A Comparison Of Ventilation Network Simulation Programs

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Garson Mine Ventilation Model:

1317 Airway Branches (91.34km) to 2135m depth

- 11 Fans @ 670kW electric
- 4 trucks & 2 LHDs @ 3259kW diesel

Boundary atmospheric conditions:

- 102441 Pa
- Dry Bulb: 24°C | Wet Bulb: 18°C

<u>Base case:</u>

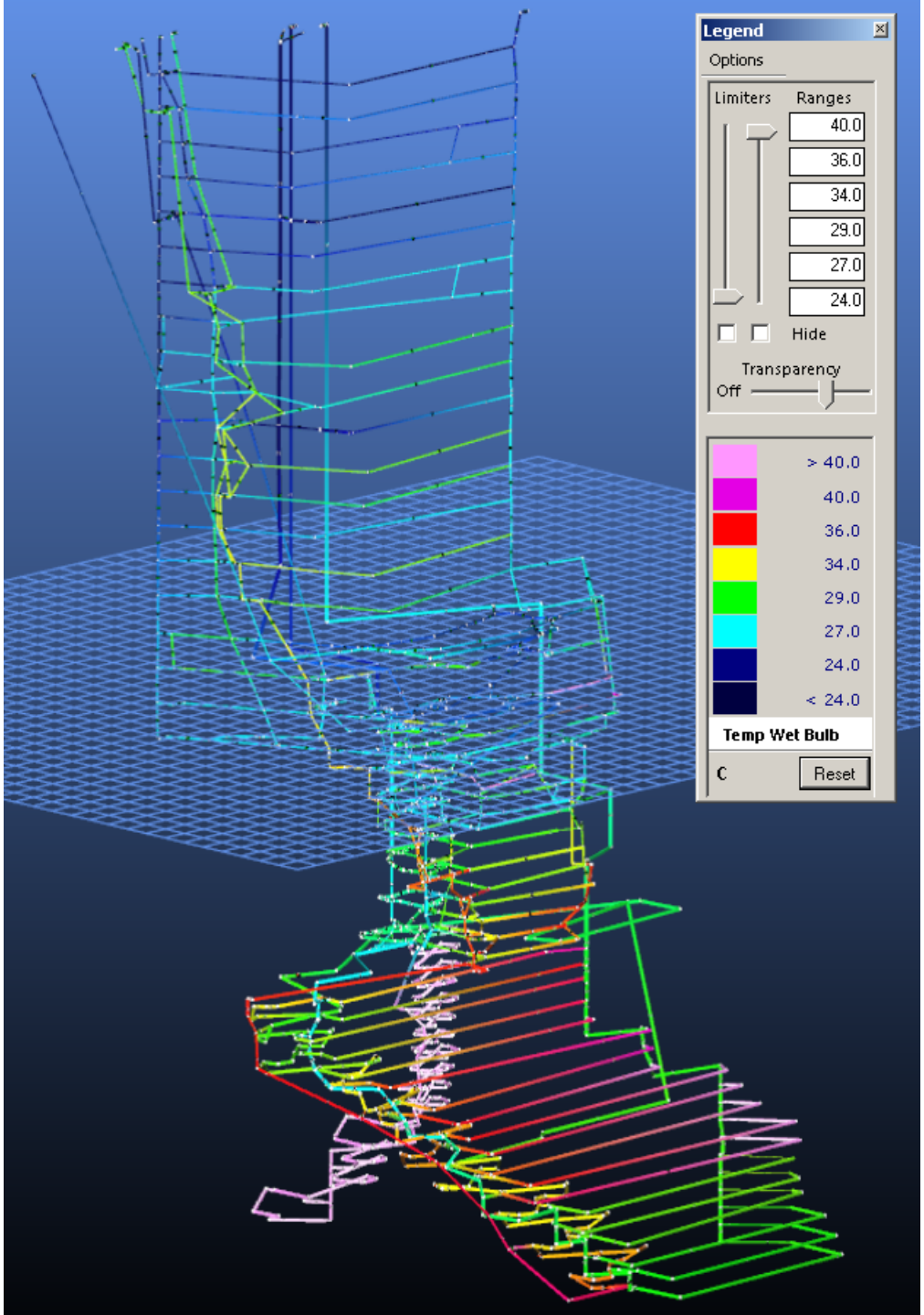
VnetPC2007 v2.0 and Climsim v1.2

- 1 NPV Fan & 3 fixed Q's

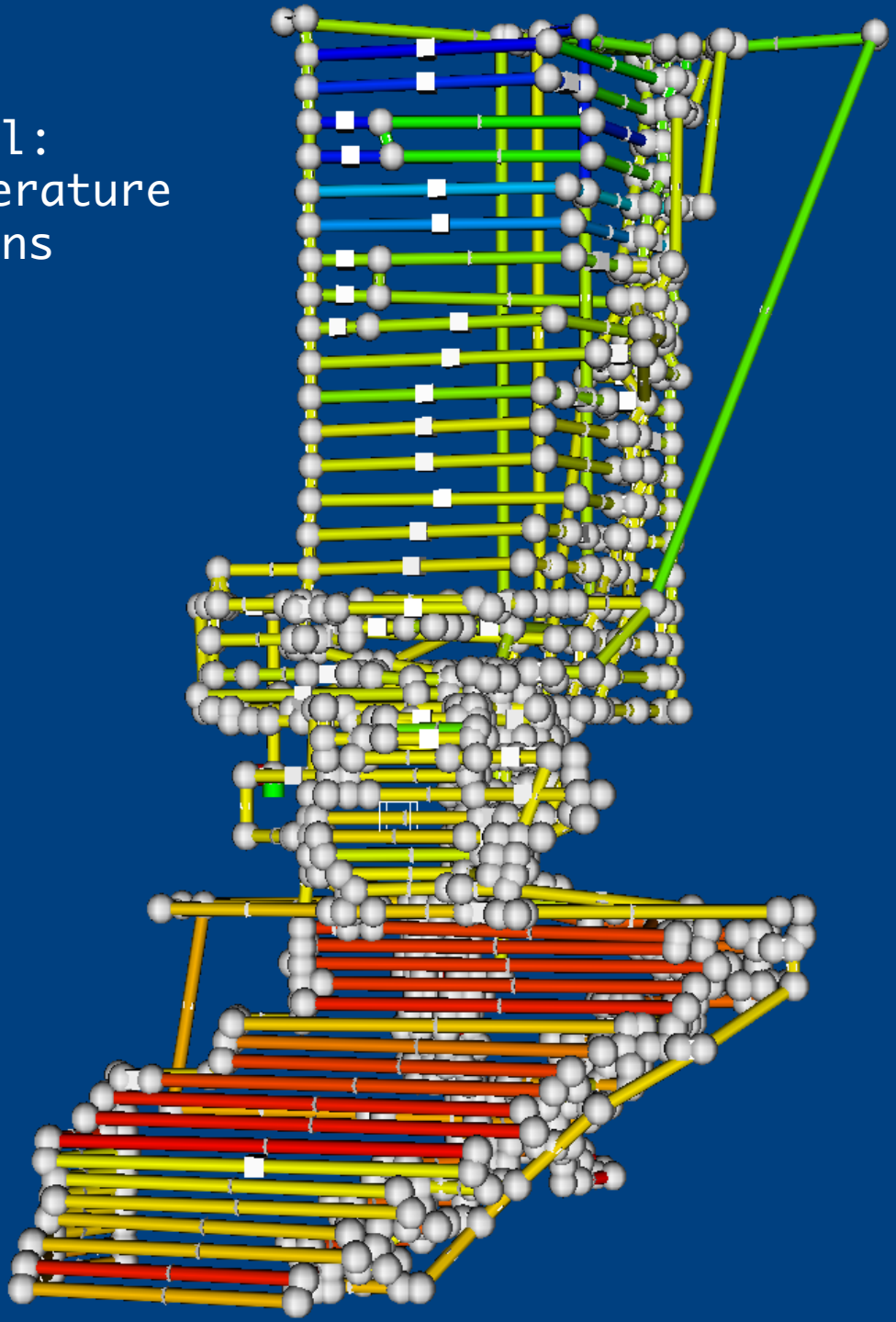
Three *equivalent* thermodynamic climactic models were developed in each of these software:

