Collaborative Research: Grounding Line Dynamics: Crary Ice Rise Revisited

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Award Abstract:

Recent observations and model results suggest that collapse of the Amundsen Sea sector of West Antarctica may already be underway. However, the timeline of collapse and the effects of ongoing climatic and oceanographic changes are key unanswered questions. Complete disintegration of the ice sheet would raise global sea level by more than 3 m, which would have significant societal impacts. Improved understanding of the controls on ice-sheet evolution is needed to make better predictions of ice-sheet behavior. Results from numerical models show that buttressing from surrounding ice shelves and/or from small-scale grounded ice rises should act to slow the retreat and discharge of ice from the interior ice sheet. However, there are very few field observations with which to develop and validate models. Field observations conducted in the early 1980s on Crary Ice Rise in the Ross Sea Embayment are a notable exception. This project will revisit Crary Ice Rise with new tools to make a suite of measurements designed to address questions about how the ice rise affects ice discharge from the Ross Sea sector of West Antarctica. The team will include a graduate and undergraduate student, and will participate in a range of outreach activities.

New tools including radar, seismic, and GPS instruments will be used to conduct targeted geophysical measurements both on Crary Ice Rise and across its grounding line. The project will use these new measurements, together with available ancillary data to inform a numerical model of grounding line dynamics. The model and measurements will be used to address the (1) How has the ice rise evolved over timescales ranging from: the past few decades; the past millennia after freeze-on; and through the deglaciation? (2) What history of ice dynamics is preserved in the radar-detected internal stratigraphy? (3) What dynamical effect does the presence/absence of the ice rise have on discharge of the Ross Ice Streams today? (4) How is it contributing to the slow-down of the proximal Whillans and Mercer ice streams? (5) What dynamical response will the ice rise have under future environmental change?

Field Work and Location:

The active source seismic component of the project took place during field seasons (see map) during November-December 2015.

Field Equipment and Procedures:

Datalogger: All data during both field seasons was acquired with a 64 channel Stratavisor that was provided by the PASSCAL instrument center.

Geophones and Cables: 40 Hz geophones provided by the PASSCAL instrument center were used for all surveys. Geophones were typically planted in holes ~1 meter below the surface and then recovered with snow. We utilized 4 150-meter cables with 10-meter takeouts provided by the PASSCAL instrument center.

