ATB
Leibniz-Institut für Agrartechnik
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Effect of lactation number on the respiratory rate of dairy cows on hot days

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Study Background

- "Optimized animal specific barn climatisation facing temperature rise and increased climate variability – OptiBarn" (ERANET)

OptiBarn

- Consortium: 6 institutes from 4 countries + Associated partner from Australia

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PIK

AARHUS UNIVERSITY

bc3

UNIVERSIDAD POLITÉCNICA VALENCIA

USQ UNIVERSITY OF SOUTHERN QUEENSLAND AUSTRALIA

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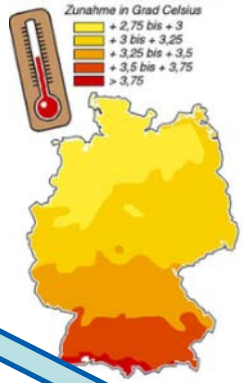
Content

1. Motivation and Hypotheses
2. Material and Methods
3. Results
4. Conclusion and Outlook

1.1. Stress levels factors for dairy cattle



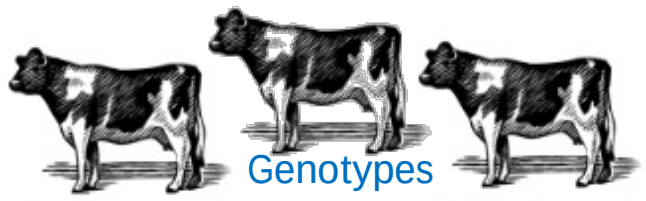
Environmental

- Barn
- Climate

Ambient temperature and Relative Humidity **= THI**

Climate change

Barn climate



Behavior

- Dry matter intake
- Water intake
- Feeding time/frequency
- Lying time
- Rumination

Production

- Milk Yield
- Reproduction/ conception rate

Later indicator

Early indicator

Physiology

- Body temperature
- Heart frequency
- Blood parameters
- Respiratory rate

Stress levels

1.2. Temperature Humidity Index (THI)

NRC, 1971

$$THI = (1{,}8*T_{db}+32)-(0{,}55-0{,}0055RH)*(1{,}8*T_{db}-26{,}8)$$

Where T_{db} is the dry bulb temperature in [°C] and RH is the relative humidity in percent [%]

Luft	Relative Luftfeuchte																
Temp. °C	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
20	64	64	64	64	65	65	65	66	66	66	66	67	67	67	68	68	68
21	65	65	65	66	66	66	67	67	67	68	68	68	69	69	69	70	70
22	66	66	66	67	67	67	68	68	69	69	69	70	70	71	71	71	72
23	67	67	67	68	68	69	69	70	70	70	71	71	72	72	73	73	74
24	68	68	69	69	69	70	70	71	71	72	72	73	73	74	74	75	75
25	69	69	70	70	71	71	72	72	73	73	74	74	75	75	76	77	77
26	70	70	71	71	72	72	73	74	74	75	75	76	77	77	78	78	79
27	71	71	72	72	73	74	74	75	76	76	77	78	78	79	79	80	81
28	72	72	73	74	74	75	76	76	77	78	78	79	80	80	81	82	83
29	73	73	74	75	75	76	77	78	78	79	80	81	81	82	83	84	84
30	74	74	75	76	77	77	78	79	80	81	81	82	83	84	85	85	86
31	75	75	76	77	78	79	80	80	81	82	83	84	85	85	86	87	88
32	76	76	77	78	79	80	81	82	83	84	84	85	86	87	88	89	90
33	77	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92
34	78	79	80	80	81	82	83	84	85	86	87	88	89	90	91	92	93
35	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
36	80	81	82	83	84	85	86	87	88	89	90	91	93	94	95	96	97
37	81	82	83	84	85	86	87	88	90	91	92	93	94	95	96	98	99
38	82	83	84	85	86	87	89	90	91	92	93	95	96	97	98	99	101
39	83	84	85	86	87	89	90	91	92	94	95	96	97	99	100	101	102
40	84	85	86	87	89	90	91	93	94	95	96	98	99	100	102	103	104

Armstrong, 1994.

