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Polar mesosphere summer echo studies at 51.5 MHz at Resolute Bay, Canada: Comparison with Poker Flat results

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Abstract. We present a study of seasonal and diurnal variations of polar mesosphere summer echoes (PMSE), along with temperature and wind data collected during summer 1998 using the 51.5 MHz VHF radar located in Resolute Bay, Canada (75°N, 95°W). The latitudinal dependence of PMSE occurrence and strength are examined by comparing Resolute Bay observations with earlier Poker Flat (65°N, 147°W) observations. Temperatures measurements at Resolute Bay using the radar in the meteor mode are compared with satellite measurements at similar latitudes of Resolute Bay and Poker Flat. The temperature measurements are in good agreement, and, as expected, PMSE is strongly controlled by the seasonal temperature variations. Differences found in the daily composite and monthly average winds, and in the monthly evolution of the amplitudes and phases of the diurnal and semidiurnal tides at Resolute Bay and Poker Flat, are discussed in order to establish the role that they play in the occurrence of PMSE. In general, we find that the diurnal occurrence of PMSE at Resolute Bay also follows the diurnal variation of temperature. The echoes tend to occur more frequently and with greatest intensity when the temperatures are the coldest, in a period centered around local noon. We show that the diurnal wind components at Resolute Bay appear to correlate with the occurrence of PMSE, as also seen at Poker Flat. PMSE at Resolute Bay are not as strong or as frequent as reported at Poker Flat, differing with what we had expected since strongest and more frequent echoes have been observed in the European sector approaching the pole. New observations are needed to establish a possible longitudinal dependence of PMSE occurrence given that the present American sector data are compared with data taken over 10 years ago.

1. Introduction

Polar mesosphere summer echoes (PMSE) are an intriguing phenomenon, characterized by very strong radar echo returns from the high-latitude mesosphere, and are still not well understood after 20 years of study. Multiple theories have been proposed to explain their existence, but there is not as yet an established theory (for a review the reader is referred to *Cho and Kelley* [1993] and *Cho and Röttger* [1997]).

It has certainly been accepted in the scientific community that PMSE are linked to very cold temperatures. Simultaneous measurements of PMSE and of temperature with rockets have shown that a

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sufficiently cold mesopause temperature is one of the necessary conditions for the existence of these radar echoes [*Lübken et al.*, 1995]. Additional support for a causal temperature mechanism was provided by *Cho et al.* [1992], who showed that a significant reduction in plasma diffusivity would occur in the presence of a large number of charged ice particles or very large water cluster ions, making a favorably environment for the occurrence of PMSE. Furthermore, *Balsley and Huaman* [1997] reported a study of PMSE occurrence and low seasonal mesopause temperatures showing that the maximum occurrence of PMSE corresponds to the minimum temperature with a delay of 7-10 days.

It is also reasonable to consider the effects that the mean mesospheric wind field, gravity waves, and tidal modes could play in PMSE generation because they are closely related to the temperature field in the polar summer mesosphere. Multiple studies have indicated that variations of PMSE are influenced by tidal modes [*Hoppe et al.*, 1988; *Czechowsky et al.*, 1989; *Rüster*, 1995; *Cho and Morley*, 1995; *Williams et al.*, 1995; *Bremer et al.*, 1996a], gravity waves [*Williams et al.*, 1989; *Hall*, 1990; *Bremer et al.*, 1995], and the mean mesospheric wind field [*Kelley et al.*, 1990; *Bremer et al.*, 1996b]. Thus an understanding of the background wind and waves in the region of PMSE is particularly important.

The need to monitor all these parameters simultaneously and in a common volume seemed clear. In part on the basis of this motivation, among others, a new radar facility was installed at Resolute Bay in 1997 [*Hocking et al.,* this issue]. The intent was to design a VHF radar system that, working in the mesosphere-stratosphere-troposphere (MST) mode, would be capable of observing PMSE and that, when working in the meteor mode, would be capable of measuring temperature and wind [*Hocking*, 1999; *Hocking and Thayaparan* ,1997]. Preliminary data were obtained in 1997. During the 1998 summer season PMSE, temperatures and winds were monitored on a nearly continuous basis.

In this paper we examine the latitudinal extent of PMSE occurrence, present a correlation with low mean mesospheric temperature, and discuss relationships to the dynamics of the mesosphere at Resolute Bay. We also present the diurnal temperature variation and discuss its correlation with the diurnal variation of PMSE occurrence. We compare our results at Resolute Bay with Poker Flat results from the early 1980s. We also study how the seasonal scattering strength varies with seasonal temperature variations. More generally, we discuss the significance of the relationship between PMSE occurrence, wind, and temperature on a seasonal and daily basis and present a study of the monthly evolution of amplitudes and phases of the diurnal and semidiurnal tides in both zonal and meridional components.

2. Background: Resolute Bay (75°N, 95°W)

A VHF wind profiler developed at the University of Western Ontario, similar to the Canadian (London, Ontario) VHF atmospheric radar (CLOVAR) system [*Hocking,* 1997], was installed at Resolute Bay in the Canadian Arctic during summer 1997. Since then, the radar system has been upgraded allowing it to work both as a standard wind profiler and as a meteor radar. This new capability makes possible the study of winds in the region of 80-100 km altitude by determining the location and drift speeds of meteor trails [*Hocking and Thayaparan,* 1997], while studies of the decay times of underdense meteors give information about the temperatures [*Hocking,* 1999].

The system is currently working both modes continuously, but during the 1998 summer months the system worked continuously in both modes, alternating between PMSE and meteor modes; that is, a few consecutive days were dedicated to the PMSE mode, and a few days were dedicated to the meteor mode. The data coverage has been improved since last summer (2000) after the facility was upgraded. A detailed description of this radar system is presented by *Hocking et al.* [this issue].

3. Data Presentation

3.1. PMSE Observations at Resolute Bay

Plate 1 shows the hourly averaged mean diurnal signal-to-noise ratio (SNR) for the vertical beam, Resolute Bay radar observations for 23 days between June 14 and August 24, 1998. The echo intensities on average are on the order of 3-6 dB above the noise. The height of PMSE occurrence ranges from 82 to 88 km.

