

IT Agriculture for Climate Change Adaptation and Precision Farming

HONDA Kiyoshi

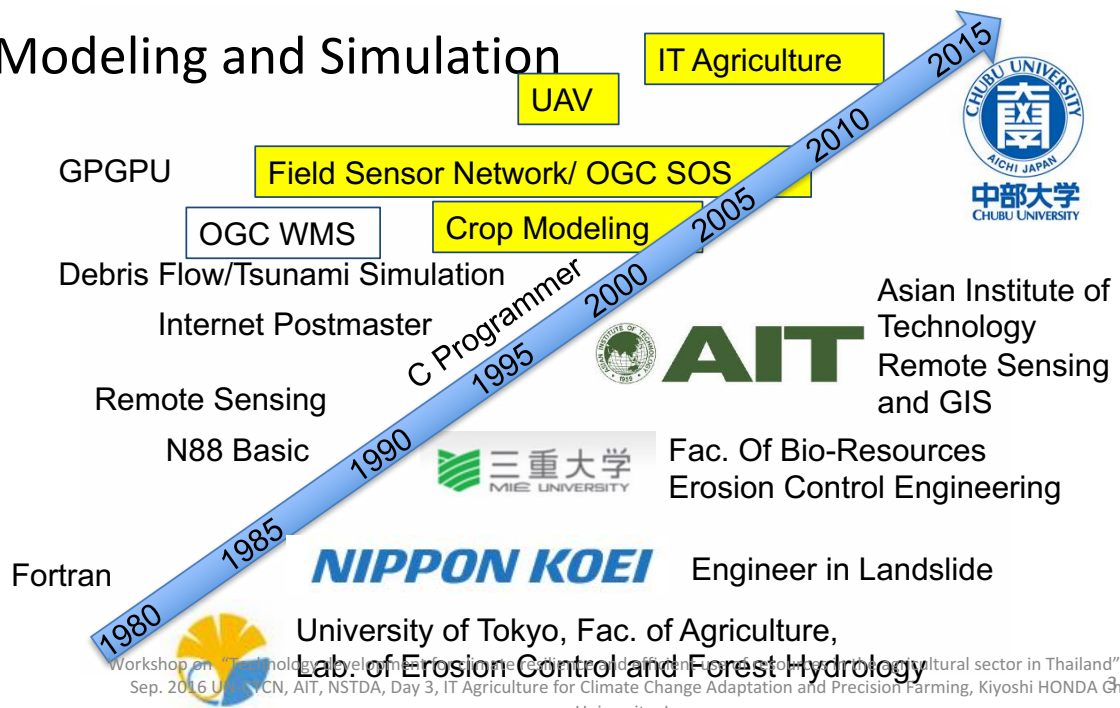
Int'l Digital Earth Applied Science Research Center(IDEAS)
 Chubu Institute for Advanced Studies
 Chubu University

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Bio Data

- Geo-Spatial Information Science

- Modeling and Simulation



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IT Agriculture for Climate Change Adaptation and Precision Farming

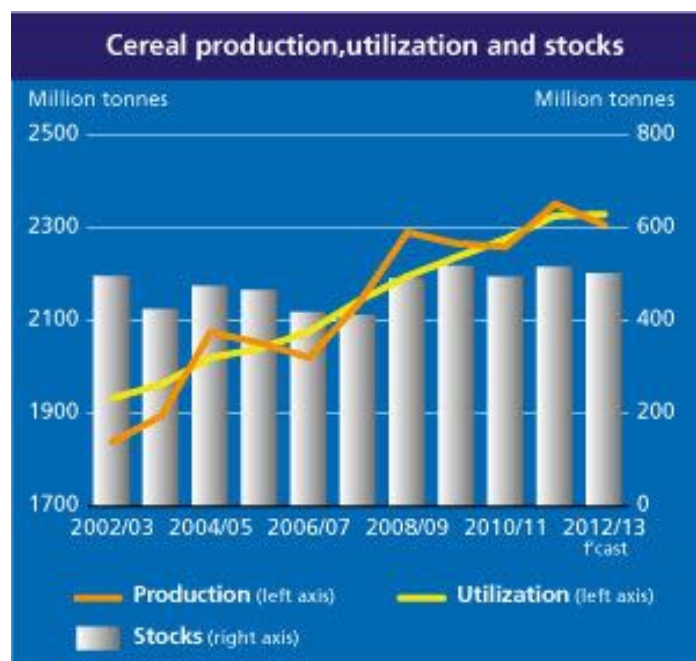
- Part 1 Modeling and Simulation
 - Why Modeling and Simulation ?
 - Crop Models and Calibration
 - Uncertainty and Weather Generator
 - A Framework of DSS System for Adaptation and PF
- Part 2 Data Driven Agriculture
 - Interoperability, Standard, and Web Services
 - Field Sensor Network
 - Sensing Technologies – new satellite/UAV
 - Applications on Interoperable Sensor Networks
 - Movement in Japan and the World

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Need of Precision Farming for Higher Productivity

- Growing population
- Increasing Demand
- Bio-Energy
- Living Standard

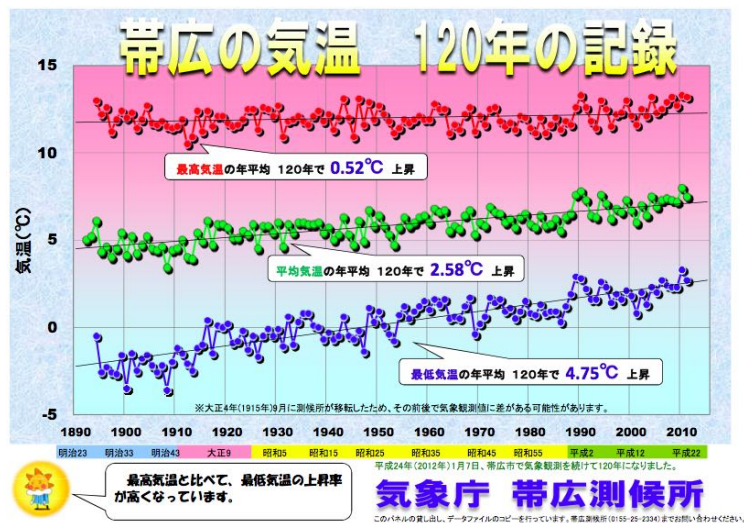
- Limited Land Development and Irrigation Infra.
- Need to improve productivity
- Precision Farming



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Climate Change Variability

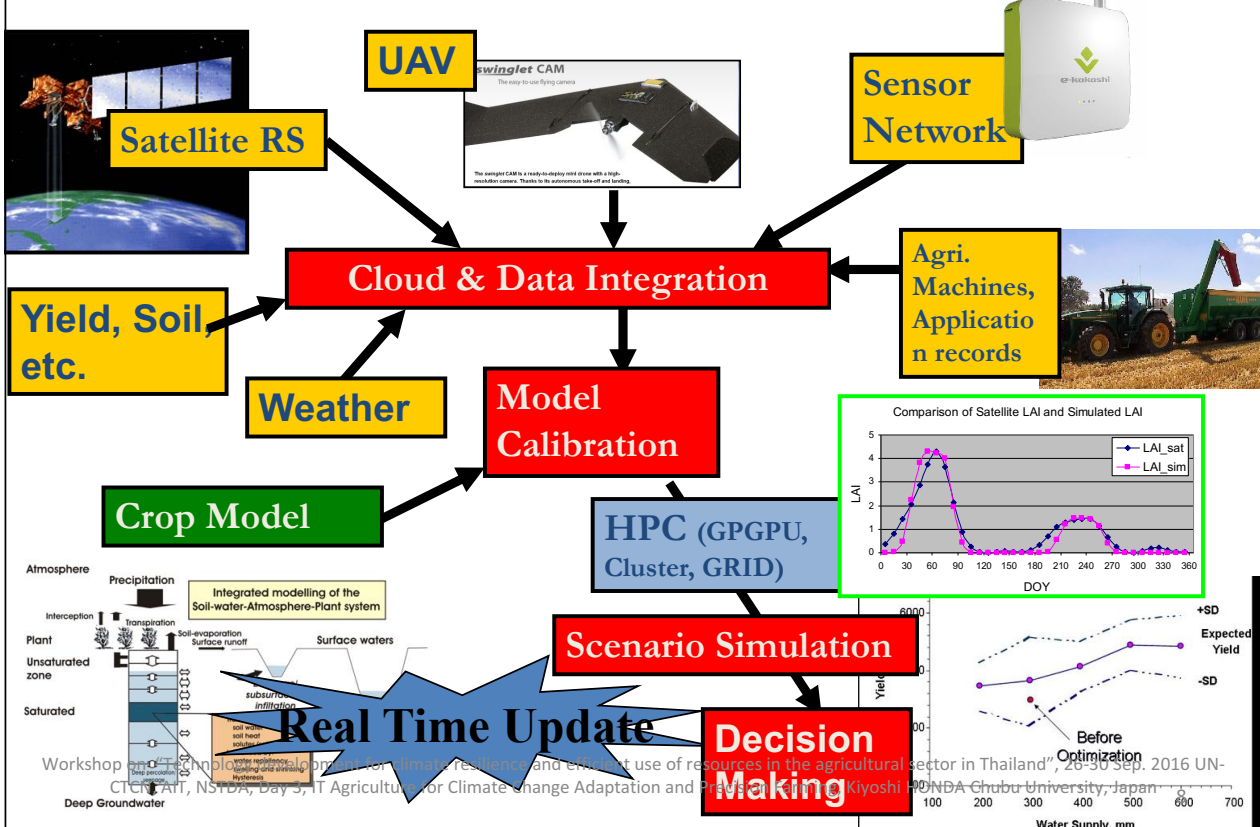
- Impacting crop growth
- Extreme Event
- Need of adaptation
- Scenario Simulation
- Risk Assessment



Scenario Evaluation

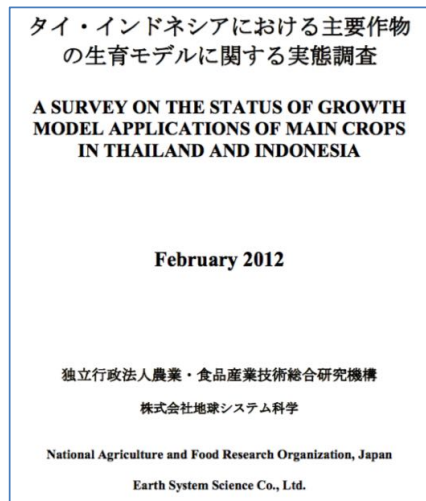
- What if
 - Climate change
 - Yield changes ? Suitability changes ?
 - New crops ? New variety ?
 - Precision Farming -> Fertigation, Planting dates ?
 - When ? How much ?
- Uncertainty
 - Weather, Model Parameters
- Prepare scenarios, and simulate for optimization

Agriculture Information Service on Modeling and Scenario Simulation

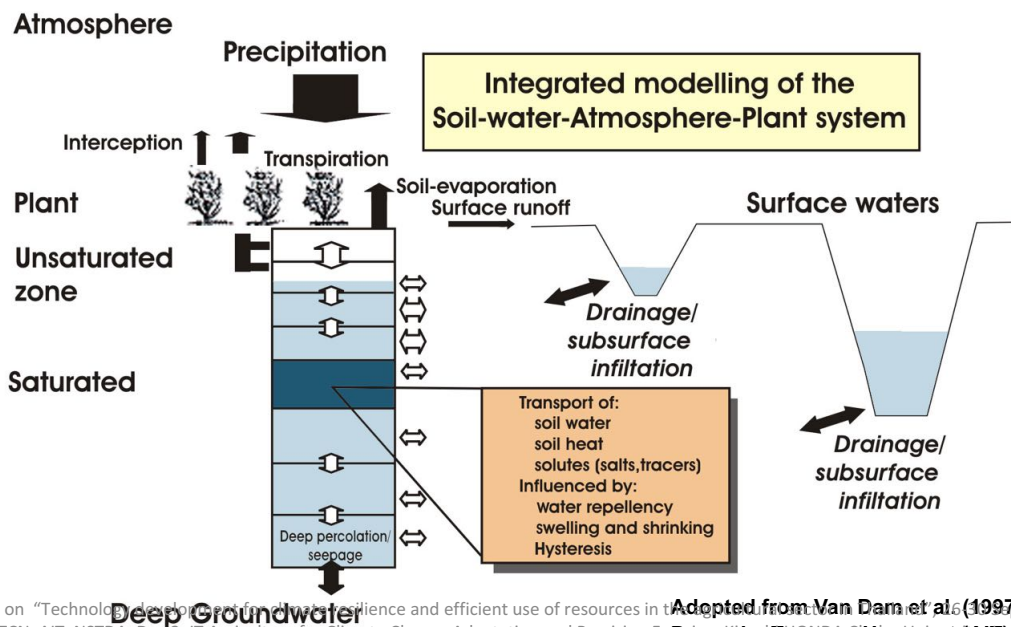


Various Crop Models (Physical Simulation Based)

- Rice
 - DSSAT-CERES-Rice
 - ORYZA
 - SIMREW
 - SWAP-WOFOST
 - CROPWATCH
 - H08
 - CATCHCROP
- Cassava, Sugarcane, Rubber



Structure of Bio-Physical Crop Model example Soil-Water-Atmosphere-Plant Model (SWAP)

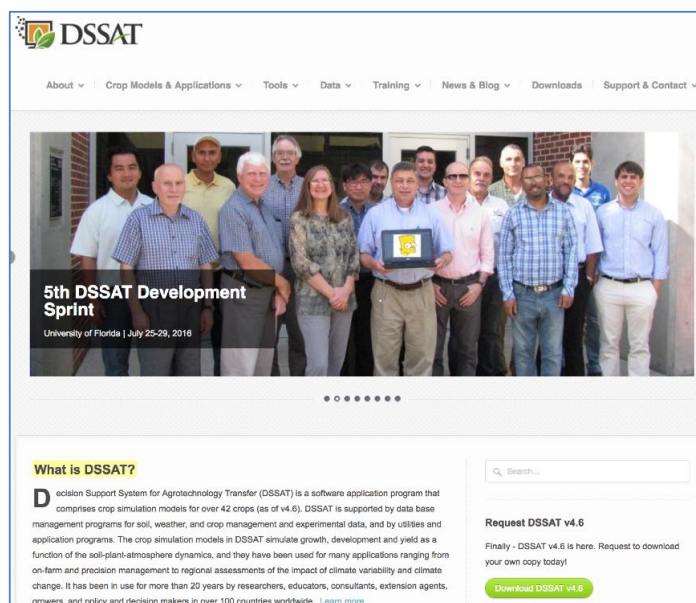


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Adopted from Van Dam et al. (1997)
Drawn by Teerayut Horanont (AIT)

DSSAT

Decision Support System for Agrotechnology Transfer

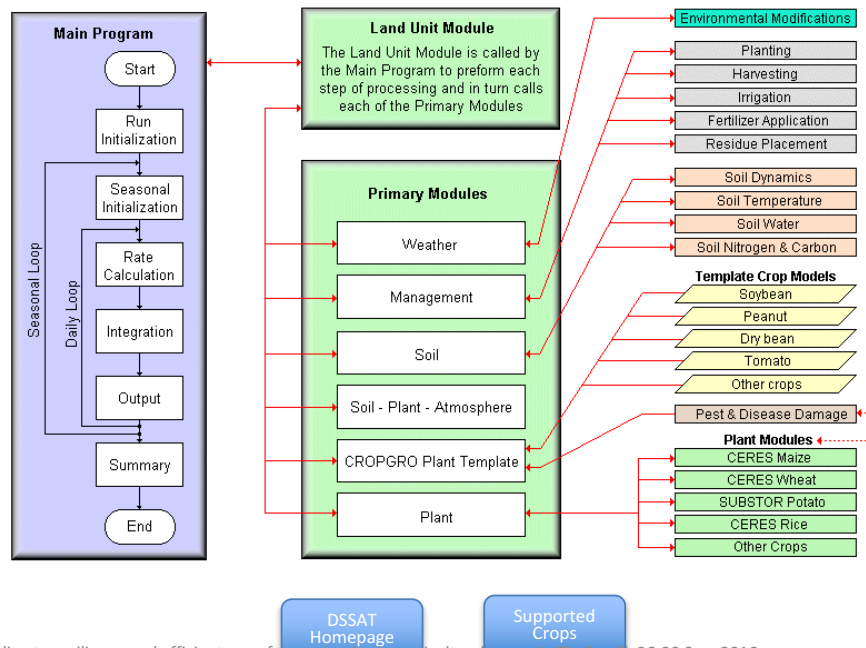
- Developed by an int'l community of agronomists
- A platform supporting 42 crop models
- GUI as well as command based execution
- Trainings and development sprints
- Including model calibration



