

Civil and Environmental Engineering (CEE) 255: Project #1

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Handed out: 09/02/2022

Due : 09/23/2022 at 9:59am

Collaboration policy: Projects should be done in groups of two or three. Individual projects are exceptions, and as such, will be allowed only in special circumstances. If you feel you should be considered for an individual project, please email the instructors.

Each group must submit their own original paper in bCourses and all written work must be their own. One submission per group is sufficient.

Submission policy: Submission must be done via bCourses.

Each paper must begin with the students names.

Example: Project #1 : firstname1, lastname1 - firstname2, lastname2 - firstname3, lastname3

Each uploaded paper (and code if any) must be named as follows:

- F22-CE255-p1-lastname1-lastname2-lastname3.pdf

IMPORTANT: We will not rerun the codes that you submit. So anything that needs to be considered for grading should be included in the PDF that you upload in bCourses, including figures and results.

Failure to follow these instructions will result in the paper not being graded.

Project

The purpose of this project is to study a freeway section in California and provide a detailed analysis about traffic characteristics that will help manage and operate the system.

The project is divided in three sections and each one must be completed. The first part of the project consists in analyzing the presence of recurrent bottlenecks in a freeway section of your choice. The second part consists in analyzing non-recurrent bottlenecks, the third part consists in analyzing some traffic characteristics.

The data for this project is taken from the Performance Management Systems (PeMS), <https://pems.dot.ca.gov/>

Task 0: Choose a study section

The goal of this task is to choose a study section and download the relevant data (see appendix).

1. The study section must be chosen such that recurrent and non recurrent bottleneck analysis can be done on the same section. The bottleneck analysis will be performed on a single travel direction for a limited amount of time (am or pm peak hours for recurrent bottlenecks). Guidance for choosing a section: A good section has good detectors, evenly spaced and must show recurrent bottlenecks on normal weekdays (Tuesday, Wednesday and Thursday). The recurrent bottleneck front should be located at the center of the section if possible. The length

of the freeway section and the time period of analysis must be long enough for identifying the generation, propagation and dissipation of the bottleneck (suggested 8-10 miles).

The same section must display at least one or more non recurrent bottlenecks. Hint: you can use PeMS to visualize the relevant data prior to choosing a study section and downloading the data.

Task 1: Recurrent bottleneck analysis

The goal of this task is to recognize and identify a recurrent bottleneck. Those types of bottleneck occur in the same location and time periods of the day. Their behavior and characteristics are reproducible over many days.

1. Bottleneck study. Once the study section is identified, the next goal is to identify the bottleneck, show how it is generated and dissipated and how it evolves in time and space. The study have to address the following:
 - Location and duration of the bottleneck
 - Cause for the creation of the bottleneck
 - Bottleneck impacts on traffic (delay and queues)

Task 2: Non recurring bottleneck analysis

The goal of this task is to recognize and identify a non-recurrent bottleneck. Those types of bottleneck are caused by random events as accidents, breakdowns, weather, etc.

1. Non-recurring bottleneck study. Once the study section is identified, the next goal is to identify the non- recurring bottleneck, show how it is generated and dissipated and how it evolves in time and space. The study have to address the following:
 - Location and duration of the bottleneck
 - Cause for the creation of the bottleneck
 - Bottleneck impacts on traffic (delay and queues), portion of the non-recurrent delay as a function of the total delay.

Task 3: Traffic analysis

The goal of this portion of the project is to analyze traffic conditions and characteristics in the study section selected above. The analysis should be done using PeMS data for the study section chosen for the bottlenecks analysis. It will be performed in a single travel direction for an amount of time of your choice. You must justify the amount of time chosen. Based on the section of your choice and the data available in that section you may choose two topics of your choice

- *Traffic characteristics*: Plot flow vs speed, flow vs. occupancy. Estimate free flow speed, areas of undersaturated, oversaturated and queue discharge flows.
- *Incident impact*: Investigate the incident frequency and characteristics at the study corridor. Derive key statistics and distributions of incident frequency, severity and duration. Estimate total delay and relation with incident frequency.
- *Weather impact*: Investigate key statistics on how weather impacts traffic. Estimate the delay caused by the weather conditions and how they impact the creation of bottlenecks.

- *Travel times*: Estimate the average travel time. Explore how the travel time statistics are affected by the presence and severity of bottleneck(s). Is the travel time measure reliable in the study section?

