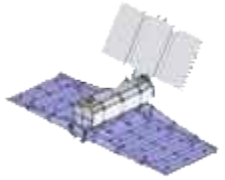
CONAE
COMISION NACIONAL DE ACTIVIDADES ESPACIALES



SAOCOM Mission and SMAP Cal/Val Site

Marc Thibeault
CONAE

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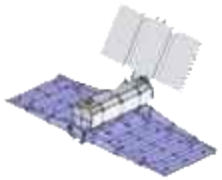
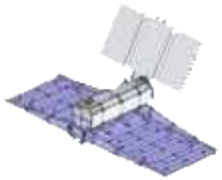
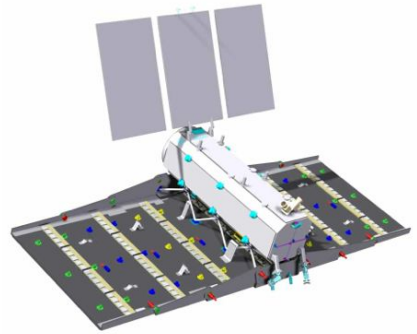


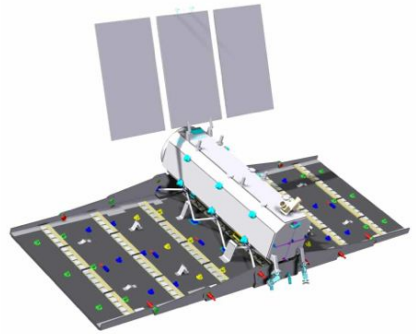
- Introduction to SAOCOM Mission
- SMAP (Bell Ville) Cal/Val site
- Protocols and ground truth

SAOCOM Mission

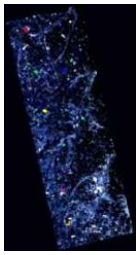


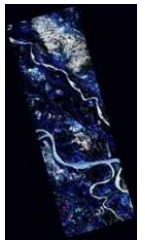
The SAOCOM 1 Mission is composed of two satellites, SAOCOM 1A and SAOCOM 1B, presently under development. Both satellites are equally designed and each one carries a full polarimetric L-band SAR instrument



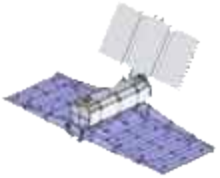


This mission has as main driver the generation of Soil Moisture Maps over the Pampas Region in Argentina, with the aim of providing an essential quantitative input of the soil moisture content for giving support to agricultural, hydrological and health applications, and emergencies in general. (SAOCOM Strategic Applications).



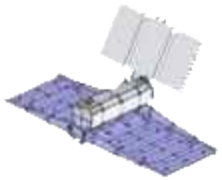


SAOCOM Mission

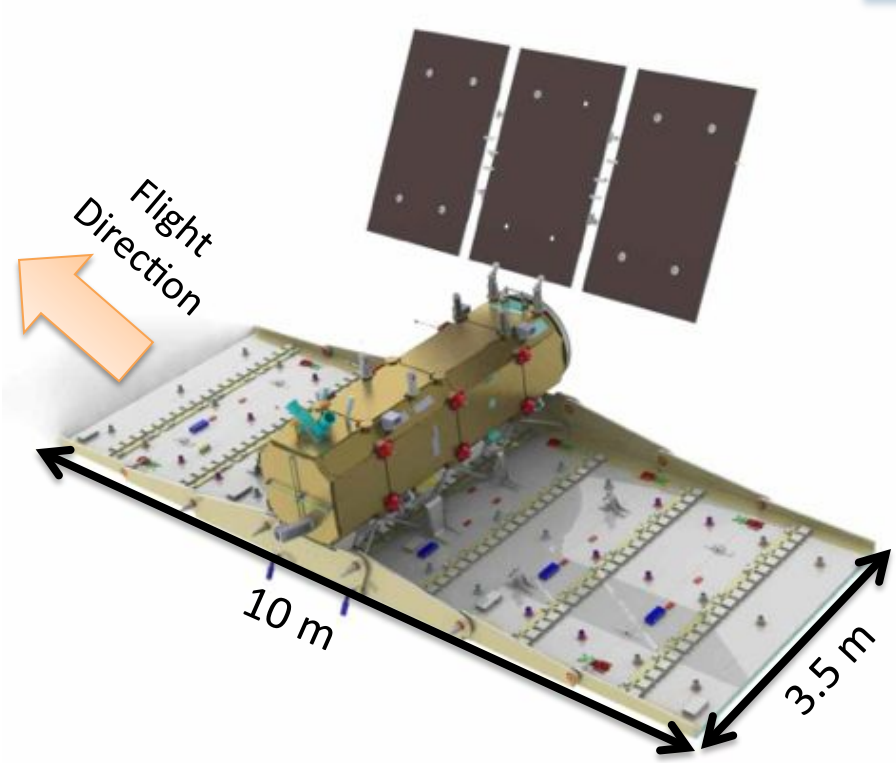


- a constellation of two identical satellites, SAOCOM 1A and SAOCOM 1B, carrying each one a polarimetric L-band SAR instrument (1,275 GHz)
- Sun synchronous, nearly circular frozen polar orbit (06:12 am LTAN/619.6 km)
- repeat cycle of 16 days for each satellite
- (8 days for the constellation)
- Mission lifetime: 5 years
- Launch:
  - SAOCOM 1A: 2015
  - SAOCOM 1B: 2016

SAOCOM SAR Instrument

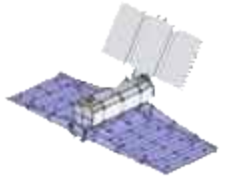


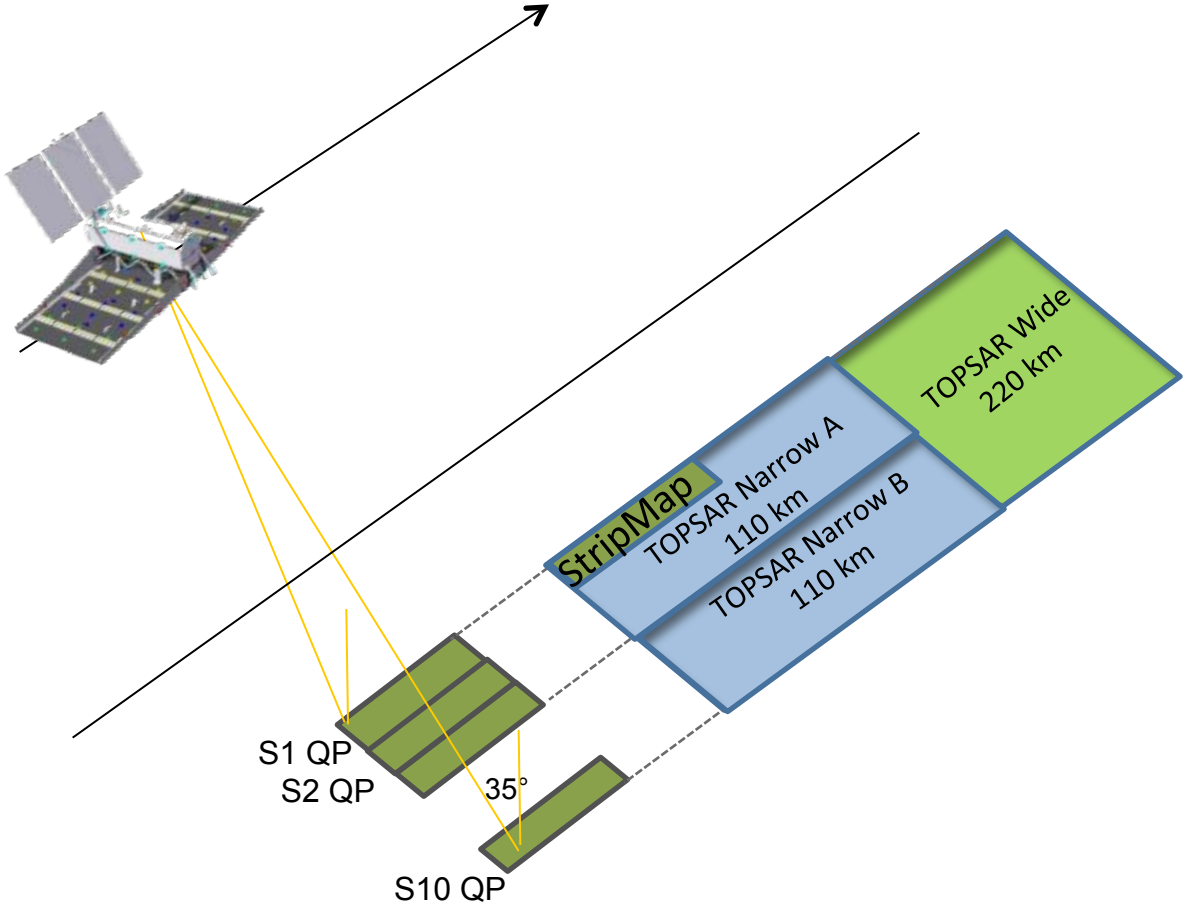
MAIN CHARACTERISTICS



- L-Band SAR
- Right looking SAR
- Left looking capability
- 10m x 3.5m active phased array antenna with 140 TRMs
- TOPSAR & Stripmap acquisition modes
- Single, dual and quad polarization operative modes
- More than 2600 beams

