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Managing drowsy driving risk using information-rich data from fatigue detection systems

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Overview

- Introduction to drowsiness data
- Data collection
- Results
  - Circadian patterns
  - Longer-term trends
  - Shift effects
  - Geolocation correlations

Introduction

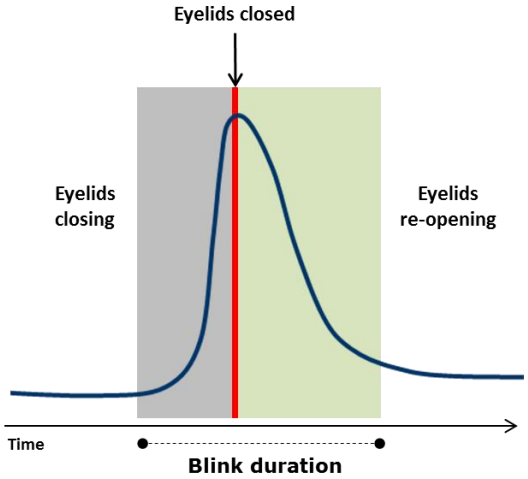
- Many different types of devices and appliances are now generating data

- A new type of data is available having arisen from the development of fatigue detection systems
- Optalert systems continuously monitor the driver using an objective measure of drowsiness
- How can this data be used?

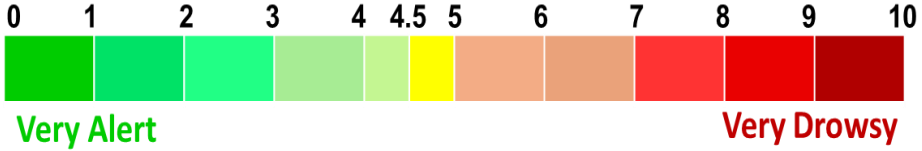
Scaled measure of drowsiness

Optalert's drowsiness scale is called the Johns Drowsiness Scale (JDS)

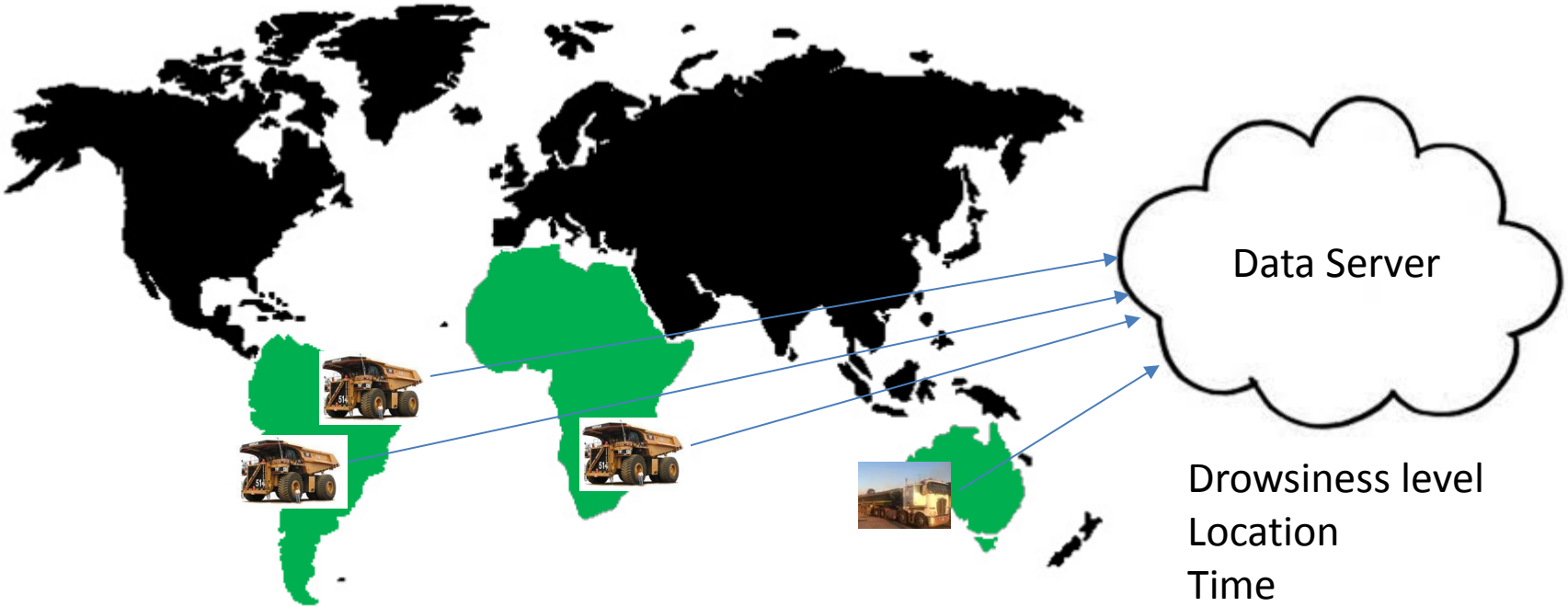
- The JDS uses a weighted combination of variables derived from blinks