Report

The report should be self-contained as it is meant to mimic a technical report.

The report should contain:

1. Introduction
2. Problem statement
3. Methodology
4. Results
5. Discussion of the results
6. Conclusion
7. References
8. Appendix (if any)

It is suggested that you use the three week project as follows:

- Week 1: PeMS understanding, study section selection and data download
- Week 2: Recurrent and non-recurrent bottleneck analysis
- Week 3. Traffic analysis and report writing

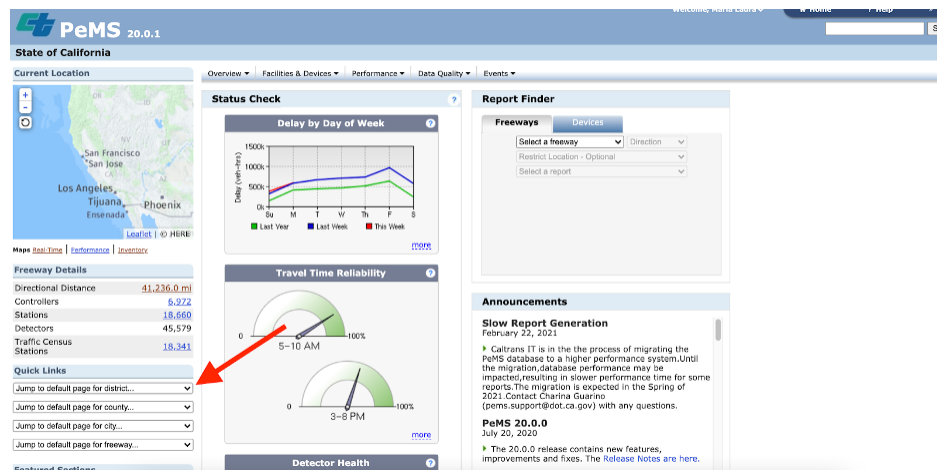
1 Appendix: Downloading the data for the project

This guide will get you started with PeMS but you should explore on your own to take advantage of all the features.

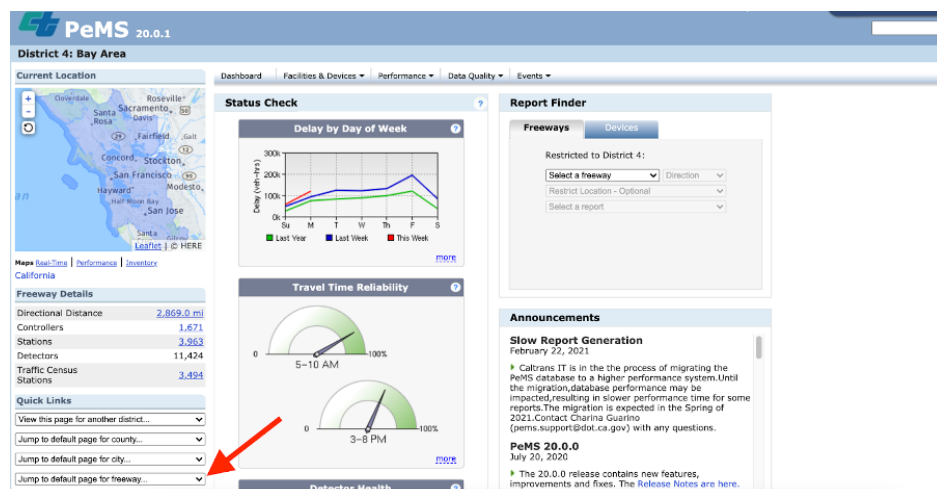
1. Go to <https://pems.dot.ca.gov/> and create an account
2. Once your account is approved follow these instructions to download the data

Option 1: 5 minutes detector loops (sufficient for this study)

- a) On the home page click on “Jump to default page for district” and choose a district



- b) Once you choose a district, the page will reload and you can choose a specific freeway in that district in a particular direction



- c) Choose your freeway and you will land in the page with all the detectors available in that freeway and direction of travel

PeMS 20.0.1

Freeway 1280-N

Current Location:

Facilities & Devices > Performance > Data Quality > Configuration > Events

Facilities & Devices > Field Elements > Stations

Day: 08/03/2021

Owner: All

Sensor Technology: Any Sensor Technology

Station Types: ☒ Col/Dist ☒ Conventional Highway ☒ HOV ☒ Fly-Fwy ☒ Mainline ☒ On Ramp ☒ Off Ramp

