RDW

Method correlation & temperature correlations

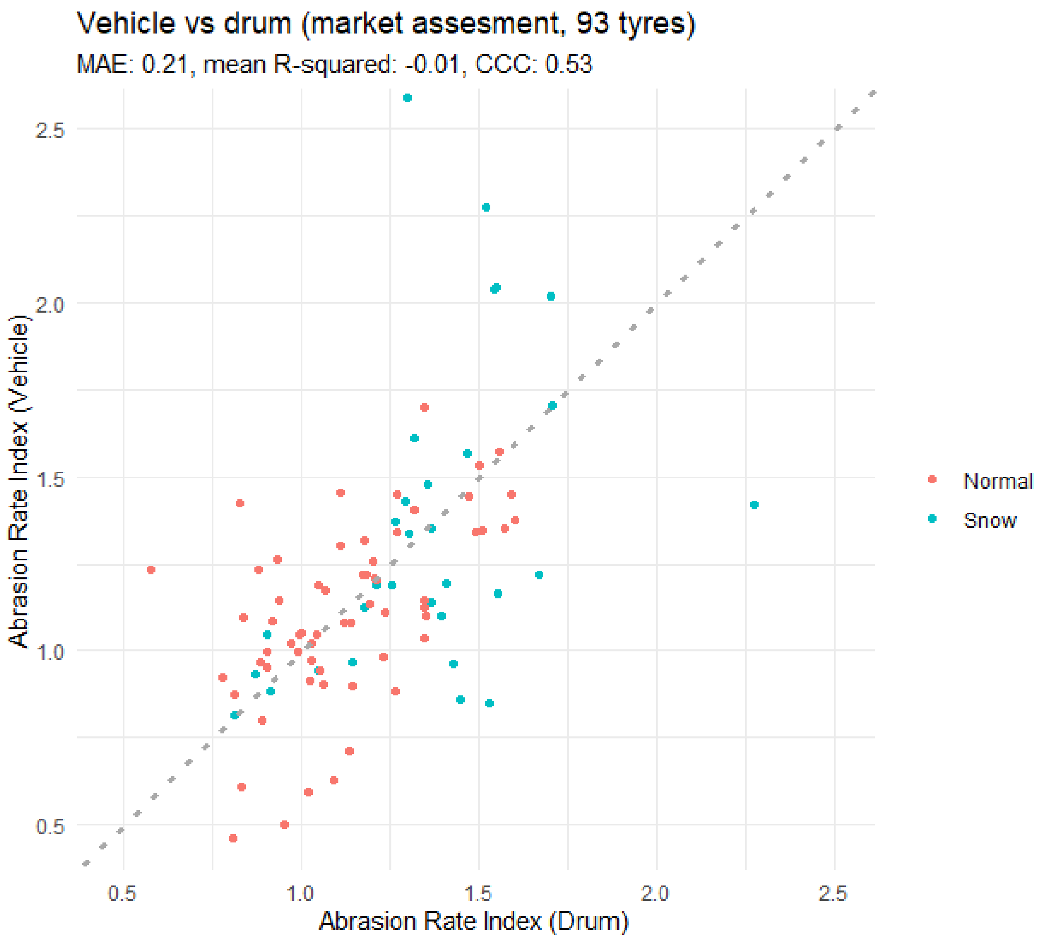
16-04-2025

Correlation between methods

- 3 metrics used to compare the methods
  - MAE: mean absolute error
  - Mean R-squared: mean of both the R-squared values, since R-squared is not symmetric when flipping axis
  - CCC: Concordance Correlation Coefficient. Measures the agreement between two variables
    - One (arbitrary) scale is given below

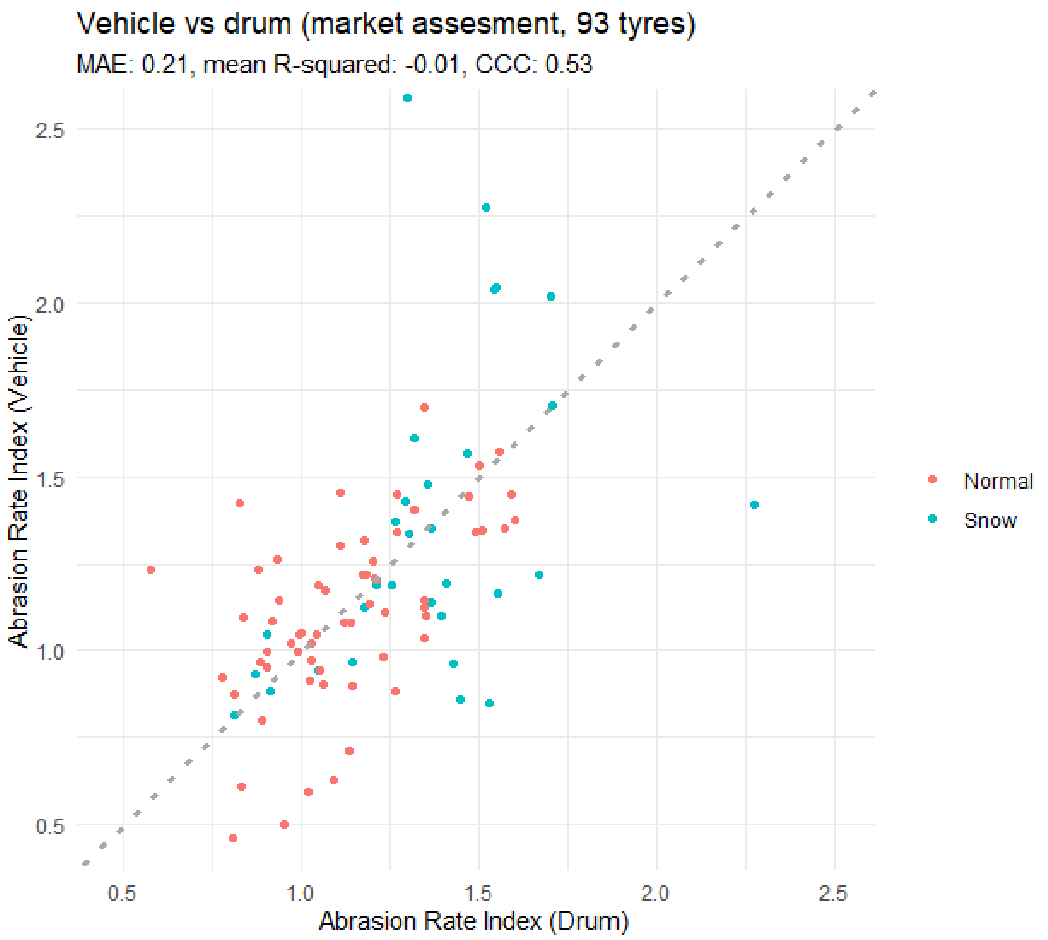
Kappa	Interpretation
< 0	Poor agreement
0.01 – 0.20	Slight agreement
0.21 – 0.40	Fair agreement
0.41 – 0.60	Moderate agreement
0.61 – 0.80	Substantial agreement
0.81 – 1.00	Almost perfect agreement

