National Institute of
Advanced Industrial Science
and Technology
AIST

Validation of Satellite Image with Ground Sensor Network based on OGC Web Services Framework

Sarawut NINSAWAT

Ryousuke Nakamura, Hirokazu Yamamoto, Akihide Kamei and Satoshi Tsuchida

GEO Grid Research Group/ITRI/AIST

National Institute of Advanced Industrial Science and Technology
AIST

Introduction

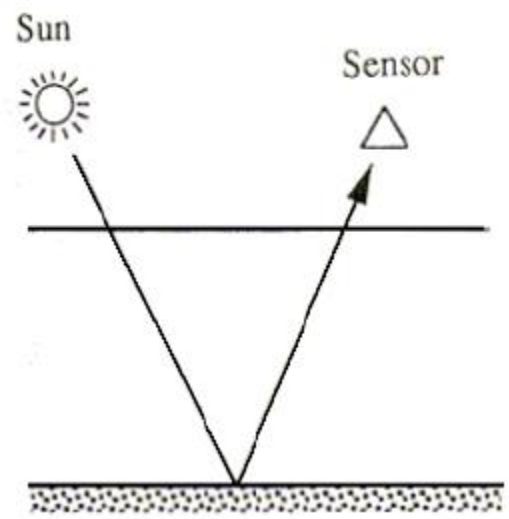
- The utilization of satellite remote sensing image
  - Widely applied and been recognized as powerful and effective tool
  - Monitoring state of the environments

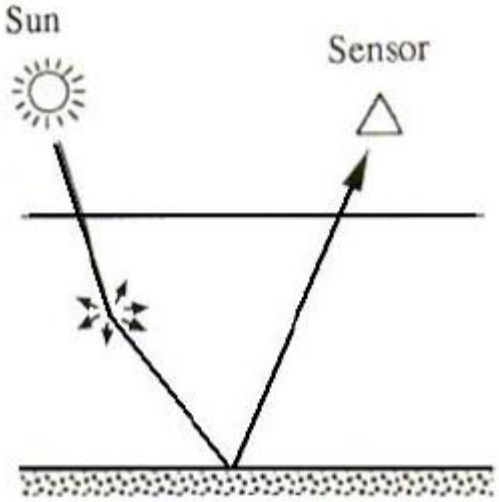
- Benefit of satellite RS:
  - Cheap and rapid over large geographic area
  - Regional coverage and broadly spectral resolution
  - Continuous acquisition of data
  - Archive of historical data

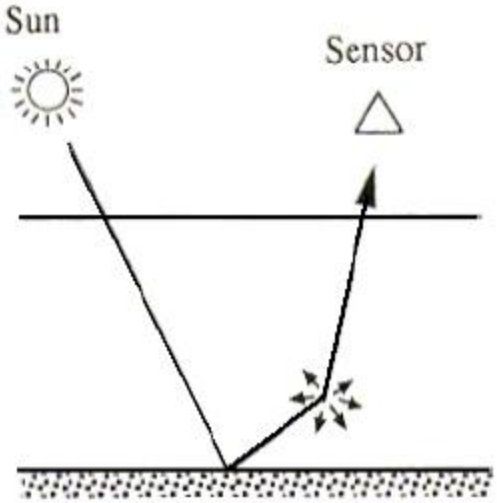
- Limitation of satellite RS:
  - Not direct sample of the phenomenon.
  - Interference of atmospheric gaseous and particles
    - Absorbing (H_20, O_3 etc.) and Scattering (aerosol particles such as dust, ash and smoke)

National Institute of Advanced Industrial Science and Technology
AIST

Surface reflectance and Top of the atmosphere







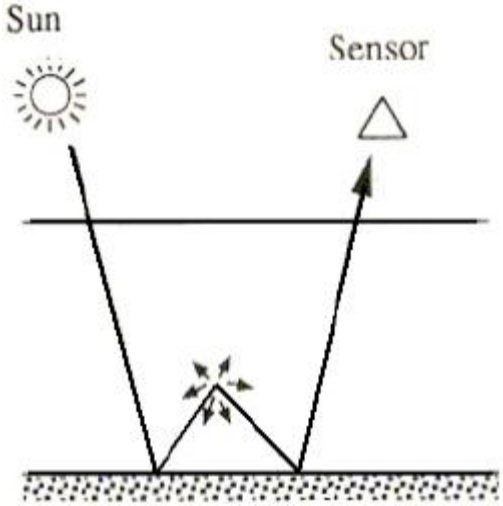


Image from: http://www.profc.udec.cl/~gabriel/tutoriales/rsnote/cp9/cp9-2.htm

National Institute of Advanced Industrial Science and Technology
AIST

Atmospheric Correction

- 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
  - Radioactive transfer model
- 6**S** = **S**econd **S**imulation of the **S**atellite **S**ignal in the **S**olar **S**pectrum
  - Work in cloud free condition
- Necessary Input parameters:
  - Geometrical condition
  - Atmospheric model for gaseous components
  - Aerosol mode (Type and concentration)
  - Spectral condition
  - Ground reflectance (type and spectral variation)

National Institute of Advanced Industrial Science and Technology
AIST

MODIS (MODerate-resolution Imaging Spectroradiometer)

- Capable of viewing the entire globe daily at moderate resolutions
  - Ranging from 250 meters to 1 kilometer pixels.
  - 36 spectral bands ranging in wavelength from 0.4 μm to 14.4 μm
  - Land, Cloud, Aerosol properties, Atmosphere, Ocean color etc.
- Various products generated for earth observation purpose
  - Vegetation indices, leaf area index, sea surface temperature.
- 6S is a basic code for MODIS atmospheric correction algorithm.
  - Gaseous condition - > MOD05 and MOD07
  - Cloud mask -> MOD35
  - Aerosol concentration -> MOD04

National Institute of Advanced Industrial Science and Technology
AIST

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	

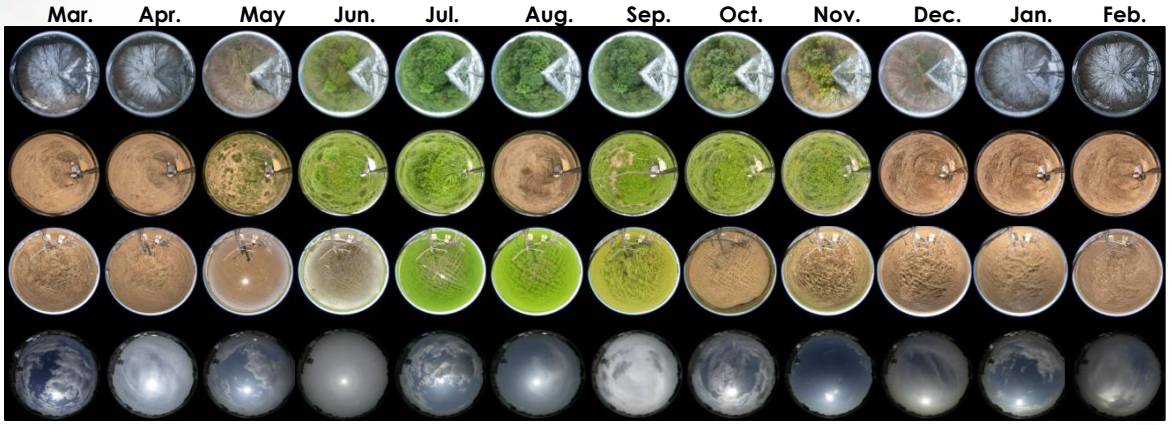
National Institute of Advanced Industrial Science and Technology
AIST

