

EUR RMA HMU Infrastructure and ASE Examples

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EUROCONTROL

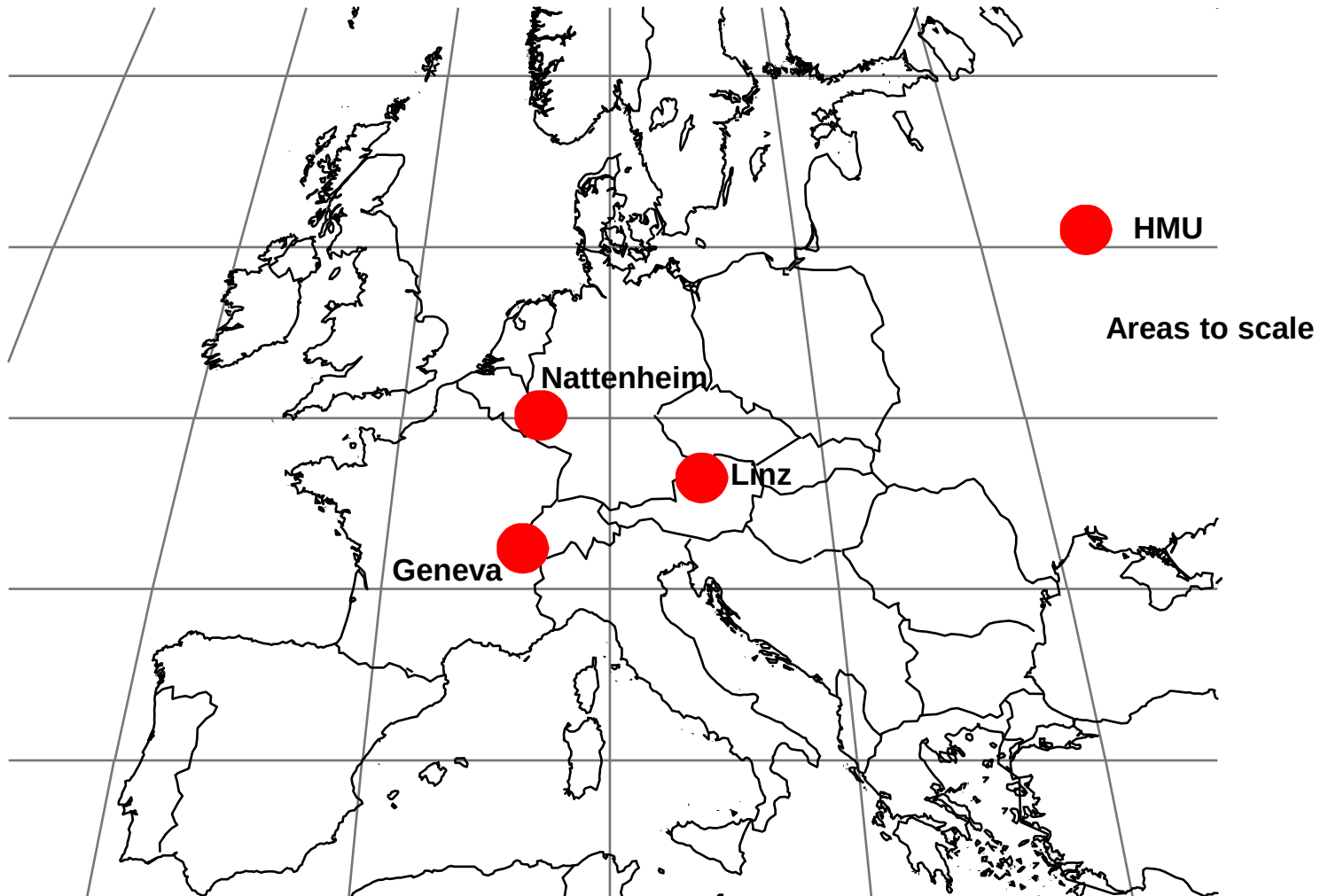
ASE Workshop
Atlantic City
13 – 15 September 2016

Height Monitoring in Europe - 1

- 3 x Height Monitoring Units (Nattenheim, Geneva and Linz)
- Each HMU consists of 5 passive multi lateration receivers, central processing system and aircraft Total Vertical Error estimation software (TMU)
- 45 nm radius coverage at RVSM levels
- All aircraft with transponders passively monitored*
- 24/7 unmanned operation with fully automated data transfers
- RCMS for system and parameter monitoring
- Capable of monitoring 400 individual aircraft at any one time

* Minimum track length 20 nm and no major turns, climbs or descents

EUROCONTROL HMU Infrastructure



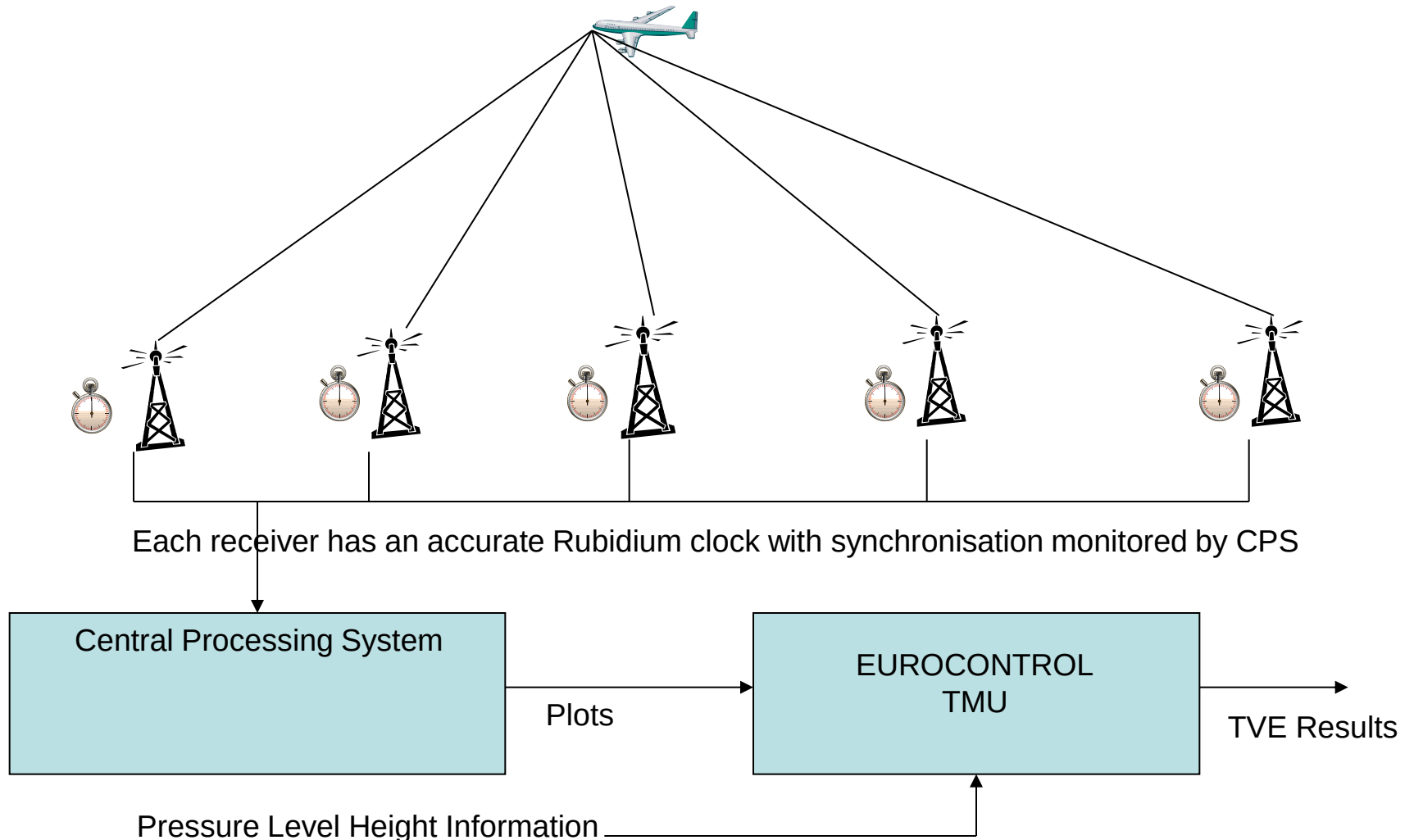
Height Monitoring in Europe - 2

- One plot per second derived from high accuracy multi lateration system
- Accuracy maintained by individual receivers by common clock triggering and accurate individual Rubidium based internal oscillators
- Receiver synchronisation monitored by central processing system and comparing returns from individual receivers
- Receiver accuracy approximately $\pm 5\text{nS}$
- System synchronisation accuracy $\pm 10\text{nS}$

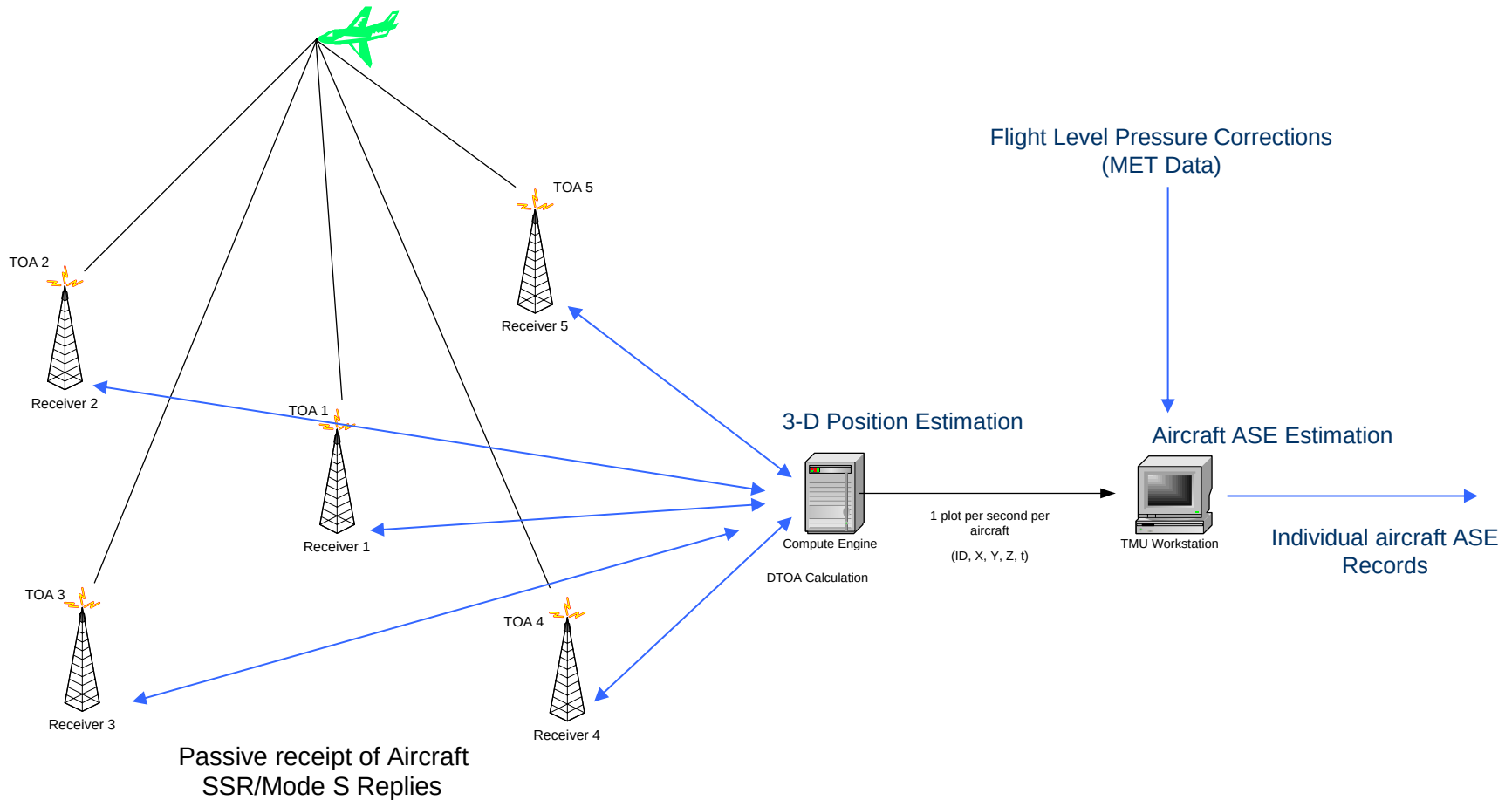
TVE Monitoring Unit

- Processes individual plots to form aircraft tracks
- Applies geometric height corrections for variations in meteorological pressure conditions
- Backward and forward smoother applies final correction to remove errors which may have been introduced by inaccuracies in forecast met data and pressure curve modelling
- Output consists of individual height monitoring results for each flight or flight segment in coverage area
- Principle data fields are Deviation from Assigned Altitude (derived from transponder signal) and Total Vertical Error (difference between estimated geometric height of reported flight level and measured geometric height of the aircraft)
- Altimetry System Error is estimated as the difference between TVE and AAD

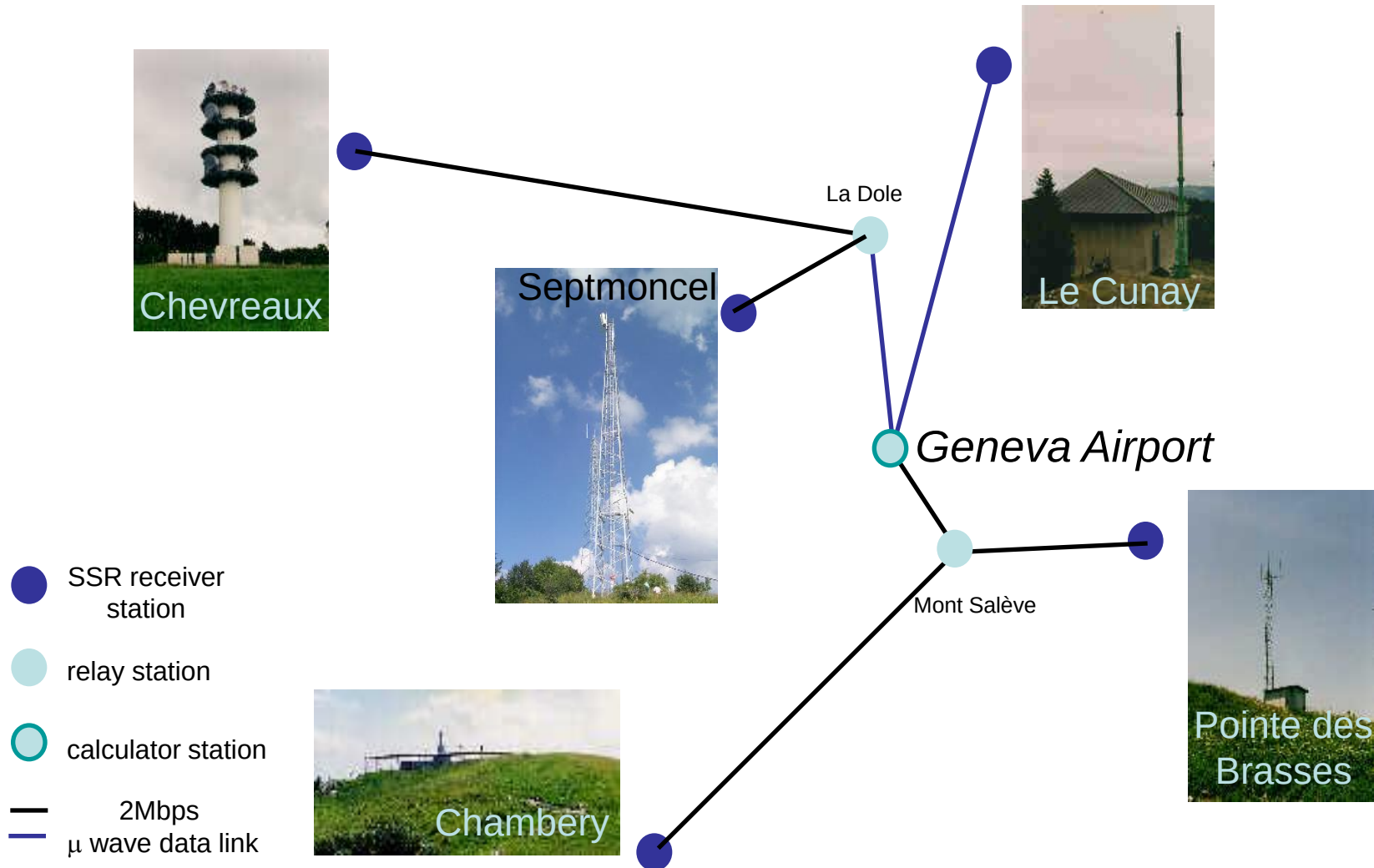
Generic HMU Configuration



Basic HMU Configuration



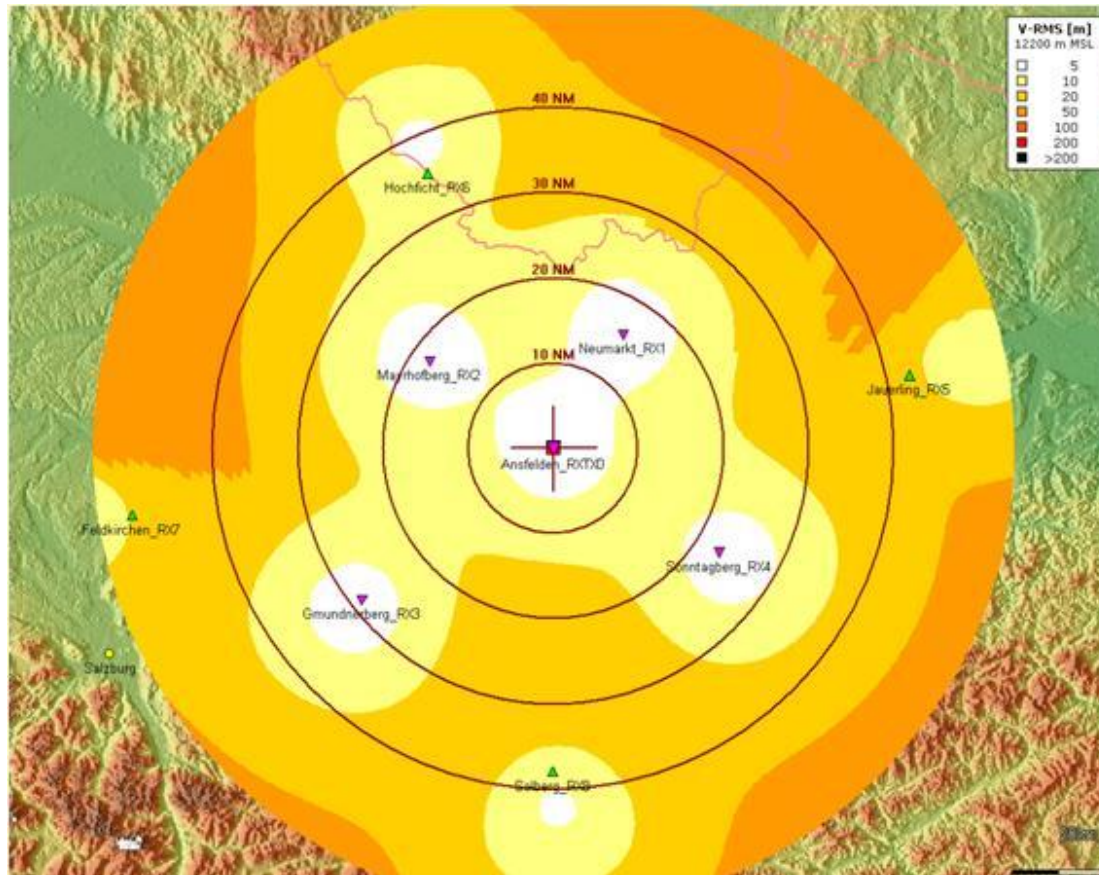
Geneva HMU



Data Verification

- HMU system does not have uniform accuracy throughout the coverage area

Linz HMU Coverage at 32,000 ft.





