Session 35

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Genetic parameters for milk, fat and protein in Holsteins using a multiple-parity test day model that accounts for heat stress

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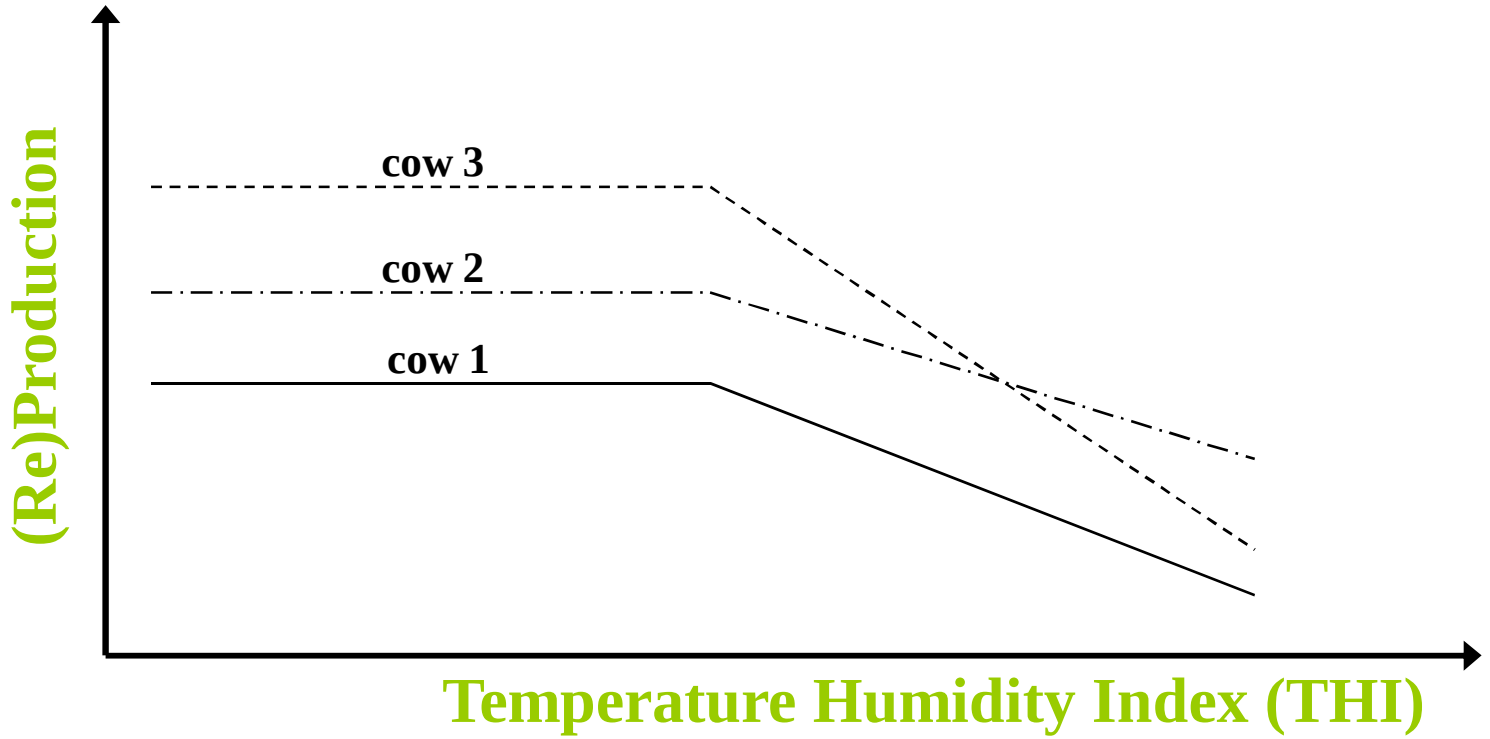
Introduction

- Losses due to heat stress
  - Production, fertility, mortality
- Substantial genetic variation for heat tolerance (Ravagnolo and Misztal, 2000)
- Profile of heat tolerant bulls (Bohmanova et al., 2005)
  - Selection for fluid milk only decreases heat tolerance
- All studies first-parity only using repeatability test day models

Objectives

- How genetic variances of heat stress change with parity?
- Does sensitivity to heat stress vary throughout lactation?
- What are the genetic trends for heat stress?

