WEATHER IMPACT

on FLOATING CAR DATA

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ABSTRACT

Floating Car Data (FCD) is an accepted data source for capturing traffic states, especially in urban regions. If obtained from running fleet management systems, they are cheap to acquire, nearly no investments into the infrastructure are necessary. Since these data are very "noisy" – which means traffic state information generated from single vehicles vary very much – approaches exist how to obtain reliable traffic state information even from very sparse FCD. Within this paper the influences weather conditions have on the daily speed variation curves derived from FCD are shown. This information is very meaningful for prediction applications and can be taken into account in historical data analysis.

INVESTIGATION AREA

For the computation of the results weather information from eight weather stations in Berlin and one in Potsdam (neighboring city of Berlin) were collected, from November 2009 to February 2010. One dataset contains the aggregated weather information of the last hour, which is in detail: the name of the weather-station, the timestamp of the related hour, the temperature in degrees Celsius, a verbal description of the weather condition and the rainfall of the last hour in liter per square kilometer.

station	time	temp[°C]	weather condition	rainfall [l/m²]
Potsdam	02.11.2009 04:00	2,4	trocken (dry)	0,0
Potsdam	02.11.2009 05:00	2,5	trocken (dry)	0,0
Potsdam	02.11.2009 06:00	2,5	leichter Regen (light rain)	< 0.05
Potsdam	02.11.2009 07:00	2,2	mäßiger Regen (moderate rain)	0,5

Potsdam	02.11.2009 08:00	2,2	mäßiger Regen (moderate rain)	1,1

Table 1: Weather data sample from Potsdam

Furthermore the FC-Data delivered from about 4000 taxis of a taxi fleet in Berlin were used. These FCD are map matched with the DLR – map matching process (2). The results of the map matching are links-based velocities.

For the comparison with the weather data areas of 10x10km around the weather stations where defined, a sample area around the station in Potsdam is shown in figure1.

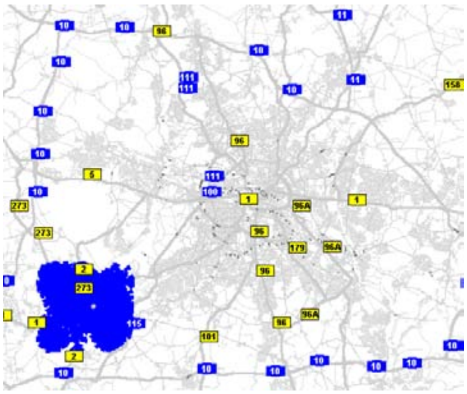

Figure1. Example of investigation area: 10x10km (blue) around the weather station in Potsdam

DATA ANALYSIS

The first step is the creation of normal daily courses for the investigation areas.

For the speed profiles, FC-Data of complete months (November and December 2009) were taken and the mean daily courses reconstructed. All data were aggregated to 15-minute intervals and smoothed then afterwards using the method described in (1), a fit based on Singular Value Decomposition (SVD-Fit) to suppress the noise. The result is one averaged daily speed course for each area; figure 2 shows exemplarily the daily course for the average speed.

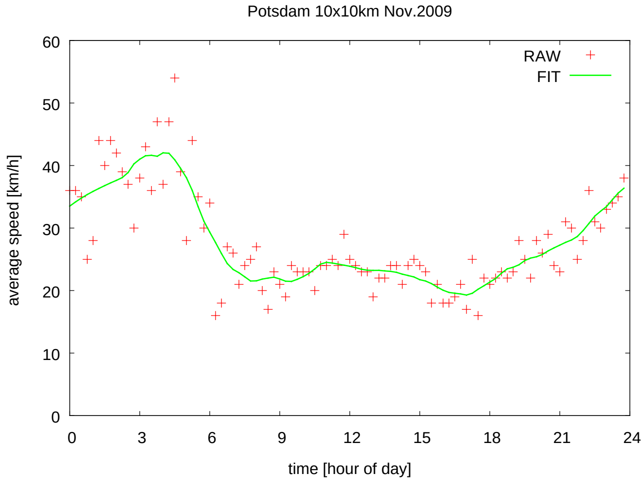

Figure 2: Aggregated raw speed data from FCD (red crosses) and the resulting daily speed course after smoothing with SVD-Fit (green curve).

The second step is the construction of the daily courses (for each day) for the areas under investigation. Here the SVD-Fit method was used, too.

Thus, the average traffic conditions in the areas during the two investigated months are described and can be compared to the daily course of one particular day, especially the days with (heavy) rain and icy conditions.

