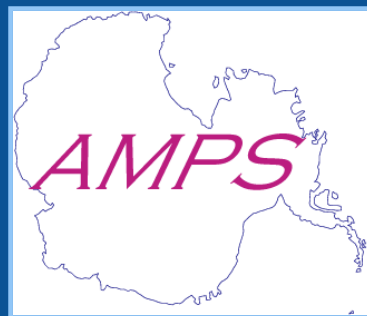


AMPS Support for Antarctic Science and Logistics— A Decennial Review

Jordan G. Powers

AMPS Lead
Mesoscale and Microscale Meteorology Division
NCAR Earth System Laboratory
National Center for Atmospheric Research

6th Antarctic Meteorological Observation, Modeling, and Forecasting Workshop
Hobart, Tasmania
Australia
June 23, 2011



AMPS— The Antarctic Mesoscale Prediction System

- Real-time mesoscale NWP capability to support Antarctic forecasting and science
- Priority mission: **U.S. Antarctic Program (USAP)** weather forecasting support
- Resources permitting: Assist int'l community
- Current collaborators: NCAR & The Ohio State University

<http://www.mmm.ucar.edu/rt/amps>



THE ANTARCTIC MESOSCALE PREDICTION SYSTEM (AMPS)

[Products Directory](#)

[GRIB Directory](#)

[AMPS-Related Links](#)

Forecast Hr	Grid / Window	Initial Time	Product
00 h	15 km	2011042212	<input checked="" type="radio"/> SFC <input type="radio"/> Sfc RH <input type="radio"/> Sfc RH (H2O) <input type="radio"/> SLP/Precip <input type="radio"/> Cloud base <input type="radio"/> Sea ice
<input checked="" type="radio"/> Animations <input type="radio"/> SOM <input type="radio"/> Obs Stats <input type="radio"/> AMPS Info	<input type="radio"/> Full <input type="radio"/> New <input checked="" type="radio"/> Scaled	<input type="button" value="Go Left"/> <input type="button" value="Go Right"/>	Upper air Soundings Tables Cross sections PseudoSat Sfc wind Meteograms SOM

AMPS User Groups Over the Years

1. USAP Weather Forecasters

–Space and Naval Warfare Systems Center (SPAWAR)



USAF C-17
Ice Runway, McMurdo

- **Station forecasting**

- ◇ McMurdo, South Pole, Palmer
- ◇ Field camps across Ice

- **Air operations forecasting**

- ◇ US Air Force, New York Air Nat'l Guard
- ◇ Kenn Borek Air & PHI (helos)

- **Marine forecasting**

2. Researchers / Students

3. International Users

4. Scientific Field Campaigns

AMPS Motivations and Beginning

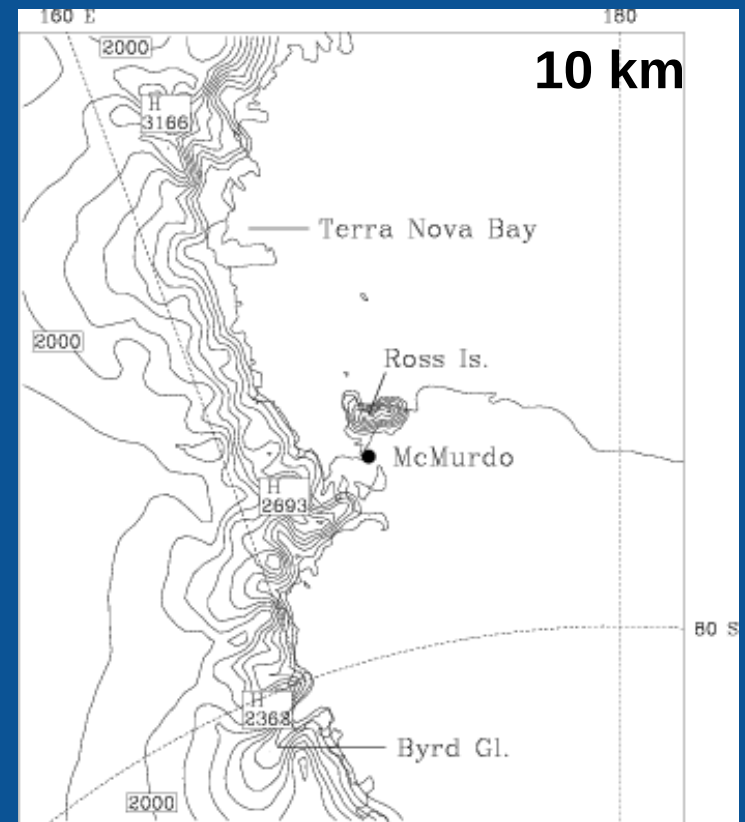
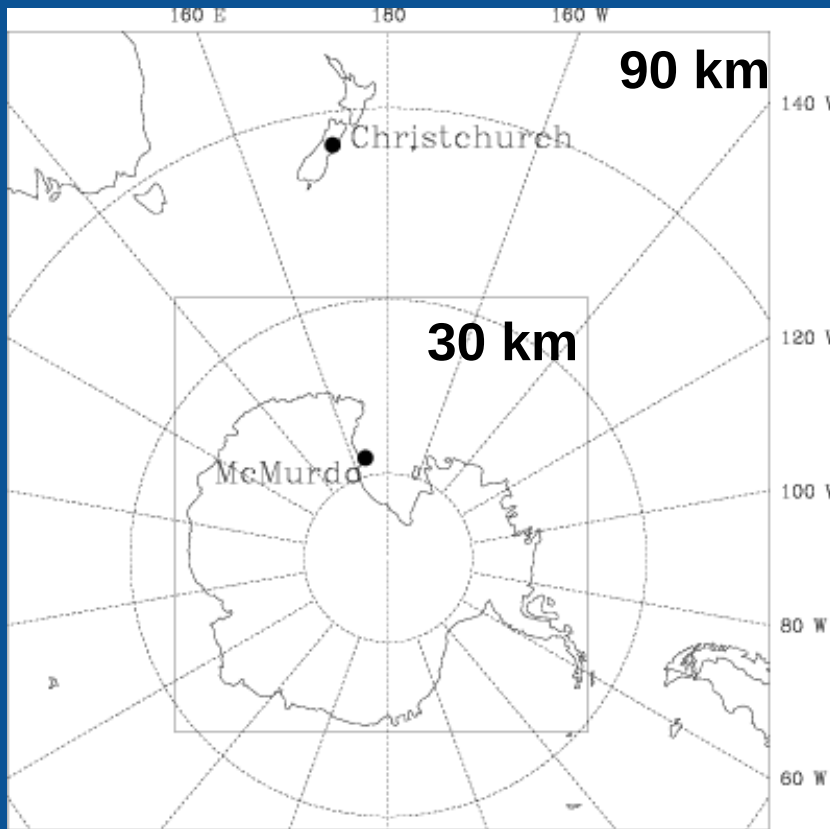
- Community review: The Antarctic Weather Forecasting Workshop (May 2000, The Ohio State Univ.)
 - Recognized weaknesses in available Antarctic NWP
 - Inadequate resolution
 - Model physics: Representation of Antarctic PBL / troposphere
 - Recommendation: A robust, high-resolution NWP system tailored to the needs of the McMurdo forecasters
- ⇒ AMPS Started: September 2000**

