A Rather Rare West-Coast Sting-Jet Event during December 12-13th, 2015

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1. Introduction

According to Browning (2004), sting jets occur within the dry slot at the "tail end of the bent-back front", and are regions of potentially extremely damaging winds. Other studies have shown, through satellite observations and numerical modeling, their three-dimensional structure as a corridor of winds descending from the area near the bent-back warm front and toward the surface, often with violent effect (Browning and Field 2004; Clark et al. 2005).

On December 12th, 2015, a significant wind and rain storm battered the South Coast and Vancouver Island of British Columbia (BC), Canada. Higher elevations of the Island and Coast Ranges of Southern BC received impressive snowfalls from this storm: up to 75 cm in one case (Lindsay 2015a). Strong winds were reported at many locations with more than 20,000 customers without power on southern Vancouver Island and part of the Lower Mainland of southwestern BC (Lindsay 2015a). At one ski resort on Grouse Mountain near Vancouver, more than 300 tourists were trapped overnight on the mountain (where shelter was available) as the Gondola used to transport visitors from the parking area at the foot of the mountain to the base station could not operate under the wind velocities that developed (Lindsay 2015b).

This note provides a brief description of this storm based on observational data and the conceptual model of a sting jet proposed by Browning (2004).

2. Observational evidence

Synoptically, a deepening low (approximately 970 mb) was moving ESE toward central Vancouver Island on the afternoon of the 12th. From imagery (Fig. 1), the process of occlusion was well underway, and the trailing surface cold front was rapidly crossing Vancouver Island, heading east. Perhaps the most compelling evidence for a sting jet event on December 12-13th 2015 are the radiosonde data taken from a fortunately nearby launch site, Quillayute, located on the NW coast of in Washington State (Fig. 2). Storm development was supported by a jet stream traveling in excess of 180 kt, although this was estimated from model forecasts as observations did not extend to that level on the 00Z Quillayute sounding – the radiosonde traveled too far downrange and out of contact with the receiving station. Of note is the strong subsiding drying and warming evident between approximately 400 and 600 mb. This is a typical feature of sting jets (Browning 2004).

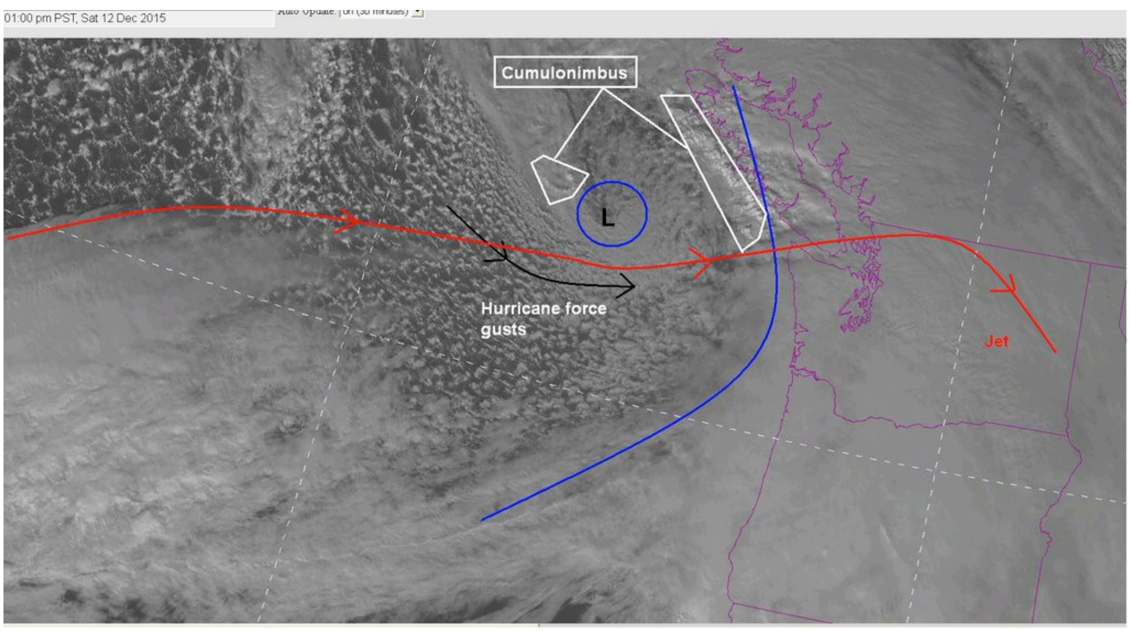

Figure 1: Visible satellite imagery taken at 1:00 pm PST (2100 UTC), 12 December 2015.