Data Verification

- HMU system does not have uniform accuracy throughout the coverage area
- Met data can vary in quality depending on weather stability (Met Quality Indicator included with each data point)



EUROCONTROL

N LAT POINTS=4 N LON POINTS=4 NMOST LAT=50.56 WMOST LON= 5.00

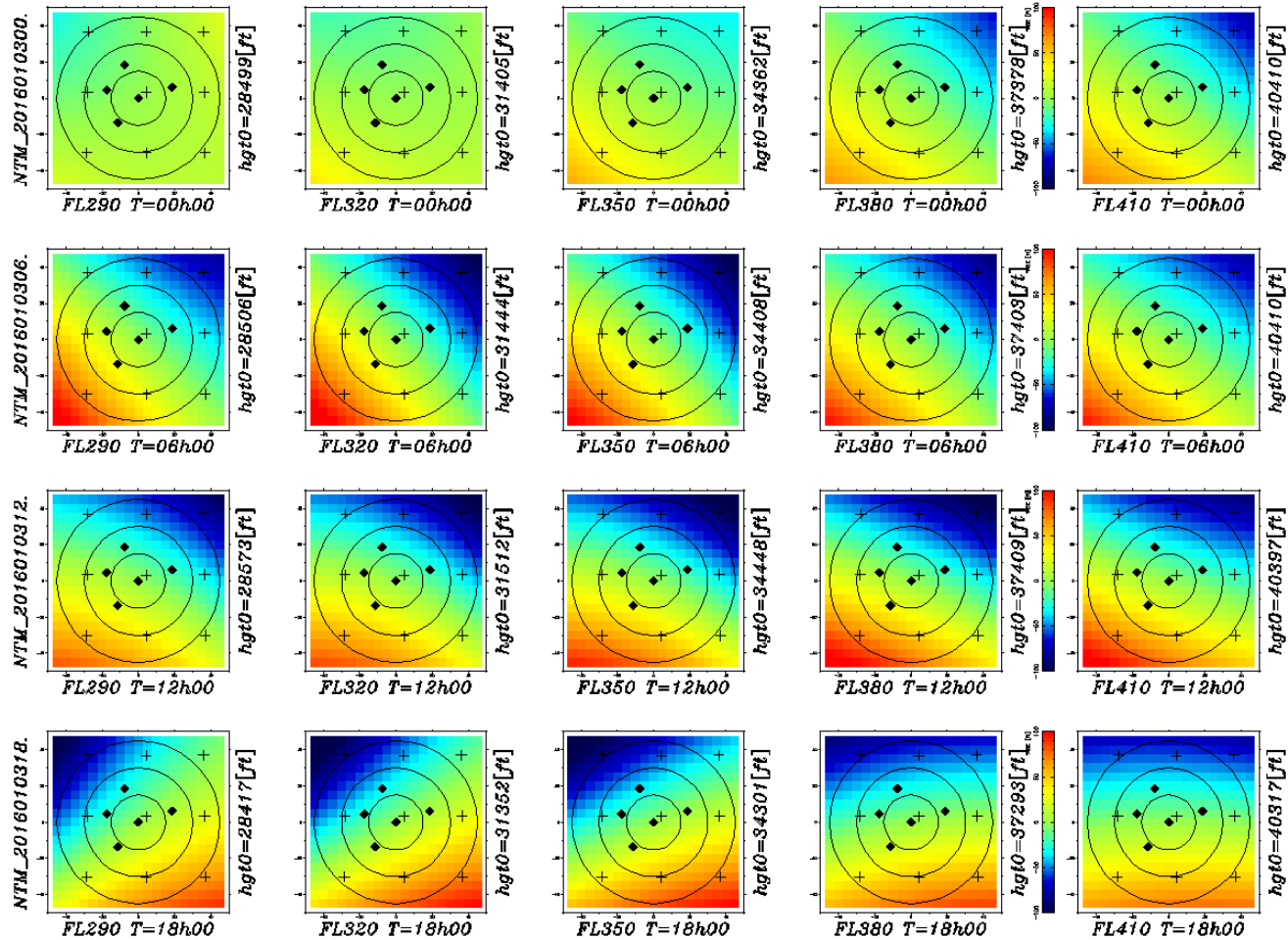
NO OF FLT LVLS=20 MIN FLT LVL= 220 FLT LVL INCREMENT=10

FORECAST GEOMETRIC HEIGHTS FOR NATTENHEIM

1TIME/DATE= 12 2 6 2016

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QUALITY		989	989	989	989	989	989	989	989	989	989	989	989	989	989	989	989	989	989	989	989
50.56,	5.83	22453	23479	24504	25527	26547	27566	28582	29595	30606	31613	32618	33619	34618	35613	36607	37602	38598	39599	40605	41615
QUALITY		989	989	989	989	989	989	989	989	989	989	989	989	989	989	989	989	989	989	989	989
50.56,	6.67	22425	23450	24474	25496	26516	27533	28549	29561	30571	31577	32581	33582	34581	35579	36577	37575	38576	39580	40589	41602
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50.56,	7.5	22393	23416	24439	25459	26478	27495	28510	29523	30532	31539	32544	33546	34546	35546	36546	37547	38550	39558	40570	41586
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50.00,	5.83	22437	23463	24488	25510	26531	27548	28564	29576	30585	31591	32594	33595	34593	35590	36586	37584	38584	39587	40595	41607
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50.00,	6.67	22407	23432	24455	25477	26497	27515	28530	29543	30552	31559	32562	33564	34563	35561	36560	37559	38562	39568	40579	41594
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50.00,	7.5	22371	23395	24417	25438	26458	27475	28490	29503	30512	31519	32523	33525	34526	35526	36528	37531	38537	39547	40561	41578
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49.44,	5.83	22416	23441	24465	25487	26506	27524	28540	29552	30562	31569	32573	33574	34573	35570	36567	37565	38566	39571	40582	41597
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49.44,	6.67	22385	23410	24433	25455	26475	27493	28508	29521	30530	31536	32539	33539	34538	35537	36536	37536	38541	39549	40563	41581
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48.89,	5.83	22399	23423	24446	25467	26486	27503	28518	29531	30540	31547	32550	33552	34552	35550	36549	37549	38552	39560	40573	41590
QUALITY		989	989	989	989	989	989	989	989	989	989	989	989	979	969	969	969	979	979	989	989
48.89,	6.67	22368	23391	24412	25432	26451	27468	28482	29494	30503	31509	32512	33514	34513	35513	36513	37515	38520	39531	40546	41567
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48.89,	7.5	22343	23363	24382	25401	26417	27432	28445	29455	30463	31468	32471	33472	34474	35477	36482	37489	38499	39514	40533	41556
QUALITY		979	969	969	979	979	979	979	989	989	989	989	989	979	969	959	969	969	979	979	989

Monitoring Met Conditions



Data Verification

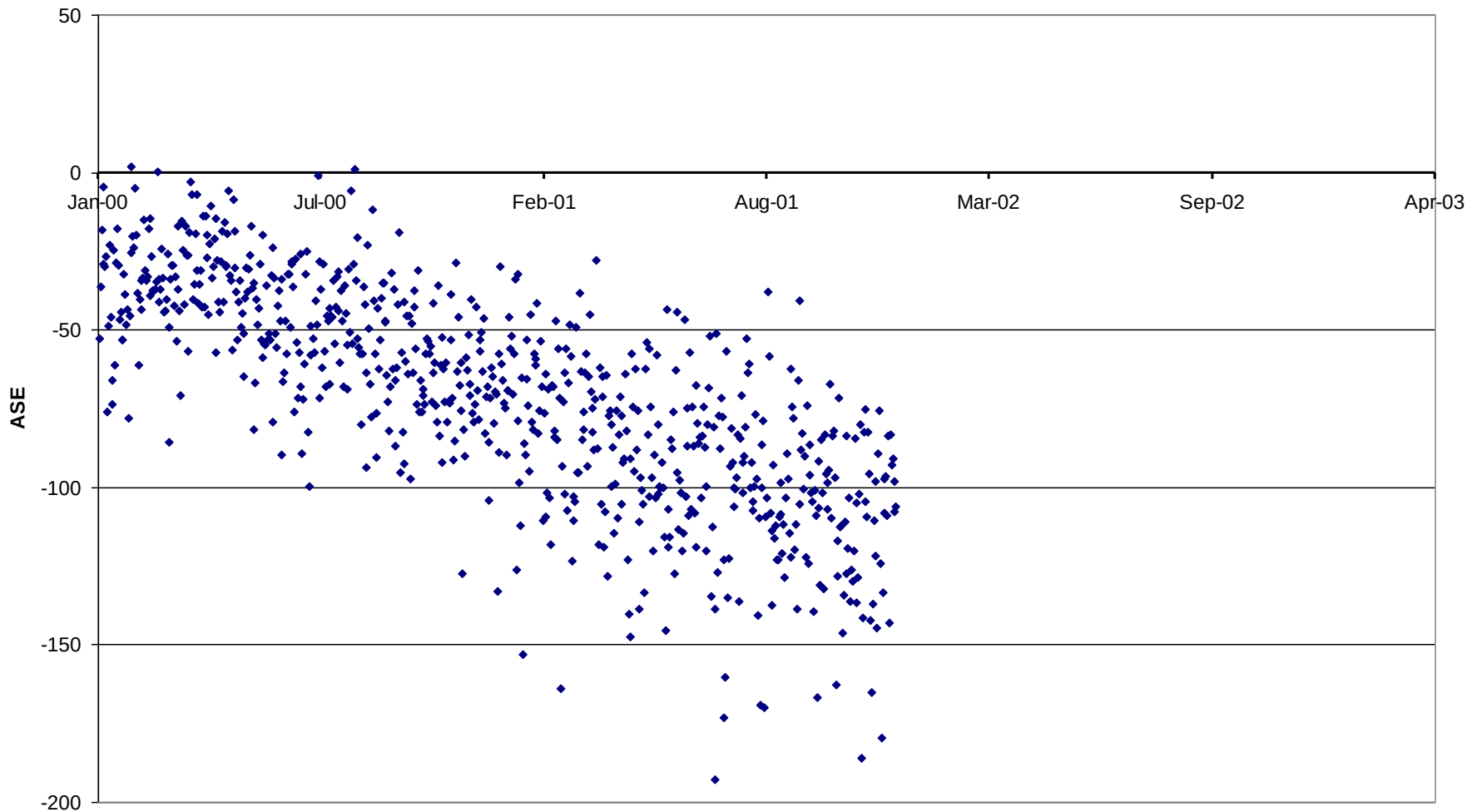
- HMU system does not have uniform accuracy throughout the coverage area
- Met data can vary in quality depending on weather stability (Met Quality Indicator included with each data point)
- Sudden aircraft maneuvering not captured by tracking process
- Error in aircraft transponder data
- The EUR RMA conducts a manual quality control check of all large ASE results

ASE Case Studies

- Assess results of Collision Risk Analysis with airspace Target Level of Safety
- Raise generic performance issues with TC/STC regulator. Liaise directly with TC/STC holder when requested.
- Raise individual airframe/operator performance issues with RVSM approval authority. Liaise directly with operator when requested.

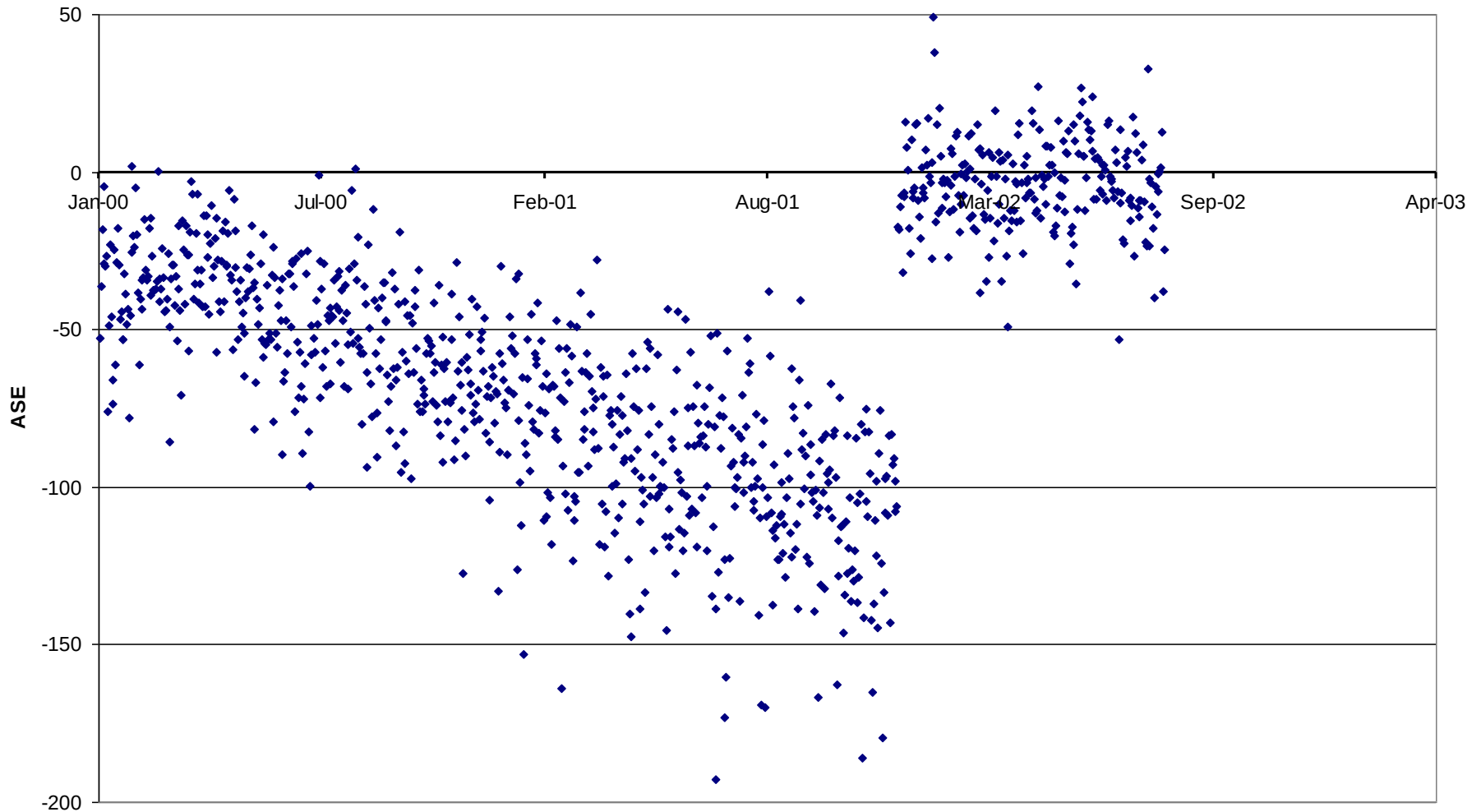
ASE Analysis

ASE Drift: Aircraft ID 13556



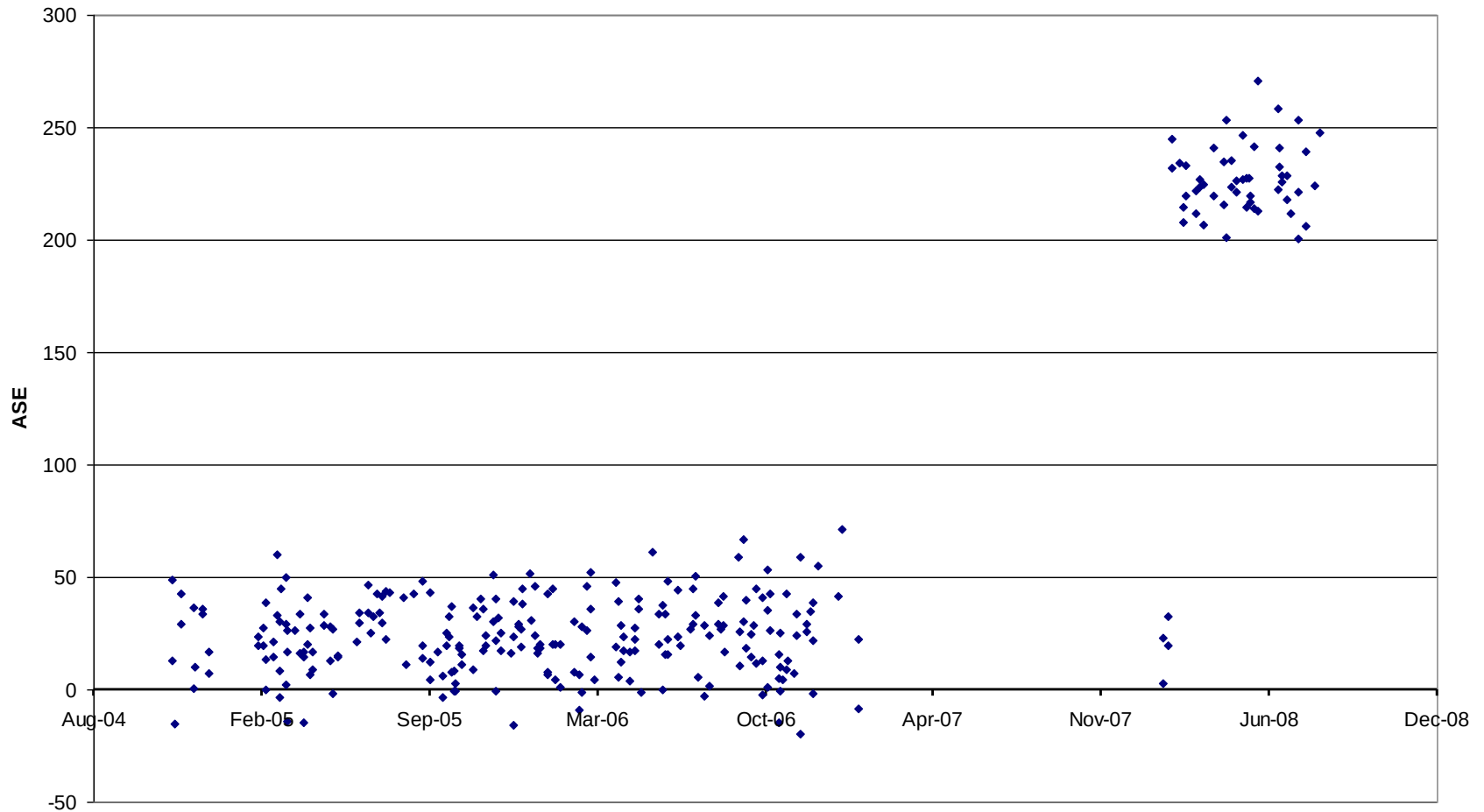
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ASE Drift: Aircraft ID 13556



