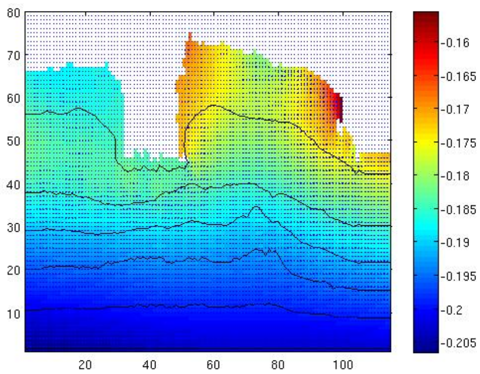
Userguide for

LAMP3D

A. M. Doglioli and V. BRUN

Aix-Marseille University, Mediterranean Institute of Oceanography (MIO) ;
France.



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The LAMP3D package is the result of a collaborative work of different scientists. Indeed, it is based on the precious contribution of M.G Magaldi, L. Vezzulli, S. Tucci.

The LAMP3D (Lagrangian Assessment for Marine Pollution 3D Model) project has been supported by the INFM (National Institute for the Physics of Matter), the Regione Liguria, the CNR (National Research Council), the Italian National Agency for New Technologies, and finally the ENEA (Energy and Environment).

LAMP3D project web site : `http://mio.pytheas.univ-amu.fr/~doglioli/`.

LAMP3D download web site : `http://mio.pytheas.univ-amu.fr/~doglioli`.
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1 Introduction

This guide presents the LAMP3D package of Matlab and Fortran routines, designed to simulate the dispersion of polluants released from a marine fish farm in the Ligurian Sea (Western Mediterranean).
Aquaculture is known since the fourth millennium BC. For two centuries now an impressive increase of the aquaculture production has been observed. This massive development has created major issues on the marine environement due to the release of organic wastes. (Doglioli and al., 2004). This is why a lot of studies have been made in order to measure these impacts using real historic current-metre data, settling velocity values and using different models in order to simulate the dispersion of aquaculture waste. (De Gaetano and al., 2008). Furthermore, as these productions have real changes and impacts on community structures and biodiversity it is interesting to study a potential impact before a new fish farm is established.

LAMP3D project (Lagrangian Assessment for Marine Pollution 3D Model, 2001 ; `http://mio.pytheas.univ-amu.fr/~doglioli/`) was designed to simulate the dispersion of polluants released from a marine fish farm in the Ligurian Sea. LAMP3D has been interlocked into the numerical hydrodynamical model POM (Princeton Ocean Model).
In order to reach this goal, the project was highly multidisciplinary, with a strategy based on a combined use of satellite data, numerical model results and in situ measurements from different papers that had study the area.
The main goal of the field experiment was to describe on one hand the 3D hydrodynamic flows and on the other hand the 3D dispersion of pollutants coming from a marine fish farm in the Western Mediterranean.

To accomplish this task and to treat the data, we developed the software collected in the LAMP3D package.
The software is equipped with a series of codes and user-friendly accessories and the entire package for Linux and Matlab can be freely downloaded from `http://mio.pytheas.univ-amu.fr/~doglioli`.

This is just a basic userguide.

2 Installation

2.1 System and software requirements

This toolbox has been designed for Fortran language and Matlab.
It needs at least 32 Mbites of disk space.
It has been tested on a Virtual Box Linux and Matlab from R2010a to R2012b

version.
It has been mostly used on a Virtual BoxLinux workstation, and Mac (MacBook Air) which is a personal computer.

Datasets from LAMP3D project are also included to run the tutorials described below.

2.2 Getting the files

The entire package LAMP3D can be freely downloaded from

`http://mio.pytheas.univ-amu.fr/~doglioli`.

The package LAMP3D is a free software. It is distributed in the hope that it will be useful, but without any guarantee. You can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation at `http://www.gnu.org/copyleft/gpl.html`.

2.3 Extracting the files

Uncompress and untar the file (gunzip and tar -xvf). You should obtain the following directory tree :

```
LAMP3D
   |- CONVERT
   |- POM_DATA
   |- POMLAMPFIN
   |- pomMATLAB
   |- USERGUIDE
```

Definition of the different directories :

- `CONVERT` : This directory contains different scripts that allow to translate the data from a Fortran langage to a Matlab langage.
- `POM_DATA` : This directory contains the data that are needed to run the various scripts. Moreover, those data were chosen from different previous studies. For exemple, hydrodynamic charateristics have been collected from Astraldi and Manzella (1983) study : hydrodynamic features in the study area, based on flow and temperature data offshore Lavagna.
- `POMLAMPFIN` : This directory contains different scripts that allow to create files such as the velocity or the elevation.

- `pomMATLAB` : This directory contains the Matlab script

2.4 Warnings

At the moment no special warnings are known.

