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Sea-effect snowfall – a special hazard for road traffic in the coastal areas of Finland

Introduction

Poor visibility and slipperiness caused by snowfall increase the traffic accident risk significantly. Based on case-studies, in Finland the days with high accident rate are often related to a low pressure passage causing snowfall in a wide area. High accident amounts can also occur when very low temperature and occasional or local snowfall are combined. In the coastal areas, local but quite dense snowfalls can be induced by the ice-free sea surface. Sea-effect snowfall can occur in basically dry large-scale weather situations and therefore it is a surprising event.

When the originally dry, cold and stable air mass is advected over an ice-free sea area, it gets energy and moisture from the surface water and becomes unstable. The air mass must be cold enough for sea-effect snowfall to be generated; at least a 13 °C temperature difference between the sea surface and atmospheric 850 hPa level (ca. 1.5 km height) is needed.

Sea-effect snowfall occurs especially at the Great Lakes of the North America, but also for example in Japan and in the coastal areas of northern Europe. A cold easterly flow over the Baltic Sea can induce significant amounts of convective snowfall at the east coast of Sweden, causing big trouble to the traffic. An example of this kind of situation can be seen in Fig. 1. On 16 and 17 December 2009 high amount of car accidents occurred in eastern Sweden (Fig. 2). The traffic stopped totally on highway E4 south of Stockholm after many trailer trucks were stuck in snow banks (source: Aftonbladet).

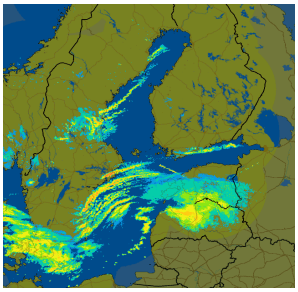

Fig. 1. Radar image on 16 December 2009 at 21 UTC showing several sea-induced snow bands over the Baltic Sea.

Fig. 2. High impact sea-induced snowstorm prevailed in eastern Sweden on 17 December 2009 (source: Aftonbladet, photo by Jonas Bilberg & Patrik Persson).

In Finland sea-effect snowfall can be generated in a northwesterly flow over the Gulf of Bothnia or in a cold air advection from southeast or east over the Gulf of Finland. Although the precipitation amounts are not usually very big, the traffic in the Helsinki metropolitan area (at the coast of the Gulf of Finland) is quite sensitive for these snowfalls.

Sea-effect snowfall cases in Finland with high accident rate

Two sea-effect snowfall cases were examined; they occurred on 20 January 2006 and 8 February 2007. The number of accidents was 371 in the first case and 219 in the latter case in the Helsinki metropolitan area and surroundings (Uusimaa county). The daily average of accidents in the same area was 79 both during winter 2005/06 and winter 2006/07 (data source: Finnish Motor Insurers' Centre, statistics of paid compensations).

Case 1: 20 January 2006

After a period of mild weather in Finland, an area of high pressure over northwestern Russia intensified and very cold air (the 850 hPa temp. ca. -20 °C) streamed from east in over Finland (Fig. 3). In Helsinki at the coast, the air temperature was as low as -15 to -20 °C on the 20th of January.

Snow bands were generated over the partly ice-free Gulf of Finland (Fig. 4). Southeasterly winds prevailed and the location of the snow bands was quite stationary during the day. In the Helsinki metropolitan area the snowfall lasted for many hours resulting in bad traffic jam and high amount of car collisions. The long duration of the event in very cold conditions enabled the formation of a very slippery layer on the road surface. The local character of the snowfall event can be seen from Fig. 4.

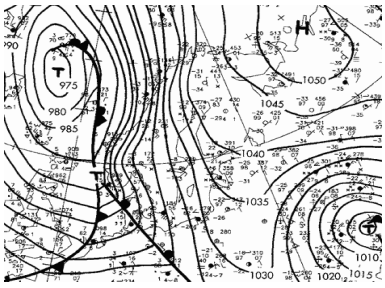

Fig. 3. The weather situation in northern Europe on 20 January 2006 at 12 UTC (analysis by DWD).

