

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

Julien Riou,

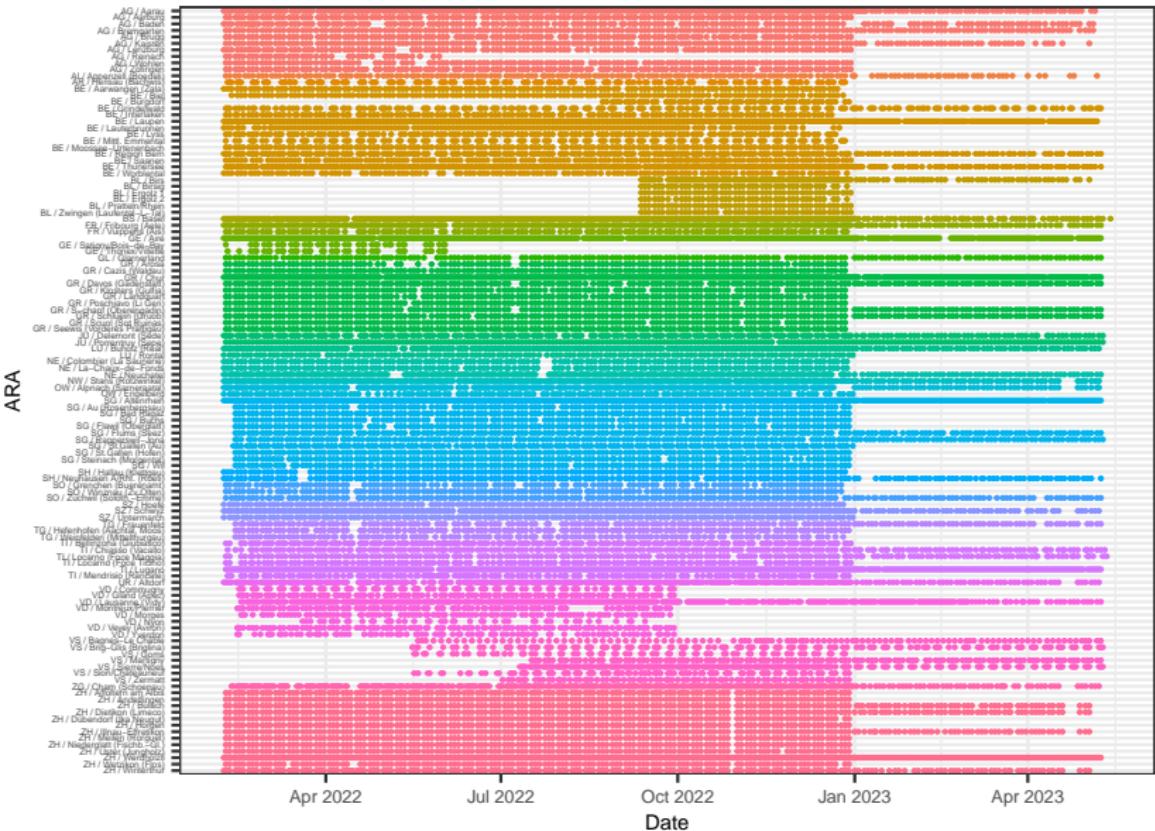
11 August 2023

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

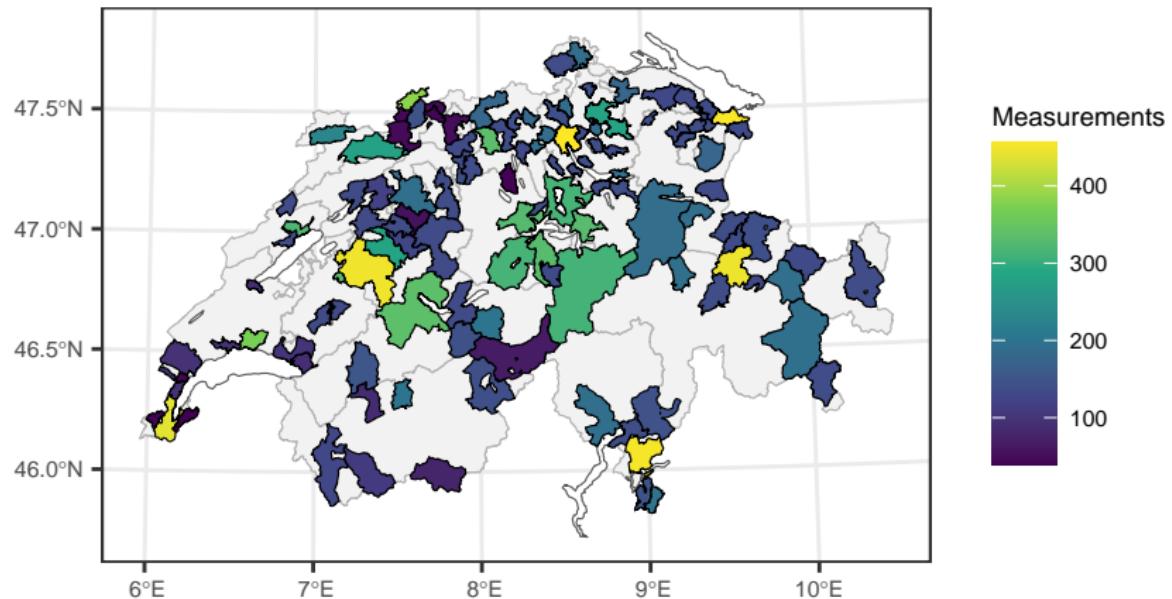


