Chapter 22

Introduction

A total of 12 test cases has been implemented. The first eight are adapted versions of the ones made available with the release of the COHERENS V1 source code and discussed in the COHERENS V1 manual. The files, used for the setup (including the *Usrdef_** files), are located in subdirectories of the **setups** folder. The main objectives for implementing the test cases are to

- check the installation of the model code by the user
- perform simulations without any programming effort by the user
- demonstrate the various options, available in the program (e.g. selection of a particular scheme by setting the appropriate switches) and, in particular, to show how model results are affected by different choices of model switches or parameters
- test the portability of the program
- verify model results against exact or analytical solutions
- provide a debugging tool for further developments of the model code.

The following test cases have been implemented:

1. Test cases for advection.

   cones

   Advection in a closed basin of an initially coned-shaped contaminant distribution rotating around the basin's centre. Four experiments are defined using different values of the model switch for scalar advection.

front
Advection (on a σ-grid) of a front by a tidal current over a sloping bottom in an open channel without "physical" diffusion (James, 1996). Four experiments are defined using different values of the model switch for scalar advection.

seich
Adjustment to equilibrium of an initial horizontal density gradient in a closed channel, through the propagation of internal waves. The numerical results are compared with an analytical solution. Five experiments are defined using different values of the model switches for scalar and momentum advection.

fredy
Development of 3-D baroclinic eddies in a closed basin. This test case was previously considered in the NOMADS project (Proctor, 1997). Four experiments are defined using different values of the model switches for scalar and momentum advection. Results are compared with those described in Tartinville *et al.* (1998).

2. Test cases for turbulence and heat formulations

pycno
A 1-D test describing the evolution of a wind-driven surface layer without rotation. An initial linear stratification is assumed and advection is neglected. The results are compared with analytical theory (Kundu, 1981; Luyten *et al.*, 1996). Seven experiments are defined using different values of the turbulent switches.

csnsp
A 1-D simulation of the seasonal evolution of thermal stratification at station CS in the North Sea. Nine experiments are defined using different values of the turbulence switches, different parameterisations for the surface exchange coefficients, or disabling the attenuation of light.

3. Density fronts and river plumes

river
Evolution of an estuarine salinity front advected by a tidal current and the corresponding estuarine circulation in an open non-rotating channel. Four experiments are defined using different values of the switches for turbulence and momentum advection.

plume

Formation and evolution of a tidally modulated river plume front. Some comparison is made with the theory of tidal plumes presented in Visser *et al.* (1994). Seven experiments are defined testing the role and form of horizontal diffusion, the scheme for momentum advection, the type of open boundary condition and the effects of the tide.

rhone

Simulation of the Rhone plume in the Gulf of Lions (Mediterranean Sea) with a real bathymetry. Seven experiments are defined with different river discharges, turbulence schemes and directions of the wind forcing.

4. Flooding and drying experiments

flood2d

Simulation of flooding and subsequent drying in a 2DV channnel. Four experiments are defined using two different bathymetries and two different drying/wetting formulations.

flood3d

Simulation of flooding and drying in a 3-D rectangular basin. Four experiments are defined using different bathymetries.

5. Shelf sea modelling

bohai

Simulation of the tides in the Bohai Sea (northern part of the Yellow Sea). Six experiments are defined using different types of open boundary conditions either in 2-D (depth-averaged) and 3-D mode.

optos

Tidal simulation in the North Sea using a nested setup. Three model domains are considered: European Continental Shelf, North Sea (nested in the Continental Shelf grid), Belgian Coastal Zone (nested in the North Sea grid). A test case is defined for each grid: ***optos_csm,*** ***optos_nos*** and ***optos_bcz***.

6. Structures and discharges

drythin

Simulates the tidal flows around obstacles, either represented by a block of dry cells (first experiment) or a series of thin dams (second experiment) within an open channel.

weirbar Five experiments are defined simulating the tidal flows over weirs and barriers within an open channel.

discharges Four experiments are designed to test the various options of the discharge module. The experiments are conducted in a closed basin where four discharge points are defined. The locations are either stationary or moving.

The instructions for installing and running a test case are already explained Section 3.3. A simulation is performed using the `Run` script with an argument in the form of a capital letter. The argument informs the program which experiment is simulated (see Table 3.1).

Further information about the setup of a test case can be obtained by inspecting the FORTRAN source files in the corresponding **/setups** subdirectory. A series of output parameters, which are described in the chapters below, are defined for each test case. If no run-time error occurred during the execution of an experiment, a file is produced at the end of the simulation. Its name is composed of 10 characters:

- characters 1–5: name of the test case (as given in the first column of Table 3.1)
- character 6: name of the experiment presented by one of the capital letters A to I
- character 7–10: "*.tst*"

Simulations were performed for all test cases on different machines and compilers. The corresponding *.tst*-files for different compilers are found in the different subdirectories of the **/setups/ptests** folder. These files are a useful tool to test the portability of the model code. The test cases are described in Chapters 23–27. The values of the test parameters, given in tabular form within the text, and the figures in the text were obtained from simulations, performed on a LINUX machine with a gfortran compiler.

