Changes in the operational use of passive sounding data in the ECMWF NWP system since ITSC-21

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Configuration of the high-resolution global NWP system

Spatial resolution: $T_{CO}1279$ (≈9km)
Incremental analysis resolution: $T_{L}399$ (≈50km)
Vertical resolution: 137 levels, up to 0.01 hPa
Assimilation system: 12h 4d-Var with 8h early delivery window; background errors of the day from 50-member Ensemble of Data Assimilations (EDA)

Major system upgrades since ITSC-21:

- **Cycle 45r1 – 5 June 2018**
- **Cycle 46r1 – 11 June 2019**

For full details see https://www.ecmwf.int/en/forecasts/documentation-and-support/changes-ecmwf-model. Only changes most relevant to ITWG are summarised on this poster.

Radiative transfer

Main changes

- Upgrade to RTTOV version 12 (in **45r1**) and 12.2 (in **46r1**) → *1p.12 (Lupu)*
- Update of the permittivity model in RTTOV-SCAT to Rosenkranz (2015) (**46r1**) → *5p.07 (Lonitz)*
- Updated RTTOV coefficient files for MW instruments (**46r1**)

Current use of satellite instruments with TOVS heritage

A – Assimilated; P – Passively monitored; E – Under evaluation; X – Failed/ withdrawn; 🌦 – All-sky treatment
Changes since ITSC-21 are highlighted through orange shading.

Satellite	Present orbit position (LTAN, approx.)	MW temperature sounder	MW humidity sounder	MW imager	IR broadband sounder or imager	IR hyper-spectral sounder
NOAA-15	19:00	A	X		X	
NOAA-18	21:00	A	X		X	
NOAA-19	17:00	A	A 🌦		P	
NOAA-20	13:30	A	A			A
Aqua	13:30	A	X			A
S-NPP	13:30	A	A			A
Metop-A	21:00	A	A 🌦		P	P
Metop-B	21:30	A	A 🌦		P	A
Metop-C	21:30	A	A 🌦			A
FY-3B	16:00	X	A	X		
FY-3C	10:00	X	A 🌦	P 🌦		
FY-3D	13:30	P & E	P & E 🌦	P & E 🌦		E
Meteor-M N2	20:30					E
DMSP-F17	18:30		A 🌦	A 🌦		
DMSP-F18	17:00		A 🌦	P 🌦		
GCOM-W1	13:30			A 🌦		
Coriolis	18:00			P 🌦		
GPM	Low-incl.		A 🌦	A 🌦		
Megha-Tropiques	Low-incl.		P 🌦			
Meteosat-8	41.5°E				A	
Meteosat-11	0°				A	
GOES-15	128°W				A	
GOES-16	75.2°W				A	
Himawari-8	140.7°E				A	
FY-4A	105°E					E

Timeline of main instrument changes since ITSC-21 **(radiances only)**

DJF 2017/18
- Activate Met-11 ASR
- Retire Met-10 ASR

MAM 2018
- Activate NOAA-20/ ATMS → *12p.12 (Bormann)*
- Blacklist FY-3C/MHWS-2 (3 weeks, geo-location errors)

JJA 2018
- Activate GOES-16 CSR

SON 2018
- Activate NOAA-20/ CriS → *7.04 (Eresmaa)*
- NOAA-18/MHS failure
- Blacklist GOES-15 (3 weeks, orbit drift)
- Blacklist SAPHIR (geolocation and reception problems)

DJF 2018/19

MAM 2019
- Activate Metop-C/ AMSU-A & MHS → *12p.12 (Bormann)*
- Loss of FY-3C/MWHS-2 (5 weeks, BUFR change)
- Loss of S-NPP CrIS (3 weeks, band 2 failure)