TOPSAR Quad pol modes

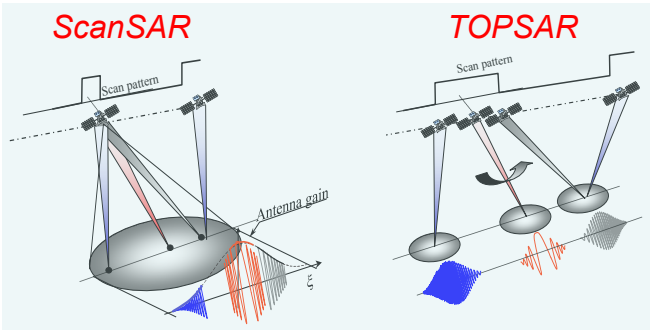




- **10 quad-pol beams** in elevation allow maximum coverage of 220 KM

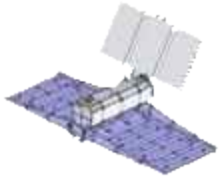
- 3 different spatial resolutions [m]
  - 100 (az) x 10 (rg) WIDE
  - 50 (az) x 10 (rg) NARROW
  - 6 (az) x 5 (rg) STRIPMAP

- The TOPSAR mode is exploited :
  - LOW scalloping
  - Wide coverage
  - High resolution
  - Scanning timeline optimization possibility

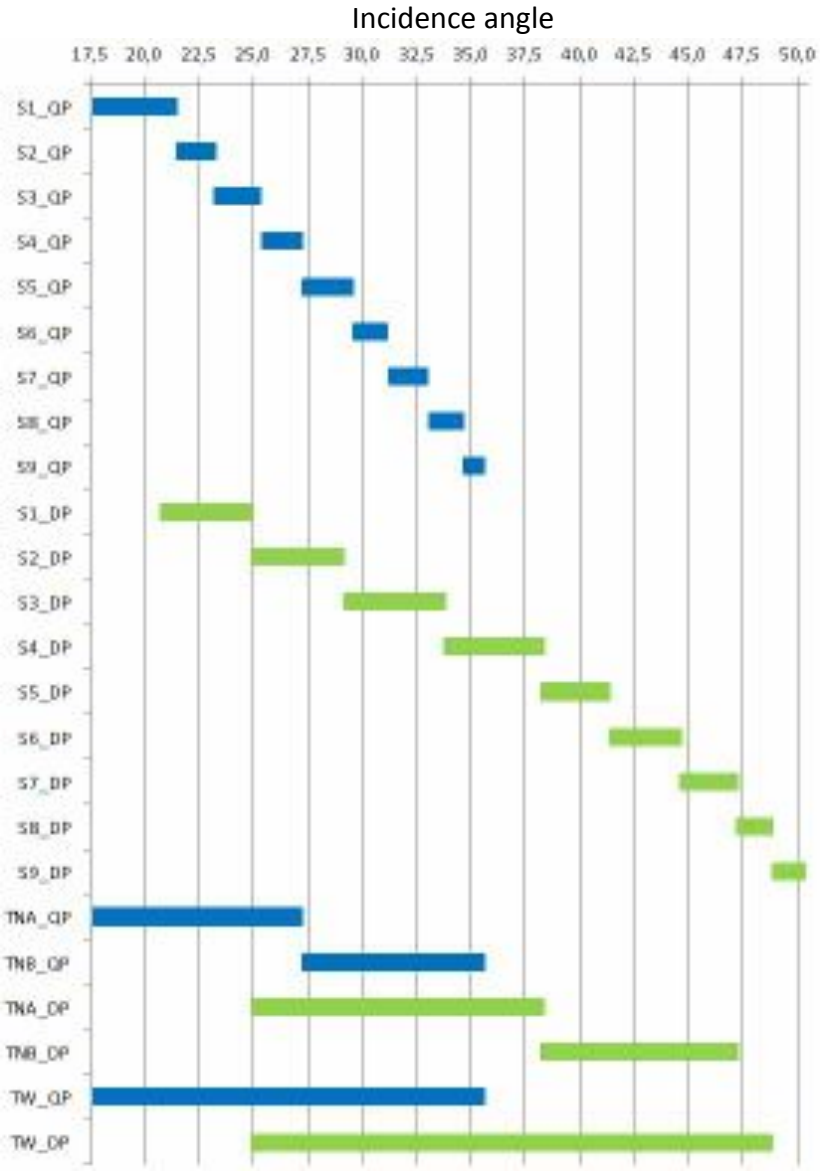


TOPSAR mode chosen to maximize coverage versus geometric & radiometric resolution

