A New Statistical Test for Volcanic Activity Variability on a 1.1 Myr Tephra from the NW Pacific

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Does climate affect volcanism?

➤ Increased volcanic activity following last glacial cycle

➤ Coinciding periodicities with $\delta^{18}O$ record

➤ Limited statistical methods

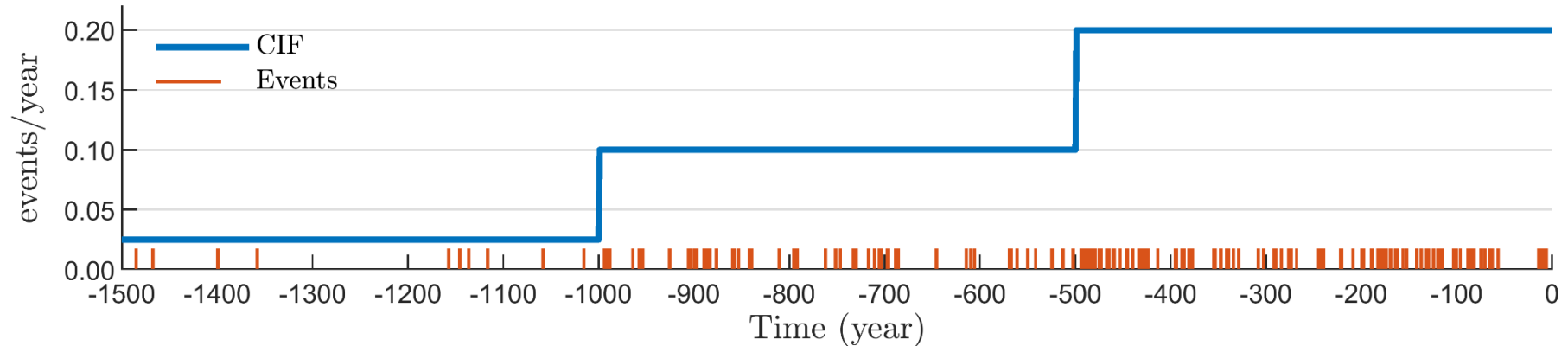Photograph courtesy Árni Sæberg, Icelandic Coast Guard http://news.nationalgeographic.com

GEOMAR
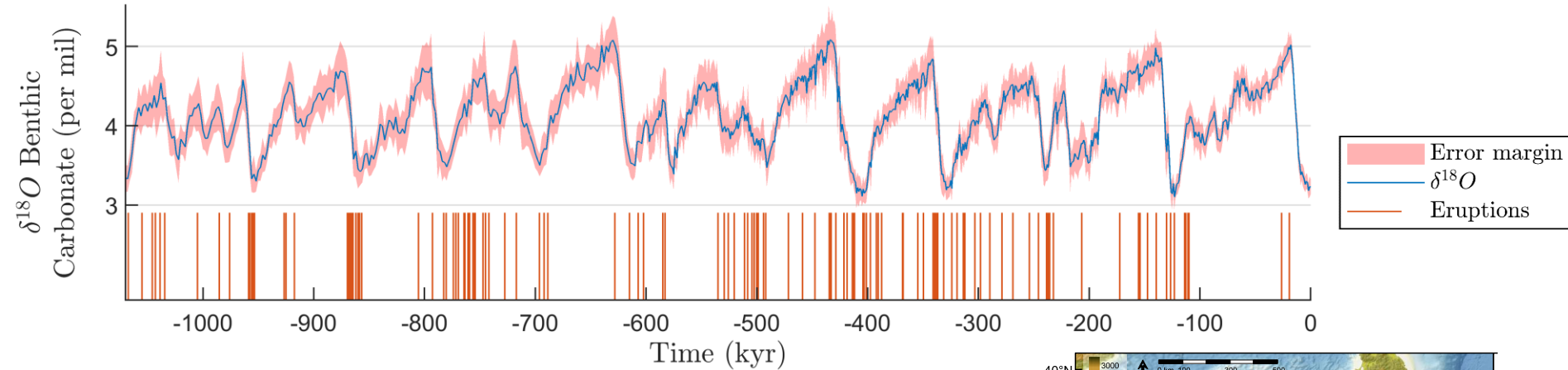
- ➤ Climate proxy – LR04 $\delta^{18}O$ global reference stack

