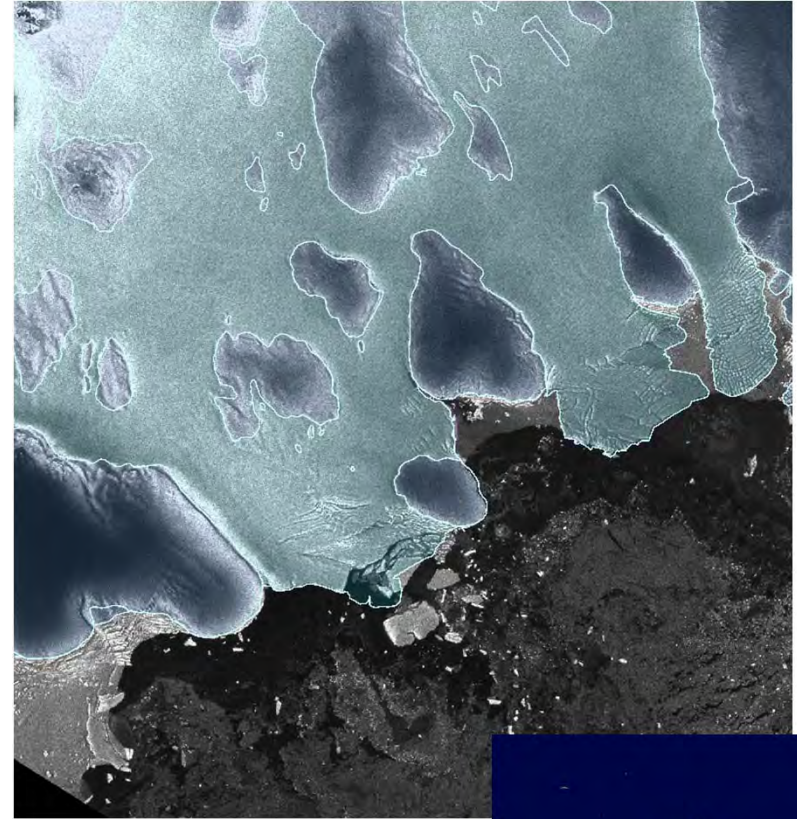


# Sea ice and West Antarctic ice-shelf stability

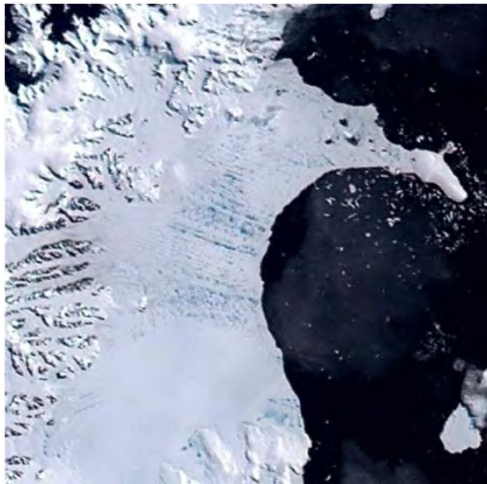


Kelly Brunt (NASA/GSFC/Cryosphere Branch)

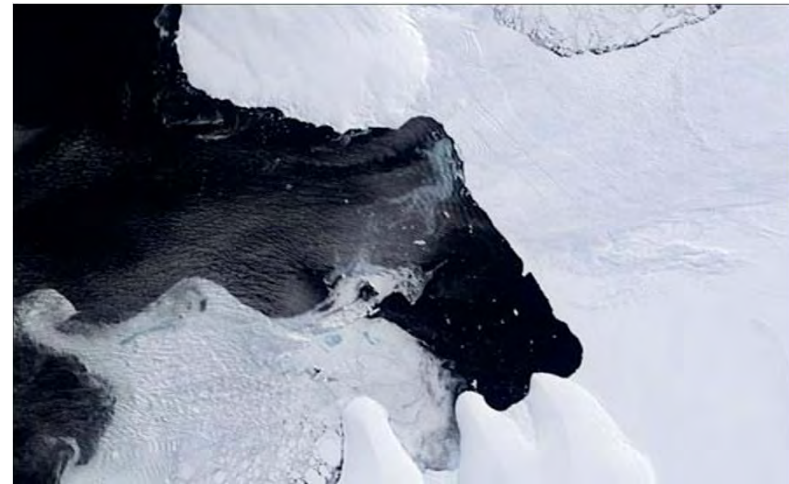
Emile Okal (Northwestern University)

Doug MacAyeal (University of Chicago)

