Supplementary Material for Seasonality of respiratory viruses causing hospitalizations for acute respiratory infections in children in Nha Trang, Vietnam

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Additional Viruses

Table 1 shows the counts of all viruses in the study and Figure S1 the results of the Poisson regression.

	ADV	HBoV	CoV	HMPV	HPIV1	HPIV2	HPIV3	HPIV4	HRV	Flu A	Flu B	RSV	Total
2007	21	9	0	28	1	2	19	0	137	84	1	149	451
2008	15	4	0	10	10	2	10	1	134	51	8	85	330
2009	20	13	0	1	5	3	9	1	129	74	10	68	333
2010	12	1	0	2	20	4	4	0	95	25	24	84	271
2011	13	3	0	24	2	0	17	1	61	37	8	69	235
2012	6	4	1	7	2	1	12	0	13	11	19	0	76
Total	87	34	1	72	40	12	71	3	569	282	70	455	1696
(%)	(5.1%)	(2%)	(0.1%)	(4.2%)	(2.4%)	(0.7%)	(4.2%)	(0.2%)	(33.5%)	(16.6%)	(4.1%)	(26.8%)	(100%)

Table 1: **Summary of viral hospitalizations over the study period.** Table shows counts of viral detections for Adenovirus (ADV), Bocavirus (HBoV), Coronavirus (CoV), Human metapneumovirus (HMPV), H. parainfluenza 1 (HPIV1), H. parainfluenza 2 (HPIV2), H. parainfluenza 3 (HPIV3), H. parainfluenza 4 (HPIV4), Influenza A, Influenza B, Rhinovirus (HRV), Respiratory syntitial virus (RSV).

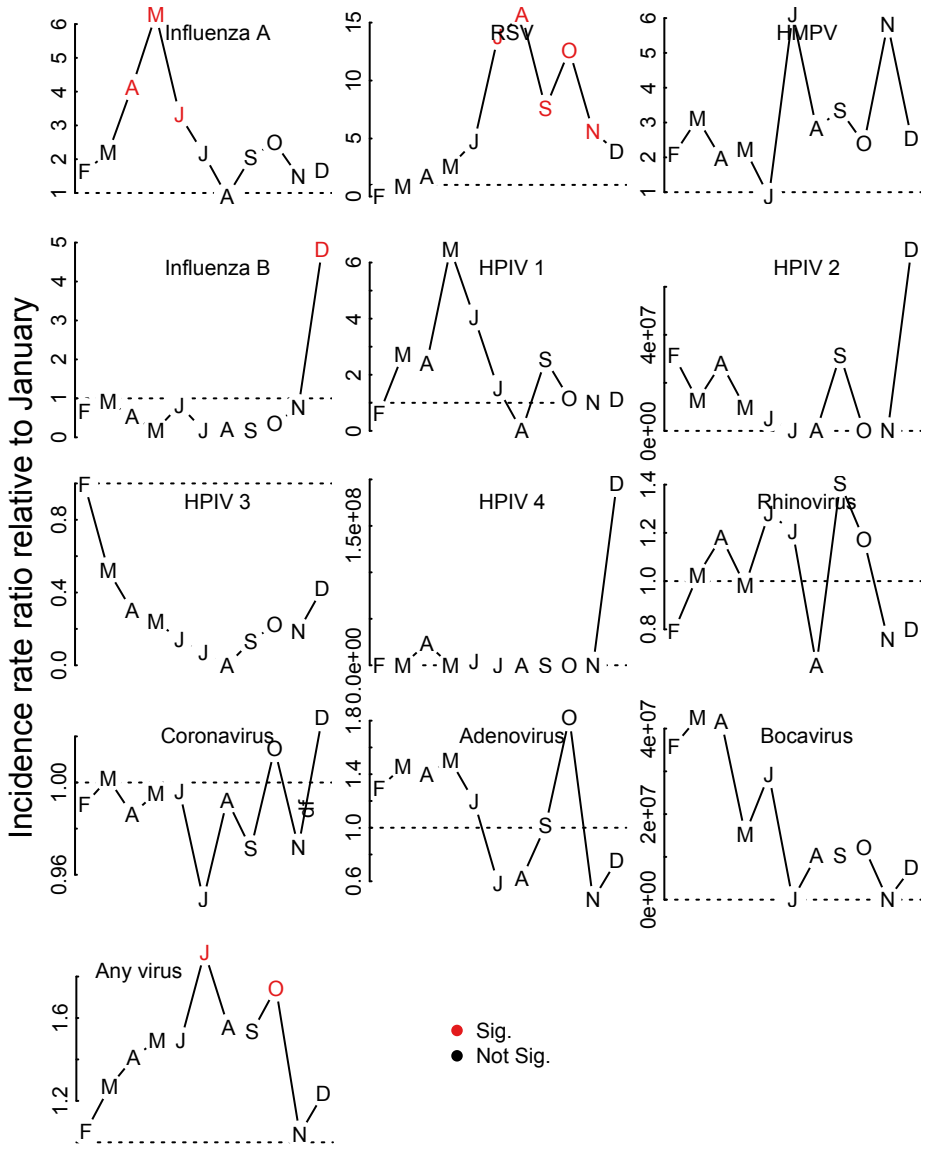

Figure S1: **Seasonality of common respiratory viruses in Nha Trang, Vietnam.** Figure shows model-adjusted incidence rate ratios for all viruses and month of year as compared to January. Red months indicates statistically significant deviations from January.