DSSAT – Crop Model

Decision Support System for Agrotechnology Transfer

- Simulating water environment
- Practical Functionality
- Popular
- Strong support
- Various plant modules
- Going to be Open source
- Nitrogen



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12

DSSAT CERES-RICE

- CERES – Cereal Crops
- CERES-Maize, Sweetcorn, Sorghum, Millet, Wheat and Rice
- Recently ORYZA was added

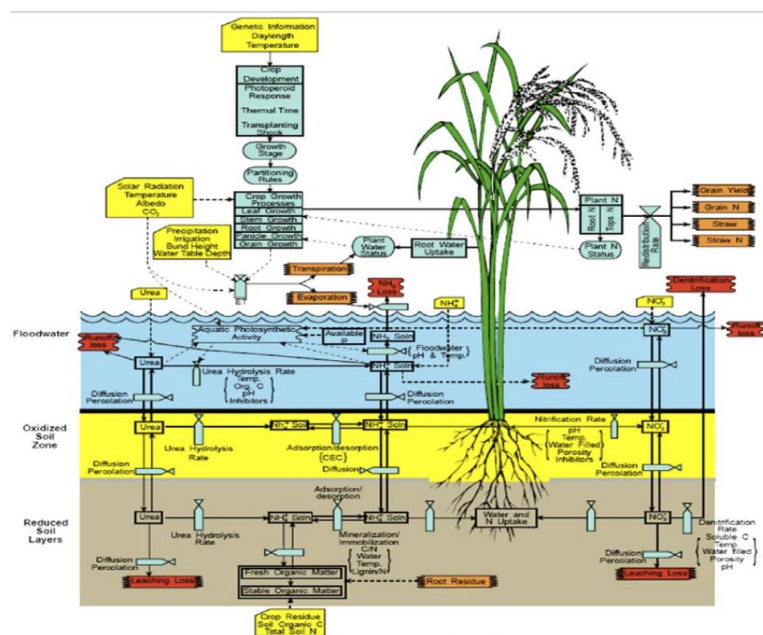
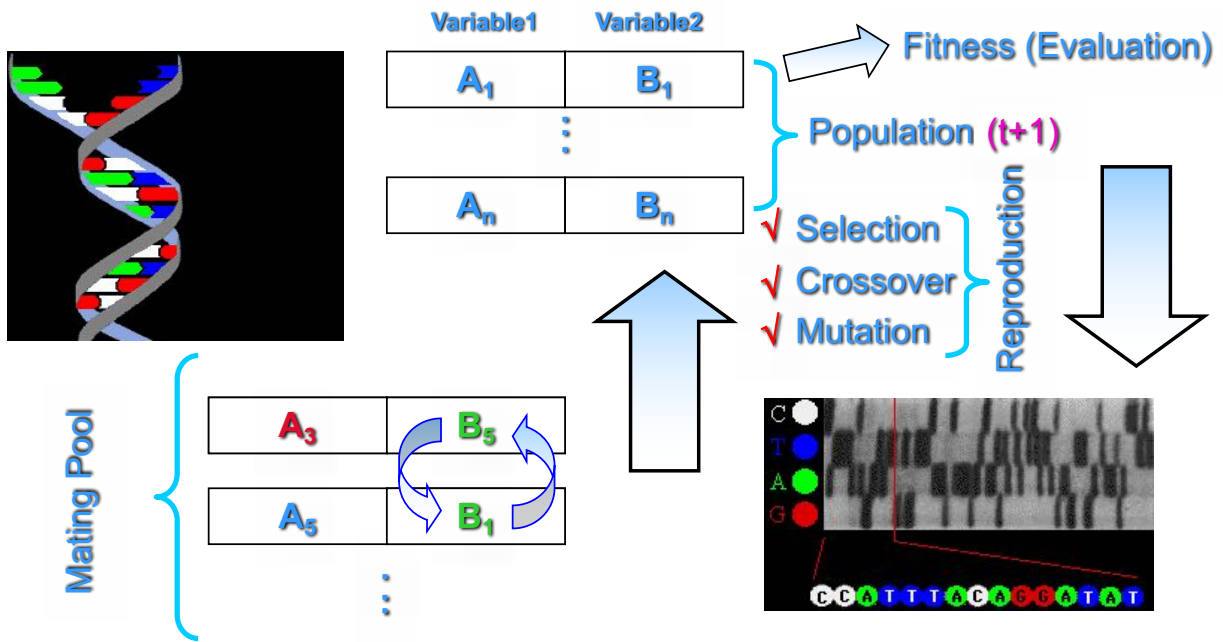


Figure 2.1 CERES Rice Model
Source: Kongthon (2009)

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Genetic Algorithm in a nutshell



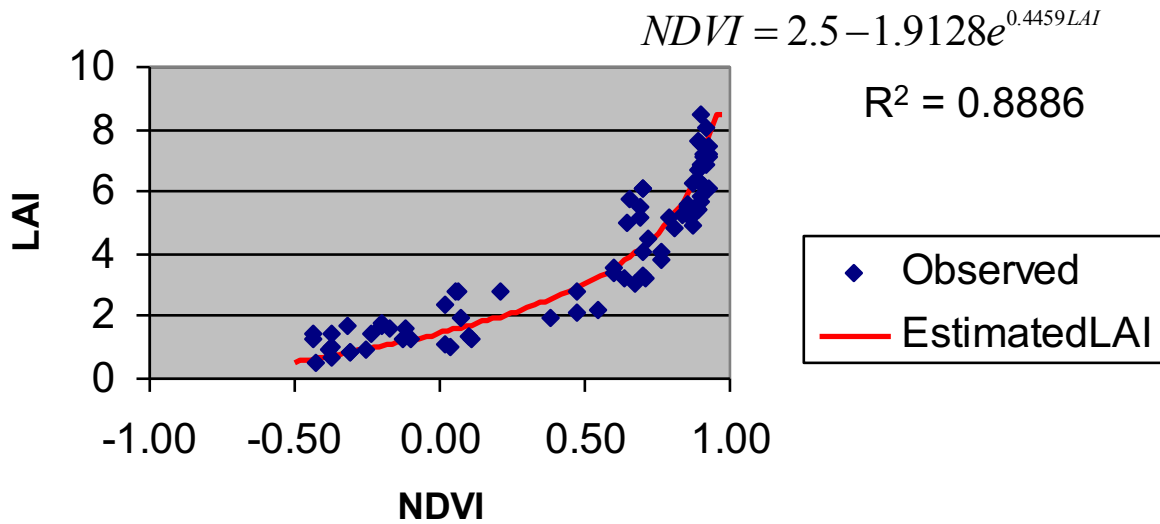
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- Longitude: 100.008133
- Latitude: 14.388195

LAI and NDVI Own Correlation

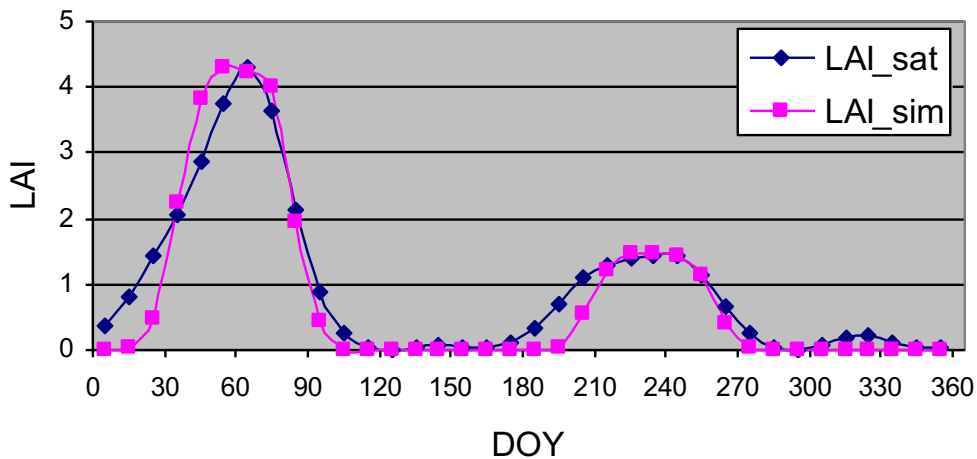
NDVI VS LAI From Field Measurement



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19

Comparison of Satellite LAI and Simulated LAI



- Estimated parameters
- DOYCrop1 = 19
- DOYCrop2 = 188
- Crop.Int.Crop2 = 0.32
- Fitness = 4.537
- Generation found = 31 (popsize=5)

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• Calculation time approximate 15 minutes

20

Objective Functions

Calibration is to minimize error (Simulated – Observed)
Objective Function (Mean Absolute Error, or Root Mean Square Error)

e.g.

$Z(\text{cultivar parms, soil parms, agri practices, weather})$
 $= a_1 * \text{Yield} + a_2 * \text{ADAT} + a_3 * \text{MDAT} + a_4 * \text{LAI} + \dots$
 $+ a_n * \text{abs}(\text{simulated} - \text{observed of a state variable})$

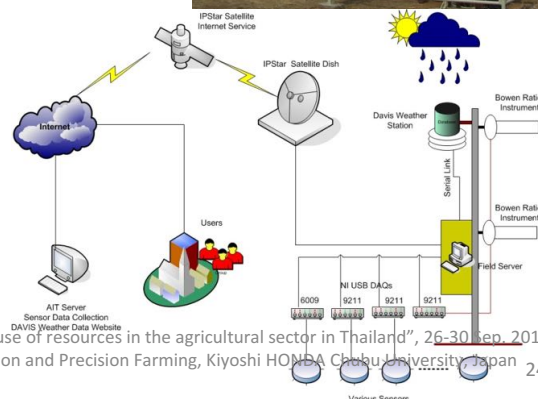
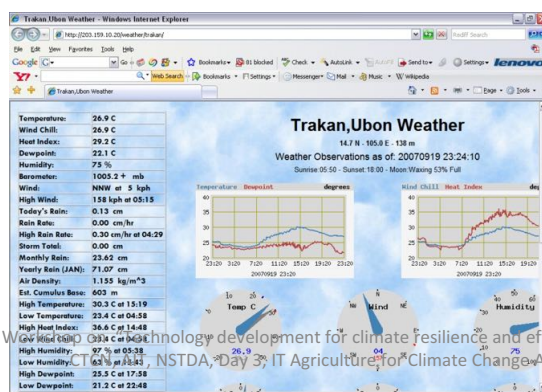
Fitness = $1/Z$

Observation, recording is important

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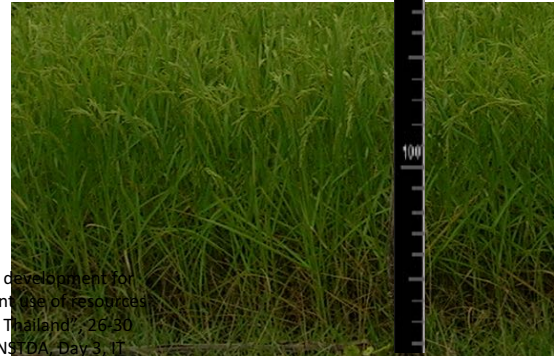
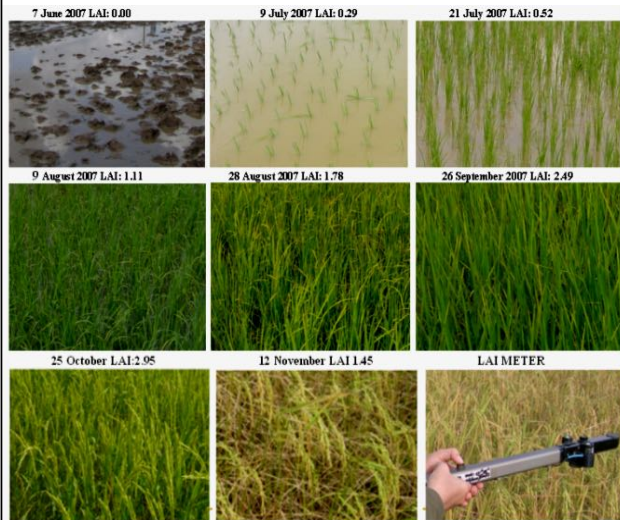
Draught Monitoring in Thailand

- Big damage to rice
- Impact assessment of dry spell
- Calibrating a rice model via data assimilation (RS and Field Sensor)
- Access to Data through SOS
- Funded by Thai Research Fund



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Crop Observation



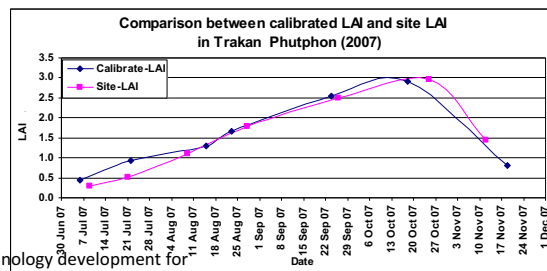
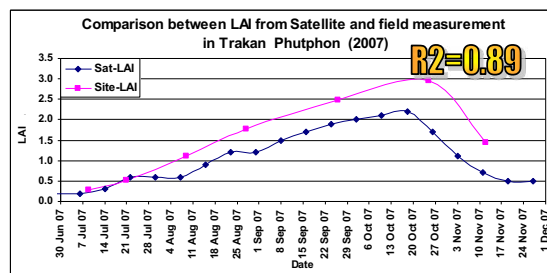
Trakan Phuphon	
Transplanting Date	2007-07-07
Harvesting Date	2007-11-17

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Sat-LAI

Leaf Area Index (LAI) derived from MODIS LAI product cannot be used directly because it underestimates the results.

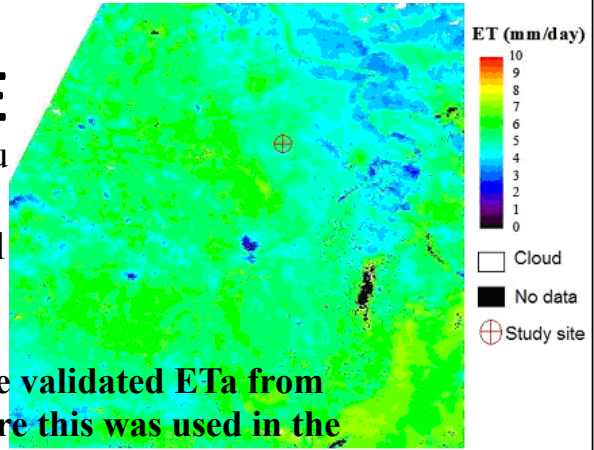
The satellite LAI was calibrated from ground measurements to reflect the field conditions before the used in the assimilation process.



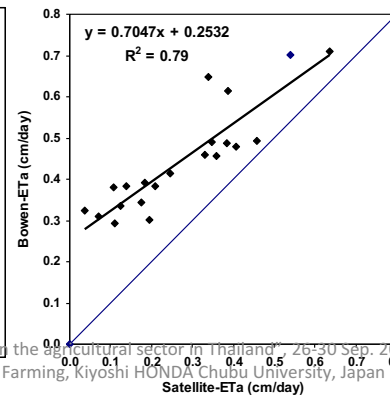
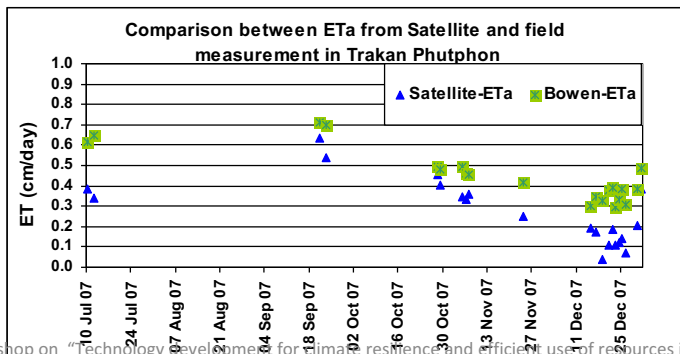
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Sat-E

SEBAL use to evaluate the instantaneous energy balance at each pixel by using remote sensing data and meteorological data to determine ETa.



The calculated ETa from SEBAL were validated ETa from Bowen-ETa observed in the field before this was used in the assimilation process.



