AMVs: past progress, future challenges

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IWW13, June 2016

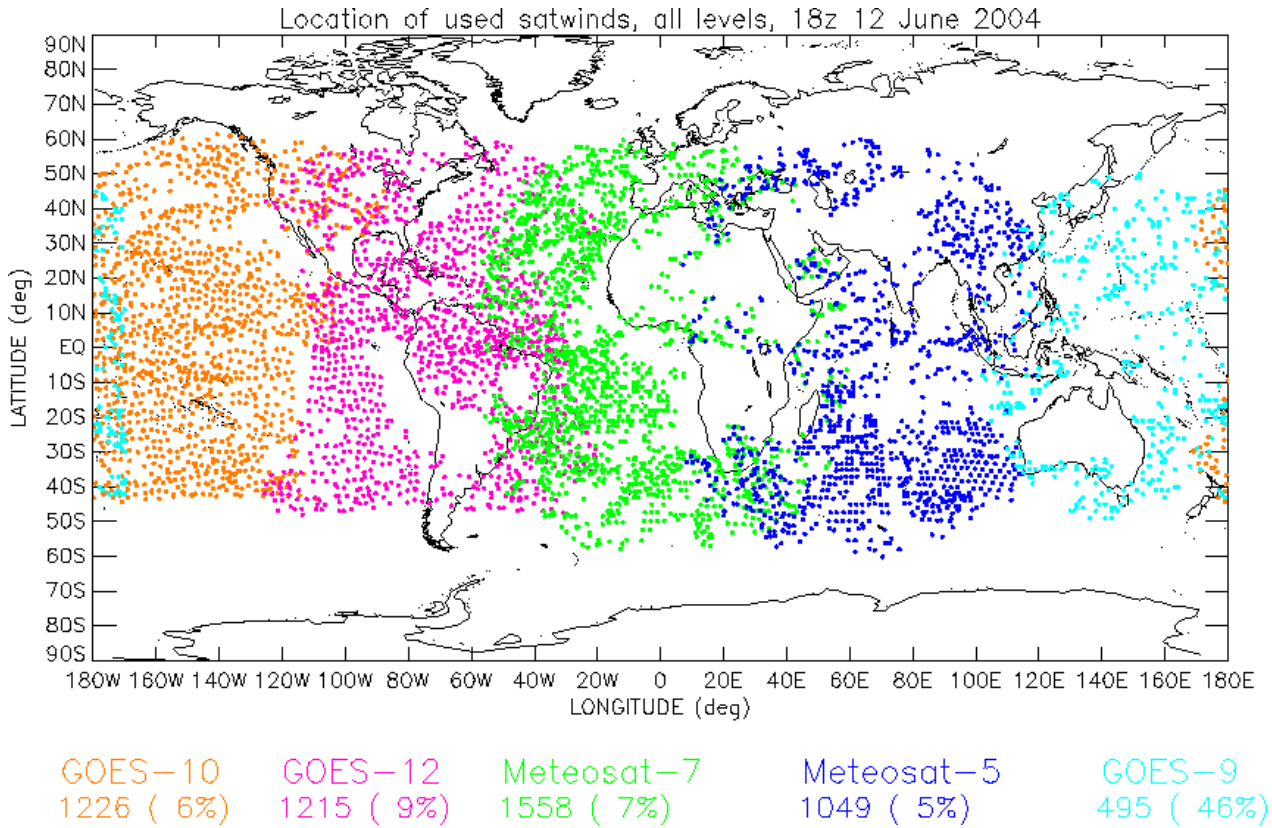
Talk Outline

- AMV data coverage – progression through time
- AMV impact and FSOI
- The challenges of high resolution

