SPQ Module 6 – Where the Wild Winds Blow

When Ray, Richard and Kevin were asked to comment on the role wind has played in their respective careers as explorers and ultra-athletes this elicited a lively commentary. Richard told of a story when he was skiing in Clyde River in the Canadian far-north into such severe winds that he was forced to turn around, and when he did the force of the wind propelled him so fast along a flat it was as though he was skiing downhill. Ray reported that while he was running across the Sahara Desert the winds were so strong at times that sand would be blown into sealed water bottles.

Antarctica is recognized as the windiest place on Earth. This is born out by meteorological statistics as well as by the anecdotes of those who have traveled and lived in Antarctica. Ray, Richard and Kevin who reported on Friday, the first day of their expedition, severe chilling winds blowing from the south, reconfirmed this reputation. As Ray stated in the expedition blog:

> **"The minute we left Hercules Inlet we were struck by unrelenting winds that reminded me of being in a sand storm, but it wasn't sand it was snow and it was very cold!"**

Why is the southern continent such a windy place? To understand what produces the high winds of Antarctica we first must understand what wind is.

Figure 1: Photo of Katabatic Winds Blowing off the Antarctic Plateau (Source: Samuel Blanc).

There are many kinds of wind. It heralds the arrival of storms, and blows hot and dry across deserts. It destroys homes and lives in the form of hurricanes, and provides us energy harnessed by windmills. Wind propelled the ships of all the early Antarctic explorers, including Amundsen and Scott, to the shores of the southern continent. The wind was a formidable foe as they advanced toward the South Pole.

There are two main factors that drive large-scale global wind patterns:

1. Differences in atmospheric pressure resulting from differences in air temperature between the equator and the poles

2. The rotation of the planet

Wind is produced when there are differences in air pressure. Areas of high pressure will naturally flow into areas of low pressure. In turn, air pressure differentials are caused by differences in air temperature. At the simplest level, variation in air temperature is caused by the warming effect of the sun and the cooling effect of the shade. As the sun is not always shining upon all parts of the earth due to the day / night cycle, and is not always shining with the same intensity due to the summer / winter cycle this causes regional and global variations in air temperature.

It is well understood that hot air rises; witness the water vapor from a boiling teakettle. Conversely cold air sinks. This occurs because hot air is less dense, or heavy, and cold air is more dense or heavy. Regional variations in air temperature because of the day/ night and summer / winter cycles result in the flow of cold dense air relative to hot air. Masses of hot air are under lower pressure and are termed low-pressure systems. Conversely masses of cold are under higher pressure and are called high-pressure systems. When these two pressure systems meet, the cold low-pressure air flows down under the warm high-pressure air which rises. The flow of air from areas of high-pressure to areas of low-pressure is called wind.

The rotation of the planet further influences wind patterns. The Earth rotates from west to east. As it rotates, the atmosphere that envelopes the earth does not move at the same speed. For someone standing on the surface of the earth this differential rotation of the planet and the atmosphere is felt as wind.

To understand how wind is produced, let us return to Antarctica and examine why it is the windiest place in the world. The air over the Antarctic Plateau sees virtually no sunlight for half the year and when it does receive solar radiation during the summer months this sunlight is weak because of the inclination of the earth at the poles. The Antarctic air mass also sits over the largest Ice cap in the world, which has a profound cooling effect. In short the Antarctic Plateau acts as a giant refrigerator that manufactures very cold and dense air.

Did You Know?

The fastest non-motorized trips from the South Pole to the Antarctic coastline have been done by Kite Skiers travelling almost 200 kilometers a day by harnessing the katabatic winds.

