Royal Netherlands
Meteorological Institute
Ministry of Infrastructure and Environment

Mode-S EHS derived observations

Siebren de Haan

ASM2013/ALADIN 23rd WK April 2013

Contents

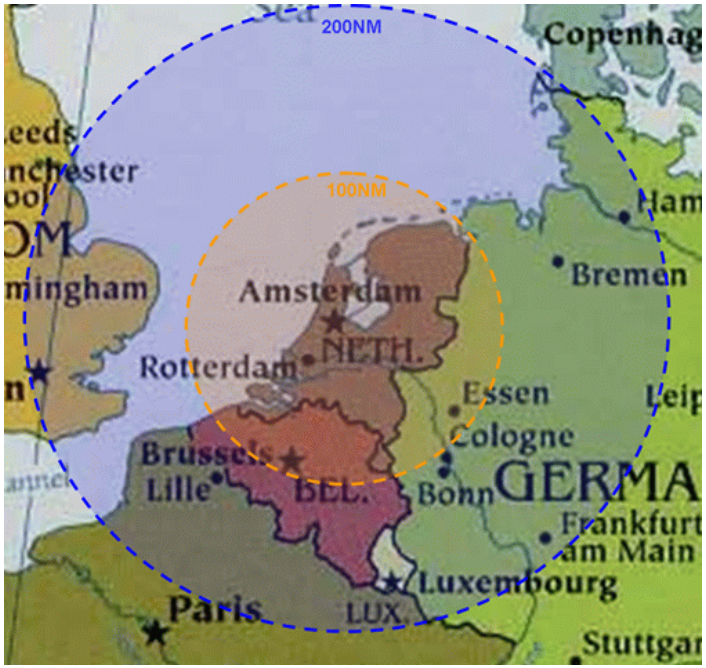
5 % improvement in wind direction by adding Mode-S EHS from a large domain over 18 to 24 hour forecast

- What is Mode-S EHS?
- Status and usage of Mode-S EHS
- Future of Mode-S EHS
- Final remarks

Origin/background

Request of Air Traffic Control the Netherlands (LVNL)

- Continuous Descent Approach (CDA)
- Environment
  - Fuel
  - Noise
- Efficiency
- Meteorological input for ATC system



Project Team under the umbrella of KDC:

KNMI: Siebren de Haan – R&D
Ad Stoffelen – R&D
Jan Sondij – Stakeholder Management

LVNL: Paul de Kraker – R&D
Ferdinand Dijkstra – R&D

Boeing: Steven Glickman – Project Manager
Louis Bailey – R&D

Knowledge Development Center Schiphol (KDC)
http://www.kdc-mainport.nl/

Mode-S Enhanced Surveillance (EHS)

Within European **designated EHS airspace**:

- All fixed wing aircraft, having a maximum take-off mass greater that 5,700 kg or a maximum cruising true airspeed in excess of 250 kts, intending to fly IFR (instrument flight regulation) general aviation traffic must be Mode-S EHS compliant.
- Functionality

  Aircraft compliant with Mode-S EHS provide basic functionality features plus the following eight downlinked aircraft parameters (DAPs):

Source: EUROCONTROL website

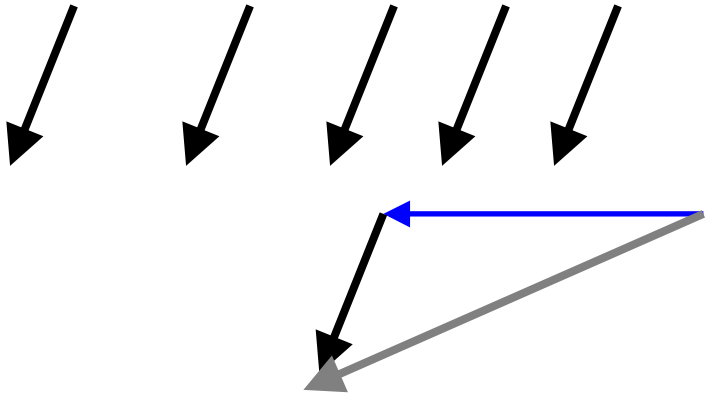
BDS Register	Basic DAP Set (if Track Angle Rate is available)	Alternative DAP Set (if Track Angle Rate is not available)
BDS 4,0	Selected Altitude	Selected Altitude
BDS 5,0	Roll Angle	Roll Angle
	Track Angle Rate	
	True Track Angle	True Track Angle
	Ground Speed	Ground Speed
BDS 6,0	Magnetic Heading	Magnetic Heading
	Indicated Airspeed (IAS) / Mach no. (Note: IAS and Mach no. are considered as 1 DAP (even if technically they are 2 separate ARINC labels). If the aircraft can provide both, it must do so).	Indicated Airspeed (IAS) / Mach no. (Note: IAS and Mach no. are considered as 1 DAP (even if technically they are 2 separate ARINC labels). If the aircraft can provide both, it must do so).
	Vertical Rate (Barometric rate of climb/descend or baro-inertial)	Vertical Rate (Barometric rate of climb/descend or baro-inertial)
		True Airspeed (provided if Track Angle Rate is not available)