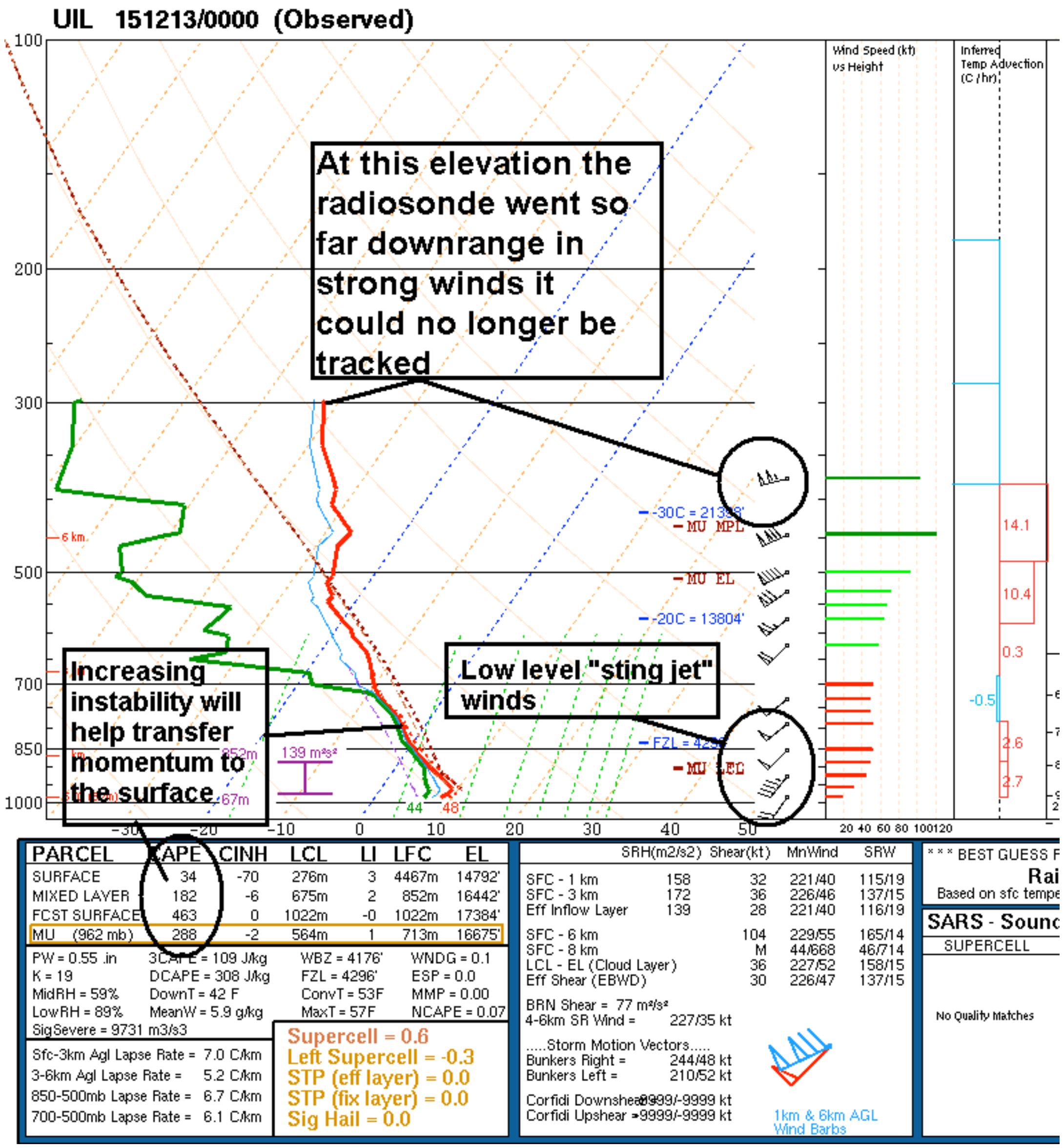

Figure 2. Quilayute sounding at 0000 UTC, 13 December 2015. Annotations are the author's.

Some observations from offshore buoys (Figures 3–5) corroborate the strong winds evident in the sounding. A buoy inshore near the