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Two stages of the Late Ordovician climate were simulated using an atmospheric general circulation model (AGCM; GENESIS v2.0). The goal of numerical experiments was to determine the role of paleogeographic changes in global cooling and its potential impact within a range of pCO_2 on the End Ordovician glaciation. Different shoreline positions based on high and low sea levels were evaluated to assess possible cooling effect of a lower sea level. Furthermore, some of the runs were performed with a lower poleward ocean heat transport to evaluate its impact on global cooling. A 3–dimensional ice sheet model was then added to the atmosphere model to investigate the role of the cryosphere. The results indicate that the paleogeographic changes coupled with an ice–induced albedo feedback might have been only preconditioning events rather than direct cause of glaciation. For all pCO_2 levels above 12x pre–industrial atmospheric level (PAL), the Caradocian (~454 Ma) experiments yielded higher annual mean temperatures than Ashgillian (~446 Ma) experiments. Below pCO_2 levels of 12x PAL extensive permanent sea ice and snow cover exists in both the Northern and Southern Hemispheres. Nevertheless, Caradocian and Ashgillian simulations with high sea level yielded no ice sheets; the ice sheets formed only in the Ashgillian simulations with pCO_2 level of 8x PAL, low sea level, as well as in the simulation with high sea level and with a reduced poleward heat transport. The pCO2 threshold for the onset of glaciation for Ashgillian paleogeography is 8x PAL with a low sea level (exposed shelfs) and/or reduced poleward ocean heat transport. The increase in upwelling indicated in simulations, could have caused the reduction of pCO_2 due to increased organic matter burial causing further cooling of the global climate. However, in this model the paleogeography and pCO_2 change alone are not sufficient to cause glaciation if the sea level stayed high (even with pCO_2 as low as 8x PAL). Therefore, sea level changes and/or poleward ocean heat transport are the factors that might have been crucial for strong observed global cooling during the Late Ordovician. New results using coupled GENESIS and MOM 2 ocean-atmospheric model may shed additional light on this problem.

American Geophysical Union
Abstract Form

Reference # 0000

1. 2002 Ocean Sciences Meeting
2. ASLO-30058400
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4. OS
5. (a) OS07
   (b) 1620, 4255
   (c)
6. N/A
7. 0% published elsewhere
8. $40
   Achim D. Herrmann
   Visa
   xxxx xxxx xxxx 2122
9. C
10. No special instructions
11. Student author

Date received: November 6, 2001
Date formatted: November 6, 2001
Form version: 1.5