

A SOM-based Assessment of AMPS Surface Layer Forecasts Using Observations from the RIS Tall Tower AWS

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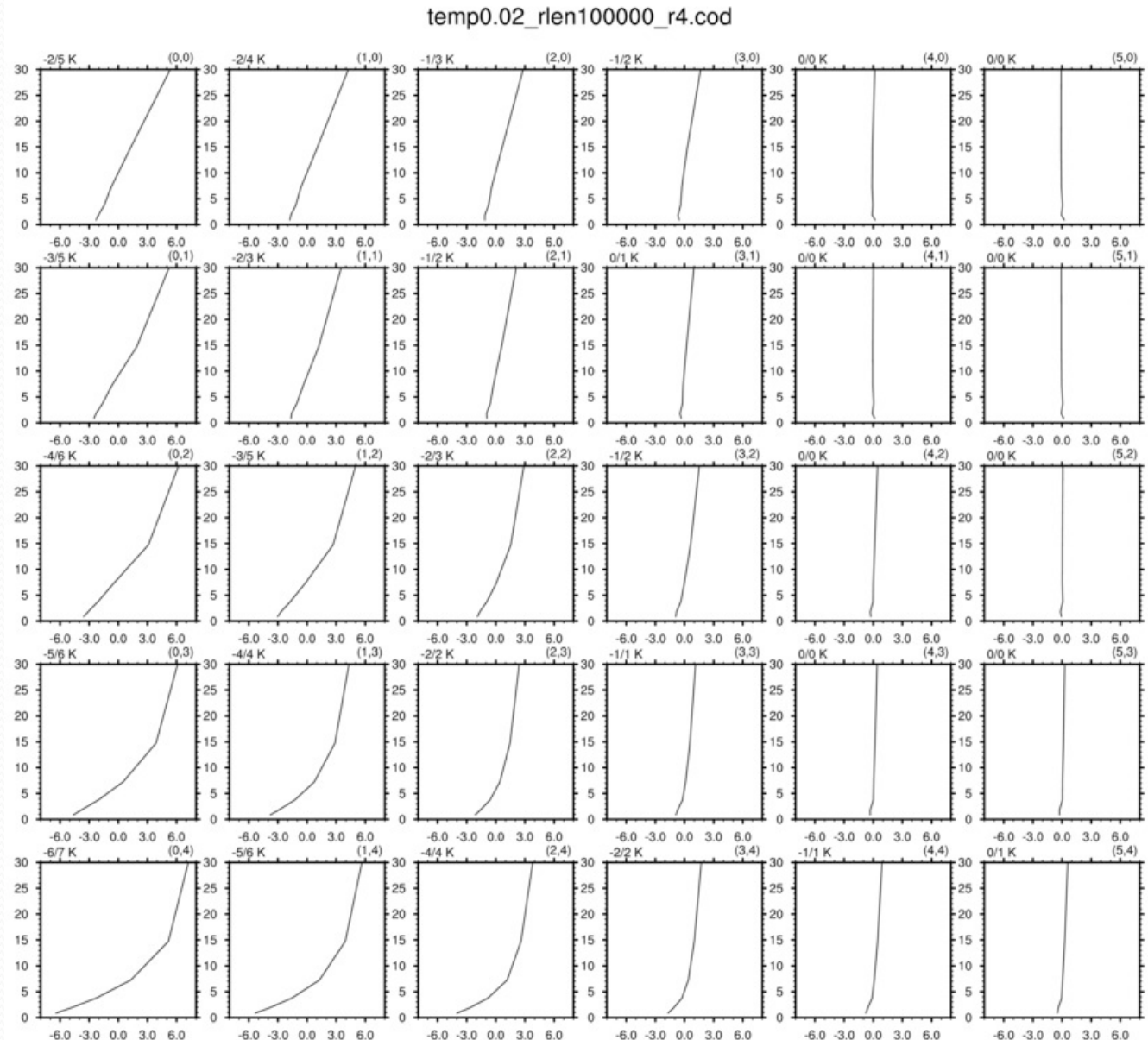
Overview

- Use 2 years (Feb 2011 – Jan 2013) of atmospheric surface layer observations from Tall Tower AWS to evaluate AMPS 12-23 h forecasts
- Classify observed and modeled temperature profiles using self-organizing map technique



