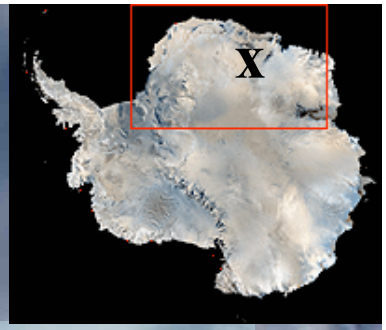


Synoptic controls of moisture transport and accumulation during 2009-2010 at the Princess Elisabeth Station, Dronning Maud Land

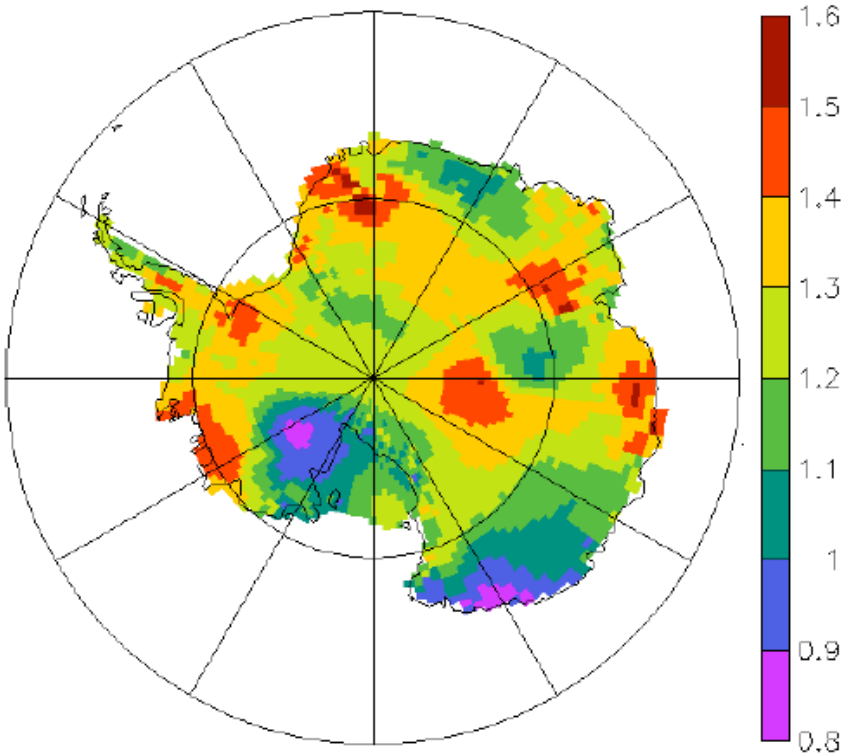
Irina Gorodetskaya, Nicole van Lipzig, Laura Scheêre
(K. U. Leuven, Belgium)

Wim Boot, Carleen Reijmeer, Michiel van den Broeke
(IMAU, Netherlands)

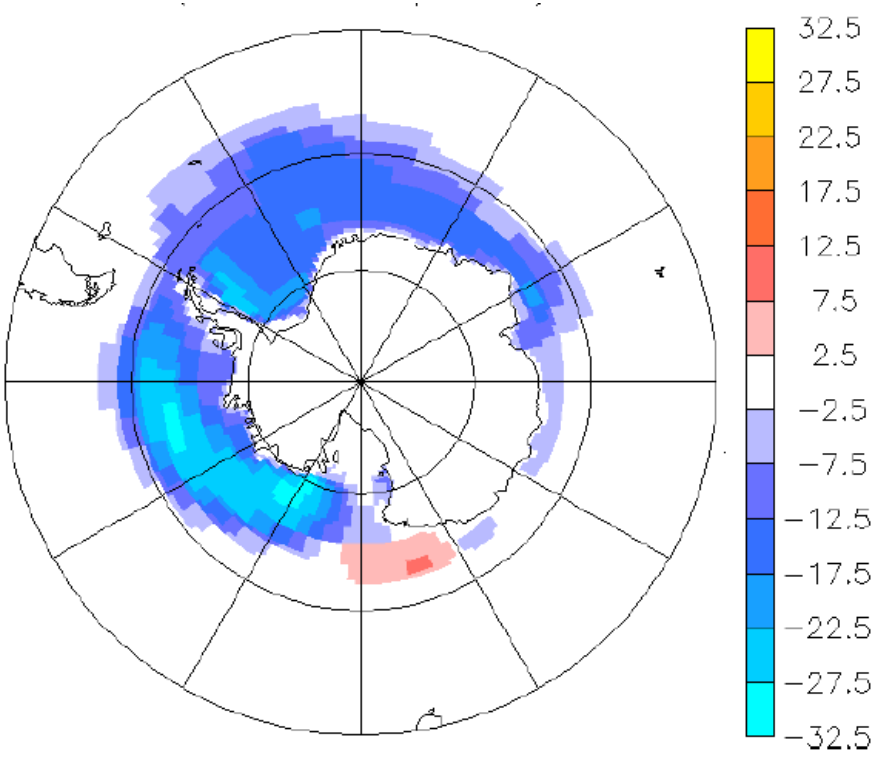
6th Antarctic Meteorological Observation, Modeling, and Forecasting Workshop, Hobart, Tasmania, Australia, 22-24 June 2011

Predicted precipitation change: LMDZ (IPSL)

Precipitation change:
2081-2100 / 1981-2000



SIC changes:
(2081-2100) - (1981-2000)

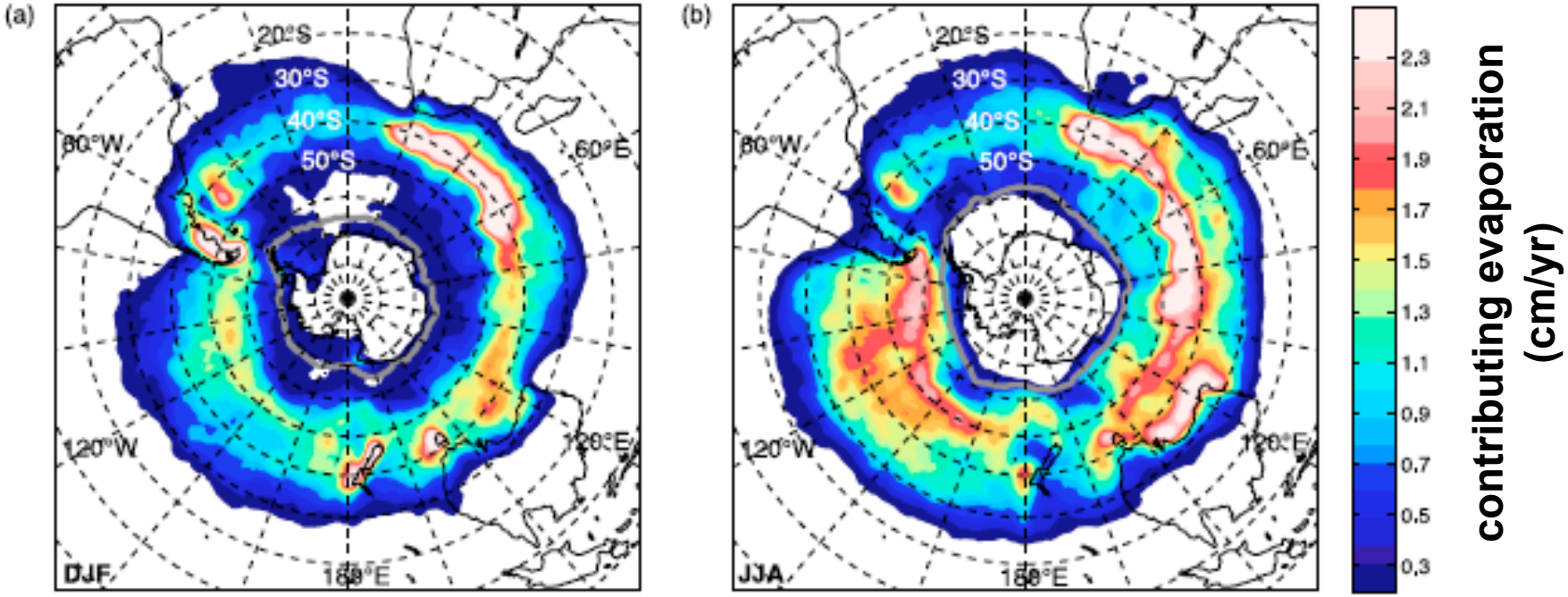


Krinner et al. 2007, 2008

Mean moisture source regions for Antarctica

Summer

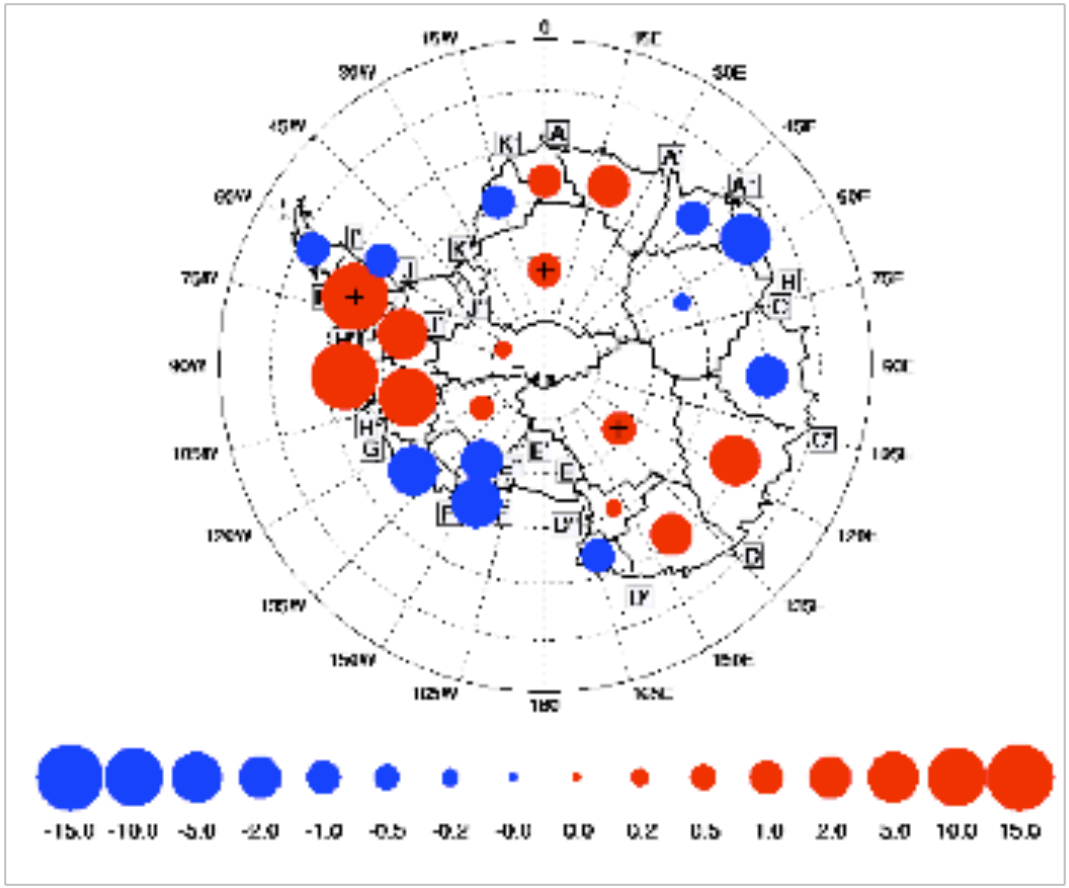
Winter



Grey line is the seasonal mean sea ice boundary
=> main moisture sources are poleward!

Changes in precipitation?