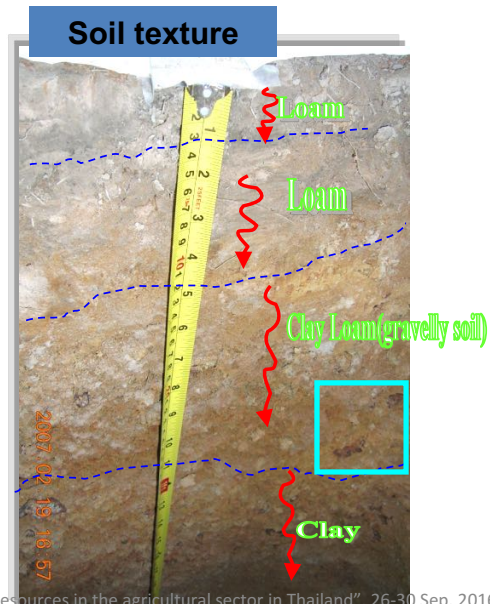
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Soil Moisture Observation

- Data can be retrieved through SOS
- Soil texture was analyzed by Kasetsart Laboratory

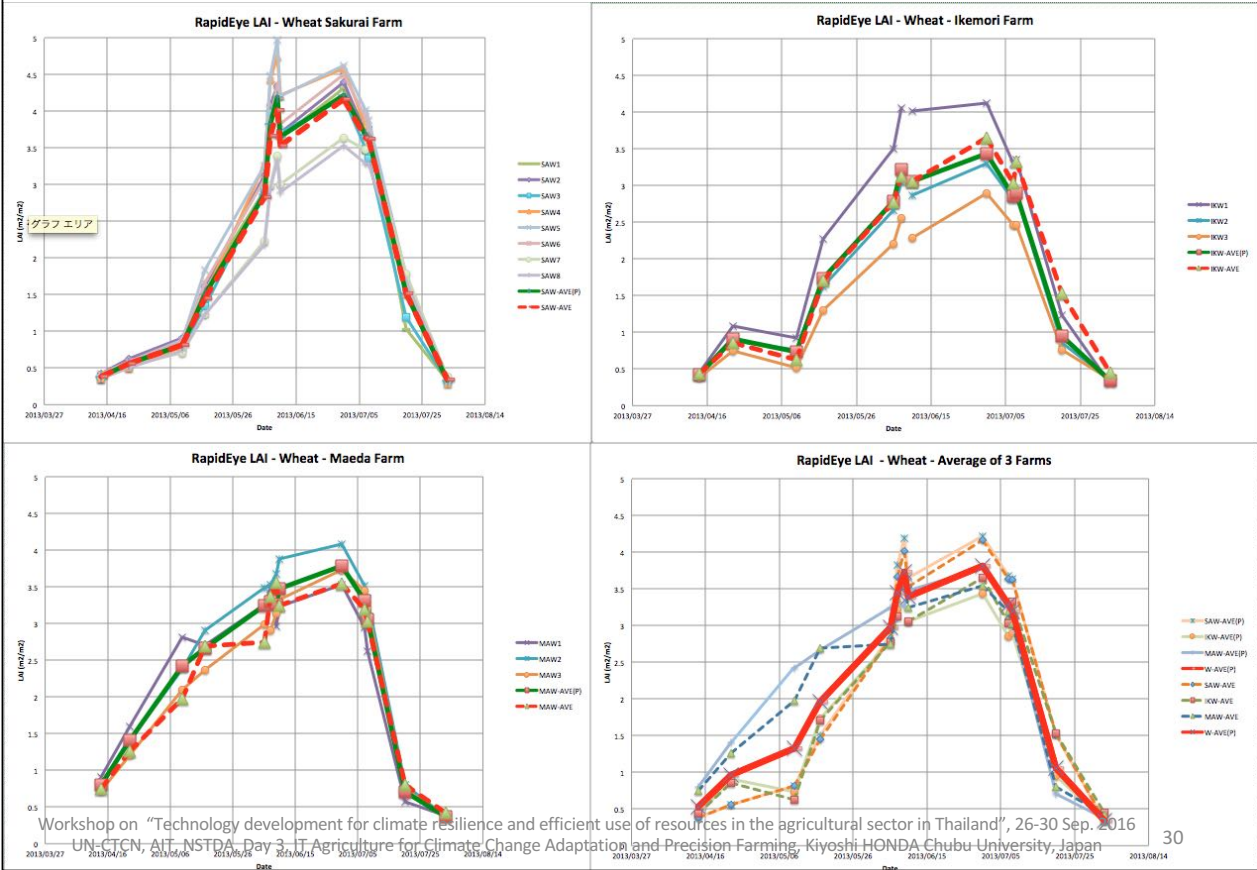


Soil moisture sensor



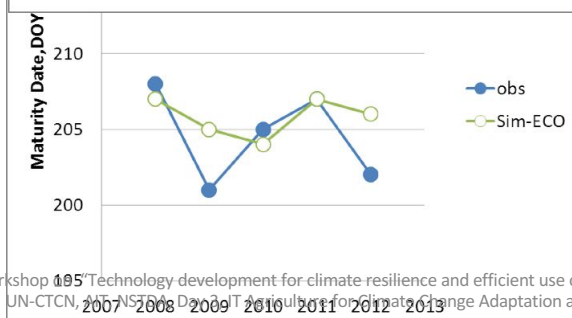
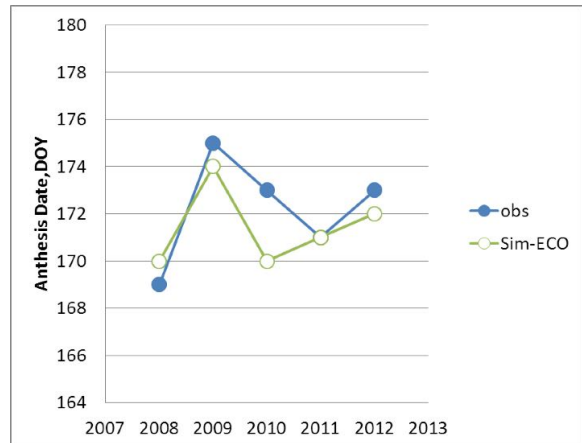
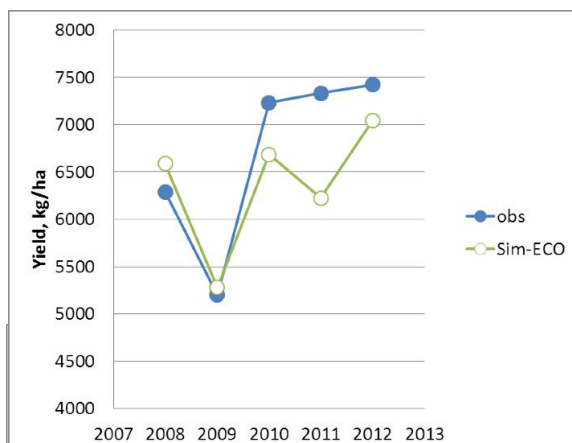
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RapidEye LAI - Wheat



30

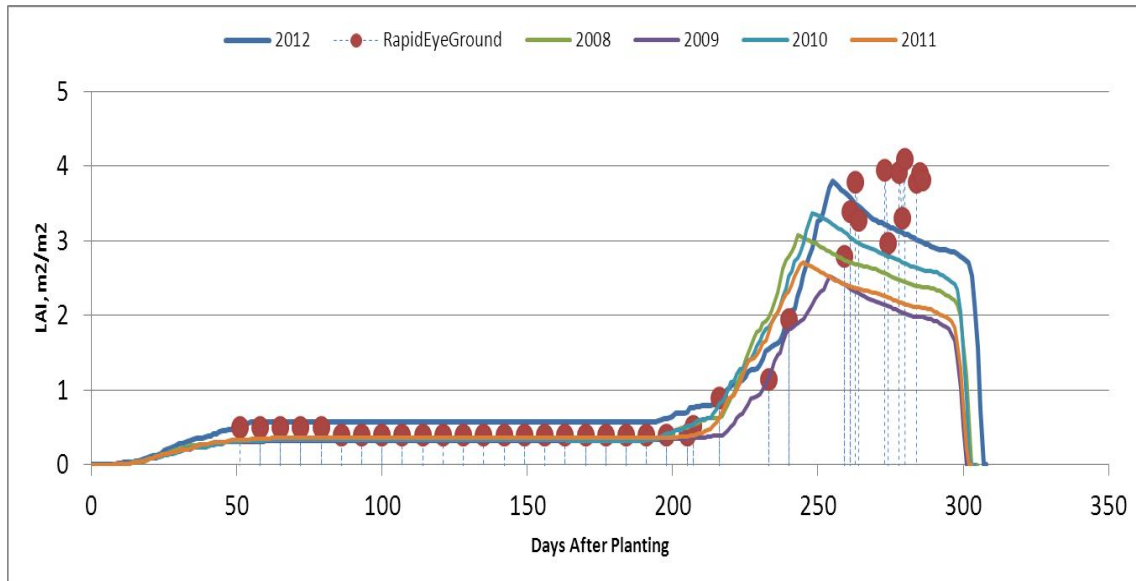
Example of Calibration for Wheat



	R	RMSE
Yield	0.824	593.264
Anthesis	0.760	1.549
Maturity	0.540	2.607

32

Example of Calibration for Wheat



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Uncertainty

- Simulating for one cropping season.
 - Can Predict the yield ?
- Weather ?
 - Use normal ?
 - Probability to have exact normal weather ?
 - Climate Change Impact, use GCM output ? 100km average weather variables ?
- Model and its parameters ?
 - Can simulate 100% exact ?
 - Are the model parameters exact ?

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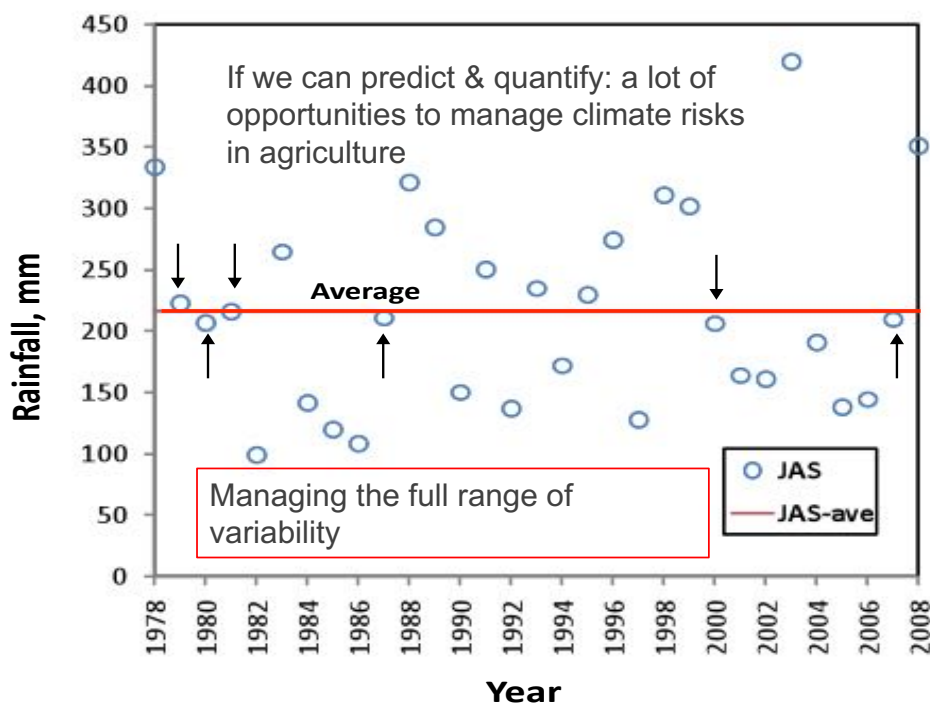
Disaggregation and Stochastic Weather Generator

- GCM output is averaged weather variables in .e.g 250km x 250km.
 - Needs to assume variabilities in the grid
 - Generate finer scale variabilities – Disaggregation
- Skill of models is not good enough for long term prediction
 - If no skill – Assume statistical distribution, If some skill – adjust the distribution,
 - Dice throwing to generate randoms that follow the dist. – Stochastic Weather Generator

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36

I. Climate Risk Management



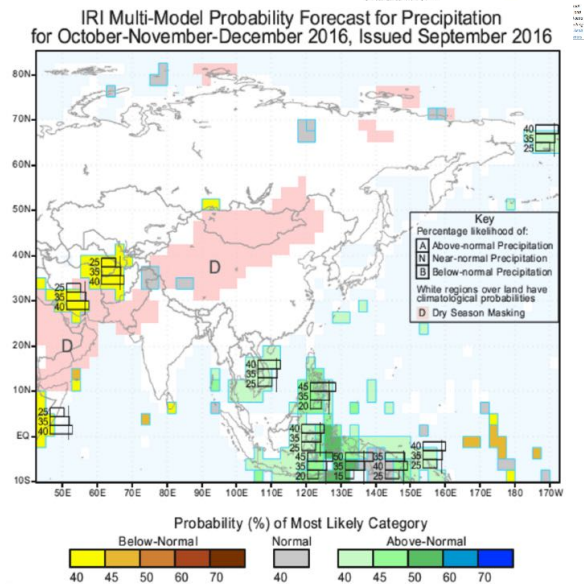
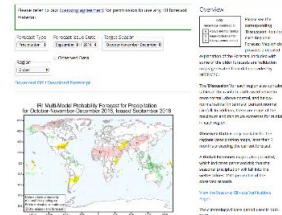
Courtesy: A novel approach for downscaling probabilistic seasonal climate forecasts: parametric or non-parametric. A.V.M Ines and E.Han

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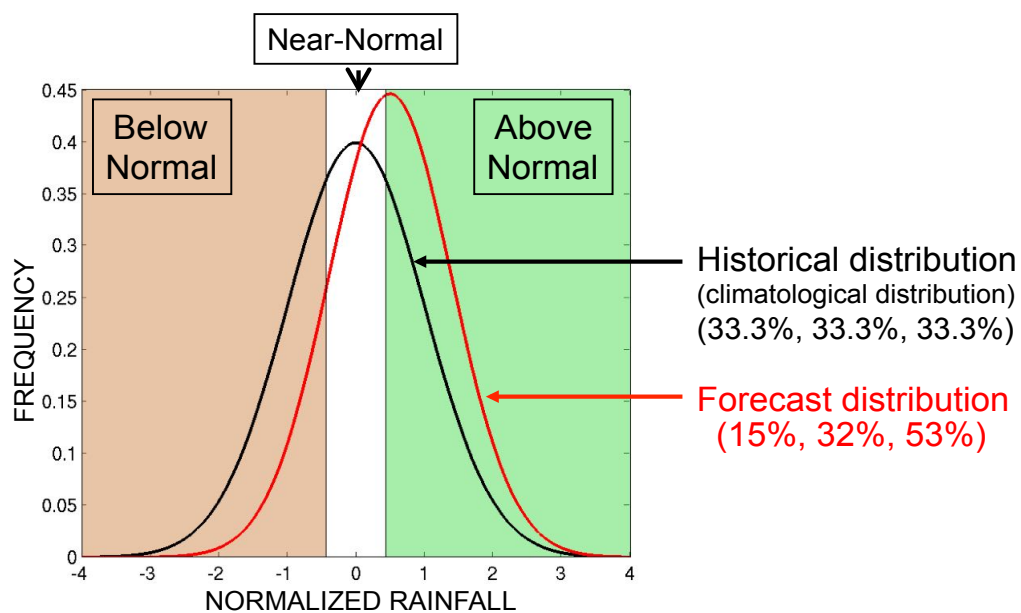
37

Seasonal Forecast

- Published by the probability of AN, NN, BN
- If no anomaly is expected, then 33:33:33
- This AN, NN, BN is used to adjust the probability density function(pdf)



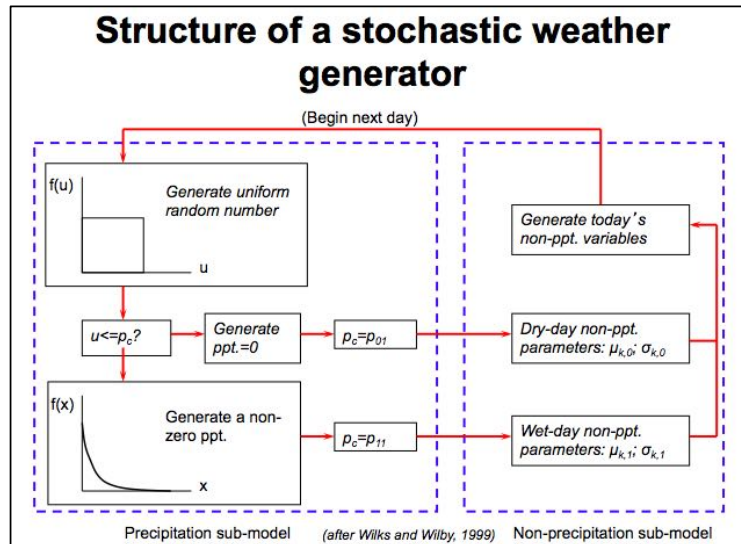
Seasonal Climate Forecast



The concept of probabilistic seasonal climate forecast (Courtesy of: Michael Tippett, Columbia University, NY)

