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Weather conditions in Trondheim

Application for FIS Nordic World Ski Championship 2021
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Abstract

The report gives weather statistics for Trondheim for the last 10 years, 2006 to 2015. The data are from the nearest stations to Granåsen. For temperature this is Kopperdammen, located 5 km north of the ski resort. The data show that for all 10 years there are periods of frost for each month December to March. For snow, data from Løksmyr, located 20 km southeast of Granåsen, and at almost the same altitude, is used. For all months, except December, the maximum snow depth is on average 50 cm or more. Wind and fog are parameters that, more than others, are influenced by local topography. Wind and visibility data from Trondheim - Voll are not considered representative for the Granåsen area, as the jumping hill is well sheltered from almost all directions. Data for Voll and estimations for Granåsen are given. However, the mounting of a local weather station near the jumping hill, will give useful in situ observations for temperature, wind, precipitation, visibility, and/or other parameters at Granåsen, and thus give more accurate information about the local climate at the ski resort.

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Weather statistics for Trondheim for 2006-2015

The report gives information about air temperature, precipitation, snow, wind and fog in Trondheim. Figure 1 shows the location of the weather stations in the area. The main station in Trondheim is 68860 Trondheim – Voll, located 8 km northeast of Granåsen at 127 meters above sea level (masl). However, both the temperatures and wind conditions here are not representative for the Granåsen area. Therefore temperature data from Kobberdammen, 288 masl, are also used. The station is located 5 km north of Granåsen. Snow conditions are from 68270 Løksmyr, 173 masl, in Melhus municipality, approximately 20 km southeast of Granåsen. 67150 Leinstrand is closer to the ski resort, but is located only 13 masl, and the snow conditions here is therefore not representative for the Granåsen area. The mounting of a local weather station near the jumping hill, will give useful in situ observations for temperature, wind, precipitation, visibility, and/or other parameters at Granåsen, and thus give more accurate information about the local climate at the ski resort.



Figure 1. Location of the weather stations

Air temperature

The standard height of measurements of air temperature is 2 m above the ground, which should be covered with snow or grass. The tables show the average, maximum and minimum temperatures for each month each year. The temperature climate at Kobberdammen, belonging to Norwegian Water Resources and Energy Directorate, is considered to be more representative for Granåsen than Trondheim – Voll. As can be seen from the tables below, the temperatures are usually lower at Kobberdammen than at Voll. As shown by the minimum temperature column, all months at both stations have had periods of frost.

December

YEAR	AVERAGE		MAXIMUM		MINIMUM	
	Kobberdammen	Trondheim - Voll	Kobberdammen	Trondheim - Voll	Kobberdammen	Trondheim - Voll
2006	3,1	4,5	8,4	10,8	-3,3	-1,2
2007	-0,2	0,2	7,4	9,7	-8,4	-8,0
2008	-2,0	-0,6	5,8	7,6	-12,8	-13,0
2009	-3,9	-2,3	4,2	6,6	-16,3	-13,6
2010	-8,5	-7,3	1,5	4,4	-21,0	-18,8
2011	-0,9	0,4	7,2	9,5	-9,1	-7,5
2012	-6,9	-5,4	5,6	7,4	-16,0	-15,9
2013	1,0	2,5	12	10,4	-11,0	-10,1
2014	-1,5	-0,2	8,2	9,4	-17,0	-16,7

January

YEAR	AVERAGE		MAXIMUM		MINIMUM	
	Kobberdammen	Trondheim - Voll	Kobberdammen	Trondheim - Voll	Kobberdammen	Trondheim - Voll
2006		0,2		9,5		-12,4
2007	-1,7	-0,5	4,7	7,8	-12,7	-12,5
2008	-1,1	0,6	6,3	8,0	-11,1	-9,3
2009	-2,5	-0,9	7,6	10,1	-14,5	-14,3
2010	-8,3	-7,0	3,2	3,9	-21,9	-21,9
2011	-1,7	-0,3	4,4	5,7	-13,4	-10,0
2012	-3,1	-1,9	4,5	5,0	-13,1	-12,1
2013	-4,4	-3,8	5,1	6,6	-14,6	-15,5
2014	-4,3	-2,3	6,5	8,9	-17,9	-16,4
2015	-1,8	0,1	5,8	6,2	-14,5	-11,6

