

# Constraining the state of locking of Northern Cascadia megathrust using long-term offshore borehole fluid pressure monitoring

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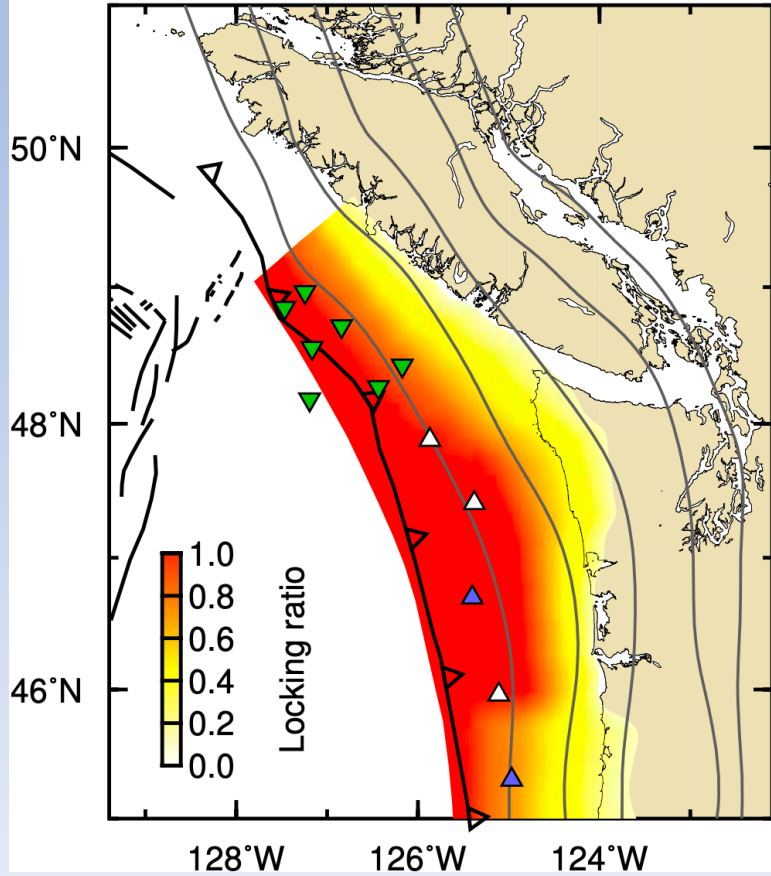
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<sup>3</sup>Rosenstiel School of Marine, Atmospheric and Earth Science, University of Miami