Weather Generation for Simulation

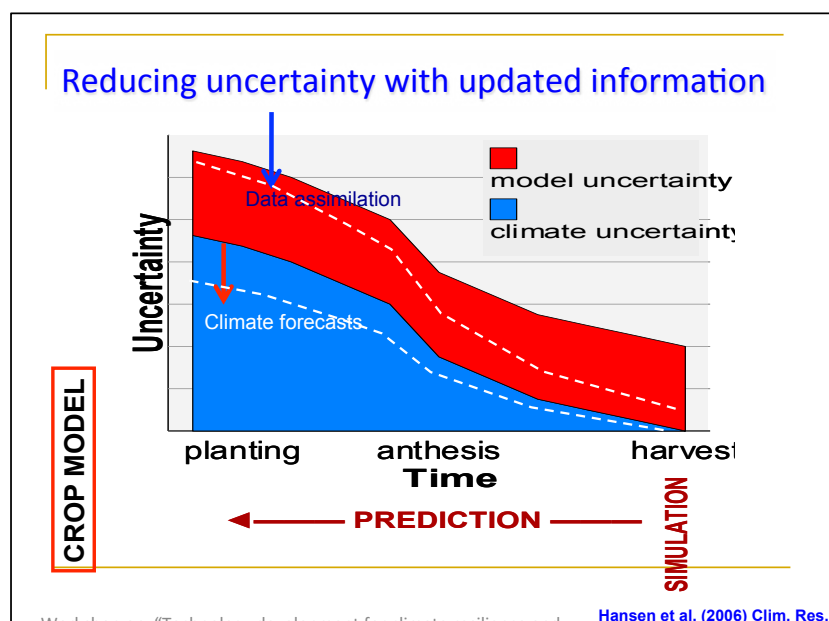
- 100 weather realization based on statistics of historical daily data
- Future weather generation
 - ΔT and ΔP (trend) (precipitation) is added to current climatology parameter
 - 100 Realization
- 100 times of DSSAT simulation X 5 planting date scenarios 5 planting date: -2, -1, 0, +1, +2 week of user defined date



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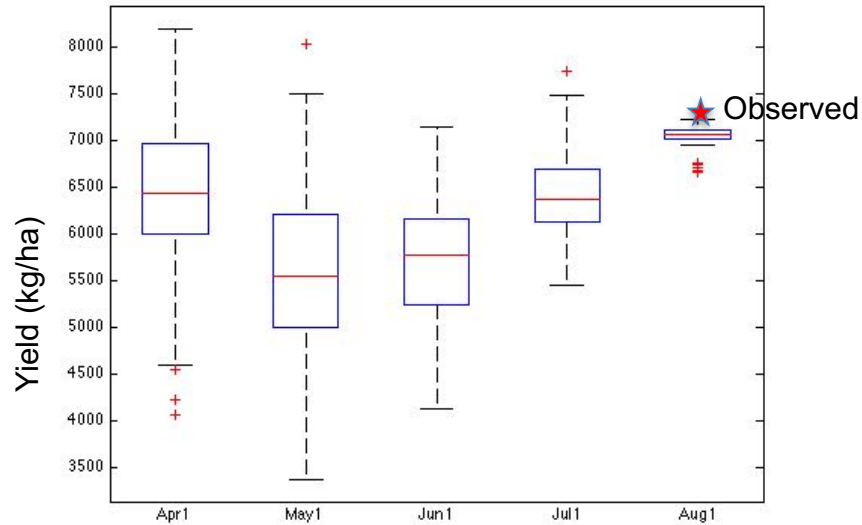
不確実性とどのようにつきあうか How to Reduce Uncertainty in Prediction

- Big Uncertainty in Weather
 - 100 of Weather Scenarios
 - Yield as a Distribution
 - Field Sensor Network
 - Climate Forecasts
- Uncertainty in Model
 - Real-time Data Assimilation



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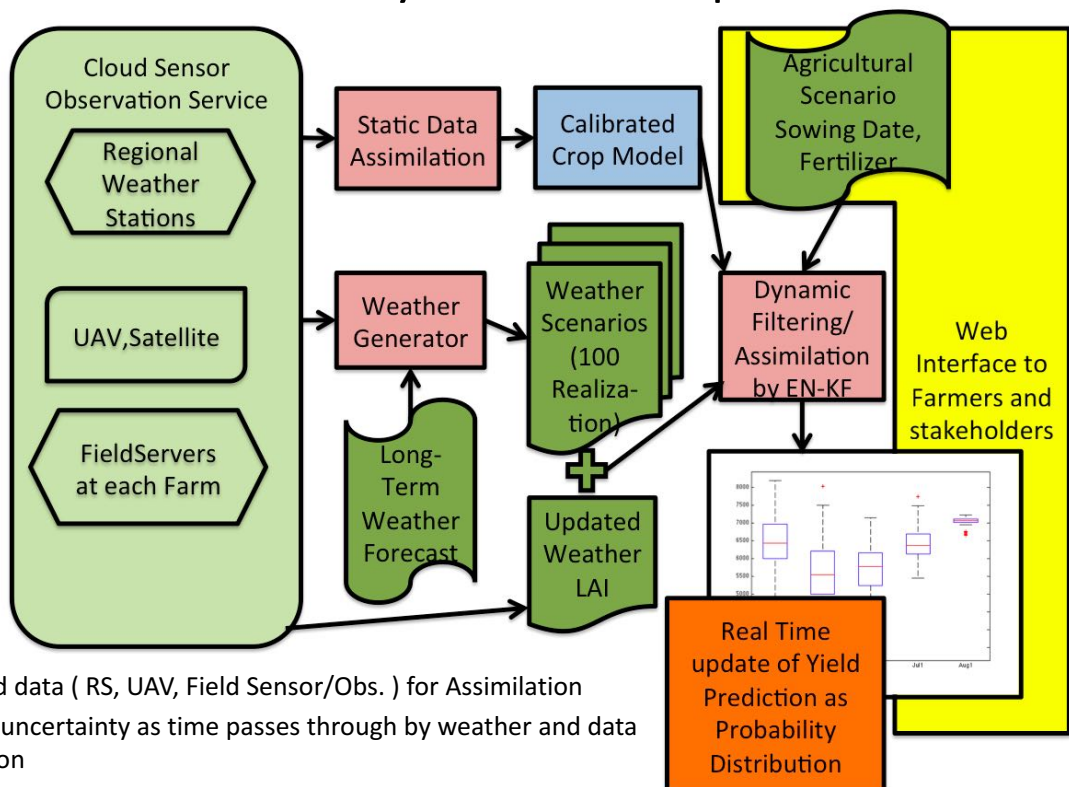
Cropping Simulation System in Prediction Mode Kitahonami, Monte Carlo GA



Prediction of wheat (Kitahonami) yield (Kg/ha) from Apr1, May1, Jun1, Jul1 and Aug1 using Monte Carlo GA derived crop parameters (Obj 5 – 0.4yield, 0.4adat, 0.2mdat). Actual yield (2011-2012) in Tokachi Agr. Experiment Station is 7,330 Kg/ha

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A Framework of DSS System for Adaptation and PF



- Integrated data (RS, UAV, Field Sensor/Obs.) for Assimilation
- Reducing uncertainty as time passes through by weather and data assimilation
- Up-to-date prediction as probability distribution and filtering
- Standard Web Services and Web Interface for information service

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Summary of Part1

- Modeling and Simulation
 - Climate Change Adaptation
 - Precision Farming
- Sensing, observed data is important for calibration
- Take into account of uncertainty in simulations
 - Generating scenarios
 - Updating scenarios
- A Framework of DSS System for Adaptation and Precision Farming

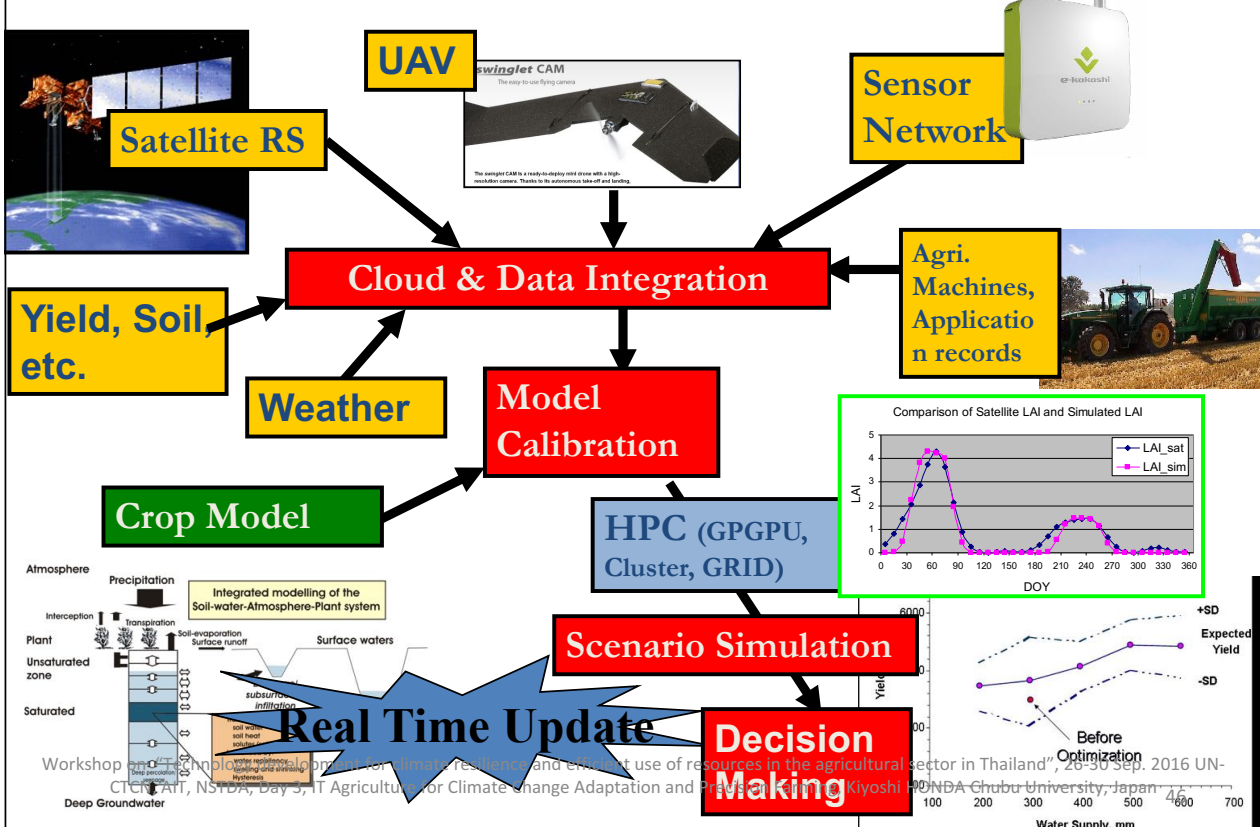
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- **Part 2 Data Driven Agriculture**
 - Interoperability, Standard, and Web Services
 - Field Sensor Network
 - Sensing Technologies – new satellite/UAV
 - Applications on Interoperable Sensor Networks

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Agriculture Information Service on Modeling and Scenario Simulation



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Field Sensor Network High-Density Environmental Data

- Small and Low-Cost Sensors
- New Field Platforms
- Mobile Internet (3G, Lora and LoraWAN, Sigfox...)
- Real-time field information from anywhere
- Environment, Disaster, Agriculture, Logistics, etc.
- Monitoring Panel, Early Warning, Simulation
- Metadata, communication over various internet, visualization, standard API, Security, User Management....



Low Cost Sensor
CO2 Sense Air



Field Platform
Field Server, e-kakashi

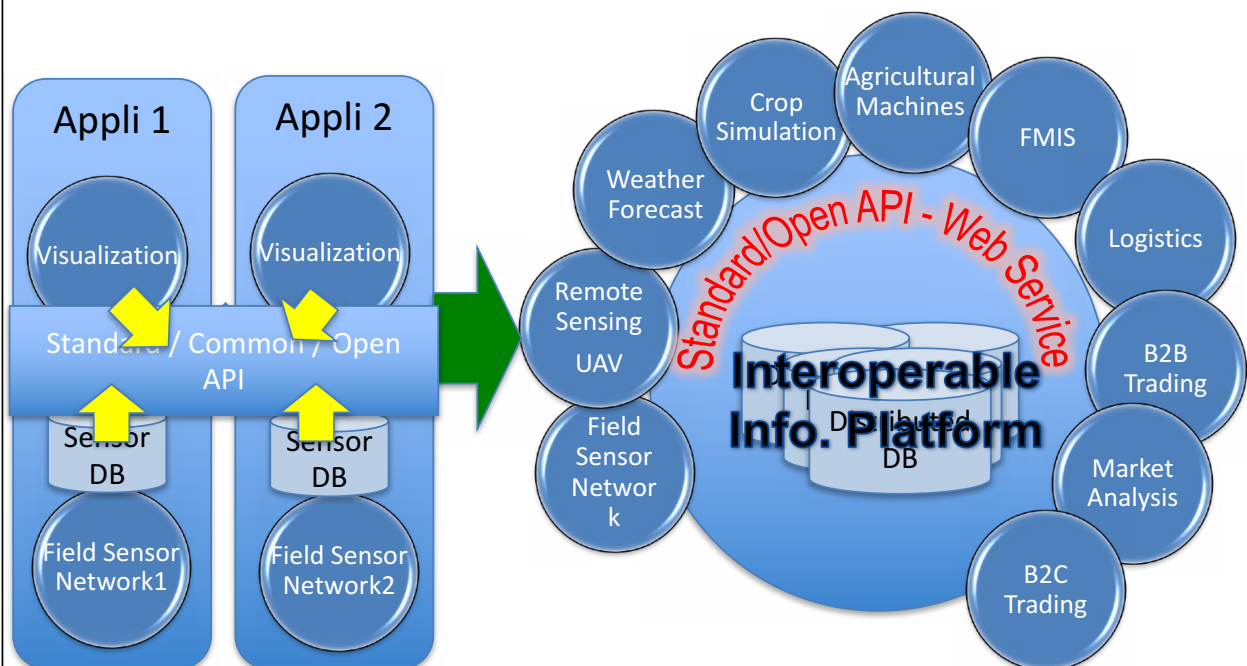
Mobile Internet



Ubiquitous Field
Sensor Network

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Isolated System to Interoperable Integrated System



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Standard Web API for Geospatial Data

- OGC's standard Web Service
 - WMS (Web Map Service), WCS (Web Coverage Service)
 - WFS (Web Feature Service), WPS (Web Processing Service)
 - SOS (Sensor Observation Service)
- Providing sensor metadata and data
 - Applications can find sensors, metadata, and data
 - 3 major queries
 - GetCapabilities -> platforms, observed properties...
 - DescribeSensor -> SensorML
 - GetObservation -> O&M doc



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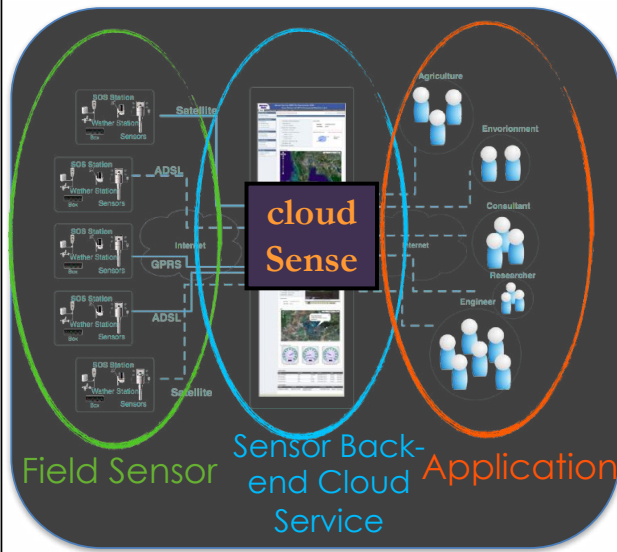
Web Service (Web API)

- Send a request to a server, usually http
 - A request is embedded in URL (HTTP GET)
 - <http://de11.digitalasia.chubu.ac.jp/soil/searchSoil.php?lat=35.279&lon=137.021&format=dssat&db=wisol&dist=100>
 - Sending a request as a file content (HTTP POST)
- Current modern systems are constructed on Web Services
- Standardized request and response
 - Enhance interoperability
 - Client can send requests to any servers if they are compliant of the standard (e.g. html)
- Vertical all in one development to layered, platform style development

Web Services and Applications

Cloud Based Sensor Back-end Service

Data Collection with Sensor Plug&Play, Metadata Management, Publishing
Rapid Application Development

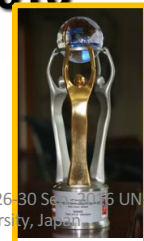


Spinach Promotion from Thailand to Japan.

