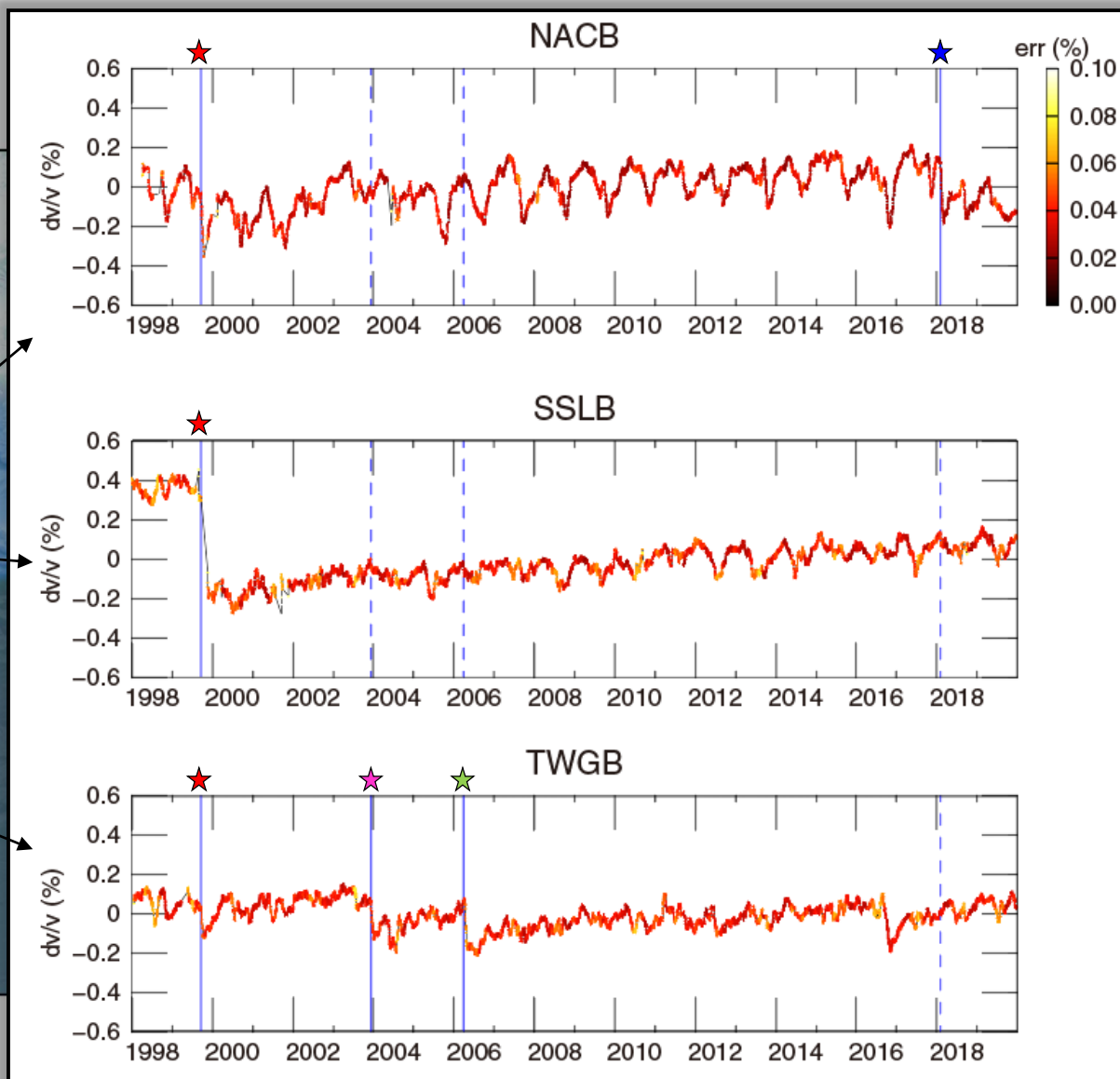
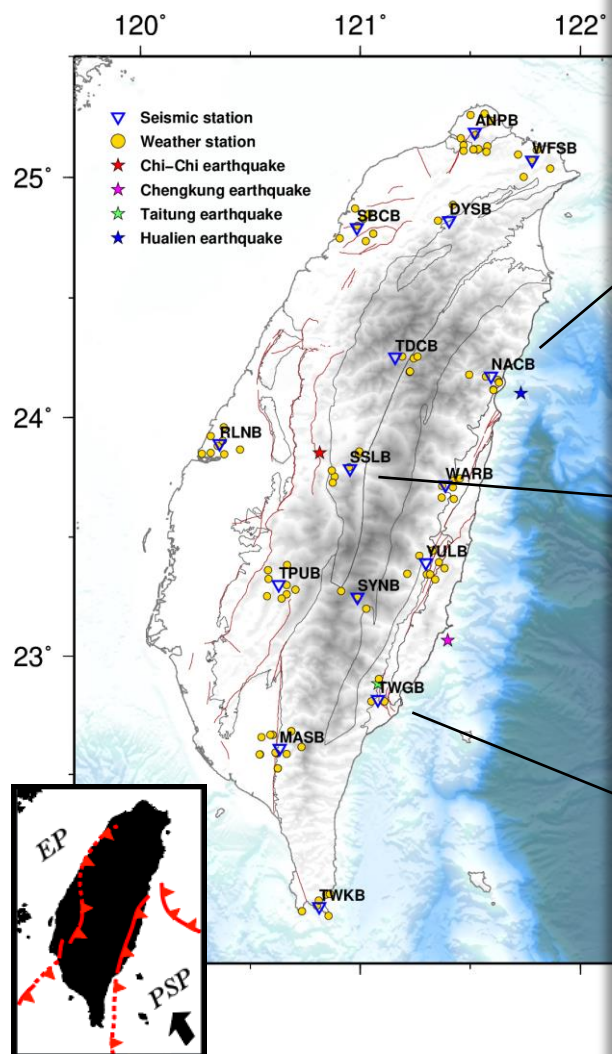