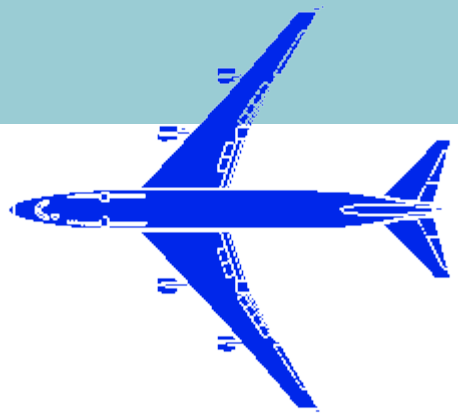
Concerning this presentation:

- DAPs: not a broadcast but **interrogation,**
- Most aircraft in Europe are EHS equipped,
- ELS and EHS radar systems are identical,
- LVNL uses ELS operationally,
- LVNL uses EHS (TAR 1) non operational,
- This presentation deals with the use of EHS.

Derived observations from Mode-S EHS

Wind:





Temperature:

Observed: Mach-number

M= V_{air}/ Vsound

Speed of Sound depends on Temperature

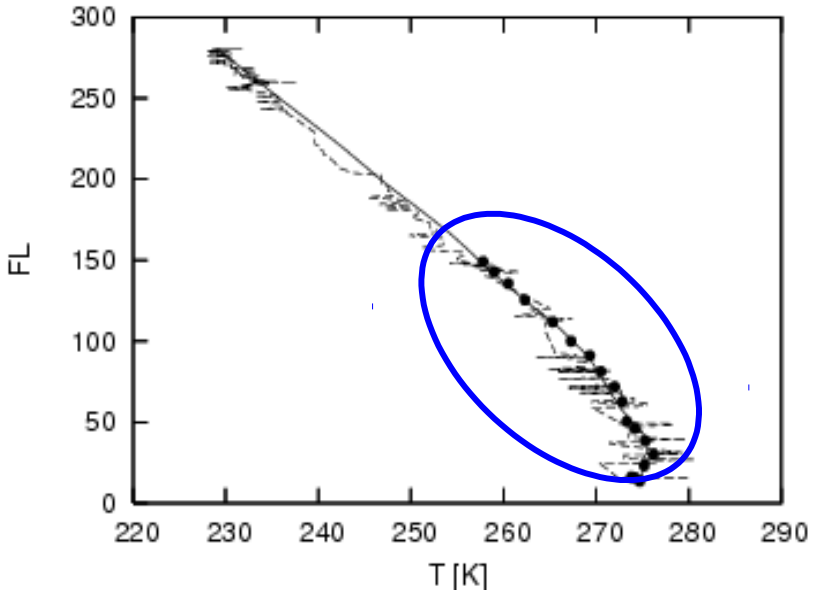
c = (C/ρ)1/2, *C* = constant en ρ airdensity ρ = p/(*R* T), *R* = constant