- The "Alert" range on this scale is 0 – 4.4
- Scores from 4.5-4.9 indicates moderate levels of drowsiness
- Scores above 5.0 are considered to indicate increasing levels of drowsiness and therefore increased risk of performance failure



Data collection – for this study

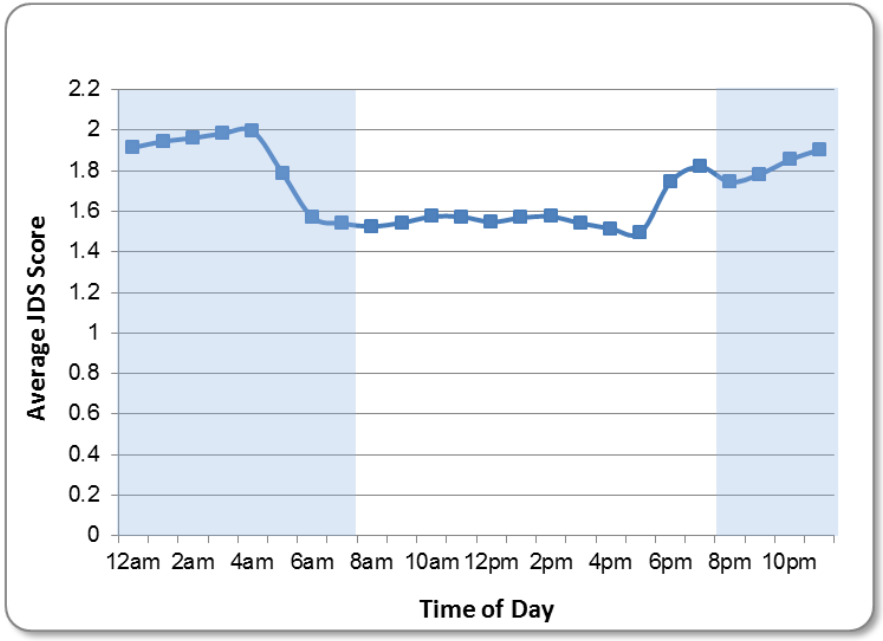


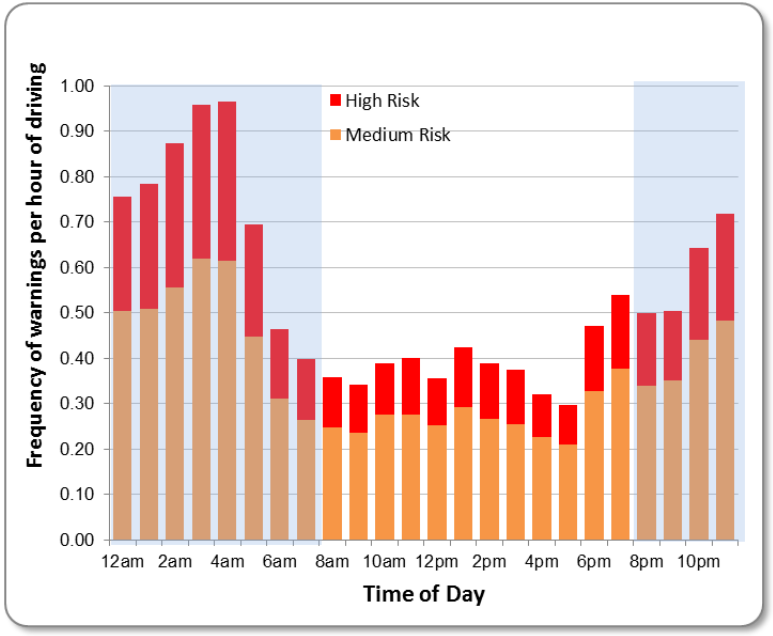
Circadian effects

- Well-known physiological changes
- Corresponding with these changes, we would expect:
  - Higher average JDS scores during night time
  - Higher frequency of Medium & High Risk Warnings during night time
  - These patterns to be repeated across geographies