Before we calculated the mean diurnal variation we looked at every single day of observations available in

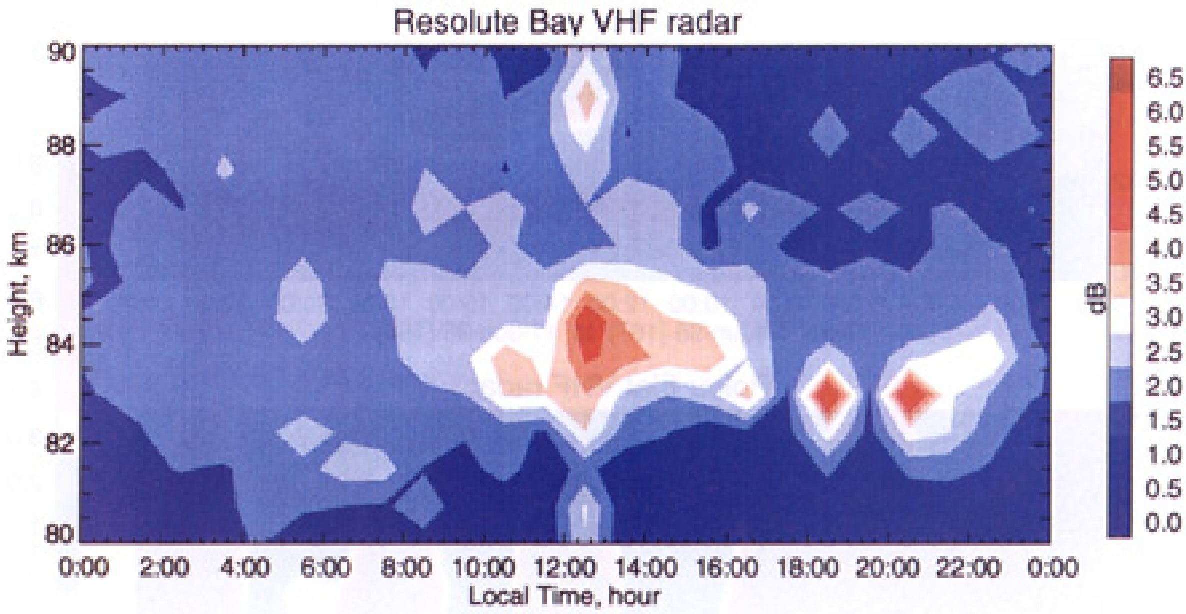

Plate 1. Contour plot of the mean diurnal signal-to-noise ratio (SNR) variations at Resolute Bay for 23 days between June 14 and August 24, 1998. The time axis is in local time units (LT=UTC-6). PMSE tend to be present after 1000 LT until 2200 LT approximately, with a mean height of occurrence of ~ 84 km.

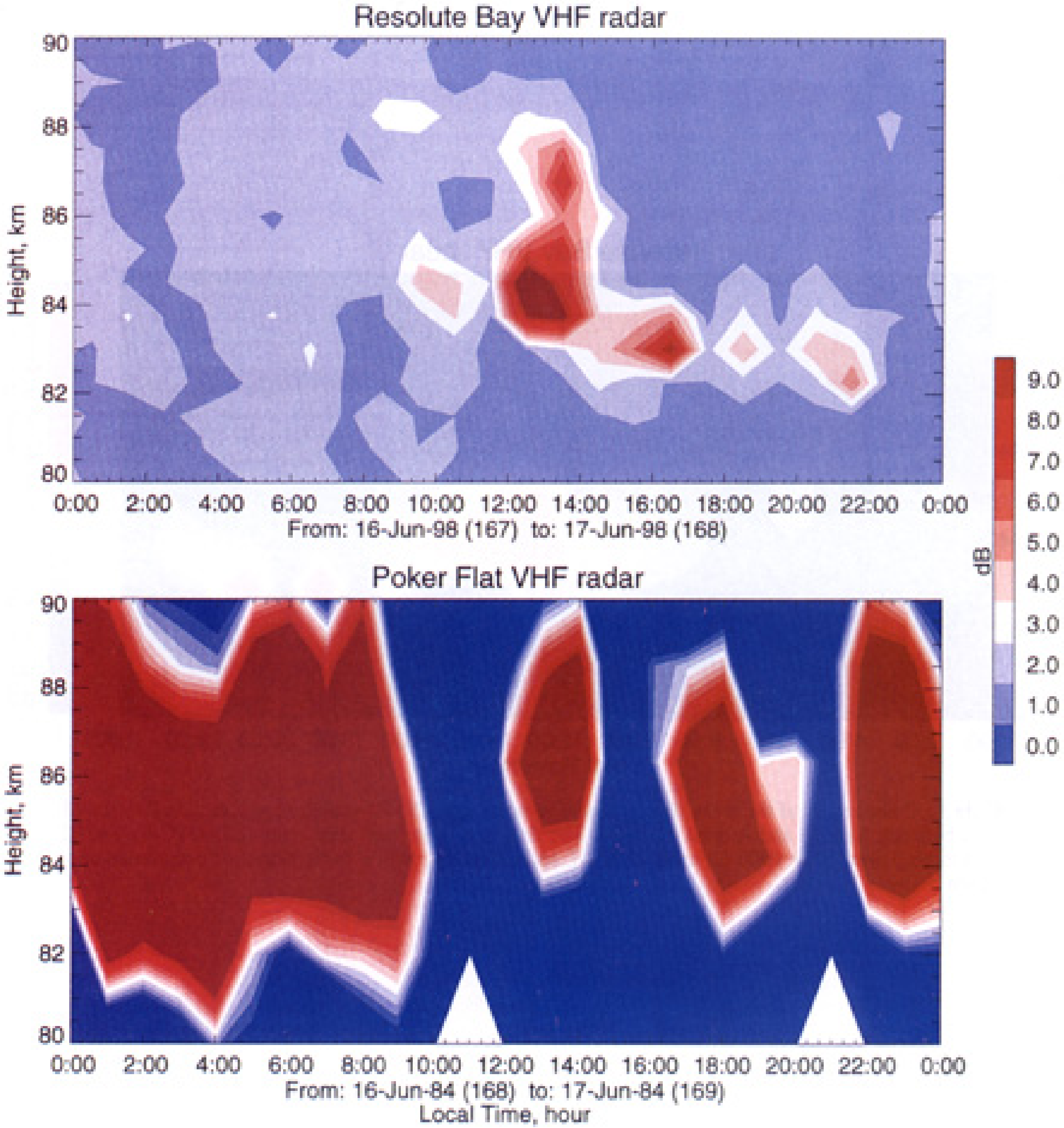

Plate 2. Contour plot of SNR (top) at Resolute Bay and (bottom) at Poker Flat for two similar days in 1998 and 1984, respectively. The Poker Flat data have been corrected to take into account that the systems have different sensitivities, i.e., transmitted power, antenna area, etc. Local time is equal to UTC minus 6 hours at Resolute Bay and UTC minus 9 hours at Poker Flat.

order to confirm how stable the PMSE maxima and PMSE minima were in local time throughout the entire season. We have observed that the echoes tend to occur most frequently, and most intensely, around local noon, with almost no echoes between 2200 LT and 1000 LT, indicating a relatively strong diurnal component. Recently, *Latteck et al.* [2000] have reported PMSE observations from Longyearbyen, Svalbard (78°N), which is located at a latitude to that of Resolute Bay (75°N), showing that the mean diurnal variation of PMSE has one maximum around local noon. This indicates a diurnal variation similar to that observed at Resolute Bay. The diurnal variation of PMSE is different from previous observations at lower latitudes where semidiurnal variations have been observed (*Hoppe et al* [1988]; *Czechowsky et al.*[1989]; *Bremer et al.*[1996b]; Hoffman et al. [1999]; among others). We will discuss this difference in section 3.6.

3.2. PMSE at Resolute Bay and Poker Flat

Plate 2 shows the PMSE occurrence as observed by the vertical beams at Resolute Bay and Poker Flat for similar days in 1998 and 1984, respectively. The top panel shows hourly averaged SNR at Resolute Bay, and the bottom panel shows the same for Poker Flat with a time axis corresponding to local time. Details of the Poker Flat system are given by *Ecklund and Balsley* [1981] and *Riddle et al.* [1989].