1) VentSim Visual v2.6
2) Vuma Network v3.5
3) Multiflux v5. 1

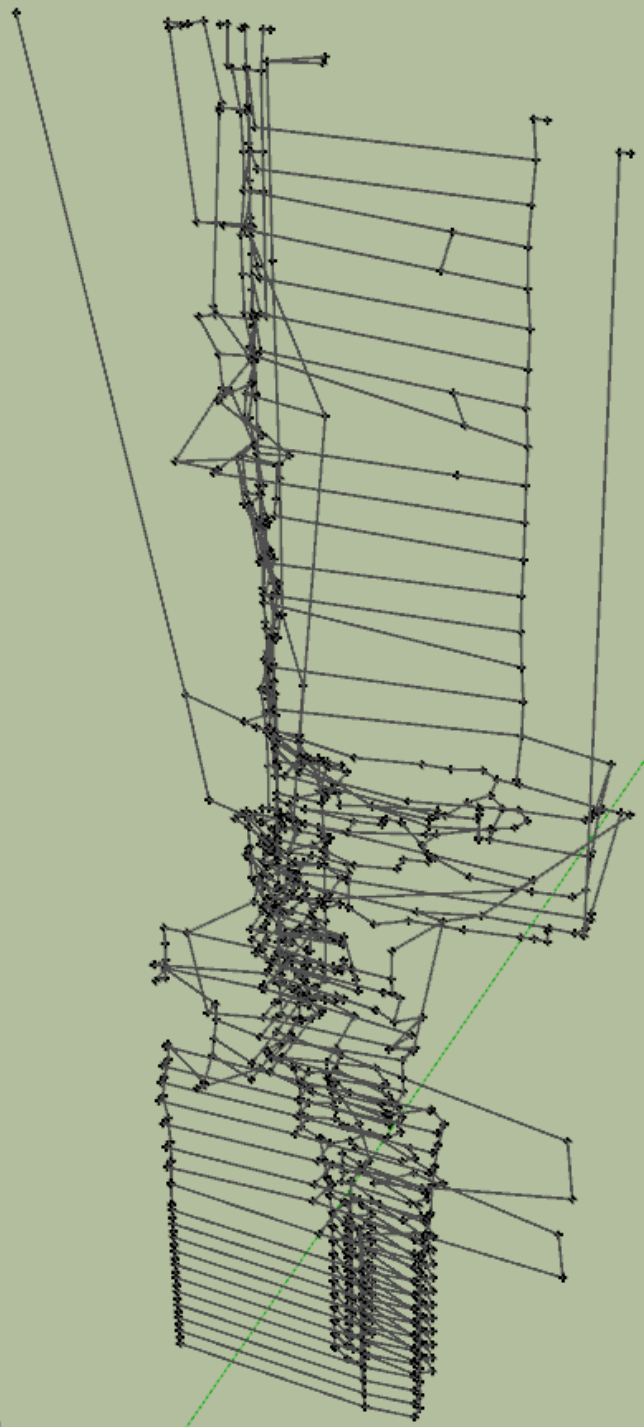
Ventsim Model: Wet Bulb temperature predictions