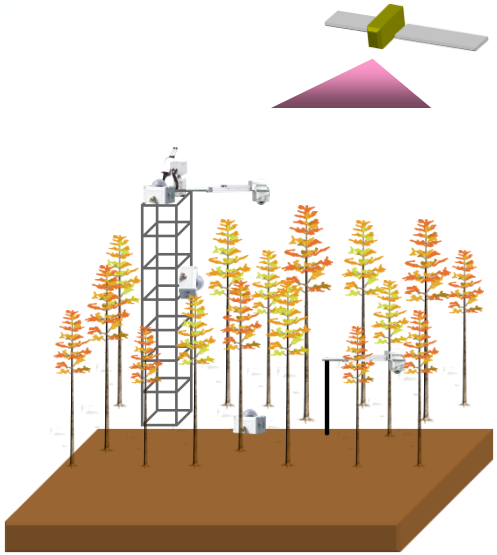
PEN

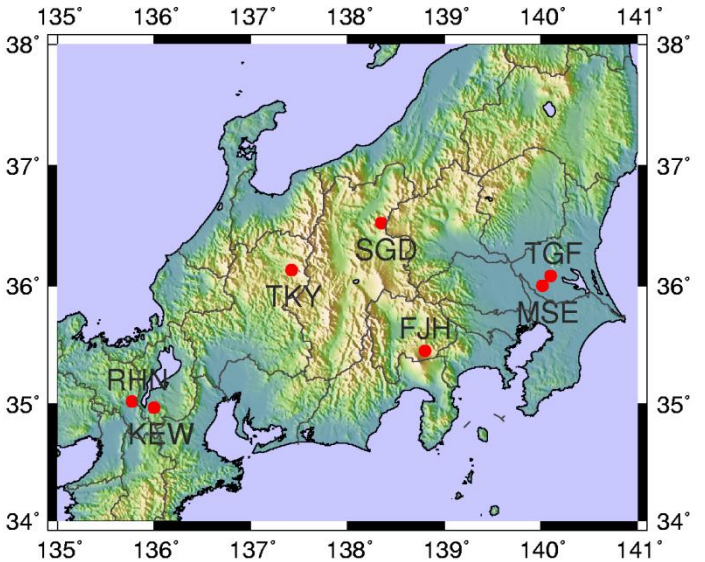
- Phenological Eyes Network
  - Monitoring dynamics of the ecosystem
  - Validate satellite information with reliable information on ground level
- Measurement equipments:
  - Sunphoto meter (SP)
    - 11 spectral bands with FOV 1 degree at 10 minutes interval
    - Optical thickness, aerosol size and 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)

