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Supplementary Material

Physics-based simulations of grassfire propagation on sloped terrain at field scale: flame dynamics, mode of fire propagation and heat fluxes

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Appendix A. Supplementary document

Table S1: Thermo-physical, pyrolysis and combustion parameters for grassfire modelling

Input parameters	**Used values**	**Source and reason**
Heat of combustion	16400 $kJ.kg^{-1}$	Blustem grass (Overholt *et a*l., 2014)
Soot yield	0.008 $g.g^{-1}$	White pine (Australian Radiata pine) (Abu Bakar, 2015)
Vegetation drag coefficient	0.125	assuming vegetation elements are spherical (Morvan and Dupuy, 2004)
Vegetation load	0.283 $kg.m^{-2}$	Mell *et al.*, 2007 -experimental
Vegetation height	0.21 m	Mell *et al.*, 2007 -experimental
Vegetation moisture content	0.065	Mell *et al.*, 2007 –experimental,
Surface-to-volume ratio of vegetation	9770 m^{-1}	Mell *et al.*, 2007 -experimental
Vegetation char fraction	0.17	Average of Mell *et al*., 2007 & bluestem grass (Overholt *et al.*, 2014)
Vegetation element density	440 $kg.m^{-3}$	White pine (Australian Radiata pine) (Abu Bakar, 2015)
Ambient temperature	$32^{o}C$	Mell *et al.*, 2007 -experimental
Relative humidity	40 %	Mell *et al.*, 2007
Emissivity	0.99	Mell *et al.*, 2007
Pyrolysis Temperature	400-500K	Morvan and Dupuy,2004
Degree of curing	100	Assuming vegetation100% cured
Vegetation heat of pyrolysis (Δh_{pyr})	200 $kJ.kg^{-1}$	White pine (Australian Radiata pine) (Abu Bakar, 2015)
Maximum mass loss rate	0.15 ($kg.s^{-1}.m^{-3}$)	Mell *et al.*, 2007 -experimental, Maximum volumetric rate of fuel allowed to be pyrolysed

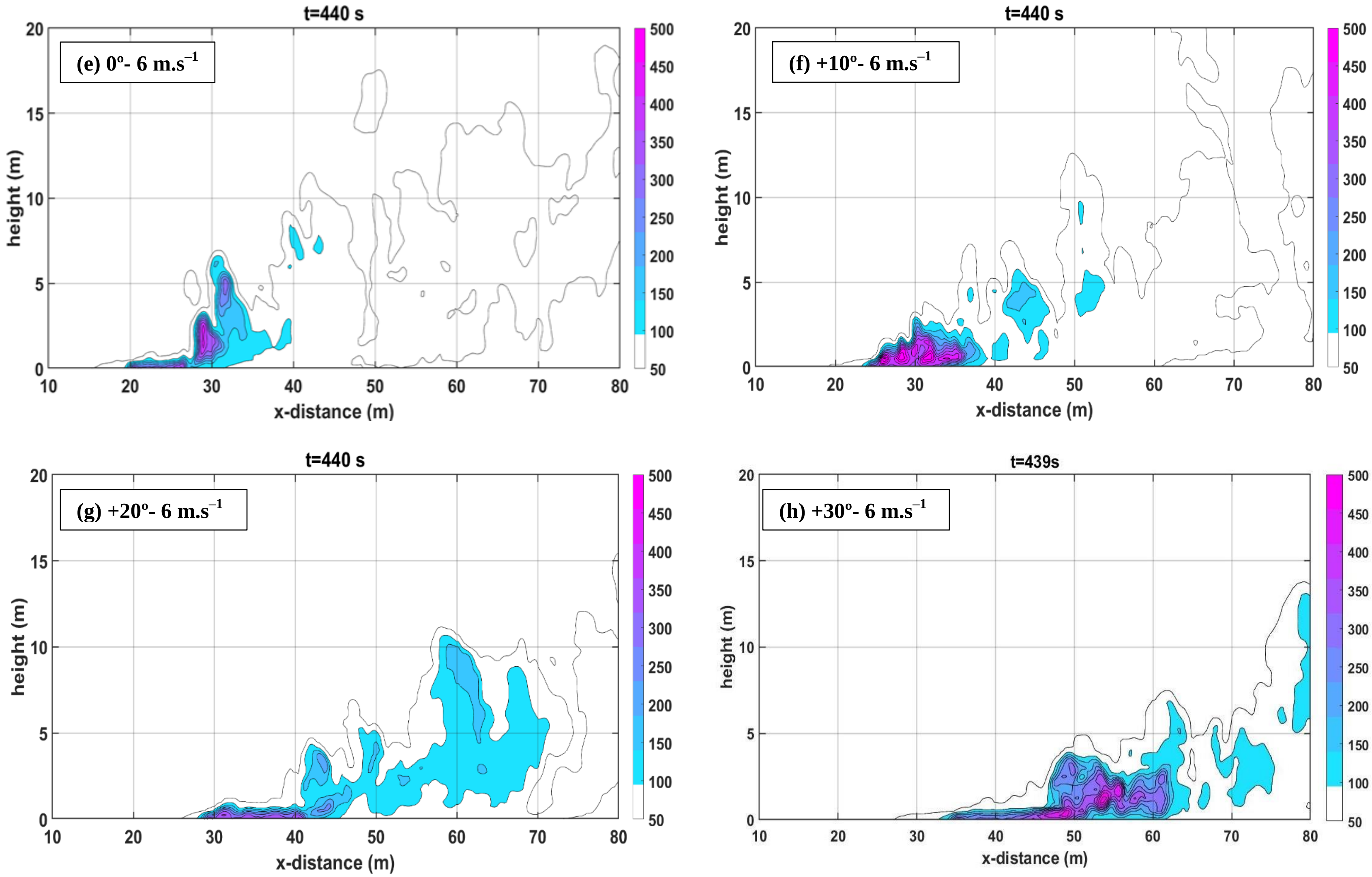


Figure *S1*: Temperature contours (representing plumes) along the geometric centreline of the grass plot, at the same instant in time (30 ± 1 s after ignition), at wind velocity 6 m.s^{-1}: Frames (e-h) 0°, +10°, +20°, +30°

