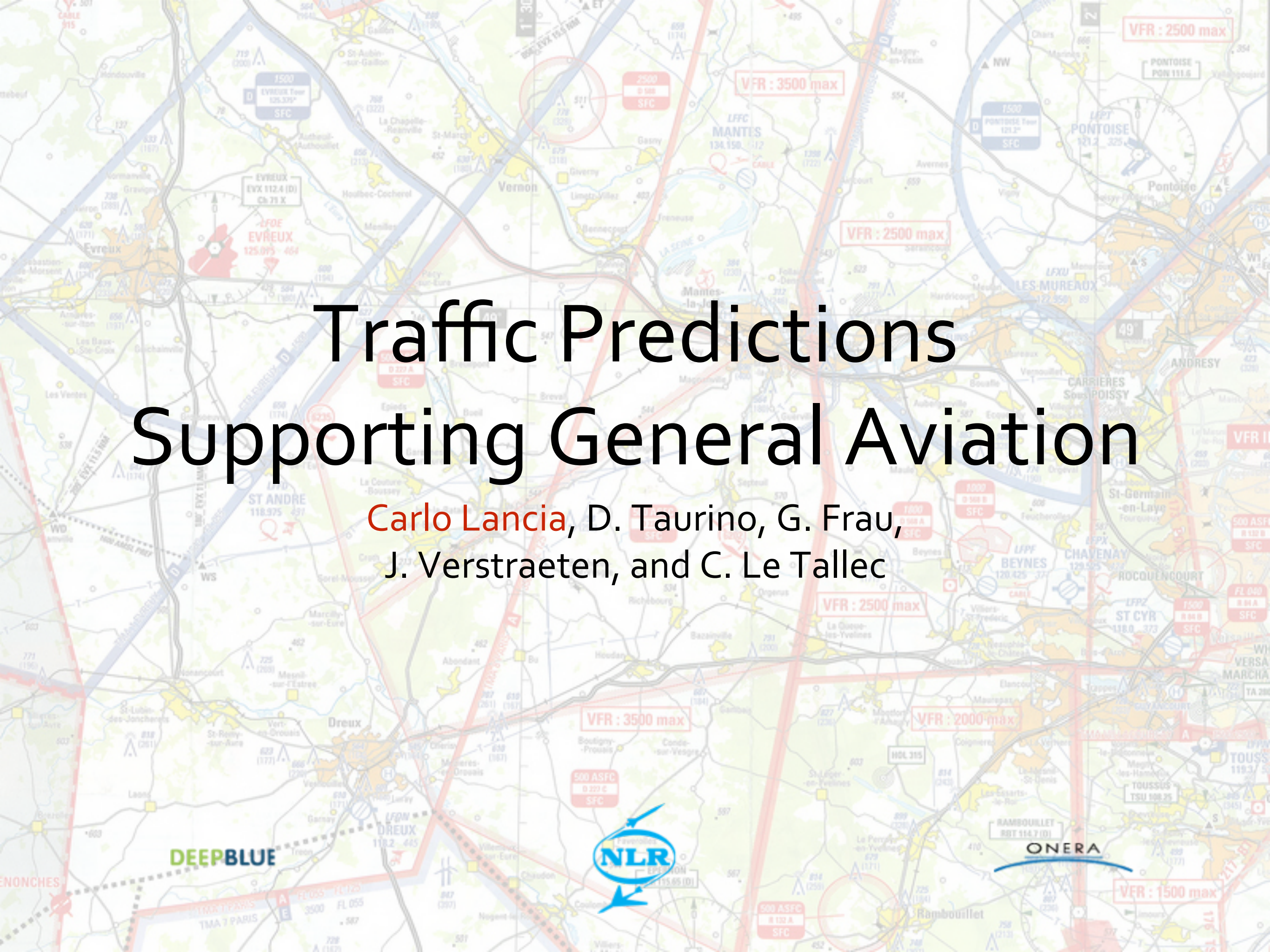


# Traffic Predictions Supporting General Aviation

Carlo Lancia, D. Taurino, G. Frau,  
J. Verstraeten, and C. Le Tallec



# Motivation

- Help GA pilots staying well-clear of surrounding traffic
- Display current/future traffic data on moving-map apps
- Expected favourable safety effects
- Mitigate the limitations of see-and-avoid principle

# Flight Intent

- Sequence of straight legs that the pilot plans to fly
- Many commercial apps can help the pilot with this planning phase
- Due to external factors, the realisation of a flight may substantially differ from the intended route



