Global worming in the dairy aspect

Sensor base cooling reduced heat stress in dairy cows

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Agenda:

1. Project goals
2. Background
3. Sensor base cooling results
4. Conclusions and discussion

Project goals:

1. Study the individual cow heat stress response – **sensor based**
2. Transforming rumen temperature to vaginal temperature (**Statistic model**)
3. Design sensor base cooling method for **forced cooling** purposes (production/welfare)

Background:

1. Temperature-humidity index standard for external heat stress. (Zimbleman et al. 2011).

Themperature		% Relative Humidity																		
°F	°C	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
72	22.0	64	65	65	[illegible]	66	66	67	67	67	68	68	69	69	69	70	70	70	71	71
73	23.0	65	65	[illegible]	[illegible]	66	67	67	68	68	68	69	69	70	70	71	71	71	72	72
74	23.5	65	66	[illegible]	67	67	67	68	68	69	69	70	70	70	71	71	72	72	73	73
75	24.0	[illegible]	[illegible]	67	67	68	68	68	69	69	70	70	71	71	72	72	73	73	74	74
76	24.5	66	67	67	68	68	[illegible]	69	70	70	71	71	72	72	73	73	74	74	75	75
77	25.0	67	67	68	68	69	[illegible]	70	70	71	71	72	72	73	73	74	74	75	75	76
78	25.5	67	68	68	69	[illegible]	70	70	71	71	72	73	73	74	74	75	75	76	76	77
79	26.0	67	68	69	[illegible]	70	70	71	71	72	73	73	74	74	75	76	76	77	77	78
80	26.5	68	69	[illegible]	[illegible]	70	71	72	72	73	73	74	75	75	76	76	77	78	78	79
81	27.0	68	69	70	70	71	72	72	73	73	74	75	75	76	77	77	78	78	79	80
82	28.0	69	69	70	71	71	72	73	73	74	[illegible]	75	76	77	77	78	79	79	80	81
83	28.5	69	70	71	71	72	73	73	74	[illegible]	75	76	77	78	78	79	80	80	81	82
84	29.0	70	70	71	72	73	73	74	[illegible]	[illegible]	76	77	78	78	79	80	80	81	82	83
85	29.5	70	71	72	72	73	74	[illegible]	[illegible]	76	77	78	78	79	80	81	81	82	83	84
86	30.0	71	71	72	73	74	74	[illegible]	76	77	78	78	79	80	81	81	82	83	84	84
87	30.5	71	72	73	73	74	75	76	77	77	78	79	80	81	81	82	83	84	85	85
88	31.0	72	72	73	74	75	76	76	77	78	79	80	81	81	82	83	84	85	86	86
89	31.5	72	73	74	75	75	76	77	78	79	80	80	81	82	83	84	85	86	86	87
90	32.0	72	73	74	75	76	77	78	79	79	80	81	82	83	84	85	86	86	87	88
91	33.0	73	74	75	76	76	77	78	79	80	81	82	83	[illegible]	85	86	86	87	88	89
92	33.5	73	74	75	76	77	78	79	80	81	82	83	[illegible]	[illegible]	85	86	87	88	89	90
93	34.0	74	75	76	77	78	79	80	80	81	82	83	[illegible]	85	86	87	88	89	90	91
94	34.5	74	75	76	77	78	79	80	81	82	83	[illegible]	86	86	87	88	89	90	91	92
95	35.0	75	76	77	78	79	80	81	82	83	[illegible]	[illegible]	86	87	88	89	90	91	92	93
96	35.5	75	76	77	78	79	80	81	82	83	[illegible]	86	87	88	89	90	91	92	93	94
97	36.0	76	77	78	79	80	81	82	83	[illegible]	85	86	87	88	89	91	92	93	94	95
98	36.5	76	77	78	80	80	82	83	[illegible]	[illegible]	86	87	88	89	90	91	92	93	94	95
99	37.0	76	78	79	80	81	82	83	84	85	87	88	89	90	91	92	[illegible]	94	95	96
100	38.0	77	78	79	81	82	83	84	85	86	87	88	90	91	92	[illegible]	[illegible]	95	96	98
101	38.5	77	79	80	81	82	83	84	86	87	88	89	90	92	93	[illegible]	95	96	98	99
102	39.0	78	79	80	82	83	84	85	86	87	89	90	91	92	[illegible]	95	96	97	98	100
103	39.5	78	79	81	82	83	84	86	87	88	89	91	92	[illegible]	94	96	97	98	99	101
104	40.0	79	80	81	83	84	85	86	88	89	90	91	93	[illegible]	95	96	98	99	100	101
105	40.5	79	80	82	83	84	86	87	88	89	91	92	93	95	96	97	99	100	101	102
106	41.0	80	81	82	84	85	87	88	89	90	91	93	94	95	97	98	99	101	102	103
107	41.5	80	81	83	84	85	87	88	89	91	92	94	95	96	98	99	100	102	103	104

No stress
Threshold
Mild stress
Moderate stress
Severe stress

Background:

