Antarctica's Weather
Observing the Forbidding Continent from Earth and Space

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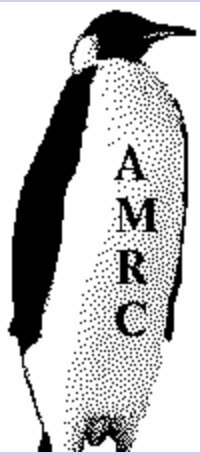
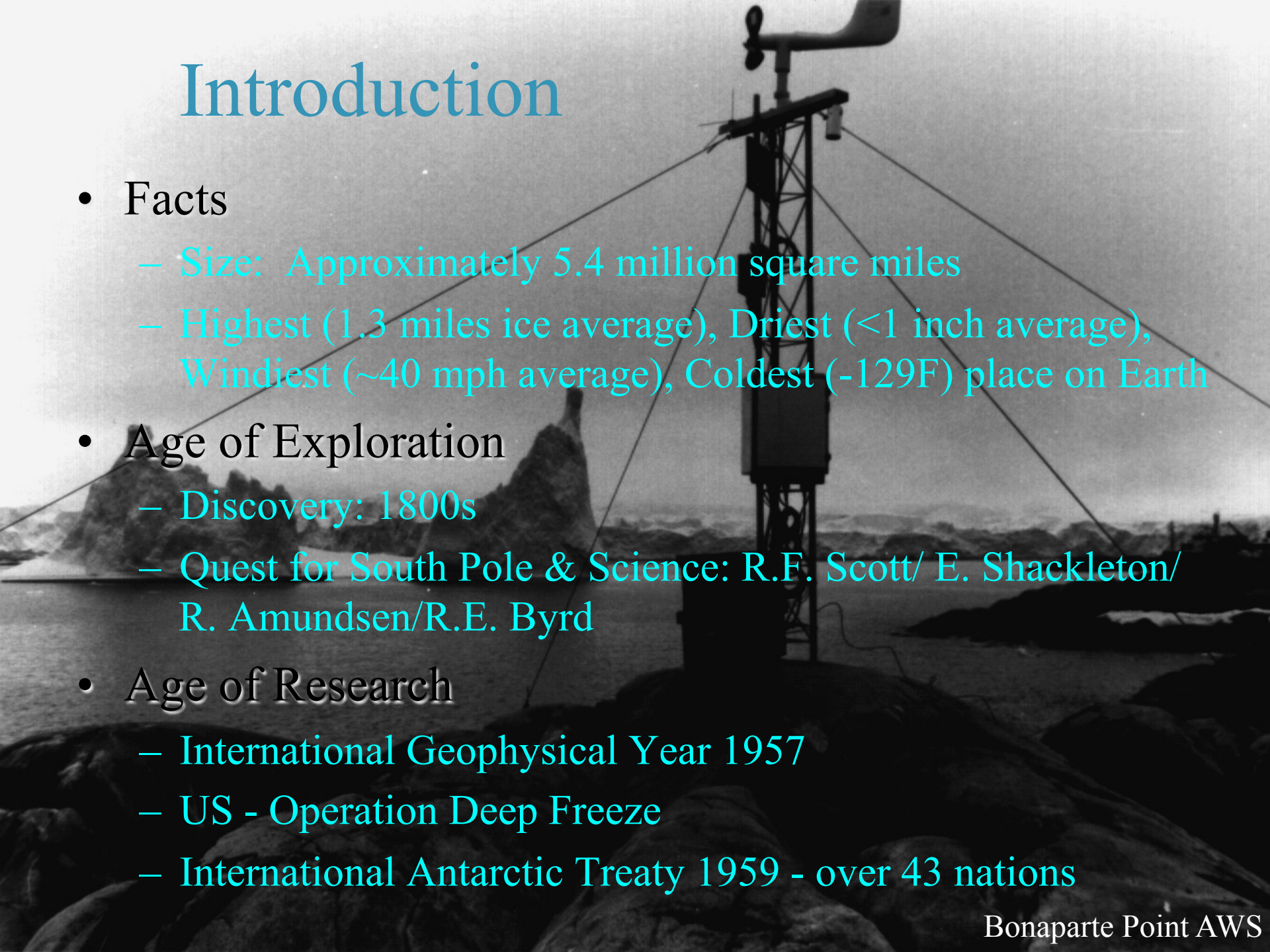


- Introduction
- Observations from Earth and space
- Research using observations
- Forecasting
- Climate research
- Observing icebergs
- Ross Island Meteorology Experiment (RIME)
- Travel to Antarctica
- Questions and Answers

Introduction

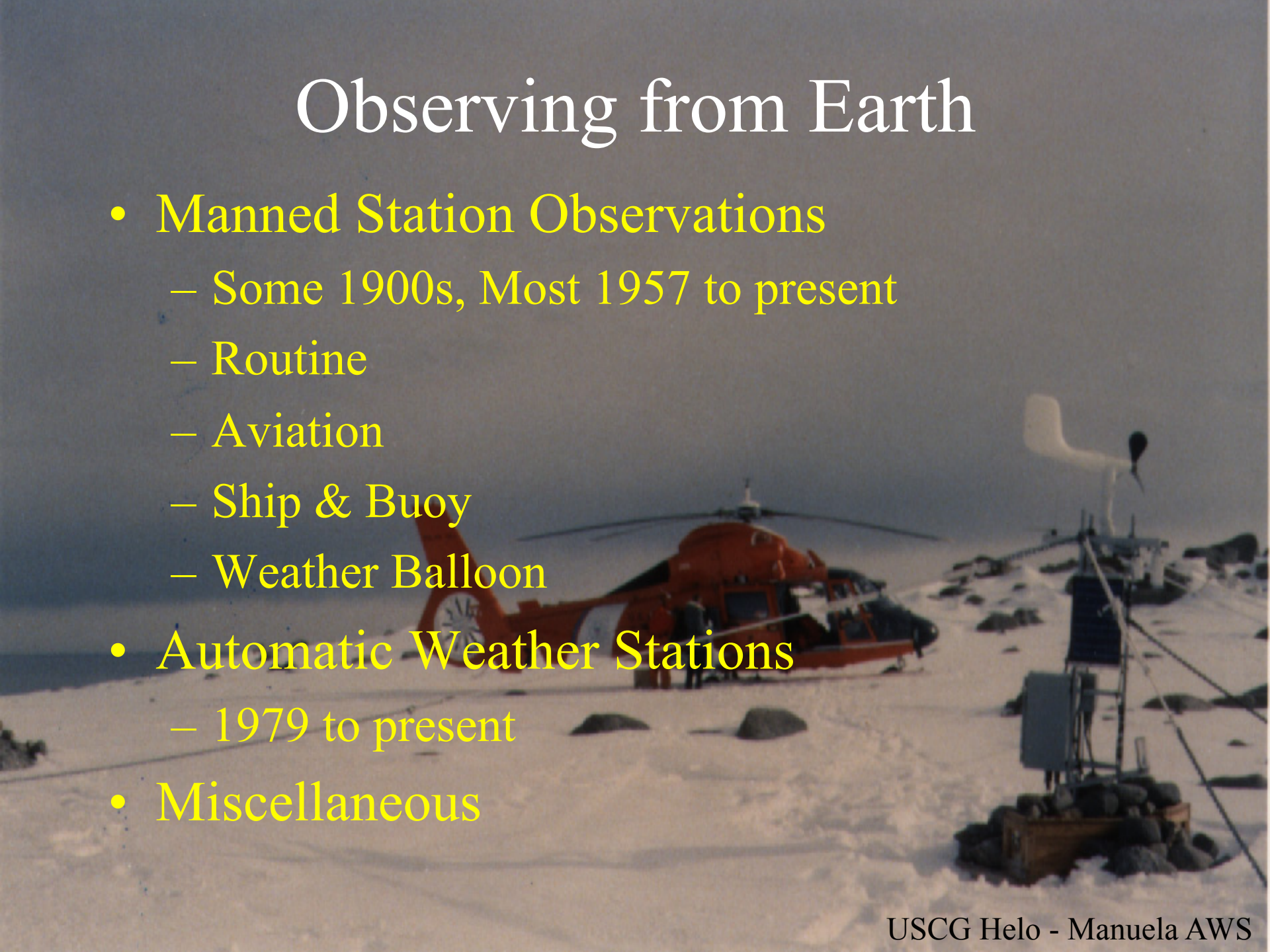
- Facts
  - Size: Approximately 5.4 million square miles
  - Highest (1.3 miles ice average), Driest (<1 inch average), Windiest (~40 mph average), Coldest (-129F) place on Earth
- Age of Exploration
  - Discovery: 1800s
  - Quest for South Pole & Science: R.F. Scott/ E. Shackleton/ R. Amundsen/R.E. Byrd
- Age of Research
  - International Geophysical Year 1957
  - US - Operation Deep Freeze
  - International Antarctic Treaty 1959 - over 43 nations



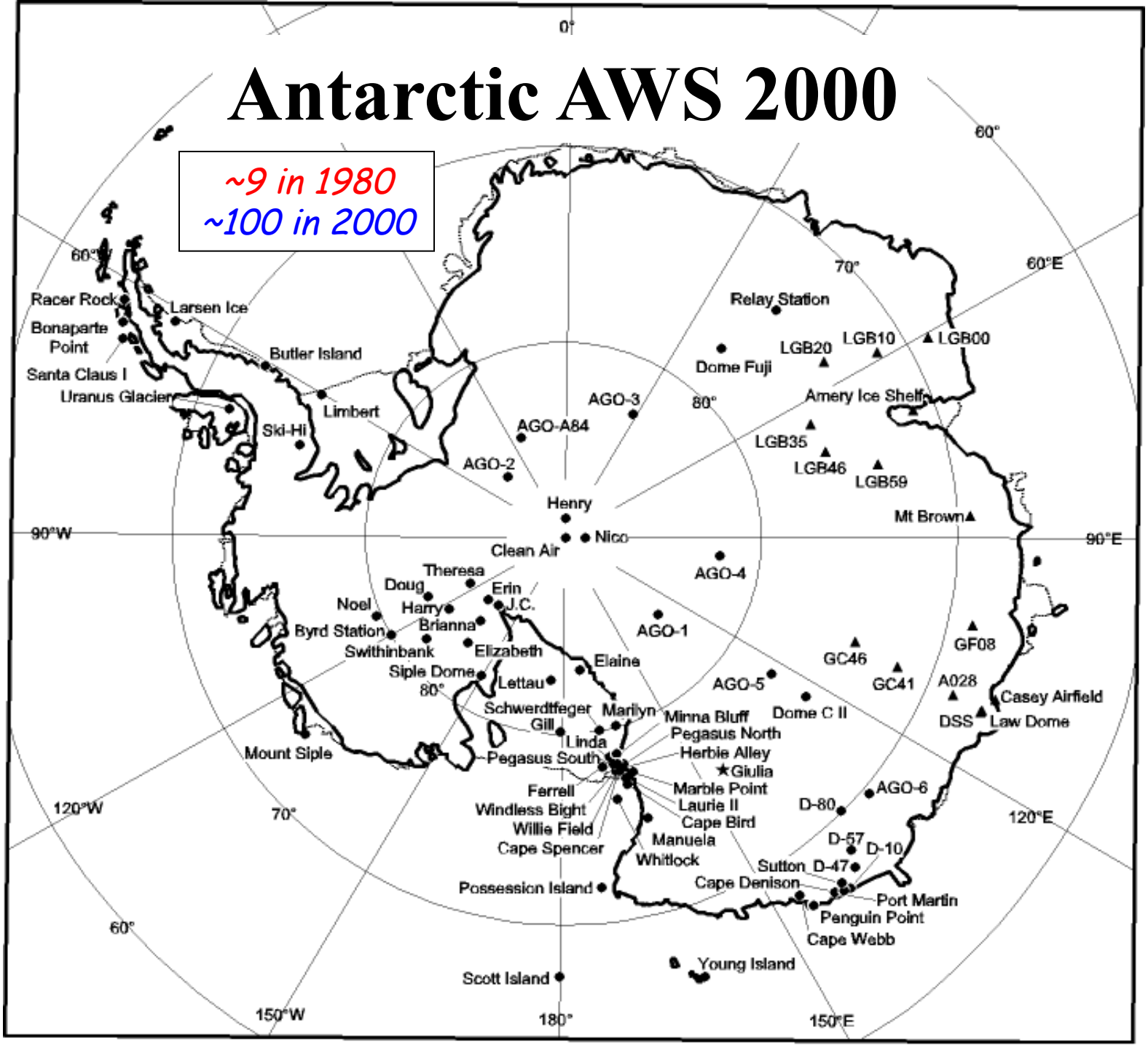
Bonaparte Point AWS

Observing from Earth

- Manned Station Observations
  - Some 1900s, Most 1957 to present
  - Routine
  - Aviation
  - Ship & Buoy
  - Weather Balloon
- Automatic Weather Stations
  - 1979 to present
- Miscellaneous

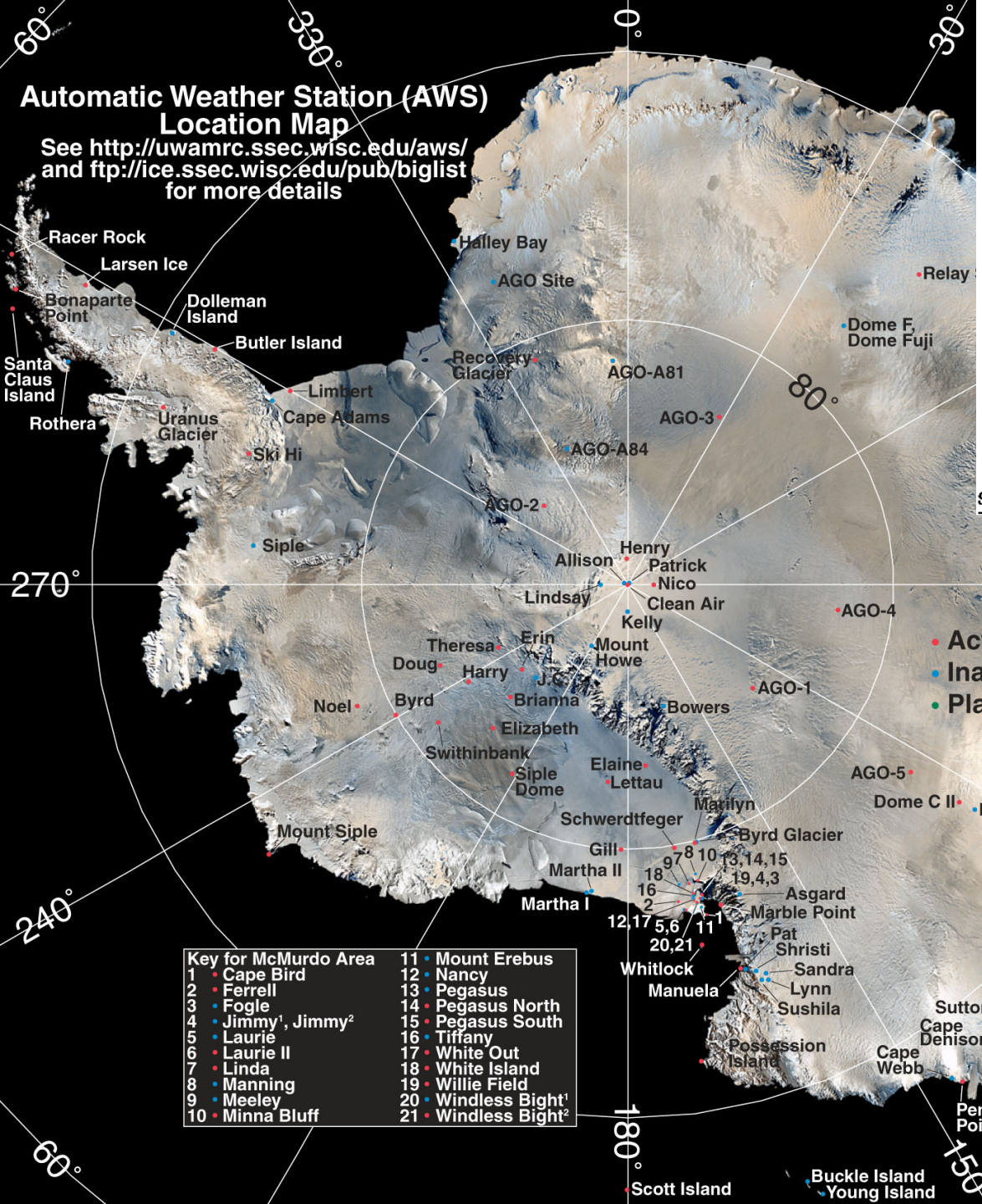


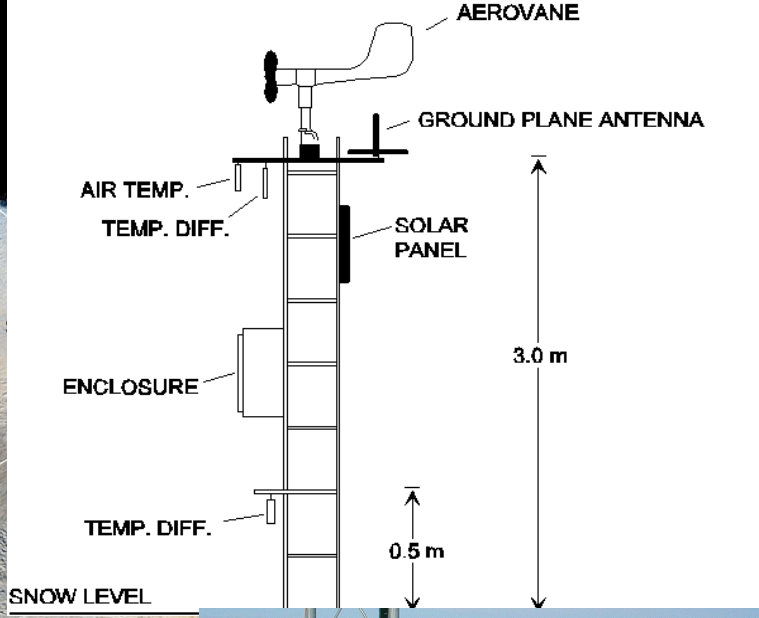
USCG Helo - Manuela AWS


Antarctic AWS 2000
~9 in 1980
~100 in 2000
0°
60°
70°
60°E
60°W
90°W
90°E
80°
120°W
120°E
150°W
180°
150°E
Racer Rock
Larsen Ice
Bonaparte Point
Santa Claus I
Uranus Glacier
Butler Island
Limbert
Ski-Hi
Mount Siple
Relay Station
Dome Fuji
LGB20
LGB10
LGB00
Amery Ice Shelf
LGB35
LGB46
LGB59
Mt Brown
AGO-3
AGO-A84
AGO-2
Henry
Nico
Clean Air
AGO-4
AGO-1
AGO-5
AGO-6
Theresa
Doug
Erin
J.C.
Noel
Harry
Brianna
Byrd Station
Swithinbank
Elizabeth
Siple Dome
Lettau
Elaine
Schwerdtfeger
Marilyn
Gill
Linda
Pegasus South
Minna Bluff
Pegasus North
Herbie Alley
Giulia
Marble Point
Laurie II
Cape Bird
Ferrell
Windless Bight
Willie Field
Cape Spencer
Manuela
Whitlock
Possession Island
Scott Island
Young Island
Cape Webb
Penguin Point
Port Martin
Cape Denison
Sutton
D-47
D-57
D-10
D-80
Dome C II
GC46
GC41
GF08
A028
DSS
Casey Airfield
Law Dome

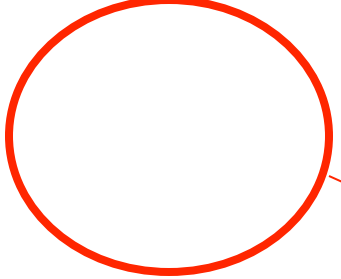
Automatic Weather Station (AWS) Location Map

See http://uwamrc.ssec.wisc.edu/aws/ and ftp://ice.ssec.wisc.edu/pub/biglist for more details

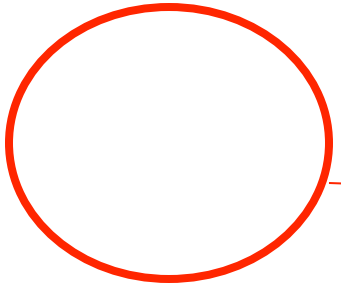




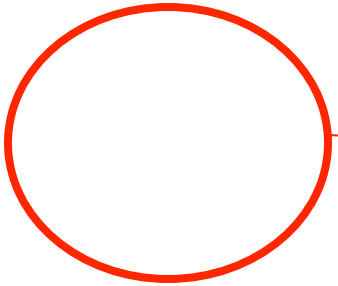
Next Generation AWS



* Small memory storage needs: Current AWS used 256 bytes, New AWS have more.

