

# Wastewater-based epidemiology of SARS-CoV-2 in Switzerland

Julien Riou, James Munday

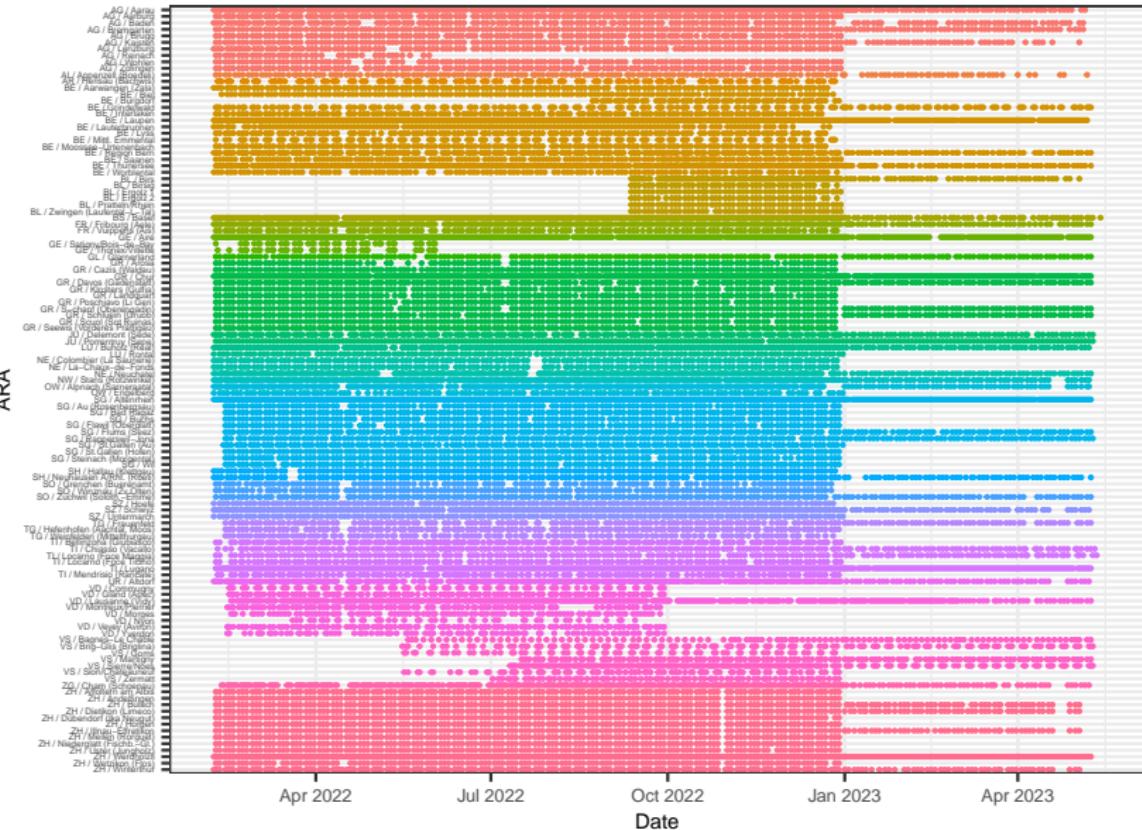
30 August 2023

# Background

Wastewater surveillance of SARS-CoV-2 in Switzerland:

- ▶ data available from 7 February 2022
- ▶ 118 ARAs (fluctuating)
- ▶ various sampling frequencies (from weekly to daily)
- ▶ samples sent to 9 different laboratories
- ▶ 20,535 total measurements as of 14 May, 2023

