

N° 11755
VILLETTE
Martin

*Propagation d'un feu de forêt :
modélisation de l'évolution d'un incendie
à des fins de prévention*

Comment modéliser efficacement la propagation d'un feu de forêt afin de mieux le contrer et de limiter les dégâts occasionnés ?

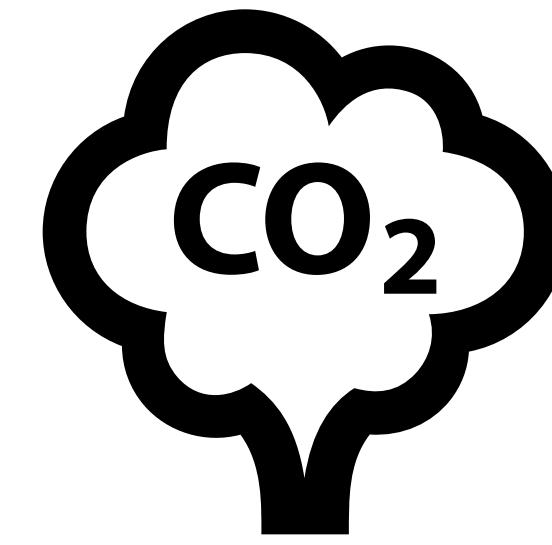
Quelques chiffres



400 millions
d'hectares brûlés / an



+33 000
morts / an

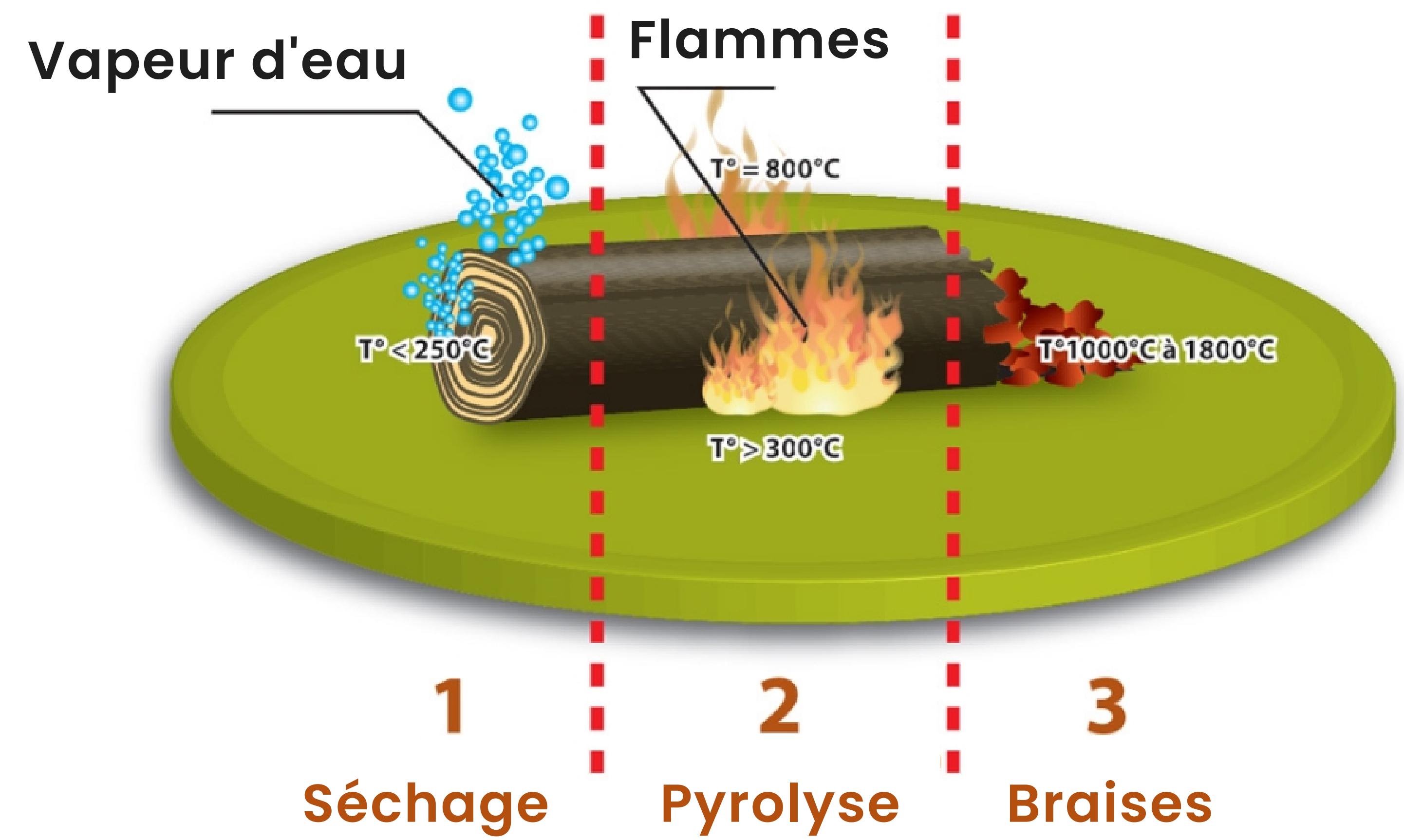


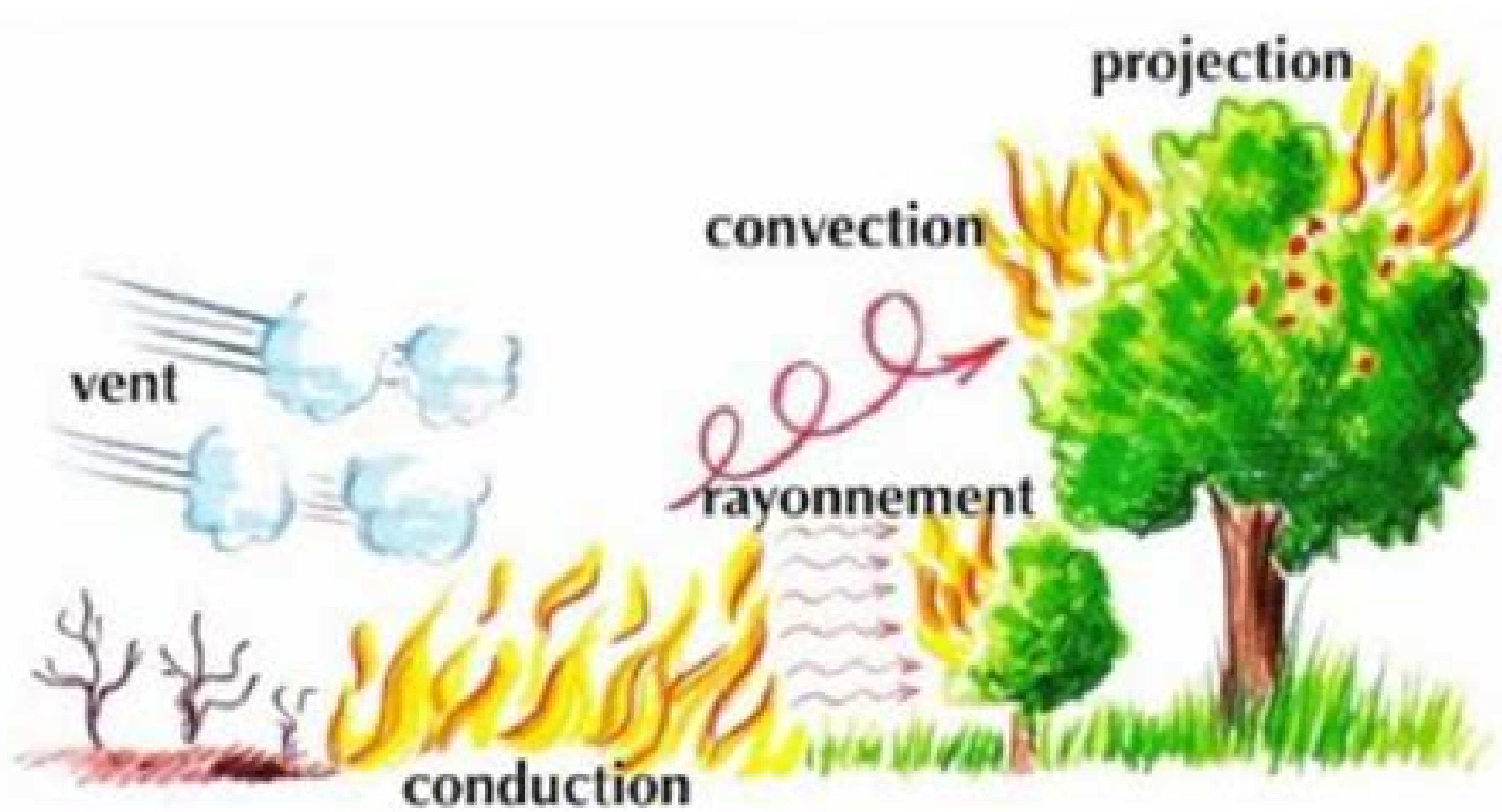
6500 mégatonnes
de CO₂ relâchées dans l'atmosphère