February

YEAR	AVERAGE		MAXIMUM		MINIMUM	
	Kobberdammen	Trondheim - Voll	Kobberdammen	Trondheim - Voll	Kobberdammen	Trondheim - Voll
2006		-0,7		7,1		-13,5
2007	-5,7	-4,0	5,9	6,3	-19,9	-18,7
2008	0,2	1,3	6,1	8,5	-12,7	-11,5
2009	-4,1	-3,0	3,4	5,3	-13,9	-11,0
2010	-7,3	-5,7	2,4	3,4	-23,5	-24,3
2011	-4,1	-2,5	6,2	8,4	-16,8	-17,1

2012	-1,9	-0,6	6,6	7,6	-15,7	-13,7
2013	-3,7	-2,6	5,2	6,0	-17,4	-19,5
2014	1,6	3,7	9,9	12,6	-9,1	-6,3
2015	0,2	1,7	8,3	9,9	-7,3	-6,2

March

YEAR	AVERAGE		MAXIMUM		MINIMUM	
	Kobberdammen	Trondheim - Voll	Kobberdammen	Trondheim - Voll	Kobberdammen	Trondheim - Voll
2006		-4,3		5,4		-17,5
2007	2,2	3,5	16,2	12,3	-6,9	-4,0
2008	-1,0	0,5	14,3	12,3	-16,0	-14,5
2009	0,3	1,8	8,8	9,7	-11,7	-9,0
2010	-1,1	-0,1	9,2	7,9	-12,8	-12,5
2011	-0,3	1,1	9,5	11,3	-11,3	-8,4
2012	2,2	3,6	9,2	9,4	-6,6	-4,5
2013	-4,0	-2,7	6,9	5,9	-17,2	-16,7
2014	1,8	3,4	12,5	11,5	-13,9	-11,5
2015	1,9	3,5	11,0	12,0	-7,6	-5,9

Precipitation

The tables show the monthly number of days with 1 mm precipitation or more. Data from 68860 Trondheim – Voll.

December

YEAR	DAYS WITH PRECIPITATION
2006	20
2007	9
2008	8
2009	11
2010	9
2011	17
2012	8
2013	14
2014	14

January

YEAR	DAYS WITH PRECIPITATION
2006	12
2007	24
2008	13
2009	9
2010	8
2011	14
2012	12
2013	13
2014	2
2015	10

February

YEAR	DAYS WITH PRECIPITATION
2006	15
2007	10
2008	17
2009	17
2010	8
2011	8
2012	21
2013	9
2014	1
2015	18

March

YEAR	DAYS WITH PRECIPITATION
2006	9
2007	11
2008	14
2009	11
2010	19
2011	18
2012	25
2013	13
2014	13
2015	9

Snow conditions

The tables show the average and maximum snow depth and also the maximum increase in snow depth from one day to another. Data from 68270 Løksmyr. For all months, except December, the maximum snow depth is usually 50 cm or more.

December

YEAR	AVERAGE SNOW DEPTH (cm)	MAXIMUM SNOW DEPTH (cm)	MAXIMUM DAILY INCREASE IN SNOW DEPTH (cm)
2006	1	19	13
2007	27	47	2
2008	35	46	4
2009	3	10	3
2010	42	67	18
2011	20	32	11
2012	6	15	8
2013	18	44	22
2014	15	45	16
Average	19	36	11

January

YEAR	AVERAGE SNOW DEPTH (cm)	MAXIMUM SNOW DEPTH (cm)	MAXIMUM DAILY INCREASE IN SNOW DEPTH (cm)
2006	17	26	2
2007	31	76	17
2008	10	30	11
2009	67	116	25
2010	26	38	17
2011	59	80	10
2012	48	69	20
2013	3	11	4
2014	0	2	2
2015	30	50	16
Average	29	50	12

February

YEAR	AVERAGE SNOW DEPTH (cm)	MAXIMUM SNOW DEPTH (cm)	MAXIMUM DAILY INCREASE IN SNOW DEPTH (cm)
2006	17	35	18
2007	48	57	15
2008	19	31	15
2009	76	102	13
2010	50	60	13
2011	47	63	13
2012	66	94	11
2013	34	40	13
2014	0	2	3
2015	18	37	13
Average	38	52	13

