Diagnosis and Numerical Simulation of the Near-surface Wind Fields at Inexpressible Island in Ross Sea, Antarctica

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1. Background

2. Wind and temperature analysis of Inexpressible Island

3. A simulation by Polar-WRF

4. Conclusions
Great wall station

Zhongshan station

New station in building

Inexpressible island
AWS set up at December 2012
One year later......
Situ data analysis

Northwest winds has accounted for more than 80%
Only in January, November and December there are some non-northwest winds.
Inexpressible island’s W-NW high wind is very different from Zhongshan station where we've had years of observational data.
A lot of strong east wind in Zhongshan station is affected by the cyclone over the southern ocean.
There is no strong East wind in Inexpressible Island in 2013.

So the cyclone over the southern ocean have little affect on the island.
<table>
<thead>
<tr>
<th>Month</th>
<th>Wind force/direction</th>
<th>E</th>
<th>≥17.2 m/s</th>
<th>≥10.8 m/s</th>
<th>≤10.2 m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>17.30%</td>
<td>30.00%</td>
<td>1.60%</td>
<td>20.60%</td>
<td>79.40%</td>
</tr>
<tr>
<td>February</td>
<td>8.40%</td>
<td>10.30%</td>
<td>5.20%</td>
<td>41.50%</td>
<td>58.50%</td>
</tr>
<tr>
<td>March</td>
<td>2.00%</td>
<td>5.00%</td>
<td>93.00%</td>
<td>10.80%</td>
<td>59.60%</td>
</tr>
<tr>
<td>April</td>
<td>0.20%</td>
<td>8.00%</td>
<td>91.80%</td>
<td>24.00%</td>
<td>65.60%</td>
</tr>
<tr>
<td>May</td>
<td>0.50%</td>
<td>9.00%</td>
<td>90.50%</td>
<td>18.10%</td>
<td>64.80%</td>
</tr>
<tr>
<td>June</td>
<td>1.20%</td>
<td>7.80%</td>
<td>91.00%</td>
<td>17.90%</td>
<td>57.10%</td>
</tr>
<tr>
<td>July</td>
<td>3.50%</td>
<td>9.90%</td>
<td>86.60%</td>
<td>14.10%</td>
<td>55.10%</td>
</tr>
<tr>
<td>August</td>
<td>2.60%</td>
<td>10.00%</td>
<td>87.40%</td>
<td>16.30%</td>
<td>57.50%</td>
</tr>
<tr>
<td>September</td>
<td>1.00%</td>
<td>12.80%</td>
<td>86.20%</td>
<td>23.40%</td>
<td>67.30%</td>
</tr>
<tr>
<td>October</td>
<td>2.50%</td>
<td>5.50%</td>
<td>92.00%</td>
<td>8.30%</td>
<td>47.90%</td>
</tr>
<tr>
<td>November</td>
<td>3.90%</td>
<td>25.00%</td>
<td>71.10%</td>
<td>0.40%</td>
<td>16.20%</td>
</tr>
<tr>
<td>December</td>
<td>14.10%</td>
<td>34.10%</td>
<td>51.80%</td>
<td>2.80%</td>
<td>32.90%</td>
</tr>
</tbody>
</table>

There are more high wind from March to September.
Situ data analysis

The Class Scatter of Wind direction and speed of 2013

High winds’ direction are concentrated at W-NW

Max wind speed is 35 m/s
The daily variation of monthly average wind speed and temperature from January to June
The daily variation of monthly average wind speed and temperature from July to December
Situ data analysis

Daily variation are not obvious in winter

Wind speed is relatively low between local time evening to midnight in summer.

Daily variation are obvious in Summer
Situ data analysis

There is relatively small wind speed in January, February, November and December.
Wind-field simulation by Polar-WRF

Time resolution: every 6 hours,
Spatial resolution: 0.1 ° × 0.1 °,
26 vertical pressure layer,
Based on Climate Forecast System Reanalysis(CFSR) data.
Description of terrain

PR, RE, and DA represent Priestley, Reeves and David glacier.
Comparison of observational data and simulation (wind speed)

January 2013

July 2013  Not accurate but really a success!
Two strong Katabatic wind in January and July

The numerical simulation basically reflects the observation.
A strong Katabatic wind between January 15 and 18, 2013

(Red point is Inexpressible island)
A strong Katabatic wind between January 15 and 18, 2013

When the wind is heading North

Wind direction is the key!

When the wind is heading East

(Red point is Inexpressible island)
January 15-18, 2013 cross-sectional analysis
The downslope wind is not only the process of the near-surface layer, but the suction action can reach the mid-troposphere stratum at an altitude of about 4000 meters.

An altitude of 1,400 meters to 200 meters is a key area for the wind to accelerate.
A strong Katabatic wind between July 24–30, 2013

(Red point is Inexpressible island)
July 24–30, 2013  cross-sectional analysis
Source of the high wind

The wind direction of Priestley glacier is the source of the strong wind (Red point is Inexpressible island)
1. The area is dominated by Katabatic wind. The Inexpressible island is unaffected by southern ocean cyclone.

2. The summer of that place have the smallest wind power and obvious daily variation.

3. During the summer work of the island, we should choose local time in the evening to early morning. High winds and flying stones should be pay special attention.

4. The numerical simulation reveals that the Katabatic wind suction can reach the mid-troposphere level of about 4000 meters.
Strong Katabatic wind at Inexpressible Island is the result of topographic forcing. The airflow from Glacier Reeves is the main source of the wind.

The steep hill between altitude 1400 meters to 300 meters is the key area to accelerate the airflow.
Thank you for your attention!