WINDNINJA-FARSITE - *High Performance Simulation*
Computational Mathematics and Data Analytics 2021-2022

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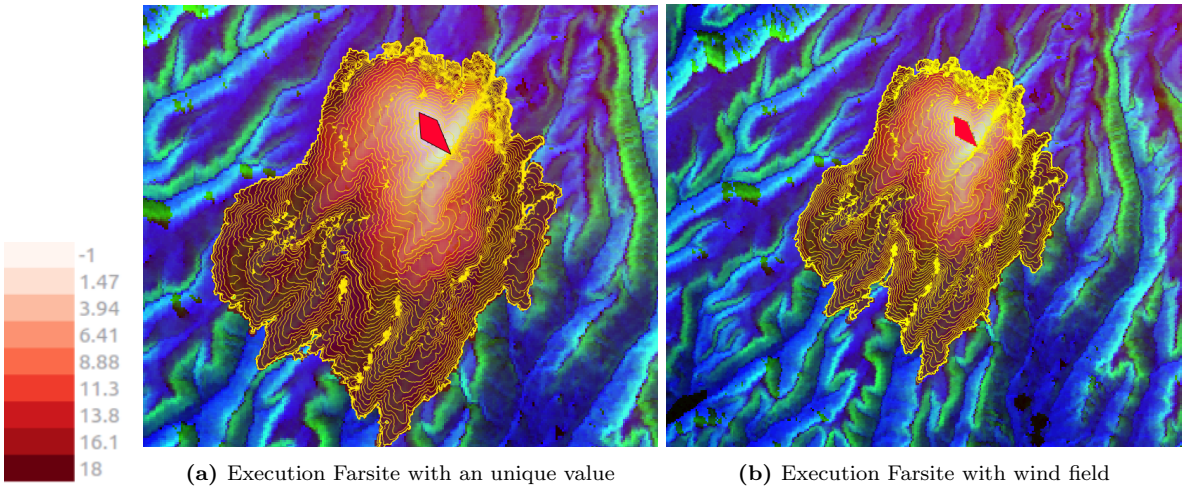
Manual coupling: Unique wind

4. Comparació dels fitxers generats: Fent servir QGis avalueu la diferència entre la propagació de l'apartat 1, i la propagació que heu obtingut a l'apartat 3. Intenteu fer la diferència simètrica entre les àrees o alguna mesura semblant que permeti estimar la diferència entre les dues propagacions.



(a) Execution Farsite with an unique value **(b)** Execution Farsite with wind field

The fire propagation obtained in exercise one using a winds file and the one of exercise three using the atmospheric simulation from WindNinja are quite similar, we believe this is due to the fact that the wind speeds used are very low, 4 mph.

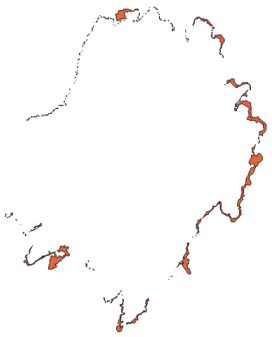
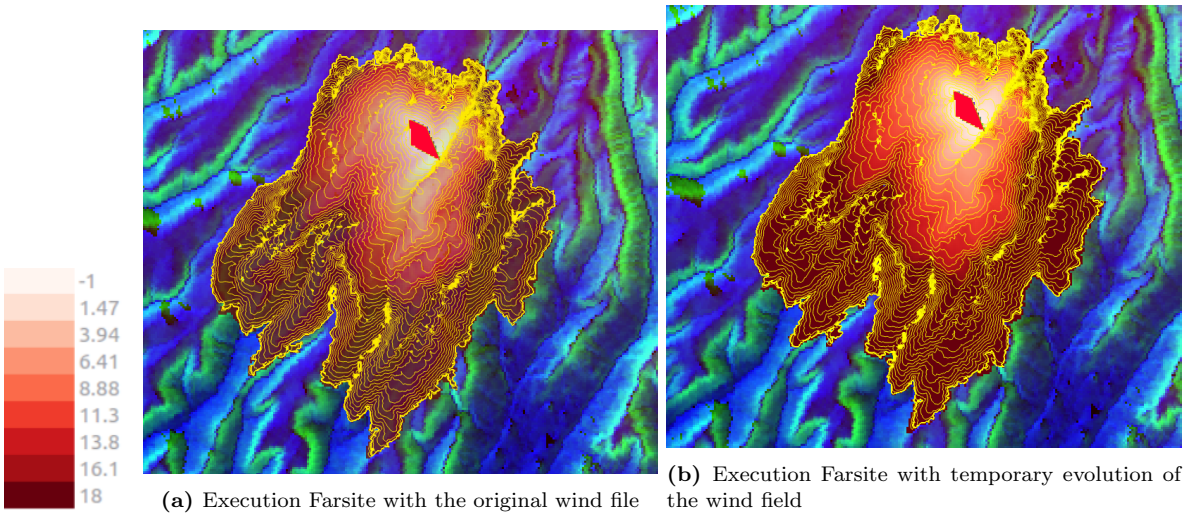