In order to compare the data we have, as best as we can, taken into account the different sensitivities of the two systems, modifying the much more powerful Poker Flat radar results by the differences in average transmitter power, antenna area, scattering volume, efficiency, and noise. The noise is estimated from the average of the signal strength at heights of non-PMSE occurrence between 70 and 80 km, and it is subtracted before the adjustments are made.

The most thorough way in which these differences may be most properly considered is by numerical integration over the polar diagrams. The key quantity to evaluate is

$$I = \iiint_{z\,\theta\,\phi} G_T(\theta,\Phi)G_R(\theta,\Phi)g(z-z')L(z')\sin\theta\, d\theta\, d\Phi\, dz \quad (1)$$

where we assume a layer L(z') of some specified thickness, a pulse g(z'), and a transmitter and polar diagram specified by G_T and G_R. This equation is adapted from *Hocking* [1985], equation (32), where we have used the fact that the effective area is given by $A_R = G_R\, \lambda^2/(4\pi)$, and we have also included a pulse-length dependence for additional thoroughness. The Poker Flat radar had a gain of 35.3 dB, and the Resolute Bay radar has a gain of 27.4 dB (and equivalent effective area of 1480 m^2), as determined from accurate numerical polar diagram calculations. The ratios of the parameter "I" above have been numerically shown to be 16.3 dB for the case of the Poker Flat radar relative to Resolute Bay. Thus, all else being equal, the Poker Flat radar should receive a 16.3 dB higher signal-to-noise ratio. However, the mean transmitter power at Poker Flat was 1.8 kW, whereas the mean at Resolute Bay was 600W, so this should increase the received power at Poker Flat to be 20.3 dB above the Resolute Bay case. Further adjustments are also required. Because of the need for long cables to feed the array, the Resolute Bay radar loses 3dB on transmission, whereas the Poker Flat radar loses only 1 dB. But the Poker Flat radar used co-co antennas, which are inefficient and usually radiate about 4 dB less power than an equivalent yagi (as determined by experiments e.g. see *Hocking et al.*, 1989). Note that we need only consider these inefficiencies for transmission, since upon reception the sky noise is attenuated with the received signal and so the net effect on the ratio is zero. Thus the net effect of these inefficiencies is that the Poker Flat values of S/N should exceed the Resolute Bay ones by 18.3 dB. However, one final point needs to be considered, and that is the bandwidth of the receivers. The Resolute Bay data were filtered using a final-stage digital filter of width +/- 2 Hz, whereas the Poker Flat data used a wider filter. Thus the Poker Flat will have a higher relative noise level. Typically the Poker Flat data were recorded with an effective data acquisition time interval of about 1/8 seconds, giving a bandwidth of about ± 4 Hz. Thus if these data are to be compared to the Resolute Bay data, an adjustment of a further factor of 2 (3 dB) must be used. Thus the Poker Flat values of S/N should exceed those at Resolute Bay by about 15 dB.

We can see that the pattern of occurrence of PMSE at Resolute Bay on this specific day is the same as the mean diurnal PMSE variations observed in Plate 1, indicating a stable PMSE occurrence with little day-to-day variability. The same behavior is not observed at Poker Flat, where there is an extreme day-to-day variability of the signal strength [*Balsley et al.*, 1983]. During the peak of the Poker Flat PMSE season there are many days where the PMSE maximum occurs around 1000 LT, and the minimum around 2200 LT. The only characteristic that changes little during the entire season is the distinct minimum in signal strength around 2200 LT.

Comparing results from the facilities normalized to the Resolute Bay system, we can say that PMSE at Poker Flat occur during almost the entire day while PMSE at Resolute Bay tend to be present only from 1000 to 2200 LT (although there are exceptions). The echoes are also much weaker at Resolute Bay. For instance, on the specific day shown in Plate 2 (June 16) the echo strength at Resolute Bay reached a maximum value of ~ 12 dB while at Poker Flat it reached a maximum value of 30 dB (after adjustment). We will try to link these differences to temperature and wind variations in sections 3.4 and 3.6. We should point out that even though the adjustments to take into account the different sensitivities in the systems are somewhat rough, the echoes at Poker Flat are much stronger, and our findings will not change if we include additional factors such as sidelobes and transmission line losses.

3.3. Temperature Measurements Using Radar Meteor Decay Times at Resolute Bay and Comparison With High Resolution Doppler Imager Temperatures at Similar Latitude and Height

Hocking [1999] has developed an algorithm that allows meteor decay times to be used to determine absolute measurements of mesospheric temperatures with a typical accuracy of the order of 4-10 K, depending on circumstances. Using this algorithm, we have calculated the seasonal temperatures at Resolute Bay using the meteor radar data as displayed in Figure 1 with an absolute accuracy of 6K. In addition, we have compared these temperature results with 1994 data from the High Resolution Doppler Imager (HRDI) instrument on the UARS satellite at a latitude and height similar to the ones at Resolute Bay.

The solid curve in Figure 1 shows the monthly

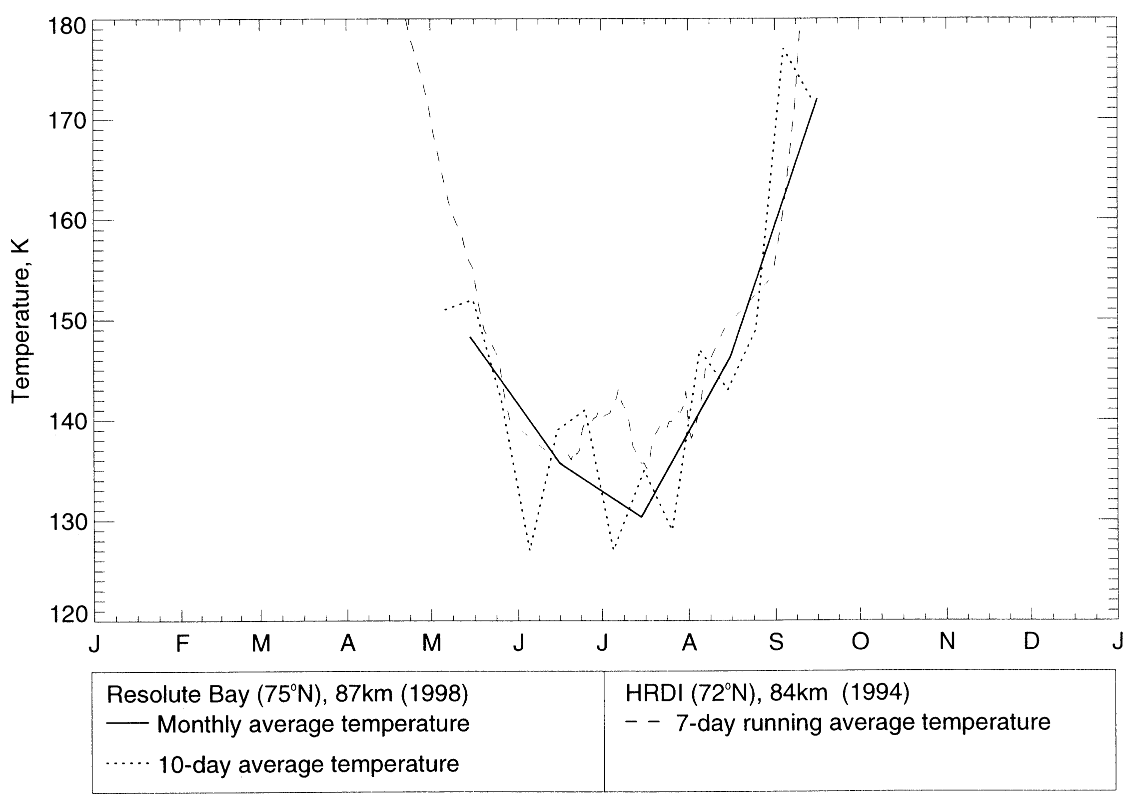

Figure 1. Comparison between seasonal mesospheric temperatures calculated using meteor detection techniques at Resolute Bay (75°N) and satellite data (HRDI) at 72°N.

