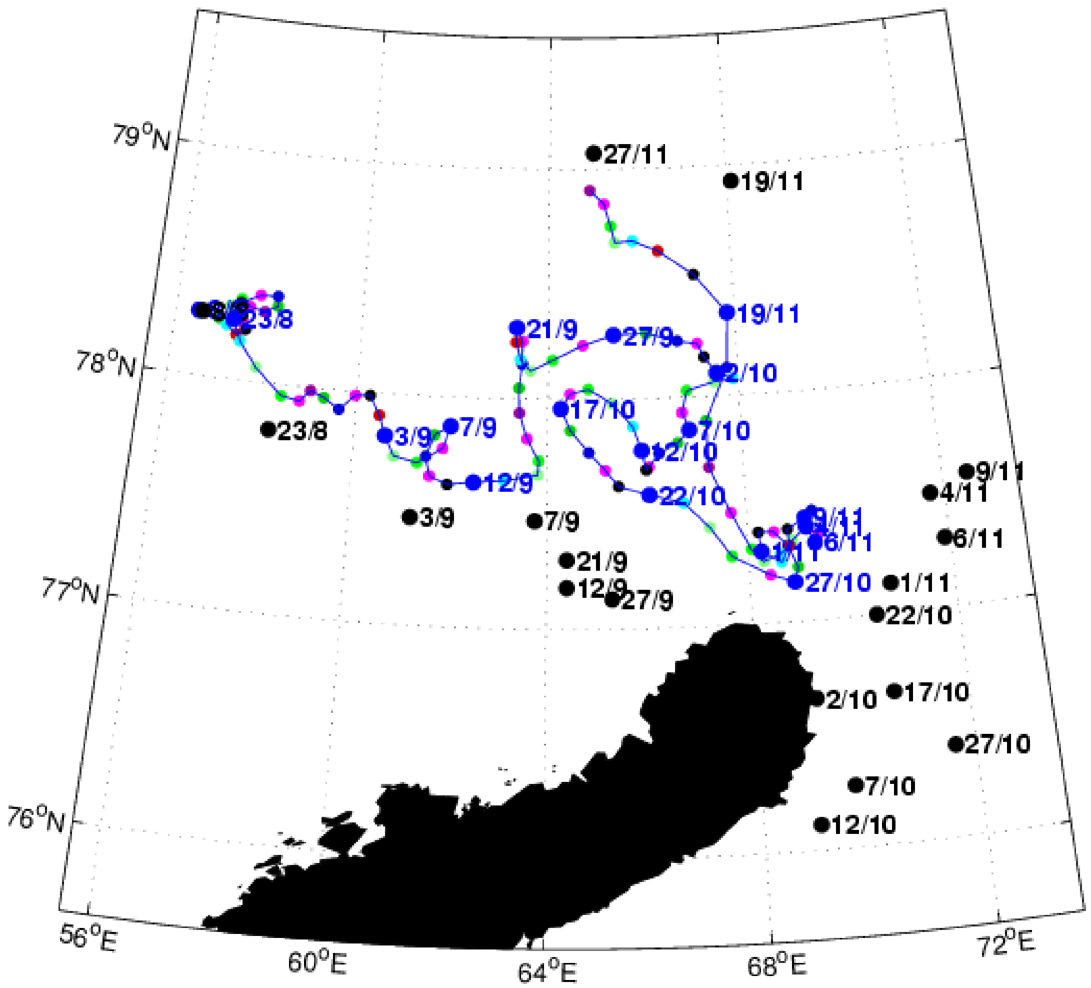


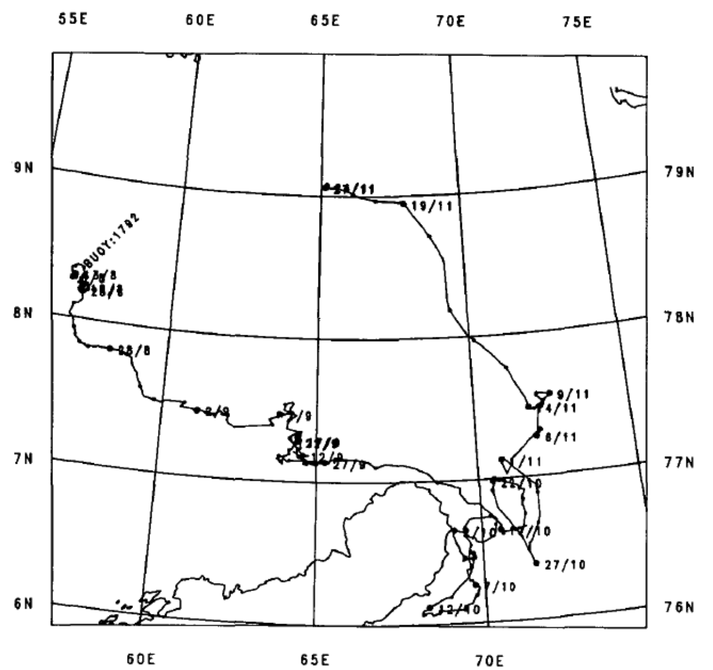
3 exp with 3 ≠ iceberg drafts
13m



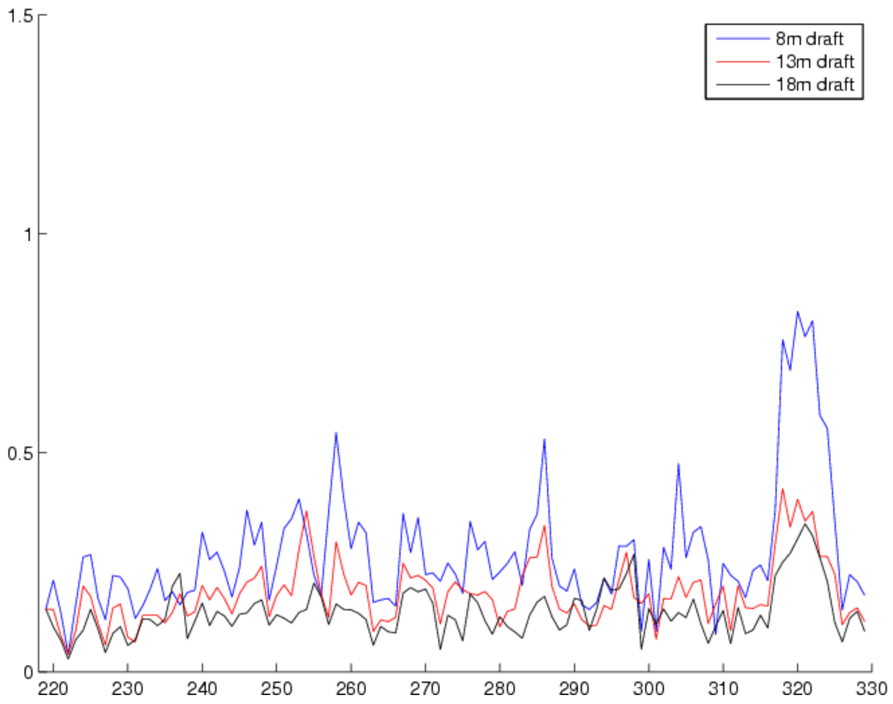


3 exp with 3 ≠ iceberg drafts
18m

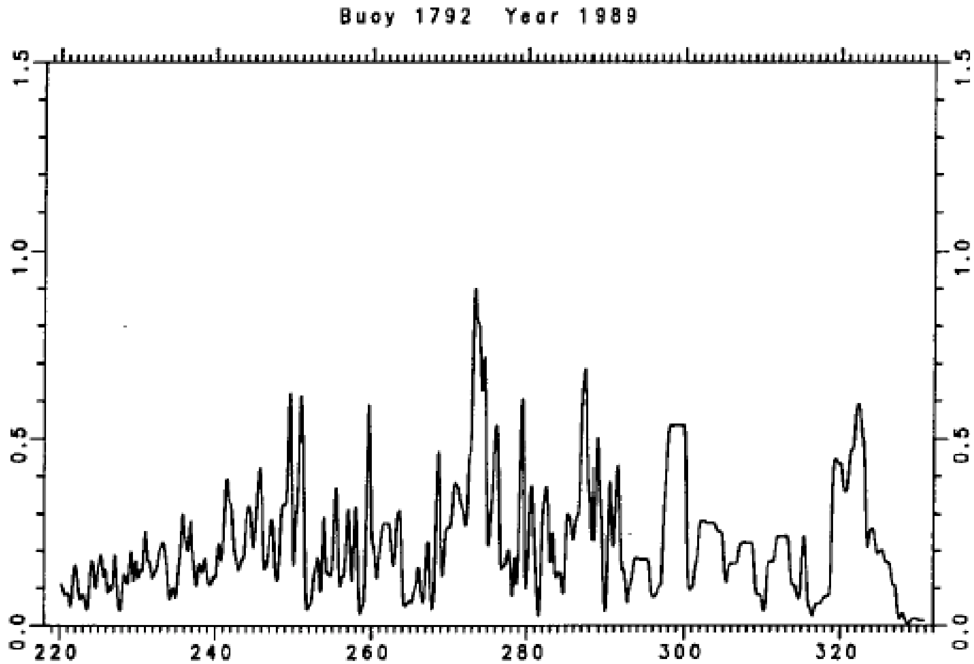




