Enthalpyas apossible indexof thermalload foranimals intransit?

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SAC, ADAS and UPM

Introduction

- **Long distance journeys are a matter of concern in relation to the welfare of the transported animals.**

- **The vehicle thermal micro-environment is a potential major source of stress and reduced welfare in all transported animals.**

- **A combination of extended journey durations (e.g. export journeys) and exposure of animals to hostile thermal environments may constitute an important welfare concern.**

Introduction

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- Elevated environmental temperature is recognised as a major factor influencing the welfare of animal in transit and causing mortality and production losses

- The detrimental effects of high temperatures may be exacerbated by high water vapour densities or humidity

- The heat loads imposed on animals in transit might be best assessed by using integrated indices of temperature and humidity such as **Enthalpy, THI** and **Apparent Equivalent Temperature**

Introduction

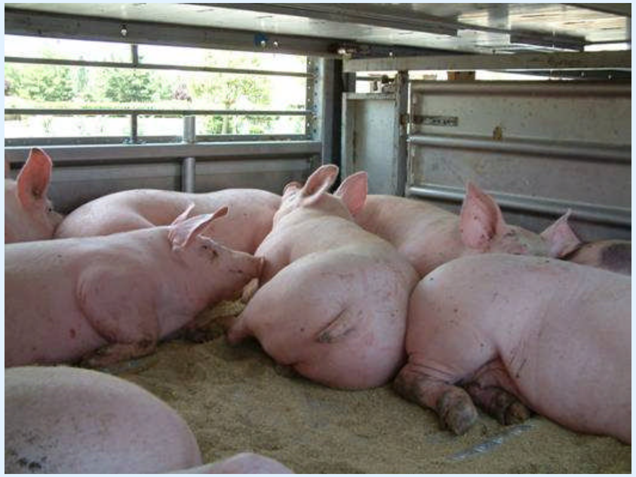
- The thermal limits for the transportation of animals in Europe are set out in the EC: Regulation 1/2005

- This indicates that " hauliers/producers should not transport pigs when ambient temperature is above 30ºC, and never above 35ºC (problem for southern European Member States)

- The regulation does not address Humidity which may have a profound effect on the animals' well being when conditions are "Hot"

Introduction

•It may be proposed that the absolute heat loads in terms of temperature and humidity are crucial in determining animal thermal comfort and well- being but also that the rate of change of these parameters and the magnitude of such changes may also exert important influences upon the animals physiological and welfare status



Introduction

Temperature and humidity on the farm may vary quite slowly BUT in transit, changes may be more rapid

Therefore this study looked at relative changes in temperature and humidity during transport

Using these data enthalpy was calculated and the results presented as psychrometric charts

Introduction

Rates of change of temperature and enthalpy were also calculated and phase space analysis applied and are presented

Methods

Experimental journeys

- 7 journeys
- Edinburgh to Malaga
- 3000km – 72 hours
- Control post in France (24 hours)
- Commercial vehicle (80 gilts @ 100kg)
- Destination – abattoir in Humilladero

Vehicleemployed inALL studies

Methods

Norwegian Sea
Reykjavík
ICELAND
Tórshavn
Faroe Islands (DENMARK)
SHETLAND ISLANDS
ORKNEY ISLANDS
Rockall (U.K.)
HEBRIDES
North Atlantic Ocean
Aberdeen
Glasgow
Edinburgh
UNITED KINGDOM
North Sea
DENMARK
Copenhagen
Belfast
Dublin
IRELAND
Isle of Man (U.K.)
Irish Sea
Leeds
Manchester
Liverpool
Birmingham
Cardiff
London
Amsterdam
Rotterdam
NETH.
Hamburg
Bremen
Berlin
Celtic Sea
English Channel
Brussels
BEL.
Lille
Essen
Cologne
Bonn
Leipzig
GERMANY
Frankfurt am Main
Guernsey (U.K.)
Jersey (U.K.)
Luxembourg
LUX.
Paris
Fougeres
Strasbourg
Stuttgart
Munich
Nantes
LIECH.
Zürich
Bern
SWITZ.
Geneva
Bay of Biscay
FRANCE
Lyon
Milan
Venice
Turin
Bordeaux
Genoa
Bilbao
Toulouse
MONACO
SAN MARINO
Florence
Porto
Andorra la Vella
ANDORRA
Marseille
Ligurian Sea
ITALY
Adriatic Sea
Zaragoza
Corsica (FRANCE)
Rome
VATICAN CITY
PORTUGAL
Madrid
Barcelona
Naples
Lisbon
SPAIN
Valencia
Balearic Sea
Sardinia
Tyrrhenian Sea
BALEARIC ISLANDS
Sevilla
Cagliari
Palermo
Mediterranean Sea
Gibraltar (U.K.)
Málaga
Sicily
Humilladero
300 Kilometers
300 Miles
MALTA
Valletta

