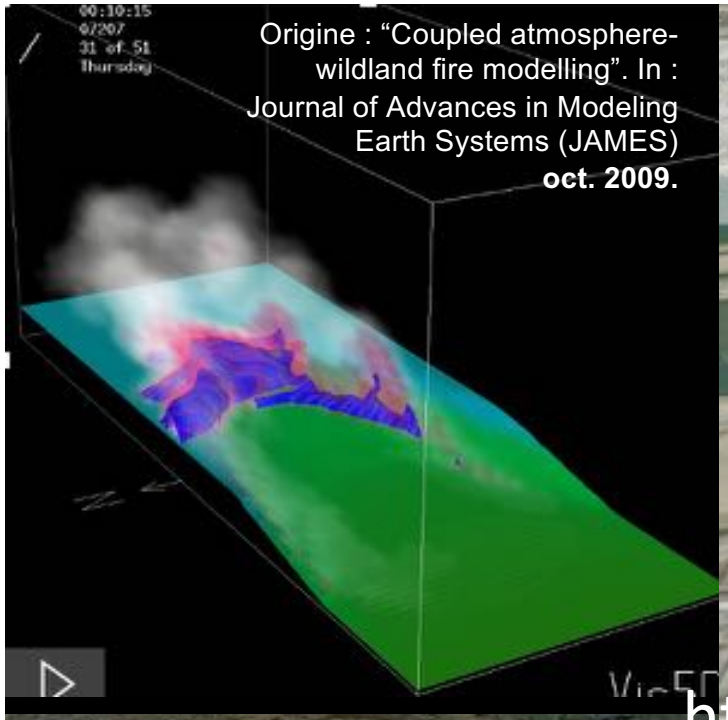
Florence Vaysse
Frédéric Allaire
Ronan Paugam
Yolanda Perez
Jean-Baptiste Vincentelli
Lila Ferrat
Dominique Cancellieri
Jean-François Léon
Patrick Le Moigne
Christine Lac
Valery Masson
Vivien Mallet
Mélanie Rochoux
Yohan Jouves
Antoine Belgodere
Florian Gueniot
Aurelien Costes

Jean-Baptiste Filippi. - CNRS – UMR SPE Università di Corsica Pasquale Paoli

Journées RésoFeux 2023

Codes et exemples de simulation de grands incendies par couplage incendie atmosphère, du front de flamme au PyroCumuloNimbus,

GDR Incendie 2006/2007 (18 ans). Benchmark Lançons.



Origine : “Coupled atmosphere-wildland fire modelling”. In : Journal of Advances in Modeling Earth Systems (JAMES) **oct. 2009.**

https://www.youtube.com/watch?v=gsAId2M5jHs

Université di Corsica Pasquale Paoli | Laboratoire Sciences pour l'Environnement UMR 6134 SPE | cnrs

Inria

FireCaster.org
Wildfire research so hot that it burns numbers in your supercomputer

