Discussion of “Comparison of wave refraction and diffraction models” by J. P. Y. Maa, T. W. Hsu, C. H. Tsai and W. J. Juang, *Journal of Coastal Research*, **16**, 1073-1082, 2000.

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1 Discussion of Wave Angle Results in Maa et al

In the paper under discussion, Maa et al (2000) compare six numerical codes which solve either the full mild slope equation or, in two cases, forward scattering approximations of the full problem. Each model is applied to the shoal experiment of Berkhoff et al (1982). Resulting wave heights are compared to laboratory data. Local wave angles are also plotted and basically intercompared for consistancy, since there is no “correct” answer per se. In this comparison, the authors produce a plot (Figure 8) which basically indicates that the REF/DIF 1 model does not reproduce the rotation of wave angles during focussing or subsequent evolution of the wave field in the lee of the shoal. This result is completely false.

The REF/DIF 1 model is freely available from the web site http://chinacat.coastal.udel.edu/ kirby/programs/refdif. Using the version obtained there, the Berkhoff et al (BBR) shoal experiment can be run as a standard test of the model installation. A model run produces (among others) files containing computed wave heights and wave angles at the input grid locations. These files have been used here to construct arrow plots of wave direction in a form similar to Figures 6, 7 and 8 in Maa et al, using the Matlab routine given in Appendix A. (Maa et al give no indication of how angles are constructed from any of the model results under discussion). Resulting plots are shown in Figure 1 for the case of linear waves, and in Figure 2 for the case of nonlinear waves, where wave nonlinearity is represented through a partially empirical extension of Stokes wave dispersion (Kirby and Dalrymple, 1986) which is included as a standard REF/DIF 1 feature. It is known, for this particular experiment, that nonlinear effects on the wave focussing process are significant and that the nonlinear REF/DIF 1 calculation provides an excellent description of the wave height pattern, as compared to the relatively inaccurate linear results displayed in Figure 11 (Kirby and Dalrymple, 1984). For the computations, the actual measured wave height of $4.64cm$ is used (rather than the artificial value of 1 cm used in Maa et al) since accurate waveheight is needed to account properly for amplitude dispersion effects in the nonlinear wave case.

The results in both figures indicate that wave vector rotation is indeed properly modelled in REF/DIF 1, in contrast to the assertion in Maa et al (2000). Results in Figure 1 here are essentially similar to results in Figure 6 of Maa et al for the full elliptic models, and are significantly better than the RCPWAVE results given in Figure 7 by Maa et al. Further, since nonlinearity is known to be important in this example and since it is known that the nonlinear REF/DIF 1 provides a more accurate spatial distribution of waveheights in this example than do the linear models (Kirby and Dalrymple, 1984), it is likely that the wave vector distribution shown in Figure 2 here is more accurate than the full elliptic (but linear) result shown by Maa et al their Figure 6.

Appendix: Matlab algorithm to plot wave vectors from REF/DIF 1 output

```
%  waveangle.m
%
%  Create quiver plot of scaled wave vectors based on the data
%  in files height.dat and angle.dat from ref/dif.  Orientation
%  of plot chosen arbitrarily to correspond to figures in Maa et al, 2000.
%
%  James T. Kirby, 12/5/01

   load height.dat
   load angle.dat
   load depth.dat

%  normalize height

   href=height(1,1); height=height/href;

%  coordinates

   x=(0:99)*.25; y=x;

%  quiver vector components

   u=-height.*cos(angle*pi/180); v=-height.*sin(angle*pi/180);

%  construct plot

   subplot(2,1,1), hold off
   [c,h]=contour(x,y,flipud(fliplr(depth'))); clabel(c,h),hold on, ...
   quiver(x,y,flipud(fliplr(u')),flipud(fliplr(v'))), axis equal,...
   axis([0 15 10 20]), xlabel('x (m)'), ylabel('y(m)')
   subplot(2,1,2), hold off
   [c,h]=contour(x,y,flipud(fliplr(depth'))); clabel(c,h),hold on, ...
   [c,h]=contour(x,y,flipud(fliplr(height'))); clabel(c,h),axis equal,...
   axis([0 15 10 20]), xlabel('x (m)'), ylabel('y(m)')
```

