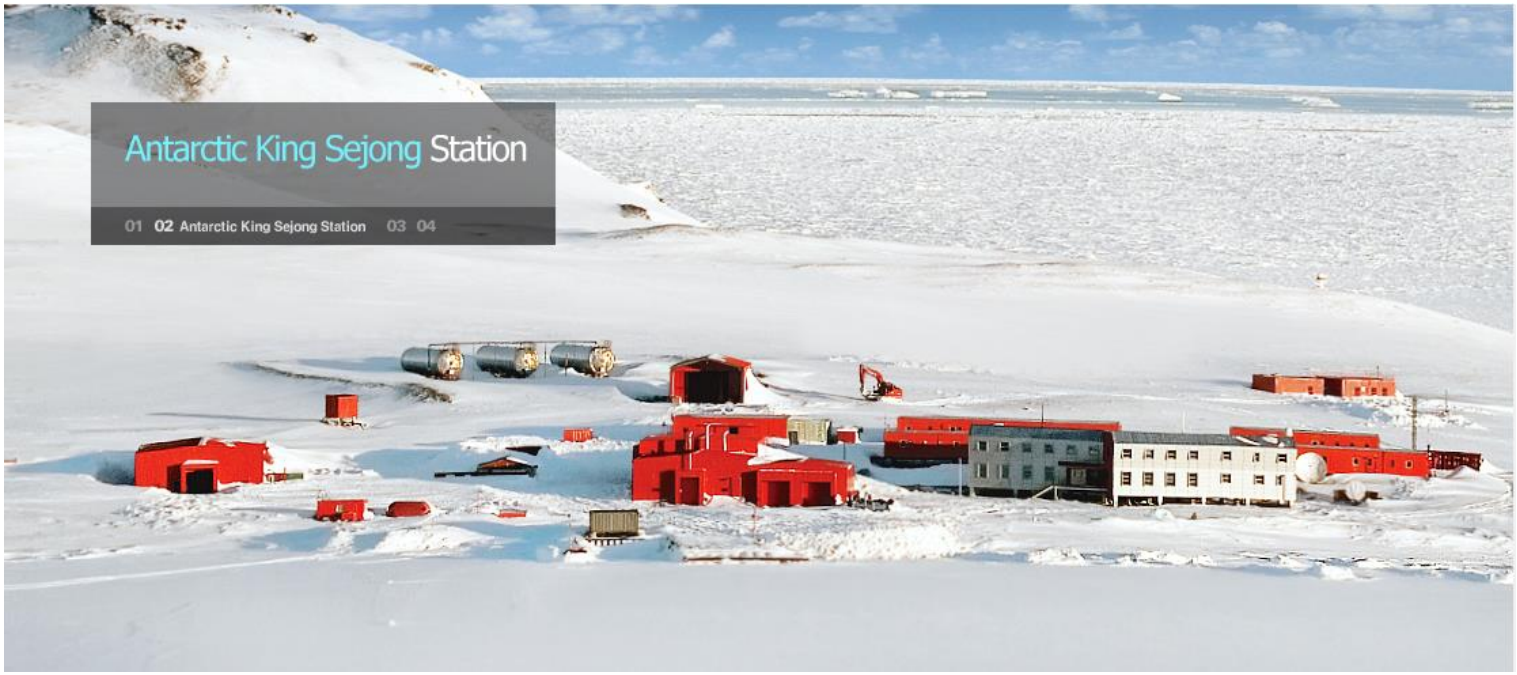
A Numerical Simulation of Blizzard caused by Polar Low at King Sejong Station, Antarctica

Hataek Kwon, Sang-Jong Park, Solji Lee, Seong-Joong Kim and Baek-min Kim

Division of Polar Climate Change Research, Korea Polar Research Institute



[http://eng.kopri.re.kr/index_12.jsp]

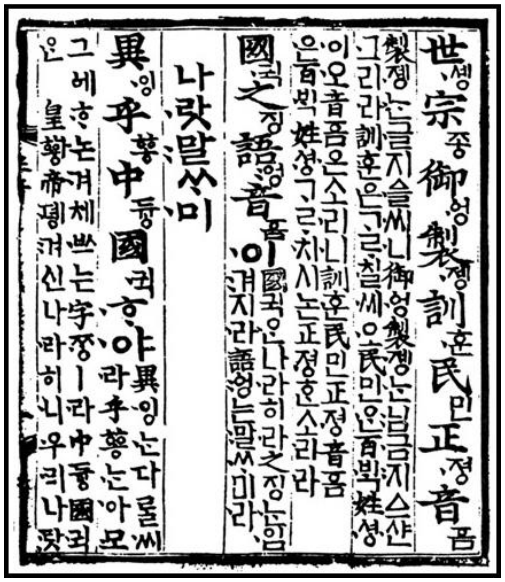
King Sejong Station

http://www.kopri.re.kr/home/contents/m_1115000/view.cms

Sejong the Great

https://en.wikipedia.org/wiki/Sejong_the_Great

King Sejong



Hangul : native phonetic alphabet system for the Korean language

Cheugugi : the world's first rain gauge (1442)

Blizzard at KSJ Station on 7 Jan 2013

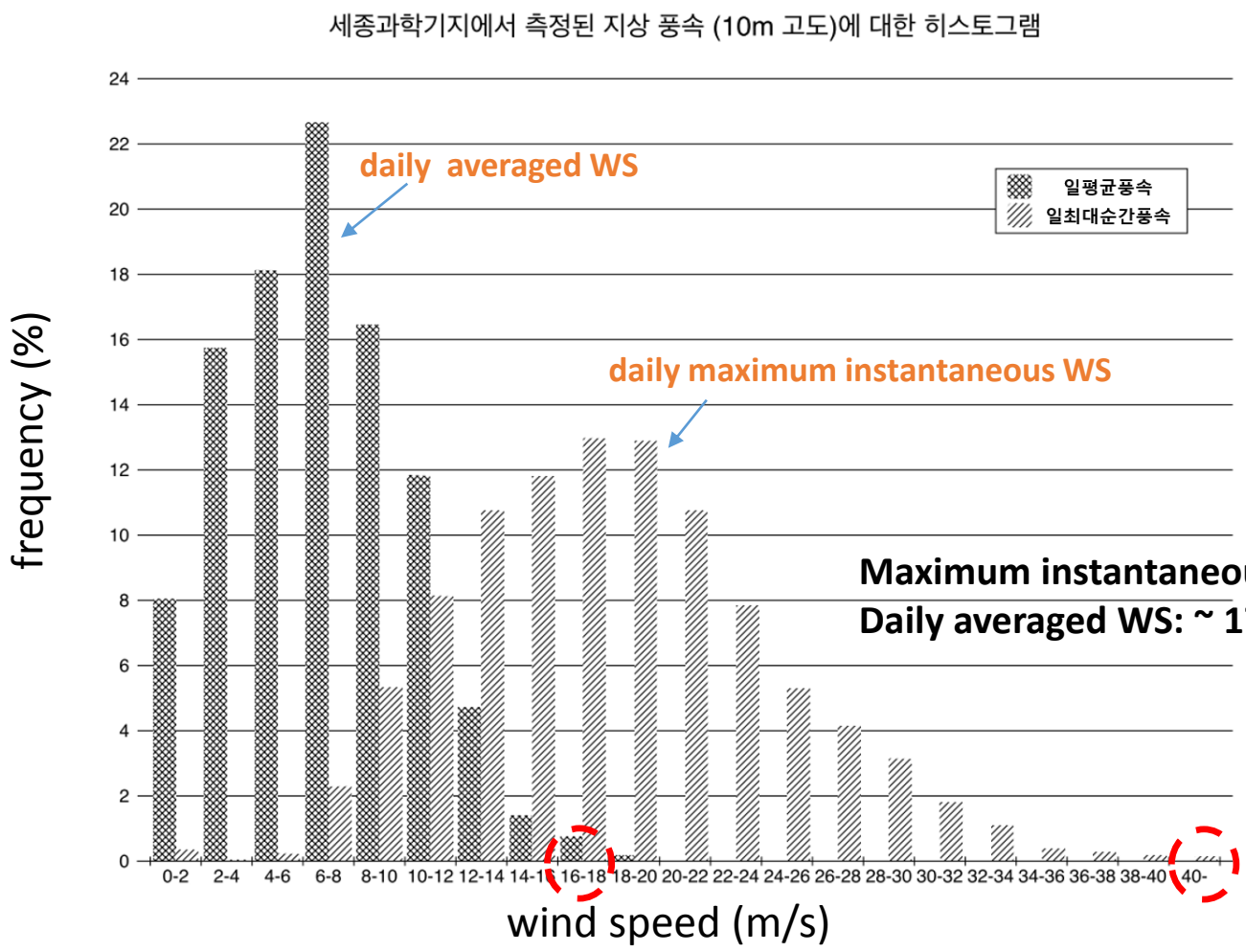
Maximum instantaneous wind speed: ~42 m/s
Daily averaged wind speed: ~ 17 m/s