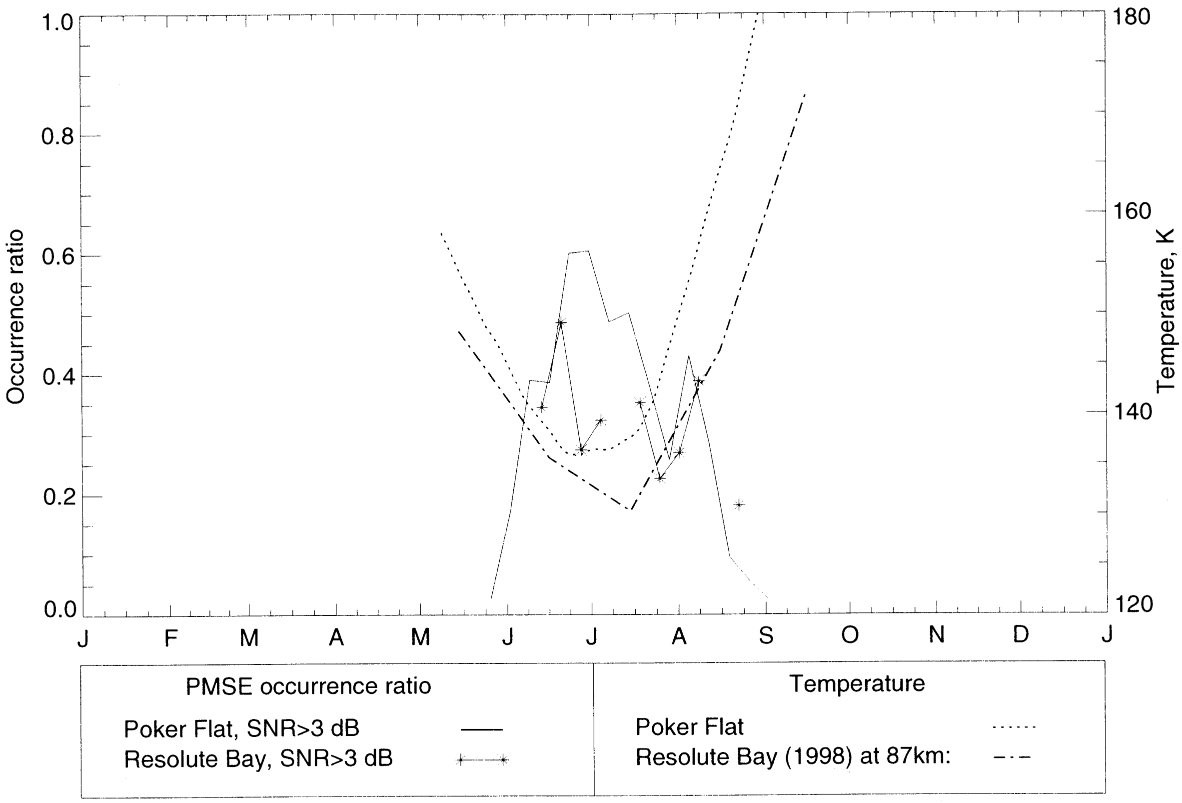

Figure 2. Comparison of the seasonal variation of PMSE occurrences at Resolute Bay and Poker Flat together with mean seasonal temperature variations obtained from meteor detection techniques at Resolute Bay and previous reported results at Poker Flat [*Balsley and Huaman*, 1997] including HRDI results (that is, the results at Poker Flat were calculated averaging all the curves presented by Balsley and Huaman plus the results obtained using HRDI satellite data).

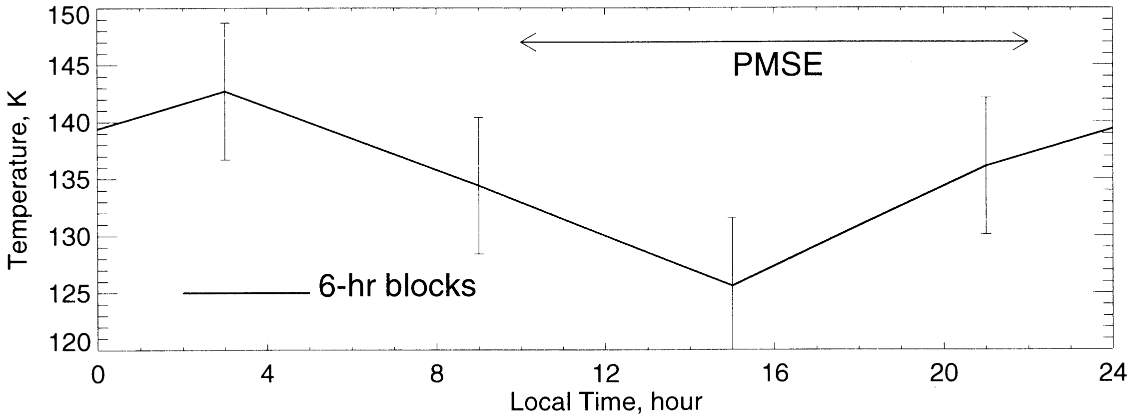

Figure 3. Diurnal variations in temperature during the months of June and July (1998) at Resolute Bay. We have also included the period of time where PMSE have been observed in Plate 1. We can see the strong correlation between the minimum temperature and the maximum occurrence of PMSE.

