Effective geometry based parametrization of the neutral drag coefficients for different sea ice morphology regimes

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A hierarchy of parameterizations of the neutral 10 m drag coefficients over polar sea ice with different morphology regimes is obtained based on a physical concept and data analysis. The concept which uses an effective geometry approach for the description of roughness elements consists in the partitioning of the total drag into skin drag and form drag, where the latter is specified as a sea ice morphology dependent function of the sea ice concentration. It is shown that the new parameterizations describe the large observed drag variability in both the marginal sea ice zones (MIZ) and in the summertime inner Arctic regions. In the MIZ form drag is generated by floe edges. Similarly, in the inner Arctic these edges occur at melt ponds and leads due to the elevation of the ice surface relative to the open water surface. It is shown that some parameterizations of drag coefficients suggested earlier can be obtained as special cases within the new concept, when specific simplifications concerning the floe and melt pond geometry are applied. The new derivation needs less assumptions than previous similar approaches. The final parameterizations can be applied to climate, weather prediction and sea ice models for present sea ice conditions but also for future climate scenarios with changing sea ice conditions.