

CFD simulations in local wind fields: A parametric study

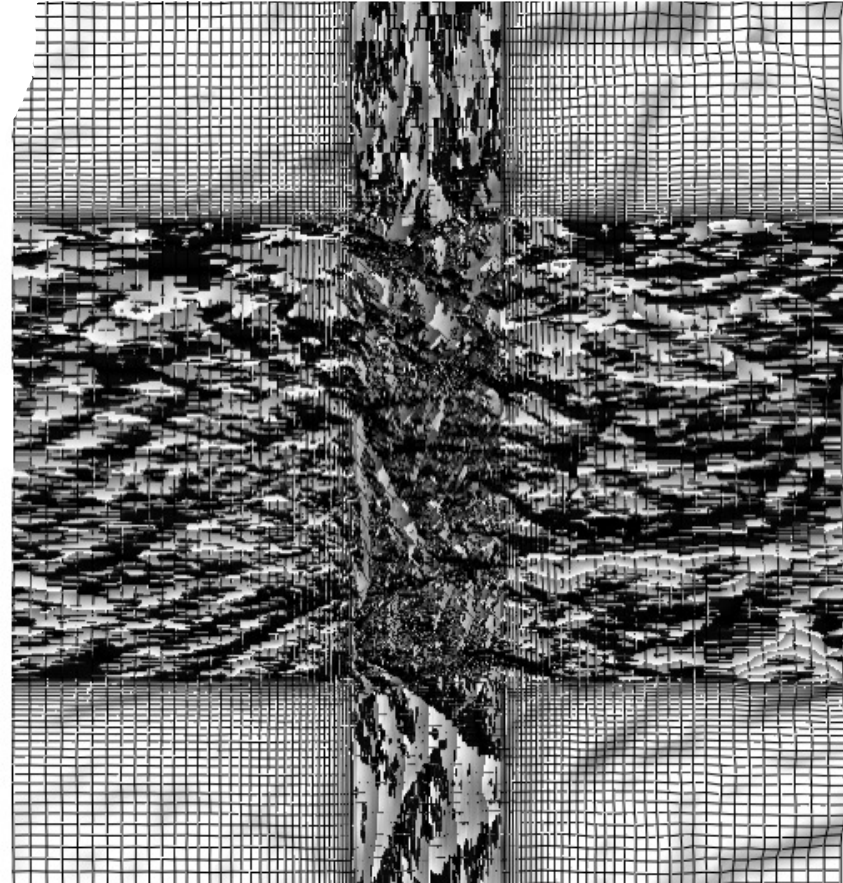
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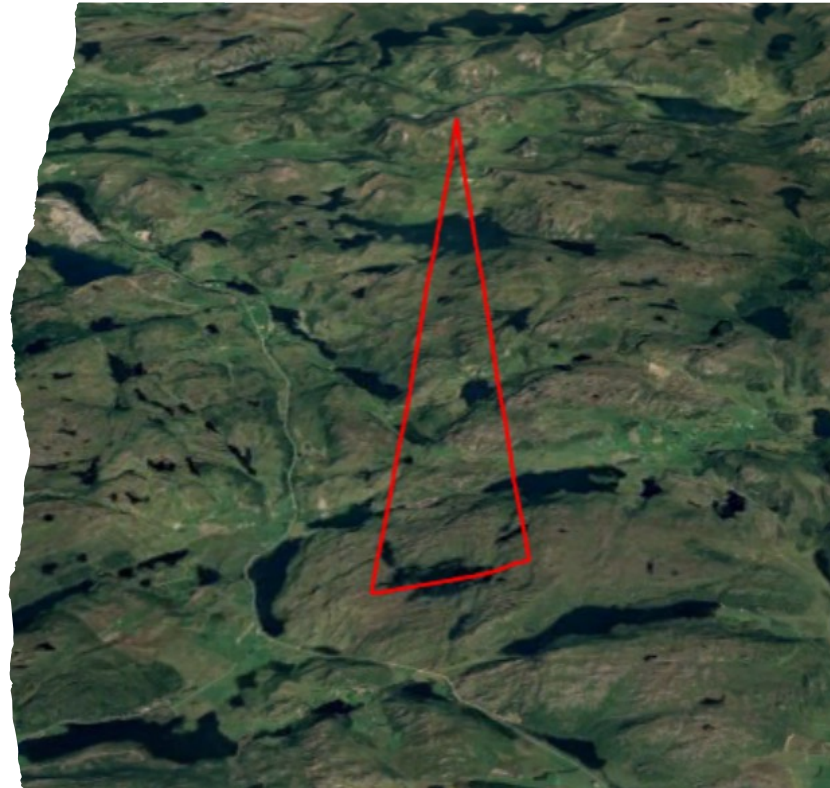
Goals & Objectives

