

# **New CPS Project in Japan**

## **CPS-IP: CPS Integrated Platform for Efficient Social Services**

Yuzuru Tanaka

Meme Media Laboratory

Hokkaido University

N-13, W-8, Sapporo, 060-8628, Japan

[tanaka@meme.hokudai.ac.jp](mailto:tanaka@meme.hokudai.ac.jp)

# CPS-IP: CPS Integrated Platform for Efficient Social Services

- MEXT's 5 year Project
  - Last year: Feasibility Study Project
  - 09/2012-03/2017
  - \$2.5 M for 2012
  - Project Consortium
    - NII (National Institute of Informatics)
    - Hokkaido Univ.
    - Osaka Univ.
    - Kyushu Univ.
- Targeting applications in 3 major focused goals out of the 5 goals of the 4<sup>th</sup> Science and Technology Basic Plan
  - Health innovation
  - Green Innovation
  - Advanced IT Platforms for Science and Technology
  - Secure and Comfortable Society
  - Disaster Management and Response



# Research Focus of Hokkaido Univ. Team

- **Social CPS Platform Technologies**
  - Improvisational Federation of Cyber-Physical Resources
    - for the Integrated Information Monitoring, Sharing, Analysis, Visualization, and Decision Making
    - to cope with both planned-for and improvisational scenarios
- **Target applications**
  - Smart Snow Plowing and Removing in Sapporo
  - Disaster management and response (with BBK, Fraunhofer)
  - EU FP7 Large Scale Integration Program: p-medicine (Personalized Medicine)

# Efficient Snow Plowing and Removing Snow in Sapporo

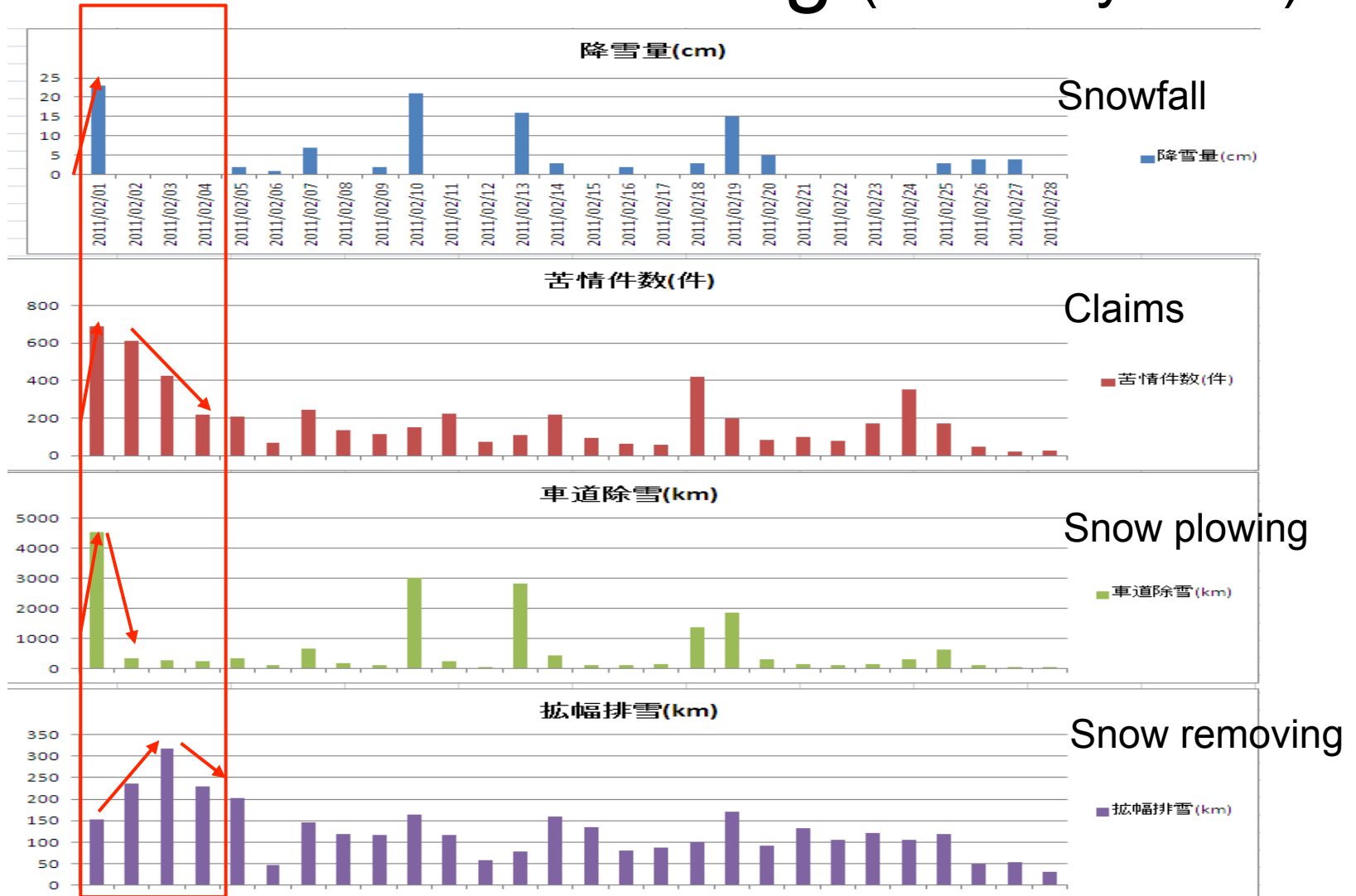
- **Snow in Sapporo**

- **Population:** **1,920,739** (The 5<sup>th</sup> largest in Japan)
- Number of house holds: 896,449
- **Annual snowfall:** **597cm**
  - Largest annual snowfall: 680cm (Oct. 1995 - March 1996)
- The largest daily snowfall: 63cm (Jan. 31<sup>st</sup>, 1970)
- The deepest snow: 169cm (Feb. 13<sup>th</sup>, 1939)
- **Annual budget for snow plowing and removing (2010):**  
**14,729,000,000 yen (189,000,000 \$)**