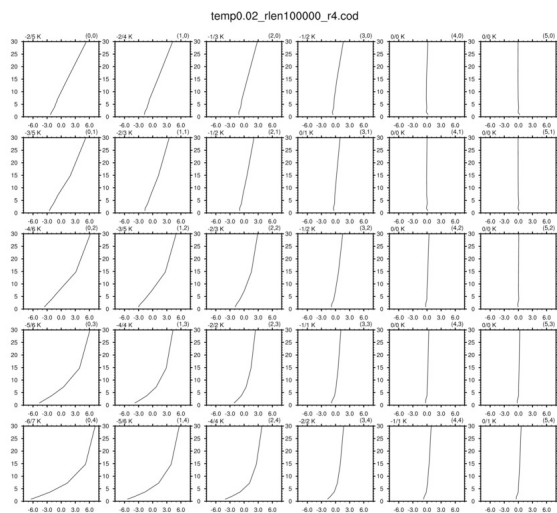
Potential Temperature SOM

- SOM used to identify range of potential temperature profiles in over 100,000 10 minute observations
- Left – stratified
- Right – well mixed
- Bottom – stronger stability
- Top – weaker stability



TT AWS Annual Pattern Frequency

- Right two columns: Well mixed to weakly stable profiles are the most commonly observed profile type
- Top center: Moderate inversions are next most commonly observed profile type
- Bottom left: Inversions > 10 K observed 6.5% of the time

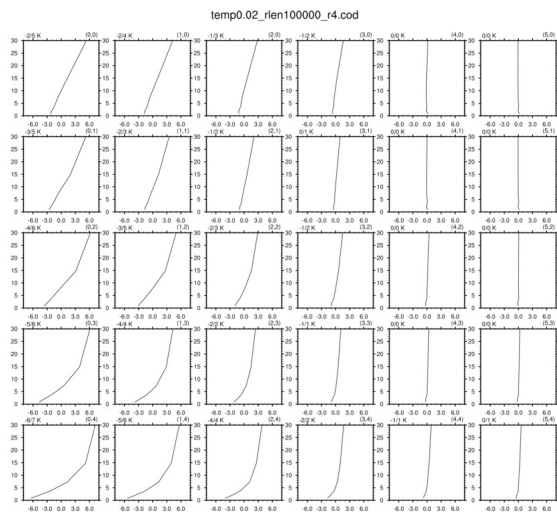


Annual

SOM Pattern	0	1.34%	1.70%	2.49%	1.97%	0.73%	3.15%
	1	1.09%	1.40%	2.62%	2.91%	1.24%	9.18%
	2	2.01%	1.12%	2.09%	2.83%	3.42%	23.64%
	3	1.07%	1.14%	1.31%	2.26%	3.99%	9.14%
	4	2.26%	1.18%	1.22%	1.22%	3.63%	6.65%
		0	1	2	3	4	5
		SOM Pattern					

AMPS Annual Pattern Frequency

- Right two columns: Well mixed to weakly stable profiles are the most commonly simulated profile type
- Bottom center: Moderate inversions are the next most common profile type
- Bottom left: Inversions > 10 K are not simulated by AMPS

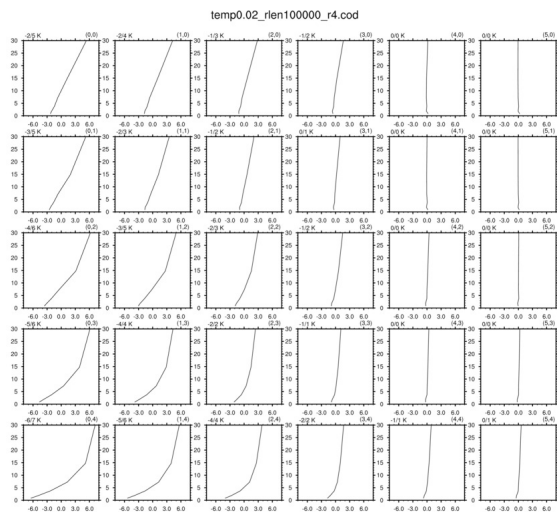


Annual

SOM Pattern	0	1.99%	2.06%	2.40%	0.79%	0.73%	7.93%
	1	0.44%	2.53%	2.01%	1.21%	2.04%	2.60%
	2	0.04%	0.01%	2.14%	3.10%	0.96%	9.92%
	3	0.00%	0.00%	4.86%	8.28%	3.15%	8.26%
	4	0.00%	0.00%	0.75%	8.57%	12.57%	10.66%
		0	1	2	3	4	5
		SOM Pattern					

AMPS – TT AWS Annual Pattern Frequency

- AMPS simulates more moderate stability patterns (bottom center and top left) than observed
- AMPS under-simulates strong inversion patterns (bottom left)
- AMPS simulates nearly well mixed patterns in right two columns 59% of the time compared to 65% of the time in observations