AMPS Model Configuration: Then (2000) v. Now (2011)

	<u>Then</u>	<u>Now</u>
Model:	MM5	WRF
Domains:	3	7
Main—	90 km (48 h)	45 km (1) (120 h)
	30 km (48 h)	15 km (1) (120 h)
	10 km (24 h)	5 km (3) (36 h)
		1.67 km (1) (36 h)
Secondary—	Global MM5 (120 h) ~ 120-km @ pole	15 km 1-way nest (72 h)
Top:	100 mb	10 mb
Vert. Levels:	29	44
Freq:	2 fcsts/day	2 fcsts/day
Units:	0000, 1200 UTC	0000, 1200 UTC

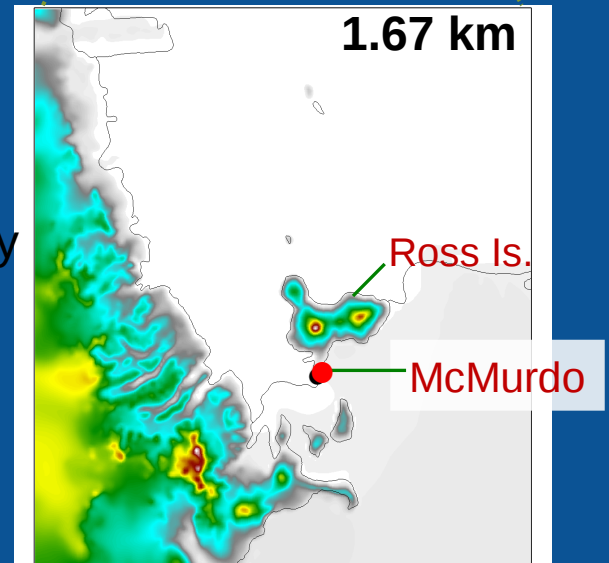
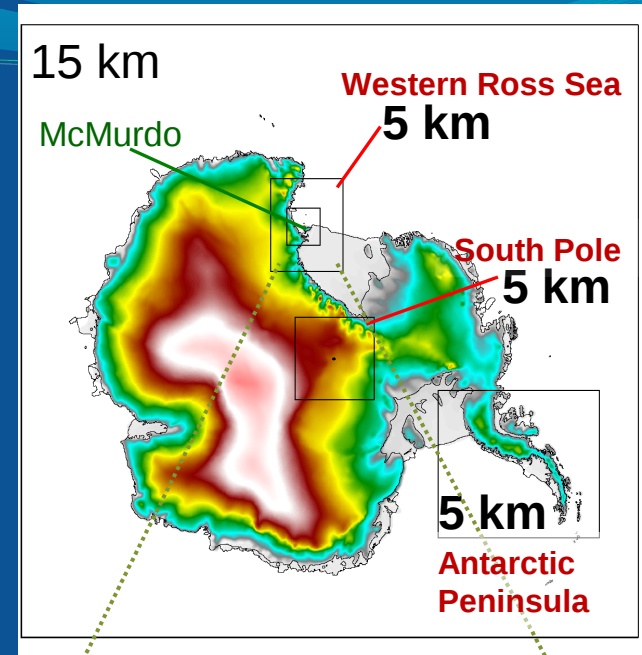
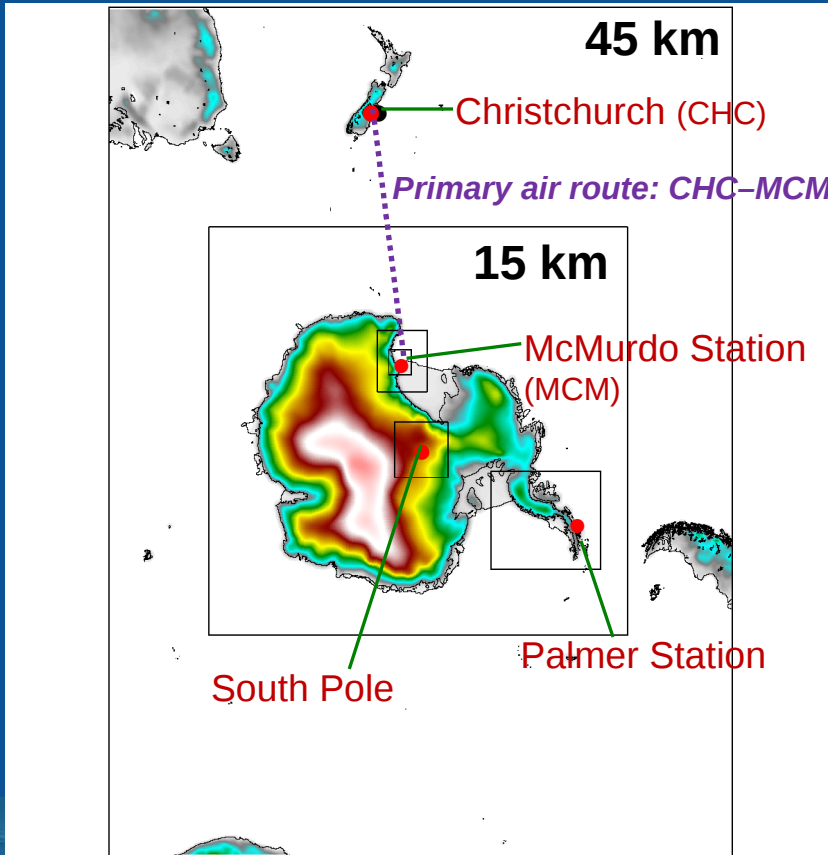
AMPS 2000: Model Configuration

- Model: MM5– Penn State/NCAR Mesoscale Model 5
- Polar modifications implemented into AMPS later



AMPS 2011: Model Configuration

- Model: WRF- Weather Research and Forecasting Model
- WRF contains both new and released polar modifications



