

29th Annual RPUG Conference

Denver, CO November 14-17

Relationship between
repair situation
and roughness conditions



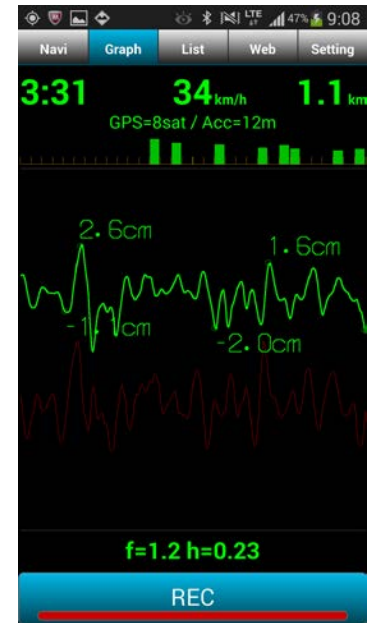
BumpRecorder

YAGI, Koichi

<http://www.bumprecorder.com>
info@bumprecorder.com

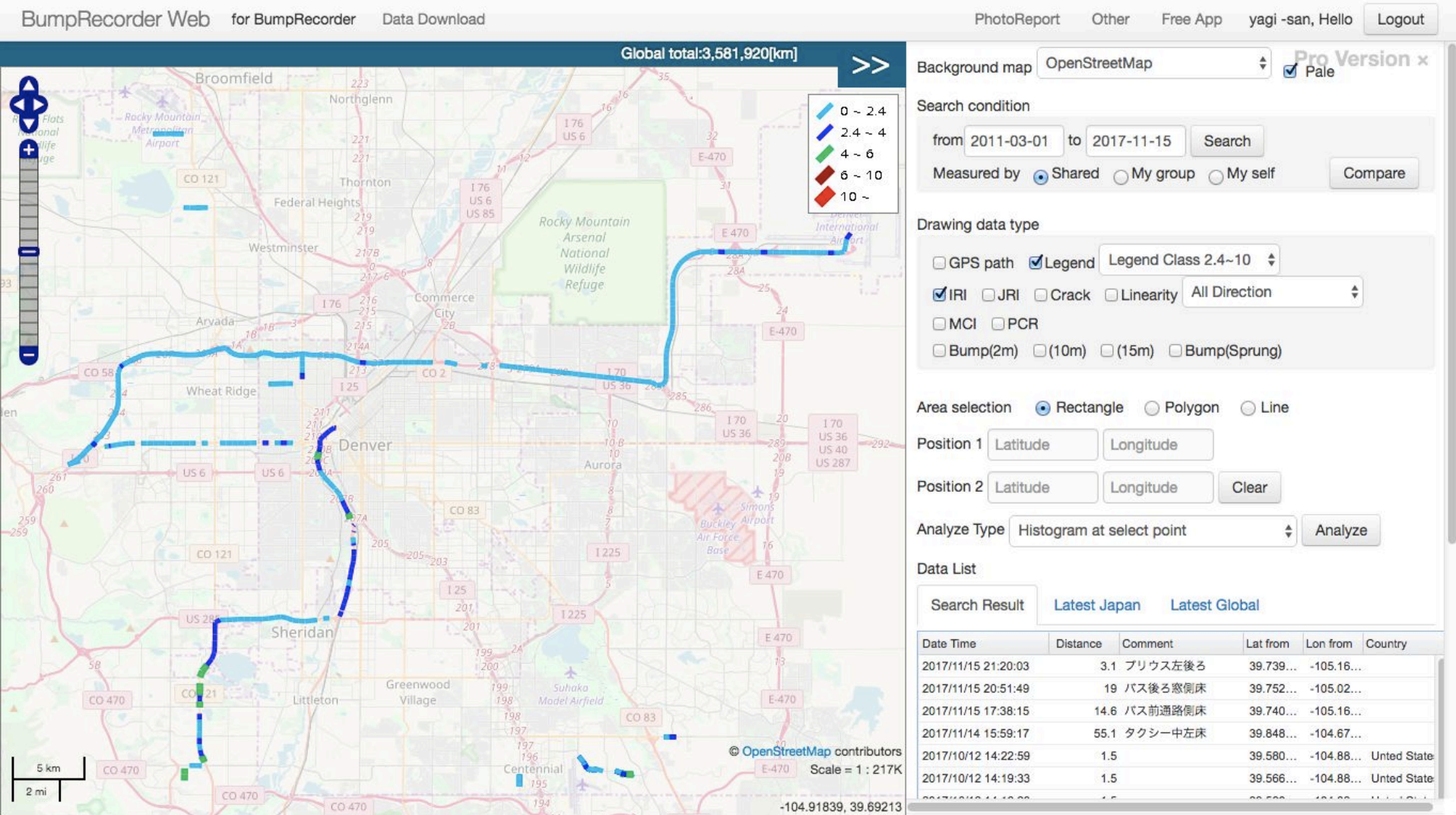
What is **BumpRecorder**

- **BumpRecorder** is a smartphone application which evaluate road condition IRI, cracking rate, and bump step locations.



IRI situation on Denver

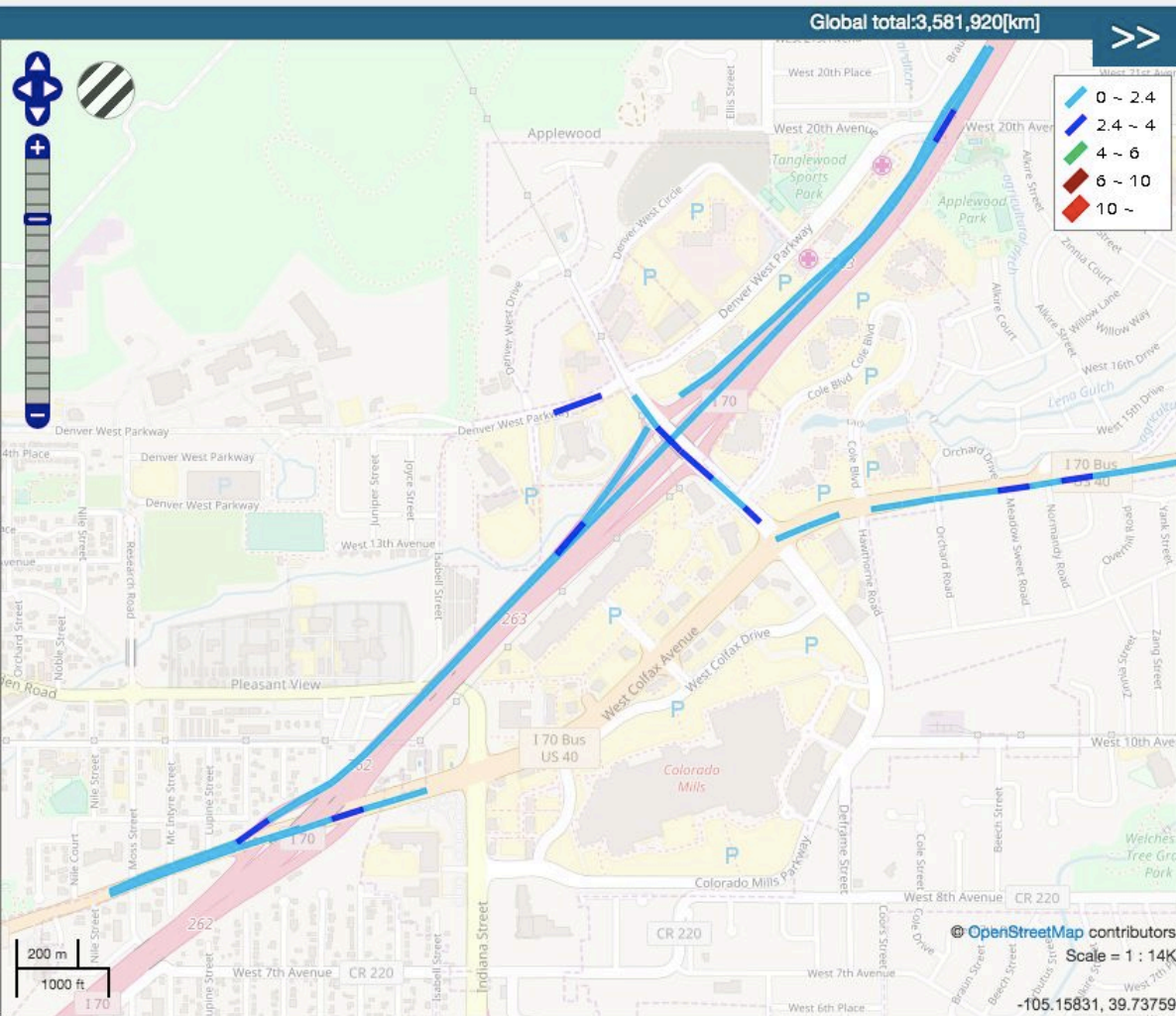
Data was collecting on Taxi and Bus.



IRI situation near Marriott

BumpRecorder Web for BumpRecorder Data Download

PhotoReport Other Free App yagi-san, Hello Logout



Background map: OpenStreetMap Pro Version x
Pale

Search condition

from 2011-03-01 to 2017-11-15 Search

Measured by Shared My group My self Compare

Drawing data type

GPS path Legend Legend Class 2.4-10

IRI JRI Crack Linearity All Direction

MCI PCR

Bump(2m) (10m) (15m) Bump(Spring)

Area selection Rectangle Polygon Line

Position 1 Latitude Longitude

Position 2 Latitude Longitude Clear

Analyze Type Histogram at select point Analyze

Data List

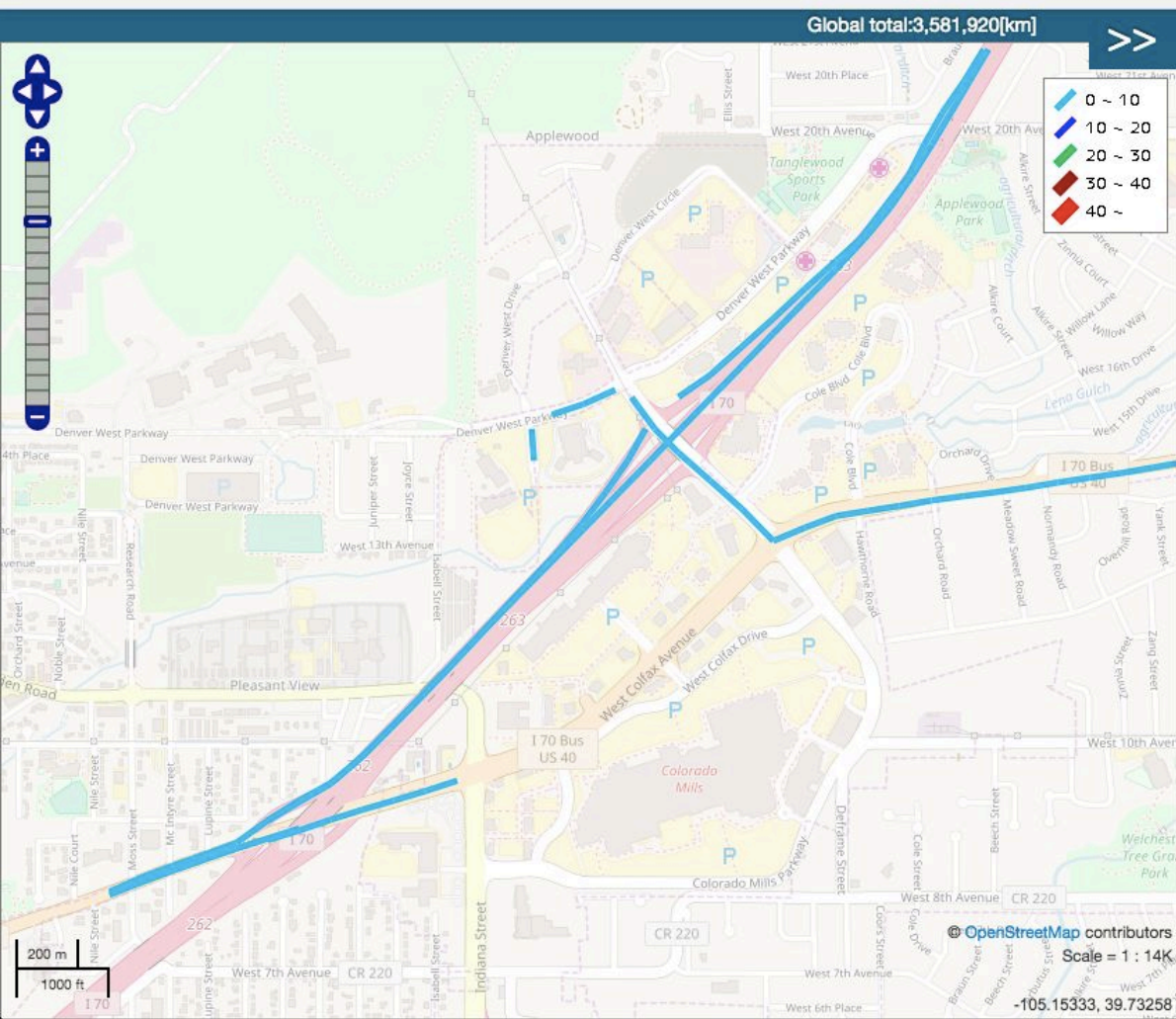
Search Result Latest Japan Latest Global

