NOVELTIS

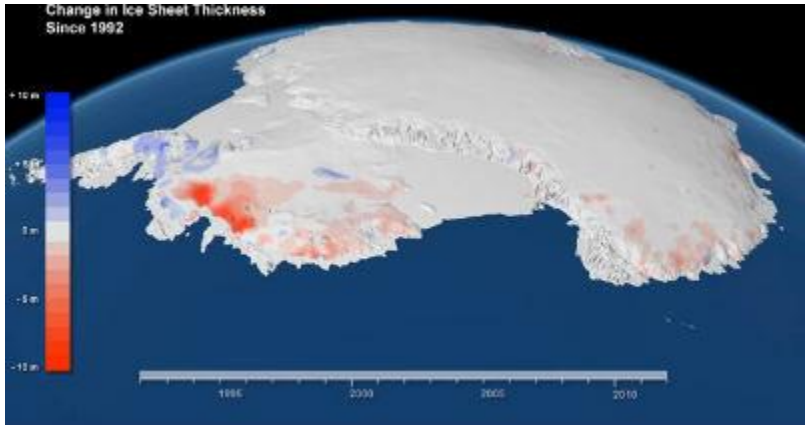
L'innovation au service de la Protection du Vivant

EM modeling of Antarctica

afaq ISO 9001 Qualité AFNOR CERTIFICATION

- Global warming may result in Antarctic ice-sheet melting

- The 3D structure and physical properties are not well known



- Remote sensing is needed
- ESA's POLARIS did a pretty good job at it
- Extraction of ice-sheet properties still open

Figure 1.1 POLARIS mounted on the Basler DC-3T aircraft during the IceGrav campaign.

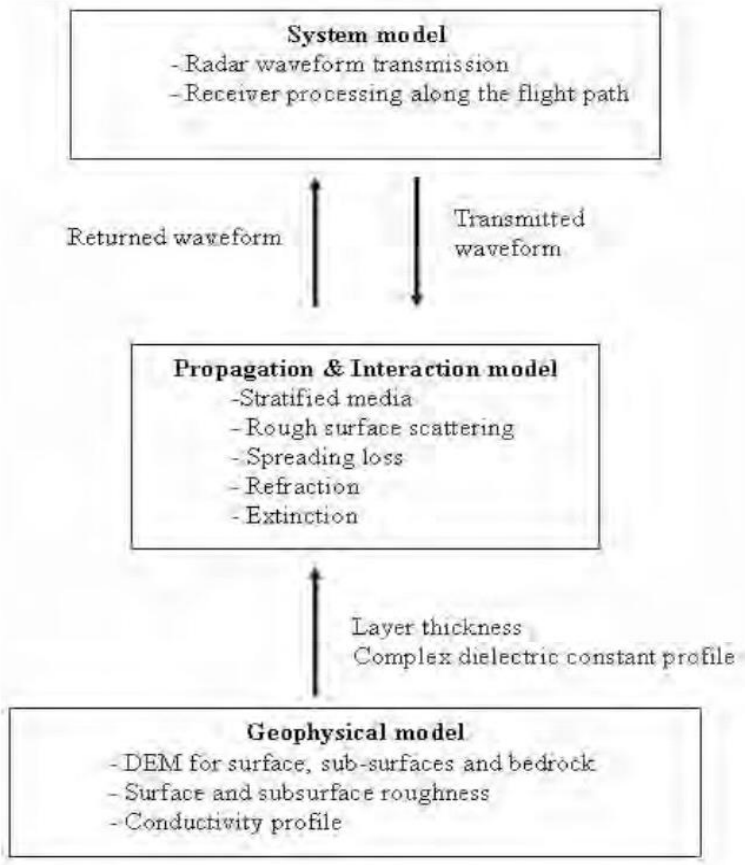
- Objective is twofold
  - To build realistic models of Antarctic ice properties: with such models, data are easily interpreted
  - Using them, to assess the feasibility of a spaceborn radar

