OBSERVING & CHARACTERIZING AVALANCHE ACTIVITY USING PLÉIADES AND AIRBORNE HDR IMAGERY

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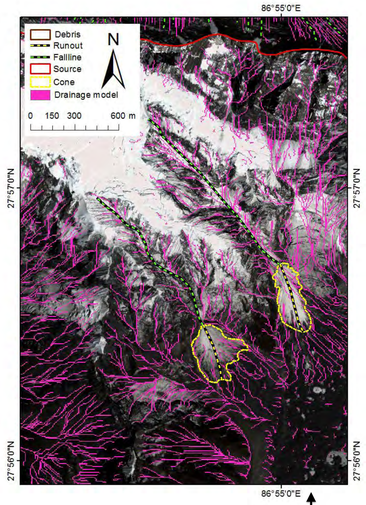
MOTIVATION:

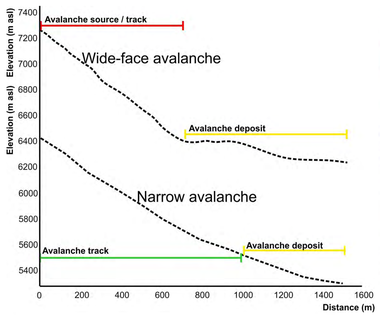
- avalanches are important mass accumulation sources for many (debris-covered) glaciers
- rock fall/mixed avalanches are important sources of debris to debris-covered glaciers
- few observations of gravitational mass movements in Khumbu Himal

Can we use high quality remotely-sensed optical imagery (Pléiades tri-stereo images from Spring 2016 and DLR HDR airborne photogrammetry from autumn 2014) **to characterize avalanche activity?**

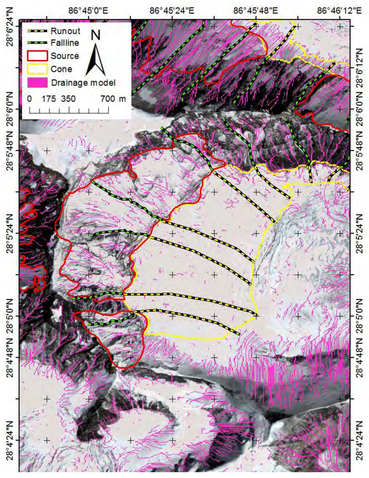
type 1: narrow-track (N) avalanches

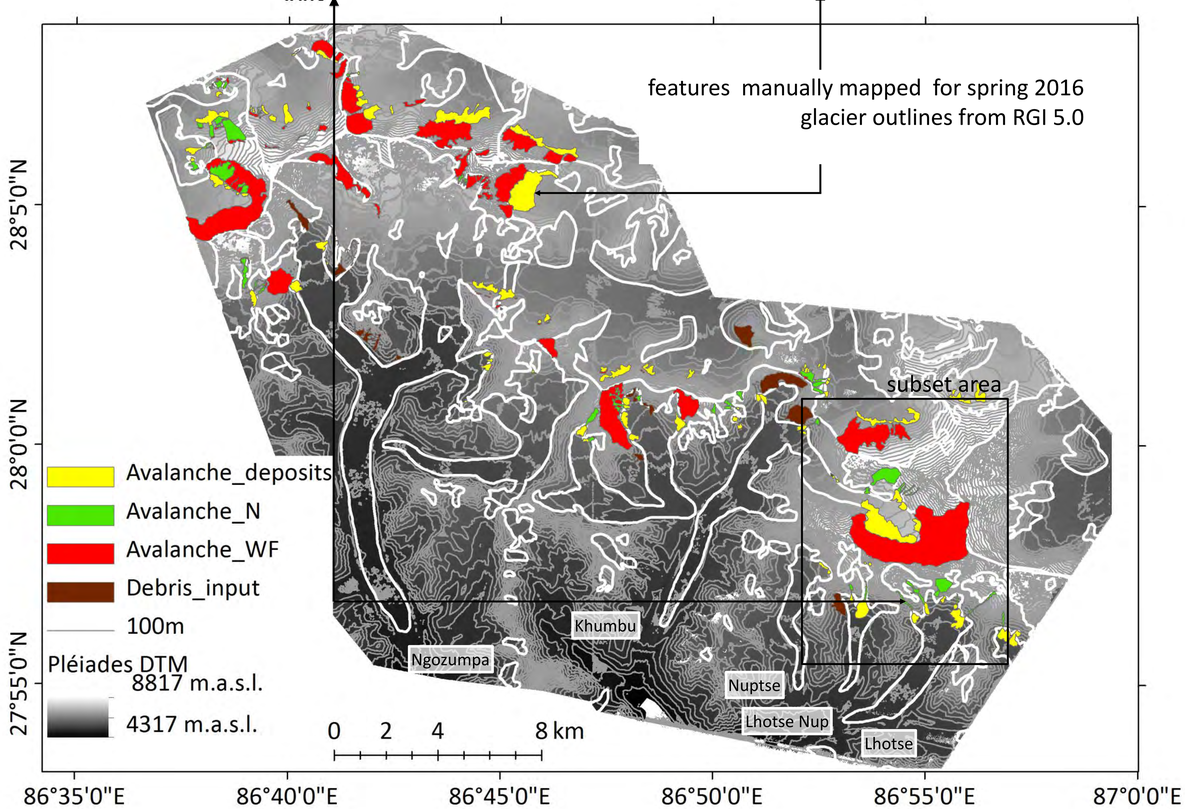


avalanche tracks and runout deposits determined using ArcGIS hydrology tool box on 5m DTM. flow direction raster → accumulated flow (pink) → manually digitized tracks (dashed)