Revealing seasonal crustal seismic velocity variations in Taiwan with single-station cross-component analysis

Kuan-Fu Feng¹, Hsin-Hua Huang², Ya-Ju Hsu² and Yih-Min Wu¹



Seismic data

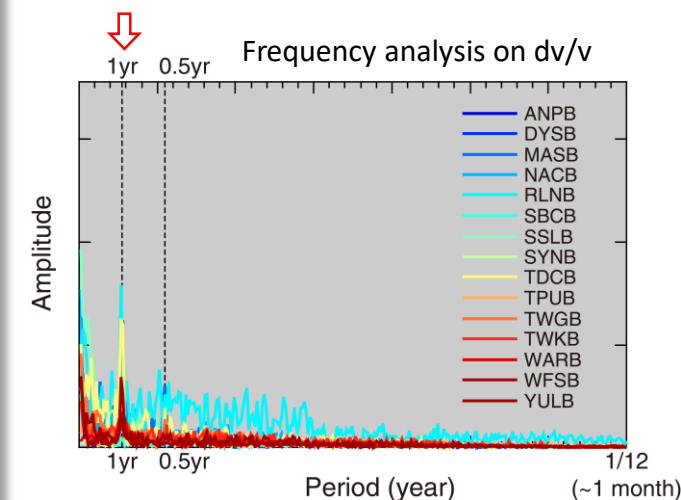
- Broadband Array in Taiwan for Seismology (BATS)
- **1998-2019**
- Single-station cross-component analysis
- Frequency band of **0.1-0.9 Hz**
- **Stretching** and MWCS methods

Weather data

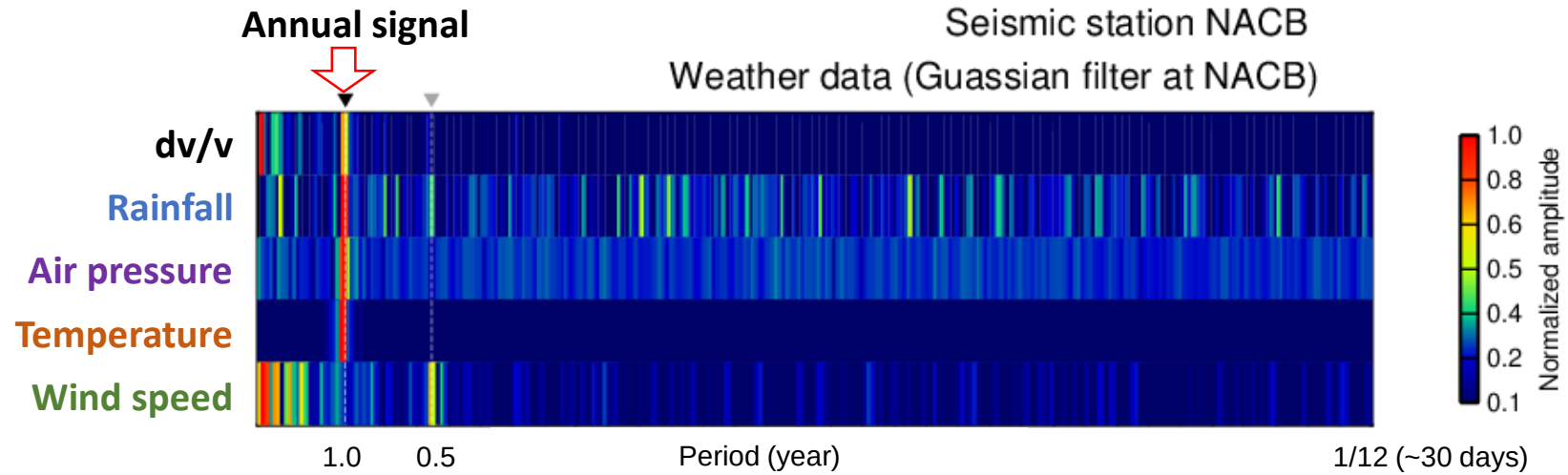
- Rainfall, air pressure, temperature, and wind speed
- Gaussian spatial filtering