# U1364A site location and CORK observatory configuration

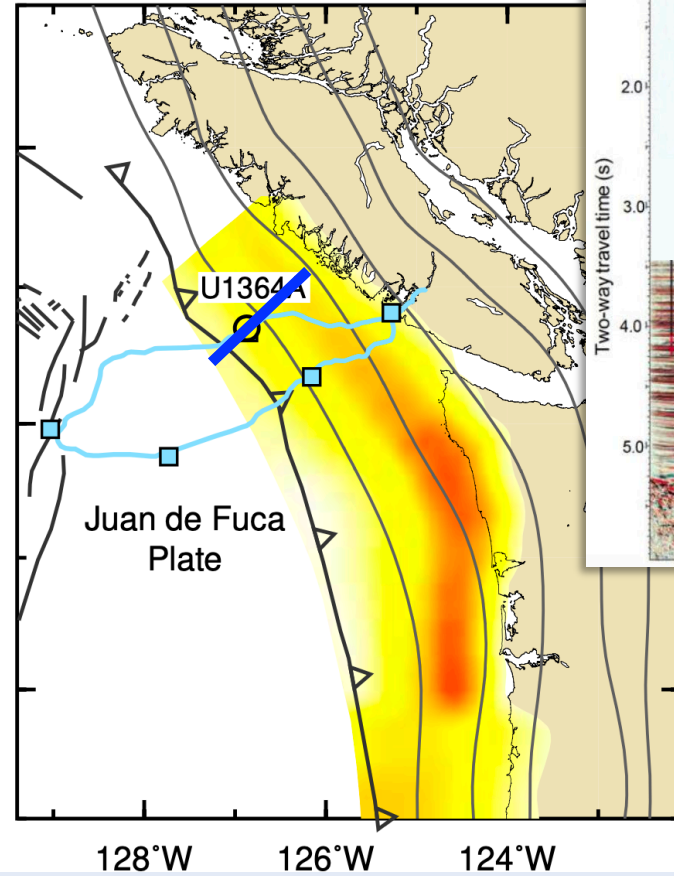
Gamma model



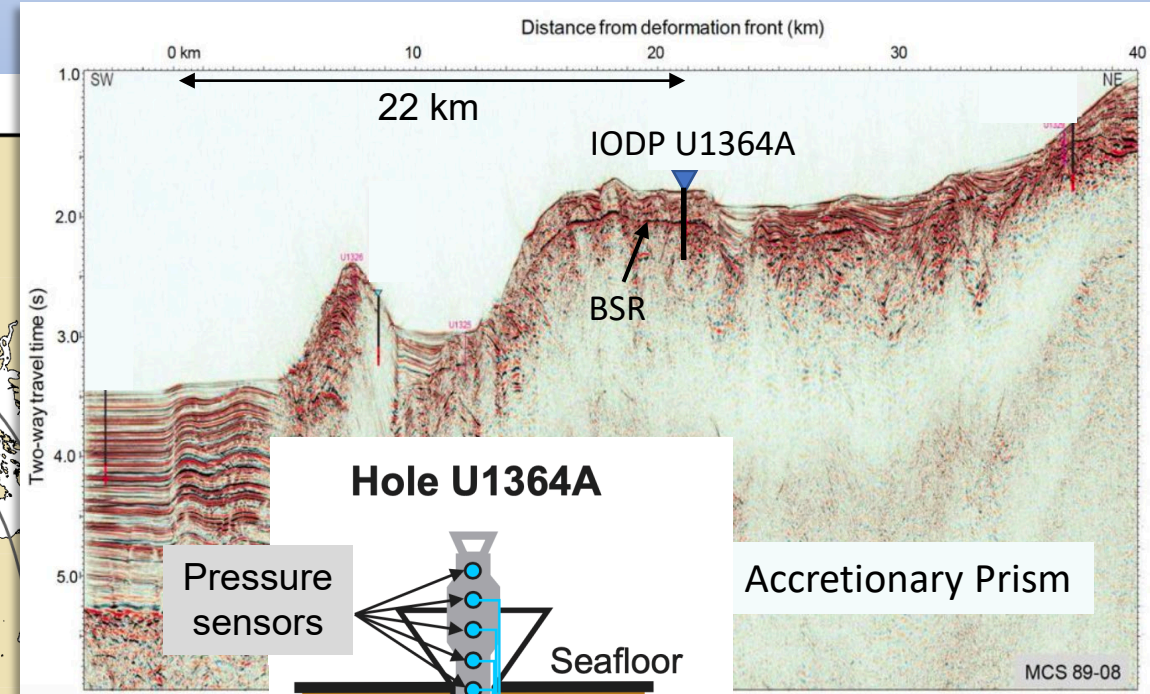
Seafloor GNSS/A sites

- ▲ existing
- ▲ upcoming

