Transregional Collaborative Research Center 32

Interactions between groundwater dynamics and bio-geophysical processes – a case study using the TerrSysMP

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Outline

1. Features of the TerrSysMP
2. Real Test Case Simulation
3. Conclusions

Features of the TerrSysMP

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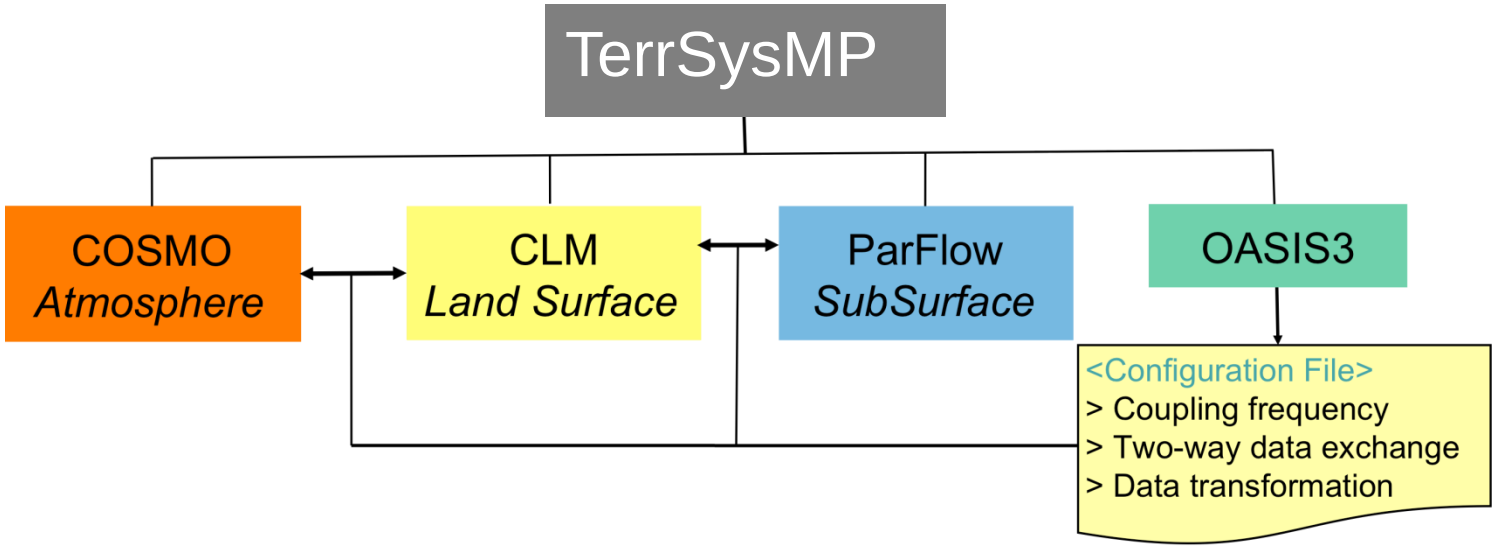

Configuration Options:

0 COSMO standalone
1 CLM standalone
2 ParFlow standalone
3 COSMO+CLM
4 CLM+ParFlow
5 COSMO+CLM+ParFlow

Features of the TerrSysMP

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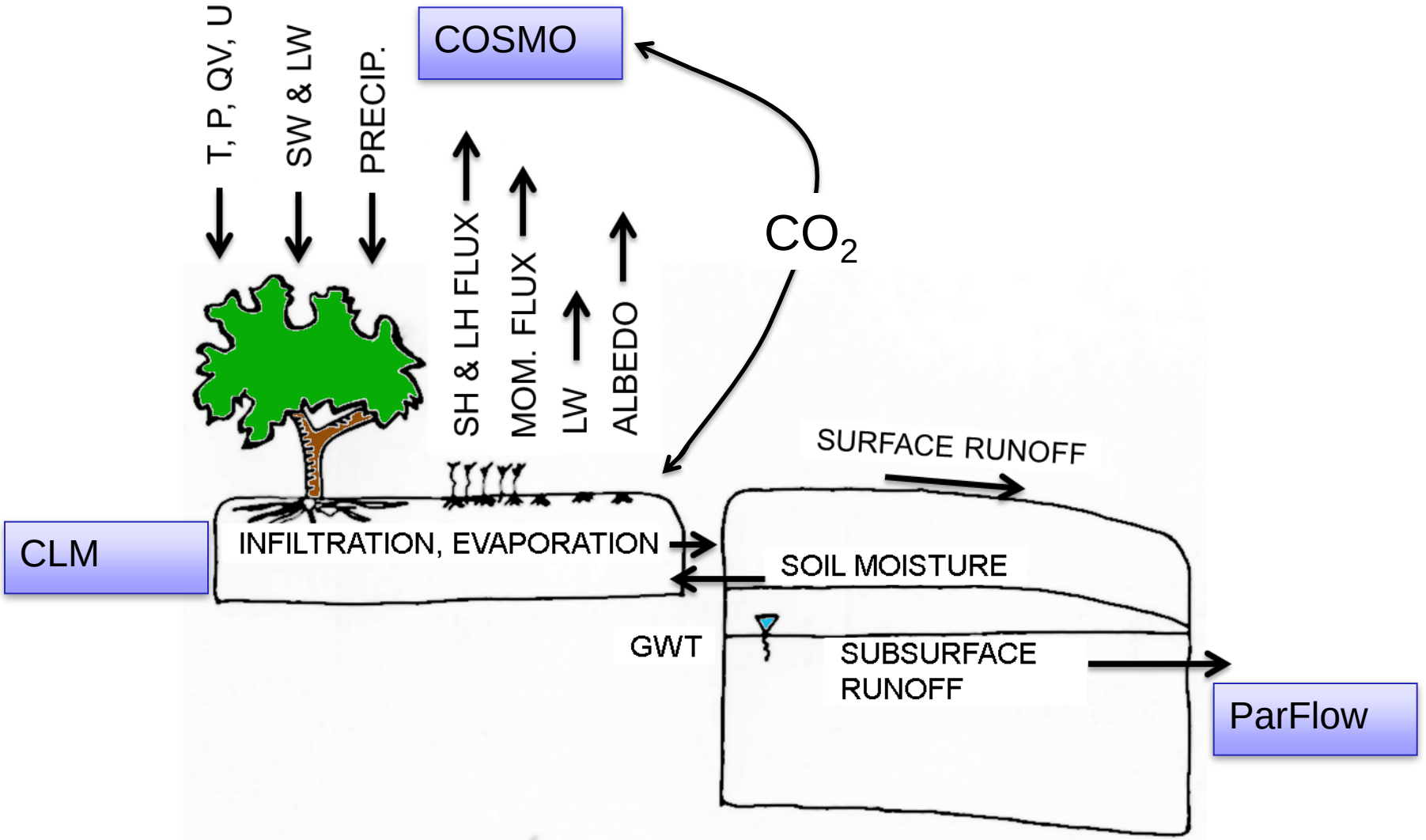

Real Test Case Simulation

- Effect of GWT dynamics on surface fluxes
  - North-Rhine Westphalia (NRW domain, 150X150 km)
  - Clear sunny days (May, 2008)
  - Model integrated for 5 days
  - Soil Moisture and Temperature Initialized with CLM spinup
  - COSMO-DE 2.8 km analysis files from DWD used for initial and lateral boundary condition for COSMO
  - Mosaic approach used
    - $\Delta x, \Delta y = 1.0$km (atmosphere)
    - $\Delta x, \Delta y = 0.5$km (land-surface and sub-surface)

