MTO Major, DRCOND

The time series comprises all accidents which resulted in major injury. The data were aggregated to monthly time series from January 1992 to December 1998. So there are $n = 84$ observations. May 1996 corresponds to observation #53 in this series. There are 16 time series corresponding to the variables for hour window (11PM, 12AM, 1AM, 2AM), weekgroup (SunWed, ThuSat) and driver condition (sober, drunk). The codes used and their defintions are given in the table below.

#	Code	Definition
1	PM11SS	11PM SunWed Sober
2	AM12SS	12AM SunWed Sober
3	AM1SS	1AM SunWed Sober
4	AM2SS	2AM SunWed Sober
5	PM11TS	11PM ThuSat Sober
6	AM12TS	12AM ThuSat Sober
7	AM1TS	1AM ThuSat Sober
8	AM2TS	2AM ThuSat Sober
9	PM11SD	11PM SunWed Drunk
10	AM12SD	12AM SunWed Drunk
11	AM1SD	1AM SunWed Drunk
12	AM2SD	2AM SunWed Drunk
13	PM11TD	11PM ThuSat Drunk
14	AM12TD	12AM ThuSat Drunk
15	AM1TD	1AM ThuSat Drunk
16	AM2TD	2AM ThuSat Drunk

May 1996 corresponds to observation #53 in this series. A step intervention model defined by,

$$z_t = \mu + \delta_1 \xi_t + N_t$$

where N_t is the error term. Based on the pre-intervention data we assume initially that N_t is normal and independent, so ordinary multiple linear regression can be used. The intervention series are defined by,

$$\xi_t = \begin{cases} 0 & t < 53 \\ 1 & t \geq 53 \end{cases}$$

The pre-intervention series is fairly short so the following two-step approach to the ARIMA identification of the error term N_t will be used. In the first stage the model in eqn. (1) is fit using standard regression. Then the residuals, the estimated values, $\hat{N}_t$, are obtained and the residual autocorrelation of these residuals is examined. This approach should be expected to work well and is indeed theoretically superior to the alternative approach of basing the model identification on the pre-intervention residuals. The reason for this is that in the estimates of the autocorrelations of $\hat{N}_t$ are first-order efficient as are the estimates in the pre-intervention approach. However since the sample size is larger, this approach provides better estimates.

Regression Results

In the residual autocorrelation, a small amount of positive autocorrelation is detected. Hence these initial regression estimates of the intervention are statistically efficient but due to the small amount of positive autocorrelation, their significance is a little overstated. An ARIMA intervention will be below and it will be shown that there are only minor changes in the results below.

		Estimate	SE	TStat	PValue
PM11SS	1	1.38462	0.153925	8.99539	7.34968×10^{-14}
	ξ	**-0.478365**	**0.249387**	**-1.91817**	**0.0585706**

		Estimate	SE	TStat	PValue
AM12SS	1	1.88462	0.188355	10.0057	8.88178×10^{-16}
	ξ	-0.353365	0.30517	-1.15793	0.250254

		Estimate	SE	TStat	PValue
AM1SS	1	1.28846	0.138821	9.28144	1.9984×10^{-14}
	ξ	**-0.413462**	**0.224916**	**-1.83829**	**0.0696404**

		Estimate	SE	TStat	PValue
AM2SS	1	1.92308	0.179189	10.7321	0.
	ξ	**-0.579327**	**0.290319**	**-1.99548**	**0.0493104**

		Estimate	SE	TStat	PValue
PM11TS	1	2.59615	0.220541	11.7717	0.
	ξ	**-1.40865**	**0.357318**	**-3.9423**	**0.000169088**

		Estimate	SE	TStat	PValue
AM12TS	1	3.42308	0.300949	11.3743	0.
	ξ	**-1.79808**	**0.487593**	**-3.68766**	**0.000405503**

		Estimate	SE	TStat	PValue
AM1TS	1	1.61538	0.167885	9.62196	4.21885×10^{-15}
	ξ	-0.0528846	0.272005	-0.194425	0.846324

