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The dynamics of heat lows over flat terrain

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The numerical model for a heat low developed by Racz and Smith (1999) is extended to include a representation of radiative heating and cooling. The model is run with a higher horizontal resolution than the original version and is used to investigate additional dynamical aspects of the structure and evolution of a heat low over a subcontinental- or continental-scale circular island surrounded by sea. Of particular interest is the diurnal and day-to-day evolution of the upper- and lower-level circulations and the degree of balance that exists in these. The heat low is surmounted by an anticyclone, the development of which is closely tied to the outflow branch of the sea breeze. The anticyclone has a much smaller diurnal variation than the heat low and, unlike the heat low is largely in balance, except in the region affected by the upward-propagating gravity wave induced by the inland-penetrating sea breeze. There is a strong analogy to certain aspects of tropical cyclones, which have a warm core, a shallow unbalanced boundary layer, and which are surmounted also by an anticyclone. Principles governing the absolute angular momentum budget are the same as those relating to the tropical cyclones and to the zonal-mean flow over Antarctica. Implications of these principles for obtaining a realistic steady state in long-term integrations of axisymmetric models are discussed.