



SITRAER 2015

AIR TRANSPORTATION SYMPOSIUM

São José dos Campos, SP, Brazil

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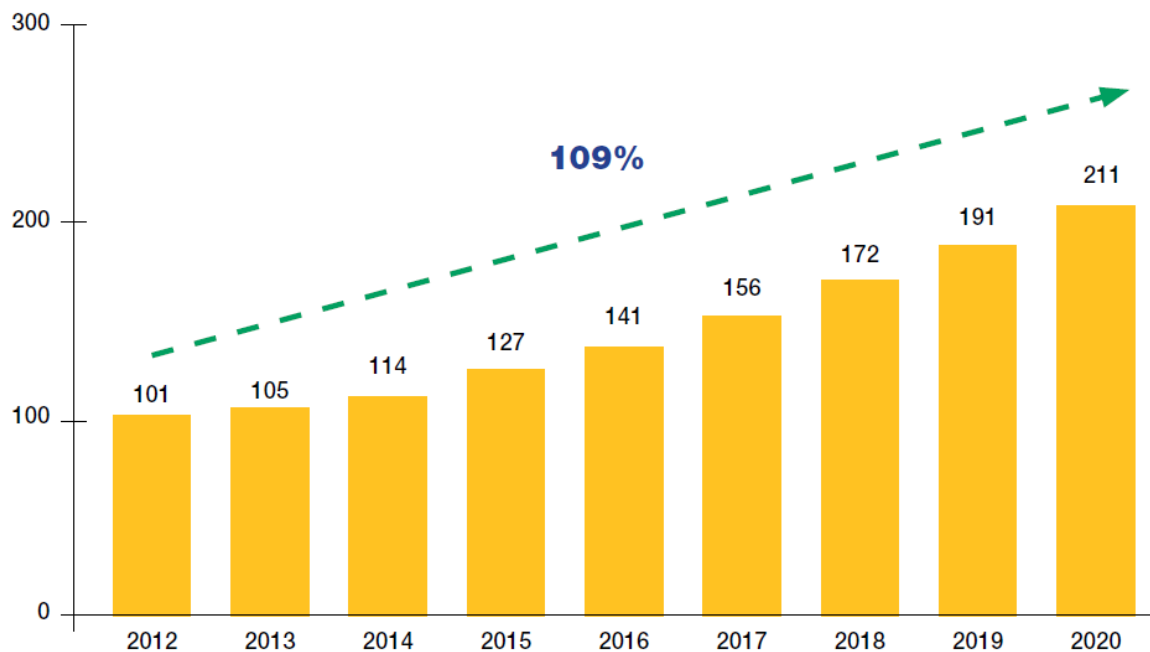
Suely Silva – Atech/CNPq

IMPROVED FLIGHT TRAJECTORY PREDICTION ACCURACY BASED ON ENHANCED AIRCRAFT MODELS



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Potencial de passageiros transportados no Brasil (doméstico e internacional, em milhões)



Fonte: Bain & Co – estimativa jan/2013.

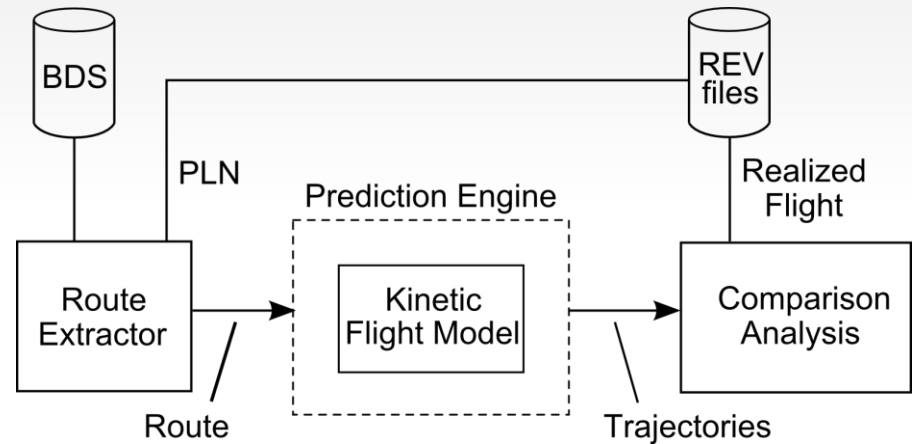


Objective:

Understand how trajectory prediction can be improved by aircraft flight and intent modeling

Challenges:

- Flight data files analysis
- Flight Track analysis
- Comparison of trajectories