2. Body temperature increase due to hyperthermia.

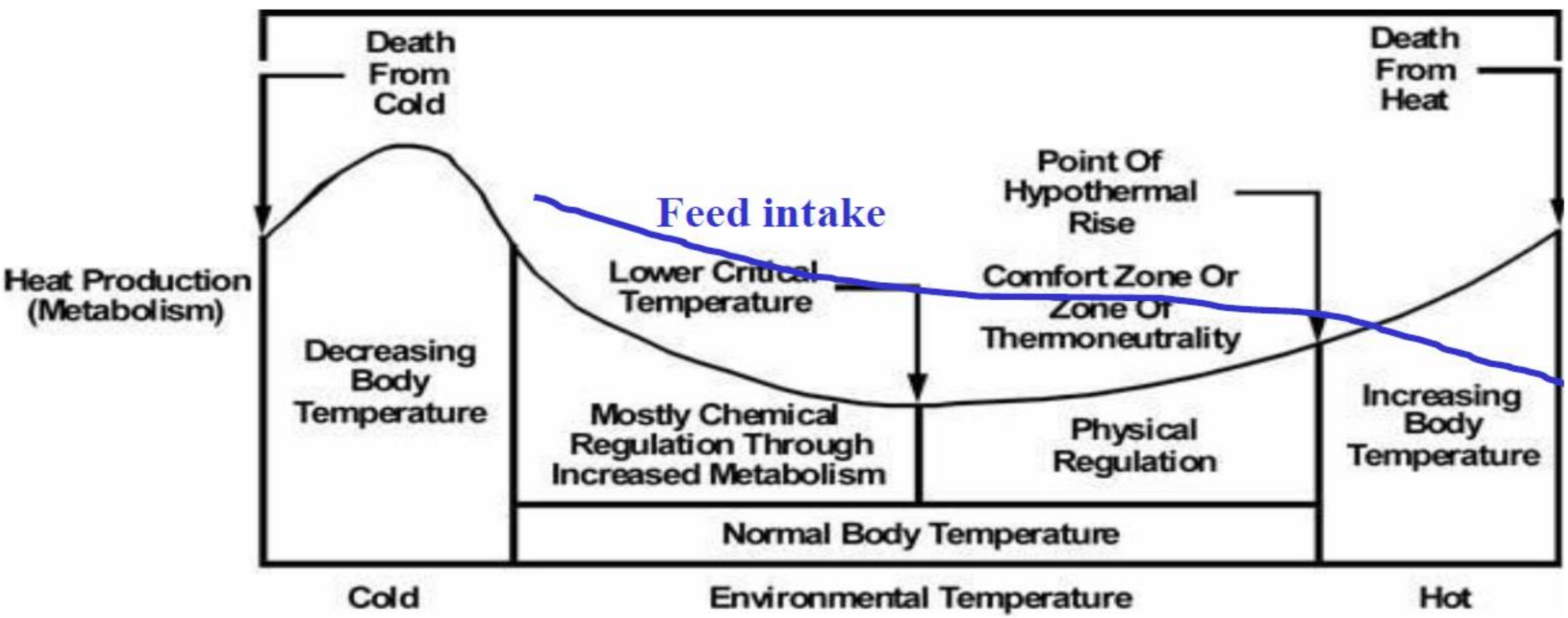
(D.T. Beatty et al. 2008) .

Our threshold:

1. Body temperature over 39^{o}C
2. Respiration over 80 per min

Background:

3. Feeding duration and DMI decreases in order to maintain normal thermoregulation. (Tian et al. 2016).



(Curtis, 1981)

Background:

Cooling management in Israel

1. Base on environmental temperature (THI)

2. Normal routine- time base (3-8)

Materials and Methods

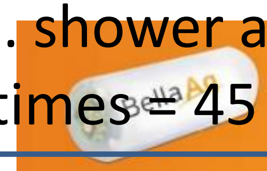
2016: **8 cooling vs. 5 cooling per day**

2017: **Sensor-based** cooling vs. **pre-defined** cooling (3 cooling)

1. ARO, Volcani, research dairy barn
2. (2016) 24 Holstein cows, 14 days
   (2017)30 Holstein cows, 3 months,
3. Data:

- Run
- Vag
- Eati
- The ation, wind).
- Sev erature, HRV)

