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Investigation of the stochastic properties of wind

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Understanding atmospheric motion in the form of wind is essential to many fields in hydroclimatics. The wind is considered one of the most important processes in hydrometeorology since, along with temperature, it generates and drives climate dynamics. Currently, the interest has increased due to its involvement to renewable energy resources through wind power production and forecasting. However, there seems to be a puzzle about which stochastic model best describes the wind process. In this analysis, we attempt to explain the reason around this confusion regarding the stochastic properties of the wind process using statistical as well as hydrometeorological reasoning, starting from the microscale of turbulence and extending the analysis to the macroscale of climatic processes. Particularly, some models seem to exhibit good agreement with data mostly due to instrumental errors. Moreover, we show that extending the theory of turbulence to the atmospheric motion can reveal stochastic properties that are not only accompanied with physical interference but also exhibit excellent agreement with wind measurements. Finally, we apply the theoretical analysis to multiple stations around the globe and we derive conclusions on the variation of stochastic parameters of wind regarding dominant climatic conditions.