PROJECT. Community Snow Project

The Community Snow Project is an effort across a number of groups that is aimed to improve the representation of snow in CLM and by extension climate in CAM-CLM.
People who are involved in the project or whose prior research efforts are represented include: David Lawrence, Keith Oleson, Nan Rosenbloom (NCAR); Guo-Yue Niu, Liang Yang (U. Texas); Mark Flanner, Charlie Zender (UC Irvine); Xubin Zeng, Aihui Wang (U. Arizona); Andrew Slater, Peter Lawrence (CIRES)
The primary motivation of this project is to implement a number of recent independently derived improvements to the snow model into the latest version of CLM (CLM3.5) and to evaluate these improvements in CAM3.5-CLM3.5 when integrated together. Evaluations will include an analysis of both the snow simulation and the impact on climate.
Snow diagnostics page
For the initial phase of this project, we will evaluate improvements to the snow model that are based on research that is in the literature or in press. The modifications that will be evaluated include:
1. Snow cover fraction (Niu and Yang, 2007: An observations-based snow cover fraction formulation and evaluation over large North American river basins, submitted to JGR)
2. Snow burial fraction over short vegetation (Wang and Zeng, 2007: Improving the treatment of vertical snow burial fraction over short vegetation in the NCAR CLM3, submitted to GRL)
3. Snowpack radiation heating (Flanner and Zender, 2005: Snowpack radiative heating: Influence on Tibetan Plateau Climate, GRL)
4. Snow age and albedo (Flanner and Zender, 2006: Linking snowpack microphysics and albedo evolution, JGR)
5. Black carbon (and dust) on snow.
During this process, some unphysical behavior that occurs during snow layer splitting was detected. Corrections include a fix to maintain snowpack vertical temperature profile after split and to calculate snow overburden as sum of layers above layer in question plus half of the layer in question (DML)
Other potential future modifications related to snow (provided by Guo-Yue Niu)
"Radiation transfer through the canopy. We should blame the Mosaic approach more than the two-stream approximation. Mosaic approach imposes too much snow (or grass for Peter's dynamic vegetation) to solar radiation, neglecting shadows on snow or grass. But changing the mosaic approach may involve other changes in computing latent and sensible heat fluxes.
Re-examine stability correction to the aerodynamic resistance for snow surface both at open and vegetated areas. The surface layer overlying snow surface is very stable, which suppreses the turbulent transfer between the atmosphere and snow surface. Without consideration of stability would lead to a much higher snow-climate feedback strength, or too great snow sensitivity to the Arctic warming trend. Sam's 1.0 and 1.3 W/m2/K feedback strength is much larger than other estimates (0.6).
Snow interception by the canopy."
Further issues with snow to be dealt with in future (after discussions with Guo-Yue and Andrew Slater
1. Temperature range for snow formation in CAM (currently linear scaling snow/rain mix from -5C (all snow) to 0C (all rain). Possibly minimum T is too cold.
2. Snow density function, derived from data from Alta, Utah, is likely not appropriate elsewhere. Other functions exist (from book on Snow Hydrology?). Can an appropriate function be derived that is applicable globally.
3. Blowing snow redistribution (Pomeroy model?)
4. Constructive metamorphism
RUN STATUS
cam3_4_11_con: Keith ran this one and it had incorrect lon information. Corrected files are in /DLAWREN/csm/cam3_4_11_con/hist
cam3_4_11_snow1: Snow cover fraction. Done
cam3_4_11_snow2: SCF, Snow burial fraction. Done
cam3_4_11_snow3: SCF, SBF, snow age. Did not finish, incorrect setup
cam3_4_11_snow4: SCF, SBF, snow age + vertical heating, snow capping turned off. Done
cam3_4_11_snow5: SCF, SBF, SA, VH, + black carbon on snow. Crashed 1995. Snow grain radius out of bounds?
cam3_4_11_snow6: SCF, SBF, SA, VH, + eff porosity singularity fix. Snow capping fixed? Done
cam3_4_11_snow6b: SCF, SBF, VH, + eff porosity singularity fix, snow capping fixed, corrections to snow layer splitting + snow compaction
cam3_4_11_snow7: SCF, SBF, SA, VH, ep fix, snow cap fix, + black carbon on snow. Crashed in year 1985. ERROR in aerosol routine "interval was not found for col i 6".
cam3_4_11_snow8: Same as snow7 but with dust turned on. Same problem.
cam3_4_11_snow9: Same as snow7 but with Danni's fix to aerosol sedimentation routine (not expected to solve problem). Crashed as before.
cam3_4_11_snow10: SCF, SBF, + aerosols on. Test of aerosols in cam3_4_11. Done. Indicates that bug is in SNICAR.
cam3_4_11_snow11: Same as snow10 but with fix to eliminate potential divide by zero in SCF. Crashed in same place as before. When running with debug on, model stopped in ncd_iolocal trying to transpose flx_absf.
cam3_4_11_snow12: Same as snow11 but with mods to snicar to try to correct problem in ncd_iolocal (create new dimension, levsno1 for snow levels plus 1)
cam3_4_11_snow15: SCF, SBF, SA, VH, black carbon and dust on snow, effpor fix, Bundy fix to carbon sed, fdb token unset, 0 snow fix (Flanner). This run finally works!!
NOTES:
The snow burial fraction parameterization needs to be incorporated into the relevant routines for CN and DGVM when implemented into the main CLM trunk.
Getting QNEG warnings in all versions of cam3_4_11, including the control simulation
CAM/CLM without SNICAR (170 days per hour on 16 procs)
CAM/CLM with SNICAR with aerosols (146 days per hour on 16 procs)
CAM/CLM with SNICAR no aerosols (254 days per hour on 32 procs)
Mark estimates that the cost of SNICAR is only 10-15% for CLM.
Run cam3_4_11_snow4 had a segmentation fault at 1994-04-07. We have not figured out why and as of 6/28/2007 I have not been able to get it going again to try to sort things out. Decided to proceed with runs with snowcapping fix (see below).
On 6/28/2007, Brian Eaton discovered a bug in CLM3.5 in which effective porosity could go to zero in SoilHydrologyMod.F90 which would lead to a FPE. Keith put in a fix that restricts eff_porosity to a minimum value of 0.01. All runs including and after cam3_4_11_snow6 have this fix in them.
Runs cam3_4_11_snow6 and above also have Mark Flanner's fix to snow capping. In snow4 and snow5, snow capping is turned off and there are consequent trends in snow depth over glacier points.
8/8/2007 Runs cam3_4_11_snow7 (SNICAR with black carbon) and cam3_4_11_snow8 (SNICAR with black carbon and dust) both crashed with errors (interval was not found in col i) after 8 and 10 years respectively. Mark says that over the course of many many aerosol runs that he has seen this before, but not often. Have sent an email to Danni Bundy about it.