Visualize Wildfire Spread Progress in Valley

Po-Jen Hsu (hsu248@purdue.edu)
Shuang Wu (wu1716@purdue.edu)

IEEE 2022 SciVis Contest Datasets

3 set of wildfire simulation

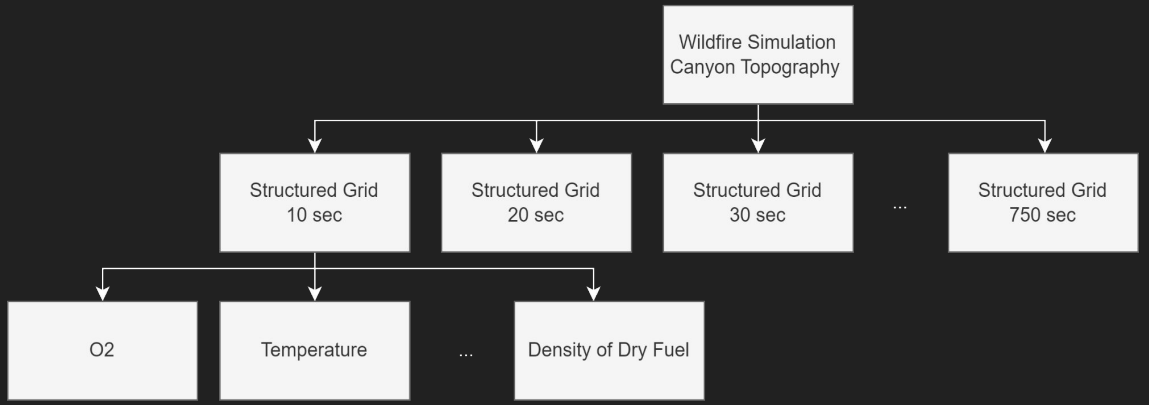
- Two different mountain topographies (back curve & head curve)
- A canyon topography - Las Conchas Fire (June 29, 2011 @ New Mexico)

Each dataset has a 750-second simulation

- Samples in every ten second
- 75 Structured Grid files

Each Structured Grid file

- 9 scalar fields



Scalar Fields in Dataset

Scalar Fields	Meanings	Visualization Object
o2	**oxygen concentration**	**Wind**
convht_1	convective heat transfer (W/m^3)	
frhosiesrad_1	fire-induced radiative heat transfer to the fuels (W/m^3)	
rhof_1	**bulk density of dry fuel (kg/m^3)**	**Vegetation**
rhowwatervapor	bulk density of the moisture released to the atmosphere as a result of fire (kg/m^3)	
theta	**potential temperature (K)**	**Fire**
u, v, w	**Three component vectors of wind**	**Wind**

Problem Statement

1) Discover the location of fire (Static)

    Visualize Fire (Flame & Smoke)

    Visualize Vegetation

    Visualize Wind

2) Observe the movement of Las Conchas Fire (Dynamic)

    Spread progress

Preprocessing

Original Structured Grid file is about 1GB

Extracted Structured Grid file (2x MB)

- Extract region of interest & downsampling
- Remove unwanted scalar fields
- Convert to Image Data file for Fire Volume Rendering

Visualization Method - Fire

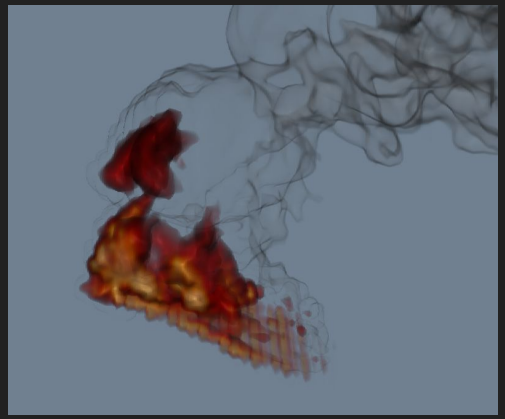
Volume Rendering (slow)

Transfer Function:

Smoke: 310K

Flame: 400K ~ 800K

Linearly increase alpha (0.1 ~ 0.5)