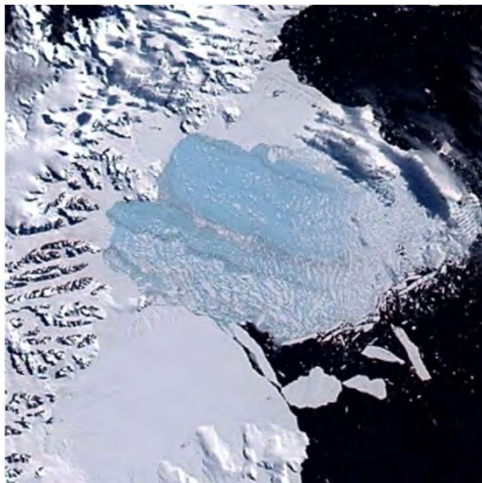
## Catastrophic Ice-Shelf Breakup



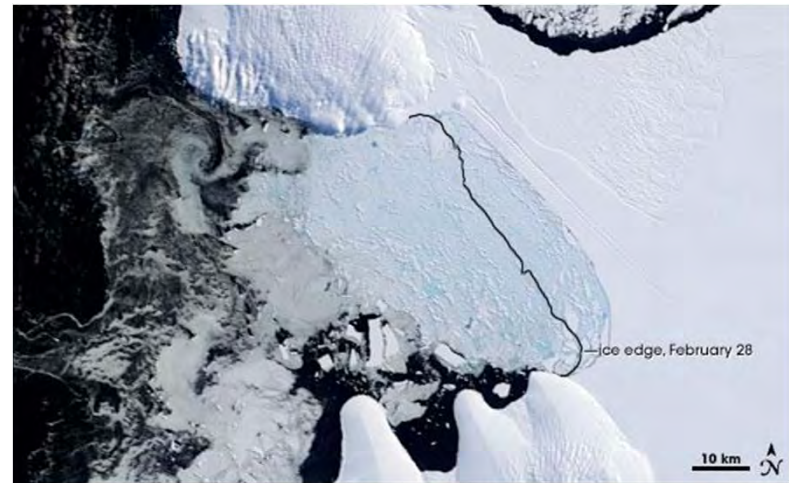
*MODIS, 31 Jan 2002*



*MODIS, 28 Feb 2008*



*MODIS, 13 Apr 2002*

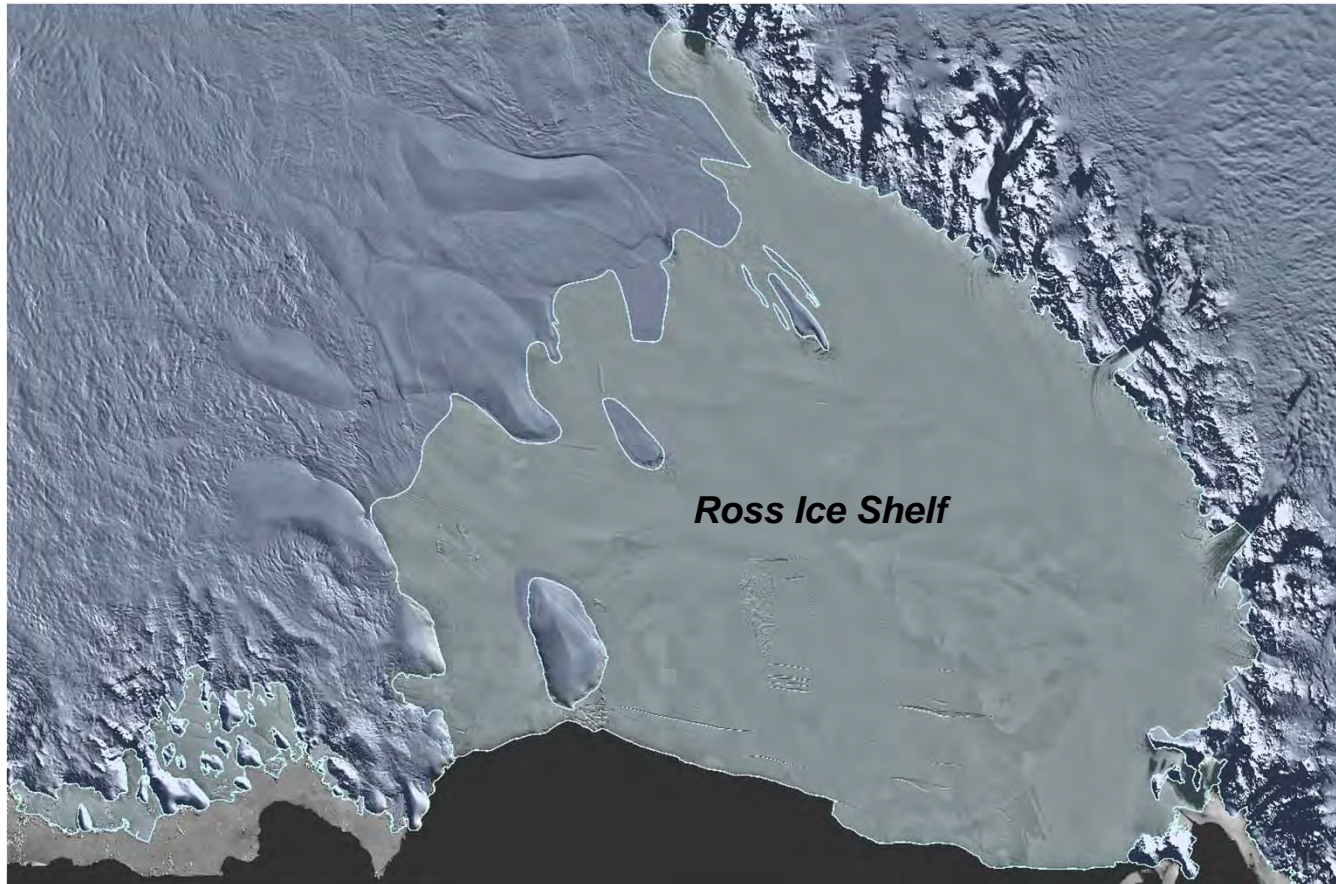


*MODIS, 17 Mar 2008*

