



# B.L.T. SHORTLINE

DEPARTMENT OF  
CIVIL  
ENGINEERING

## An Investigation of the Effects of Weather on Rail Heating

*Research sponsored by:*



CANADIAN  
PACIFIC  
RAILWAY



Transport  
Canada Transports  
Canada



For further information visit: [www.ucalgary.ca/~railtemp](http://www.ucalgary.ca/~railtemp)

U of C Grad Conference  
1 May 2006

Researcher: Jim Bertrand  
Supervisor: Dr. Lynne Cowe Falls

Track Buckle Mitigation Strategies  
Reducing the Risk...  
By Understanding the Problem...

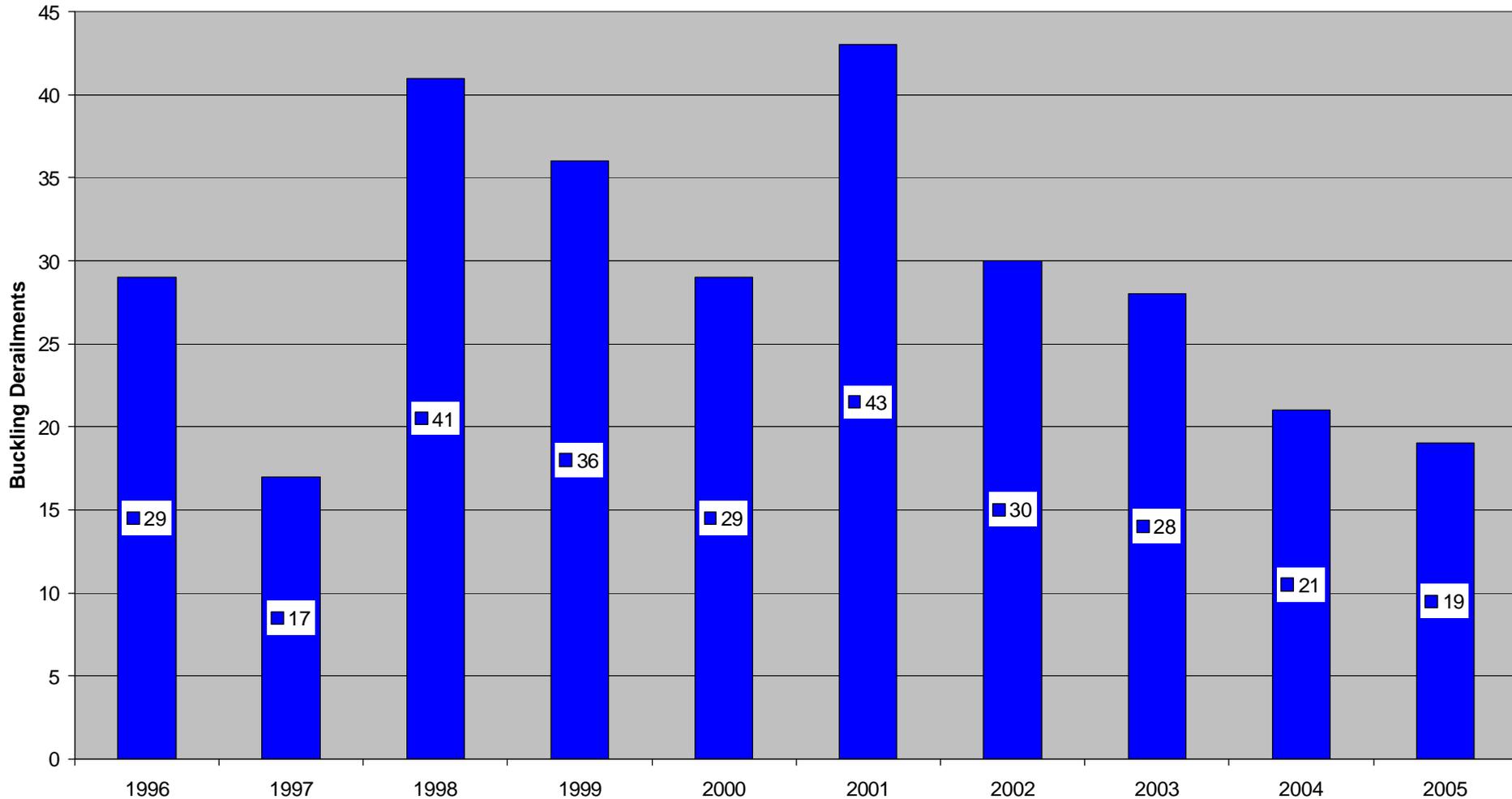


# Why Study Weather & Rails?



- Track buckling incidents compromise the efficiency & safety of railway operations...