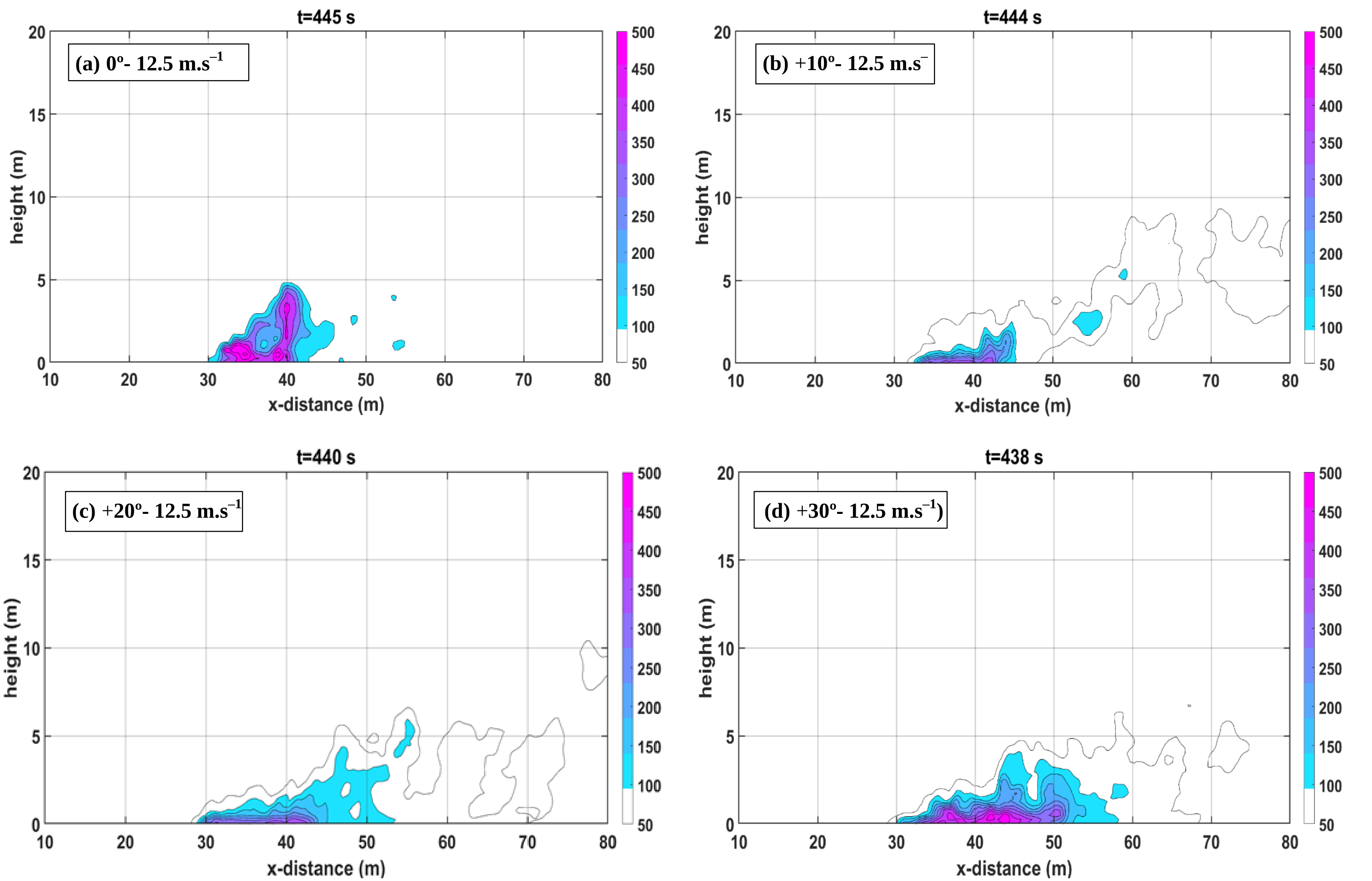


Figure S2 (a-d): Temperature contours (representing plume) at the same firefront location, at wind velocity 12.5 m.s^{-1} : 0°, +10°, +20° and +30° slopes