# Cyber Physical Data Mining

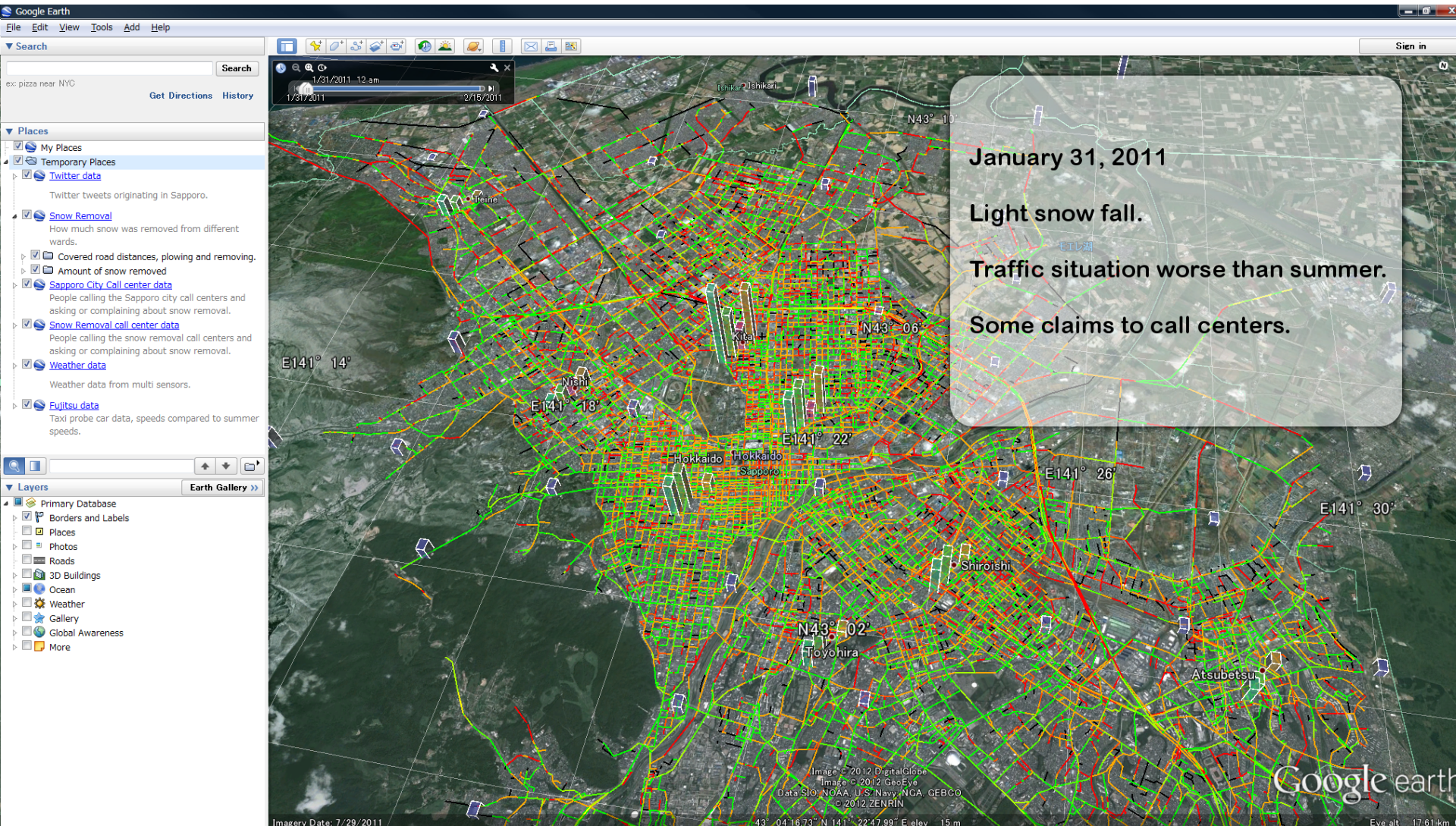
- **Retrospective data**
  - Probe car data (**+real-time data**)
    - private cars, taxi cars
  - Traffic jam sensor data
  - Meteorological multi-sensor data (52 locations) (**+real-time data**)
  - Weather mesh data
  - Snow plowing and removing records (**+real-time data**)
  - Statistical subway passenger records
  - Claim texts from residents
  - etc.
- **Mining specific probe-car-data patterns** that correspond to **specific road conditions and/or traffic conditions** requiring snow plowing and/or removing
- **Real-time probe car data**
  - to **detect specific road conditions and/or traffic conditions**
  - for evidence-based strategic snow plowing and removing