National Institute of Advanced Industrial Science and Technology
AIST

PEN Equipments



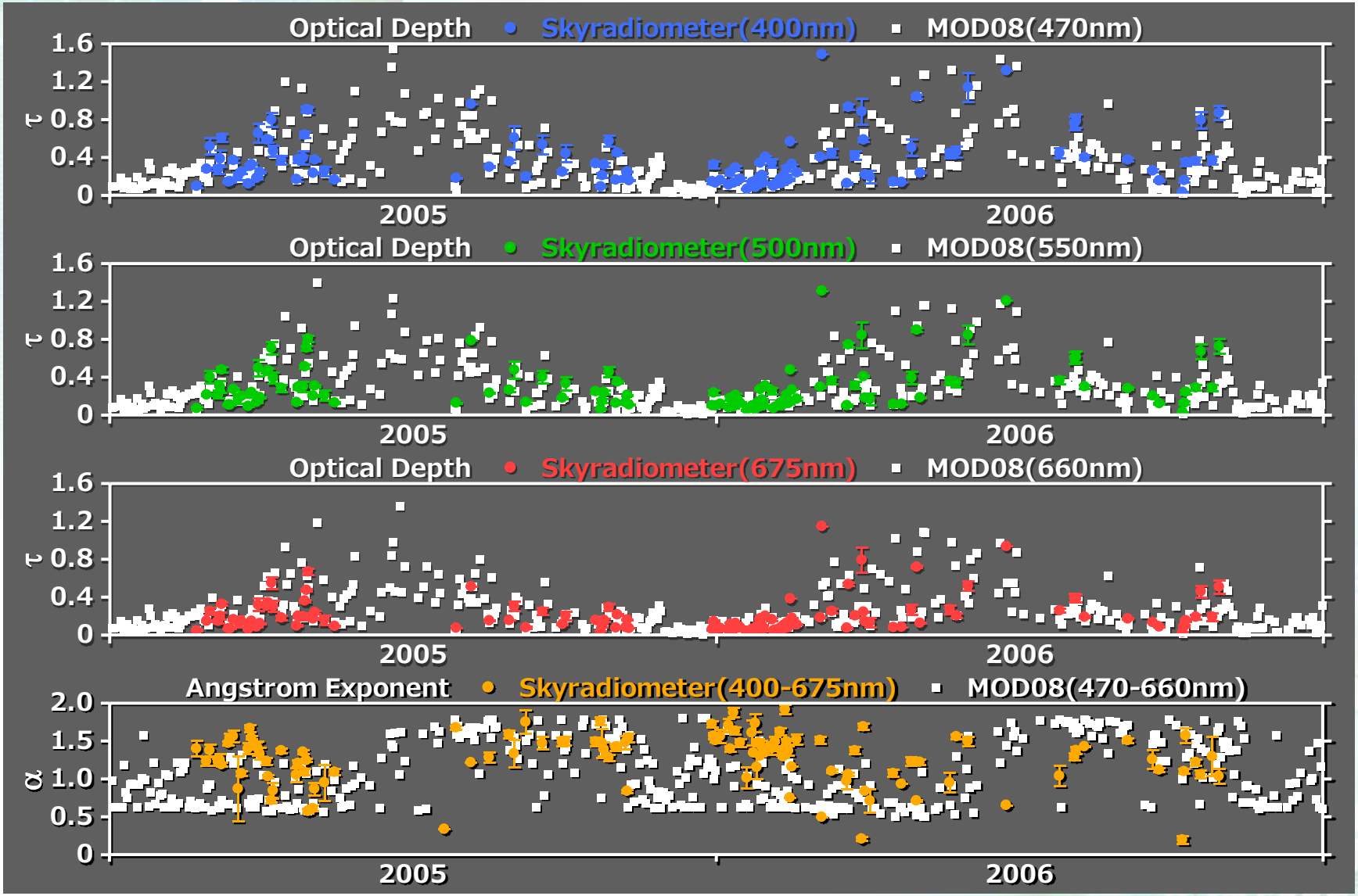




http://www.pheno-eye.org

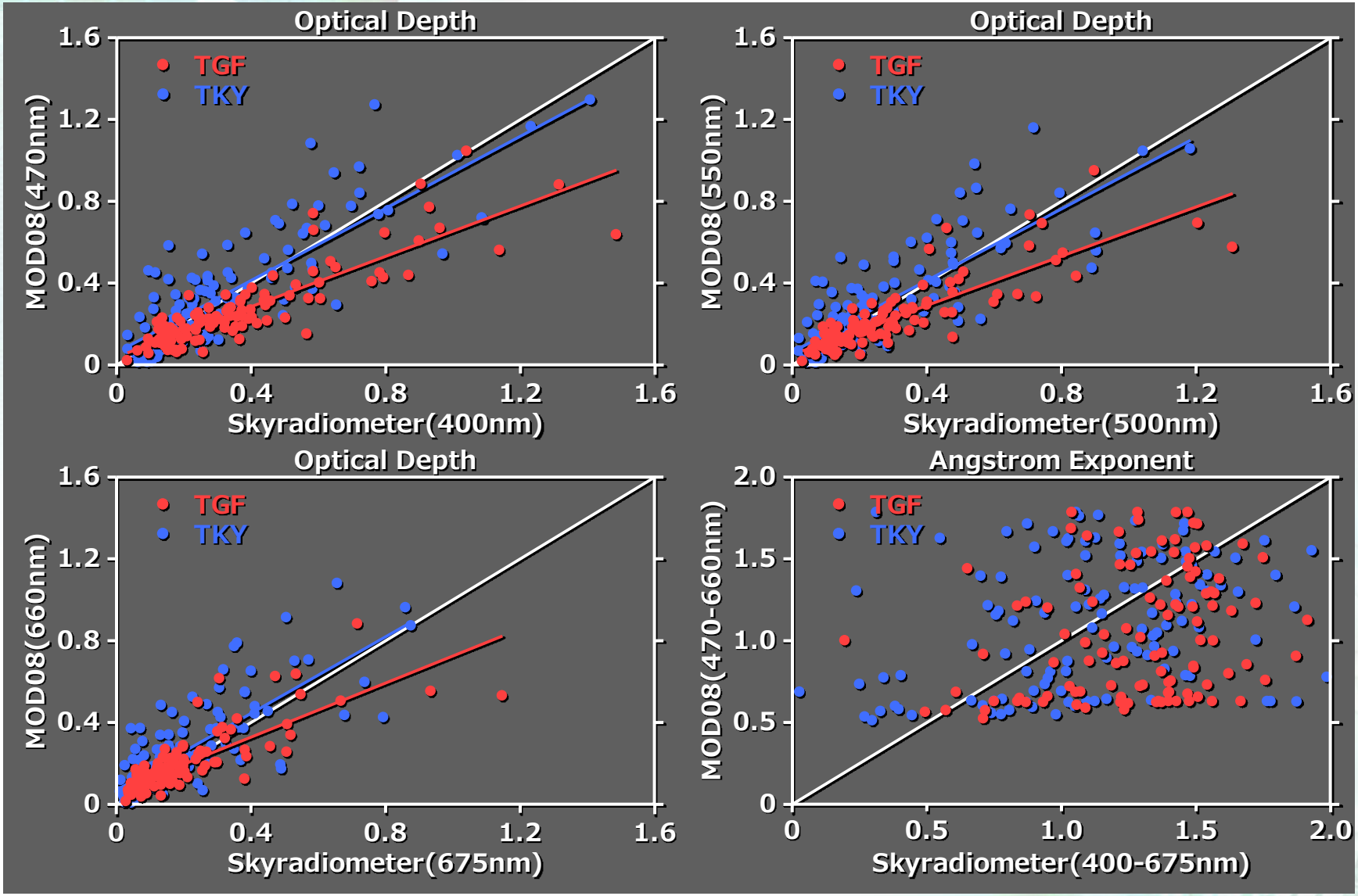
National Institute of Advanced Industrial Science and Technology
AIST

Validation (SP & MOD08)



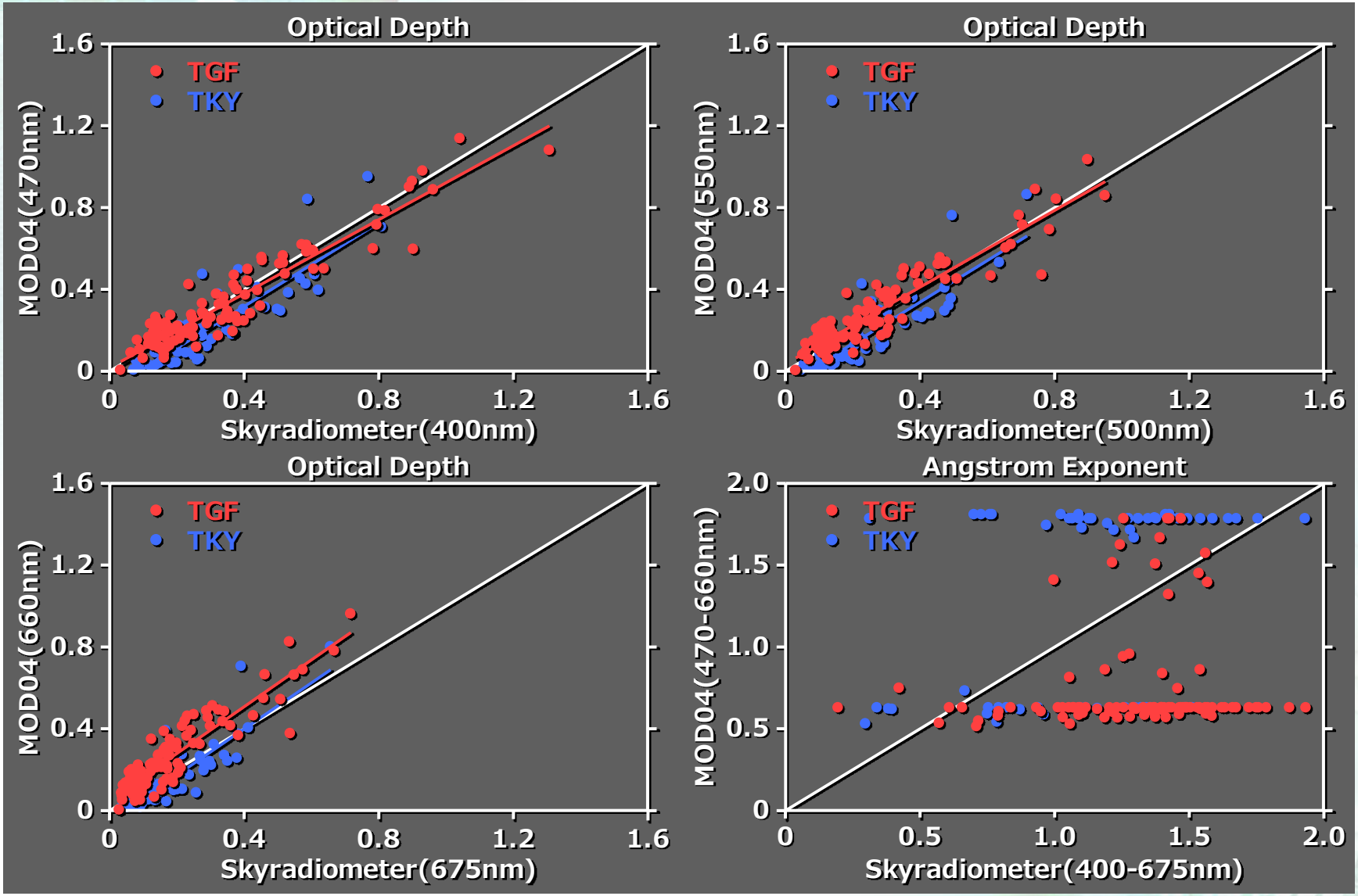
National Institute of Advanced Industrial Science and Technology
AIST