- Parameter sensitivity
- Grid dependency
- Simulation time



Site Selection

- Terrain complexity
- Terrain data
- Roughness data
- Generating the .gws
- Measurement data



Method

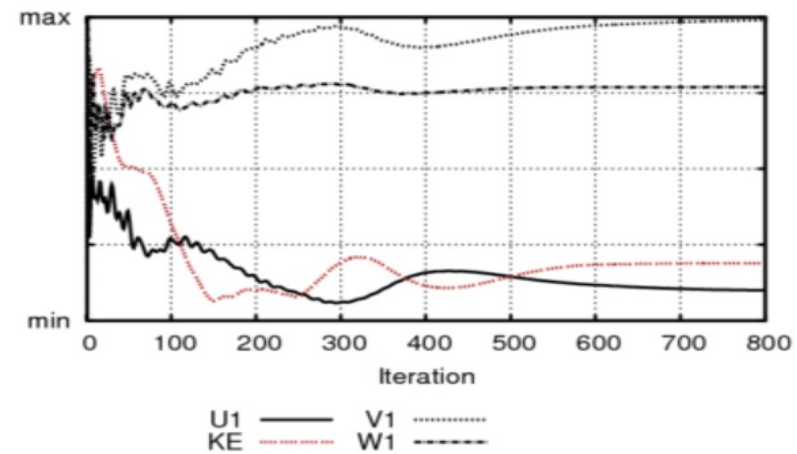
- Defining a base case
- Parameters
- Establishing the numerical models

Numerical Settings:		Domain Size (km)	Grid Cells	Cells	Resolution (m)	Grid extension Z (m)
Case:	<i>(Lx, Ly)</i>	<i>(nx, ny, nz)</i>	<i>(nx*ny*nz)</i>	<i>(dx, dy)</i>	<i>Lz</i>	
S1	<i>Base_Case</i>	24.1, 33.2,	242, 606, 24	3519648	25x25	3642.7
S2	<i>Reso 10</i>	24.1, 33.2	534, 1444, 24	18506304	10x10	3634.5
S3	<i>Reso 50</i>	24.1, 33.2	136, 318, 24	1037952	50x50	3653.2
S4	<i>Reso 100</i>	24.1, 33.2	79, 170, 24	322320	100x100	3665.9
S5	<i>Reso 200</i>	24.1, 33.2	46, 92, 24	101568	200x200	3647.8
S6	<i>Reso 500</i>	24.1, 33.2	22, 40, 24	21120	500x500	3668.6
S7	<i>Domain 1</i>	6.1, 15.2	186, 550, 23	2352900	25x25	2786.2
S8	<i>Domain 3</i>	10.1, 19.2	204, 568, 23	2665056	25x25	2811.6
S9	<i>Domain 5</i>	14.1, 23.2	218, 582, 22	2791272	25x25	2134.6
S10	<i>Domain 20</i>	44.1, 53.2	274, 638, 25	4370300	25x25	4703.3
S11	<i>Domain 25</i>	54.1, 63.2	288, 652, 26	4882176	25x25	6139.3
S12	<i>Domain 30</i>	64.1, 73.2	300, 664, 26	5179200	25x25	6145.7
S13	<i>Refine 0</i>	22.1, 31.2	162, 526, 24	2045088	25x25	3645.5
S14	<i>Refine 0.5</i>	23.1, 32.2	202, 566, 24	2743968	25x25	3647.6
S15	<i>Refine 3</i>	28.1, 37.2	402, 766, 25	7698300	25x25	4724.0
S16	<i>Refine 5</i>	32.1, 41.2	562, 926, 25	13010300	25x25	4725.6
S17	<i>Refine 7</i>	36.1, 45.2	722, 1086, 25	19602300	25x25	4707.1
S18	<i>Vertical 10</i>	24.1, 33.2	242, 606, 10	1466520	25x25	3630.6
S19	<i>Vertical 35</i>	24.1, 33.2	242, 606, 35	5132820	25x25	3664.0
S20	<i>Vertical 50</i>	24.1, 33.2	242, 606, 50	7332600	25x25	3491.3

