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Thehygro -thermal environmentsof horses duringlong -haulair transportation

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Introduction

- Thoroughbred horses are frequently transported by air over large distances
- This process is often associated with “shipping fever” (bacterial pleuro-pneumonia)
- The incidence and severity may be linked to environmental conditions and air quality
- Surprisingly little research (compared to road transport)

Introduction

- “Hemi-sphere” shuttling is now common (breeding, racing, competition, Olympics etc)
- Journeys are long (> 24 hours!)
- Environmental conditions poorly characterised or understood
- A series of journeys have therefore been examined

Methods

- **A series of 6 flights were studied over various routes**
- **2 have been selected for detailed analysis**
- **Flight 3 and Flight 5**

Flight 3: Shannonto Sydney

Flight 5: Sydneyto New York

Flightdetails

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Flight 3: Shannonto Sydney

Boeing747 -200 Cargo- Dubai Airwing (25 hours)

3 legs: Shannonto Dubai

Dubai to Perth

Perth to Sydney

Carrying 11 horses

Flightdetails

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Flight 5: Sydney to New York

MD 11 Cargo – Fedex (19 hours)

2 legs: Sydney to Honolulu

Honoluluto New York

Carrying 22 horses

Horsetransport byair

- **20 Data loggers were placed in stalls on each flight**
- **Recordings were taken every minute from loading to final unloading**
- **The total databank includes over *__1.5__ __million__* observations**

Horsetransport byair

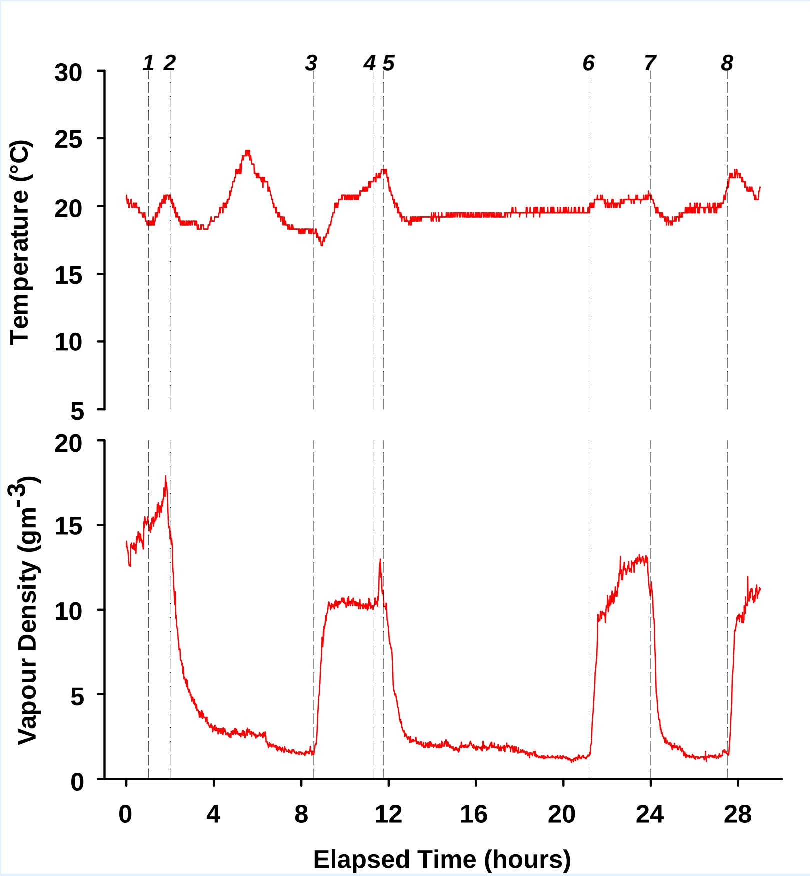
- **Temperature and Relative Humidity (RH) were measured using "Tinytag" loggers**

- **Water Vapour Density was then calculated from temperature and relative humidity.**

•The flights were of 25 (A) and 19 (B) hours duration.

