High resolution InSAR time series of transient creep on the Concord Fault, Eastern Bay Area

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Hayward fault
Calaveras fault
Concord fault
Alignment arrays:

<table>
<thead>
<tr>
<th>Concord fault</th>
<th>SF-05, Salvio Street</th>
<th>SF-03, Ashbury Drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td></td>
<td>1985</td>
</tr>
<tr>
<td>1990</td>
<td></td>
<td>2000</td>
</tr>
<tr>
<td>50mm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Geologic slip rate: 2-5mm/yr
- Average creep rate: 3mm/yr
- Episodic creep events at shallow depths?

Galehouse and Liencamper, 2003

ERS 1/2, 1992-2002

Envisat, 2006-2010

Xu et al, 2018
Alinement arrays

- **Aperture**: 100 m
- **Distance**: ~500 m

![Graph showing displacements over time with two lines, one red for CASH and one black for CSAL. The graph covers the years 1980 to 2015.](Image)
Sentinel-1: 2015 - 2019

Descending track 42

Ascending track 35

Perpendicular baseline (m)

Time (yr)
Methods: summary

• Created coregistered SLCs with ISCE processing software.

• Used adaptive multi-looking for noise reduction and coherence estimation (similar to Ferretti et al., 2011).

• Processed data in batches using the Sequential EVD (inspired by Ansari et al., 2017)

• Applied CANDIS atmospheric correction (Tymofyeyeva and Fialko, 2015)

• Decomposed data from two lines of sight into vertical and fault-parallel components (e.g., Tymofyeyeva and Fialko 2018)
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Methods: adaptive multilooking

- For each pixel, **identify a family of distributed scatterers** that belong to the same structure

- **Compute coherence matrix and average** for each pixel based on the identified families

(similar to SqueeSAR™, Ferretti et al., 2011)
Methods: Sequential EVD

- Data are divided into **mini stacks**

- Mini stacks are compressed using **eigenvalue decomposition**

- **New data are added** without recalculating the full coherence matrix
Track 42: comparison

Our approach:

Sequential time series:
Sentinel-1 tracks with different look geometries

Descending track 42    Ascending track 35

Decomposition:

\[
\begin{bmatrix}
e_a \sin(\alpha) + n_a \cos(\alpha) & u_a \\
e_d \sin(\alpha) + n_d \cos(\alpha) & u_d
\end{bmatrix}
\begin{bmatrix}
D_H \\
D_V
\end{bmatrix}
= \begin{bmatrix}
D_a \\
D_d
\end{bmatrix}
\]

\[\alpha = N28W\]

- Applied **CANDIS atmospheric correction** (Tymofyeyeva and Fialko, 2015)
Fault parallel displacements

Vertical displacements
Fault-parallel displacements: 2015-2018

Displacement profile average

(Tymofyeyeva et al., in prep)
Fault-parallel displacements: 2015-2018

(Tymofyeyeva et al., in prep)
Cumulative displacement time series

Hayward fault
Calaveras fault
Concord fault
Conclusions

• We apply adaptive multilooking and sequential EVD methods to the study of shallow fault creep on the Concord Fault in the Eastern San Francisco Bay Area, where continuous GPS stations and other geodetic instruments are not available close to the fault.

• We use data from the European Sentinel-1 mission to observe a transient shallow creep event on the Concord fault.

• We are able to determine that the event began in the summer months of 2017, with variable slip along the fault, and a peak cumulative slip amplitude of approximately 12 mm in the direction parallel to the fault trace.
References


