Changes in regional weather and extremes are coupled with changes in large-scale atmospheric circulation. The interannual variability of the large-scale circulation may be affected by changes in external forcings, such as changes in greenhouse gas concentrations in possible future climates. Using an Analysis of Variance-based method, the interannual variability of the seasonal mean of an atmospheric climate variable is separated into (a) intraseasonal, (b) slow-internal, and (c) slow-external components; where the slow-external component is related to the atmospheric response to radiative forcings, including greenhouse gases. The corresponding modes of variability are estimated by eigenvalue decomposition of the component covariance matrices. The method is applied to 500 hPa geopotential height from Coupled Model Intercomparison Project Phase 3 (CMIP3) climate models for Southern Hemisphere summer and winter. When compared with reanalysis data, it is found that the better CMIP3 models reproduce well the slow and intraseasonal modes of variability observed in the second half of the 20th century for summer and winter. For this subset of good CMIP3 models, the modes of variability for the second half of the 21st century were then estimated. It is found that there is little change in the intraseasonal or slow-internal modes of variability in either summer or winter. However, there are large changes in the dominant slow-external mode. This indicates that the largest changes to the interannual variability of the seasonal mean geopotential height in possible future climates are related to the changes in greenhouse gas forcing.