Simulations

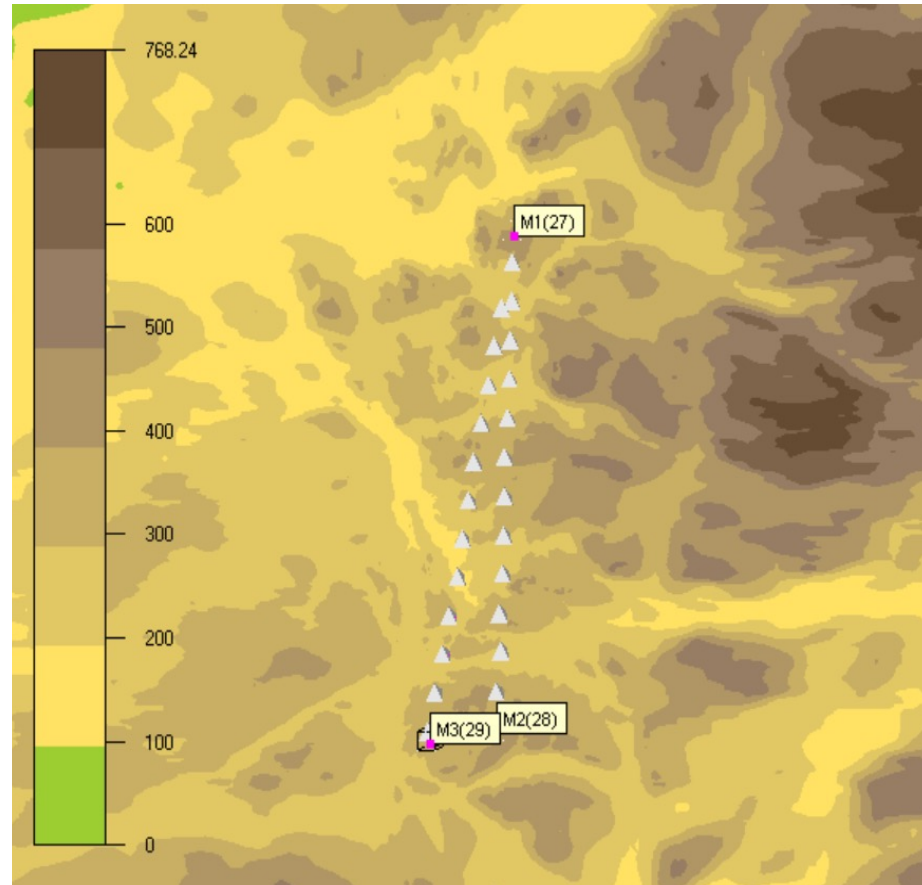
- Single sector
- Convergence
- WindSim assistance

