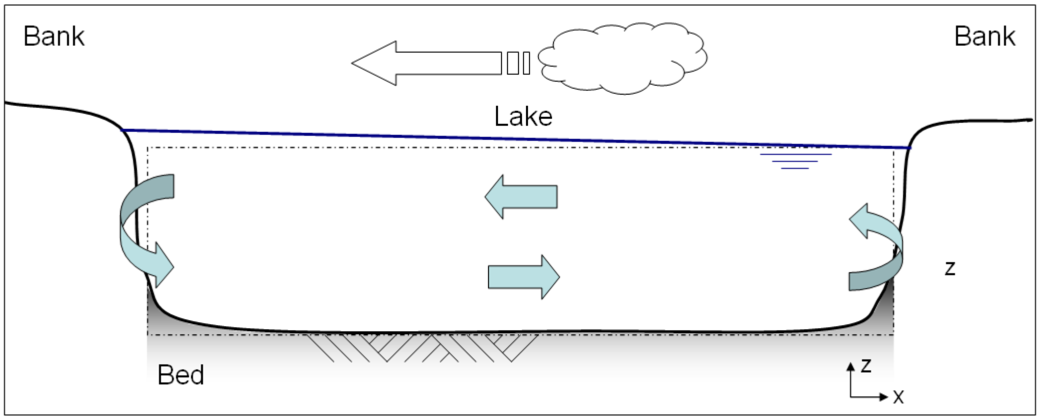
Exercise 3 Part 1: The vertical structure of barotropic currents



Typically in closed basins the water near the surface will flow in the direction of the wind (Coriolis effect neglected) while continuity (conservation of mass) requires a return flow in deeper layers. If the wind is constant a stationary circulation will be established.

Goal

- Test the performance of the four available turbulence models for the case of a closed basin with wind forcing.
- First, pay special attention to the behaviour of the solution near the edges of the closed basin.
  - What happens if you make the last grid cell next to the borders much larger in the grid editor (see ce5377_6077-d3d-general-hints.pdf previously given out in Lecture 1)?
  - What happens if you adapt the depth file, such that near the edges of the lake the lake becomes more shallow similar to what you did in Lecture 2?
  - What is the essential difference between a depth averaged simulation and a 3D simulation of a lake under wind forcing? Which one would suffice when the objective is to predict surges, and which one when the objective is to calculate the spreading of substances (sediments, algae, oil spills)?
- Consider the following in your results:
  - What is the influence of the background viscosity on the spin-up time and the final stationary results?
  - How can you affect the spin-up time by specifying a gradually increasing wind, rather than a stepwise increasing wind?
  - **For CE6077 -** what happens at the level where $\partial u/\partial z = 0$
  - **For CE6077-** what does the shear stress profile look like?

Tips

- Use previous grid or a similar one with dx=1000 and dy=10000
- Create a minimum of 10 layers in the vertical direction in the Flow Input Editor (Fig. 3-1)
- Use a uniform bathymetry as in Exercise 1
- Activate the relevant process (wind) in the Flow Input Editor. Delft3D uses the nautical convention (e.g. 0° is wind blowing from North to South while 180° is wind blowing from South to North)

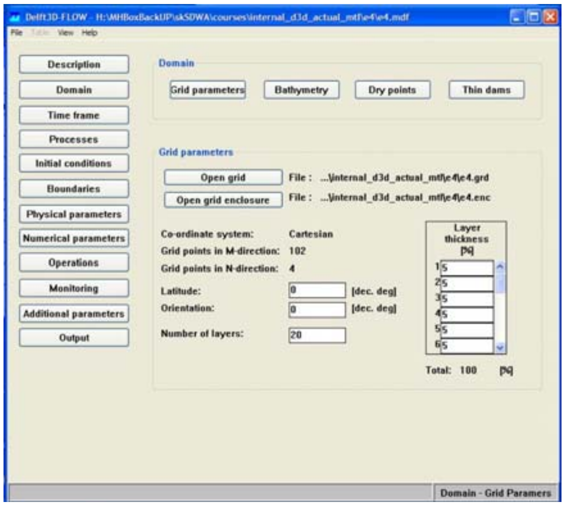


Figure 3-1: Creating layers in the vertical direction (in this case 20 layers)

