



Validation of CryoSat Sea-Ice Products: Instruments and Methods

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- **Snow & Ice Properties**
- **EM & Laser Thickness & Ridge Profiling**
- **CryoVex 2003: Laser Scanner & ASIRAS**
- **Integration of SAR imagery**



Uncertainties

- **Snow and ice properties (density!)**
- **Ice thickness and topography**
- **Freeboard**
- **Floe size distribution**



Ice and snow properties





EM ice thickness measurements

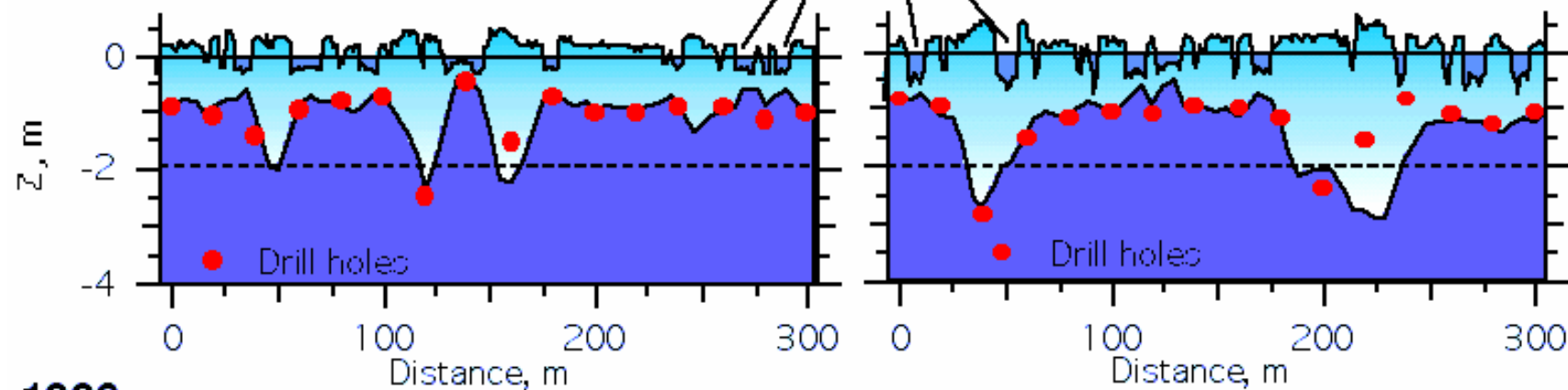




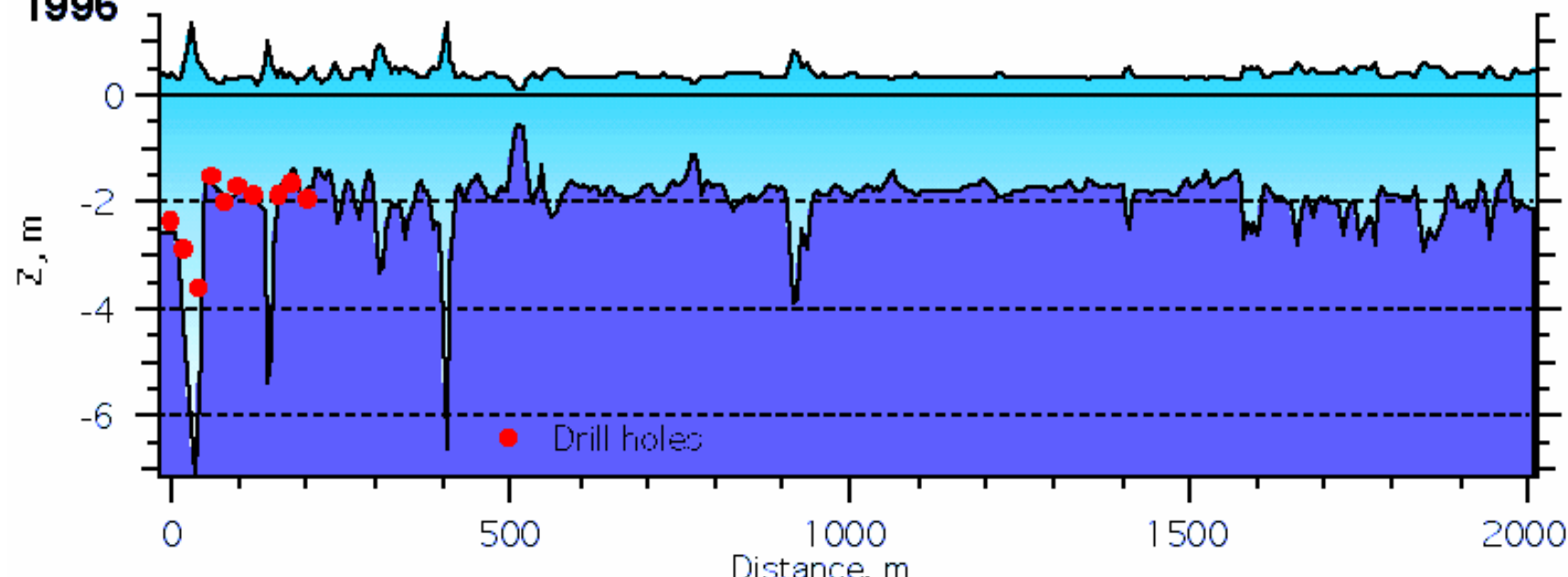
EM thickness profiles

1995

Melt ponds



1996





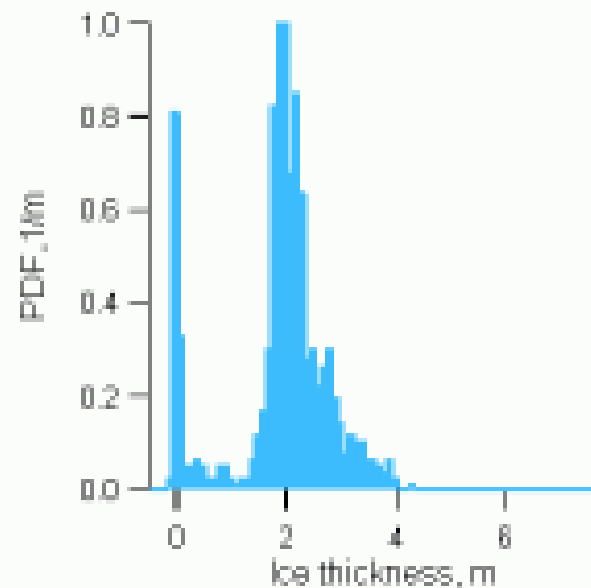
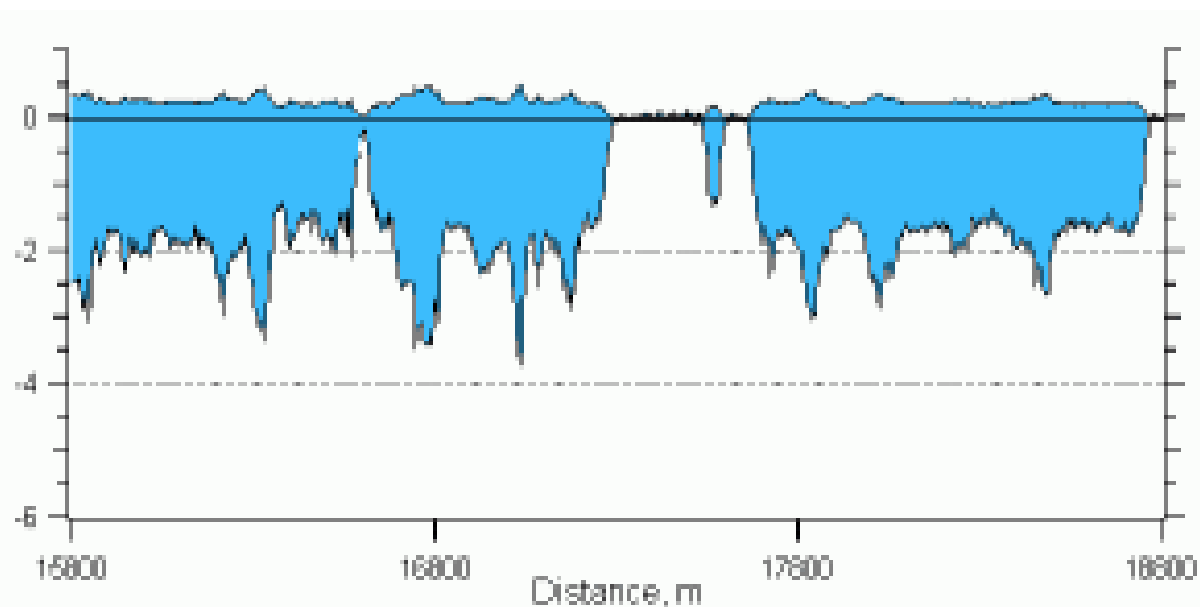
Airborne EM thickness profiling