Topography shaded

AMPS 2011: Windows and Nests

Regular Forecast Grids

Western Ross Sea

South Pole

Antarctic Peninsula

Ross Island

Recent 1-Way Nests

CTAM

LARISSA

Palmer

Plotting Windows

Ross-Beardmore

Marie Byrd Land

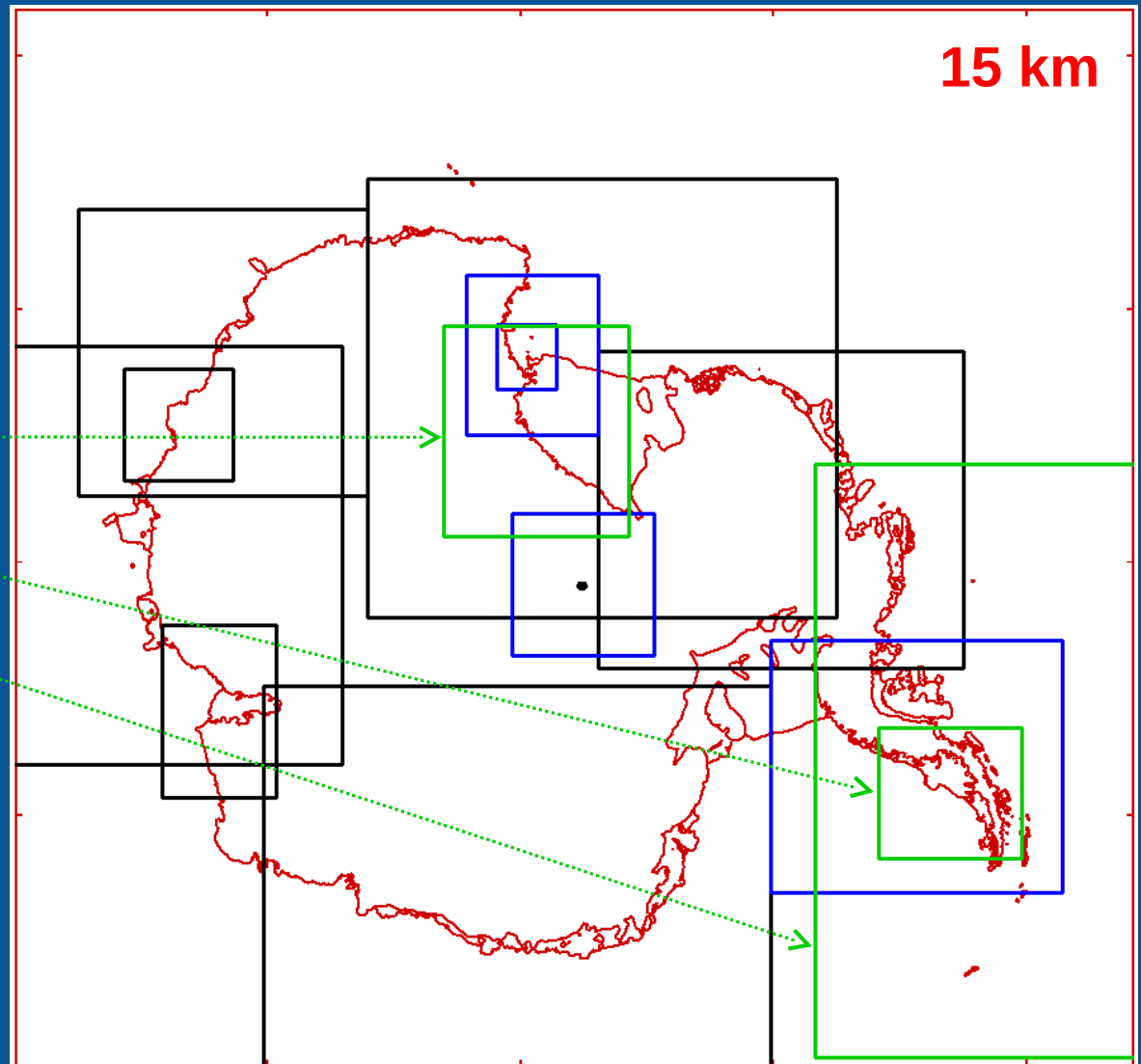
Queen Maud Land

Casey

Casey-Dumont

Casey-Davis

Davis/Mawson



AMPS Assistance to International Antarctic Community

– Provision of special products, forecast windows, and services

- Italy
- Australia
- UK
- Germany
- South Africa
- Chile
- China
- New Zealand

SA Agulhas (South Africa)

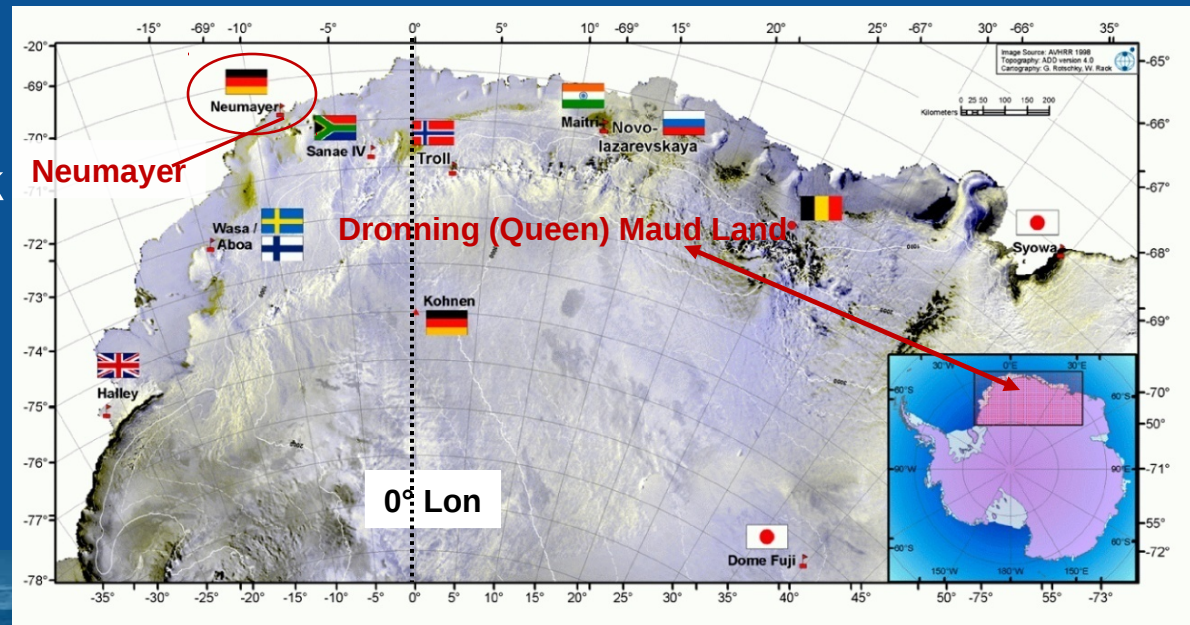
RV Polarstern (Germany)



