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Radiance assimilation in the presence of systematic errors

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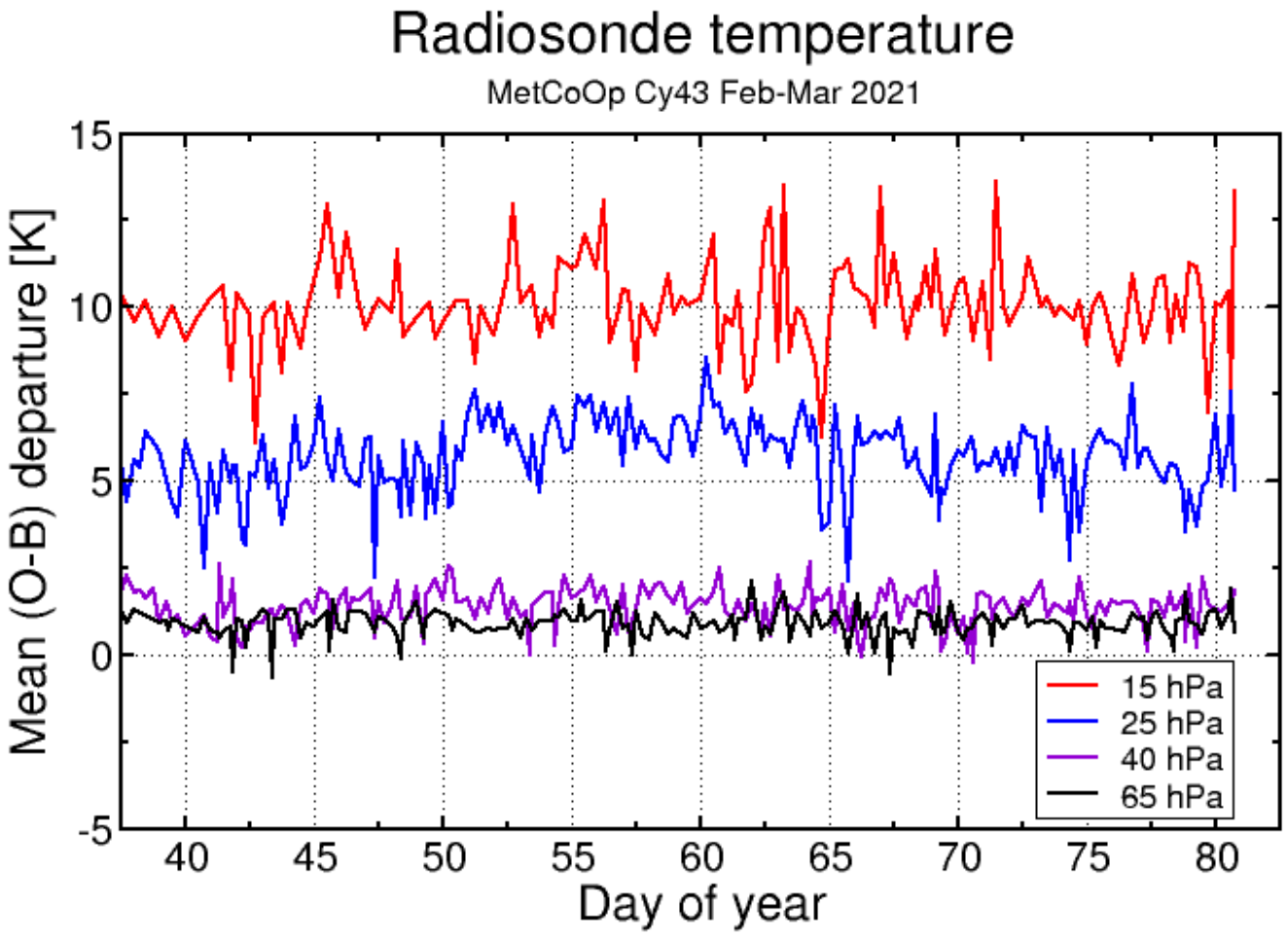
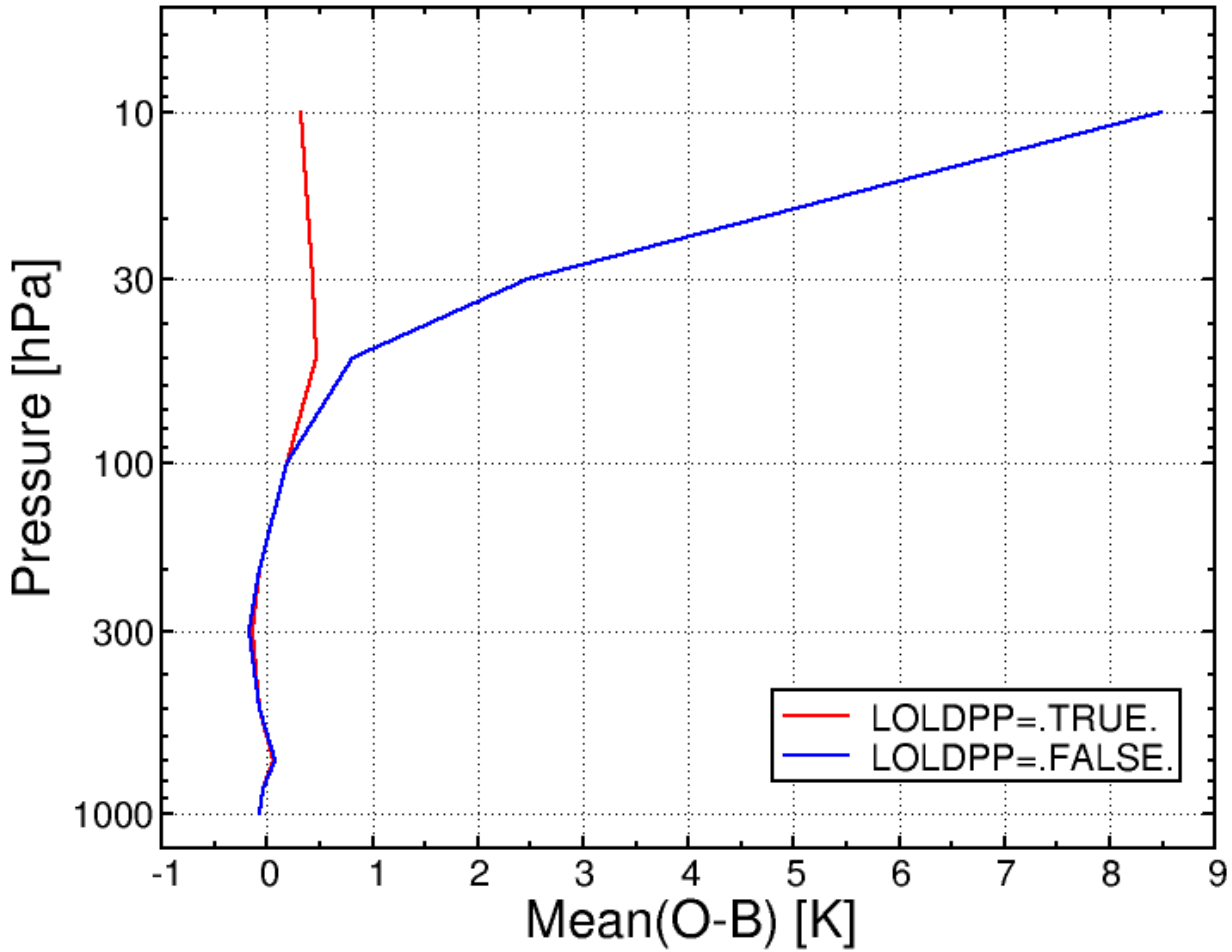
12-16 April 2021
ACCORD All Staff Workshop