Studying heat stress with weather records



Breeding value: BV = a1 + f(THI)*a2

a1 – regular breeding value **a2** – heat-tolerance breeding value

f(THI) – function of temperature humidity index

Data

- Georgia Holsteins data from AIPL USDA
- TD for Milk, Fat and Protein
- First, second and third lactations
- Lactations registered 1993 – 2004
- Editing:
  - At least 4 TD
  - First TD < 75 DIM
  - TD between 5 – 305 DIM
  - Age at calving
  - Cows were required to have a “valid” first lactation

Weather Data

- Hourly temperature and relative humidity available from public weather stations (9)
- Hourly THI

  T-(0.55-0.55*RH*.01)*(T-58) (NOAA, 1976)
- Herd assigned to closest weather station
- TD records matched with average daily THI from the previous 3rd day

Production Data

	Lactation		
	1	2	3
TD	350,623	160,262	74,834
Cows	38,608	17,549	8,210
HTD	16,467	13,043	10,156
Pedigree data		68096	

Descriptive Statistics

	Milk (kg)		Fat (kg*100)		Protein (kg*100)	
Lact	Mean	SD	Mean	SD	Mean	SD
1	27.5	7.0	94.8	27.7	85.7	20.4
2	31.6	9.4	109.3	36.3	97.5	26.3
3	33.0	10.1	114.8	39.5	100.7	28.1

	Mean	SD	Min	Max
THI	62	12	23	83

Models

- Model I
  - Test-day repeatability model
    - Milk, fat & protein

$$y = \ldots + a1 + a2 * f(thi) + p1 + p2 * f(thi) + e$$

$$f(thi) = \max(0, THI - 72^{o}F) \qquad 72^{o}F = 22^{o}C$$

- Model II
  - Test-day random regression model
    - Linear splines with knots at 5, 50, 200 and 305 DIM
    - Milk

$$y = \ldots + \sum a1_i \varphi_i + a2\, f(thi) + \sum p1_i \varphi_i + p2\, f(thi) + \sum h1_i \varphi_i + h2\, f(thi) + e$$

Estimates for multiple-trait test-day repeatability model

	Milk			Fat (kg*100)			Protein (kg*100)		
	1	2	3	1	2	3	1	2	3
$\text{var}(a1)$	5.6	7.5	6.5	74	94	109	43	57	52.2
$\text{var}(5a2)$*	4.0	7.0	9.0	37	75	142	22	48	108
$\text{corr}(a1, a2)$	-0.46	-0.38	-0.47	-0.39	-0.39	-0.30	-0.43	-0.36	-0.50

* Variance of heat stress effect at 5.5^{o} C over the threshold

Additive (co)variances and genetic correlations between knots and THI for milk in the first, second, and third parities

	Parity														
	First					Second					Third				
	5	50	200	305	THI	5	50	200	305	THI	5	50	200	305	THI
5	**3.96**	0.64	0.41	0.32	-0.25	**8.73**	0.74	0.47	0.37	-0.17	**5.98**	0.55	0.44	0.23	0.10
50		**5.46**	0.85	0.62	-0.45		**8.50**	0.70	0.51	-0.31		**9.27**	0.63	0.18	-0.21
200			**6.28**	0.84	-0.40			**7.89**	0.84	-0.43			**9.24**	0.76	-0.41
305				**8.27**	-0.27				**16.35**	-0.39				**15.64**	-0.37
THI					**0.02**					**0.04**					**0.07**

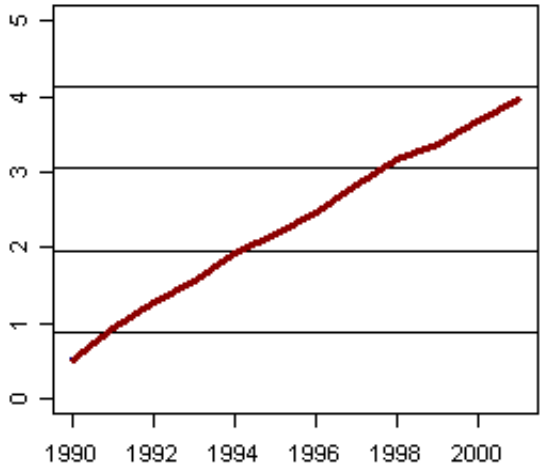
THI for 0.55 degree C

Genetic Evaluation

- 5 million Holsteins
- 90 million test day records for milk
- Random regression model

