12B.4 EXAMPLES OF MOUNTAIN INDUCED WINDS IN ATLANTIC CANADA

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1. INTRODUCTION

Examples are presented of local down slope wind events that occur in Atlantic Canada. Although the terrain is less than 500 metres in elevation wind gusts reaching in excess of hurricane force are often reported.

The Meteorological patterns and forecasting challenges are described.

Examples of some unusual down slope winds are also given.

2. LOCATION

The principal area of study is the west coast of Cape Breton Island where the Northeast to Southwest oriented Cape Breton Highlands slope steeply down to the Gulf of St Lawrence from a rather flat plateau of around 480 metres. Southeasterly winds blowing across the highlands frequently accelerate into down slope wind storms.

A large proportion of the local population are of French Acadian descent and French is widely spoken in the area. Locally these winds are known as “Les Suêtes,” which is derived from a corruption of the French pronunciation of Southeast, “Sud est.” The fact that the winds have been given a name is indicative of the fact these are not isolated events and that the locals are familiar with their occurrence.

Across the Cabot Strait, in southwestern Newfoundland, similar but somewhat higher elevations combined with added effects of some degree of funneling and channeling, result in often even stronger winds in the area which is appropriately named “Wreckhouse.”

3. HISTORY

3.1 The scenery along the west coast of Cape Breton Island shows some of the impacts of these frequent wind events, for example the trees show less growth on the side facing the mountain slopes. There have been much greater impacts, tractor trailers blown over, damage to buildings, etc.

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3.2 In response to the local reports, AES (Atmospheric Environment Service –now MSC Meteorological Service of Canada) installed a U2A anemometer, with a Monroe chart recorder at Grand Étang, a few kilometres south of Cheticamp, in October 1975 and collected data until April 1977.Studies from the data confirmed the local reports and provided some insight into the cause. Later a full automatic weather station was set up at the site, and for the first time gave forecasters real time feedback allowing them to develop ways of recognizing when these events were likely to develop.

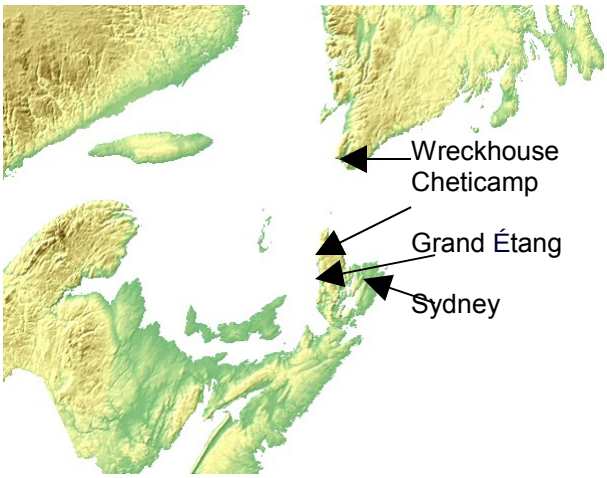

Fig 1. Atlantic Canada topographic map© Department of Natural Resources Canada. All rights reserved

4. CLIMATOLOGY OF LES SUÊTES.

Suête events can occur year round but tend to be more frequent and stronger in winter months. Gusts in excess of 90 km/h occur several times a month on winter.

Wind gusts of 147 km/h (80 knots), or more, have been recorded at least once in each year for the last 15 years. Gusts in excess of 160 km/h (87 knots) were recorded at least once in 11 of those years and gusts in excess of 200 km/h (109 knots) in 2 of the last 15 years.

In a randomly selected 6 month period from July to December in 2006 there were 11 events

exceeding the warning criteria of gusts over 90 km/h (49 knots).
Suête events typically last 5 or 6 hours but can be as short as 1 hour or, persist for more than 12 hours.

5. FORECASTING SUÊTE EVENTS

5.1 In the early days forecasters looked for patterns. Clearly a Southeast, cross barrier flow was the first requirement. Southeasterly winds are common ahead of approaching low pressure systems and frontal troughs.

5.2 The second element was to assess if the flow was deep enough to allow the Suête winds to form, guidance for this was taken from examining the 850 mb pattern. Possibly incorrectly, it was regarded as necessary to have a southeasterly flow as high as 850 mb. Usually Suête wind events did not occur and were not forecast if the 850 mb flow was around the Southwest.