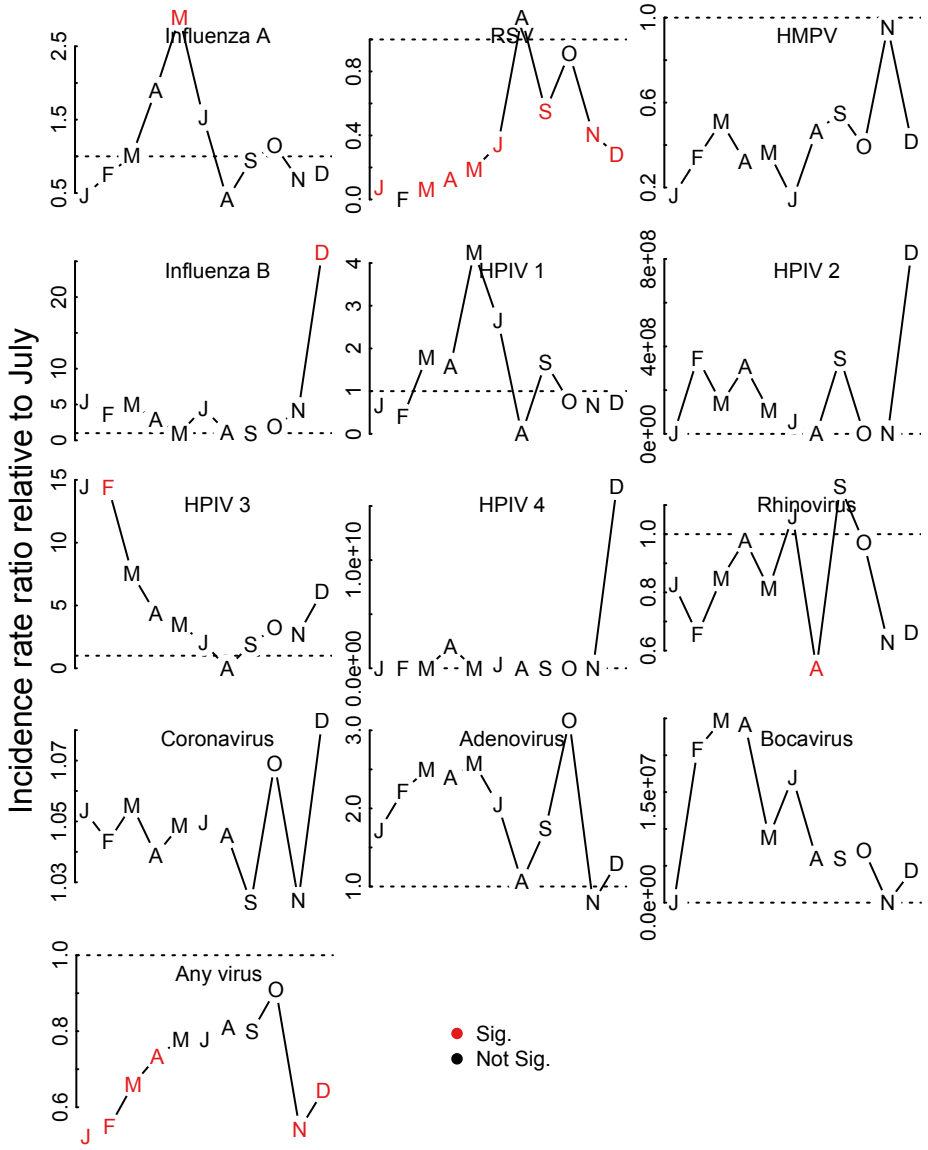

Figure S2: **Poisson regression results with July as the reference category.** Figure is identical to Figure S1 but with July as the reference category instead of January. Red months indicates statistically significant deviations from July.

Weather

Figure S3 shows the weather over the study period (highlighted in blue) and in the 5 years before and after. Similar patterns are seen across the time period.

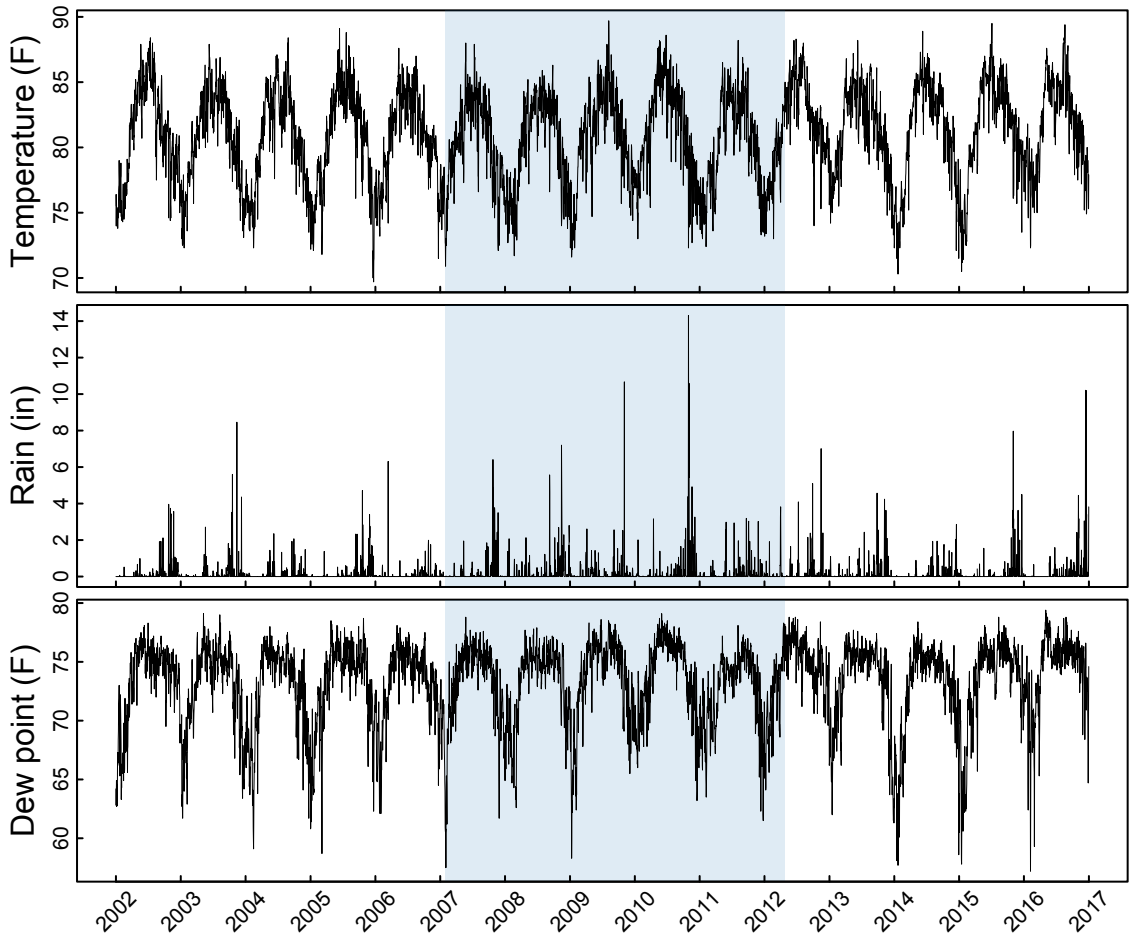

Figure S3: **Wether dynamics in Nha Trang, Vietnam.** Figure shows the weather variables before, during, and after the study period. We see stable dynamics in weather patterns.

Logistic regressions

A series of logistic regression models were fit to assess seasonality. Outcomes were detection of a virus by PCR (yes/no) with month as the mani predictor, adjusted for weather, commune of residence, age, sex, smoking indoors, socioeconomic status (SES), and calendar year. We fit 5 separate models and compared fit using Akaike's information criterion (AIC):

$$
\begin{aligned}
Y_{\text{virus detection}} &= \text{month} && (1)\\
Y_{\text{virus detection}} &= \text{month} + \text{commune} + \text{age} + \text{sex} + \text{smoke} + \text{SES} + \text{Cal. year} && (2)\\
Y_{\text{virus detection}} &= \text{month} + \text{commune} + \text{age} + \text{sex} + \text{smoke} + \text{SES} + \text{Cal. year} \\
&\quad + \text{rain}(t_0) + \text{temperature}(t_0) + \text{dew point}(t_0) && (3)\\
Y_{\text{virus detection}} &= \text{month} + \text{commune} + \text{age} + \text{sex} + \text{smoke} + \text{SES} + \text{Cal. year} \\
&\quad + \text{rain}(t_{-7 \text{ to } -1}) + \text{temperature}(t_{-7 \text{ to } -1}) + \text{dew point}(t_{-7 \text{ to } -1}) && (4)\\
Y_{\text{virus detection}} &= \text{month} + \text{commune} + \text{age} + \text{sex} + \text{smoke} + \text{SES} + \text{Cal. year} \\
&\quad + \text{rain}(t_0) + \text{temperature}(t_0) + \text{dew point}(t_0) \\
&\quad + \text{rain}(t_{-7 \text{ to } -1}) + \text{temperature}(t_{-7 \text{ to } -1}) + \text{dew point}(t_{-7 \text{ to } -1}) && (5)
\end{aligned}
$$

This allows the data to chose the best fitting model. We refer to models (1)–(5) as the 'simple', 'no weather', 'admission weather', 'past weather', and 'full' models, respectively.