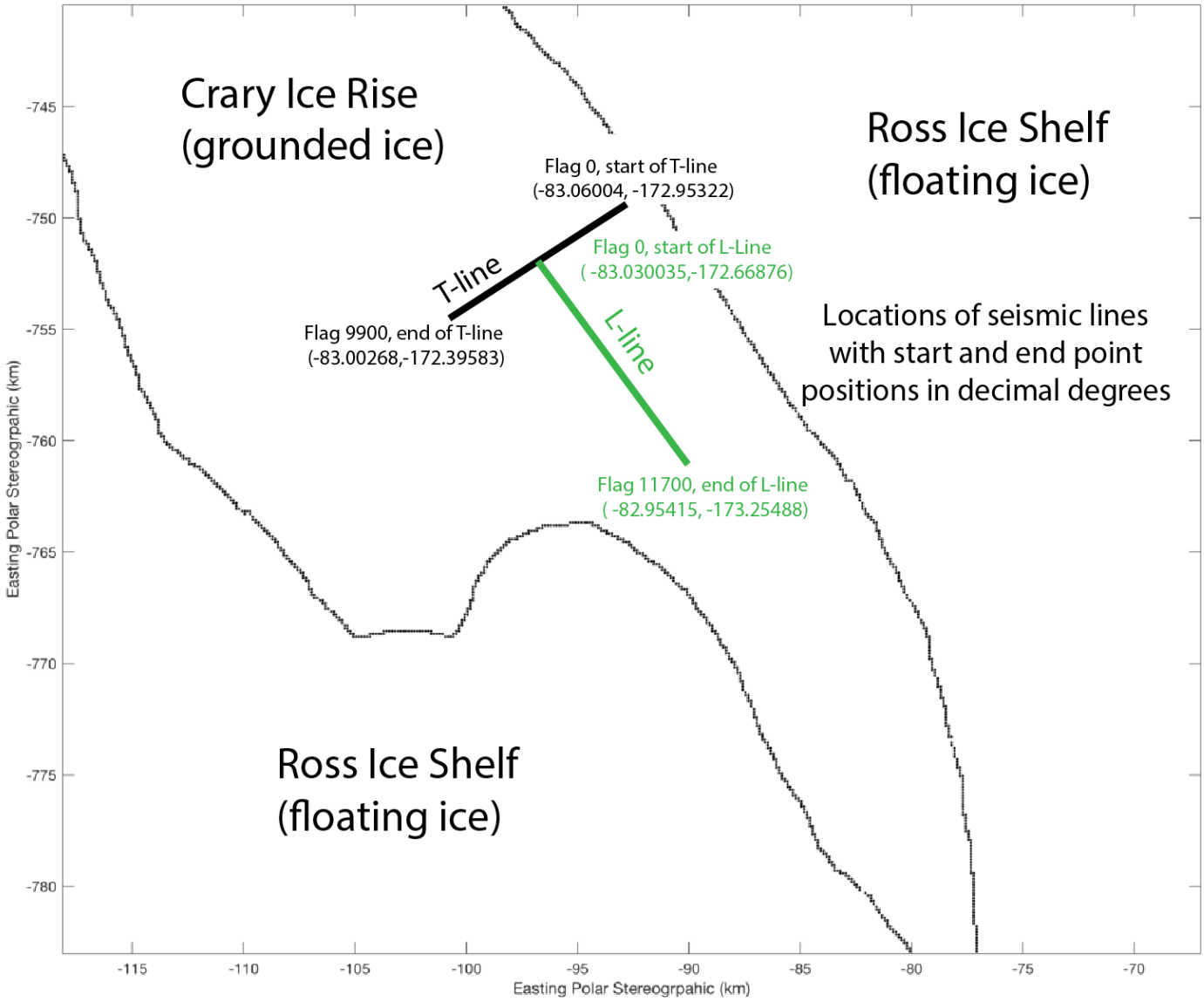
Source: The sources were 2 400 g Pentex PPP Booster detonated with DaveyDet electric detonator. Explosives were placed at depth (~ 25 meters) with holes made by a hot water drill provided by the Ice Drilling Design and Operations (IDDO). GPS timing was utilized to synchronize detonation and data acquisition with shot boxes provided by Sridhar Anandakrishnan of Penn State University.

Geometry: All data was collected in linear profiles. Lines were surveyed with a laser range finder. The geographic coordinates of the first and last "flag" positions are provided. Geophone were spaced approximately 10 meters. Shot and geophone positions are approximate distance (in meters) from flag 0 of each line, however, there may be discrepancies actual offset due to surveying errors, however start coordinate of the L-Line intersects the T-Line at 5100.

All geometry details are recorded in the header fields of the two segy files (CIR_TLINE.segy and CIR_LLINE.segy)

Geographic locations of lines (decimal degree).
L-line start (-83.030035, -172.66876)
L-line end(-82.95415, -173.25488)

T-line start (-83.06004, 172.95322)
T-line end (-83.00268, -172.39583)


Crary Ice Rise
(grounded ice)
Ross Ice Shelf
(floating ice)
Flag 0, start of T-line
(-83.06004, -172.95322)
T-line
Flag 9900, end of T-line
(-83.00268,-172.39583)
Flag 0, start of L-Line
(-83.030035,-172.66876)
L-line
Flag 11700, end of L-line
(-82.95415, -173.25488)
Locations of seismic lines
with start and end point
positions in decimal degrees
Ross Ice Shelf
(floating ice)
Easting Polar Stereogrpahic (km)
-745
-750
-755
-760
-765
-770
-775
-780
-115
-110
-105
-100
-95
-90
-85
-80
-75
-70
Easting Polar Stereogrpahic (km)