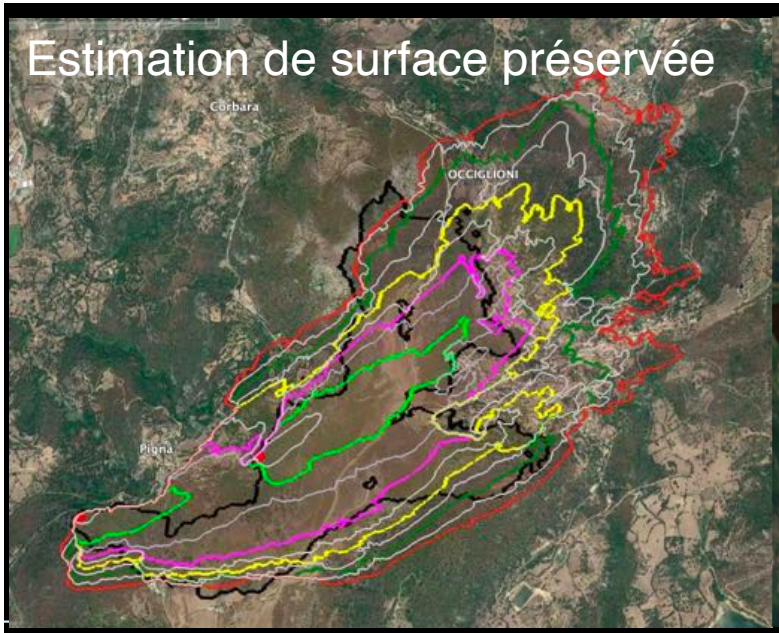
METEO FRANCE

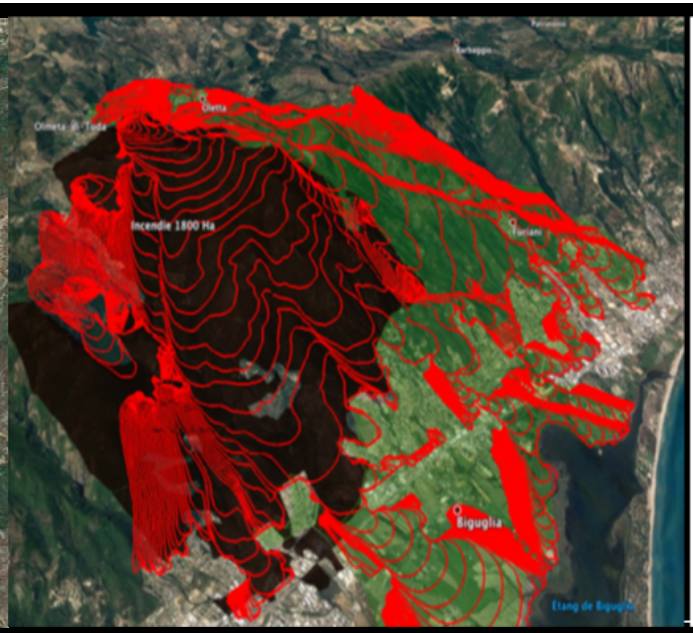
FIRE-RES

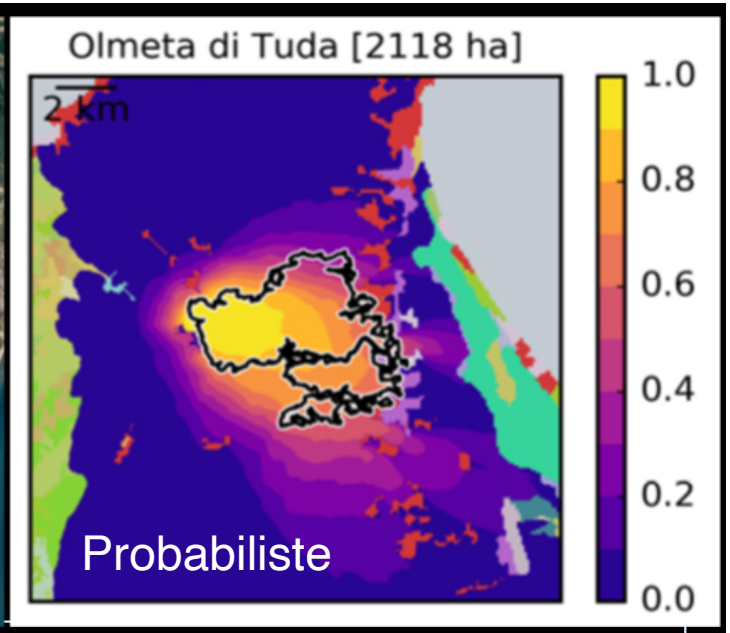
Laero

anr

https://www.youtube.com/@firecaster42

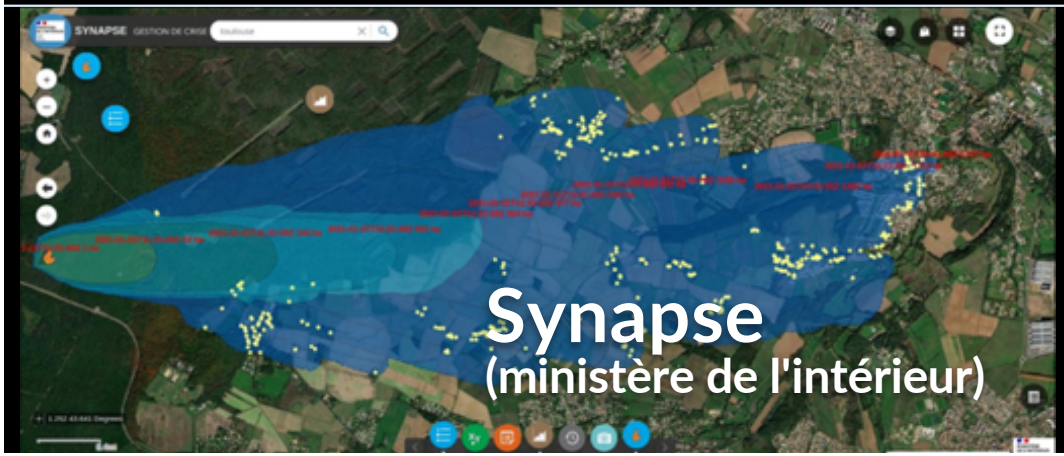


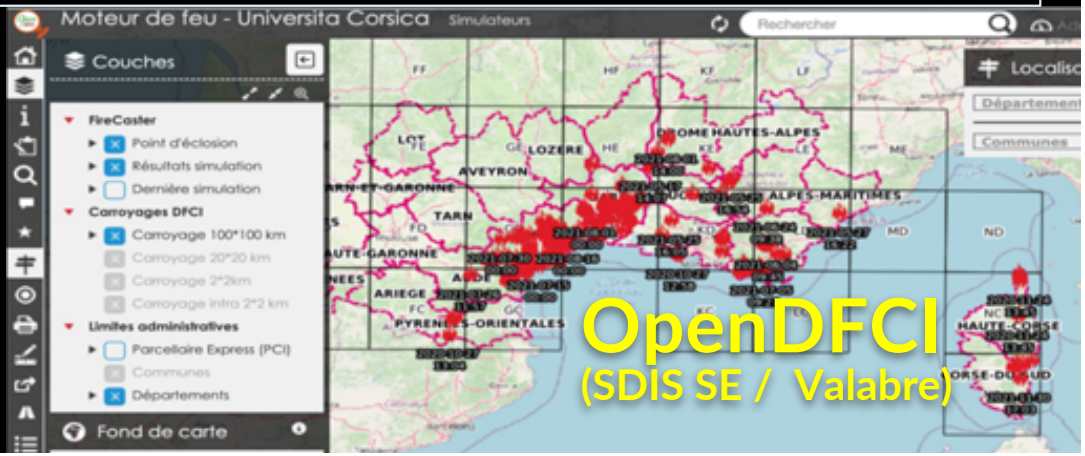




Code CNRS Università di Corsica, ouvert et libre https://github.com/forefireAPI

Simulation à 20m de résolution en Europe, moins de 10 seconde pour 1000Ha



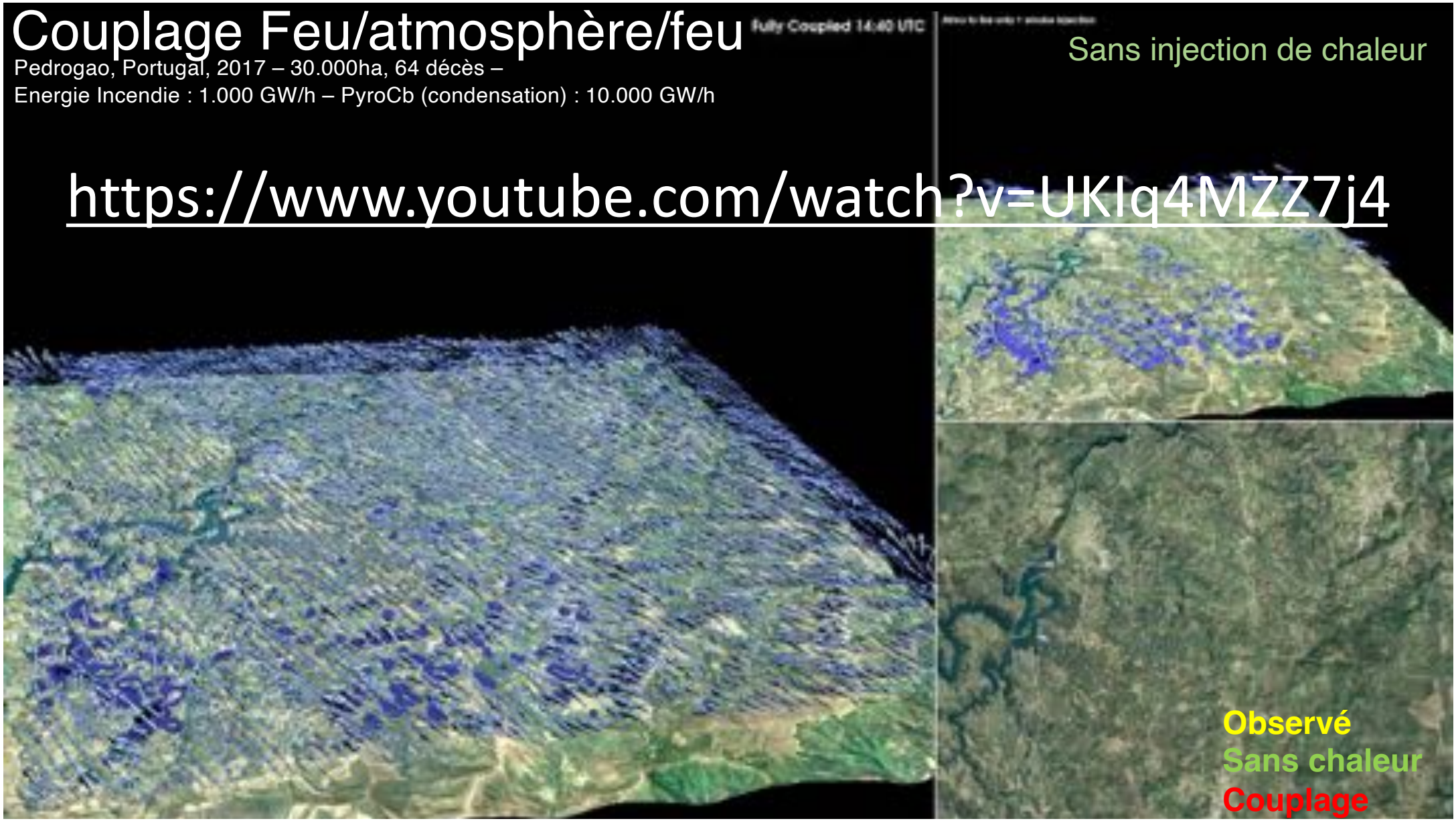



Pigna - 25-08-2023 FireCaster SIS28 Corsica Filippi / Planettes 19:00 UTC
https://www.youtube.com/watch?v=iWW_Ifk7kXc
1.7e+01
15
10
5
6.1e-01

Couplage Feu/atmosphère/feu

Pedrogao, Portugal, 2017 – 30.000ha, 64 décès –
Energie Incendie : 1.000 GW/h – PyroCb (condensation) : 10.000 GW/h

https://www.youtube.com/watch?v=UKIq4MZZ7j4




14:40 - CNRS Freecaster - J.B. Filippi
Wind m/s
0
5
10
https://www.youtube.com/watch?v=pMWuNuXDJT4

Code – Compilation Meso-NH ForeFire

Git clone + CMake

firefront / CMakeLists.txt

antonio-leblanc create .so lib with cmake ✓

Code | Blame | 16 lines (10 loc) · 422 Bytes

```
1   cmake_minimum_required(VERSION 3.10)
2   set(CMAKE_CXX_STANDARD 17)
3   set(CMAKE_CXX_STANDARD_REQUIRED ON)
4
5   project(forefire VERSION 1.0)
6
7   set(CMAKE_RUNTIME_OUTPUT_DIRECTORY  ${CMAKE_BINARY_DIR}/../bin)
8   set(CMAKE_LIBRARY_OUTPUT_DIRECTORY ${CMAKE_BINARY_DIR}/../lib)
9
10  link_libraries("-lnetcdf_c++ -lnetcdf")
11
12  file(GLOB_RECURSE SRC_FILES src/*.cpp)
13
14  add_executable(forefire ${SRC_FILES})
15
16  add_library(forefireL SHARED ${SRC_FILES})
```

