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Extreme wind speed analysis: a new approach to observational high-resolution modelling data (Young Scientist Travel Award)

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Previous analysis of wind speed maxima data on many Russian Arctic stations for several decades revealed surprising features concerning the sample distribution, namely that a volume of observed samples are strictly divided into two sets of variables. The each one is reliably described by own Weibull distribution parameters. Because the common statistical conditions are the attribute of identity of extreme events we therefore hypothesize that two different groups of extreme wind events adhere to different circulation processes. These groups were named as "Black Swans" [Taleb, 2010] and "dragons" (or "kings") [Sornette, 2009]. This result motivates our interest on ability to detect, analyze, and understand such different extremes. We have shown previously, that the modern global atmospheric model (INM-CM4) could not reproduce the largest extremes ('dragons') [Kislov, Matveeva, 2016].

Therefore, in this study we have applied the same approach according to many Russian Far East stations and the high-resolution model archive [Platonov et al., 2017] to investigate an extent of these statistical features on mesoscale. We have utilized the long-term (1985 – 2015) meteorological archive, with 13.2 km spatial and 1-hour temporal resolution covering the Okhotsk Sea and Sakhalin Island, obtained by regional climate simulation using the COSMO-CLM nonhydrostatic model.

Statistical analysis of observational data has revealed the same statistical features at all stations. We found that the empirical pdfs consistently deviate from the theoretical line starting with certain large threshold values. This means that the empirical tail diverges from the Weibull model, indicating that a different model might describe the most extreme wind speed data well.

However, an applying the same analysis to the high-resolution modelling data has shown somewhat contradictory results. On the one hand, the distribution pattern is very similar to the observational one, i.e. the empirical pdfs of wind velocity extremes could be approximated by two different Weibull distributions, which refers to ability of the model to reproduce the statistical structure of wind maximum. On the other hand, the Weibull distribution parameters related to the 'dragons' sample obtained by model are significantly different, wind speed thresholds are lower (12 – 22 m/s at most), i.e. the extremity of wind speed maximum would not well reproduced.

Statistical analysis of the long-term model archive allowed to confirm the proposed approach based on the observations, and reproducibility of the 'dragons' extremes by the regional atmospheric model, i.e. the near-surface wind speed reproduction was markedly improved. However, model with a given resolution was not able to reproduce some essential parts of wind speed maximum' statistical properties. Therefore, this gap could be covered as using higher resolution, as by areal estimation techniques and many others. These assumptions will be used as a basis for the further development of the study.