Analysing the Impact of the COVID19 Lockdown on Vehicle Flow and Speeds in the UK

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ABSTRACT

The period of 'lockdown' during the global COVID-19 pandemic in 2020 saw a rapid decline in traffic flows on all roads. This study uses data from Automated Traffic Counters (ATCs) to investigate the relationship between flow and various measures of vehicle speeds. Data were collected from 91 permanent survey sites in England from a variety of speed limits, for March and April 2020, and processed. A Bayesian approach was taken to modelling the interactions between speed and flow data that produced results demonstrating how speed metrics vary when a reduction in 10,000 vehicles was detected at sites, grouped by speed limit.

The observed changes showed some variation by speed limit, with greater decreases on rural single carriageway roads with a 60-mph limit. The model returned results, when transformed for flow, that indicated changes in average speeds of between +0.851 and +2.232 mph. Changes in 85th percentile speeds were higher, increasing by between +0.851 and +3.126 mph. Further analysis of the highest-speed offenders indicated an even larger proportional increase in those travelling at 15mph above the posted speed limit, with higher-speed roads again demonstrating greater shifts.

This study is drawing attention to important issues that demand further analysis of additional variables, such as time of data and day of week, and which would be expected to elicit further insight into changes in speeds choice in these extraordinary times.

INTRODUCTION

On March 23rd 2020, the UK Government imposed a series of so-called 'lockdown' measures in response to the growing COVID19 pandemic. The Prime Minister Boris Johnson stated that, "People will only be allowed to leave their home for…very limited purposes". The four reasons were: shopping for basic necessities, doing one form of exercise a day, providing medical services, or going to work if it is absolutely vital. Schools were closed (apart from children of key workers) and very few shops remained open.

The UK Department for Transport has been collecting daily data on road traffic[i] at 275 Automatic Traffic Count (ATC) sites across Great Britain in a continuous series since 2011. This data features in Government briefings via PowerPoint slides but the underlying data has not been published for general use by researchers. At the same time, evidence has been raised by road safety professionals, (including police officers) regarding increased numbers of vehicles travelling at very high speeds, and a reduction in overall speed compliance[ii].

Local authorities across Great Britain maintain their own sets of ATCs for use in monitoring local traffic levels and speeds. The authors of this report have gathered data from a number of these ATCs for the months of March and April 2020 to review the changes in traffic on different roads, and review changes in traffic speeds at the same time. The purpose of this study is to analyse the relationship between changes in traffic levels and the speeds of vehicles that continued to use the road network during lockdown.

LITERATURE REVIEW

At this time, the authors have not identified any literature that references temporary changes in vehicle flows, density, and speeds during circumstances similar to the current pandemic. The relationship between speed and density is well understood and has been studied for many decades. Wang 2011[iii] summarises the various models created and proposes a family of speed-density models from the perspective that increased density results in reduced speeds. Traffic density and flow for the same road segment are different measures, but clearly interdependent. The current situation is resulting in a significant and semi-permanent reduction in traffic flows and we wish to investigate the impact on speeds.

Various internet searches were conducted to establish whether there is any similar live research being carried out at present. A number of countries or local administrations[iv] have reduced speed limits during the pandemic. This has been undertaken to protect the increasing number of vulnerable road users, such as cyclists and pedestrians, that are now using the road network in both urban and rural areas. As our study is looking at roads which have not been subject to a speed limit change, any evidence associated with those policy decisions is not considered in this paper.

Some international evidence has been published on the observed changes in speeds pre- and post-lockdown, including studies from the East Coast of the USA[v] where speeds in normally busy commuter periods have increased by more than 50%. This, of course, reflects the supressed speeds in congested traffic rather than speed choice by motorists on roads which may otherwise have also been free-flowing, but just with less traffic. No evidence has been gathered on the relationship between average 24 hour or free-flow speed with reduced flow / density.

It is worth noting that early evidence is emerging on the relationship between reduced traffic and reduced collisions and casualties. The French Road Safety Observatory published interim data[vi] showing a 75.6% reduction in casualties this April (4,234 to 1,099) compared to April 2019. Fatality numbers have only reduced by 55.8, however (233 to 103). Similar results are show in The Netherlands,[vii] with a 46% reduction in the six-week lockdown period compared to the average for the same time of year in the preceding three years. However, the report also highlighted that the number of fatalities per collision has increased by 14%; a similar finding to that in France. The data from the Netherlands also shows the biggest increase in collision severity is in less urbanised areas and on faster roads, with a speed limit of 80kmh (50mph) or higher.

SCOPE OF STUDY AND DATA

The data used in this study was obtained from 91 permanent traffic and speed detection loops operated by four local authorities in England. These Automatic Traffic Counters (ATCs) report data, often in real-time, to a web portal or similar system for analysis. The amount of detailed information collected is very significant and includes more detailed speed ranges, hourly counts and speeds, plus breakdowns by vehicle type e.g. motorcycle.

Authority A and Authority D are large county authorities in England. Authority B is a small, highly-urban local authority. Authority C is mixed-density and small in size.

TABLE 1 – DISTRIBUTION OF ATC LOCATION BY SPEED LIMIT AND AREA

Speed Limit (Mph)	Authority A	Authority B	Authority C	Authority D
20		1		
30	6	26	8	3
40	11	4	4	4
50	2		2	
60	8		3	4
70	3		1	1

For this study we exported daily traffic flows for all vehicles, together with five different speed measures:

- Average Speed
- 85th Percentile Speed
- Percentage of traffic exceeding the Posted Speed Limit (PSL)
- Percentage of traffic exceeding the Minimum Enforcement Threshold (MET) (PSL + 10% + 2mph)[viii]
- Percent of traffic exceeding the PSL by more than 15 MPH

These figures were therefore obtained for each ATC for every day in March and April 2020. Some ATCs had missing data for part of the period and were excluded from the analysis.

The intention is to review how the change in traffic flows during the lockdown period impacted upon the speed metrics selected, and any differences by speed limit. No analysis of variance between authorities was considered.

MODELS

A Bayesian approach to modelling the interactions between speed and flow data before and after the introduction of the lockdown was taken. Prior distributions were set for each variable, and data taken from the ATCs was used to update the parameters in these distributions. The resulting posterior distributions were then sampled using Markov-Chain-Monte-Carlo methods, using the *tensorflow*[ix] packages in *R*. In every instance of sampling, 1,000 samples were taken from 4 Markov chains, after a burn-in period of 1,000 steps. Data sampled from these posterior distributions was then used to draw conclusions about the impact of the lockdown on vehicular speeds and flow on the road network.

We proceed under the assumption that flow is Poisson distributed, with baseline mean flow values λ_i that varies by site, i, and that changed by a factor of $\exp(\theta)$ after lockdown. We assume that average speeds and 85th percentile speeds are normally distributed, and that their mean values, $\mu_{i,j}^{(1)}$ and $\mu_{i,j}^{(2)}$, are dependent linearly on flow, with coefficients $\beta_j^{(1)}$ and $\beta_j^{(2)}$ that vary by speed limit j, with baseline speeds *(intercepts)* $\gamma_i^{(k)}$ ($k \in \{1,2\}$) that vary by site. This allows for variation in sites that have the same speed limit but that experience different baseline speeds. Finally, we assume that the percentage of vehicles over the speed limit, the percentage of vehicles travelling at excessive speeds *(more than 15mph over the speed limit)*, and the percentage of vehicles travelling over the MET limit are all normally distributed with mean values, $\mu_{i,j}^{(3)}$, $\mu_{i,j}^{(4)}$ and $\mu_{i,j}^{(5)}$, that depend exponentially on flow, with coefficients $\beta_j^{(2)}$, $\beta_j^{(3)}$ and $\beta_j^{(4)}$ that vary by speed limit j and baseline speeds *(intercepts)* $\gamma_i^{(k)}$ ($k \in \{3,4,5\}$) that vary by site.

Formally, the following prior distribution was assumed for the speed and flow variables, for $i \in \{1,2,\dots,N\}$, $j \in \{1,2,\dots,M\}$, and $k \in \{1,2,3,4,5\}$:

$$flow_i \sim \mathrm{Pois}(\lambda_i)$$

$$avespeed_{i,j} \sim \mathrm{N}\left(\mu_{i,j}^{(1)}, \sigma_1^{(1)}\right)$$

$$eightyfifth_{i,j} \sim \mathrm{N}\left(\mu_{i,j}^{(2)}, \sigma_1^{(2)}\right)$$

$$overlim_{i,j} \sim \mathrm{N}\left(\mu_{i,j}^{(3)}, \sigma_1^{(3)}\right)$$

$$excessive_{i,j} \sim \mathrm{N}\left(\mu_{i,j}^{(4)}, \sigma_1^{(4)}\right)$$

$$overacpo_{i,j} \sim \mathrm{N}\left(\mu_{i,j}^{(5)}, \sigma_1^{(5)}\right)$$

$$\lambda_i = \exp(\theta \cdot lockdown + \alpha_i)$$

$$\theta \sim \mathrm{N}(0,3)$$

$$\alpha_i \sim \mathrm{N}(0,\sigma)$$

$$\mu_{i,j}^{(k)} = \gamma_i^{(k)} + \beta_j^{(k)} \cdot flow_i$$

$$\beta_j^{(k)} \sim \mathrm{N}\left(0, \sigma_2^{(k)}\right)$$

$$\gamma_i^{(k)} \sim \mathrm{N}(0,5)$$

$$\sigma, \sigma_1^{(k)}, \sigma_2^{(k)} \sim \mathrm{HalfCauchy}(0,1)$$

Here, $N = 88$ is the number of sites, $M = 5$ is the number of different speed limits (30mph, 40mph, 50mph, 60mph and 70mph) which are indexed as 1 to 5 in that order, $flow_i$ is the total flow at site i, $avespeed_{i,j}$, $eightyfifth_{i,j}$, $overlim_{i,j}$, $excessive_{i,j}$ and $overacpo_{i,j}$ are the average speed, 85th percentile speed, percentage of vehicles over the speed limit, percentage of vehicles travelling more than 15mph over the speed limit, and the percentage of vehicles travelling over the MET limit respectively at site i which has speed limit indexed by j, and $lockdown$ is a Boolean value determining whether the data was taken after 23/03/2020 (1) or not (0).