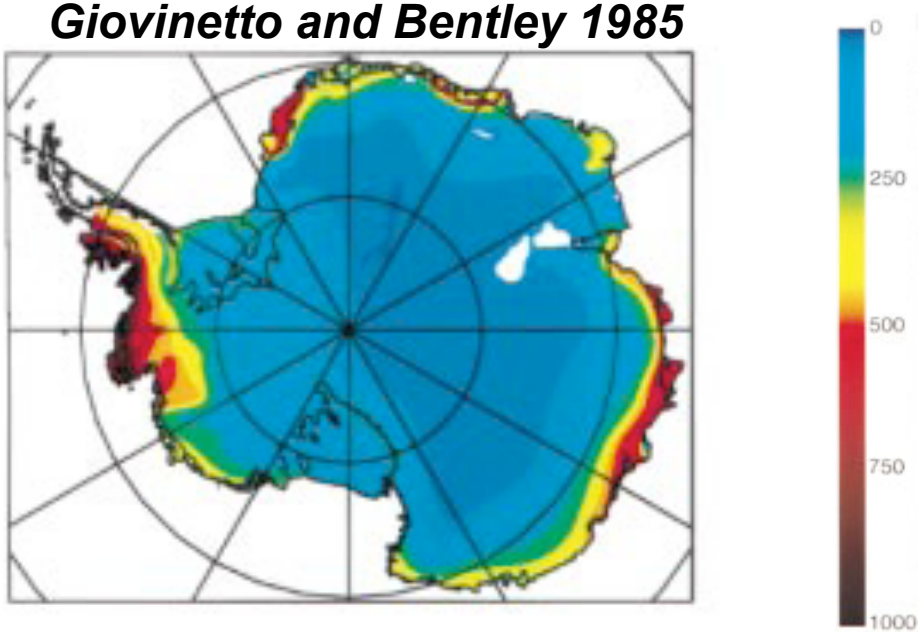
Linear trends of annual snowfall accumulation
(mm yr $^{-1}$ decade $^{-1}$) for 1955-2004