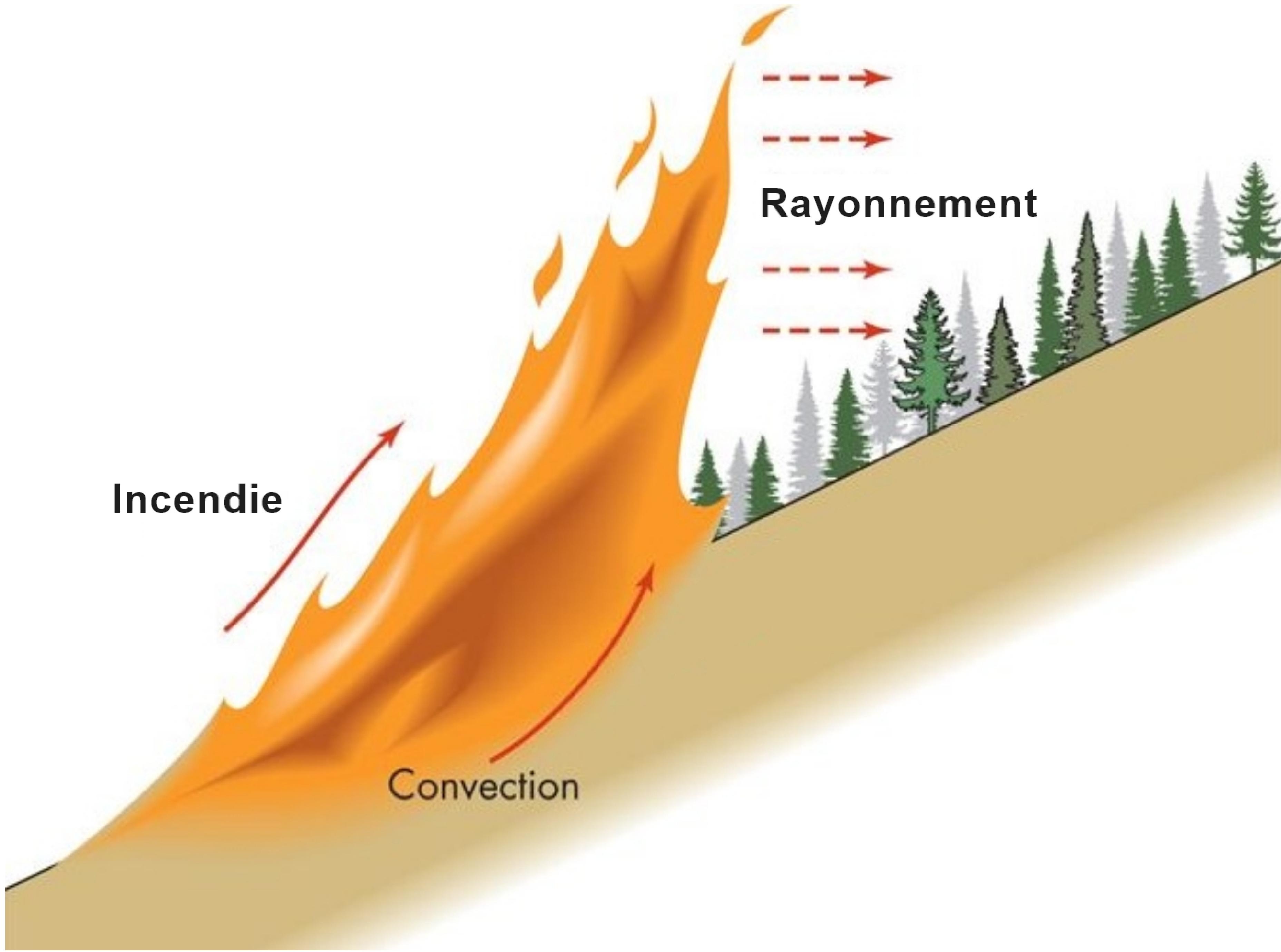
Sommaire

- I Fonctionnement d'un feu
- II Un modèle de propagation d'un feu
- III Contrôle des divers paramètres du modèle
- IV Comparaison à la simulation et amélioration possible

Naissance et propagation d'un feu : étapes





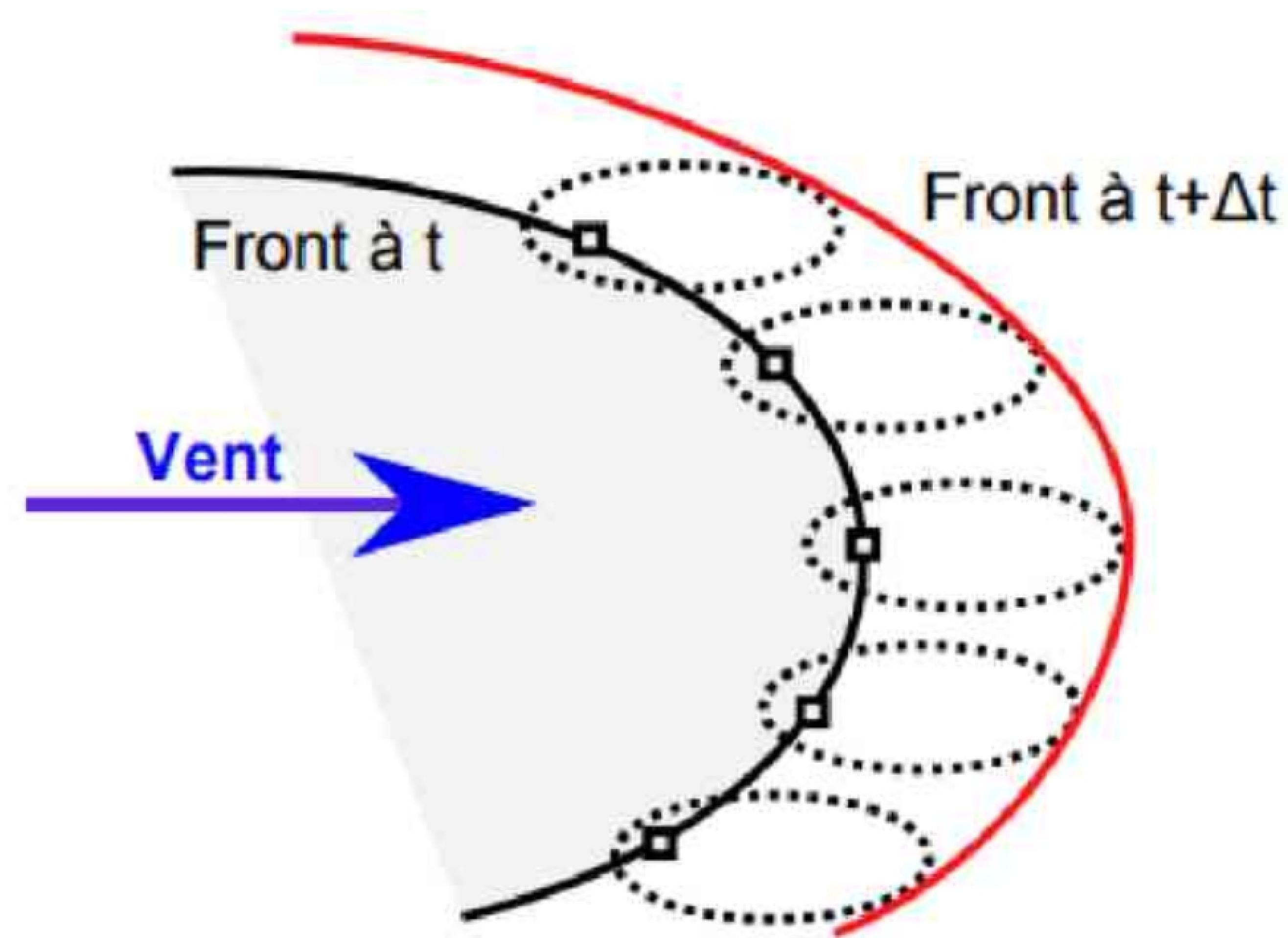


Mise en situation



Durée de propagation : 2min

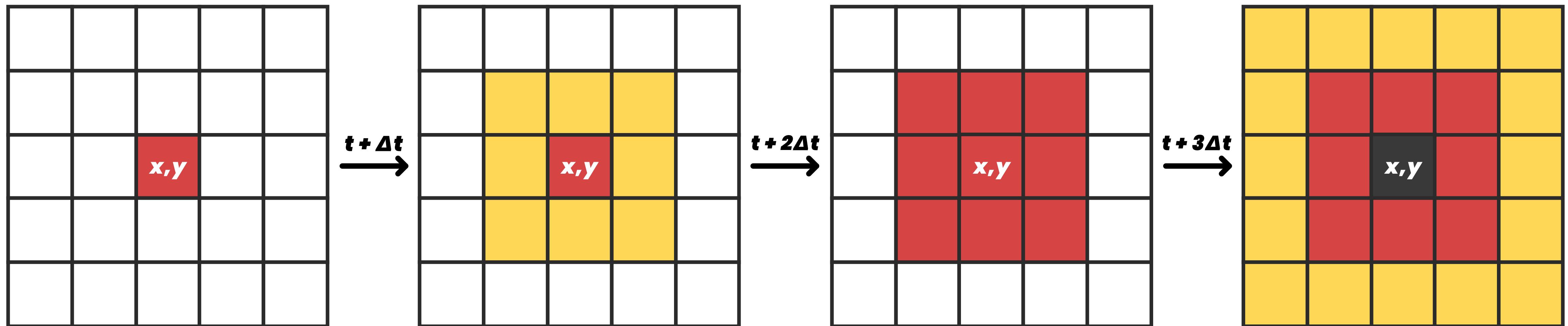
Principe de Huygens



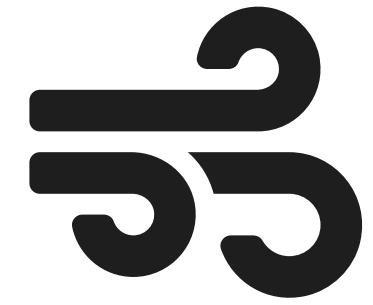
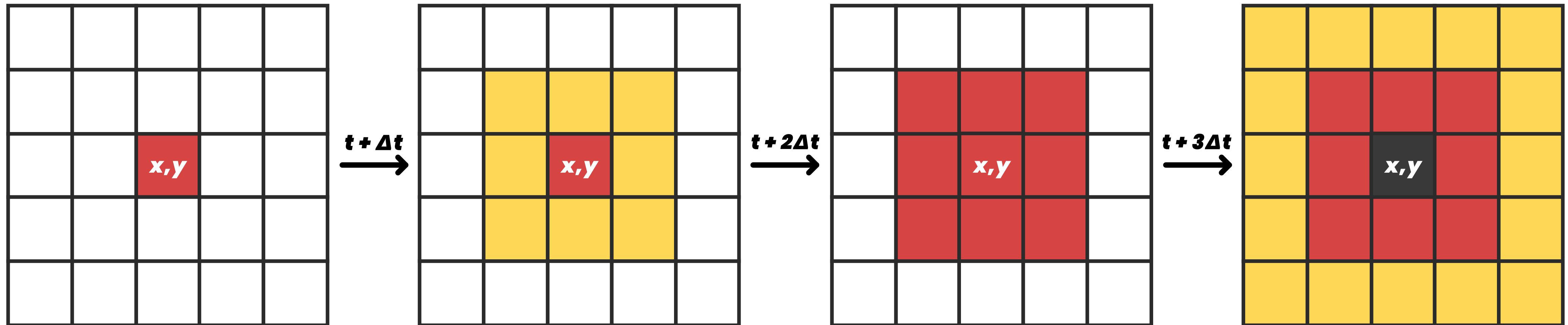
Un outil pour modéliser la propagation du feu :