# Snowfall, Claims, Snow Plowing, and Snow Removing (February 2011)



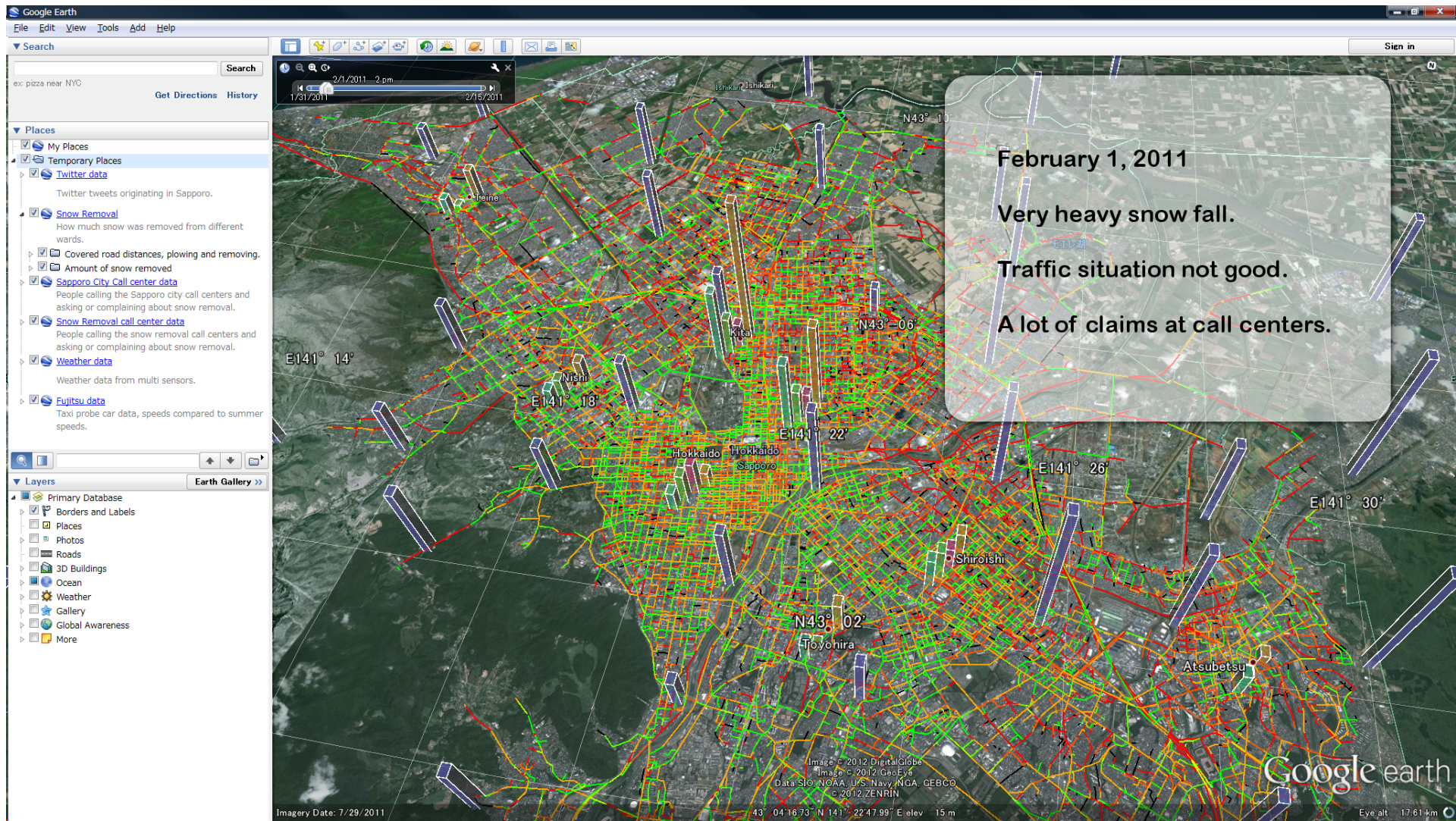


# Influence of Snowfall, Snow Plowing and Removing to Average Car Speed: Jan. 31 (no snow)



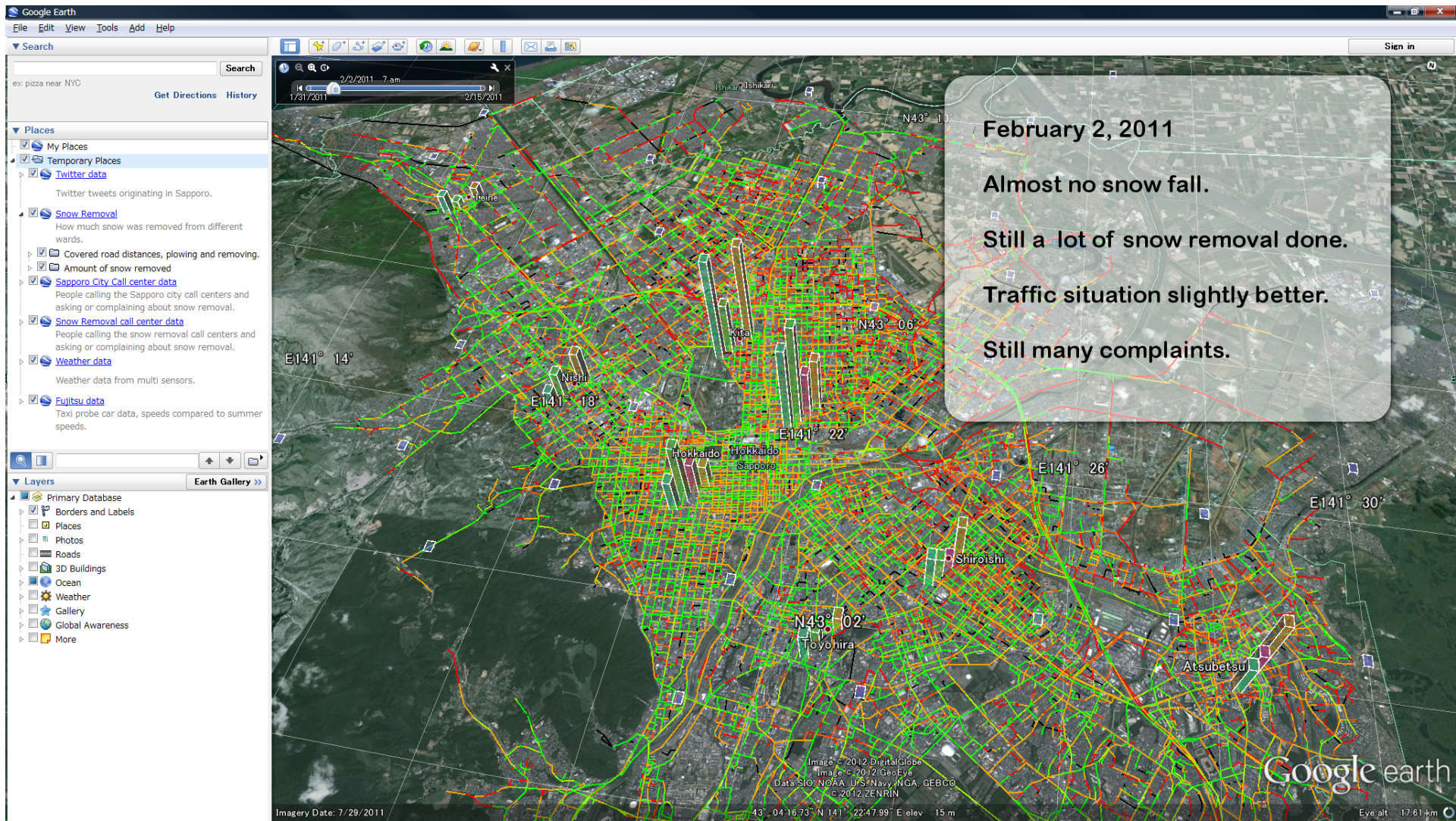


# Influence of Snowfall, Snow Plowing and Removing to Average Car Speed: Feb. 1 (heavy snow and snow plowing)



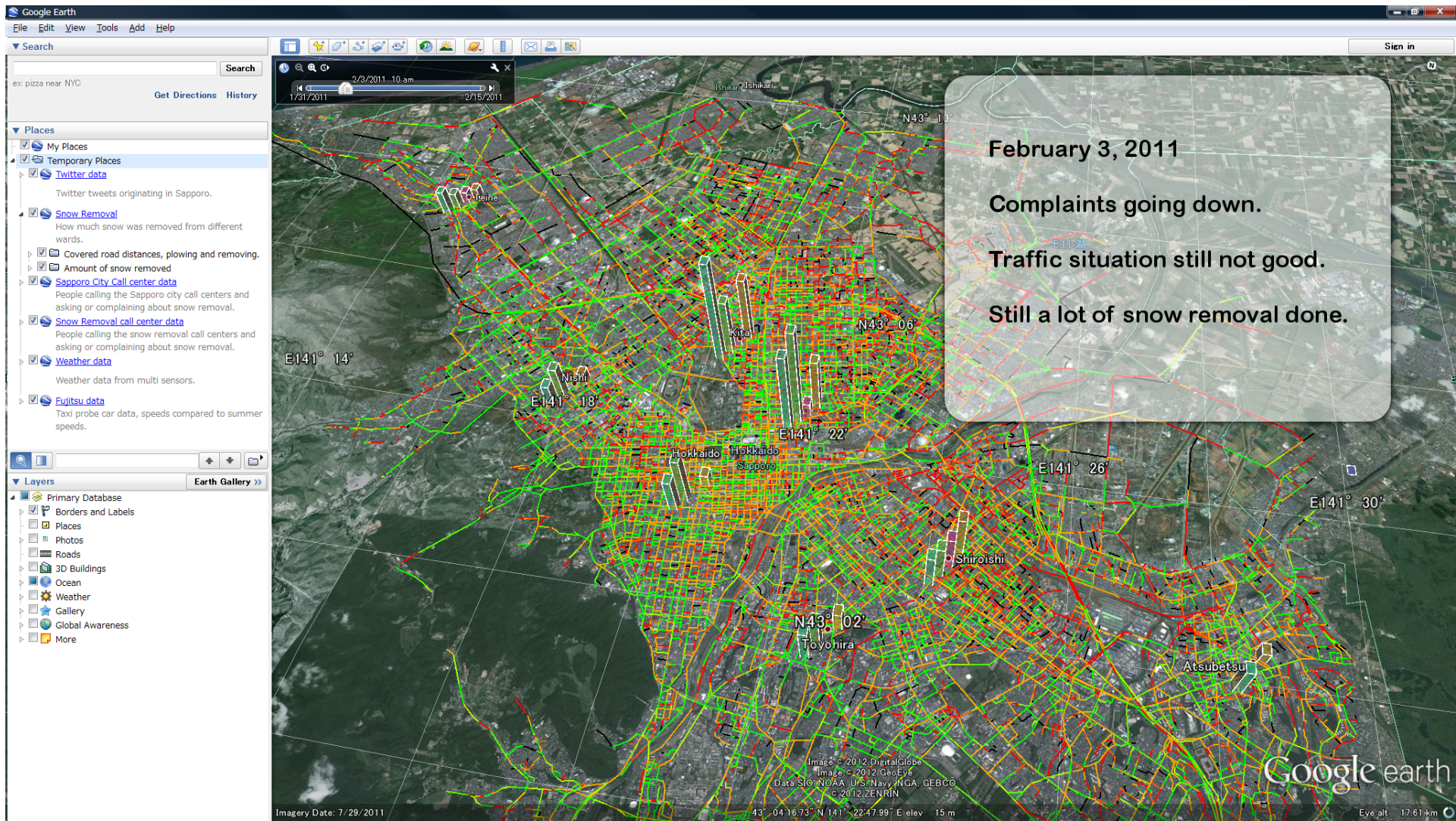