For technical reasons, to ensure that all data is of a similar order of magnitude in the model, flow is provided in tens of thousands of vehicles, both average speed and 85th percentile speed are provided in tens of miles per hour, and the proportions of vehicles over the speed limit and over the MET limit are provided in tens of percentage points.

Sampling the posterior of the model, given the data from the ATCs, will give approximate distributions for the model's parameters. Sampling $\exp(-\theta)$ will indicate the relative reductions in flow from before the lockdown to after the lockdown. Sampling the coefficients $\beta_j^{(k)}$ ($k \in \{1,2,\ldots,5\}$), on the other hand, will provide information of the effects on speed, via the various metrics afforded by the ATC data, of these observed reductions in flow. Together, this should provide a good picture of what happened to speed and flow on the road network during the lockdown.

Bayesian correlation tests were carried out to determine how well the model reflects the real-world observations. Correlation (ρ) was measured at each site between total daily flow and the following measures of speed: daily average speed; daily 85th percentile speeds; the logarithm of the percentage of vehicles travelling above the posted speed limit; the logarithm of the percentage of vehicles travelling at more than 15mph above the posted speed limit; and the logarithm of the percentage of vehicles exceeding the MET limit. The prior assumption is that the joint distribution between total daily flow and the chosen measure of speed is bivariate normal, $N(\mu, \Sigma)$, where

$$\mu = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix}, \qquad \Sigma = \begin{pmatrix} \sigma_1^2 & \rho\sigma_1\sigma_2 \\ \rho\sigma_1\sigma_2 & \sigma_2^2 \end{pmatrix},$$

$$\mu_1, \mu_2 \sim N(0,1000),$$

$$\sigma_1, \sigma_2 \sim U([0,1000]),$$

$$\rho \sim U([-1,1]).$$

Given the data provided by the ATCs, the posterior distribution for ρ was sampled to determine the correlation between total daily flows and each measure of speed. The following section describes the outcomes of these tests. Note that values of ρ near -1 indicate a strong negative correlation, values of ρ near 1 indicate a strong positive correlation, whilst values of ρ near 0 indicate a lack of discernible correlation.

Observed Changes

Before considering the results of the model it is valid to highlight the observed changes.

Figure 1 shows the average total daily flow across all the sites, grouped by the posted speed limit. Regardless of the speed limit, there was a marked decrease in the average total daily flow after the introduction of the lockdown on 23rd March, although there are clear signs that traffic flow was starting to fall in the week leading up to the restrictions as more people were encouraged to work from home, but schools were not yet closed. There are also slight increases in flow towards the end of April, although nowhere near as high as the pre-lockdown levels. The authors are aware that the trend towards pre-lockdown traffic levels has continued into May and early June. Interestingly, the flow patterns that distinguish weekdays from weekends persisted despite the lockdown, to a relatively similar extent. It is also worth noting that there were two bank holidays in April (Friday 10th and Monday 13th) which show reduced traffic levels in Figure 1.

Flows decreased more on higher-speed roads as shown in Table 2 with urban roads slightly less effect———ed, although still with flows less than half pre-lockdown levels.

TABLE 2 – CHANGES IN FLOW BEFORE AND AFTER LOCKDOWN ANNOUNCEMENT

Speed Limit	Change In flow	Percentage Change in Flow
30	**-6702**	**-58%**
40	**-85234**	**-59%**
50	**-13873**	**-64%**
60	**-5263**	**-63%**
70	**-9704**	**-64%**

FIGURE 1 – OBSERVED CHANGES IN AVERAGE TOTAL DAILY FLOW BEFORE AND AFTER THE LOCKDOWN

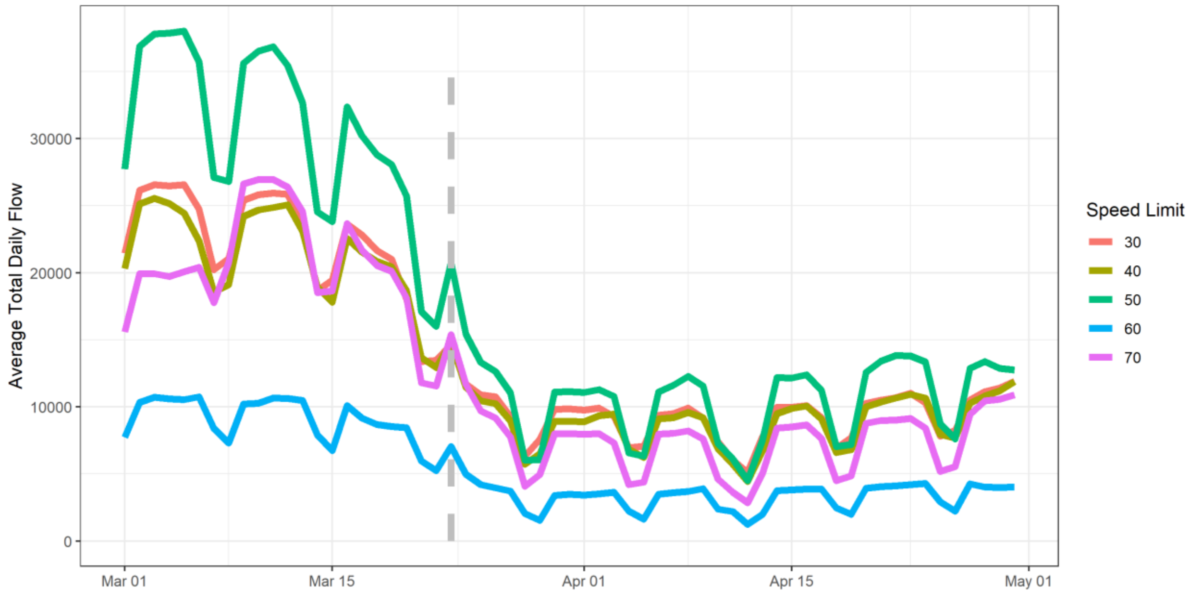


Figure 2 and Figure 3 show the average daily speeds and average 85th percentile speeds, both before and after the introduction of lockdown. There are clear increases in speeds leading up to the introduction of the lockdown, with highest speeds after the 23rd March when traffic flow was at its lowest. There is also a slight reduction in speed towards the end of April, as traffic flows started to increase.