March

YEAR	AVERAGE SNOW DEPTH (cm)	MAXIMUM SNOW DEPTH (cm)	MAXIMUM DAILY INCREASE IN SNOW DEPTH (cm)
2006	27	35	9
2007	30	42	19
2008	35	51	14
2009	85	98	12
2010	58	91	16
2011	49	83	17
2012	37	69	15
2013	45	55	13
2014	15	52	21
2015	2	6	4
Average	38	58	14

Wind

The standard height of wind measurements is 10 m above the ground. An average over 10 minutes defines the mean wind speed. Wind gusts are usually recorded for 3 seconds intervals.

Figure 2 shows a wind rose for Trondheim – Voll for the months December to March, where we can clearly see the domination of winds from the south and southwest.

The wind conditions are to a large degree dependent on the surrounding terrain, and the condition at Granåsen may therefore be considerably different from Voll. Although Voll is within the urban area of Trondheim, it is situated in a relatively open field and exposed to wind from all directions (Figure 3). Granåsen, which is shown in Figure 4, has quite different surroundings. The ski jumping hill is surrounded by spruce forest, which provides shelter from the wind. In addition to this most of the jumping hill is also sheltered by the surrounding terrain, especially to the south southwest. This is important in this regard, as south and south-southwest are the wind directions that occur most frequently in Trondheim (Figure 2). The consequence of the sheltering terrain and the spruce forest is that Granåsen will be considerably less exposed to wind than Voll, and wind observation from Voll will give a too high frequency of strong winds.

Unfortunately there are no wind observations in the vicinity of Granåsen, which makes it difficult to quantitatively relate the wind at Voll and Granåsen to each other. However the Norwegian guidance to wind loads on structures (Standard Norge, 2009) can help us to perform a coarse estimate as it distinguishes between different categories of terrain. Considering the spruce forest surrounding Granåsen and the relatively open surroundings at Voll, the wind loads at Granåsen would be between 60 and 70 % of the loads at Voll according to Standard Norge. Though these figures are valid for wind with 50 year return period, they provide an indication of the difference between these two sites. In reality the difference would be larger because of the sheltering terrain south southwest of the ski jumping hill. It is likely that moderate winds from south or south-southwest, will give calm conditions at Granåsen.

Wind rose, frequency distribution of wind

Winddirection divided in sectors of 30°

Frequency distribution of wind speed in percent %

Wind speed (m/s)

- >20.2
- 15.3-20.2
- 10.3-15.2
- 5.3-10.2
- 0.3-5.2

Calm (%)



Year: 2006 - 2015

Jan, Feb, Mar, Dec

Hour: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23 (NMT)

68860 TRONDHEIM - VOLL

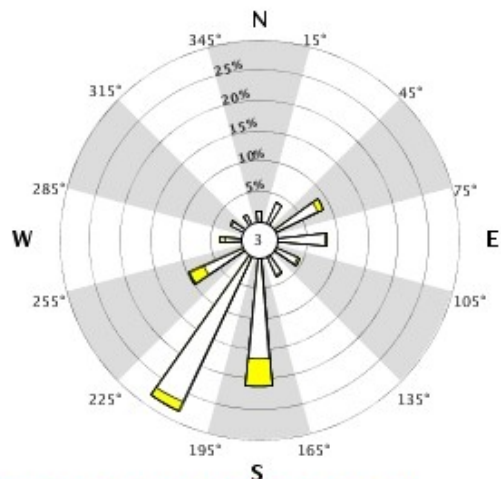


Figure 2. Wind rose for Trondheim - Voll for 2006-2015



Figure 3. Voll meteorological station



Figure 4. Granåsen ski jumping hill

The tables below show the number of days each month with highest mean wind below 1.5 m/s, between 1.5 and 2.8 m/s and above 6.7 m/s. Also the highest 3 seconds gust recorded each month is listed. The data are from Trondheim - Voll, but estimations for Granåsen are given in brackets. The calculations are performed by setting the wind at Granåsen as 70 % of the values at Voll.

