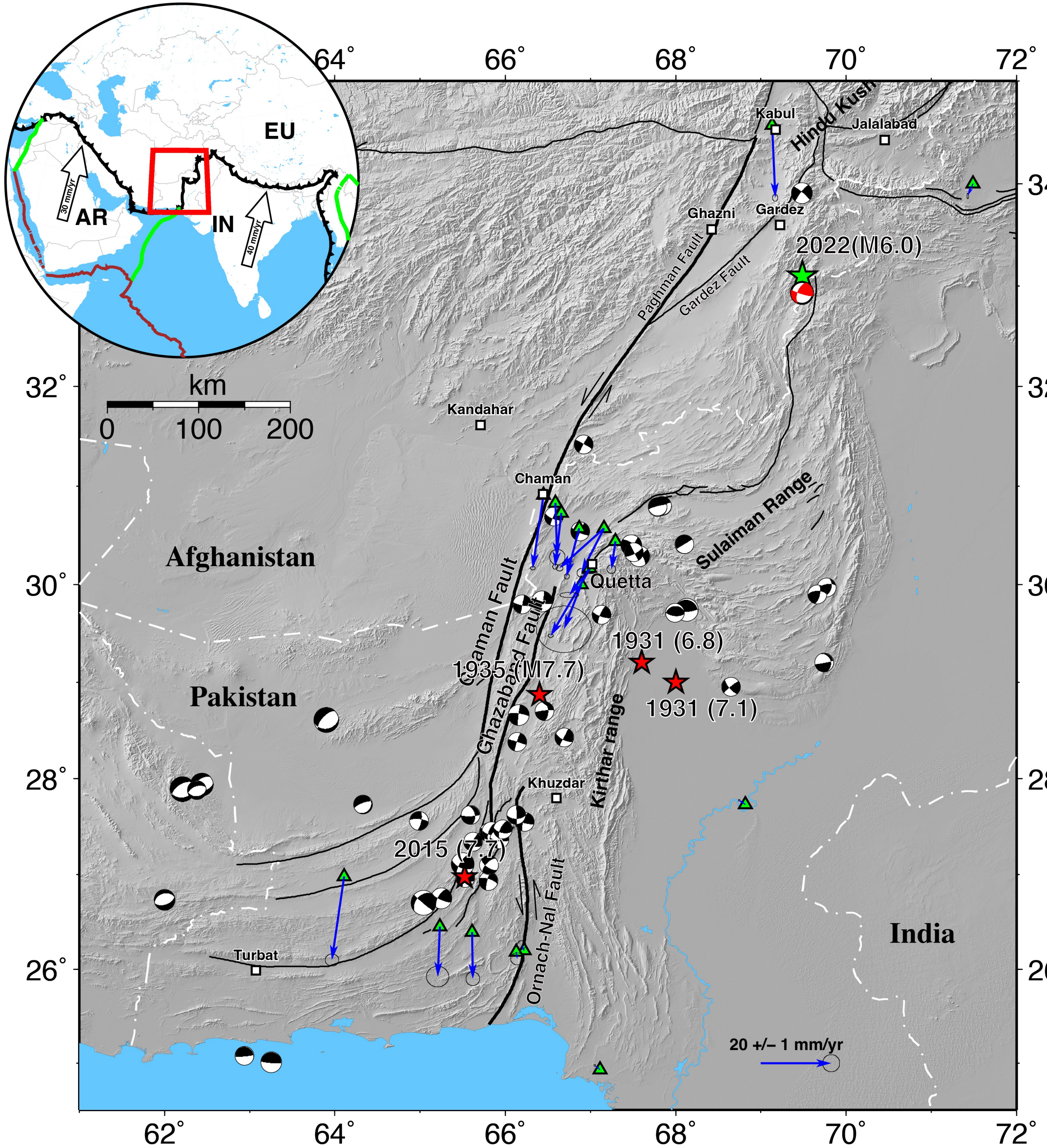
Characterization of the spatial and temporal distribution of fault slip and ground subsidence along the Chaman plate boundary with Sentinel-1 InSAR

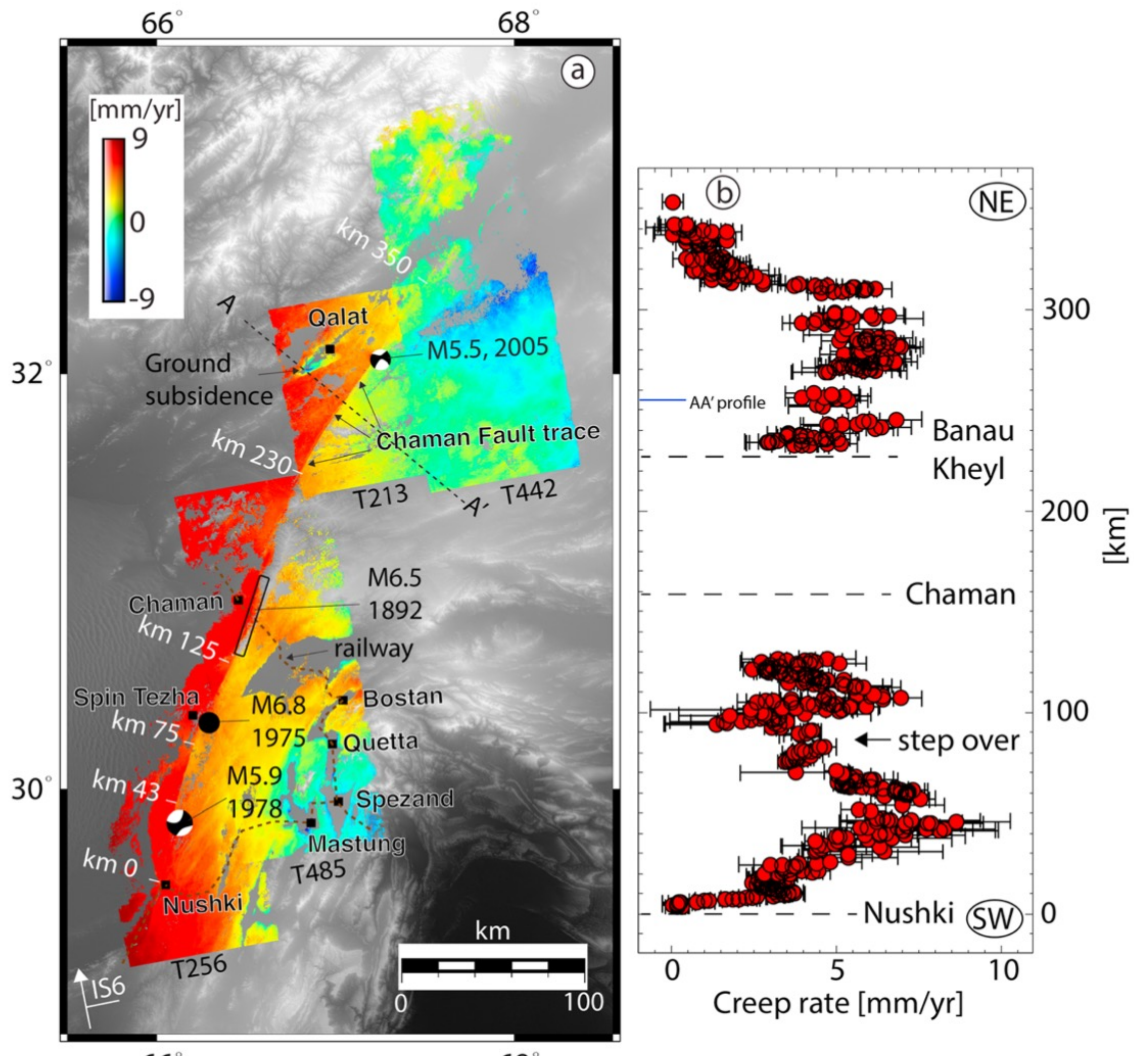
Kang Wang[1], Yuexin Li[1], Najeeb Ullah[2] , Roland Bürgmann[1], and Roger Bilham[3]

[1]Berkeley Seismological Lab., University of California, Berkeley
[2]Department of Geology, University of Balochistan, Quetta, Pakistan
[3]University of Colorado, Boulder

