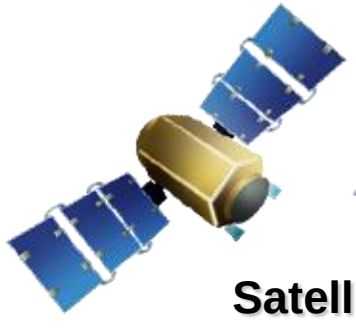
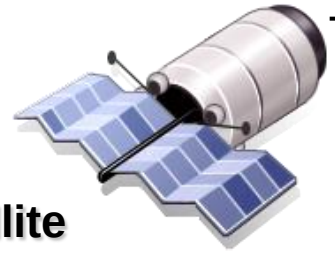
SFI: Framework for Integration of Satellite Data and Field Sensor Data

Sarawut NINSAWAT
Remote Sensing & GIS FoS,
School of Engineering and Technology
Asian Institute of Technology

Geospatial Data Gathering



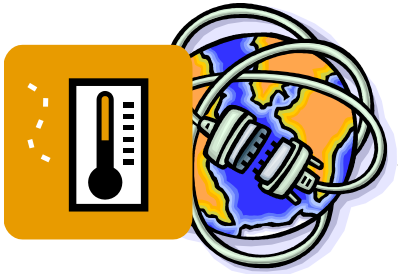
Satellite



Field Survey
with Laboratory

Data Center

Data Logger



Smart Sensor

Internet

Satellite RS & Ground-based

- Benefit of satellite RS:
  - Cheap and rapid over large geographic area
  - Regional coverage and broadly spectral resolution
  - Continuous acquisition of data
  - Archive of historical data

- Limitation of satellite RS:
  - Interference of atmospheric gaseous and particles
    - Absorbing (H_20, O_3 etc.) and Scattering (mainly by aerosol particles such as dust, ash and smoke)
  - Not direct sample of the phenomenon.

- Ground-based observation:
  - Direct sample of the phenomenon is possible
  - Real-time or Near Real-time observation
  - High temporal resolution
  - Expensive for wide area observation

Air Temperature

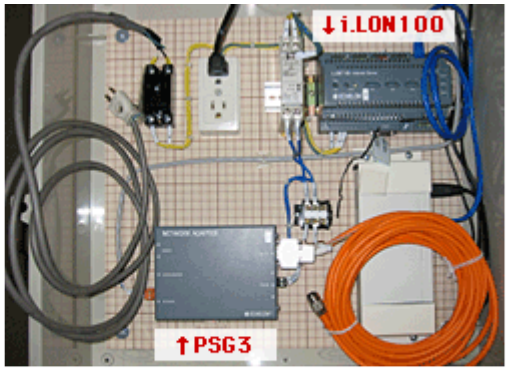
- Air temperature near the Earth's surface
  - Key variable for several environmental models.
  - Agriculture, Weather forecast, Climate Change, Epidemic
  - Commonly measure at 2 meter above ground
- In most case, Spatial interpolation from sample point of meteorological station is carried out
  - Based on Land use, elevation etc.
- Uncertainly spatial information available of air temperature is often present.
  - Limited density of meteorological station
  - Rarely design to cover the range of climate variability with in region

MODIS LST

- MODIS Land Surface Temperature
  - Day/Night observation
  - Target accuracy ±1 K.
- Derived from Two Thermal infrared band channel
  - Band 31 (10.78 - 11.28 μm)
  - Band 32 (11.77 – 12.27 μm)
  - Using split-window algorithm for correcting atmospheric effect
- Not a true indication of "ambient air temperature"
- However, there is a strong correlation between LST and air temperature
  - Evaluation of a correlation between the measured air temperature from meteorological station and LST can estimated air temperature.

Weather Station : Live E! project

- “Weather Station” is a the biggest available Sensor Network.
- Live E! is a consortium that promotes the deployment of new infrastructure
  - Generate, collect, process and share “Environmental Information”
- Accessible for Near/Real-time observation via Internet Connection
  - Air temperature
  - Humidity
  - Wind Speed
  - Wind Direction
  - Pressure
  - Rainfall



【写真：左】 デジタル百葉箱（=小型マルチ気象観測ユニット）
【写真：上】 気象観測盤

State of Problems

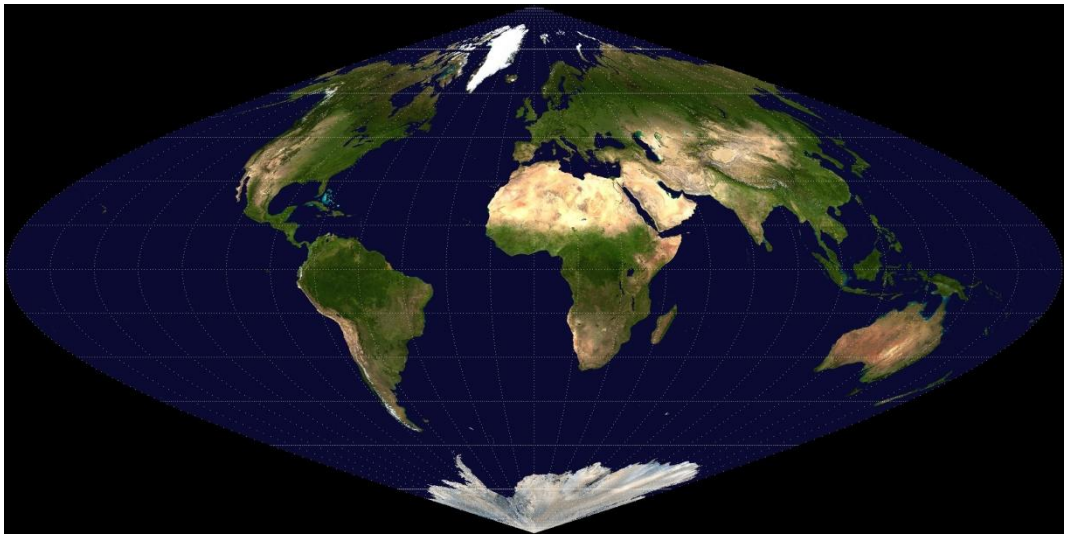
- Lack of comprehensive framework that provides an estimated air temperature map from satellite remote sensing image with ease of use to the end-users.