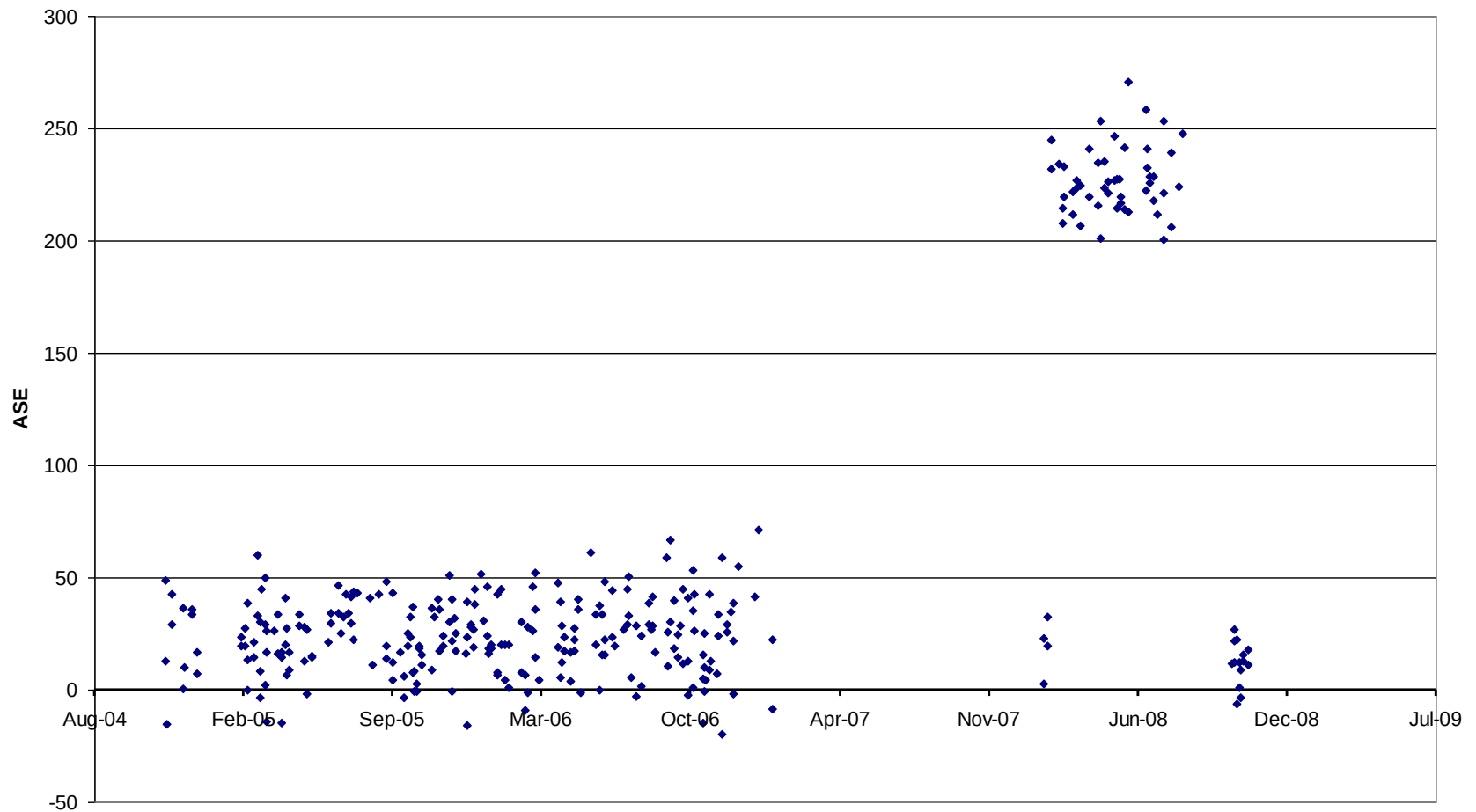
ASE Analysis

ASE Jump: Aircraft ID 17443

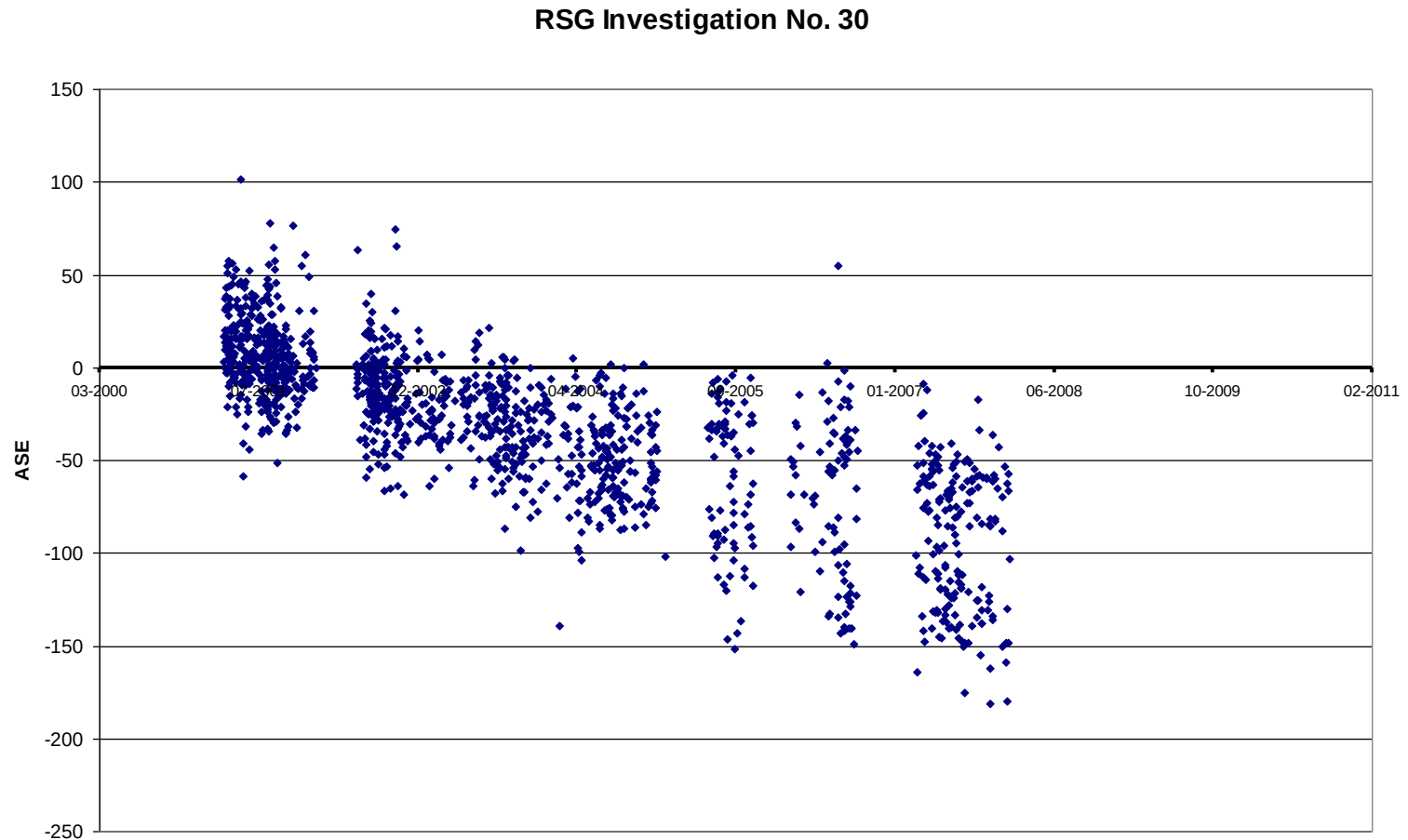


ASE Analysis

ASE Jump: Aircraft ID 17443

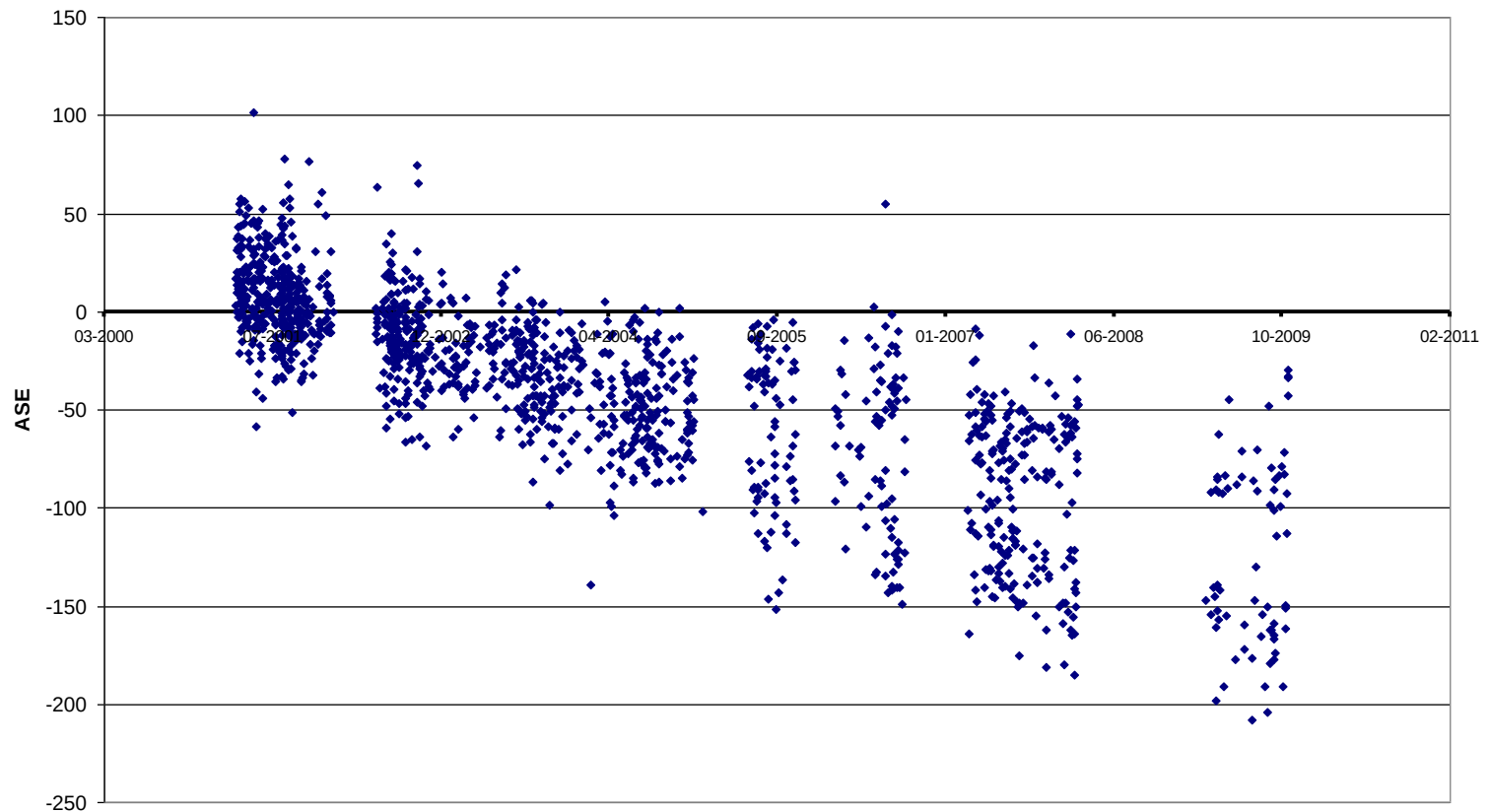


Example of Drift Investigation

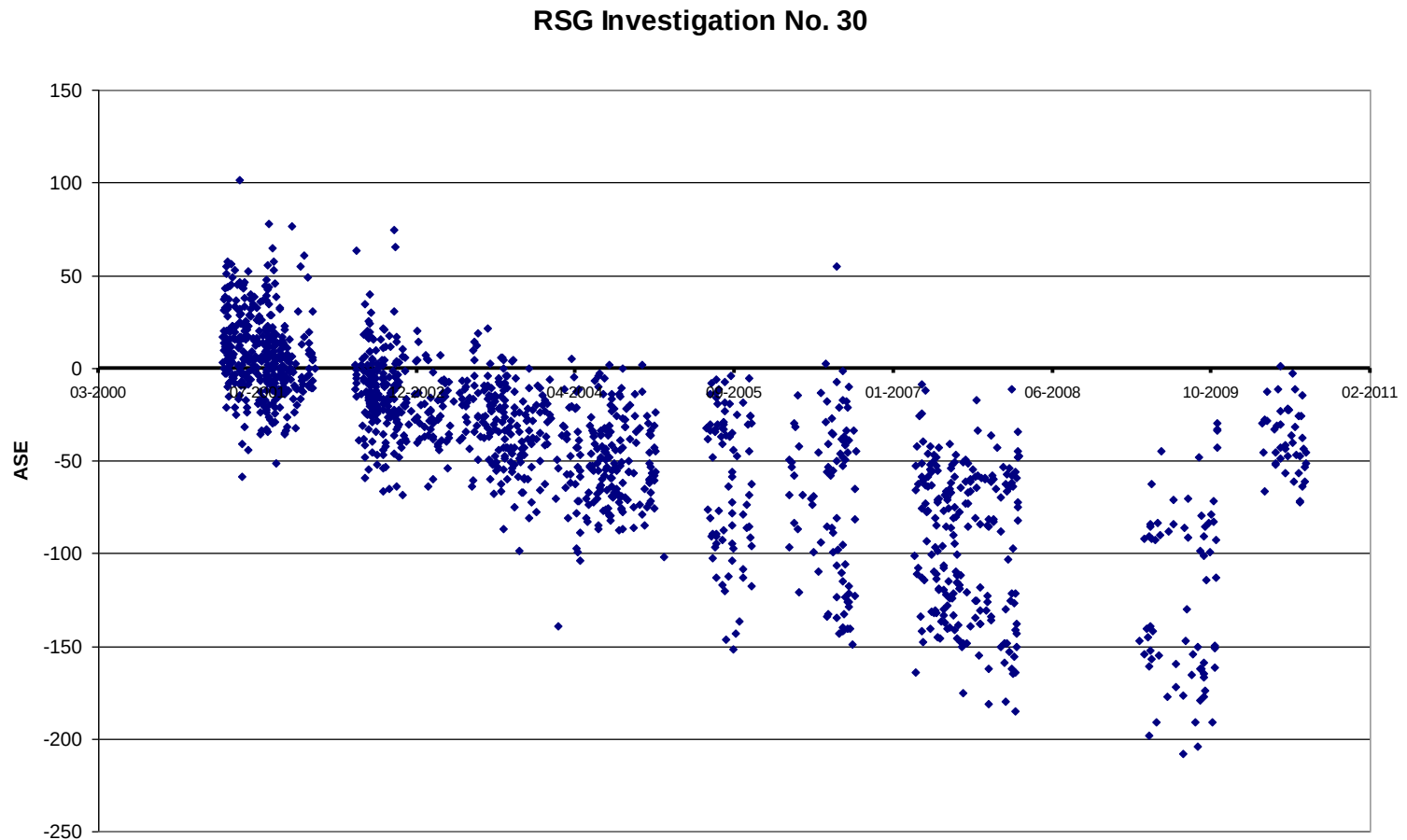


Example of Drift Investigation

RSG Investigation No. 30

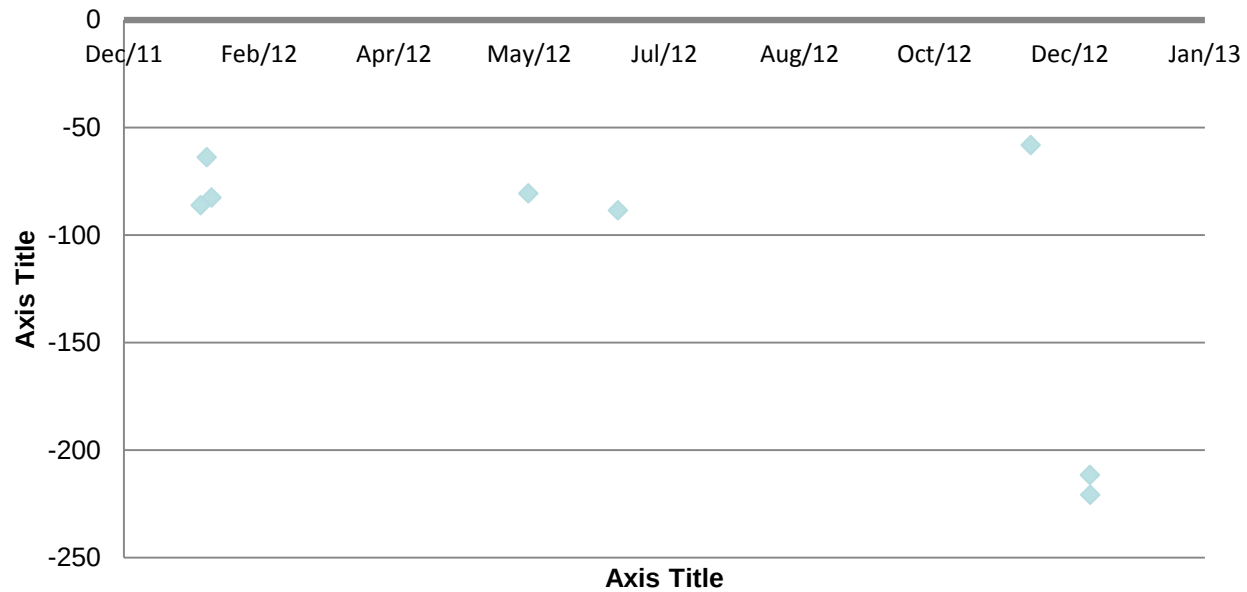


Example of Drift Investigation