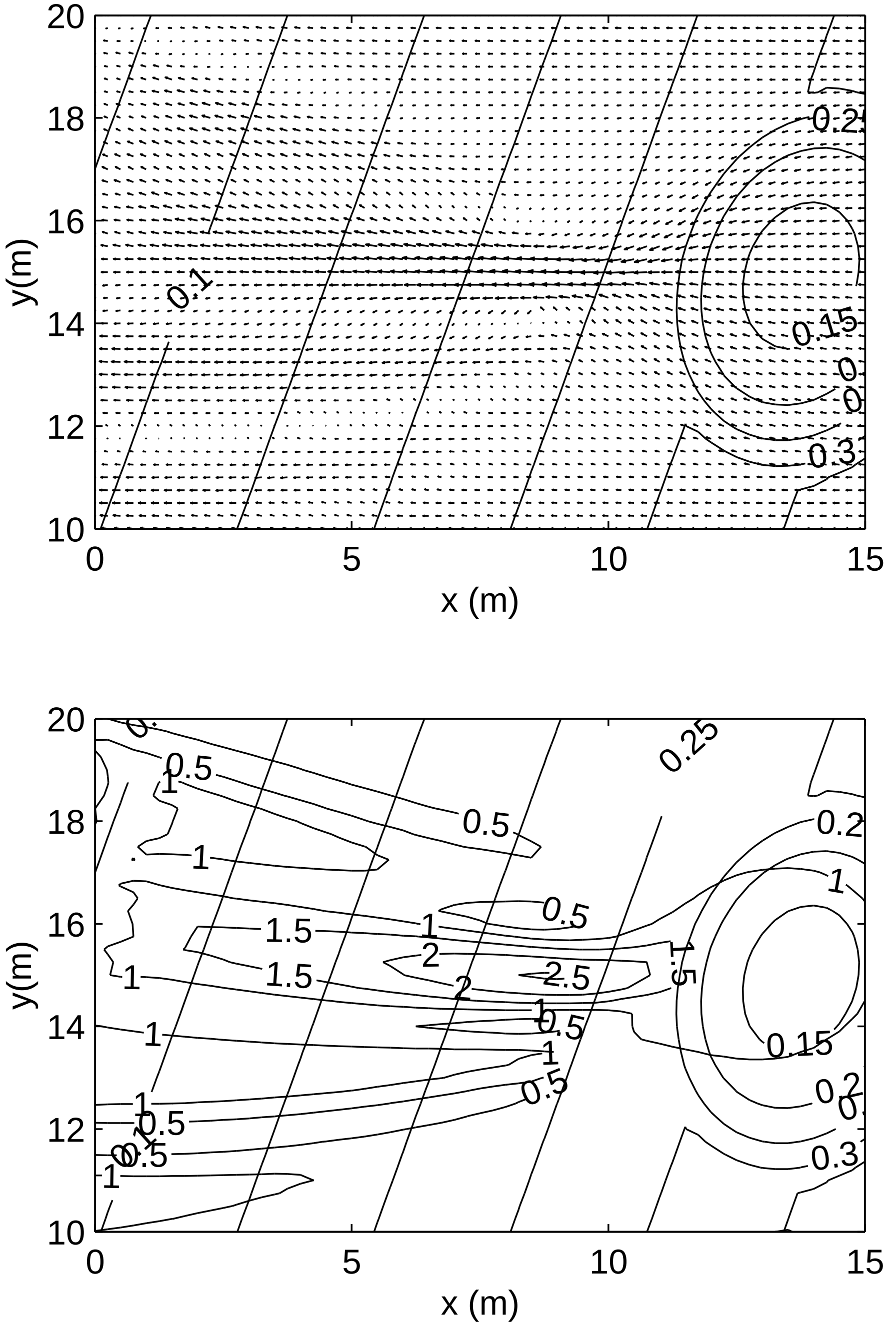

Figure 1: Calculated wave vectors (top) and normalized wave height contours (bottom) behind the elliptic shoal using the REF/DIF 1 model. Linear dispersion results.

