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Federating Satellite RS data and Ground Sensor data based on OGC Web Service Standards

Sarawut NINSAWAT
GEO Grid Research Group/ITRI/AIST

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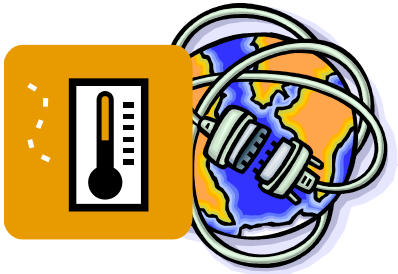
Geospatial Data Gathering

Satellite

Field Survey with Laboratory

Data Center

Data Logger



Smart Sensor

Internet

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

- 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

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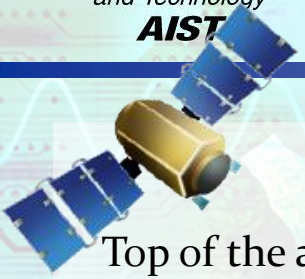
Validation satellite products



Basic Product

Top of the atmosphere

Surface Reflectance

Higher Product

Land Surface Temperature

Sea Surface Temperature

Gross Primary Productivity

Chlorophyll A

Land Cover

Vegetation Indices

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MODIS Ocean Products

- Ocean Temperature
  - **Long-wave SST (11-12 μm),** day and night
  - Short-wave SST (3.9 - 4.0 μm), night only
  - SST quality level (0-4)

- Ocean Color (day only)
  - Normalized water-leaving radiances, nLw(λ)
  - **Chlorophyll, C_a**
  - Diffuse attenuation, $K_d(490)$
  - Aerosol type and concentration
  - Processing flags
    - Cloud, land, glint, atmfail, atmwarn, chlfail, chlwarn, etc.

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GLEON

- Global Lake Ecological Observatory Network (GLEON)
  - Network of researchers, educators and community groups
  - Utilizing time series and high frequency observation on/in lakes all over the world
- Participating lakes:
  - Lake Sunapee, New Hampshire, USA
  - Lough Feeagh, County Mayo, Ireland
  - Trout Lake, Wisconsin, USA
  - Lake Rotorua, New Zealand etc.
- Each observation will be send in near-real time to web-accessible database
  - At web portal, various web services are provide user to access and utilizing observed data

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Lake Rotorua monitoring

- Data collected from the buoy will be used to monitor and improve of lake health
  - Due to impact of both urban and rural development
- Since 2007-07-13 every 15 minutes

Sensors	Make/model	Depths
Water temperature	Apprise TempLine	0.5 - 20.5 every 2m
Dissolved oxygen	D-opto	0.5, 20
Chlorophyll	Seapoint/Trios	1
Phycocyanin	Trios	1
Climate	Vaisala WXT510	n/a