1: Boundary and initial conditions	
Do Nesting	Disregard nesting
Sector input type	Manually set sector angles
Sectors for next run	330
Height of boundary layer	500
Speed above boundary layer height	10
Use previous run as input	False
Boundary condition at top	Fixed pressure
2: Physical models	
Potential temperature	Disregard temperature
Air density	1.225
Turbulence model	Standard k-epsilon



Objects

- Positioning the turbines & .ows
- Why are we placing turbines?
- Measurement points

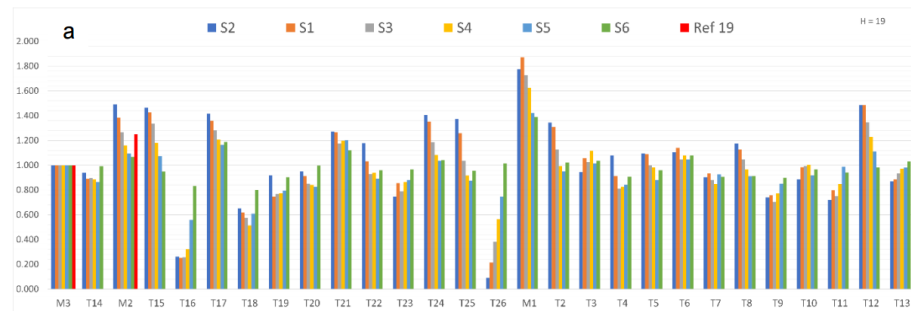


Data processing

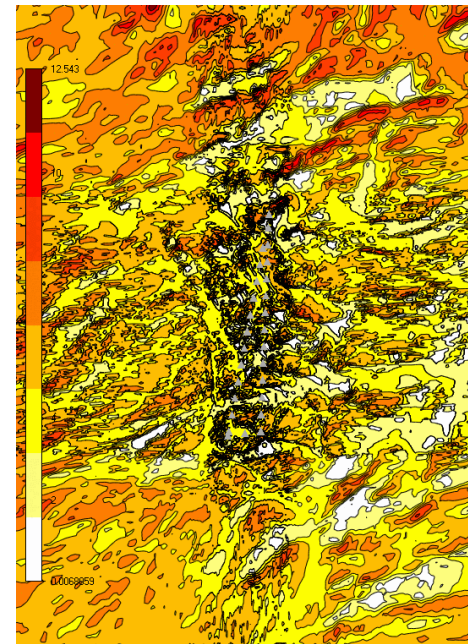
- Vertical profiles
- Interpolation
- Normalization

WindSpeeds Height	T1	T2	T3	T4	T5	T6
	Speed_2D	Speed_2D	Speed_2D	Speed_2D	Speed_2D	Speed_2D
	(m/s)	(m/s)	(m/s)	(m/s)	(m/s)	(m/s)
1.00	1.20	3.482	1.526	3.04	3.839	2.78
3.30	1.22	4.547	2.956	3.53	4.289	3.705
6.30	1.04	5.038	3.638	3.646	4.451	4.124
10.20	0.72	5.353	4.123	3.76	4.556	4.452
15.25	0.57	5.589	4.461	3.889	4.671	4.778
21.80	1.21	5.805	4.717	4.051	4.818	5.126
30.35	2.07	6.033	4.933	4.263	5.009	5.495
41.45	2.91	6.297	5.121	4.541	5.255	5.885
55.85	3.74	6.6	5.298	4.896	5.555	6.3
74.60	4.56	6.928	5.478	5.326	5.911	6.743
99.00	5.42	7.255	5.68	5.809	6.323	7.212
130.75	6.30	7.566	5.922	6.309	6.79	7.697
172.00	7.15	7.859	6.227	6.809	7.312	8.174
225.55	7.91	8.143	6.631	7.313	7.87	8.617
295.20	8.53	8.435	7.182	7.834	8.42	9.014
Height						
19	0.934	5.713	4.608	3.982	=FORECAST.LINEAR(\$A\$21	
49	3.345	6.456	5.214	4.727	FORECAST.LINEAR(
100	5.451	7.265	5.688	5.825	6.558	7.227