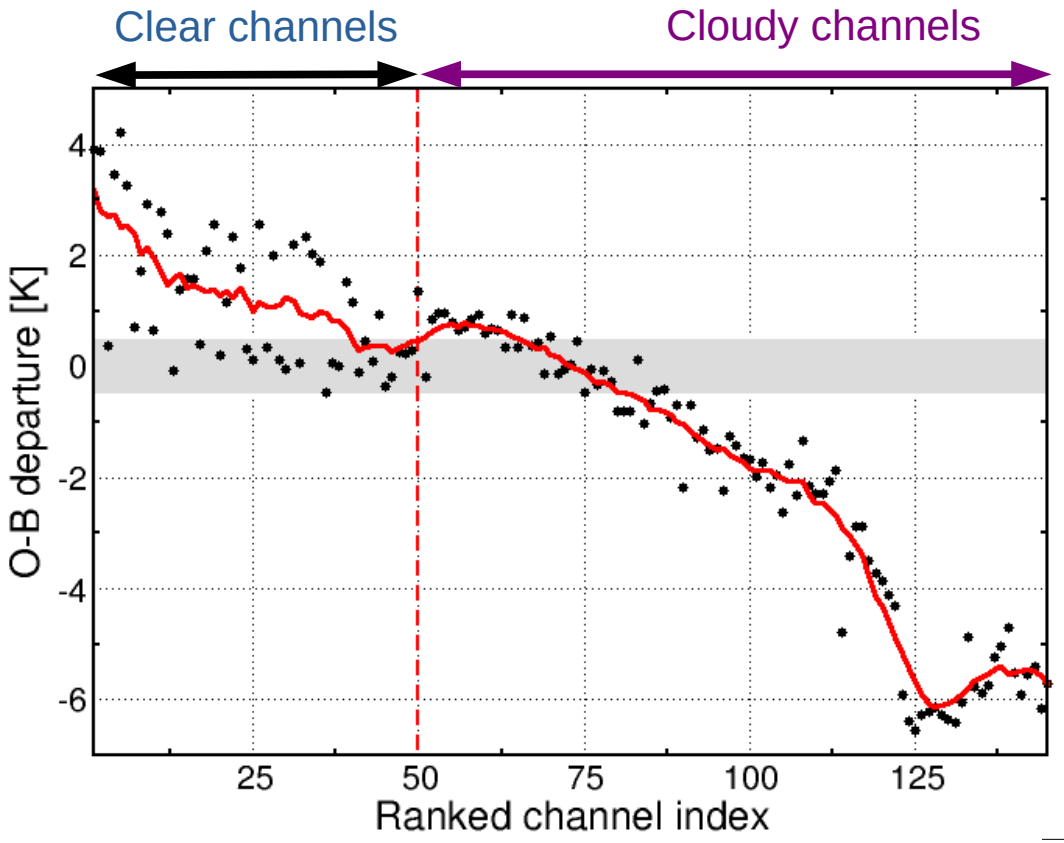
Apparent cold bias in model stratosphere …