Real Test Case Simulation: NRW surface data

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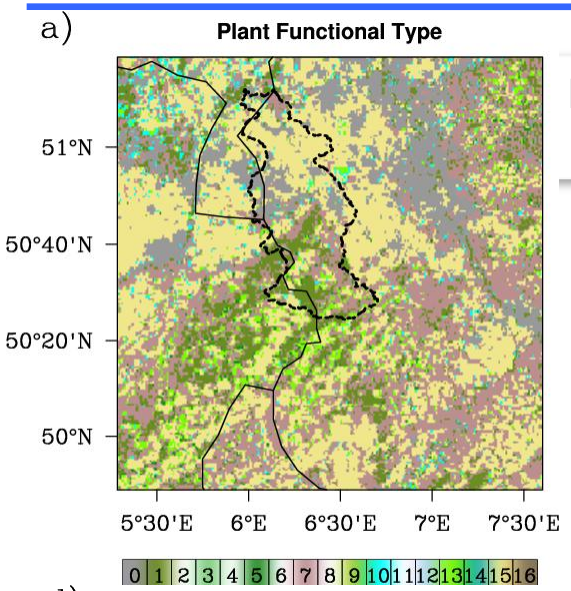
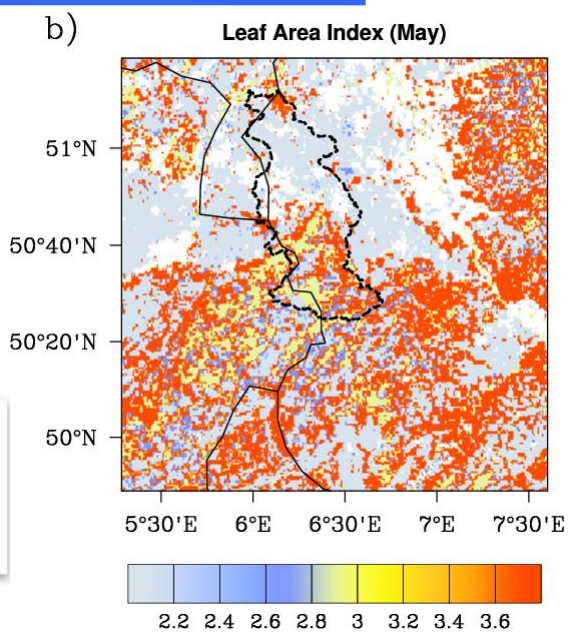
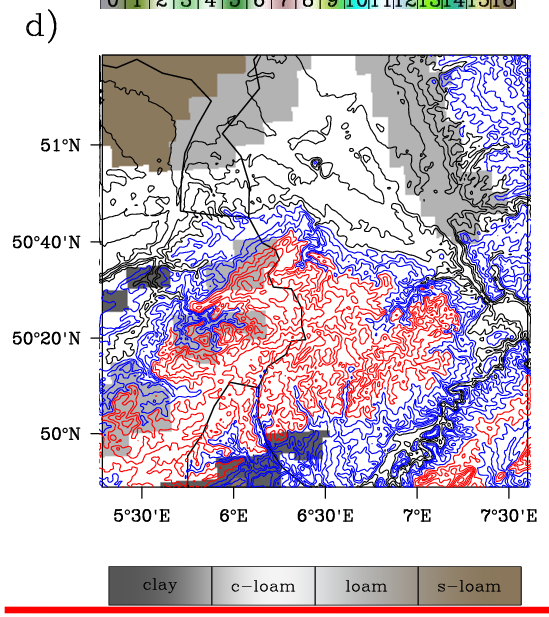


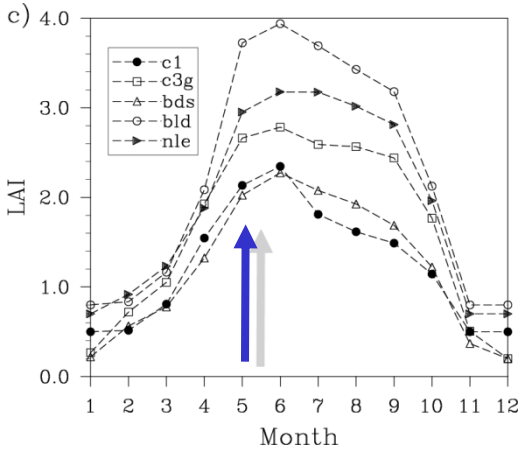
MODIS MCD12Q1:
LandCover



MODIS MCD15A2:
8 day composite LAI
<processed>



COSMO-DE 2.8km soil texture map



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Real Test Case Simulation: Description

TerrSysMP setup:

COSMO :	150X150X50,	Δx=1.0km,	Δt=10s
CLM :	300X300X10,	Δx=0.5km,	Δt=900s
ParFlow :	300X300X30,	Δx=0.5km,	Δt=900s
OASIS3 :	Δcplfreq = 900s		

Test Case Description:

- Soil Hydrology Equivalence between CLM and ParFlow
  - REF [1], RUN1 [4], RUN2 [2], RUN3 [4]
- Effect of soil permeability on surface fluxes
  - RUN4 [4], RUN5 [4]
- Effect of vegetation and subsurface flow
  - RUN6 [5], RUN7 [5]

SVA Option: [0 = COSMO standalone 1 = CLM standalone 2 = ParFlow standalone 3 = COSMO + CLM 4=CLM+ParFlow 5 = COSMO+CLM+ParFlow]