3 Tutorial : LAMP3D

3.1 Functioning principles

LAMP3D is a Lagrangian single partcile numerical model. It adoptes a zeroth order autoregressive dispersion process which corresponds to a simple random walk model :

$$r_{n+1} - r_n = U_n \Delta t + \rho$$

To assign a value to the 'random jump' ρ, the LAMP3D algorithm uses the fortran generator of pseudorandom numbers with uniform [0,1] to obtain a normal probability density distribution with zero mean and given stanard deviation sigma. Thus, the standard deviation is a model input parameter and the user have to assign its value on the basis of field or experimental data.

The model uses a constant standard value on the horizontal grid which decreases, as the intensity of turbulent processes, with the depth :

$$\sigma_{i,j}(z_n) = \sigma_{i,j}(0)(1 + \frac{z_n}{H_{i,j}})$$

Specific properties can be assigned to each single particle. An exponential decay which uses the T90 parameter is applied to decaying particles :

$$c = c_0.10^{\frac{-t}{T_{90}}}$$

A sedimentation velocity w=(0,0,w(sed)) is added to deterministic velocity U of settling particles.

POM-LAMP3D coupled model : POM is a finite difference, free surface numerical model utilizing the Boussinesq and the hydrostratic approximations. It adopts the mode split technique : the two-dimensional calculation of the free surface elevation and the velocity transport in barotropic approximation is separate from the three-dimensional calculation of velocity and thermodynamics. The barotropic approximation (POM2D) is simplier to calibrate, more numerically stable and faster as computing time. The two models POM2D and LAMP3D had been coupled and run together. POM2D provides the depth averaged current field to LAMP3D. The dispersion model contains a submodel based on the Ekman transport and on the mass conservation, to obtain a 3D field for the three components of the velocity. Then LAMP3D executes the dispersion calculation and the counting of particles on the numerical grid. The output data are printed by the POM2D subroutines.

3.2 Running the demo

Once you have downloaded the file, you should obtain the following directory : LAMP3D.tgz. You just need to unzip it in order to access the different directories. Once you are in the terminal, you need to reach the directory LAMP3D/POMLAMPFIN in order to execute the file makepomlamp.sh. The following terminal will prompt you : "Number of simulation ?", you need to answer 240 in order to create the file pomlamp240.exe and other associated files. This file is an executable which means that the computer will perform indicated tasks according to encoded instructions. When you have succeed the compilation you need to execute pomlamp240.exe. This program will create different files such as UAB_240.pom, VAB_240.pom, ULAMP240.pom, repor240.txt, encin240.txt.
Once this step is completed, you will have created all the files that you need for the following steps.

Now, you need to reach the directory LAMP3D/CONVERT. The files in this directory will allow you to convert the files that contain the velocity, the bathymetry, the elevation etc into files that can be use with Matlab software.

The first step is to execute the file makeconvert.sh. This file will create the executable file which is convert.exe. You need to execute it in order to convert the height, the elevation, the horizontal average velocity according to U, and the horizontal average velocity according to V. The following terminal will request you "DX" and "DY", at this stage you have to answer 200 for both variables. This step defines 'the zoom' of the area that you observe. After the terminal ask you the simulation code, here you can answer whatever you want, it will only determine the name of the output file. Finally, you will be required to enter the simulation number where you need to answer 240, in order to respect the file name. To summarize this step, here is an example if you answer to the previous question with : DX ? 200, DY ? 200, Simulation code ? AB, Simulation number ? 240. The output file will be created in pomMATLAB directory under the name : r2DAB240.txt.

For the final stage on Fortran language, you now need to execute makeconvertlamp.sh which is also in the same directory CONVERT. This program will create the final file that you need : lamp_240.txt. When you execute makeconvertlamp.sh, the terminal will require : simulation number, IOLAMP and JOLAMP. You need to answer 240, 20, 20, respectively. As you answer 20 for both variables, this means that the map you observe is a very precise area compare to the first figure where you can see the land in white. This file .txt will contain the values for : i, j, k,

time, ULAMP, VLAMP, WLAMP and the concentration. As you can see it is a 3D matrix plus the time, opposite to the other file that you have created. At this point, you have created all the files that you need for Matlab part.
You now need to transfer the two files r2DXX240.txt and lamp_240.txt into a folder that you will use for Matlab if you are using a Virtual Box and that Matlab is on an other operating system. Otherwise, you only have to open your Matlab software and run the script. Just be sure that you are in the write folder.

This file will provide you figures. First of all you will have different maps which represent the bathymetry with the oceanic circulation and the height. And after you will have different maps of the concentration, still in the same area. Here you can change different parameters. For the second block of figures, as it is a 4D matrix, you can not observe this dimension in a plot. What you can change is the value of the depth. At the line containing the pcolor of the concentration, you can change the third column. Here is an example :
pcolor(squeeze(CONC(:, :,1,t))) will represents the surface concentration as the 1 is the first floor of the water column.