Findings

- ✓ Co-seismic dv/v drops
- ✓ Seasonal variations with different characteristics

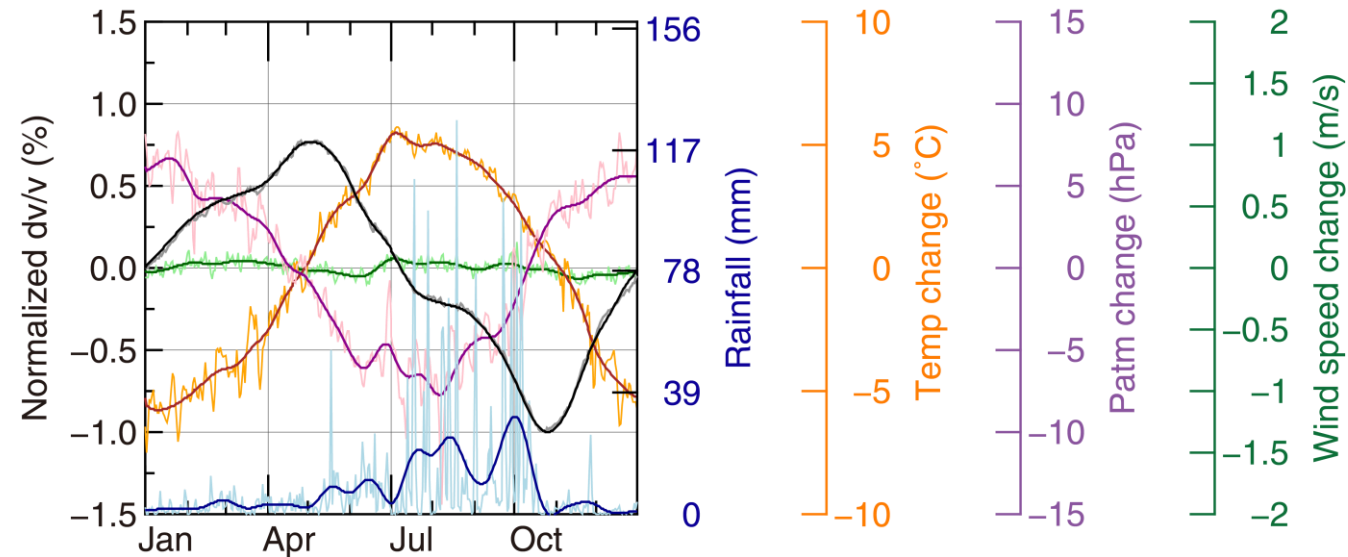


Frequency analysis

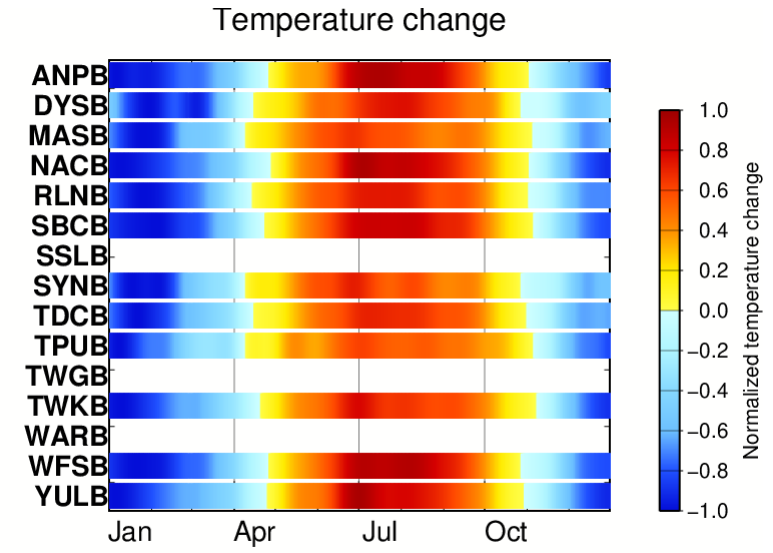
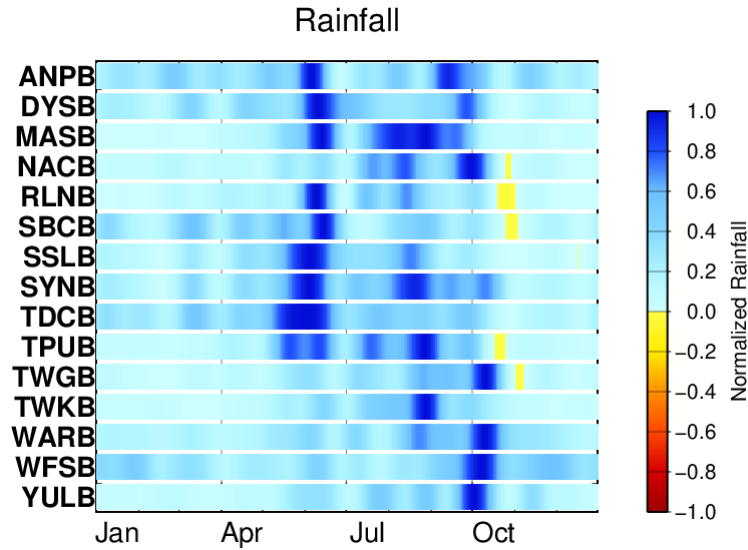
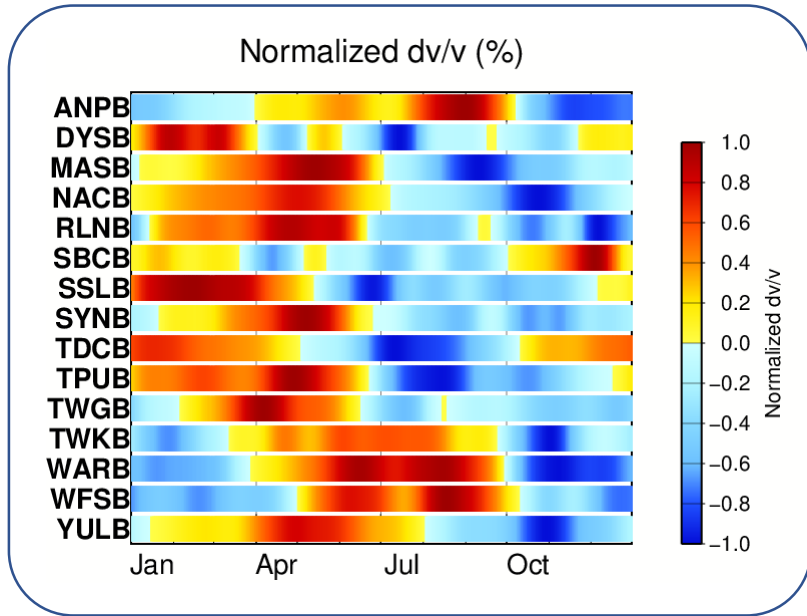