Date Time	Distance	Comment	Lat from	Lon from	Country
2017/11/15 21:20:03	3.1	プリウス左後ろ	39.739...	-105.16...	
2017/11/15 20:51:49	19	バス後ろ窓側床	39.752...	-105.02...	
2017/11/15 17:38:15	14.6	バス前通路側床	39.740...	-105.16...	
2017/11/14 15:59:17	55.1	タクシー中左床	39.848...	-104.67...	
2017/10/12 14:22:59	1.5		39.580...	-104.88...	United State
2017/10/12 14:19:33	1.5		39.566...	-104.88...	United State

Cracking situation near Marriott

BumpRecorder Web for BumpRecorder Data Download

PhotoReport Other Free App yagi-san, Hello Logout



Background map: OpenStreetMap Pro Version x Pale

Search condition
 from 2011-03-01 to 2017-11-15
 Measured by Shared My group My self

Drawing data type
 GPS path Legend Legend Class 10~40% IRI JRI Crack Linearity All Direction MCI PCR
 Bump(2m) (10m) (15m) Bump(Spring)

Area selection Rectangle Polygon Line

Position 1
 Position 2

Analyze Type

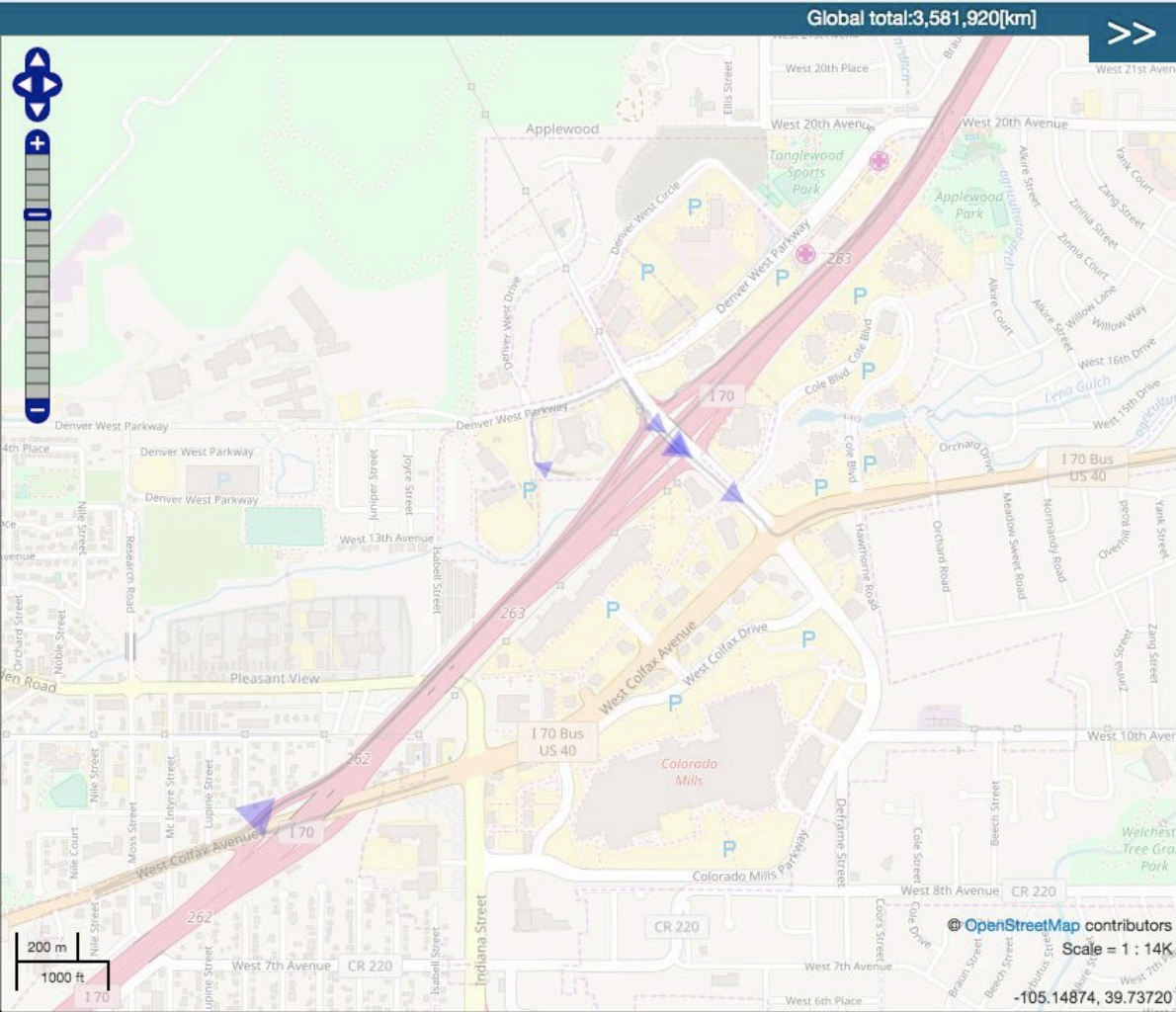
Data List

Date Time	Distance	Comment	Lat from	Lon from	Country
2017/11/15 21:20:03	3.1	プリウス左後ろ	39.739...	-105.16...	
2017/11/15 20:51:49	19	バス後ろ窓側床	39.752...	-105.02...	
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2017/10/12 14:22:59	1.5		39.580...	-104.88...	United State
2017/10/12 14:19:33	1.5		39.566...	-104.88...	United State

Bump step location near Marriott

BumpRecorder Web for BumpRecorder Data Download

PhotoReport Other Free App yagi-san, Hello Logout



Background map: OpenStreetMap Pro Version x Pale

Search condition

from 2011-03-01 to 2017-11-15 Search

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Area selection Rectangle Polygon Line

Position 1 Latitude Longitude

Position 2 Latitude Longitude Clear

Analyze Type Histogram at select point Analyze

Data List

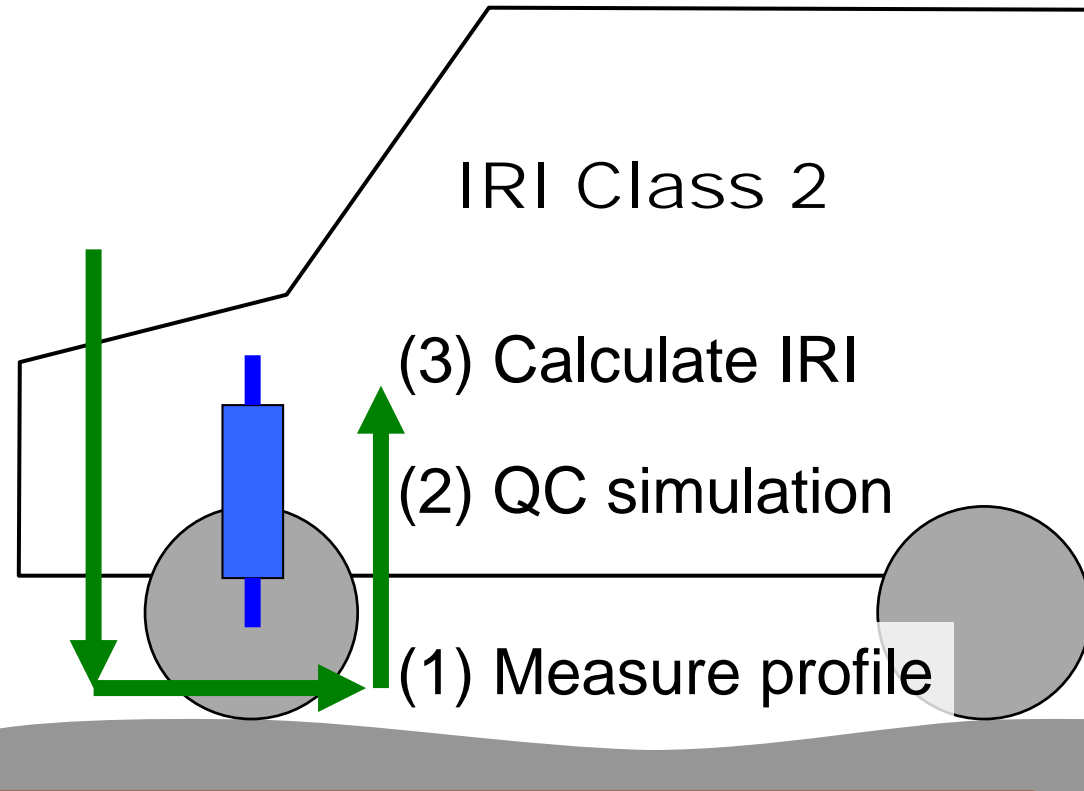
Search Result Latest Japan Latest Global

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2017/11/15 21:20:03	3.1	プリウス左後ろ	39.739...	-105.16...	
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2017/10/12 14:22:59	1.5		39.580...	-104.88...	United State
2017/10/12 14:19:33	1.5		39.566...	-104.88...	United State

BumpRecorder is IRI Class 2

BumpRecorder

- Measure acceleration (a)
- Suspension estimation (b)
- Inverted QC simulation (c)
- Calculate profile (d)



Auto calibration is done during measurement driving.
Good repeatability.

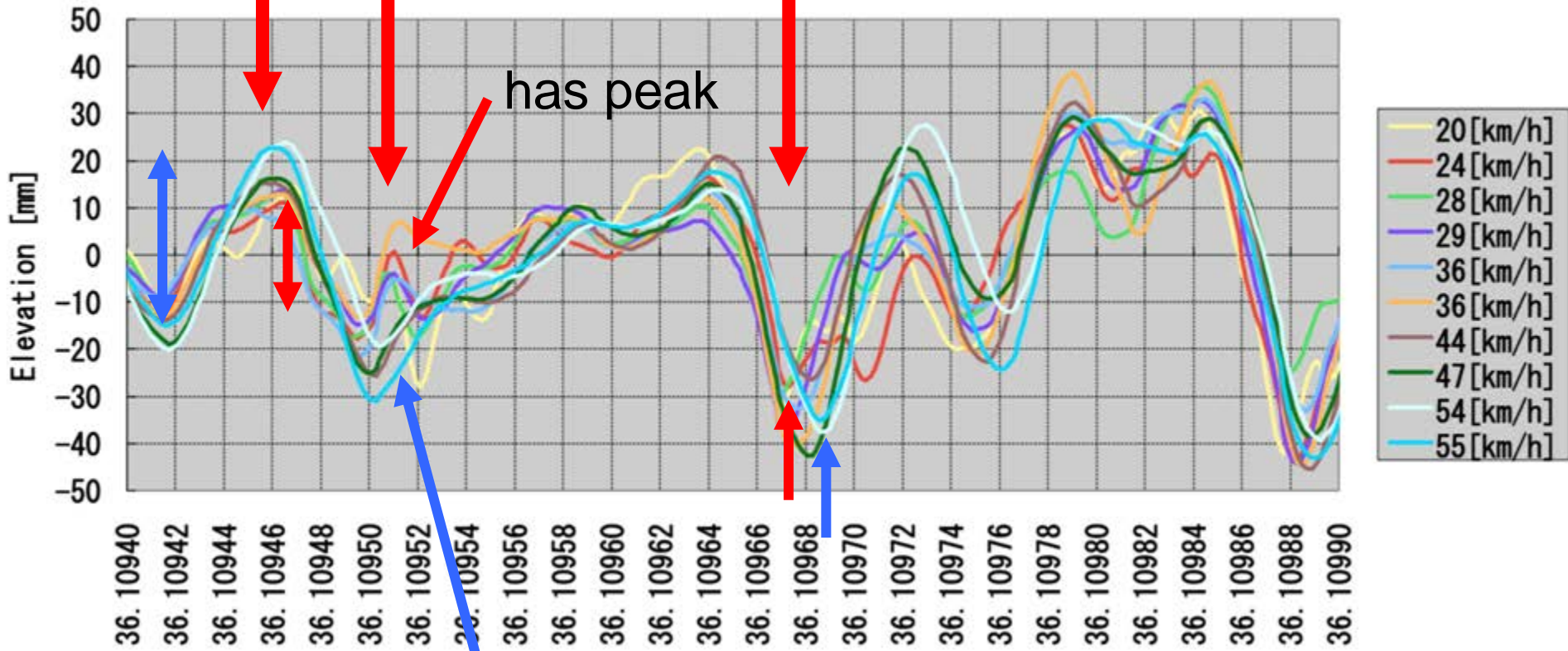
When no calibration...



