Review of PhD thesis *Wind effect on ice dynamics* by Parisa Radan

Knut V. Høyland
The Norwegian University of Science and Technology (NTNU)
7491 Trondheim, Norway
The University Centre in Svalbard (UNIS)
knut.hoyland@ntnu.no

Summary

I recommend that the thesis of Parisa Radan entitled *Wind effect on ice dynamics* is accepted. The thesis consists of 8 chapters and contains three main parts;

- Developing experimental set-up and carrying out experiments
- Analysing data from experiments
- Numerical modelling.

The thesis presents interesting and well conducted experiments, thorough analysis and applies the interesting results in the advanced numerical model DynaRICE. In general the thesis is well written, but at times the text could have been shorter and more to the point. There are also some unclear points that are detailed below.

In my mind the strongest part is the one about experimental set-up and the experiments themselves. To my knowledge they are novel and very interesting. She also carried out repeated experiments with same number of fans and ice concentrations, and from the analysis this seems to have been necessary.

The analysis of the experiments is also well and thorough carried out. It is good that she quantifies not only the averaged values, but also studied the variability (standard deviations).

The application to full-scale cases is interesting and well written. As a PhD in engineering it is nice to see how the new knowledge can be implemented and applied in practical cases. It is sad that the new geopolitical situation prevents research collaboration as in case study number 2 .

1. Experiments

Radan has developed an advanced set-up to measure how wind affects ice drift. Especially the measurements techniques to quantify the wind and ice velocities are impressive. The experimental set-up seem to be well tested and the experiments well carried out. I have some questions and points for clarification below:

1. Coordinate systems. What are x, y and z directions? I cannot find these in Figure 3-9. In Figure 3-12 it looks like the vertical direction is called y?

2. What is the next step in experimental development? Can the next PhD student use your set-up, or should she develop some of the experimental techniques further?

2. Data analysis

The results were analysed and different results derived. A couple of points could be clarified:

1. Wind velocity profile.
   (a) What are vertical velocities in Figures 4-11 to 4-19? Is it really vertical, or should it be horizontal perpendicular to main wind and ice drift velocity?
   (b) Equations 2-1 and 5-1 both seem to give wind velocity at altitude z. What is 8.5 in 2-1? What is u_*
   (c) Can you explain what is the smoothing length?
2. Wind shear stress
   (a) Should equation 5-2 have included C_a so that it becomes $\tau = \rho_a \cdot C_a \cdot v^2$?
   (b) Is thee a typo on page 124 when describing the choice of C_a for DynaRICE? Should it be $15 \cdot 10^{-3}$ or should it be $1.5 \cdot 10^{-3}$?
   (c) Could you explain how you derived the wind drag coefficient (C_a) from Equation 5-3.

3. Numerical modelling and comparison

1. What is the unit (or dimension) in Equations 3-1 to 3-6? You use the term $forces$, but as far as I can see the dimension is stress (Force / area).
2. Material model.
   (a) As far as I can understand DynaRICE applies so-called continuous material (not discrete elements). Is this correct?
   (b) In such a continuum approach any discrete pieces of material should in principle be much smaller than the numerical elements. It looks like the size of FEM elements were similar to ice pieces. Can you comment on this? Does the continuum hypothesis work in this case? I should add that this requirement is very difficult to comply to when working with ice mechanics, but I would anyway appreciate some thoughts on it.
   (c) On page 64 is says that DynaRICE uses a *viscous-plastic* constitutive law. I cannot find any information about this. Please explain
   (d) Figure 3-26. Did you observe thickening and rafting of ice pieces?
3. DynaRICE and wind:
   As a follow up from above on the derivation of the drag coefficient I would you to explain more clearly how you applied these in lab and in full-scale cases. The physical dimensions

are different and to my knowledge the standard is to apply 10 m wind velocity to derive the drag coefficient.