Recent changes in the operational use of passive sounding data in the ECMWF NWP system

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Outline

1. Passive sounding data usage
2. Major upgrades of ECMWF system since ITSC-22
3. Upcoming changes (47R3)
4. Challenges: contribution of legacy POES satellites
5. Towards wider earth system assimilation: an in-house SST analysis

Microwave instruments

	AMSUA	MHS (all sky)	ATMS	SSMIS (all sky)	MWHS	MWHS2	MWRI	GMI	AMSR2
Metop-A	5,6,9-14	3-5							
Metop-B	5-14	3-5							
Metop-C	5-14	3-5							
NOAA-15	5,7-10,12-13								
NOAA-18	5-8,10-14								
NOAA-19	5-6,9-14	4-5							
AQUA	8-14								
S-NPP			6-15,18-22						
NOAA-20			6-15,18-22						
F-17				8-14,16-17					
F-18				9-11					
FY-3B					3-5				
FY-3C						2-7,11-15			
FY-3D						2-7,11-15	3-7,9		
GCOM-W1									7-11,13
GPM								3-6,8,12-13	

Instruments/Channels in red stopped working or not available for assimilation

Hyper-spectral infrared sounders usage

	Long-wave	Window-Ozone	Water-vapour	Short-wave
METOP-A	165	16	32	7
METOP-B	165	16	32	7
METOP-C	165	16	32	7
AIRS	89	22	7	19
S-NPP	94	15	37	
NOAA20	94	15	37	

Geostationary radiances usage

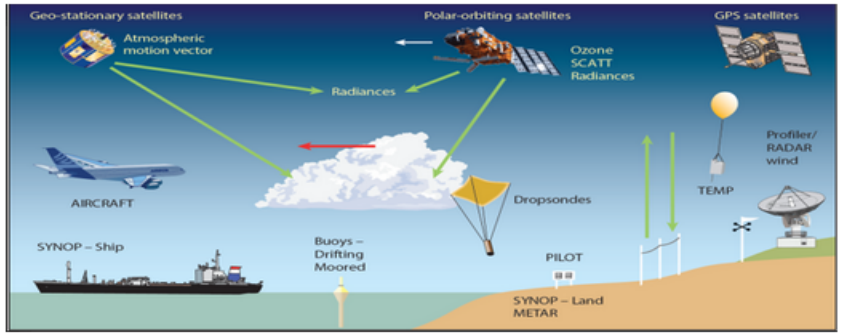
	Channels
GOES-16 (CSR)	6.2, 6.9, 7.3 micron (WV)
GOES-17 (CSR)	6.2, 6.9, 7.3 micron (WV)
HIMAWARI-8 (CSR)	6.2, 6.9, 7.3 micron (WV)
MET-8 (ASR)	6.2, 7.3 micron (WV)
MET-11 (ASR)	6.2, 7.3 micron (WV)

https://confluence.ecmwf.int/display/FCST/Observations+data+events

Observations data events

Created by Umberto Modigliani, last modified by Mohamed Dahoui on Jan 04, 2021

Observations are essential for numerical weather prediction (NWP) systems. They are used by the data assimilation system to produce the best estimate of the initial conditions (analysis). The quality of the analysis and the subsequent forecasts depend, amongst other factors, on the quality and availability of observations. To ensure optimal use of observations timely detection of availability and quality issues is necessary to trigger mitigation actions. On this space we keep chronological record of data events that affected the observing system used at ECMWF. Such information might be of interest to ECMWF's forecast users and to the wide NWP community. The estimated impact of these events on the analysis/forecast is not systematically assessed and therefore not included. The list is updated manually on a regular and best effort basis. It includes only the main events and new additions/cessation of data. If you have related questions please contact the email address below (reply is on best effort basis)