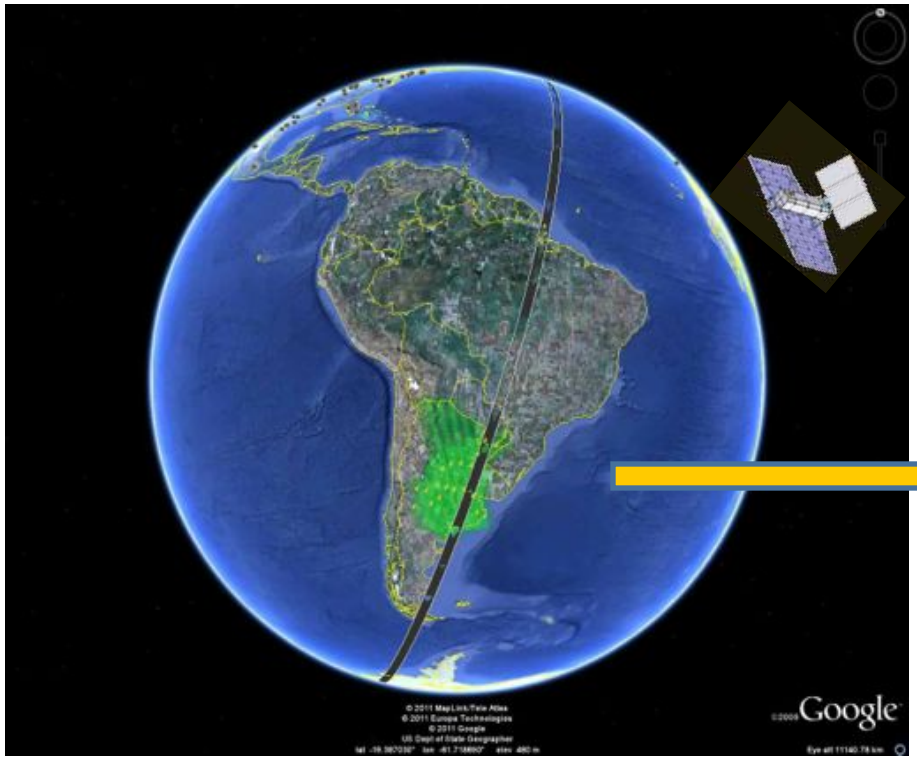
SAOCOM Beams Design

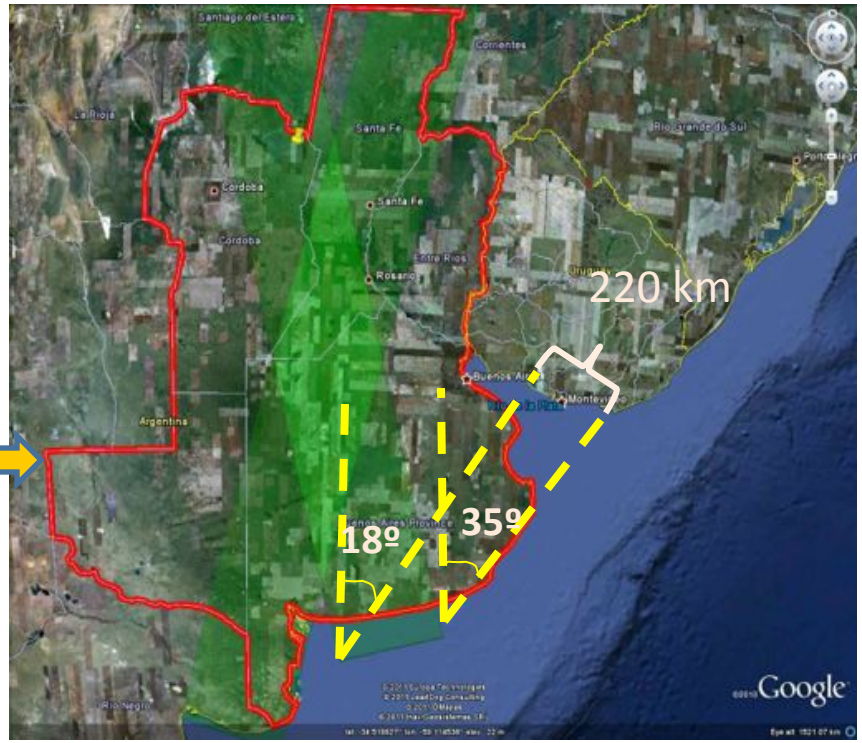


Mode	Beam Name	Swath	Inc. Ang. Near	Ing. Ang. Far
	[Km]	[Km]	[Deg]	[Deg]
Stripmap Quad Pol Modes	S1_QP	44	17.6	21.5
	S2_QP	22	21.4	23.3
	S3_QP	26	23.2	25.4
	S4_QP	24	25.3	27.3
	S5_QP	31	27.2	29.6
	S6_QP	22	29.6	31.2
	S7_QP	26	31.2	33.1
	S8_QP	23	33.0	34.7
	S9_QP	15	34.6	35.6
Stripmap Dual Pol & Single Pol Modes	S1_DP	52	20.7	25.1
	S2_DP	55	24.9	29.2
	S3_DP	64	29.1	33.9
	S4_DP	69	33.7	38.4
	S5_DP	51	38.2	41.4
	S6_DP	58	41.3	44.7
	S7_DP	50	44.6	47.3
	S8_DP	33	47.2	48.9
	S9_DP	33	48.8	50.4
Topsar Narrow Quad Pol Modes	TNA_QP	115	17.6	27.3
	TNB_QP	113	27.2	35.6
Topsar Narrow Dual & Single Pol Modes	TNA_DP	184	24.9	38.4
	TNB_DP	157	38.2	47.3
Topsar Wide Quad Pol Modes	TW_QP	227	17.6	35.6
Topsar Wide Dual, Single & Compact Pol Modes	TW_DP	369	24.9	48.9



SAOCOM Strategic applications



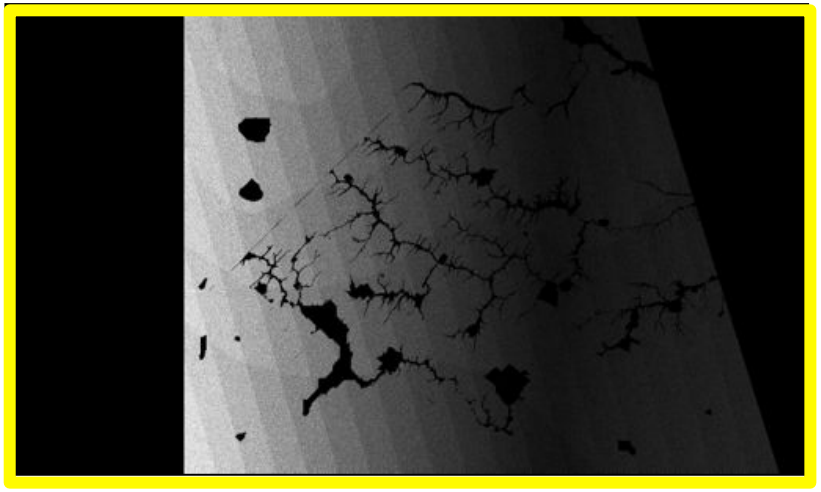


Mode	Polarization (TxRx)	Swath (nominal)	Spatial Resolution (nominal)
TOPSAR WIDE QP	HH/HV/VH/VV	220 km	< 100 m