- Huge amount of effort from user such as

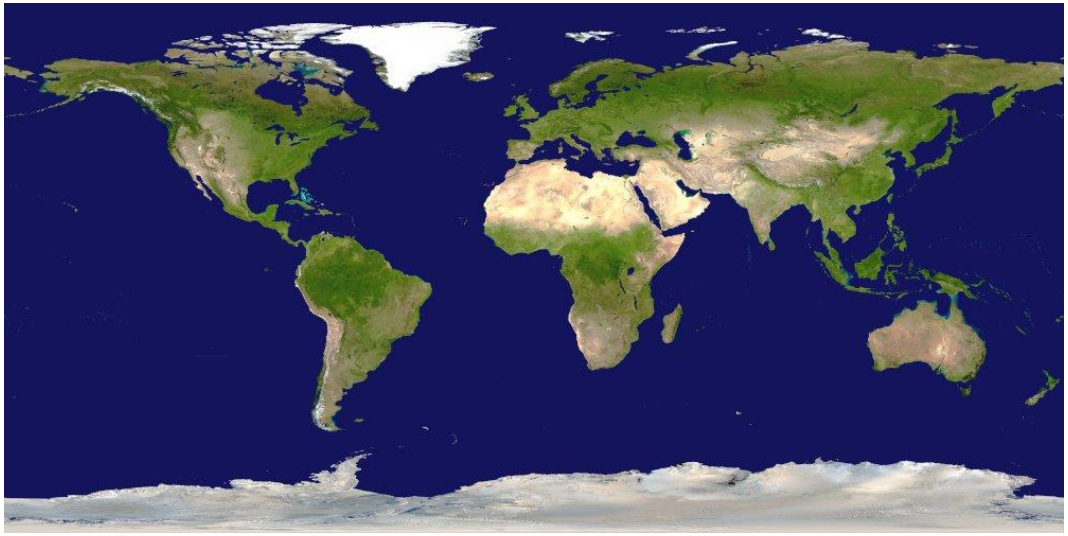
  - Prepare, analyze and process both of datasets to achieve final results.

  - High requirement of user skills and sufficient computer support system.

Map Projection

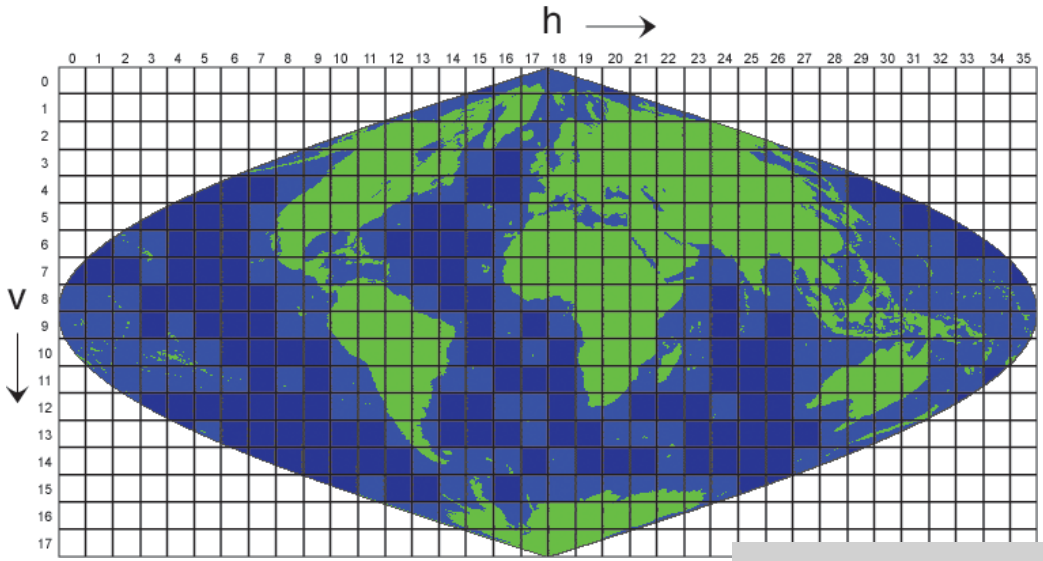


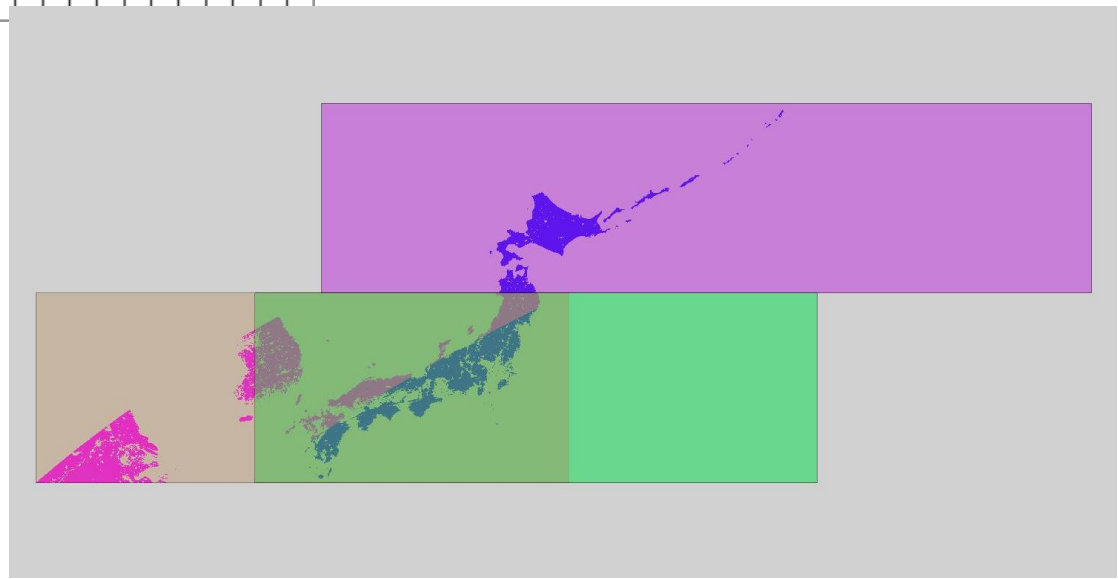
- Sinusoidal
  - a pseudo cylindrical equal-area map projection



