



Supplement of

Design and operation of a long-term monitoring system for spectral electrical impedance tomography (sEIT)

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S1: Data coverage

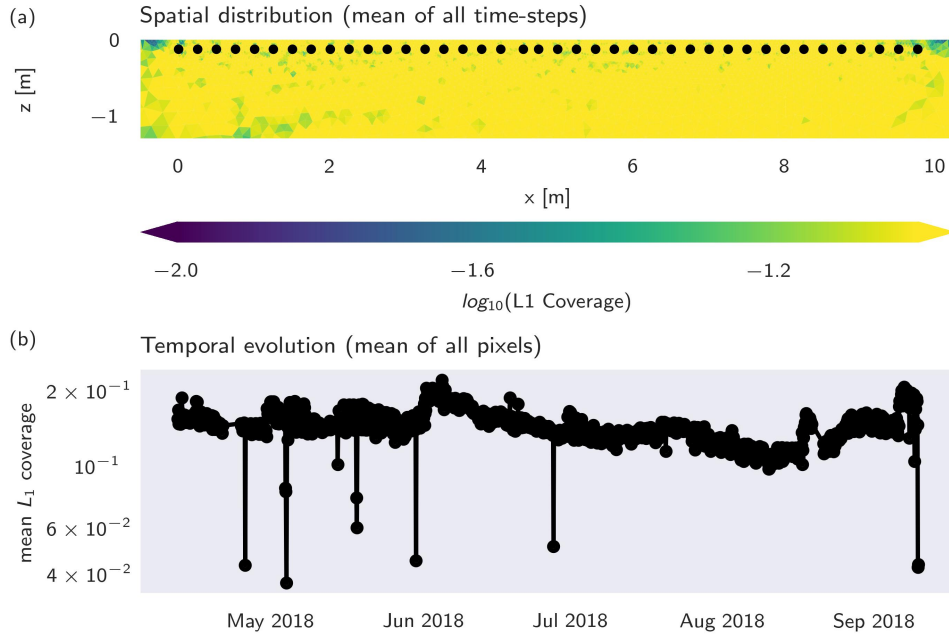


Figure S1: (a) Mean normalized L1-coverage of the central image region for the season 2018. (b) Temporal evolution of per-measurement \log_{10} -averaged L1-coverage statistics for the season 2018.

Image appraisal is often done using the computationally inexpensive normalised cumulated sensitivity, also called coverage. The coverage sums up the sensitivity contributions of all measurements for a given pixel values of the FE mesh and weights those contributions by the error estimates of the individual measurements (e.g., Weigand et al., 2017). Normalisation of the ensuing coverage ensures better comparability between data sets. We here use the L1 normalised coverage for image appraisal:

$$(s_{L1})_k = \frac{1}{a_{\max}} \frac{|a_{ik}|}{\epsilon_i}, \quad (1)$$

where $(s_{L1})_k$ is the coverage values for the k -th pixel, a_{\max} the maximum coverage value for all pixels, a_{ik} the sensitivity of the i -th configuration of the k -th pixel, and ϵ_i the data error of the i -th measurement.

Fig. S1a presents the temporal median values of the normalised L1 coverage of the central image region. The image region exhibits a homogeneous coverage distribution, indicating that information is recovered from the whole image region on a similar level. Apart from a few outliers, the temporal evolution of the mean coverage of the subsurface under the electrode line down to a depth of 1.3 m does not change much (Fig. S1b).

S2: Monthly changes in extracted SIP spectra

Fig. S2 presents intrinsic spectra for the central plot for different dates. Labels denote the (x/z) position in the tomogram where the spectra were extracted. The spectra represent the median values of all inversions in a 24 hour interval around the target time considering all inversion results with RMS values between 0.95 and 1.05.