Results

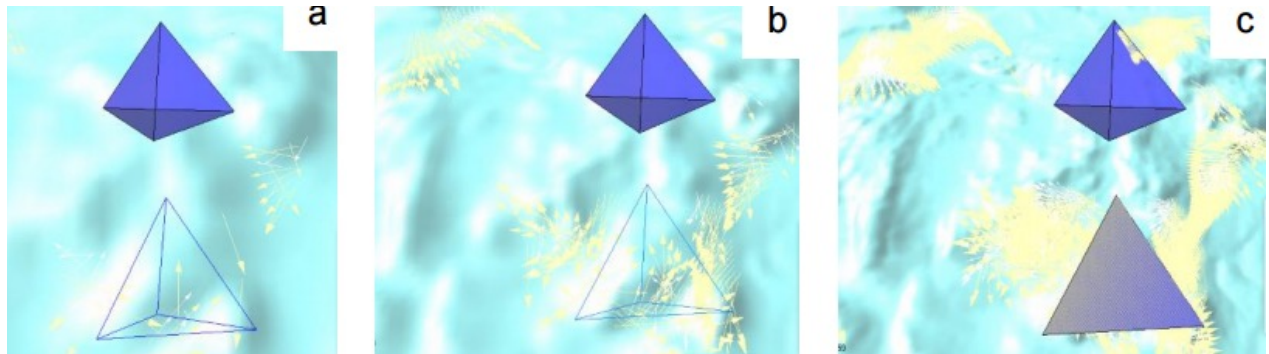
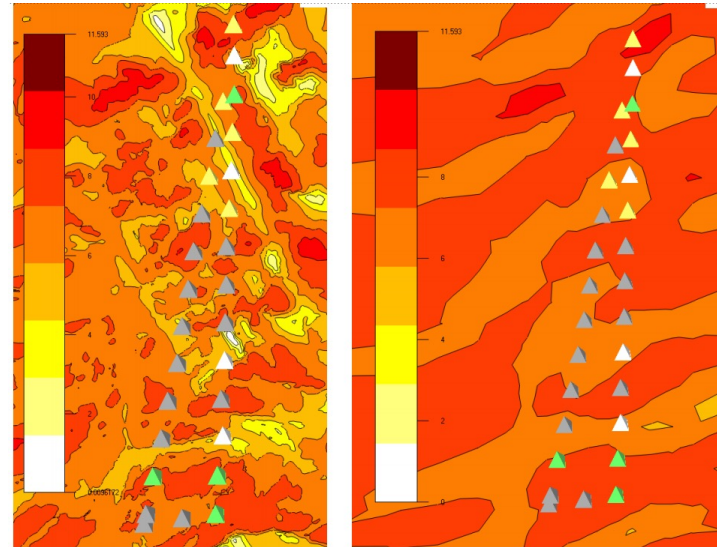