# Influence of Snowfall, Snow Plowing and Removing to Average Car Speed: Feb. 2 (snow removing)



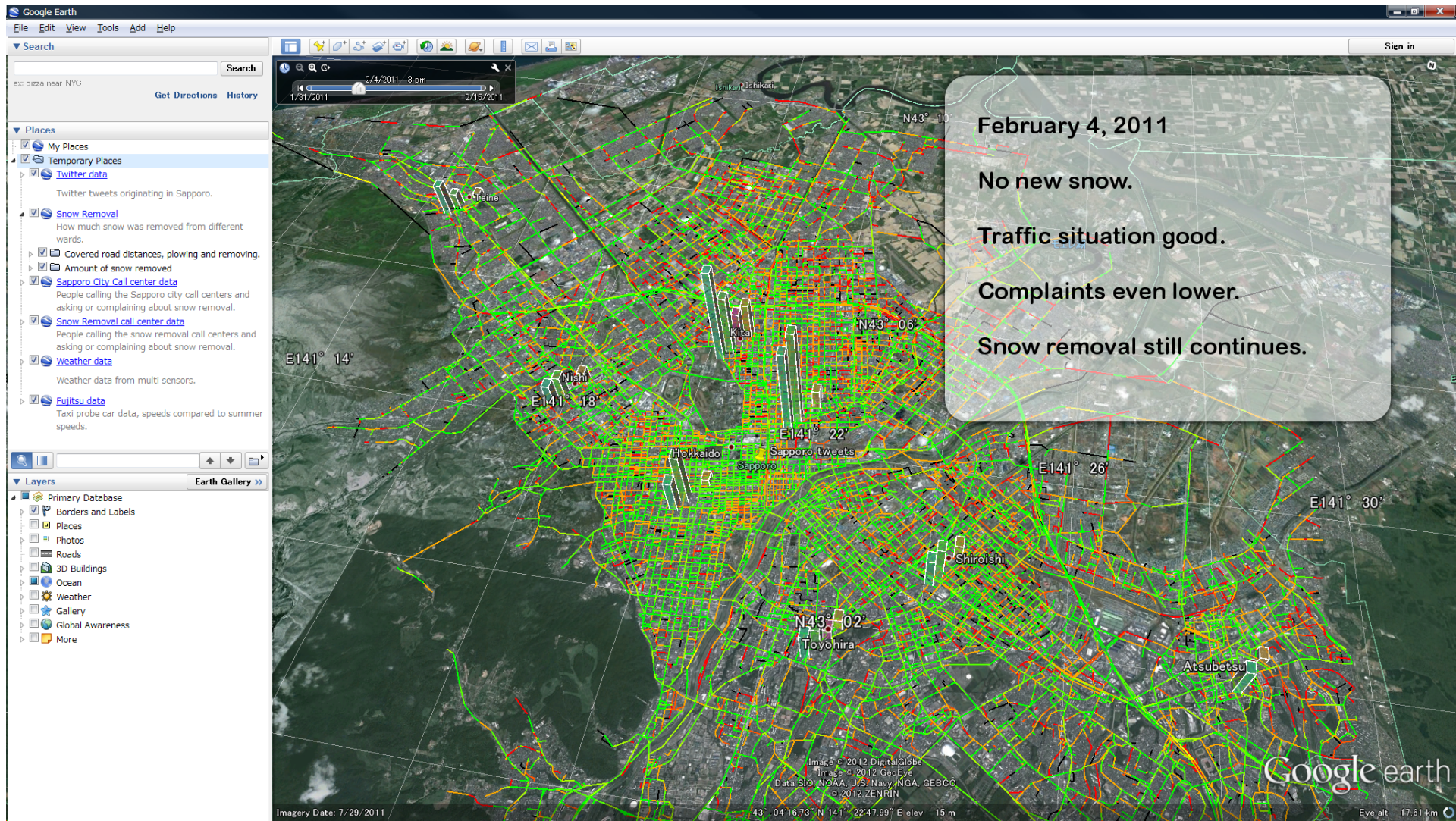


# Influence of Snowfall, Snow Plowing and Removing to Average Car Speed: Feb. 3 (snow removing)



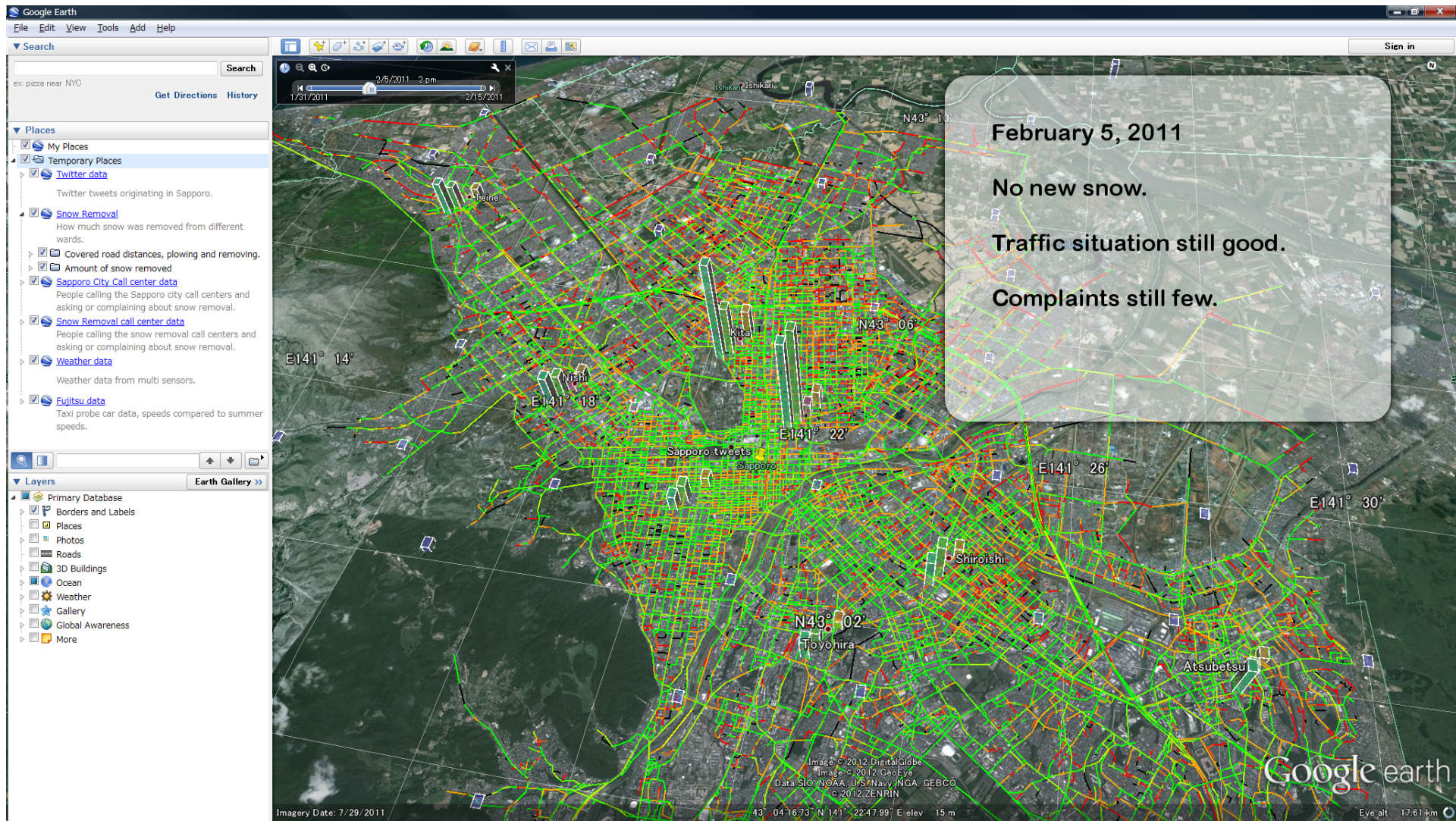


# Influence of Snowfall, Snow Plowing and Removing to Average Car Speed: Feb. 4 (snow removing)



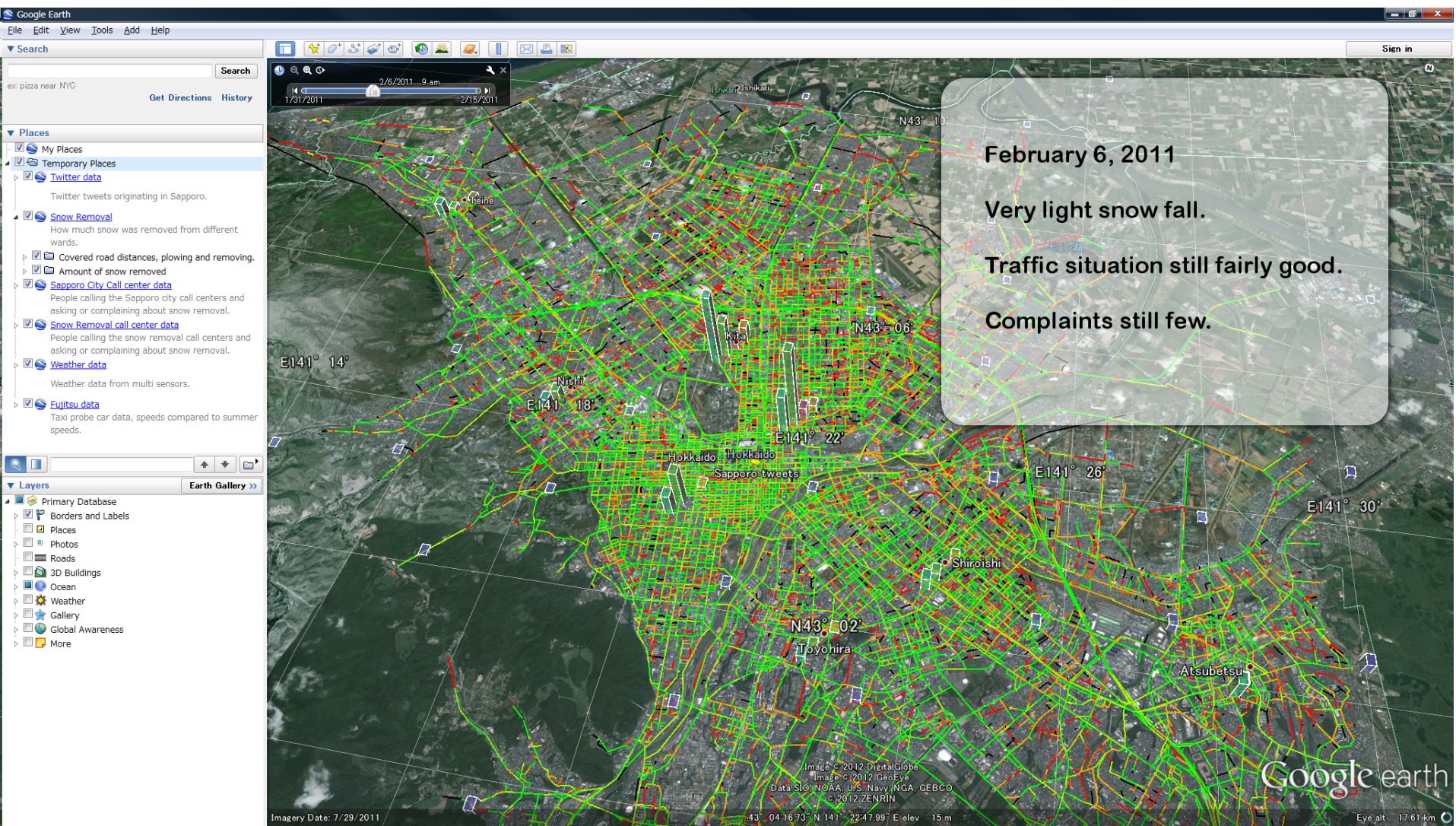


