Analysis of Sask3 Data from Nov12,2022-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”

Sask3: Top/bottom entrance; No Slatted Rack

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 – bees near box4-south sensor; added 2-2/3lb sugar bricks
12/10/22 (4:00) – only ½ brick left – added 1.25 lbs bricks
12/17/22 (noon) – bricks ½ gone – added 1- 1/2lb brick
12/30/22 – bricks mostly still there
1/11/22 – added ½ lb brick
1/17 or 18 – bees flying mostly using top entrance
1/19/23 (3:30) plenty of food – bees covering top of frames in box4
2/8/23 (9:30) – plenty of food – LOTs of bees in box4
2/15/23 (1:15)- plenty of food - LOTS of bees up at box 4
2/27/23 (11:15)
- added another 1/2lb brick
- LOTS of bees in box 4 - top
- Added ½ pollen patty (global)

3/3/23
- lots of cleansing flights in apiary – wasn't home so didn't see which colonies
- They are only using the top entrance on any cleansing flights.

3/9/23 (noonish)
- Bees on top box4 – no pollen patty
- Added ½ patty

3/18/23 (10:30ish)
- Tons of bees in box4
- Added ½ patty

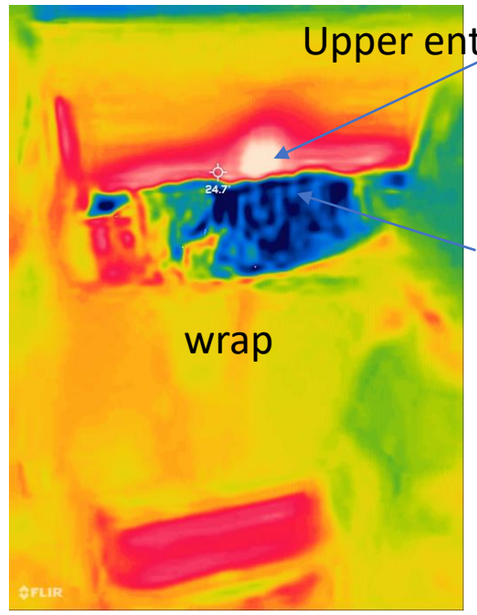
3/27/23 (4:15ish)
- Added ½ patty – still had sugar

3/29/23 (3pmish)
- Added medium with 3 partial

Honey frames, 5 drawn + feeder

Date	Sask3	Notes
5/26/2022	0.0%	
6/25/22	0.00%	
7/22/2022	Not tested	Treated Formic-
8/31/2022		Lots of capped queen cells
9/23/2022		Good larva/egg pattern
10/8/2022	14.00%	Treated Sask3 OA dribble

Mite Test Data (Alcohol Wash)



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)

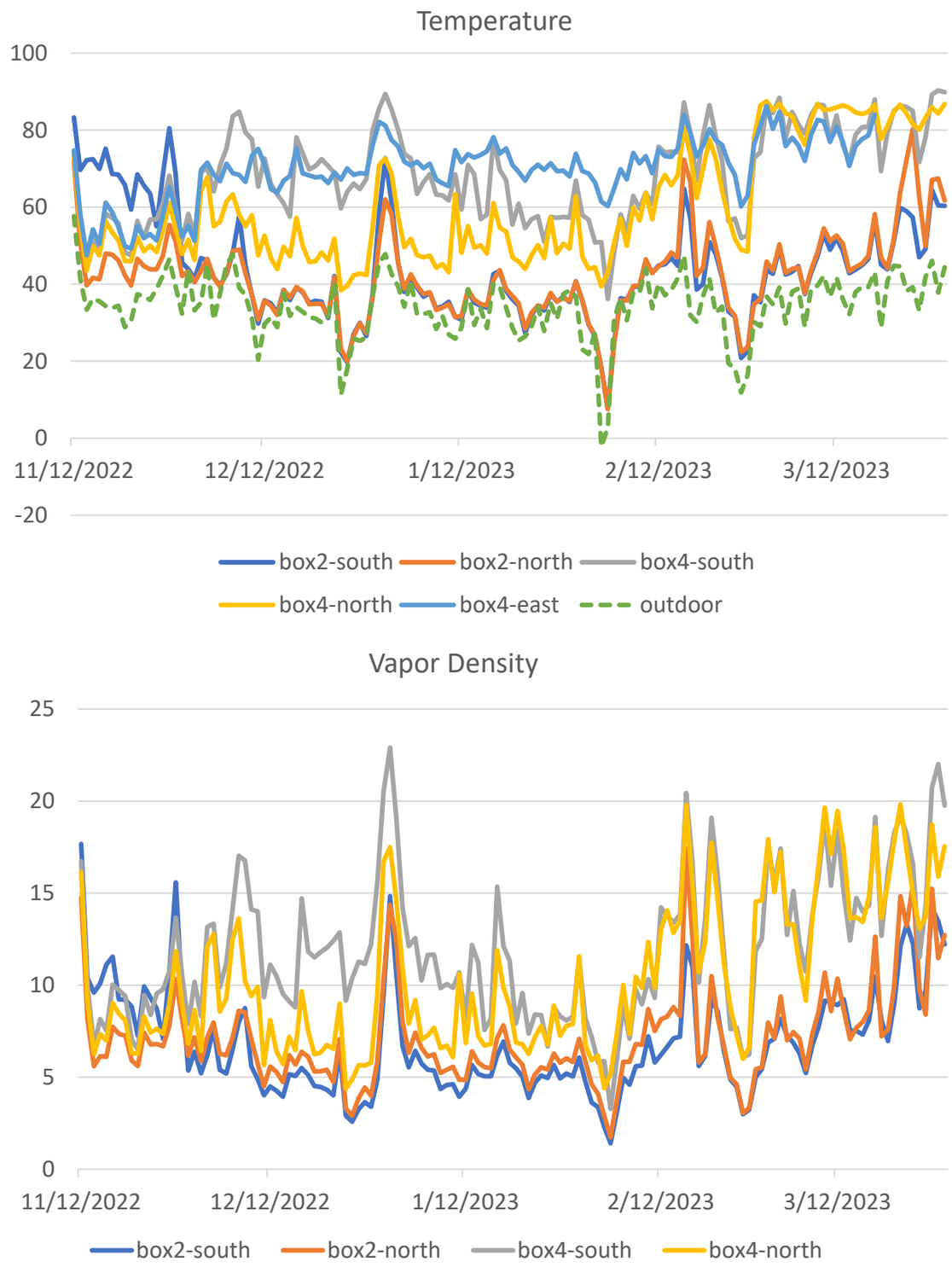
- **Vapor Pressure Deficit (VPD)** is a measure of how much more “room” there is for humidity (water vapor) in the air, at the current temperature

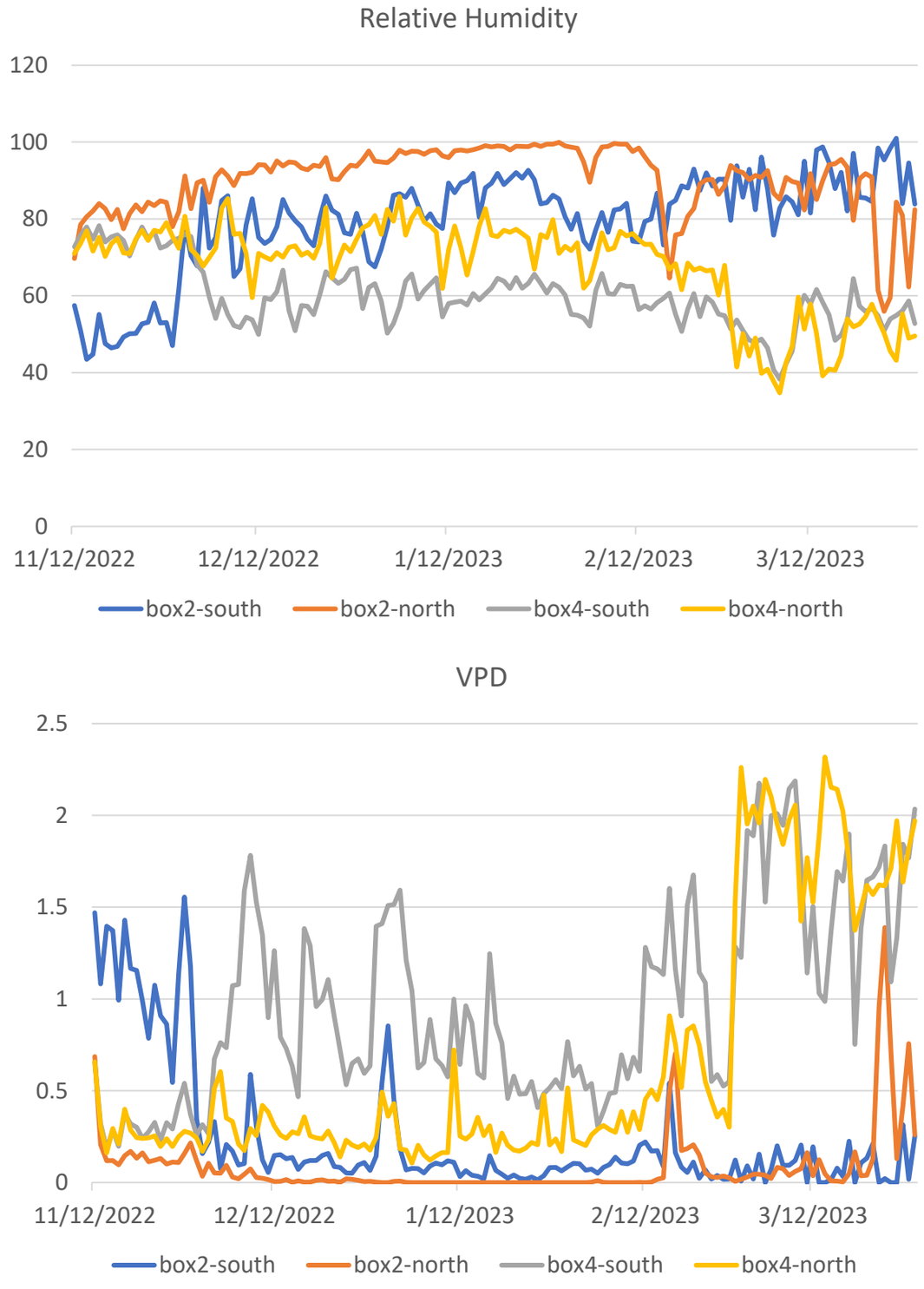
Notes from Etienne Tardif on Bee-L forum

- 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 – Sask3 (No rack, top/bottom entrance only)