Amplitude

Shape

Peak Location



no peak

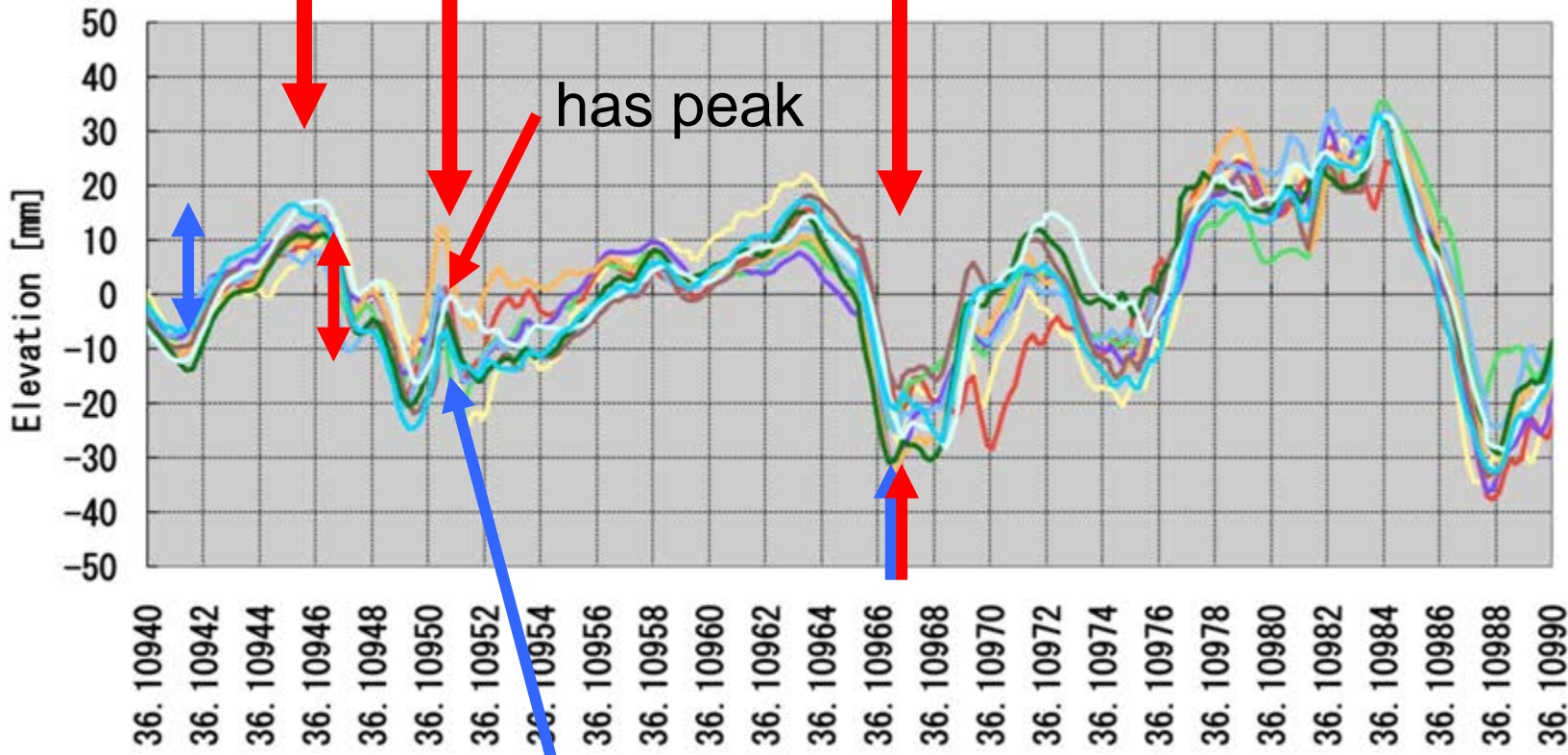
Low reliability

Suspension calibration effects

Amplitude

Shape

Peak Location

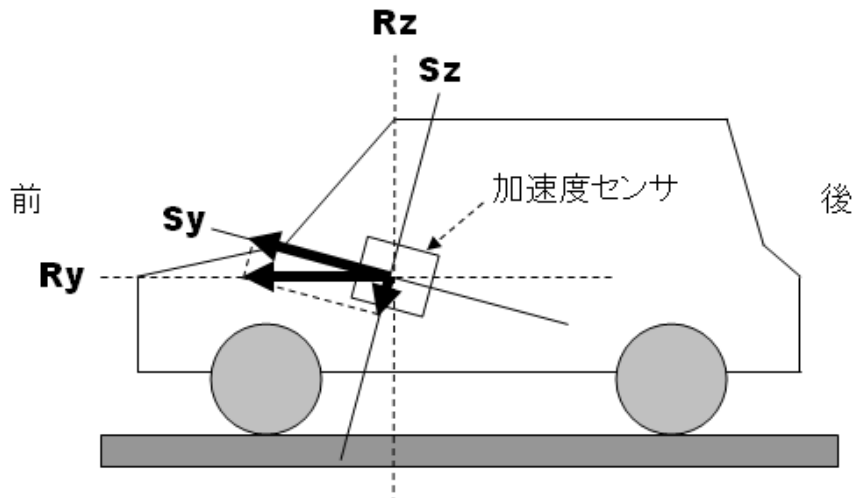


has peak

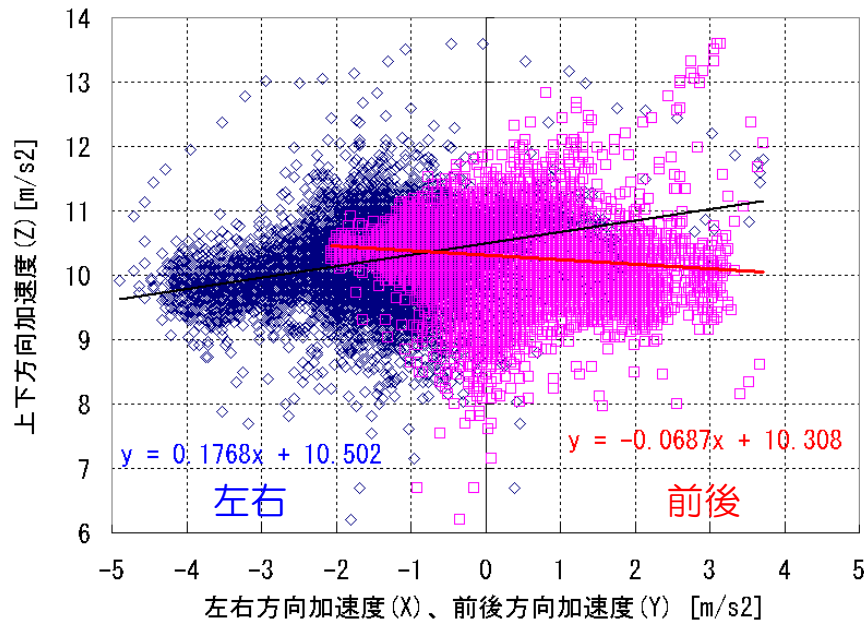
has peak

Good reliability

Tilt calibration

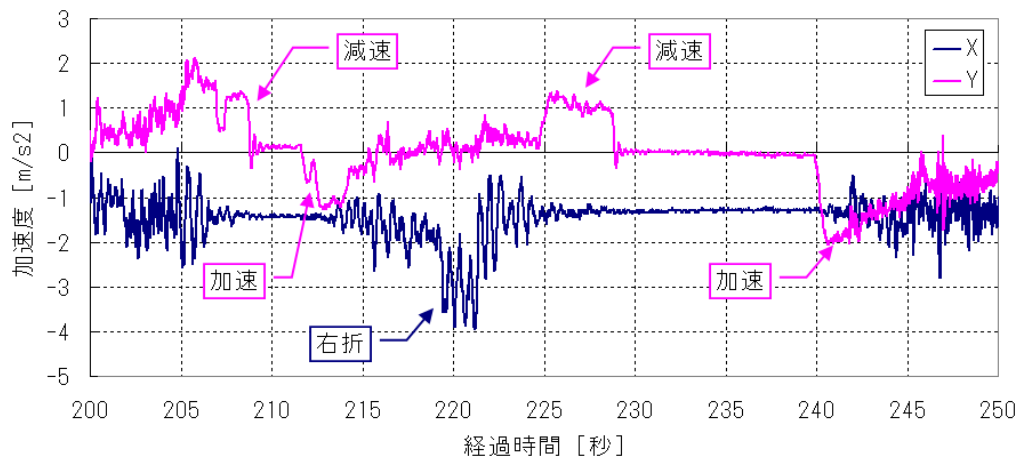


- When smartphone sensor has tilt, virtual vertical acceleration will be occurred.
- Road has slope and cant, it is not easy to place completely horizontal angle.
- **BumpRecorder** estimate tilt angle automatically from relationship of 2 axis acceleration.

