Radiance assimilation in MetCoOp limited-area NWP systems

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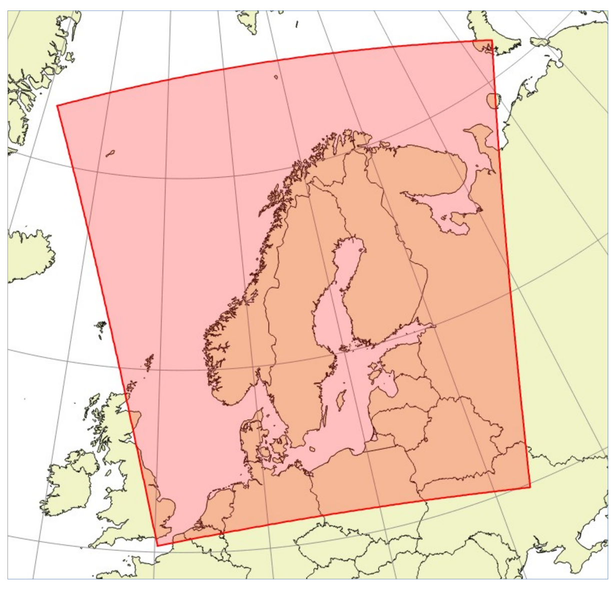
MetCoOp: Meteorological Co-operation on Operational NWP

MetCoOp started in 2011 as a co-operation project of *Swedish* and *Norwegian* national meteorological institutes. The project started operational production of regional NWP forecasts in 2014. *Finnish* and *Estonian* national institutes joined the project in 2017 and 2020, respectively.

MetCoOp maintains two operational NWP systems: MEPS and MNWC. The systems rely on Harmonie-Cy43h2.2 code base, kindly provided to us by the international HIRLAM program, with the support from the 26-member ACCORD research consortium.

The Euro-Mediterranean ACCORD consortium: A Consortium for COnvection-scale modelling Research and Development.



The computing domain of the MetCoOp NWP systems

MetCoOp Ensemble Prediction System (MEPS)

- → 3-hourly cycling with 75-minute observation cutoff time
- → 3D-Var analysis and a non-hydrostatic forecast out to +66-hour lead time
- → An ensemble prediction system consisting of a deterministic run and 14 perturbed members
- → The ensemble production is lagged in time such that five new members run at each analysis hour
- → Forecast output is available to users within 135 minutes after the nominal analysis time

MetCoOp Nowcasting System (MNWC)

- → 1-hourly rapid-refresh system with 25-minute observation cutoff time
- → 3D-Var analysis and a non-hydrostatic forecast out to +12-hour lead time
- → No cycling: uses the deterministic MEPS forecast as a background in the data assimilation
- → A deterministic run only (i.e., no ensemble prediction)
- → Forecast output available to users within 60 minutes after the nominal analysis time

Both MEPS and MNWC run in a 2.5 km grid on 65 model levels extending from 12 meters altitude to 10 hPa pressure. They take lateral boundary forcing from the ECMWF global forecast.