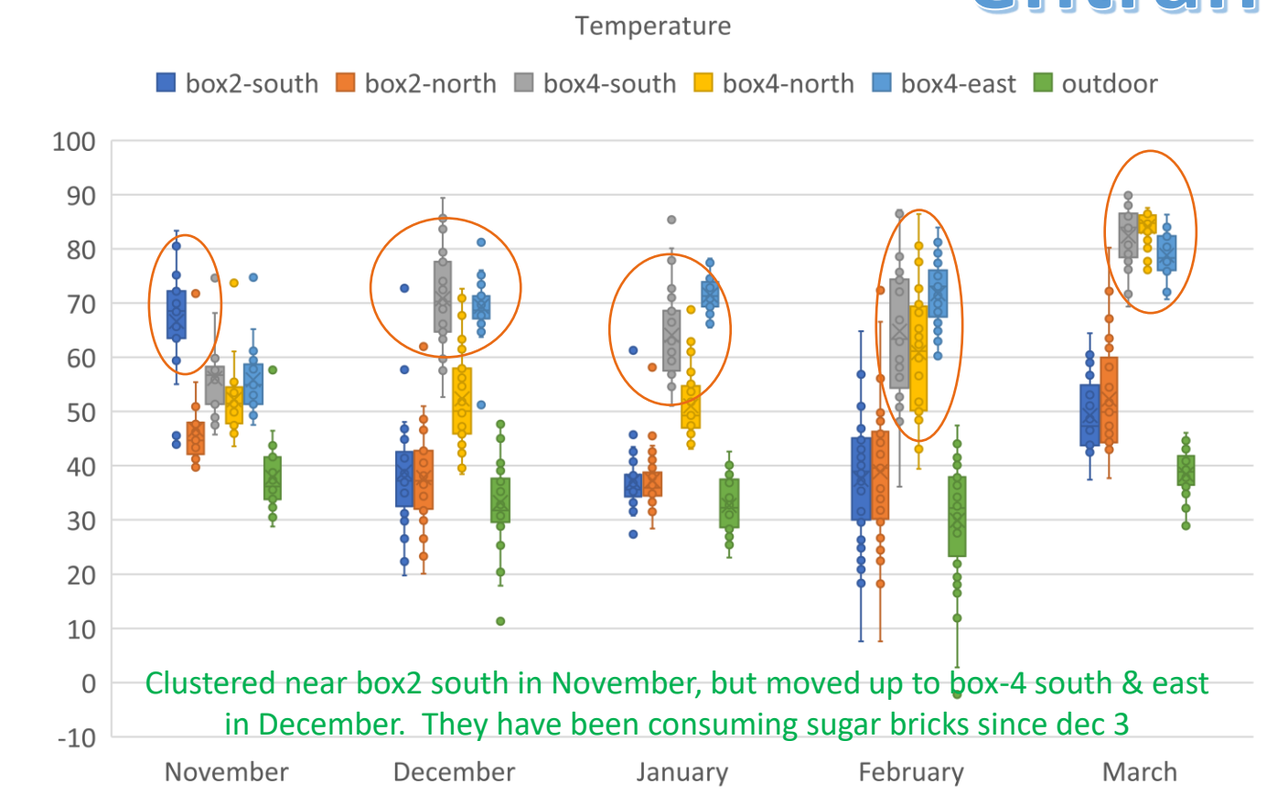


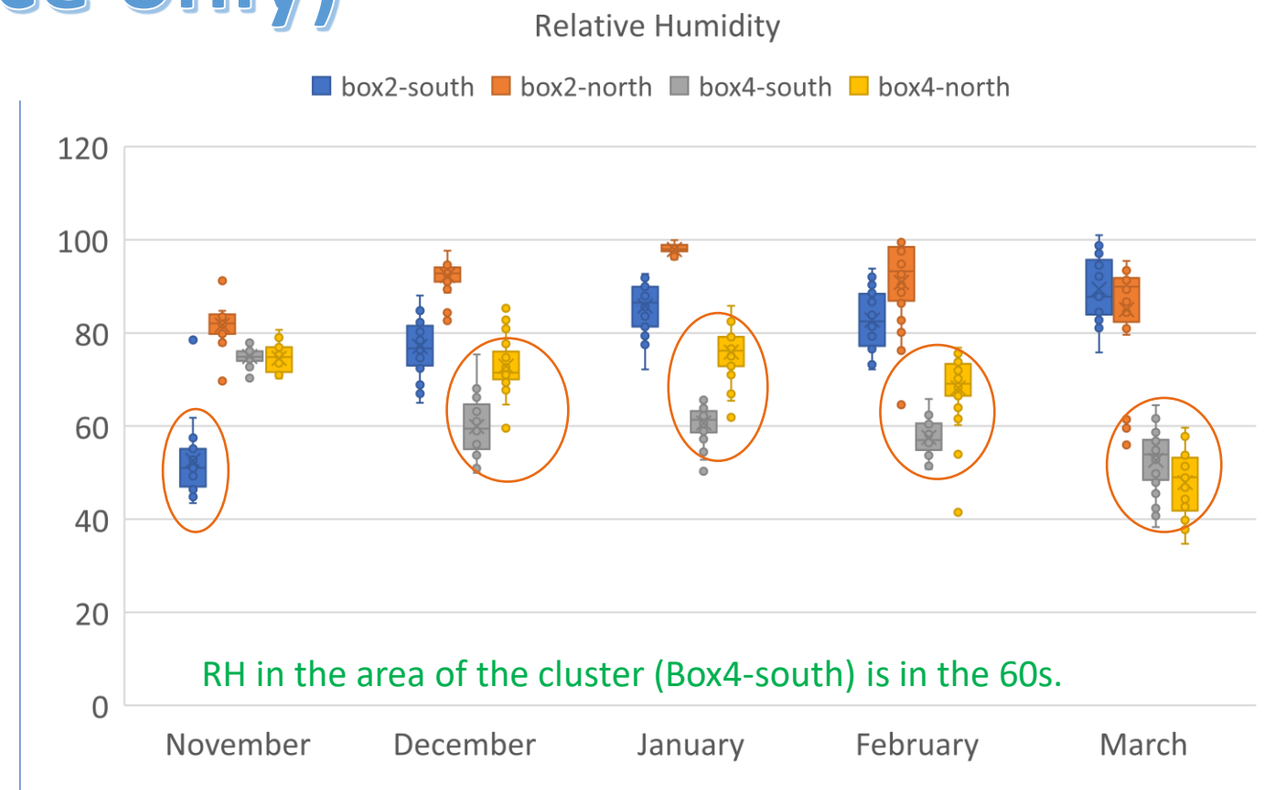


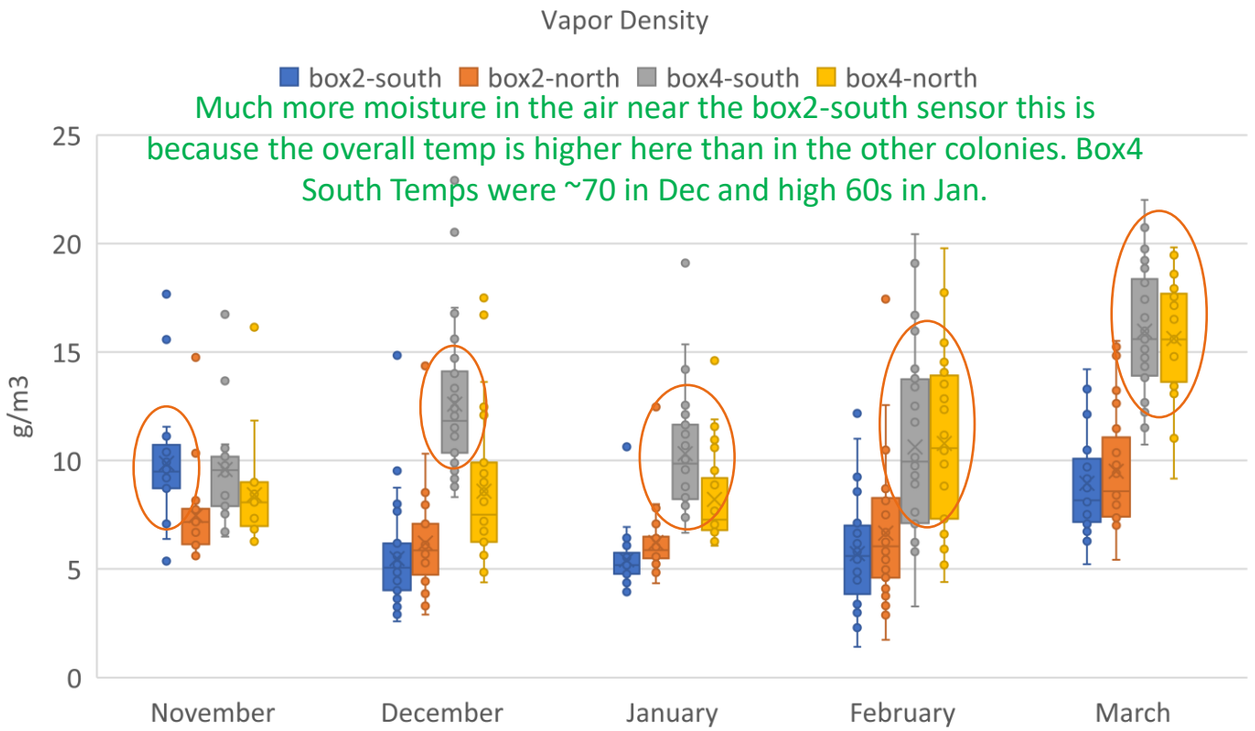
*Box4-east is temp only and stopped recording in late March

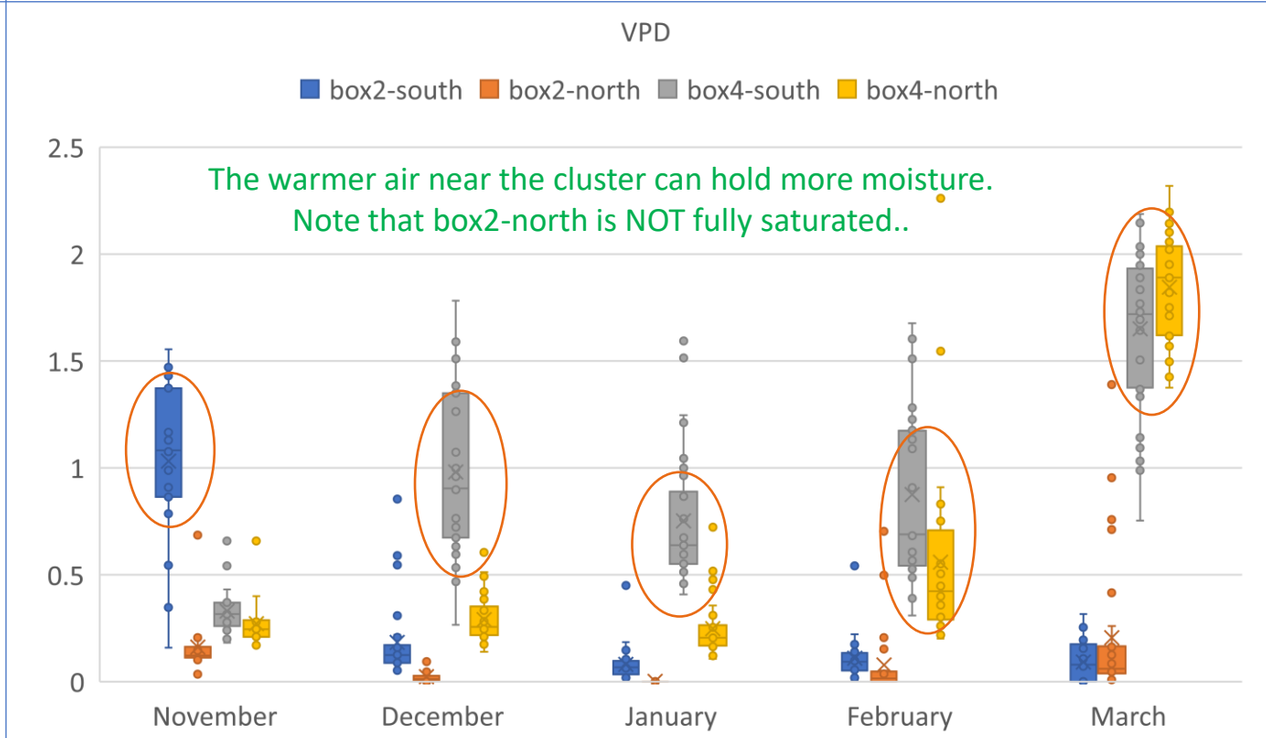
Mean Daily Values – Sask3 (No rack, top/bottom entrance only)

ORANGE CIRCLE indicates approximate cluster location









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(Sask3)

Sask3	Temp(F)					Vapor Density(g/m3)				
	Nov	Dec	Jan	Feb	Mar	Nov	Dec	Jan	Feb	Mar
box2-south	64.00	37.17	36.45	35.89	47.46	8.99	5.20	5.34	5.49	8.53
box2-north	44.83	36.73	36.82	37.44	50.60	6.89	5.89	6.12	6.35	8.87
box4-south	53.47	68.07	61.96	61.43	79.35	8.81	11.79	9.72	9.56	14.62
box4-north	50.13	50.38	49.58	58.51	82.81	7.73	7.84	7.76	10.01	14.83
outdoor	35.03	30.74	31.13	26.90	35.09	4.12	3.78	3.91	3.02	3.78

Notice in February – that box4-north is lower temperature, but has more moisture in the air (vapor density = 10) than box4-south. This is probably because it is not in the direct airflow path. The same is true for the box2-south & north sensors from Jan→March)