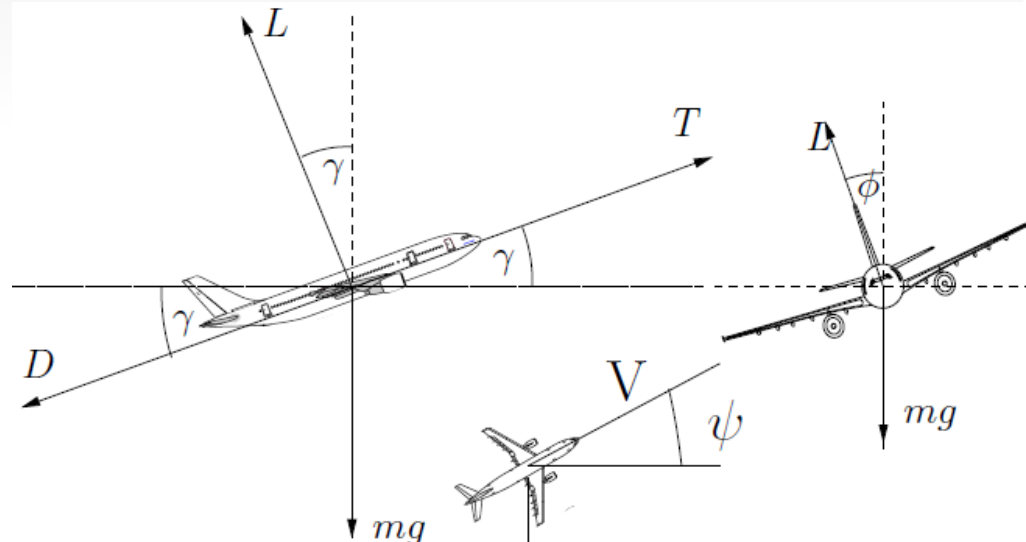


The Aircraft Performance Model (APM)

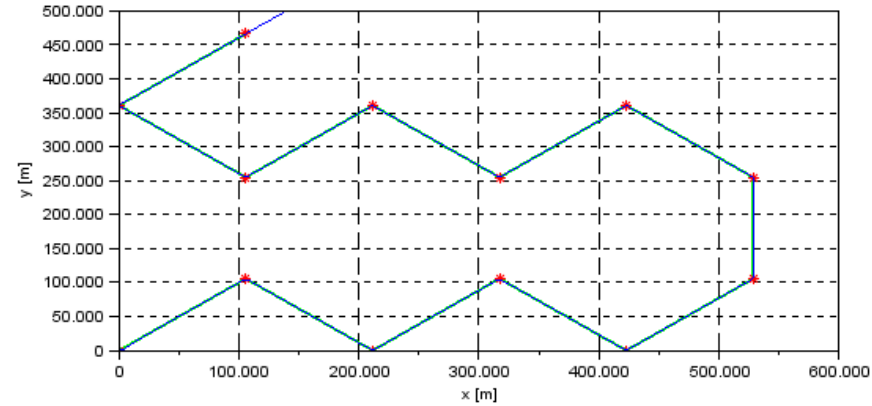
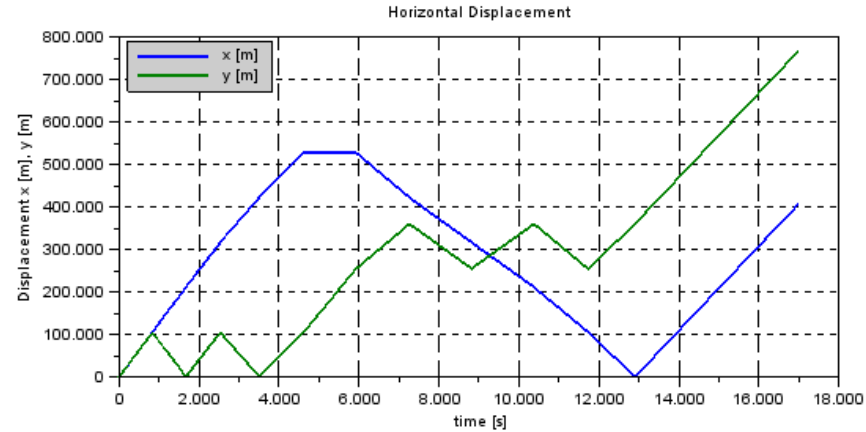
- Kinetic flight model (Glover, Lygeros, 2004)
- Equations of Motion given as ODE's

$$\dot{z}(t) = f(z(t), u, t), \quad z_0 = z(t_0)$$

- Non-linear, non-autonomous mapping $f(\cdot)$, in general
- Aircraft state vector – $z(t)$
- Input vector – $u(t)$