Satellite radiance data used in MetCoOp

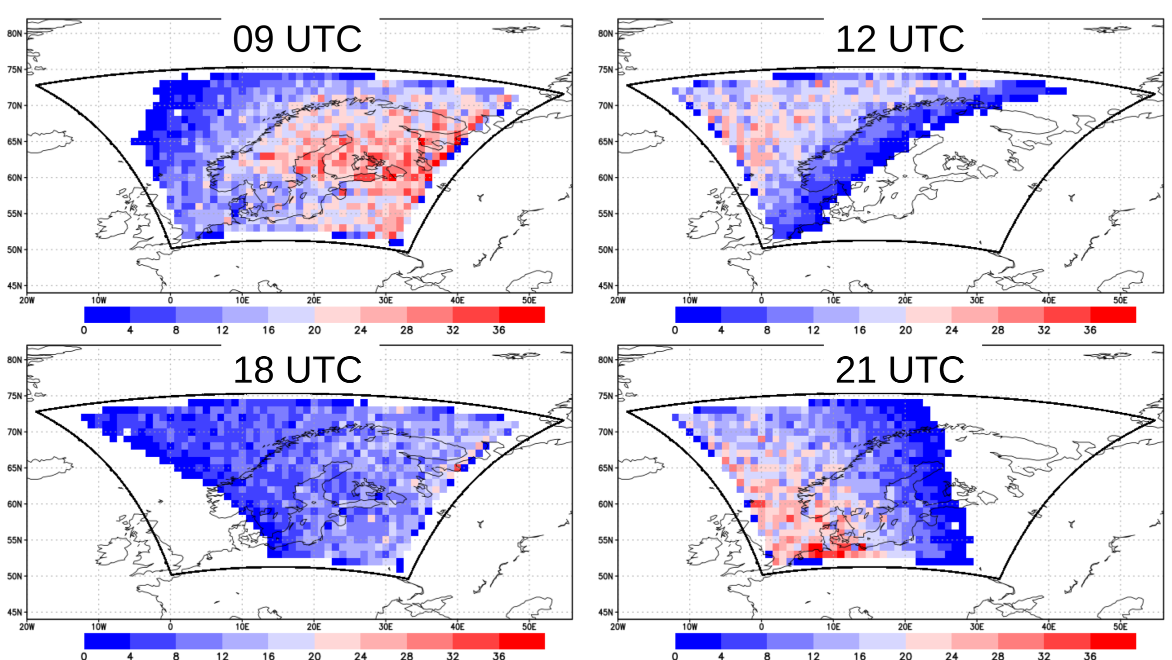
Spacecraft	Launch date	Equatorial crossing in local time (* indicates drift)	Infrared sounding	Microwave temperature sounding	Microwave humidity sounding
NOAA-18	05 / 2005	10:25*	(HIRS)	AMSU-A	(MHS)
NOAA-19	02 / 2009	08:20*	(HIRS)	AMSU-A	MHS
Suomi-NPP	10 / 2011	01:25	CrIS	ATMS	
Metop-B	09 / 2012	09:30	IASI	AMSU-A	MHS
FengYun-3D	11 / 2017	02:00	HIRAS	MWTS2	MWHS2
NOAA-20	11 / 2017	01:25	CrIS	ATMS	
Metop-C	11 / 2018	09:30	IASI	AMSU-A	MHS

Currently in use | Preoperational | Lower priority | (No data access)

***Operational** and **pre-operational** use of sounder channels:*

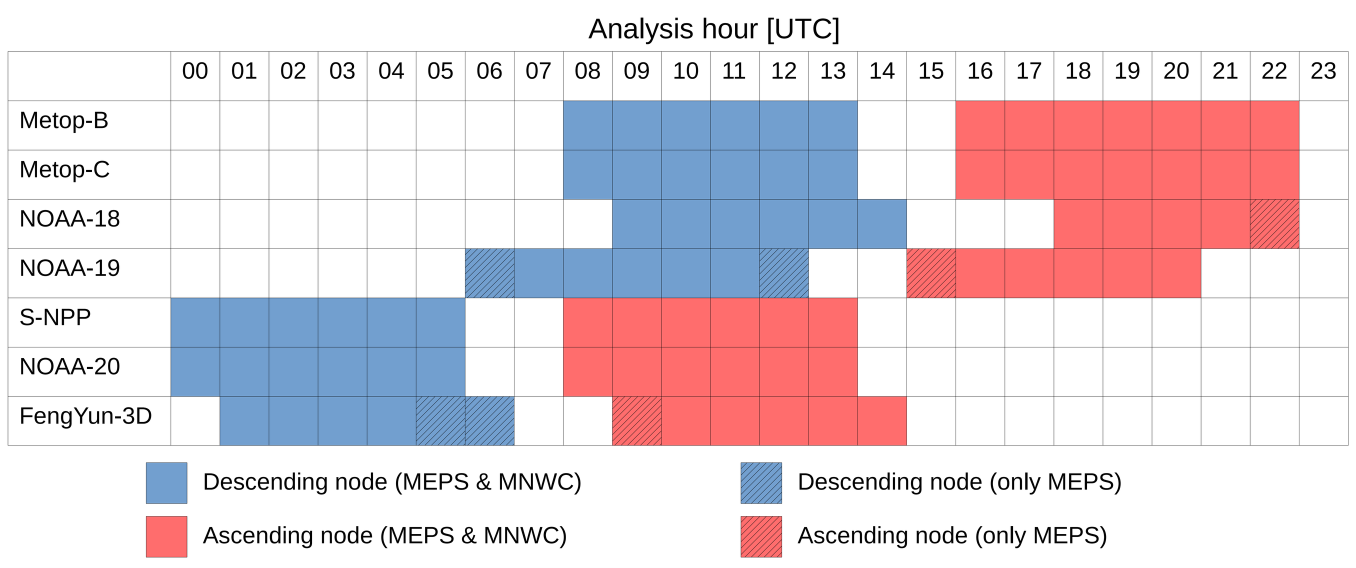
AMSU-A: 5, 6, 7, 8, 9
MHS: 3, 4, 5
ATMS: 6, 7, 8, 9, 10, 18, 19, 20, 21, 22
MWHS2: 11, 12, 13, 14, 15
IASI: 38, 51, 63, 85, 104, 109, 167, 173, 180, 185, 193, 199, 205, 207, 212, 224, 230, 236, 239, 242, 243, 249, 296, 333, 337, 345, 352, 386, 389, 432, 2701, 2819, 2910, 2919, 2991, 2993, 3002, 3008, 3014, 3098, 3207, 3228, 3281, 3309, 3322, 3438, 3442, 3484, 3491, 3499, 3506, 3575, 3582, 3658, 4032
CrIS: 82, 85, 88, 91, 94, 97, 100, 103, 106, 109, 116, 119, 122, 125, 132, 135, 138, 141, 144, 147, 161, 173, 177, 181, 185, 195, 898, 914, 972, 988, 1018, 1029, 1046, 1053, 1060, 1064, 1076, 1112, 1189, 1205

