Land Surface Modeling Informed by Earth Observation Data: Towards Understanding Blue-Green Water Fluxes in High Mountain Asia

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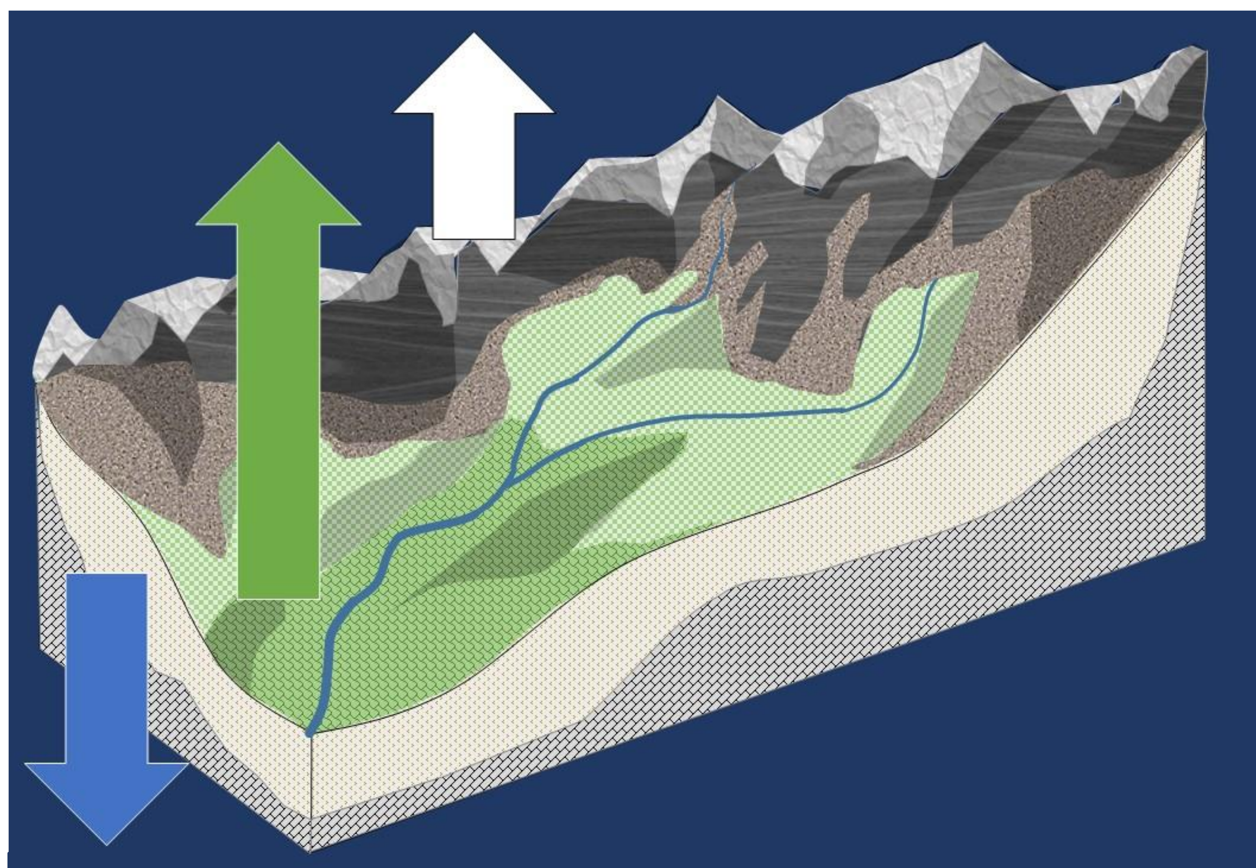
1. Abstract

The propagation of water from High Mountain Asia (HMA) headwaters to downstream areas is not fully understood, as interactions in the mountain water cycle between the cryo-, hydro- and biosphere remain elusive. We update the definition of blue and green water fluxes and provide an assessment of modelling the interactions between spheres in high mountain catchments . Land surface models are uniquely able to account for such complexity. We present a pilot study application of the mechanistic land surface model Tethys & Chloris to a glacierized watershed in the Nepalese Himalayas and explain the use of high resolution earth observation data to constrain the meteorological uncertainty and validate our model results. We use these insights to highlight the remaining challenges and future opportunities that remote sensing data presents for land surface modelling in HMA.