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

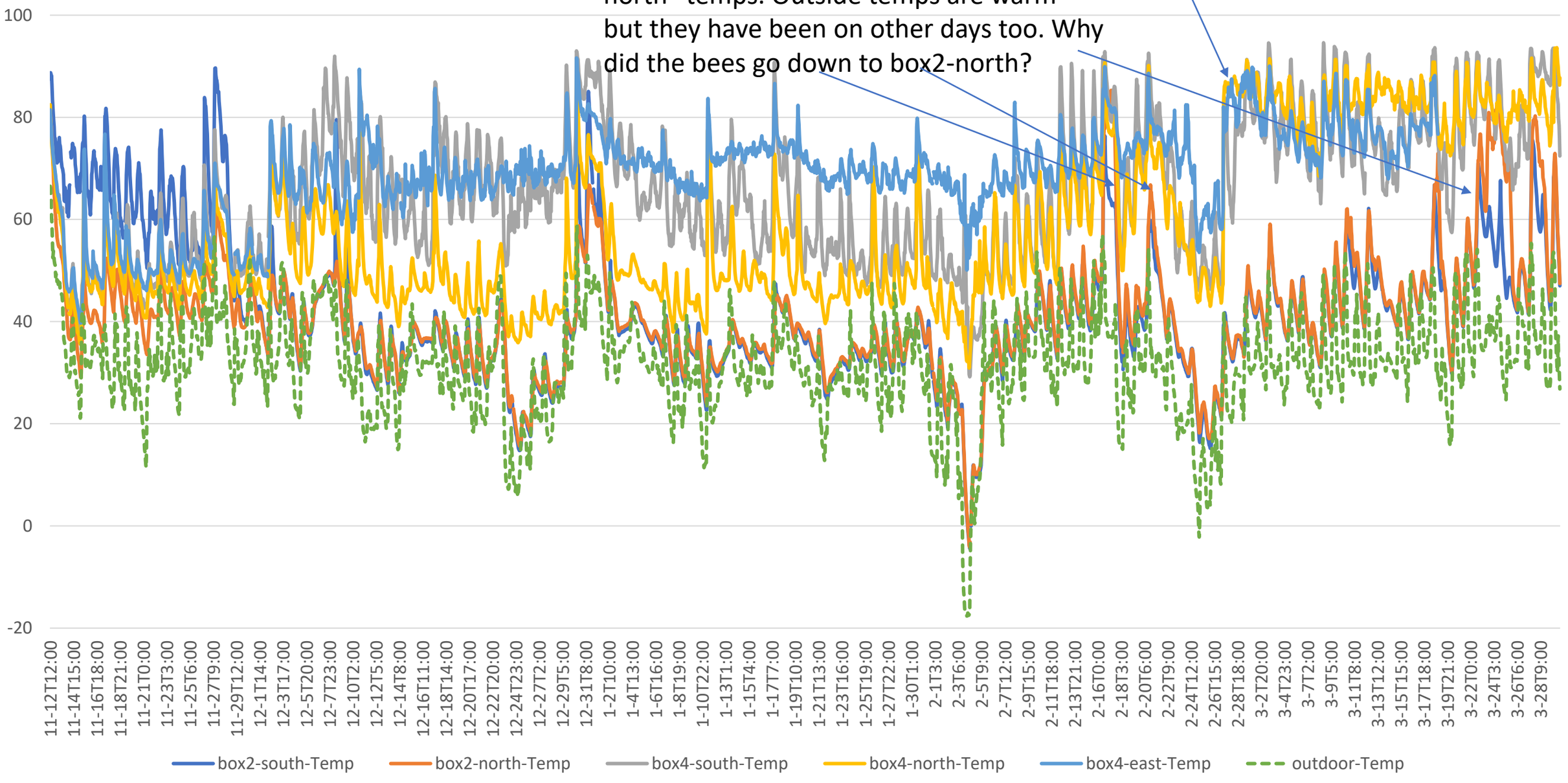
- if the temps at the sensor are in the low 60s, vapor density is 9-11
- temps in the 50s , vapor density is 7-8
- temps in the 40s,vapor density is 6-7 (There is one case – sask2, box4 east that is closer to 8 in Nov)
- temps in the 30s,vapor density = 5-6 (but outdoor vapor density is in the 4 rang)

All data points

Temperature Sask3 (top/bottom entrance, NO slatted rack)

This is interesting – look at the "box2-north" temps. Outside temps are warm – but they have been on other days too. Why did the bees go down to box2-north?

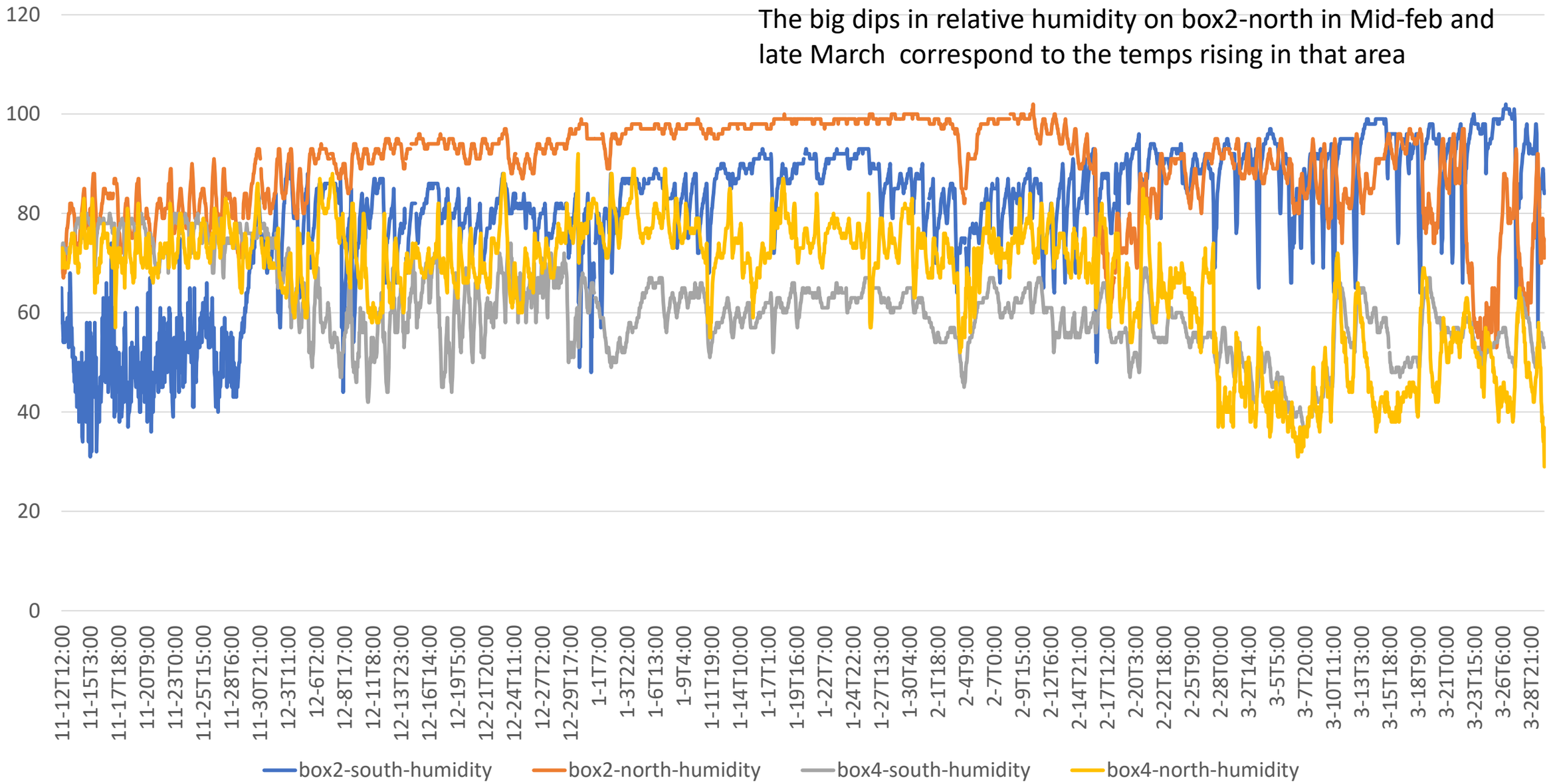
Added pollen patty 2/27 ~@11:15



- Bees have been clustered around box4-south and/or box4-east since mid Dec
- From January on, there have been LOTS of bees on the frames in box 4 (by observation). Adding the pollen patty seemed to have spread out the bees across more sensors)
- On Feb16-18 and in the last week of March – the bees were going down to box 2 – mostly north side, but some on the south – was this to get moisture?

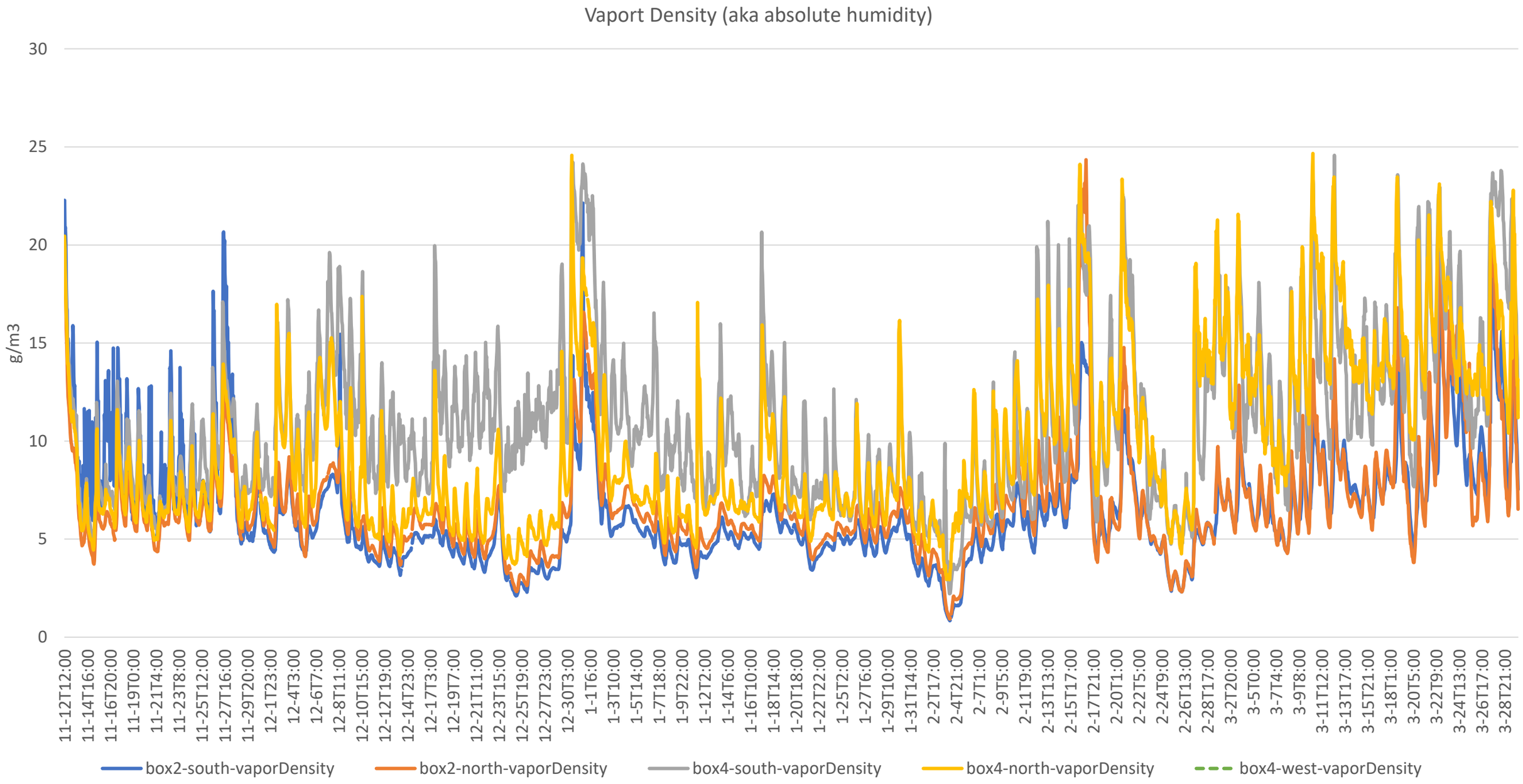
Relative Humidity Sask3 (No slatted rack, top/bottom entrance)