intersection of southern Georgia and eastern Juan de Fuca Straits (Fig. 6) shows elevated wind speeds although not of the same velocities as the offshore buoys.

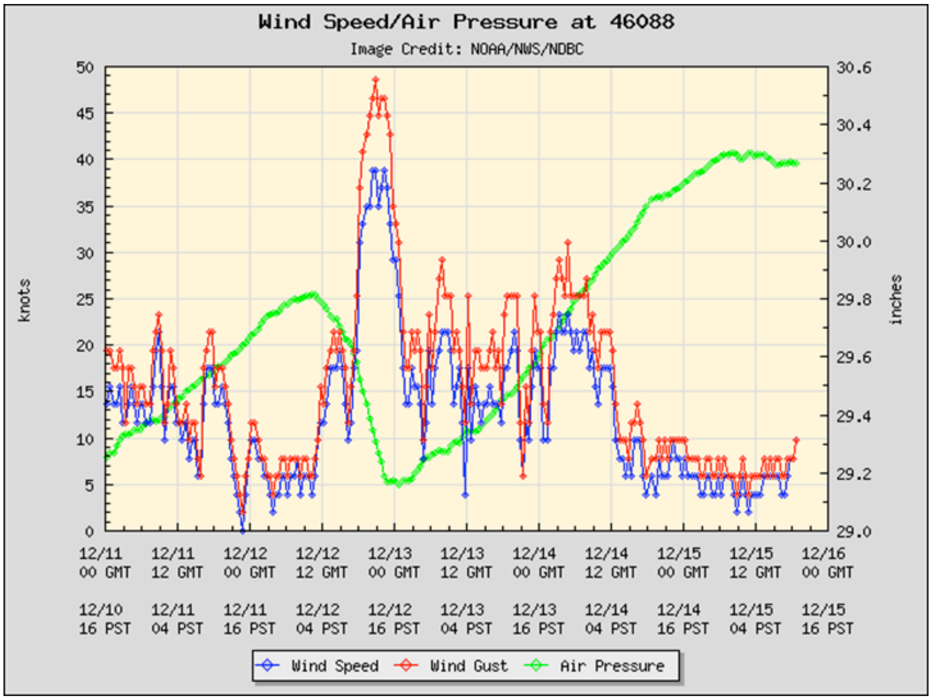

Figure 3: Station 4608:, New Dungeness, 17 NM NE of Port Angeles, WA.