Courtesy of B-M Kim

- How much is it strong?
- What caused this kind of strong Blizzard??

How much is it strong?

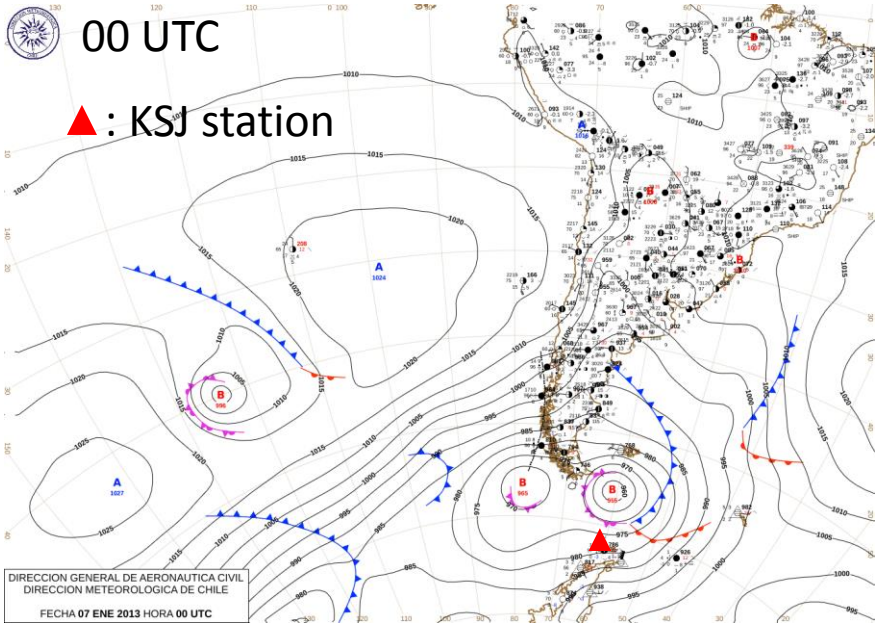
Frequency distribution of daily averaged 10m WS and daily maximum Instantaneous 10m WS (2005-2013)