Daily data cycle with Metop-B



Shading indicates the number of Metop-B IASI observations assimilated in each 1°x1° box during a 30-day period in late Northern summer.

Satellite radiance data use hours



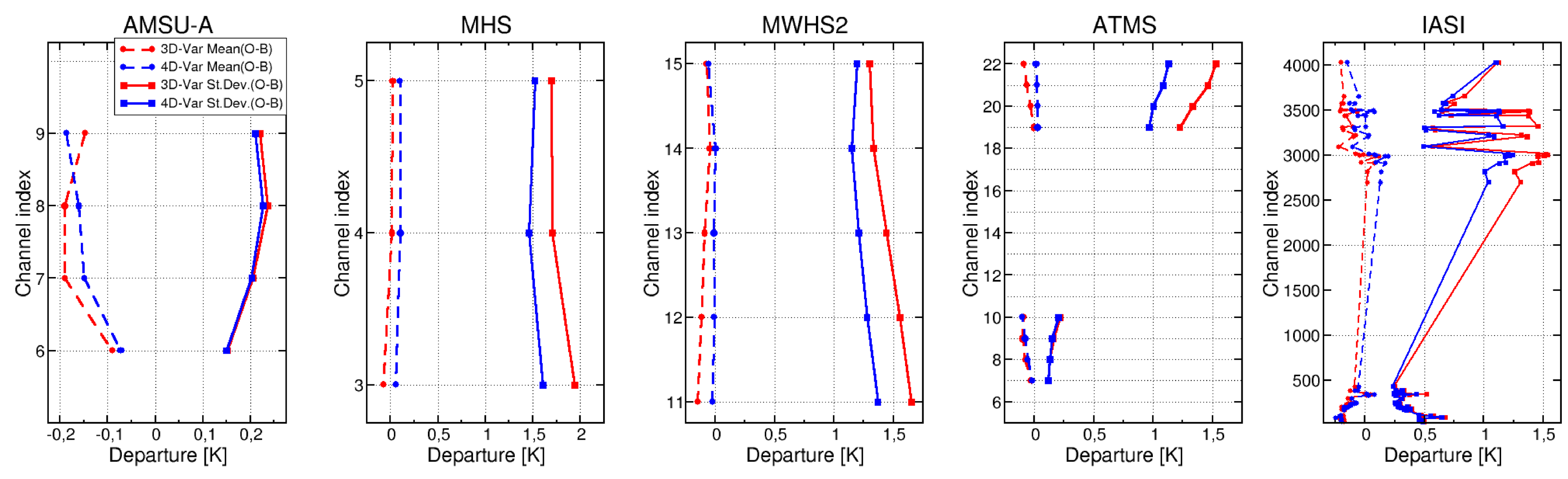
Scandinavian point-of-view: the best is yet to come

The following developments are in preparation for operational implementation in 2023:

- → Assimilation of CrIS and the low-peaking channels of ATMS (target date latter half of April)
- → Migration to 4D-Var (target date end of May)
- → Bringing new instruments into passive monitoring and, potentially, into active assimilation too: FengYun-3E MWHS2, NOAA-21 ATMS, NOAA-21 CrIS, MSG-SEVIRI, MTG-FCI

