

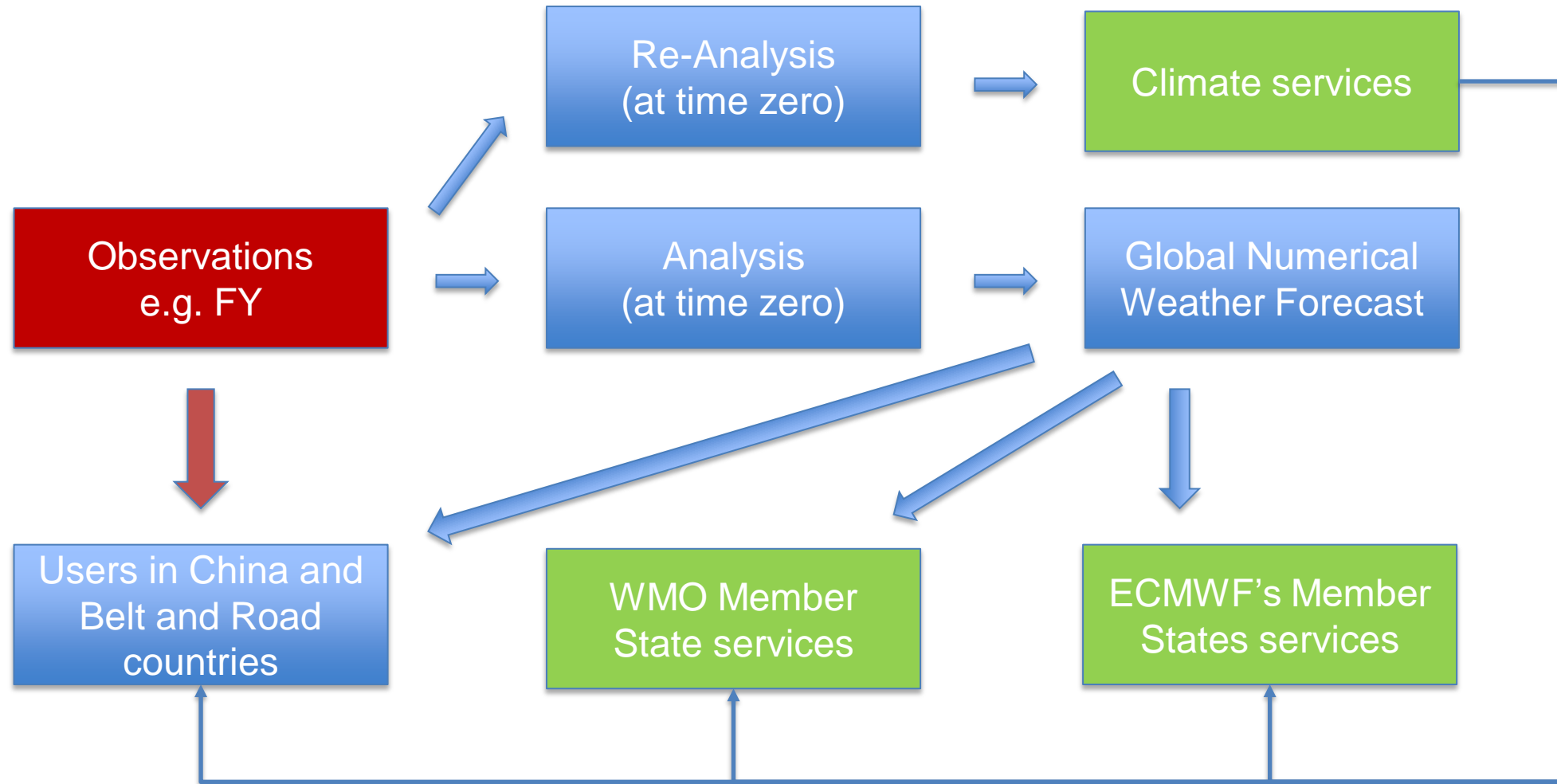
ECMWF NWP developments with a focus on use of FY observations