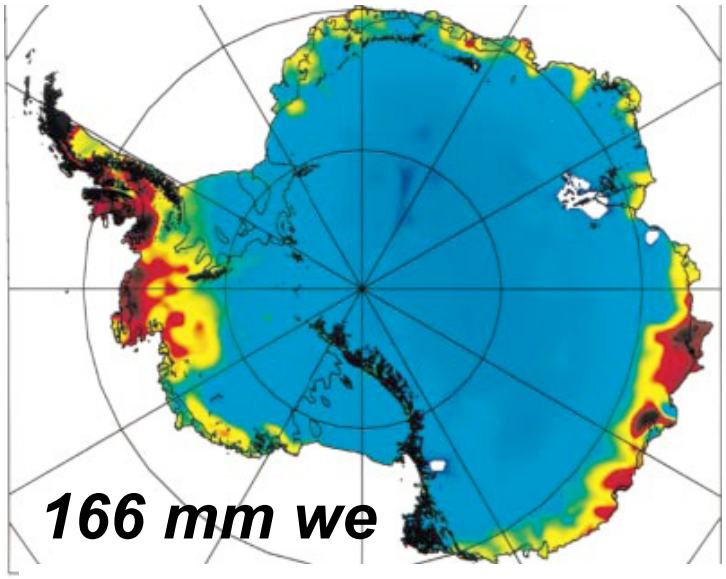
Monaghan et al 2008

SMB compilations

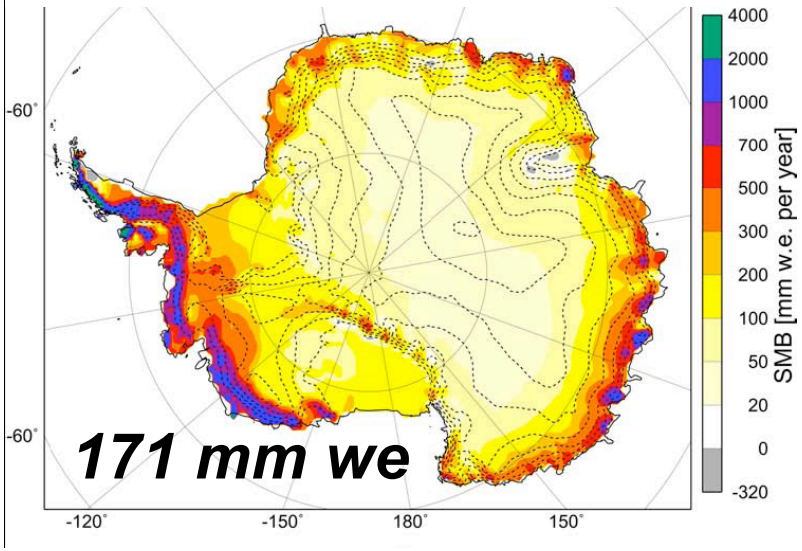
Giovinetto and Bentley 1985



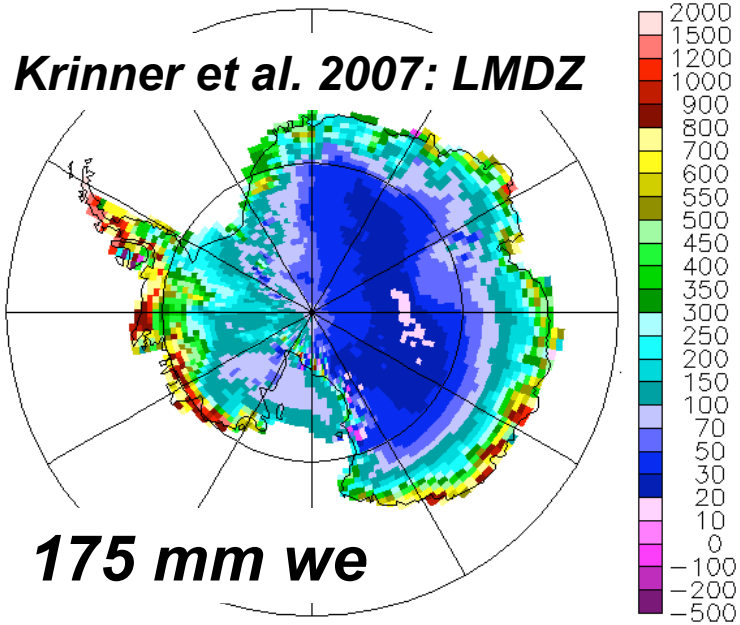
Vaughan et al. 1999



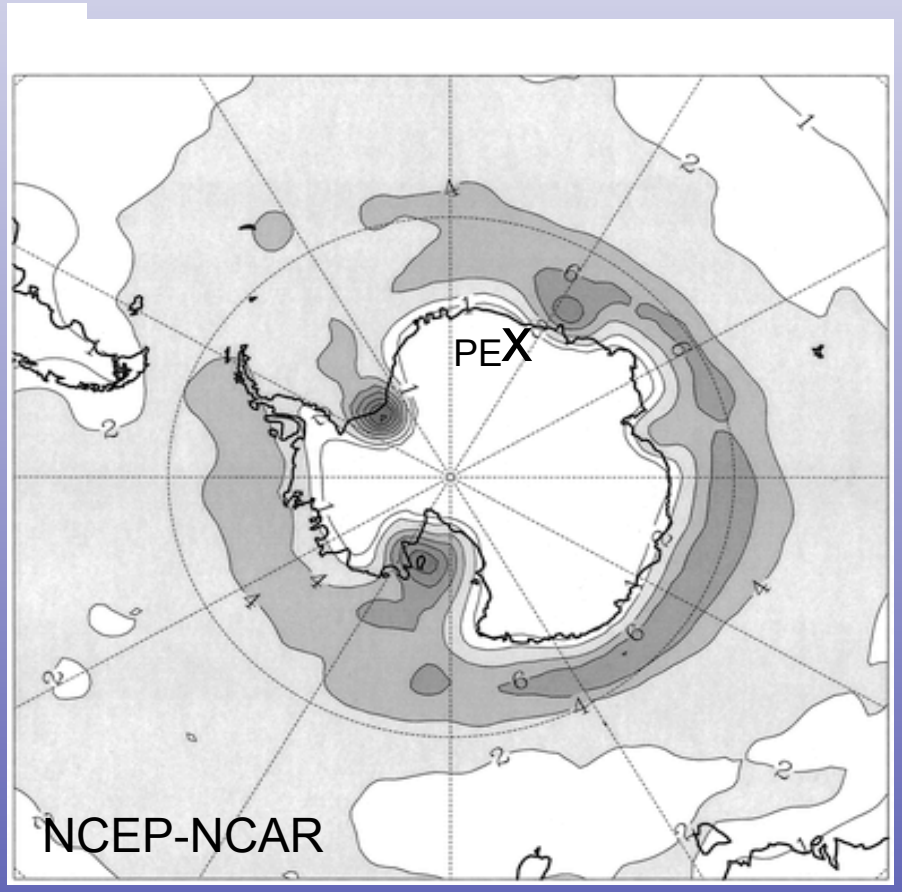
van den Berg et al. 2006: RACMO



Krinner et al. 2007: LMDZ

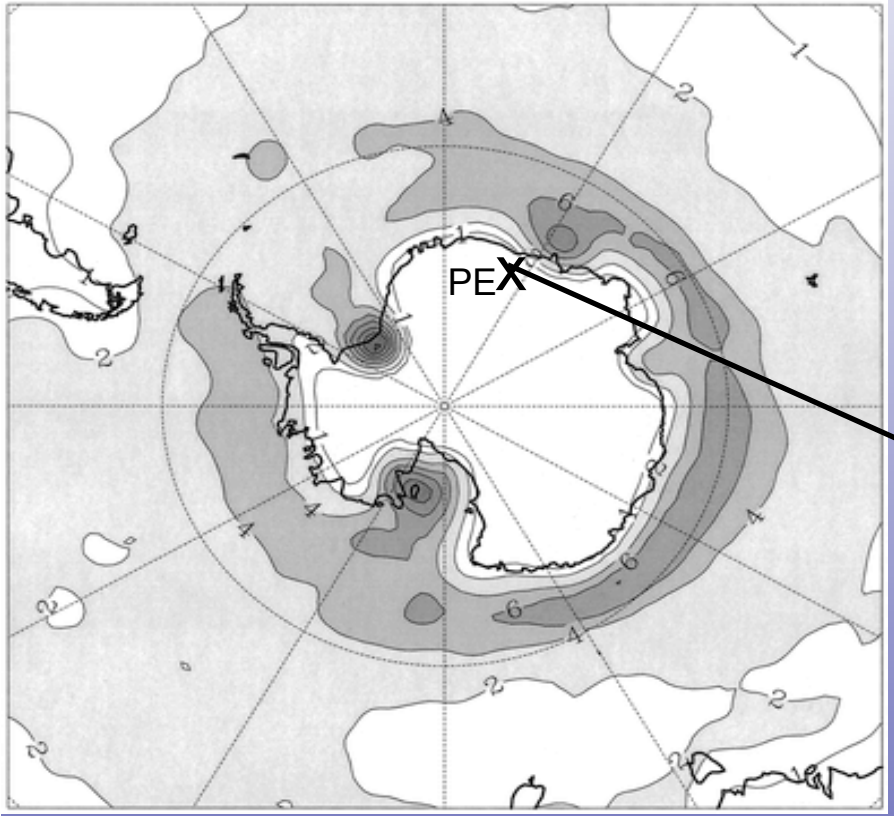


Density of cyclones in winter

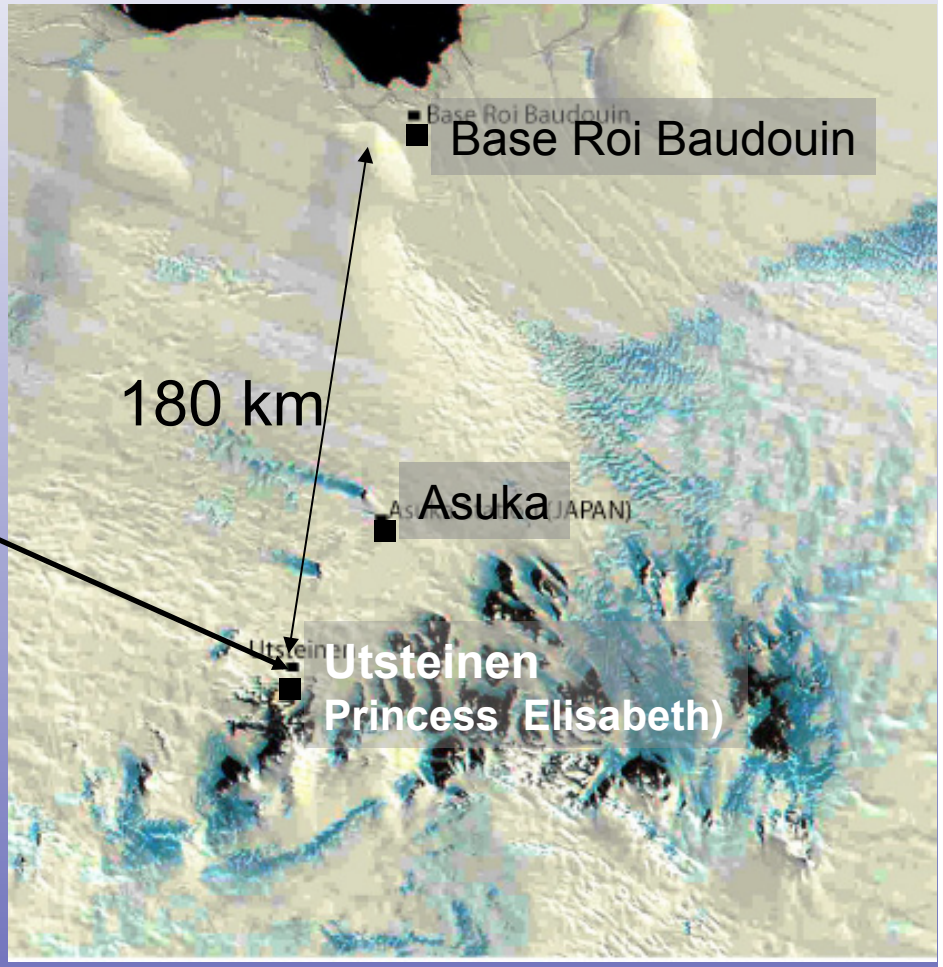


Simmonds and Keay 2000

Density of cyclones in winter

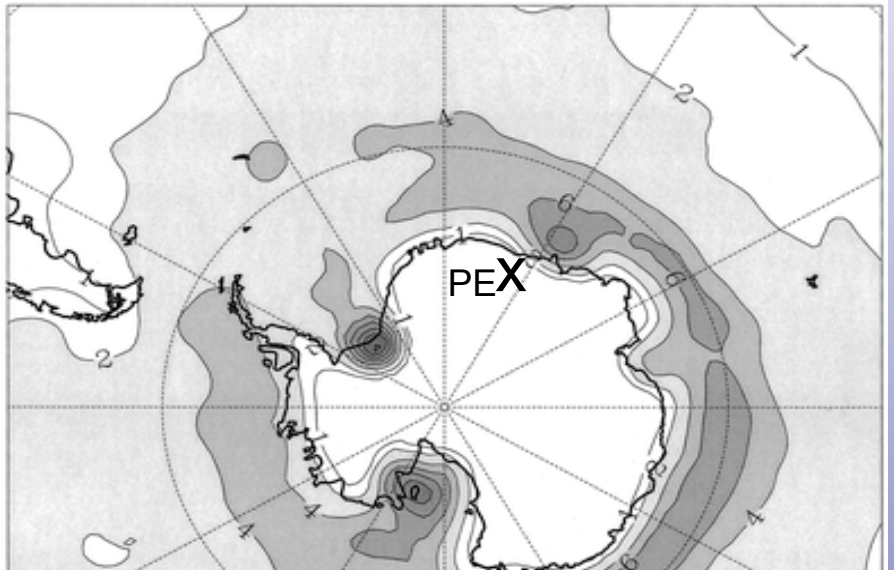


PE base location

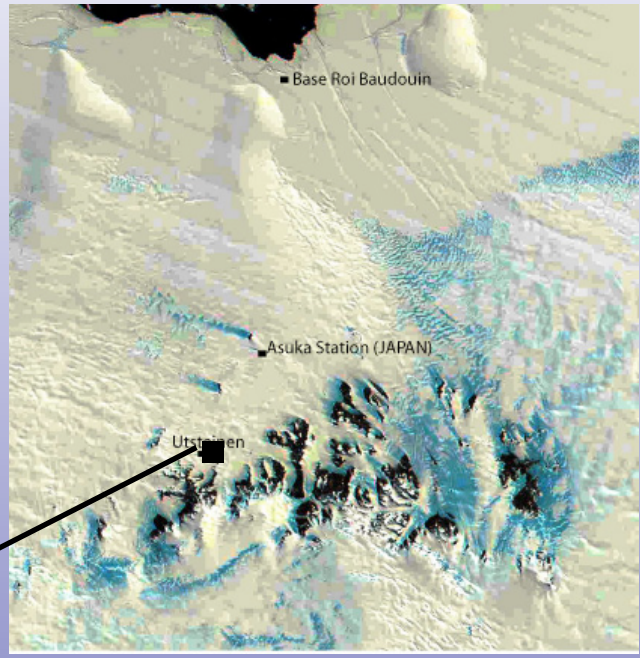


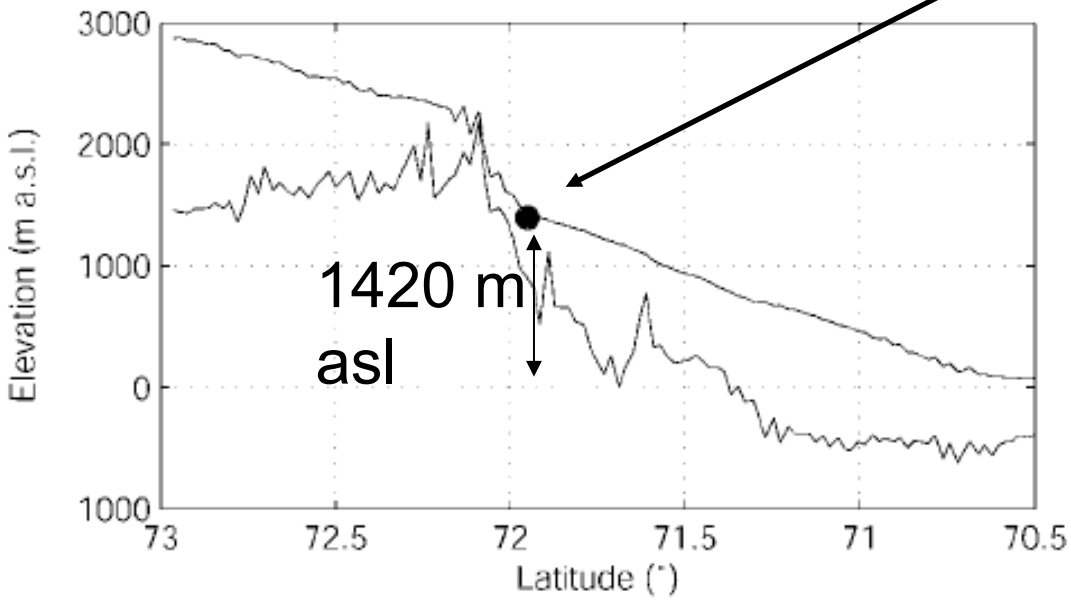
MODIS image of the Sor Rondane Mountains and station locations

Density of cyclones in winter



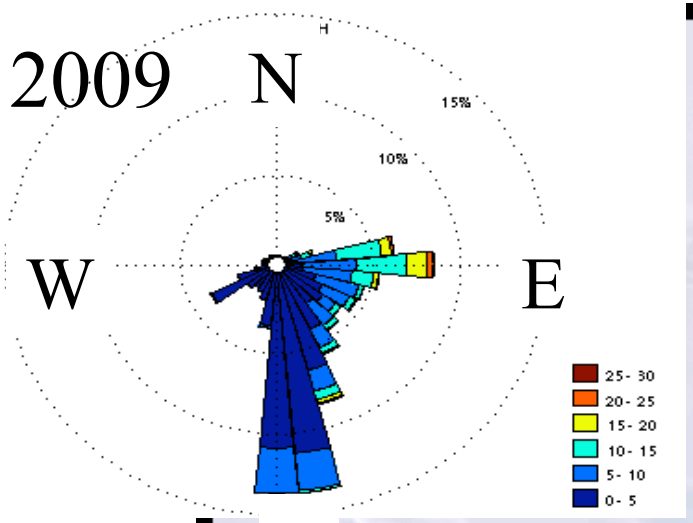
PE base location





Surface and bedrock topographic profile along the 23 E meridian

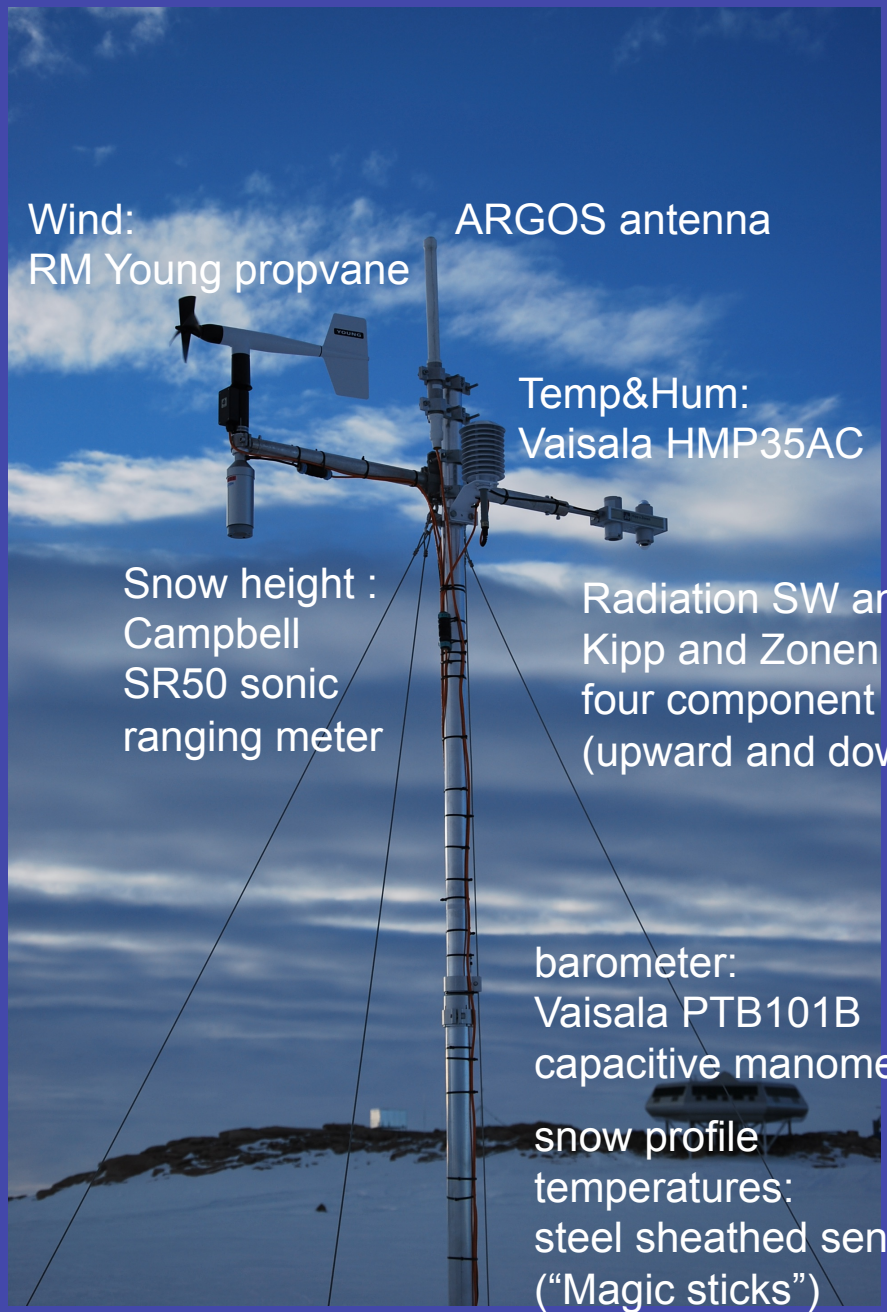
(Pattyn et al. 2009)