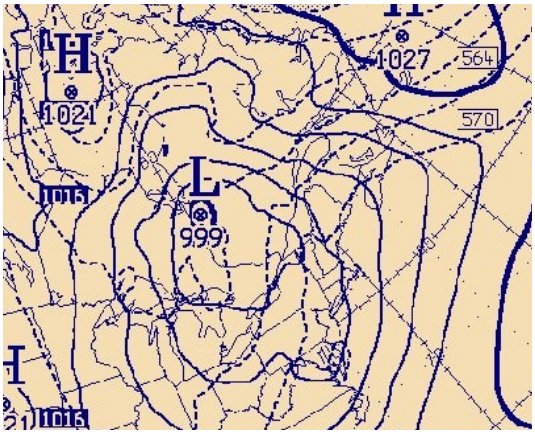

Fig 2. Surface Analysis indicating a Southeasterly flow over Cape Breton. 00UTC 30 June 2008

5.3 More recent guidance from the Canadian Regional model produced displays of maximum low level winds. During Suête events the gusts recorded at Grand Étang were usually in reasonably close agreement with the maximum low level wind in the model, so given the required pattern described above, the value of the maximum low level winds became a good first guess for the strongest gust forecast.

5.4 With improvements in numerical models came improved displays and particularly prog soundings out to 48 hours became another useful tool for forecasters, more clearly indicating the height and strength of any inversion. The prog soundings also presented a vertical wind profile.

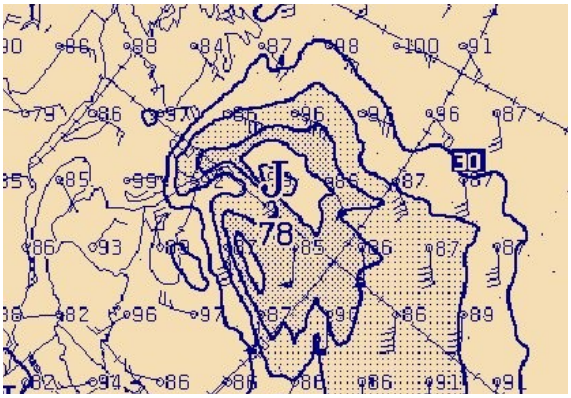

Fig 3 Maximum low level winds, from Canadian GEM model. 00 UTC 30 June 2008
(Winds are contoured in knots. Numbers indicate the pressure level at which the maximum winds are forecast in tens of millibars, (i.e. 87 would indicate 870 mb)

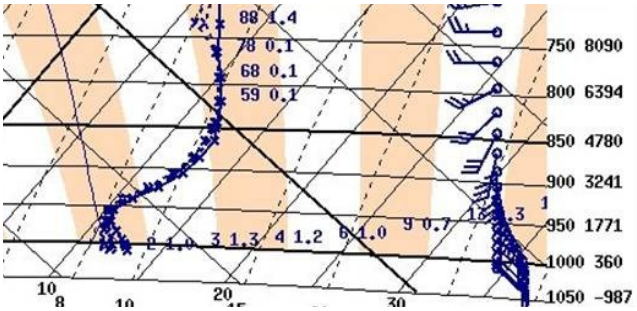

Fig 4. Prog sounding for 00 UTC 30 June 2008 for Inverness, from Canadian GEM model indicating a strong inversion based near 900 mb.

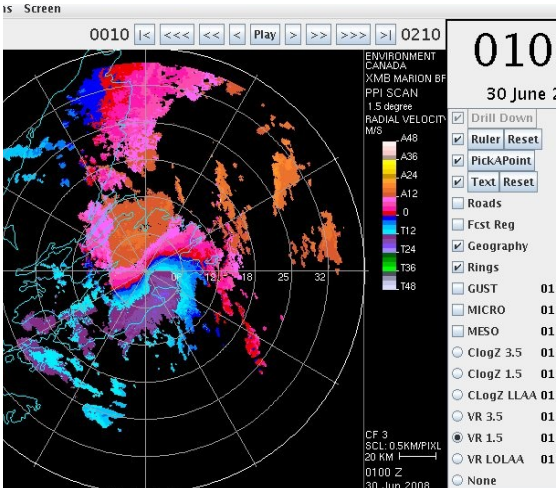

Fig 5. Doppler image from Marion Bridge at 1.5 degree elevation for 0100 UTC 30 June 2008

5.5 Monitoring Suête events has been aided by the installation of a Doppler radar at Marion Bridge, which is near Sydney on the eastern side of Cape Breton Island.. Provided there are precipitation targets Doppler radar gives a clear image of the depth of the Southeasterly wind.

5.6 The most recent development has been the implementation of the GEM LAM with 2.5 km resolution. This new model runs only once a day, it is not received in the forecast office until near 0900 UTC and it only has a 24 hour forecast out to 0600 UTC on day 2. This limits its usefulness as a tool for forecasting as warnings are normally issued a day before they would appear in the GEM LAM window, but it does provide a means of studying and learning about the phenomena as well as providing some confirmation to forecasters once an event comes within its forecast period.