Landis and Koch (1977, p. 165).



Weak correlation between methods

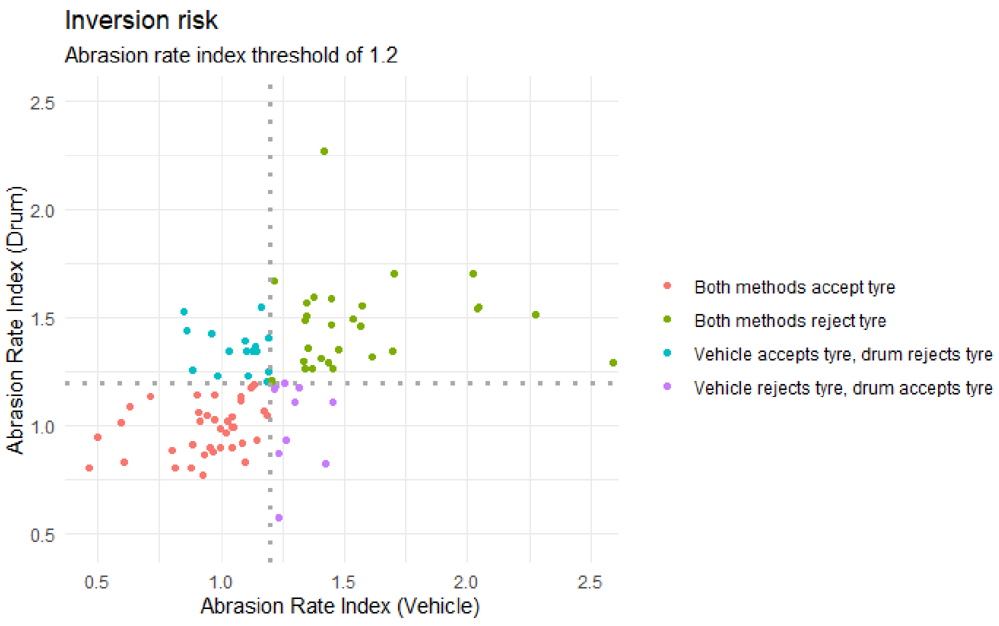
- Low R-squared value
- CCC moderate agreement