Figure 1: Number of viral load measurements by ARA.

Data

Large heterogeneity across time and space:

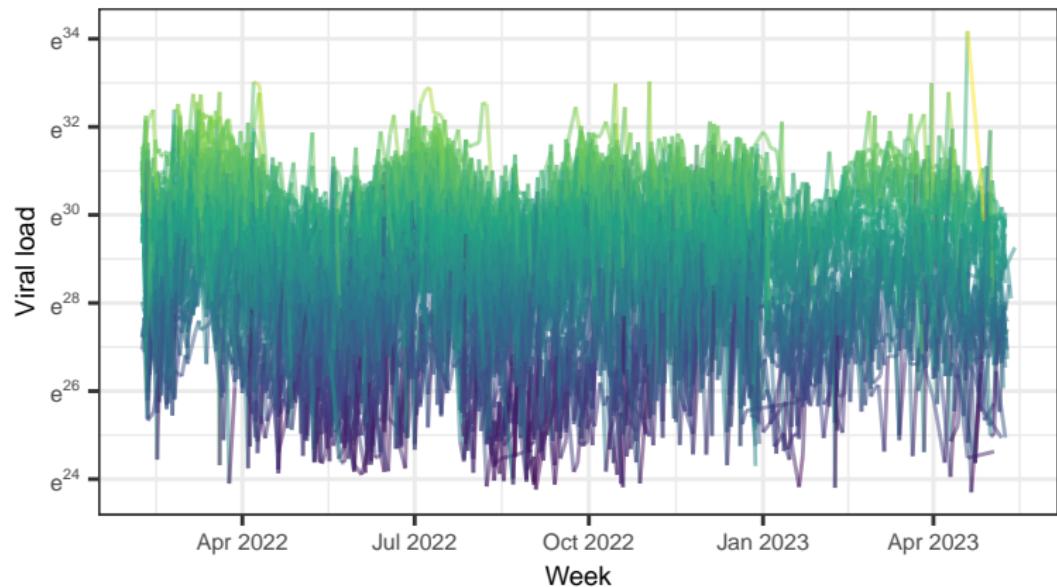


Figure 2: Daily SARS-CoV-2 viral load in wastewater by ARA (removing values below the LOD or LOQ).