W. Sleegers
INT. VEETRANSPORT BV
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Methods

Sensors and behaviour

- **Temperature and humidity measurements**
  - In home pen facilities
  - On-board the truck
  - In the lairage – control post
  - In the lairage – slaughterhouse

- **Ambient conditions in Edinburgh and Humilladero**

Methods

Sensors and behaviour

Quantified durations of and latencies to drink and rest (indicators of transport stress)

Drinking – water balance

Resting - fatigue

Methods

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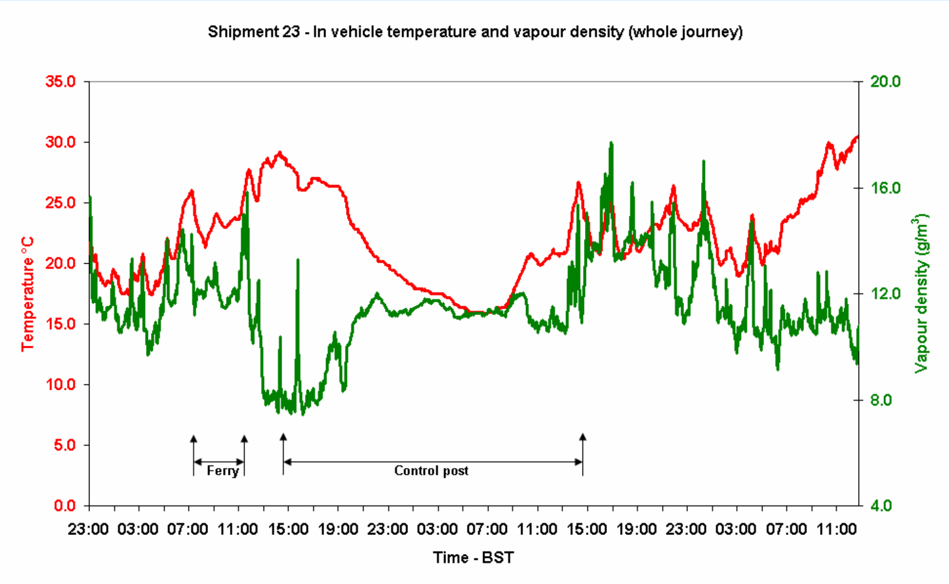
Processing of temperature and humidity data:

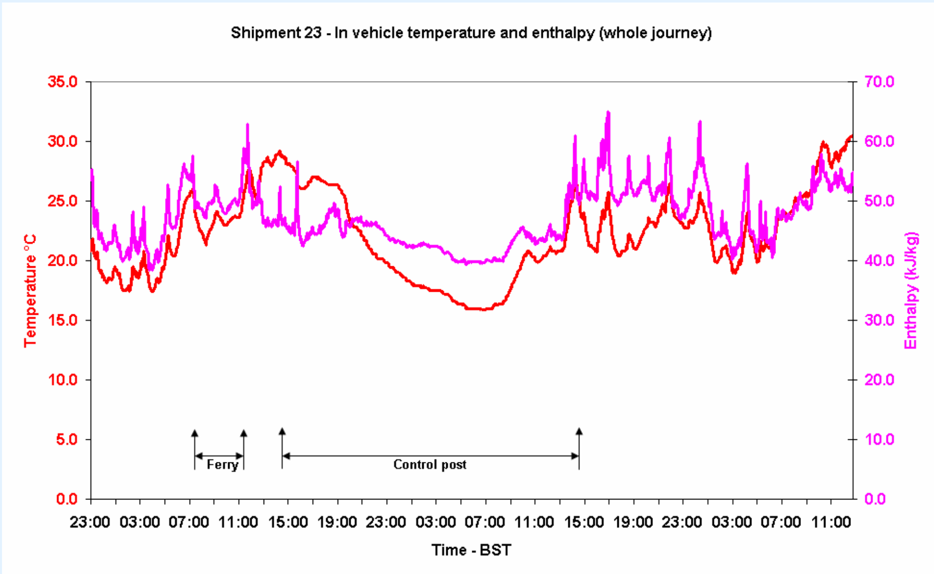
•The temperature derivative was computed using the Savitzky-Golay algorithm to compute the numerical derivatives using the Savgol routine in Matlab (version 7.0, Mathworks Inc, 2004). A polynomial was used to fit the data surrounding each data point

•**The speed of change** (with respect to a previous value) or **gradient** of temperature (dT/dt) and enthalpy (dH/dt) at each location was calculated

•The phase space has been applied to the gradients of temperature and enthalpy. The areas of the **polygons (P_{area})** that included all the data points in the temperature gradient space per journey have been calculated

