MAE598 Fall 2012 HW8

The difficulty level of this assignment is "**M**"

A numerical weather or climate prediction model incorporates many physical parameterization schemes to calculate the diabatic heating, momentum damping by friction, etc. Please first choose one of the following categories of physical parameterization and find one key paper that describes a scheme for the parameterization. The key task here is for you to read that paper and write a summary of (i) The physical process that is being parameterized, (ii) The mathematical formulas that represent the unresolved physical process in terms of the resolved model variables (u, v, T, q, etc.) for the basic prognostic equations, and (iii) a critique of the scheme (its desirable features and shortcomings).

(A) **Orographic gravity wave drag**. When the prevailing wind blows over complicated terrain it can generate gravity waves. This process can remain unresolved by the model if the waves are generated by unresolved small-scale topography. The net effect of the process is a "form drag" acting on the mean flow to damp it. What environmental parameters govern this process? Which equations (for u, v, T, q, etc.) are affected by this process? How is it parameterized?

(B) **Evaporation of rain/cloud droplets in the precipitation process**. Some of the rain drops that form during moist convection may diminish substantially, or evaporate completely, before they reach the ground. Similarly, cloud droplets can form by condensation or diminish by evaporation even in the absence of significant upward motion (convection). What environmental parameters govern this process? Which equations (for u, v, T, q, etc.) are affected by this process? How is it parameterized?

(C) **Accumulation, melting, and evaporation of snow at the surface**. This process is important for climate simulations that span multiple seasons. The existence of snow at ground has implications for the surface radiative energy balance (e.g., snow is highly reflective of solar radiation compared to bare soil) and water budget (e.g., snow accumulated at the top of a mountain in winter would become a source of water vapor in spring). How is the process parameterized in numerical weather/climate models? Note that this process is often included as a sub-component in the "land surface model" (LSM) that is coupled to the weather/climate prediction model. In that case, you may choose a key paper that describes the whole LSM but the review should focus on snow.

Please attach a copy of the key paper you review along with your report.