Results – circadian effects

Mine site in Africa

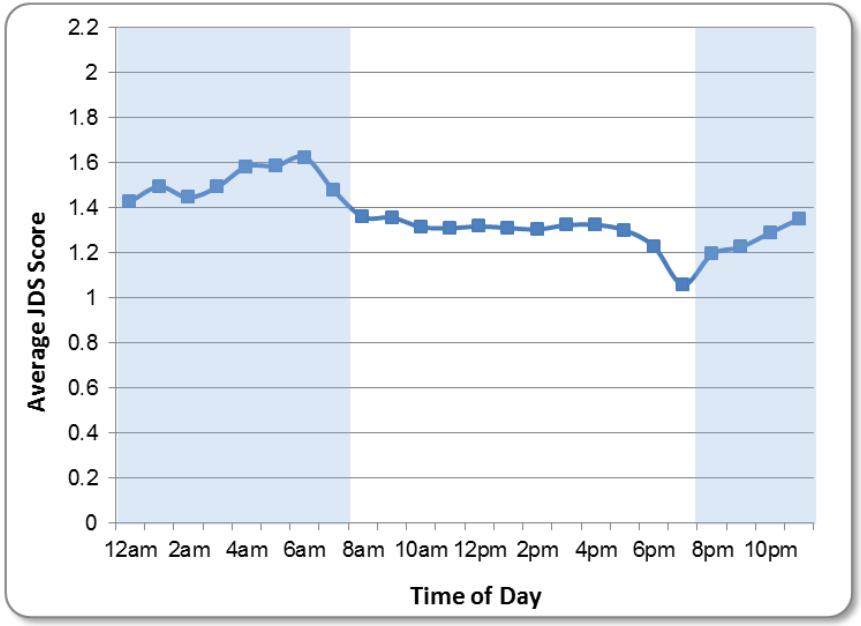


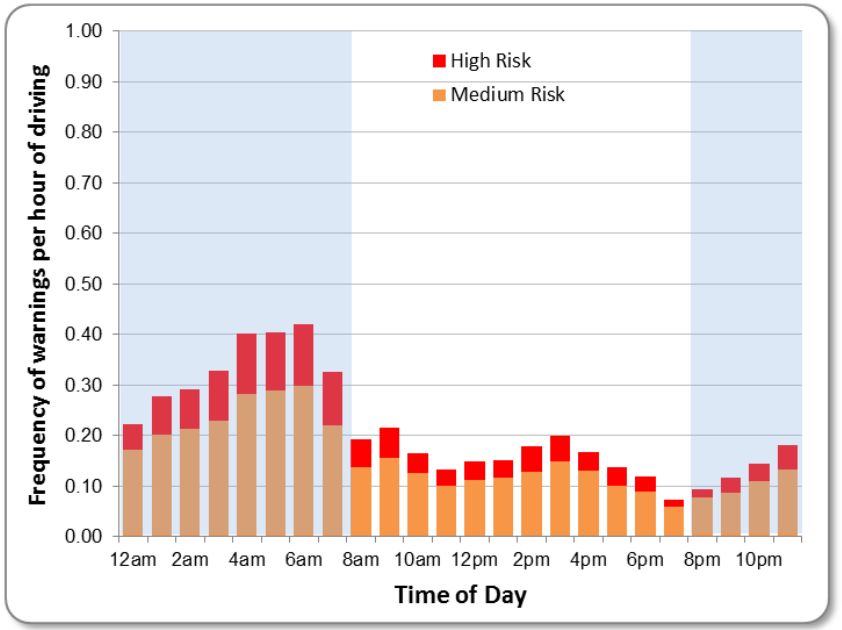


Data collected from 467 drivers and 95 vehicles during day, night and afternoon shifts between 1st July2015 – 30th June 2016 (12months)
Blue shaded periods graph represent Nightshift