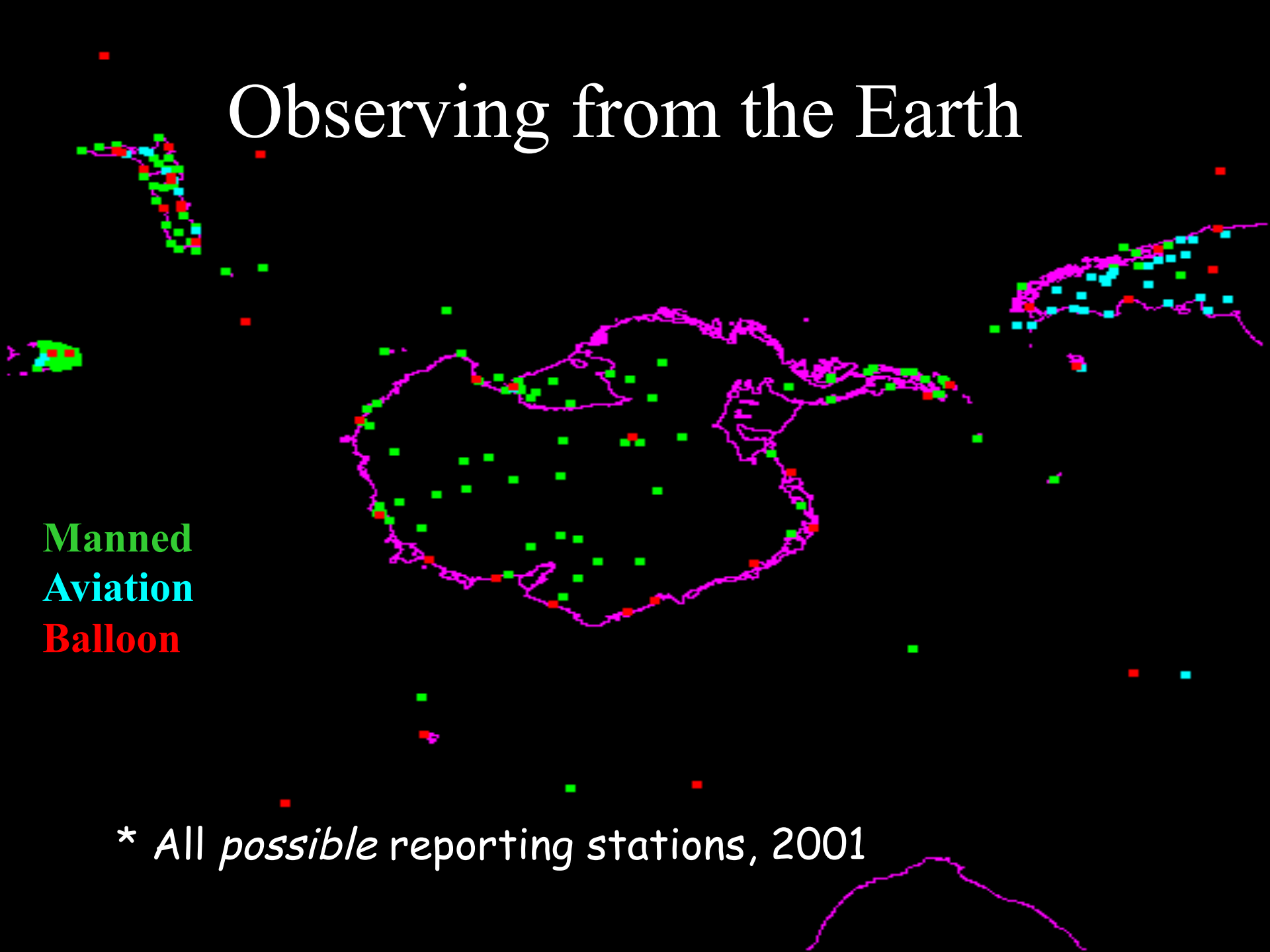


* Able to send data via satellite, radio, etc.



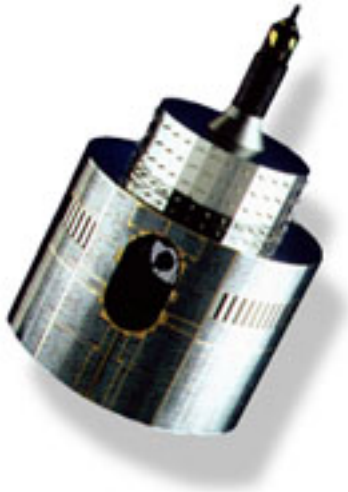
*60 Watt-Hours power used all year long (power used to run a 60 watt light bulb for 1 hour!) New AWS will use 1/2 of that!!

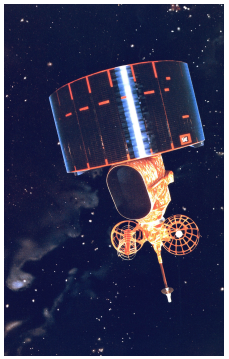
Observing from the Earth

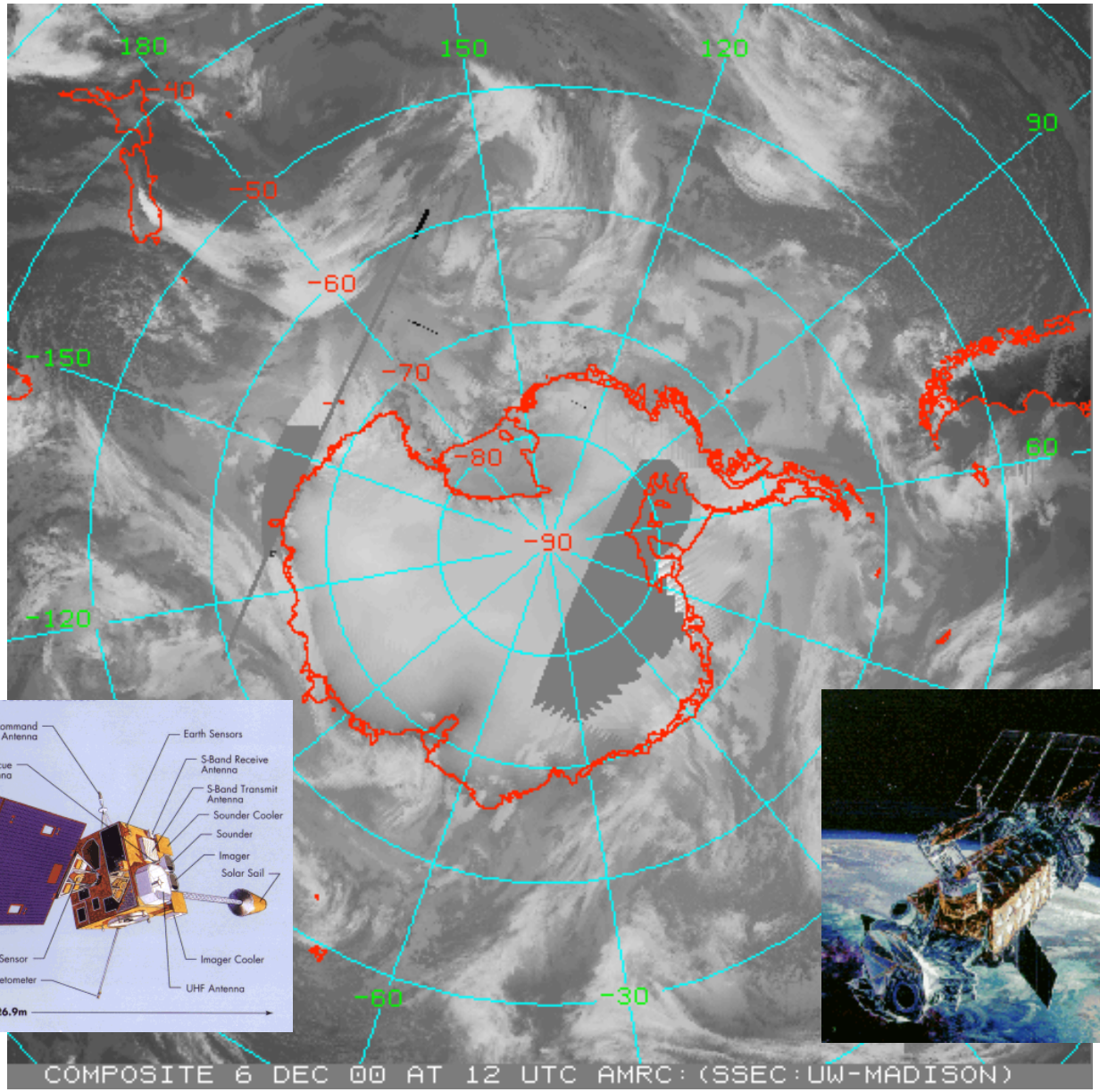


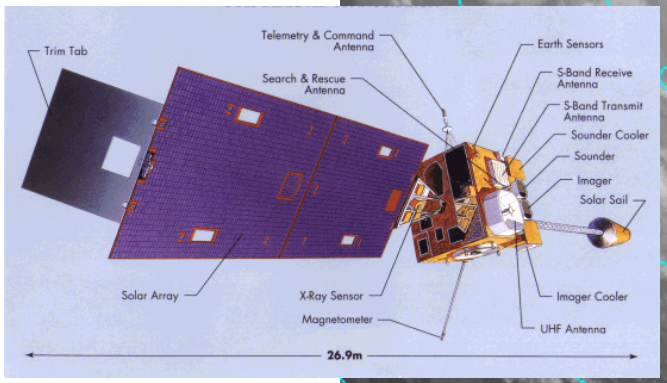
* All *possible* reporting stations, 2001

