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Recent advances in time series InSAR

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Despite the multiple successes of InSAR at measuring surface displacement, in many instances the signal over much of an image either decorrelates too quickly to be useful or is swamped by atmospheric noise. Time series InSAR methods seek to address these issues by essentially increasing the signal-to-noise ratio (SNR) through the use of more data. These techniques are particularly useful for applications where the strain rates detected at the surface are low, such as postseismic/interseismic motion, magma/fluid movement, landslides and reservoir exploitation.

Our previous developments in this field have included a persistent scatterer algorithm based on spatial correlation, a full resolution small baseline approach based on the same strategy, and procedure for combining the two [Hooper, GRL, 2008]. This combined method works well on small areas (up to one frame) at ERS or Envisat strip-map resolution. However, in applying it to larger areas, such as the Guerrero region of Mexico and western Anatolia in Turkey, or when processing data at higher resolution, e.g. from TerraSAR-X, computer resource problems can arise. We have therefore altered the processing strategy to involve smarter use of computer memory. Further improvement is achieved by the resampling of the selected pixels (whether persistent scatterers or distributed scatterers) to a coarser resolution – usually we do not require a resolution on the scale of individual resolution cells for geophysical applications. Aliasing is avoided by summing the phase of nearby selected pixels, weighted according to their estimated SNR. This is akin to smart multilooking, but note that better results can be achieved than by starting the analysis with low-resolution (multilooked) data.

Another development concerns selecting pixels only in images where they appear reliable. This allows for resolution cells that become correlated/decorrelated either in a temporary fashion, e.g., due to snow cover, or in a permanent way due to the appearance or removal of scatterers. The detection algorithm relies on the degree of spatial correlation for the pixel of interest in each image. We have also modified our 3-D phase-unwrapping algorithms to allow for the resulting differing combinations of coherent pixels in every interferogram.

We demonstrate our improved techniques on volcanoes in Iceland and the 2006 slow-slip event in Guerrero, Mexico.