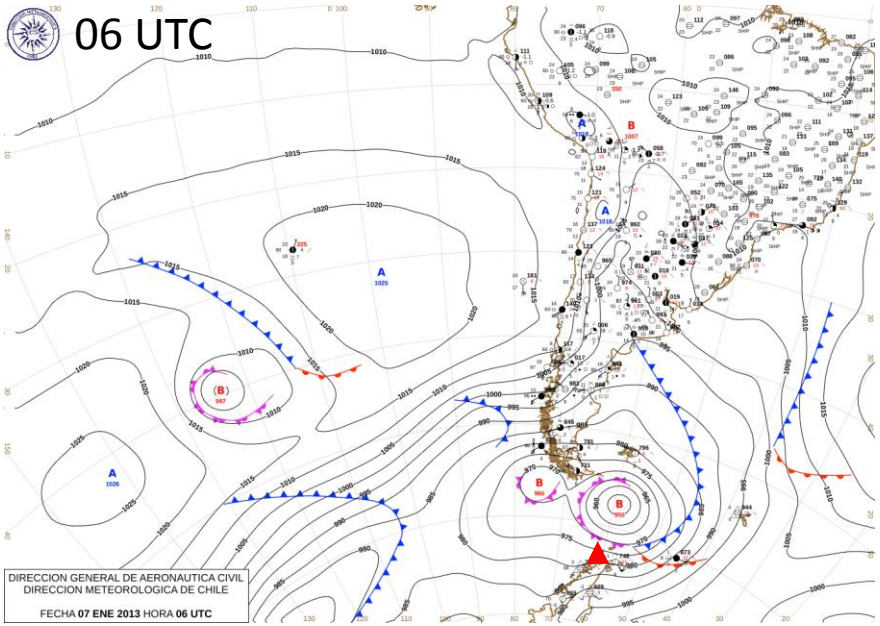
Surface Weather Charts: 07 Jan 2013

00 UTC

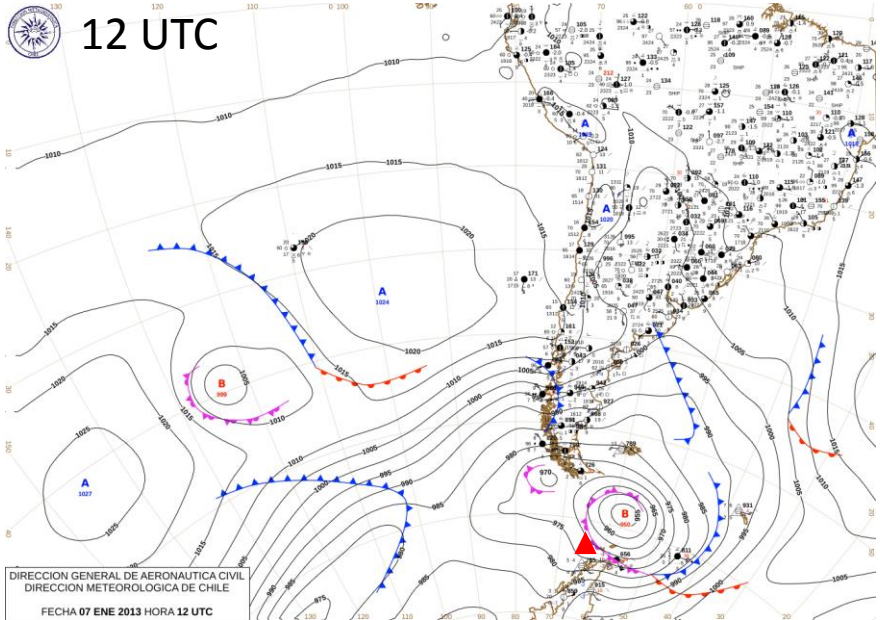
▲ : KSJ station



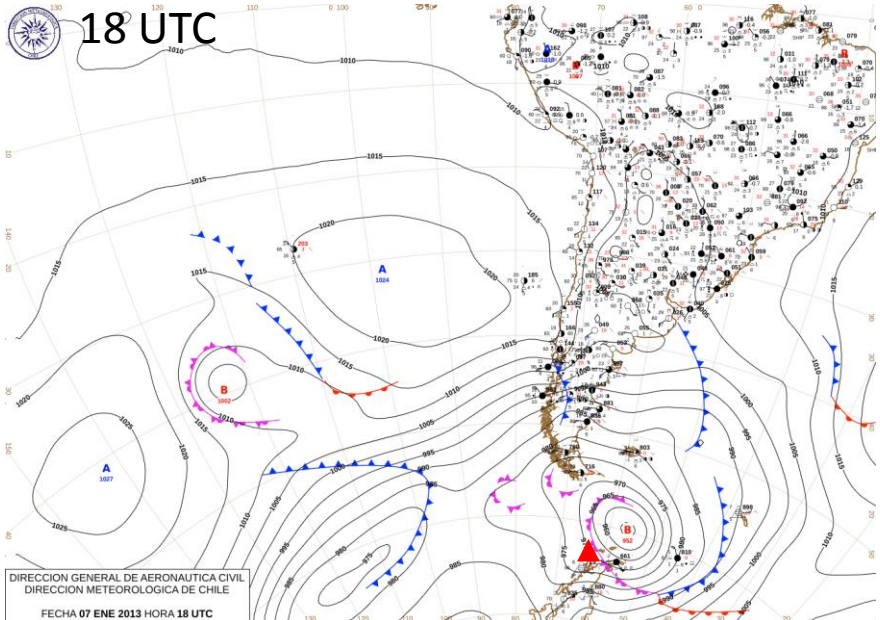
06 UTC



12 UTC



18 UTC



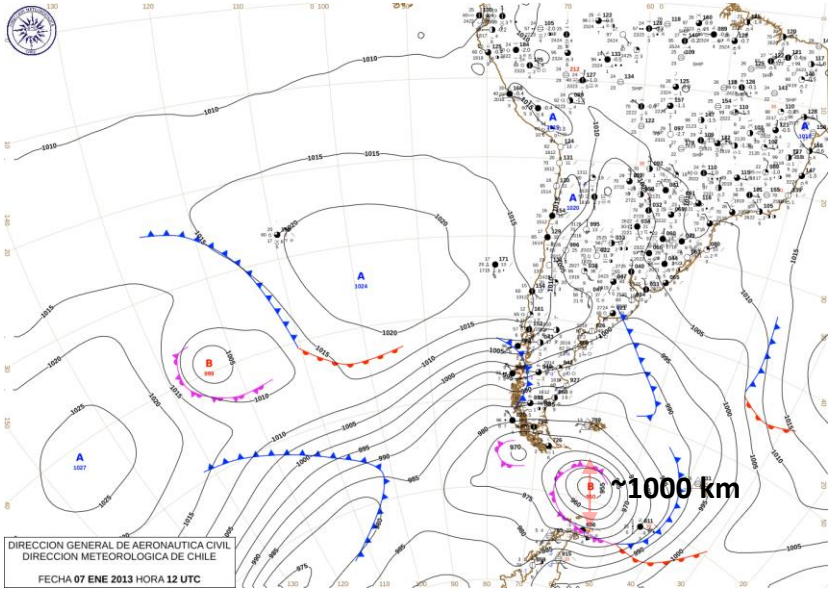
Polar Low

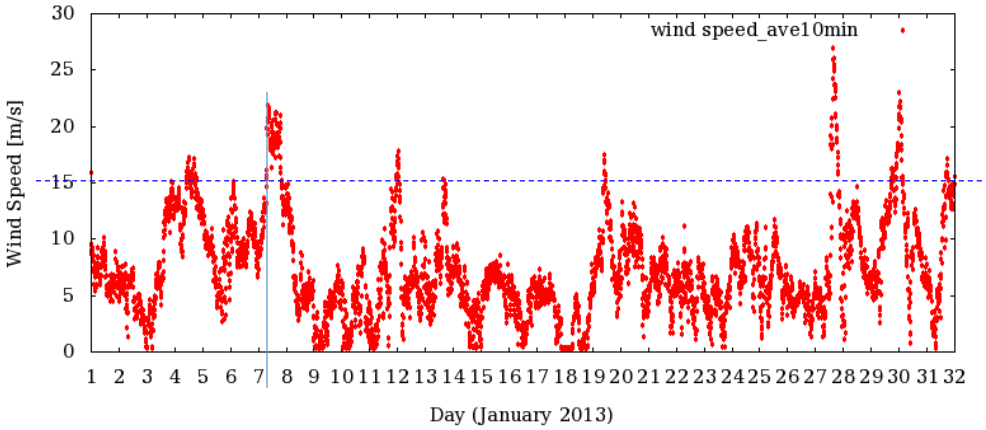
< Definition of the European Polar Low Working Group (1994) >

- The term '**polar meso-scale cyclone**' ('polar mesocyclone') is the generic term for all meso-α and meso-β-scale cyclonic vortices poleward of the main polar front (scale definition according to Orlanski, 1975).

- The term '**polar low**' should be used for **intense maritime mesocyclones** with scales up to about **1000 km** with a near-surface **wind speed exceeding 15 m/s**. Almost all cases of polar MC are found in the meso-α-scale (200-2000km), with few in the meso- β-scale (20-200 km).

