Sensitivity of site-level CLM simulations to input meteorology

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Framework for PTCLM multisite ensembles

Multisite fullrun
(copy run directories and modify namelists for n sites)

Main script: Call_PTCLM

1. Run PTCLM
   mkgriddata
   mksurfdata
      (use site-level soil, pft info)
   mkdatadomain
   Ncl script for ndep
   Ncl script for aerdep
   create_newcase
   Xmlchange (env_run, conf)
   Namelist creation

2. Compile and submit
   Configure case
   Apply srcmods
   Pft-physiology mods
   Build cesm
   Namelist customizations
   Create PBS script
   Submit to queue

4 generic cases
Spinups and transient

Multisite fullrun
Gap-filled tower driver datasets

- Tower observations usually have ~10-20% gaps in meteorological observations (power outages, quality control, etc.)

- Gaps are filled with:
  - Nearby flux towers (within 50 km and 100m elevation)
  - Nearby NCDC reporting station, bias corrected (hourly or if daily, diurnal cycle imposed using simple relationships) – T, precip, sometimes cloud cover
  - Multiyear mean monthly diurnal cycle

- CLM forcing files currently available for NACP flux tower sites (~45 sites)

- Can be generated for FLUXNET sites on demand.

- Can extract single-point reanalysis datasets to CLM format
## Summary of selected reanalysis products

<table>
<thead>
<tr>
<th>Product</th>
<th>Spatial resolution</th>
<th>Temporal resolution (hr)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tower observed</td>
<td>Site-level</td>
<td>0.5 or 1</td>
<td>Ricciuto et al. (in prep)</td>
</tr>
<tr>
<td>CRU-NCEP</td>
<td>0.5° x 0.5°</td>
<td>6</td>
<td>Viovy and Ciais</td>
</tr>
<tr>
<td>ERA-interim</td>
<td>1.5° x 1.5°</td>
<td>6 or 12</td>
<td>Uppala et al. (2005)</td>
</tr>
<tr>
<td>NARR</td>
<td>32km</td>
<td>3</td>
<td>Mesinger et al. (2004)</td>
</tr>
<tr>
<td>NCEP</td>
<td>1.9° x 1.9°</td>
<td>6</td>
<td>Kalnay et al. (1996)</td>
</tr>
<tr>
<td>NCEP2</td>
<td>1.9° x 1.9°</td>
<td>6</td>
<td>Kalnay et al. (1996)</td>
</tr>
<tr>
<td>NLDAS*</td>
<td>1/8° x 1/8°</td>
<td>1</td>
<td>Cosgrove et al. (2003)</td>
</tr>
<tr>
<td>Daymet</td>
<td>1km</td>
<td>24*</td>
<td>Thornton et al. (2012)</td>
</tr>
<tr>
<td>Princeton</td>
<td>1° x 1°</td>
<td>3</td>
<td>Sheffield et al. (2006)</td>
</tr>
</tbody>
</table>
Radiation biases in reanalysis products

Average over 34 AmeriFlux and FLUXNET Canada sites

Highest bias overall under cloudy conditions (except ERA-interim)

CRU-NCEP, Princeton (Sheffield) product have lower biases overall but low-biased under high-light (correction factor applies on a monthly basis)
Wavelet analysis of selected products

Residual power

Long-term bias

Coherence

ERA-interim  NCEP  Sheffield
Biases in radiation and precip by site-year

[Graph showing biases in radiation and precipitation by site-year with various data points and labels indicating different datasets.]
CLM4-CN version

- clm4_0_40 - ORNL
- Simulations for 8 sites, 6 products
- Modifications:
  - Plant N pool
  - Site-level harvest
- T-sensitivity
  - Q10_Vcmax modification
  - Cold-temperature photosynthesis modification
Differences in CLM-CN model output

UMBS site (Michigan)
Same years used for spinup/transient simulation
Large differences in soil carbon, LAI (up to 3x)
Simulations driven by tower forcing → lower stocks, productivity
Observed forcing and fluxes → more variability
Hypotheses: Radiation bias, variability, precipitation distribution
Comparison of simulated diurnal cycles

Radiation biases do not explain differences in NEE
Compensating effects (precipitation, variability in T, P, SRad)
More analysis needed
Effects on interannual variability

- GPP
- NEE
- ER
- FSDS
- RAIN
- TBOT

Legend:
- tower
- CRU
- NARR
- NCEP
- Princeton
- Daymet
Take-home messages

- Using site-level forcing results consistently in less carbon and lower fluxes
  - Lower solar radiation, precipitation distribution and higher variability
  - If using site-level runs to do model tuning/validation, may not be relevant at global scales.

- The choice of reanalysis forcing dataset matters
  - Large source of uncertainty in predicted carbon balance (factor of 2)
  - Both long timescale biases and short-term variability are important

- Driver uncertainty should be considered in overall uncertainty analysis
  - As important or more important than parameter, structural differences