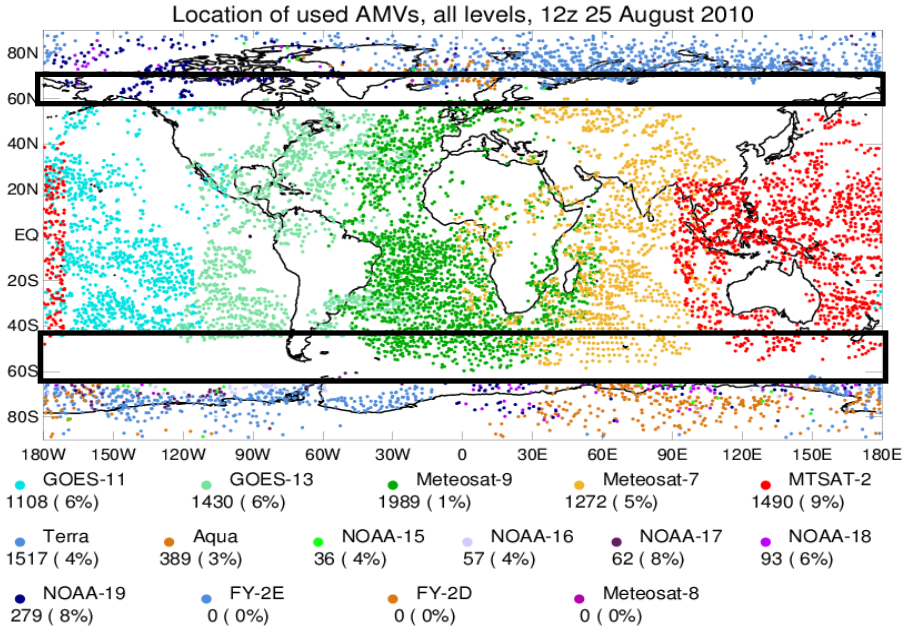
AMV data coverage

progression through time

AMV coverage – 2004

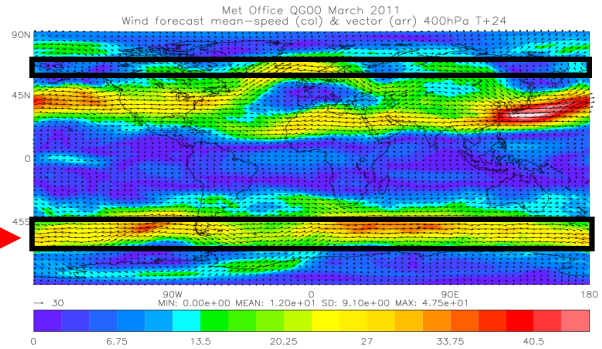


AMV coverage – 2010



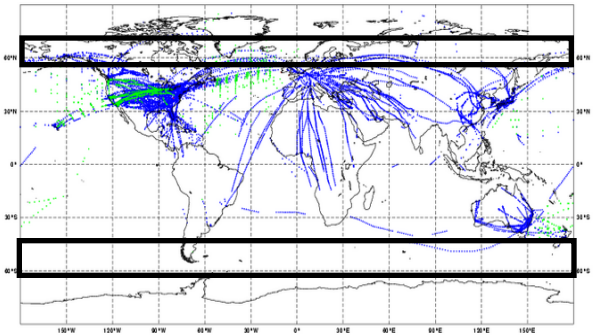
Improving, but still data gaps

Useful for constraining polar front jets

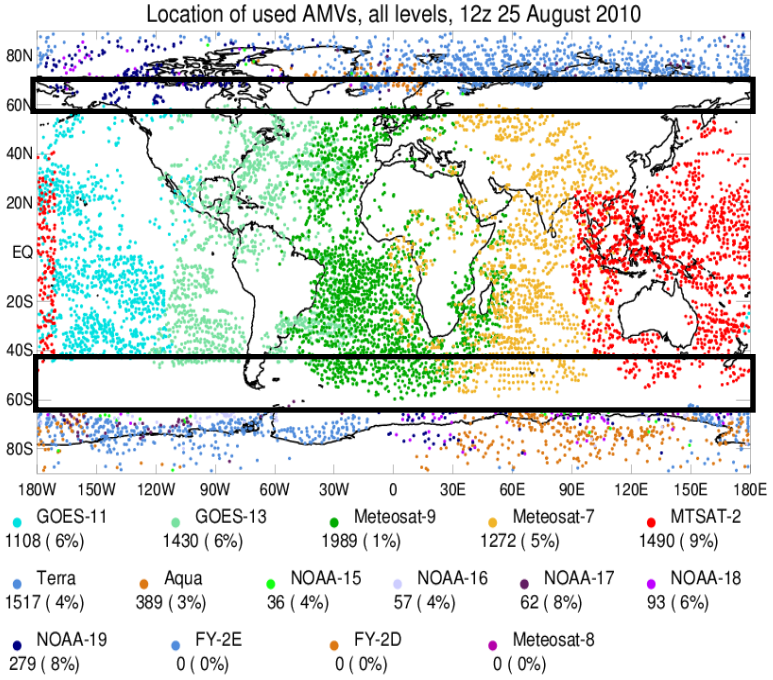


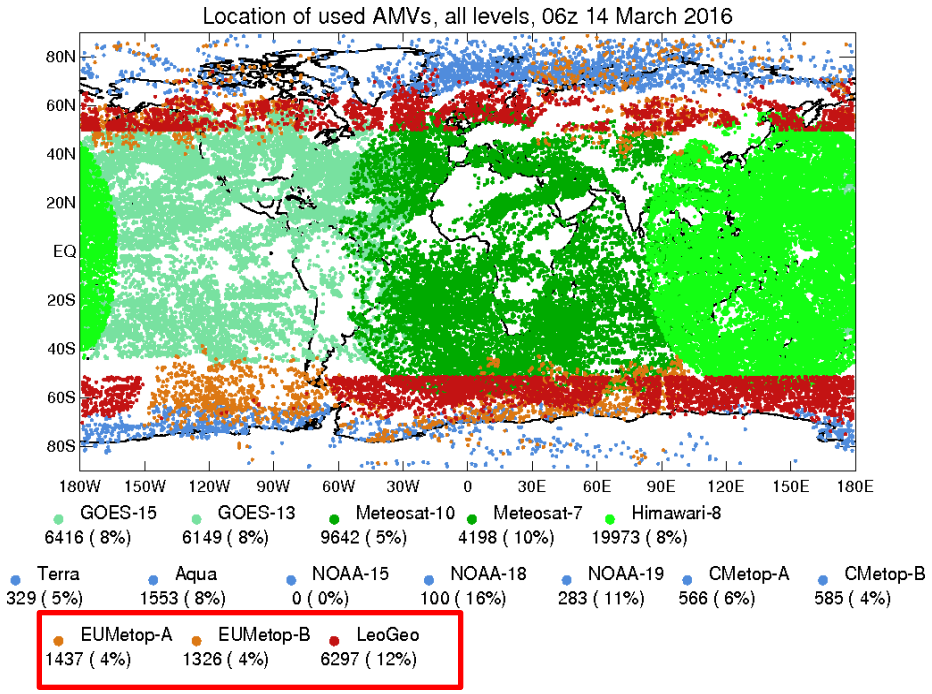
Lack of other wind data in AMV data voids

Aircraft



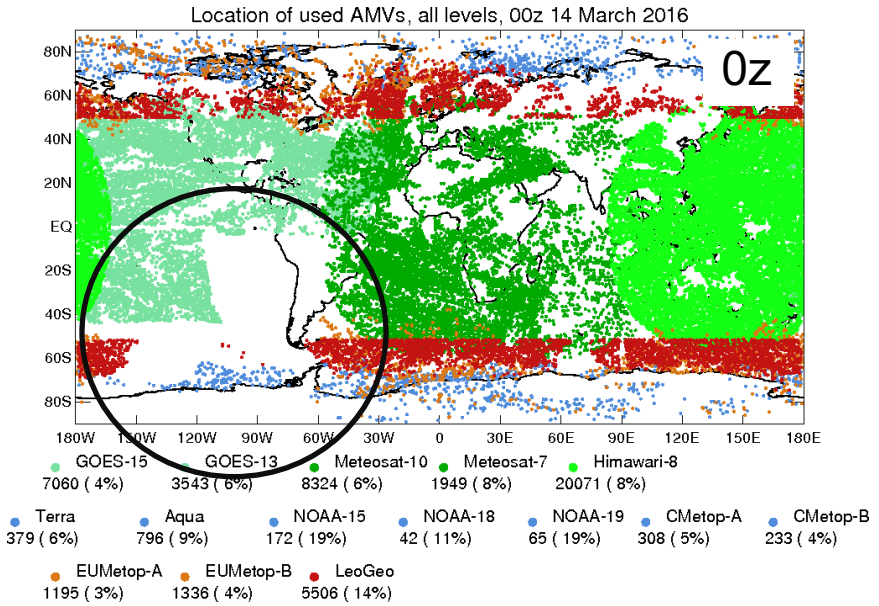
AMV coverage - 2016

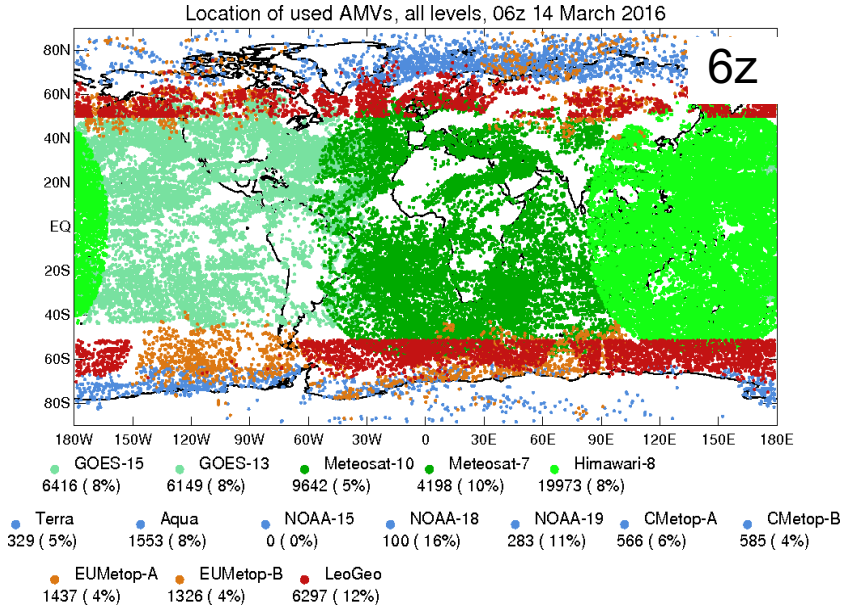




The gap is closed..... or is it?

