Analysis of StalkerData from Nov 12, 2022-Mar 30, 2023

Colony	Entrance faces	Wrap	Slatted Rack?	Upper Entrance With wind block	Lower Entrance
Sask1	South	Cozy (R8)	Yes	No	1.8”x3/8”
Sask2	South	Cozy (R8)	No	No	1.8”x3/8”
Ital1	South	Cozy (R8)	Yes	1/2” x 3/8”	½ oval – 1” x 3/8”
Sask3	South	Cozy (R8)	No	1/2” x 3/8”	½ oval –1”x 3/8”
Stalker	North	3 layers of R3.7 Colony quilt (R11.1)	No	1/2” x 3/8”	½ oval – 1” x 3/8”

Stalker: Top/bottom entrance; No Rack, R11.1, North facing

11/12/22@ noon:
- returned sensors to under inner cover & added shim with weather stripping
- total height between 1 1/2"--> 1 3/4" depending on compression of weather stripping

11/17/22@ noon :
- wrapped colony & reduced entrances

12/2/22 – a few bees near the box4-east sensor.

12/30/22 – couldn't hear/see bees

1/19/23 (3:30) bees down in colony – buzzing loud

2/27/23 (11:15)
- added another 1/2lb brick
- Added ½ pollen patty (global)

3/3/23
- lots of cleansing flights in apiary – wasn't home so didn't see which colonies

3/9/23 – noonish
- Hadn't touched patty or sugar

3/18/23 – 10:30ish
- LOTS of bees in box 4
- Had eaten a little patty and sugar

3/27/23 – 4:15ish
- Patty gone/ still had sugar
- Added ½ patty

3/29/23 – 3pmish
- Added medium with 3 partial honey frames, 5 drawn frames + frame feeder

Mite Test Data (Alcohol Wash)

Date	Stalker	Notes
5/26/2022	0.0%	
6/25/22	0.17%	
7/22/2022	0.33%	Treated Formic-
8/31/2022	0.50%	
10/8/2022	0.33%	

Taken 3/9/23 @5am – heat is coming out the upper entrance in the inner cover

Definitions

- **Vapor Density = Absolute humidity :** (expressed as grams of water vapor per cubic meter volume of air) is **a measure of the actual amount of water vapor (moisture) in the air, regardless of the air's temperature**. (from weather.gov).
  - Absolute humidity is also referred to as vapor density of the air.
  - The equation used to calculate this is :
    - (0.611*10) * Power(2.71828,(17.502*T)/(T+240.9)) * (RH*2.18647)/(273.15+T)
    - Where RH is the relative humidity as measured by broodminder and T measured temp In Celsius

- **Relative humidity** also measures water vapor but **RELATIVE** to the temperature of the air. It is expressed as the amount of water vapor in the air as a **percentage** of the total amount that **could** be held at its current temperature. (www.zehnderamerica.com)

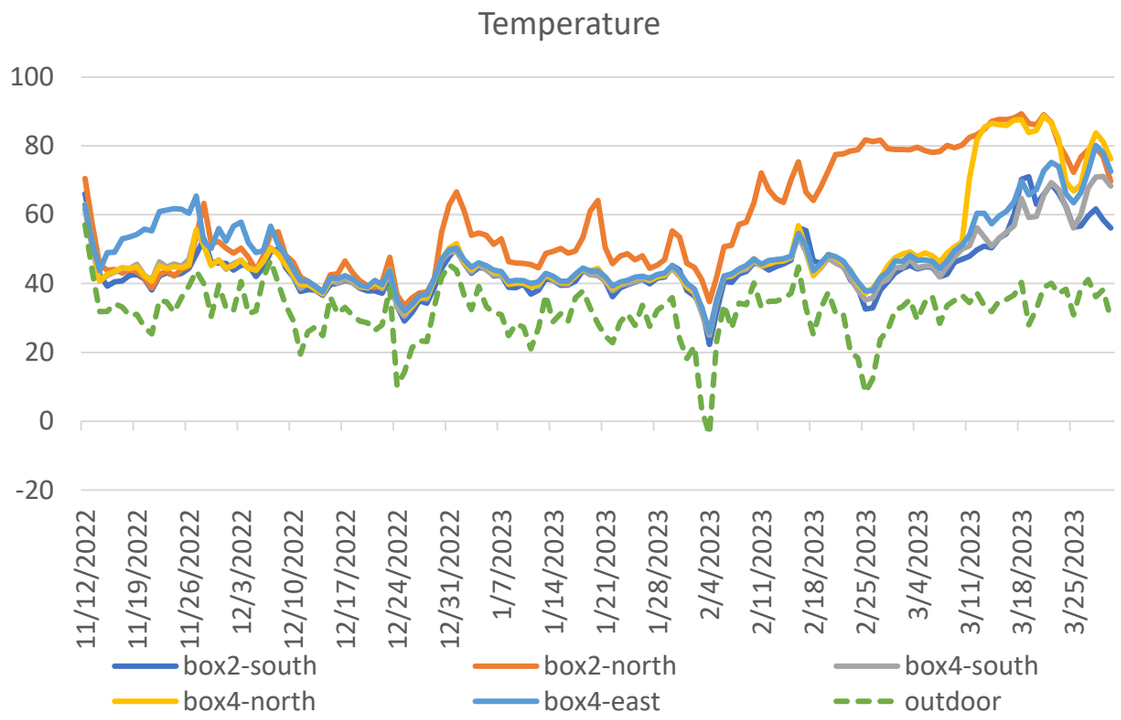
- **Vapor Pressure Deficit (VPD)** is a measure of how much more “room” there is for humidity (water vapor) in the air, at the current temperature

Notes from Etienne Tardif on Bee-L forum

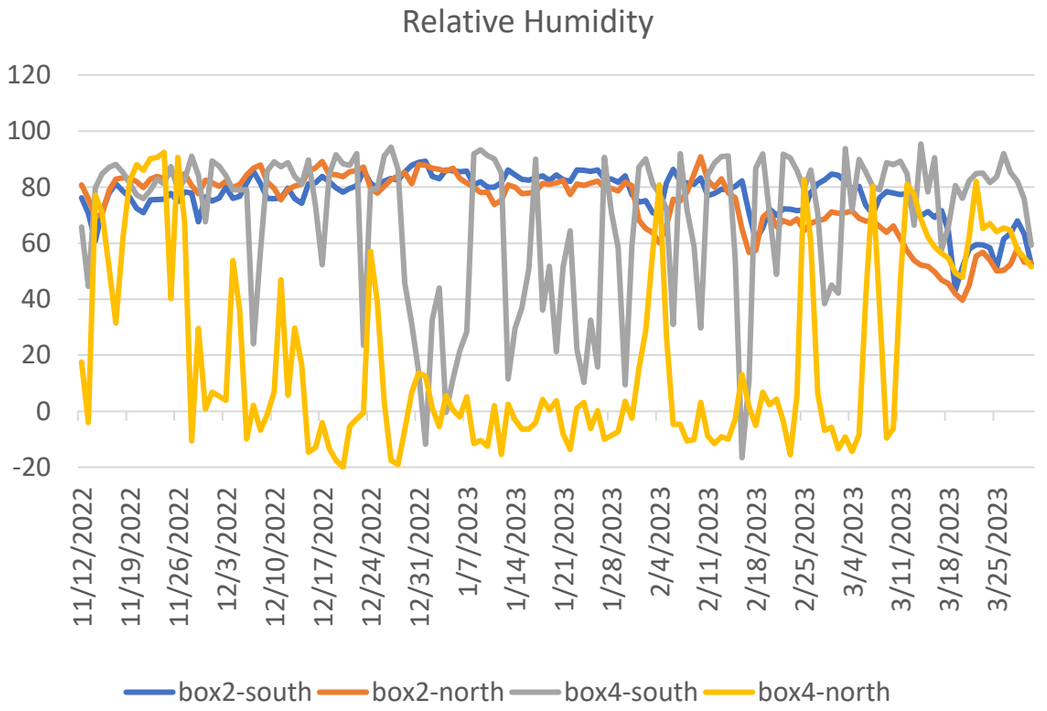
- 1) Moisture conservation - Bees seem to prefer 60-75%RH (@18C) 10-15g/m3 (moisture content) in cluster or in the "hot“ hive.
- Remember that air at 100%RH 0C only contains 4.85g/m3, so even in warmish very humid winters, bees are required to up regulate moisture via metabolic processes to maintain their setpoint. I believe bees under certain conditions purposefully generate moist heat for the purpose of humidifying which also results in internal condensation both of which increases the in hive RH during very dry cold periods -30C Air @100% RH 0.46g/m3 .
- We do know that bees have mastered evaporative cooling which can also be used to humidify air at cooler temperatures, ok in a hot hive but not practical when bees are tightly clustered.

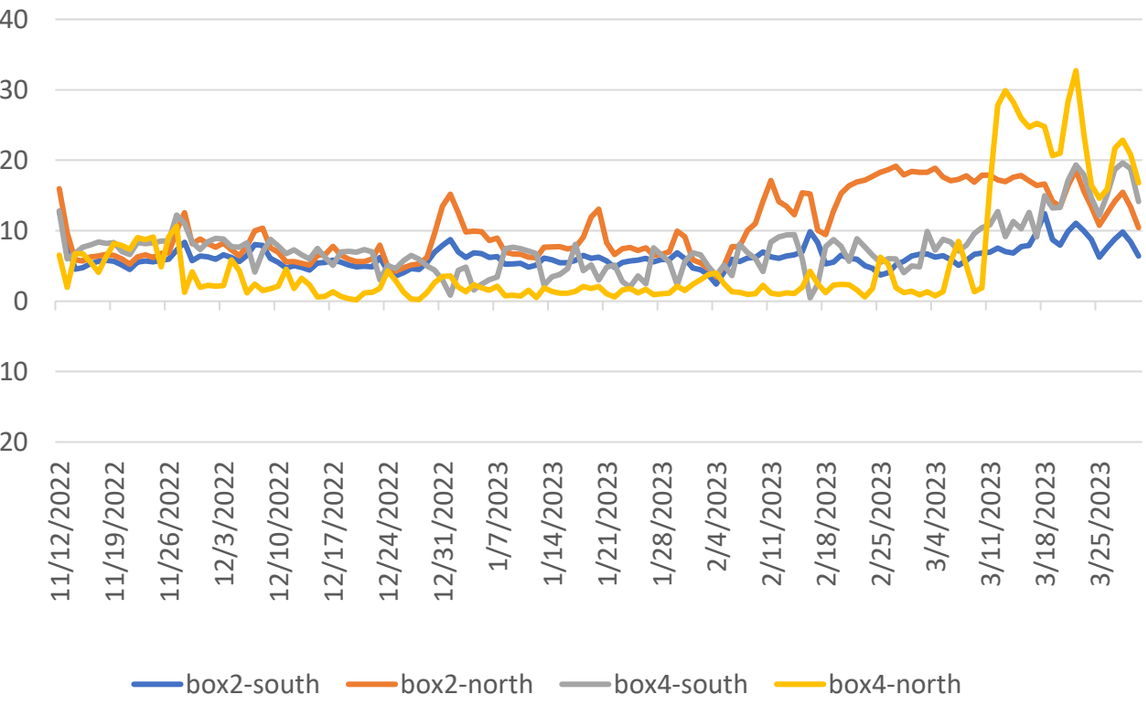
Daily **mean** values

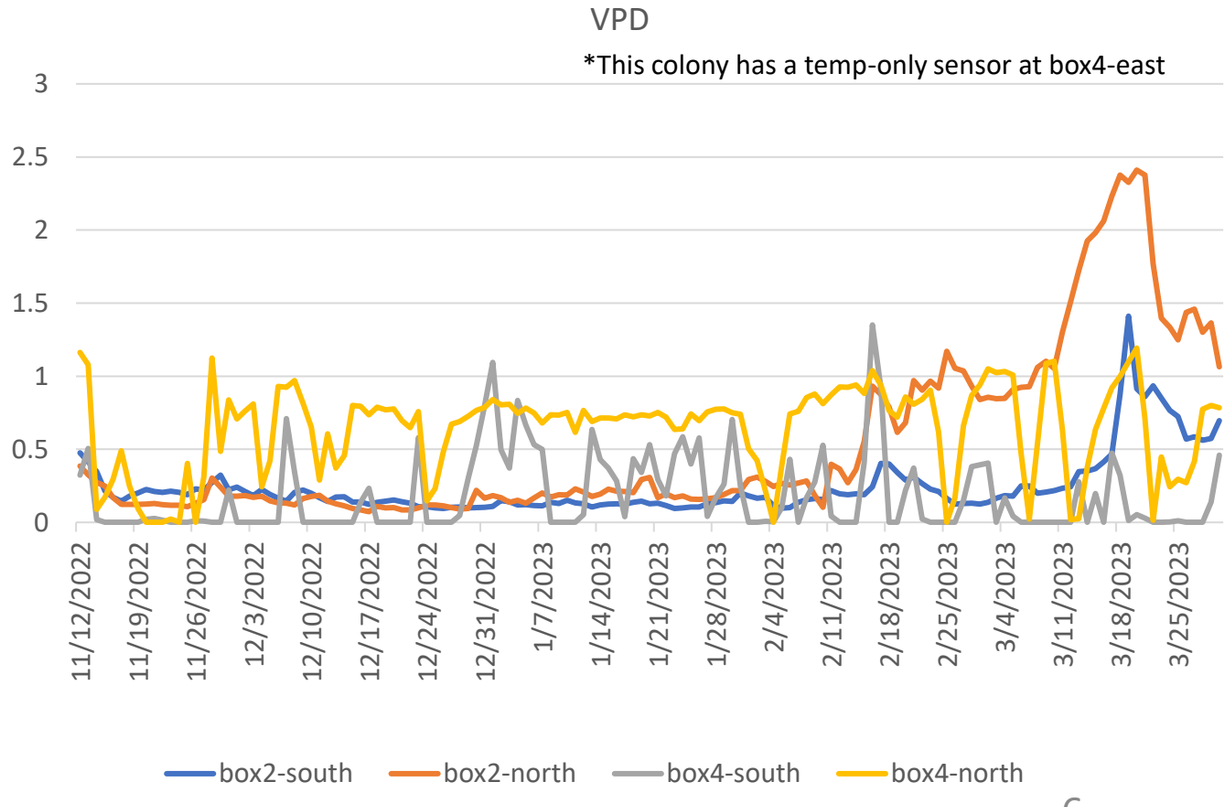
Mean Daily Values – Stalker (No rack, top/bottom entrance,north facing, R11.1)



Not sure the RH readings for box4-north and box4-south are accurate as they were reading 0 (the negative numbers are due to applying a correction factor that was determined prior to installing all of the sensors in the colonies)