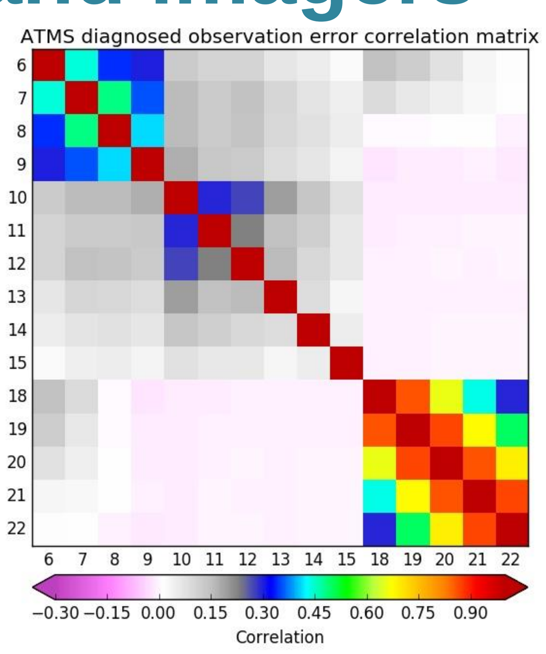
JJA 2019
- Blacklist S-NPP CrIS (2 months, band 2 switch)
- Blacklist GOES-15 (3 ½ weeks, anomaly)
- Blacklist NOAA-20/CrIS (ongoing, prep. NSR to FSR change)

SO 2019
- Activate Metop-C/IASI → *7.04 (Eresmaa)*
- Blacklist Metop-A IASI (switch to Metop-C)

MW sounders and imagers

Main changes

- Activation of constrained variational bias correction for the top-most temperature-sounding channel on AMSU-A and ATMS (**45r1**)
- Observation error upgrade for S-NPP ATMS, including inter-channel error correlations (**46r1**)



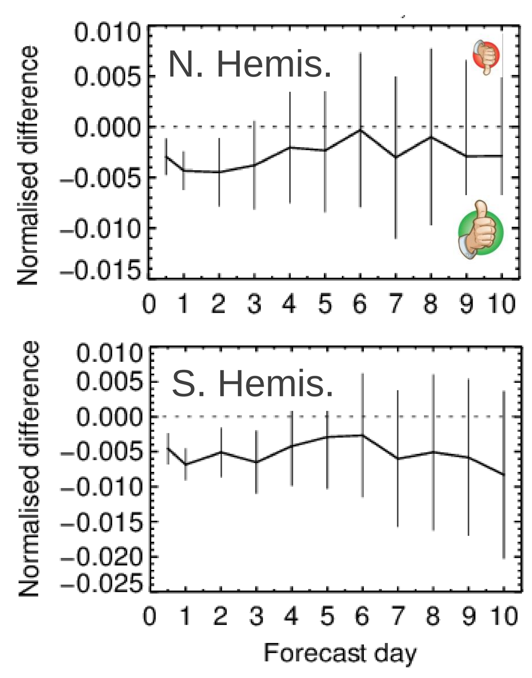
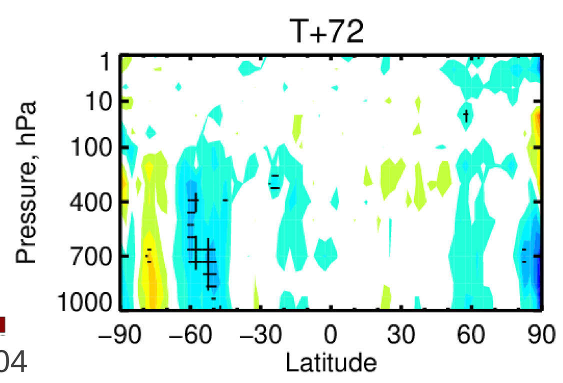
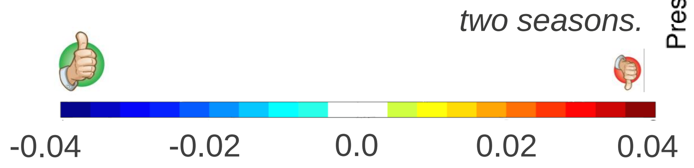


Fig. (top): New assumed error correlation matrix for S-NPP ATMS (left), and normalised difference in RMSE for 500 hPa wind forecasts (right) resulting from the observation error upgrade. Experimentation covered 6 months over two seasons.