### Reportable Buckling Derailments 1996-2005 (source: FRA)



Ten times more thermal misalignments and buckling incidents NOT resulting in derailment...

# Factors contributing to a buckle...

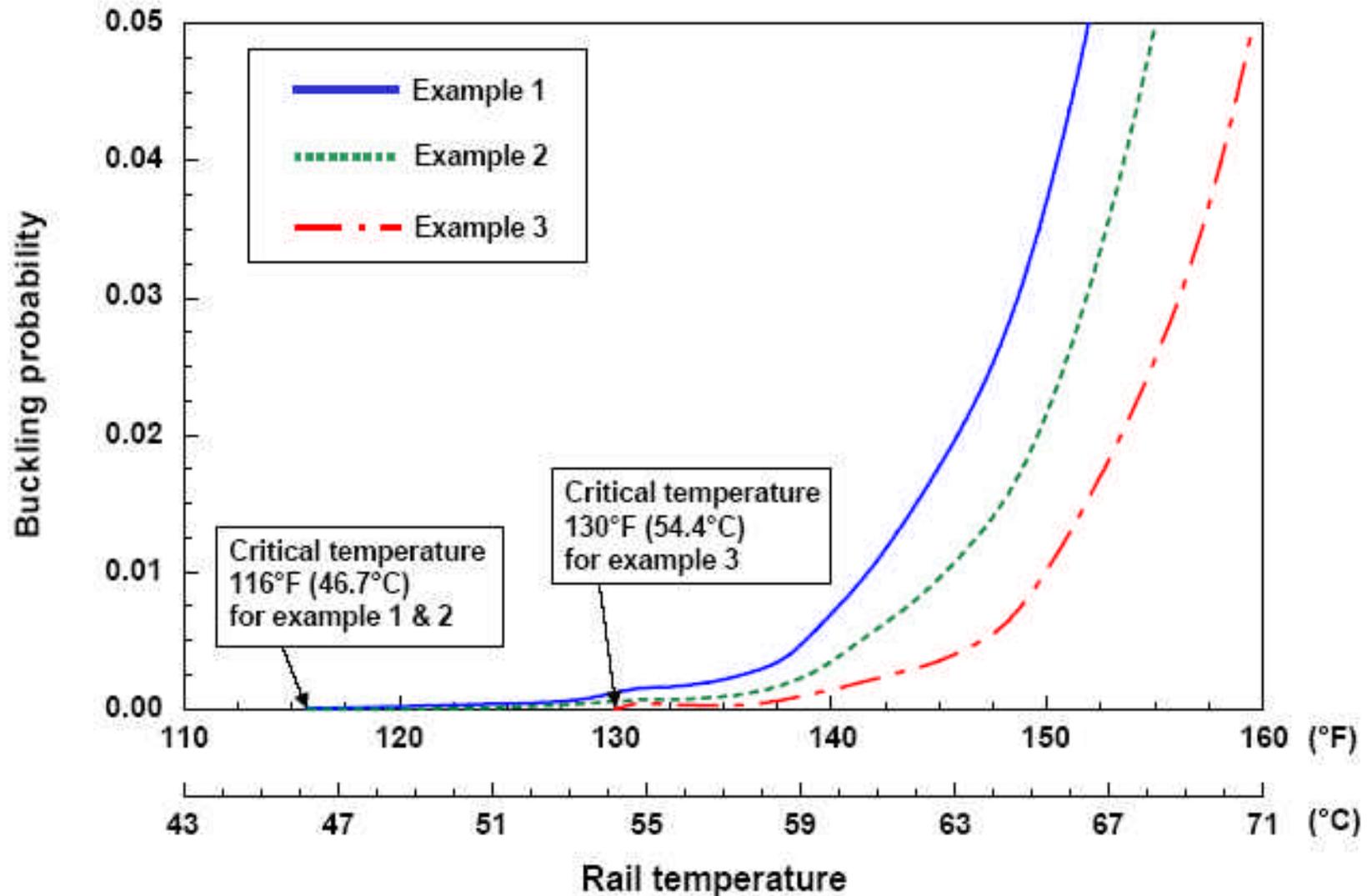
- Little risk if 'everything' is 'to standard' but.... the stars do occasionally align!
  - 1) Reduced rail neutral temperature
    - Laying or 'fixed-in-place' temperature
    - Often disturbed by rail mtce. or train operation
  - 2) Reduced lateral resistance of track panel
    - Loosened, disturbed or poor quality ballast section
    - Weak ties or inadequate rail fixation
  - 3) Critical rail temp from daytime heating
    - Results in excessive axial forces in rail
    - Little buckling potential without this element