Time series analysis

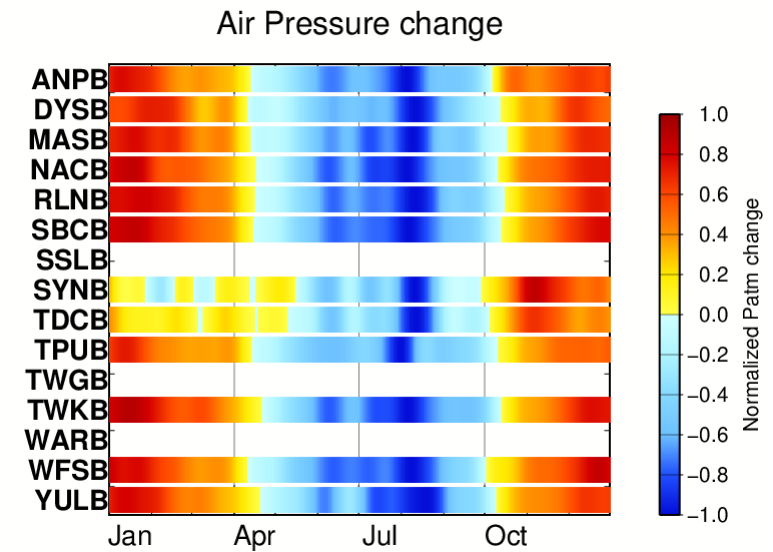
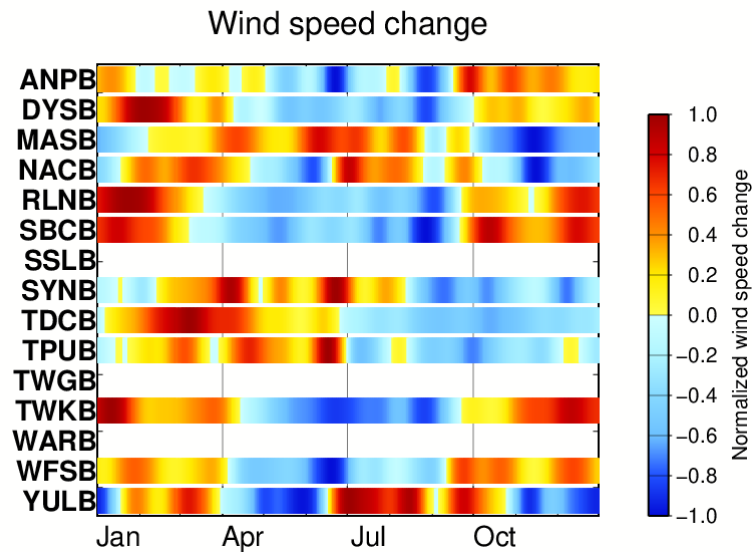
Annual stack (NACB)



Annual stack



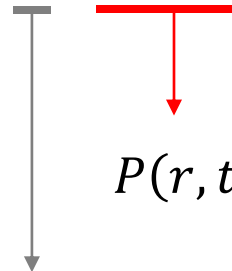
↑
site-dependency



$\delta v/v$ and rainfall induced pore-pressure change

- One-dimensional fully coupled diffusion equation [Talwani et al. 2007]
- Consider **a linear relation** between seismic $\delta v/v$ and **pore pressure change** [Rivet et al. 2015; Wang et al. 2017]
- The direct pore pressure changes ($P(r, t)$) are due to **diffusion within a certain distance r** from the daily precipitation at the surface

$$\frac{\delta v}{v}_{syn} = A \cdot P(r, t) + B$$



$$P(r, t) = \sum_i^n \delta p_i \operatorname{erfc} \left[\frac{r}{(4c(n-i)\delta t)^{1/2}} \right]$$