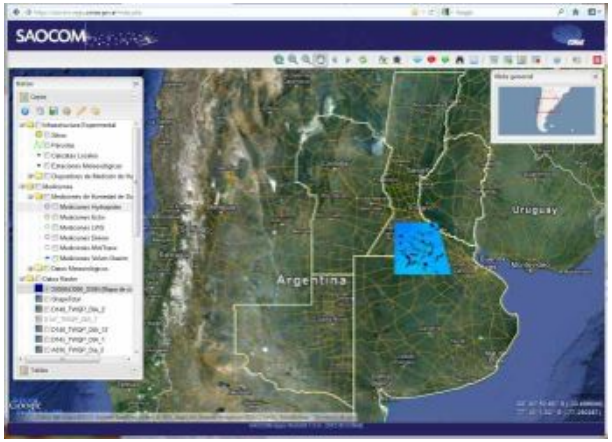
SAOCOM GIS and Testbed

TWQP Ascending path
#orbit 35

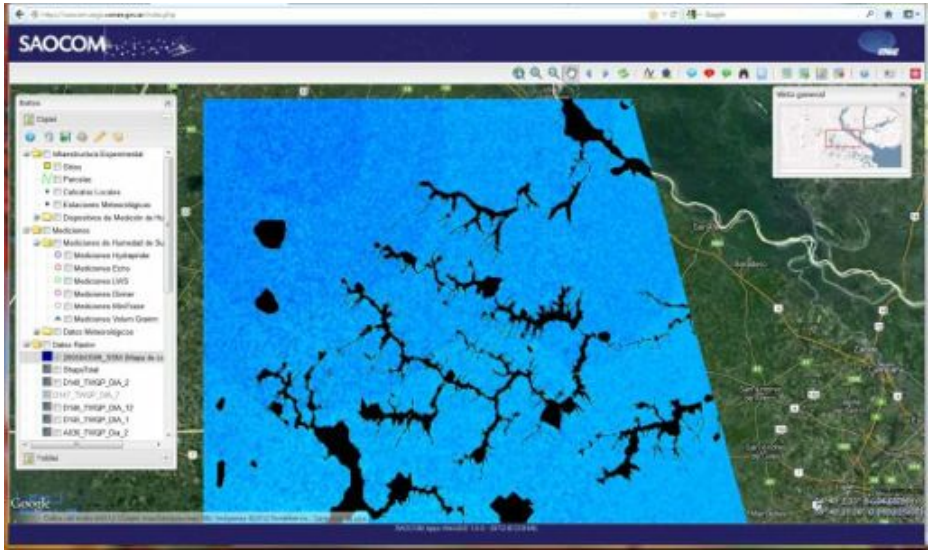
Arrecifes basin



σ^0_{HH}

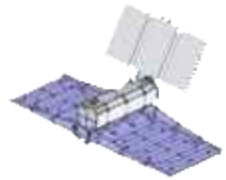


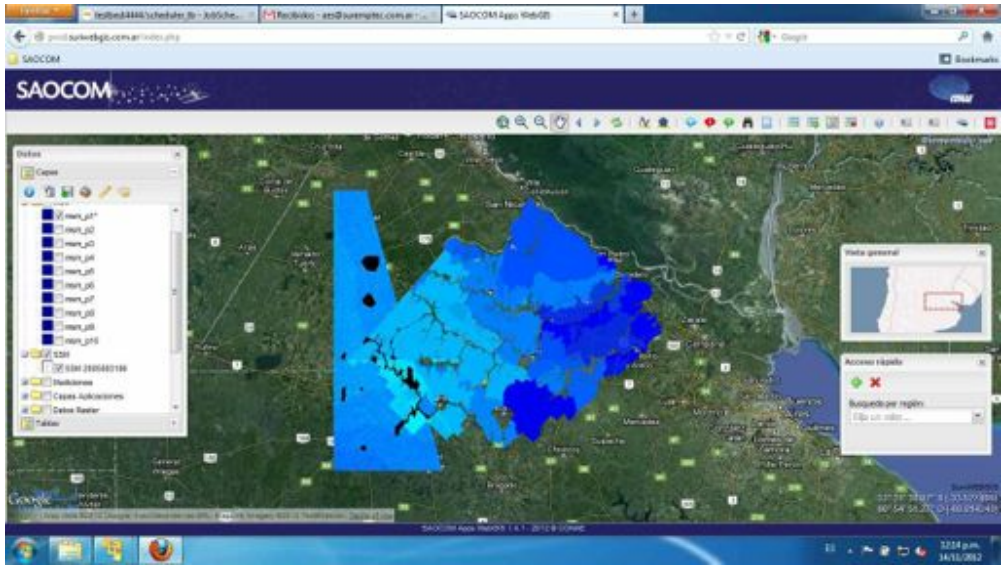
SAOCOM WebGis



Simulated Soil Moisture Map

SAOCOM GIS and Testbed

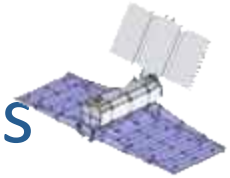




Homegeneous región profiles map, 5 cm depth

Homegeneous región profiles map, 90 cm depth

SAOCOM strategic applications objectives



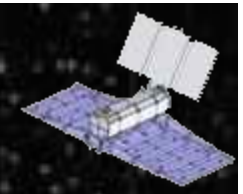
INTA:

1. optimize sowing time and fertilizer.
2. optimize the use of chemicals to control crop diseases (Head Blight disease).

INA:

minimize economic losses due to flooding by improving hydrologic forecasts.

SIASGE System



Quasi-simultaneous observacions

4 Italian

✓X-Band SAR

✓ COSMO SkyMed

✓ 4 already en orbit

2 Argentine

✓L-Band SAR

✓SOACOM 1A, 1B

Decision Support Data (DSD)

Provides yield scenarios considering farmers preferences on crop management and fertilization treatments.

Outputs	Crop yield scenarios and soil moisture profile
Units and layout	Yield: kg/ha, graphs and tables. Soil moisture profile: volumetric soil water content per soil layer, graph and table.
Available crops	Wheat, maize, soybean, and sunflower.
Temporal Resolution	Daily
Spatial Resolution	Local (on sites of 100ha)
Regional coverage	Buenos Aires, Córdoba, Entre Ríos, Santa Fe, and La Pampa
Availability	Web service and downloadable XML data
Timeliness	About 1 minute upon demand

Head Blight Desease

	PCP product	**UFC product**
Temporal Resolution	Daily	Daily
Grid cell size	(100ha)	Local on point values (100ha)
Timeliness	< 24 hours	< 24 hours
Areal coverage	Region of interest	Region of interest
Output	A progressive three level color map of the risk of FHB.	Progressive FHB index (Range: 0-100%)

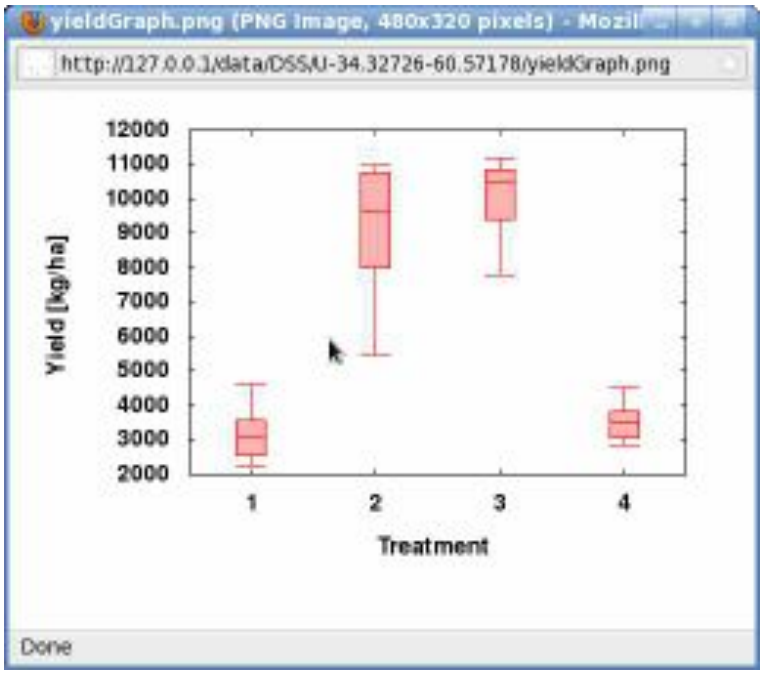
SYSTEM – Prototype - Input

Identification of site geographic coordinates with the aid of a tool like Google Maps.

Screen image of the web form used to enter farmer's queries.

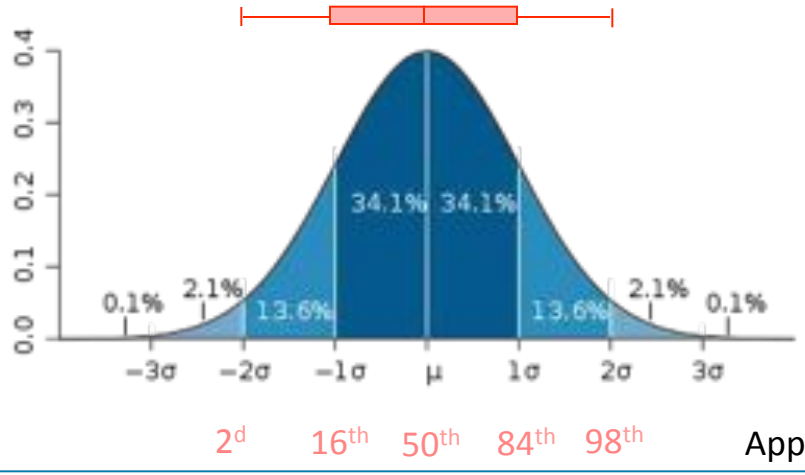
Calendar used for date selection.

SYSTEM – Prototype - Output



Maize yield distribution per treatment (including median) for Pergamino:

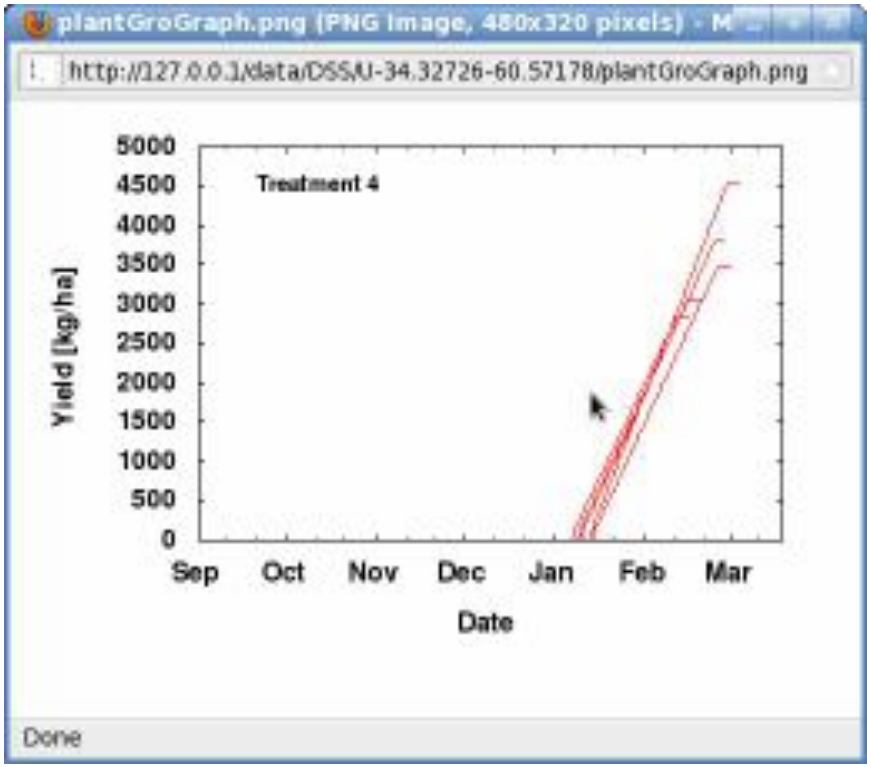
1. Without fertilization or irrigation;
2. N=100kg/ha, no irrigation;
3. N=100kg/ha, 100mm of water;
4. No fertilization, 100mm of water.