- Addition of SSMIS-F17 150h GHz and GMI 166 v/h GHz channels (**46r1**) → *5p.04 (Lonitz)*
- Improved use of land/sea-mask in the field of view for microwave imagers (**46r1**)

Fig. (right): Normalised difference in RMSE of 72 h wind forecasts resulting from the all-sky assimilation of 150/166 GHz channels. Experimentation covered 6 months over two seasons.





IR sounders and imagers

Main changes

- Assimilation of non-surface-sensitive IR channels over land (**45r1**)

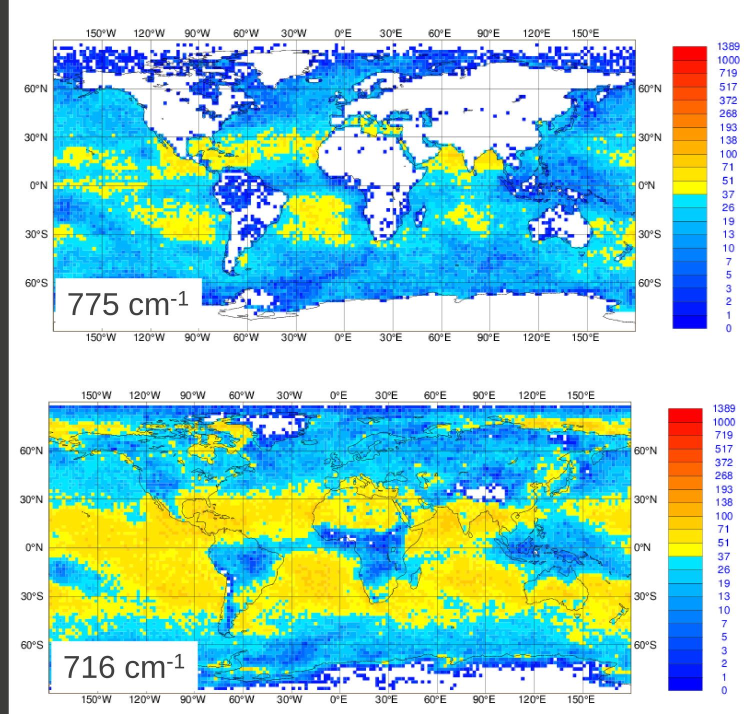
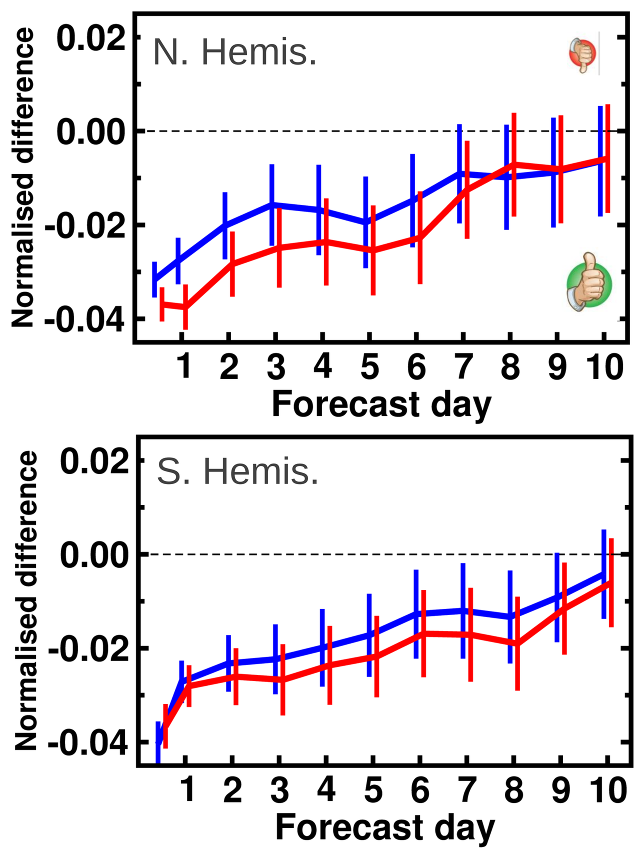
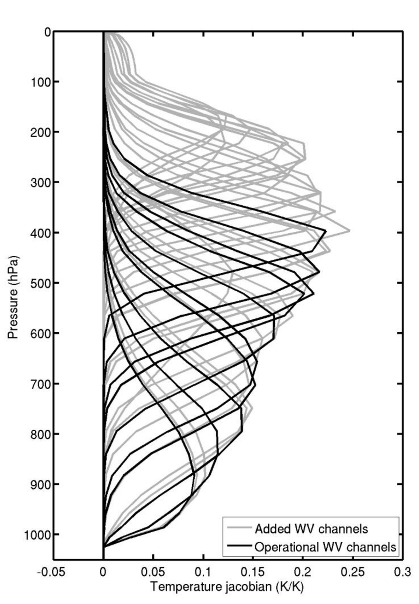