Figure from http://www.lernz.co.nz/gallery/lakerotorua.html

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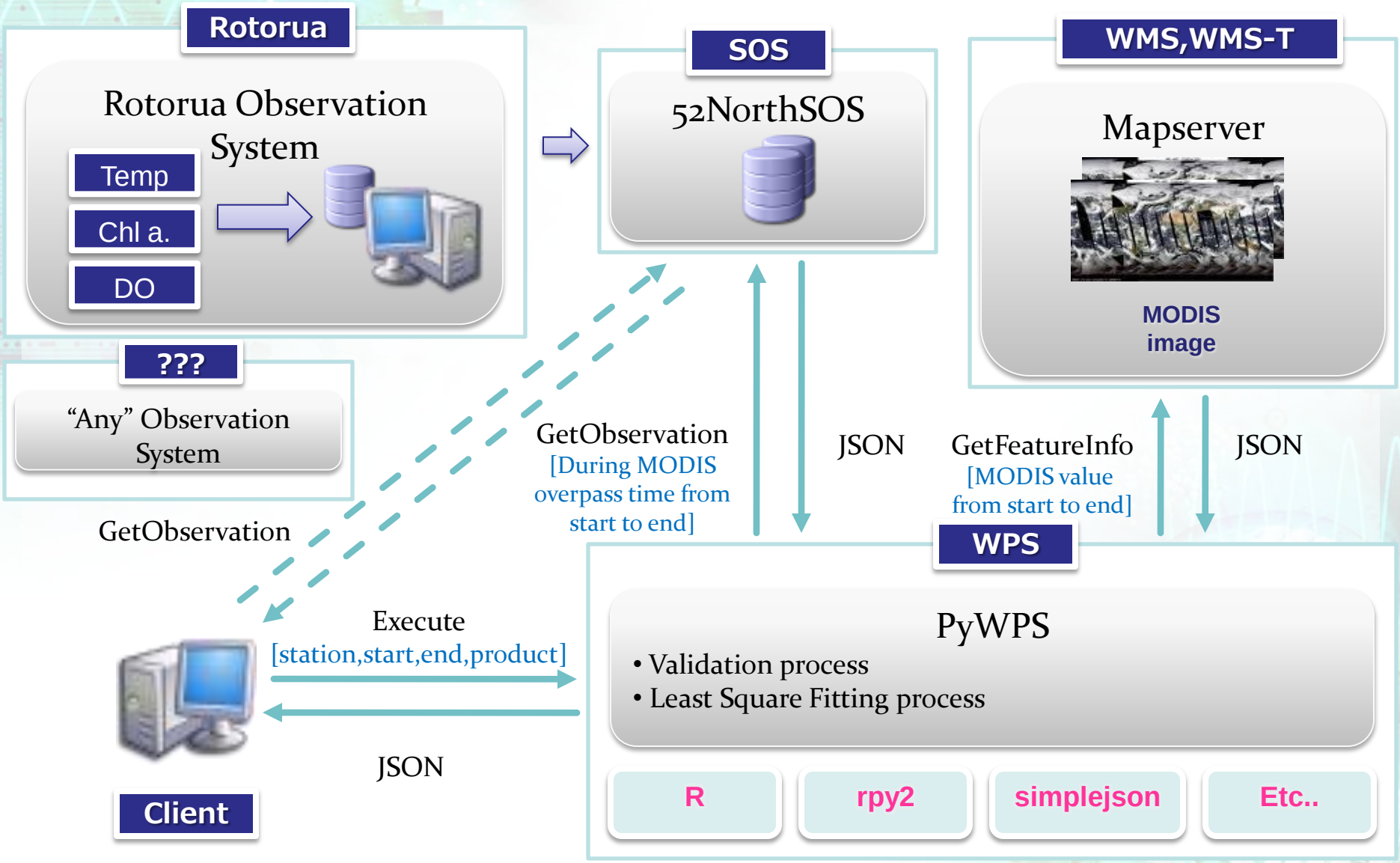
OGC System Framework