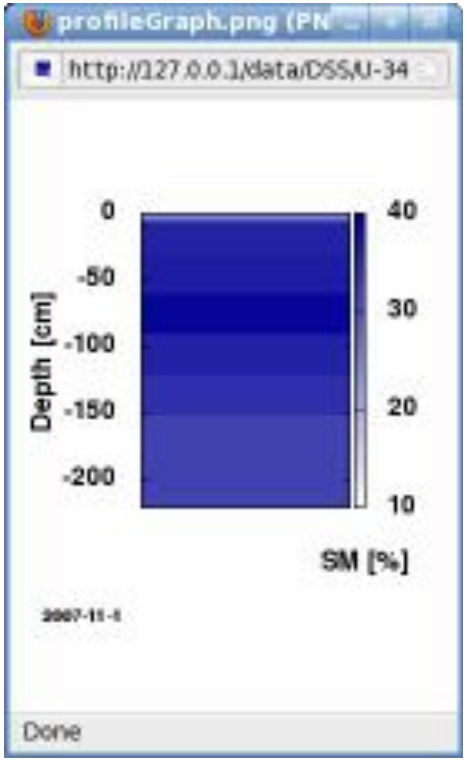
Relation between percentiles and the area under the normal curve.

Approx. percentiles

SYSTEM – Prototype - Output



Evolution of the grain dry weight over the time. The lines represent values for 2rd, 16th, 50th, 84th and 98th percentiles.



Soil water profile calculated with up-to-date values.

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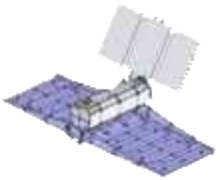
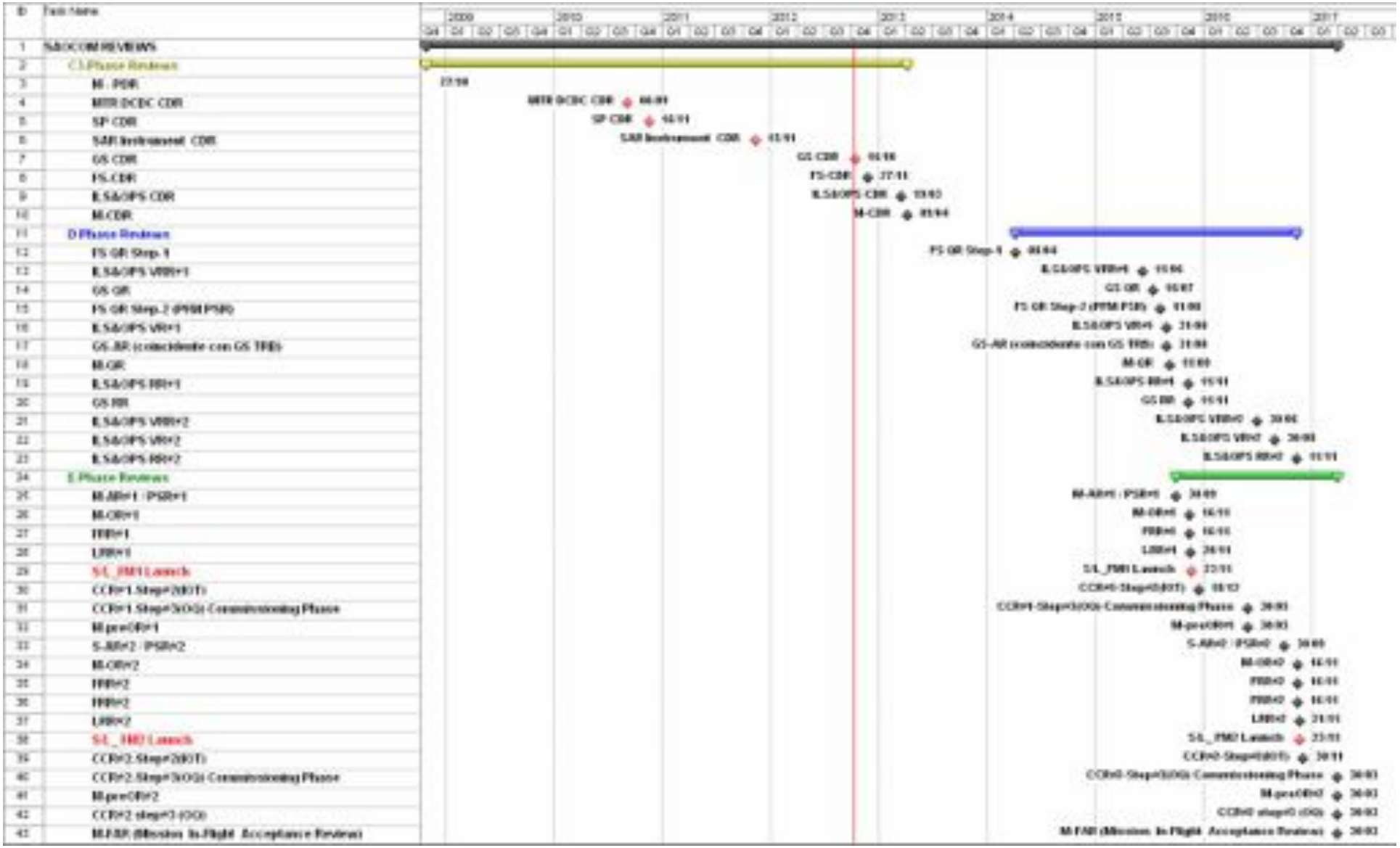
SAOCOM PROJECT MASTER SCHEDULE