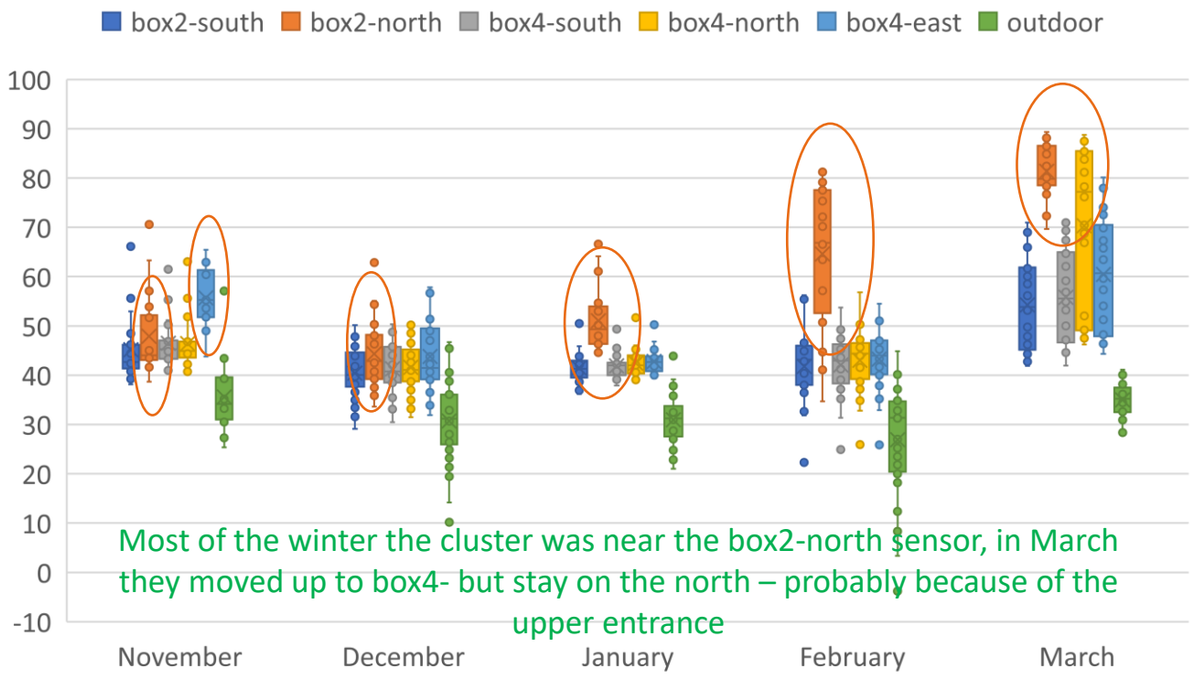


*Box4-east is temp only and stopped recording in late March

Mean Daily Values – Stalker (No rack, top/bottom entrance,north facing, R11.1)

ORANGE CIRCLE indicates approximate cluster location

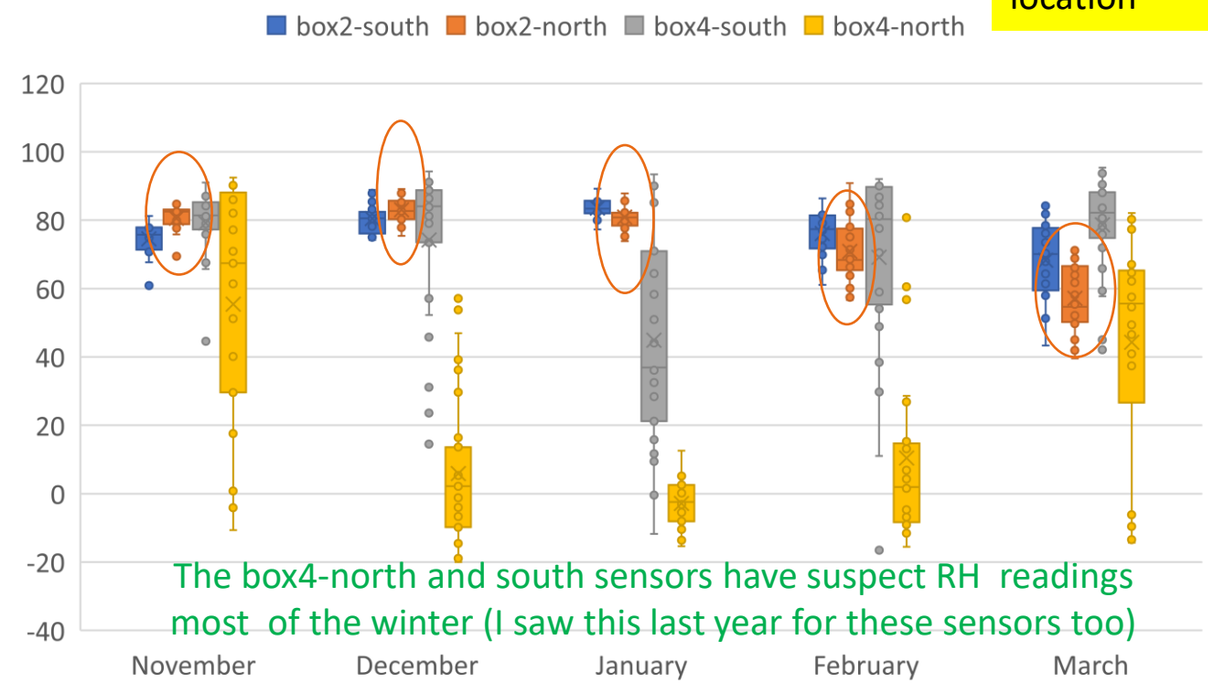
Temperature



Most of the winter the cluster was near the box2-north sensor, in March they moved up to box4- but stay on the north – probably because of the upper entrance

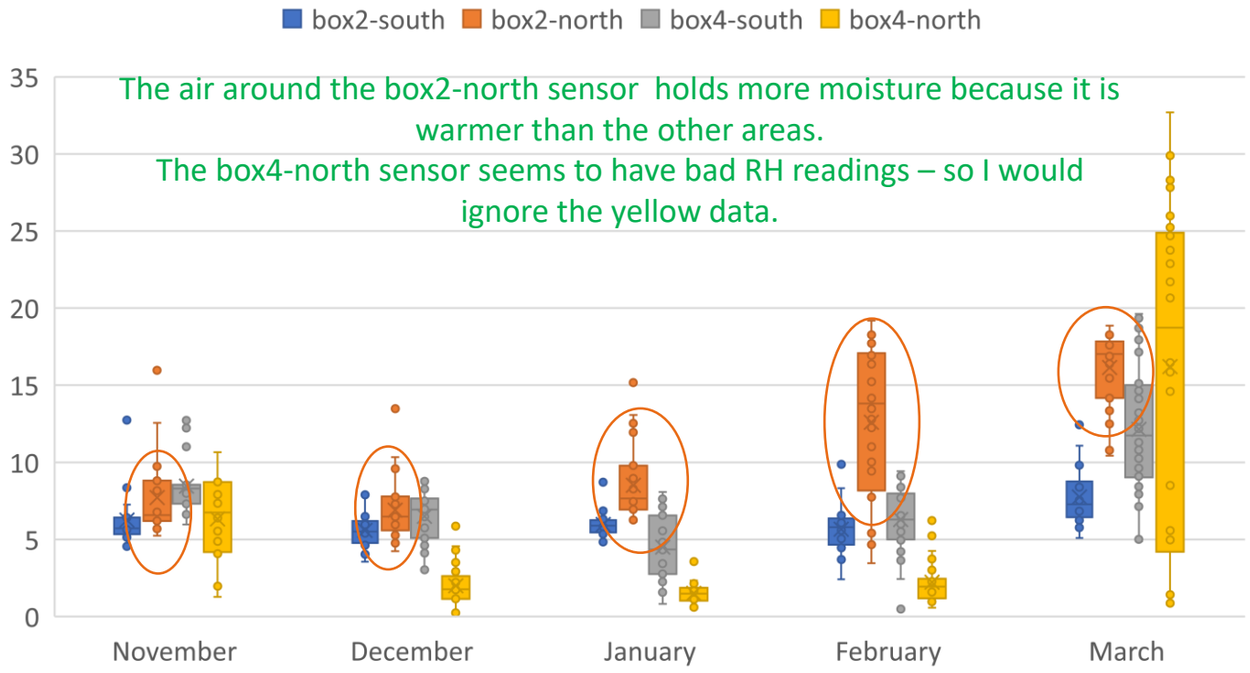
*This colony has a temp-only sensor at box4-east

Relative Humidity



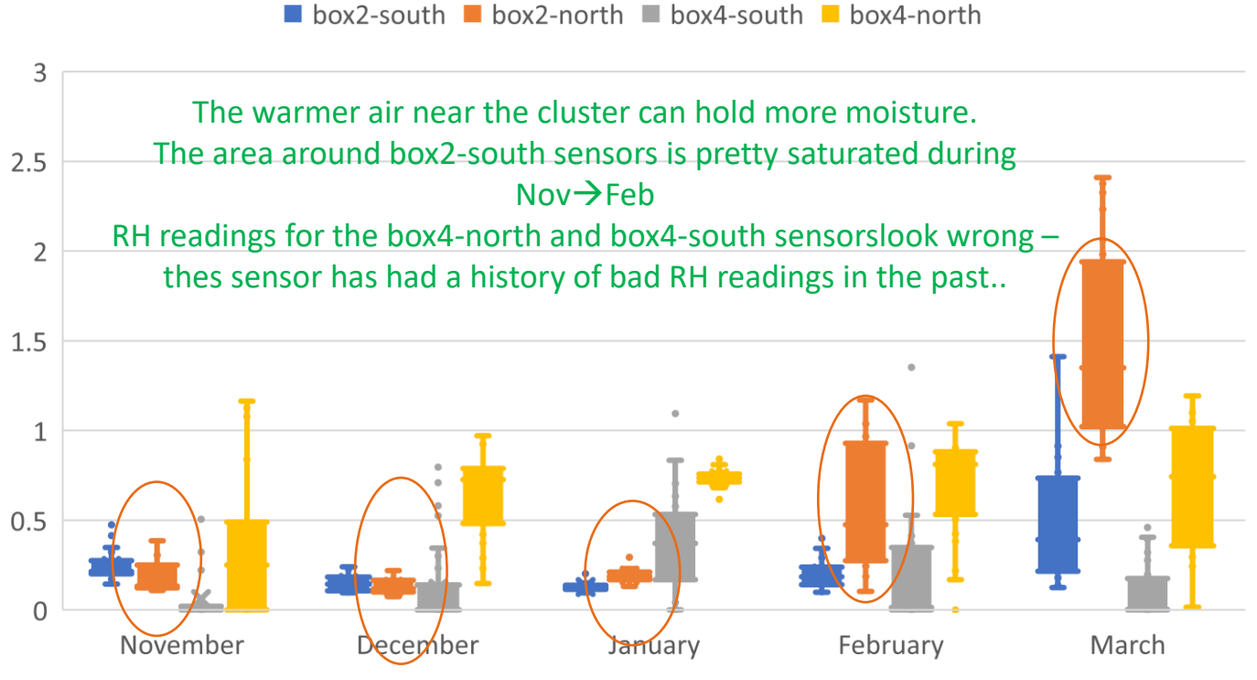
The box4-north and south sensors have suspect RH readings most of the winter (I saw this last year for these sensors too)

Vapor Density



The air around the box2-north sensor holds more moisture because it is warmer than the other areas.
The box4-north sensor seems to have bad RH readings – so I would ignore the yellow data.

VPD



The warmer air near the cluster can hold more moisture.
The area around box2-south sensors is pretty saturated during Nov→Feb
RH readings for the box4-north and box4-south sensorslook wrong – thes sensor has had a history of bad RH readings in the past..

Box2-north generally has more moisture in the air (higher vapor density) than box2-south. It is interesting to note that the box2-north area isn't fully saturated (VPD > 0) where as in the colony with only a bottom opening it is always saturated

PINK indicate approximate area of the cluster

Monthly Stats – Mean Values

NOT Slatted – Top & Bottom Entrance(stalker) – R11.7, north facing

stalker	Temp(F)					Vapor Density(g/m3)				
	Nov	Dec	Jan	Feb	Mar	Nov	Dec	Jan	Feb	Mar
box2-south	44.54	40.39	41.49	41.80	54.26	6.06	5.58	5.97	5.66	7.79
box2-north	46.93	44.05	51.07	64.62	81.65	7.38	6.82	8.52	12.58	16.28
box4-south	46.07	41.30	41.86	42.06	55.51	8.33	6.49	4.59	6.28	12.09
box4-north	45.99	41.59	42.42	43.01	70.15	6.30	2.00	1.50	2.22	16.27
box4-east	55.49	43.79	42.79	43.25	60.16					
outdoor	35.03	30.74	30.95	26.90	35.09					

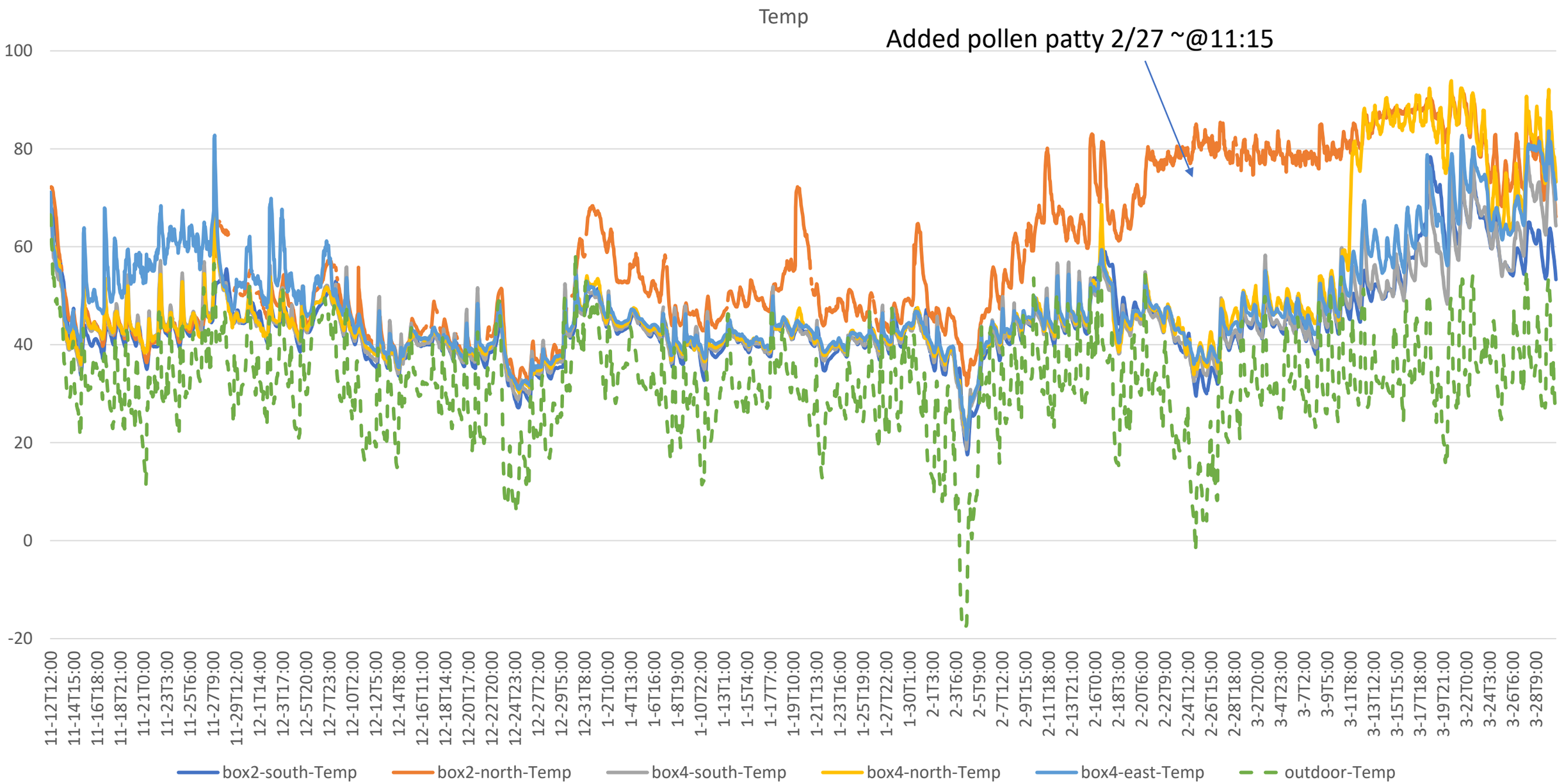
*This colony has a temp-only sensor at box4-east

Looking at the temps corresponding vapor densities, all colonies look pretty similar :

- if the temps at the sensor are in the low 60s, vapor density is 9-11
- temps in the 50s , vapor density is 7-8
- temps in the 40s,vapor density is 6-7 (There is one case – sask2, box4 east that is closer to 8 in Nov)
- temps in the 30s,vapor density = 5-6 (but outdoor vapor density is in the 4 rang)