**Is a lack of sea ice a necessary precursor to ice shelf calving/collapse?**

# Two 2011 calving events

## Sea ice conditions are a factor in both events



**Sulzberger**  
~11 Mar 2011

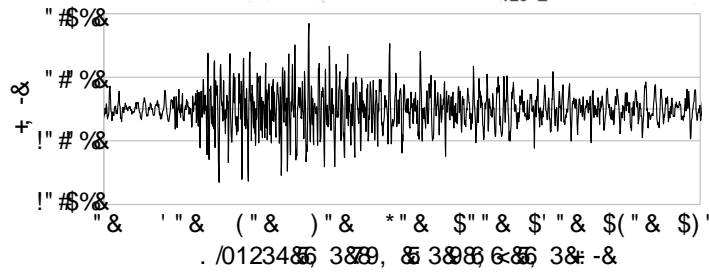
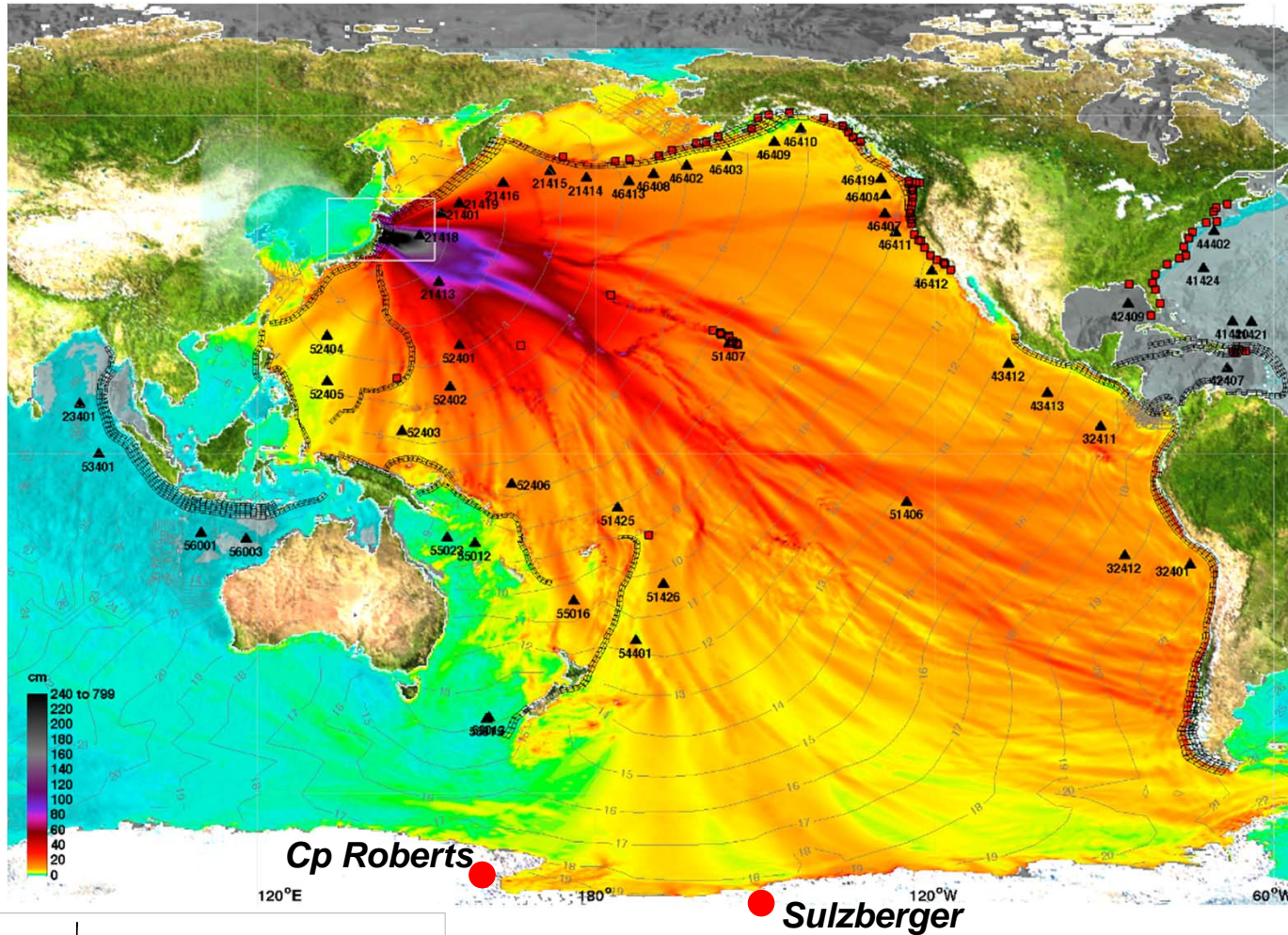
**McMurdo**  
~25 Feb 2011

