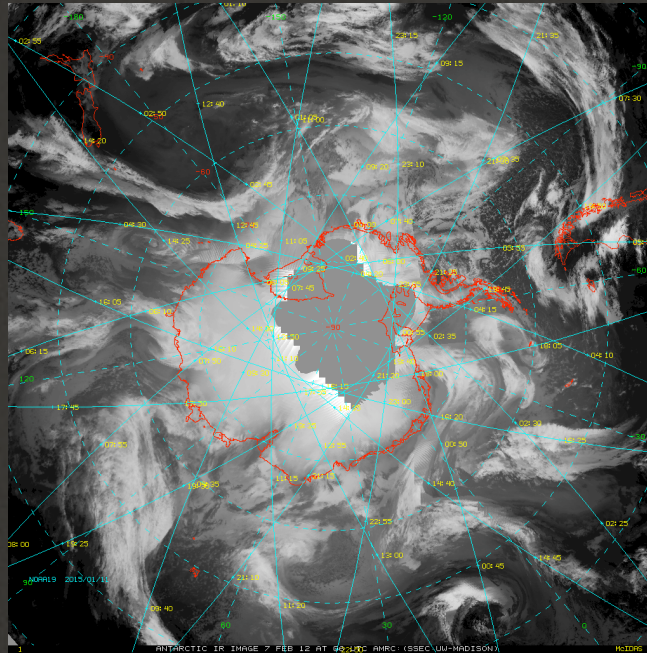


Cloud Mass Meridional Transport Events From the Southern Ocean into Antarctica



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Cloud Mass Meridional Transport Event (CMMT)

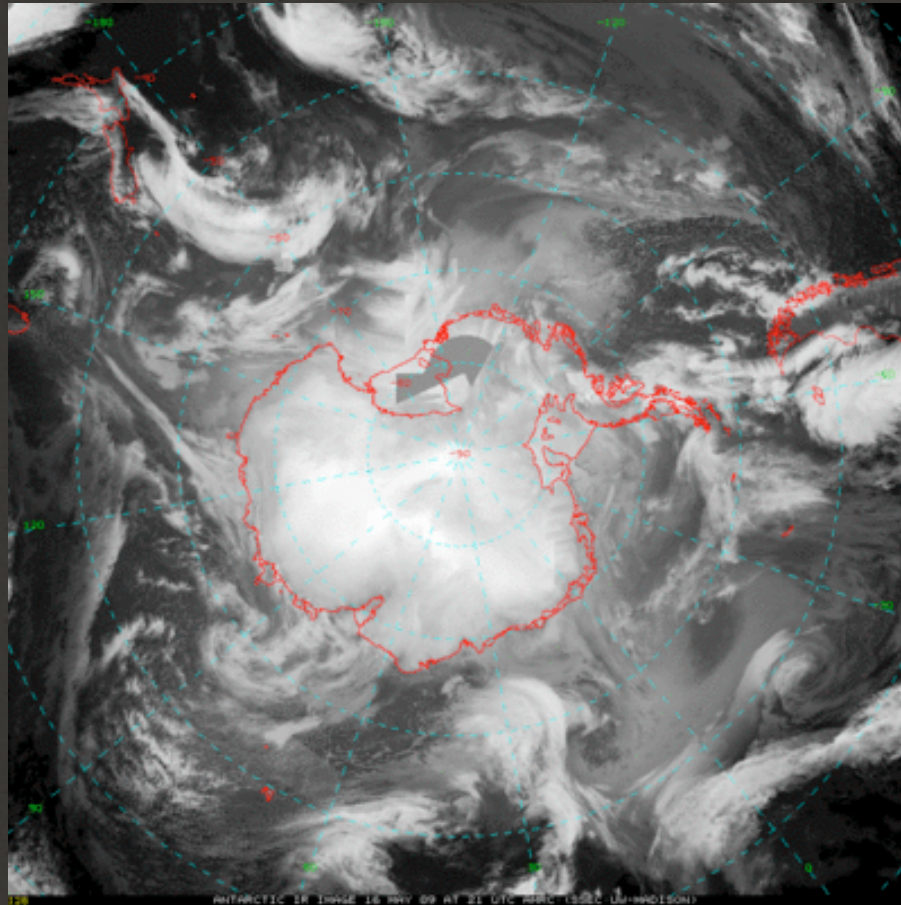
Motivation and Implementation

- Distinct “storm events” across generally zonal flow seen by satellite composite imagery
- Associated with precipitation, high winds
- Identify favorable regions
- Climatology Nov 1992 – 2012
- IR

CMMT

Definition

- Poleward-propagating synoptic-scale cloud mass
- Min 48 hr poleward advection
- Two events within 12 hrs → assumed same system
- Skirting Events