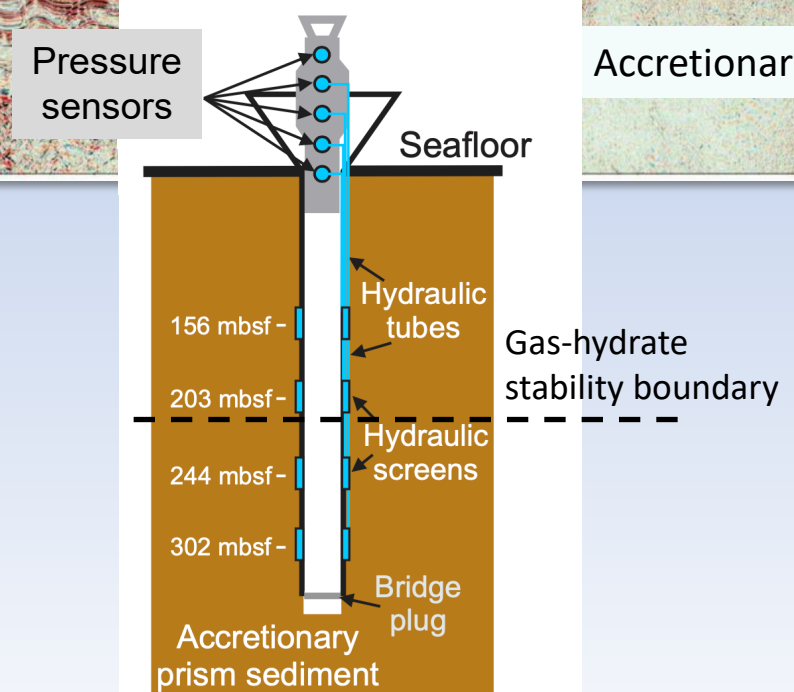
Gaussian model



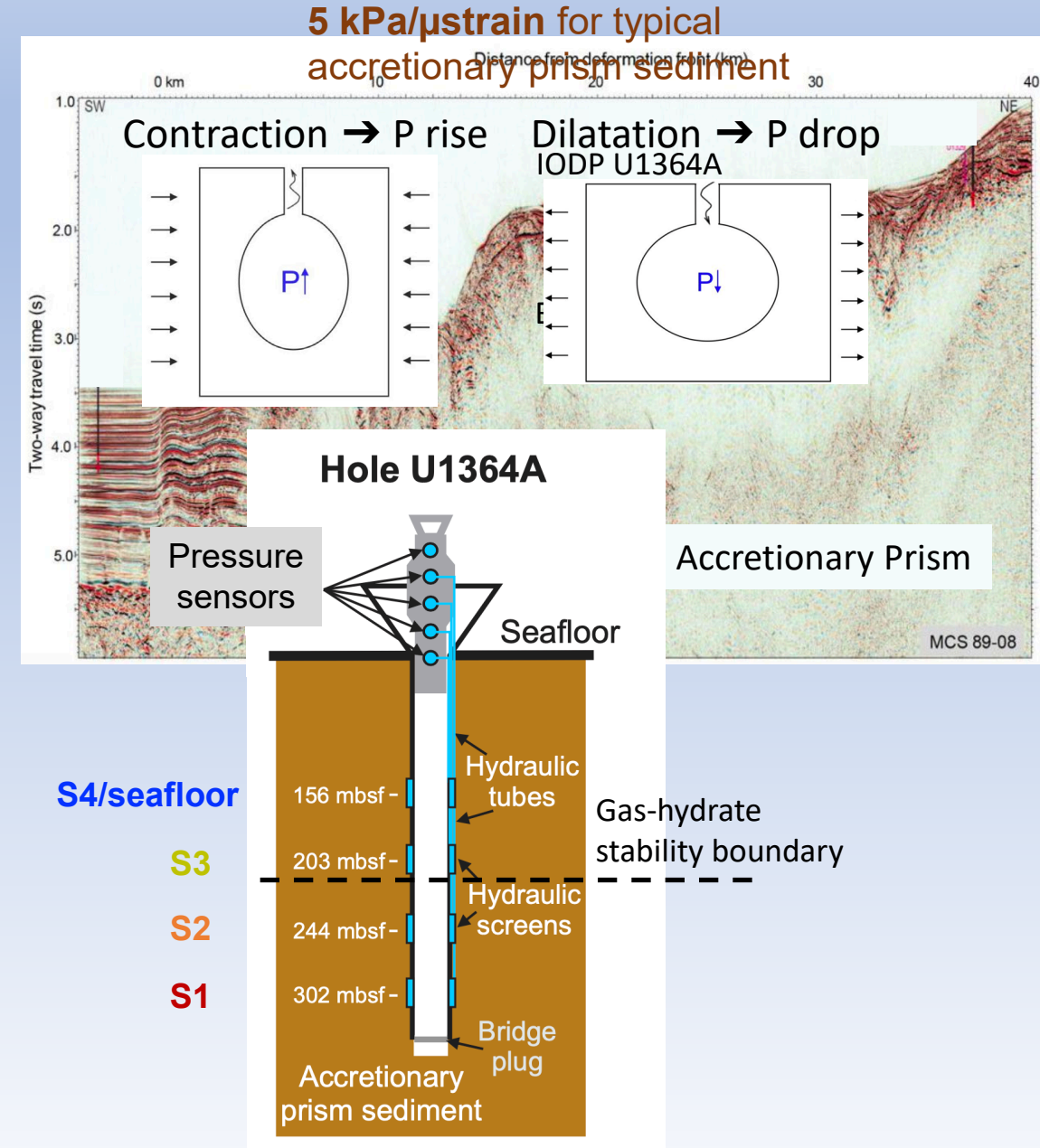
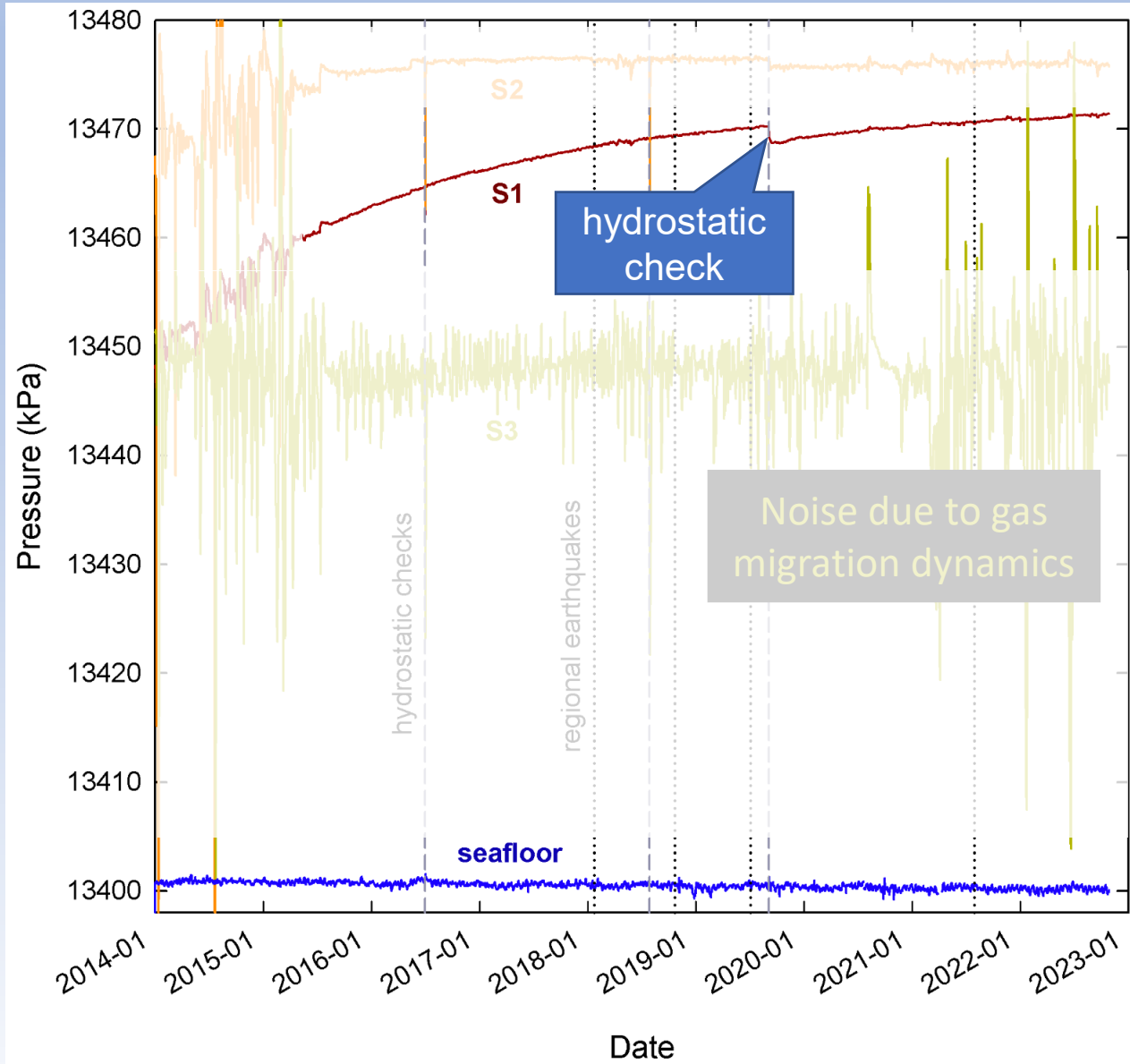
Locking models using land GNSS data (Schmalzle et al., 2014)



