

ESEIAAT

Masters's Thesis



**UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH**

**Escola Superior d'Enginyeries Industrial,
Aeroespacial i Audiovisual de Terrassa**

ALGORITHMS FOR THREE-DIMENSIONAL ATMOSPHERIC SIMULATIONS

BUDGET

Master's Degree in Aerospace Engineering

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Student: Pau Nadal Vila

Director: Manel Soria Guerrero

Co-Director: Enrique José García Melendo

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Chapter 1

Introduction

This document contains the economical review of the **Algorithms for three dimensional atmospheric simulations** master's thesis and its corresponding costs related to the project realization.

The documenting and bibliographic tasks of the project have principally been done using the online free text editor *Overleaf* in a *Windows* operation system. Additional software that has been used as complementary elements are textitMicrosoft Office Word, *Microsoft Office Excel*, *Mendeley*. Furthermore, for the development of some numerical tests the *Matlab* software has been employed.

The programming and simulating tasks of the project have mainly been done in a using *C+MPi* in an external Solid State Drive (SSD) with a *Linux (Ubuntu)* operating system. *Paraview* software has also been used for the post-processing of the simulations.

No commuting nor trips have been done due to the realization of this project.

Chapter 2

Budget

2.1 Human task breakdown

Table 2.1 includes the breakdown of all the tasks personally carried out during the project realization, both related to bibliographic and programming activities, and the amount of time (hours) spend in each of them:

TASK	QUANTITY (h)
Bibliographic research	40
Introduction (Report)	5
Atmospheric model (Report)	25
Numerical discretization (Report)	50
Algorithm architecture (Report)	10
Research related the BAT module	30
Modifications of the BAT module	50
Implementation of tests	25
Preparation of the simulations	10
Post-processing of results	15
Verification	15
Verification (Report)	5
Results (Report)	10
Conclusions (Report)	5
Revision	5
Budget and self-assessment	3
TOTAL	303

Table 2.1: Human task breakdown

2.2 Human labor cost

The total costs of the human labor can be obtained by taking into account the amount of hours spend in the project and the average junior engineer unit salary in Spain(12€/h)¹:

QUANTITY (h)	UNIT SALARY (€/h)	TOTAL (€)
303	15	3636

Table 2.2: Total human labor costs

¹*Payscale*. Average Junior Software Engineer Salary in Spain. Available at: https://www.payscale.com/research/ES/Job=Junior_Software_Engineer/Salary

2.3 Simulation cost breakdown

Table 2.3 summarizes the different simulations carried out and the approximate computation time they required:

TASK	CPU (h)
MATLAB Verification	2
Testing and verification	70
Robert Rising Bubble	40
TOTAL	112

Table 2.3: Simulation time breakdown

The simulations were carried out with a personal computer with *Intel i7 7500U* processors. Its consumption during simulations was measured using a power meter *KWE-PM01-EU*, obtaining an average power consumption of 79W. The mean cost of the national electric demand in Spain for the month of August was 111.36€ /MWh.² Therefore, the price per CPU/h can be estimated as:

$$111.36\text{€} / \text{MWh} \cdot 79 \times 10^{-6} \text{MW} = 8.80 \times 10^{-3} \text{€} / \text{CPUh}$$

CPU time (h)	UNIT COST (€ /CPUh)	TOTAL (€)
112	8.80×10^{-3}	0.99

Table 2.4: Simulation cost breakdown

2.4 Software cost breakdown

Table 2.5 contains the license expenses of the software that has been used during the project (even if it is free). Some programs are accessed based on a periodic subscription, in which case the price of 6 subscription months is calculated:

ITEM	PRICE(€)
Microsoft Office license	34.5
Matlab Student license	34.5
Mendeley Desktop	0
C+MPI	0
Paraview	0
TOTAL	69€

Table 2.5: Total software costs

2.5 Hardware cost breakdown

For the development of the project, just a personal computer and a external Solid State Drive have been used. Since the personal computer was already an owned asset, it will not be computed.

²*omie*: Informe Mensual Agosto 2021. Available at: <https://www.omie.es/es/publicaciones>

ITEM	PRICE(€)
SSD ³	72
TOTAL	72€

Table 2.6: Total hardware costs

2.6 Total cost of the project

Finally, the total cost of the project can be obtained by adding the several costs detailed before:

ITEM	COSTS(€)
Human labor	3636
Simulation cost	0.99
Software cost	69
Hardware cost	72
TOTAL	3777.99

Table 2.7: Total project costs

Therefore, the overall cost of the entire project is **3778€**.

³FNAC. Disco duro interno Sandisk Disco duro 2,5" SSD de 128 GB . Available at:
<https://www.fnac.es/Disco-duro-interno-Sandisk-Disco-duro-2-5-SSD-de-128-GB-Almacenamiento-Dispositivo-de-almacenamiento/a896468>