

## Project ColdSpots: A new way to improve winter road condition forecasts

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### ABSTRACT

The objective of Project ColdSpots is to improve the present high-resolution weather and road condition models by establishing a novelty database containing detailed local information from problematic road sections in Finland. Presently, a wealth of useful information is available in various databases but not necessarily available to model developers. A test set of some fifty most problematic locations have been selected by studying how many of the accidents have occurred due to freezing, and basing on local knowledge of the road maintenance people. More accurate information of these spots will be implemented in the road condition models. The new system will be verified with pilot studies during the next two winter periods by applying state-of-the-art verification methodologies. Project ColdSpots is co-funded by the Ministry of Transport and Communications Finland, Finnish Road Administration, and the consortium of three public and private partners: Foreca Ltd, Finnish Road Enterprise and Finnish Meteorological Institute.

**Keywords:** Weather forecasting, weather observations, road condition forecasting, forecast verification, winter road maintenance

### 1. BACKGROUND

Ways to forecast and observe winter weather and road conditions have improved significantly during recent years. In Finland, the producers of weather services and road maintenance are able to use a very high-quality and dense observing network of road weather stations maintained by the Finnish Road Administration. This data is assimilated into advanced high-resolution local area weather forecasting models. Road condition models are applied to further process this data to be most suitable for specific end users. However, it still is a paradox that weather forecasting models are most skilful in the upper atmosphere, but forecasting becomes much more challenging close to the ground level, and especially at the surface.

The computing resolution of weather forecasting models has improved significantly due to advances in modeling science and especially due to increased computing power. Now, the typical weather model horizontal resolution is of the order of 10 kilometers. However, to be able to forecast local conditions even more precisely and to take into account the most dangerous locations that freeze more often than the nearby road stretches such a resolution is not sufficient. We should find ways to assess the so-called sub-grid scale processes that depend on many factors, most importantly on the nearby environmental conditions, topography, vertical structure of the road construction, surface albedo, shading by trees, etc.

There are many databases that contain such information but, unfortunately, this information has so far not been in the reach of model developers. One objective of Project ColdSpots is to collect these data and create a system where it is easily accessible for those that need more information on the problematic road spots and sections.

Project ColdSpots was initiated in early 2005, after a major and very tragic wintertime road accident where a bus and a lorry collided. Both public and private actors within the winter weather and road maintenance sectors joined their forces to find ways to improve the forecasting models further and also to develop new communication methods. Project ColdSpots is one of the resulting development projects. It is co-funded by the Ministry of Transport and Communications Finland, Finnish Road Administration, and the consortium of three partners: A private weather company Foreca Ltd, acting as the coordinator, Finnish Road Enterprise and Finnish Meteorological Institute. The initial phase with background studies is completed by the end of 2005. Model development and pilot tests will follow and at the moment the project has funding till the end of 2007.

## 2. WEATHER AND ROAD CONDITION FORECASTING AND VERIFICATION IN FINLAND

There are mainly two parties providing weather forecasts and related services to winter road maintenance, i.e. Finnish Meteorological Institute (FMI) and a private weather company, Foreca Ltd. Both are working with the same observational information, but the solutions for weather and road condition models are different.

FMI's road condition model has been used in operations since 2000. It is based on a ground model that has been further developed to better represent road conditions [1-2]. The numerical weather model providing the boundary conditions is either HIRLAM [3], ECMWF [4] or a combination of the two. The duty forecaster has an option to modify model output manually. Figure 1 gives an example of the output of FMI's road condition model. Other applications have been developed based on the road condition model, e.g. road maintenance model [5], where the model results include the removal of snow from the road surface.