Event:
0600 UTC 17 May
2009 – 1500 UTC 21
May 2009

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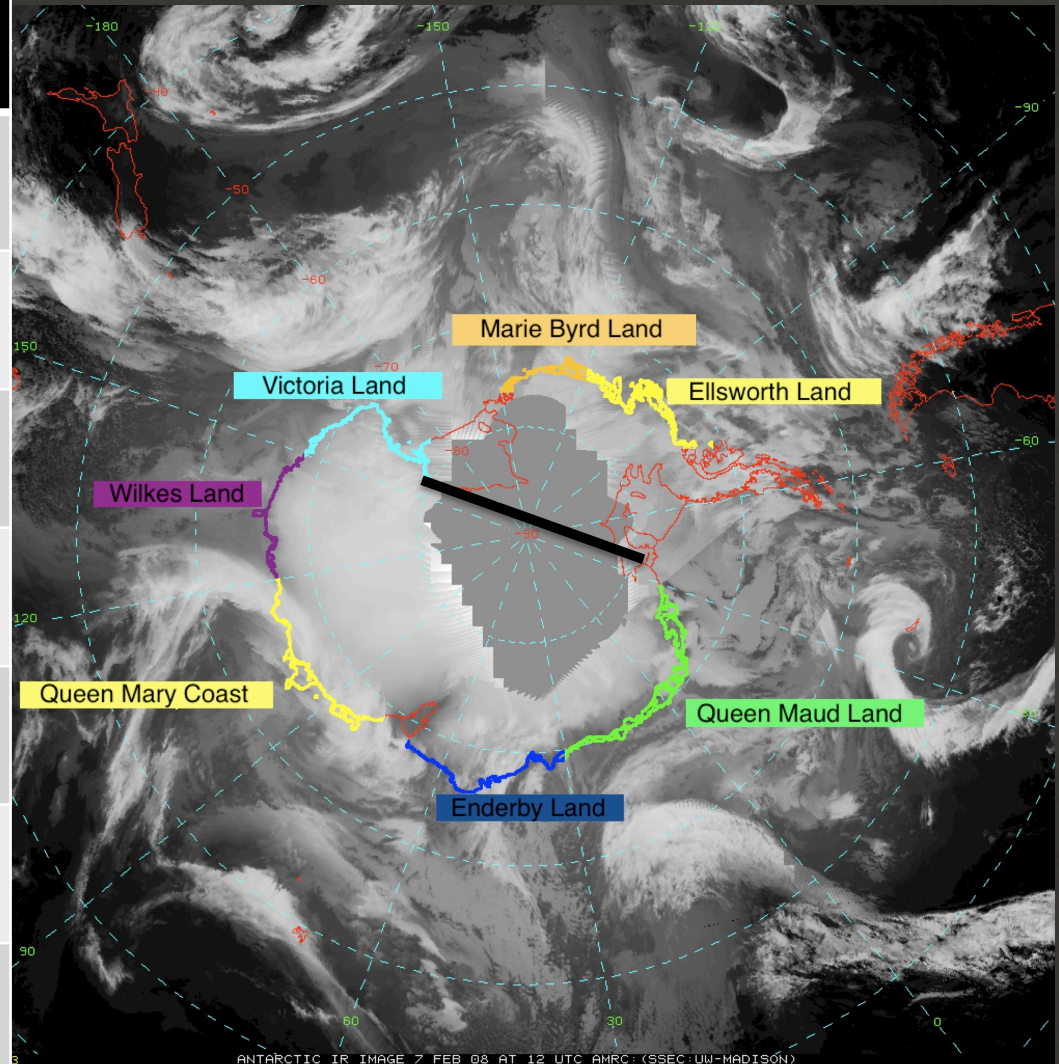
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Splitting up the continent

CMMT Sectors

Sector	Longitudinal Bounds
Marie Byrd Land (MBL)	120°W - 150°W
Ellsworth Land (ELS)	75°W - 120°W
Queen Maud Land (QML)	30°E - 30°W
Enderby Land (END)	75°E - 30°E
Queen Mary Coast (QMC)	120°E - 80°E
Wilkes Land (WLK)	150°E - 120°E
Victoria Land (VCT)	150°E - 180°E



