Ozone Modeling Study Over The Tri-Cities Region: Part I – Meteorological Modeling & Analysis

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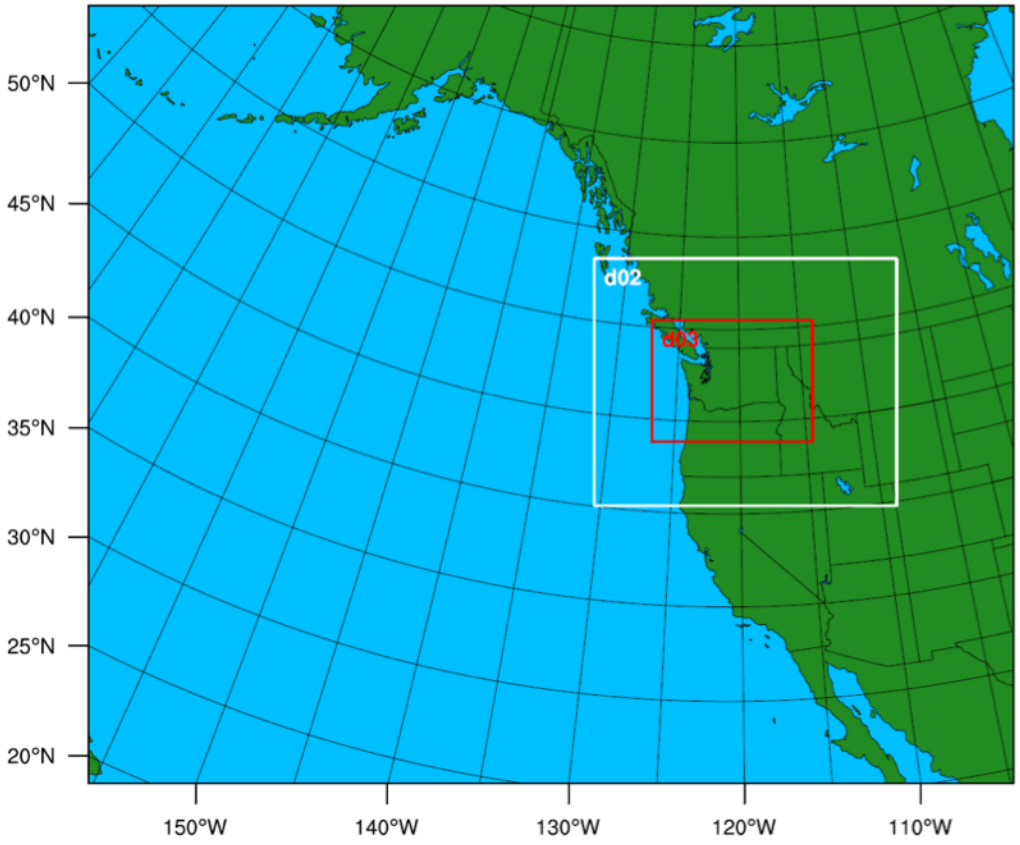
WRF Modeling Configuration

- Three Nested domains:
- 36, 12, & 4 km (151x127; 148x121; 235x178)
- One-way nesting
- 38/30 sigma vert. levels
- Two Physics options:

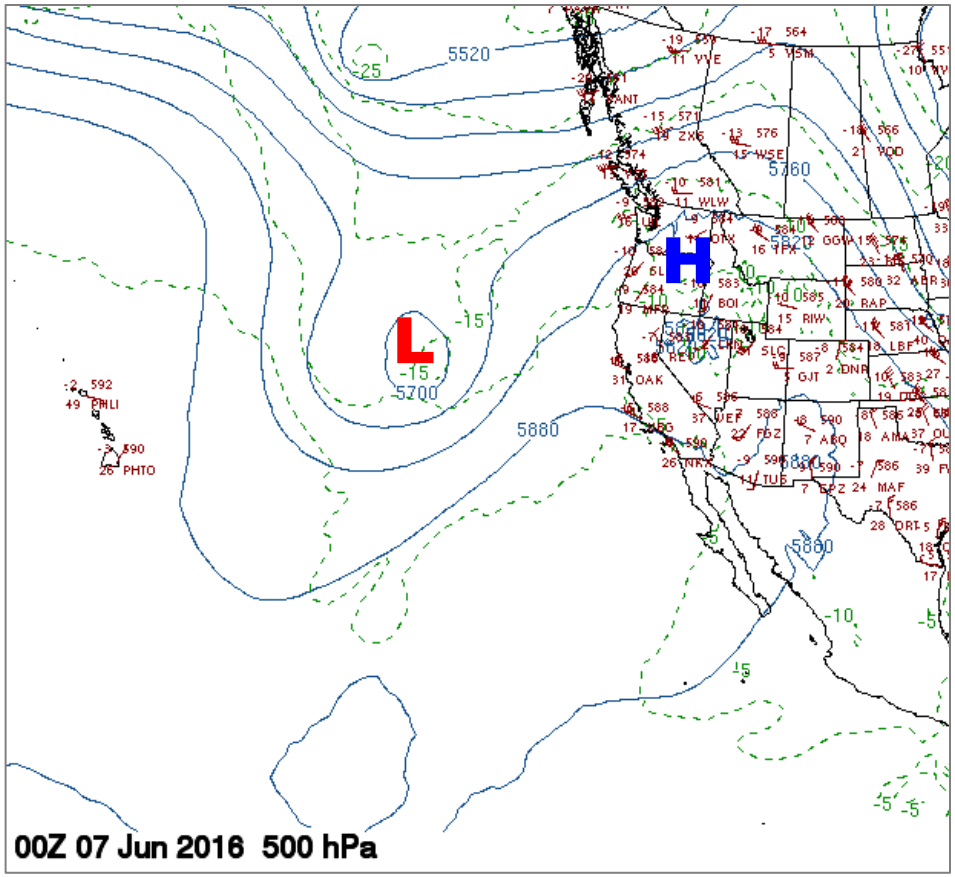
1. Control-option
2. UW-option

- Input data:
  - GFS, NAM, RAP, OTIS-SST
- Simulation options:

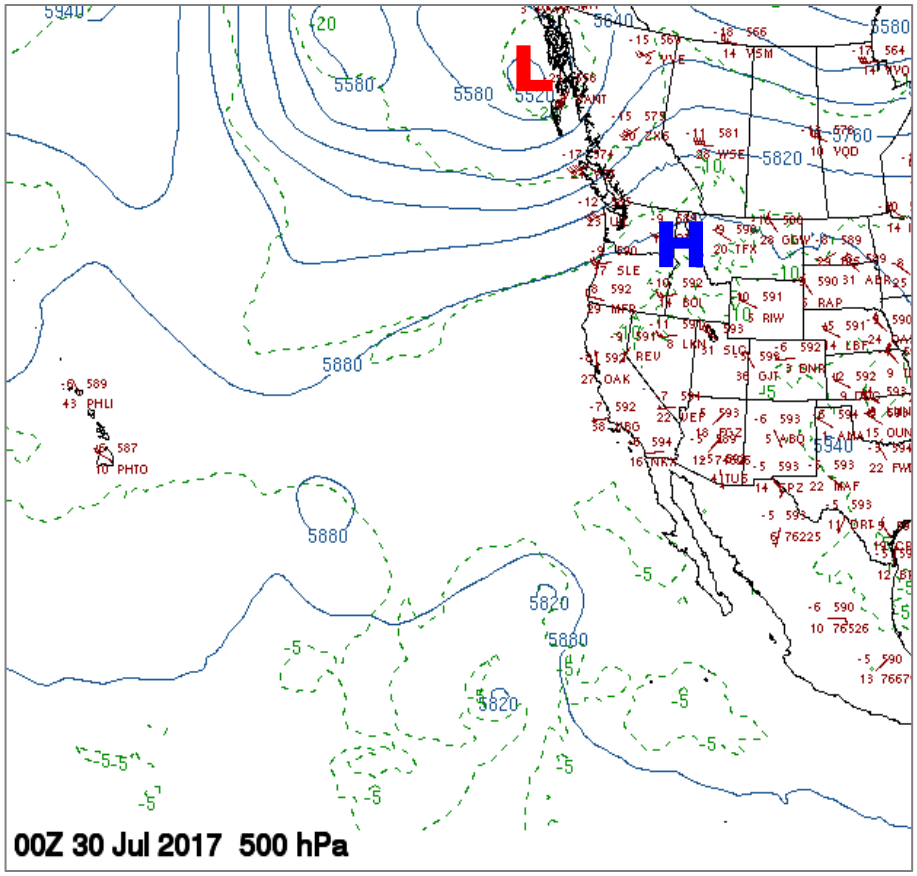
- With & without analysis nudging
- Two cases:
- 2 - 9 Jun 2016 (5 - 7 high O3 days)
- 23 Jul – 1 Aug, 2017 (29 – 30 high O3 days)
- 6-runs per case + 1.3km UW-operational run



6-7 Jun 2016



29-30 Jul 2017



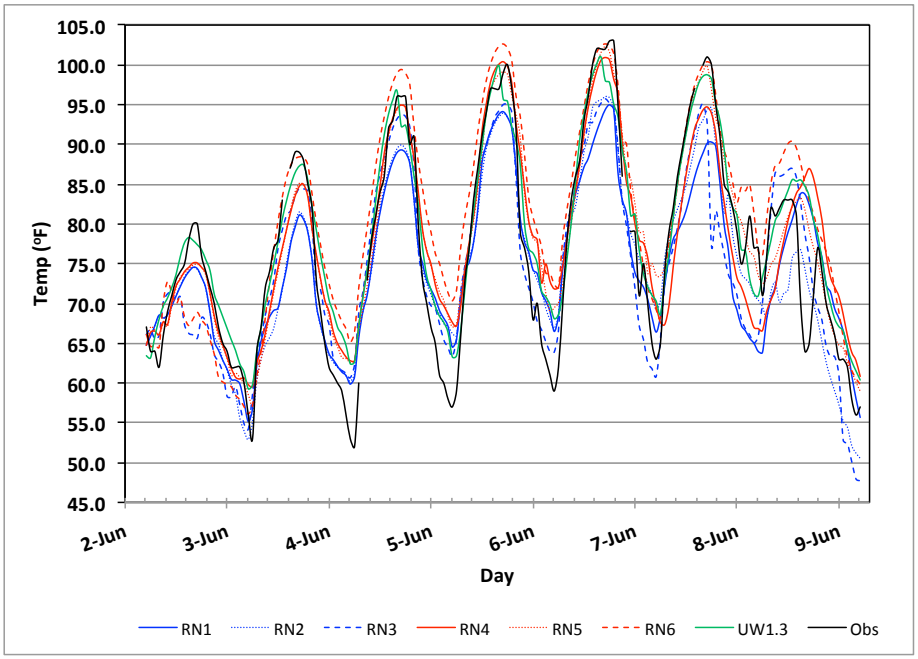
- Both cases were chosen, because:

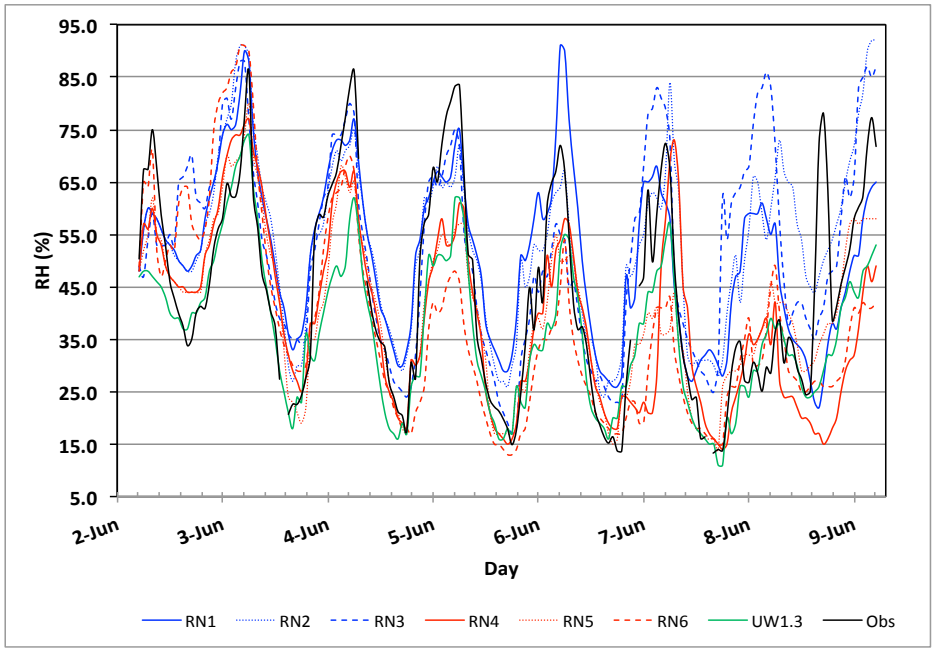
1. O3 peaked over the Tri-Cities
2. No smoke from wildfires
3. No clouds (high pressure system)

