

Application Layer in Science Data Systems:

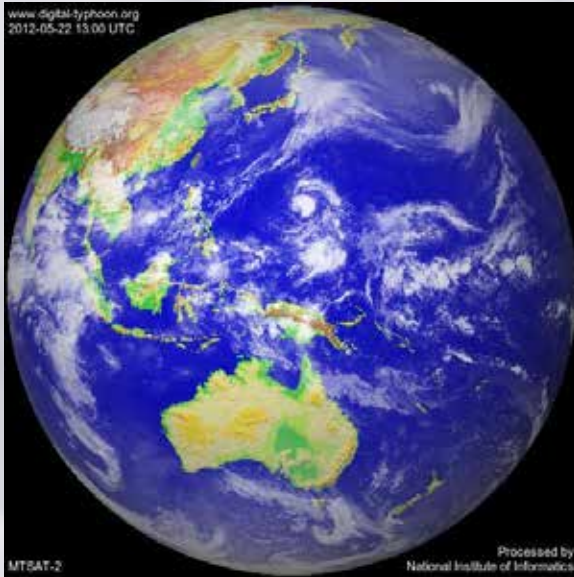
Case Study of “Digital Typhoon” and
“2011 Great Tohoku Earthquake”

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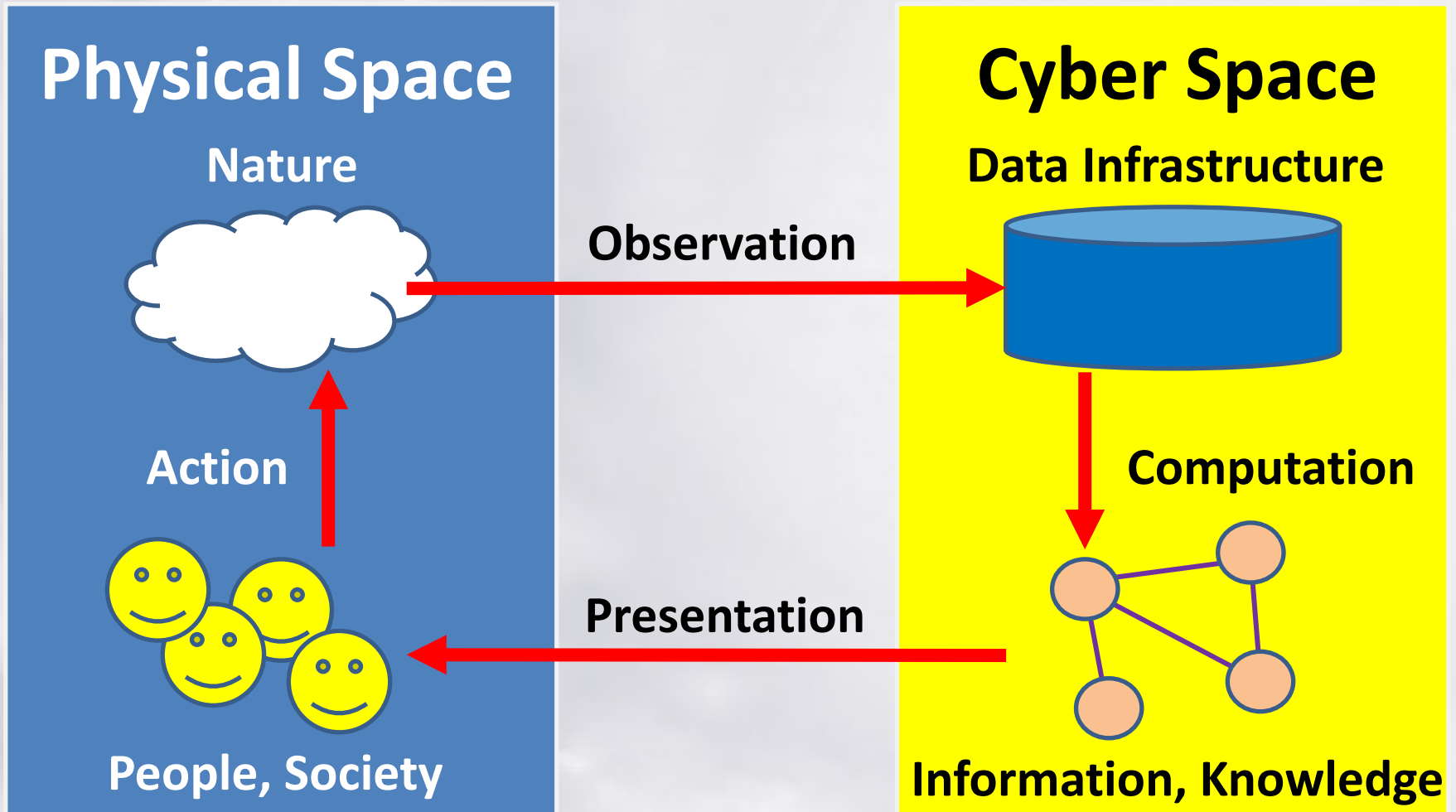
<http://agora.ex.nii.ac.jp/~kitamoto/>

Introduction



- **Background:** informatics (not geoscience).
- **Personal interests:** meteorology and earth environment.
- **Current projects:** data-related activities for geoscience as a personal project and under a big project (e.g. DIAS-GRENE).

