

Effect of Climate Evolution on the Dynamics of the Wildfires in Greece

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Abstract: Understanding the potential effects of climate change on forest fire behavior and the resulting release of combustion products is critical for effective mitigation strategies in Greece. This study utilizes data from the MAGICC 2.4 (Model for the Assessment of Greenhouse Gas-Induced Climate Change) climate model and the SCENGEN 2.4 (SCENarioGENerator) database to assess these impacts. By manipulating various model parameters such as climate sensitivity, scenario, time period, and global climate models (GCMs) within the SCENGEN 2.4 database, we analyzed climatic trends affecting forest fire generation and evolution. The results reveal complex and nuanced findings, indicating a need for further investigation. Case studies are conducted using the FARSITE 4 (Fire Area Simulator) model, incorporating meteorological changes derived from climate trends. Simulations of two fires in East Attica, accounting for different fuel and meteorological conditions, demonstrate an increase in the rate of combustion product release. This underscores the influence of changing meteorological parameters on forest fire dynamics and highlights the importance of proactive measures to mitigate future risks. Our findings emphasize the urgency of addressing climate change impacts on wildfire behavior to safeguard environmental and public health in Greece.

Keywords: MAGICC climate model; FARSITE; combustion product release rate; wildfire; PM_{2.5}; PM₁₀; computer simulation

3. Results and Discussion

Initially, the forest fire in Neos Voutzas was simulated for the first four (4) hours according to the conditions prevailing on the day of the fire. The total burned area of both forest fires considered is shown in the black outline in the study area.

FARSITE simulated the fire and the PM_{2.5} release rate along the fire front was close to 0.0014 Mg/ha/min.

The PM₁₀ release rate along the fire front was close to 0.0016 Mg/ha/min (Figure S1).

The CO release rate along the fire front was close to 0.0169 Mg/ha/min (Figure S2).

The CO₂ release rate along the fire front was close to 0.0008 Mg/ha/min (Figure S3).

Similarly, the CH₄ release rate along the fire front was close to 0.1512 Mg/ha/min (Figure S4).

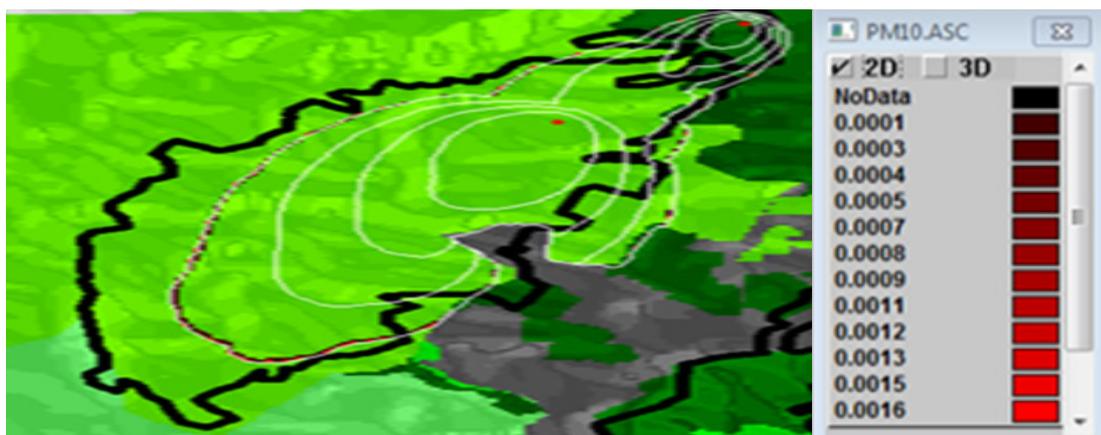


Figure S1. The simulation of the first four hours (4h) of forest fire in Neos Voutzas. The PM₁₀ release rate along the fire front was close to 0.0016 Mg/ha/min

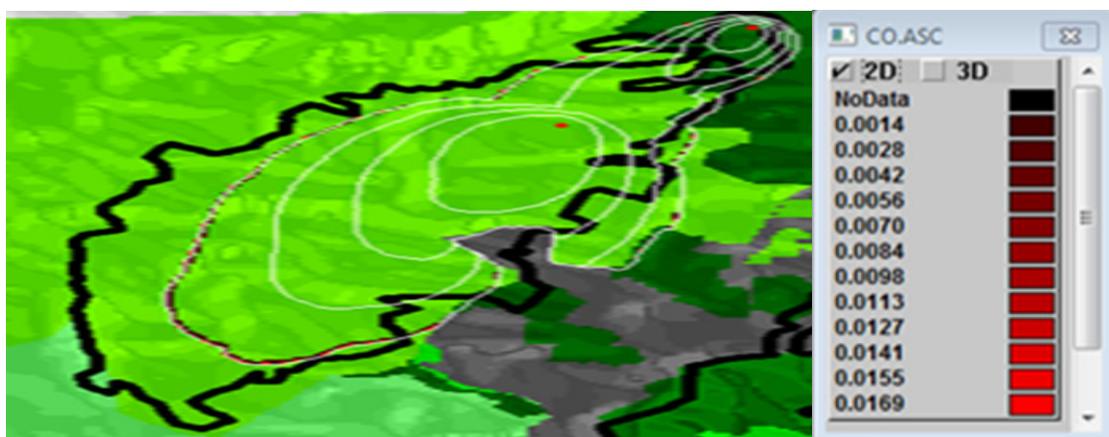


Figure S2. The simulation of the first four hours (4h) of forest fire in Neos Voutzas. The CO release rate along the fire front was close to 0.0169 Mg/ha/min