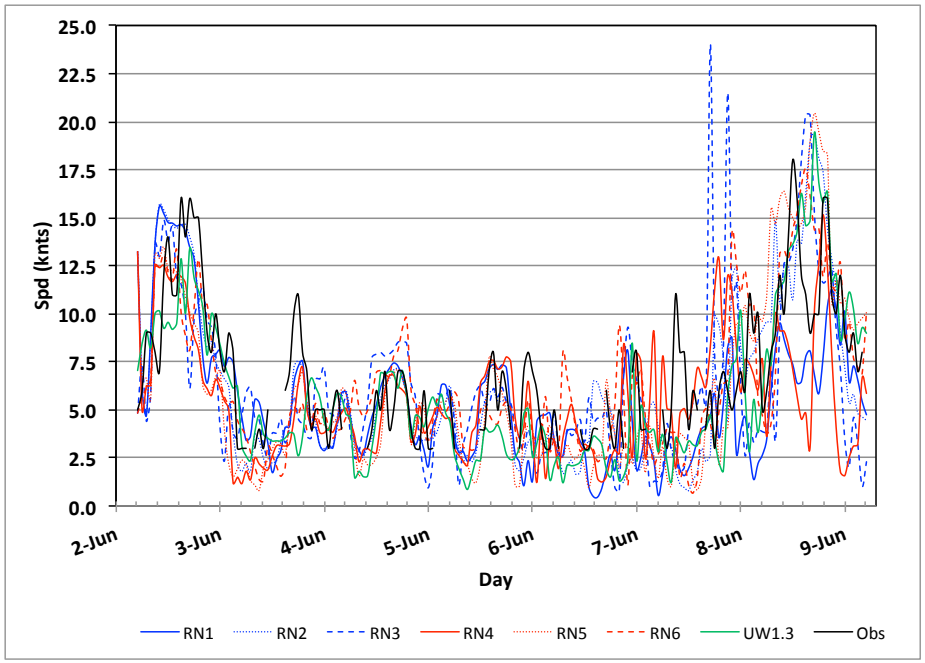
Model Inputs & Runs

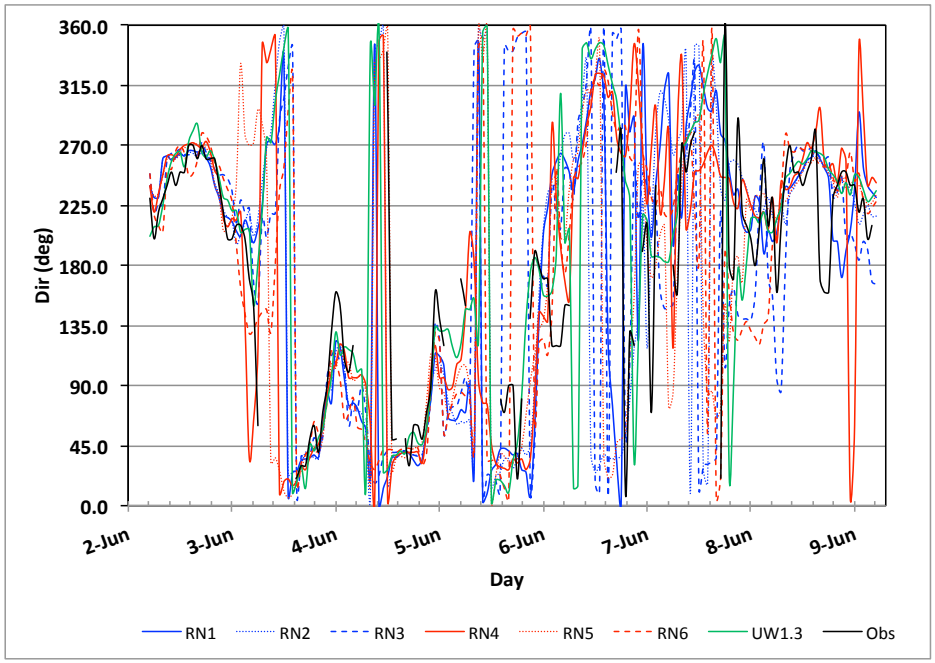
- Large scale data input
  - GFS/FNL at 1-deg (~110 km resolution) (2 runs per case)
  - GFS + NAM (40 km) + RAP (13 km) + OTIS SST (1 run each)
- Simulations per case, per met input
  - Control run: Run1 – Run3
  - Control run with analysis (grid) nudging
  - UW-physics option run with analysis nudging
- WRF 4-km outputs analyzed
  - Run 1-3: control runs
  - Run 4-6: UW-physics runs
  - UW1.3: Operational UW WRF output