Hole U1364A

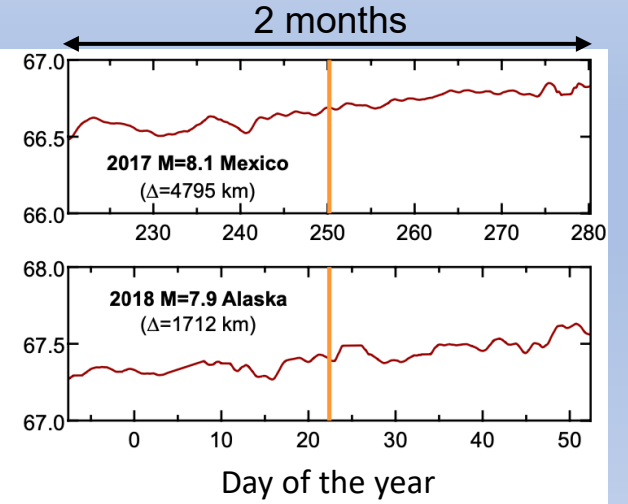
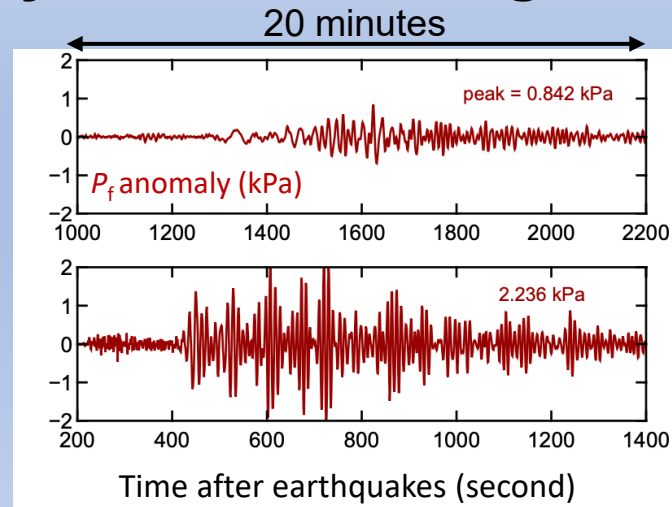
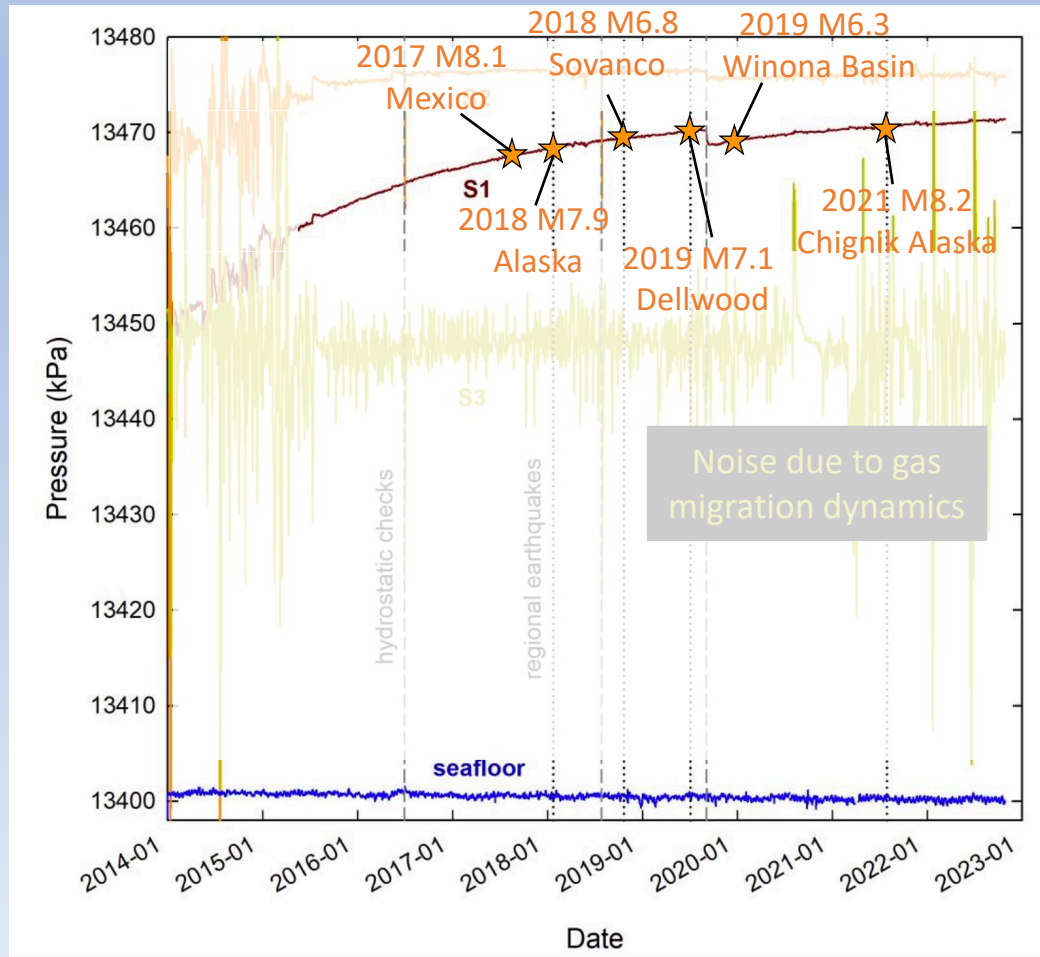


# Borehole fluid pressure monitoring as a geodetic tool





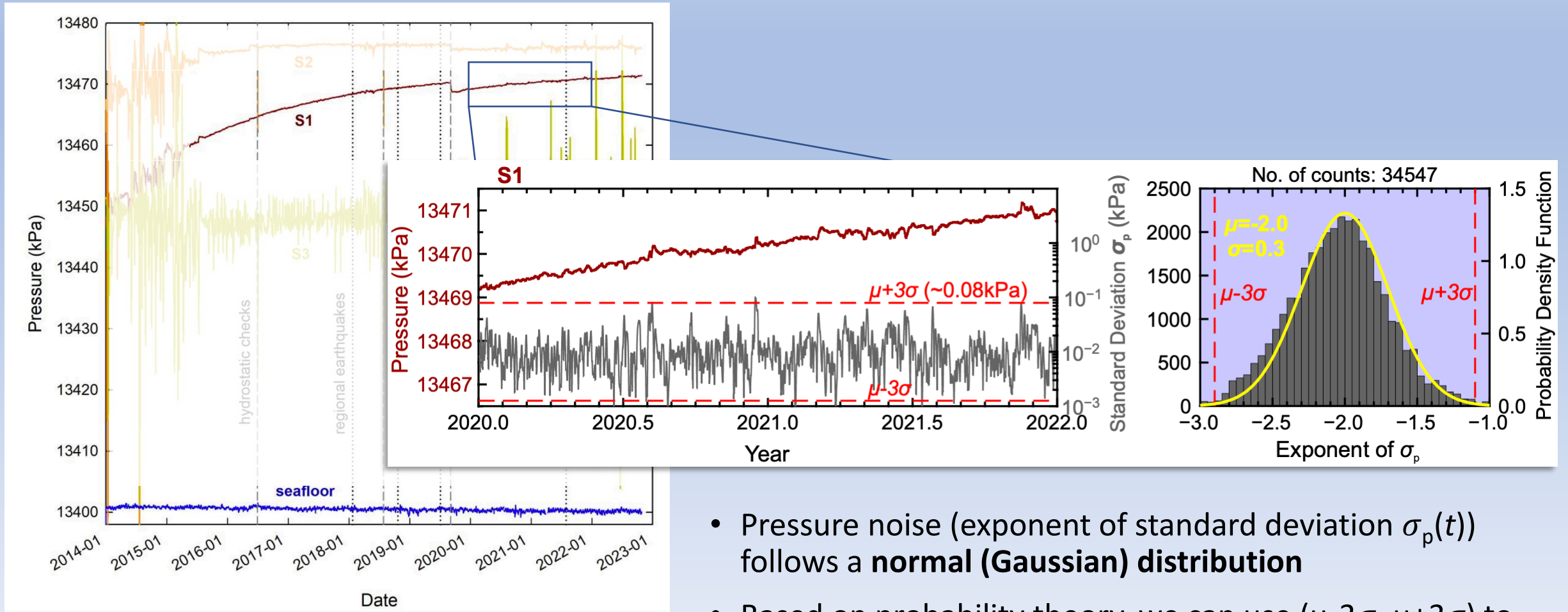
# No pressure transients despite large dynamic stressing



A lack of pressure transients/offsets indicates **no dynamic triggering of slip** (McGuire et al., 2018), in sharp **contrast with Hikurangi, Nankai, Costa Rica**, etc. (Wallace, 2020; Araki et al., 2017; Davis et al., 2015).