# Data



# Data

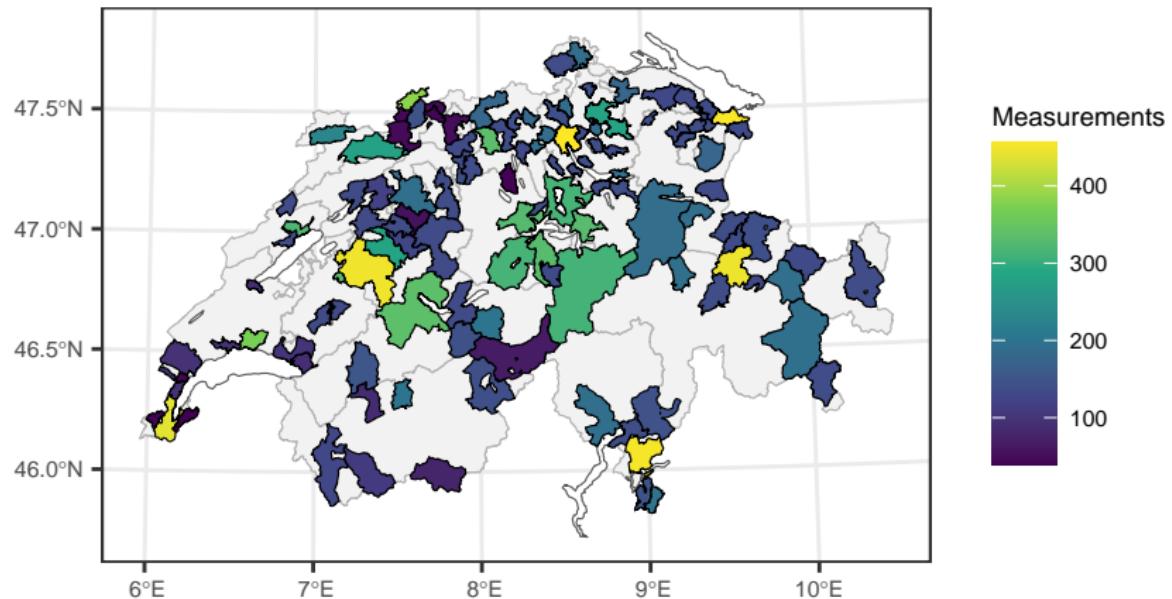


Figure 1: Number of viral load measurements by ARA.

# Data

Large heterogeneity across time and space:

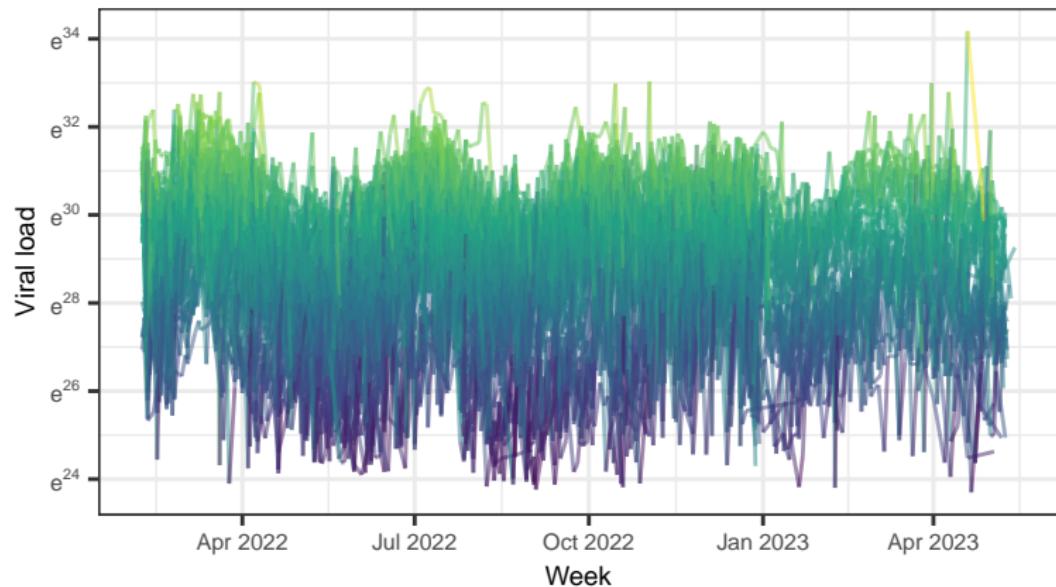


Figure 2: Daily SARS-CoV-2 viral load in wastewater by ARA (removing values below the LOD or LOQ).

# Objectives

1. Disentangle the various sources of heterogeneity
  - ▶ laboratory, quantification method, systematic temporal or spatial effects, remaining noise...
2. Extract a clean, "noise-free" temporal signal
  - ▶ at the national and/or regional level
3. Assess the agreement with other types of surveillance
  - ▶ confirmed cases, hospitalizations, Sentinella, CH-SUR, pooled tests...

