QUIC-Fire Output File Description

Sara Brambilla, Rod R. Linn, and Michael J. Brown

Los Alamos National Laboratory

November 16, 2022

LA-UR-22-30570

Table of Contents

Wind only simulation

File name	File type	Write Statement	Units
QU_velocity.bin	Binary	Layer VEL(:,:,1) is in the ground and is all zeros. Velocity are cartesian components. Data (INT): header 1 U(qugrid%nx, qugrid%ny, qugrid%nz+1) Data (INT): header 2 Data (INT): header 1 V(qugrid%nx, qugrid%ny, qugrid%nz+1) Data (INT): header 2 Data (INT): header 1 W(qugrid%nx, qugrid%ny, qugrid%nz+1) Data (INT): header 1 Repeat for all the win time steps in QU_simparams.inp	[m/s]

Fire simulation

Unless otherwise specified, binary files have headers (INT32) between different record. Hence, if the variable “a”, defined as:

```
real, dimension(7) :: a
```

is written, the file size will be:

4 bytes (starting header) + 4 bytes (REAL) * 7 (number of elements) + 4 bytes (closing header) = 4 + 28 + 4 = 36 bytes

1.1 Simulation info

File name	File type	Write Statement	Units
fire_indexes.bin	Binary	Data 1 (INT): header Data 2 (INT): number of cells with fuel (var name: firegrid%num_fuel_cells = nfuel below) Data 3 (INT): max index of the cells with fuel in the vertical direction Data 4-(nfuel+3) (INT): unique cell identifiers (firegrid%num_fuel_cells) Data (nfuel+4)-(2*nfuel+4) (INT): i,j,k cell indexes Data (INT): header	
grid.bin	Binary	File describing the grids used in QUIC-Fire. 1. QUIC-URB cell bottoms, starting from the ground (i.e., first value is zero) in meters (qugrid%nz+2) 2. QUIC-URB cell middle point, starting from the ½ cell below the ground in meters (qugrid%nz+2) 3. If there is topo: a. QUIC-URB sigma levels bottoms, starting from the ground (i.e., first value is zero) in meters (qugrid%nz+2) b. QUIC-URB sigma levels middle point, starting from the ½ cell below the ground in meters (qugrid%nz+2) c. QUIC-URB cell bottoms total elevation in meters defined as: terrain elevation – minimum terrain elevation + cell bottom above ground. 3D array (qugrid%nx, qugrid%ny, qugrid%nz+2) d. QUIC-URB cell middle point relative to the ground in meters. 3D array (qugrid%nx, qugrid%ny, qugrid%nz+2) e. QUIC-URB cell volume correction in presence to terrain, non-dimensional (qugrid%nx, qugrid%ny) 4. If there is fire: a. Number of cells in the vertical used to allocate and compute fire%energy_to_atmos b. FireCA energy to atmosphere vertical cell size in meters (fire%energy_to_atmos)	See description
QF_elevation.bin	Binary	Elevation map after smoothing and interpolation + derivative infos	See description

		Data 1 (INT): header Minimum terrain elevation [m] Data 2 (INT): header Terrain elevation – minimum terrain elevation [m], with ghost cells around the border. Size (qugrid%nx+2, qugrid%ny+2) Data 2 (INT): header Terrain first derivative with respect to x [m/m] Data 2 (INT): header Terrain first derivative with respect to y [m/m] Data 1 (INT): header	
timelog.log	Text	Simulation infos including runtime	-

1.2 Buoyant plumes

File name	**File type**	**Write Statement**	**Units**
plume_trajectory.bin	Binary	For each plume write (one header in the beginning and one at the end) • Plume id [-] INT • Simulation time [s] INT • Plume age [s] INT • Plume trajectory coordinate x [m] REAL • Plume trajectory coordinate y [m] REAL • Plume trajectory coordinate z [m[REAL • Plume trajectory u-velocity [m/s] REAL • Plume trajectory v-velocity [m/s] REAL • Plume trajectory w-velocity [m/s] REAL • Plume radius in the horizontal plane [m] REAL (rh) • Plume base vector for rh (3 components) [m] REAL • Plume radius in the plume plane, perpendicular to rh [m] REAL (rn) • Plume base vector for rn (3 components) [m] REAL • From which subroutine the write statement was invoked	See description
plume_trajectory.csv	CSV	Columns 1. Plume id [-] INT	See description