*MODIS Mosaic of Antarctica 2003-2004*

# Tōhoku Earthquake (M = 9.0) and Tsunami, 11 Mar 2011



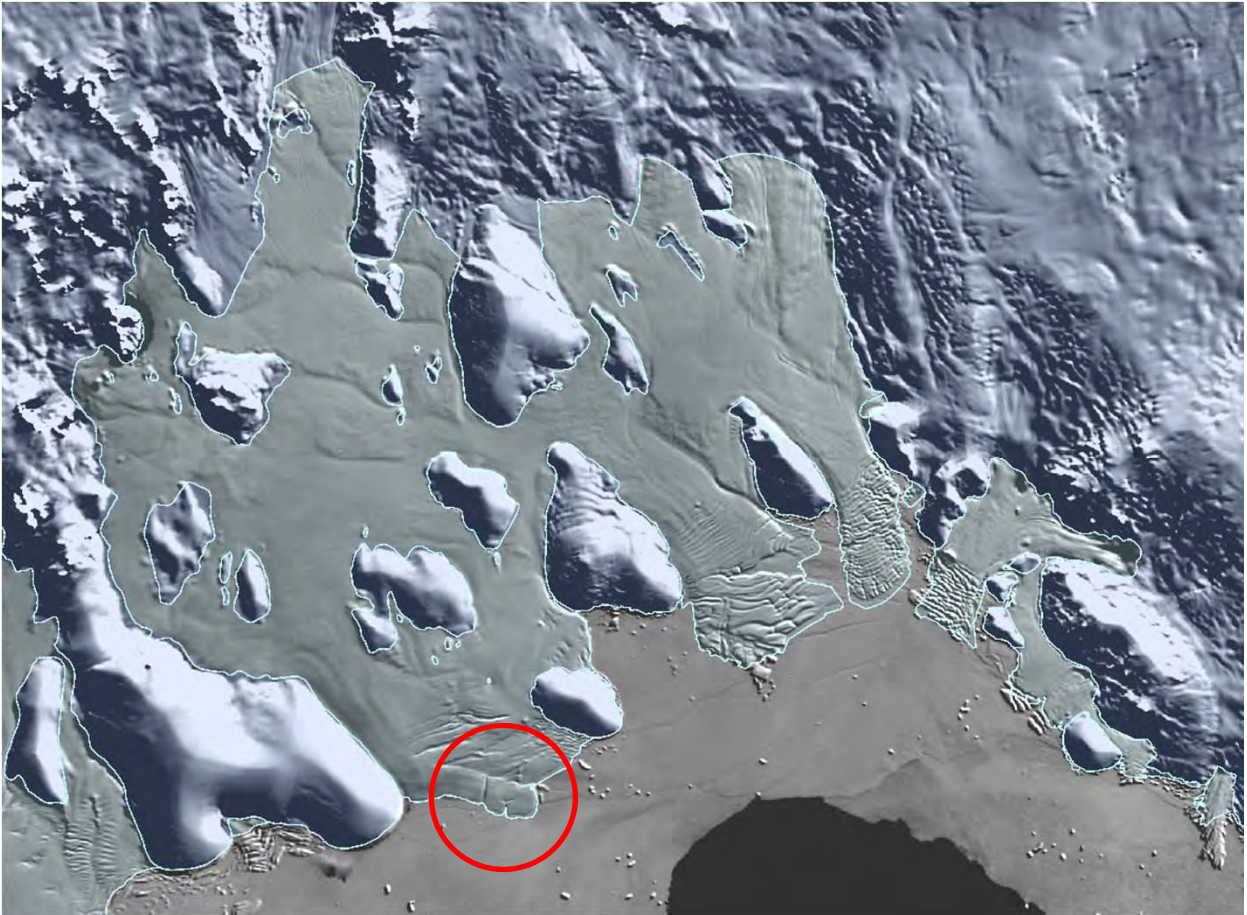
NOAA modeled maximum wave amplitude



# Sulzberger Ice Shelf



N  
50 km

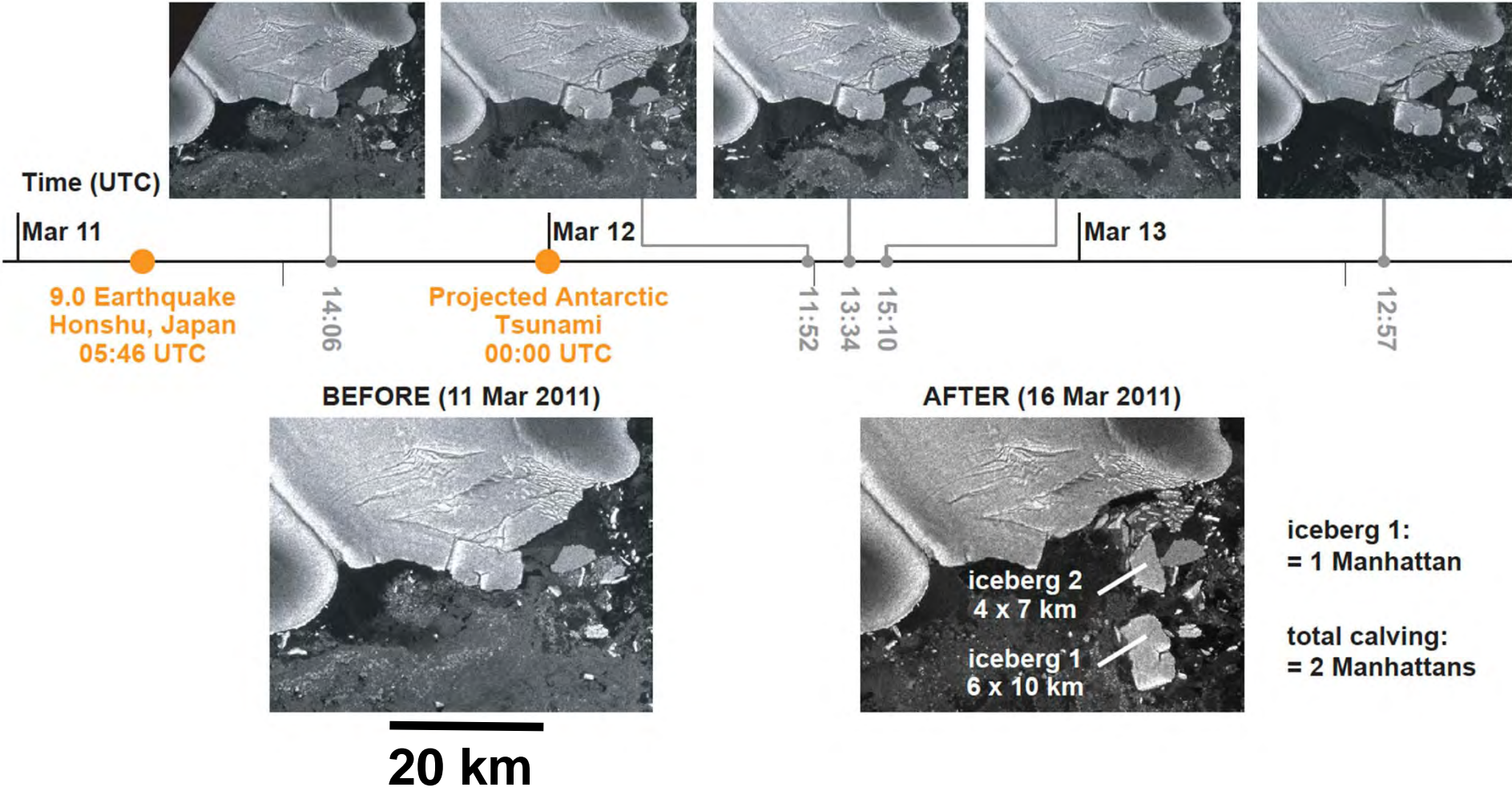


*MODIS Mosaic of Antarctica 2003-2004*

# Sulzberger Ice Shelf



ESA Envisat Advanced Synthetic Aperture Radar (ASAR)





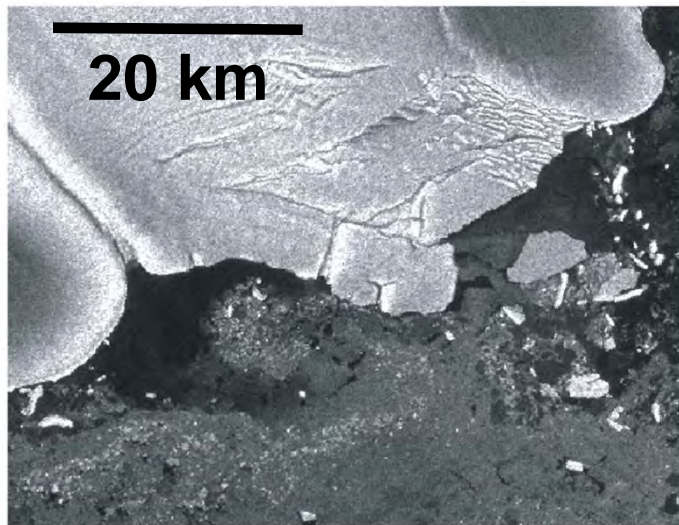
# Coincidence?