Node Frequency Differences AMPS - Tall Tower - ALL

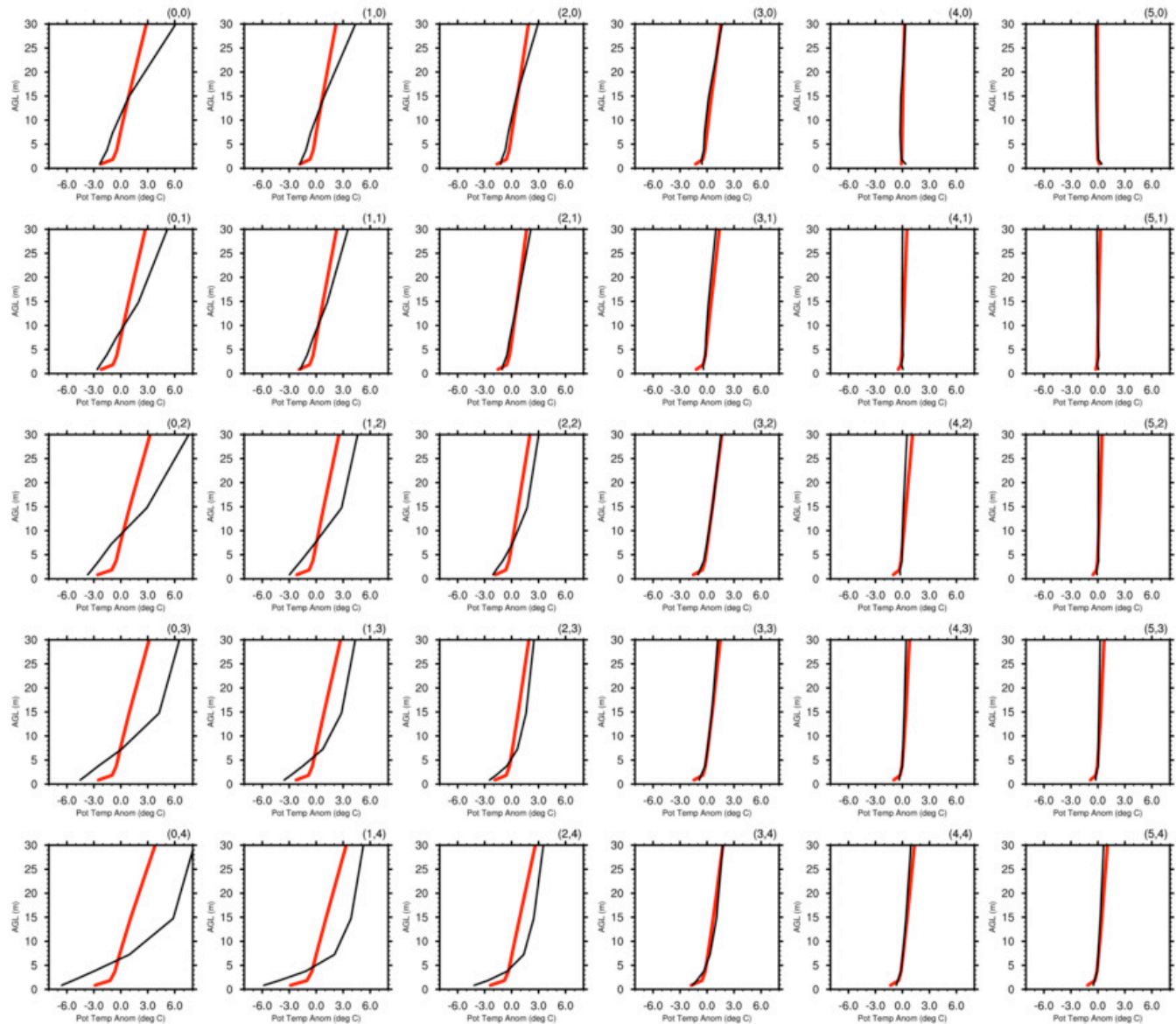
0	0.65%	0.36%	-0.08%	-1.18%	0.00%	4.78%
1	-0.65%	1.13%	-0.61%	-1.70%	0.80%	-6.58%
2	-1.97%	-1.11%	0.05%	0.26%	-2.46%	-13.72%
3	-1.07%	-1.14%	3.55%	6.02%	-0.83%	-0.88%
4	-2.26%	-1.18%	-0.48%	7.35%	8.94%	4.01%
	0	1	2	3	4	5

SOM Pattern

SOM Pattern

Comparison of Potential Temperature Profiles

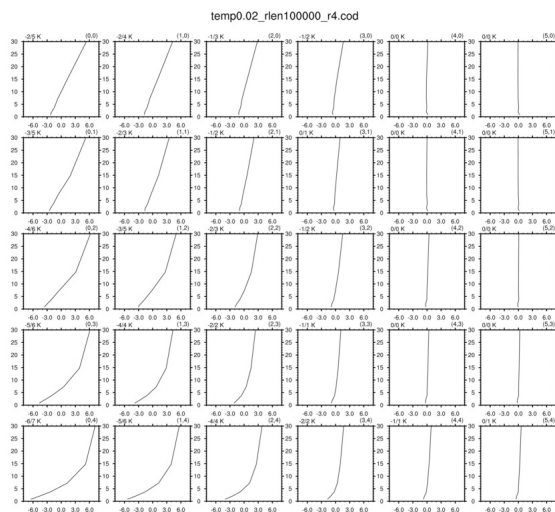
- TT AWS – black
- AMPS – red
- Compare AMPS forecasts to all TT profiles that map to each SOM pattern
- AMPS profiles very similar to observed profiles for well mixed to weak inversion cases
- AMPS underestimates inversion strength for most strong inversion patterns