Postmile Range: (8.37 - 56.93)

17 56.5 Show Crossings

VIEW INFO EXPORT TEXT EXPORT TO ALL EXPORT TO PDF

Fwy	Dist	County	City	CA PM	Abs PM	Length	ID	Name	Lanes	Stn. Type	Sensor Type	HOV	Controller	ID	MS ID	IRM
1280 N	4	San Jose	San Jose	1.8	0.18	0.330	401403	US 101 IC (McLaughlin Ave)	2	Mainline	Loop	No	403032	DT966	C2-N-37-280	00018
				8.47	0.47	0.000	405426	McLaughlin Ave on loop	1	On Ramp	Loop	No	403273	DTA89	A1-N-37-280	00047
				8.48	0.48	0.000	405428	McLaughlin Ave on diag	1	On Ramp	Loop	No	403273	DTA89	A1-N-37-280	00048
				8.48	0.48	0.190	401055	McLaughlin Ave rrm-n-loop/diag	5	Mainline	Loop	No	403273	DTA89	L5-N-37-280	00048
				8.56	0.56	0.005	401008	oppo McLaughlin Ave off-n-diag	6	Mainline	Loop	No	403289	DT588	L6-N-37-280	00056
				1.29	1.29	0.515	403402	oppo S 11th St rrm-s-diag	5	Mainline	Loop	No	404779	DTB11	L5-N-37-280	00129
				1.59	1.59	0.280	400799	10TH ST	4	Mainline	Loop	No	402573	DT599	L4-N-37-280	00159
				1.65	1.65	0.230	400593	4TH ST/REED ST	4	Mainline	Loop	No	402574	DT268	L4-N-37-280	00185
				2.05	2.05	0.235	402101	N of 1st St	5	Mainline	Loop	No	403391	DT509	L5-N-37-280	00205
				2.24	2.24	0.000	413868	Almaden Blvd off to Rt 87	2	Off Ramp	Loop	No	412156	DTB35	L2-N-37-280	00224
				2.32	2.32	0.360	413878	Almaden Blvd rrm-n-diag	4	Mainline	Loop	No	412198	DTB35	L4-N-37-280	00232
				2.36	2.36	0.000	413879	Almaden Blvd on	2	On Ramp	Loop	No	412198	DTB35	L2-N-37-280	00236
				2.46	2.46	0.000	413880	Almaden Blvd off to Bird Ave	1	Off Ramp	Loop	No	412198	DTB35	L2-N-37-280	00246
				2.68	2.68	0.000	414205	NB S750 87 on	2	On Ramp	Loop	No	412464	DTB36	L3-N-37-280	00268
				2.77	2.77	0.265	414284	NB S750 87 rrm-n-fly/diag	5	Mainline	Loop	No	412464	DTB36	L5-N-37-280	00277
				82.81	2.81	0.000	405425	Bird Ave off	2	Off Ramp	Loop	No	403121	DTB80	L2-N-37-280	00281
				82.85	2.85	0.100	401042	RUID AVE	6	Mainline	Loop	No	403491	DTB83	L6-N-37-280	00285
				2.97	2.97	0.330	413877	Bird Ave rrm-n-diag	5	Mainline	Loop	No	412205	DTB57	L5-N-37-280	00297

d) Here choose the date and the postmile range to obtain only the detectors for your study section

PeMS 20.0.1

Freeway 1280-N

Current Location:

Facilities & Devices > Performance > Data Quality > Configuration > Events

Facilities & Devices > Field Elements > Stations

Day: 08/03/2021

Owner: All

Sensor Technology: Any Sensor Technology

Station Types: ☒ Col/Dist ☒ Conventional Highway ☒ HOV ☒ Fly-Fwy ☒ Mainline ☒ On Ramp ☒ Off Ramp

Postmile Range: (8.37 - 56.93)

