Impact Of Soil Moisture Routing On Land Surface-Atmosphere Feedbacks in Medium Scale Catchments – LES Runs With WRF-Hydro

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CAOS

Catchments as Organized Systems

Hypotheses and Objectives

Hypotheses

- Catchment distribution of energy balances (EBs) feed back to convective processes via large eddies/circulations
- EBs driven by soil moisture availability and turbulence characteristics
- Horizontal soil moisture fluxes usually neglected in coupled models such as WRF-NOAH – limiting representation of soil moisture and EB distribution
- It is unknown how significant lateral routing processes are for short model runs, at LES scales

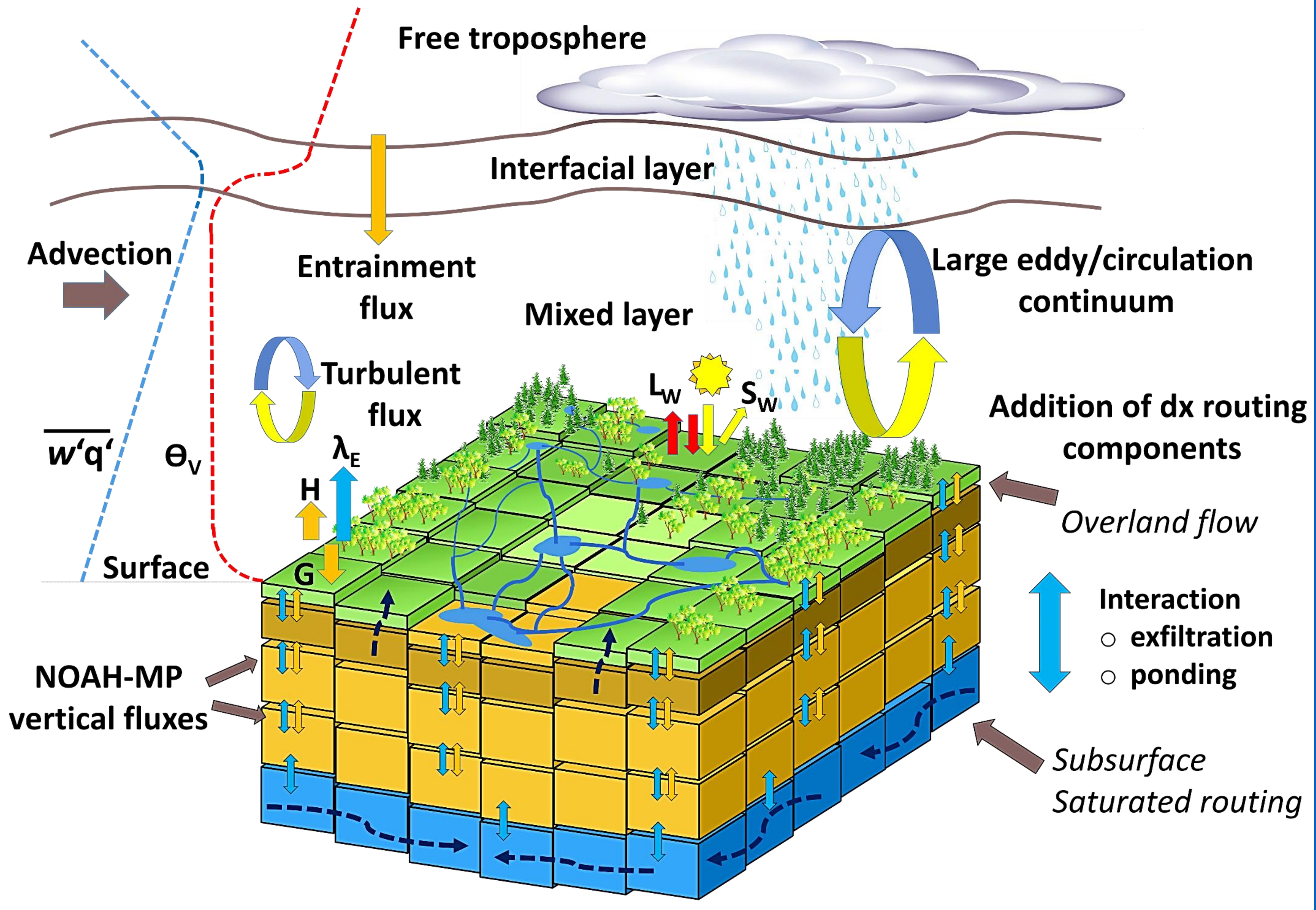

Figure 1: Land surface/atmosphere feedback processes within WRF-NOAH-MP, and potential for augmentation with horizontal soil moisture fluxes, using the WRF-Hydro framework