- WGS84
  - latitude, longitude pair coordinates in degrees with Greenwich as the central meridian

Mosaic


h
v
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17



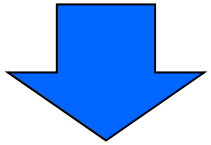
File Formats

HDF : Hierarchical Data Format

HDF4 and HDF 5

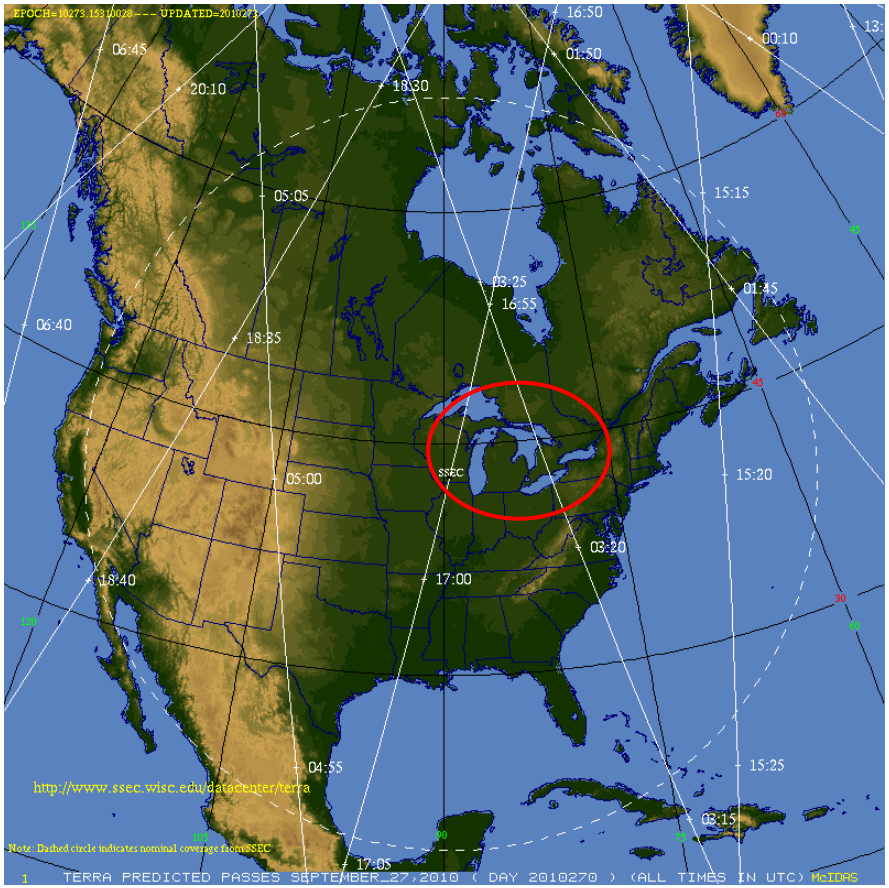
HDF-EOS : Hierarchical Data Format – Earth Observing System

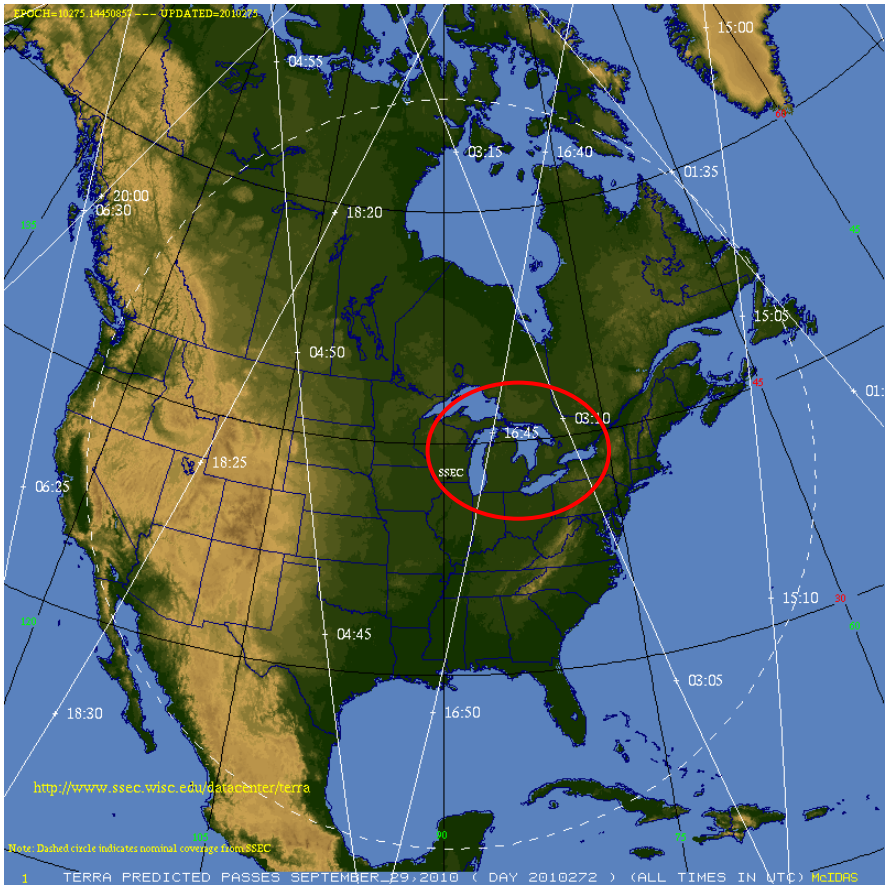
HDF-SDS : Hierarchical Data Format – Scientific Data Set



