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A case of extreme air quality hazard in Bergen: Observations and simulations

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Atmospheric conditions observed during the cold winter 2010-2011 in Bergen resulted in a case of extreme air quality hazard. Very high concentrations of the atmospheric pollutants, notably NO_2, were measured. Attempts to reduce their emission rates by policy measures leaded to city life disorganization and severe economic damage. Using the advantage of turbulence-resolving simulations and extensive meteorological observations in the city, analysis of the event has been conducted. The simulations (the mesh resolution was 30 m) combined with the available emission inventory recovered the detailed map of the concentrations. It has been demonstrated that the slope winds contributed considerably into the air quality hazard. Moreover, it was shown that only a special type of temperature inversion in the central Bergen area contributes to this event. The strong clear sky radiation cooling in Bergen causes cold air subsidence along the hill slopes and the near surface northward flow. At the same time the mean air flow is directed southward as atmospheric soundings reveal. Above the central city area those flows meet and lock polluted air. The strong radiative inversion, seen both in the model and in the data from Geophysical Institute, prevent normal air mixing in the deep layer. The inversion top is clearly seen on the photo as the height of improved visibility.