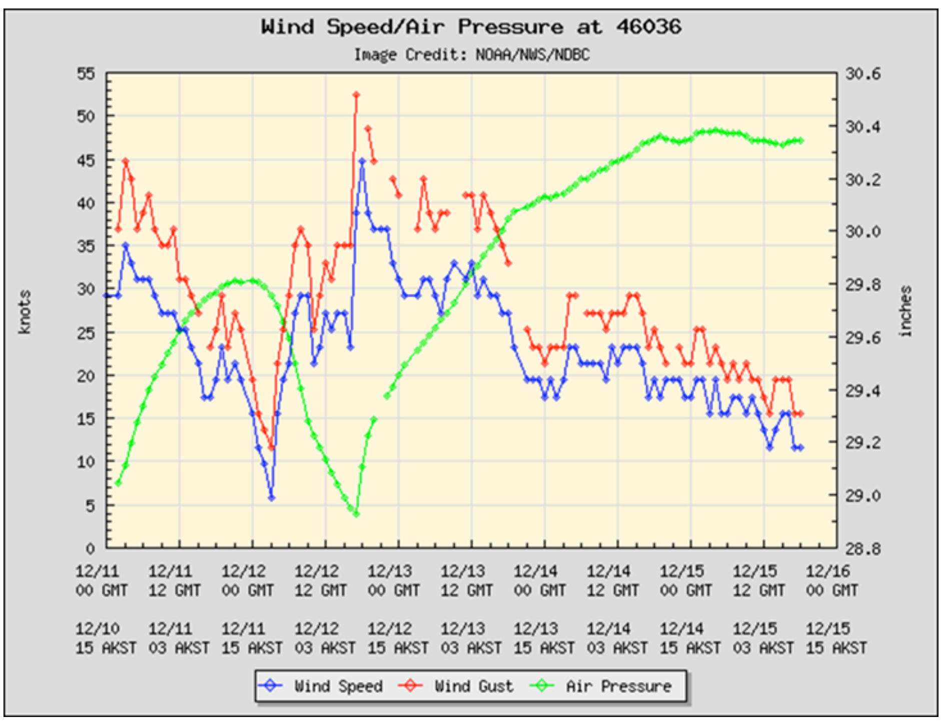

Figure 4: Station 46036: Environment Canada South Nomad buoy, 48.355^{o}N, 133.938^{o}W.

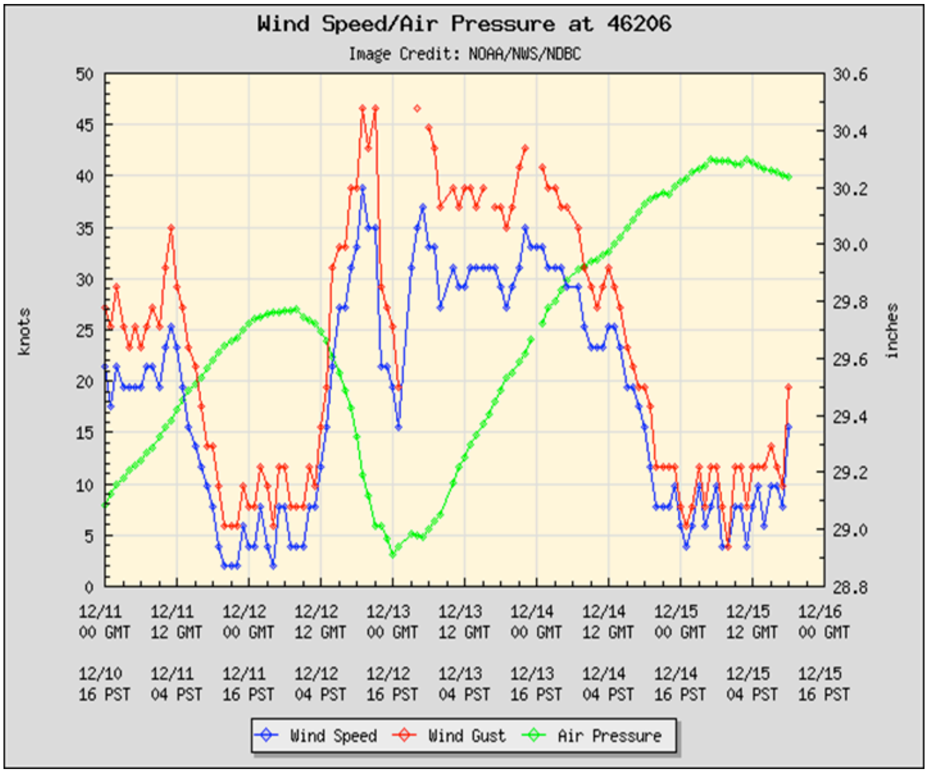

Figure 5: Buoy 46206: Environment Canada La Perouse Bank Buoy, 48.835°N, 125.59°W.