Real Test Cases: Effect of permeability on surface fluxes

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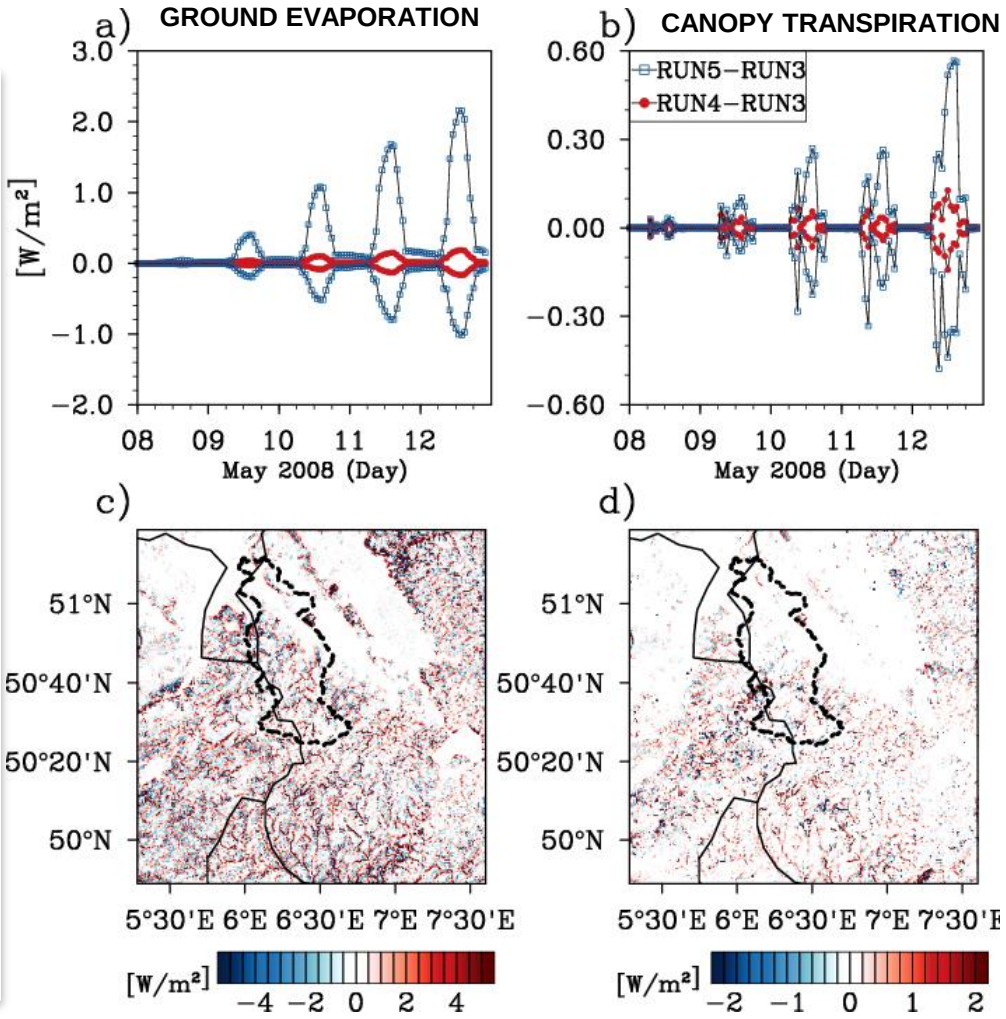
RUN3: CLM-ParFlow coupled run (Slope = 0)

RUN4: CLM-ParFlow coupled run (subsurface, Ksat =0.0024 m/hr)

RUN5: CLM-ParFlow coupled run (subsurface, Ksat =0.024 m/hr)



a, b) Differences spatially averaged over NRW domain.
c,d) Spatial patterns of the difference for RUN5-RUN3