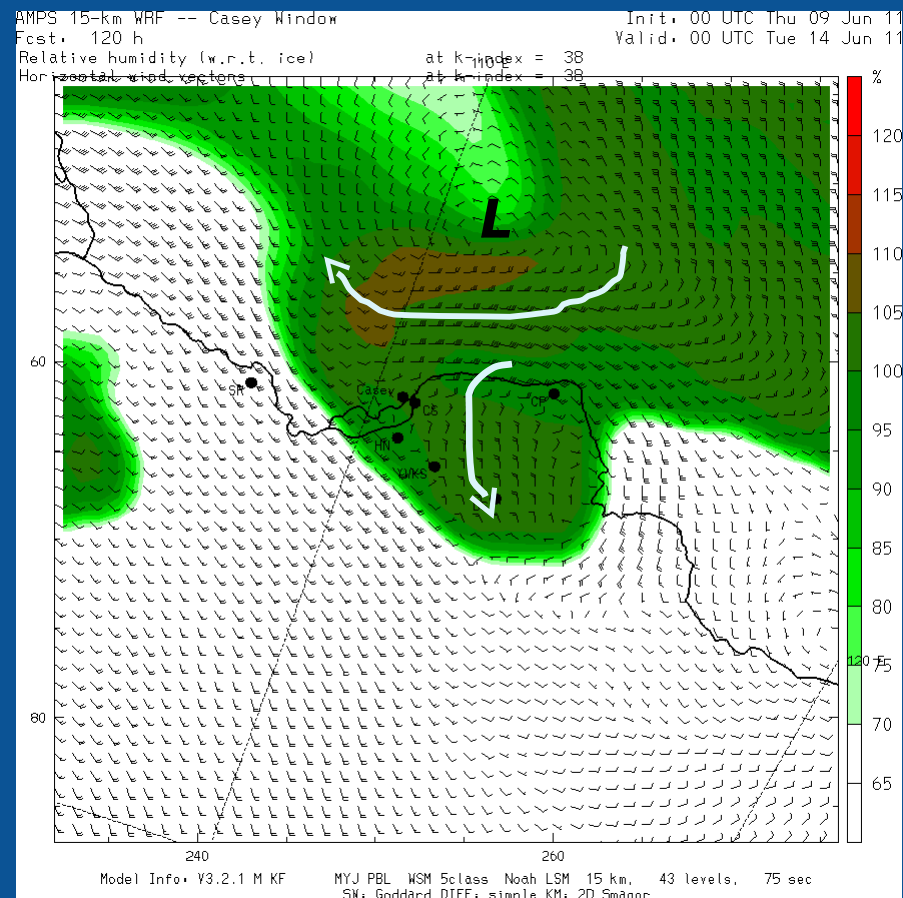
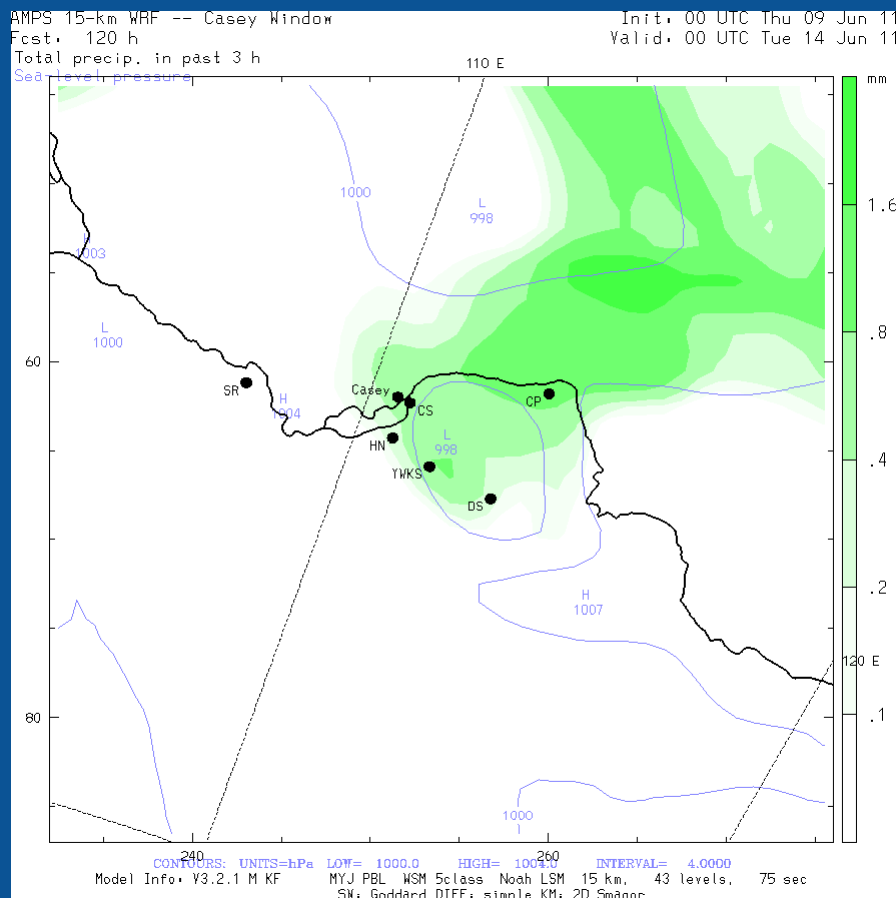
- DROMLAN— Dronning Maud Land Air Network

Germany, Russia, India, Japan, Norway, Sweden, Finland, Belgium, UK, South Africa*

** Provides Forecasting*



AMPS Products (Non-USAP)— Casey Window (AUS)



9 June 2011 00 UTC Init

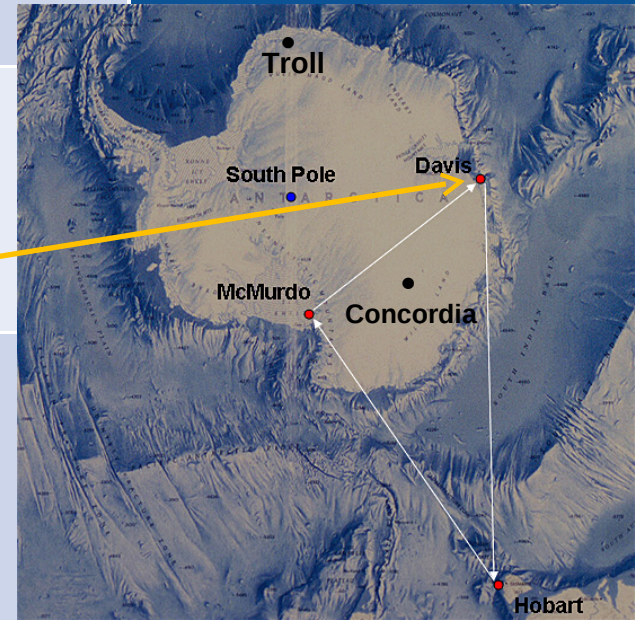
Hr 120

AMPS Support for Antarctic Rescues and Emergencies: 2001–2011

Date	Location	Emergency / Response
April 2001	South Pole	Medevac of Raytheon station doctor (Shemenski) Twin Otter flown through Rothera Marginal conditions: $\sim -55^{\circ}\text{C}$
June –July 2002	Queen Maud Land coast	<i>Magdalena Oldendorff</i> evacuation German ship (<i>Magdalena Oldendorff</i>) trapped in ice Rescue ships dispatched S. Africa— <i>Agulhas</i> Argentina— <i>Almirante Irizar</i> Feedback: AMPS outer grid extended to South Africa
September 2003	South Pole	Medevac flight Feedback: AMPS 10-km Antarctic Peninsula grid implemented



