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Projected changes in the annual wind-wave cycle

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The uneven distribution of the sun's energy directly and indirectly drives physical atmosphere and ocean processes. This creates intricate spatial patterns within the seasonal cycle where higher order harmonics are seen to play an important role in regional climates. The annual cycle and associated harmonics are the strongest oscillations within the climate system and describe the majority of variance across the oceans. Consequently when studying climate oscillations, it is common practice to remove the seasonal cycle in order to elucidate inter-annual cycles. Furthermore the annual cycle plays an important role in the evolution of other inter-annual oscillations through non-linear coupling (e.g ENSO). Despite the important role of the seasons within the climate system very few studies describe the seasonality with any rigor. Therefore our focus is to describe the higher harmonics linked to the annual cycle and how they are expected to evolve in a changing climate.

Using simulations from the Coordinated Ocean Wave Climate Project, the seasonality of multiple mid and end of the 21st century wind-wave climate projections are analyzed relative to historical experiment forced simulations. A comparison of various GCM forced wave simulations to reanalysis datasets reveals that a multi-model ensemble best describes the seasons. This ensemble is used to describe the changes within the wave seasonality. A systematic analysis reveals the primary mode of the seasons is relatively unchanged in the mid and end century. The largest changes occur in the second and third modes. The second mode defines the shift or translation within the seasons while the third mode characterizes relative change between the seasonal extremes (ie sharpening or flattening of the waveform). The relative changes in the second and third modes are not homogeneous and intricate patterns are revealed. Certain regions have sharper contrast in seasonality while other regions have a longer strong season. In summary, the changes in wave seasonality are spatially dependent. The wave field is a filtered version of the atmospheric forcing and it is expected that the results can be extrapolated to other variables.