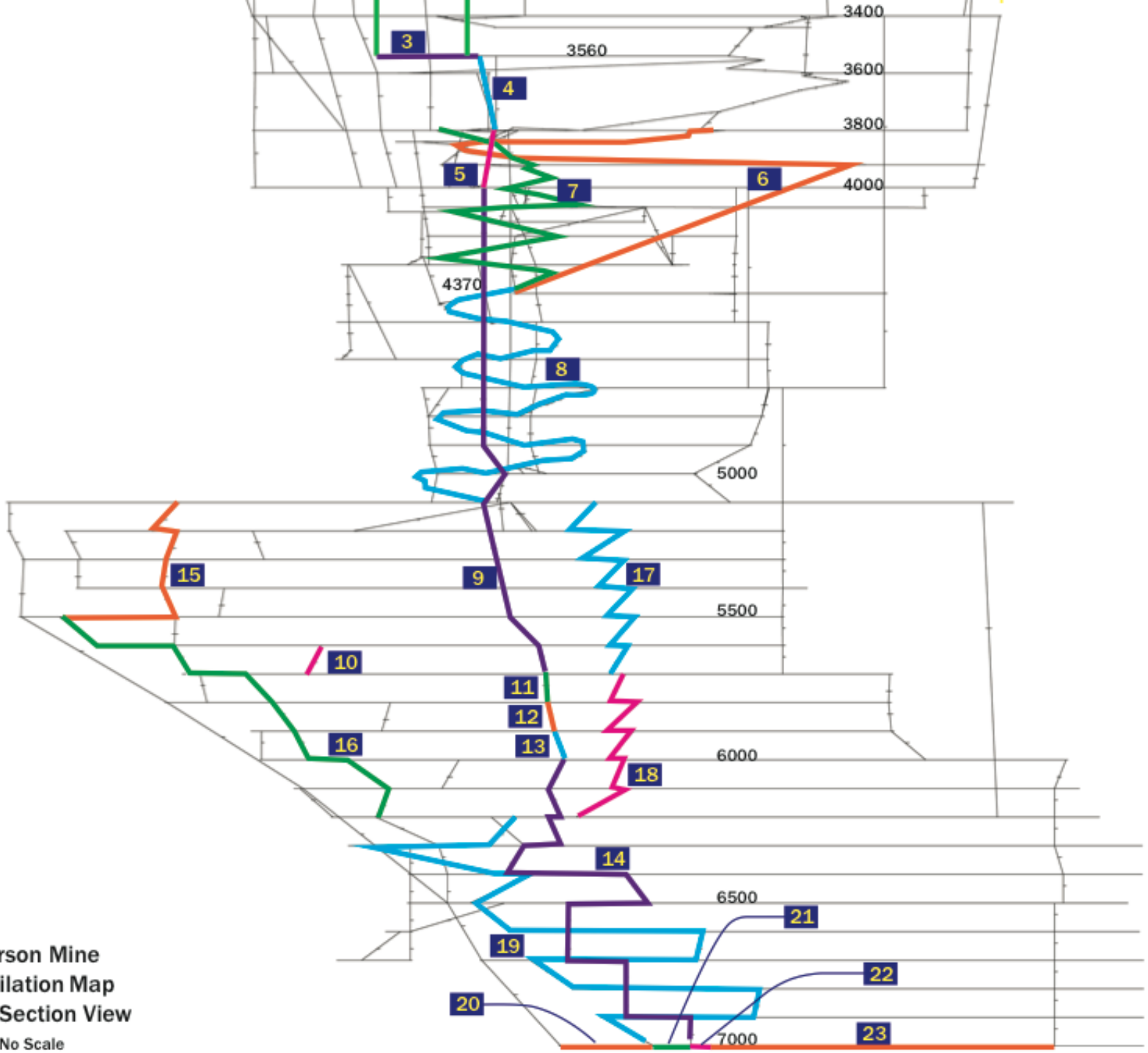


Vuma Model:
Wet Bulb temperature
predictions



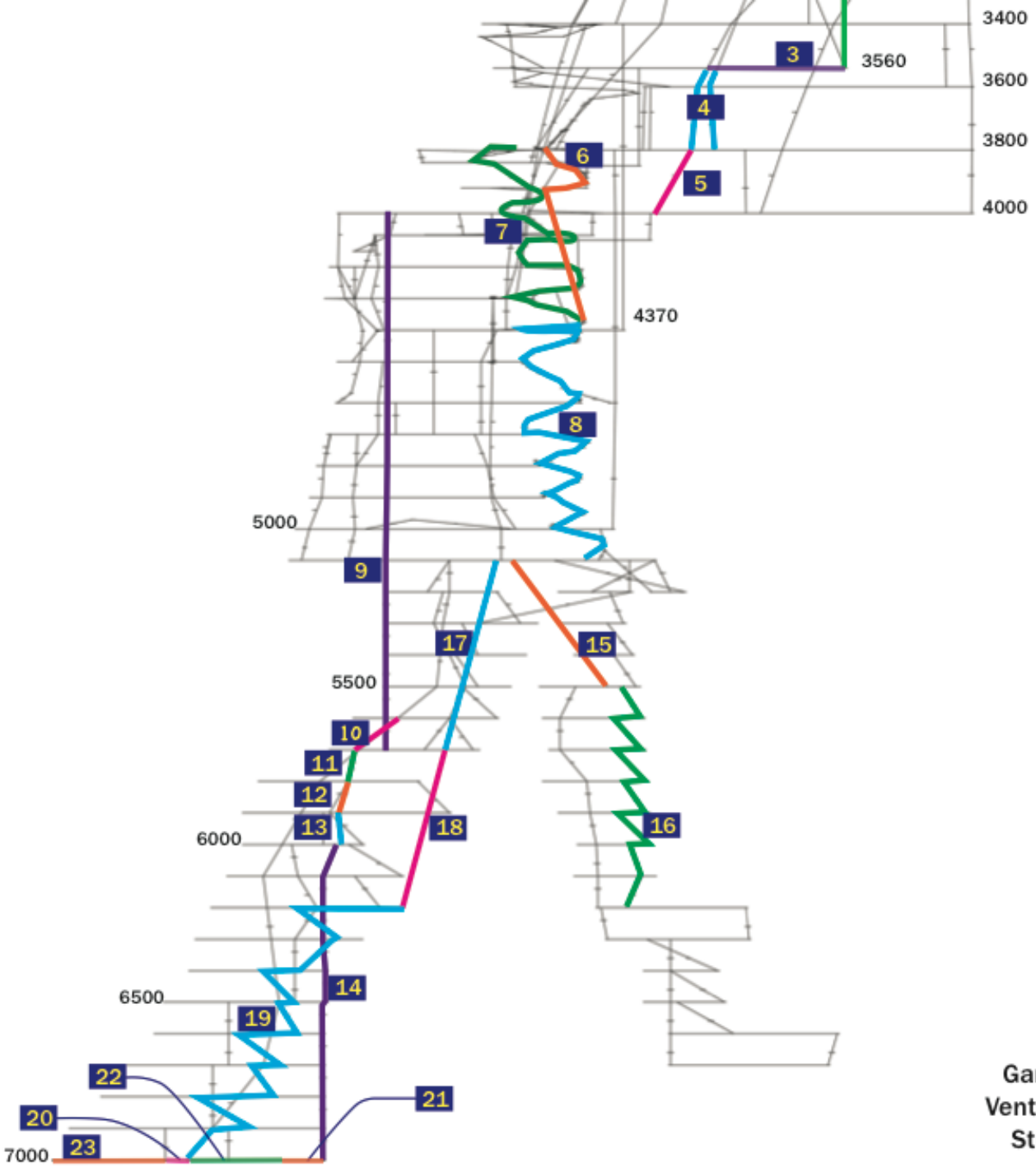
MULTIFLUX Model:
Garson Mine





Garson Mine
Ventilation Map
Cross-Section View

No Scale



Garson Mine
Ventilation Map
Strike View

No Scale

Airflow Quantity, Pressure Drop & Resistance predictions comparative table

ClimSIM Branch#	Vnet			Ventsim			MULTIFLUX			Vuma		
	Q(cms)	ΔP(Pa)	R(Ns^2/m^8)	Q(cms)	ΔP(Pa)	R(Ns^2/m^8)	Q(cms)	ΔP(Pa)	R(Ns^2/m^8)	Q(cms)	ΔP(Pa)	R(Ns^2/m^8)
1	234.9	948.7	0.01720	247.0	937.2	0.01855	262.0	1148.4	0.01674	221.4	1180.1	0.01710
2	390.0	562.6	0.00370	415.4	593.3	0.00370	329.3	1015.3	0.00936	372.9	514.4	0.00370
3	387.2	650.6	0.00434	381.7	717.8	0.00493	326.6	451.5	0.00423	338.4	532.4	0.00470