Date	Location	Emergency / Response
April 2004	McMurdo	Medevac
October 2008	Troll (Queen Maud Land) Norway	Medevac
November 2008	Davis Australia	Australian suffered multiple fractures in ATV accident Transport: 109 th Airlift Wing NY Air Nat'l Guard LC-130 Route: MCM—Davis—Hobart
September 2010	McMurdo	Medevac New Zealand P-3 aircraft flown to remove American
January 2011	Concordia France	Medevac MCM—Concordia flight



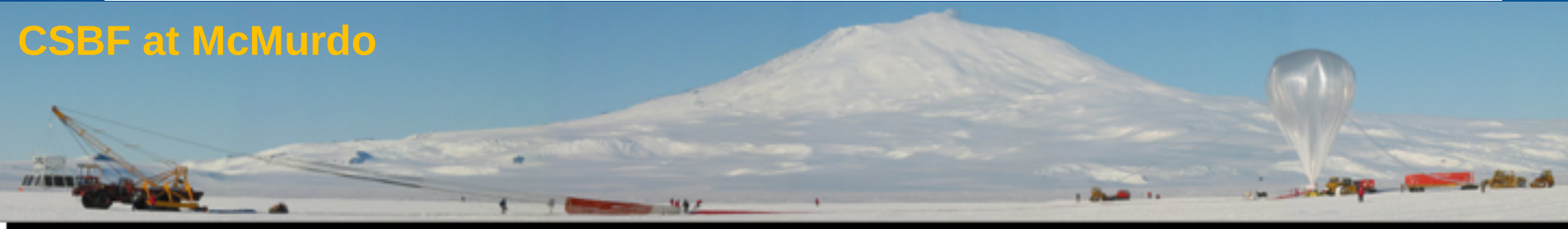
**AMPS rescue avg:
1 per 17 mos.**

$\nu = 2.3 \times 10^{-8} \text{ Hz}$
(23 nHz)

AMPS Support of Field Campaigns: 2002–2011

Campaign	Period	Activity
GLOBEC Ecology	2002+	Global Ocean Ecosystem Dynamics Operations in Marguerite Bay, Antarctica
MaudNESS Oceanography	2005	Dronning Maud Land Nonlinear Equation of State System Study Weddell Sea oceanography
WAIS Divide Ice Core Glaciology	2005+	WAIS= West Antarctic Ice Sheet Forecast products for planning and sites location
Pine Island Bay Survey Glaciology	2007	Survey of Pine Is. Bay Glacier region Research flights from South America
CSBF Atmosphere	2007+	Columbia Scientific Balloon Facility Launches of high-altitude, long- duration balloons from MCM