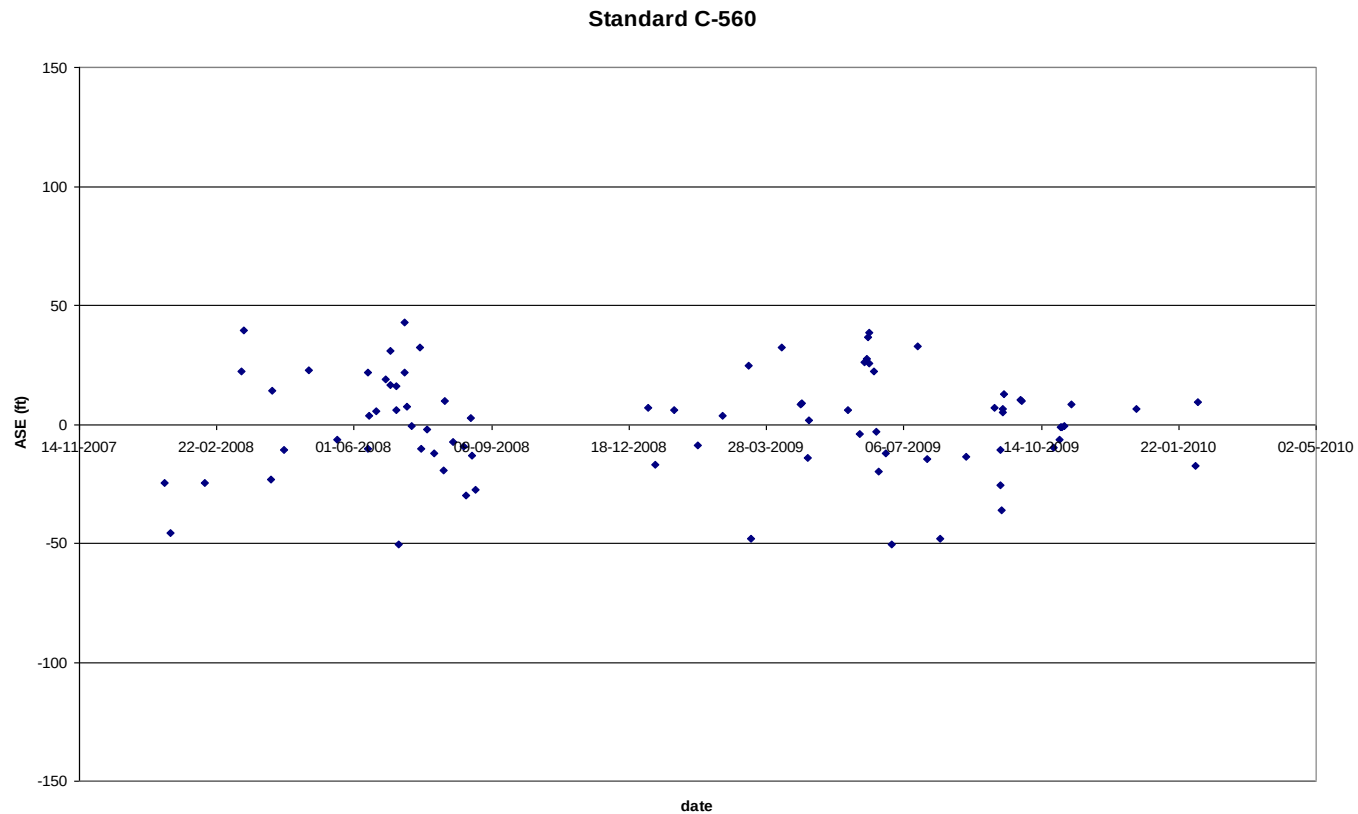


Outliers

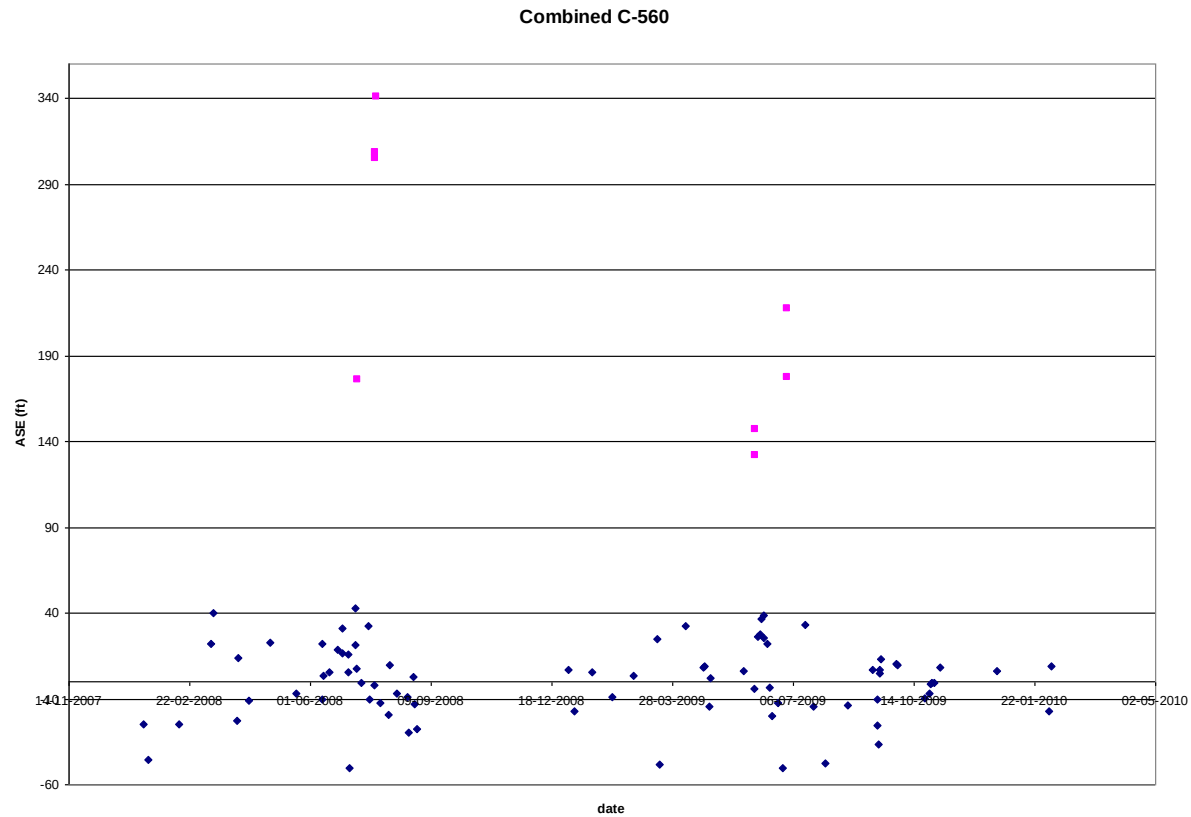
DCCFF



Standard C-560 ASE Performance



Combined C-560 ASE Performance



Standard Model



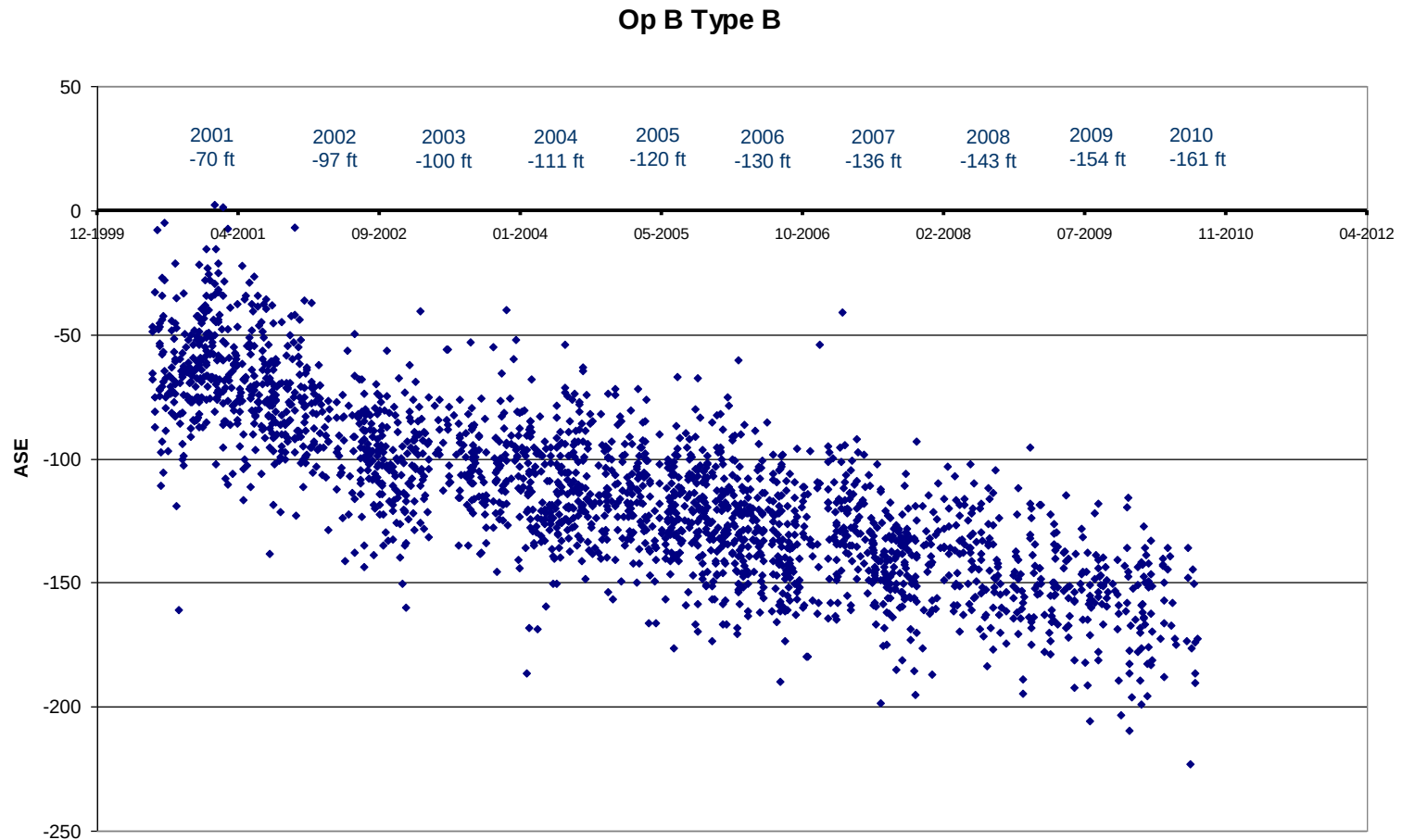
Standard Model?



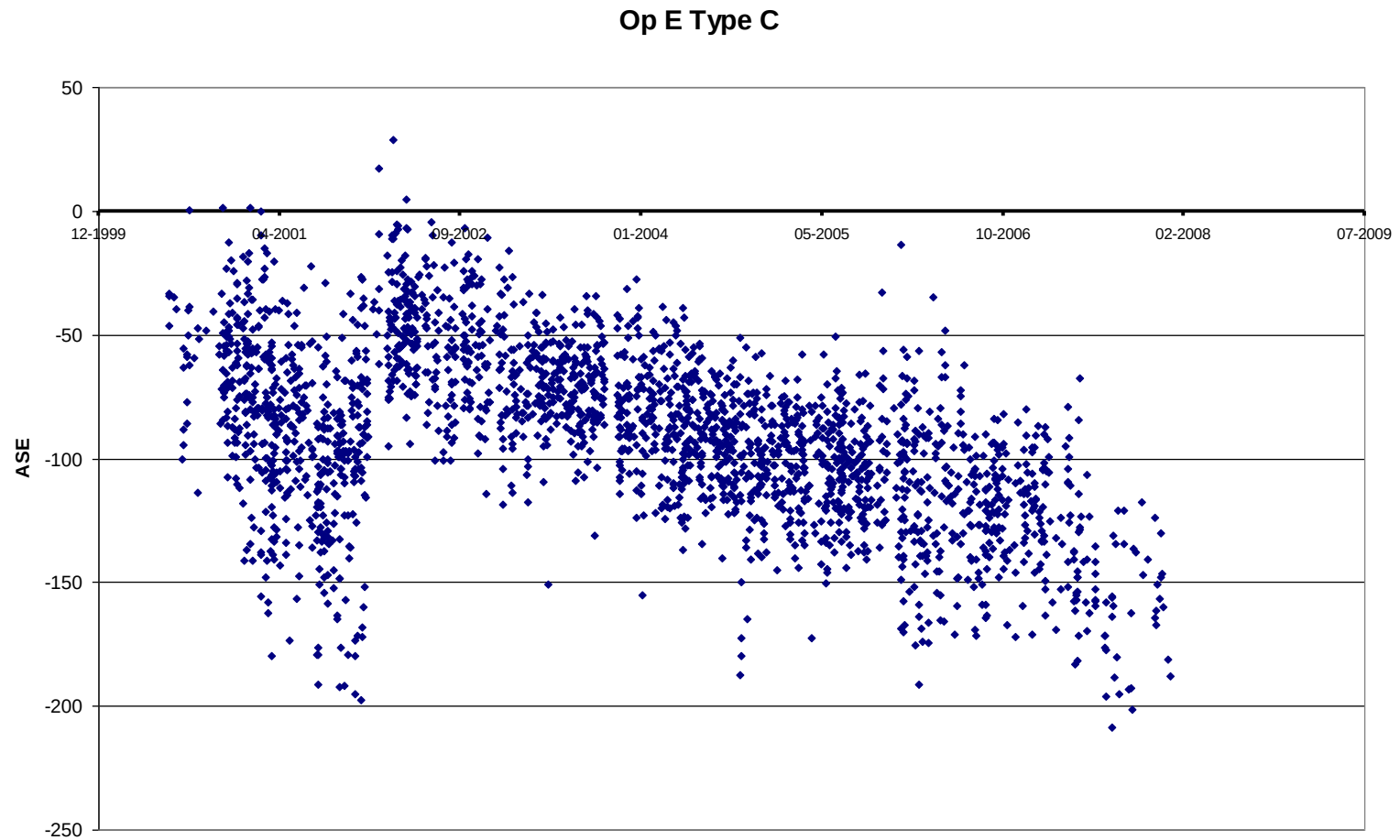
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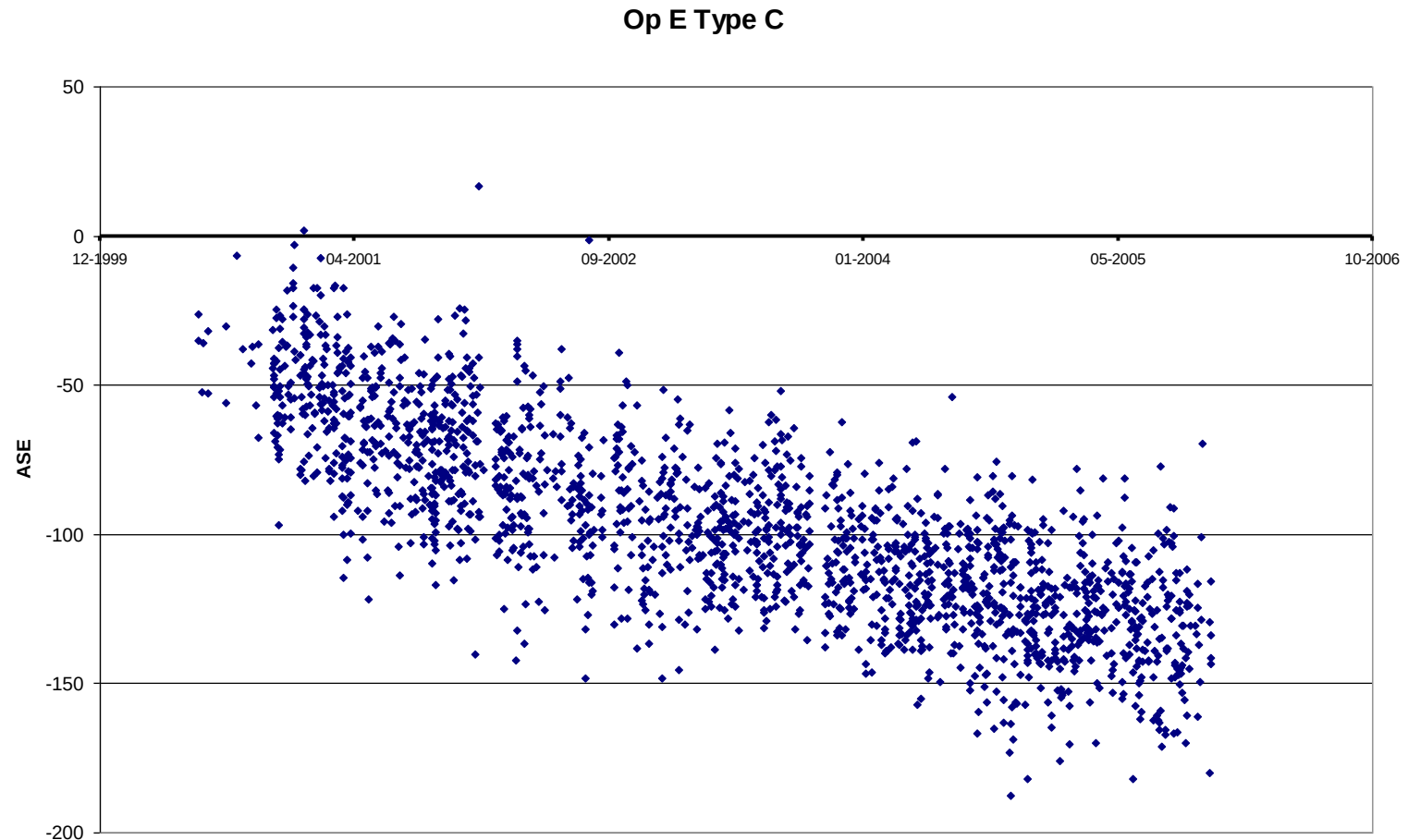
Long Term Linear Drift