GeoTiff, JPEG2000 etc

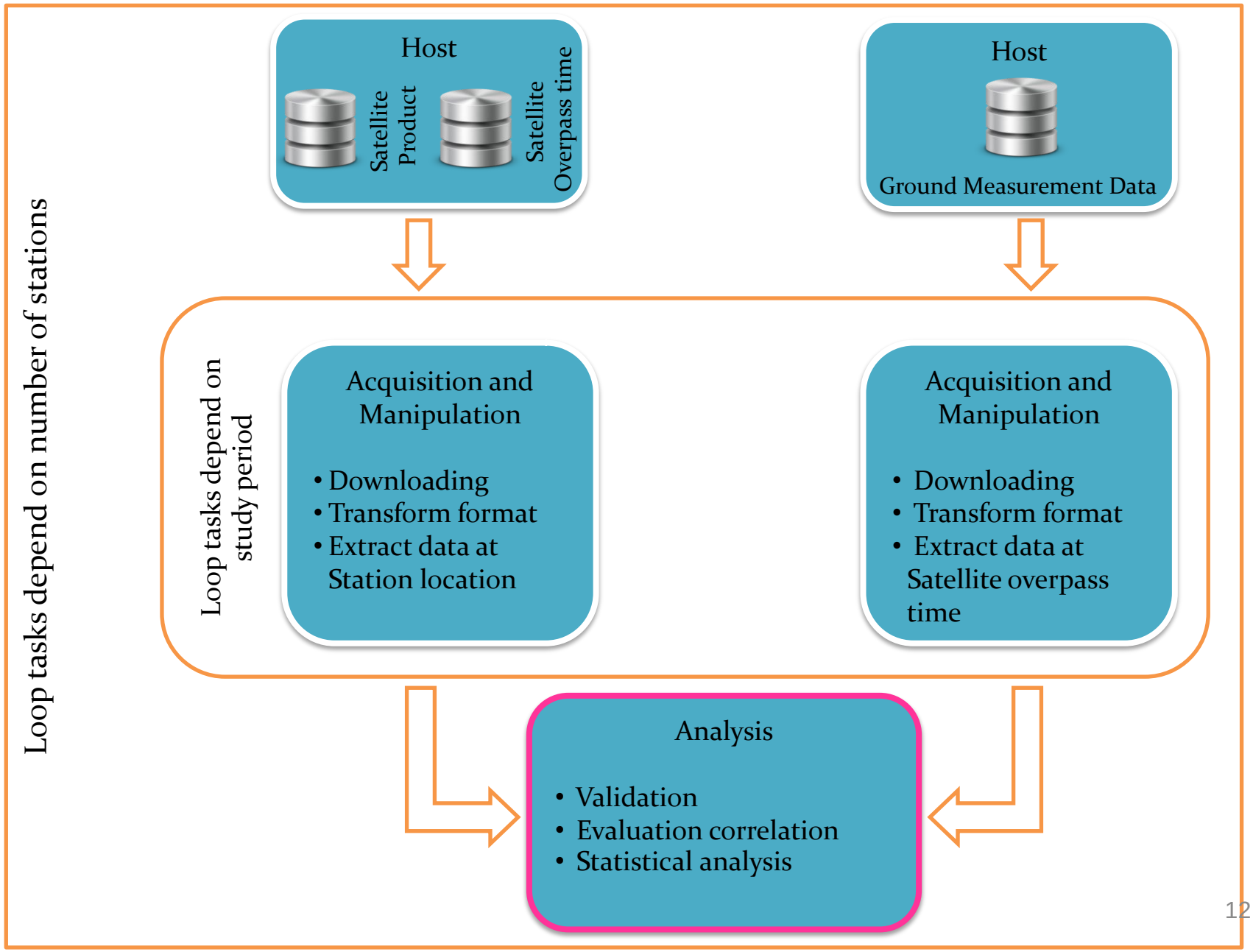
Overpass time





- 27th September 2010 pass area between 16:55 – 17:00
- 29th September 2010 pass area on 16:45

Traditional Workflow



Satellite Field Integrator (SFI)

- Design to reduce the onerous tasks of
  - Data gathering
  - Manipulating
  - Processing

- Supports heterogeneous data formats in both remote sensing and sensor observation data
- Scalability to handle the increasing number of datasets currently available.
- Offers a robust, on-demand processing service

Open Geospatial Consortium (OGC)

- Open Geospatial Consortium (OGC)
  - Non-profit, international voluntary consensus standards organization
  - Industry, government, and university members

- Over 406 members worldwide – over 30 countries & 5 continents
  - 186 European members
  - 50 Asia-Pacific members - Japan, Republic of Korea, Australia, China, Taiwan and etc

What makes a standard “Open”?

- **Available** – Anyone is allowed to read and implement the standard.
- **No Royalties** – Free to implement without paying hefty licensing fees or royalties.
- **Not controlled by a single vendor -** Maximizes end-user choice and makes the market more competitive with no lock-in to a single vendor's implementation
- **Agreed to by a formal consensus process**.

Standards in real world
Electrical Plugs (and voltage!)

- Electronic devices need standardized access to electrical power.

No Standards in real world

= 6 =

7 (may be interpreted as 5 by Malaysian or Singaporean Chinese)