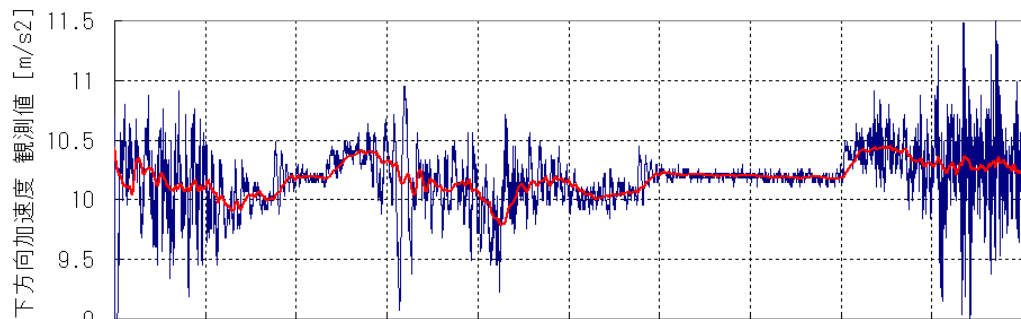


Tilt calibration effects

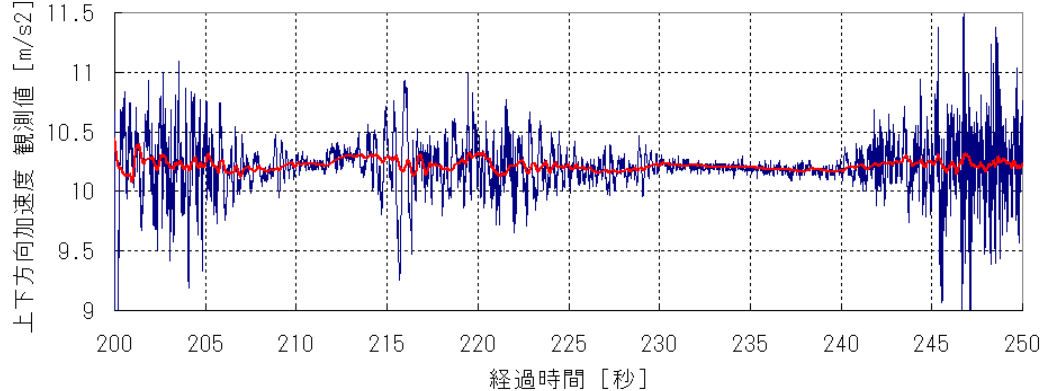
Stop & go
and turn



Original
vertical
acceleration



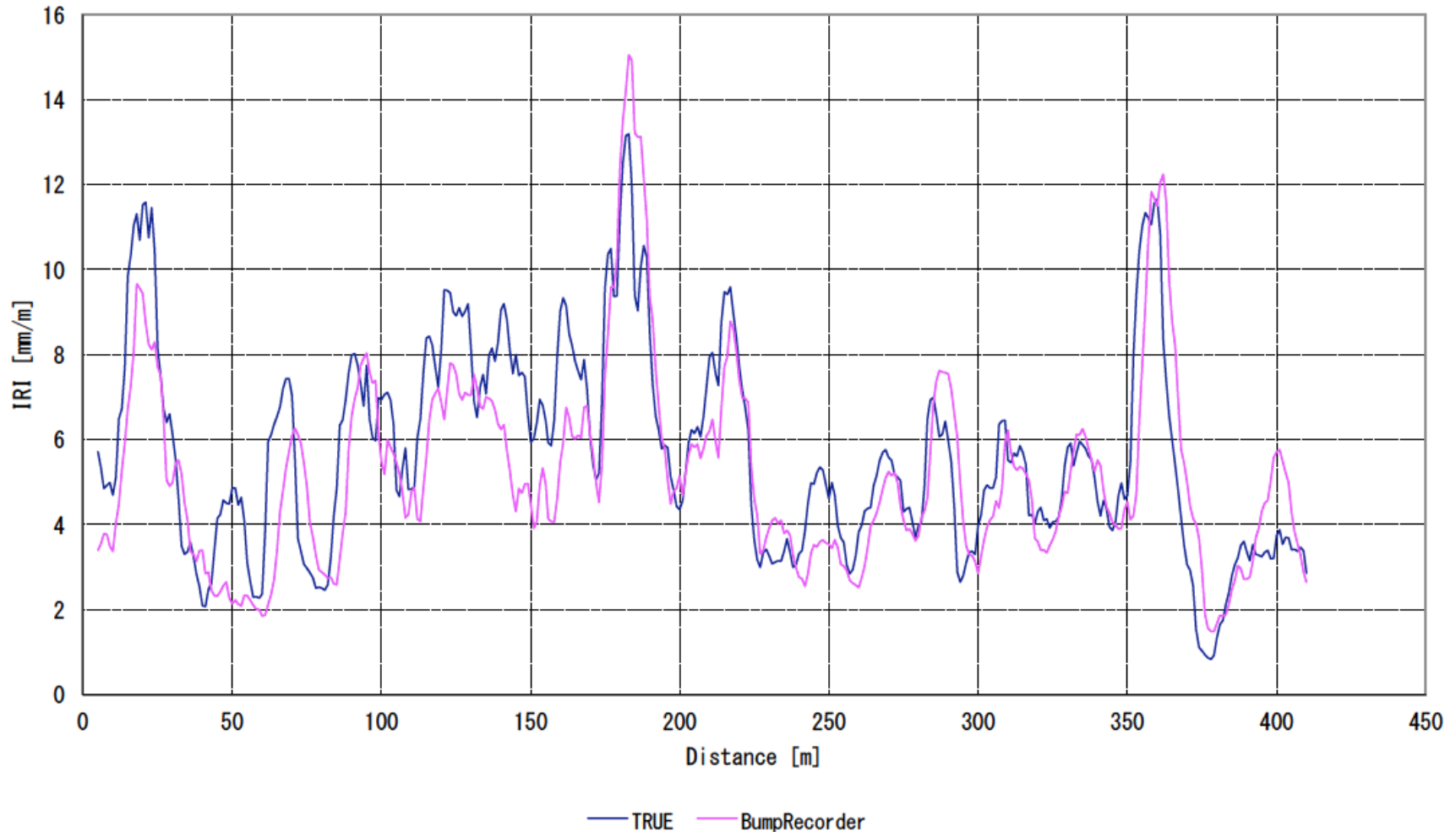
After
calibration



Comparison of longitudinal profile

Join “IRI common test” and compare with Class 1 profiler.

IRI Comparison



Today's topic



- Previously, Data collection spend much cost, so, road administrator **make decision without data.**
- Now, there are smartphone application.
- It is removing one the obstacle of cost side.
- In fact, many **road administrator faced difficulties "how to use measurement data?"**

Road conditions recording

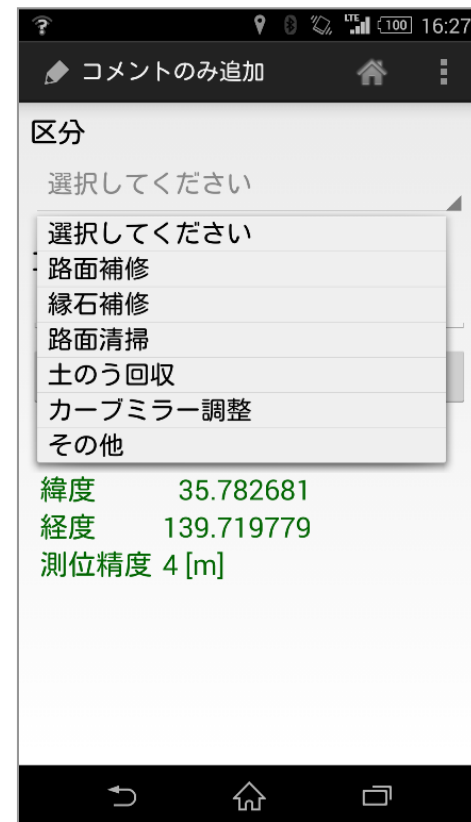
- From before, the "Aizu-Wakamatu" city road administrators are doing regular patrol few times in a week for human visual inspections and quick repairs.
- Since January 2015, they are **starting regular roughness measurement** during this patrol on 20 vehicle by using Smartphone App "**BumpRecorder**".
- It not increasing man-hour cost.

They knows road conditions data.



Quick repair history recording

- Patrol result was hand writing on the notebook, previously.
- Since June 2016, by using smartphone, they are starting to record GPS location data, one word comment and/or site photo.



Daily Report

Purpose of recording is to reduce reporting time.

道路・河川巡視員業務日誌

平成 28年05月12日 木曜日

課長	GL	巡視員

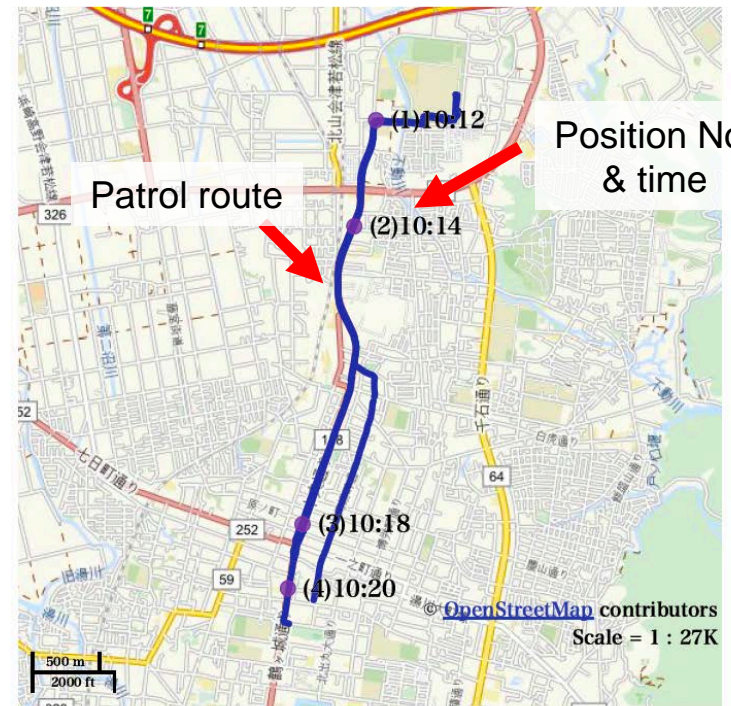
Position No.

対応番号	Repair type	所見及び対応
(1)	路面補修	
(2)	路面清掃 3箇所	
(3)	カーブミラー調整 左方	
(4)	その他	
(5)		
(6)		
(7)		
(8)		

【記事】

路面補修	水門点検	その他	直営・業者施工要	常温合材使用量
ヶ所	ヶ所	ヶ所	件	

道路・河川巡視員業務日誌(平成 28年05月12日 木曜日)



Position No.
& time

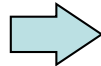
Patrol route

Purposes of this research

They have road condition data and quick repair results more than 1 years.

First Step

Quick repair



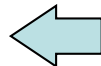
road condition data



Is there relationship?

Next Step

Quick repair



road condition data



To evaluate repair possibility
and making repair planning

Trial city "Aizu-Wakamatsu"

Aizu-Wakamatsu is located at north place from Tokyo.

BumpRecorder Web for 会津若松市役所 Data Download

Global total:3,565,370[km]

PhotoReport Other Free App aizu_BL-01_1-san, Hello Logout

Background map OpenStreetMap Pale

Search condition

from 2011-03-01 to 2017-11-07 Search

Measured by Shared My group My self

Drawing data type

GPS path Legend Legend Class 2.4-10

IRI JRI Crack Linearity North to South

MCI PCR

Bump(2m) (10m) (15m) Bump(Spring)

PhotoReport 路面補修 (4362)

Area selection Rectangle Polygon Line

Position 1 Latitude Longitude

Position 2 Latitude Longitude Clear

Analyze type Data download Analyze

Data List

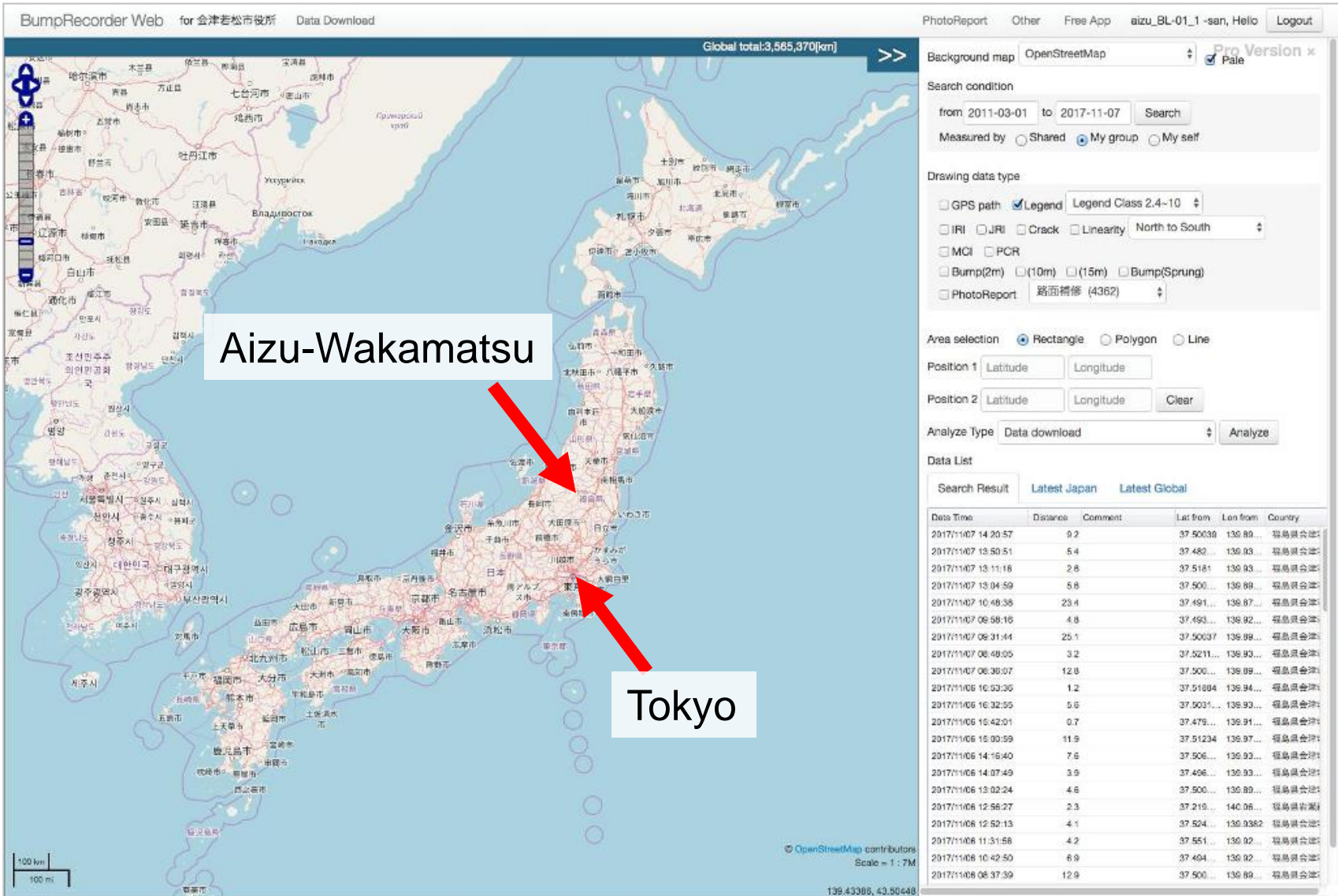
Search Result Latest Japan Latest Global

Date Time	Distance	Comment	Lat from	Lon from	Country
2017/1/07 14:20:57	9.2		37.50030	136.89...	福島県会津
2017/1/07 13:50:51	5.4		37.482...	136.93...	福島県会津
2017/1/07 13:11:16	2.6		37.5181...	136.93...	福島県会津
2017/1/07 13:04:59	5.8		37.500...	136.89...	福島県会津
2017/1/07 10:46:38	23.4		37.491...	136.87...	福島県会津
2017/1/07 09:58:16	4.8		37.493...	136.92...	福島県会津
2017/1/07 09:31:44	25.1		37.50037	136.89...	福島県会津
2017/1/07 06:48:05	3.2		37.5211...	136.93...	福島県会津
2017/1/07 06:36:07	12.8		37.500...	136.89...	福島県会津
2017/1/06 16:03:36	1.2		37.51894	136.94...	福島県会津
2017/1/06 16:32:55	5.6		37.5031...	136.93...	福島県会津
2017/1/06 15:42:01	0.7		37.479...	136.91...	福島県会津
2017/1/06 15:00:59	11.9		37.51234	136.97...	福島県会津
2017/1/06 14:16:40	7.6		37.506...	136.93...	福島県会津
2017/1/06 14:07:49	3.9		37.496...	136.93...	福島県会津
2017/1/06 13:02:24	4.6		37.500...	136.89...	福島県会津
2017/1/06 12:56:27	2.3		37.219...	140.06...	福島県岩手
2017/1/06 12:52:13	4.1		37.524...	136.9382	福島県会津
2017/1/06 11:31:58	4.2		37.551...	136.92...	福島県会津
2017/1/06 10:42:50	6.9		37.494...	136.92...	福島県会津
2017/1/06 08:37:39	12.9		37.500...	136.89...	福島県会津