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Result

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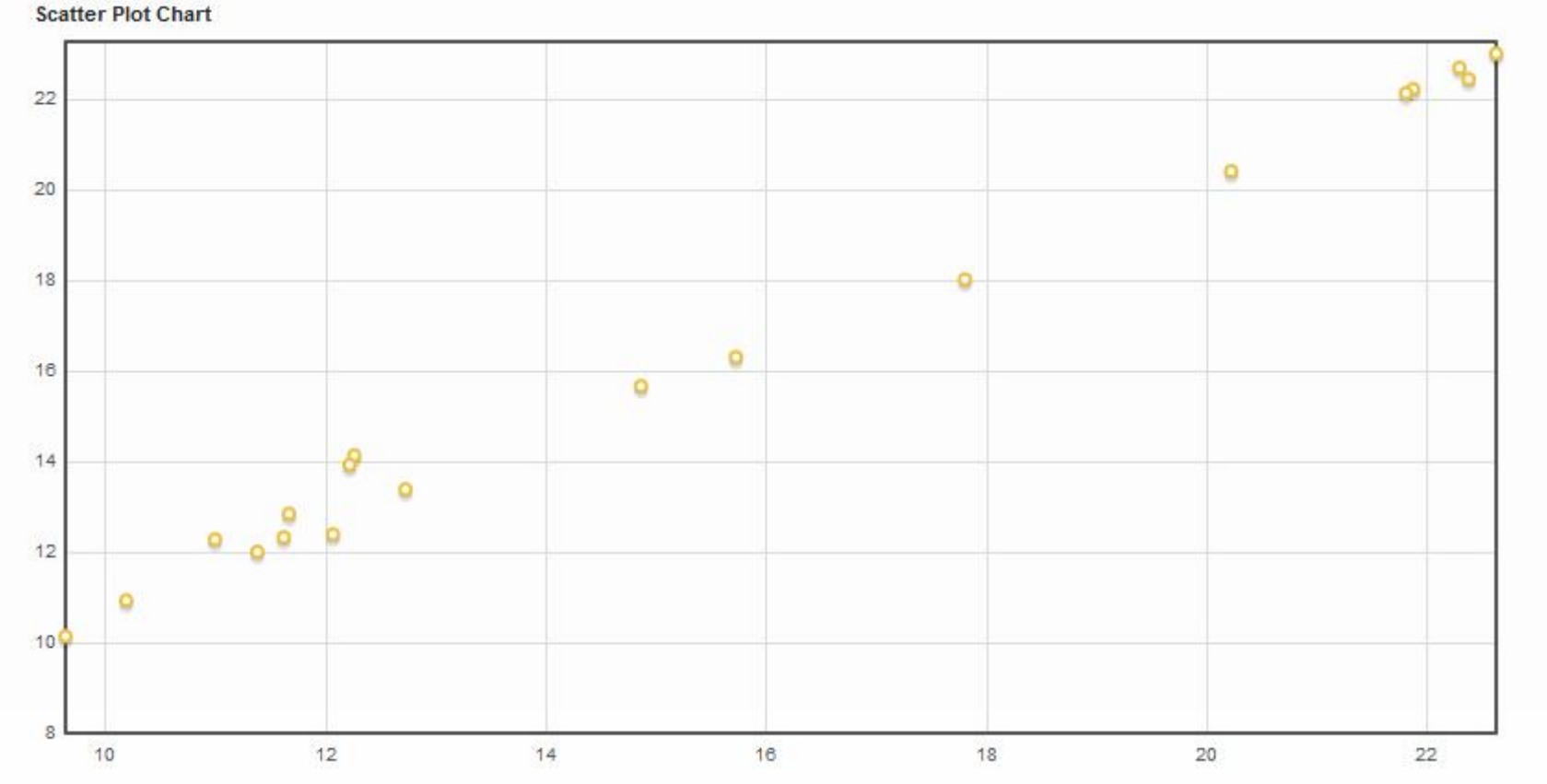
Result



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Cal/Val for satellite products

- Surface reflectance is basic product for higher level products (land use, land cover, biomass, etc …)
  - Need to convert the “top of the atmosphere” signal to the “surface reflectance”.
  - Estimating the surface spectral reflectance as it would have been measured at ground level
  - Use Radiative Transfer Model (6S, MODTRAN, etc …)
  - Need atmospheric parameters (satellite-based and/or ground-based)
  - Especially, aerosol over land is complicated by the higher variability and spatial heterogeneity
  - Need to calibrate/validate for surface reflectance and atmospheric parameters
- Focused on aerosol parameters in this research

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MOD04 and MOD08

- The algorithm retrieves daily Aerosol Optical Depth (AOD) as known as MOD04 in Level two product
  - Using seven bands of MODIS.
  - Resolution at 1 x 1, 5 x 5 and 10 x 10 km.
- The MOD08 is a Level three product as global dataset from MOD04
  - Daily Global, Eight-day Global and Monthly Global (Resolution 1º x 1º)
- Validation with ground observation is necessary to improve uncertainly estimate.

Band	Wavelength (μm)	Resolution (m)	Primary Use
1	0.620-0.670	250	Land/Cloud/Aerosols Boundaries
2	0.841-0.876	250	
3	0.459-0.479	500	
4	0.545-0.565	500	Land/Cloud/Aerosols Properties
5	1.230-1.250	500	
6	1.628-1.652	500	
7	2.105-2.155	500	

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PEN

- Phenological Eyes Network
  - Monitoring dynamics of the ecosystem
  - Validate satellite information with reliable information on ground level
- Measurement equipments:
  - Sunphoto meter (SP)
    - 11 spectral bands with FOV 1 degree at 10 minutes interval
    - Optical thickness, aerosol size and aerosol reflective index etc.
    - Main purpose for atmospheric correction and monitoring pollutants
  - Automatic-capturing Digital Fisheye Camera (ADFC)
    - High quality images of the sky, canopy, branch and ground
    - 2 – 180 minutes interval
    - Sky condition at satellite overpass time.
  - Hemi-Spherical Spectral Radiometer (HSSR)