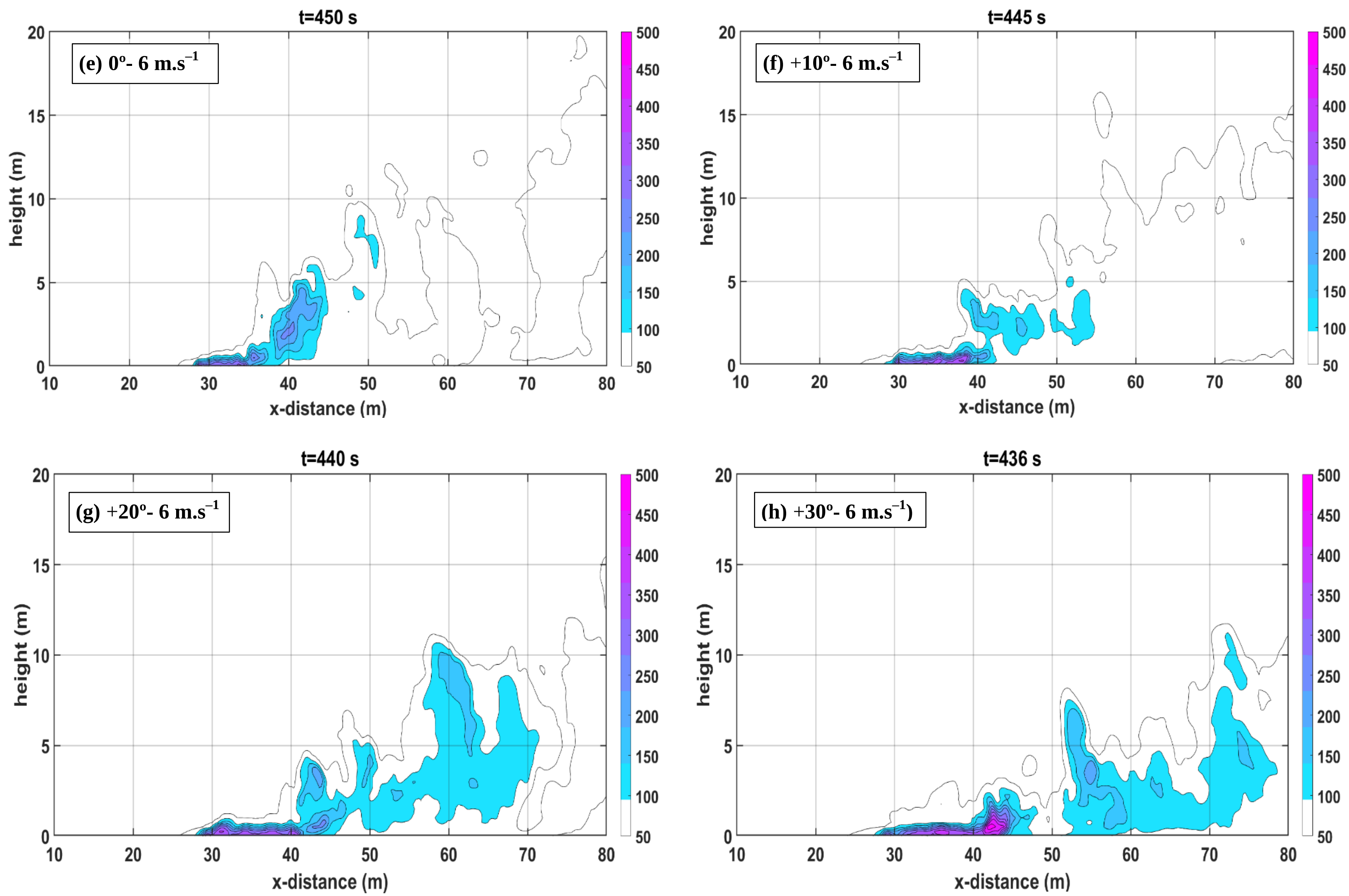


Figure S2 (e-h): Temperature contours at the same firefront location, at wind velocity 6 m.s^{-1} : 0°, +10°, +20° and +30°