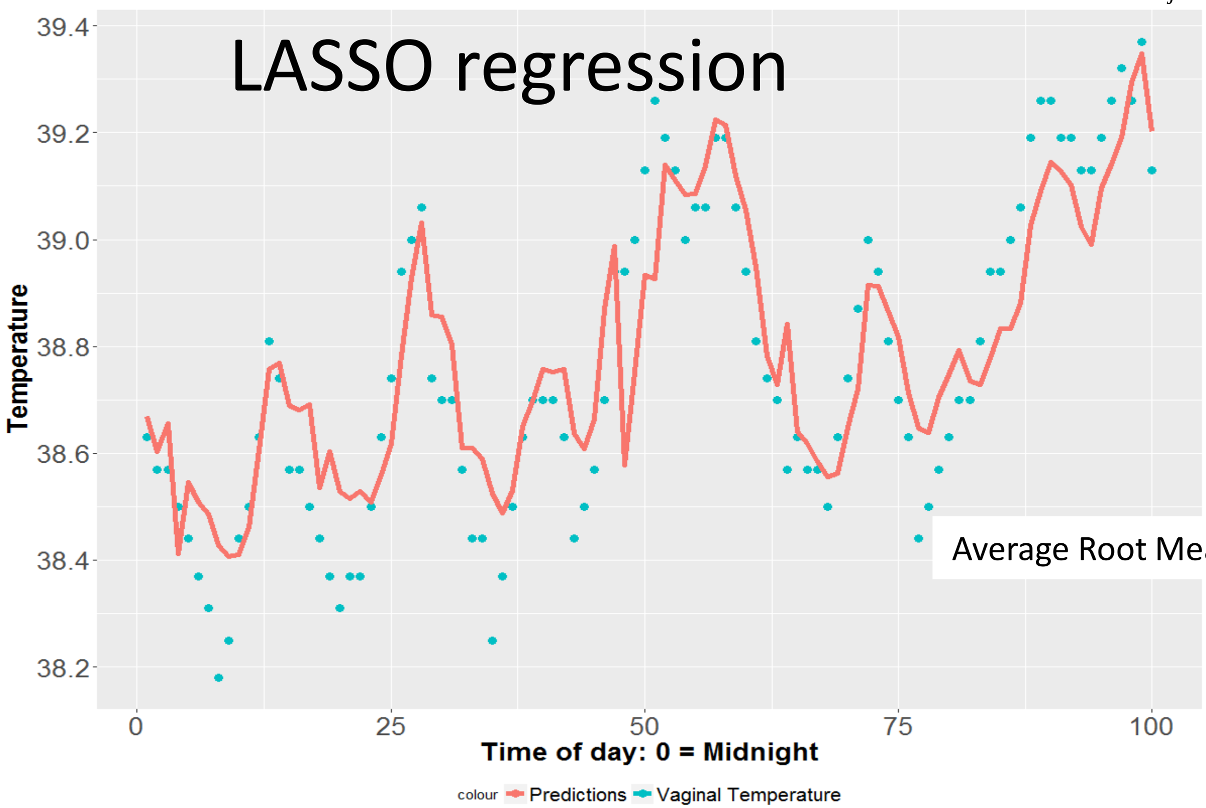
Cooling session:
1 min. shower and 4 min. fan
x 9 times = 45 min



Materials and methods – algorithm (2016)

How to "exchange" vaginal with bolus temperatures ?

$$\sum_{i=1}^{n}[y_i - (\beta_0 + \sum_{j=1}^{k}\beta_j x_{ij})]^2 + \lambda\sum_{j=1}^{k}|\beta_j| = \|\mathbf{Y} - \mathbf{X}\boldsymbol{\beta}\|_2^2 + \lambda\|\boldsymbol{\beta}\|_1$$