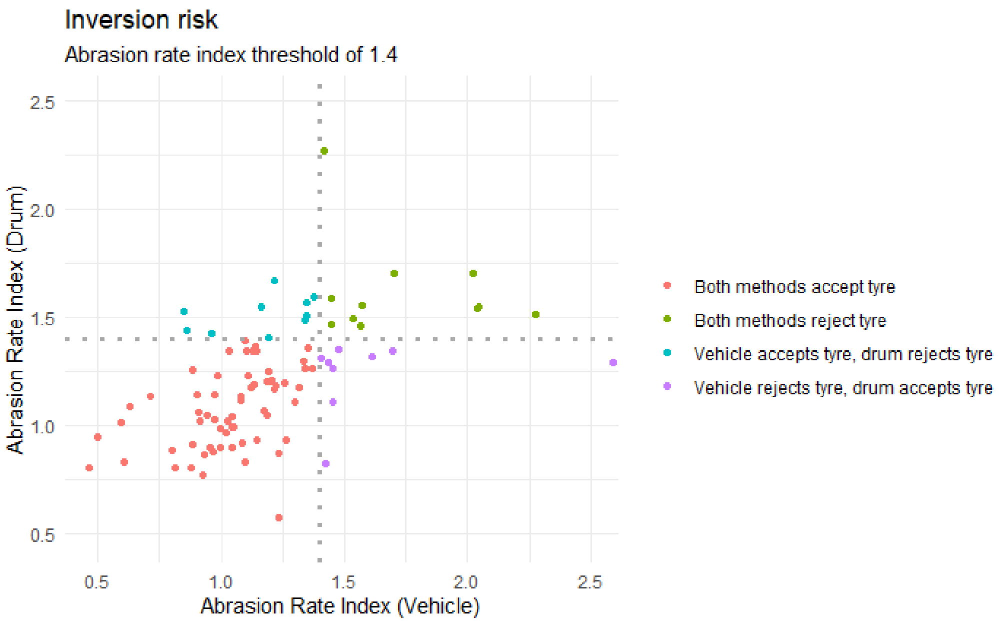


RDW

Inversion risk

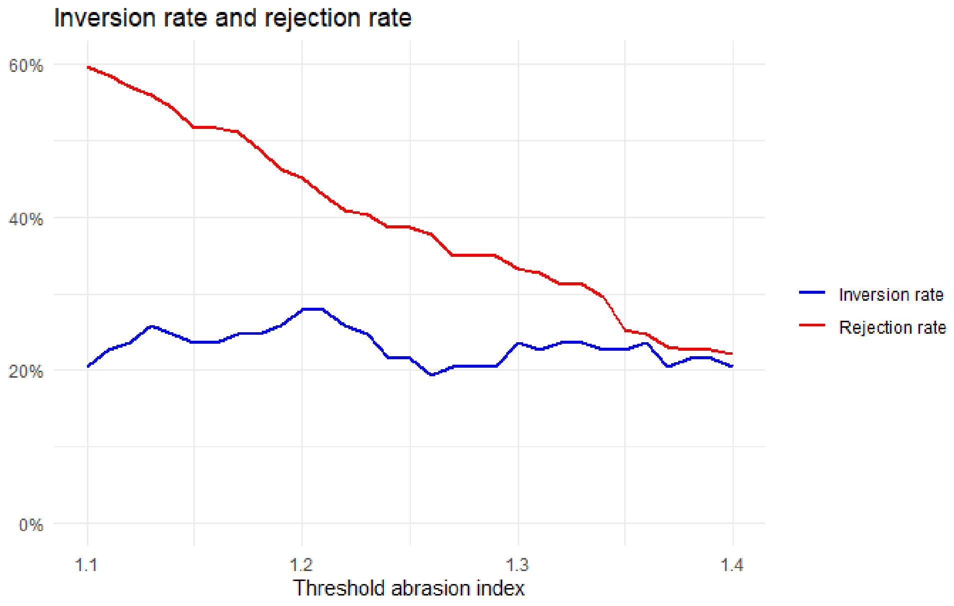
- Risk of accepting tyres for one method and rejecting for the other
- Based on threshold value of abrasion rate index





Is there enough correlation between methods?

- Inversion rate between 20 and 30%
- Low value for R^2-squared
- Is there enough grounds at the moment to support the use of both methods?
  - Or do they need to be closer to eachother before using both?

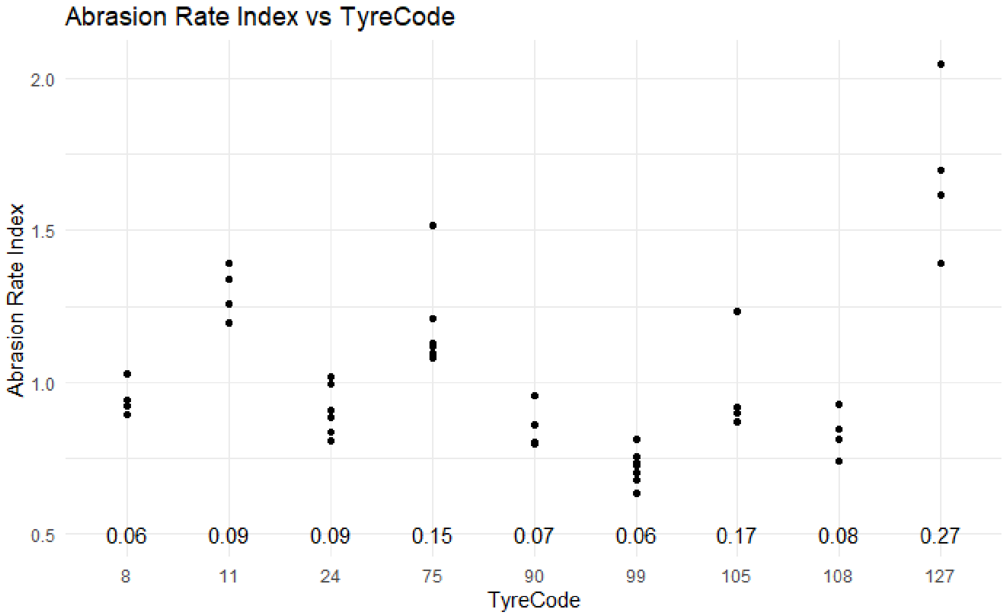


Variance within one method

- The following slides look at variance and complications of variance within one test method
  - We look at vehicle method

- Pooled standard deviation of vehicle method
  - 0.13 for all tyres
    - 0.17 for normal
    - 0.08 for snow

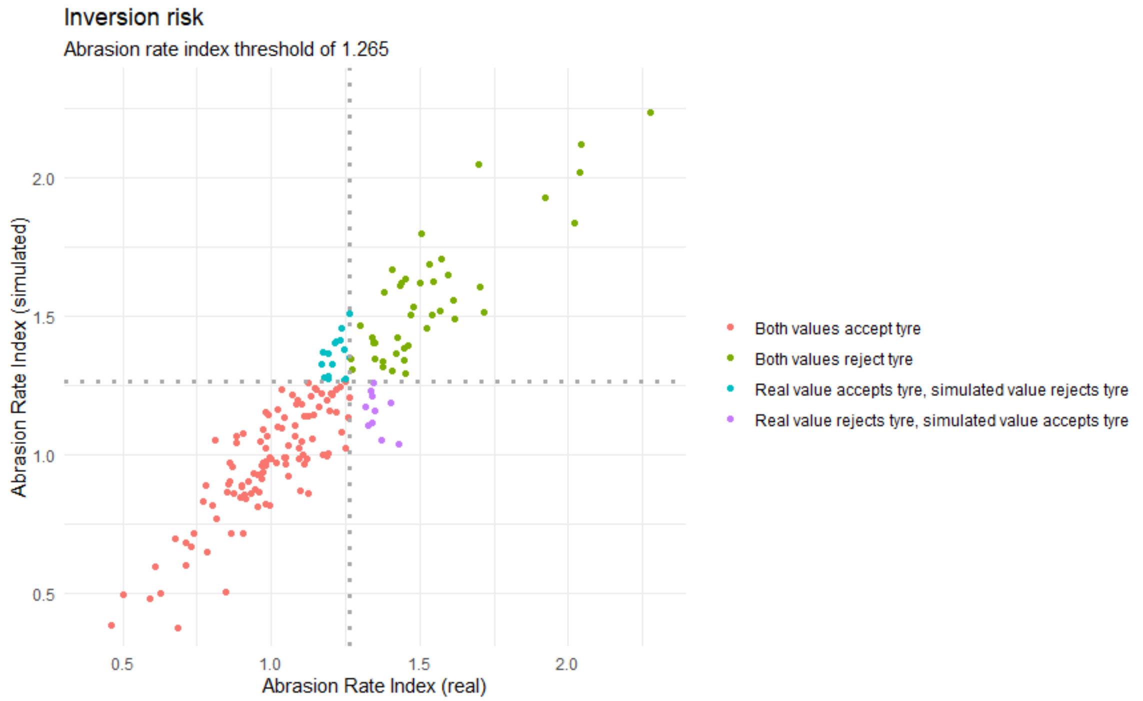
- What does this implicate?