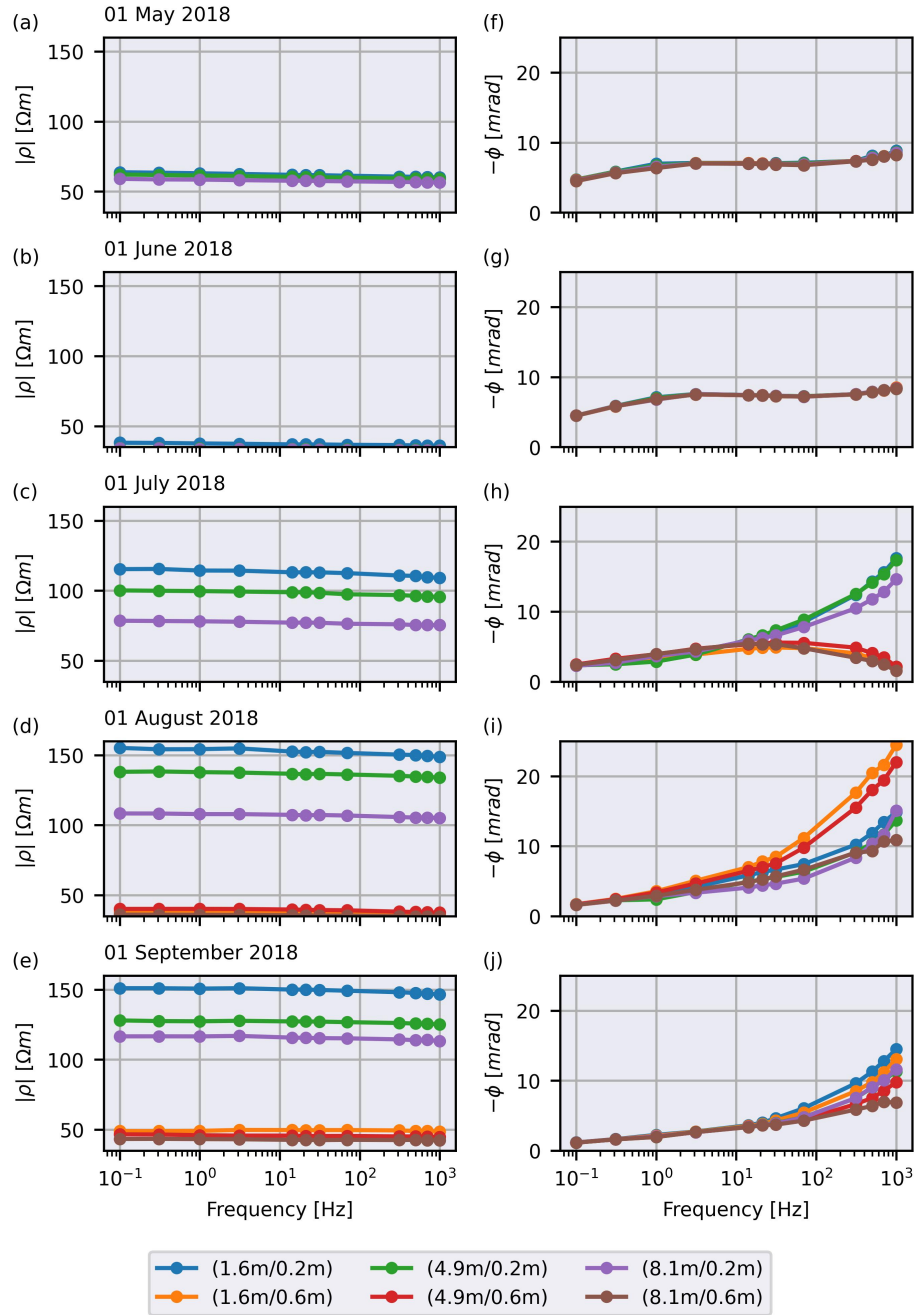


Figure S2: Intrinsic spectra extracted from tomographic analyses of all frequencies for different times during the growing season 2018. Labels denote the (x/z) position in the tomogram where the spectra were extracted. The spectra represent the median values of all inversions in a 24 hour interval around the target time considering all inversion results with RMS values between 0.95 and 1.05.