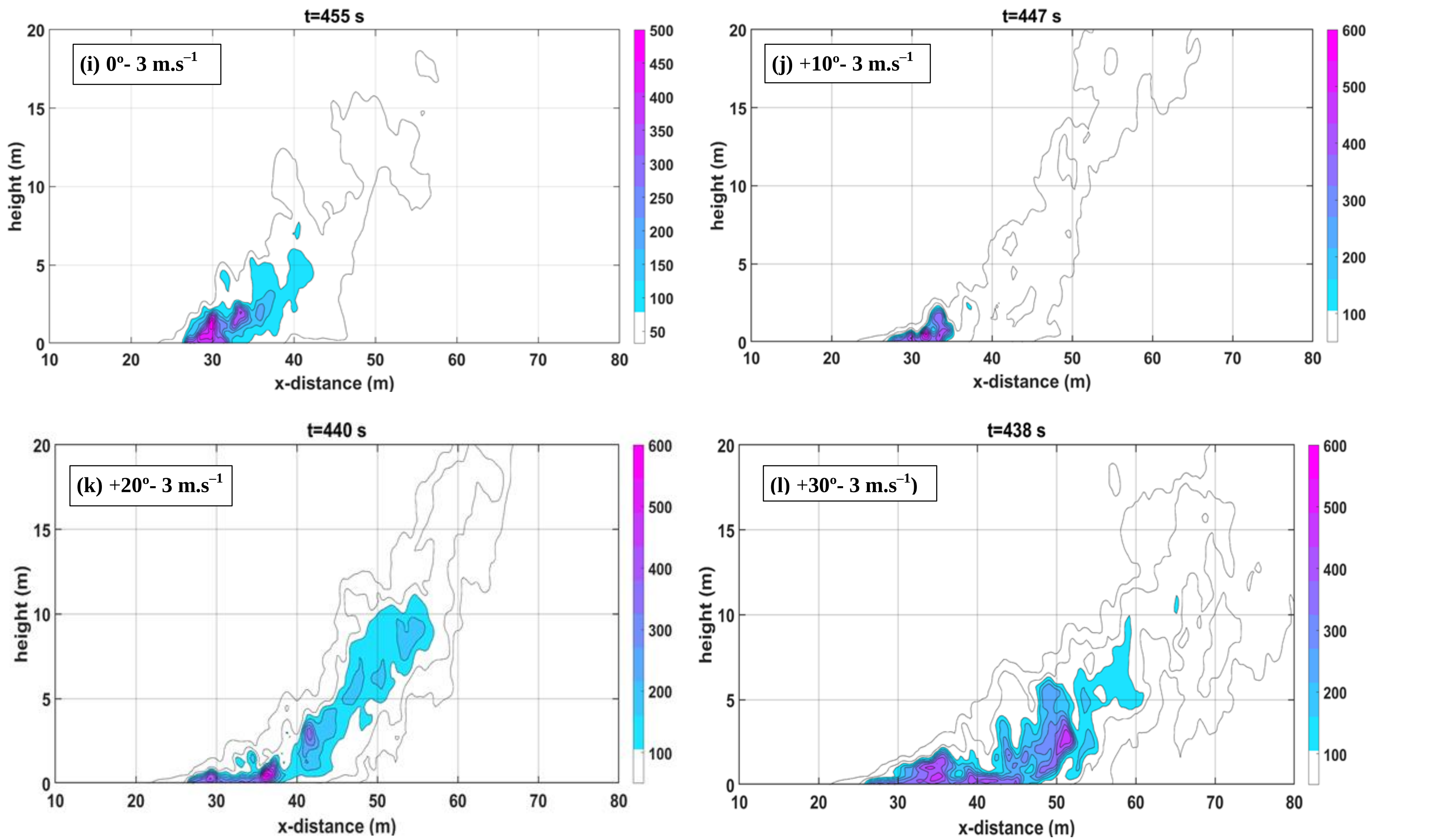


Figure S2. Temperature contours (representing plumes) along the geometric centreline of the grass plot, at the same fire front location from ignition line: Frames (a-d) - 0°, +10°, +20°, +30° at 12 m.s^{-1}; Frames (e-h) - 0°, +10°, +20°, +30° at 6 m.s^{-1}; Frames (i-l)- 0°, +10°, +20°, +30° at 3 m.s^{-1}