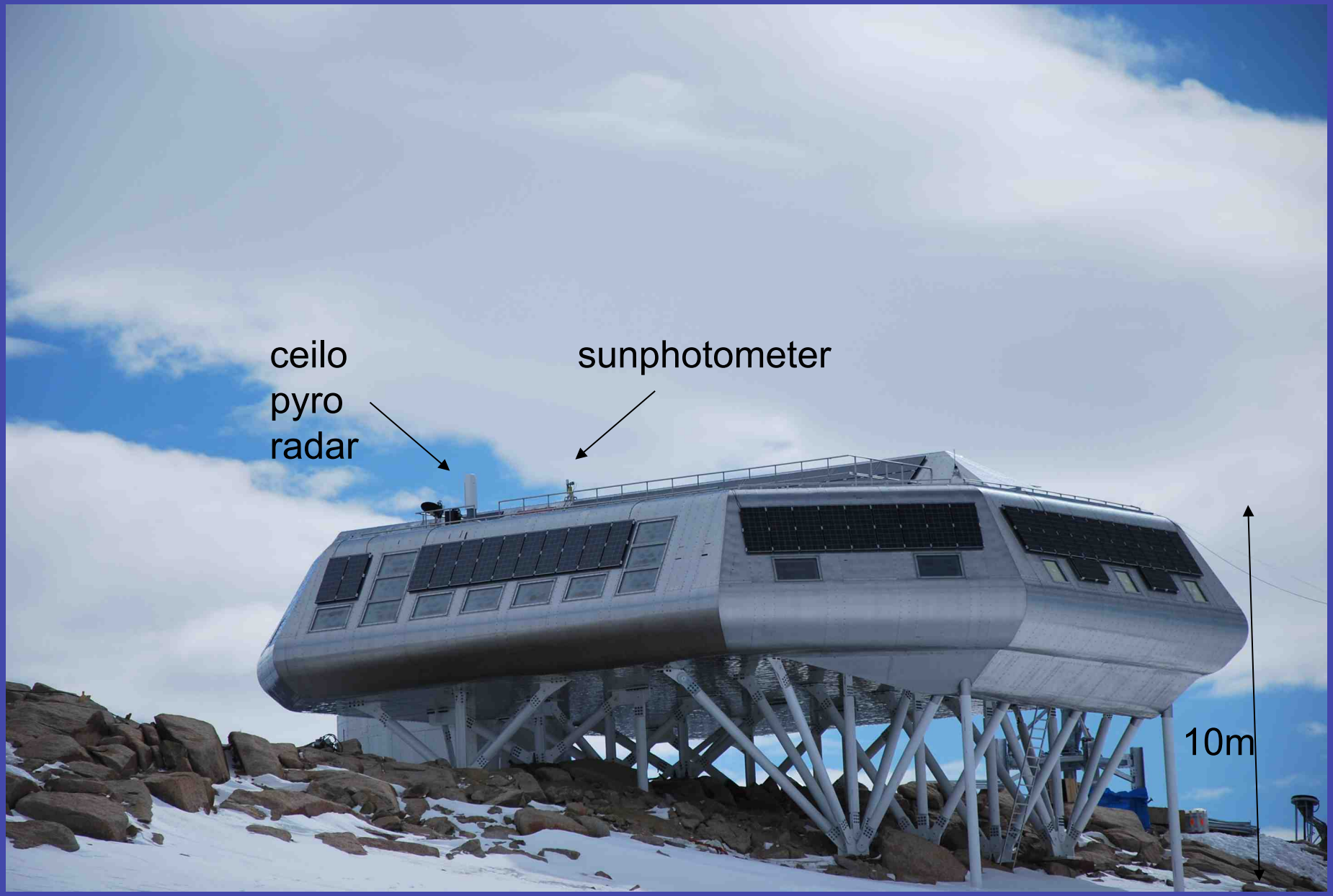

2009
N
W
E
S
15%
10%
5%
25 - 30
20 - 25
15 - 20
10 - 15
5 - 10
0 - 5

UTTNIBA
PierreBohnen
DeBreuckbreen
BRATTNIPANE
Accumulation stake line
installed in Jan 2010
DOTTEN
UTSTEINEN
AWS
Synoptic
winds
Gillockbreen
Ellisbreen
Jenningsbreen
PINGVINANE
TELTET
Duboisbreen
Ketelersbreen
VEGEN
Gunnestadbreen
DEROMFJELLET
Gjelbreen
TANNGARDEN
VIKINGHØGDA
SVINDLANDFJELLET
WALNUMFJELLET
LUNCKERYGGEN
OTTO BORCHGREVINKFJELLET
VERHEYEFJELLET
WIDERØEFFJELLET
DUFEKFJELLET
Katabatic
winds
NILS LARSENFJELLET

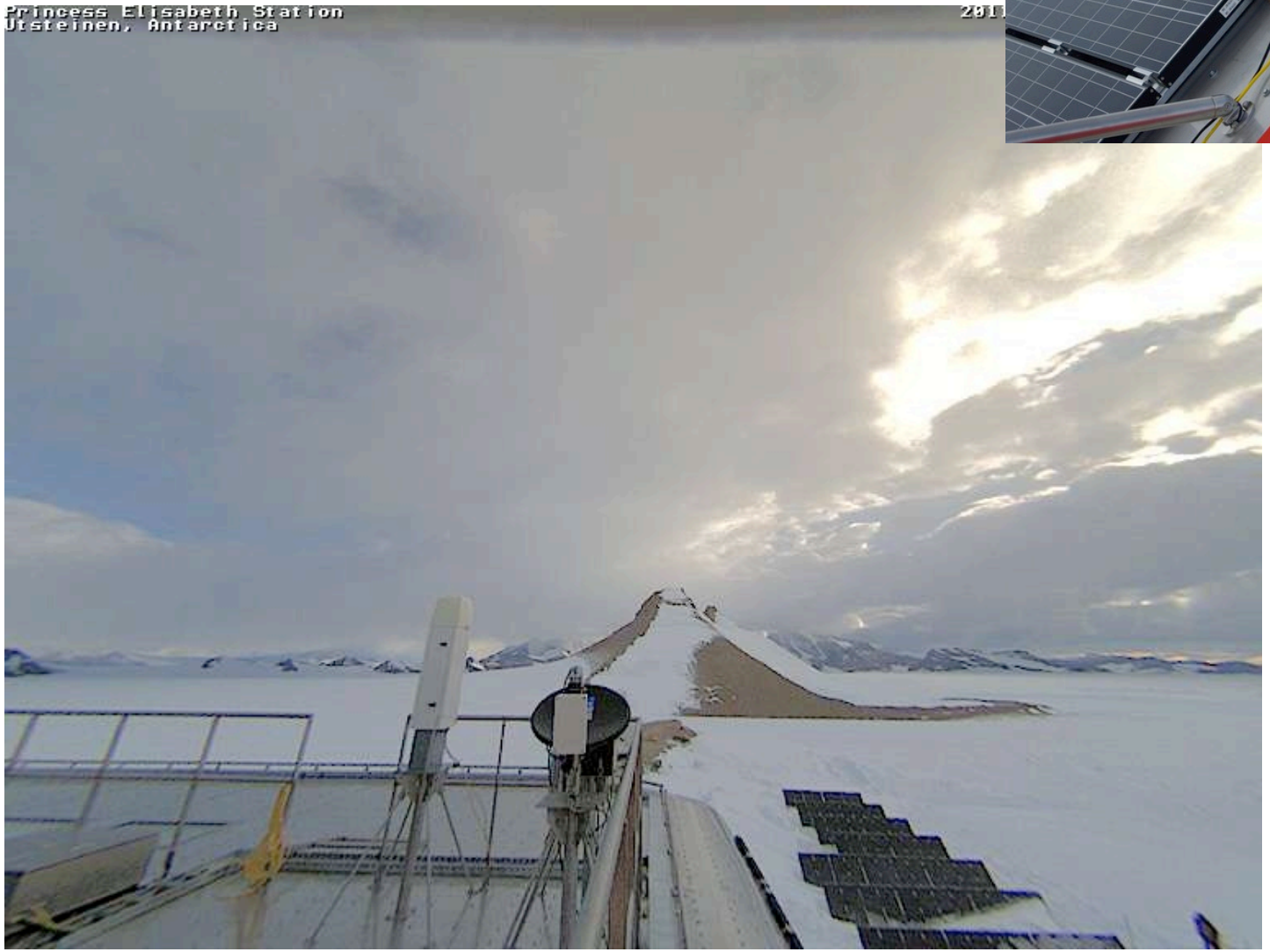
Automatic Weather Station :

- **AWS16 designed by IMAU (Netherlands)**
- **Installation: February 2009**
- **Instrument infromation and real time meteo:** http://ees.kuleuven.be/hydrant/instruments/



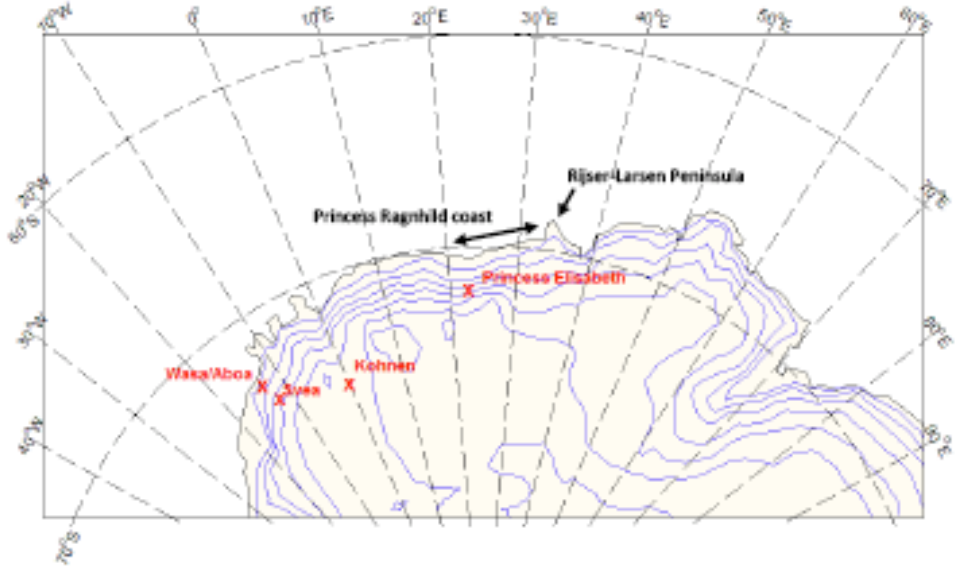

ceilo
pyro
radar
sunphotometer
10m

Webcam
(Mobotix M24M Allround L11) :



Webcam movie

Annual means Dronning Maud Land stations



Stations	Utsteinen		Wasa/Aboa	Svea	Kohnen
Observation period	Feb 2-Nov 21 **2009**	Jan 12-Dec 31* **2010**	4 Feb 1998-3 Feb 2001	14 Jan 1998-13 Jan 2002	1 Jan 1998-31 Dec 2001
Elevation, m	1420		363	1160	2892
Sfc slope, m/km	9		13.5	15	1.3
Air Temp (K)	254.0	253.7	254.9	250.2	228.8
RH (%)	61	48	83	78	93
Specif humidity, g/kg	0.58	0.52	1.01	0.72	0.17
Wind speed, m/s	5.3	4.6	7.8	7.7	4.8
Total accum,	**235**	**26***	**179**	**267**	**74**

Annual means for Dronning Maud Land stations

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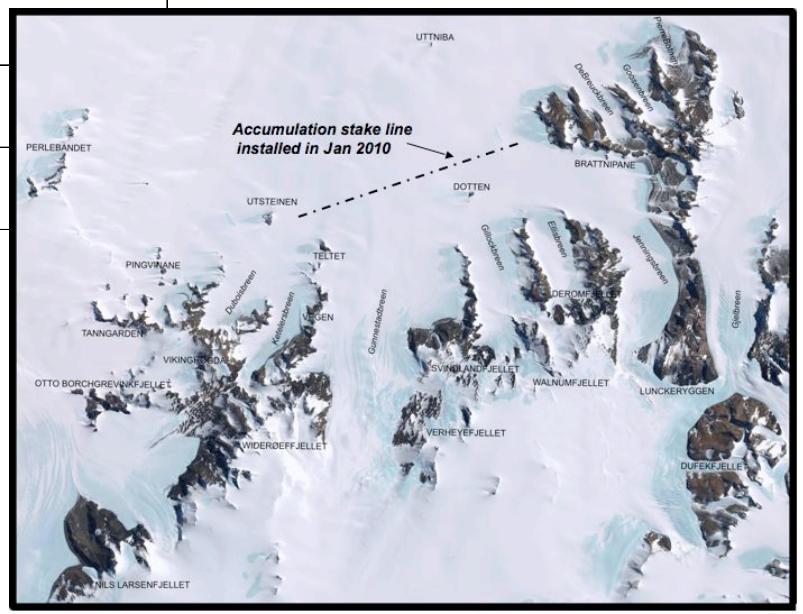
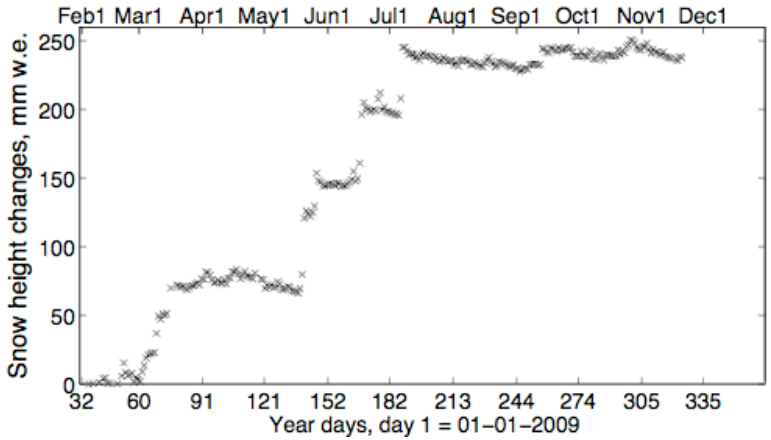
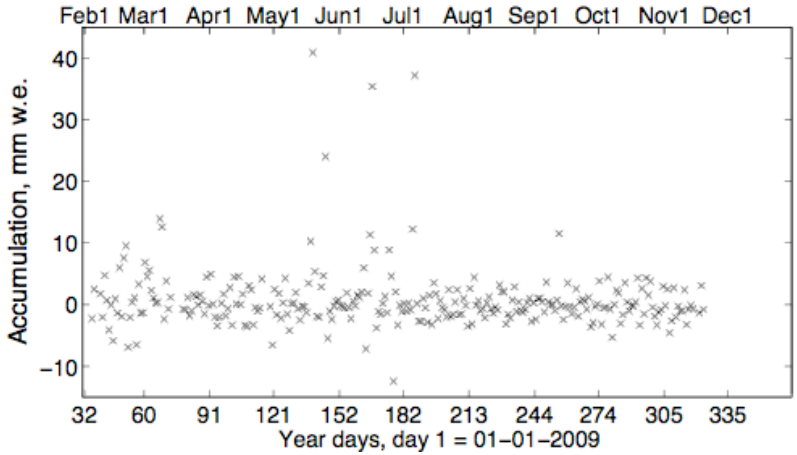
Traverse PE-Brattnipane:
mean = 6.1 mm we
(Jan 2010-Jan 2011)