EM Bird



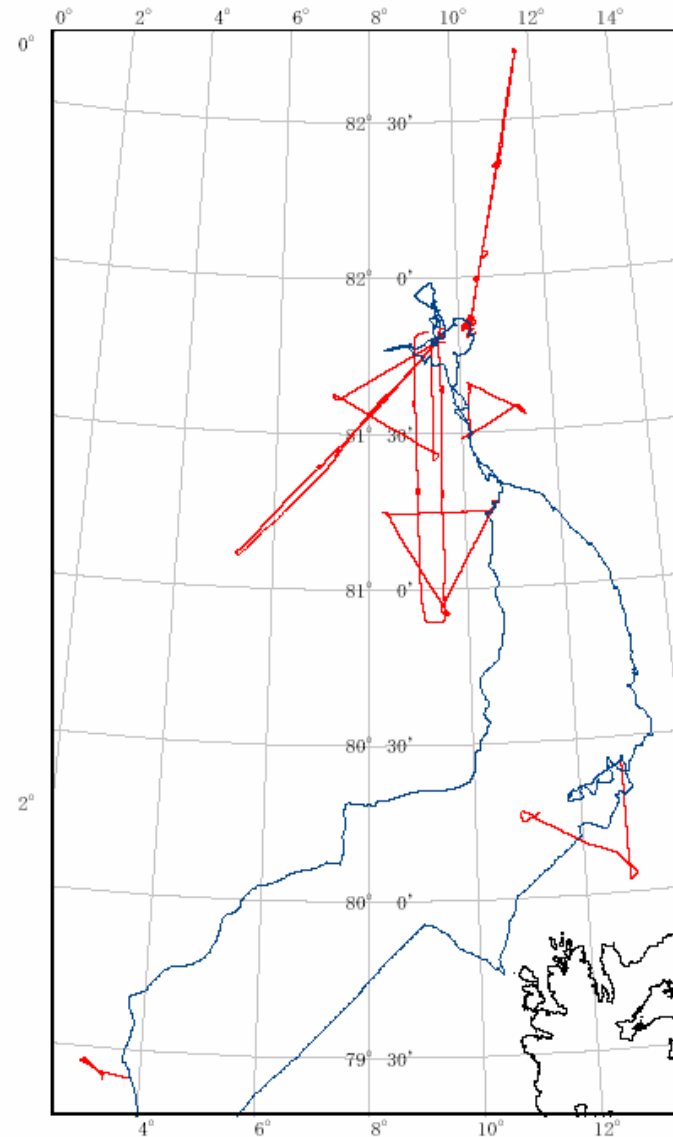
Typical EM bird thickness profile and distribution