Option compilation

```
102 #  FOREFIRE
103 #
104 export MNH_FOREFIRE=1.0
105 #
```

```
(base) UDC-1-0401:exe filippi_j$ ls -G
DIAG-LXgfortran-R8I4-MNH-V5-6-0-FF-MPIAUTO-O2
LATLON_TO_XY-LXgfortran-R8I4-MNH-V5-6-0-FF-MPIAUTO-O2
LFI2CDF-LXgfortran-R8I4-MNH-V5-6-0-FF-MPIAUTO-O2
MESONH-LXgfortran-R8I4-MNH-V5-6-0-FF-MPIAUTO-O2
MNH2LPDM-LXgfortran-R8I4-MNH-V5-6-0-FF-MPIAUTO-O2
PREP_IDEAL_CASE-LXgfortran-R8I4-MNH-V5-6-0-FF-MPIAUTO-O2
PREP_NEST_PGD-LXgfortran-R8I4-MNH-V5-6-0-FF-MPIAUTO-O2
PREP_PGD-LXgfortran-R8I4-MNH-V5-6-0-FF-MPIAUTO-O2
PREP_REAL_CASE-LXgfortran-R8I4-MNH-V5-6-0-FF-MPIAUTO-O2
PREP_SURFEX-LXgfortran-R8I4-MNH-V5-6-0-FF-MPIAUTO-O2
SPAWNING-LXgfortran-R8I4-MNH-V5-6-0-FF-MPIAUTO-O2
SPECTRE-LXgfortran-R8I4-MNH-V5-6-0-FF-MPIAUTO-O2
ZOOM_PGD-LXgfortran-R8I4-MNH-V5-6-0-FF-MPIAUTO-O2
libForeFire.so
(base) UDC-1-0401:exe filippi_j$ pwd
/Users/filippi_j/soft/MNH-V5-6-0/exe
```

Copie shared lib

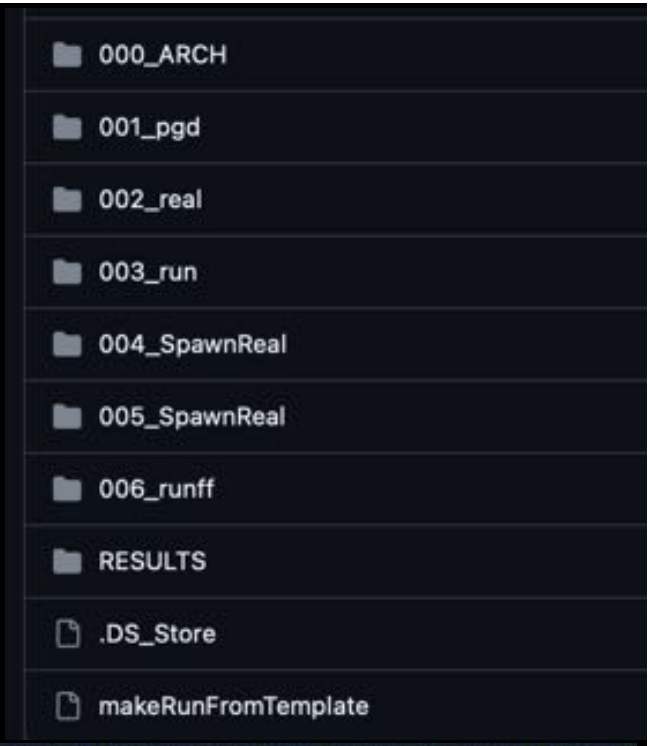
Génération de cas

Copier tools/sampleUses.py

```
orig = "/scratch/filippi_j/"
toulouse20190814 = {
    "run_info": {
        "start_time": "2019-08-14T10:00:00",
        "end_time": "2019-08-15T03:00:10",
        "latitude_center": 44.43,
        "longitude_center": 0.48590,
        "XOR1TO2": 46,
        "YOR1TO2": 46,
        "XOR2TO3": 60,
        "YOR2TO3": 60
    },
    "ignitions": [
        {"when": "2019-08-14T14:10:00", "latitude": 44.43, "longitude": 0.48222},
        {"when": "2019-08-14T14:20:00", "latitude": 44.43, "longitude": 0.48322}
        ],
    "case_path": "%s/"%orig,
    "template_path": "3nestFFCASE",
```

Template 3nest

+ mars request (here doc)