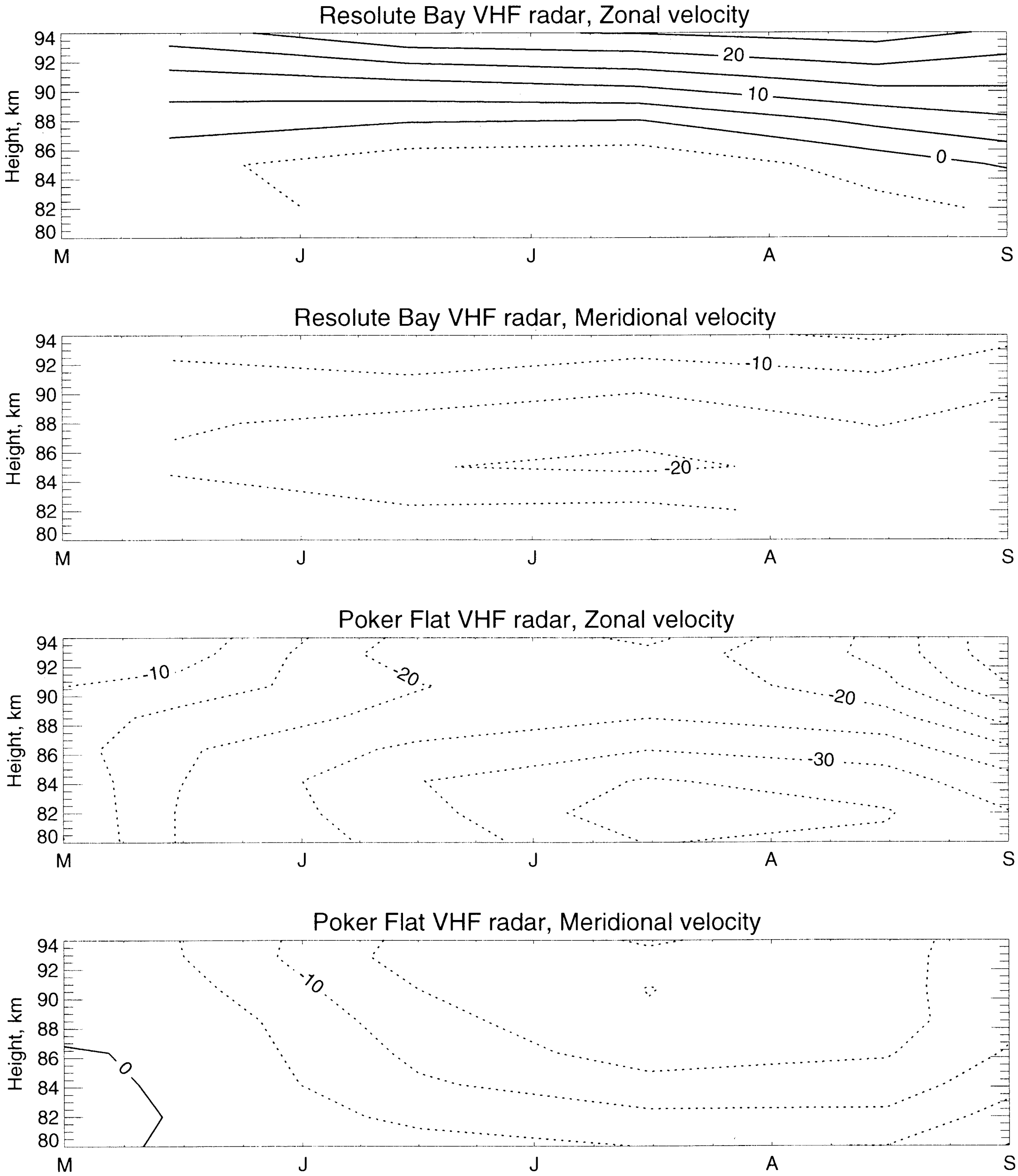

Figure 4. Height versus month contours of zonal and meridional winds over Resolute Bay and Poker Flat. Contours are based on monthly average observations taken during 1998 and 1984 at Resolute Bay and Poker Flat, respectively. Contour spacing is 5 ms^{-1}. Dotted contour curves indicate negative values, and solid contour curves indicate positive values. The time axis corresponds to the months of May (M), June (J), July (J), August (A), and September (S), indicating the beginning of the corresponding month.

average temperature values while the dotted curve shows 10 day average temperature values, both using the meteor decay algorithm to calculate temperature. The dashed curve represents the 7 day running average temperature values of the HRDI data. We can see that the agreement is reasonably good, though the HRDI values are higher. The general pattern of temperature is the same for both measurement sets: a decrease and an increase at the beginning and end of the summer season. Also, we should point out that

HRDI temperature values are measured at 72°N while Resolute Bay is at 75°N, and we should expect the temperatures to be colder as we approach the pole.

3.4. Relationship Between Seasonal PMSE Occurrence and Seasonal Temperature at Resolute Bay and Poker Flat

A demonstration of the seasonal occurrence of PMSE and seasonal temperatures at Resolute Bay similar to that given by *Balsley and Huaman* [1997] for Poker Flat is shown in Figure 2. In both cases we have counted the number of PMSE occurrences (events where the hourly mean SNR values are greater than 3 dB) and divided by the number of possible occurrences in each week. In order to make a real comparison we have again taken into account that the systems at Resolute Bay and Poker Flat have different sensitivities. We have been able to convert the SNR values at Poker Flat as if they had been observed by the Resolute Bay radar. We should point out that for the Resolute Bay case the radar was working in the PMSE mode alternately with the meteor mode and there could have been days where there were stronger and continuous echoes that were not observed. The correspondence between seasonal PMSE occurrence and seasonal temperature, as previously reported by *Balsley and Huaman* [1997], is apparent in Figure 2 as well. The time when the PMSE season starts and ends at both locations is also similar.

We can see that PMSE occurrence at Resolute Bay is much weaker and more sporadic than at Poker Flat even though temperatures are much warmer at Poker Flat. This result is contrary to that of *Latteck et al.* [2000]. They have presented a comparative study of PMSE observations obtained at 68°N, 69°N, and 78°N during summer 1999 showing that the echoes at Longyearbyen, Svalbard (78°N), are present over the entire day, while the echoes at Andenes, Norway

