New methods for fuel classification and carbon estimation from point clouds

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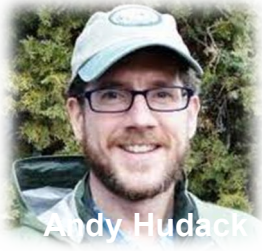
The Team



Universidad de Oviedo

IMIB

universidad de león

Funding: 3DFuels project & Pyrocarbon3D project

Fuel classification

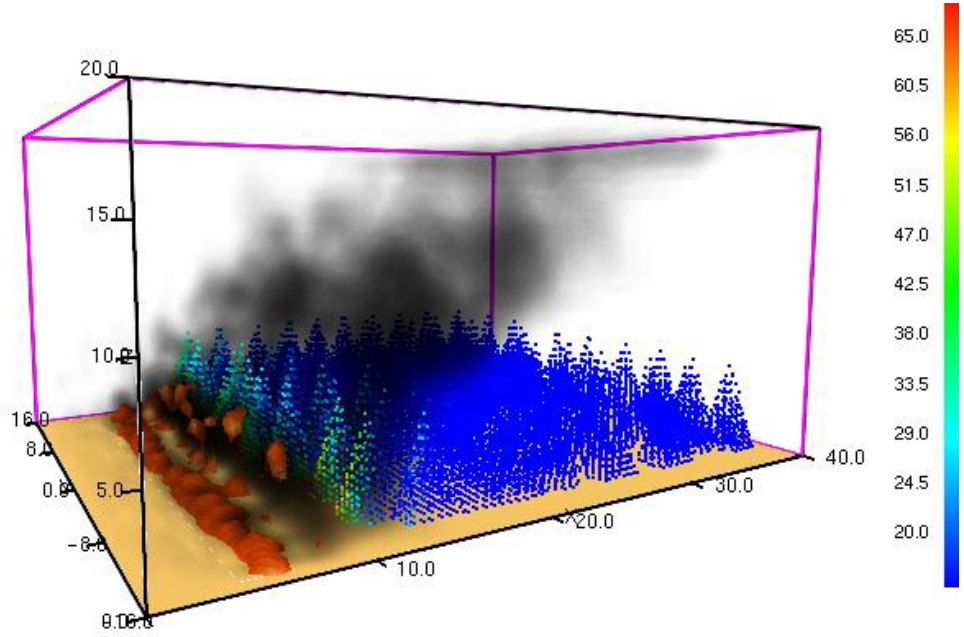
Fire behaviour models

Physical
Empirical

+ 3D data