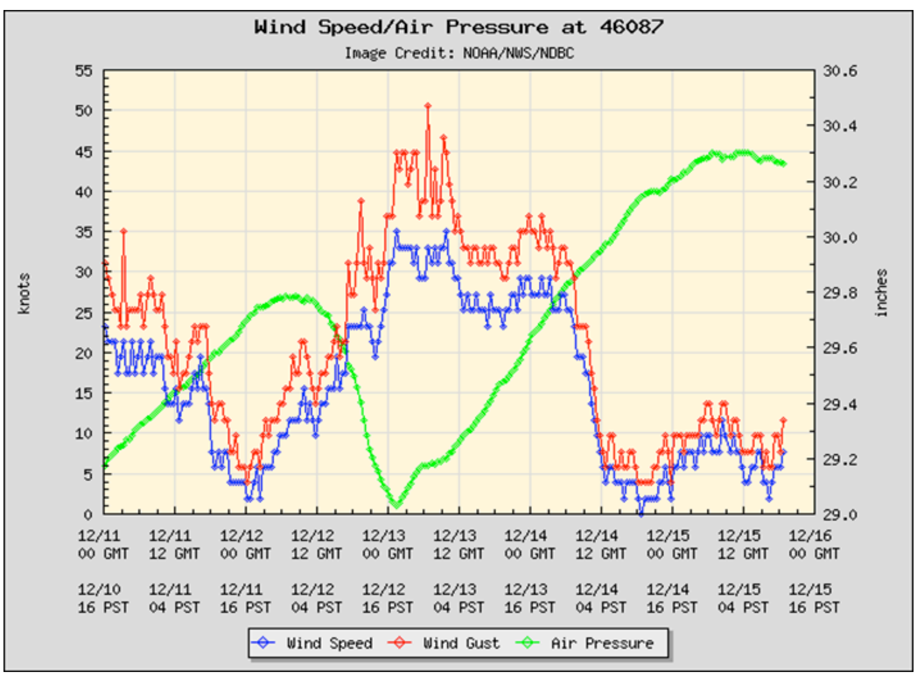

Figure 6: Station 46087: Neah Bay, 6NM North of Cape Flattery, WA.

Satellite imagery (Figure 7) recorded at a time nearly coincident with the Quillayute sounding indicated storm structure consistent with a classic sting jet.