Simulation based on variance

- For the simulation:
  - Only one simulation
    - Mostly to get a feeling about the effects of a sd of 0.13
  - Measured value for vehicle method is “real” value
    - This is of course not the exact abrasion index, but we need to use a value
  - We look at all market assement data for vehicle method
  - Threshold based on rejecting 30% of tyres
  - **No systematic effects**

- Biggest risk based on abrasion:
  - Accepting tyres that actually have too much abrasion
    - For the simulation: 10/53 (19%)



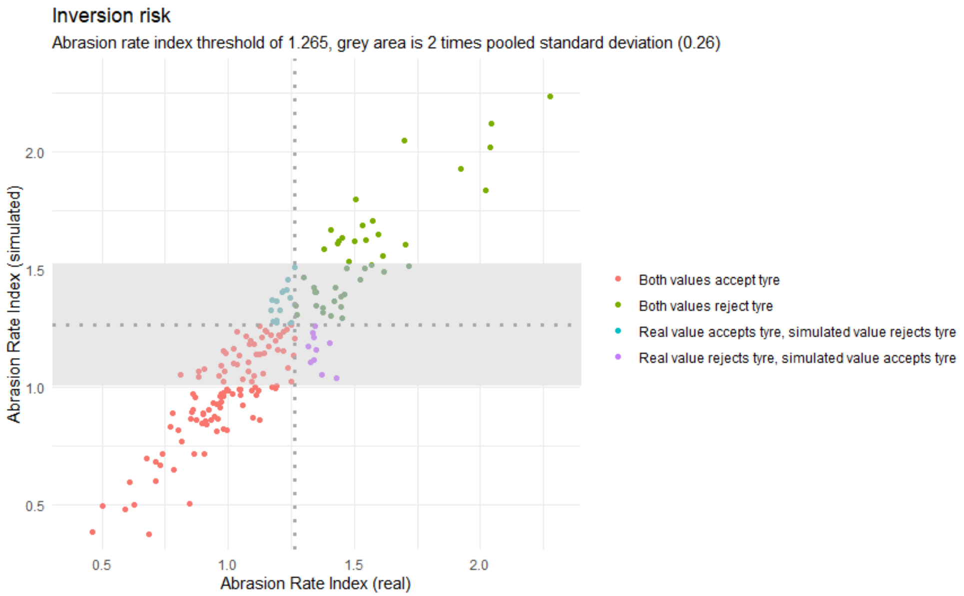
RDW

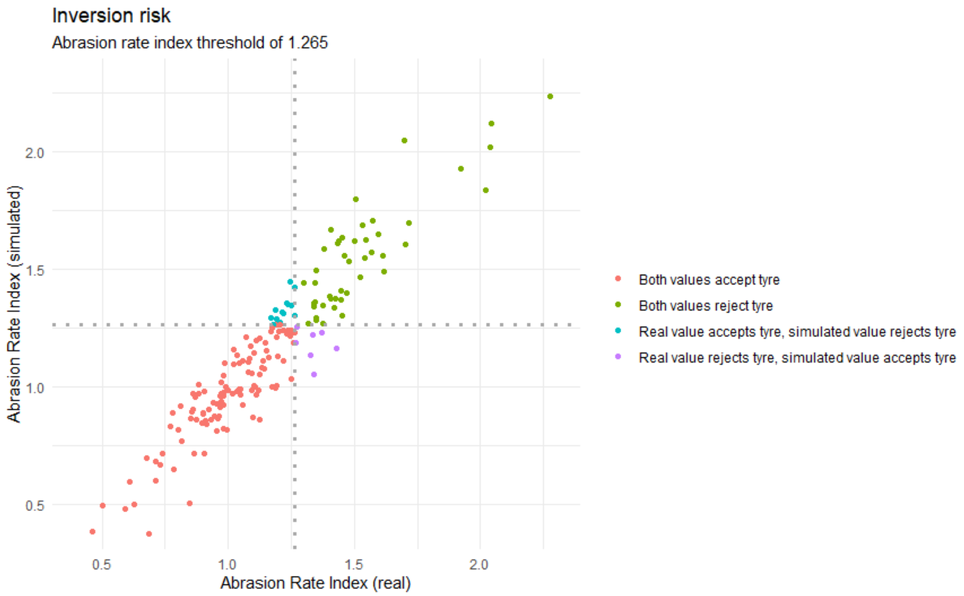
What to do with tyres close to threshold value?