Virus	Chosen model	AIC full	AIC past	AIC admission	AIC no weather	AIC simple
Influenza A	simple, (1)	541.09	535.67	548.29	547.68	535.39
RSV	past weather, (4)	715.58	715.28	715.91	728.86	741.2
HMPV	no weather, (2)	294.98	289.47	292.1	286.98	293.6
Influenza B	simple, (1)	419.8	417.66	421.46	417.51	393.43
HPIV 1	simple, (1)	275.06	270.49	271.04	267.35	250.66
HPIV 2	simple, (1)	117.46	121.62	115.1	116.91	87.65
HPIV 3	simple, (1)	313.63	317.22	310.36	312.81	296.79
HPIV 4	simple, (1)	84	78	78	72	35.5
Rhinovirus	adm. weather, (3)	923.84	925.34	922.83	932.2	966.96
Coronavirus	simple, (1)	84	78	78	72	35.05
Adenovirus	simple, (1)	315	309.57	311.51	309.32	296.26
Bocavirus	simple, (1)	131	130.53	127.84	126.85	107.16
Any virus	past weather, (4)	1407.44	1402.92	1429.58	1434.33	1457.07

Table 2: **AIC of models used to assess seasonality.** Table shows AIC and chosen model ("simple", "no weather", "admission day weather", "previous week model", or "full" models as given in the main text) for each virus.

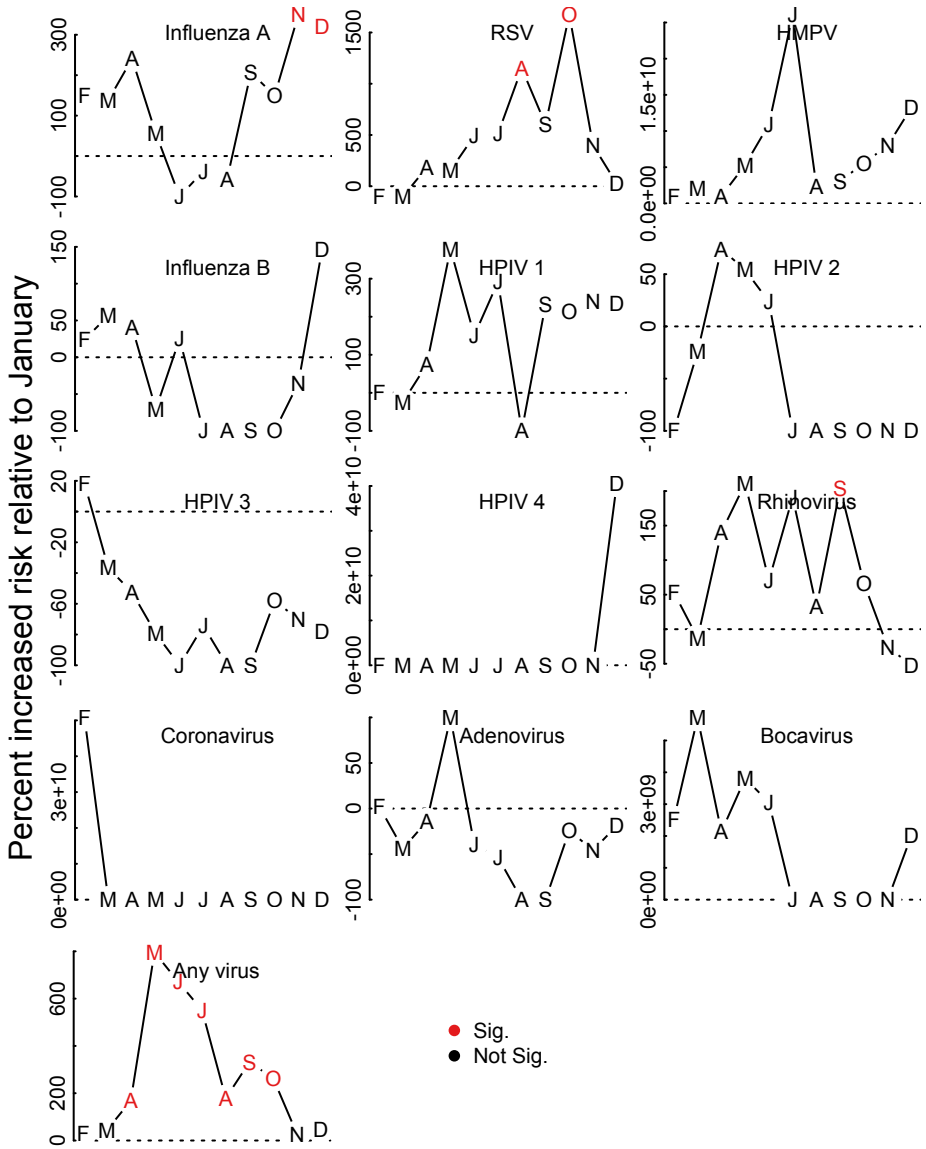

Figure S4: **Seasonality of common respiratory viruses in Nha Trang, Vietnam.** Figure shows logistic model-adjusted excess odds for month of year as compared to January, with model choice as given in Table 2. Red months indicates statistically significant deviations from January.