Results – circadian effects

Mine site in Chile

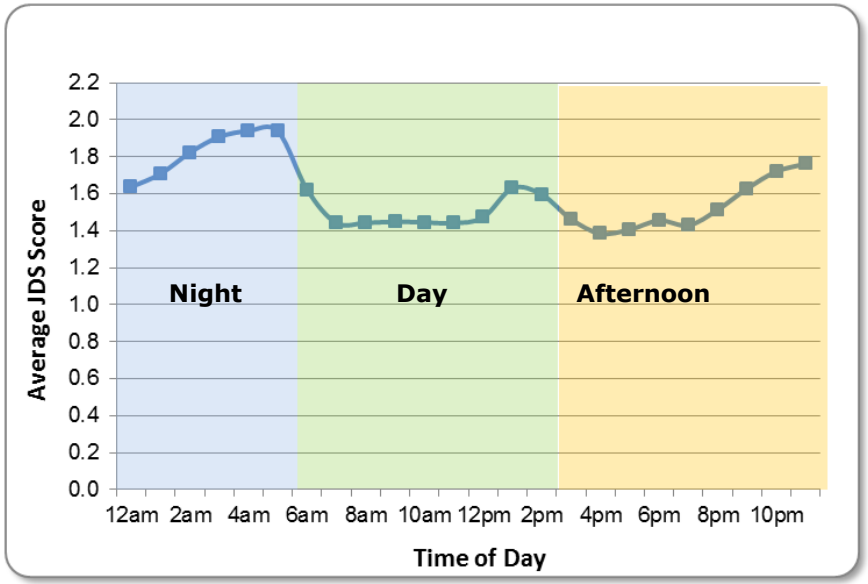


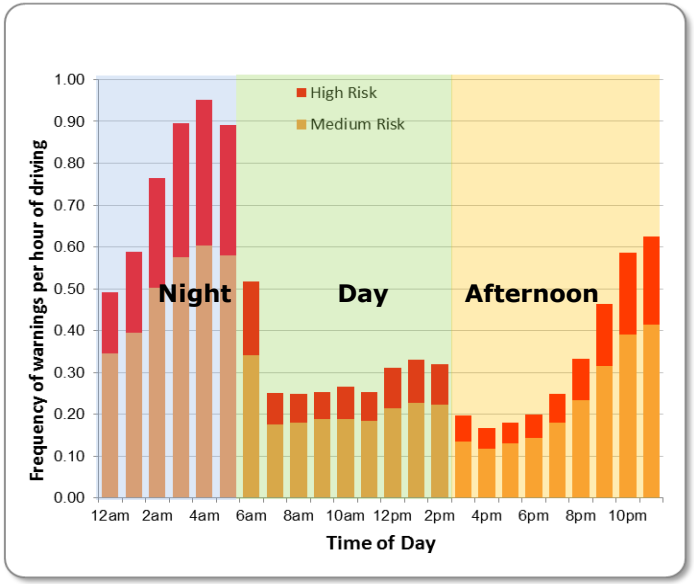


Data collected from 221 drivers (47 vehicles) during day shifts and night shifts between 1st May 2015 – 30th September 2015 (5months)
Blue shaded periods graph represent Nightshift

