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A satellite-based study of tornado climatology in forested regions of northeast Europe

Andrey Shikhov (1) and Alexander Chernokulsky (2)

(1) Perm State University, Perm, Russian Federation (and3131@inbox.ru), (2) A.M.Obukhov Institute of Atmospheric Physics, Russian Academy of Sciences, Moscow, Russian Federation (a.chernokulsky@ifaran.ru)

It is presented a novel method of tornado track identification in forested regions based on remote sensing data. The method allows to estimate objectively (i.e. independently from the population density and weather observation network) climatology of relatively strong tornadoes in forested regions. The method is based on discriminating of narrow and elongate areas from forest disturbances obtained with LANDSAT satellite images and LANDSAT-based Global Forest Change Map. These areas were subsequently verified with high-resolution satellite images for specifying tornadic cause of treefalls. MODIS satellite images, the NCEP Climate Forecast System reanalysis (CFSR) data, weather station observations and media reports were additionally involved to determine tornado dates. Minimal F-scale tornado intensity was estimated by a Weibull distribution model, using information on tornado path length and width. The method has been implemented to the forested regions of northeast Europe where 111 tornado tracks were revealed for the 2000-2015 years (105 of them were unreported and discovered for the first time). For some regions, tornado density estimated by the new method is 2-3 times higher than previously published. The largest number of tornadoes occurred in 2009; June is the most favourable month for tornado formation (including strong tornadoes and tornado outbreaks). Most identified tornadoes have path length less than 10 km, maximum width around 200–300 m, and mean width close to 100-200 m. A few tornadoes with long and wide paths were found. In addition, some characteristics of devastating tornado outbreak of 9 June 1984 were verified based on LANDSAT satellite images.