FIGURE 2 – OBSERVED CHANGES IN AVERAGE DAILY SPEEDS BEFORE AND AFTER THE LOCKDOWN

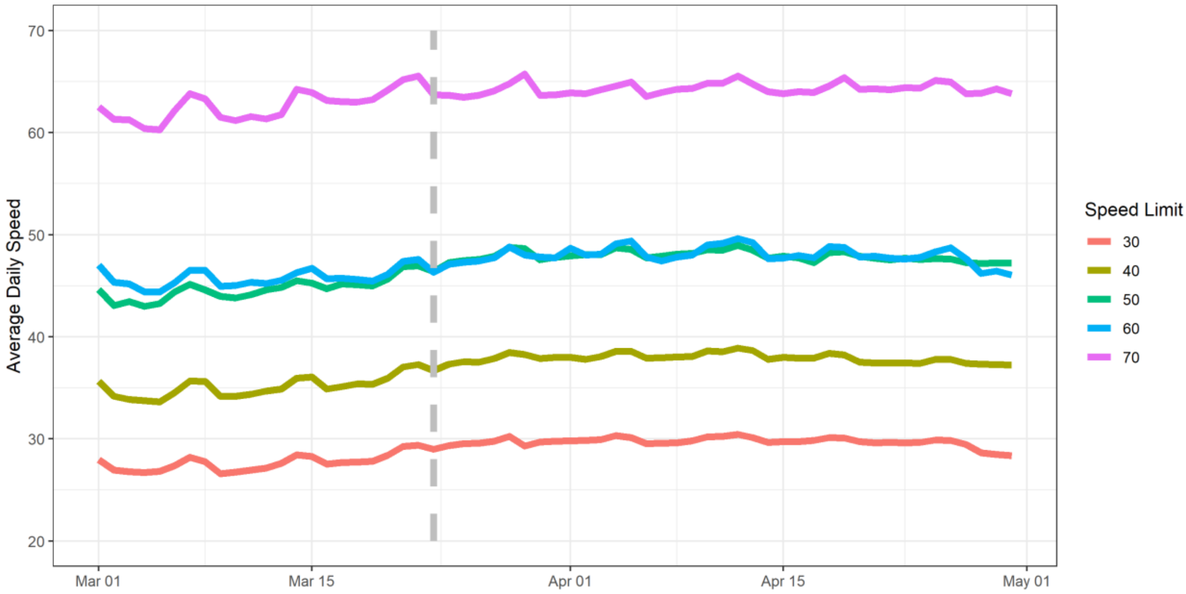


FIGURE 3 – OBSERVED CHANGES IN AVERAGE 85TH PERCENTILE SPEEDS BEFORE AND AFTER THE LOCKDOWN

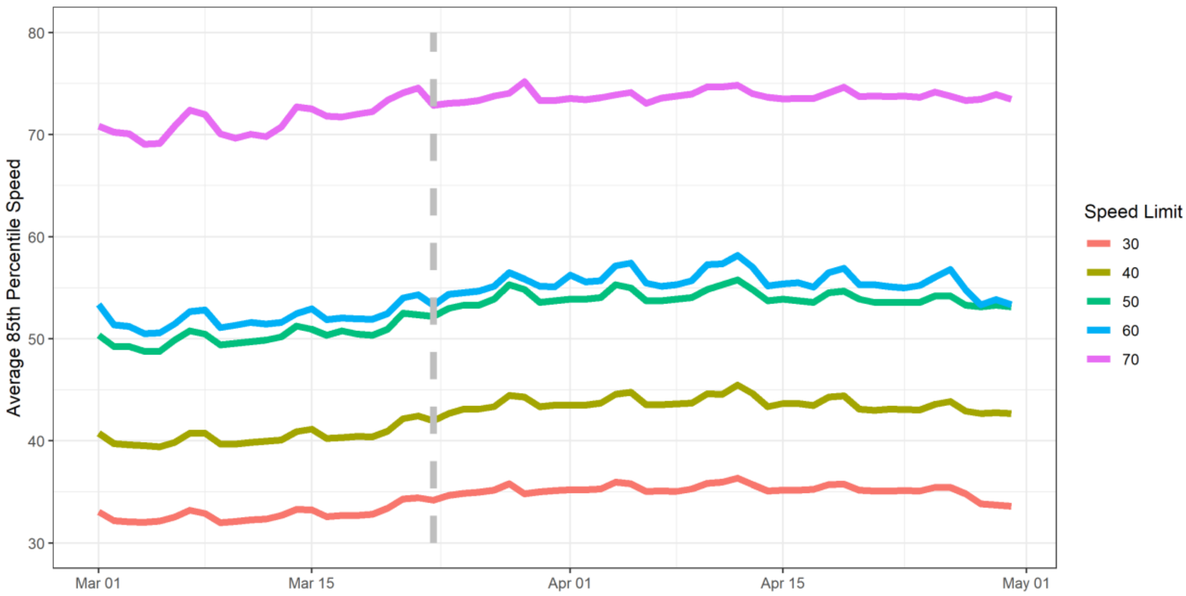


Figure 4, Figure 5 and Figure 6 show the observed changes in the average percentage of vehicles travelling over the speed limit, more than 15mph over the speed limit, and over the MET limit respectively. The increases in relative speeding levels observed in these three charts are more marked than in Figure 2 and Figure 3, as they experience the culmination of both fewer vehicles on the road and higher vehicle speeds.

FIGURE 4 – OBSERVED CHANGES IN THE AVERAGE PERCENTAGE OF VEHICLES OVER THE SPEED LIMIT BEFORE AND AFTER THE LOCKDOWN

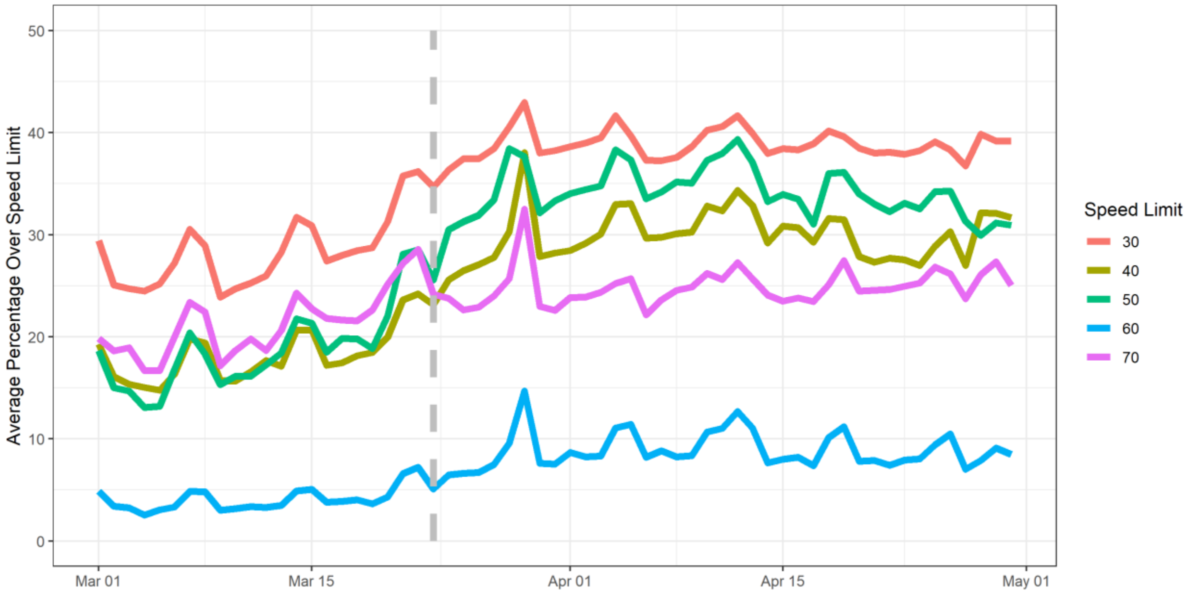


FIGURE 5 – OBSERVED CHANGES IN THE AVERAGE PERCENTAGE OF VEHICLES MORE THAN 15MPH OVER THE LIMIT BEFORE AND AFTER THE LOCKDOWN

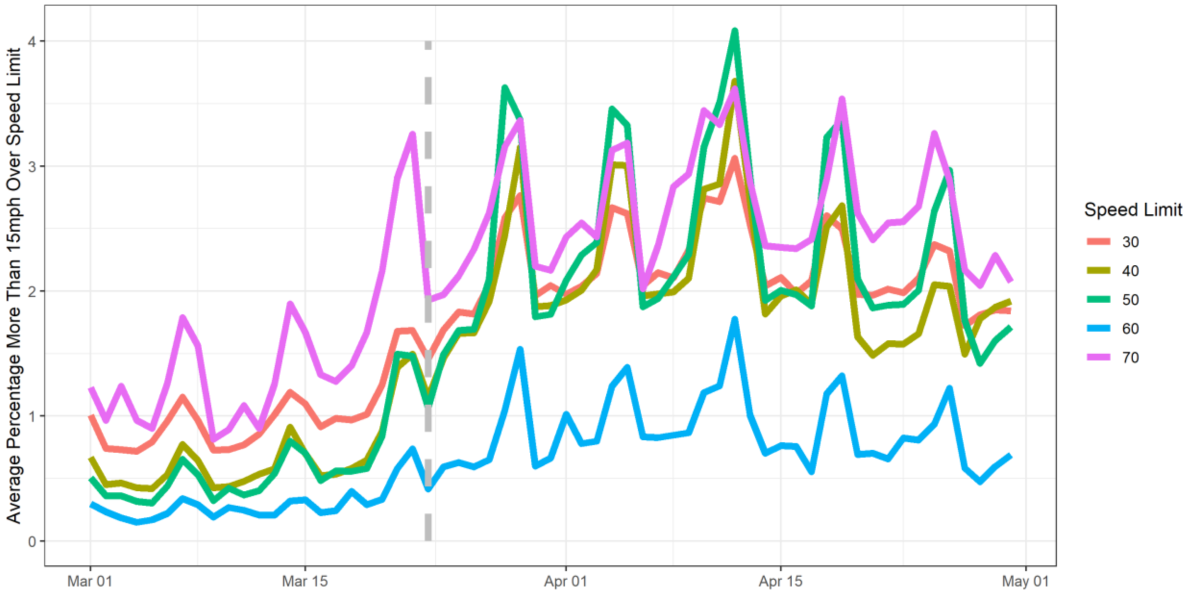
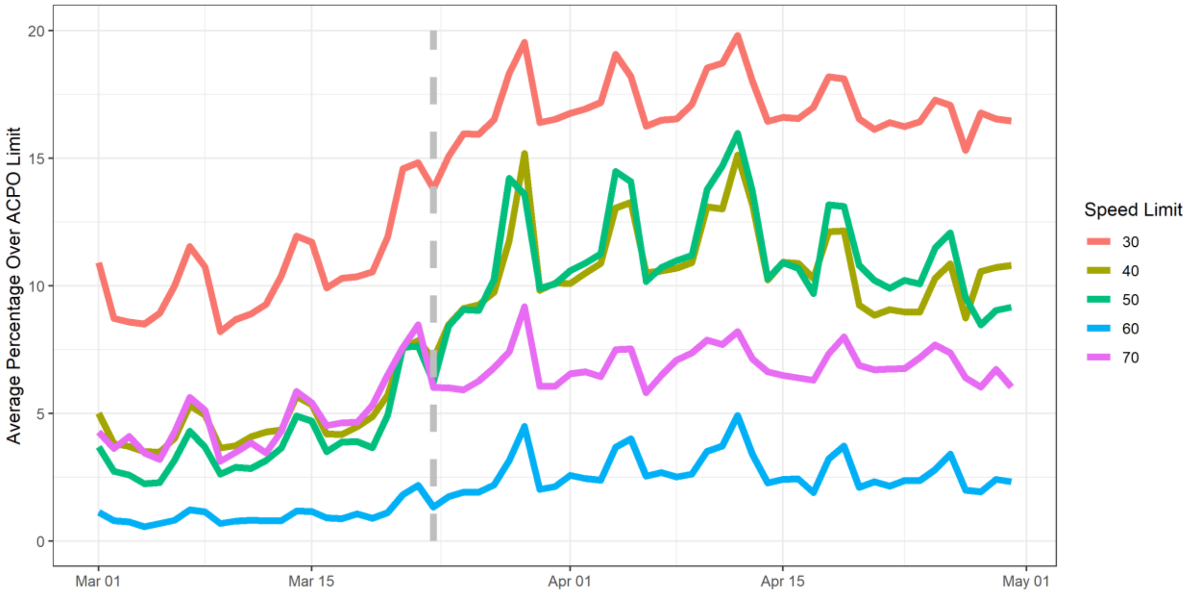


