Datasets across CTSM-FATES

Thanks to: FATES development team and CTSM software engineers
HLM provides climate and site conditions. Current HLMs: CLM, ELM, NorESM, ATS.

All HLMs use netCDF to read/write datasets

FATES handles vegetation structure and physiology, seeds and litter.

FATES is a module, and must be associated with HLM

FATES is HLM agnostic
   - Supplemental data not required for all HLM

Questions for when you add data:
   - What are dimensions and attributes of data?
   - Will FATES adjust units per HLM format?
   - Or force expected units?
Methods of reading data

- **Streamfiles**
  - Data format for controlling input data as part of CIME
  - Power and flexibility without custom code
  - Interpolate spatially and in time
  - Existing user-defined interpolation options

- **Surface dataset**
  - Data fixed on file at read time
  - Data is at model resolution
  - Fixed in time
## “Essential” datasets global simulation

<table>
<thead>
<tr>
<th>Description</th>
<th>Use</th>
<th>Type</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFT fractions</td>
<td>FATES-SP &amp; FATES-fixed biogeography</td>
<td>surface dataset</td>
<td>operational</td>
</tr>
<tr>
<td>LAI (climatology or data)</td>
<td>FATES-SP</td>
<td>surface dataset or streamfile</td>
<td>to-test</td>
</tr>
<tr>
<td>Land use history</td>
<td>Transient change</td>
<td>Landuse timeseries</td>
<td>V1 in-testing V2 to-test</td>
</tr>
<tr>
<td>Lightning strikes</td>
<td>FATES-SPITFIRE</td>
<td>streamfile</td>
<td>operational</td>
</tr>
<tr>
<td>Population Density</td>
<td>FATES-SPITFIRE</td>
<td>streamfile</td>
<td>to-test</td>
</tr>
<tr>
<td>GDP</td>
<td>FATES-SPITFIRE</td>
<td>surface dataset</td>
<td>to-test</td>
</tr>
</tbody>
</table>
Adding new datasets to FATES

- Generic template for adding datasets as streamfiles
  - Example: Lightning strike data owned by HLM and passed into FATES (CTSM PR #991) [https://github.com/ESCOMP/CTSM/pull/991](https://github.com/ESCOMP/CTSM/pull/991)
  - Adaptable as framework for other dataset cases
  - HLM evolves dataset and methods independent of FATES (HLM reads the data both when running with FATES and without)
  - Uses CIME streams capability

- What about data owned exclusively by FATES?
  - Benefits: data available regardless of HLM
  - FATES must perform dataset management
  - FATES would need to add an efficient I/O library
## optional datasets

<table>
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<tr>
<th>Description</th>
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<th>Type</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veg structure</td>
<td>initialization</td>
<td>netCDF Text file (set of points)</td>
<td>to-create, txt point set: operational</td>
</tr>
<tr>
<td>wind</td>
<td>wind module, dispersal</td>
<td>datm forcing, streamfile</td>
<td>to-create</td>
</tr>
<tr>
<td>seeds</td>
<td>dispersal</td>
<td>Streamfile, model informed per year?</td>
<td>to-create</td>
</tr>
<tr>
<td>prescribed burned area</td>
<td>FATES-SPITFIRE</td>
<td>streamfile</td>
<td>to-create</td>
</tr>
<tr>
<td>prescribed albedo</td>
<td>Potential reduced-complexity mode. <strong>Unsure if feasible</strong></td>
<td>streamfile, FATES-SLIM model?</td>
<td>to-create</td>
</tr>
<tr>
<td>Prescribed soil moisture</td>
<td>Potential reduced-complexity mode.</td>
<td>Streamfile (CTSM history file)</td>
<td>to-test</td>
</tr>
</tbody>
</table>
Optional cases comments

- Wind (dispersal, wind damage/mortality)
  - Format: datm forcing only (if read as separate file could conflict with datm forcing)
  - Need direction (datm fixed NE) (currently have 10m speed)
  - Need daily “intensity/gustiness” (time at speed in direction)
  - Use CAM or CPLHIST to include forcing direction & pass to FATES
  - How to best capture “intensity/gustiness” from half-hourly data?

- Prescribed burned area
  - Format: streamfile, similar to prescribed soil moisture (history file)
  - Useful in CTSM and to inform FATES
  - Benefits: HLM research informs/updates dataset and is available to FATES

- Prescribed albedo
  - Format: streamfile? (current is part of BGC and created for each subgrid type)
  - Potential of using SLIM model to run with FATES?
CTSM gridcell-level balance checks

• C Mass balance checks at gridcell-level in addition to column (CTSM PR #984)

• Balance checks span dynamic landcover change along with physics
  – Trigger model stop with mass balance fail at grid cell OR column level
  – Check balance treats whole land system as black box
    • Handles pools and fluxes that interact between grid cell and atmosphere
  – Harvested wood and crops removed from land model (use and consumption)
  – “Dribble” terms apply annual transient update across time steps

• May catch issues with FATES integration

gridcell C balance = gridcell C + Wood production C + Crop harvest C +

grc_endcb(g) = totgrcc(g) + tot_woodprod_grc(g) + cropprod1_grc(g) + &
hrv_xsmrpool_amount_left_to_dribble(g) + &
dwt_conv_cflux_amount_left_to_dribble(g)

Maintenance respiration
Conversion pool
Final thoughts

● “Essential” datasets
  ○ Many are operational or ready for testing
  ○ Small amount of development for fire datasets (GDP, pop density)

● Optional datasets
  ○ Generic framework for adding streamfiles
  ○ Expands user-defined possibilities for testing/exploration

● Gridcell-level balance checks
  ○ Higher level of mass-balance testing across landcover change with physics response

● FATES connection to MEGAN needs development (not functional)
  ○ CTSM issue #115 https://github.com/ESCOMP/CTSM/issues/115#event-3439492456
Thank you!

You will find only what you bring in.

-Yoda

WellQuo

Empire Strikes Back