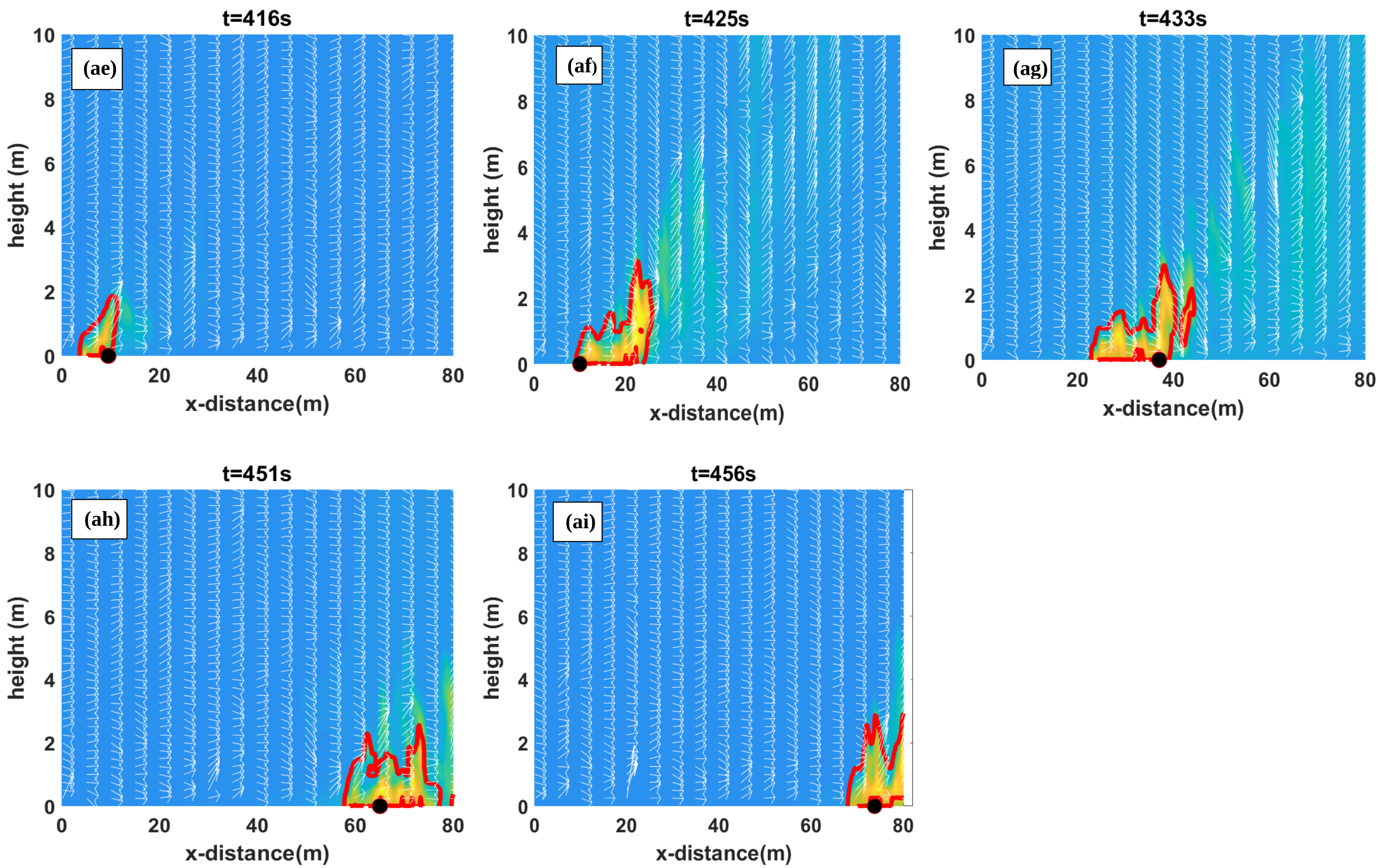


Figure S3 **(ae–ai):** +30° at 6 m.s^{-1}

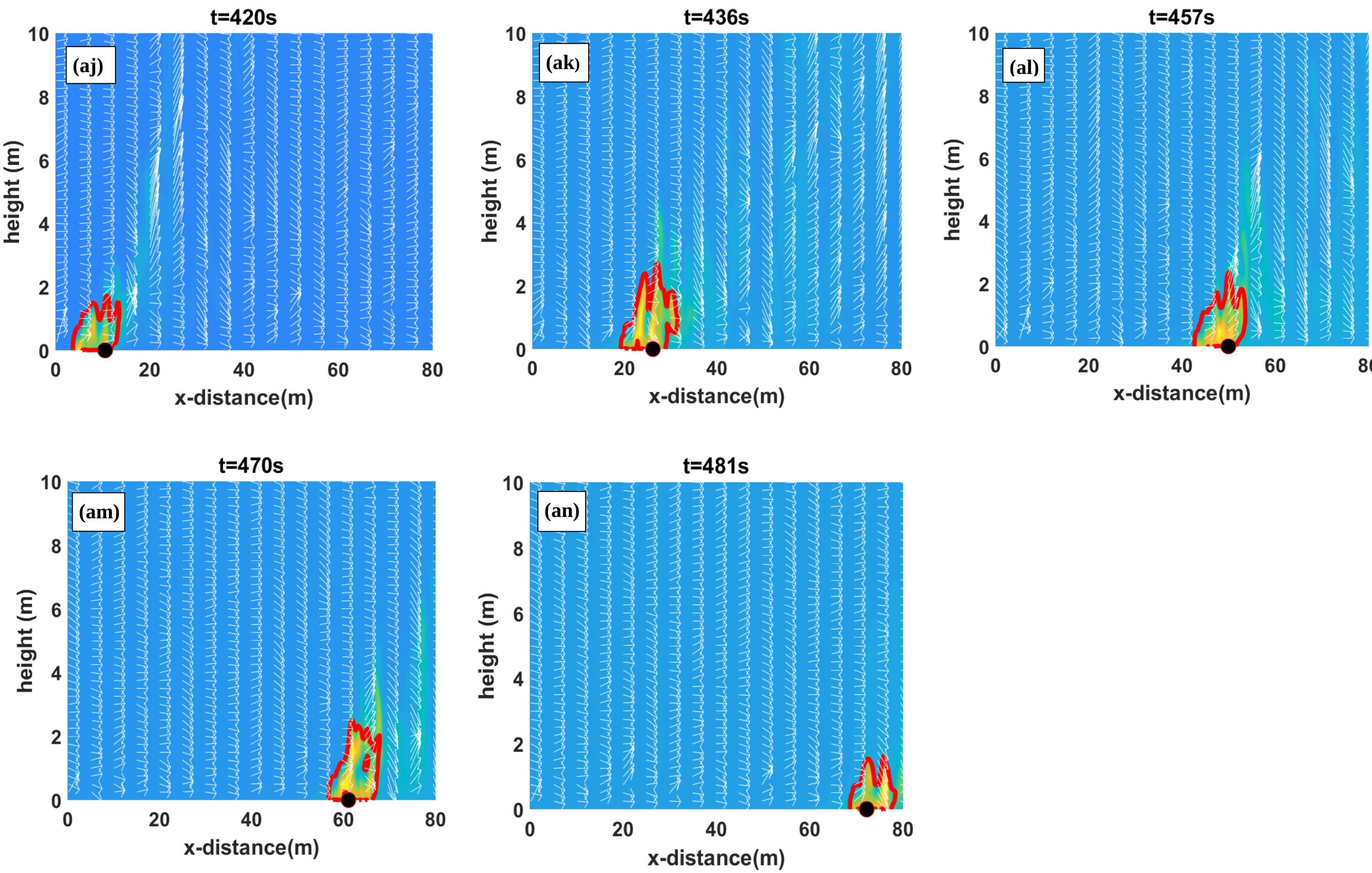


Figure S3 **(aj–an):** +10° at 6 m.s^{-1}

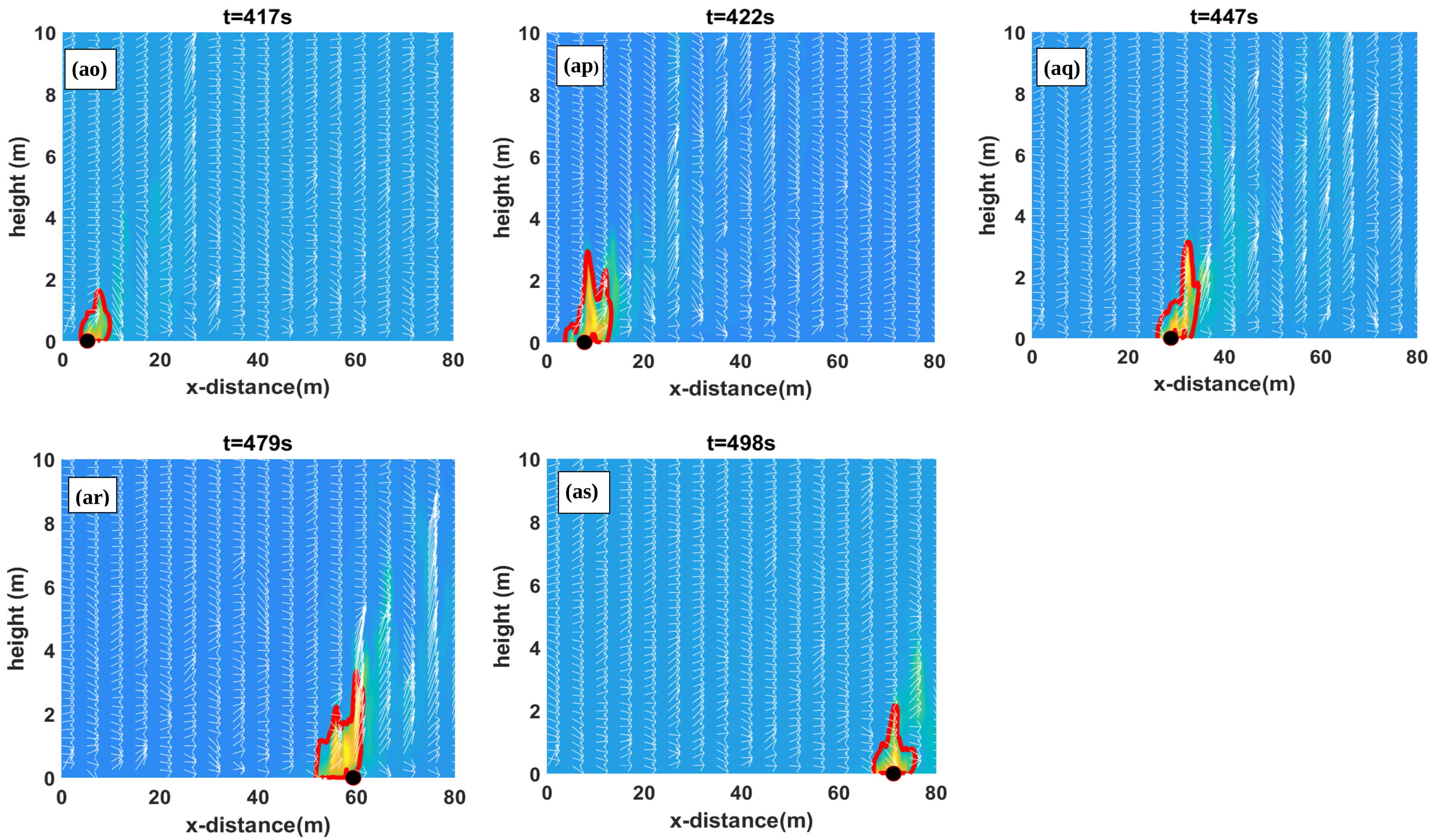
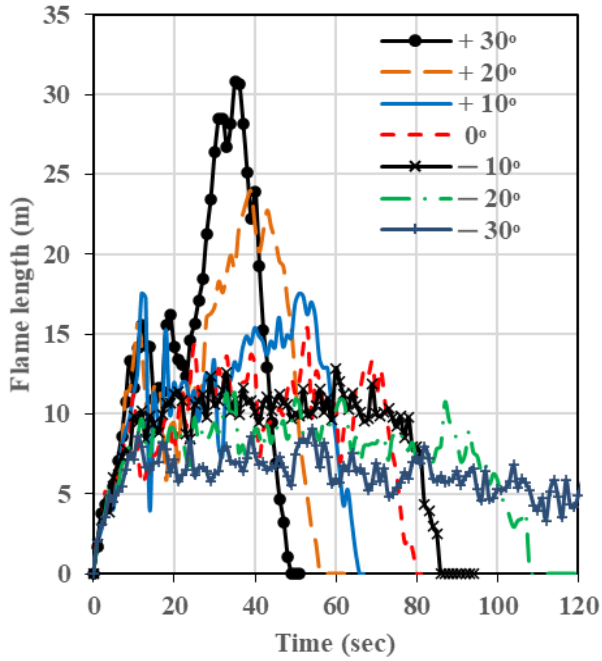
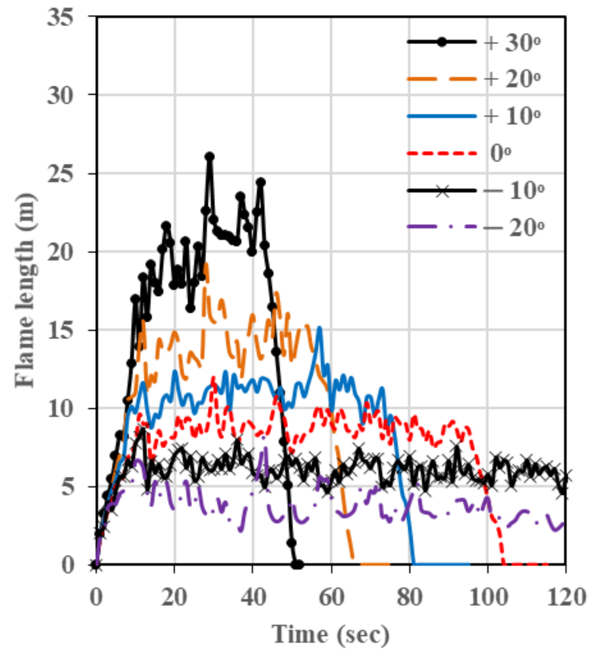


Figure S3 (ao–as)**:** 0° at 6 m.s^{-1}