S3: Temporal Development of Inversion Results

In this appendix, the temporal development of resistivity magnitude and phase values at 1 and 1 kHz extracted from the imaging results is presented for alternative data processing strategies. Results for data without any inductive correction applied are shown in Fig. S3. Inversions conducted using the same data as presented in the main text, but a different phase error model with a relative phase error model, $\Delta\phi = \tilde{a}\phi + \tilde{b}$, are shown in Fig. S4 for $\tilde{a} = 0.05$ and $\tilde{b} = 0.3$ mrad. Finally, inversions where data were filtered using a temporal filter that only retained measurement configurations present in at least 80 % of all time steps are shown in Fig. S5.

While small temporal details vary between the phase responses of all three scenarios we note that the overall patterns stay the same, even for the case where data was additionally filtered to only include data points present in at least 80% of the time steps (Fig. S5). The only significant variation in the results can be observed for phase values at 1kHz, highlighting the effect of a proper inductive correction procedure (compare Fig. 15 of the main text and Fig. S3). We therefore conclude that while a proper treatment of data filtering procedures and inversion settings is crucial for quantitative approaches, qualitative results should be quite robust for a wide range of different processing choices.

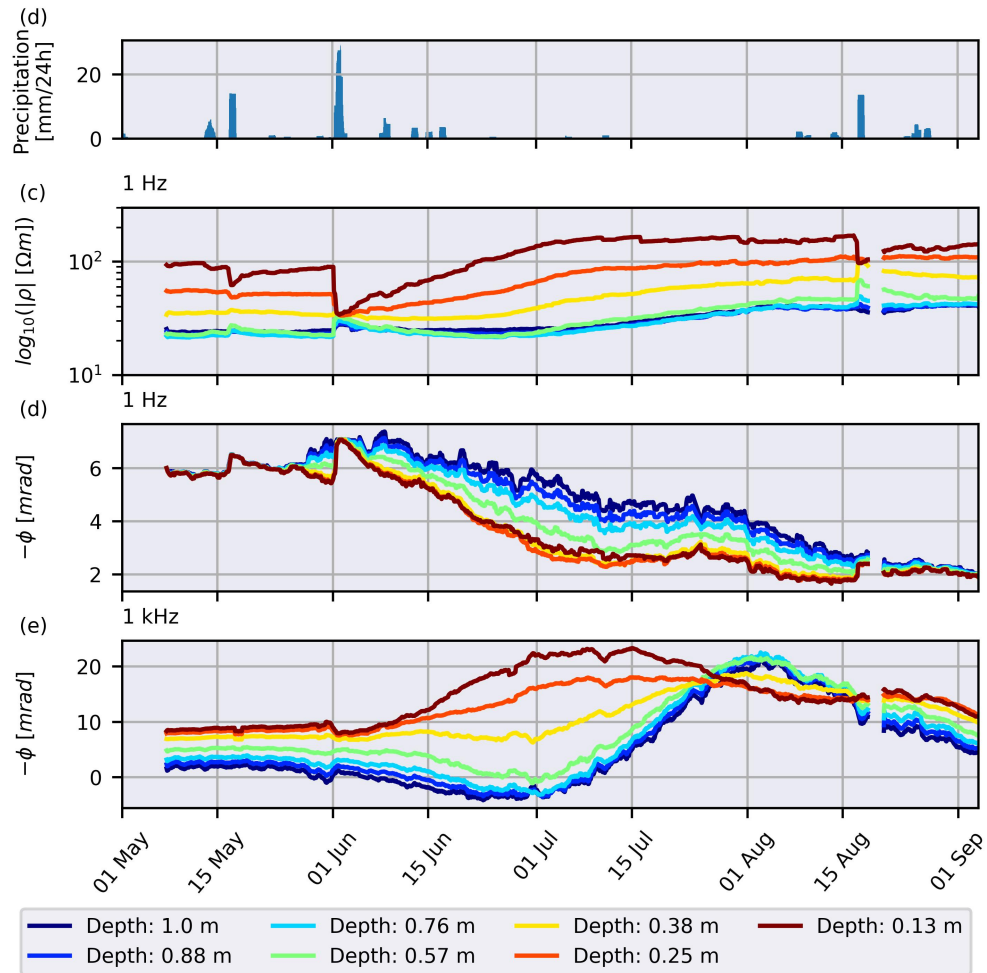


Figure S3: Temporal long-term evolution of tomographic imaging results. No inductive correction was applied to the measured impedance spectra. Shown are rolling median values for the central plot of the profile (3.25 - 6.5 m) over 24 hour windows for different depths. An absolute phase error of 0.8 mrad was assumed for all inversions. (a) Precipitation during the season 2018. Plotted is a rolling cumulative sum over 24 hour intervals. (b) Time evolution of resistivity magnitude at 1 Hz. (c) Time evolution of resistivity phase at 1 Hz. (d) Time evolution of resistivity phase at 1 kHz.

