Climate bistability on an energy balance model incorporated land and ocean surface

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In recent years, global warming is a critical problem to realize sustainable society. Intergovernmental Panel on Climate Changes (IPCC), have discussed about future global climate and how global warming impact. IPCC Fifth Assessment Report (AR5) shows temperature simulations of future climate using four warming scenarios and these periods are about decades or a hundred years. On the other hand, the past records of temperature from Antarctic ice cores show the temperature increased quickly but decreased slowly. This suggests what we should take into account when we discuss about climate changing.
One of the answers to this question is a climate bistability problem. A climate bistability, originally suggested by Budyko and Sellers, is the idea that global climate has two stable states and change irreversibly from one stable state to another, or has no stable state and change reversibly. The main factor of this stability problem is ice-albedo feedback. To reveal the problem, we adopted Energy Balance Models (EBMs).
Wagner and Eisenman proposed an energy balance model which incorporates meridional heat transport and seasonality. This model has completely water surface and an idealized representation of sea ice and climate in hemisphere domain. According to this paper, meridional heat transport and seasonality make bistability smaller. However, the earth has not only sea and sea ice surface but land and land ice surface. Land and land ice have different characteristics and distributions from sea and sea ice. The examples are heat capacity, perpetual snow on high altitude. Thus we add land and land ice to an energy balance model based on the model introduced Wagner and Eisenman.
To use this energy balance models, we study how four components; meridional heat transport, seasonality, snow melting point, and differences between land albedo, sea surface albedo, snow albedo, affect climate bistability. The preliminary result shows meridional heat transport and seasonality make bistability smaller and higher snow melting point and different albedo value make larger.

Keywords: climate change, bistability, energy balance model, ice-albedo feedback