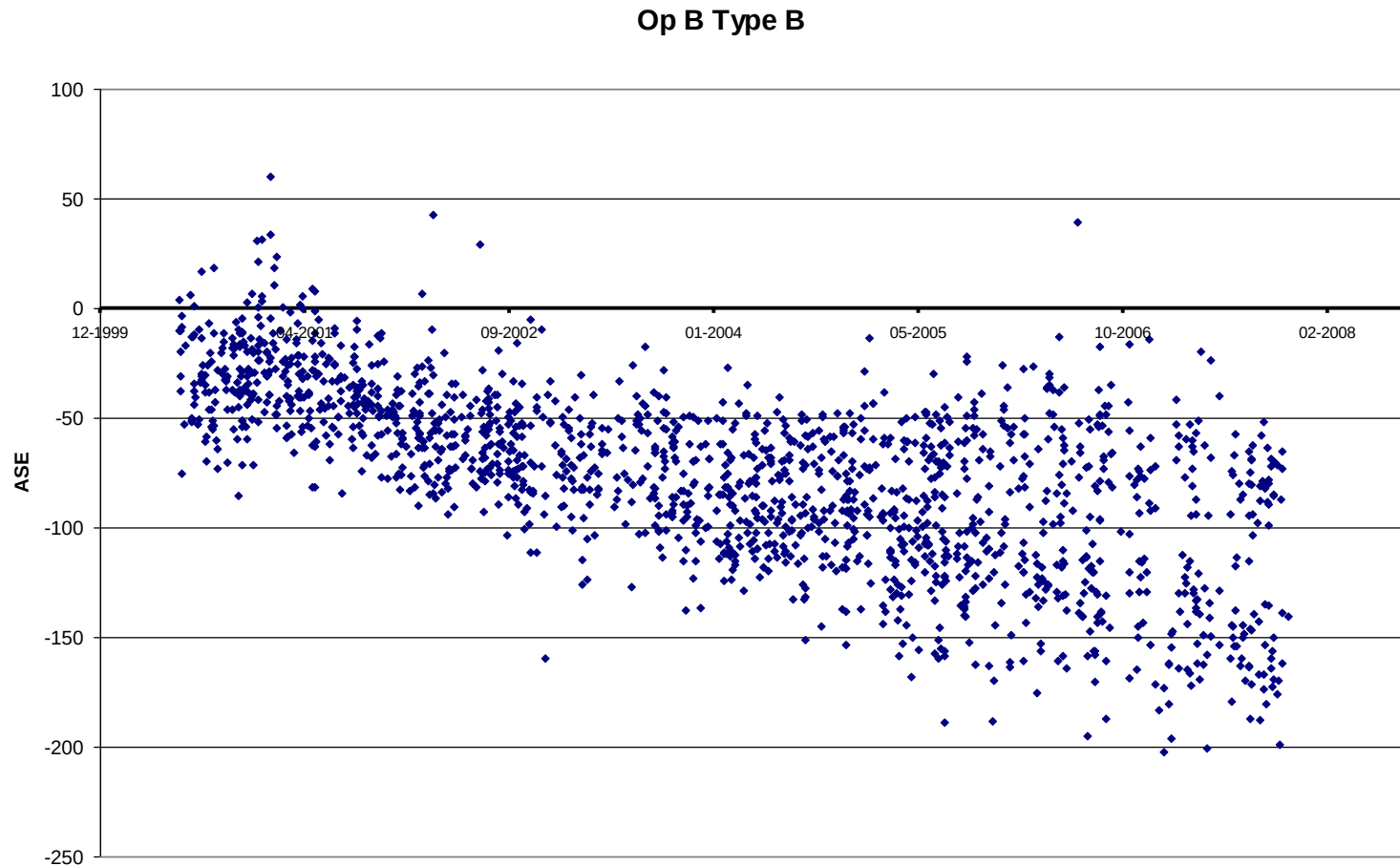
Saw Tooth Drift



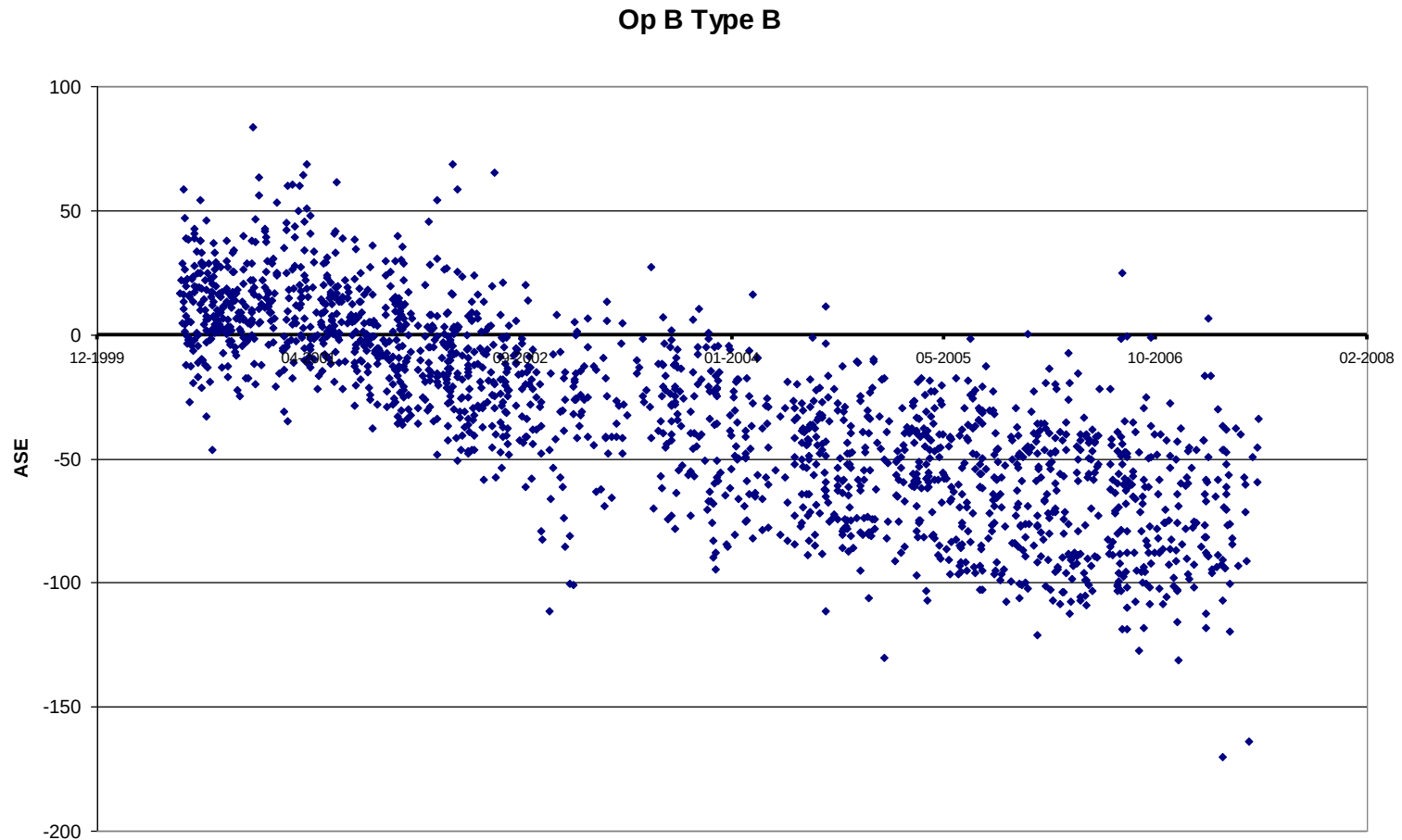
Long Term Linear Drift



Long Term Linear Drift + Divergence

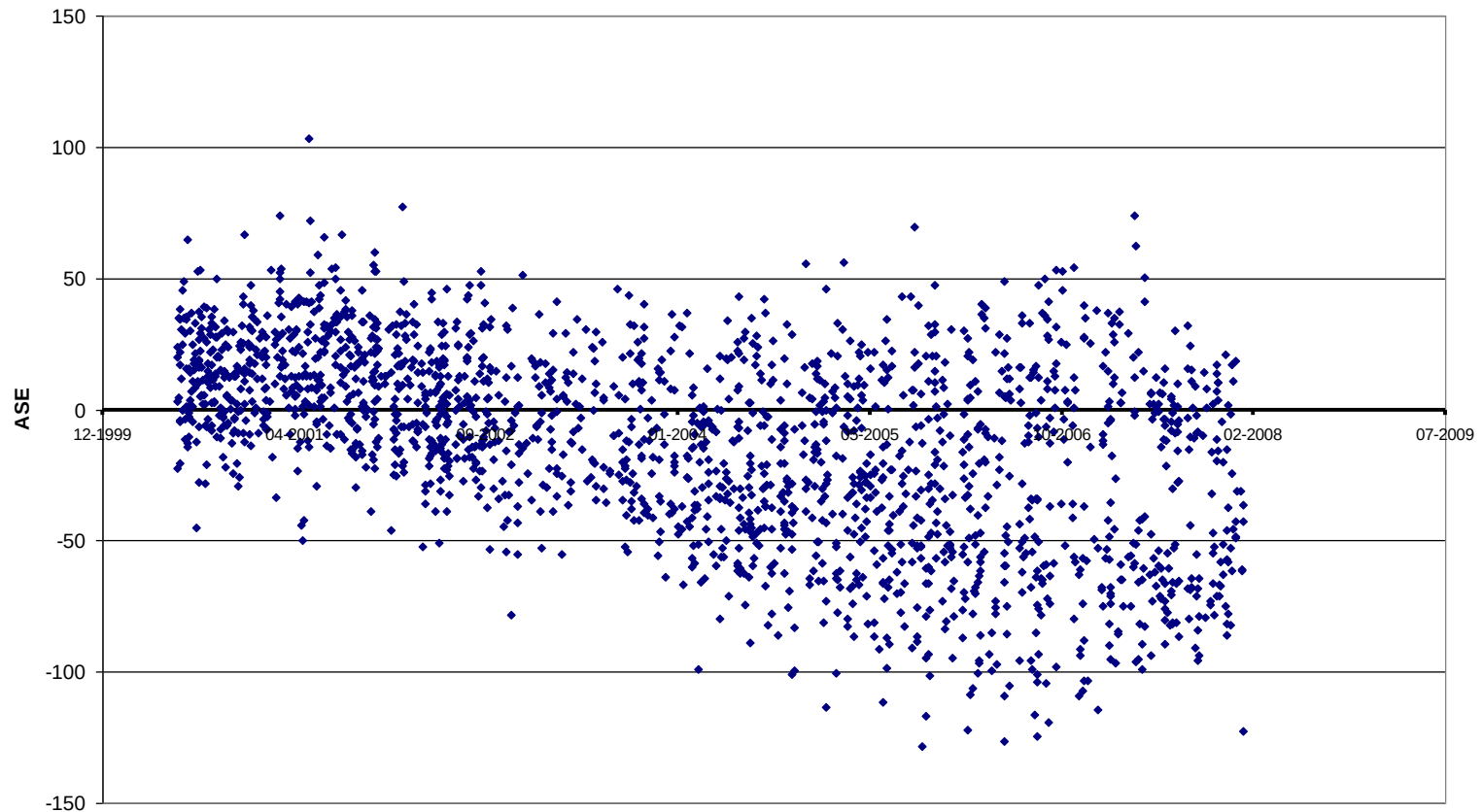


Long Term Linear Drift

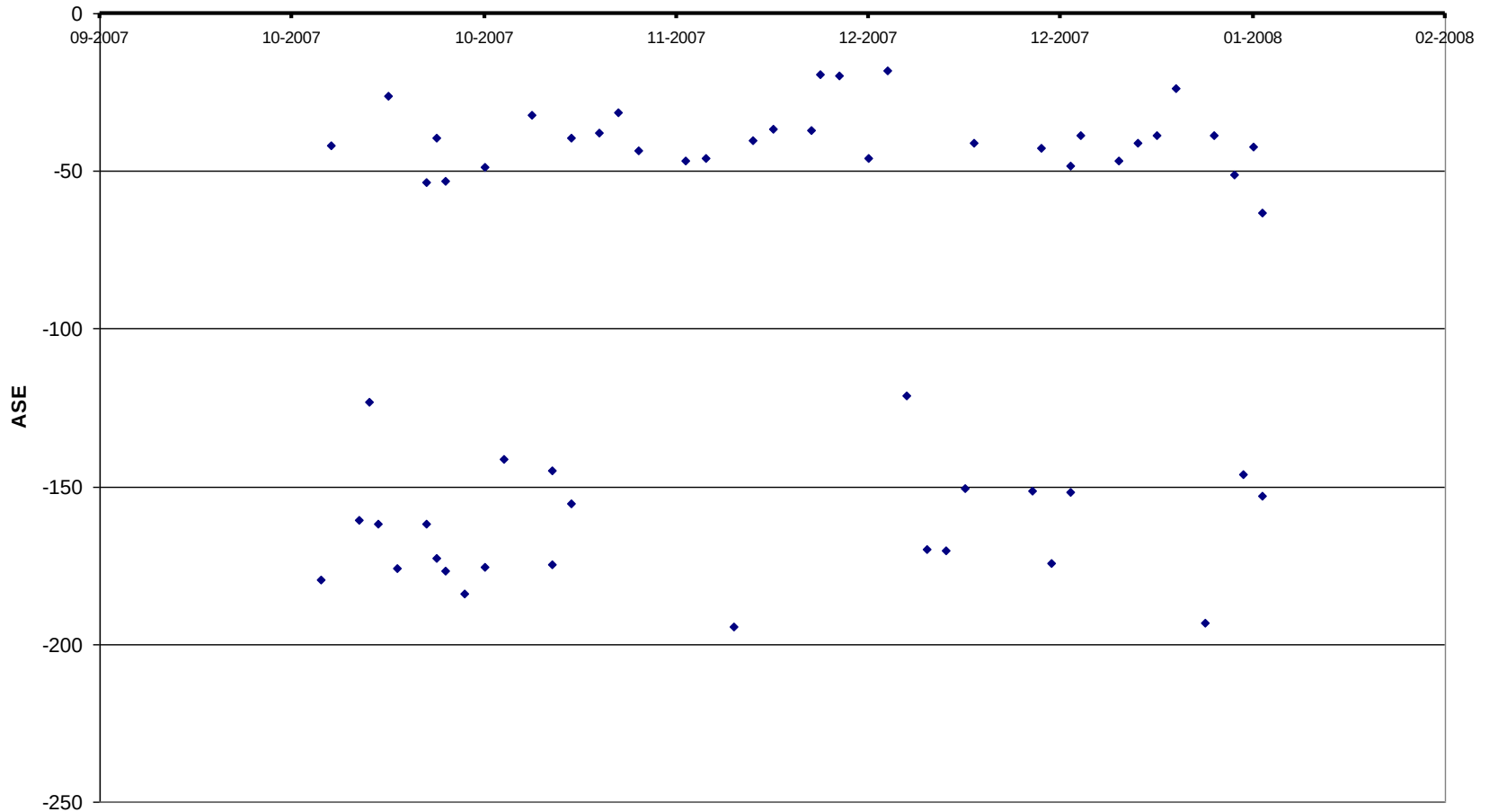


Long Term Linear Drift + Divergence

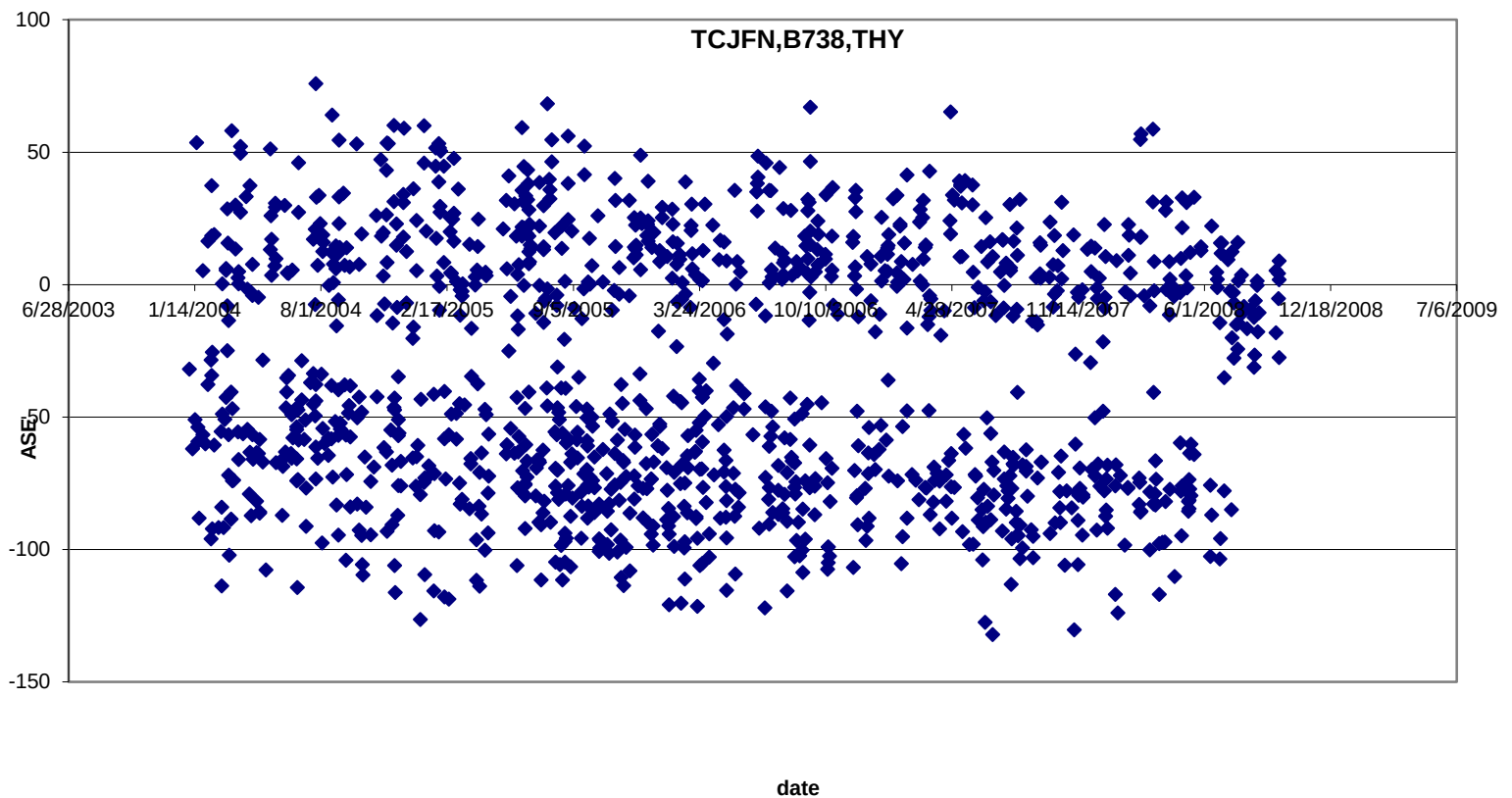
