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TURBULENCE: AN IMPORTANT FACTOR FOR FLIGHT OPERATIONS AT ANTARTIC STATION COM. FERRAZ

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Abstract: This study presents the case of an extreme wind gust event that occurred between the 18th and 19th of January of 2002, in the Brazilian Antarctic Station (EACF) area, where the near-ground air turbulence hindered a helicopter from landing for more than 10 hours, even under favorable general synoptic conditions. The EACF (62°05'S; 58°23,5'W) is located on the Keller Peninsula (3.8 km long, 2.2 km wide), which is a ridge of elevations between 250 e 360 m msl protruding into Admiralty Bay, King George Island, Antarctica. Turbulence was estimated using the wind gust factor and wind turbulence definitions that are normally applied in engineering studies of applied meteorology.

Keywords – *Wind Turbulence, Gust Factor, Flight Operations, King George Island, Antarctica.*

1. INTRODUCTION

The Antarctic Peninsula Region is noted for its intense airborne activity. On King George Island (KGI), in the South Shetland Archipelago, with elevations up to 700 m, aligned in the NE-SW direction, and where wind speeds can easily reach 36 ms^{-1} (70 knots) at least once every month (Romão et al., 2005), it is common for airplanes and helicopters to face local turbulence. Among the many scientific stations at KGI, the Brazilian scientific station *Estação Antártica Comandante Ferraz* (EACF) is located on the Keller Peninsula, deep inside the northern sector of a fjord known as Admiralty Bay, the largest inlet on KGI (Figure 1).

Figure 1. Map of King George Island, Keller Peninsula (black arrow) and EACF (red dot).

During the 18th and 19th of January 2002, a Uruguayan Air Force helicopter (Bell UH-1H) approaching EACF aborted its landing on the helipad many times after facing near-ground air turbulence. At least three air currents occurred at that moment: one, coming down from the local glaciers in the north, another from the sea at south and east, and the third coming down from Flagstaff Mt., the 216 m elevation at west behind the EACF.

The objective of this work is to understand the structure of this atmospheric turbulence that occurred at the EACF helipad.

2. MATERIALS AND METHODS

The EACF helipad (62º05'S; 58º23,5'W) is located on the east side of the Keller Peninsula, approximately 800 m from the base of Flagstaff Mt., situating this station inside a zone of turbulent recirculation, where severe regional meteorological conditions are common. Turbulence analysis was made according to the definitions normally employed in applied meteorology studies for engineering problems, e.g. as in Plate (1982), Bergstrom (1987), Kristensen et al., (1991) and Young and Kristensen (1992). The analysis of wind gusts is one of the ways to study the structure of turbulence at any place, and where such events can be defined as the sudden increase/decrease of wind speed at very small and continuous cycles.

For the purpose of comparison, the event of 2002 was analyzed in relation to two other years, 2001 and 2003, during the period of 15th to the 25th of January in the three years. The wind data was obtained with a Wind Monitor Sensor R.M.Young Model 05103. This equipment is installed on a 10 m anemometric tower adjacent to EACF, at 20 m msl. Wind speed and direction were stored in a Datalogger Campbell 21X, and where the full hour value registered is the average of the last ten minutes interval, sampled at each second – see http://www.cptec.inpe.br/antartica. The parameters measured were the 10-minutes average scalar speed (ms^{-1}),

10-minutes average direction (degrees), and the daily maximum gust; the calculated variables were the wind gust factor, gust amplitude (ms^{-1}) and turbulence intensity.

3. RESULTS

Table 1 shows the measured values of speed and maximum speed) and the calculated values of the variables: gust factor $G = V_{max} / V_{mean}$, gust amplitude $A = (V_{max} - V_{mean})$, and turbulence intensity $I = \sigma_{speed} / V_{mean}$.

At investigating the maximum and minimum average wind speeds, the wind gust factor and turbulence intensity from the 15th to the 25th of January, 2002, we were able to establish that from the 15th on, turbulence conditions occurred with values over the registered mean values for the EACF region. The maximum registered wind speed were approximately 30 ms^{-1} for the 15th, 15 ms^{-1} for the 16th, 22 ms^{-1} for the 17th, 25 ms^{-1} for the 18th and 17 ms^{-1} for the 19th. The landing of any aircraft was possible only on the latter day. Wind gust amplitude values were also high for the same period, varying between 20 and 10 ms^{-1}. The turbulence intensity for the same period stabilized around 0.6. The synoptic conditions during this period showed extra-tropical cyclones located over the eastern side of the Antarctic Peninsula (southeast of the EACF) and occluding on the 18th.

Year	2001					2002					2003				
Day	V_m	V_{max}	G	A	I	V_m	V_{max}	G	A	I	V_m	V_{max}	G	A	I
15	8.3	18.5	2.2	10.2	0.5	9.4	29.6	3.1	20.2	0.6	3.3	11.2	3.4	7.9	0.3
16	4.5	14.7	3.3	10.2	0.4	5.2	14.7	2.8	9.5	0.6	2.3	8.1	3.5	5.8	0.3
17	7.7	17.2	2.3	9.6	0.3	6.2	22.0	3.6	15.8	0.6	2.3	8.2	3.5	5.9	0.4
18	2.3	9.3	4.1	7.1	0.3	7.2	25.1	3.5	17.9	0.5	1.1	5.2	4.6	4.0	0.5
19	3.2	10.1	3.1	6.9	0.5	6.4	17.0	2.7	10.6	0.4	5.5	9.8	1.8	4.3	0.8
20	3.7	11.9	3.3	8.2	0.4	6.7	21.3	3.2	14.6	0.5	8.0	16.2	2.0	8.2	0.3
21	3.6	9.0	2.5	5.3	0.6	4.1	25.3	6.2	21.3	0.4	3.0	9.8	3.3	6.8	0.6
22	4.5	10.5	2.3	6.0	0.6	2.1	8.0	3.8	5.9	0.6	2.3	6.9	3.1	4.7	0.6
23	7.2	23.2	3.2	16.0	0.6	5.5	13.6	2.5	8.1	0.4	2.3	7.6	3.3	5.3	0.4
24	3.8	10.4	2.8	6.7	0.4	4.0	13.0	3.3	9.0	0.4	9.7	18.3	1.9	8.6	0.4
25	3.7	9.1	2.5	5.4	0.7	3.6	10.1	2.8	6.6	0.6	10.0	22.9	2.3	12.8	0.2

Table 1. Mean values for wind characteristics: mean speed (V_m), maximum speed (V_{max}), wind gust factor (G), gust amplitude (A) and turbulence intensity (I).

4. CONCLUSION

Between the 18th and the 19th of January, 2002, the EACF faced adverse wind conditions for helicopter landing, noticed in the average and maximum wind speed, and in the wind gust factor and amplitude. The reason for such results is that this factor is obtained dividing the maximum speed by the average speed. Noteworthy is the fact that the wind gust factor of 2002 is inferior to the compared 2001 and 2003 corresponding periods. Turbulence intensity did not present any distinct behavior when related to the observed wind speed for the period in 2002. This is probably due to the wind circulation complexity deep inside the fjord, and also to persistent regional winds. 2001 and 2003 served as the baseline to compare and analyze the 2002 extreme event, which presented above average climatological values. The occurrence of this event is possibly related to the relatively high average wind intensity (~5 ms^{-1} above average) and predominating southeast winds, that when combined to the KGI topography and the EACF position on Keller Peninsula, result in a near-ground air turbulence and wind gust occurrence zone, making flight operations potentially difficult or even hazardous.

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