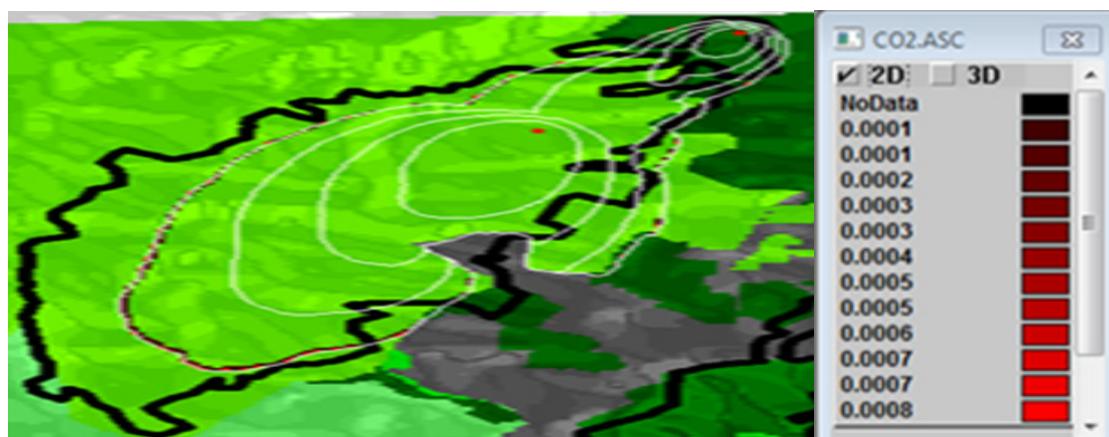


Figure S3. The simulation of the first four hours (4h) of forest fire in Neos Voutzas. The CO₂ release rate along the fire front was close to 0.0008 Mg/ha/min

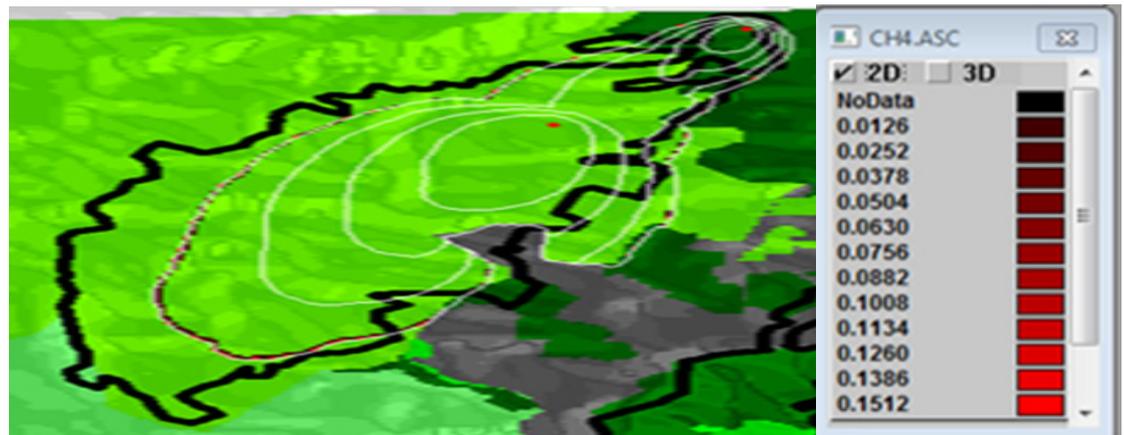


Figure S4. The simulation of the first four hours (4h) of forest fire in Neos Voutzas. The CH₄ release rate along the fire front was close to 0.1512 Mg/ha/min

Case Study 1:

FARSITE simulated the new fire in Neos Voutzas and the PM_{2.5} release rate along the fire front was close to 0.0023 Mg/ha/min .

The PM₁₀ release rate along the fire front was close to 0.0027 Mg/ha/min (Figure S5).

The CO release rate along the fire front was close to 0.0284 Mg/ha/min (Figure S6).

The CO₂ release rate along the fire front was close to 0.0013 Mg/ha/min (Figure S7).

Similarly, the CH₄ release rate along the fire front was close to 0.2490 Mg/ha/min (Figure S8).

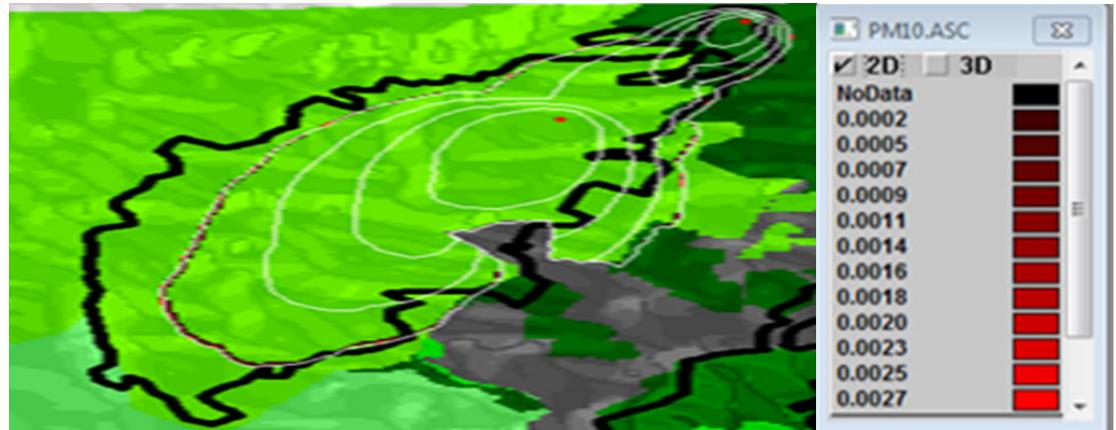


Figure S5. The simulation of the first four hours (4h) of forest fire in Neos Voutzas according to Case Study 1. The PM₁₀ release rate along the fire front was close to 0.0027 Mg/ha/min