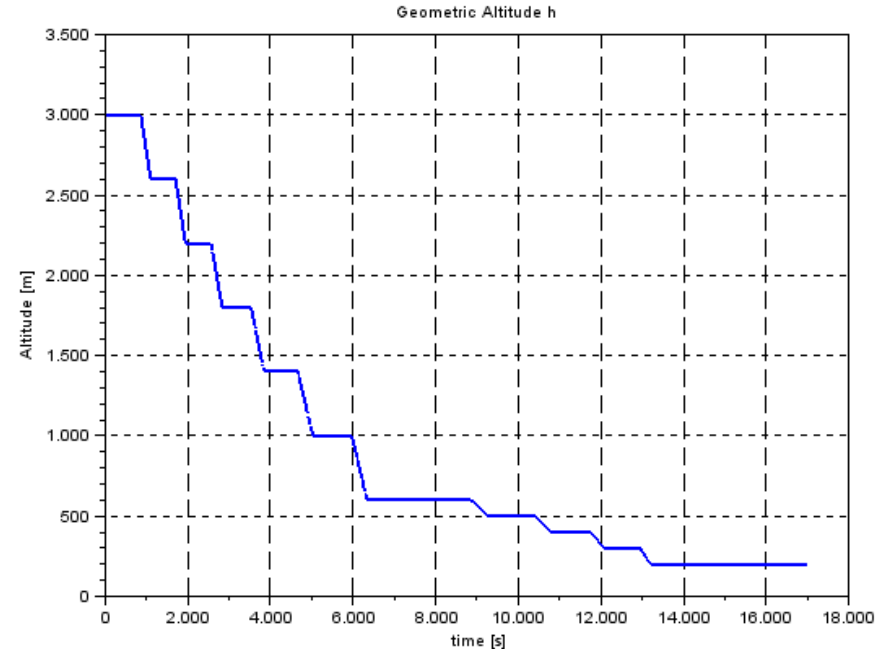


Example: Numerical Results

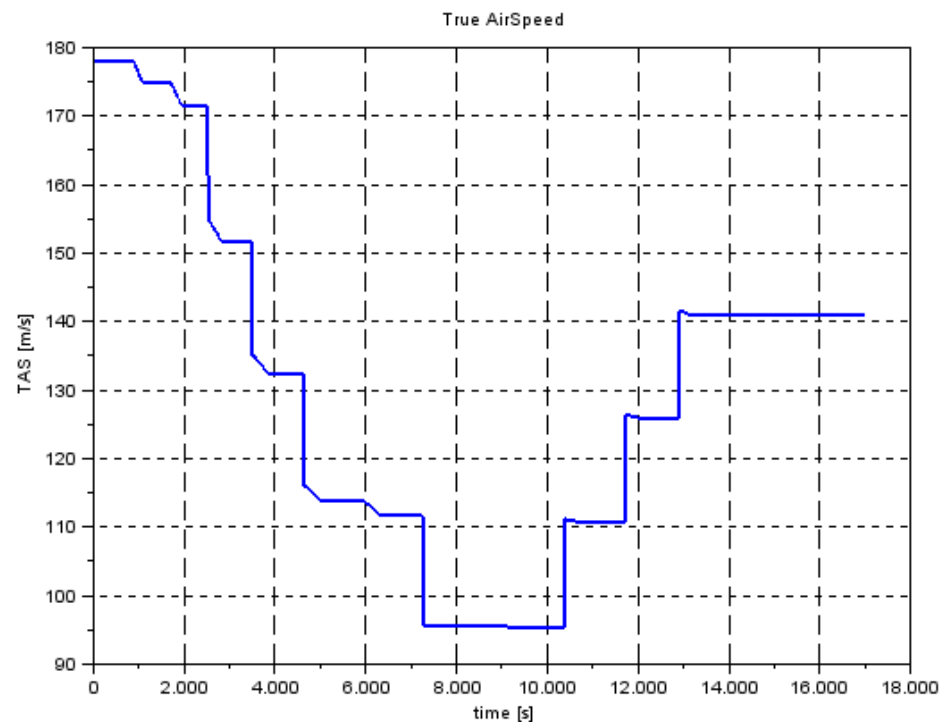
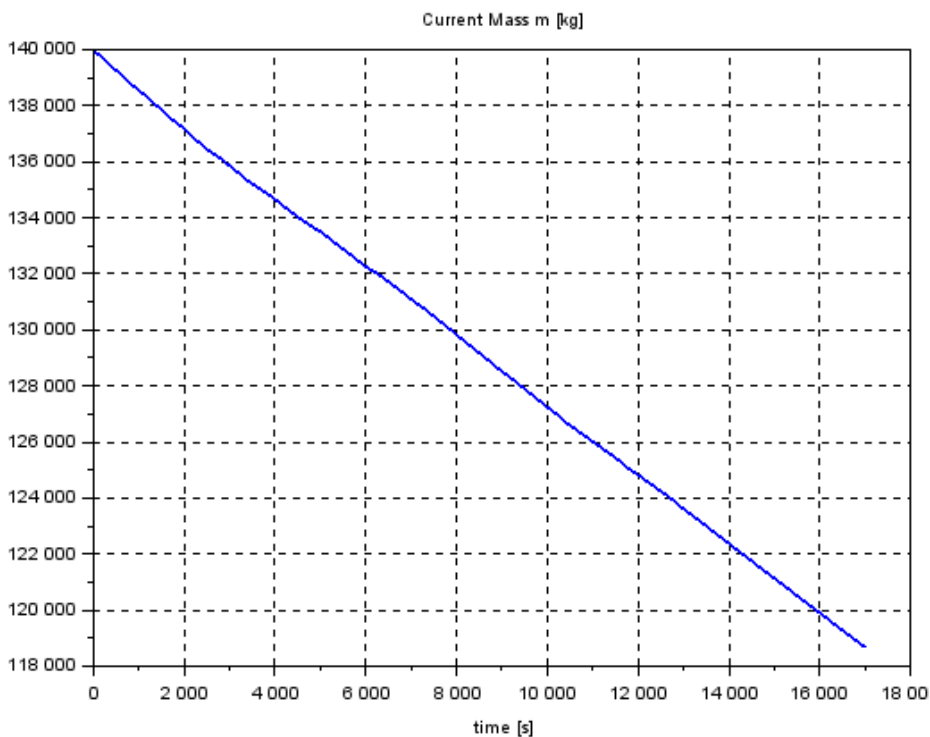


TOW: 140 tons

Elapsed flight time: 17000s or 4h43



Example: Numerical Results



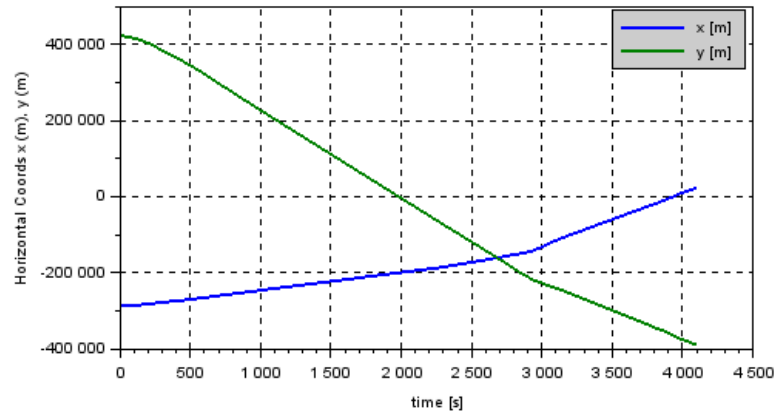
Case studies:

- track data for 3 real domestic flights

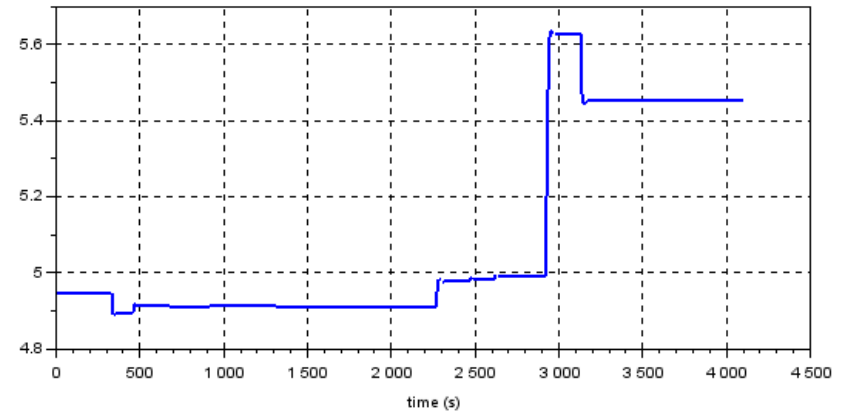
Flight Indicativo	ADEP	ADES	FL	V (kn)	Flight duration
XXX1111	SBGO	SBSP	390	450	01h15
YYY2222	SBCF	SBEG	340	462	00h30
ZZZ3333	SBGR	SBRP	240	342	00h41

Flight Trajectory Reconstruction – xxx1111

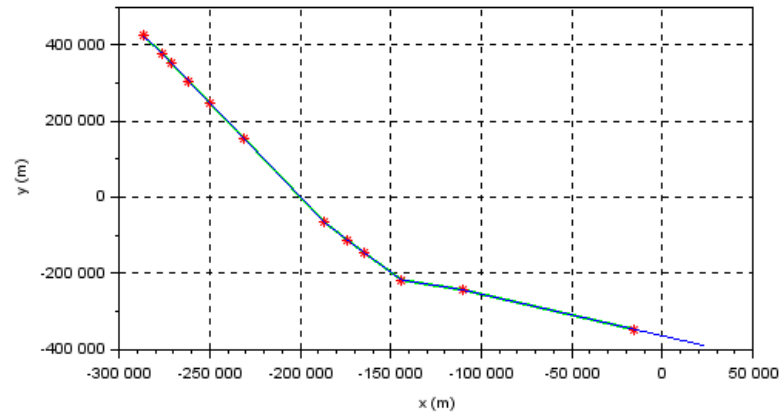
Translational Displacement



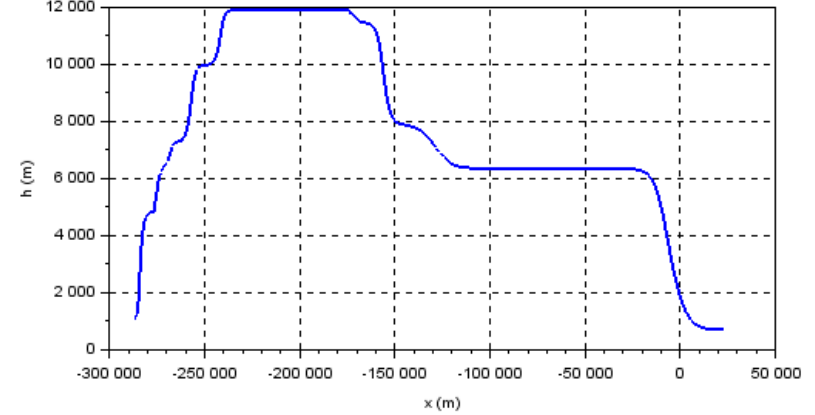
Heading angle [rad]