Figure 3 shows exemplarily the difference plot between the average speed-profile of the area around Potsdam and the 4th November speed-profile (green line). It is obvious, that the speed breaks down a little bit more than on normal days, one hour after the peaks in the rainfall (~10 o'clock and ~14 o'clock).

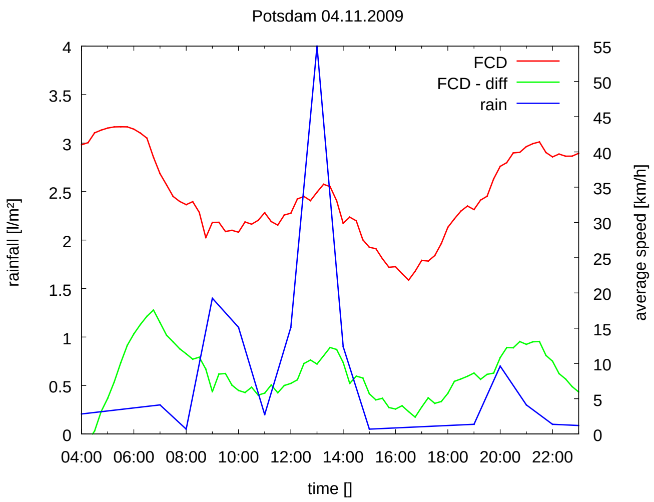

Figure 3: Rainfall (blue), speeds from FCD (red) and difference between FCD and the normal daily course (green)

The second example is from an ice incident in the winter period 2009/10 on January 9th (Saturday) Here data from the weather-station on the closed airport Tempelhof is compared to the FCD of the nearby urban freeway in Berlin (A100). Typically expected here is nothing special, because its weekend. The daily course of that day – generated with the SVDFit Method again - is plotted in figure 4 (red). To compare it to normal Saturdays, the data from the following Saturdays is plotted against it. It is obvious, that the breakdown in the afternoon is not that heavy on normal Saturdays. The only outlier is the 23rd January (green) but on this day there were -10 degrees and a little snowfall, so that it was a day with bad weather conditions too.

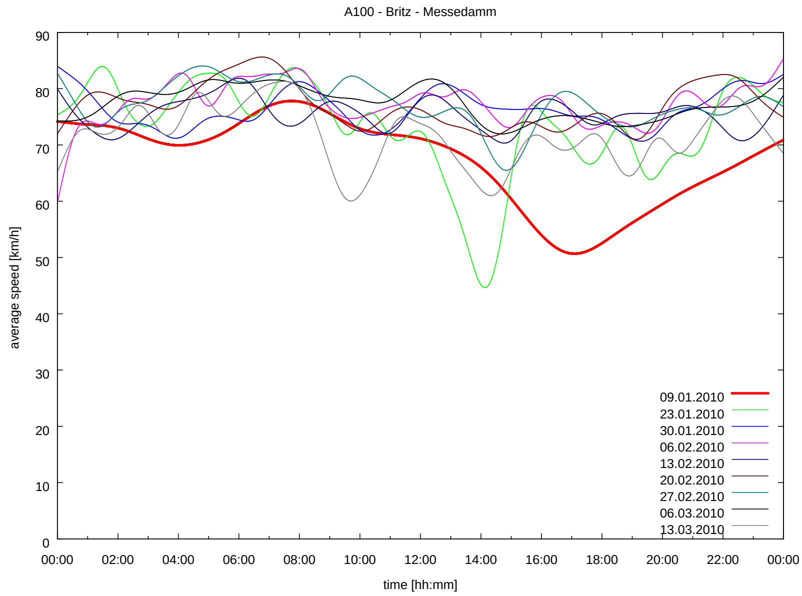

Figure 4: FCD on 9th January (red) and on 8 following weeks

To show the impact of the unusual incident, the raw-data distributions were compared with a moving Kolmogorov-Smirnov (K-S-Test). The distribution of 100 data-points from the same time is compared. Afterwards the window is moved one step ahead. Figure 5 shows the result of the K-S-Test for the 9th January and the 13th March. Additionally the rain volume on the 9th January is plotted (green).