- Bar-Charts
- Wind speed graphics



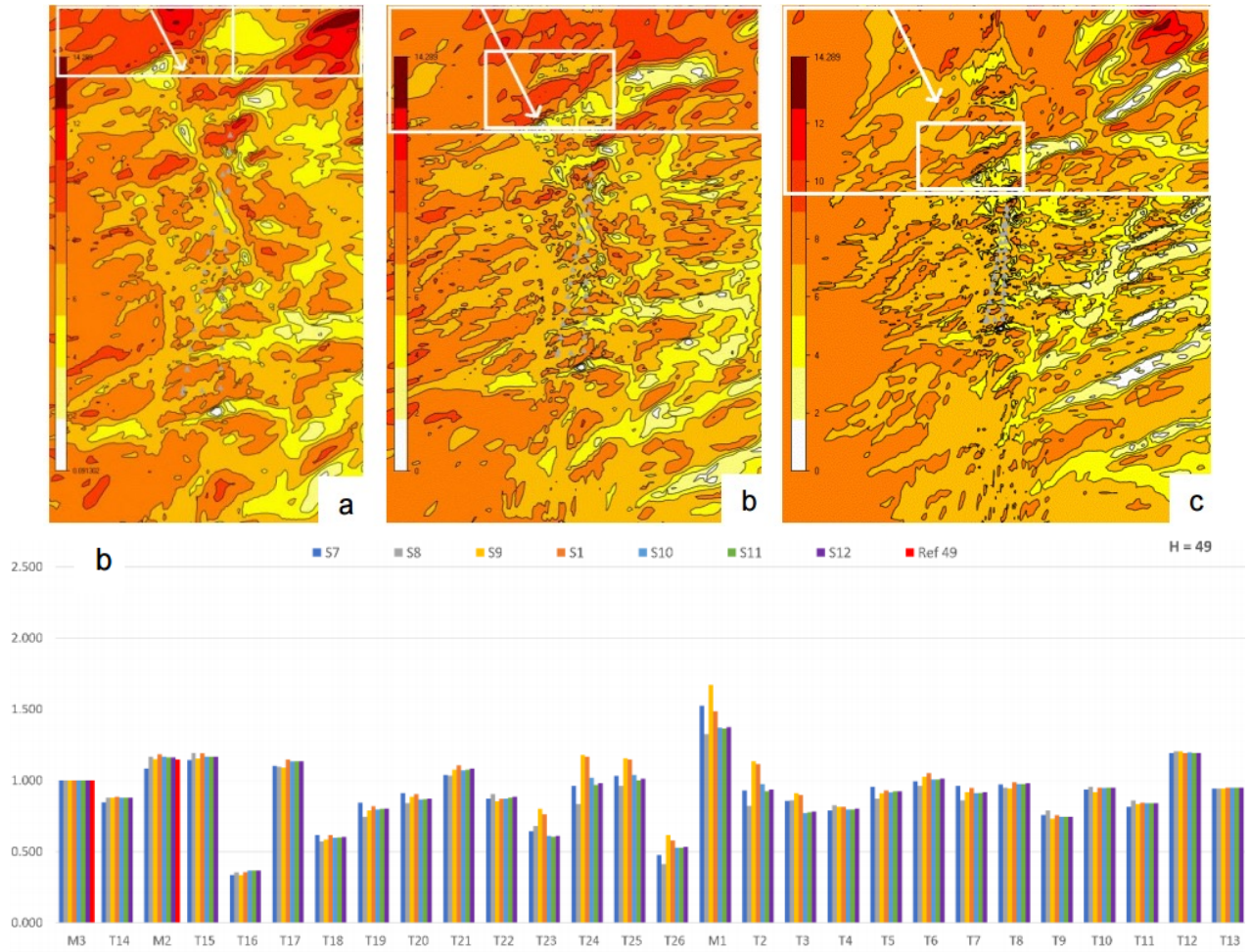
Resolution

- Max and min resolutions
- Areas of low wind speed
- Recirculation
- Grid dependency
- Sensitivity