TT Vertical Potential Temperature Difference

Potential temperature difference between 29.75 m and 0.85 m

- Top right: Unstable
- Bottom right: Weakly stable
- Left: Strongly stable
- Bottom left: Strongest stability

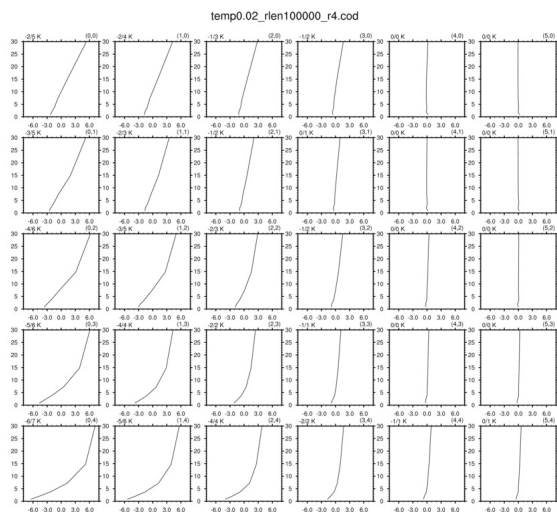


SOM Pattern	0	10.2 8.1 7.1	6.7 6.1 5.4	4.7 4.1 3.6	2.7 2.2 1.8	0.4 0.1 -0.6	-0.3 -0.5 -1.1
	1	9.1 7.7 6.6	5.9 5.2 4.7	3.5 3.2 2.8	1.7 1.4 1.0	0.0 -0.0 -0.1	-0.1 -0.2 -0.3
	2	14.2 10.7 9.0	8.7 7.5 6.5	6.1 5.0 4.2	2.9 2.5 2.2	0.9 0.8 0.6	0.3 0.1 -0.0
	3	12.9 10.8 9.5	9.1 7.8 6.7	6.0 4.9 4.1	2.3 2.0 1.8	0.9 0.8 0.7	0.6 0.5 0.4
	4	17.8 14.4 12.2	12.5 11.0 9.7	9.5 7.4 6.2	4.0 3.4 2.8	1.8 1.6 1.4	1.3 1.1 0.9
		0	1	2	3	4	5
		SOM Pattern					

AMPS-TT Vertical Potential Temperature Difference

Potential temperature difference between 29.75 m and 0.85 m

- Right three columns: AMPS generally slightly more stable than observations
- Left three columns: AMPS has much weaker inversions than observations