		Estimate	SE	TStat	PValue
AM2TS	1	2.40385	0.226379	10.6187	0.
	ξ	0.0961538	0.366776	0.26216	0.793856

		Estimate	SE	TStat	PValue
PM11SD	1	1.38462	0.153925	8.99539	7.34968×10^{-14}
	ξ	**-0.478365**	**0.249387**	**-1.91817**	**0.0585706**

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		Estimate	SE	TStat	PValue
PM11TD	1	2.59615	0.220541	11.7717	0.
	ξ	**-1.40865**	**0.357318**	**-3.9423**	**0.000169088**

		Estimate	SE	TStat	PValue
AM12TD	1	3.42308	0.300949	11.3743	0.
	ξ	**-1.79808**	**0.487593**	**-3.68766**	**0.000405503**

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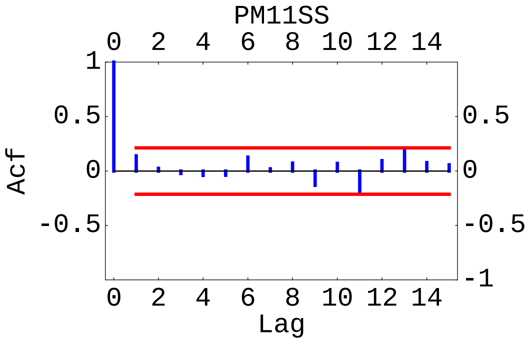
		Estimate	SE	TStat	PValue
AM2TD	1	2.40385	0.226379	10.6187	0.
	ξ	0.0961538	0.366776	0.26216	0.793856