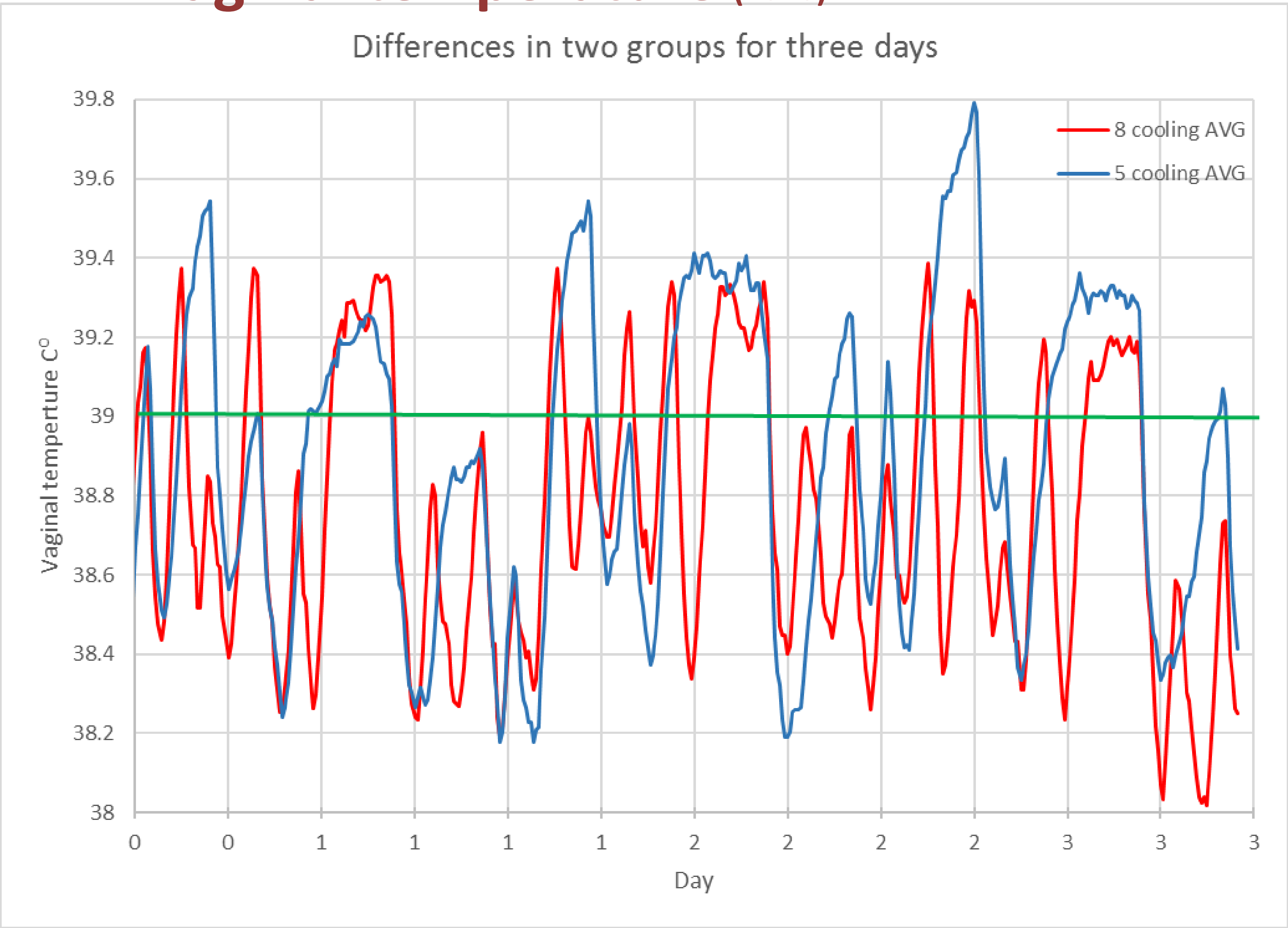


- Cow: 3304
- RMSE: 0.128

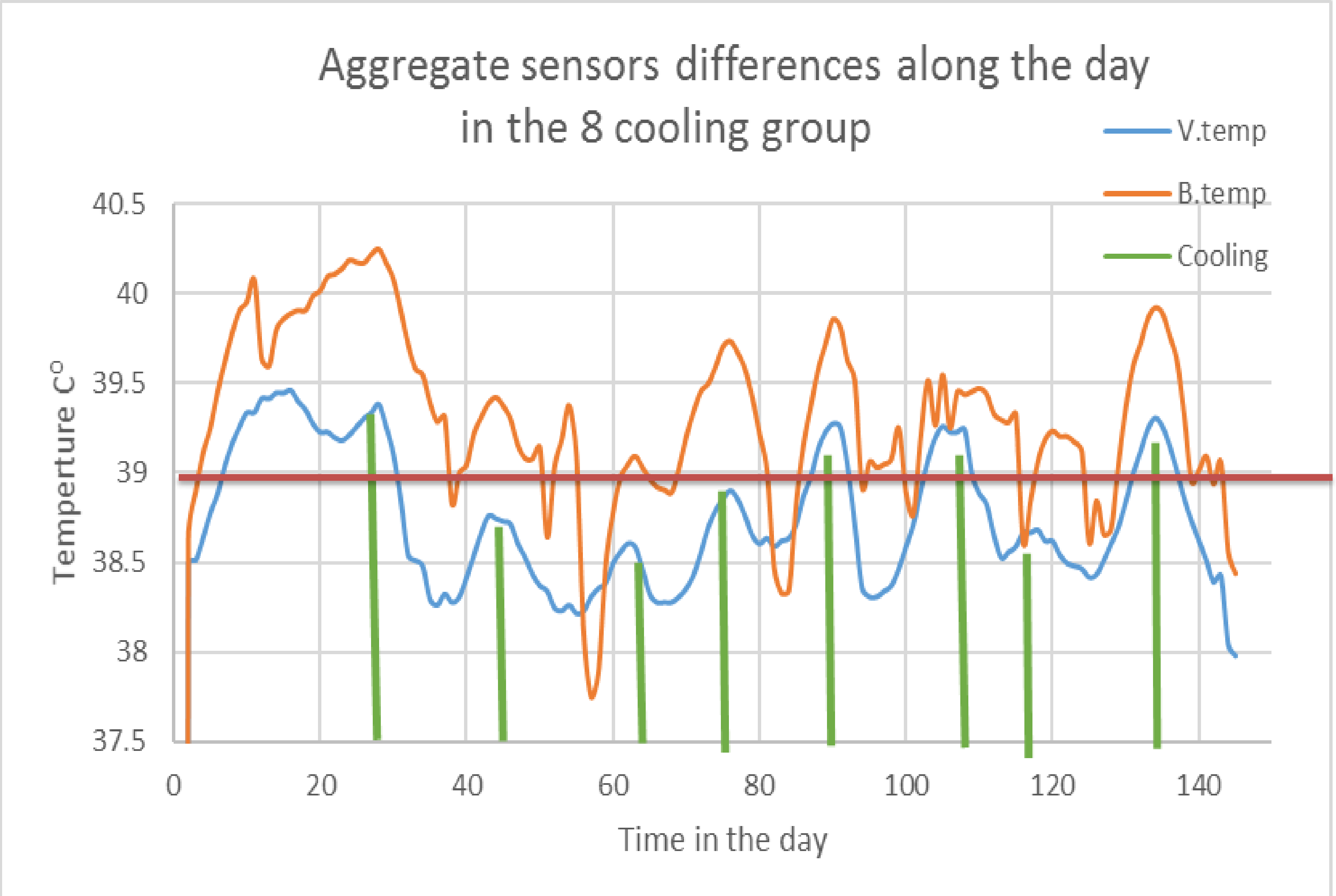
Average Root Mean Square Error =0.162°C

Borrowed from
Shlomi Goldshtain
Master work

Materials and methods :
Vaginal temperature (2016)

