Recent changes in the ECMWF NWP system

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CHANGES SINCE ITSC-19

New model cycles

Since ITSC-19, ECMWF implemented only one new model cycle (41R1 on 12 May 2015). This cycle gave a good positive impact. It comprised several data assimilation and model changes:

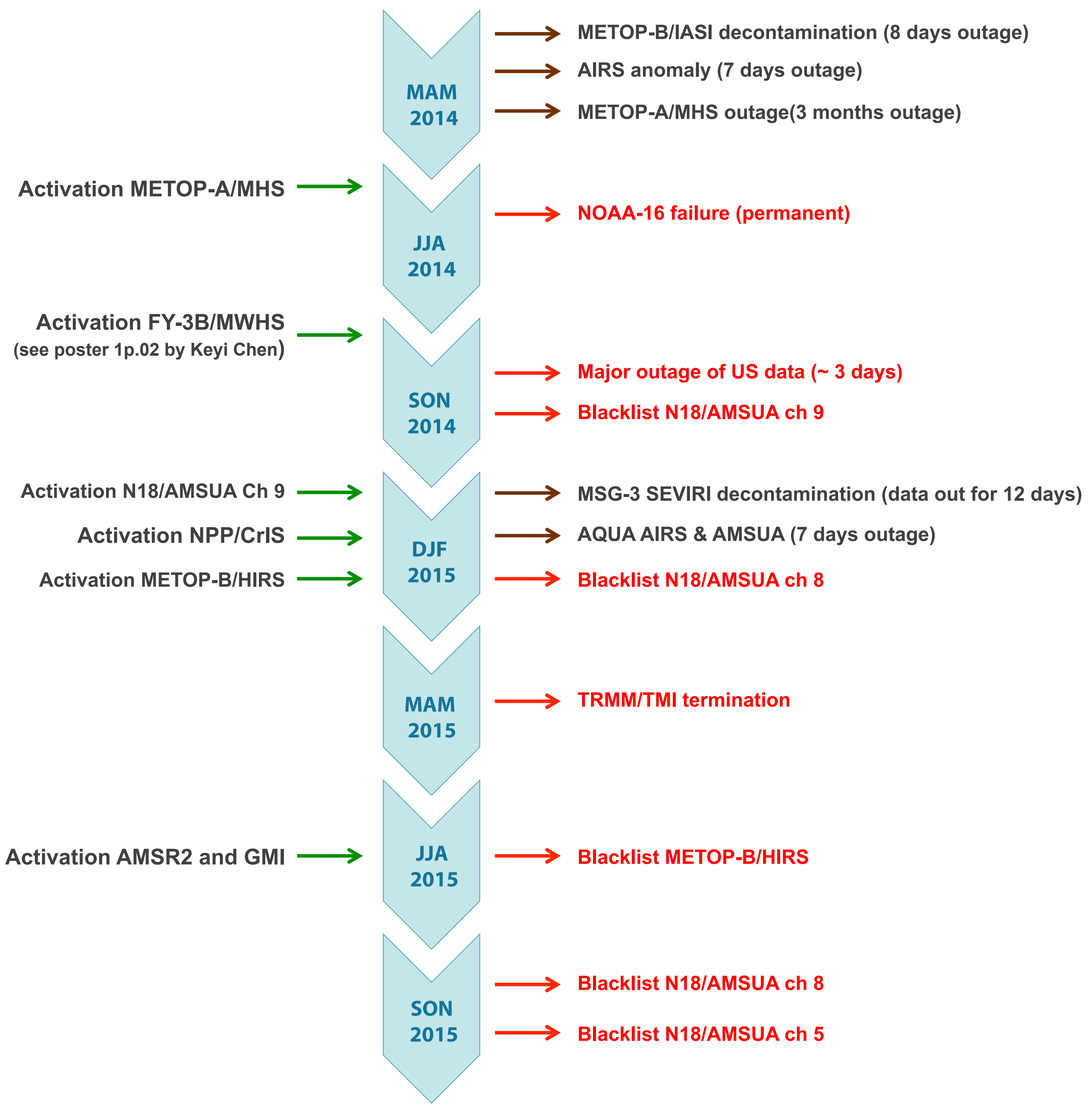
Data assimilation changes:

- **Switch to all sky mode for the assimilation of MHS** (see ITSC-19 item 9.01)
- **Assimilation of SSMIS moisture sounding channels over land and sea-ice**
- **Assimilation of surface-sensitive ATMS channels over land** (see ITSC-19 item 1p.12)
- **Upgrade of radiance observation operator with RTTOV-11** (see ITSC-19 item 4p.03)
- **Assimilation of GPS-RO with two-dimensional observation operator**
- **Assimilation of ASCAT in soil moisture analysis**
- **Assimilation of Altika and Cryosat altimeter wave height data**
- Assimilation of high-resolution radiosondes
- Upgrade of inner loop resolutions of 4D-Var to T_L255 for each of the three iterations of the outer loops.
- Changed calculation of background error covariances from using EDA samples of perturbations from last cycle (1/3) and climatology (2/3).
- Reduction of number of iterations in 1st inner loop and use of full linear physics package.

Model changes:

- New surface climate fields (land-sea mask, sub-grid orography)
- New CO_2/O_3/CH_4 climatologies from latest MACC-II reanalysis produced at ECMWF.
- **Revised semi-Lagrangian extrapolation reducing stratospheric noise (good impact on satellite data usage)**.
- Revised interpolation of moist variables in the upper-troposphere/lower stratosphere (UTLS).
- Activation of the lake model (FLAKE).
- Cloud scheme change of rain evaporation, auto-conversion/accretion, riming, precipitation fraction.
- Improved representation of super cooled "freezing" rain.
- Modified convective detrainment.
- Active use of wave modified stress in coupled mode.
- Revised sea-ice minimum threshold, sea-ice roughness length and consistency between SST and sea ice concentration.

Operational changes of satellite data usage (radiances only)



Microwave imagers

- Three microwave imagers are currently active (using the all sky approach):
  - **GCOM-W1/AMSR2** (channels 7 to 11 and 13) active since 12 August 2015
  - **GPM/GMI** (channels 3 to 6 and 8) active since 12 August 2015.
  - **F17/SSMIS** (channels 12 – 14 and 16 – 17)
- The addition of AMSR2 and GMI improve the fit to almost all other observations (except for AMSUA – the reasons are understood)
- Decrease of geopotential Standard deviation of forecast error up to day 4
- Forecast scores for humidity appear degraded for lower troposphere up to day 4 (however increments are larger and analysis more active).

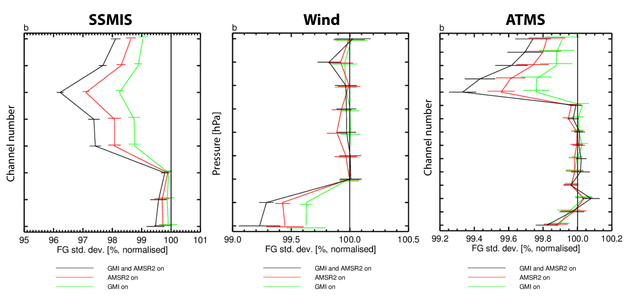


Figure 2. Normalised change in standard deviation the first-guess departure differences from SSMIS, wind and ATMS. The difference in standard deviation of FG departure between the experiment and the Control run is normalized by the Control (with F17 SSMIS only). Values less than 100% indicate beneficial impacts from the use of additional microwave imagery.

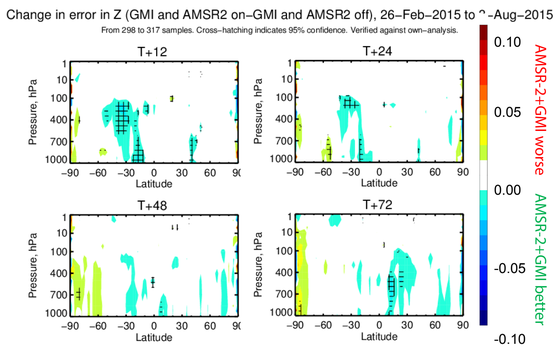


Figure 3. Normalized change in the standard deviation of geopotential forecast error between GMI and AMSR-2 on and Control (with F17 SSMIS only). Cross-hatched areas show changes that are significant at the 95% confidence interval. Results cover the time period from 26 February 00UTC to 20 July 2015 12 UTC.