Horizontal Displacement

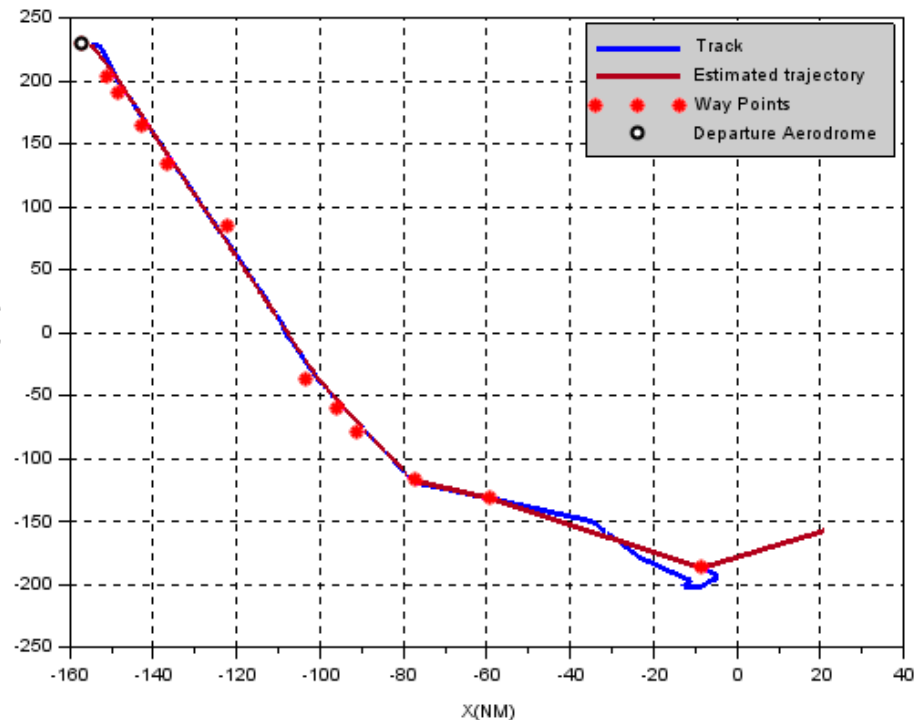


Vertical Displacement

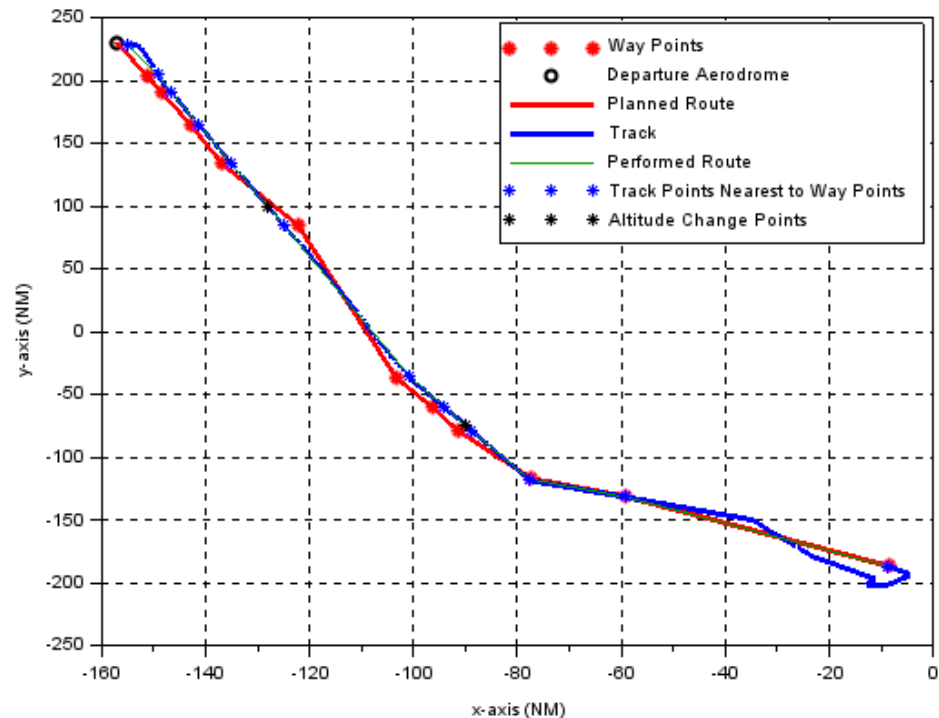


Flight Trajectory Reconstruction

Track and Estimated Trajectory

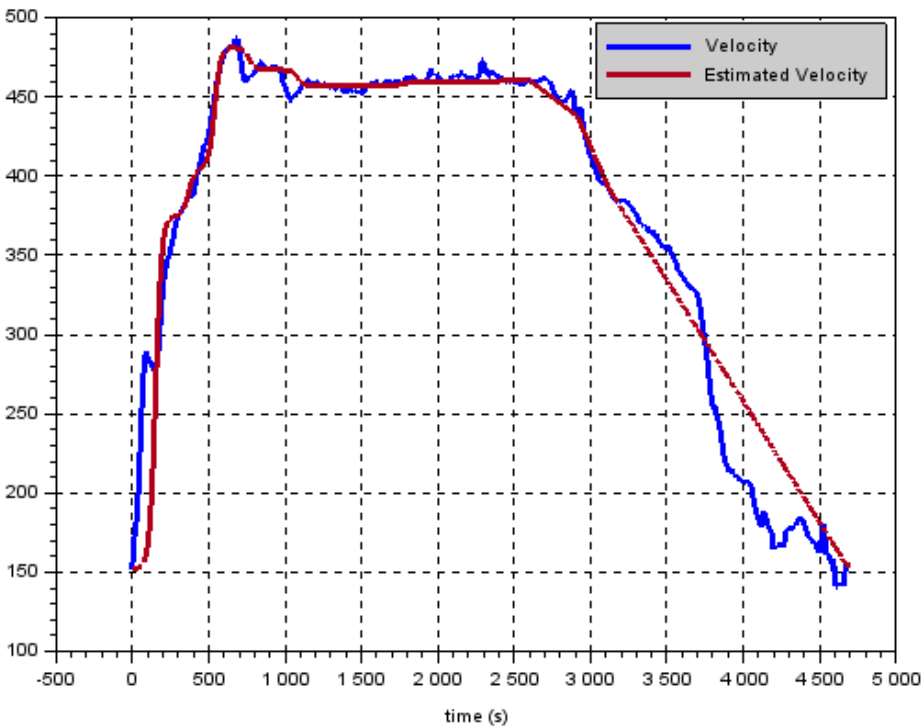