Real Test Cases: Effect of vegetation and subsurface flow

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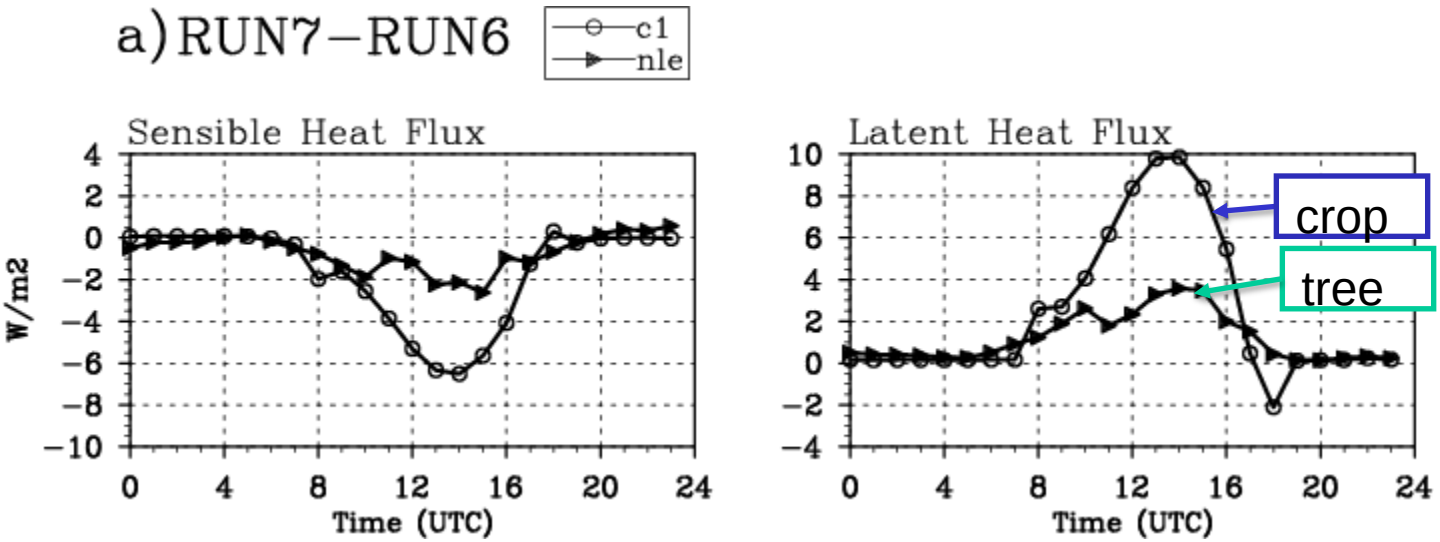
Spatially averaged surface fluxes

MASKS: PFT and region with increase in LH flux

RUN6: COSMO-CLM-ParFlow coupled run (slope = 0)

RUN7: COSMO-CLM-ParFlow coupled run



Real Test Cases: Effect of vegetation and subsurface flow

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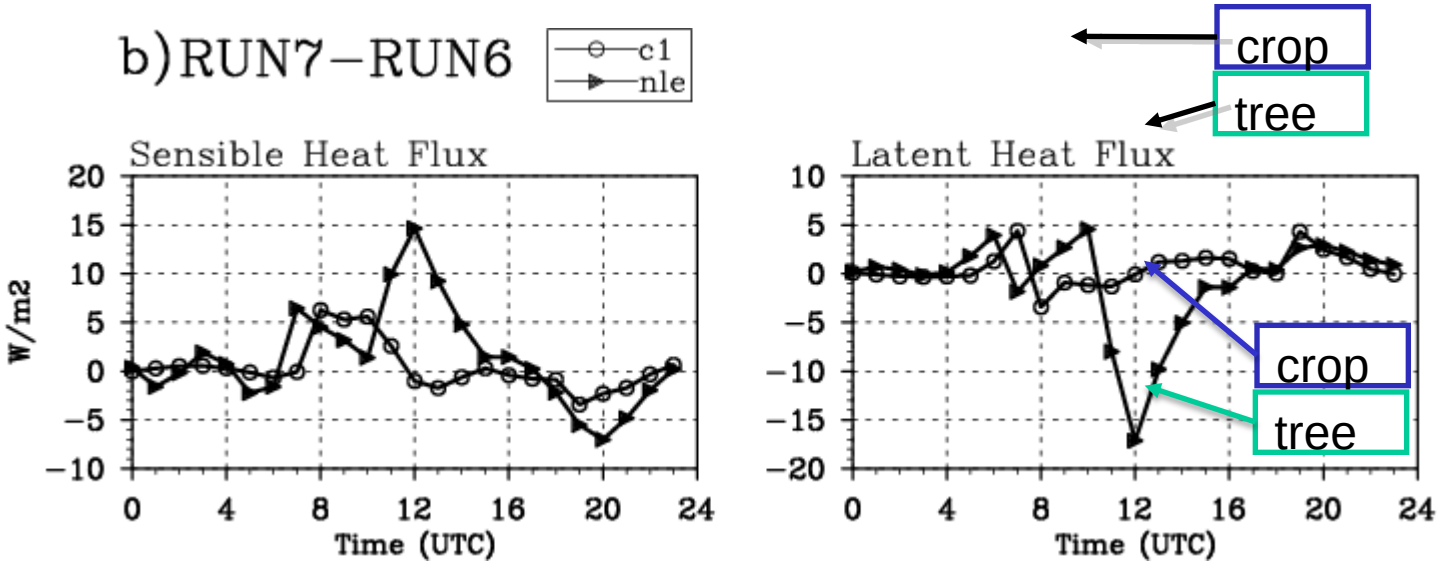
Spatially averaged surface fluxes