Residual Autocorrelation Analysis

The residual autocorrelation from the regression model are examined and used to select tentative ARIMA models.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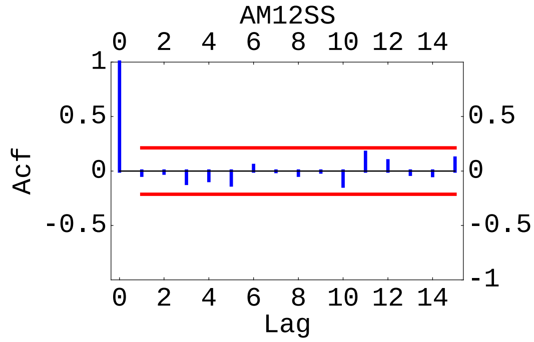
Acf
Lag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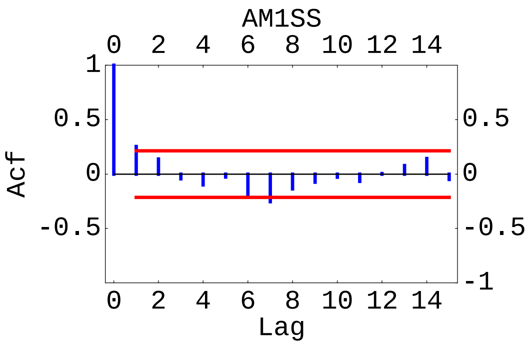
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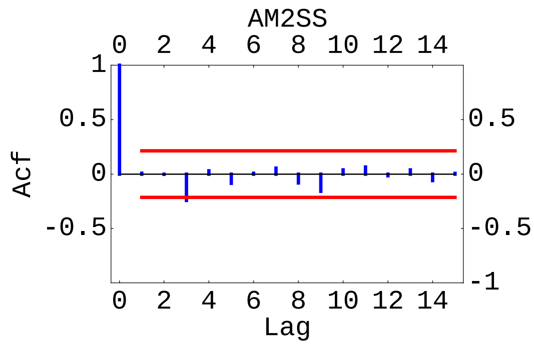
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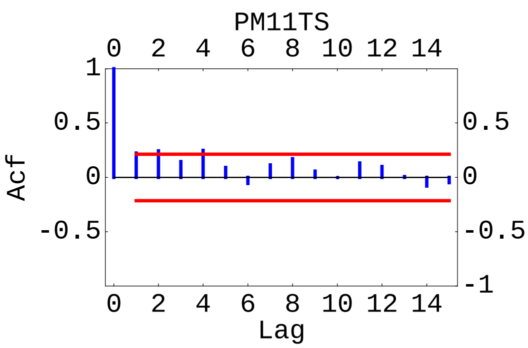
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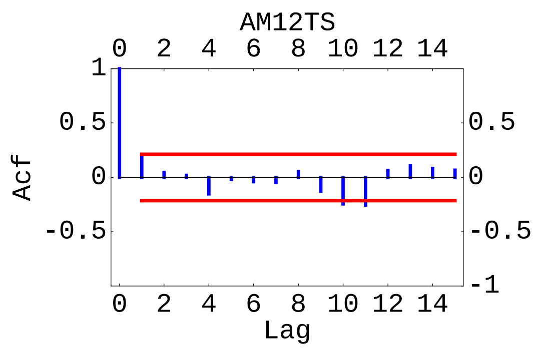
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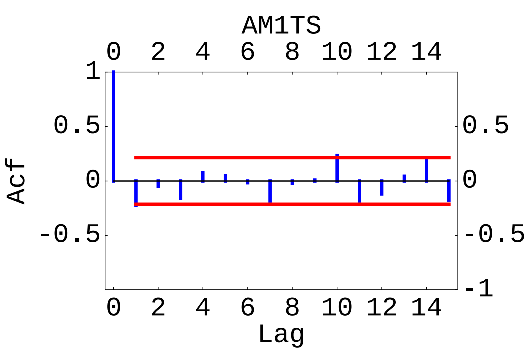
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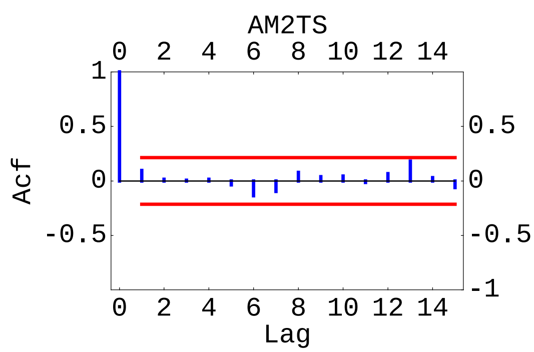
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Acf
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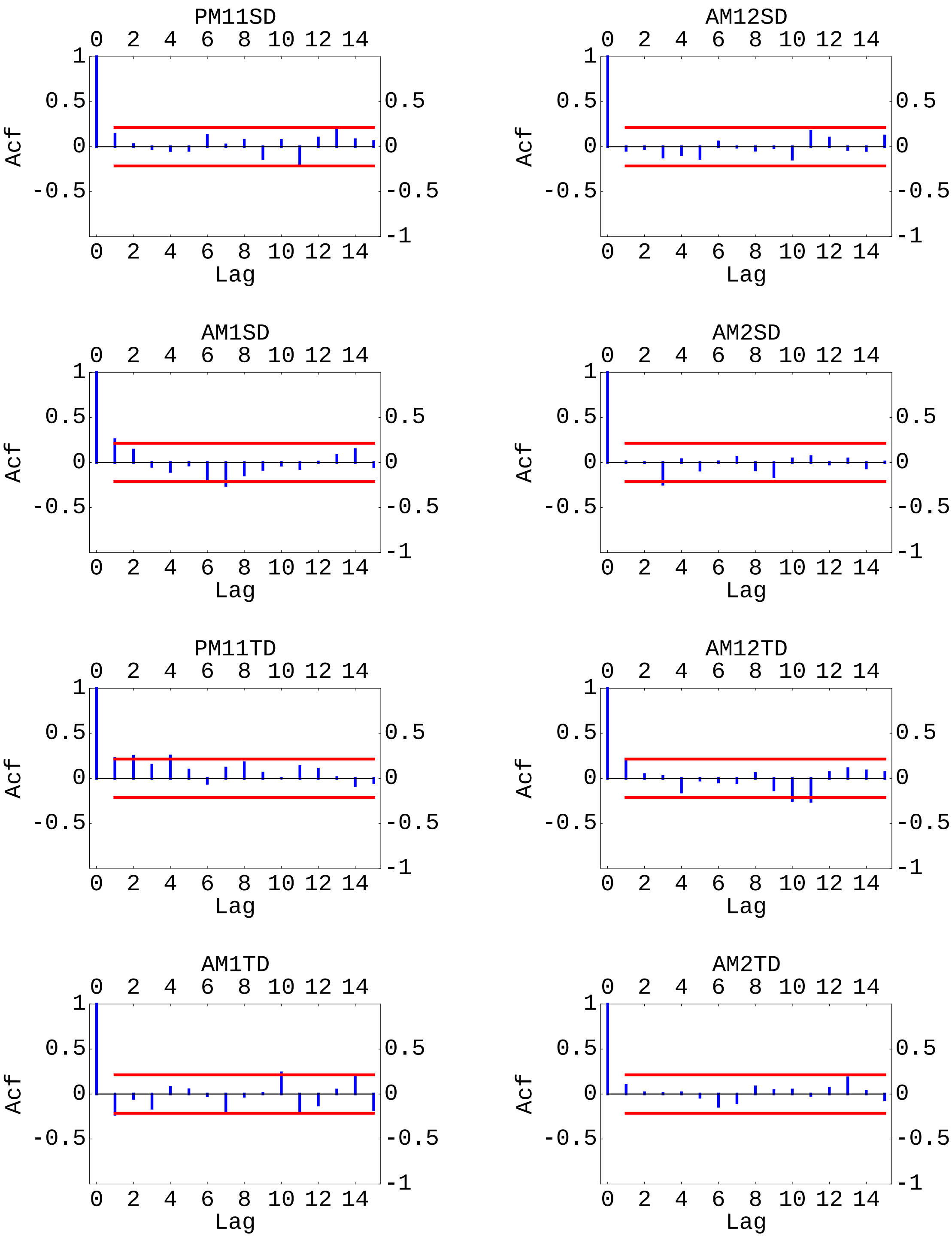