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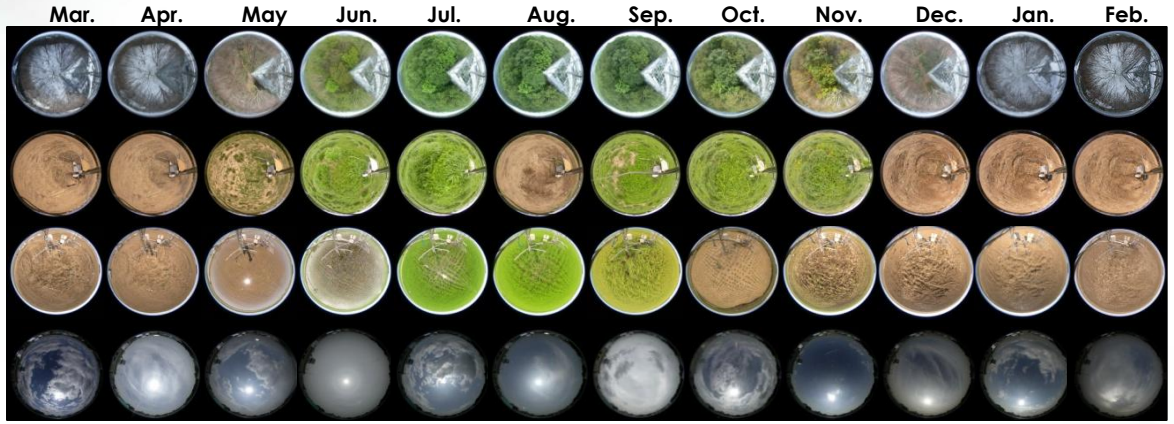
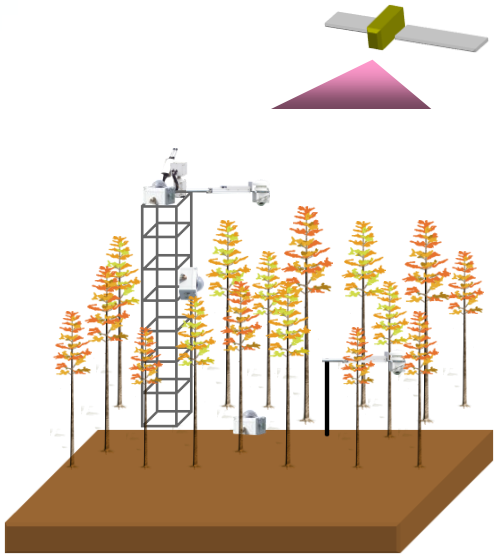
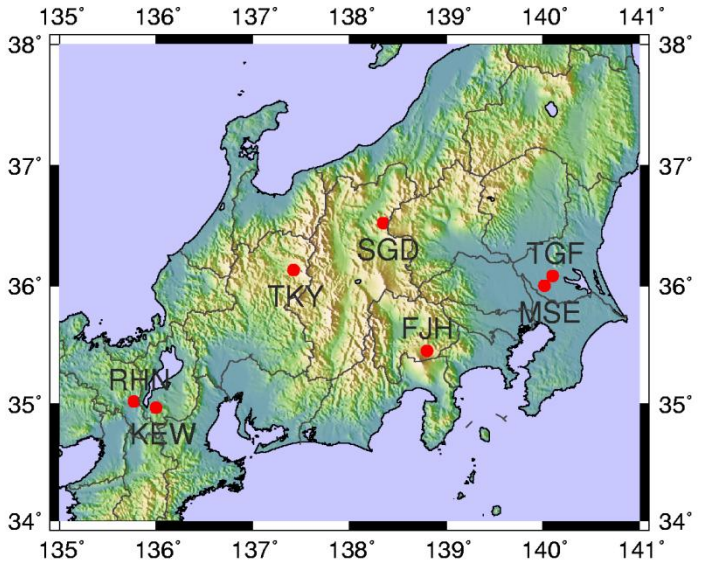
PEN Equipments