Objectives

- Couple WRF NOAH-MP with Hydro overland/subsurface saturated routing schemes and run for a radiation-driven clear-sky day (no precipitation)
- Compare impacts of routing on distribution of soil moisture and EBs, vertical velocities, and cloud development

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Hydrology components added to WRF

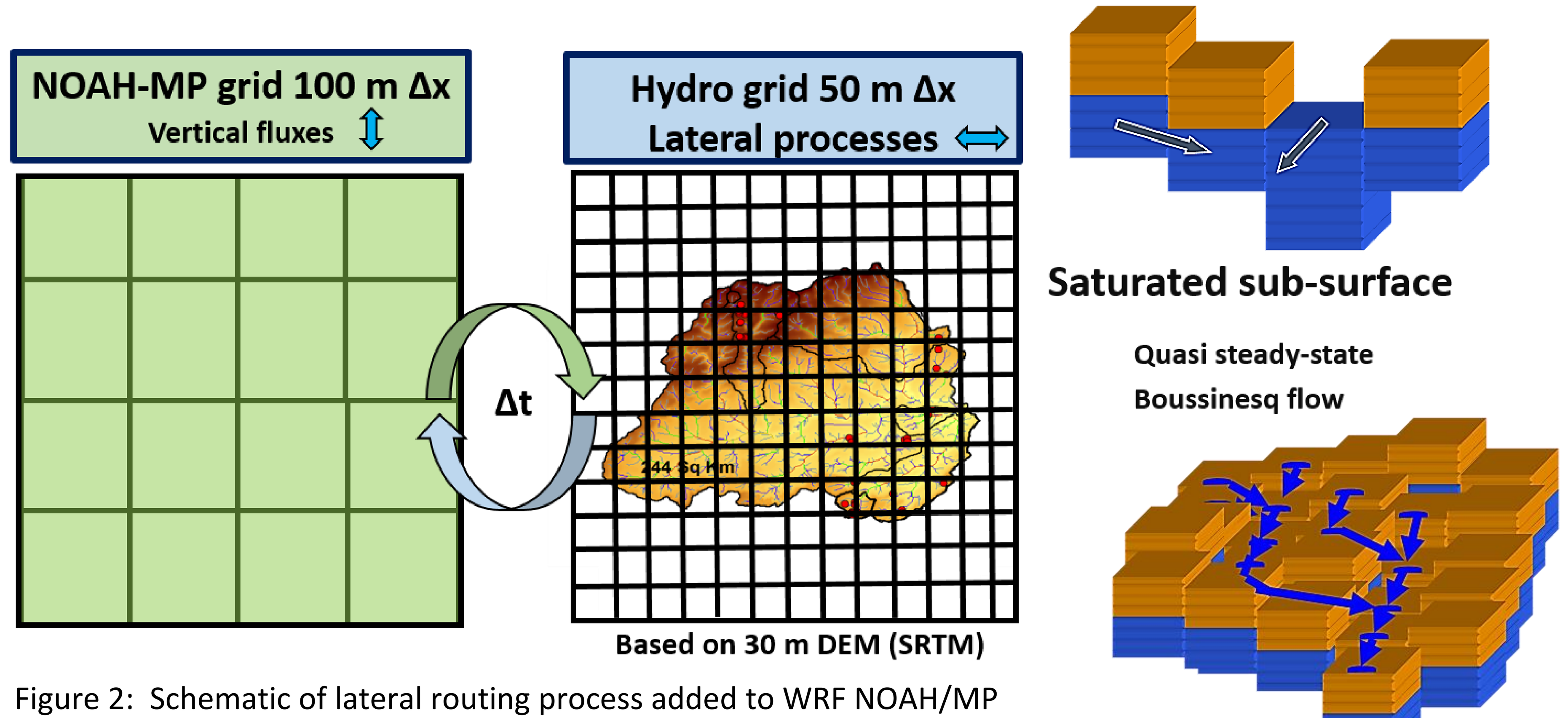

Figure 2: Schematic of lateral routing process added to WRF NOAH/MP (Right). Subsurface flow is calculated before overland flow, to allow for prior exfiltration. The left hand panels show the conservative regridding used for data transfer between NOAH-MP and Hydro grids. The center panel shows how the 250 km^2 Attert catchment, Luxembourg is located within the finest model domain