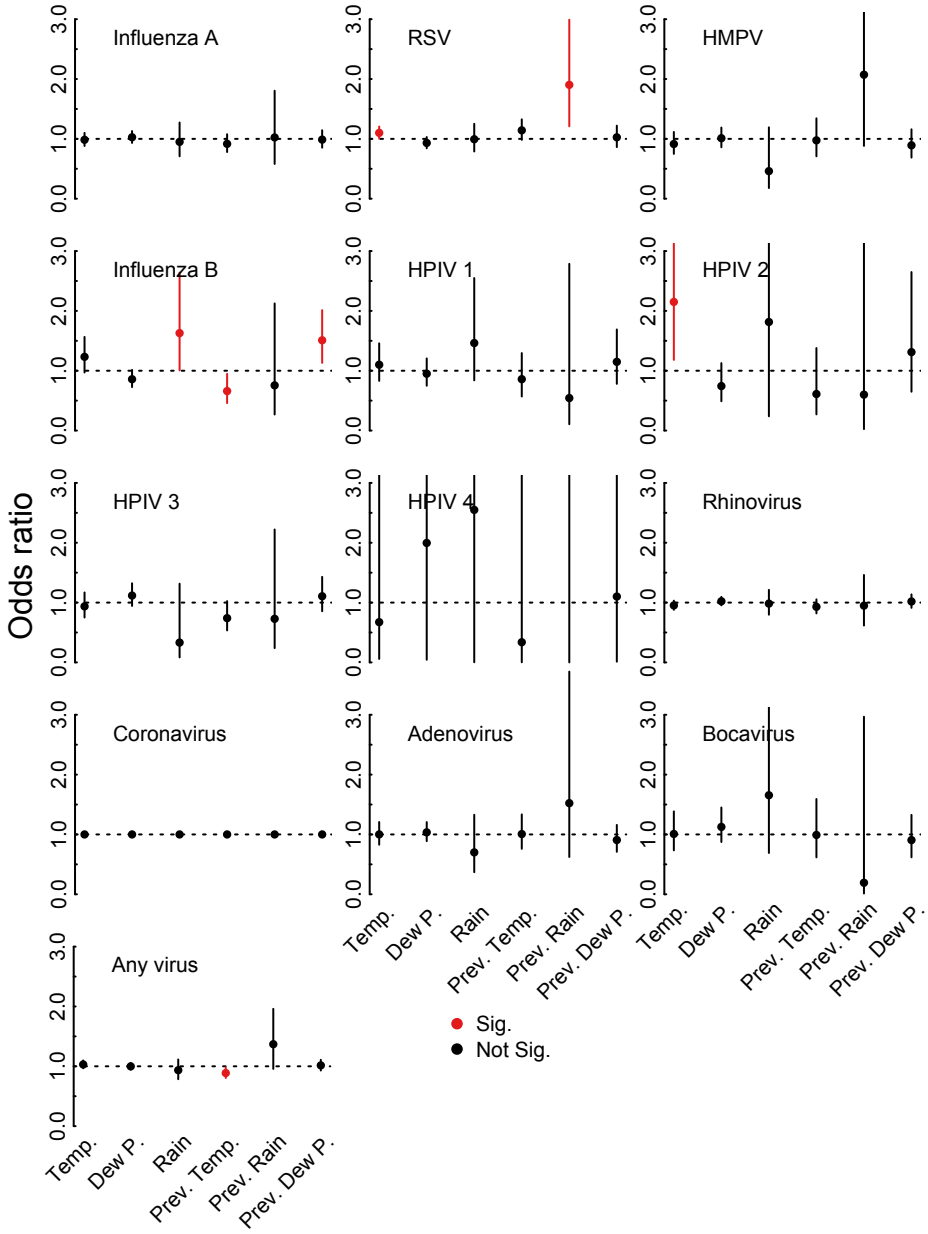

Figure S5: **Effects of weather on virus hospitalizations.** Figure shows model-adjusted odds ratios for the main six weather effects: admission day rainfall, temperature, and dew point, and the previous 7-day average rainfall, temperature, and dew point.

Supplemental Cross-wavelets

Figure S6 shows the cross-wavelet transform of RSV and rainfall with non-significant arrows plotted for convenience. We see RSV leading rainfall by 90° at the one year period band.

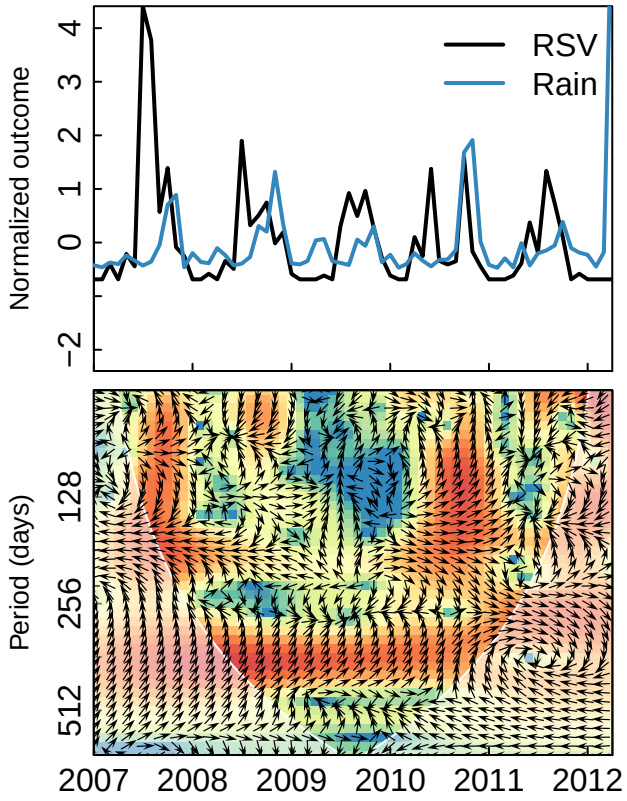

Figure S6: **Cross-wavelet transform of the z-standardized RSV and rainfall time series.** Figure shows the cross-wavelet of Adenovirus and rainfall, temperature, and dew point. The 5% significance level against red noise is shown as a thick contour. The relative phase relationship is shown as arrows (with in-phase pointing right, out-of-phase pointing left, and weather leading Adenovirus by 90° pointing straight down).

Figures S7–S17 show cross-wavelet transforms for the viruses not presented in the main text.

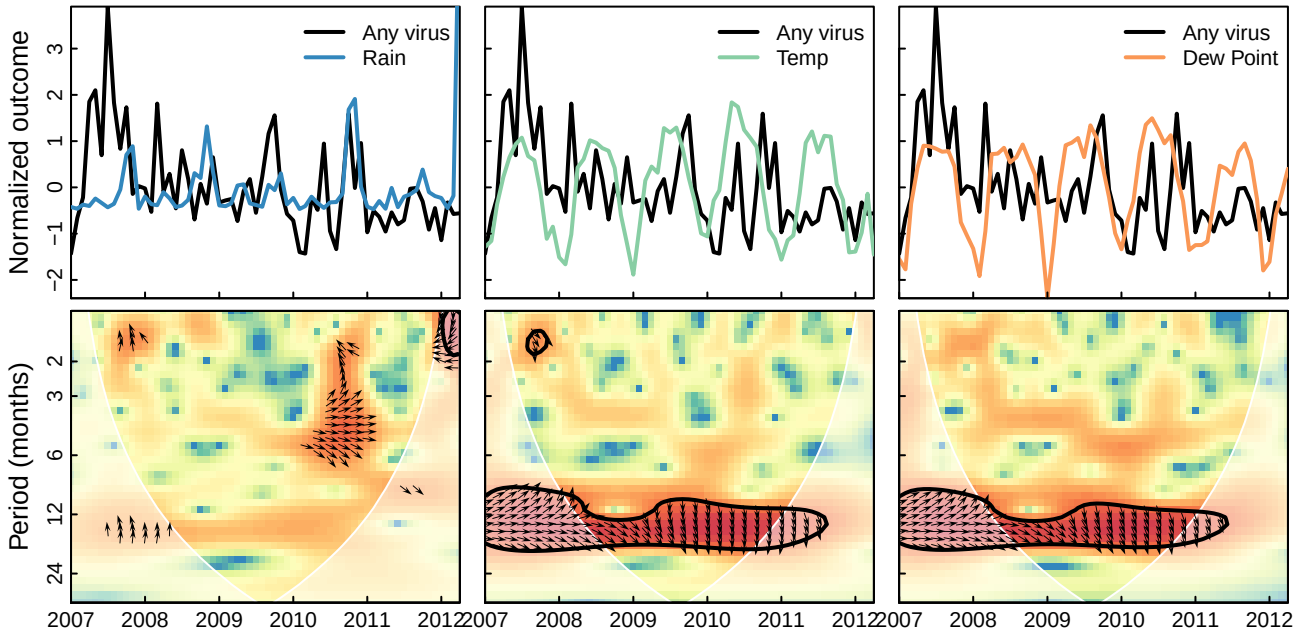

Figure S7: **Cross-wavelet transform of the z-standardized Any virus and weather time series.** Figure shows the cross-wavelet of Any virus and rainfall, temperature, and dew point. The 5% significance level against red noise is shown as a thick contour. The relative phase relationship is shown as arrows (with in-phase pointing right, out-of-phase pointing left, and weather leading Any virus by 90° pointing straight down).