- Tyres within 95% confidence based on sd around the threshold
  - What happens if we test these again?
    - Have to test 94/177 (53%) again
    - Compute the average of two measurements

- Rate of accepting tyres that actually have too much abrasion reduces to 7/55 (13%)

- These retests assume there are no systematic effects
  - If there are systematic effects (temperature, circuit), it is still possible to systematically test above or below the threshold, while the true value is on the other side

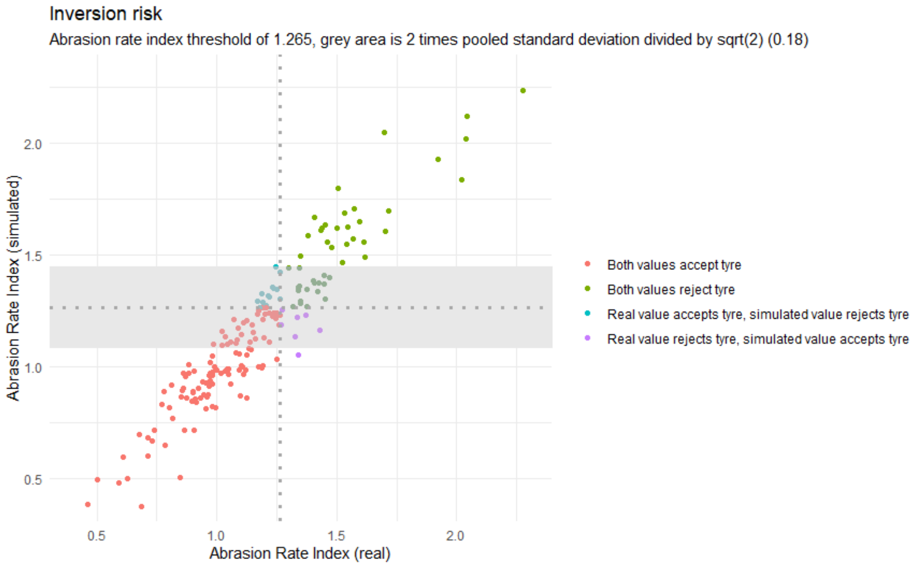


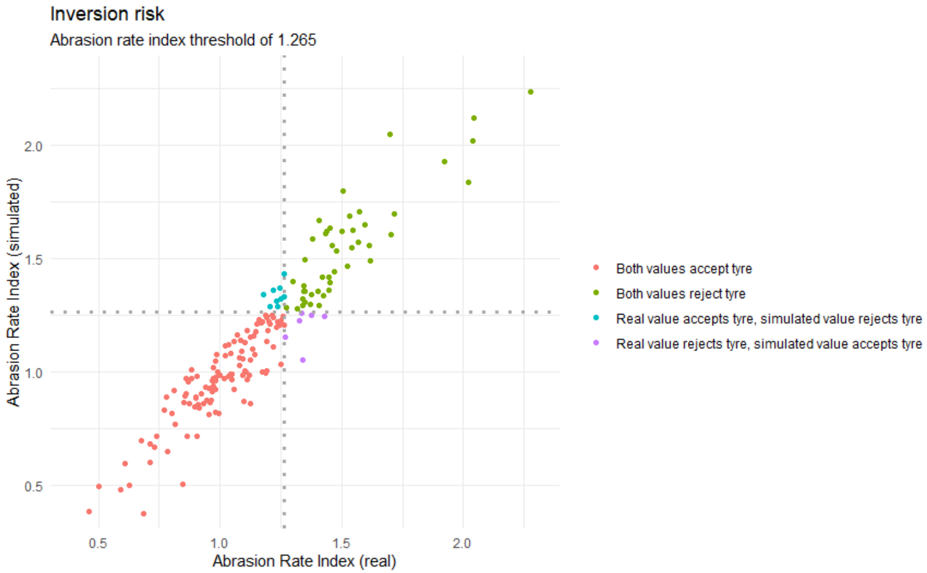


RDW

What to do with tyres that are still close to threshold values?

- Since you took 2 measurements the uncertaintity of the average reduces
  - By square root of 2
- Could look at values that are within 2 times standard deviation, divided by square root of 2
- Of course time and costs are involved in doing extra tests
  - Only one test per tyre? Or more?
    - What if you measure a bit below or above the threshold?





When is a tyre accepted?

- When is a tyre accepted?
  - How to handle measurement uncertaintity?
    - How close to the threshold is accepted/rejected?
    - How do we handle systematic effects?
  - What is the test plan if an abrasion index close to the threshold is measured?

- What are the implications of a higher measurement uncertaintity?
  - Higher risk of inversion
  - More retests if you want to be sure within x standard deviations
    - Retests don’t help if there are systematic effects

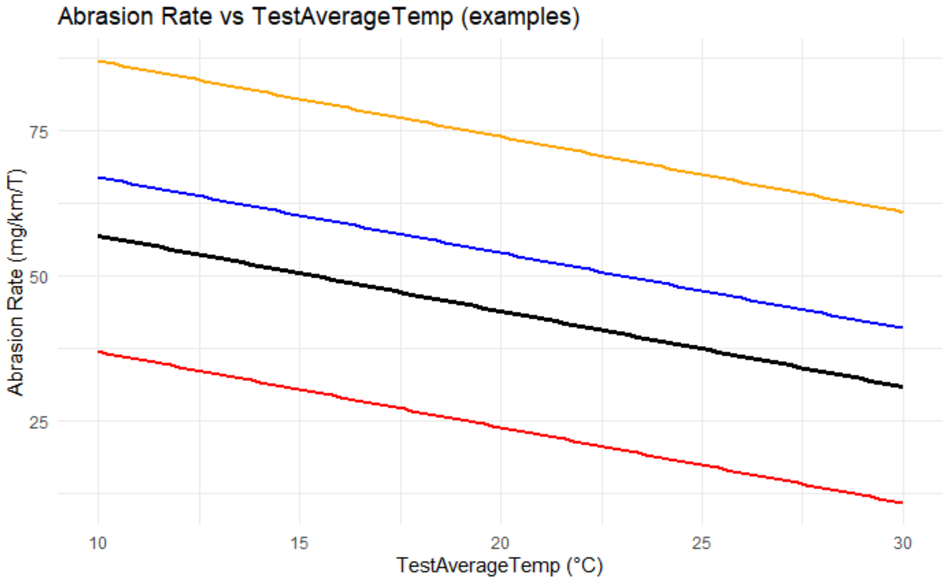
- Can we reduce the measurement uncertaintity?
  - Correction for temperature effects possible?