Overland

- Infiltration excess
- 1D Steepest slope or 2D
- Diffusive wave/momentum - St Venant
- Backwater/adverse
- Ponding (head) - interactive with LSM

Model Physics – YSU (SG-PBL), MM5 (surface), Morrison 2-moment (MP)

Impacts of routing after a 12 hour simulation

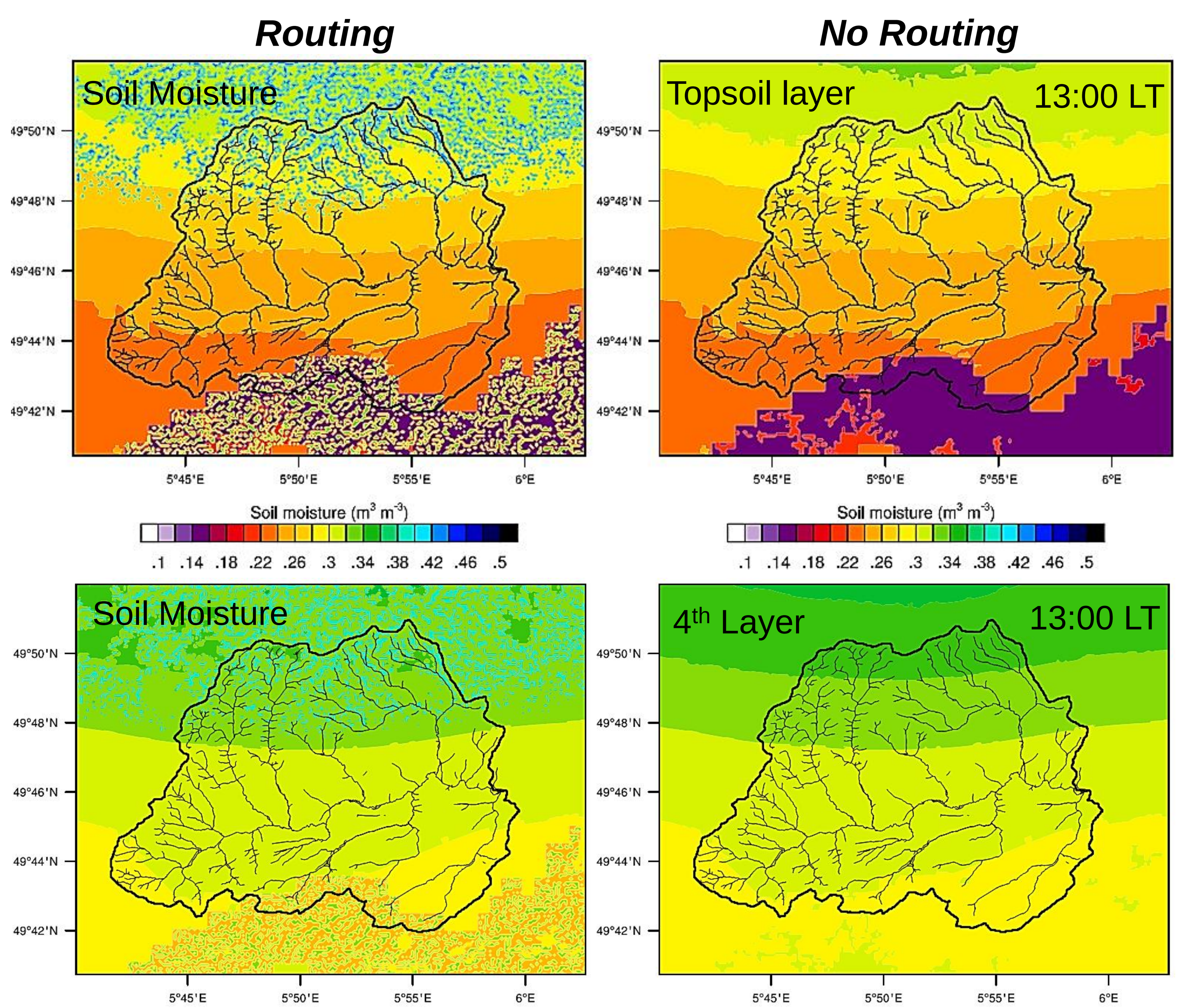

Figure 3: Soil moisture in soil layers 1 (top) and 4 (bottom) is significantly redistributed, after a 12 hour simulation period. Impacts are controlled by various factors: soil moisture, porosity, slope, water table depth, ..