Contact email address	servicedesk@ecmwf.int

Browse per year

2021

2020

2019

2018

2017

2016

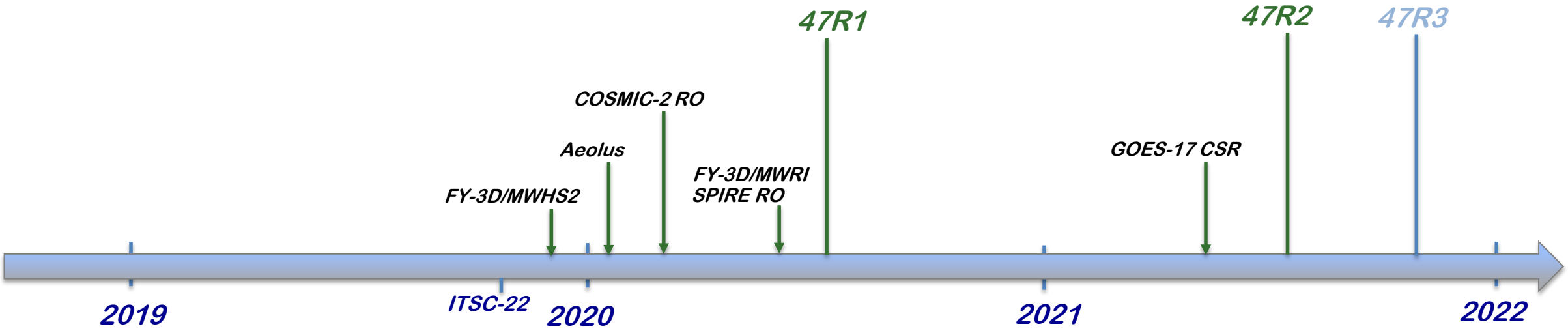
2015

2014

2013

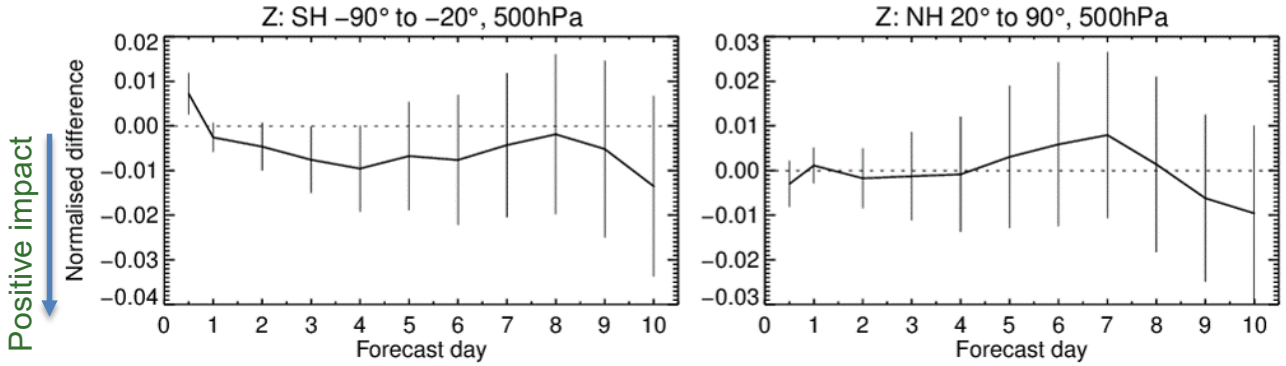