100 km 100 mi

© OpenStreetMap contributors Scale = 1 : 7M

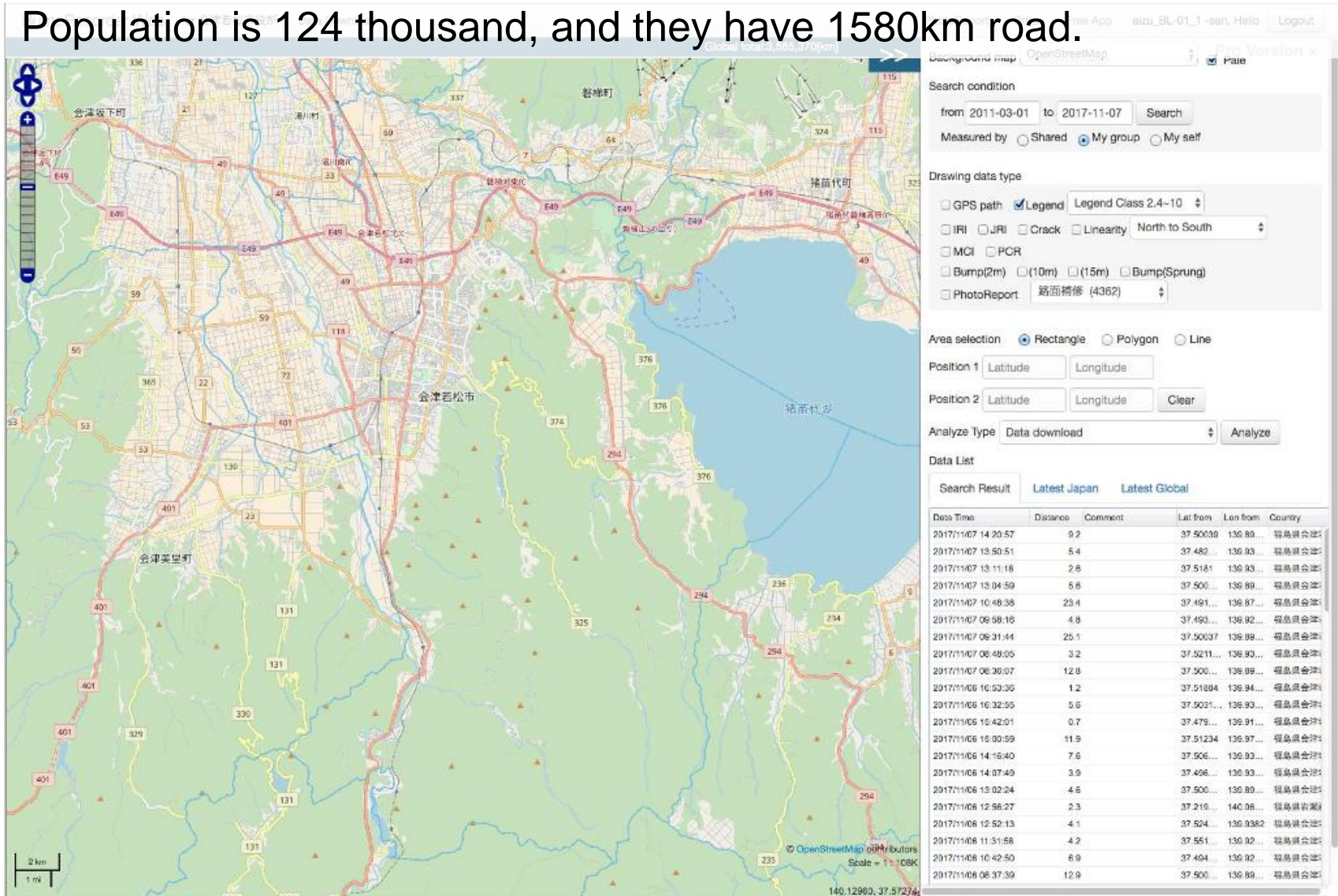
139.43386, 43.50448



Trial city "Aizu-Wakamatsu"

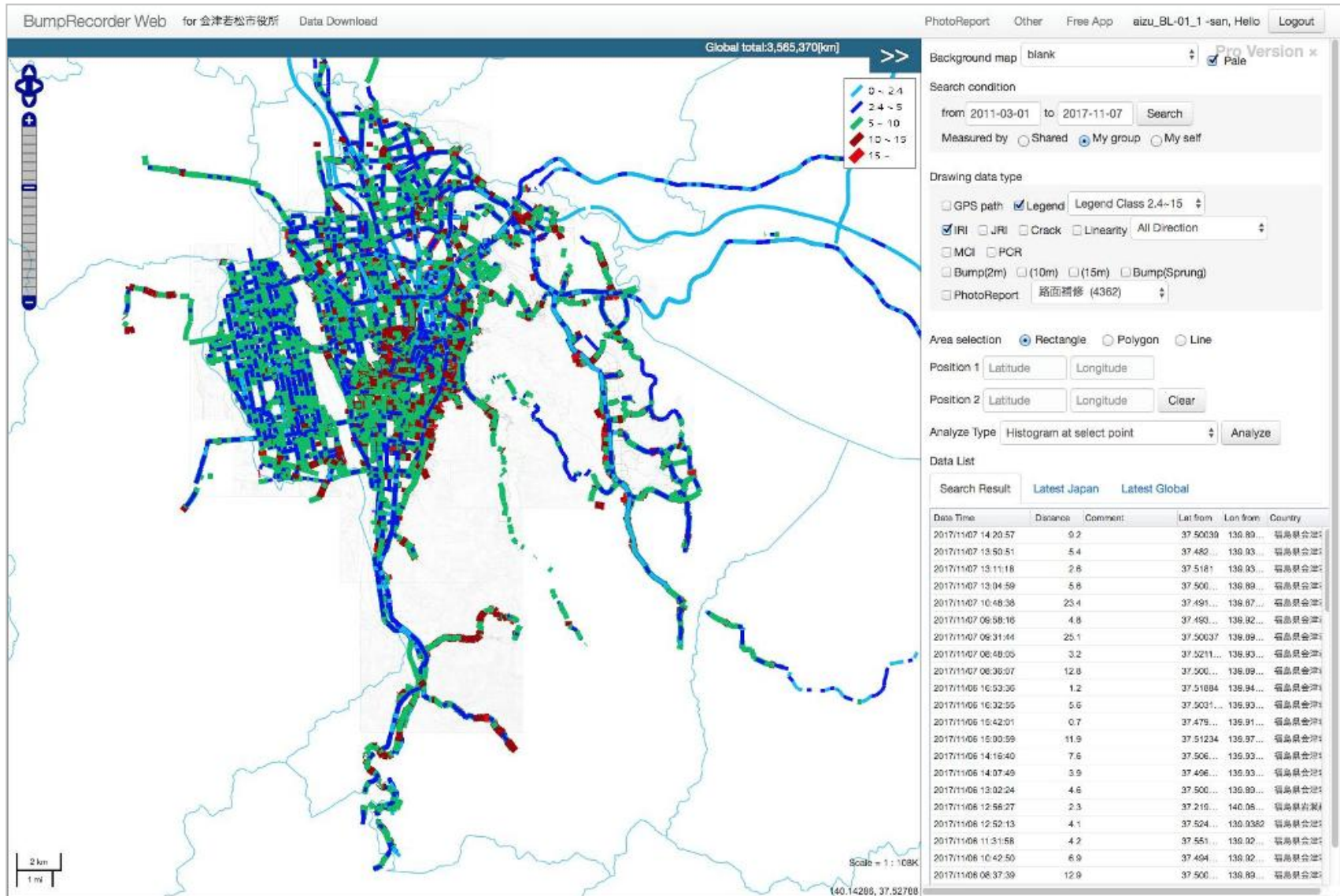
They have downtown side, mountain side and lake side.

Population is 124 thousand, and they have 1580km road.



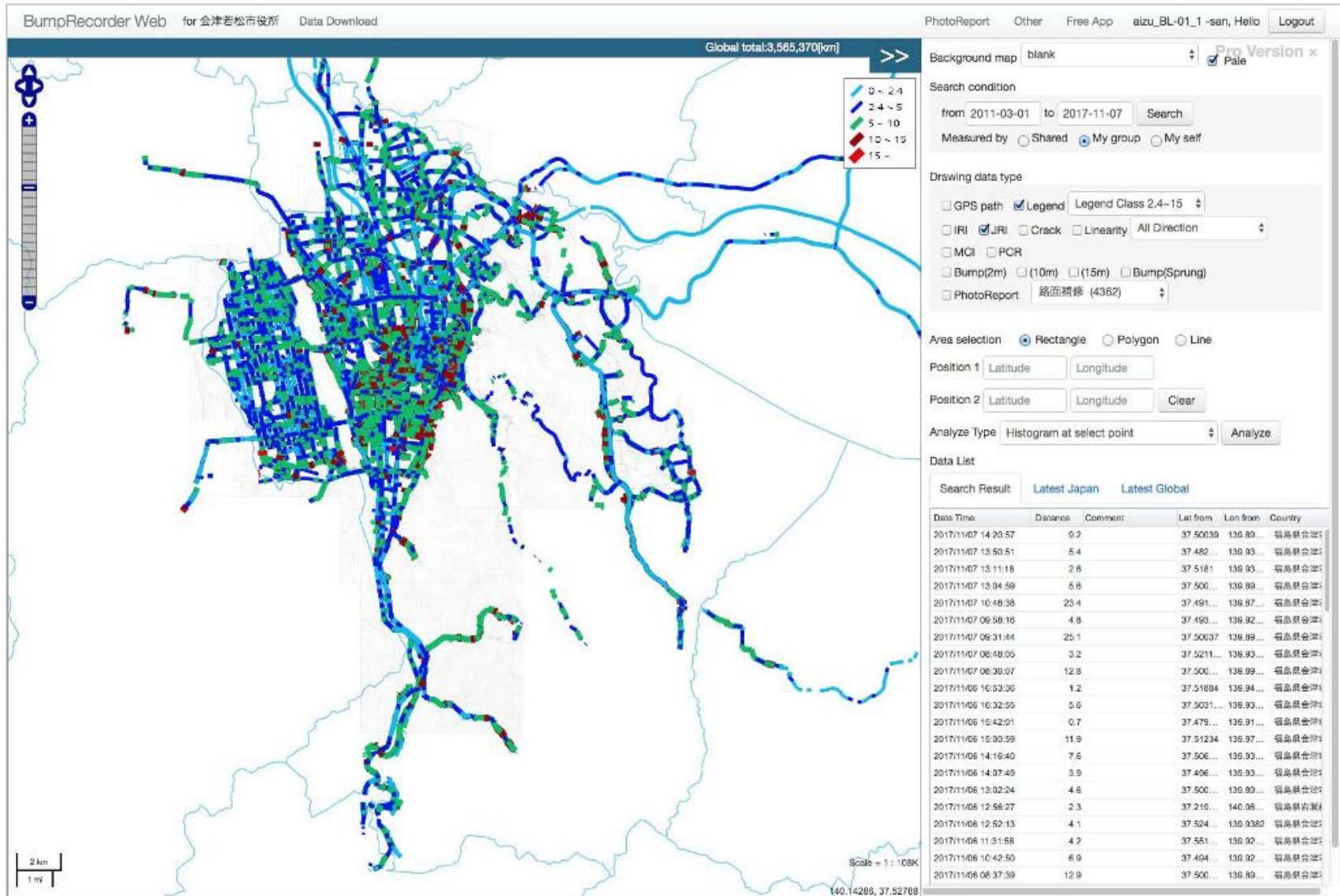
Data collection : IRI

Since 2015, regular data collection was starting. It collect few days in a week.