Observing from Space

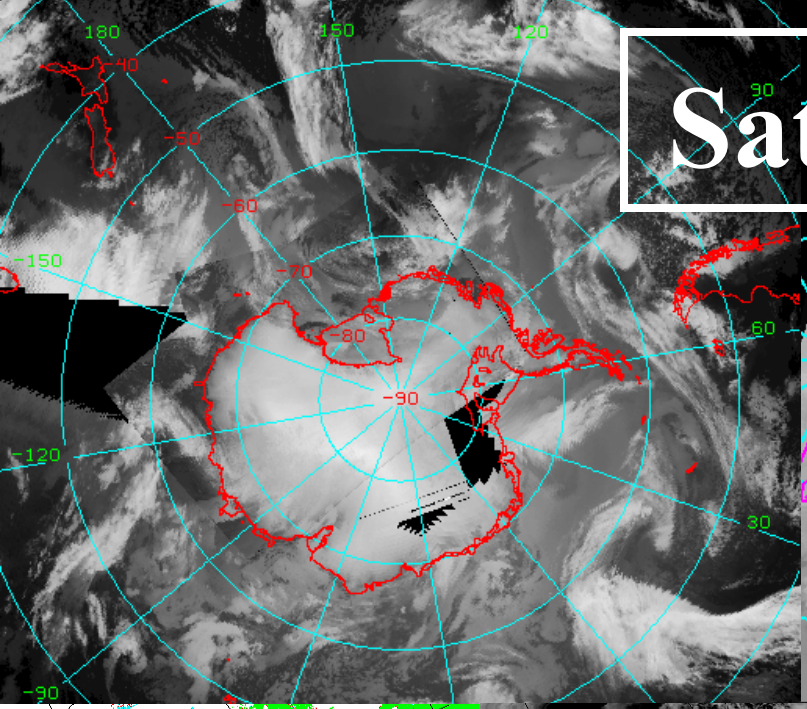


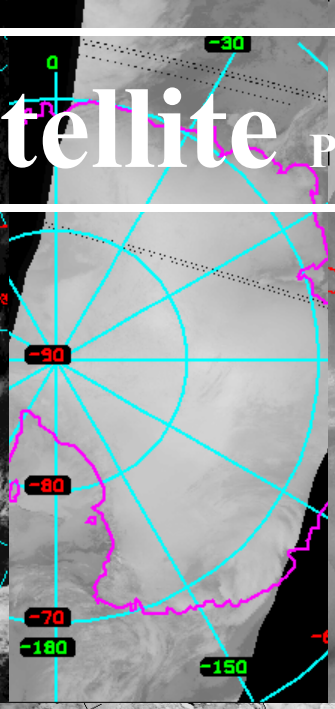


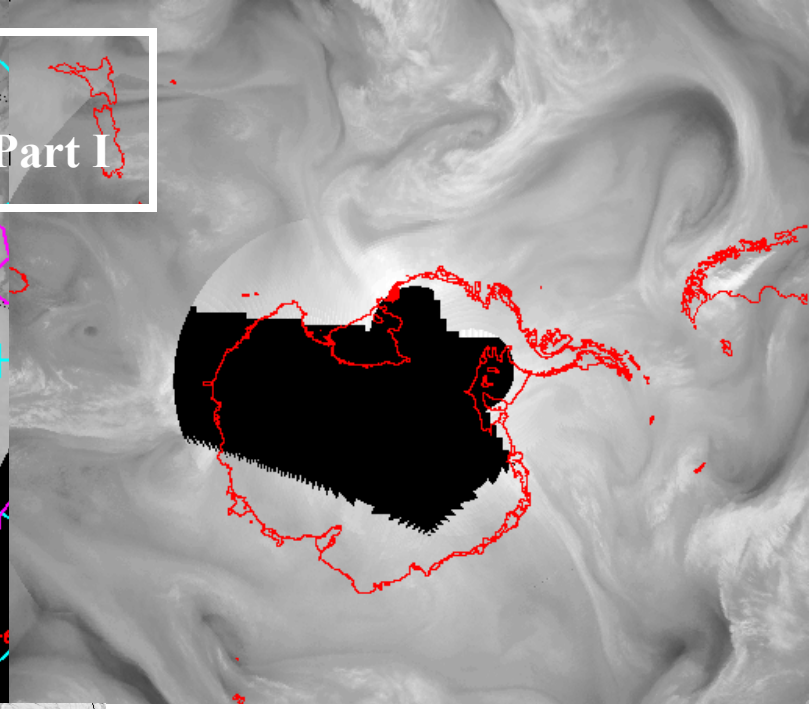


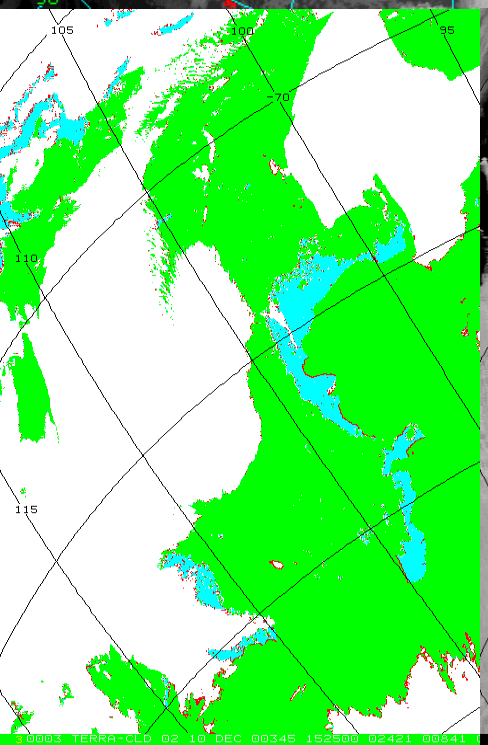


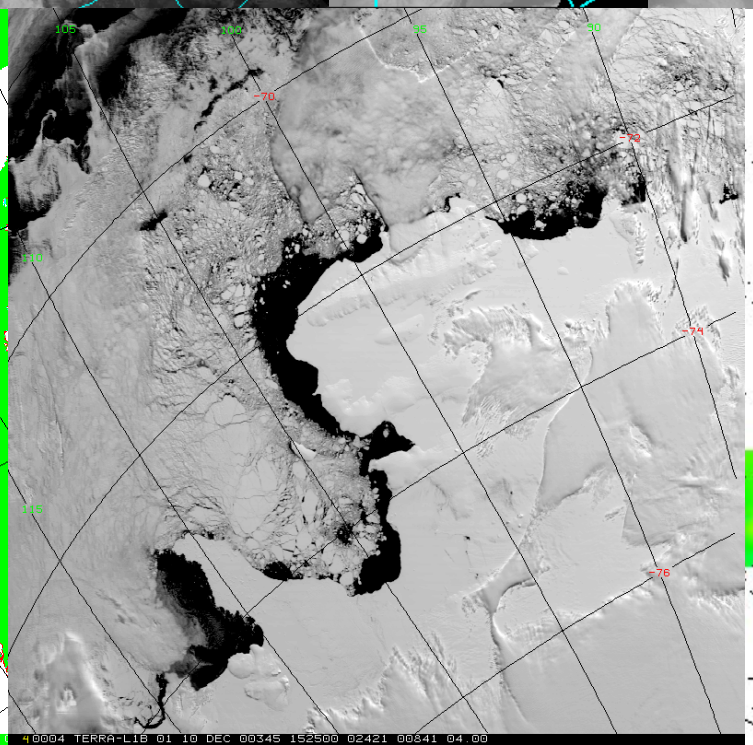
Satellite Part I

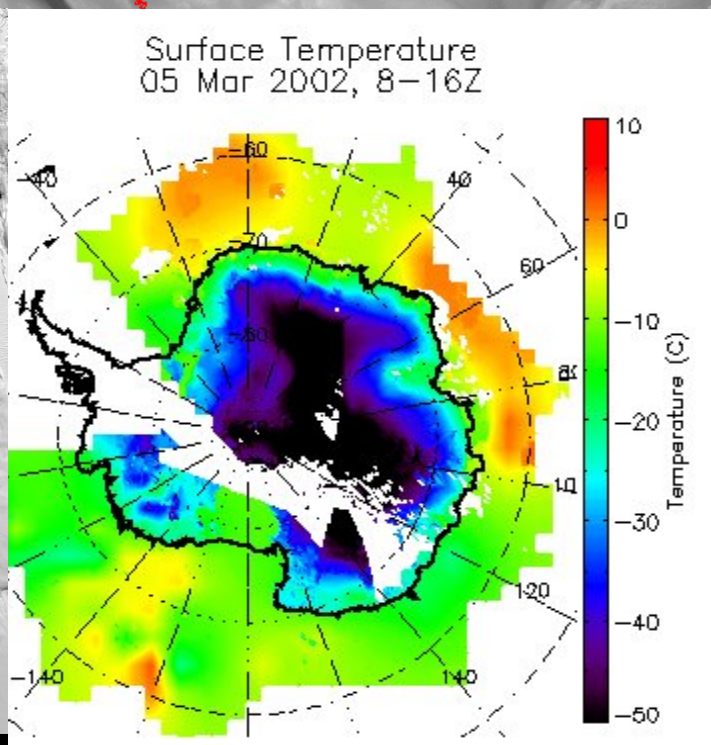




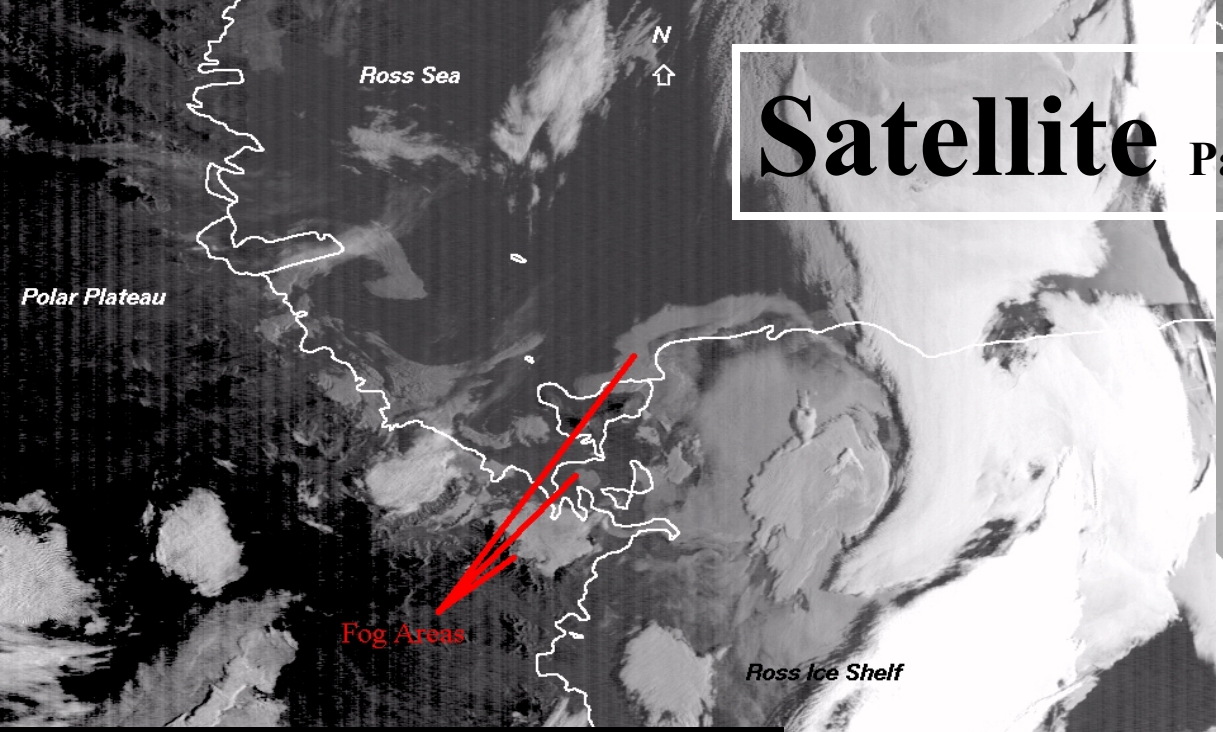


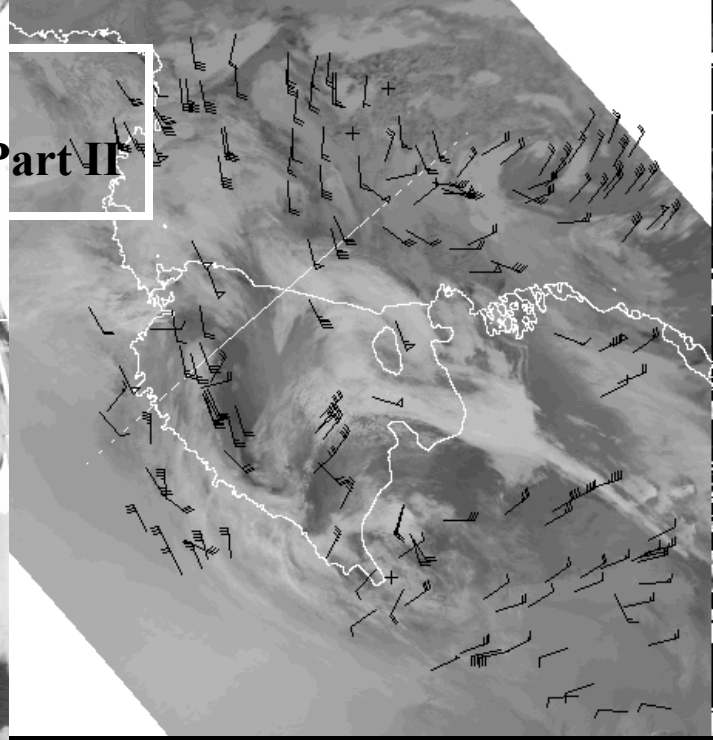


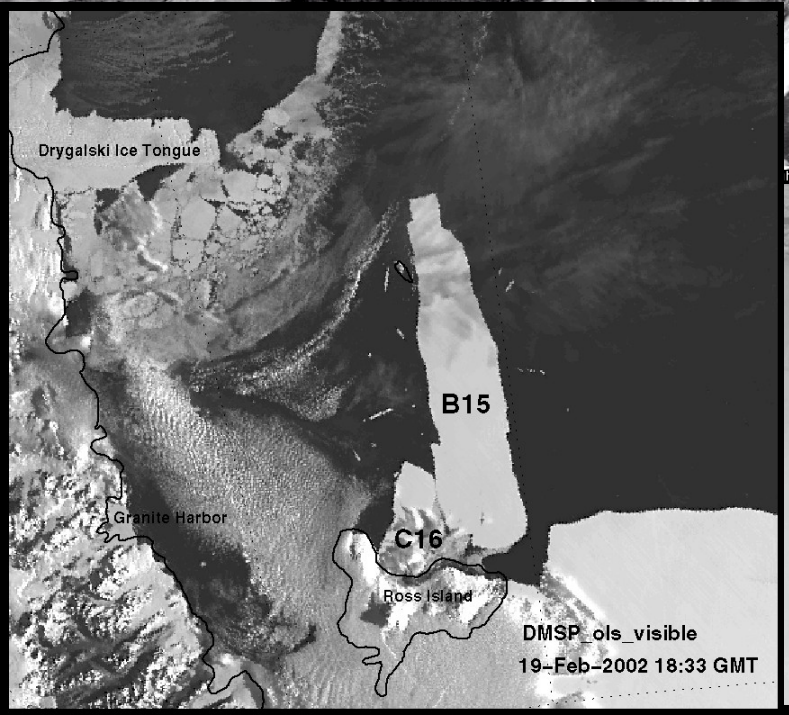


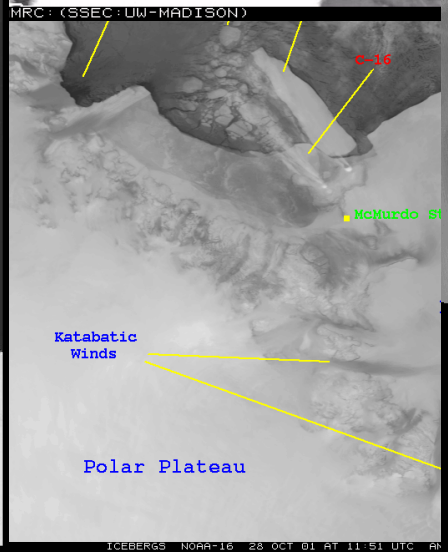


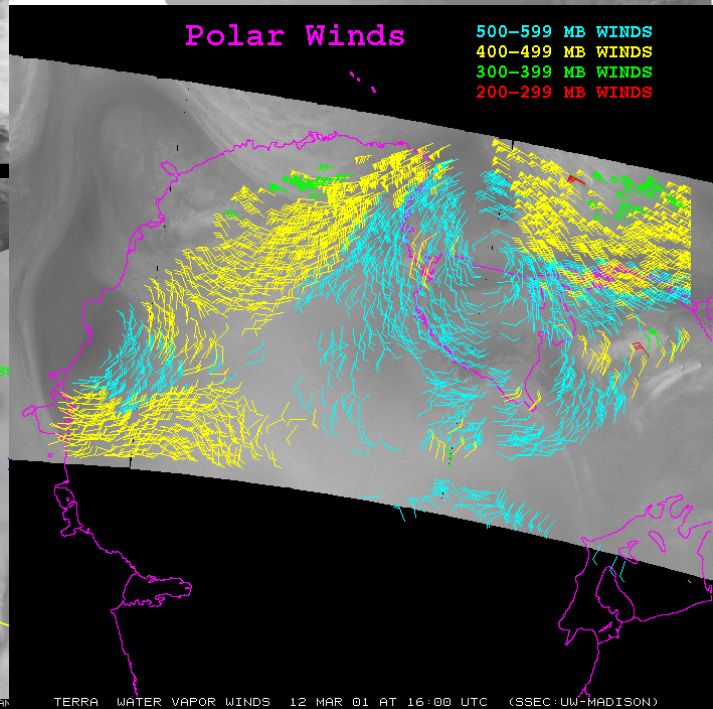
Satellite Part II







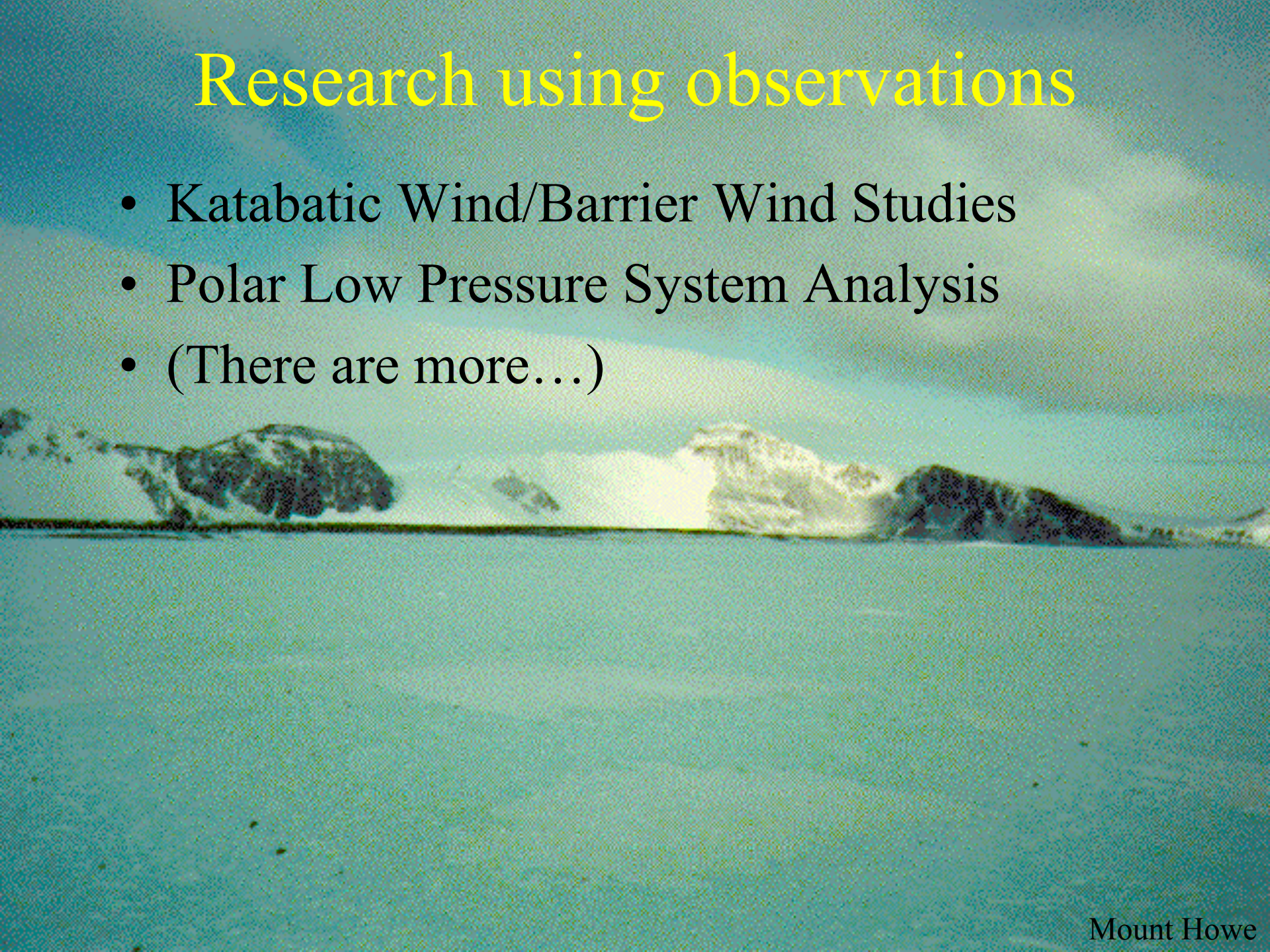





The Forbidding Continent
Terra MODIS January 22, 2001 13:35 UTC 1.38 micron
5 0005 TERRA-L1B 06 22 JAN 01022 133500 00785 01433 04.00

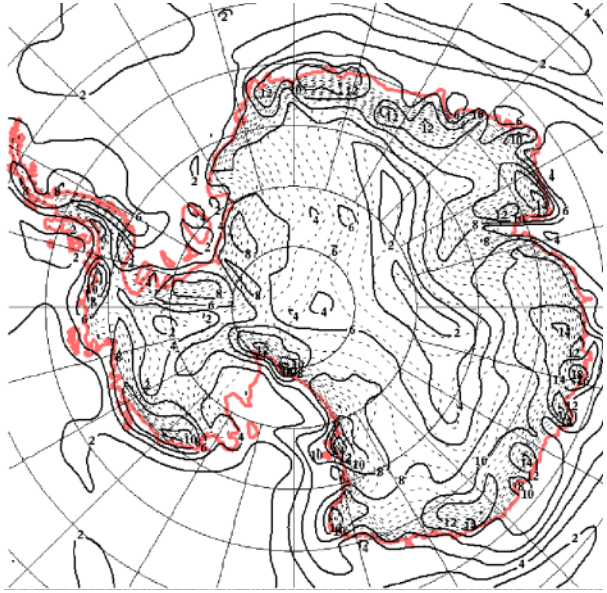
Research using observations

- Katabatic Wind/Barrier Wind Studies
- Polar Low Pressure System Analysis
- (There are more…)

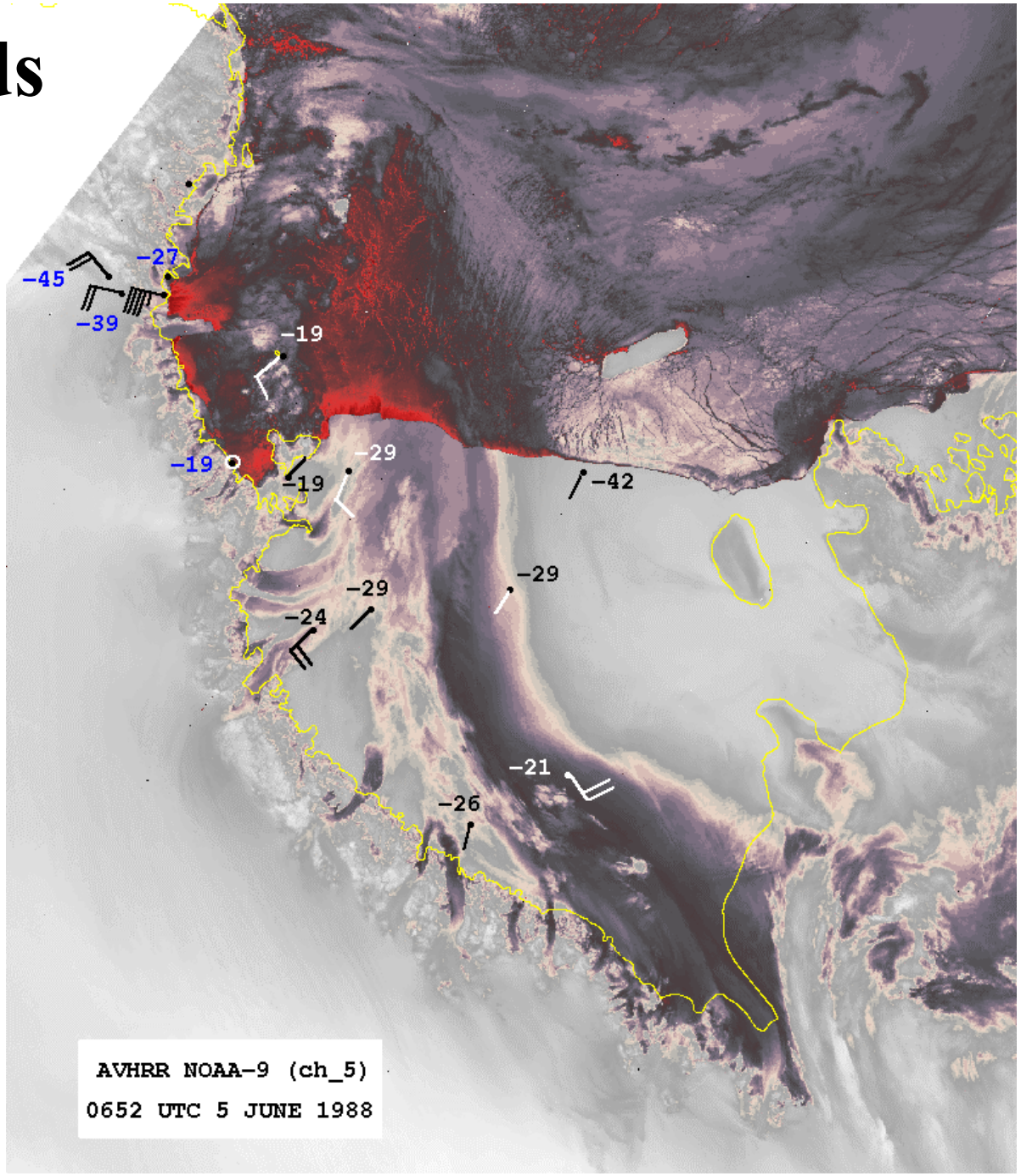


Katabatic Winds from Space

(Bromwich, 2001)



Mean streamlines at lowest sigma level (10 m agl) from MM5 simulations for midwinter period 15 June – 15 July 2001. Antarctic terrain contour heights (m) represented by dashed lines.
(Parish et al. 2001)



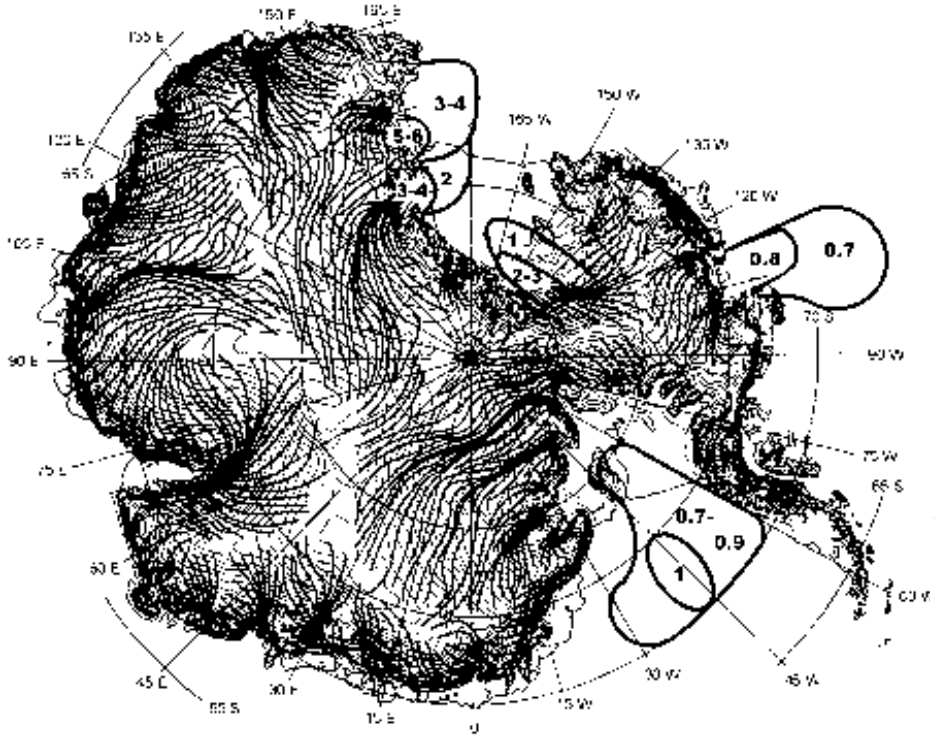
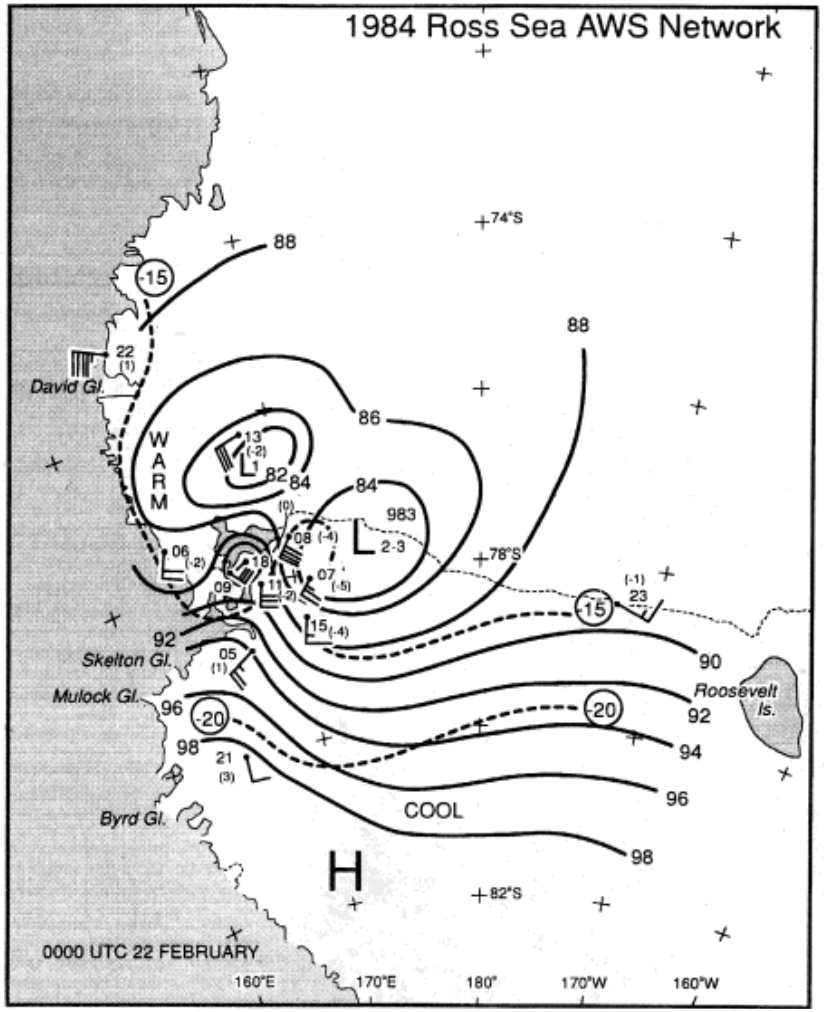


Fig 6 Areas of the maximum annual normalized distribution of mesoscale vortices superimposed on the katabatic wind drainage of Antarctica as simulated by Parish and Bromwich (1987)

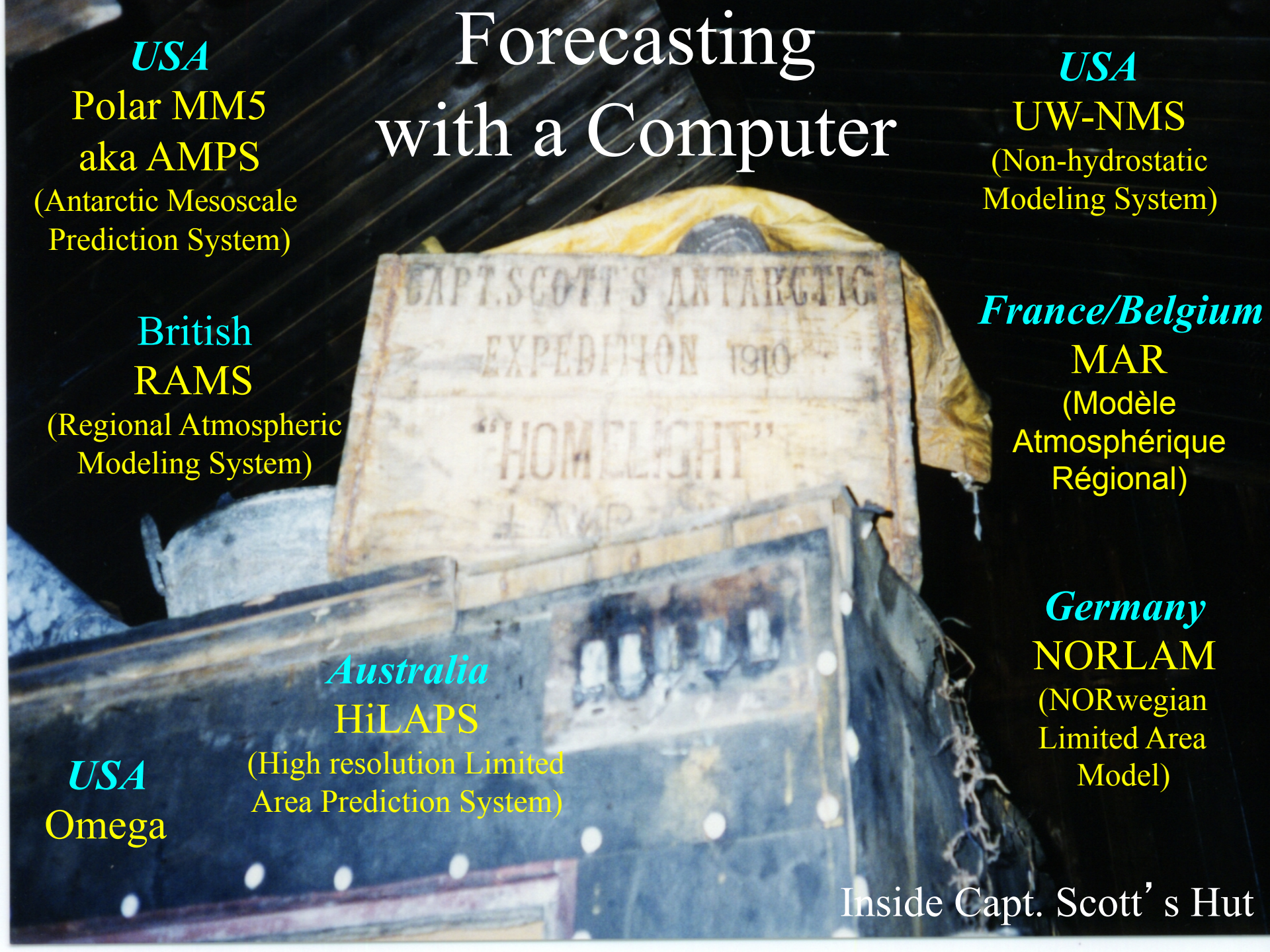
Polar Low Studies from the Surface

(Bromwich, 2001)



Regional analysis of the sea level isobars (hPa, solid, 88=988) and surface isotherms (°C, dashed) from AWS observations at 00 UTC 21 February 1984. Note the that the isobars are perpendicular to the Transantarctic Mountains, which is characteristic of barrier wind events. From O'Connor et al. (1994).