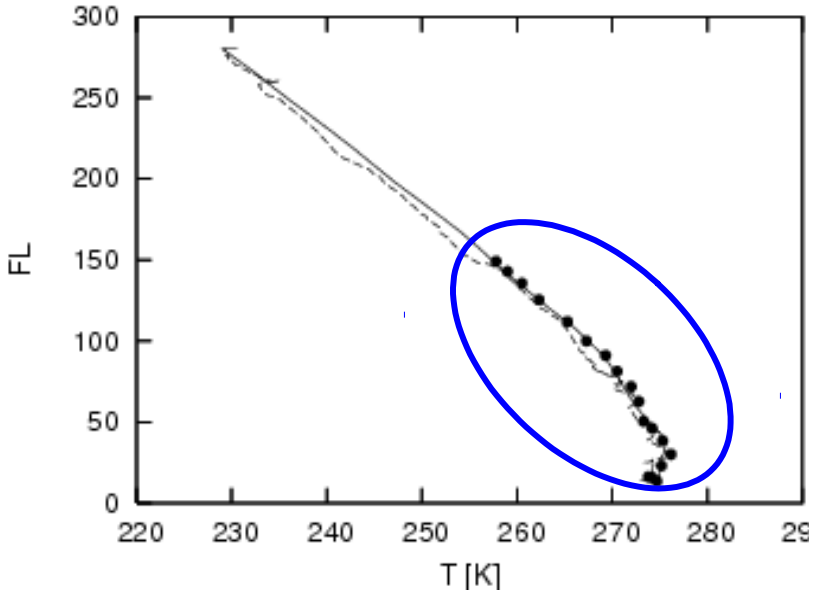
Thus: Vair = *K* M T1/2 with *K* constant

Temperature observations improvements

Smoothing over 60 seconds for Temperature (15 obs.)

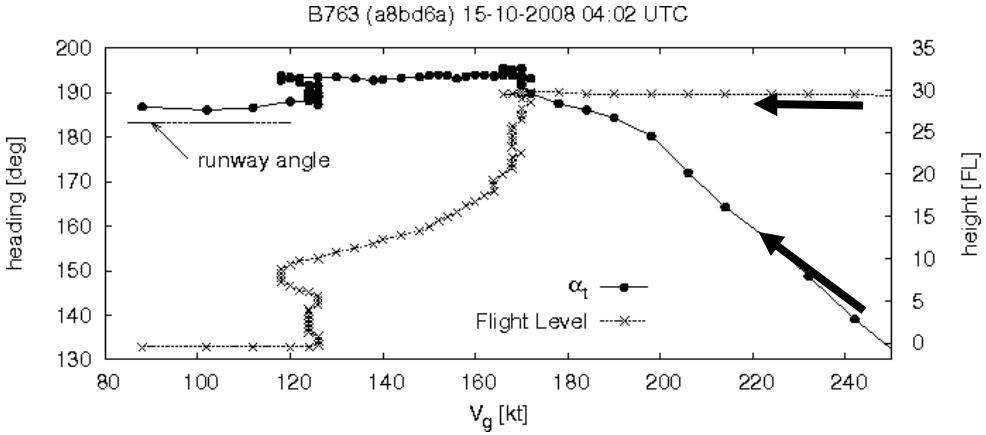
- Linear approximation of T and Vtrue over 60 sec
- Reduction of noise in T and Vtrue

