Recent updates on the NLDAS Science Testbed

David M. Mocko\textsuperscript{1,2}, Sujay V. Kumar\textsuperscript{1}, Christa D. Peters-Lidard\textsuperscript{1}, Shugong Wang\textsuperscript{1,2}, Kristi Arsenault\textsuperscript{1,2}, Yudong Tian\textsuperscript{1,3}, Youlong Xia\textsuperscript{4,5}, Michael B. Ek\textsuperscript{4}, Jiarui Dong\textsuperscript{4,5}

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\textsuperscript{1} – NASA/GSFC; \textsuperscript{2} – SAIC; \textsuperscript{3} – Univ. MD; \textsuperscript{4} – NOAA/NCEP/EMC; \textsuperscript{5} – IMSG
The LIS group has developed an NLDAS Science Testbed, designed to test LSMs, parameters, and data assimilation within the **Land Information System (LIS)** using the NLDAS configuration. These simulations are also being evaluated against the four operational LSMs running in NLDAS Phase 2.

- **Spin-Up**: 70 years (1979 to 2014 twice) – and then running 1979 to 2015
- **Evaluation period**: (2002-2012; 11 years with the most evaluation data)
- **Output**:
  - Monthly water/vegetation states during the two spin-up periods
  - Daily output during the third simulation of all relevant energy/water terms
- **Evaluation**: Using the **Land Verification Toolkit (LVT)** to evaluate soil moisture, snow, ET/fluxes, surface radiation, runoff, streamflow, groundwater, etc.
Soil Moisture – anomaly correlations

SM evaluations show: 1) CLSM-F2.5 does not do as well as Mosaic; 2) Noah-3.x versions are improved over Noah-2.8; 3) Noah-MP slightly better than Noah-3.x; 4) Noah-MP dynamic veg. does about as well as default Noah-MP; and 5) VIC-4.1.2.l does not do as well as VIC-4.0.3.
Soil Moisture – anomaly correlations
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Streamflow evaluations show: 1) CLSM-F2.5 does not do as well as Mosaic, and has low values for streamflow; 2) Noah-3.x performs similarly to Noah-2.8; 3) Noah-MP is slightly worse than Noah-3.x; and 4) VIC-4.1.2.l has higher streamflow and is improved over VIC-4.0.3.
Groundwater evaluations show: 1) CLSM-F2.5 does better than Noah-MP; and 2) Noah-MP dynamic vegetation does slightly worse than default Noah-MP.
Groundwater – Anomaly correlations

CLSM–F2.5 – 2002–2012 – 136 USGSGW sites

Latent heat flux evaluations show: 1) CLSM-F2.5 has high latent heat and VIC-4.1.2.1 has low latent heat; 2) Noah-3.x has higher latent heat than Noah-2.8, with Noah-MP in the middle; and 3) other reference datasets (ALEXI, MOD16, UW ET) don’t compare better to FLUXNET than LSMs.
Evaporation over Precipitation

FLUXNET = reference ET product

NLDAS-2 operational LSMs

Mosaic and SAC have high ET
Noah-2.8 has lower ET
VIC-4.0.3 has low ET esp. in the SE
Evaporation over Precipitation

**FLUXNET** = reference ET product

**NLDAS Science Testbed LSMs**

**CLSM-F2.5** has higher ET than Mosaic

**Noah-3.6** has higher ET vs. Noah-2.8
Runoff over Precipitation

USGS = reference Q product

NLDAS-2 operational LSMs

Mosaic and SAC have lower Q
Noah-2.8 and VIC-4.0.3 compare well to USGS
Runoff over Precipitation

USGS = reference Q product

NLDAS Science Testbed LSMs

CLSM-F2.5 again has low Q
Noah-MP-3.6 does well (although notably not very well in the Sandhills or in FL)
The WACMOS-ET project – Part 2: Evaluation of global terrestrial evaporation data sets

D. G. Miralles¹,², C. Jiménez³, M. Jung⁴, D. Michel⁵, A. Ershadi⁶, M. F. McCabe⁶, M. Hirschi⁵, B. Martens², A. J. Dolman¹, J. B. Fisher⁷, Q. Mu⁸, S. I. Seneviratne⁵, E. F. Wood⁹, and D. Fernández-Prieto¹⁰

Three different models partitioned the ET _very_ differently. These are GLOBAL percentages of total ET (2005-2007).


http://www.hydrol-earth-syst-sci.net/20/823/2016/
NLDAS-2 LSMs (1980-2013)

Mosaic
Noah-2.8
VIC-4.0.3

GLEAM v3.0a

Pie charts and values in the table are area-averaged over the NLDAS domain 1980-2013

Interception
Soil evap.
Transpiration

NLDAS Science Testbed

CLSM-F2.5
Noah-3.6
Noah-MP-3.6 WRF default
Noah-MP-3.6 dynamic veg.
Noah-MP-3.6 Noah-like
VIC-4.1.2.l

<table>
<thead>
<tr>
<th>Reference/ LSM</th>
<th>Qle [W/m²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLEAM v3.0a</td>
<td>37.2</td>
</tr>
<tr>
<td>FLUXNET</td>
<td>37.7</td>
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<tr>
<td>N2 Mosaic</td>
<td>46.7</td>
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<tr>
<td>N2 Noah-2.8</td>
<td>33.5</td>
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<td>N2 VIC-4.0.3</td>
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<tr>
<td>CLSM-F2.5</td>
<td>45.2</td>
</tr>
<tr>
<td>Noah-3.6</td>
<td>44.4</td>
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<tr>
<td>MP WRF default</td>
<td>38.7</td>
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<tr>
<td>MP dynamic veg</td>
<td>37.4</td>
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<tr>
<td>MP Noah-like</td>
<td>38.1</td>
</tr>
<tr>
<td>VIC-4.1.2.l</td>
<td>33.8</td>
</tr>
</tbody>
</table>

[*] - converted from [mm day⁻¹]
[**] - 1984-2007 climatology
BFI is defined as the baseflow divided by the total runoff.

In the LSMs using the ALMA convention:

$$BFI = \frac{Q_{sb}}{Q_s + Q_{sb}}$$
BFI is defined as the baseflow divided by the total runoff.

In the LSMs using the ALMA convention:

\[
BFI = \frac{Q_{sb}}{Q_s + Q_{sb}}
\]
The different methodologies and the observed BFI values all generally show the same features:

1) Higher BFI in the western U.S. high terrain
2) Lower BFI in the central U.S.
3) Pocket regions of higher BFI on the east side of the Appalachians and in the Northeast
4) High BFI around the western Great Lakes
5) High BFI in the Sandhills region (Nebraska)

\[
BFI = \frac{Qsb}{(Qs + Qsb)}
\]
USGS Base Flow index (Wolock, 2003)

Digital filter method (Santhi et al., 2008)
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Other areas of development

• CLM-4.5 LSM has been integrated into the LIS software and will be evaluated in the NLDAS environment
• RUC LSM is also in LIS and is being evaluated for NLDAS
• Adding new evaluations to the Testbed (updated North American Soil Moisture Database, GLEAM ET and soil moisture, etc.)
• Evaluating the NLDAS router against the HyMAP router
• Testing Noah-MP various options (vegetation, canopy stomatal resistance, runoff/groundwater, surface layer drag coeff., etc.)
• Looking to improve performance of CLSM-F2.5 or later version

http://ldas.gsfc.nasa.gov/nldas/  David.Mocko@nasa.gov