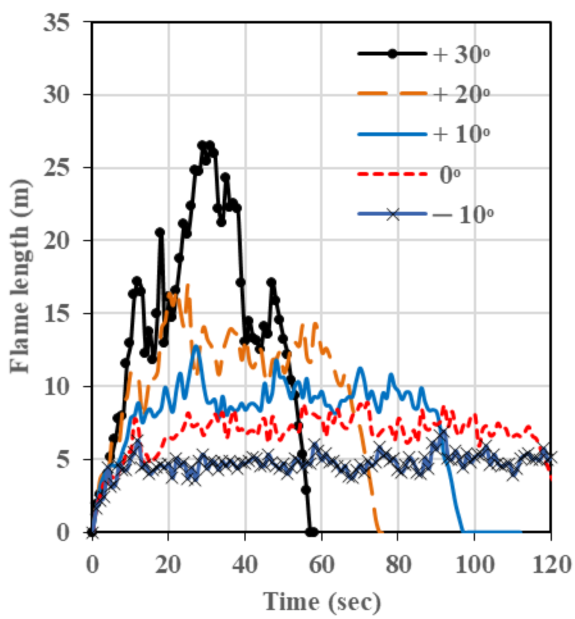
Figure ***S6***. Flame contour (red) with temperature contour shaded in the background along with detachment locations (black dot) and wind vector plots (white arrows), at various instants in time for wind velocity 6 m.s^{-1}, Frames (ae–as): +30°, +10° and 0°