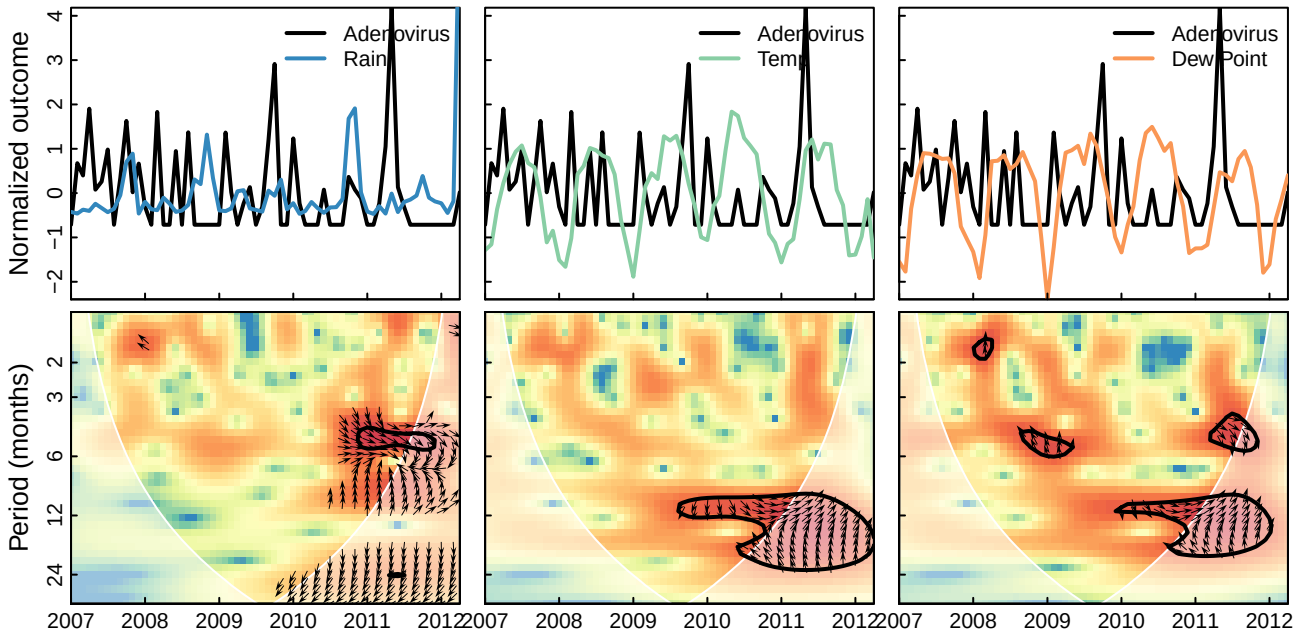

Figure S8: **Cross-wavelet transform of the z-standardized Adenovirus and weather time series.** Figure shows the cross-wavelet of RSV and rainfall, temperature, and dew point. The 5% significance level against red noise is shown as a thick contour. The relative phase relationship is shown as arrows (with in-phase pointing right, out-of-phase pointing left, and weather leading RSV by 90° pointing straight down).

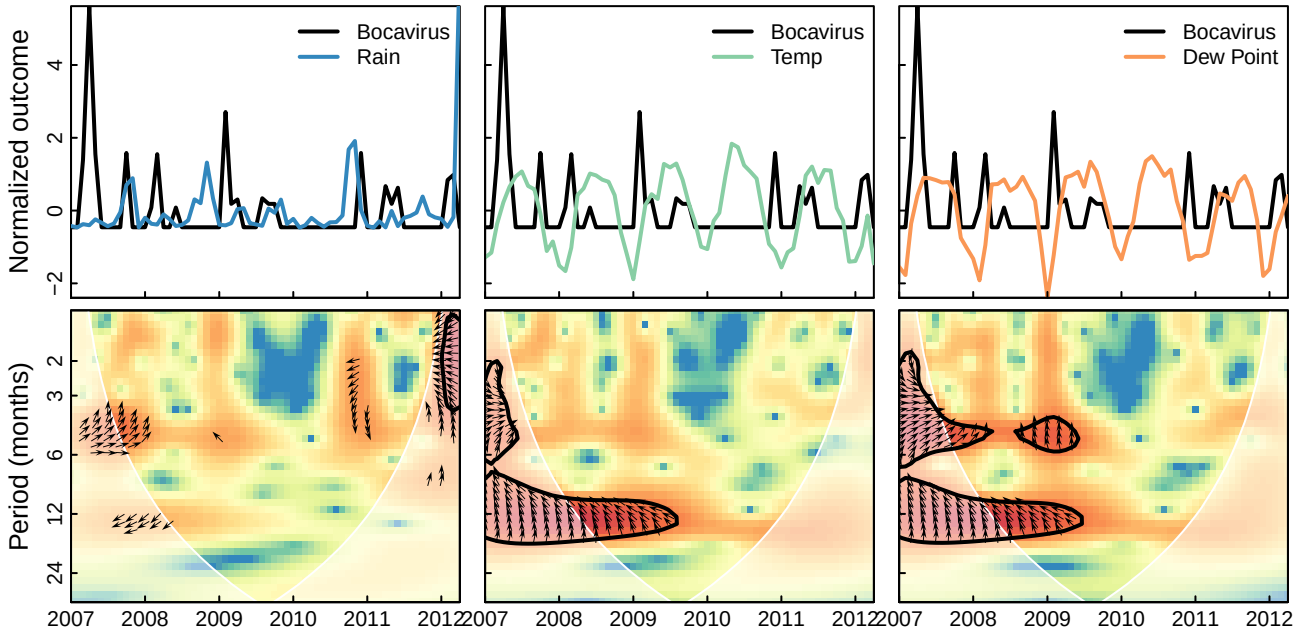

Figure S9: **Cross-wavelet transform of the z-standardized Bocavirus and weather time series.** Figure shows the cross-wavelet of Bocavirus and rainfall, temperature, and dew point. The 5% significance level against red noise is shown as a thick contour. The relative phase relationship is shown as arrows (with in-phase pointing right, out-of-phase pointing left, and weather leading Bocavirus by 90° pointing straight down).

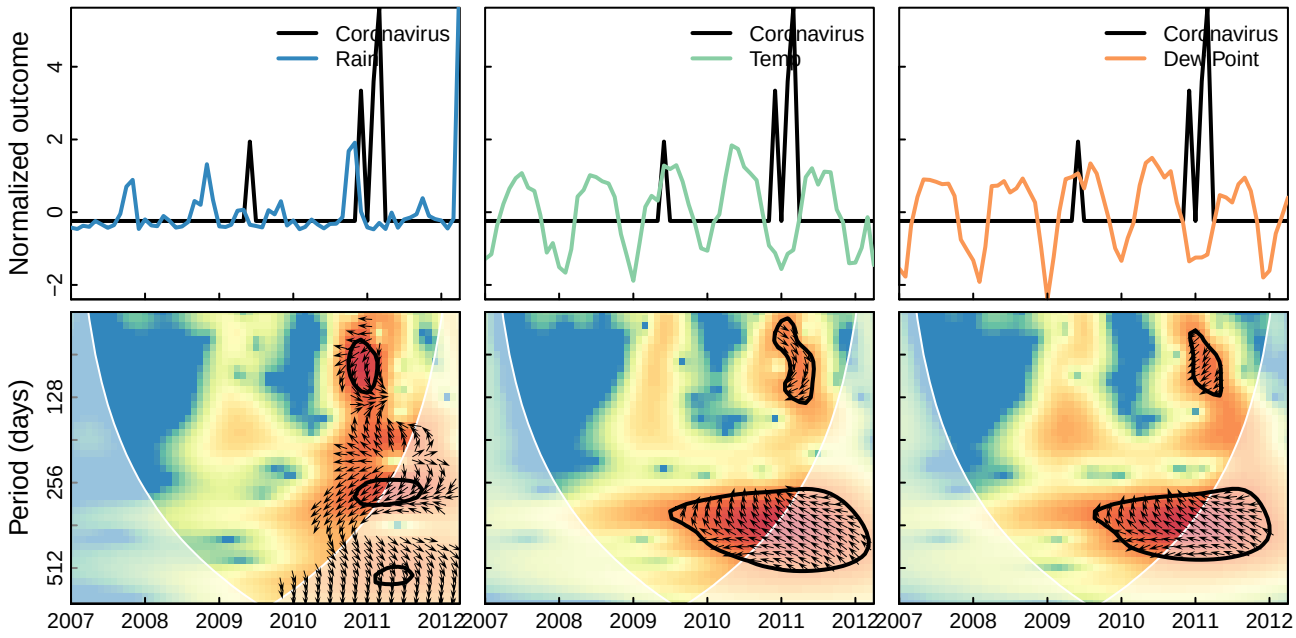

Figure S10: **Cross-wavelet transform of the z-standardized Coronavirus and weather time series.** Figure shows the cross-wavelet of Coronavirus and rainfall, temperature, and dew point. The 5% significance level against red noise is shown as a thick contour. The relative phase relationship is shown as arrows (with in-phase pointing right, out-of-phase pointing left, and weather leading Coronavirus by 90° pointing straight down).

