SIMULATION OF BLOWING SNOW WEATHER CONDITION BY WRF MODEL IN MAYITASI, XINJIANG

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ABSTRACT: Snowcover play an import role in earth's ecosystem. In Apline and terrain with complex topography, the blowing snow have heavy impact on snow accumulation and ablation. The Mayitas region is world famous for suffering from blowing snow hazards, which is also without covering the meteorological observation. To sovle the lack of observation, this study uses the date time of blowing snow occurrence that retrieved from news on Internet as the quasi observation. And the wind field and snowfall is reproduced by WRF model. Results show that when the daily snowfall is more than 1.03 mm/day and the mima of daily maximum wind speed is more than 8.84 m/s could be the practical criteria for forecasting the blowing snow events. And finer grides could improve the wind speed's spatial characteristics with the experience from field survey.

KEYWORDS: Partition;snowfall;news; criteria

1 INTRODUCTION

Snowcover play a crucial role in cryosphere, which could change the surface radiation balance and the soil temperature(Bernhardt 2008; Liston; Elder 2006). In a year round cycle, snowcover experienced the accumulation process and ablation process on different spatio-temporal scale. This two processes are impacted not only by energy balance and mass balance(Matsuzawa et al. 2005; Vionnet et al. 2013), but also affected by the physical transportation. In natural condition, the physical transportation could make the stronger impact than the energy and mass balance in a short time(Déry; Yau 2001).

Mayitas is small region in western part of Northern Xinjiang, which is the world famous for gale. In winter time, the strong wind often goes with snowfall in Mayitas that is called snow drift or blowing snow. The blowing snow could build snow wall cutting off the main roads connecting with other big cities and bury the grassland near Mayitas region.

In recent years, the local transportation administration build some automatic weather station(AWS) along the main roads in the purpose of monitor the weather condition when the blowing snow occurs. These AWS which is assemblied with plastic wind cup for anemometer. Usually, after the first 2~3 blowing snow events, the mechanical parts are frozen or crusshed by strong wind. Due to these practical problems, some engineers from railway company equipes the AWS with the anemometer like plane heading-nose. Yet, the blowing snow hazards often have the long duration that would

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reduce the efficiency of solar energy utilization by the solar panel or eventually cover the solar panel with harden snow. In the view of these natural conditions, it is hard to collect the weather data by observation.

For the sake of solving the problem of data hunger in Mayitas, WRF that is the state of art of atmospheric science, is employed for downscaling the large scale of reanalysis dataset getting the weather condition data. The methodology in this study is other than conventional research method. The news which works as the quasi observation, is collected and extracted the information about the blwoing snow. With this quasi observation, the fundamental knowledge about the weather conditions in Mayitas, Xinjiang is clear to understand. The following section is composed like: the section 2 is introduction of methodology and WRF's configuration. The section 3 is assessment of WRF's wind speed and snowfall by the quasi observation. The section 4 is about the comparison of wind speed on different horizontal resolution. The section 5 is the occuring criteria for blowing snow with WRF's simulation.

2 METHODOLOGY

2.1 *Study Area*

Mayitas region, sitted at the western part of Jungar Basin, Xinjiang , has the high terrain in the west and low terrain in the east(in Figure 1). The whole geomorphy in Mayitas is same like the corridor in mountains. The easterly wind is prevailing in winter time. But when snowfall occurs, the wine direction turns to west.

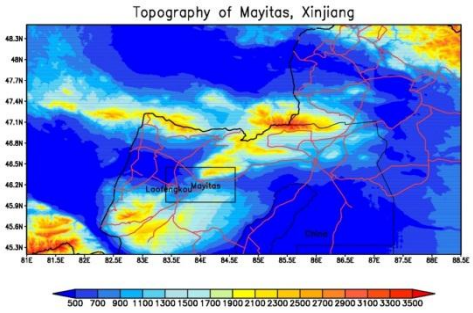


Figure 1 Topography of Mayitas, Xinjiang
(The red line notes to roads. The Rectangle is the nesting region of WRF)