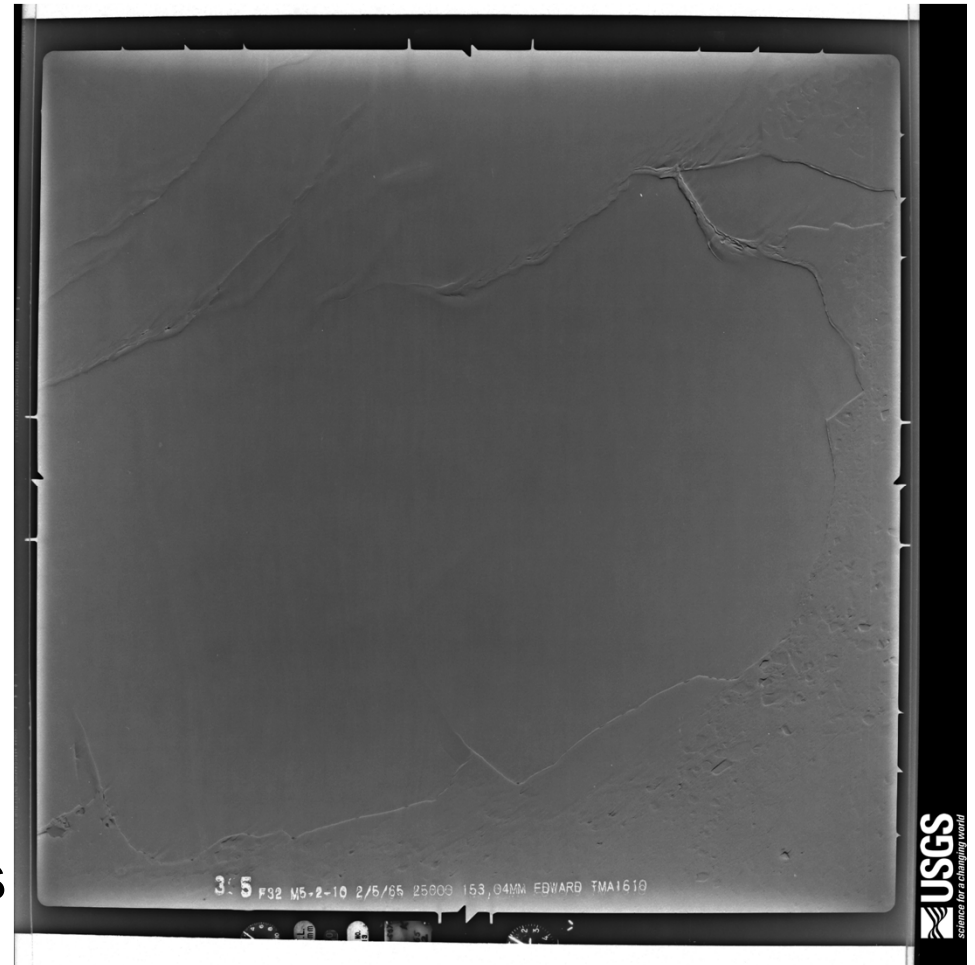
*USGS trimetrogon aerial photograph*

**11 Mar 2011**

*Envisat ASAR*



**stable for +46 years**



**05 Feb 1965**



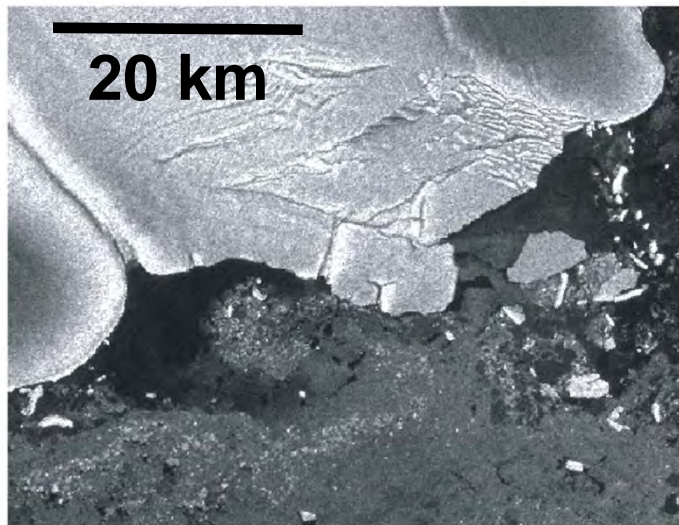
# Sea ice at Sulzberger

- Dampens swell
- Buttresses ice shelf

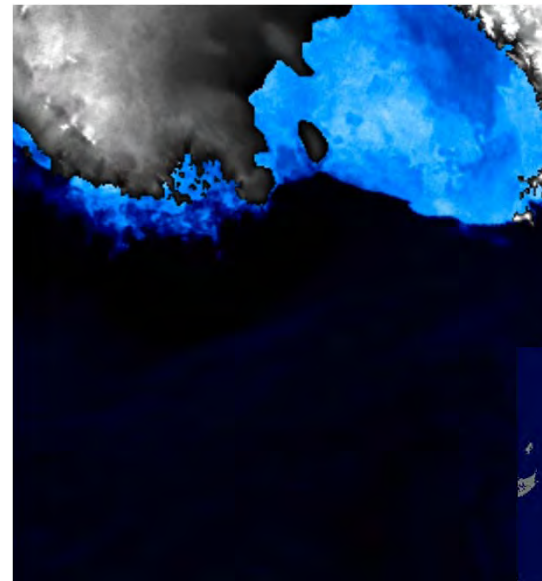


11 Mar 2011

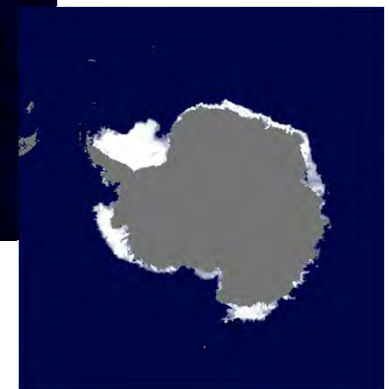
*Envisat ASAR*



01 Mar 2011



*AMSR-E PR89*  
*Alvaro Ivanoff (NASA/GSFC)*

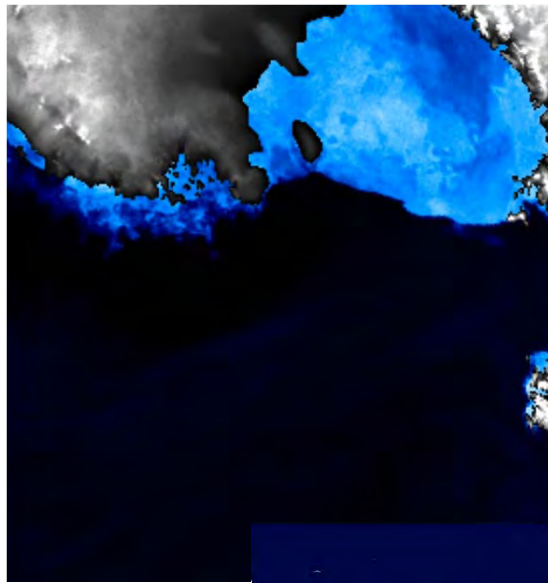


# Sea ice at Sulzberger

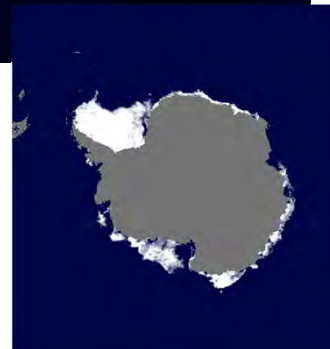
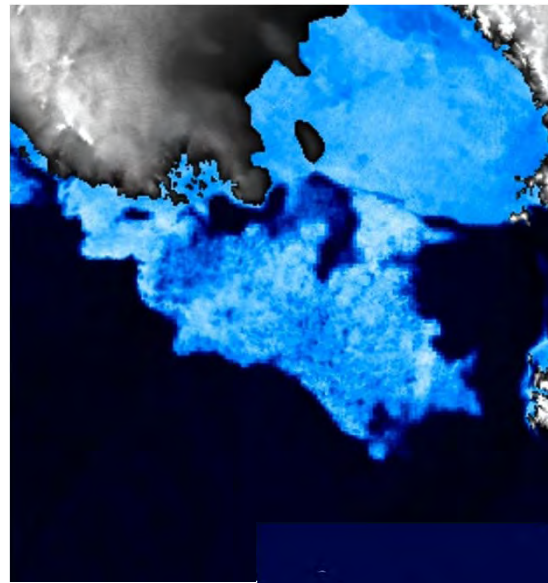
- Dampens swell\*
- Buttresses ice shelf



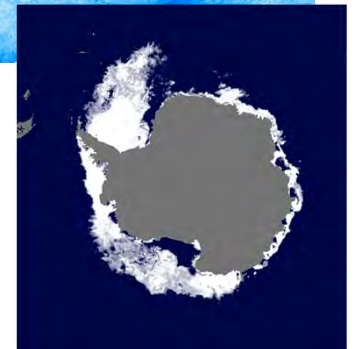
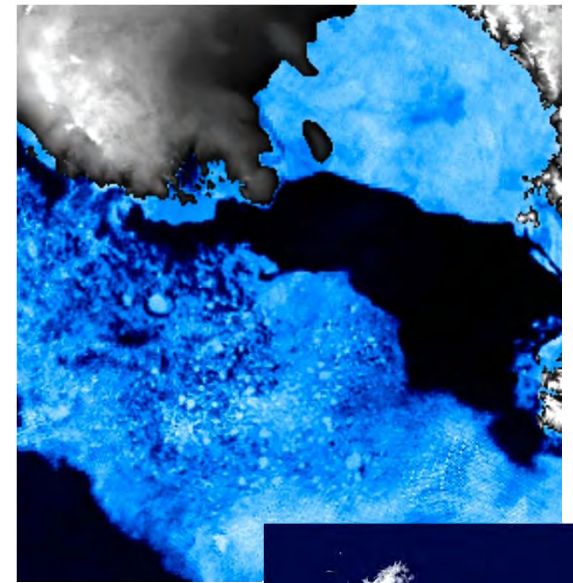
01 Mar 2011



