REMOTE SENSING OF ANTARCTIC CALVING FRONT DYNAMICS

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Introduction

- The Antarctic ice sheet has the potential to dramatically raise global sea levels.
- Iceberg calving is responsible for almost half of the current mass loss of the Antarctic ice sheet.
- Retreat of the calving front location can increase ice discharge through loss of buttressing effects. This can enhance mass loss of the ice sheet.
- Remote sensing is the only source that provides information about front locations with high temporal and spatial coverage.

Circum-Antarctic Front Changes

- Changes of glacier and ice shelf fronts along the Antarctic coastline vary depending on region, glacier type and environmental conditions.
- Many ice shelves of the Antarctic Peninsula retreated or even collapsed.
- Along the West Antarctic Ice Sheet glaciers show cyclic behavior and very dynamic fluctuations.
- Along the East Antarctic Ice Sheet glacier retreat and advance can occur alongside neighboring glaciers.

Antarctic Calving Front Changes (1997 to 2014)

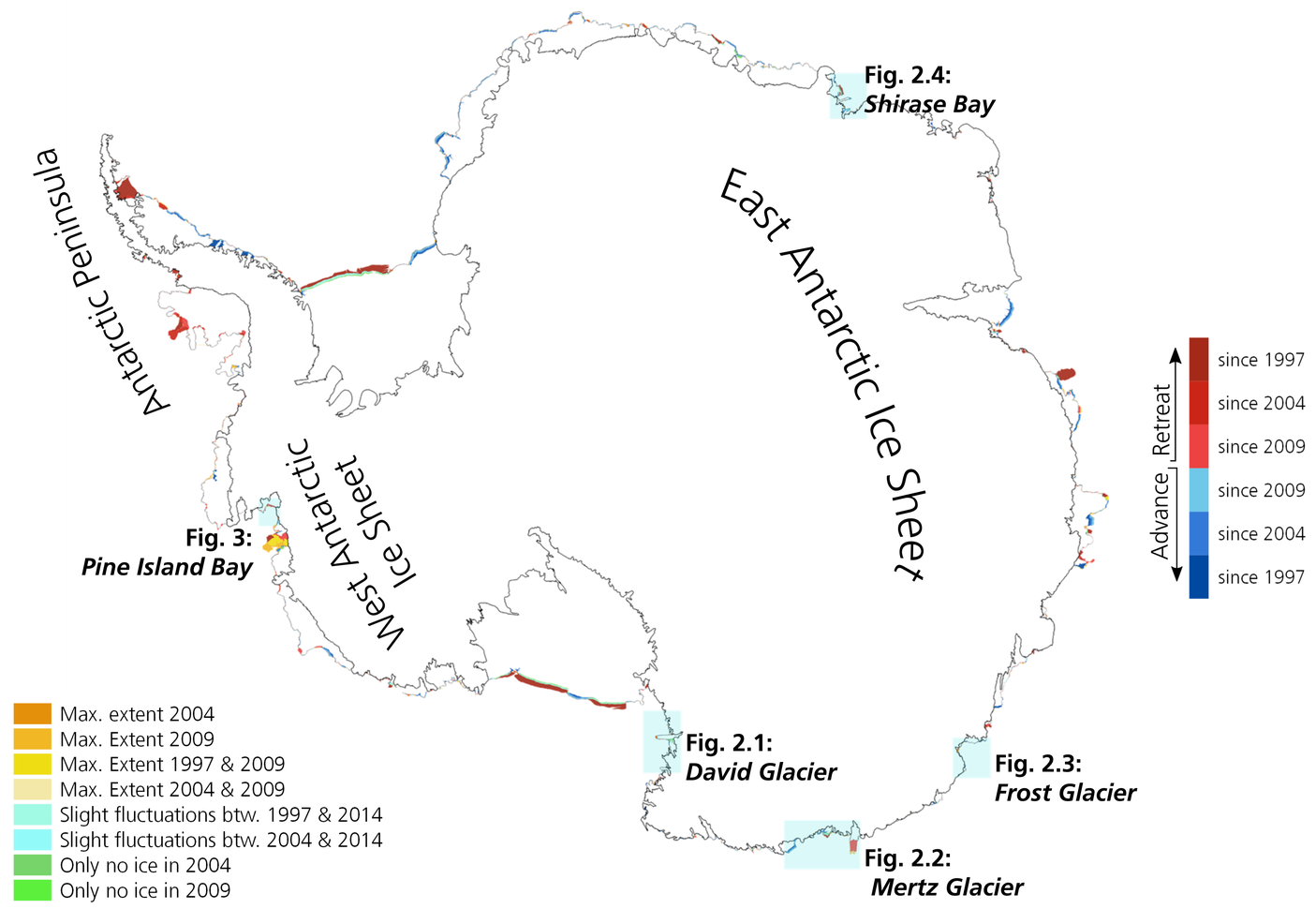

Fig. 1: *Circum-Antarctic calving front fluctuations derived from optical and radar satellite imagery. Coastline products of the Radarsat Mosaic 1997 and MODIS Mosaics 2004, 2009 & 2014.*