Railways response to unpredictable risk...  
slow rail traffic and inspect track on hot days...

# Research on Exposed Rail Heating...

- Neither well researched nor documented
- Ad hoc studies unpublished and difficult to obtain
- Previous research by meteorology departments
- Most previous research is unpublished
- India (1927), Hungary and Egypt (1938)
- Richards (England 1950-64, icing and siting)
- Whittingham (Australia 1967, max temps)
- Hagaman (Australia 1988, Summary of CWR mtce practices and track buckling research)
- Thompson (England 1987, met. conditions)
- Esveld (Netherlands 1989, sun and clouds)

# Critical Temperatures (T<sub>cr</sub>) by Kish...



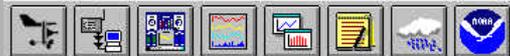
# Current State of Industry...

- AREMA - recommends industry standards
  - Indicate rails heat 40°F above ambient
- Researchers - buckling potential models
  - Established  $T_{cr}$  as 116°F and 130°F
- Railways - risk prevention (ambient >85°F)
  - Reduce train speeds and physical inspection
- Cloud cover and wind not factored
- Most industry standards & research based on ideal maximum rail heating...

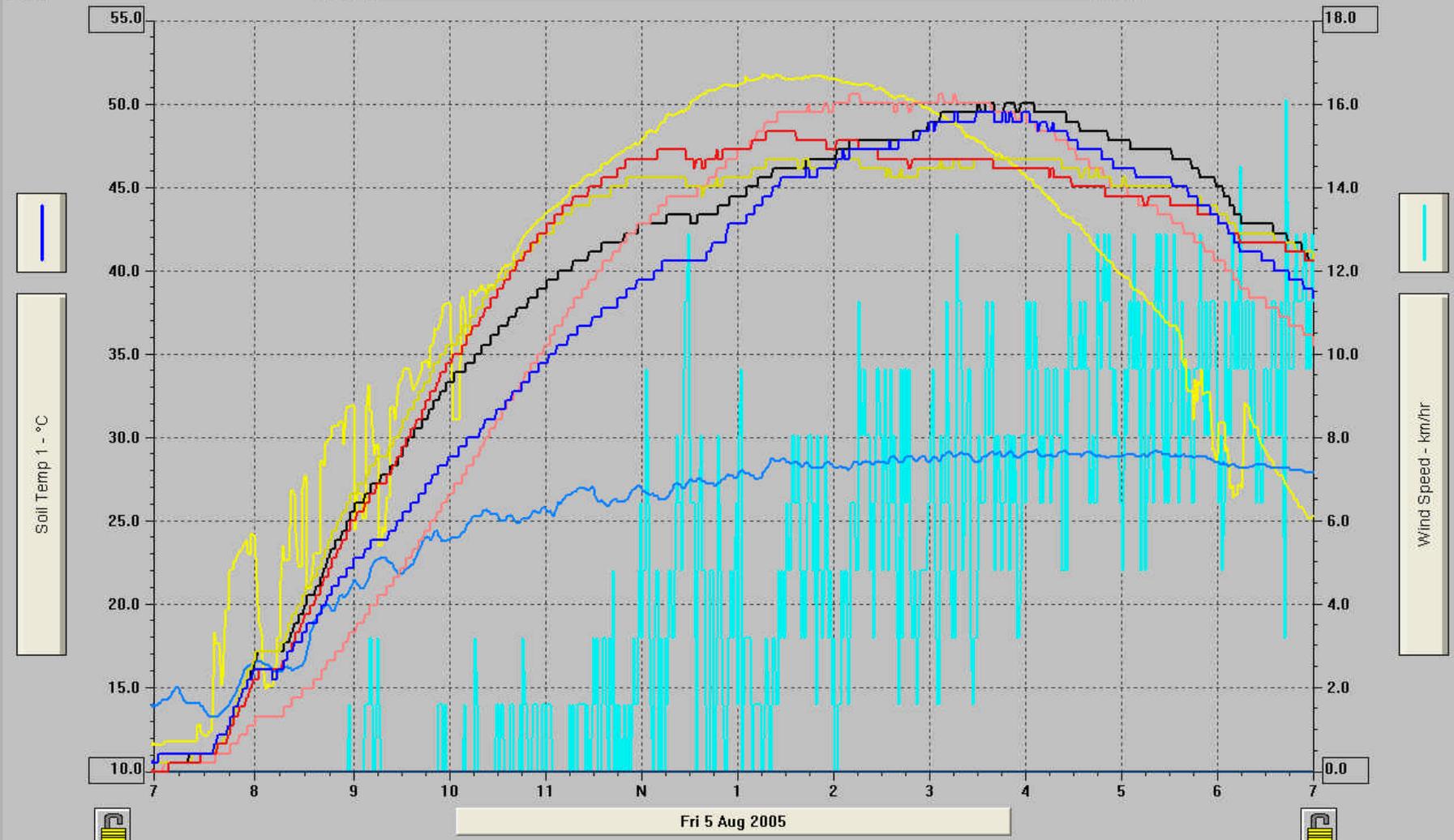
# B.L.T. Research Set-up...