Forecasting with a Computer



USA
Polar MM5
aka AMPS
(Antarctic Mesoscale Prediction System)

British
RAMS
(Regional Atmospheric Modeling System)

USA
Omega

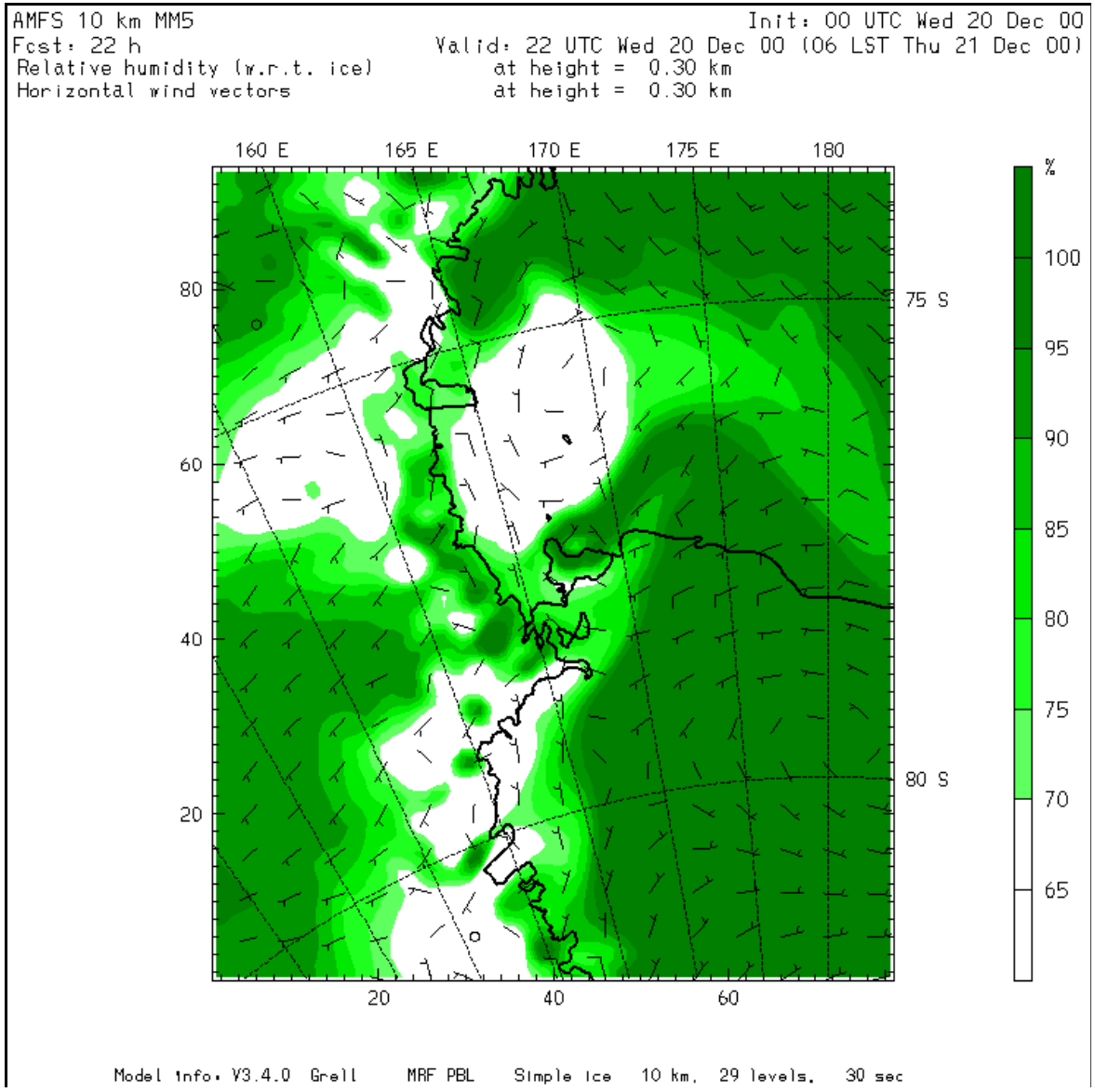
Australia
HiLAPS
(High resolution Limited Area Prediction System)

USA
UW-NMS
(Non-hydrostatic Modeling System)

France/Belgium
MAR
(Modèle Atmosphérique Régional)

Germany
NORLAM
(NORwegian Limited Area Model)

Inside Capt. Scott's Hut



Polar MM5

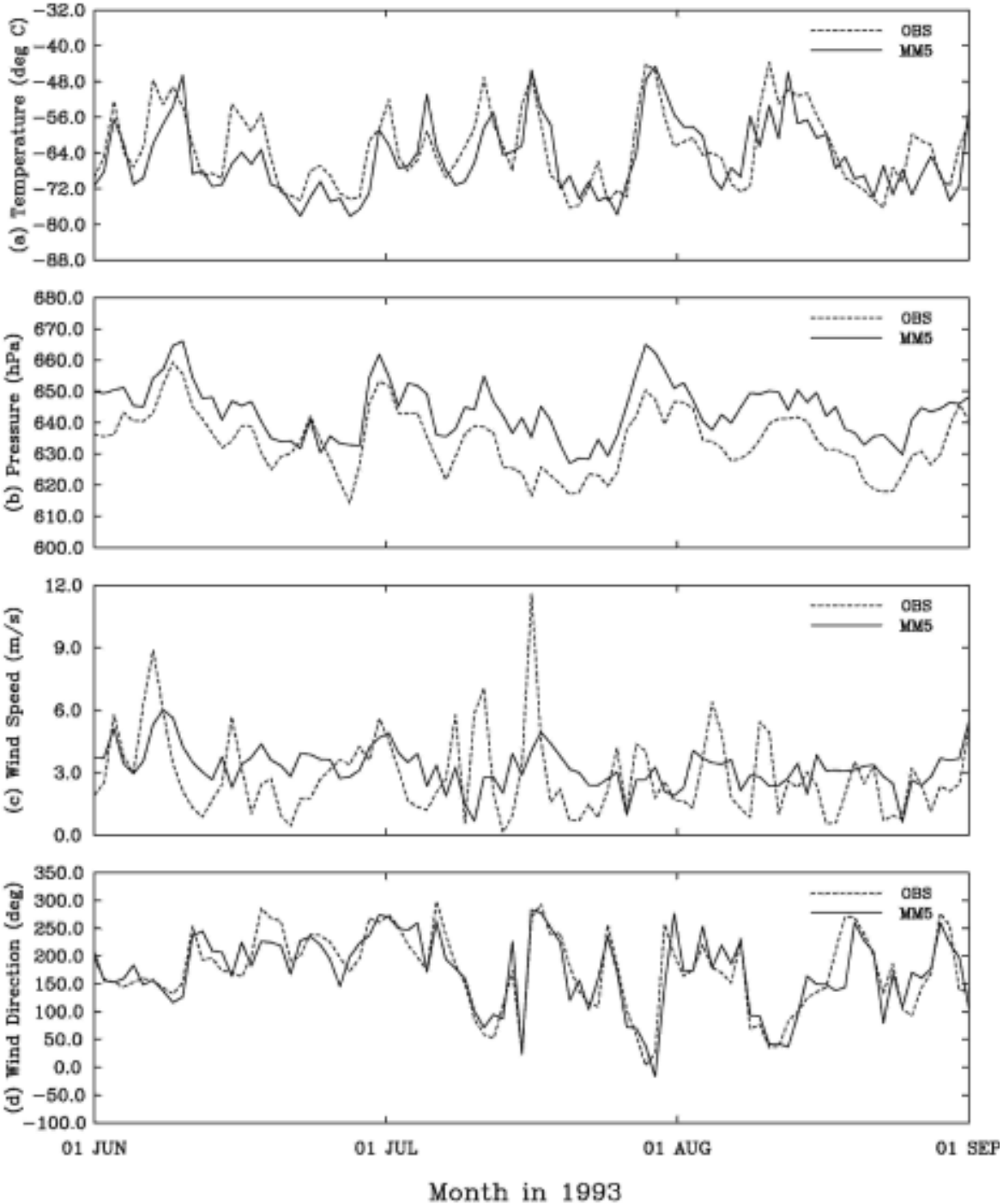
aka AMPS

(Antarctic Mesoscale Prediction System)
Part I

* MM5 with improved physics/parameterizations for the polar atmosphere (Bromwich/Cassano and others at BPRC/OSU)

* Run operationally at NCAR for NSF/United States Antarctic Program (USAP)

* Being released into MM5 - version 3.5 and later



Polar MM5

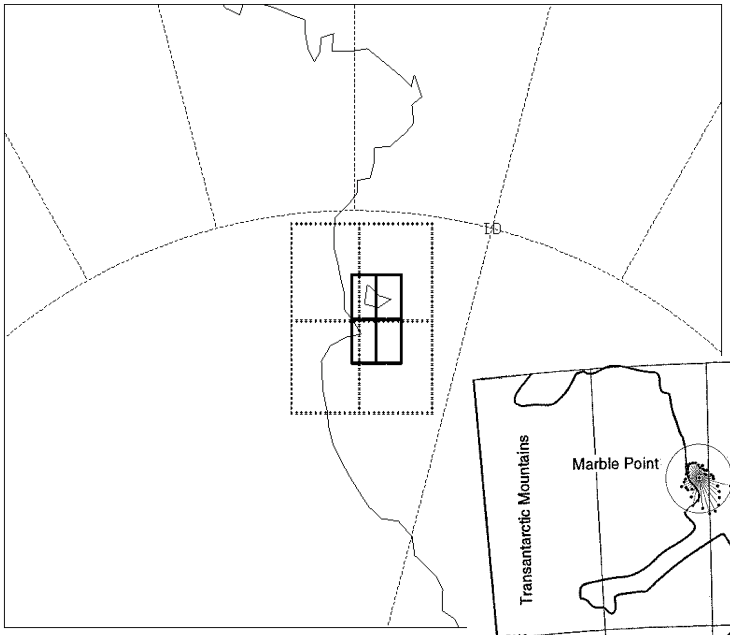
aka AMPS

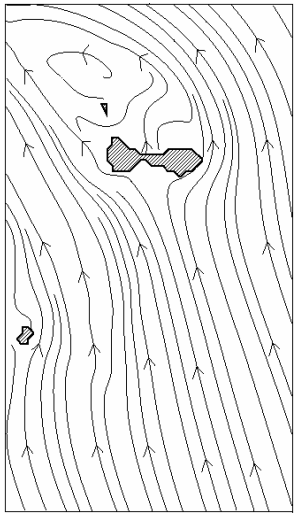
(Antarctic Mesoscale Prediction System)
Part II

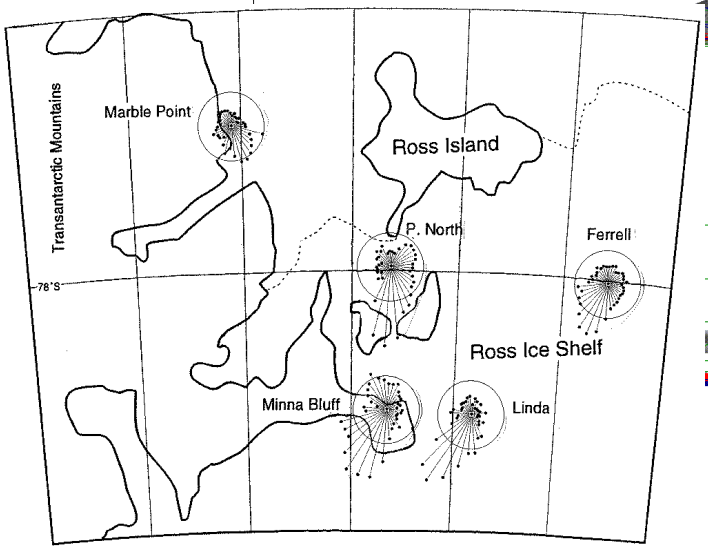
Time series of daily running mean AWS (dotted lines) and Polar MM5 (solid lines) data at Dome C AWS for Jun. Jul. and Aug. 1993. (Guo et al. 2001)

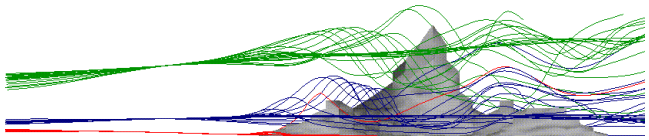
UW-NMS

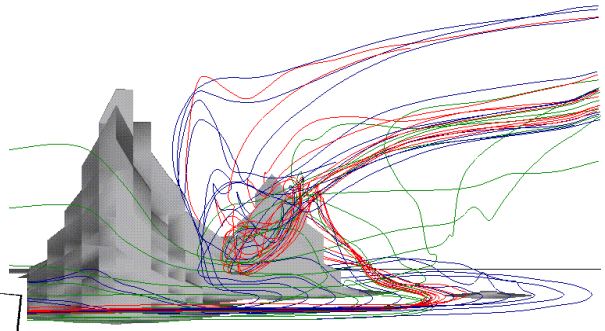
(Seefeldt et al. In press)

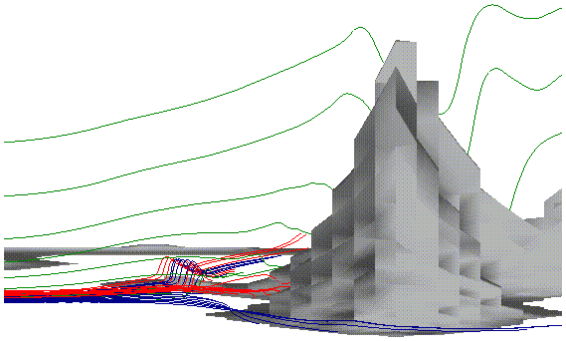


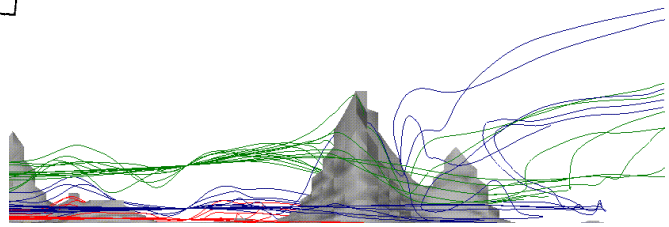








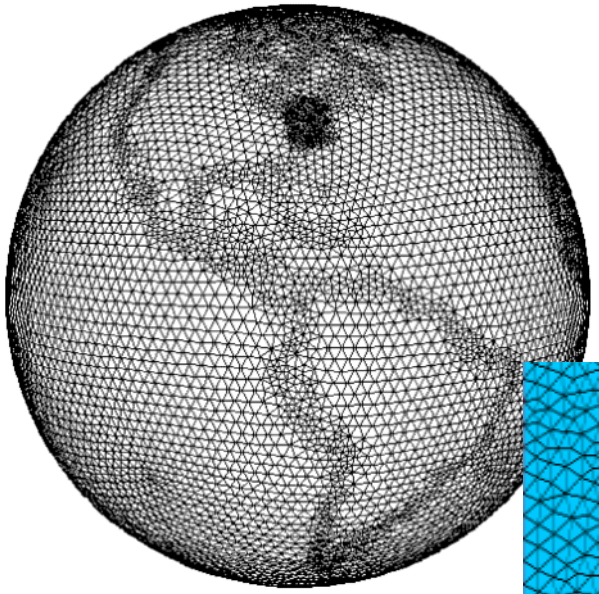


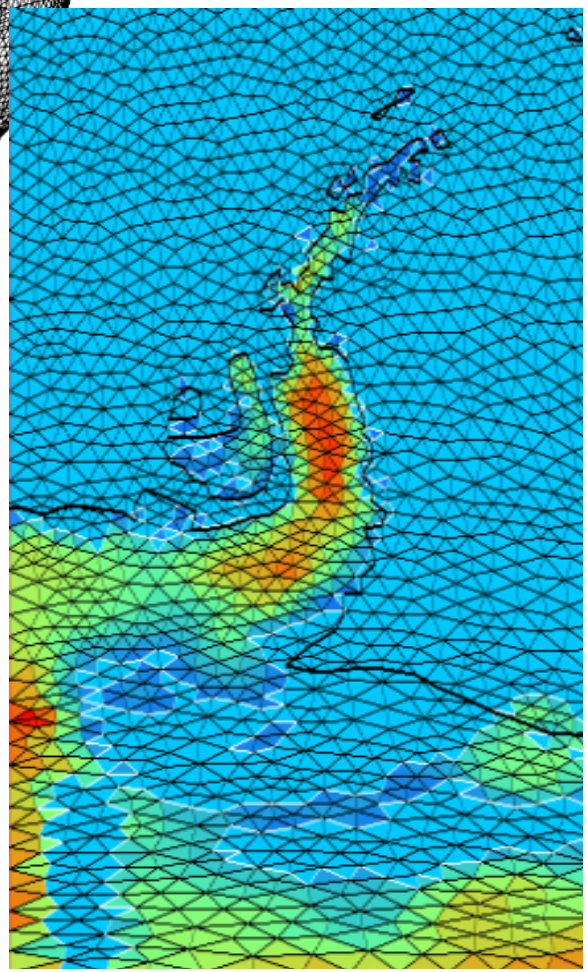


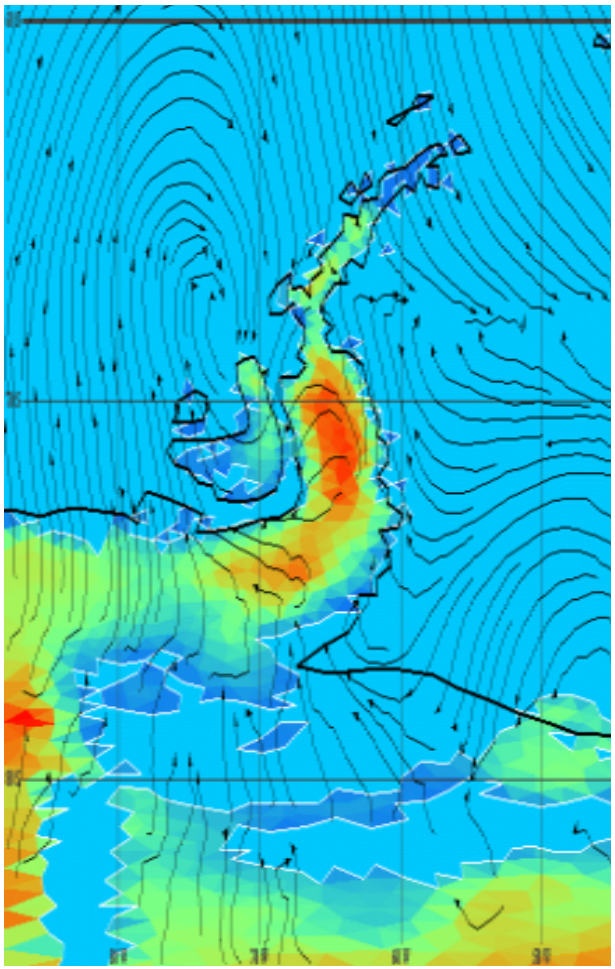
* High resolution
* Good dynamics
* Not much in the way of thermodynamics or moisture…more work needs to be done