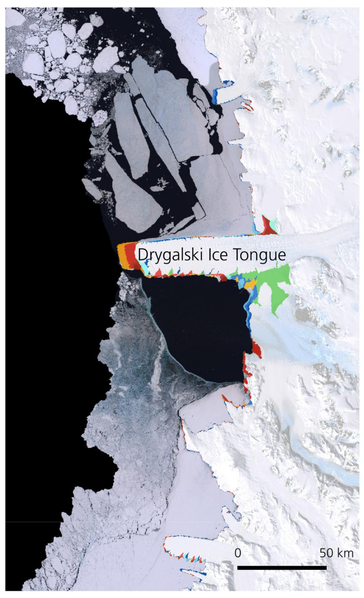

Fig. 2.1: *Part of Victoria Coast with Drygalski Ice Tongue which is vulnerable to icebergs from Ross Ice Shelf. © LIMA Mosaic 1999-2002*

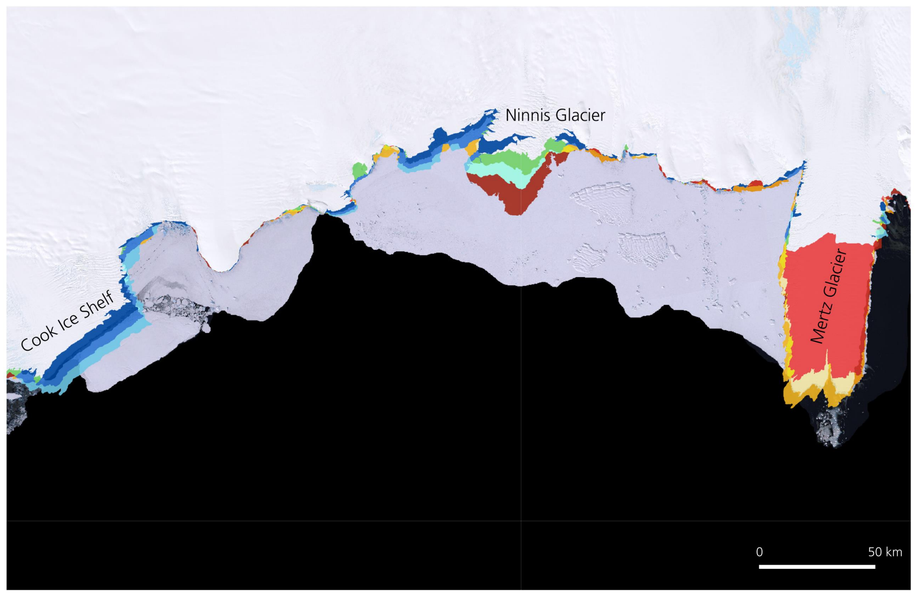

Fig. 2.2: *George V Land with Ninnis and Mertz Glacier as well as Cook Ice Shelf. Almost half of the Mertz Glacier tongue was left after a calving event took place in 2010. The Cook Ice Shelf shows steady advance. © LIMA Mosaic 1999-2002*

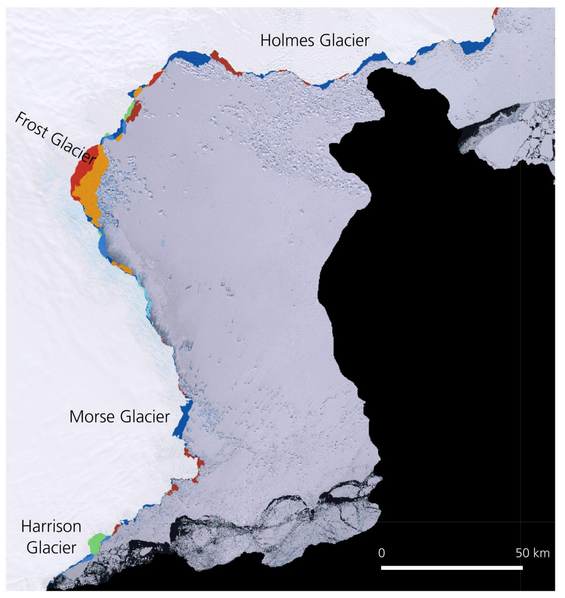

Fig. 2.3: *Part of Wilkes Land with Frost Glacier. As most of the glaciers in this area, the ice tongue and icebergs are held in place by multi-year sea ice. © LIMA Mosaic 1999-2002*