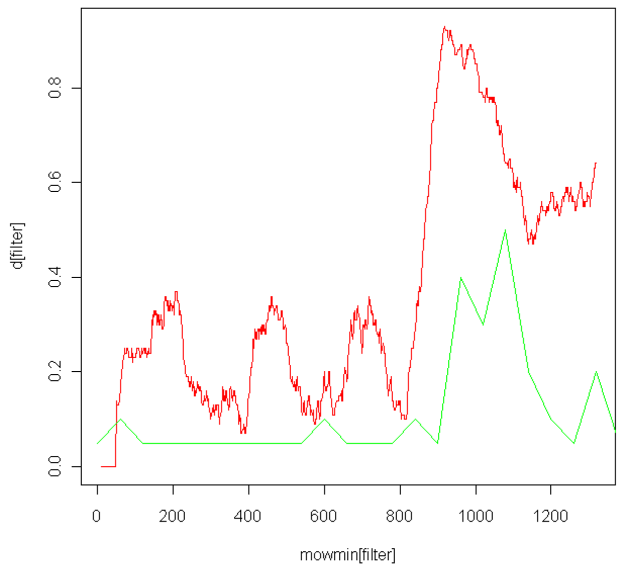

Figure 5: Kolmogorov-Smirnov Test (red) and rain [l/m²] (green)

It seems, that the K-S-Test statistic value is rising before the rain starts, but since the weather data is only sampled in 1 hour intervals, the current point in time can not determined that exact. Appendix A shows the KS-Tests of each day plotted in figure 5 against the 9th January and KS-Tests of each Saturday and its following Saturday, to show that the test this time is not indicating.

Conclusions

In the international literature influences of weather conditions like rain and ice are not uniformly defined. In (3) the influence on the travel-speed on fast-lane freeways is assumed to be between -12 and -33 km/h. In contrast to that in (5) the speed breakdown is supposed to be between -6 and -13 km/h for the same road-class type. It seems that at least the order is confirmed.

REFERENCES

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(2) Schäfer, R.-P.; Thiessenhusen, K.-U.; Brockfeld, E.; Wagner, P. (2002): A traffic information system by means of real-time floating-car data. ITS World Congress 2002, 11th-14th Oct 2002, Chicago, USA.

(3) Okamoto, N, Ishida, H., Furuya, H. and Furukawa, H., in the83rd TRB Annual Meeting, 2004, "Including Weather Condition Factors in the Analysis on the Highway Capacity"

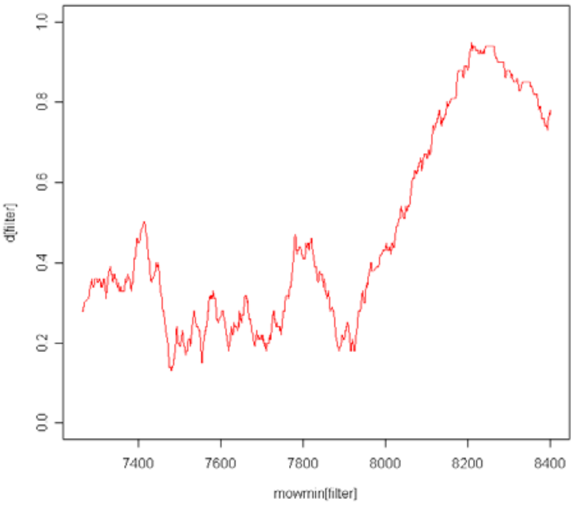
(4) Highway Capacity Manual 2000, chapter 22, p.9

(5) Brilon, W. and Ponzlet, M. in Transportation Research Record, TRB, Washington DC, No. 1555, Variability of Speed-Flow Relationships on German Autobahns, pp. 91 - 98 1996

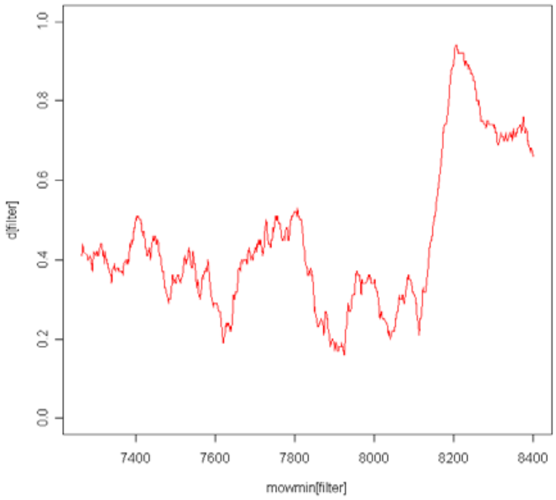
Appendix A

KS Test all Saturdays vs. 2010-09-01 (black ice)

