Multi-site Validation of Daily SCOPE-Model-Simulated Carbon and Energy Fluxes

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Questions: Using SCOPE not for solar-induced chlorophyll fluorescence (SIF)

- how well does the SCOPE model simulate ecosystem fluxes?
  - [spoiler: extremely well]
- which plant functional type (PFT) specific values lead to more accurate flux simulations?
  - [spoiler: default]
- which group of input parameters is the most important: meteorological, structural or biochemical?
  - [spoiler: meteorological]

Results: Seasonal cycle and Interannual variability captured well

Gross primary productivity (GPP):  
- daily root-mean-square error (RMSEs) 2.5 µmol CO\(_2\) m\(^{-2}\) s\(^{-1}\) (R\(^2\) 0.72) (Figure 2, top)  
- annual RMSE 285 g C m\(^{-2}\) year\(^{-1}\) (R\(^2\) 0.67) (Figure 3, top)

Latent heat flux (LE) and Evapotranspiration (ET):  
- daily RMSE for LE 39 W m\(^{-2}\) (R\(^2\) 0.40) (Figure 2, bottom)  
- annual RMSE 106 mm year\(^{-1}\) (R\(^2\) 0.53) (Figure 3, bottom)

Puzzle: PFT-specific data and seasonality worsen the simulations

Models allow playing with parameters (meteorology, LAI, biochemistry, seasonality) to identify their importance (Figure 4).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>RMSE</th>
<th>R(^2)</th>
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<tbody>
<tr>
<td>+ + + +</td>
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<td>0.67</td>
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<tr>
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<tr>
<td>+ + + +</td>
<td>360</td>
<td>0.53</td>
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</tbody>
</table>

RMSEs of GPP for naive [all average] and complete cases are equally bad.

Take-home messages

- SCOPE model works extremely well for GPP simulations
- SCOPE model works well for ET simulations in temperate (energy-limited) climates
- PFT-specific Vcmax\(_{25}\) with LAI-imposed seasonality reduced bias in annual GPP
- literature Vcmax\(_{25}\) may perform dramatically worse than the default SCOPE values
- higher complexity does not automatically mean higher accuracy

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