Two aspects of flow past vegetation in the atmosphere: Effects of roadside hedges on pollutant dispersion in the urban environment and storm stability of forest stands

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Abstract

The talk consists of two parts. In the first part, the influence of hedgerows on concentrations of traffic pollutants in urban street canyons is addressed. Roadside flanking hedgerows in either central or eccentric arrangement inside street canyons were studied. For perpendicular approach wind, overall improvements in air quality were found at pedestrian level and at the building facades in comparison to the hedge-free case. The greatest improvements were obtained for hedgerows in central arrangement. Reductions in traffic pollutant concentrations of up to 61% were observed in the midsection of the street canyon. For hedgerows in eccentric arrangement, reductions of up to 39% were found in the midsection. These reductions are of particular relevance to urban planning and street design since the highest traffic pollutant charges generally occur in the midsection of street canyons.

In the second part, the flow phenomena above a forest and the associated downward momentum transport into the canopy are addressed for an atmospheric boundary layer flow in combination with superimposed extreme gusts. Forest stands with two types of leading edge configurations, tapered ($\alpha = 45°$) and vertical ($\alpha = 90°$), and gusts of different durations (sizes) were investigated. In the cases with gusts, fundamentally different flow phenomena at the canopy top in the forest edge region were observed compared to the atmospheric boundary layer flow alone. Upon impingement of an extreme gust on the forest edge, a clock-wise rotating vortical motion was found to develop at the canopy top. The vortical motion translated downstream over the forest top and after a distance of approximately 2 tree heights h behind the forest edge, a patch with downward directed velocity appeared in its lee. This patch was found to cause the maximum downward transfer of horizontal and vertical momentum into the forest canopy. The location of the maximum downward transfer was at approximately 1.5 tree heights h behind the forest edge and independent of the gust duration and the taper angle of the leading edge. The magnitude of the downward momentum transfer, however, showed a dependency on the gust duration and the leading edge configuration. It increased with increasing gust duration and was larger for the forest with tapered leading edge in comparison to a vertical edge.