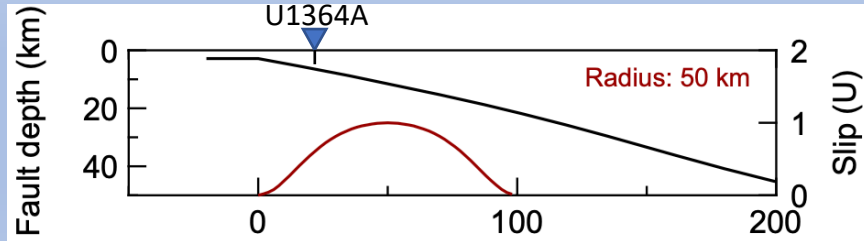
# Determining the “detection threshold” based on pressure noise-floor level



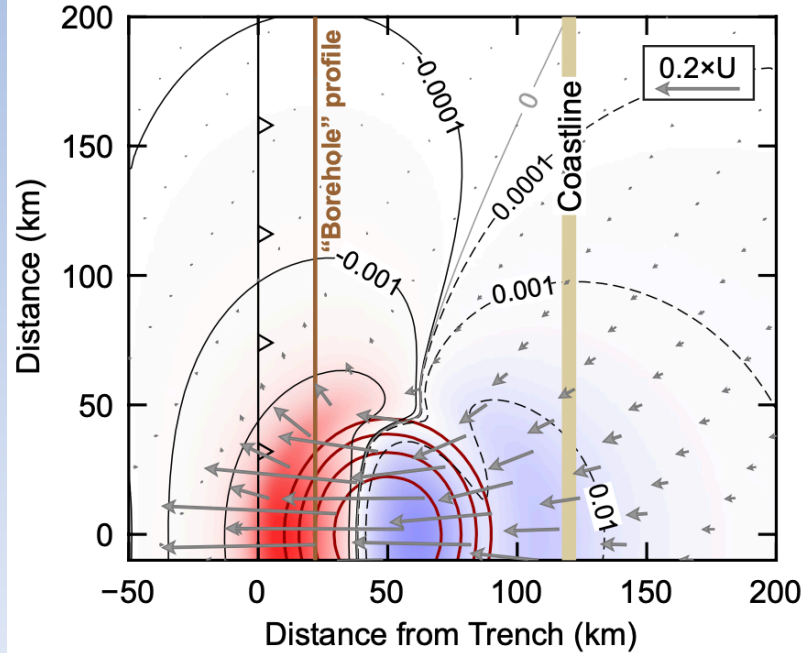
- Pressure noise (exponent of standard deviation  $\sigma_p(t)$ ) follows a **normal (Gaussian) distribution**
- Based on probability theory, we can use ( $\mu-3\sigma$ ,  $\mu+3\sigma$ ) to exclude the range of “extremely unlikely”
- $\mu+3\sigma$  represents a **detection threshold of 0.08 kPa** (equivalent to 16 nanostrain)

# Determining the “resolvable slip” based on simple dislocation modeling

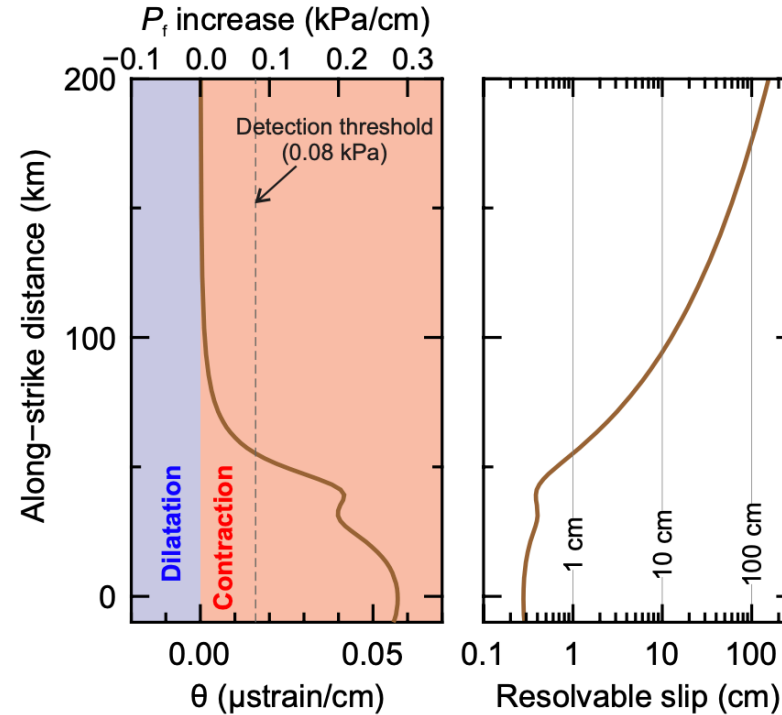
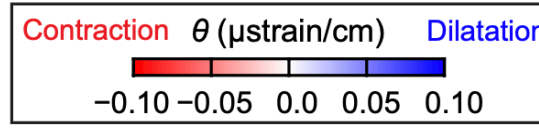
Side view



Map view

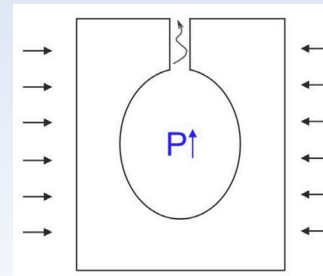


Slip (U)



If borehole is right updip, it can detect a slip of ~0.3 cm.