7/8

9

10

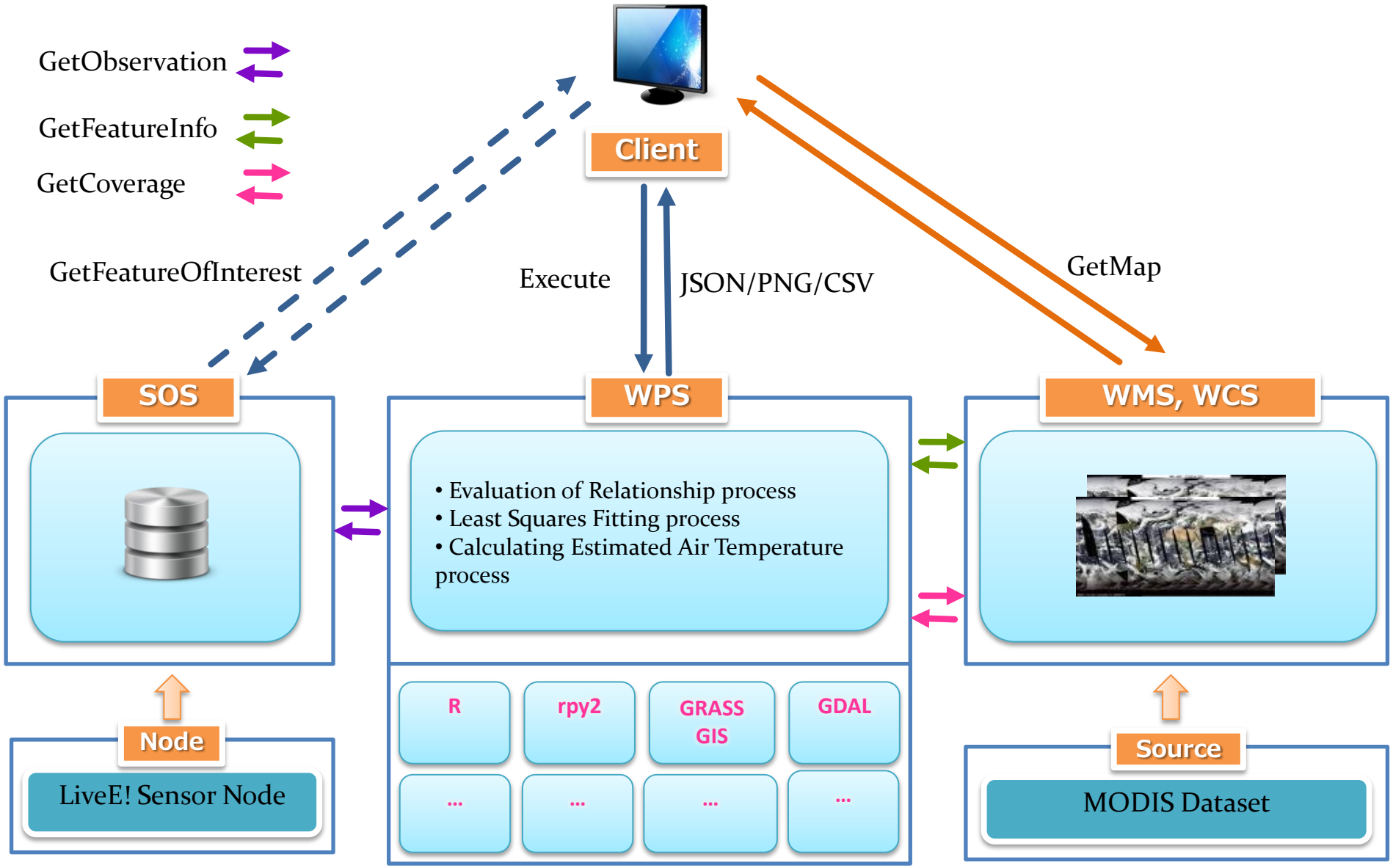
Reference
http://en.wikipedia.org/wiki/Chinese_number_gestures

World without standard

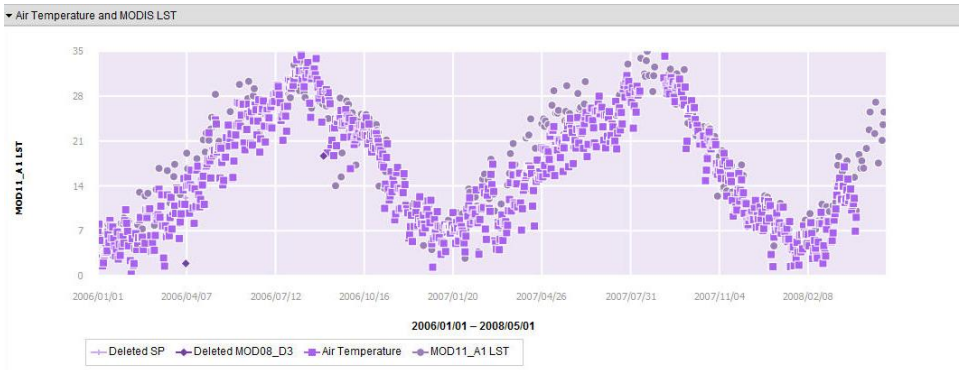
Satellite Field Integrator (SFI)

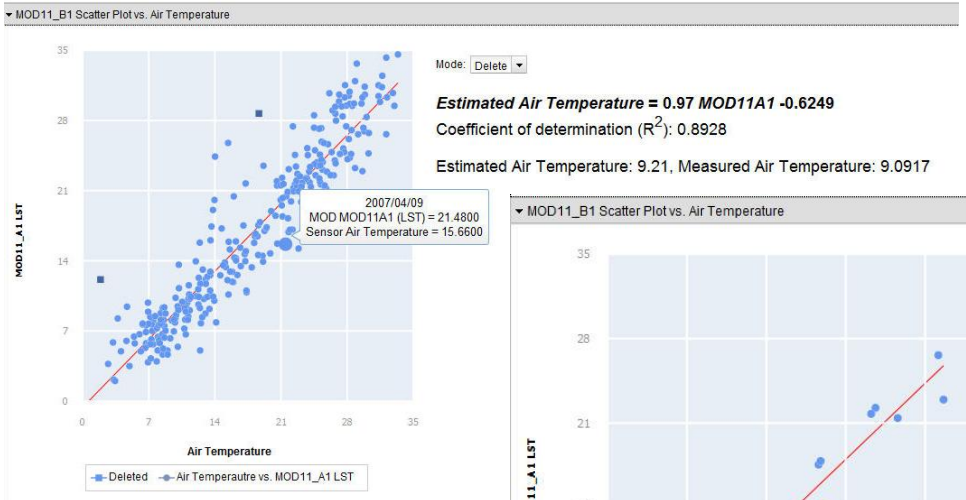
- The development is based on various open standards of OGC Web Service specifications such as
  - Web Mapping Service (WMS)
  - Web Coverage Service (WCS)
  - Sensor Observation Service (SOS)
  - Web Processing Service (WPS)

