

S589: Venting

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*Adapted for the 2022 WFBS Course, S589 Module
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Heading: Arial 32pt centred, vertical=0.5cm

Section Title: Corbel 40pt centred hor.

Text: Level 1 = Calibri 28 pt

Text level 2 = Calibri 24pt

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Objectives

- Describe venting and its effects on fire behaviour
- Calculate the venting index by calculating the atmosphere's mixing height and winds

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Venting

4

- The ability of the lower atmosphere to mix and transport smoke through the boundary layer (normally considered to extend up to 3000', or 1000m AGL)
 - Can be higher, especially in unstable air masses
 - During a surface inversion the ability of the atmosphere to disperse smoke is virtually zero

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Ventilation Index

5

- What is it?
 - It is a crude estimate of how well smoke released into the atmosphere will be carried away from the surface during the afternoon –i.e. will the valley be cleaned up quickly?
- How is it calculated?
 - Using the mixed layer depth (m) multiplied by the wind speed (m/s).

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Ventilation Index

6

CAUTION!

- It is not related to calculation of the Air Quality Index
- It was not designed for small fires in cold valleys, it was designed for large fires on level ground.
- Clear and cold winter days are usually poor venting days.
- It has little to do with the way a plume behaves near the ground.

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7


- Low mixing heights usually result in smoke that stays near the surface:
- Poor
- Poor
- Firing



8

Ventilation Index

- High mixing heights usually allow for the dispersion of smoke through a deeper part of the atmosphere
- Burn operations are more successful when dispersion is good
- Categorized as Poor, Fair, or Good

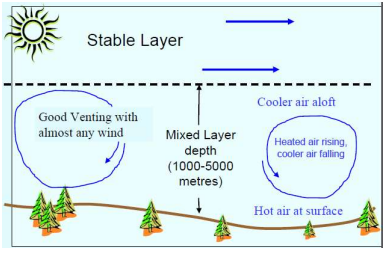


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9

Mixing Height

- The top of the surface layer where a parcel of air (smoke) stops rising
- This layer is turbulent and well mixed together

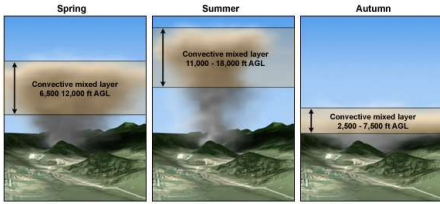


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Mixing Height

10

Seasonal Variation in the Height of the Mixing Layer



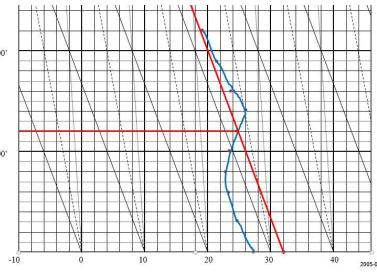
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Mixing Height

11

Calculating the afternoon mixing height

- Using the 00 UTC sounding if available
- Extend the temp profile to the max temp for the day (use forecast if earlier in the day)
- Follow a line using the dry adiabatic lapse rate until it intersects the temperature profile



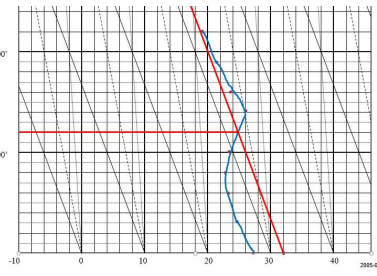
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Mixing Height

12

Estimating the afternoon mixing height

- Extend the temp profile to the forecast maximum temp for the day, or
- Using the 00 UTC sounding if available
- Follow a line using the dry adiabatic lapse rate until it intersects the temperature profile (assuming air is dry throughout this layer)



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Transport Winds

13

- Important factor in smoke management forecasts

- The **average** speed and direction of all winds in the mixing layer

- Used to predict horizontal smoke dispersion



The higher the wind speed, the lower the concentration of smoke, and the better the venting.

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14

Venting Exercise

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15

Venting Exercise

- Required

- WFBS spreadsheet

- Blank Thermodynamic diagram

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16

WFBS Spreadsheet

Sprinkler Connection Number	
To fire	
Connection Number Value	0.00
Power	
Fire intensity (kW/m²)	
Heat	
Distance from fire to fire (m)	
Heat	
Exposure at height (m) (kW/m²)	
Heat of spread (kW/m²)	

Radiation Intensity	
To fire	
Radiation intensity (kW/m²)	0.00
Power	
Fire intensity (kW/m²)	
Heat	
Distance from fire to fire (m)	
Heat	
Exposure at height (m) (kW/m²)	
Heat of spread (kW/m²)	