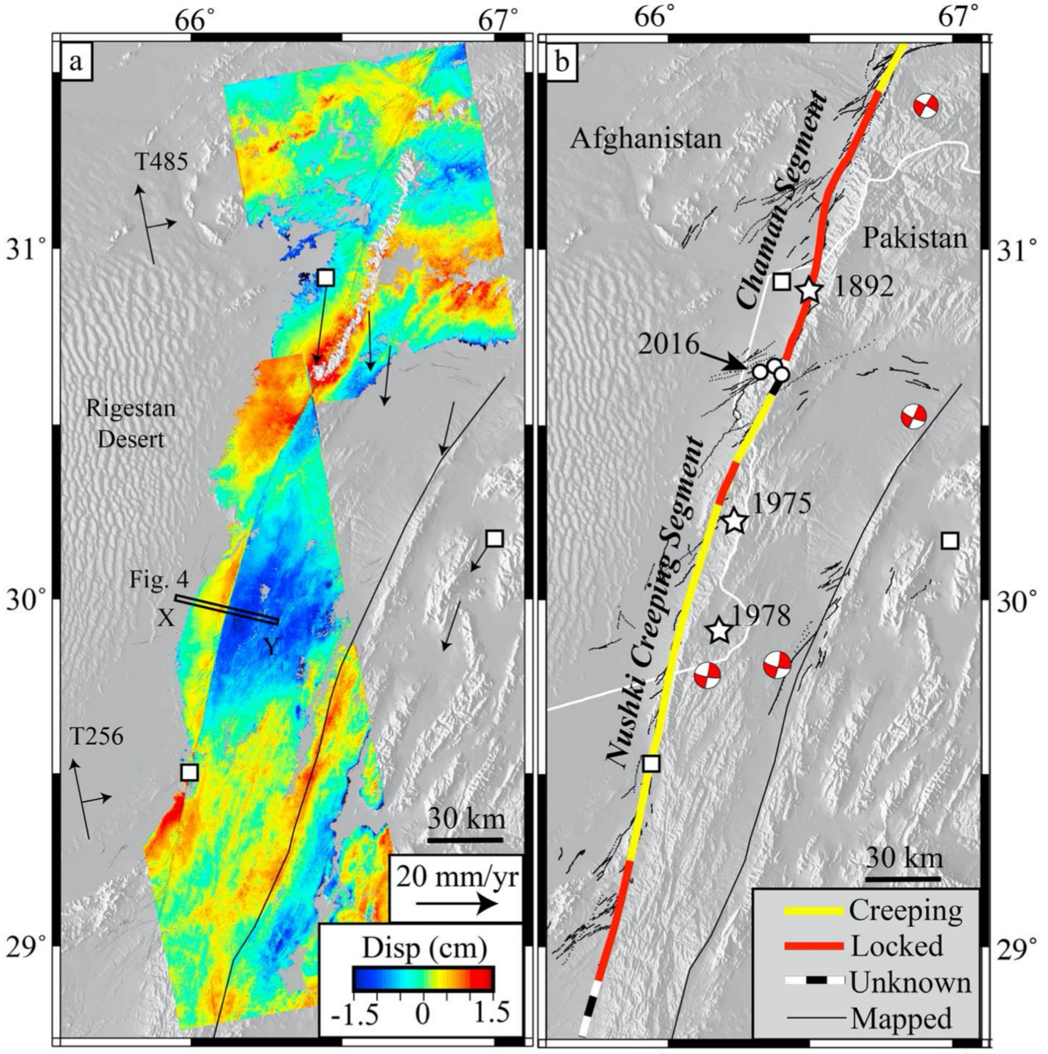


- ➢ Frequent large earthquakes
- ➢ Understanding of the spatiotemporal distribution of fault slip and strain across the fault is limited.

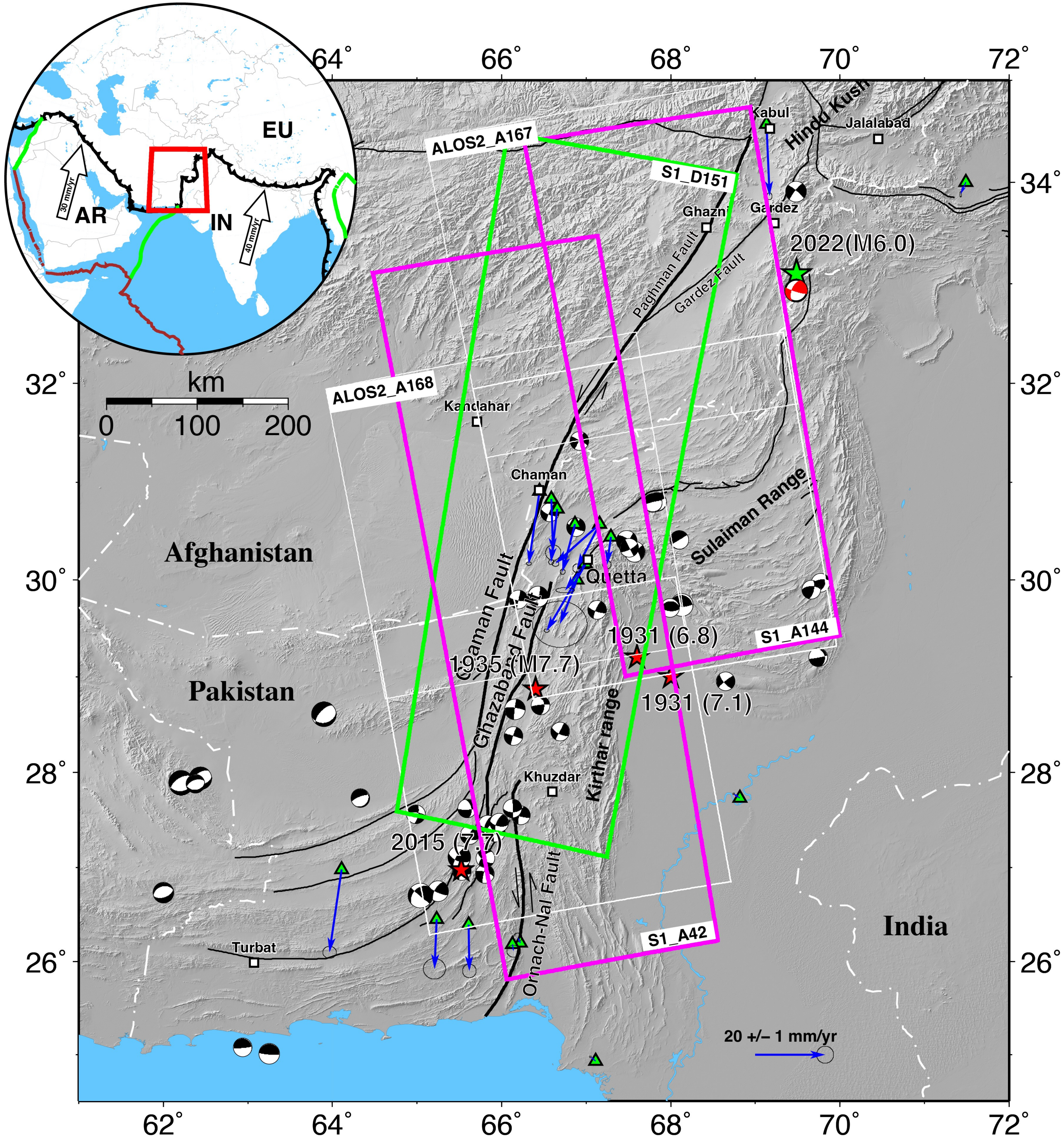
Fault creep estimated with Envisat InSAR (2004-2011)