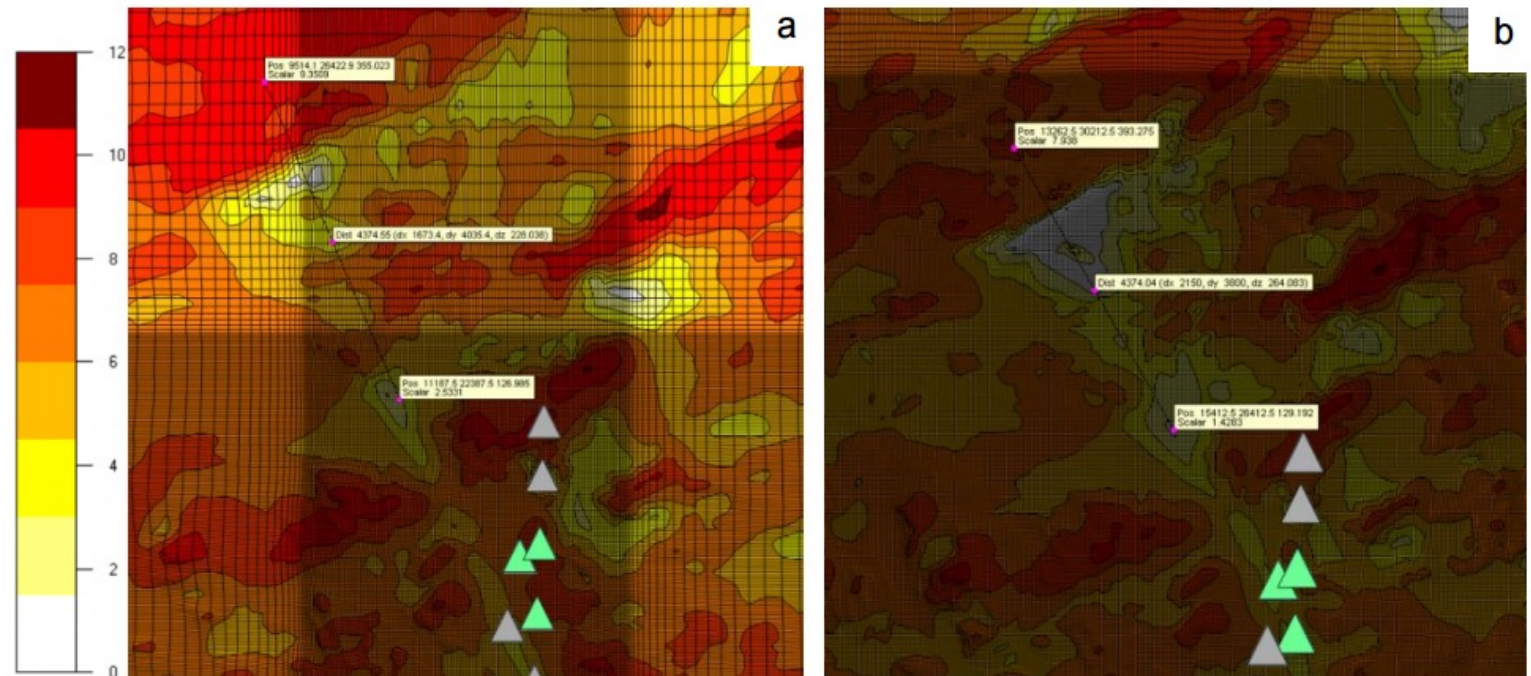
Domain buffer size

- Model border
- Flow development
- Grid dependency
- Sensitivity



Refinement Area

- Border
- Grid dependency
- Sensitivity



Vertical Layers

- Grid dependency
- Sensitivity

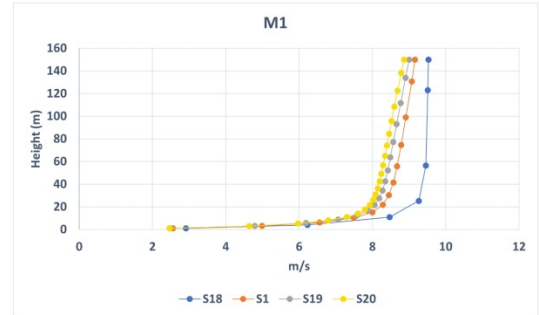