		2. Simulation time [s] INT 3. Plume age [s] INT 4. Plume trajectory coordinate x [m] REAL 5. Plume trajectory coordinate y [m] REAL 6. Plume trajectory coordinate z [m[REAL 7. Plume trajectory u-velocity [m/s] REAL 8. Plume trajectory v-velocity [m/s] REAL 9. Plume trajectory w-velocity [m/s] REAL 10. Plume radius in the horizontal plane [m] REAL (rh) 11. Plume base vector for rh (3 components) [m] REAL 12. Plume radius in the plume plane, perpendicular to rh [m] REAL (rn) 13. Plume base vector for rn (3 components) [m] REAL 14. From which subroutine the write statement was invoked	
plume_mergetrajectory.bin	Binary	Plume merge information (one header in the beginning and one at the end): • ID of the plume being merged [-] INT • ID of the new merged plume [-] INT • Time of merging [s] INT	See description
plume_mergetrajectory.csv	CSV	Plume merge information, columns: 1. ID of the plume being merged [-] INT 2. ID of the new merged plume [-] INT 3. Time of merging [s] INT	See description

1.3 Diagnostics

File name	**File type**	**Write Statement**	**Units**
fire_front_distance.csv	CSV	Times at which user specified distances are reached by the fire front (see QFire_FireFrontDistances.inp) Row 1: Column 1: String (Ignition center x [m]) Column 2: Center of the ignitions in the x-direction	See description

		Row 2: Column 1: String (Ignition center y [m]) Column 2: Center of the ignitions in the y-direction Row 3: Column 1: String (Ignition center UTM-x [m]) Column 2: Center of the ignitions in the x-direction in UTM coordinates Row 4: Column 1: String (Ignition center UTM-y [m]) Column 2: Center of the ignitions in the y-direction in UTM coordinates Following rows: Column 1: String Column 2: Distance [m] Column 3: String Column 4: Time for the fire to reach the distance [s] Distances that are not reached will not be printed out	
output_times.txt	Text	List of output times per each output file category as specified in QUIC-Fire.inp and QFire_ListOutputTimes.inp. Contains for rows corresponding to: 1. Fire variables output times 2. Instantaneous QU-winds output times 3. Emissions and thermal radiation output times 4. Averaged QU-winds output times	[s]

1.4 Emissions

File name	**File type**	**Write Statement**	**Units**
co_emissions-XXXXX.bin	Binary	Mass of CO emitted between two emission file output times Compressed linear array	[g]
emissions_distribution-XXXXX.bin	Binary	Size of PM2.5 emitted between two emission file output times Two variables:	[g]

		• mu of the lognormal distribution (real, compressed linear array) • sigma of the lognormal distribution (real, compressed linear array) See https://en.wikipedia.org/wiki/Log-normal_distribution for reference	
pm_emissions-XXXXX.bin	Binary	Mass of PM2.5 emitted between two emission file output times Compressed linear array	[g]
total_emissions.csv	CSV	File summarizing the total emissions throughout the domain Column 1: Time [s] Column 1: CO emitted during between emission output times [g] Column 1: PM2.5 emitted during between emission output times [g] Column 1: Water emitted during between emission output times [g] Column 1: Total CO emitted during the simulation [g] Column 1: Total PM2.5 emitted during the simulation [g] Column 1: Total water emitted during the simulation [g]	See description
water_emissions-XXXXX.bin	Binary	Mass of water emitted between two emission file output times (fuel moisture + water from combustion) Compressed linear array	[g]

1.5 Firebrands

File name	**File type**	**Write Statement**	**Units**
firebrands.bin	Binary	Firebrand landing behavior Data 1 (INT): header Data 2 (INT): current simulation time [s] Data 3-5 (INT): i,j,k indexes of the cell on the fire grid where the firebrand tracer has been deposited Data 6 (INT): 0 = firebrands landed in cell with burning fuel 1 = firebrands landed in cell that has not burned at all 2 = firebrands landed in cell where fuel is burnt out when landing 3 = firebrands landed in cell without fuel 4 = firebrands landed in cell where fuel is burnt out after germination	See description

		5 = firebrands landed in cell with fuel but in the empty fraction Data 7 (INT): header	
firebrabrands_traj.bin	Binary	Firebrands trajectories For each firebrand: Data 1 (INT): header Data 2-4 (REAL): Firebrand's coordinates in the QUIC-domain [m] Data 5 (REAL): Firebrand's time [s] Data 6 (INT): header	See description