AMV coverage - 2016

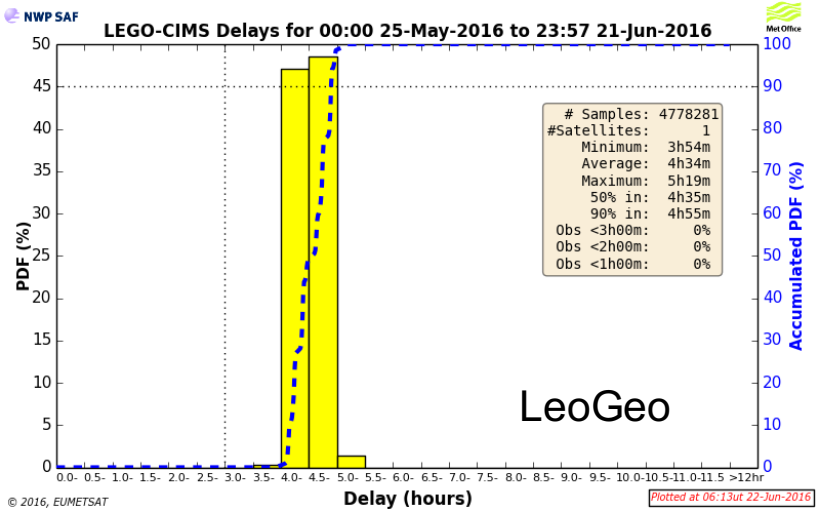


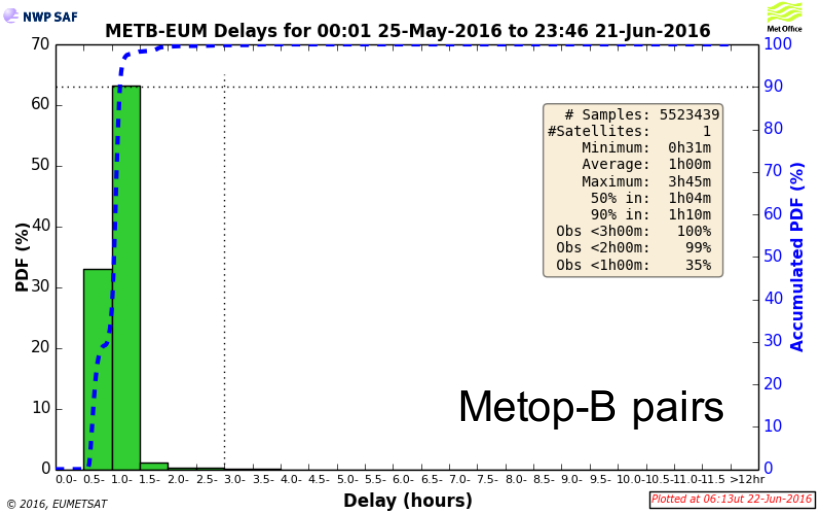


Not all update runs show such good coverage

AMV coverage - 2016

What about the timeliness?





Most LeoGeo AMVs do not arrive in time for main forecast runs

The potential is there

AMV timeliness – June 2016

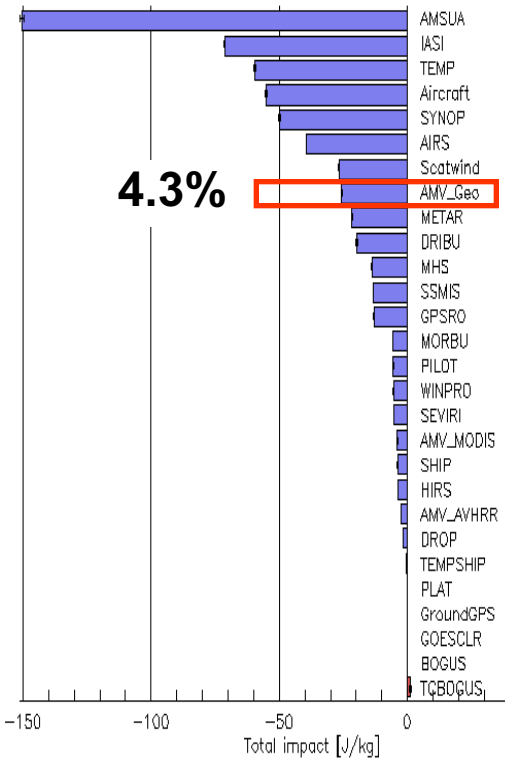
Dataset	average	% Main FC	% Update
Meteosat-10	0h37m	78	100
Meteosat-7	0h36m	70	100
GOES-13	0h58m	76	100
GOES-15	0h54m	73	100
Himawari-8	0h56m	75	100
INSAT-3D	1h00m	64	100
FY-2E	2h15m	17	98
FY-2G	1h45m	100	100
EUM Metop	1h25m	66	100
NES S-NPP	4h03m	32	90
NESDIS MODIS	~5h	6	70
DB MODIS	~2h15m	42	92
CIMSS LeoGeo	4h34m	19	86
MISR	1h43m	64	99