G. Heinemann, 1996





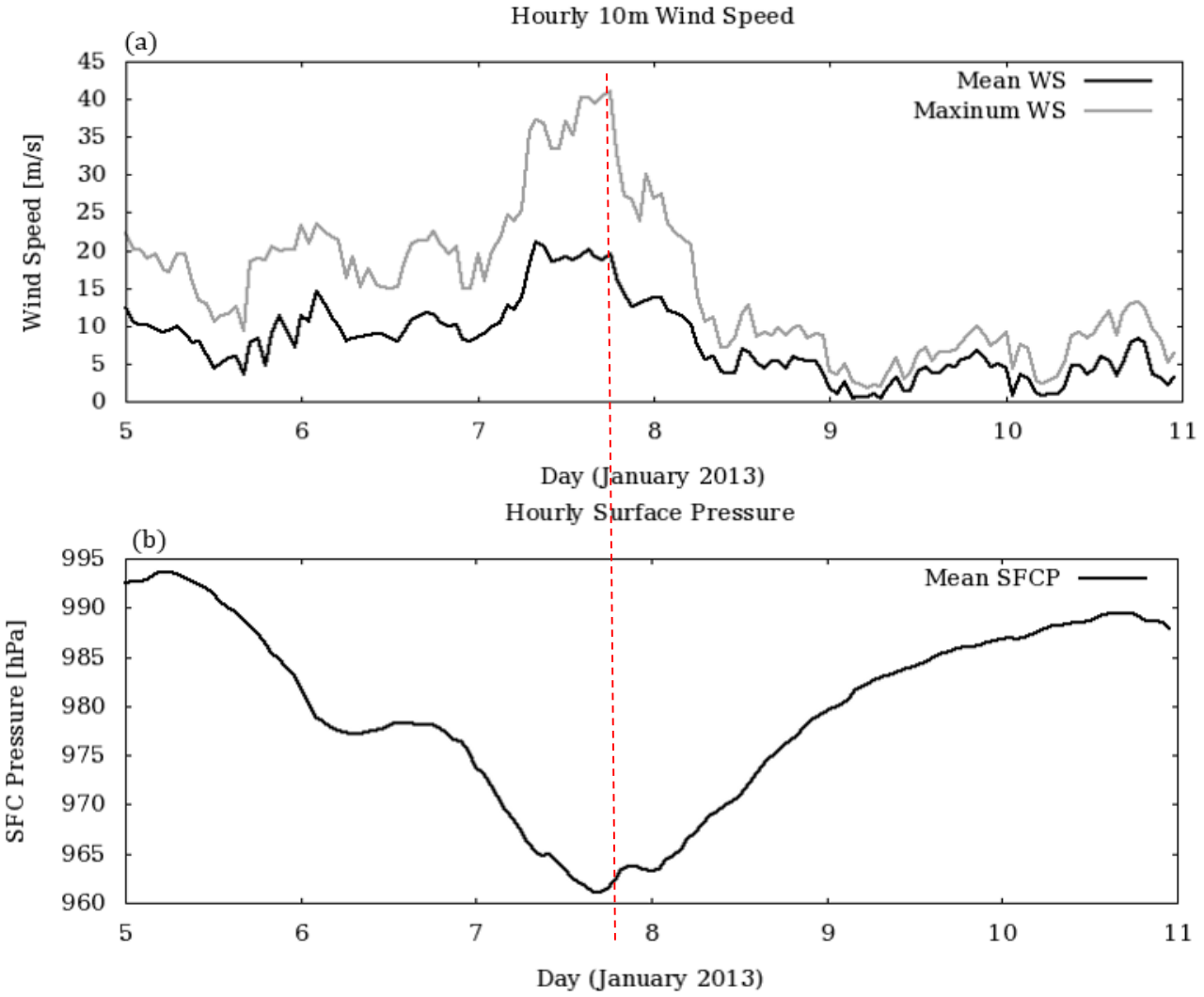
Numerical Simulation using Polar WRF

- Can Polar WRF simulate the strong wind event affected by Polar low reasonably well?

- Validate model results with AWS observations at KSJ station

CASE: 7 Jan 2013

AWS observations at KSJ station

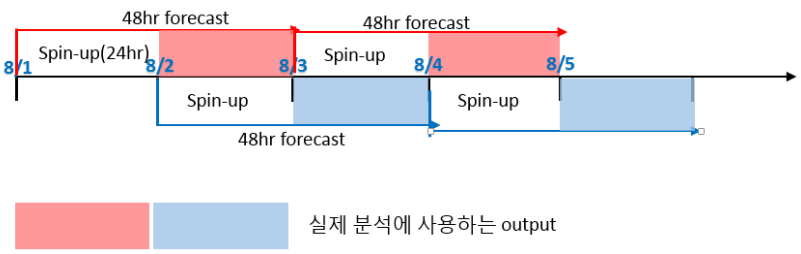


PWRF configuration

❖ PWRF V3.7.1 Model setup

Domain	Domain 1	Domain 2	Domain 3
Horizontal grid	240 x 230	124×103	100×109
Resolution	27 km	9 km	3 km
Vertical layers	44 Layers (model top: 10 hPa)		
Geog data resolution	10m'	30s'	30s'
Initial, lateral boundary condition	**ERA-Interim** (6-hour intervals with a spatial resolution of 0.75°×0.75°)		
Time period	2013.01.05 00 UTC ~ 01.11 00 UTC (6 days)		
Integration	48h forecast from global analysis (first 24 h used for model spin up)		
Base state temperature	273.16 K		
Relaxation zone	4 grid point (Default)		

❖ Time integaration

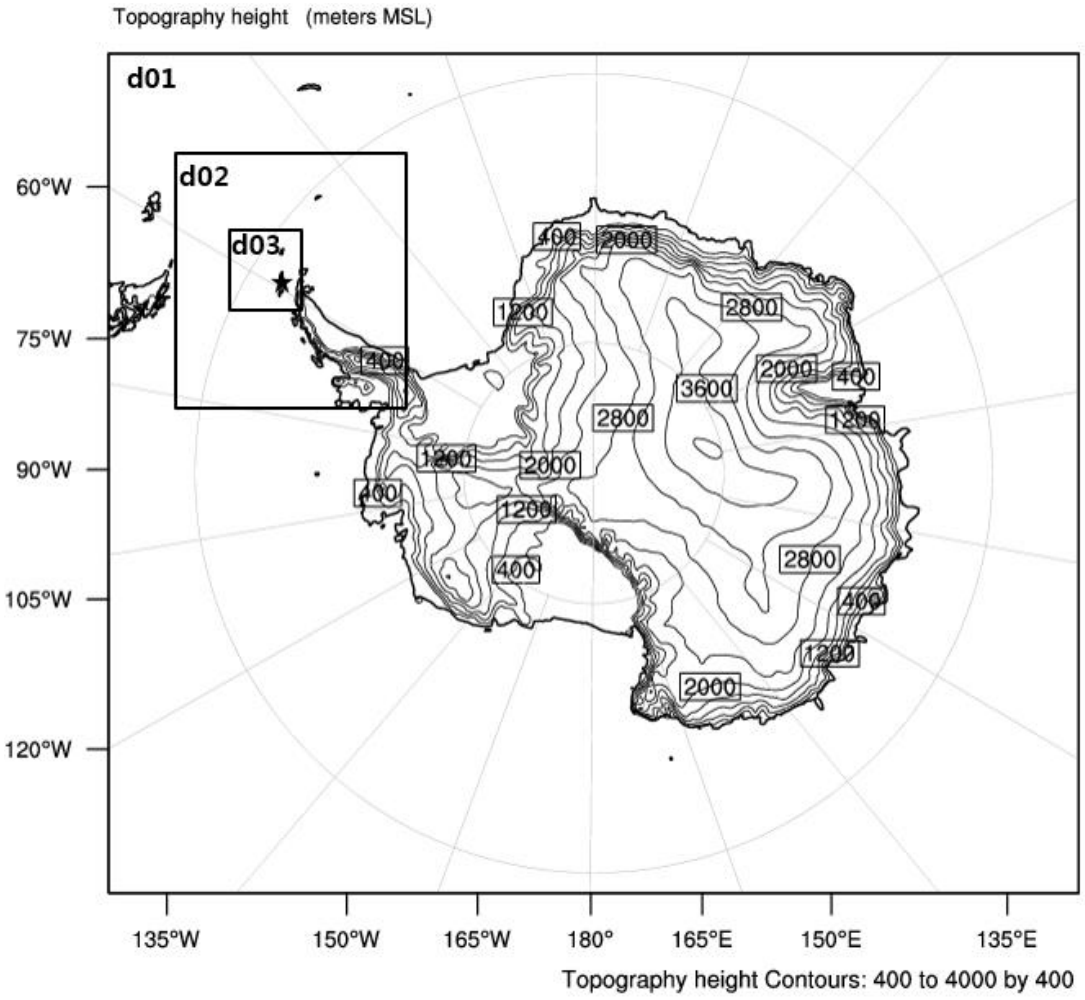


Refer to Bromwich et al., 2013

❖ List of physics schemes

Physics scheme (domain 1, 2, 3)	
Microphysics	WRF Single-Moment 5-class
Longwave rad.	RRTMG scheme
Shorwave rad.	RRTMG shortwave
Land surface	Noah Land Surface Model
Surface layer	Monin-Obukhov
PBL	Mellor Yamada-Janjic TKE
Cumulus param.	Grell-Devenyi ensemble (only for domain 1(27km))