Eligible Fire Area (m²)	
To fire	
Eligible Fire Area (m²)	0.00
Power	
Fire intensity (kW/m²)	
Heat	
Distance from fire to fire (m)	
Heat	
Exposure at height (m) (kW/m²)	
Heat of spread (kW/m²)	

Power of the Wind	
To fire	
Power of the Wind	0.00
Power	
Fire intensity (kW/m²)	
Heat	
Distance from fire to fire (m)	
Heat	
Exposure at height (m) (kW/m²)	
Heat of spread (kW/m²)	

Venting Index	
To fire	
Venting Index	0.00
Power	
Fire intensity (kW/m²)	
Heat	
Distance from fire to fire (m)	
Heat	
Exposure at height (m) (kW/m²)	
Heat of spread (kW/m²)	

Power of the Fire	
To fire	
Power of the Fire	0.00
Power	
Fire intensity (kW/m²)	
Heat	
Distance from fire to fire (m)	
Heat	
Exposure at height (m) (kW/m²)	
Heat of spread (kW/m²)	

Temperature Intensity	
To fire	
Temperature Intensity (kW/m²)	0.00
Power	
Fire intensity (kW/m²)	
Heat	
Distance from fire to fire (m)	
Heat	
Exposure at height (m) (kW/m²)	
Heat of spread (kW/m²)	

Fire Intensity	
To fire	
Fire Intensity (kW/m²)	0.00
Power	
Fire intensity (kW/m²)	
Heat	
Distance from fire to fire (m)	
Heat	
Exposure at height (m) (kW/m²)	
Heat of spread (kW/m²)	

Percent Slope	
To fire	
Percent Slope	0.00
Power	
Fire intensity (kW/m²)	
Heat	
Distance from fire to fire (m)	
Heat	
Exposure at height (m) (kW/m²)	
Heat of spread (kW/m²)	

Convert Feet to Meters	
To fire	
Convert Feet to Meters	0.00
Power	
Fire intensity (kW/m²)	
Heat	
Distance from fire to fire (m)	
Heat	
Exposure at height (m) (kW/m²)	
Heat of spread (kW/m²)	

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17

WFBS Spreadsheet

Ventilation Index versus Computed Ventilation

Venting Index	
Venting conditions are	POOR
To fire	
Venting Index	9.00
Power	
Fire intensity (kW/m²)	
Heat	
Distance from fire to fire (m)	
Heat	
Exposure at height (m) (kW/m²)	
Heat of spread (kW/m²)	

Convert Feet to Meters	
To fire	
Convert Feet to Meters	0.00
Power	
Fire intensity (kW/m²)	
Heat	
Distance from fire to fire (m)	
Heat	
Exposure at height (m) (kW/m²)	
Heat of spread (kW/m²)	

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18

Thermodynamic (Stuve) diagram

- Electronic versions of this are available in the course material (*ThermodynamicDiagram.pdf, StuveDiagram.png*).
- Be sure you have this on your computer.
- It is probably easiest to load into a Word or Powerpoint document and annotate the diagrams there.

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Calculate Venting

19

- Plot the temperature profile on the diagram
- Max temperature for the day was 24C
- Calculate the mixing height by following the dry adiabatic from the max temp until it crosses the temp profile
- Calculate the average winds within the mixing layer

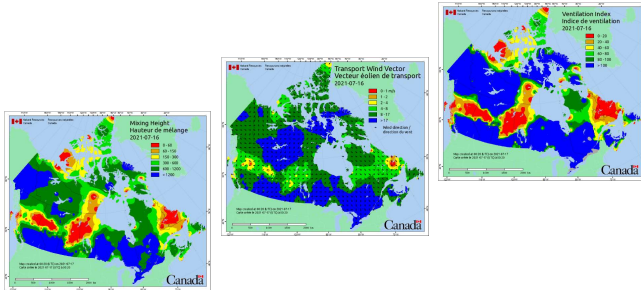
Minisonde sounding for Oct 20, 2017 at 17 UTC

Time (min:sec)	P (hPa)	T (C)	RH (%)	Wsp (km/h)	Wdir (Gd)	Lon (-)	Lat (-)	Altitude (ft)	GeoPot (ft)
0:00	956.2	17.4	57	6	113	-93.0004	49.0539	0	0
0:10	944	15.3	58.8	14.8	115.8	-93.001	49.0549	358.9	357.3
0:40	926.5	15.1	61.5	22	161.8	-93.0015	49.0559	881.9	879.1
1:04	914	14.6	63.9	32.3	174.8	-93.0015	49.0576	1260.9	1254
1:28	903.9	14.9	47.8	38.1	175.6	-93.0017	49.0599	1570.3	1562.0
1:52	895.2	14.8	48	43.5	182.8	-93.0018	49.0626	1845.8	1836.7
2:08	889.5	15	47.3	47.1	186.2	-93.0018	49.0649	2025.9	2015.6
2:33	881.2	14.9	43.1	50.3	200.8	-93.0001	49.0673	2287.7	2277.9
2:56	872.8	14.8	41.7	55	209.3	-92.9979	49.0703	2560.1	2548
3:20	864.3	14.3	42	59.9	211.5	-92.9951	49.0734	2836.3	2823.3
3:36	858.8	14	42.1	63.1	211.7	-92.9931	49.0756	3014.6	3001.1

