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COMMENTS ON THE FEASIBILITY OF GROUND-BASED MM-WAVE MEASUREMENTS OF ANTARCTIC CLO

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To accord with current modeling scenarios dealing with the observed rapid depletion of ozone in the lower stratosphere during spring on the eastern side of Antarctica, there should be a marked increase in stratospheric ClO in the same altitude range, commencing about the time of solar return (approx. Aug. 15 at 75 degrees south, the latitude of Halley Bay), and persisting until the breakup of the polar vortex in mid to late November. We assume that chlorine will be released by photolysis to equilibrium concentrations shortly after sun-up, and that the concentration of ClO will remain high during the entire period of catalytic ozone destruction. From these assumptions, what are the prospects for a successful measurement of ClO in the 15-30 km altitude range, using the ground-based mm-wave spectrometer technique which we have employed successfully for the measurement of ClO over the past several years?

A. Model Predictions of ClO Signal Strength.

We have considered model profiles for vertical ClO distribution from two sources, the Harvard model of McElroy, et al. and the NOAA model of S.Solomon, et al. These two models yield rather different vertical profiles for ClO, and we have not obtained predictions from the Harvard model for altitudes above 30 km, but in both cases the rotational emission line intensity predicted from the mixing ratio profiles below 30 km leads to a dramatically increased signal strength, compared with normal mid-latitude values. Moreover, the amount of ClO at low altitudes is sufficient, particularly in the Harvard model, to yield an unmistakeable contribution to the pressure broadened line shape, sufficient to allow our line shape deconvolution techniques to get a good measure of the vertical profile down to about 22 km, and possibly lower.

B. Accessibility of Antarctic Sites

The best currently operating antarctic stations appear to be the station at Halley Bay operated by the U.K. and the U.S. station at the South Pole.Neither is easily accessible. Halley Bay is normally supplied only by ship, during the months of December and January.The Amundsen-Scott South Pole station is accessed by plane, between approximately mid November and mid February at best, via the U.S. station at McMurdo Sound. The plane-access season at McMurdo is not much longer in duration - generally early or mid October to the beginning of March. McMurdo is reached by plane or ship from New Zealand.

The normal first-access times at either Halley Bay or the Pole are thus too late to allow adequate (or probably <u>any</u>) observations to be completed before ozone has recovered from the spring depletion cycle, especially if equipment set-up and debugging must first be accomplished under unfamiliar and hostile conditions.

The alternatives are (a) to set up the equipment and leave it to winter over, counting on station personnel to start it up and take data, after undergoing some training (or to leave one or two dedicated volunteers to stay at the station along with the equipment); or (b) to explore early means of reaching Halley Bay by plane, e.g. via the Falklands, in late September or early October.

C. Enviornmental Factors

Ground-based mm-wave observations require low water vapor column density. It is desirable to have less than 2 mm of precipitable water vapor overhead. This condition appears to be met about 25% of the time at Halley Bay in spring, according to balloon sounding profiles of water vapor collected during 1957 and 1958.About 50% of the time, precipitable water vapor is below 2.3mm, so that conditions varying between adequate and quite good could be expected for reasonable periods . Stratospheric mm-wave observations can be carried out through cloud cover if water is in ice crystal form (e.g. high cold cirrus). Halley Bay, as a coastal site, is subject to substantial low cloud cover and fog, in part associated with open water leads which may come and go, particularly near the shore, even in the depths of winter. The Amundsen-Scott South Pole station in mid-continent at an elevation of 2800 meters , with a considerably colder and drier climate year round, would be more favorable, were it not for its remoteness and fearsomely low temperatures.

Our equipment has functioned without problems down to about -20 C which is typical for Halley Bay in mid-spring (October), but was not designed for the -65 C minimum temperature encountered at the South Pole in the same season. Some cold-proofing would have to be done and protection from wind and wind-blown snow would be needed at either site.

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We conclude that ground-based mm-wave observations could readily test the hypothesis that the spring depletion of ozone in East Antarctica is due to a large enhancement in the normal Cl_x concentration in the lower to mid stratosphere. The problems of logistics and of adapting our equipment to the harsh enviornment are substantial, but probably no more so than for most other ground based experiments conducted in Antarctica. A solution would entail extensive advanced planning, expense, and coordination with other experimental efforts in order to maximize cost-effectiveness and scientific return. It would appear that no "quick in and out" experiment is possible if the goal is to measure ClO.