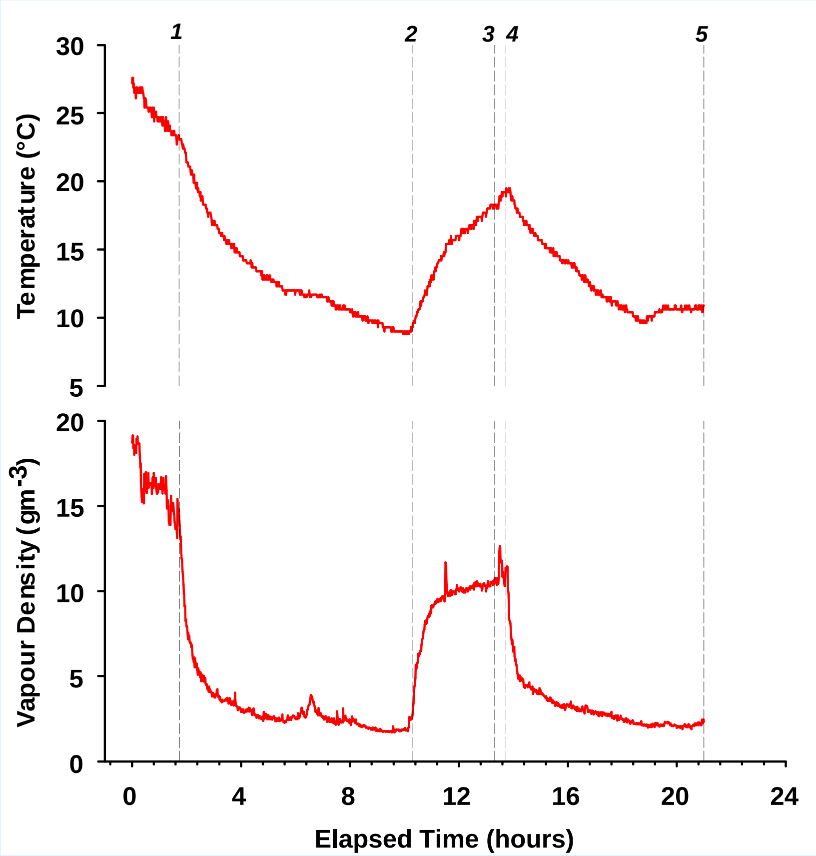
•The mean temperature conditions on the two flights were:- A: 20.9±3.8ºC, range 13.6-20.9ºC and B: 19.9±1.1ºC, range15.1-25.4ºC.

•The corresponding mean water vapor densities were A: 6.6±3.3 gm^{-3} and B: 5.4±3.0 gm^{-3} but with minima of A: 1.0 and B: 4.8 gm^{-3}.



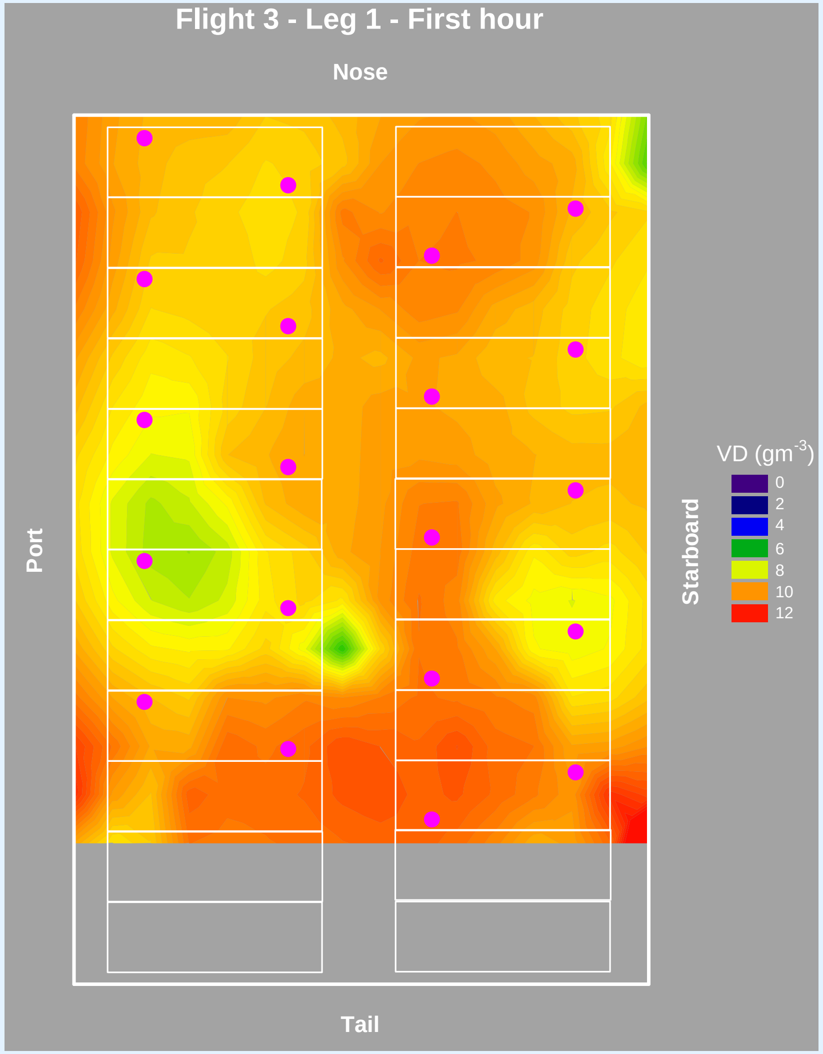
- **The lowest in-flight values in this aircraft were below 1.0g/m³, and these extremely low values were seen repeatedly and for long periods.**