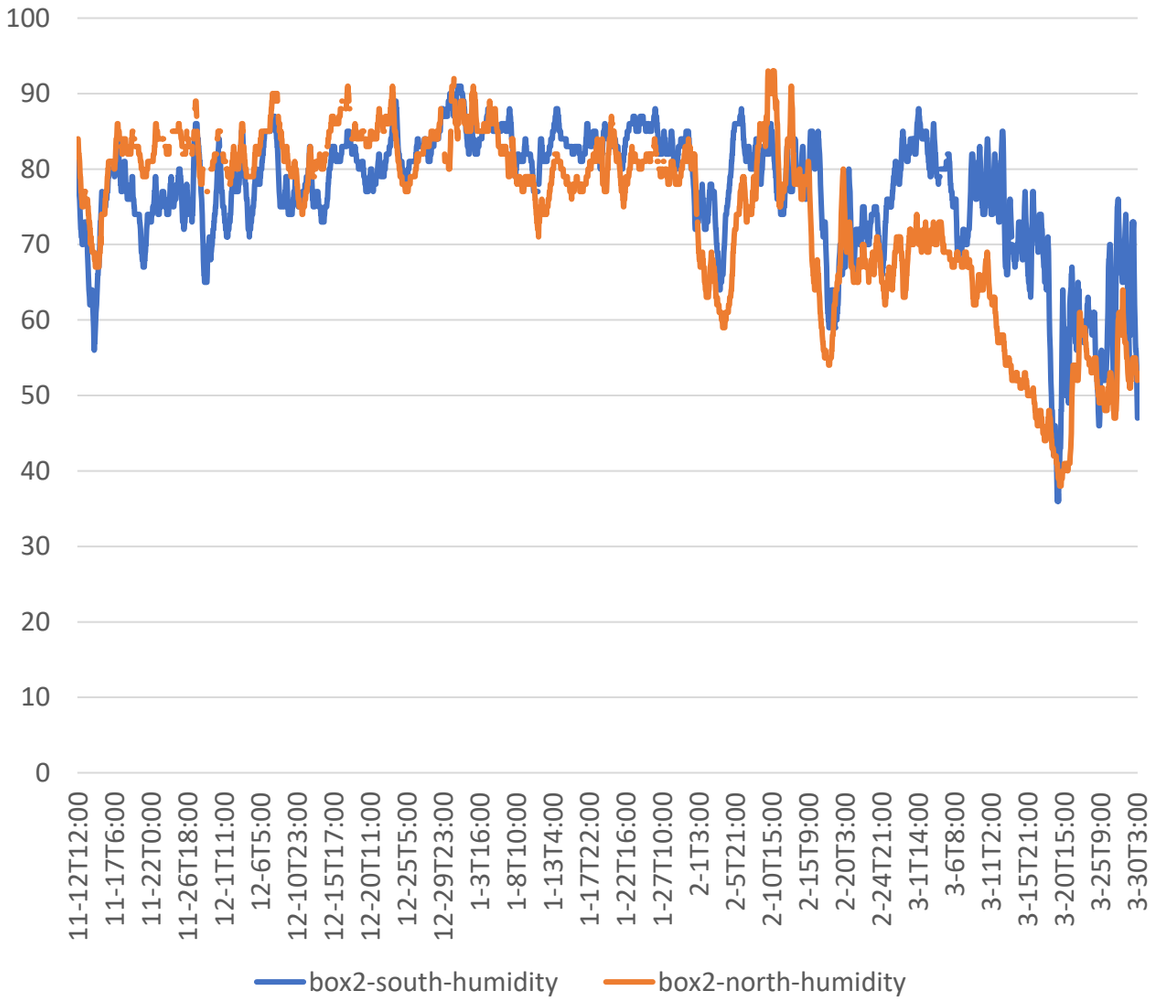
All data points

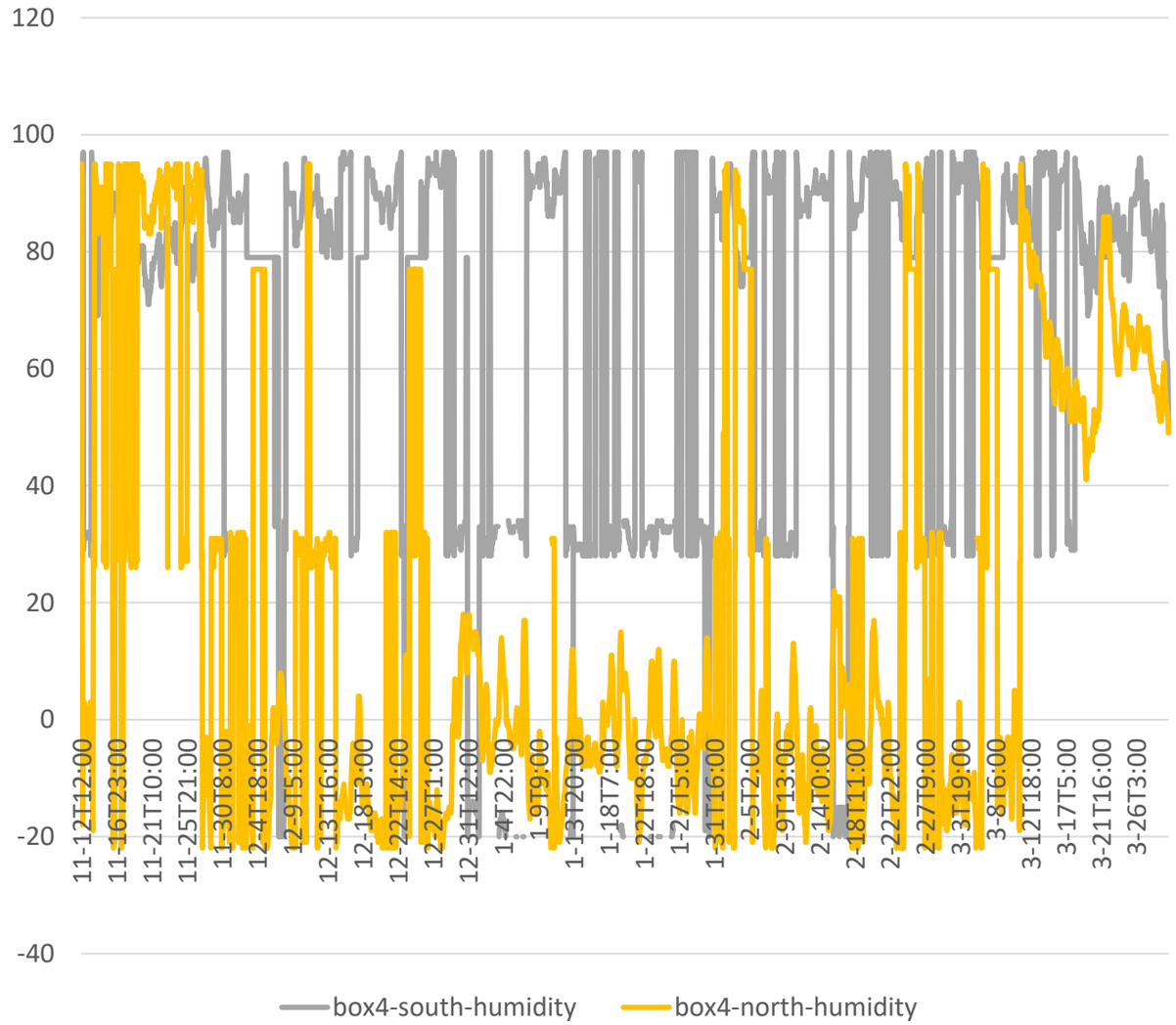
Temperature Stalker (top/bottom entrance, NO slatted rack, north facing)



- Bees have been clustered closest to the box2-north sensor since late December.
- General wisdom says they would cluster on the box2-south side since it warms up quickest – but we haven't seen this for the last 2 years in the colony. Are they staying on the north side because it has the higher airflow?

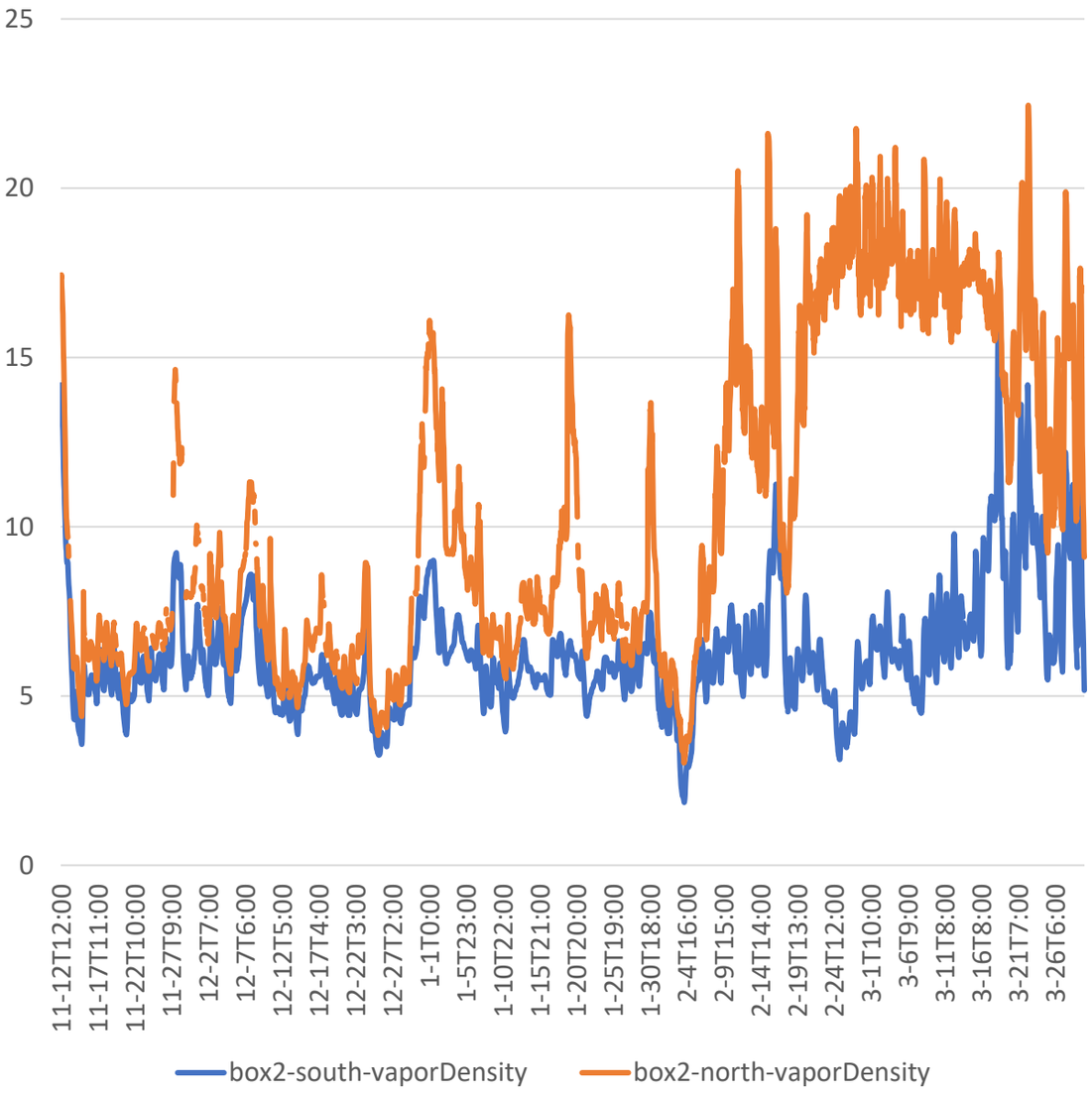
Relative Humidity Stalker (No slatted rack, top/bottom entrance, north facing)

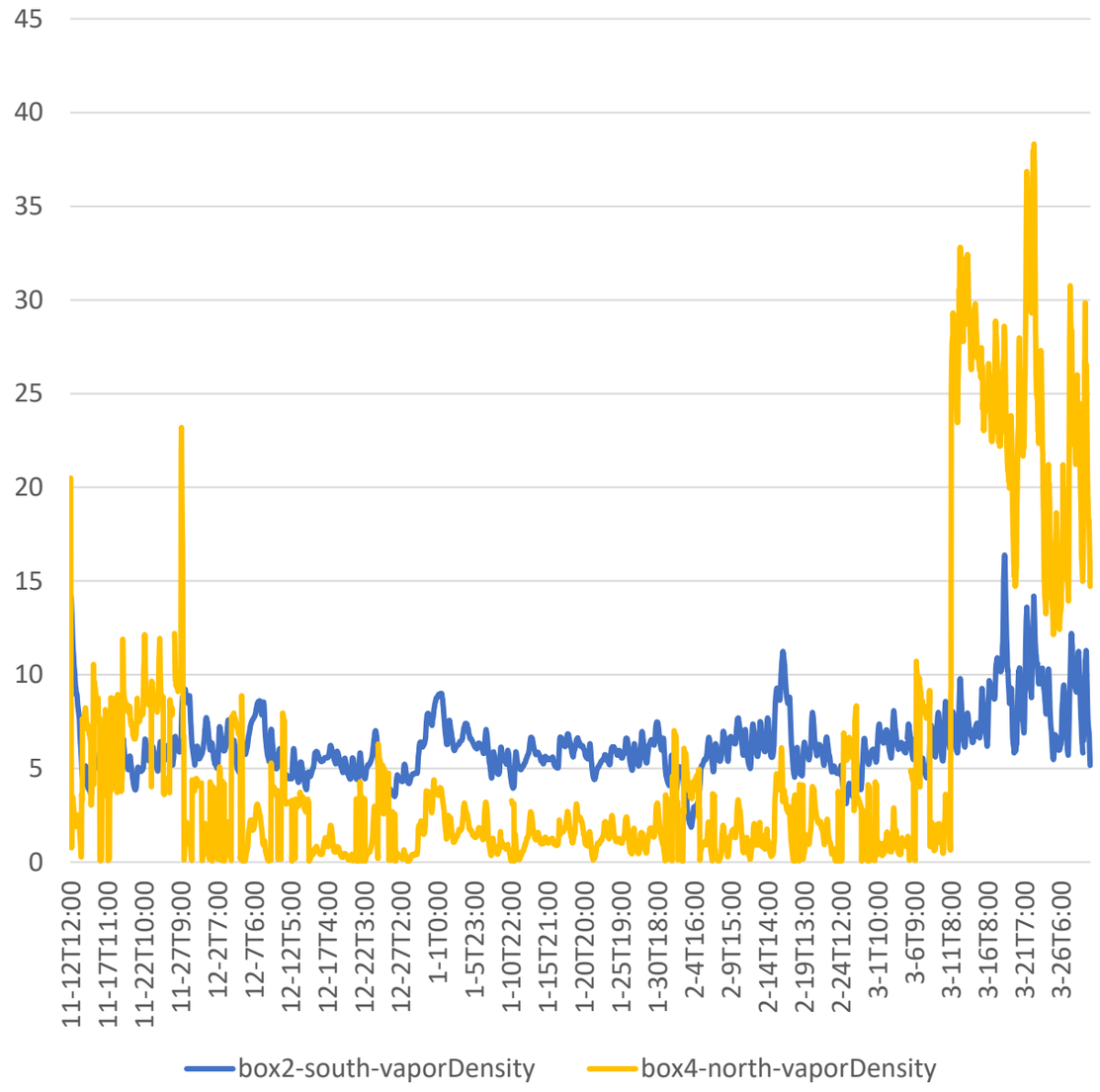




- *Bees have been clustered closest to the box2-north sensor since late December. until mid March
- The box4-south/north sensors have taken odd humidity readings all year. Before starting the project, I put all of the sensors together in a dark root cellar to compare readings. These two sensors consistently reported RH 21 and 22 points higher than the other sensors so I applied that “correction factor” to all of the readings. If you remove that factor, you will no longer have negative readings but you will see readings > 100 – neither of which is valid.