The big dips in relative humidity on box2-north in Mid-feb and late March correspond to the temps rising in that area



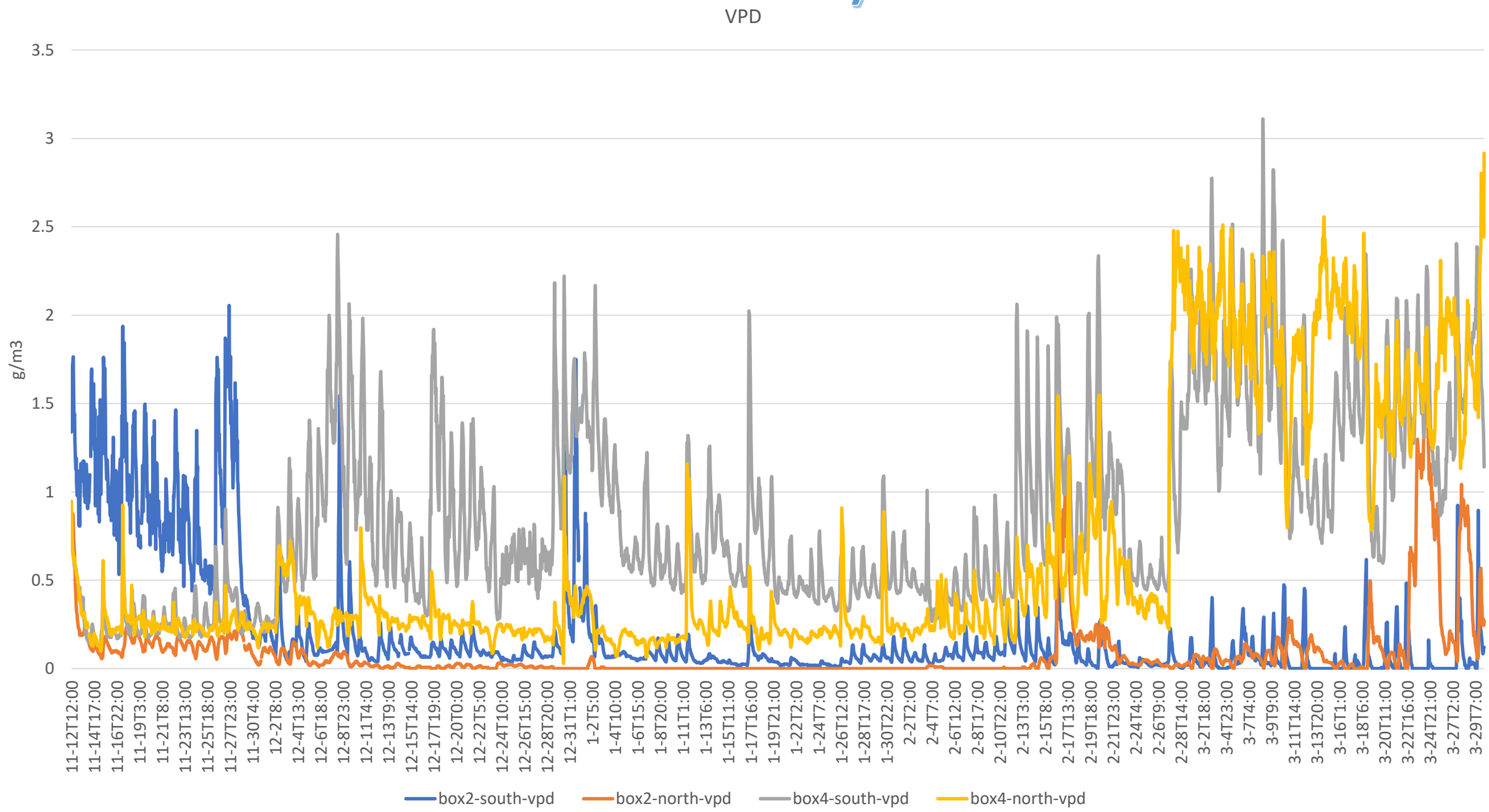
*Bees are clustered near box4-south and/or box4-east Sensor.
Box4-east sensor is temp only so no RH readings
Relative Humidity at all of the sensors is as expected.
Box2-north sensor has the highest humidity because it is not near the cluster or the air flow between the entrances. However, we see on 2/18 and late march – the relative humidity drops – were the bees going down to get moisture?

Vapor Density – Sask3 (No slatted rack, top/bottom entrance)



- Vapor Density Seems to vary quite around the cluster which is surprising – is this due to temps changing during the day?
  - There are really big swings in box4 north and box4-south
    - Box2-east is a temp only sensor.

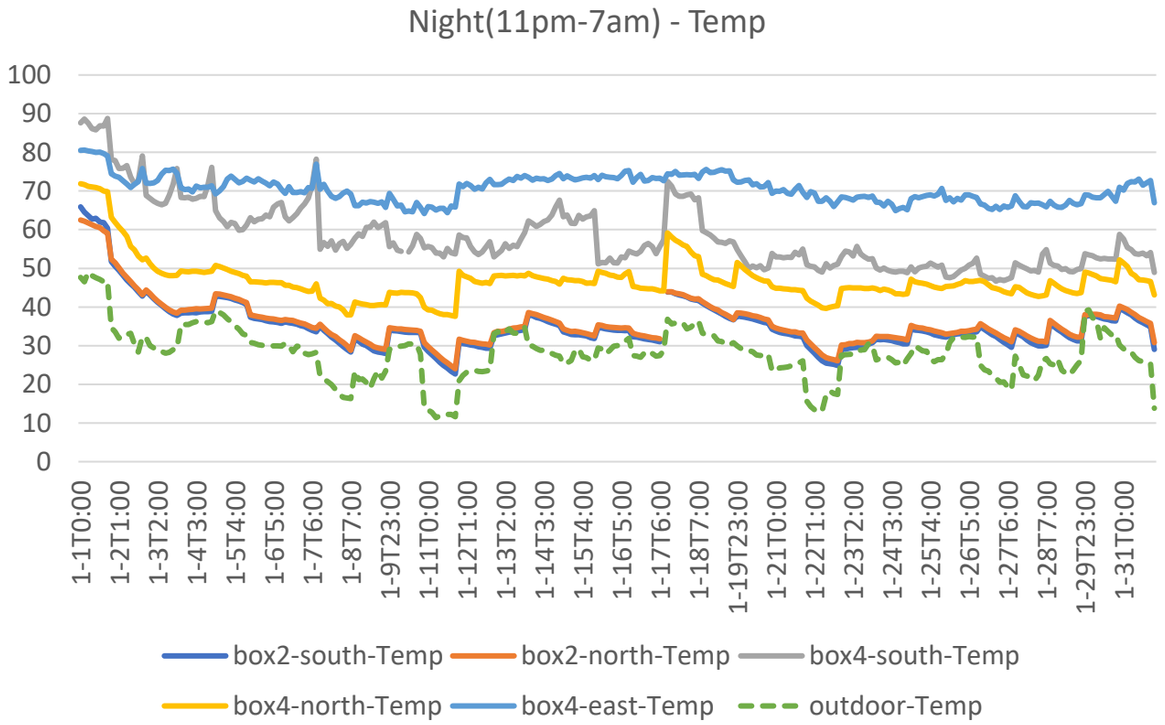
VPD– Sask3 (No slatted rack, top/bottom entrance)

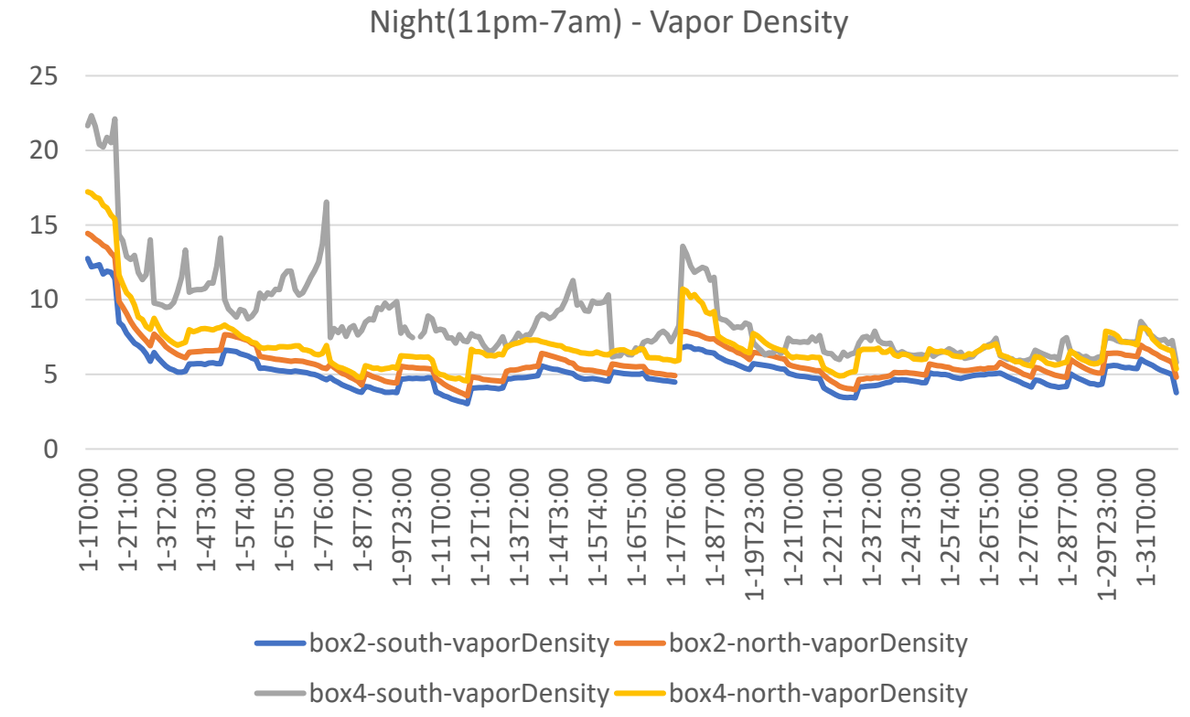


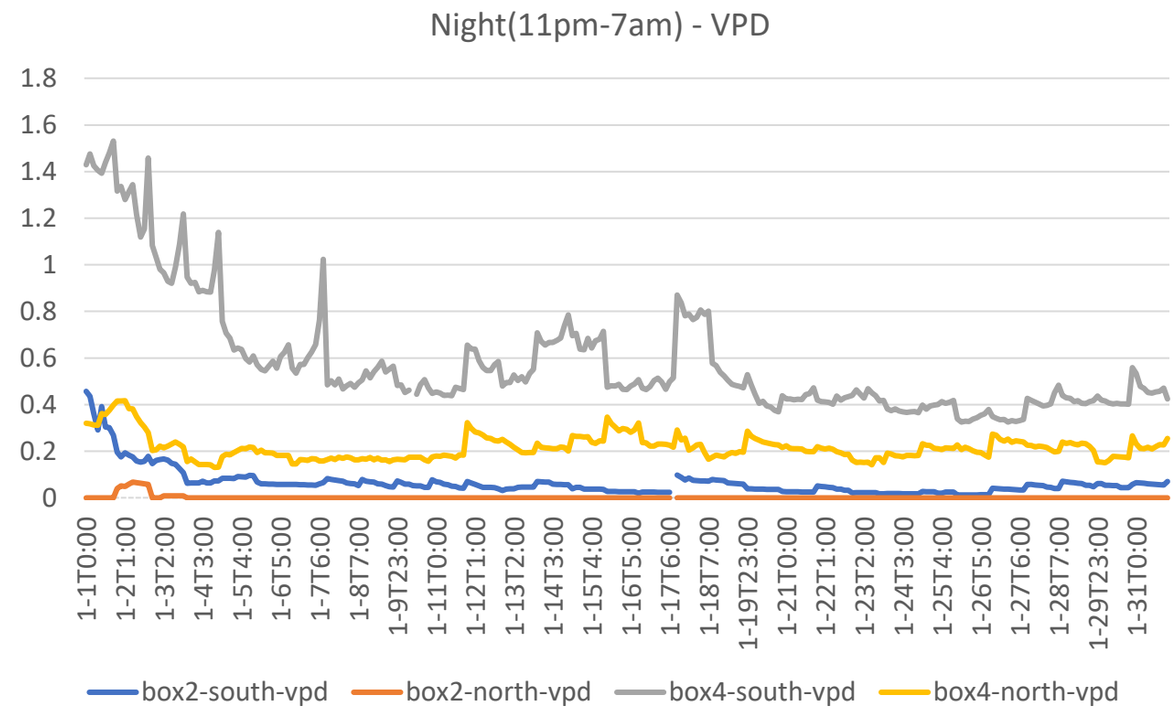
- Box2-east is a temp only sensor.
- Box2-north sensor area is saturated in Jan and early Feb. As temps warm, it can hold more moisture – but there are big swings meaning the bees moved into the area – maybe to get more moisture?