Results – circadian effects

Mine site in Brazil

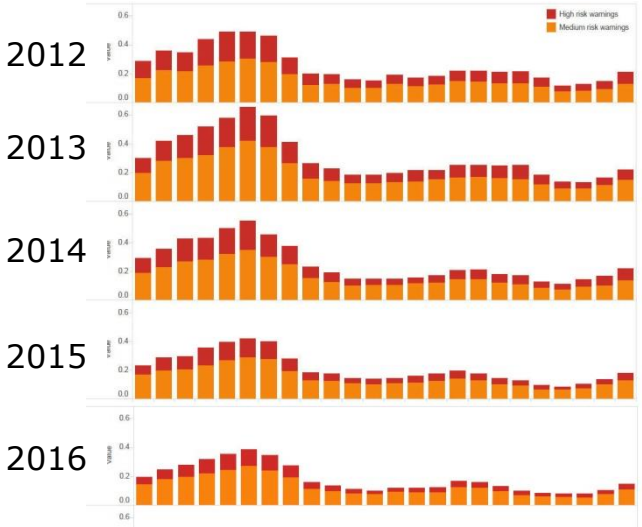


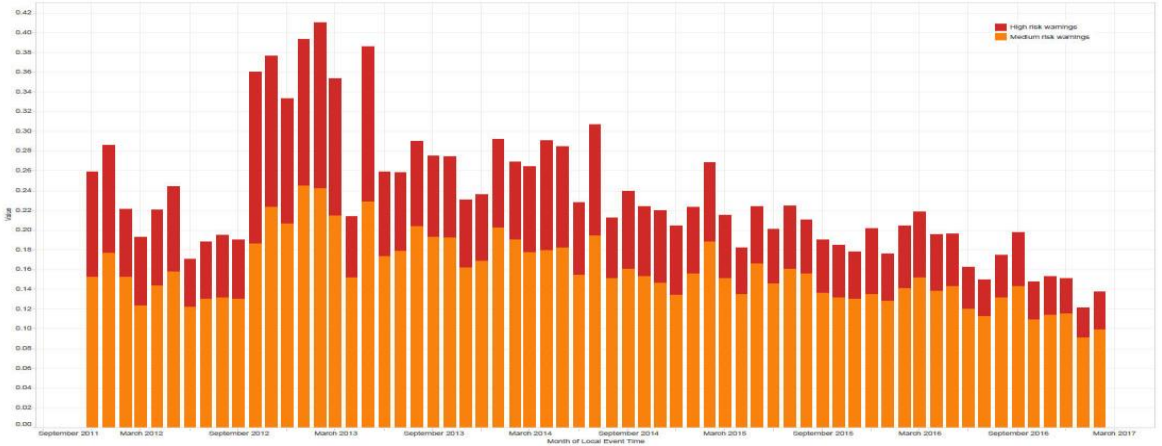


Data collected from over 400 drivers and 90 vehicles during day, night and afternoon shifts between 1st July2015 – 30th June 2016 (12months)

Results – trends

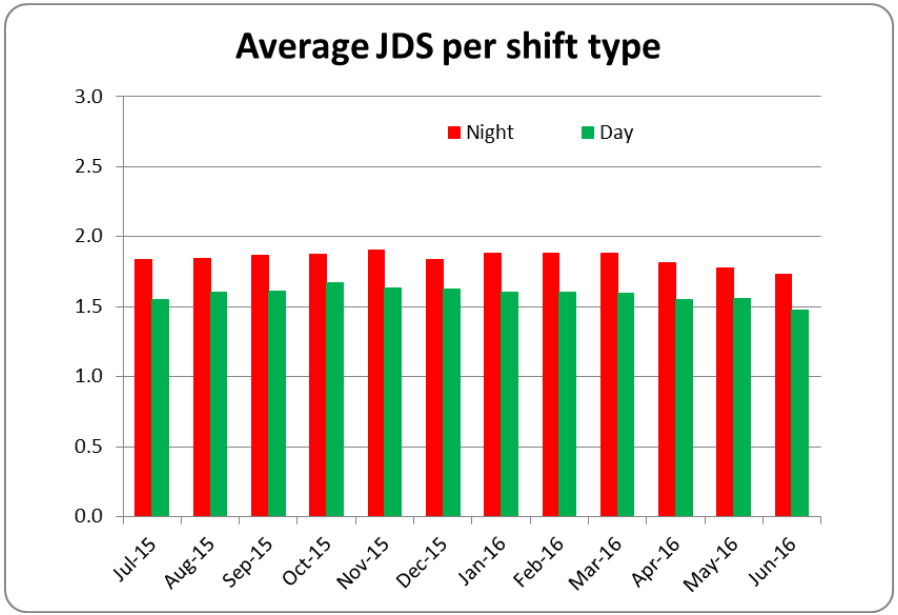
Looking at data over longer periods of time can reveal underlying trends