L'Automate cellulaire

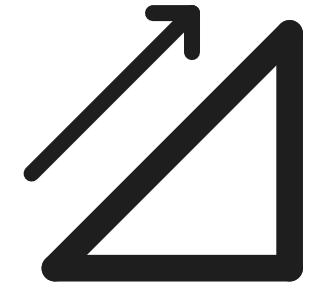
Automate cellulaire



Automate cellulaire



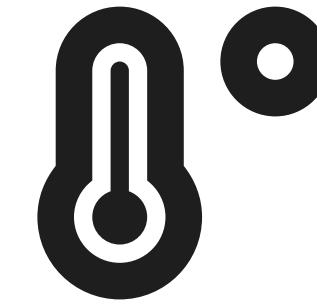
Vent



Pente



Humidité

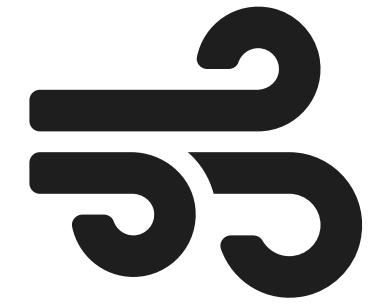
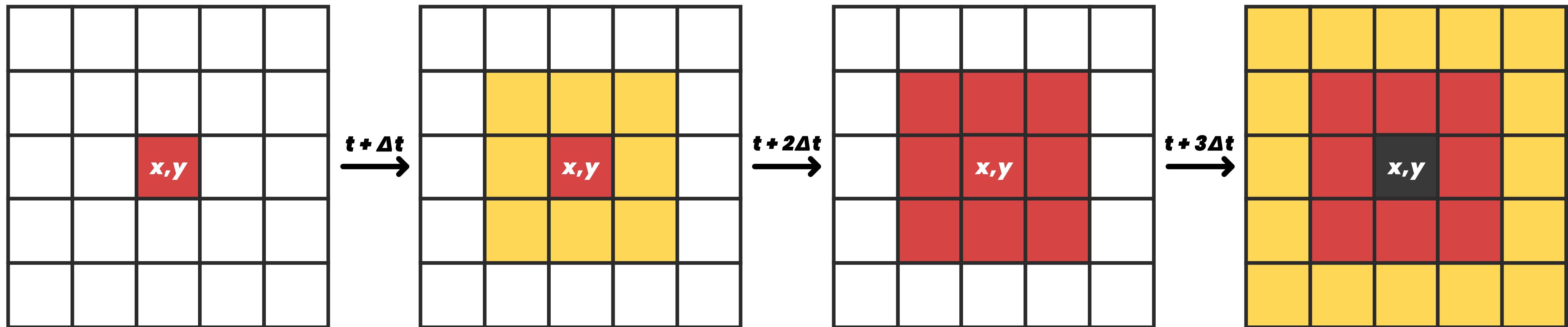