# Influence of Snowfall, Snow Plowing and Removing to Average Car Speed: Feb. 5 (no snow)



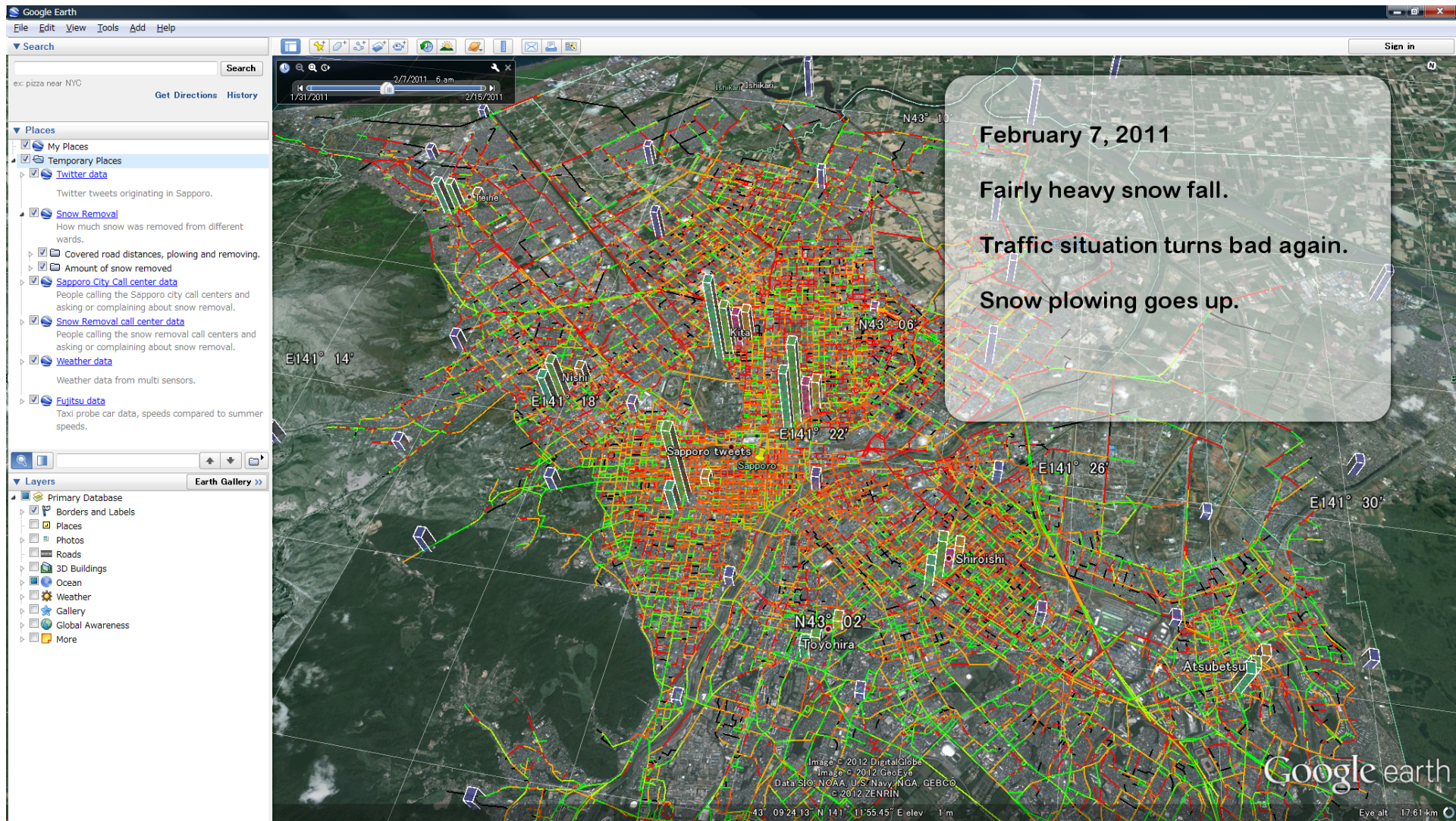


# Influence of Snowfall, Snow Plowing and Removing to Average Car Speed: Feb. 6 (light snow)

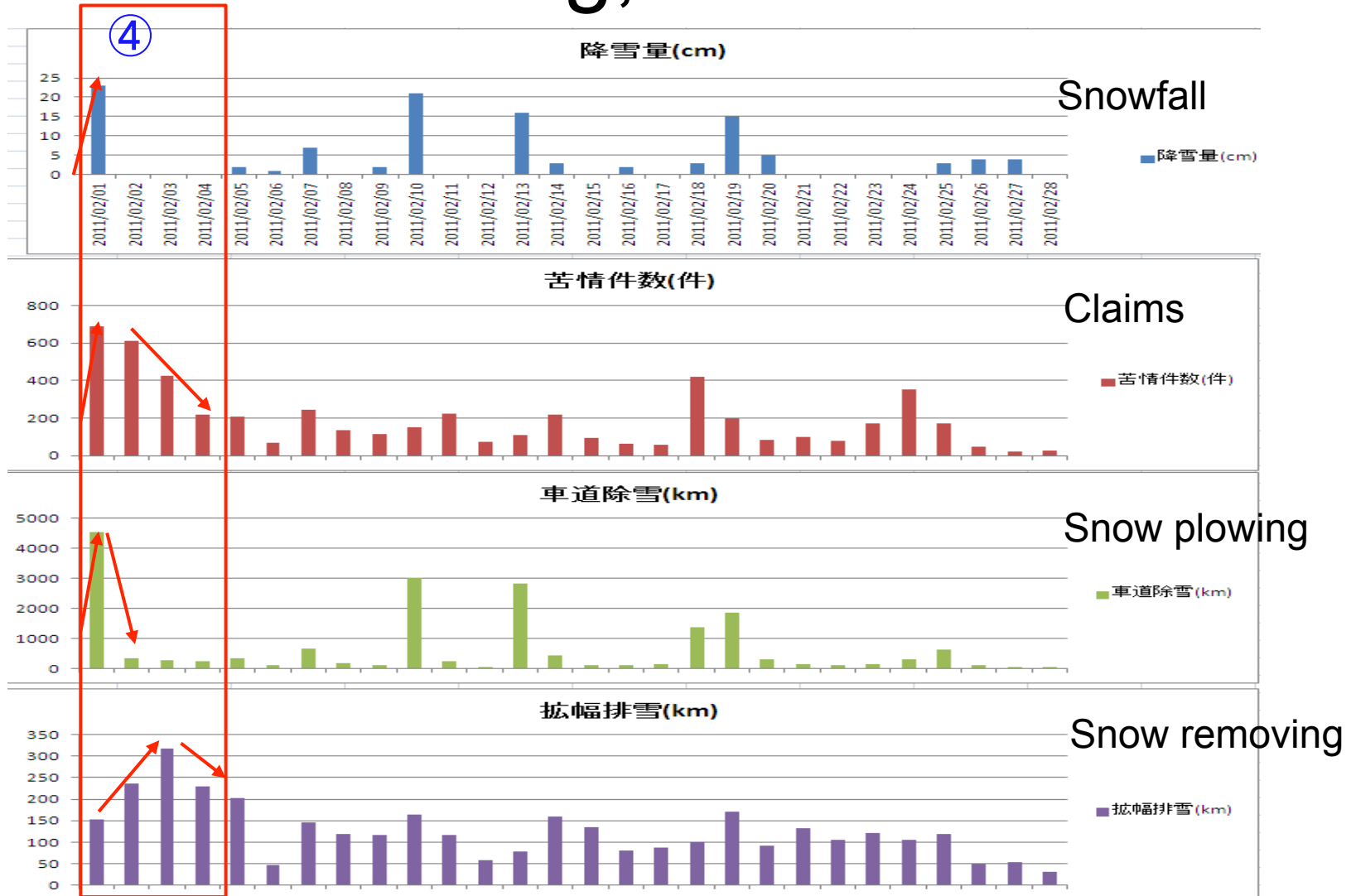




# Influence of Snowfall, Snow Plowing and Removing to Average Car Speed: Feb. 7 (snow)

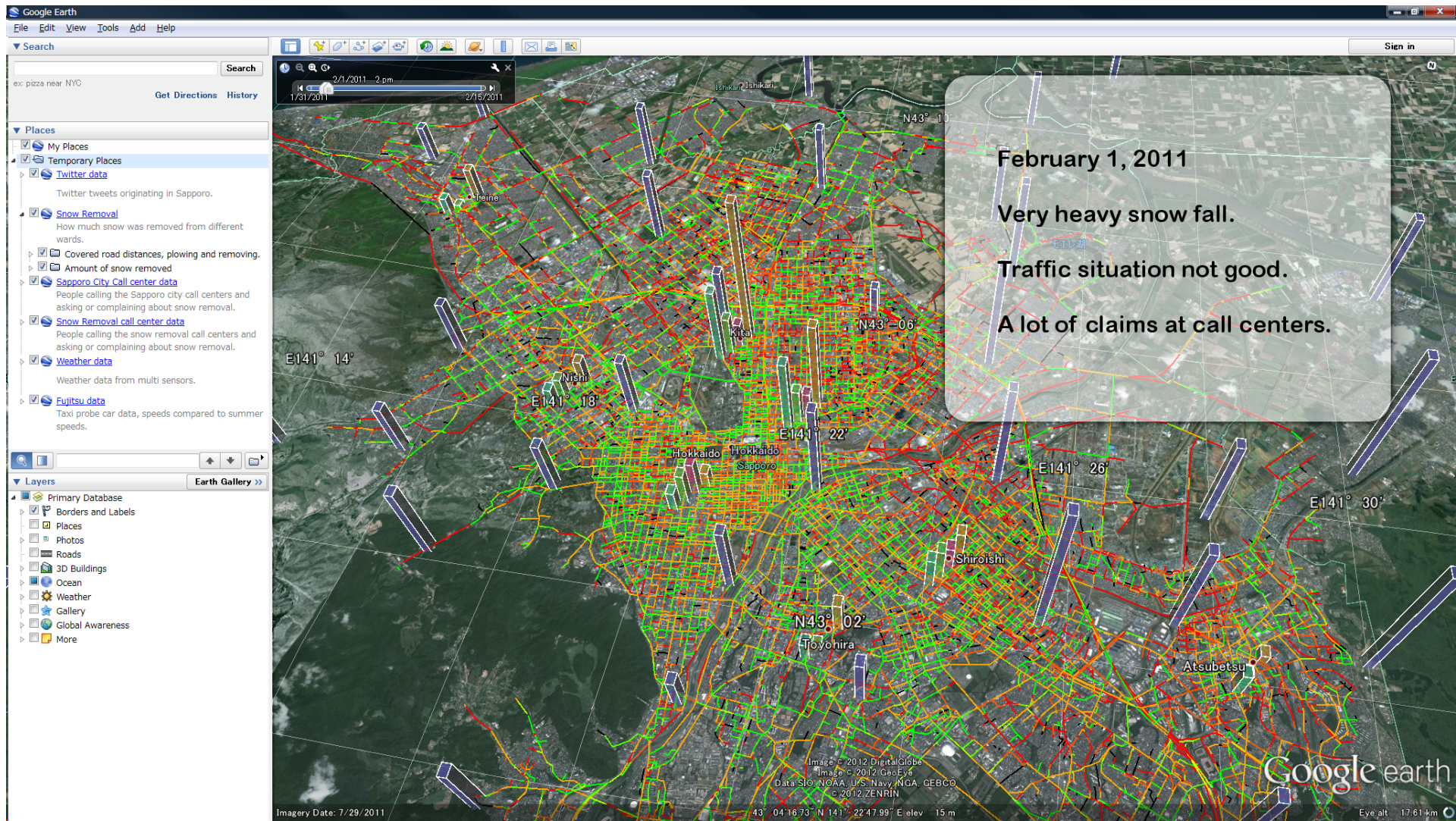