# Four Kinds of Uncertainty

Aircraft Kinematic State

Leg Adherence

Flight Intent Adherence

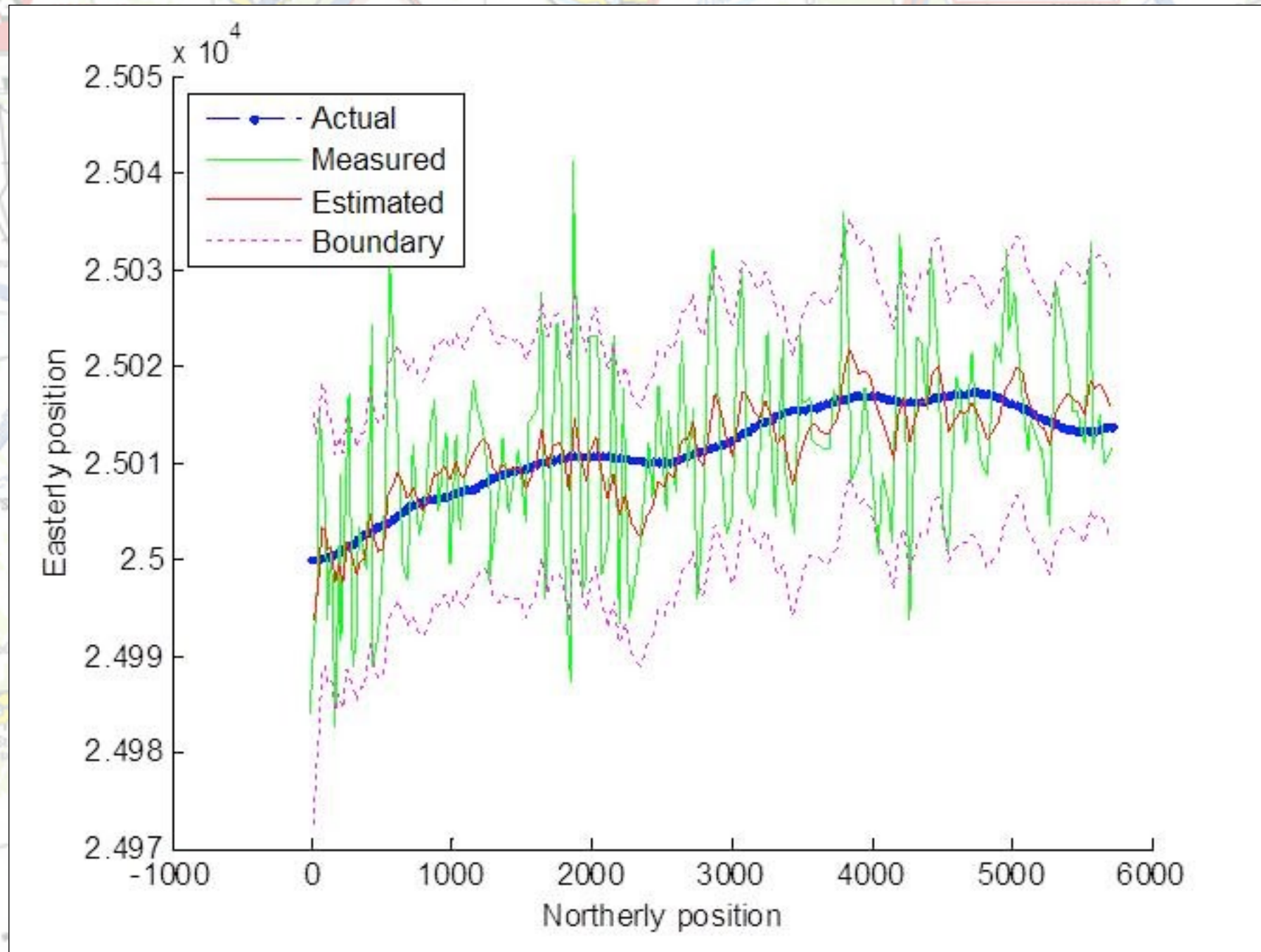
Flight Intent Availability

meters

$10^3$  m

$10^5$  m

# Aircraft Kinematic State



# State-based Prediction

$x_t$ : aircraft state (e.g. position and speed)  