Route and Track

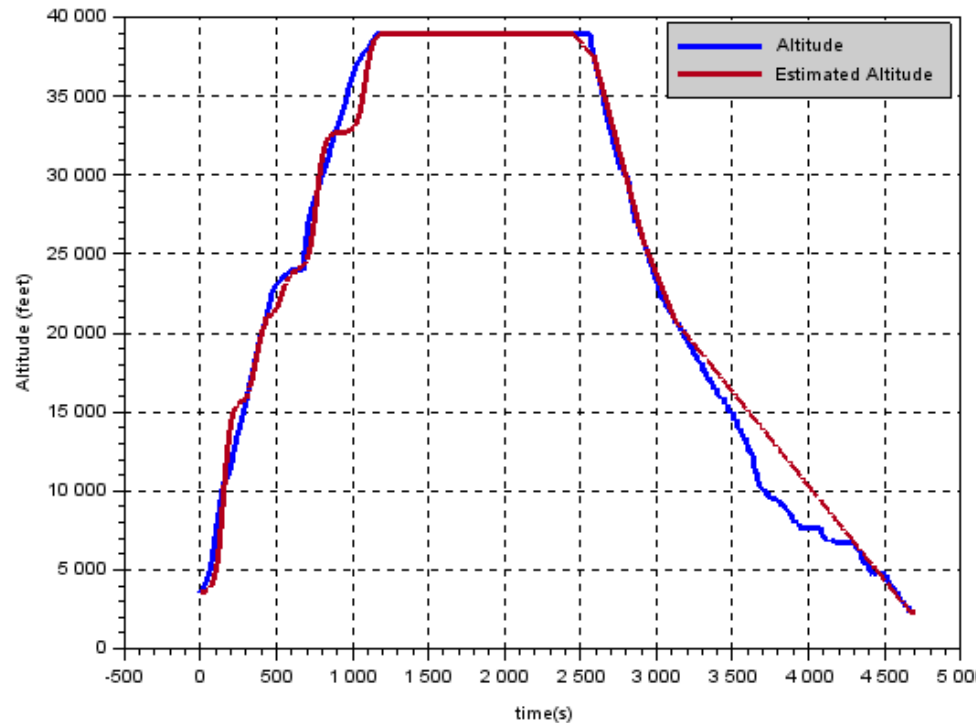


Flight Trajectory Reconstruction (cont.)

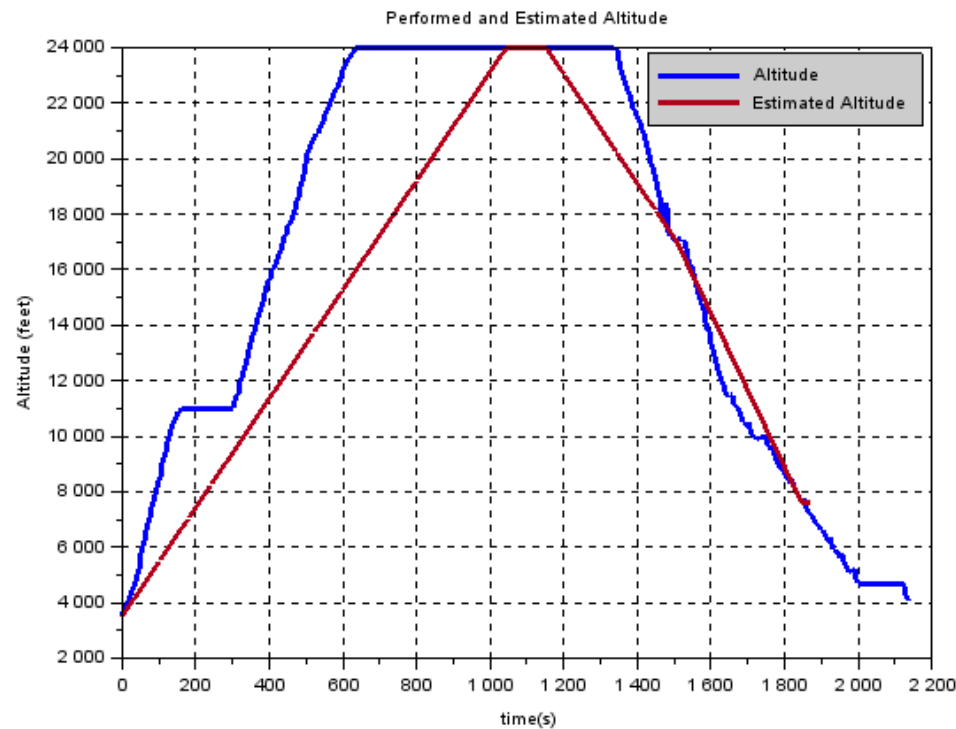
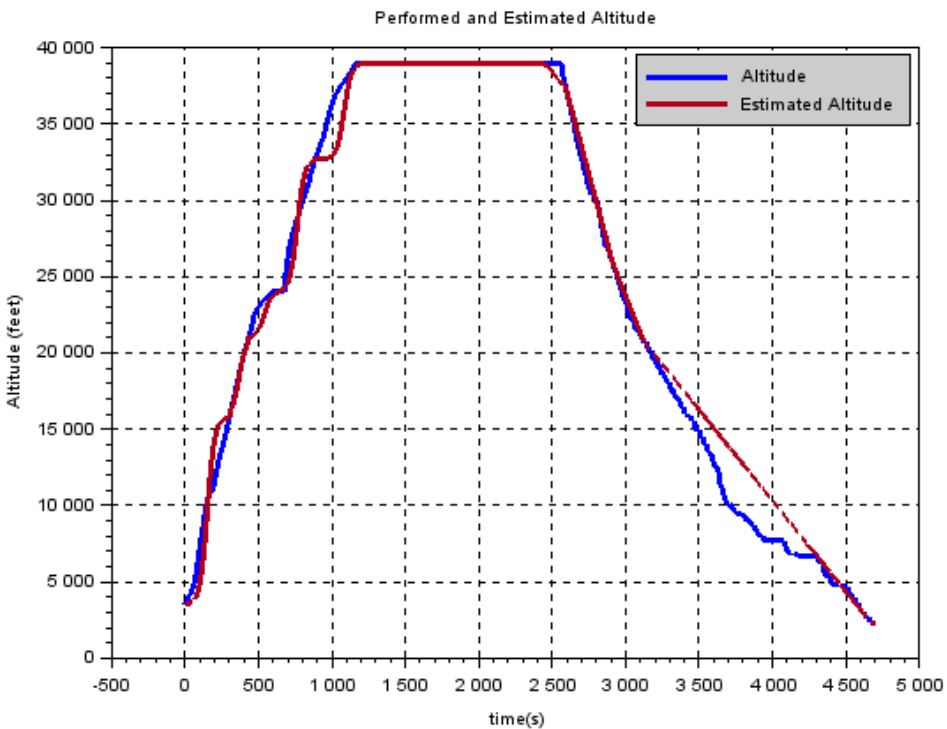
Performed and Estimated Velocity