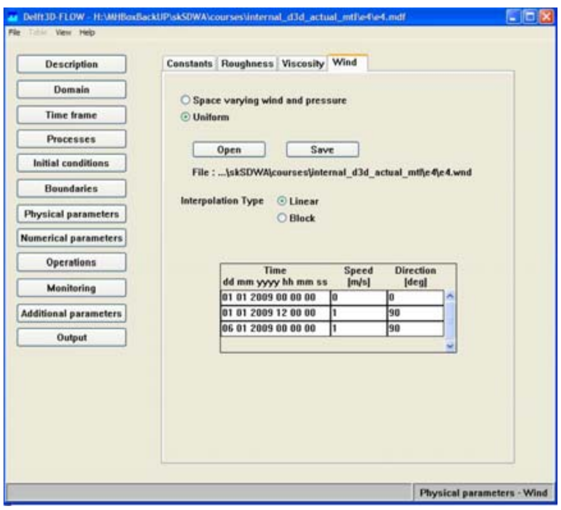
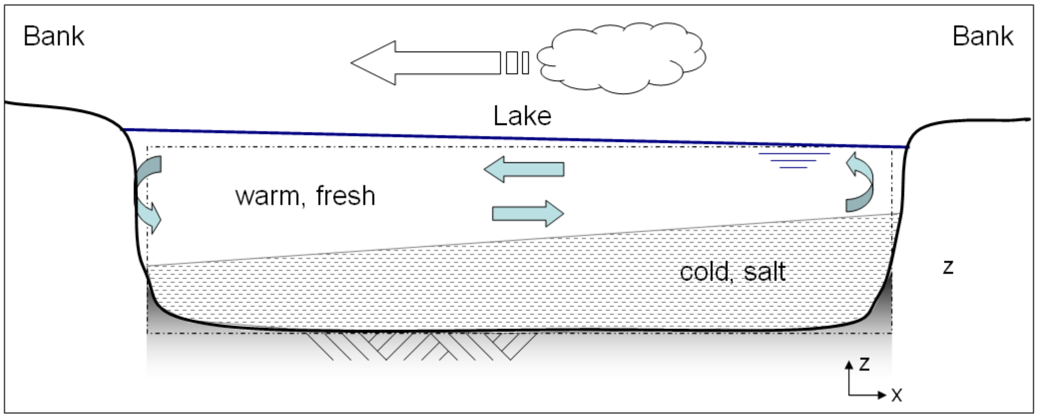


Figure 3-2: Activating the wind (in this case blowing from the East)

Exercise 3 Part 2: The vertical structure of baroclinic currents



What happens if the water in the basin is stratified?

Goal

- Carry out a similar exercise to Part 1 but now use an initial condition file to create an initial stratification. Fig. 3-3 shows what your initial stratification should look like
- What should the flow pattern look like, and how does it look?
- What happens to the stratification over time?
- Test the effect of switching on the Forrester filter (vertical), and the Correction for sigma-coordinates (Stelling & van Kester, 1994).

Tips

- In addition to the previous steps in Part 1, activate the relevant process (salinity or temperature) in the Flow Input Editor and ensure that your initial conditions file should contain data for the processes you activated.

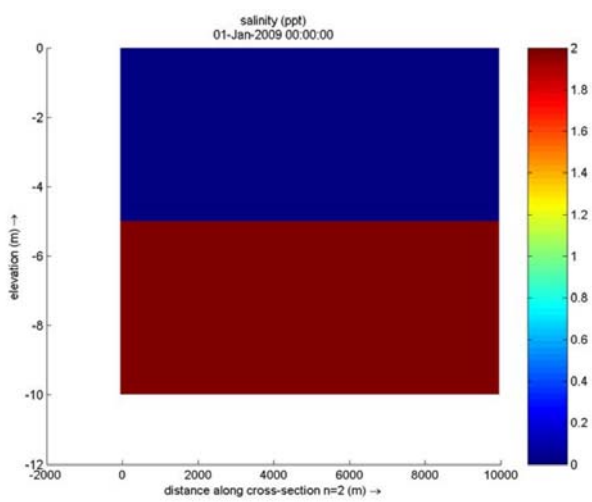


Figure 3-3: Example of initial stratification.