Initial 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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New objectives after discussing with James

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

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Spatial regression model accounting for:

- ▶ population covered
- ▶ limits of detection (LOD) and of quantification (LOQ)
- ▶ laboratory and quantification method
- ▶ systematic temporal effects (public holidays, weekends)
- ▶ systematic bias by ARA

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Technical aspects:

- ▶ INLA
- ▶ gamma likelihood (strictly positive)
- ▶ logarithmic link implying multiplicative effects
- ▶ iterative model development (model selection tools)
- ▶ random walks for temporal trends
- ▶ (for now) iid for spatial correlation (BYM didn't improve the fit)

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Results

Posterior predictive check (model fit) is quite good.

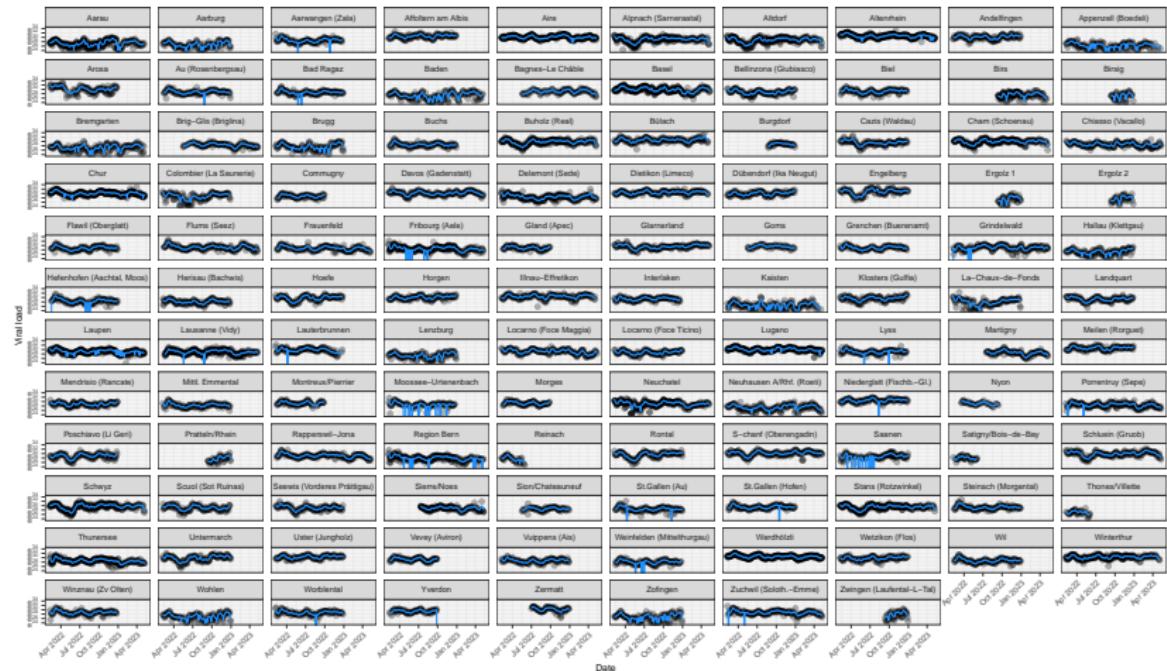


Figure 3: Model fit.