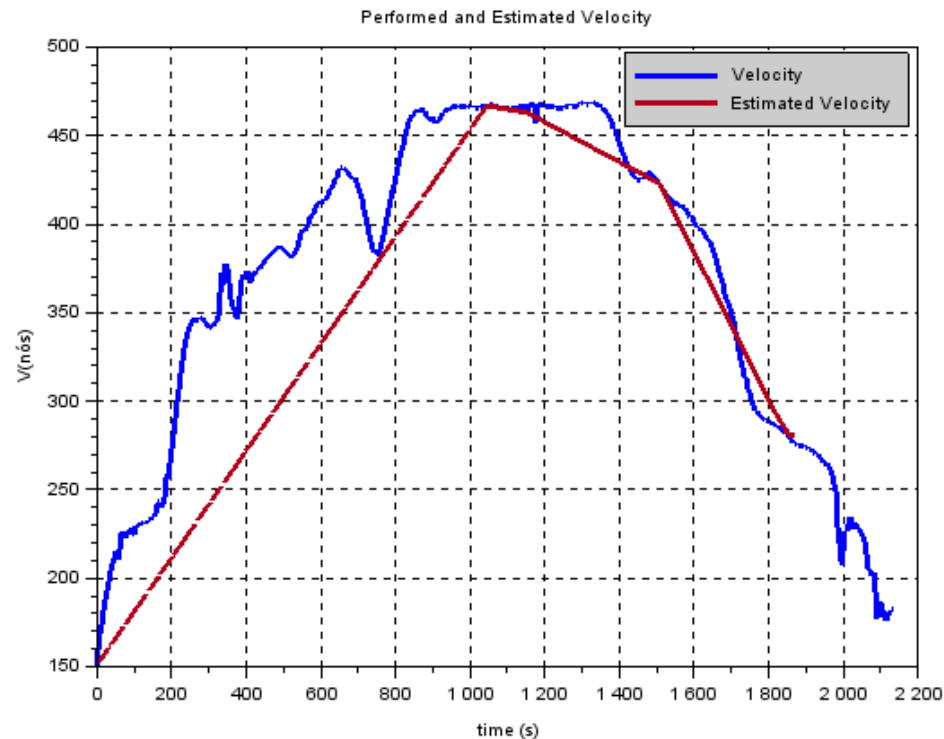
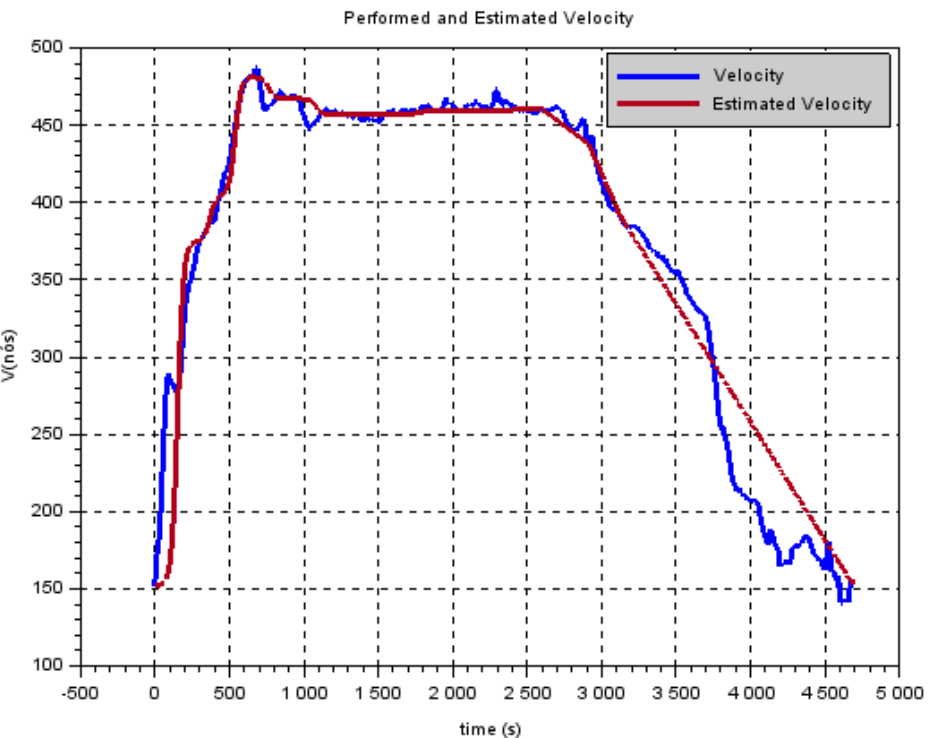
Performed and Estimated Altitude