Figure 2: Symmetrical Area Difference between using a one line .wnd file and one .atm file.

As we can see in Figure 2 and as we said previously, we see that there is a slight difference between both areas. Concretely, we can observe almost the same thickness of difference along all the perimeter.

Manual coupling: Wind with temporary evolution

8. Comparació dels fitxers generats: Fent servir QGis avalueu la diferència entre la propagació de l'apartat 5, i la propagació que heu obtingut a l'apartat 7. Intenteu fer la diferència simètrica entre les àrees o alguna mesura semblant que permeti estimar la diferència entre les dues propagacions.



(a) Execution Farsite with the original wind file

(b) Execution Farsite with temporary evolution of the wind field

In this case both fire propagation obtained are also very similar, again this is probably due to the low wind speeds, 4 mph on the first day, 2 mph on the second, and 11 mph on the third.

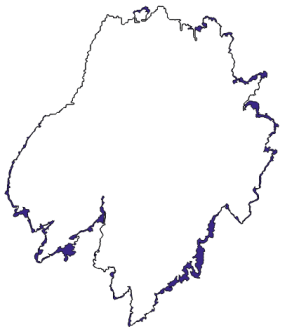
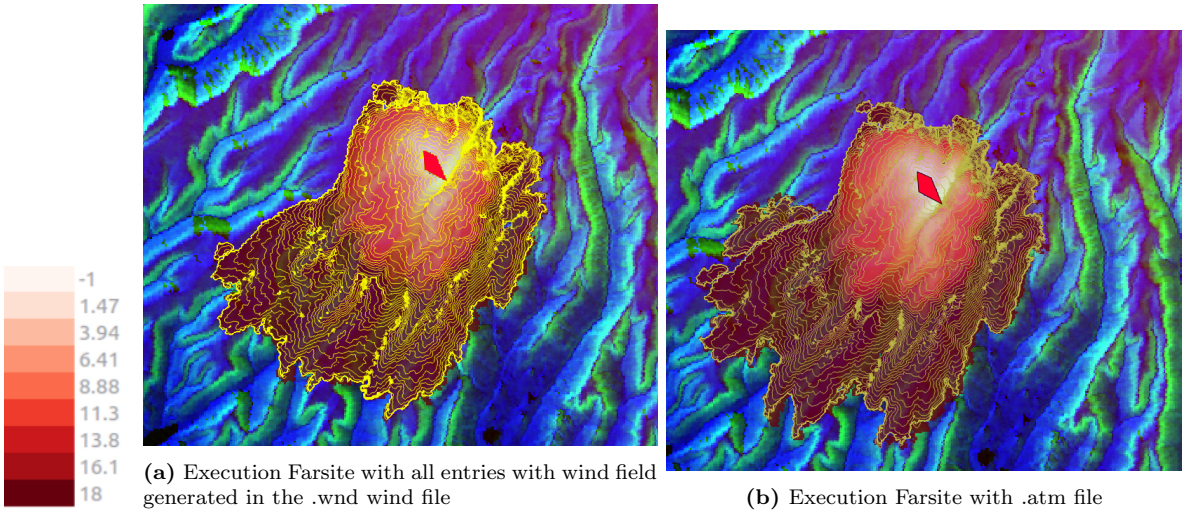


Figure 4: Symmetrical Area Difference between using the reduced .wnd file and the reduced .atm file.