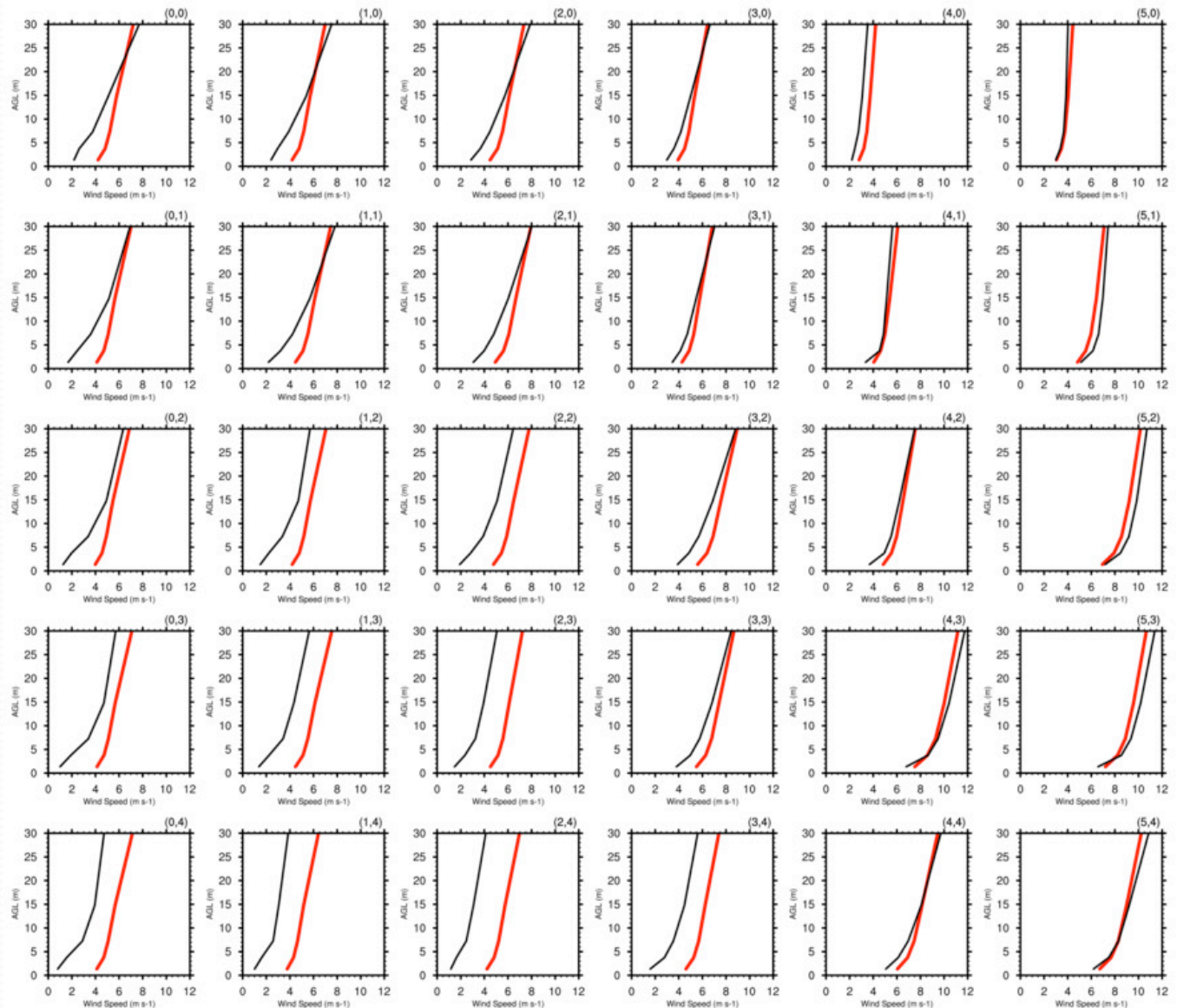


Differences AMPS - Tall Tower

SOM Pattern	Differences AMPS - Tall Tower					
	0	1	2	3	4	5
0	-1.90 -3.30 -5.01	0.21 -2.20 -3.86	1.22 -0.74 -2.43	3.44 0.44 -1.61	1.99 -0.17 -0.15	1.41 0.02 0.05
1	-1.31 -3.07 -4.15	1.03 -1.27 -2.92	1.94 -0.22 -1.68	3.87 0.97 -0.88	3.64 0.48 -0.53	2.68 0.18 -0.46
2	-5.70 -4.50 -6.58	-1.17 -2.79 -4.46	0.17 -1.26 -2.68	2.57 0.23 -0.80	4.32 0.92 -0.63	2.35 0.44 -0.13
3	-4.68 -5.02 -6.96	-1.41 -2.79 -4.80	0.28 -1.26 -2.36	3.21 0.51 -0.57	2.13 0.78 -0.06	2.59 0.78 -0.08
4	-8.80 -7.48 -8.16	-3.92 -4.51 -6.52	-1.02 -2.37 -4.31	2.07 -0.16 -1.05	3.03 0.71 -0.20	3.08 0.74 -0.17
	0	1	2	3	4	5

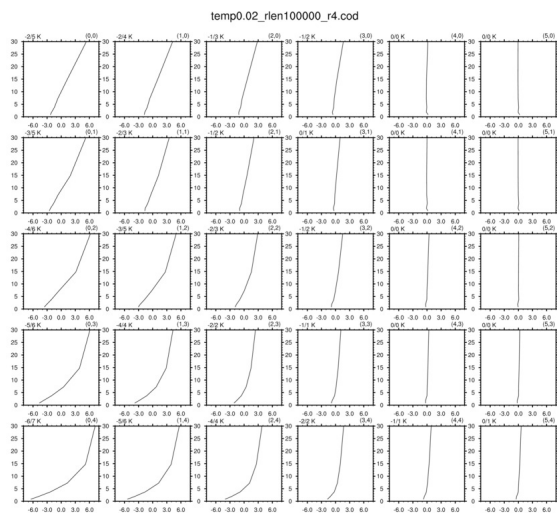
Comparison of Wind Speed Profiles

- TT AWS – black
- AMPS – red
- AMPS has similar winds to TT for well mixed conditions (right two columns)
- AMPS overestimates wind speed over depth of tower for strong inversions (bottom center and left)
- AMPS overestimates surface wind speed and underestimates wind shear for patterns in top left corner of SOM