 $z_t$ : "noisy" observation of  $x_t$

Dynamical  
model:

$$x_{t+1} \sim x_t$$

Prediction Phase:

$$x_{t+1} | z_t$$

New observation  $z_{t+1}$   
available

Observation  
model:

$$z_t \sim x_t$$

Update Phase:

$$x_{t+1} | z_{t+1}$$

# Leg Adherence

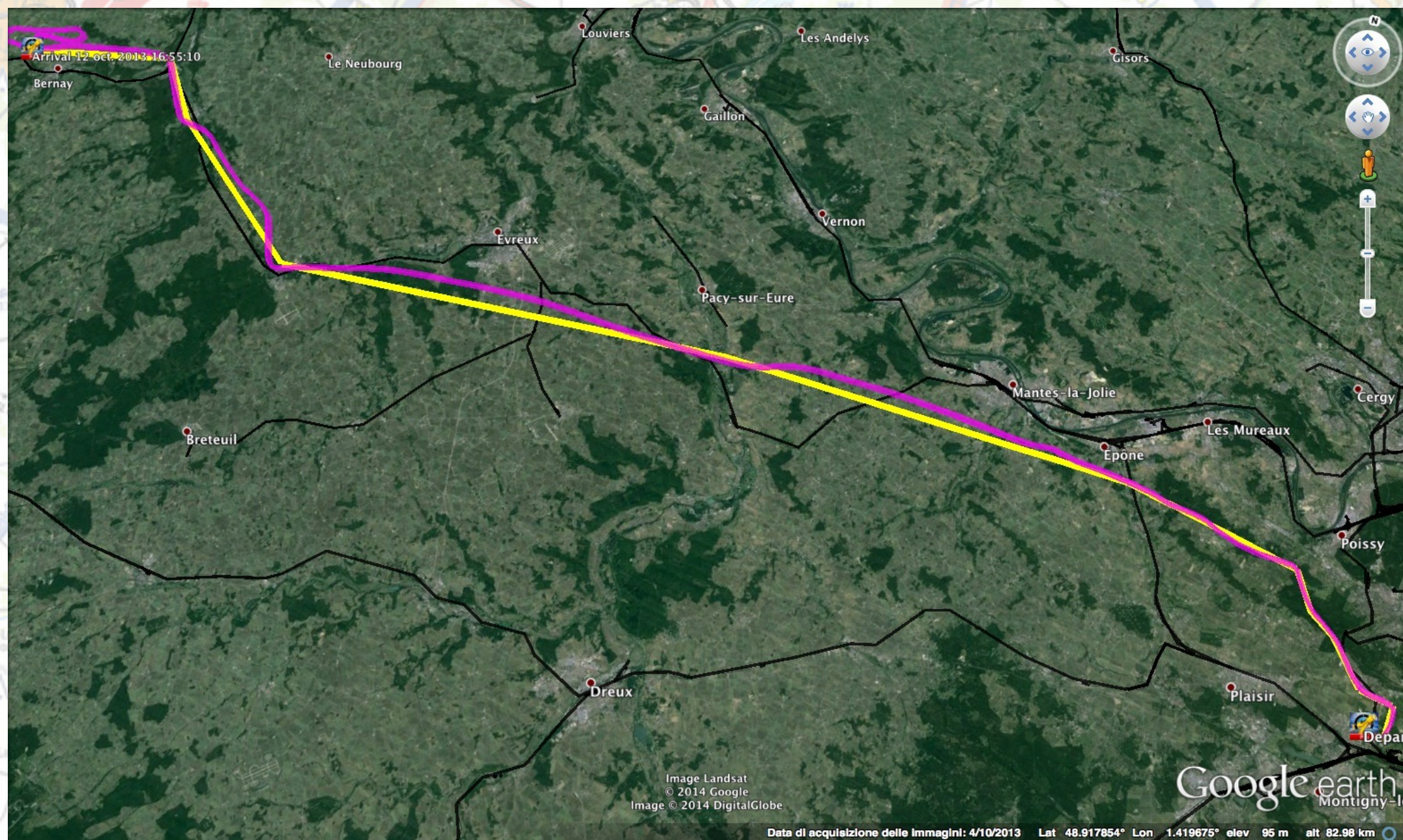
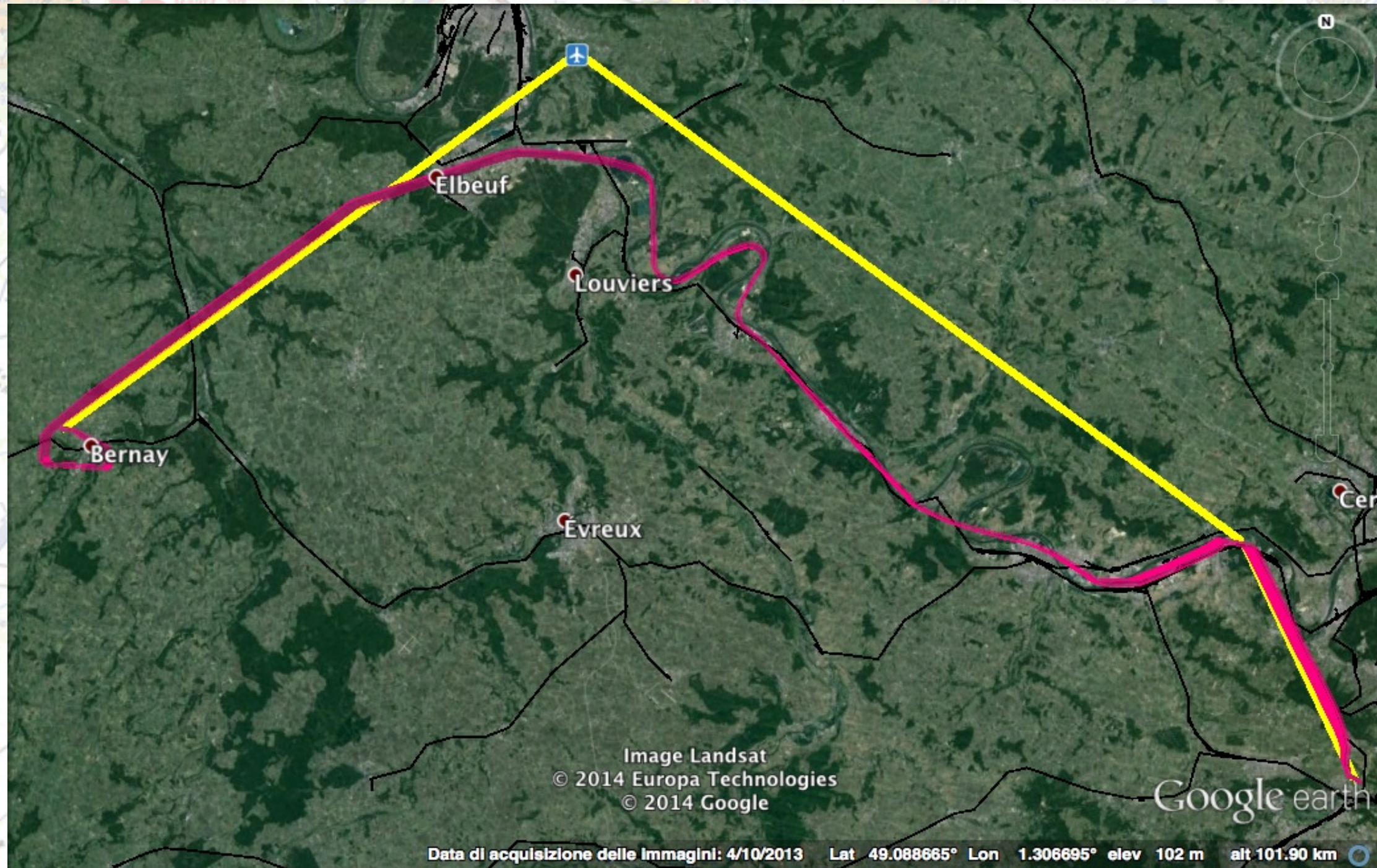