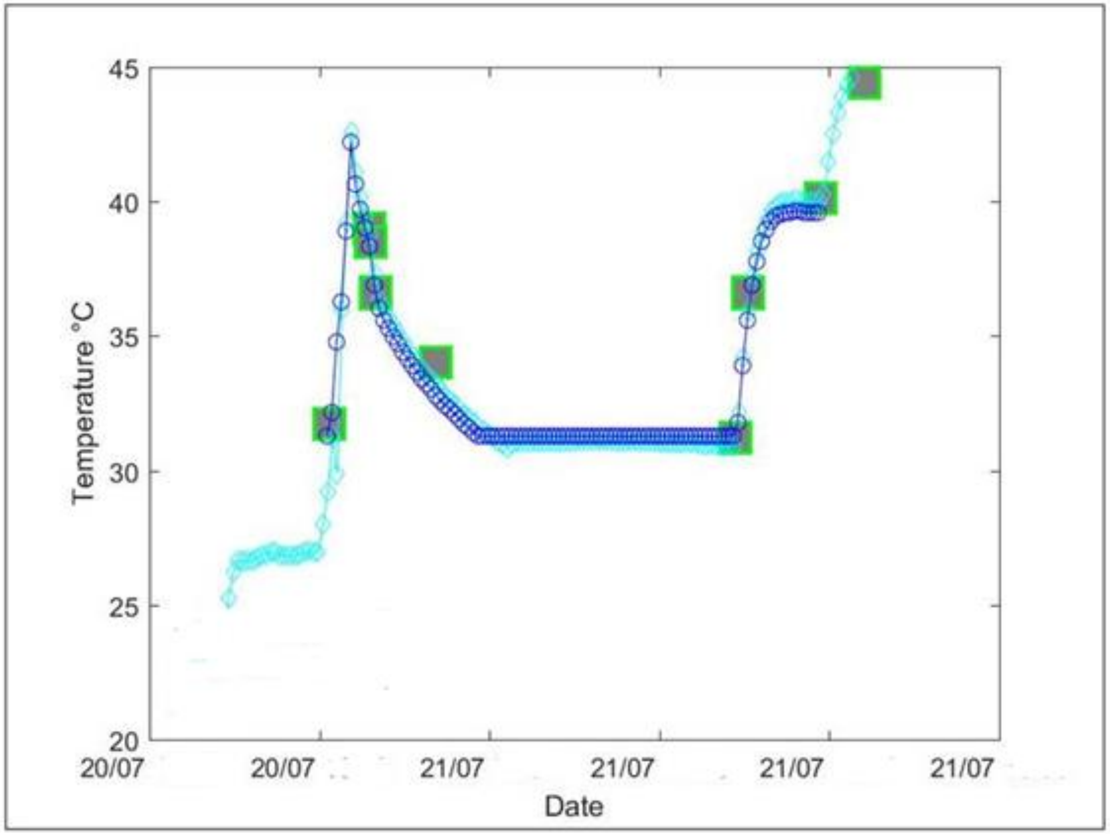


Materials and methods :
Rumen VS vaginal temperature (2016)



