Regardless of which type of viscosity function is implemented, a smoothing algorithm is applied to to the viscosity field between time steps. This technique was suggested by Jeroen Van Hunen (personal communication) after it was discovered that an Arrhenius temperature law and strain rate-dependent viscosity subroutines caused wild swings in the viscosity field between time steps in the particular version of Citcom used in this thesis. After the viscosity subroutine is called, the viscosity information is saved, and in the next time step, the new viscosity and old viscosity are averaged using

$$\ln(\eta_{new}) = (1-w)\ln(\eta_{old}) + w\ln(\eta_{new}), \tag{1.48}$$

where $w = 0.2$ is a weighting factor.

1.6 The Onset of Convection

Whether convection can occur in an ice layer is governed by the relative balance of thermal buoyancy forces to viscous restoring forces in the ice. The stability of a basally heated fluid layer against convection can be judged by examining the balance between thermal buoyancy, which drives the formation of plumes at the base of the fluid layer, thermal diffusion, which acts to decrease thermal buoyancy, and the viscous restoring forces that retard plume growth. The balance of forces against thermal diffusion is expressed by the Rayleigh number, and convection can occur in a fluid layer if the Rayleigh number of the fluid layer exceeds a critical value (Ra_{cr}) which depends on the wavelength of initial temperature perturbation issued to the layer and the geometry of the layer.

1.6.1 Linear Stability Analysis

The onset of thermal convection in fluids is commonly modeled using the technique of linear stability analysis (*Chandrasekhar*, 1961; *Turcotte and Schubert*, 1982), in which the growth or decay of an initial temperature perturbation embedded in a con-