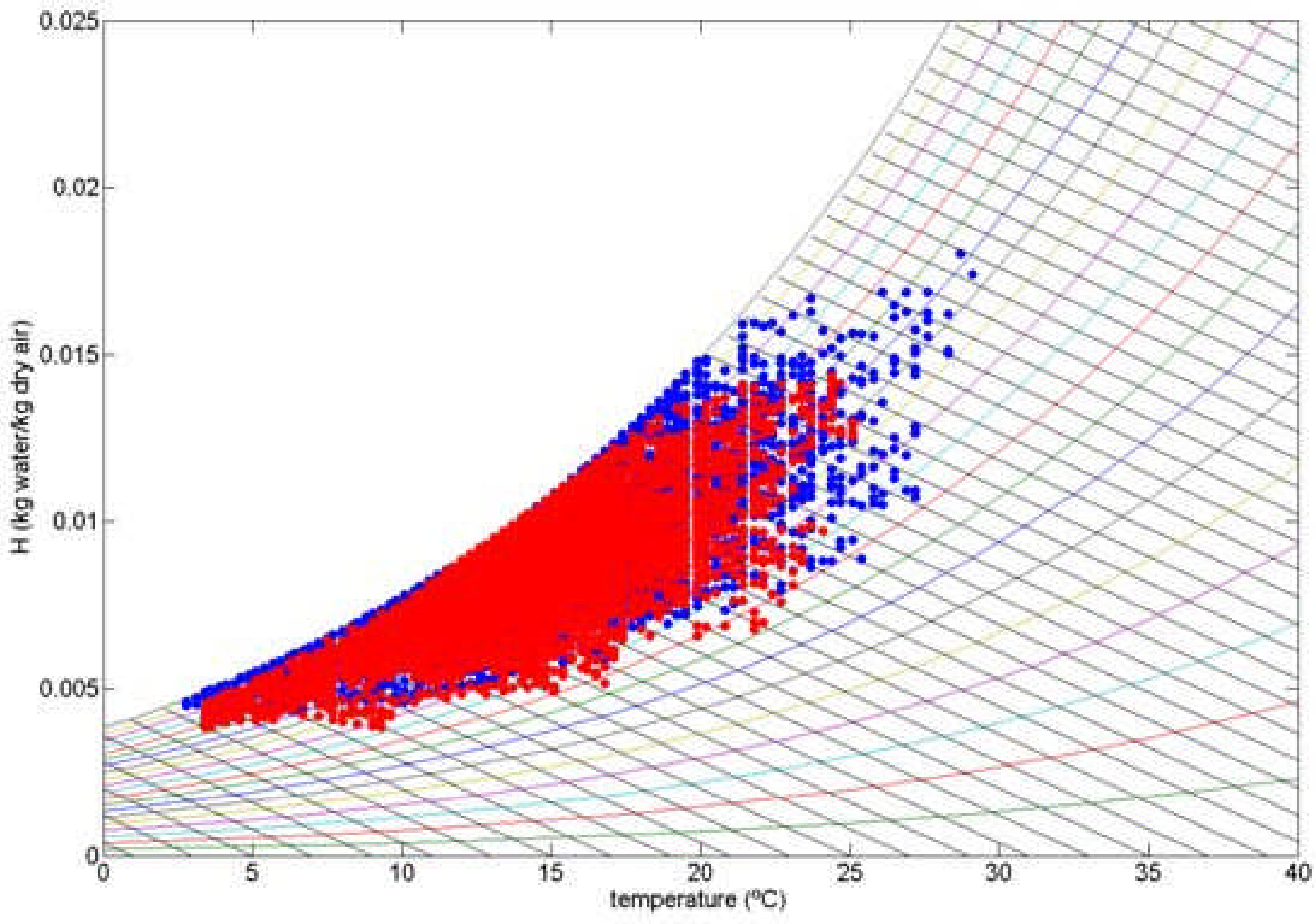
Results



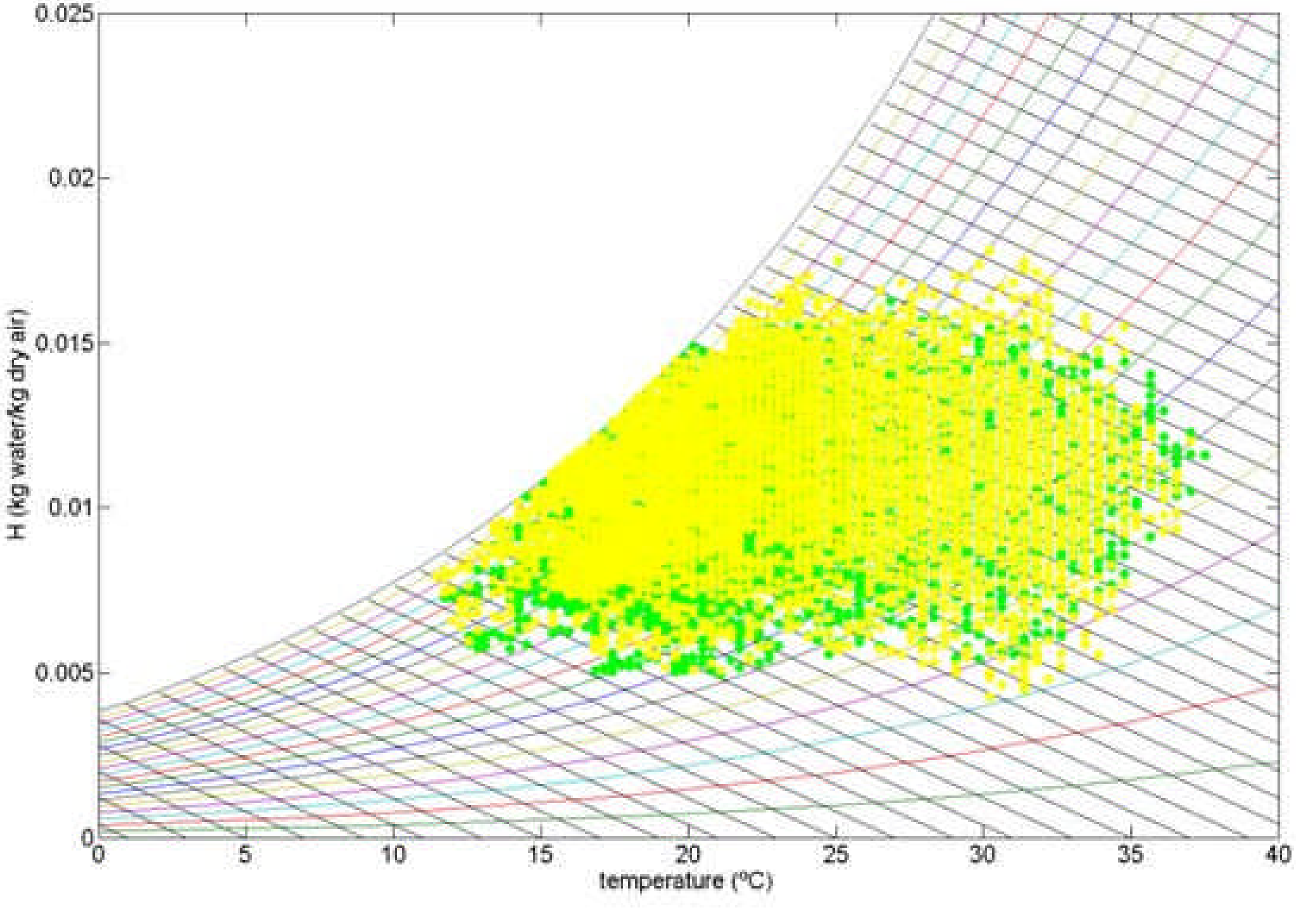


Journey 3, (note resting stage in France) . Journeys lasted approximately 64 h.