AMV impact and FSOI

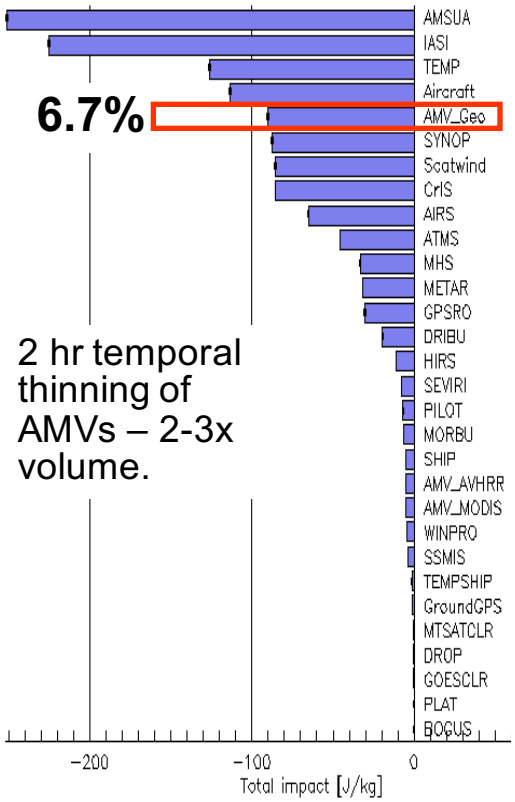
Impact on 24-hr forecast error - FSOI

- Increasing FSOI as increase AMV data assimilated at Met Office

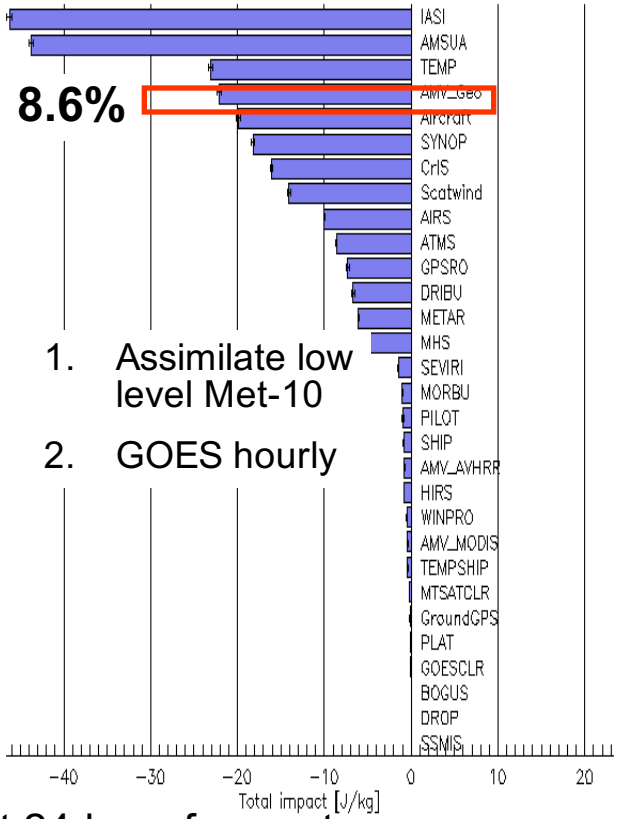
Jan-Mar 2012



Apr-July 2013



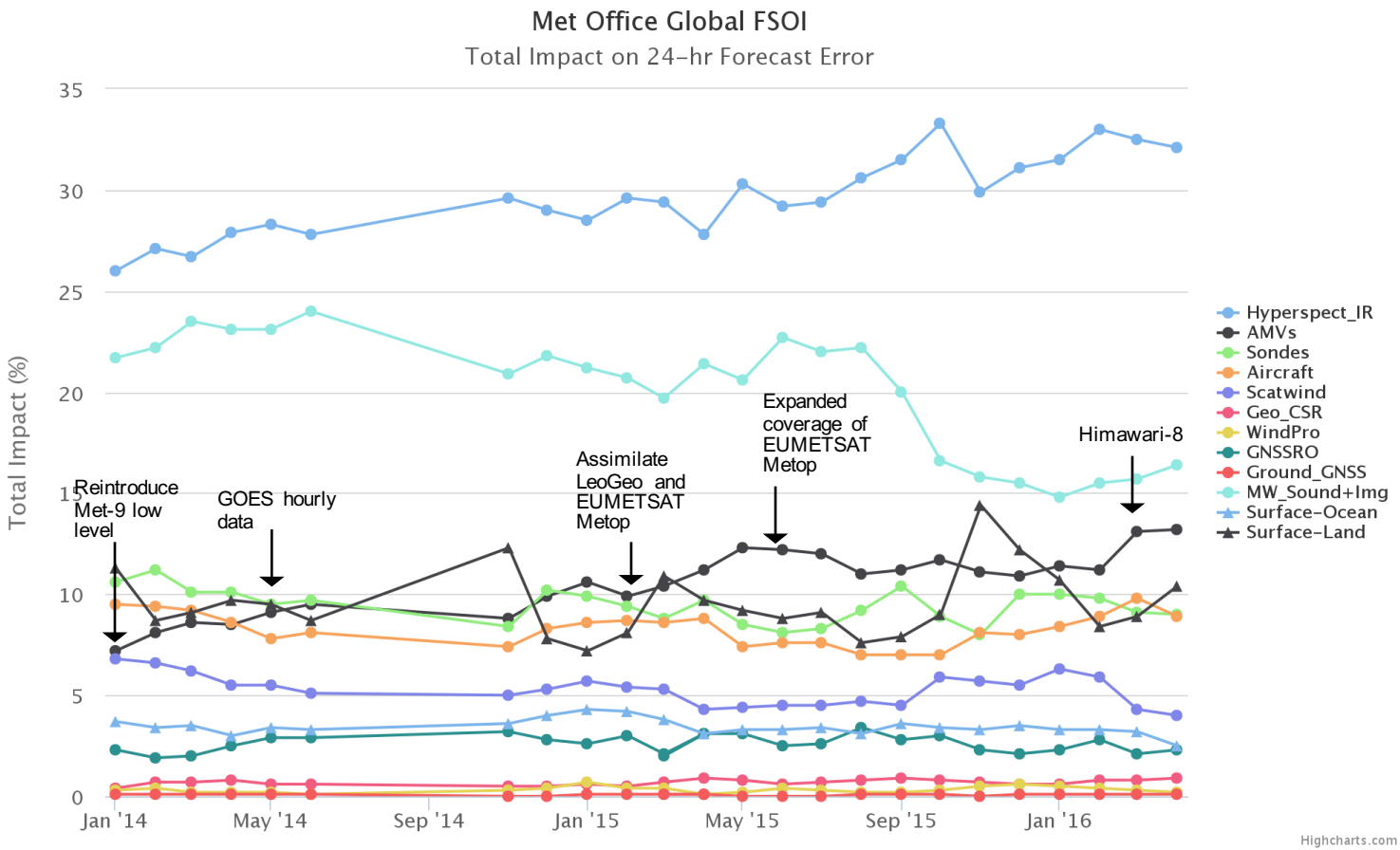
May 2014



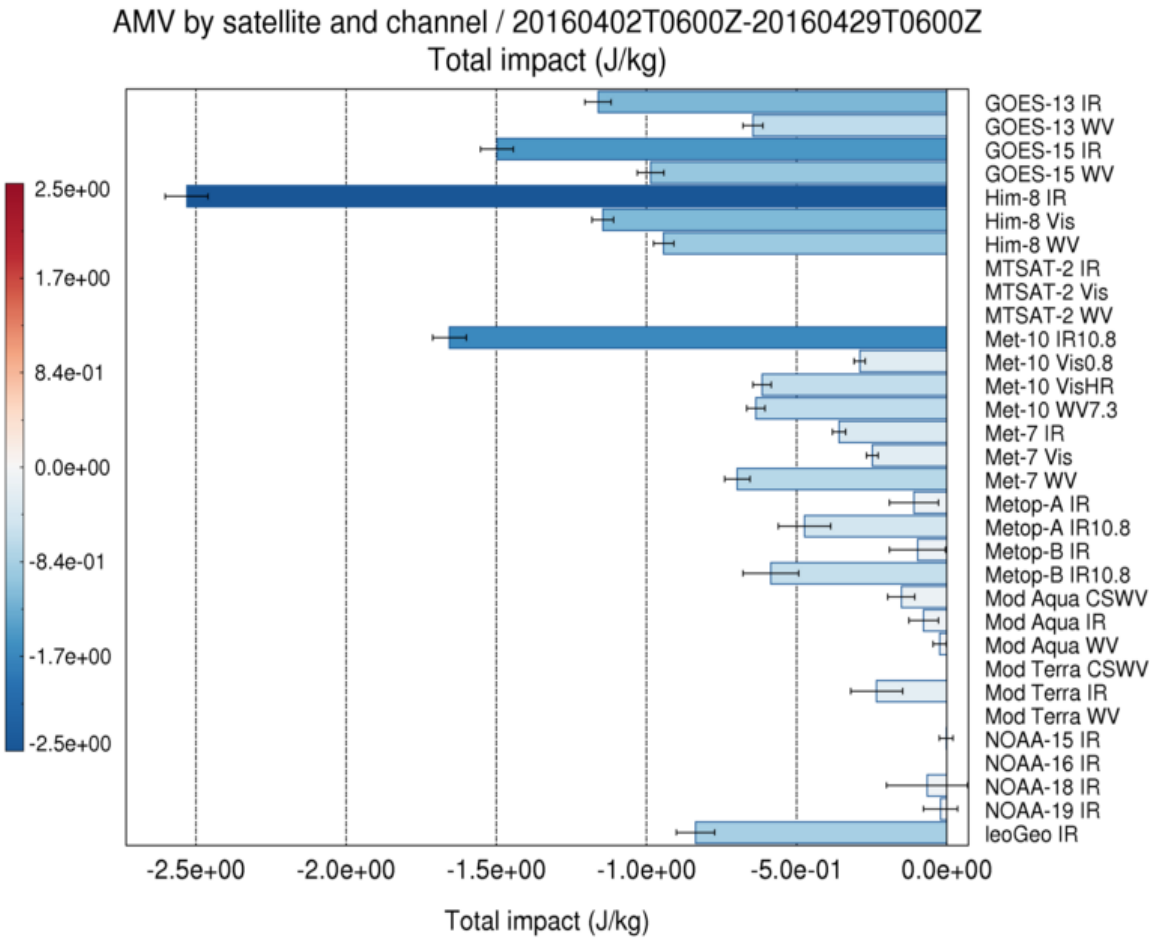
Contributions to the total observation impact on a moist 24-hour forecast-error energy-norm, surface-150 hPa (from Richard Marriot and James Cotton)