Model Results: Hermiston - OR, 2-9 Jun2 2016

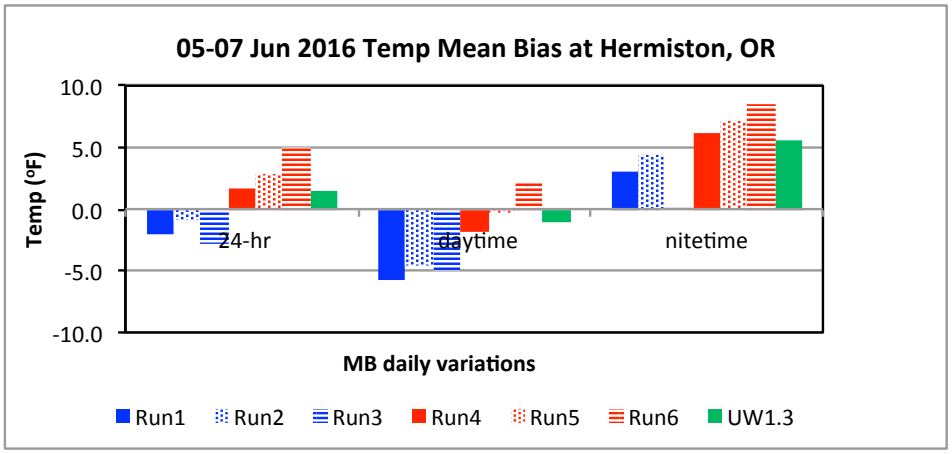


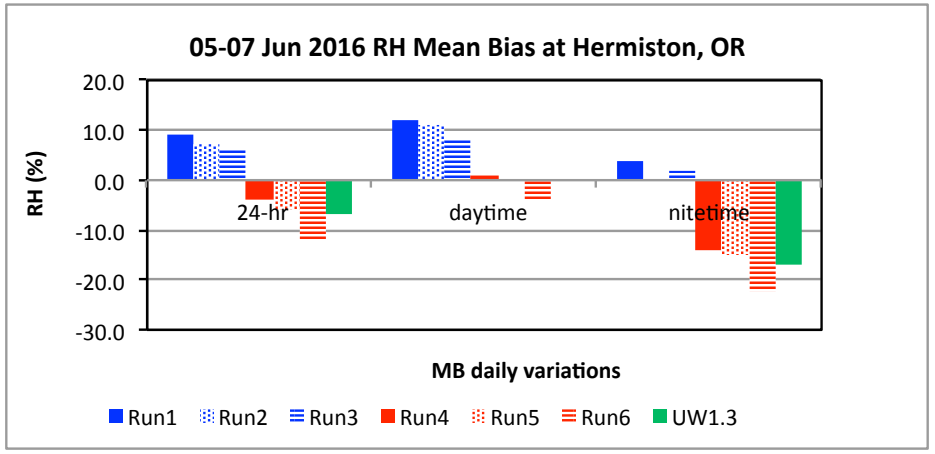


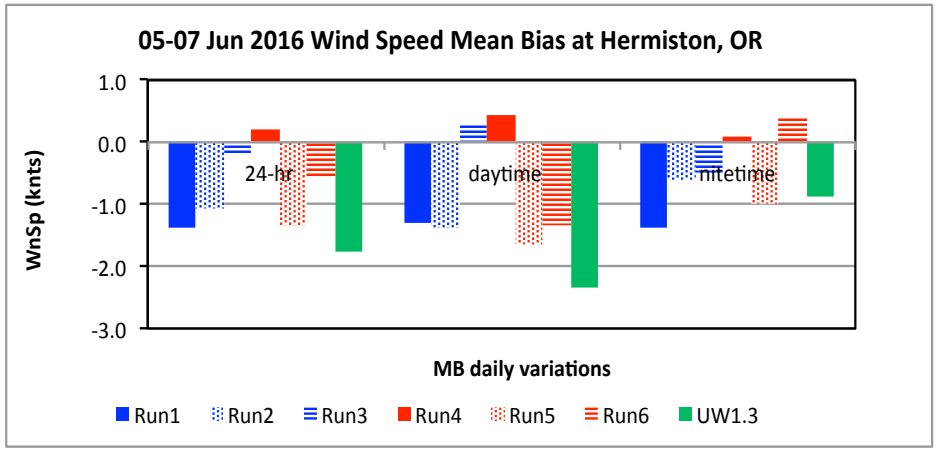


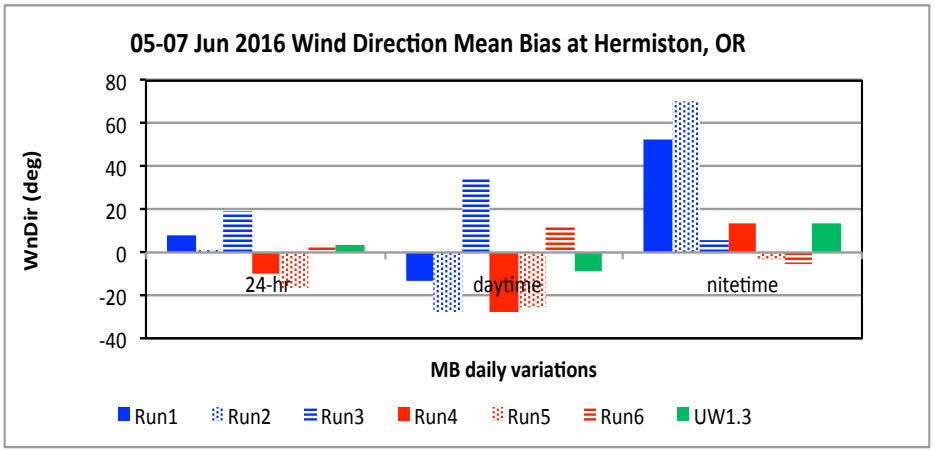


Model Bias Comparison

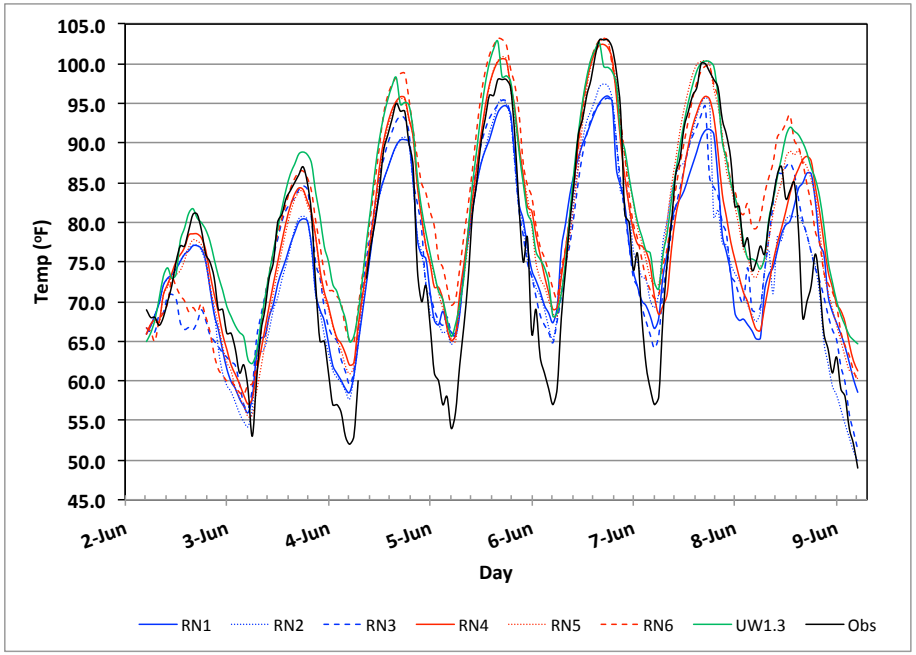


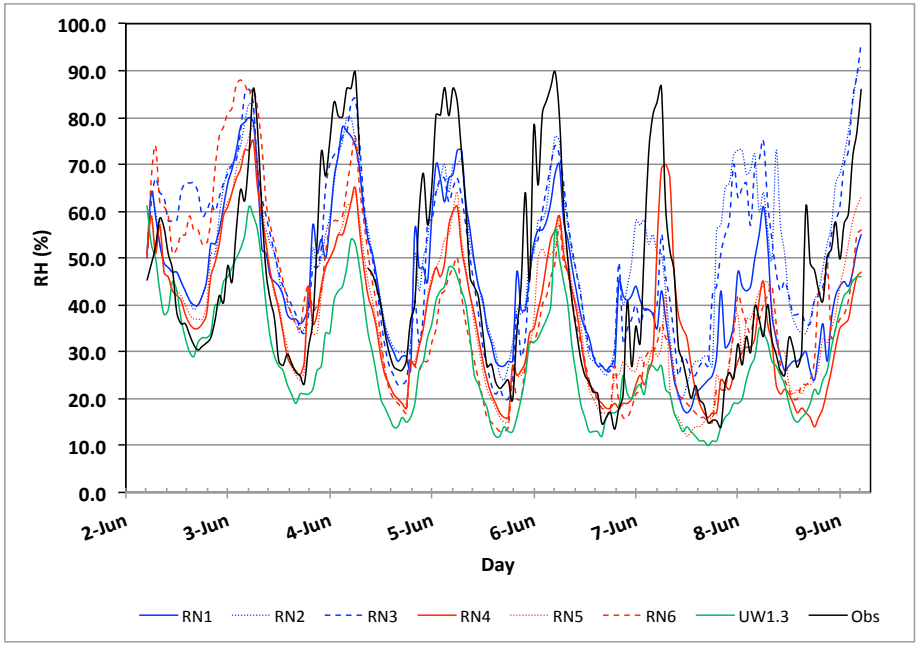


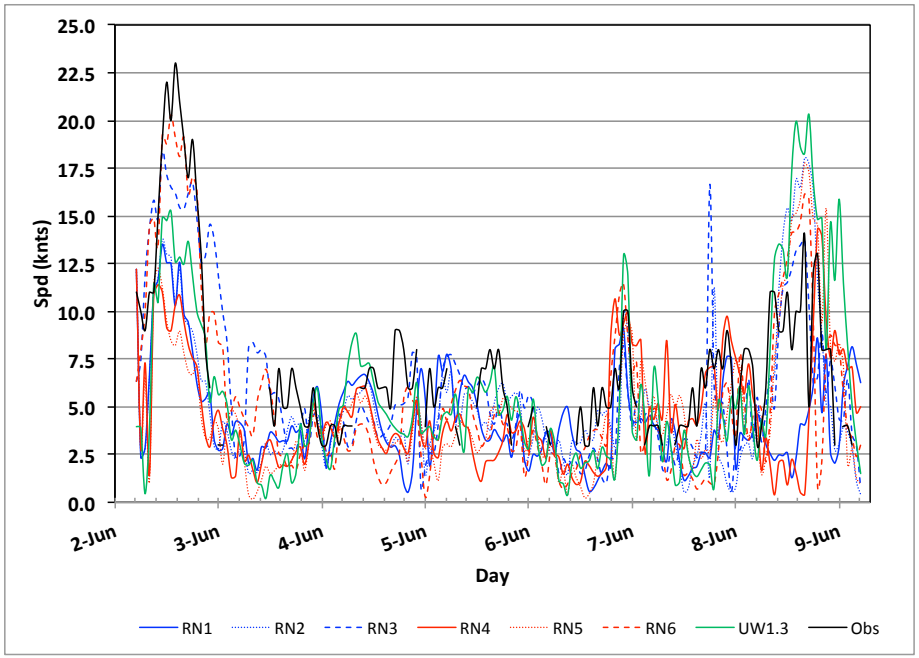


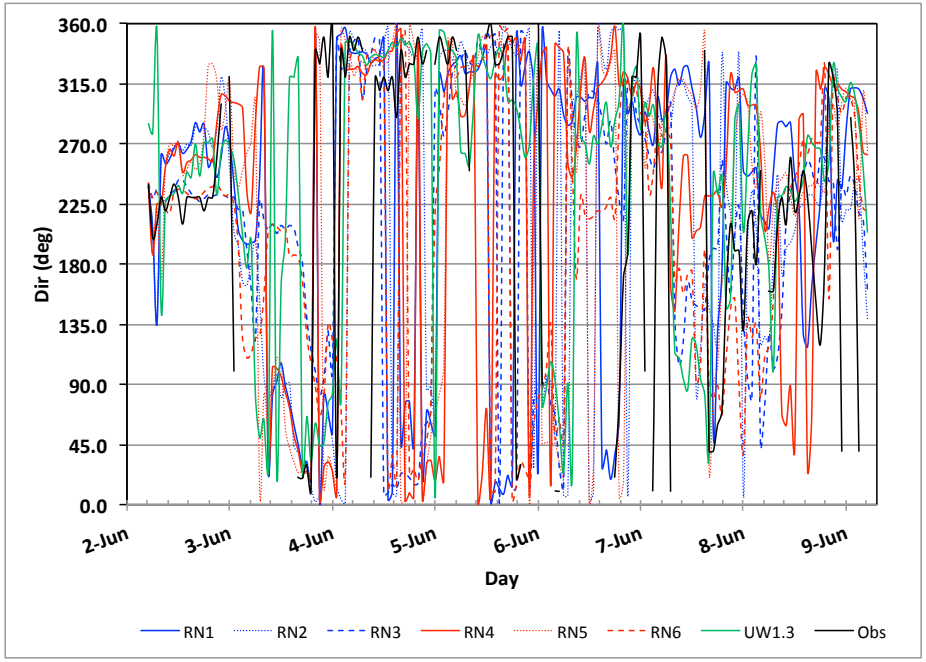


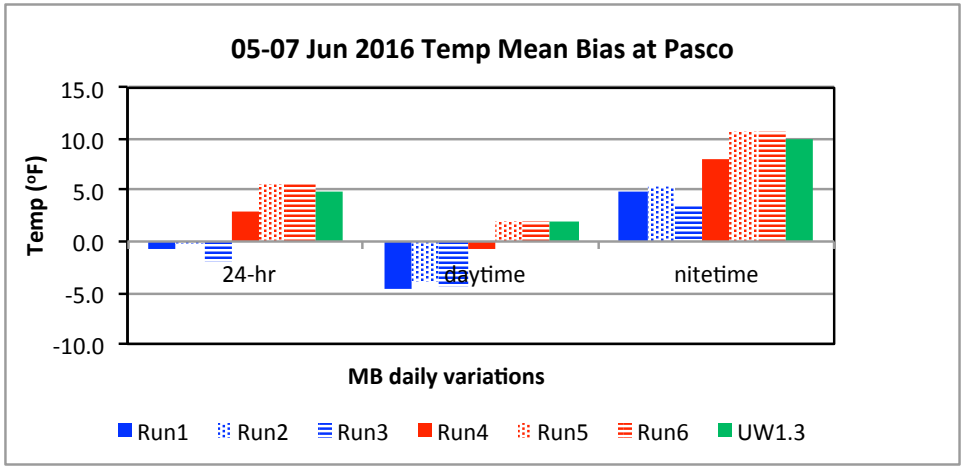
Pasco - WA, 2 - 9 June 2016

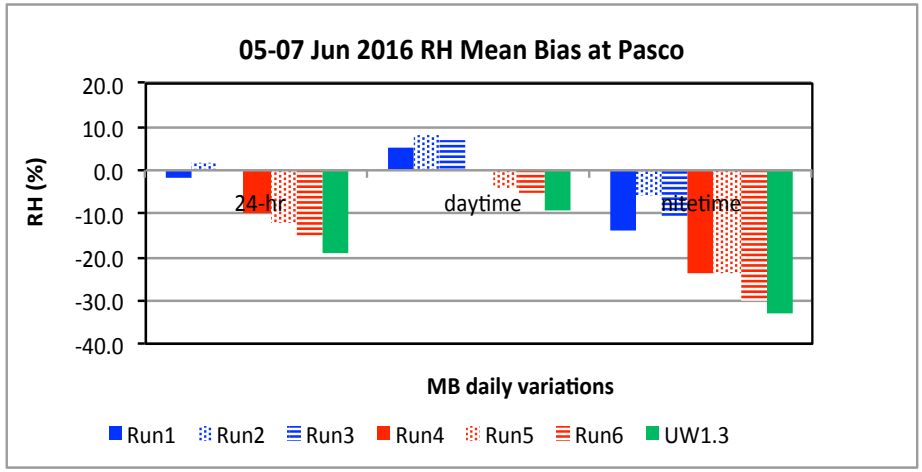


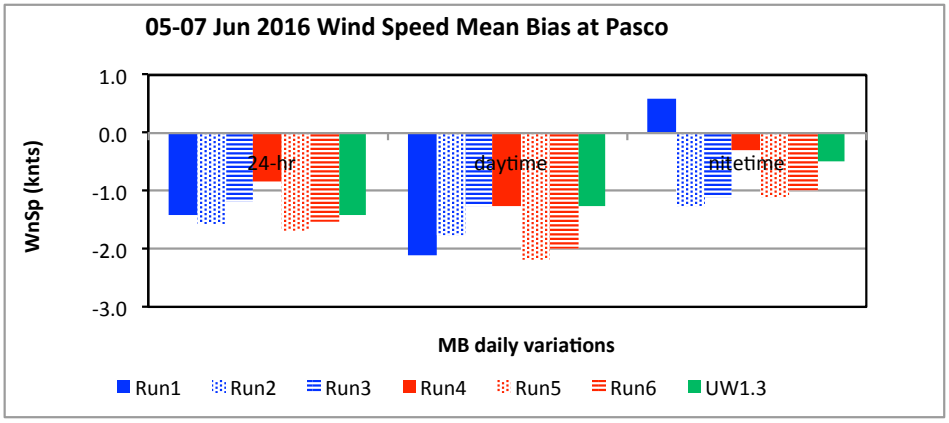


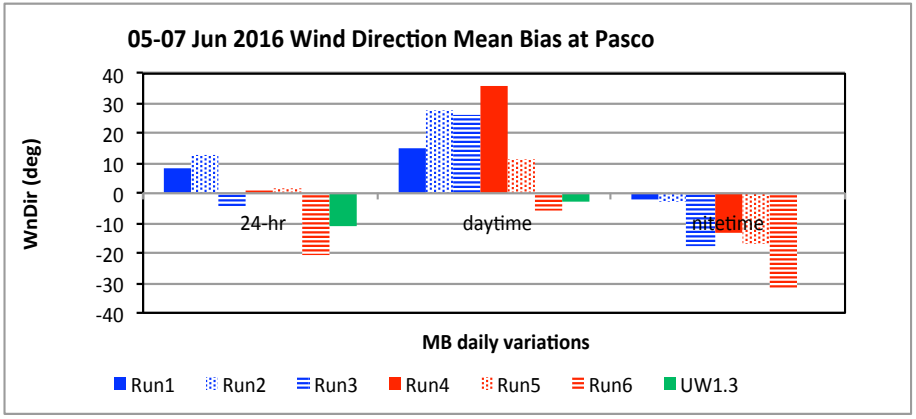




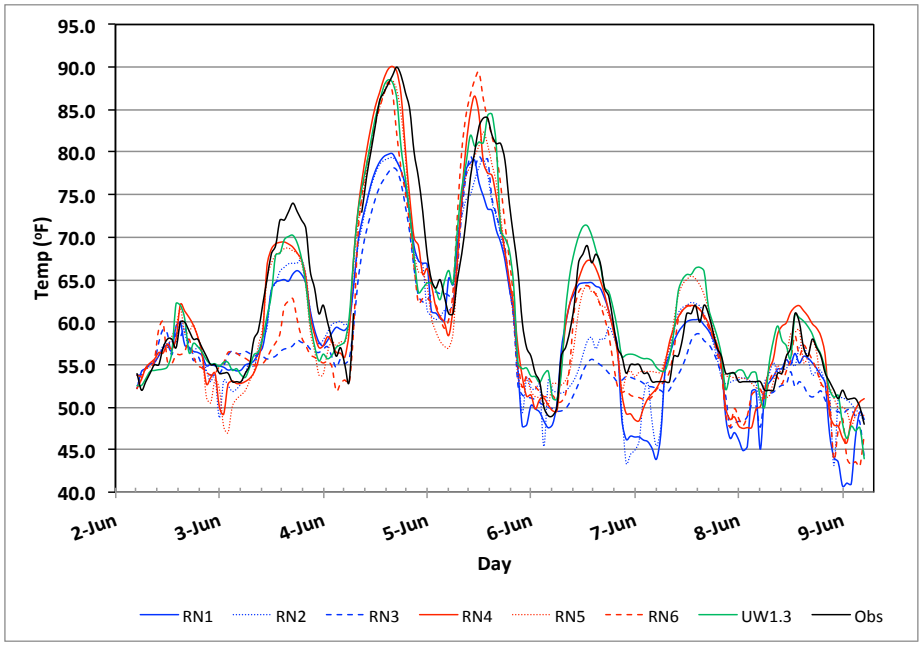

05-07 Jun 2016 Temp Mean Bias at Pasco
Temp (ºF)
15.0
10.0
5.0
0.0