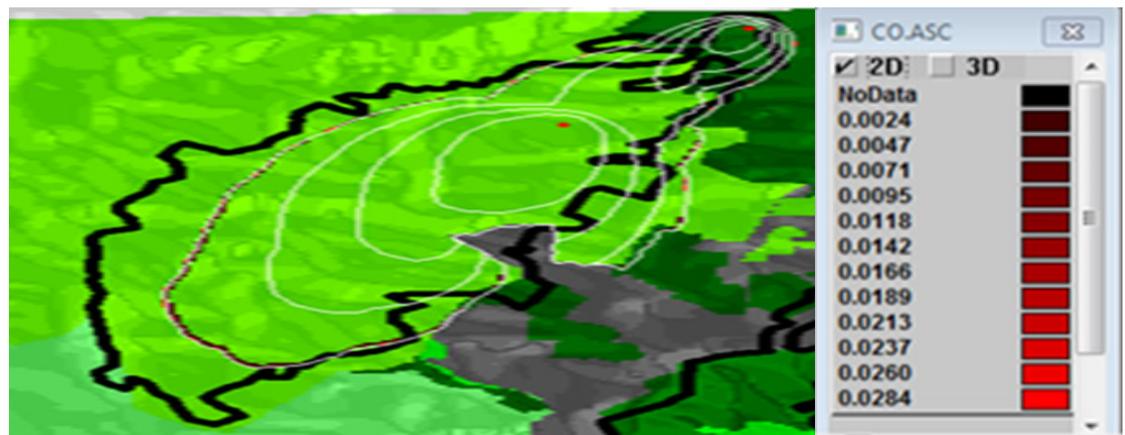


Figure S6. The simulation of the first four hours (4h) of forest fire in Neos Voutzas according to Case Study 1. The CO release rate along the fire front was close to 0.0284 Mg/ha/min

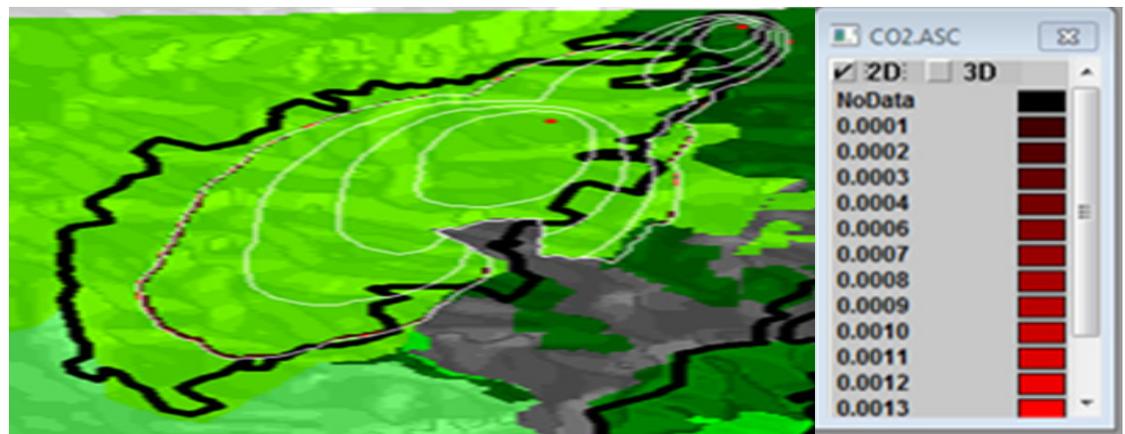


Figure S7. The simulation of the first four hours (4h) of forest fire in Neos Voutzas according to Case Study 1. The CO₂ release rate along the fire front was close to 0.0013 Mg/ha/min

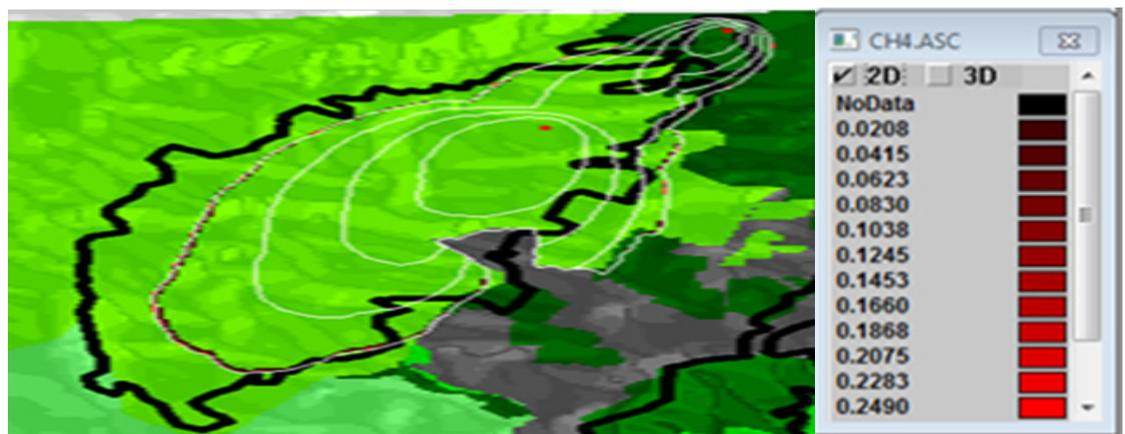


Figure S8. The simulation of the first four hours (4h) of forest fire in Neos Voutzas according to Case Study 1. The CH₄ release rate along the fire front was close to 0.2490 Mg/ha/min

Case Study 2:

FARSITE simulated the new fire in Neos Voutzas and the PM_{2.5} release rate along the fire front was close to 0.0453 Mg/ha/min.

The PM₁₀ release rate along the fire front was close to 0.0534 Mg/ha/min (Figure S9).

The CO release rate along the fire front was close to 0.4635 Mg/ha/min (Figure S10).

The CO₂ release rate along the fire front was close to 0.0236 Mg/ha/min (Figure S11).

Similarly, the CH₄ release rate along the firefront was close to 10.5905 Mg/ha/min (Figure S12).