FIGURE 6 – OBSERVED CHANGES IN THE AVERAGE PERCENTAGE OF VEHICLES OVER THE MET LIMIT BEFORE AND AFTER THE LOCKDOWN



Results

Table 3 below shows a summary of the parameters sampled from the posterior distributions in the model.

The distribution of $\exp(\theta)$ shows the relative change in traffic flow from before the lockdown to after the lockdown. It can be interpreted as expecting a $100(1\text{-}\exp(\theta))\%$ reduction in flow after the introduction of lockdown.

The distribution of $\beta_i^{(1)}$, $i \in \{1,2,\dots,5\}$, shows the change in daily average speeds (in tens of miles per hour) resulting from an increase in flow of 10,000 vehicles at a site with speed limit indexed by i. It can be interpreted as expecting a $10\left(-\beta_i^{(1)}\right)$mph increase in daily average speeds, at a site with speed limit indexed by i, following a decrease in flow of 10,000 vehicles. Likewise, the distribution of $\beta_i^{(2)}$, $i \in \{1,2,\dots,5\}$, shows the change in daily 85th percentile speeds (in tens of miles per hour) as flow varies. This can be interpreted as expecting a $10\left(-\beta_i^{(2)}\right)$mph increase in daily 85th percentile speeds following a decrease in flow of 10,000 vehicles, at a site with speed limit indexed by i.

The distribution of $\exp\left(\beta_i^{(3)}\right)$, $i \in \{1,2,\dots,5\}$, shows the relative change in the proportion of vehicles travelling over the posted speed limit (indexed by i) as a result of flow increasing by 10,000 vehicles. It can be interpreted as expecting a $100\left(\exp\left(-\beta_i^{(3)}\right) - 1\right)\%$ increase in the proportion of vehicles travelling over the speed limit, at a site with speed limit indexed by i, following a decrease in flow of 10,000 vehicles. Likewise, the distributions of $\exp\left(\beta_i^{(4)}\right)$ and $\exp\left(\beta_i^{(5)}\right)$, $i \in \{1,2,\dots,5\}$, show the relative change in the proportion of vehicles travelling more than 15mph over the speed limit and in the proportion of vehicles travelling over the

MET respectively as flow changes. These can be interpreted as expecting a $100\left(\exp\left(-\beta_i^{(4)}\right)-1\right)\%$ increase in the proportion of vehicles travelling more than 15mph over the speed limit, and a $100\left(\exp\left(-\beta_i^{(5)}\right)-1\right)\%$ increase in the proportion of vehicles travelling more than over the MET, following a decrease in flow of 10,000 vehicles (where the speed limit of the site is indexed by i).

TABLE 3 – SUMMARY STATISTICS OF SAMPLED MODEL PARAMETERS

Parameter	Summary Statistics		Quantiles				
	Mean	*SD*	*2.50%*	*25%*	*50%*	*75%*	*97.50%*
$\boldsymbol{\theta}$	-0.86533	0.026617	-0.91195	-0.88739	-0.86575	-0.84309	-0.81889
$\boldsymbol{\beta_1^{(1)}}$	-0.1268	0.002752	-0.13228	-0.12865	-0.12682	-0.12484	-0.12145
$\boldsymbol{\beta_2^{(1)}}$	-0.15148	0.003548	-0.1583	-0.15393	-0.15145	-0.14902	-0.14471
$\boldsymbol{\beta_3^{(1)}}$	-0.12999	0.006654	-0.14285	-0.13455	-0.13004	-0.12552	-0.11699
$\boldsymbol{\beta_4^{(1)}}$	-0.42359	0.010443	-0.44427	-0.43066	-0.42353	-0.41668	-0.40284
$\boldsymbol{\beta_5^{(1)}}$	-0.10339	0.00731	-0.118	-0.10827	-0.10347	-0.09842	-0.08871
$\boldsymbol{\beta_1^{(2)}}$	-0.12698	0.003039	-0.13293	-0.1291	-0.12703	-0.12498	-0.1211
$\boldsymbol{\beta_2^{(2)}}$	-0.15735	0.003933	-0.165	-0.15997	-0.15738	-0.15462	-0.14973
$\boldsymbol{\beta_3^{(2)}}$	-0.14615	0.007044	-0.15989	-0.15069	-0.1463	-0.14158	-0.13193
$\boldsymbol{\beta_4^{(2)}}$	-0.59378	0.01139	-0.61587	-0.60135	-0.59377	-0.58629	-0.57081
$\boldsymbol{\beta_5^{(2)}}$	-0.13269	0.007768	-0.14753	-0.13808	-0.13261	-0.12734	-0.11731
$\boldsymbol{\beta_1^{(3)}}$	-0.08413	0.00267	-0.08917	-0.08601	-0.08418	-0.08221	-0.07892
$\boldsymbol{\beta_2^{(3)}}$	-0.16194	0.00545	-0.17326	-0.16522	-0.16184	-0.15821	-0.15165
$\boldsymbol{\beta_3^{(3)}}$	-0.31590	0.01597	-0.34783	-0.32648	-0.31583	-0.30394	-0.28674
$\boldsymbol{\beta_4^{(3)}}$	-1.04245	0.05893	-1.16302	-1.07960	-1.03784	-0.99846	-0.94518
$\boldsymbol{\beta_5^{(3)}}$	-0.15030	0.02126	-0.19169	-0.16190	-0.14962	-0.13674	-0.10555
$\boldsymbol{\beta_1^{(4)}}$	-0.11508	0.00241	-0.11996	-0.11665	-0.11508	-0.11347	-0.11036
$\boldsymbol{\beta_2^{(4)}}$	-0.50239	0.01470	-0.53238	-0.51152	-0.50282	-0.49284	-0.47204
$\boldsymbol{\beta_3^{(4)}}$	-1.08600	0.06670	-1.21882	-1.13520	-1.08010	-1.03545	-0.97365
$\boldsymbol{\beta_4^{(4)}}$	-2.12421	0.13671	-2.38650	-2.21349	-2.12843	-2.02406	-1.88080
$\boldsymbol{\beta_5^{(4)}}$	-0.68448	0.11456	-0.87972	-0.75423	-0.69286	-0.59337	-0.48677
$\boldsymbol{\beta_1^{(5)}}$	-0.08538	0.00243	-0.09010	-0.08703	-0.08550	-0.08382	-0.08052
$\boldsymbol{\beta_2^{(5)}}$	-0.30995	0.00696	-0.32213	-0.31560	-0.30937	-0.30496	-0.29699
$\boldsymbol{\beta_3^{(5)}}$	-0.71361	0.03798	-0.78855	-0.73846	-0.71768	-0.68701	-0.64733
$\boldsymbol{\beta_4^{(5)}}$	-2.00998	0.20513	-2.26329	-2.14892	-2.09025	-1.91712	-1.60165
$\boldsymbol{\beta_5^{(5)}}$	-0.32606	0.02580	-0.37873	-0.33916	-0.32332	-0.30920	-0.27199

The results in this table can be summarised as follows.