- ➤ 1.1 Myr tephra record from IODP hole 350-U1437B
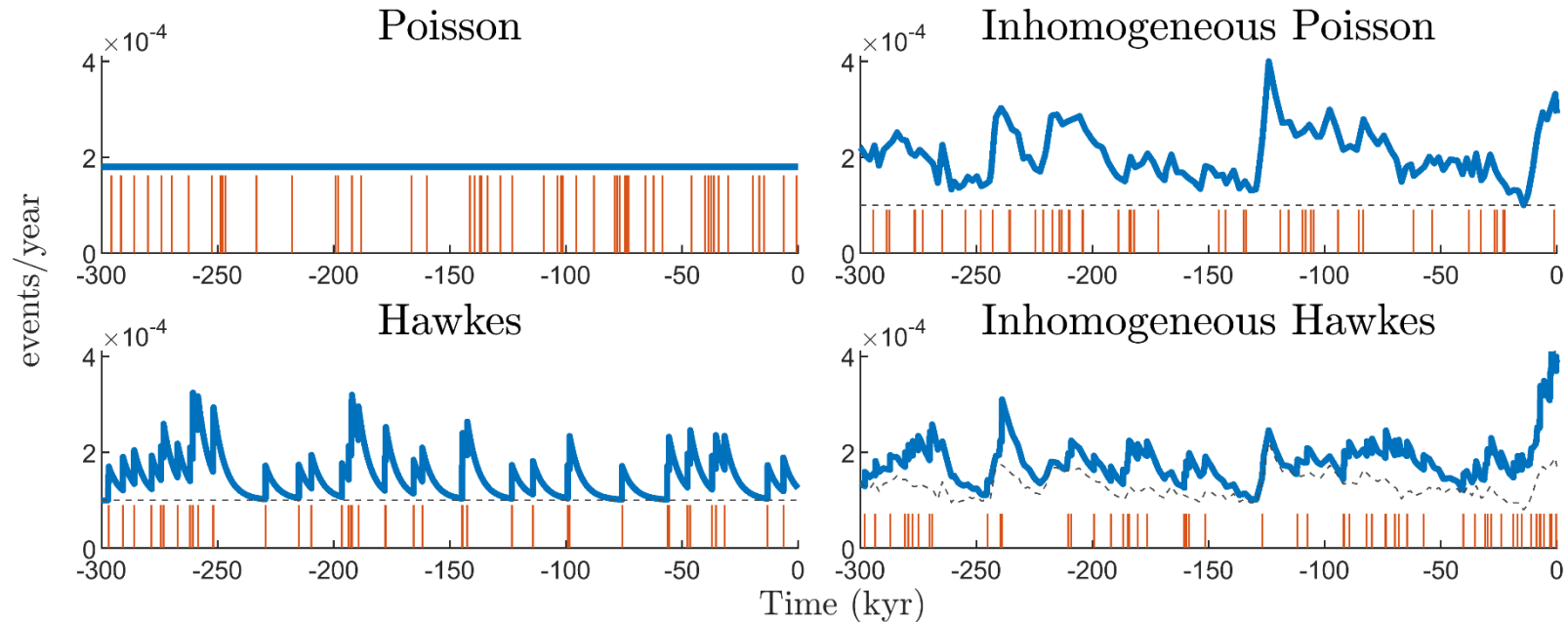
HELMHOLTZ
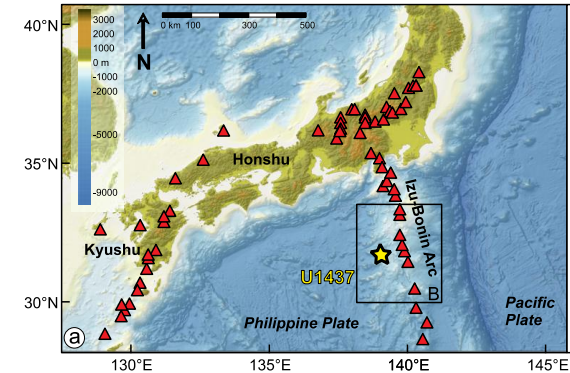
Point processes