Omega (SAIC)

(Bacon, 2001)







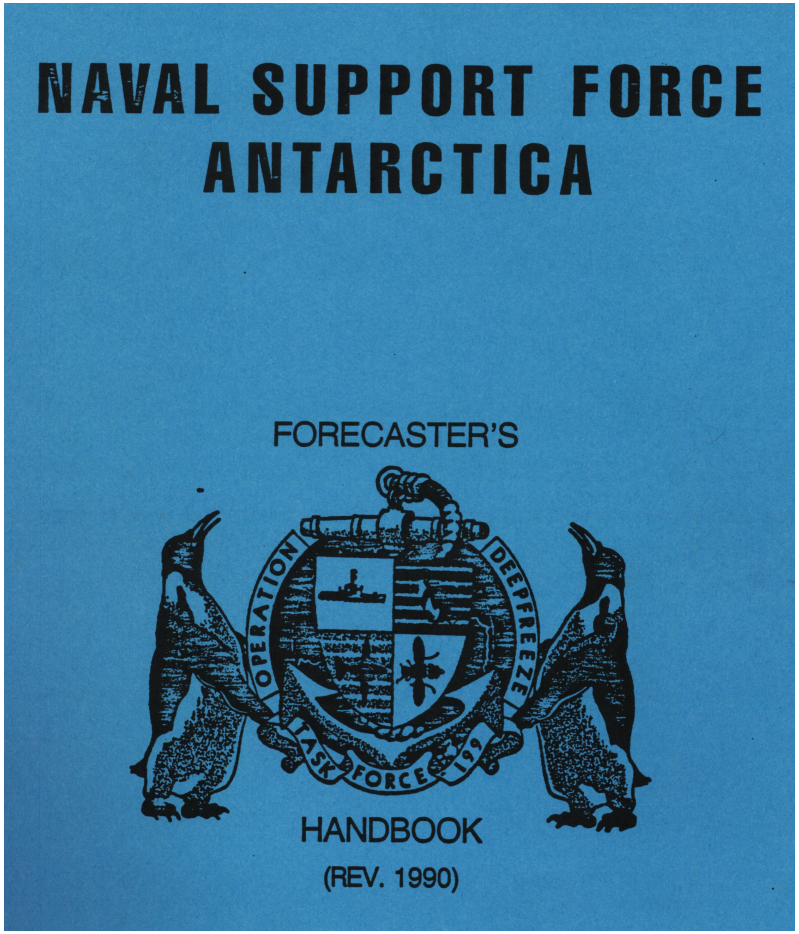
* Unique Grid Spacing

* Resolves Unique Features

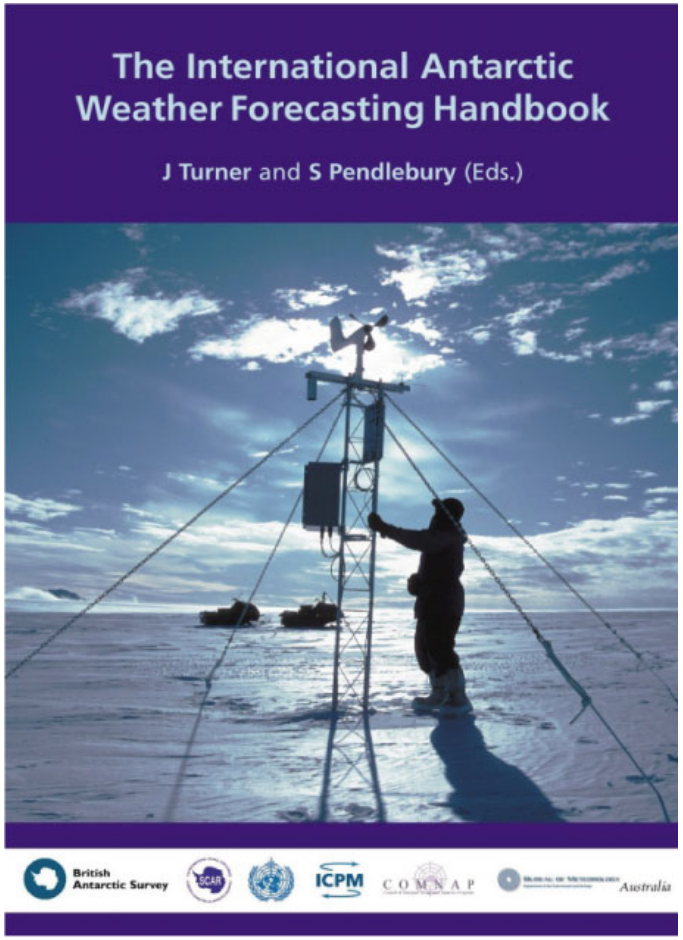
* Still has yet to be effective…work in progress

Forecasting Handbooks

Pre-1990: Rules of thumb



Post-2000: Well documented, updated, science, and more...



Climate Research

- Sea Ice Edge and El Nino/La Nina
- Precipitation and Evaporation and Southern Oscillation
- Ross Sea Sector Temperature and Pressure and El Nino
- (There is more…)

Admunsen Sea/West Antarctica: Center of ENSO Impact?

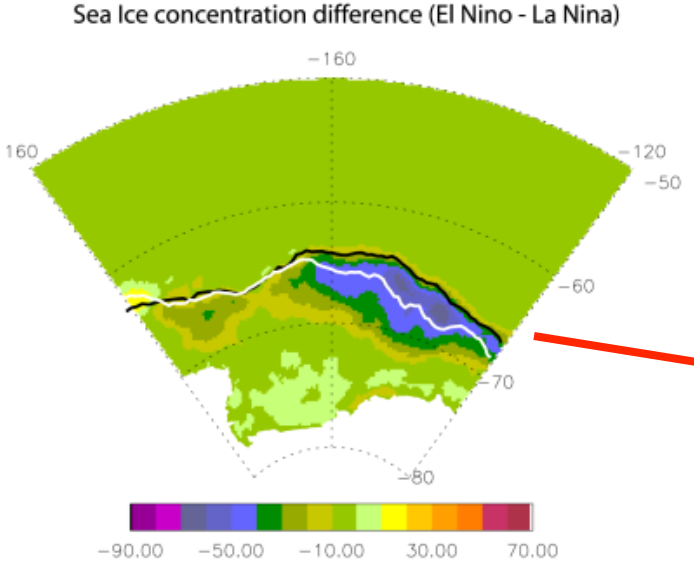


Figure 1 The ENSO impact on sea ice generated by subtracting mean ice concentration in May following 4 La Nina events from the mean ice concentraion in May following 5 El Nino events. The white (black) line indicates the mean ice edge following El Nino (La Nina) events.

(Yuan, 2001)

* Big differences in sea ice extent and concentration between El Nino and La Nina years!!

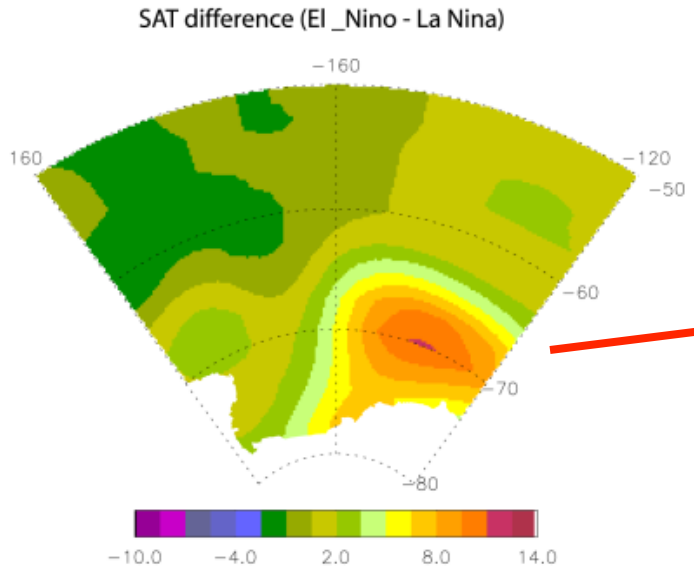
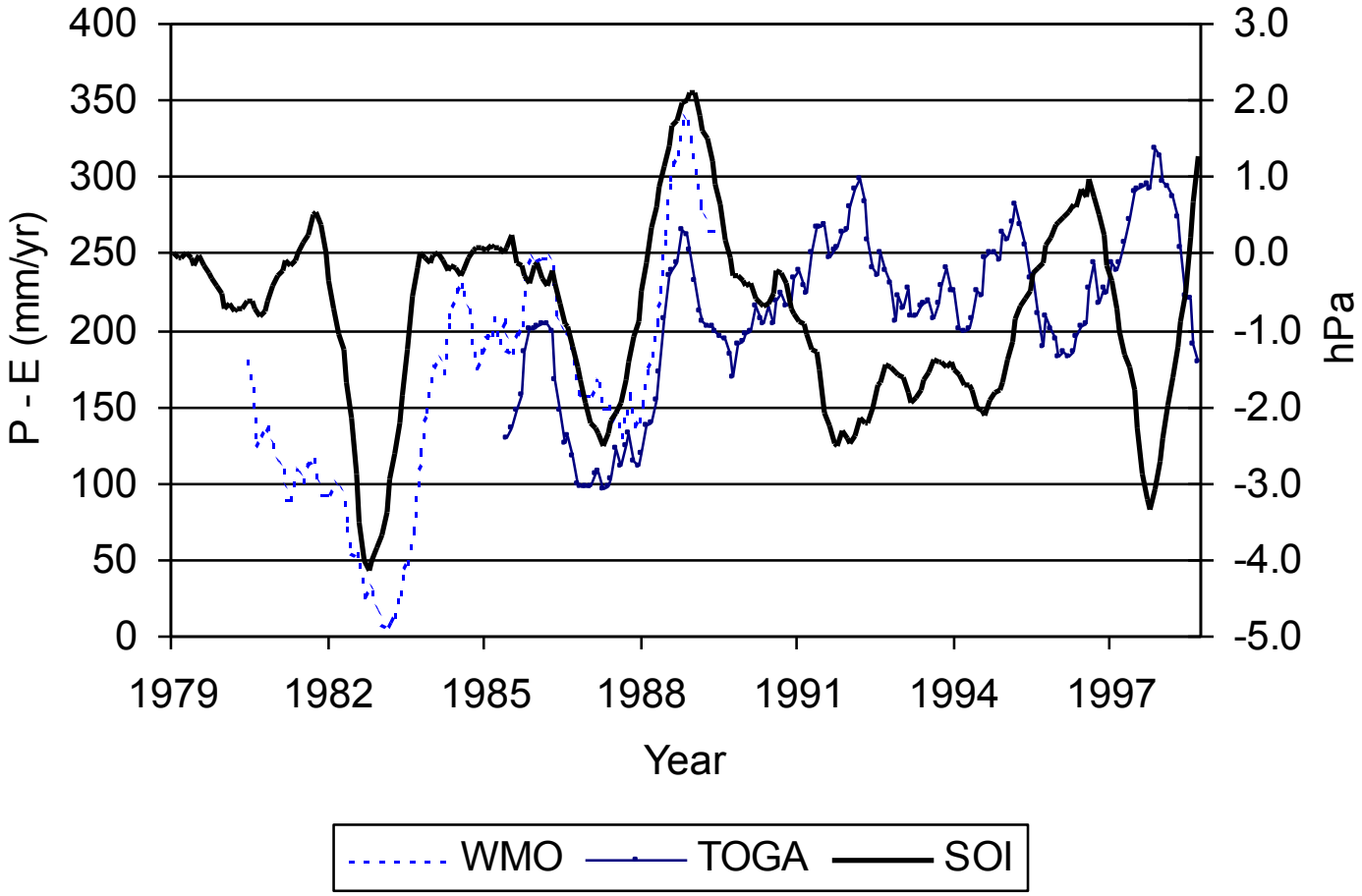


Figure 2 The ENSO impact on surface air temperature generated by subtracting mean air temperature in May following 4 La Nina events from the mean air temperature in May following 5 El Nino events.

(Yuan, 2001)

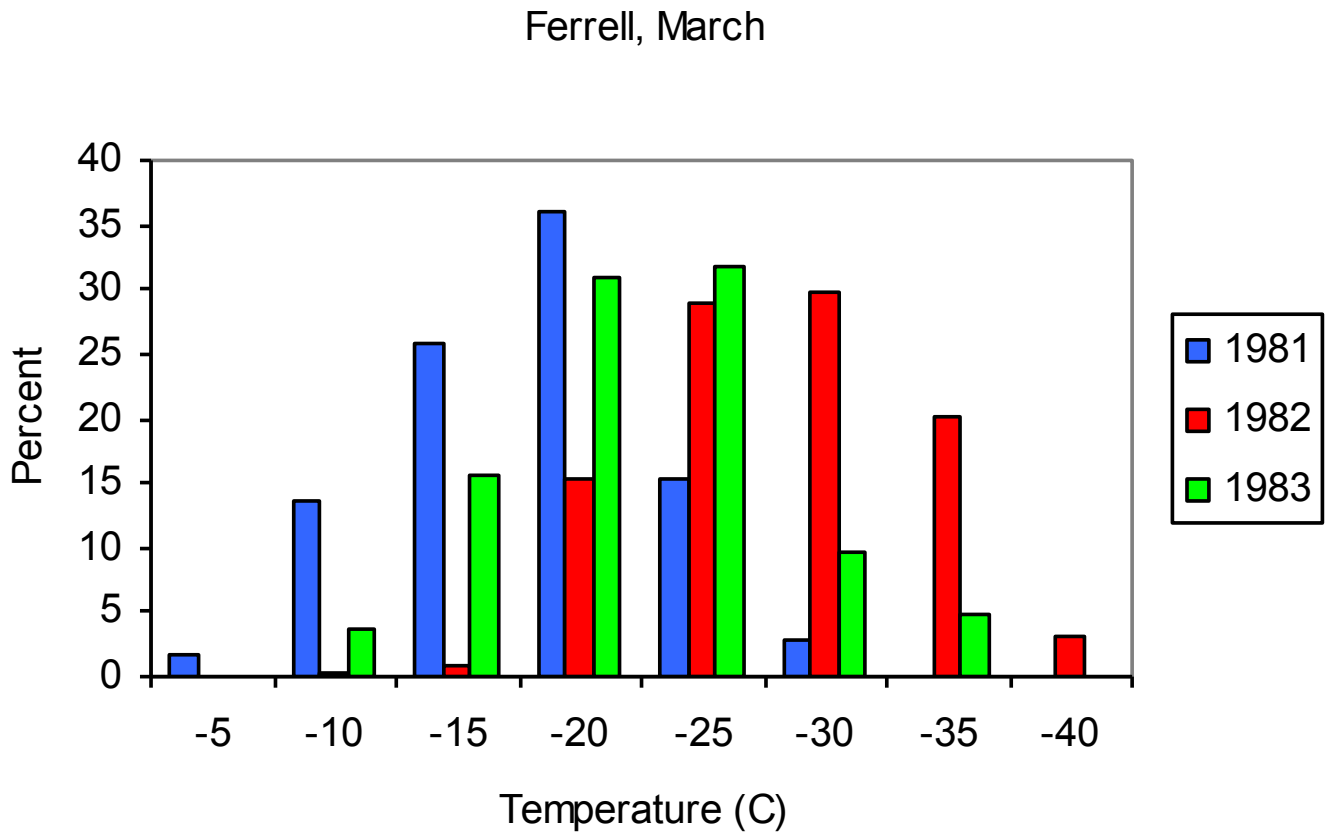
* Big differences in surface air temperature between El Nino and La Nina years!!

Precipitation minus Evaporation vs. Southern Oscillation Index



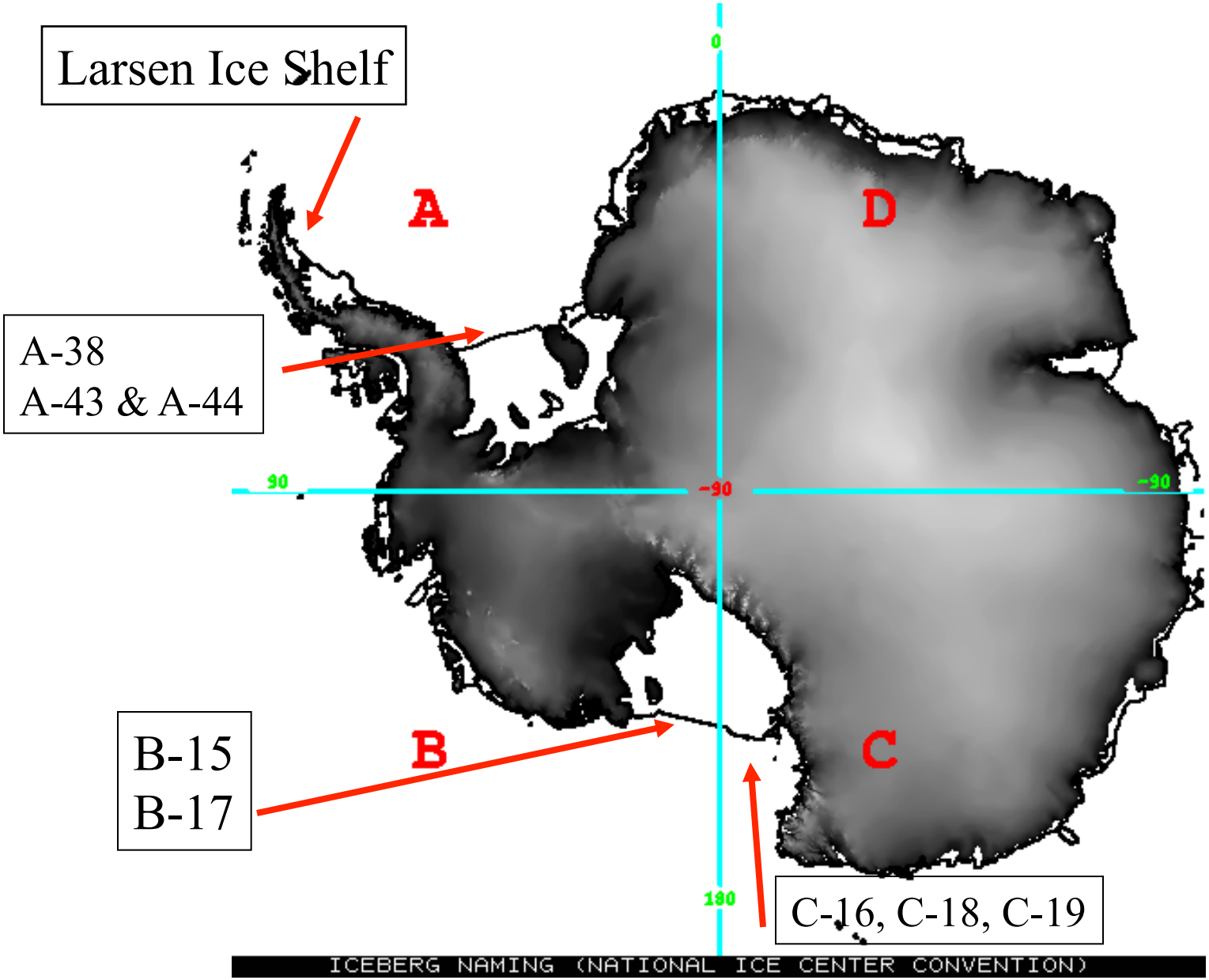
Bromwich, 2001

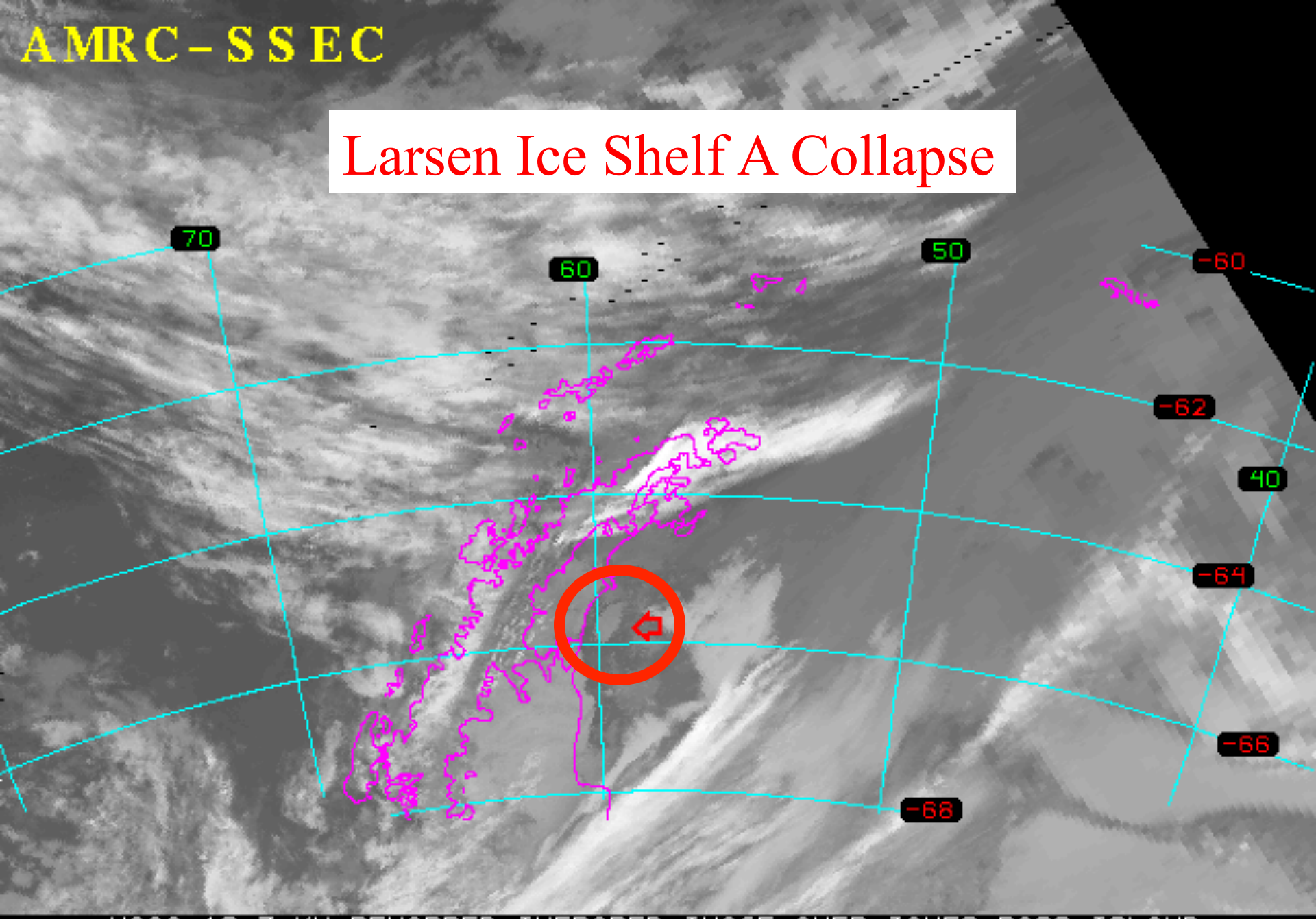
University of Wisconsin's Automatic Weather Stations Detect El Nino...