… vertical interpolation related ?



The infrared (IR) cloud detection scheme



McNally and Watts cloud detection (2003):

– Take a large number of channels from the 15 μm (long-wave IR sounding band

– Rank O-B departures in vertical and apply a smoothing filter

– Find the ”breaking point” that marks the distinction between clear and cloud-affected channels

McNally & Watts (2003): *A cloud detection algorithm for high-spectral-resolution infrared sounders.* https://doi.org/10.1256/qj.02.208

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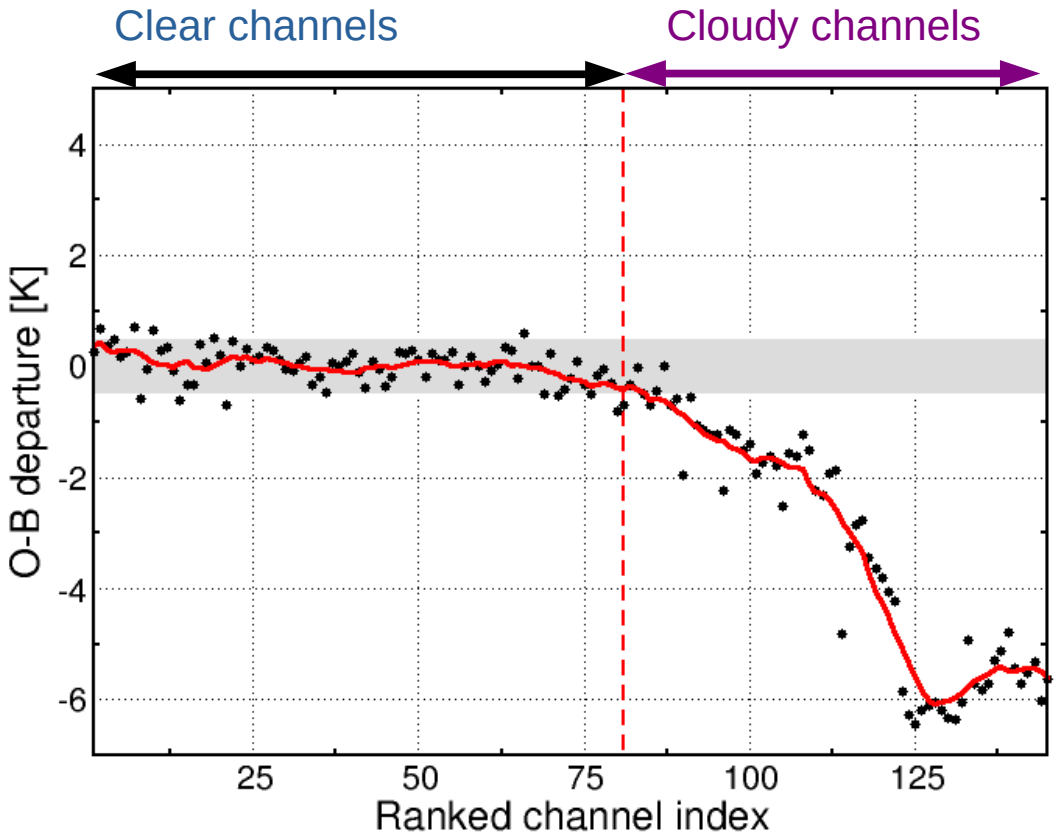