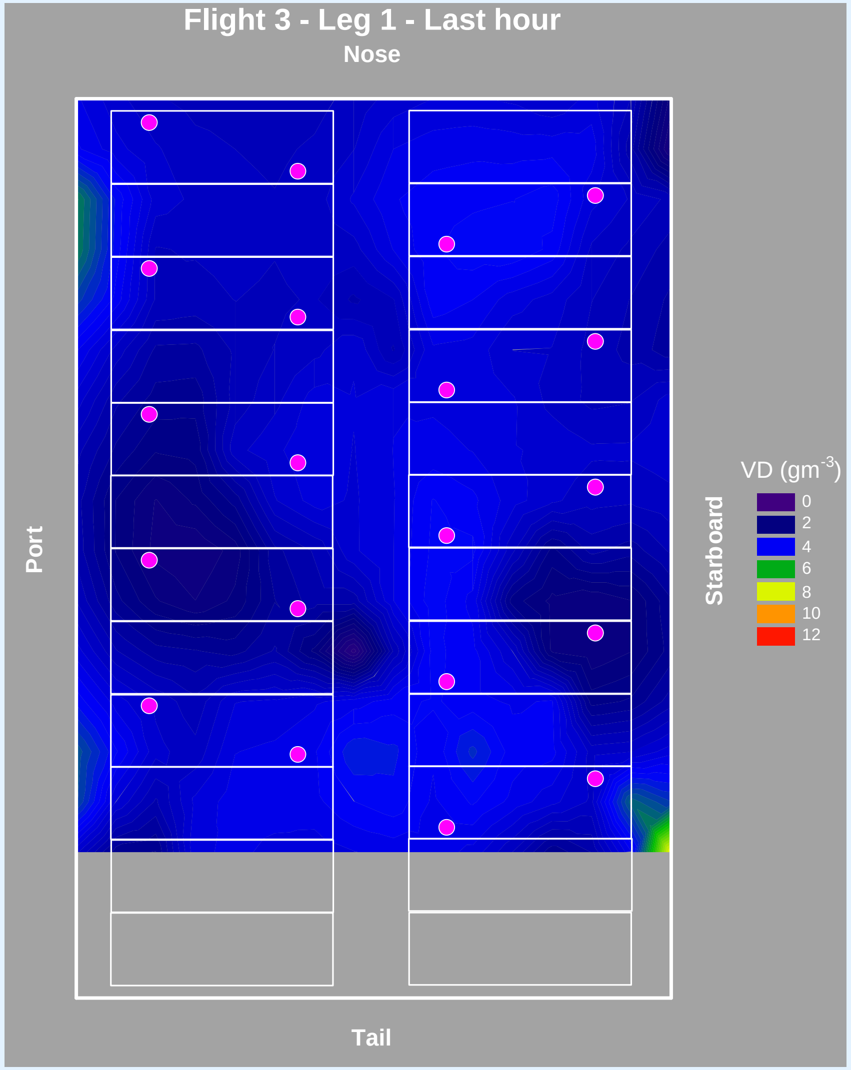
Figure 1. Temperature and vapour density profiles from the internal environment of flight 3. *1* – close Shannon, *2* – take-off Shannon, *3* – land Dubai, *4* – close Dubai, *5* – take-off Dubai, *6* – land Perth, *7* – take-off Perth, *8* – land Sydney.



