



# Volpe Center Research Update

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## Outline

- ◆ **FHWA TNM Pavement Effects Implementation Study**
  - OBSI adjustment implementation
  - REMEL implementation
  - Pavement sound absorption
- ◆ **Tire/pavement noise temperature effects study**
  - Certainty of relationship between sound level and temperature
  - Variable results

# FHWA TNM PAVEMENT EFFECTS IMPLEMENTATION STUDY



## TNM PEI Study

- ◆ **Currently assessing options for implementing in TNM the effects of pavement on tire/pavement interaction noise**  
A.k.a, FHWA's TNM Pavement Effects Implementation Study  
(TNM PEI Study)
- ◆ **Study overview**
  - Investigate **adjusting the tire/pavement noise sub-source** in TNM using pavement-specific **OBSI data**
  - Investigate introducing **new pavement-specific REMEL data** in TNM
  - Investigate introducing new **pavement-specific EFR (sound absorption) data** in TNM

## TNM PEI Study Updates – OBSI Adjustment Implementation

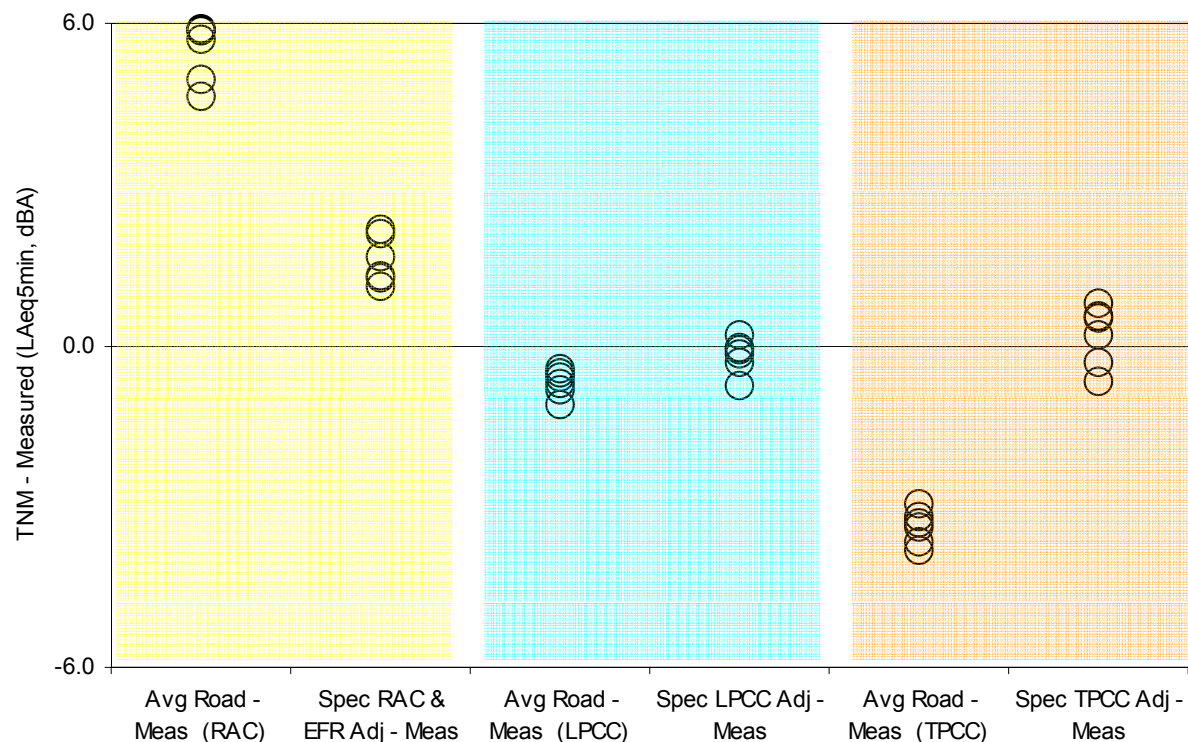
- ◆ **OBSI adjustment is a valid way to account for pavement effects in TNM**

