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Northern Hemisphere mid latitudinal cyclones: geometry, composites and insights for air-sea interaction

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Climatology of the atmospheric cyclone sizes and their change over the cyclone life cycle is analysed on the basis of tracking of 57 years of NCEP/NCAR reanalysis sea level pressure data over the Northern Hemisphere. In order to quantify the atmospheric cyclone sizes we used the coordinate transform that allows for the co-location of the cyclone center with the virtual pole and for the establishment of the unique coordinate system for the further determination of cyclone geometry. This procedure was incorporated into the numerical cyclone tracking scheme and provided quantitative estimation of cyclone geometry at every stage of the cyclone development.

Using the long-term climatology of cyclone sizes, climate variability of the cyclone size characteristics during the last 5 decades over the Northern Hemisphere mid-latitudes is assessed. Mean effective cyclone radius may experience significant changes, ranging from 300-400 km over the continents to more than 900 km over the oceans. There has been found strong dependence of the cyclone effective radius on the cyclone life time and intensity, implying the largest cyclone sizes for the most intense and long-living transients. Analysis of the cyclone size changes during the cyclone life cycle implies the cyclone radius increase during the cyclone development stage from 50 to 150%. Evolution of the cyclone size during the cyclone life cycle implies a universal dependence of the normalized cyclone effective radius and the normalized cyclone age. The actual maximum cyclone radius can be determined from these two non-dimensional parameters and cyclone central pressure.

New methodology allows for the design of the composites of cyclones for different stages of cyclone development and different regions and provides an effective tool

for analyzing the mechanisms controlling the cyclone energy balance. Analysis of cyclone composites shows particularly the decrease of the cyclone water vapor content from 20-30 kg/m^2 to 8-10 kg/m^2 during the life cycle. Furthermore, cyclone composites were applied to the estimation of the role of atmospheric synoptic transients in the ocean surface balance. Particularly, estimation of the cyclone heat gain due to evaporation which ranges from 10^{15} to – 10^{19} J.