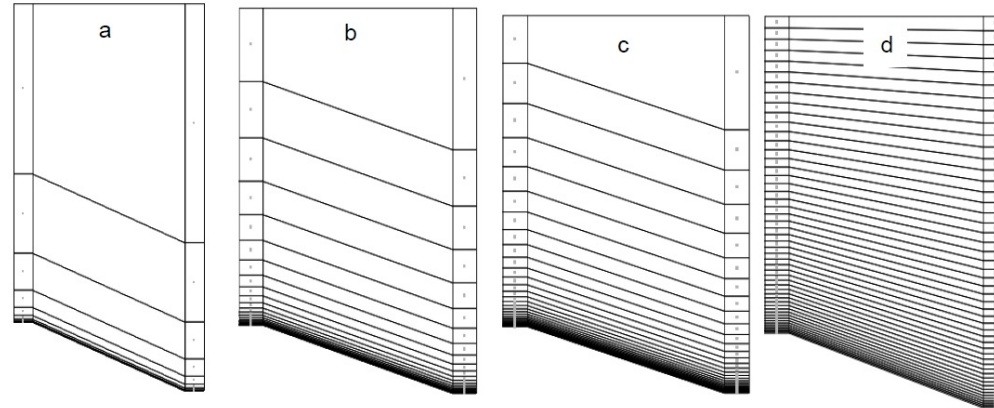
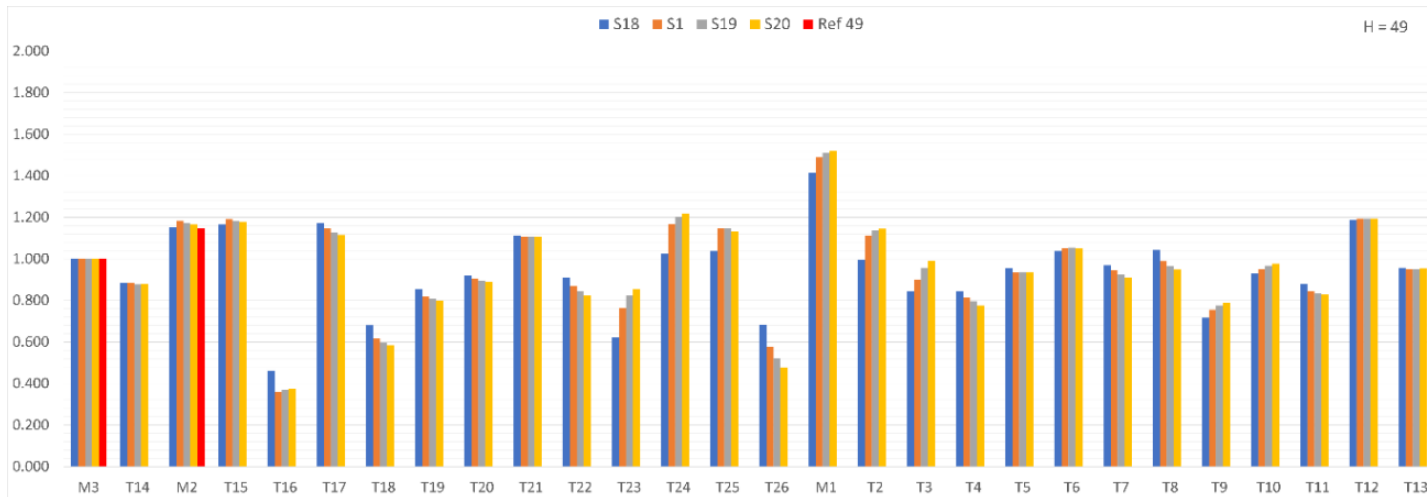
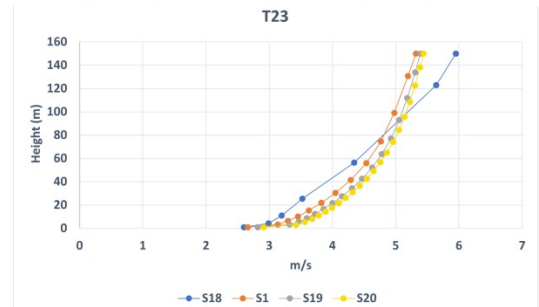


Figure 36 Vertical plot of the simulated wind speed at respective heights at turbine position M1



Conclusion

- Parameter sensitivity
- Resolution & Accuracy
- Domain Size