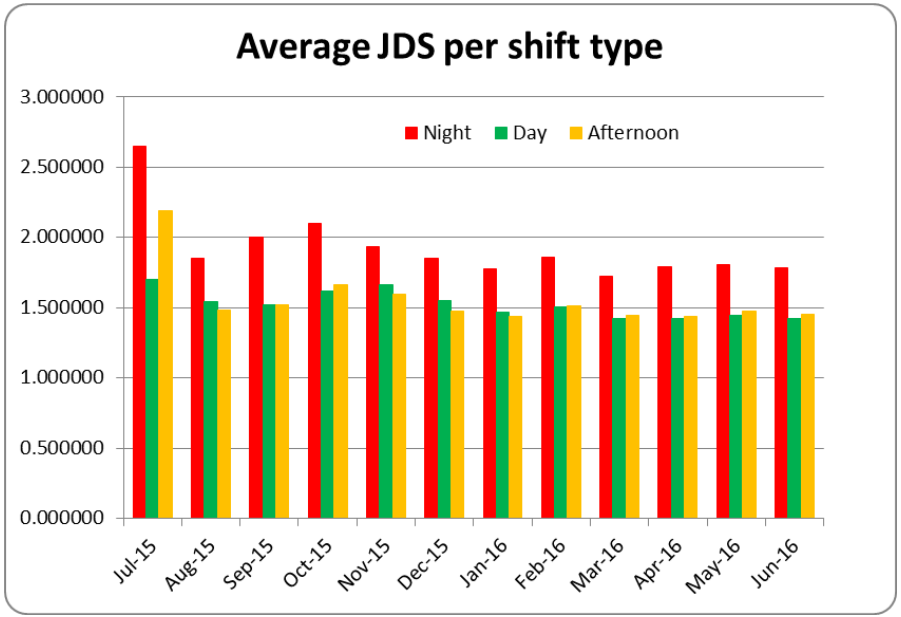




Results – shift day vs night

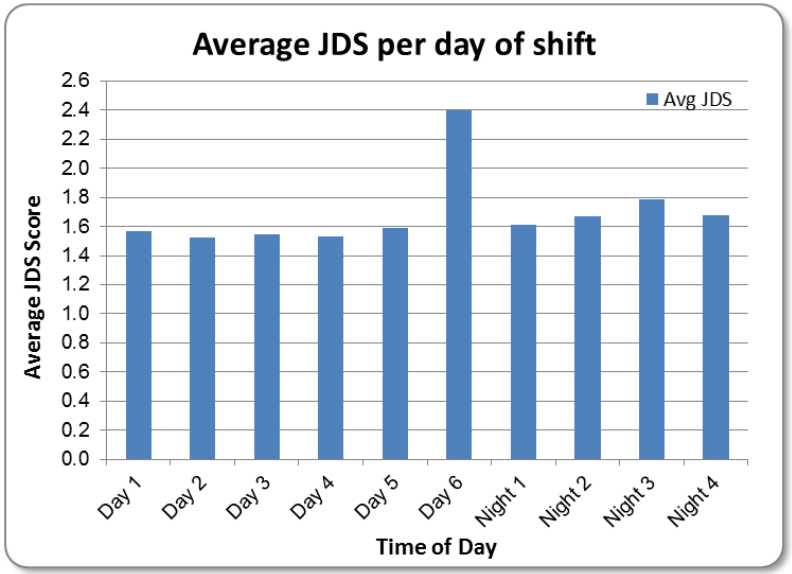
- Consistently higher average JDS scores for Night shift