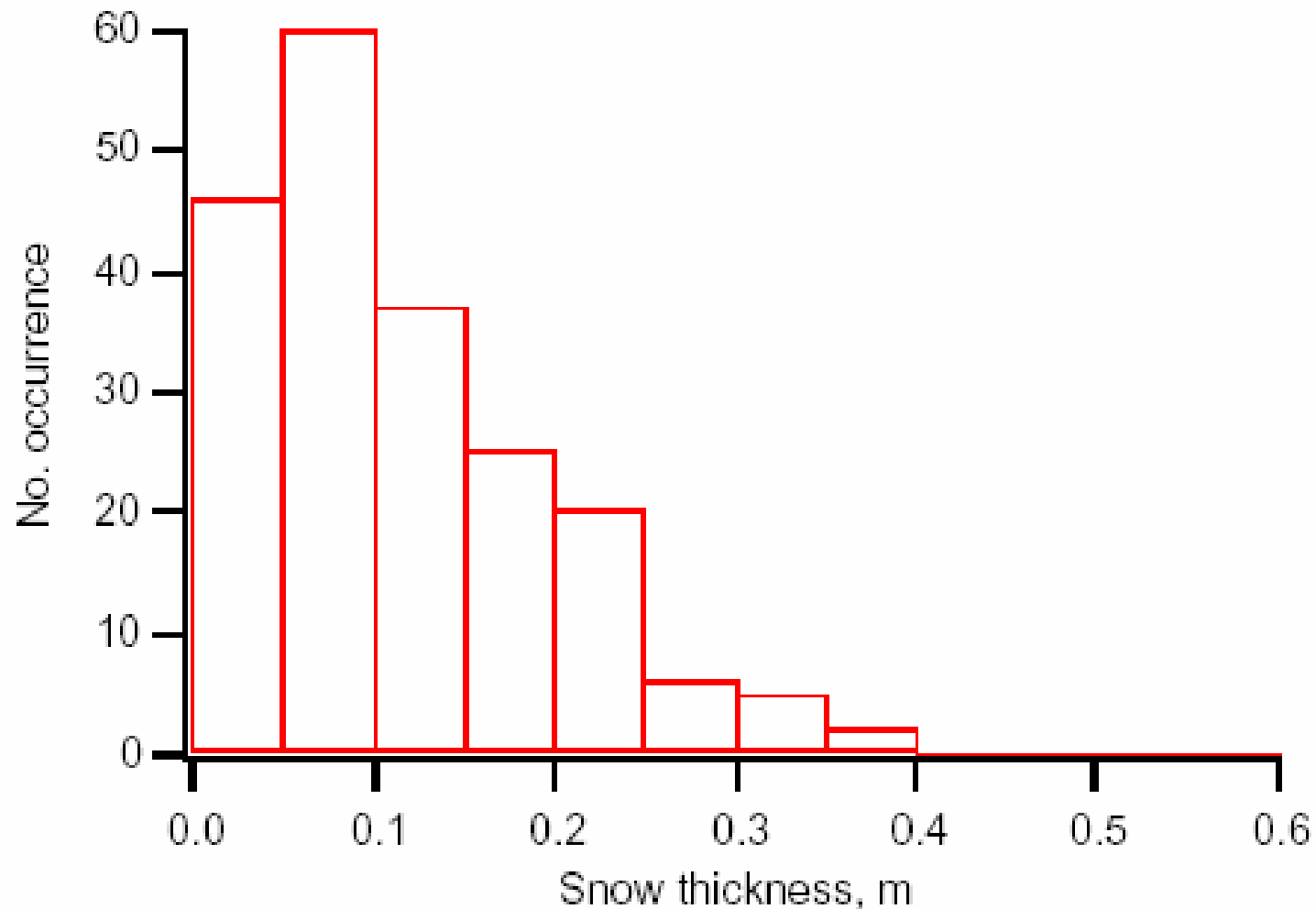
CryoVex 2003

- Coincident HEM/Twin Otter-Laser Scanner and D2P/ASIRAS flights in Fram Strait
- Investigation of freeboard retrieval uncertainty, snow penetration uncertainty
- Cooperation between AWI, KMS (Denmark), and John Hopkins University (USA)