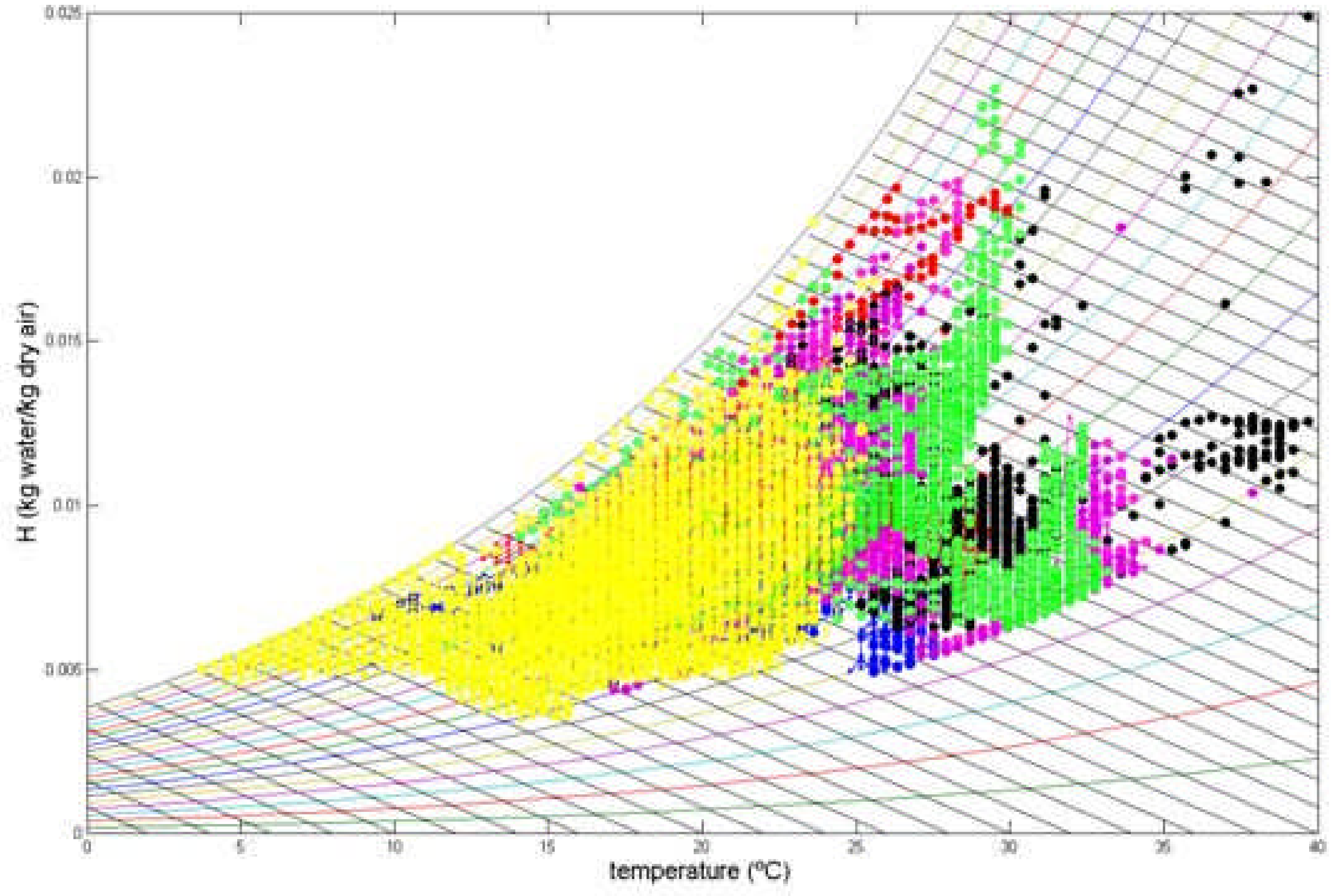
Enthalpyon farm



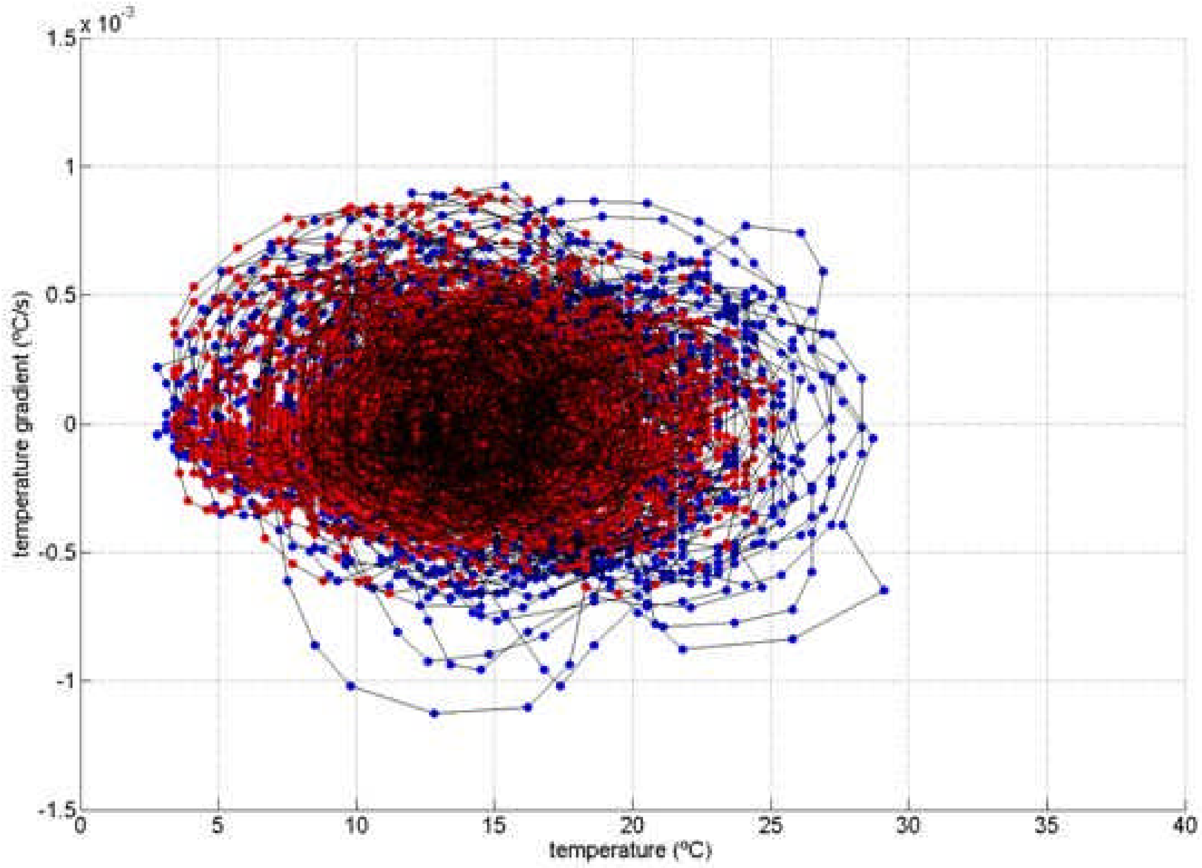
Enthalpyat abattoir



Enthaplyon journey



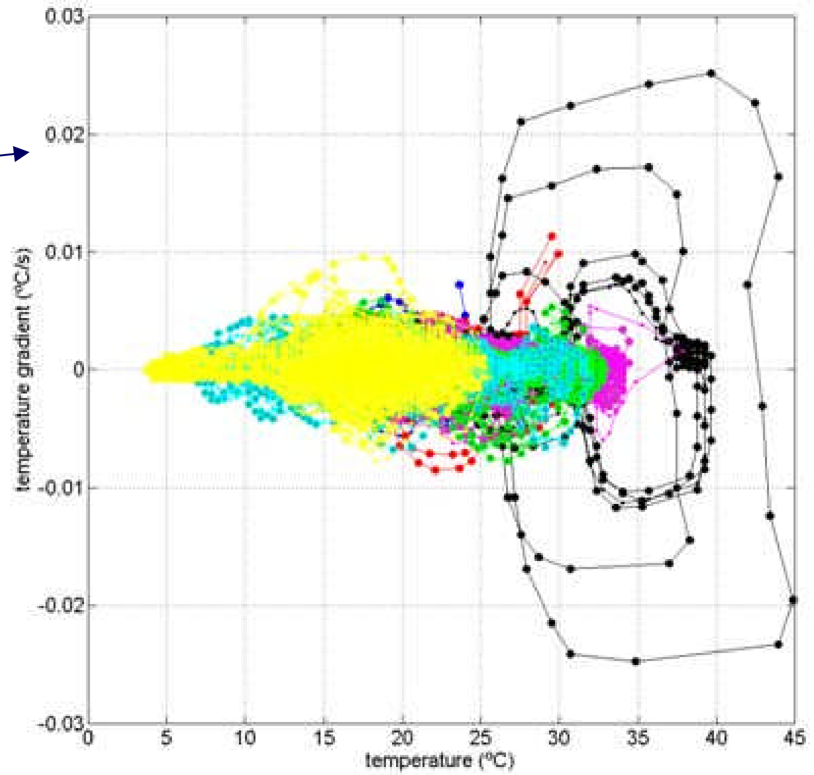