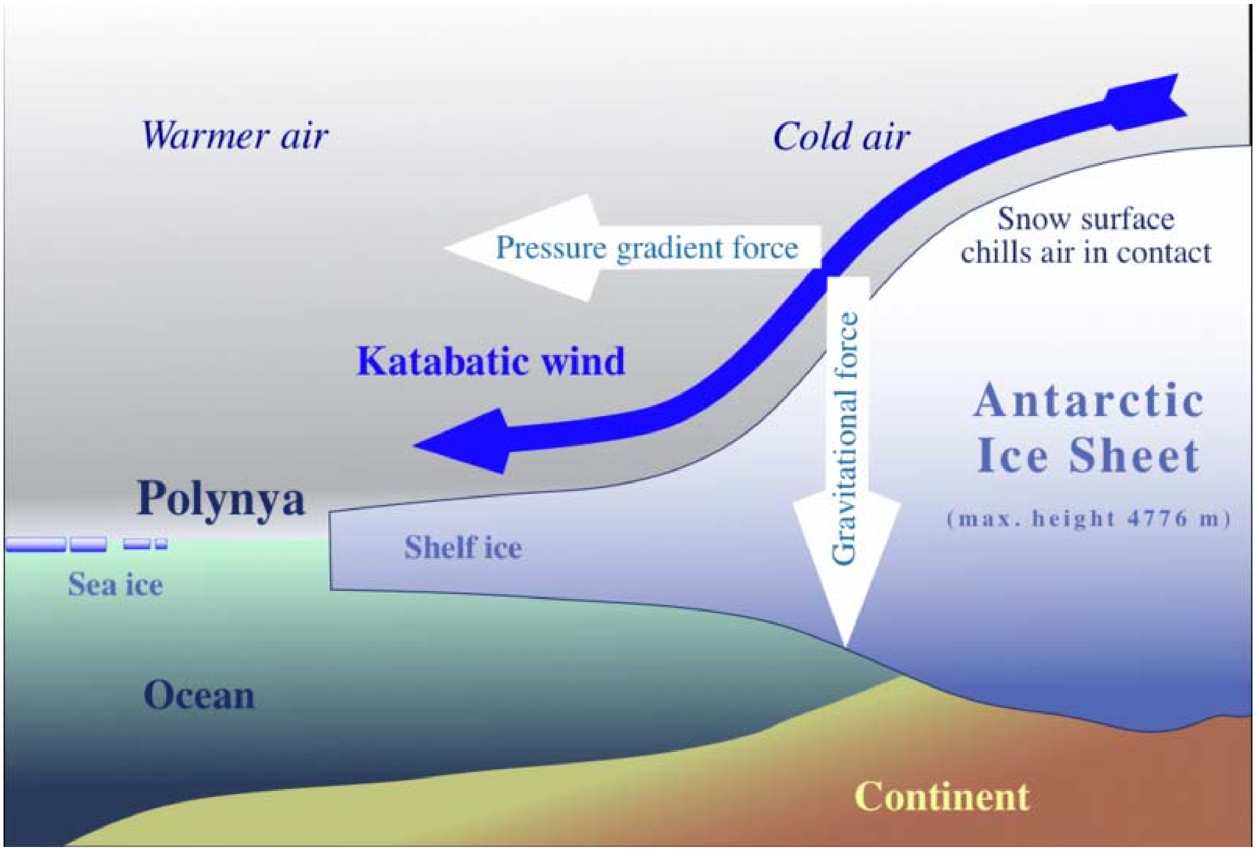

Figure 2: Katabatic wind formation (Source: Hannes Grobe, Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany).

The tendency of cold dense air is to flow downward, displacing warmer air. The Antarctic Plateau sits at very high elevation, much of it at 10,000 feet or more. This causes the cold dense air off the Ice Cap to flow outward towards the coastline displacing the warmer air at lower elevations. As the elevation of the continent drops suddenly toward the coast the flow of cold air speeds up, and it spills down to the Southern Ocean often at great speeds as a katabatic wind. The term katabatic is derived from Greek and means 'to go down'.

Katabatic winds occur in many parts of the world, but those in Antarctica are the fiercest, and have been measured at over 300 kilometers an hour. Other than the wind velocity measured in tornados, the katabatic winds in Antarctica are some of the strongest measured at ground level on the planet.

The windiest spot on Earth is said to be Cape Dennison at Commonwealth Bay in Eastern Antarctica. At Cape Dennison converging katabatic flow from the East Antarctic Ice Sheet results in a mean annual wind speed of 50 miles per hour (80 kilometers per hour).