Keller/Weidner/Stearns, 1999

Icebergs and Ice Shelf Collapses



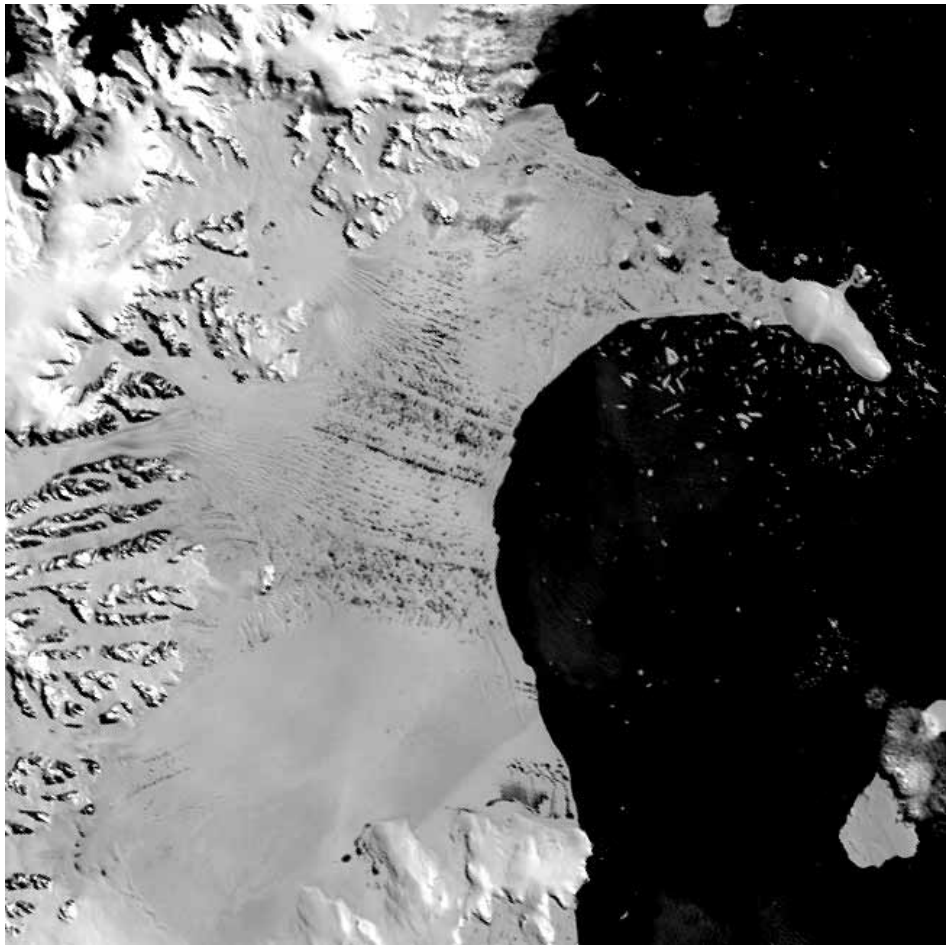

AMRC-SSEC
Larsen Ice Shelf A Collapse
70
60
50
-60
-62
40
-64
-66
-68
NOAA-12 3 KM REMAPPED INFRARED IMAGE OVER JAMES ROSS ISLAND
01:01 UTC 2 MAR 95 (SSEC:UW-MADISON)
ANTARCTIC METEOROLOGY RESEARCH CENTER (AMRC)

Collapse of the Larsen B Ice Shelf

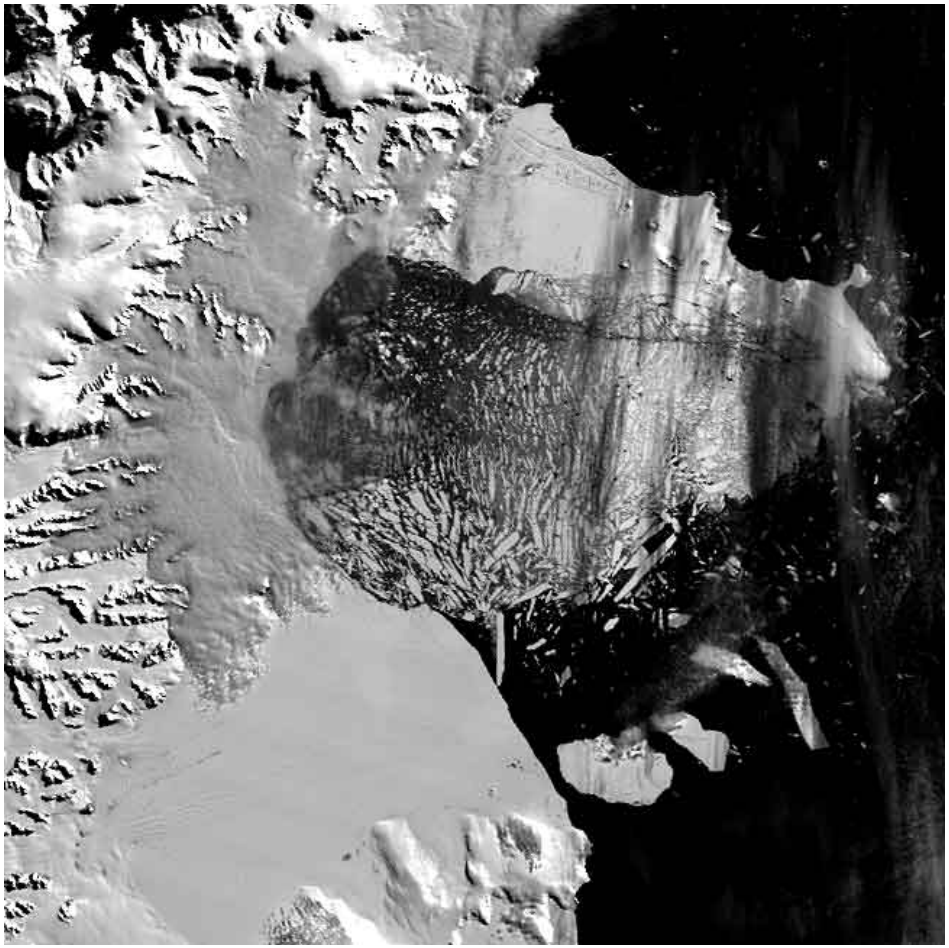
Larsen B Ice Shelf Collapse

NASA's Terra Satellite (National Snow and Ice Data Center)

Before: January 31, 2002



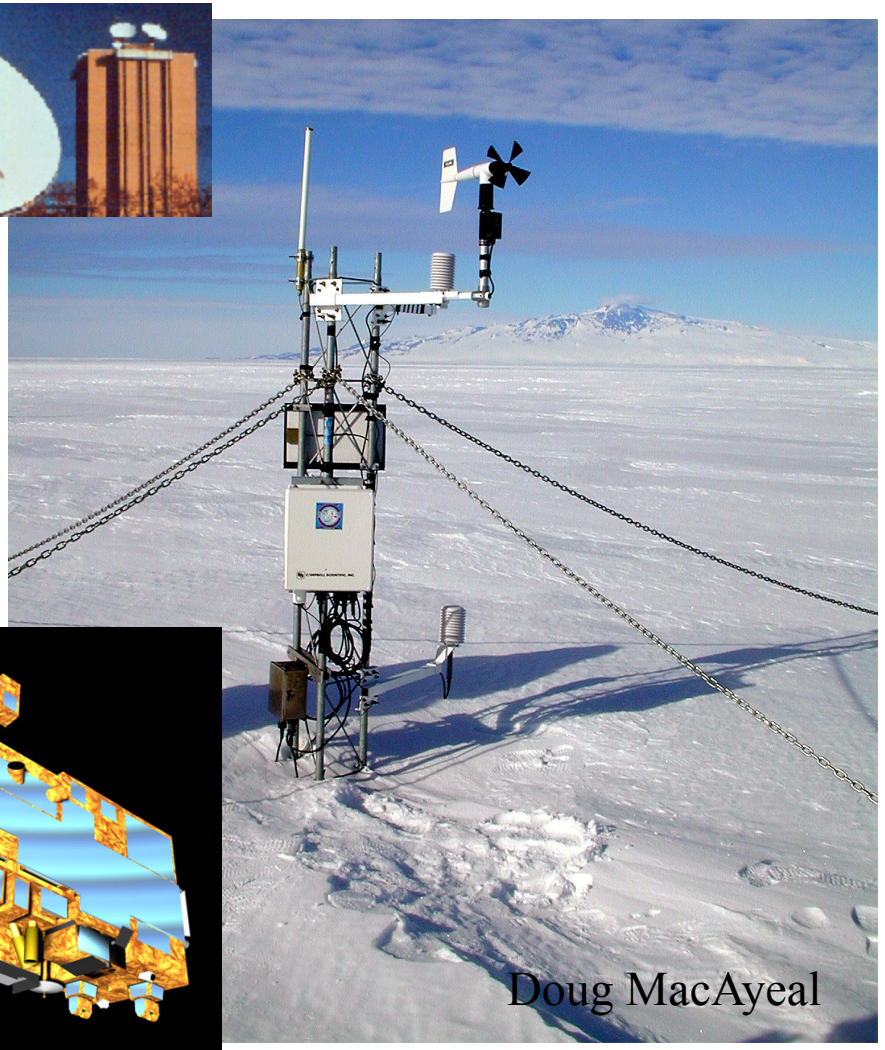
After: March 5, 2002

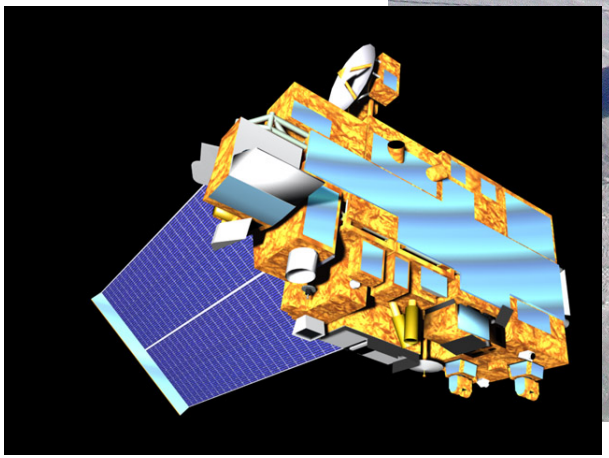


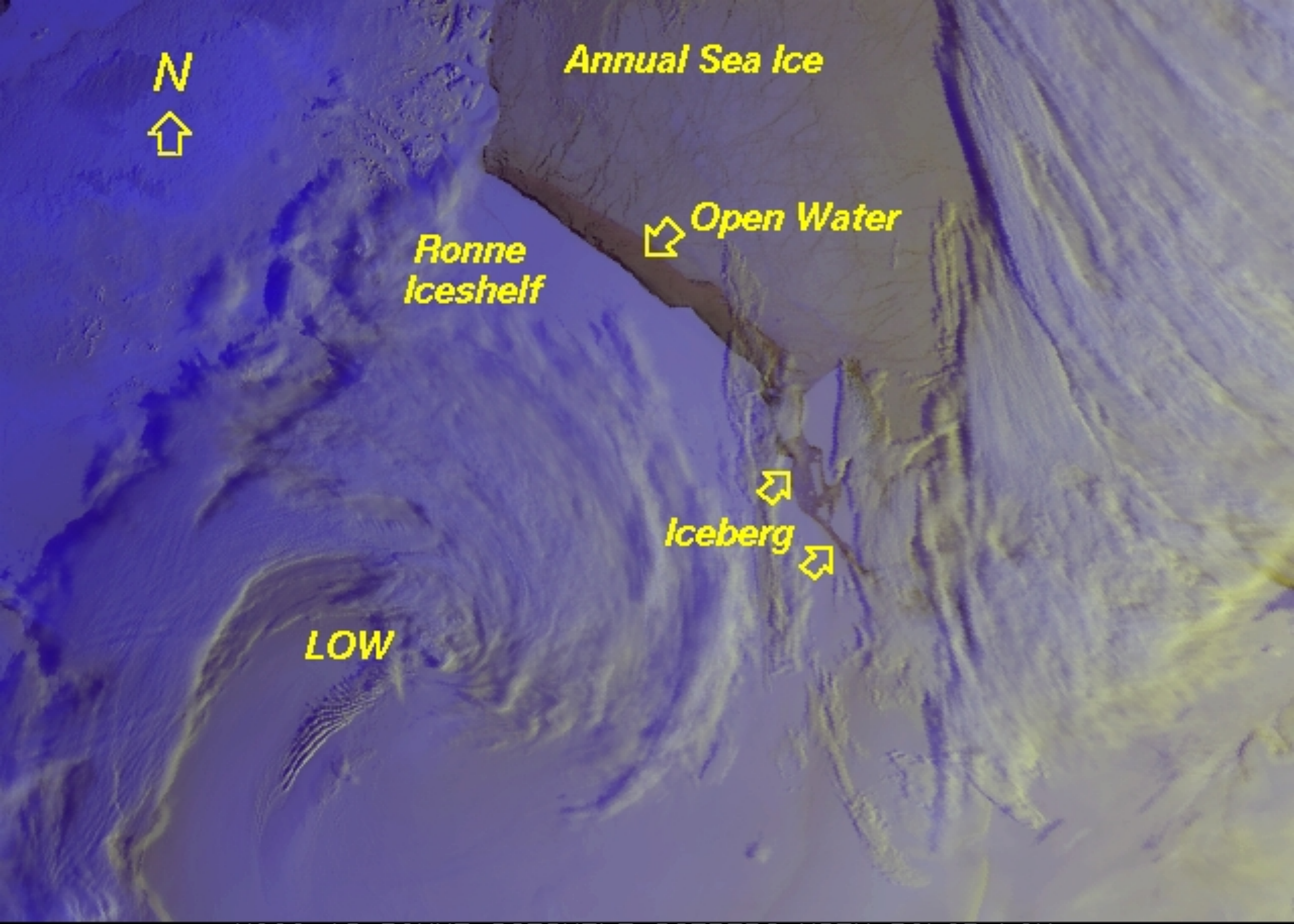
Boston Globe

Observing: Satellite and Automatic Weather Station (AWS)

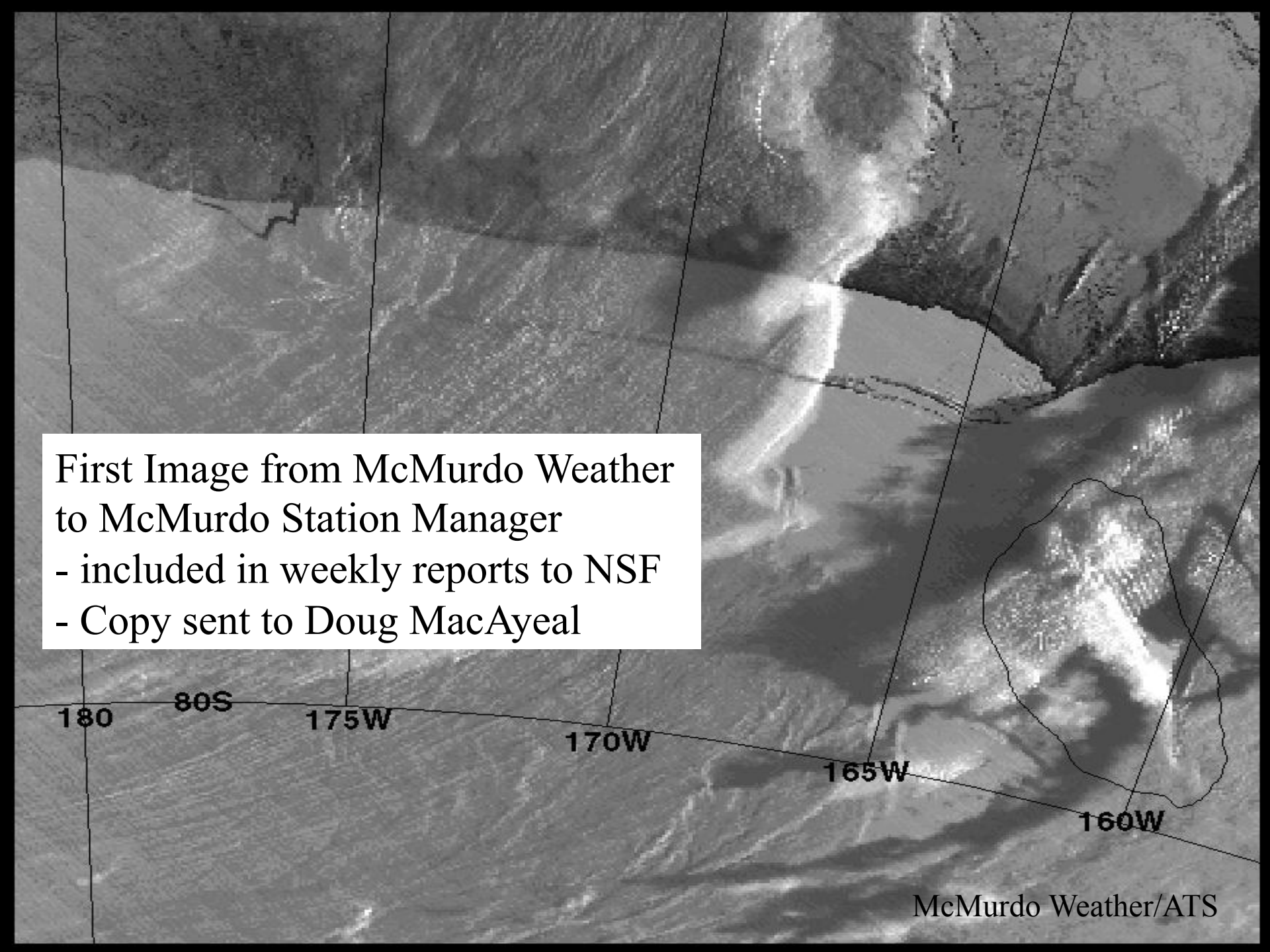
- Satellite
  - NOAA AVHRR
  - DMSP OLS/SSM/I
  - Quikscat
  - ERS ATSR
  - Terra MODIS
- AWS
  - GPS
  - Weather