Daily snow height and accumulation at Utsteinen:

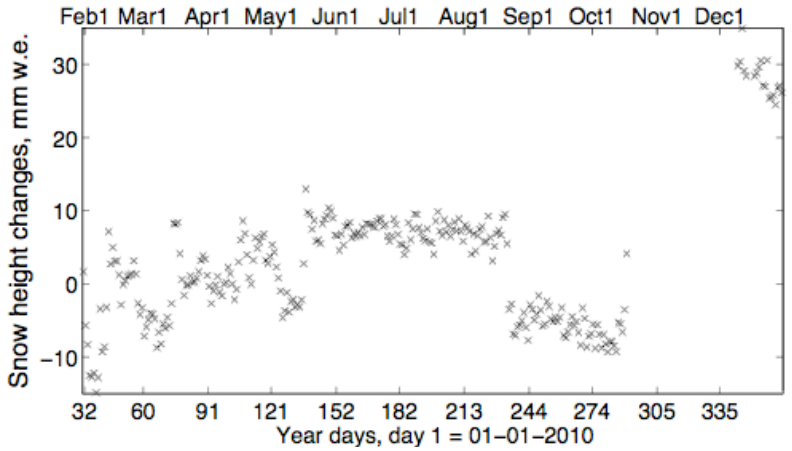
2009

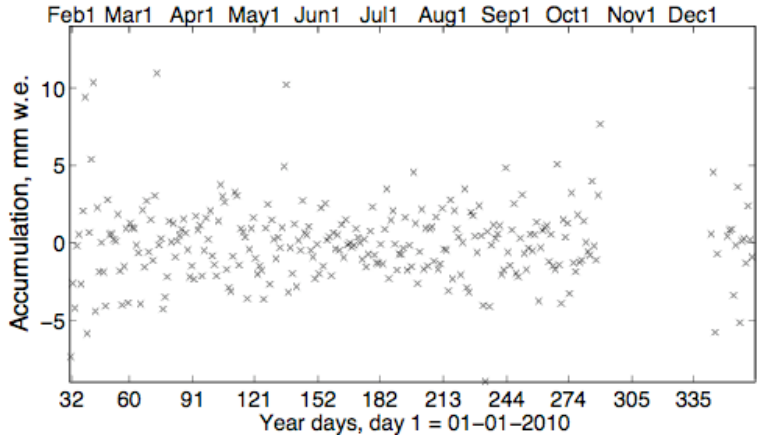




85 % days: ≤5 mmwe/day=>43% tot Acc
13% days: > 5 mmwe/day=>56% tot Acc
(**most is due to >10 mmwe/day**)

2010





46% days: < 1 mmwe/day=>13% tot Acc
48% days: 1-5 mm we/day => 60% tot Acc
+ data gap

Meteorological regimes from multivariate cluster analysis

Variables use for cluster analysis:

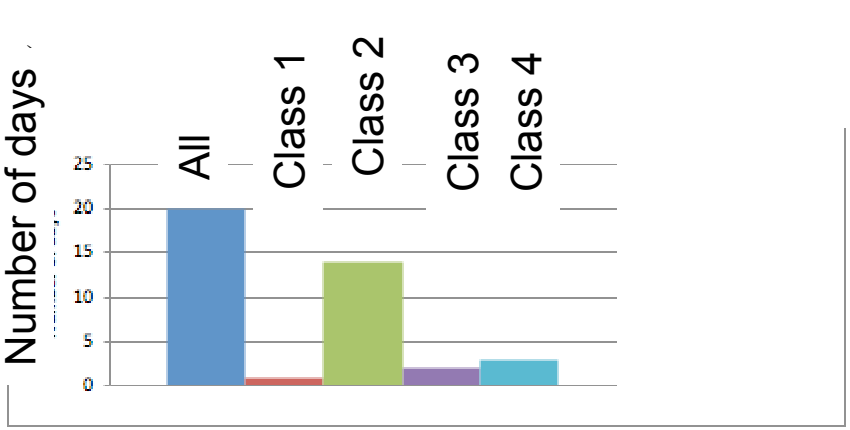
- **Temp inversion**
- **Specific humidity**
- **Wind speed**
- **LW down flux**
- **Pressure**

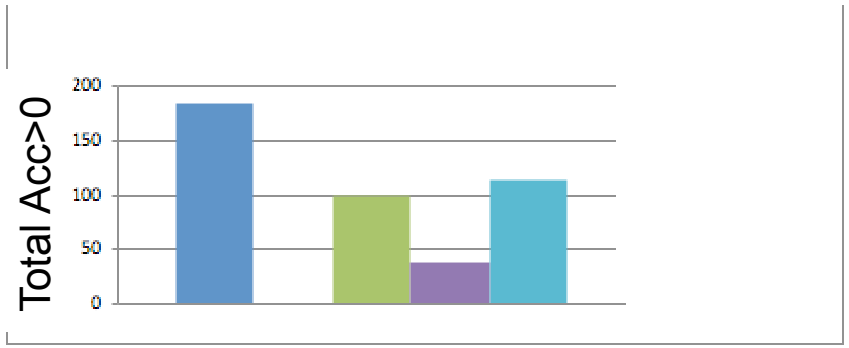
Variables	2009			2010		
	Warm	Transit	Cold	Warm	Transit	Cold
T air (K)	258	256	251	262	249	251
RH (%)	92	69	43	67	48	36
q, g/kg	1.2	0.7	0.3	1.2	0.3	0.2
Wind speed, m/s	12	5	3	6	6	3
Wind dir	97	143	180	122	148	177
LW down, W/m^2	228	188	135	213	140	138
$\sum dH$, mm w.e.	184	-51	36	-13	-26	31
$\sum dH > 0$, mm w.e.	251	205	109	77	52	103
$\sum dH < 0$, mm w.e.	-67	-257	-73	-90	-78	-72

Amount of positive accumulation by daily accumulation classes:

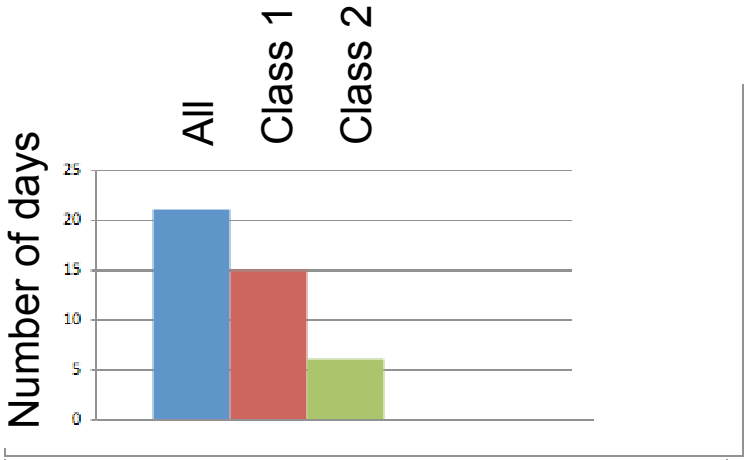
class 1 = 0-4
class 2 = 4-17
class 3 = 17-33
class 4 = > 33

