Local enhancement of granular snow from low stratus (industrial snow) (VSS1999/244)

Lokal verstärkter Schneegriesel bei tiefem Stratus (Industrieschneees)

Funding: National (Switzerland)
Duration: Dec 2002 - Mar 2005
Status: Complete with results

Background & policy context:
In freezing conditions precipitation from stagnant low stratus in the form of snow grains is enhanced near concentrated sources of moisture. The area affected by snow grains is typically 4 km square and the amount of precipitation is usually small but leads to slippery conditions on frosty road surfaces. Winter road maintenance is needed for the affected roads and sidewalks. Normally the use of salt is sufficient. In extreme cases mechanical snow removal is needed. The very local occurrence of snow covered roads in generally stable weather conditions without precipitations is often surprising for road users as well as for road maintenance services. Thus the phenomenon increases the risk of accidents. Locally enhanced precipitation of snow grains occurs most frequently in the cold morning hours. With low stratus persisting all day it can also occur after dusk.

Objectives:
The relevant meteorological processes shall be identified in case studies. Local sources of water vapor, atmospheric capacity for water vapor and amount of industrial snow shall be compared. Transport processes from the sources of water vapor to the affected road networks shall be investigated quantitatively. Methods for routine forecasts of industrial snowfall shall be defined and proposed.

Methodology:
The information gathering includes research in road inspectorates, power supplies, disposal systems, meteorological services and in the literature. The data is used for adaptation of the existing model convection on wintry night operation with local sources of heat, water vapor, gases and aerosols.

Parent Programmes:
ARAMIS - ARAMIS information system

Institute type: Public institution
Institute name: Swiss Government: State Secretariat for Education and Research
Funding type: Public (national/regional/local)

Partners:
Switzerland
Swiss Federal Roads Office
Analysen & Konzepte

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Key Results:

The essential factors for the phenomenon of local snow fall are a concentrated source of moisture feeding the low stratus with limited release of heat, so that the exhaust cannot penetrate significantly into the dry air above the stratus. The contribution of locally produced aerosols seems to be of minor importance as the phenomenon occurs also without concentrated moisture sources — the amount of precipitation being much smaller—and as the phenomenon occurs simultaneously with different sources of moisture. Local super-saturation, however, seems to be a critical factor for the amount of precipitation. Cooling towers of nuclear power plants are the most intense moisture sources. Their release of heat, however, is sufficient to allow significant penetration of the released moisture into the inversion above the stratus. Moisture is added to the dry layers above the stratus and precipitation of snow grains is not enhanced near cooling towers.

With frosty low stratus local precipitation in form of snow grains is also observed in the approach and take-off sectors of Zurich airport during the first flights in the morning. The turbulence generated by the airplanes when descending or climbing through the stratus triggers crystalisation and the growth of snow grains at the expense of super-cooled droplets. The turbulence of the warm and moist exhaust of industrial chimneys might also initiate crystalisation and support the growth process.

Prediction of local snow grains must be based on the prediction of low stratus and fog. Current synoptic weather models are not satisfactory in this aspect, as they do not treat local topography and convective mixing at the required resolution.

A specialised boundary layer model for convection in complex topography has been expanded to nocturnal radiation conditions. Nocturnal cooling of the boundary layer can be treated in conditions with low stratus. The model completes operational weather models and will improve local predictions in calm weather. The application of the model to selected areas will show its potential for road and airport maintenance in winter. Predictions of fog formation and dissipation can be obtained from this topographical boundary layer model. Warnings for road traffic and improved management of airport and airway operations can be expected. In locations with concentrated moisture sources the prediction of locally enhanced snow grains is possible.

Technical Implications

The research is carried out practically oriented. The Research Centre has practical experience in the development of local and regional prediction methods that are used operationally at governmental weather services.

Other results

Article about industrial snow in road and traffic 11/2004 on the main topic of winter maintenance.

Related Projects:

Research organisation: Swiss Federal Roads Office; Research Roads-Bridges-Tunnels
Project number VSS2006/601
Project title Strassenwettervorhersagen für Frost und Nebel

Documents:

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STRIA Roadmaps: Infrastructure
Transport mode: Road transport
Transport sectors: Passenger transport, Freight transport
Geo-spatial type: Other