-5.0
-10.0
24-hr
daytime
nitetime
MB daily variations
Run1
Run2
Run3
Run4
Run5
Run6
UW1.3

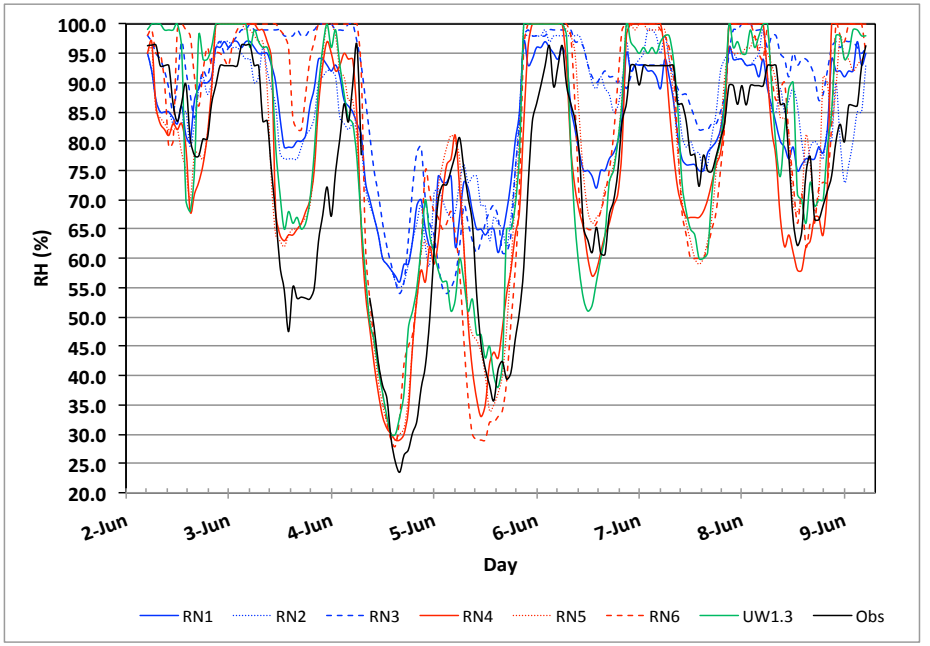

05-07 Jun 2016 RH Mean Bias at Pasco
RH (%)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
24-hr
daytime
nitetime
MB daily variations
Run1
Run2
Run3
Run4
Run5
Run6
UW1.3

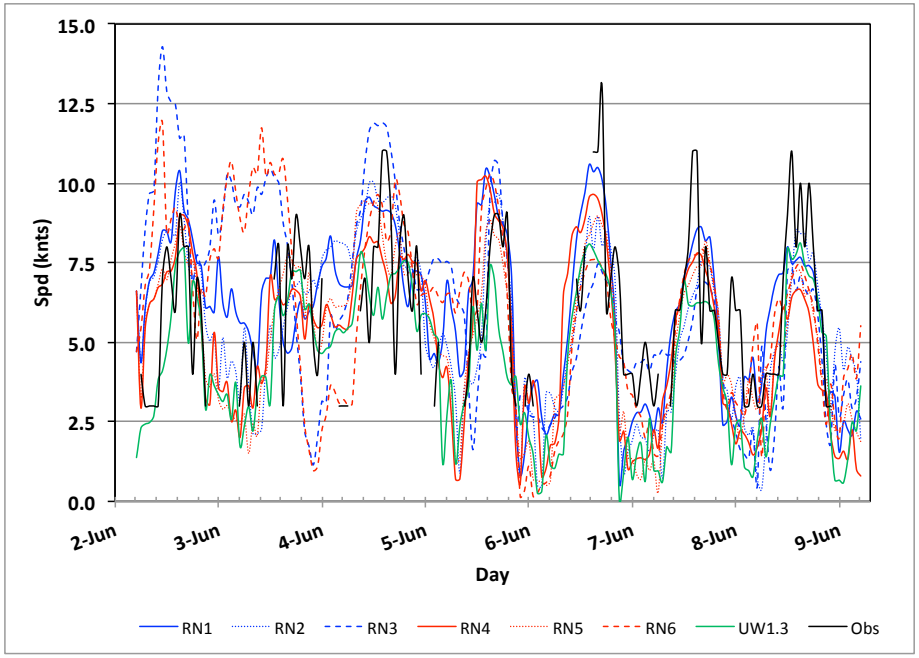

05-07 Jun 2016 Wind Speed Mean Bias at Pasco
WnSp (knts)
1.0
0.0
-1.0
-2.0
-3.0
24-hr
daytime
nitetime
MB daily variations
Run1
Run2
Run3
Run4
Run5
Run6
UW1.3

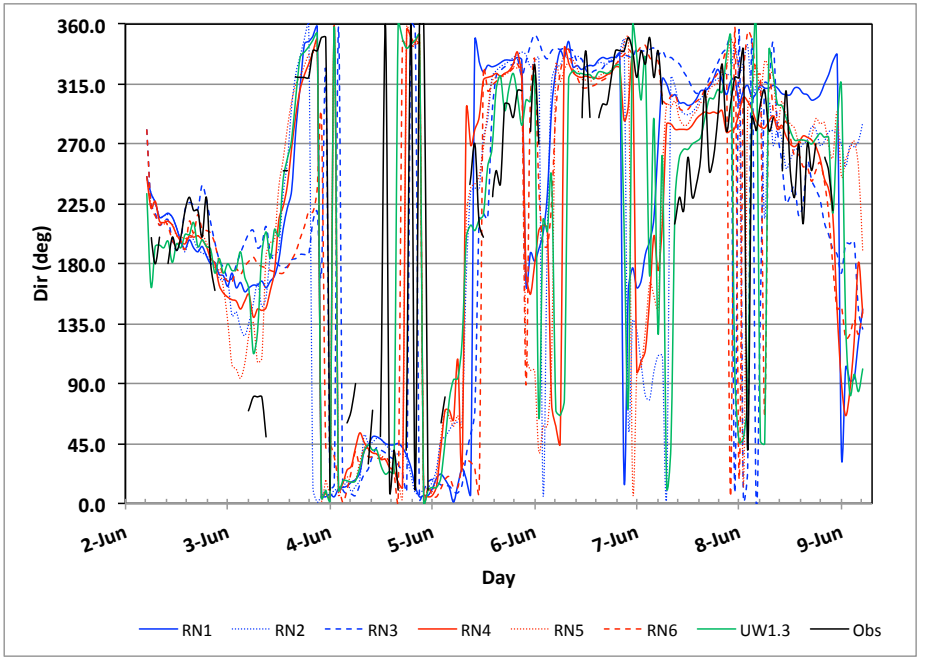

05-07 Jun 2016 Wind Direction Mean Bias at Pasco
WnDir (deg)
40
30
20
10
0
-10
-20
-30
-40
24-hr
daytime
nitetime
MB daily variations
Run1
Run2
Run3
Run4
Run5
Run6
UW1.3