4 The other programs

4.1 params98_lamp.fi

The program `params90_lamp.fi` contains all parameters for the model simulation. However you can change those parameters depending on what you want to observe. You can change the number of days of the simulation and it frequency for each day. A great number of days will make the simulation longer, also as a high frequency. It is also possible to modify the sedimentation velocity, depending on what particles you consider.

4.2 comblk98_lamp.fi

The program `comblk98_lamp.fi` contains most of the variables values.

4.3 runpomlamp240.out

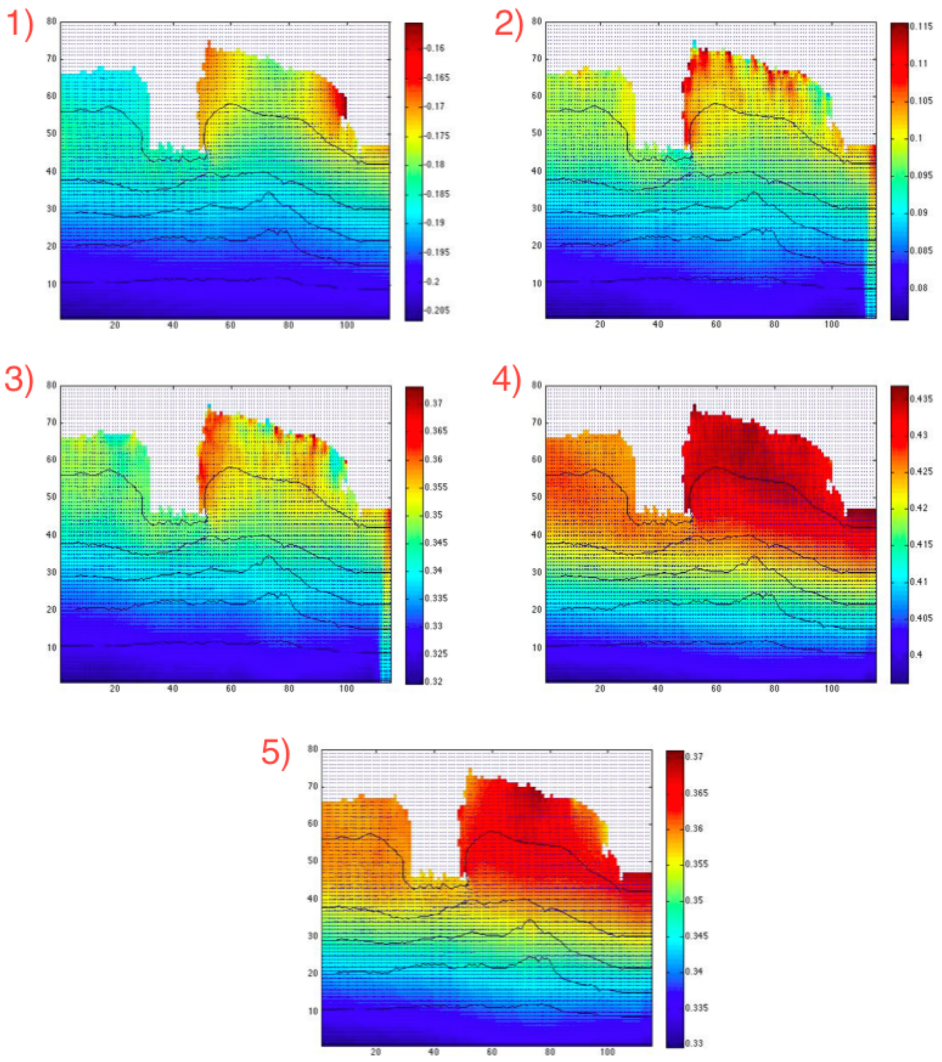
The program `runpomlamp240.out` contains all messages that the terminal wrote during the execution of the different programs.