TT Averaged WS at Lowest Tower level

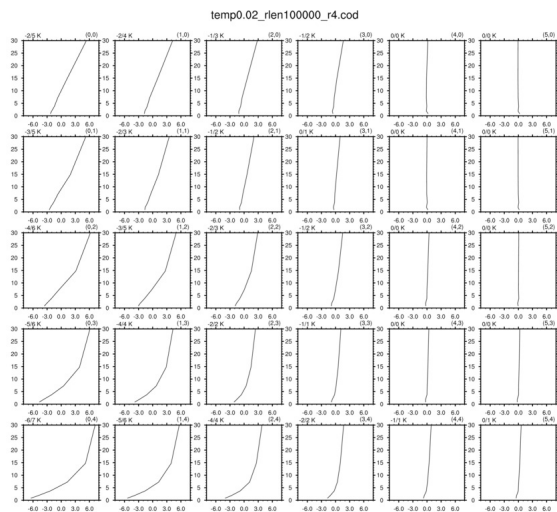
- Bottom right: Strongest winds correspond to nearly well mixed conditions
- Bottom left: Lightest winds correspond to strongest stability
- Top right: Light/moderate winds correspond to unstable stratification



SOM Pattern	0	3.9 2.2 0.2	3.9 2.5 0.7	4.7 2.9 0.9	5.4 2.9 0.8	4.8 1.7 0.7	5.4 2.8 0.8
	1	3.5 1.5 0.2	4.1 2.0 0.9	5.0 3.0 1.1	6.2 3.5 0.9	5.8 3.0 1.3	8.4 4.9 2.1
	2	2.7 1.2 0.2	2.8 1.4 0.2	3.4 1.9 0.3	6.3 4.0 1.5	6.8 3.3 1.0	12.6 6.7 2.5
	3	2.3 1.0 0.2	2.5 1.4 0.2	2.8 1.4 0.2	6.8 3.8 1.1	10.9 6.9 2.5	11.1 6.3 2.2
	4	1.9 0.2 0.2	2.2 1.0 0.2	2.2 1.2 0.2	3.5 1.5 0.2	8.4 5.0 1.5	9.4 6.6 2.0
		0	1	2	3	4	5
		SOM Pattern					

AMPS - TT Averaged WS at Lowest Tower level

- AMPS wind speeds are consistently faster than observed
- AMPS overestimation of wind speed increases as the inversion strength increases