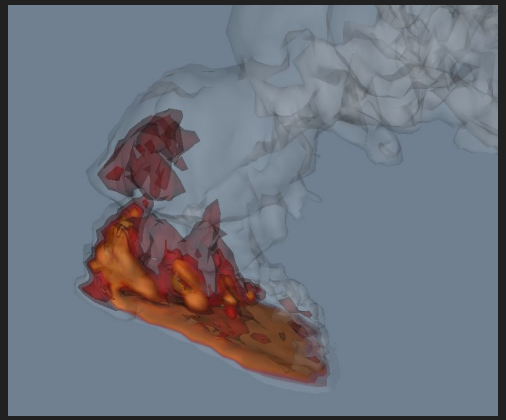
Isosurfacing (fast)

Isovalues:

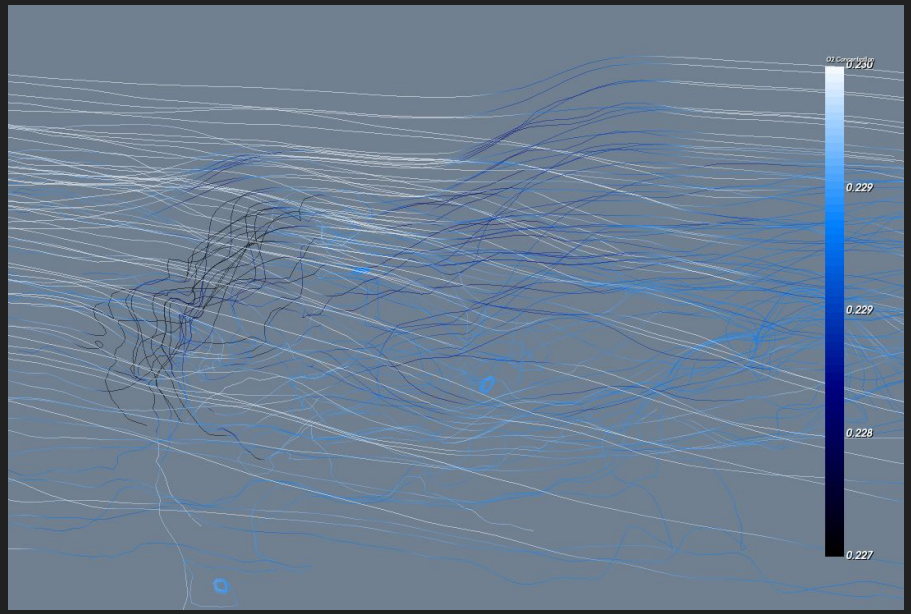
Smoke: 310K

Flame: 400K, 500K, …, 800K

Linearly increase alpha (0.5 ~ 0.7)