Results

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

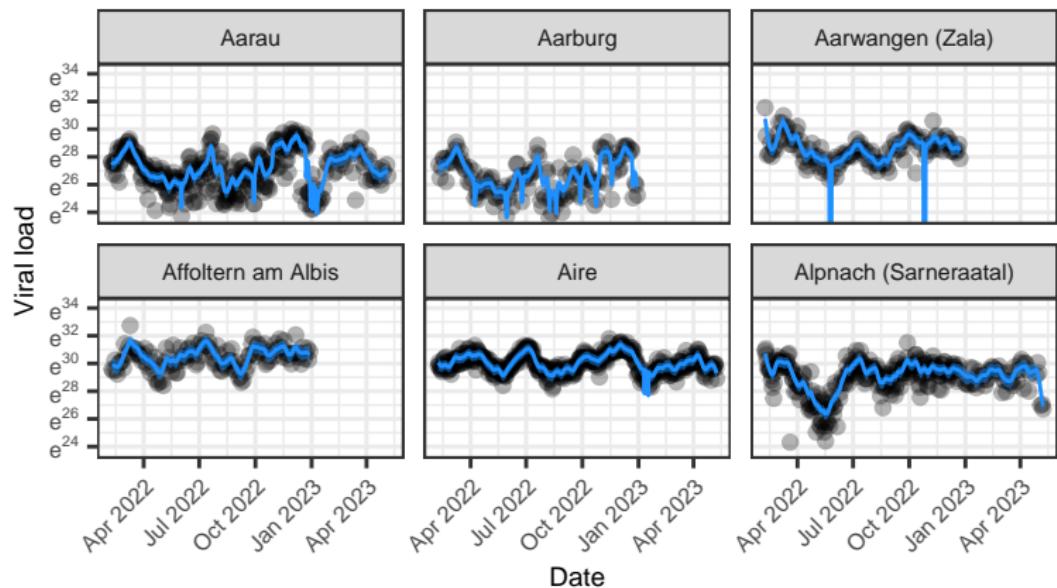


Figure 4: Model fit.

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

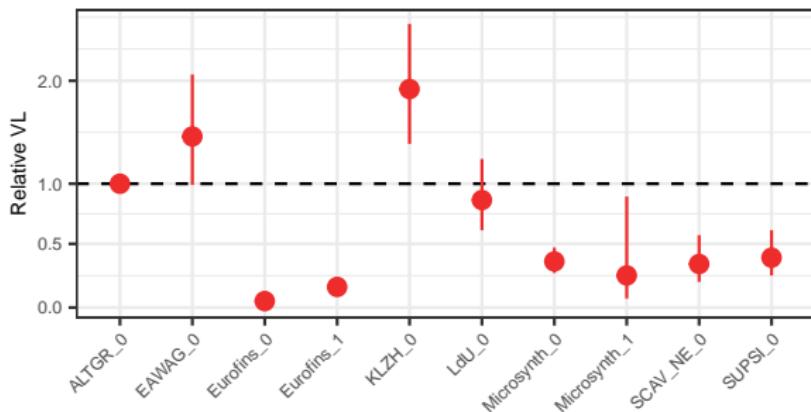


Figure 5: Estimated effect of laboratory (laboratory name) and method change (marked by 0 and 1).

Results

Effect of public holidays and weekends:

- ▶ no clear influence

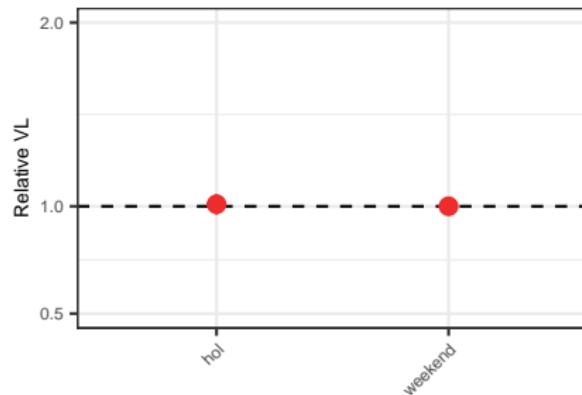


Figure 6: Estimated effect of holidays and weekends.

Results

Effect of specific ARAs:

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

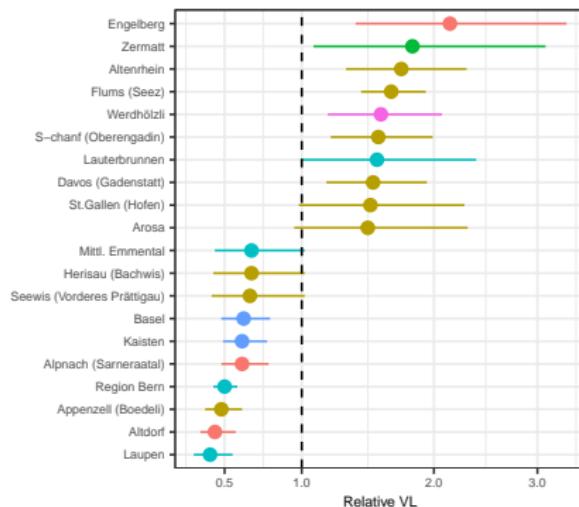


Figure 7: Estimated ARA-specific effects.