Validation (SP & MOD08)



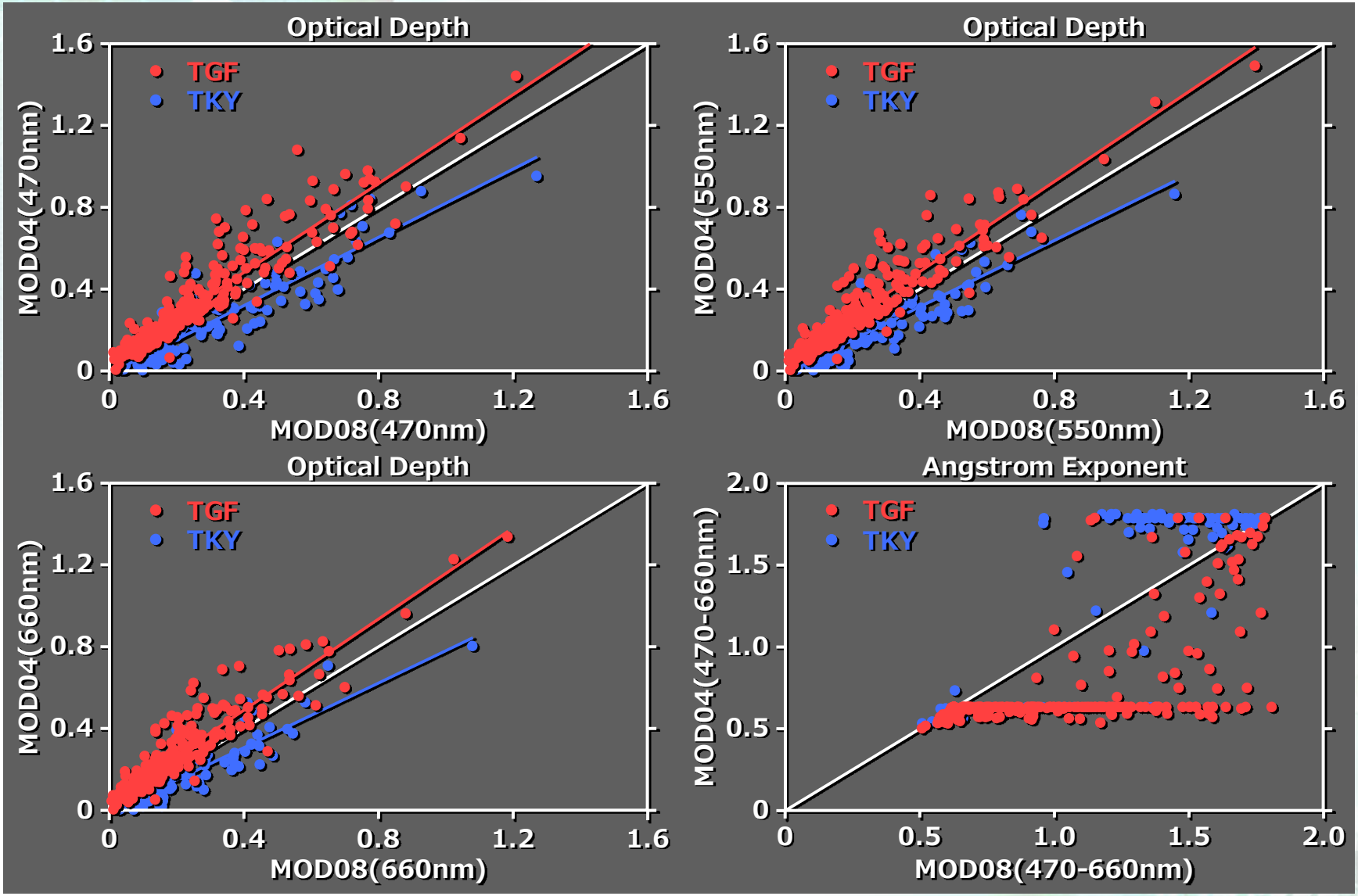
National Institute of Advanced Industrial Science and Technology
AIST

Validation (SP & MOD04)