9 25 Show Crossings

VIEW INFO EXPORT TEXT EXPORT TO ALL EXPORT TO PDF

Fwy	Dist	County	City	CA PM	Abs PM	Length	ID	Name	Lanes	Stn. Type	Sensor Type	HOV	Controller	ID	MS ID	IRM
1280-N	4	San Jose	San Jose	15.25	5.25	0.000	408072	Stevens Creek off	2	Off Ramp	Loops	No	409093	DT596	L2-N-37-280	00525
				15.26	5.26	0.000	411975	SB 17 conn	2	Fwy-Fwy	Loop	No	411136	DTB82	C2-N-37-280	00526
				15.33	5.33	0.771	407710	17/880 IC	3	Mainline	Loop	No	411136	DTB82	L3-N-37-280	00533
				15.34	5.34	0.000	411976	NB 17 conn	1	Fwy-Fwy	Loop	No	411136	DTB82	C1-N-37-280	00534
				4.7	6.08	0.000	408094	Leland Ave on	2	On Ramp	Loop	No	408021	DTB40	L2-N-37-280	00470
				4.7	6.08	0.406	401400	Bascom & Leland	6	Mainline	Loop	No	408021	DTB40	L6-N-37-280	00470
				4.76	6.14	0.695	400714	Winchester Blvd rrm-n-diag	4	Mainline	Loop	No	402563	DTB58	L4-N-37-280	00476
				6.09	7.47	1.435	400414	Saratoga Ave rrm-n-diag	4	Mainline	Loop	No	402565	DT598	L4-N-37-280	00609
				7.63	9.61	1.165	400500	Stevens Creek Blvd rrm-n-diag	4	Mainline	Loop	No	402567	DT598	L4-N-37-280	00763
				8.42	9.80	0.950	400499	WOOLFE RD	4	Mainline	Loop	No	402568	DTB99	L4-N-37-280	00842
				9.53	10.91	1.295	419057	De Anza Blvd rrm-n-diag	4	Mainline	Loop	No	415577	DTA90	L4-N-37-280	00953
				9.54	10.92	0.000	419058	De Anza Blvd on	2	On Ramp	Loop	No	415577	DTA90	L2-N-37-280	00954
				11.01	12.39	0.000	406769	SB 85 conn loop	1	Fwy-Fwy	Loop	No	407949	DTB09	C1-N-37-280	01101
				11.01	12.39	1.685	401815	SB 280 / NB 85 & NB 280 / SB85	4	Mainline	Loop	No	407949	DTB09	L4-N-37-280	01101
				12.9	14.28	3.445	400726	200' N of St. Joseph Ave	4	Mainline	Loop	No	402395	DT199	L4-N-37-280	01290

e) Choose the detector and click on it

PeMS 20.0.1

Freeway 1280-N

Current Location:

Facilities & Devices > Performance > Data Quality > Configuration > Events

Facilities & Devices > Field Elements > Stations

Day: 08/03/2021

Owner: All

Sensor Technology: Any Sensor Technology

Station Types: ☒ Col/Dist ☒ Conventional Highway ☒ HOV ☒ Fly-Fwy ☒ Mainline ☒ On Ramp ☒ Off Ramp

Postmile Range: (8.37 - 56.93)

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Fwy	Dist	County	City	CA PM	Abs PM	Length	ID	Name	Lanes	Stn. Type	Sensor Type	HOV	Controller	ID	MS ID	IRM
1280-N	4	San Jose	San Jose	15.25	5.25	0.000	408072	Stevens Creek off	2	Off Ramp	Loops	No	409093	DT596	L2-N-37-280	00525
				15.26	5.26	0.000	411975	SB 17 conn	2	Fwy-Fwy	Loop	No	411136	DTB82	C2-N-37-280	00526
				15.33	5.33	0.771	407710	17/880 IC	3	Mainline	Loop	No	411136	DTB82	L3-N-37-280	00533
				15.34	5.34	0.000	411976	NB 17 conn	1	Fwy-Fwy	Loop	No	411136	DTB82	C1-N-37-280	00534
				4.7	6.08	0.000	408094	Leland Ave on	2	On Ramp	Loop	No	408021	DTB40	L2-N-37-280	00470
				4.7	6.08	0.406	401400	Bascom & Leland	6	Mainline	Loop	No	408021	DTB40	L6-N-37-280	00470
				4.76	6.14	0.695	400714	Winchester Blvd rrm-n-diag	4	Mainline	Loop	No	402563	DTB58	L4-N-37-280	00476
				6.09	7.47	1.435	400414	Saratoga Ave rrm-n-diag	4	Mainline	Loop	No	402565	DT598	L4-N-37-280	00609
				7.63	9.61	1.165	400500	Stevens Creek Blvd rrm-n-diag	4	Mainline	Loop	No	402567	DT598	L4-N-37-280	00763
				8.42	9.80	0.950	400499	WOOLFE RD	4	Mainline	Loop	No	402568	DTB99	L4-N-37-280	00842
				9.53	10.91	1.295	419057	De Anza Blvd rrm-n-diag	4	Mainline	Loop	No	415577	DTA90	L4-N-37-280	00953
				9.54	10.92	0.000	419058	De Anza Blvd on	2	On Ramp	Loop	No	415577	DTA90	L2-N-37-280	00954
				11.01	12.39	0.000	406769	SB 85 conn loop	1	Fwy-Fwy	Loop	No	407949	DTB09	C1-N-37-280	01101
				11.01	12.39	1.685	401815	SB 280 / NB 85 & NB 280 / SB85	4	Mainline	Loop	No	407949	DTB09	L4-N-37-280	01101
				12.9	14.28	3.445	400726	200' N of St. Joseph Ave	4	Mainline	Loop	No	402395	DT199	L4-N-37-280	01290