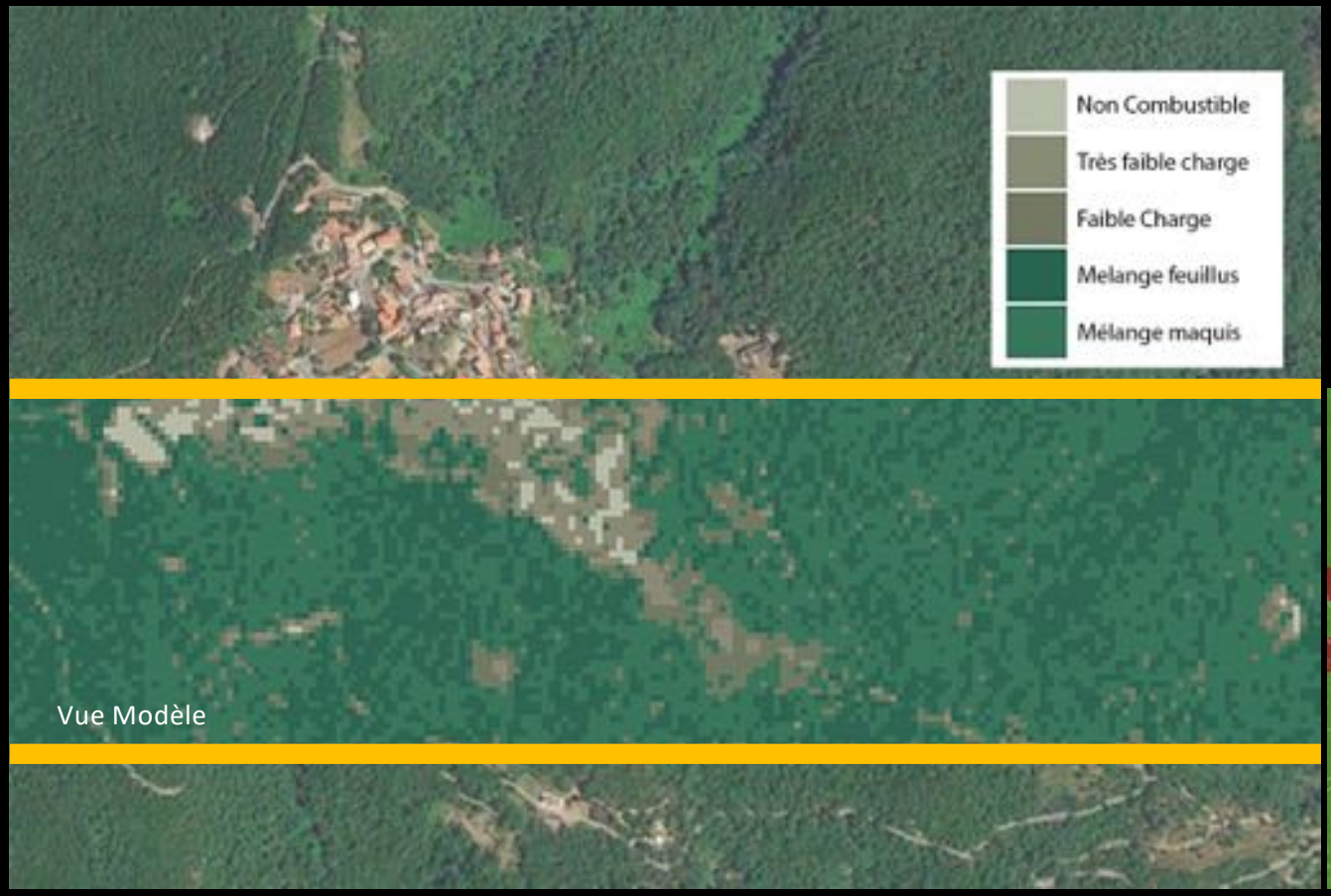
Génération de script automatique modèle atmosphérique

```
In [60]: runfile('/Users/filippi_j/soft/firefront/tools/sampleUses.py', wdir='/Users/filippi_
soft/firefront/tools')
Reloaded modules: preprocessing.geo_to_kml, preprocessing.ffToGeoJson,
preprocessing.prealCF2Case, preprocessing, preprocessing.learnFuelTifPng
# Fire at date 20190814, ignition at time 2019-08-14 14:10:00
# Run from 2019-08-14T10:00:00 to 2019-08-15T03:00:10
# First domain running alone from 09 to 15
# Domain 2 and 3 starting at time 13 that is hourly step 4 of run1 that started at 09
# Domain 1-2-3 starting at time 13 (file init 4) using PREAL BC from 12 to 27 inited at 09
# Configuration files generation script :
cp -r /scratch/filippi_j//firecaster/2023/nest150Ref /scratch/filippi_j//
cd /scratch/filippi_j//
cd 001_pgd/ ; bash MAKE_PGD 44.43 0.4859 46 46 60 60
cd ../002_real/ ; bash MAKE_PREAL 09 27 20190814
cd ../003_run/ ; bash MAKE_RUN1 9 15 20190814
cd ../004_SpawnReal/ ; bash MAKE_SPAWNREAL 4 20190814 13
cd ../005_SpawnReal/ ; bash MAKE_SPAWNREAL23 20190814 13
cd ../006_runff/ ; bash MAKE_RUNFF 20190814 12 27 4 13
```

Un problème de Combustible

```
model = tf.keras.Sequential([
    tf.keras.layers.Dense(32, activation='relu', input_shape=(tiff_data.shape[1],)),
    tf.keras.layers.Dense(32, activation='relu'),
    tf.keras.layers.Dense(inimagedata.shape[1], activation='softmax')
])
model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])
```

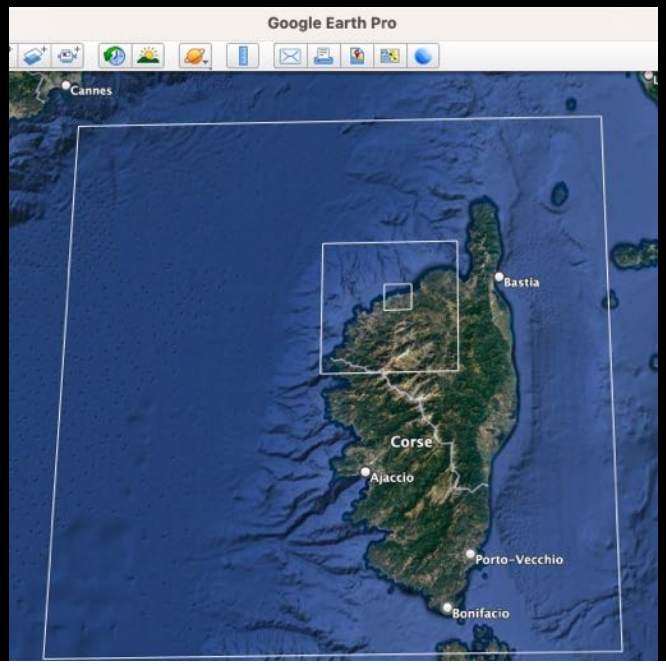
```
if gen_fuel_map:
    from preprocessing.learnFuelTifPng import makeFuelMapFromPgd
    print(PGDFILES[-1])
    makeFuelMapFromPgd(PGDFILES[-1],fuel_TIF_path,fuel_png_path,fuel_kml_path)
```