# Snowfall, Snow Plowing, Snow Removing, and Claims





# Influence of Snowfall, Snow Plowing and Removing to Average Car Speed: Feb. 1 (heavy snow and snow plowing)

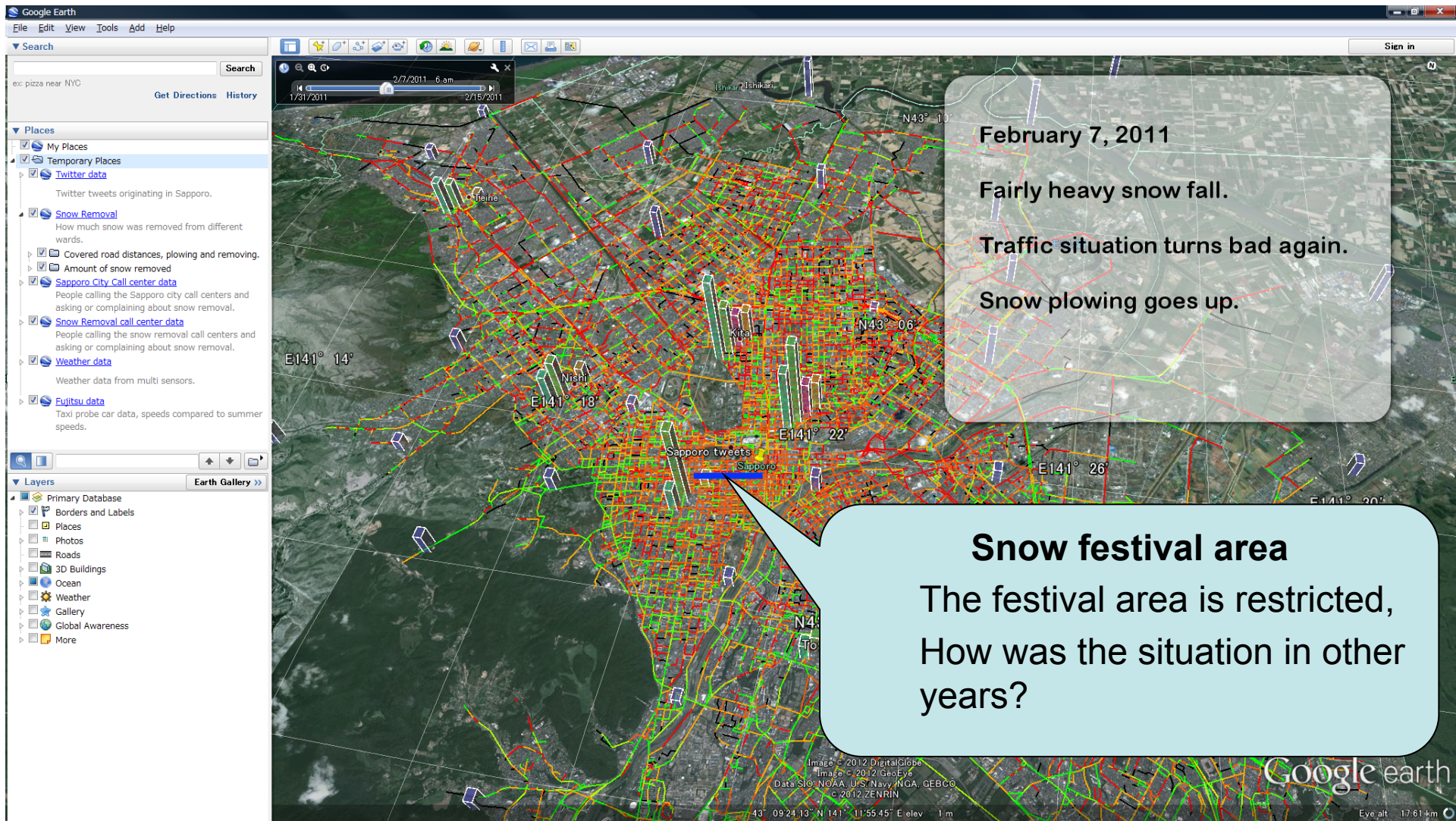


# Real World is not so simple

- Reality is counterintuitive!
- Macro analysis does not tell you what is happening.
- Many factors are working together for the reality.
  - Any influence of the Sapporo Snow Festival that just began on February 7<sup>th</sup> in 2011?