2012

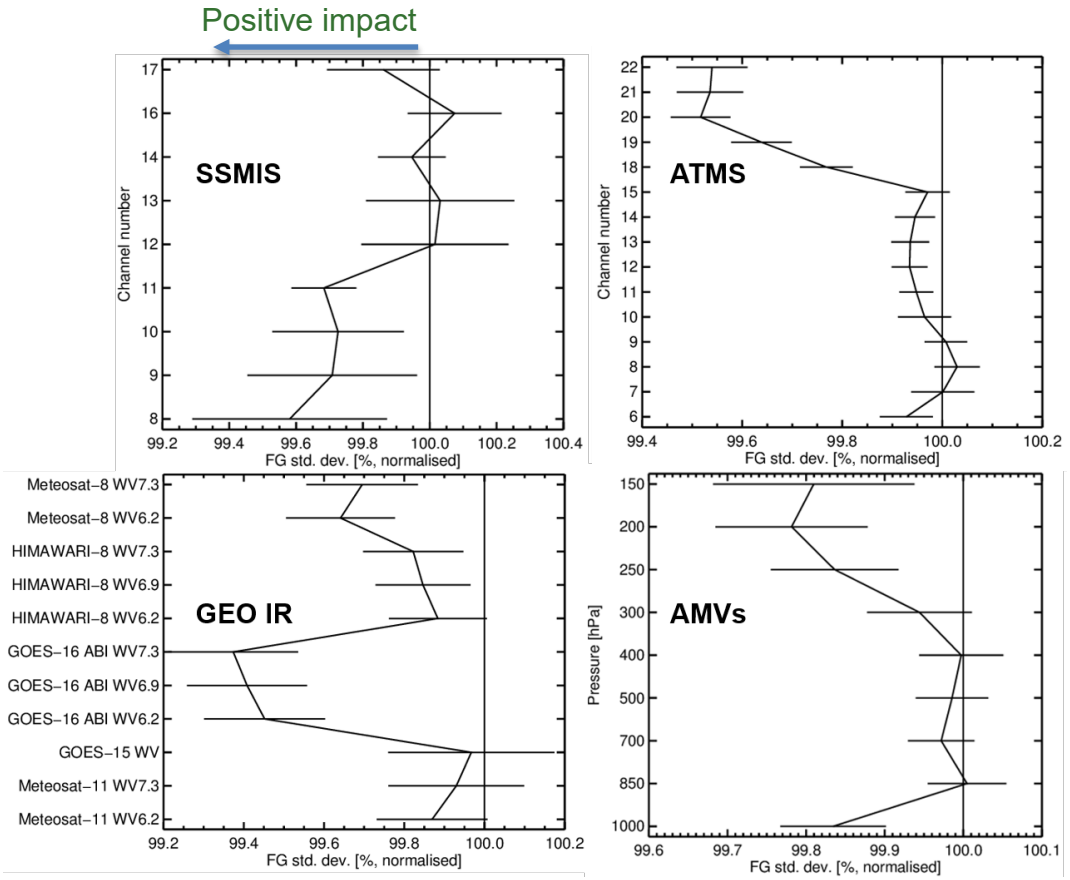
Major upgrades of ECMWF system since ITSC-22



FY-3D MWHS-2

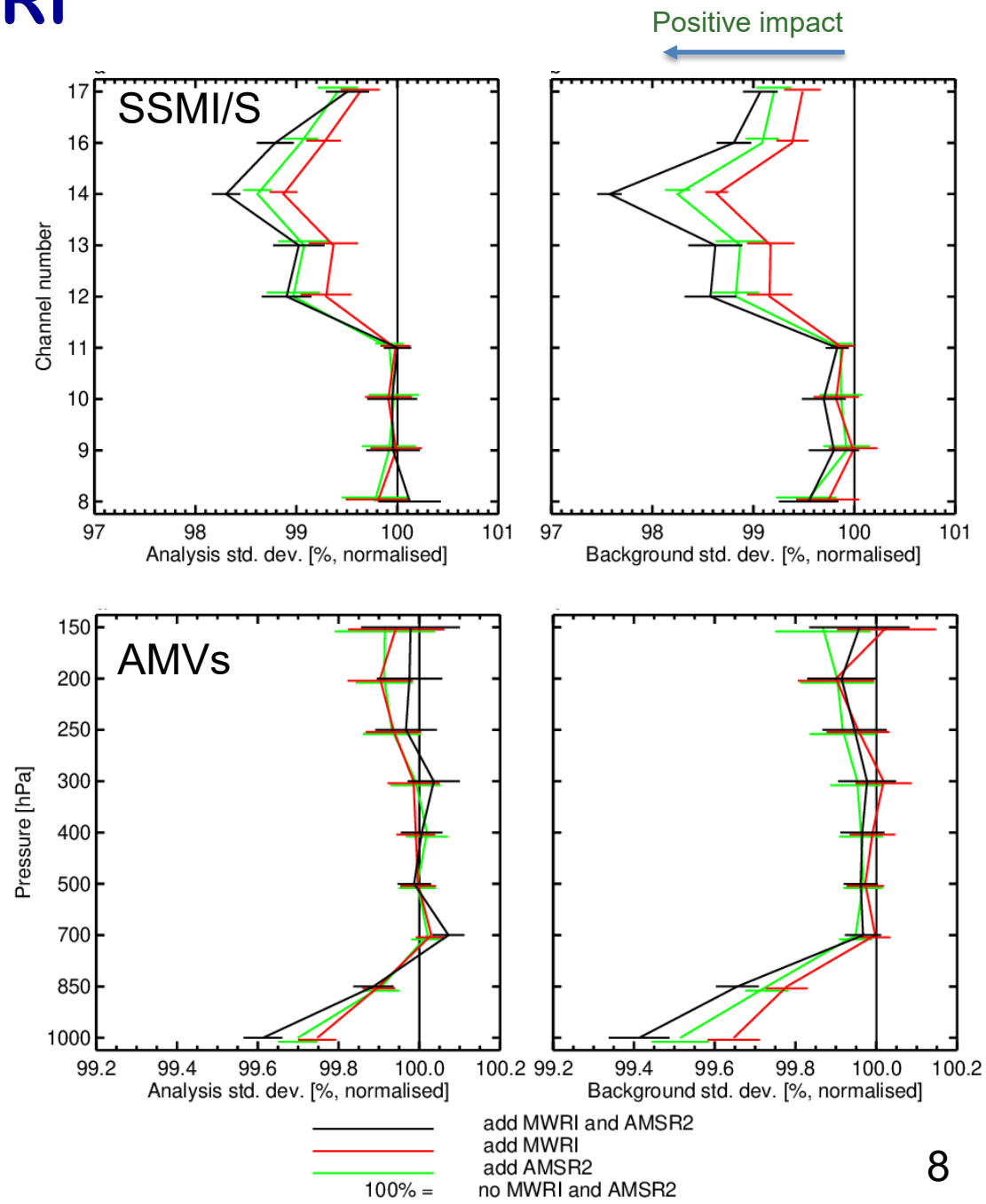
- FY-3D MWHS2 activation was useful after the failure of FY-3B/MWHS and reduction of FY-3C/MWHS2
- Positive to neutral impact (OSE)
- 2.3% FSOI in first half of 2020 (similar to F17 SSMIS)