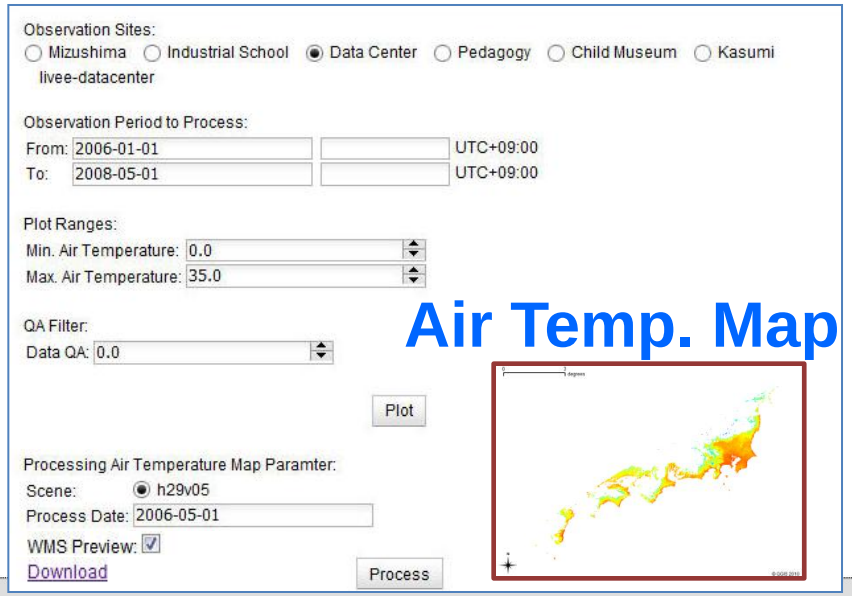
SFI architecture



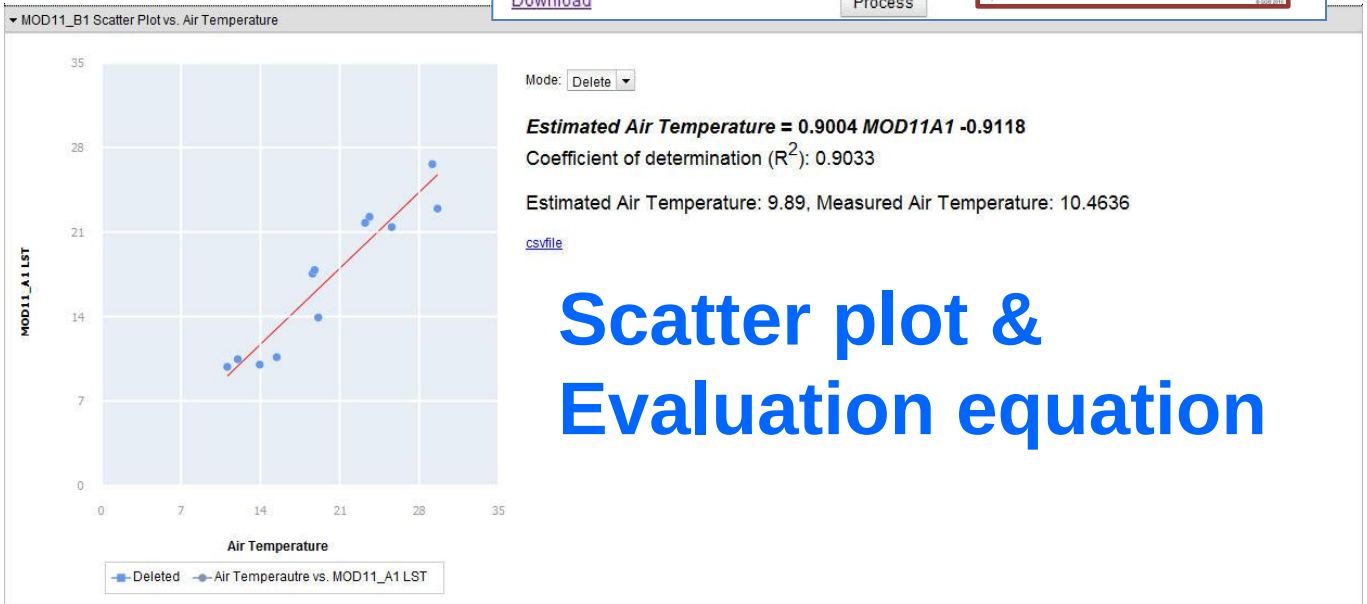
Prototype System





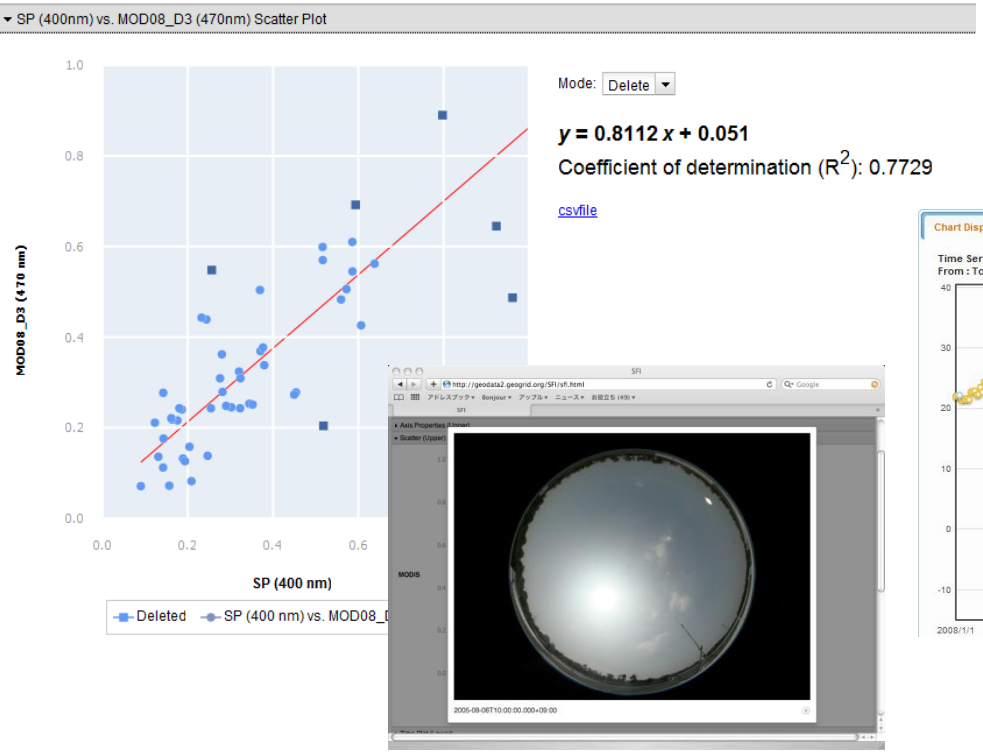


Air Temp. Map



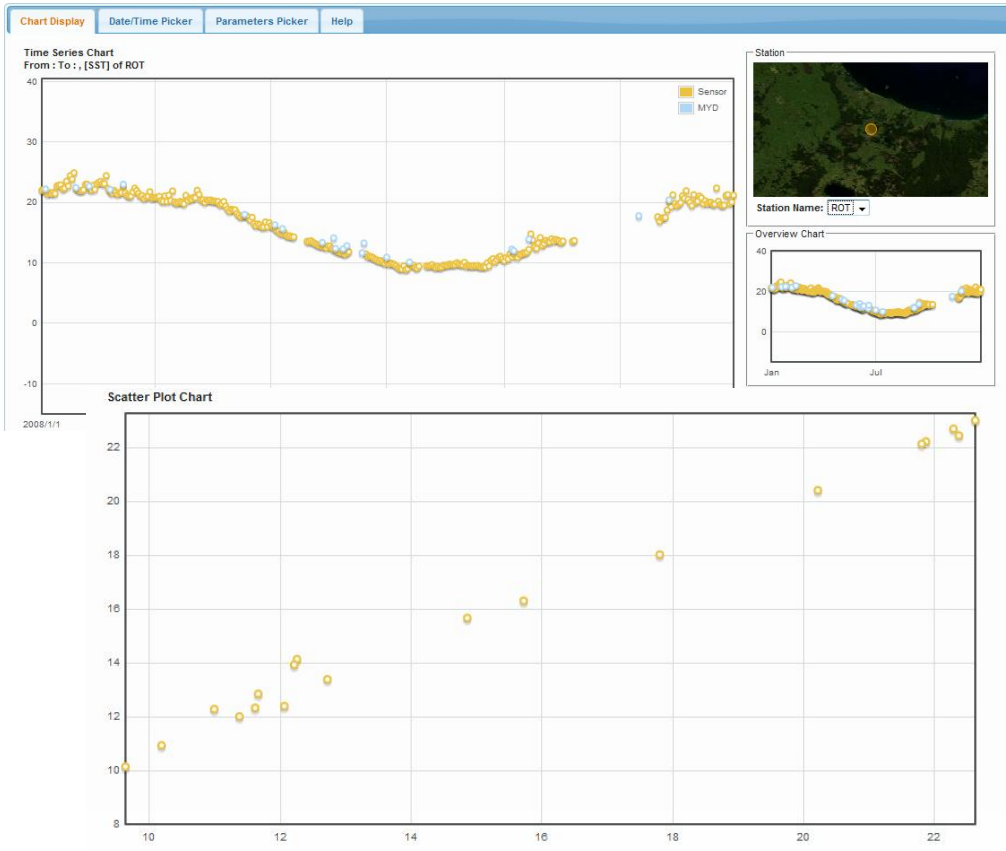
Scatter plot & Evaluation equation

Various Applications



Aerosol Optical Depth

Sea Surface Temperature



AMeDas

- AMeDas : Automated Meteorological Data Acquisition System
- High-resolution surface observation network by Japan Meteorological Agency