In this other case, we can appreciate in Figure 4 that the differences between the simulations are more notorious. This difference with the previous section can be due to the fact that in this one, the second day of the simulation has a bigger wind (higher speed/intensity). Even if still, this wind is not as big as to have a deciding impact in the simulation.



(a) Execution Farsite with all entries with wind field generated in the .wnd wind file

(b) Execution Farsite with .atm file

Automatic coupling

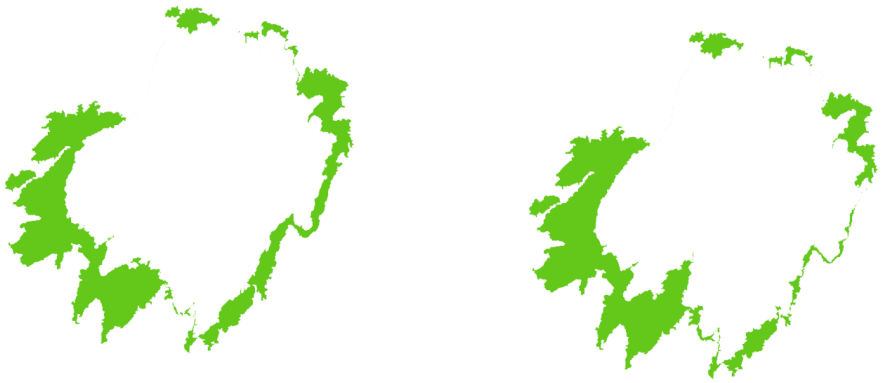
11. Execució amb l'entorn automàtic: Execució del cas (a baixa resolució 50m) del vostre cas utilitzant l'entorn automàtic.Observeu amb QGis els fitxers de sortida que ha generat FARSITE (.shp i .toa) i compareu-los amb els que heu obtingut en els apartats 5 i 7.

In this other case, without looking the symmetrical difference between the areas, we can see a clear difference in the centre-left part of the figures as in the second picture simulates some fire while the first one not.

Figure 6: Symmetrical Area Difference between using the full .wnd file and the full .atm file.

Once we look Figure 6, the difference between the areas, we can verify what we were saying previously. While in the rest of the figure, we can see trivial difference among all the perimeter of the simulation.

Comparing the results of the automatic coupling simulations with the results of the previous exercises:



(a) Symmetrical difference between using the full .atm file from the automatic coupling simulation and using an .atm file from one WindNinja from the first exercise.

(b) Symmetrical difference between using the full .atm file from the automatic coupling simulation and using the reduced .atm file from the first exercise.

Finally, we can see two figures where we can appreciate the difference of the areas. In figure 7a we can notice a little bit much more difference as it is comparing the automatic simulation with one-wind simulation, than in figure 7b that it compares with the reduced file.

Time comparison using wind field (.atm) vs not using it (.wnd) and number of threads