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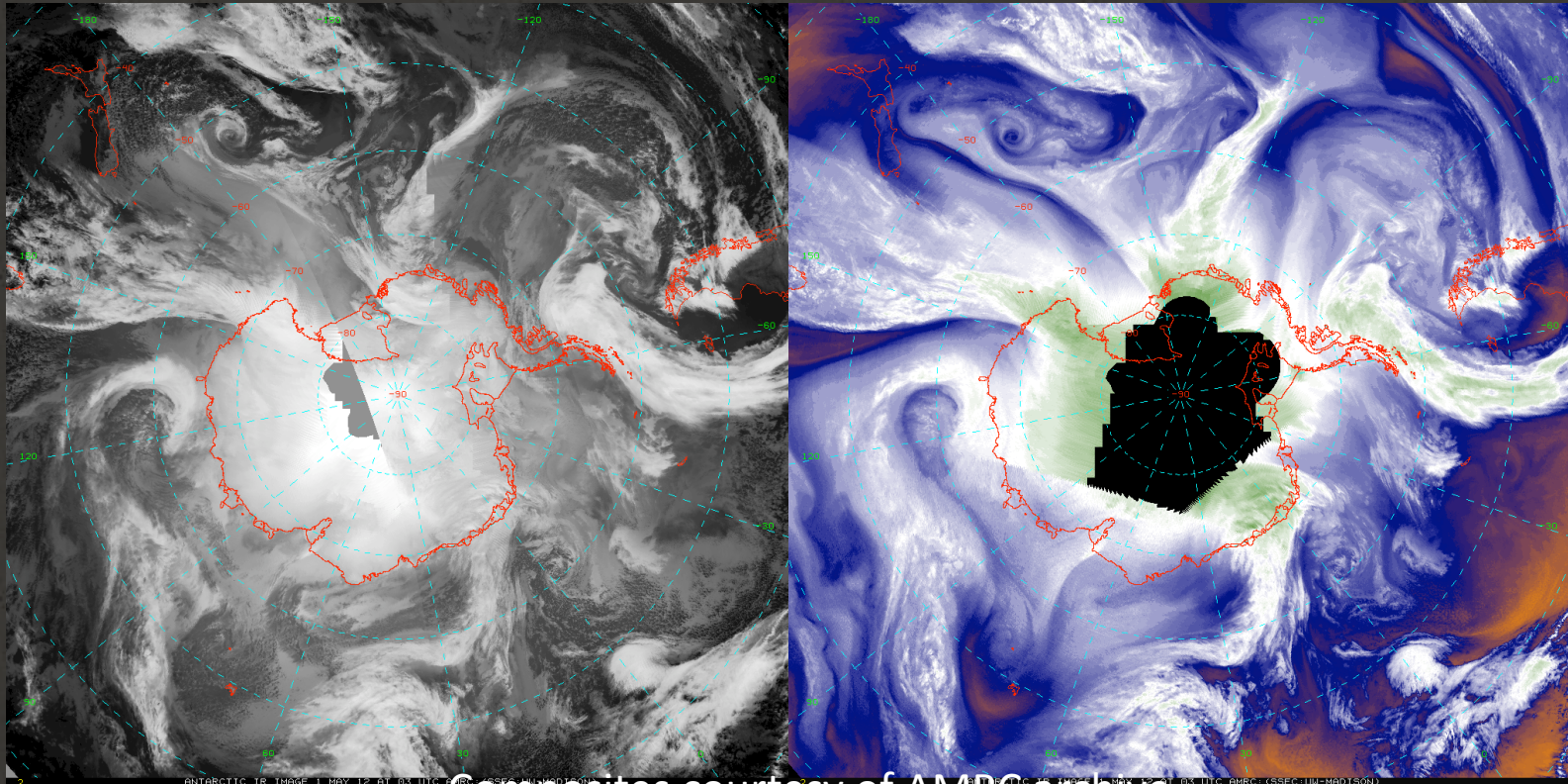
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Counting Method

Composite Images

- Reviewed 'loops' of IR composites
 - Monthly for 3hrly composites
 - Load 248 images for 1hrly (~1/3 of a month)
- WV helpful for start/end time



Composites courtesy of AMRC archive

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Counting Method

Addressing Numerous Counters

- Multiple people over time have counted CMMT events to compiled the climatology
- Introduces potential errors
- Test year 2009
 - IR event # and duration correlations high (.9)
- Similar counting methodology

Climatology

Antarctic Continent

- 920+ Events
- 2650+ Days Affected (over 35% of 20 year period)

Austral Season	Number of Events	Days Affected
Spring (Sept-Nov)	258	729
Summer (Dec-Feb)	192	526
Fall (Mar-May)	230	672
Winter (Jun-Aug)	244	724

- 53% two-day events
- Longest event: 10 days, skirting

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Climatology

West Antarctica | East Antarctica

• 2 Sectors (MBL, ELS)

• 5 Sectors (QML, END, QMC, WLK, VCT)

Regional Area

2,024,257.59 km²

9,617,556.68 km²

3X more active

Nearly 5X larger

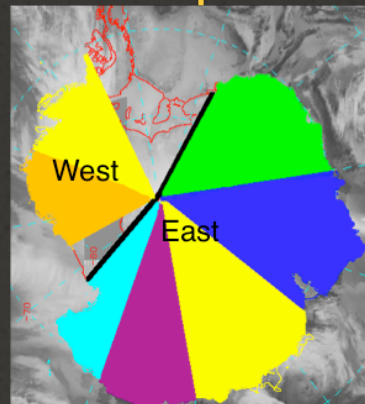
Active Season

Austral Winter (Jun-Aug)

Austral Spring (Sept-Nov)