Température

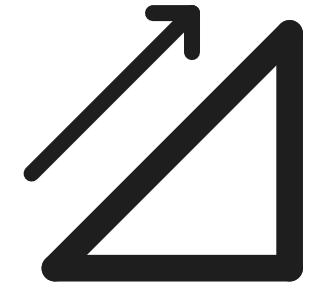


Végétation

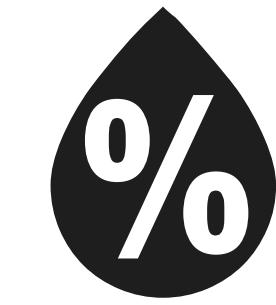
Automate cellulaire



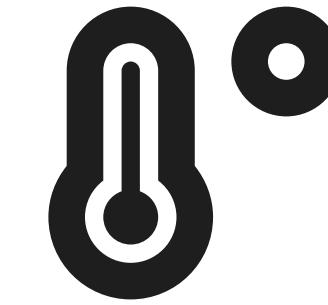
Vent



Pente



Humidité



Température



Végétation



Capitaine Franck Doppler

Basé sur

Forest fire spread simulation algorithm based on cellular automata

Xiaoping Rui • Shan Hui • Xuetao Yu • Guangyuan Zhang • Bin Wu



- 2018

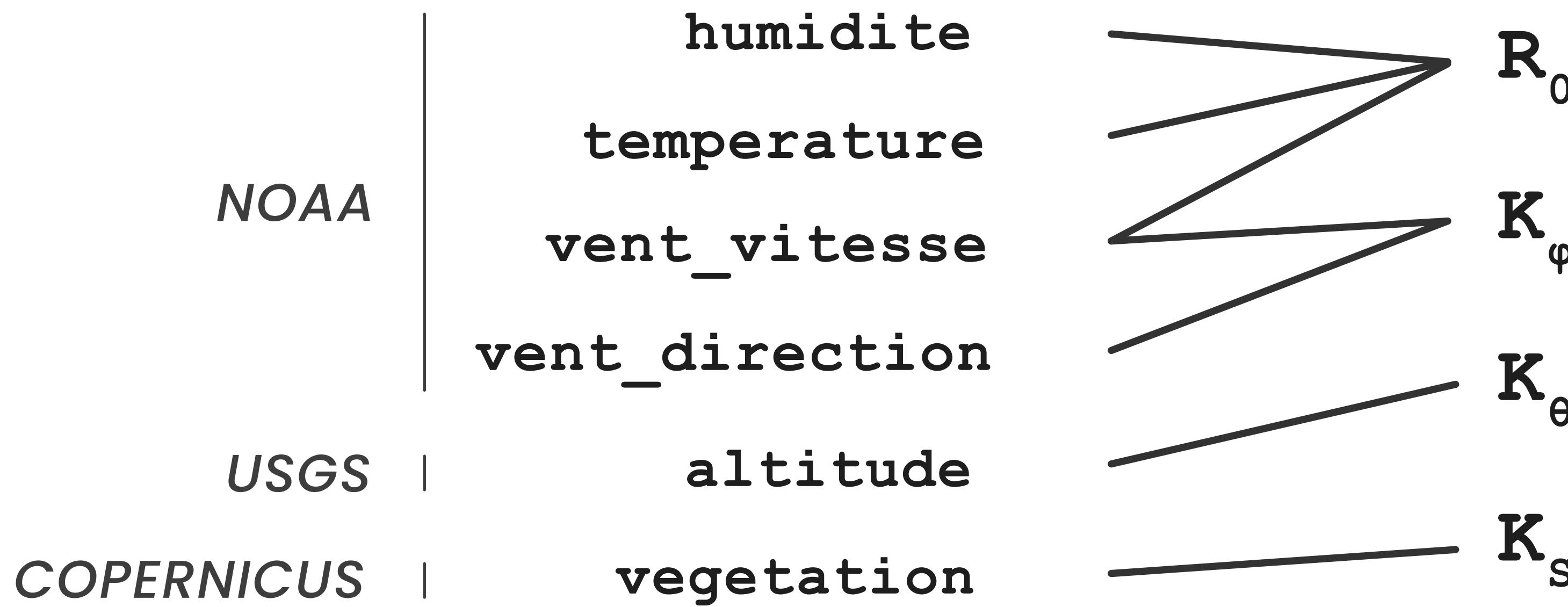
Basé sur

Forest fire spread simulation algorithm based on cellular automata

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x,y

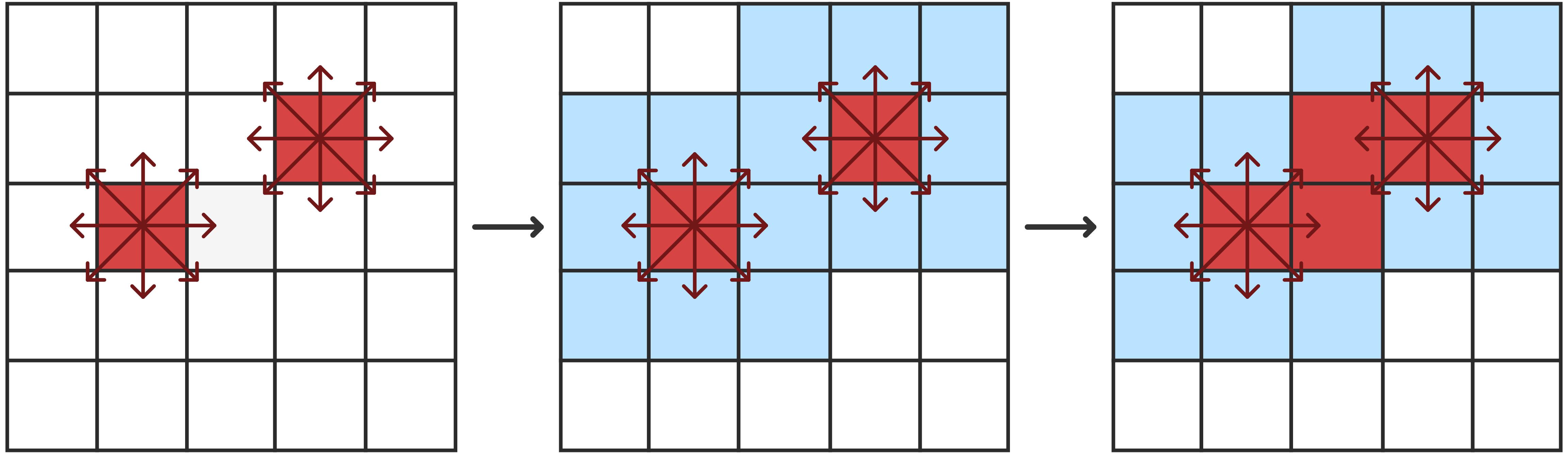
- 2018



$$R_{i,j} = R_0 \cdot K_\varphi \cdot K_\theta \cdot K_s$$

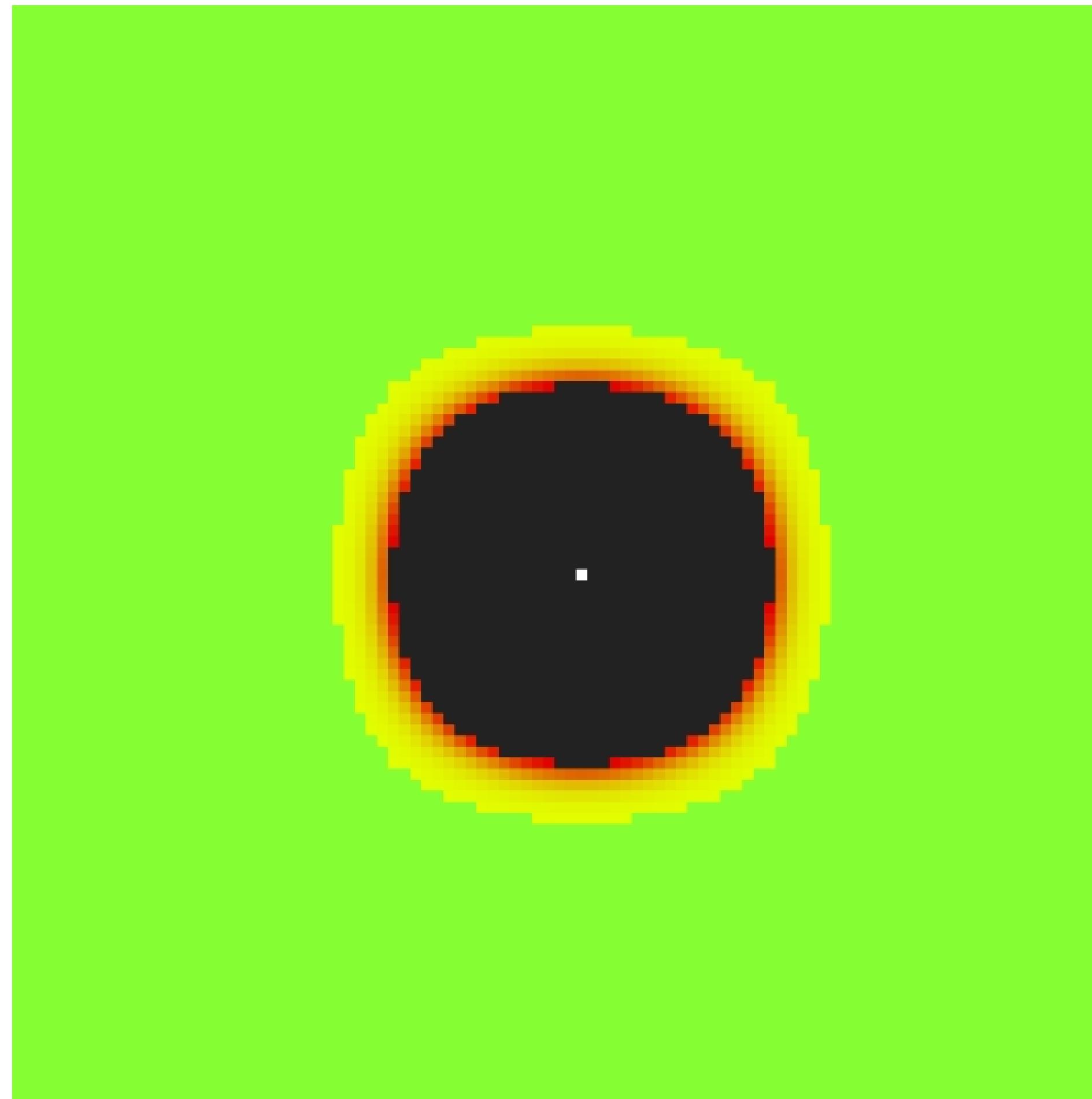
$$S(t + \Delta t) = S(t) + \frac{(R_{i-1,j-1} + \dots + R_{i+1,j+1})}{L} \Delta t$$

$$s(t + \Delta t) = s(t) + \frac{(R_{i-1,j-1} + \dots + R_{i+1,j+1})}{L} \Delta t$$