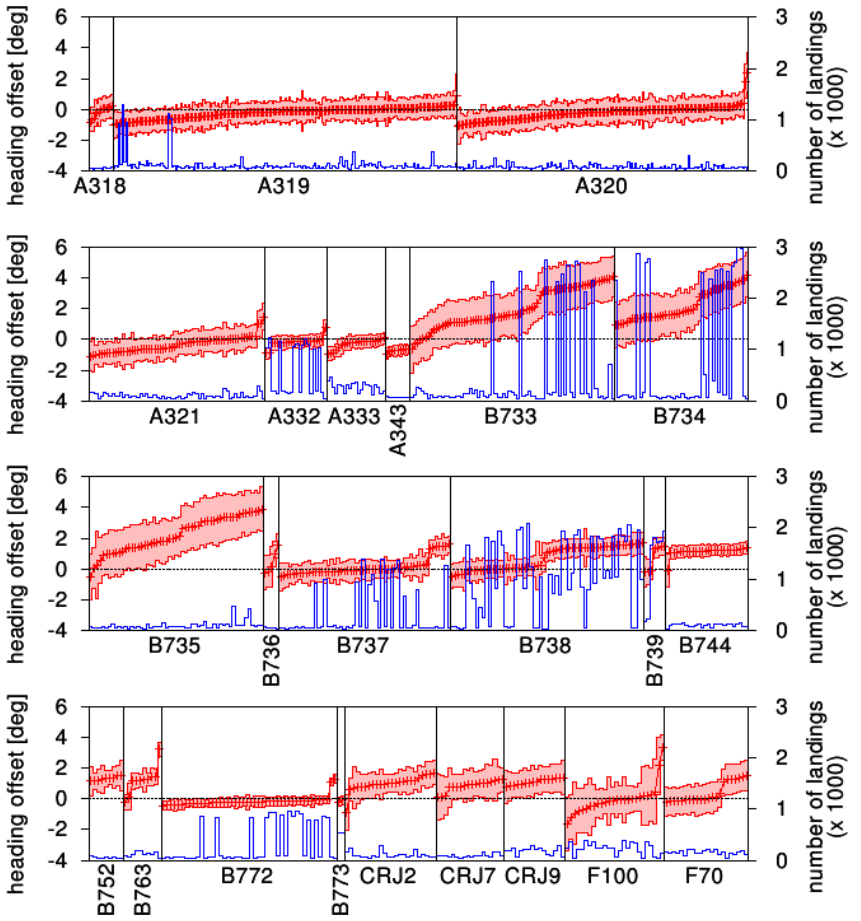




Wind improvements
Heading correction

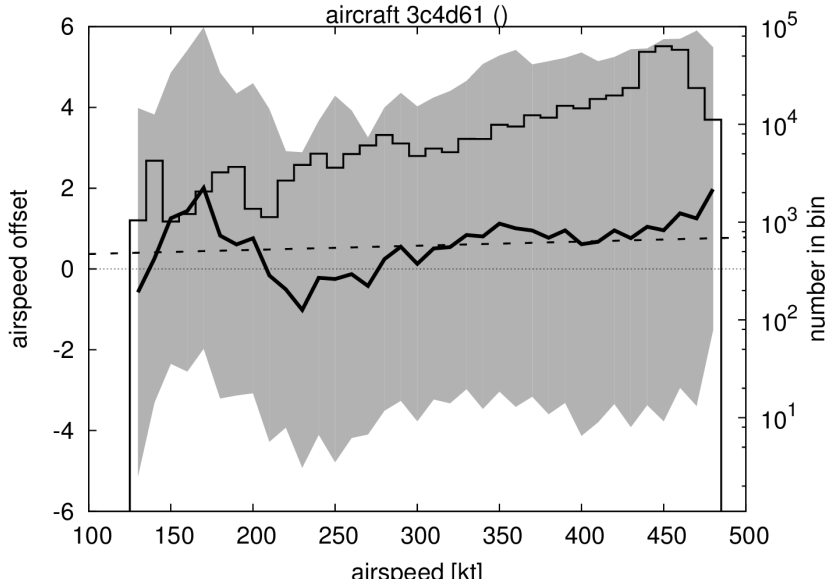
- "Heading" correction
- "Magnetic" North versus "true"-North
  - Correction : 0 tot 1 degree
- Landing calibration per aircraft
  - More than 10 landings
  - Correction: 1-2 degrees
  - Landing aircraft at Schiphol (1 yr)
- NWP calibration per aircraft