THI ≤72:
Comfort zone

73 – 78:
Mild stress

79 – 84:
Danger

THI ≥85:
Emergency

1.3. Overview Indicators – Why respiratory rate?

- Non invasive animal measurement
- Visual measurement is less dependent on housing facilities
- Early & sensitive indicator
- Commonly used as heat stress indicator in cattle

1.4. Objectives

- Aim: Assess the effect of lactation number on the respiratory rate of dairy cows on high temperature days

1.5. Hypotheses

- The cows individually differ in the respiratory rate based on cow-related factors under heat stress conditions

- The respiration frequency in lactating cows differs between early morning and afternoon

2.1. Variables

- Two different groups

Climate related variables

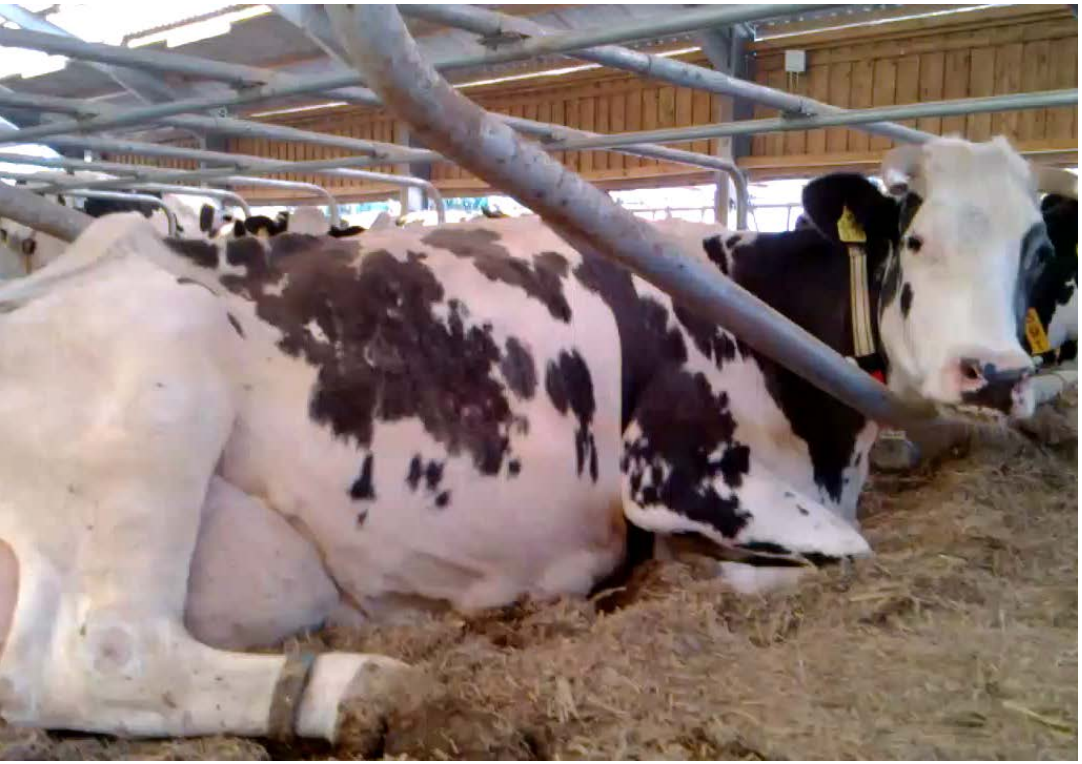
- Ambient temperature, relative humidity
- Temperature Humidity Index (THI) (NRC, 1971)

Cow related variables

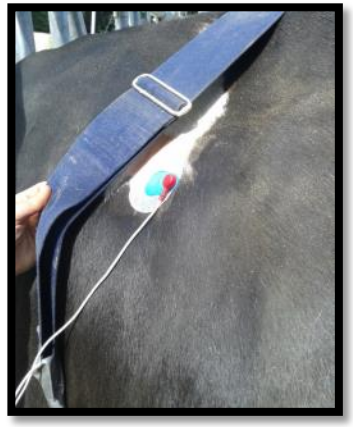
- Holstein 1st – 8th lactation
- Heart Rate (HR)
  - Stethoscope
- Heart Rate Variability (HRV)
  - eMotion HRV® / Faros 90° HRV
- **Respiratory rate (RR)**
  - visually 30 seconds
- Rectal Temperature (RT)

- Measurement time from 07:00h to 15:00h

2.2. Data collection



2.3. Experiment 1



- 15 cows (≥ 2nd lactation);
- morning and afternoon measurements of RR (HR, HRV, RT)
- 17 days: Jun – Aug