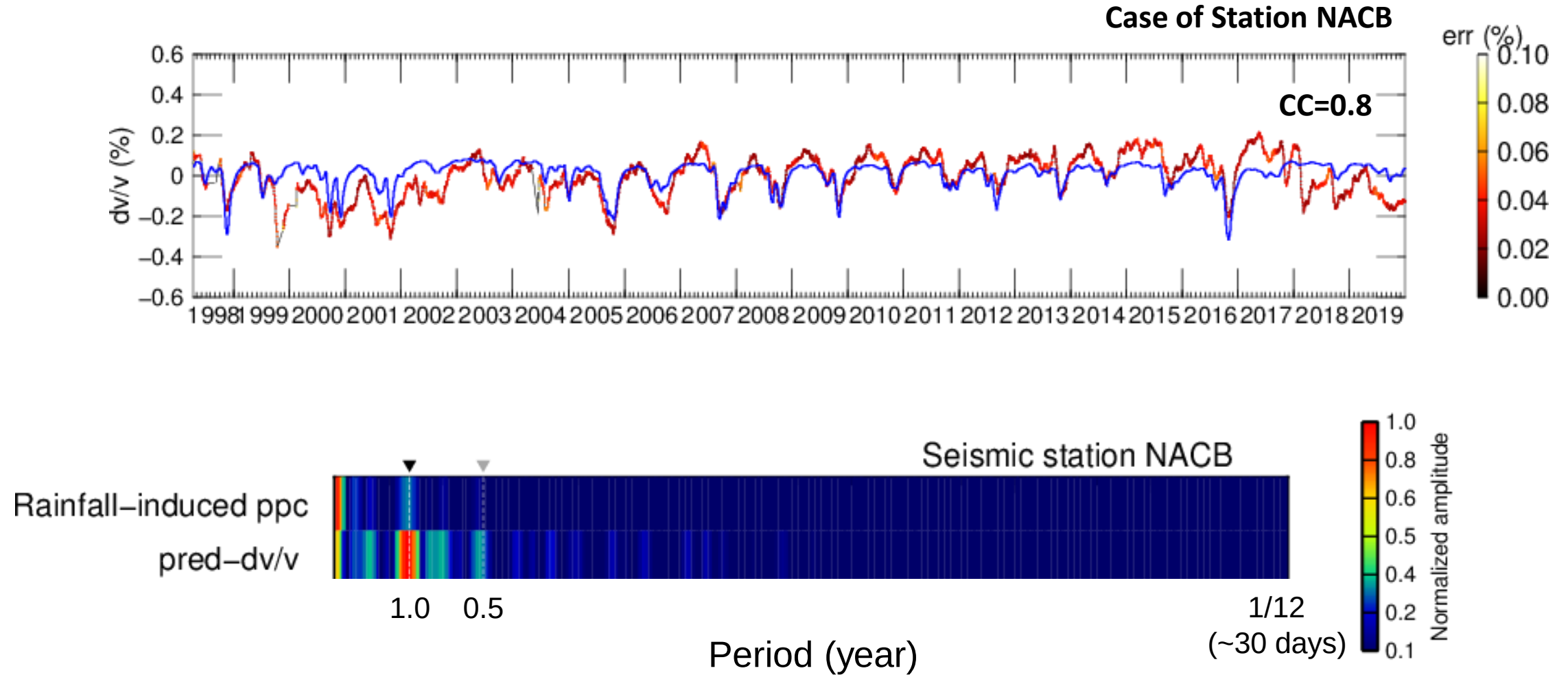
Amplitude factor: $A = \frac{\operatorname{cov}(\frac{\delta v}{v}(t), P(t))}{\operatorname{var}(P(t))}$

$$\checkmark \sigma^2(c) = \frac{1}{n} \sum_{i=1}^n \left(\frac{\delta v}{v}(i) - \frac{\delta v}{v}_{syn}(i, c) \right)^2$$

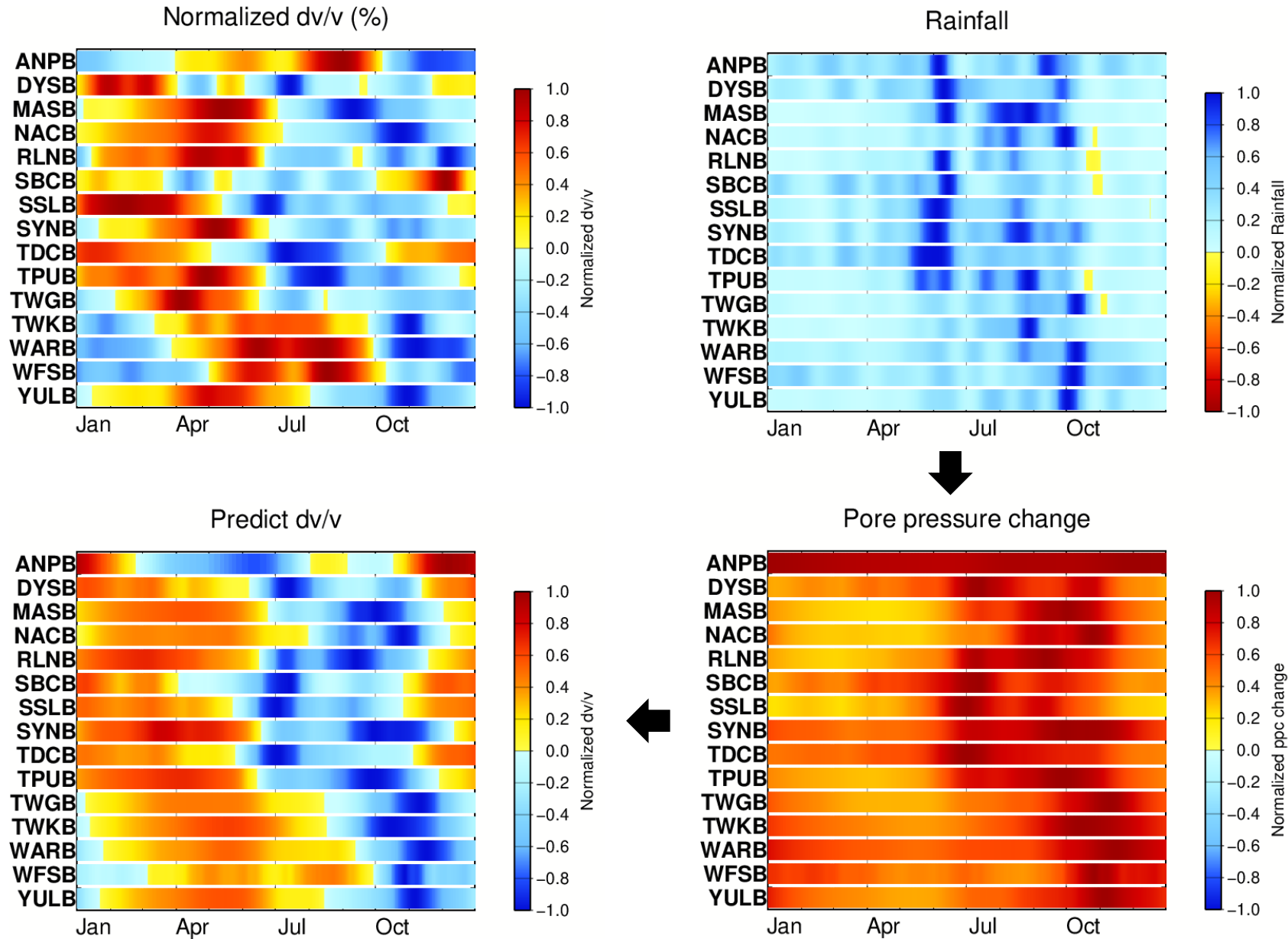
$$\checkmark CC \left(\frac{\delta v}{v}_{obs}, \frac{\delta v}{v}_{syn} \right)$$