~50% Days Affected

~30% Days Affected



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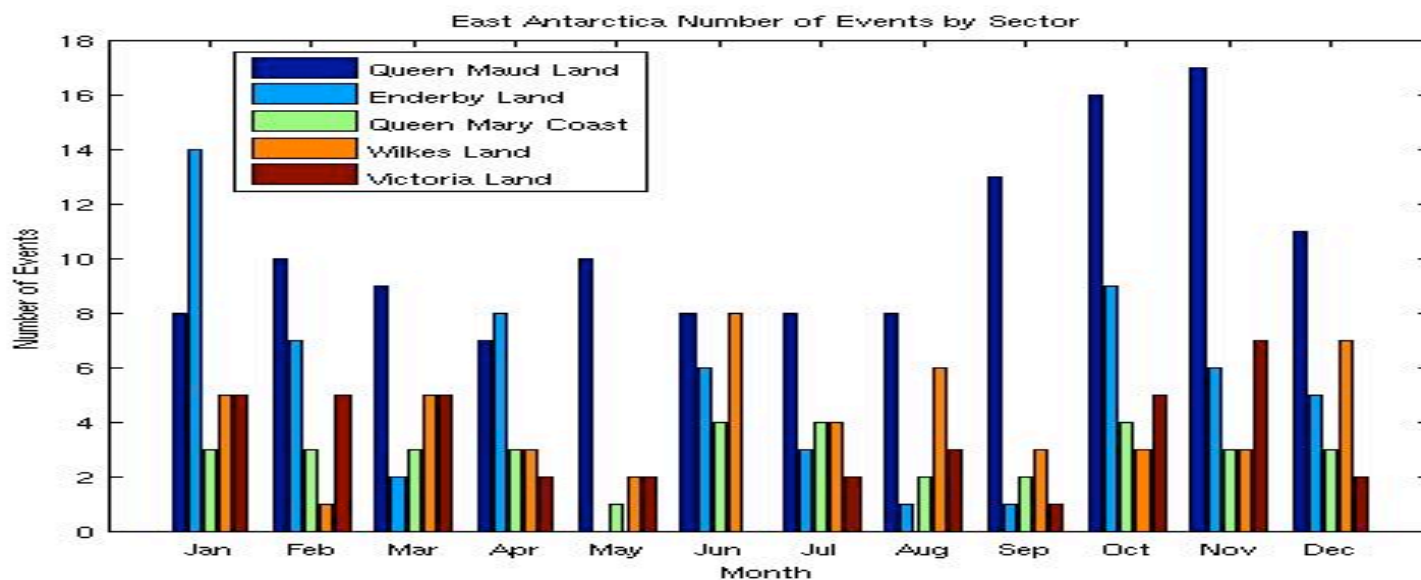
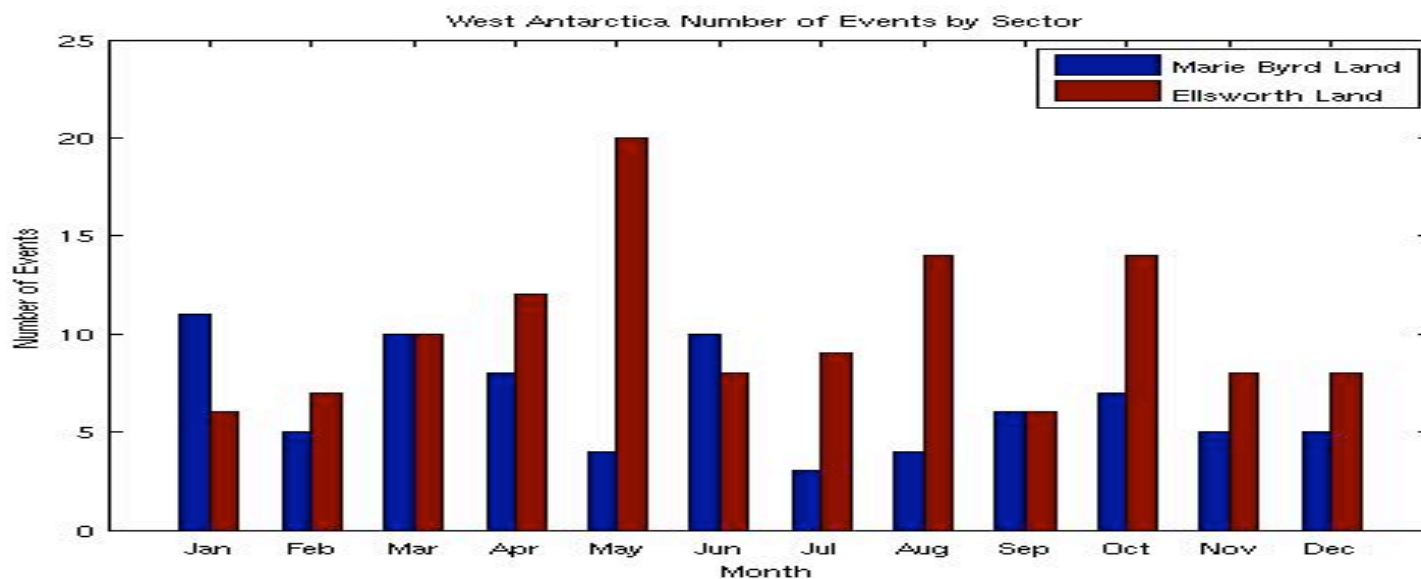
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Climatology

West Antarctica | East Antarctica

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Climatology

Notable Sectors

Most Active Sector Ellsworth Land

(West Ant.; 75°W-120°W; 1,392,962 km²)

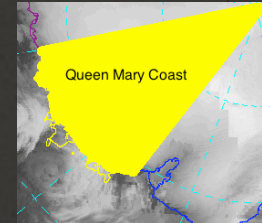
- 122 CMMT Events
- 354 Days Affected
- May most active