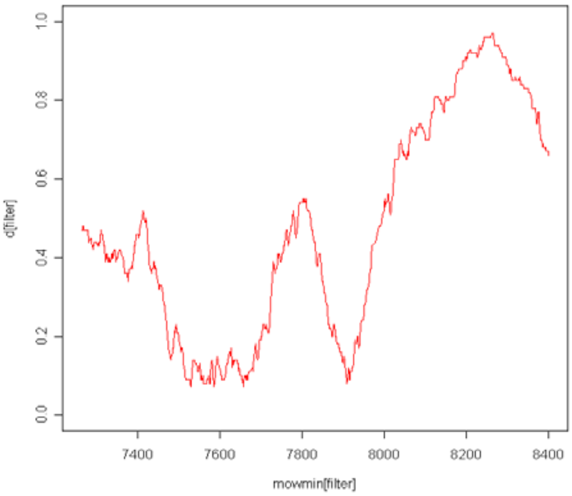
09.01.2010 – 16.01.2010



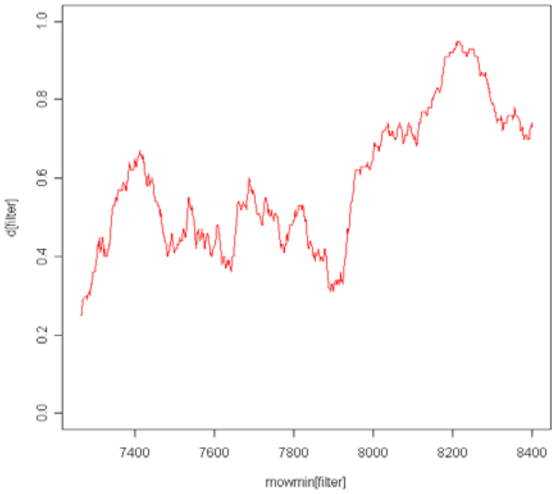
09.01.2010 - 23.01.2010



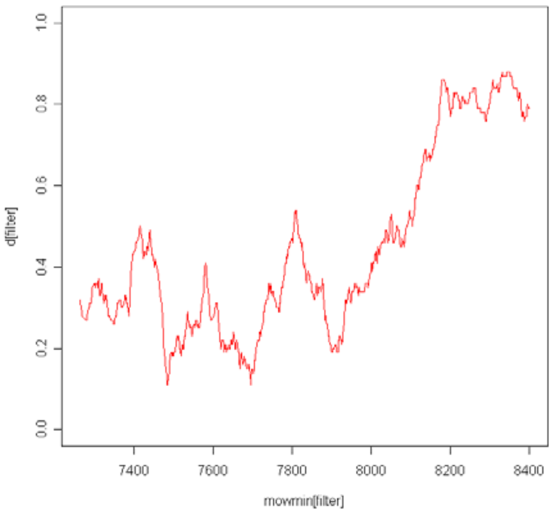
09.01.2010 – 30.01.2010



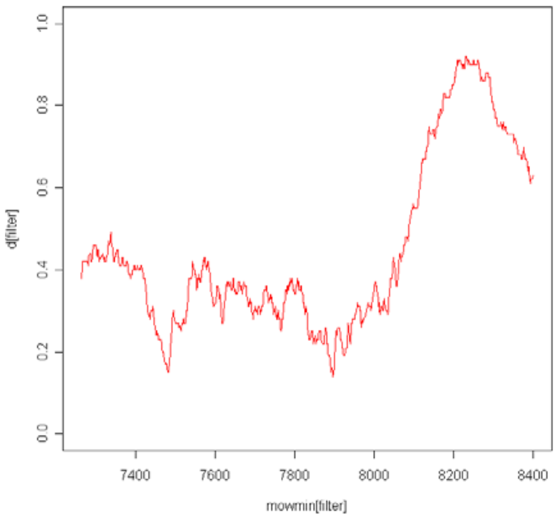
09.01.2010 - 06.02.2010



09.01.2010 – 13.02.2010

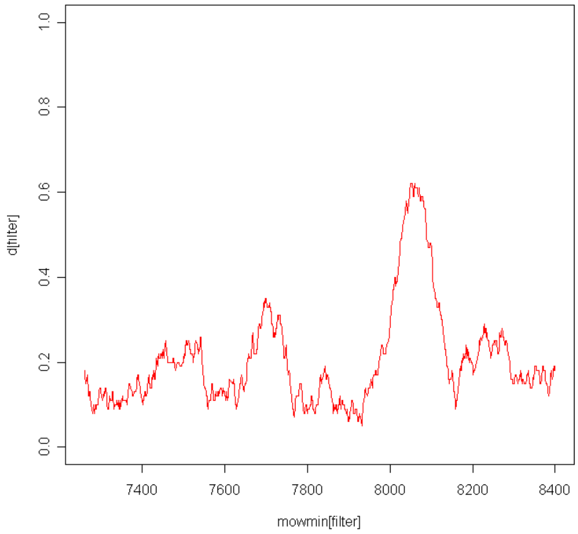


09.01.2010 – 20.02.2010