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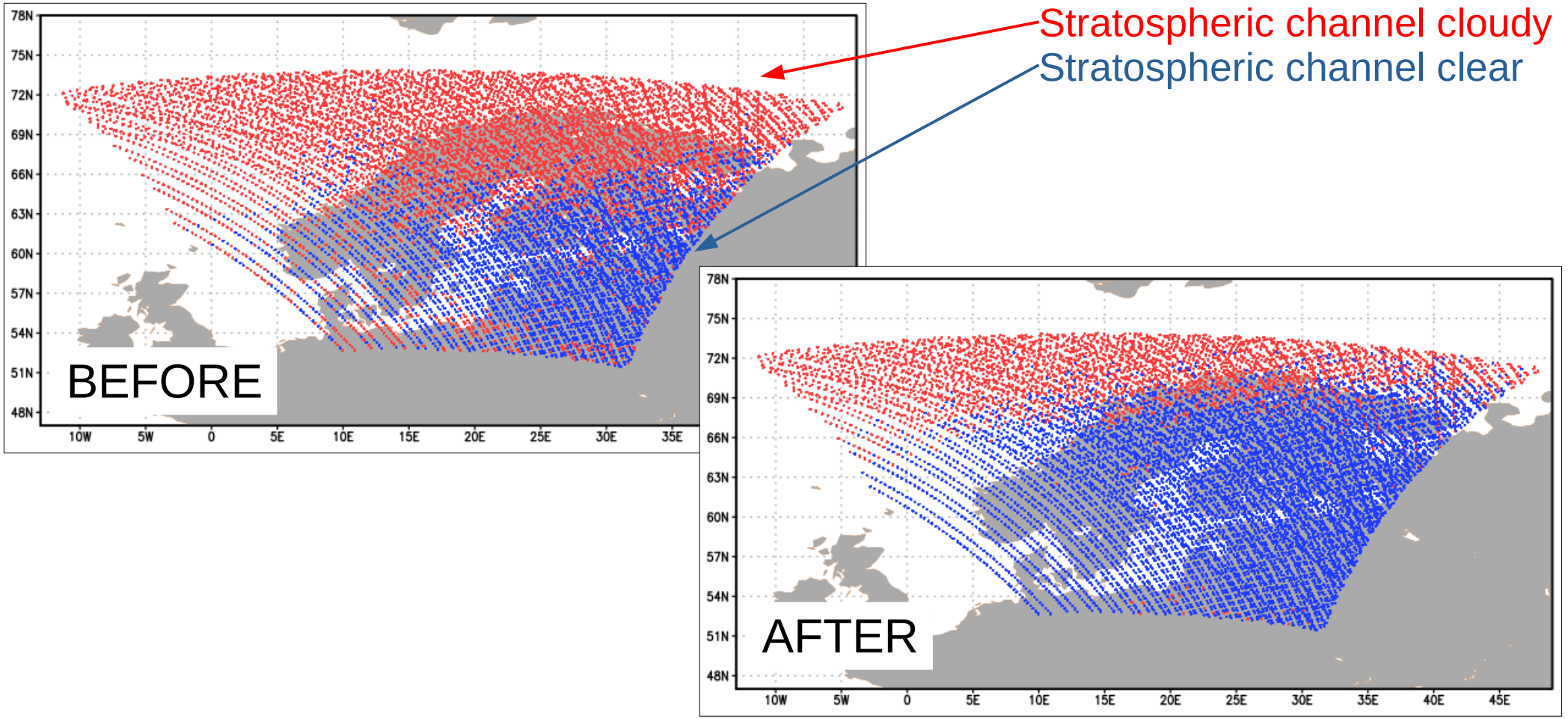
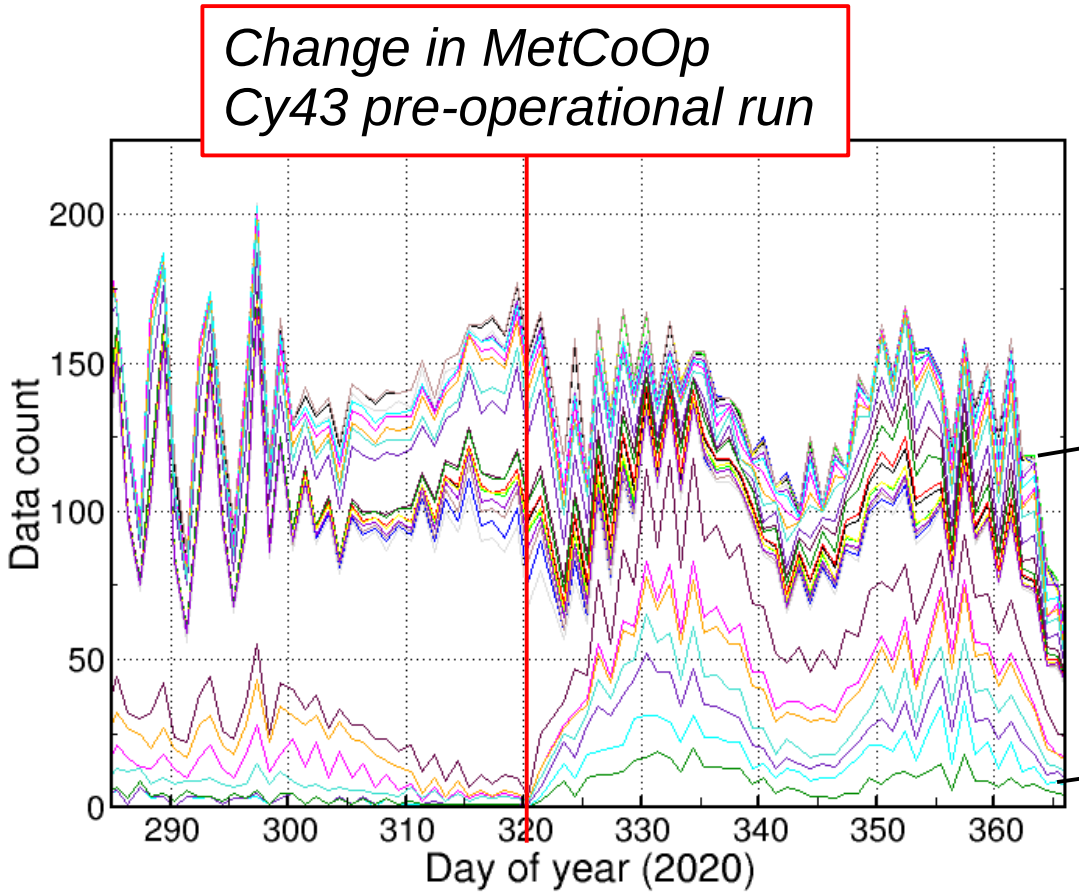
– For best results you do this with bias-corrected O-B departure data!