- 6-ft. full-scale panel to main track standards
- On-site weather station
- Internal temp probes located in web & head
- Solar power, battery backup and wireless communications
- Polled every 2.5 sec
- Data logged at one minute intervals





12 Hours Primary RailTemp Analysis Plot

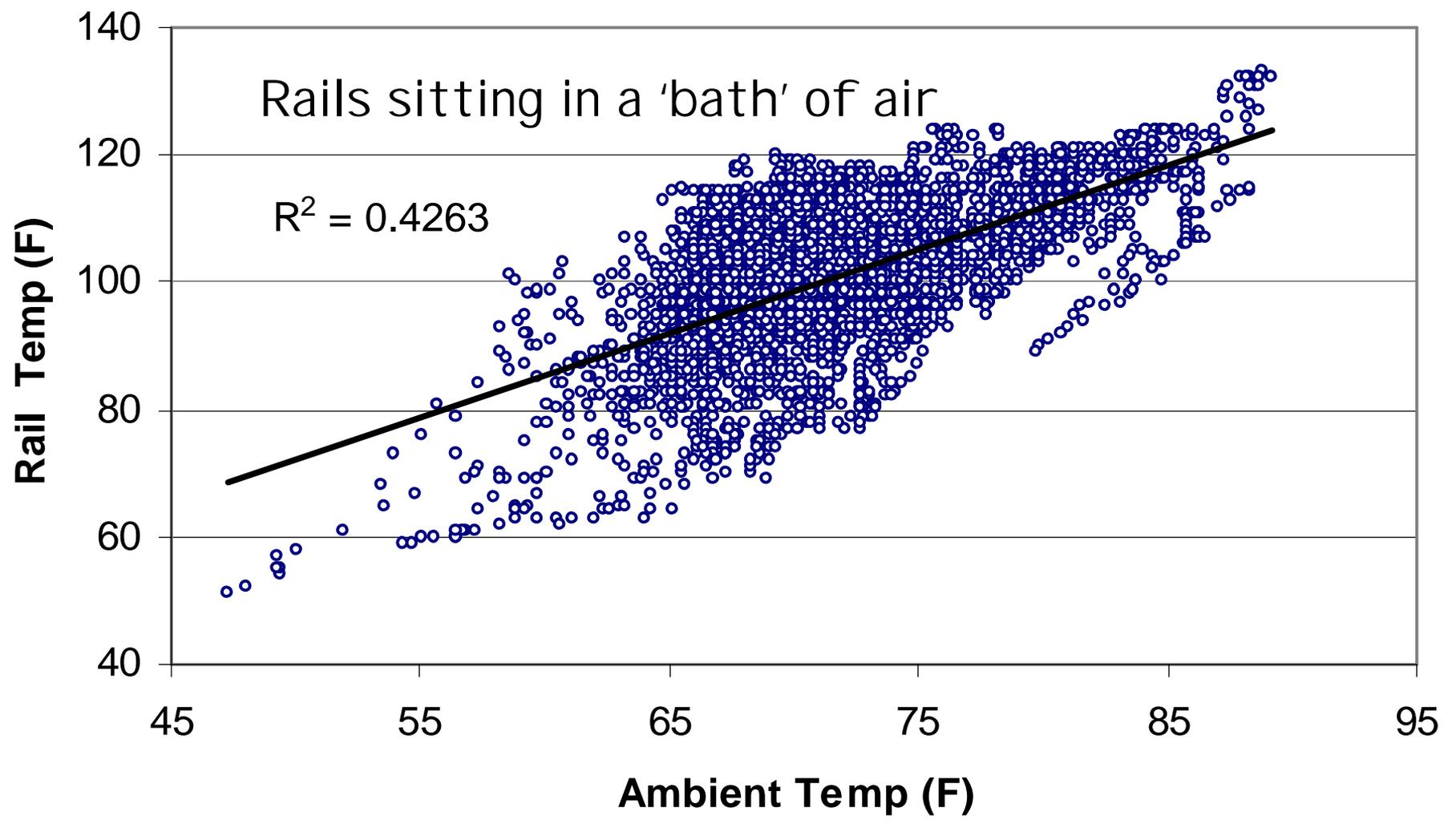


- |                                              |                                              |                                        |                                                 |                                                 |                                          |                                              |
|----------------------------------------------|----------------------------------------------|----------------------------------------|-------------------------------------------------|-------------------------------------------------|------------------------------------------|----------------------------------------------|