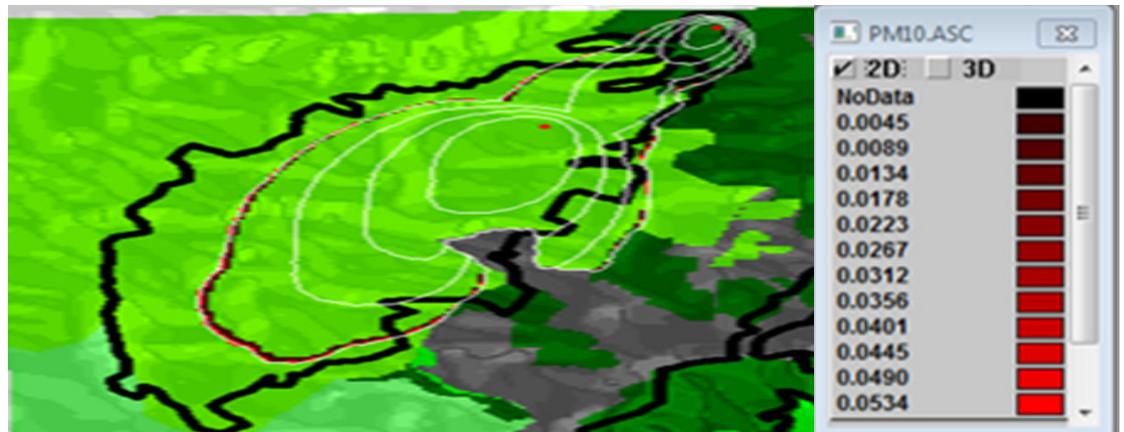


Figure S9. The simulation of the first four hours (4h) of forest fire in NeosVoutzas according to Case Study 2. The PM₁₀ release rate along the fire front was close to 0.0534 Mg/ha/min

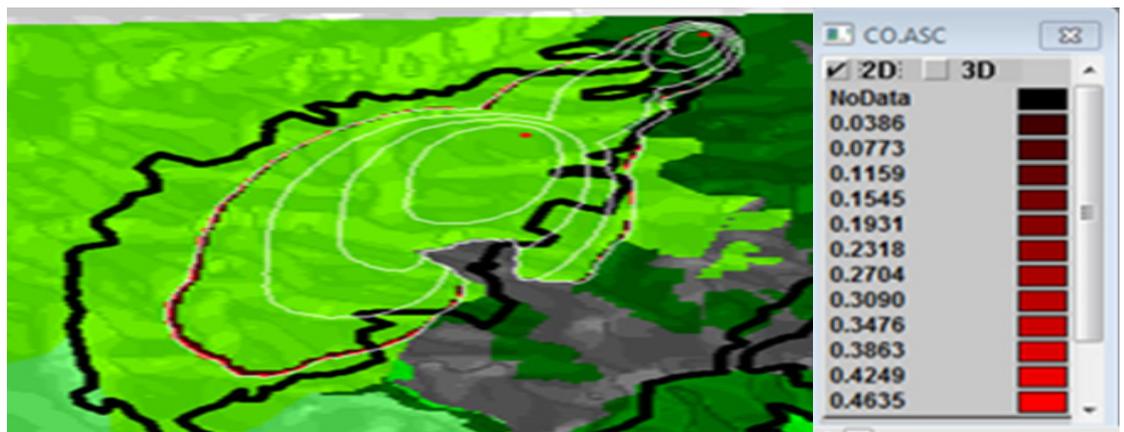


Figure S10. The simulation of the first four hours (4h) of forest fire in Neos Voutzas according to Case Study 2. The CO release rate along the fire front was close to 0.4635 Mg/ha/min

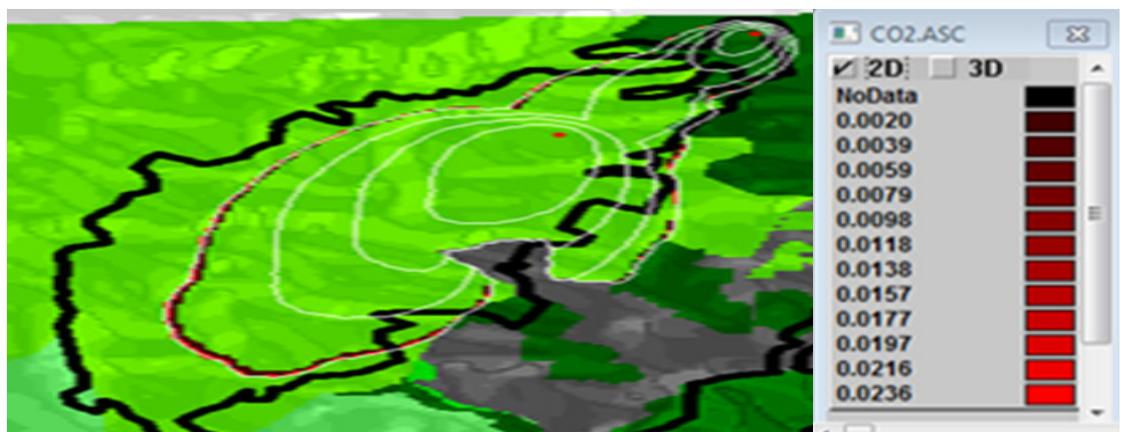


Figure S11. The simulation of the first four hours (4h) of forest fire in Neos Voutzas according to Case Study 2. The CO₂ release rate along the firefront was close to 0.0236 Mg/ha/min