Least Active Sector Queen Mary Coast

(East Ant.; 120°E-80°E; 2,449,855 km²)

- 35 CMMT Events
- 88 Days Affected
- June/July most active



Skirting Events

- 413 CMMT events
- 1280 days affected
- Austral Winter most active season
- 45% two-day durations
- Longest event: 10-day West Ant. Nov 1997

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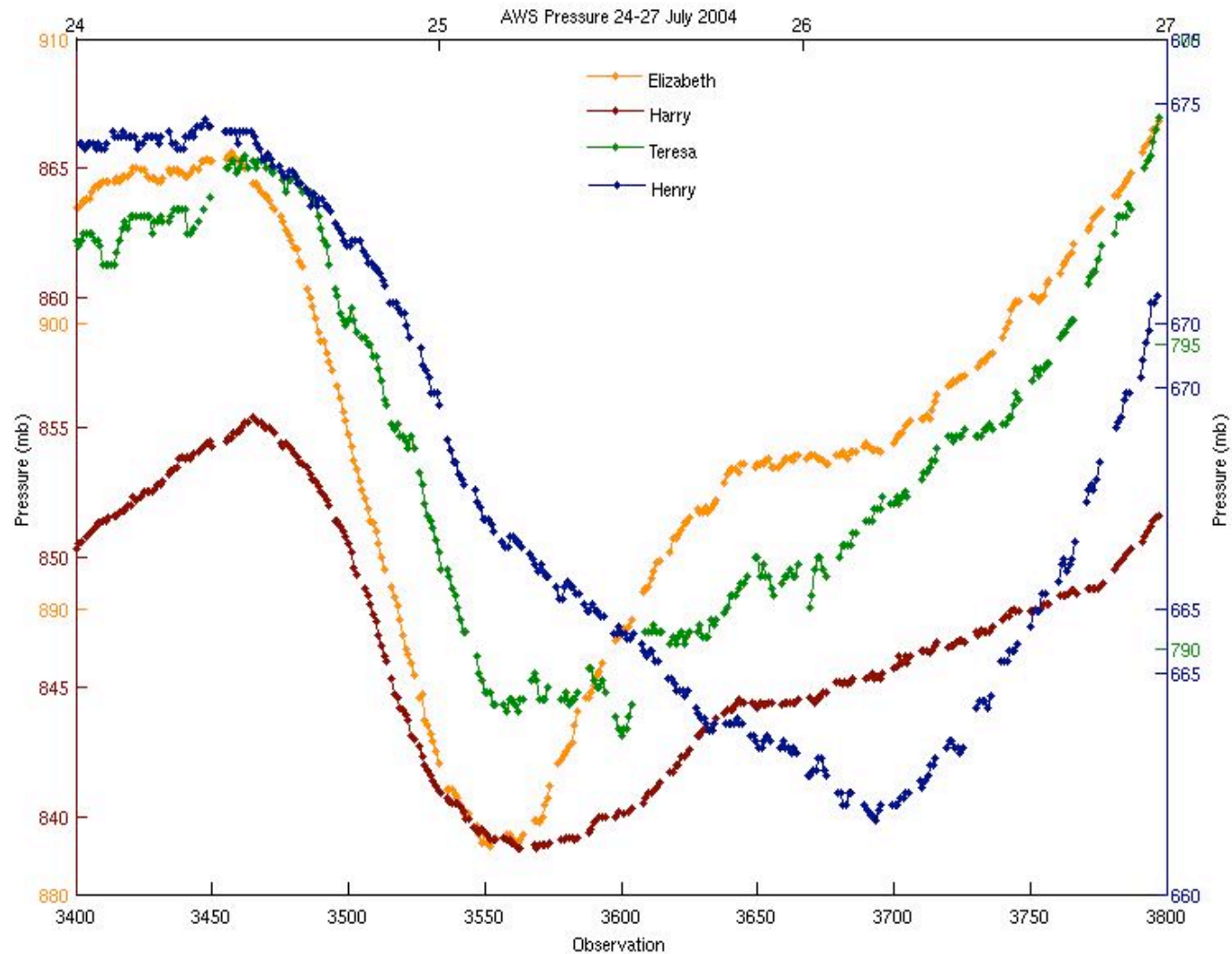
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The Importance of CMMT Events