Image courtesy of Claude Le Tallec, Onera

# Flight-Intent Adherence



# Flight-Intent Availability



Plan ➡ Brief ➡ File ➡ *Share?*

<http://www.visualsoft.co.uk/ecommerce-blog/wp-content/uploads/2011/05/share-button1.jpg>

# Prevailing Uncertainties

Aircraft Kinematic State

Leg Adherence

Flight Intent Adherence

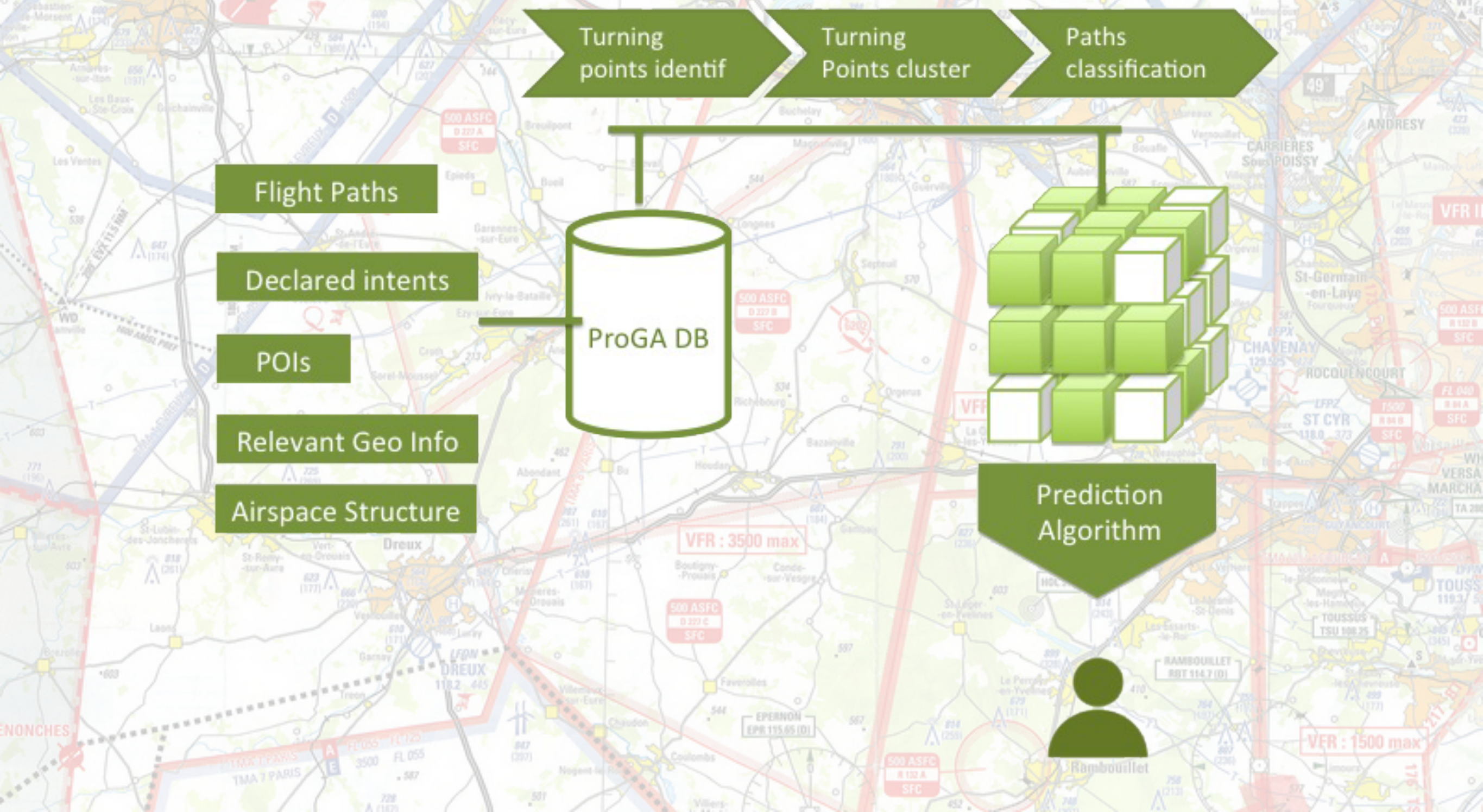
