Abstract
The San Andreas Fault creeps at the surface along a 150 km-long section between San Juan Bautista and Parkfield with slip occurring in bursts known as creep events. We seek to better constrain and understand creep events along the San Andreas by (1) identifying the creep events, (2) determining their along-strike length, and (3) examining the slip–rate evolution during the creep event onsets.

We detect creep events using a cross-correlation approach. By isolating intervals with high similarity and significant slip, we successfully detect at least 99% of the creep events identified in a visual inspection. We use neighbouring creepmeters to estimate the length of creep events. We determine that 10–17% of creep events found at XHR are also found at CWN meaning their along strike length must be at least 4 km which is a significant fraction of the along–depth extent of the seismogenic zone, suggesting that shallow creep events may play an important role in the creeping region’s slip dynamics. Currently, we are examining the shape of the onset of creep event. We are investigating how slip–rate decays with time after the event begins: whether it decays as a power–law, as expected for velocity–strengthening friction, or as an exponential, as expected for distributed viscous shear.

Data
- We use data from USGS creepmeters XSJ (San Juan Bautista), XHR (Harris Ranch) and CWN (Cooma Winery North) installed along the creeping section of the San Andreas Fault (Figure 1a).
- The creepmeter records are decades-long time–series datasets with slip values recorded every 10 minutes (Figure 1b).

Detection
- We detect creep events using a cross–correlation approach.
- We identify places of high similarity within the creep record that also have significant amounts of slip.
- We have produced a creep event catalogue that contains at least 99% of the creep events identified by visual inspection.

Propagation
- We detect creep event propagation by comparing the timing of creep events at neighbouring creepmeters XSJ, XHR and CWN (Figure 2).
- We conduct bootstrapping on one of the creepmeters to calculate a 70% confidence interval for the percentage of creep events found at one creepmeter occurring at the other.
- We find 10–17% of creep events at XHR occurring within 6 hours of a creep event at CWN.

Propagations: Bootstrapping and Shifting
- We test the null hypothesis that creep events are unrelated at each creepmeter.
- We time shifting the entire creep record at one of the creepmeters and calculate the percentage of creep event occur closest spaced in time between creepmeters.
- We compare these percentages to the bootstrapping and find that creep event detections at XHR and CWN are related as the bootstrapping percentages are at least 1.8 times greater than the shifted ones (Figure 3a–e).
- These results imply that XHR and CWN are detecting the same creep events which must have an along strike length of at least 4km.
- In contrast, the creep event detections at XHR and XSJ appear unrelated as we found no statistical significance to reject the null hypothesis that correlated creep events occurred by chance (Figure 4f).

Onset
- We have isolated the initial elastic response of creep events at XSJ and CWN.
- We fit the displacement–time evolution laws predicted by velocity–strengthening friction, a linear viscous rheology, and power–law viscous rheologies to the initial elastic response using a least–squares regression to calculate the misfit (Figure 5).
- Our initial results indicate that each creepmeter has the lowest total misfit for all creep events with an initial response modelled in a velocity–strengthening friction regime.

Summary/Conclusion
- We have used a cross–correlation approach to create a creep event catalogue which included at least 95% of creep events identified by visual inspection.
- We find that 10–17% of creep events found at XHR are also found at CWN meaning that these creep events are at least 4km in along–strike length.
- We do not find any statistical significance between events detected at XHR and XSJ meaning creep events detected at each creepmeter are likely to be unrelated.
- Our initial onset analysis results indicate that the initial elastic response is best modelled as a velocity–strengthening friction regime.

References

Acknowledgements
This work was supported by the UKRI Natural Environment Research Council grant number: NE/S007474/1.