CryoSat Validation Implementation

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**Validation objective:** to verify the mission requirements and quantify the uncertainties in the Cryosat products

The Cryosat validation concept document (CVC) provides detailed evaluation of sources of uncertainties and potential methods available to estimate them. Major sources of uncertainties include:

**Ice**
- Snowfall fluctuations
- Ice surface density
- Time-varying penetration of signal
- Atmospheric refraction error

**Sea Ice**
- Snow loading
- Preferential sampling
- Ice density
- Freeboard error due to time-varying penetration of radar signal
- Other freeboard errors due to ocean modelling uncertainties
- Atmospheric refraction error

CryoSat Calibration and Validation Concept (CVC): Provides evaluation of sources of uncertainties and potential methods available to estimate them

CryoSat Calibration and Validation Announcement of Opportunity (AO): Announcement of Opportunity for calibration, validation and retrieval for the CryoSat mission

CryoSat Validation and Retrieval Team (CVRT) Meetings: working meetings plan for calibration and validation experimental activities.

CryoSat Validation Implementation Plan (CVIP): draft plan of experimental activities for the validation of CryoSat Products
el of 11 polar scientists and engineers assessed proposals against CVC: completeness, gaps and duplication with respect to characterising error sources; feasibility and performance; opportunities for co-location in time and space of individual experiments; technical capability and likelihood of funding.

Proposals from 10 countries accepted as Cal/Val proposals.

For detailed negotiations 22 teams from 8 countries joined CryoSat Calibration and Retrieval Team (CVRT).

Initial planning meetings of CVRT:
- 14-25 Sep 2002 at ESTEC;
- 10-21 Nov 2002 at KMS, Copenhagen.

Issue of Cryosat Validation Implementation Plan (CVIP): August 2003

IP provides details of validation experiments
Validation based on dedicated independent, ground-based and airborne measurements

Include detailed investigations of retrieval methods applied to the satellite measurements

In terms of planning experiments, the Cryosat validation requirements imply:

1. **Repeated experiments** at different times of the year to address the variable penetration of the Cryosat radar signal into the snow cover.

2. **Coordinated ground and airborne measurements** in order to bridge the spatial scales from local in situ measurements to satellite-based products. Strategy is to compare in-situ measurements with collocated simultaneous airborne laser and radar acquisitions.

3. **Prelaunch experiments** to validate the experimental concept. Validation experiments have not generally been carried out before and require testing/validation.

Identification of validation super-sites for coordinated validation activities
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<tr>
<th>Airborne</th>
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<td>Polar 228</td>
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<td>Saab Twin Otter</td>
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<td>D2P Radar Altimeter</td>
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<td>PS, Neutron Probe, Coring</td>
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<td>Coffee Can, gamma profiling, roughness profiling</td>
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<td>bore holes, ice/snow density, wetness, grain size,</td>
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<td>salinity, upward looking looking sonar (Sea)</td>
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Alert/North Greenland
- Snow loading
- Ice density
- Geometric and penetration errors
- Preferential sampling

Devon Ice Cap
- Snowfall fluctuation
- Surface Density
- Time-varying penetration

EGIG Line
- Snowfall fluctuation
- Surface Density
- Time-varying penetration

Austfonna Ice Cap
- Snowfall fluctuation
- Surface Density

Fram Strait
- Prelaunch validation of experimental concept
- Snow loading and other validation objectives associated with sea ice

Bay of Bothnia
- Geometric and penetration errors
- Ice density
Dronning Maud land

Antarctic Peninsula
as:
Collection of simultaneous, colocated airborne laser and radar altimeter data
Collection of additional colocated helicopter borne ice thickness measured using electromagnetic probe and borehole data for validation of retrieval
Prelaunch trial experiment to assess overall validation concept

Experiment details:
Experiment dates: April 03 – 19, 2003
Airborne laser scanner and D2P radar altimeter located on KMS Twin Otter
Coordination of airborne acquisitions with icebreaker Polarstern acting a drifting station in the Fram Strait
Additional airborne collocated radar-laser altimeter data sets collected over key Cryosat validation sites
Major Cryosat validation experiment focused on

In-situ/airborne experiments to address major

- time-varying penetration of Ku-band radar
  
signal
- density measurements in support of ice mass
  
  balance estimation
- surface topographic effects

Experiment details:

Alfred Wegner Institute Dornier 228 plane with

IRAS and Laser altimeter used

Joint acquisitions of airborne and in-situ data at

different Arctic sites: Austfonna, EGIG

Insect and Devon Island.

In-situ teams located on ice caps

April 13-May 10 and September 10-25, 2004
Cap Field Work
12/05/04
22/09/04

Austfonna Ice Cap
NPI Fieldwork
12/04/04-26/04/04

EGIG Line
DAN/UK Fieldwork
30/03/04 – 21/04/04
23/08/04 – 22/09/04 (UK)
For expeditions on skis new (unexpected) source of validation data

Two expeditions in 2004, Poletrak (www.poletrack.com) and MagneticNorth (www.magneticnorth2005.com)

Measurement protocol defined by ESA with CVRT. Measurements focus on thickness measurements (validate snow loading and climate models)
Termination of uncertainties is a key mission goal

Detailed Cal./Val. campaigns already underway

Preliminary results from cal./val. to be presented at this workshop

Number of lessons learned from pre-launch campaigns

Experimental concept for sea ice thickness validation tested during Cryovex 2003

Testing of Cryosat Satellite software for Level 1b/2

Penetration/mass balance validation underway using Cryovex 2004 data

Large scale post-launch cal./val. experiments planned for 2006

Validation experiments example of good collaboration between and the Cryosphere scientific community