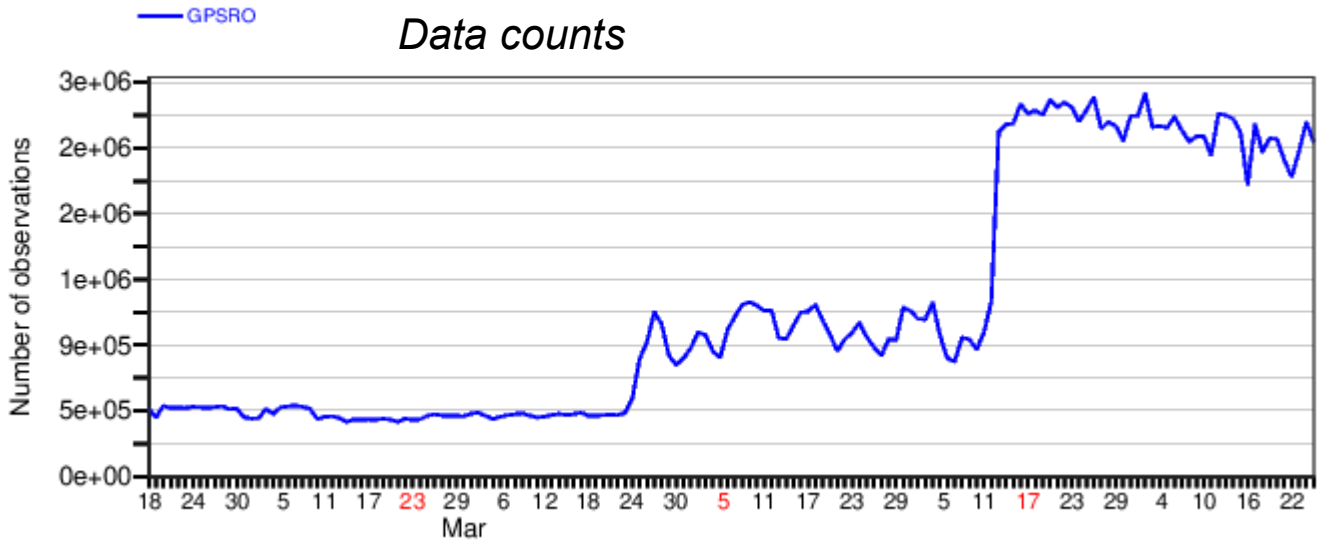


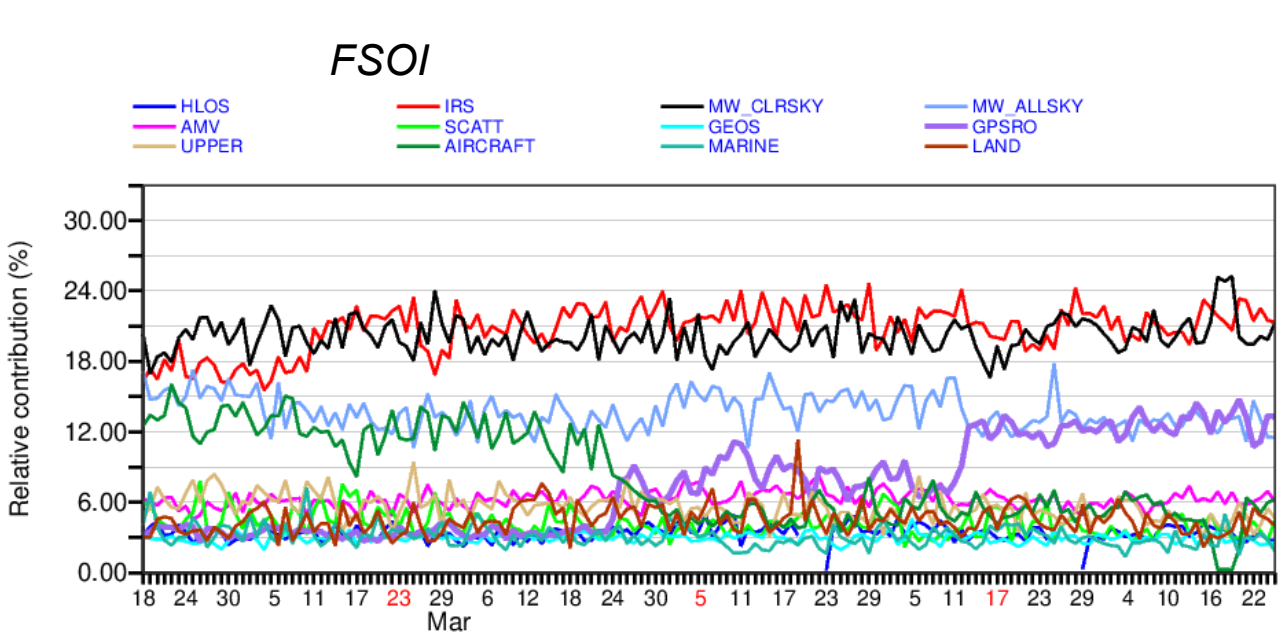
FY-3D MWRI

- Provides primarily information on total column water vapour, cloud and precipitation in all-sky assimilation.
- Data quality slightly worse than AMSR-2, but overall acceptable.
- Best results are obtained when AMSR-2 and MWRI are both assimilated (black)