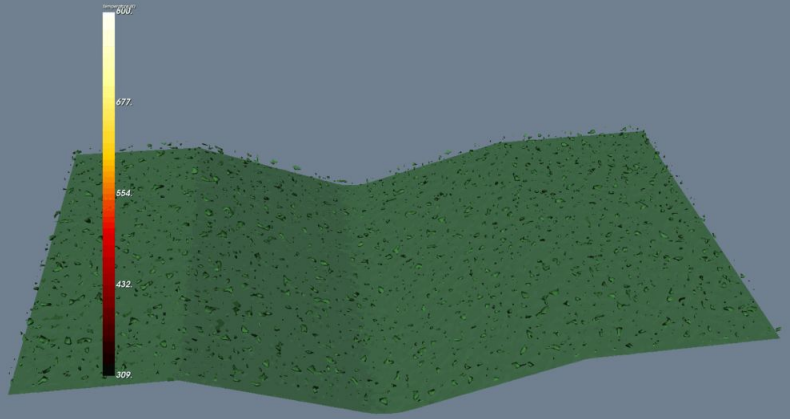


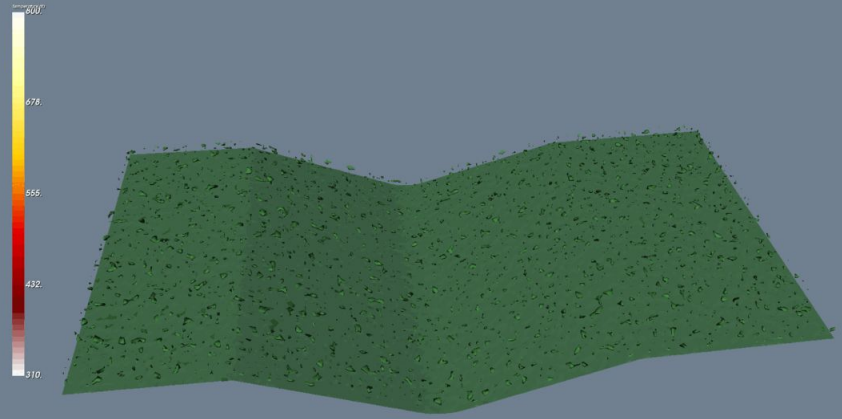
Visualization Method - Wind

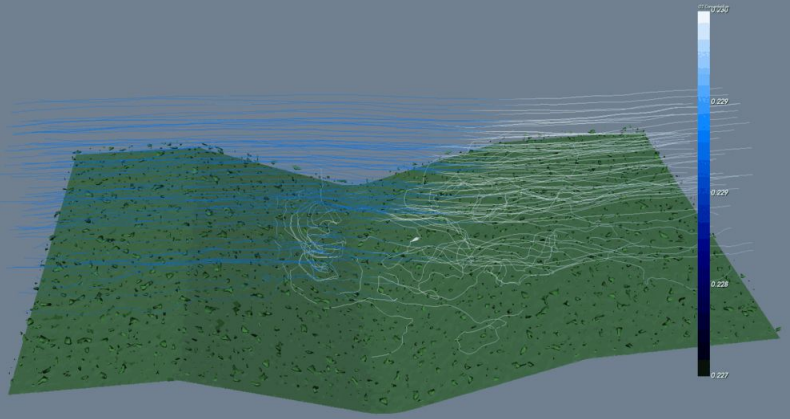


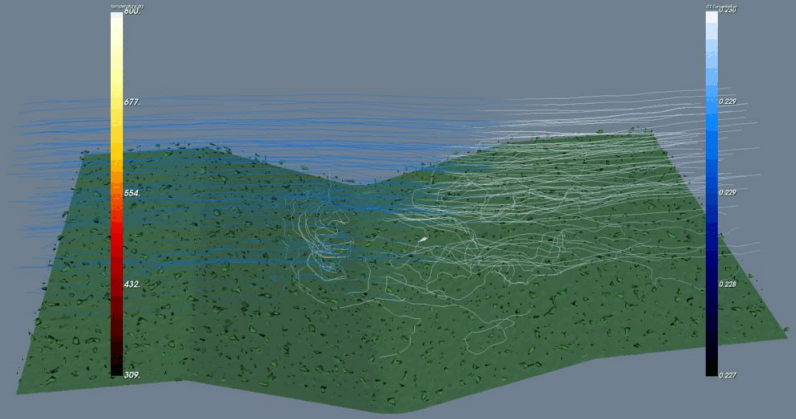
- Apply 100 streamlines
- Set the source around the ignition point
- Propagate in both directions
- Map colors to
  - oxygen concentration
  - velocity