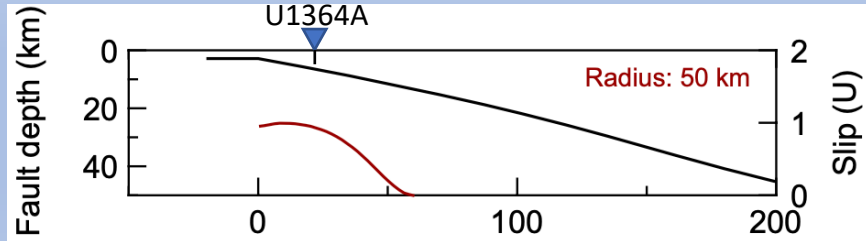
a “hypothetical” shallow buried slip



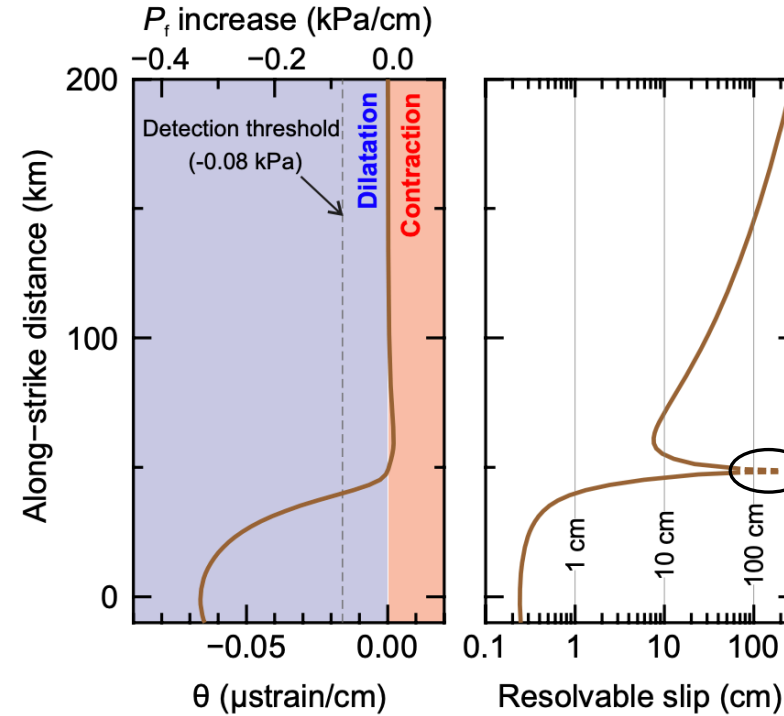
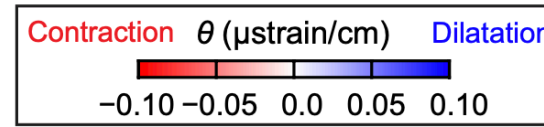
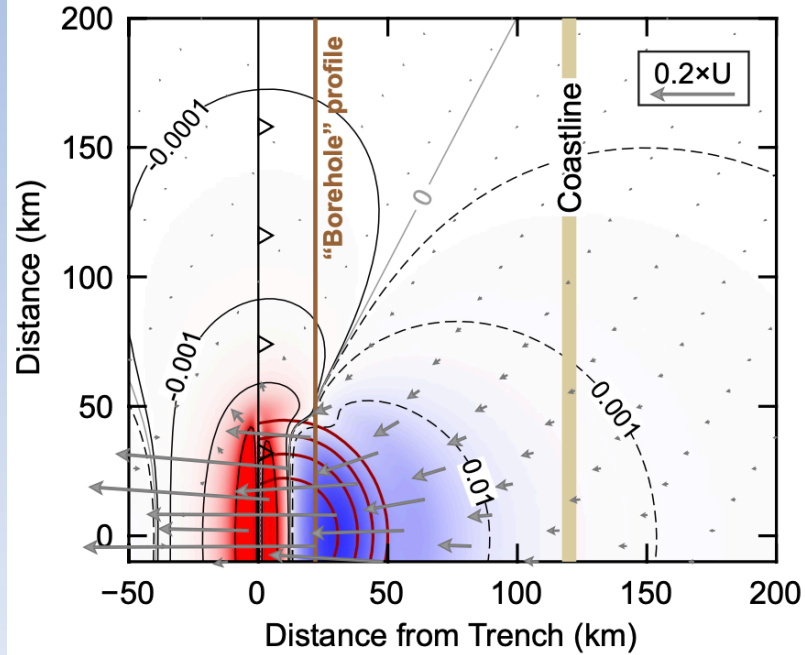
$P_f$ -strain coefficient =  
5 kPa/ $\mu$ strain