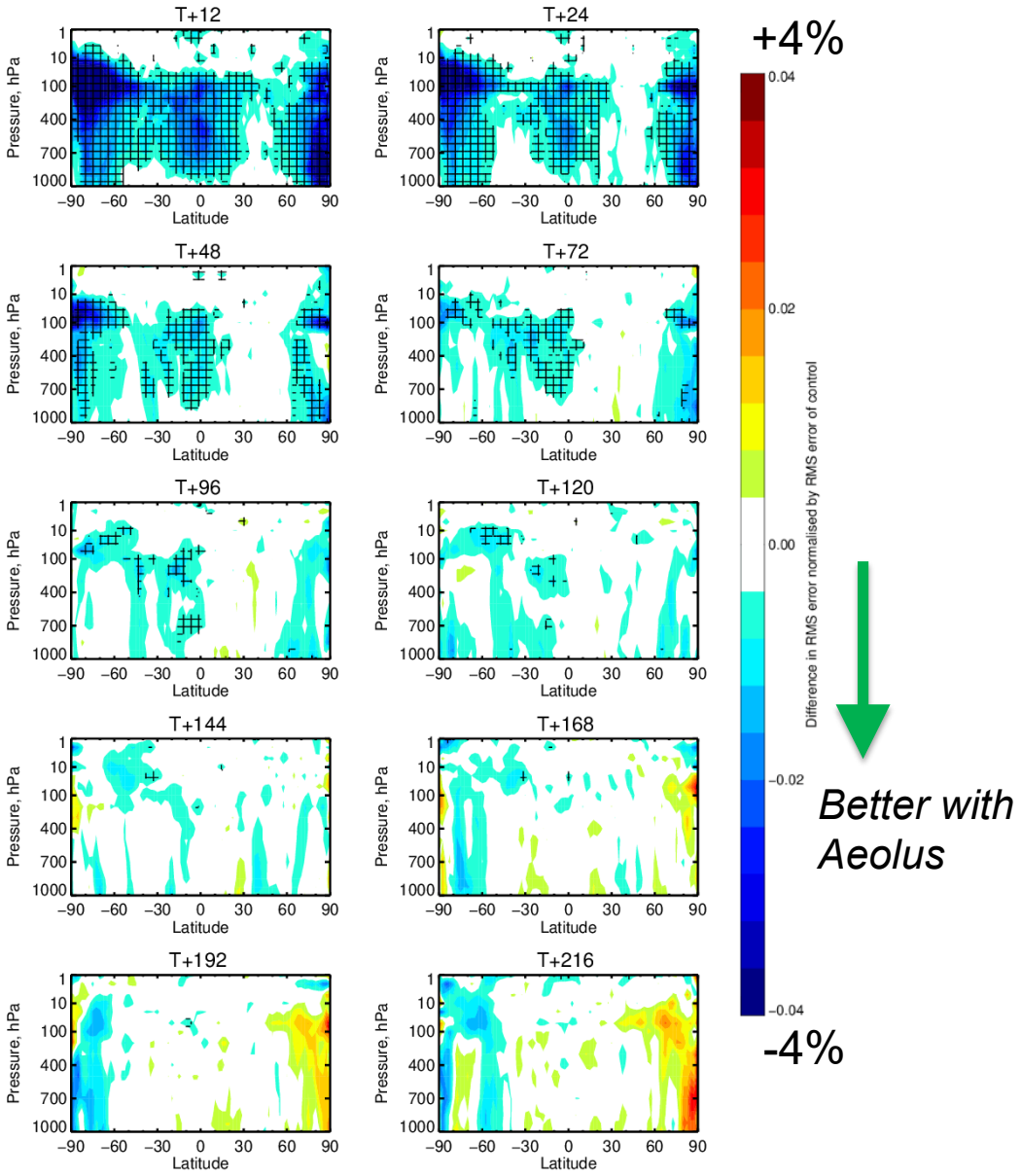
Additional GPSRO





Aeolus

Mid-2020 NRT data OSE



- Verification against ECMWF operational analysis
- **Good positive impact** in tropical troposphere and lower stratosphere
  - Throughout forecast range in LS
- **Good positive impact** in polar troposphere
  - Up to 3-4 day range
- Similar patterns of impact for temperature and humidity forecasts (not shown)

IFS CY47R1 (June 2020)

Passive sounding:

- channel-specific aerosol detection for the hyperspectral IR sounders
- Observations error correlations for NOAA-20 ATMS
- Revision of the skin-temperature background errors used for many sounding instruments: Instead of a constant global value the 50-members EDA spread generates flow dependent SKT background errors of the day which vary spatially and in time during the 12-h assimilation window.
- Revision of weak-constraint 4D-Var in the stratosphere (relevant for stratospheric peaking MW and IR sounding channels)

Other changes:

- The time step of the last minimisation of the 4DVAR set the same for the outer and inner loop (reduce spurious gravity waves increments)
- Quintic interpolation in semi-Lagrangian advection (relevant mainly for the stratosphere)
- Revision of drag coefficient for very strong winds
- Update to greenhouse gases and total solar irradiance
- Improvement of the specification of surface albedo
- Changes to the convection scheme

IFS CY47R2 (May 2021)

- Use of single precision for the Ensembles (forecast up to d+46 and re-forecasts) and HRES (forecast)
- Increase of the vertical resolution of the ensembles (137 as for the HRES)
- No cycle specific data assimilation changes.