Day vs Night Data
By Month

January –Night – Sask3 (No slatted rack, top/bottom entrance)

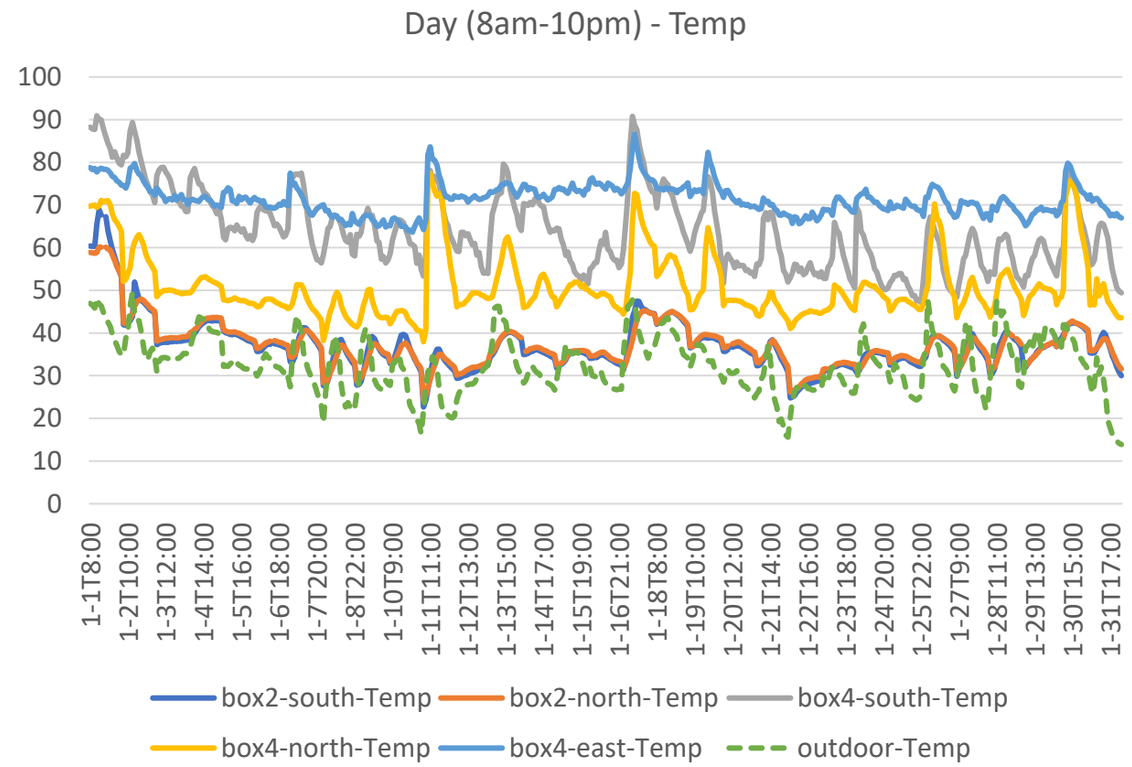


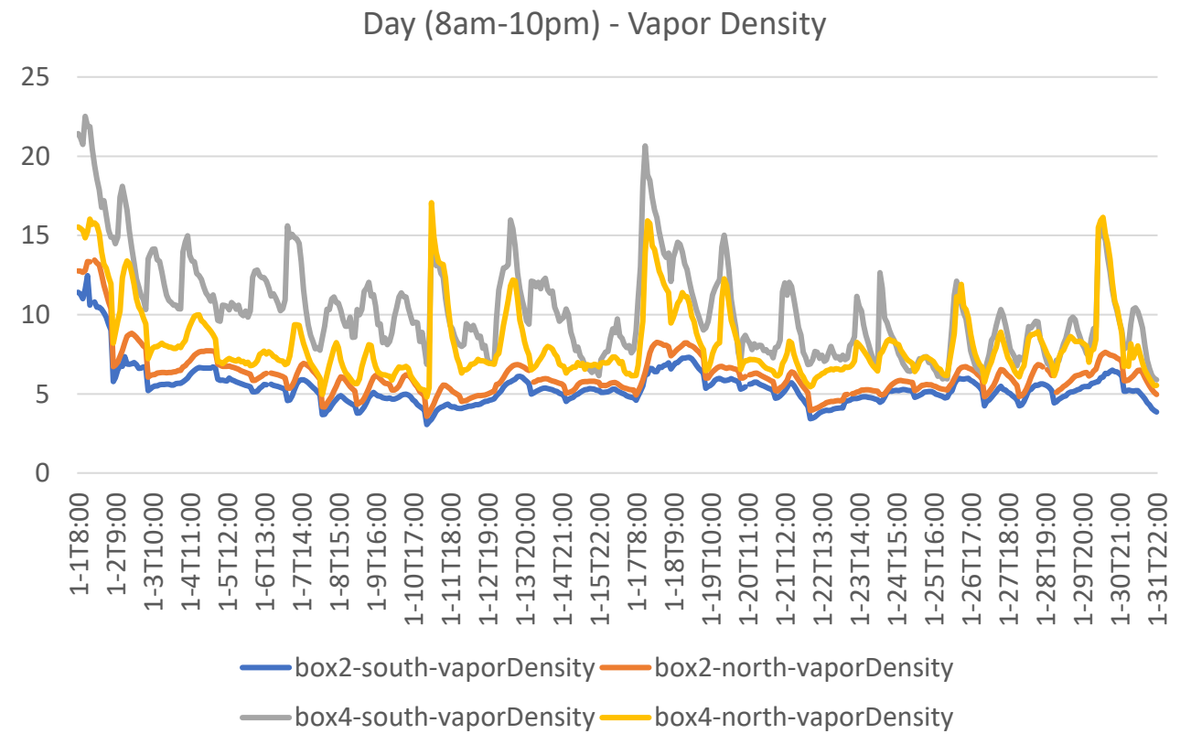


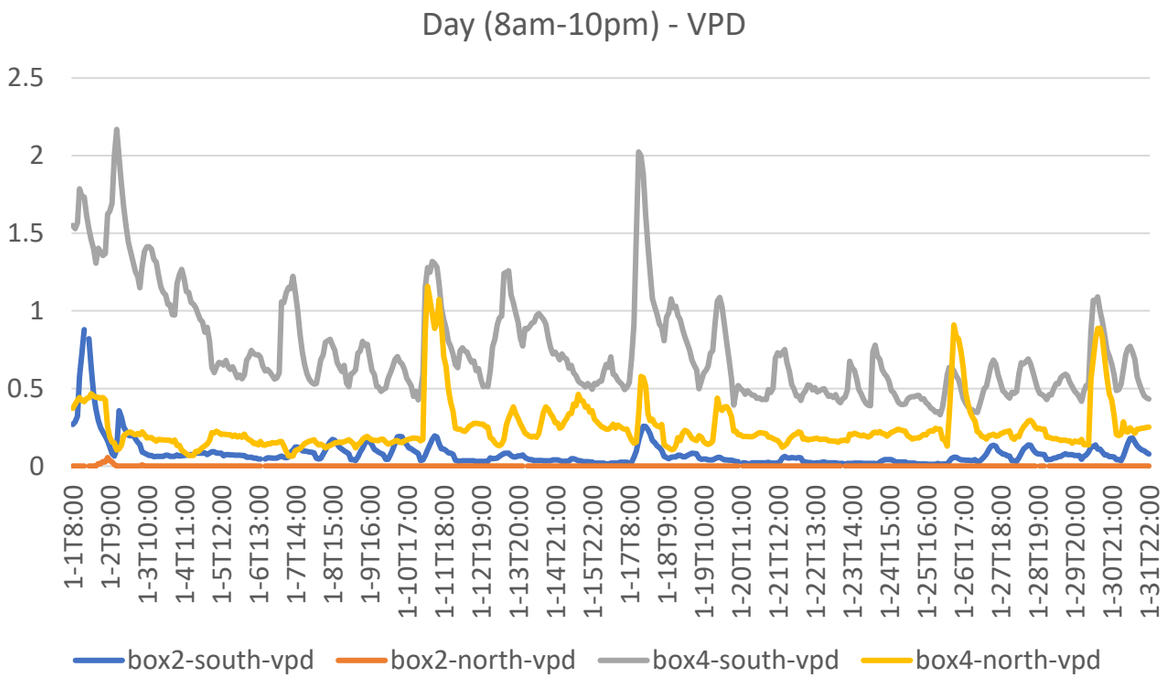


- Bees are nearest the box4—east sensor
- Box4-east sensor is temp only.
- The vapor density of the box2-north/south & box4 north sensors are all very similar.
- There is more moisture in the area around the box4-south sensor, until the last couple weeks of January
- The area around the box2-north sensor is completely saturated.
- The area around the box2-south sensor is almost fully saturated, but there is slightly less moisture there – probably because it is close to the airflow path between the entrances.

January –Day – Sask3 (No slatted rack, top/bottom entrance)