- Use Excel to make the initial conditions file: see the Delft3D-FLOW user manual appendix: A.2.9 Initial conditions. Use the same Excel set-up as for the depth file in exercise 2 (Figure 6.1).

```
[   1 block ] for waterlevels (as depth file, but at centers)
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```
[kmax blocks] for u-velocities
[kmax blocks] for v-velocities
[kmax blocks] for salinities
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- Activate the relevant process (salinity or temperature) under 'processes' in the input editor. The initial conditions file should contain data for the processes you activated, and not for processes you did not activate.

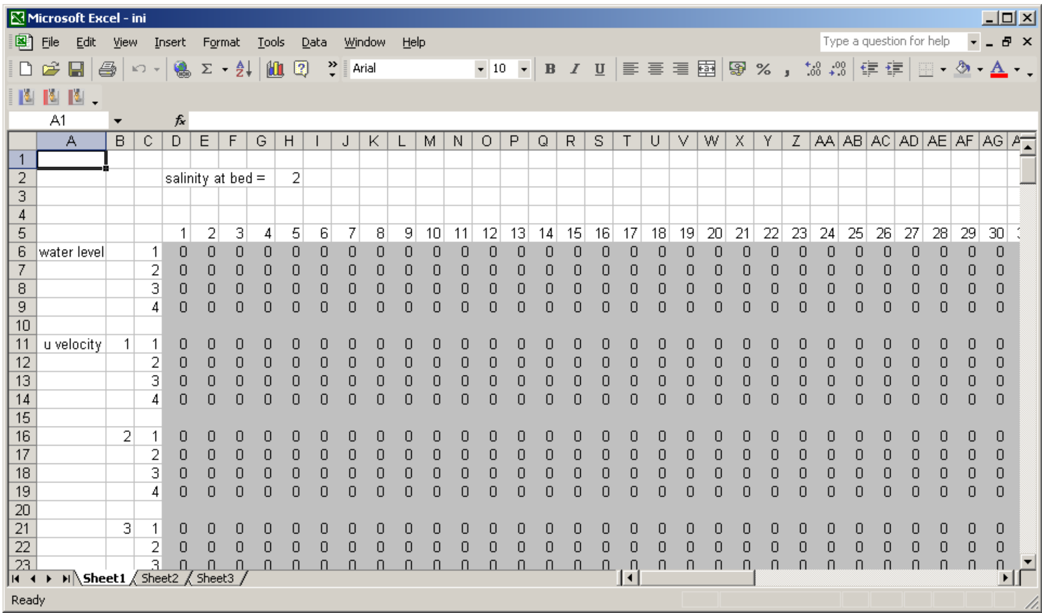

Figure 3-4. Excel file example to make initial conditions file. Only copy the gray area to an ASCII file, the white area is for comments.

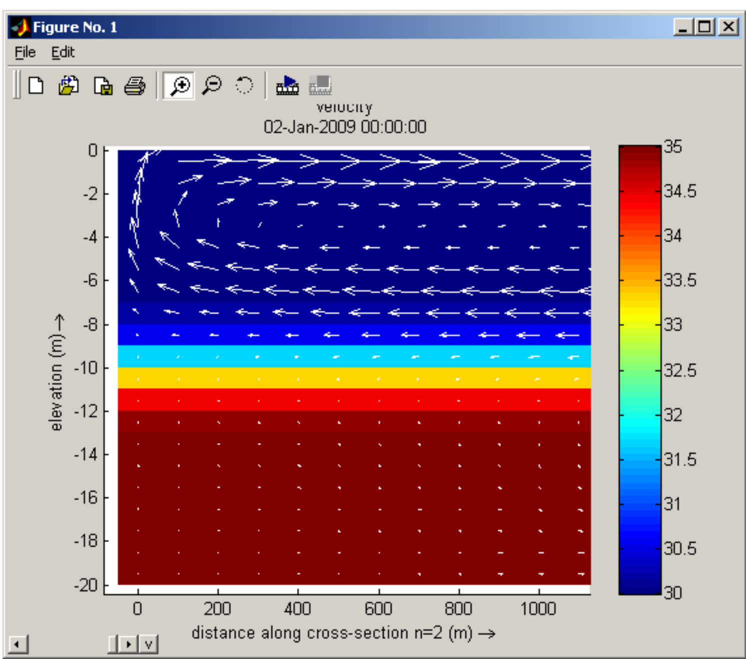

Figure 3-5. Slice in (x,z plane) near eastern lake boundary, with salinity as color values, and velocities as white arrows.