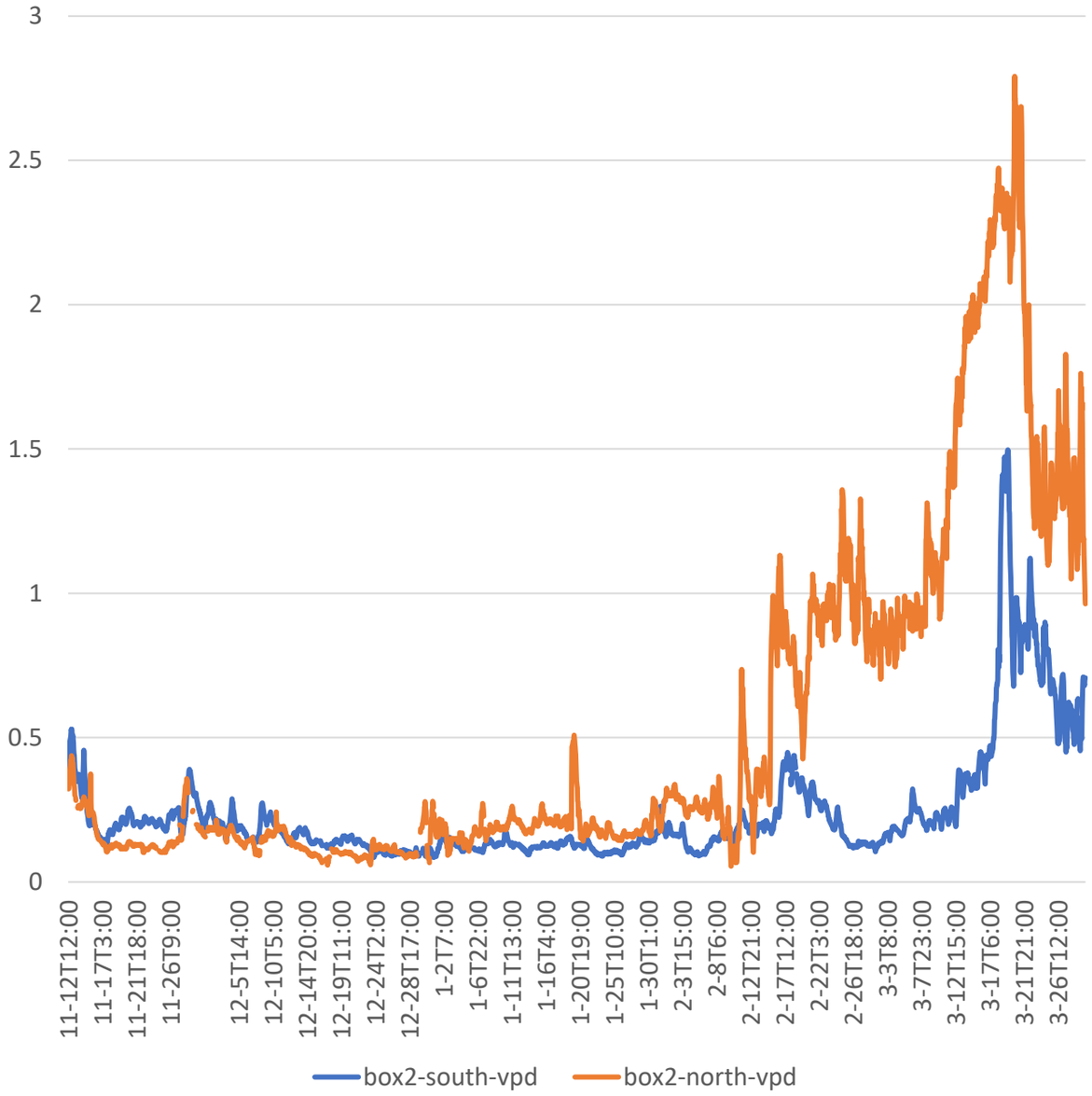
Vapor Density – Stalker (No slatted rack, top/bottom entrance, north facing)

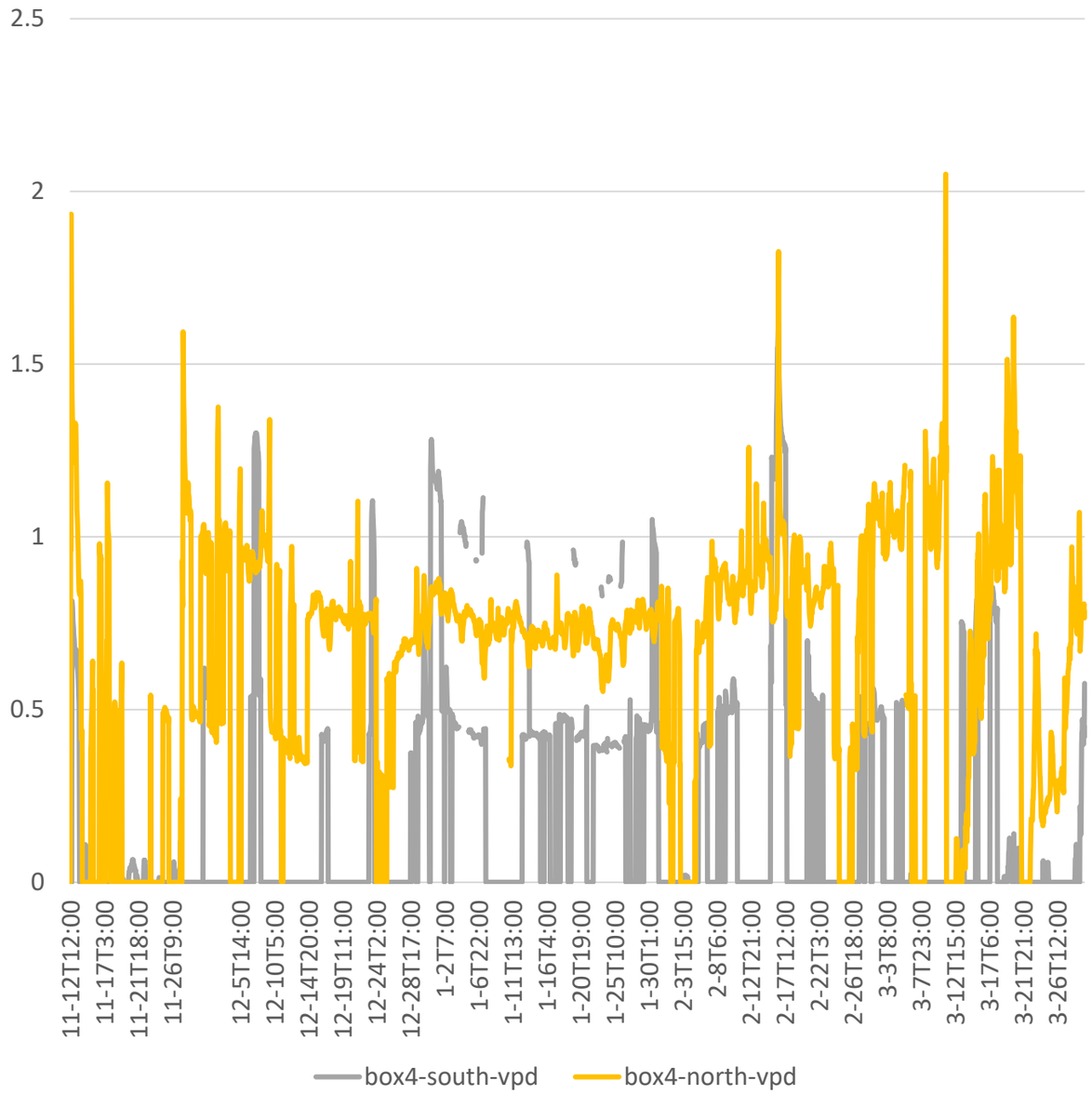




- Bees are clustered near the box2-north sensor until mid March
- *Note – vapor density calculations set any negative number to 0 – hence why the right graph doesn't show negative numbers and the RH graph did.

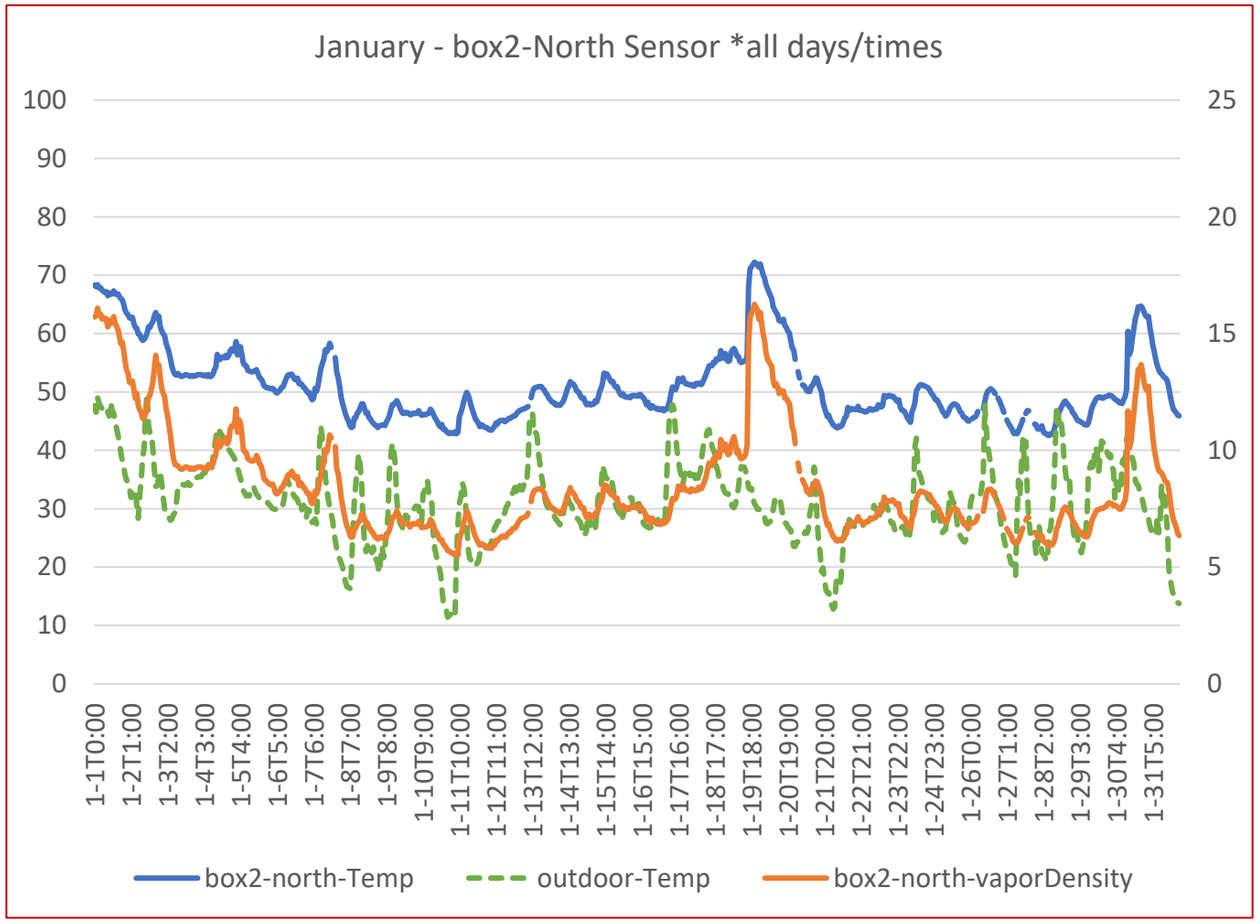
VPD– Stalker (No slatted rack, top/bottom entrance, north facing)



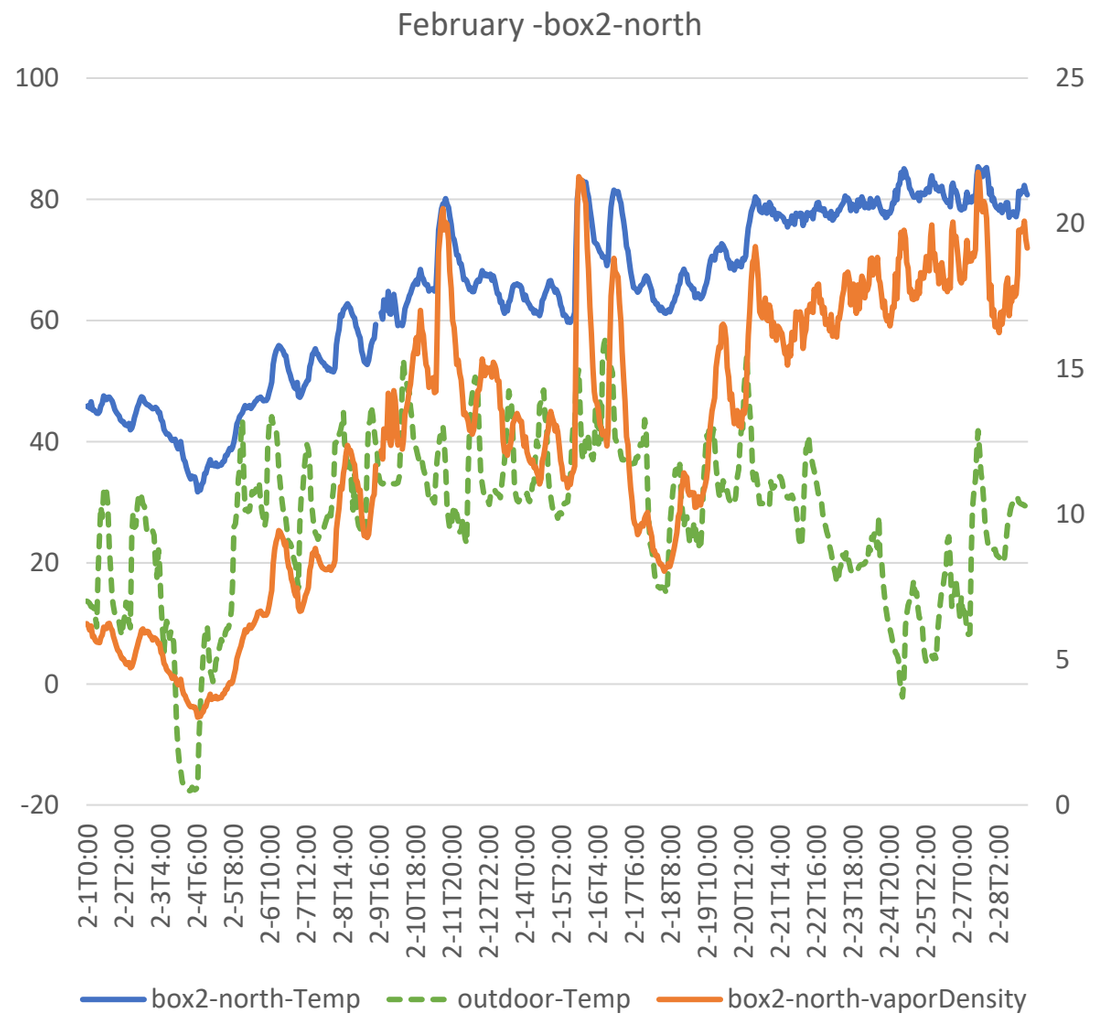


- Bees are clustered near the box2-north sensor until mid March
- *Note – vapor density calculations set any negative number to 0 – hence why the right graph doesn't show negative numbers and the RH graph did.