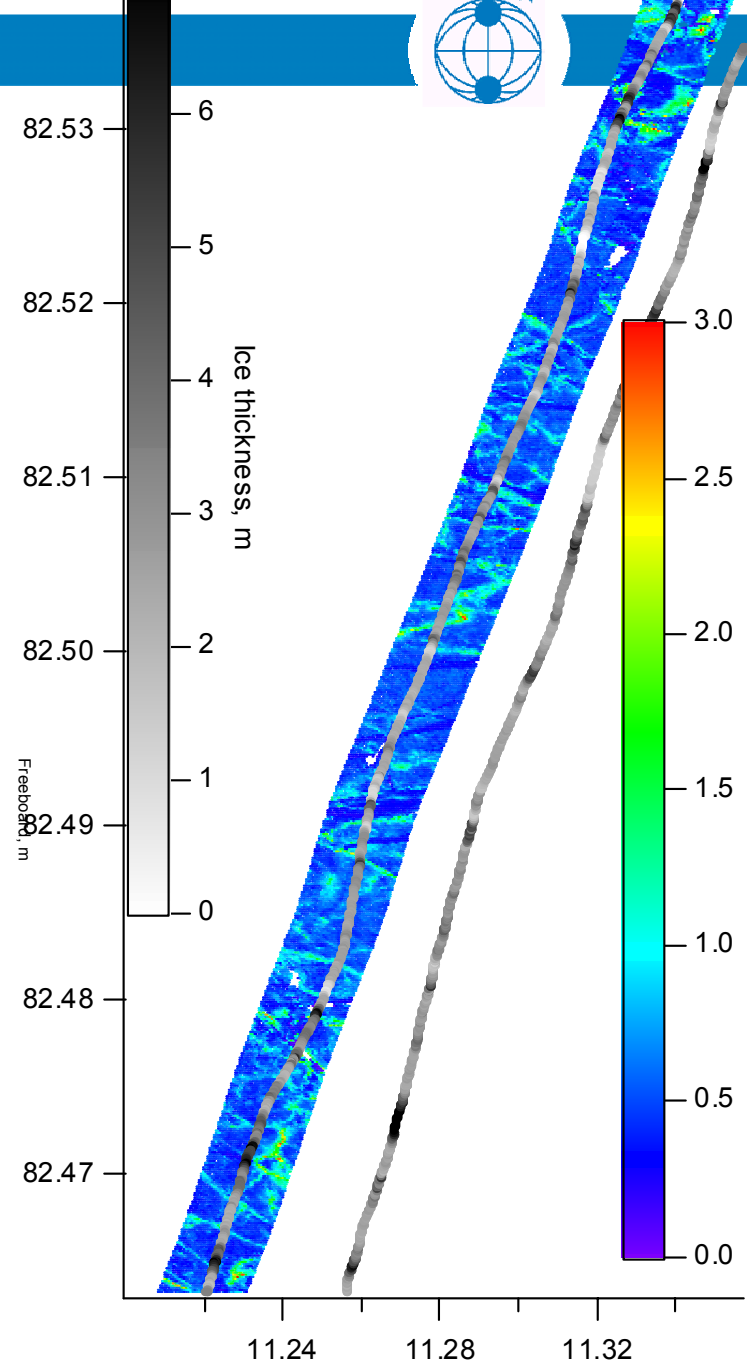
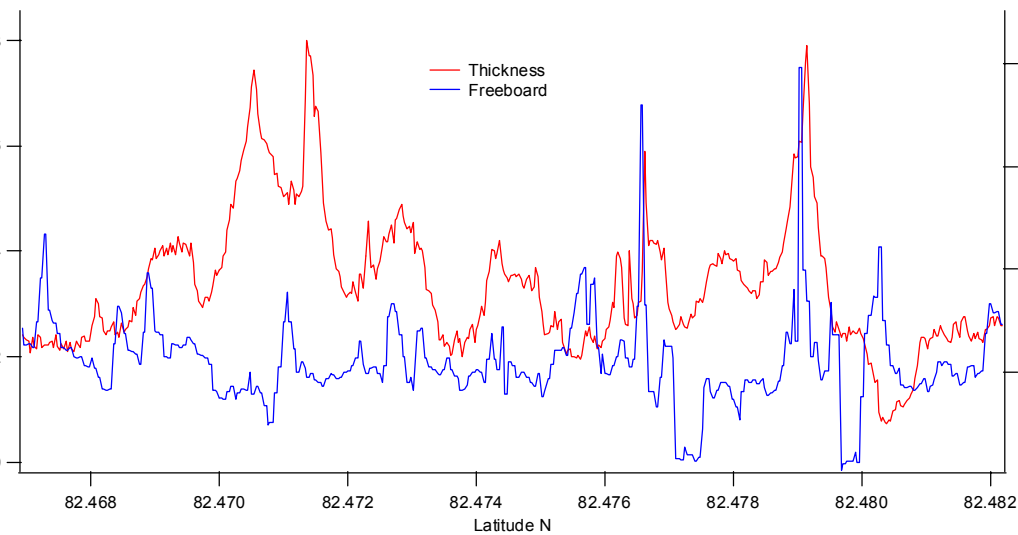