- Dedicated models
  - Cannot be exact solver of Maxwell equations
  - Many models in the literature (Elfouhaily & al.)
- Able to reproduce:
  - Surface scattering
  - Internal reflections (ILLUSTRATION)
  - Bedrock reflection
  - Attenuation level

- ESA's project: *Antarctic Ice Sounding Experiment using ESA's P-band Polarimetric Sounder* (AnIS)
- Contractors: NOVELTIS, DTU, BAS, eOsphere
- NOVELTIS: main driver of EM model definition and validation

- The model is called EMIce
  - C++ code
  - Typical sim time of a few hours
- Developed at NOVELTIS
- It gives the return waveform of a given scene shot by a given air-borne radar

- CEMIce modules
  - System simulator: pulse generation, signal processing
  - Geophysics simulator
  - Interaction / propagation model
- Pretty much independent on each other
  - Each was adapted to the POLARIS case
- (multi-)Antenna patterns



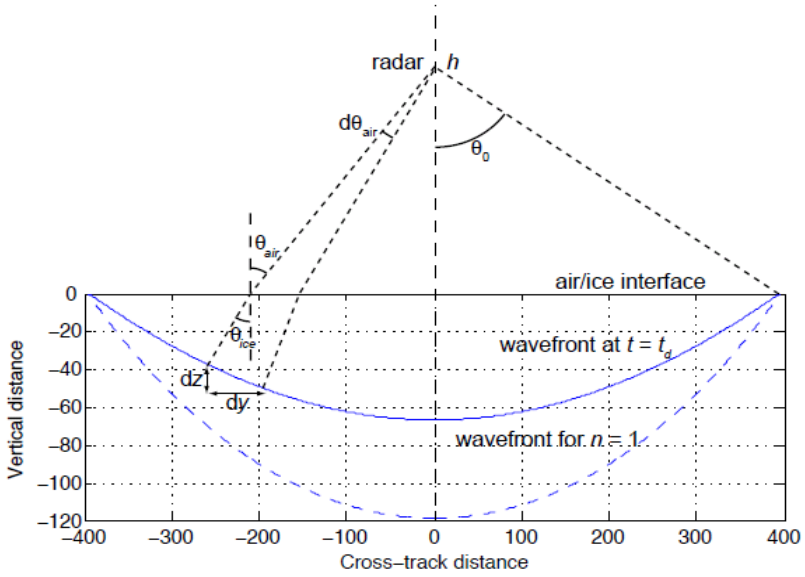
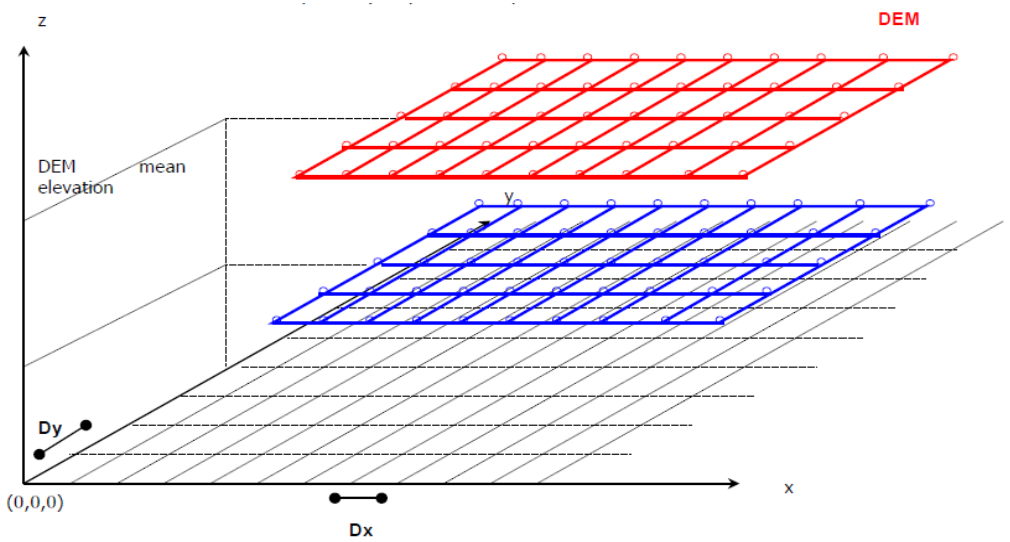


Figure 1 Ice sounding geometry.