Flight Intent Availability

10 seconds

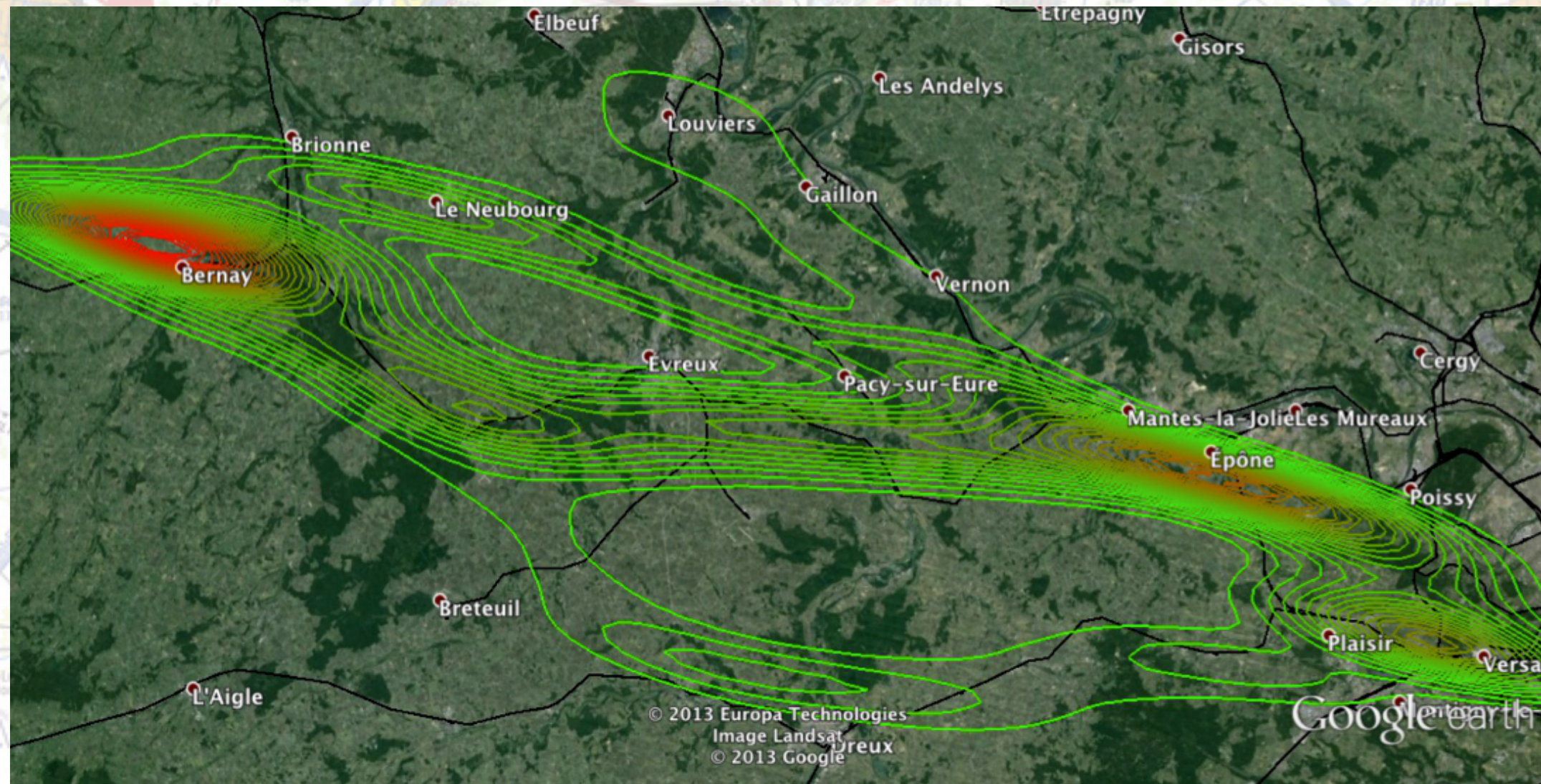
$10^2$  seconds

$10^3$  seconds

# Flight-Intent Replacement



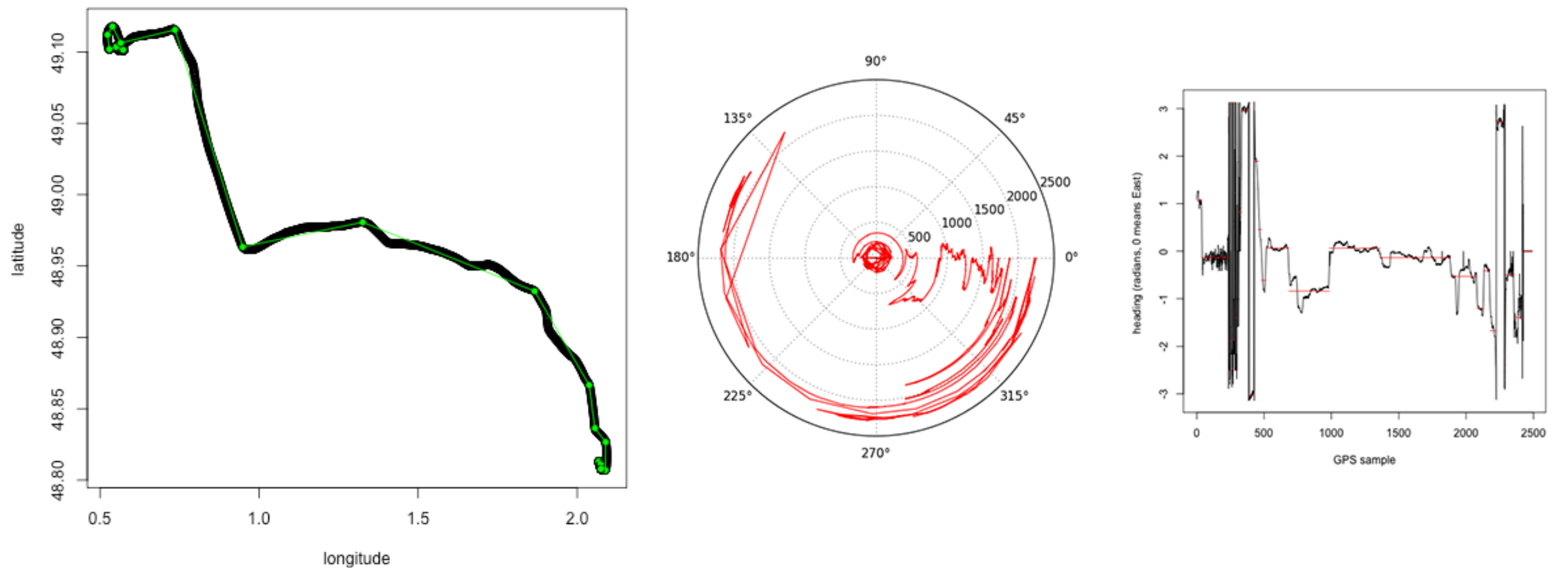
# Mining GA Typical Paths



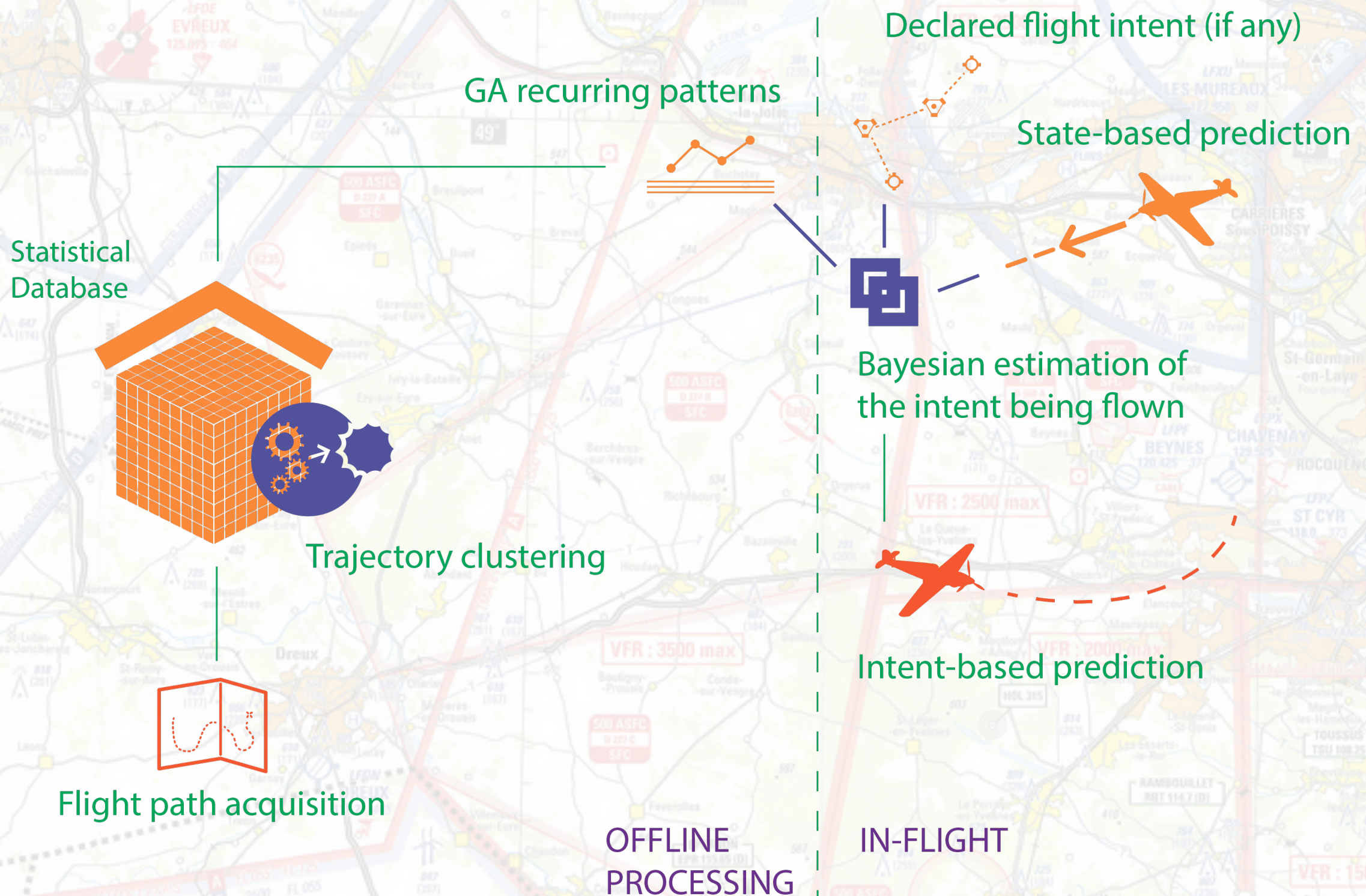
Kernel Density Estimation of Airspace Occupancy  
from GNSS traces flown between LFPZ and LFPD