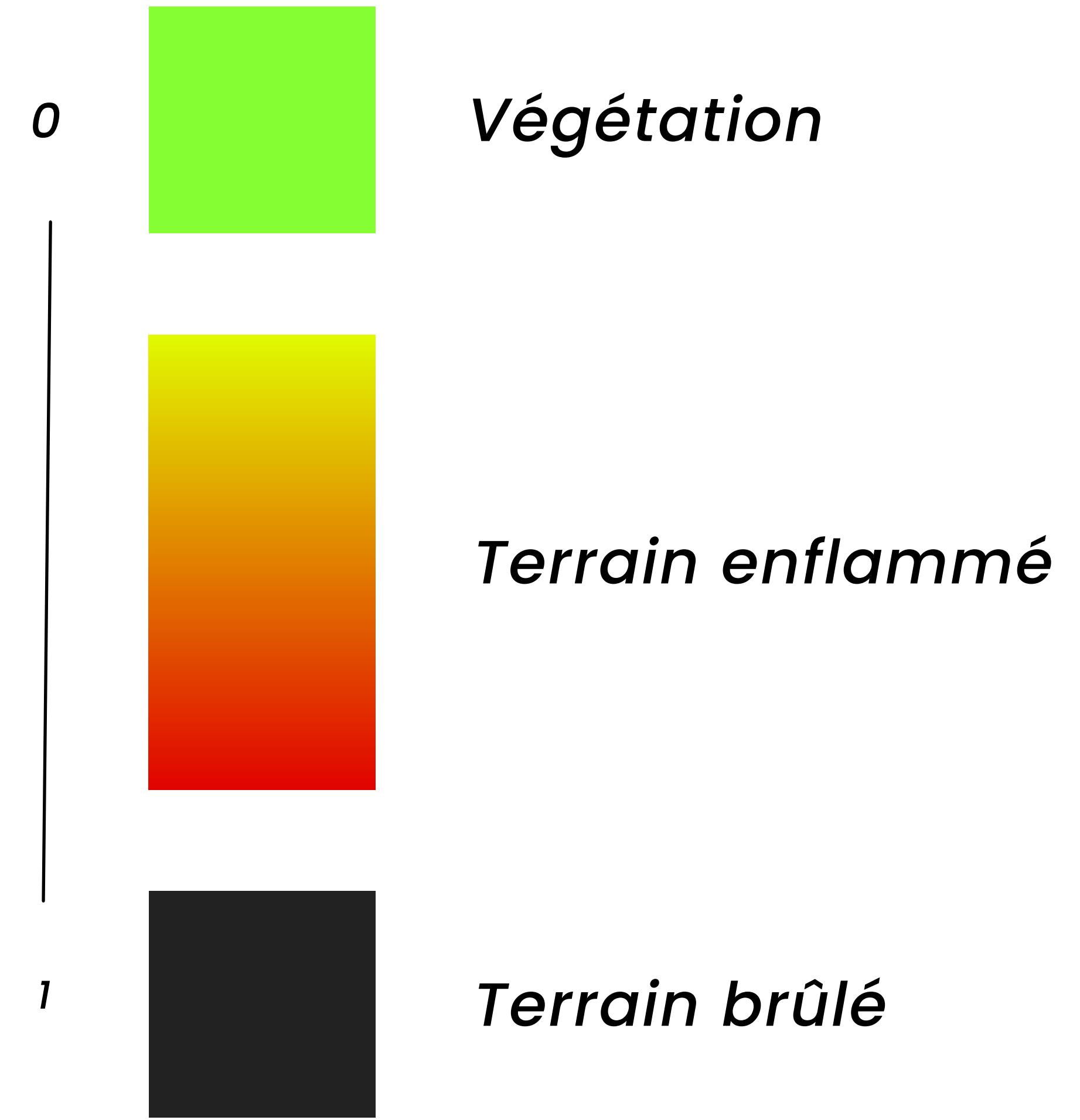


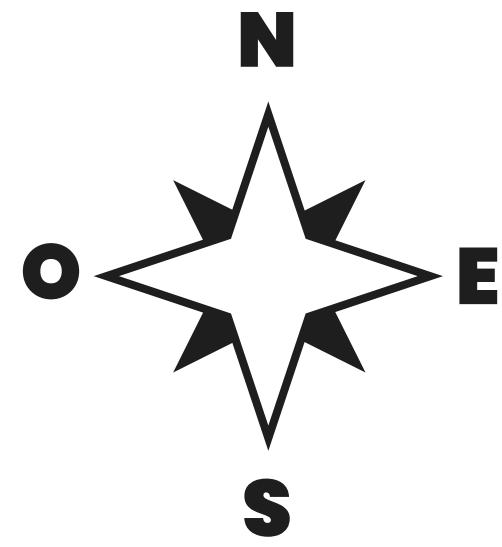
Contrôle des divers paramètres

Modèle simple



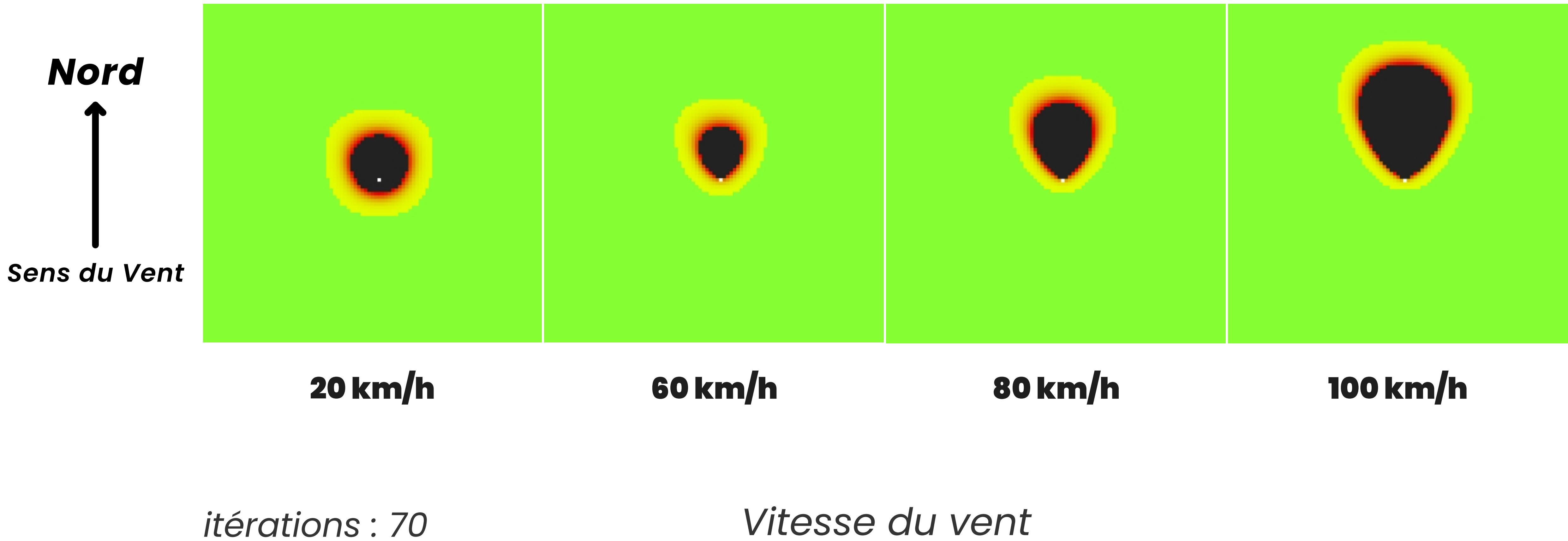
itérations : 30

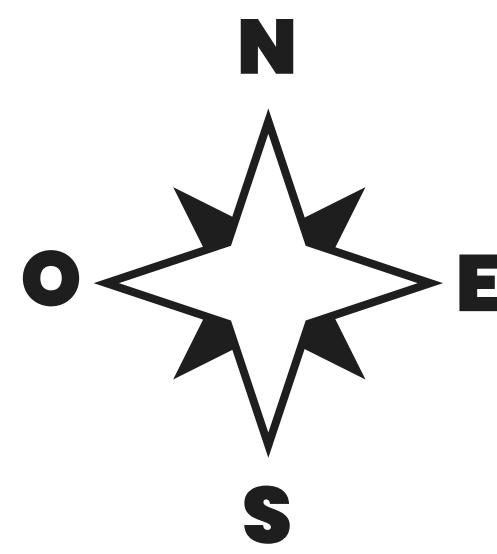




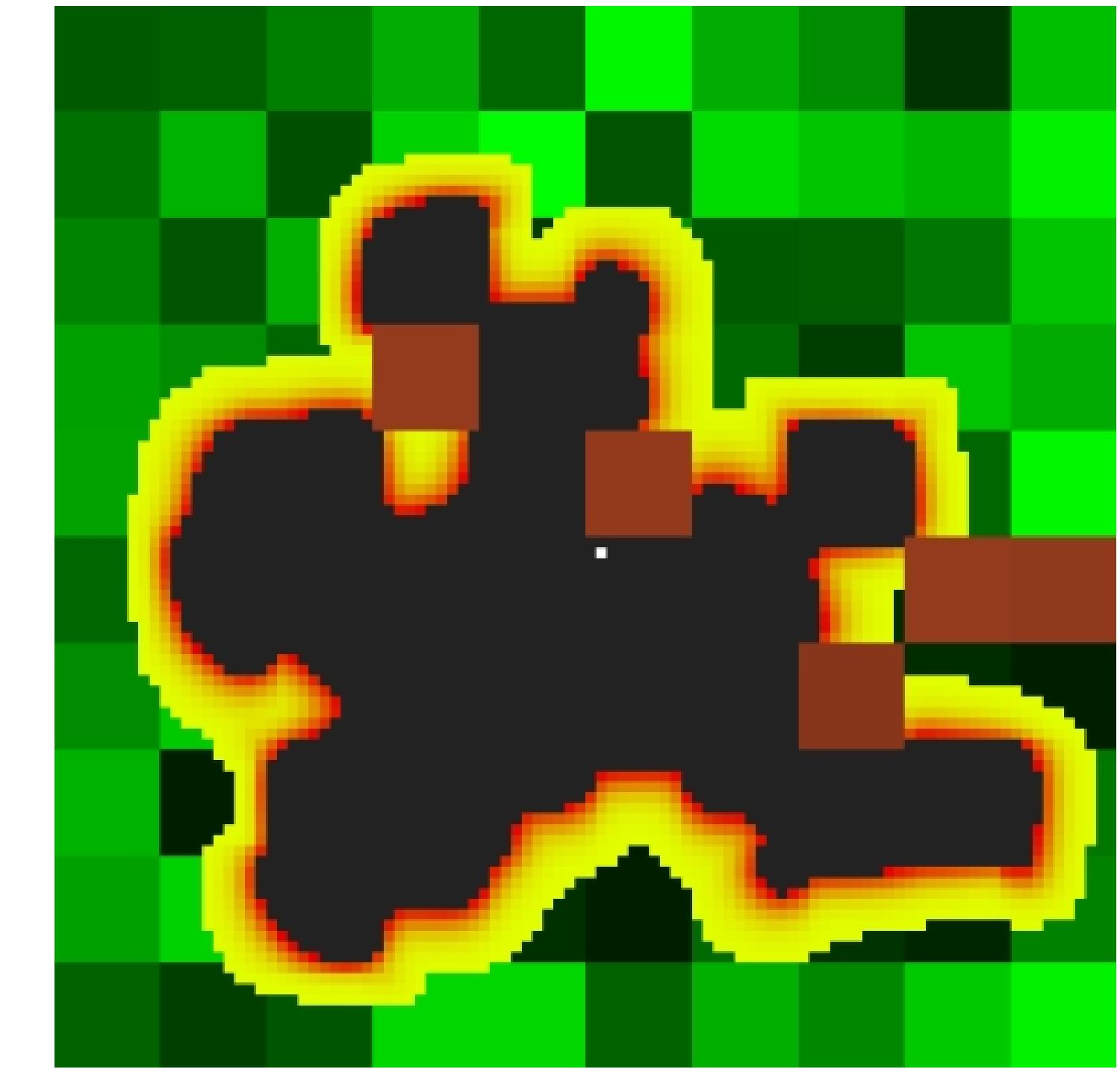
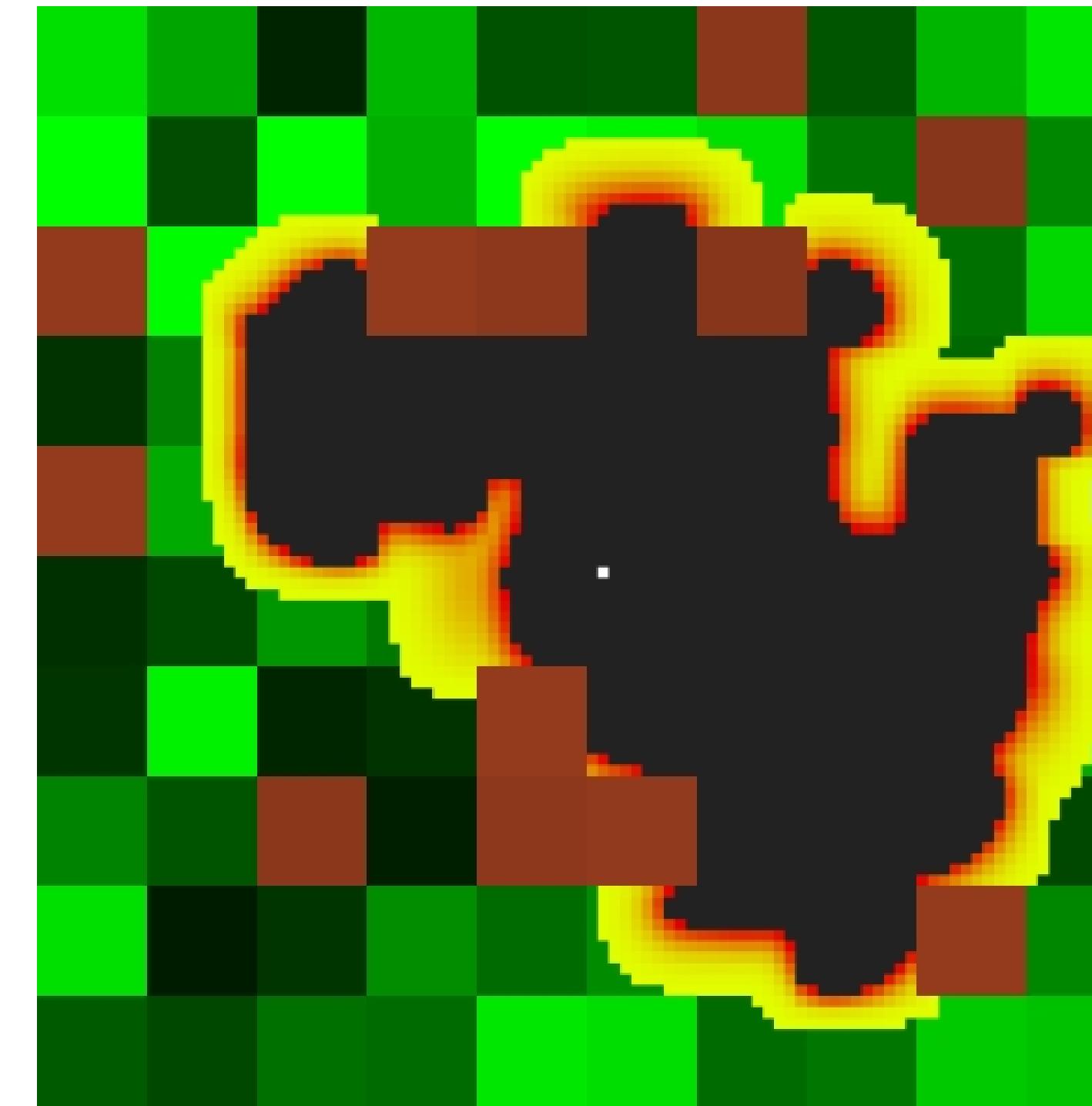
Modèle $\bar{\omega} K_\varphi$