TABLE 4 – INTERPRETATION OF MODEL PARAMETERS

Result of reduction in flow by 10,000 vehicles	**Speed Limit**				
	30mph	**40mph**	**50mph**	**60mph**	**70mph**
Increase in average speed	+1.27	+1.51	+1.30	+4.24	+1.03
95% CI	*[1.21,1.32]*	*[1.45,1.58]*	*[1.17,1.43]*	*[4.03,4.44]*	*[0.89,1.18]*
Increase in 85th percentile speed	+1.27	+1.57	+1.46	+5.94	+1.33
95% CI	*[1.21,1.33]*	*[1.5,1.65]*	*[1.32,1.6]*	*[5.71,6.16]*	*[1.17,1.48]*
Increase in proportion of vehicles over the speed limit	+8.78%	+17.58%	+37.15%	+183.62%	+16.22%
95% CI	*[8.21,9.33]*	*[16.38,18.92]*	*[33.21,41.6]*	*[157.33,219.96]*	*[11.13,21.13]*
Increase in proportion of vehicles over the MET	+8.91%	+36.34%	+104.13%	+646.32%	+38.55%
95% CI	*[8.39,9.43]*	*[34.58,38.01]*	*[91.04,120.02]*	*[396.12,861.47]*	*[31.26,46.04]*
Increase in proportion of vehicles more than 15mph over the speed limit	+12.2%	+65.27%	+196.24%	+736.63%	+74.02%
95% CI	*[11.67,12.74]*	*[60.33,70.3]*	*[164.76,238.32]*	*[555.88,987.54]*	*[59.12,86.22]*

Figure 7

Appendix 2 – Scatter Plots

Figure 12

Bayesian correlation tests were carried out to ascertain how accurately the model reflects the observations at each site. The plots are shown in Appendix 1 with the associated scatter plots in Appendix 2. These measured the correlation (ρ) at each site between total daily flow and the following measures of speed: daily average speed (Figure 7 and (Figure 12); daily 85th percentile speeds (Figure 8 and Figure 13); the logarithm of the percentage of vehicles travelling above the posted speed limit (Figure 9 and Figure 14); the logarithm of the percentage of vehicles travelling at more than 15mph above the posted speed limit (Figure 10 and Figure 15); and the logarithm of the percentage of vehicles exceeding the MET (Figure 11 and Figure 16). For each correlation test, there is a plot showing the mean value of a sample of ρ, inside a 95% confidence interval, as well as a collection of scatter plots at each site whose x-axes display total daily flow and whose y-axes display the measure of speed. Note that these scatter plots have had their axes removed to visualise the extent of the correlation more clearly, and each is plotted to a different scale.

Figure 7, Figure 9, Figure 11 and Figure 10, alongside their associated scatter plots, show that there is a strong negative correlation at each site between total daily flow and average speeds, as well as with the logarithms of the percentages of vehicles over the speed limit, more than 15mph over the speed limit, and over the MET. However, Figure 8 shows that fewer sites exhibit as strong a correlation between total daily flow and 85th percentile speeds. This may, however, be an artifact of the data. At a large number of sites (but not all sites, due to differences in recording techniques in different regions), vehicle speeds are collected as integer values (in km/h) rather than absolute values, resulting in more discrete 85th percentile speeds. This can be seen in Figure 13, where one can see that there may have been better correlation had these values not been rounded. Nonetheless, this should be borne in mind.

Discussion and Recommendations

The significant and sustained drop in vehicle flow seen in the national data was clearly reflected in the period after lockdown, although flows had already started to decrease in the week before, due to advice recommending the end of non-essential travel. The data allows for a comparison of periods immediately prior to the lockdown announcement on 23rd March 2020. Pre-Lockdown is considered to include 23rd March as the announcement was made in the evening of that day.

The results have been expressed in terms of a change in average daily flows (per 10,000 vehicles) and these averages are shown in Figure 1 for the two-month analysis period. Due to the individual characteristics of the sites in each speed limit, average flows were different in each group of sites and therefore a change of 10,000 vehicles represents a different percentage change. Table 4 summarises an adjustment to the results shown in Table 4 to reflect the average flows shown in Table 2.

Changes to average and 85th percentile speeds bear side-by-side comparison as they illustrate both the difference in speed changes between speed limits, and indicate a shift towards much higher speeds by a greater percentage of drivers. In 30mph limits there is no difference in the change in both average speed and 85th percentiles speeds (+0.851 mph) but in 60mph limits, for example, there is a clear difference with average speeds up 2.232 mph and 85th percentile speeds up 3.126 mph. This means that speed choice is higher for the average driver, but even more so for the top-end speeder.

There is an argument that the speed value in different speed limits is not the most relevant number and that change relative to the limit should be considered instead. For example, is a 1 mph change in speed in a 30 mph limit the same as a 2 mph change in a 60 mph limit? In either case, the increases in speeds in 60 mph limits are still above those in 30 mph limits.

TABLE 5 – INTERPRETATION OF MODEL PARAMETERS TRANSFORMED FOR FLOW

Result of reduction in flow by 10,000 vehicles	Speed Limit				
	30mph	**40mph**	**50mph**	**60mph**	**70mph**
Increase in average speed	+0.851	+1.287	+1.803	+2.232	+0.999
Increase in 85th percentile speed	+0.851	+1.338	+2.025	+3.126	+1.291

It is worth noting that compliance in 60mph limits is much better, both before and after the lockdown period than other limits, with speeding only exhibited by 8.85% of vehicles, compared to 36.13% in 30 mph limits.

In the UK, it is commonly understood that although exceeding the speed limit is an offence, there are minimum thresholds below which a penalty notice will not be issued. The Minimum Enforcement Threshold is well understood by the public and been referred to by the media for several decades, and this threshold is commonly used by police forces and local authorities in justifying the installation of enforcement equipment. Understanding the number and percentage of drivers exceeding this threshold is therefore important.

The results show that the change in proportions falling into this category on 30mph roads is similar to that seen for those now exceeding the limit. This indicates little change in the shape of the speed compliance profile and that in these speed limits there is a general increase in vehicle speeds in all bands. This is less the case in 40 mph and 70mph limits, where the models show a proportional increase of around twice that for motorists travelling above the limit. In 50mph limits the proportion is around 2.8 times that seen for motorists exceeding the limit and in 60mph limits it is around 3.5 time the same figure. There is value in restating that the number of motorists in 60mph limits choosing to travel at these speeds is still low, but it points to a difference in speed choices on roads with alternative speed limits.

The figures do indicate far higher speeds on faster roads, and more high-end speeding is backed up by the review of the results for the percentage of vehicles travelling at 15mph above the limit. The model provides proportional increases per 10,000 change in vehicles that are higher than those seen for vehicles over the MET. This is exhibited in all limits, although this is most pronounced on 50 mph and 60 mph roads.

Although the purpose of this study was to review changes before and after lockdown, and not analyse other periods, it can be clearly seen that there are much higher spikes in vehicle speeds at weekends, especially for those significantly over the limit. This traffic is much more likely to be recreational, rather than work related, but it may also be a factor associated with very quiet roads.

FURTHER ANALYSIS

This study has only reviewed a limited time period during lockdown at a fixed number of sites and the evidence would be made stronger by increasing the number of surveys analysed from different parts of the country and with better coverage in certain limits (20mph, for example). Extending the analysis period into February would allow a greater 'before lockdown' period, although it would run into a one-week school holiday period which would see reduced traffic flows. Extension into May and June is also possible, although lockdown restrictions were eased gradually during this period and traffic flows have increased considerably, with people returning to work and undertaking more leisure and shopping activities.

We would also wish to see a higher definition of the 85th percentile data, although the analysis indicates that it provides significant and reliable results as is.

The existing data would allow for a more detailed analysis of weekday and weekend data and possibly examine the observed increases in speeds at weekends. One analysis would be to review whether the reduced flows and increased speeds fit the same model, or whether they indicate a much more marked shift in speed choice that would reflect the different drivers using the roads in these periods.

There is other data available which was not extracted from the ATCs that would allow for analysis of time periods during the day. This would allow an examination of review whether speed choice was more affected in peak hours, evenings or at night. This could also identify whether speeds were supressed in the pre-lockdown period by traffic congestion (density) and if these results are just displaying a natural progression to slightly higher speeds in more free-flowing traffic.

Finally, there would also be the possibility of extracting data by vehicle types. This would only cover cars, goods vehicles and motorcycles but would nevertheless provide some insight into patterns for different motorists.