Box-2 North Sensor – Jan/Feb Data
Stalker (No slatted rack, top/bottom entrance, North Facing)

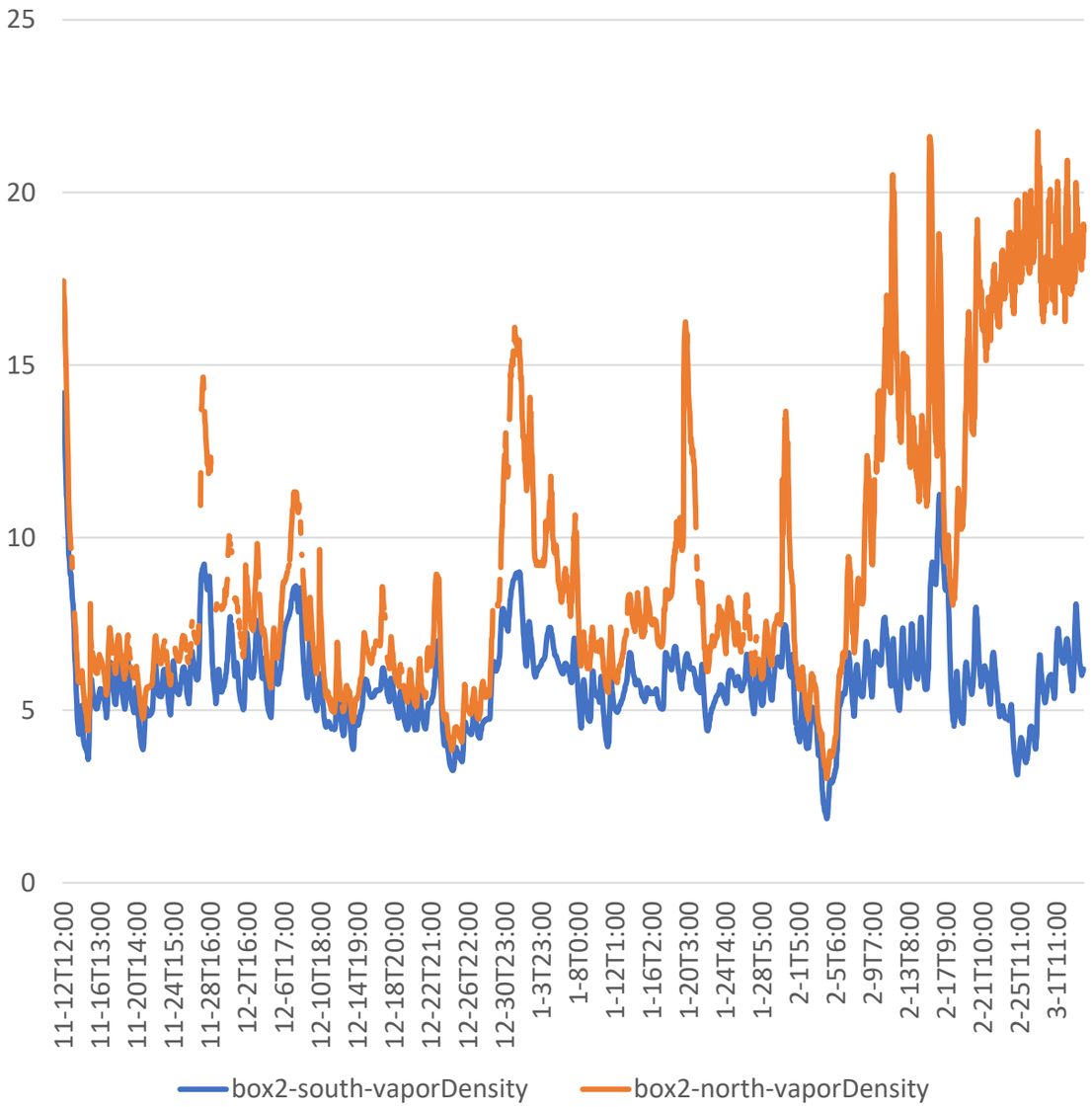


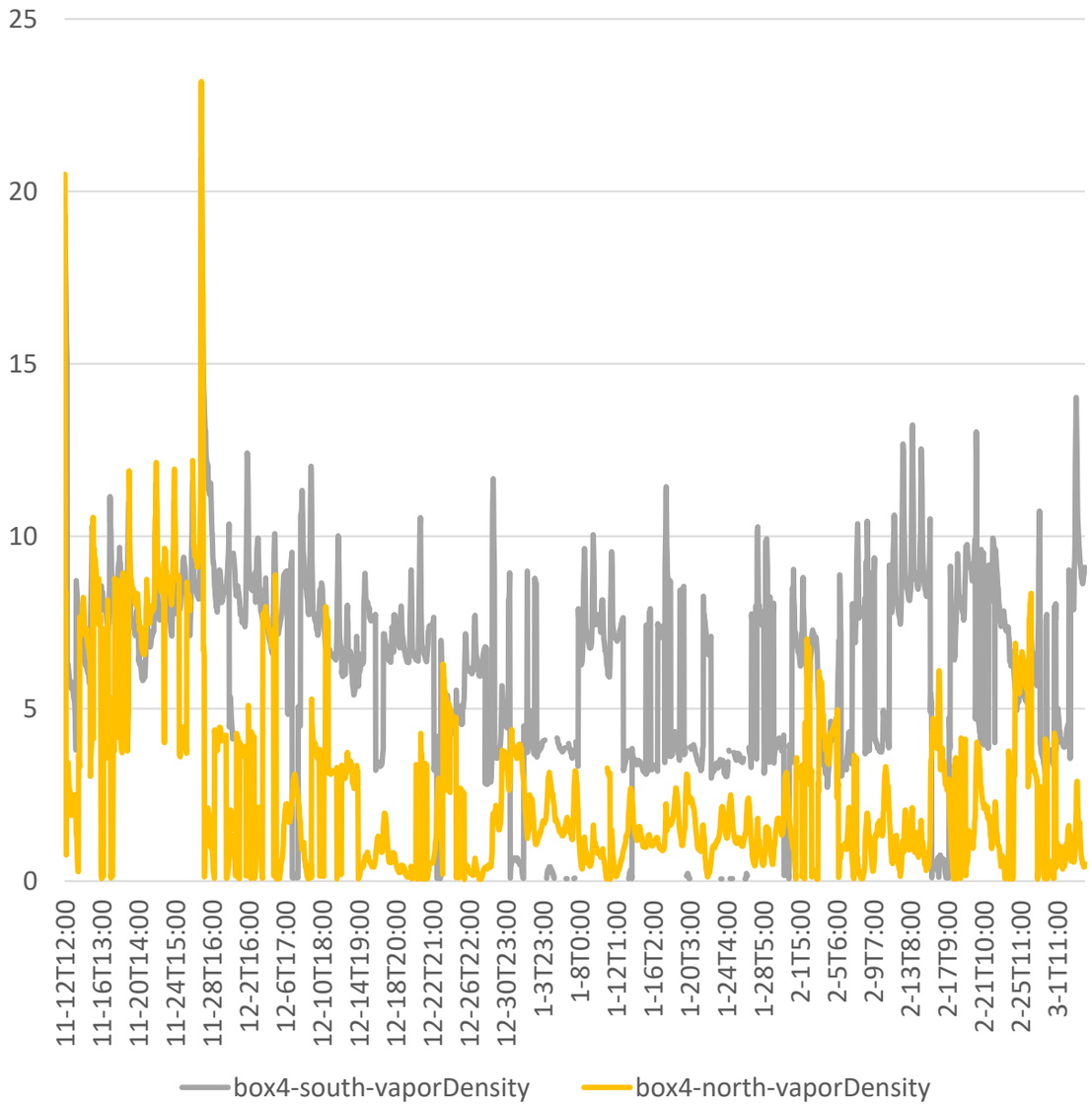
- Bees are nearest the box2-north sensor
- Interesting that the two peaks in temperature are when the outdoor temp was falling during the day. Maybe the bees were moving around to get in a tighter cluster?



- Bees are nearest the box2-north sensor
- We see the same typ of peak on Feb 11.
- Toward the end of the month the bees are clustered right at the box2-north sensor.

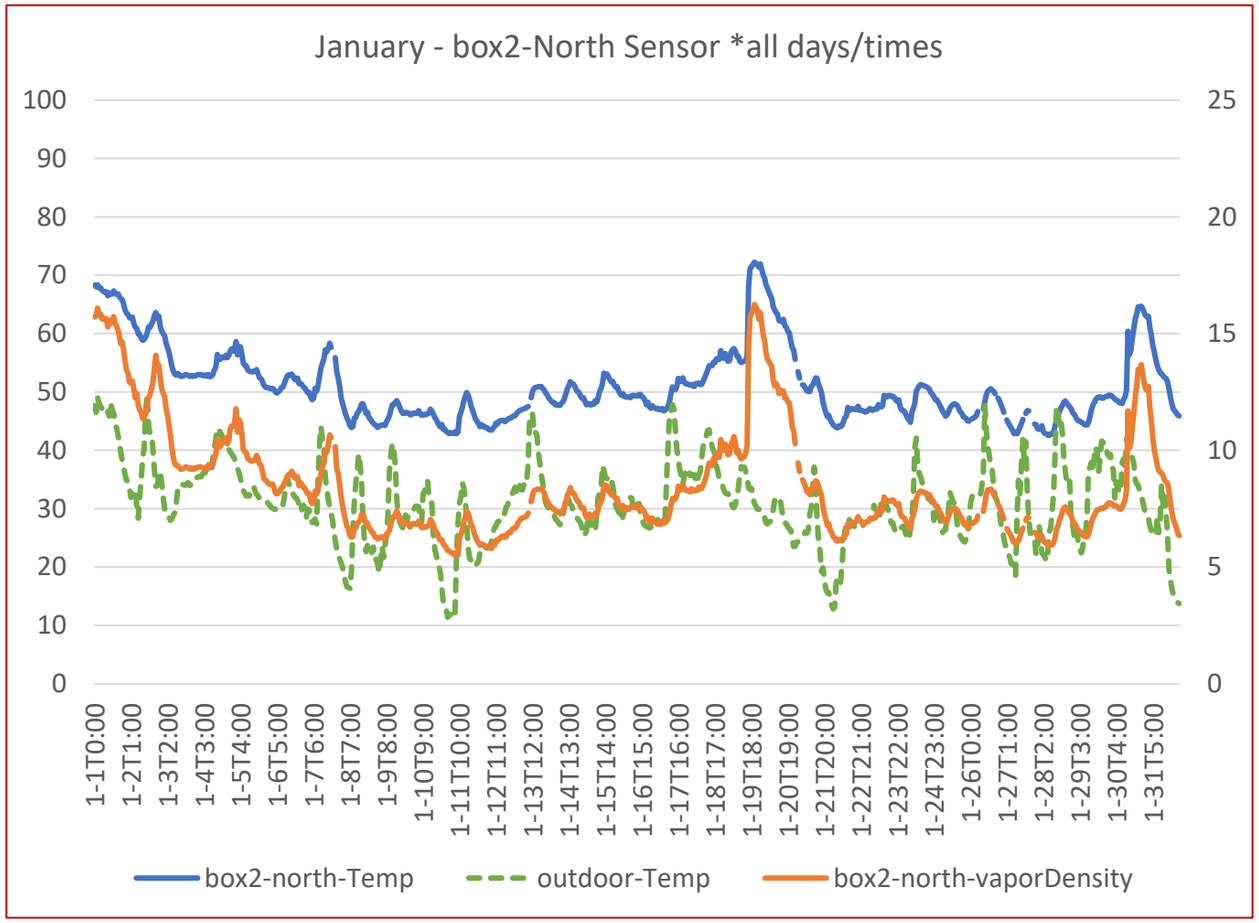
Vapor Density – Stalker (No slatted rack, top/bottom entrance, north facing)



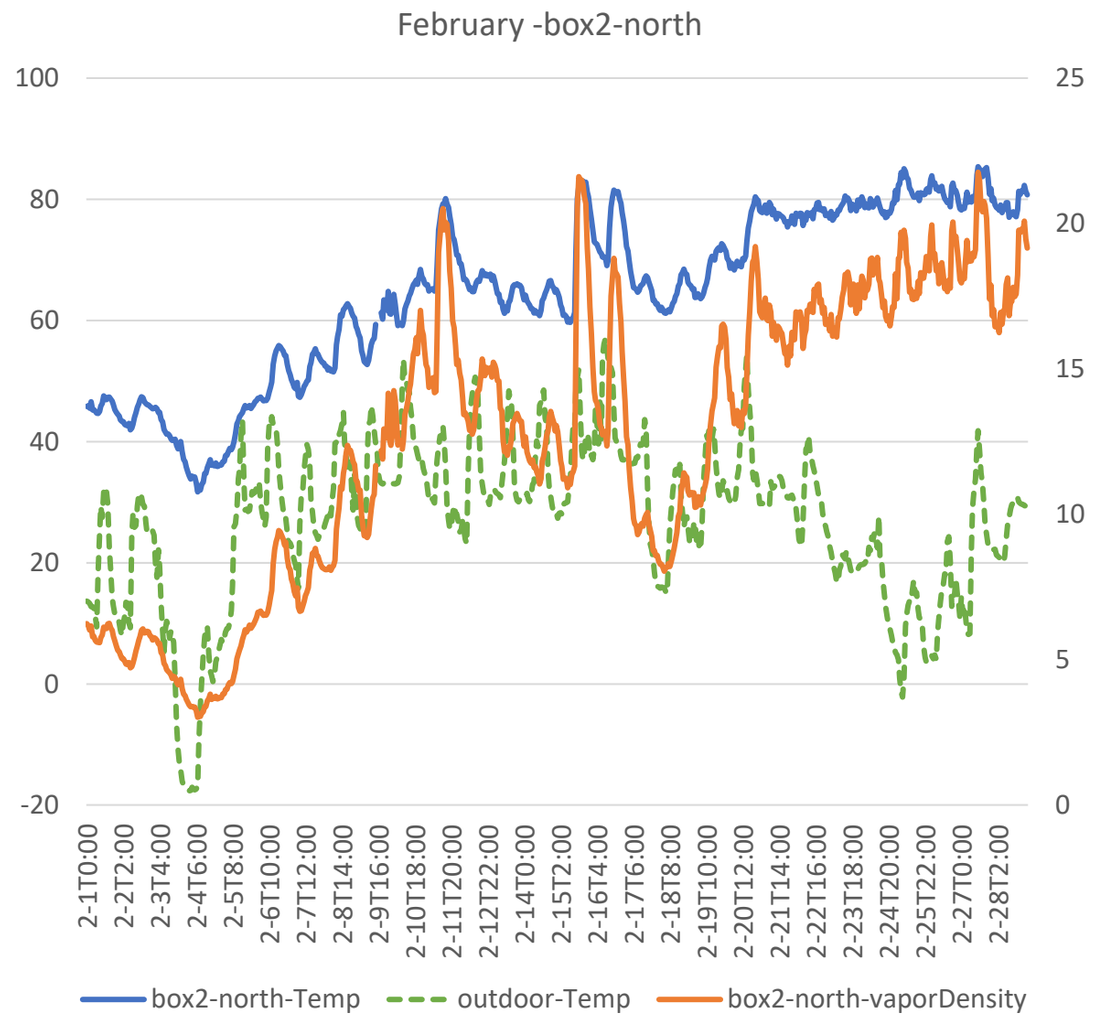


- Bees are clustered near the box2-north sensor.
- *Note – vapor density calculations set any negative number to 0 – hence why the right graph doesn't show negative numbers and the RH graph did.