Materials and Methods
sensor validation

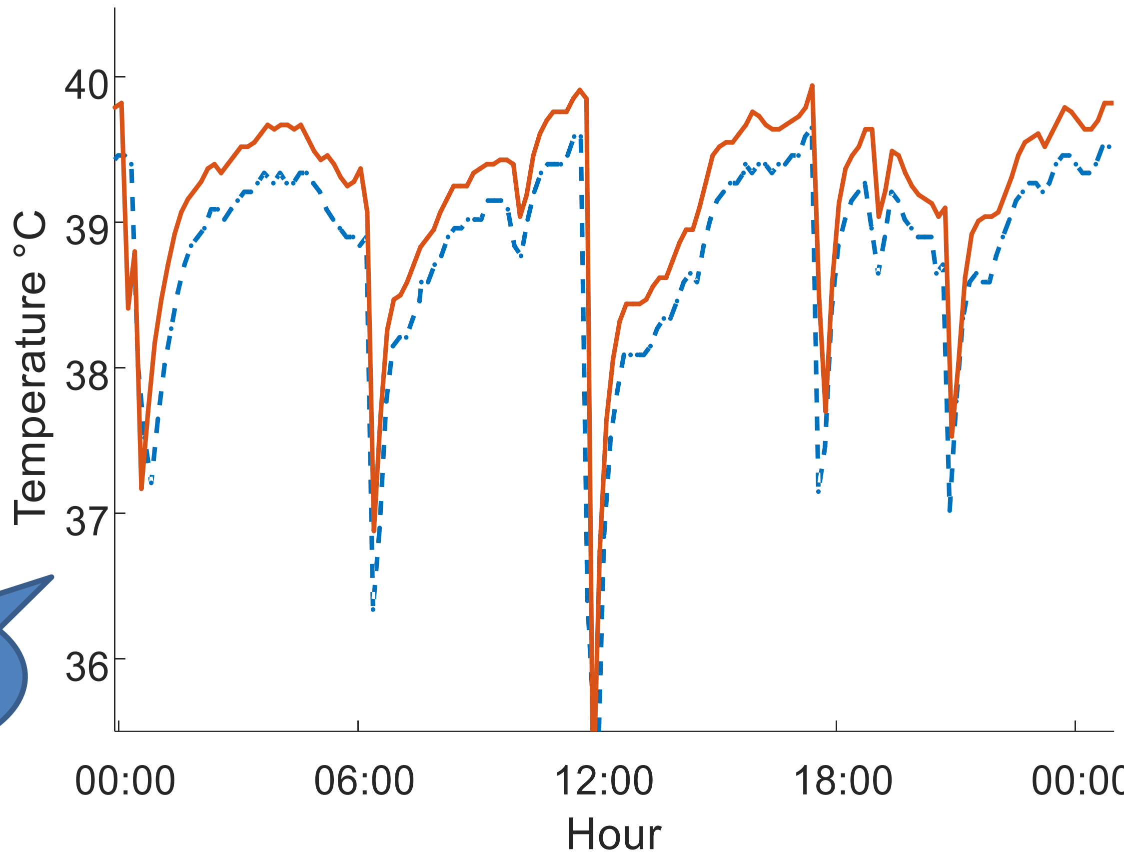
Two different manufactures - in the lab



Materials and Methods
sensor validation

Two different bolus manufactures in a one single cow