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APPENDIX 1 – CORRELATION VALUES

FIGURE 7 – CORRELATION VALUES BY SITE COMPARING DAILY AVERAGE SPEED TO TOTAL DAILY FLOW

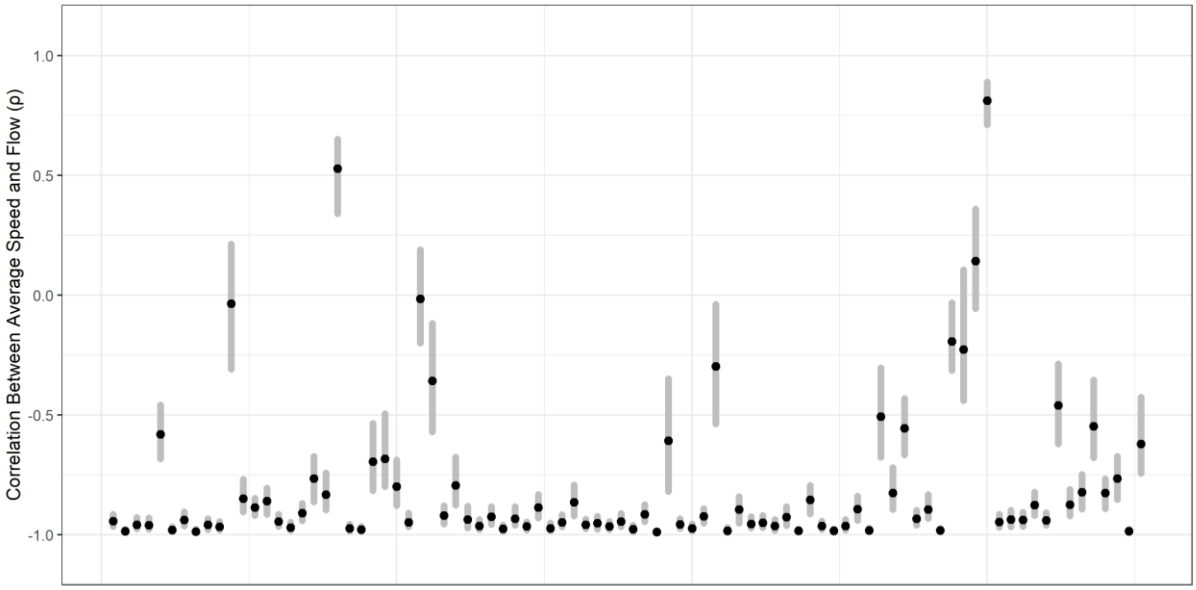


FIGURE 8 – CORRELATION VALUES BY SITE COMPARING DAILY 85TH PERCENTILE SPEED TO TOTAL DAILY FLOW

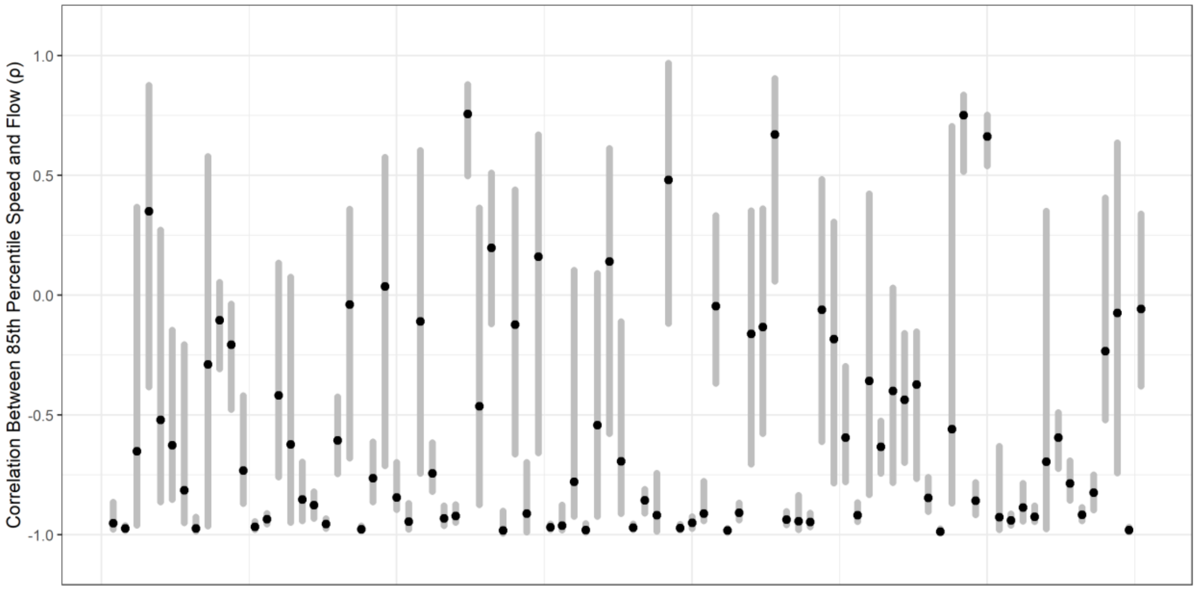


FIGURE 9 – CORRELATION VALUES BY SITE COMPARING LOG(% OVER LIMIT) TO TOTAL DAILY FLOW

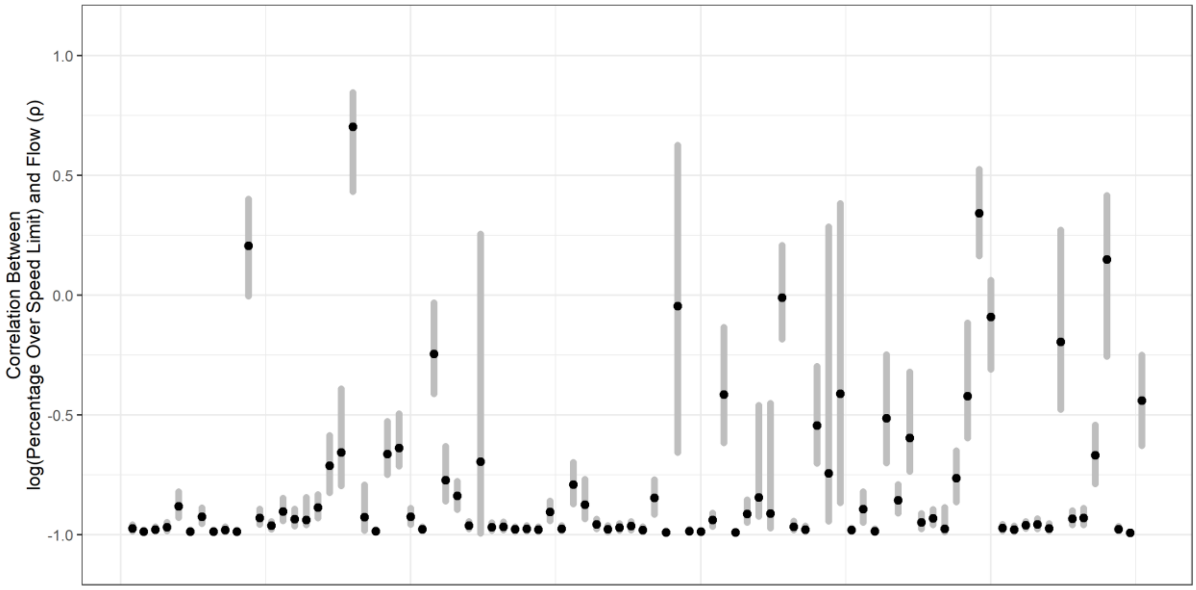


FIGURE 10 – CORRELATION VALUES BY SITE COMPARING LOG(% OVER LIMIT +15MPH) TO TOTAL DAILY FLOW

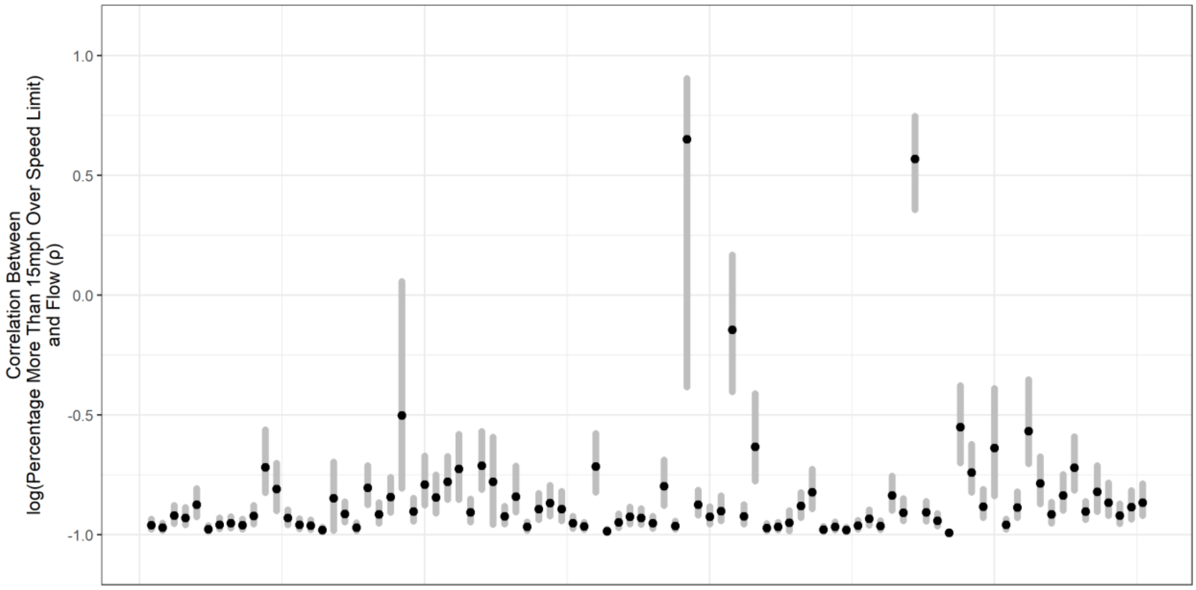
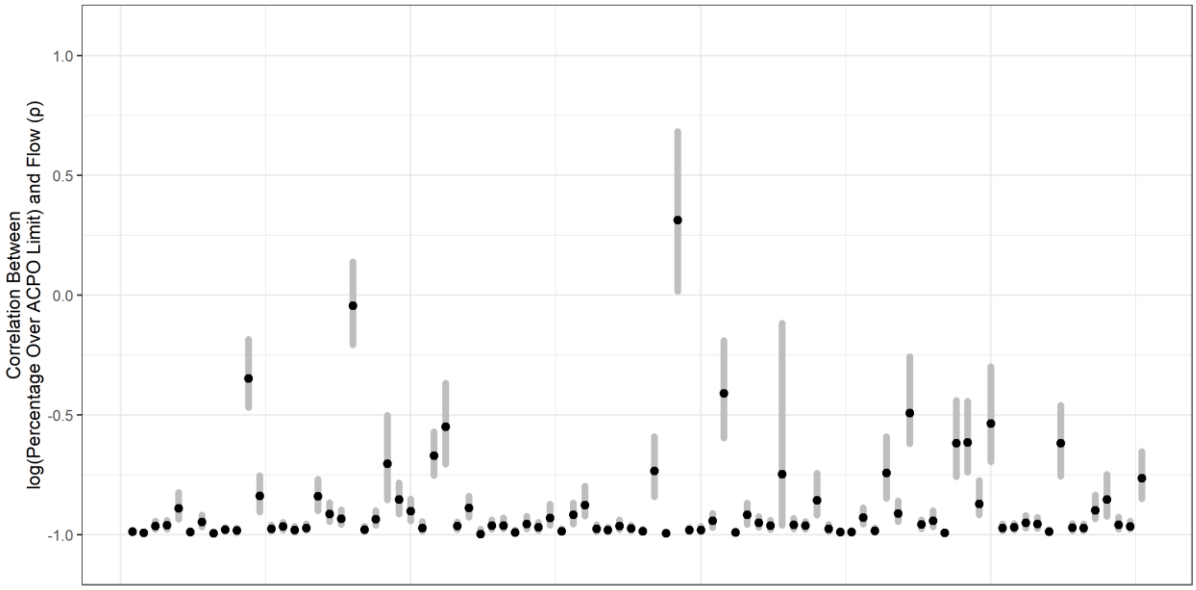