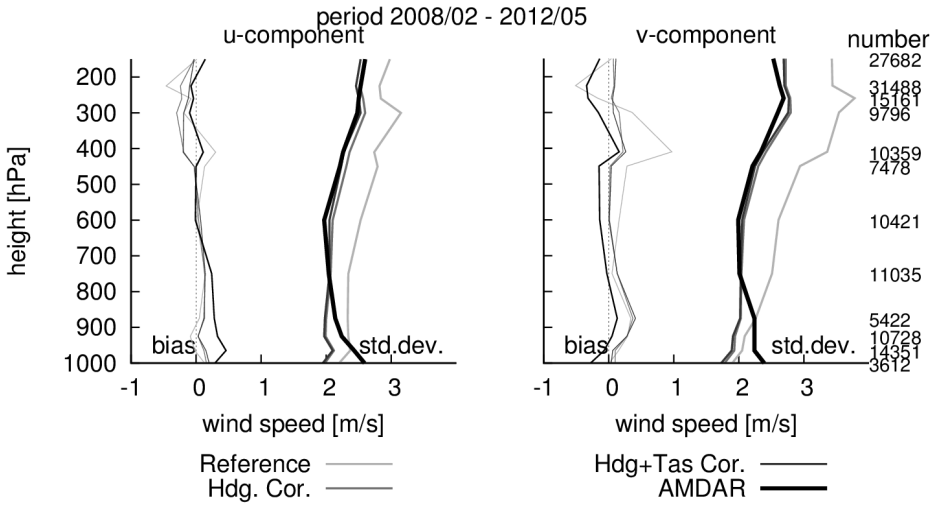


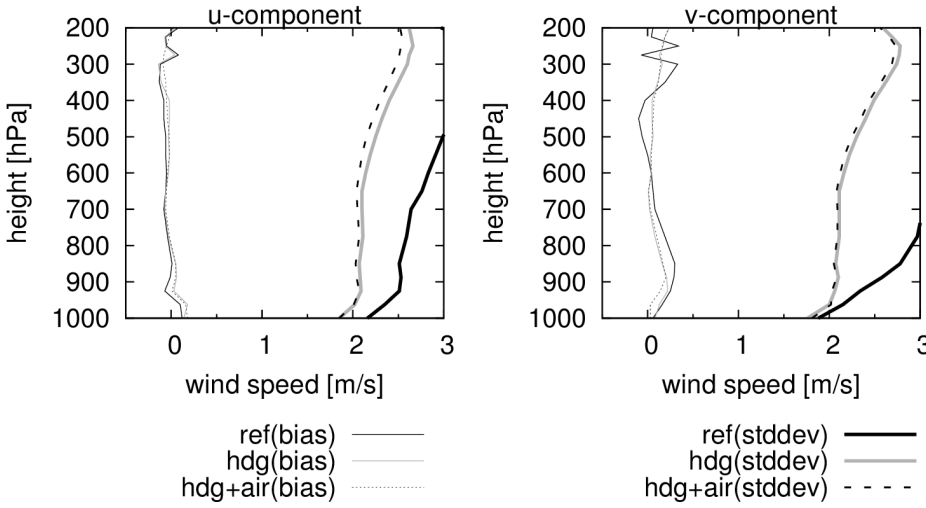


Wind improvements
Airspeed calibration

- Using NWP wind as truth estimate (ECMWF)
  - Heading correction
  - Airspeed calibration
- Dynamic lookup table for heading correction
- Static lookup table for airspeed calibration



