Supporting Information for Return of the Atacama deep Slow Slip Event : the 5-year recurrence confirmed by continuous GPS

E. Klein[1], C. Vigny[1], Z. Duputel[2], D. Zigone[3], L. Rivera[3], S. Ruiz[4], B. Potin[4]

[1]Laboratoire de géologie, Département de Géosciences, ENS, CNRS, UMR 8538, PSL research University, Paris, France

[2]Observatoire Volcanologique du Piton de la Fournaise, Université de Paris, Institut de Physique du Globe de Paris, CNRS, F-75005, Paris, France

[3]Institut Terre & Environement Strasbourg (ITES), UMR7063, Université de Strasbourg/CNRS ; Strasbourg, France

[4]Departamento de Geofísica, Universidad de Chile, Santiago, Chile

Contents of Supporting information

S1 Data analysis

We describe here the analysis methodology of cGPS data, implemented with the PYACS toolbox. First, estimate and remove an overall trend on all time series, in order to be able to precisely estimate and correct any instrumental offsets. Second, we filter time series using the common mode filter based on the 4 stations PAZU, FMCO, TRST, PCHO. The resulting filter is showed on Fig. S1. We tested a common mode without the station FMCO which is the closest from the source, which results in no significant changes.

We show here the total time series of station COPO (decommissioned in 2014, in blue) which allowed to originally suspect the 5-year recurrence of the SSE, and of station UDAT (installed in 2014, in red).

Once the time series are filtered and cleaned from all offsets, we estimate and remove the 1-year trend estimated between 2019 and the end of February 2020. Figures S3 show the comparison between time series before filtering and offset removal (blue dots) and final filtered time series (red lines).

To precisely extract cumulative displacements from the noise, we estimate a trend between March 1st and August 31st, depicted by the green line on Fig.S4. We then predict from this trend positions at the presumed beginning and at the end of the period, depicted by blue dots on the figure. We deduce the total displacements by differentiating the final and the initial predicted position. Uncertainties associated with these displacement are calculated from the misfit between predicted and observed positions.

Figure S5 shows additional aligned between the SSE2014 period, measured by sGPS and the SSE2020 period measured by cGPS. Contrary to the other 4 stations (TOT5, COP5,

Corresponding author: E., Klein , klein@geologie.ens.fr

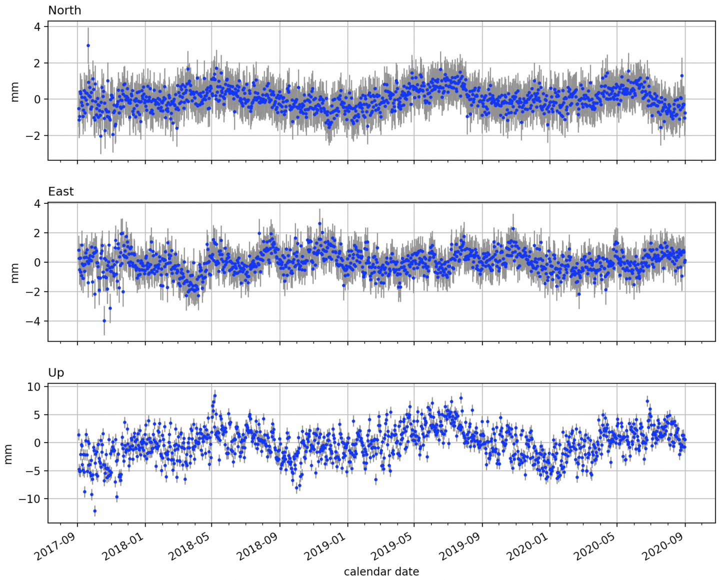

Figure S1. Common mode estimated using stations PAZU, FMCO, TRST, PCHO. See Fig. 1 for location of these stations.

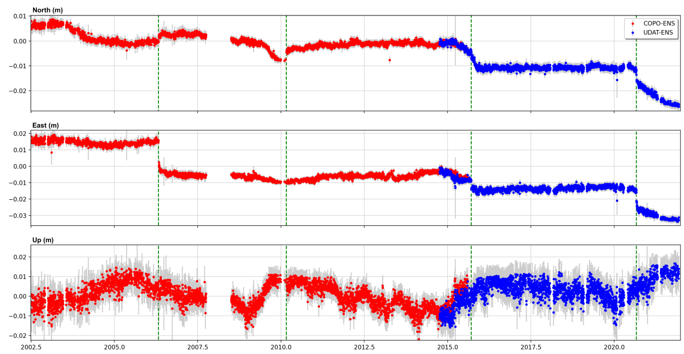

Figure S2. 3-component time series (from top to bottom: North-East-Up) of stations COPO (between 2002 and 2014, red) and UDAT (between 2014 and 2020, in blue) separated by less than 5 km.

BAR2 and MMOR) that were sGPS markers installed in permanent, TTRL is a brand new point installed at less than 7km from the closest sGPS marker TOT1. Both still compare remarkably well.