27 Feb 2010



21 Dec 2004



AMSR-E PR89  
Alvaro Ivanoff

# McMurdo Ice Shelf

- Dampens swell
- Buttresses ice shelf\*

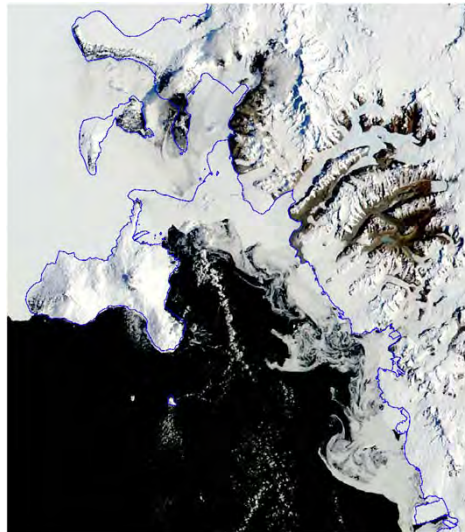


40,000 km<sup>2</sup> fast ice lost in ~40 days

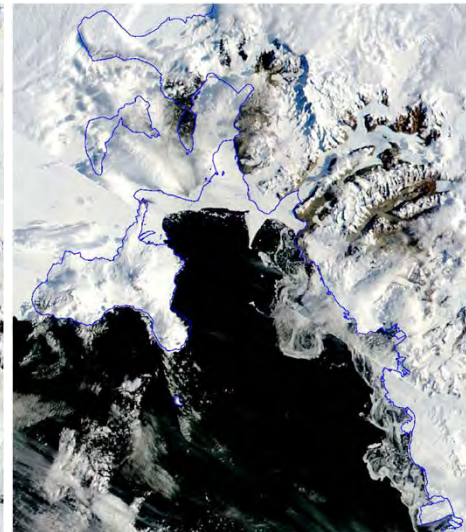
75 km N ↓



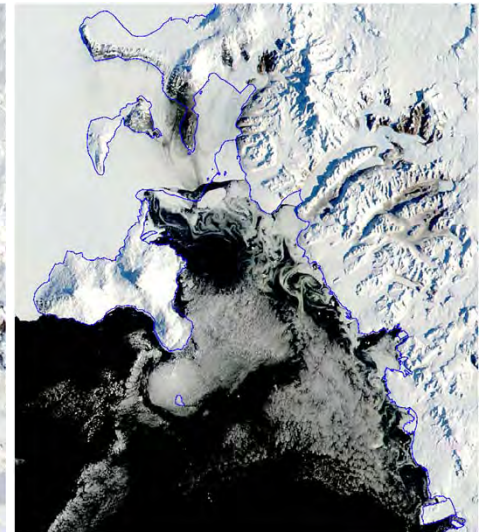
17 Jan 2011



29 Jan 2011



06 Feb 2011

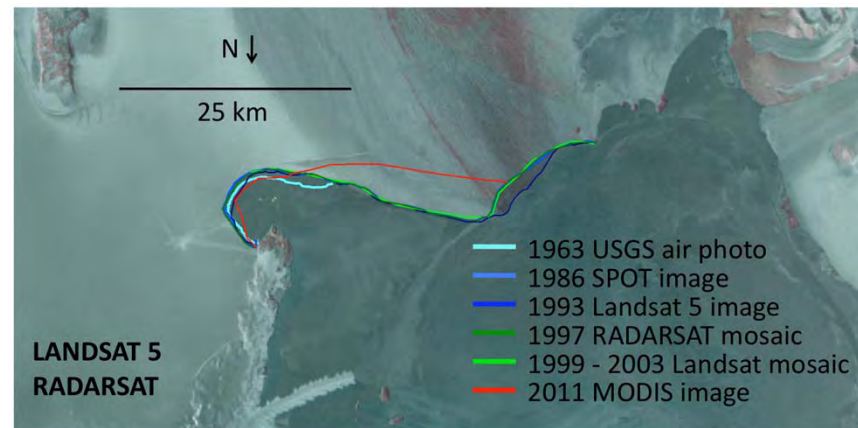
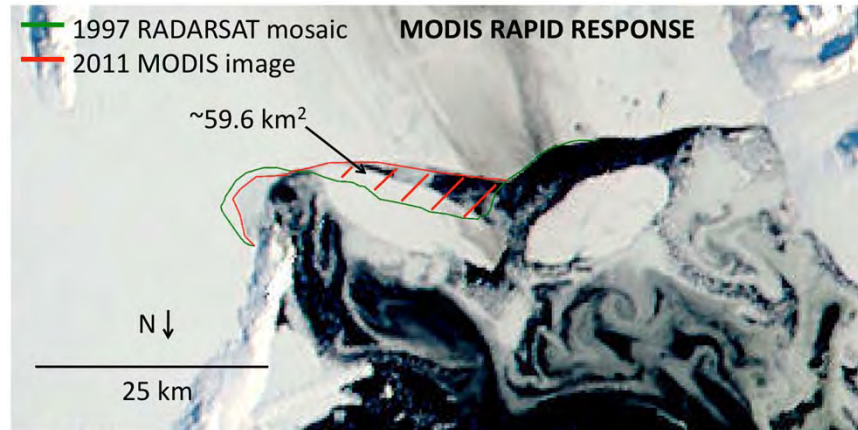


25 Feb 2011

*MODIS Rapid Response*

# McMurdo Ice Shelf

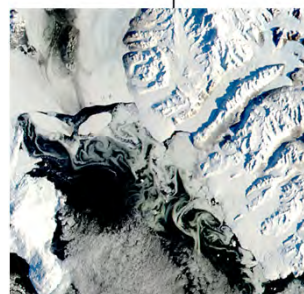
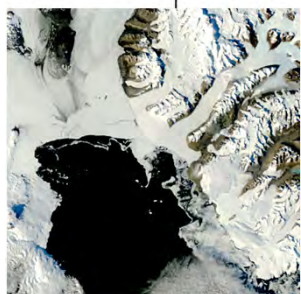
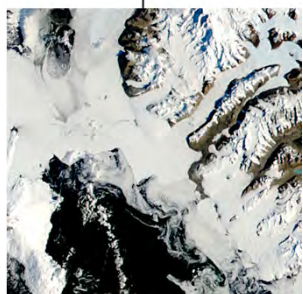
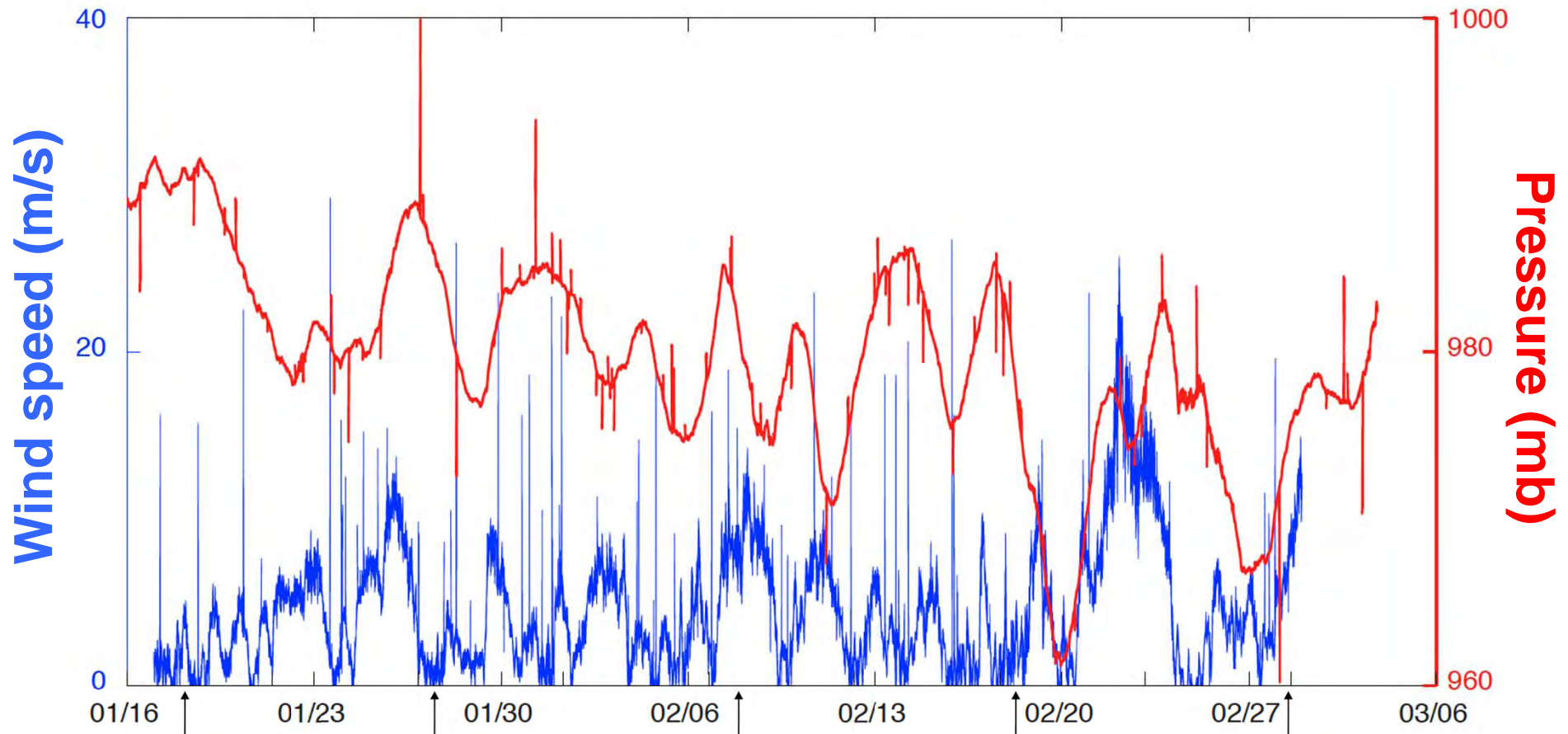
- Dampens swell
- Buttresses ice shelf\*