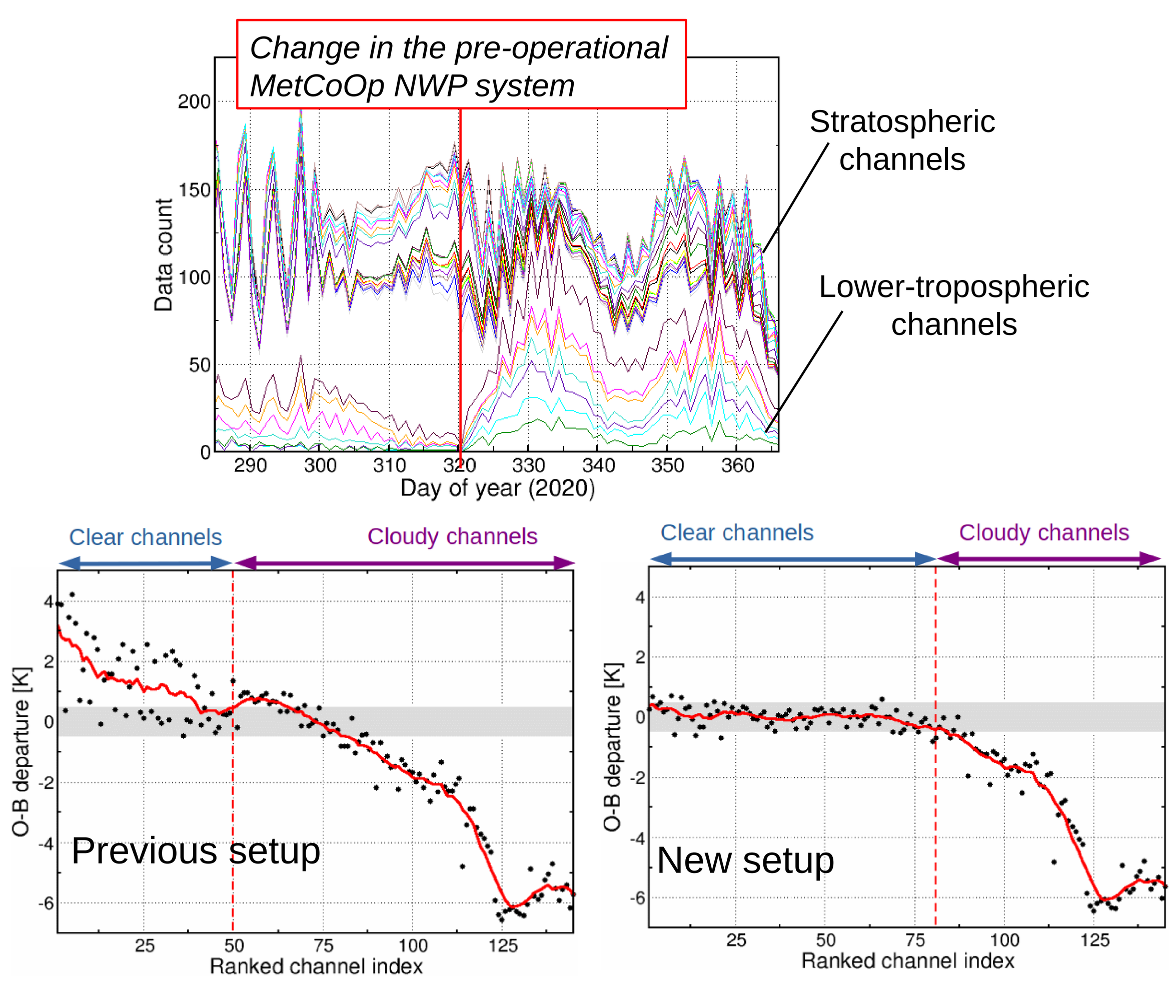
In the time frame beyond 2023, we will continue bringing more satellite radiance data into operational assimilation. A strong emphasis will be put on quick implementation for Metop-SG sounders (MWS, IASI-NG), MTG-IRS, and the microwave satellites in the Sterna programme.

In parallel, we plan to upgrade the NWP suites to Harmonie-Cy46 code base and increase the vertical resolution by introducing a 90-level grid in 2024. We will also continue refining the handling of gross, systematic, and random components of observation error in all our assimilated data types.



In terms of observation minus background data fit statistics, the MetCoOp pre-operational 4D-Var analysis system (blue) beats the operational 3D-Var system (red) with a great margin. This is particularly clear on humidity-sensitive data.

The importance of bias correction in infrared cloud detection channels



The infrared cloud detection process typically makes use of many more channels than what are included in active data assimilation.

MetCoOp used to correct bias only in the actively-assimilated subset of 55 IASI channels. A large number of cloud-detection channels were included in the variational bias correction scheme for the first time in November 2020. The vertical sounding capability from IASI radiance data was greatly improved.