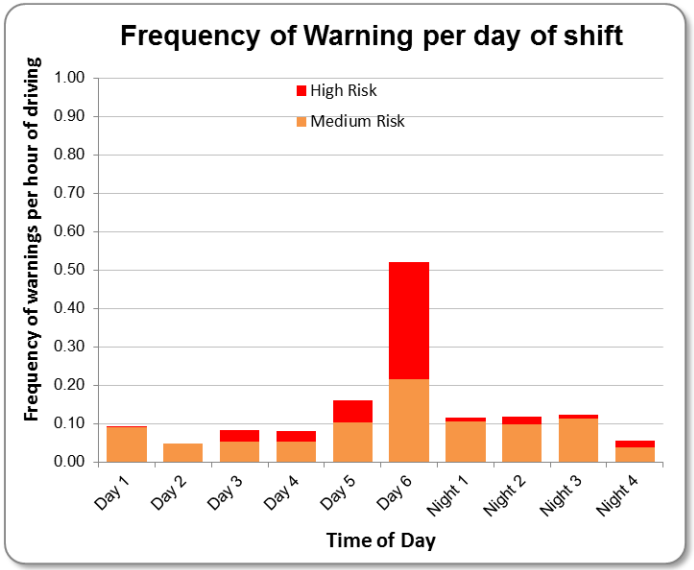




Results – time on shift

- Increase in drowsiness towards the end of shift rotations



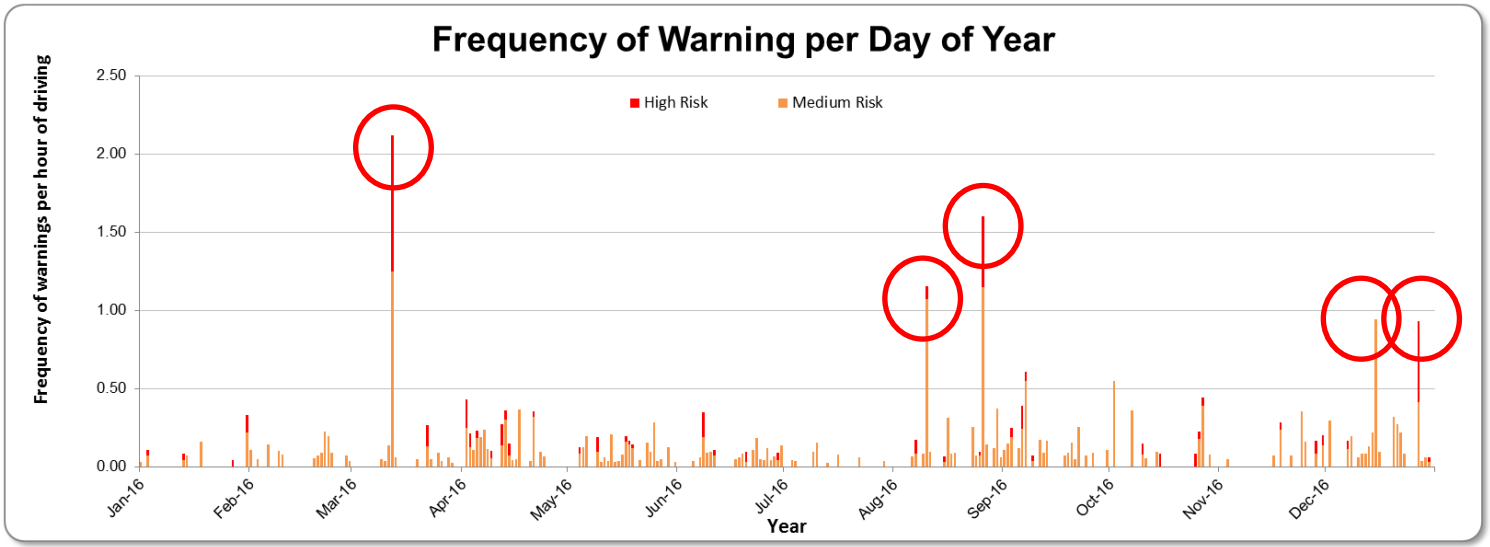


Results - geolocation

- All drivers, all days of year

Results - geolocation

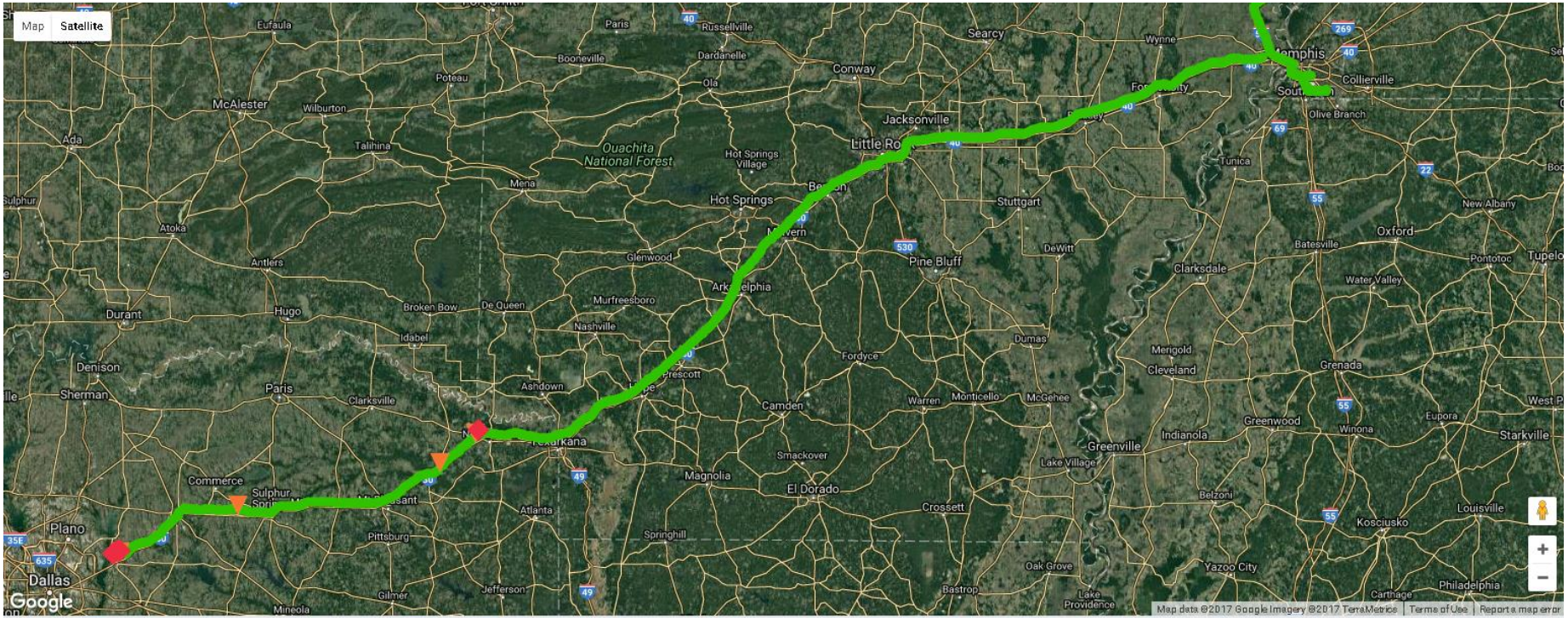
- Drill-down to identify riskier days of the year