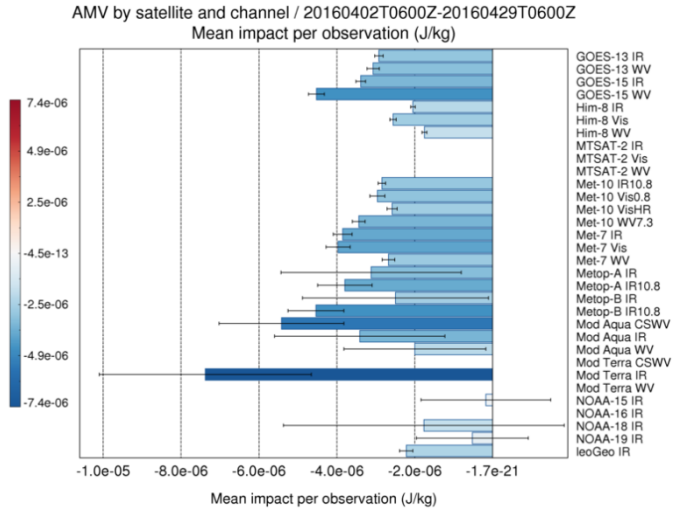
Impact on 24-hr forecast error - FSOI

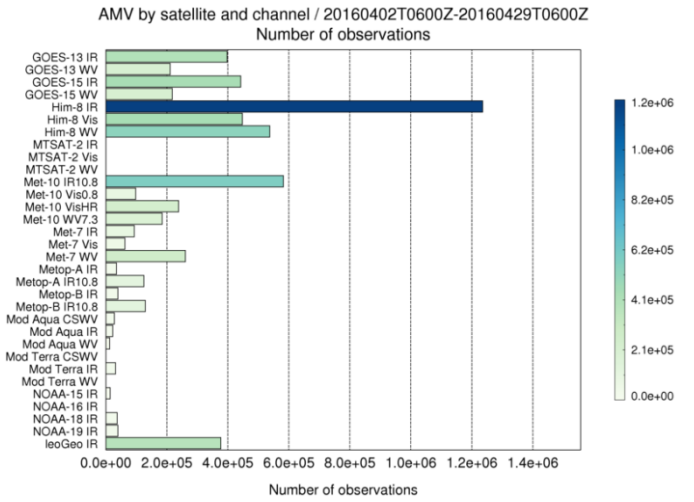
- Increasing FSOI as increase AMV data assimilated at Met Office



FSOI by Satellite-channel – Apr 2016







Observing System Experiments (OSEs)

- A coordinated set of OSE's designed to give us a snapshot of impacts from observations and to analyse the consistency with Forecast Sensitivity to Observations Impacts (FSOI).

The following set of data denial experiments have been run:

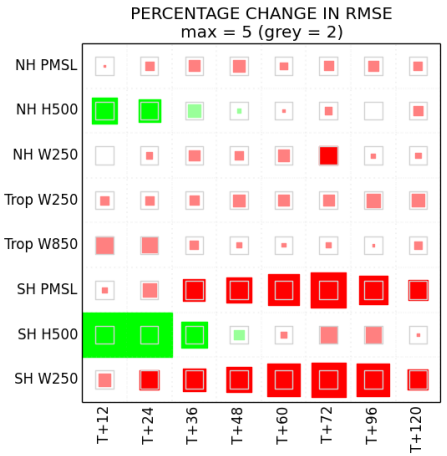
Exp	Data Denied
Expt 1	No IR data (no IASI, CrIS, AIRS, HIRS or SEVIRI)
Expt 2	No MW data (no AMSU/MHS, ATMS, SSMIS, AMSR-2, Saphir, FY-3C)
Expt 3	No MW Humidity (no MHS, ATMS18-22, FY-3C, Saphir, SSMIS 9-11 & 12-16, AMSR-2)
Expt 4	No MW Imagers (no AMSR-2, SSMIS 12-16)
Expt 5	No Adv IR sounder humidity channels (AIRS, CrIS and IASI) and no HIRS 11,12
Expt 6	No AMVs
Expt 7	No GNSSRO
Expt 8	No Scat
Expt 9	No TEMPs
Expt 10	No Ground based GNSS