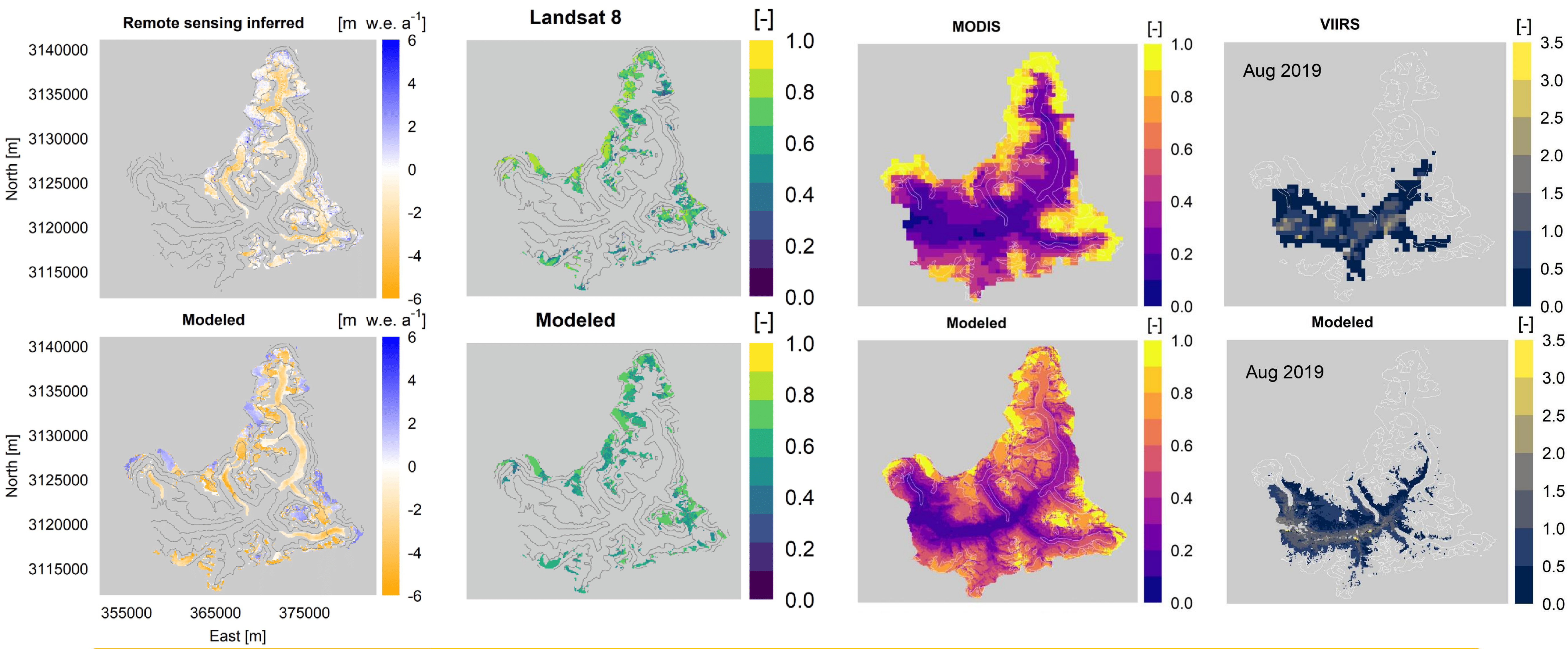
Conceptual watershed with updated blue-green-white water fluxes scheme:
blue water (liquid/flowing water contributing to runoff), **green water** (water lost to the atmosphere through evapotranspiration), and **white water** (evaporation and sublimation from snow and ice)

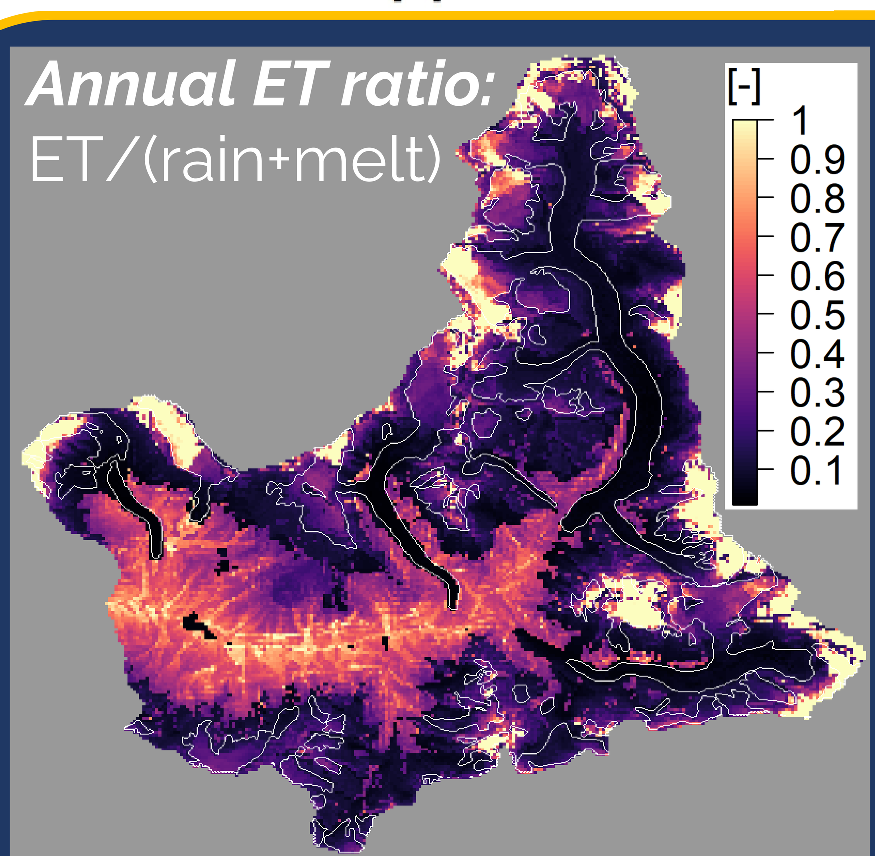
2. Model

Tethys & Chloris (*T&C*; Fatichi et al., 2012), a physically-based land surface model which solves the coupled fluxes of water, energy, and carbon between the land surface and atmosphere.
We applied *T&C* to the glacierized Langtang Valley, Nepalese Himalayas (100 m spatial resolution; hourly timesteps; 3 year simulation period).

3. Results

Glacier mass balance | Glacier albedo | Snow cover fraction | Leaf area index





Conclusions & challenges

- Mechanistic land surface modelling (utilizing earth observation data) can produce distributed results, in which the relationships between water cycle components (with complex feedbacks between topography, elevation & land cover) is preserved
- Green & white water fluxes are of key importance in the high mountain water cycle
- The direct quantification of water balance components (precipitation, runoff, groundwater, evapotranspiration) & belowground conditions (soil depth) from space remains challenging