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A reaction-diffusion model of the ice-albedo feedback mechanism.

The ice–albedo feedback is an example of a positive feedback mechanism in the Earth's climate system. It arises when the polar regions of the Earth are covered with snow and ice and the equatorial region and lower latitudes are ice-free, and is a consequence of the fact that the albedo (the fraction of the solar energy reflected back into space) is much higher for snow and ice than for open water and soil. The ice-albedo feedback mechanism can be modeled by a reaction-diffusion equation for the average surface temperature in a latitudinal zone around the globe. An expansion of the temperature in a series of Legendre polynomials shows that the reaction-diffusion equation is equivalent to an infinite-dimensional dynamical system. By introducing the concept of a moving *ice line*—the line separating the ice-free lower latitudes from the ice-covered higher latitudes—and assuming that the dynamics of the ice line proceed on a much slower time scale than the dynamics of the zonally averaged surface temperature, we reduce the model to a fast–slow dynamical system. Assuming symmetry about the equator, we show that, to lowest order, this system yields a temperature profile that matches the freezing temperature of salt water (-10°C) at latitude 72.6°. (Received September 19, 2012)