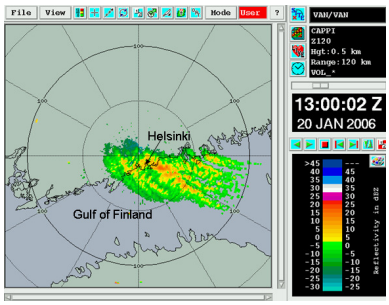

Fig. 4. Radar image on 20 January 2006 at 13:00 UTC (15:00 h local time).

Case 2: 8 February 2007

As in the 20 January 2006 case, also in this case very cold air (the 850 hPa temp. ca. -16 °C) streamed from east in over Finland. An area of high pressure moved slowly over Finland to southeast (Fig. 5) and the wind over the Gulf of Finland became southeasterly on 8 February but remained weak.

The big temperature difference between the air mass and sea surface generated an area of snowfall that hit the coast and Helsinki city (Fig. 6). The event lasted for many hours resulting in a big amount of car collisions. The road surface temperature at Vaskisalmi station (ca. 4 km west of Helsinki city centre) was about -17 °C in the morning and ca. -10 °C in the afternoon.

Due to the low temperature, salting wasn't possible. Based on the road surface friction measurements in the Vaskisalmi station (by Vaisala's optical DSC111 device), the friction values dropped to ca. 0.4 due to the snowfall. The minimum observed value was 0.33 at 10:00 local time and the somewhat lowered friction values prevailed until the evening (Fig.7).

Wintry weather and friction; conclusions

In the EU/ROADIDEA project, the Finnish Meteorological Institute has investigated the relation between weather conditions and road surface friction. For this purpose, data from two winters, 2007/08 and 2008/09 were used. In the studies, road weather observations from a couple of representative stations in southern Finland were examined. The friction was measured with Vaisala's DSC111 optical instrument.

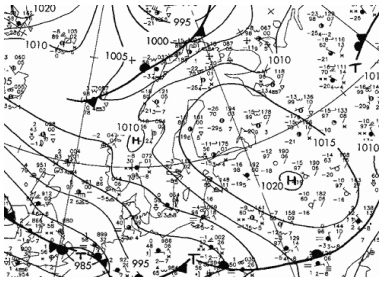

Fig. 5. The weather situation in northern Europe on 8 February 2007 at 12 UTC (analysis by DWD).

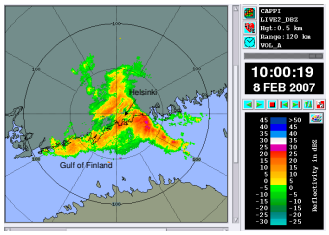

Fig. 6. Radar image on 8 February 2007 at 10:00 UTC (12:00 h local time).

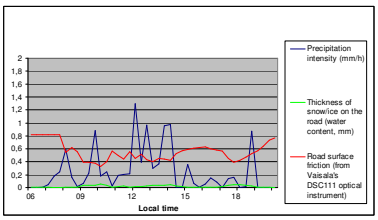

Fig. 7. Road weather observations at Vaskisalmi station (about 4 km west of Helsinki city center) on 8 February 2007 06-20 local time: precipitation intensity, thickness of snow/ice on the road as well as road surface friction measured by Vaisala's DSC111 optical instrument (data source: the Finnish Road Administration).

The investigations showed for example, that friction is dependent on the thickness of snow and ice on the road, but the dependence is not linear especially at the lower end of the friction values and the distribution is quite wide (see Fig. 8). But when the cold cases (road surface temperature below -5 °C) were examined separately, it appeared that the distribution is much narrower. During very cold conditions (when salting is not used), even a relatively thin layer of snow/ice on the road can decrease the friction values substantially. **Sea-effect snowfall** often occurs in cold conditions and therefore it is **a surprising local event** causing a **decrease in road surface friction** and also **visibility**, thus increasing accident risk.

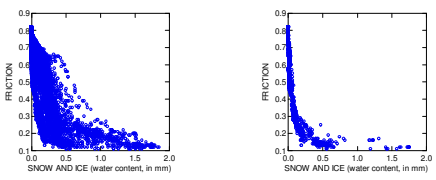

Fig. 8. Scatter plot of friction vs. the sum of snow and ice (water content in mm) on the road. Based on DSC111 observations in Utti (in southeastern Finland) during winter 2007/08. The left figure includes all observations, the right figure covers those cases when road surface temperature was below -5°C (data source: the Finnish Road Administration).