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Preferred structures in large-scale circulation and the effect of doubling greenhouse gas concentration in HadCM3

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Preferred structures in the surface pressure variability are investigated in and compared between two 100-year simulations of the Hadley Centre climate model HadCM3. In the first (control) simulation, the model is forced with pre-industrial carbon dioxide concentration (1×CO2) and in the second simulation the model is forced with doubled CO2 concentration (2×CO2). Daily winter (December-January-February) surface pressures over the Northern Hemisphere are analysed. The identification of preferred patterns is addressed using multivariate mixture models. For the control simulation, two significant flow regimes are obtained at 5% and 2.5% significance levels within the state space spanned by the leading two principal components. They show a high pressure centre over the North Pacific/Aleutian Islands associated with a low pressure centre over the North Atlantic, and its reverse. For the 2×CO2 simulation, no such behaviour is obtained. At higher-dimensional state space, flow patterns are obtained from both simulations. They are found to be significant at the 1% level for the control simulation and at the 2.5% level for the 2×CO2 simulation. Hence under CO2 doubling, regime behaviour in the large-scale wave dynamics weakens. Doubling greenhouse gas concentration affects both the frequency of occurrence of regimes and also the pattern structures. The less frequent regime becomes amplified and the more frequent regime weakens. The largest change is observed over the Pacific where a significant deepening of the Aleutian low is obtained under CO2 doubling.