ARIMA Modelling

Based on the residual autocorrelations of the regression, the following ARIMA models are suggested.

Model Identification

#	Code	ARIMA(p,d,q)
1	PM11SS	$(0,0,1)(0,0,0)_{12}$
2	AM12SS	$(0,0,0)(0,0,0)_{12}$
3	AM1SS	$(1,0,0)(0,0,0)_{12}$
4	AM2SS	$(0,0,0)(0,0,0)_{12}$
5	PM11TS	$(0,0,2)(0,0,0)_{12}$
6	AM12TS	$(0,0,1)(0,0,0)_{12}$
7	AM1TS	$(0,0,1)(0,0,0)_{12}$
8	AM2TS	$(0,0,0)(0,0,0)_{12}$
9	PM11SD	$(0,0,0)(0,0,0)_{12}$
10	AM12SD	$(0,0,0)(0,0,0)_{12}$
11	AM1SD	$(1,0,0)(0,0,0)_{12}$
12	AM2SD	$(0,0,0)(0,0,0)_{12}$
13	PM11TD	$(0,0,2)(0,0,0)_{12}$
14	AM12TD	$(0,0,1)(0,0,0)_{12}$
15	AM1TD	$(0,0,1)(0,0,0)_{12}$
16	AM2TD	$(0,0,0)(0,0,0)_{12}$

1. PM11SS (0, 0, 1)

	Estimate	SE	P-Value
μ	1.384	0.134	0
δ	-0.481	0.275	0.08
θ_1	-0.133	0.108	0.217

Since the θ_1 estimate is not significantly different from zero, we will go the the previous model for this data.

3. AM1SS (0, 0, 1) $(0, 0, 0)_{12}$

	Estimate	SE	P-Value
μ	1.277	0.14	0
δ	-0.395	0.284	0.164
ϕ_1	0.255	0.106	0.016

Only minor change even though the AR parameter is significant. We keep this model.