Op B Type B



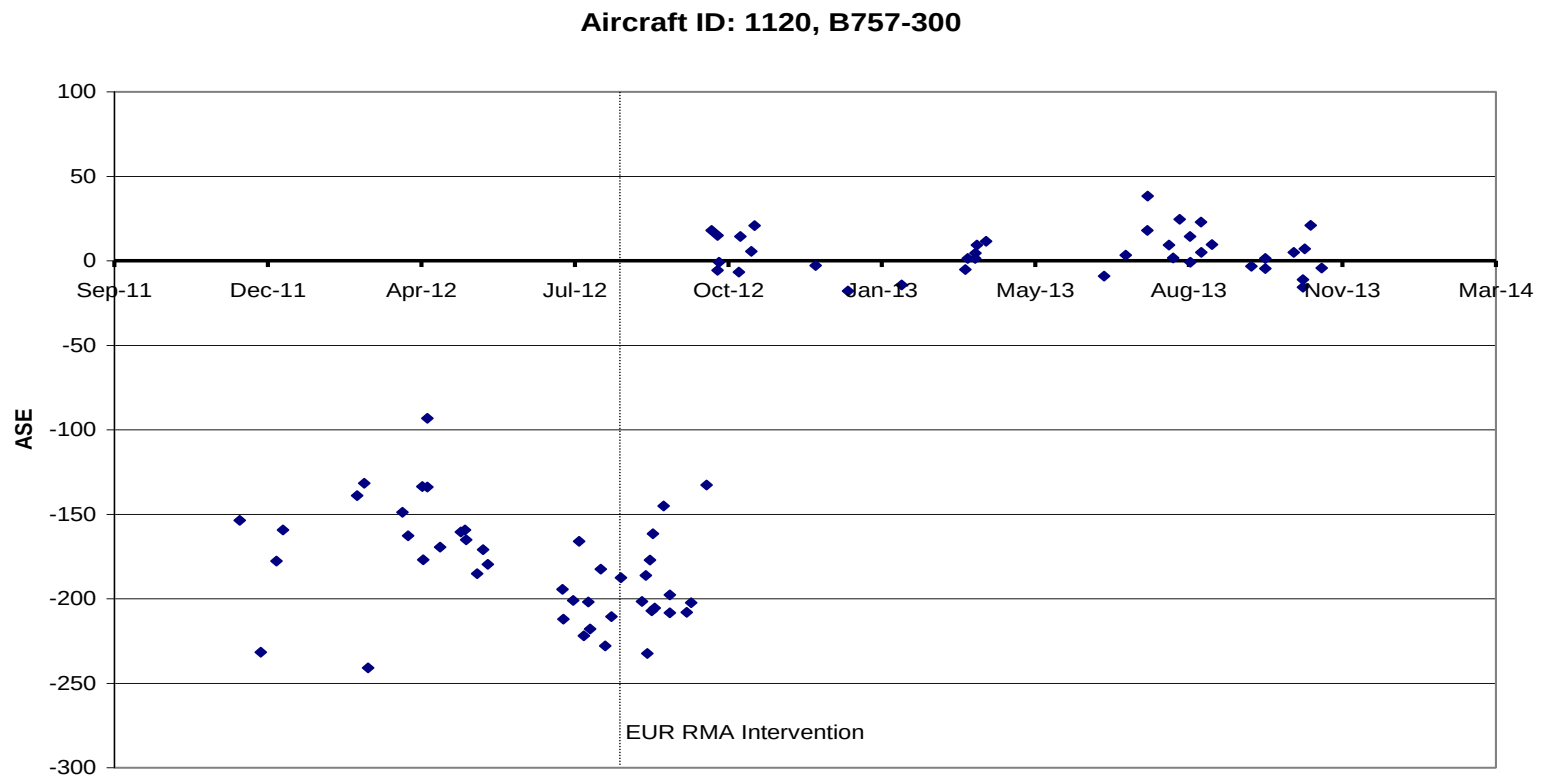
Bi-Modal Split Between Aircraft Systems



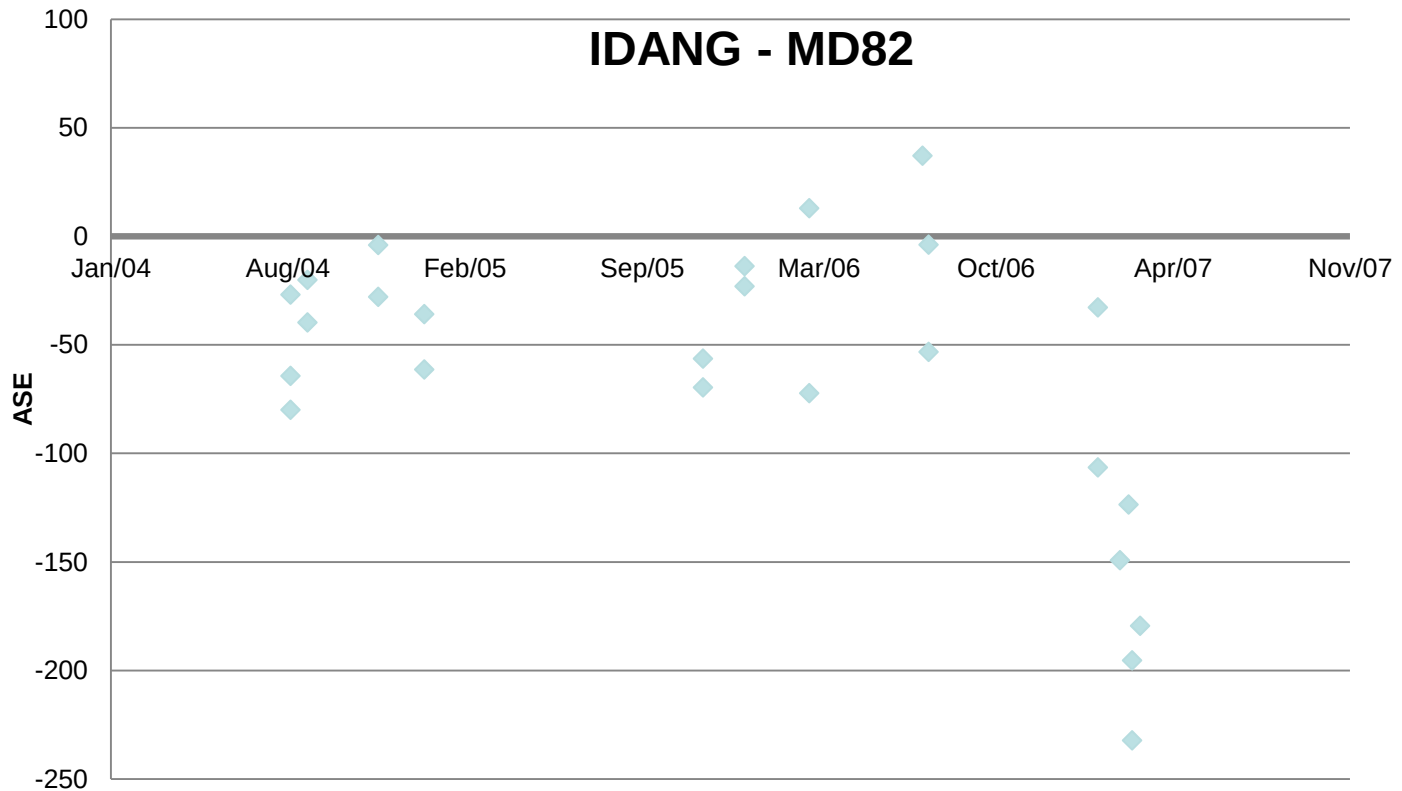
Bi-Modal Split Between Aircraft Systems



Other Examples

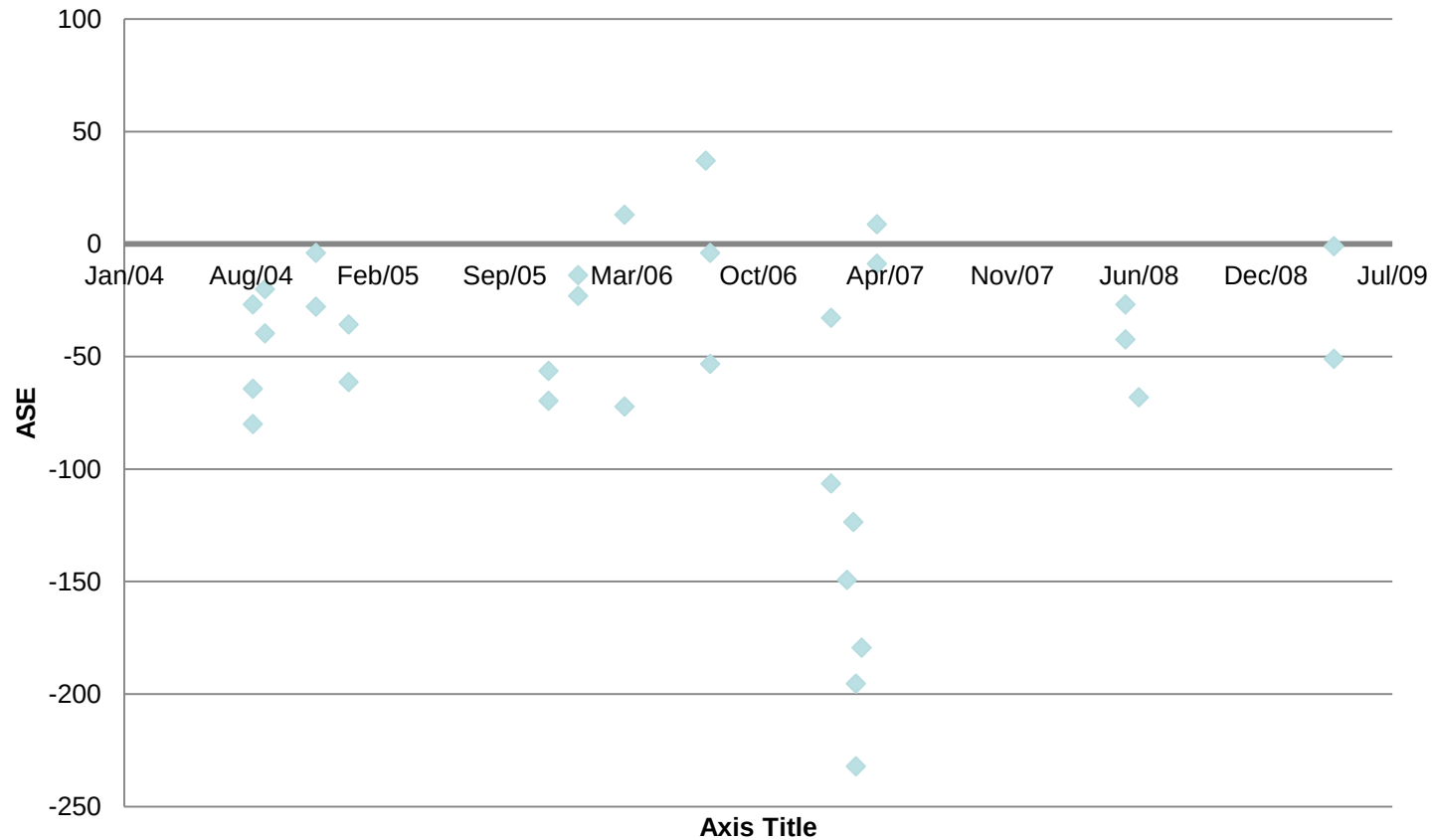


Other Examples



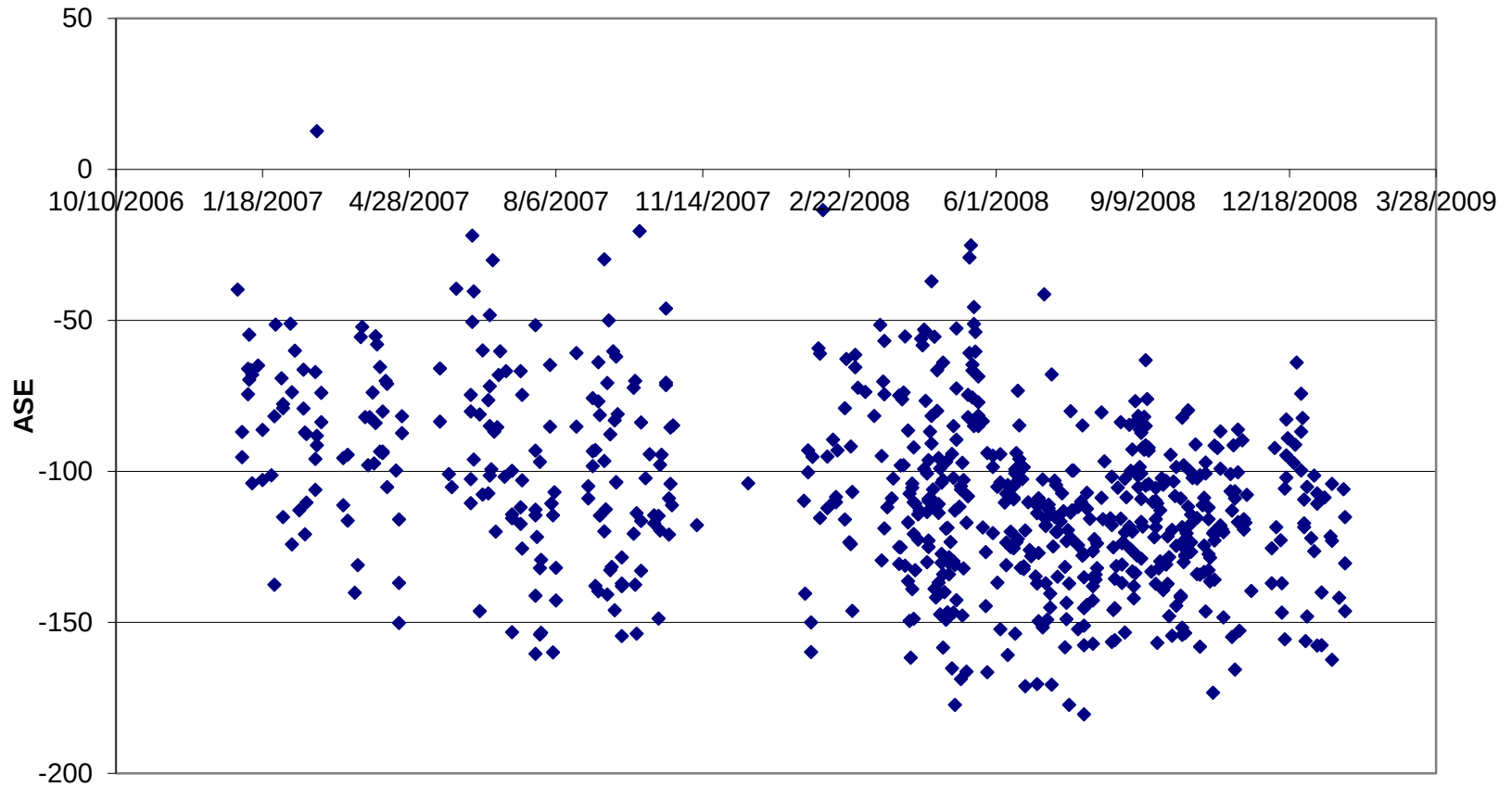
Other Examples

IDANG - MD82



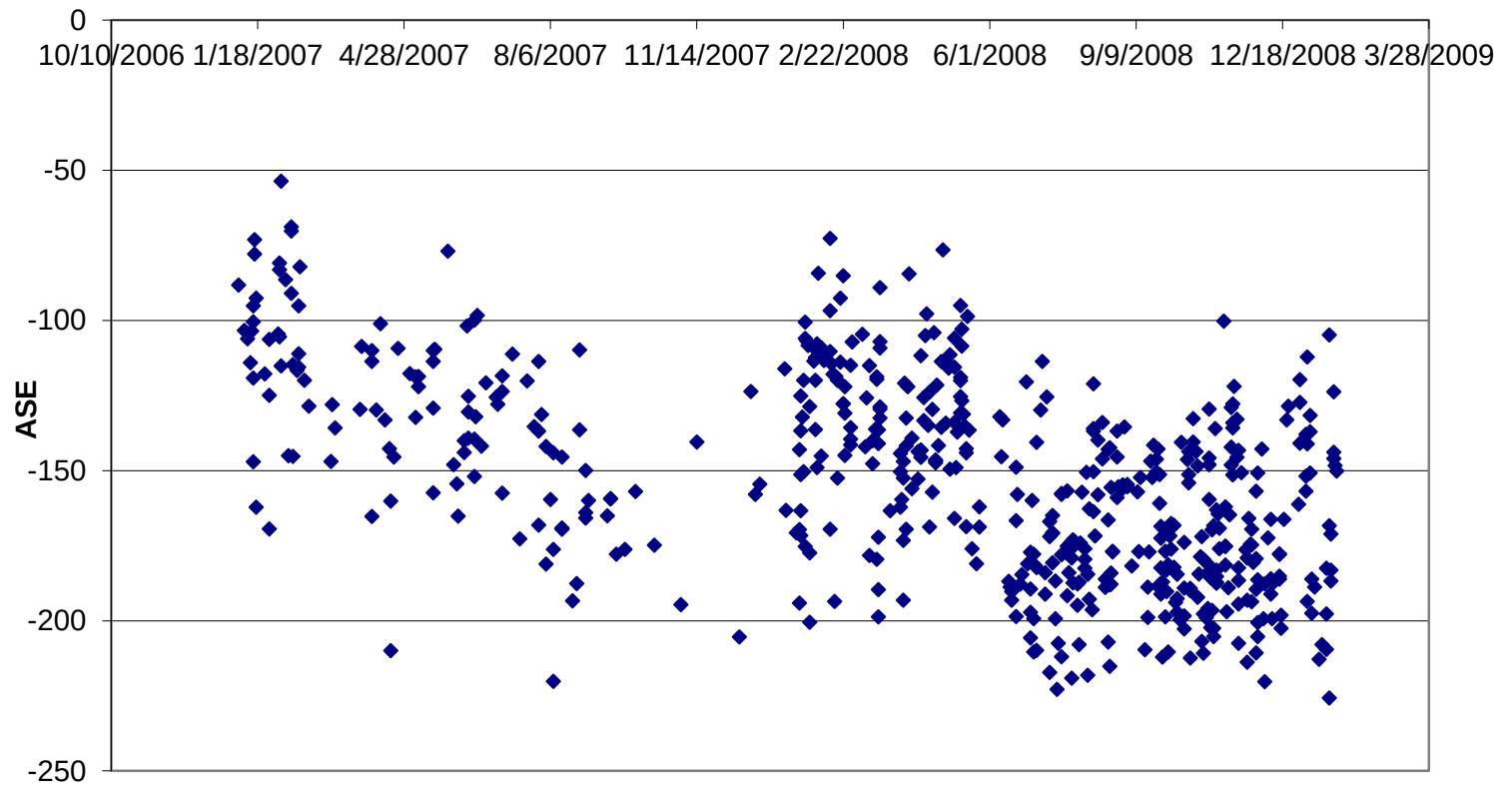