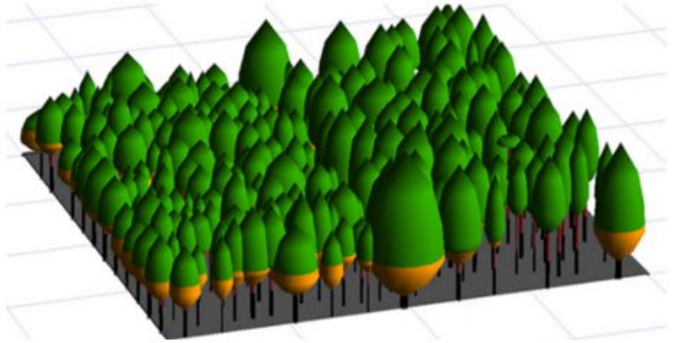
+ Computacional power

FDS
Quickfire



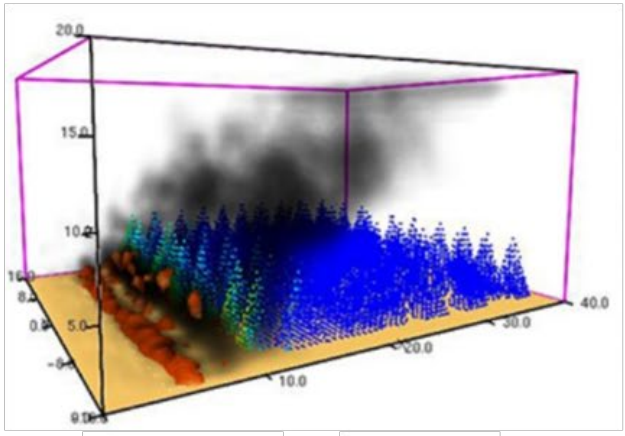
Physics-based fire behaviour models

3D Fuel models



FastFuels

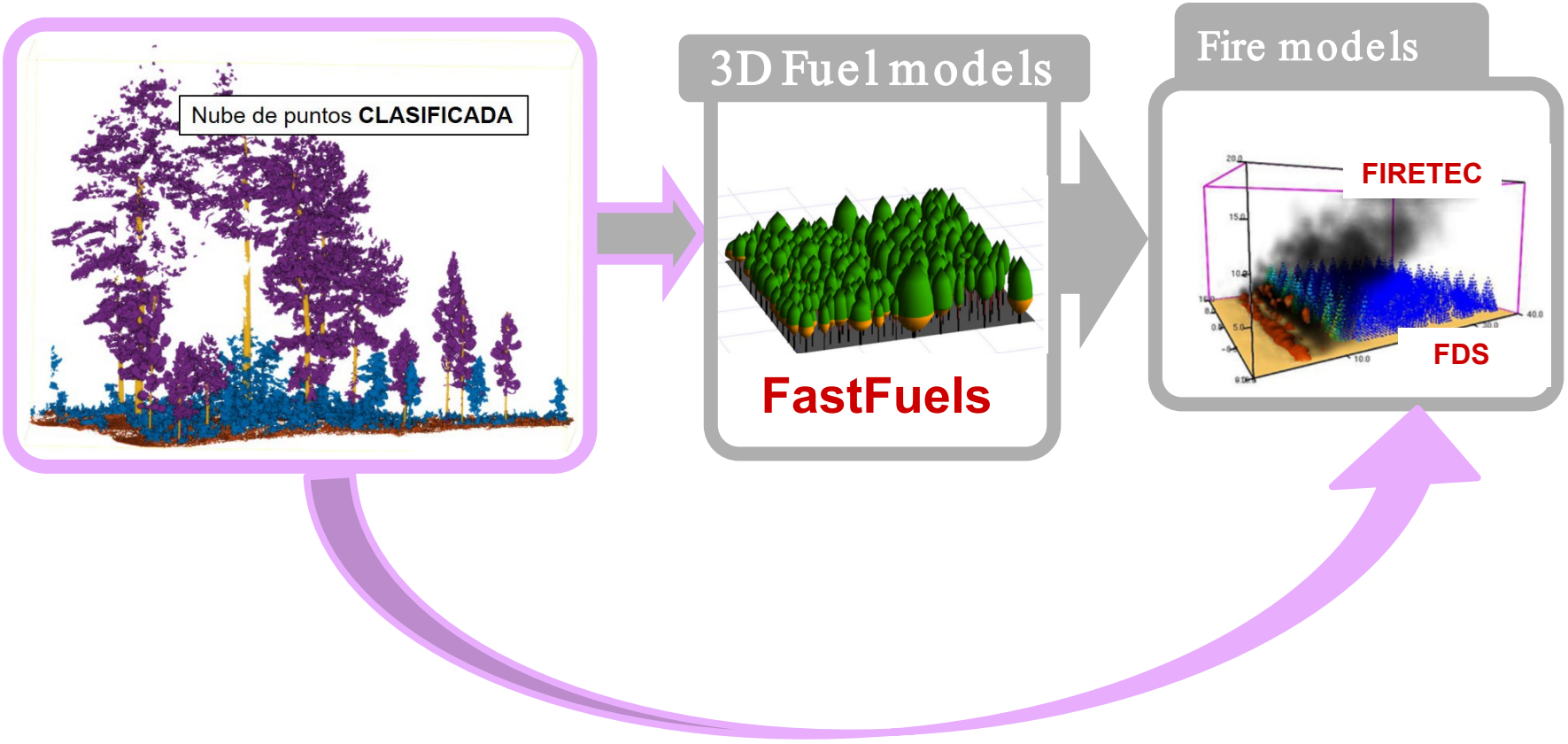
Fire behaviour models



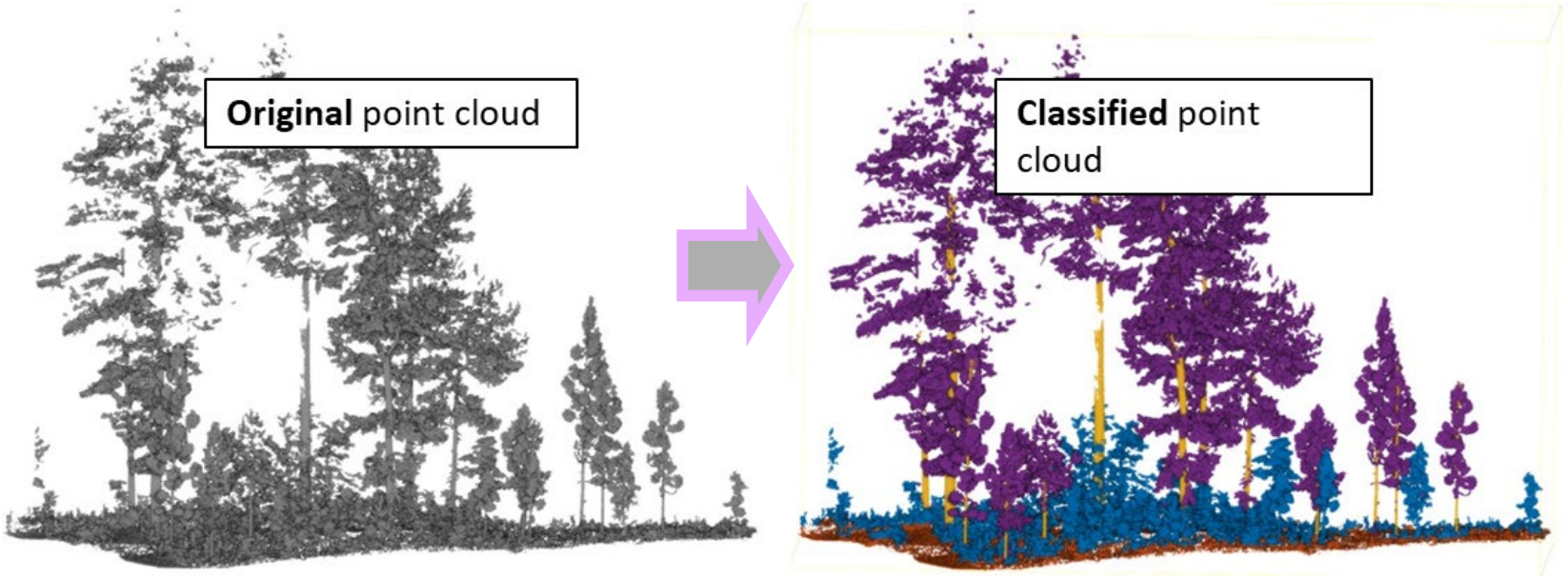
FIRETEC FDS

Physics-based fire behaviour models

Integrating real 3D fuel data



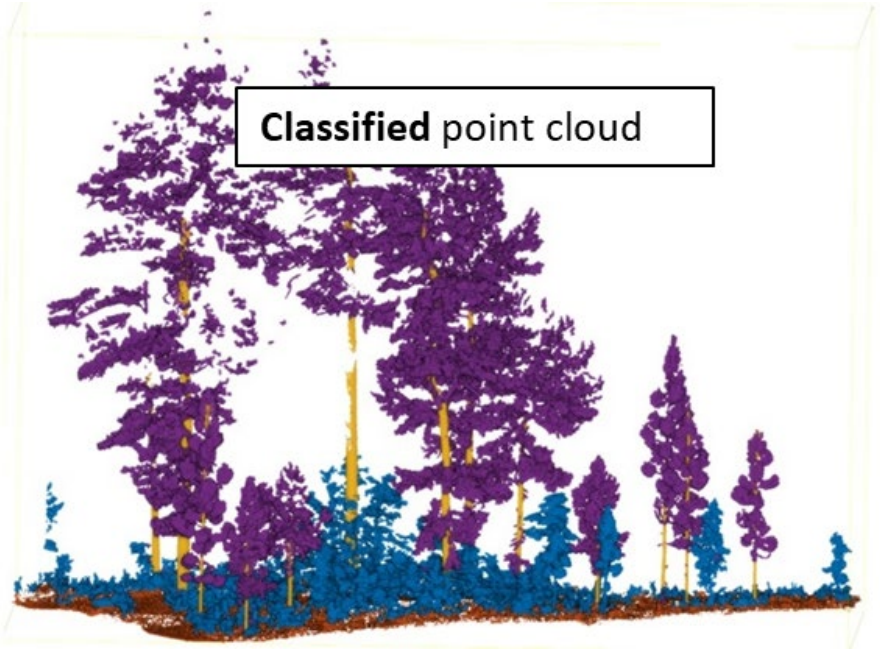