2.4. Experiment 2 & 3

- 30 cows (2nd – 8th lactation);
- RR (HR, RT) once in the morning and in the afternoon
- 12 days: Jun – Aug

- 15 cows (1st – 8th lactation);
- RR every hour
- 7 days: Aug

2.5. *Data analysis*

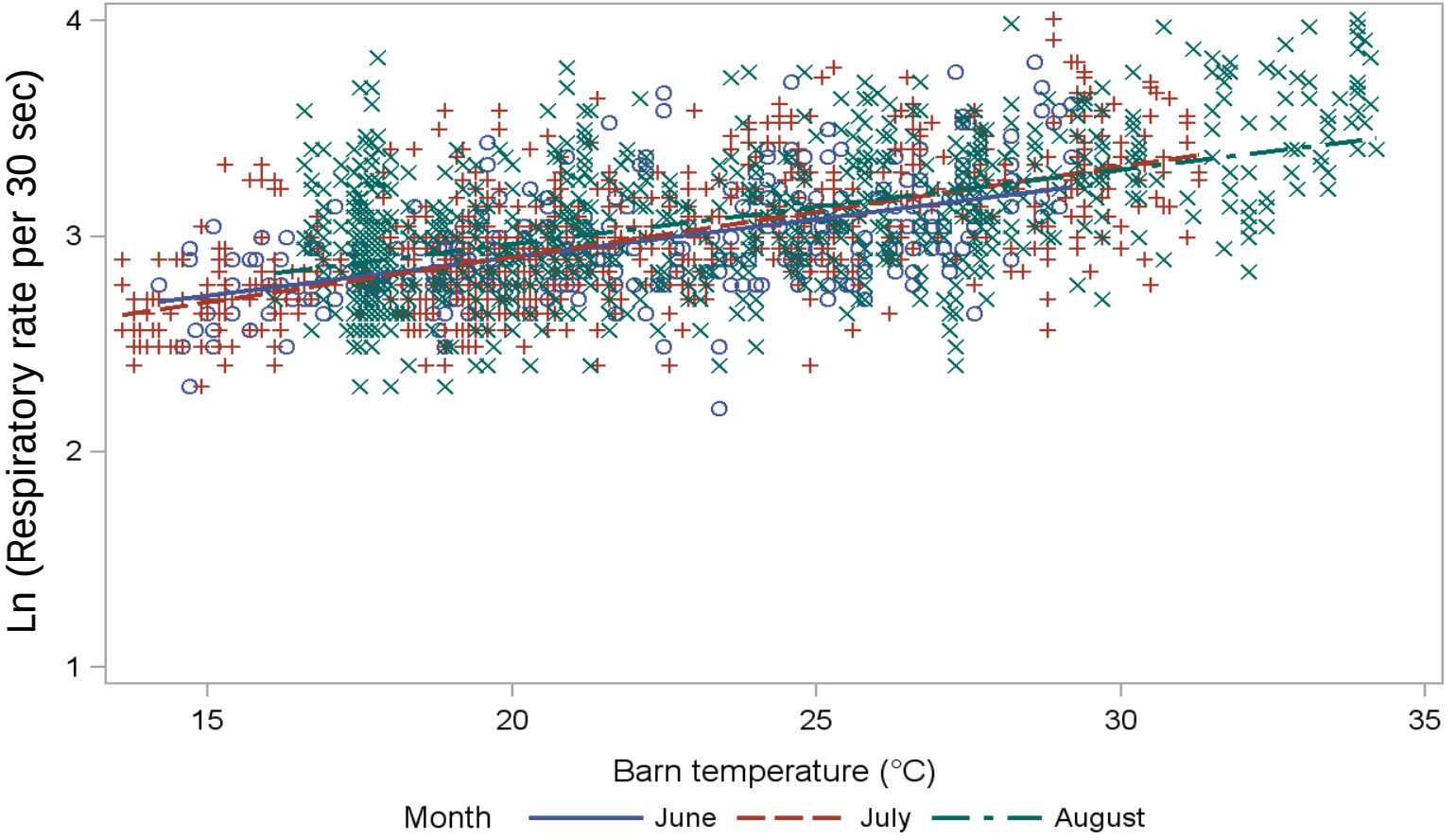
- Data of all experiments for morning (07:00 h – 10:00 h) and afternoon (11:00 h – 15:00 h)
- Test: Effect of animal factors on RR - significance level of 0.05 ($p < 0.05$)
- Fixed effects: body posture, lactation number, test day, co-variable temperature

