I. Summary
This study develops a stacking based approach to mapping ice shelf flow velocity using interferometric synthetic aperture radar (InSAR).

- We describe a method to determine 2-d ice shelf flow vectors independently of model predictions of tide and atmospheric pressure, by stacking conventional and multiple aperture (MAI) InSAR observations of the Dotson Ice Shelf in West Antarctica.
- Stacking creates a longer observation period, enhancing long-period (flow) displacement signals, relative to rapidly-varying (tide and atmospheric pressure) signals and noise.
- Tide and atmospheric pressure models are used as error models - to simulate the statistics of the tidal and atmospheric pressure signals in a stacked interferogram, yielding ~ 22 m/yr cross-track error.
- With the upcoming launch of several satellite missions, offering the prospect of regular short-repeat SAR acquisitions, this study demonstrates that stacking can improve estimates of ice shelf flow velocity.

II. Study Area & Data
We map flow speeds of the Dotson Ice Shelf, in the Amundsen Sea Sector of West Antarctica (Fig. 1), using six SAR scenes from the ERS-1 satellite (3 day repeat phase). Tidal predictions from the FES2004 model and atmospheric predictions from the ERA-40 reanalysis were used to model residual errors from vertical ice shelf motion and also to assess the stacking method.

III. Stacked Flow Velocity
1. Interferograms were stacked so as to minimise tide and atmospheric pressure signals, thus providing a map of 2-d ice flow which is independent of model predictions.

2. To assess our stacking method we compared our stacked across-track flow velocity to a method that uses model predictions to simulate and remove the tidal and atmospheric pressure signals.

IV. Stacked Velocity Error
Our stacked flow prediction still contains residual tidal and atmospheric pressure signals, which translate into errors in flow velocity. We use model statistics to estimate these errors.

V. Generalisation of Method
Sensitivity to satellite revisit time
- The satellite revisit time affects the magnitude of the tidal and atmospheric pressure signals within a stack of interferograms.
- We use each model to investigate the sensitivity of these signals to alternative sampling regimes (e.g. Sentinel-1 & Radarsat Constellation).
- The tidal signal exhibits considerable sensitivity to sampling regime; a consequence of the strong fortnightly beating which is evident in Fig. 4.

Benefits of Larger Stack
- We have only been able to stack 3 regularly-sampled interferograms.
- We use model statistics (eg Fig. 5) to investigate the potential reduction in tidal and atmospheric pressure errors offered by larger image stacks.
- Simply stacking 2 interferograms can substantially reduce tidal error.
- By stacking 5 consecutive 6-day interferograms tidal and atmospheric pressure errors could each be reduced to ~ 5 m/yr.


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