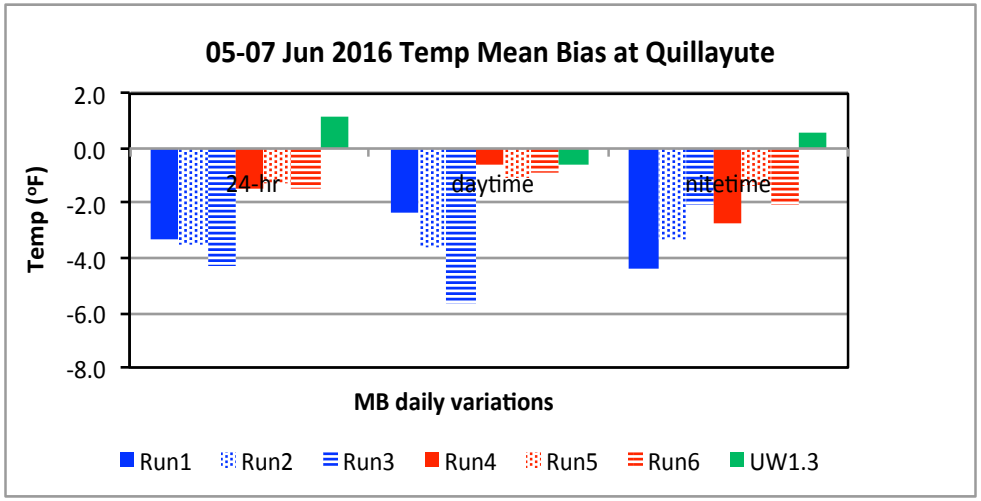
Quillayute - WA, 2 - 9 June 2016

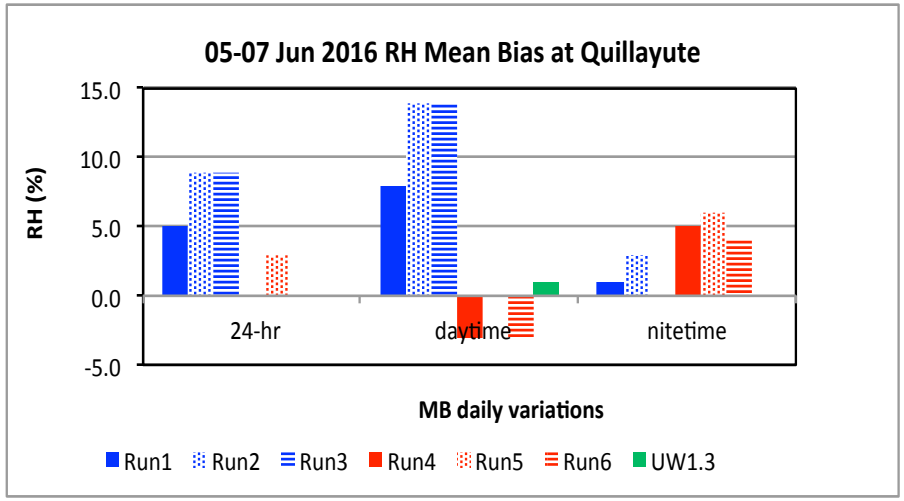


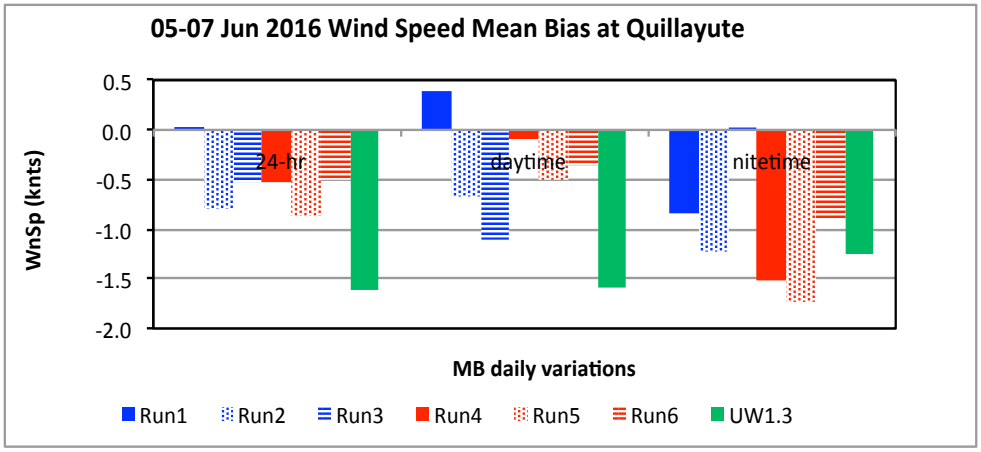


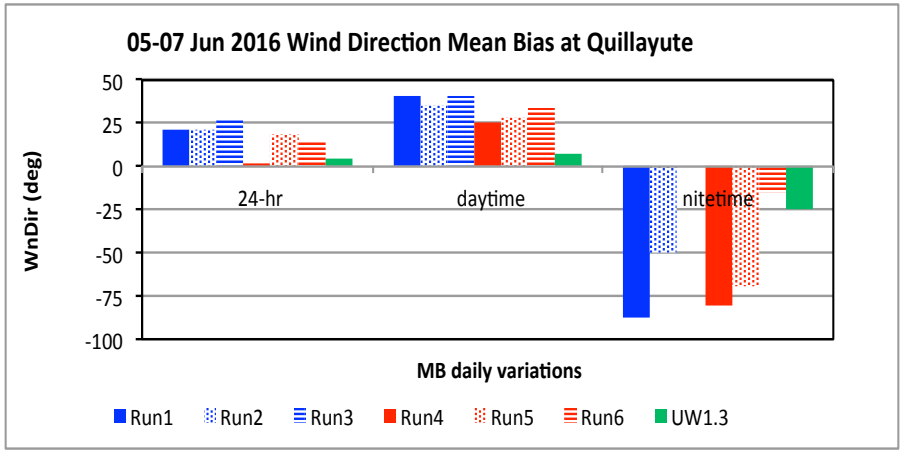




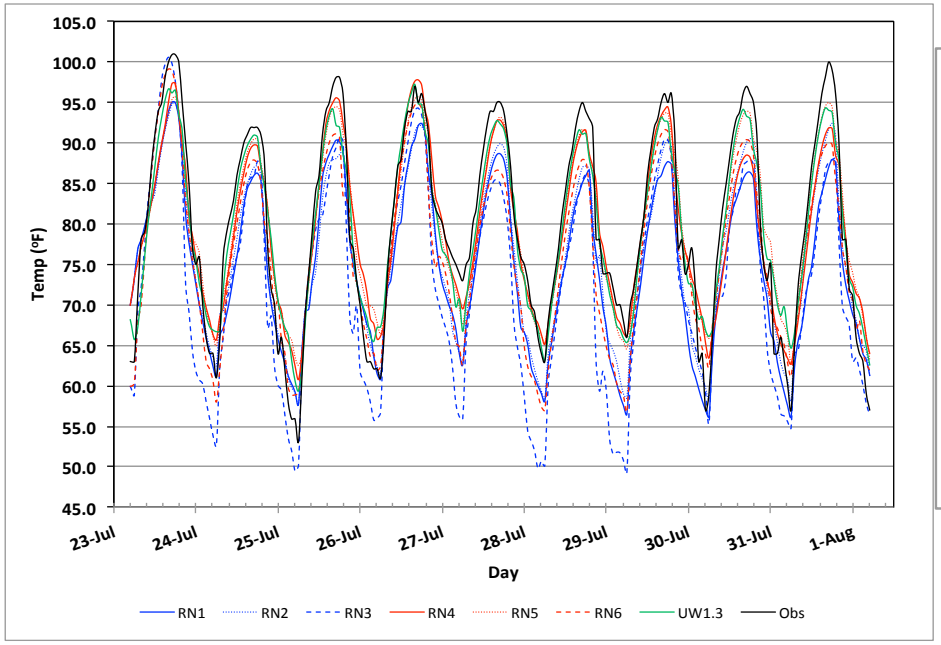

05-07 Jun 2016 Temp Mean Bias at Quillayute
Temp (°F)
2.0
0.0
-2.0
-4.0
-6.0
-8.0
24-hr
daytime
nitetime
MB daily variations
Run1 Run2 Run3 Run4 Run5 Run6 UW1.3

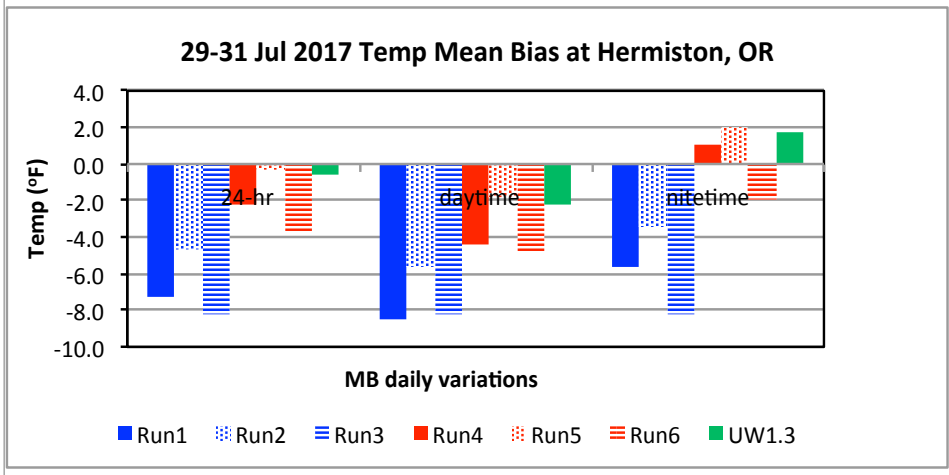

05-07 Jun 2016 RH Mean Bias at Quillayute
RH (%)
15.0
10.0
5.0
0.0
-5.0
24-hr
daytime
nitetime
MB daily variations
Run1 Run2 Run3 Run4 Run5 Run6 UW1.3

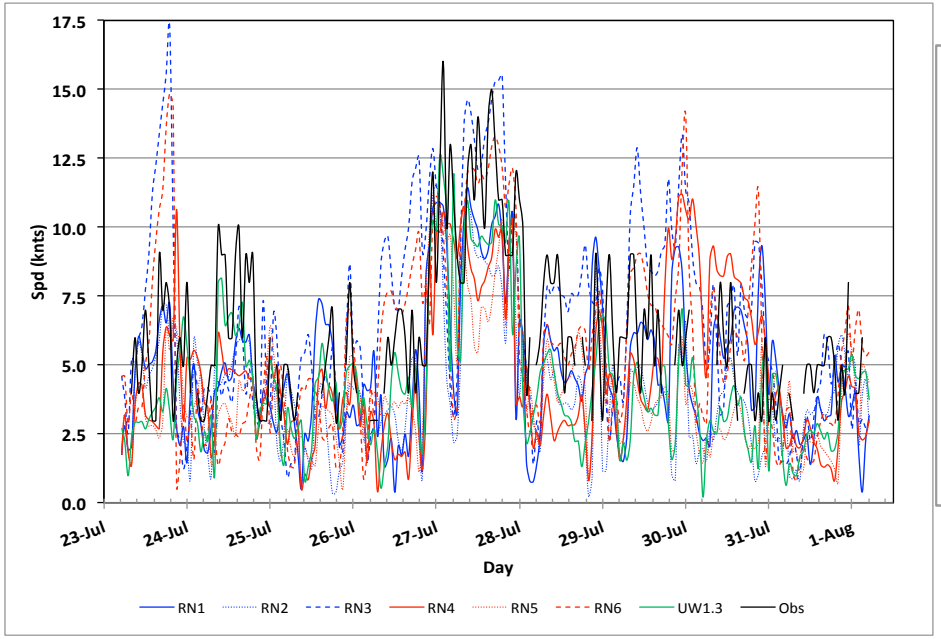

05-07 Jun 2016 Wind Speed Mean Bias at Quillayute
WnSp (knts)
0.5
0.0
-0.5
-1.0
-1.5
-2.0
24-hr
daytime
nitetime
MB daily variations
Run1 Run2 Run3 Run4 Run5 Run6 UW1.3

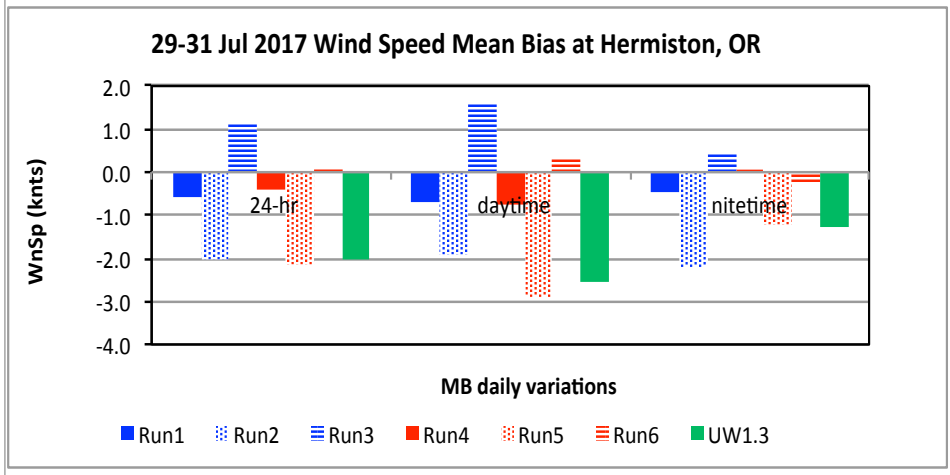

05-07 Jun 2016 Wind Direction Mean Bias at Quillayute
WnDir (deg)
50
25
0
-25
-50
-75
-100
24-hr
daytime
nitetime
MB daily variations
Run1 Run2 Run3 Run4 Run5 Run6 UW1.3