Letting more clear data through QC



Improved sampling of troposphere



Stratospheric channels of IASI

Lower-tropospheric channels of IASI

Radiance observations are inherently biased

– and so is the model background

Let's suppose that we have

– A set of ($\mathbf{y}$-$H[\mathbf{x}_b]$) departures with non-zero mean (i.e., bias in either observations, background, or both)

– A method to manipulate the departures to make them zero mean (i.e., a bias correction scheme)

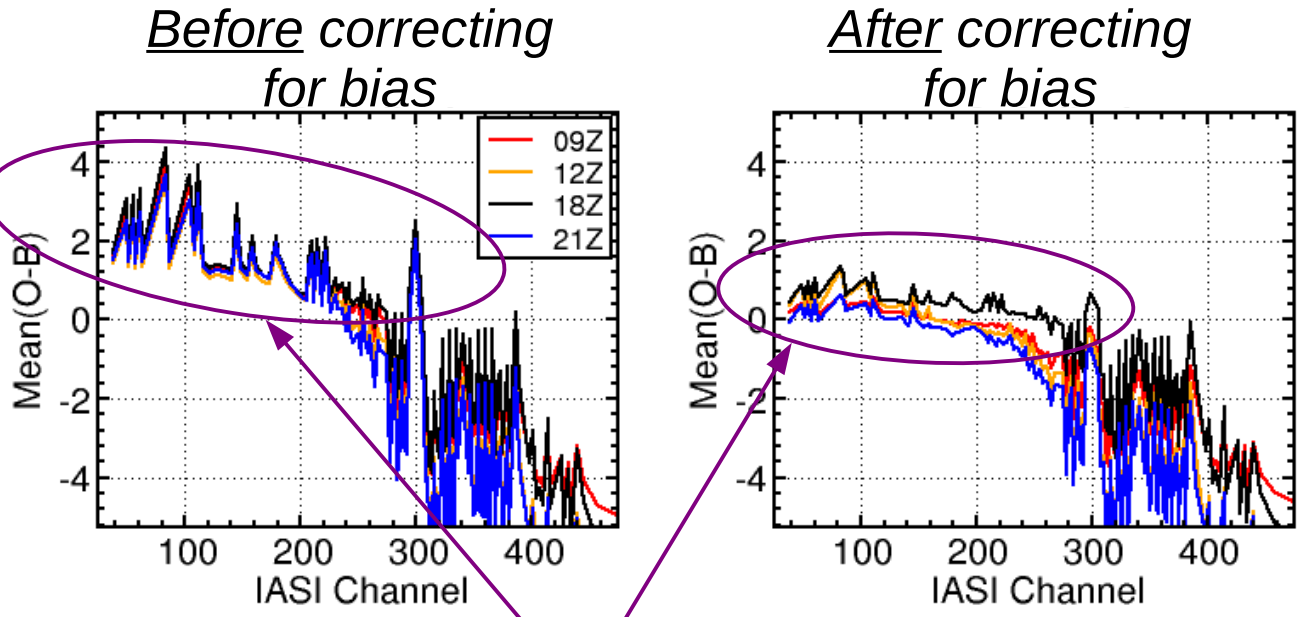
Let's also suppose that we don't know which is more biased: observations or background field.

	Observation more biased	Background more biased
Bias corrected	Zero-mean increment + Unbiased background = Unbiased analysis	Zero-mean increment + Biased background = Biased analysis
Bias not corrected	Non-zero mean increment + Unbiased background = Biased analysis	Non-zero mean increment + Biased background = Potentially unbiased analysis

Variational Bias Correction (VarBC):

– Does it correct for observation bias only?