Automatic classification *of* terrestrial point clouds *in* forest plots



Automatic classification *of* terrestrial point clouds *in* forest plots

Physics-based fire behavior models

1. Point cloud classification of different fuel structures:
   - Branches + leaves
   - Stems
   - Shrubs
   - Grass
2. Synthesis of the 3D information → voxels



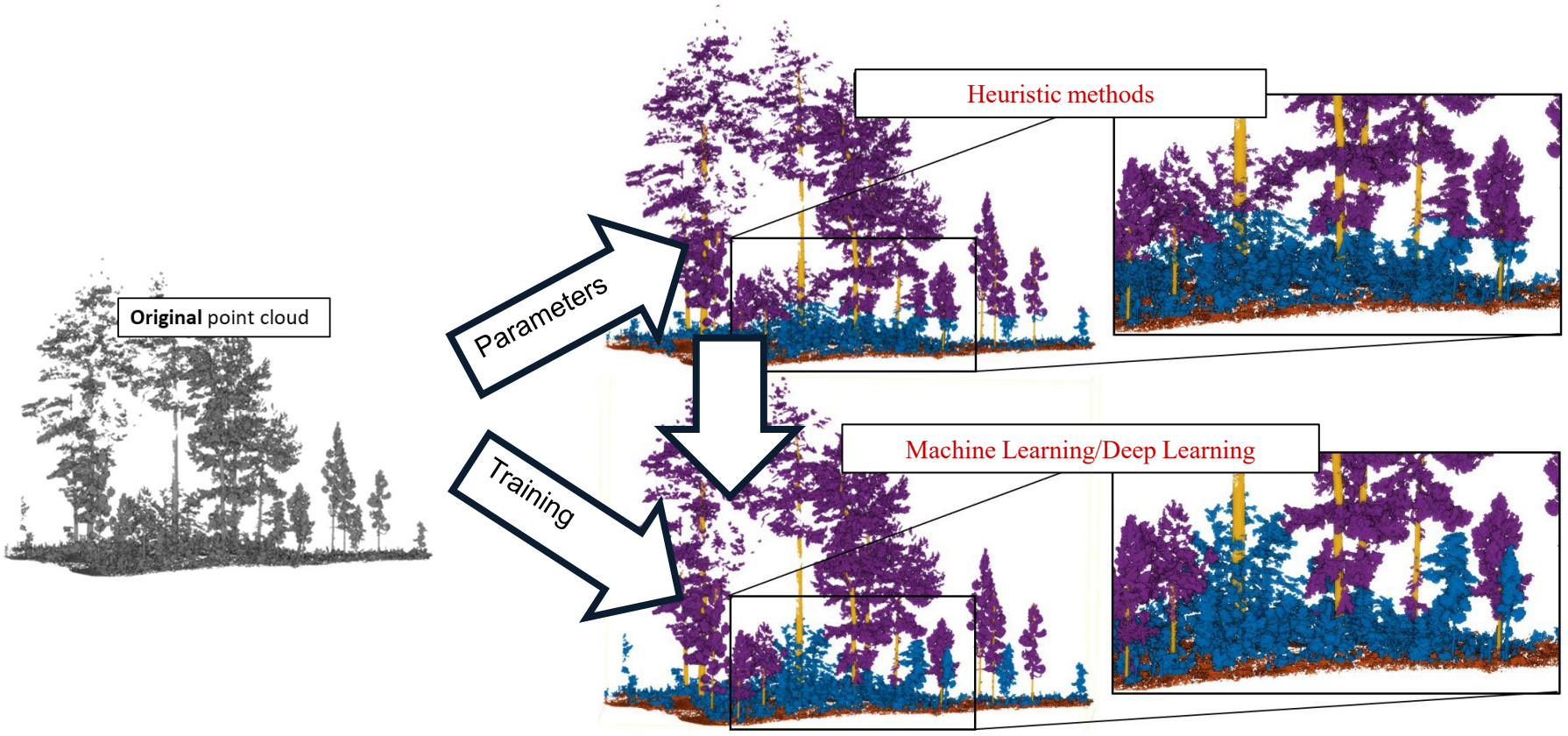
Approaches tested:

Heuristic algorithms (based on geometric rules)

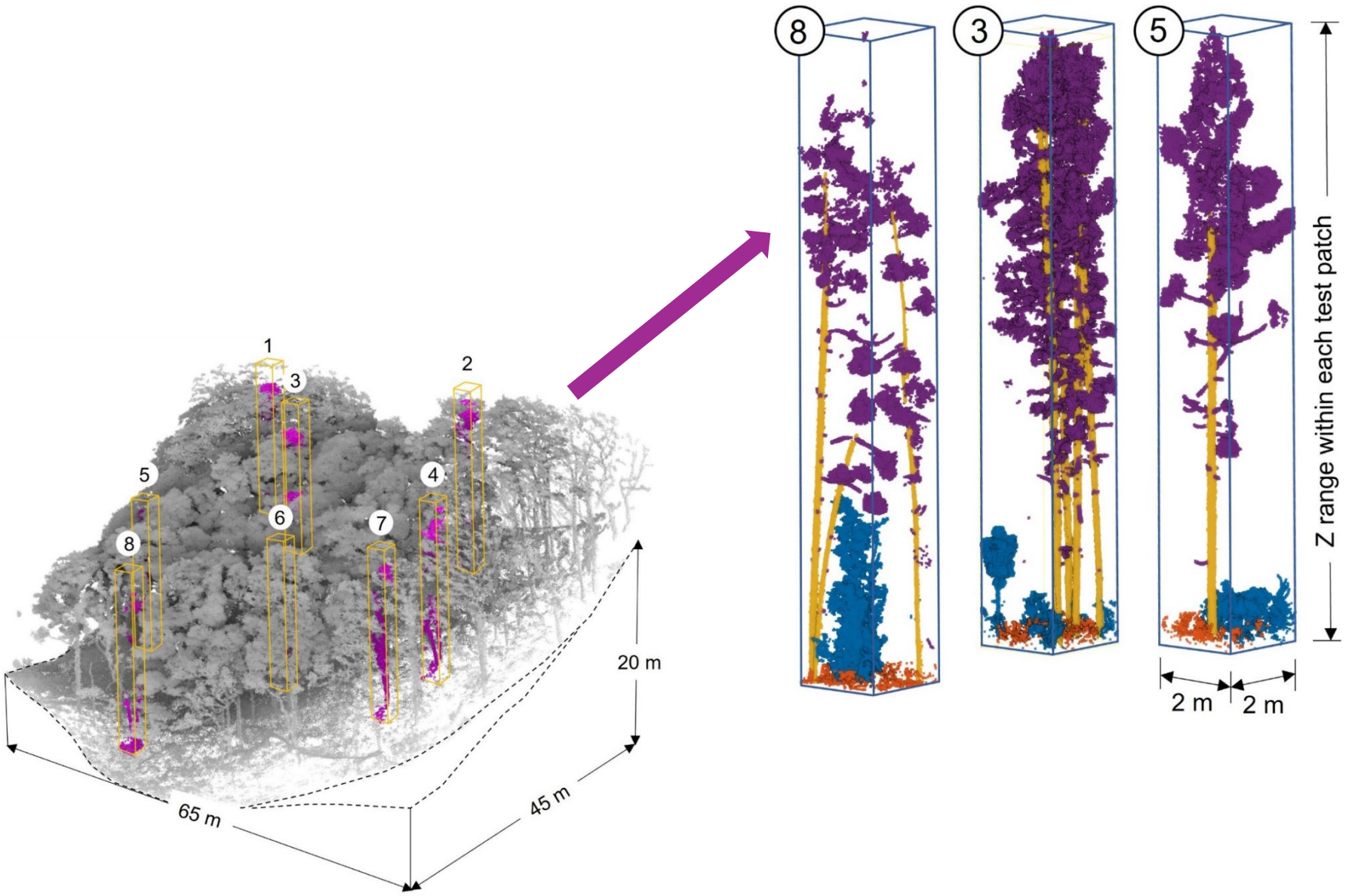
Artificial intelligence algorithms
(based reference data → to 'learn'/train)

- **Machine learning**
- **Deep learning**

Approaches tested:



Validation:



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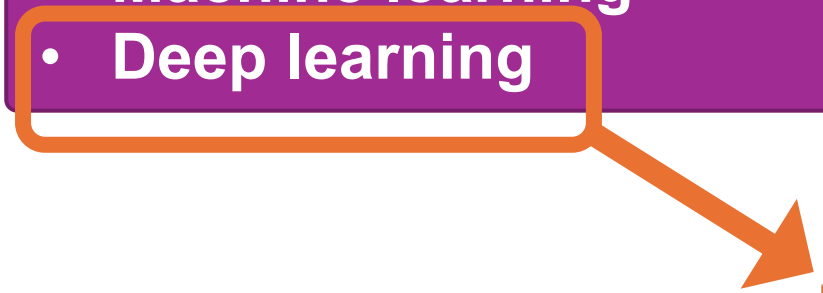
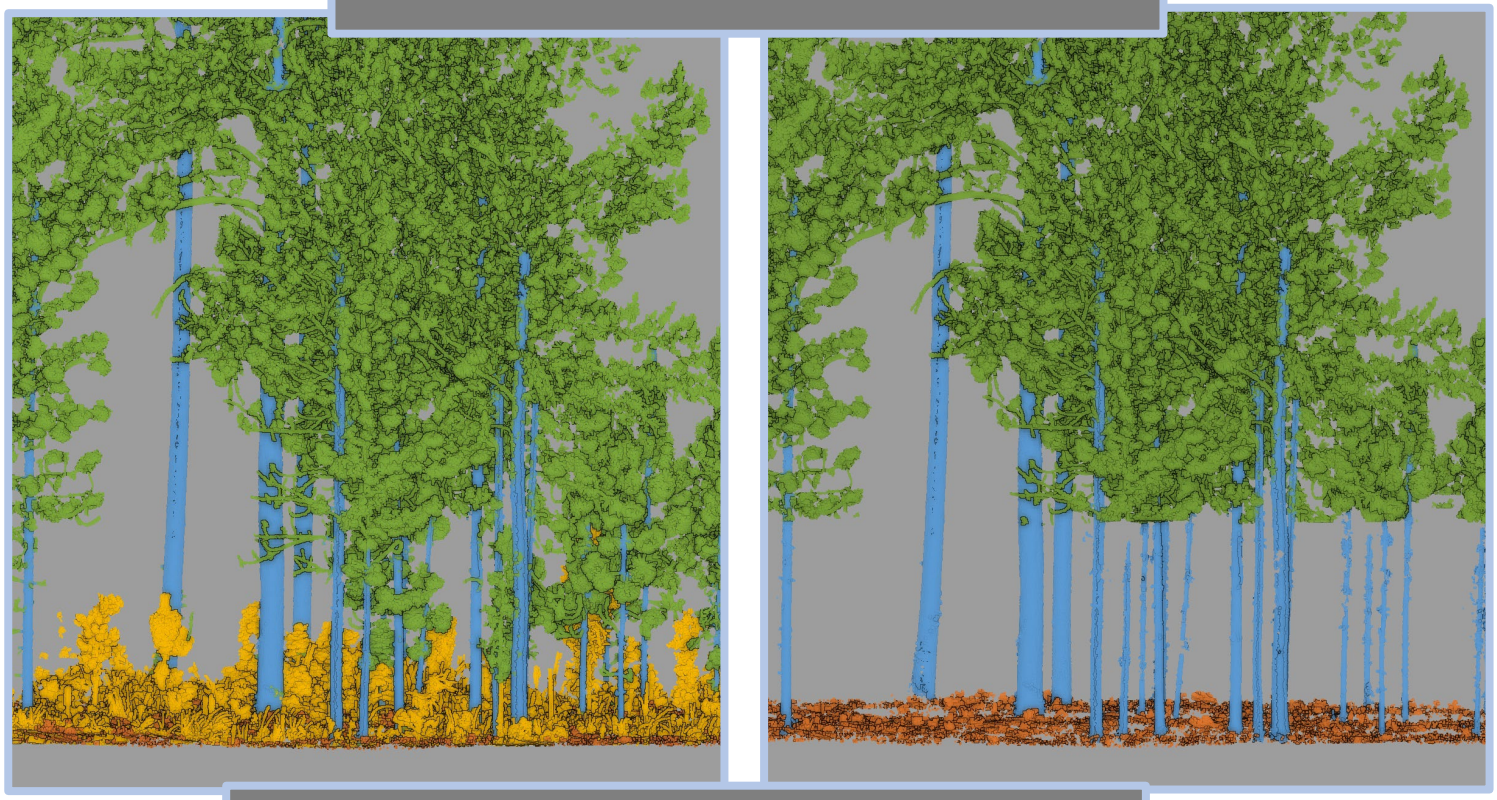