Impacts via AWS network



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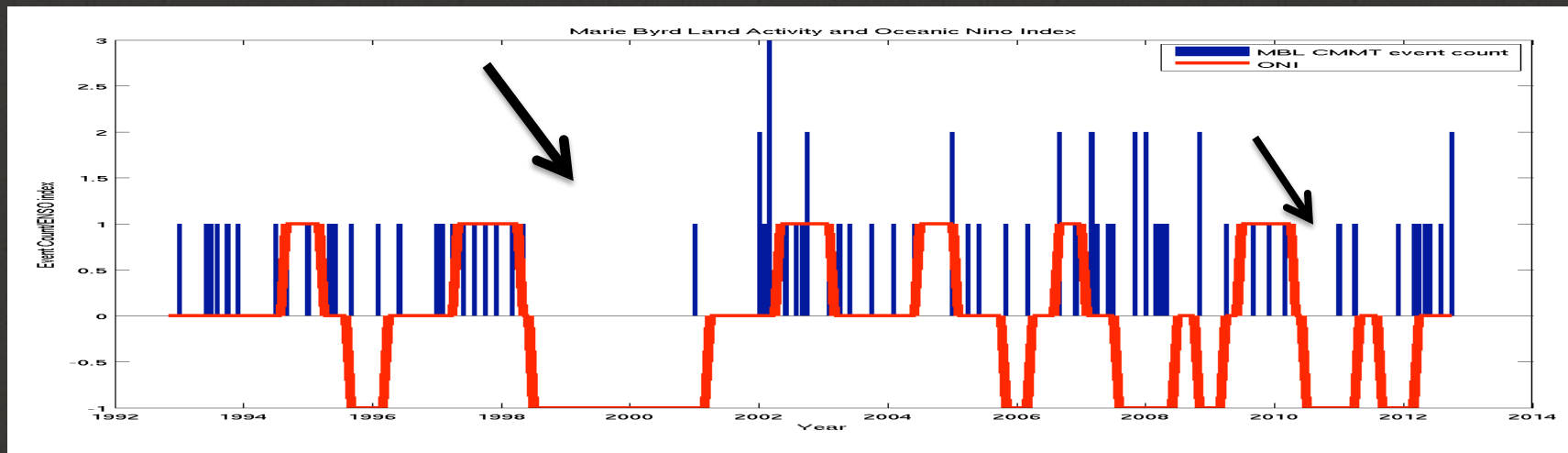
Summary

The Importance of CMMT Events

Link to Climate Indices?

Correlations between event #/days affected and 4 climate indices: SOI, SAM, MEI and EMI

Generally little/no correlation. Highest positive correlation: **.12 Wilkes Land and EMI**. Highest negative correlation: **-.13 Victoria Land and SAM**



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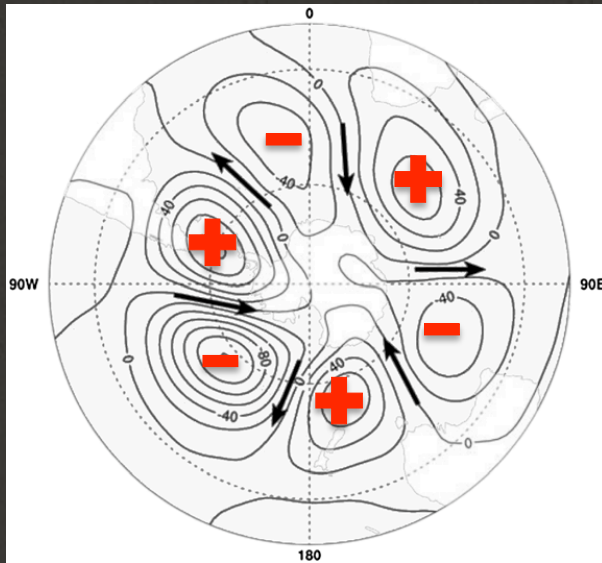
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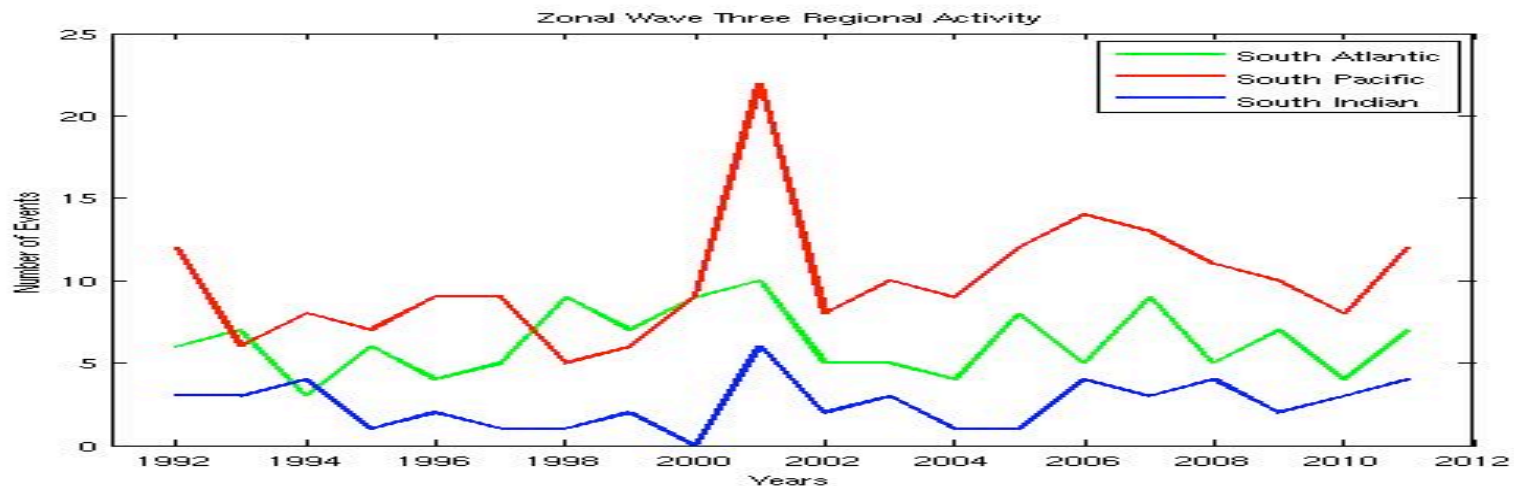
The Importance of CMMT Events