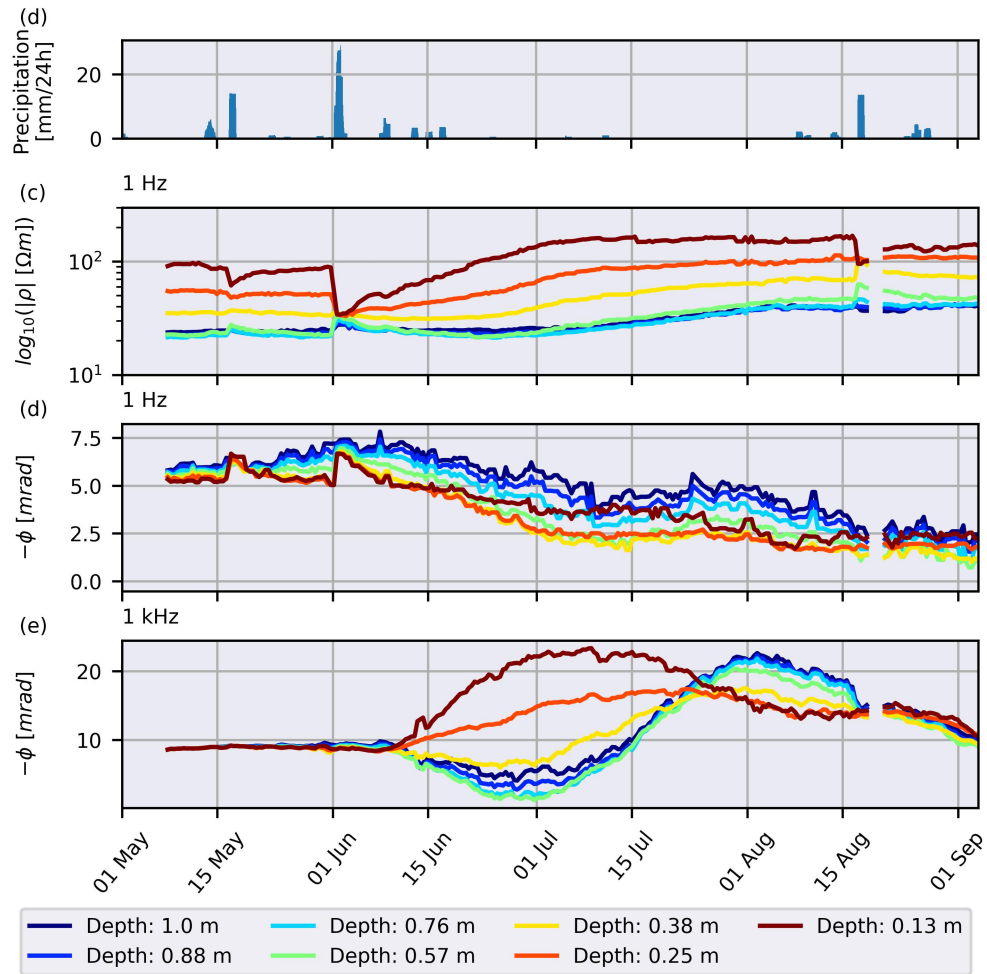


Figure S4: Temporal long-term evolution of central part (3.25 - 6.5 m) of the profile. Phase inversions were carried out with a relative phase error of 5 %, with a stabilizing absolute phase error of 0.3 mrad. Shown are rolling median values with a window width of 24 hours. (a) Precipitation during the season 2018. Plotted is a rolling cumulative sum over 24 hour intervals. (b) Evolution of resistivity magnitude values at 1 Hz for different depths. (c) Evolution of phase values at 1 Hz for different depths. (d) Evolution of phase values at 1 kHz for different depths.