- Wind direction, Wind peed, Precipitation, types and base heights of clouds, Visibility, Air temperature, Humidity, Sunshine duration and air pressure.

AMeDas

- 1,300 statior

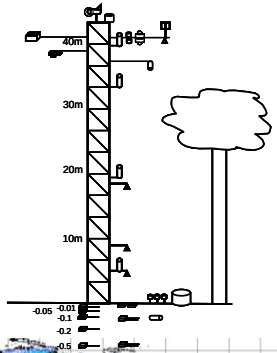
- Located at

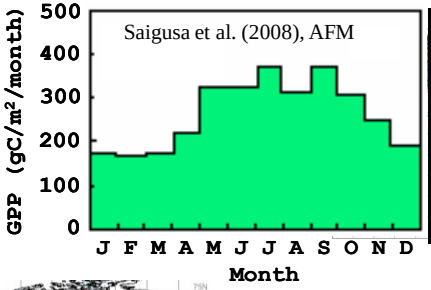
an average inte

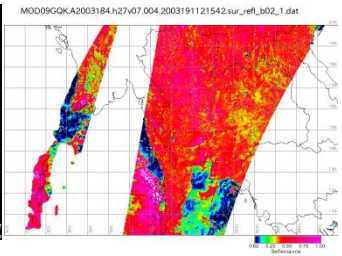
- Every 10 min

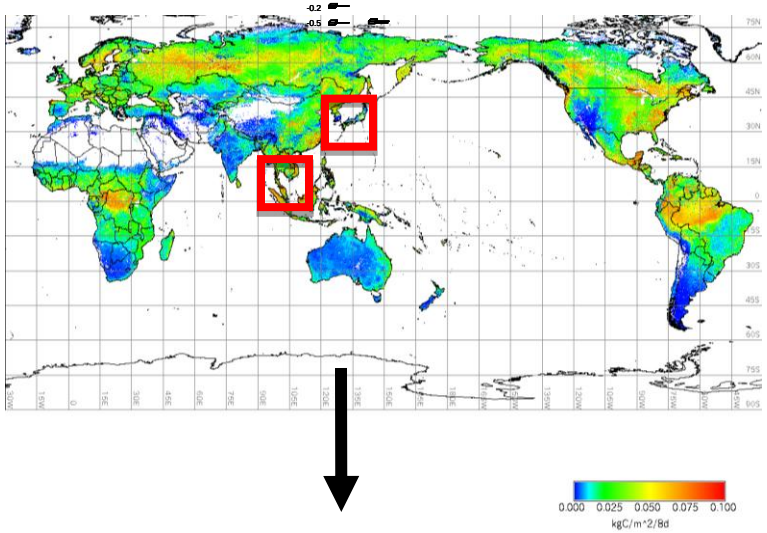
Field Observation data
(Primary production, daily)

