Application of FLake for the prediction of ice thickness for inland waters in the Netherlands

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A lake parameterisation module FLake has been implemented in HARMONIE. Experiments with an off-line version of FLake have been conducted for inland waters in the Netherlands. Predicted ice thickness is compared with pseudo observations at Cabauw. Subsequently FLake has been applied for Friesland during the winter of 1985.

1. Ice skating on inland waters

Ice skating is very popular in the Netherlands. In cold spells numerous ditches, canals and lakes get frozen and many people go out for ice skating tours. In these periods there is a great interest

Fig. A: Impression of a frozen lake in the Netherlands.

in ice thickness predictions. KNMI issues ice thickness predictions, based on a model of De Bruin and Wessels [1]. The surface scheme of HARMONIE contains a lake model which also produces ice-thickness. In this paper we compare FLake with the KNMI model and with ice thickness observations.

2. FLake model

The lake model is a so called bulk-model based upon a self-similar parametric representation of the evolving temperature profile in the water column[2]. The same concept is used to describe the temperature structure in snow, ice and water sediment. Simple thermodynamic arguments are invoked to develop the evolution equations for ice and snow depths. The resulting equations are computationally efficient, but still incorporate much of the essential physics.

3. Pseudo ice thickness

Ice thickness is not routinely observed. In the winter of 1996/1997 extra instruments were deployed at Cabauw in cooperation with Wageningen University. In a ditch with a cross section of 5 by 0.5 m a water temperature profile was measured. During the frost period the five sensors on fixed depths gradually got frozen in. When air temperature is below 0 °C ice thickness can be derived by linear interpolation of the profile to T=0 °C. When the thaw sets in this method does not work because the temperature profile becomes isothermal.

4. Tests for Cabauw and Friesland

FLake has been driven by observations from Cabauw. Input variables are 2m temperature and humidity, 10m wind, and net radiation. Results are depicted in Fig. B. The operational model and FLake are close to the observations. FLake overestimates the ice growth slightly when ECMWF +24h forecasts

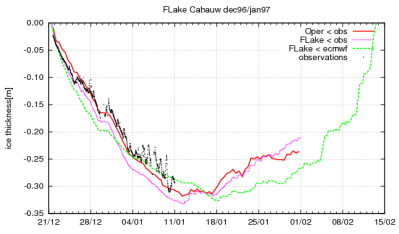

Fig. B:Forecasted and observed ice thickness at Cabauw for the winter of 1997.

are used as input. This is related to an under estimation of the down welling shortwave radiation of the ECMWF model.

Finally FLake is run for the winter of 1985, when substantial snow fall was reported (Fig. C). The ice growth is suppressed by the snow deck in January, while in February with less snow fall a solid ice layer of 0.25m is formed. Again FLake tends to over predict the ice layer, also because the temperature of the deepest bottom layer is an uncertain factor. Note that the observations in January are carried out after snow removal.

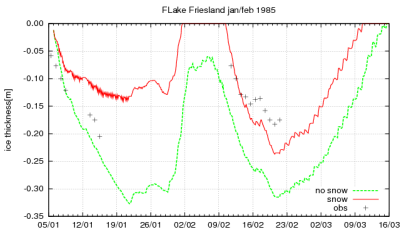

Fig. C: Forecasted and observed ice layer for the winter of 1985 for Friesland.

5. Conclusions

- **FLake has predictive power and is competitive with the operational model.**
- **Ice growth depends on accurate snowfall prediction from a NWP model.**

6. References

[1]H.A.R. de Bruin and H.R.A.Wessels, 1988. A model for the formation and melting of ice on surface waters. J. Applied Meteorology, 27:164-173

[2] Mironov D.V. 2008, Parameterization of lakes in numerical weather prediction. Description of a Lake model. COSMO Technical Report, No 11, DWD, Offenbach am Main, Germany, 41 pp

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