Geophysical Research Abstracts,
Vol. 11, EGU2009-10613, 2009
EGU General Assembly 2009

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January 13, 2009

ABSTRACT

Rotors, formed as a result of flow separation in the adverse pressure field of mountain lee waves can be described as low-level horizontal vortices rotating along an axis parallel to the mountain range. They form beneath the crests of trapped lee waves, & pose a substantial threat to aviation due to their region of recirculation air and severe turbulence. The role of surface heating in modifying the structure & magnitude of these rotor flows has been discussed by several authors (e.g. Kuettner 1959, Doyle & Durran 2002). Here the numerical model BLASIUS has been used to conduct a high-resolution investigation into the effect of lee-slope heating on lee waves & rotors generated in flow, which consists of a sinusoidal jet, over a single two-dimensional ridge. Several initial lee-wave rotor regimes were generated, & subjected to a increasing amounts of surface heating.

This has two principal effects. The first is on rotor structure, where moderate heating enhances both rotor amplitude & strength if a rotor is initially present beneath a lee wave crest. This is particularly evident in the structure of the first rotor downstream of the mountain. Strong heating has the same effect initially, but increased sub-rotor turbulence further downstream erodes rotor & lee wave structure to cause a collape of the lee wave rotor regime. The second effect is on the wavelength of the lee wave train. Increased surface heating effects a lengthening influence on the resonant wave mode. This is seen for all initial wave regimes investigated, and in some stronger heating cases, two competing resonant wavelengths are observed. The explanation appears to be that increased heating significantly modifies the background flow structure, altering the wave mode that the flow profile is ableto support. A heated 3-dimensional case has also been simulated to investigate the internal structure & strength of the sub-rotor circulations.