2.2 *WRF's Configuration*

In this study, the domain in Maytas is configure with two-way nesting.the outer domain is covered the most parts of Northern Xinjiang, which is shown in Figure 1. The outer domain's boundary is far from the high mountainous region in Tianshan Mountains for eliminating the huge altitude chagne between basin and mountain. the inner domain's horizontal resolution is 2km, which is finer than the outer domain's resolution of 10km. because of the scarcity of computing resources, the inner domain just cover the Mayitas region noted with rectangle boundaries in Figure 1. The detailed WRF's configure is shown in Table 1. Conventionally, although the culumus convection scheme could be turned off, when the horizontal resolution is less than 10km. the cloud microphysics in WRF could not depict the mechanism of precipitation. The Cumulus convection scheme is still kept in this study. All the simulation start at the October 1st, and stops at the next year's April 1st. And the time step is 60s with adaptive time step. For fixed time step, nudging technique is working on for improving the accuracy of atmospheric variable.

Table 1 The main parameter scheme in WRF configuration.

	Outer domain	Inner domain
Horizontal	10km	2km

resolution		
Vertical level	30	40
East-west grids	45	70
North-south grid	45	65
Cumulus Parameter	Tiedtke	Tiedtke
Cloud mirocphysic	WSM3	WSM3
Long wave scheme	CAM	CAM
Short wave scheme	Dudhia	Dudhia
Land surface model	untified NOAH	untified NOAH
PBL	YSU	YSU

2.3 *Partition of Snowfall and Rainfall*

According to the previous study, the method for partition of snowfall and rainfall is basically using the temperature criteria(Guo; Li 2015). Thus, the 2m temperature from WRF is devides into the series above 2 ℃ and the one below 2 ℃, which have considered the cold bias of 1.4 ℃ from WRF. With the temperature critical, the snowfall is seperated year by year.

2.4 *Quasi Observation*

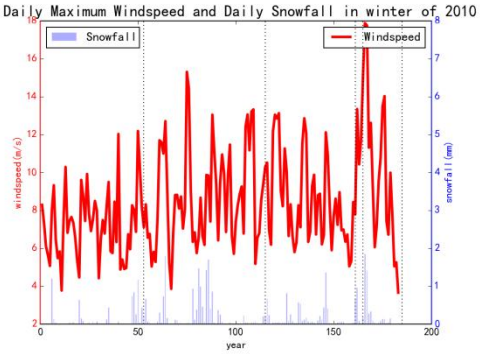
For evaluation of the ability of WRF's simulated, the study uses the search engine for collecting the news about blowing snow in Mayitas, Xinjiang. And the useful information like date is recorded as the quasi observation for blowing snow events. In this way, the blowing snow series log is built covering the period from 2010 to 2015.

3 RESULT

3.1 *Comparisons between Quasi Observation and WRF's Weather Condition*

It is shown in Figure 2 that there is outstanding characteristics relationship between WRF's wind speed and snowfall and blowing snow events, although there is some defect on the quasi observation that is only heavy blowing snow events impacting the transportation is reported on Internet with neglecting small intensity class of blowing snow. It is plotted that there are the strong wind accompanying with snowfall when blowing snow occures. Before the 50th day, it is the middle time in November. So the surface temperature above 2m is basically above 0℃ without snowfall. From the end of November to March, all the precipitation is snowfall according to the temperature below 0℃. It is seen it does not occur the snowfall in each strong wind day. If it had snowed, it must have the strong wind.

In 2010，there is only 4 blowing snow events, but in the following years of 2011，2012，2013，there are 6 events, 7 events，8 events，respectively. Thus, the increasing trend of blowing snow occurrence is noted. One thing regional climate change should be claimed to this upward tendency, the other thing the news hold open attitude to natural disaters without hiding the truth. As a result, there are some other days with strong wind and snowfall which is not reported on Internet.



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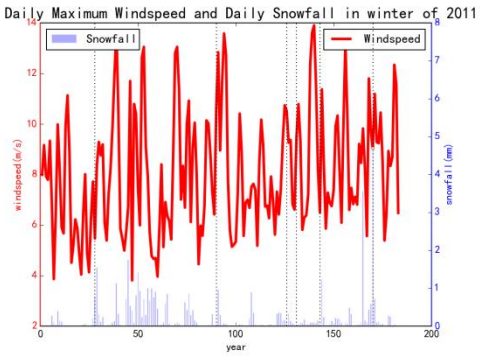