3DFoS *in CloudCompare*

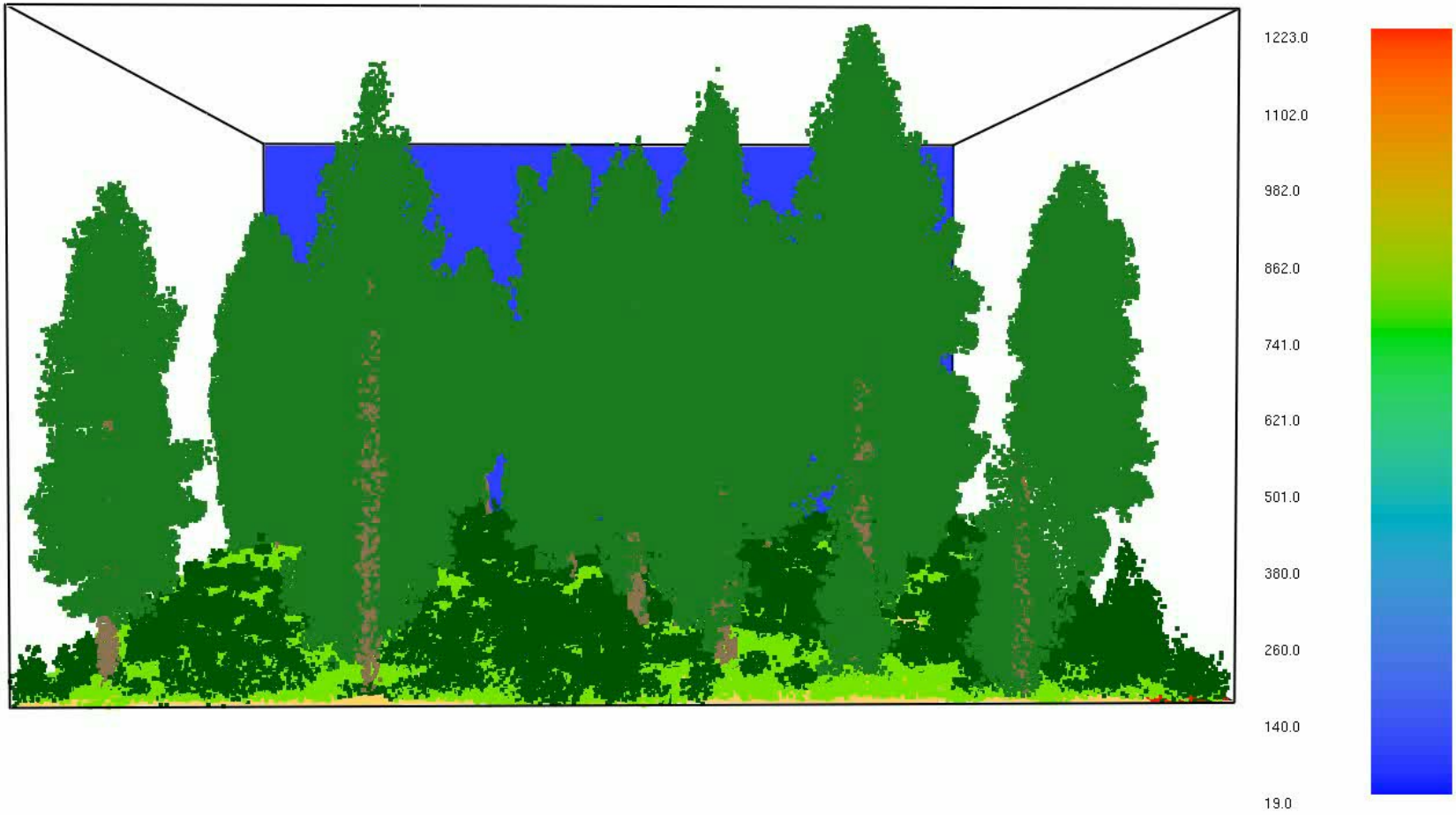
virtual treatments



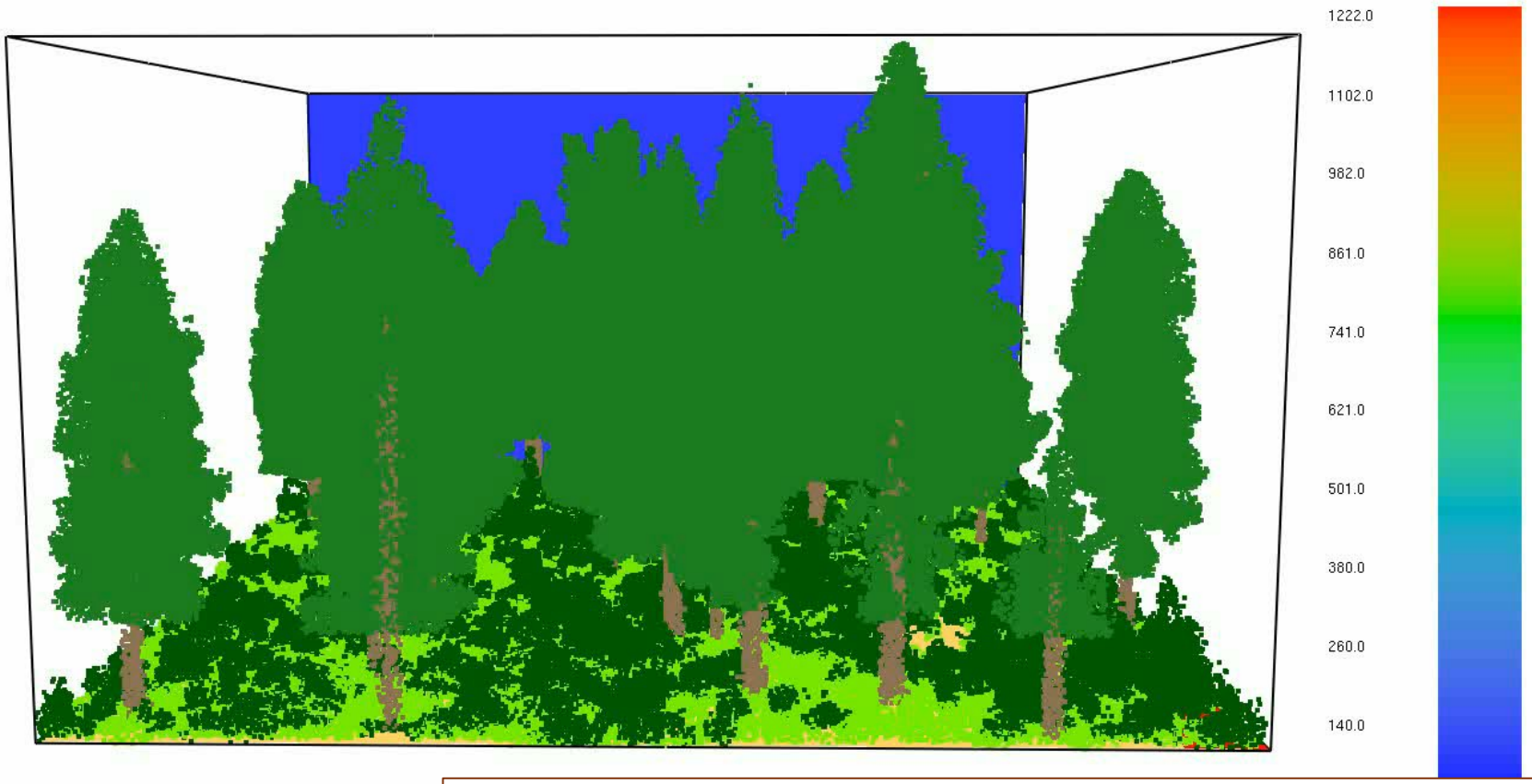
forest management simulations

3DFoS *in CloudCompare*

FDS fire simulations