Zonal Wave Three



Uotila, P., T. Vihma, and M. Tsukernik (2013), Close interactions between the Antarctic cyclone budget and large-scale atmospheric circulation, *Geophys. Res. Lett.*, 40, 3237-3241.

- Re-group sectors to correspond with northerly flow
 - S. Pacific Ocean: MBL, ELS
 - S. Atlantic Ocean: QML
 - S. Indian Ocean: WLK
- Summed up activity in 1yr increments
- Generally no correlation
 - 2000-2005 exception



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Major Findings

- West Antarctica favored
 - 3x more active than East Antarctica
 - Active during winter
- Little correlation between CMMT and ENSO
 - La Nina/MBL hiatus
- Possible connection to ZW3

Future Work

- Understand impact of CMMT events on:
 - Sea Ice Extent
 - Precipitation
- Pseudo-Automatically track CMMT events?
- Extend climatology

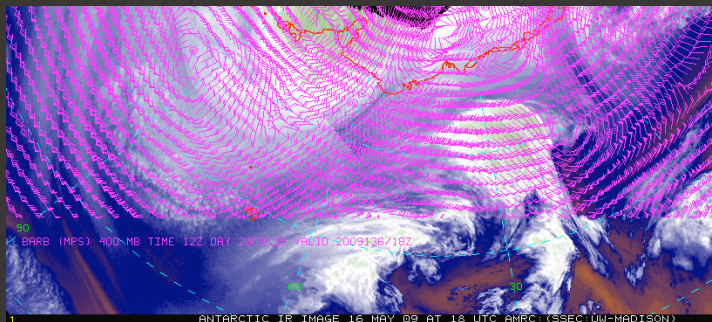
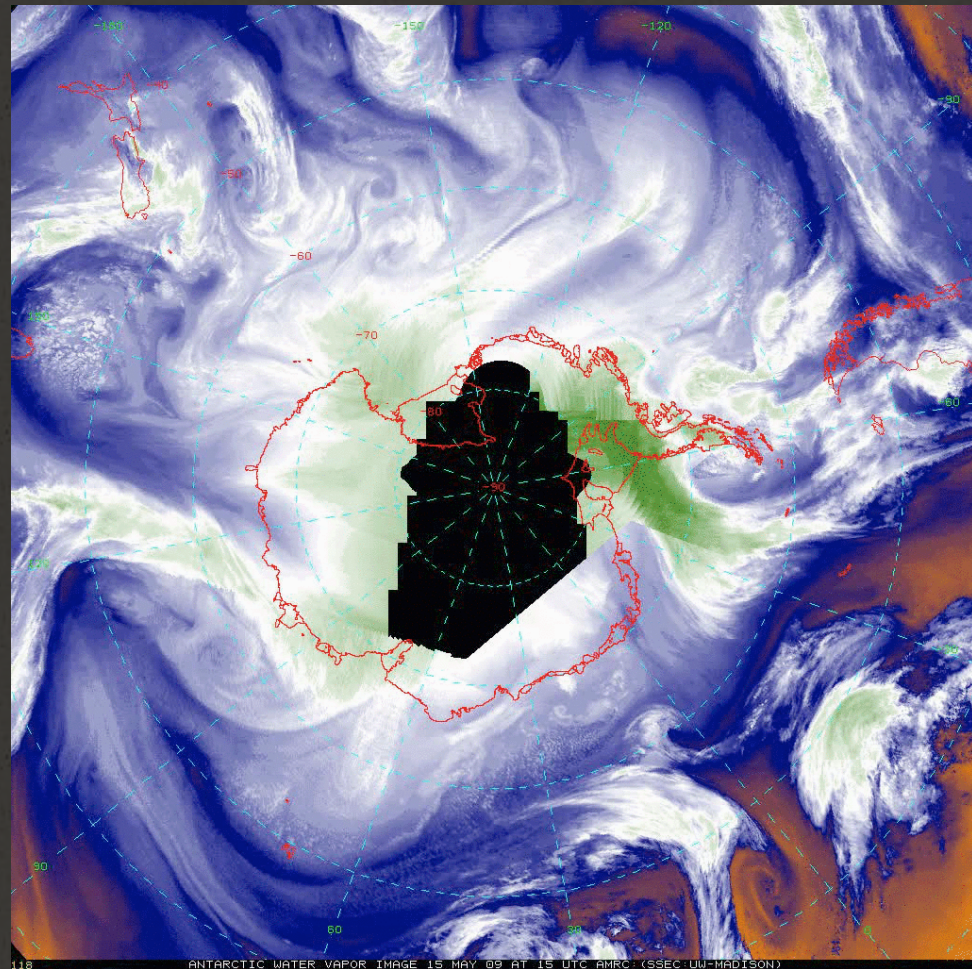
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Thank you! Questions?

