Moving fetch and cat's paws on calm sea surface

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Natural winds are usually gusty and patchy. On otherwise calm sea surface this phenomena yields to appearance of moving wave covered patches, cat's paws. Equations are presented to, at least partially, explain the appearance and development of these patches.

There are in fact two wind speeds to consider regarding the wave growth process: the inception wind speed and the critical wind speed. The first one is the speed at which the waves start to grow and the latter one is the speed that is required to generate observable waves. The inception wind speed should be practically independent of fetch. The latter one should be time and fetch dependent. Even when the waves grow, it takes time and fetch before they reach the necessary height to be readily observable.

The spatial appearance of the cat's paws can be illustrated by a curve which describes the fluctuations of the wind speed as function of time and a line which describes the critical wind speed. When wind speed begins to increase, at first all local maxima of the wind speed remains under the critical wind speed. At this point no waves has appeared on a calm sea surface. When the mean wind speed has increased enough, some part(s) of the curve exceeds the critical wind speed. The waves begin to appear inside the corresponding regions of sea surface. As the mean wind speed further increases, more and more parts of the curve exceeds the critical wind speed. Finally, at some mean wind speed all minimums have exceeded the critical wind speed. At this point the whole sea surface has become roughened with visible waves.

Two different growth rate functions, one theoretically derived exponential growth rate function and one defined by using wind-wave flume measurements have been utilized in the numerical studies.

The numerical results have been compared to each other and to the observations at open sea.