PROGRESS REPORT ON THE O-QNET, A NEW CANADIAN WINDPROFILER NETWORK.

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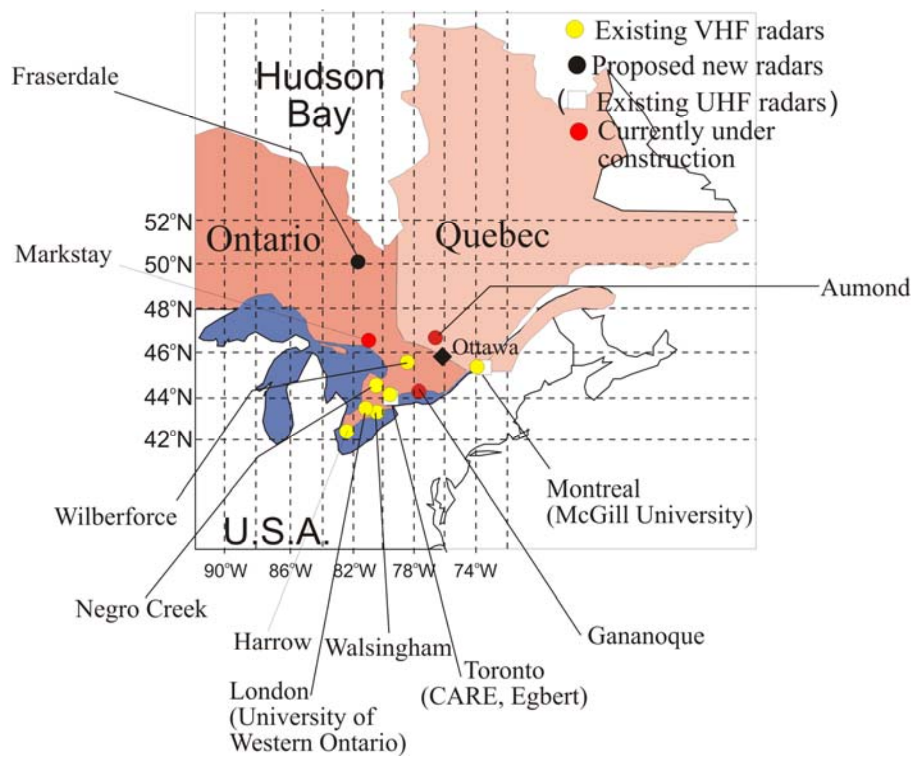
Introduction.

The O-Qnet was introduced to the MST community in Hocking et al., (2007). The basic design features were discussed there, and progress to date was described. In this paper, we provide an update on progress since 2006, highlighting any changes in direction and describing the current status of the system.

New Sites. General Progress.

One of the main changes since the last report has been development of new sites, in some cases at new locations. New locations have often been necessitated for logistical reasons.

Fig. 1. Revised locations of sites for the O-QNet.



The revised sites are shown in fig. 1. Locations are close to the previous distribution, but are not all identical. Five sites are now complete, and giving data on an hourly basis. The data from the sites are updated at http://www.yorku.ca/oqnet/

Design updates.

The radars consist of dual sub-radars, comprising a large Doppler radar for upper level wind determinations and a smaller sub-system for wind measurements between 400m and 2000m altitude. The Doppler system is well established, and reliable. The boundary-layer mode has required some extra development. During the period leading up to MST11, extensive investigations of methods to measure boundary layer winds were discussed (Hocking, 2006; 2007). In contrast to other systems, our system was limited by lack of available bandwidth, so use of short pulses was not permitted. Pulse lengths were limited to typically 300m and more, but it was our intent to measure winds down to altitudes of 400m and lower. This required new approaches to antenna placement and software design. A bistatic antenna arrangement, with separate transmitter and receiver antennas was mandated by this requirement, and a design was required that limited direct ground-wave pick-up of the transmitter signal by the antennas. As discussed by Hocking (2007), a variety of approaches were applied, including the use of loop antennas. A view of some loop antennas is shown in fig. 2.

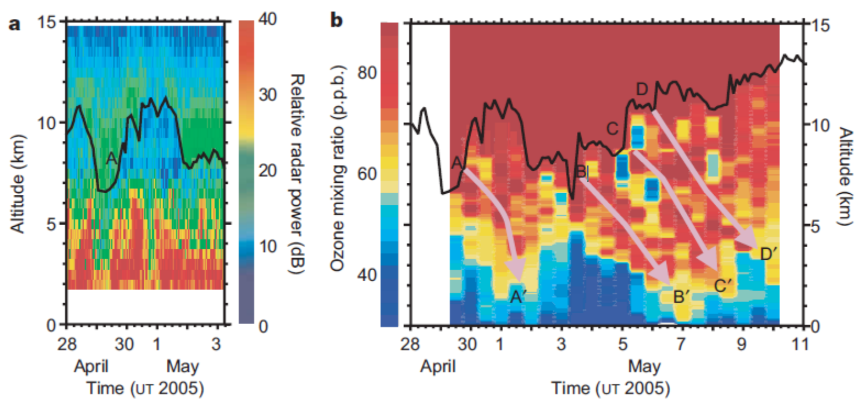
Fig. 2. View of loop antennas through the boundary-layer transmitter antennas