Vent uniquement





Modèle K_s
Végétation uniquement



*Fortement
inflammable*



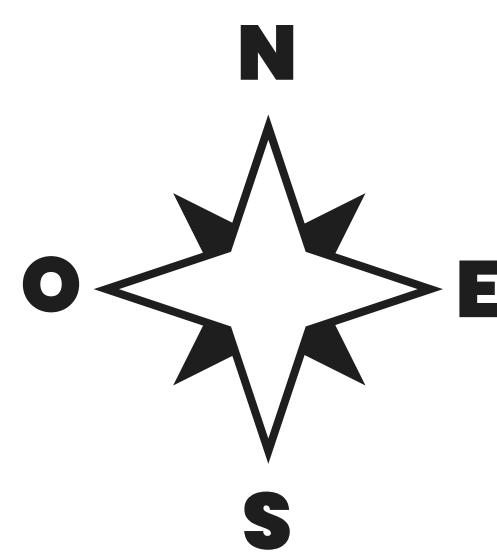
Inflammable

itérations : 70

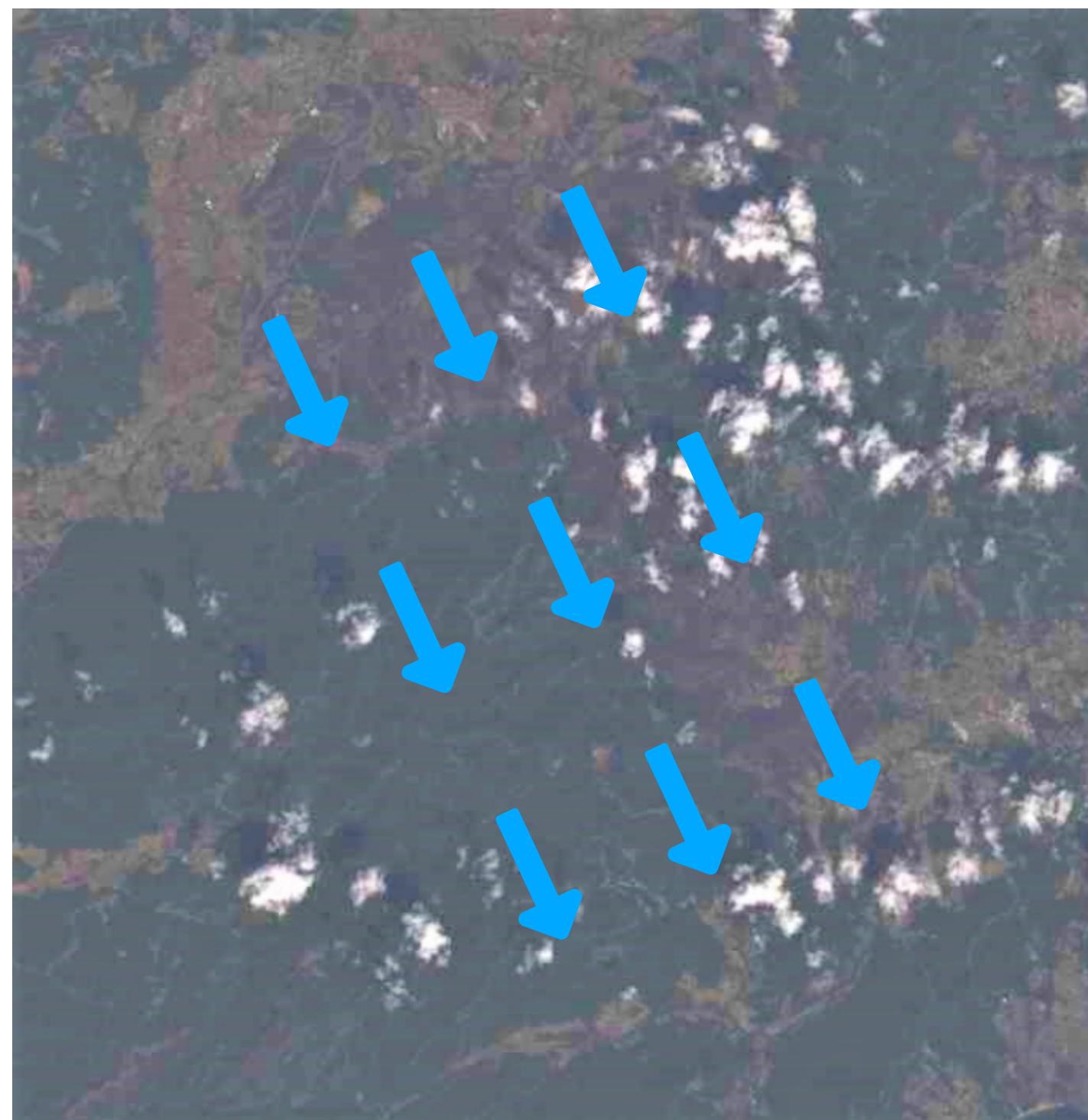
Incendie du 16 août 2021 dans le Var

43° 20' 00" N, 6° 24' 00" E



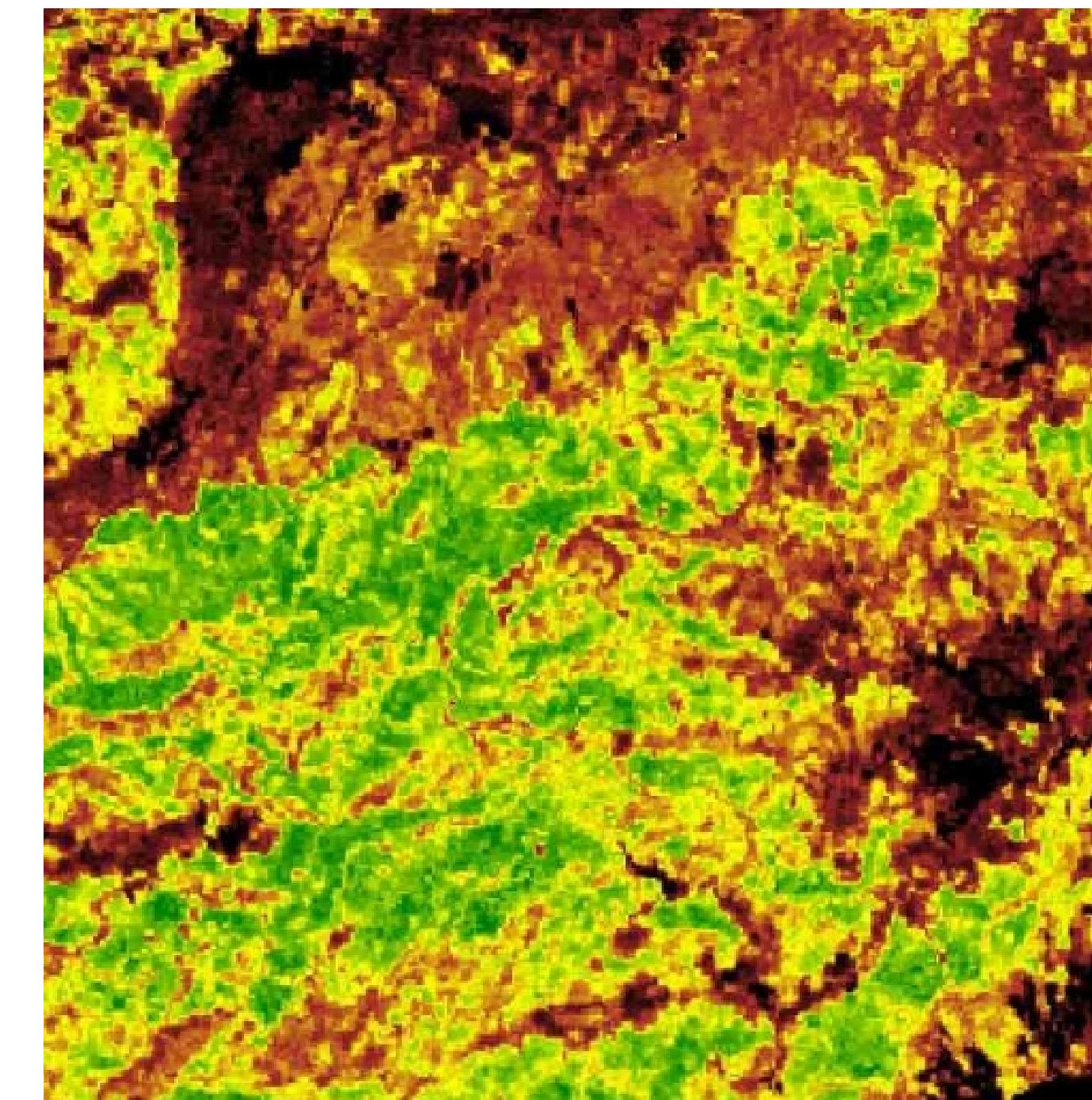


Incendie du 16 août 2021 dans le Var

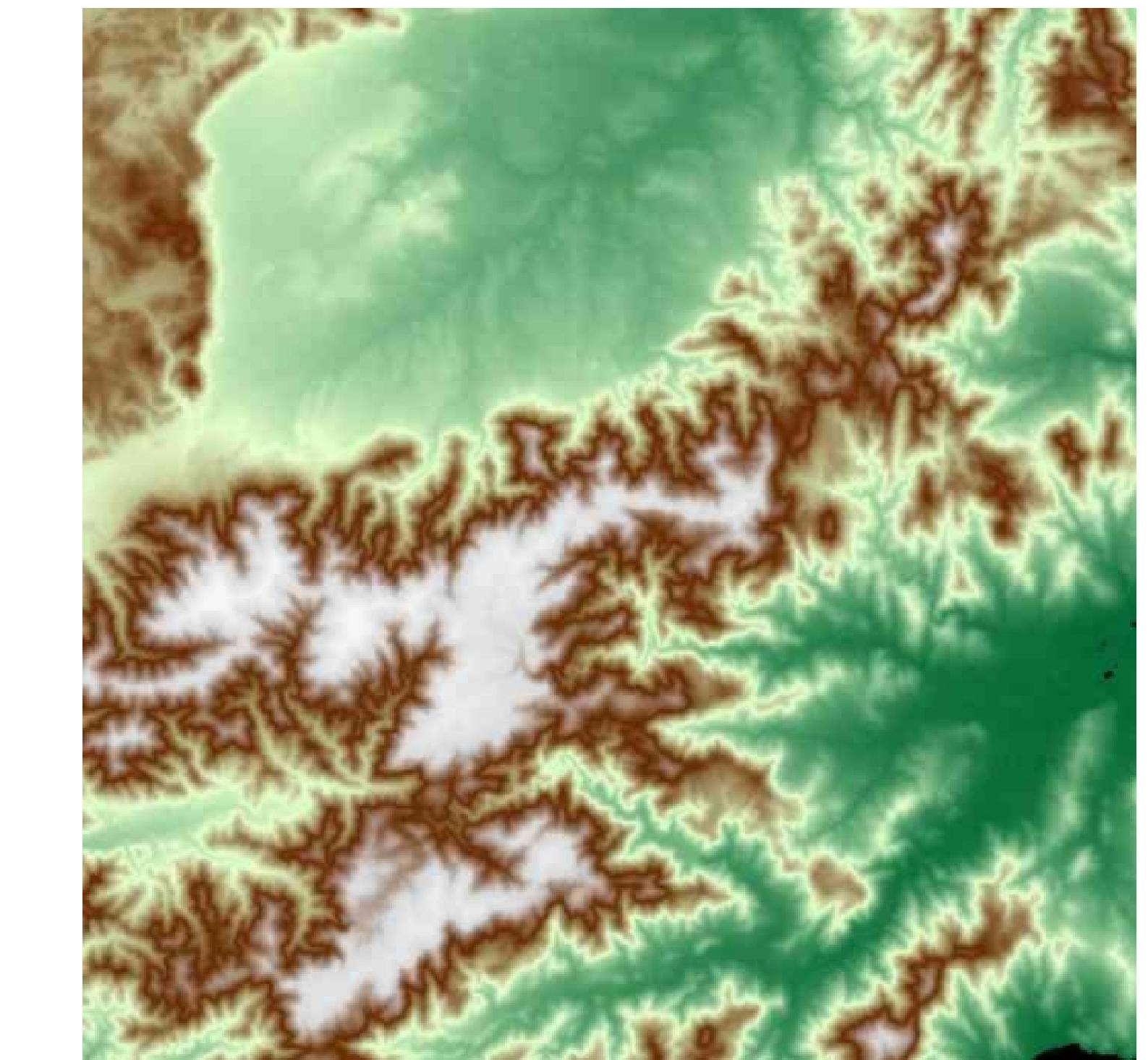


Vent

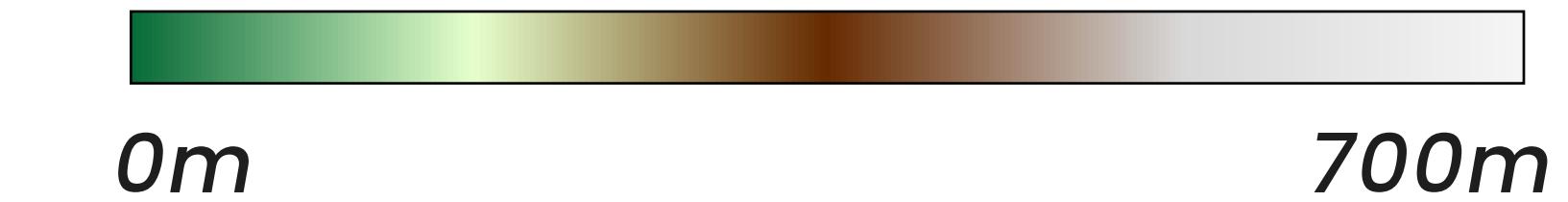