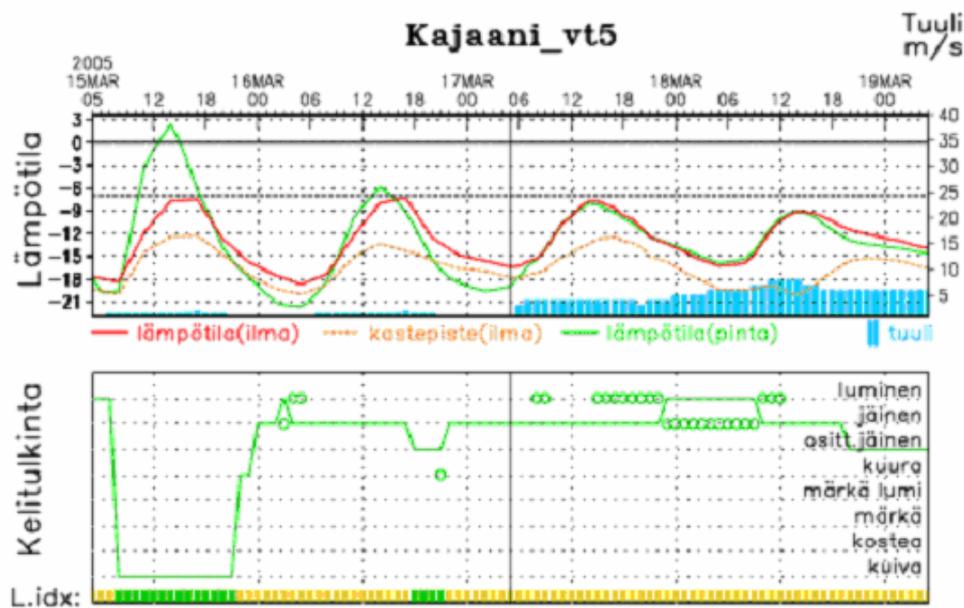


Fig. 1. An example of FMI's road condition model results. The upper part shows air temperature, dew point, surface temperature and wind in red, orange, green and blue, respectively. The lower part shows classification of assessed road condition and a road traffic weather index. Green signifies normal and yellow bad driving conditions. The vertical line separates observed and forecasted conditions.

Foreca Ltd is running its own high-resolution weather model, ETA, which is the operational version of the model used by the US weather service. Kalman filtering based on synoptic and road weather observing network is applied to forecast surface conditions. To define risks for slipperiness due to several factors such as freezing, frost and snowfall, point forecasts for each road weather station are derived based on practical rules and boundary values defined by the road maintenance experts. Figure 2 gives an example of a map showing such risks.

For general weather forecasts, verification has been a common practice for decades and there exist well established and generally approved methods. Verification of weather and road condition models is a more challenging task and the issue is not trivial. A general description of the various methods and scores to perform verification are described in [6]. Figure 3 shows an example from FMI's operational forecast quality control report.

The contract of national winter road weather services issued by Finnish Road Administration requires as one essential component of the service a very comprehensive set of verification routines.

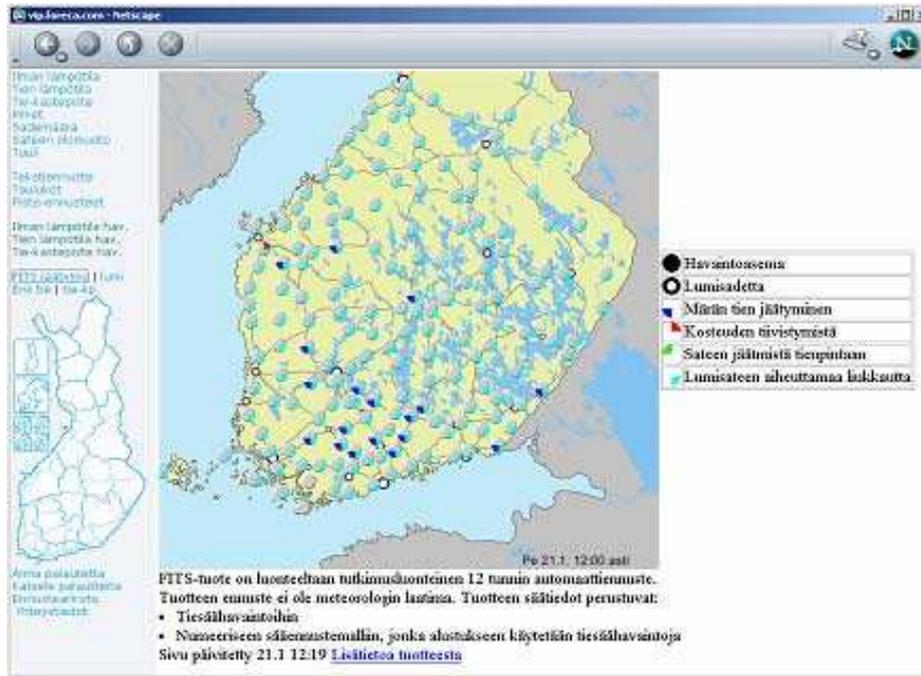


Fig. 2. A forecast map showing several risks for slipperiness included in the winter road weather service of Foreca Ltd.

Project ColdSpots will provide road condition forecasts with very high spatial and temporal accuracy. The challenge will be to find the best way on how to verify the quality of these new forecasts. The essential question is where to get more reliable and representative observations for verification. The present observing network is not dense enough for this purpose. Additional observations have to be made and one possibility is to use the new optical friction observations that will be tested at c. ten locations in Finland.

### 3. USER REQUIREMENTS

In the very early phase of the Project, a User Forum was gathered to find out what is the most essential and important information and improvements to present systems that users want to have. The User Forum attendance covered model developers, road maintenance and traffic information experts.