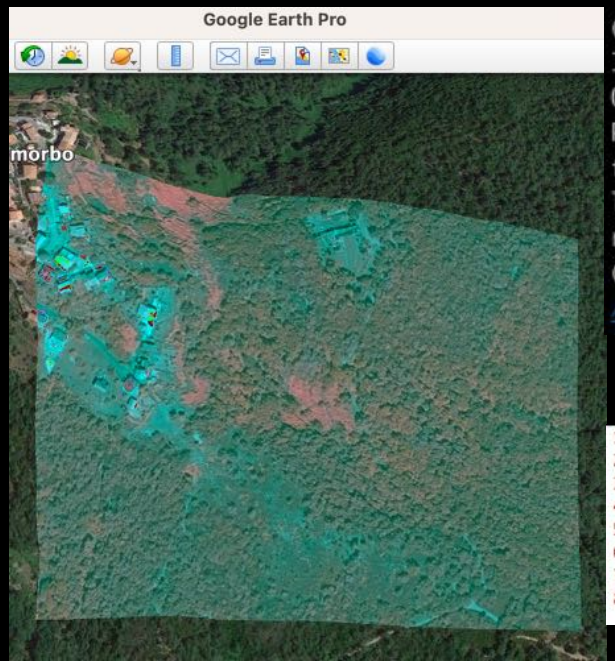


- Traitement image aérienne /
- Résolution 5/10 mètres
- 5 classes de combustible
- Sècheresse haute/moyenne/basse
- Code et modèle pré-entrainé (keras) dans répertoire tools/
- Outils pour entrainer soi même son modèle

Génération de « paysage » à partir de fichier atmo

```
if gen_domain_kml:
    from preprocessing.kmlDomain import pgds_to_KML
    pgds_to_KML(PGDFILES,OUTKMLDOMAINFILE)

if gen_FAF_case:
    from preprocessing.prealCF2Case import PGD2Case
    from preprocessing.ffToGeoJson import ffFromPgd
    domTime = datetime.fromisoformat(CAST['run_info']['start_time'])
    PGD2Case(PGDFILES[-1],fuel_png_path,UnCoupledLandscape_path, domTime)
    with open(initff_path, 'w') as file:
        file.write(ffFromPgd(PGDFILES[-1],domainDate=domTime,ignitions = CAST['ignitions']))
```






```
(base) UDC-1-0401:ForeFire filippi_j$ ls -1
Init.ff
Outputs
Params.ff
fuels.ff
land.nc
run.ff
(base) UDC-1-0401:ForeFire filippi_j$ pwd
/Users/filippi_j/data/2023/toulouse/006_runff/ForeFire
```

```
1 ireDomain[sw=(114480,114480.000000,0);ne=(126640.000000,126640.000000,0);t=43000]
2 startFire[loc=(116000.0,117520.0,0.);t=43000.0]
3 startFire[loc=(117520.0,117520.0,0.);t=43000.0]
4 startFire[loc=(119040.0,117520.0,0.);t=43000.0]
5 startFire[loc=(120560.0,117520.0,0.);t=43000.0]
6 startFire[loc=(122080.0,117520.0,0.);t=43000.0]
7 startFire[loc=(123600.0,117520.0,0.);t=43000.0]
8 startFire[loc=(125120.0,117520.0,0.);t=43000.0]
```

RUN atm-fire

```
(base) UDC-1-0401:ForeFire filippi_j$ cat run.ff
setParameters[ForeFireDataDirectory=.;fireOutputDirectory=
include[Params.ff]
setParameters[atmoNX=152;atmoNY=152]
setParameters[windU=0;windV=5]
include[Init.ff]
step[dt=720]
print[]
save[]
(base) UDC-1-0401:ForeFire filippi_j$ forefire -i run.ff
```

```
0x0layer for normal wind doesn't rely on existing windU and windV lay
Creating netCDF file: /Users/filippi_j/data/2023/toulouse/006_runff/F
FireDomain[sw=(114480,114480,0);ne=(126640,126640,0);t=43720]
       FireFront[id=2;domain=0;t=43000]
              FireNode[domain=0;id=4;fdepth=20;kappa=0.162633;loc=(
              FireNode[domain=0;id=152;fdepth=20;kappa=0;loc=(11600
              FireNode[domain=0;id=140;fdepth=20;kappa=-0.000194858
              FireNode[domain=0;id=6;fdepth=20;kappa=0.111274;loc=(
              FireNode[domain=0;id=144;fdepth=20;kappa=2.19575e-13;
              FireNode[domain=0;id=138;fdepth=20;kappa=-0.000402137
              FireNode[domain=0;id=8;fdepth=20;kappa=0.11779;loc=(1
              FireNode[domain=0;id=10;fdepth=20;kappa=0.00204882;lo
```

```
46 &NAM_CONFn NSV_USER=1
47 /
48 &NAM_FOREFIRE   LFOREFIRE=T, COUPLINGRES=200,
49                        NFFSCALARS=1, FFSVNAMES(1)='BRatio',
50                        FFOUTUPS(1)=300, PHYSOUT(1)=1, FLOWOUT(1)=1, CHEMOUT(1)=0
51                        FFOUTUPS(2)=120, PHYSOUT(2)=1, FLOWOUT(2)=1, CHEMOUT(2)=0
52                        FFOUTUPS(3)=20, PHYSOUT(3)=1, FLOWOUT(3)=1, CHEMOUT(3)=0
53 /
```

fire-atm-fire

```
17 . ~/runMNH
18 rm -rf MODEL1/*
19 rm -rf MODEL2/*
20 rm -rf MODEL3/*
21 rm -rf vtkout1/*
22 rm -rf vtkout2/*
23 rm -rf vtkout3/*
24 rm -rf ForeFire/Outputs/*
25 rm -rf parallel/*.domain*
26 rm -rf parallel/1/*
27 rm -rf parallel/0/*
28 rm -rf OUTPUT*
29 export MPIRUN="mpirun -np 8"
30 time ${MPIRUN} MESONH${XYZ}
```

Mode interactif pour regarder les sorties pendant le run (plotFire.py)