Rateof changeof Tº onfarm



Speed of change in temperature: range = 0.0008 ºC/s to - 0.001 ºC/s

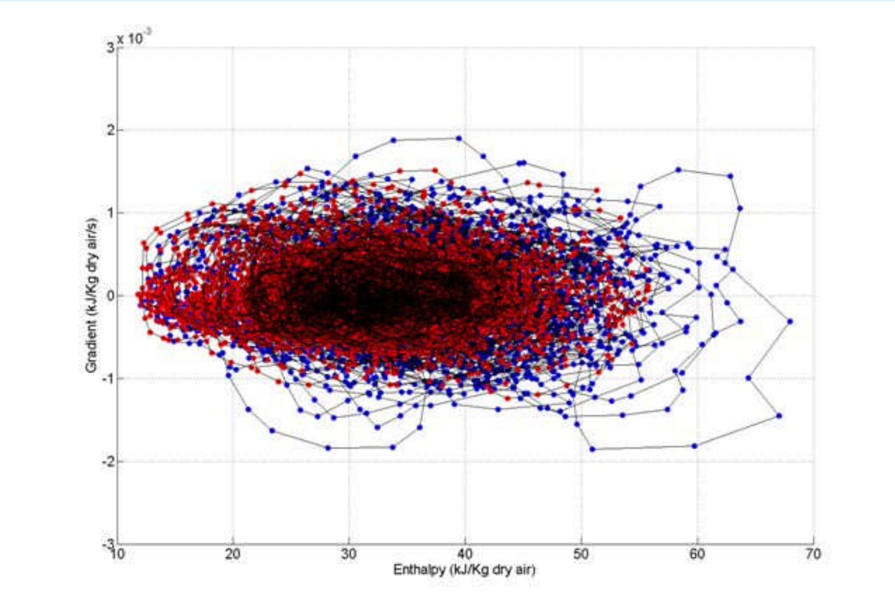
Rateof changeof T° onjourney

Order of magnitude