3.1. Mean of temperature & rel.humidity during the trial period

- 36 days: June – August 2015

Time of the Day	Mean Ambient Temperature (°C)	Standard Deviation	Mean Relative Humidity (%)	Standard Deviation
Morning	19.2	2.52	77.1	11.69
Afternoon	25.1	4.36	57.4	14.20

3.2. Influence of the barn temperature on the respiratory rate



- Increase in barn temperature leads to increase in respiratory rate

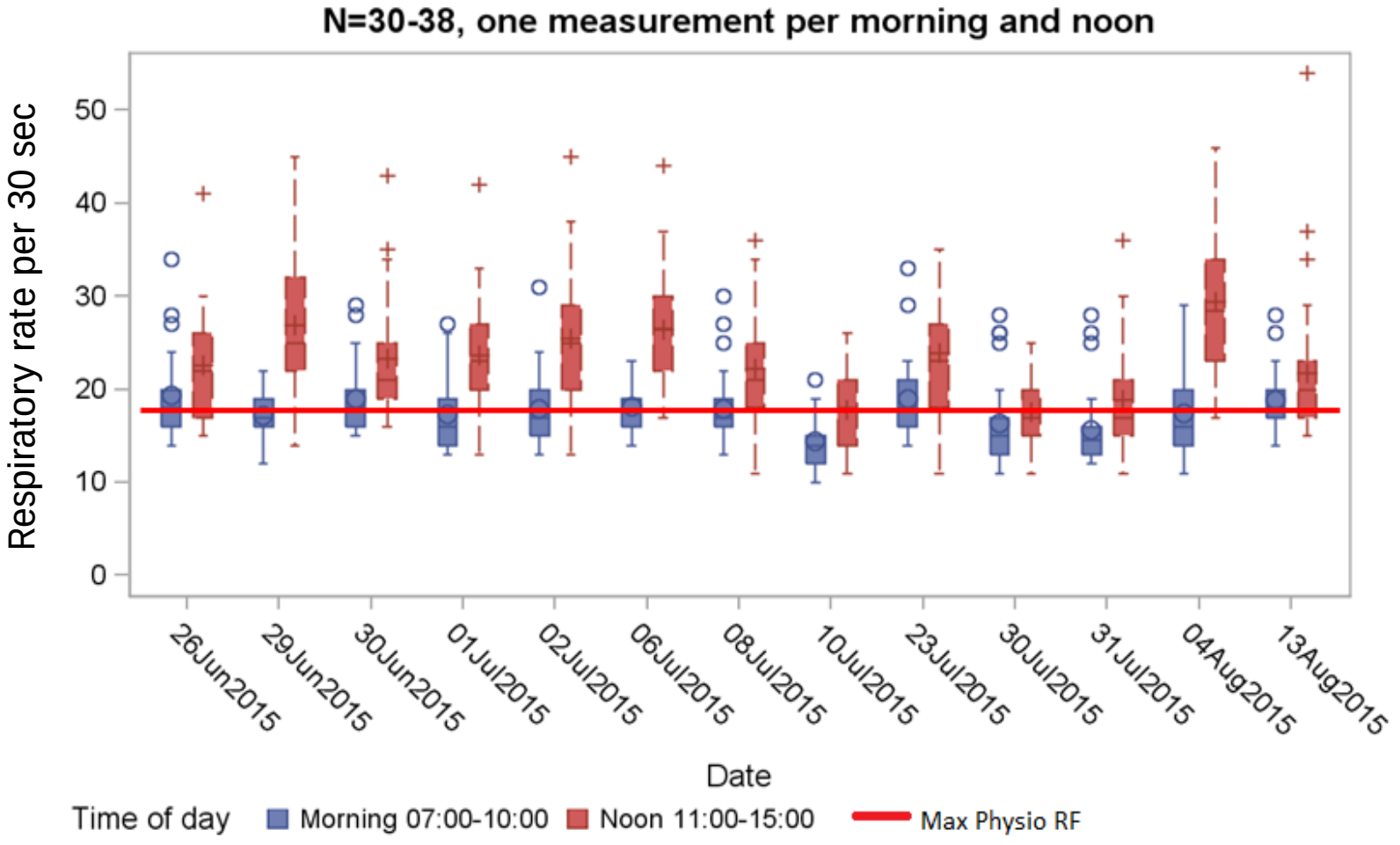
3.3. Behavior