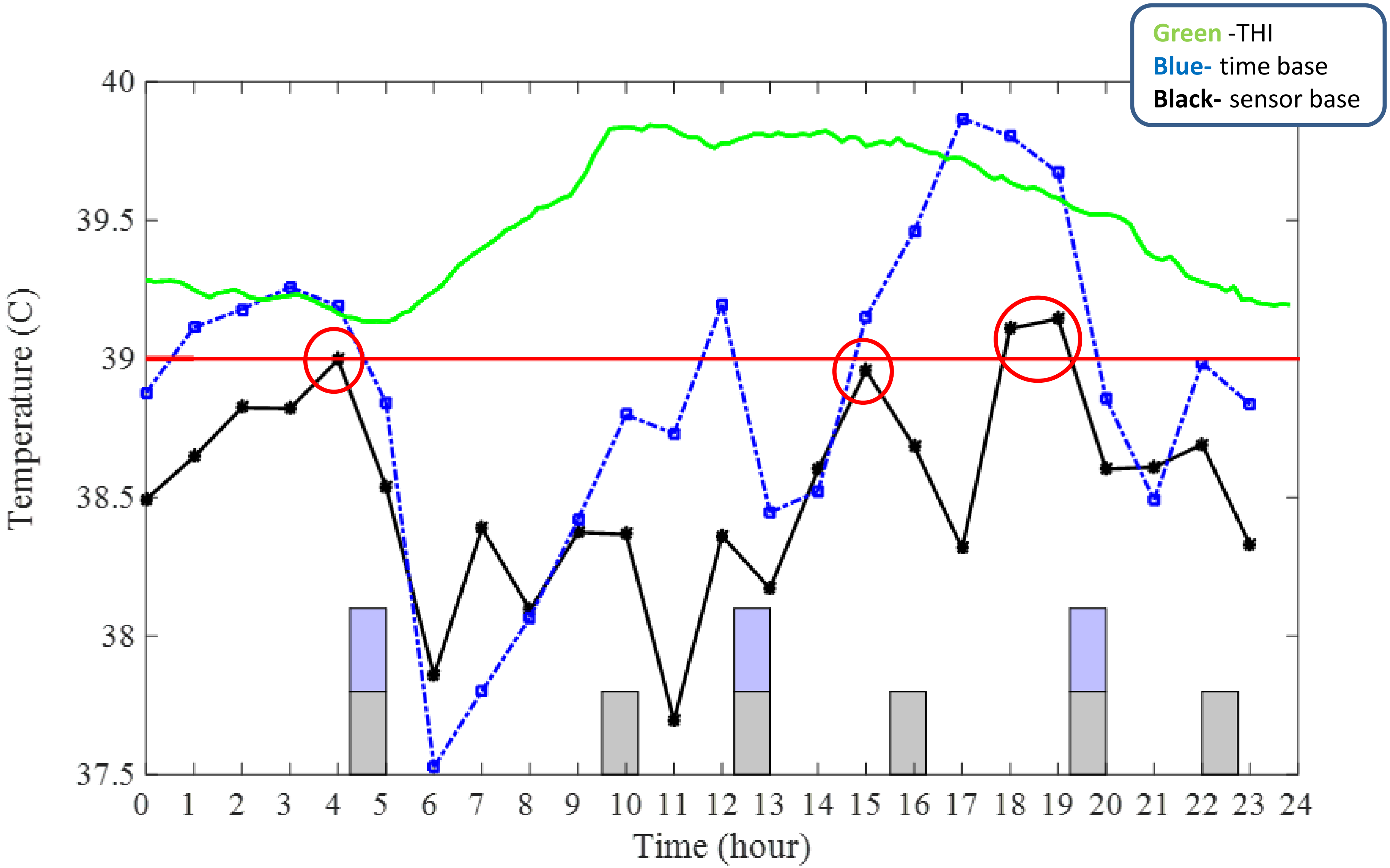
3300



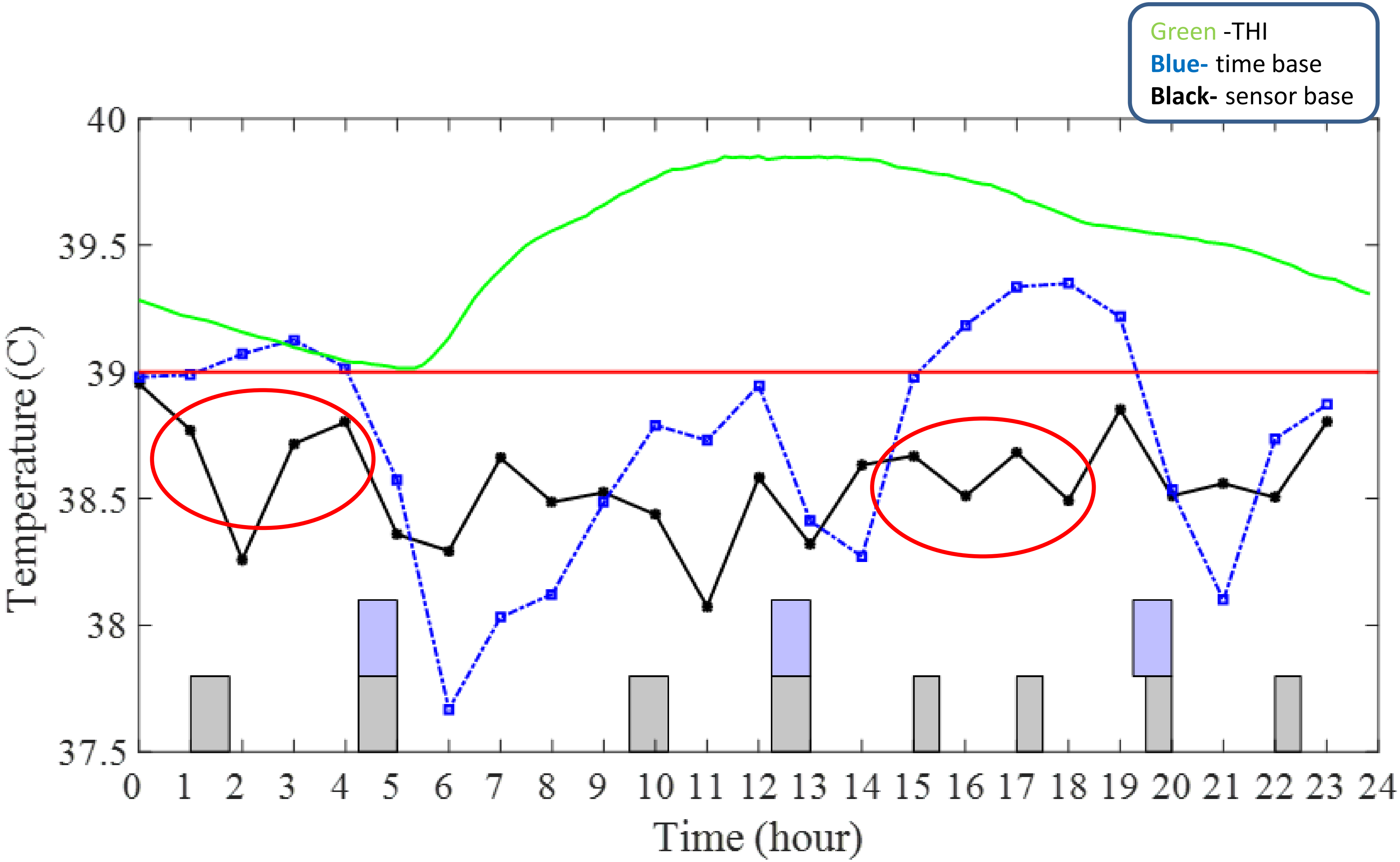
0.3°C difference

Repeat in **6** cows

Result: Animal response to sensor-based cooling changes (2017)