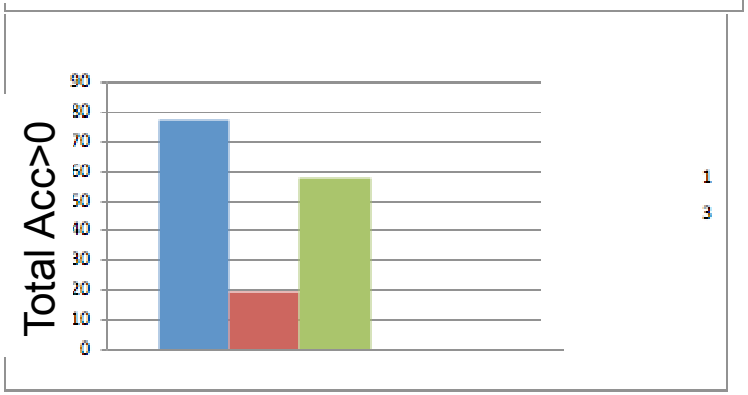
mmwe/day





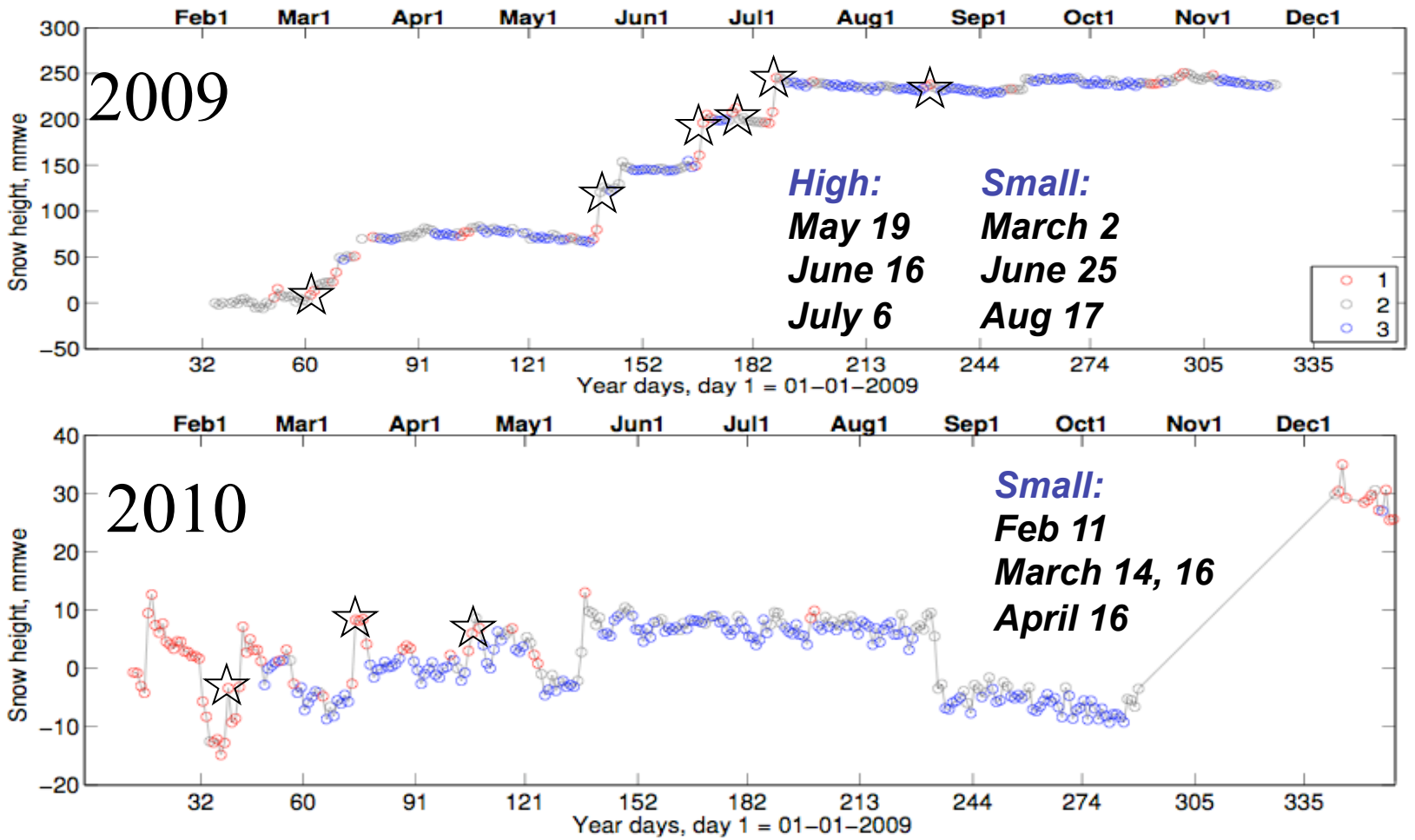
2009





2010

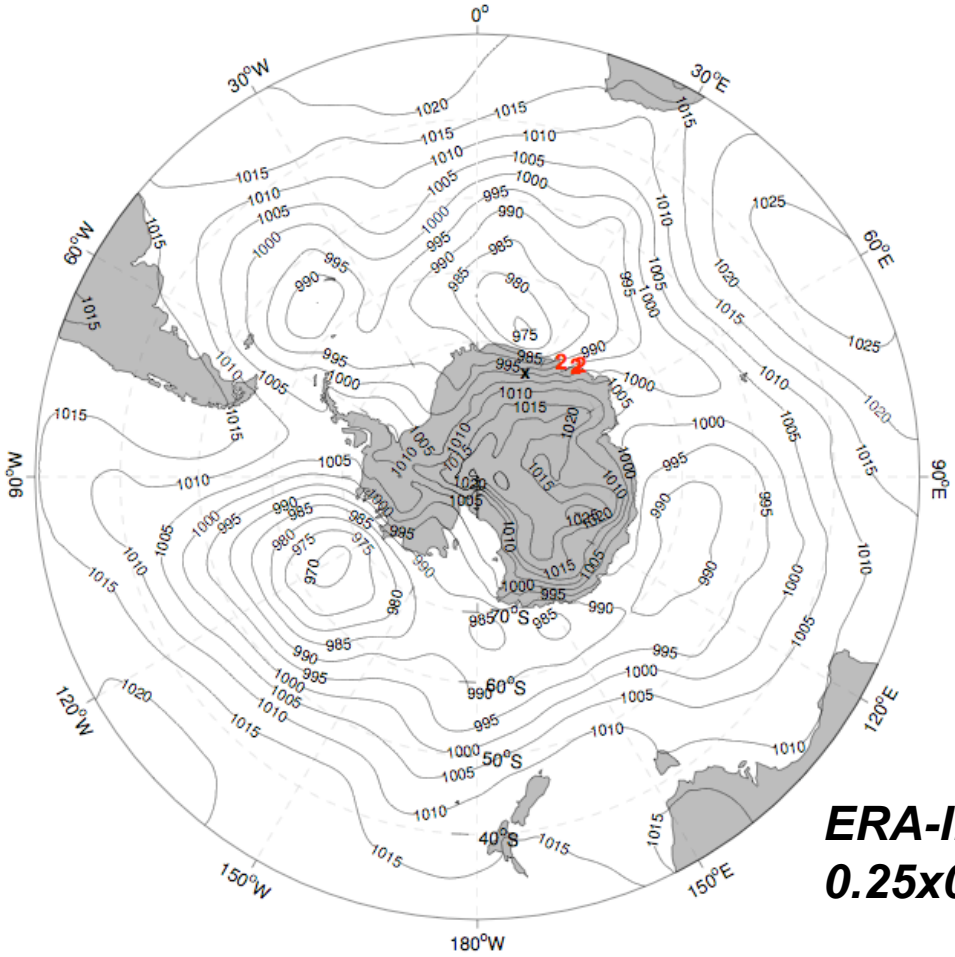
Snow height changes by met regimes



☆ : warm events analyzed

Mean sea level pressure composites for SMALL accumulation events

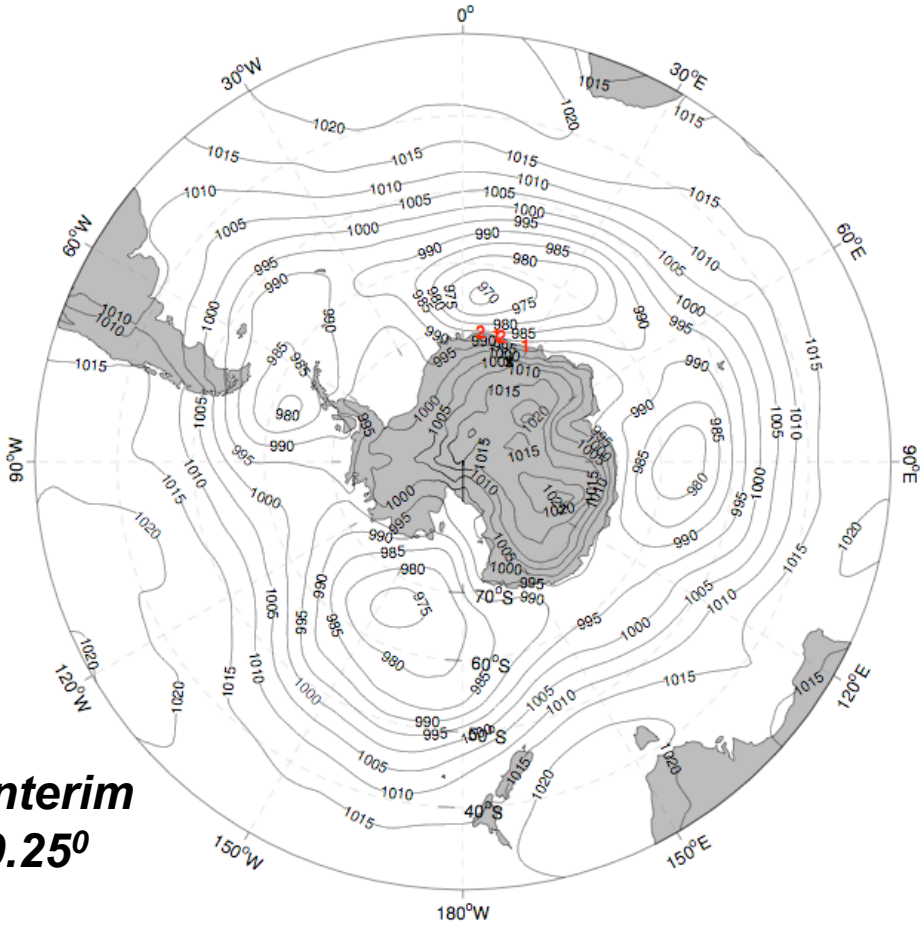
2009



3 day average

ERA-Interim
0.25x0.25⁰

2010

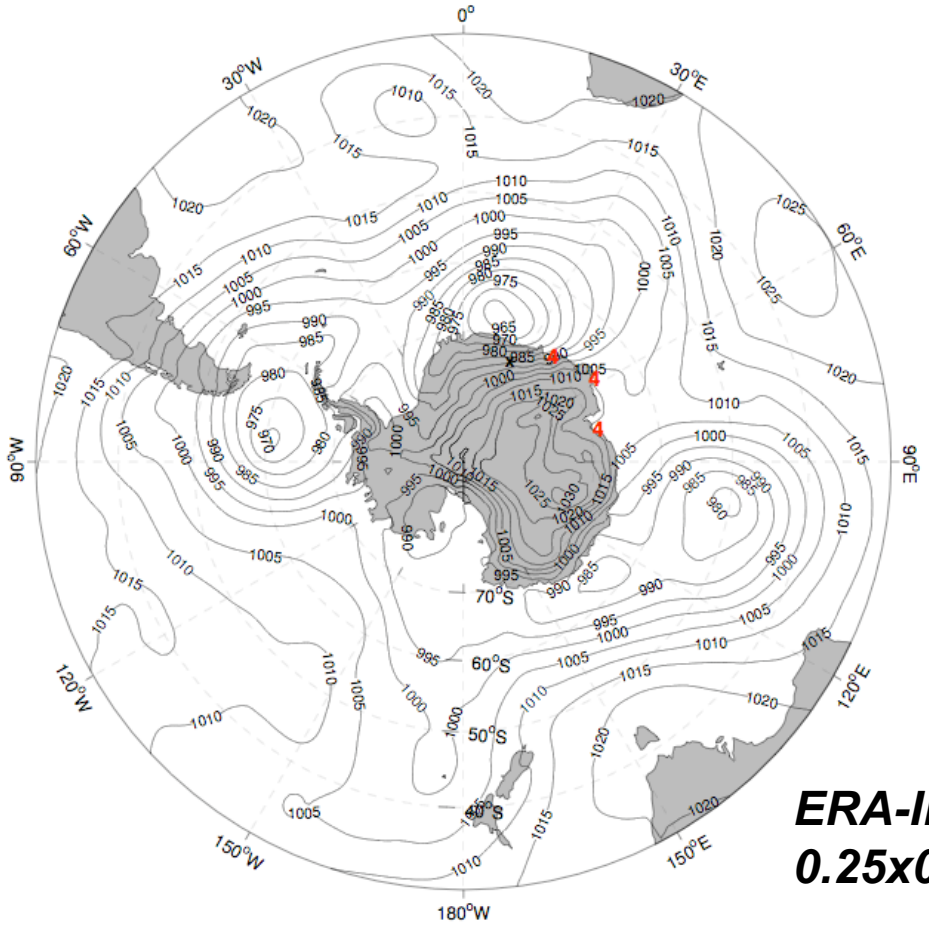


4 day average

Mean sea level pressure composites

HIGH accumulation events

2009

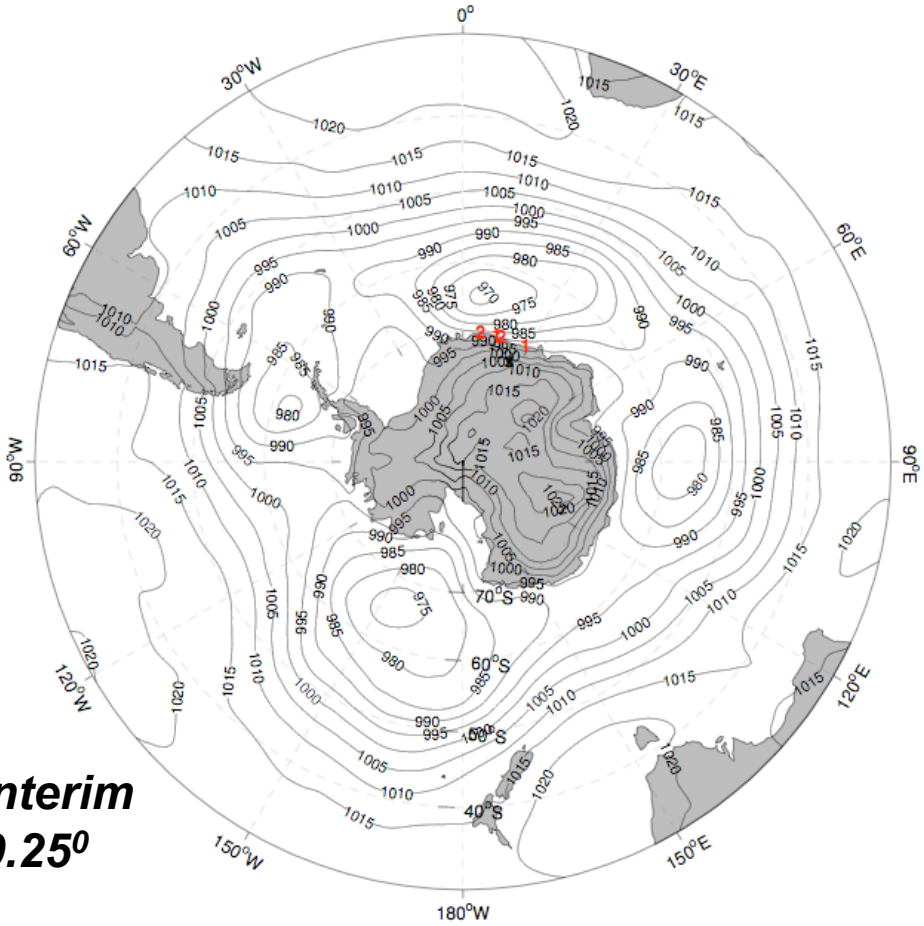


3 day average

ERA-Interim
0.25x0.25⁰

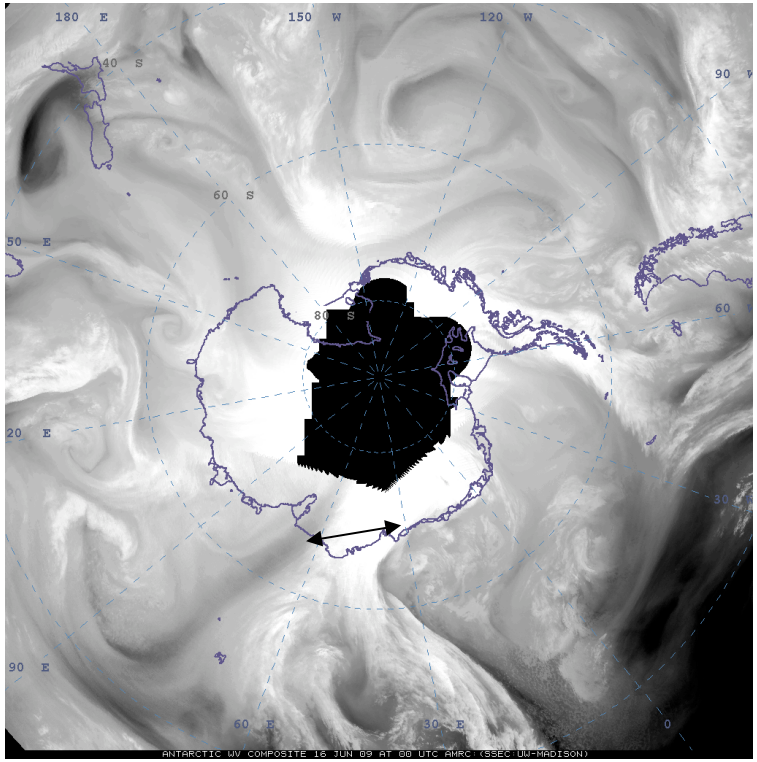
SMALL accumulation events

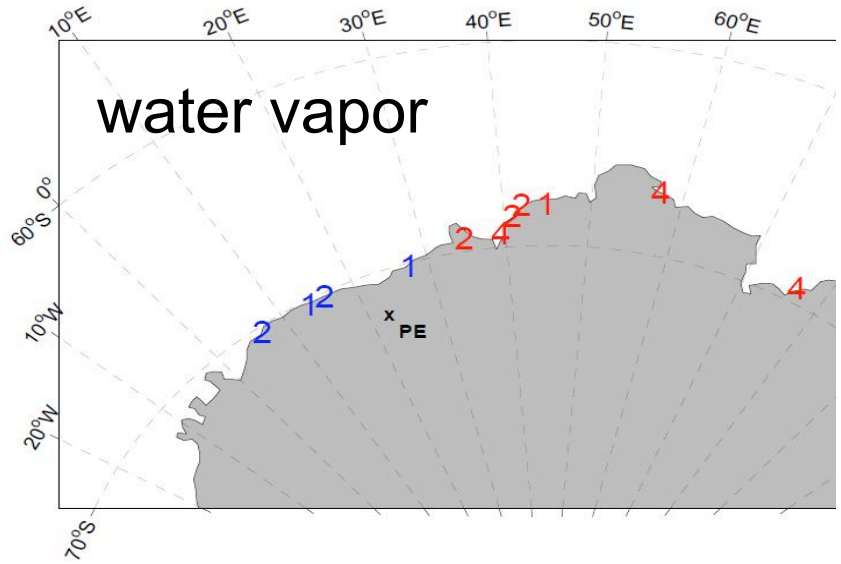
2010

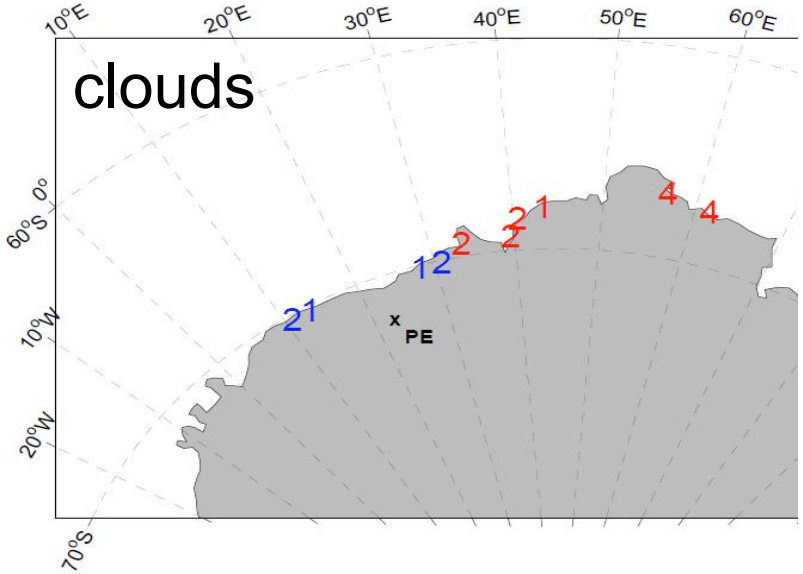


4 day average

Water vapor and cloud inflow meridian: satellite map analysis 2009-2010