Fattahi and Amelung, 2016

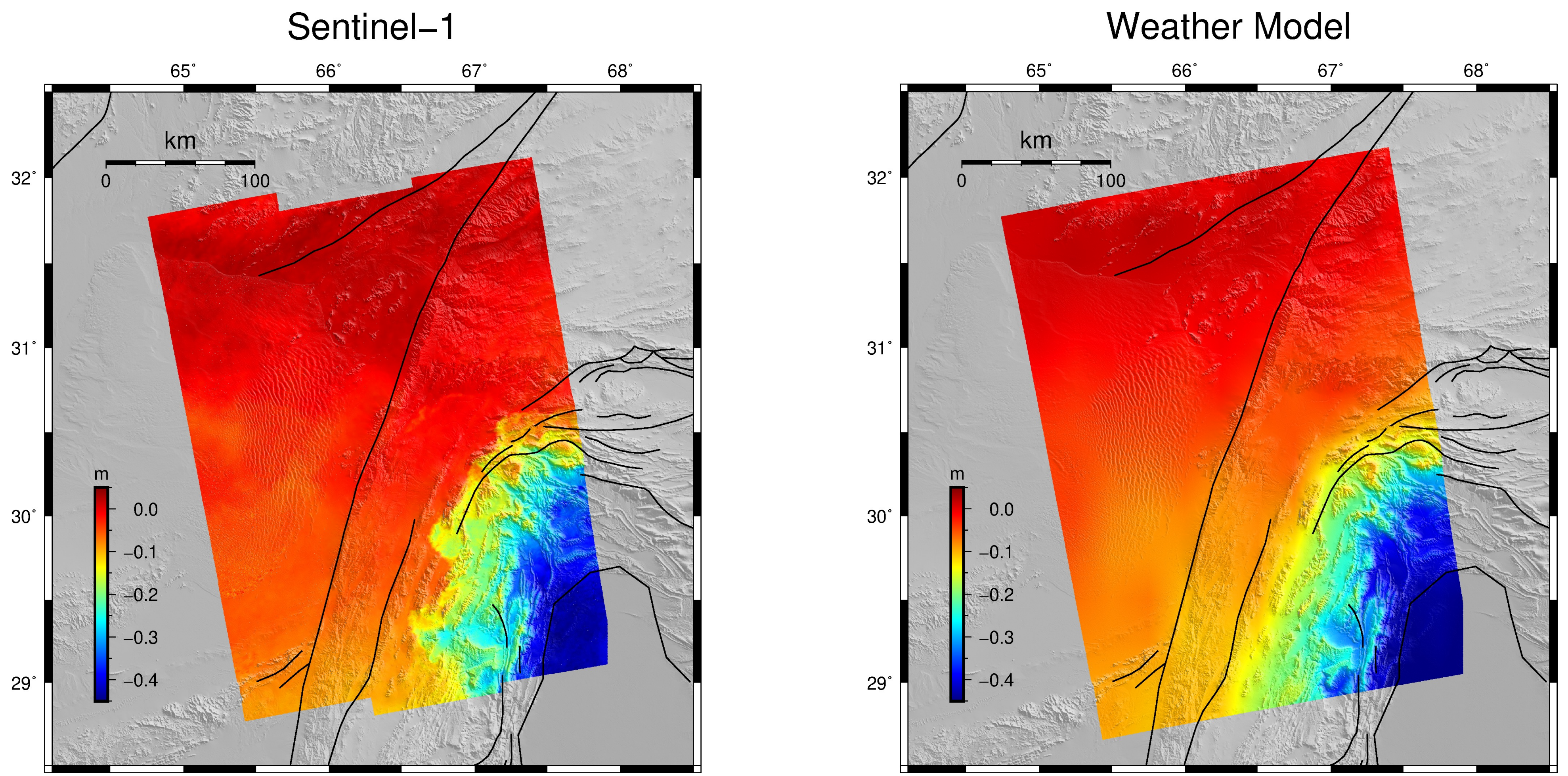


Barnhart, 2017



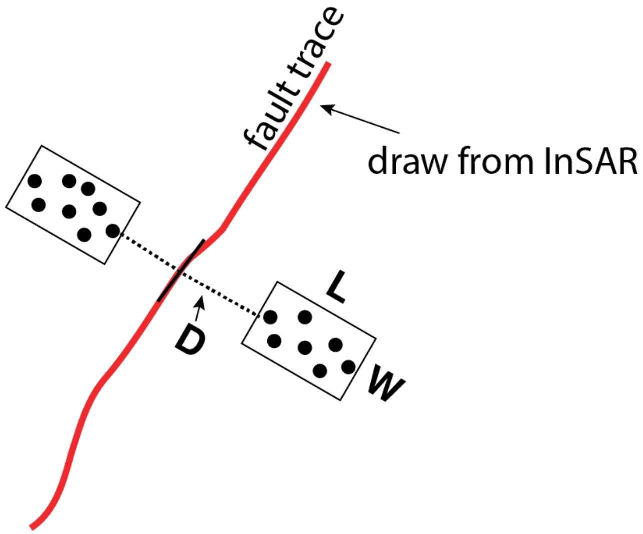
- Frequent large earthquakes
- Understanding of the spatiotemporal distribution of fault slip and strain across the fault is limited.
- New SAR missions provide new opportunities.

Atmospheric phase delays

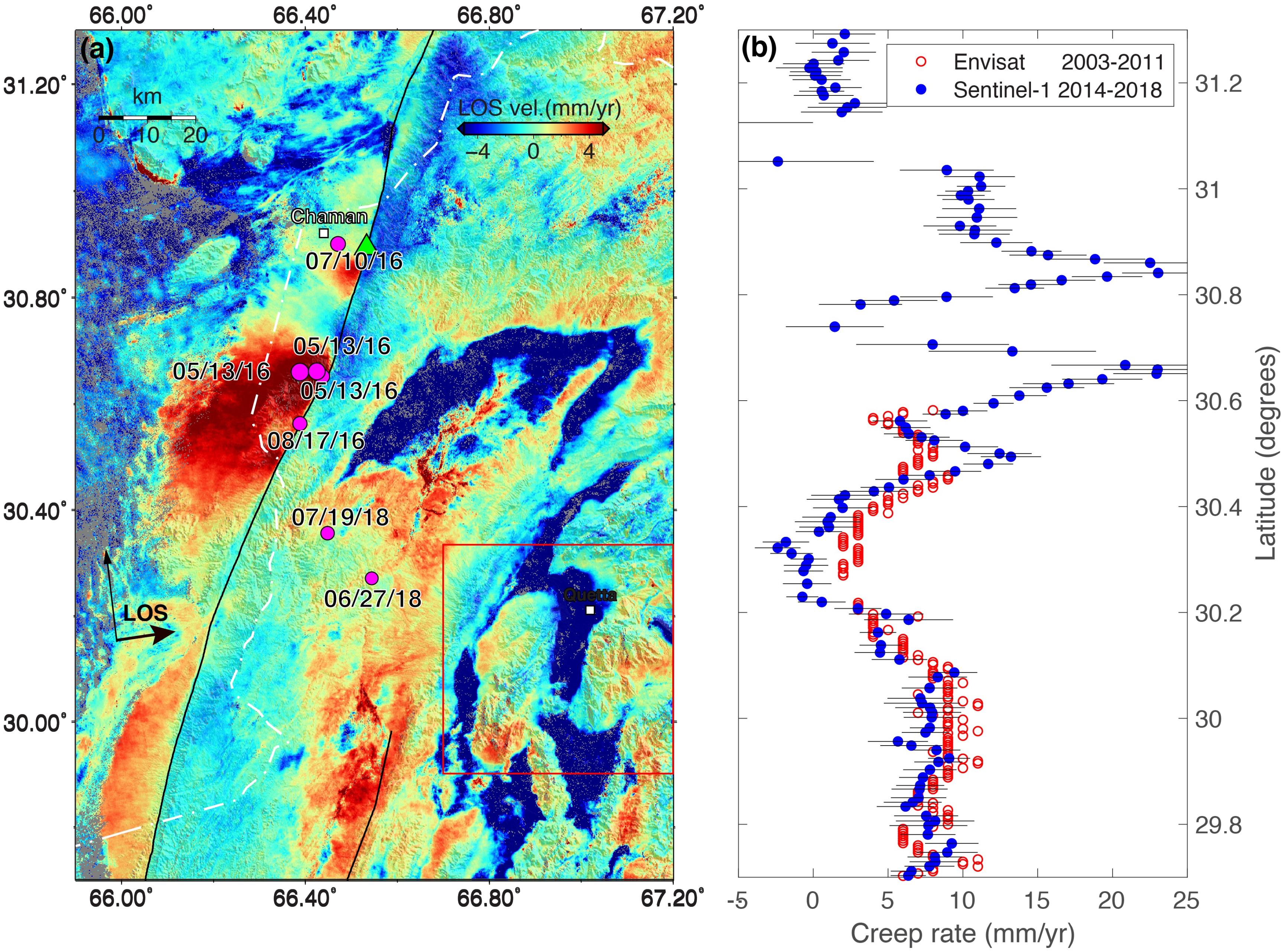


- Atmospheric noise is mitigated with ERA-5 weather model for each interferogram
- Using Small Baseline (<=36days) Subset interferograms to solve for time series

