ADIABATIC TESTCASE RESULTS:

The testcase consists in a steady monochromatic wave shoaling from 4 to 6 m depth on a slope without breaking nor bottom friction, and for an inviscid fluid (Ardhuin et al 2008 and Bennis et al 2011). The references results from Bennis et al, 2011 are attached here to compare (Fig 4). To have a simple testcase we decided to force NEMO by the wave fields calculated in WW3 and not to couple NEMO with WW3.

The initial condition for WW3 are a significant wave hight Hs=1.02m, a mean period Tm=5.26s and a wave direction θ= 90° (propagation in the x direction). WW3 results show an increase of the wave amplitude by 2.7%, associated with an increase of the surface Stokes drift, in the shallower part as described in Bennis et al, 2011.

For the ocean current, we obtained an homogenous quasi-eulerian velocity as expected, nevertheless the order of magnitude of the velocity does not coincide with the one of Bennis et al, 2011. Indeed, the calculation of the Stokes drift with the Breivik,2014 or Breivik,2016 approximation (deep water approximation) does not give a good result for the vertical decay of the Stokes drift (Fig 2).

This test case is related to intermediate water and not deep water so the Breivik approximations mustnot be used.

Problem: these 2 implementations of the Stokes drift decay are the only options remaining in the NEMO 4.0.X version.

We implemented the Stokes drift calculation as in Michaud et al, 2012 for intermediate/shallow water and obtained results similar to the one of Ardhuin et al,2008 and Bennis et al 2011 (Fig 1). This confirms that the GLM is well implemented in NEMO and the only problem is the calculation of the Stokes drift in function of depth.

Problem: The goal of a testcase is not to includ a new option of calculation for the Stokes drift. It should be discussed for a next version of NEMO.
This has been discussed in the last NEMO ST meeting and the suggestion was to:
1) include an additional Stokes Drift profile parameterization in the tescase MY_SRC;
2) include it as a userdef parameterization in OCE/USR/ folder.

Another possibility could be use the option ln_wave_test (already in NEMOv4.0.x). With this option we can give to NEMO a uniforn field with a significant wave hight Hs=1.02m, a mean wave period T=5.26s and a surface Stokes drift in x-direction Us (0)=0.05m/s. In this case (ln_wave_test), we can add the calculation of the Stokes drift for a monochromatic wave in intermediate/shallow water (Fig 3).

Problem : The significant wave high and the surface Stokes drift are constant and we neglect the effect of the bottom on the propagation of the wave field (obtained with WW3).