- **Figure 2.** Temperature and vapour density profiles from the internal environment of flight 5. *1* – take-off Sydney, *2* – land Honolulu, *3* – close Honolulu, *4* – take-off Honolulu, *5* – land New York

WaterVapour Density





WaterVapour Density

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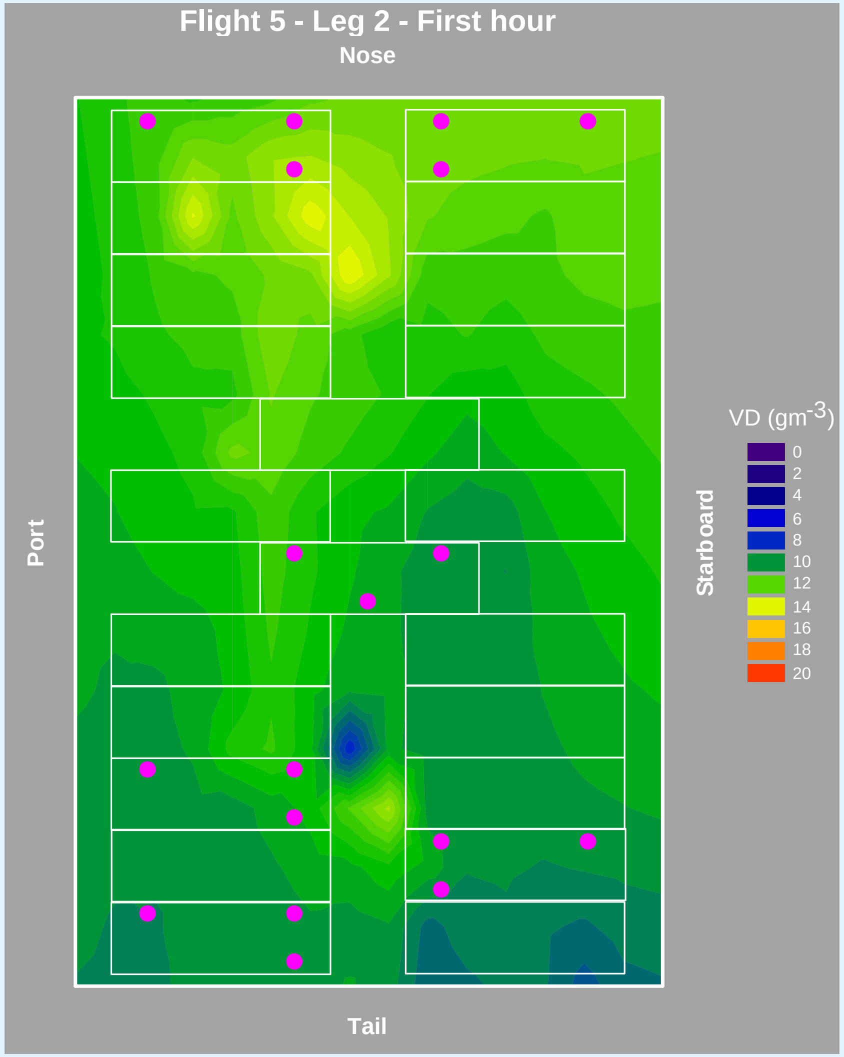

