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Turbulence feature modifications from high to low wind conditions: results from the CCT observations at Ny-Ålesund, Svalbard.

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The turbulence features in the quasi neutral surface layer are investigated as the intensity of the wind decreases, i.e. as the forcing due to the shear decreases.

In this aim, a 5-year (2012-2016) set of observations of meteorological and micro-meteorological parameters acquired on the Climate Change Tower (CCT) in Ny-Ålesund, Svalbard Islands, is used. The 34-m high tower, operated by the Italian National Council of Research (CNR) is equipped with four slow response wind and temperature probes and three fast response sonic anemometers and is located on heterogeneous terrain. One of the fast sensors was installed by KOPRI since 2012. The observations are averaged over 10 and 30 minutes intervals.

The analysis addresses the share of the mean turbulent kinetic energy (TKE) among the along-wind, cross-wind and vertical velocity variances (respectively $< u^2 >$, $< v^2 >$, $< w^2 >$), with attention to the parameterizations of the boundary layer commonly used in NWP models: the classical Mellor-Yamada (1982) scheme with the return-to-isotropy term by Rotta(1951) and its modifications, and the recent approach by Zilitinkevich and coworkers (2013).

The results show that the share of TKE among the vertical $< w^2 >$ and the total horizontal variance $< u^2 > + < v^2 >$ is weakly dependent on the wind velocity while the share of the total horizontal variance between the along-wind and cross-wind components depends on wind speed. At high velocity (and large wind shear) a clear anisotropy , with $< u^2 >\approx 2 < v^2 >$, is observed, quite consistent with literature (Tampieri, 2017, pag. 69). As the velocity decreases, the ratio $< u^2 > /(< u^2 > + < v^2 >)$ displays a wide flat distribution between 0.2 and 0.8 with median values corresponding approximately to horizontal isotropy: $< u^2 >\approx< v^2 >$.

These features can be parameterized using suitable coefficients, function of the wind intensity in the equations for the TKE share, capturing the average behaviour of the flow.

A further investigation based on estimates of the relative importance of the high frequency and low frequency spectral distribution of TKE suggests that the presence of slow motions (like meandering) affects the tendency to isotropy; in absence of such effects, the horizontal turbulence is anisotropic both in high and in relatively low wind conditions.

Some comparison with the results from other data sets is outlined, to give a preliminary answer to the possible generalization of such features.

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