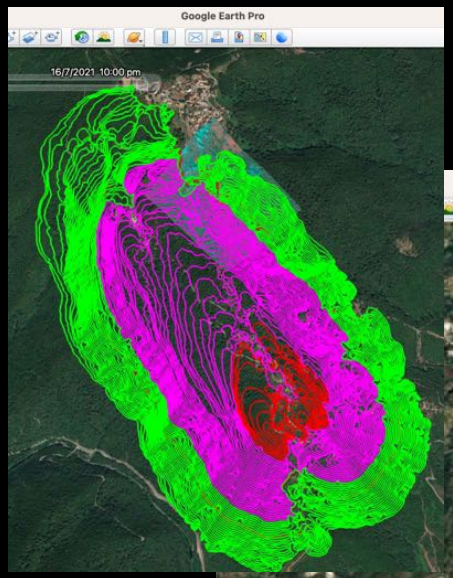
Fonctionne très bien sur MacARM ! (même cas 3 nest / 8 cpus)

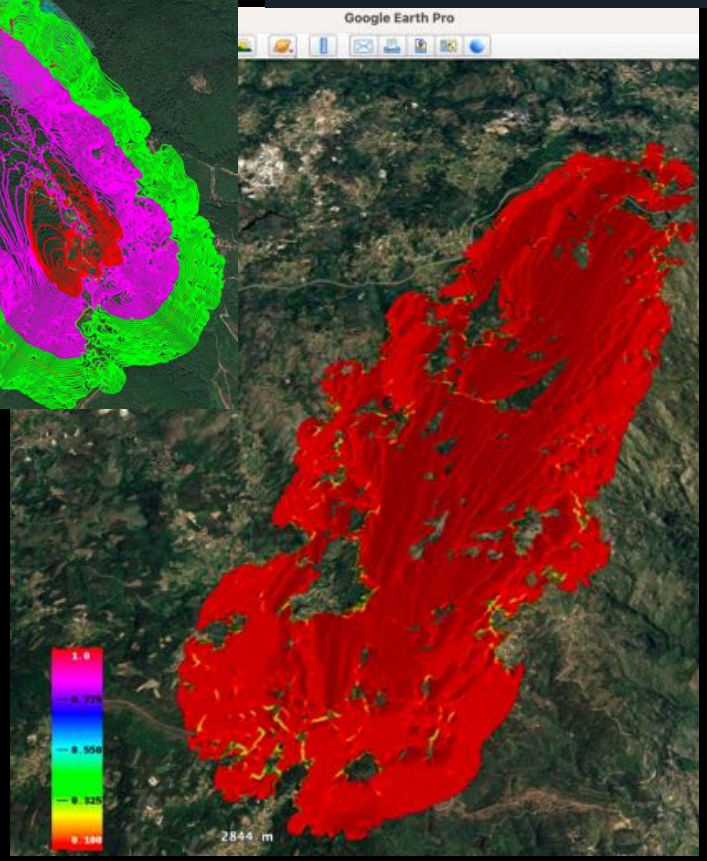
fire-atm

Set heat & vapor flux = 0

```
setParameters[ForeFireDataDirectory=ForeFire;fireOutputDirectory=ForeFire/Outputs;atmoOutputDirectories=MO
pdate=20]
setParameters[NetCDFfile=land.nc;fuelsTableFile=fuels.ff;fluxNetCDFfile=land.nc]
setParameters[relax=0.8;smoothing=4]
setParameter[spatialIncrement=0.2]
setParameter[minimalPropagativeFrontDepth=20]
setParameter[perimeterResolution=8]
setParameter[propagationModel=Rothermel]
setParameter[propagationSpeedAdjustmentFactor=0.5]
setParameter[windReductionFactor=0.5]
setParameter[minSpeed=0.01]
setParameters nominalHeatFlux=50000.;burningDuration=200;nominalVaporFlux=0.005;burningTresholdFlux=1.0]
```

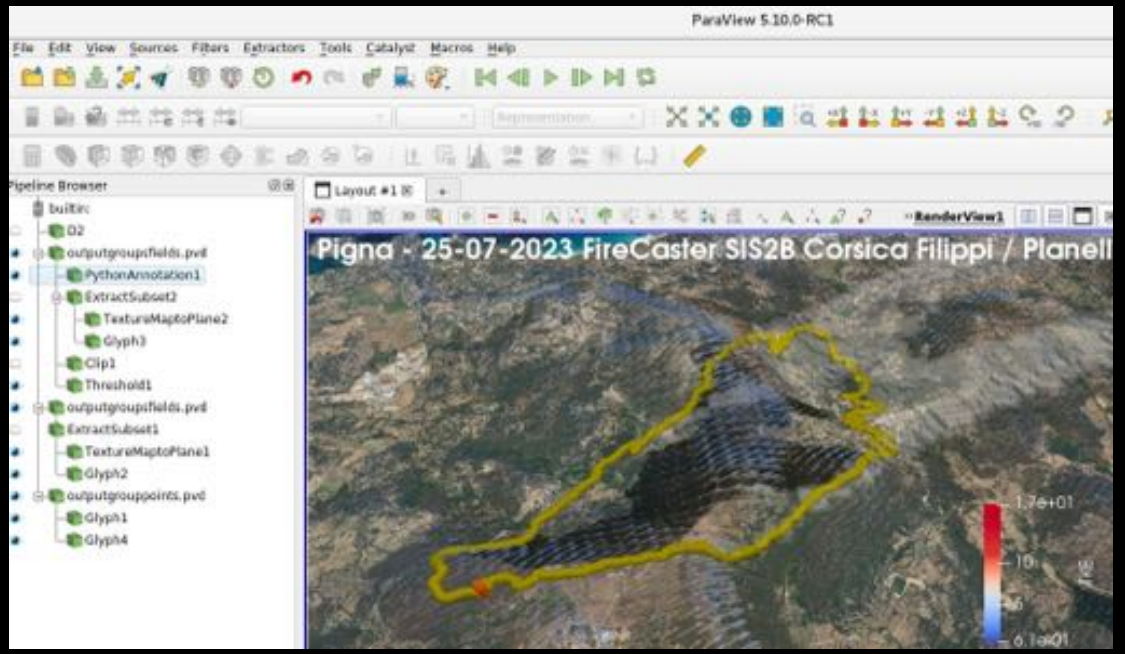
Post-Processing. – Python, GIS, Paraview en batch