Water vapor channel composite images every 1-3 hours from U Wisconsin-Madison (many thanks to Matt Lazzara and Elena Wilmott for providing the maps)

Isentropic analysis for selected positive accumulation days during warm events

1. High accumulation:

May 19, 2009: 40 mmwe/day

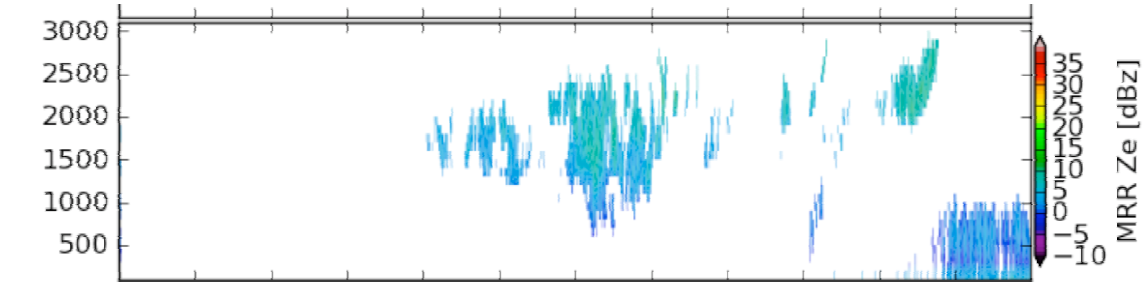
2. Small accumulation:

March 14, 2010: 10 mmwe/day

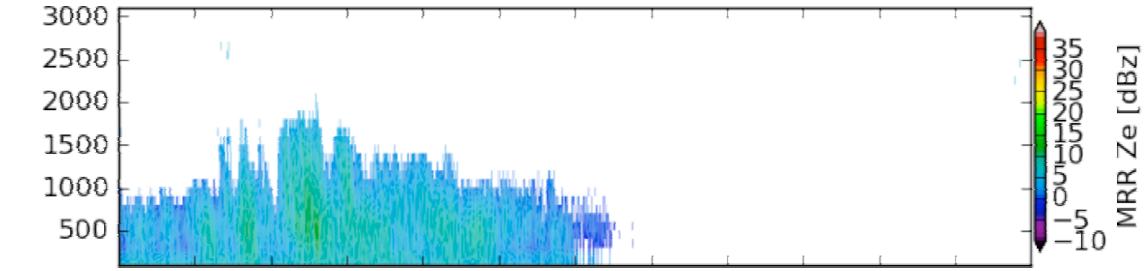
March 16, 2010: 0.3 mmwe/day

Radar reflectivities: during March 14-15, 2010

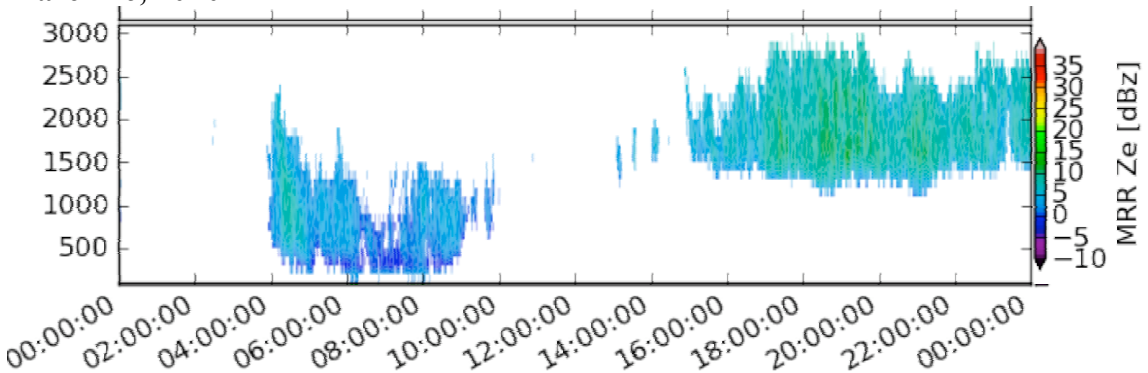
March 14, 2010



March 15, 2010

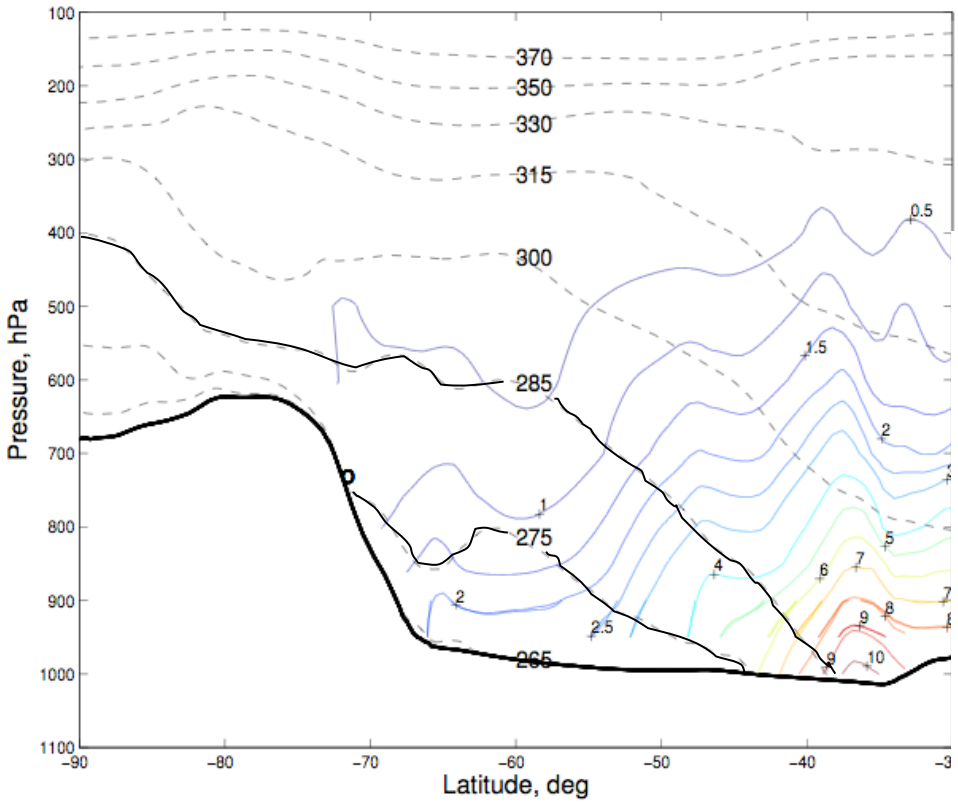


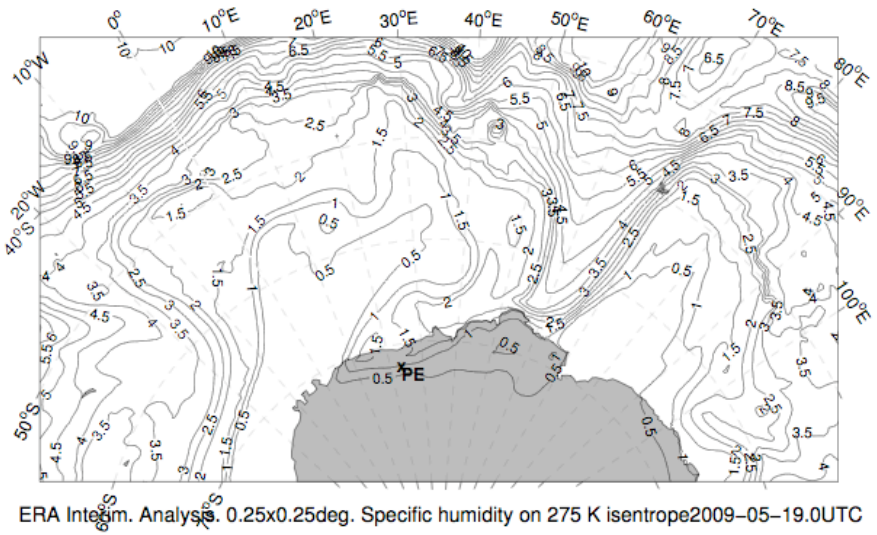
March 16, 2010

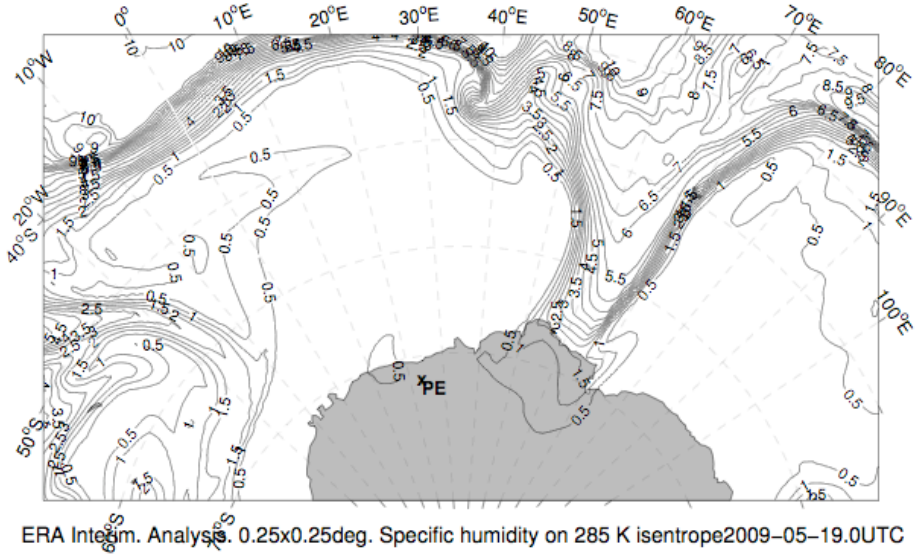


ERA-Interim

Isentropic analysis for HIGH accumulation event (may 19, 2009)