5. PM11TS (0, 0, 2) $(0, 0, 0)_{12}$

	Estimate	SE	P-Value
μ	2.586	0.223	0
δ	-1.426	0.451	0.002
θ_1	-0.189	0.108	0.08
θ_2	-0.162	0.108	0.132

The MA parameters are not significant at 5% so we keep the previous model.

■ **6. AM12TS (0, 0, 1) (0, 0, 0)$_{12}$**

	Estimate	SE	P-Value
μ	3.803	0.279	0
δ	-1.828	0.57	0.001
Θ_1	-0.204	0.107	0.056

The autocorrelation is small but significant, we keep this model.

■ **7. AM1TS (0, 0, 1) (0, 0, 0)$_{12}$**

	Estimate	SE	P-Value
μ	1.816	0.089	0
δ	-0.078	0.186	0.675
Θ_1	0.315	0.104	0.002

Very minor impact of the size or significance of the intervention coefficient but we keep this model.

■ **11. AM1SD (1, 0, 0) (0, 0, 0)$_{12}$**

	Estimate	SE	P-Value
μ	1.277	0.14	0
δ	-0.395	0.284	0.164
ϕ_1	0.255	0.106	0.016

Only minor change in the intervention coefficient. AR parameter signficant so we keep this model.

■ **13. PM11TD (0, 0, 2) (0, 0, 0)$_{12}$**

	Estimate	SE	P-Value
μ	2.586	0.223	0
δ	-1.426	0.451	0.002
Θ_1	-0.189	0.108	0.08
Θ_2	-0.162	0.108	0.132

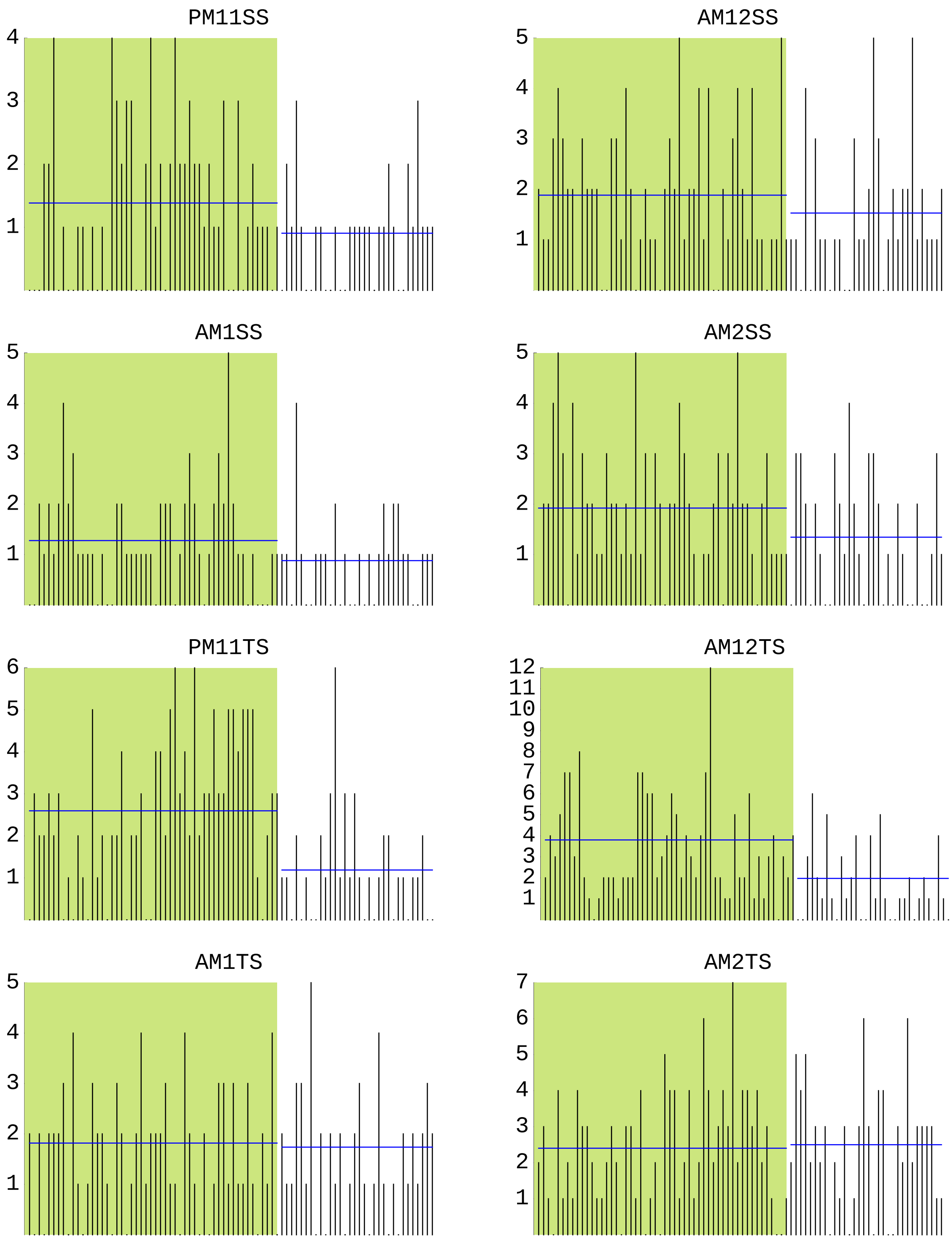
The ARIMA parameter is not significant, so the original model will be used.