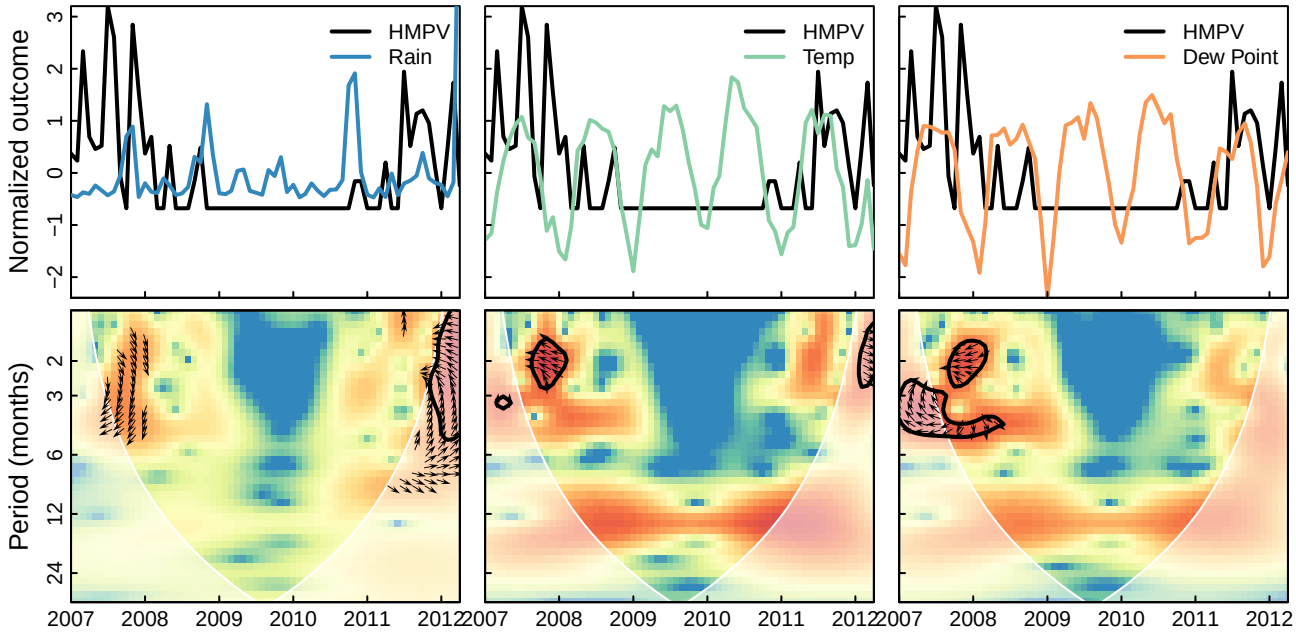

Figure S11: **Cross-wavelet transform of the z-standardized HMPV and weather time series.** Figure shows the cross-wavelet of HMPV and rainfall, temperature, and dew point. The 5% significance level against red noise is shown as a thick contour. The relative phase relationship is shown as arrows (with in-phase pointing right, out-of-phase pointing left, and weather leading HMPV by 90° pointing straight down).

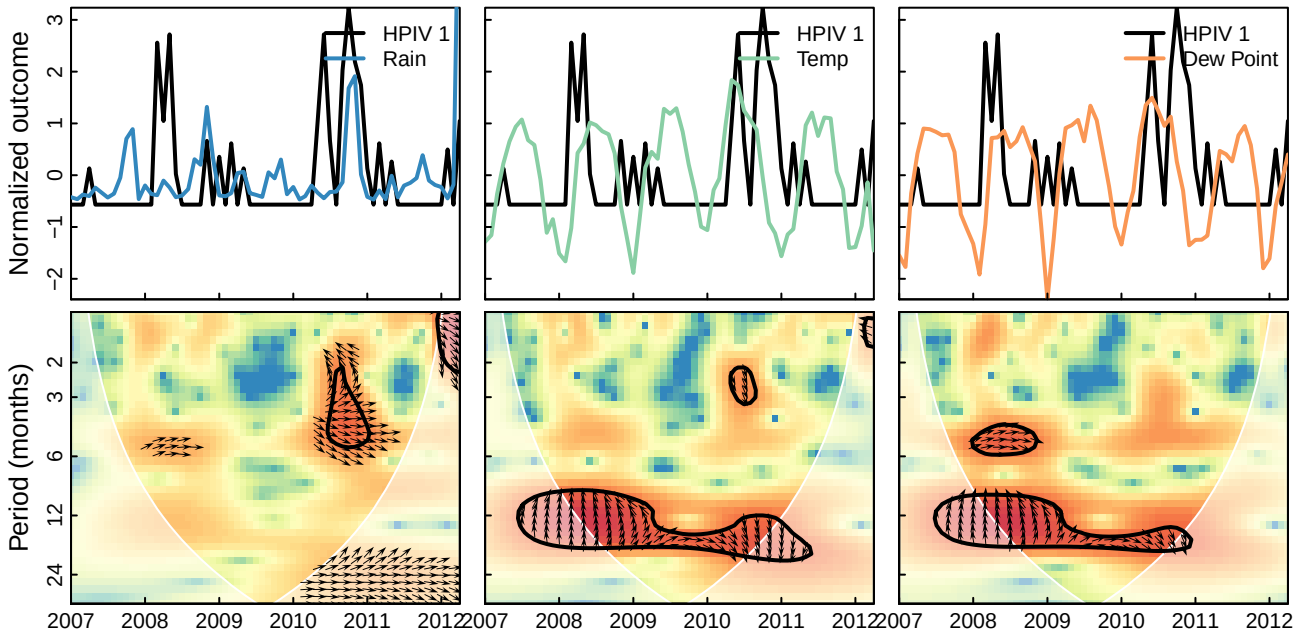

Figure S12: **Cross-wavelet transform of the z-standardized HPIV 1 and weather time series.** Figure shows the cross-wavelet of HPIV 1 and rainfall, temperature, and dew point. The 5% significance level against red noise is shown as a thick contour. The relative phase relationship is shown as arrows (with in-phase pointing right, out-of-phase pointing left, and weather leading HPIV 1 by 90° pointing straight down).