Cyber-Physical Systems



Components

1. **Data infrastructure** to archive and access a massive amount of data.
2. **Computational algorithm** to extract information and knowledge from data.
3. **Presentation interface** as a feedback to the society of information and knowledge.
4. **Social platform** for motivating people to take actions using data as “evidence.”

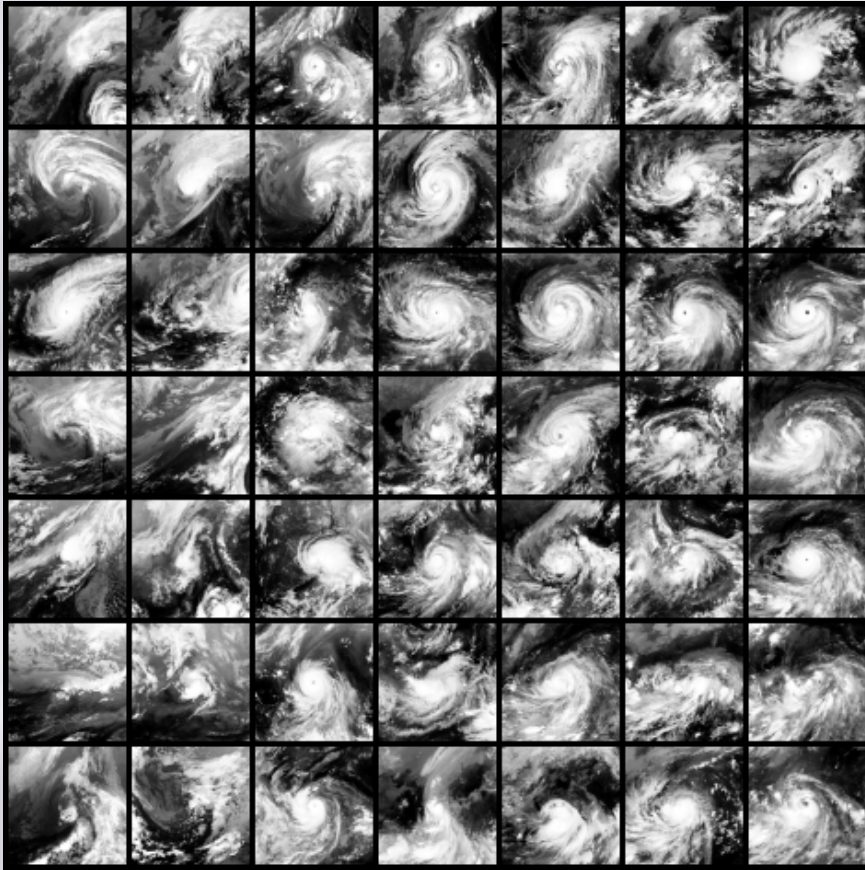
Case Study: Digital Typhoon

<http://goo.gl/XAe7V>

The screenshot displays the Digital Typhoon website. At the top, there's a navigation bar with links like Home, Earth, Digital Typhoon, and Japanese. Below this is a section for 'Real-time Typhoon Information' featuring a satellite image of a typhoon and its details: 'T 201202', 'MTSL200220', '201202 (WNP)', 'N15.4, E111.7', and '996 hPa / 40 kt'. To the right, there's a 'Number of Typhoons' section stating 'This year = 2 (Best Track) (Forecast Track)' and 'Average = 2.5 (1951-2010)'. Below that is a 'Latest Typhoon Informations' section with links to various resources. The bottom section is divided into 'Typhoon Database' and 'Meteorological Satellite Images'. The 'Typhoon Database' has two main categories: '1. Search by Metadata' (including search by date, name, map, place, pressure, wind, day, activity calendar, and timeline) and '2. Content-based Image Retrieval' (including similarity-based image search). The 'Meteorological Satellite Images' section shows a satellite image of the Earth with a typhoon over the Pacific, dated '2012-05-22 21:00 (UTC)'.



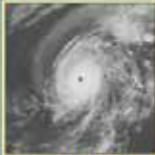
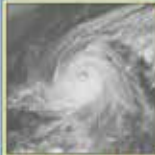
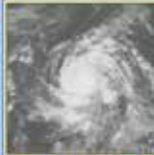






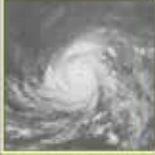



- One of the largest collection of typhoon satellite images.
- Comprehensive data archives from scientific data to social data.
- +150 million page views since May 2003.