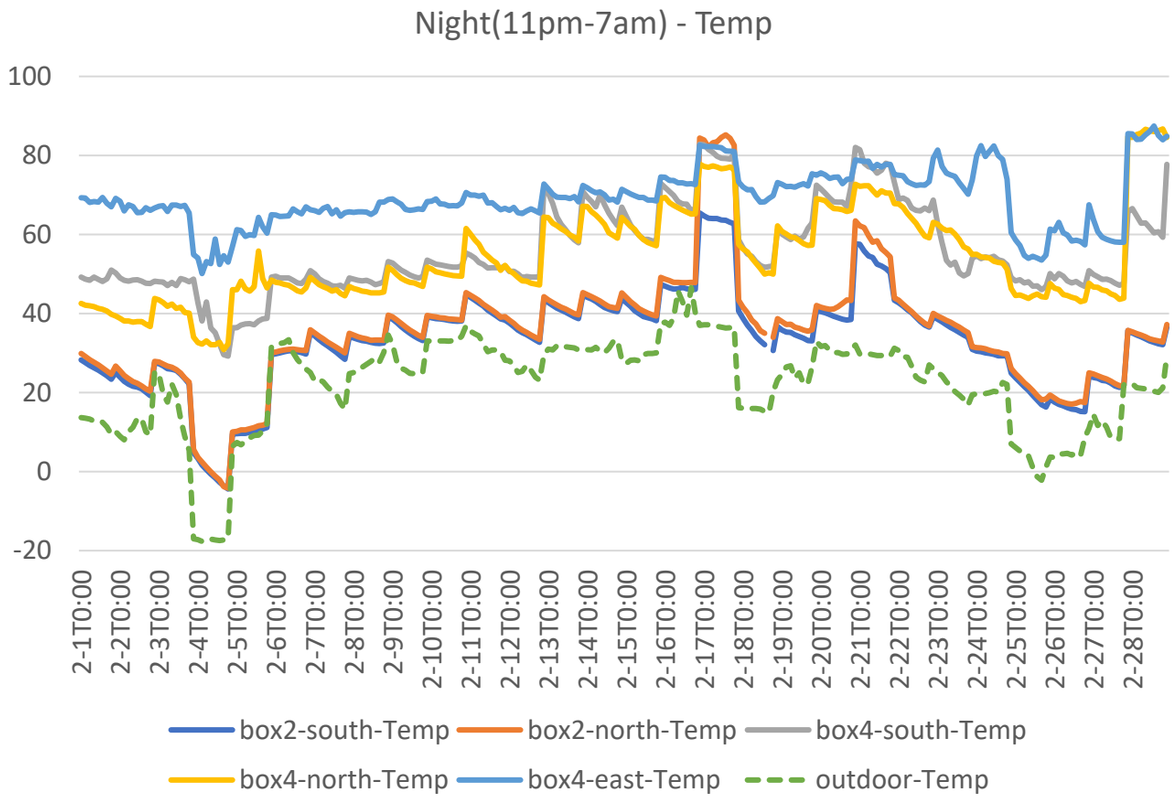


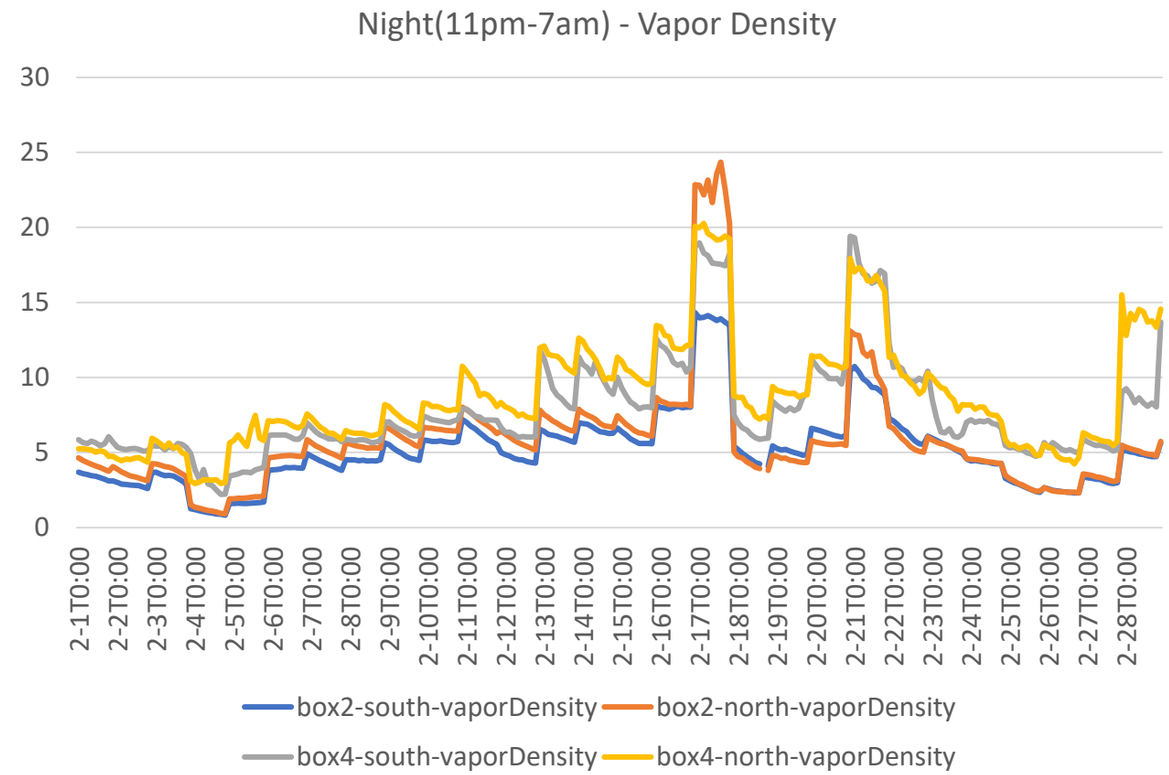


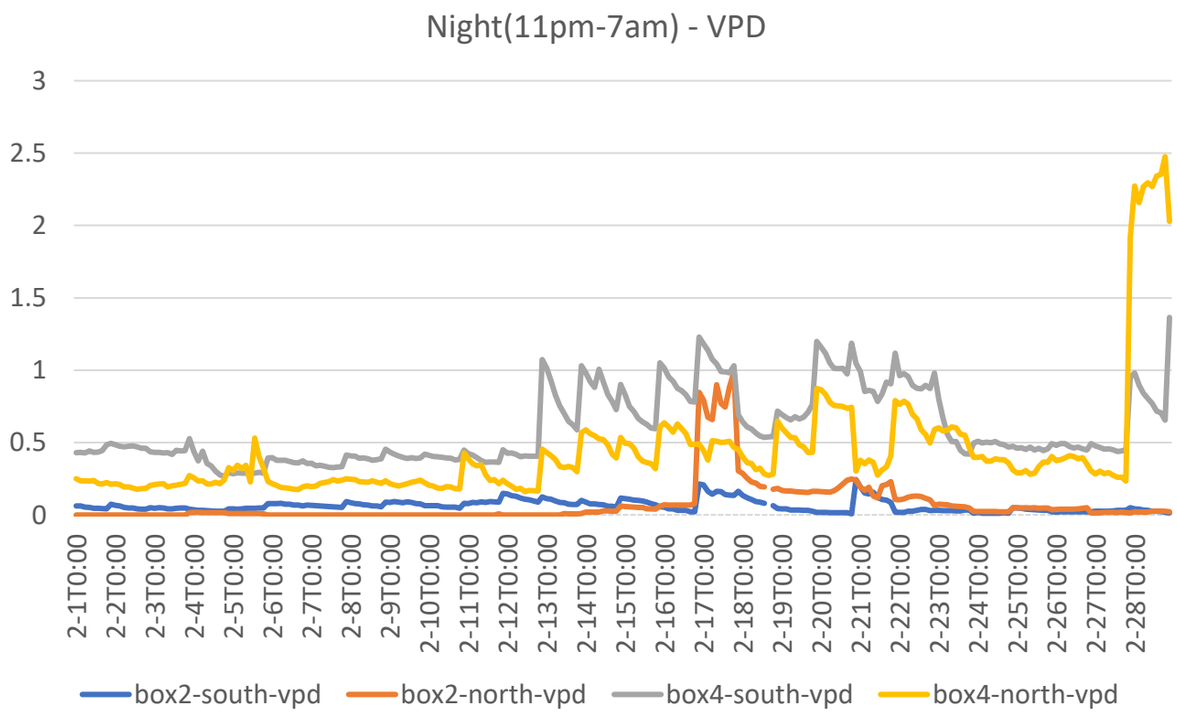


- Bees are nearest the box4—east sensor
  - Box4-east sensor is temp only.
  - Similar observations to what is listed for the Jan-night.
- The box2-north/south temps are almost the same throughout the month with the south being slightly warmer due to the sun on the front of the colony. On days when it isn't sunny, the temps are close to the outside temps.

Feb –Night – Sask3 (No slatted rack, top/bottom entrance)

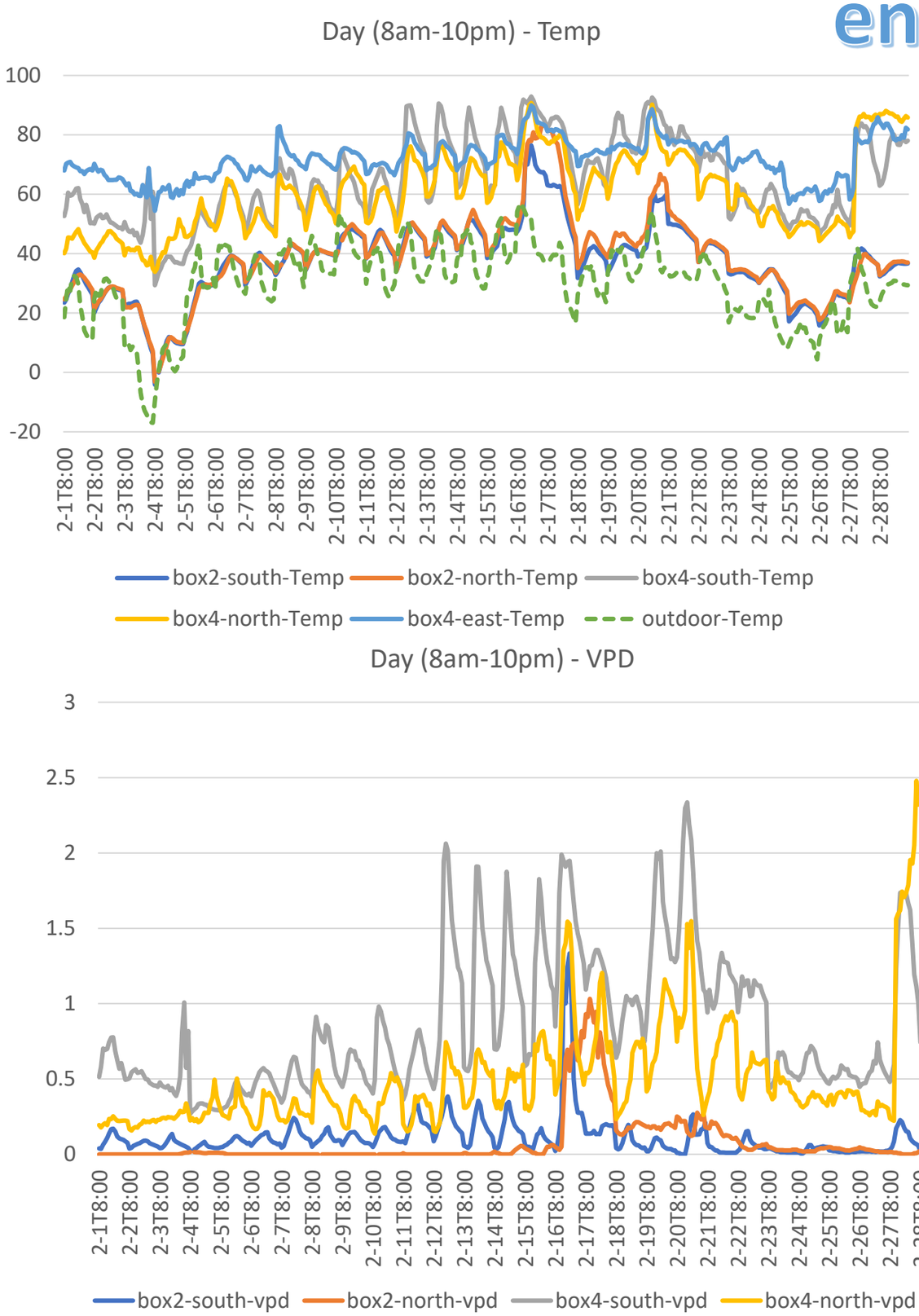


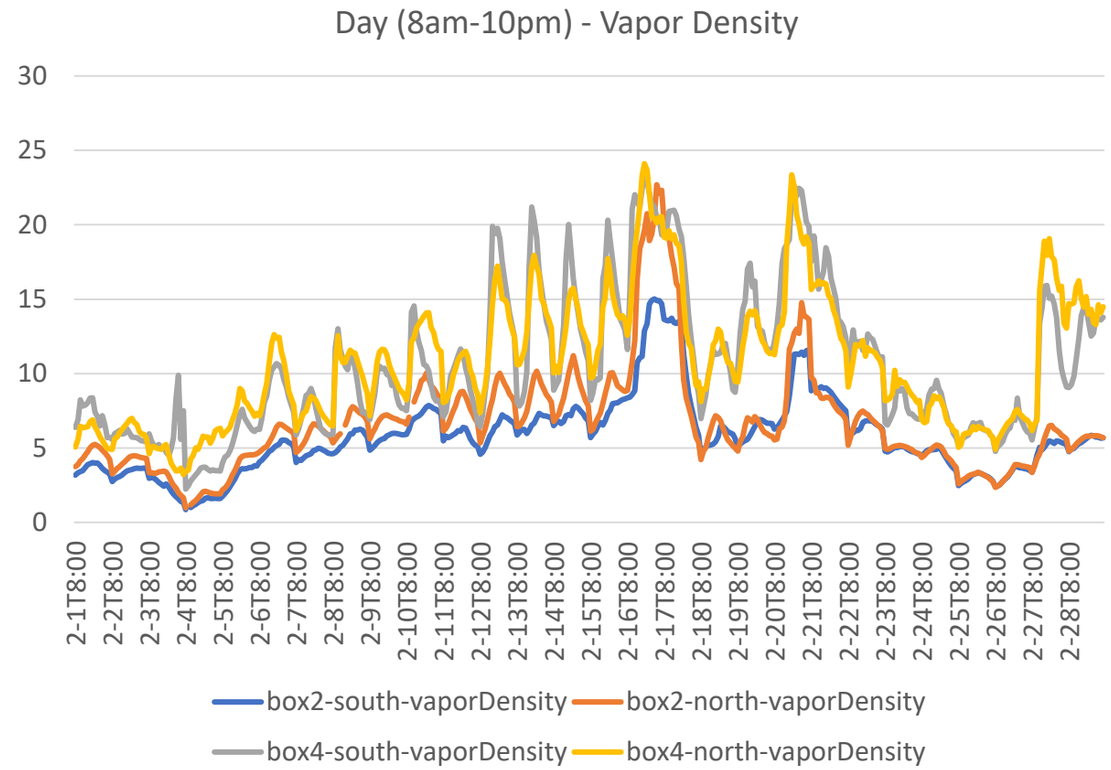




- Bees are covering the top rails in box 4.
- Look at box2 temps on 2-4 = they are below 0!
- What happened on 2/17 - the box2-north sensor went to 80! It was warm outside that day so the bees must have been moving around a lot..
- Except for 2/17-2/22: area around the box2-north sensor is fully saturated with moisture because the temps are cold
- The box2-south sensor isn't 100% saturated – but close.
- The box4-east sensor is temp only