December

YEAR	NUMBER OF DAYS 0-1.5 m/s	NUMBER OF DAYS 1.5-2.8 m/s	NUMBER OF DAYS ≥ 6.7 m/s	MAXIMUM GUST (m/s) at Voll and estimated values for Granåsen	
2006	0 (0)	0 (2)	18 (10)	26,7	18,7
2007	0 (1)	3 (7)	8 (3)	17,7	12,4
2008	0 (0)	4 (11)	10 (4)	18,4	12,9
2009	0 (0)	3 (13)	6 (0)	15,8	11,1
2010	0 (0)	4 (11)	2 (0)	14,8	10,4
2011	0 (0)	2 (6)	13 (11)	30,3	21,2
2012	0 (0)	3 (14)	6 (2)	19,6	13,7
2013	0 (0)	0 (1)	19 (7)	31,8	22,3
2014	0 (0)	0 (3)	10 (3)	20,0	14,0

January

YEAR	NUMBER OF DAYS 0-1.5 m/s	NUMBER OF DAYS 1.5-2.8 m/s	NUMBER OF DAYS ≥ 6.7 m/s	MAXIMUM GUST (m/s) at Voll and estimated values for Granåsen	
2006	2 (3)	2 (6)	17 (10)	23,0	16,1
2007	0 (0)	0 (3)	13 (5)	19,3	13,5
2008	0 (0)	1 (3)	17 (10)	22,6	15,8
2009	0 (0)	5 (7)	16 (6)	20,1	14,1
2010	2 (3)	3 (11)	7 (2)	20,4	14,3
2011	0 (0)	1 (7)	12 (5)	22,8	16,0
2012	0 (1)	2 (10)	8 (3)	23,5	16,5
2013	0 (0)	2 (14)	2 (2)	18,8	13,2
2014	0 (0)	2 (4)	19 (4)	20,6	14,4
2015	0 (0)	0 (2)	14 (1)	19,8	13,9

February

YEAR	NUMBER OF DAYS 0-1.5 m/s	NUMBER OF DAYS 1.5-2.8 m/s	NUMBER OF DAYS ≥ 6.7 m/s	MAXIMUM GUST (m/s) at Voll and estimated values for Granåsen	
2006	0 (0)	1 (9)	4 (3)	21,6	15,1
2007	0 (8)	0 (5)	11 (4)	19,5	13,7
2008	0 (0)	0 (3)	17 (5)	24,6	17,2
2009	0 (0)	0 (13)	0 (0)	11,2	7,8
2010	0 (0)	0 (10)	0 (0)	13,6	9,5
2011	0 (0)	0 (2)	11 (5)	20	14,0
2012	0 (1)	2 (6)	12 (3)	17,4	12,2
2013	0 (0)	5 (13)	5 (1)	19,1	13,4
2014	0 (0)	0 (2)	21 (5)	19,7	13,8
2015	0 (0)	2 (7)	18 (8)	26,5	18,6

March

YEAR	NUMBER OF DAYS 0-1.5 m/s	NUMBER OF DAYS 1.5-2.8 m/s	NUMBER OF DAYS ≥ 6.7 m/s	MAXIMUM GUST (m/s) at Voll and estimated values for Granåsen	
2006	0 (0)	0 (13)	5 (0)	17,2	12,0
2007	0 (0)	4 (11)	14 (3)	20,4	14,3
2008	0 (0)	1 (5)	10 (5)	21,1	14,8
2009	0 (0)	1 (6)	14 (5)	17,7	12,4
2010	0 (0)	2 (13)	4 (0)	13,7	9,6
2011	0 (0)	0 (2)	19 (9)	24,9	17,4
2012	0 (0)	1 (4)	21 (8)	24,0	16,8
2013	0 (0)	0 (6)	6 (3)	25,6	17,9
2014	0 (0)	2 (6)	17 (6)	23,6	16,5
2015	0 (0)	2 (6)	15 (7)	21,7	15,2

Fog

The formal definition of fog is that the visibility is below 1 km. Like wind, fog also shows large local variations, due to varying topography. Trondheim – Voll has only a short series of measurements of visibility, going back to 2010. For the months December to March, the daily variation is small and for the period 2010 to 2015 the visibility was less than 1 km only in 12 out of 2485 daytime observations, giving an average for all four months of 0.5 %.

Fog frequency increases with height, so slightly higher figures for Granåsen could be expected for the highest hills in the area.