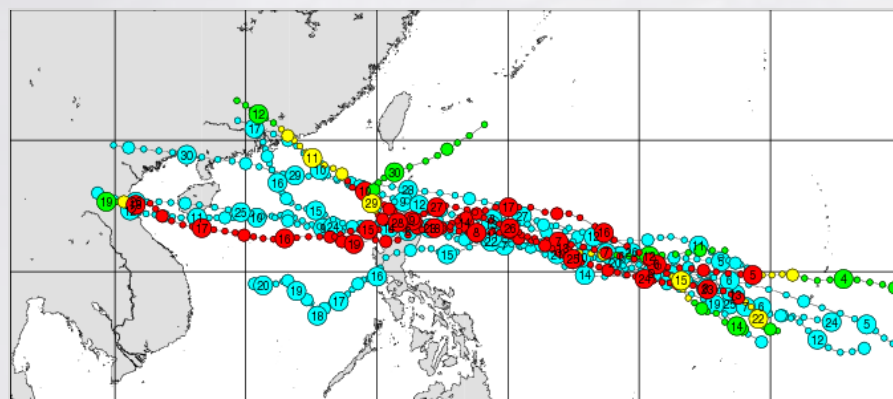
Data Integration



- **Geostationary satellite image (Himawari) (1978-)**
- **Typhoon image (1978-)**
- **Typhoon best track (1951-)**
- **AMeDAS weather sensor observations (1976-)**
- **Mass media online news (2003-)**
- **Disaster information (1951- or 1971-)**
- **Social media streams (2004-)**
- **Weather forecast GPV data (2002-)**

Content-based Search and Ranking

Query 1	1	2	3	4
				
MTS110101803	GMS181031416	GMS402110508	G0E904101711	GMS595103114
201013 (WNP)	198101 (WNP)	199228 (WNP)	200423 (WNP)	199520 (WNP)
(N17.4, E122.6)	(N14.5, E161.4)	(N18.2, E134.8)	(N20.2, E130.2)	(N12.4, E130.9)
885 hPa / 125 kt	975 hPa / 60 kt	915 hPa / 100 kt	940 hPa / 85 kt	955 hPa / 80 kt
5	6	7	8	9
				
GMS491112714	GMS389042113	GMS597083013	MTS106102811	GMS502030213
199128 (WNP)	198902 (WNP)	199718 (WNP)	200619 (WNP)	200202 (WNP)
(N12.7, E143.5)	(N14.5, E148.5)	(N16.6, E138.6)	(N15.2, E126.5)	(N10.3, E135.1)
900 hPa / 115 kt	920 hPa / 100 kt	985 hPa / 50 kt	975 hPa / 65 kt	960 hPa / 75 kt
10	11	12	13	14
				
MTS109091718	GMS386051912	GMS179101518	GMS179051212	GMS501122111
200914 (WNP)	198603 (WNP)	197920 (WNP)	197904 (WNP)	200125 (WNP)
(N22.5, E139.3)	(N11.6, E156.2)	(N18.9, E129.4)	(N11.0, E120.2)	(N10.5, E157.0)
945 hPa / 85 kt	910 hPa / 120 kt	925 hPa / 100 kt	1000 hPa / 0 kt	965 hPa / 70 kt



1h Precipitation

Number	Name	Location	Value	Historic Ranking
88836	NAZE	Kagoshima	63.5	Rank 9 of 30,160
94036	KABIRA	Okinawa	28	Rank 251 of 20,171
94081	ISHIGAKIJIMA	Okinawa	27	Rank 259 of 18,161
94082	MAEZATO	Okinawa	21.5	Rank 67 of 3,375
94001	IBARUMA	Okinawa	19	Rank 543 of 20,176