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EXTRA: Calculating sector area

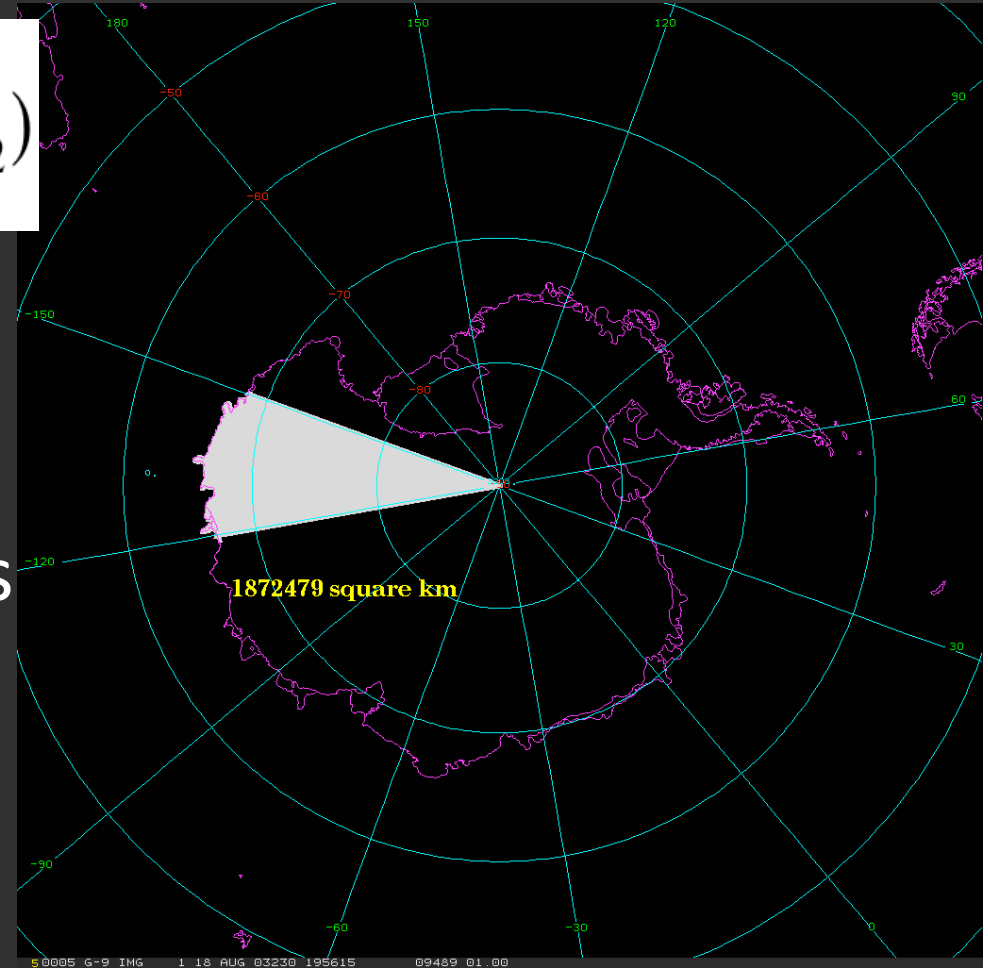
$$\frac{\pi}{180} R^2 (\sin \phi_1 - \sin \phi_2) * (\lambda_1 - \lambda_2)$$

Where

R: Radius of Earth

$\phi_{1,2}$: latitudinal bounds

$\lambda_{1,2}$: longitudinal bounds



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EXTRA: Climate Indices

1. Southern Oscillation Index (SOI)

- normalized mean sea level pressure anomaly difference between Tahiti, French Polynesia and Darwin, Australia (Troup, 1965; Parker, 1983)
- Courtesy of the Australian Bureau of Meteorology

2. Southern Annular Mode (SAM)

- normalized monthly zonal mean sea level pressure difference between 40°S and 65°S
- Courtesy of the British Antarctic Survey

3. Multivariate ENSO Index (MEI)

- uses six variables observed over the tropical Pacific in order to monitor ENSO
- Wolter and Timlin (2011) have discussed the methods behind the calculation in great detail
- Courtesy of the NOAA Earth System Research Laboratory

EXTRA: Climate Indices

4 El Niño Modoki Index (EMI)

- differs from a conventional El Niño in that the maximum sea surface temperature anomalies are located in the tropical central Pacific, as opposed to the tropical eastern Pacific for the canonical El Niño
- Courtesy of the Japan Agency for Marine-Earth Science and Technology

5 Oceanic Niño Index (ONI)

- takes into account the warming trend in the Niño-3.4 region since 1950 that results in an inaccurate reflection of interannual ENSO variability. The ONI is calculated using the Niño-3.4 Index but based on centered thirty-year base periods updated every five years.
- Courtesy of the Climate Prediction Center