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Long-Term Internal Variability Effects on Centennial Dynamic Sea Level Projections

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The Earth's surface is warming in response to anthropogenic emissions of greenhouse gases, especially carbon dioxide (CO_2). Sea level rise is one of the most pressing aspects of global warming with far-reaching consequences for coastal societies. However, sea level rise did and will strongly vary from coast to coast. Here we investigate the long-term internal variability effects on centennial projections of dynamic sea level (DSL), the local departure from the globally averaged sea level. A large ensemble of global warming integrations was conducted with a climate model, where each ensemble member was forced by identical CO_2-increase but started from different atmospheric and oceanic initial conditions taken from an unforced millennial control run. In large parts of the mid- and high latitudes, the ensemble spread of the projected centennial DSL trends is of the same order of magnitude as the globally averaged steric sea level rise, suggesting internal variability cannot be ignored when assessing 21st century DSL changes. This conclusion is also supported by analyzing projections with other climate models. The ensemble spread is strongly reduced in the mid- to high latitudes if only the atmospheric initial conditions are perturbed; suggesting uncertainty in the projected centennial DSL trends there is largely due to the lack of ocean information. Thus climate model projections of regional sea level would benefit from ocean initialization.