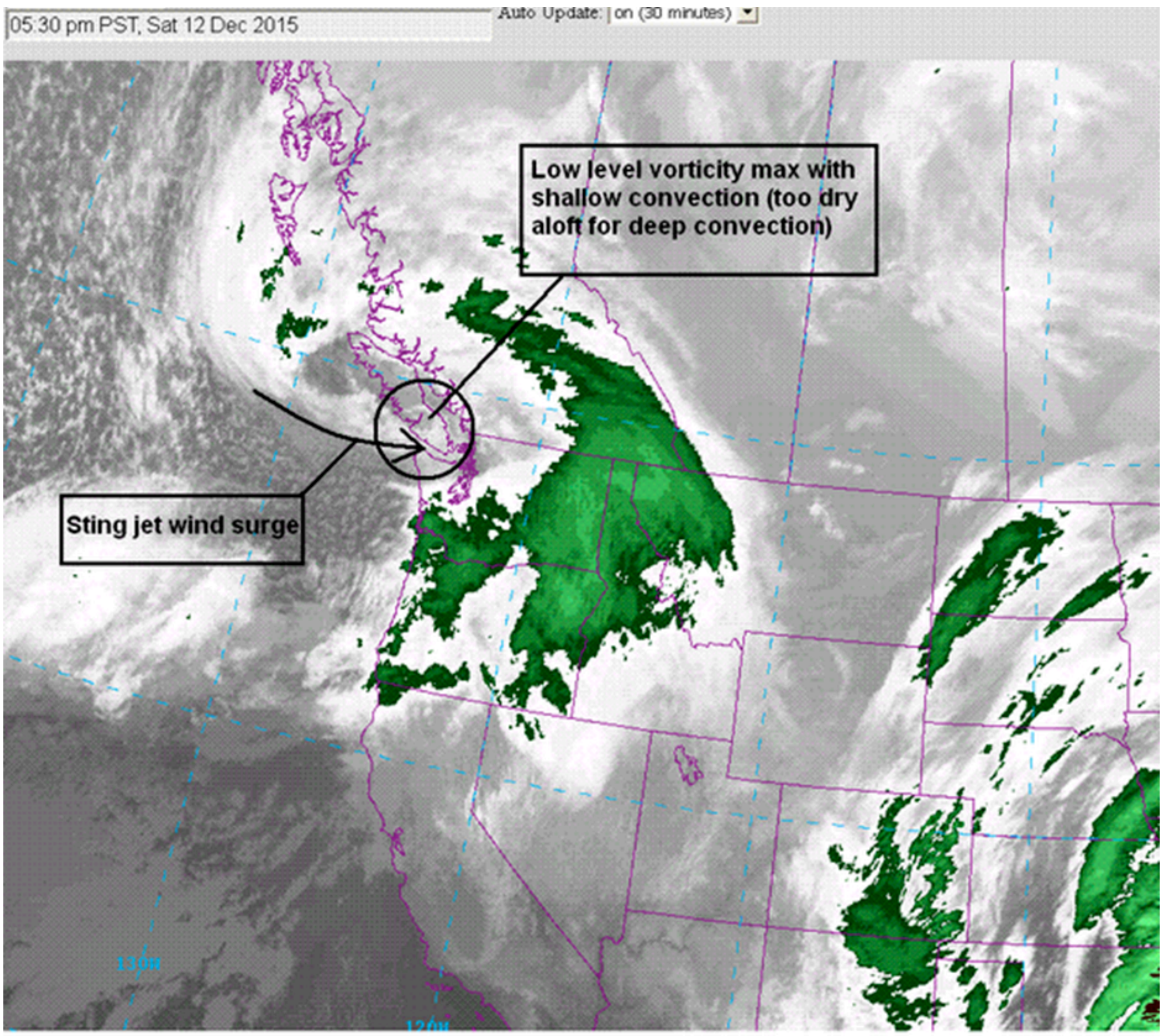

Figure 7: Infrared satellite imagery taken at 17:30 p.m. PST, 12 December 2015 (0230 UTC, 13 December 2015). Annotations are the author's.

3. Conceptual model

Figure 7 can be compared with the conceptual model of a sting jet proposed by Browning (2004), as illustrated in Figure 8 (Figure 2 in Browning 2004).