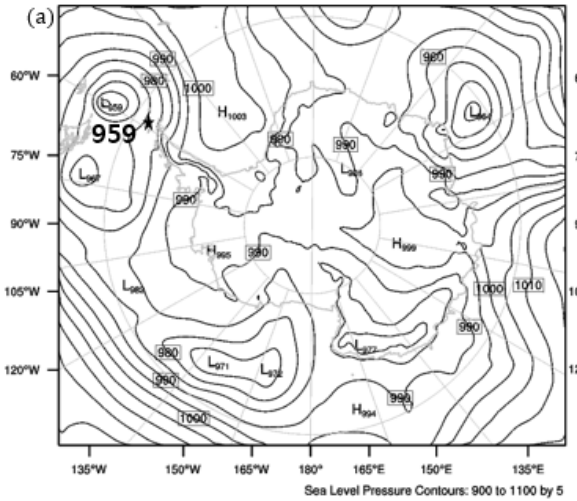
Polar WRF domains



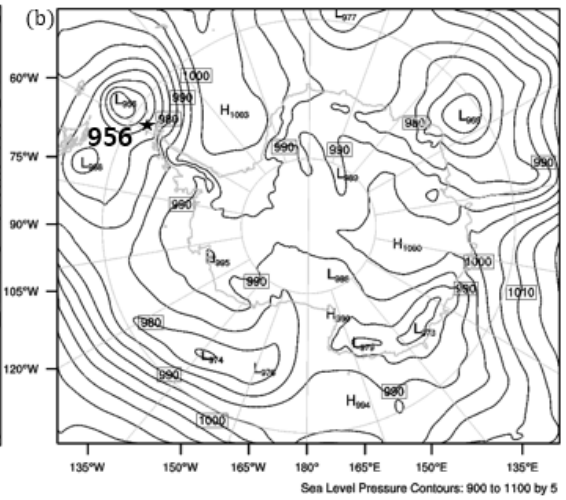
d01: 27 km
d02: 9 km
d03: 3 km

Results: Sea level pressure (27 km)