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4. Forecasting/nowcasting
  - ▶ historical data, LFO validation
5. Future surveillance strategies
  - ▶ site selection, sampling frequency, rotation

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# Methods

Spatial regression model accounting for:

- ▶ limits of detection (LOD) and of quantification (LOQ)
- ▶ systematic temporal effects (public holidays, weekends)
- ▶ overall time trend by region (RW2)
- ▶ systematic shift for each ARA (IID)
- ▶ deviations from regional trend for each ARA (RW1)
- ▶ effect of laboratory and quantification method

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# Methods

```
ma5.3.3 = INLA::inla(vl ~ 1 +
  f(below_loq,model="iid") +
  f(below_lod,model="iid") +
  f(day,model="rw2", scale.model=TRUE, constr=TRUE,
    group=NUTS2, control.group=list(model="iid"),
    hyper=list(prec = list(prior = "pc.prec", param = c(1, 0.01)))) +
  f(weekend,model="linear",mean.linear=0,prec.linear=.2) +
  f(hol,model="linear",mean.linear=0,prec.linear=.2) +
  f(aral1,model="iid") +
  f(day1,model="rw1", scale.model=TRUE, constr=TRUE,
    group=ara2, control.group=list(model="iid"),
    hyper=list(prec = list(prior = "pc.prec", param = c(1, 0.01)))) +
  lab_method,
  data = ww_all,
  family = "gamma",
  control.compute = list(waic=TRUE,config=TRUE),
  control.predictor = list(compute=TRUE,link=1))
```

# Results

Posterior predictive check (model fit) is quite good.

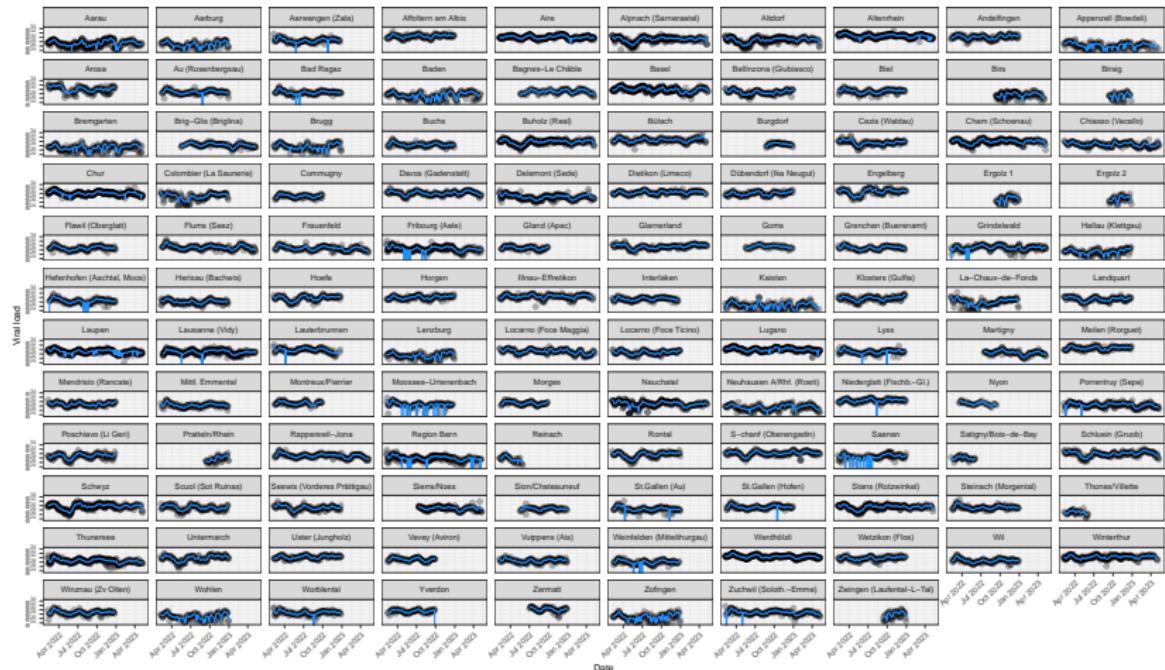


Figure 3: Model fit.

# Results

Posterior predictive check ([model fit](#)) is generally quite good.