- ◆ **Need data for more pavement types**

- ◆ **Need to further investigate issues related to ...**

- **Extending traditional OBSI lower frequency range below 500 Hz**
- **Variation by vehicle type**

- ◆ **Volpe Center in process of acquiring OBSI system**



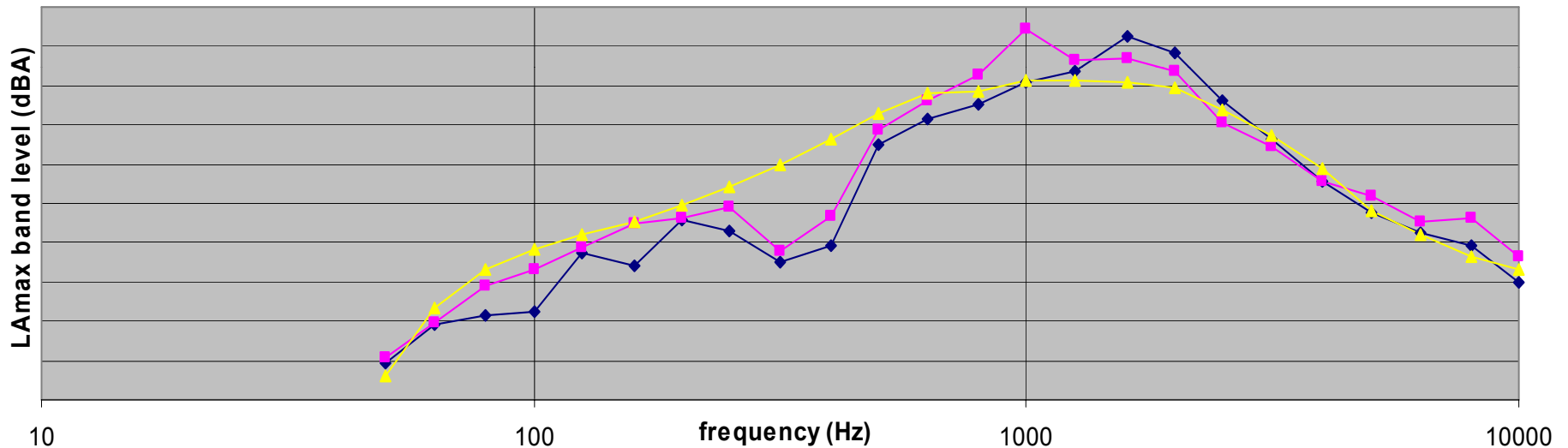
# TNM PEI Study Updates – REMEL Implementation

## ◆ Data analysis

- Traditional analysis process (regression) minimizes tonality in spectral results

Fine for non-tonal pavements

May be an issue for tonal pavements



- Investigating modifications to analysis process

## TNM PEI Study Updates – Pavement Sound Absorption (EFR)

- ◆ **Is it important to consider highway pavement sound absorption when predicting highway traffic noise? Yes.**

Investigation using TNM showed it may result in a 2-dB difference in sound level

- ◆ **Experimental measured/analyzed pavement EFR values (cgs rayls)**

Cement concrete sidewalk	Old DGAC <sup>1</sup>	New BWC <sup>2</sup> 30mm	New DGAC <sup>1</sup> 30mm	New OGAC <sup>3</sup> 30mm	New RAC Type O <sup>4</sup> 30mm	ARFC <sup>5</sup> 30mm aged 2.5 years	New OGAC <sup>3</sup> 75mm
20000	14500	12300	8800	8700	6100	6000	4200

1. dense-graded asphalt
2. bonded wearing course
3. open-graded asphalt
4. open-graded rubberized asphalt
5. asphalt rubber friction course

## TNM PEI Study Updates – Pavement Sound Absorption (EFR)

- ◆ In the process of upgrading EFR data collection instrumentation
- ◆ Need to collect EFR data for many more pavement types and aging pavements
  - To further test analysis technique
  - To help understand relationship between specific pavement type and EFR
  - To build a database
  - [Measurements planned on NCAT test track – likely Fall 2009](#)



# FHWA TIRE/PAVEMENT NOISE TEMPERATURE EFFECTS STUDY



## Temp Effects Study – Background

- ◆ **Comparing sound level results for tire/pavement noise measurements**
  - Important to minimize sound level differences due to parameters other than pavement
- ◆ **Questions to answer**
  - How much does **temperature** affect measured sound levels?
  - Should corrections be made to the measured sound levels to remove the temperature effect?
    - If so, how should temperature corrections be made?