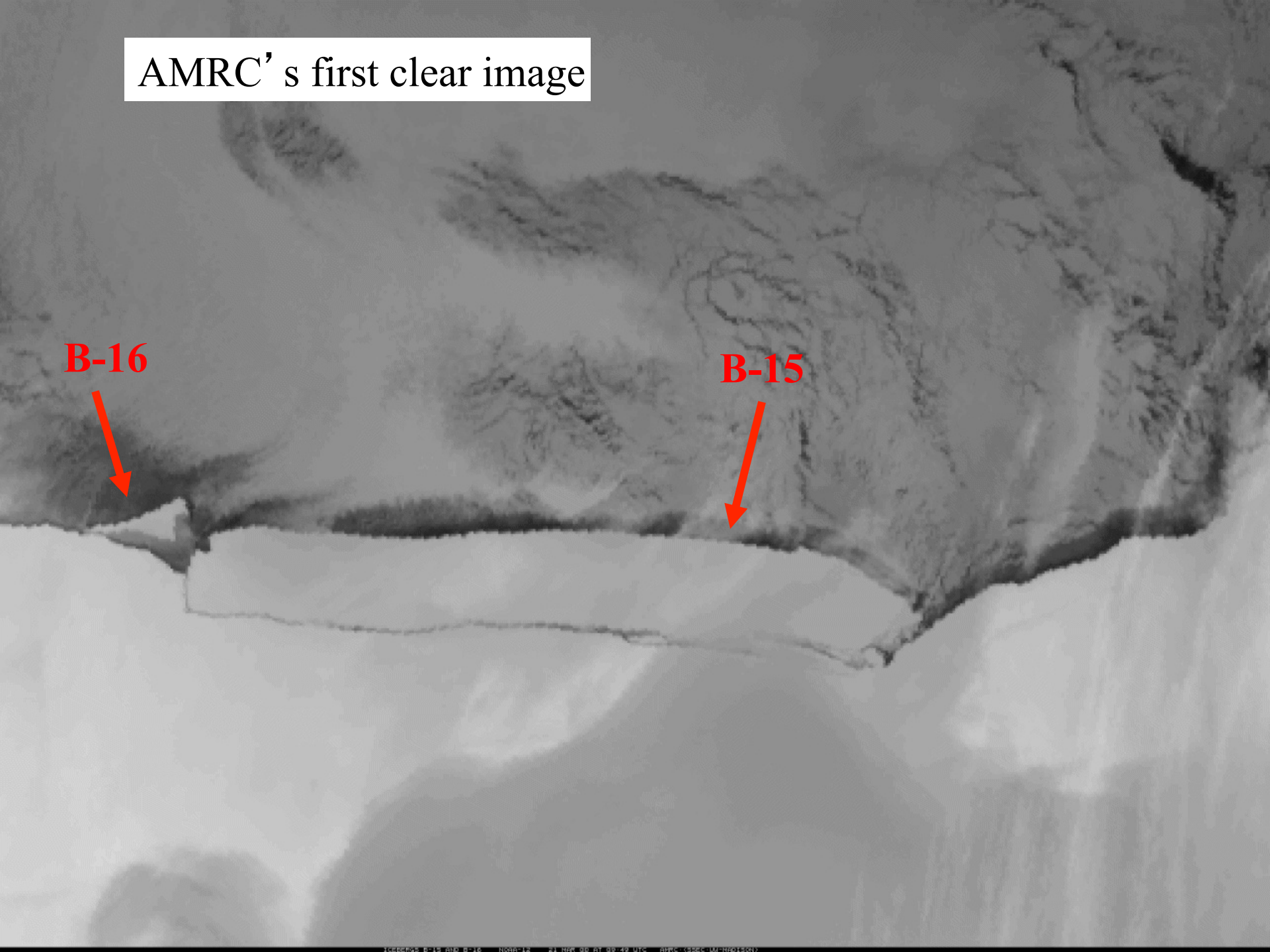


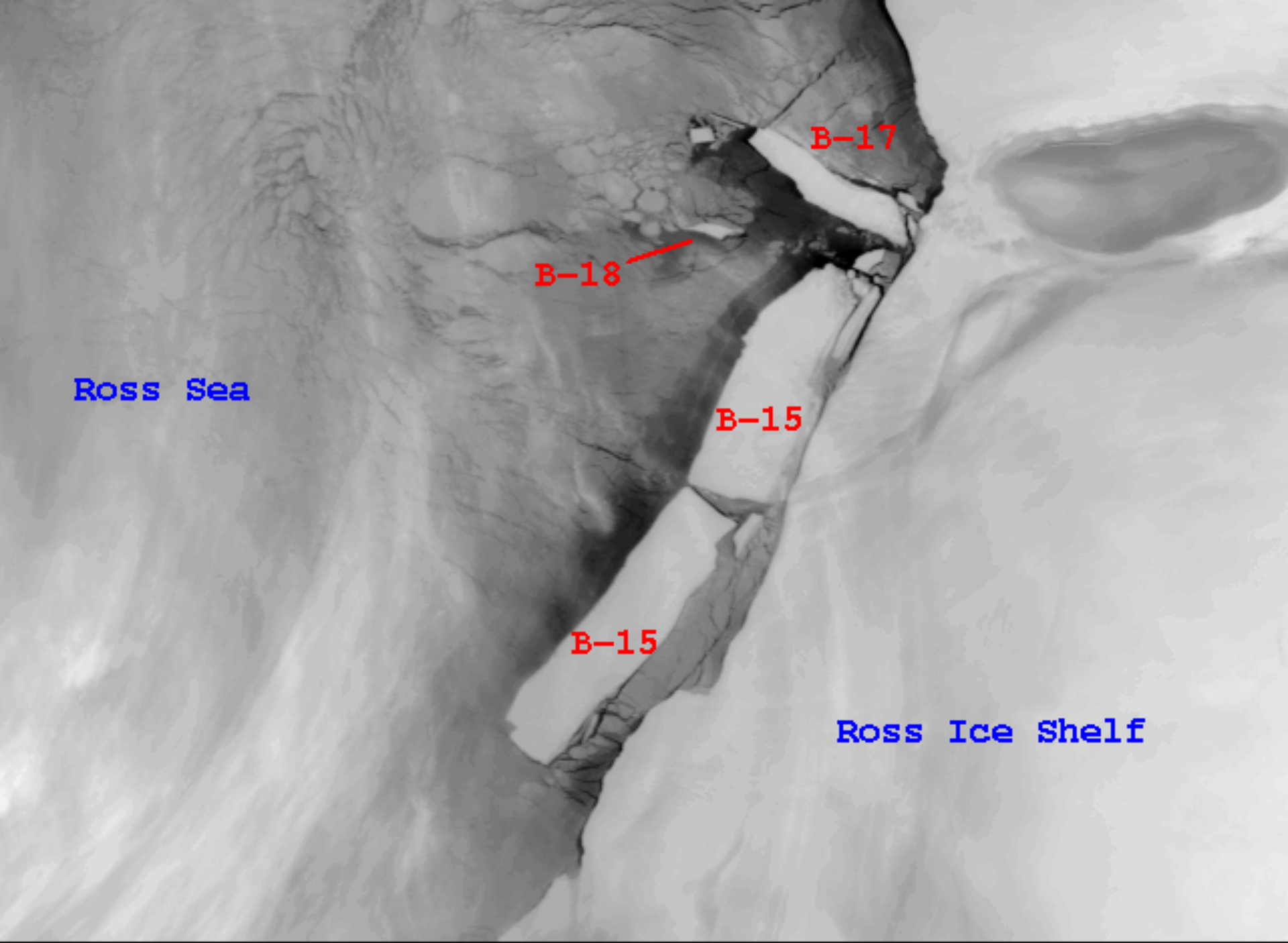


NOAA-12 RONNE ICESHELF ICEBERG WITH POLAR LOW
3 NOV 98 AT 08:23:48 (AMRC:SSEC:UW-MADISON) USAP 00-202-0

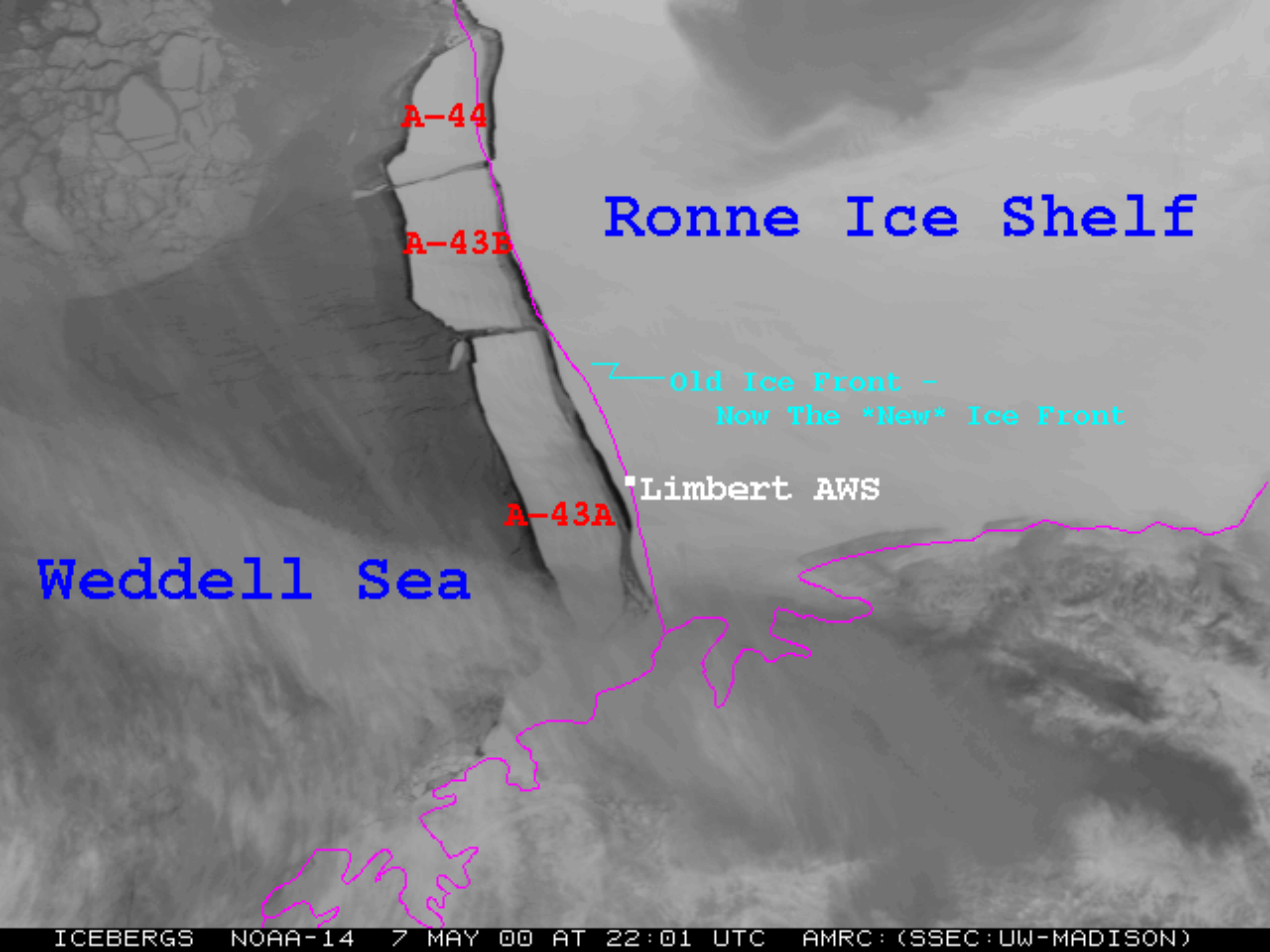

First Image from McMurdo Weather
to McMurdo Station Manager
- included in weekly reports to NSF
- Copy sent to Doug MacAyeal
180
80S
175W
170W
165W
160W
McMurdo Weather/ATS

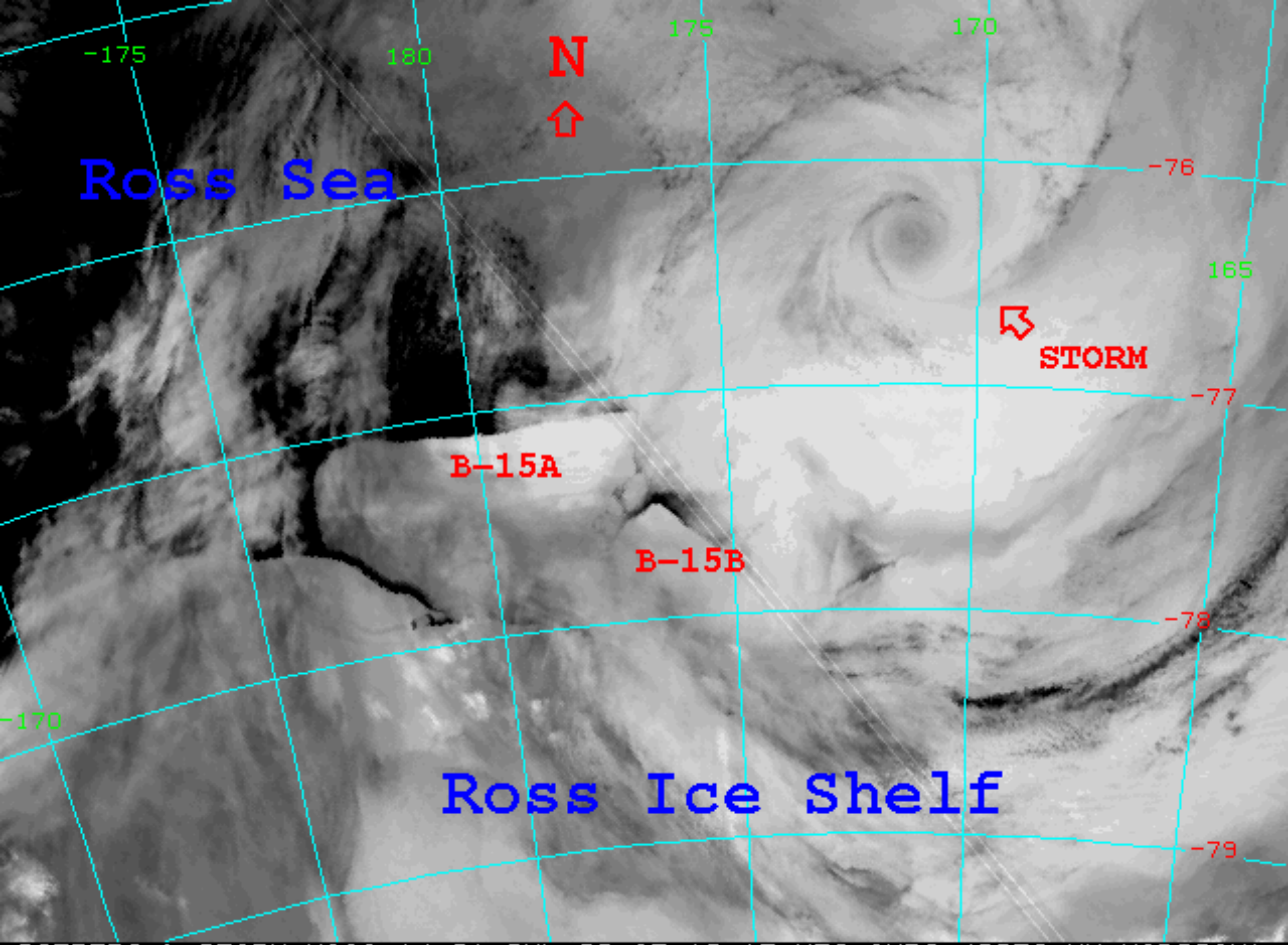
AMRC's first clear image

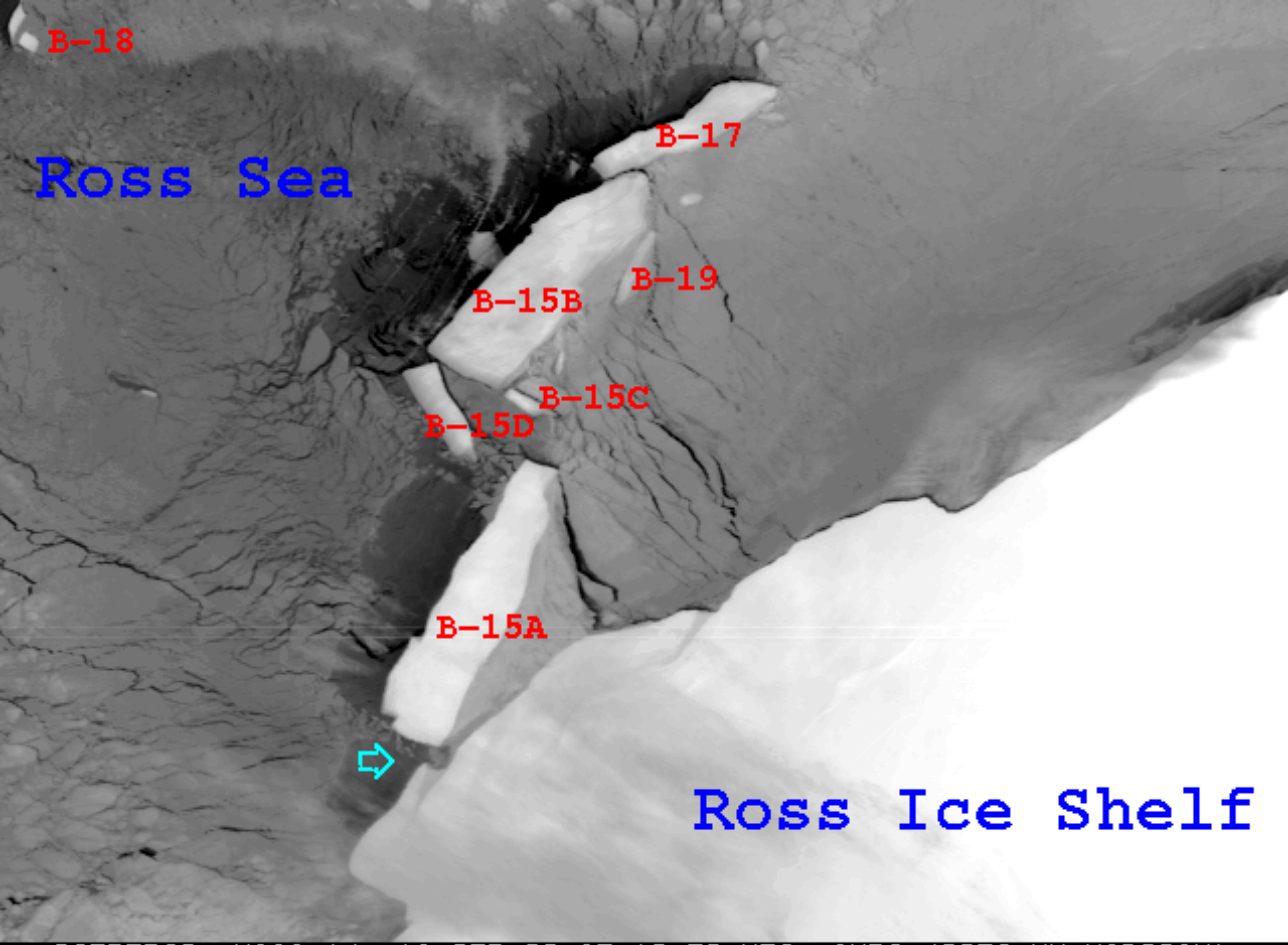




ICEBERGS NOAA-14 23 MAY 00 AT 10:17 UTC AMRC:(SSEC:UW-MADISON)

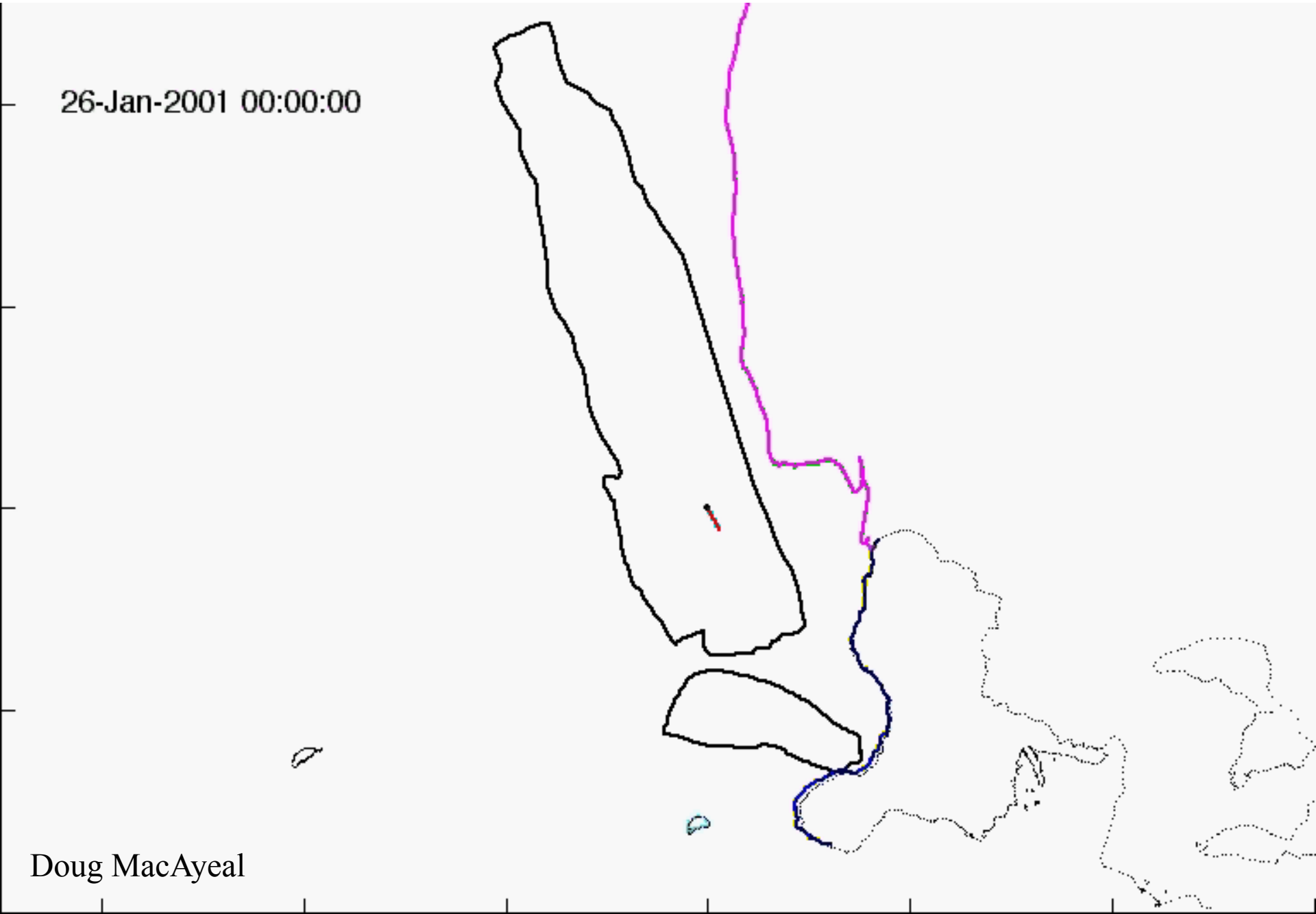

A-44
A-43B
Ronne Ice Shelf
Old Ice Front -
Now The *New* Ice Front
Limbert AWS
A-43A
Weddell Sea
ICEBERGS NOAA-14 7 MAY 00 AT 22:01 UTC AMRC:(SSEC:UW-MADISON)