Energy balance and clouds

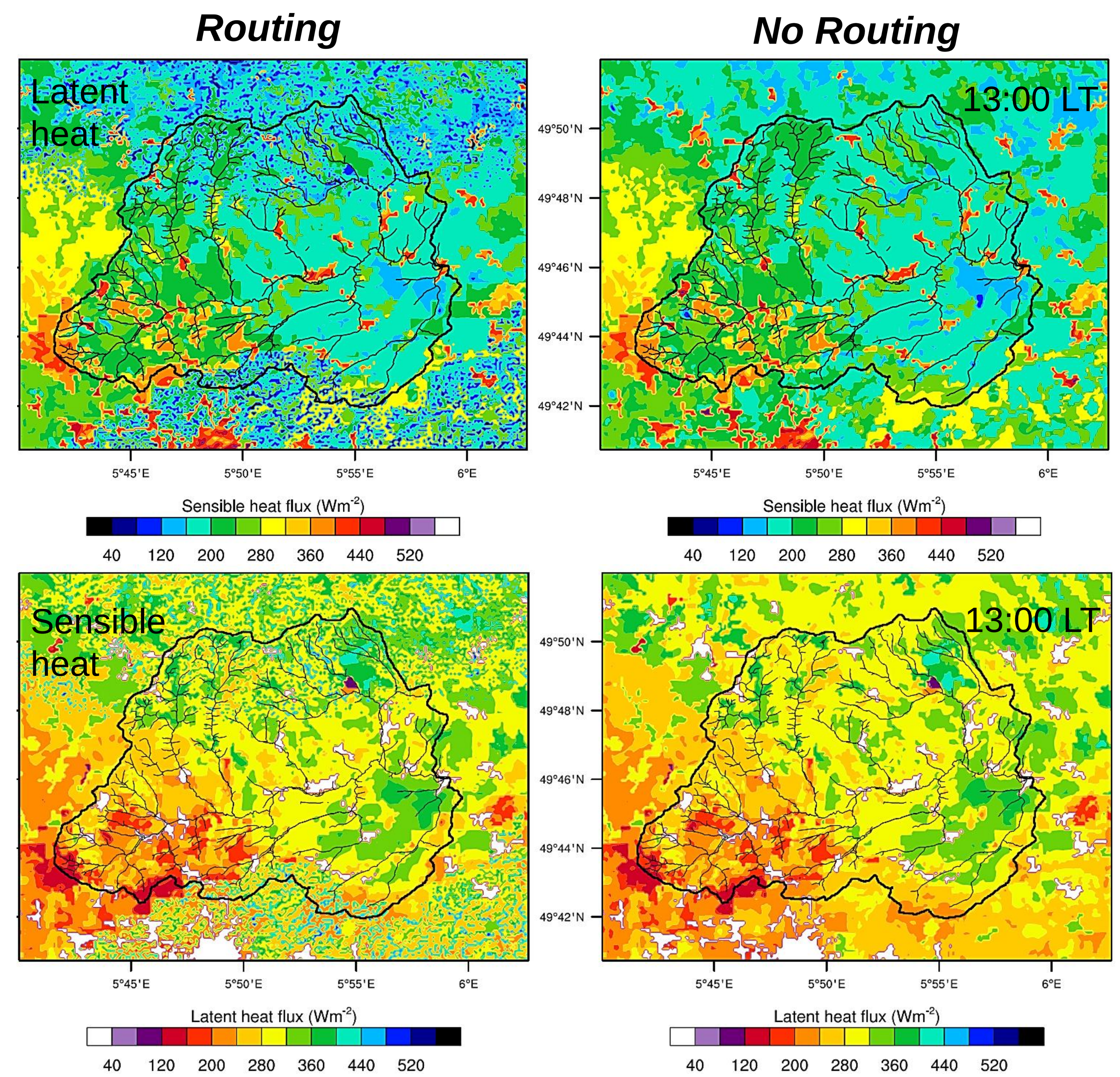

Figure 4: Energy balances are similarly redistributed, with large decreases in Bowen ratio where the soil moisture has increased