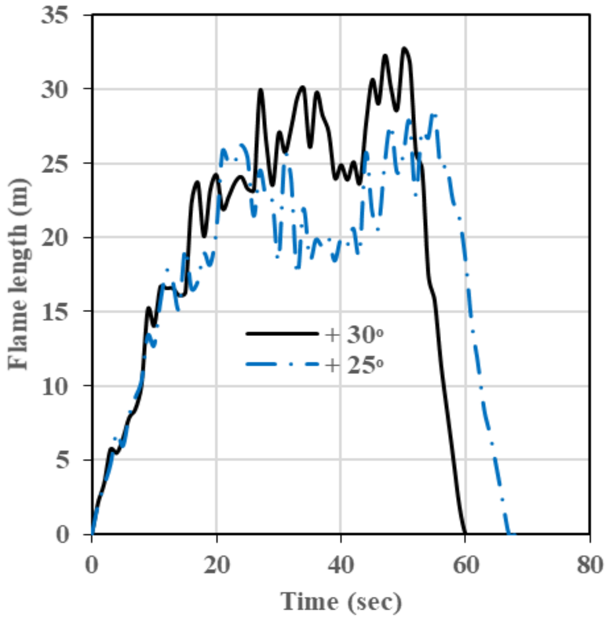
(a) Flame length,12.5m.s^{-1}, 80 × 40 m plot



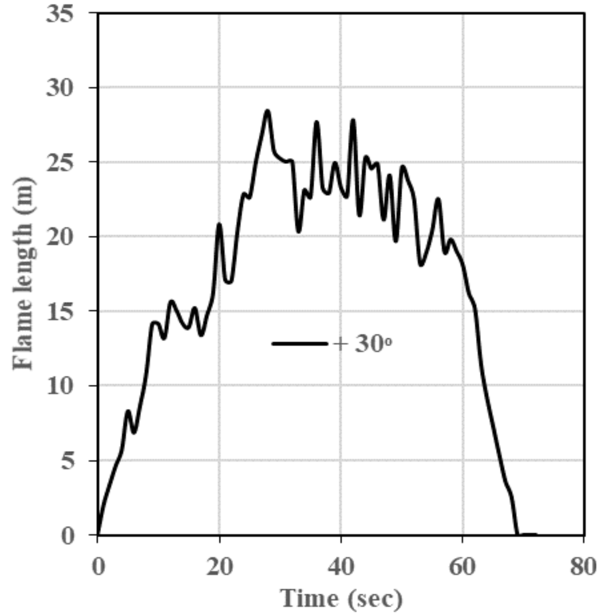
(b) Flame length, 6m.s^{-1}, 80 × 40 m plot



