Overview

- Argentina National Space Plan and satellites missions
- SAOCOM mission
- Soil Moisture Map as the main driver
- The satellites: spacecraft and sensor
is centered in the development of Spatial Information Cycles involving different applications

As a starting point: CONAE’s National Space Plan

- **Cycle I**: agricultural, fishing and forestry production
- **Cycle II**: weather, hydrology & oceanography
- **Cycle III**: natural and human-induced disasters
- **Cycle IV**: environment and natural resources
- **Cycle V**: cartography (including territorial, urban and regional planning), geology (including oil and gas prospecting), and mining production
- **Cycle VI**: health
Courses of Action

CONAE

Satellite Missions

Access to Space

Information Systems

Ground Infrastructure

Institutional Development

SAOCOM Mission Overview
L. Frulla, J. Medina, J. Milovich, G. R. Ortega, Marc Thibeault
CEOS SAR Cal/Val Workshop, Fairbanks (Alaska) USA, November 7-9, 2011
The National Space Program provides three satellite series, depending on the main instruments they carry on board.

**SAC Series**

Instruments centered on the optical, thermal and passive microwave ranges.

**SAOCOM Series** (or SAR series)

Instruments centered on the active microwave range (SAR).

**SARE Series**

Technological and/or earth sciences objectives which can include:

- any type of the sensors mentioned
- test of segmented architecture
A constellation of two identical satellites (SOACOM 1A, SAOCOM 1B) L-Band polarimetric SAR

To be launched during 2014/2015

- An end-to-end Earth Observation System dedicated to the remote sensing and data exploitation
- The satellites shall be injected into a sun-synchronous nearly circular frozen polar orbit
  - altitude: 620 km
- Pass over the Equator: 6 AM ascending node
- With a maximum repeat cycle of 16 days (8 days with full constellation)
- Mission lifetime of 5 years
SIASGE System
(Italian-Argentinean satellite system for societal benefit, emergency management and economic development)

Quasi-simultaneous observations

4 Italian
- X-Band SAR
- COSMO SkyMed
- all already in orbit

2 Argentinean
- L-Band pol. SAR
- SOACOM 1A, 1B
As a starting point, and to be prepared to the use of SAOCOM & SIASGE data,
Mission Objectives

• user needs:
  - to obtain **soil moisture maps** (hydrology-including floods, agriculture, climate and health)
  - to exploit the capability of SAR **interferometry** for information extraction (terrain modeling, terrain displacement mapping, vulcanology, etc.)
  - to give support to emergencies in general

• **National Space Plan**-Space information Cycles
General SAOCOM Features

- The SAOCOM main payload is a SAR and the objectives are to provide:
  - all weather, day/night, polarimetric L-Band SAR information,
  - a uniform worldwide observation coverage
  - real time/stored acquisition modes,
  - data with high/medium spatial resolution from 10 to 100 m,
  - an access area of about 220 to 430 km,
  - acquisitions at different incidence angles ranging approximately from 20 to 50 degrees.
  - right-looking, in nominal condition
  - left-looking capability
SAOCOM Ground Segment

➤ Ground Segment Facilities

✔ The **ETC** (*Estación Terrena de Córdoba*), located in *Falda del Carmen*, Province of Córdoba, Argentina shall be the main Ground Station available in Argentina by CONAE, for TT&C and SAR data download.

✔ The Italian **Matera Ground Station** shall be an available station for L-Band SAR data download. This is according to the availability given to CONAE by ASI through SIASGE cooperation.
At least the following levels of products shall be obtained:

- **RAW** data products,
- **Level 0** products
  - Annotated RAW data-AR
- **Level 1** products
  - Level 1A: Single Look Complex-SLC,
  - Level 1B: Detected Image-DI,
  - Level 1C: Ground Ellipsoid Corrected-GEC,
  - Level 1D: Geocoded Terrain Corrected-GTC.
- **Higher** level products.
Partially financed by the Interamerican Development Bank

Based on the development of three applications considered as “strategic” because of its socio-economic impact.

Area of interest: *Pampas region* and the catchments from the fraction of the “*del Plata Basin*” (~83,000,000 ha).

The main Argentinean region dedicated to *agriculture* and *cattle production*.
The Pampa region is an extended low and flat land. Over 73% of the area, have variations in the terrain heights from 0 to 200 m.

NDVI study based on one year of NDVI 16-days MODIS data. In terms of the areas cultivated, the main crops are soybean, wheat, corn and sunflower, in that order. Secondary crops are sorghum, barley, potatoes.

Permittivity
The soil texture of the region is mostly loam, silt loam, sandy loam and clay loam. Soil Data Base INTA (National Agricultural Technology Institute of Argentina).

Simulation, Perplinsky-Dobson’s and Topp’s model, for the Pampa's soils
Numerical Forward models generate data cubes according to the vegetation type. The more robust algorithms used backscatters: $\sigma_{HH}^0$, $\sigma_{VV}^0$, $\sigma_{HV}^0$.