IFS CY47R3 (Late 2021)

Passive sounding:

- Assimilation of AMSUA in all-sky mode (See item 9.03 by D. Duncan)
- major upgrade of the radiative transfer coefficients for hyperspectral instruments
- Inter-channel correlations for AIRS

contribution of legacy POES satellites

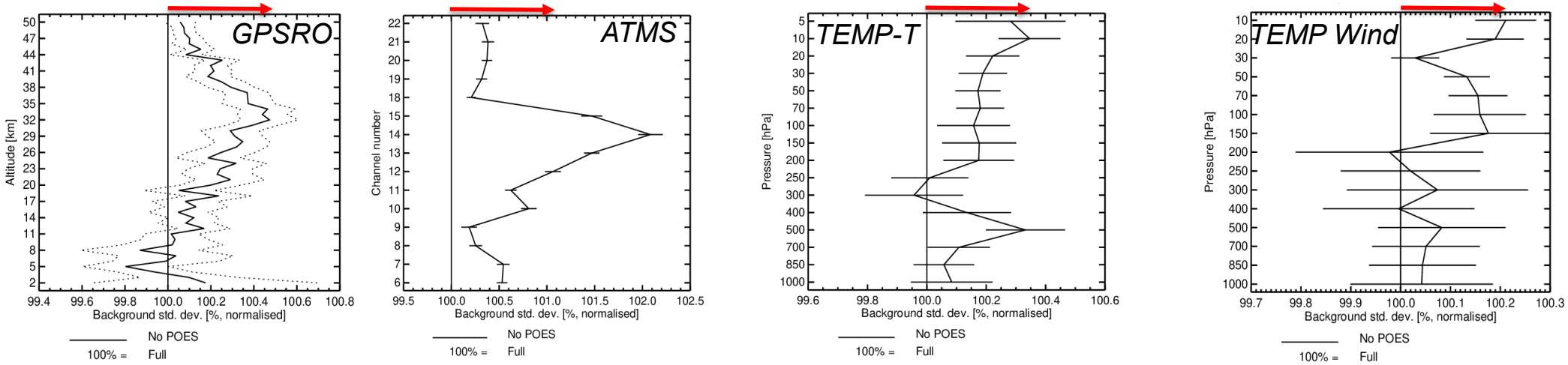
Background

- NOAA-15, -18, -19 continue to provide useful data (even though a small number of channels has failed)
- The data are still actively assimilated in NWP, and provide complimentary temporal coverage
- Impact studies were conducted to support the continuation of data provision