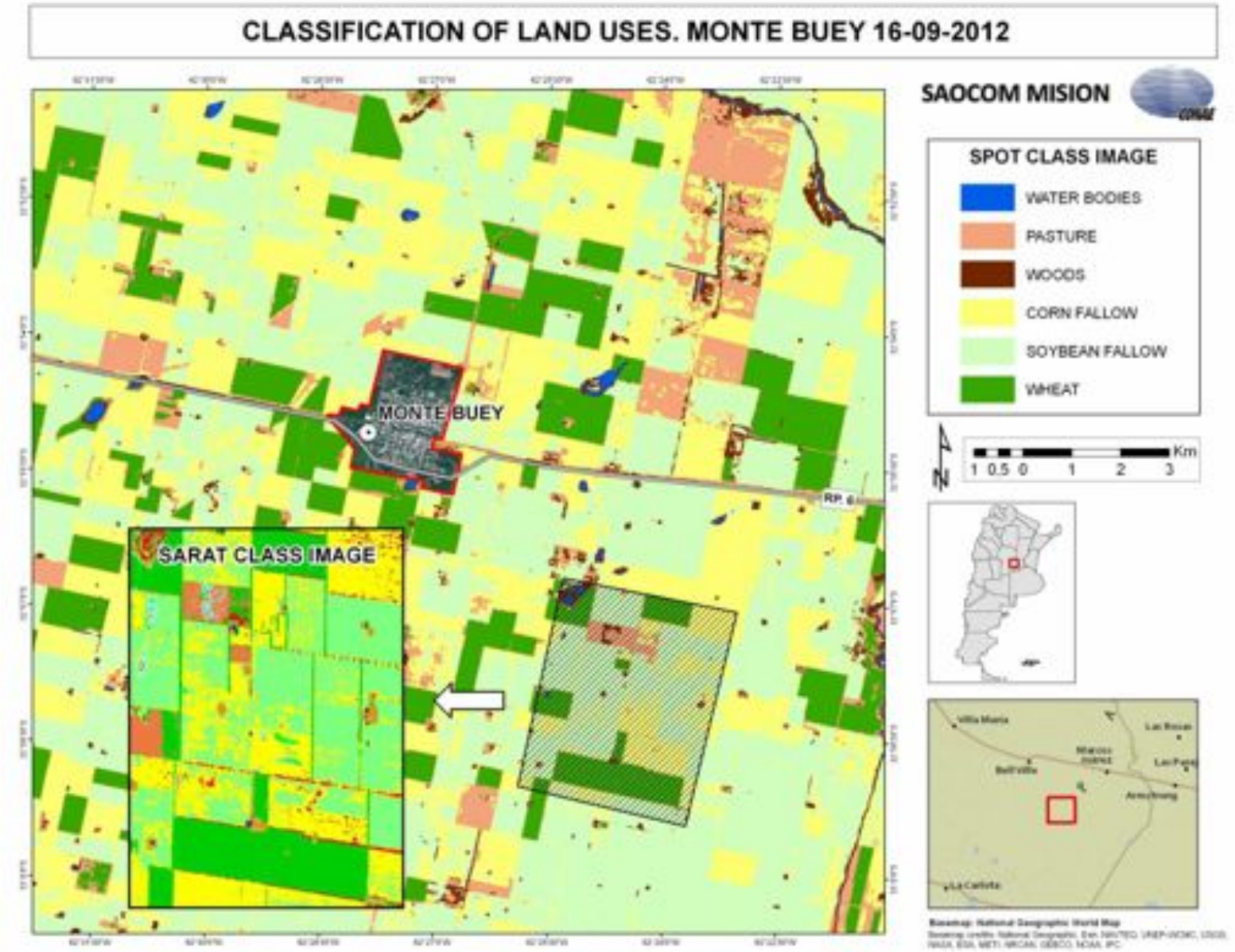




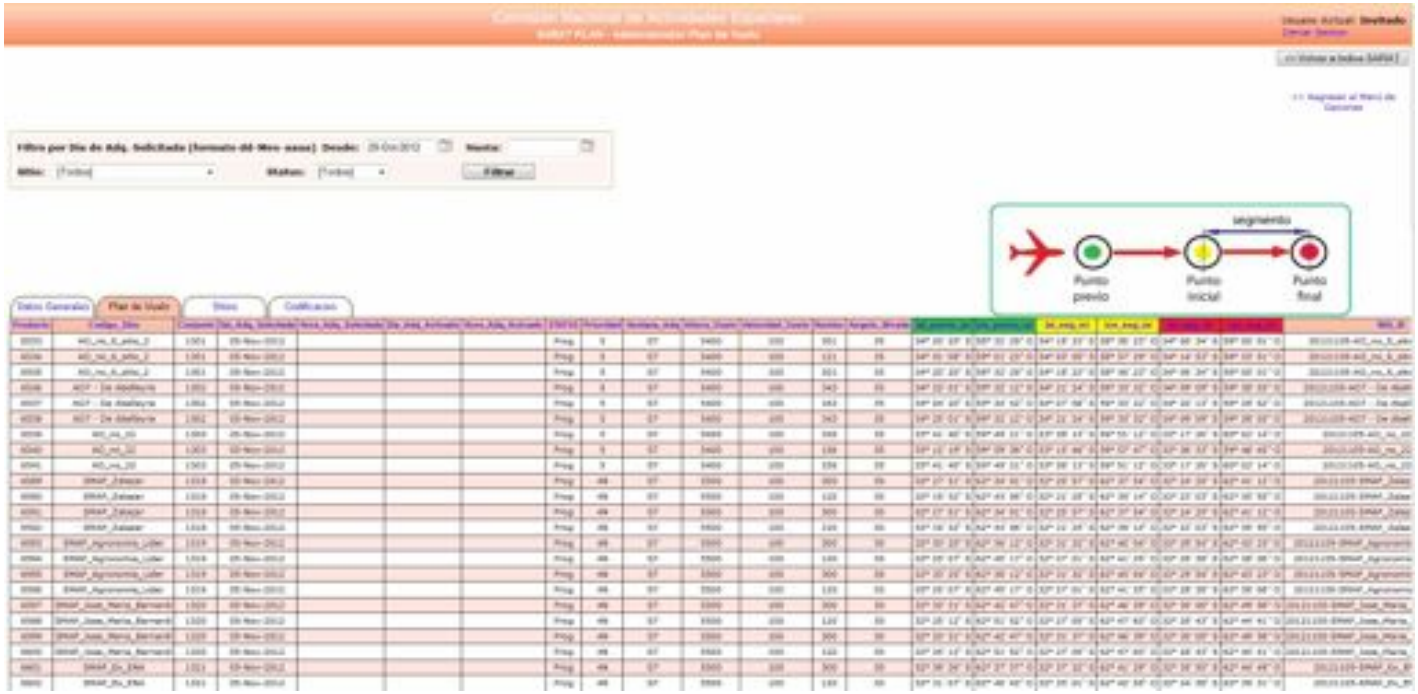
Existing Cal Val Network

Proposed SMAP Val. site,
Also ALOS-2 CVST site

Classification and Land Cover

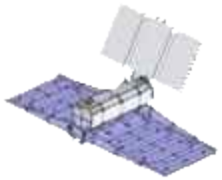


L-band Airborne SAR campaigns



Field trip campaigns

Objectives of the protocols



- To standardize the measuring process of soil moisture and related variables, ensuring the repeatability of the measurements

Comparable data

- To define measurement processes to satisfy the Strategic Applications requirements

- To contribute to obtaining reliable and validated data

Input of the Soil moisture CAL/ VAL Process

Measurement Protocols

2nd ROUND TABLE-WORK MEETING ON SOIL MOISTURE last April

- ✓ ***Soil Moisture Protocols***
  - **Direct Measurements** ⇨ **Gravimetry/Volumetry**
  - **Indirect Measurements**
    - **Portable Sensors (HPII)**
    - **Diviner Probe**

- ✓ **Biomass and Phenology** ⇨ "Crop measurements for model evaluations" – A. Oviedo

- ✓ **Data analysis** ⇨ "Spatial Analysis of In-Situ Soil Moisture Data" – A. Soldano