➤ Random events $(t_1, t_2, t_3, ...)$ over a fixed time interval $[-T, 0]$

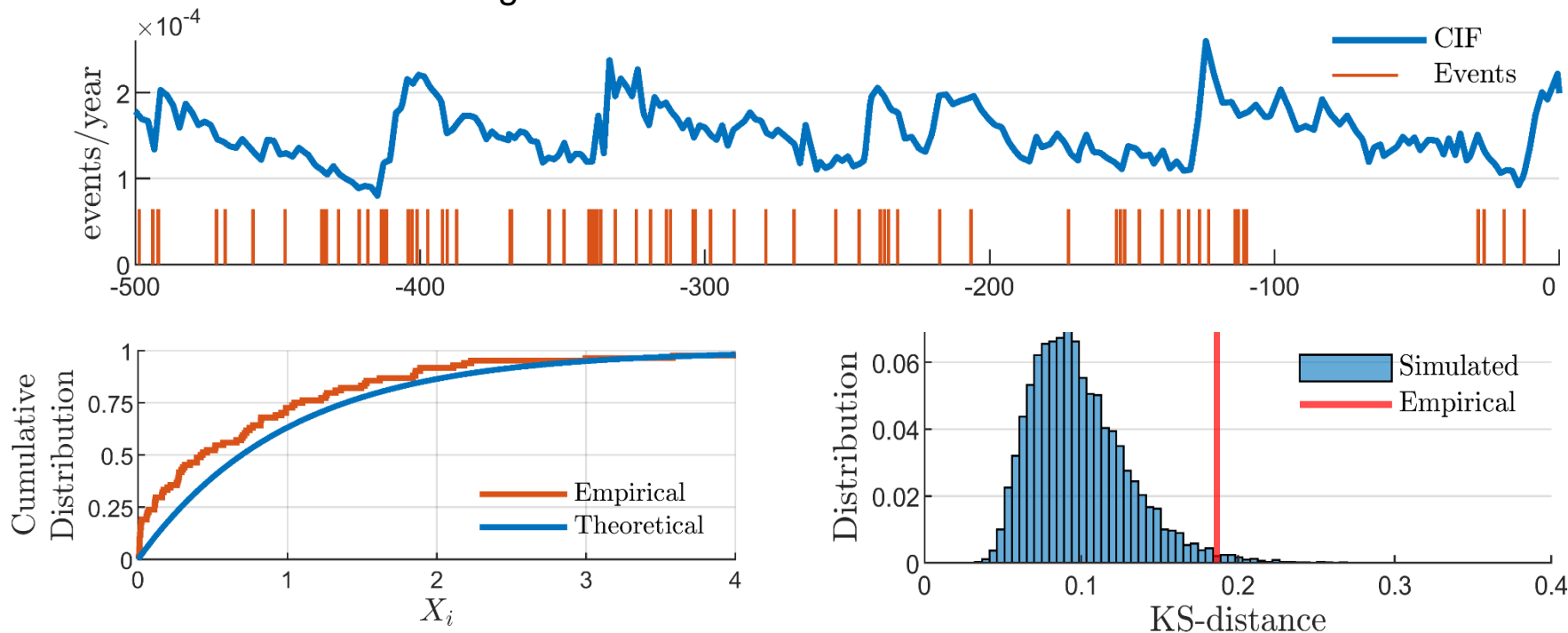➤ Conditional Intensity Function (CIF) – Eruption rate at each instant

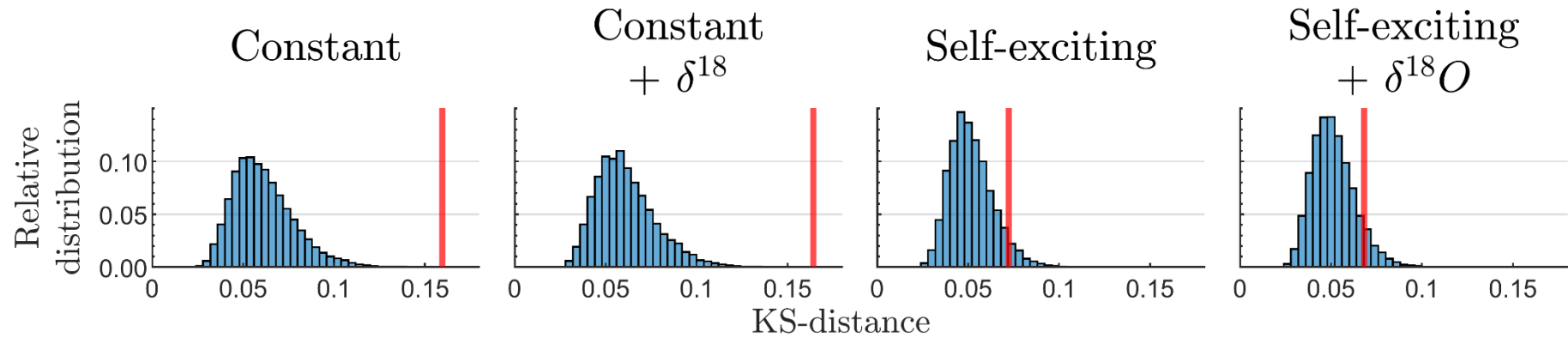➢ Does the CIF depend on the climate proxy?