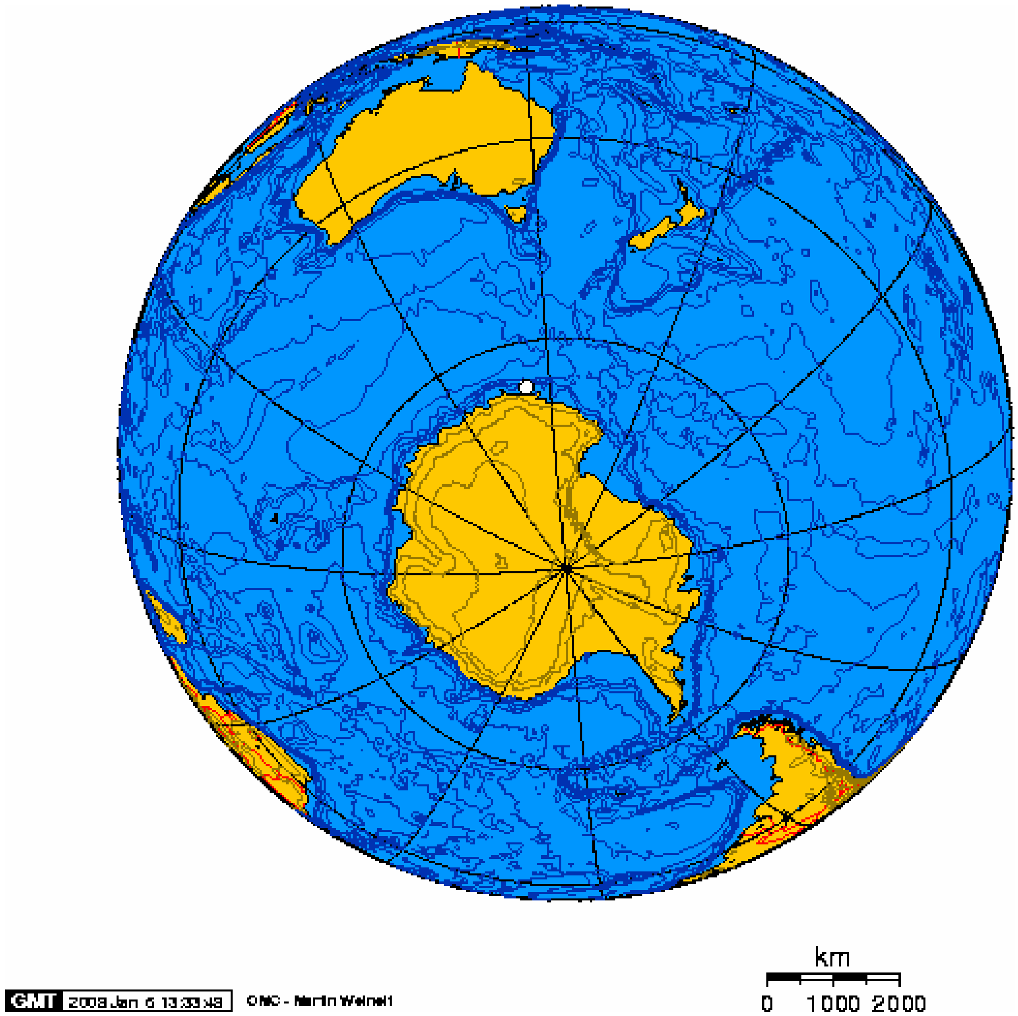

Figure 2: Cape Denison marked by a white spot, is considered to be the windiest spot on Earth (Source: Wikimedia Commons, Hal8999).

As Ray, Richard and Kevin head toward the South Pole they will be steadily rising and as such can expect to have the wind in their faces. This wind should be strongest earlier in their expedition when they will be climbing most sharply. The greatest threat this wind possesses is wind chill. Wind increases the rate at which a body loses heat, even though the absolute temperature outside remains the same. A wind chill adjusted temperature can be calculated from the projected heat loss from the body at various wind strengths.

Temperature (°F)

Wind (mph) / Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes | 10 minutes | 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph) *Effective 11/01/01*

Figure 4: Calculated wind chill temperatures in Fahrenheit at various temperatures and wind speeds (Source: National Oceanic and Atmospheric Administration)