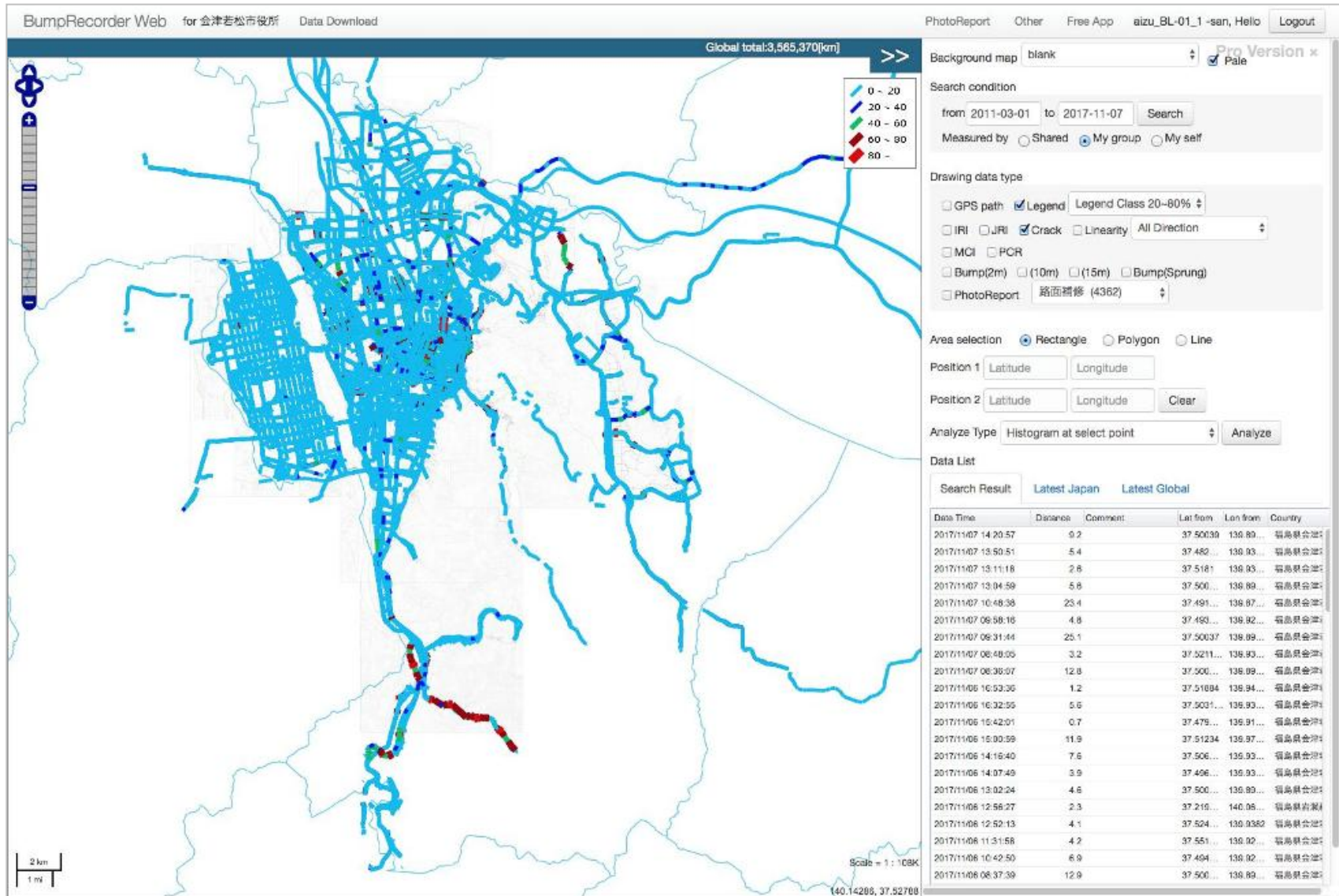
JRI : Japanese Roughness Index

JRI is the Japanese standard which reflect shorter wave length than IRI.



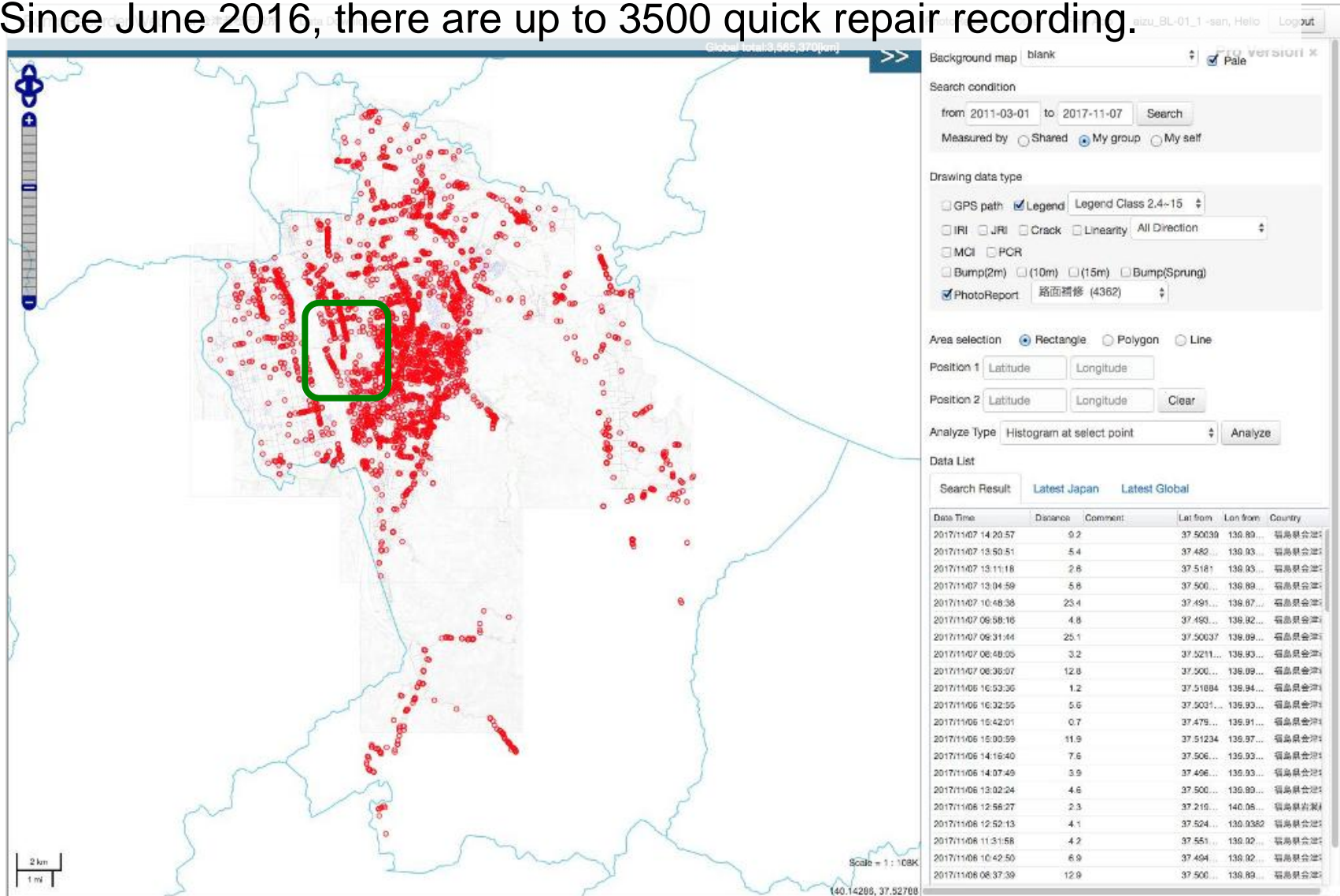
Cracking rate

Cracking rate also collect by using smartphone App "**BumpRecorder**".



Quick repair history

Repair history is recording by using smartphone during regular patrol.
 Since June 2016, there are up to 3500 quick repair recording.



Close-up Downtown area

Red line : City main road, Blue line : Community road

BumpRecorder Web for 会津若松市役所 Data Download

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PhotoReport 路面補修 (4362)

Area selection Rectangle Polygon Line Modify

Position 1 Latitude Longitude Save Load

Position 2 Latitude Longitude Clear

Analyze Type Data download Analyze

Download Type Monthly

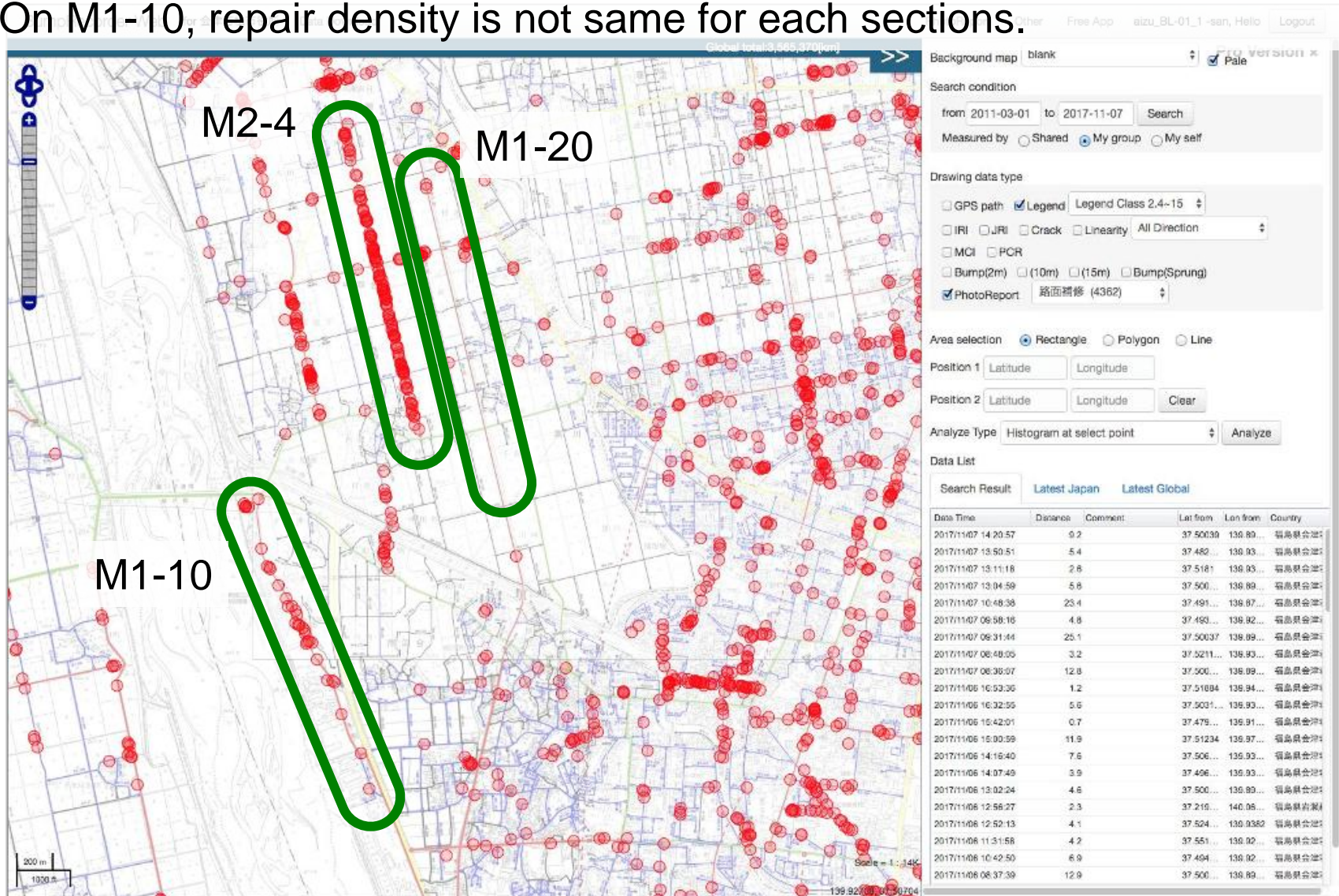
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2017/11/07 08:48:05	3.2		37.5211...	136.93...	福島県会津
2017/11/07 08:38:07	12.8		37.500...	136.89...	福島県会津
2017/11/06 16:53:36	1.2		37.51884	136.94...	福島県会津
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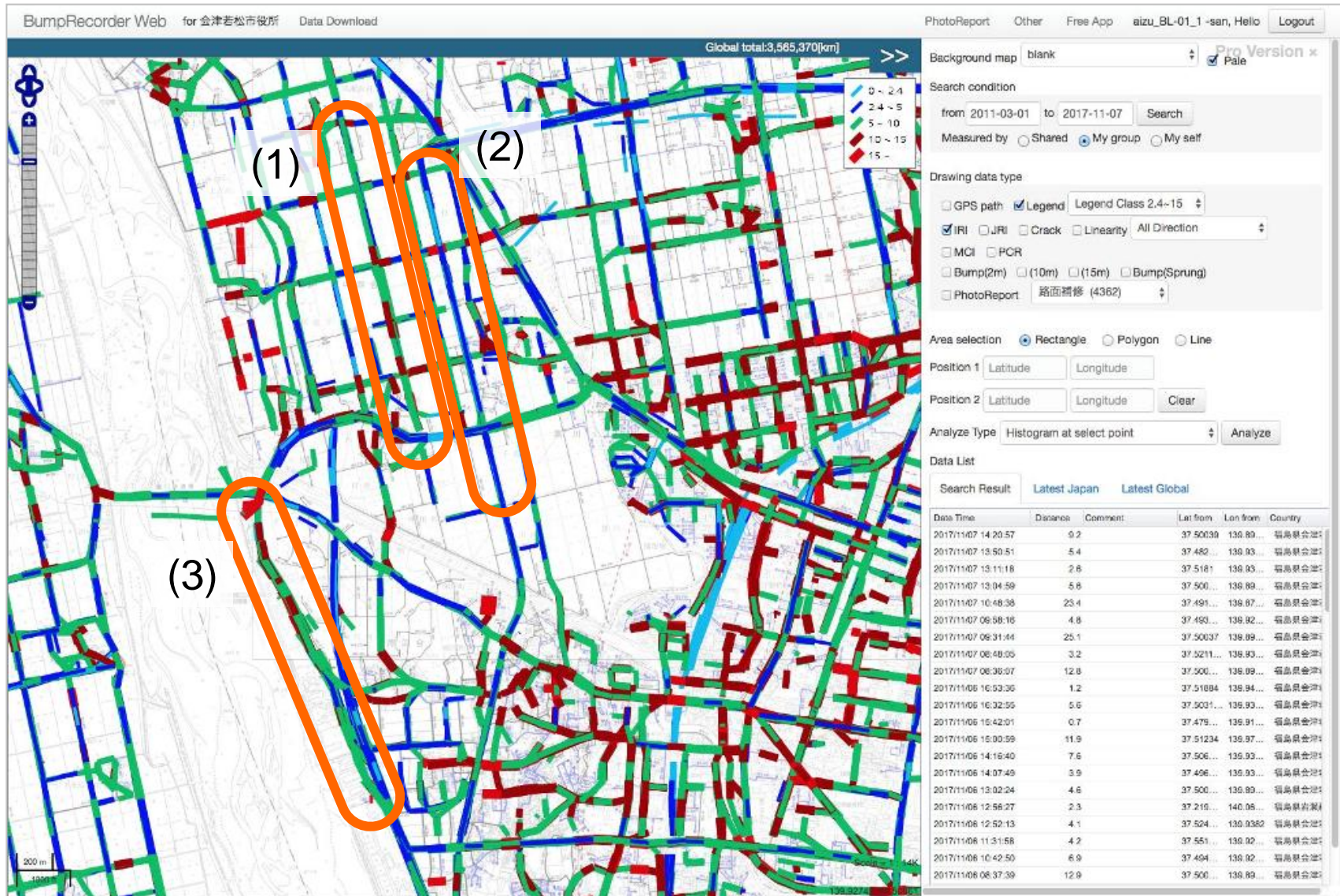
Quick repair at Downtown area

M2-4 and M1-20 is neighboring road, but repair frequency is different.
 On M1-10, repair density is not same for each sections.