Loop antennas were considered good candidates because, when properly aligned, they were considered to have superior rejection of ground-level pickup from the transmitter. However, measurements also showed that they had narrow bandwidth (600 kHz) and were 10-15 dB less efficient than a 2-element Yagi. In order to improved the efficiency, a design was developed that involved not a single loop but a closely-wound double loop made from semi-rigid coaxial cable, which improved efficiency, but it suffered from an unexpected characteristic – even a small amount of water between the coils caused the resonant frequency to shift by several hundred kHz, so the loops wouild not work during rain! Eventually the loop antennas were replaced by 3-element Yagi antennas, as discussed in Hocking (2007), Hocking et al., (2007). Examples of the 3-elementYagis are shown in fig. 3.

Another important characteristic requited for good boundary-layer operation is a wide bandwidth for the transmitter antennas. Even if the antennas are tuned so that the VSWR at the central frequency is 1.0, the VSWR will become more than 1.0 as the frequency moves away from the central frequency. The transmitted pulse contains a range of Fourier components, and if the VSWR is different from unity at any of these Fourier components, some of the pulse (at these frequencies) will be reflected back to the transmitter. In order to reduce the effect, the VSWR needs to be as close to unity over as wide a band a possible. Reflected parts of the pulse may then reflect further from the transmitter, and so bounce back and forth between the antenna and transmitter. Hence remnants of the pulse may persist even for delays of several times the pulse length, and if these signals are collected by the space antenna receivers as ground-waves, they will complicate the extraction of true atmospheric signal. These multiple reflections occur in almost all radars, and are often confused with "ground echoes". Hence a wide bandwidth, and good suppression of direct pickup between the receiver antennas and the transmitter antennas, are crucial to the correct operation of boundary-layer system. More detail about the extraction process in boundary-layer mode can be found in Hocking and Hocking, 2010 (this issue). The new design optimizes these factors.

Fig. 3. Three-element Yagi antennas used for spaced-antenna reception at the Harrow site are seen in the foreground, just beyond the fence.

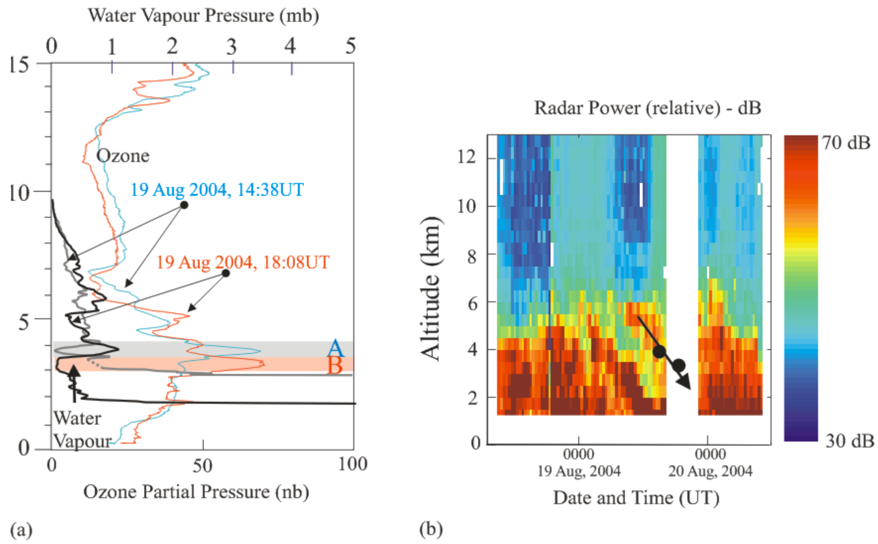
Fig. 4. Tracking the tropopause via radar (left), and (right) ozone intrusions seen using ozonesonde measurements. (from Hocking et al., 2007)



Significant recent Results.

The network has already proved useful for a variety of studies, including demonstration of the capability of windprofilers to forecast ozone intrusions from the stratosphere (Hocking et al., 2007). However, another result of that study is that it is sometimes possible to detect and track layers of ozone which have entered the troposphere from the stratosphere above. Fig. 5 shows ozone peaks observed using two successive ozonesonde measurements made only 4 hours apart. The peaks A and B not only have high ozone but also normally have low water vapour, and also steep gradients in water vapour content at their edges. These water vapour gradients help to produce enhanced radio backscatter, and the radar-signal enhancement shown in fig. 1(b) by the downward sloping arrow in fact tracks the ozone maximum. The two black dots in that figure show the height of the peaks in ozone density for events A and B (although unfortunately the radar was not operational for case B).

Fig. 5. Descending ozone layer (left) and corresponding radar backscatter (right) observed with the Clovar radar.



Future plans.

Unquestionably the major objective in the coming years is to integrate the windprofiler data into numerical forecast models. The output of the radars has been modified to produce bufr format as a standard output, and bufr files are sent to the forecast centre in Dorval (Quebec) every hour from all sites. Integration and testing of the usefulness of the profiler data in improving forecasting skill is currently underway, and results should be available by MST13.

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