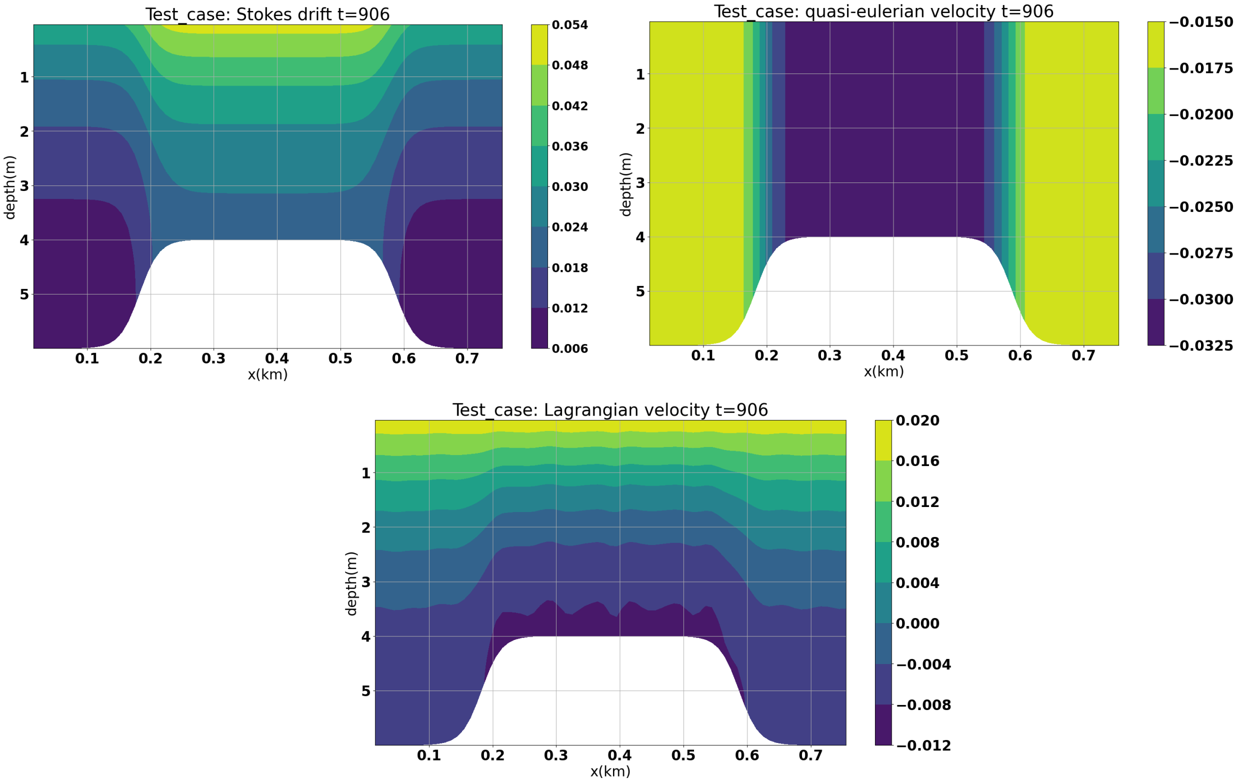
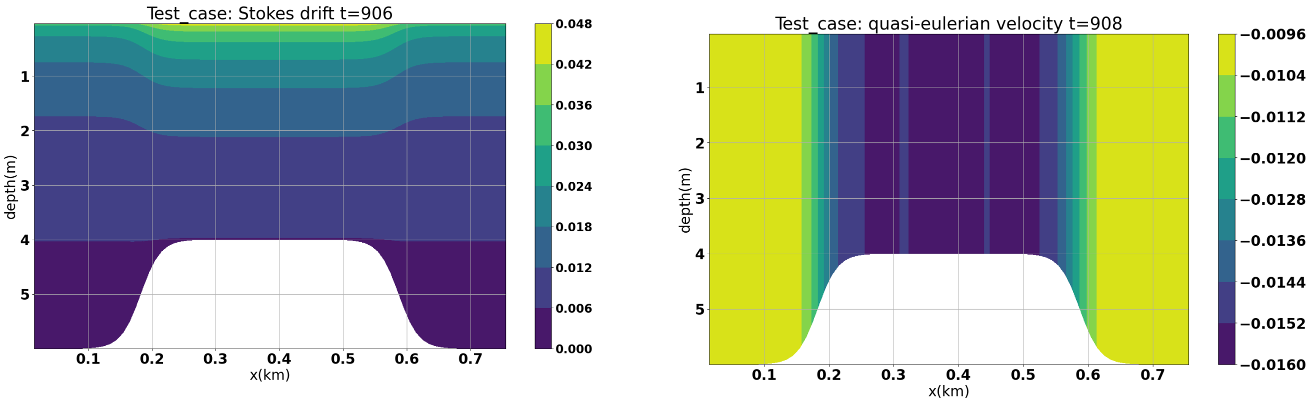
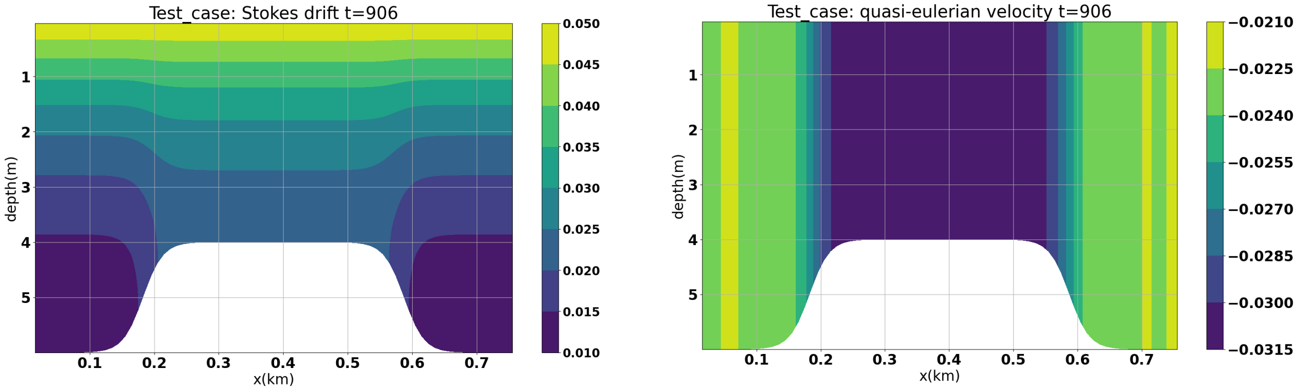