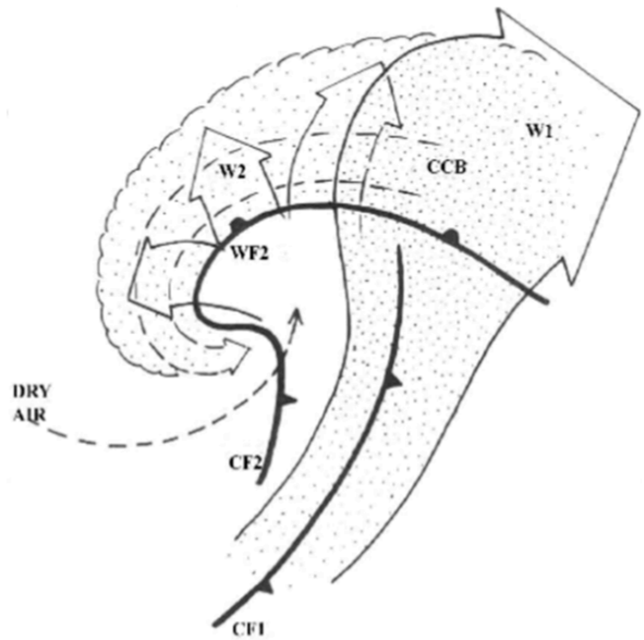

Figure 2. Conceptual model of the principal airflows in an extratropical cyclone undergoing transition from Stage III to Stage IV in Fig. 1. The flows are drawn relative to the cyclone system which is travelling towards the top right-hand corner of the page. The two main cloud features are shown stippled: (i) the polar-front cloud band, which is associated with the ascent of the primary warm conveyor belt (broad arrow labelled W1) as it travels parallel to the primary cold front (CF1); and (ii) the cloud head (to the left of the bent-back front WF2), which is associated with the ascent of the secondary warm conveyor belt (W2, represented by three broad diffluent arrows originating to the right of WF2/CF2) and the cold conveyor belt (broad dashed arrow labelled CCB representing a flow beneath W1 and W2). Notice the hooked end of the cloud head where the cold conveyor belt intrudes into the dry slot behind the secondary cold front (CF2) beneath an intrusion of recently-descended very dry air (thin dashed line). (Redrafted from Bader *et al.* 1995.)

Figure 8: The conceptual model of a sting jet proposed by Browning (2004).

Further evidence of sting jet structure can be found in the 850 mb height and temperature analysis (Figure 9), courtesy of the University of Washington weather web site: http://www.atmos.washington.edu/data/. Here we can see a warm core seclusion of 850 mb with temperatures in excess of 0C wrapped almost completely around the low center; the surface cold front well inland through Washington State, and the dry air intrusion in-line with the sting jet.

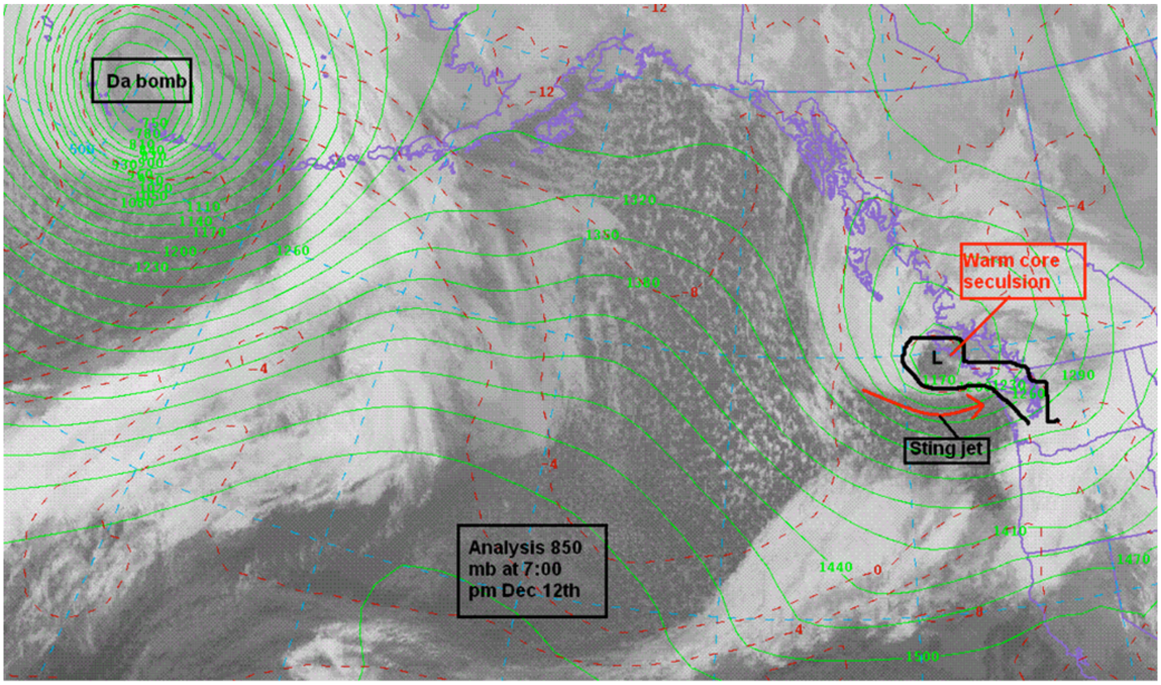

Figure 9: 850 mb height and temperature analysis valid 0300 UTC, 13 December 2015, courtesy the University of Washington Atmospheric Sciences. Annotations are the Author's.