One basic problem in today's systems is the information overflow that disturbs effective decision making especially in those critical situations when weather is causing unexpected problems. Thus it is most important to design the new products in such a way that the end user can easily understand and get the right information in critical situations. There must also be effective ways to deliver this critical information to road users. Some recent accidents have shown that present methods where information is sent through mass media such as radio are much too slow to reach drivers in time. TV weather forecasts shown the previous night may be 100 % correct and, consequently, warnings issued. Still, the next day drivers affected by adverse weather will not change their risky driving behaviour. This is the ultimate challenge where one should find workable solutions.

### 4. NEW INFORMATION INTO MODELS

Project ColdSpots has studied various Finnish databases as potential data sources to future modeling purposes. For instance, road structure and road accident registers, map information, road maintenance feedback and quality control data have been used in deriving the first draft version of the new ColdSpots database. The first about 50 spots have been selected based on this data and local user information. Figure 4 shows one road stretch in Southern Finland with five selected points and the number of accidents at those spots. The westernmost spots is very problematic with four registered accidents due to freezing.

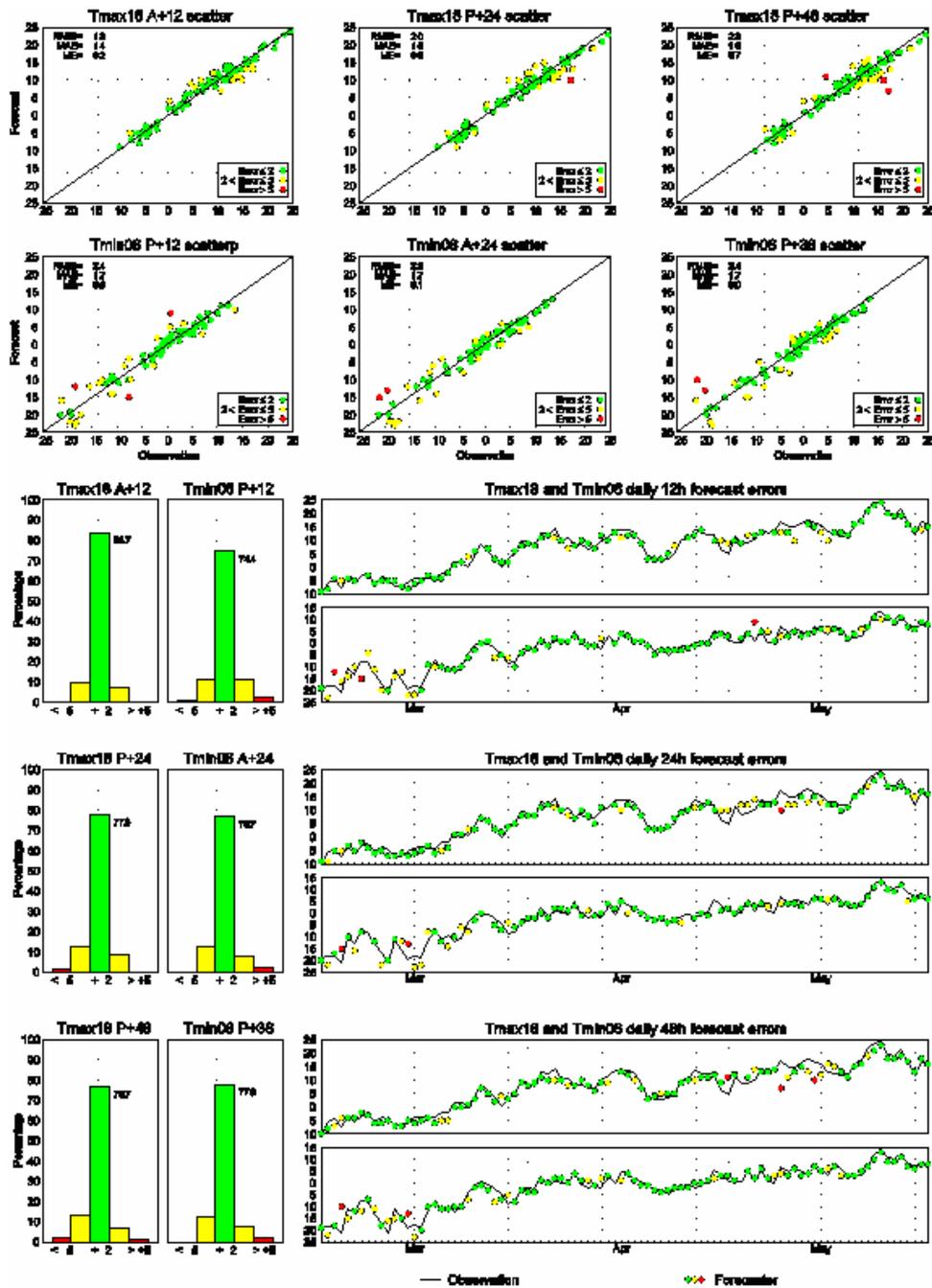


Fig. 3. An example page from the quarterly (spring 2005) forecast verification report of the Finnish Meteorological Institute in spring 2005.