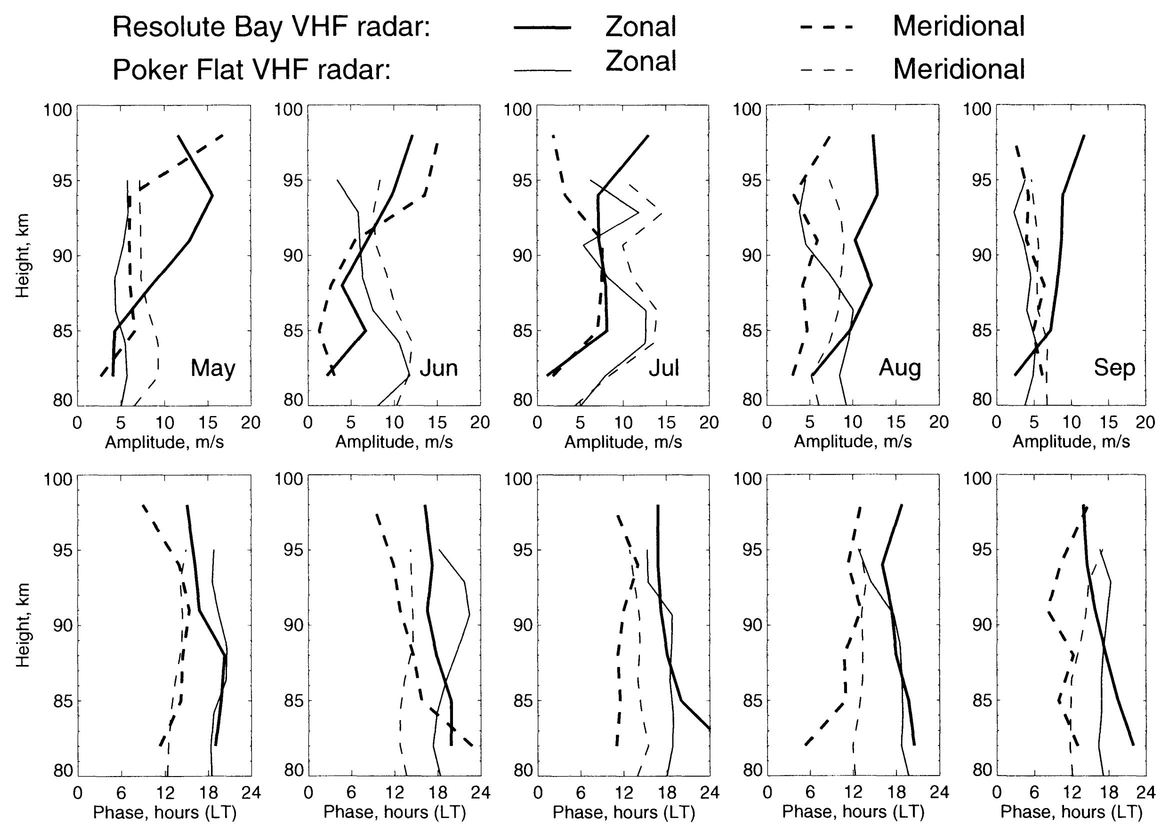

Figure 5. Height profiles of the amplitude and phase of the zonal and meridional components for the diurnal tide observed at Resolute Bay (1998) and Poker Flat (1984) for the months of May, June, July, August, and September. The solid curves represent the zonal components (thick solid curve for Resolute Bay and thin curve for Poker Flat). The dashed curves represent the meridional components (thick dashed curve for Resolute Bay and thin dashed curve for Poker Flat).

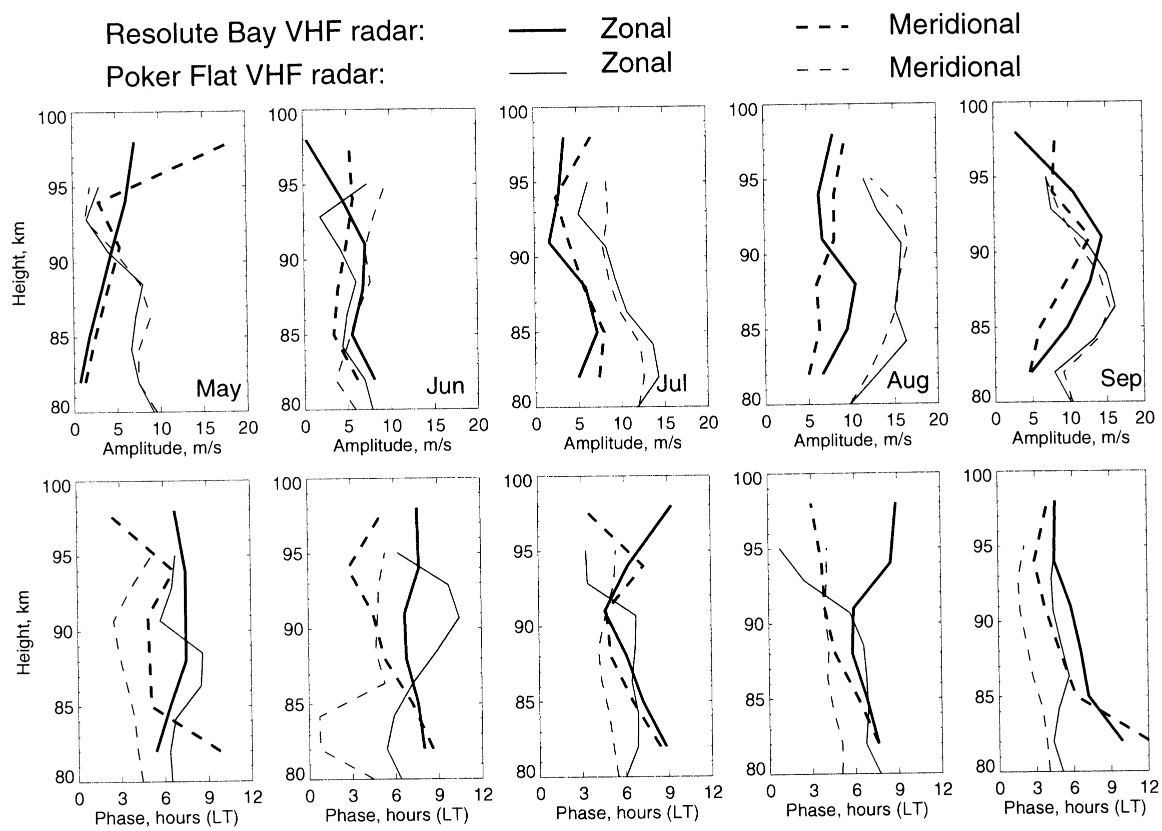

Figure 6. Same as Figure 5, but for the semidiurnal tide.

(69°N), and at Kiruna, Sweden (68°N), are more sporadic. PMSE thus seem to increase approaching the pole in this sector. This contradictory result could either be a real longitude effect or be due to a climate change over the past decade. Simultaneous measurements in the North American sector need to be done with similar radar systems to distinguish these effects. A recent NSF proposal has been funded to continue these studies.

3.5. Diurnal Variation of Temperature at Resolute Bay

A composite temperature plot of the diurnal variation of temperature at Resolute Bay is shown in Figure 3. We have combined all the data available in 6 hour blocks from both June and July 1998 and calculated temperatures for a "composite day" over both months including the error bars. A clear diurnal variation is present with maximum temperatures being around 0300 LT (143 K typically) and minimum temperatures at around 1500 LT (around 126K). Referring to Plate 1, we can see that PMSE occur between 1000 LT and 2200 LT. We represent this period in Figure 3 by the double arrowhead. The coincidence between occurrence of PMSE and the cold temperatures is very strong. This result is important because for the first time ever we have been able to show the close correlation between cold temperature and PMSE occurrence on a daily basis.

3.6. Monthly Average Winds at Resolute Bay and Poker Flat

We investigated the dynamics of the high-latitude Northern Hemisphere through comparative analyses of winds measured by radars at Resolute Bay and Poker Flat. This comparison will help us to link any observed variations of the wind field to the seasonal PMSE occurrence differences observed at Resolute Bay and Poker Flat.

Contours plots of the monthly average zonal and meridional winds during the summer over Resolute Bay and Poker Flat are presented in Figure 4. The top two panels show the monthly-average zonal and meridional winds at Resolute Bay, while the bottom two panels show the monthly average zonal and meridional winds at Poker Flat.

Considering first the zonal circulation, both the Resolute Bay and Poker Flat data exhibit prevailing westward winds at least for heights between 80 and 86 km, just below where PMSE tend to occur. The zonal winds change direction with height at Resolute Bay, becoming eastward and reaching values of ~20 ms^{-1}, while the zonal winds at Poker Flat stay westward with a smaller value of 10 ms^{-1}.