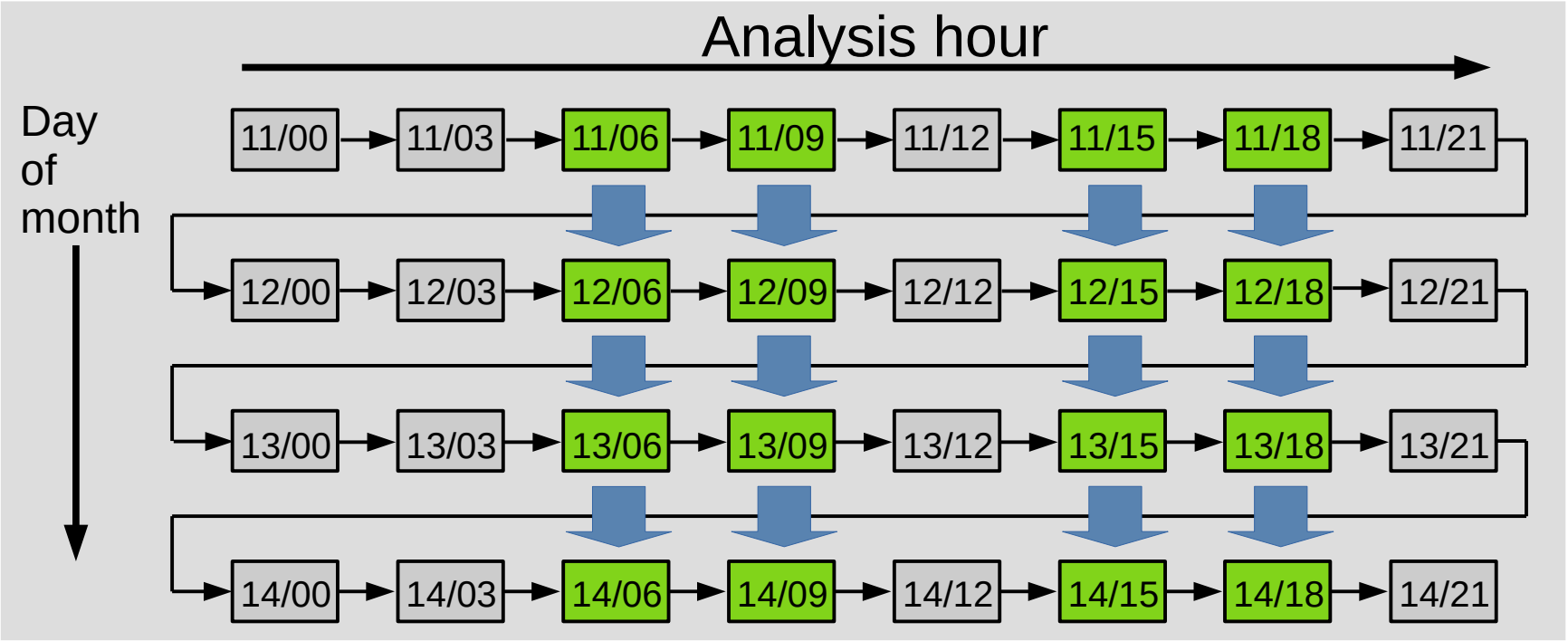
Up to 4K bias on stratospheric channels



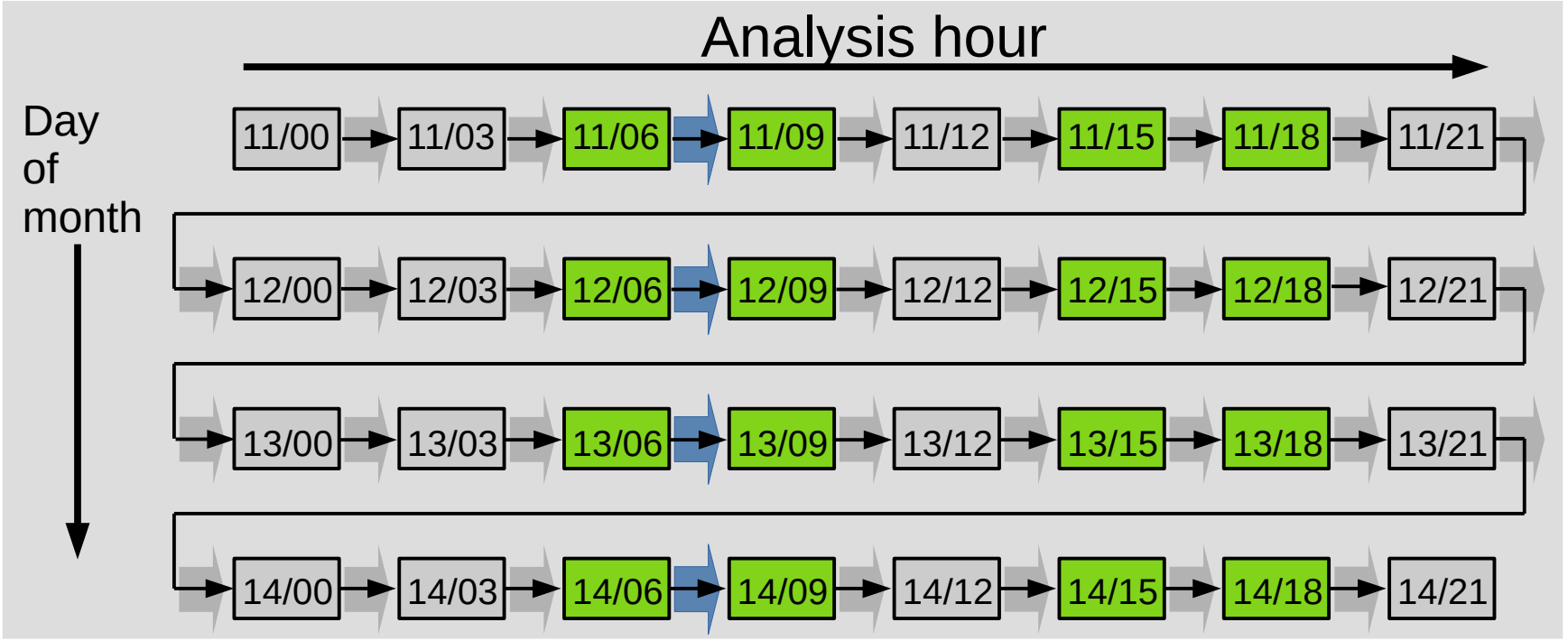
Uncorrected statistics are similar at all analysis hours…
… *but bias-corrected statistics are not*