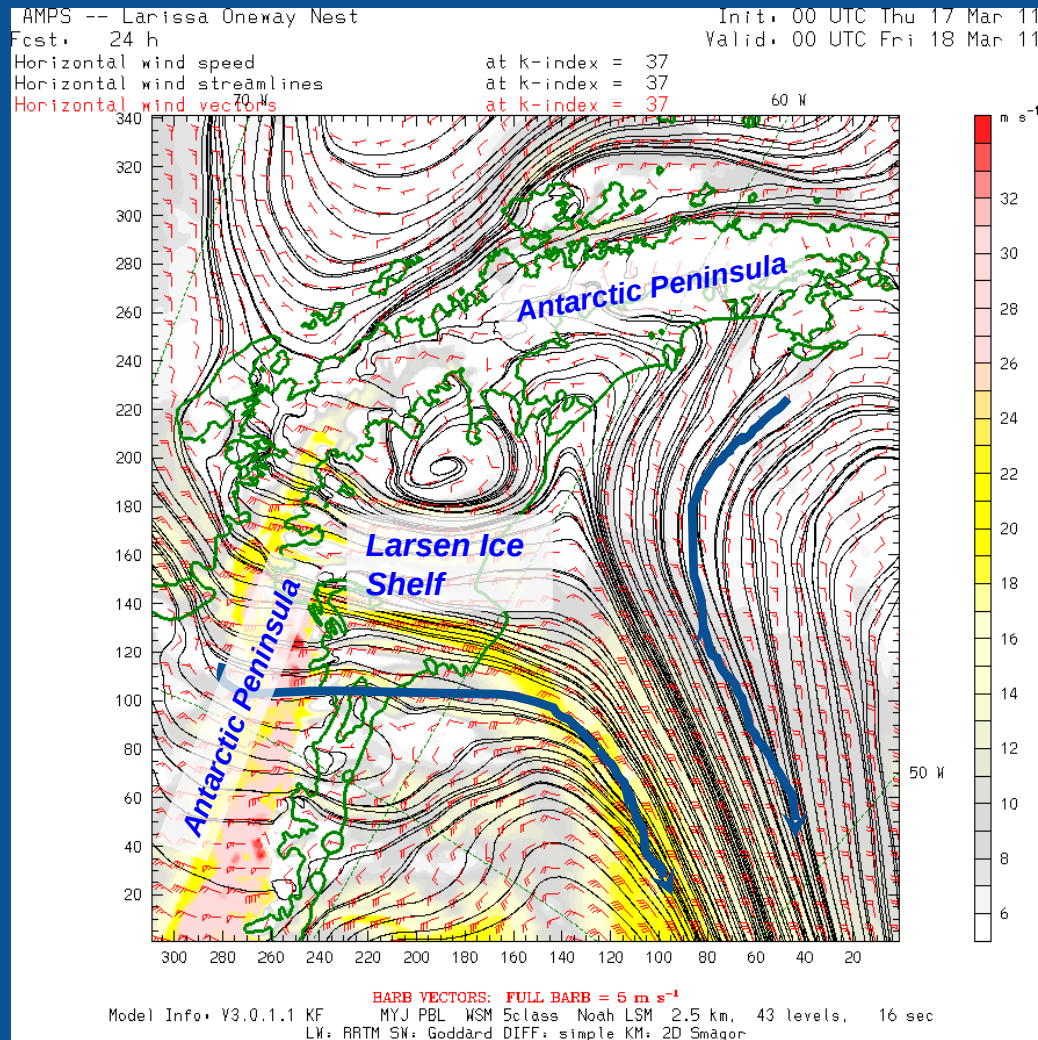
CSBF at McMurdo



Campaign	Period	Activity
AGAP Geology	2008–2010	Antarctica's Gamburtsev Province Surveys of Gamburtsev Subglacial Mountains
Terra Nova Bay Polynya Study Meteorology	2009	Study of PBL and surface fluxes over Terra Nova Bay region UAV flight forecasting
LARISSA Meteorology, glaciology	2009–2010	Larsen Ice Shelf System, Antarctica Helicopter and field activity forecasting
ICEBRIDGE Glaciology	2009–2010	NASA study of Antarctic ice sheets, glaciers, sea ice Flight forecasting products
R/V Nathaniel B. Palmer Antarctic cruise	2011	Ross Sea mission of <i>N.B. Palmer</i> Ship-tracking forecast window developed
Pine Island Glacier Activity	2011–2012	Field camps at Pine Is. Glacier New forecast nest

Field Campaign Support: LARISSA

LARISSA: Larsen Ice Shelf System, Antarctica (2010)



◇ Study of conditions over Larsen Ice Shelf

◇ 2.5-km 1-way AMPS nest for helo and other planning

◇ Grid continued after field phase

← Wind speed (ms⁻¹) and Streamlines

1000 ft (308 m) AGL

Hr 24

3 Mar 2011 00 UTC init

AMPS Archive: 2001–2011

- **Repository of AMPS Forecast Output**

- Storage at NCAR

- ◇ **MM5:** 2001–2009

- ◇ **WRF:** 2006–2011

- ✓ Full model output and plots

- ✓ Selected fields: GRIB data

- **Online database / archive:** The Ohio State Univ.

- ◇ Selected fields, levels, times (means included)

- ◇ <http://polarmet.osu.edu/PolarMet/ampsdb.html>

- **Applications**

- (1) Model Verification / Forecast Review

- (2) Case / Process Studies

- (3) Site / Region Climatologies

Range of Archive-Based Studies: A Sample

Verification

- ✓ Real-time forecasting for the Antarctic: An Evaluation of the Antarctic Mesoscale Prediction System (Bromwich et al. 2005)

Synoptic Meteorology

- ✓ Reexamination of the Near-Surface Airflow over the Antarctic Continent and Implications on Atmospheric Circulations at High Southern Latitudes (Parish and Bromwich 2007)

Mesoscale Meteorology / Case Studies

- ✓ A Dynamical Investigation of the May 2004 McMurdo Antarctica Severe Wind Event Using AMPS (Steinhoff et al. 2008)

Climatology

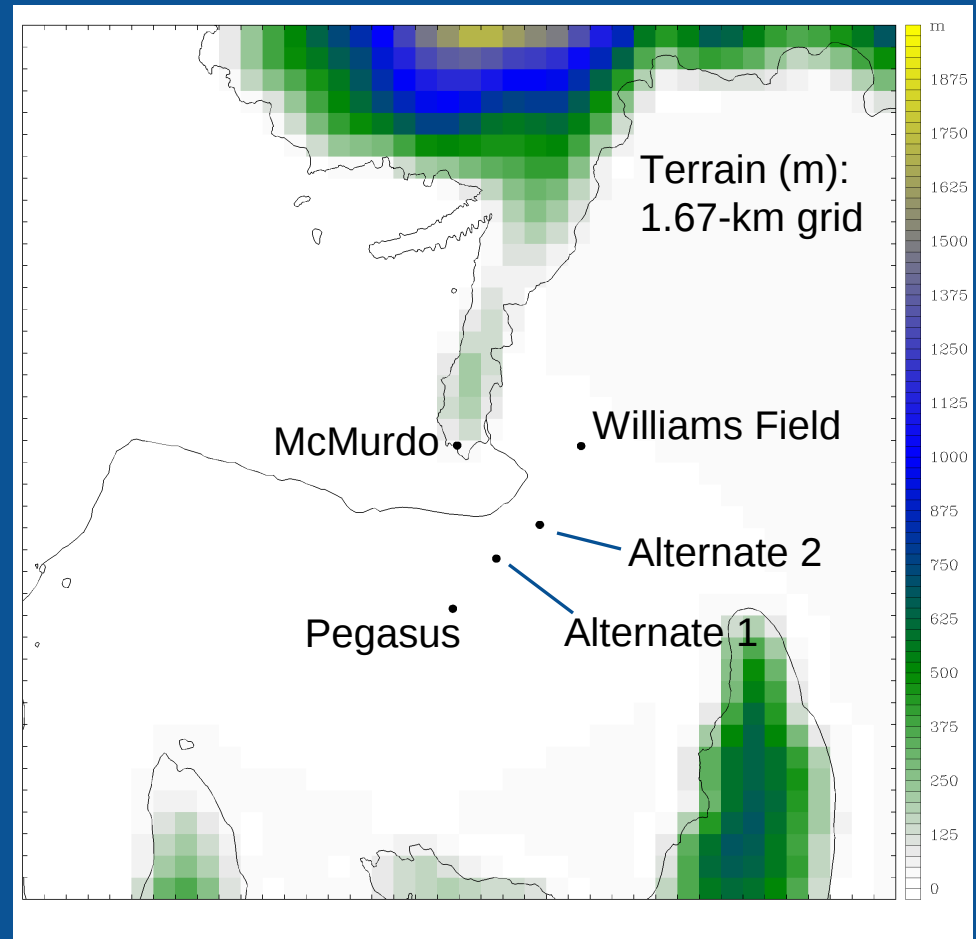
- ✓ The Climate of the McMurdo, Antarctica Region as Represented by One Year of Forecasts from AMPS (Monaghan et al. 2005)
- ✓ Precipitation Regime of Dronning Maud Land, Antarctica Derived from AMPS Archive Data (Schlosser et al. 2008)