-175
180
175
170
N
Ross Sea
-76
165
STORM
-77
B-15A
B-15B
-78
-170
Ross Ice Shelf
-79
ICEBERG & STORM NOAA-14 21 JUL 00 AT 12:15 UTC AMRC:(SSEC:UW-MADISON)

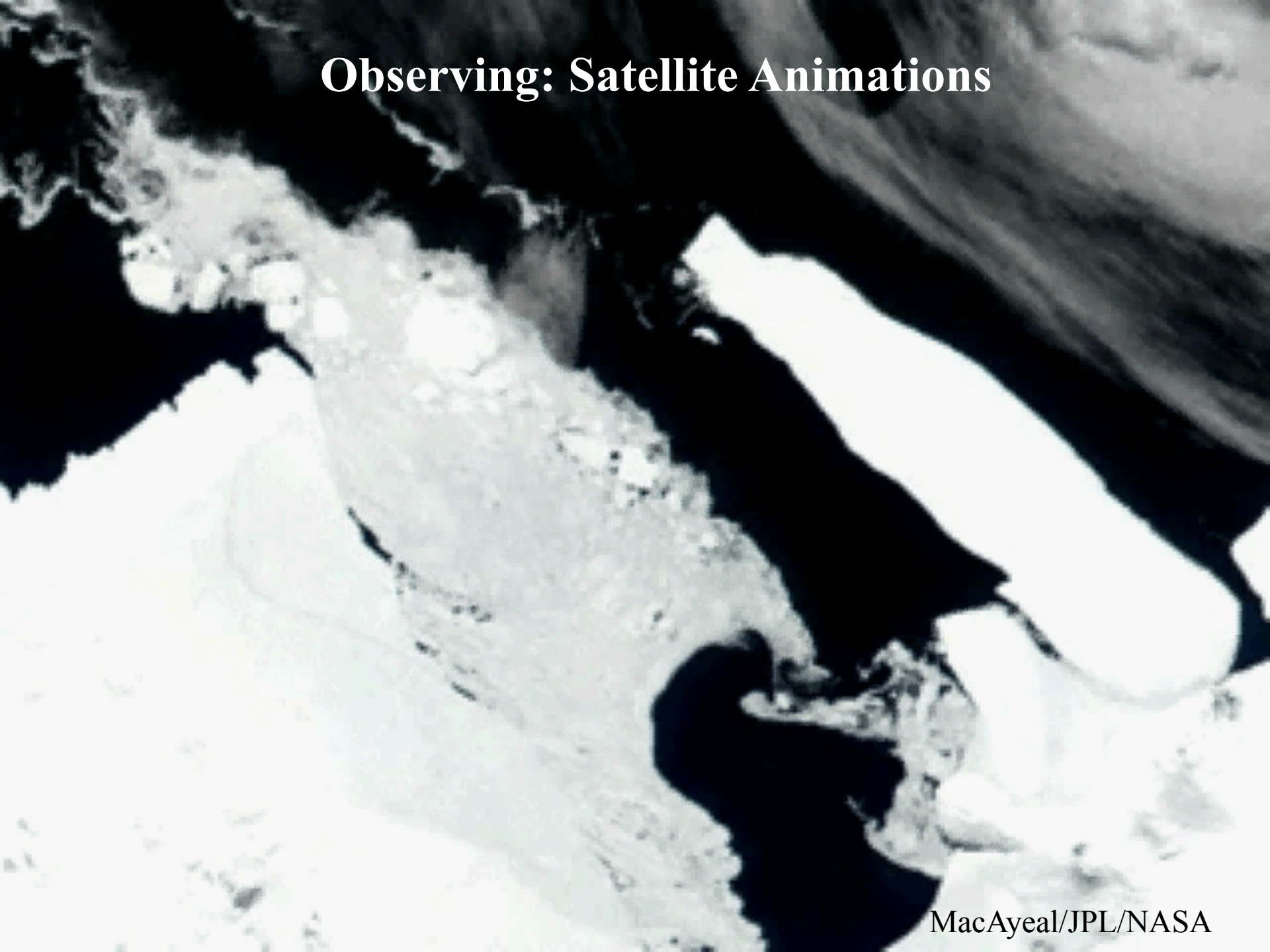

B-18
B-17
Ross Sea
B-19
B-15B
B-15C
B-15D
B-15A
Ross Ice Shelf
ICEBERGS NOAA-14 18 SEP 00 AT 12:32 UTC AMRC:(SSEC:UW-MADISON)


N
Ross Sea
B-15D
B-15B
B-17
B-19
B-15C
Franklin Island
B-15A
C-16
Beaufort Island
Ross Island
McMurdo Station
Ross Ice Shelf
ICEBERGS NOAA-14 24 OCT 00 AT 12:10 UTC AMRC:(SSEC:UW-MADISON)

Observing: AWS Animations



Observing: Satellite Animations



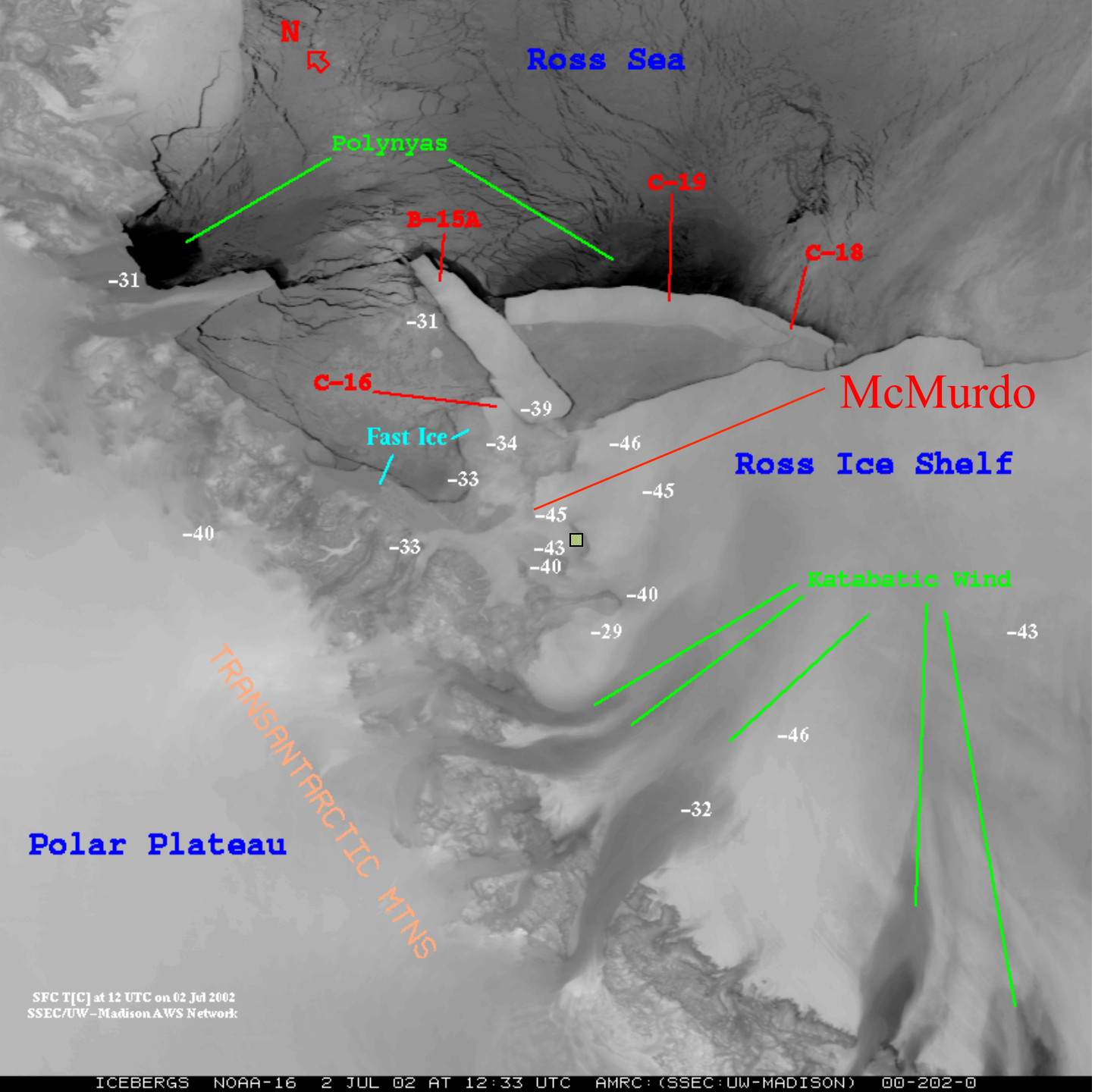
MacAyeal/JPL/NASA

Observing: Over flight Photo

Andy Bliss

C-16 AWS

Andy Bliss



Icebergs!

July 2, 2002 Location of Icebergs B-15A, C-16, C-18, and C-19 near McMurdo Station, Ross Island.
(Temperatures in degrees Celsius)

NOAA satellite (Antarctic Meteorological Research Center)

Ross Island Meteorology Experiment (RIME)

- Plans:
  - Process studies & modeling
  - Regional and local scale
  - Two field seasons with intensive ***observing*** periods
- "Steering Committee"

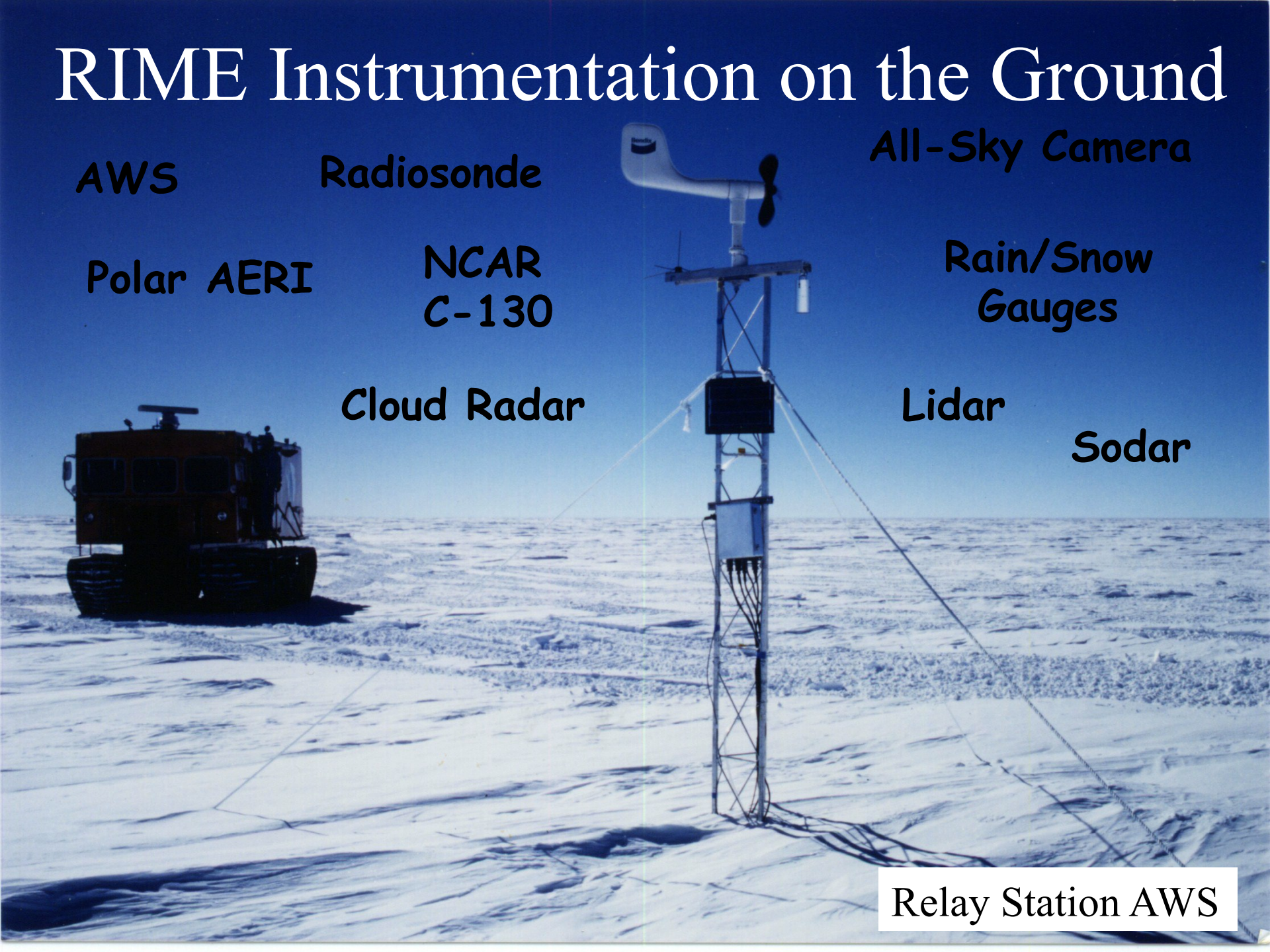
Science Plan Authors

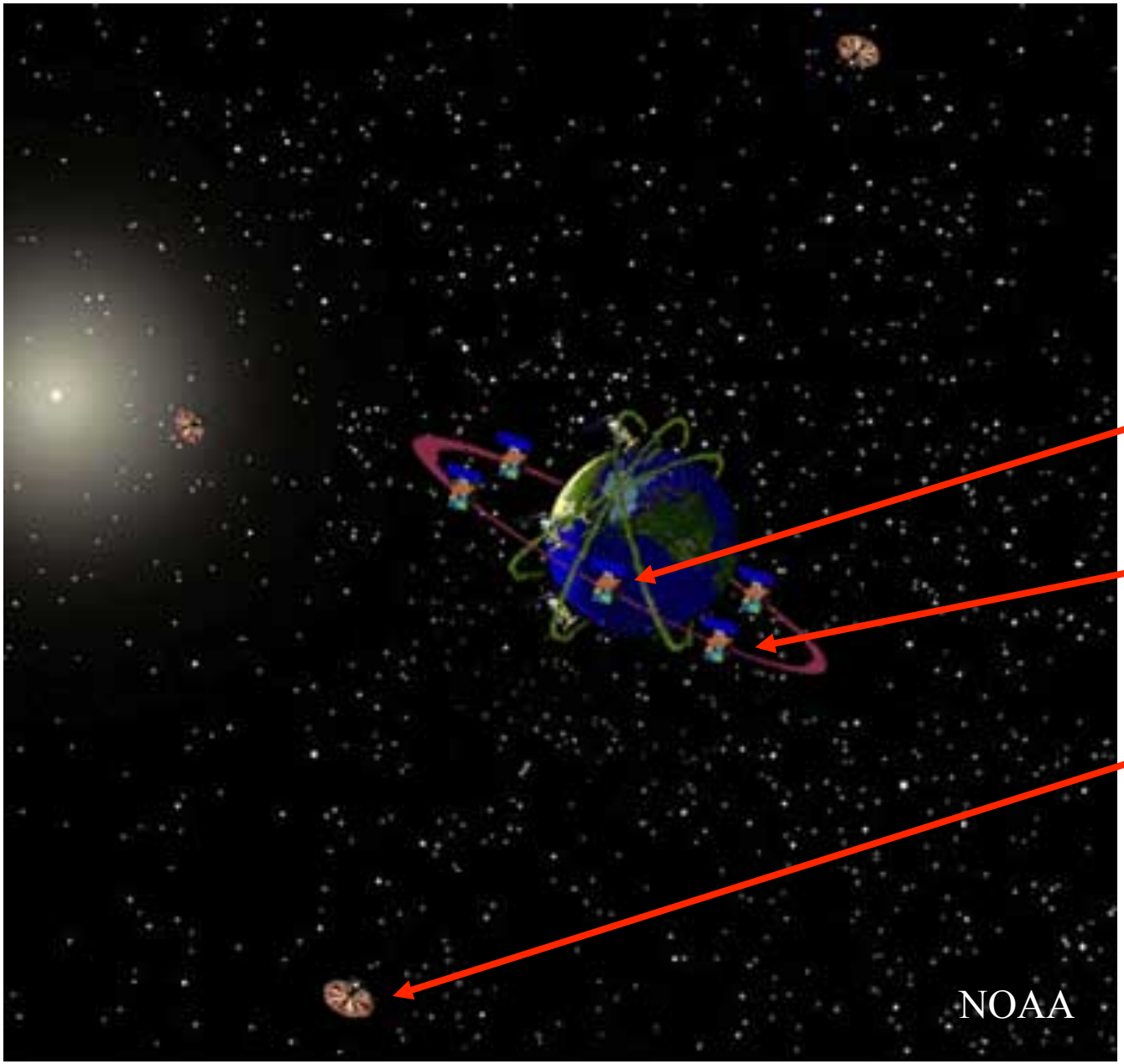
- T. Parish, U. of Wyoming
- D. Bromwich, Ohio State U.
- V. Walden, U. Idaho
- J. Cassano, U. of Colorado
- M. Lazzara, U. of Wisconsin
- Others...

RIME Timeline: 2003-2010

Hut point - McMurdo Station, Sea Ice Runway and Scott Base

RIME Instrumentation on the Ground





RIME

Instrumentation from Space

Polar Orbiters

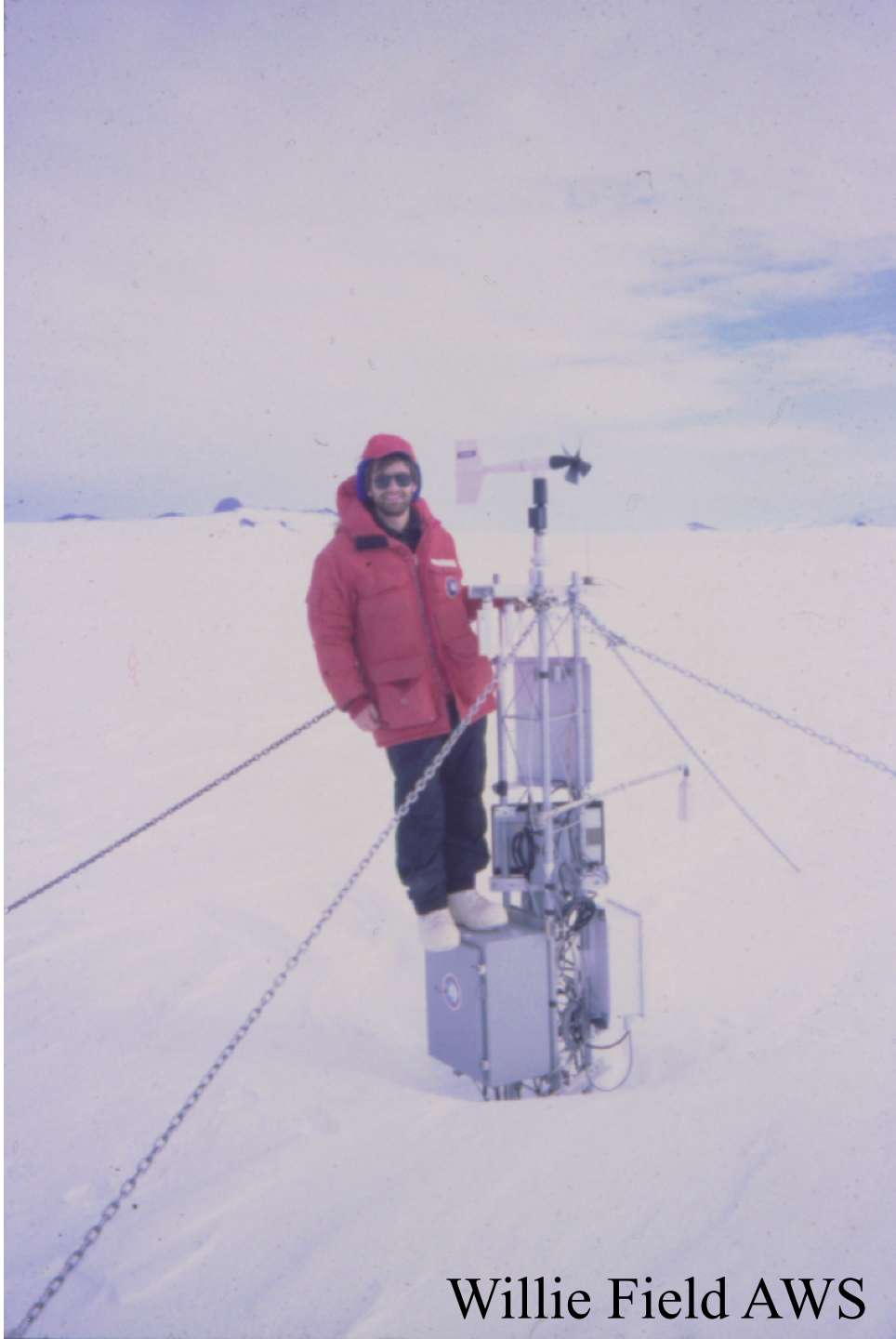
Geostationary

Polar Stationary?

Slide Show

Travel to Antarctica

E-mail:
mattl@ssec.wisc.edu
Web:
http://amrc.ssec.wisc.edu



Willie Field AWS