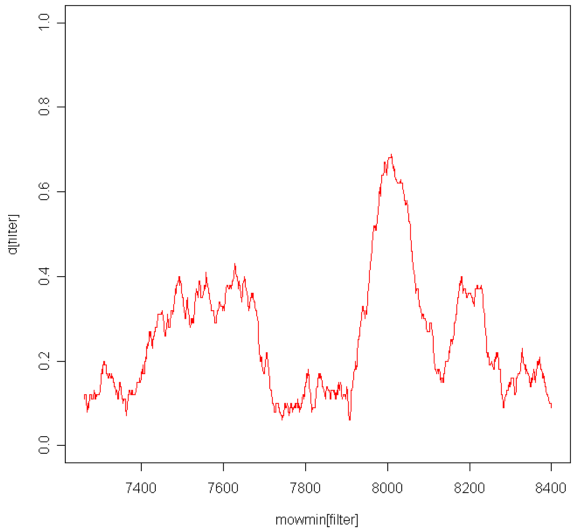


KS-Test „normal“ Saturday against its follower

16.01.2010 – 23.01.2010



23.01.2010 – 30.01.2010



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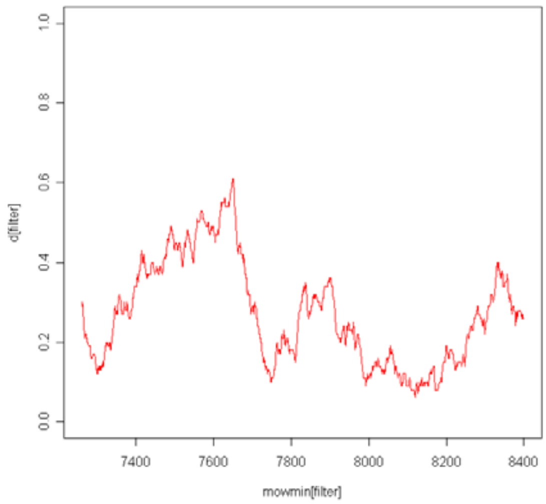
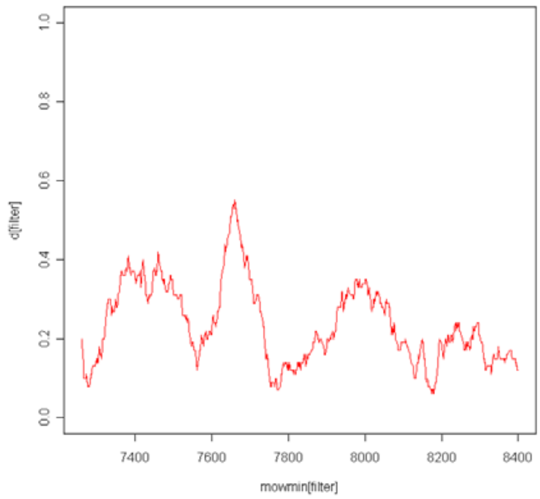
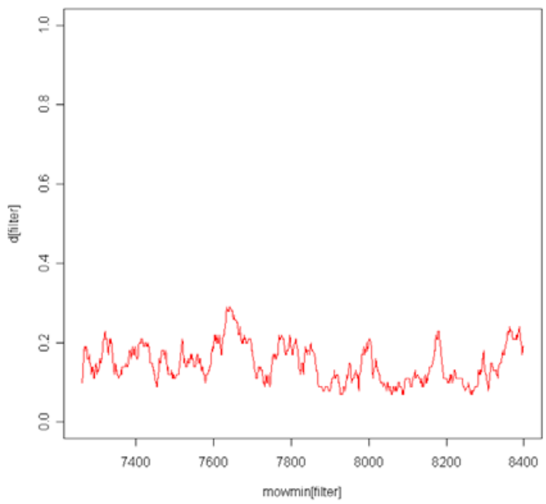


06.01.2010 – 13.02.2010



13.02.2010 – 20.02.2010



20.02.2010 – 27.02.2010