THE EFFECT OF PH ON LOW FREQUENCY SOUND ABSORPTION IN THE OCEAN

D. G. BROWNING and R. H. MELLEN
Naval Underwater Systems Center
New London, Connecticut 06320
U.S.A.

ABSTRACT

The low frequency sound attenuation anomaly has been identified as a relaxation-absorption involving boron in sea water. A modified form of the Thorp equation has been developed to account for effects of variable pH. New results are reported for near-surface propagation where the absorption values are as much as twice Thorp's. Estimates for the higher pH values compare favorably with experiment.

INTRODUCTION

While the low frequency sound absorption anomaly is now clearly identified as a relaxation-absorption involving boron in sea water [1], details of the reaction are not yet known. However, the fundamental process appears to be the boric acid-borate reaction which should be sensitive to pH. Experimental data have been found to support this hypothesis.

Our pH correction [2][3] has the absorption increasing exponentially with pH over the range of ocean values, nominally, 7.5 to 8.4. The boron absorption is given by $\alpha_B = 0.1\ Af^2 f_r/(f_r^2 + f^2)$ dB/kyd. The relaxation frequency f_r is given by the empirical relation $f_r = 10^{(T - 4)/100}$ (kHz) where T is the temperature in degrees Celsius and the coefficient A is given by $A = 10^{(pH - 8)}$. The constants were chosen to reduce to Thorp's equation [4] for pH = 8.0 and T = 4°C.

New data are presented for some experiments involving near surface propagation where the higher pH values evidently cause boron absorption to be as much as twice Thorp's value.

EXPERIMENTAL RESULTS

Figure 1 shows some experimental results from surface duct experiments in the Gulf of Aden and the Bismarck Sea [5]. In surface ducts extra loss in addition to absorption may arise from surface scatter as well as from diffraction. Surface scatter appears to be negligible in these experiments. Diffraction, however, becomes important at low frequencies

MULTI-AREA TRANSMISSION LOSS MODELS

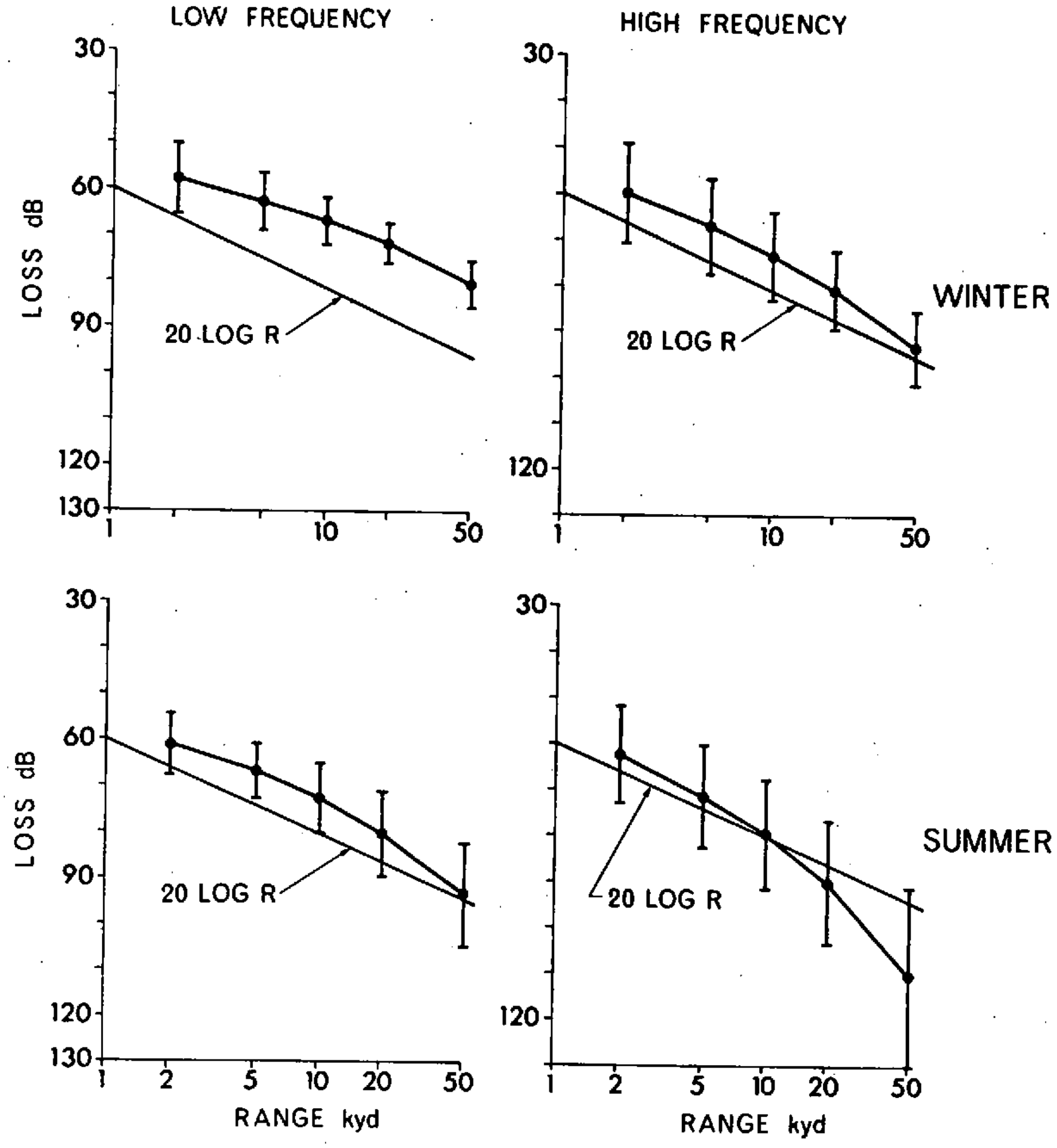

Fig. 5 Multi-area transmission loss models