- Cows spend more time standing with increasing barn temperatures

Morning

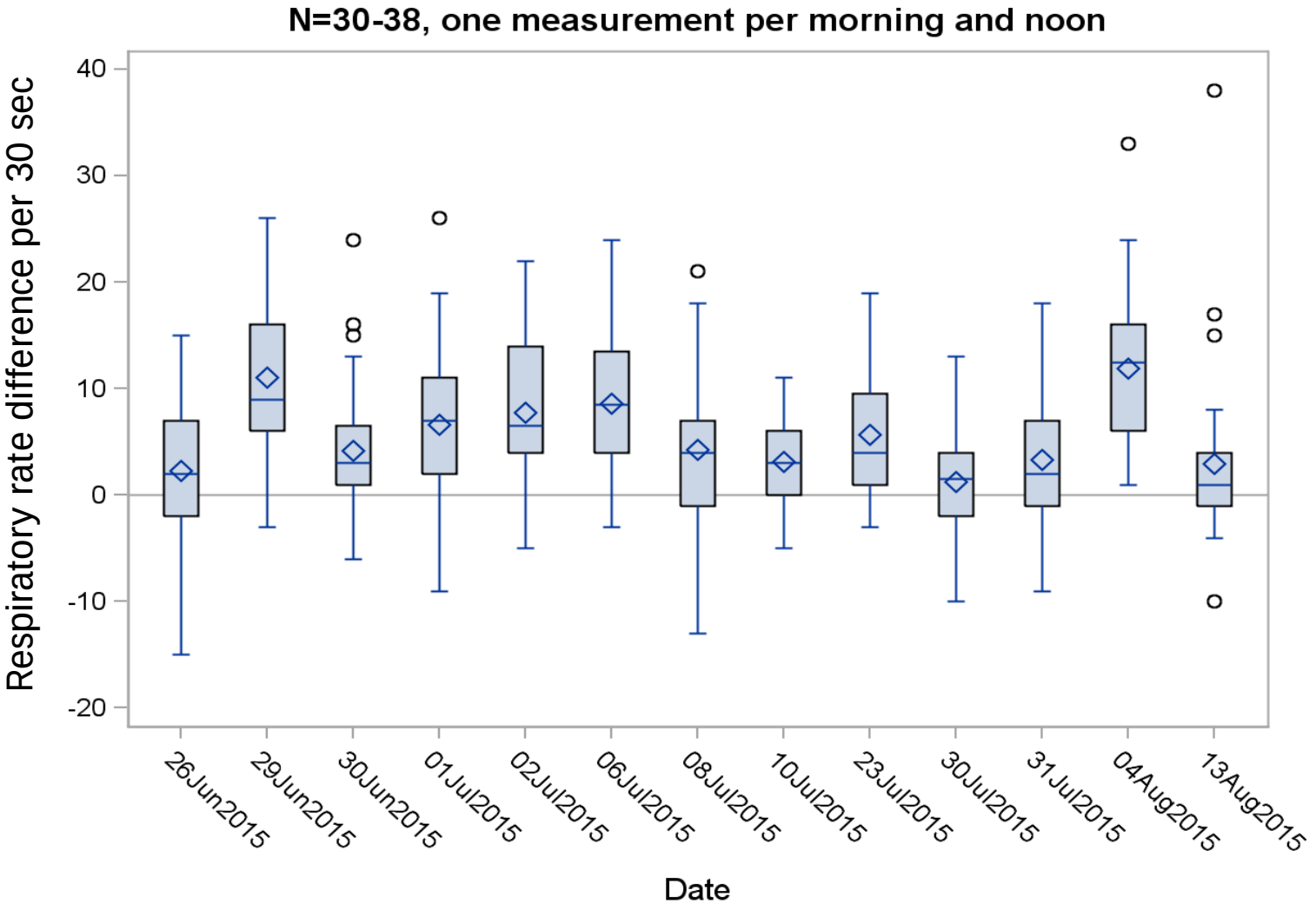
Afternoon

3.4. Daily respiratory rate morning and afternoon



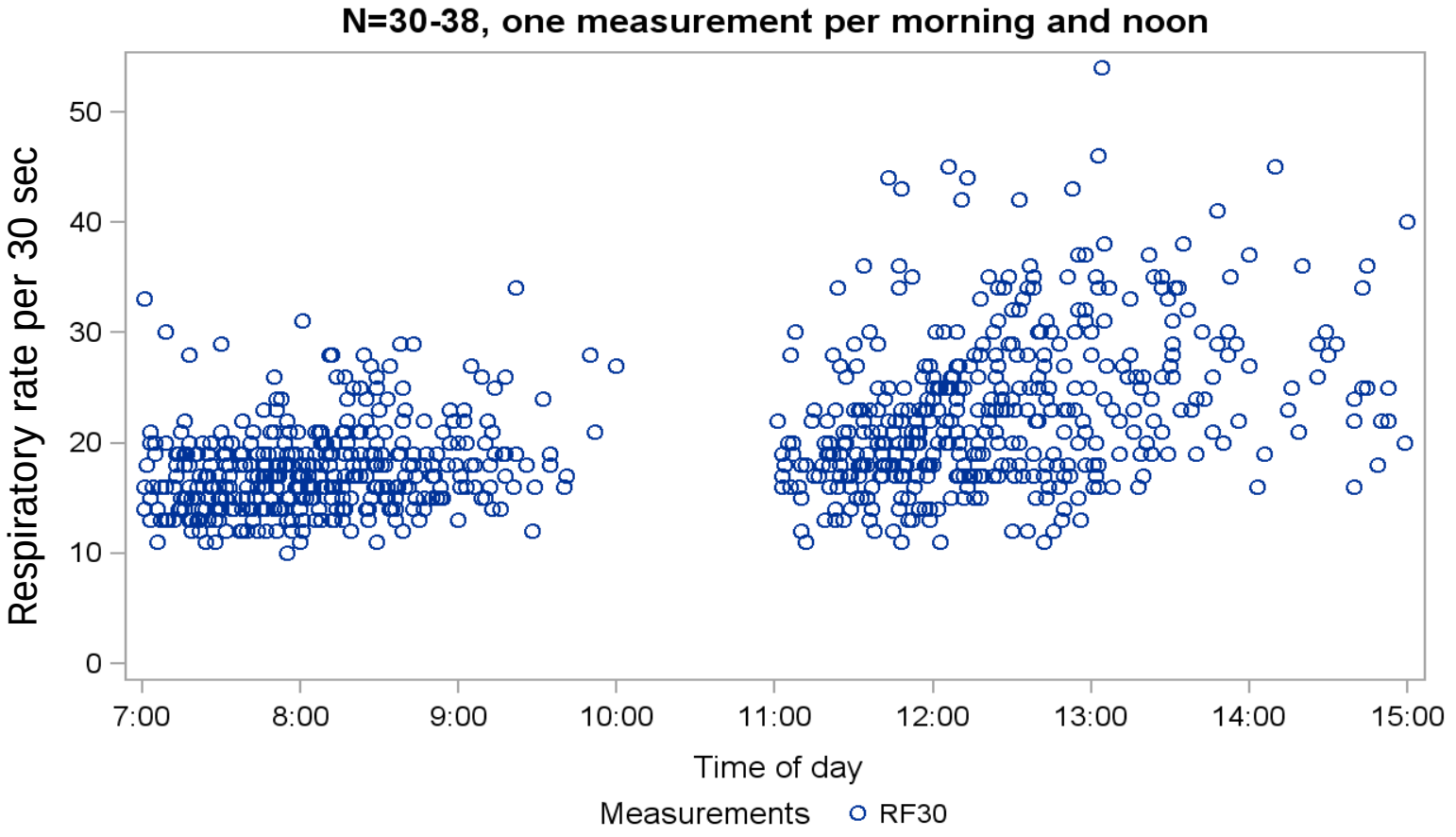
- RR increase in the afternoon in comparison of morning