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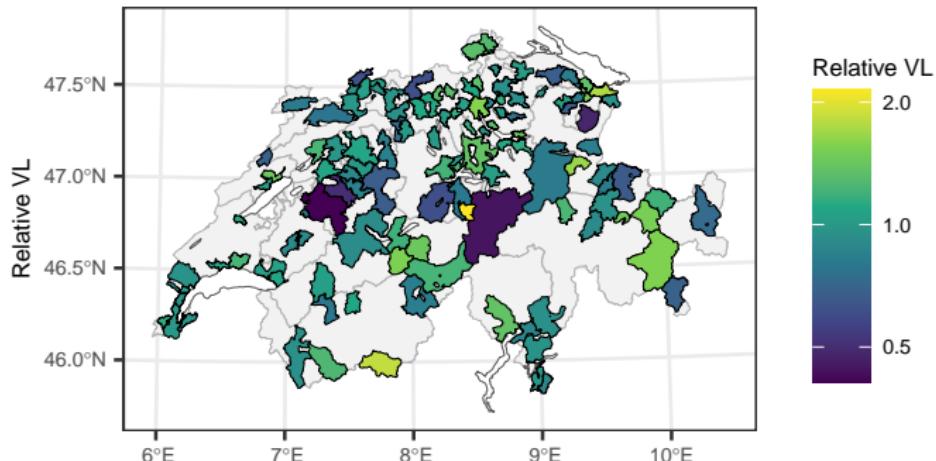


Figure 8: Estimated ARA-specific effects.

Results

Average temporal trend at the national level:

- ▶ accounts for all aspects described before

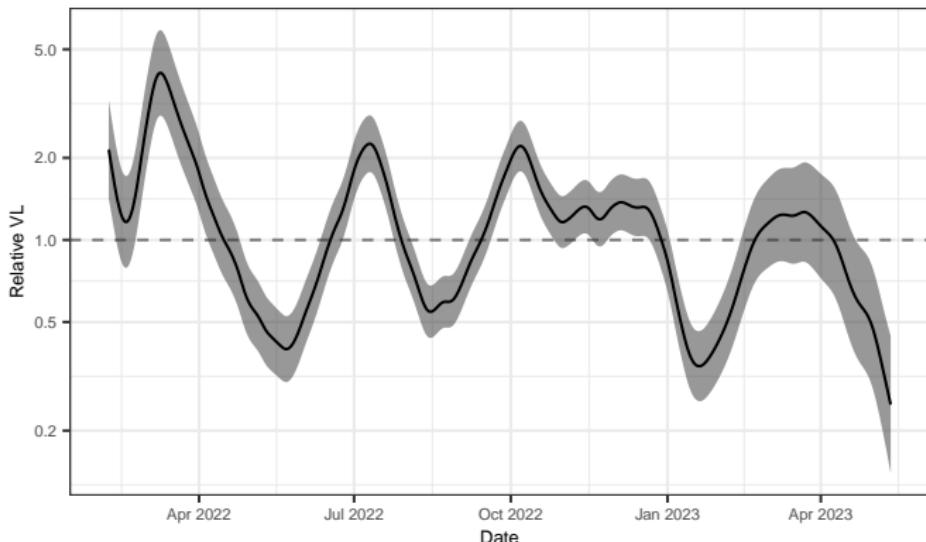


Figure 9: Estimated average temporal trend at the national level.