Fig. (left): Coverage at given wave-numbers before and after the introduction of hyper-spectral IR data over land.

Fig. (right): Normalised change in RMSE for the 500 hPa geopotential (right), resulting from the assimilation of hyper-spectral IR instruments before (blue) and after (red) the introduction of hyper-spectral IR channels over land. Experimentation covered 8 months over two seasons.





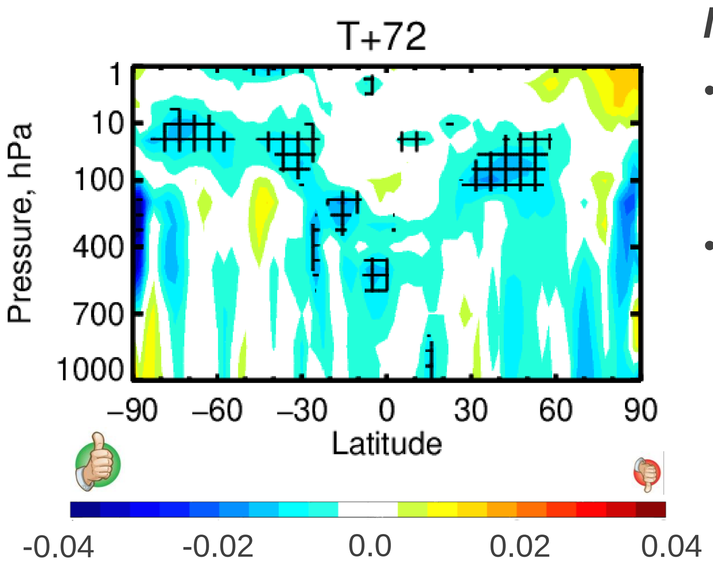


Fig: Jacobians of the additional IASI WV channels (left; grey lines) and the resulting normalised change in RMSE for 72-h forecasts of geopotential (right). Experimentation covered 7 months over two seasons.

Main changes (continued)

- Assimilation of more WV channels from IASI (39 instead of 10; **46r1**) → *9.02 (Salonen)*
- Improved assimilation of geostationary radiances (extended disk, slant-path, correlated observation error, **46r1**)

Assimilation configuration

Main changes (46r1):

- Continuous data assimilation (use of late-arriving observations, 4 outer loops, 8h early-delivery window) → *12p.13 (Lean)*
- 50 members in the Ensemble of Data Assimilations (EDA), enabled through significant reductions in computational cost.
- Weakly coupled data assimilation for sea-surface temperature in the tropics