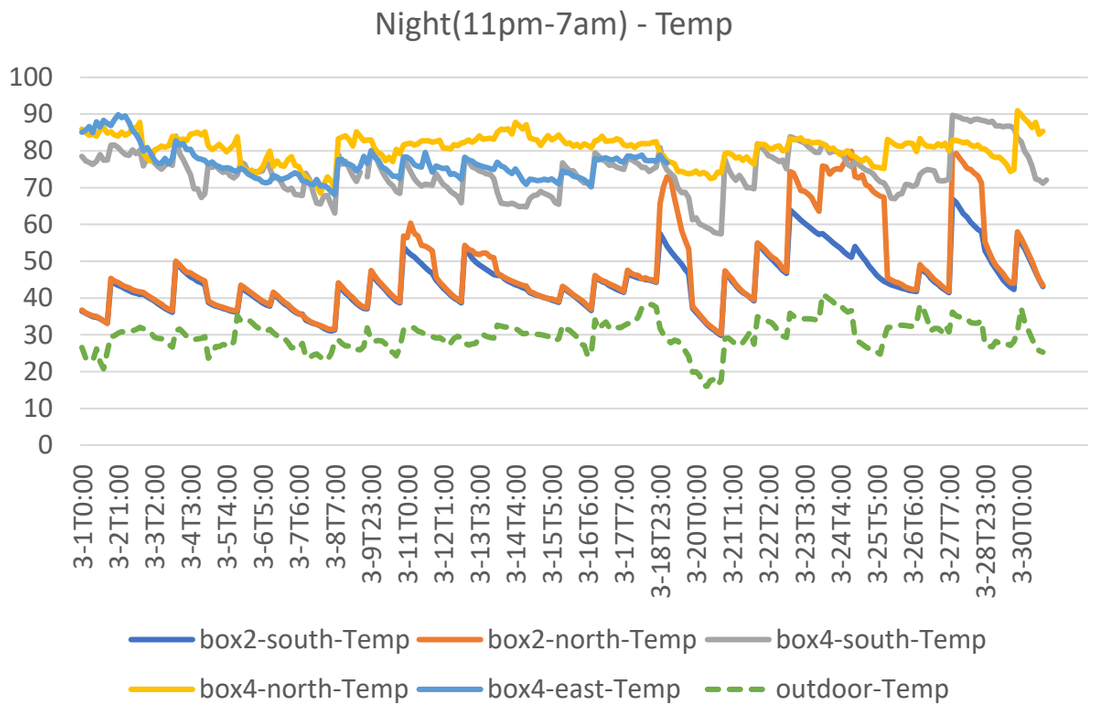
Feb –Day – Sask3 (No slatted rack, top/bottom entrance)

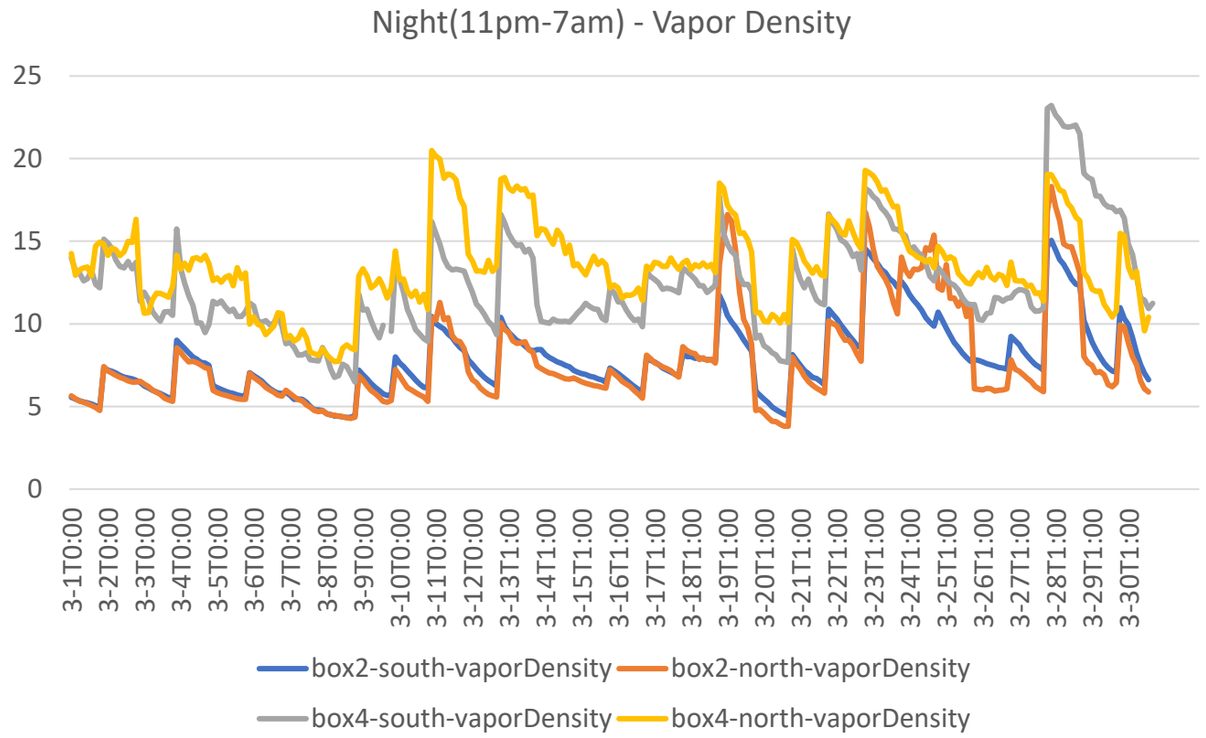


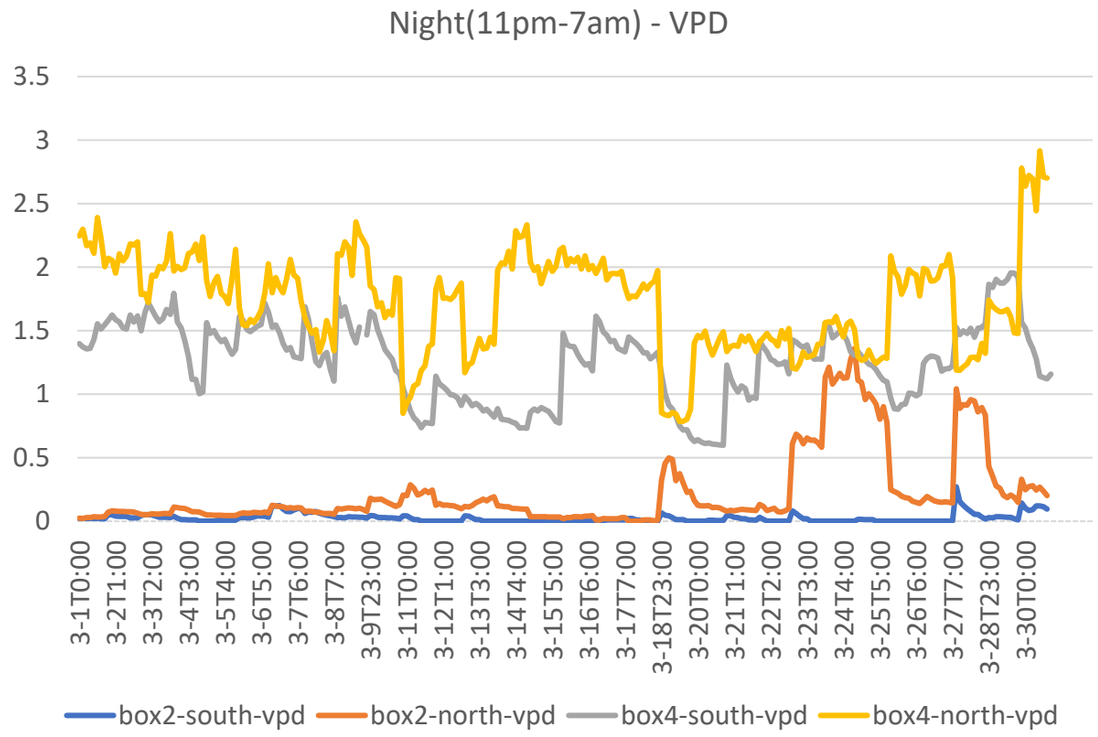


- Bees are covering the box4 rails.
- Box4-east sensor is temp only
- Same comments as previous page – about box2 sensors
- Area around the box4-south sensor holds more water than the north sensor – probably because it is warmer due to the sun?

March –Night – Sask3 (No slatted rack, top/bottom entrance)