The project is organized by **Application on the cloud Service**
University of Tokyo, University COOP in Japan and Fujitsu Design Co., Ltd., AIT,

Asia Pacific ICT Alliance Award 2010

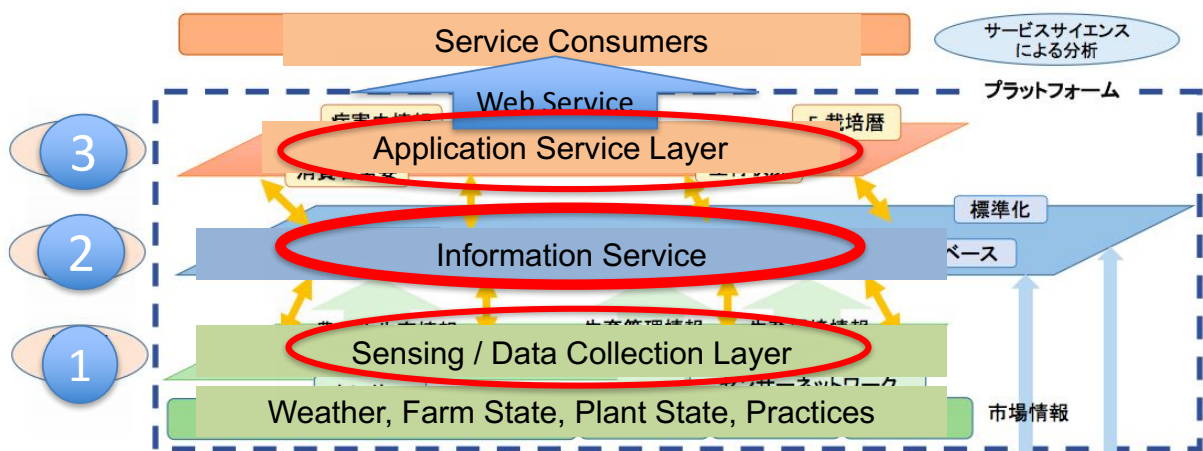
Winner
Tools and Infrastructure Applications Category



OGC's Standard Web Service: Sensor Observation Service(SOS) enables Rapid, Low Cost and Flexible Application Development

Workshop on "Technology development for climate Resilience and efficient use of resources in the agricultural sector in Thailand", 26-30 Sep. 2016 UN-CTCN, AIT, NSTDA, Day 3, IT Agriculture for Climate Change Adaptation and Precision Farming, Kiyoshi HONDA, Chubu University, Japan

Interoperable Information Platform Structure InterAct Project



Interdisciplinary Agricultural Information and Communication Technology,
Ministry of Agriculture, Japan

革新的技術創造促進事業(異分野融合共同研究)
「情報工学との連携による農林水産分野の情報インフラの構築」ICT活用農業事業化・普及プロジェクトより

<http://www.naro.affrc.go.jp/brain/ibunyakyodo/news/2014/053158.html>

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8 types of platforms, with multiple sub systems and sensors. data Interfaces

- 8 Platforms/operators, different data access
- 80 observed properties published in different names
- No metadata web service – location, UOM
- Huge work required to connect applications to sensor data.

Sumitomo Precision Industry Co., Ltd. | Vaisala WXT Weather Station | ARPL | NIAES | MeteoCrop DB | elab.experiencec Inc. | Pyranometer (PV module) | NTT-Docomo | Weather Station | MeteoCrop DB | NIAES | AMeDAS

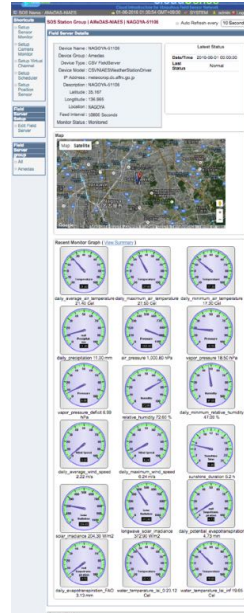
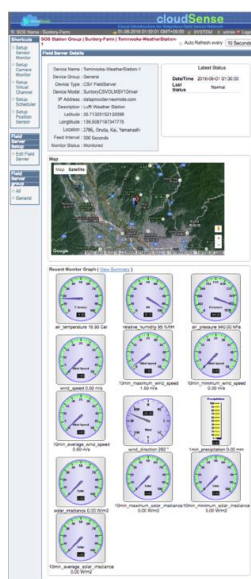
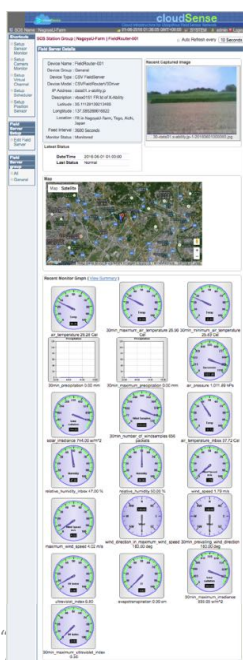
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Showing data from different platforms in a same format, provides SOS API

FieldRouter

LUFFT

MeteoCropDB(AMeDAS-NIAES)



MeteoCropDB AMeDAS-NIAES

- Same access method with local sensor platforms

Workshop on "Technology development for climate re
UN-CTCN, AIT, NSTDA, Day 3, IT Agriculture for Cl

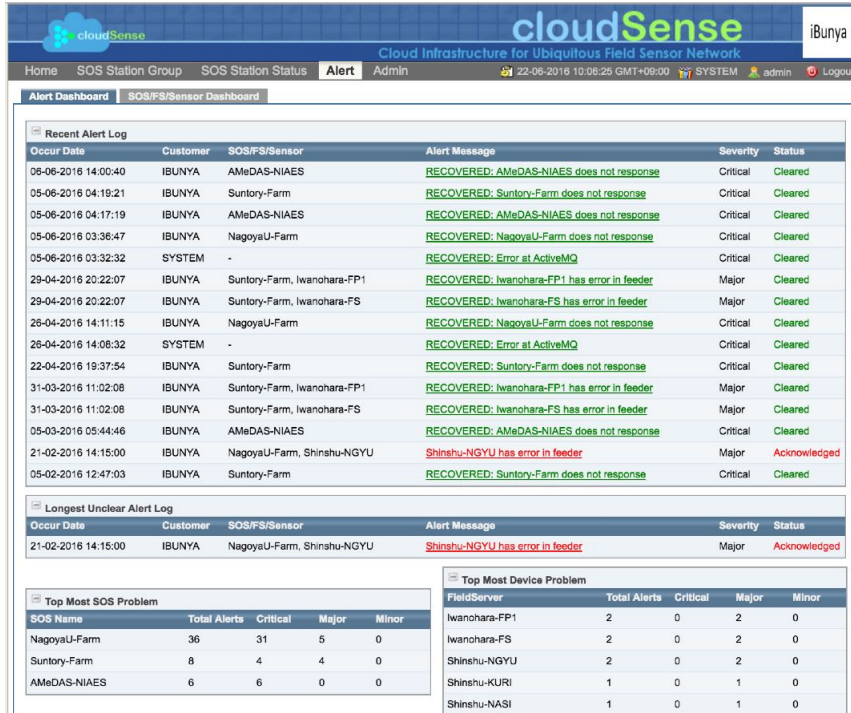
Name	Type	Model	Last Sync Data
NAGAOYA-51108	CSV FieldServer	CSVNIAESWeatherStationDriver	2016-06-20 00:00:00 (2 days ago)
TOYOTA-51116	CSV FieldServer	CSVNIAESWeatherStationDriver	2016-06-20 00:00:00 (2 days ago)
OKAZAKI-51228	CSV FieldServer	CSVNIAESWeatherStationDriver	2016-06-20 00:00:00 (2 days ago)
GAMAGOOORI-51281	CSV FieldServer	CSVNIAESWeatherStationDriver	2016-06-20 00:00:00 (2 days ago)
MINAMICHIITA-51311	CSV FieldServer	CSVNIAESWeatherStationDriver	2016-06-20 00:00:00 (2 days ago)
TAJIMI-52806	CSV FieldServer	CSVNIAESWeatherStationDriver	2016-06-20 00:00:00 (2 days ago)
OZUMI-49036	CSV FieldServer	CSVNIAESWeatherStationDriver	2016-06-20 00:00:00 (2 days ago)

Various Management

- User management
- User role setting
- Token generation
- Platform models
- Sensor models
- UOM database
- Alert Setting
- ...

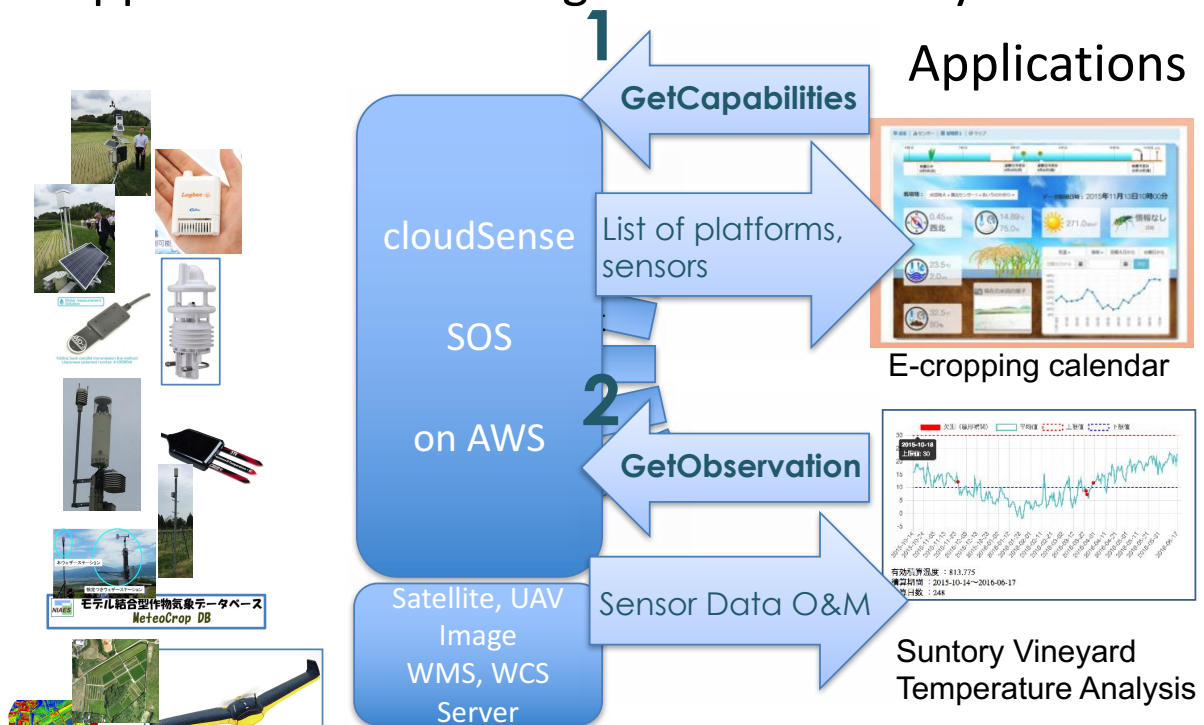
Workshop on "Technology developm
UN-CTCN, AIT, NSTDA, Day 3, IT

Sensor operation monitoring



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Single standard web service connecting applications to heterogeneous sensor systems

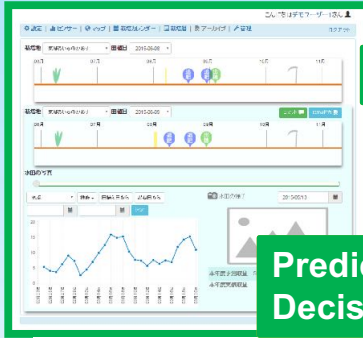


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Concepts of Dynamic “e-Crop Calendar”

Courtesy:
AFITA 2016,
Emi Kameoka

Archive of accumulated data ↔ Communicate with other users!



Knowledge and Experience

Field monitoring
by sensors

Field monitoring

Prediction
Decision

e-Crop
calendar



Best schedules based
on crop phenology
models

Cultivation
record

Standardized records with ontology



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Field Touch Overview

IHI
Realize your dreams

An information platform to provide useful information
on crop cultivation to farmers and other stakeholders

Real Time and
spatial information
for decision making



- Higher Yield
- Better Quality
- Land Management
- Cost reduction
- Risk Management
- Inherit/Sharing Farming Skill

Farm log / SNS

Scenario
Simulation

Precision
Farming

Application

Crop, Land, Weather Monitoring

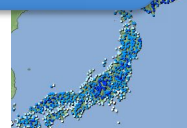
OGC API

Providing Unified Access to Geo-Spatial Data

Satellite / Aircraft /
UAV observation

Field Sensor
Network

Cloud based
Data source



Own or
External
sensing
devices

Fieldtouch UI

- Development led by IHI. Chubu U provides sensor cloud, simulation and UAV technology
- Support Precision Farming using Satellite RS, Sensor Network, Simulation Technologies
- Currently serving to 300 Farmers in Hokkaido/Japan
- Going to be world wide

High-Resolution Satellite RS updated every two weeks. Monitor spatial variability of growth in fields to adjust fertilizer. Airborne and UAV images will be integrated in 2013.

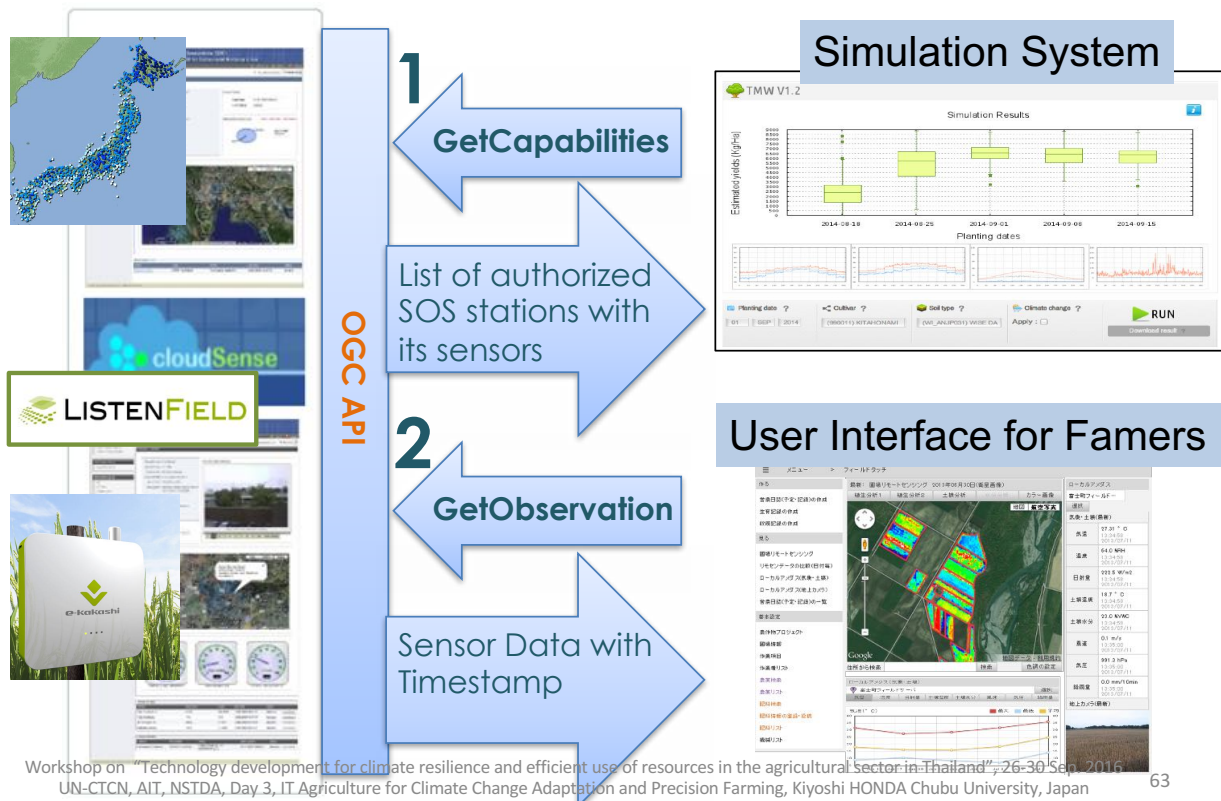
Agricultural treatment history

Real time weather, soil moisture, photos, Processed as a convenient form such as temp accumulation graphs. Heavy access from farmers every morning. cloudSense provides data via SOS, enabling quick adding/modification of sensor nodes