Figure 10 is a recent picture of the north shore highlighting the gondola track up to the base of the Grouse Mountain lifts. Much of the recent relatively low elevation snow is attributable to the sting jet storm and the strong orographic ascent forced by the intersection of the jet and south facing topography.

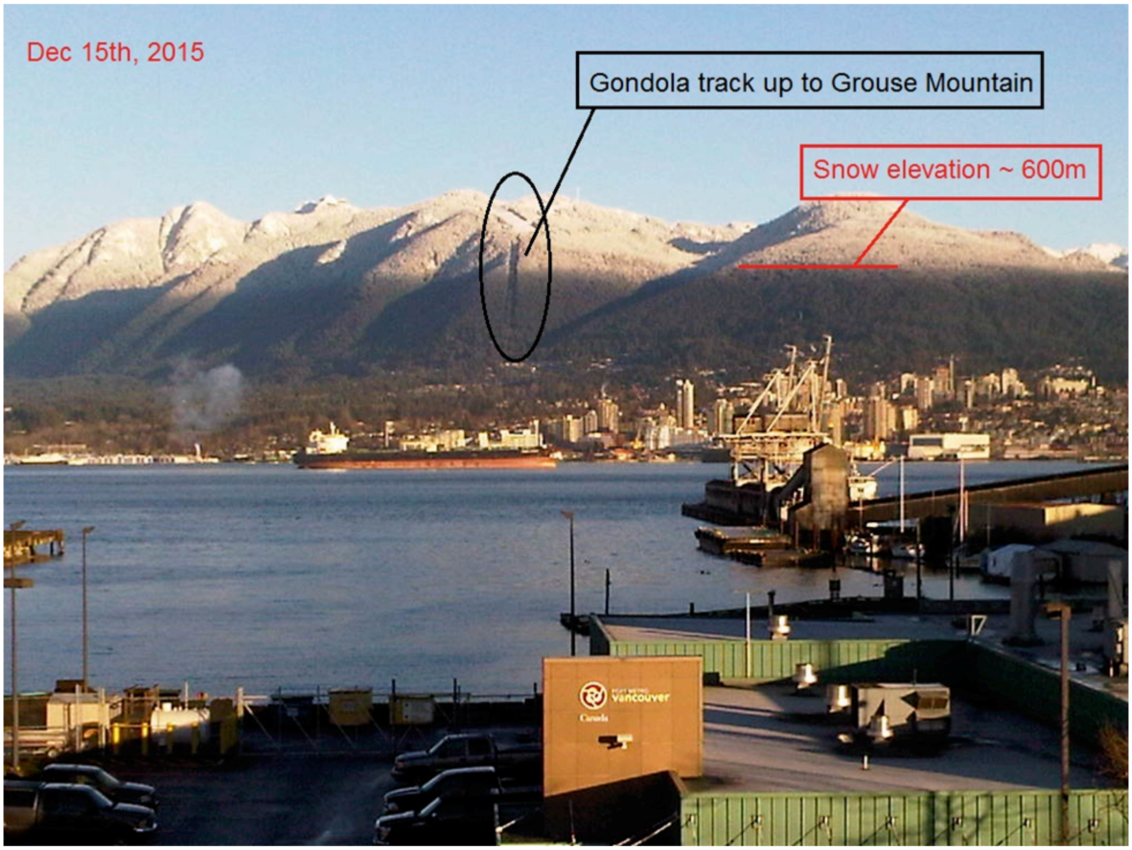

Figure 10: Grouse Mountain in North Vancouver.

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Lindsay, B., 2015b: Hundreds stranded overnight on North Vancouver’s Grouse Mountain as wind forces gondola. National Post, 14 December 2015. [Online version available at http://news.nationalpost.com/news/canada/high-winds-force-gondola-closure-hundreds-stranded-overnight-on-vancouvers-grouse-mountain].