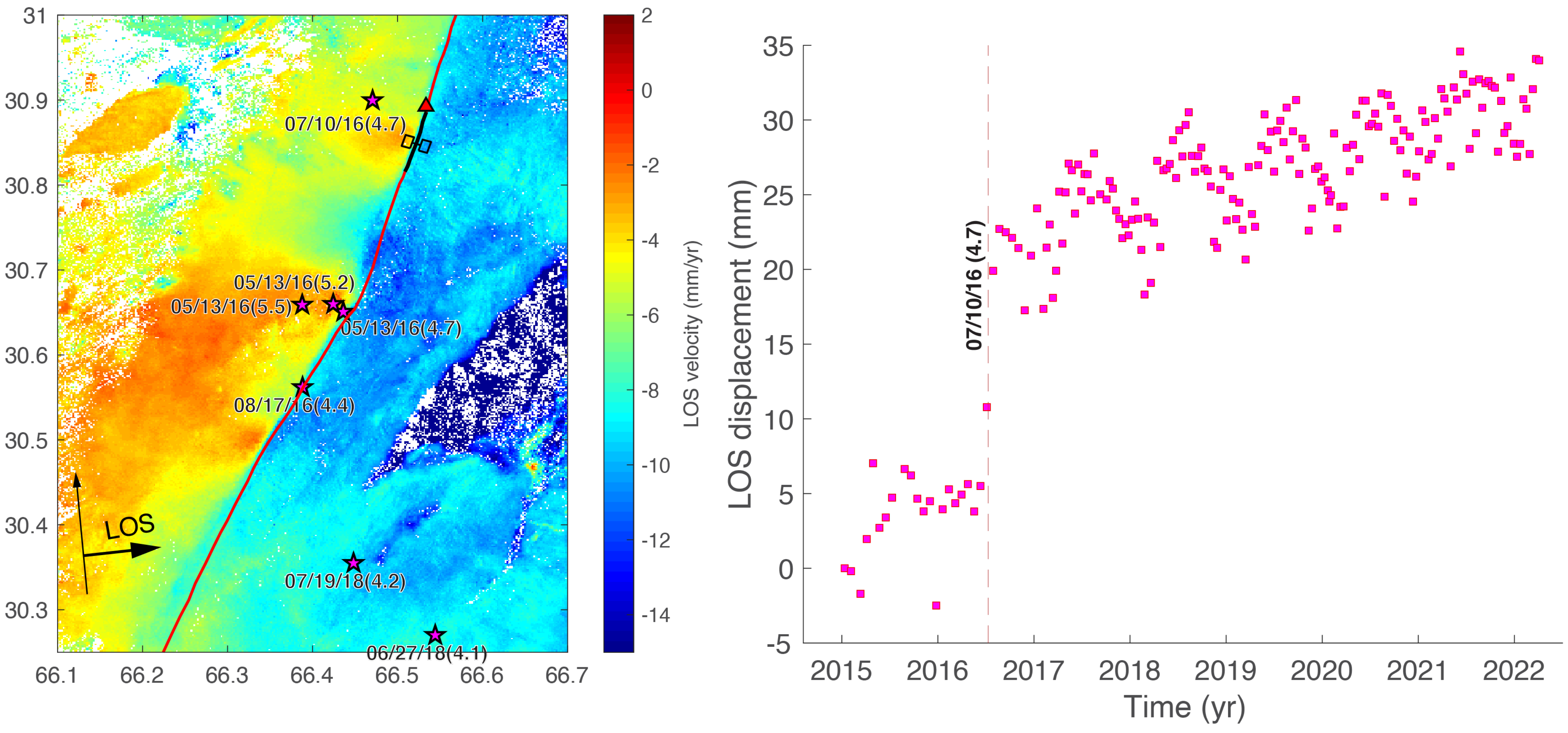
Average creep rate along the central Chaman fault