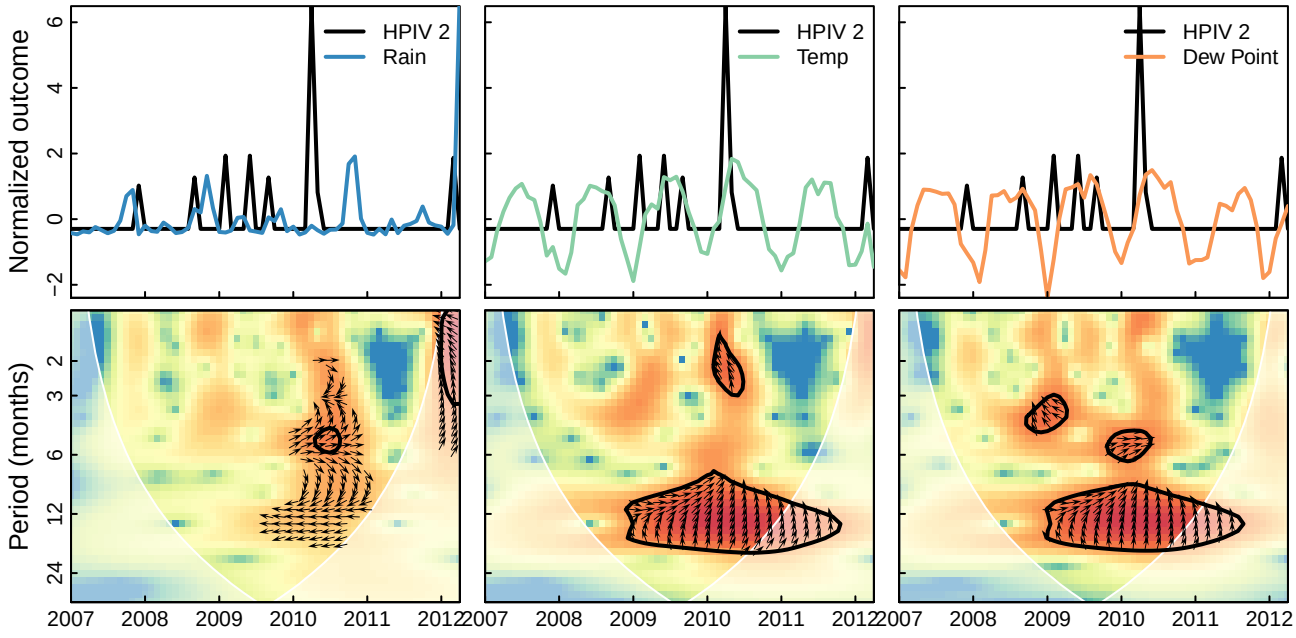

Figure S13: **Cross-wavelet transform of the z-standardized HPIV 2 and weather time series.** Figure shows the cross-wavelet of HPIV 2 and rainfall, temperature, and dew point. The 5% significance level against red noise is shown as a thick contour. The relative phase relationship is shown as arrows (with in-phase pointing right, out-of-phase pointing left, and weather leading HPIV 2 by 90° pointing straight down).

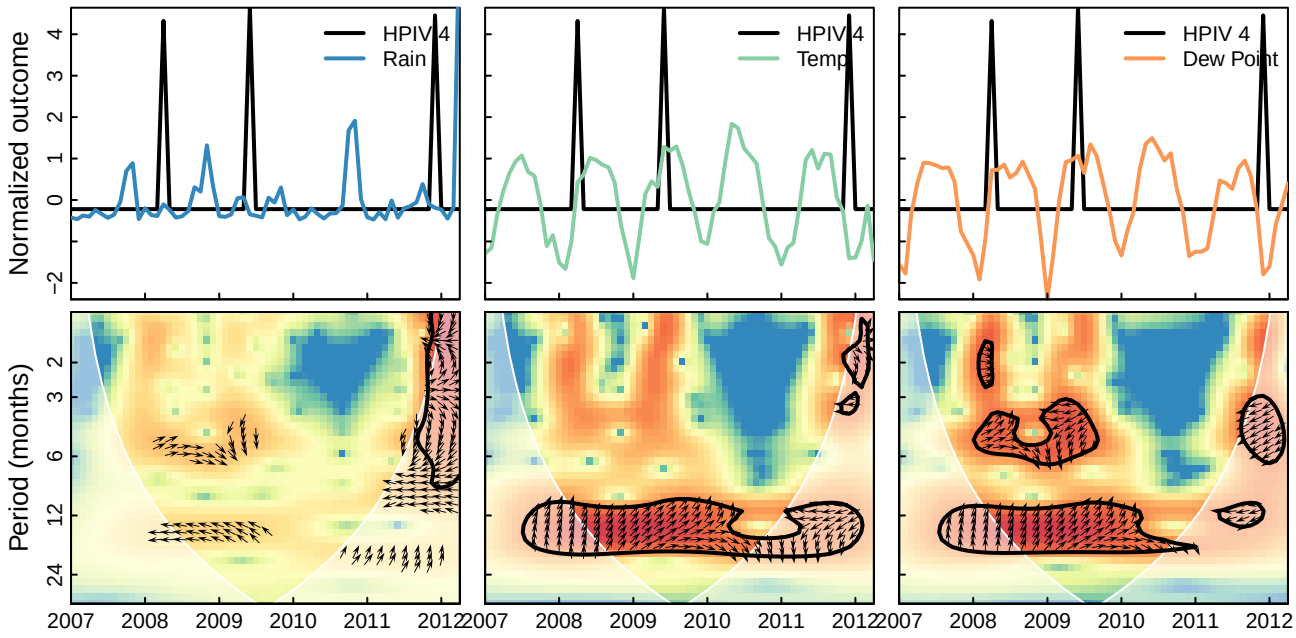

Figure S14: **Cross-wavelet transform of the z-standardized HPIV 4 and weather time series.** Figure shows the cross-wavelet of HPIV 4 and rainfall, temperature, and dew point. The 5% significance level against red noise is shown as a thick contour. The relative phase relationship is shown as arrows (with in-phase pointing right, out-of-phase pointing left, and weather leading HPIV 4 by 90° pointing straight down).