➢ Based on the Kolmogorov-Smirnov distance

Constant Constant $+ \delta^{18}$ Self-exciting Self-exciting $+ \delta^{18}O$

Relative distribution — KS-distance

➢ p-values: 0%, 0%, 5.5%, 8.7%

➢ First two hypotheses rejected

➢ Last two not rejected at a 95% level

Conclusions

Analysis of the data

➤ Eruption rate is not constant
➤ Clustering effect
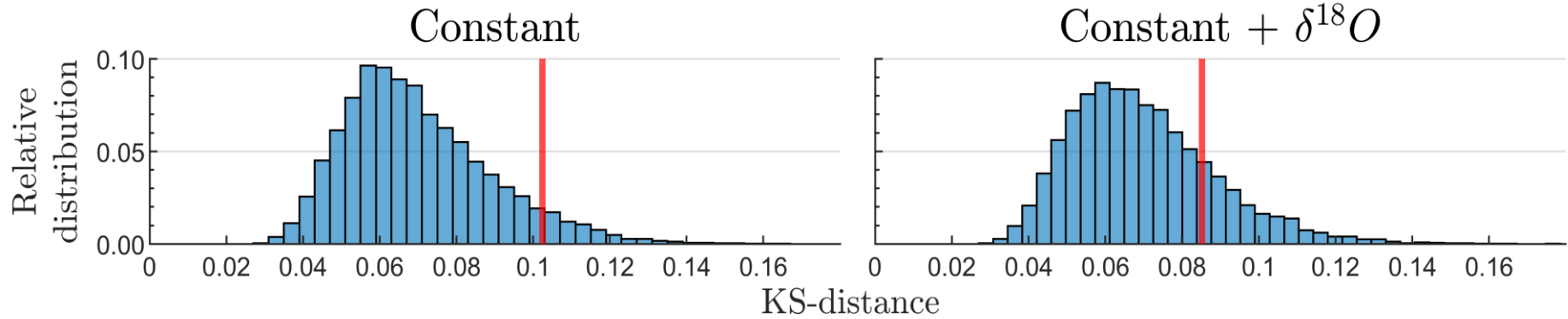➤ Behavior depends on composition of magma

The method

➤ Reliable even for small datasets
➤ Sound statistical procedure
➤ Flexibility - any time frame or external factor

MATLAB code available at OceanRep – Point Process Tools
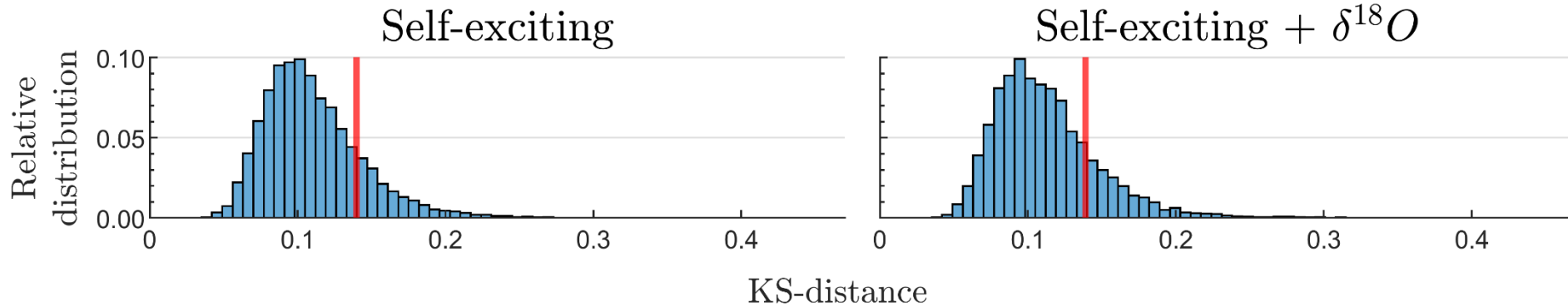Kling et al. (2023) - Under review process for Frontiers of Earth Science

Thank you

Nikolas Linke/GEOMAR – Stromboli (expedition AL533)

➢ p-values:6.56% and 19.01%

Self-exciting

Self-exciting $+ \delta^{18}O$

KS-distance

➤ p-values:16.63% and 18.55%