Snow thickness distribution on Tomato Island



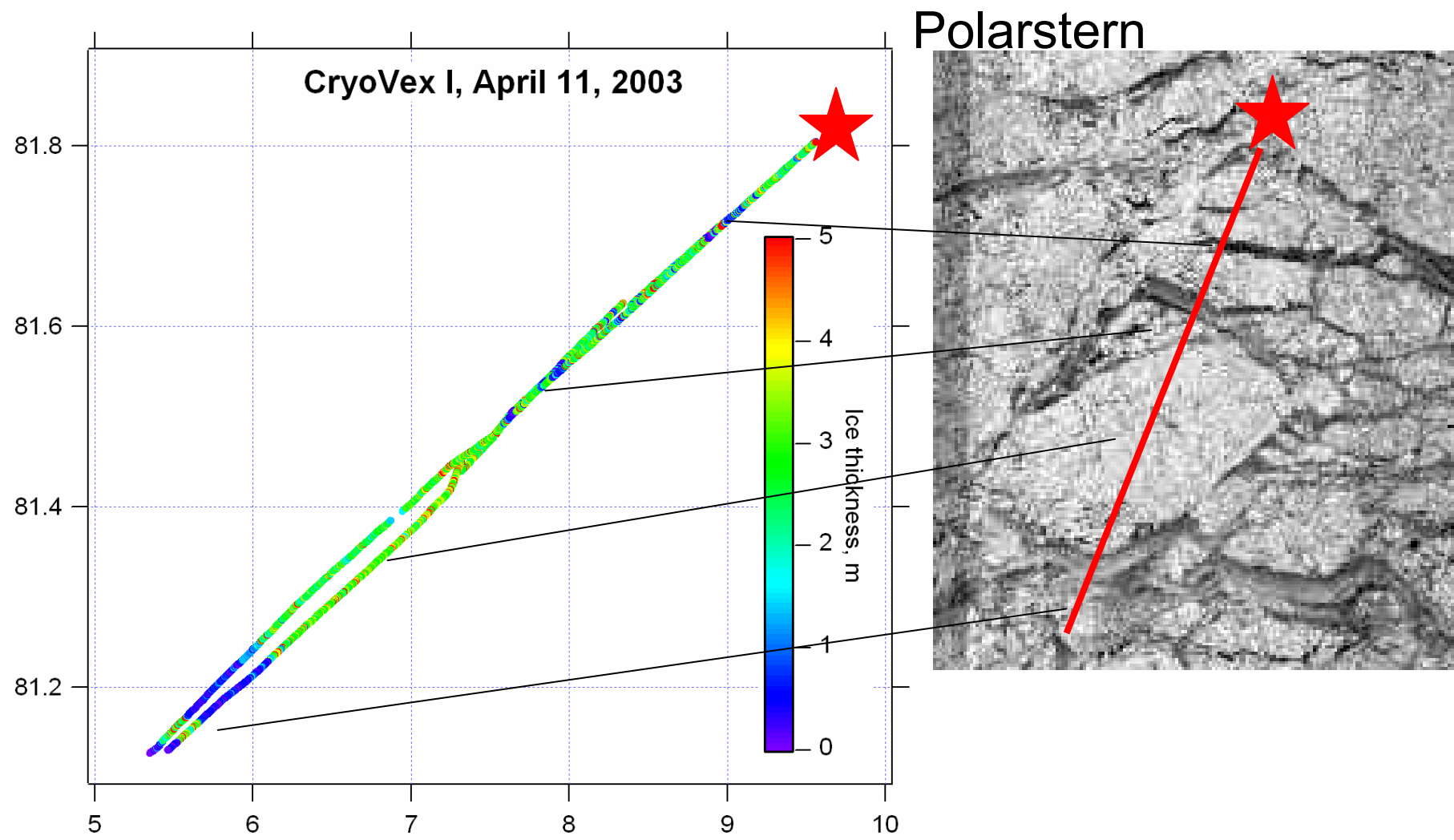
$N = 72$, Mean $Z_s = 0.09$

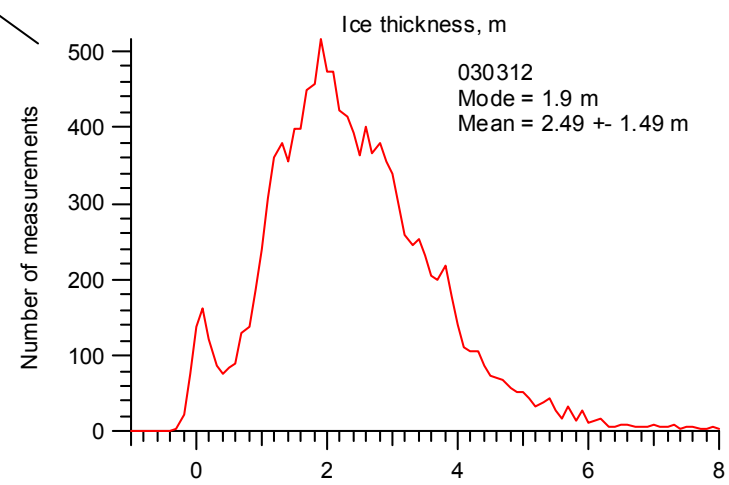
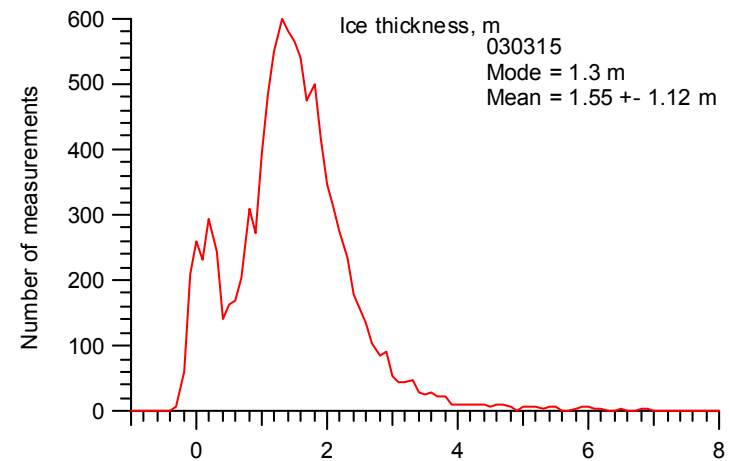
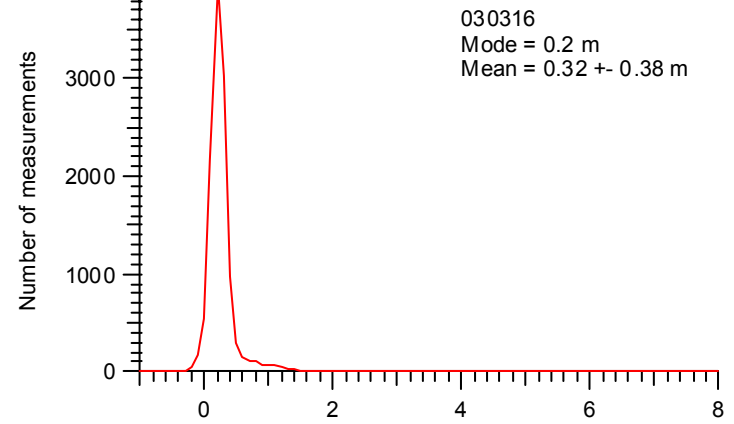