Hermiston - OR, 23 Jul - 01 Aug 2017

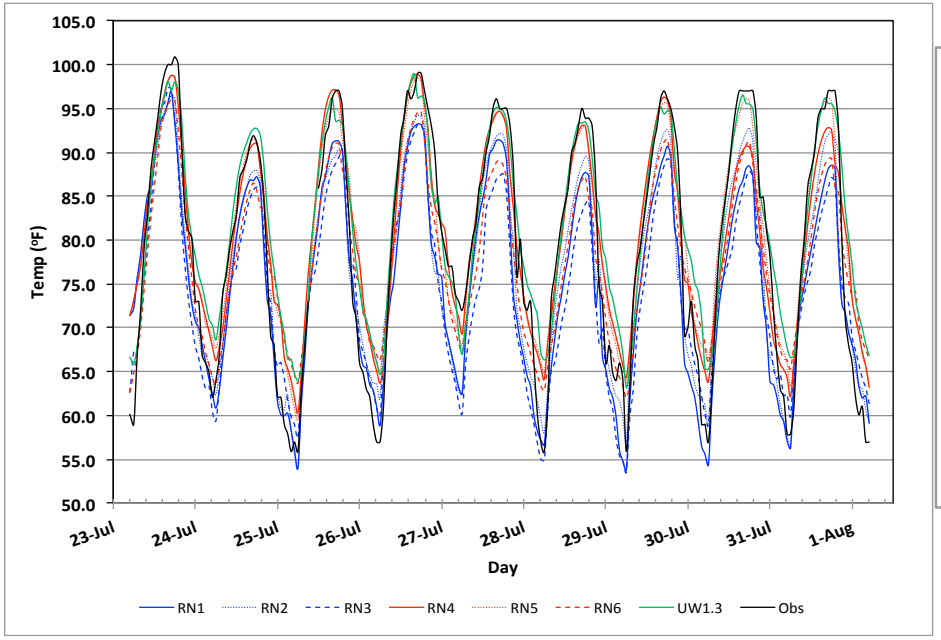


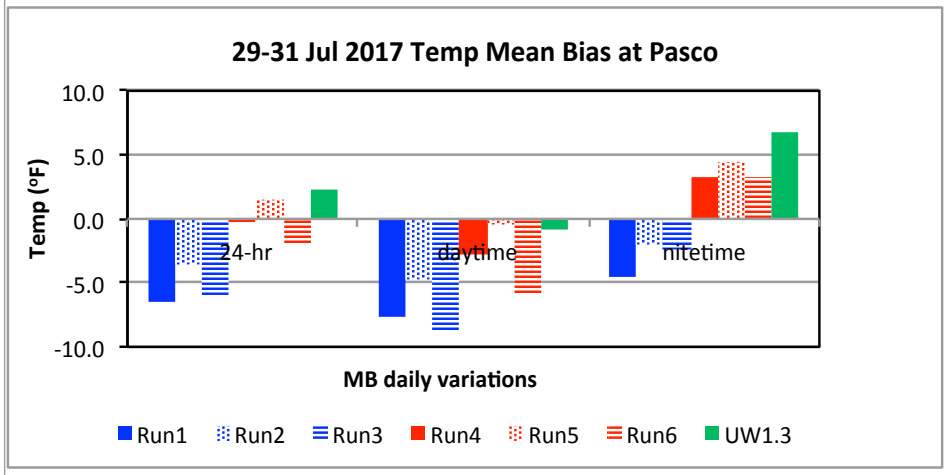


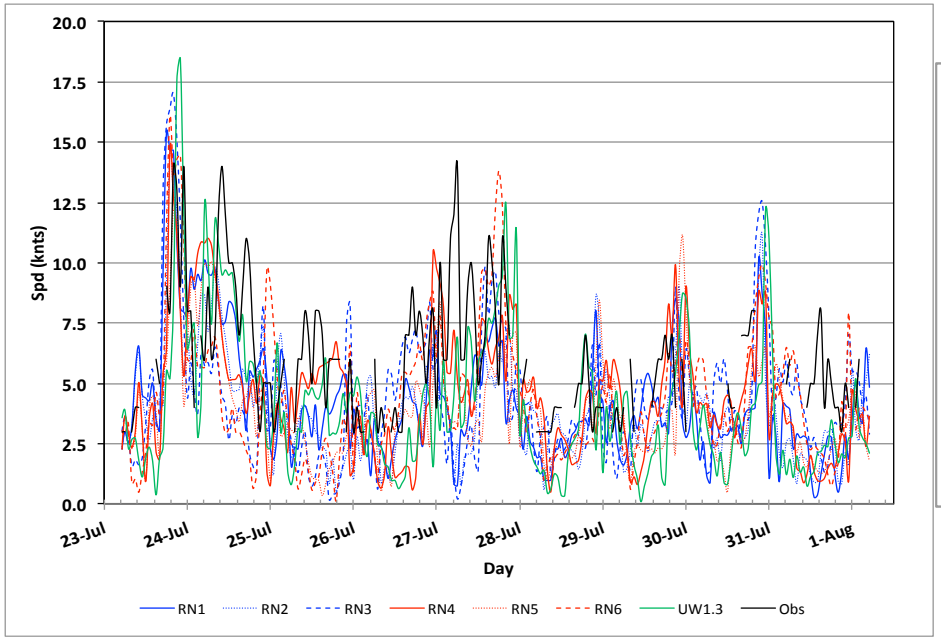


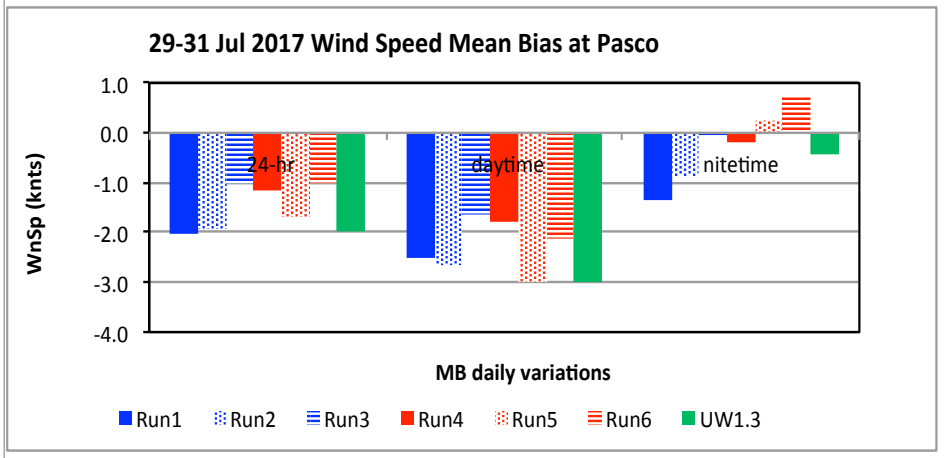


Pasco - WA, 23 Jul - 01 Aug 2017

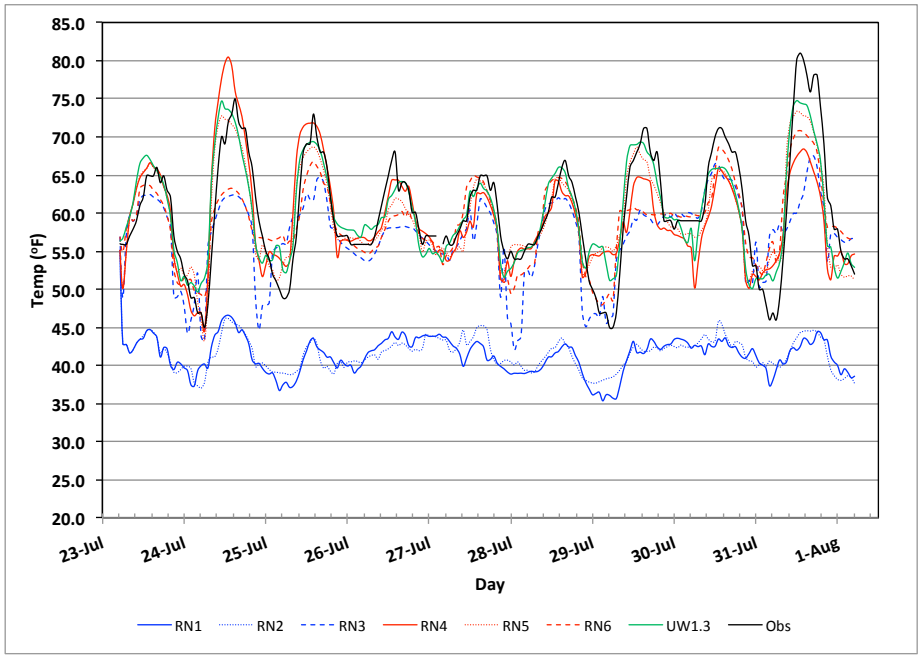


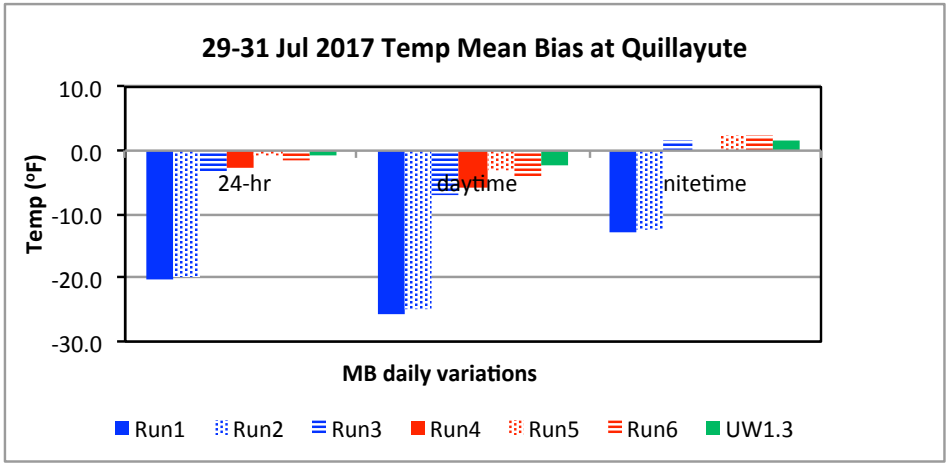


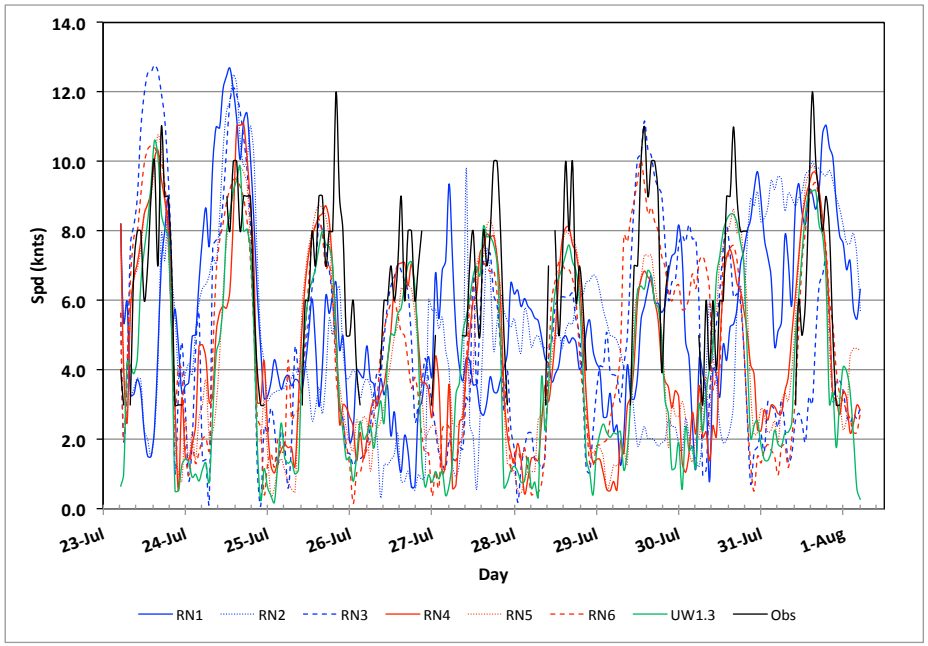


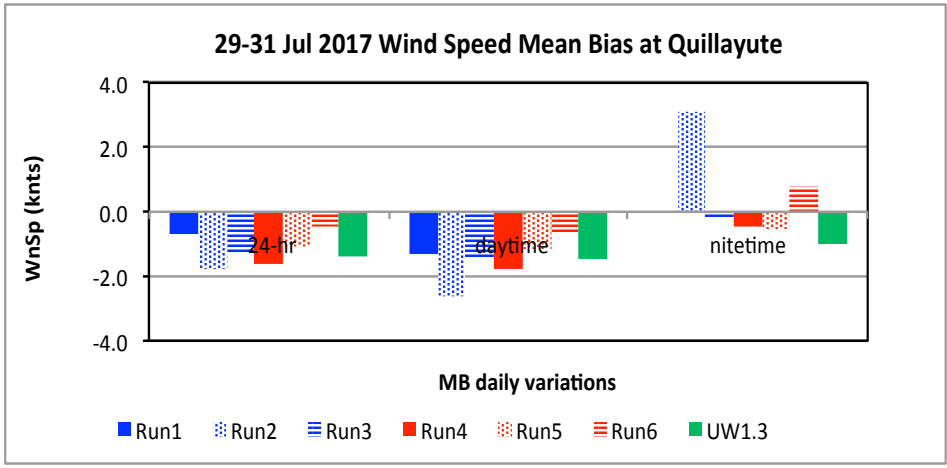


Quillayute - WA, 23 Jul - 01 Aug 2017





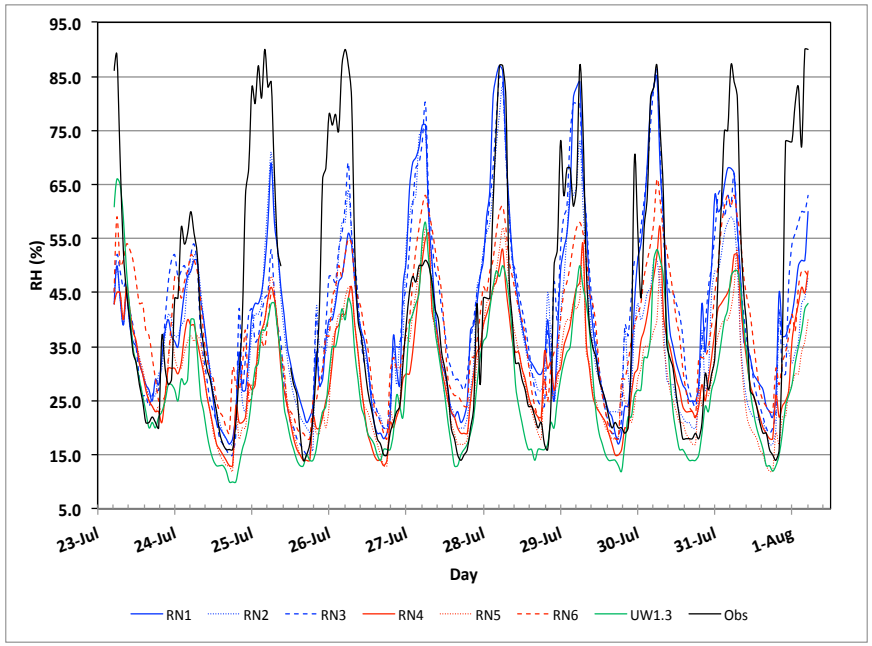


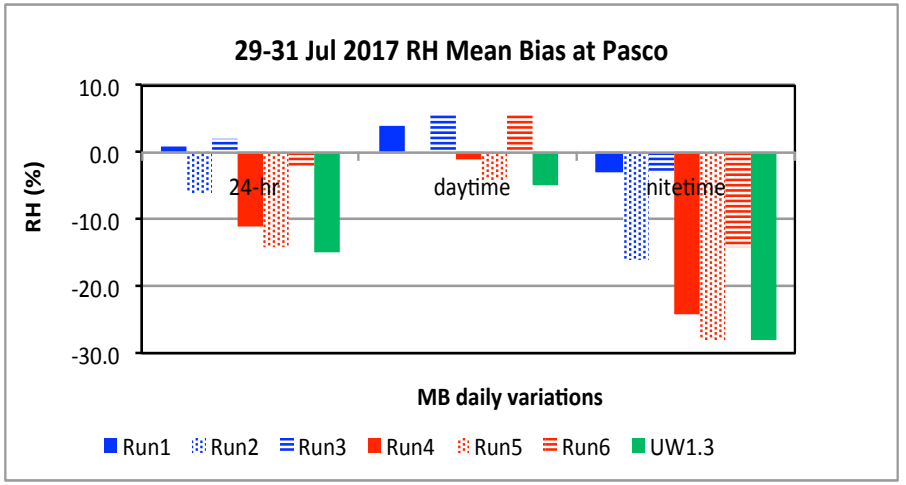


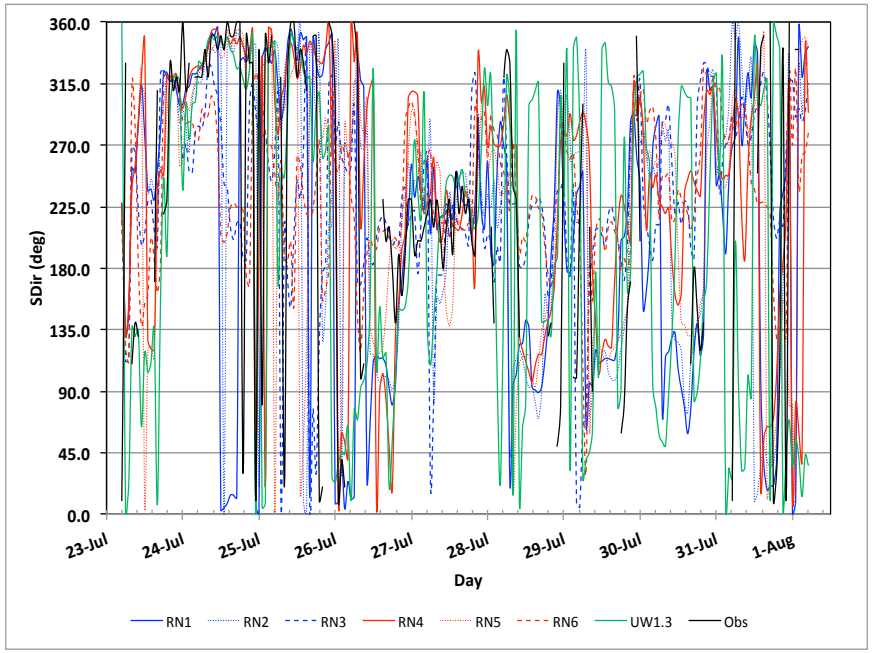
Summary

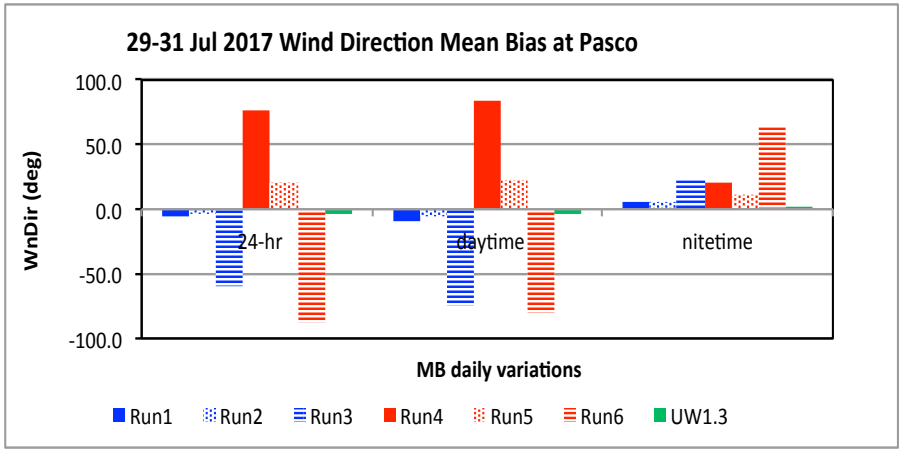