35km/h



Végétation



Dénivelé



Simulation

$L = 1623m$



Parcelle

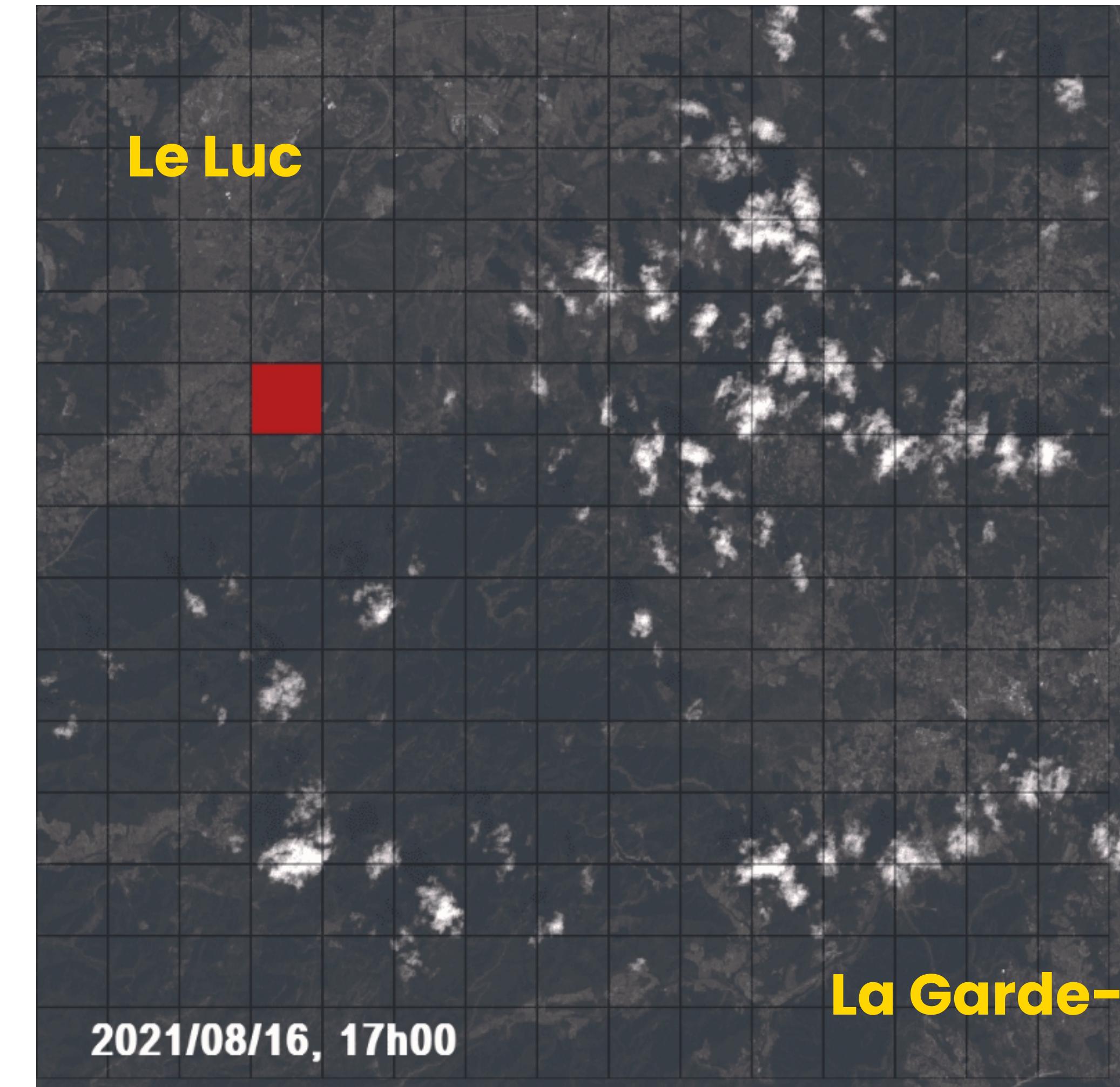


Parcelle en feu



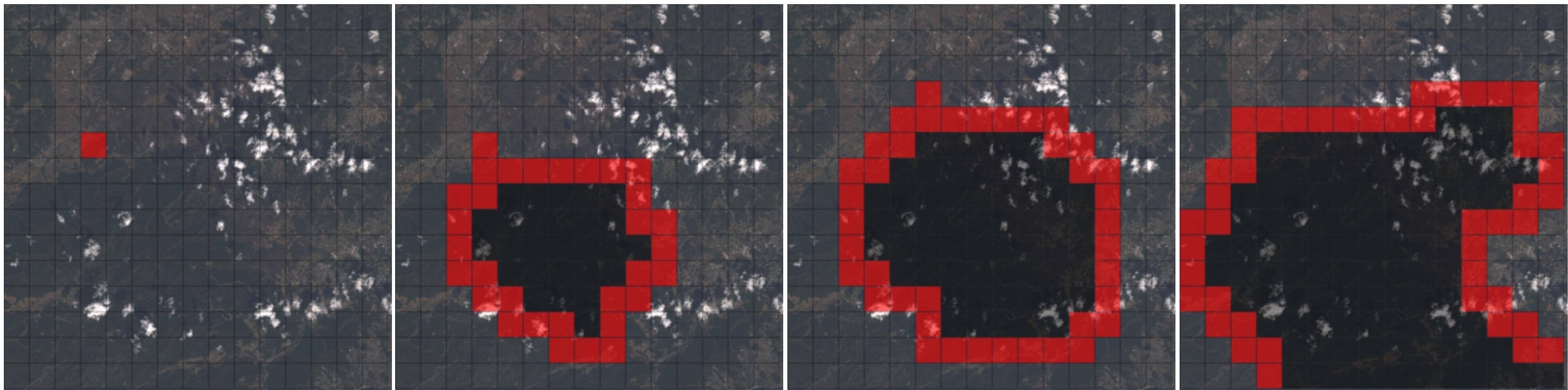
Parcelle brûlée

$\Delta t = 8min$



Direction Les Mayons ↓

Résultats de notre automate



i = 0

16 Août 17h00

i = 579

19 Août 12h37

i = 1158

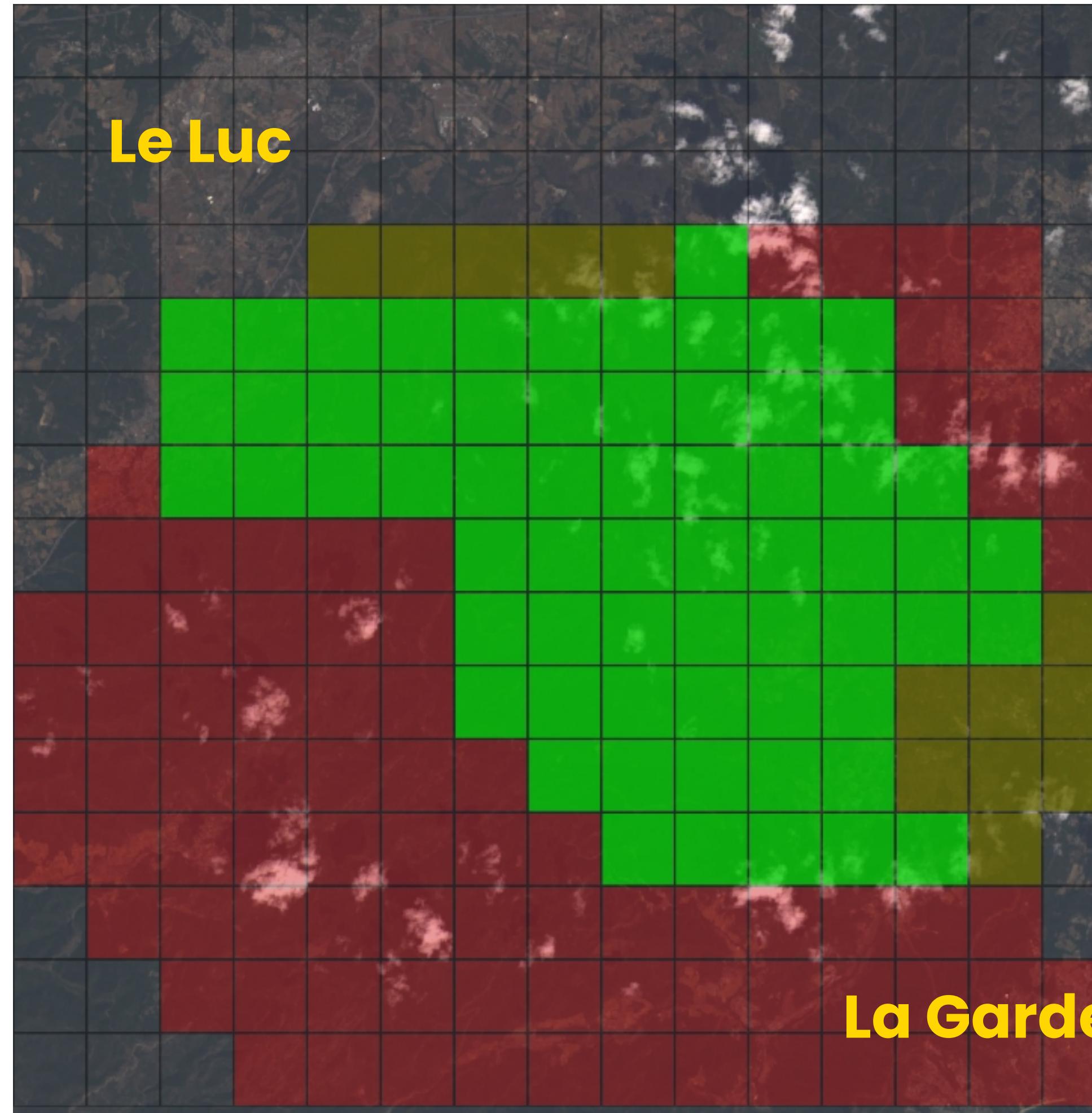
22 Août 08h15

i = 1736

26 Août 11h57