Genetic trends of daily milk yield for 3 parities – regular effect

First



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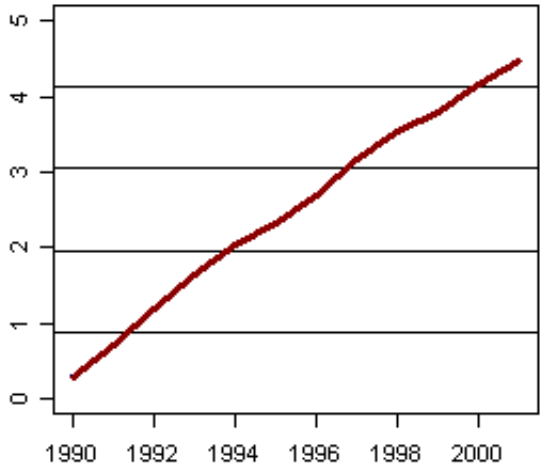

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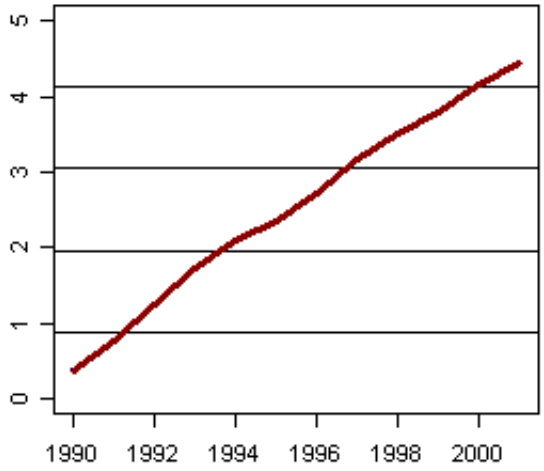
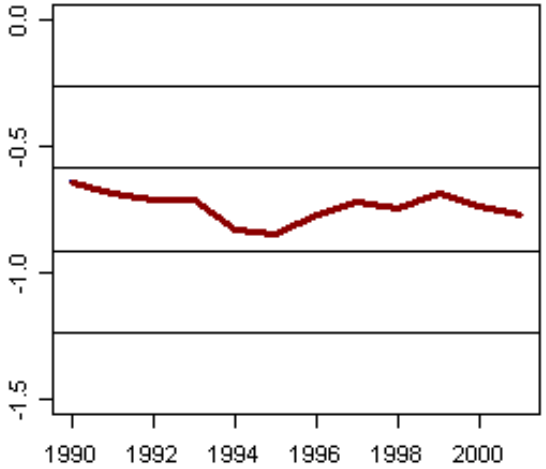


Genetic trends of daily – heat stress effect at 5.5º C over the threshold

First



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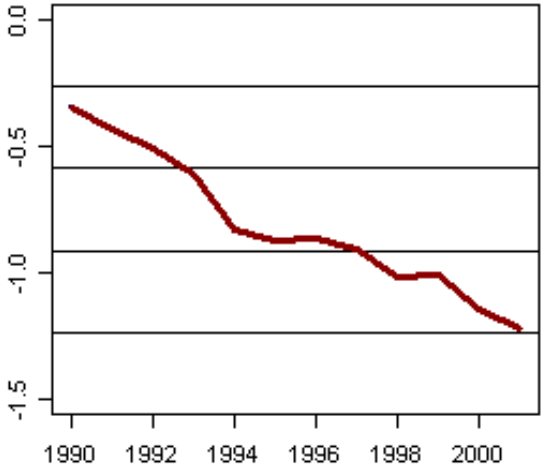

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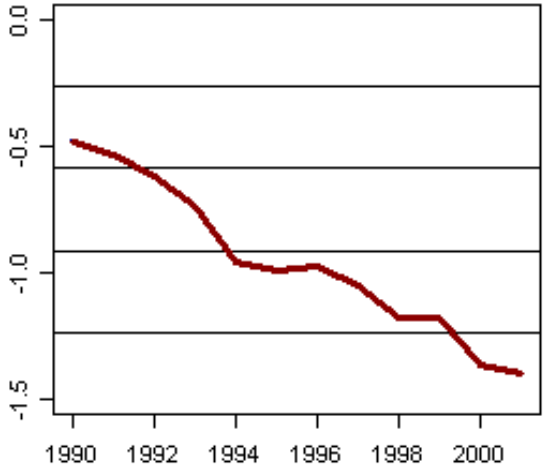

Conclusions

- Sensitivity to heat stress greatly increases from 1 to 3rd parity

- Negative trend for heat tolerance for 2nd and third parities