| <input type="checkbox"/> UV Dose             | <input type="checkbox"/> Hi UV Index         | <input type="checkbox"/> Heating DD    | <input type="checkbox"/> Cooling DD             | <input type="checkbox"/> Inside Temp            | <input type="checkbox"/> Inside Humidity | <input checked="" type="checkbox"/> Temp 2nd |
| <input checked="" type="checkbox"/> Temp 3rd | <input checked="" type="checkbox"/> Temp 4th | <input type="checkbox"/> ET            | <input checked="" type="checkbox"/> Soil Temp 1 | <input checked="" type="checkbox"/> Soil Temp 2 | <input type="checkbox"/> Soil Temp 3     | <input type="checkbox"/> Soil Temp 4         |
| <input type="checkbox"/> Leaf Temp 1         | <input type="checkbox"/> Leaf Temp 2         | <input type="checkbox"/> ISS Reception |                                                 |                                                 |                                          |                                              |

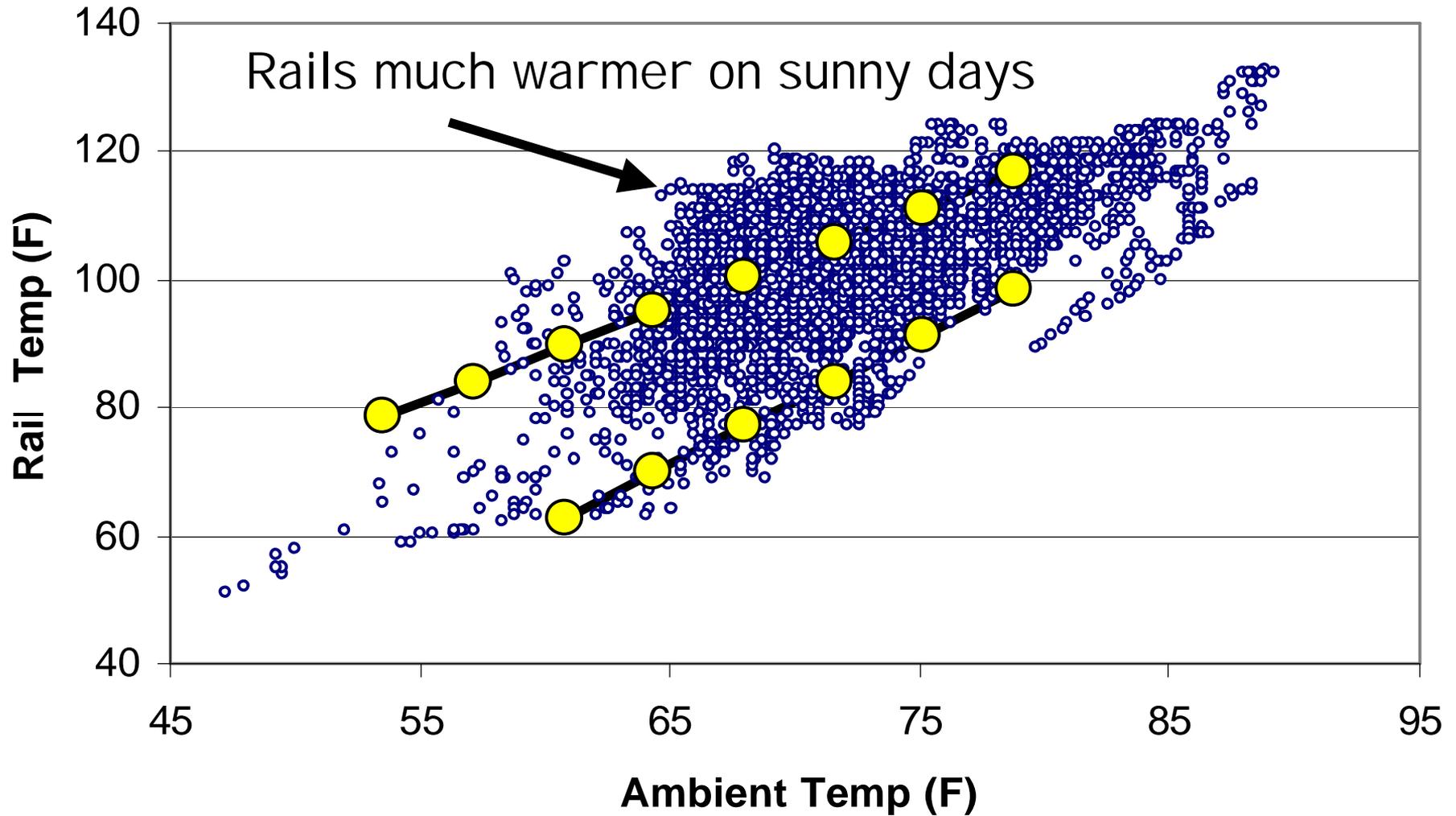
# Preliminary 2004-05 Findings (205 days)