→ How do we prevent VarBC from correcting for background-model bias ?

VarBC update strategy (as it stands for e.g. NOAA-19 in the MetCoOp system)



My proposal for VarBC update strategy (applicable to NOAA-19)



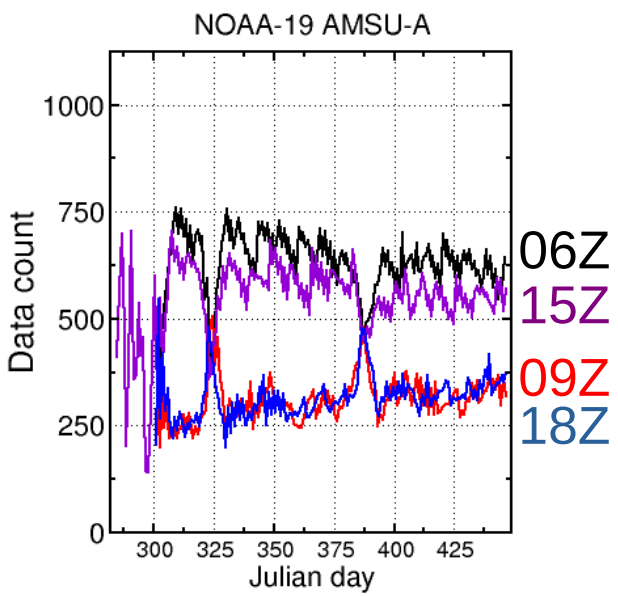
Including active use of NOAA-19

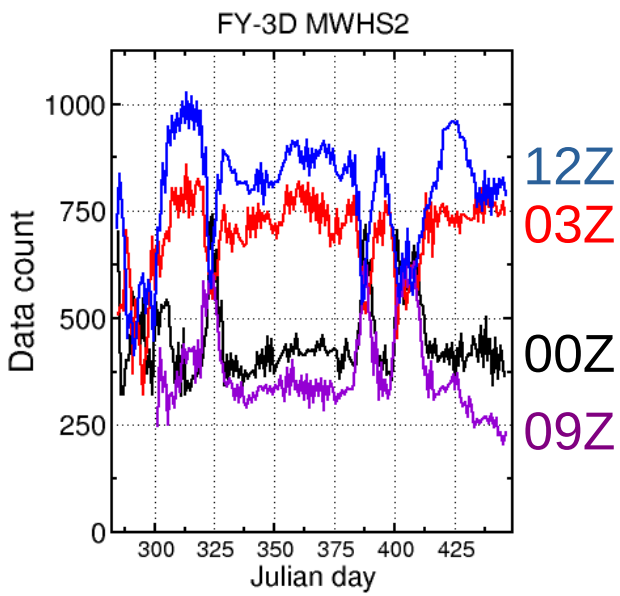
Background field information in 3-hourly cycling

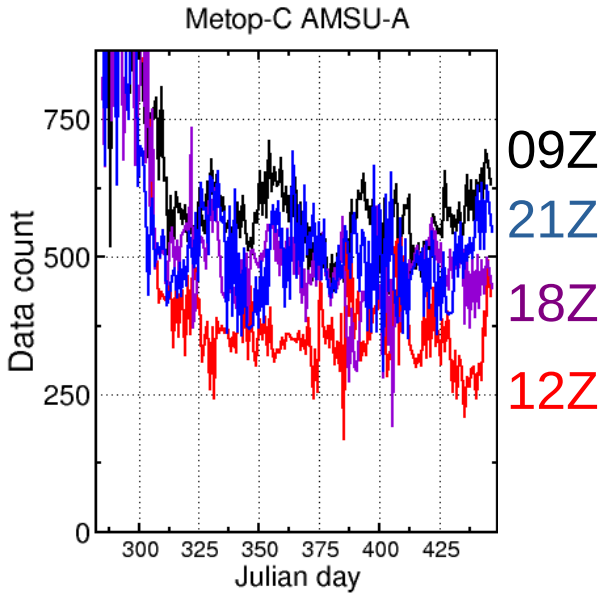
Passing VarBC coefficients without updating them