Box-2 North Sensor – Jan/Feb Data
Stalker (No slatted rack, top/bottom entrance, North Facing)



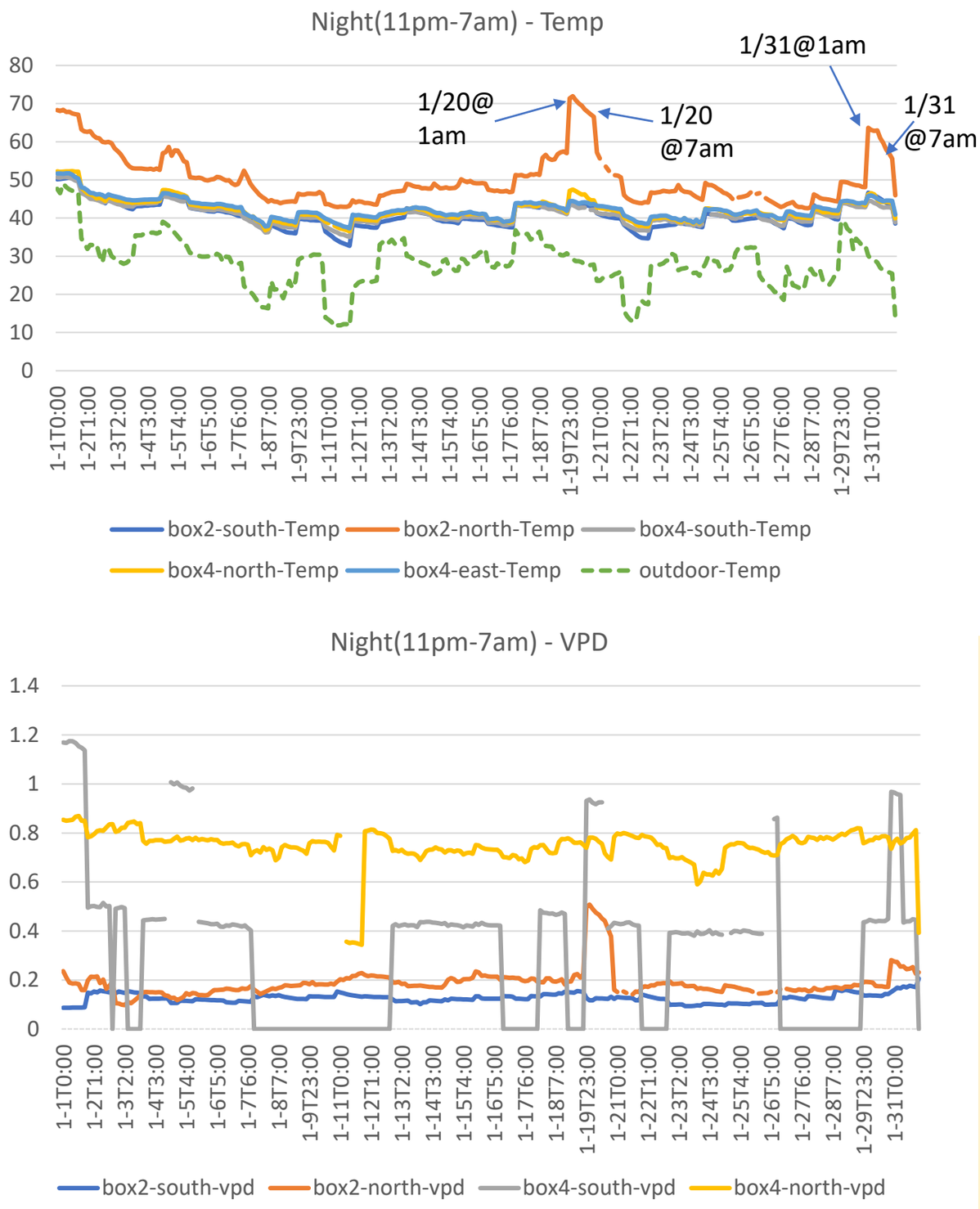
- Bees are nearest the box2-north sensor
- Interesting that the two peaks in temperature are when the outdoor temp was falling during the day. Maybe the bees were moving around to get in a tighter cluster?

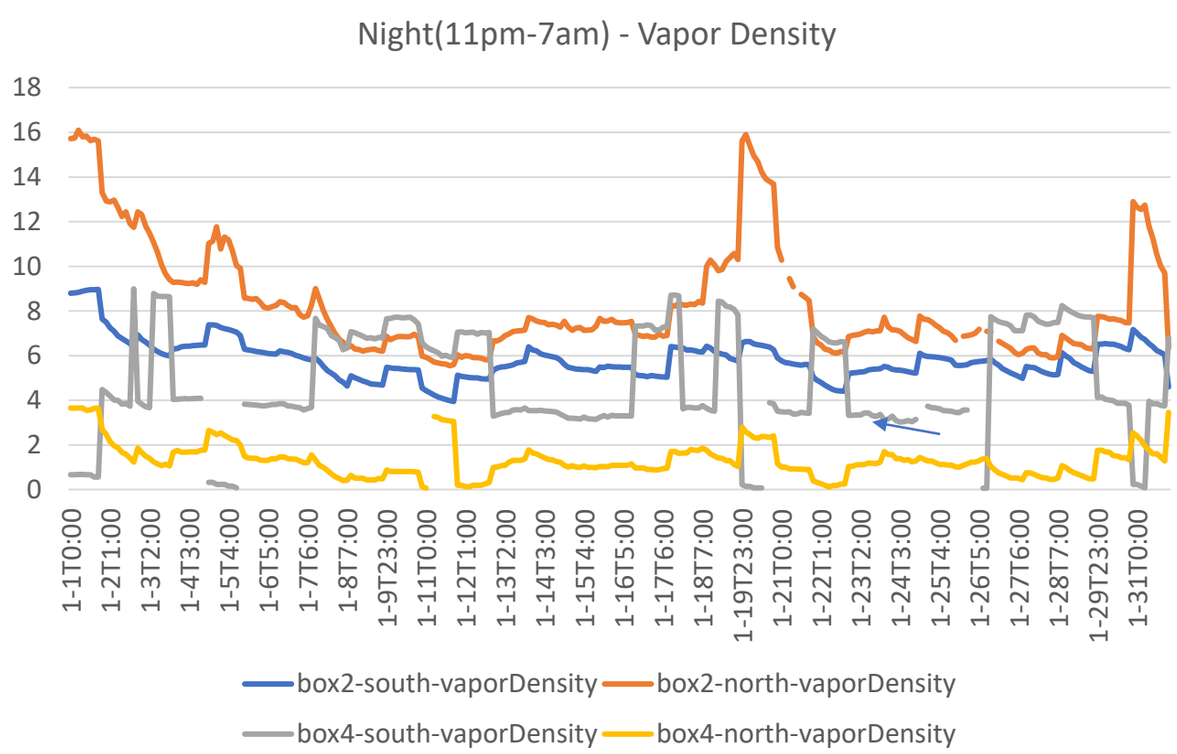


- Bees are nearest the box2-north sensor
- We see the same typ of peak on Feb 11.
- Toward the end of the month the bees are clustered right at the box2-north sensor.

Day vs Night Data
By Month

January –Night – Stalker (No slatted rack, top/bottom entrance)

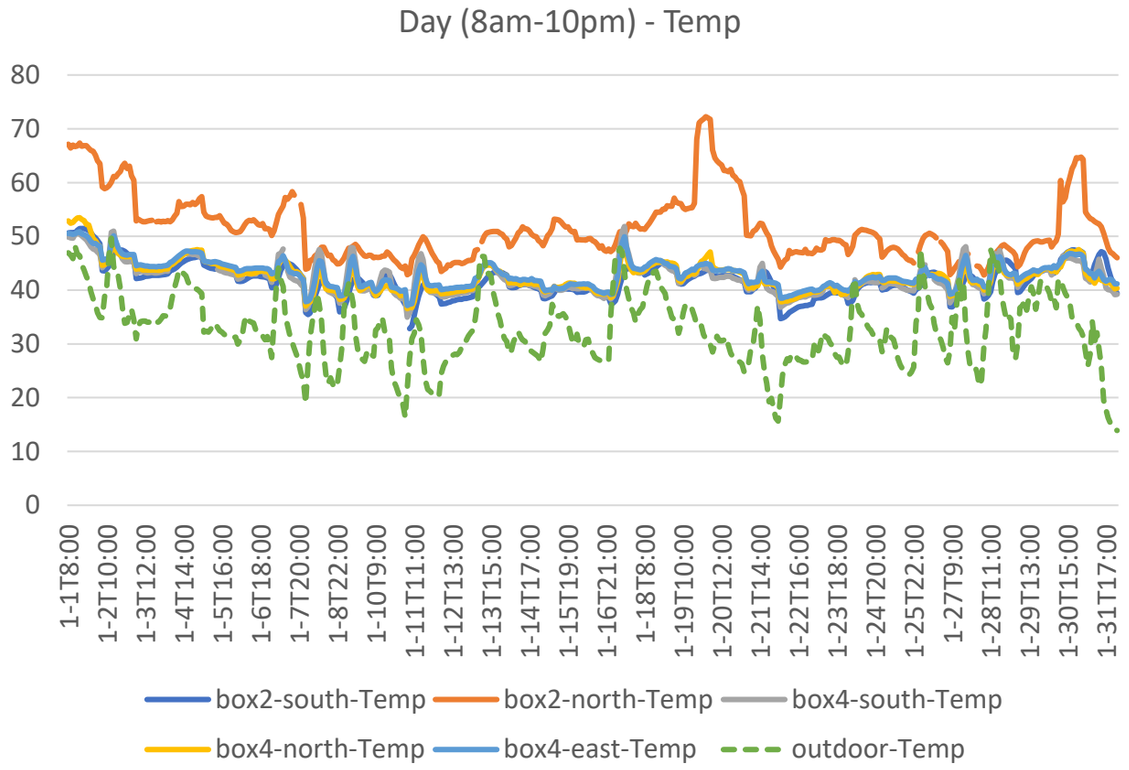


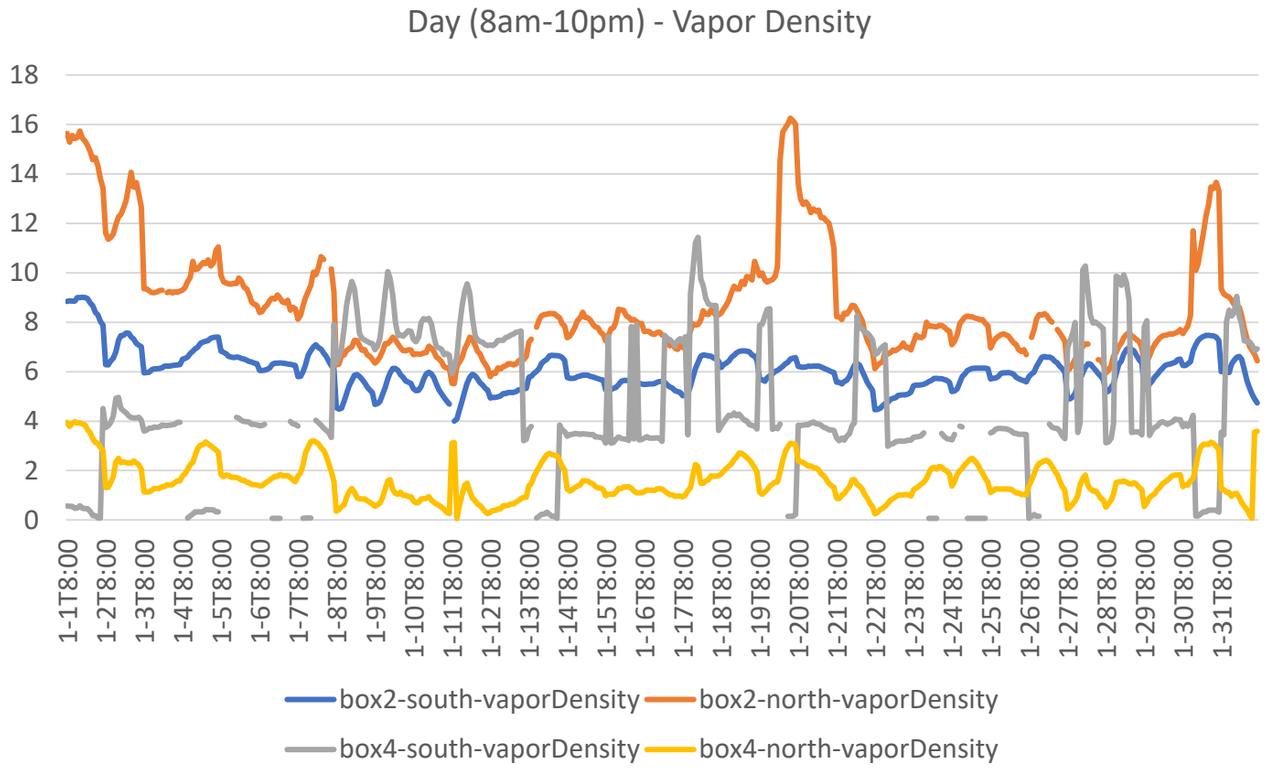


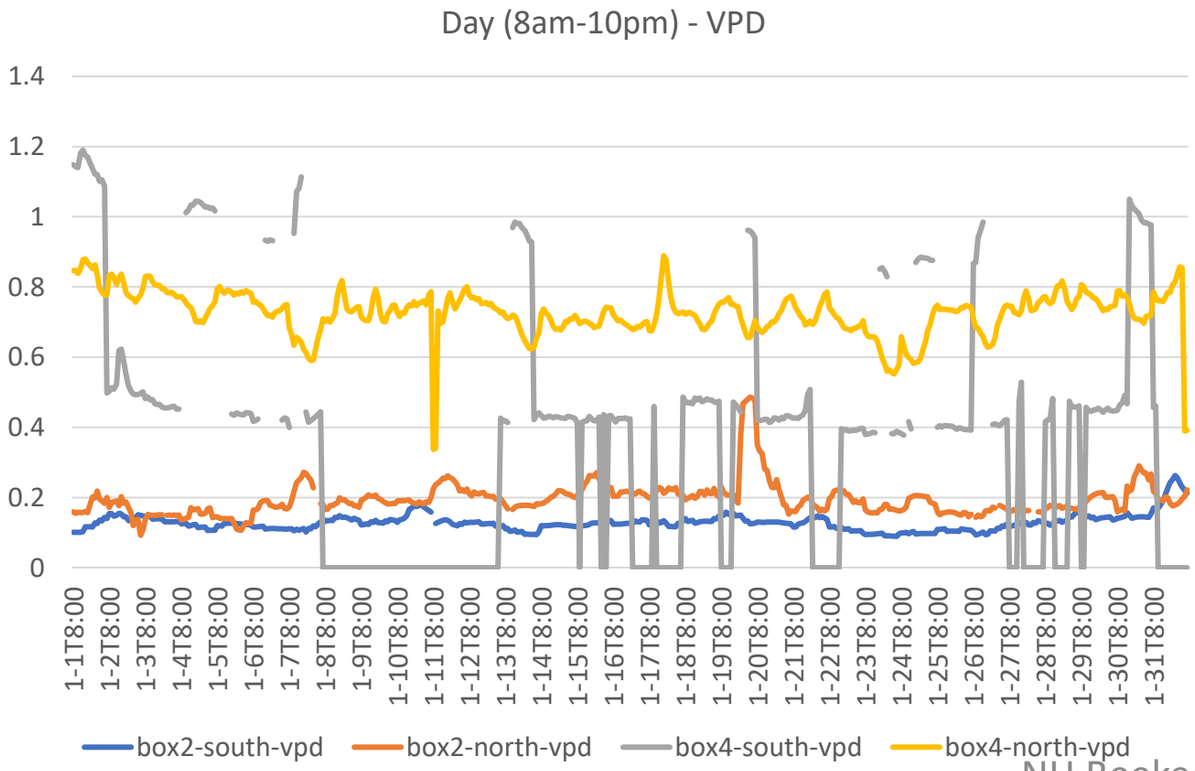
- Bees are nearest the box2-north sensor
- Box4-east sensor is temp only.
- Box4-south & box4-north sensors give suspect humidity readings as was seen in earlier graphs.

