

## **Geophysical Models at NCAR: A Scoping and Synthesis Workshop**

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# **Anthropogenic Land Cover Change Experiments in the CCSM**

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## **Part 1. Model basics and procedures**

The Community Climate System Model (CCSM) is comprised of four sub models to simulate the atmosphere (Community Atmosphere Model - CAM), the ocean (Parallel Ocean Program - POP), sea ice surface (Community Sea Ice Model - CSIM), and the terrestrial surface (Community Land Model - CLM). Anthropogenic forcings of climate change can be divided into those affecting atmospheric composition (e.g., greenhouse gases and aerosols), simulated in the CAM, and those that affect land cover, simulated in the CLM. Anthropogenic land cover change alters energy, water, and carbon exchanges between land and atmosphere and in doing so alters climate. The first part of this session will focus on how these processes are simulated in the CLM, and how similar land cover changes in different environments can result in different climate changes

## **Part 2. Simulation scenarios and statistical considerations**

To simulate human land cover change in the CLM, datasets are developed to show how natural vegetation is replaced by croplands and grazing lands. Simulations can be categorized as equilibrium simulations where the model reaches equilibrium conditions with a fixed land cover type. Alternatively, transient simulations simulate climate through time with changing land surface conditions. Transient simulation could also include atmospheric forcing where, for example, greenhouse gas concentration change over time along with land cover change. We will illustrate typical outcomes from such simulations using the older Parallel Climate Model. We will also discuss problems that arise when determining statistical confidence from these high temporal and spatially correlated climate variables.

## References

### CLM Literature (Model description etc.)

Bonan, G.B., K.W. Oleson, M. Vertenstein, S. Levis, X. Zeng, Y. Dai, R.E. Dickinson, and Z. Yang, 2002: The Land Surface Climatology of the Community Land Model Coupled to the NCAR Community Climate Model. *J. Climate*: (15) 22, 3123-3149.

Collins, W.D., C.M. Bitz, M.L. Blackmon, G.B. Bonan, C.S. Bretherton, J.A. Carton, P. Chang, S.C. Doney, J.J. Hack, T.B. Henderson, J.T. Kiehl, W.G. Large, D.S. McKenna, B.D. Santer, and R.D. Smith, 2006: The Community Climate System Model version 3 (CCSM3). *J. Climate*, 19(11) 2122-2143.

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Oleson, K.W., and Y. Dai et al., (2004): Technical description of the Community Land Model (CLM), NCAR Technical Note NCAR/TN-461+STR, National Center for Atmospheric Research, Boulder, CO, 173 pp.

### PCM Literature (land cover change)

Feddema J.J., K. Oleson, G. Bonan, L. Mearns, W. Washington, G. Meehl, and D. Nychka, (2005a): A comparison of a GCM response to historical anthropogenic land cover change and model sensitivity to uncertainty in present-day land cover representations, *Climate Dynamics*, 25: 581-609.

Feddema, J.J., K. Oleson, G. Bonan, L.O. Mearns, L. Buja, W.M. Washington, and G. Meehl, (2005b): How important is land cover change for simulating future climates? *Science* 310(5754): 1674-1678.

### SRES and Land cover change literature

If anyone is burning to know there is a paper in press as well

Nakicenovic, N, and R. Swart (eds) (2000): Emissions scenarios-a special report of working group III of the intergovernmental panel on climate change. Cambridge University Press, Cambridge pp 599. See <http://www.grida.no/climate/ipcc/emission/>

Ramankutty, N., and J.A. Foley (1999). Estimating historical changes in global land cover: croplands from 1700 to 1992, *Global Biogeochemical Cycles* 13(4), 997-1027.  
see <http://www.sage.wisc.edu/pages/landuse.html> <<http://www.sage.wisc.edu>>

RIVM (Rijks Instituut voor Volksgezondheid en Milieu), (2002): IMAGE 2.2 CD release and documentation. The IMAGE 2.2 implementation of the SRES scenarios: A comprehensive analysis of emissions, climate change and impacts in the 21st century. See <http://www.rivm.nl/image/> for further information.