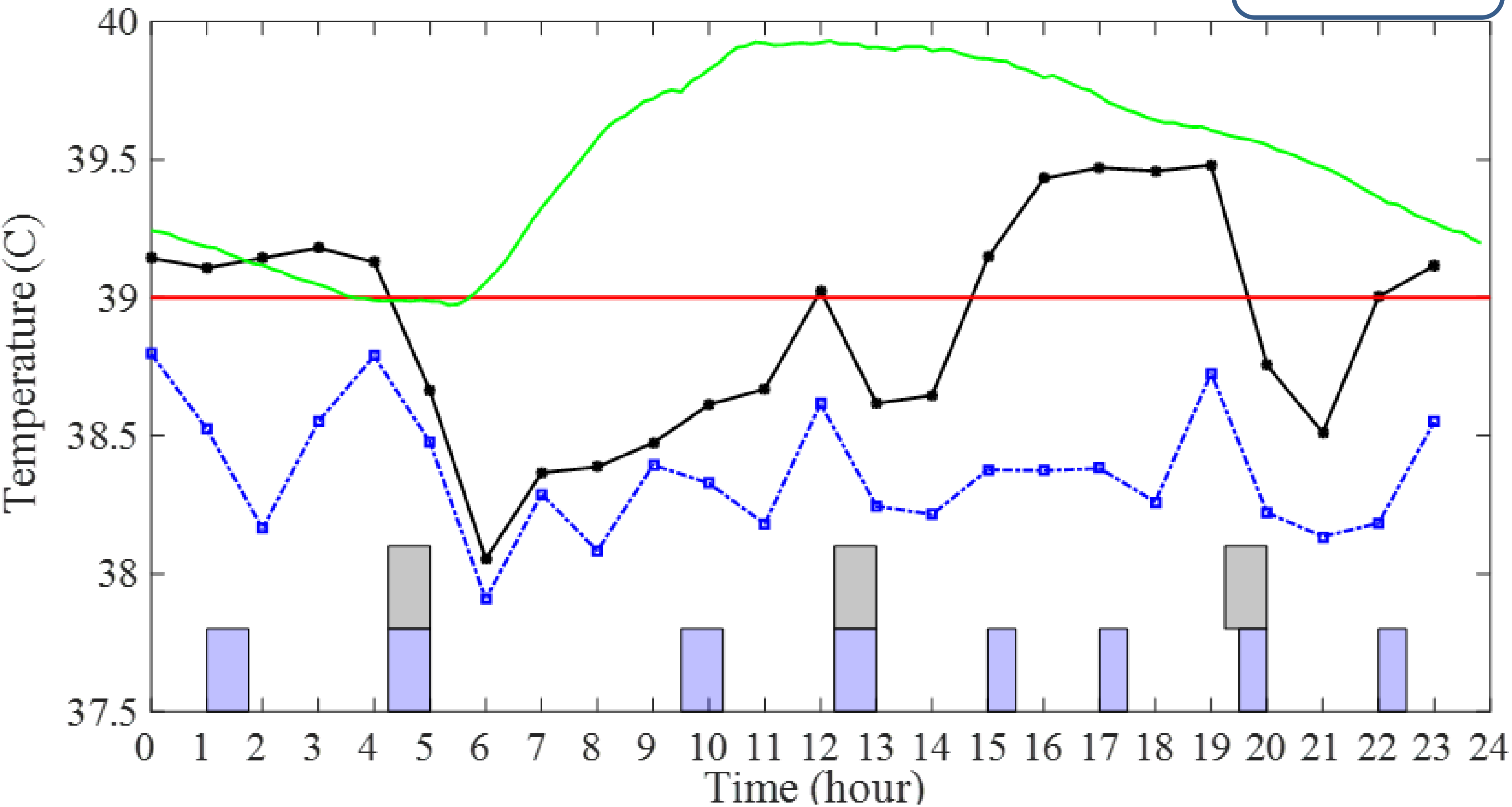


The preferred sensor-based cooling regime
(2017)



Animal response to crossover experiment
(2017)

Green -THI
Blue- sensor base
Black- time base



Production performance

Trait	TB (3 cooling)	SB (8 cooling)	*SEM*	*p*
Milk, kg/d	44.7	44.7	0.37	0.99
Milk Fat, %	3.46	3.72	0.01	0.001
Milk Protein, %	3.15	3.26	10.0	0.001
Milk Lactose, %	4.89	4.83	0.01	0.001
ECM, kg/d	41.3	42.8	0.30	0.001
FCM 4%, kg/d	41.0	42.7	0.30	0.001
ECM/DMI	1.59	1.53	0.01	0.001
RFI, kg DM/d	1.03	1.03	0.01	0.93
N	15	15		

Milk solids (fat, protein) were more affected then the milk volume

Feeding behavior and welfare

Trait	TB (3 cooling)	SB (8 cooling)	*SEM*	*p*
DMI, kg/d	26.4	28.4	0.19	0.001
Eating rate, g DM/min.	131.6	142.6	1.72	0.001
Eating time, min./d	200.6	199.1	2.46	0.112
Valid visits/d	9.31	7.69	0.06	0.001
Visit duration, min.	23.7	28.1	0.33	0.001
Visit size, kg DM	2.83	3.80	0.05	0.001
Lying, Min./d	558.8	563.9	6.74	0.598
Pedometer, Steps/h	97.9	136.5	2.46	0.001
Body Weight, kg	639.6	656.4	2.54	0.001
Rumination, min./d	393.4	487.6	95.4	0.001

Conclusion Exp. 2017:

- Higher milk solids
- Higher feed consumption

- Change in eating behavior
- Change in production

- Better thermoregulation (Av. 38.6^{o}C)

Effective tool to manage the dairy's cooling regime and ease cow's heat stress.

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Discussion