Visualization Result



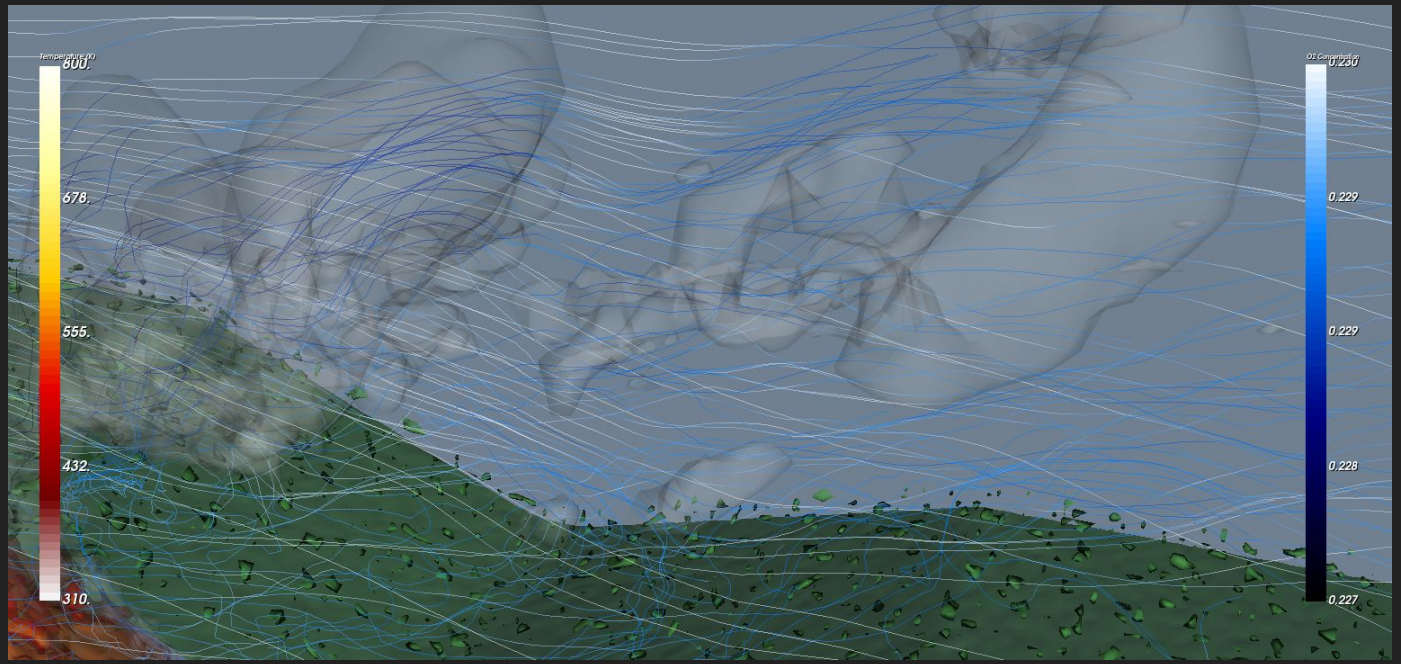






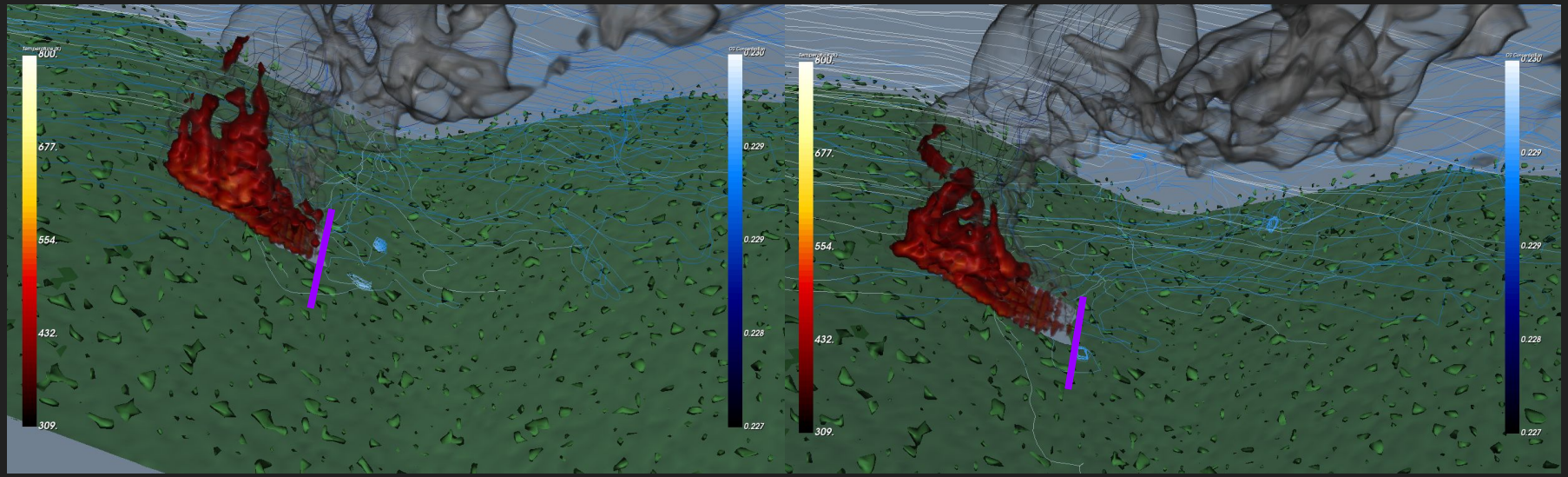
Insight

The location of smoke plumes has relatively lower oxygen concentration



Insight

Stagnant air in the valley with low oxygen concentration limits the flame direction



Insight

The vegetation density indicates the trail of the flame

Strong wind on the hill forces the flame to split and turn its progress direction