MOD09, MOD17a2
→Vegetation Index (EVI,NDVI)
→ GPP



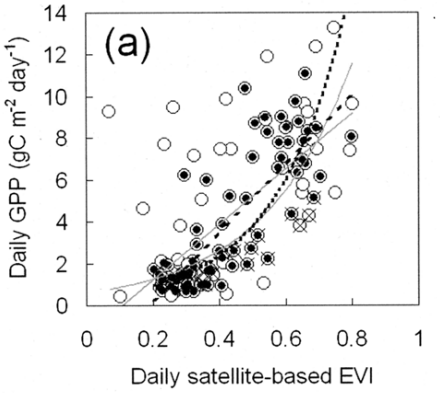






Satellite / Field data study

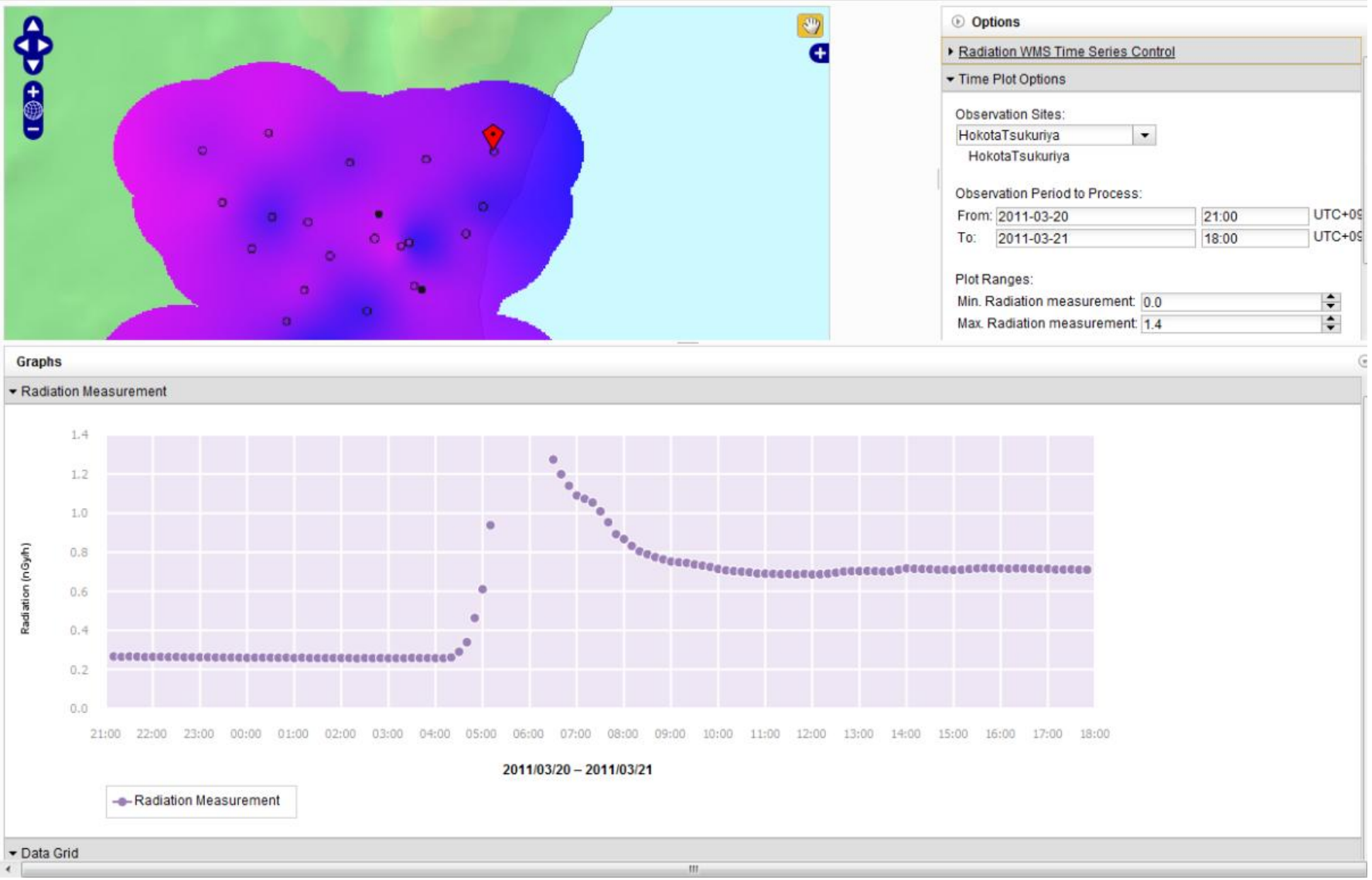
Applying to same forest type for GPP map.



(Nagai et al., submitted to IJRS)

・The prototype system will done with observation in Japan, Taiwan and Thailand.
・The success of study will extend sensor network to regional and global FLUX group.

SOS for Radiation monitoring sites around North Ibaraki region



Conclusions

- Comprehensive web-based GIS system framework enabled
  - Based on various open standards of OGC specifications
- Assimilation of sensor observation data and satellite image
  - Wider area, More accuracy, Reasonable cost
  - Possibly to apply for other applications
    - Disaster : Rainfall – One hour rain fall from Satellite image
- Minimal effort by overcoming the need for
  - Complex workflow, high skills requirement, and expensive facilities
  - Customization is possible
    - Difference process in WPS
- HPC & Cloud for Geo Science
  - **Source** : Spatial and Temporal
  - **Cost** : Disk Space, Network, Processing Power etc.


THANK
YOU