FIGURE 11 – CORRELATION VALUES BY SITE COMPARING LOG(% OVER MET) TO TOTAL DAILY FLOW



APPENDIX 2 – SCATTER PLOTS

FIGURE 12 – SCATTER PLOTS FOR INDIVIDUAL SITES COMPARING DAILY AVERAGE SPEED TO TOTAL DAILY FLOW

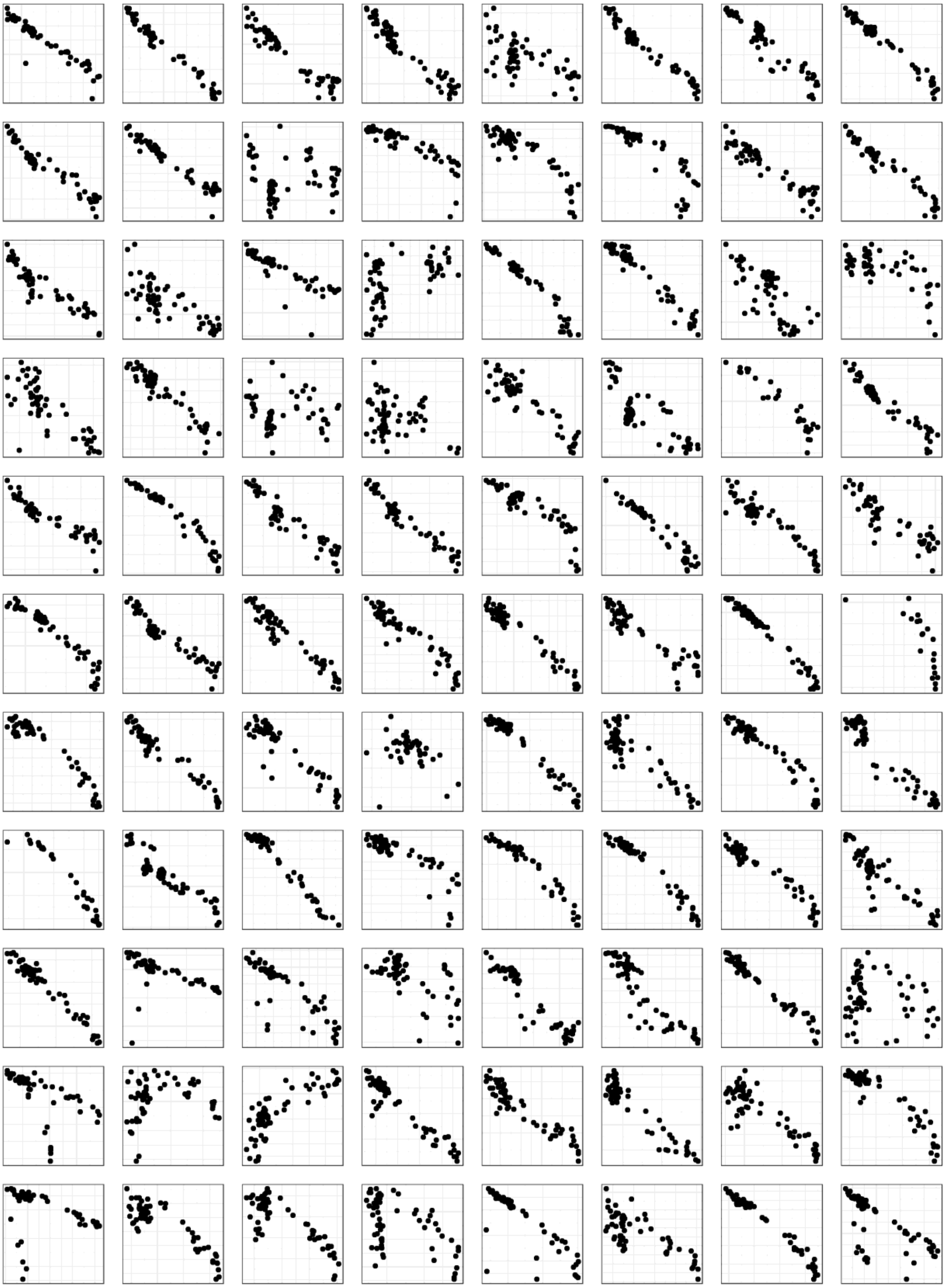


FIGURE 13 – SCATTER PLOTS FOR INDIVIDUAL SITES COMPARING DAILY 85TH PERCENTILE SPEED TO TOTAL DAILY FLOW

FIGURE 14 – SCATTER PLOTS FOR INDIVIDUAL SITES COMPARING LOG(% OVER LIMIT) TO TOTAL DAILY FLOW