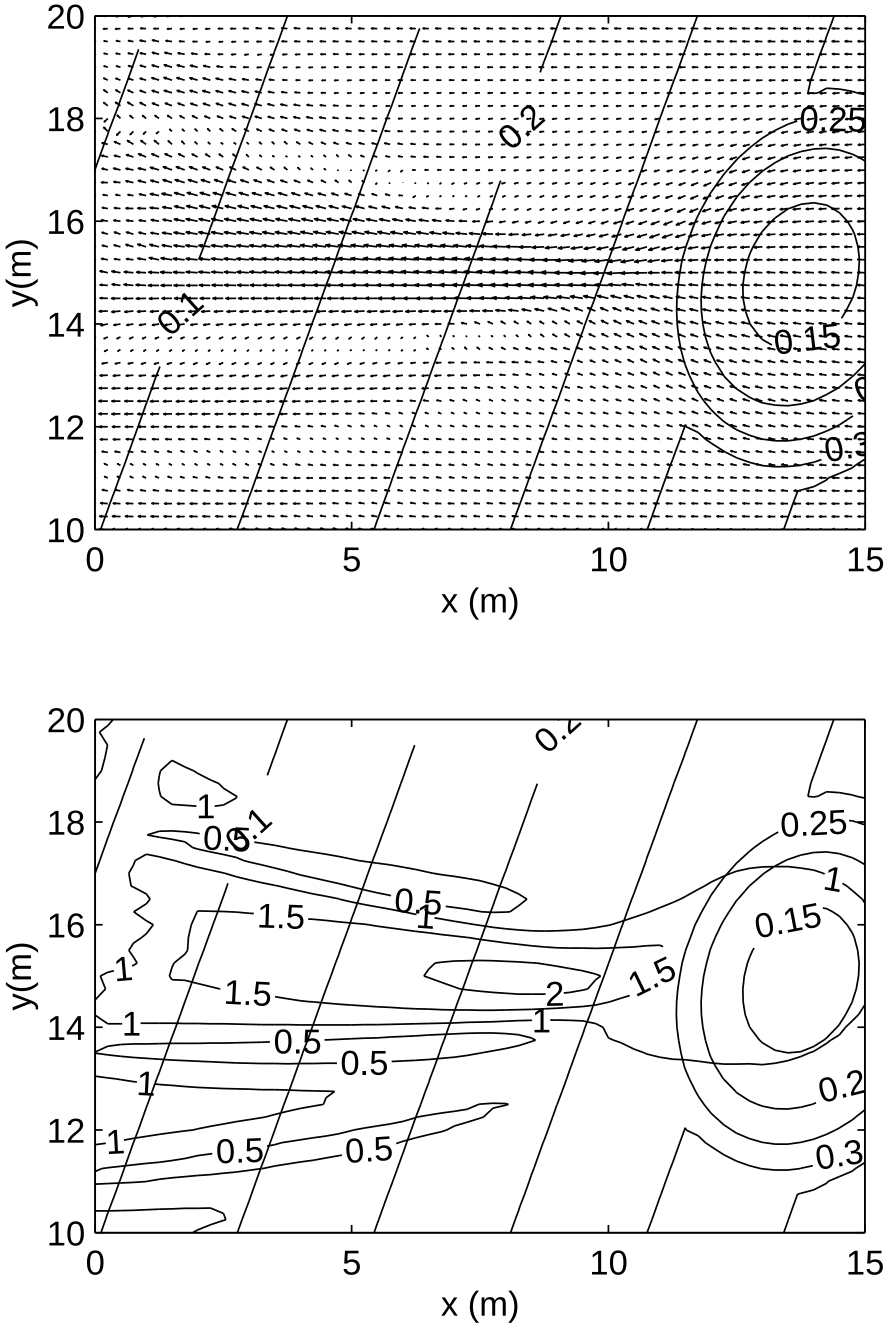

Figure 2: Calculated wave vectors (top) and normalized wave height contours (bottom) behind the elliptic shoal using the REF/DIF 1 model. Nonlinear dispersion results.

References

Berkhoff, J. C. W., Booij, N. and Radder, A. C., 1982, “Verification of numerical wave propagation models for simple harmonic linear water waves”, *Coastal Engineering*, **6**, 255-279.

Kirby, J. T. and Dalrymple, R. A., 1984, “Verification of a parabolic equation for propagation of weakly-nonlinear waves”, *Coastal Engineering*, **8**, 219-232.

Kirby, J. T. and Dalrymple, R. A., 1986, “An approximate model for nonlinear dispersion in monochromatic wave propagation models”, *Coastal Engineering*, **9**, 545-561, and reply to discussions, **11**, 87-92, 1987.

Maa, J. Y. P., Hsu, T. W., Tsai, C. H. and Juang, W. J., 2000, “Comparison of wave refraction and diffraction models”, *J. Coastal Res.*, **16**, 1073-1082.