Applying Noah LSM in NASA-NCEP Land Information System (LIS) to Provide a Realtime and 25-year Retrospective Global Land Data Base for Climate Model Impact Studies in the NOAA-NCEP Climate Test Bed

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Abstract

Accurate initialization and physical simulation of land surface states, namely, soil moisture, soil temperature, vegetation, and snowpack, is critical in weather and climate prediction systems because of their regulation of surface water and energy fluxes between the surface and atmosphere over a variety of spatial and temporal scales. For those climate models in the NOAA-NCEP Climate Test Bed (CTB, *http://www.cpc.ncep.noaa.gov/products/ctb/*) that execute the Noah LSM as their land component, we seek to provide optimal land-state initial conditions that are both 1) the product of surface forcing that utilizes observed rather than model precipitation and 2) self-consistent with the inherent climatology of the Noah LSM. We achieve this by applying the uncoupled, land-component only, Land Information System (LIS, *http://lis.gsfc.nasa.gov*) with the Noah LSM. LIS, developed primarily by NASA Goddard Space Flight Center (GSFC) with close collaboration with NOAA National Centers for Environmental Prediction (NCEP), aims to perform high-quality land surface simulation using state-of-art LSMs and observation-based precipitation and radiation, and satellite land data assimilation techniques. The LIS infrastructure has been ported to the NCEP supercomputer that serves the CTB framework. In this implementation, the NCEP Global Reanalysis-2 (GR2) and the NCEP Climate Prediction Center (CPC) Merged Analysis of Precipitation (CMAP) are used to drive the Noah LSM for multi-decadal uncoupled land surface simulations. The latest version of Noah LSM has been coupled to the operational NCEP Global Forecast System (GFS) for weather prediction and test bed versions of the NCEP Climate Forecast System (CFS) for climate prediction. It is crucial that the uncoupled LIS/Noah use exactly the same Noah code (and soil and vegetation parameters therein), and execute on the same horizontal grid, landmask, terrain, soil and vegetation types, seasonal cycle of green vegetation fraction and surface albedo, as in the coupled GFS/Noah and CFS/Noah.

To support CTB, LIS/Noah has been executed on the same T126 gaussian grid as of CFS, starting with a pre-execution 10-year spin-up, to generate the approximately 25-year (1980-2005) retrospective global land surface states. This LIS/Noah retrospective will be used for the global land surface climate variability assessment and land initial conditions for the ensemble CFS seasonal hindcast experiments. Also, this LIS/Noah retrospective will provide the global land climatology and anomaly needed as the foundation for a global drought/flood monitoring and prediction system that includes realtime updates of the land surface states. Future plan includes the snow assimilation using the Air Force Weather Agency 25-year satellite-derived global snow analysis.

Land Surface Modeling at NCEP

At NCEP the Noah LSM has been implemented in
- Operational Global Forecast System (GFS) and its 4DDA (GDAS)
- Operational North American Mesoscale forecast system (NAM) and its 4DDA (NDAS)
- Operational 25-year N. American Regional Reanalysis (NARR)
- Experimental uncoupled Land Data AssimilationSystems (GLDAS and NLDAS)
- Experimental Eta Regional Climate Model (Eta RCM)
- NOT in operational Climate Forecast System (CFS, uses ancestor OSU LSM)

Add Noah LSM to CFS: will CFS skill improve?

Land Models in the Current and the New CFS

	New CFS	Current CFS
Horizontal Resolution	T126 (~1° global, 384 X 190)	T62 (~2° global, 192 X 94)
Soil Layers	4 layers (10, 30, 60, 100 cm)	2 layers (10, 190 cm)
Land Surface Model	Noah • addition of frozen soil physics • improved physics: – snowpack – evaporation – ground heat flux – infiltration & runoff	OSU
Land Initial Conditions	GR2/OSU and LIS/Noah	GR2/OSU

CFS Land Modeling and Initialization Exps

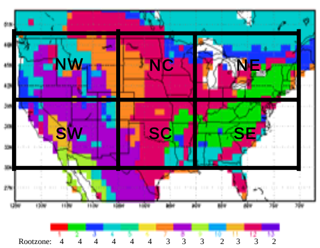
	CFS/Noah	CFS/OSU
Land Initial Conditions	LIS/Noah	LIS/Noah
	LIS/Noah Climatology	LIS/Noah Climatology
	GR2/OSU	GR2/OSU
	GR2/OSU Climatology	GR2/OSU Climatology

Each experiment runs for
5-10 years X 2 seasons (summer/winter)
X 10-15 ensemble members.

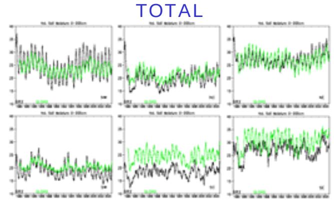
2-meter Column Soil Moisture (1980-2004)

--- GR2/OSU --- LIS/Noah

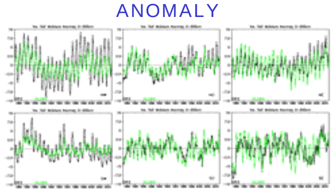
Noah VEGETATION TYPE



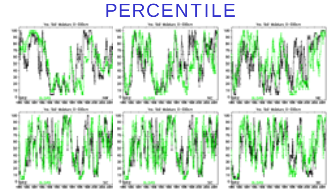
TOTAL



ANOMALY



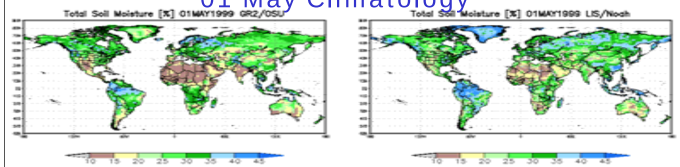
PERCENTILE



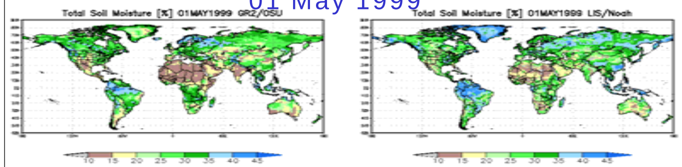
2-meter Column Soil Moisture

GR2/OSU LIS/Noah

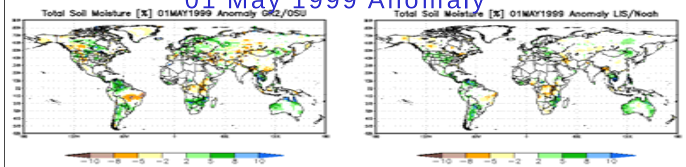
01 May Climatology



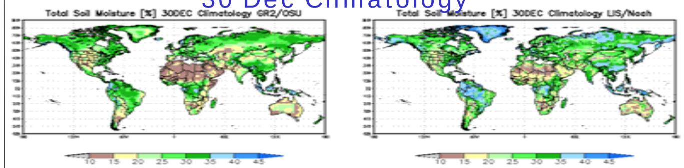
01 May 1999



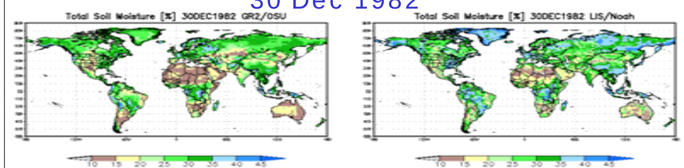
01 May 1999 Anomaly



30 Dec Climatology



30 Dec 1982



30 Dec 1982 Anomaly