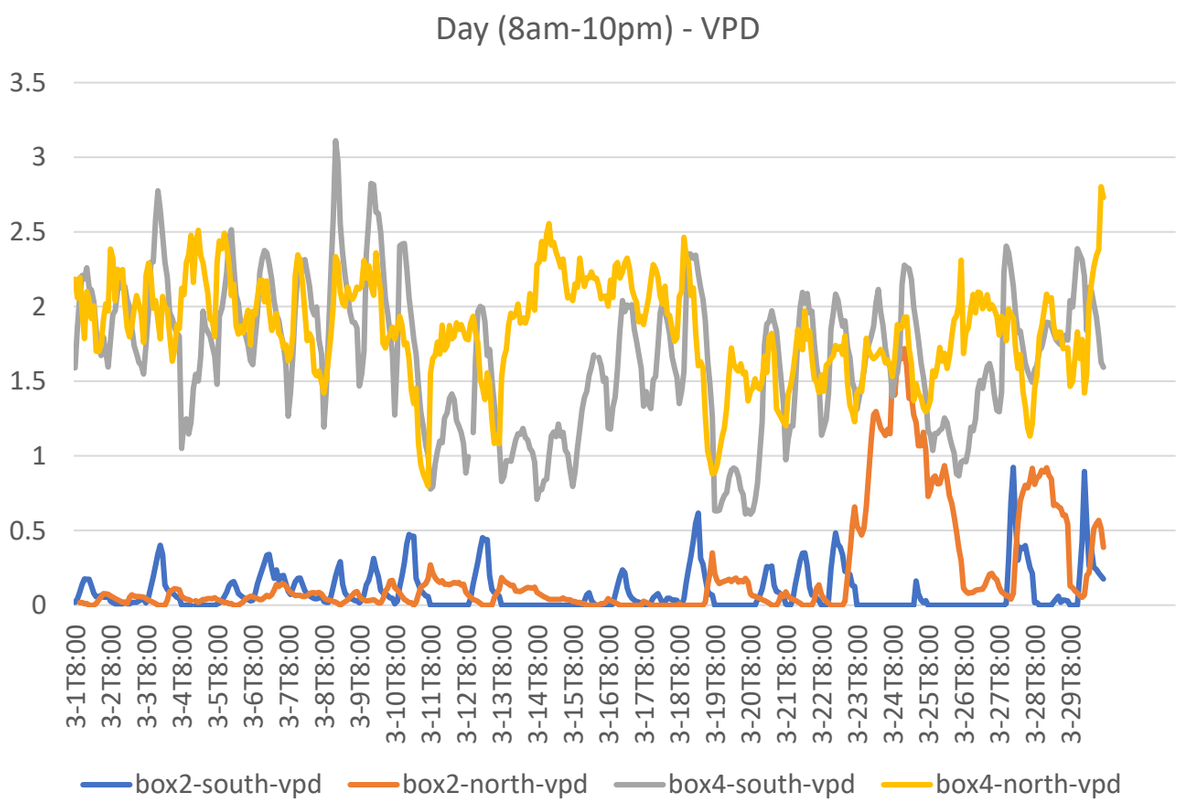


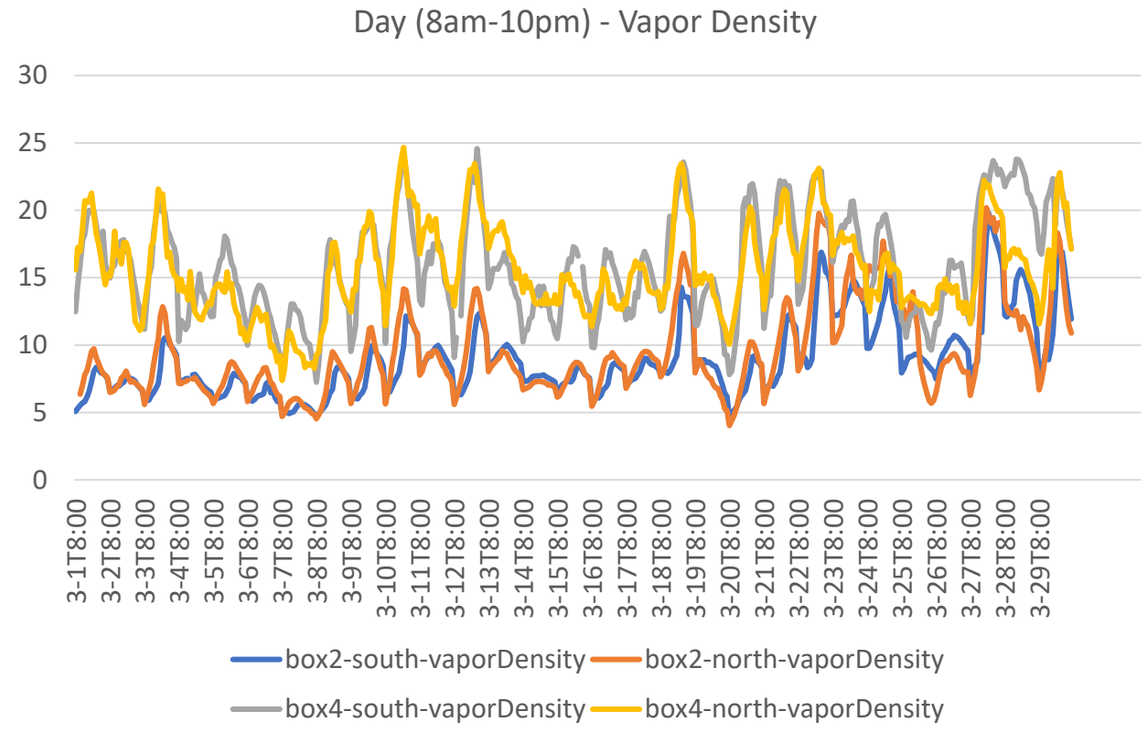




- Bees are covering the top rails in box 4 and are most likely raising brood
- Bees moved to box2-north side on 3/18, 3/23-25 and 3/27 – Was this to move moisture around? You can see that box4-south vapor density went up– you can see the change in vapor density meaning there was more moisture in the air.

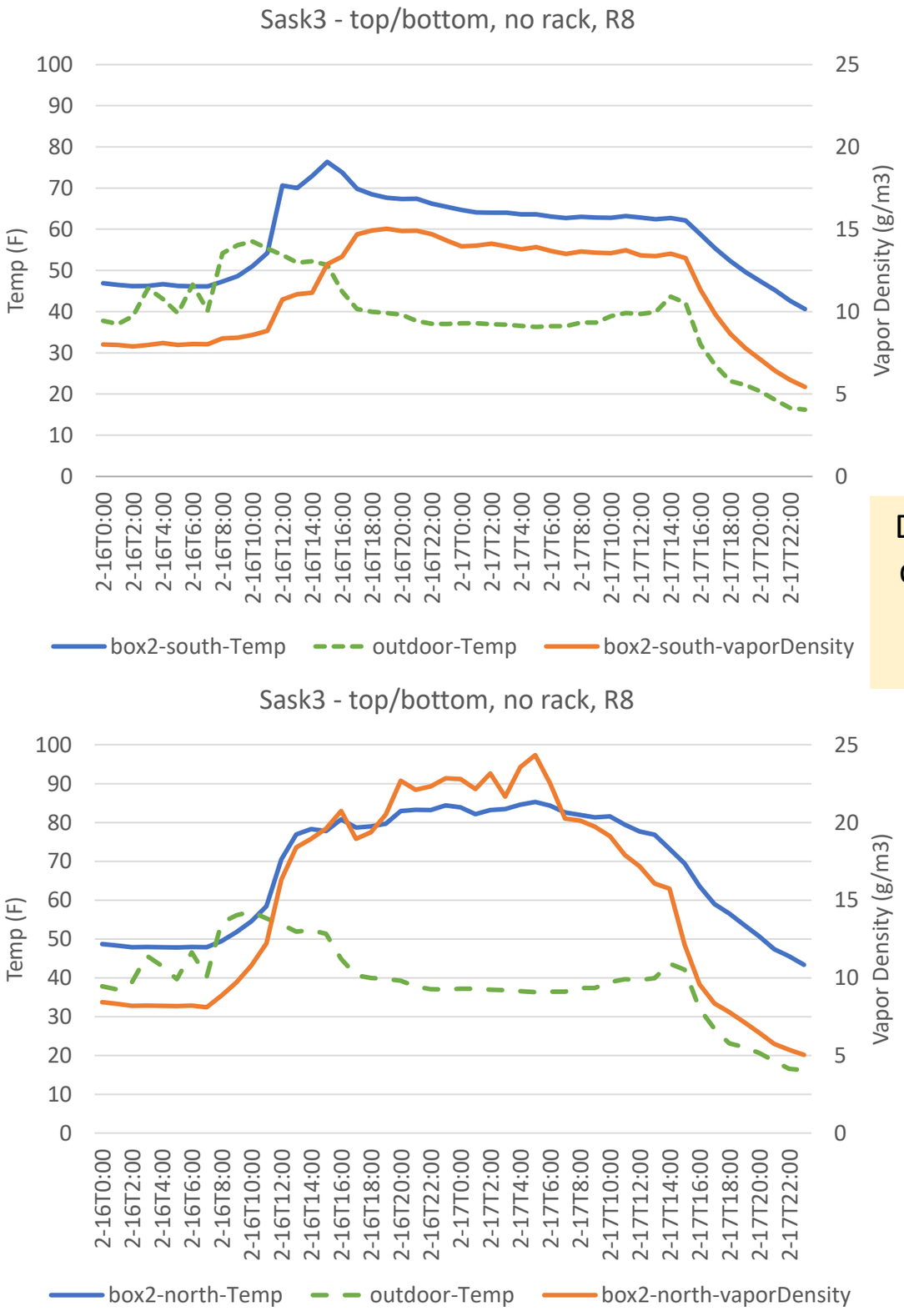
March –Day – Sask3 (No slatted rack, top/bottom entrance)

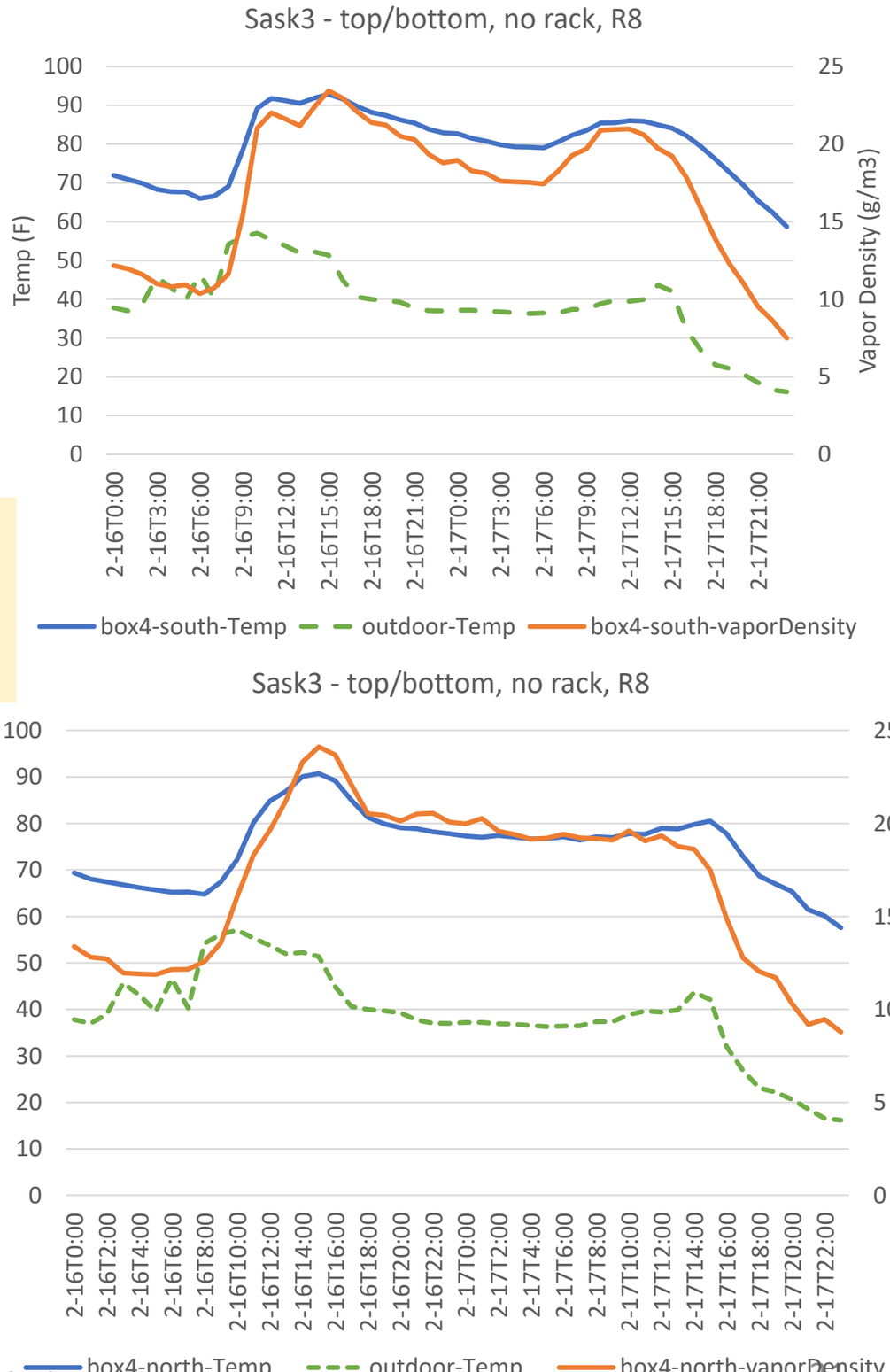




- Bees are covering the box4 rails.
- Box4-east sensor is temp only
- Same comments as previous page – about box2 sensors

Temps & Vapor Density at each sensor on 2/16-2/17





Did the bees go down to box2-north area to get water?