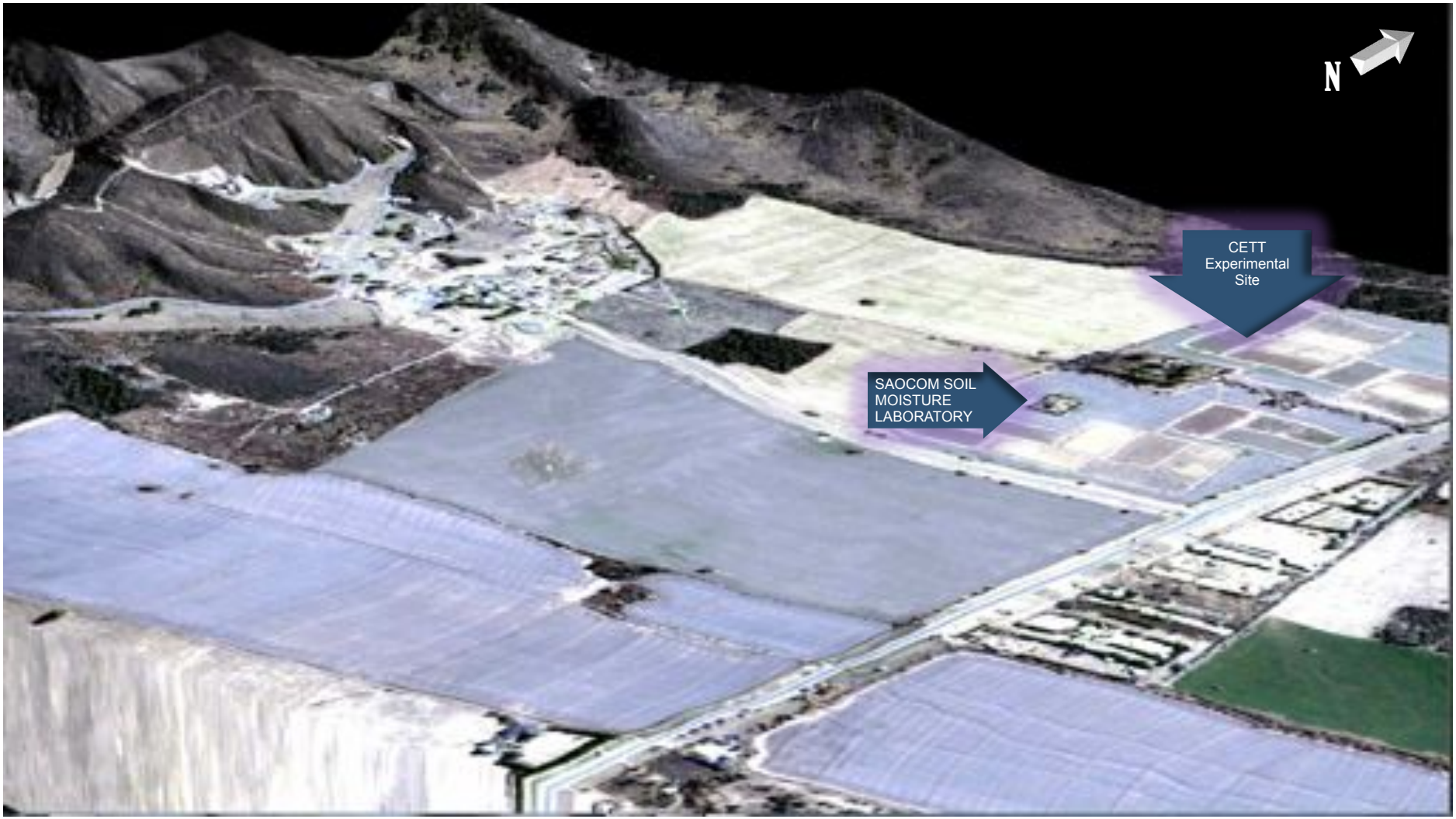
- ✓ ***Photographic, etc.***

Thank you

Back up slides

CETT- Teófilo Tabanera Space Center - CONAE

Characterization of the experimental site: Digital Elevation Model



World View II Images. Date: July 22, 2011
Spatial Resolution: 50cm.

Perspective view

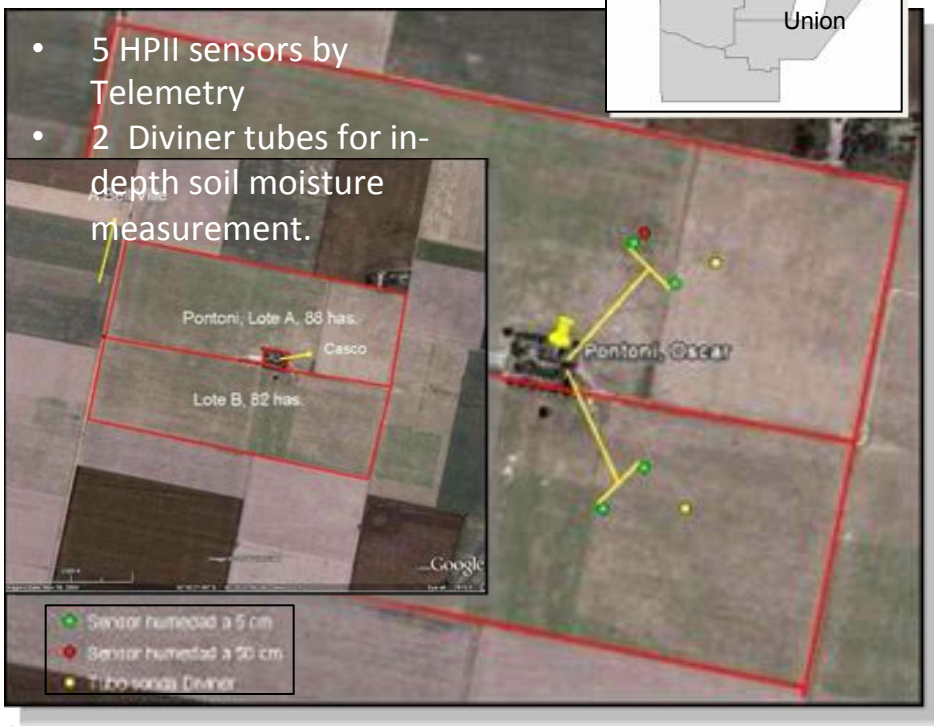
Vertical exaggeration factor: 5.

Industrial Sites: Examples

9 Industrial Sites in Cordoba Province: 1 Agro-technical Schools
8 Farmers

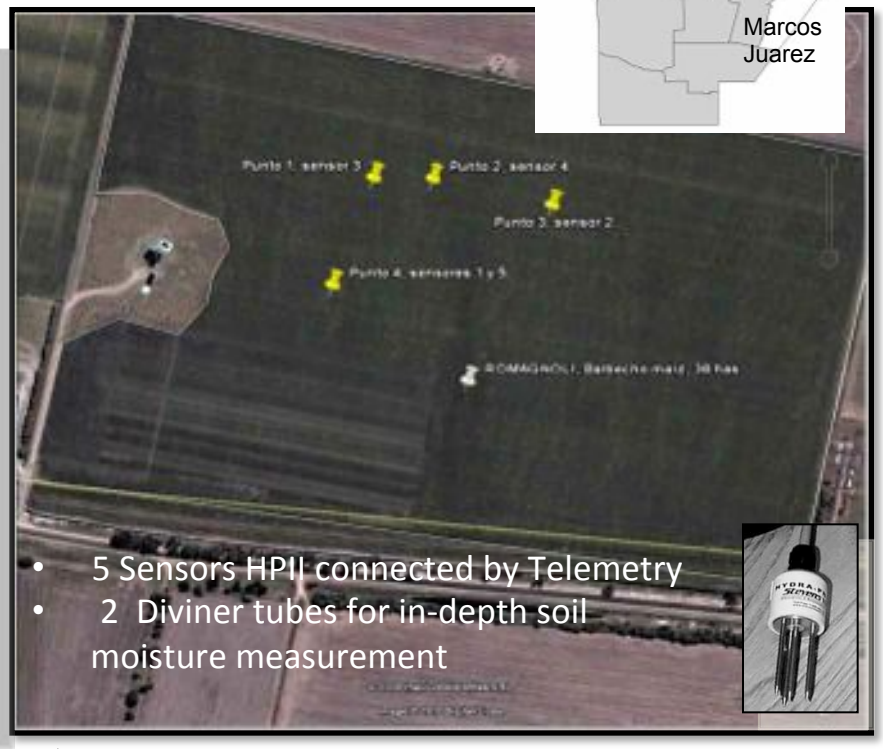
Belle Ville (4 sites)

Monte Buey (5 sites)



- 5 HPII sensors by Telemetry
- 2 Diviner tubes for in-depth soil moisture measurement.