f) Choose from the window menu Performances → Aggregates → Time series

PeMS 20.0.1

Mainline VDS 400714 - Winchester Blvd rm-n-diag

Change Location

Change Log

Performance

Data Quality

Events

Map

Station Details

Aliases

LDS

Owner

Assoc. Traffic

Census Station

Comm Type (LDS)

Speeds

Max Cap.

Vehicle Classification

Change Log

Date	Status	Name	Lanes	CA PM	Abs PM	Length	Lat	Lng
08/01/2001	Active	Winchester Boulevard	1 2 3 4	4.76	6.14	0.38	37.316788	-121.953512
02/22/2006	Active	Winchester Blvd rm-n-di	1 2 3 4	4.76	6.14	0.38	37.316788	-121.953512
07/15/2011	Active	Winchester Blvd rm-n-di	1 2 3 4	4.76	6.14	0.38	37.316788	-121.953512
04/06/2012	Active	Winchester Blvd rm-n-di	1 2 3 4	4.76	6.14	0.38	37.316788	-121.953512
04/30/2012	Active	Winchester Blvd rm-n-di	1 2 3 4	4.76	6.14	0.38	37.316788	-121.953512
03/05/2013	Active	WINCHESTER BLVD	1 2 3 4	4.76	6.14	0.70	37.316788	-121.953512
04/03/2013	Active	WINCHESTER BLVD	1 2 3 4	4.76	6.14	0.70	37.316788	-121.953512
04/18/2013	Active	WINCHESTER BLVD	1 2 3 4	4.76	6.14	0.70	37.316788	-121.953512
07/10/2013	Active	WINCHESTER BLVD	1 2 3 4	4.76	6.14	0.56	37.316788	-121.953512
03/07/2014	Active	Winchester Blvd rm-n-diag	1 2 3 4	4.76	6.14	0.56	37.316788	-121.953512

g) Customize your time interval, quantity and lanes. Fix the granularity at 5 minutes and then export your data to .xls

PeMS 20.0.1

Mainline VDS 400714 - Winchester Blvd rm-n-diag

Change Location

Change Log

Performance

Data Quality

Events

Map

Station Details

Aliases

LDS

Owner

Assoc. Traffic

Census Station

Comm Type (LDS)

Speeds

Max Cap.

Vehicle Classification

Performance > Aggregates > Time Series

From: 08/28/2021 00:00 To: 09/03/2021 03:59

Time of Day: All

Include Days: Su, Mo, Tu, We, Th, Fr, Sa, Holidays

Quantity: Flow

Granularity: 5 Minutes

Lanes: Agg, 1, 2, 3, 4

Second Quantity: None

EXPORT TO XLS

5 Minutes	Lane 1 Flow (Veh/5 Minutes)	Lane 2 Flow (Veh/5 Minutes)	Lane 3 Flow (Veh/5 Minutes)	Lane 4 Flow (Veh/5 Minutes)	Flow (Veh/5 Minutes)	# Lane Points	% Observed
08/28/2021 00:00	31.0	24.0	4.0	17.0	76.0	4	100.0
08/28/2021 00:05	32.0	25.0	3.0	29.0	89.0	4	100.0
08/28/2021 00:10	36.0	27.0	2.0	23.0	88.0	4	100.0
08/28/2021 00:15	32.0	26.0	1.0	20.0	79.0	4	100.0
08/28/2021 00:20	25.0	21.0	1.0	12.0	59.0	4	100.0
08/28/2021 00:25	32.0	22.0	3.0	20.0	77.0	4	100.0
08/28/2021 00:30	34.0	17.0	2.0	27.0	80.0	4	100.0