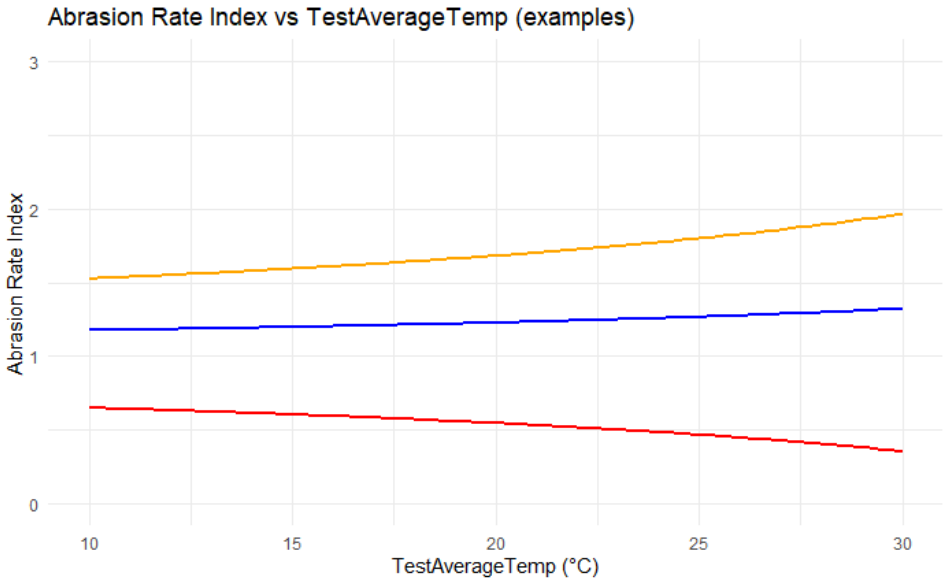
Identical temperature slopes can still produce difference abrasion index values

- Showed this example last year

- Tyres with identical temperature coefficients as the reference tyre still measure different abrasion rate index at different temperatures
  - Because abrasion rate index is a ratio

- If we assume candidate tyres have identical slopes to reference tyres
  - We can bring both abrasion rates back to a reference temperature and calculate abrasion index
    - But what if slopes are not equal?

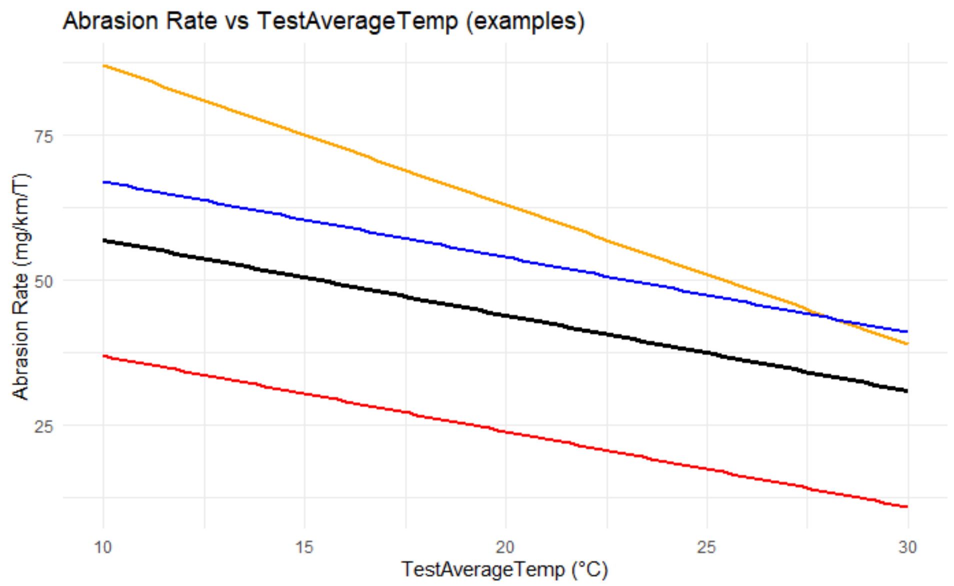


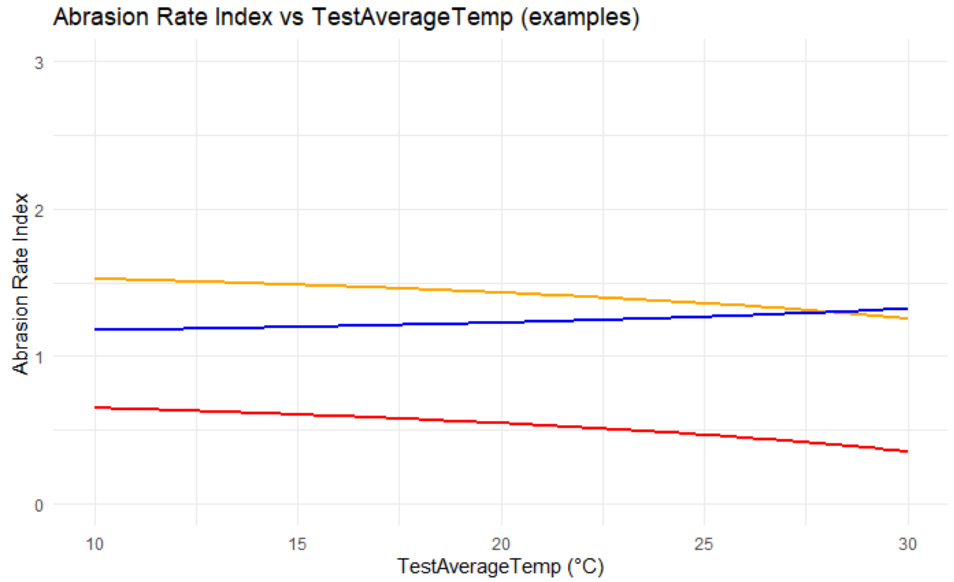


RDW

What if the slope of candidate tyre is different

- For the orange line, now if you measure are higher temperatures you measure a lower abrasion index
- Can we assume the slope of candidate tyres and reference tyres is equal?