- 101 days ambient temp  $>68^{\circ}\text{F}$  ( $>49\%$  of time)
- Hottest ambient temp  $90^{\circ}\text{F}$ 
  - 4 days ambient  $>86^{\circ}\text{F}$  ( $30^{\circ}\text{C}$ )
- Hottest rail temperature  $133^{\circ}\text{F}$  ( $31.9^{\circ}\text{C}$ )
  - 30 days  $T_{\text{cr}} > 116^{\circ}\text{F}$  (max  $T_{\text{cr}}$  for weak-avg track)
  - 1 day  $T_{\text{cr}} > 130^{\circ}\text{F}$  (max  $T_{\text{cr}}$  for good track)
- Greatest ambient-rail temperature differential was  $51^{\circ}\text{F}$  ( $28.3^{\circ}\text{C}$ )
  - 37 days differential  $>40^{\circ}\text{F}$  ( $>18\%$  time)
- Estimating rail temperatures from ambient temperatures is neither precise nor reliable

# Correlation of Rail vs. Air Temperature



# RailTemp vs. Esveld (heating on sunny & cloudy days)



# Bottom Line...

- Rails often heat to critical temperatures on warm days
- Rail orientation appears to be a factor in rail heating (critical temps at different times)
- Ambient temp  $>65^{\circ}\text{F}$ , mostly clear sky & light wind are ideal for maximum rail heating
- Critical rail heating is a function of direct full-sun heating on relatively cloudless days
- Rails heat more than previously thought on warm days with clear skies

# Current status of research...

- Additional transmitters – quantify directional orientation heating (N, NNW, NW, W, SW)
- Additional field stations for climatic comparison (latitude, elevation, etc. with EC & US-NCDC)
- Develop integrated decision framework of significant factors that affect rail heating
- Integrate results of regression analyses into weather information & forecasting tools (CP RailWIS and EC modified RWIS (longer term))



RailTemp, Calgary AB



EC C.A.R.E. Egbert, Ontario



EC Bratt's Lake, Saskatchewan



Lytton, BC  
facing north  
Additional  
ballast  
required

# RailTemp, Calgary AB



Questions...



[www.ucalgary.ca/~railtemp](http://www.ucalgary.ca/~railtemp)



B.L.U. Electric Inc.  
In Remembrance of the Chief of Police of Waterloo by Bill Hocking  
1-800-441-1111

2 11:55