The SMAP Level-4 ECO Project: Linking the terrestrial water and carbon cycles

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(2) Universities Space Research Association, GESTAR
(3) Science Systems and Applications
Outline

1. The Level-4 ECO Project
2. Catchment vs. Catchment-CN
3. SMAP Level-2 Passive Assimilation
4. Modeled vs. Observed FPAR
5. Next Steps
The L4-ECO project

Objective: Develop a fully coupled hydrology-vegetation data assimilation algorithm to generate improved estimates of hydrological fields and carbon fluxes
The L4-ECO project

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**L4 Soil Moisture:**
Assimilate SMAP observations into a land surface hydrology model to generate improved soil moisture estimates

**L4 Carbon:**
Use L4 SM estimates and MODIS fraction of absorbed photosynthetically active (FPAR) observations in carbon model to estimate carbon fluxes
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Land surface hydrology impacts biosphere (carbon fluxes), but not vice versa
The L4-ECO project

L4 ECO:

- Catchment-CN: Coupled land surface hydrology model (Catchment) and dynamic vegetation model (CLM4) to allow full feedback

Catchment-CN (Koster et al., 2014)

CLM4 dynamic vegetation model (Oleson et al., 2010; Thornton et al., 2007)

Catchment land surface model (Koster et al., 2000; Ducharne et al., 2000)
The L4-ECO project

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- Assimilate:
  - MODIS FPAR
  - SMAP brightness temperatures (Tbs)
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- **Assimilate**:
  - MODIS FPAR
  - SMAP brightness temperatures (Tbs)

Generate improved estimates of hydrological fields and carbon fluxes
Catchment vs. Catchment-CN

Evaluation against CVS data

Surface

Root zone

<table>
<thead>
<tr>
<th>Surface</th>
<th>Root zone</th>
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<tbody>
<tr>
<td>correlation [-]</td>
<td>correlation [-]</td>
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<tr>
<td>abs(bias) [m³ m⁻³]</td>
<td>abs(bias) [m³ m⁻³]</td>
</tr>
<tr>
<td>ubRMSE [m³ m⁻³]</td>
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<table>
<thead>
<tr>
<th>Catchment-CN</th>
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Evaluation against CVS data
Catchment vs. Catchment-CN

Evaluation against CVS data

- Surface: Catchment-CN improves correlations but slightly degrades ubRMSE compared to Catchment
- Root-zone: slight skill degradation with Catchment-CN
Assimilation of SMAP L2SMP

Evaluation against CVS data

Surface

Root zone

Δ correlation [-]

Δ abs(bias) [m³ m⁻³]

Δ ubRMSE [m³ m⁻³]

DA-L2P-CatCN

DA-L2P-Cat
Assimilation of SMAP L2SMP

Evaluation against CVS data

- Assimilation of SMAP L2P retrievals yields correlation and ubRMSE skill improvements in both cases
- Slightly smaller surface skill improvements for Catchment-CN, because of improved model skill
Catchment-CN FPAR vs. MODIS FPAR

Mean FPAR Apr 2015 - Mar 2017
Catchment-CN FPAR vs. MODIS FPAR

- Model and observations show strong discrepancies in absolute values and dynamics
- Differences may be too large to correct through assimilation alone
Catchment-CN FPAR vs. MODIS FPAR

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→ calibrate Catchment-CN to obtain more realistic model simulations
Next steps…

(1) Calibrate Catchment -CN

- Use MODIS FPAR observations to estimate optimal vegetation parameters for Catchment-CN
- Obtain more realistic FPAR simulations
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(2) SM and FPAR assimilation
• Jointly assimilate SMAP Tbs and MODIS FPAR observations into calibrated Catchment-CN
• Test OCO-2 SIF assimilation
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(3) Data generation
- Use fully coupled data assimilation system to generate improved estimates of hydrological fields and carbon fluxes
Thank you!
References

Reichle, R.H., Koster, R., Collatz, G.J. (NASA ROSES 2015 - SUSMAP), The SMAP Level 4 Eco-Hydrology Product: Linking the terrestrial water and carbon cycles through the joint assimilation of SMAP data and MODIS and OCO-2 vegetation observations


EXTRA SLIDES
Assimilating SMAP L2P SM into Catchment-CN

Evaluation against CVS data

Surface

Root zone