1.6 Fuels

File name	**File type**	**Write Statement**	**Units**
fire-energy_to_atmos-XXXXX.bin	Binary	Energy released to the atmosphere that generates buoyant plumes 3D array, extended fire grid (firegrid%nx, firegrid%ny, firegrid%nz_en2atmos) See grid.bin for firegrid%nz_en2atmos	[kW]
fire-reaction_rate-XXXXX.bin	Binary	Reaction rate Compressed linear array	[kg/m^3/s]
fuels-dens-XXXXX.bin	Binary	Fuel density Compressed linear array	[kg/m^3]
fuels-moist-XXXXX.bin	Binary	Fuel moisture content Compressed linear array	[g water/g air]
groundfuelheight.bin	Binary	2D array with fuel height in the ground layer. Size (firegrid%nx, firegrid%ny)	[m]
mburnt_integ-XXXXX.bin	Binary	2D file containing the % of mass burnt for each (i,j) location on the fire grid (vertically integrated)	[%]
totalinitialfuelheight.bin	Binary	2D array with total fuel height. Size (firegrid%nx, firegrid%ny)	[m]
total_mass_burnt.csv	CSV	File summarizing the total mass burnt throughout the domain Column 1: Time [s] Column 2: Mass burnt [kg] Column 3: Mass burnt [%]	See description

1.7 Ignitions

File name	File type	Write Statement	Units
ignite_selected.dat	Binary	Locations of the ignitions points in QUIC-Fire. Data 1 (INT): header i,j,k indexes of the cells with ignitions (INT) Data (INT): header	[-]

1.8 Start-up file

File name	File type	Write Statement	Units
qu_StartupWindXXXXXXXXXXXX.bin	Binary	Winds after mass consistency that can be used to start up simulations Data 1 (INT): header Data (REAL): u-component, QUIC-URB grid, staggered (qugrid%nx+1, qugrid%ny+1, qugrid%nz+2) Data 2 (INT): header Data (REAL): v-component, QUIC-URB grid, staggered (qugrid%nx+1, qugrid%ny+1, qugrid%nz+2) Data 2 (INT): header Data (REAL): w-component, QUIC-URB grid, staggered (qugrid%nx+1, qugrid%ny+1, qugrid%nz+2) Data 1 (INT): header	[m/s]

1.9 Thermal radiation

File name	File type	Write Statement	Units
thermaldose-XXXXX.bin	Binary	Thermal dose Compressed linear array	$[(W/m^2)^{4/3} \times s$
thermalradiation-XXXXX.bin	Binary	Thermal radiation	$[W/m^2]$

		Compressed linear array	

1.10 Winds

File name	File type	Write Statement	Units
qu_winduXXXXX.bin	Binary	u-components (3D array, QUIC-URB grid, cell centered)	[m/s]
qu_windvXXXXX.bin	Binary	v-components (3D array, QUIC-URB grid, cell centered)	[m/s]
qu_windwXXXXX.bin	Binary	w-components (3D array, QUIC-URB grid, cell centered)	[m/s]
qu_wplumeXXXXX.bin	Binary	Plumes updrafts before mass consistency (3D array, QUIC-URB grid, cell centered)	[m/s]
qu_windu_aveXXXXX.bin	Binary	Time-averaged u-components (3D array, QUIC-URB grid, cell centered)	[m/s]
qu_windv_aveXXXXX.bin	Binary	Time-averaged v-components (3D array, QUIC-URB grid, cell centered)	[m/s]
qu_windw_aveXXXXX.bin	Binary	Time-averaged w-components (3D array, QUIC-URB grid, cell centered)	[m/s]
SlopeFlowWindU.bin	Binary	u-component correction from slope-flow algorithm (3D array, QUIC-URB grid, staggered)	[m/s]
SlopeFlowWindV.bin	Binary	v-component correction from slope-flow algorithm (3D array, QUIC-URB grid, staggered)	[m/s]
SlopeFlowWindW.bin	Binary	w-component correction from slope-flow algorithm (3D array, QUIC-URB grid, staggered)	[m/s]
winduXXXXX.bin	Binary	Fire u-components, cell centered 3D array, fire grid with an extra layer at the top of the domain	[m/s]
windvXXXXX.bin	Binary	Fire v-components, cell centered 3D array, fire grid with an extra layer at the top of the domain	[m/s]
windwXXXXX.bin	Binary	Data: w-components, cell centered 3D array, fire grid with an extra layer at the top of the domain	[m/s]