Transferring updated VarBC coefficients after 06Z analysis only

On the choice of daily VarBC update time







Two desirable conditions:

1) A good number of data available from the sensor of interest
2) Radiosonde data are available to serve as anchors

Preferred update times:

– 06Z for NOAA-19
– 12Z for FY-3D
– 18Z for Metop-C

What system changes does this require?

1) scr/Fetch_assim_data

– VarBC cycling at $FCINT interval

2) nam/harmonie_namelists.pm

– Interface to alter configuration details

3) src/arpifs/module/varbc_setup.F90

– Modify one subroutine call to include analysis time

4) src/arpifs/module/varbc_rad.F90

– Provide the default configuration

– Determine whether or not to update the VarBC coefficients at each given situation

```
'N_UPD_SATID_HOUR(3,1:4)' => '20918,22306,318,518',
'N_UPD_SATID_HOUR(73,1)' => '52312',
'N_UPD_SATID_HOUR(19,1:2)' => '22412,22512',
```

Sensor ID

Sensor-specific lists of allowed *SSSHH* with
SSS: satellite ID
HH: Analysis hour

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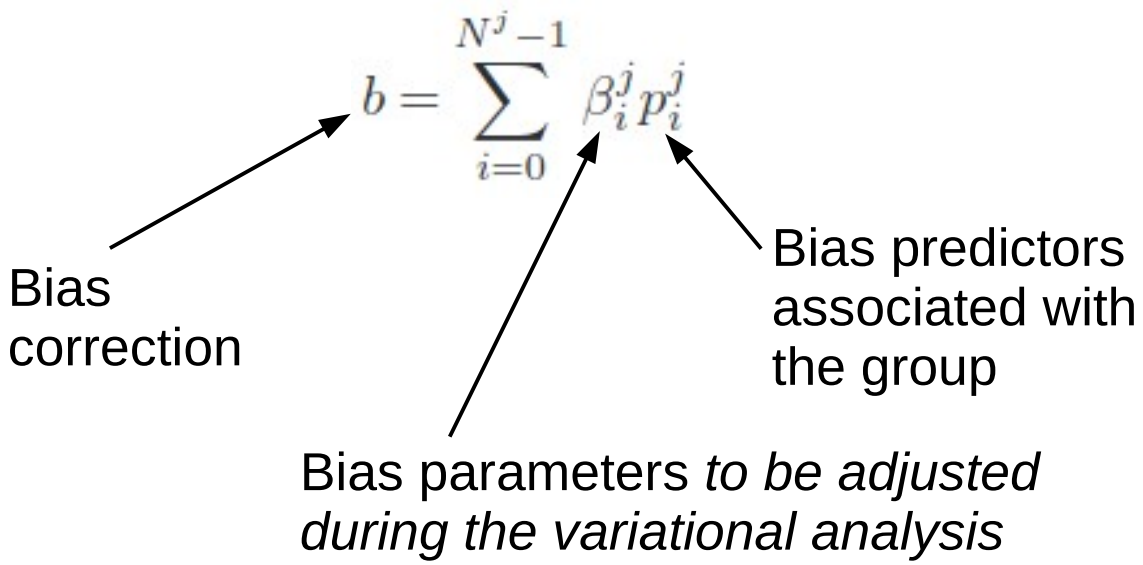
Summary

1) Please apply VarBC consistently on all those channels that you use in quality control
   – This is particularly important in the cloud screening for IR radiances

2) I propose to cycle VarBC coefficients together with the general DA update cycling interval (e.g. 3 hours)
   – *However updating VarBC coefficients just once per day for each instrument*
   – The daily update time should be satellite-dependent and coincide with good availability of radiosonde data

Backup slides

Variational Bias Correction (VarBC)



(c) IFS Documentation CY47R1 – Part II: Data Assimilation (www.ecmwf.int)

TABLE 1. List of selected predictors in the ARPEGE/ ALADIN models.

Predictor No.	Predictor
0	Constant
1	1000–300-hPa thickness
2	200–50-hPa thickness
3	Skin temperature
4	Total column water
5	10–1-hPa thickness
6	50–5-hPa thickness
8	Nadir-viewing angle
9	Nadir-viewing angle **2
10	Nadir-viewing angle **3
11	Nadir-viewing angle **4
15	Land or sea ice mask
16	View angle (land)
17	View angle **2 (land)
18	View angle **3 (land)

(c) Benáček and Mile (2019)