Glaciology

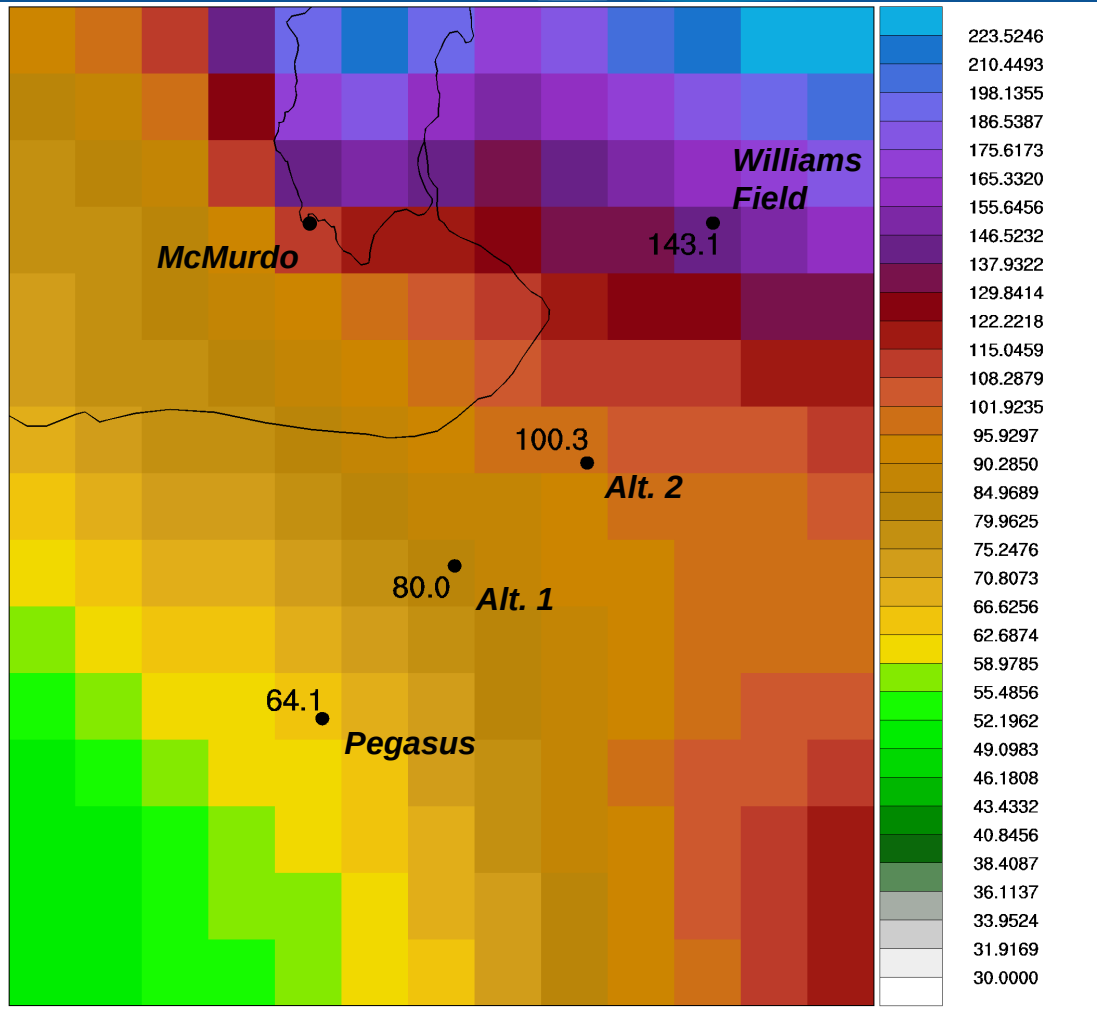
- ✓ Strong-Wind Events and Their Influence on the Formation of Snow Dunes: Observations from Kohnen, Dronning Maud Land (Birnbaum et al. 2010)

Recent Archive Application: Pegasus Site Weather

- Investigation: Weather at potential alternate sites for Pegasus airfield
- NSF request
- Sites Investigated:
Alternates 1 and 2
- AMPS output analyzed
 - 2008–2011 field seasons
 - Wind, T , T_d , RH, precip analyzed



