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Similarity in turbulent mixing and dissipation for scalars measured in Arctic at the Tiksi observatory

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Measurements of atmospheric turbulence made at the Tiksi observatory located in the Russian East Siberia near the coast of the Arctic Ocean are used to study turbulent fluxes, scaling laws for turbulent mixing, dissipation rates, structure parameters, and correlation coefficients of various scalars (temperature, water vapor, and carbon dioxide). Turbulent fluxes along with other turbulent statistics and mean meteorological data were measured continuously throughout the year and reported hourly at various levels on the 20-m flux tower. According to our data collected during 2012-2014, strong upward sensible and latent heat fluxes are observed throughout the summer months indicating unstable stratification on average. During the Polar winter and cold seasons when the air temperature falls below freezing, the near-surface environment is generally stably stratified (downward sensible but upward latent heat fluxes). It is found that observed temporal variability of the carbon dioxide vertical flux was generally in phase with Monin-Obukhov stability parameter, z/L (L is the Obukhov length scale). On average the turbulent flux of carbon dioxide was mostly negative (uptake by the surface) for $z/L < 0$ and vice versa. Our study also analyzes the Bowen ratio and the similarity between the turbulent mixing of sensible heat, water vapor (latent heat), and carbon dioxide with a specific focus on the difference between different similarity functions including the dissipation rates. It has been traditionally assumed that turbulence transports scalars (e.g., water vapor, carbon dioxide, methane) similarly to temperature. The Tiksi data show that the water vapor and carbon dioxide are transported similarly (i.e. in the same "way" and with the same efficiency) to one another. However both water vapor and carbon dioxide fluxes are transported differently (but not substantially) as compared with the heat flux.
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