Observations of Bottom Currents in Drake Passage from cDrake

T. Chereskin, K. Donohue, R. Watts, K. Tracey, Y. Firing, and A. Fearing
cDrake goals

Quantify transport & dynamics of the Antarctic Circumpolar Current for 4 years (2007-2011)

- Transport line to determine the horizontal and vertical structure of the time-varying transport.
- Local dynamics array (LDA) to describe the mesoscale eddy field and to quantify the vertical transfer of ACC momentum.
CPIES: current and pressure recording inverted echo sounder

Measures bottom current (50 m off bottom).

Emits 12kHz sound pulses. Measures round trip travel times of acoustic pulses to sea surface and back.

Measures bottom pressure.
cDrake Timeline

- Deployment (Nov/Dec 2007) & Recovery (Nov/Dec 2011) cruises
A CPIES array yields daily maps of upper and deep streamfunction.

Look-up tables interpret acoustic travel times as geopotential height (0 referenced to 5000 dbar).

2-D arrays of CPIES estimate horizontal gradients of geopotential to calculate geostrophic velocities.

Velocity profiles are referenced by measured near-bottom currents.

Bottom pressures are leveled using time-mean near-bottom currents.
Bottom Currents and the Antarctic Circumpolar Current

- ACC is a deep reaching current, strongly influenced by topography.
- Bottom torques thought to balance wind stress and wind stress curl that drives the ACC and sets its transport.
- Deep jets make direct observations difficult.
Recent Observations of ACC Bottom Currents

- Instantaneous bottom velocities in the range 4-20 cm/s eastward (Donohue et al., 2001; Cunningham et al., 2003).

- Mean speeds 2-6 cm/s eastward observed in AUSSAF and SAFDE (Phillips and Rintoul, 2000; Tracey et al., 2006).

- Transient eddies can have much larger currents - peak speeds observed in SAFDE were ~30 cm/s.
Record-length (~1 yr) mean currents (50-m above bottom) and standard deviation ellipses

**Northern Drake Passage:**

Means exceed 10 cm/s at 15 sites. Directions not aligned with surface flow.

**Southern Drake Passage:**

Mean bottom flow near PF ~5-8 cm/s Directions aligned with the front.

[Mean SAF & PF streamlines identified from altimetry (Lenn et al., JPO 2007)]
Mean (1999-2009) surface EKE from altimetry

Mean (2007-2008) bottom EKE from mapped currents and pressures from cDrake

1/6 degree, 42 levels, MITgcm, assimilation (altimetry; ARGO)

SOSE mean bottom currents (100-m above bottom) and 3500 m pressure anomaly

Courtesy of Matthew Mazloff
D01 max speed 69.3
max 69.3 cm/s

D02 max speed 71.1
max 71.1 cm/s

E01 max speed 57.7
max 57.7 cm/s
SAF/PF meanders and deep cyclogenesis
Conclusions

- Velocity variance is largest in northern Drake Passage, both at the surface and the bottom.
- Year-long-mean bottom currents between the SAF and PF exceed 10 cm/s, and the direction is not parallel with the surface flow.
- Multiple bottom current events, with peak speeds of 70 cm/s, last for 10 days or more and are correlated between sites separated by 45 km.
- Events indicate deep cyclogenesis occurs in the high EKE zone between the SAF and the PF.