MASKS: PFT and region with decrease in LH flux

RUN6: COSMO-CLM-ParFlow coupled run (slope = 0)

RUN7: COSMO-CLM-ParFlow coupled run



Conclusions:

- The SVA modeling system is highly modular and can be used to study land-atmosphere interactions with explicit linkages to groundwater dynamics.
- Similar trend of soil hydrology between CLM and CLM-ParFlow (slope = 0) can be achieved by using equivalent vG parameters and adjusted initial pressure head.
- Pressure head obtained from CLM spinup is not in equilibrium with the topographic gradient.
- Sub-surface permeability affects the simulated surface fluxes
- Canopy cover and sub-surface flow appears to be strongly linked.

Acknowledgements

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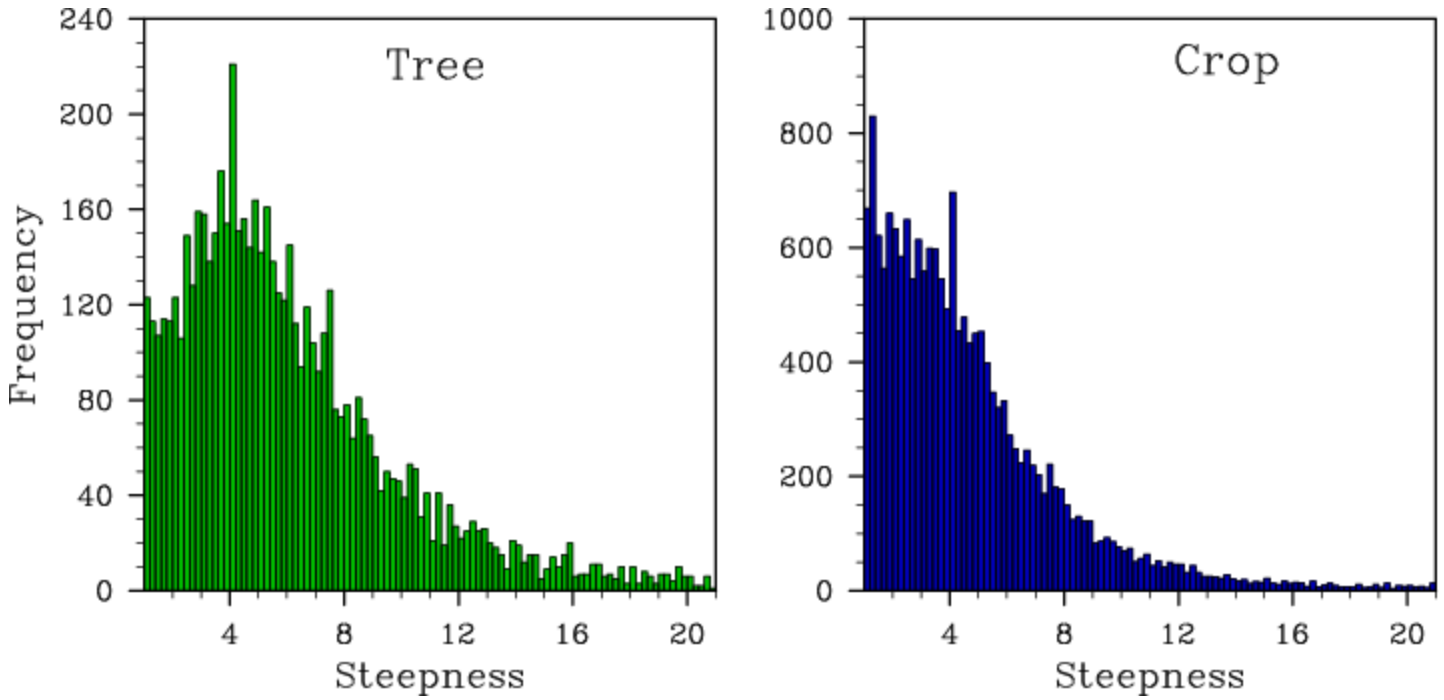
All analysis and plotting were done using NCL 6.0.0


Tree
Frequency
240
200
160
120
80
40
0
4
8
12
16
20
Steepness
Crop
1000
800
600
400
200
0
4
8
12
16
20
Steepness