- The temps were kept pretty consistent at night at all sensors– except for two times where the bees moved onto the box2-north sensor for a few hours. This corresponded to a dropping outside temp as we saw in the graphs that showed all of the data for the month.
- The Vapor Density Peaks correspond to the times the temp increased.
- Overall the VPD near the cluster is consistant except for the period where the temp reached 70.

January –Day – Stalker (No slatted rack, top/bottom entrance, faces north)



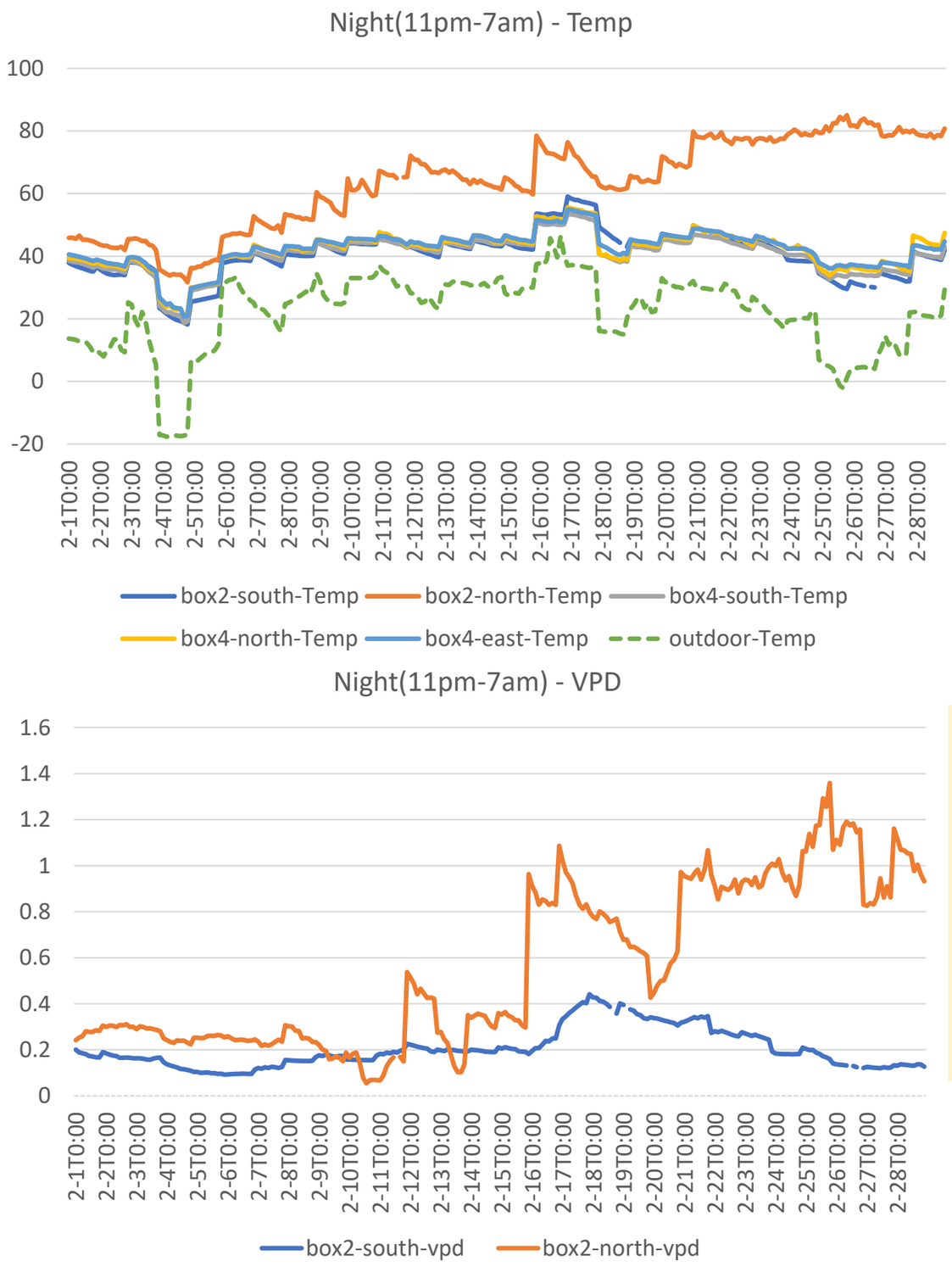


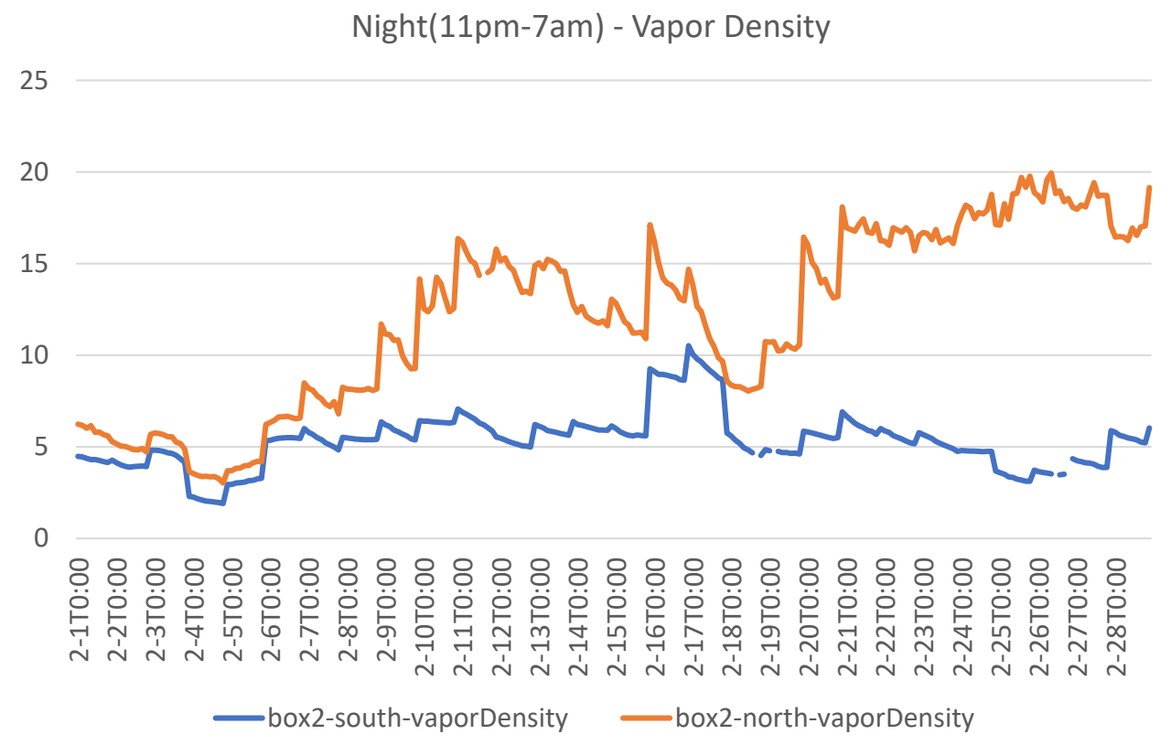


- Bees are nearest the box2-north
- Box4-east sensor is temp only.
- Box4-south & box4-north sensors give suspect humidity readings as was seen in earlier graphs.

- Similar observations to what is listed for the Jan-night.
- Temps at the sensors other than box2-north are very consistent with box2-south sensor being the coldest.

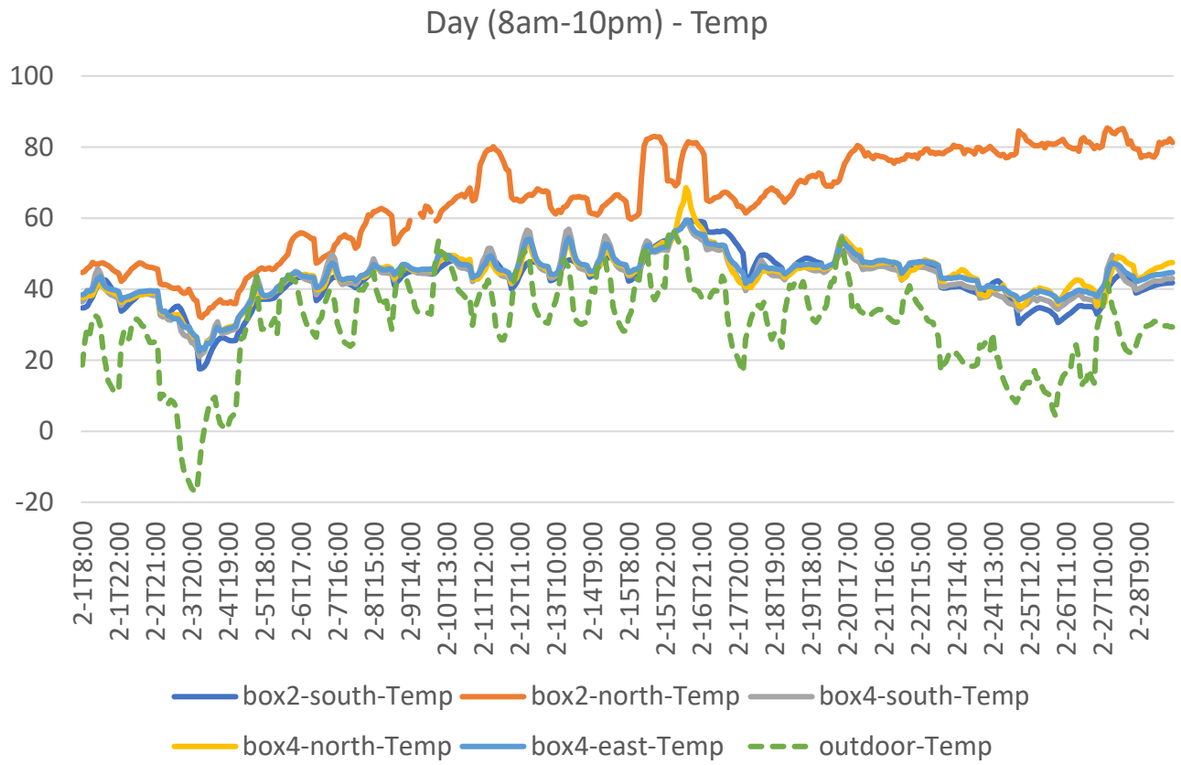
Feb –Night – Stalker (No slatted rack, top/bottom entrance,faces north)

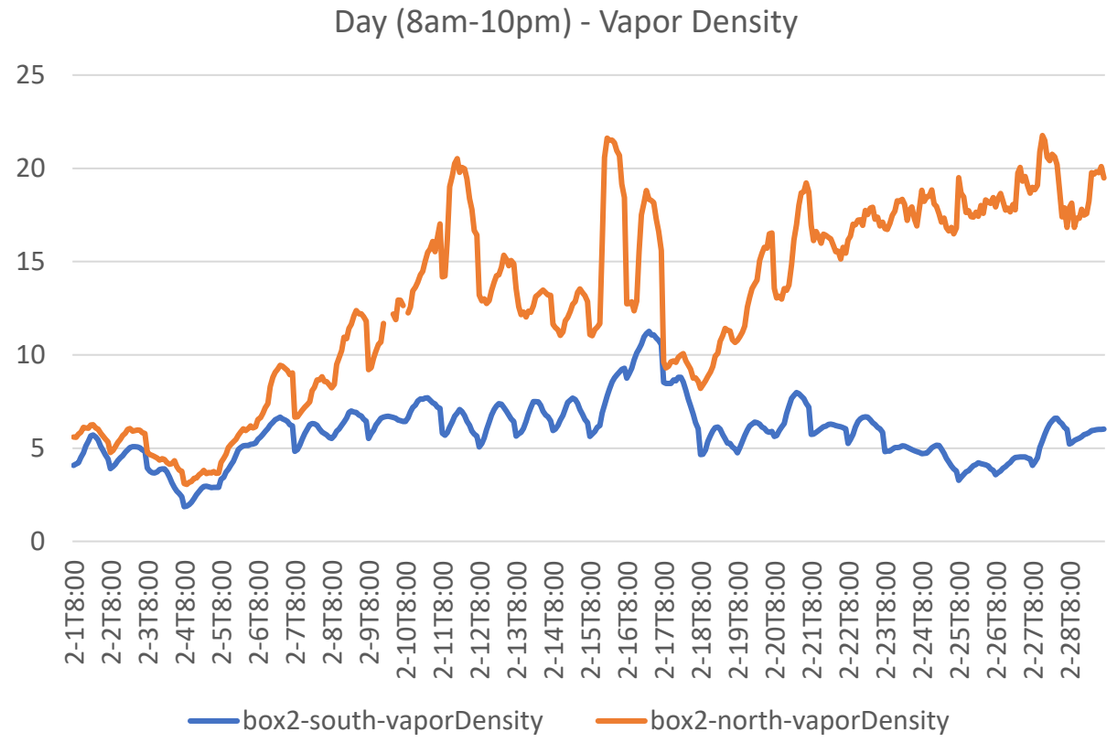


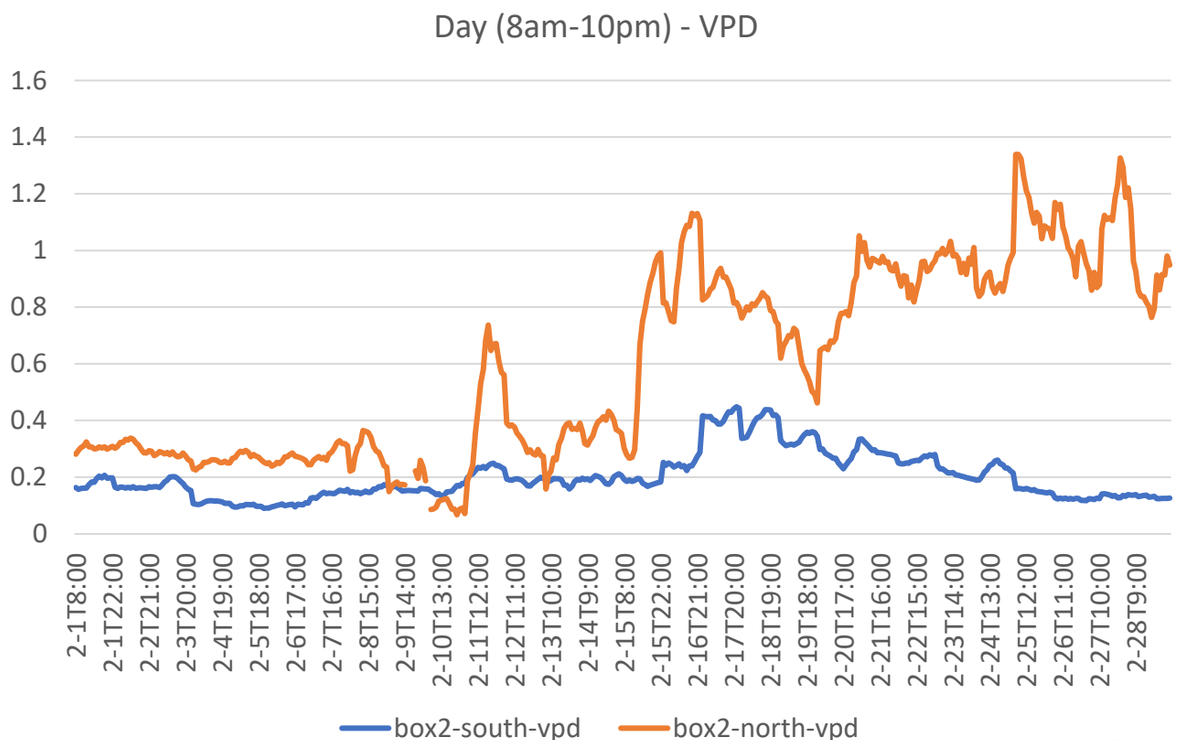


- Bees are nearest the box2-north sensor
- Box4-east sensor is temp only.
- Box4-south & box4-north sensors give suspect humidity readings as was seen in earlier graphs so they were removed.
- The dip in vapor density (increase in VPD) in box2-north sensor around 2/18 is interesting. The bees pulled moisture from the air? Maybe they were fanning?