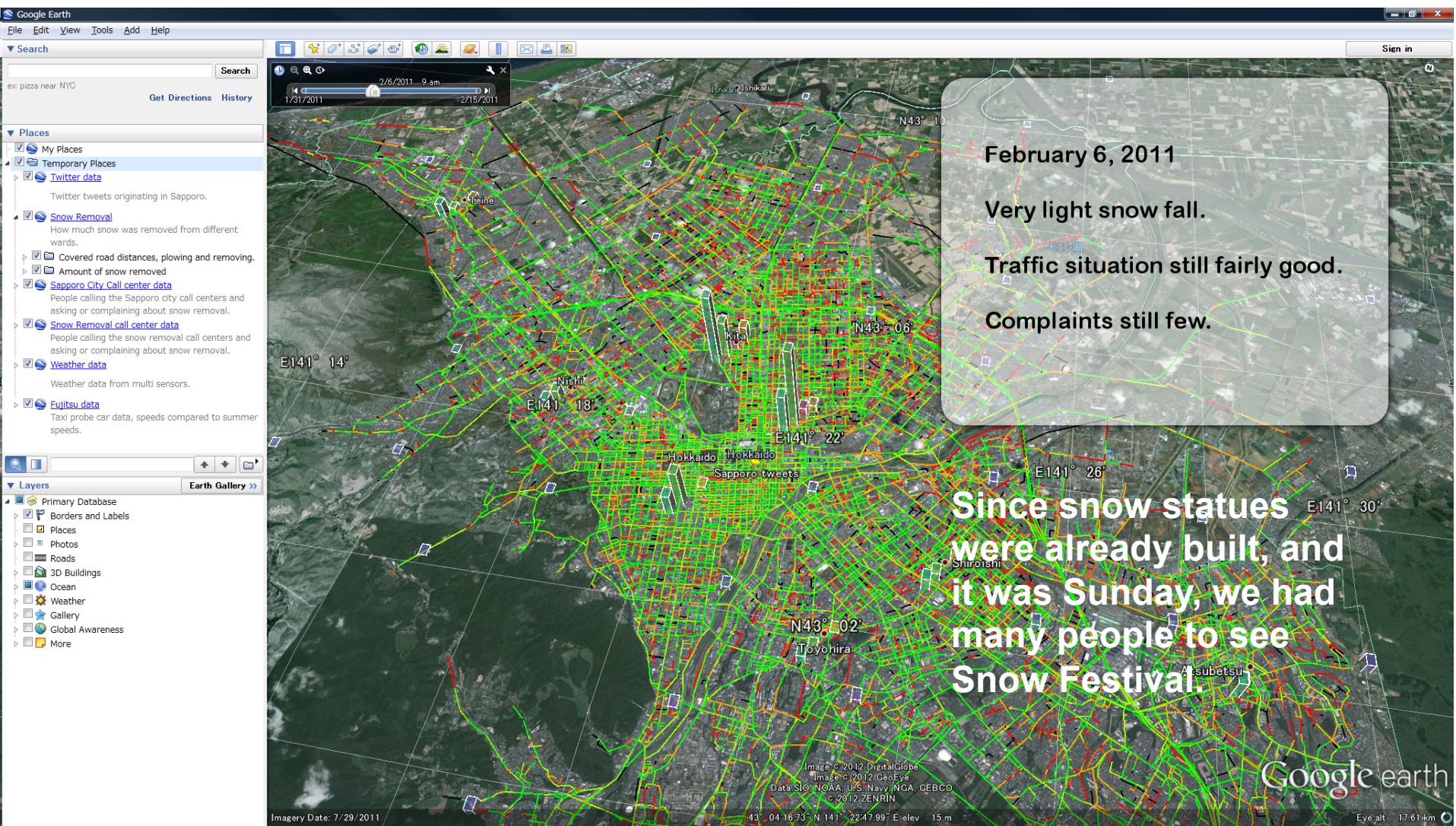


# Influence of Snowfall, Snow Plowing and Removing to Average Car Speed: Feb. 7 (snow)





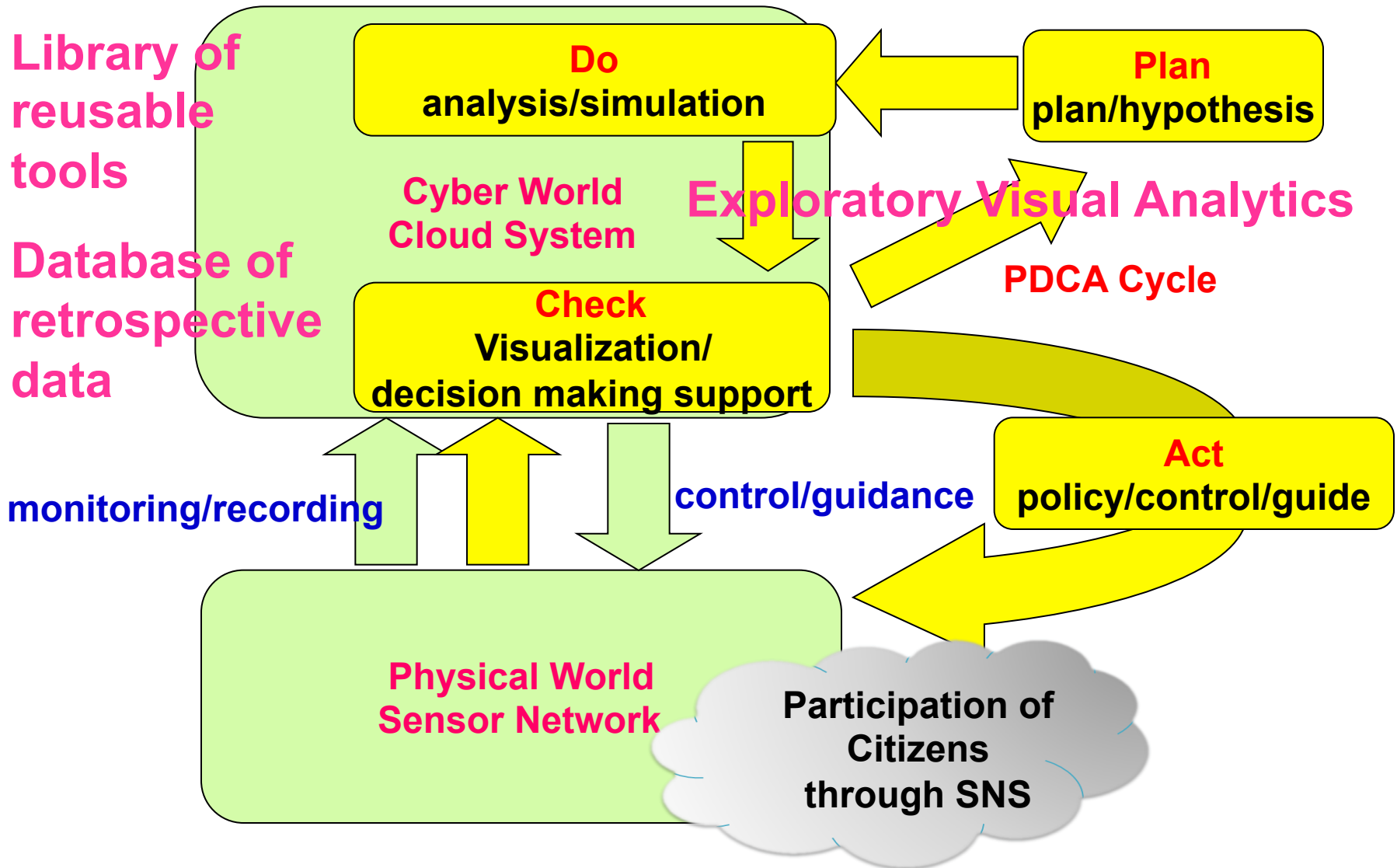
# Influence of Snowfall, Snow Plowing and Removing to Average Car Speed: Feb. 6 (light snow)