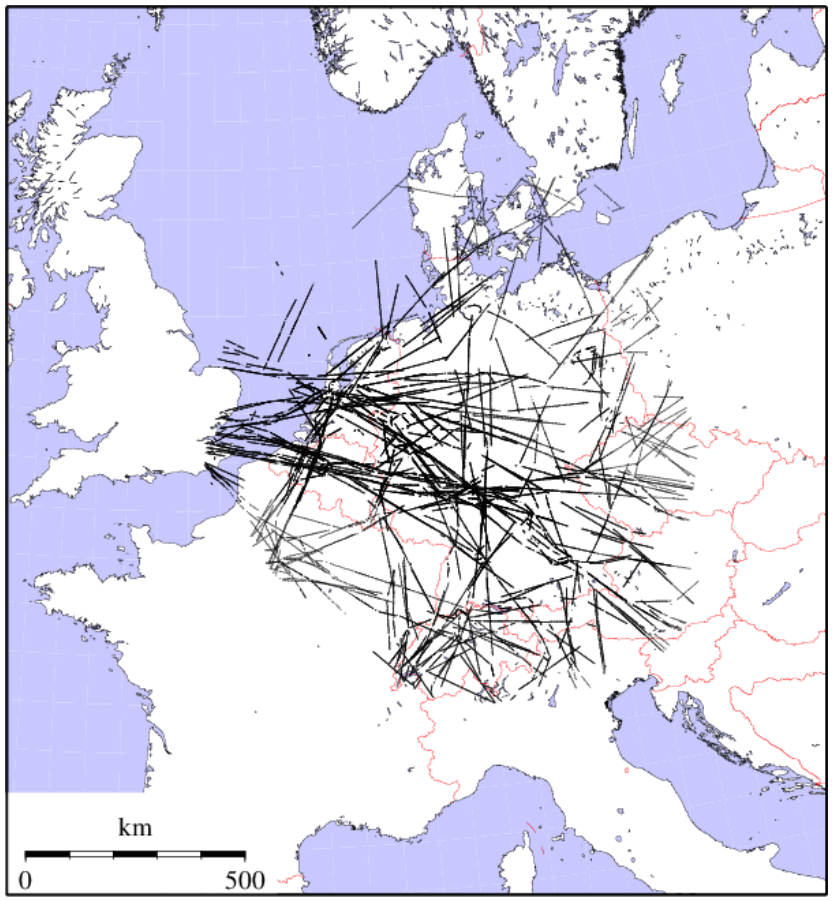




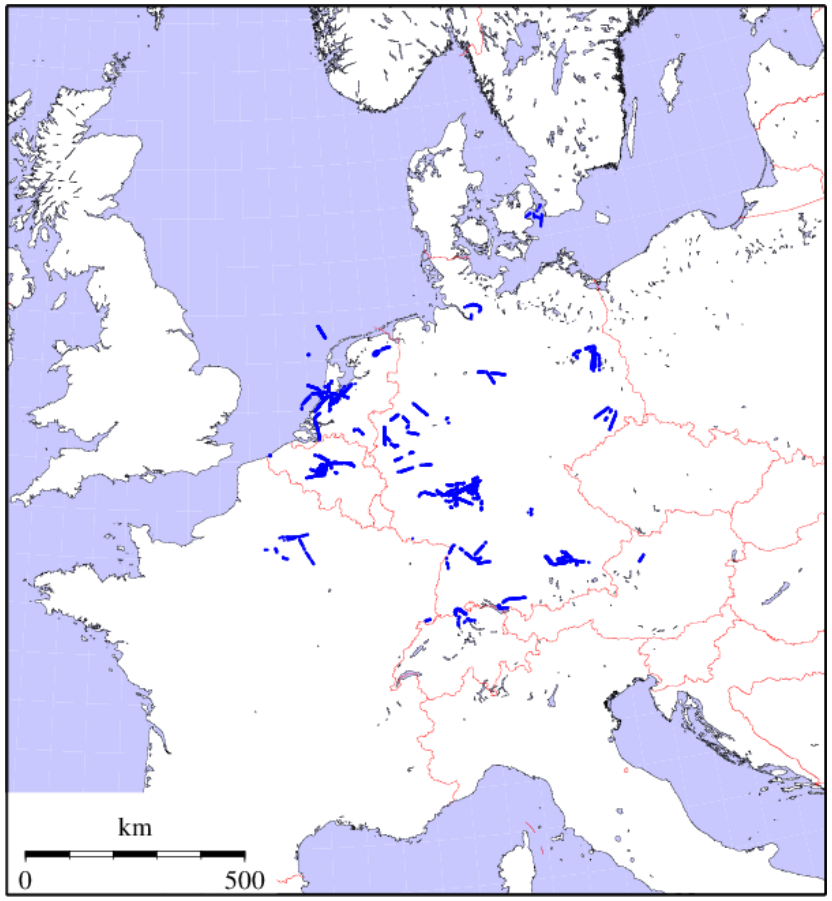
Current coverage of Mode-S EHS observations available at KNMI

derived Wind and Temperature (quality controlled)

All Wind and Temperature observations (73.370) valid 2012/08/09 1000 1015 UTC



Wind and Temperature observations below FL100 (6.673) valid 2012/08/09 1000 1015 UTC



Example of 15 minutes of derived Wind and Temperature observations from Mode-S EHS data of a day in August 2012 over Western Europe, source MUAC, processed by KNMI

Impact of MUAC Mode-S EHS

HIRLAM v7.4 / 11km / hourly

- Rapid cycle (start HH:12)
- Radar radial wind, GNSS ZTD (deHaan,2013)
- Mode-S EHS from LVNL (Netherlands)
  - reforecast (start HH+1:05)
- AMSU/ASCAT/radiosonde data
- MSG cloud initialization (Sibbo vd Veen)
  - FG for rapid cycle
  - ECMWF hourly boundaries

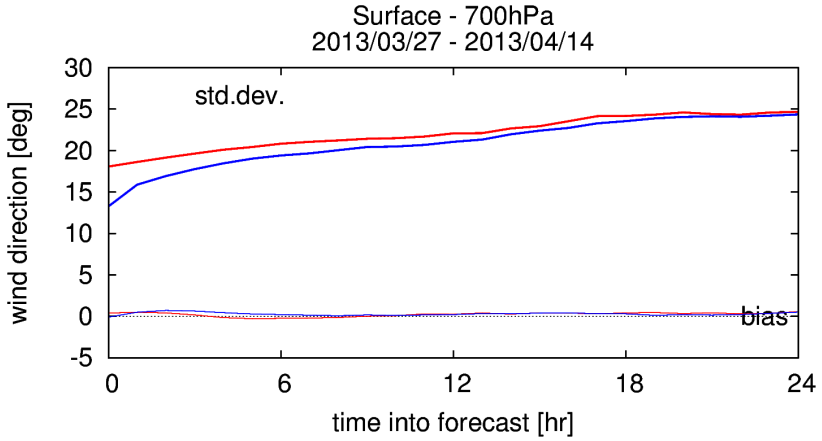
MUAC Mode-S EHS data:

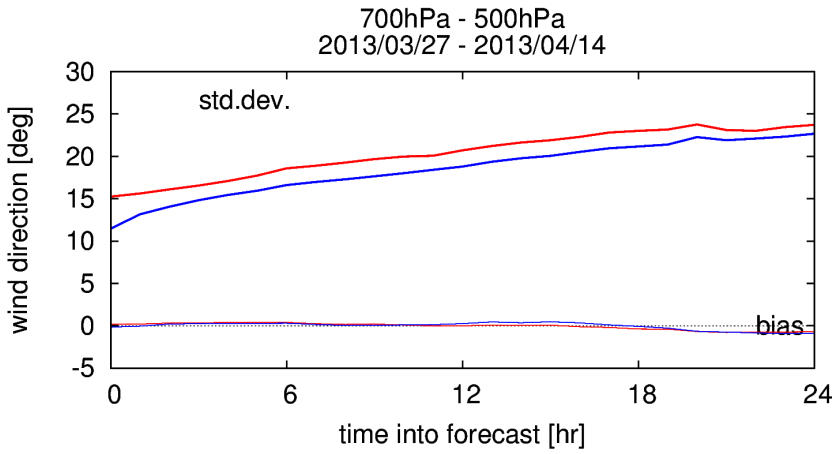
- Thinning in 50kmx50kmx300m boxes
- AMDAR resolution in space/time
- All necessary corrections applied

Impact of Mode-S EHS

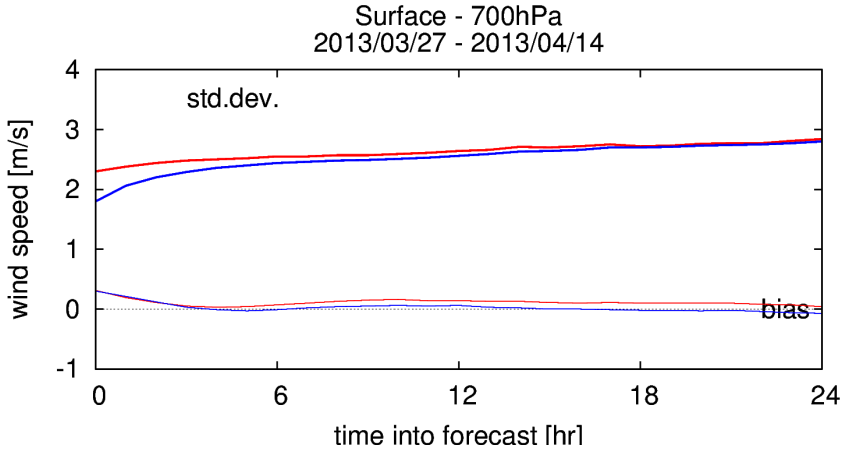
Compare assimilated Mode-S MUAC derived wind data with forecasts

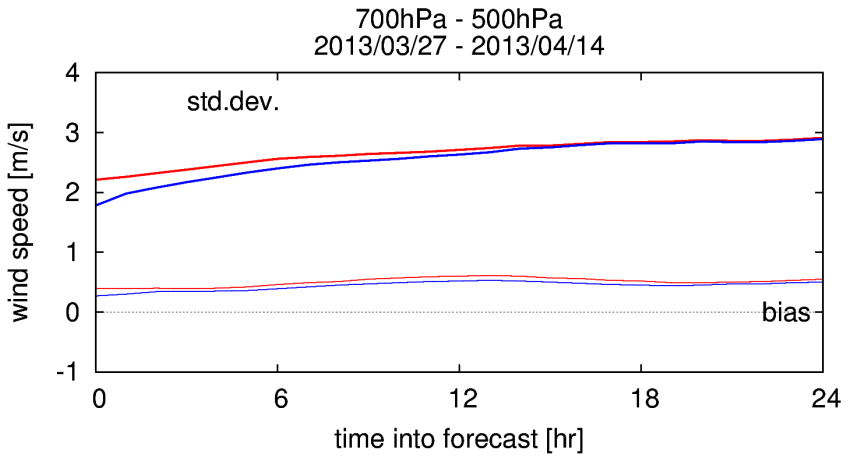
Wind direction





Wind speed





MUall.H11.bias
MUall.H11.stddev
MUall.H11MUAC.bias
MUall.H11MUAC.stddev

MUall.H11.bias
MUall.H11.stddev
MUall.H11MUAC.bias
MUall.H11MUAC.stddev

Conclusions

- High resolution models benefit from high resolution observations of good quality over a large area
  - Mode-S is such a data set
- Data usage can be optimized
  - HARMONIE: Cisco de Bruijn and Meteo France (SESAR WP 11.2)
- Mode-S data will be available Met-community
  - Starting July 2013
  - Delay 10 minutes
  - Every 15 minutes
  - BUFR/ASCII
  - ftp-server