These numerical models assumed bare soil models and these cubes should flatten to planes for low vegetation. In this case, we are left with two inputs: $\sigma_{HH}^0$, $\sigma_{VV}^0$. 
Architectural Design

SAOCOM image subset
topography masked

Bare vs Vegetated Soil
- Code image (BVS-Code image)

BVS of pixel (i,j)

TDP (Tree Decision Processing)

Angle of pixel (i,j)

IAM ( Incident Angle Map)

BVS = 10

BVS = 20 to 30

BVS = 00

Look Up Table

SBP (Soil Moisture Bare Soil Processing)

no processing

SVP (Soil Moisture with Vegetation Processing)

Surface Soil Moisture Product

Data Cube

Crop A
Crop B
Crop C
Crop N

Angle
SAOCOM Main Commitment

INTA (agriculture):
1. to optimize the agrochemical use in crop disease control
2. to optimize sowing time and fertilizers

INA (hydrology):
- minimize losses due to floods in Argentina.

the generation and the distribution of operative soil moisture maps over the area of interest.
The challenge

- to infer **surface soil moisture** values from SAR measurements,

- to generate **surface soil moisture maps** in an **operative way** over the area of interest,

- to assimilate the **surface soil moisture** values into **crop growing models** in order to obtain **improved soil moisture profiles** (up to **2 meters**) needed by the agricultural applications,

- to assimilate the **surface soil moisture** values into **hydrological models** in order to improve the **hydrological forecasts**
**SAOCOM Spacecraft**

- **L-Band SAR payload**
- **Communications**
  - **S band** for telecommand and telemetry
  - **X band** for SAR payload data download
- **Power**
  - **2.5 kW** average power generation
  - **3.6 kW** average SAR consumption during acquisition
  - **650 W** average platform consumption
- **Attitude control:**
  - **Zero Doppler** pointing
  - **Right/left** looking capability
- **3 Tons** total mass
SAOCOM SAR Instrument

SAOCOM Mission Overview
L. Frulla, J. Medina, J. Milovich, G. R. Ortega, Marc Thibeault
CEOS SAR Cal/Val Workshop, Fairbanks (Alaska) USA, November 7-9, 2011
SAOCOM SAR Central Electronics

**Main Characteristics**

- **Signal & Synchronism Generator**
  - Arbitrary waveform generation up to 50MHz & 60μs @ L band (split BW possibility)
  - Synchronizing signals generation

- **Central Receiver**
  - Low noise echo signal amplifier
  - Signal filtering and down conversion to IF

- **Central Transmitter**
  - SAR signal power amplifier

- **Solid State Recorder**
  - Mass memory for science and auxiliary data (256 Gb)

**Control & Digitization Unit**

- Command & telemetry
- MTRs configuration & control
- Echo digitization
  - @ 12:8 bits (truncated) or 12:4 bits (BAQ)
  - Sampling frequency @ 120MHz / 60MHz / 30MHz
SAOCOM SAR Antenna

MAIN CHARACTERISTICS

- 10m x 3.5m active phased array antenna
- Azimuth and range beam steering capability
- 7 panels of 20 rows each
- 140 L-band TRMs
- 3.9kW peak radiated power
SAOCOM SAR DATA DOWNLINK

MAIN CHARACTERISTICS

- Transmitted data formatted according to CCSDS recommendations
- Data rate of 310Mbps
  - 2 X-band (8.0 to 8.4GHz) 8PSK transmitters providing two 66.65MHz channels capable of transmitting at a bitrate of 155.5Mbps each
  - The output of the transmitters is injected to an output multiplexer
  - One single transmit antenna is used.
- Stored, real and quasi real time (acquisition bitrate > DDL) download modes.
## SAOCOM Operation Modes

<table>
<thead>
<tr>
<th>Acquisition Mode</th>
<th>Polarization Mode</th>
<th>Polarization Combinations (TxRx)</th>
<th>Nominal Swath</th>
<th>Spatial Resolution</th>
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<tr>
<td>StripMap</td>
<td>SP</td>
<td>HH or HV or VH or VV</td>
<td>&gt;40 km</td>
<td>&lt; 10 m</td>
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<td>DP</td>
<td>HH/HV or VV/VH/VH</td>
<td>&gt;40 km</td>
<td>&lt; 10 m</td>
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<td>QP</td>
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<td>DP</td>
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## SAOCOM Beams Design

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<th>Inc. Ang. Near [Deg]</th>
<th>Inc. Ang. Far [Deg]</th>
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</table>
SAOCOM SAR Features Summary

- **Polarimetric capabilities:** single, dual, quad & compact pol
- **Central Frequency:** 1275 MHz
- **Pulse BW & duration:** up to 50 MHz & 60 μs (programmable)
- **PRF:** up to 2500 Hz per channel (programmable)
- **Radiated peak power:** 3.9 kW
- **Quantization:** 8 bits or BAQ 4 bits
- **Operation time:** 15 minutes average per orbit
- **Mass memory:** 256 Gbits
- **Download bitrate:** 310Mbps
- **Download modes:** stored, real time and quasi real time
- **Acquisition modes:** stripmap and topsar
SAOCOM Launch

SAOCOM 1A
→ December 2014
→ Vandenberg TBC
→ Space-X Falcon 9

SAOCOM 1B
→ December 2015
→ Vandenberg TBC
→ Space-X Falcon 9
Thank you
### SAOCOM Mission Schedule

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