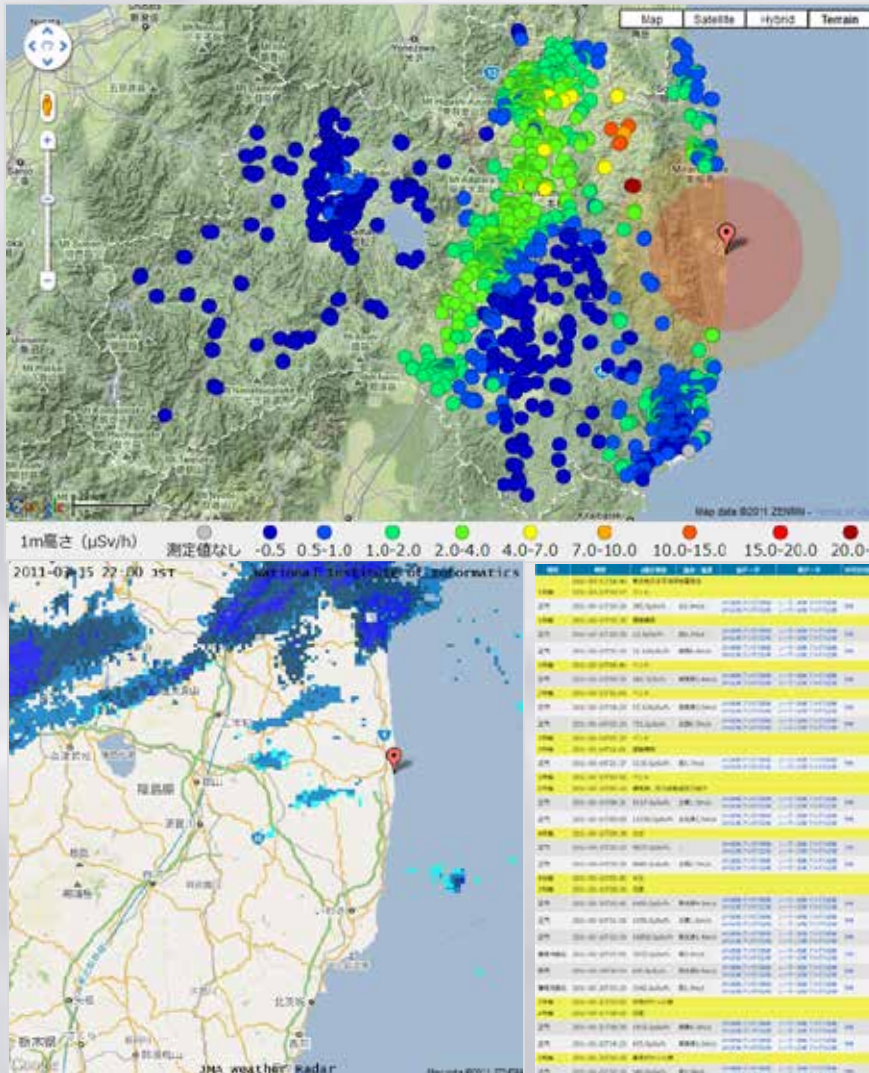
Social Sensors

<http://goo.gl/vglQV>, <http://goo.gl/7f61r>



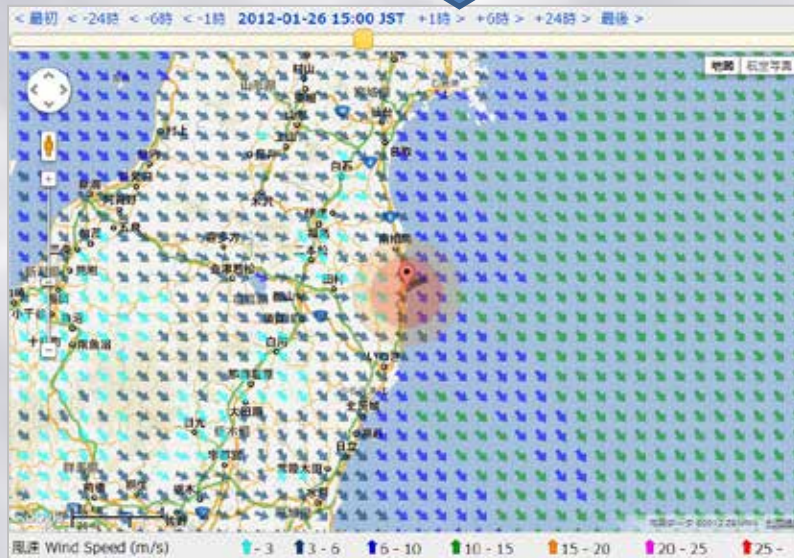
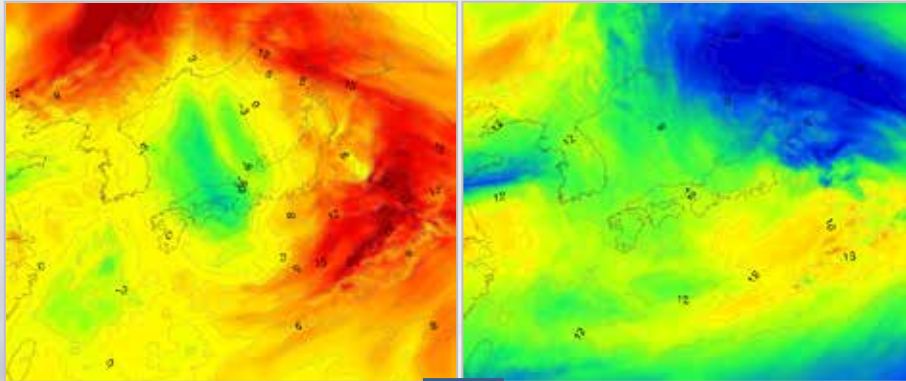
- Using blogs and Twitter to aggregate typhoon information.
- Noisy, but real-time, distributed, and “emotional” media.
- Complementary to scientific data.