higher than farm
or abattoir



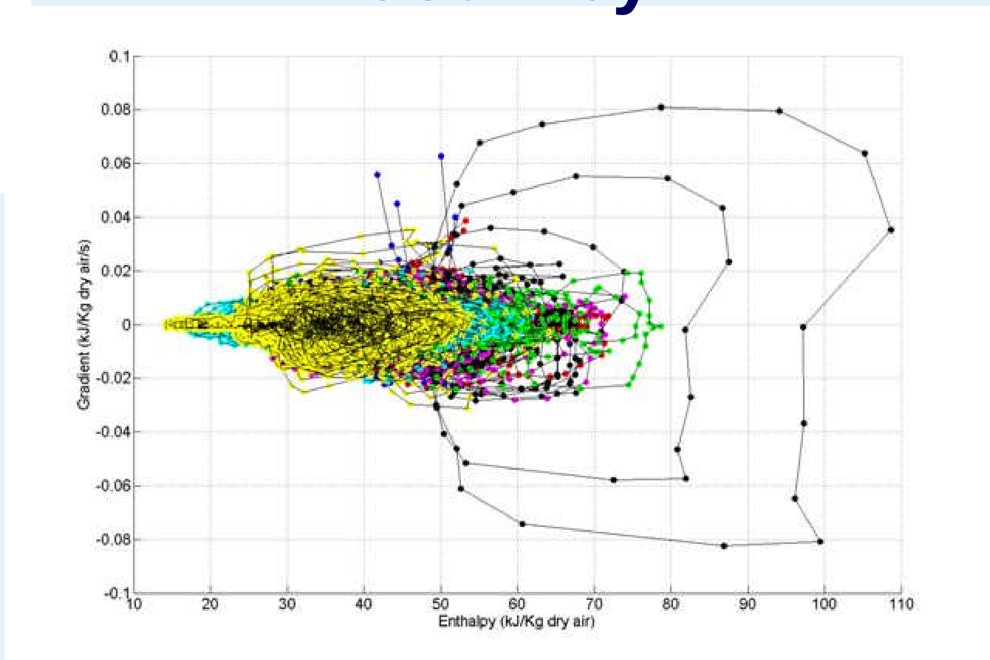
Speed of change in temperature: range 0.0025 °C/s to - 0.025 °C/s

Rateof changeof enthalpy



Farm

Journey