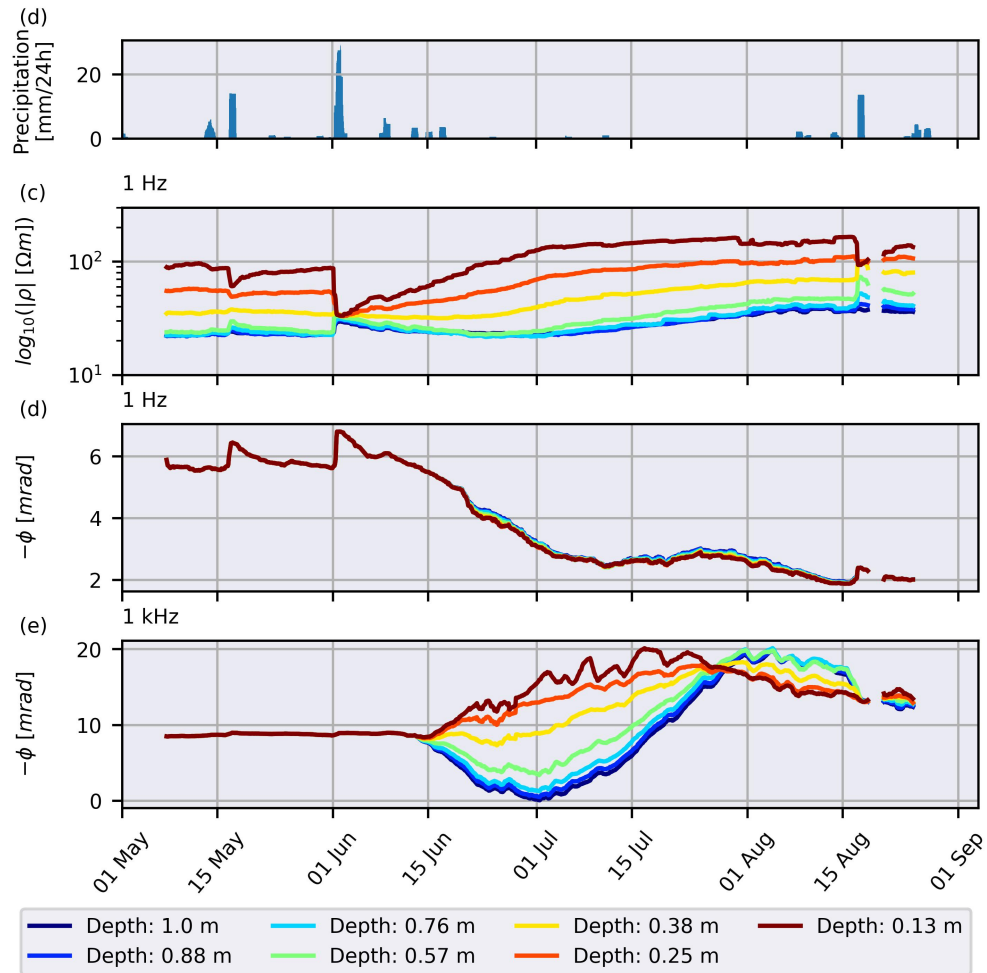


Figure S5: Temporal long-term evolution of tomographic imaging results for the time-filtered data set which uses only measurement configurations present in at least 80 % of the time steps. Shown is data from the central plot of the profile (3.25 - 6.5 m) for different depths. An absolute phase error of 0.8 mrad was assumed for all inversions. Shown are rolling median values with a window width of 24 hours. (a) Precipitation during the season 2018. Plotted is a rolling cumulative sum over 24 hour intervals. (b) Time evolution of resistivity magnitude at 1 Hz. (c) Time evolution of resistivity phase at 1 Hz. (d) Time evolution of resistivity phase at 1 kHz.

References

Weigand, M., Flores Orozco, A., and Kemna, A.: Reconstruction quality of SIP parameters in multi-frequency complex resistivity imaging, *Near Surface Geophysics*, 15, 187–199, <https://doi.org/10.3997/1873-0604.2016050>, 2017.