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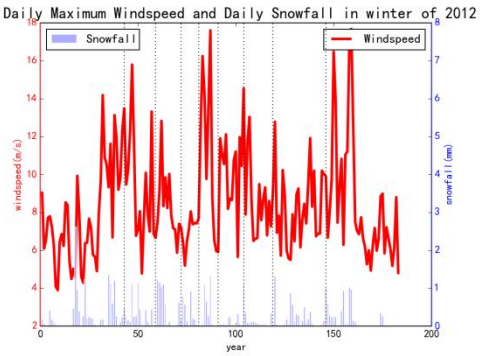

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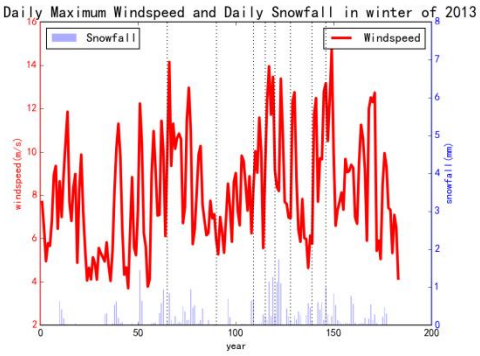

(d)

Figure 2 the evaluation of WRF's weather conditions and blowing snow events retrieved from news

In this study, two classes of horizontal resolution is simulated by WRF model. In Figure 3，the wind speed in resolution of 10km has the same changing tend on temporal evolution even in data serie's peak and valey. There is still tiny different shown in Figure 3 that the daily maximum wind on 2km resolution is greater 1~2 m/s that one in 10km. As a result, it illustrates the finer grids have the ability of simulating the tiny change impacted by complex topography. And the changing trend on 10km shows more smooth in changing turning than the one on 2km

3.2 *Wind Speed's Conparison with Different Horizontal Resolution*

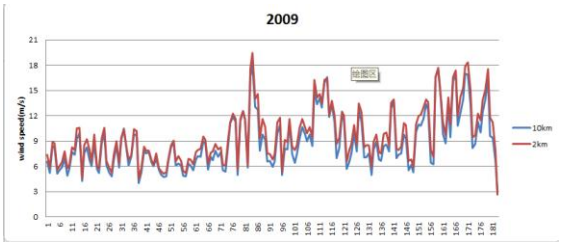

Figure 3 The wind speed's conparison with different horizontal resolution in 2009

Based with the data on Table 2，the Mima of daily maximum wind speed to blowing snow events that is retrieved from news on Internet is 8.84 m/s on 10km grids and 10.22 m/s on 2km grids. In each year, the Mima of daily maximum wind speed on 2km grids is bigger than the one on 10km. For snowfall, only the snowfall on 2km grids in 2012and 2014 is smaller than the snowfall on 10km grids. In the other years, the snowfall on 2km grids seems bigger than those on 10km. In this way, it has great uncertainty on spatial scale.

3.3 *Blowing Snow Occurrence's Criteria*

Table 2 Daily maximum wind speed and daily snowfall in horizontal resolution of 10km and 2km, when blowing snow occurs.

Year	2010	2011	2012	2013	2014	avg
Wind speed (m/s)	8.33 (10.56)	7.70 (9.10)	8.37 (10.73)	9.35 (10.26)	10.46 (10.47)	8.84 (10.22)
Snowfall (mm/	0.80 (1.13)	1.16 (1.2	1.44 (1.06)	0.77 (0.86)	1.47 (0.90)	1.12 (1.03)

day)	2)

Notes: The number in bracket is the result in 2km resolution.

4 CONCLUSION

According to the field survey, the snow physical condition is simply in Mayitas, which has only dry snow. Generally, it is different from the snow in the Great Prairie, Northern American. After analysis of the weather condition including the Mima of daily maximum wind speed and daily snowfall, it is found the minimum daily maximum wind speed is 10.22 m/s on the 2km grids for blowing snow happens, and 8.84 m/s on the 10km grids. The snowfall on the 10km grids and 2km grids is more than 1.03 mm/day. These two conditions could be simplified to one criteria that it will have great possibility of blowing snow events occuring, when the daily snowfall is more than 1.03 mm/day and the mima of daily maximum wind speed is more than 8.84 m/s. This blowing snow occurrence criteria is usefull to prediction of blowing snow. Finaly, the higher resolution could get the strong wind signal which is close to the actual wind field in Mayitas based on field survey.

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