Case Study: 2011 Great Earthquake



Different Presentations

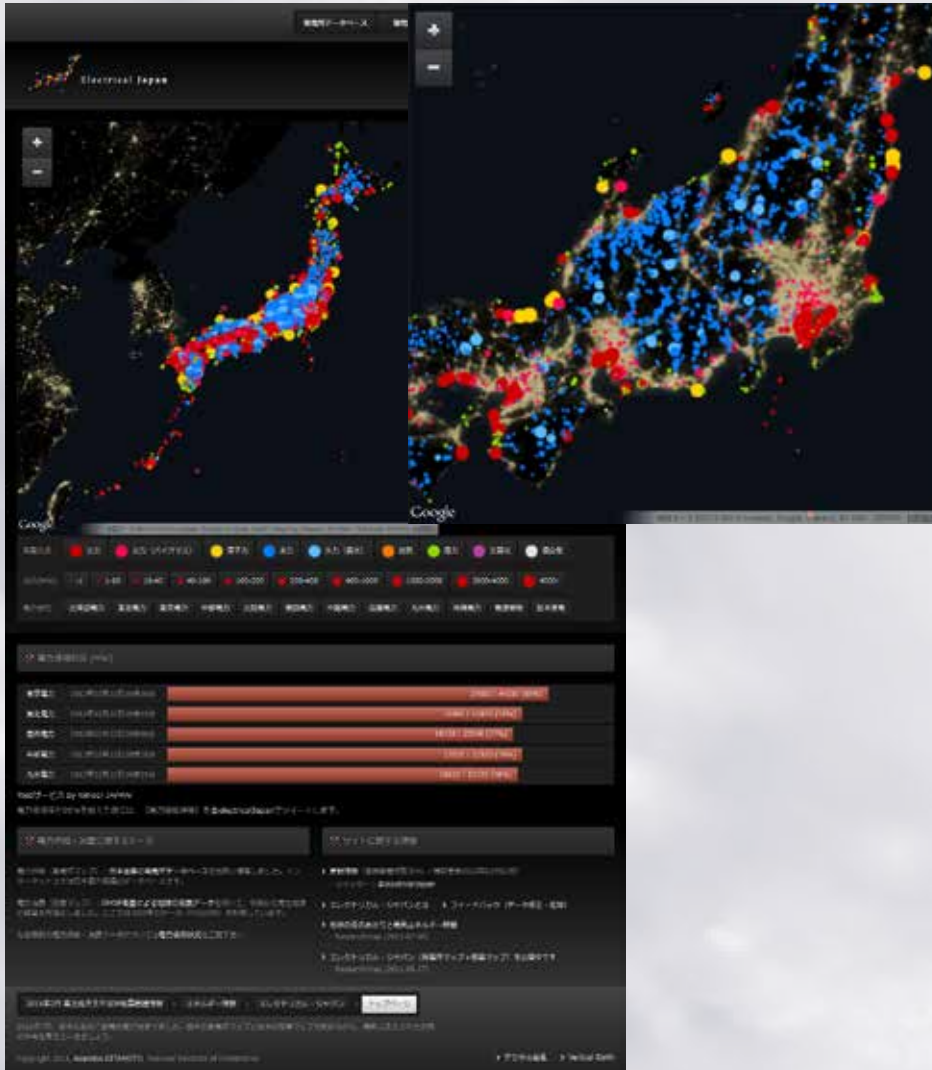
<http://goo.gl/gzPmR> , <http://goo.gl/c0wqf>



- **GPV wind data** is visualized on a map.
- **Before:** u / v wind = difficult to read.
- **After:** arrows on Google Maps + Fukushima Daiichi = easy to read.

Mash-up and Visualization

<http://goo.gl/HwLVC>

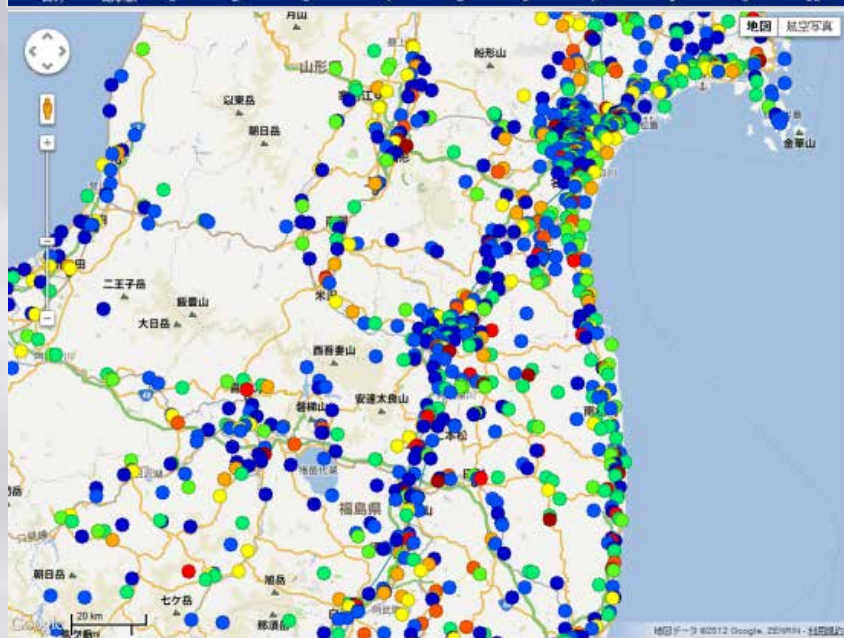


- **Electrical Japan:** the database of power stations (3045).
- **Base map:** DMSP nighttime light = energy demand.
- **Points:** power plants = energy supply.

