The spatial variability of the snow cover is driven by wind-induced snow-transport processes and larger scale precipitation gradients. The main aim of this study is to investigate the link between the scaling behavior of topography, the local wind field and the snow distribution. We use very high-resolution atmospheric and snow-transport simulations to compare their spatial characteristics with snow depths obtained from airborne and terrestrial laser scans. We show that smoothing of alpine terrain first occurs at a small scale (1m), rather independent of wind-induced snow transport processes. Typical features of snow redistribution by wind such as snow dunes and cornices occupy the next larger scale (10 m), are persistent in space and time and further contribute to landscape smoothing. At the next larger scale (100 m), preferential deposition of snow is dominant, which differentiates windward and lee slopes. For both processes, snow transport and preferential deposition respectively, the scaling behaviour of the local flow field (as a driver) is similar to that of the associated snow distribution. Finally, at the next larger scale (1 km), the snow distribution can be explained by a conventional altitudinal gradient plus terrain roughness. This requires that average snow depth over rather homogeneous topographical units is considered. The terrain roughness is estimated as the intercept of the variogram at meter resolution and allows for the first time to satisfactorily explain observed snow distribution from terrain parameters alone.