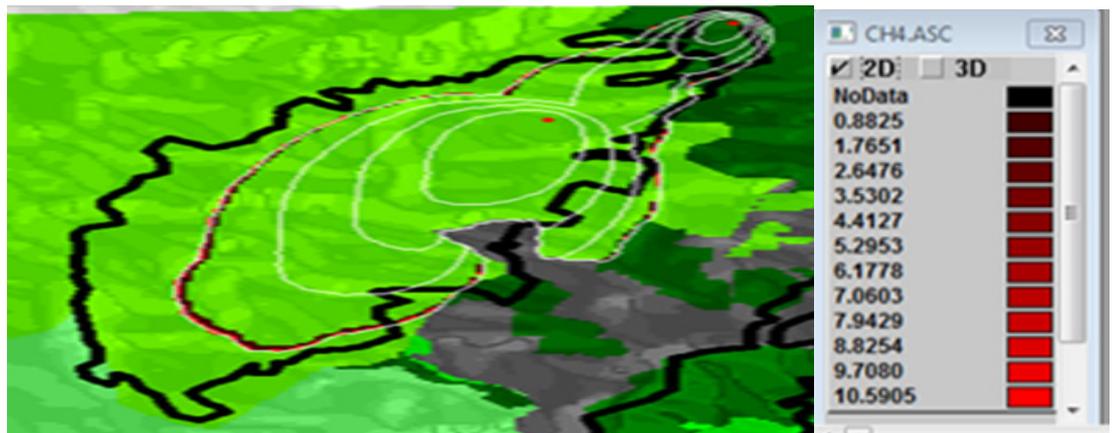


Figure S12. The simulation of the first four hours (4h) of forest fire in Neos Voutzas according to Case Study 2. The CH₄ release rate along the firefront was close to 10,5905 Mg/ha/min

Forest fire in Rafina

The forest fire in Rafina was simulated for the first four (4) hours according to the conditions prevailing on the day of the fire.

FARSITE simulated the fire and the PM_{2.5} release rate along the fire front was close to 0.8202 Mg/ha/min (Figure S13).

The PM₁₀ release rate along the fire front was close to 0.9679 Mg/ha/min (Figure S14).

The CO release rate along the fire front was close to 9.9456 Mg/ha/min .

The CO₂ release rate along the fire front was close to 0.4708 Mg/ha/min (Figure S15).

Similarly, the CH₄ release rate along the firefront was close to 101.6196 Mg/ha/min (Figure S16).

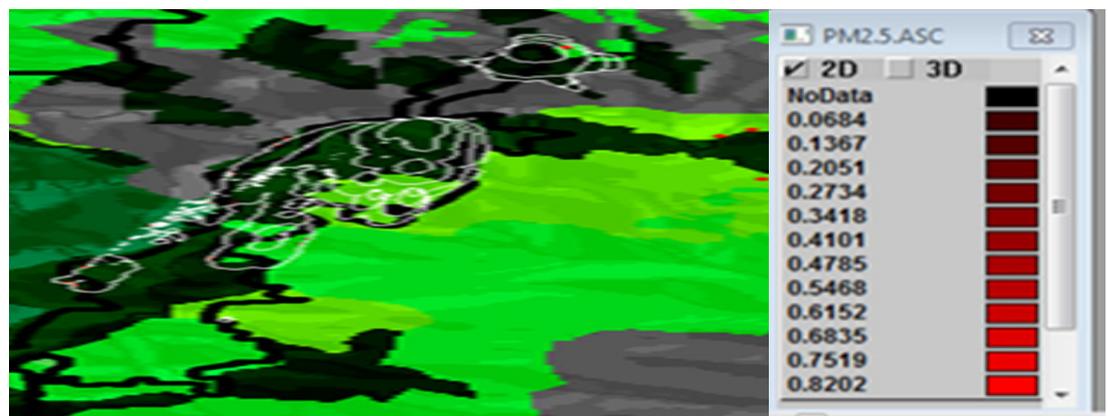


Figure S13. The simulation of the first four hours (4h) of forest fire in Rafina. The PM_{2.5} release rate along the fire front was close to 0.8202 Mg/ha/min

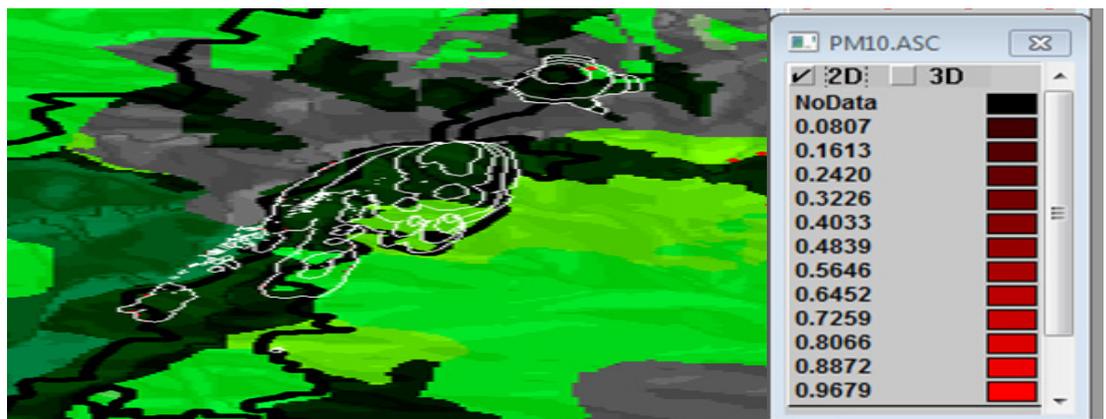


Figure S14. The simulation of the first four hours (4h) of forest fire in Rafina. The PM₁₀ release rate along the fire front was close to 0.9679 Mg/ha/min