# How to mine Knowledge?

- **Well-formed or ill-formed problem?**
  - Efficient Snow Plowing and Removing
  - Disaster management and response
- **Current knowledge mining technologies**
  - For well-formed problem
  - Formalized with clear frameworks and/or models
- **How to fill in this gap?**

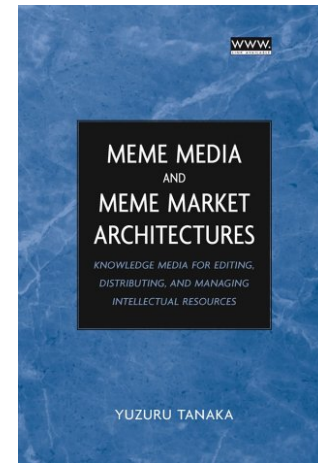
# How to fill in this big gap?





# Challenges

- How to establish a huge library of reusable tools?
  - **Generic wrapper** to wrap resources to reusable components
- How to improvisationally federate tools and data?
  - **Improvisational federation architecture** based on
    - **mime media technologies (1993- )**
    - **knowledge federation technologies (2004- )**
- How to provide an interactive visualization environment for visual analytics?
  - **Virtual reification framework**, instead of visualization frameworks



**Wiley-IEEE  
Press 2003**

... This book ... cannot be compared to any other book—It opens the gates to new territories and time will tell how readers apply this information about knowledge media. ... (E-Stream Vol.7, No.4)



**Springer 2005**

# Generic Wrapping of Resources

- Wrapping knowledge processing tools into components
  - Web services (done) and Web applications (partially done)
  - Statistical analysis / Text and data mining tools
    - mainly using R, Octave, Python and Ruby for their development.
    - Generic wrapping of tools developed in these languages
      - . (done for R (with graphical output) and Octave)
  - Image processing
- Wrapping of other fundamental tools
  - GIS
    - ArcGIS (done)
  - SNSs

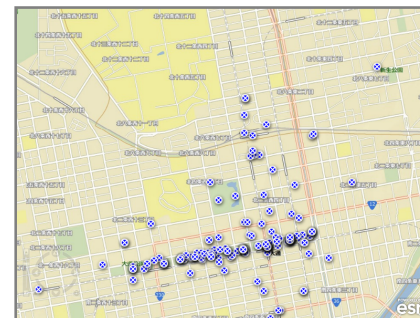


- Digital Dashboard  
for Visual Analytics

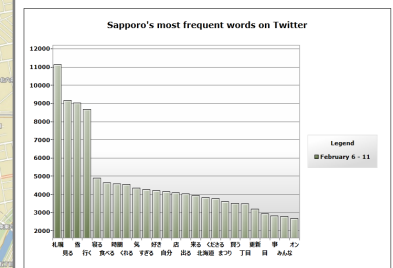
Twitter



ArcGIS



Chart



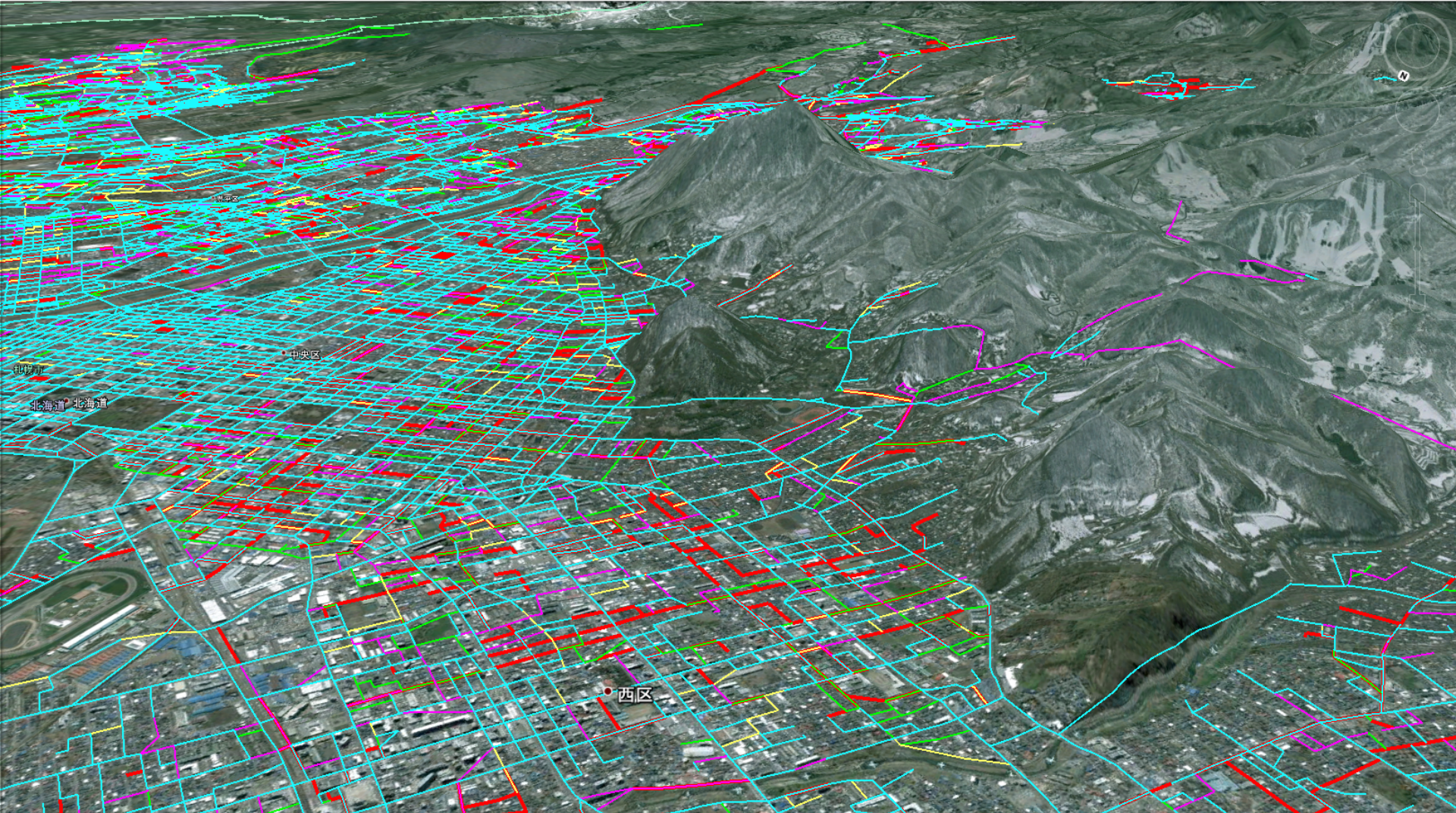
2012/02/06 2012/02/11

Improvisational Federation



# Clustering Road Segments in terms of Snow Influence

Clustering to 5 clusters using average speed every 5 minute on a day of heavy snow





# Goals of Smart Snow Plowing and Removing

- **Optimization of the timing and the route** of snow plowing and removing
- **Effective guiding** of citizens' behaviors by the Web publishing of snow plowing and removing result
  - To change routes
  - To change times
    - The Web publishing of snow plowing and removing plan results in an adverse effect.
- **Analysis** of citizens' reactions extracted **from SNSs**
- Integrated **information presentation and acquisition** to and from Citizens
- **Estimation** of road surface freezing, drifting snow, and the number of effective lanes **from probe car data**