Baseline is a PS37 N320 control from 12 Nov - 15 Jan 2015/16

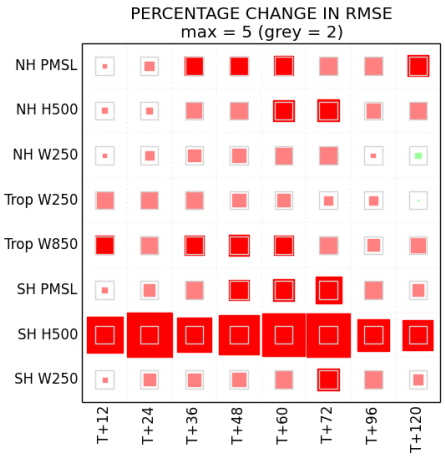
Impact Scorecards

Versus Observations

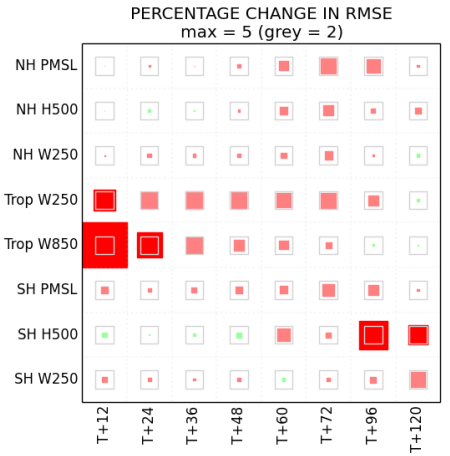
No IR



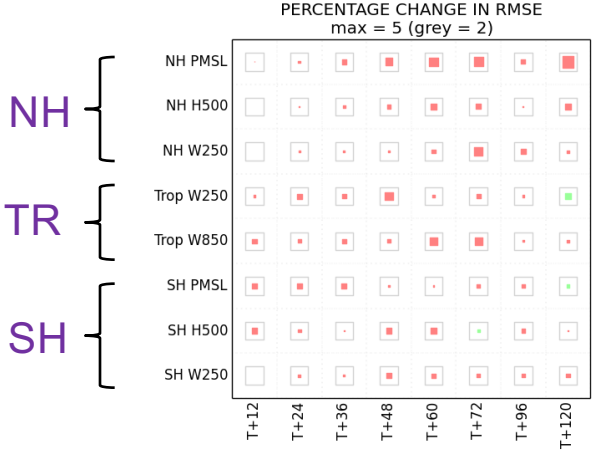
No MW



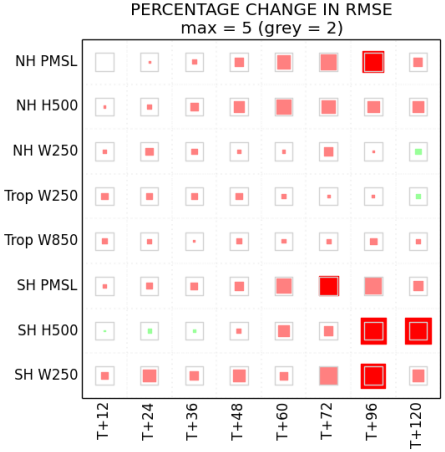
No AMV



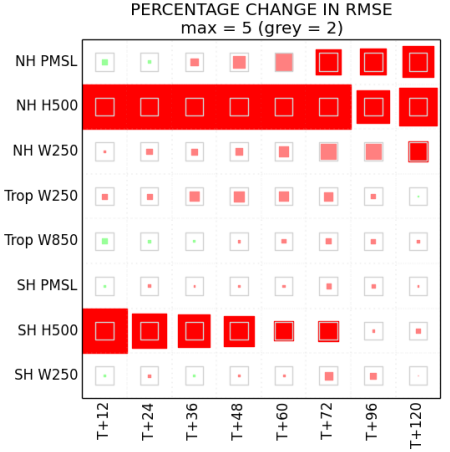
No Scat



No GNSSRO



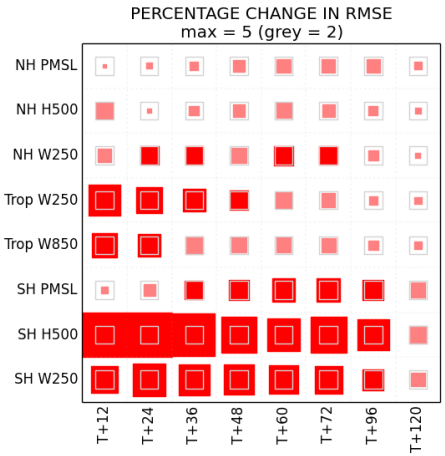
No Sonde



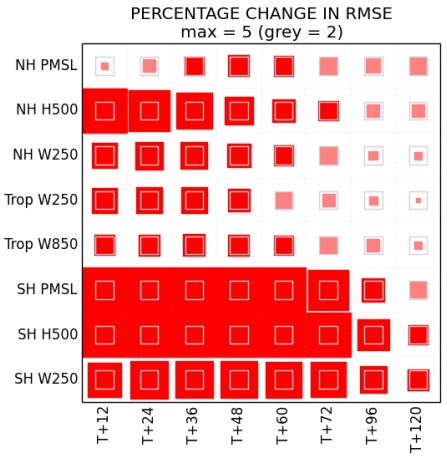
Impact Scorecards

Versus ECMWF Analysis

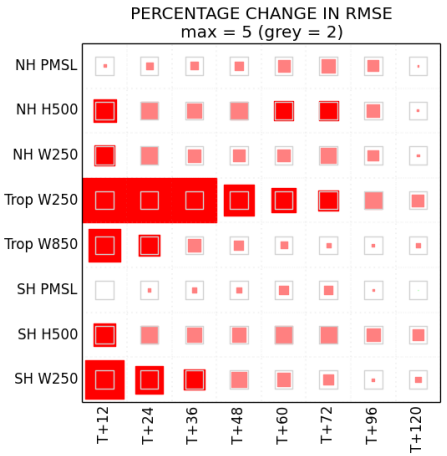
No IR



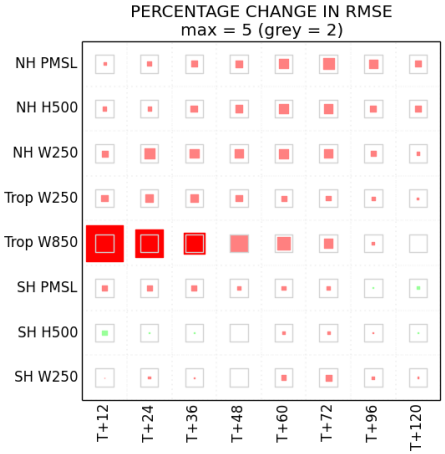
No MW



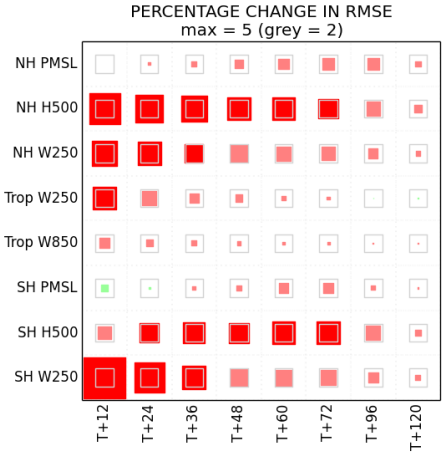
No AMV



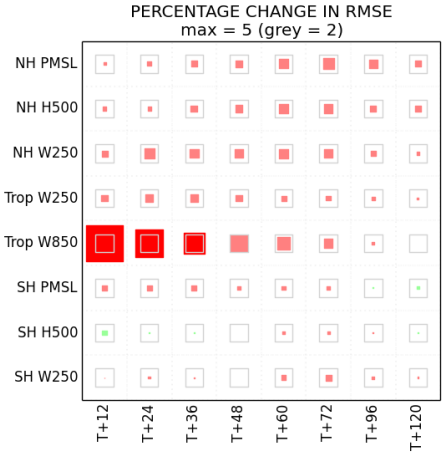
No Scat



No GNSSRO



No Sonde



FSOI Comparison

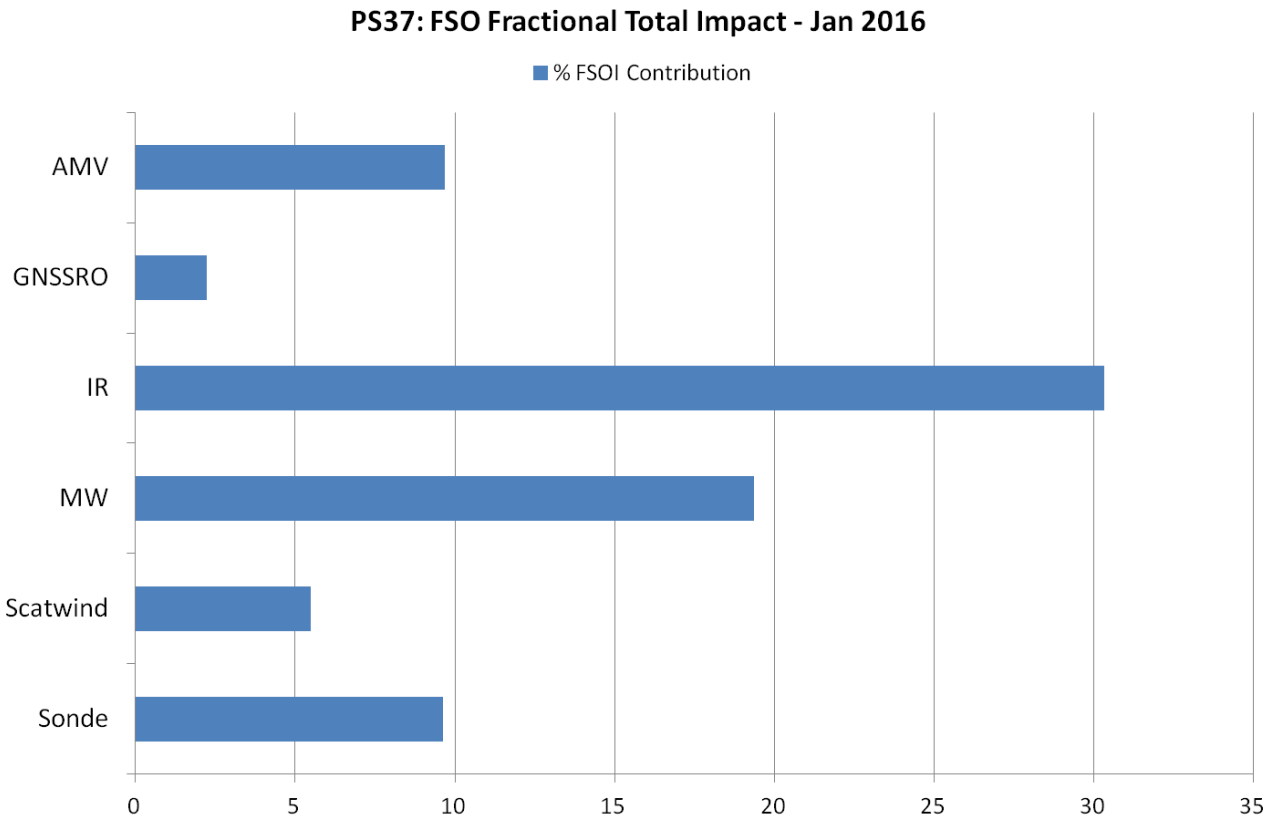
Forecast Sensitivity to Observations Impact (FSOI)