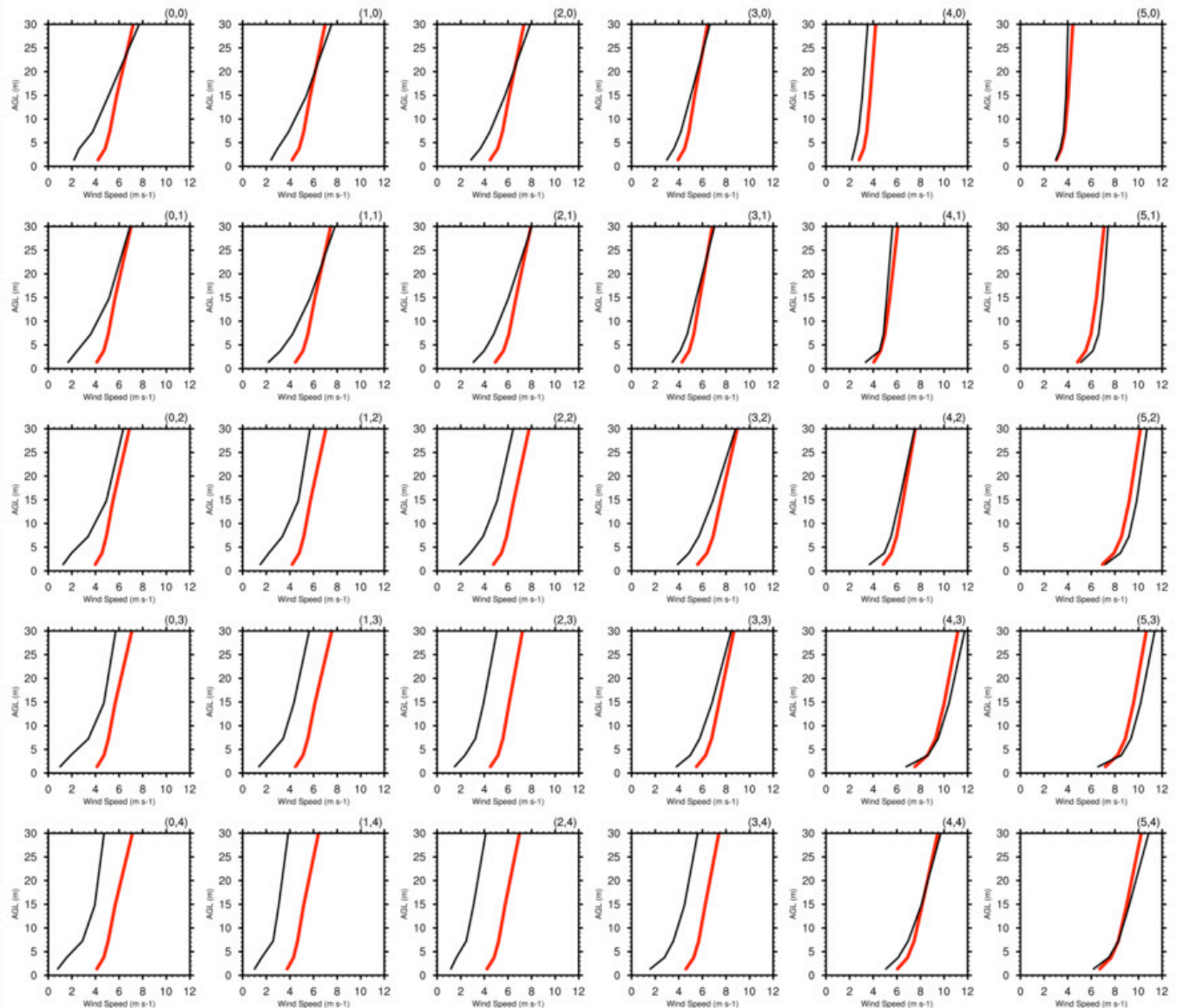


Differences AMPS - Tall Tower

SOM Pattern	0	1	2	3	4	5
0	3.0 1.9 1.9	3.4 1.4 1.2	3.0 1.4 1.0	1.3 0.8 0.8	0.5 0.4 0.3	-0.0 -0.2 0.2
1	3.4 2.3 1.9	2.8 2.2 1.3	3.4 1.5 1.3	0.9 0.5 0.8	2.1 0.6 -0.1	-0.5 -0.2 -0.3
2	3.8 2.5 1.6	4.5 2.5 1.6	5.0 2.4 1.7	2.6 1.2 1.3	1.1 1.1 1.1	-1.2 0.0 0.5
3	4.1 3.0 1.8	5.2 2.5 1.8	5.7 2.4 1.4	2.0 1.6 1.2	0.3 0.7 1.1	0.1 0.7 1.1
4	4.1 3.8 2.0	4.6 2.3 1.3	6.3 2.5 1.3	5.0 2.6 1.4	0.6 0.8 1.5	0.9 0.0 1.3
SOM Pattern	0	1	2	3	4	5

Comparison of Wind Speed Profiles

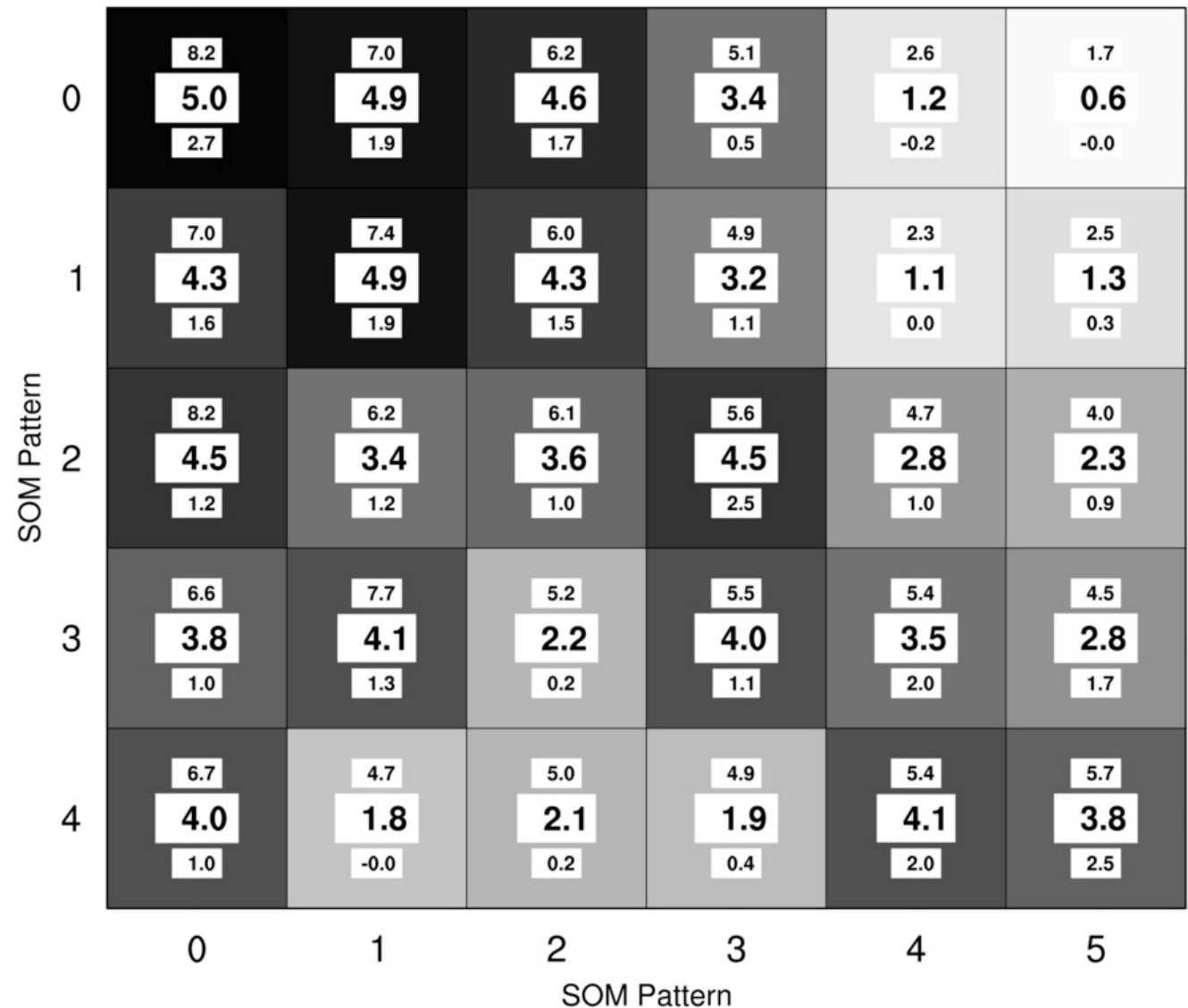
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- AMPS – red
- AMPS has similar winds to TT for well mixed conditions (right two columns)
- AMPS overestimates wind speed over depth of tower for strong inversions (bottom center and left)
- AMPS overestimates surface wind speed and underestimates wind shear for patterns in top left corner of SOM