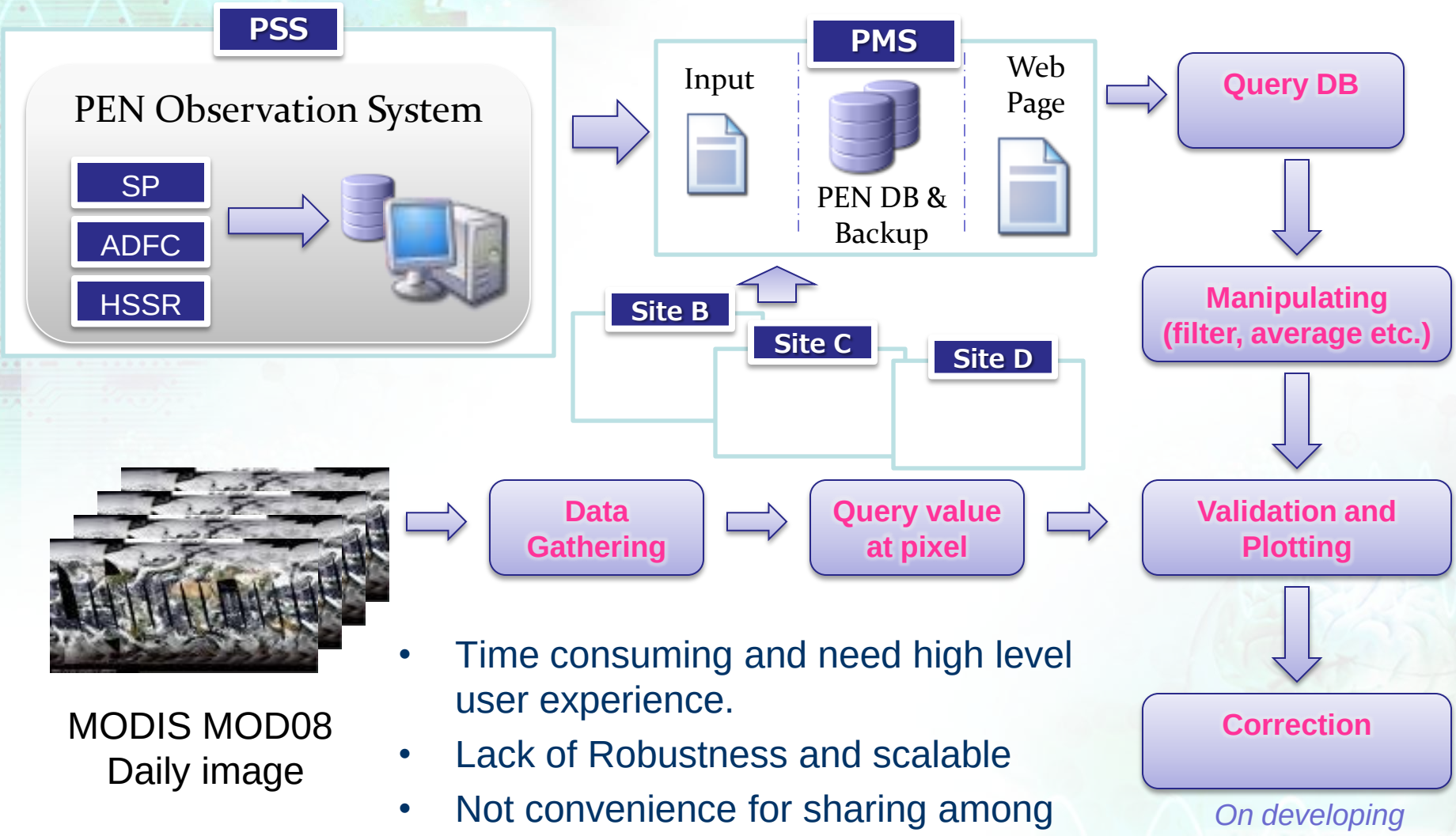
National Institute of Advanced Industrial Science and Technology
AIST

Validation (MOD08 & MOD04)



National Institute of Advanced Industrial Science and Technology
AIST

Previous System Framework



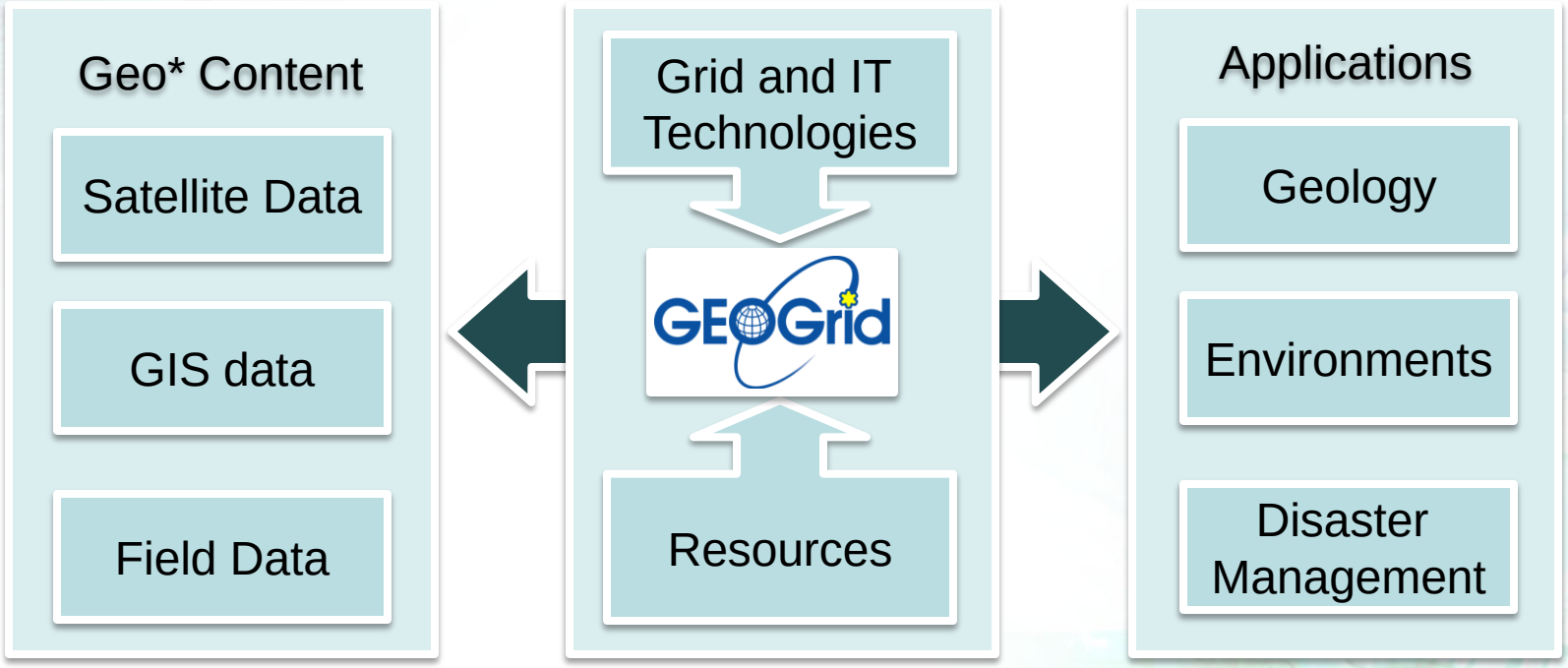
MODIS MOD08
Daily image

- Time consuming and need high level user experience.
- Lack of Robustness and scalable
- Not convenience for sharing among communities