Natural Language Processing

<http://goo.gl/okeUn>

2011-03-20	982	群衆	東日本大震災	放水	物資	活動	被災者	被災地	救援	試合	選手
2011-03-19	1277	東日本大震災	被災者	群衆	放水	受け入れ	義援金	物資	入場	救援	結果
2011-03-18	1018	東日本大震災	介入	被災者	日本	義援金	放水	伝達	情報	群衆	被災地
2011-03-17	1880	東日本大震災	物資	日本	計画停電	円	義援金	救援	放水	中止	情報
2011-03-16	1970	中止	義援金	東日本大震災	日本	計画停電	延期	地震	寄付	群衆	被災地
2011-03-15	1596	計画停電	地震	東日本大震災	日本	中止	義援金	被災	東北地方太平洋沖地震	延期	延期
2011-03-14	1355	地震	計画停電	東日本大震災	東北地方太平洋沖地震	大地震	日本	停電	状況	情報	中止
2011-03-13	875	地震	東日本大震災	大地震	被害	津波	被害者	被災	停電	中止	東北地方太平洋沖地震
2011-03-12	1141	地震	大地震	中止	東北地方太平洋沖地震	津波	被害	東北・太平洋沿岸地震	発生	午後	東北地方太平洋沖地震
2011-03-11	916	地震	震災	震災	東北・太平洋沿岸地震	午後	中止	発生	大地震	沖	東北・関東大震災



- **Online news analysis:** 220,000+ earthquake-related news.
- **Text** is analyzed by NLP to show and search relevant words.
- **Place-names** are extracted by GeoNLP to show on a map.

Comparison with Traditional Systems

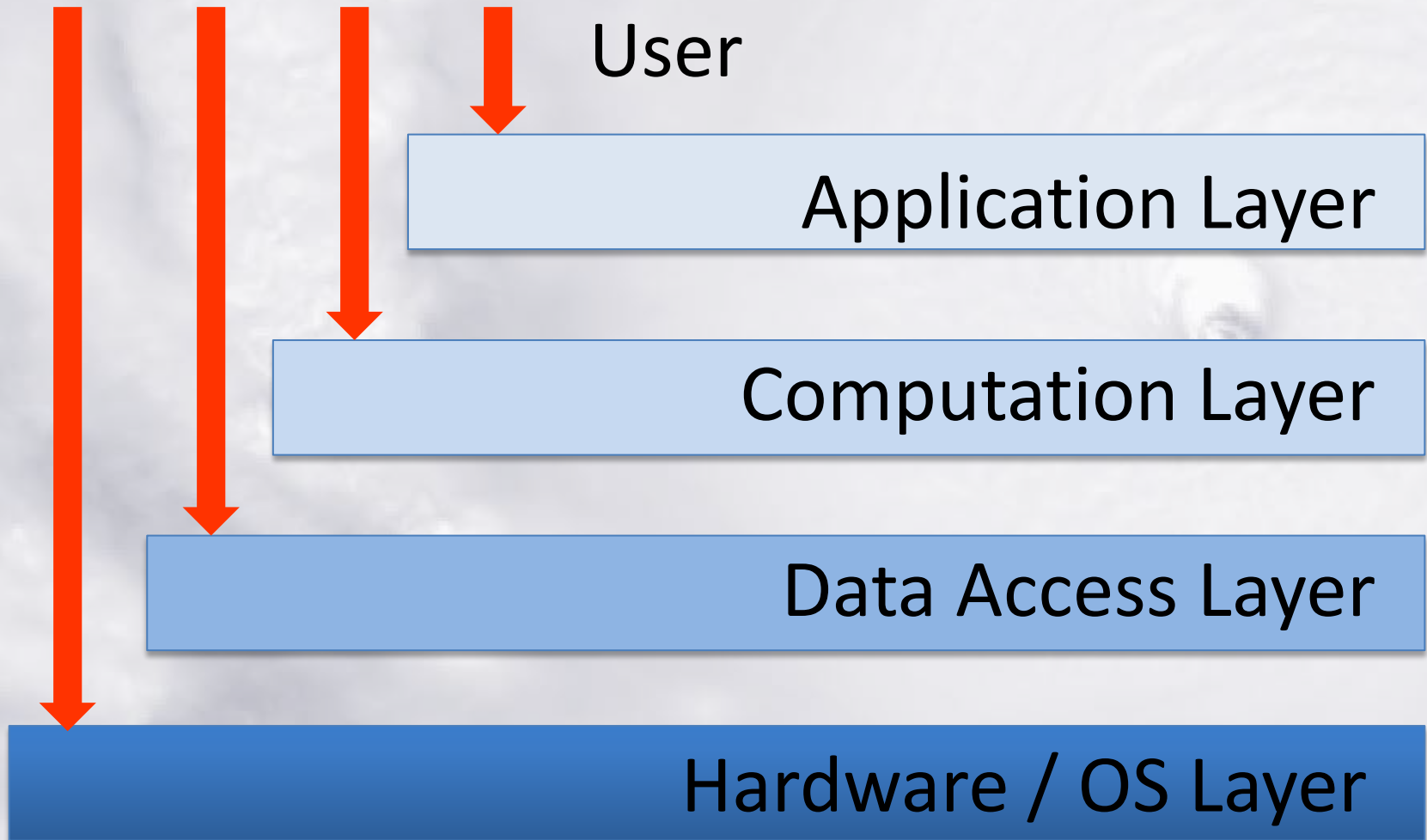
Traditional System

- Data is provided as simple files.
- Data is collected from a single discipline.
- Data is not linked and separated in “silos.”
- Search is based on metadata, not content.