6. SAMPLE EVENTS

6.1 29/30 June 2008

A recent typical event occurred on June 29 2008….In this case a 999 mb low moved northeastward across Ontario and into Northern Quebec. A warm front stretching southeastward from the low moved across Cape Breton as shown in Fig 2. A relatively minor Suête event developed in the stable Southeasterly flow ahead of the warm front. In this case the Maximum low level wind was only 41 knots, and the prog sounding, (fig 4) showed a strong inversion with temperatures near 10C at 970 mb rising to about 13 C at 860 mb. The sounding also indicated southeast winds of 32 to 37 knots (59 to 68 km/h) between 1300 ft and 3200 ft (396 to 975 metres).

Grand Etang reported a maximum gust of 102 km/h at 2100 and 2200 UTC and was reporting gusts in excess of 90 km/h for a period of 6 hours.

An interesting aside to this particular case was that although low level flow was stable, it was unstable above the inversion, resulting in heavy showers to occur at the same time as the strong southeasterly winds. Cheticamp, a few kilometers north of Grand Étang, reported 11.8 mm rain in one hour at 0300 UTC.

Fig 5 shows the Doppler radar from Marion Bridge, located near Sydney on the eastern side of Cape Breton. The strongest southeast winds can be seen below 600 m with winds veering to the southwest above.

6.2 Storm of the Century

In March 1993 a huge low pressure system which had been named “the storm of the century” brought major snow falls and very strong winds to a large proportion of the Eastern US and Atlantic Canada. Winds reached hurricane force over the marine areas around the Maritimes causing the loss of the Atlantic Conveyor with all hands. At 0400 UTC on 14 March, during the passage of the storm, Grand Étang recorded mean winds of 139 km/h with gusts to 211 km/h. There were significant impacts, for example, the roof was lifted off the hospital at Cheticamp. Subsequent studies resulted in changes to the local building codes to make allowances for Suête wind conditions.

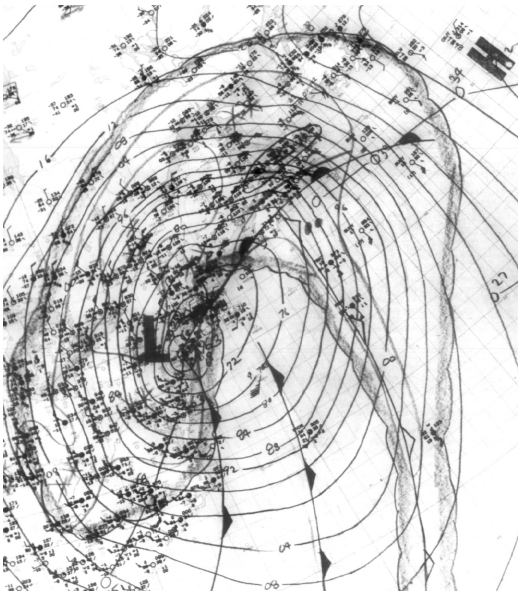

Fig 6. Surface analysis for 0600 UTC 14 March 1993, the “Storm of the Century.”

Cape Breton can barely be made out in Fig 6, but it is in the strong gradient just north of the warm front.

6.3 17 December 2007

On 17 December 2007 Grand Étang reported mean winds of 112 km/h with gusts to 156 km/h (85 knots). This was reasonably well represented by GEM LAM, which, as shown in fig 7, depicted maximum winds of 130 km/h (71 knots) in the Suête area.

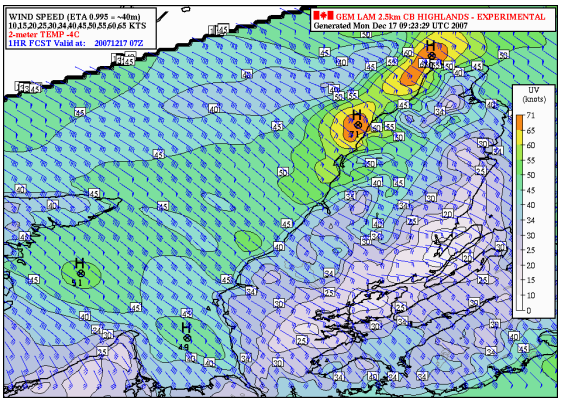

Fig 7. GEM LAM 1 hr forecast of 0.995 eta level winds valid 0700 UTC 17 Dec 2007

7. WHY ARE SUETE EVENTS SO INTENSE?.

7.1 There are several components that make the wind so strong in this area:

7.1.1 Location.

This region is on the eastern edge of the continent and just north of the Gulf Stream in a cyclogenetic area. Low pressure systems form along the eastern Seaboard and often intensify rapidly as they move across this region, bringing widespread strong winds, which are further accelerated in down slope flow.