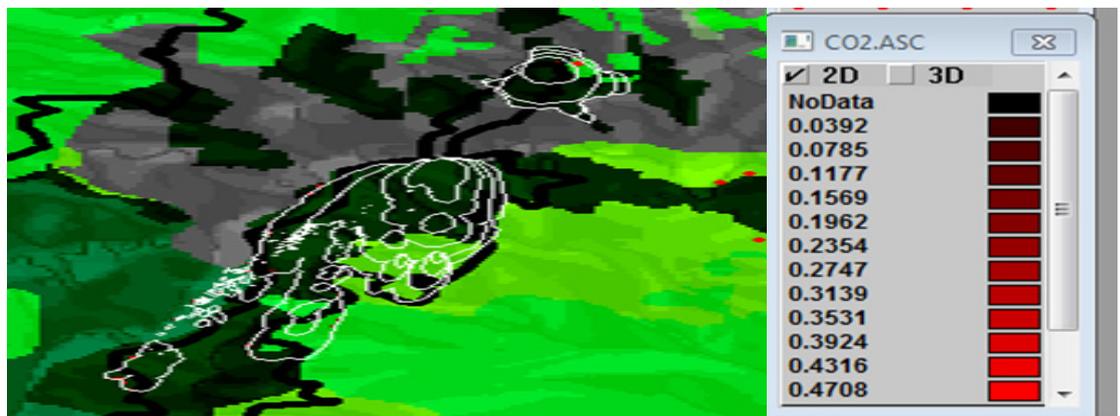


Figure S15. The simulation of the first four hours (4h) of forest fire in Rafina. The CO₂ release rate along the fire front was close to 0.4708 Mg/ha/min

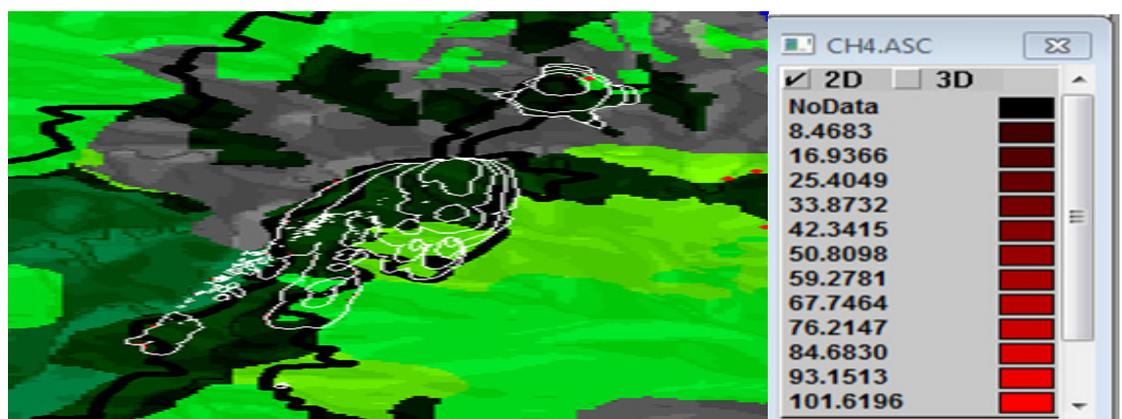


Figure S16. The simulation of the first four hours (4h) of forest fire in Rafina. The CH₄ release rate along the firefront was close to 101.6191 Mg/ha/min

Case Study 1:

FARSITE simulated the new fire in Rafina and the PM_{2.5} release rate along the fire front was close to 1.1337 Mg/ha/min (Figure S17).

The PM₁₀ release rate along the fire front was close to 1.3378 Mg/ha/min (Figure S18).

The CO release rate along the fire front was close to 13.4631 Mg/ha/min.
 The CO₂ release rate along the fire front was close to 0.6429 Mg/ha/min (Figure S19).
 Similarly, the CH₄ release rate along the fire front was close to 156.9365 Mg/ha/min (Figure S20).

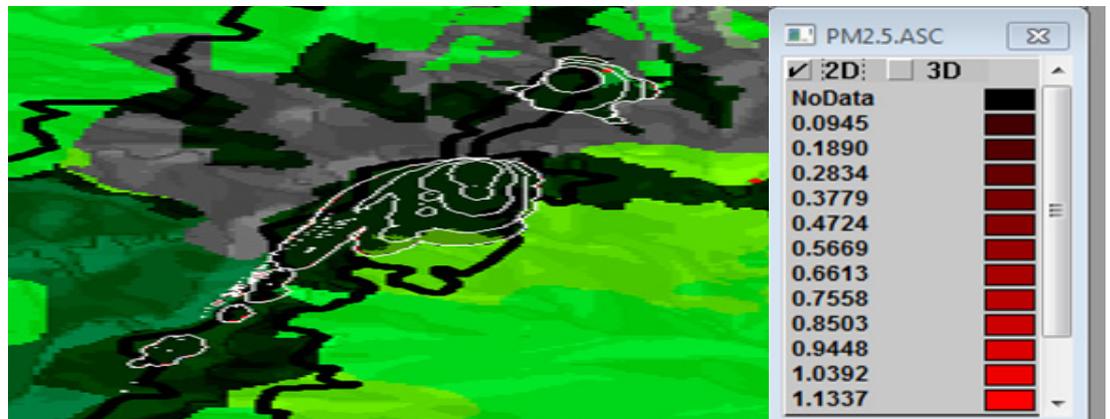


Figure S17. The simulation of the first four hours (4h) of forest fire in Rafina according to Case Study 1. The PM_{2.5} release rate along the fire front was close to 1.1337 Mg/ha/min