Feb –Day – Stalker (No slatted rack, top/bottom entrance)

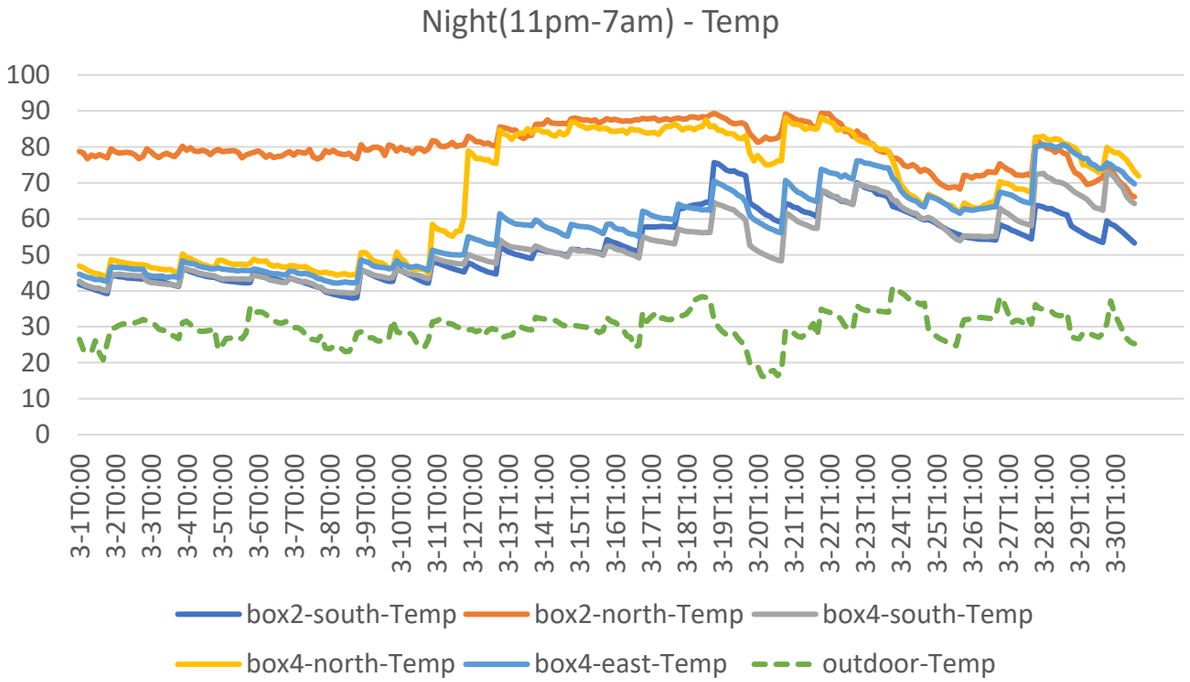


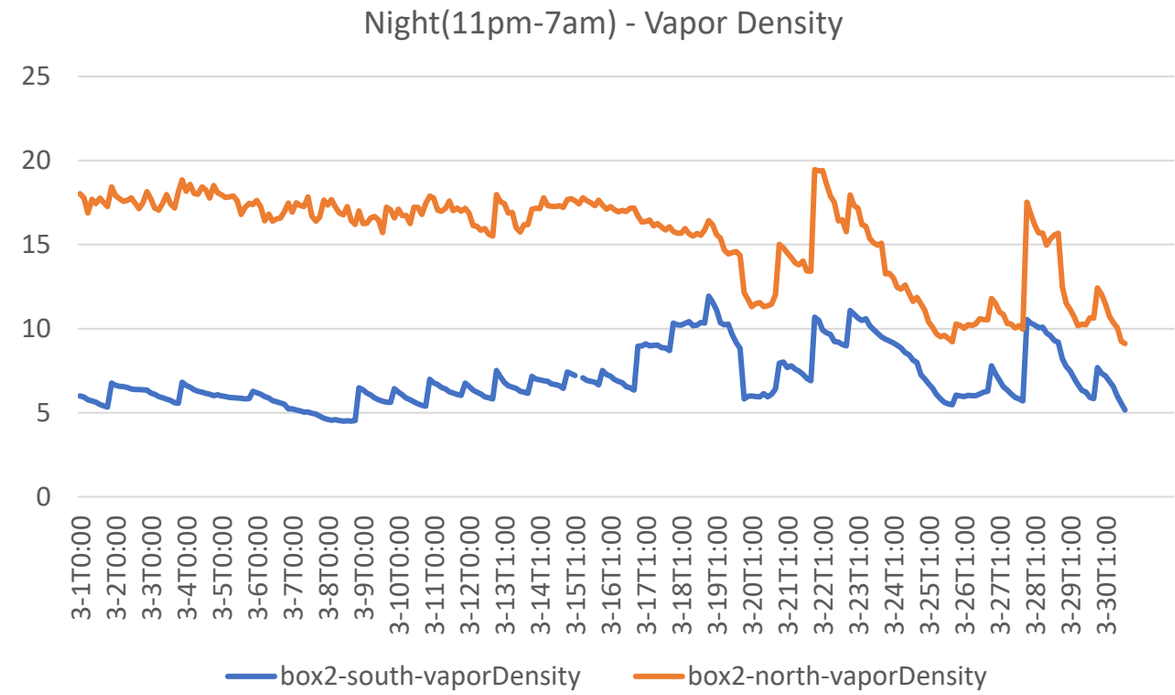


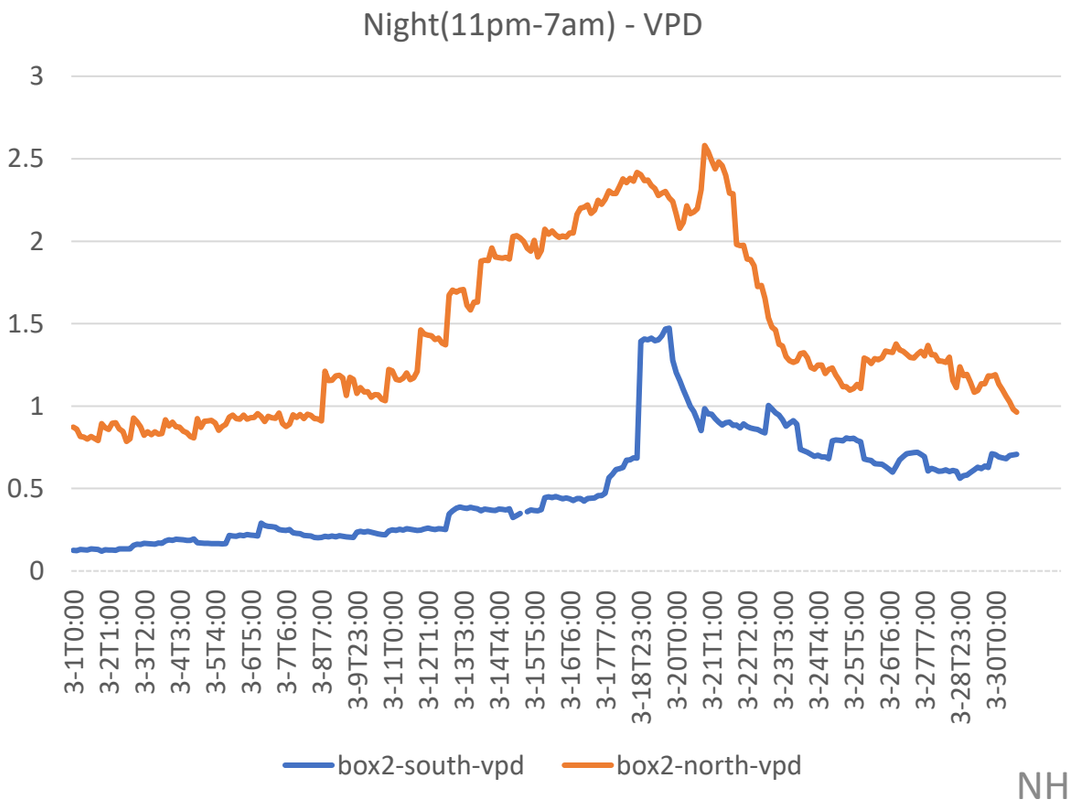


- Bees are nearest the box2-north sensor
- Box4-east sensor is temp only.
- Box4-south & box4-north sensors give suspect humidity readings as was seen in earlier graphs so they are removed
- The dip in vapor density (increase in VPD) on box2-north sensor around 2/18 is interesting
- The bees pulled moisture from the air? Maybe they were fanning?

Mar –Night – Stalker (No slatted rack, top/bottom entrance,faces north)

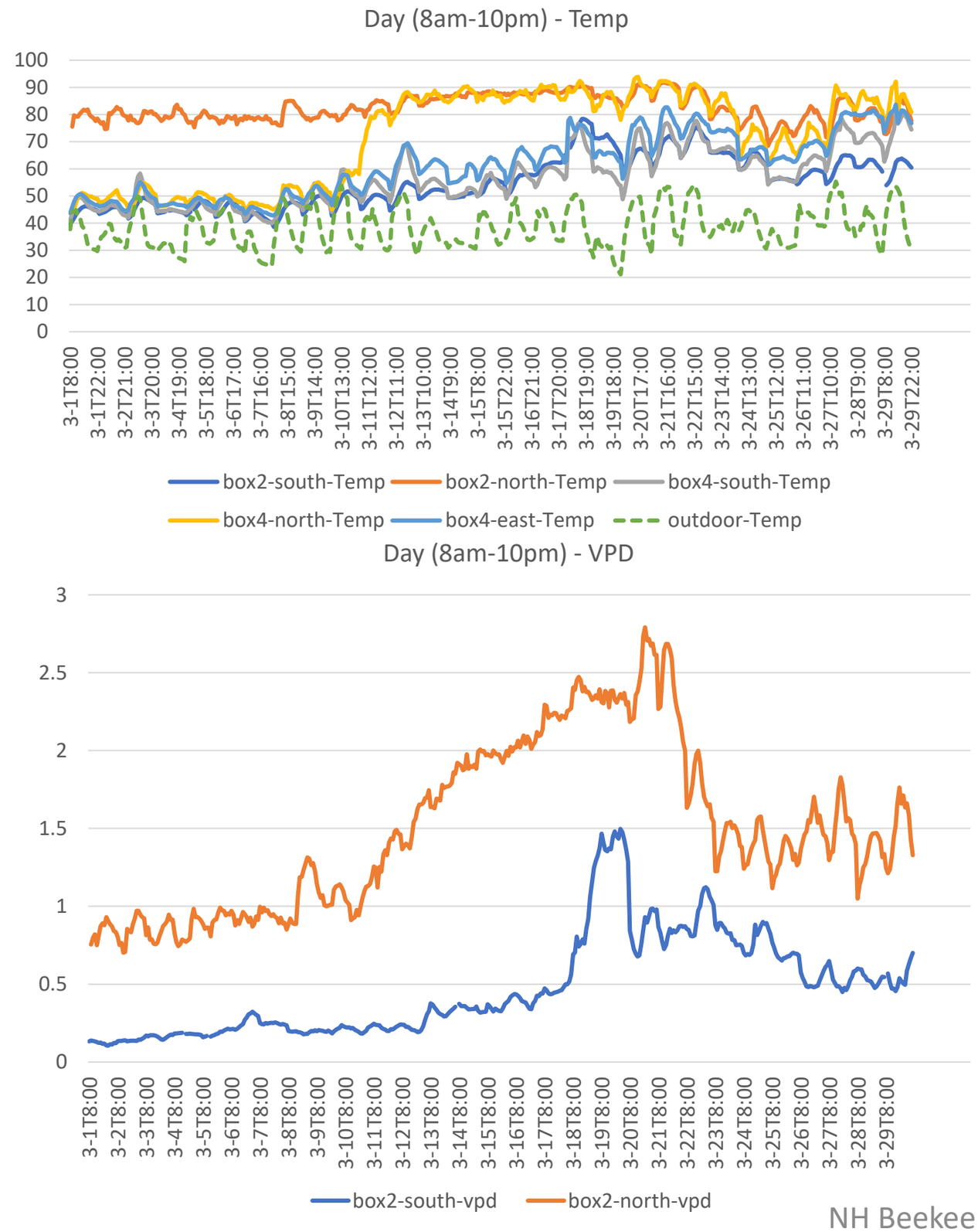


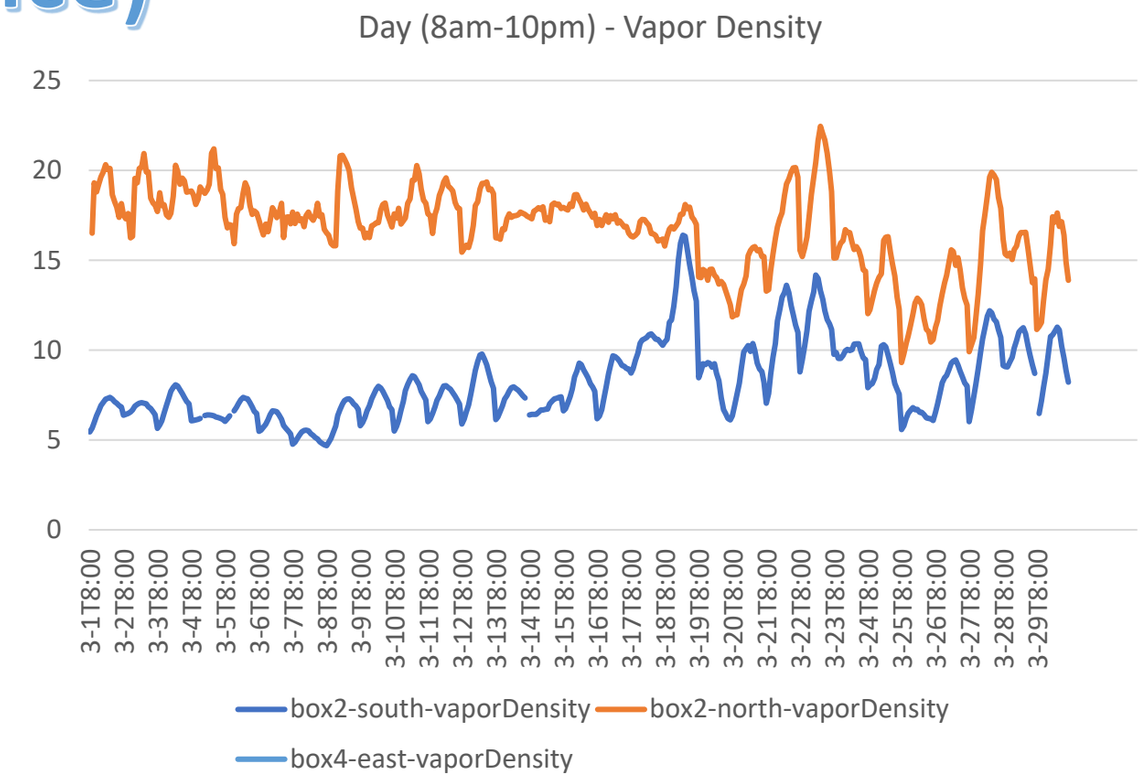




- Bees are clustered around the box2-north sensor until Mar 11 – when they move up to box4 – they appear to clustering on cold nights still in box2
  - Box4-east sensor is temp only.
- The box4 sensors are giving suspect RH readings – so they were removed from vapor density and VPD graphs.

Mar –Day – Stalker (No slatted rack, top/bottom entrance)





- Bees are nearest the box2-north sensor and then moved up to box4-north on 3/10– They stayed between the two sensors to the end of the month
- Box4-east sensor is temp only.
- Box4-south & box4-north sensors give suspect humidity readings so they are removed..