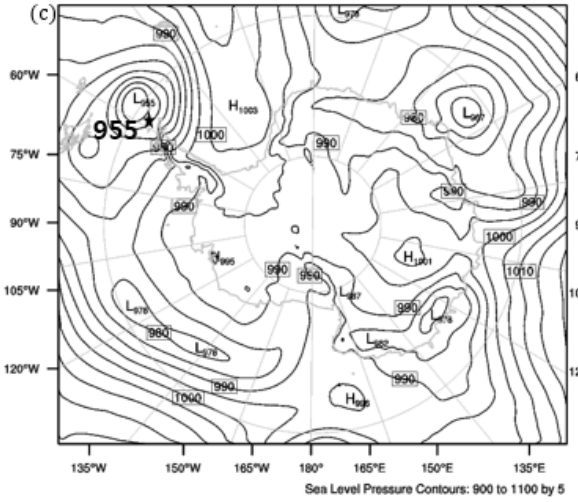
a) 00 UTC



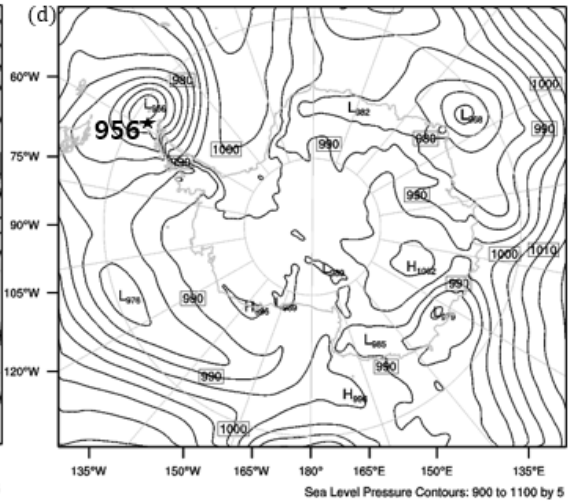
b) 06 UTC



c) 12 UTC

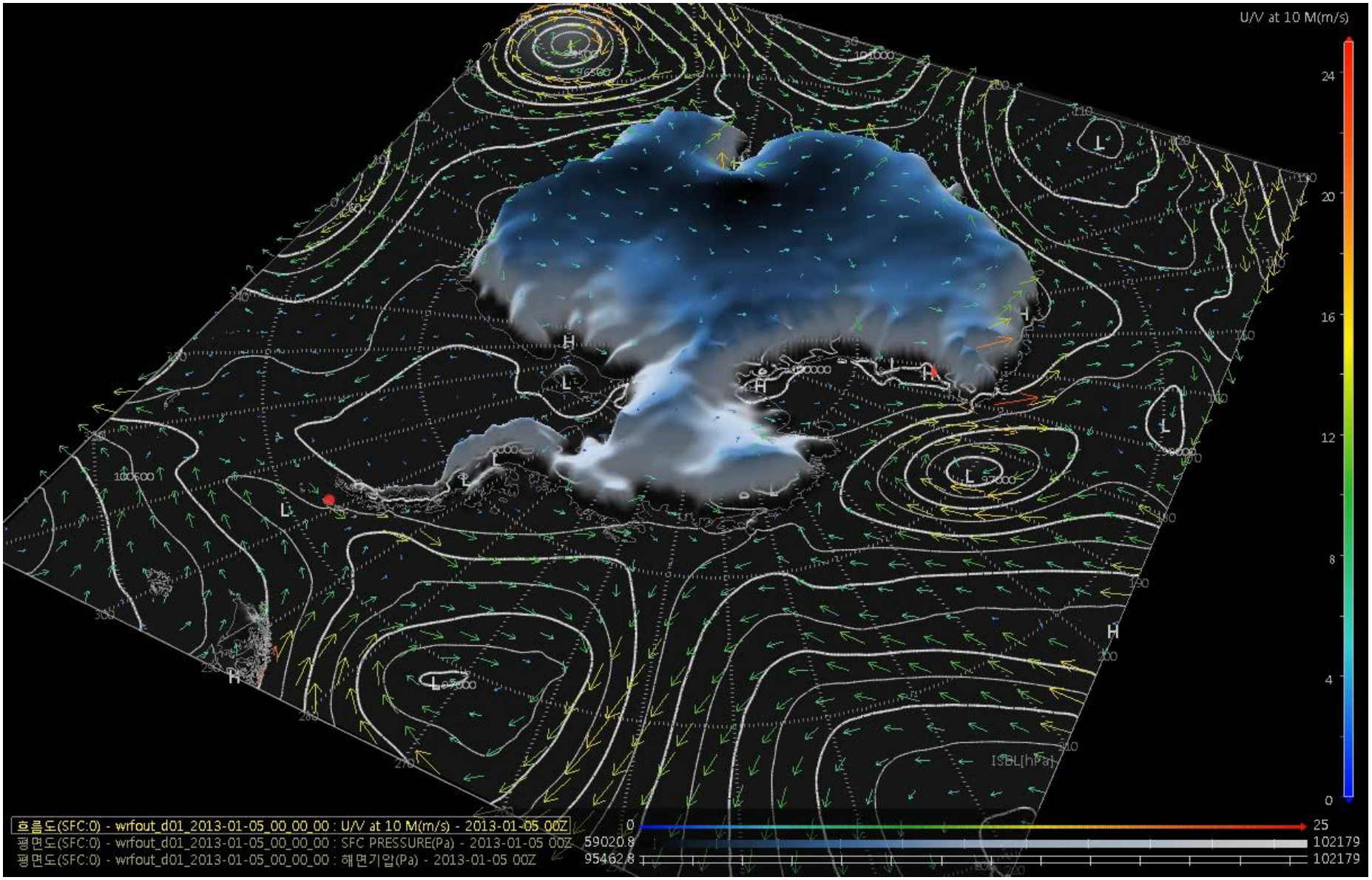


d) 18 UTC



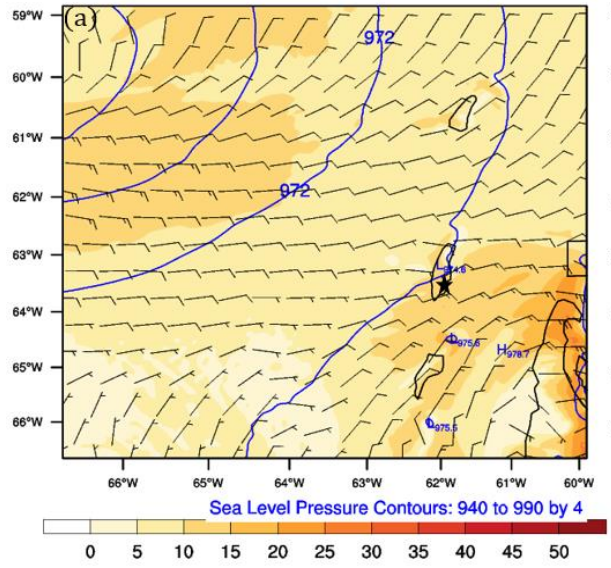
07 January 2013

Wind and Sea level pressure (27 km)

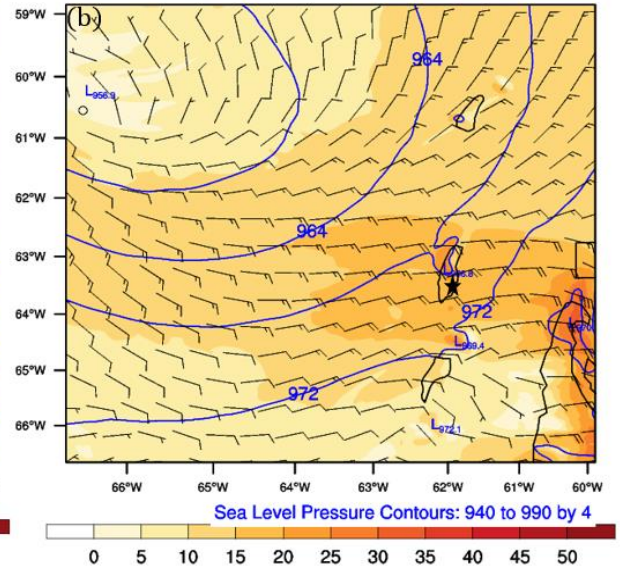


Results : Wind and sea level pressure (3 km)