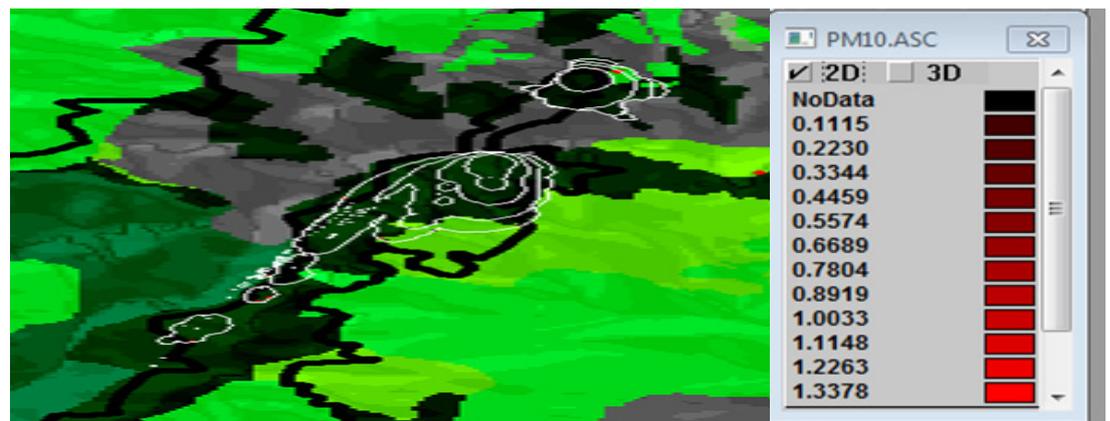


Figure S18. The simulation of the first four hours (4h) of forest fire in Rafina according to Case Study 1. The PM₁₀ release rate along the fire front was close to 1.3378 Mg/ha/min

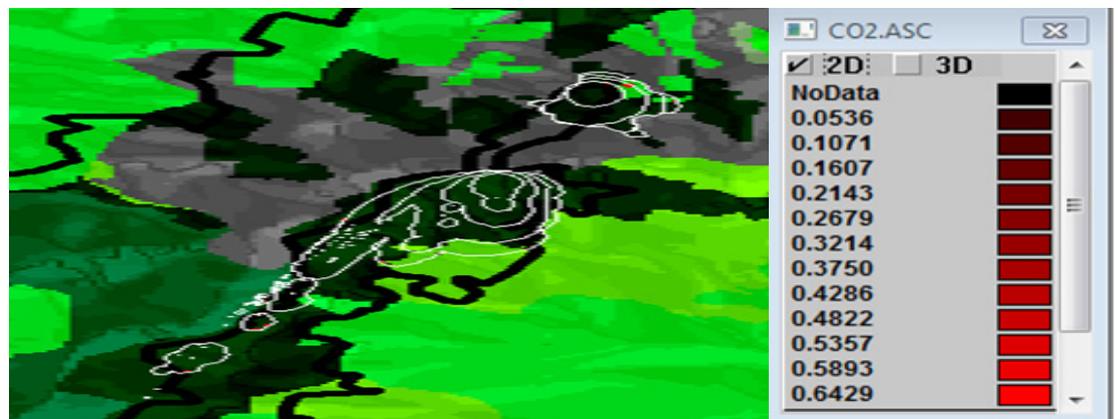


Figure S19. The simulation of the first four hours (4h) of forest fire in Rafina according to Case Study 1. The CO₂ release rate along the fire front was close to 0.6429 Mg/ha/min

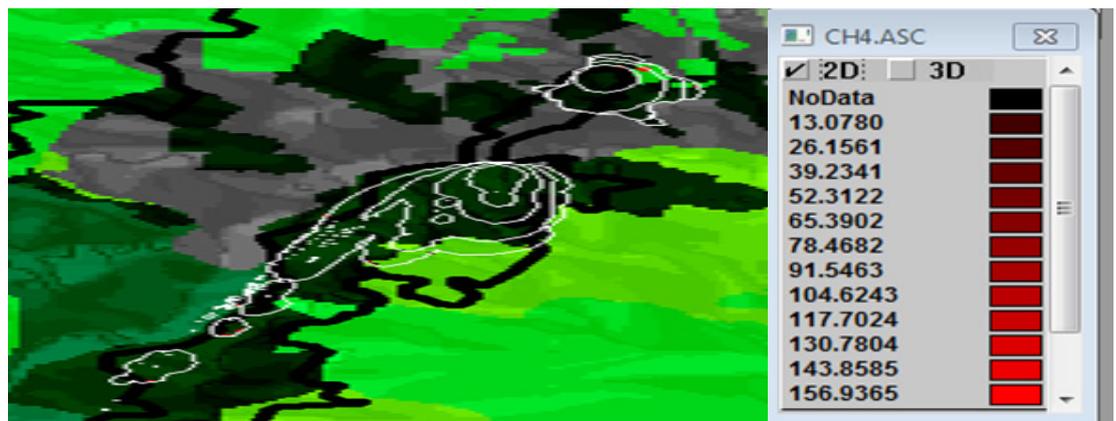


Figure S20. The simulation of the first four hours (4h) of forest fire in Rafina according to Case Study 1. The CH₄ release rate along the fire front was close to 156.9365 Mg/ha/min

Case Study 2:

FARSITE simulated the new fire in Rafina and the PM_{2.5} release rate along the fire front was close to 3.0219 Mg/ha/min (Figure S21).

The PM₁₀ release rate along the fire front was close to 3.5659 Mg/ha/min (Figure S22).

The CO release rate along the fire front was close to 34.1512 Mg/ha/min.

The CO₂ release rate along the fire front was close to 1.6652 Mg/ha/min (Figure S23).

Similarly, the CH₄ release rate along the firefront was close to 519.0742 Mg/ha/min (Figure S24).

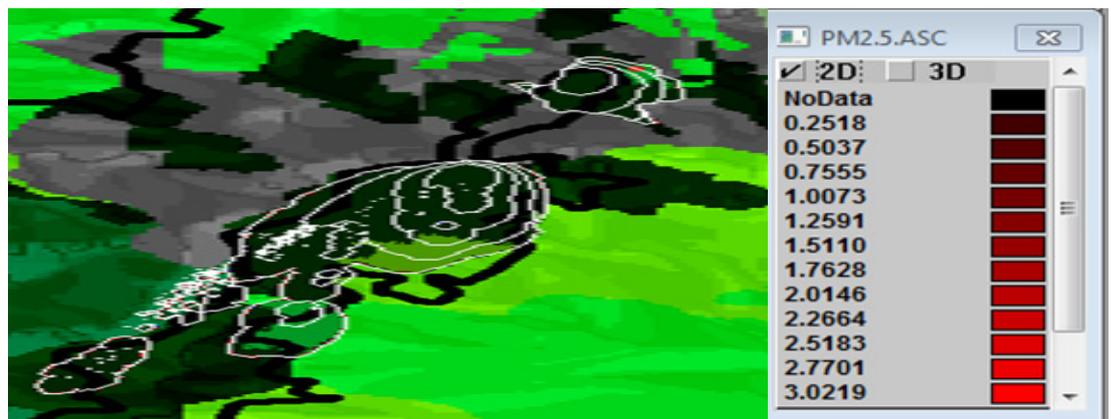


Figure S21. The simulation of the first four hours (4h) of forest fire in Rafina according to Case Study 2. The PM_{2.5} release rate along the firefront was close to 3.0219 Mg/ha/min