Areaof polygonsfor gradient

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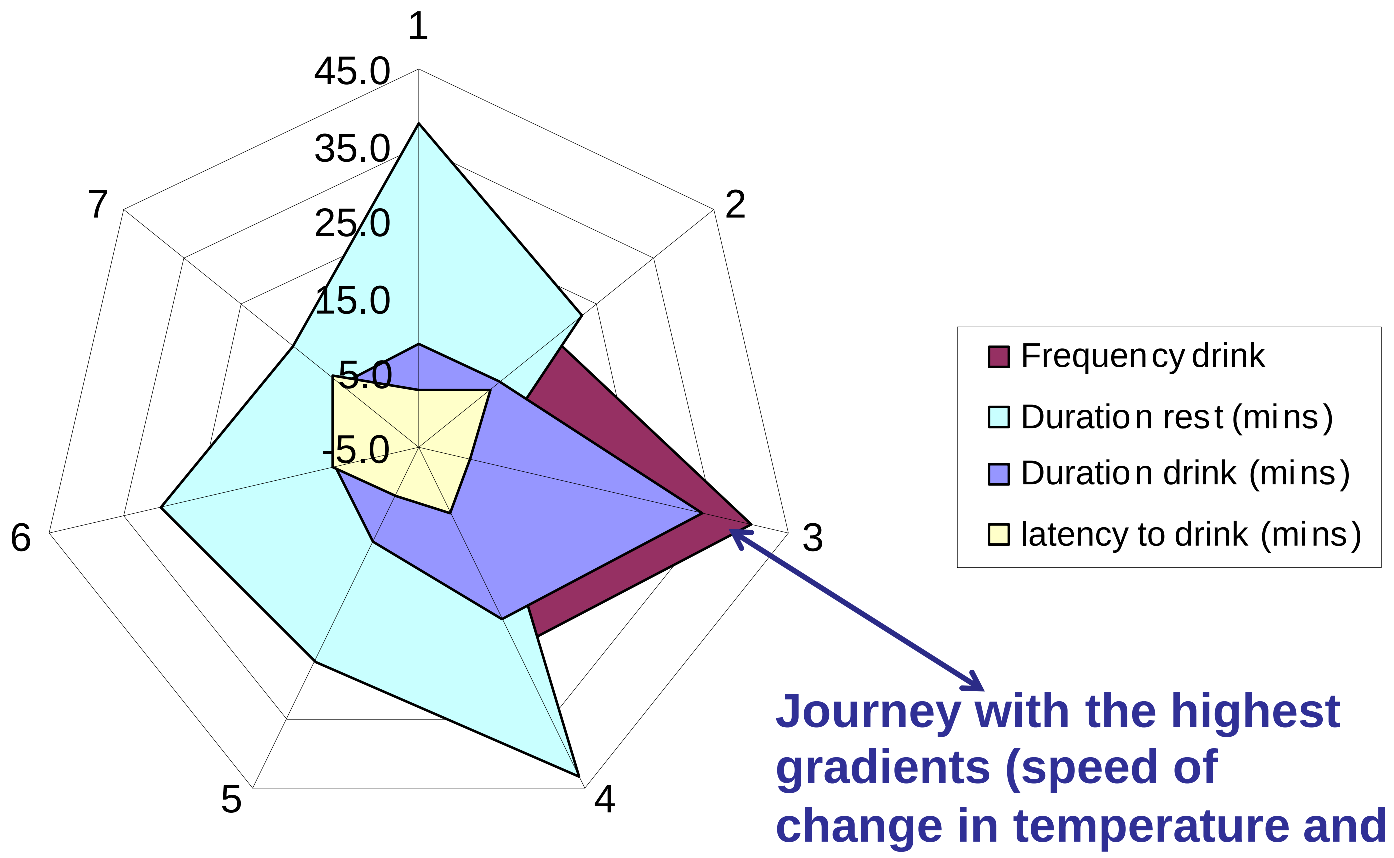
Trip	P_{area} (ºC²/s)
1	0.071
2	0.102
3	0.389
4	0.120
5	0.151
6	0.133
7	0.101

