Simulation of Antarctic boundary layer using Polar WRF : a case of Antarctic King Sejong station

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1. Introduction

Due to extreme weather conditions in polar regions, Polar versions of NWP systems have been developed. Bromwich et al. (2005) presented an evaluation of model simulations over the Antarctic using Polar MM5 for annual period. Powers and Manning (2007) simulated the Polar WRF and the standard WRF model for 2-week periods in summer and fall conditions in Antarctica. Esa et al. (2010) concentrated exclusively in the Antarctic winter conditions. However Numerical model predictions in Antarctic are still far from accurate.

In this study we tested the sensitivity of Polar WRF V3.3.1 to surface layer parameterization in Antarctic. The results of model simulation were compared to observation data of Antarctic King Sejong station. Alse we compared the heat flux data obtained from Antarctic King Sejong station.

2. Model experiment and observation data

Because surface layer parameterization of numerical model is crucial to atmosphere-sea-ice interaction, we tested the model sensitivity and heat flux to surface layer parameterization. The simulations in this study were conducted with Polar WRF V3.3.1, for the period 01 July - 10 July 2011. Spatial domains are represented Fig1. Horizontal resolutions are 25km, 8.3km, 2.8km respectively, for the three two-way nested domains. 25km domain includes entire Antarctic peninsula, 8.3km domain covers Ellsworth Land and Amundsen Sea, Weddel sea and 2.8km domain was designed to King George island. Initial, boundary conditions were provided at 6-hour intervals with a spatial resolution of 1°×1° FNL(Final Analysis) data of NCEP(National Centers for Environmental Prediction). Under the same conditions, the only difference between two case is surface layer scheme. (Table1.)

Meteorological observation data was obtained from AMOS(Automatic Meteorological Observation System) in Antarctic King Sejong station and heat flux was calculated using eddy-covariance data.

3. Summary and Result

The simulation results represented that case1 was showing a pattern very similar to the observations in case of temperature. But case2 should significant warm bias. Simulated relative humidities in the two cases agreed better than temperature. In case of heat fluxes, the two cases produced very different results in magnitude and even in vertical direction. Observed sensible heat flux showed mainly downward while latent heat flux showed upward.

4. References

Bromwich,D.H.,A.J.Monaghan,K.W. Manning, and J.G. Powers, 2005: Real-time forecasting for the Antarctic: An evaluation of the Antarctic Mesoscale Prediction System (AMPS). *Mon. Wea. Rev.*, 133, 579-603.

Powers, J. G., and K. W. Manning, 2007: Polar WRF testing in Antarctica. *Extended Abstracts, Eighth WRF Users' Workshop*, Boulder, CO, NCAR, P.12.

Tastula, E.M., Vihma, T., 2011: WRF Model Experiments on the Antarctic Atmosphere in Winter. *Mon. Wea. Rev.,* 139, 1279–1291.

Physics scheme	case1	case2
mp_physics	WRF Single-Moment 6-class	
ra_lw_physics	RRTMG scheme	
ra_sw_physics	RRTMG shortwave	
sf_surface_physics	Noah Land Surface Model	
sf_sflay_physics	MM5 similarity	MYNN surface layer
bl_pbl_physics	MYNNLevel 2.5 PBL	
	SST_update option	

Table. 1. Physics scheme description of Polar WRF experiment.

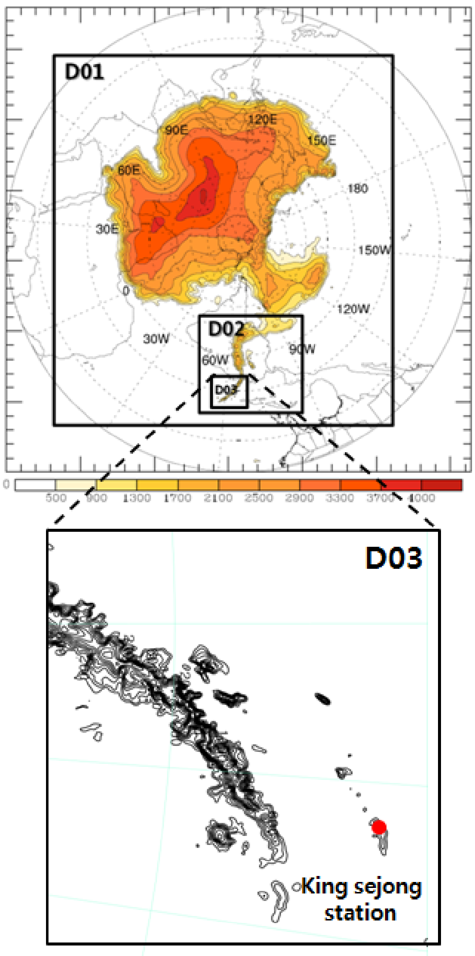

Figure. 1. Polar WRF domain.

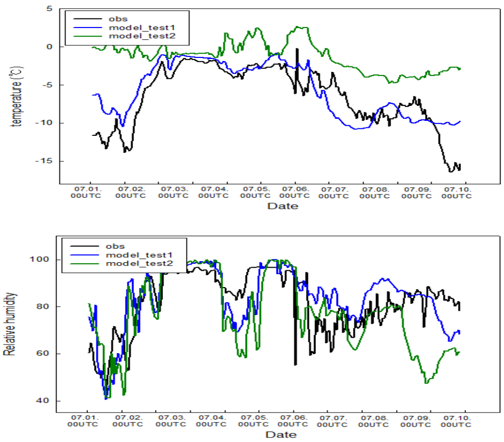

Figure. 2. Temperature and humidity time series for Antarctic King Sejong station.