AMPS Archive Investigation: Pegasus Site Weather



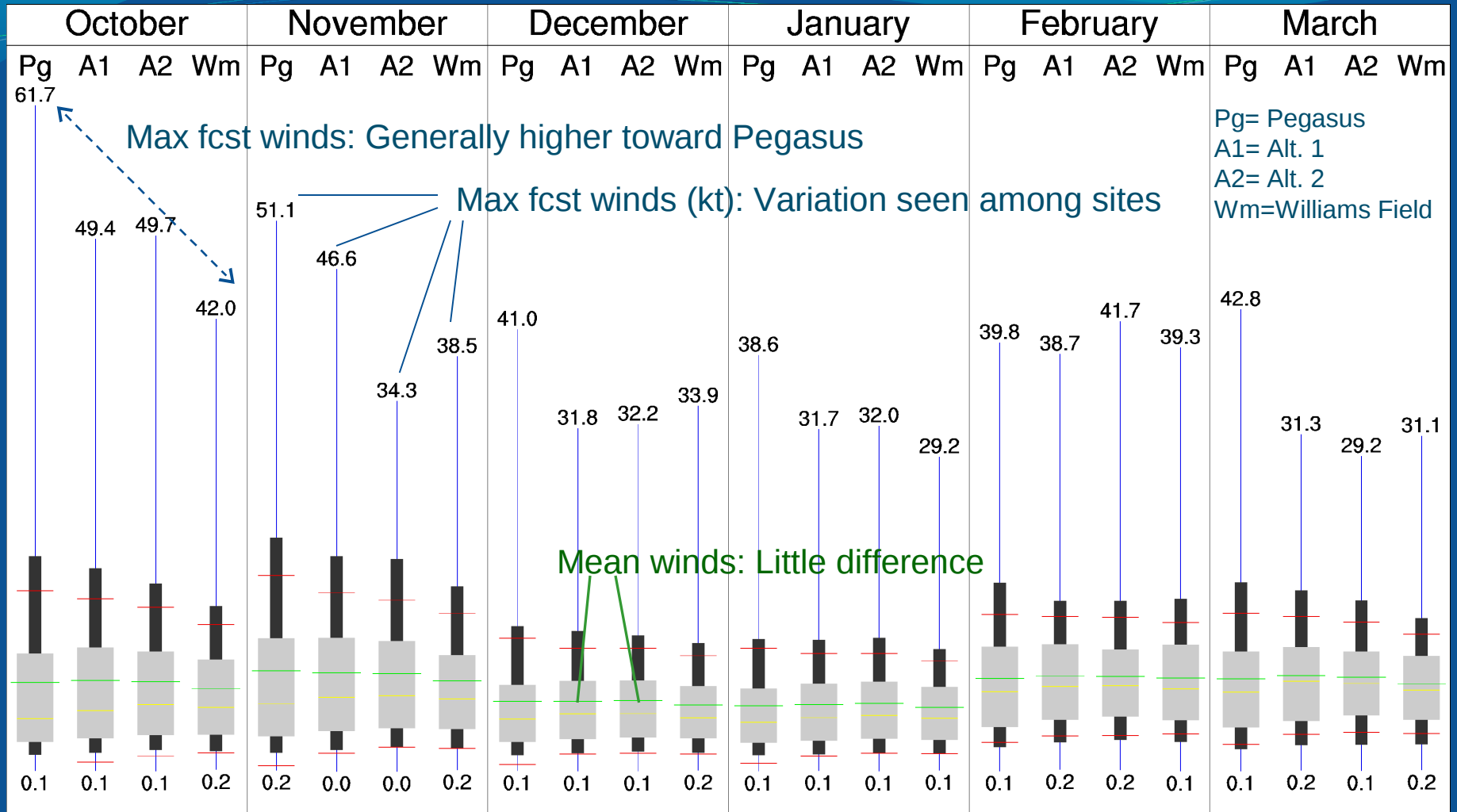
Precip comparisons

Alt. 1 = 125% Pegasus

Alt. 2 = 156% Pegasus

**Seasonal precipitation accumulation (mm) from AMPS:
2008–09, 2009–10, 2010–11 (Oct.–Mar.)**

AMPS Archive Investigation: Pegasus Site Weather

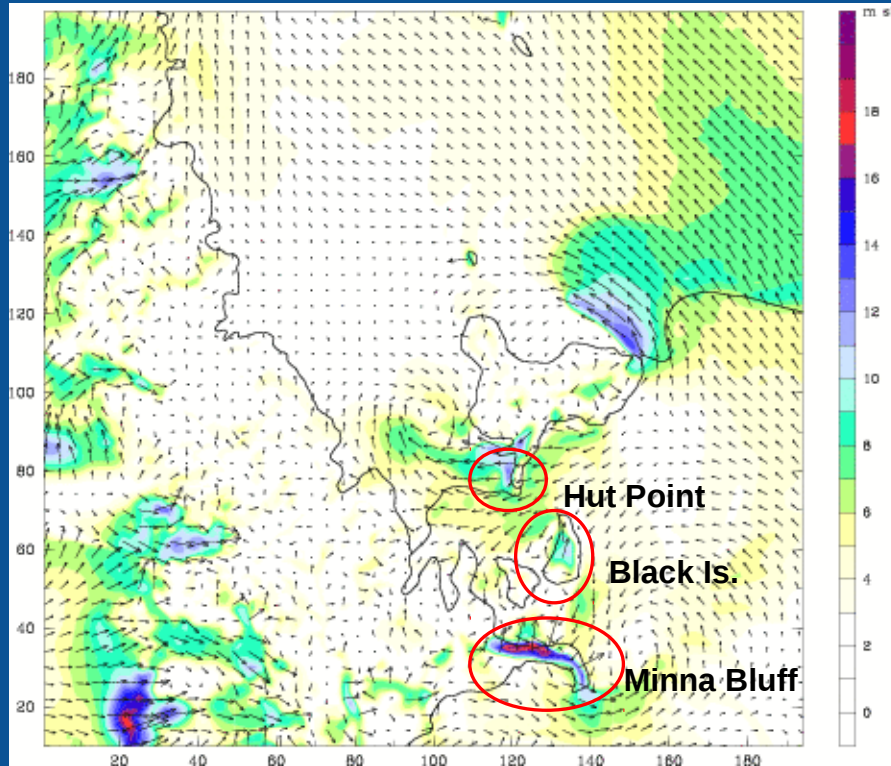


Wind speed (kt) statistics from AMPS: 2008/09, 2009/10, 2010/11 seasons.
 Blue= data min/max. Black/gray blocks= 10th–90th, 25th–75th percentiles.
 Green= mean (hrs 12-24); yellow = median; red= ±1σ.

AMPS Future— Possible Enhanced Resolution

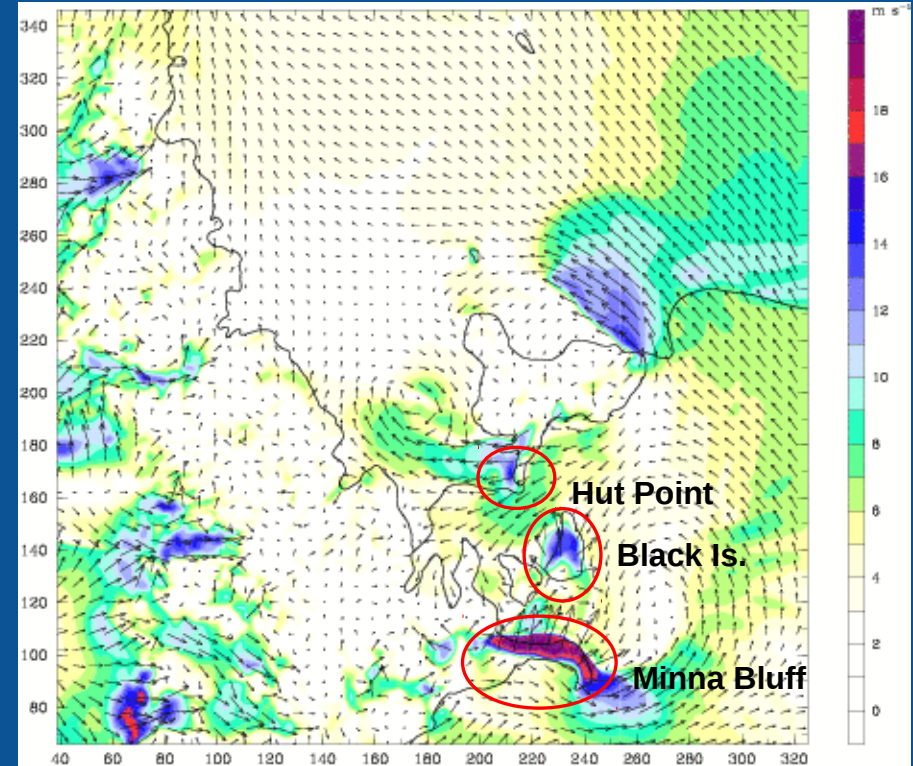
30 / 10 / 3.3 / 1.1 km

Current: 1.67-km



Max wind: 20.8 ms⁻¹ / 40.7 kt

Tested: 1.1-km



Max wind: 24.8 ms⁻¹ / 48.5 kt

Surface winds (ms⁻¹) (6 hr fcst) Speed increase @ max: 19%

Timing: 6 hrs wallclock / 8 hrs fcst (4 domains only)

Valid: 1800 UTC 11 April 2011

Init: 11 April 1200 UTC

Summary

- **AMPS: A Decade of Service and Support**

- Original goal met: Robust, high-res NWP system tailored for McMurdo forecasters
- Original plan exceeded
 - ✓ **USAP forecasting and planning**
 - + **International community**
 - + **Research and education**
 - + **Scientific field campaigns**
 - + **Emergency operations**

- **Future Plans**

- Higher-res grids (*Computer dependent*)
- Advance polar physics for WRF
- Assimilation of new data types