## Temp Effects Study – Literature

### ◆ Literature review

- General trend of slightly decreasing vehicle pass-by noise levels with increasing temperature  
-0.028 to -0.056 dB per 1 °F increase (-0.05 to -0.10 dB per 1 °C increase)

Example: +30 °F adjustment = -0.056 dB \* 30 = -1.68 dB

- Effect can be dependent on pavement type, pavement surface texture, and vehicle type (tire type)
- Temperature coefficient different for pavement or air temperature
- Some semi-generic temperature correction coefficients are recommended based on each major group of vehicles (tires) and each major group of road surfaces

## Temp Effects Study – Overview

### ◆ Current study

- **Determine relationship between sound level and temperature ...  
examine data with broad temperature ranges  
apply proper statistics to determine certainty of relationship**
- **Contribute to database of temperature correction coefficients**
- **Make recommendation on use of temperature coefficients and if more research is needed**

## Temp Effects Study – Wayside Data Being Investigated

### ADOT's QPPP: Sites 3B and 3C

Pavement types: transversely tined PCC (ttPCC)  
asphalt rubber friction course (ARFC)  
Measurement methodology: time-averaged method (CTIM)  
Average temperature range: 11 °F (6 °C) for air and 27 °F (15 °C) for pavement

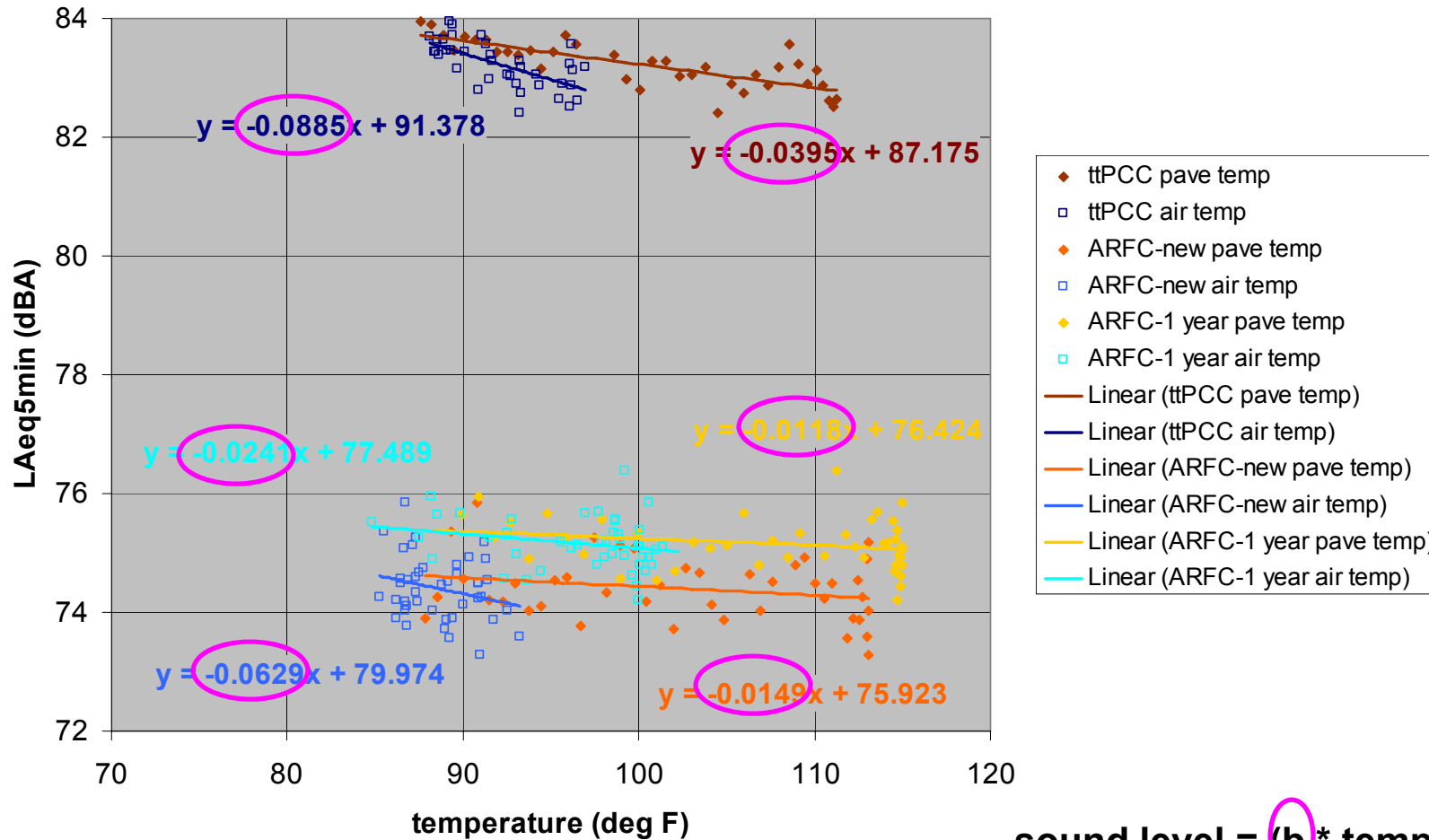
### Caltrans Thin Lift Study on LA138

Pavement types: dense-graded asphalt (DGAC)  
open-grades asphalt, 75 mm thickness (OGAC)  
Measurement methodology: pass-by method (SIP)  
Average temperature range: 26 °F (14 °C) for air and 62 °F (34 °C) for pavement

### FHWA TNM PEI Study

Pavement types: DGAC  
longitudinally tined PCC (ltPCC)  
longitudinally ground PCC (lgPCC)  
Measurement methodology: pass-by method (REMEL procedure)  
Average temperature range: 19 °F (10 °C) for air and 30 °F (17 °C) for pavement

# Temp Effects Study – Temperature Coefficient



sound level = (b \* temperature) + a  
 b = slope = temperature coefficient

## Temp Effects Study – Temperature Coefficient

### ◆ Certainty of slope

- Since slopes are so small, it is necessary to determine if they are truly not zero

- Apply R-squared? No.

Proportion of vertical variability that is “explained” by the regression equation

R values reduce drastically as slope approaches zero

R statistics are not relevant to slope uncertainty

- Apply P-value? Yes.