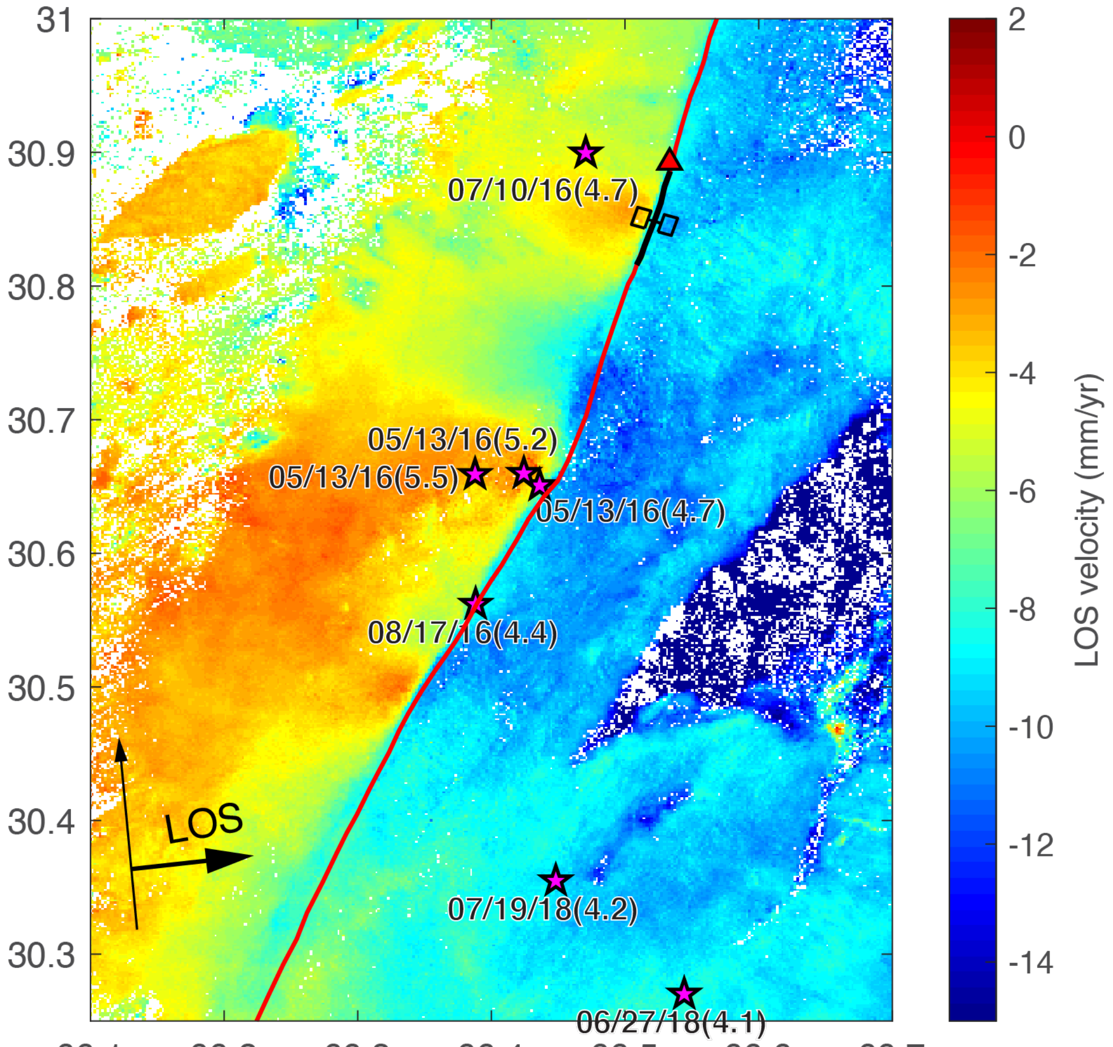
L =1500 m
W =1000 m
D = 500 m

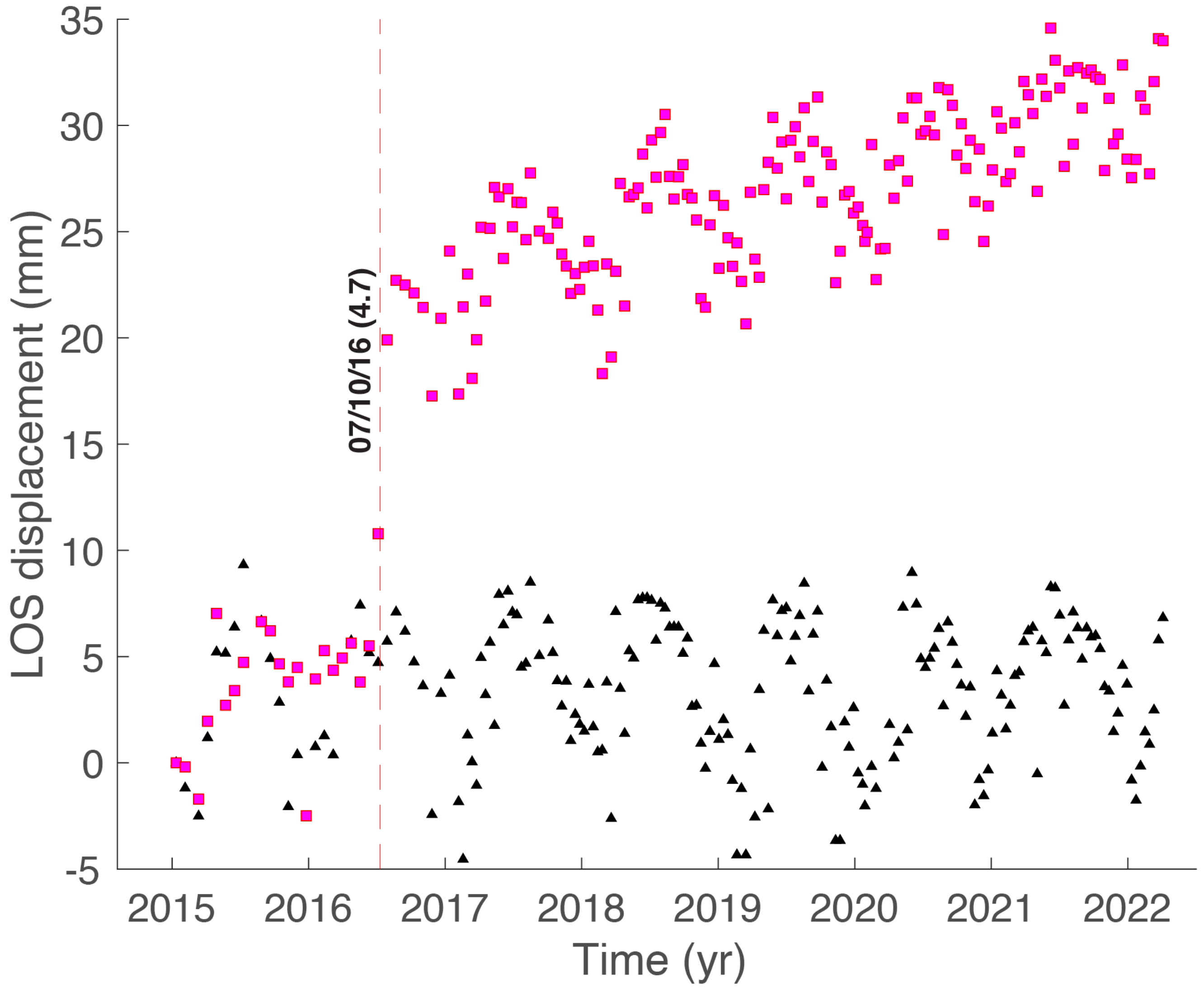


Temporal variation of fault creep

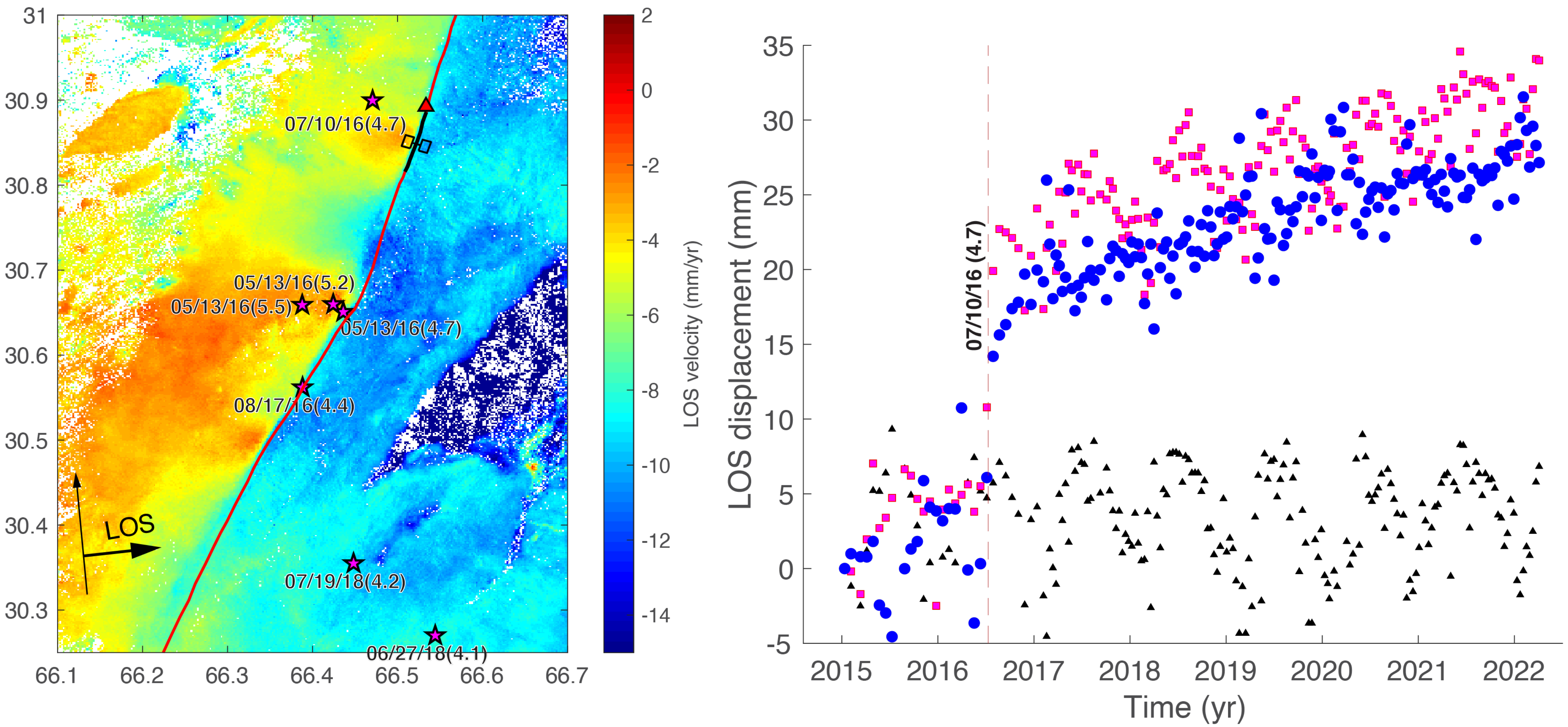


Temporal variation of fault creep

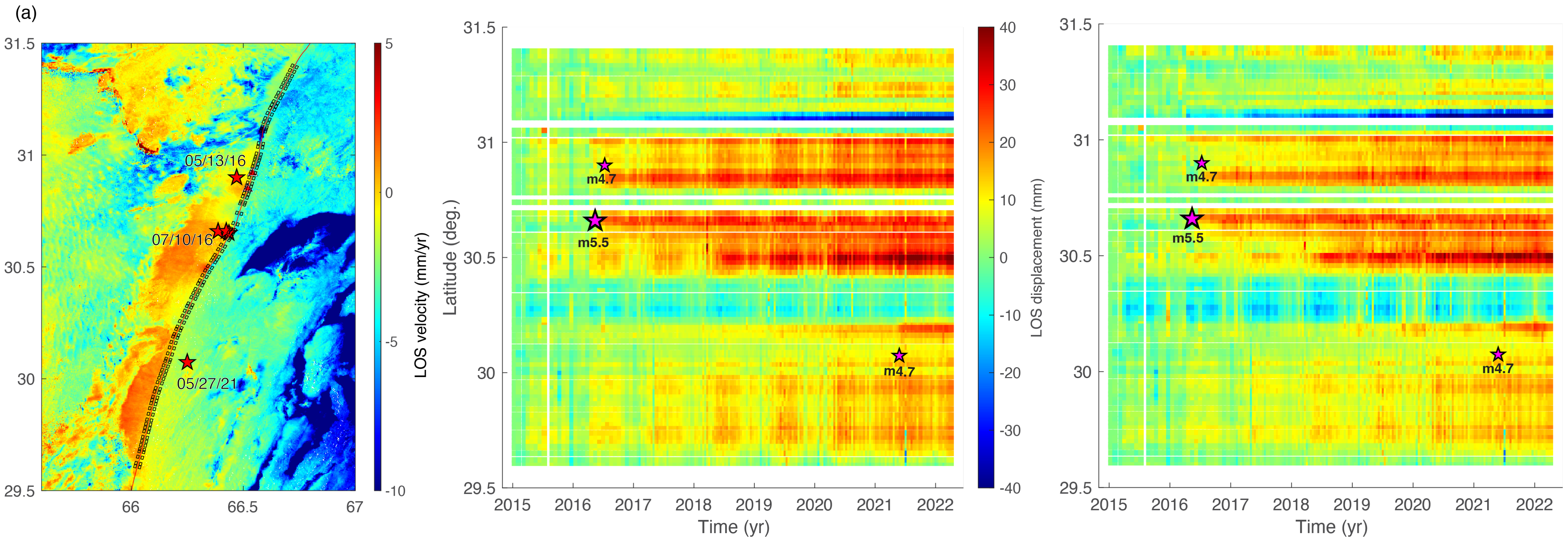




Temporal variation of fault creep