Drift speed

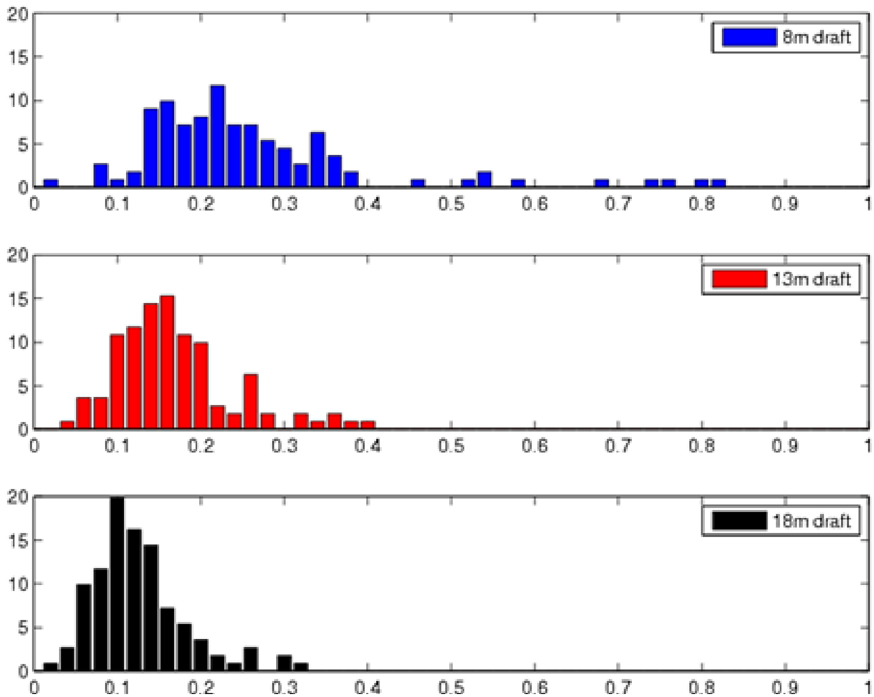


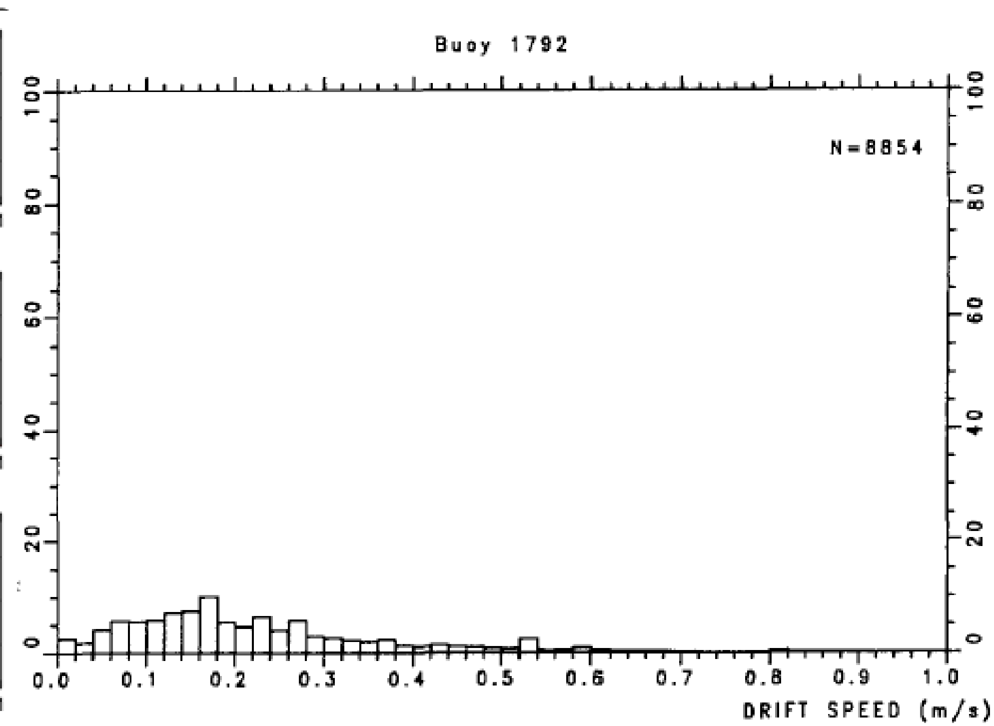
N=111



N=8854

Icebergs velocities distributions

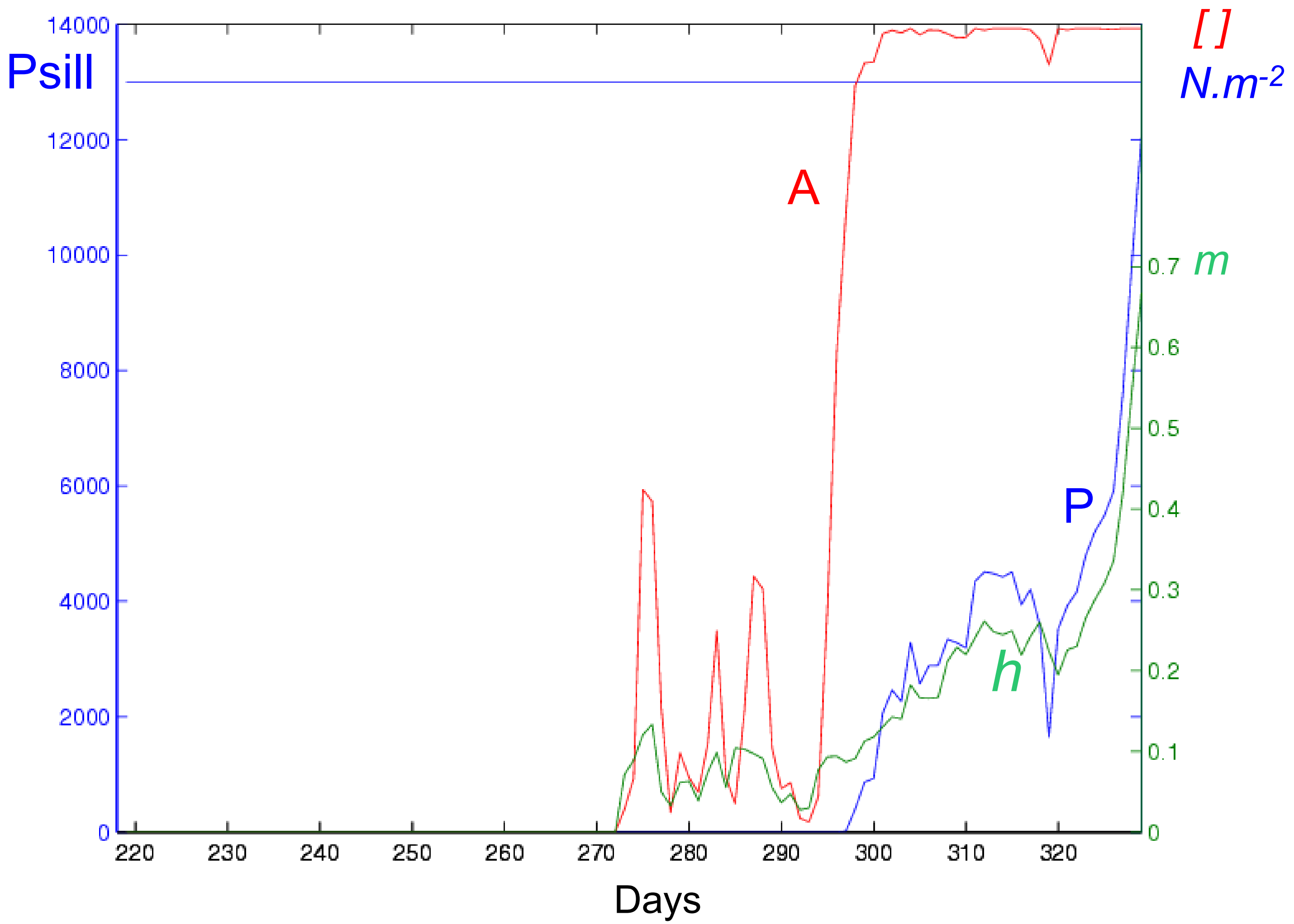




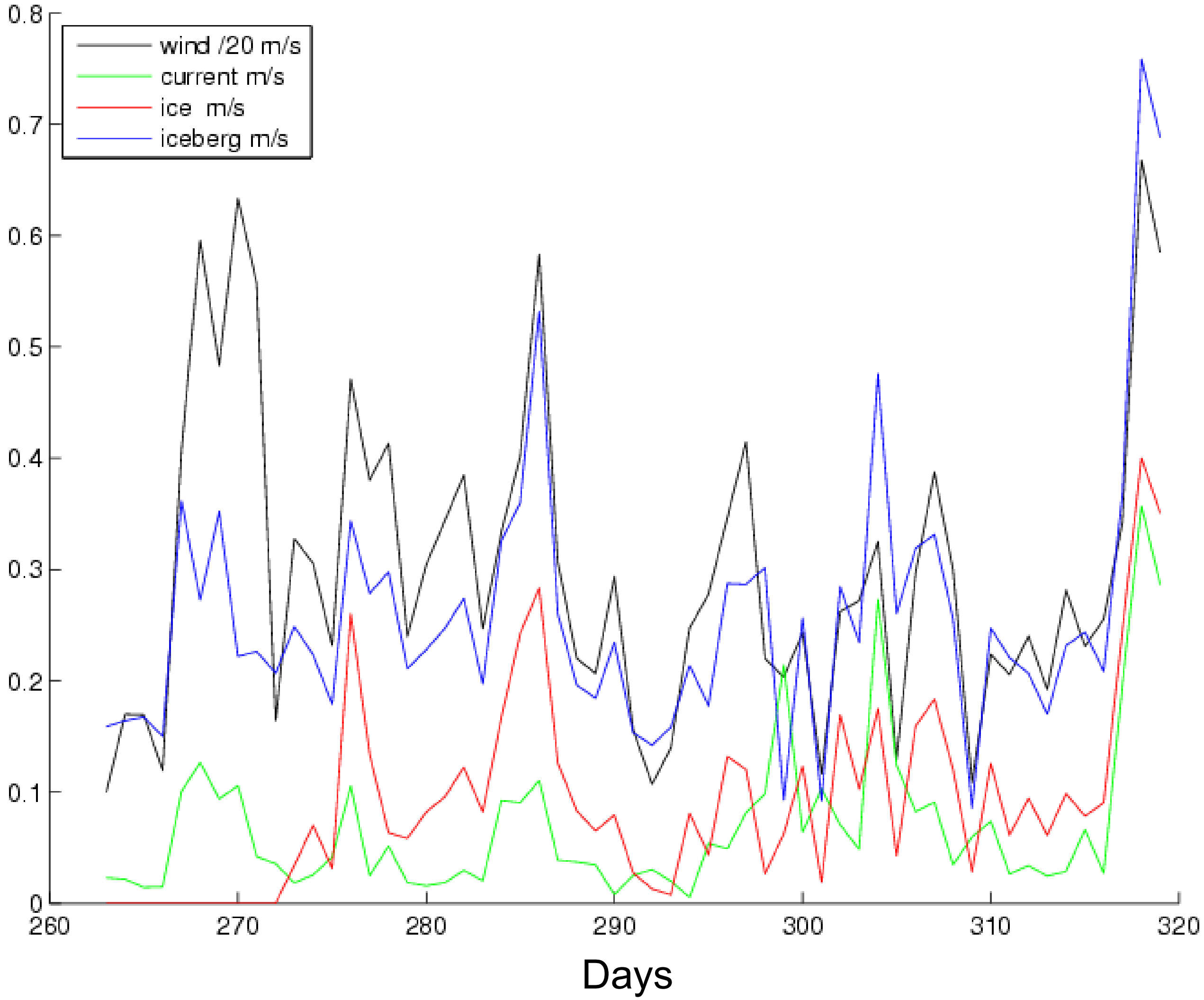
N=111

Sea ice strength characteristics ex: 8m draft iceberg

$$P = P^* * h * \exp\{-20(1 - A)\}$$



Forcing velocities ex: 8m draft iceberg



Conclusion

- **Modeled trajectories and velocity distributions are comparable with the observed one**
- **The model is sensitive to the iceberg draft size**
- **The wind is the dominant contribution in this example**

Future work

- **Test the model on other iceberg drift events**

- **Model improvements**
  - Include tides
  - Melting
  - Higher resolution of the forcing fields (STORM winds)

- **Ensemble run with perturbation of**
  - the size of the icebergs
  - the initial position of the iceberg
  - each forcing component

Thank you !