- Measures the impact on 24-hour forecast error

Data denial Experiments

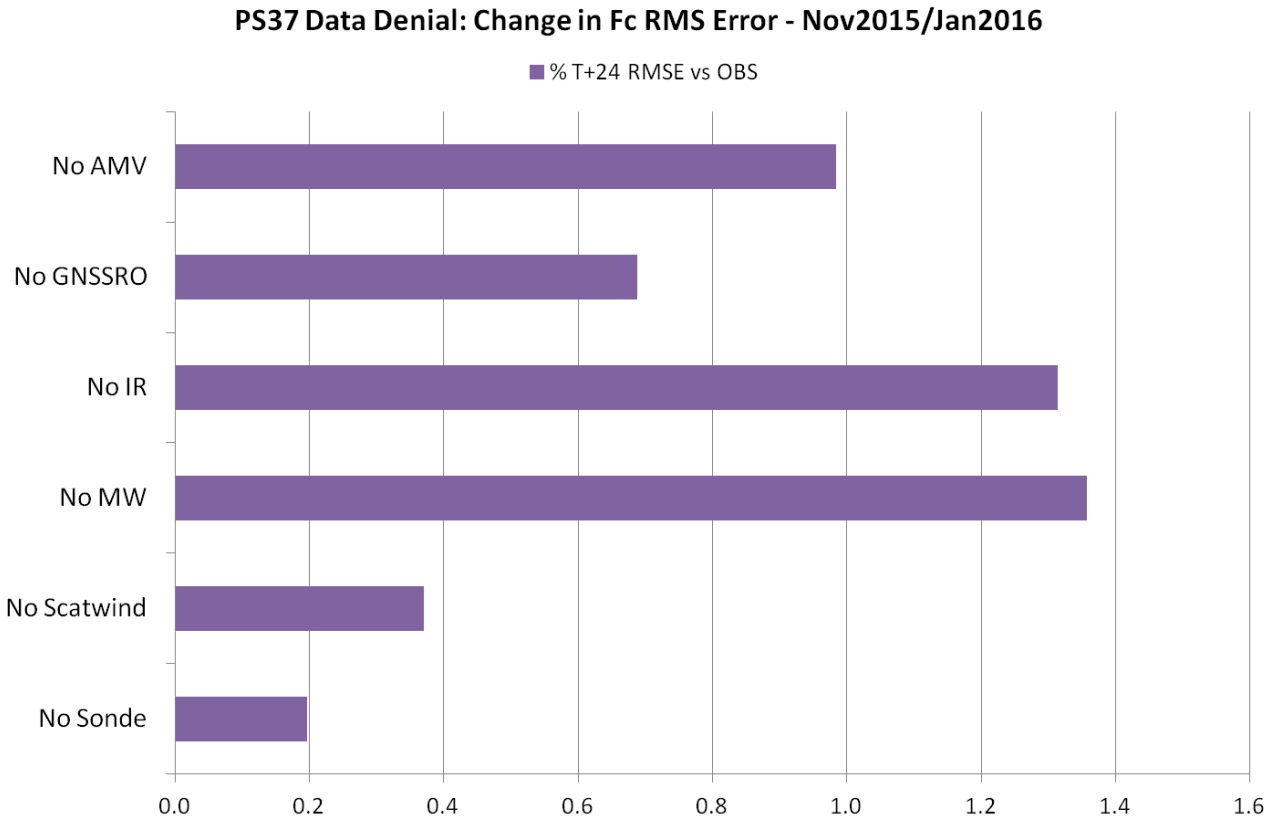
- Percentage change in T+24 forecast RMS error
- Mean of 6/8 variables
    - Northern hemisphere: (H500), PMSL, Wind 250 hPa
    - Tropics: Wind 850 hPa, Wind 250 hPa
    - Southern hemisphere: (H500), PMSL, Wind 250 hPa

FSOI Fractional Impact



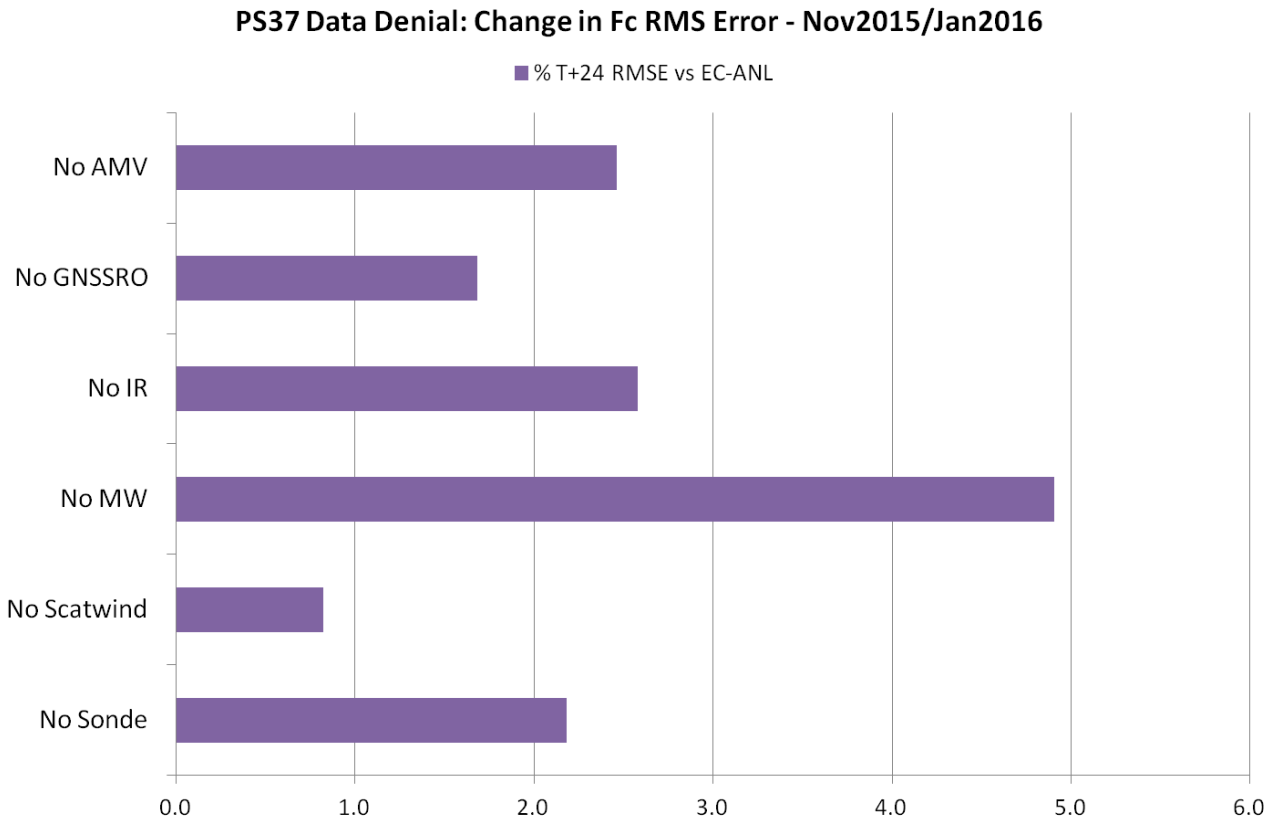
FSOI	*RMSE OBS*	*RMSE EC*
1. IR		
2. MW		
3. AMV		
Sonde		
5. Scatwind		
6. GNSSRO		

Denial T+24 RMSE vs OBS



FSOI	*RMSE OBS*	*RMSE EC*
1. IR	1. MW	
2. MW	2. IR	
3. AMV	3. AMV	
Sonde	4. GNSSRO	
5. Scatwind	5. Scatwind	
6. GNSSRO	6. Sonde	