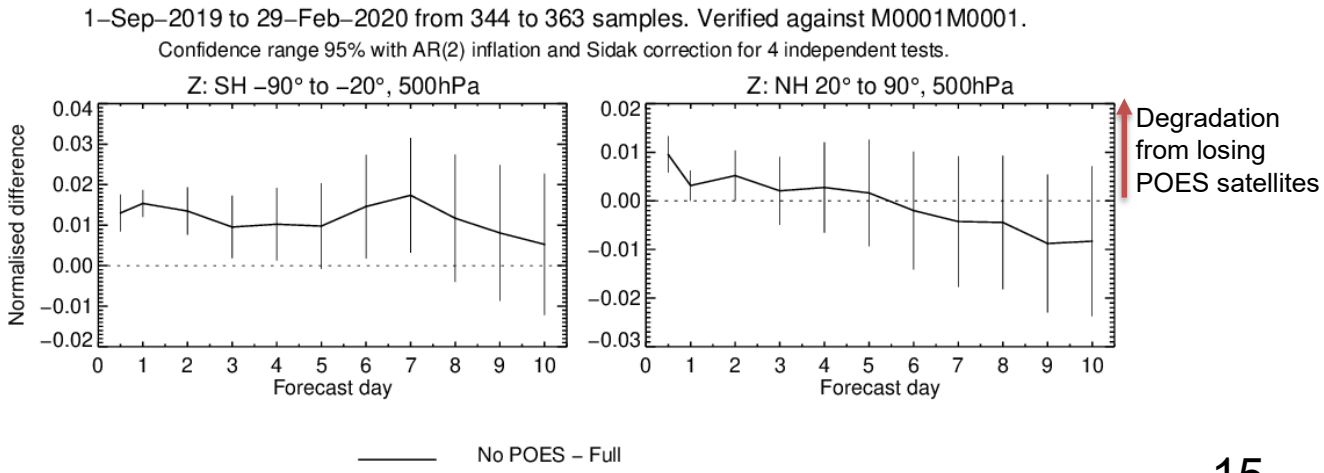
Experimentation

- "Full" experiment: Observation use equivalent to operations
- "No POES" experiment: Denial of:
  - NOAA-15 AMSU-A and AVHRR AMVs
  - NOAA-18 AMSU-A and AVHRR AMVs
  - NOAA-19 AMSU-A, MHS, AVHRR AMVs, and SBUV ozone retrievals

Degradation for short-range forecasts from losing the legacy POES satellites for temperature wind and humidity



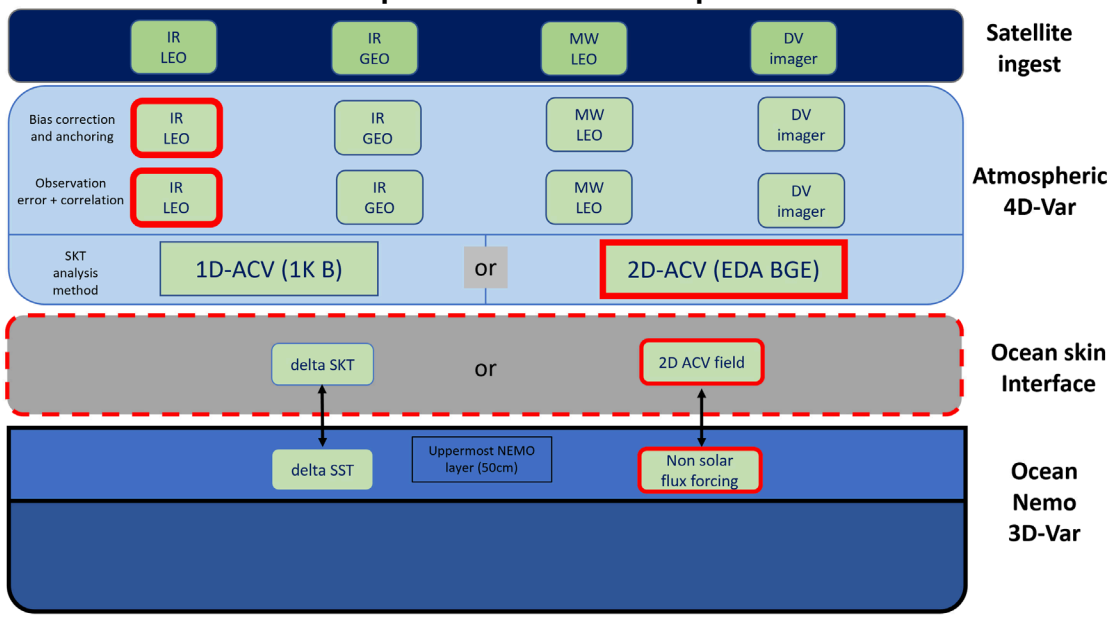
significant degradation for medium-range forecasts from losing the legacy POES satellites, especially over the Southern Hemisphere (out to day 7!).



Towards wider earth system assimilation: an in-house SST analysis

- Good SST analysis is vital for forecasting (Atmosphere and ocean) and for optimal assimilation of satellite radiances in the 4D-VAR (influence of Skin temperature on surface emissivity).
- External SST analyses (e.g. OSTIA foundation SST) are overall good but can be affected by inconsistencies with ECMWF fields, lag in depicting rapidly changing conditions and lack of diurnal cycle representation
- In-house SST analysis will ensure:
  - Consistent adjustment of Skin temperature (together with other model variables) directly from assimilating radiances and other in-situ observations.
  - The extracted SKT will be used by Atmosphere-Ocean couple data assimilation to constrain the ocean and consequently improve coupling with the atmospheric model throughout the model integration
  - Proper representation of diurnal cycle

One of the implementation options



IASI extracted SKT, NEMOVAR increments