4	387.1	203.8	0.00136	380.7	204.8	0.00136	326.4	339.9	0.00319	338.1	155.5	0.00140
5	334.9	32.5	0.00029	337.0	25.8	0.00033	279.4	21.9	0.00028	279.0	33.0	0.00860
6	-76.7	-4.3	0.00073	61.6	-4.7	0.00073	-76.5	-4.4	0.00075	-88.9	-5.8	0.00070
7	-98.0	-9.8	0.00102	93.1	-8.9	0.00102	-108.0	-17.0	0.00146	-101.4	-13.2	0.00120
8	60.3	2.1	0.00058	122.1	6.3	0.00067	96.9	5.3	0.00057	42.7	1.7	0.00060
9	192.5	9.6	0.00026	220.2	5.0	0.00031	179.8	8.1	0.00025	215.5	13.1	0.00030
10	192.4	11.8	0.00032	219.5	8.3	0.00038	179.8	10.1	0.00031	214.8	16.6	0.00040
11	192.3	24.0	0.00065	219.0	37.5	0.00078	179.8	20.6	0.00064	211.5	32.9	0.00070
12	192.3	11.5	0.00031	218.7	7.7	0.00038	179.8	9.9	0.00031	211.2	15.6	0.00030
13	192.2	10.7	0.00029	218.0	6.5	0.00036	179.7	9.4	0.00029	210.6	14.8	0.00030