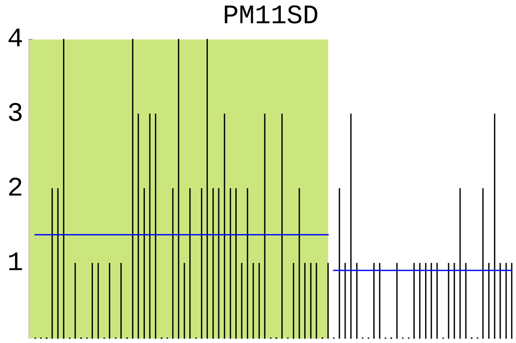
Final Intervention Parameter Estimates

The table below gives the estimates of the overall mean μ and the step-intevention parameter δ for the final selected model for each series. For each series μ is the upper entry and δ is the lower entry.

	Estimate	SD
PM11SS	1.38462	0.153925
	−0.478365	0.249387
AM12SS	1.88462	0.188355
	−0.353365	0.30517
AM1SS	1.27658	0.140046
	−0.394649	0.283723
AM2SS	1.92308	0.179189
	−0.579327	0.290319
PM11TS	2.59615	0.220541
	−1.40865	0.357318
AM12TS	3.80263	0.278819
	−1.82818	0.569666
AM1TS	1.81581	0.0888371
	−0.0779229	0.185618
AM2TS	2.40385	0.226379
	0.0961538	0.366776
PM11SD	1.38462	0.153925
	−0.478365	0.249387
AM12SD	1.88462	0.188355
	−0.353365	0.30517
AM1SD	1.27658	0.140046
	−0.394649	0.283723
AM2SD	1.92308	0.179189
	−0.579327	0.290319
PM11TD	2.59615	0.220541
	−1.40865	0.357318
AM12TD	3.80263	0.278819
	−1.82818	0.569666
AM1TD	1.81581	0.0888371
	−0.0779229	0.185618
AM2TD	2.40385	0.226379
	0.0961538	0.366776