FDS fire simulations



After treatment

Time: 0.0

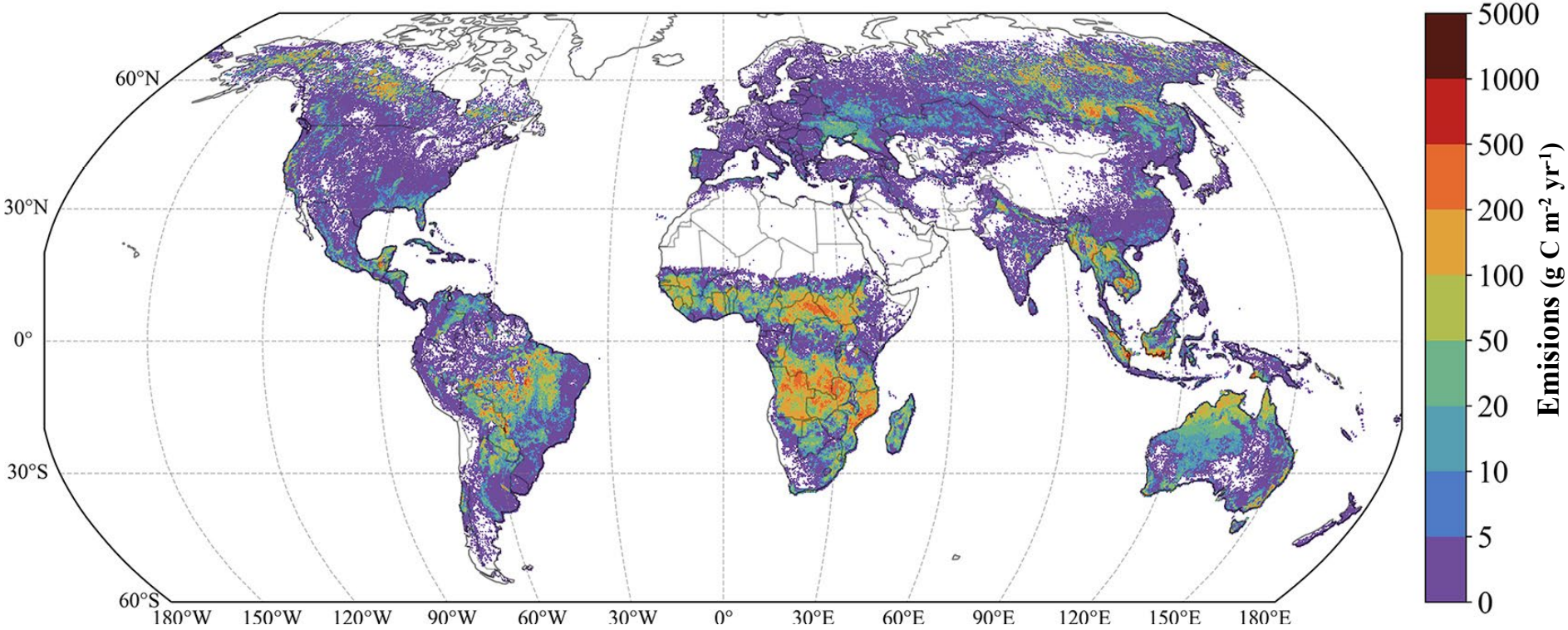
Limitations… or further research!

- Down wood and litter
- Leaves vs branches
- Limited plot sizes
- Overkill for fire behaviour models?