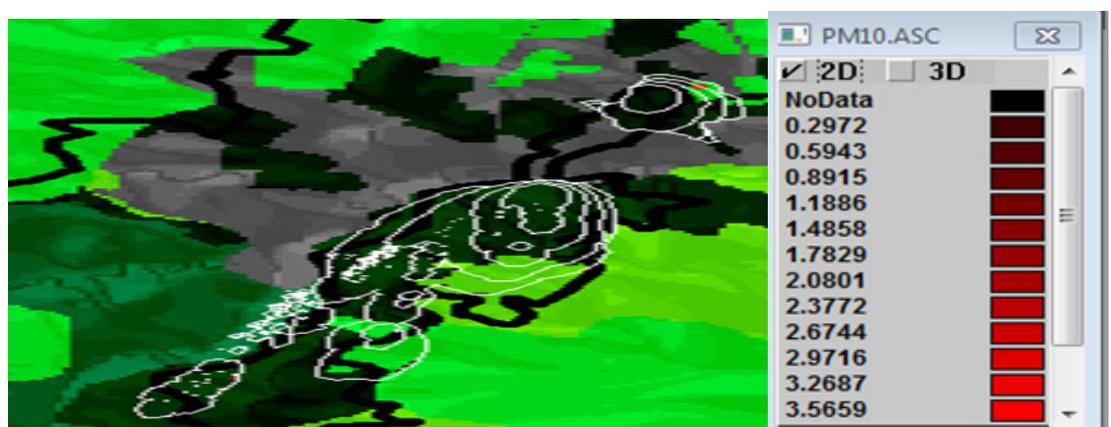


Figure S22. The simulation of the first four hours (4h) of forest fire in Rafina according to Case Study 2. The PM₁₀ release rate along the firefront was close to 3.5659 Mg/ha/min

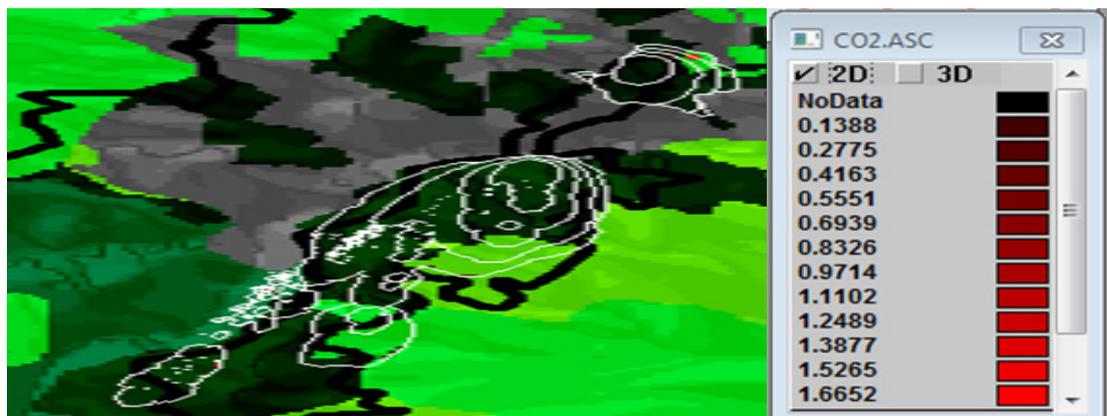


Figure S23. The simulation of the first four hours (4h) of forest fire in Rafina according to Case Study 2. The CO₂ release rate along the fire front was close to 1.6652 Mg/ha/min

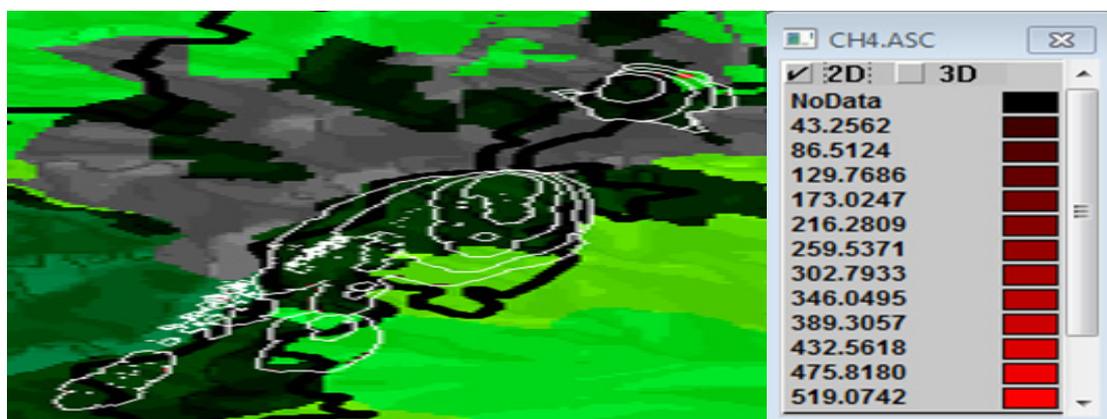


Figure S24. The simulation of the first four hours (4h) of forest fire in Rafina according to Case Study 2. The CH₄ release rate along the fire front was close to 519.0742 Mg/ha/min