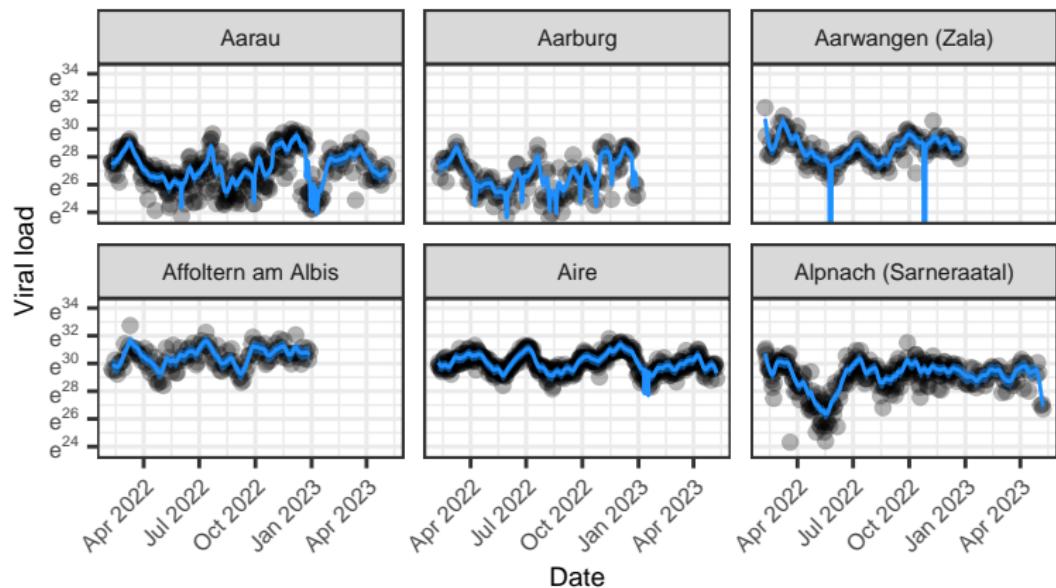


Figure 4: Model fit.

## Results

Effect of laboratory and method (reference is ALTGR\_0):

- ▶  $\exp(\beta)$  can be interpreted as a relative viral load, e.g., the viral load is *on average* 1.43 times higher (0.99 to 2.07) in EAWAG\_0 than ALTGR\_0

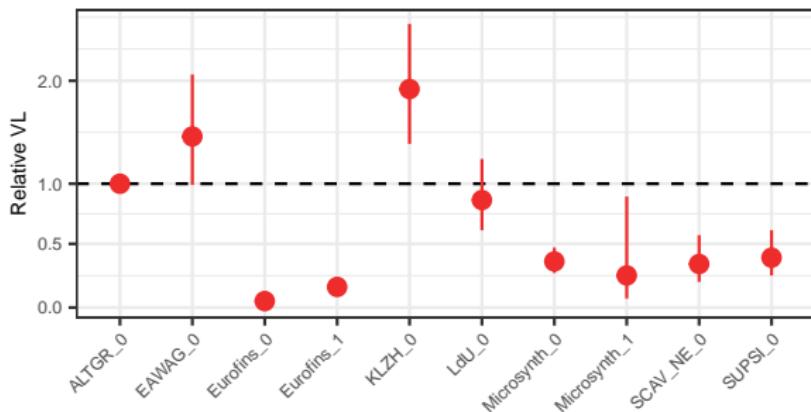


Figure 5: Estimated effect of laboratory (laboratory name) and method change (marked by 0 and 1).

# Results

Effect of public holidays and weekends:

- ▶ no clear influence

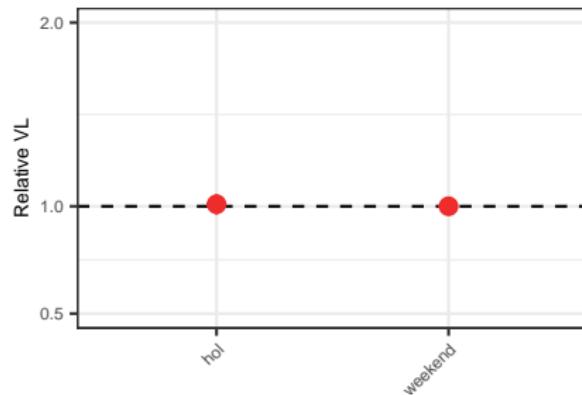


Figure 6: Estimated effect of holidays and weekends.

# Results

## Effect of specific ARAs:

- ▶ some ARAs have consistently higher or lower viral loads
- ▶ may be issues with **population** covered (tourism...)