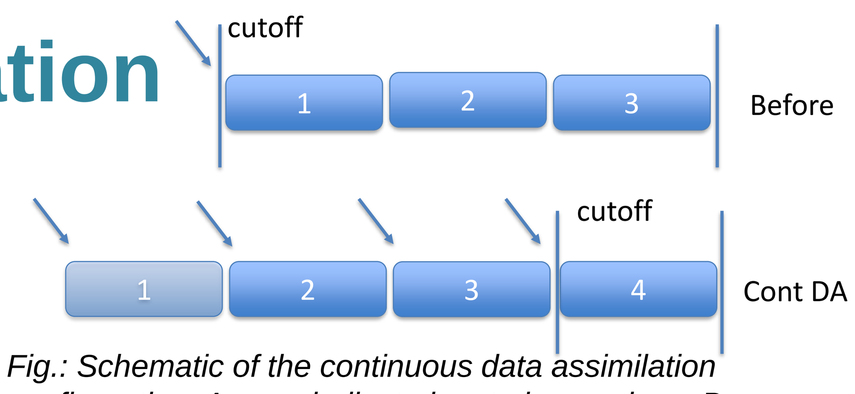


Fig.: Schematic of the continuous data assimilation configuration. Arrows indicate input observations. Boxes represent outer loops of 4D-Var.

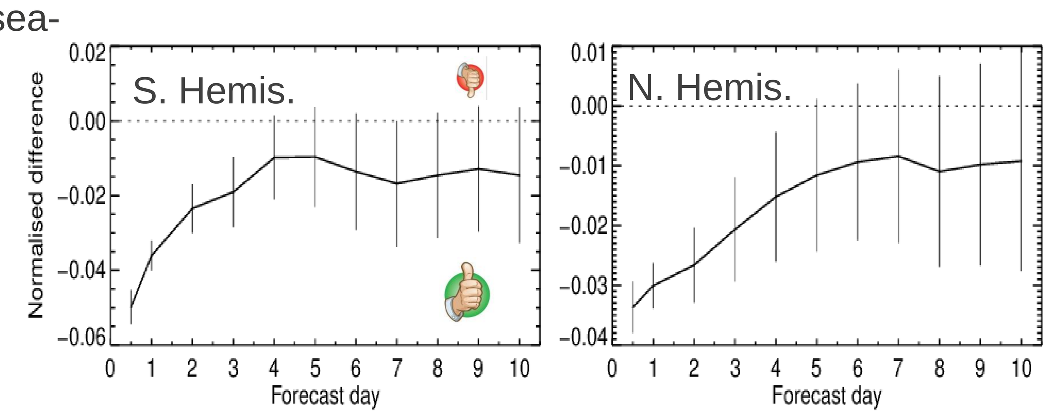


Fig: Normalised change in the RMSE of 500 hPa geopotential forecasts resulting from the introduction of continuous data assimilation. Experimentation covers a 6-month period over two seasons.

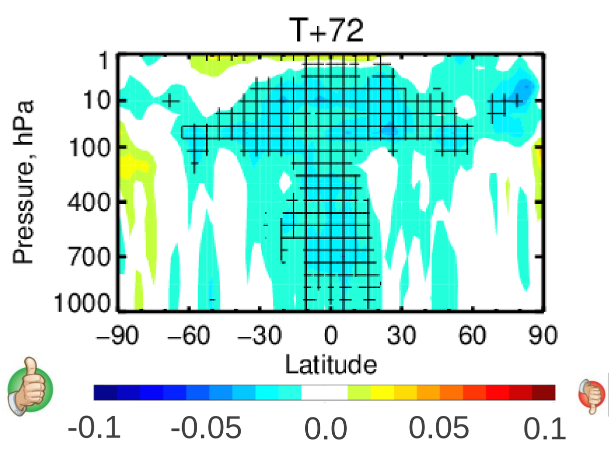


Fig: Normalised change in the RMSE for 72-h forecasts of geopotential resulting from the introduction of the 50-member EDA. Experimentation covered 3 months over two seasons.

Acknowledgements

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