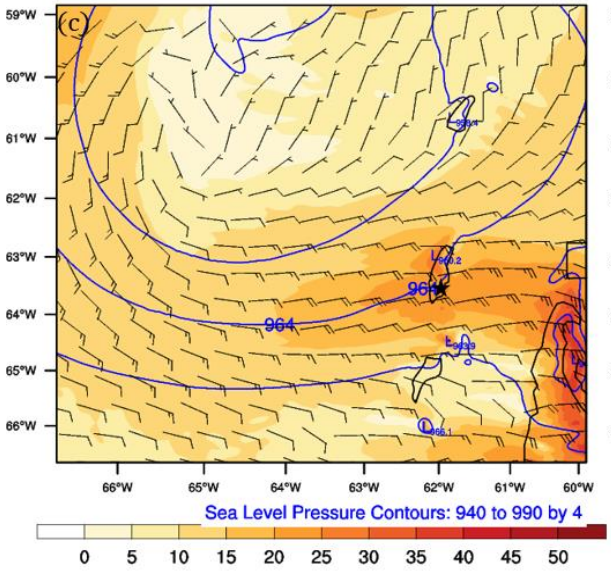
a) 00 UTC



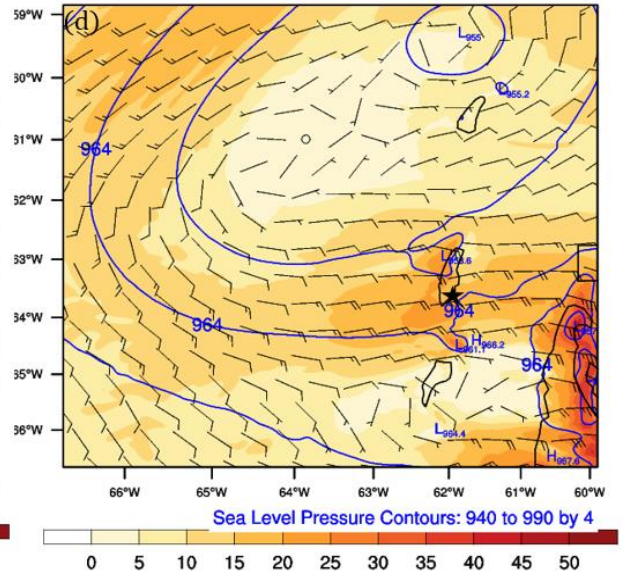
b) 06 UTC



c) 12 UTC



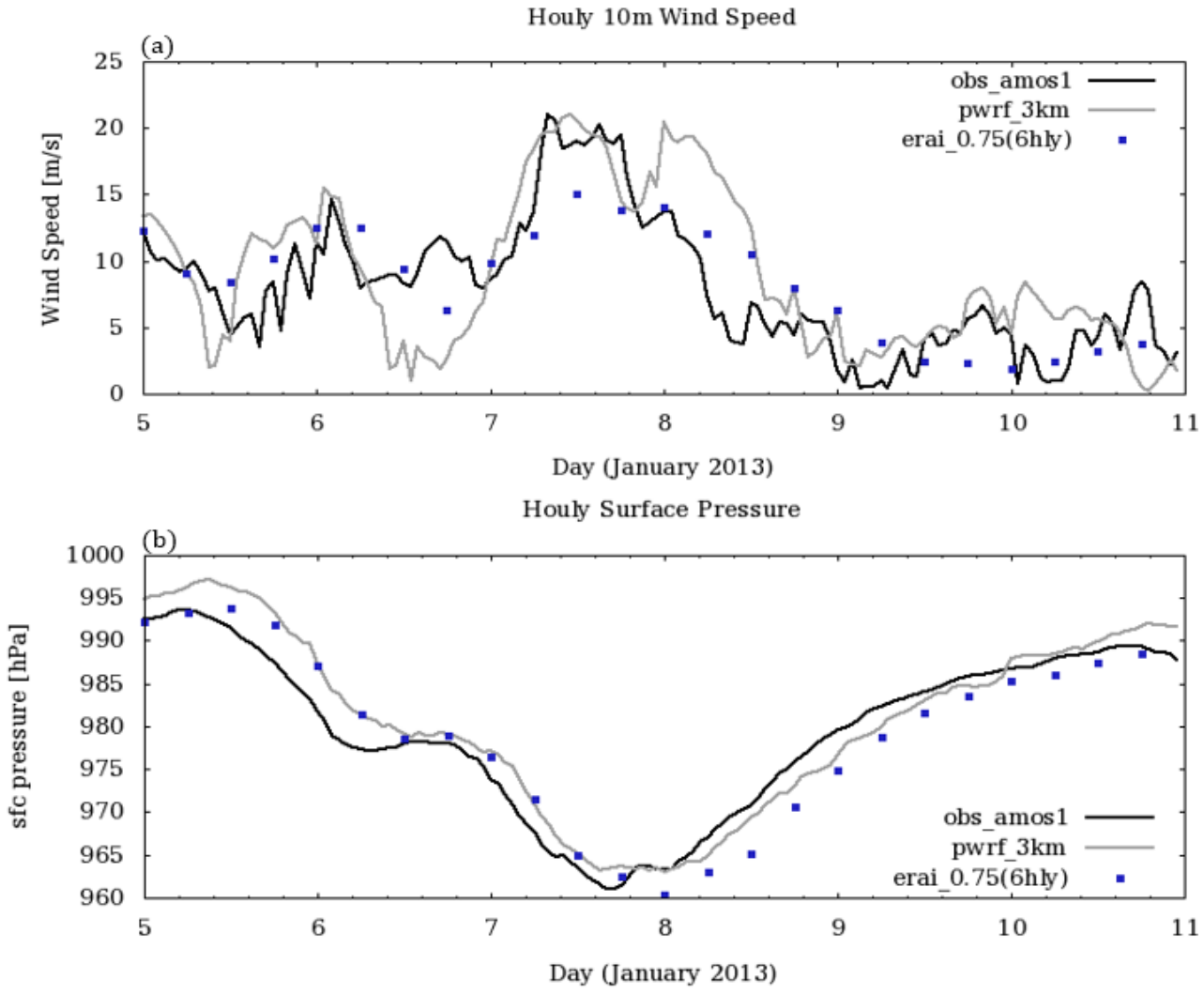
d) 18 UTC



07 January 2013

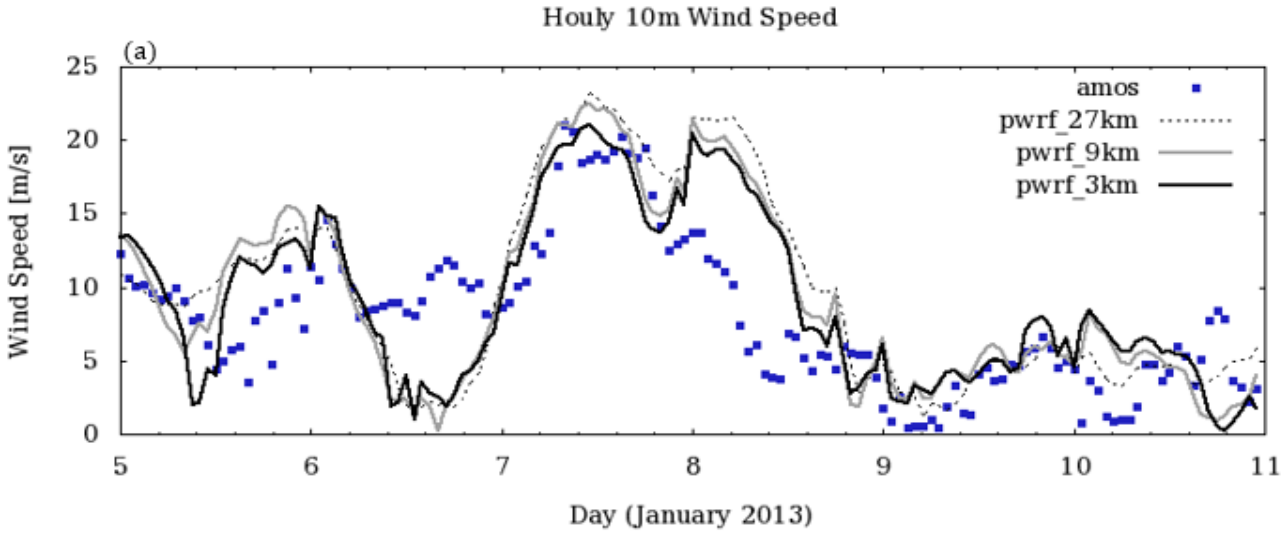
Results: Obs vs PWRF_3km, Era-interim

Time series of hourly 10m WS and Psfc at AWS station

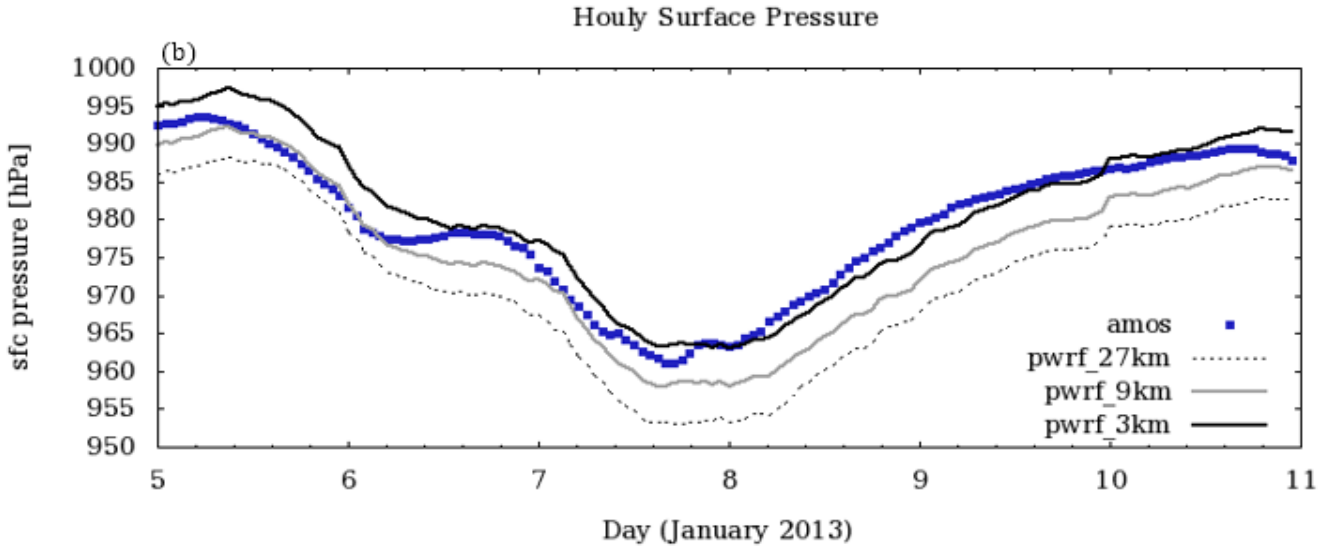


Results: Obs vs PWRF_3,9,27 km

Time series of hourly 10m WS and Psfc at AWS station



Bias:
27 km: −1.8 m/s
9 km: −1.4 m/s
3 km: −1.1 m/s



Bias:
27 km: 7 hPa
9 km: 4 hPa
3 km: −1.2 hPa

Summary

- We selected a **case of high wind speed event(maximum instantaneous ws: ~ 42m/s**) on 7 January 2013 recorded at AWS in King Sejong station, Antarctica.