National Institute of Advanced Industrial Science and Technology
AIST

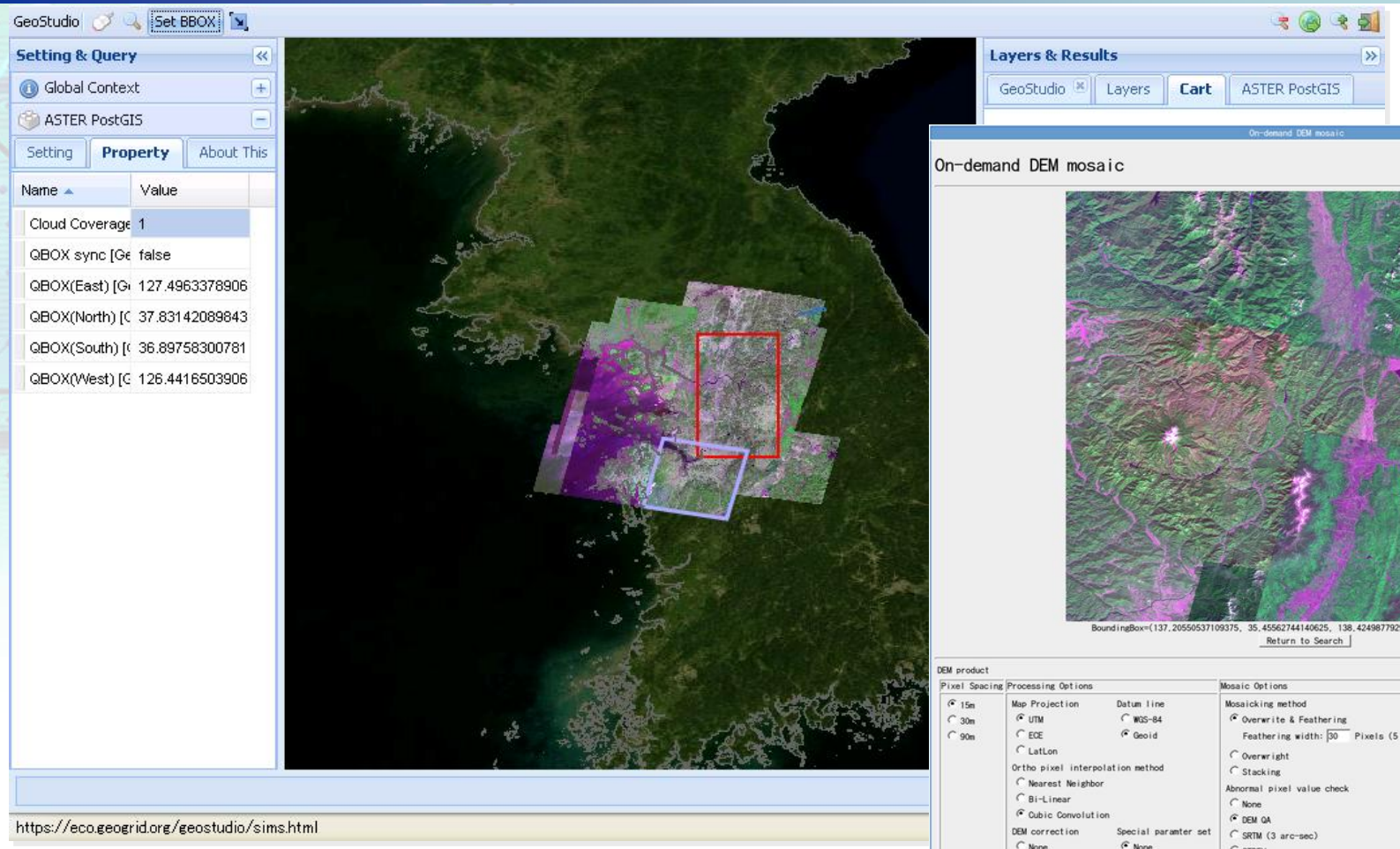
Geo Grid

- GEO (Global Earth Observation) GRID
  - An E-Infrastructure to accelerate GEO science based on the concept that whole data related to earth observation are ***virtually integrated*** with a ***certain access management*** and ***easy to handle*** by the end-users those are enabled by a set of Grid and Web Service technologies.



