Homework Assignment #4

Due: April 27

Problem 1 (50 points)

Analysis of radiative heating/cooling rates of volcanic aerosols

Volcanic eruptions in high northern latitudes release significant amount of volcanic aerosols into the Arctic environment that can significantly perturb the entire Arctic's climate system.This task involves calculation and analyses of radiative heating rates using radiative fluxes computed with SBDART for the 2009 eruption of Mt. Redoubt. The SBDART calculations of the profile of SW and LW fluxes were performed for a volcanic aerosol layer from 3-20 km, low (AOD=0.38) and high (AOD=2) aerosol optical depth at 550 nm, low sun (SZA=75^0) and high sun (SZA=35^0), and over seawater and snow surfaces (see *Instruction* below).

1) For high aerosol optical depth, compute and plot SW, LW and total heating/cooling rates. Interpret the behavior of rates as a function of surface reflectivity and sun angle.
2) Repeat similar analyses for low aerosol optical depth.
3) Identify and interpret the major differences in heating/cooling rates between high and low AOD cases.

Instruction:

Data files are available here http://irina.eas.gatech.edu/EAS8803_SPRING2012/data/

Each file provides: altitude (from 20 km to 0km), pressure, downward flux, upward flux

Name of SBDART data files:

SW fluxes for high and low AOD: e.g., case1_lowAOD,..

case1 = high sun over seawater

case2 = low sun over seawater

case3 = high sun over snow

case4 = low sun over snow

LW fluxes for high and low AOD:

LW_lowAOD.txt

LW_highAOD.txt

Problem 2 (50 points)

Radiative forcing of clouds

Indirect radiative forcing remains one of the largest uncertainties in predicting climate change. The main challenge is to quantify how anthropogenic aerosols change cloud properties and resulting changes in how clouds will affect the shortwave and longwave radiation. One mechanism, called the first aerosol indirect effect or albedo effect, involves changes in cloud reflectivity of solar radiation due to aerosol-induced changes in cloud droplet sizes.

By performing the SBDART modeling, investigate how change in effective size of cloud drops affects the SW albedo. Consider two types of clouds: optically thin and optically thick.

Instruction:
To run SBDART use one of the following links:
http://ira2.eas.gatech.edu/irina/EAS8803_Fall2009/sbinpf.htm

http://slava.eas.gatech.edu/irina/EAS8803_Fall2009/sbinpf.htm