Carbon emissions

Carbon emissions

- 2.1 Pg C into the atmosphere
- Equivalent to ~ 22% fossil fuels emisions



Van Wees *et al.* 2023

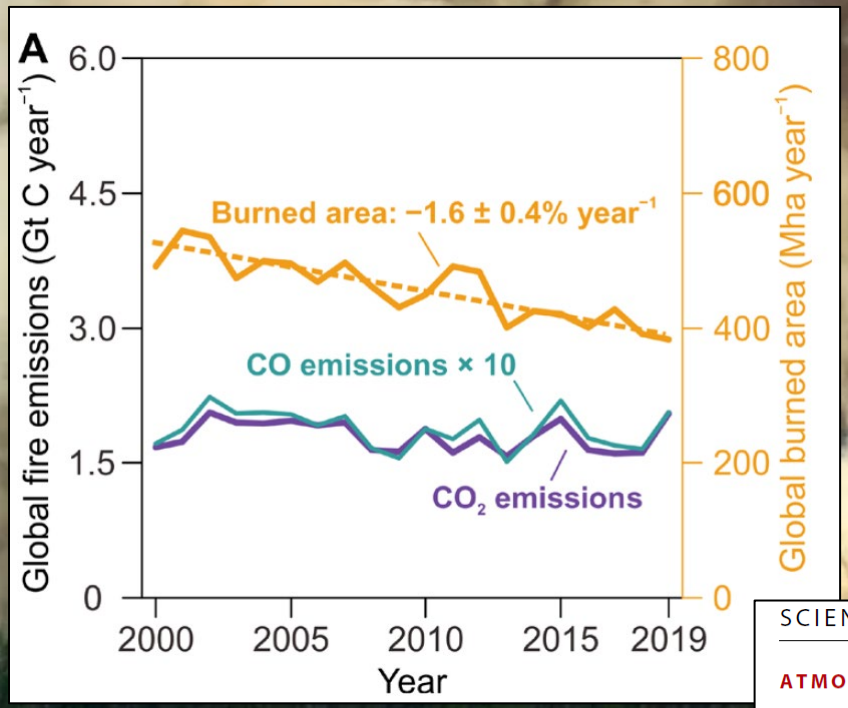
Carbon emissions

Most fires are considered
'zero'-carbon events

But those where vegetation does not recover & peatland fires
0.4 Pg C yr^{-1} C net emissions (equivalent~ 4% fossil fuel combustion)

Van der Werf *et al.* 2017

Carbon emissions



SCIENCE ADVANCES | RESEARCH ARTICLE

ATMOSPHERIC SCIENCE

Increasing forest fire emissions despite the decline in global burned area

Bo Zheng[1,2]*, Philippe Ciais[2,3], Frederic Chevallier[2], Emilio Chuvieco[4], Yang Chen[5], Hui Yang[6]

Emisions estimations have very high uncertainity

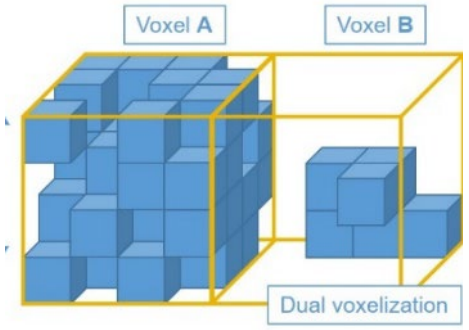
PyroCarbon3D

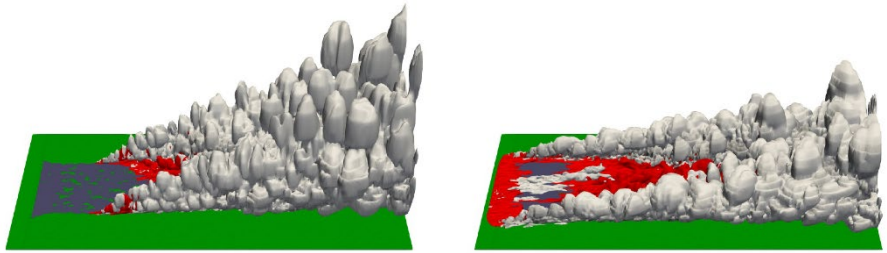
IMIB

Swansea University
Prifysgol Abertawe

Quantification of biomass from 3D point clouds (3DFoS)

+ Carbon in biomass
+ Spatially explicit
+ Before vs. after fire: **C lost**





PyroCarbon3D

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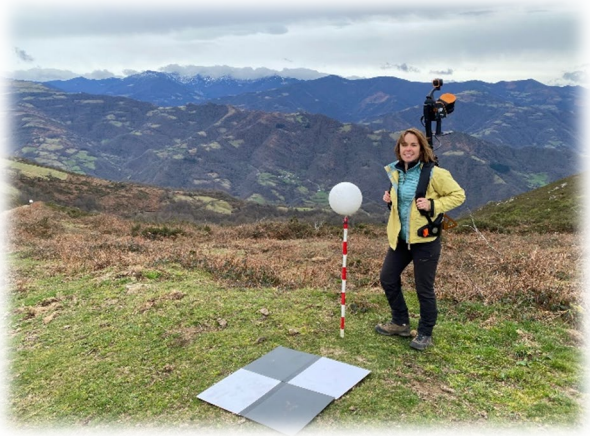


Thanks for your attention!