Future

- More Mode-S EHS derived observations
  - Mode-S EHS radars in
    - France
      - Toulouse research EHS radar
      - Auch (30 km west of Toulouse, summer 2013)
    - UK
      - ?
- More other wind (and temperature observations)
  - Wind profilers/VAD winds
  - **Radar radial winds/reflectivities: OPERA!**

Acknowlegdement

- Jan Sondij
- LVNL
- EUROCONTROL

THE END ……

FINAL REMARKS

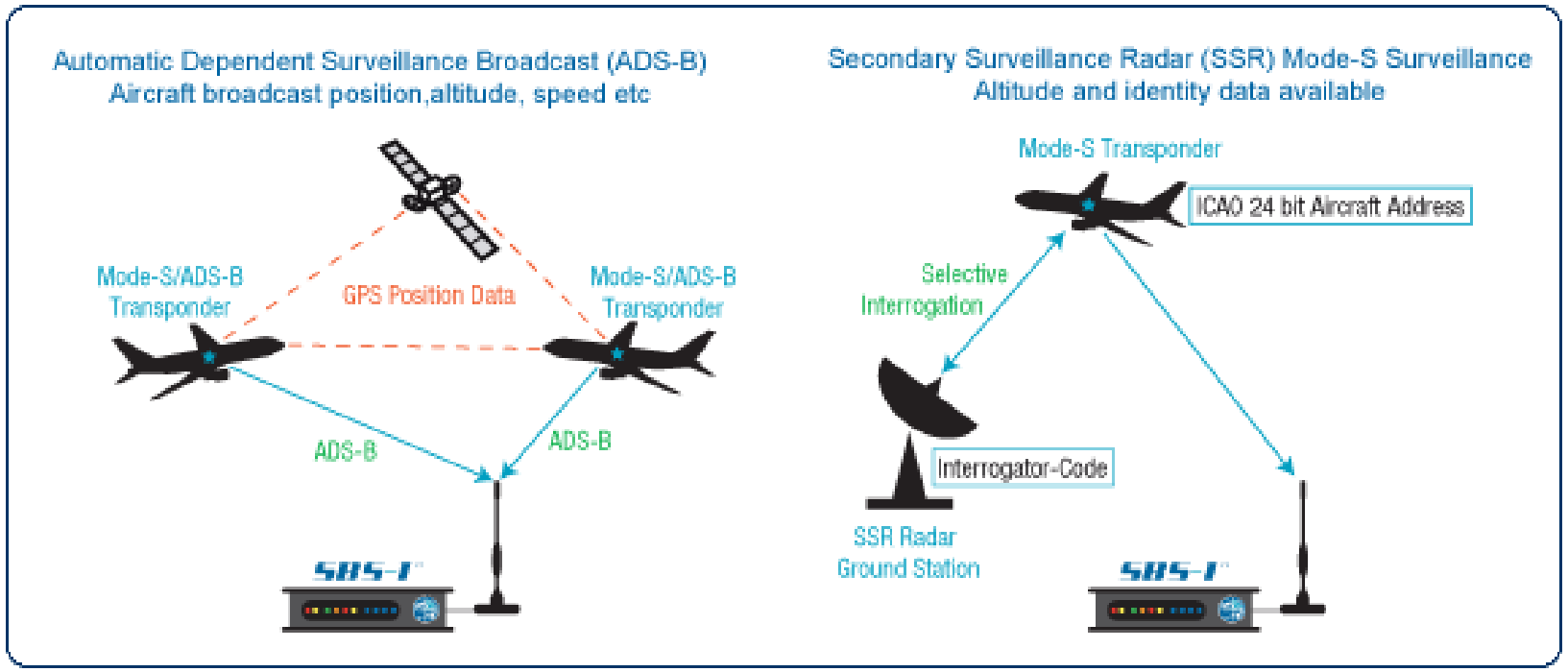
- Sharing observations is good for everybody
  - E-GVAP ZTD and its impact on NWP

- So .....

WE SHOULD START SHARING

- *Especially high resolution (space/time) observations*

Mode-S: technique



Source: www.javiation.co.uk