# Mining GA Typical Paths

A turning-point analysis enables paths classification



# System Overview



# Experiments

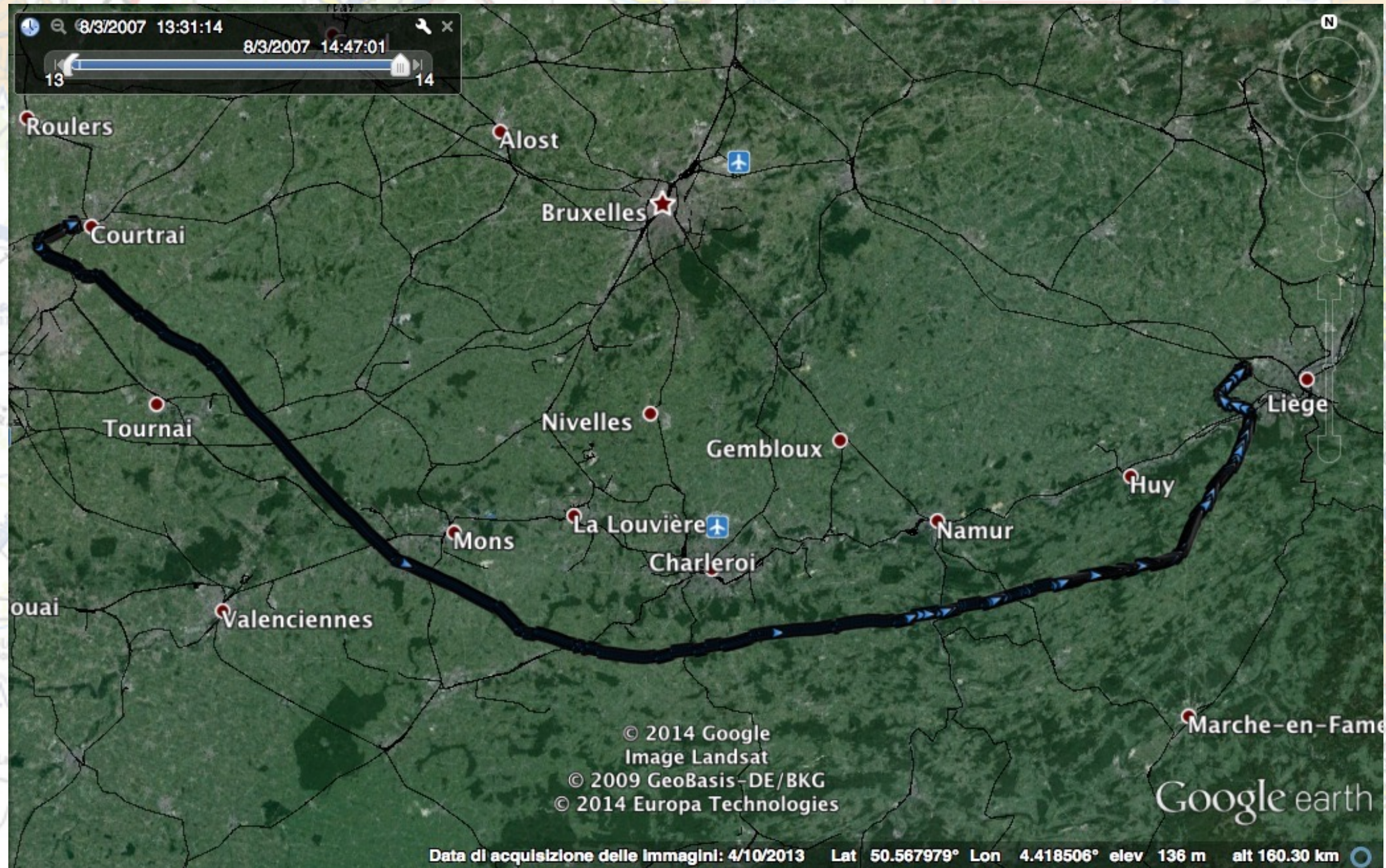
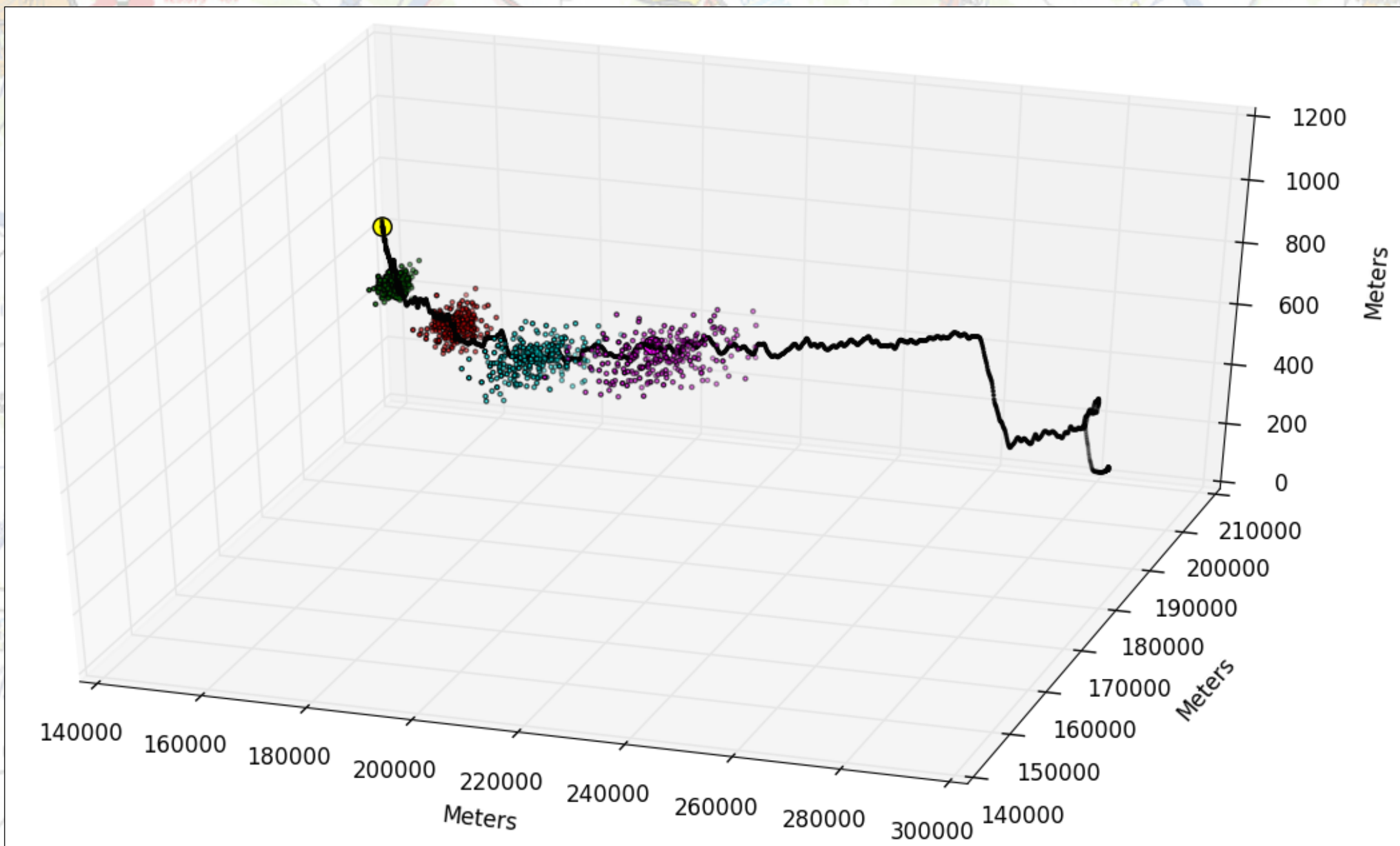
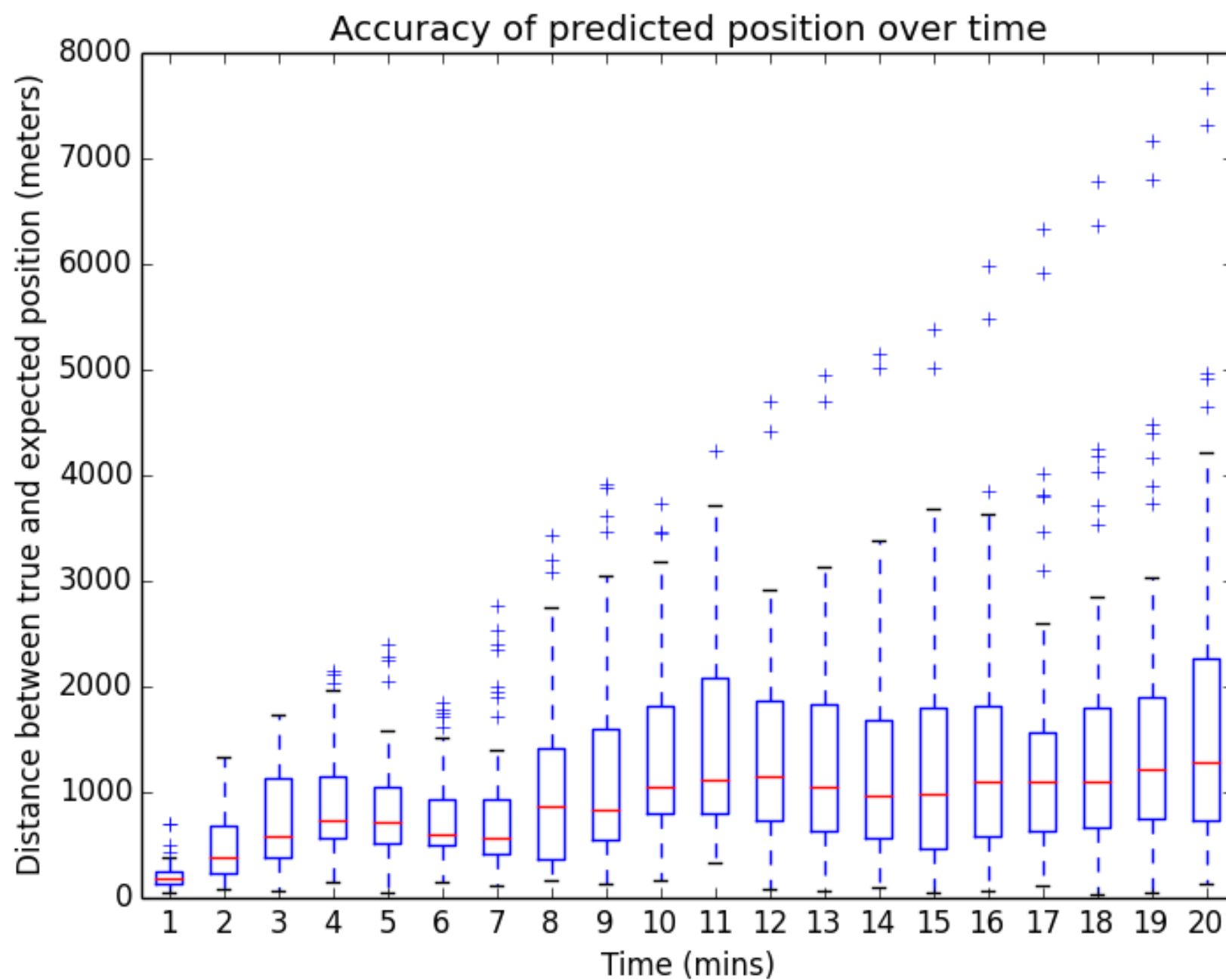