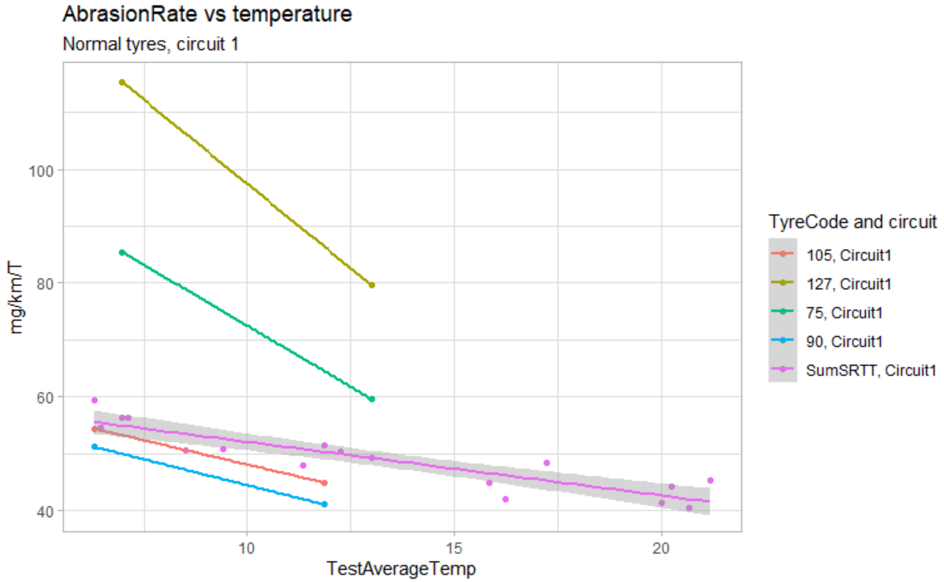


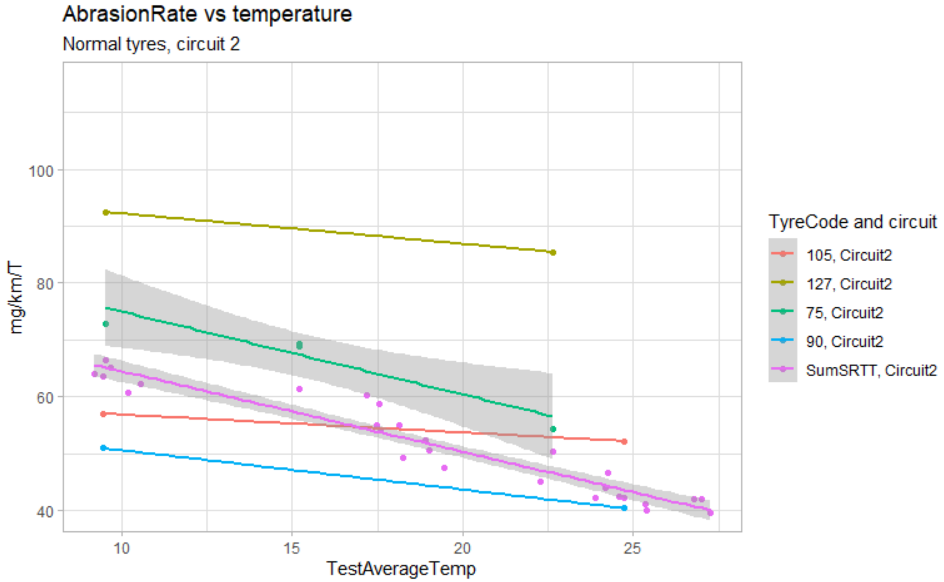


Slopes of candidate tyres and reference tyres not always equal

- Difficult to make statement about slopes of candidate tyres
  - For most tyres only 2 measurement per circuit
    - Random effects relatively big effect because of low amount of measurements

- Tyre 127 has two different slopes for the circuits
  - Circuit 1: larger temp coefficient than SRTT
    - Testing the tyre at **higher** temperature measures a **lower** abrasion index
  - Circuit 2: smaller temp coefficient than SRTT
    - Testing the tyre at **lower** temperature measures a **lower** abrasion index