14	46.8	0.5	0.00022	50.8	11.9	0.00028	44.0	0.4	0.00022	43.2	0.5	0.00030
15	-72.0	-1.6	0.00030	70.7	-1.7	0.00035	-67.5	-1.3	0.00029	-69.4	-1.4	0.00030
16	72.4	3.5	0.00067	70.1	3.3	0.00080	68.3	3.1	0.00066	70.7	3.1	0.00070
17	-74.4	-6.9	0.00124	72.8	-7.8	0.00147	-70.0	-6.0	0.00122	-69.9	-5.8	0.00130
18	-71.1	-1.3	0.00025	69.8	-1.5	0.00030	-66.5	-1.1	0.00025	-38.7	-0.4	0.00030
19	-141.8	-7.8	0.00039	151.5	-10.8	0.00047	-132.8	-6.8	0.00039	-138.1	-7.2	0.00040
20	173.1	95.3	0.00318	139.3	7.0	0.00036	166.8	87.7	0.00315	147.4	84.0	0.00360
21	46.8	0.5	0.00024	50.9	0.8	0.00030	43.9	0.5	0.00024	43.9	0.5	0.00030
22	-122.5	-12.4	0.00083	119.1	-14.4	0.00102	-115.2	-11.0	0.00083	-122.5	-12.5	0.00090
23	50.6	0.7	0.00029	33.6	2.4	0.00212	51.5	0.8	0.00029	50.1	0.7	0.00030