S2 Localisation of the source

In order to confirm that the high amplitude of posterior slip is mainly due to the high number of parameters compared to the low number of observations, we run a model on the original geometry used in [*Klein et al., 2018b*], with patches 4 times larger than the geometry used here. The mean posterior slip distribution presented on Fig. S6-A shows a very similar slip pattern located at 27.5°S, as in the preferred model. But as expected, uncertainties are significantly smaller, not exceeding 10 cm everywhere except at great depth were slip remain largely unresolved.

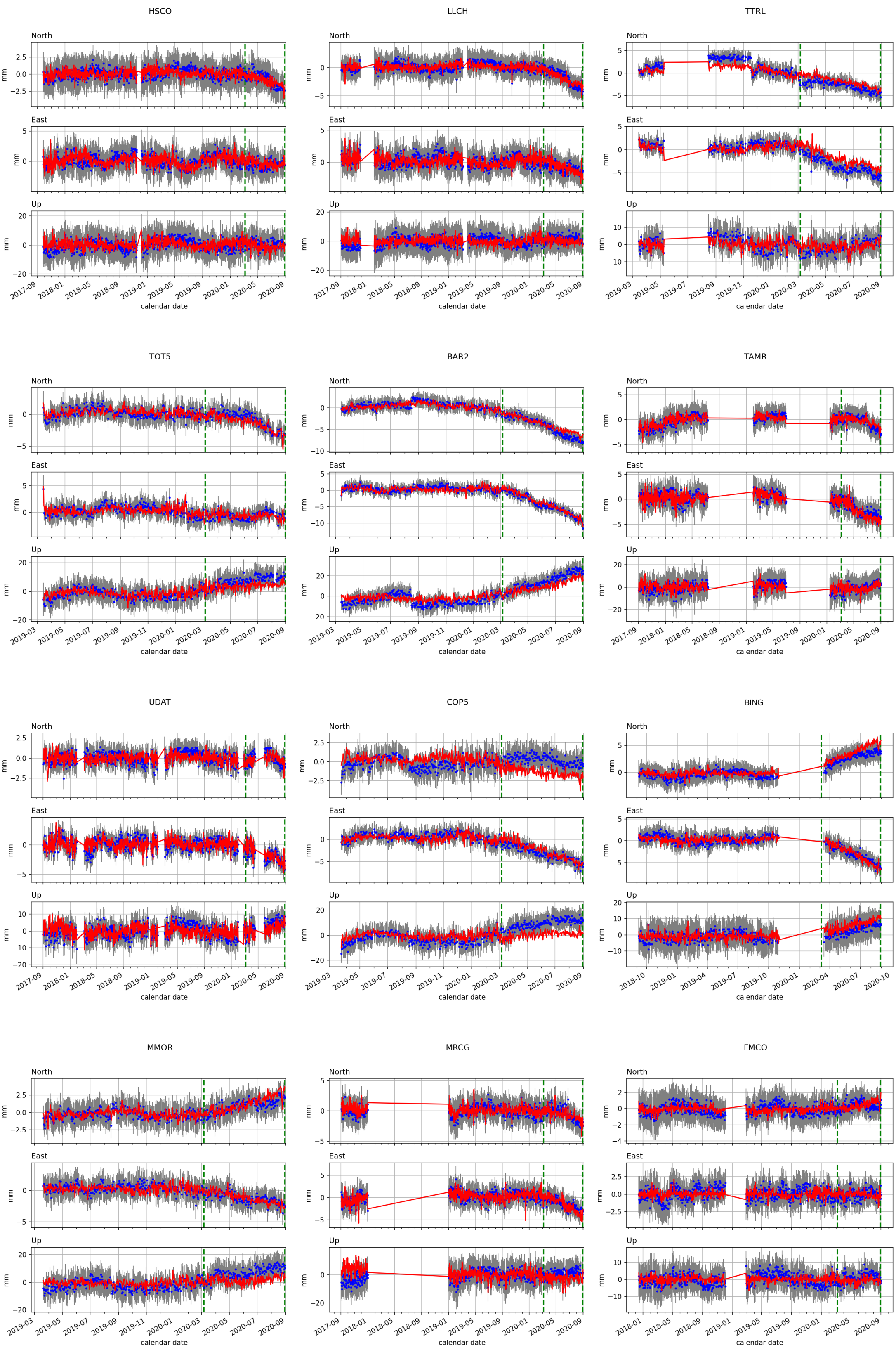

Figure S3. Raw time series (blue dots) vs filtered time series (red line) for all stations, from south to north. The 2 green vertical dotted lines depict the presumed beginning date of the SSE and September 1st, date of the Copiapo sequence [*Klein et al., 2021*, see references in the main article]. See Fig. 1 for the location of stations.