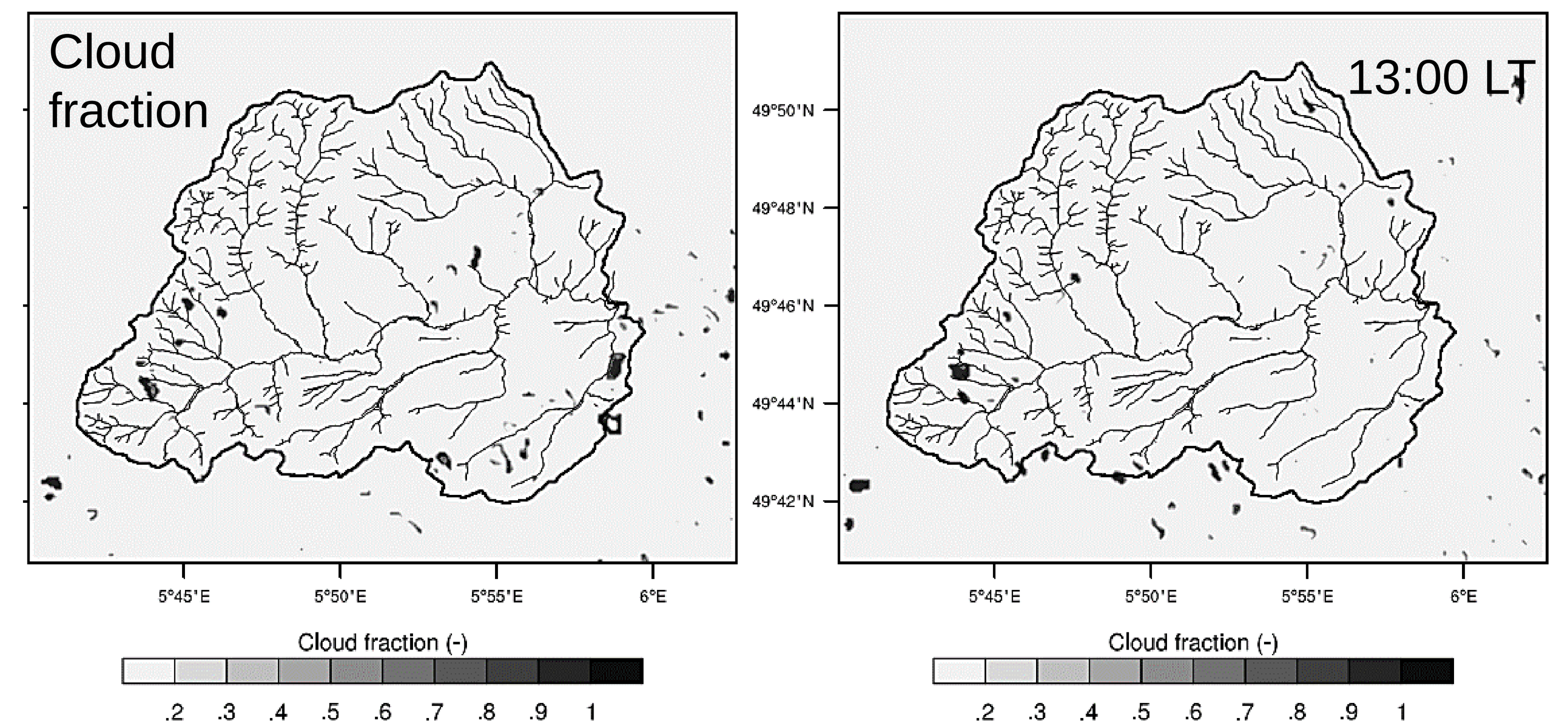

Figure 5: Changes in Cloud Fraction at 1400m. Small differences are noticeable particularly in the lowest valleys (bottom left) where an increase of clouds occurs when routing is added

Tentative conclusions

- Addition of lateral routing schemes have a significant impact on soil moisture and atmospheric feedbacks
- Sensitive to soil moisture initialization at short timescales

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