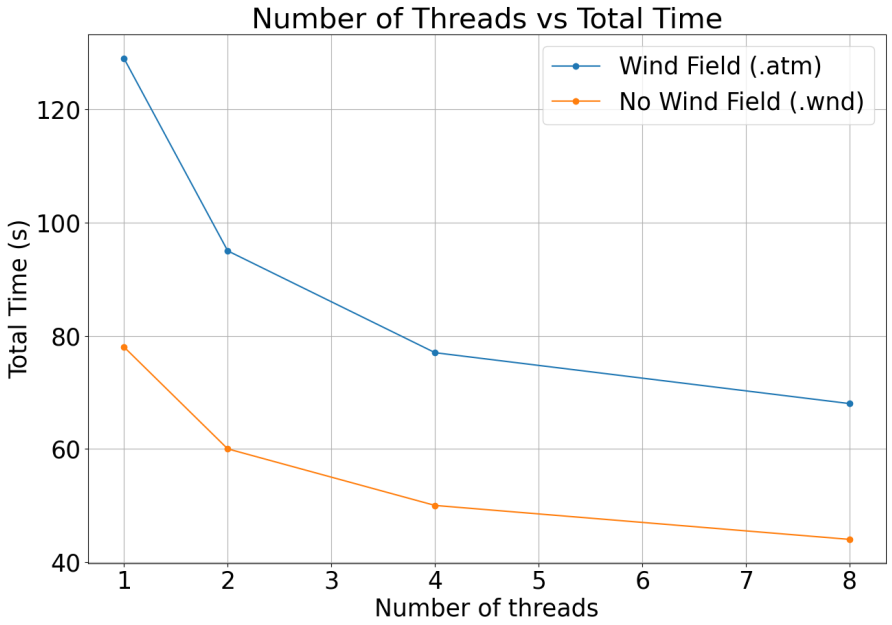


Figure 8: Effect of the number of threads and the type of input wind file used (.wnd or .atm) on the Farsite simulation time in seconds. Each point is the result of averaging the times of three identical runs.

In Figure 8 we see the computational time in seconds of Farsite fire simulations using different number of threads and different input wind files. These results have been computed by taking the average of three identical simulations for each data point. The simulation parameters where the following:

- Time Step: 60m
- Visible Step: 1h
- Secondary Visible Step: 24h
- Perimeter Resolution: 30m
- Distance Resolution: 30m

As we would have expected increasing the number of threads decreases the simulation time, but not linearly meaning that there are some parts of the simulation that are not parallelizable and therefore the speed improvement is less as more threads are added.

Regarding the type of input wind file, using a .wnd with a single wind for each time step[1] is much faster than using a .atm file with an atmospheric simulation producing a wind field for each time step, this was also expected as using a wind field is clearly computationally more demanding than using a single wind. However as we have seen on the previous sections the results produced by using these wind fields are quite different than the ones using a single wind at each time step.

Resolution Effects on Time.

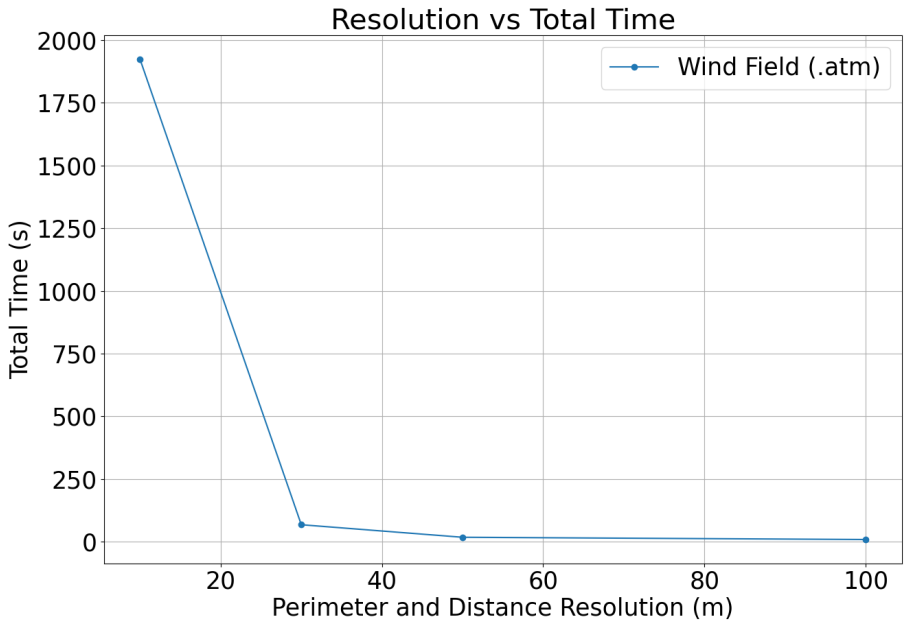


Figure 9: Effect of the perimeter and disolution on the Farsite simulation time in seconds. Each point is the result of averaging the times of three identical runs.