▲ Example: Pontoni farmer's field

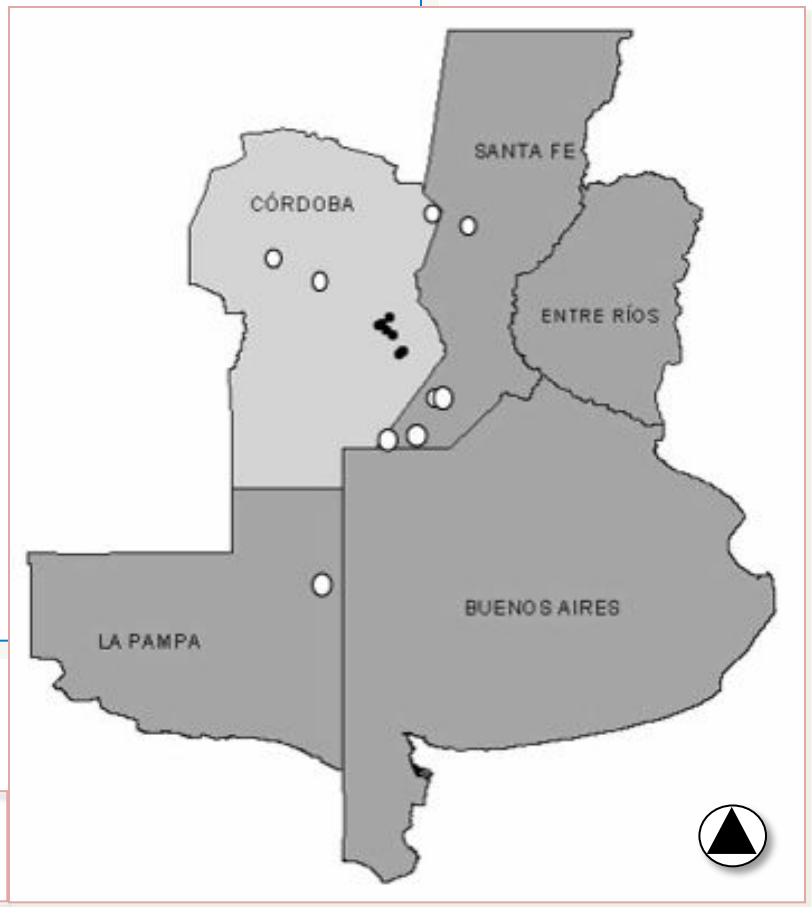


- 5 Sensors HPII connected by Telemetry
- 2 Diviner tubes for in-depth soil moisture measurement

▲Romagnoli-Monte Buey Group farmer's field

Summary of sites and sensors distribution

- ✓ **19 SAMPLING SITES** (10 of this total of 19 are connected through the telemetric network)**:**
  - 10 EXPERIMENTAL SITES.
  - 9 INDUSTRIAL SITES.
- ✓ **47 ECH$_2$O PROBES**
- ✓ **56 HYDRA PROBE II PROBES**
- ✓ **40 DIVINER TUBES** (1 instrument)



Preliminary remarks

- These protocols are applied during measurement campaigns conducted in the experimental sites

Core Sites – A. Soldano ✓

- Have been developed considering the SAOCOM Soil moisture Cal/Val Requirements and other existing protocols

SAOCOM Soil Moisture Cal/Val Requirements – M. Thibeault ✓

- Field campaigns schedules, sampling strategies and outputs of the implementation of protocols are developed in specific presentations:

Soil moisture measurements campaigns –L.Achával ✓

Crop measurements for model evaluations – A. Oviedo ✓

Spatial Analysis of In-Situ Soil Moisture Data – A. Soldano

SM Direct Measurements: Volumetry Protocol

Main application: Calibration and validation of indirect methods

Measured variable: Soil moisture (at the required depth)

Main steps:

1. Prepare the area to be sampled (Remove vegetation and litter).
2. Take the sample (a. Insert the can into the soil. b. Remove the can. c. Use the spatula to smooth the edges. d. Put the caps).
3. Tare (to obtain wet weight of the soil sample).
4. Dry the soil sample in the oven for approximately *24 hours* at *105 ºC*.
5. Tare (to obtain dry weight).
6. Compute the volumetric soil moisture through $VSM = (V_w / V_p)$ [cm^3/cm^3]

$V_w = W_w/\rho_w$ = Volume of water lost in the drying [cm^3]
V_p = Volume of the can [cm3]


1


2a


2b


2c


2d

3/5


4

SM Indirect Measurements: Portable sensors HPII

Main application: Field campaigns associated with SARAT campaigns – routine measurements campaigns

Measured variable: Soil moisture at surface, 10 and 50 cm depths (These sensors can measure other variables like soil salinity, soil temperature, etc.)

Main steps:

1.Select the soil surface or dig a hole at the required depth with a shovel. Use a spatula to smooth the surface of the soil where sensor is to be installed **trying not to disturb the soil**. Remove vegetation and litter.

2.Connect the sensor to the PDA and choose the Stevens Hydramon software in the display. After opening the software, set up sensor and ***soil conditions (Manufacturer-supplied calibrations)***.

3.Create a file with the name of the site (field or plot) and date of sampling.

4.Insert the sensor into the prepared surface soil. Push the tines of the Hydra Probe into the soil until **the base of the tines is flush with the soil**.

5.Take the soil moisture measurement by pressing “Sample”.

6.Read the soil moisture value at real time from the PDA screen and record the obtained values in the field sheet.

SM Indirect Measurements: Portable

PDA

Taking measurements at 5 cm depth

HPII at different depths

Soil surface measurements

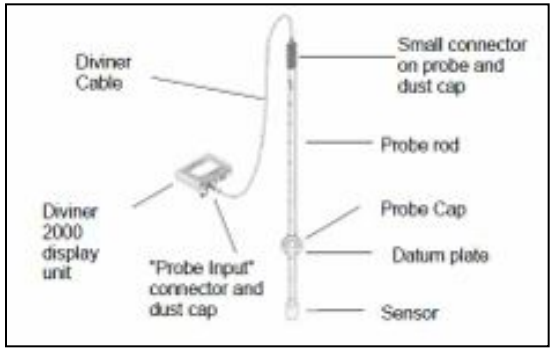
SM Indirect Measurements: Diviner 2000

Main application: Routine measurements campaigns – SARAT Campaigns

Measured variable: Soil moisture profile, 10 to 160 cm depths (readings every 10 cm)

Main steps:

1. Unscrew the cap on the access tube and insert the probe.
2. Align the two lugs on the access tube top cap base with the gap in the Diviner 2000 datum plate.
3. Screw down the probe cap to the top of the access tube.
4. On the display unit, press SCAN. The selected soil profile, time and date appear on the top of the screen. Verify that the soil profile is correct.
5. Press ENTER. The prompt “Position the probe at start point” appears.
6. Position the probe at start point.
7. Insert the probe at a constant rate to the depth of the profile.
8. Remove the probe at the same constant rate.
9. Press ENTER to try again or DELETE to exit. The readings are displayed in the default screen that you selected during setup.



Components

Access tube installed

Taking measurements

Photografic Protocol

Main application: : Field campaigns associated with SARAT campaigns – routine measurements campaigns.

Objective: To get a real picture of the scene at the time of measurement to complement the information of the measured variables.

Main steps:

• Register: Name of photographer, date acquired, number of plot and treatment, capture number and direction (north, south, east, west).
• Locate the camera at appropriate distance to focus the entire plot without using the camera zoom (1st and 2nd photo).
• Repeat the capture at least twice, from different angles and orientations of the plot to obtain a well represented spatial variability.
• If the plot has vegetation, take photographs comparing the plant height with a standard pattern (3rd photo).
• Photograph vertically the vegetation coverage at least in two or three representatives sites within the plot (4th photo).
• Place a ruler or object of known length (shovel, hammer, knife, etc.) in the visual field of photography to size the image frame (4th photo).

Photografic Protocol

1

2

3

Wooden ruler (1 m)

Shovel

Hammer

4

Final remarks

• The basic protocols have been developed and are currently applied in the measurement field campaigns.

• Next protocol documents to develop:

- Related with upload data of field campaigns to the GIS database
- Document for Field campaigns associated with SARAT campaigns

• Next protocols to develop:

- Data quality protocol
- Sensor calibration protocol (HPII + Diviner 2000)

The goal is to have a protocol for each measurement or validation activity related to soil moisture field campaigns

Crop measurements

The crops data are used as input for the Calibration/Validation of the Crop Simulation Models and the model describing the interaction between the electromagnetic wave and the vegetation.

Phenologic and phenometric observations:

1- Phenology

2- Plant height

3- Biomass: wet and dry weight (stems, leaves and reproductive organs)

4- Length / Width leaf

5- Length / Width stem

6 Length / Width reproductive organ

7- Percent Ground Coverage

8- Yield components: number of plants/m2, spikes or chapters or pods/ plant, grains/ spikes or chapters or pods, grain weight.

9- IPAR and LAI in plant canopies.

- General observations:

10- Degree of weed infestation

11- Infection plagues of soil, leaves, grain

12- Diseases: leaf, vascular

13- Adversities: intensity.

14- Type of adversity: frost, hail, flooding, overturn, drought.

15- Detailed photo of the plant, and panoramic photo of the plot.

16- General condition