Scene definition

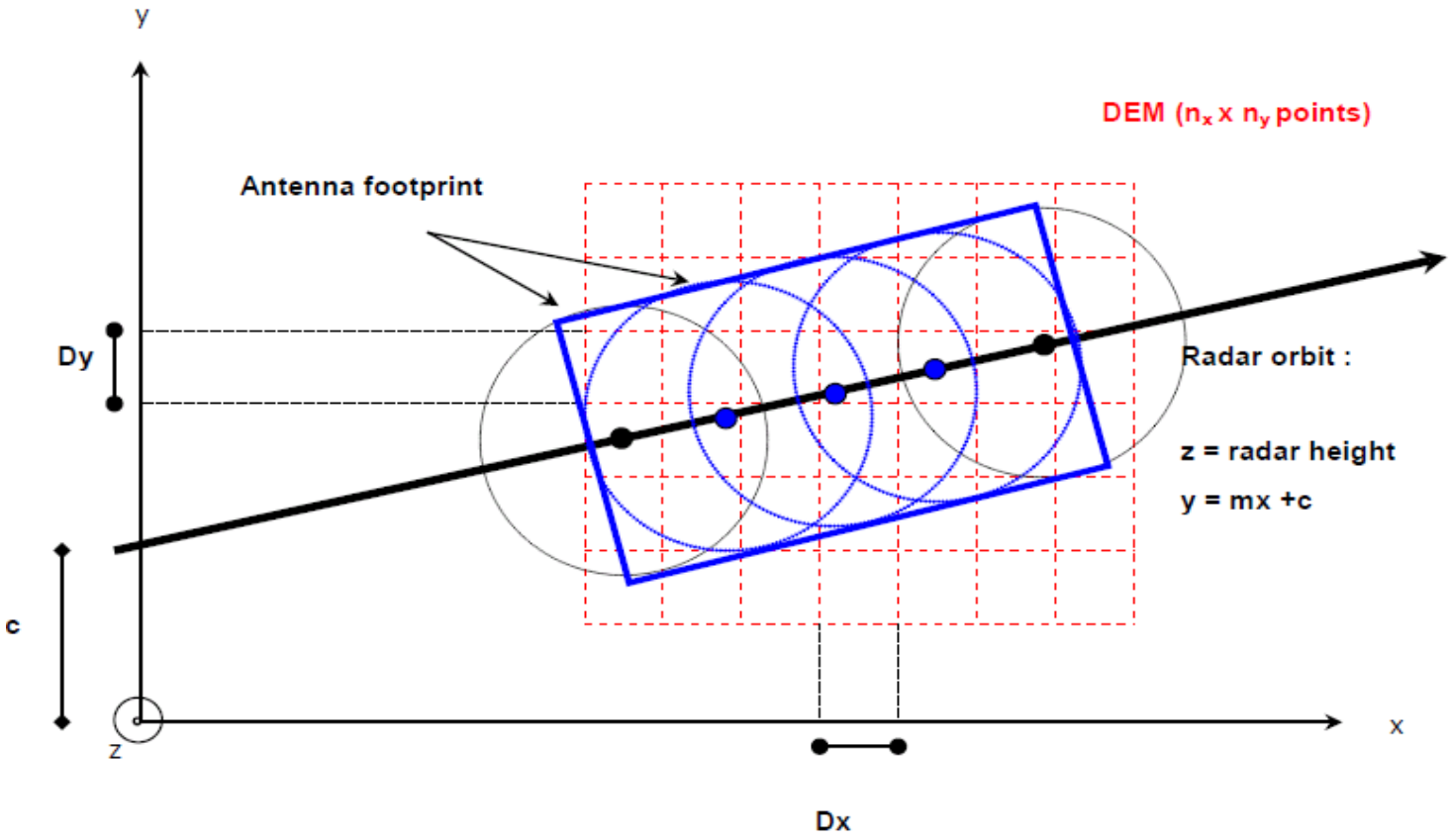


Figure 6 : Orbit definition over the simulation domain

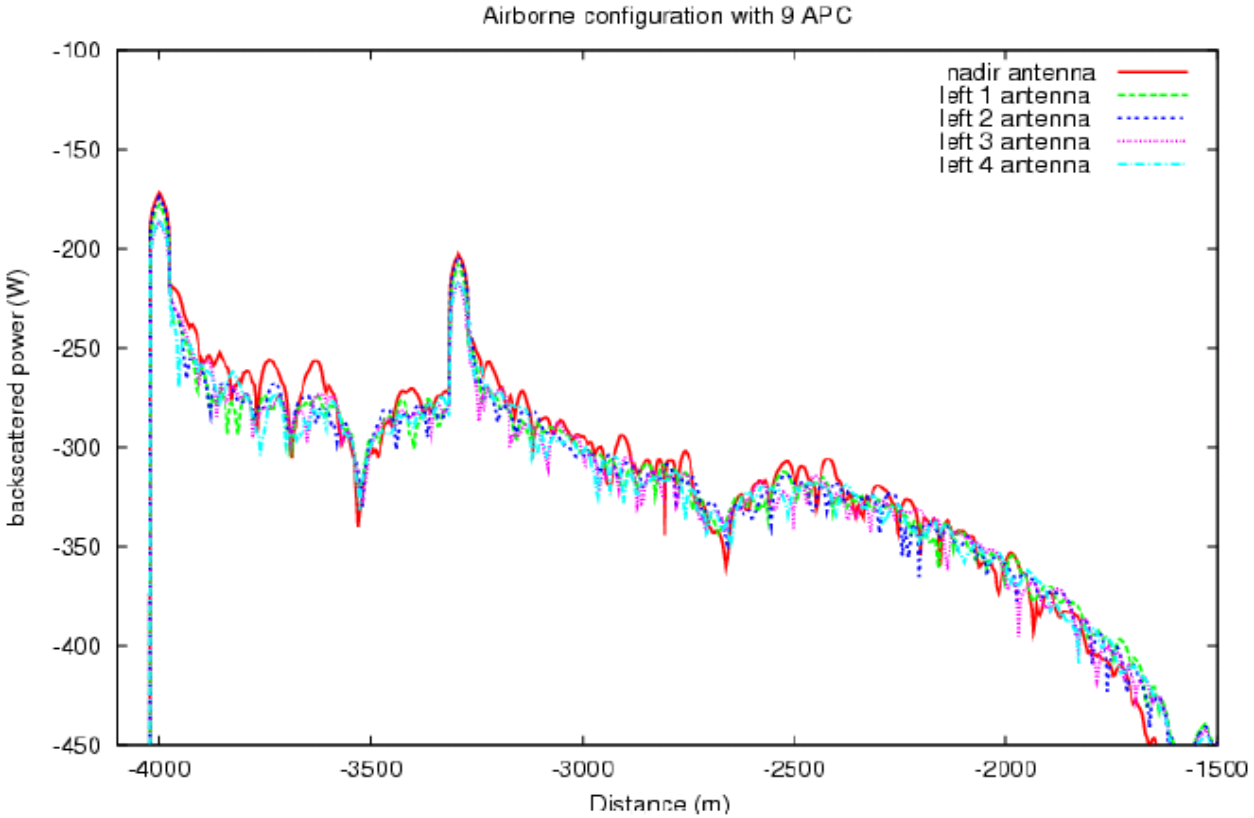


Figure 11: Airborne configuration 5 APC (1 nadir and 4 from the left) backscattered signal (2 m interval between phase center). No point targets considered. Surface at 4000 m elevation and a sub-surface at 3600 m elevation