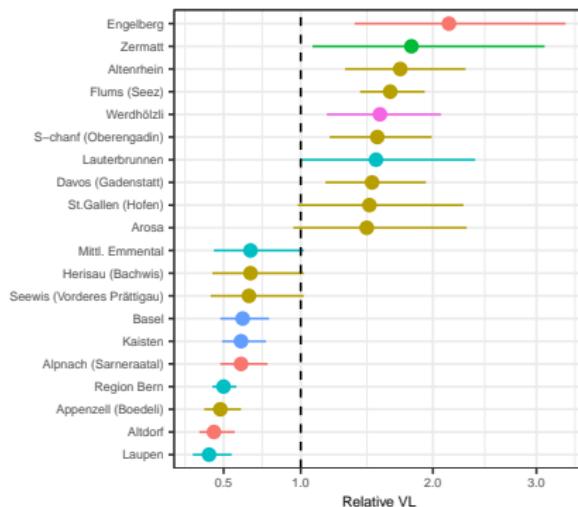


Figure 7: Estimated ARA-specific effects.

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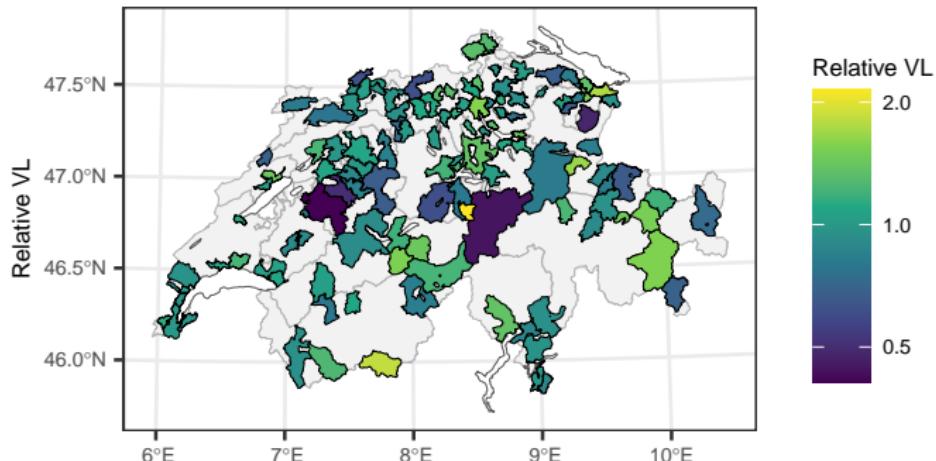


Figure 8: Estimated ARA-specific effects.

# Results

Average temporal trend at the national level:

- ▶ accounts for all aspects described before

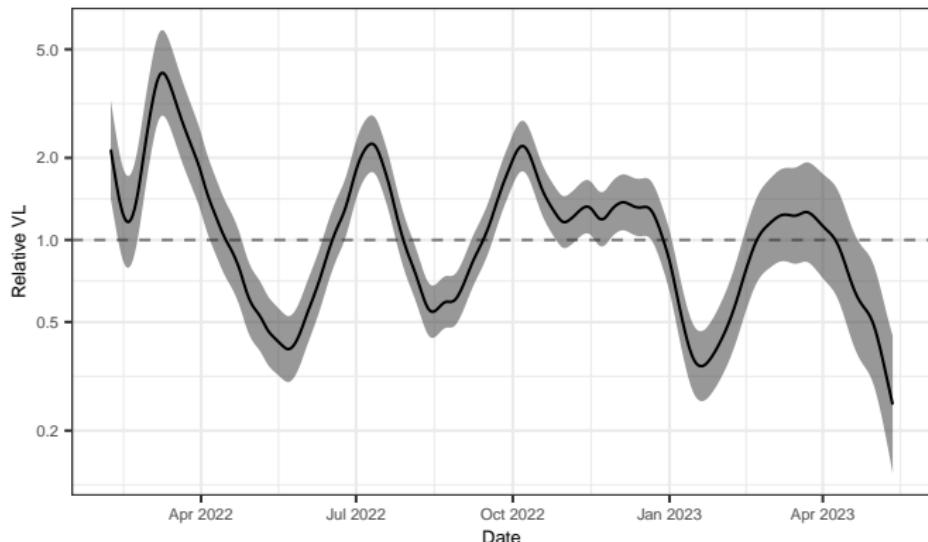


Figure 9: Estimated average temporal trend at the national level.