Infrared sounders

- Four infrared sounders are being used:
  - **IASI from METOP-A and METOP-B (since February 2014)**
  - **AQUA (AIRS)**
  - **NPP/CrIS (78 channels) activated on 22 January 2015**
  - **One HIRS instrument (METOP-A)**
- The addition of **CrIS** (with or without the presence of AIRS) shows:
  - Positive to neutral impact on forecasts.
  - Slightly better fit of the background to independent observations (except for some microwave sounding channels)

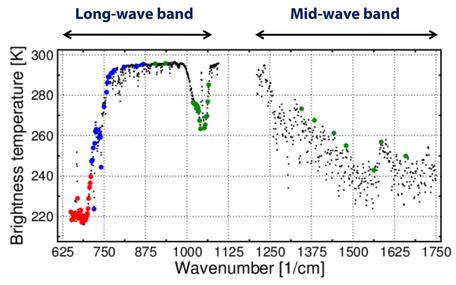


Figure 4. CrIS spectrum. Used channels are represented by colourful dots: **Stratospheric channels:** used over sea, sea-ice and land (30), **Tropospheric channels:** used over sea-ice and sea (23) and **Window / ozone / water vapour channels (25):** used over sea only

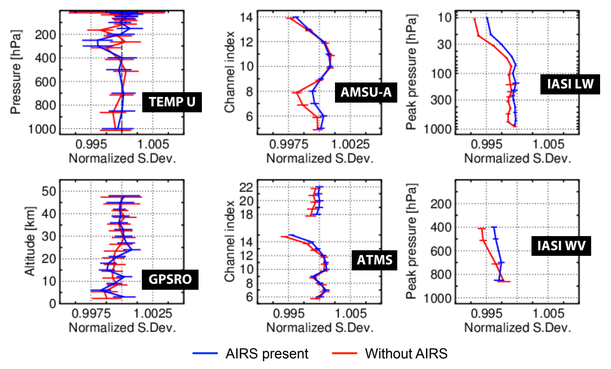


Figure 5. Impact of adding CrIS with (red) and without (blue) the presence of AIRS. The impact is shown in terms of background fit to selected observation types. Statistics are normalized by the control run (operational set-up) and represent a global sample

Microwave sounders

Table 1. Channels assimilated

	AMSUA	MHS (all sky mode)	ATMS	SSMIS (all sky mode)	MWHS
Metop-A	5,6,9-14	3-5			
Metop-B	5-15	3-5			
NOAA-15	5,7-10,12-13				
NOAA-18	6-7,10-14	3-5			
NOAA-19	5-6,9-14	4-5			
AQUA	6,8-14				
NPP			6-15,18-22		
F-17				9-11	
FY-3B					3-5

- In Cycle 41R1, MHS is used in all sky mode allowing
  - Doubling of the observation coverage in the mid-latitude storm tracks
  - Improvement of mid-latitude dynamical forecasting

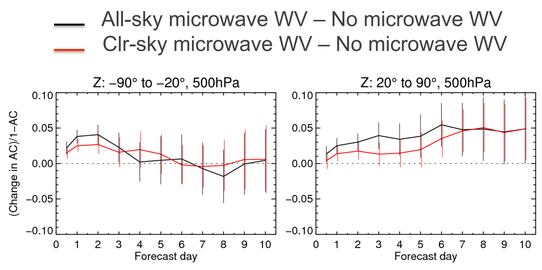


Figure 6. Forecast impact of switching MHS to all sky mode

Main upcoming satellite changes (cycle 41R2)

The upcoming ECMWF model cycle 41R2 (expected to be implemented in Q1/Q2 2016) will be mainly dedicated to a significant resolution increase affecting almost all model and data assimilation components (see table 2). The cycle will also include significant satellite data assimilation changes:

- Activation of F-18 humidity sounding channels over ocean and extend all-sky assimilation to snowy land surfaces
- Situation dependent observation errors for AMSUA (see poster 5p.06 by Heather Lawrence)
- Improved IASI aerosol screening (see poster 8p.04 by Reima Eresmaa for Julie Letertre-Danczak)
- 25% increase of GPSRO observation errors
- Update of RTTOV coefficient files for microwave instruments (see item 2.03 by Cristina Lupu)
- Allow Meteosat mid-height IR AMVs

Grid res	HRES	ENS LegA	ENS LegB/M'ly	4DVAR Inner Loops 1st	4DVAR Inner Loops 2nd	4DVAR Inner Loops 3rd	EDA Outer	EDA 1st	EDA 2nd
128 km								TL159	TL159
				TL255	TL255	TL255		TL191	TL191
64 km			TL319		TL319				
32 km		TL639	TCo319			TL399	TL399		
16 km	TL1279	TCo639					TCo639		
9 km	TCo1279								

Table 2. Expected resolution upgrade for the different components of the ECMWF forecasting system. Blue indicates the current resolution. The expected resolution is in red

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