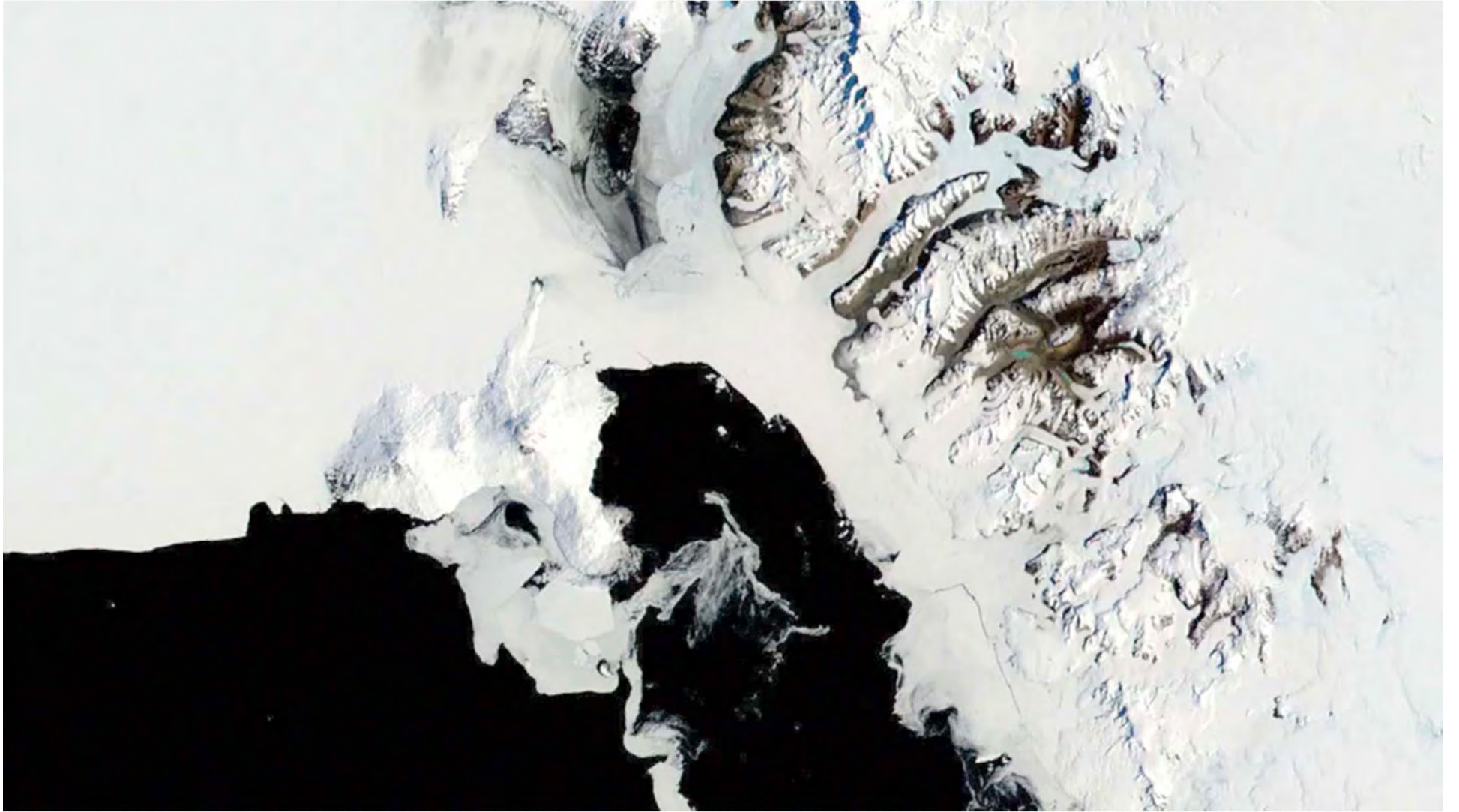


**stable for +48 years**

# McMurdo Ice Shelf

# Marble Point AWS



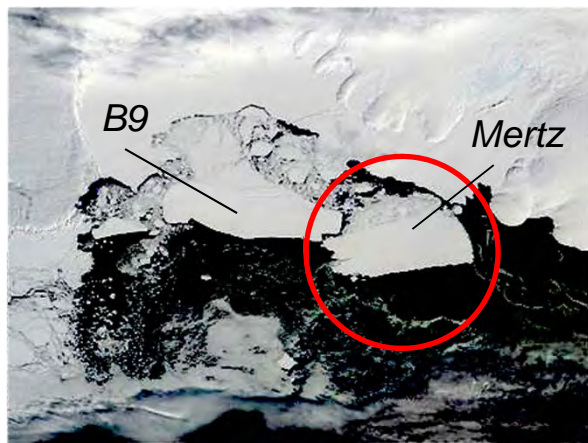


## Examining the interaction between multi-year landfast sea ice and the Mertz Glacier Tongue, East Antarctica: Another factor in ice sheet stability?

Robert A. Massom,<sup>1,2</sup> A. Barry Giles,<sup>2</sup> Helen A. Fricker,<sup>3</sup> Roland C. Warner,<sup>1,2</sup>  
Benoit Legrésy,<sup>4</sup> Glenn Hyland,<sup>1,2</sup> Neal Young,<sup>1,2</sup> and Alexander D. Fraser<sup>2,5</sup>

