Snow is an important component of water storage in the Himalayas. Previous snowmelt studies in the Himalayas have predominantly relied on remotely sensed snow cover. However, this provides no information on the actual amount of water stored in a snowpack i.e. the snow water equivalent (SWE). Therefore, we assimilated remotely sensed and in situ snow observations into a snow model to estimate the SWE. We modelled snow depth in a Kalman filter framework. This allows for data-constrained estimation of snow depth rather than snow cover alone and this has great potential for future studies in complex terrain, especially in the Himalayas.

Study area

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Methodology

- Validation of remotely sensed snow cover with in situ snow observations (snow depth and surface temperature)
- Obtain optimal model parameter values by assimilating snow depth measurements and remotely sensed snow cover into the modified seNorge snow model (Saloranta, 2016) using an Ensemble Kalman Filter (EnKF)
- Testing climate sensitivity of SWE by perturbing air temperature and precipitation (Table 1)

Results

- Validation of remotely sensed snow cover (Landsat 8 and MOD10A2) show high accuracies (85.7 and 83.1% respectively) against in situ snow observations (Fig.1)
- SWE increases with increasing elevation due to lower air temperatures and consequently less melt (Fig.3)
- An increase in temperature and therefore an increase in melt can be compensated by an increase in precipitation (Fig.4)

Conclusions

- Data assimilation of snow cover and snow depth data proves to be successful for obtaining optimal model parameter values
- The spatial distribution of SWE shows an increase in SWE with increasing elevation and also reflects the spatial and temporal distribution of precipitation.
- Climate sensitivity tests show a strong relative decrease in SWE in the valley. At higher elevations an increase in precipitation partly compensates for increased melt due to higher temperatures.
- The compensating effect of precipitation emphasizes the importance and need for accurate prediction of change in spatial and temporal distribution of precipitation.

References