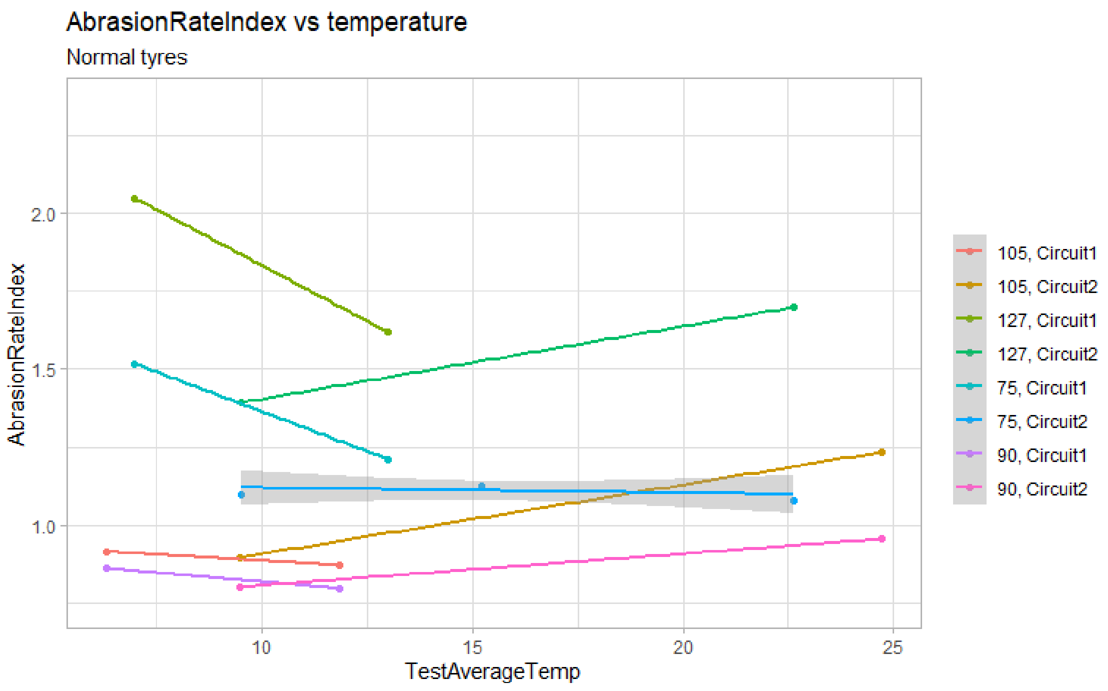


Temperature effect visible for abrasion rate index

- Temperature a cause of spread for the abrasion rate index

- Tyre 127 temperature effects are as expected from previous slide
  - Circuit 1: lower index at higher temperature
  - Circuit 2: lower index at lower temperature

- Can we make a correction for this temperature component?
  - If this is not possible, temperature is a cause for **systematic** effects
    - Meaning: it's possible to test tyres at higher or lower temperatures to measure higher or lower abrasion indexes



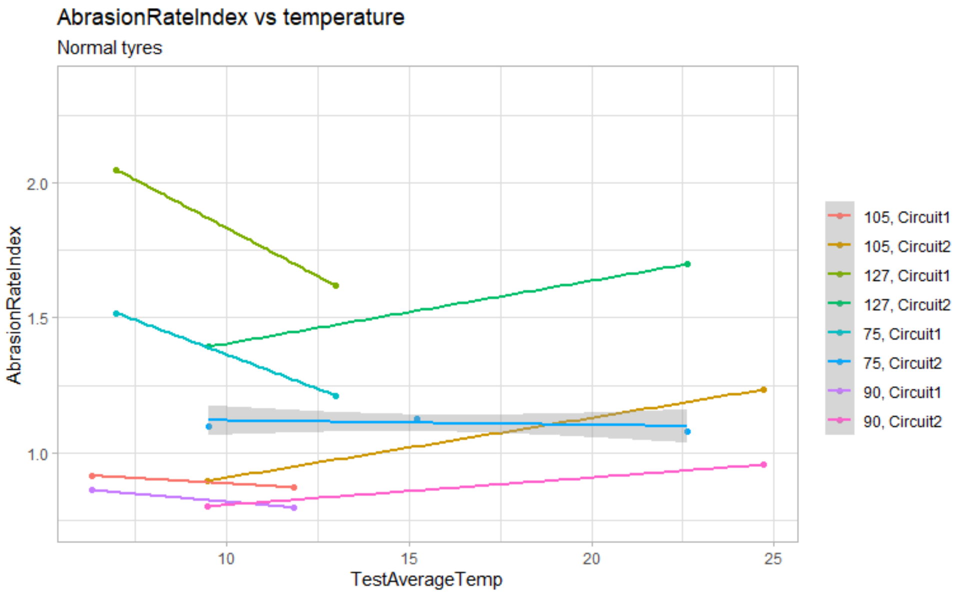
RDW

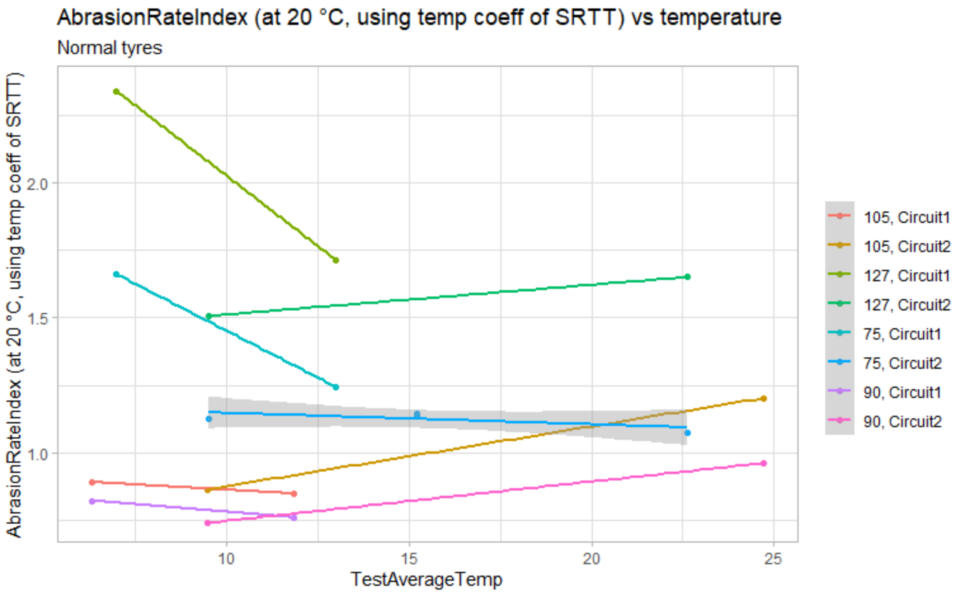
Bringing abrasion index back to reference temperature

- Bring both candidate abrasion rate and reference abrasion rate back to value you expect at 20 °C
  - Based on temperature coefficient of reference tyre on corresponding circuit

- Temperature effects still visible
  - Making the temperature correction for correlation validation tyres (normal tyres) increases the pooled standard deviation for normal tyres from 0.17 to 0.23

- Coefficients of candidate tyres needed to make a good correction
  - Since you only do one measurement normally, you don't have the temp coefficient for candidate tyre





Discussion points

- Is there enough correlation between the methods to support both methods?
- What to do when the measured value is close to threshold?
  - How does the test plan look when close to the threshold?
- What can we do about temperature effects?
  - Ideally you know the temperature coefficients of the candidate tyre
    - If a tyre is retested, test at a different temperature?

Thank you for listening!