National Institute of Advanced Industrial Science and Technology
AIST

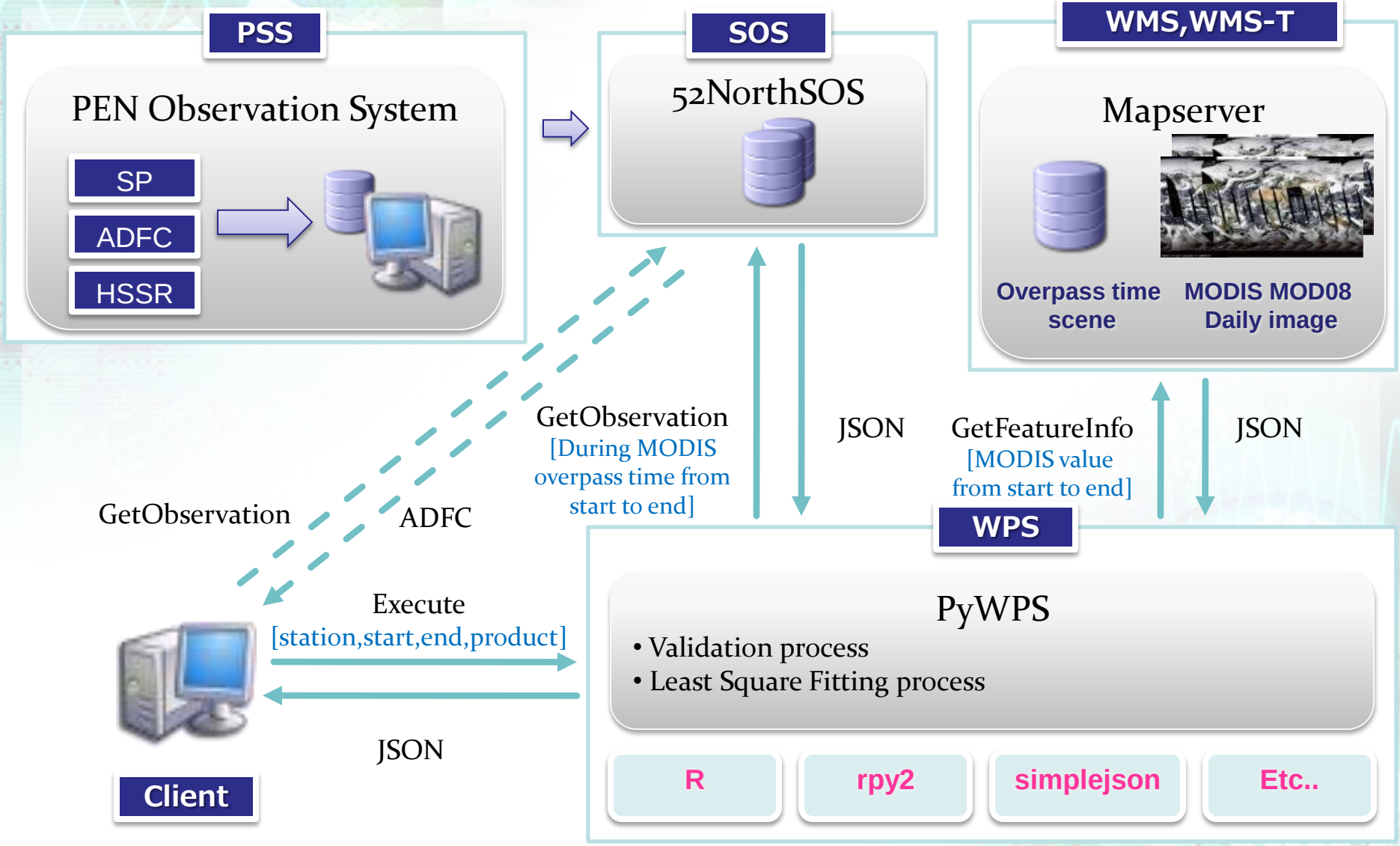
ASTER DEM on demand mosaic system



- ASTER and PRISM DEM 3D Generation
- Simulation of Pyrosclstic flows on volcano

National Institute of Advanced Industrial Science and Technology
AIST

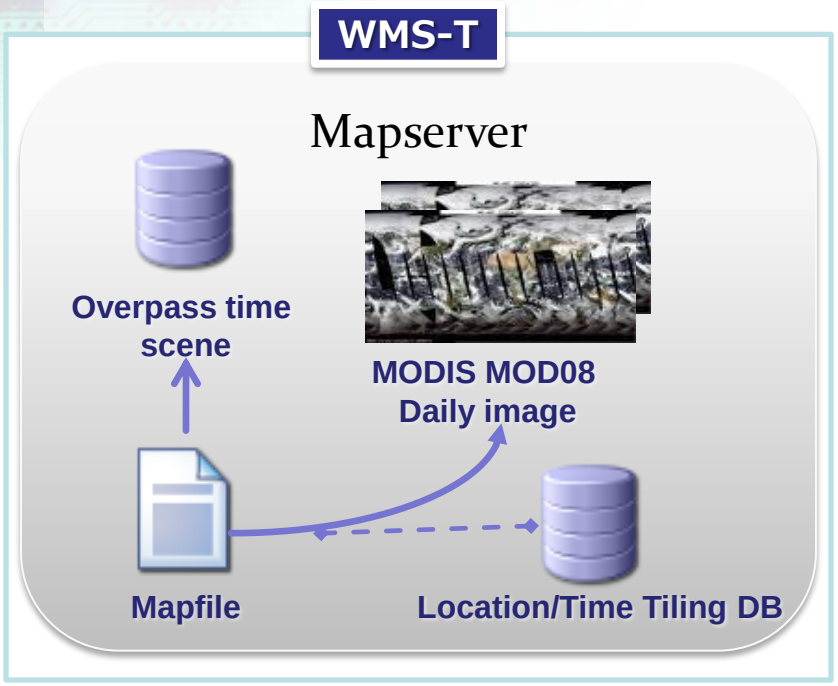
OGC System Framework



National Institute of Advanced Industrial Science and Technology
AIST

WMS Time Tiling

- WMS-T support for time request
  - Time instance (etc. 2002-01-01)
  - Time period (etc 2002-01-01/2002-10-01)
- Currently, Mapserver do not support for WMS Time Tiling for “GetFeatureInfo” request with raster layer
  - “errors that look like this msShapefileOpen(): Unable to access file. (f:/msapps/gmap-ms40/htdocs/my_layer_idx **” Ticket #2796**
  - Solution : WxS mapscript



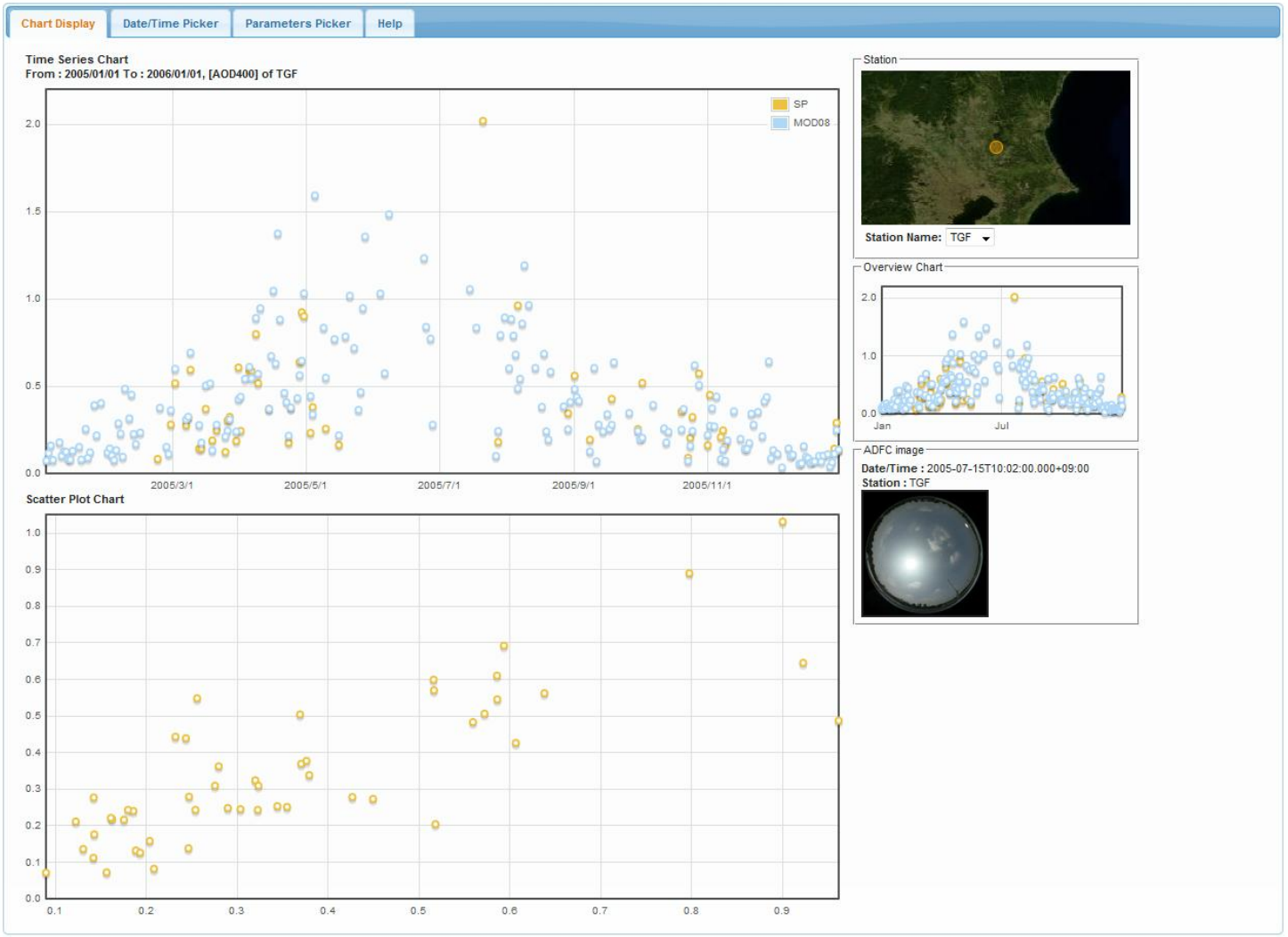
gid	filename	the_geom	otime
1	tiff/470/MOD08_D3_A2002010.tif	01030…	2002-01-10
2	tiff/470/MOD08_D3_A2002011.tif	01030…	2002-01-11
3	tiff/470/MOD08_D3_A2002012.tif	01030…	2002-01-12
..	……	……	……