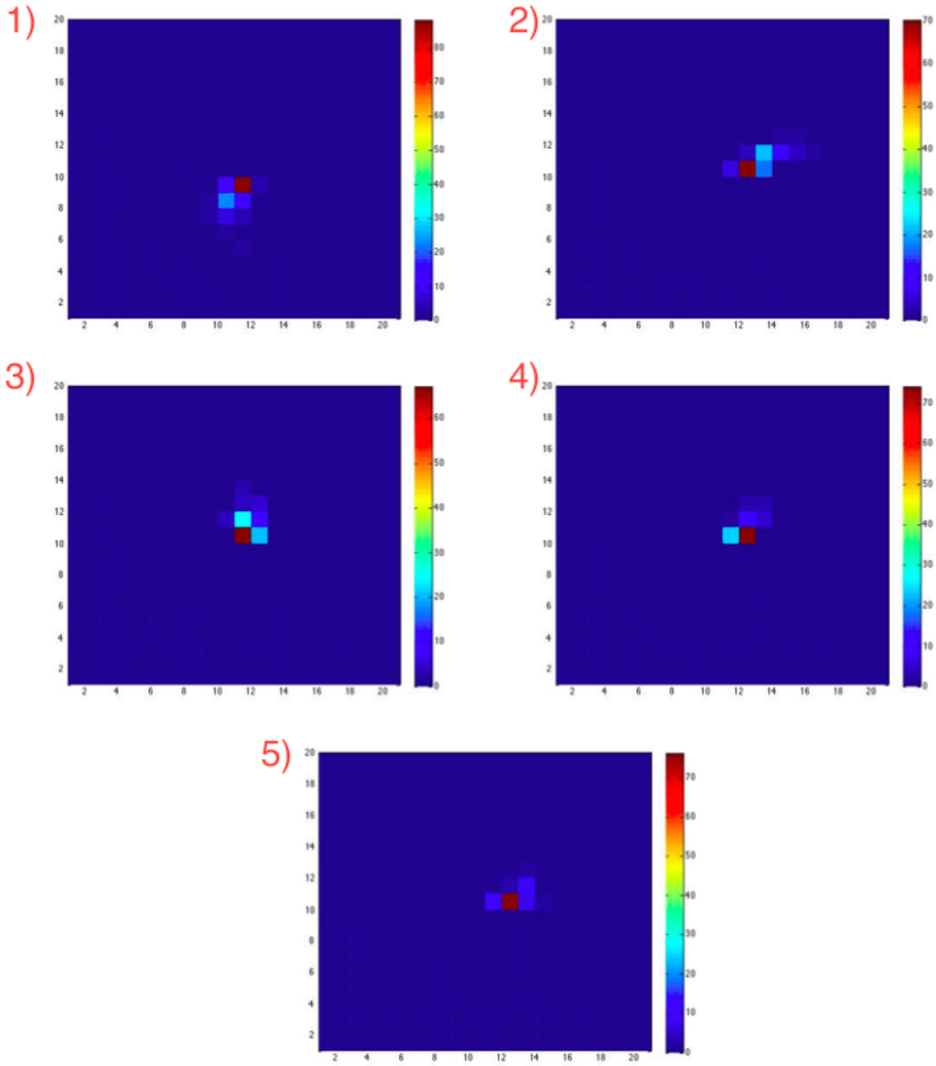
4.4 icond_lamp240.f

In this script you can modify the dispersion of the concentration. It means that if you want to obtain a figure with particles all around the map you have to modify the parameter Sigma. This parameter is defined in the pseudo random initialization in the "Initial conditions for LAMP3D" in the present script. The parameter value should be around 5 if you want the particles to be in a close area, and around 10 if you want to see the particles well dispersed.

5 Figures

Here is an example of figures that you can obtain with the following parameters :
DX=200, DY=200
Simulation number=240
IOLAMP=20, JOLAMP=20
Days=5
Time step (DTE)=0.5
Sedimentation velocity=0 m/s
Sigma=5

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6 REFERENCES

A.M Doglioli et al., 2004. Development of a numerical model to study the dispersion of wastes coming from a marine fish farm in the Ligurian Sea (Western Mediterranean). *Aquaculture, Volume 231, Issues 1-4, Pages 215-235.*

De Gaetano et al., 2011. Impact of new measured Mediterranean mineralization rates on the fate of simulated aquaculture wastes. *Aquaculture Research, Volume 42, Issue 9, Pages 1359-1370.*

De Gaetano et al., 2008. FOAM, a new simple benthic degradative module for the LAMP3D model : an application to a Mediterranean fish farm. *Aquaculture Research, Volume 39, Issue 11, Pages 1229-1242.*

Vassallo et al., 2006. Determination of physical behaviour of feed pellets in Mediterranean water. *Aquaculture Research, Volume 32, Issue 2, Pages 119-126.*

Oscar PÃľrez et al., 2014. Food and faeces settling velocities of meagre (Argyrosomus regius) and its application for modelling waste dispersion from sea cage aquaculture. textitAquaculture, Volumes 420-421, Pages 171-179.

Astraldi et Manzella 1983. Some observations on current measurments on the east ligurian shelf, Mediterranean Sea. *Continental Shelf Research, Volume 2, Issues 2-3, Pages 179-194.*

Chelossi et al., 2003. Antibiotic resistance of benthic bacteria in fish-farm and control sediments of the Western Mediterranean. *Aquaculture, Volume 219, Issues 1-4, Pages 83-97.*

Enell, 1995. Environmental impacts of nutrient from nordic fish farming. *Water Science and Technology, Volume 31, Issue 10, Pages 61-71.*