日射量	5.5 W/m2
18:58:14	2013/07/09
土壤温度	21.5 °C
18:58:14	2013/07/09
土壤水分	21.0 %VWC
18:58:14	2013/07/09
風速	0.4 m/s
18:58:16	2013/07/09
気圧	979.9 hPa
18:58:16	2013/07/09
降雨量	0.0 mm/10min
18:58:16	2013/07/09
地上カメラ(最新)	

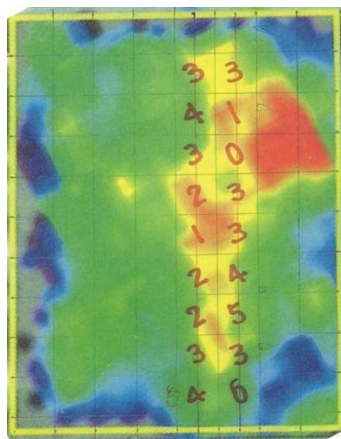
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Giving Interoperability to heterogeneous sensing data via OGC Standard Web Service



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Precision Farming higher and homogenous yield



Fertilizer Planning

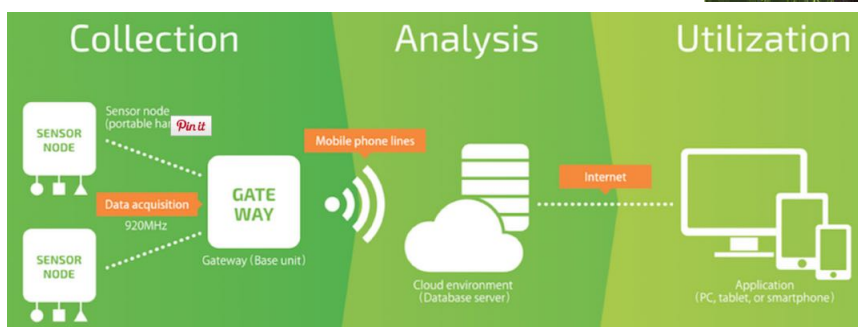
Tractor and Broadcaster
Communicates over ISOBUS



GPS Fertilizer
Broadcaster

e-kakashi

- Durable Field Sensor Network
- Analysis Application Layer
- Dynamically suggest options based on sensed environment



Courtesy:
PS-Solutions

Next of the Sensing

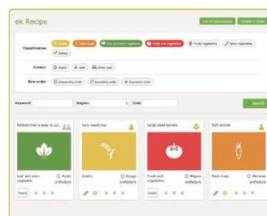
- Environmental data will be commodity of the society soon.
- Guidance system utilizing on simulation, AI will be the arena of the competition

Applications
Web applications



Dashboard

On the dashboard, users can easily observe the status of e-kakashi or activity in the cultivation field. Users can receive support from IoT and the web.



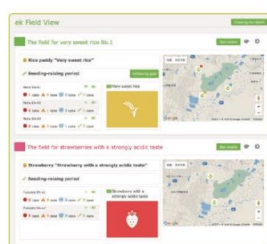
ek Recipe

ek Recipe is available to create cultivation management techniques and know-how, like cooking recipes. It can also install e-kakashi sample recipes and new recipes created by others. (To use recipes created by others, the approval of the creators is required.)



Sensor Data

The sensor data is UI, which is familiar to existing users of e-kakashi. In addition, the software is reliably updated. Its fluid operation will amaze users.



ek Field View

ek Field View is the new function that integrates sensor data with ek Recipe. It supports guidance in the cultivation field, addressing problems such as what management work is necessary, whether the value of a measurement is appropriate, or how many days are expected until harvest time.

Courtesy:
PS-Solutions

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Tomorrow's Crop



TMC Tomorrow's Crop
An on-line tool based on DSSAT crop simulation systems

Tomorrow's Crop (TMC) is an on-line tool based on DSSAT crop simulation systems. Users can see how planting date influences yield as probability distributions that are based on 100 of possible weather scenarios generated from historical weather data. Currently, it has two components, which are Tomorrow's Rice (TMR) and Tomorrow's Wheat (TMW).

- **TMR** collects the historical weather data from IRI, Columbia University (daily minimum temperature, maximum temperatures and rainfall) and NASA (daily solar radiation). TMR also estimate the impact of climate change by applying World Bank's climate change data set.
- **TMW** collects the historical weather data from CloudSense via OGC's SOS(Sensor Observation Service). The original data source is NIAES's agro-weather data derived by model calculation from AMeDAS data. Currently only Memuro and Obihiro data is provided. The cultivar parameters of Kitahonami variety was calibrated against yield and field observation by a research project between Chubu University and IHI Corporation.

Let's start

TMR V1.2



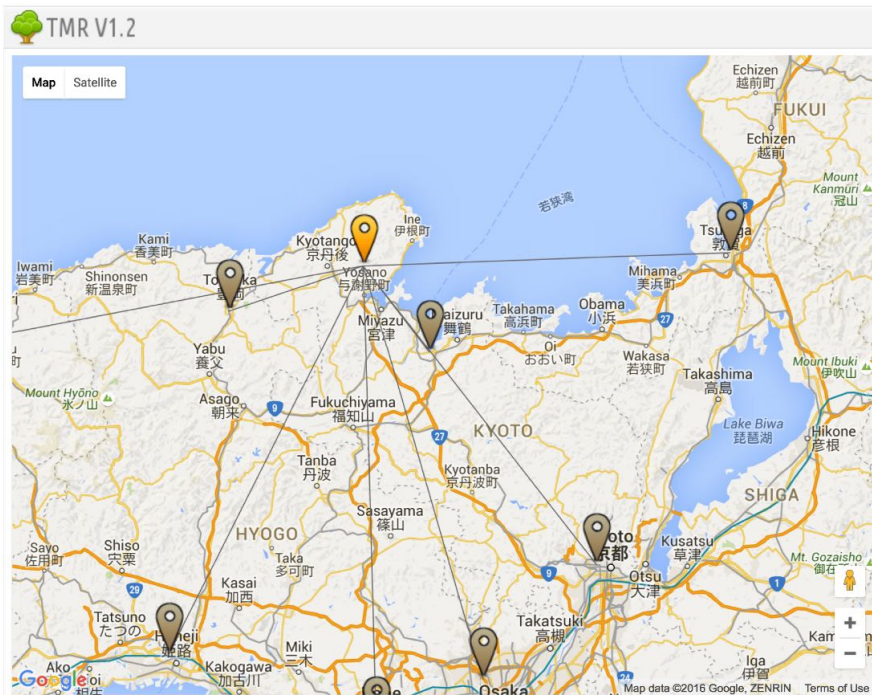
Start

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68

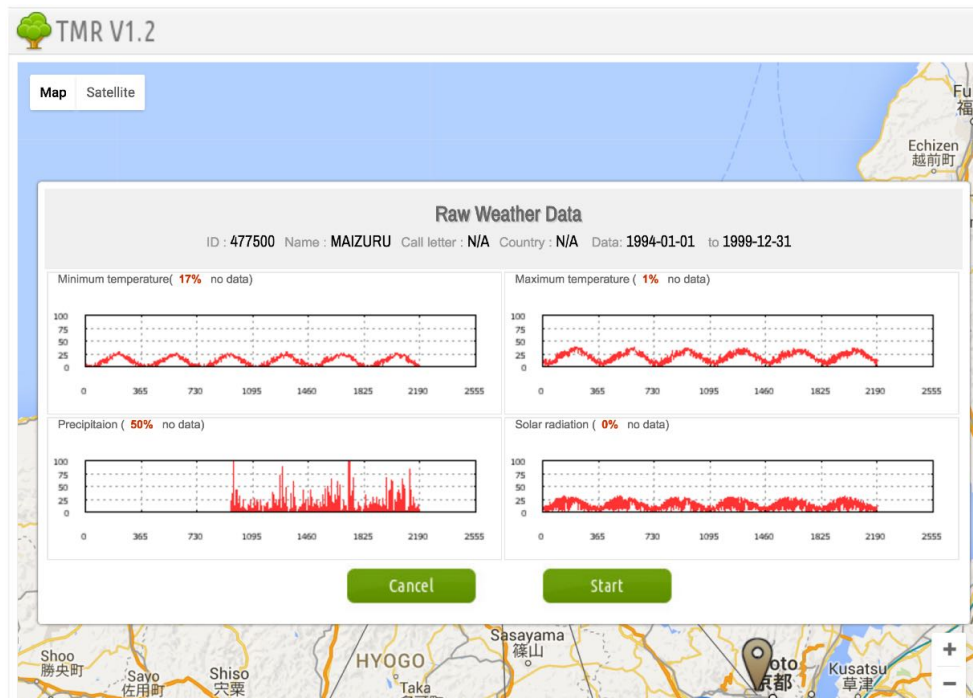
Where is your farm ?



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69

Check the historical weather data



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70

Date ? Cultivar ? Soil Type ?

TMR V1.2

Tomorrow's RICE

Minimum temperatures Maximum temperatures Solar radiations Precipitations

Planting date ? 10 APR 2014

Cultivar ? (990003) JAPANESE

Soil type ? ((1B00000004) DEFAULT - t)

Climate change ? Apply :

RUN

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71

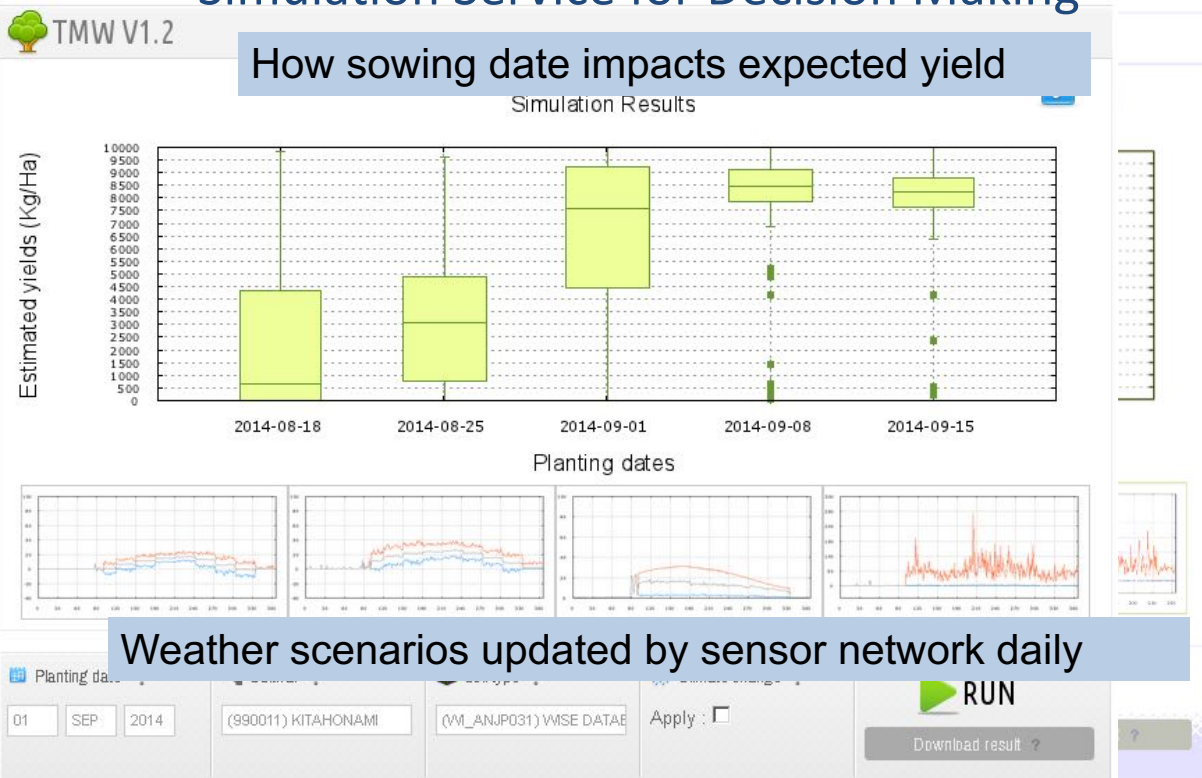
3 Apr is the best, then gradually reduces. In May 20% lower yield



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Simulation Service for Decision Making

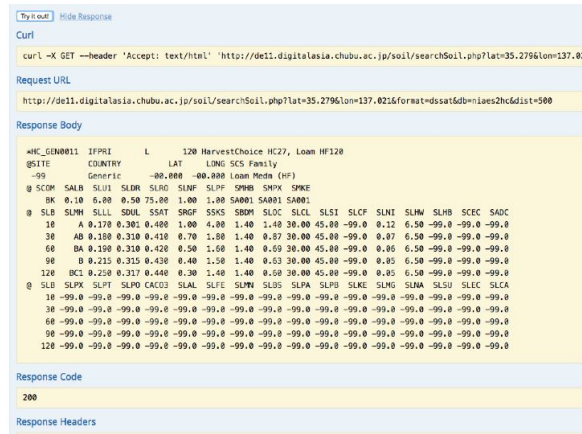
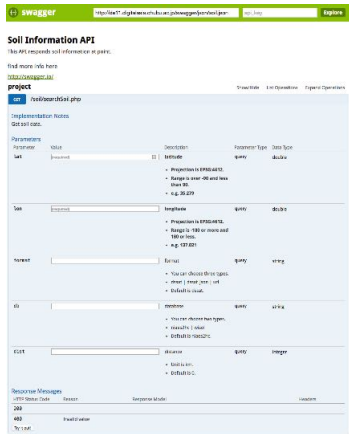
How sowing date impacts expected yield



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Soil API

- Soil physical property is important for running models.
- Web service to provide soil property from lat/lon
- World Soil DB WI.SOL (point data)
- Fusing with Japanese soil database
- Directly generate soil parameter in DSSAT native, DSSAT json format or key value in soil database of DSSAT
- Important Web Service to automate model runs



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Grid Weather Data to SOS Service NARO 1km Grid in Japan

- Weather data is becoming gridded by sophisticated interpolation techniques.
- Hiding specific data structure and access method by SOS to give interoperability
- Important to generate weather scenario in automatic model runs

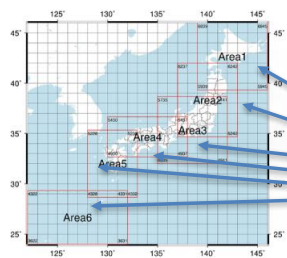


図1. メッシュ気象観測データサーバーが提供するデータの領域 (赤線) 領域内の数字は、それぞれに設置する気象観測点1次メッシュ番号を示す。

Convert Specific Access method to SOS Standard API

NARO Agent API

Returns NARO meta data of SOS and observed data by converting NARO NetCDF to non-binary format in REST API interface. Only IP registered clients can access this API.