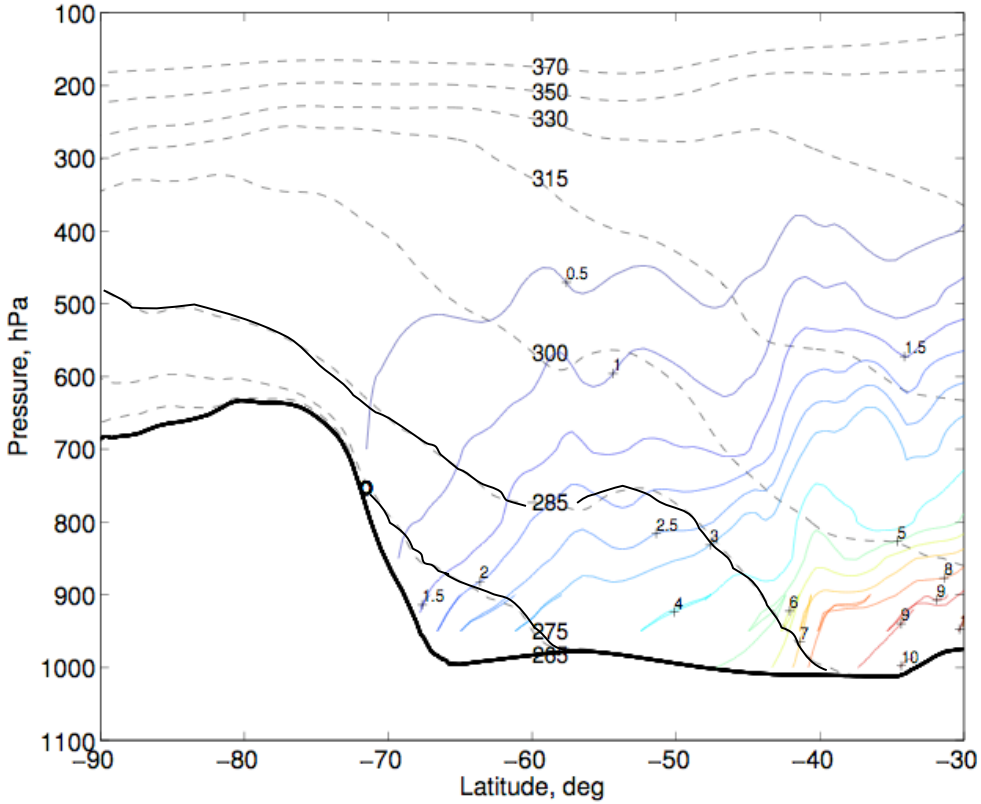


Mean meridional cross-section (20-60^{0}E) of isentropic surfaces with specific humidity color contours

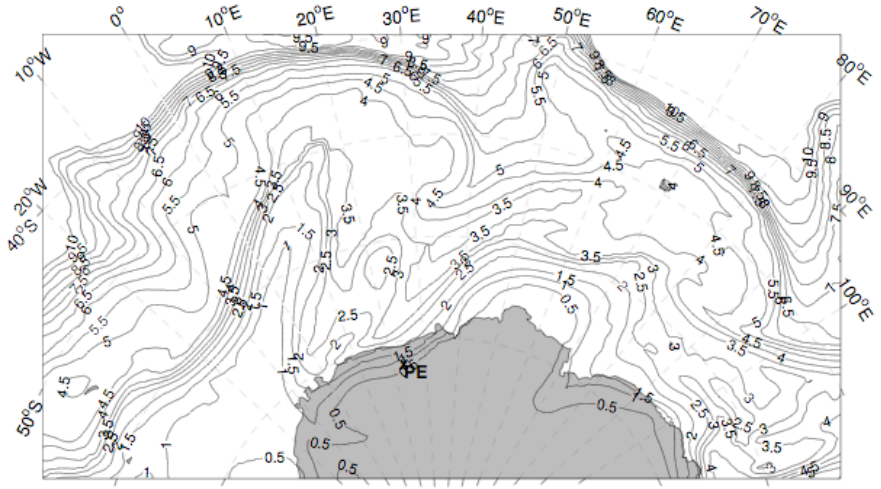
Specific humidity on 275K and 285K isentropic surfaces

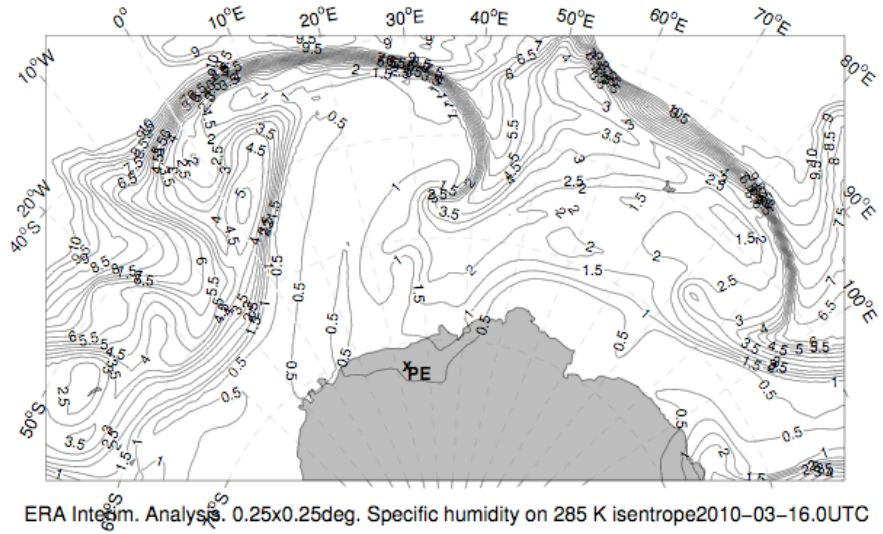
ERA-Interim

Isentropic analysis for LOW accumulation event (march 16, 2010)



Mean meridional cross-section (20-60^{0}E) of isentropic surfaces with specific humidity color contours

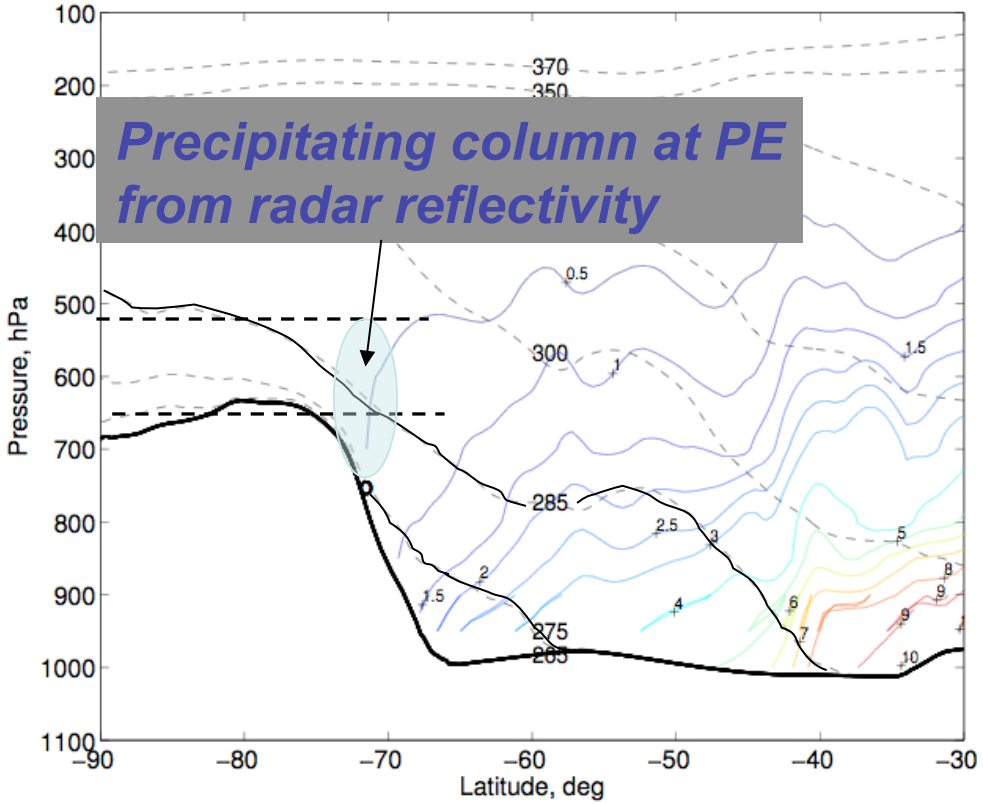


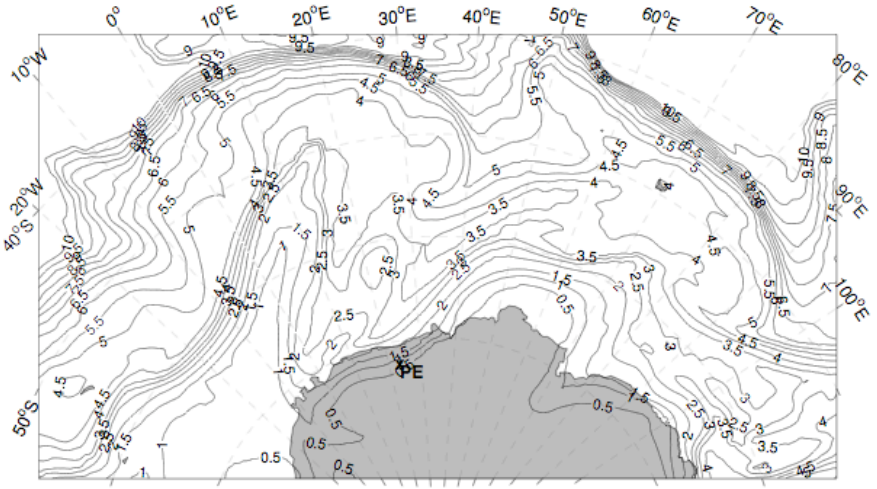


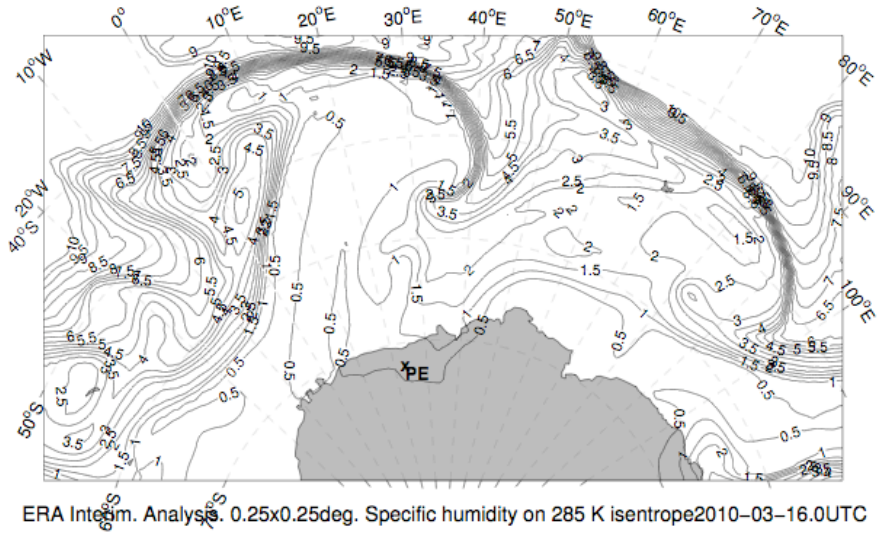
Specific humidity on 275K and 285K isentropic surfaces

Isentropic analysis for LOW accumulation event (march 16, 2010)

ERA-Interim







Mean meridional cross-section (20-60^{0}E) of isentropic surfaces with specific humidity color contours

Specific humidity on 275K and 285K isentropic surfaces

Conclusions

- **The two years of observations at the Princess Elisabeth station in Dronning Maud Land showed drastic differences in accumulation amounts (235 mmwe & 26 mmwe)**

- **The steering of the atmospheric dynamics and the flow energetics, rather than the origins of moisture, determine the amount of precipitation at the ascent to the East Antarctic plateau in Dronning Maud Land**

- **The location of the new observatory in Dronning Maud Land is very relevant for model validation being on the edge of the moisture penetration during the most energetic flows**

Thank you!

For your attention and
(hopefully! very much needed!)
feedback

and also to everyone who has been helping on the way
with field work, data and advice:
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