- Generally, our UW-physics option runs performed better when GFS input data with analysis nudging is used.
- UW1.3km operational (that was used every 12-hrs output) performed well overall, as expected.
- More WRF output analyses will be done to examine transport and dispersion processes.
- Currently, SMOKEv4.5 and CMAQv5.2 is being tested.

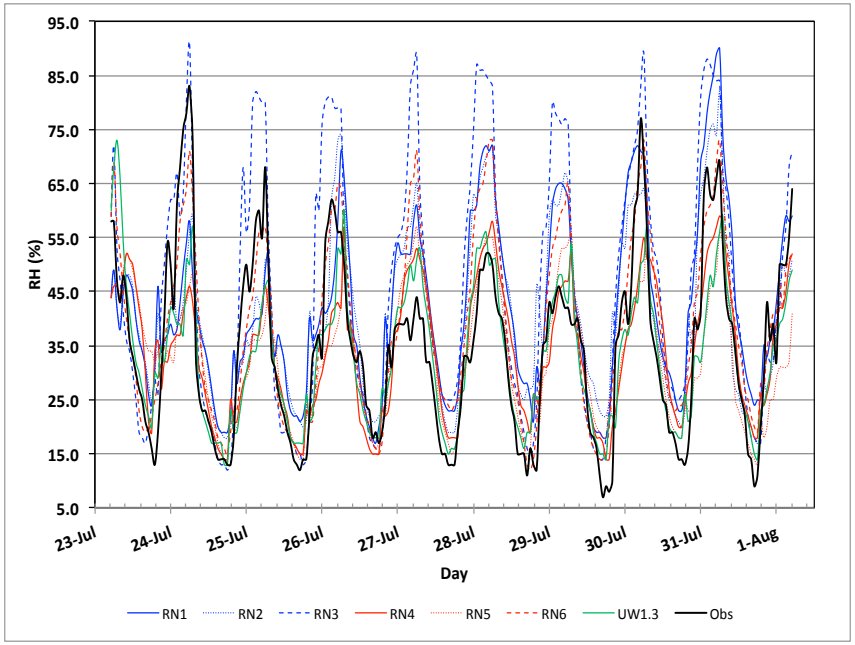
~ Questions/comments! ~

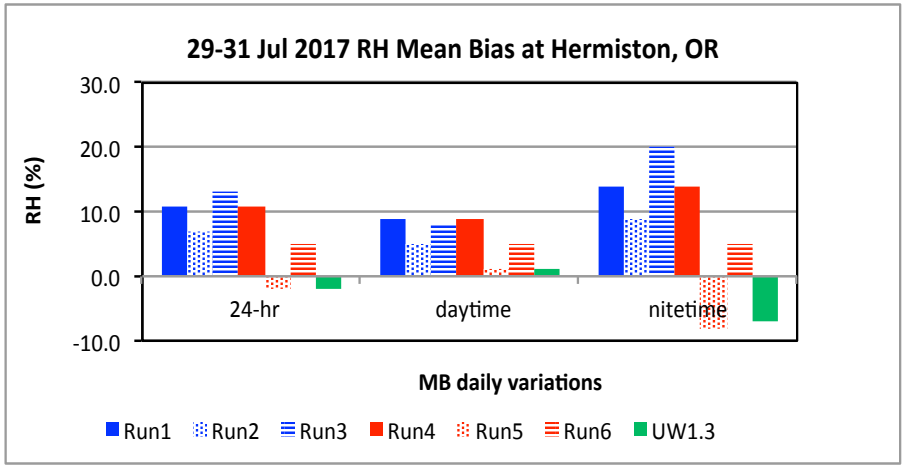

RH (%)
95.0
85.0
75.0
65.0
55.0
45.0
35.0
25.0
15.0
5.0
23-Jul
24-Jul
25-Jul
26-Jul
27-Jul
28-Jul
29-Jul
30-Jul
31-Jul
1-Aug
Day
RN1
RN2
RN3
RN4
RN5
RN6
UW1.3
Obs