[1km Mesh Manual \(Japanese\)](#)

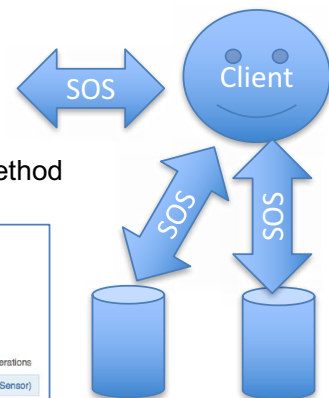
[NARO OpenDAP](#)

SOS Show/Hide List Operations Expand Operations

- GET** /api/sos/describesensor(proc) Meta data of SOS Station (for DescribeSensor)
- GET** /api/sos/getcapabilities Meta data of SOS Station (for GetCapabilities)
- GET** /api/sos/getobservation(offering) Measured Data of Specified Location, Period and Data Types (for GetObservation API)

Utilities Show/Hide List Operations Expand Operations

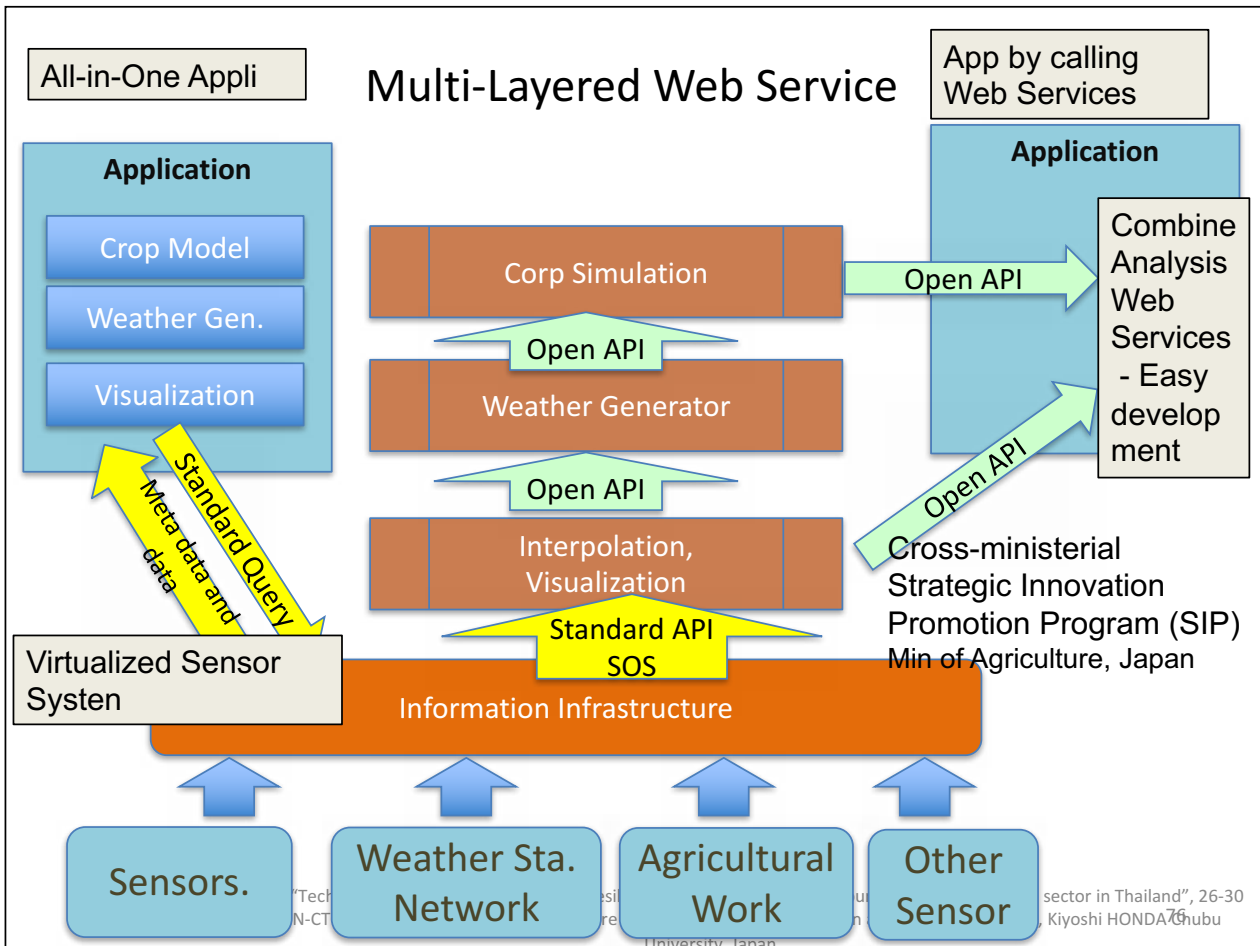
[BASE URL:]



SOS Data Source

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Thailand", 26-30 Sep. 2016 chubu University, Japan



New Satellite Systems

- Constellation
- High-resolution, High-Frequency, Better resolution

編隊衛星がリモセンの農業利用を変える High Resolution High Frequency Satellite Data

- Conventional Satellite RS
- High Reso – Low Frequency
- High Frequency – Low Reso



- Constellation by 5 identical satellites
- High Resolution – High Frequency
- Highly applicable for Agriculture

RAPIDEYE SATELLITE CONSTELLATION UNRIVALED EARTH OBSERVATION CAPACITY



The Collection Benchmark

RapidEye's constellation of five identical satellites orbit the earth at an altitude of 630 km, and offer an unrivaled combination of attributes within the industry.

An unprecedented amount of high-resolution, multi spectral imagery can be collected from the satellites: over one billion square kilometers every year.



Spectral Bands	Blue	Green	Red	Red Edge	Near-Infrared
	440 – 510 nm	520 – 590 nm	630 – 685 nm	690 – 730 nm	760 – 850 nm
Ground sampling distance (nadir)	6.5 m				
Pixel size (orthorectified)	5 m				

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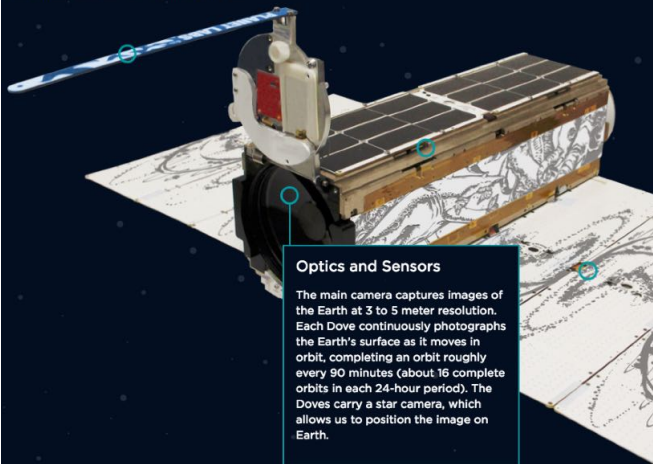
Planet labs 120 Dove Satellites in 2016

- Everyday 3.5m resolution by 120 Dove constellation

MEET THE DOVE

Planet's Dove satellites act like a line scanner for the planet, creating a unique data stream that helps solve our world's toughest challenges and triggers industry-changing opportunities.

Our Doves, which make up the world's largest constellation of Earth-imaging satellites, are launched in flocks and provides a whole-Earth dataset that is unmatched in its breadth and freshness.



Optics and Sensors

The main camera captures images of the Earth at 3 to 5 meter resolution. Each Dove continuously photographs the Earth's surface as it moves in orbit, completing an orbit roughly every 90 minutes (about 16 complete orbits in each 24-hour period). The Doves carry a star camera, which allows us to position the image on Earth.



AXELSPACE

Microsat Constellation



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81

UAV for Agriculture

- UAV is rapidly becoming popular
- Now new sensors are becoming available
 - Multi-Channel Camera
 - Thermo Camera
 - Lidar

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82

UAV for Agriculture 農業用固定翼UAV例



eBee Ag

The precision agriculture drone

The eBee Ag is the only precision farming UAV you need. With its full drone-to-tractor workflow you can scout your crops, analyse plant health, create prescriptions and begin treatment all on the same day.

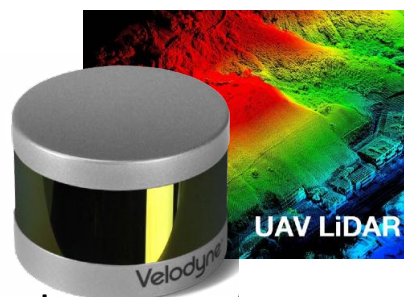


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83

Various Imaging Sensors for UAV

- RGB
- NIR
 - Basic Band for Vegetation
- RE
 - High sensitivity for the status of plants <http://velodynelidar.com/>
- 4 Channel (G, R, RE, NIR + Irradiance)
 - Reflectance
- Thermal
 - ETa
 - Water Stress



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www.sensefly.com

84

Advantages and Limitations of UAV

- Agile
 - Immediate flight
 - Observation under cloud cover
 - Needs of own operation, Wind, Landing Place.
- High Resolution
 - mm to cm level
 - 0.5 – several km²
- Sensor
 - Multi-band, Thermal
 - Limited payload
- Data Processing

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87

Autonomous UAV Flight



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88



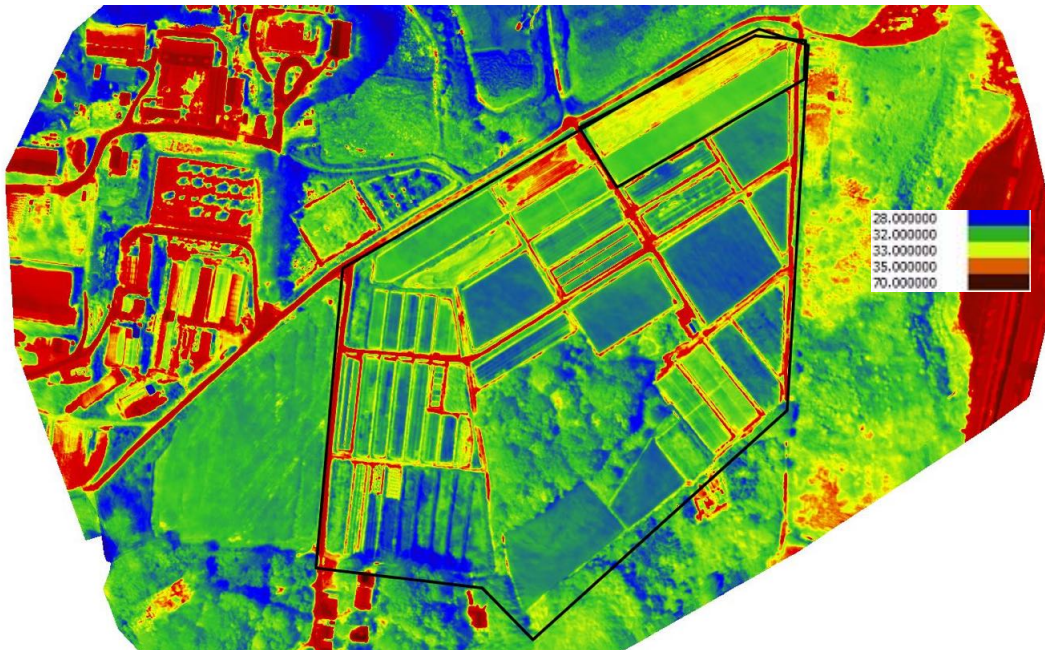
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Nagoya University Experimental Farm DATE: 2015-05-08, RGB



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DATE: 2015-09-02, Thermal Image



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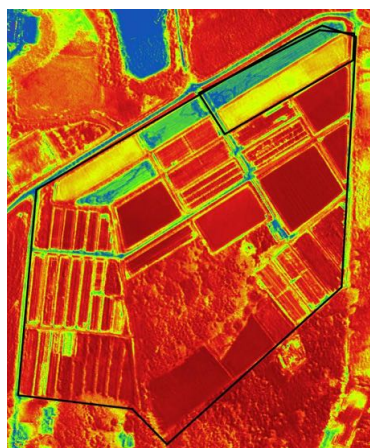
91

DATE: 2015-09-02

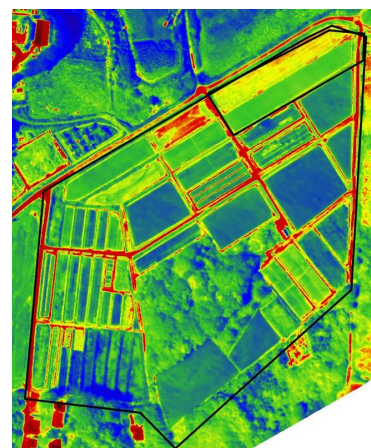
RGB



M4C NDVI



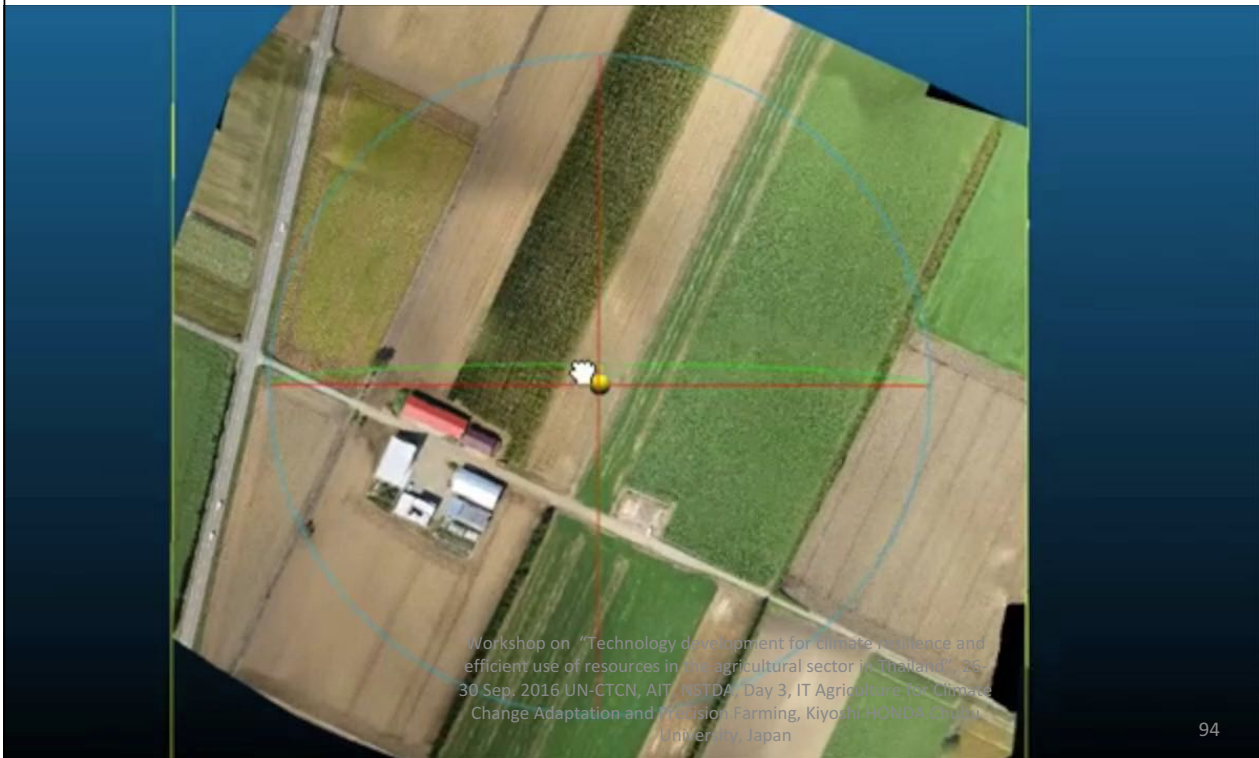
Temperature



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92

Producing 3D from UAV Images



94

UAV Data Server

Hondalab gserver 名前: hondalab

[Settings](#) [Help](#) [Logout](#)

Map management Map retrieval When the 2005 search

Top <Previous Next> last

Map ID	Title	Edit	Date	Creation date	preview	User	1-13 / 13	Delete
y20140523_kayamouse_habitat_rgb	y20140523_kayamouse_habitat_rgb	Edit	February 9, 2016	February 9, 2016	Show	admin		Delete
y20150309_nagoyauexpfarm_m4c	y20150309_nagoyauexpfarm_m4c	Edit	February 9, 2016	February 9, 2016	Show	admin		Delete
y20150309_nagoyauexpfarm_rgb_10cm	y20150309_nagoyauexpfarm_rgb_10cm	Edit	February 9, 2016	February 9, 2016	Show	admin		Delete
y20150309_nagoyauexpfarm_rgb_5cm	y20150309_nagoyauexpfarm_rgb_5cm	Edit	February 9, 2016	February 9, 2016	Show	admin		Delete
y20150309_nagoyauexpfarm_rgb_kml	y20150309_nagoyauexpfarm_rgb_kml	Edit	February 9, 2016	February 9, 2016	Show	admin		Delete
y20150508_nagoyauexpfarm_m4c	y20150508_nagoyauexpfarm_m4c	Edit	February 9, 2016	February 9, 2016	Show	admin		Delete
y20150508_nagoyauexpfarm_rgb	y20150508_nagoyauexpfarm_rgb	Edit	February 9, 2016	February 9, 2016	Show	admin		Delete
y20150809_nagoyauexpfarm_m4c	y20150809_nagoyauexpfarm_m4c	Edit	February 9, 2016	February 9, 2016	Show	admin		Delete
y20150809_nagoyauexpfarm_m4c_kml	y20150809_nagoyauexpfarm_m4c_kml	Edit	February 9, 2016	February 9, 2016	Show	admin		Delete
y20150809_nagoyauexpfarm_rgb	y20150809_nagoyauexpfarm_rgb	Edit	February 9, 2016	February 9, 2016	Show	admin		Delete
y20150902_nagoyauexpfarm_m4c	y20150902_nagoyauexpfarm_m4c	Edit	February 9, 2016	February 9, 2016	Show	admin		Delete
y20150902_nagoyauexpfarm_rgb	y20150902_nagoyauexpfarm_rgb	Edit	February 9, 2016	February 9, 2016	Show	admin		Delete
y20150902_nagoyauexpfarm_th	y20150902_nagoyauexpfarm_th	Edit	February 9, 2016	February 9, 2016	Show	admin		Delete