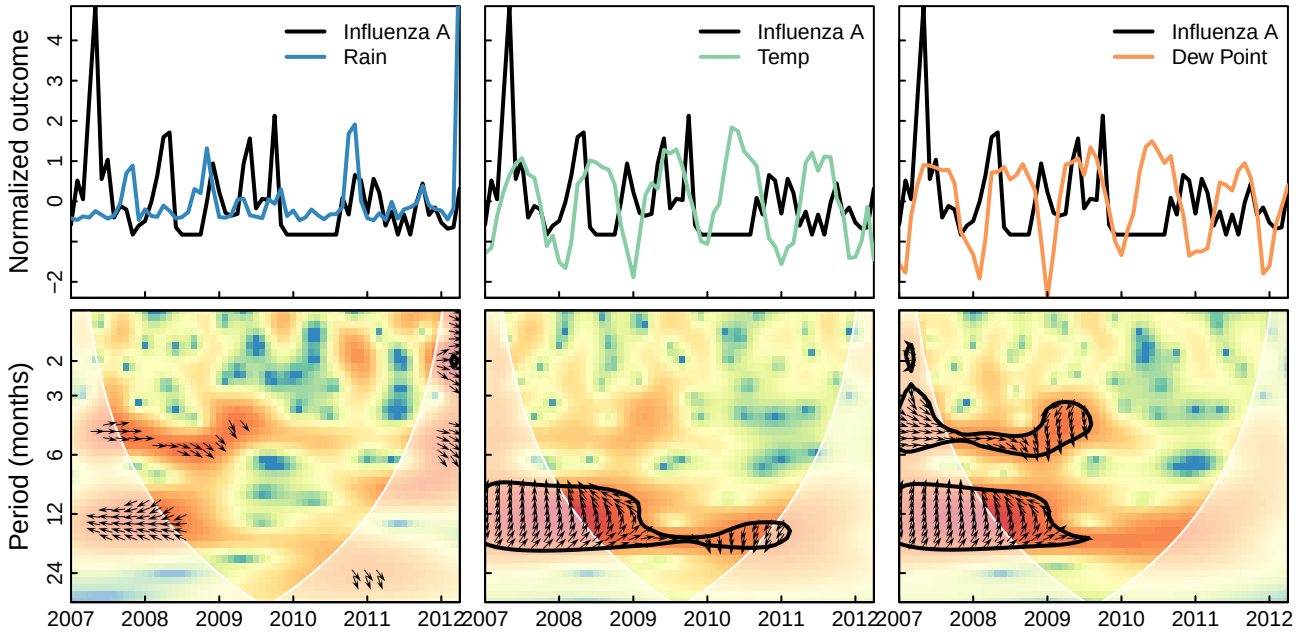

Figure S15: **Cross-wavelet transform of the z-standardized Influenza A and weather time series.** Figure shows the cross-wavelet of Influenza A and rainfall, temperature, and dew point. The 5% significance level against red noise is shown as a thick contour. The relative phase relationship is shown as arrows (with in-phase pointing right, out-of-phase pointing left, and weather leading Influenza A by 90° pointing straight down).

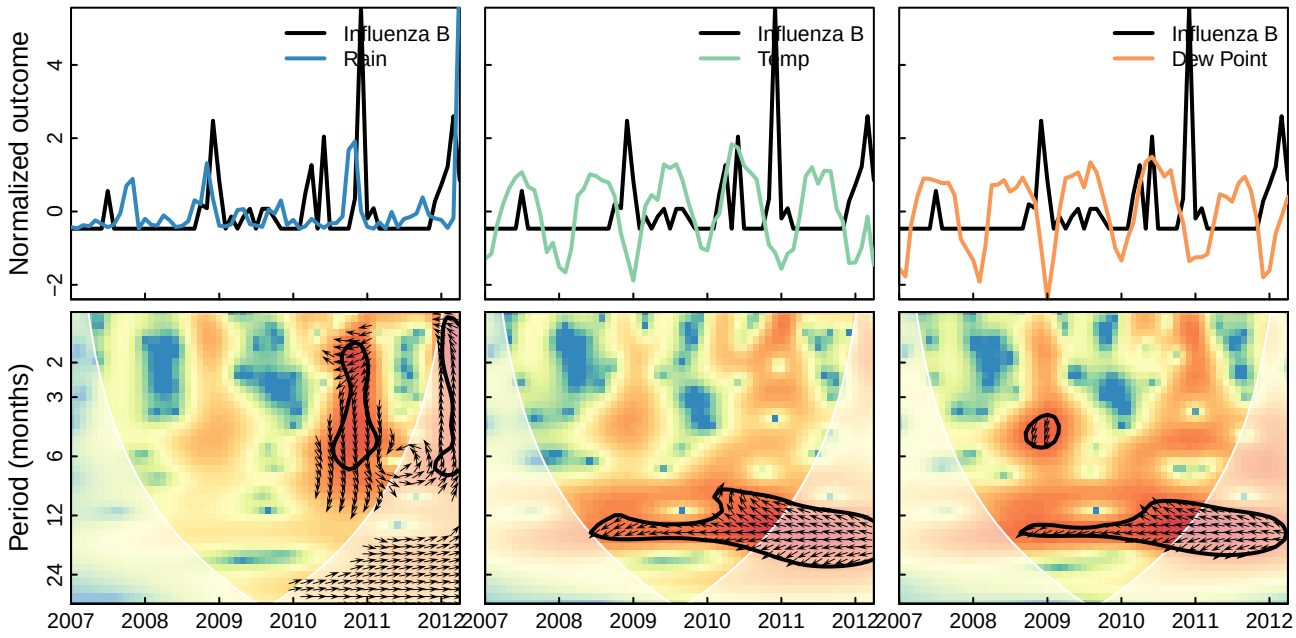

Figure S16: **Cross-wavelet transform of the z-standardized Influenza B and weather time series.** Figure shows the cross-wavelet of RSV and rainfall, temperature, and dew point. The 5% significance level against red noise is shown as a thick contour. The relative phase relationship is shown as arrows (with in-phase pointing right, out-of-phase pointing left, and weather leading Influenza B by 90° pointing straight down).

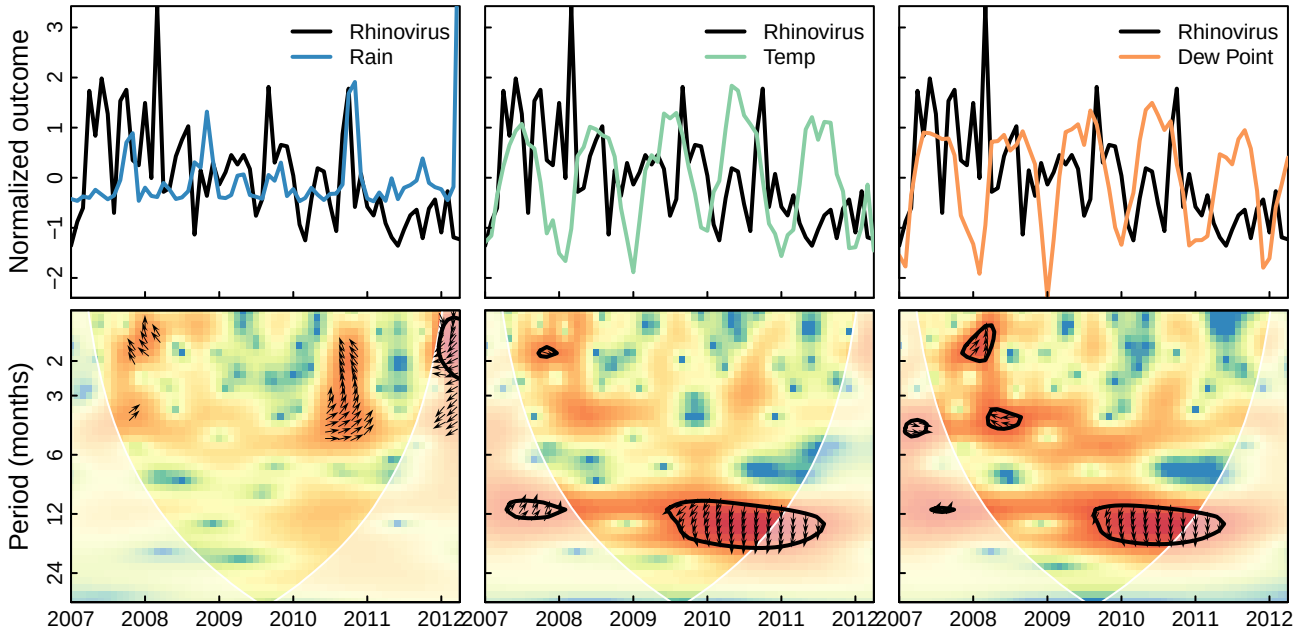

Figure S17: **Cross-wavelet transform of the z-standardized Rhinovirus and weather time series.** Figure shows the cross-wavelet of Rhinovirus and rainfall, temperature, and dew point. The 5% significance level against red noise is shown as a thick contour. The relative phase relationship is shown as arrows (with in-phase pointing right, out-of-phase pointing left, and weather leading Rhinovirus by 90° pointing straight down).