British Airways

GDOCY



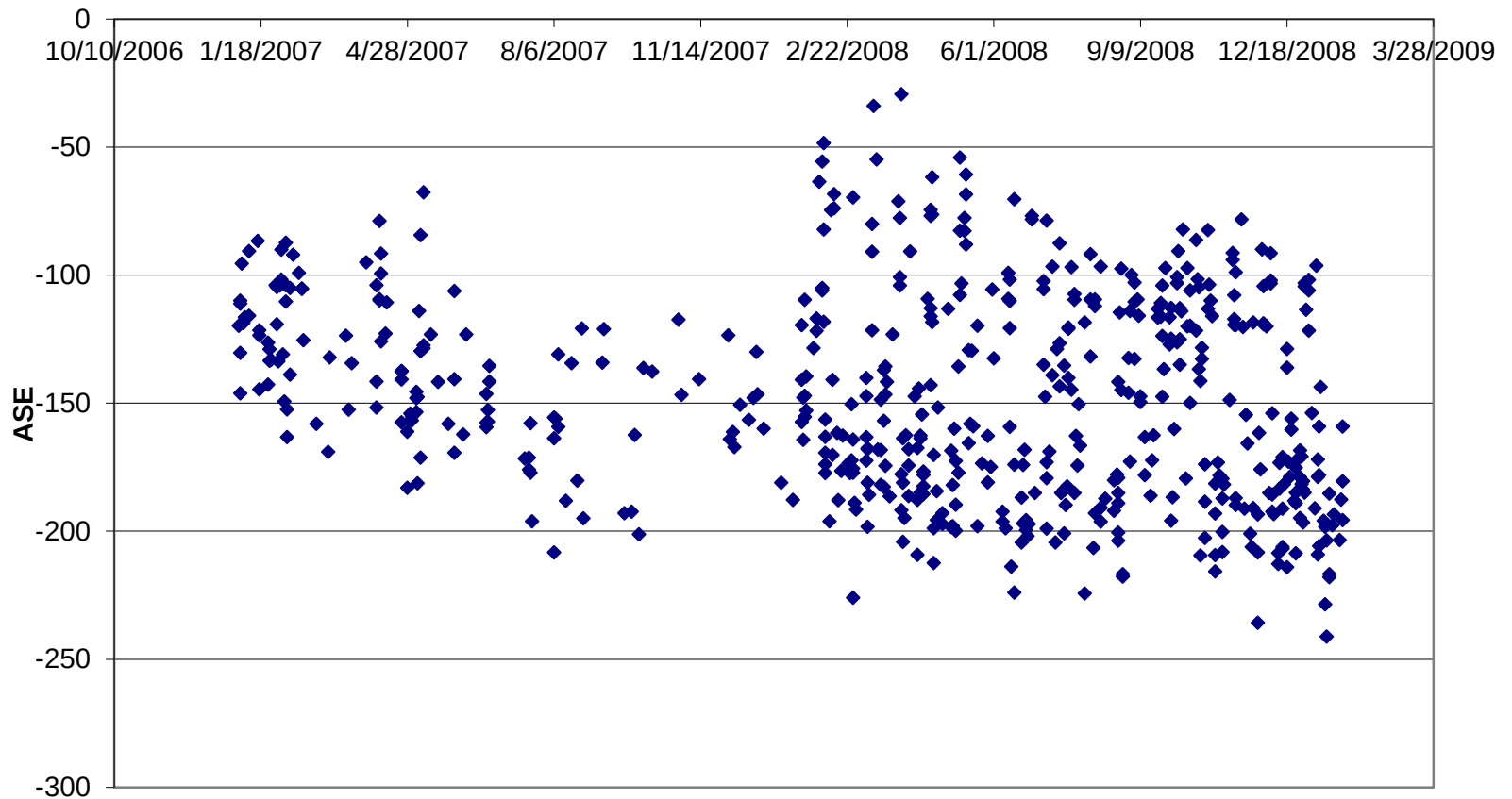
British Airways

GBZHC

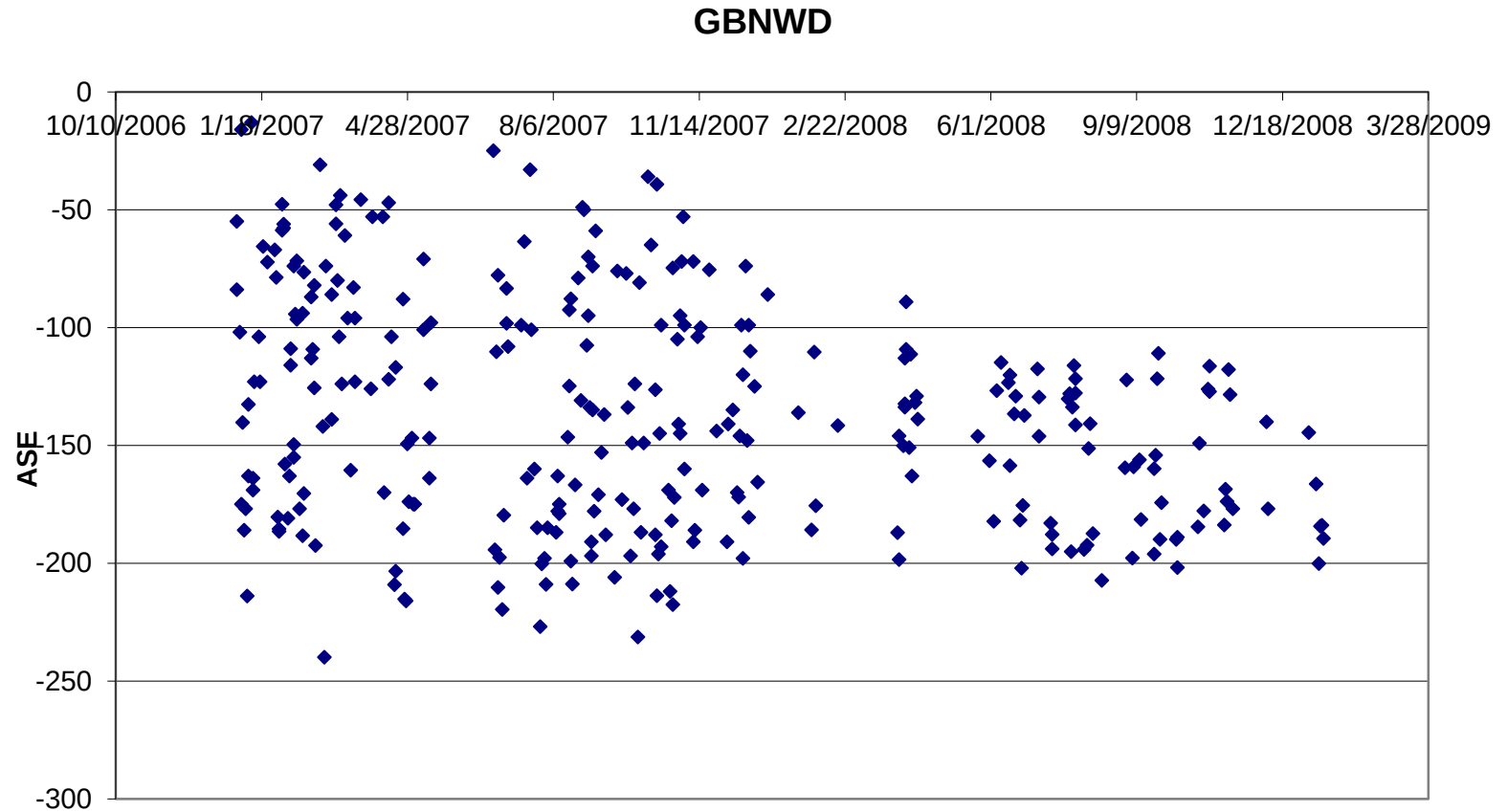


British Airways

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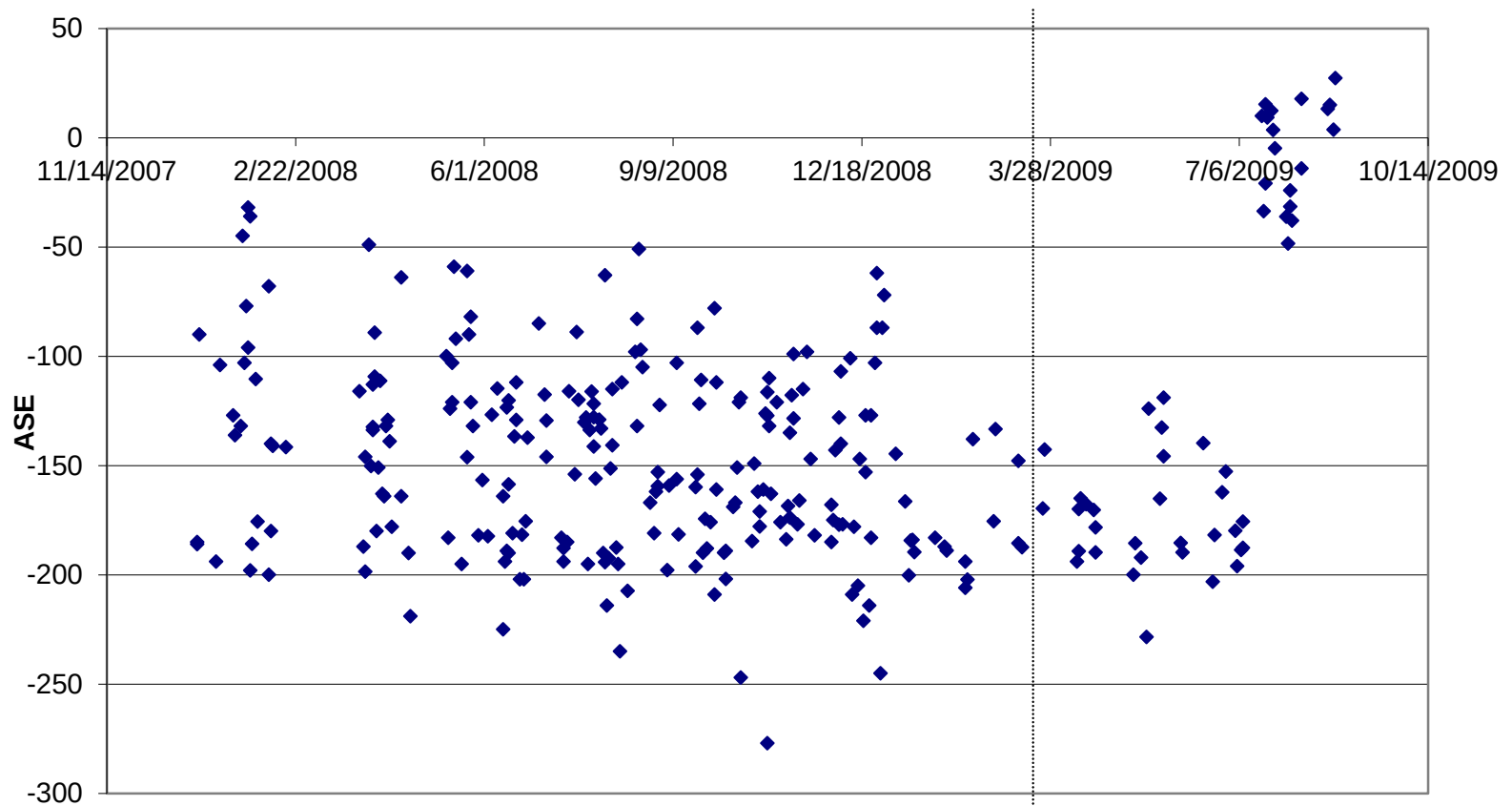


British Airways



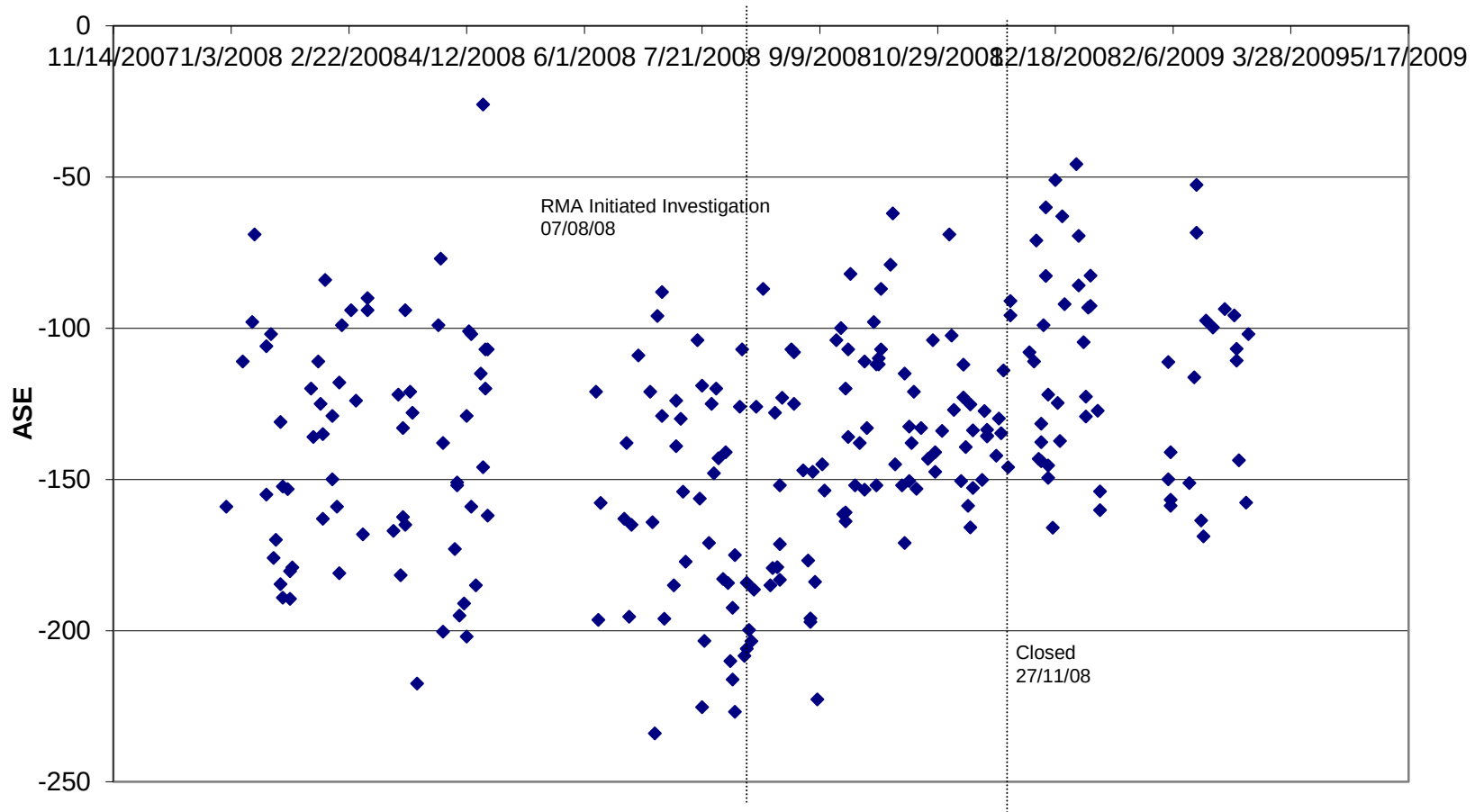
British Airways

GBNWD (08 - 09)