- δp_i is the precipitation load changes ($\rho \cdot g \cdot \delta h_i$) at the sampled instant t_i
- δt is the time increment from the first day i
- c is the diffusion rate $\left(\frac{m^2}{s}\right)$
- n indicates the number of days
- $\operatorname{erfc}(x)$ is the complementary error function

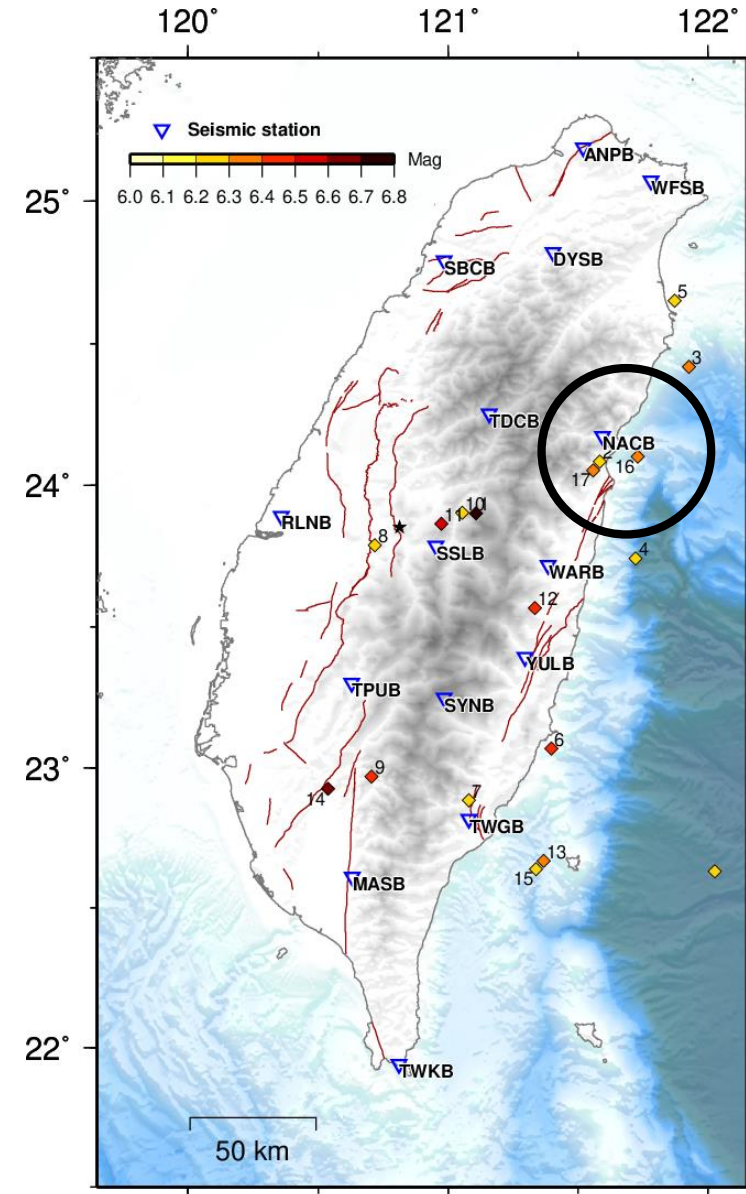
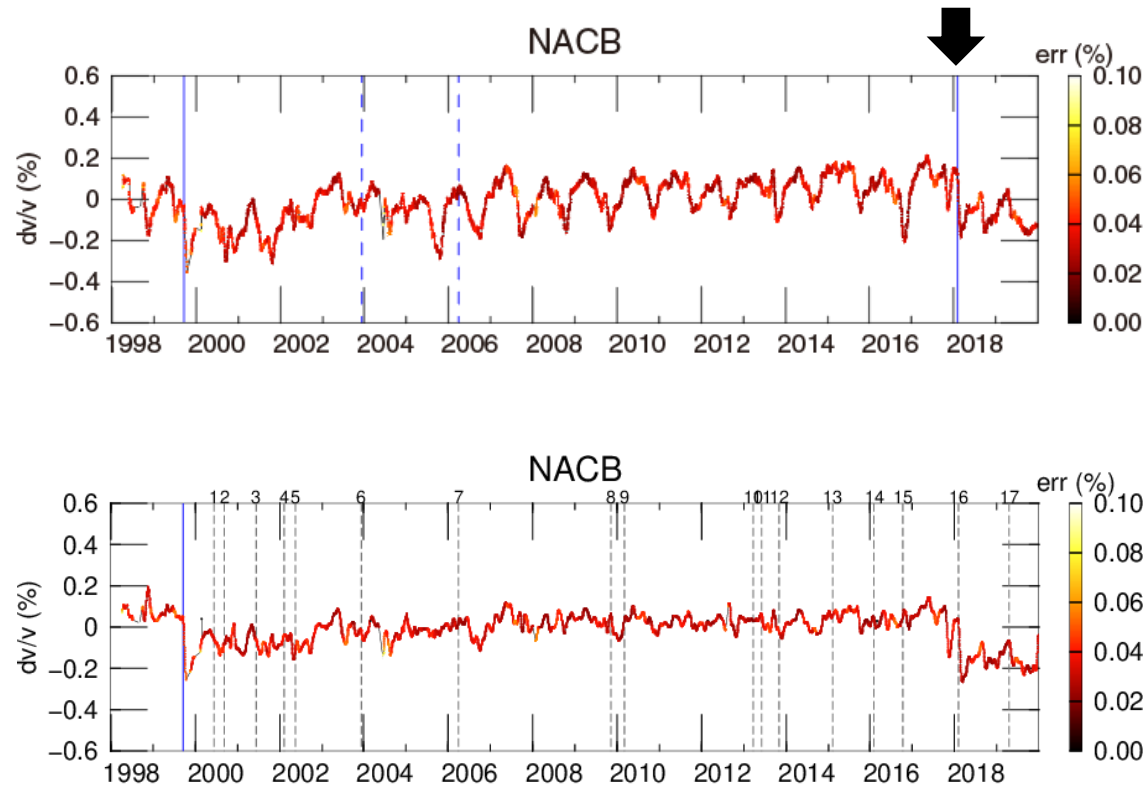
dv/v and rainfall induced pore-pressure change



dv/v and rainfall induced pore-pressure change



dv/v before and after correction



Summary

By measuring ~ 20 years dv/v of BATS stations, our results show that...

- We observe **co-seismic velocity drops** associated with the inland/offshore moderate earthquakes.
- **Clear seasonal cycles**, with a period of near one-year, are also revealed at most stations, but with different characteristics.
- The **rainfall-induced pore-pressure change** is likely the main environmental factor causing the seasonal dv/v variations in Taiwan.
- The strong site-dependency of these seasonal variations suggests **spatially-varying complex hydro-mechanical interaction** across the orogenic belt in Taiwan.
- After correct the effect induced by non-tectonic factor, we can further deal with the effect of tectonic factors, i.e. earthquakes.

Thank you for your time!