# Results

Average temporal trend at the regional level:

- ▶ accounts for all aspects described before

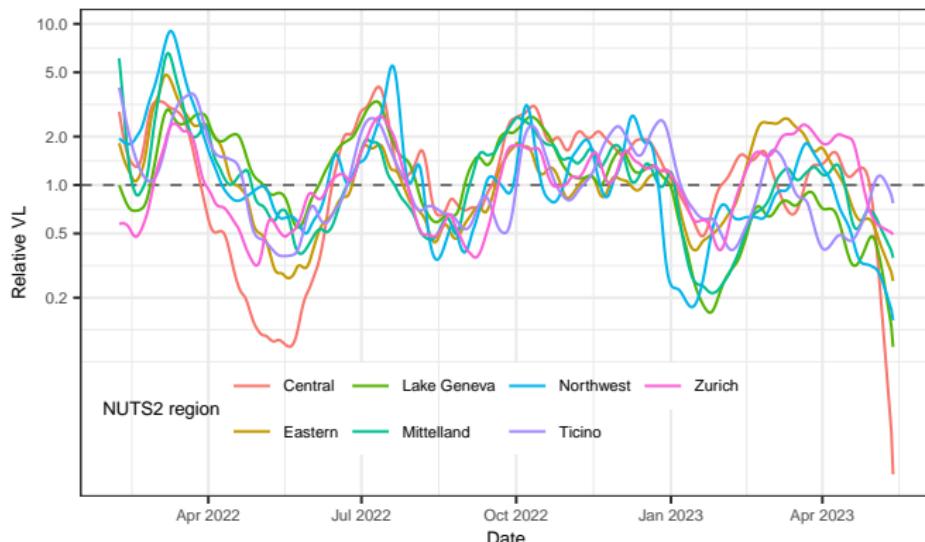


Figure 10: Estimated average temporal trend at the regional level.

# Results

Residual deviations from the average temporal trend:

- ▶ come on top of all aspects described before

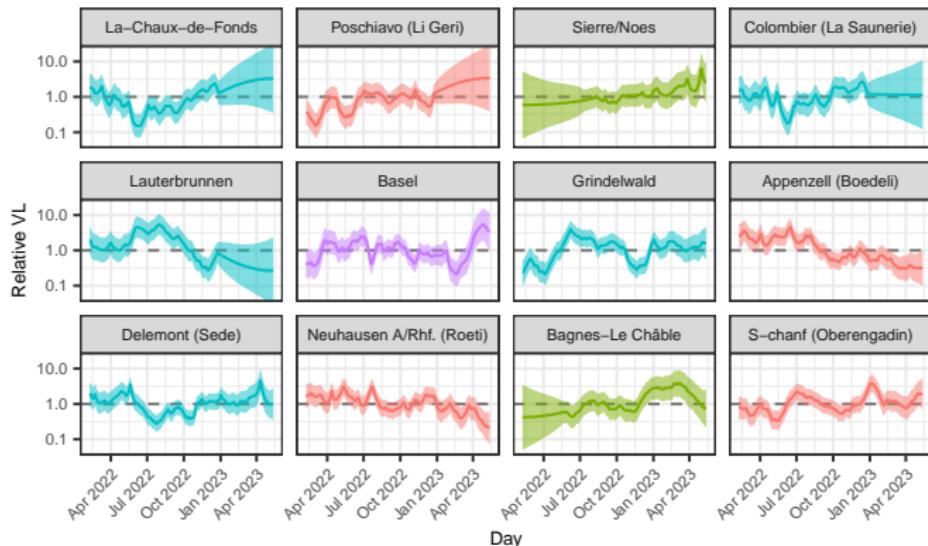


Figure 11: Residual deviations from the average temporal trend (top 12 on absolute value).

## Discussion

1. Disentangle the various sources of heterogeneity
  - ▶ important heterogeneity across laboratories and ARAs
  - ▶ no clear effect of weekends and public holidays
  - ▶ possible issue with population covered (tourism and/or mistake)

## Discussion

2. Extract a clean, “noise-free” temporal signal
  - ▶ doable at both the national and regional level
  - ▶ can look at residuals to identify special situations  
(Neuchâtel-Jura / Berner Oberland)

## Future work

- ▶ Improved spatio-temporal model (SPDE)
- ▶ Additional covariates: socio-economic position (SEP), population density, urban/rural, working population, ethnicity...
- ▶ Separate between covariates that influence the epidemic dynamics (SEP...) and covariates that influence the measurement of the viral load (laboratory, method...)
- ▶ Assess the agreement with other types of surveillance (obs. 3; joint modelling of reported cases/hospitalizations and viral load)
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