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Comparison of Two Methods for Computing Upstream Surface Roughness

Zsuzsanna Vizi and Mark Saunders
Department of Space and Climate Physics, University College London, UK (z.vizi@ucl.ac.uk)

Upstream surface roughness can significantly affect the 10-min windspeed and peak 3-sec gust measured locally at 10m height. For example, a high upstream roughness (typical of urban built-up areas and forests) will decrease 10-min windspeed by 20-30% and decrease the peak 3-sec gust by 5% compared to a reference upstream surface roughness (typical of grass and open, flat terrain). With insurance, renewable energy and other industries requiring realistic 10-min windspeed and gustspeeds values on spatial scales of 100 m or less, accurate upstream surface roughness values are essential for computing reliable wind/gustspeeds at locations where anemometer stations do not exist.

Two methods cited in the literature for computing upstream surface roughness are the Beljaars theoretical gustiness model and the U.S. Environment Protection Agency AERSURFACE system. The Beljaars model requires coincident wind and gust observations, while AERSURFACE requires upstream landcover types and an inverse-distance weighting scheme. We apply the Beljaars gustiness model using hourly peak 10-min wind and peak 3-sec gust records combined with the known response characteristic of individual anemometers and recorders. We apply the AERSURFACE system using the European Environment Agency's CORINE land use data base at 100 m resolution with surface roughness values assigned to each land cover category and surface roughness calculated as an inverse distance-weighted mean for different directional sectors out to 1km.

We evaluate and compare upstream surface roughnesses computed with the Beljaars model and with the AERSURFACE system for 30-degree arc segments around 160 UK weather stations for the past $\sim$10 year period when surface roughness was largely constant. Results will be shown for individual weather stations and for all stations combined. The current AERSURFACE weightings will be modified to maximise the agreement with the upstream roughnesses derived with the Beljaars model; this to permit realistic 10-min wind and peak 3-sec gust values to be computed at locations where anemometer stations do not occur but where high spatial resolution land cover data exist.