Calculation times for all test case experiments are listed in Table 22.1. The simulations are permormed on a LINUX PC in serial mode and a parallel cluster at ECMWF (European Center for Medium Range Weather Forecasting, UK) using different number of processors.

Table 22.1: Calculation times (in seconds) for test case experiments on a LINUX serial PC using gfortran and a parallel cluster using XL Fortran at ECMWF. The number after the '-' sign denotes the number of processes.

Name	Experiment	LINUX-0	ECMWF-1	ECMWF-4	ECMWF-16	ECMWF-32
cones	A	0.7	4.0	2.4		
	B	2.8	1.0	1.4		
	C	3.7	4.1	2.1		
	D	1.6	2.2	2.1		
front	A	0.7	4.7	5.3		
	B	2.7	1.9	2.5		
	C	1.2	3.0	3.0		
	D	3.2	4.8	4.9		
seich	A	2.5	2.3	5.9		
	B	0.5	3.8	5.7		
	C	2.6	2.1	5.7		
	D	2.9	2.4	3.6		
	E	1.0	4.6	5.2		
fredy	A	100	118	80	70	
	B	220	248	146	105	
	C	143	199	105	80	
	D	260	346	167	101	
pycno	A	2.4	10.2			
	B	4.8	10.3			
	C	4.8	10.7			
	D	2.4	6.5			
	E	4.5	7.9			
	F	4.7	8.3			
	G	2.8	6.4			
csnsp	A	16	41			
	B	17	43			
	C	17	42			
	D	14	46			
	E	17	39			
	F	15	42			
	G	15	41			
	H	17	38			
	I	15	35			
river	A	13	26	26		
	B	12	25	24		

(Continued)

Table 22.1: Continued

	C	14	27	25		
	D	20	37	35		
plume	A	320	441	184	92	98
	B	191	296	120	70	77
	C	225	321	143	79	88
	D	215	286	134	72	82
	E	213	280	134	72	79
	F	214	278	133	72	83
	G	301	400	188	94	94
rhone	A	848	1282	501	253	224
	B	850	1053	502	234	222
	C	816	1012	480	226	216
	D	851	973	502	233	219
	E	849	952	501	232	223
	F	845	1272	496	230	222
	G	847	1156	498	236	238
bohai	A	498	432	291	285	
	B	467	431	263	220	
	C	465	424	267	214	
	D	938	1244	632	319	
	E	887	1211	659	315	
	F	888	1188	640	316	
flood2d	A	20	61	71		
	B	23	46	74		
	C	81	101	143		
	D	91	115	164		
flood3d	A	422	614	320	254	
	B	633	1017	439	276	
	C	2314	3486	1347	590	
	D	198	345	195	206	
drythin	A	267	361	376		
	B	270	398	346		
weirbar	A	21	61	105	166	358
	B	360	509	270	532	408
	C	370	508	266	517	399
	D	367	514	269	540	384
	E	10292	15185	5471	1829	1328
discharges	A	52	95	79		

(Continued)

Table 22.1: Continued

	B	50	68	77
	C	50	73	63
	D	52	65	68
optos_csm[1]	A	15713	2306	
optos_nos[2]	A	5270	928	
optos_bcz[3]	A	6878	1308	
bedload	A	0.02	0.45	
	B	0.01	0.14	
	C	0.01	0.10	
	D	0.01	2.1	
	E	0.01	0.11	
	F	0.01	2.5	
totload	A	0.01	2.5	
	B	0.01	0.08	
	C	0.01	0.10	
	D	0.01	0.07	
	E	0.01	0.07	
	F	0.01	0.05	
wavload	A	2.4	2.8	
	B	0.5	4.1	
	C	2.8	2.7	
	D	2.9	4.7	
sedvprof	A	4.7	7.2	
	B	8.3	20.8	
	C	8.2	20.5	
	D	8.2	18.6	
	E	11.3	22.0	
	F	8.3	21.3	
	G	8.6	20.9	
	H	10.3	22.3	
sedhprof	A	0.7	4.5	4.9
	B	2.6	1.5	1.5
	C	2.5	3.1	3.4
	D	0.6	1.3	1.5
	E	2.6	1.4	3.6

(Continued)

[1]18 processes in parallel mode
[2]16 processes in parallel mode
[3]14 processes in parallel mode

Table 22.1: Continued

	F	0.4	3.0	1.4	
	G	9.4	14.0	8.4	
seddens	A	6.3	14.1	10.6	
	B	6.2	13.9	7.9	
	C	8.9	13.5	10.1	
	D	6.2	10.2	7.7	
	E	8.4	11.2	10.2	
thacker	A	93	163	50	25
	B	85	171	48	26
	C	631	625	277	96
	D	544	816	283	108