Intervention Visualization

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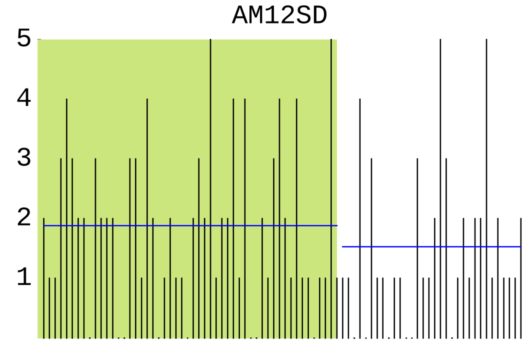
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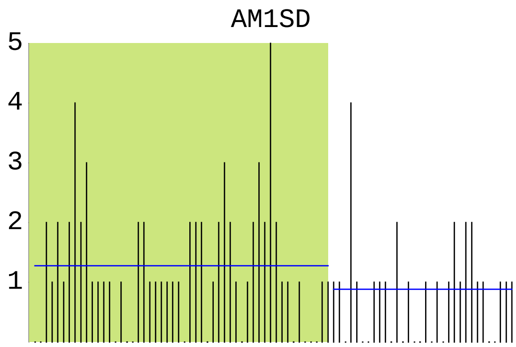
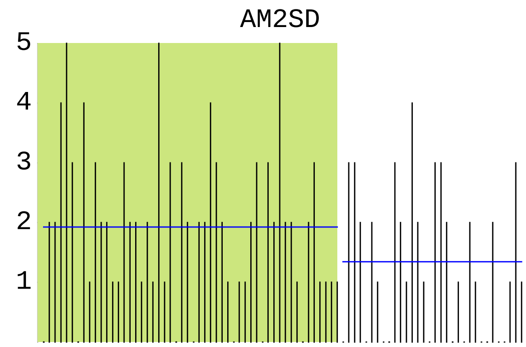
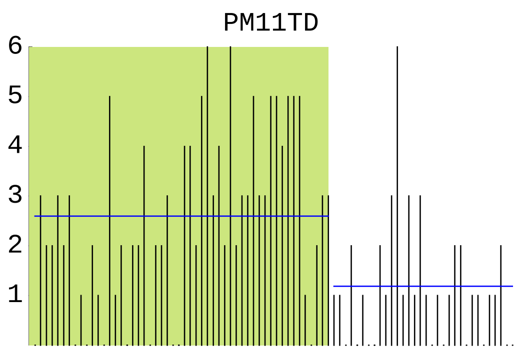

AM1SD


AM2SD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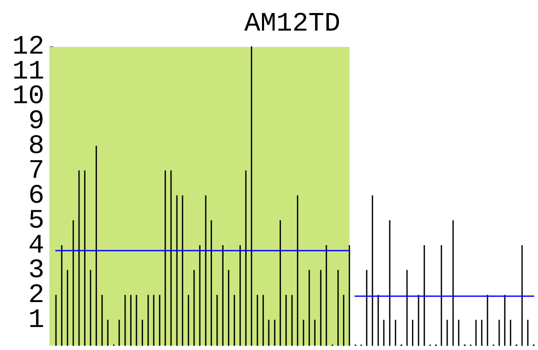
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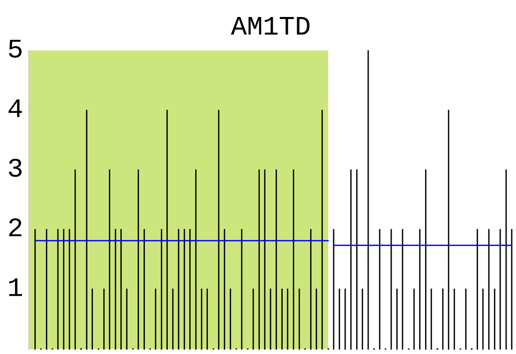
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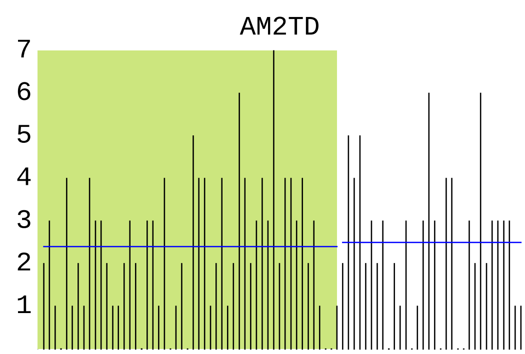
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