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Forecasting and Mapping Ice Thickness for Ice Skating on Natural Lakes and Canals

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Introduction

Ice skating on natural lakes and canals is fun! However, the opportunities to do ice skating are very limited in many mid latitude regions, while the general public is very keen on being on the ice as soon as possible. Safety is an important prerequisite for ice skating, which must be guaranteed by sufficiently thick ice. Forecasting of ice thickness is a challenging task for meteorologists since ice growth is a delicate physical process depending on the weather conditions, but also on local land use, hydrology, canal depth, and nearby buildings and vegetation. So far, the currently in use ice thickness forecasting tools (e.g. De Bruin and Wessels, 1988) do not account for these details.

This project consists of three components. First, we develop and implement a new generation forecast model for ice thickness "Ice Thickness Model 2.0 (ITM2.0)" that accounts for local information using available geo-information databases. Secondly, observed local snow and ice thickness and weather information will be gathered at high spatial scale via crowdsourcing (ijsdikte.eu and wunderground.com) in order to optimally initialize and drive the model, as well as for model validation. Finally, forecasted ice thickness will be mapped in a GoogleMaps environment, and distributed via a website and an app.

Goals

Our overall objective is to improve the quantitative forecasting of ice growth in water bodies of various morphology and topology, and to communicate this in a fast way to the general public. Hence, we have formulated four specific objectives:

1. Set up a forecasting system that provides spatially high resolution mesoscale weather forecast (e.g. the Weather Research and Forecasting model, WRF) results as input to the ice thickness model, which is validated against crowdsourced observations from wunderground.com.

2. Introduce data assimilation of observed ice thickness and snow cover at high spatial detail into the ice thickness model. Both variables are key initial conditions for a successful forecast. These data will be based on crowdsourcing from websites of ijsdikte.eu and sneeuwdikte.eu.

3. Improve the physical aspects of the ice thickness model concerning available spatial information on water depth, nearby buildings (sky view factor) and vegetation and trees adjacent to lakes and canals, and advanced physics of the aging of snow, and water temperature and salinity.

4. Model forecast visualization and rapid communication via a website and an app using a GoogleMaps environment. Continuous forecast evaluation against with data based on crowdsourcing of measured ice thickness.

Research steps

The above listed goals will be achieved by the following steps:

a) Coupling of the ice growth model with a mesoscale weather forecast model on a high spatial and temporal scale. Up till now only coarse scale meteorological information acts as input for the ice thickness model. More spatial detail allows for effects of local landuse, snow cover, effects of topography and land-sea contrasts.

b) An updated scheme for the temporal evolution of the thermal properties of snow will be implemented in the De Bruin and Wessels (1988) model. The new scheme provides a physically sound method for snow thickness and thermal conductivity due to aging than the semi-empirical method currently present in the BW88 model. Note that the new snow scheme has shown improved skill over the empirical scheme in the ECMWF model. Also, the role of salinity of the water bodies will be introduced

c) In the next step the ITM2.0 will be equipped with on available geo-information databases on land use, buildings along canals, bathymetry, tree database etc. These factors affect the radiation and energy balance, and thus the ice development.

d) Finally, model validation will take place based on crowd-sourced data collected via the internet. This is a powerful and well established method to obtain high temporal and spatial scale data that cannot be achieved by a single research effort alone. The continuous model validation steps will also identify remaining points of improvement of the ITM2.0.