Nombre d'itérations

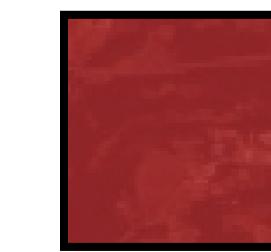
Comparaison



Correspondance entre les deux

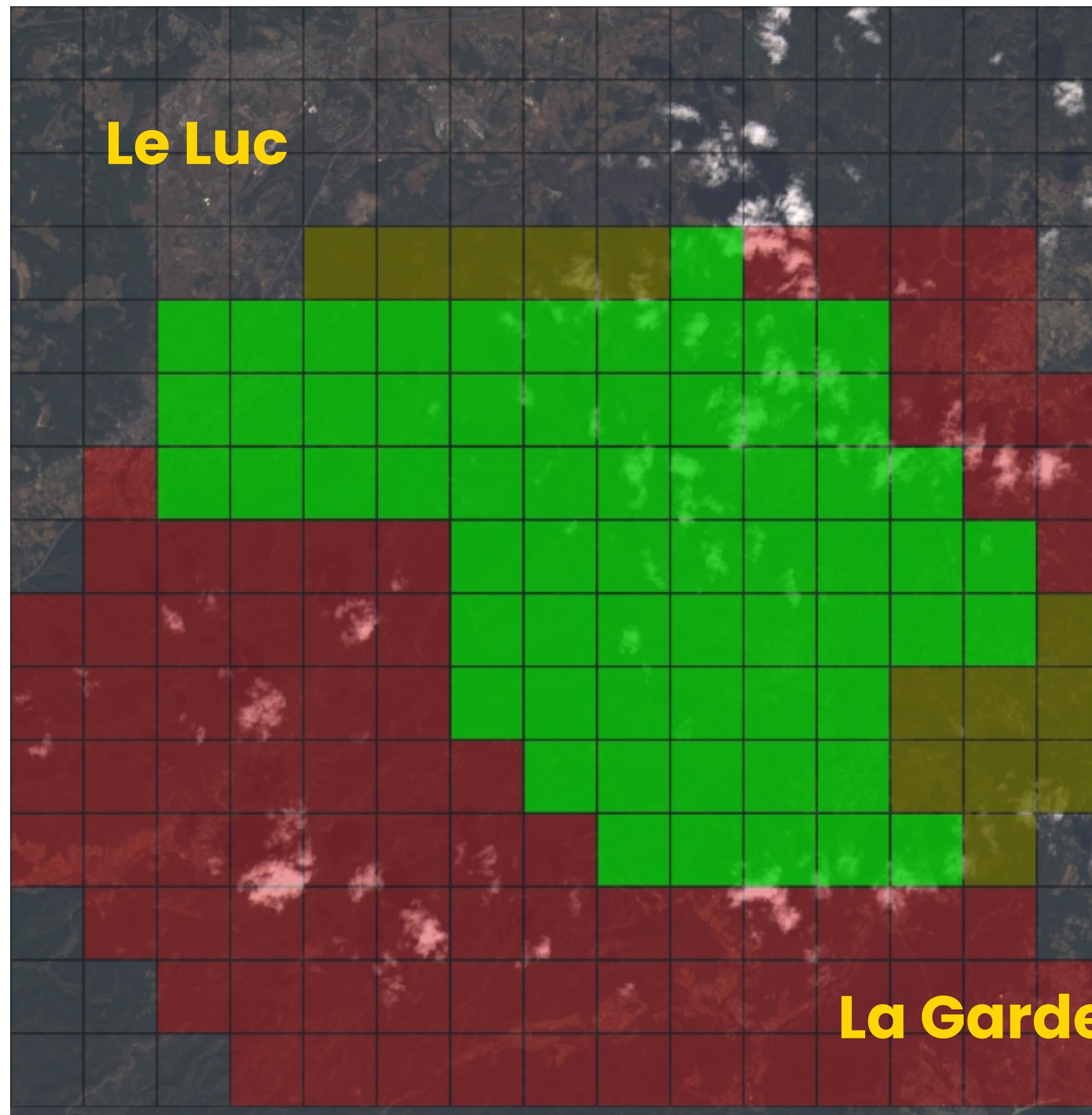


Uniquement sur l'image satellite

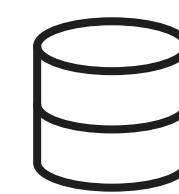


Uniquement sur la simulation

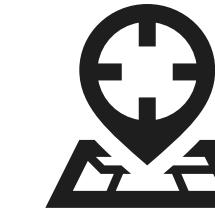
Ecart Possibilités



Direction Les Mayons ↓



Manque de données



Précision des données



Intervention des pompiers

Conclusion