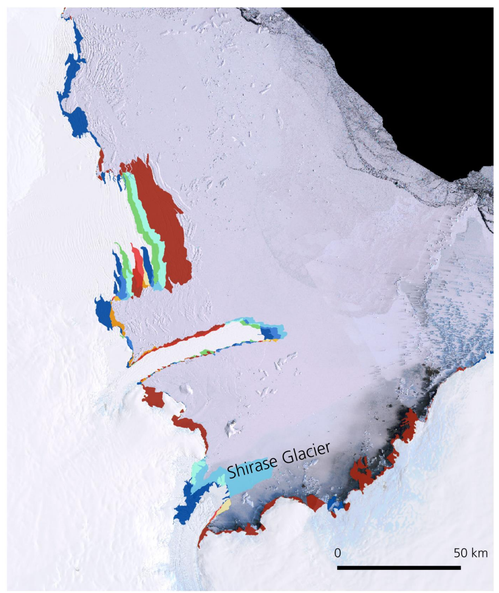

Fig. 2.4: *Shirase Bay at Dronning Maud Land. Shirase Glacier is one of the fastest flowing glaciers of Antarctica. The eastwards turning glacier tongue results from the asymmetric bedrock topography. © LIMA Mosaic 1999-2002*

Recent Calving of Pine Island Glacier

- Since 1947 Pine Island Glacier showed steady advance. Periodic calving events took place about every 4-6 years.
- Recently, the glacier calved in early August 2015, September 2017 and October 2018. The calving frequency seems to increase compared to earlier records (see Figure 3).
- The front retreated significantly compared to 2000, the maximum glacier extent since the first records in 1947.

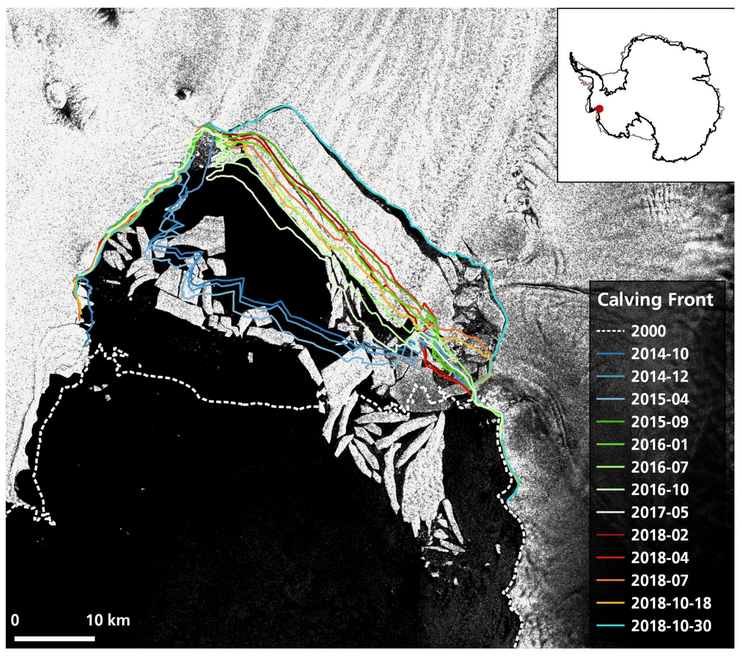

Fig. 3: *Pine Island Glacier with calving front positions derived from Sentinel-1 data and Radarsat (year 2000). © Copernicus Sentinel-1 Data 2018-10-29.*

Conclusion

- Remote sensing has a great potential to monitor glacier and ice shelf front changes.
- Circum-Antarctic analyses of glacier retreat and advance are still rare and cover short time periods.
- New satellites like Sentinel-1 offer great opportunities for calving front location studies with high temporal and spatial resolution as can be seen on Pine Island Glacier.
- More detailed studies on glacier retreat and advance are necessary to better understand future glacier and ice shelf dynamics.

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