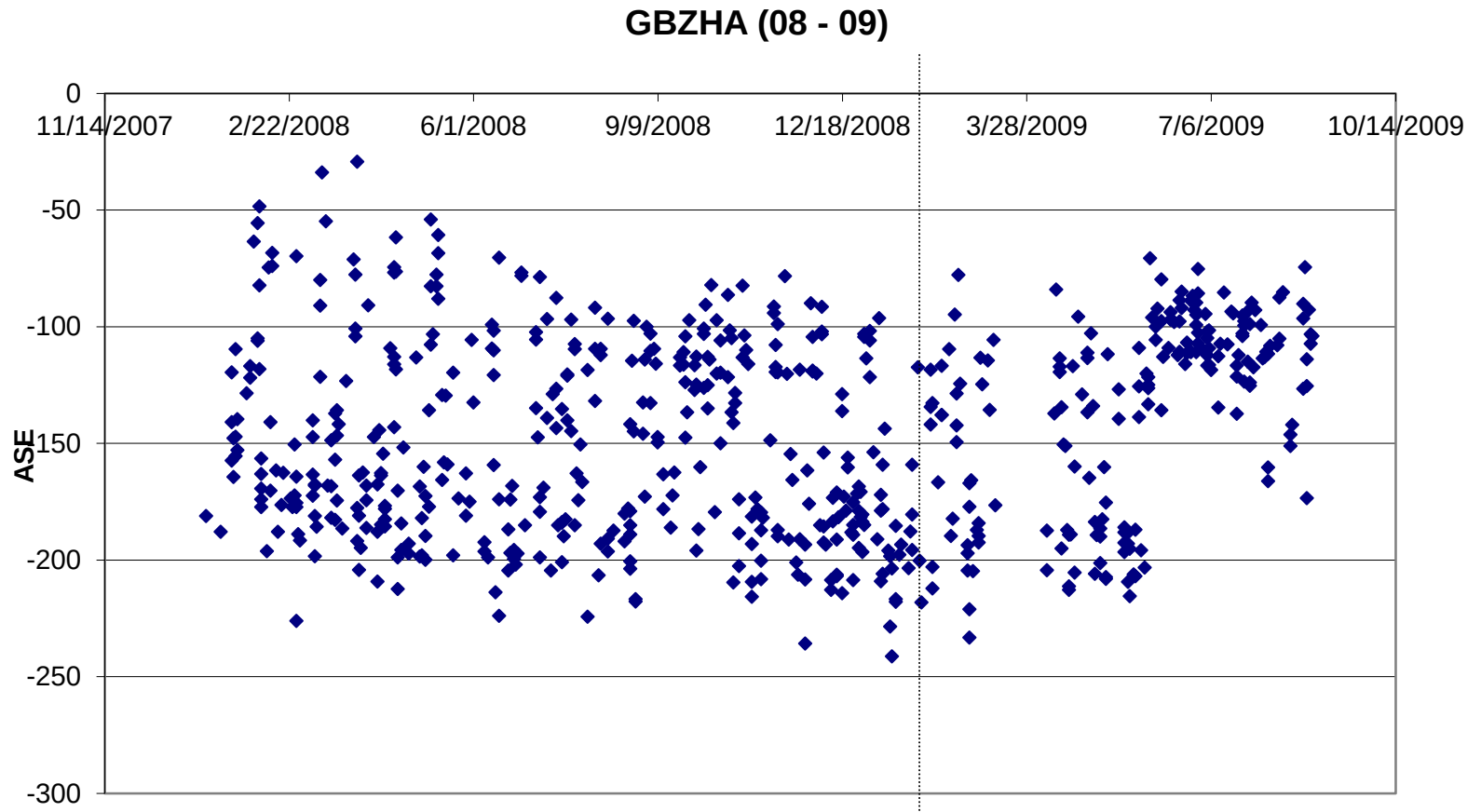


British Airways

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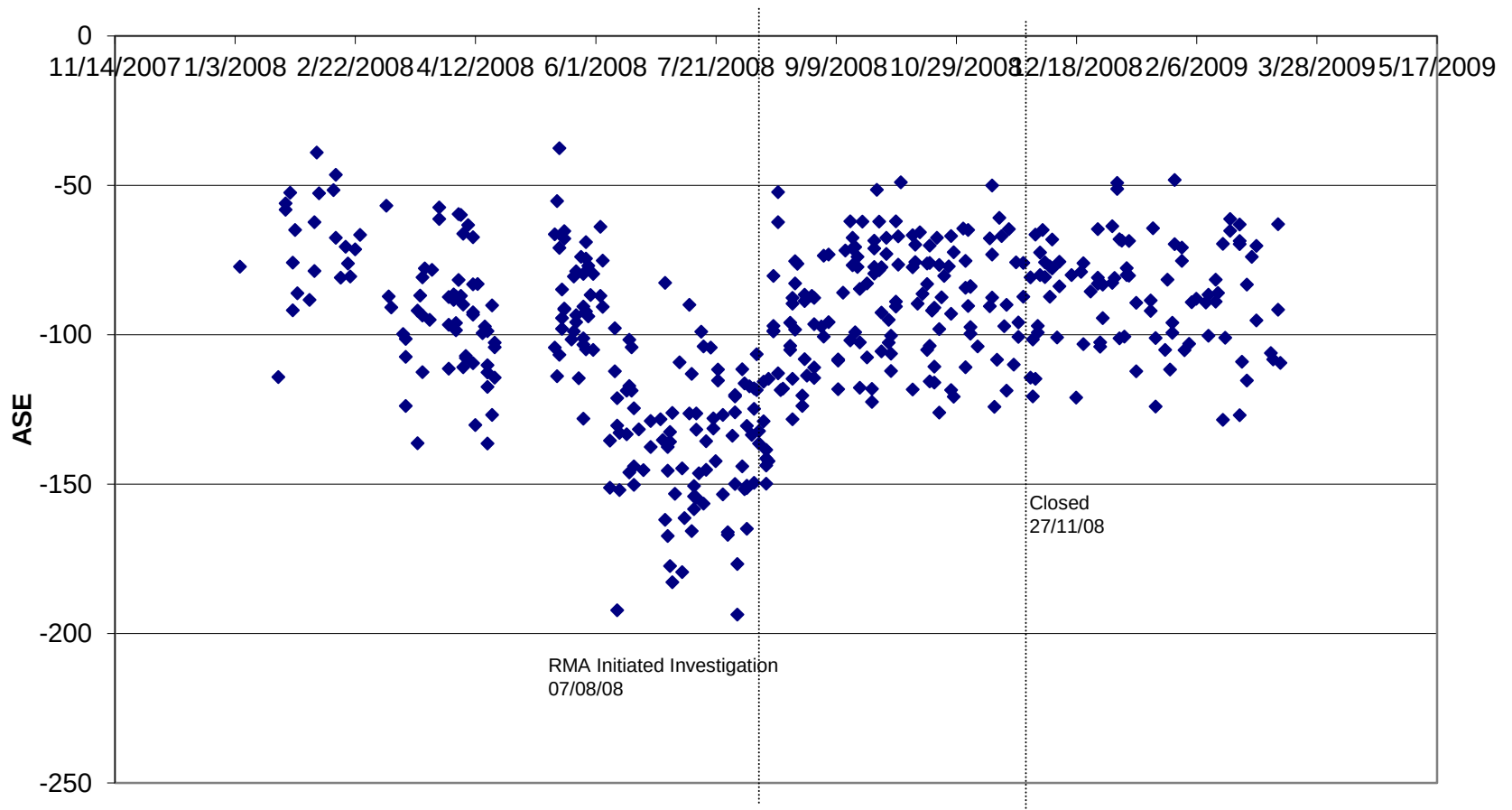


British Airways



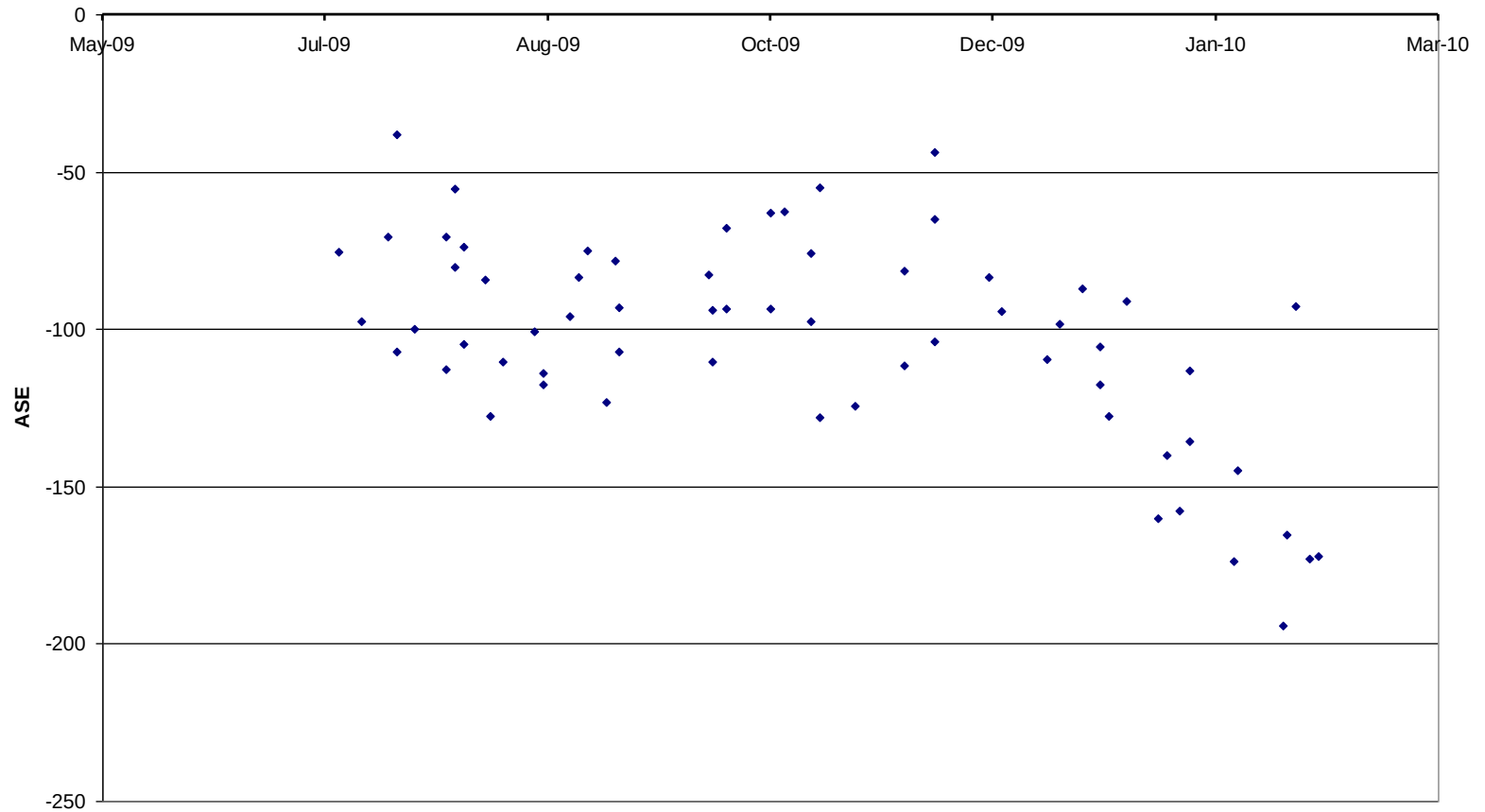
British Airways

GDOCX



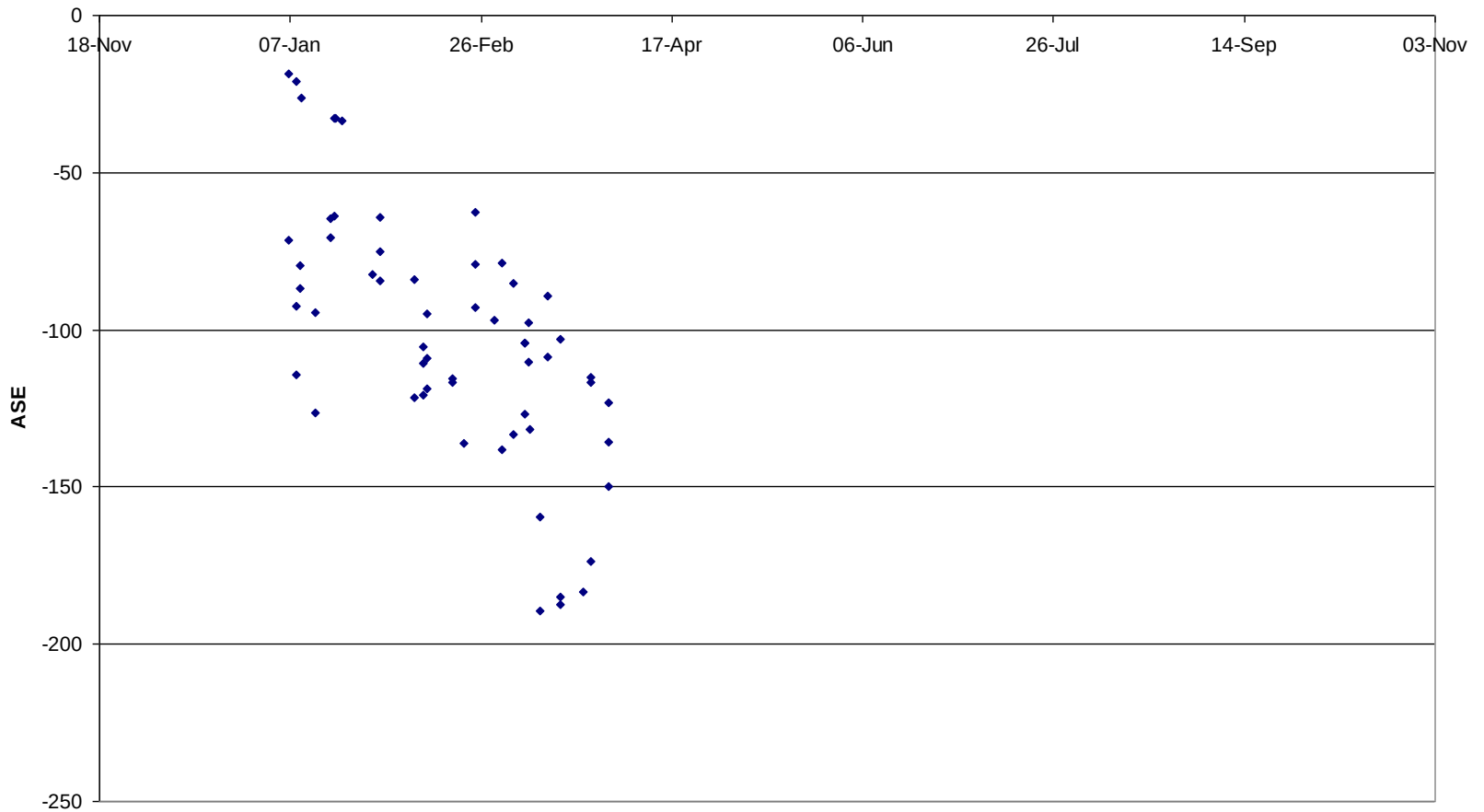
ASE Analysis

RSG Ref: 109



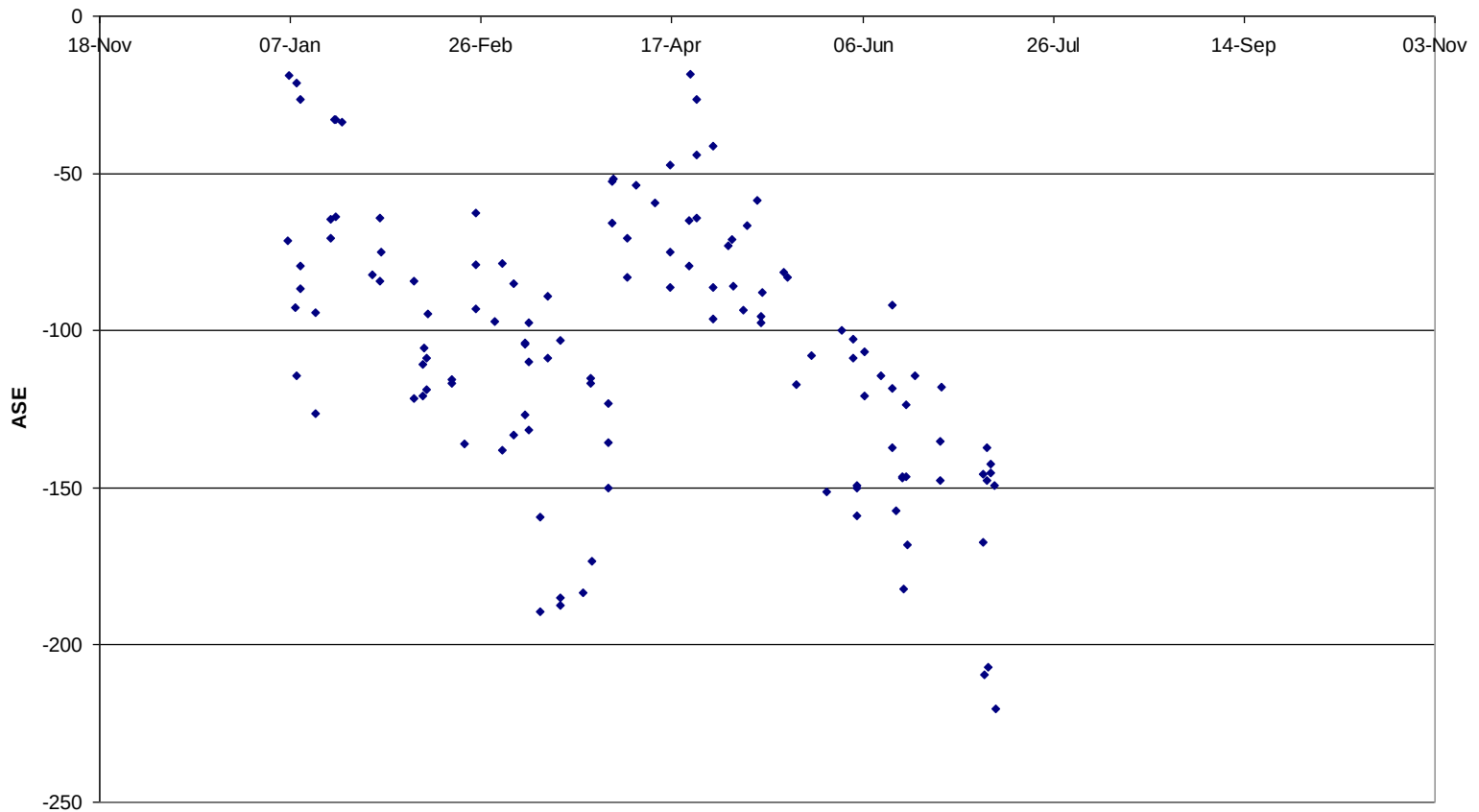
ASE Analysis

RSG Ref: 145



ASE Analysis

RSG Ref: 145



ASE by SN Type: 0048