Our System

- Data is processed and visualized as a product.
- Data from many sources is integrated.
- Data is linked across datasets for navigation.
- Search is based on metadata and content.

Layer Model



Role of the Application Layer

- Implement **domain-dependent algorithms** to improve quality and functionality.
- Provide **visual presentation and interface** to enhance accessibility and understandability.
- Integrate data from various sources to support **navigation on the link** across datasets.
- Compare data from various sources to **assess the reliability** of data and sources.

How to Motivate People?

<http://goo.gl/cNEva>

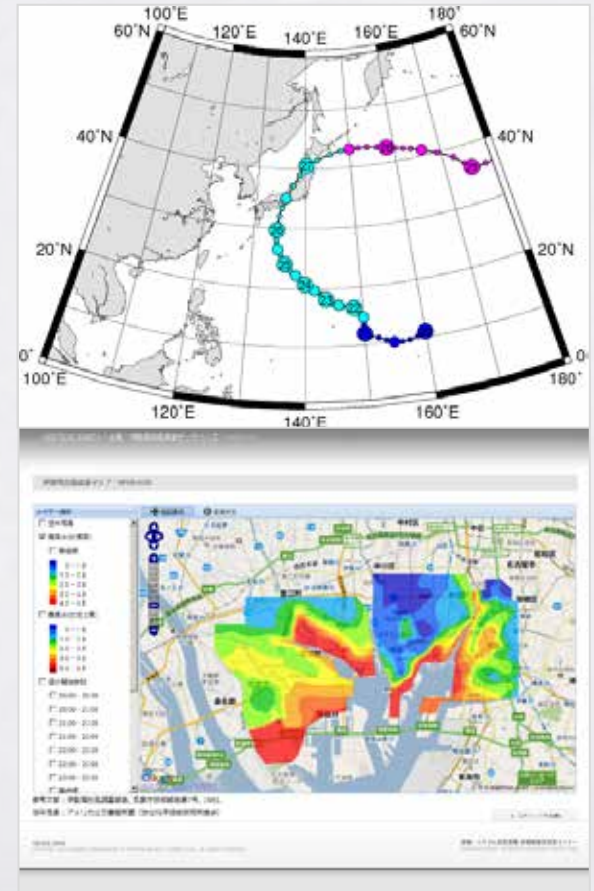
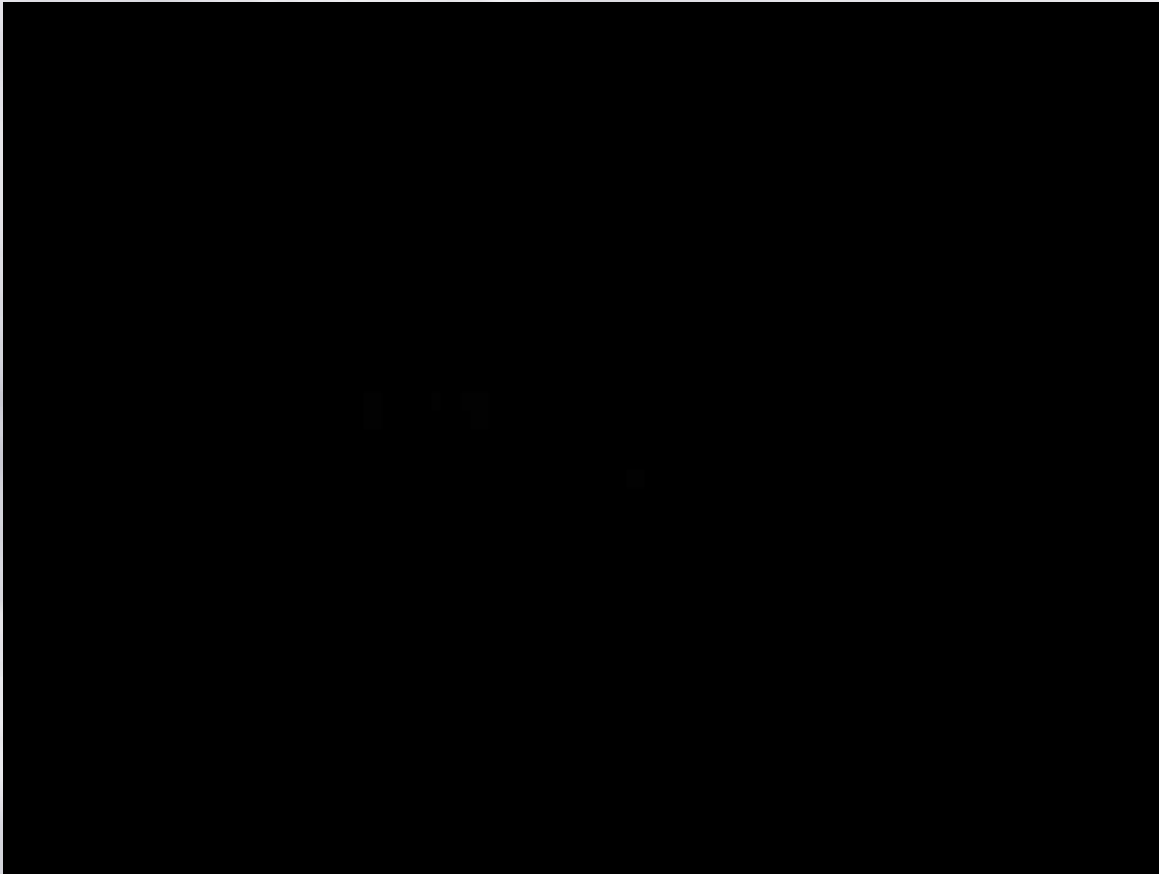