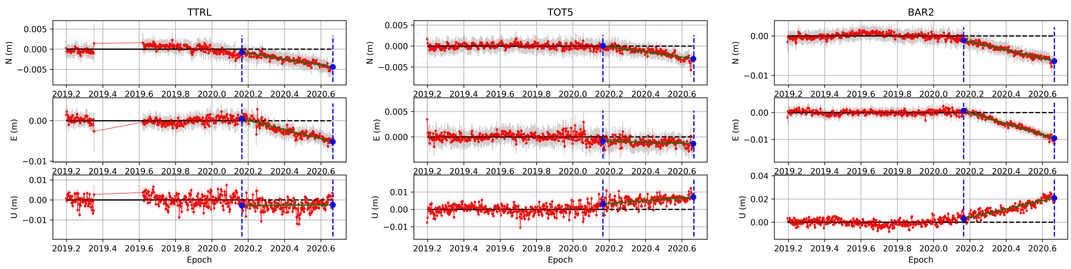

Figure S4. Filtered time series showing the methods of estimation of cumulative displacements. The dotted black line depict the trend estimated between March, 1st and August 30th (both dates represented by the dotted blue vertical lines). Positions measured at both dates are highlighted by a larger blue dots. See Fig. 1 for the location of stations.

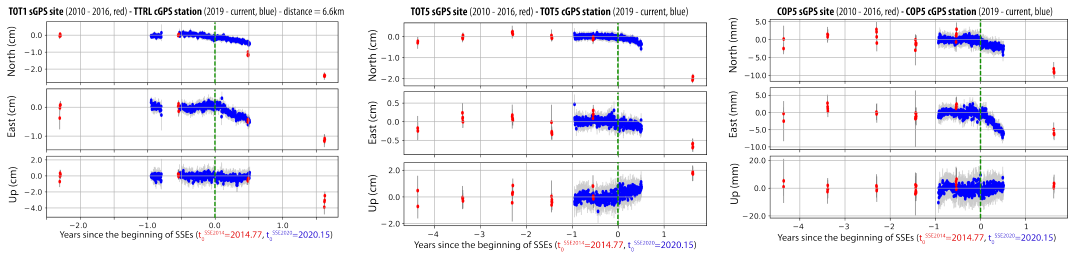

Figure S5. Comparison of sGPS sites with corresponding cGPS stations. All time series have been aligned in time around the presumed date of SSE's beginning (estimated at 2014.77 and 2020.15), the sGPS time series are detrended from the 2010-2014.5 trend, the cGPS time series from the 2019-2020.0 trend. See Fig. 1 for the location of stations.

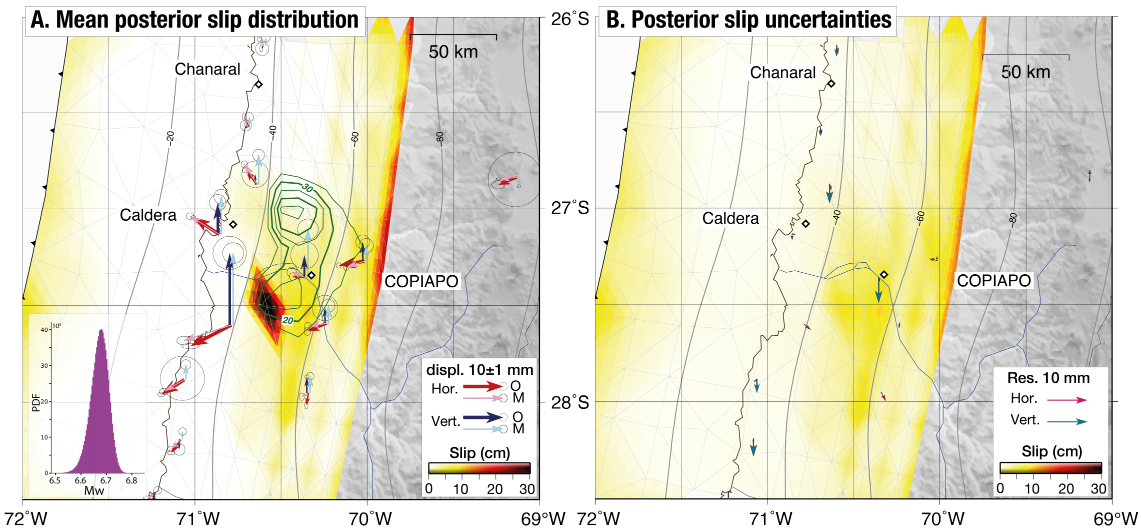

Figure S6. Slip model of the deep SSE2020 on rougher geometry. A. Mean posterior slip distribution in cm (represented by the white-to-red color scale). Observations are represented by the red (horizontal) and dark blue (vertical) arrows, compared to the model prediction in pink (horizontal) and light blue (vertical). The slip distribution of the SSE2014 is represented by +5 mm green contours *Klein et al., (2018b)*. Inset shows the probability density function (PDF) of Mw of the deep patch of slip. B. 1σ posterior slip uncertainties represented with the same color scale as the slip distribution. Residuals (Obs.-Mod.) are represented by the red (horizontal) and blue (vertical) arrows.