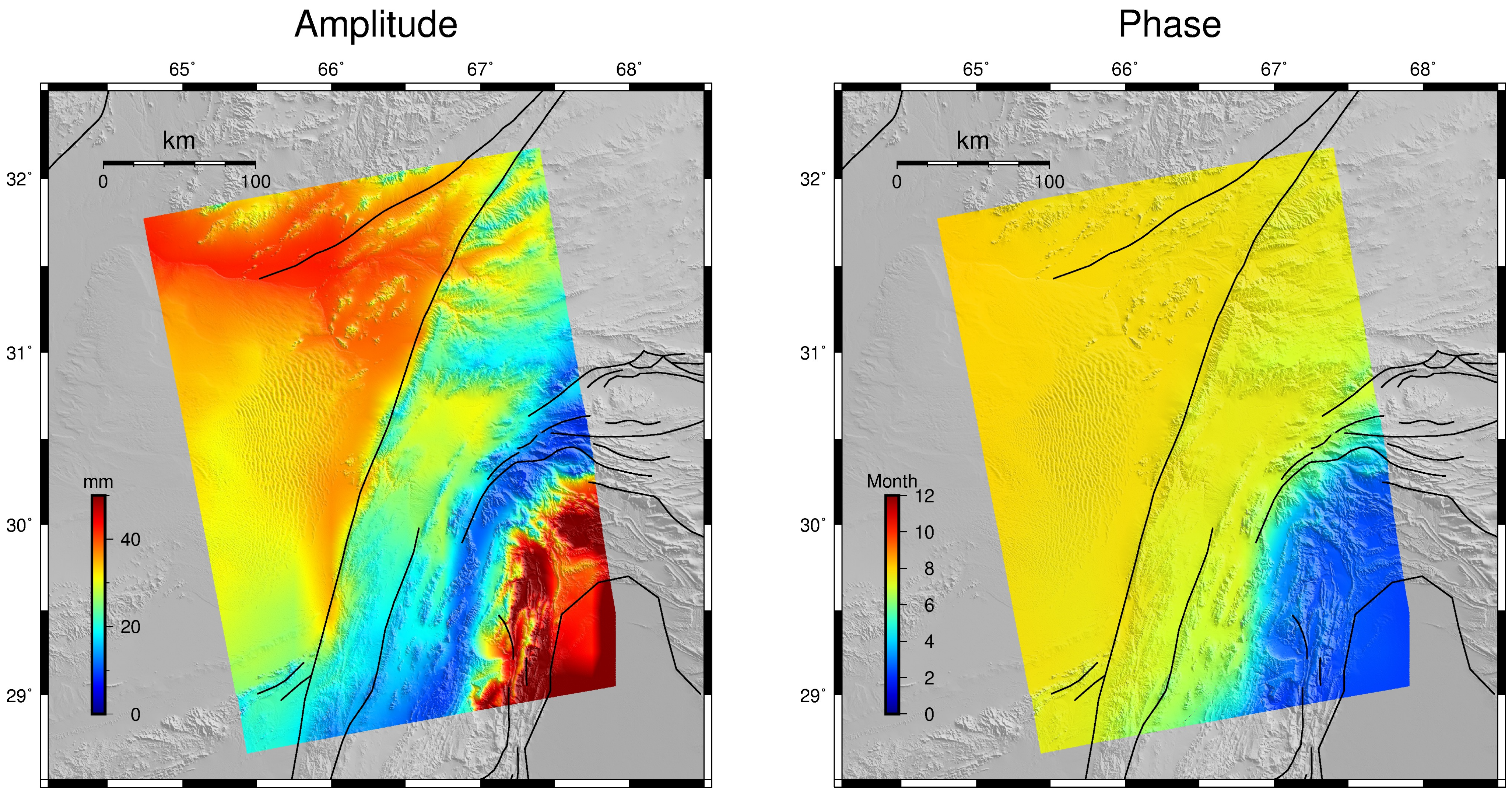


Effect of tropospheric delay on ‘creep’ estimate

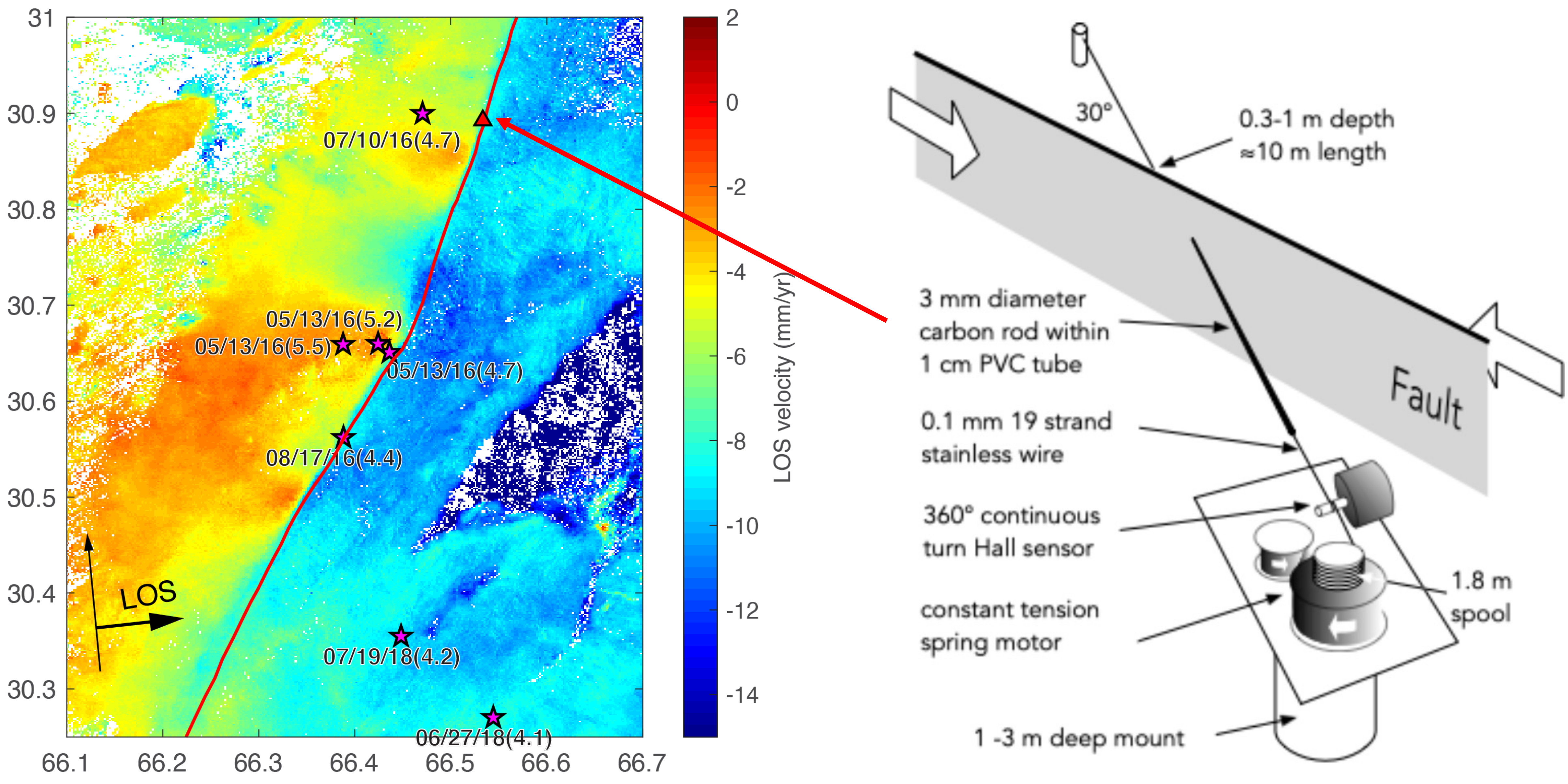


- Center: surface creep time series without correcting for atmospheric delay
- Right: surface creep time series with correcting for atmospheric delay using ERA5 weather model