The Project has now entered its second phase where these new data is used in studying how the weather models behave in the selected ColdSpots, and comparing those to some reference points which seem to have no risk factors compared to the problem spots. Next, the present model versions will be modified based on the comparison studies. During winter months 2006-2007, pilot demonstrators will be ready for operational test. Detailed verifications and comparisons of present and new model versions will prove whether the new system is notably better and ready for operational implementation.

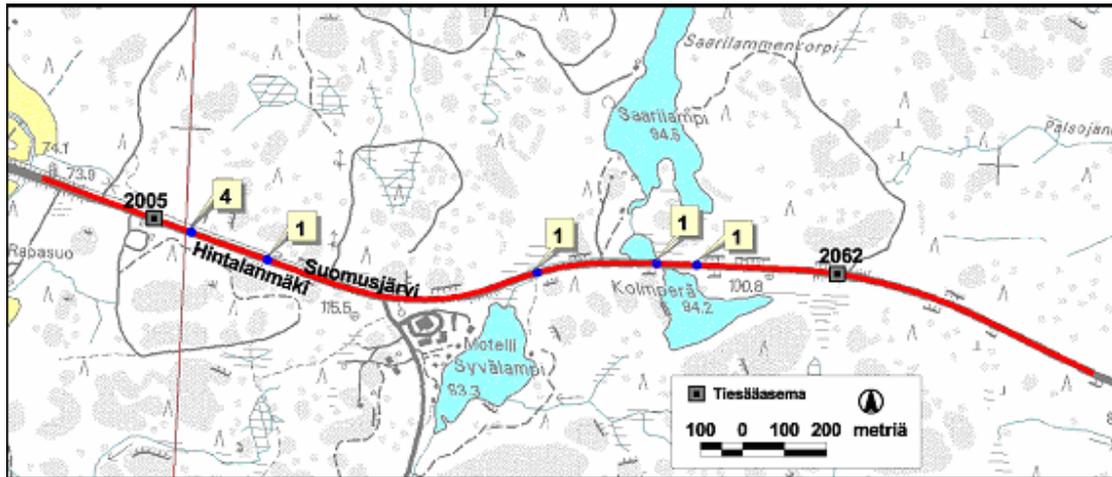


Fig. 4. Potential ColdSpots on Highway 1 in Southern Finland. Figures in boxes show how many accidents have occurred during the last five years due to frozen road surface. Grey squares are road weather observing stations.

## 5. SUMMARY

Project ColdSpots was initiated by public and private partners active in winter road weather forecasting in Finland, in order to improve the present road condition models and reach better spatial accuracy. The approach is to start with the most problematic locations, which are prone to accidents due to freezing. Status of the present systems, user requirements and potential databases which may help in the improvement have been studied and a first test set of “coldspots” selected.

Local information, which especially the elder generation of maintenance people still have is a resource which is at risk. Thus it was found very urgent to contact those people that have worked a long time in the area doing practical road maintenance. There is plenty of this kind of “silent” information, which has not been gathered to any existing databases.

Next steps will be studies how the present models behave in these and reference spots, improvement of models, and finally pilot tests and verifications of new systems in winter 2006-2007.

## 6. REFERENCES

- [1] Fougstedt, B., 1992: En studie över temperaturen i jordmänen. Master Thesis, University of Helsinki, Department of Meteorology.
- [2] Kangas, M., M. Heikinheimo and A. Venäläinen, 2001: Tiesäämalli – tienpinnan lämpötilan, kelin ja liikenneolosuhteiden ennustamiseen. Suomen Tieyhdistys. Kunnosta on kysymys – seminaari teiden ja katujen ylläpidosta (in Finnish). Tampere. 6 p.
- [3] Unden, P. (ed) 2002: HIRLAM-5 Scientific Documentation. HIRLAM-6 Project, c/o Per Unden, SMHI, S-601 76 Norrköping, Sweden.
- [4] Persson, A. and F. Grazzini, 2005: User Guide to ECMWF Forecast Products. (ECMWF Meteorological Bulletin M3.2, Version 4.0, June 2005).
- [5] Hippi, M., 2004: Teiden talvihoito ja Ilmatieteen laitoksen tiesäämallin jatkokehittäminen (in Finnish). Master Thesis, University of Helsinki, Department of Meteorology.
- [6] Nurmi, Pertti, 2003: Recommendations on the verification of local weather forecasts. ECMWF Technical Memorandum No. 430. 19p.