(c) Flame length, 3m.s^{-1}, 80 × 40 m plot

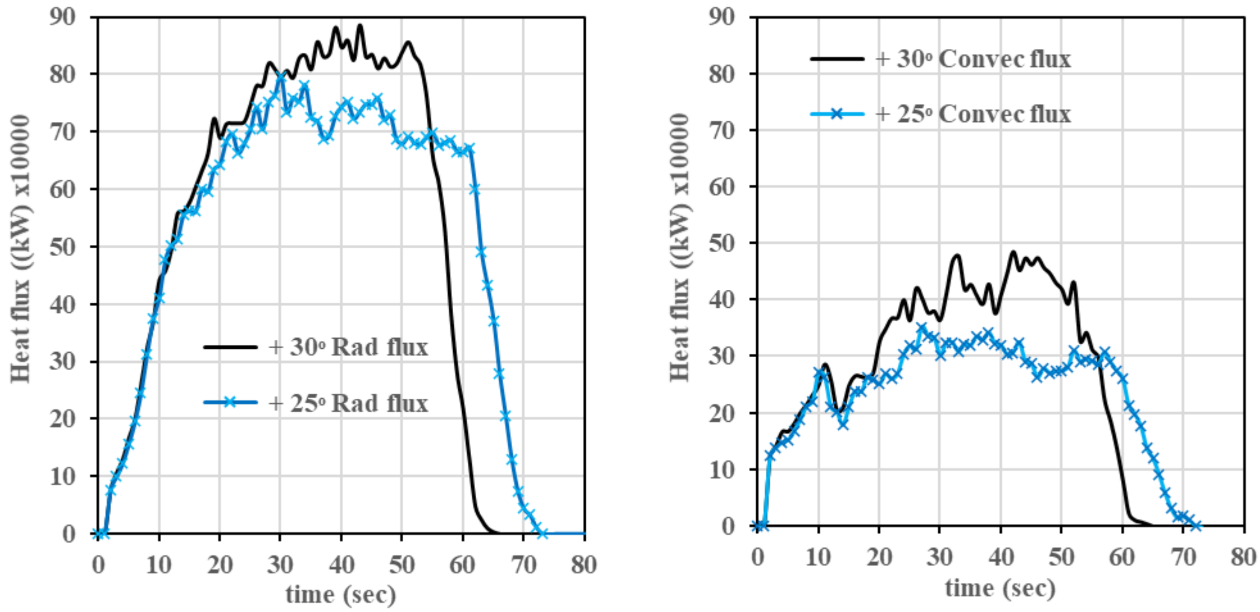


(d) Flame length,12.5m.s^{-1}, 120 × 40 m plot



(e) Flame length,6m.s^{-1}, 120 × 40 m plot

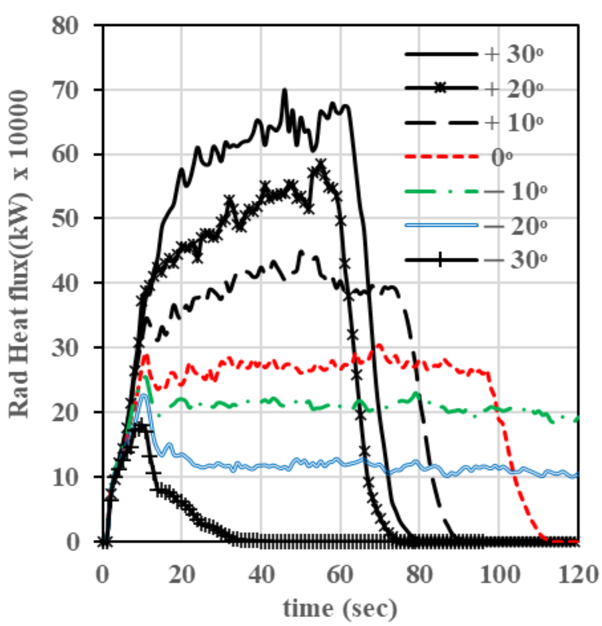
Figure S4*:* Flame length vs time for the upslope and downslope cases at wind velocities; (a) 12.5m.s^{-1} , 80 × 40 m plot, (b) 6m.s^{-1}, 80 × 40 m plot, (c) 3m.s^{-1}, 80 × 40 m plot, (d) +30°, +25° at 12.5m.s^{-1}, 120 × 40 m plot and (e) +30° at 6m.s^{-1}, 120 × 40 m plot



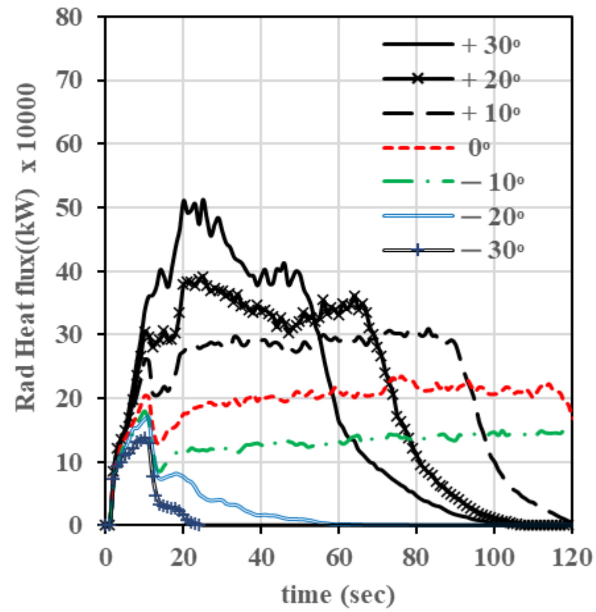
(a) Radiative heat flux vs time- 12.5ms^{-1}

(b) Convective heat flux vs time- 12.5ms^{-1}

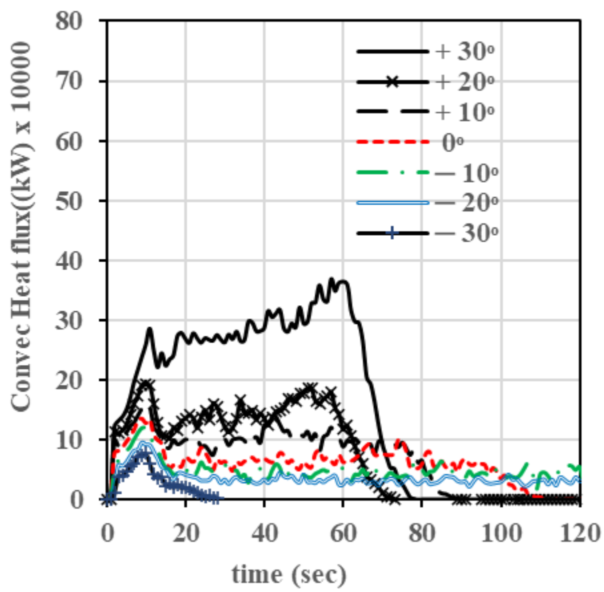
Figure S5: Heat flux as a function of time from 120 × 40 m burnable grass plot simulation for higher upslopes at wind velocity 12.5m.s^{-1}: (a) Radiative heat flux vs time and (b) Convective heat flux vs time



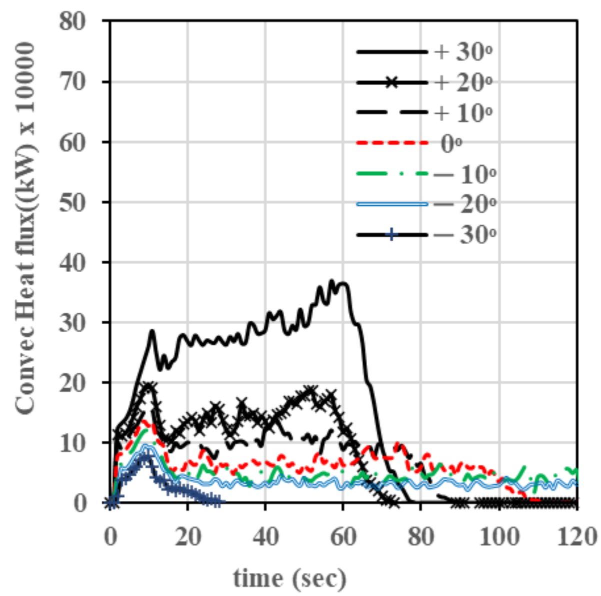
(a) Radiative heat flux vs time- 6m.s^{-1}



(b) Radiative heat flux vs time-3m.s^{-1}



(c) Convective heat flux vs time-6m.s^{-1}



(d) Convective heat flux vs time-3m.s^{-1}

Figure S6: Total Heat fluxes as a function of time. (a) Radiative heat flux vs time at velocity 6 m.s^{-1}, (b) Radiative heat flux vs time at velocity 3m.s^{-1}, (c) Convective heat flux vs time at 6m.s^{-1} and (d) Convective heat flux vs time at 3m.s^{-1}. Please note that in (a) and (c), +30^{o} profile is from 120 × 40 m burnable plot simulation.

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