MOD08_D3_A2002010.tif

MOD08_D3_A2002011.tif

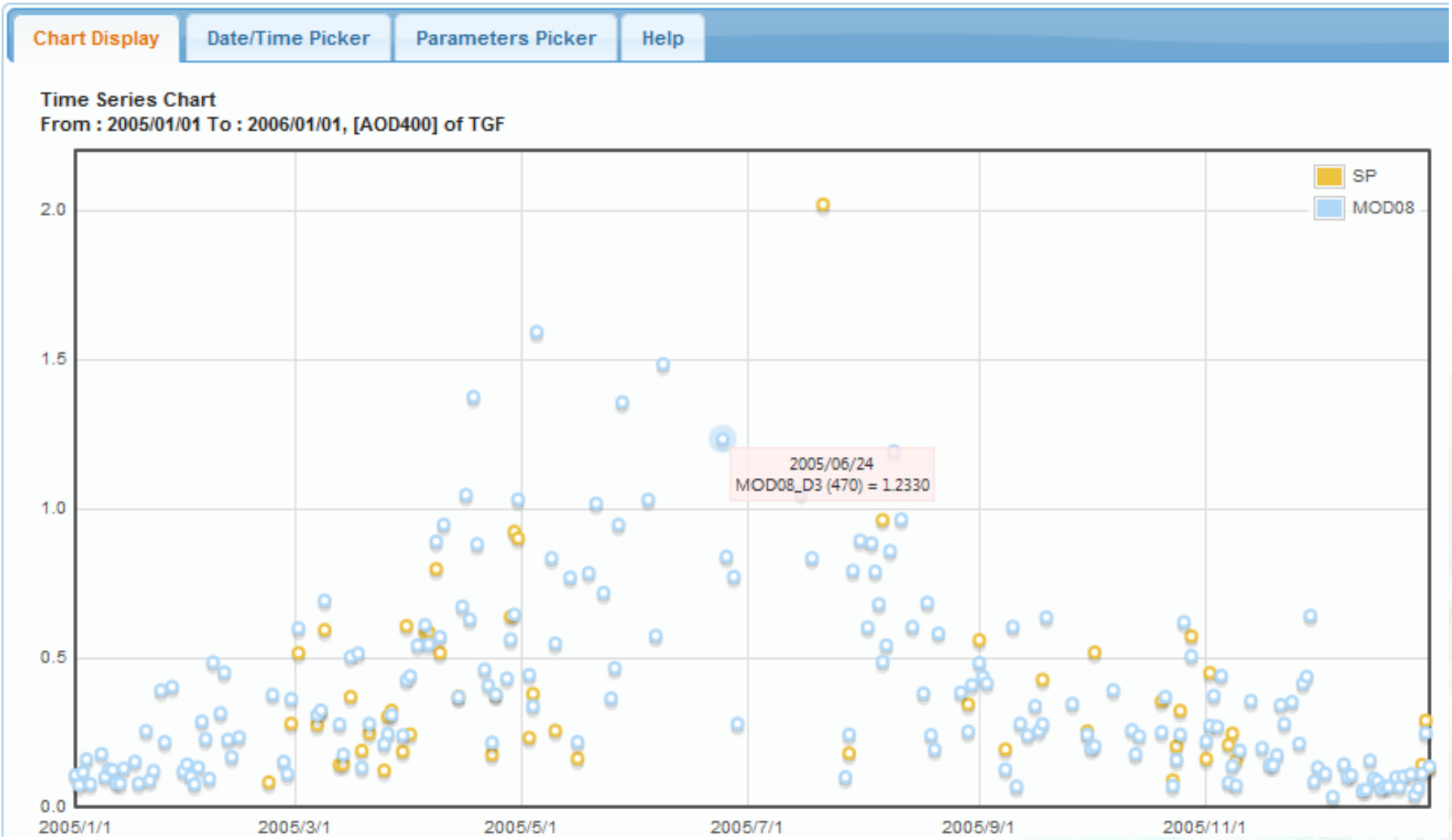
National Institute of Advanced Industrial Science and Technology
AIST

Prototype Application



National Institute of
Advanced Industrial Science
and Technology
AIST

Prototype Application



National Institute of
Advanced Industrial Science
and Technology
AIST

Chart Zooming

National Institute of Advanced Industrial Science and Technology
AIST

Conclusion

- Comprehensive web-based GIS system framework enabled
  - Based on various open standards of OGC specifications
  - Using FOSS
    - Mapserver, 52North SOS, PyWPS
    - OpenLayers, jQuery,
- Assimilation of sensor observation data and satellite image
  - Wider area, More accuracy, Reasonable cost
- Validation of aerosol properties from Satellite estimation with ground based sites
  - Improve the following product which relied on satellite image “surface reflectance”

National Institute of Advanced Industrial Science and Technology
AIST

Future Development

- Increase atmospheric observation network
  - Skynet
- Improving performance
  - Distributing ground site data source
    - More than two million records for two station and four years
  - WMS-T full supported with Mapserver
  - MOD03 overpass time to MOD08 Global dataset
    - Possible to error 5 minutes observation
- Satellite image product validation
  - GLEON (Global *Lake* Ecological Observatory Network)
    - Lake monitoring : SST, Chl. A : MODIS Ocean product
  - CO Flux monitoring : Asiaflux / Japanflux
- Water Column Correction
  - CREON (Coral Reef Environmental Observatory Network)
- Validation with higher satellite image resolution
  - ASTER, FORMOSAT-2

National Institute of
Advanced Industrial Science
and Technology
AIST