One important matter to consider! (xxx1111 vs. zzz3333)



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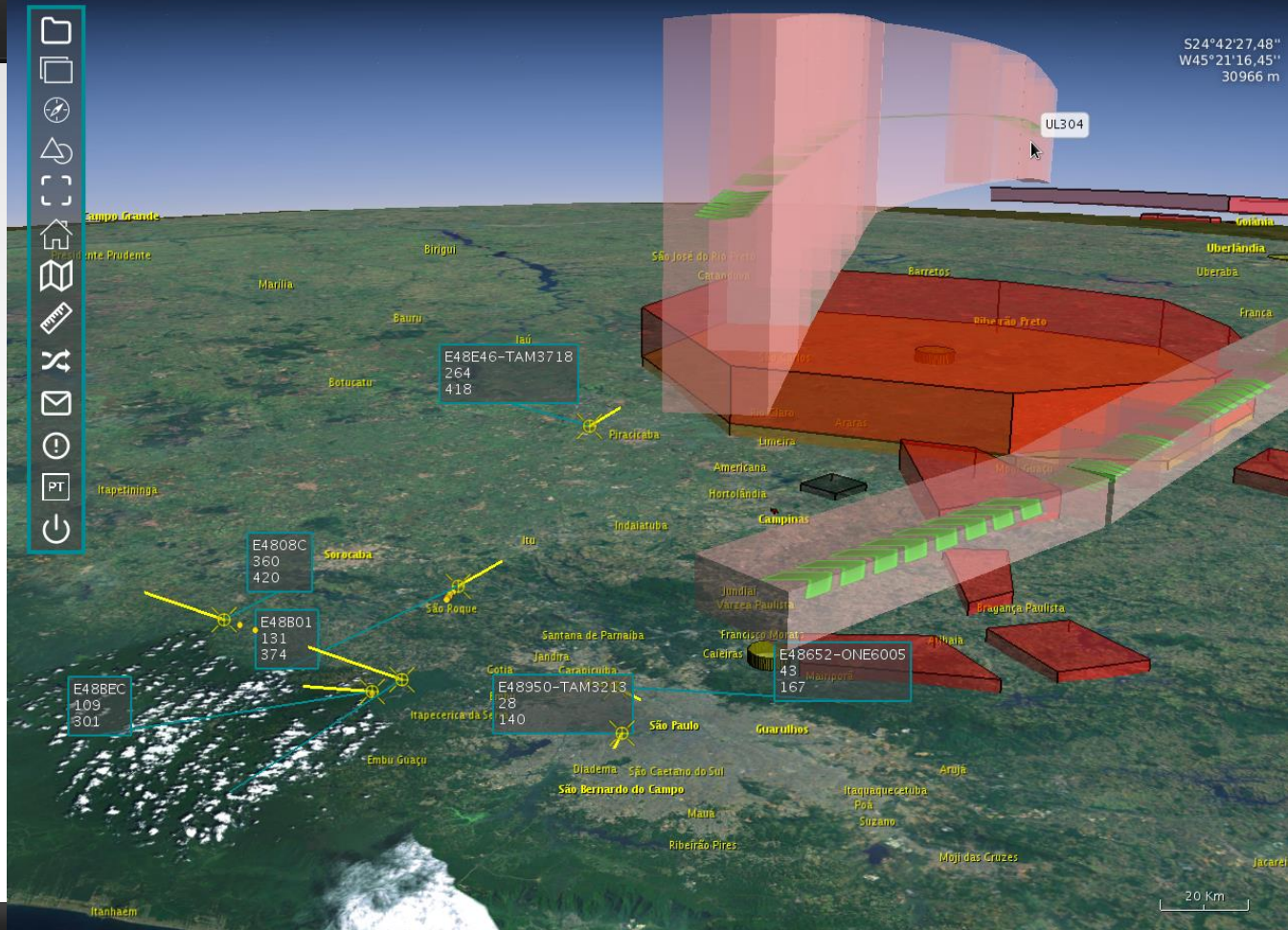
- Qualitative spatial error analysis
 - Snapshot of ongoing TP development
 - Model can be tuned in many ways

Flight Indicativo	DE (%)	AE (%)	Flight duration
XXX1111	0,599	1,00	01h17
YYY2222	0,219	0,89	00h30
ZZZ3333	1,000	1,00	00h41

- Flight Intent information is extremely important

More or less intent information will greatly affect results!

- waypoint intent modeling: “TP results are very close for one flight; not good for other”



The Capabilities Framework – Atech

Airspace structure displayed in 3D mode:

- airways
- TMAs
- conditioned airspace
- ADS-B tracks

- Preliminary results for in-house research
 - Objective: Impact of new concepts and techniques in the Brazilian controlled airspace
- Kinetic flight dynamics model for Trajectory Prediction
- Prediction is sensitive to flight intent modeling
- Significant application potential for future ATM/ATC systems
- Model flexibility-of-use:
 - Easily incorporates flight related factors
 - Impact on performance
- Current research
 - Models (versions) analyses
 - Trajectory prediction analyses

Atech

- Product Engineering
- Innovations Group
 - Eder Souza, Eduardo Pereira, Fabio Aguchiku, Fabio Takase, Giovanna Koroishi, Paula Garcia, and Rafael Leme
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