Pattern Averaged Vertical Wind Speed Difference

Average wind speed difference between top and bottom of AWS

- Top right: Small WS difference under unstable conditions
- Bottom right: Moderate WS difference for nearly well mixed profiles that occur with strongest winds
- Top left: Largest WS difference associated with light winds at surface and moderate winds at top of AWS for strong inversion cases



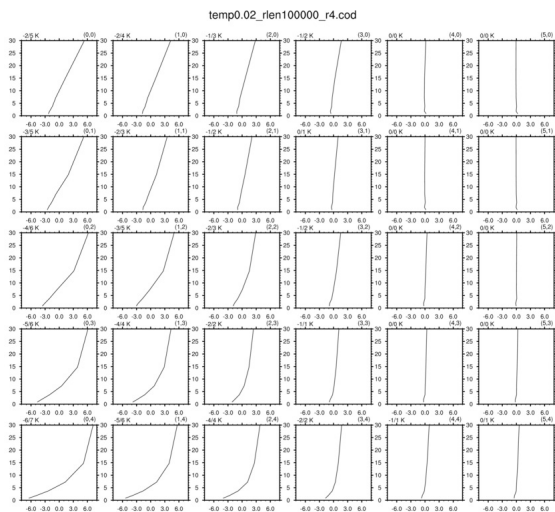
AMPS-TT Vertical Wind Speed Difference

Average wind speed difference between top and bottom of AWS

- AMPS generally simulates stronger shear for patterns on right and bottom of SOM
- AMPS simulates weaker shear for patterns in top center and top left of SOM

Differences AMPS - Tall Tower

SOM Pattern	0	-4.1 -1.7 -1.4	-2.8 -1.9 -0.8	-2.1 -1.6 -0.4	-1.1 -0.8 0.4	-0.1 0.0 0.7	0.6 0.7 0.5
	1	-2.9 -1.2 -0.2	-3.2 -1.6 -0.8	-1.7 -1.1 0.0	-1.0 -0.4 -0.1	1.5 0.7 0.7	1.0 1.0 0.6
	2	-4.0 -1.5 -0.1	-2.0 -0.3 -0.4	-1.8 -0.4 0.1	-1.1 -1.0 -0.6	-0.8 -0.0 0.4	0.9 0.8 0.8
	3	-2.3 -0.7 0.3	-3.3 -0.8 0.2	-0.9 0.8 0.5	-1.1 -0.6 0.2	-0.4 0.2 0.2	0.5 0.6 0.4
	4	-2.5 -0.7 0.2	-0.6 1.1 0.7	-0.7 0.7 0.6	-0.6 1.0 0.5	-1.0 -0.5 0.0	-1.1 -0.2 -0.3
		0	1	2	3	4	5
		SOM Pattern					



Conclusions

- Data from Tall Tower AWS provides a unique dataset for evaluating AMPS ability to simulate surface layer profiles
- AMPS simulates nearly well mixed profiles slightly less frequently than observed, moderate inversion cases more frequently than observed, and does not simulate cases with inversion > 10 K
- Nearly well mixed to slightly stable cases slightly more stable in AMPS than obs
- Moderate and strong inversions much weaker in AMPS than obs
- AMPS wind profiles match obs for well mixed cases
- Surface wind speed is consistently faster in AMPS than obs
 - This is most pronounced for moderate and strong inversion cases
- AMPS underestimates wind shear over depth of tower for moderate and strong inversion cases