Dry Bulb / Wet Bulb predictions comparative table

Climsim Branch	Climsim Model				VentSim Outputs		MULTIFLUX Outputs		Vuma Outputs	
	Inputs		Outputs							
	Dry Bulb (°C)	Wet Bulb (°C)	Dry Bulb (°C)	Wet Bulb (°C)	Dry Bulb (°C)	Wet Bulb (°C)	Dry Bulb (°C)	Wet Bulb (°C)	Dry Bulb (°C)	Wet Bulb (°C)
1	23.40	18.00	31.83	22.96	29.90	21.90	24.01	17.32	37.13	23.87
2	23.40	18.00	31.05	22.63	29.70	20.90	23.77	17.32	31.81	21.48
3	31.05	22.63	30.09	22.67	32.80	24.70	23.79	17.92	29.23	21.52
4	30.09	22.67	30.20	22.95	32.00	24.90	23.79	18.08	29.23	21.60
5	30.20	22.95	30.55	23.20	32.50	25.20	23.79	18.07	29.04	21.79
6	30.20	22.95	25.69	24.23	31.50	24.70	24.60	23.20	36.72	24.38
7	30.20	22.95	26.92	24.30	34.90	26.20	25.83	23.32	39.48	25.72
8	26.38	24.27	26.97	26.29	33.60	27.00	28.74	28.01	37.68	27.50
9	30.55	23.20	33.21	25.19	33.40	27.30	24.00	18.21	28.85	23.86
10	33.21	25.19	32.84	25.18	33.60	27.40	24.02	18.42	28.95	23.99
11	32.84	25.18	33.01	25.31	33.60	27.50	24.04	18.43	28.80	24.00
12	33.01	25.31	33.17	25.43	33.50	27.50	24.05	18.44	28.90	24.13
13	33.17	25.43	33.34	25.55	33.70	27.60	24.06	18.44	29.02	24.26
14	33.34	25.55	35.11	26.91	34.90	29.10	24.37	18.68	29.84	25.84
15	26.97	26.29	27.46	26.82	39.50	32.50	33.85	33.06	41.35	33.39
16	23.02	22.74	28.07	27.27	35.20	30.60	30.85	29.97	39.93	33.57
17	26.97	26.29	29.26	28.16	33.60	29.00	27.98	26.93	38.46	34.20
18	23.89	23.39	25.51	24.45	41.90	34.20	36.92	35.38	33.35	31.45
19	26.81	25.87	30.55	28.89	38.50	34.60	33.46	31.64	38.26	33.04
20	30.55	28.89	30.53	28.89	46.60	37.40	36.12	34.17	39.48	30.23
21	35.11	26.91	34.87	26.91	35.00	29.20	30.22	23.32	39.39	28.59
22	34.87	26.91	35.33	27.50	41.00	35.90	36.89	28.72	35.81	29.31
23	35.33	27.50	40.44	31.76	34.90	29.20	36.12	28.37	48.09	31.55

Correlation error calculation:

$$\frac{Sum[Absolute\ Value(Baseline\ airflow - Model\ airflow)]}{Sum(Model\ airflows)}\ x\ 100$$

Repeated for pressure drop, resistance and temperature predictions.

Correlation error comparison table

	Q(cms)	P(Pa)	DB(°C)	WB(°C)
Vuma	4.47%	1.11%	9.22%	15.96%
Multiflux	10.26%	18.18%	10.96%	31.28%
Ventsim	37.19%	0.06%	11.14%	9.40%

Min. and Max differences between baseline and predicted branch values

		Q(cms)		P(Pa)		R(Ns^2/m^8)		DB(°C)		WB(°C)	
		Branch ID	Value	Branch IDs	Value	Branch IDs	Value	Branch ID	Value	Branch ID	Value
Vuma	min	22	0.0	14,21,23	0.0	2,15	0.00000	22	0.48	6	0.15
	max	5	55.8	1	231.4	5	0.00831	15	13.89	18	7.00
Multiflux	min	6	0.2	21	0.0	18	0.00000	7	1.09	7	0.98
	max	2	60.7	2	452.7	2	0.00566	18	11.41	18	10.93
Ventsim	min	5	2.1	15	0.1	2,4,6,7	0.00000	21	0.13	6	0.47
	max	19	293.3	20	88.3	20	0.00282	18	16.39	18	9.75

Conclusions:

Ventilation engineers must understand particular simulation software limitations and features behind the *"black box"*.

Reliable technical support is required to guide the engineer through the intricacies of the model configuration.

The simulation of underground mine ventilation and cooling networks is not an exact process.

Validation of simulation results with measurements taken in the mine being modeled is PARAMOUNT before using the simulation for future planning.

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Thanks for your attention!

Questions?