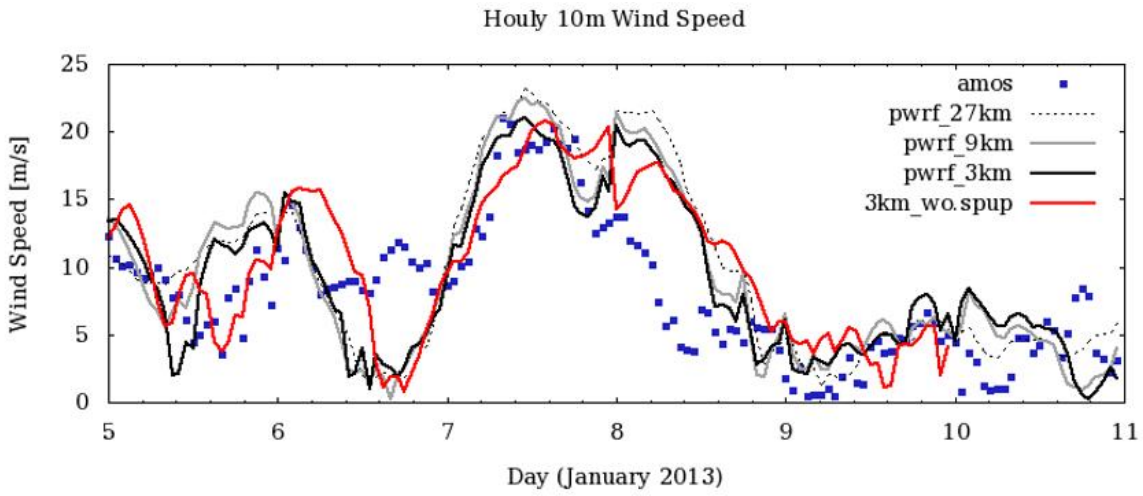
- It is revealed by in situ observations, numerical weather prediction, and reanalysis fields that the synoptic and mesoscale environment of the strong wind event was due to the **passage of a strong mesoscale polar low** of center pressure 950hPa.

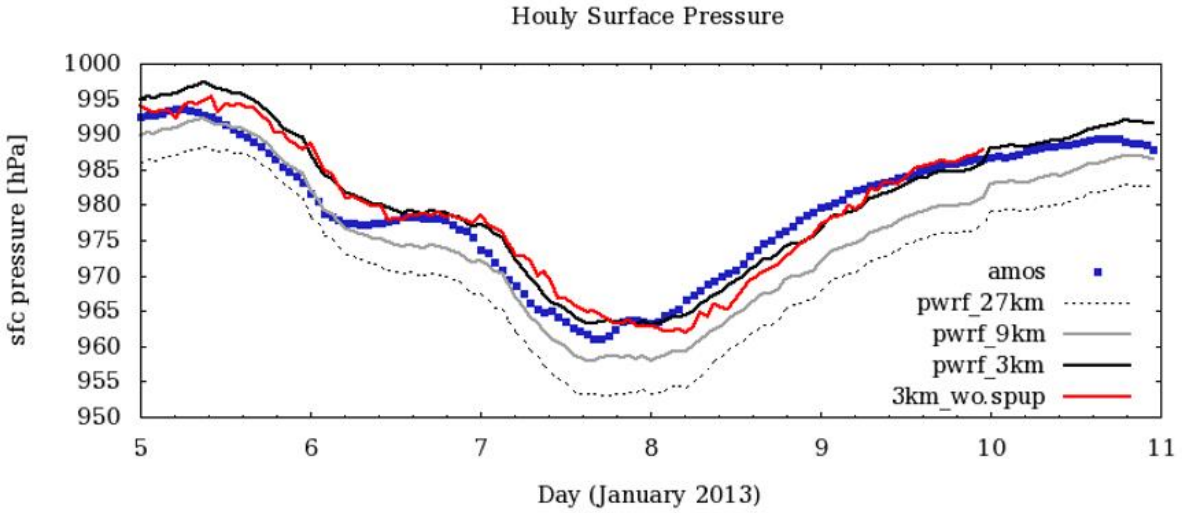
- Verifying model results from 3km grid resolution simulation against AMOS observation showed that **high skill in simulating wind speed and surface pressure with a bias of -1.1m/s and -1.2hPa**, respectively.

- Our evaluation suggests that the Polar WRF can be used as a useful dynamic downscaling tool for the simulation of Antarctic weather systems and the near-surface meteorological instruments installed in King Sejong station can provide invaluable data for polar low studies over West Antarctica.

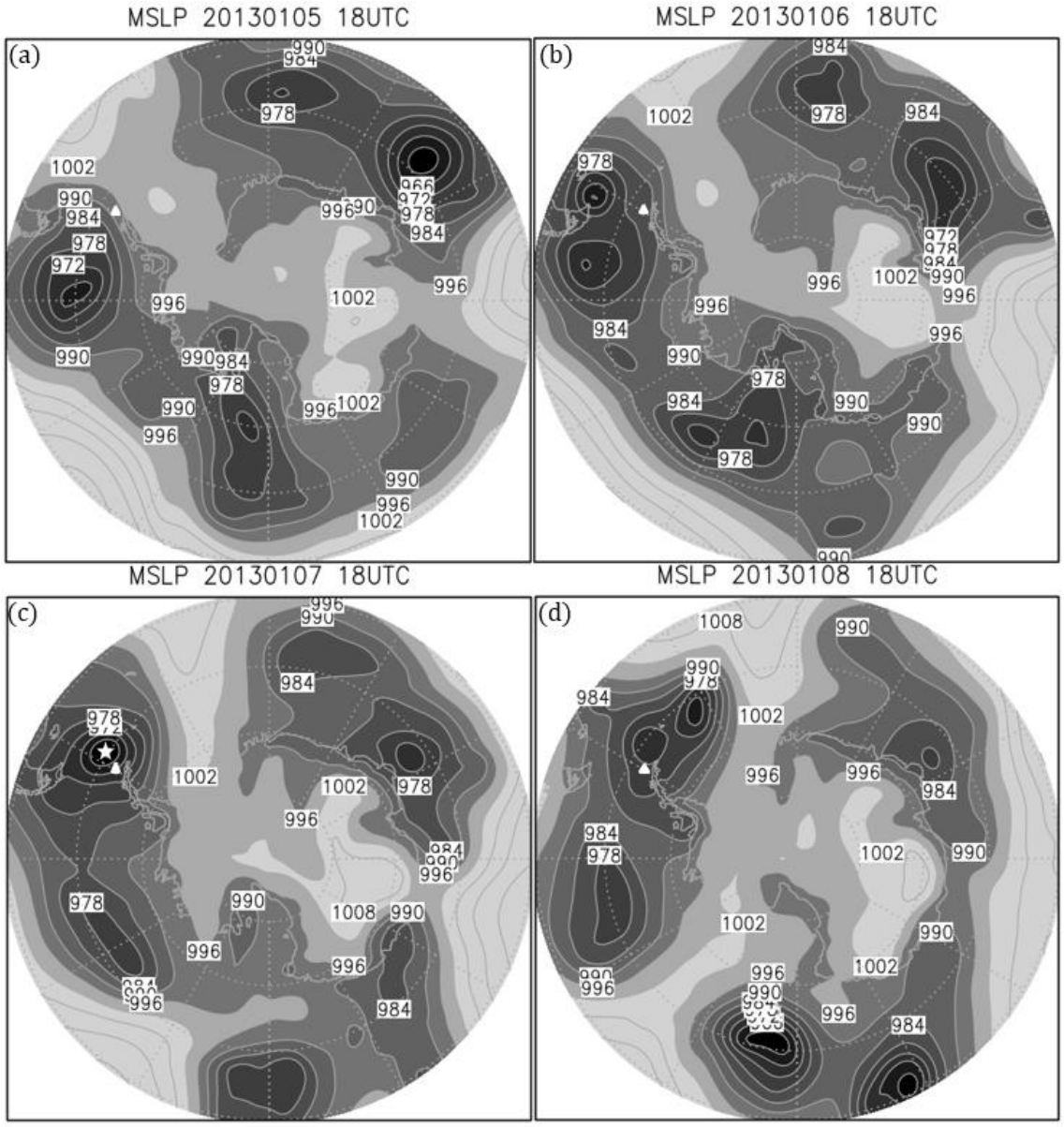
Thank you for your listening!

Summary and future plans





Sea level Pressure: ERAI_0.75



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