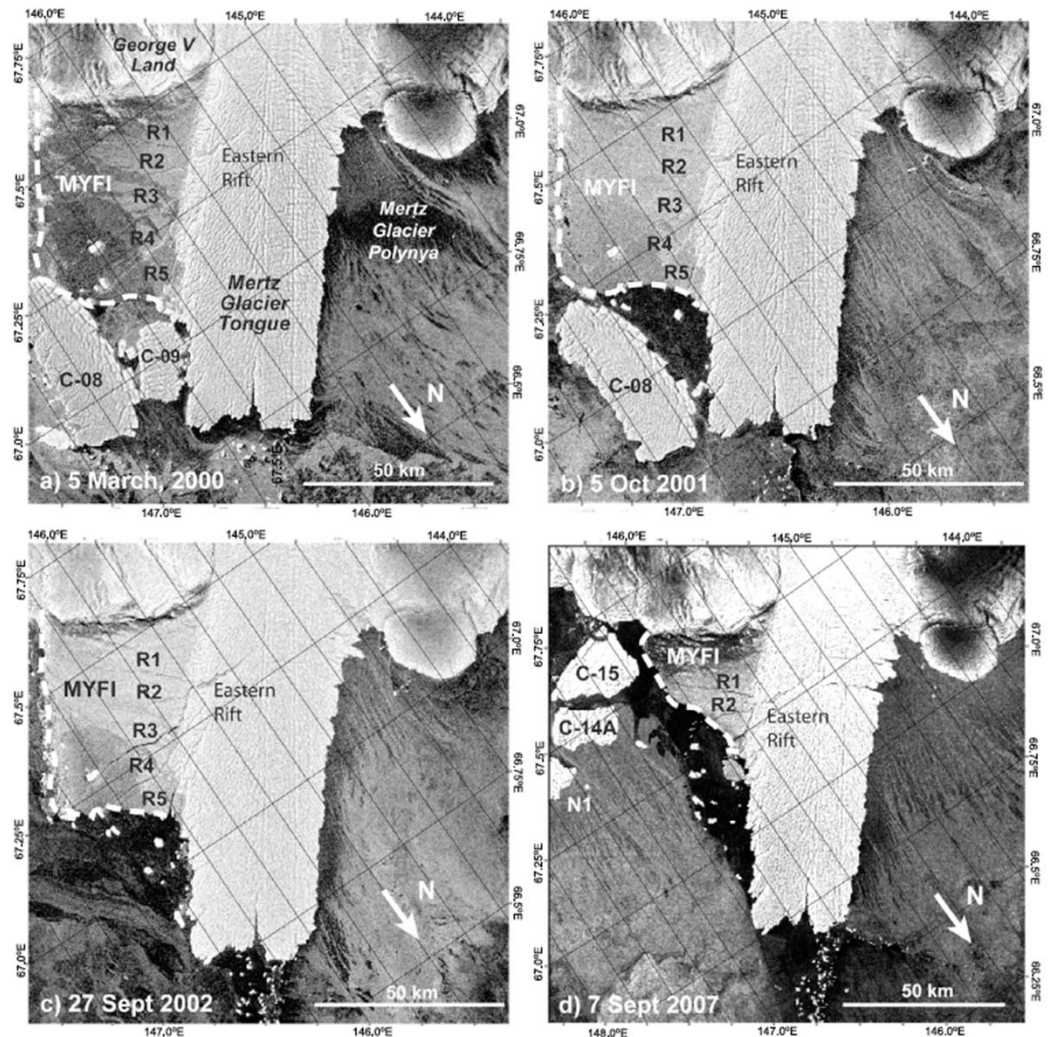


- Dampens swell\*
- Buttresses ice shelf\*



MODIS, 26 Feb 2010

Radarsat SAR



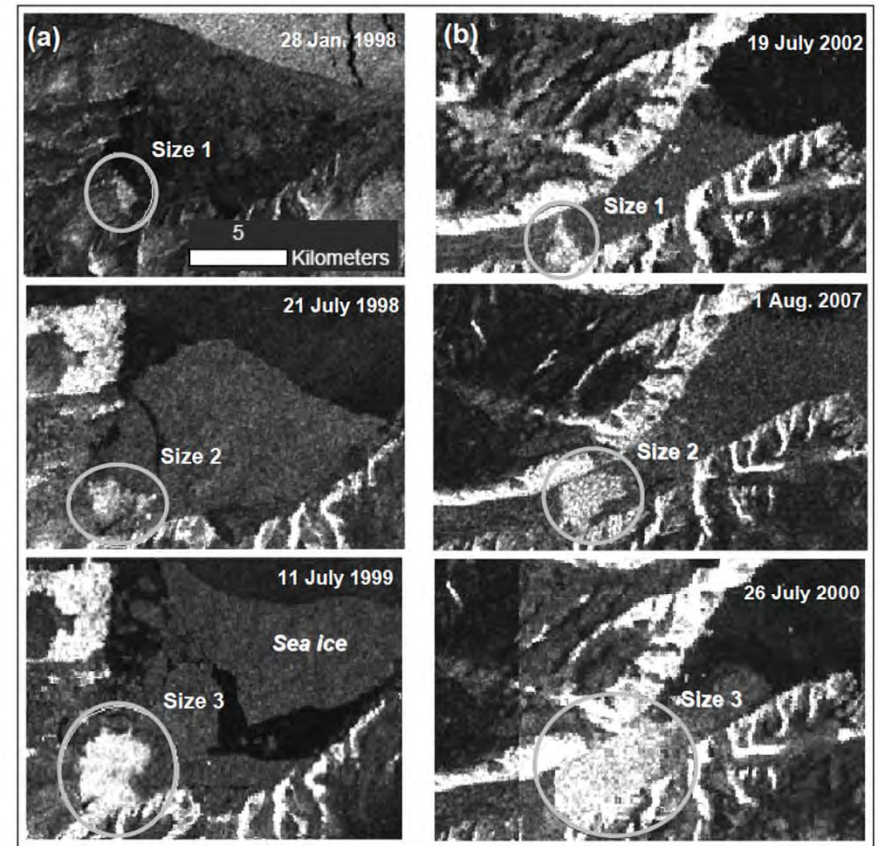
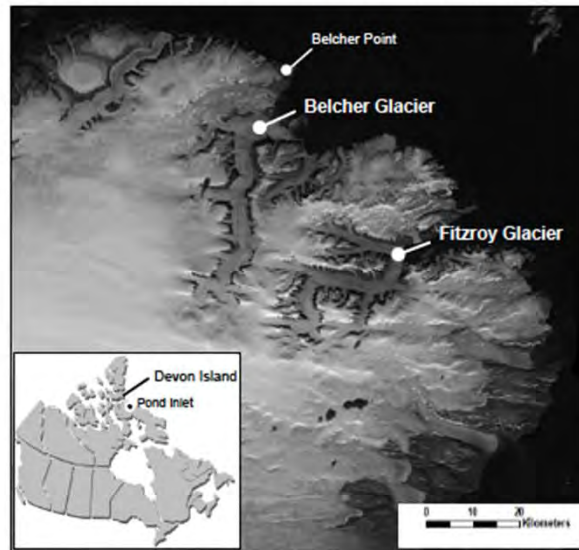
**Relationships between iceberg calving and sea ice conditions on NE Devon Ice Cap, Nunavut**

Emilie Herdes and Luke Copland ([luke.copland@uottawa.ca](mailto:luke.copland@uottawa.ca))

Department of Geography, University of Ottawa, Ottawa, Ontario K1N 6N5, Canada.

Brad Danielson and Martin Sharp

Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta T6G 2E3, Canada





# Conclusions:

- **Sulzberger Ice Shelf calving event**
  - Distant teleconnection (13,000 km)
  - Links unrelated phenomena
  - Tsunami-induced swell occurs when Sulzberger Bay is devoid of sea ice
- **McMurdo Ice Shelf calving event**
  - Loss of 40,000 km<sup>2</sup> of 'persistent' sea ice
  - Mild storm event triggers calving
- **Sea ice plays a critical role in ice-shelf stability**

**Controls on calving/collapse include**

  - Thermodynamic (e.g., Larsen B)
  - Mechanical (e.g., Sulzberger, McMurdo, Wilkins)
  - Sea ice

**Big Thanks:** *Alvaro Ivanoff (NASA/GSFC), Jeremy Bassis, Paul Morin*