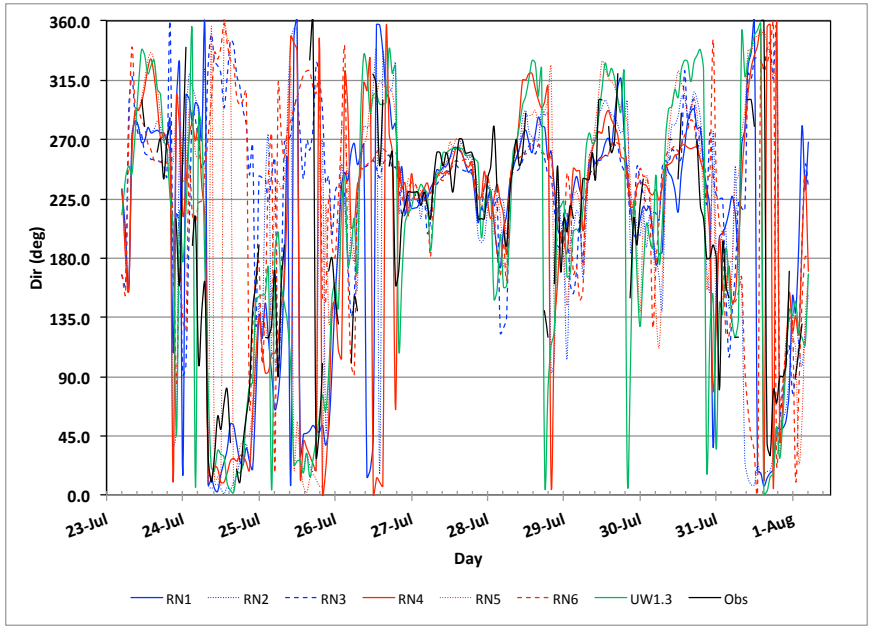

29-31 Jul 2017 RH Mean Bias at Pasco
RH (%)
10.0
0.0
-10.0
-20.0
-30.0
24-hr
daytime
nitetime
MB daily variations
Run1
Run2
Run3
Run4
Run5
Run6
UW1.3

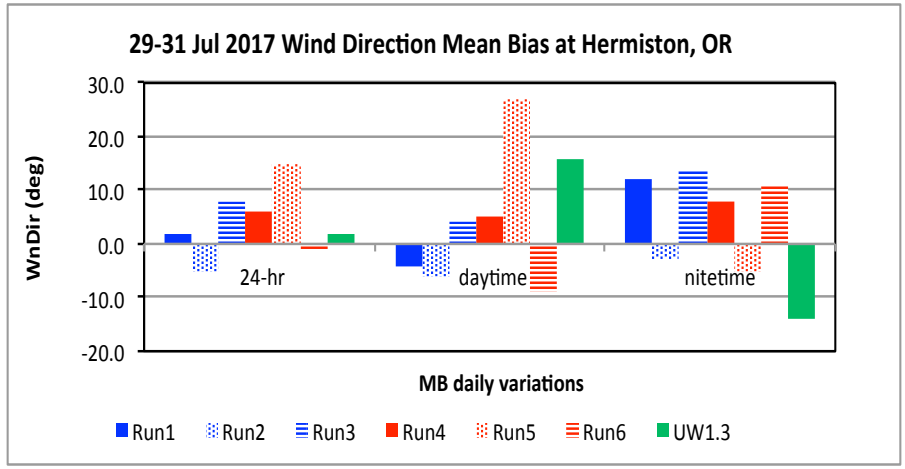

SDir (deg)
360.0
315.0
270.0
225.0
180.0
135.0
90.0
45.0
0.0
23-Jul
24-Jul
25-Jul
26-Jul
27-Jul
28-Jul
29-Jul
30-Jul
31-Jul
1-Aug
Day
RN1
RN2
RN3
RN4
RN5
RN6
UW1.3
Obs

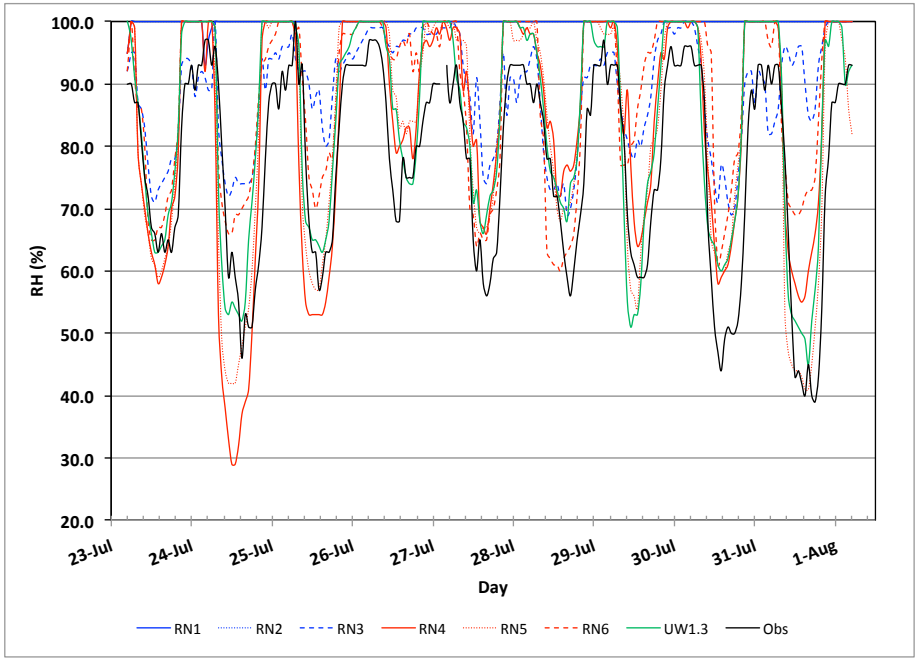

29-31 Jul 2017 Wind Direction Mean Bias at Pasco
WnDir (deg)
100.0
50.0
0.0
-50.0
-100.0
24-hr
daytime
nitetime
MB daily variations
Run1
Run2
Run3
Run4
Run5
Run6
UW1.3

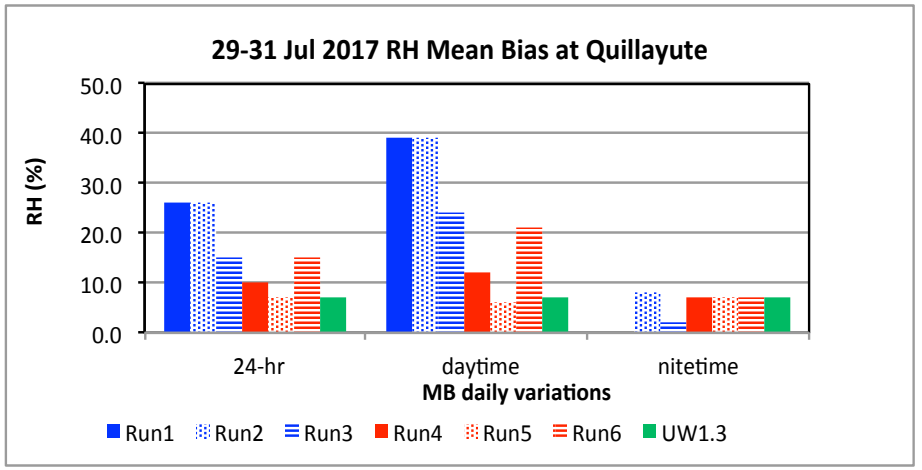

95.0
85.0
75.0
65.0
55.0
45.0
35.0
25.0
15.0
5.0
RH (%)
23-Jul
24-Jul
25-Jul
26-Jul
27-Jul
28-Jul
29-Jul
30-Jul
31-Jul
1-Aug
Day
RN1
RN2
RN3
RN4
RN5
RN6
UW1.3
Obs

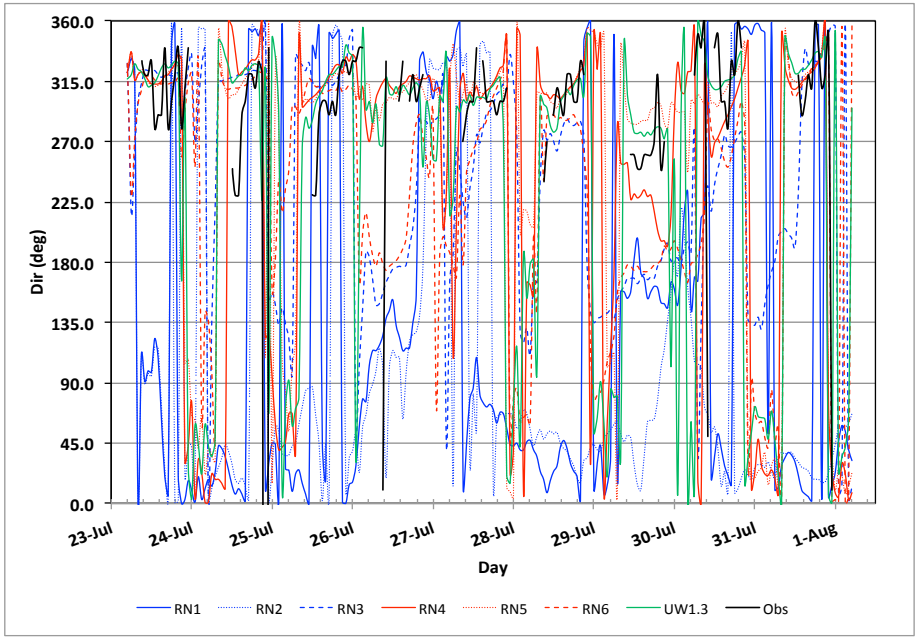

29-31 Jul 2017 RH Mean Bias at Hermiston, OR
30.0
20.0
10.0
0.0
-10.0
RH (%)
24-hr
daytime
nitetime
MB daily variations
Run1
Run2
Run3
Run4
Run5
Run6
UW1.3

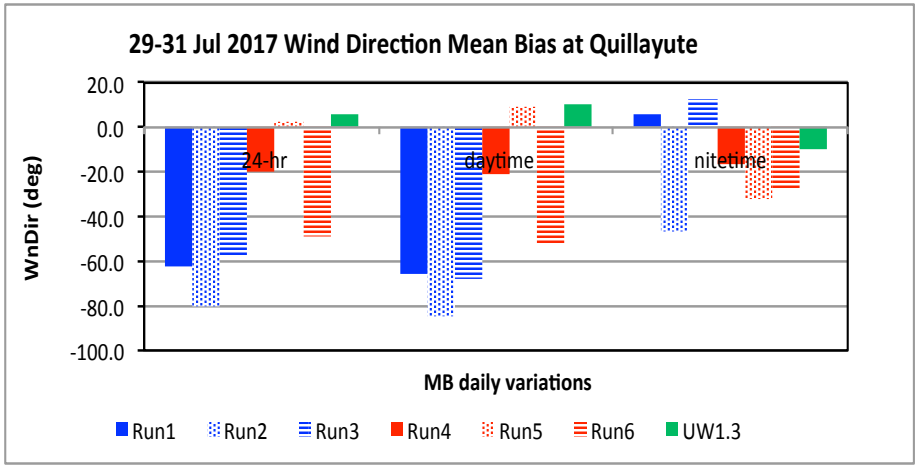

360.0
315.0
270.0
225.0
180.0
135.0
90.0
45.0
0.0
Dir (deg)
23-Jul
24-Jul
25-Jul
26-Jul
27-Jul
28-Jul
29-Jul
30-Jul
31-Jul
1-Aug
Day
RN1
RN2
RN3
RN4
RN5
RN6
UW1.3
Obs


29-31 Jul 2017 Wind Direction Mean Bias at Hermiston, OR
30.0
20.0
10.0
0.0
-10.0
-20.0
WnDir (deg)
24-hr
daytime
nitetime
MB daily variations
Run1
Run2
Run3
Run4
Run5
Run6
UW1.3


RH (%)
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
23-Jul
24-Jul
25-Jul
26-Jul
27-Jul
28-Jul
29-Jul
30-Jul
31-Jul
1-Aug
Day
RN1
RN2
RN3
RN4
RN5
RN6
UW1.3
Obs


29-31 Jul 2017 RH Mean Bias at Quillayute
RH (%)
50.0
40.0
30.0
20.0
10.0
0.0
24-hr
daytime
nitetime
MB daily variations
Run1
Run2
Run3
Run4
Run5
Run6
UW1.3


Dir (deg)
360.0
315.0
270.0
225.0
180.0
135.0
90.0
45.0
0.0
23-Jul
24-Jul
25-Jul
26-Jul
27-Jul
28-Jul
29-Jul
30-Jul
31-Jul
1-Aug
Day
RN1
RN2
RN3
RN4
RN5
RN6
UW1.3
Obs


29-31 Jul 2017 Wind Direction Mean Bias at Quillayute
WnDir (deg)
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
24-hr
daytime
nitetime
MB daily variations
Run1
Run2
Run3
Run4
Run5
Run6
UW1.3