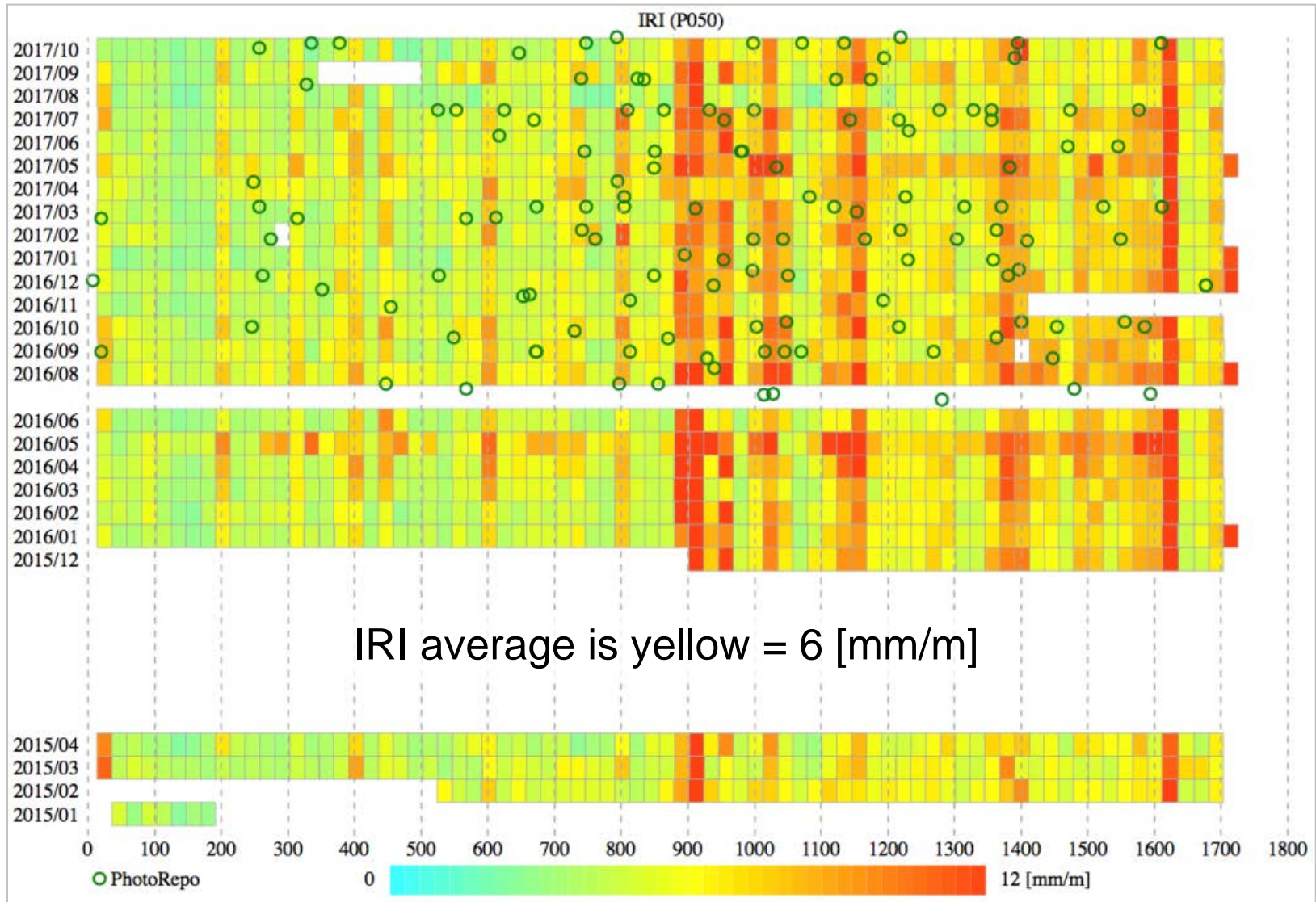
IRI conditions

IRI of (1) is bad than (2)



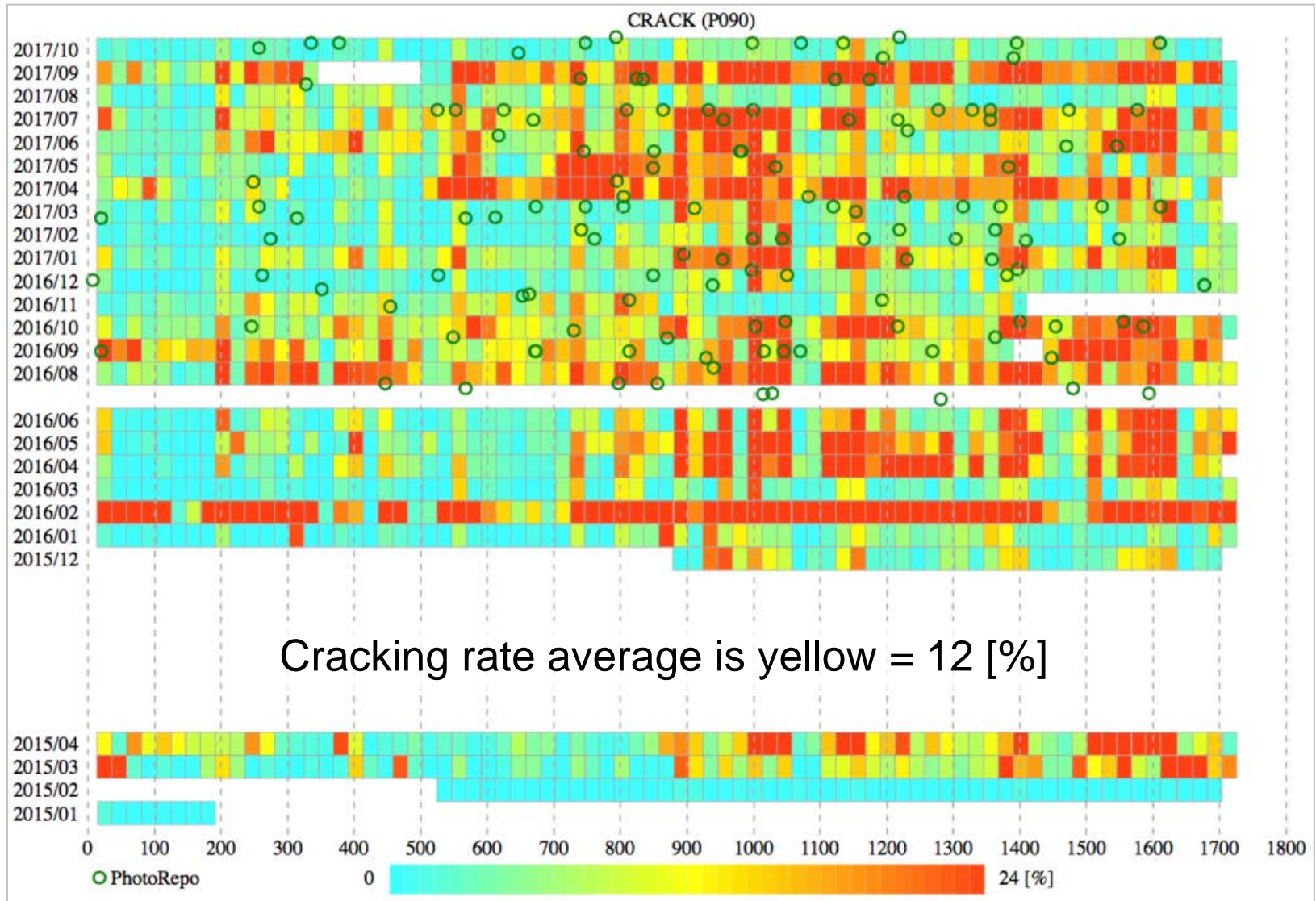
Contour plot of Main road (1)

Repair location has IRI > 4[mm/m]



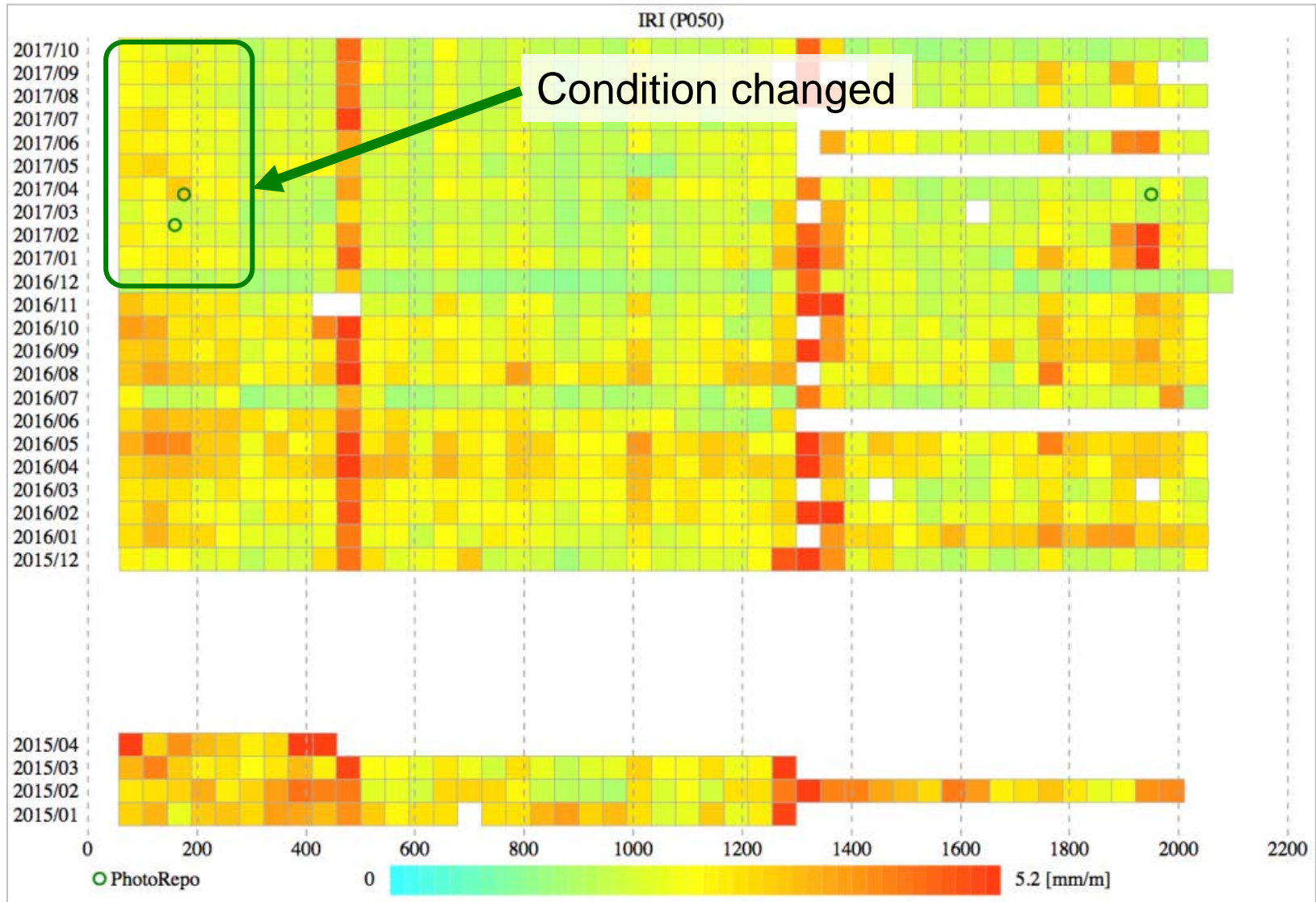
Contour plot of Main road (1)