# Determining the “resolvable slip” based on simple dislocation modeling

Side view

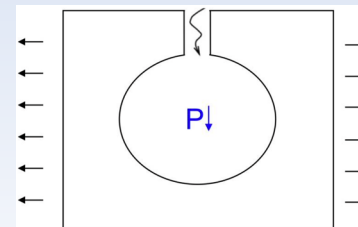


Map view



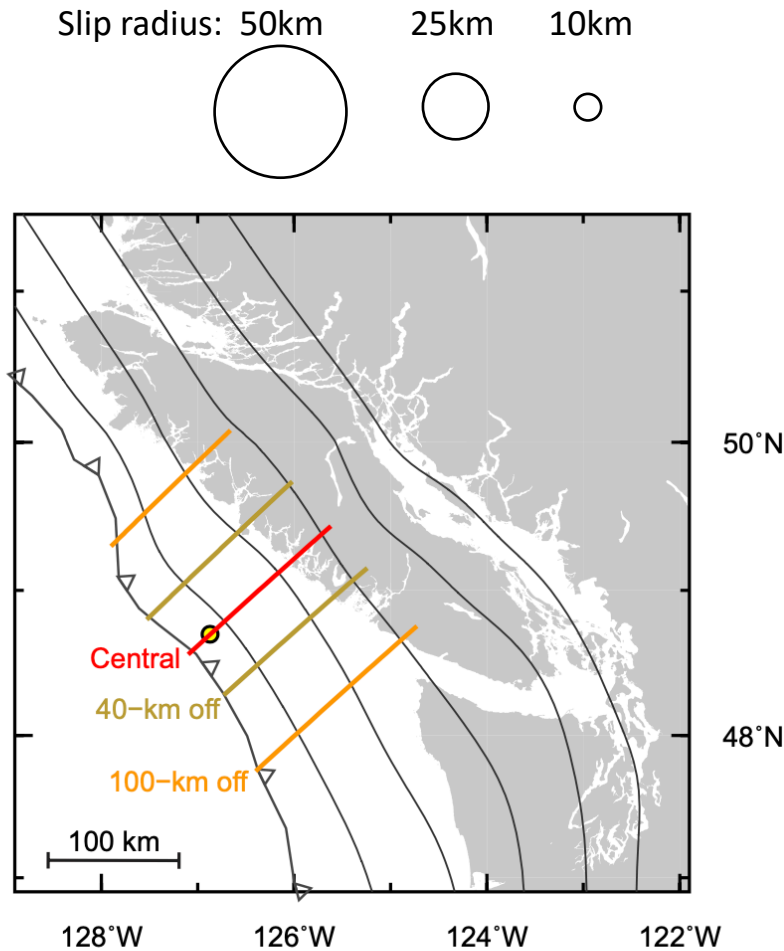
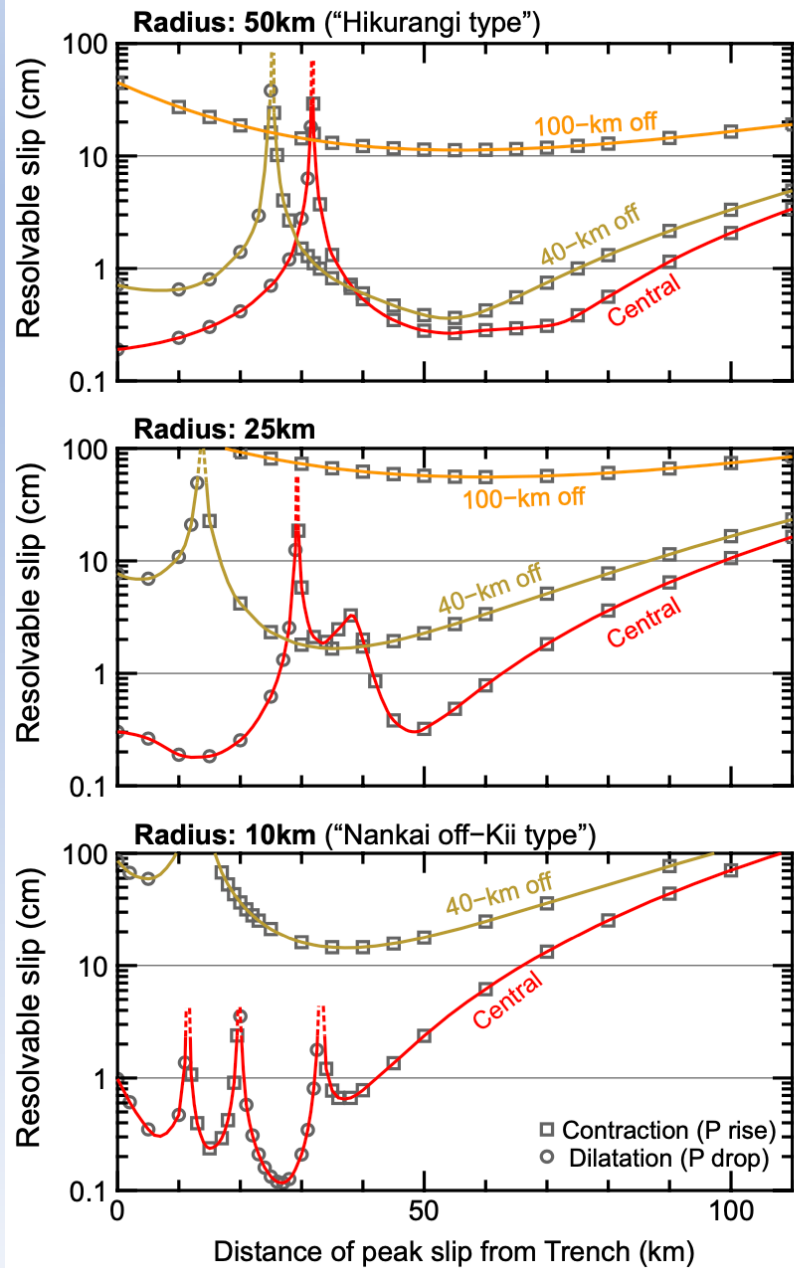
“blind spot” where strain is neutral

a “hypothetical” trench-breaching slip

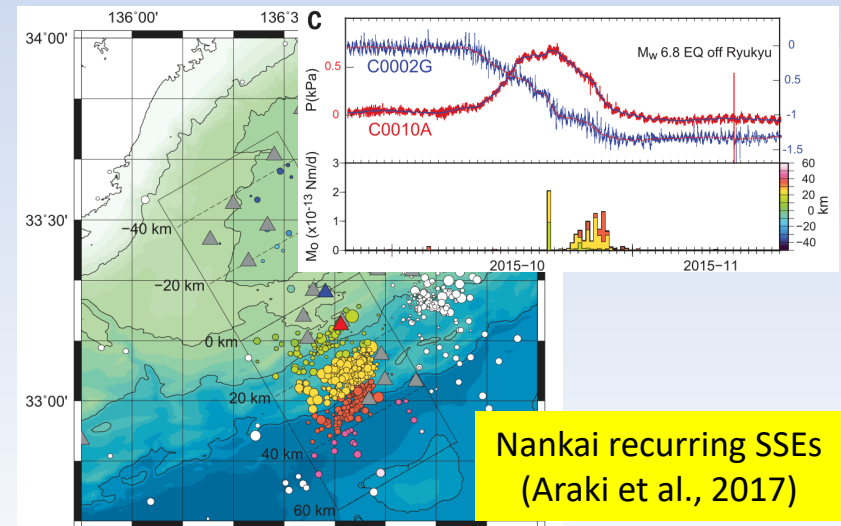
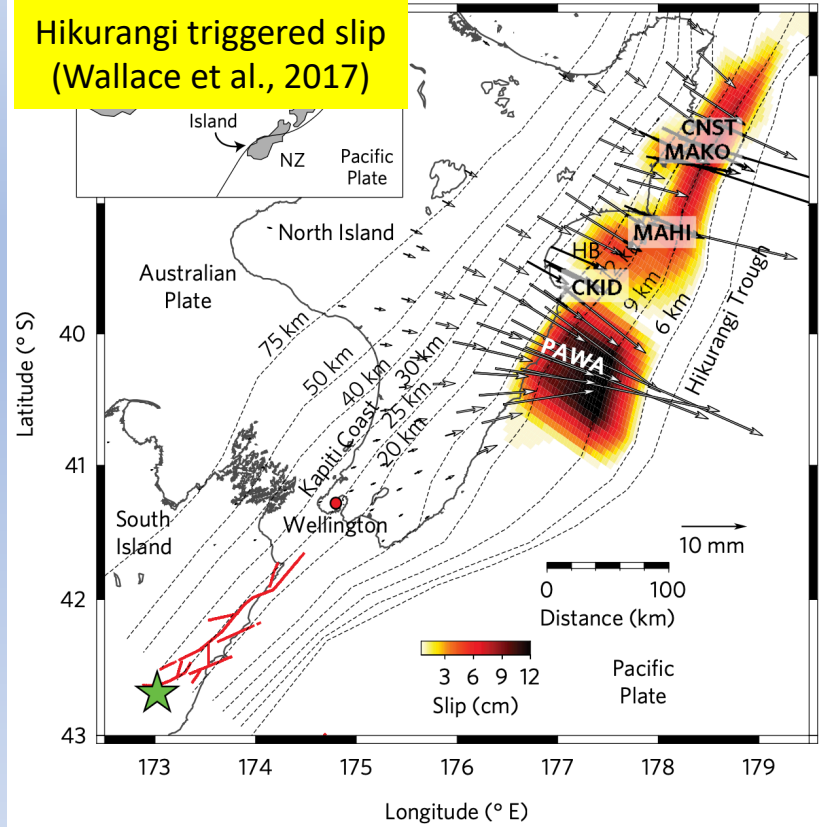