7.1.2 Marine inversion.

Southeasterly winds approaching the Maritimes and Newfoundland blow across a huge thermal gradient in Sea surface temperatures due to the Gulf Stream to the south and the Labrador Current near the coast. In winter the Sea surface temperature near the coast is often near, or even below, freezing. Occasionally sea ice will move out from the Gulf of St Lawrence through the Cabot Strait. Further south the waters over the Scotian Slope waters can be near 20 deg C.

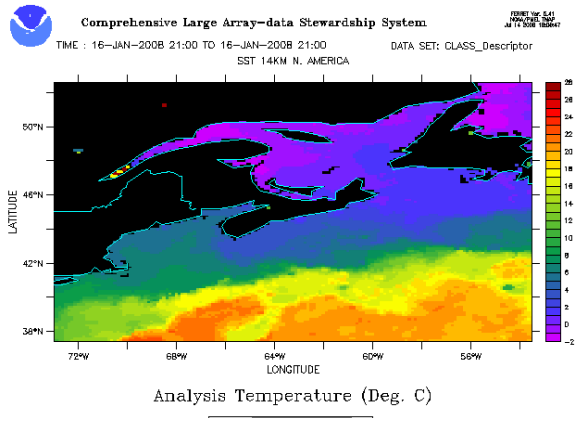

Fig 8. Sea surface temperatures 16 Jan 2008

This strong sea surface temperature gradient in turn leads to a very strong temperature inversion at heights that are comparable to local elevations. It is strongly suspected that this is the key factor in producing such strong down slope wind effects in this region of relatively low terrain.

8. A FEW OTHER INTERESTING WIND EFFECTS IN ATLANTIC CANADA.

8.1 Wreckhouse.

Across the Cabot Strait in Newfoundland similar wind storms occur in the area aptly known as Wreckhouse. Winds here can often be stronger that Suête wind gusts. This is due to several factors: the terrain is a little higher reaching to just over 500 m…there is a degree of funneling and channeling of the down slope winds giving further acceleration, and finally it is a little further to the Northeast, consequently developing storms have frequently intensified a little further by the time they impact on southwestern Newfoundland.

In the Wreckhouse area there have even been trains blown off the tracks in days when there used to be trains there. In the 1930's the railway company in Newfoundland paid Lockie MacDougall, a farmer in the area, 20 Dollars a month to provide warning of such wind conditions. A service he continued to provide until his death in 1965


Fig 9. an overturned rig along the Trans-Canada Highway at Wreckhouse on Wednesday.21st May 2008 (Submitted by Wayne Osmond) credit CBC

The Weather Doctor's Weather Almanac Newfoundland's Wreckhouse Winds ©2005, Keith C. Heidorn, PhD.

8.2 "Reversed Suêtes."

Pattern recognition often leads us to expect certain wind directions to be more stable than others. Typically in Atlantic Canada winds approaching from the Southeast, or Southwest tend to be stable and winds from the Northwest tend to be quite unstable. So one would not expect to see down slope winds occurring in northwest winds but in fact they do occur surprisingly

frequently. Wave cloud patterns are frequently seen with northwest winds passing over the Cape Breton Highlands, and at times strong wind gusts are reported at Ingonish on the eastern side of the Highlands. These cases are referred to a "reversed Suêtes" by forecasters. The cause is a shallow intrusion of cold air following the surface passage of a cold front, leaving much warmer air aloft and a trapping inversion in the low levels. One example occurred on 13 Sept 2003 when Ingonish reported gusts to 35 knots (64 km/h), over 60 percent greater than the 22 knot (40 km/h) gusts recorded at North Mountain on the highest part of the highlands.
On 10 January 2008 a similar situation resulted in gusts to 49 kt (90 km/h)

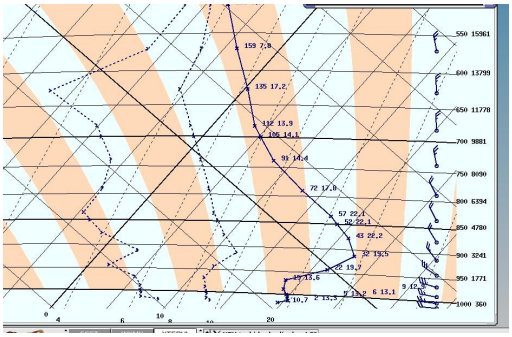

Fig 11. 12 hour Prog Sounding for Sydney Valid 0000 UTC 13 Sept 2003

Again similar situations arise in Newfoundland and are particularly marked at Englee on the eastern side of the Great Northern Peninsula where westerly winds accelerate in down slope flow and then are channeled and funneled creating gusts that can reach hurricane force.

9. CONCLUSION
Relatively low elevations can lead to very dramatic down slope wind storms. The effect of a strong marine inversion at heights similar to terrain elevations combined with strong cyclonic development are considered to provide a considerable influence on down slope wind storms in Atlantic Canada.

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