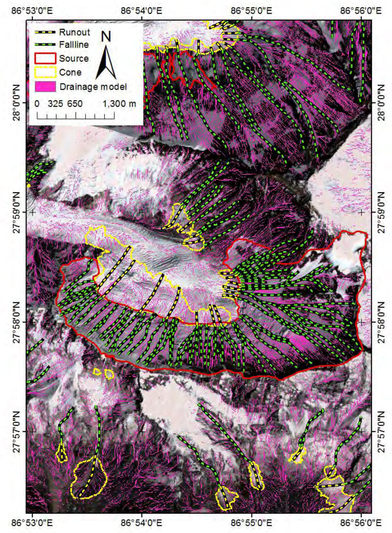


type 2: wide-face (WF) avalanches

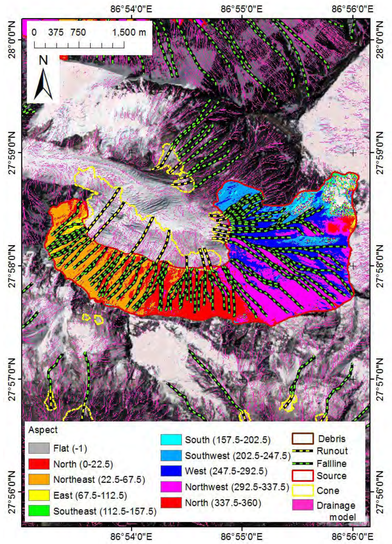




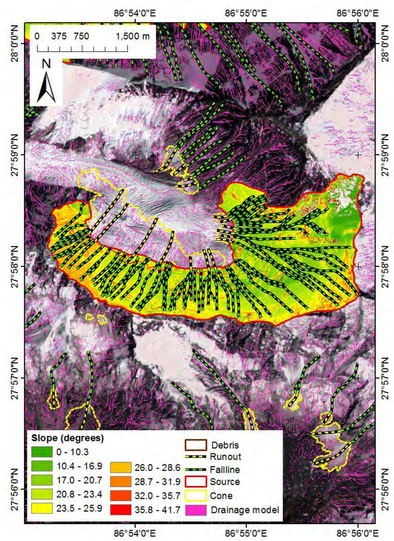
subset area: upper Khumbu

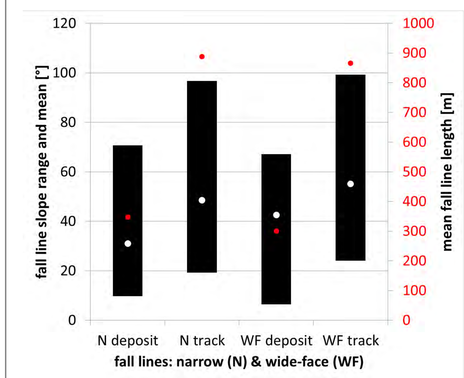


avalanches from all aspects:



avalanches from many slope angles:



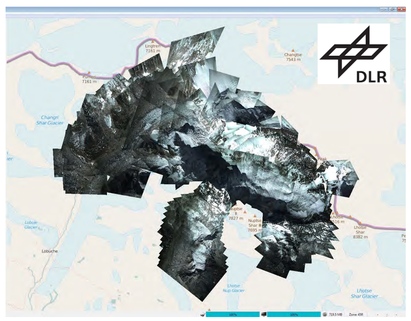


ANALYSIS SO FAR:

- some areas cannot see features due to exposure/shadowing (e.g. Ngozumpa)
- a whole range of avalanche features observed
- source slopes are often >60° (15% N; 14% WF)
- this suggests typical constraints on avalanche runout models tuned from the Alps might not be expected to apply
- typical deposit runout length might be longer for N than WF deposits (interquartile ranges of 180-484m and 149-370m respectively), and visible deposits are generally <600m in length
- this type of information can help guide the location of avalanche and debris inputs to models of glaciers and debris cover development
- deposit runout length shows no correlation with source area track properties (max elevation, elevation range, length, mean slope)

CONCLUSIONS AND OUTLOOK:

HDR airborne photogrammetry from the DLR MACS system is a possibility to examine areas with poor contrast in satellite imagery, but images are currently only available for the Khumbu glacier area in 2014.



Need better, or more tractable,classification system to try and relate avalanche mass deposits to wider terrain properties in a way that might be useful for glacier mass balance model inputs.

Exploration of more newly available Sentinel 2 imagery for avalanche frequency and association with precipitation events/amounts in the region?

Examination of effectiveness of a conditioned alpha-beta avalanche model to recreate the observed avalanche dimensions?