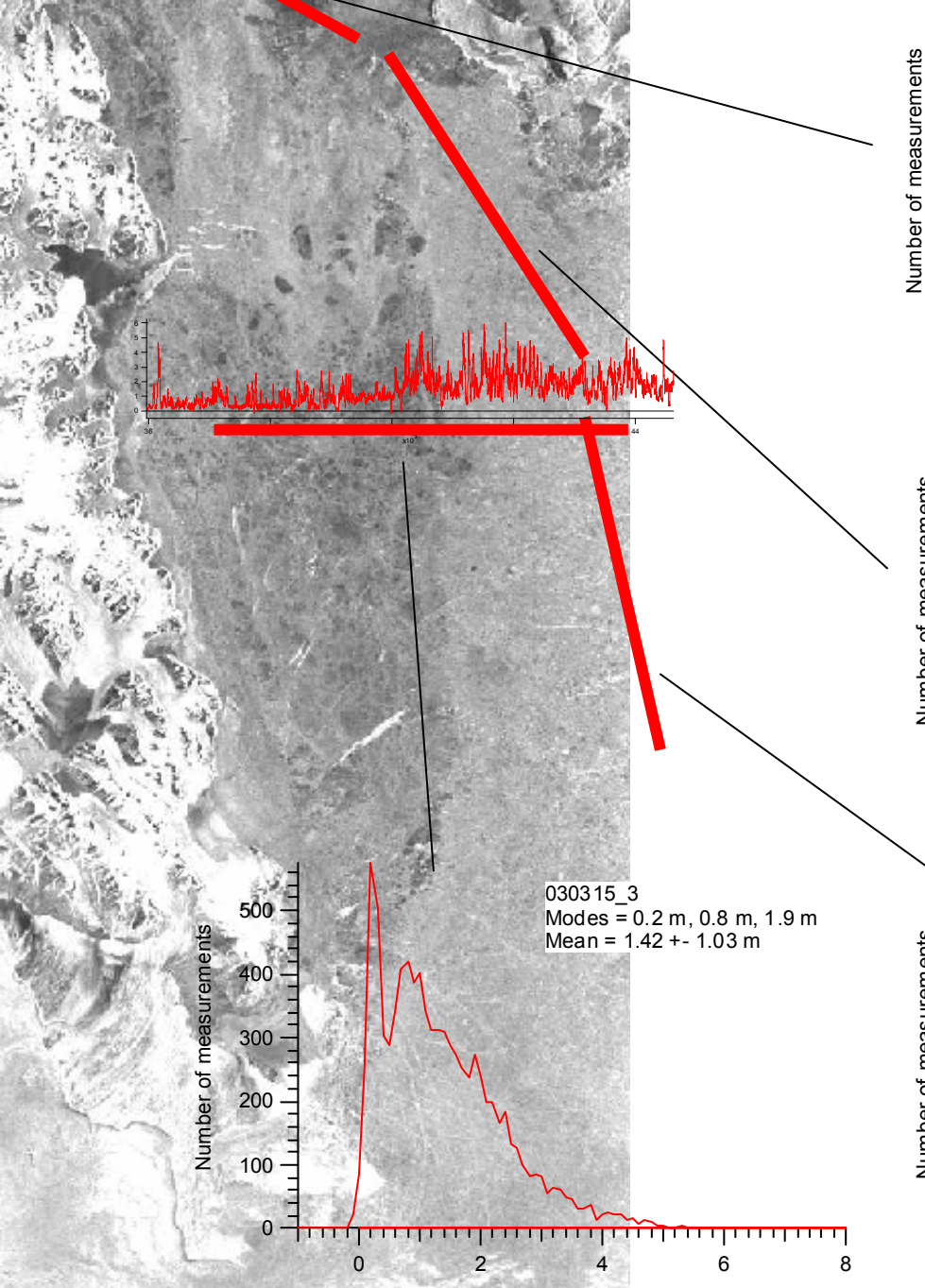
EM / laser scanner comparison





Integration of SAR imagery for algorithm development and extrapolation to larger ice regime







Conclusions & Outlook

- **Range of tools & techniques available to address thickness retrieval uncertainties**
- **CryoSat accuracy requirements are a challenge**
- **Arctic validation campaigns in May and October 2005/2006 off Greenland or Alert with ESA CVRT**
- **Antarctic validation campaign 2004/05 during ISPOL in Weddell Sea (Polarstern cruise ANT 22/2)**