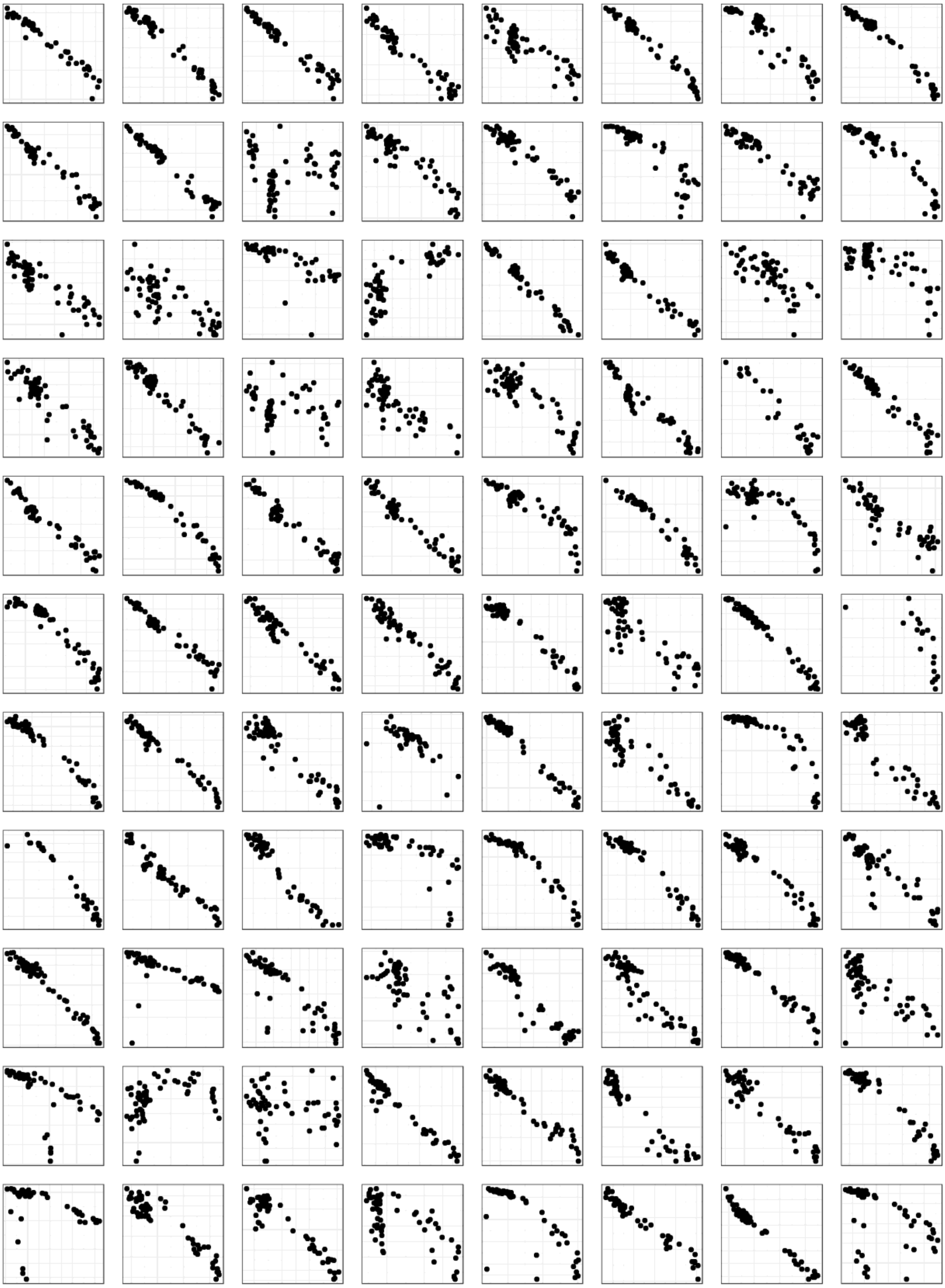


FIGURE 15 – SCATTER PLOTS FOR INDIVIDUAL SITES COMPARING LOG(% OVER LIMIT +15MPH) TO TOTAL DAILY FLOW

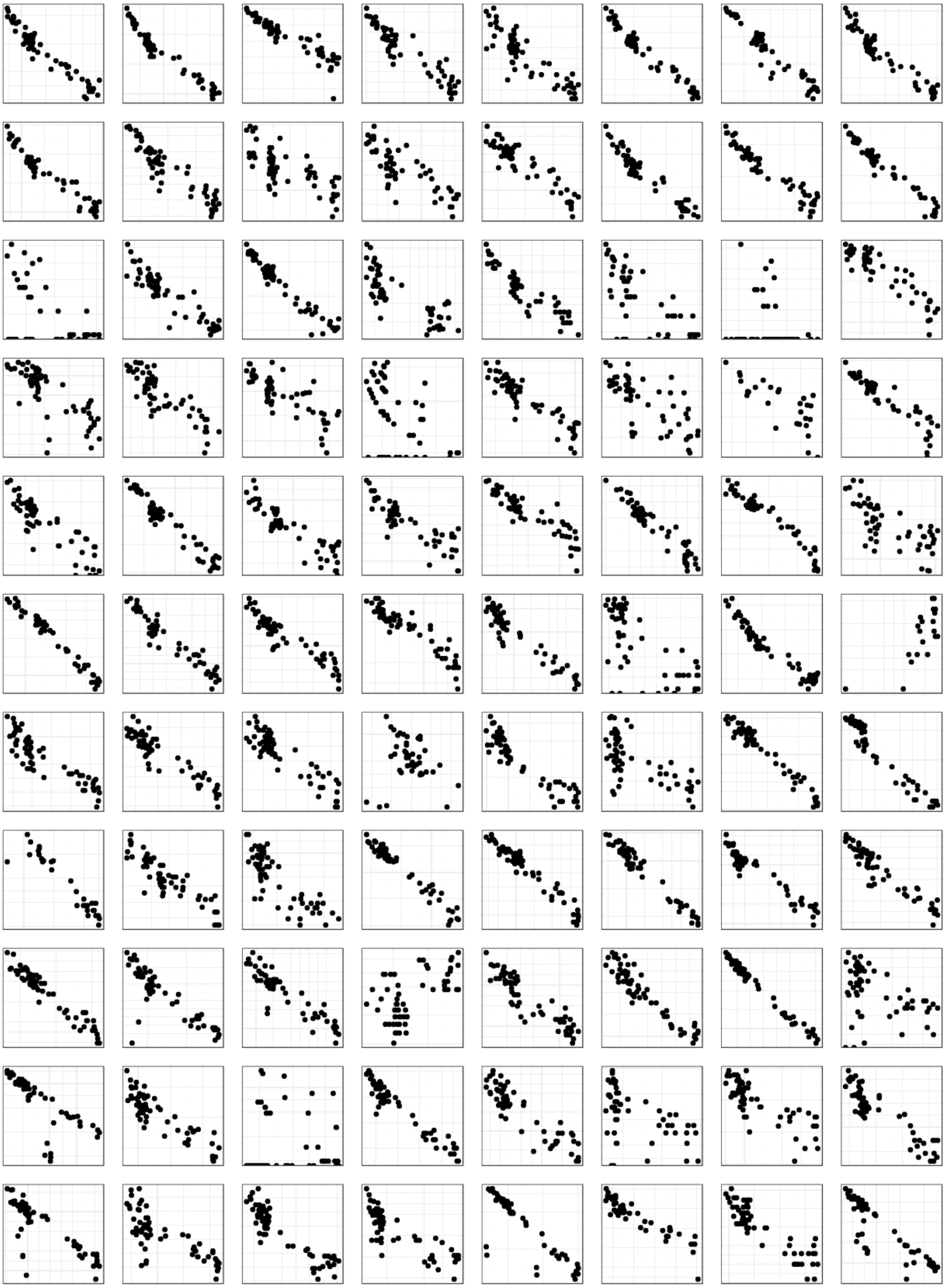
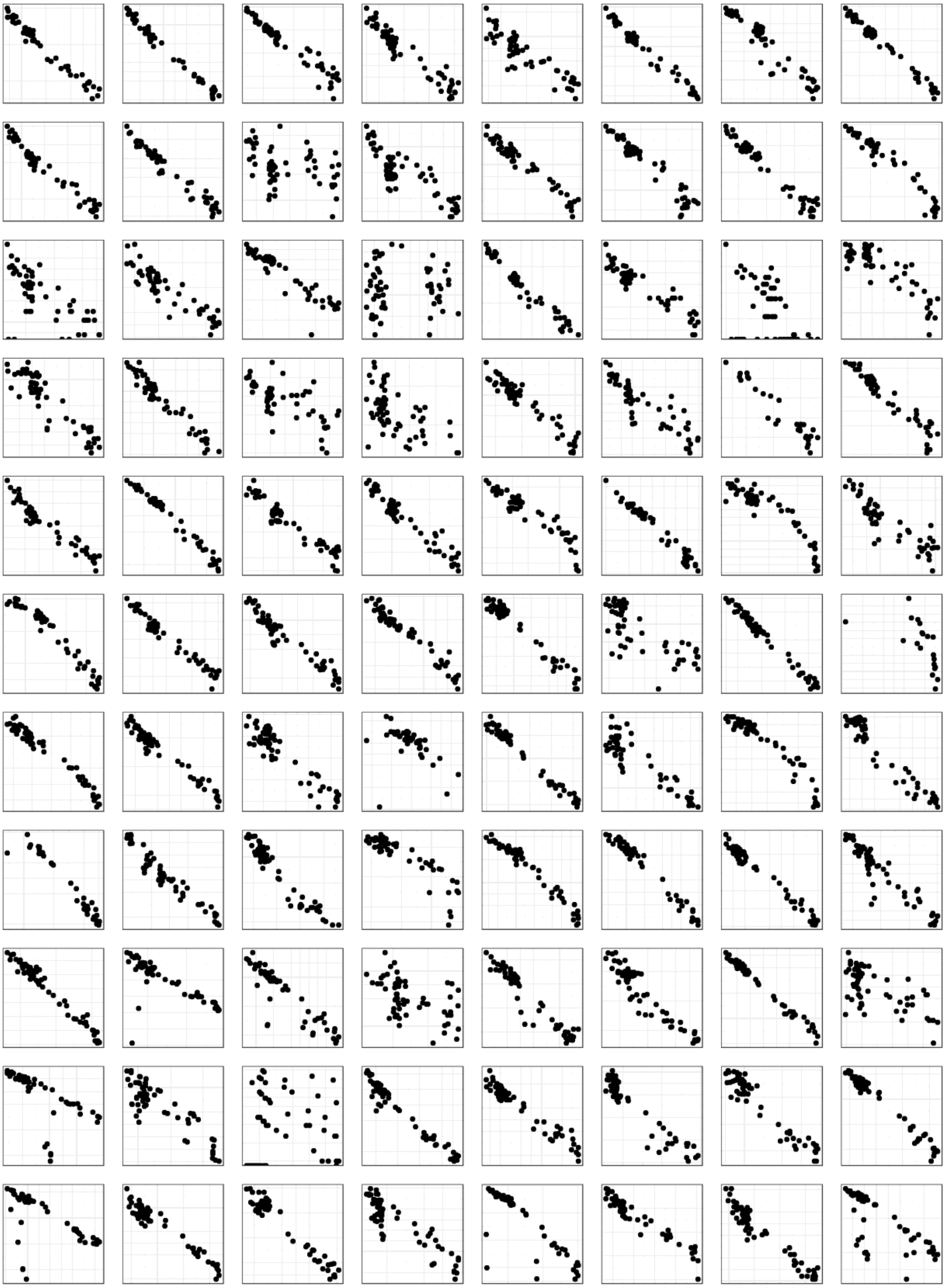


FIGURE 16 – SCATTER PLOTS FOR INDIVIDUAL SITES COMPARING LOG(% OVER MET THRESHOLD) TO TOTAL DAILY FLOW



CONCLUSION

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