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Some CWFIS Examples

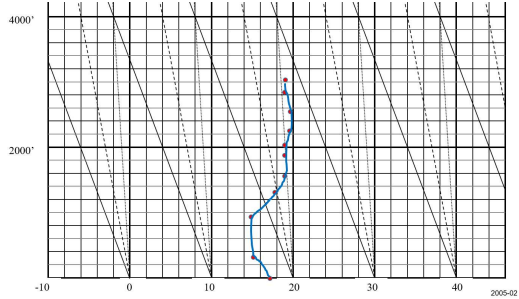
20



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Venting Exercise – Temperature Profile

21



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Calculate Wind

22

• Sum of all wind values to 1600'

• $113.2 / 5 = 22.6 \text{ km/h}$

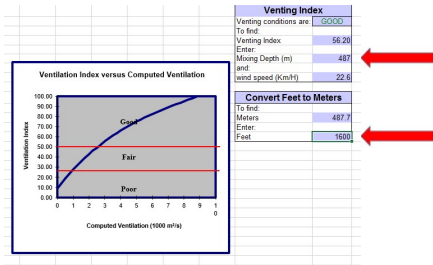
Minisonde sounding for Oct 20, 2017 at 17 UTC

Time[mm:ss]	P[hPa]	T[C]	RH[%]	Wsp[km/h]	Wdir[Grd]	Lon [-]	Lat [-]	Altitude[ft]	GeoPot[ft]
0:00	996.2	17.4	57	6	113	-93.0004	49.0539	0	0
0:16	944	15.3	58.8	14.8	115.8	-93.0001	49.0546	358.9	357.3
0:40	926.5	15.1	61.5	22	161.6	-93.0015	49.0558	881.9	874
1:04	914	18.6	53.9	32.3	174.8	-93.0015	49.0576	1260.9	1254
1:28	903.9	18.9	47.8	38.1	175.6	-93.0017	49.0599	1570.3	1562.4
1:52	895.2	18.8	48	43.5	182.8	-93.0018	49.0626	1945.8	1936.2
2:08	889.5	19	47.2	47.1	190.2	-93.0014	49.0644	2025.9	2015.6
2:32	881.2	19.9	43.2	50.3	202.8	-93.0001	49.0673	2287.7	2277.5
2:56	872.8	19.8	41.7	55	209.3	-92.9979	49.0703	2560.1	2548
3:20	864.3	19.3	42	59.9	211.5	-92.9951	49.0734	2836.3	2823.5
3:36	858.8	19	42.1	63.1	211.7	-92.9931	49.0756	3014.6	3001.1

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Spreadsheet Inputs

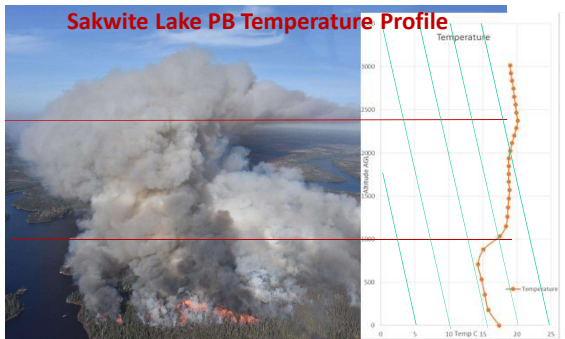
23



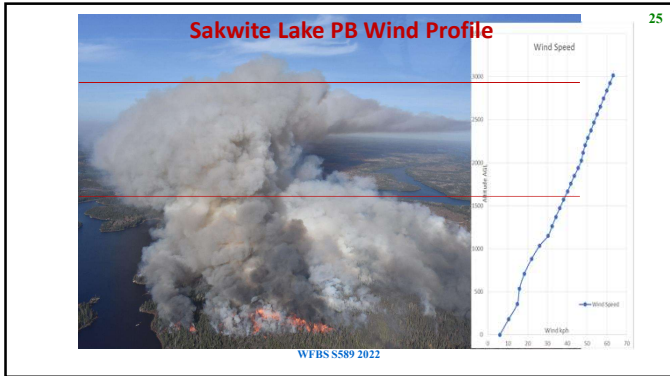
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Sakwite Lake PB Temperature Profile

24



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25

Summary

- Venting, or the Ventilation Index, is a crude estimate of how well smoke released into the atmosphere will be carried away from the surface during the afternoon
- Uses the mixed layer depth multiplied by the wind speed.

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26

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27