Results – geolocation

- Majority of warnings given to 4 drivers over 5 days of the year (12th March, 10th Aug, 26th Aug, 15th Dec, 27th Dec)

Results – geolocation



Conclusions

The combination and correlation of scaled drowsiness data with other measures results in rich data sets that can be used to:

- Identify fatigue risk
- Inform decision-making
- Measure efficacy of operational change
- Influence safety and regulation

Questions

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List of publications

Jackson, M., Kennedy, G.A., Clarke, C., Gullo, M., Swann, P., Downey, L.A., Hayley, A.C., Pierce, R., Howard, M.E. The utility of automated measures of ocular metrics for detecting driver drowsiness during extended wakefulness (2016) Accident Analysis & Prevention, 87:127-133)

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Ftouni, S., T.L. Sletten, C.L. Nicholas, D.J. Kennaway, S.W. Lockley, S.M.W. Rajaratnam. Ocular Measures of Sleepiness Are Increased in Night Shift Workers Undergoing a Simulated Night Shift Near the Peak Time of the 6-Sulfatoxymelatonin Rhythm (2015) Journal of Clinical Sleep Medicine, Vol. 11, No. 10

E. Aidman, C. Chadunowa, K. Johnson, J. Reece. Real-time driver drowsiness feedback improves driver alertness and self-reported driving performance. (2015) Accident Analysis and Prevention 81: 8–13

Anderson, C., A.M. Chang, J.P. Sullivan, J.M. Ronda, and C.A. Czeisler. Assessment of Drowsiness Based on Ocular Parameters Detected by Infrared Reflectance Oculography. (2013). Journal of Clinical Sleep Medicine. 9(9): p. 907-920.

Ftouni, S., S.A. Rahman, K.E. Crowley, C. Anderson, S.M.W. Rajaratnam, and S.W. Lockley. Temporal Dynamics of Ocular Indicators of Sleepiness across Sleep Restriction. (2013). Journal of Biological Rhythms. 28(6): p. 412-424.

Ftouni, S., T.L. Sletten, M. Howard, C. Anderson, M.G. Lenne, S.W. Lockley, and S.M.W. Rajaratnam. Objective and subjective measures of sleepiness, and their associations with on-road driving events in shift workers. (2013). Journal of Sleep Research. 22(1): p. 58-69.
Wilkinson, V.E., M.L. Jackson, J. Westlake, B. Stevens, M. Barnes, P. Swann, S.M. Rajaratnam, and M.E. Howard. The accuracy of eyelid movement parameters for drowsiness detection. (2013). J Clin Sleep Med. 9(12): p. 1315-24.

Corbett, M., D.Newman. The use of bio-feedback as a mitigation tool for pilot drowsiness (2013). Aviation, Space & Environemental Medicine, 84 (4): p320

Defence Trial Number 896- ADF Fatigue Management - Optalert, Capability Development Group, Australian Defence Test & Evaluation Office (2012)