Seasonal variation of tropospheric delays predicted by ERA-5

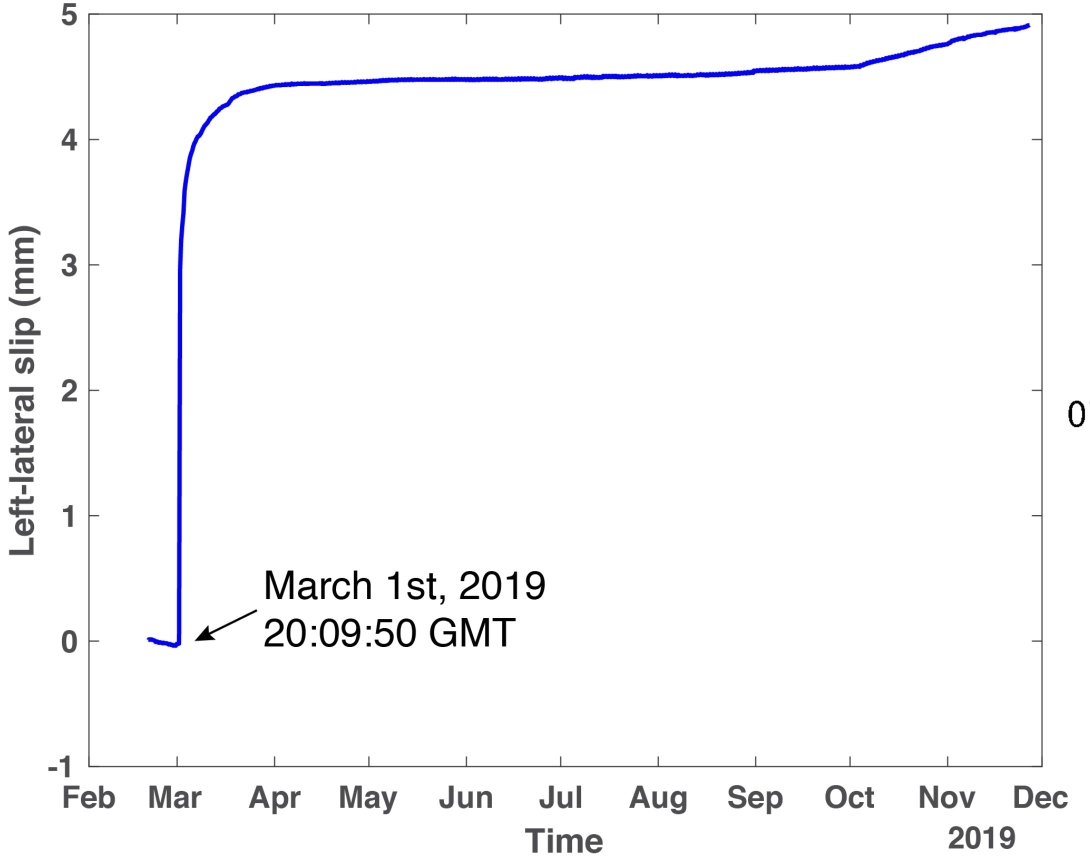


- Elevation contrast across the fault causes a difference in tropospheric delay.

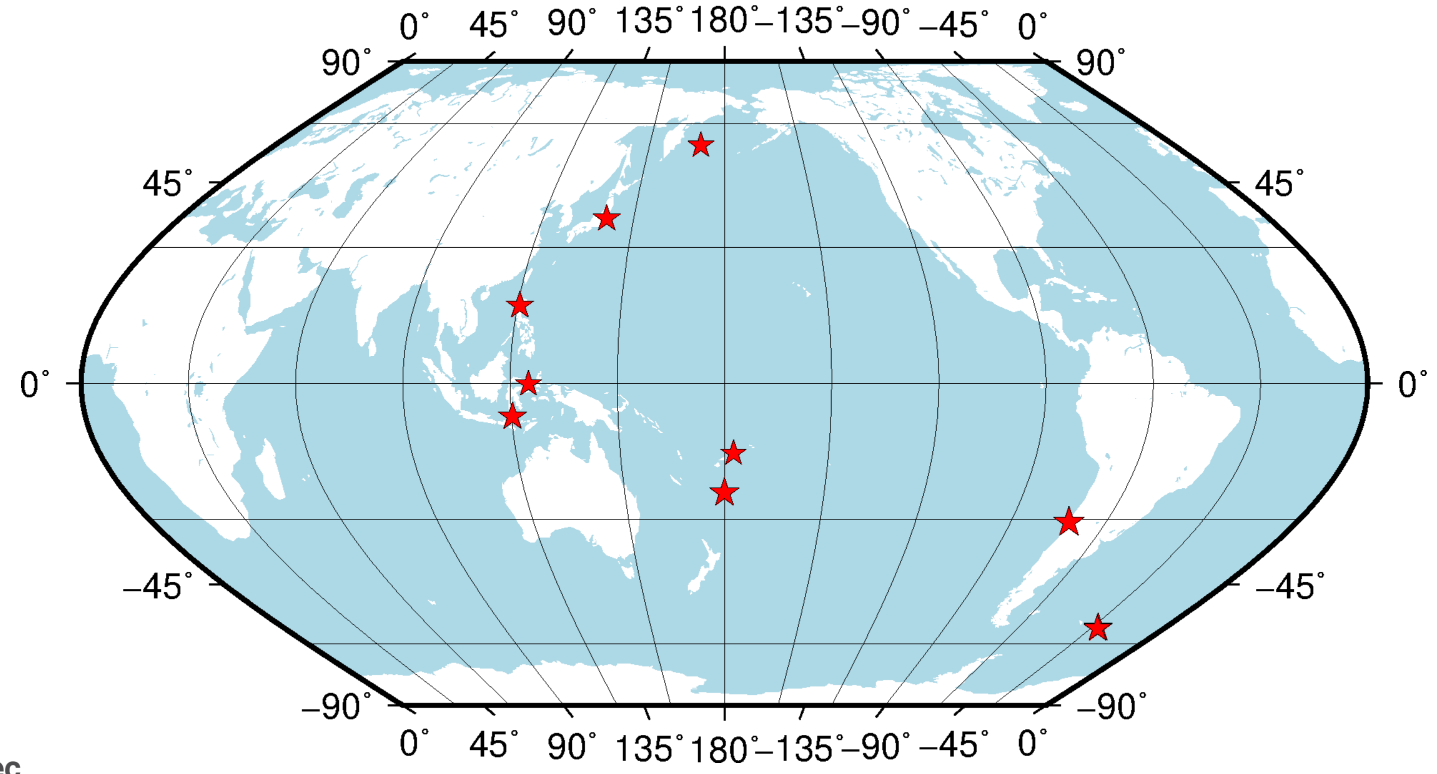


31
30.9
30.8
30.7
30.6
30.5
30.4
30.3
66.1
66.2
66.3
66.4
66.5
66.6
66.7
07/10/16(4.7)
05/13/16(5.2)
05/13/16(5.5)
05/13/16(4.7)
08/17/16(4.4)
07/19/18(4.2)
06/27/18(4.1)
LOS
LOS velocity (mm/yr)
2
0
-2
-4
-6
-8
-10
-12
-14
30°
0.3-1 m depth
≈10 m length
3 mm diameter
carbon rod within
1 cm PVC tube
0.1 mm 19 strand
stainless wire
360° continuous
turn Hall sensor
constant tension
spring motor
1.8 m
spool
1 -3 m deep mount
Fault

Spontaneous creep event



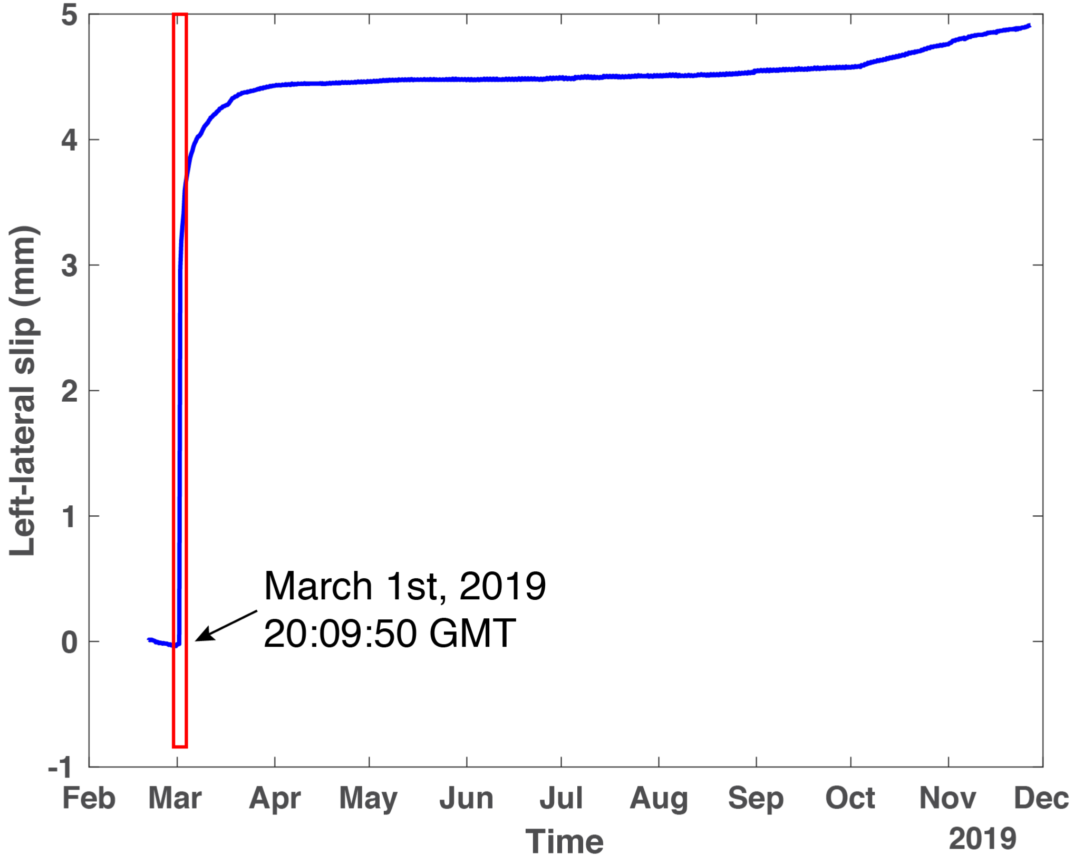
M>4 earthquakes two hours around the creep event

