Assessment of instrument STability and Retrieval Algorithms for SMOS data (ASTRA)

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I - DOMEX-2 : long time stability of L-band emission at Dome-C Antarctica

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Objectives

Verify the use of the East Antarctic plateau as an extended target for calibrating and monitoring the performances of SMOS:

- Evaluation of the long-time stability of L-band microwave emission by using ground data collected at Concordia station in 2008-2009 (Domex-2) and comparison with the results obtained during Domex-1 (2004-2005)

- Evaluation of spatial stability of microwave emission by using active and passive satellite data
Dome C: Location

- The site is viewed on a **sub-daily frequency** by polar-orbiting satellites, at a variety of incidence and azimuth angles.
- **Homogeneity** of snow surface at the **100 km scale**.
- **Small surface roughness** relative to other ice sheets.
- Low snow accumulation rate (around 3.7 cm/yr).
- **Clear sky**, and extremely dry and stable atmosphere.
- Well known topography and environmental condition.

Concordia Station (Dome C): 75.125 S, 123.25 E
3270 a.s.l.
Extrapolation to L-band indicates average seasonal amplitude << 1 K

C-band suggests that DC $T_b$s are sufficiently stable to identify drifts in SMOS calibration – But experiments needed to verify annual L-band stability
SMOS coverage at Dome-C

Typically 2-7 overlapping passes/day

- numerous overpasses per day
- distributed in incidence, azimuth
DOMEX-2 Preparation

- L-band radiometer:
  - New antenna → Potter Horn
  - New thermal system:
    - 1 year experiment in extreme environmental conditions
      Temp = -80°C / -15°C
    - thermal stability
    - Minimize sun effect (during summer)

- Radiometer Tests and Calibration
**The Instrument**

- **RaDomeX - Radiometer**
- **Frequency**: 1413 MHz
- **Bandwidth**: 27 MHz
- **Sensitivity**: $0.2\, K\, (T_i = 2\, sec)$
- **Polarization**: H and V
- **Antenna**: Potter Antenna
- **HPBW**: $20^\circ$
The Instrument

Antenna: Potter horn

OMT

Radiometer

PC

IR -radiom

180 cm

70 cm
Thermal Tests

THERMAL CHAMBER
• -25 / -65 °C
• Diurnal Cycle
• IR Lamps – solar effect
• ESA TEC – model and design
Thermal test results: OMT

12° External Temperature Variation = Negligible Internal Temperature Variation
Radiometer Calibration

Lake and Sky Measurements
Anechoic Chamber
Radiometer Calibration

\[ y = 1.3003x - 74.383 \]
\[ R^2 = 0.9989 \]

\[ y = 1.2794x - 75.192 \]
\[ R^2 = 0.9994 \]
Domex-2 Experiment

- An **experimental campaign** (DOMEX-2) with **ground based radiometers** started at Concordia Base in Austral Summer 2008 to check the stability of L band emission at yearly scale, within the framework of the ESA-SMOS calibration and validation activities.

- **Snow measurements (including ice core)** were carried out during the summer campaign in order to characterize physical snow properties of the first 10 meters. These data will be used as inputs to a multi-layer electromagnetic model able to simulate Tb.
The DOMEX Campaign

Air temperature
Mean: - 53 degs
Max: - 23 degs
Min: - 78 degs

TOWER VIEW
Concordia base
Tower Installation

RADOMEX support

RADOMEX
Tower Installation

15 m
DOMEX-2 Schedule

- Start: 29 November 2008
- End: November 2009 (TBC)
- Data Transfer: Tower → Base → Italy (1 day)
- Measurements cycle:

![Graph showing time vs incidence angle with labels for ICE - SHEET 90° - 30°, Sky (calib.) 90° - 130°, and SMOS Fixed Angle 42°]
Complementary Snow measurements

Snow layers:
- Temperature
- Hardness
- Density
- Grains shape and Size
- Dielectric Constant

Snow deposition:
Grains shape and Size Classification (precipitation, hoar, wind, etc.)
Domex-2 – Preliminary results

Not calibrated data
Domex-2 – Preliminary results
Instrument Temperature Monitoring

RF components
Cables and connectors

DAILY Fluctuations < 1.5 °C – as expected by ESA-TEC model
DOMEX-2 Temporal Stability

January / March Comparison

Time (min.)

Tb - Vertical Pol (K)

January = blue
March = pink

Not calibrated & not temperature corrected TB differences < 1 K
DOMEX-2 Status and Summary

- The instrument has been developed and successfully tested in Italy
- The instrument has been installed at Concordia base
- Experiment started at the end of November and is now in progress
- Thermal stability of the instrument is confirmed (as predicted by the ESA-TEC model)
- First results are promising
- Absolute calibration will be considered in the next months (temperature correction and deconvolution effect)
- Satellite data analysis (spatial variability) is in progress