Results

Average temporal trend at the regional level:

- ▶ accounts for all aspects described before

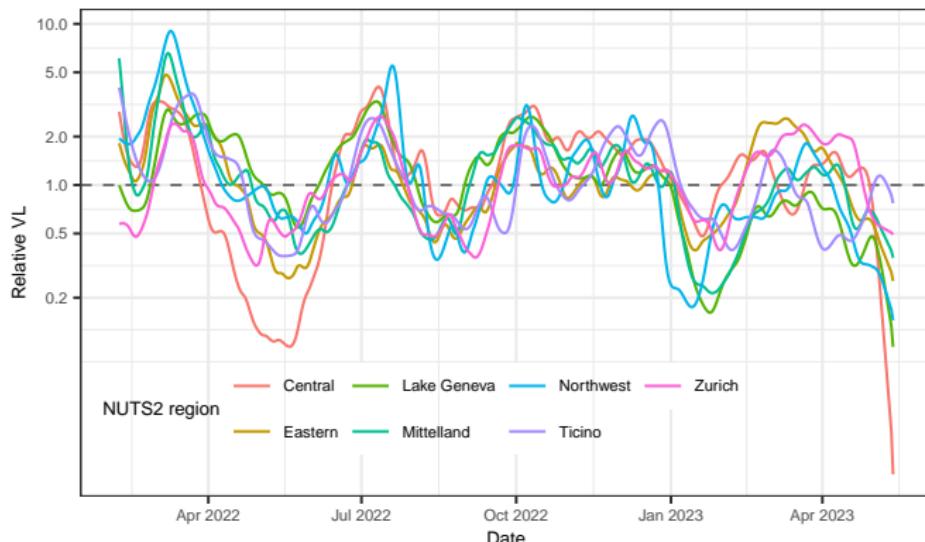


Figure 10: Estimated average temporal trend at the regional level.

Results

Residual deviations from the average temporal trend:

- ▶ come on top of all aspects described before

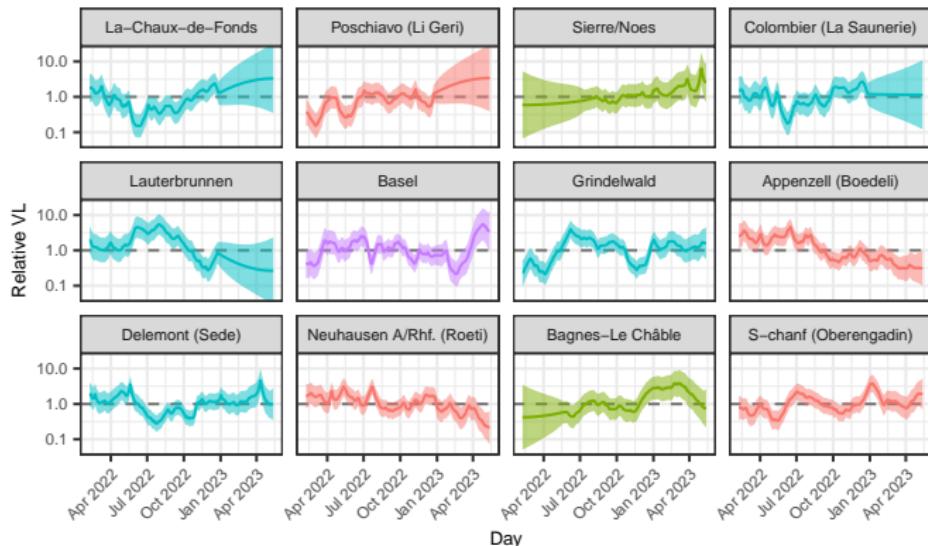


Figure 11: Residual deviations from the average temporal trend (top 12 on absolute value).

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)

Discussion

3. Assess the agreement with other types of surveillance
 - ▶ still ongoing
 - ▶ idea: joint modelling of reported cases/hospitalisations and viral load
 - ▶ discussions planned with France (Sorbonne University, Prof. Boëlle) and UK (Imperial, Prof. Blangiardo)

Future work

Integration with James's work:

- ▶ common [github](#) repo
- ▶ improved spatial model using SPDE
- ▶ new population by ARA using a finer resolution (hectare)
DONE
- ▶ additional covariates: SEP, population density, urban/rural, working population, ethnicity?
- ▶ integrate changes in [standard curves](#) as a methods change (Tim?)
- ▶ separate between covariates that influence the [epidemic dynamics](#) (SEP...) and covariates that influence the [measurement](#) of the viral load (laboratory, method...)
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