Fig 1: Results obtained with the calculation of the Stokes drift for intermediate/shallow water in NEMO after 900s.
Top left: Stokes drift Us (m/s)
Top right: Quasi-eulerian velocity u (m/s)
Bottom: Lagrangian velocity uTot=Us+u (m/s)


Test_case: Stokes drift t=906

Test_case: quasi-eulerian velocity t=908

Fig 2: Results obtained with the Breivik, 2016 implementation for the Stokes drift (deep water), after 900s.
Top left: Stokes drift Us (m/s)
Top right: Quasi-eulerian velocity u (m/s)
Bottom: Lagrangian velocity uTot=Us+u (m/s)


Test_case: Stokes drift t=906

Test_case: quasi-eulerian velocity t=906

Fig 3: Results obtained using the ln_wave_test option and a monochromatic calculation for the Stokes drift, after 900s.
Top left: Stokes drift Us (m/s)
Top right: Quasi-eulerian velocity u (m/s)
Bottom: Lagrangian velocity uTot=Us+u (m/s)

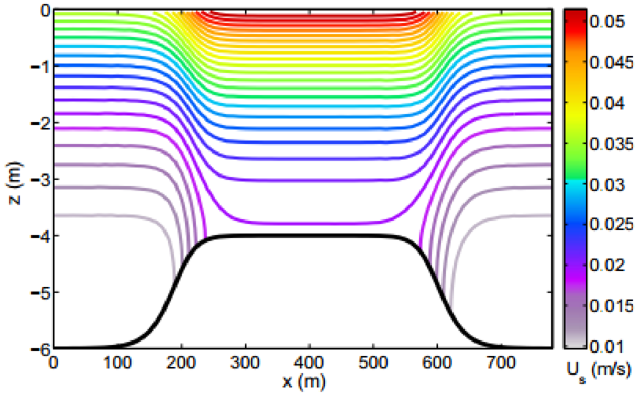


Fig. 6. Stokes velocity in x-direction for $H_s = 1.02$ m, $T = 5.26$ s and $K_z = 0\ \mathrm{m^2 . s^{-1}}$.

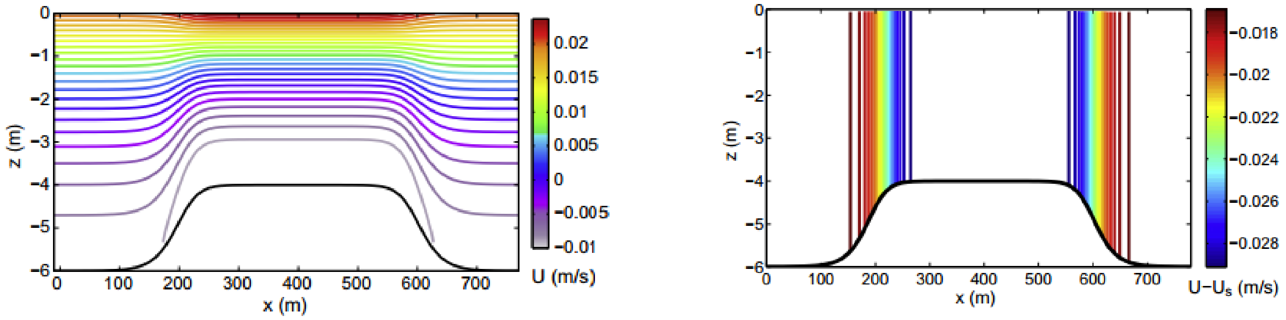


Fig. 4. Solution given in Bennis et al 2011. Stokes velocity in x-direction (top left). Lagrangian velocity U (bottom) and quasi-Eulerian velocity U + Us (bottom right).

<ins>References:</ins>

Ardhuin F., Rascle N., Belibassakis K.A., 2008. Explicit wave-averaged primitive equations using a generalized Lagrangian mean. Ocean Model. 20, 35–60.

Bennis A.C. , Ardhuin F., Dumas F., 2011.On the coupling of wave and three-dimensional circulation models: Choice of theoretical framework, practical implementation and adiabatic tests. Ocean Model. 40, 260–272.