Denial T+24 RMSE vs EC



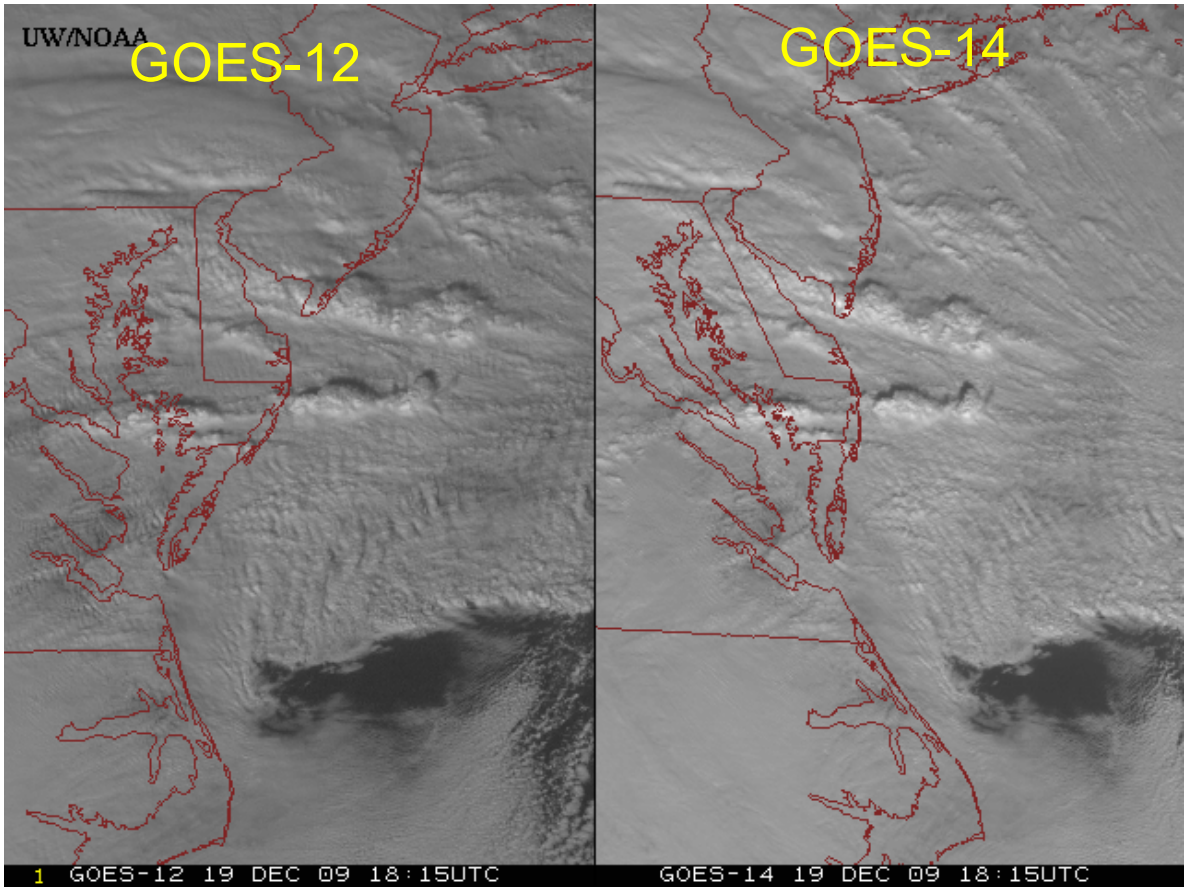
FSOI	*RMSE OBS*	*RMSE EC*
1. IR	1. MW	1. MW
2. MW	2. IR	2. IR
3. AMV	3. AMV	3. AMV
Sonde	4. GNSSRO	4. Sonde
5. Scatwind	5. Scatwind	5. GNSSRO
6. GNSSRO	6. Sonde	6. Scatwind

- Largest impact from advanced IR sounders and MW
  - FSOI: IR > MW
  - Denial: MW > IR
- AMVs and Sondes next
- GNSSRO shows larger impact with data denial, but relatively low impact with FSOI

The challenges of high resolution

High resolution AMVs

- AMVs capture broad-scale to synoptic-scale flow.
- Spatial and temporal resolution improving
- Can we derive AMVs for nowcasting or assimilation in high resolution models?
- to help with forecasting high impact weather events.

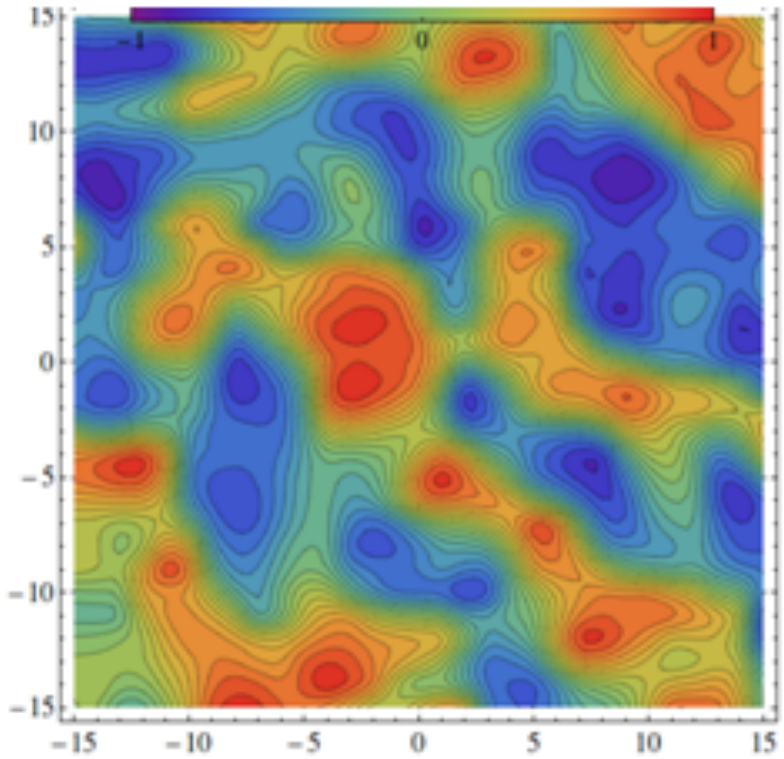


Visible data from the GOES-14 NOAA Science Test – 1 min imagery, *from Jaime Daniels, NESDIS*

High resolution AMVs

Tracking – becomes trickier

Use smaller targets and shorter imager intervals to derive high resolution AMV datasets reflecting the motion of smaller scale features of the flow.



Example correlation surface with 5x5 pixel targets.
BUT more noise - many peaks ->
Information included in target feature is not enough to determine wind vector accurately

From Kazuki Shimoji's IWW12 talk

Need to reduce noise

- clustering (e.g. Nested tracking developed at NESDIS)
- use information from correlation surface to filter out poorly constrained cases.
- averaging (see *e.g. Shimoji, IWW12*)

High resolution AMVs

Other tricky bits

AMVs

- More sensitive to satellite image registration errors (but navigation systems are improving).
- Cannot resolve slower winds well with shorter image intervals.
- Current quality indicators tuned to large-scales - penalize spatially varying, accelerating wind features

NWP

- In NWP smaller scales tend to change fast and represent only modest energy conversion. The quantity and coverage of observations to initialise and evolve these scales is a daunting challenge. Inadequate coverage could compromise the analysis of the larger scales.
- AMVs have correlated errors in space and time. To alleviate problems, data is thinned (or superobbed) and errors inflated. But if thin too much, we will lose the mesoscale information of interest

Wiki page on IWWG web page to foster collaboration

https://groups.ssec.wisc.edu/groups/iwwg/activities/high-resolution-winds-1/high-resolution-winds

Summary

1. New datasets in recent years have helped to close the data gaps between the geostationary and traditional polar AMV datasets.
2. AMV impact is around third behind hyperspectral IR and microwave radiances in both FSOI (similar to sondes, aircraft and surface) and denial experiments. Main impact on wind fields and H500.
3. High resolution AMVs remains a challenge – Session 6

Met Office

Questions?