Option 2: Using clearinghouse

a) From the home page, click on Data Clearinghouse

PeMS 20.0.1

State of California

Overview

Facilities & Devices

Performance

Data Quality

Events

Map

Freeway Details

Directional Distance

Countdown

Station

Detectors

Traffic Census Stations

Quick Links

Jump to default page for district

Jump to default page for county

Jump to default page for city

Jump to default page for freeway

Featured Sections

Station Performance Report

Detector Health

CAP Incidents

Lane Closure System

Countdown

Tools

Data Clearinghouse

PeMS User Manual

Status Check

Delay by Day of Week

Travel Time Reliability

Detector Health

Report Finder

Freeways

Selected a freeway

Reported location: Optional

Selected a report

Announcements

Slow Report Generation

February 22, 2021

PeMS 20.0.0

July 26, 2020

Updated PeMS User Guide

April 14, 2020

PeMS Maintenance

January 02, 2020

PeMS 19.0

September 30, 2019

- b) Pick the data you want, the district and the date and download .txt files. The field specification will explain the different columns of the .txt that you download. Extract needed data from the downloaded file.

Clearinghouse

The Data Clearinghouse provides a single access point for downloading PeMS data sets. You can use this page to quickly locate data by district, month and format.

After selecting the district, the type of data set, and clicking the submit button, you will be presented with a calendar for that data set. The chart shows you what months (and completeness) are available. We present a year of data at a time for ease of downloading.

File Formats & Data Sets

PeMS exports data in a variety of file formats including HPMS and comma-delimited ASCII text. Each file format has an associated list of data sets that it supports. For example, the HPMS standard specifies four distinct record types: stations, volumes, vehicle classification and truck weights. The exact list of data sets depends on the data sources available to PeMS.

Download Actions

Your browser configuration dictates the action taken once a file has been downloaded. Please check your browser documentation to determine where the file is located and default action that occurs once the download has been completed.

Compression Formats

You will need a file compression utility capable of handling gzip and bzip2 formats.

Automated Scripts

All file downloads are recorded in the PeMS database. Please do not use automated scripts to retrieve data through this service.

Type

Station 5-Minute

District

District 3

Submit

2021 Station 5-Minute

Data Summary

This dataset contains the standard PeMS rollup of raw detector data. The algorithms used to process raw detector data are described in the System Help.

Months with data are indicated by a gray rectangle. Click a rectangle to view a listing of files available for download.

Field Specification

Name	Comment	Units
Timestamp	The date and time of the beginning of the summary interval. For example, a time of 08:00:00 indicates that the aggregate(s) contain measurements collected between 08:00:00 and 08:04:59. Note that second values are always 0 for five-minute aggregations. The format is MM/DD/YYYY HH24:MI:SS.	
Station	Unique station identifier. Use this value to cross-reference with Metadata files.	
District	District #	
Freeway #	Freeway #	
Direction of Travel	N S E W	
Lane Type	A string indicating the type of lane. Possible values (and their meaning) are: <ul style="list-style-type: none"> CD (Coll/Direct) CH (Conventional Highway) FF (Fwy-Fwy connector) FR (Off Ramp) 	

Available Files

File Name	Bytes
d03_text_station_Smin_2021_01_01.txt.gz	8,030,439
d03_text_station_Smin_2021_01_02.txt.gz	8,064,674
d03_text_station_Smin_2021_01_03.txt.gz	7,995,386
d03_text_station_Smin_2021_01_04.txt.gz	8,195,553
d03_text_station_Smin_2021_01_05.txt.gz	8,269,821
d03_text_station_Smin_2021_01_06.txt.gz	8,251,997
d03_text_station_Smin_2021_01_07.txt.gz	8,272,985
d03_text_station_Smin_2021_01_08.txt.gz	8,342,415
d03_text_station_Smin_2021_01_09.txt.gz	8,126,307
d03_text_station_Smin_2021_01_10.txt.gz	7,997,585
d03_text_station_Smin_2021_01_11.txt.gz	8,249,276
d03_text_station_Smin_2021_01_12.txt.gz	8,269,760
d03_text_station_Smin_2021_01_13.txt.gz	8,298,464
d03_text_station_Smin_2021_01_14.txt.gz	8,325,471
d03_text_station_Smin_2021_01_15.txt.gz	8,402,843