Image courtesy of Hans Brandts, NLR

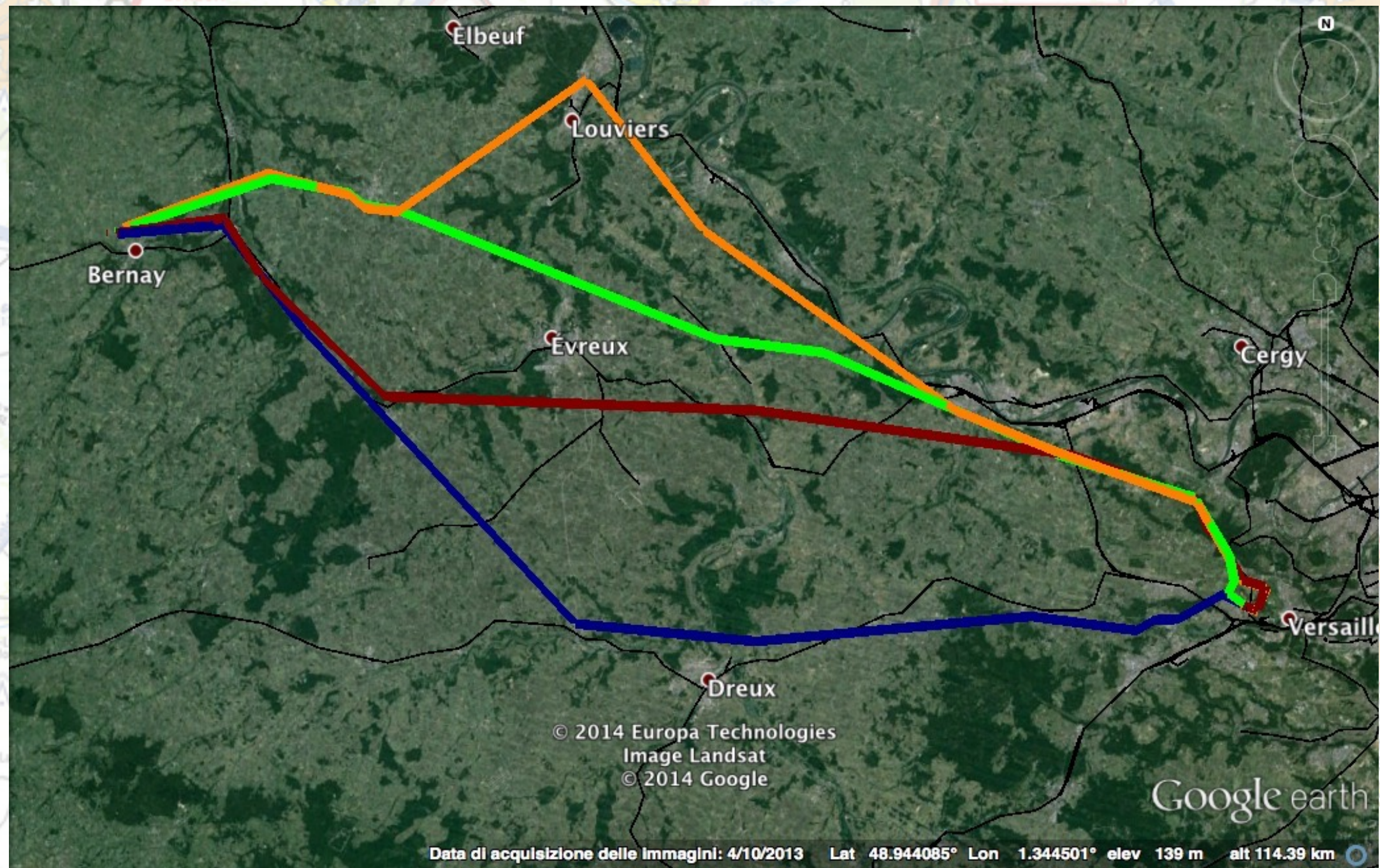
# Experiments



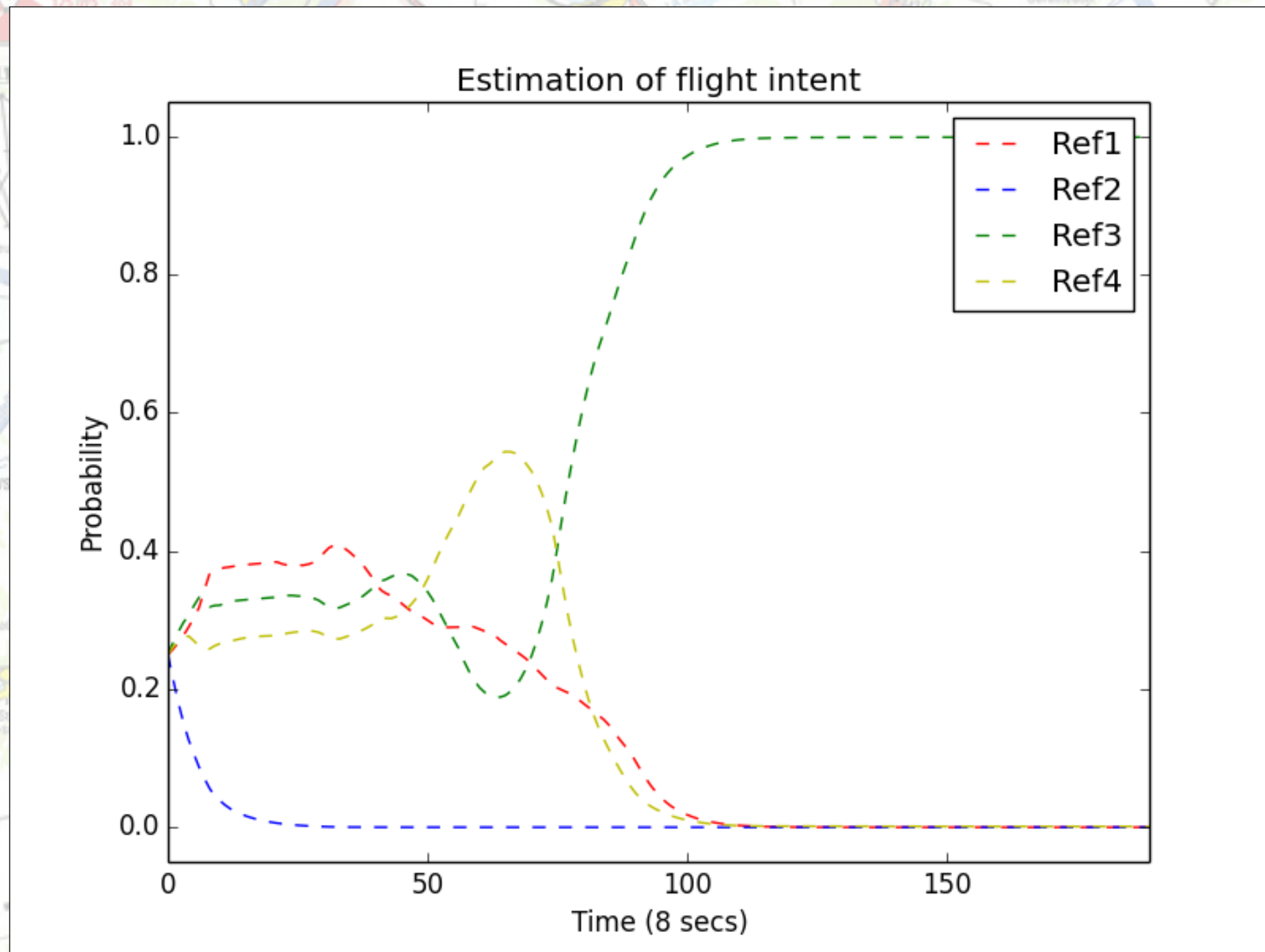
# Experiments



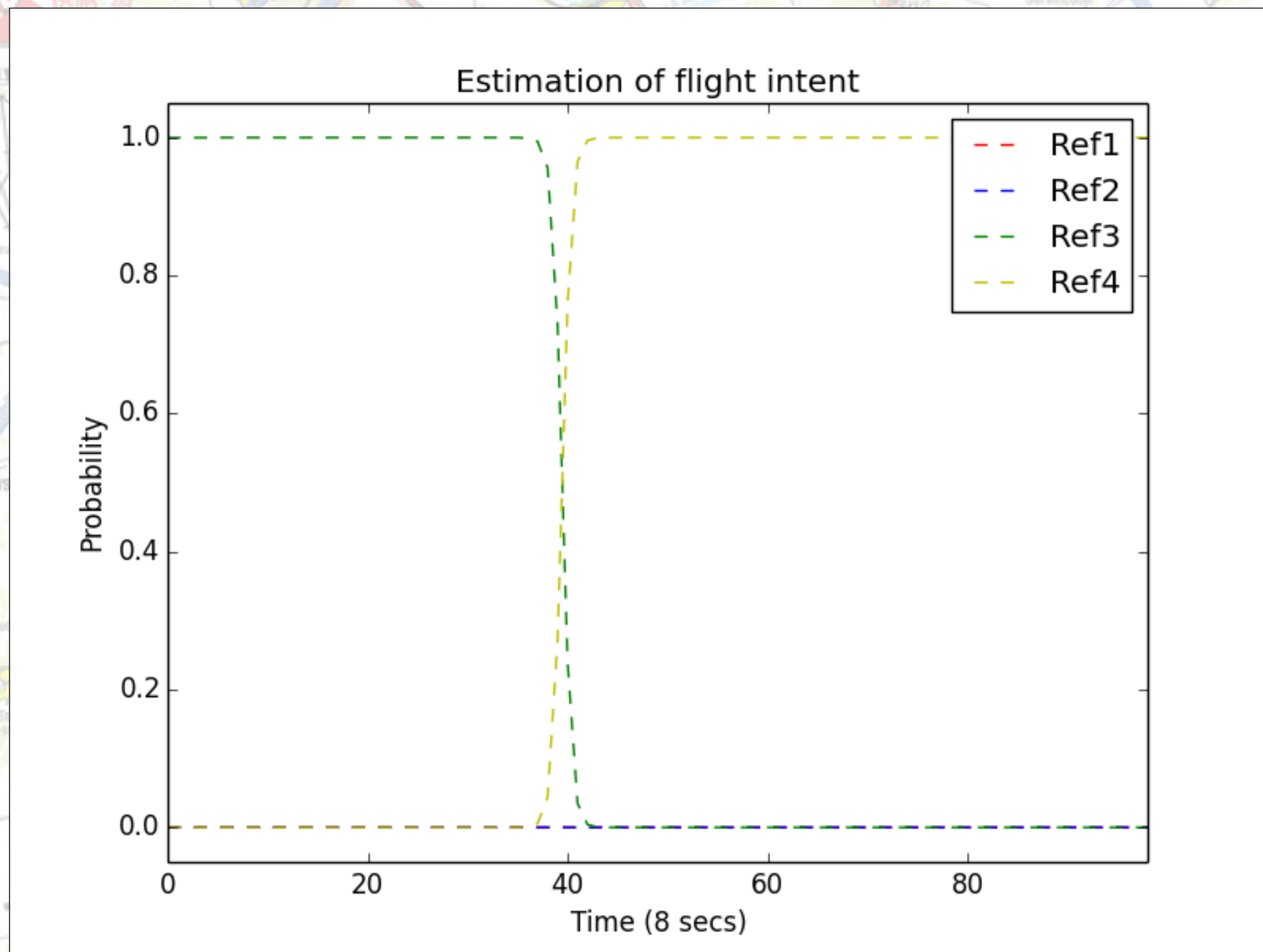
# Experiments



# Experiments



# Experiments



# Conclusions

- Aircraft state + flight intent = intent-based prediction
- Preliminary testing suggests approach is valuable
- How to fruitfully visualise long-term predictions?
- May the data-driven approach alone define an *exhaustive* description of typical GA paths?

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