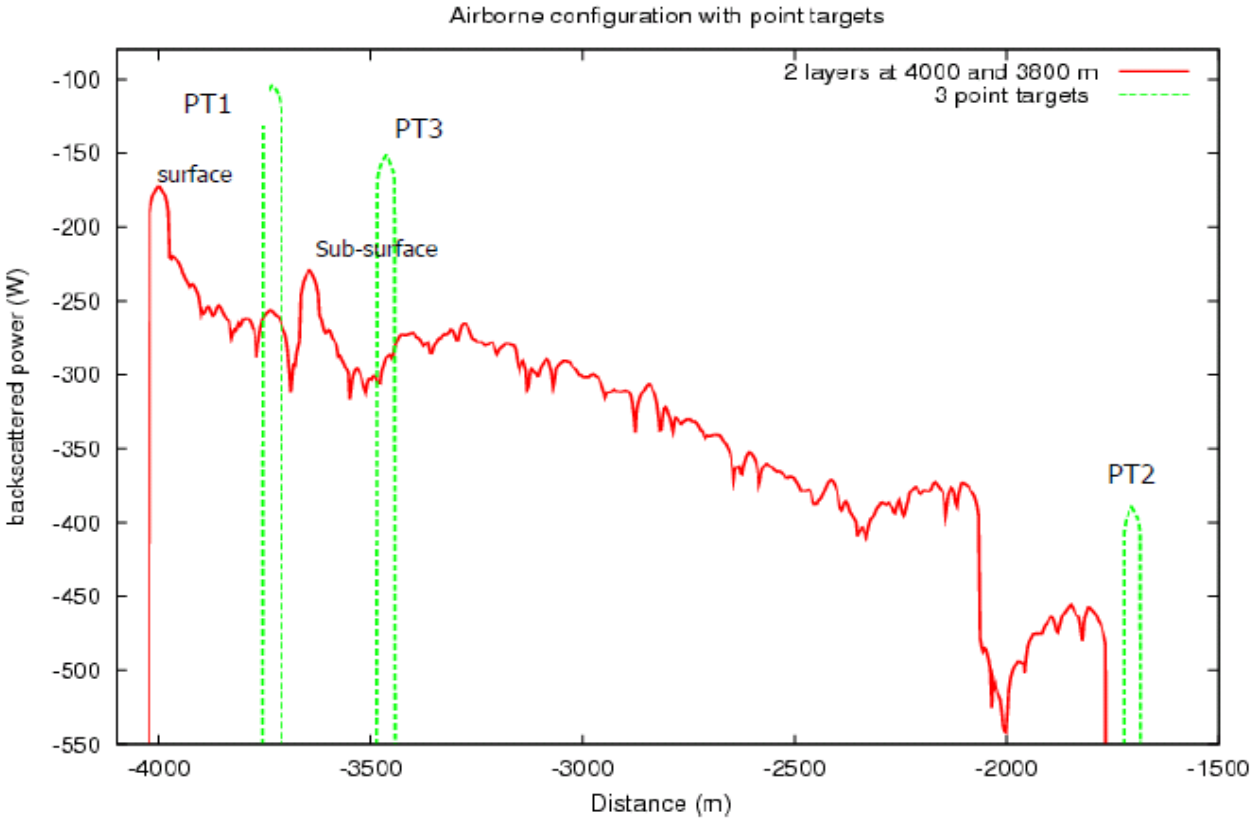


Figure 10 : Airborne configuration with point targets

- Key Ice properties (unknown parameters)
  - Thickness
  - Temperature profile
  - Roughness
  - Basal bedrock
  - Topology
- Ice surface roughness is primarly due to:
  - Wind
  - Ice flow
  - Melting

- We set up a preliminary model
- POLARIS data are used to shape and fine-tune
- In parallel of an empirical approach
  - For which ice scattering properties are extracted from POLARIS data and input in EMIce

NOVELTIS and glaciometry

- Strong expertise in EM modeling of ice
- Ice sounding and glaciology are converging
- NOVELTIS has ready-made capabilities to address these fields