Considering now the meridional circulation, the winds at Resolute Bay and Poker Flat tend to be southward, but their magnitude is smaller at Poker Flat, of the order of 5-15 ms^{-1}. These results are intriguing as it was expected from theory that the meridional winds should be stronger away from the pole.

3.7. Tidal Amplitudes and Phases at Resolute Bay and Poker Flat

The monthly evolution of the amplitude and phase of the diurnal and semidiurnal tides for the months of May through September are shown in Figure 5 and Figure 6, respectively. Both figures illustrate results from Resolute Bay and Poker Flat.

Comparison of the amplitudes of the tides between Resolute Bay and Poker Flat indicates that the magnitude of the zonal diurnal tide is stronger in Resolute Bay at the beginning and end of the summer season but weaker in June and July when PMSE occurrence peaks. The amplitude of the meridional diurnal tide is consistently stronger at Poker Flat with the exception of September where they are almost the same. The phases between zonal and meridional components at both facilities show a difference of ~ 5-6 hours for the diurnal tide, while their corresponding zonal and meridional phases are almost the same. This indicated that the zonal diurnal tide component maximum occurs at approximately 1800 LT and the meridional diurnal tide component maximum occurs at 1200 LT at both locations independently of the time zone differences.

The zonal and meridional semidiurnal amplitudes are consistently stronger at Poker Flat with the exception of the month of June, where they are almost the same. The zonal and meridional semidiurnal phases show a more complex behavior. The phases for both components fluctuate between 4 and 8 hours, depending on the month.

Comparing these results with the PMSE occurrences at both facilities, we can see that when PMSE occur the most, the amplitude of the zonal and meridional diurnal and semidiurnal tides are also the strongest. This indicates a contribution of the diurnal and semidiurnal tides to PMSE occurrence. For the case of Poker Flat the amplitudes of the diurnal tide reach values of 13 ms^{-1} in July, while in May and September (which are the beginning and end of the PMSE season, respectively), the amplitudes drop to values of 5 ms^{-1}. In the case of the amplitude of the semidiurnal tide, minimum values occur during June and then increase during the following months. These results show that when the magnitude of the diurnal tide decreases and the semidiurnal tide becomes the strongest, PMSE disappear. Both the diurnal and semidiurnal tides, correlate together with PMSE occurrence when their magnitudes are strong and do not correlate when the semidiurnal tide is predominant over the diurnal tide. This behavior can be observed better in section 3.8, where the daily composite zonal and meridional winds for both facilities are presented.

By looking at the period of time when PMSE tend to occur at Resolute Bay and Poker Flat during the day and comparing with the phases of the zonal and meridional diurnal tide components, we can conclude that PMSE are the strongest when the diurnal tide is westward and northward. The correlation of the semidiurnal tide is not as significant since even though we can see their correlation during periods of PMSE, they are also present when PMSE do not occur.

3.8. Daily Composite Zonal and Meridional Velocities at Resolute Bay and Poker Flat

The daily composite zonal and meridional velocities at Resolute Bay and Poker Flat for the months of June and September are shown in Figures 7 and 8, respectively. We have chosen the months of June and September since we should expect different behavior, as June falls in the middle of the PMSE season while September falls at the end of the PMSE season.

We can see a predominant semidiurnal variation in the zonal component at both facilities in both months, with the main difference being that the height at

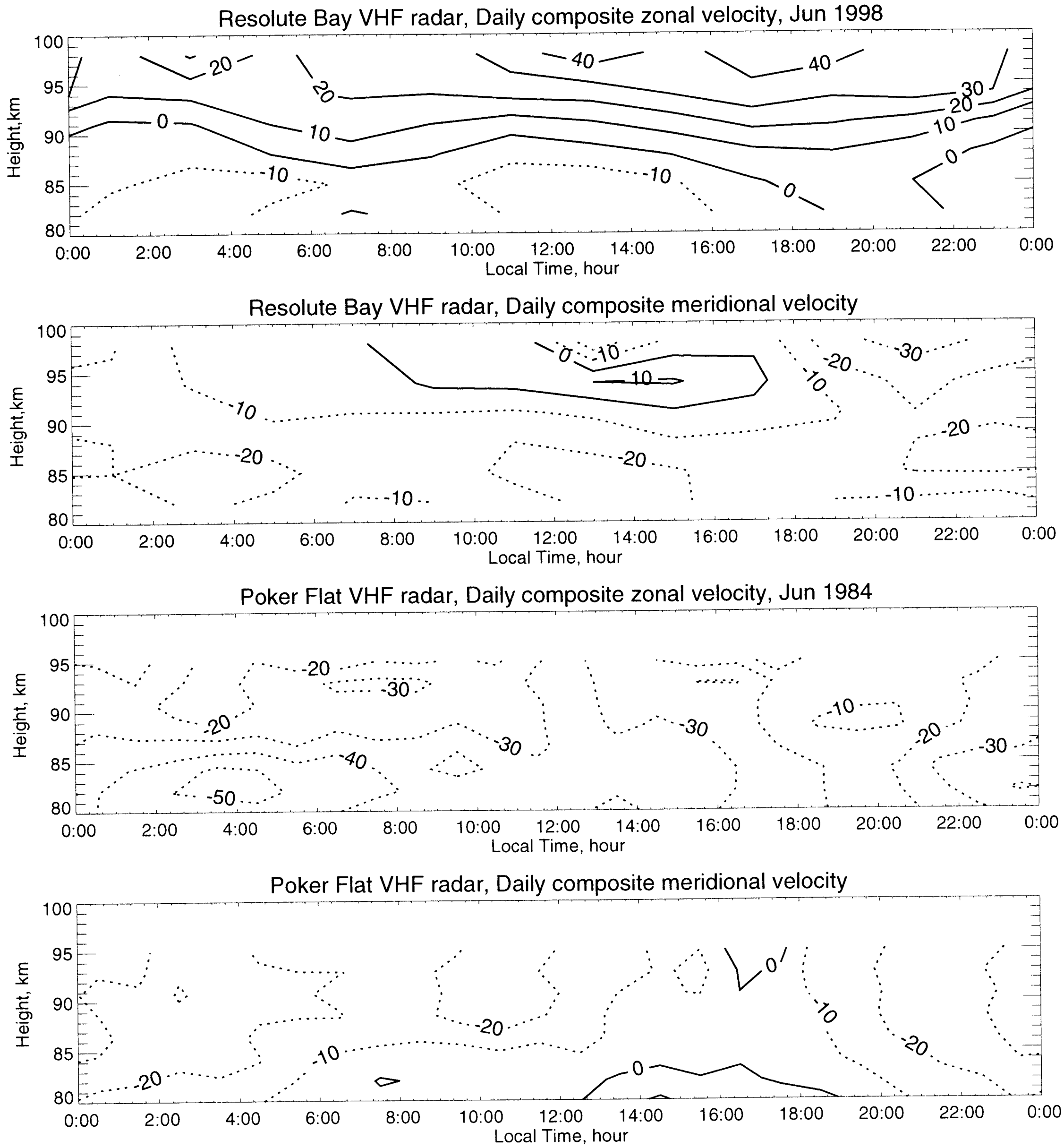

Figure 7. Daily composite zonal and meridional velocities for Resolute Bay (top two panels) and Poker Flat (bottom two panels). The period of study corresponds to June 1998 for Resolute Bay and June 1984 for Poker Flat. The daily composite zonal and meridional flows at Resolute Bay show a strong semi-diurnal variation, while at Poker Flat the semidiurnal variation is not that obvious.

which the semidiurnal variation takes place at Resolute Bay seems to be shifted with respect to the height at which it is observed at Poker Flat. The semidiurnal variation is observed at lower altitudes at Resolute Bay.