Repair location has cracking rate > 10[%]



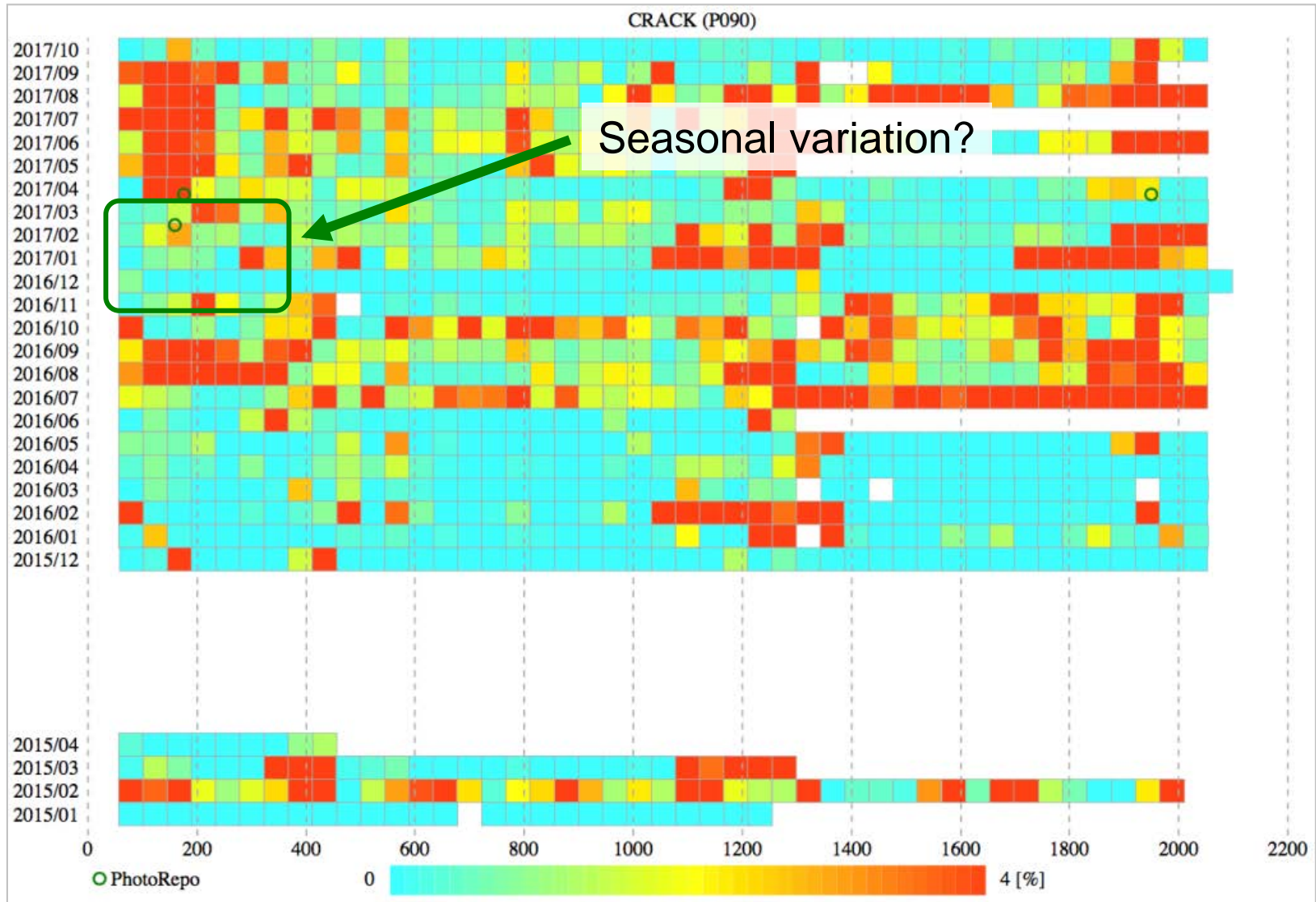
Contour plot of Main road (2)

Almost no repair, and IRI < 5[mm/m]



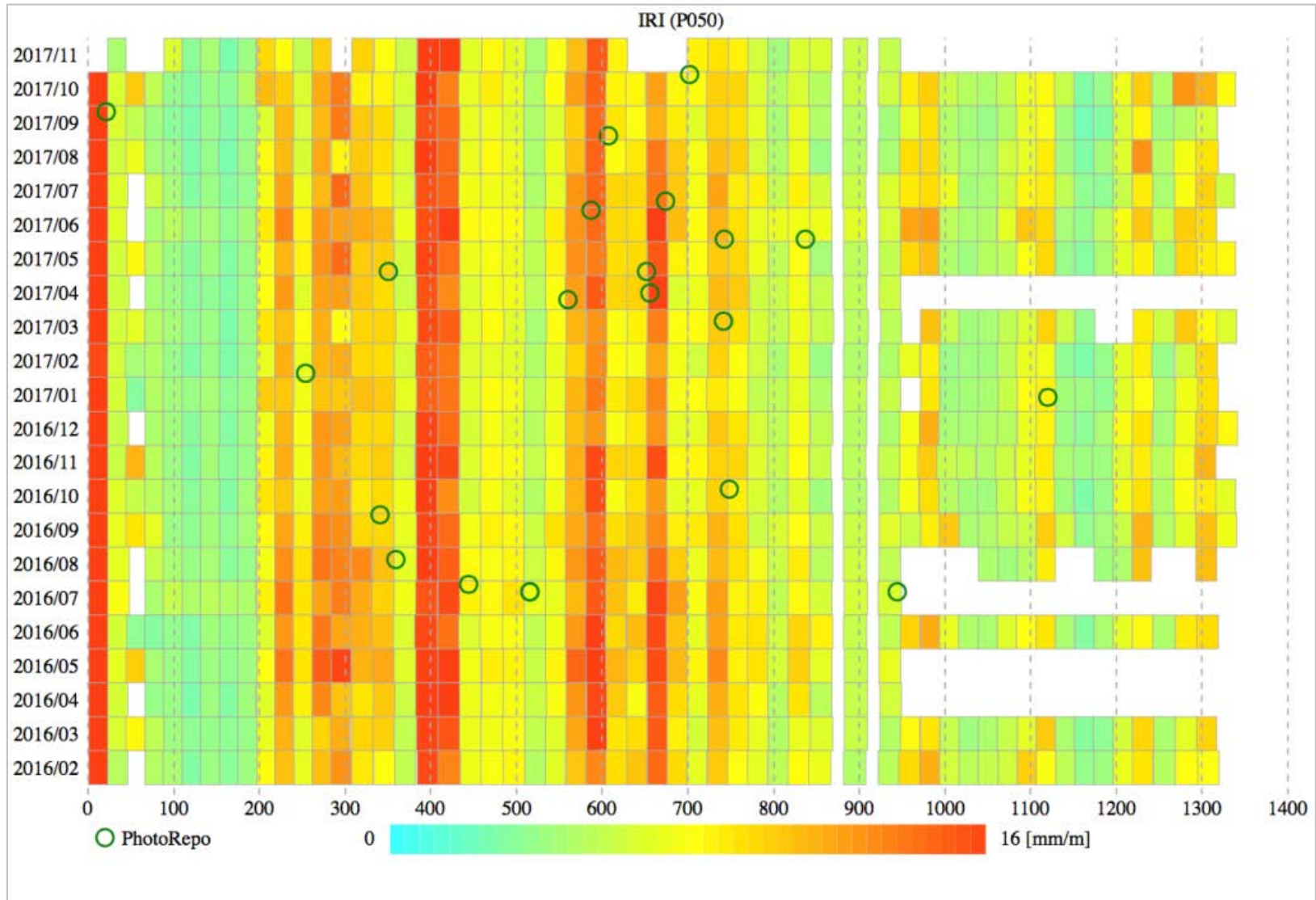
Contour plot of Main road (2)

Almost no repair, and cracking rate < 4[%]



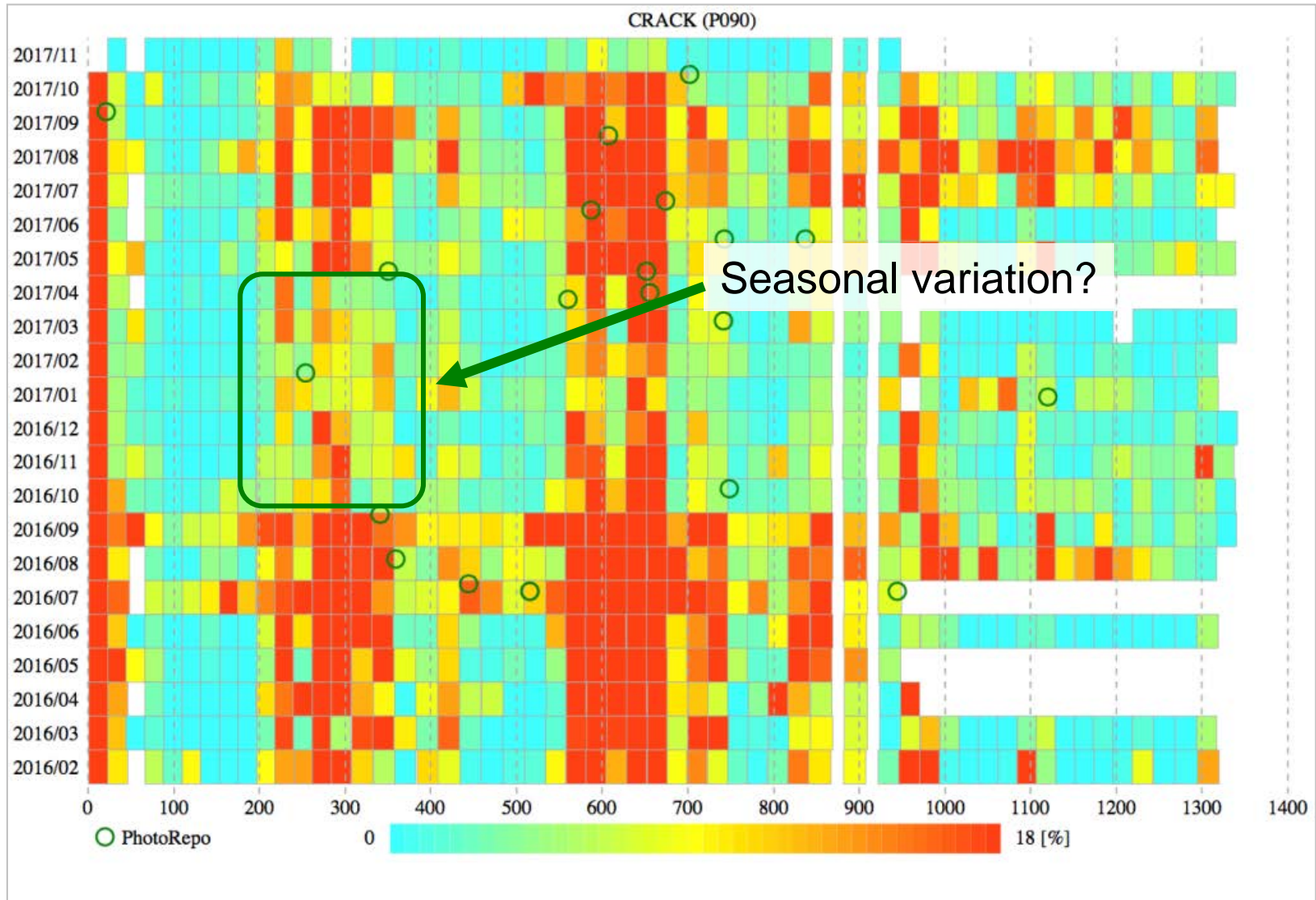
Contour plot of Main road (3)

Almost no repair, and IRI < 5 [mm/m]



Contour plot of Main road (3)

Almost no repair, and cracking rate < 4[%]



Conclusions



- This is first step to study relationship between repair history and road condition on several city main roads by using regular recording data.
- In this study, there are relationship and it found quick repair is increasing on $IRI > 6[\text{mm/m}]$ and/or Cracking rate $> 10[\%]$.

Next step

- To confirm relationship on the other road.
- When it will find related parameters and thresholds, an automatic pick-up logic will be developed.
- In future time, by using road condition data, repair risk will be evaluated.

Additional Information



BumpRecorder New service will be start!

To increase measurement data usage,

1. IRI calculation price is 1USD / km. It proved on the

BumpRecorder Web site from today

<http://map.bumprecorder.com/download>

2. IRI calculation API will provide, when you post acceleration and GPS data to **BumpRecorder** server, you will get IRI data. This function will provide in the end of this year.

When you have an interesting, please contact
YAGI, Koichi **BumpRecorder** Co., Ltd.

yagi@bumprecorder.com

or please visit TRB 2018 booth 474