http://www.pheno-eye.org

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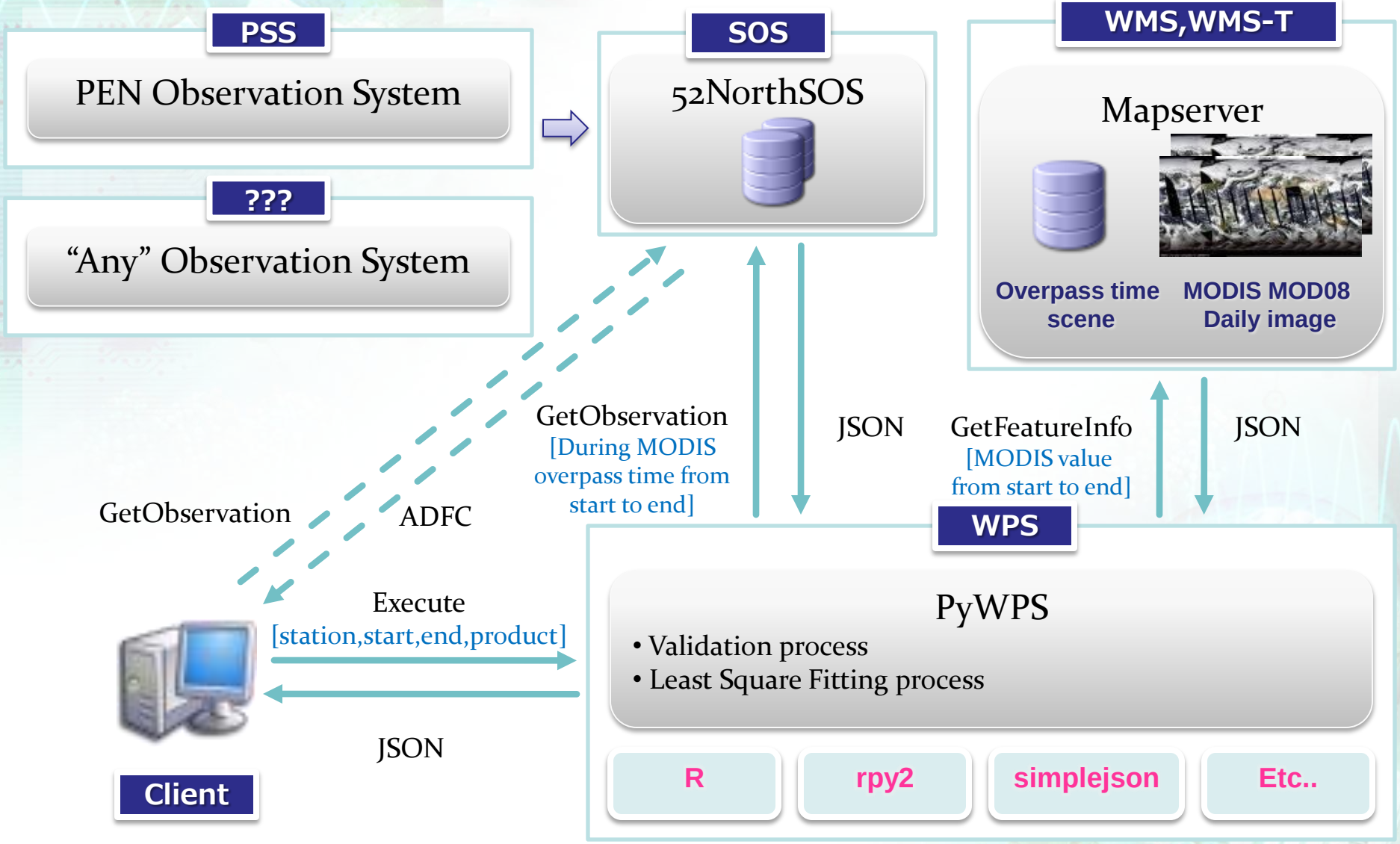

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What Next

- Increase atmospheric observation network
  - SKYNET, AERONET
- Satellite image product validation
  - CO2 Flux monitoring : Asiaflux / Japanflux
  - Rainfall : TRMM
- Validation with higher satellite image resolution
  - ASTER, FORMOSAT-2
- Enabled-security OGC web service
  - Accessible control for each sensor site
- Real-time modeling application
  - Surface Runoff with Rain-Gauge sensor in Taiwan
  - Increase processing speed

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