Role of seasonal climate-vegetation feedback in the northern high latitude climate changes driven by obliquity and precession-eccentricity forcing

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Comprehensive understanding of systematic surface climate responses to the orbital forcing is expected to contribute to further understanding of paleoclimate changes, such as the glacial cycles. In this study, we investigate the surface climate responses to individual changes of obliquity and precession-eccentricity, as the boreal summer insolation increasing, and estimate relative contributions of surface climate feedback processes. Idealized climate simulations using MIROC-GCM coupled to a global dynamical vegetation model (O'ishi and Abe-Ouchi, 2011) are conducted. A surface feedback analysis method, which proposed by Lu and Cai (2009) for an investigation of polar amplification compared to the global warming in the future, is then applied to the results. We reveal that the seasonality of the insolation is important in the northern high latitude, since it crucially effects on duration of each season and strength of climate feedbacks as well. On both land and the Arctic sea, the obliquity forcing, by which insolation increases in summer half of a year, largely amplifies the surface climate feedbacks. On the contrary, the precession-eccentricity forcing, by which insolation increases but in relatively shorter summer season, moderately amplifies the surface climate feedbacks. Vegetation distribution change which accompanied by vegetation-snow-albedo feedback has a decisive contribution on the difference of the amplification on the land. Another point of this study is that strength of winter warming on the Arctic sea is influenced by the duration of the summer season, rather than the intensity, and it is in favor of the obliquity forcing.

Key words: Orbital forcing, climate-vegetation feedback, the Arctic warming amplification, MIROC-GCM

References

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