Typhoon Front:
received 'Jury
Recommended
Works' in 2007
Japan Media
Arts Festival.

- Synchronize social feedback with a typhoon track.

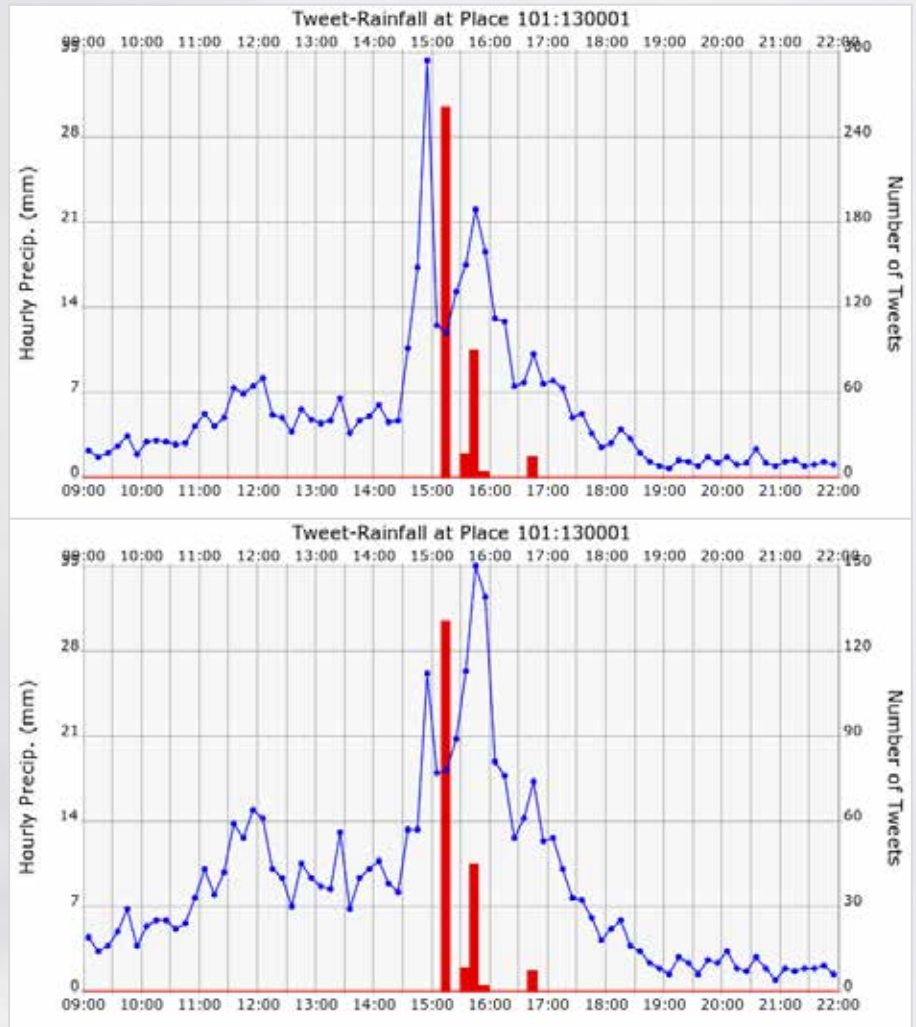
How to Feel the Reality?

<http://goo.gl/UJNrww>



- Visualize storm tide by the real scale.

Twitter as Weather Sensors



Chances in Crisis



- Crisis sets urgent agenda that cannot be solved by a single discipline.
- Motivated scientists get together as volunteers.
- Boundary of disciplines is suddenly broken, but will revive over time.

Future Directions

- **Loop connecting physical and cyber spaces:** explore it to enhance usage and impact.
- **Data and simulation for decision making:** providing evidence for the society.
- **Flexibility:** A data system can respond to emergent activities, especially during crisis.
- **Long-term sustainability:** Evolve a personal project into a sustainable long-term activity.

Related Resources

- Digital Typhoon
 - <http://agora.ex.nii.ac.jp/digital-typhoon/>
- Archives of 2011 Great Tohoku Earthquake
 - <http://agora.ex.nii.ac.jp/earthquake/201103-eastjapan/>
- Personal website
 - <http://agora.ex.nii.ac.jp/~kitamoto/>