Pigbehavioural assessment



Journey with the highest gradients (speed of change in temperature and Enthalpy)

Conclusions

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It is proposed that:-

•Gradients in temperature, humidity and enthalpy provide much more sensitive indications of potential environmental stress than absolute values

•Gradients are up to 10 times higher during transport than at farm or abattoir

•Higher pig distress appears to be correlated with higher gradients

Conclusions

•The higher values for the relative changes in temperature (ºC/second) and humidity (%RH/second) and enthalpy parameters were correlated ($p<0.01$) with behavioural indicators of increased transport stress.

• It is suggested that relative changes in enthalpy may constitute an integrated index of thermal load in transit which is more useful and sensitive than absolute values of temperature or relative humidity.

Conclusions

•Maintenance of a more constant pre-slaughter **enthalpy chain** may avoid thermal stress and improve animal welfare

•These results may facilitate the development of **smart sensors** which assess the potential risk to the animals and form the basis of control systems (incorporating algorithms to calculate temperature and/or enthalpy gradients)

Thanks to the “team in the field

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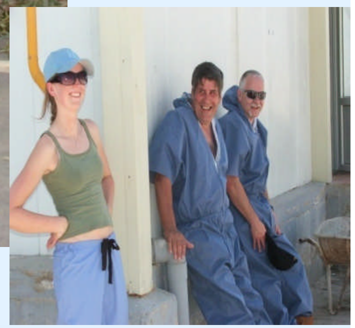

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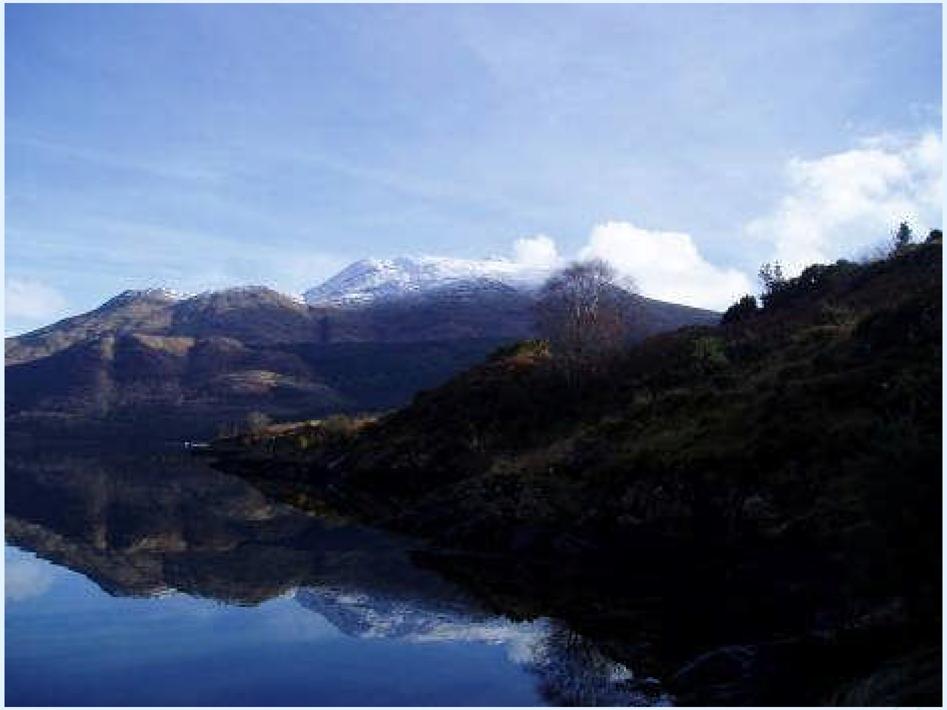

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Success through Knowledge