If we look at the daily composite variation of the meridional wind at Poker Flat in June, we can see that it tends to be diurnal while it is semidiurnal at Resolute Bay. It is interesting to note that for the month of September we can observed a semidiurnal variation at Poker Flat in both the zonal and meridional components while the diurnal variation is no longer observed.

In the case of Resolute Bay we can also link the

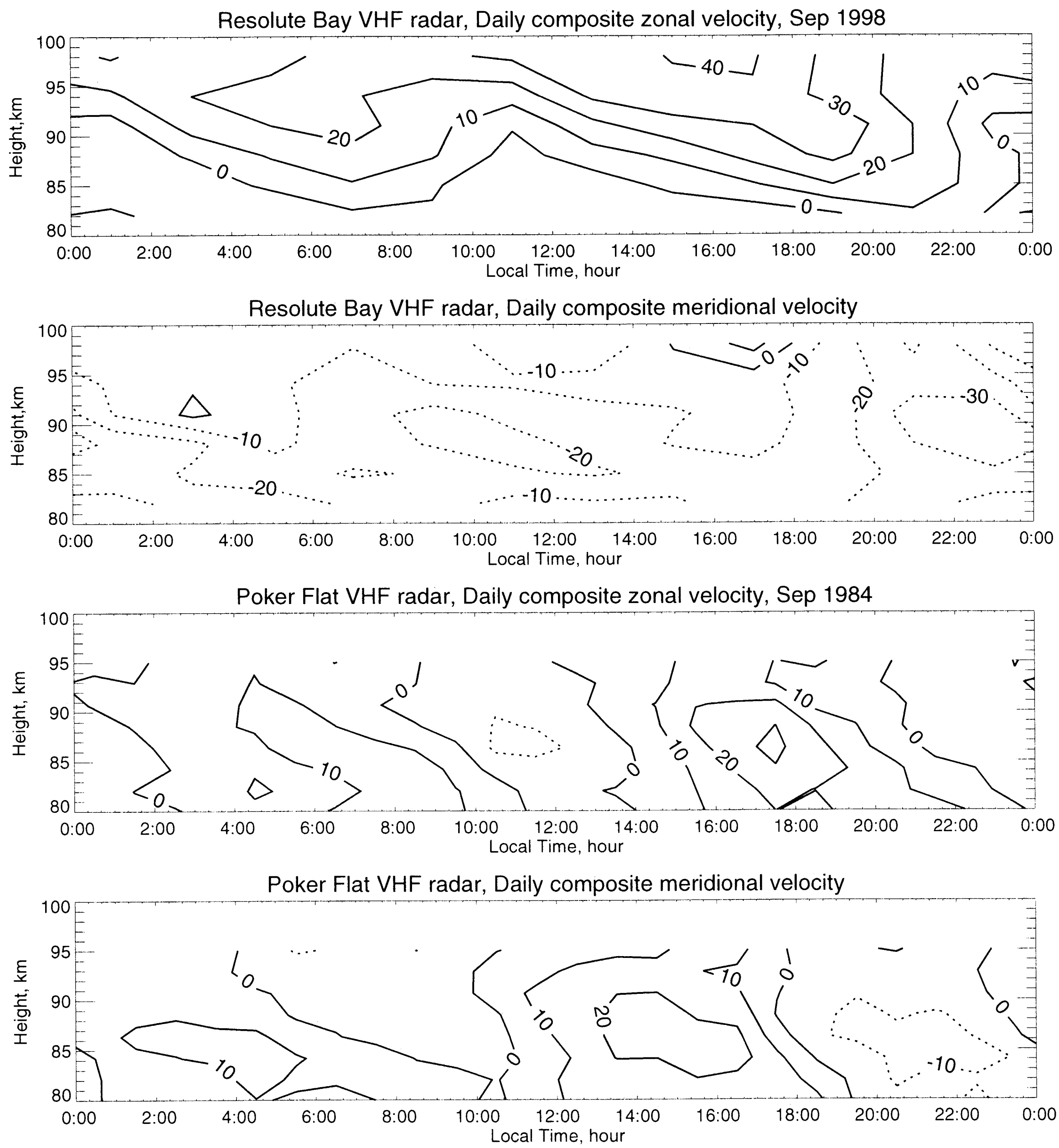

Figure 8. Same as Figure 9 but for the month of September. We can observe a semidiurnal variation at Poker Flat that was not observed in the month of June. This results suggests that PMSE are directly affected by the presence of the diurnal tide.

diurnal and semidiurnal tides to the diurnal variation of temperatures. The fact that one of the minima wind components of the semidiurnal tide, for the months of June and July, is at 1200 LT indicates that the semidiurnal tide acts to help lower the temperatures and also "broaden" the time at which the temperature stays low. The diurnal and semidiurnal tides "reinforce" each other by holding the temperatures low from ~ 1000 to 1500 LT and maybe even into 1800 LT (if the semidiurnal tide is stronger on any given day).

4. Summary and Conclusions

We present further evidence that temperature plays an important seasonal role in PMSE occurrence. We also show that the diurnal occurrence of PMSE corresponds to the diurnal variation of temperature in such a way that stronger echoes are found when the temperatures are the coldest.

After taking into account all such factors as different antenna area, power transmitted, etc., the data from Resolute Bay and Poker Flat can be compared. We find that the echoes in Resolute Bay are weaker and more sporadic than those at Poker Flat. This result indicates that PMSE might become weaker as we approach the poles even though the seasonal variation of temperature shows colder temperatures at Resolute Bay than at Poker Flat. This result is contrary to what has been observed in the European sector [*Latteck et al.*, 2000], where PMSE tend to be more frequent and stronger as the pole is approached. Another possibility is that PMSE have become weaker and more sporadic through the years as the Poker Flat observations results used in this paper were made 14 years ago. These results need to be checked by doing simultaneous measurements at two facilities located at different latitudes in the American sector and by taking into account the different sensitivities that the systems have.

On a daily basis we have observed that PMSE occurrence at Resolute Bay is most likely between 1000 LT and 2200 LT, while at Poker Flat PMSE tend to occur during the entire day and with a noticeable minimum around 2200 LT. We have found that the daily composite variations of PMSE strength as well as winds and temperature are dominated by a pronounced diurnal variation. This behavior is markedly influenced by temperature changes induced by tidal waves in the mesospheric wind field at Resolute Bay. The correlation of the diurnal tide to PMSE occurrence is definitely stronger than the correlation with the semidiurnal tide. PMSE occur when the diurnal tides are predominant with the largest amplitudes and disappear when the semidiurnal tides become predominant.

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