The Bruce Plateau Ice Cap: Ice Dynamics across the Antarctic Peninsula

LARISSA Site Beta

Barilari Bay

Scar Inlet Ice Shelf

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East versus West: how are they thermally and dynamically different?

Is the divide migrating? How does that affect the ice core analysis?
Rough Drawing from Radar Images
(not perfectly to scale!)

Divide
0km

West

Flank
~10km

East

Kansas Hill

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Divide and Ice Core Site Characteristics based on preliminary data:

Surface Elevation: divide: 2012m; ice core site: 1976m
Thickness: divide: 460m; ice core site: 447m

Distance east of the divide: ~2km
Surface slope: ~0.025 at the core site
Surface velocity: 10(+/- 4) m/yr
15m Temperature (average annual): -14.8C
Accumulation Rate (1963-2010): ~2m/yr
Pore close-off depth: 80m
Bed Temperature: -10.2C
Geothermal Flux: 88mW/m
Preliminary Dansgaard Johnsen Model

Estimated Depth-Age Scale for Bruce Plateau

Danisaard Johnsen Model with b=2m/yr

Flank

Divide
Slightly Divergent Flow due to Kansas Hill suggests additional thinning of layers.
Estimated Accumulation Pattern

-6m/yr
-2m/yr

high precip
high advection

-14.8°C

warmer ice
warmer bed
Initiation of sliding?

low precip
low advection

-10.2°C

colder ice
colder bed

-15km
0km
30km

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Larsen Ice Shelf System - Antarctica

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divide migration experiments
1. steady state

enhancement = 5
(to match surface data)

applied accumulation pattern

horizontal velocity

vertical velocity

5km

10km

3.8 m/yr

~0 m/yr

5km

10km

2000m

1500m

2000m

1500m

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Isochrones for Steady State Ice Divide

- Older Ice
- Deeper

Older Ice Near Surface
2. Change Accumulation

- **Experiment A**
  - *accumulation rate doubled*
- **Experiment B**
  - *accumulation slope doubled*
2. Change Accumulation

Experiment A: accumulation rate doubled
*divide moved ~1500 m west to new s.s.
*divide increased elevation by ~120m
*timescale for response ~ 25years

Experiment B: accumulation slope doubled
*divide moved ~800 m west to new s.s.
*divide elevation did not change
*timescale for response ~25 years
What does this mean?

These response timescales are ~1/10th of the fundamental H/b timescale (which is ~250 years at this site).

Hindmarsh (1996) predicated a timescale 1/16 H/b for accumulation-driven divide migration.

Both accumulation changes result in a WESTWARD migration - away from our ice core site

**Unlikely that our core site was on west side in past - good for interpretation**

**recent migration of the divide results in more catchment area for Larsen B - does this affect the overall Peninsula dynamics?**
Characteristics of the Bruce Platuau and the Larissa Site Beta Ice Core Site

Is the divide migrating?
How does that affect the ice core analysis?

East versus West:
how are they thermally and dynamically different?
Future

These preliminary experiments suggest further experiments:

1. Integrate the heat flow model (include viscous strain heating) to explore the onset of fast flow

2. Improve the orographic precipitation pattern

3. Apply stochastic or data-driven accumulation history to see how much the divide moves over centennial timescales and how much this change in catchment area would affect the downstream dynamics (if at all).

4. Incorporate a realistic width of the flow band and realistic rheological properties to more accurately capture the flow patterns.