Top <Previous Next> last

Category List

- 2014-05-23
- 2015-03-09
- 2015-05-08
- 2015-08-09
- 2015-09-02

Category Management

preview

[Preview List](#)

Capabilities URL

Hondalab gserver 名前: hondalab [Settings] [Help] [Logout]

Map management

- Map List
- Vector
- Raster
- WCS
- KML
- When the series
- SOS
- Selection map
- Map New

Category List

- 2014-05-23
- 2015-03-09
- 2015-05-08
- 2015-08-09
- 2015-09-02
- Category New
- Category Management

preview

- Preview List

Map setting screen << Back to map list

Map title: y20150902_nagoyauexpfarm_m4c

WMS Capabilities: http://de17.digitalasia.chubu.ac.jp/gserver/wmscapabilities?id=y20150902_nagoyauexpfarm_m4c

WCS Capabilities: http://de17.digitalasia.chubu.ac.jp/gserver/wscapabilities?id=y20150902_nagoyauexpfarm_m4c

Basic information setting | upload | Layer editing | Metadata | When you see a form of output

Map detailed information editing

ID: y20150902_nagoyauexpfarm_m4c

Title * Required: y20150902_nagoyauexpfarm_m4c

Description: [Text Area]

keyword: [Text Area]

* Between the word and the word "*" Please, separated by (comma). (Example) disaster prevention, building, evacuation

range: MinX: 137.079062 MinY: 35.107043
MaxX: 137.088277 MaxY: 35.11469
Fan Tong made

Observed Properties and UOM

- SOS publishes observed properties
 - air temperature, relative_humidity
- Key to request data
- SOS does not define how to name, UOM
 - Air_temperature, tmp, maximum air temperature, MAX ATEMP, rainfall, 10min_rainfall...
 - DegC, C, Cel, 度
 - NASA Sweet – not for agriculture
- Should be machine readable and should not be too ambiguous for higher level of semantic service

Naming Rule on Observed Property and UOM

- Combines important properties of observed data using underscore (_)
- UOM follows UCUM (The Unified Code for Units of Measure)



- 10minutes_maximum_wind_speed_2mheight [m/s]

集約時間数値		×	集約時間単位		×	集約方法		×	計測項目(計測対象_物理現象)	
timewindow value			timewindow uom			aggregation			observableProperty	
JPN	ENG		JPN	ENG		JPN	ENG		JPN	ENG
数値	numeric		秒	second		瞬時値*			気温	air_temperature
			分	minute		積算	accumulated		土壌温度	soil_temperature
			時間	hour		積算	cumulative		地表面温度	land_surface_temperature
			日	day		合計	amount_of		海面温度	sea_surface_temperature
			週	week		持続時間	duration_of		水温	water_temperature
			月	month		合計	sum		全日射	solar_irradiance
			年	year		平均	average		降水量	precipitation
			1年間の	annual*		平均	mean		雨量	rainfall
						最大	maximum		他多数	to be filled by many others
						最高	maximum			
						最小	minimum			
						最低	minimum			

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Published as a guideline

- naming rules, UOM, metadata format -

http://www.kantei.go.jp/jp/singi/it2/senmon_bunka/nougyou.html

- Ministry of Internal Affairs and Communication, Japan
- <H28-GL2> Guidelines on environment information data items in agricultural IT System (recommended for implementation) (31 Mar 2016) ([PDF](#)) ([Word](#))
- Table 1 UOM as Reference ([Excel](#) / [CSV](#))
- Table 2 Base names and UOM ([Excel](#) / [CSV](#))
- Table 3 Examples of names with aggregation information ([Excel](#) / [CSV](#))
- Table 4 Metadata format on TOR for data use ([Excel](#))
- Table 5 Metadata format on sensor specification and observation conditions ([Excel](#))
- Table 6 Metadata format on data ([Excel](#))

•<H28-GL2> Guidelines on environment information data items in agricultural IT System (recommended for implementation)

•農業ITシステムで用いる環境情報のデータ項目に関する個別ガイドライン(本格運用版)

(平成28年3月31日取りまとめ)([PDF形式](#))

※ガイドラインの本文やデータをご利用される方はこちら本文 ([Word形式](#))

別表1 基準となる単位表 ([Excel形式](#) / [CSV形式](#))

別表2 基本項目名・単位表 ([Excel形式](#) / [CSV形式](#))

別表3 集計・追加情報を付加した項目名例 ([Excel形式](#) / [CSV形式](#))

別表4 サービス利用条件のメタ情報記録フォーマット ([Excel形式](#))

別表5 センサーの仕様及び計測条件のメタ情報記録フォーマット([Excel形式](#))

別表6 計測結果のメタ情報記録フォーマット([Excel形式](#))

Published as a guideline - Interface for data exchange (API) -

http://www.kantei.go.jp/jp/singi/it2/senmon_bunka/nougyou.html

- Ministry of Internal Affairs and Communication, Japan

<H28-GL4> Guideline for exchanging agricultural information (For trial)
(31 Mar 2016) ([PDF](#)) ([Word](#))

Appendix 1 GetCapabilities.xml ([XML](#))

Appendix 2 GetCapabilities_Response.xml ([XML](#))

Appendix 3 DescribeSensor.xml ([XML](#))

Appendix 4 DescribeSensor_Response_SensorML1.0.1.xml ([XML](#))

Appendix 5 GetObservation.xml ([XML](#))

Appendix 6 GetObservation_ResponseWithSWE.xml ([XML](#))

<H28-GL4> 農業情報のデータ交換のインタフェースに関する個別ガイドライン(試行版)
(平成28年3月31日取りまとめ) ([PDF形式](#))

※ガイドラインの本文やデータをご利用される方はこちら本文 ([Word形式](#))

別紙1 GetCapabilities.xml ([XML形式](#))

別紙2 GetCapabilities_Response.xml ([XML形式](#))

別紙3 DescribeSensor.xml ([XML形式](#))

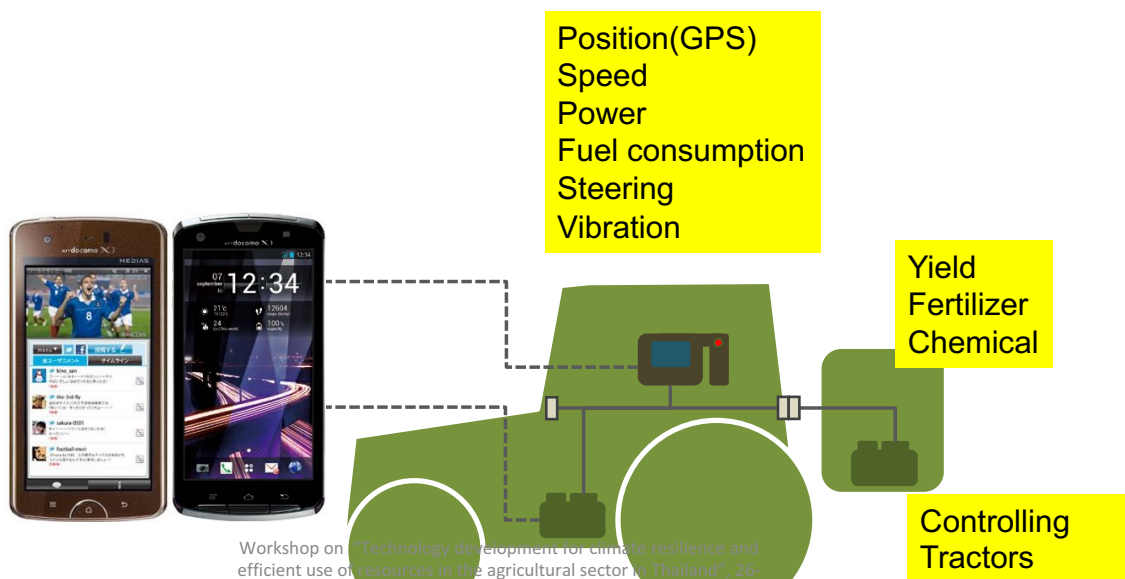
別紙4 DescribeSensor_Response_SensorML1.0.1.xml ([XML形式](#))

別紙5 GetObservation.xml ([XML形式](#))

別紙6 GetObservation_ResponseWithSWE.xml ([XML形式](#))

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M2M in Agricultural Machine ISOBUS for data communication standard for interoperability



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濱田: <https://www.facebook.com/yasuyuki.hamada.33>

Movement in the World

FI-Space

- FI-PPP (Future Internet Public-Private Partnership, since 2011, 5yrs, 300MEuro)
- FI-Space - B2B Business Platform for Agri-Business
- Acceleration Program for an ECO System



<http://www.fi-ppp.eu/>

<http://fispace.eu/whatisfispace.html>

Future Internet will facilitate:

- ... seamless B2B Collaboration (information exchange, communication, coordination of activities)
- ... rapid & easy development of customized solutions at minimal costs
- ... quick formation & evolution of open business networks



ICT in Agri-Food: International Developments

Sjaak Wolfert

Workshop AgroConnect Smart Farming/FIspace
10 March 2014, Wageningen



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Wageningen UR

- University and Research Center
- Mass of research unit



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FI-Space Git

Bitbucket Dashboard Teams Repositories Create Find a repository... Email administrators Following

FIspace (finspace)
<http://finspace.eu/>
 Team since July 2013

Overview Followers 28 Members 64

Language Find repositories

- plugin Updated 2 days ago
- archetypes Updated 2 days ago
- store Updated 2 days ago
- b2b Updated 2 days ago
- sdi Updated 2 days ago
- gui Updated 2 days ago
- bus-wrapper Updated 3 days ago
- store-ani Updated 3 days ago

Recent activity

- finspace/gui-api Repository created Francisco Pérez Durán · 2015-02-20
- finspace/store-api Repository created Francisco Pérez Durán · 2015-02-20
- FIspace User followed FIspace · 2015-01-29
- finspace/ear Repository created Francisco Pérez Durán · 2015-01-14
- FIspace User followed FIspace · 2015-01-10

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113

High Level SME - Lime Tri 200ha farm land + software engineering

AgroSense
powered by LimeTri

AgroSense Precision Agriculture
AgroSense the one stop shop for Precision Agriculture related software, pro

Plots
Benefit from a realtime connection to your plots

Award winning
AgroSense won the prestigious Duke's choice award.

Bitbucket Dashboard Teams Repositories

Overview

Workshop on "Technology development for climate resilience and efficient use of resources in the agricultural sector in Thailand", 26-30 Sep. 2016 UN-CTCN, AIT, NSTDA, Day 3, IT Agriculture for Climate Change Adaptation and Precision Farming, Kiyoshi HONDA Chubu University, Japan

Last updated 2015-02-07

114 1

Kverneland



- Positive in standardization
- Support ISOBUS and Standard data model



52north, Germany



- NFP Company for Field Sensor Network
- OGC standard + Opensource

52°North SOS

Open Source Sensor Observation Service



52 North git

52n 52°North Initiative for Geospatial Open Source Software GmbH
Münster http://www.52north.org info@52north.org

Filters Find a repository...

IlwisConnectors C++ ★ 3 ♪ 4
Integrated Land and Water Information System (ILWIS) is a remote sensing and GIS software. The connectors integrate libraries and bindings for external software in the newest version of ILWIS.
Updated 7 hours ago

IlwisCore HTML ★ 4 ♪ 4
Integrated Land and Water Information System (ILWIS) is a remote sensing and GIS software. ILWIS Core is the functional center of the new version.
Updated 7 hours ago

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118

International Soil Data Interoperability



OGC seeks participants for international Soil Data Interoperability Experiment

Contact: info@opengeospatial.org

7 May 2015 – The Open Geospatial Consortium (OGC) has announced a Call for Participation (CFP) in the OGC Soil Interoperability Experiment (Soil IE).

- * CSIRO (Commonwealth Scientific and Industrial Research Organisation), Australia
- * Landcare Research New Zealand Ltd.
- * ISRIC World Soil Information, Netherlands

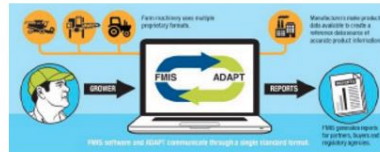
- Current Projects
- Crop Nutrient Connectivity Project II
- Crop Protection Canada Connectivity Project
- Seed Connectivity Project II
- SPADE
- Precision Ag Irrigation Language (PAIL)

SPADE Project

Note: There is more information available on SPADE on AgGateway's wiki page, here.

SPADE: Making Data Sharing & Interoperability a Reality for Precision Agriculture

Formed in 2012 through a commonly recognized need, the Standardized Precision Ag Data Exchange (SPADE) Project is a collaboration among agricultural suppliers of hardware, software, inputs, services, implements and vehicles for improved data exchange and interoperability. It targets farm operations of seeding, tillage, fertilizing, spraying and harvest to maximize the value of precision agriculture through seamless and transparent data exchange.



SPADE's vision for data flow in precision agriculture. Reference data helps ensure things have the same meaning for all participants.

SPADE seeks to:

- Establish a framework of standards to simplify mixed-fleet field operations, regulatory compliance, crop insurance reporting, traceability, sustainability assessment and field or crop-scale revenue management.
- Allow seamless data exchange between hardware systems and software applications that collect field data across farming operations.

Project Links

- Project update flyer – July 2016
- SPADE's vision for data flow – Fact Sheet
- Presentation: How Work of Standards Orgs and AgGateway Fit Together
- Read the SPADE3 press release
- SPADE public wiki page

SPADE Members

- Project Coordinator
- Jim Wilson, AgGateway, Inc.
- Member Companies
- Ag Connections
- AGCO Corporation
- AgIntegrated, Inc.
- Ag Leader Technology
- Agrian, Inc.
- CDMS
- Ceres Solutions
- CNH Americas

Works U

Commercial Agri-Platform and Weather Services

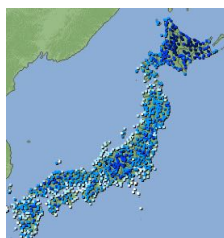
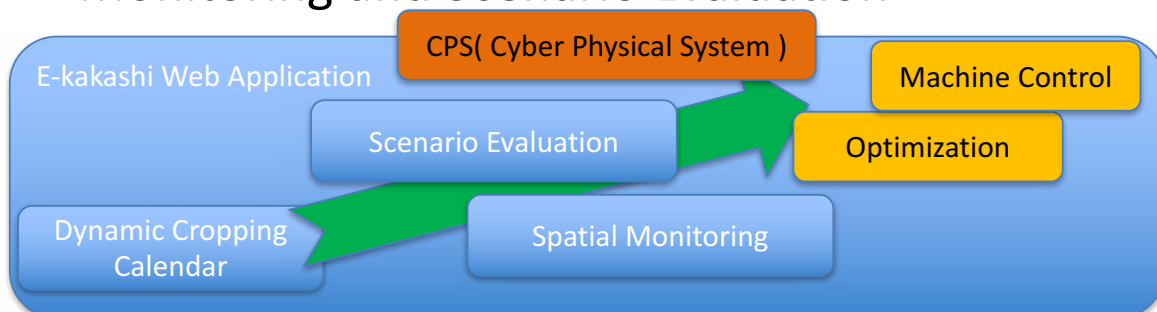
Dev aWhere Global Development Platform

- >>> Data management and analytics capture project metadata to monitor impact and progress toward objectives
- >>> Hosted platform creates a repository of information fostering collaboration amongst stakeholders and a permanent institutional memory
- >>> Open integration provides secure integration with other systems, data resources and disparate data formats
- >>> Software as a Service (SaaS) model controls operational costs and ensures long-term sustainability

“The kind of weather information aWhere has built-in is, I think, second to none. It's impressive. I've not seen any other system with that kind of flexibility in data sharing.”
- Abhishek Rathore, Senior Scientist, ICRISAT

DSS for higher level of precision farming

- Work Optimization based on Spatial Monitoring and Scenario Evaluation



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122

Summary of Part 2

- Interoperability
 - Key for data Integration
- Web Service and Standard
- Various systems developed in interoperable web services
- New UAV, Satellite systems
- Movement in Japan and the world

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123

Thank you
Q/A

www.hondalab.net

www.researchgate.net