3.5 Difference of respiratory rate between afternoon and morning



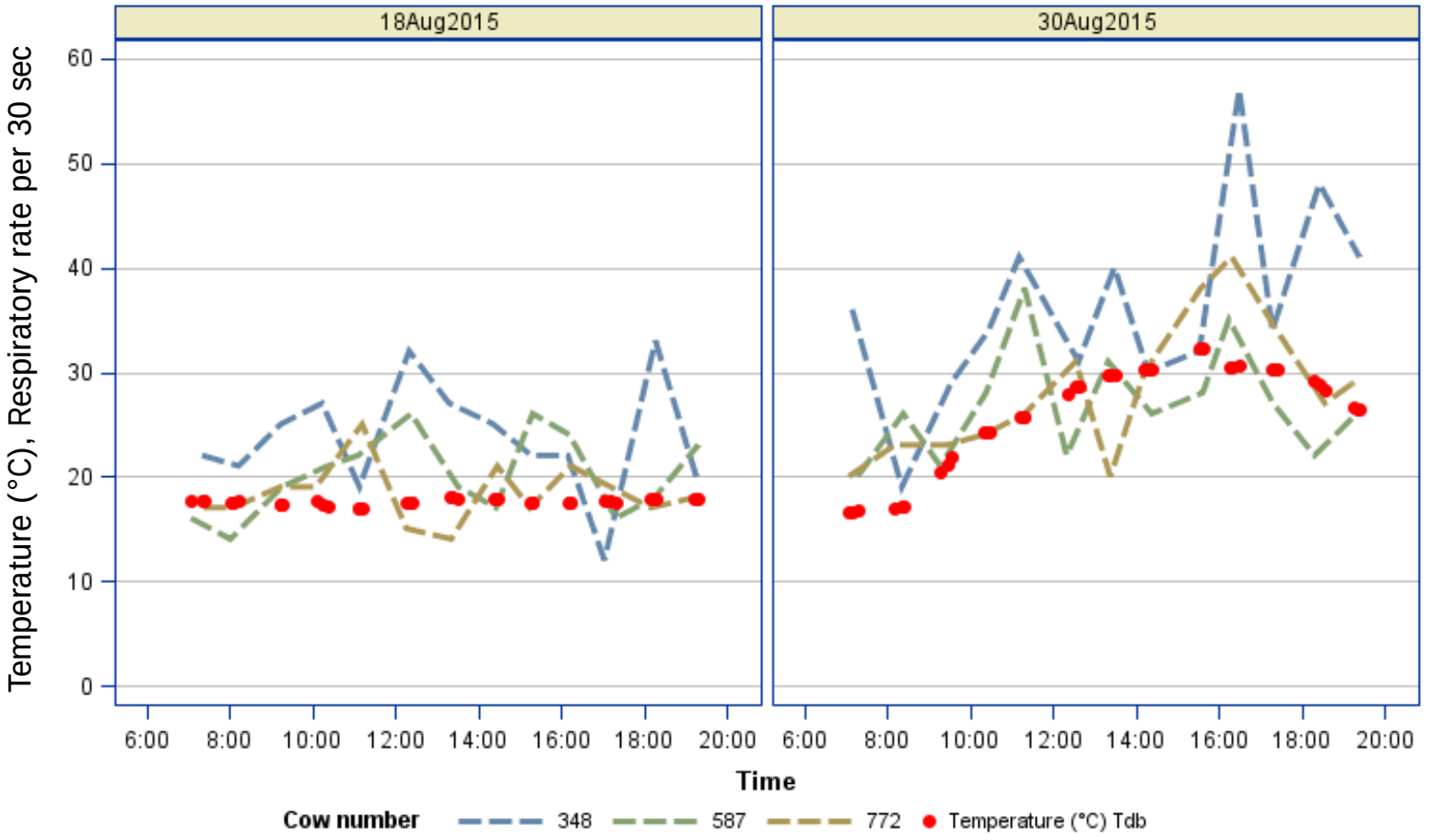
- Big range of RR -differences shows the cows' individuality, and difference between afternoon and morning.

3.6. Respiratory rate of each cow morning and afternoon – (group level)



- RR of cows in the morning are more compact, and in the afternoon are higher and diverge