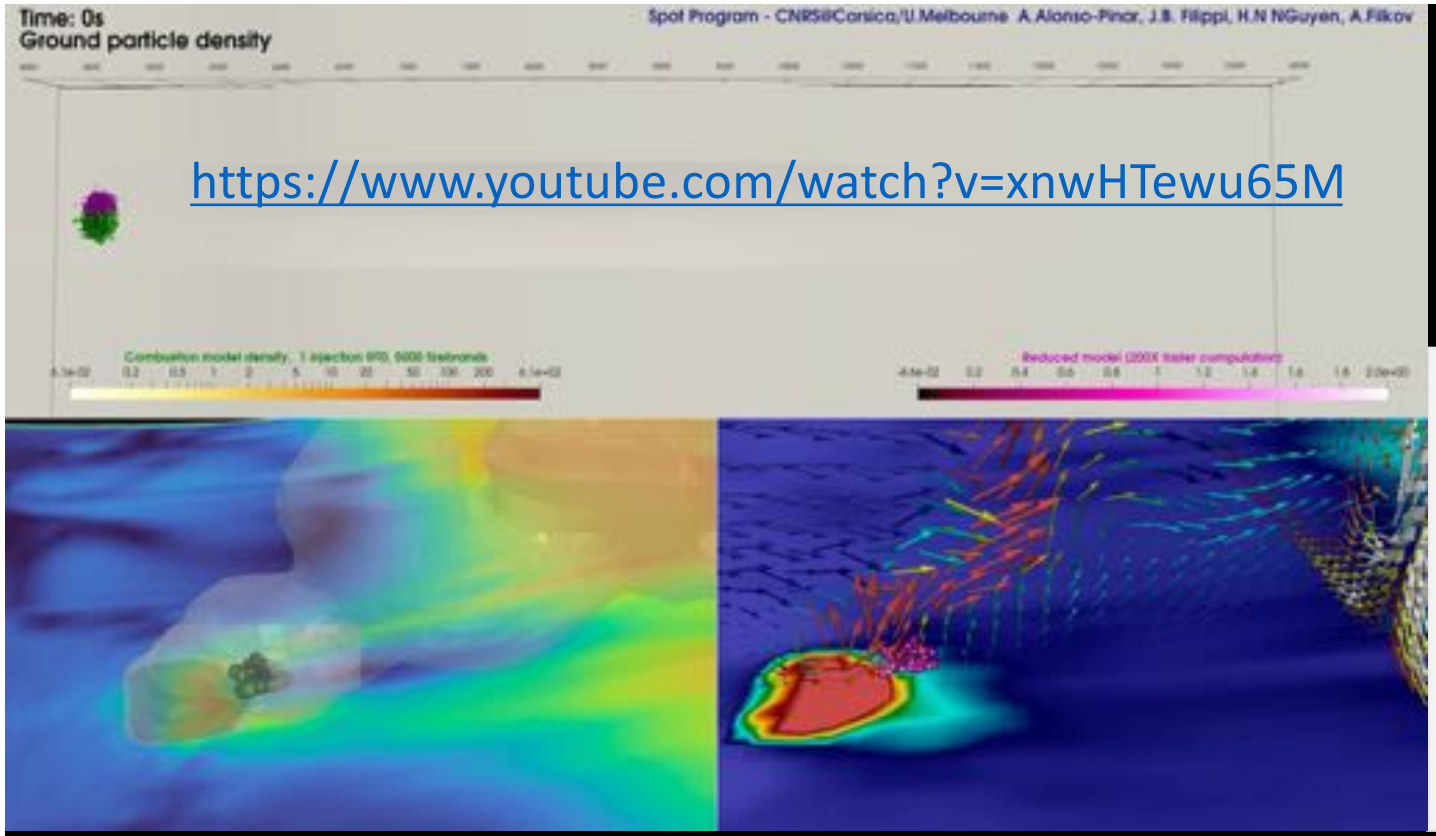

```python
if gen_3D_VTK_OUT:
    from postprocessing.pMNHFF2VTK import ffmnhFileToVtk, ffFrontsToVtk
    ffmnhFileToVtk(inpattern = MODELOUTPATTERN[1],pgdFile = PGDFILES[1],outPath = FFOUTVTKPATH[1])

if gen_KML_OUT:
    from preprocessing.ffToGeoJson import genKMLFiles
    genKMLFiles(PGDFILES[-1], BMAPFILE, FFINPUTPATTERN, BMAPKMLOUT,frontsKMLOUT, everyNFronts=6, change_color_every=30)
```

Fichiers 2D GeoJSON + KML (puissance, fronts)
Fichiers VTK PVBatch Paraview -> animation mp4



Post-Processing. – Réalité Virtuelle

https://forefire.univ-corse.fr/firecaster-vr/



Sautes de feu pour 2025 A.Pinar / Ninh Nguyen
2 co-tutelles PhD
CNRS Corse/Australie

FIRE-RES

Autres ?

WRF-SFIRE, ACCESS-FIRE (Aus). ForeFire/Meso-NH seul code couplé incendie européen. MNH-Blaze Fortran.

Coût ?

120 cpus, 50m de résolution : 10 heures d'incendie en 4 heures de calcul

Où ?

Programme EU Fire-Res + Evora, test dans toute l'Europe cet été en «Code rouge»

Problèmes ?

Parallélisation peu efficace, modèles de ROS, récupération de données