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Evaluation of different image matching methods for deriving glacier surface displacements globally

Torborg Heid and Andreas Kääb
University of Oslo, Norway (torborgh@geo.uio.no)

Although many studies use automatic image matching of images from two different times to derive glacier velocity, little work has been done on comparing and evaluating different matching methods. This study compares six different matching methods: normalized cross-correlation (NCC), the phase correlation algorithm used in COSI-Corr, and four other Fourier methods with different normalizations. This is done for five regions of the world with different glacier characteristics: Karakoram, the European Alps, Alaska, Pine Island and southwest Greenland. The study is performed on Landsat images because they expand back to 1972, they cover large areas, and at the same time the spatial resolution is as good as 15 m for images after 1999. Cross-correlation on orientation images (CCF-O) outperforms the three similar Fourier methods, both in areas with high and low visual contrast. NCC experiences problems in areas with low visual contrast, areas with thin clouds or changing snow conditions from one image to the next. CCF-O has problems on narrow outlet glaciers where small window sizes (about 16*16 pixels) are needed, and it also obtains fewer correct matches than COSI-Corr in areas with low visual contrast. COSI-Corr has problems on narrow outlet glaciers and it obtains fewer correct matches compared to CCF-O when thin clouds cover the surface. By using locally adaptive template sizes combined with one of the two most robust matching methods tested here, COSI-Corr or CCF-O, and by filtering the matching results automatically by comparing the displacement matrix to the low pass filtered displacement matrix, the matching process is highly automated. This allows for derivation of glacier velocities with minimal user interaction and hence also derivation of global glacier velocities.