PRESENTATIONS SEP-OCT 2015
EXPERT GROUP ON DRIVING BEHAVIOUR UNDER THE RDE-LDV EXPERT GROUP

results reported in:

› Chase car study: driving behaviour in the Netherlands, Belgium, France and Germany (TNO 2017 R11227)
link: https://repository.tudelft.nl/view/tno/uuid%3A2bef9ce0-8de1-46e8-acea-467e83816d72

› On-road determination of average Dutch driving behaviour for vehicle emissions (TNO 2016 R10188)
link: https://repository.tudelft.nl/view/tno/uuid%3Acb430165-414f-4203-9cf5-2d352c3c571b

› UDRIVE: V.A.M. Heijne, N.E. Ligterink, U. Stelwagen. UDRIVE deliverable 45.1 Potential of eco-driving of the EU FP7
VAPOS DETERMINATION IN DUTCH TRAFFIC
DRIVING BEHAVIOUR DETERMINATION
FOR DUTCH NATIONAL EMISSION FACTORS

- professional driver:
  - following cars and vans with constant headway
  - random selection of vehicles to follow based on licence plate numbers
- 50 km distance per trip:
  - 30 min - 1 hour of driving per trip
  - equal distance split urban/rural/motorway
- vehicle velocity based on wheel speed (GPS also available)
- So far:
  - 68 hours of data at 1 Hz
  - 120 trips collected (ongoing)
  - full coverage of Dutch roads
VELOCITY SIGNALS
REQUIRED QUALITY FOR DETERMINING ACCELERATION

GPS signal is poor, deviating, and absent 5%-15% of the time

Wheel speed gives accurate and robust signal (e.g. ABS)

Optical signal can be improved

OBD signal often “stylized”
INDEPENDENT DETERMINATION OF VELOCITY
BASED ON WHEEL SPEED CALIBRATED WITH GPS

alternative setups possible with appropriate accuracy requirements

4 ~ 0.5 metre apart
accurate (0.1%) 1Hz velocity above 1.8 km/h

fast wheel at cornering
slow wheel at cornering

clock and counter 10 kHz
light sensor
reflective stripes
typical tachometer

signal to data acquisition (calibration with GPS)

wheel rim (non-driven, kerb side)
GPS DEVIATION

outside de graph ~ 1% of the data
**V**\textsubscript{APOS} DETERMINATION

determination of Dutch \textit{v*}apos

car following of random selected cars Sept. 2015 (min 100 sec per point)

\begin{figure}
\centering
\includegraphics[width=\textwidth]{vapos_determination}
\caption{\textit{v*}apos determination in Dutch traffic}
\end{figure}
**V^*_a_{\text{pos}}** DETERMINATION

**determination of Dutch v^*_apos**

Car following of random selected cars Sept. 2015 (min 100 sec per point)

The current proposal of the boundary in $v^*_a_{\text{pos}}$ seems low, based on this data.
USING DISTANCE-AVERAGE VELOCITY

90 and above
60-90
0-60

instantaneous velocity
average velocity over 1 kilometre
TRIP LENGTHS
TRIPS DESIGNED FOR EQUAL SHARES URBAN/RURAL/MWAY

“natural trip”:
urban start → rural → motorway → rural → urban stop

combining two trips for a 50-120 minute trips
HANNING FILTER (N=3, SPSS)

- raw acceleration:
  \[ a_{i+1/2} = (v_{i+1} - v_i)/3.6 \]

- Hanning filter (smoothing, as in SPSS, combined with Heinz definition of acceleration):
  \[ v_i = 0.25v_{i+1} + 0.5v_i + 0.25v_{i-1} \]

  \[ \Rightarrow a_i = (v_{i+1} - v_i)/(2*3.6) = (0.125v_{i+2} + 0.25v_{i+1} - 0.25v_{i-1} - 0.125v_{i-2})/3.6 \]

centrepoint definition from Heinz: additional smoothing
DRIVER EXPERIENCE

› urban driving:
  › more or less fixed vehicle followed (single lane traffic)
  › limited time free-flow (no car in front) (automatic gear AUDI)

› rural and motorway driving:
  › following cars for at least 2-3 kilometres (limited vehicle variation)
  › large variation in driving styles observed
  › a number of times “let cars go” because of speed limit violations
EFFECT OF MINIMAL SAMPLE SIZE AFFECTING MAINLY RURAL DATA ON THIS DATA
EFFECT OF THE VELOCITY DEFINITION
EFFECT OF FILTERING/SMOOTHING

![Graph showing the effect of filtering/smoothing on data points. The graph plots velocity against $v^2 a_{pos}$ for filtered and raw data.]
EFFECT OF THE 90-MINUTE TRIP LENGTH (TWO-TRIP COMBINATIONS)
THE PERCENTILES OF VALID TRIPS
DISCARDING 5% OF THE TRIPS AS DRIVING BOUNDARY
UDRIVE: HTTP://WWW.UDRIVE.EU/
UDRIVE PROJECT RESULTS

~145 DRIVERS

![Graph showing vapos determination in Dutch traffic](image)

**EQUIPMENT:**
- **Vehicles:** Clio III, Clio IV, Meg III
- **Graph:** Scatter plot of vapos 95% vs. velocity (km/h)

**Data Collection:**
- **HOURS OF DATA COLLECTED**
  - 87871 total hours
  - Per vehicle:
    - Truck: 41389
    - Car: 45591
    - Motorcycle: 891

**Number of Drivers per Country:**
- **United Kingdom:** 52 drivers
- **The Netherlands:** 48 drivers
- **Spain:** 47 drivers
- **France:** 43 drivers
- **Germany:** 27 drivers
- **Poland:** 31 drivers

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