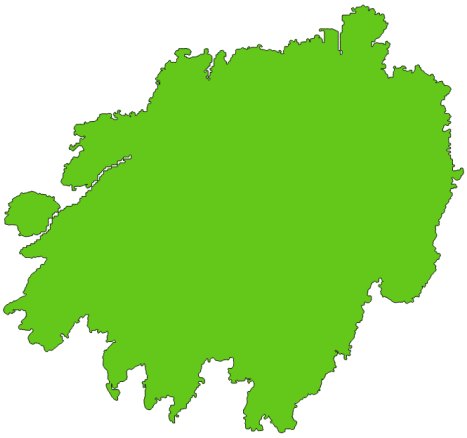
[1]Note that by time step we mean the times specified both on the .wnd and .atm file not each simulation time step.

In Figure 9 we see the computational time in seconds of Farsite fire simulations using different perimeter and distance resolutions. These results have been computed by taking the average of three identical simulations for each data point. The simulation parameters where the following:

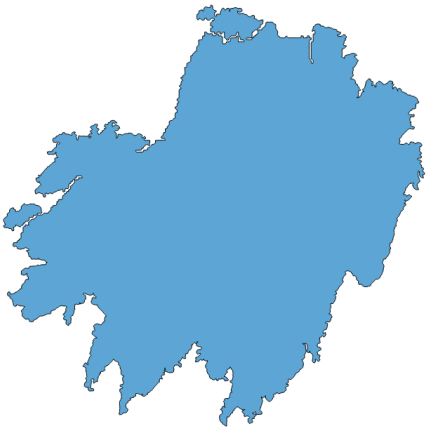
- Time Step: 60m
- Visible Step: 1h
- Secondary Visible Step: 24h
- Number of threads: 8
- Wind input file: .atm

The larger the perimeter and distance resolution the less time it takes to run the simulation, in fact there is a huge difference between using a perimeter and distance of 10 meters and using 30 meters.

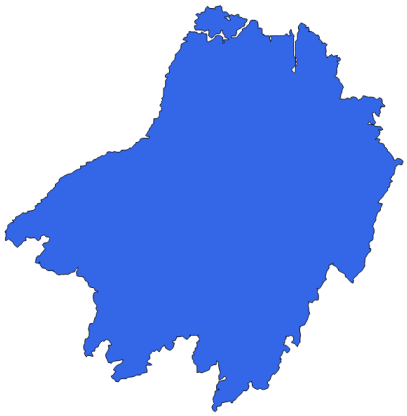
Resolution Effects on Propagation.



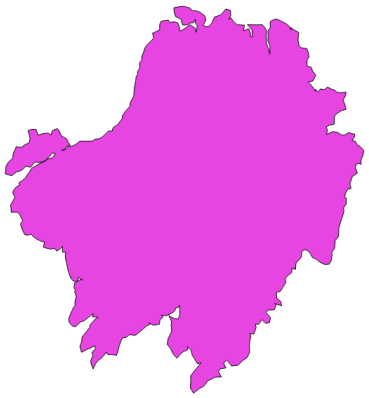
(a) Fire propagation area for the simulation using perimeter and distance resolution of 10 meters.



(b) Fire propagation area for the simulation using perimeter and distance resolution of 30 meters.



(c) Fire propagation area for the simulation using perimeter and distance resolution of 50 meters.



(d) Fire propagation area for the simulation using perimeter and distance resolution of 100 meters.

In Figure 10a we can clearly see that the fire propagation area when using perimeter and distance resolution 10 meters is larger than in the other cases. In fact the larger the resolution the smaller the fire propagation area seems to be, being the smallest in the case of perimeter and distance resolution 100 meters in Figure 10d.

An other observation is that except in the case of perimeter and distance resolution 10 meters, the three other simulation propagate the fire more to the north in the middle part of the image.