3.7. Respiratory rate of three cows within two days (individual level)



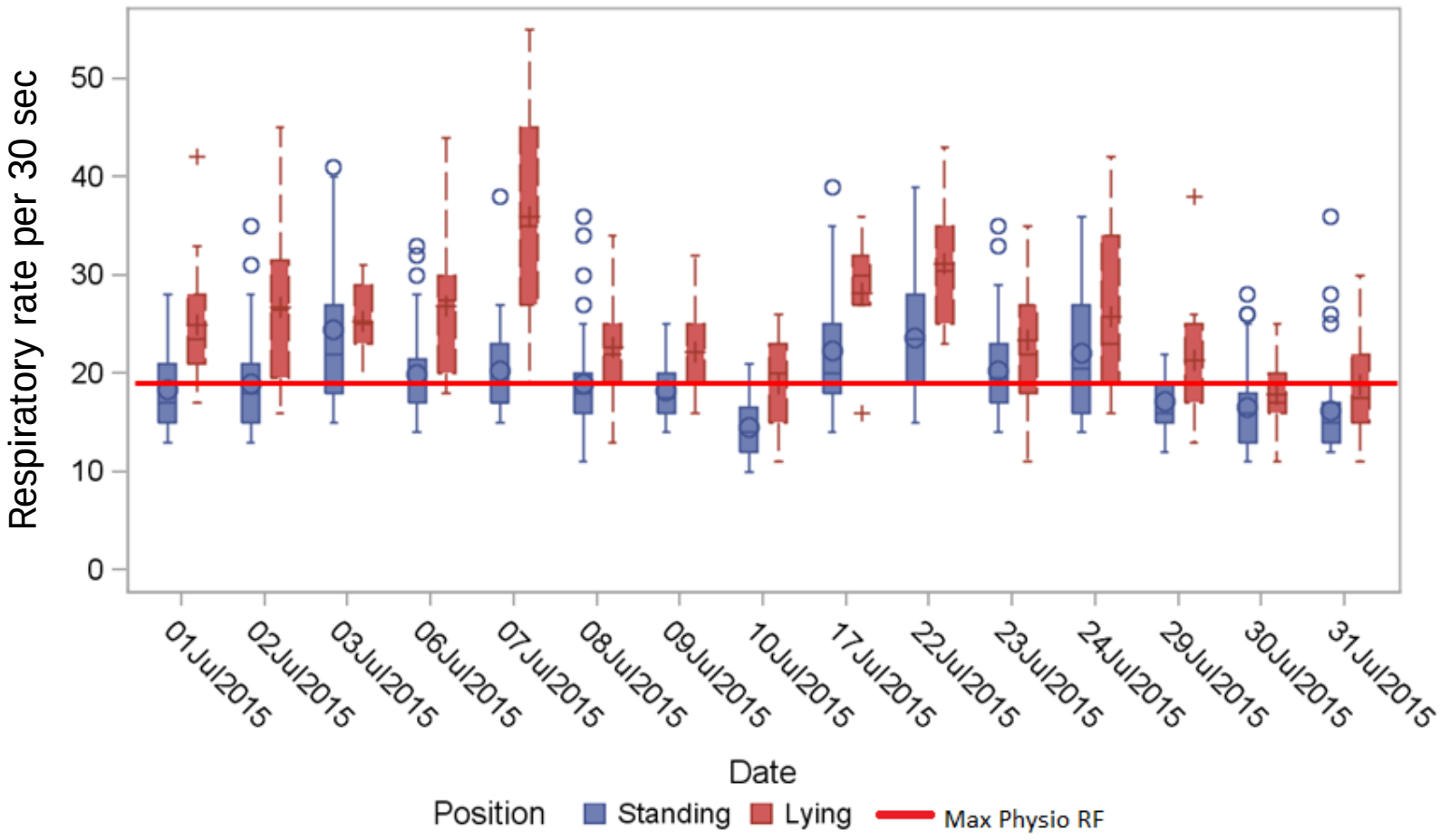
- High variability between and within cows independent of barn temperature;
- Temperature increase leads to higher respiratory rate

3.8. Mean and confidence interval of respiratory rate in different body posture and parity

Effect		*Mean Respiratory rate /30 sec*	*Limits of the 95% confidence interval*	
Body posture	Lying	22.4	21.6	23.1
	Standing	19.0	18.5	19.5
Parity	1	20.1	18.9	21.3
	2	19.9	19.2	20.5
	3+	21.9	21.3	22.6

Means in different colors differ significantly (t-Test, ±=0.05).

3.9. Daily respiratory rate during standing and lying



- RR of lying cows was higher than that of standing cows;
- High variability of RR in lying cows.

4.1. Conclusion

- The respiratory rate of lactating dairy cows is influenced by cow-related factors (e. g. lactation number and body posture) as well as climate-related variables (e. g. ambient temperature).

4.2. Next steps

Data evaluation and measurements: Germany – June 2015 – December 2016

- Consider other vital and production parameters

4.2. Next steps

Measurements: Israel – August 2016

Measurements: Spain – June 2016

- Comparison between respiratory rate and THI, in other climate zones and different seasons

Thank you for your Attention!