$P_f$ -strain coefficient =  
5 kPa/ $\mu$ strain





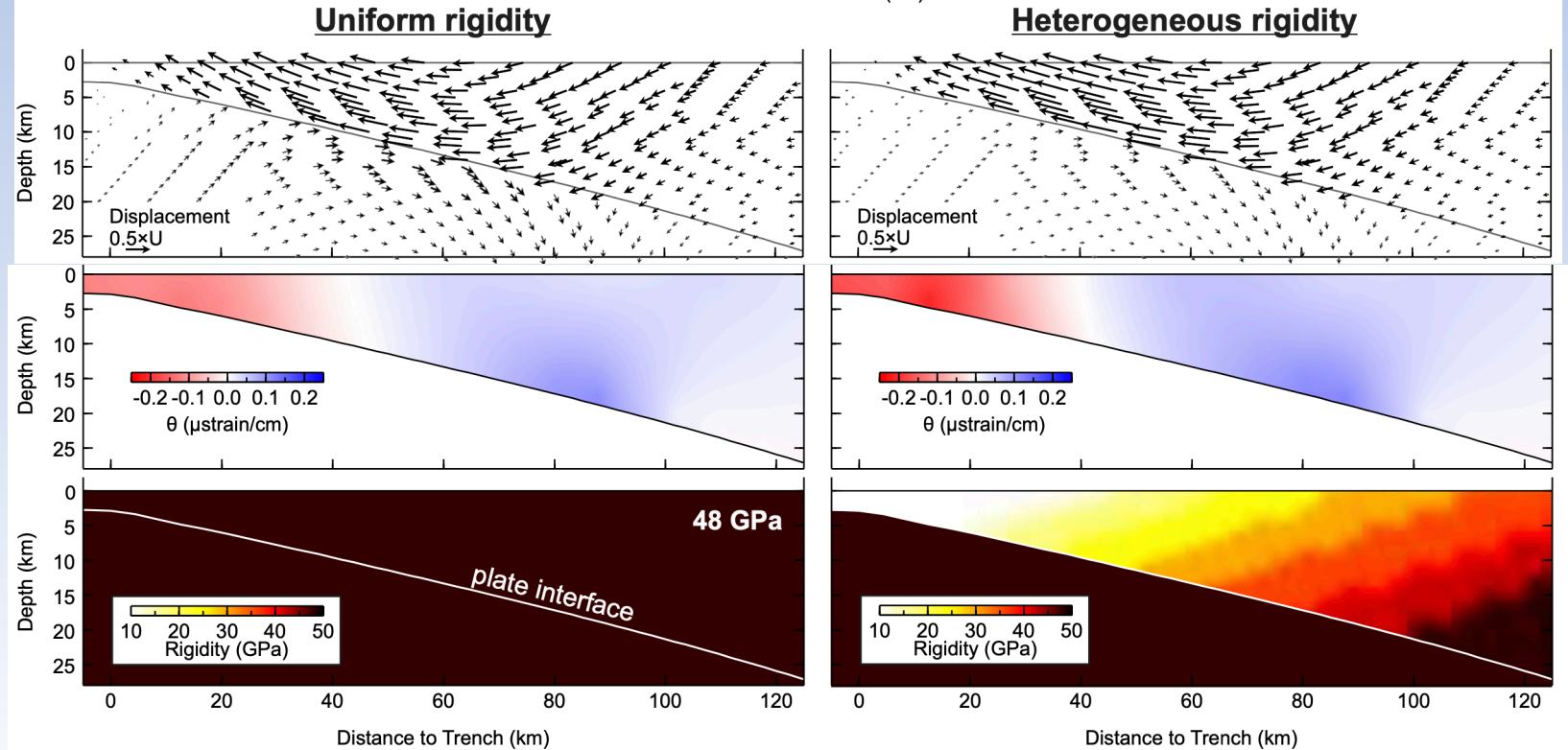
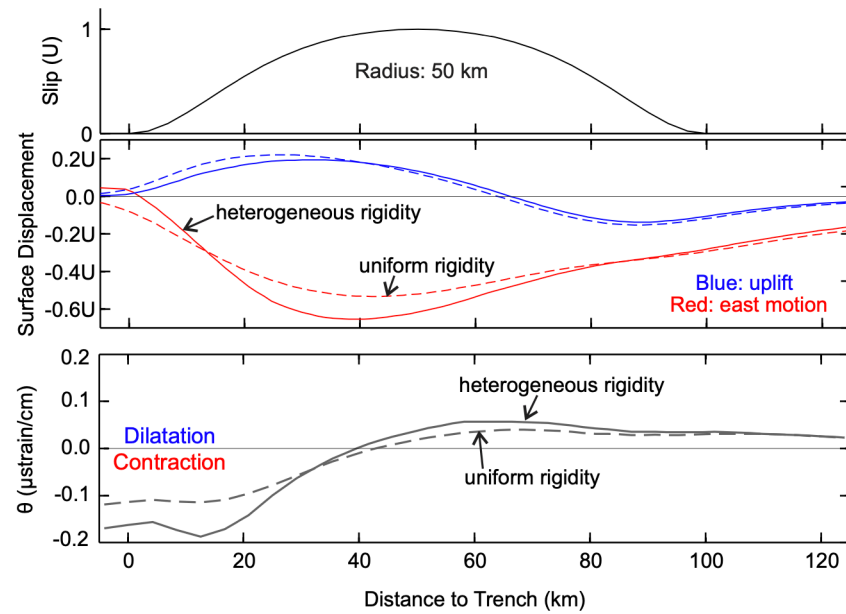
Davis, Sun, et al. (in preparation)



- Thanks! Questions?

With the **heterogeneous upper-plate rigidity**, the slip is more effective in generating volumetric strain.

Our conclusion is hence further strengthened.





Examples of **fluid pressure transients** recorded by similar CORK observatories at **other subduction margins**