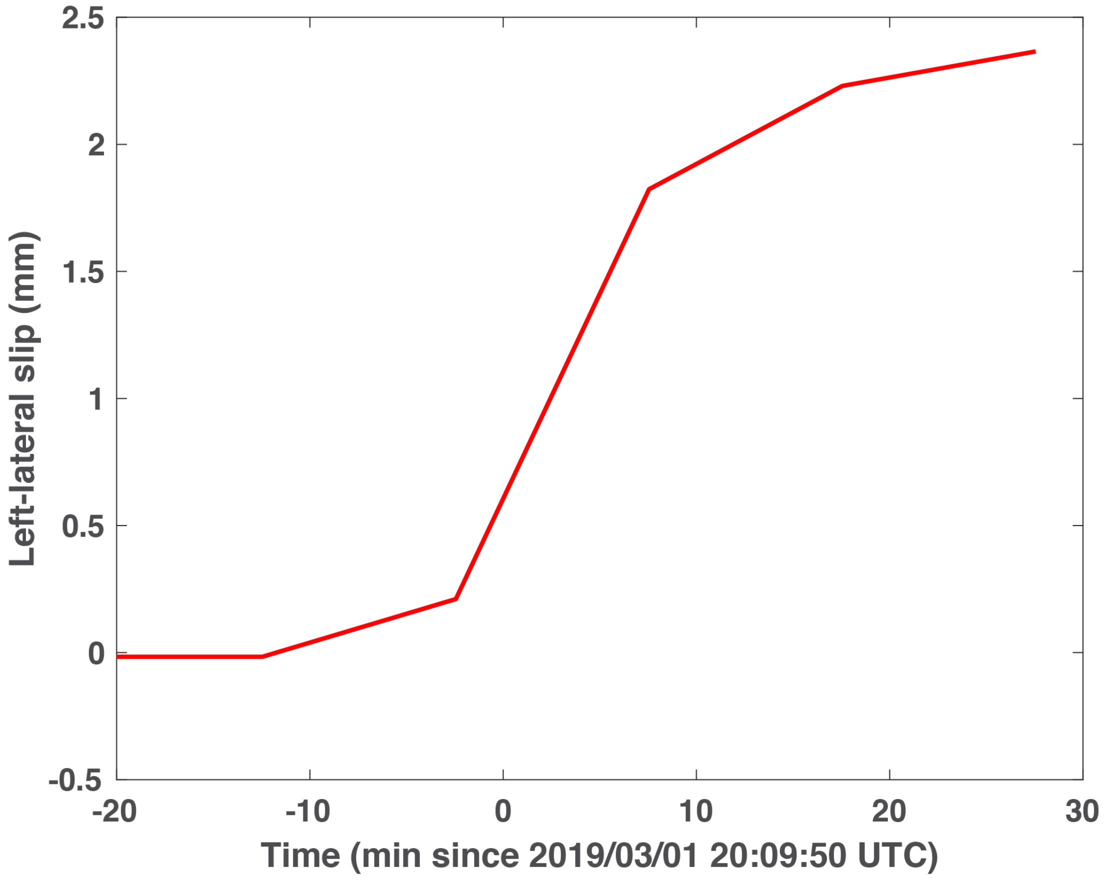


No M>5 earthquakes worldwide

The creep event is unlikely triggered by earthquakes.

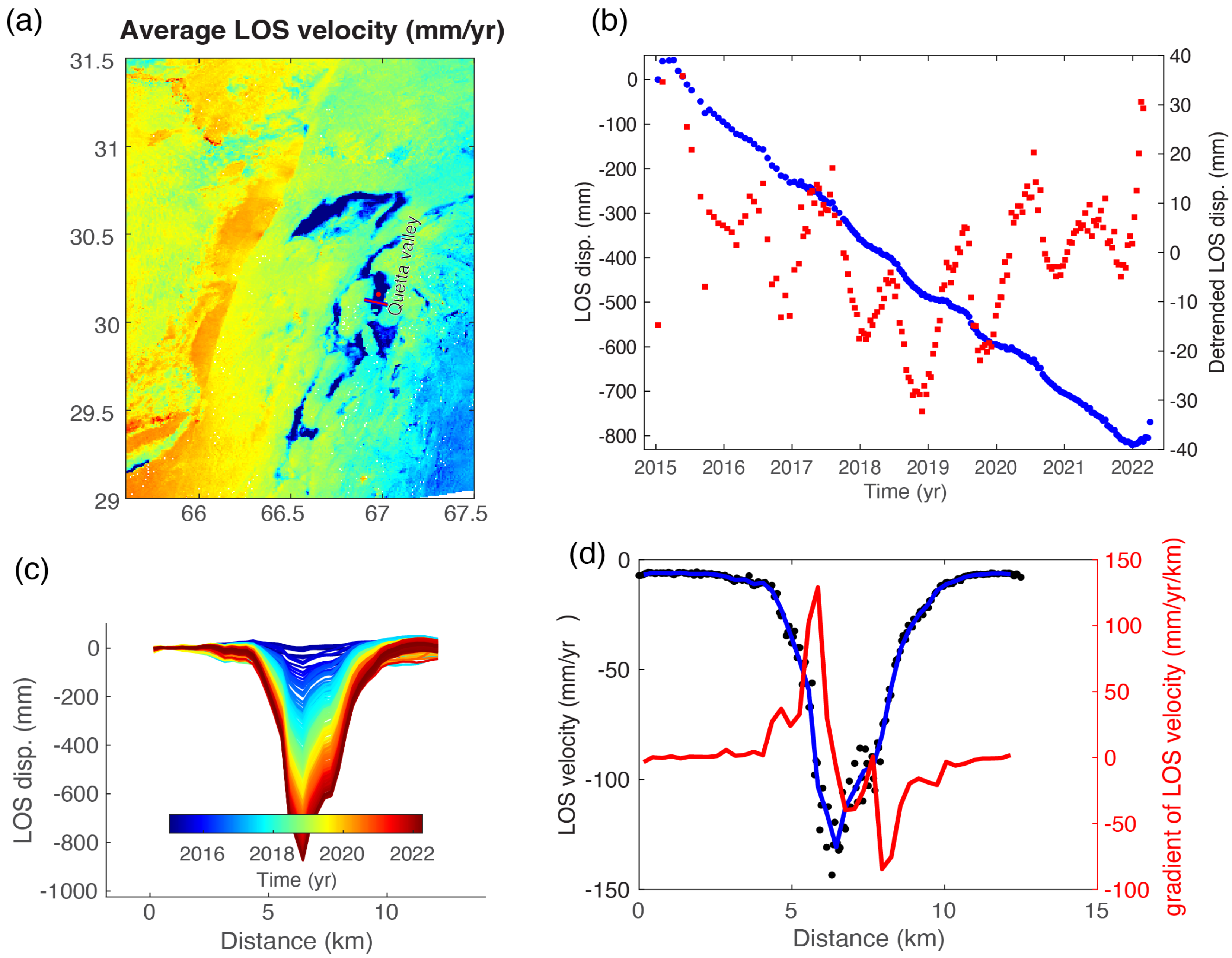
Spontaneous creep event





The creep signal looks alike a slow slip event (SSE).

Ground subsidence related to water pumping



Conclusions

- Recent SAR missions provide new opportunities to study the spatiotemporal variation of fault motion.

- Creep rate of the Chaman fault is spatially heterogeneous and temporally non-steady.

- Strain accumulation along the Chaman fault is modulated by a wide spectrum of fault motion behaviors:
  - coseismic slip
  - afterslip
  - spontaneously slow slip events

- Ongoing and future work:
  - strain partitioning across the plate boundary
  - Interplay between seismic-, aseismic fault slip and ground subsidence