



CryoSat 10 11 Years: Sea Ice

Sara Fleury, Henriette Skourup,
Robert Ricker, Sinéad Farrell

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Sea Ice #1: Thickness

- 11 years of CryoSat-2 data have provided MAJOR advances in observing sea ice thickness (SIT)
- CryoSat-2 provides a unique means to evaluate ice thickness at the basin scale
 - At the heart of SI-CCI project to provide SIT Essential Climate Variable
 - CS2 SIT data used for annual “State of the Climate” updates on Arctic climate change
- CS2 is now in fact the reference mission for the sea ice thickness long-term time series (similar to Jasons for SLA)
- Measurements over sea ice have allow to raise new fundamental altimetric questions ...
 - effects of the footprint, of the ice surface roughness, of the snow penetrations
- ... and have favored the emergence of new major altimetric technics to improve precision and uncertainties
 - large progresses regarding retrackers based on physical models beyond the Browns model, Full Focus SAR
- New synergies to improve coverage and forecasts
 - multi-mission synergy (eg, SMOS)
 - synergy with models
- Observations permit innovative scientific analysis (sea-ice dynamics and thermo-dynamics, sea ice circulation, volume budget, ...)
- **All presenters mentioned the need of CRISTAL to insure the continuity of the SIT time series**

Sea Ice #2: Retracking Techniques / Snow on Sea Ice



- New techniques (fully-focused SAR, advanced retrackers, machine learning, data merging) have been exploited more extensively
- Dual-band altimetry (Saral/Altika and CryoSat-2) is now being investigated
 - can be used to understand penetration into the snow pack; sensitivity to surface roughness and footprint size/sampling
 - Airborne and in situ campaigns now using new dual-band radar sensors (e.g., CryoVEx and MOSAiC: KuKa) for improved understanding of how radar signal is affected by (evolving) snow layer and surface roughness
 - Collecting these observations now is important for continued planning of the CRISTAL satellite mission (dual-band radar altimetry) which will simultaneously derive snow thickness and sea ice freeboard
- ICESat-2 provides unrivalled data in terms of resolution and precision
 - Useful for assessing surface roughness retrieved from CryoSat
 - As a reference for snow freeboard derived from Saral-Altika/Ka-band measurements
- Cryo2ice allows to investigate how CryoSat and ICESat-2 data can be combined to retrieve snow depth
- At the same time, especially over Antarctic sea ice, more validation and in-situ measurements are required to better understand the impact of the complex Antarctic snowpack on radar altimetry