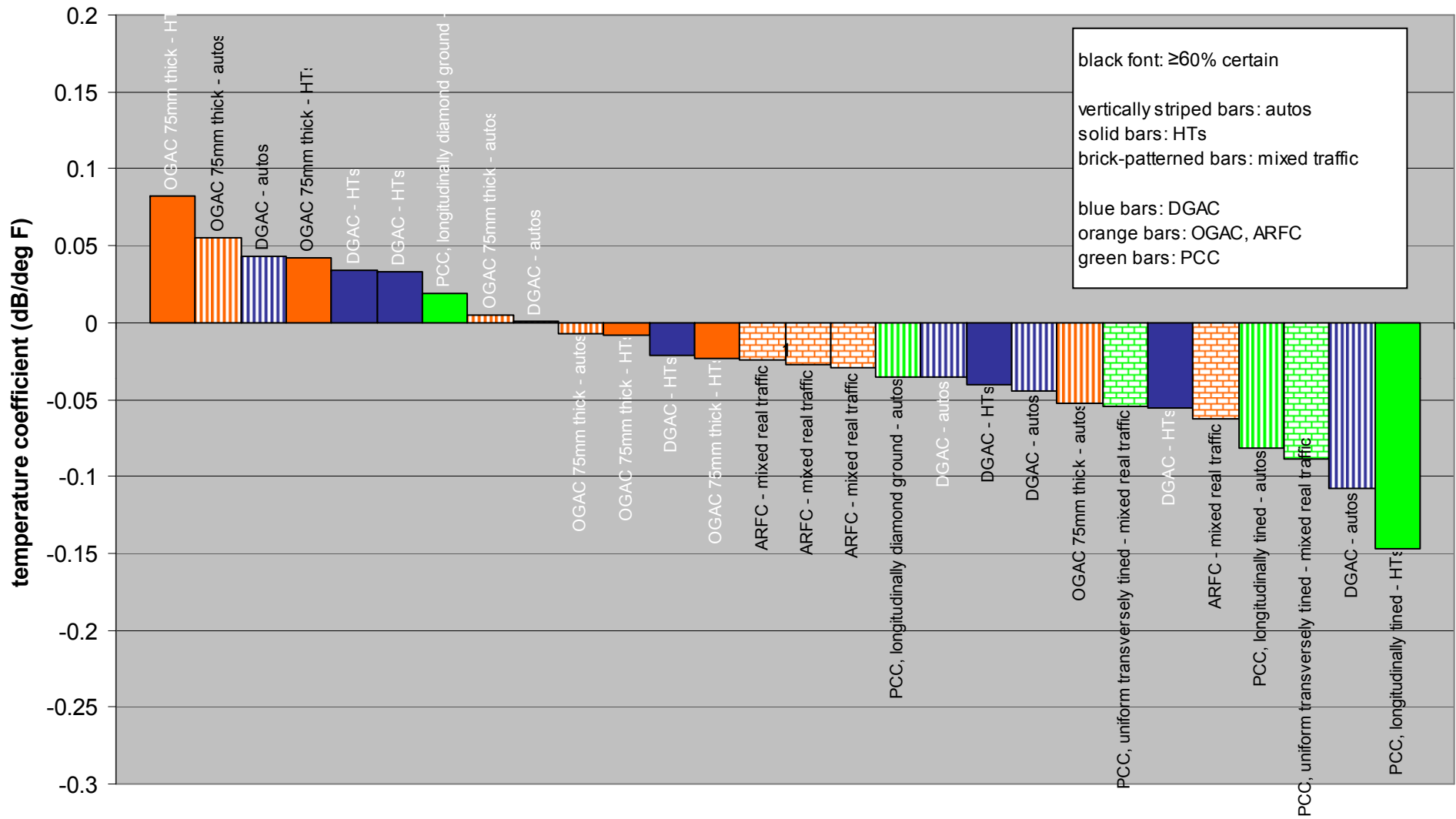
Quantitative parameter to determine if the zero slope line lies within the 95% confidence region of the regression line through measured data

Use P-value to determine percent chance that the true slope does not equal zero

“percent certain” =  $[100 * (1 - P\text{-value})]$

- ◆ If percent certain is above some threshold, this indicates there is an effect of temperature on highway noise

- Current study uses  $\geq 60\%$



## Temp Effects Study – Conclusions

- ◆ **Sound levels usually decrease slightly with increasing temperature**
  - **Exceptions**
    - Some data sets show slight increase in sound levels with increasing temperature
    - Some data sets have uncertain relationship between sound level and temperature
- ◆ **Effect varies by pavement type and vehicle type**
- ◆ **Applying temperature coefficients**
  - **Generic coefficient – not recommended**
  - **Semi-generic coefficient based on pavement and vehicle type**
    - Approximation that may be appropriate
    - Due to variation, application may or may not improve comparison among pavements
  - **Data-set-specific coefficient**
    - Most accurate
    - Cannot always acquire
- ◆ **Recommendations**
  - **Collect data under similar meteorological conditions to minimize the influence of temperature**
  - **Stay tuned for final recommendations on applying temperature coefficients**



Questions?