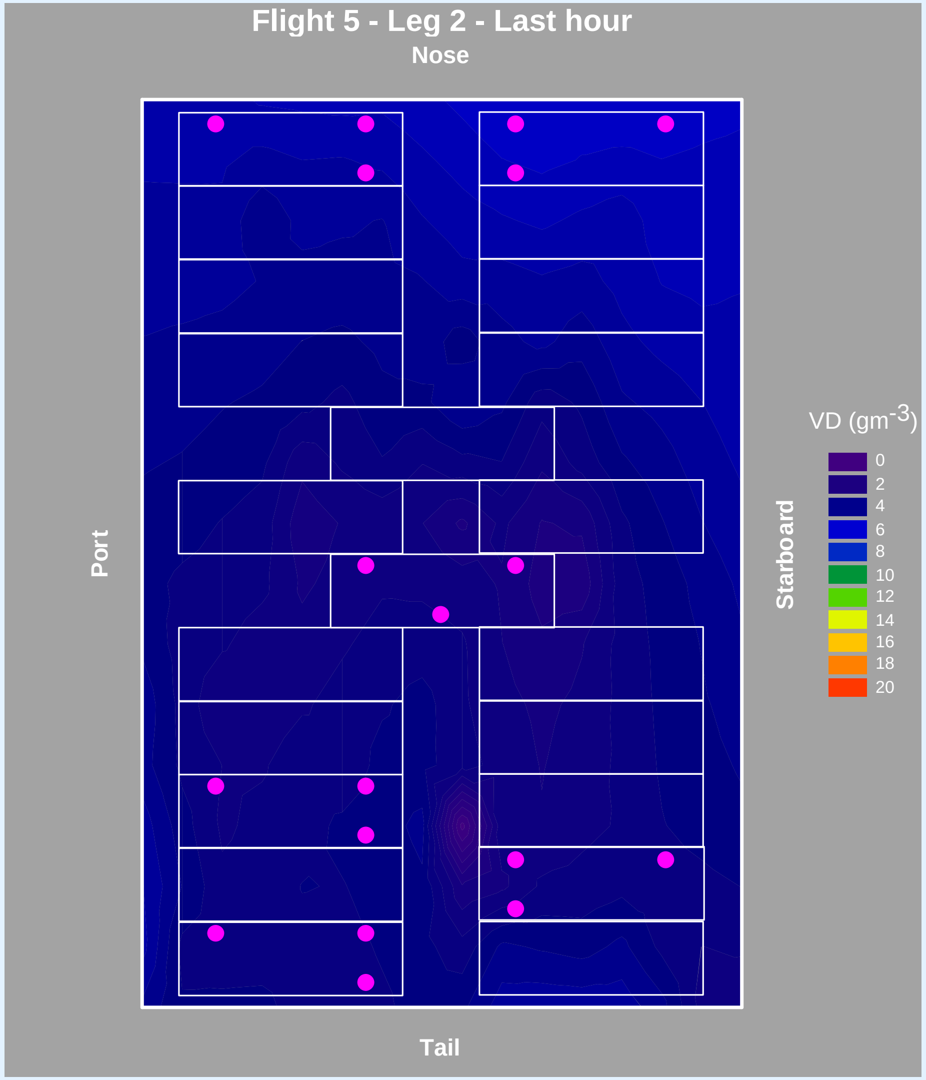

Evaporativewater loss: water vapourdensity

$$F = V^{\cdot} (\chi_s (Tb) - \chi_0) / 60 A$$

$$r_v = 60A / V^{\cdot}$$

Where:-

F =	rate of water loss
$V^{\cdot}$ =	minute volume of respiration
χ_s =	water vapour concentration at surface (gm^{-3})
χ_0 =	water vapour concentration at surface (gm^{-3})
T_b =	body temperature (°C)
A =	area of surface (m^2)
r_v =	resistance to evaporation ($s\ m^{-1}$)

Sealevel valuesof VD

Temperature (°C)	RH (%)	VD (gm^{-3})
15	45	5.8
15	70	9.0
20	45	7.8
20	70	12.1
25	45	10.4
25	70	16.1

Sealevel valuesof VD

Expired air (gm^{-3})	Ambient VD (gm^{-3})	Gradient VD (gm^{-3})
46.2	5.8	40.4
46.2	1.0	45.2
46.2	2.0	44.2
46.2	4.0	42.2

Altitudeand pressure

- **Altitude**

- **Air thermal properties:-**
  - **Air density**
  - **Kinematic viscosity**
  - **Diffusion coefficients**

- **Heat and mass transfer**

Altitudeand pressure

- **Altitude:-**

- Water loss from the respiratory tract
  - $WAT_2 = (h_e/L)/m$ (kg $m^{-3}hPa^{-1}$)

Where WAT_2 is the rate of water loss form the tract, he is the evaporative heat transfer coefficient and m = ρv = mass of air

- As he is pressure (altitude) dependent then the altitude dynamics of the parameter he/L (the rate of water loss is equivalent of the rate of drying of the airway) mean that:-

L = latent heat of evaporation

- Altitude ⟹ increased drying rate (water loss)

Waterloss inflight

- **Thus:-**
  - Very low water vapour density
  - Increased evaporative coefficients
  - Massively increased water loss from the upper respiratory tract and DRYING

- **Not replacedby hydrationof animal**

Conclusions

- In flight the water vapour pressure around the horses was greatly decreased compared to “normal values”

- The low levels of water vapour density favour evaporation from the upper respiratory tract of the horses

- Drying of the respiratory tract results from low WVD and the increased evaporation coefficient

Conclusions

The lower VD on the longer flight A (25 hours) was associated with post-transport pathology in 7 of the 11 horses

It is proposed that a major predisposing factor to bacterial pleuropneumonia is the hygro-thermal conditions prevailing in aircraft during long-haul equine transportation


THANK YOU FOR YOUR
ATTENTION !