FY User conference 2019

Stephen English, ECMWF

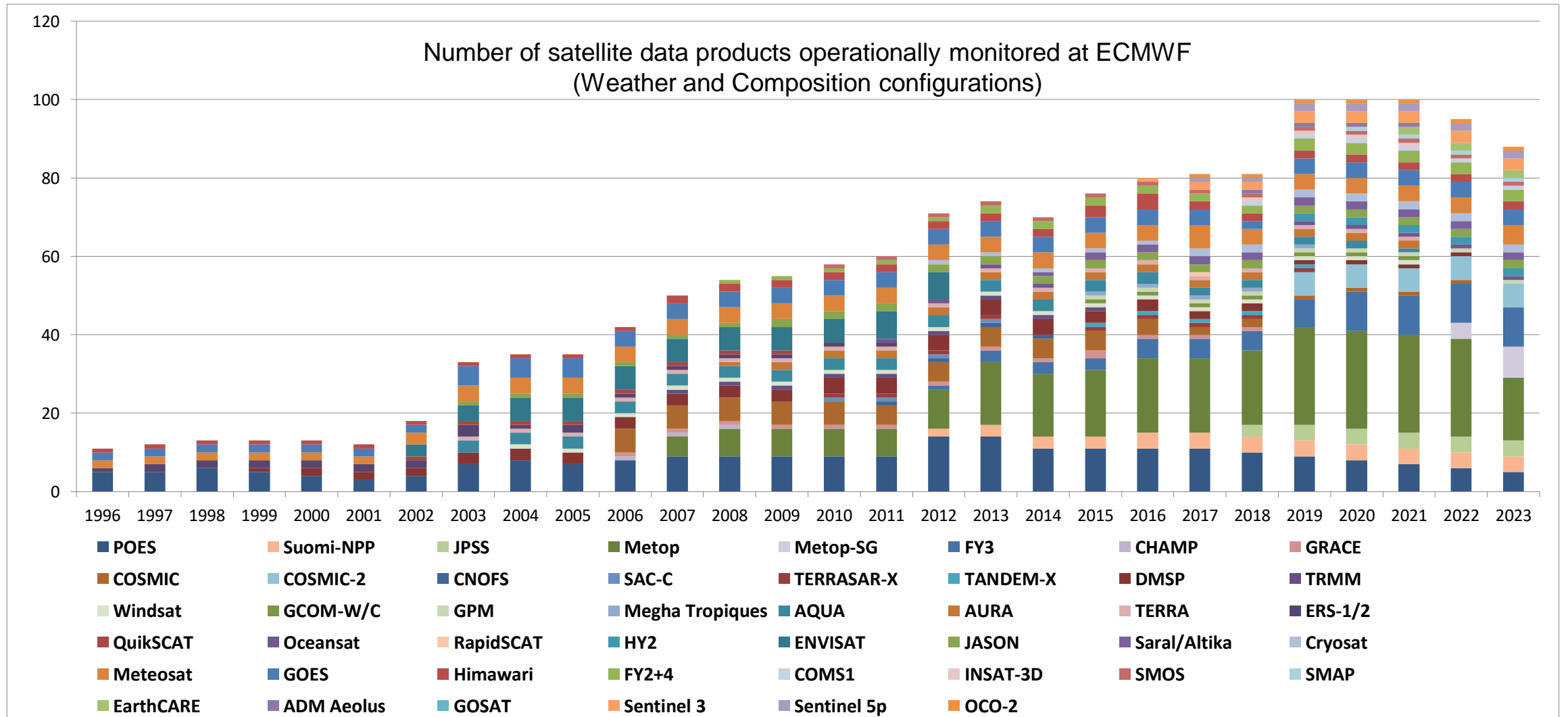


ECMWF: Global predictions for Medium Range (up to 15 days), extended range (up to 45 days ahead), Sub-Seasonal to Seasonal up to 1 year ahead

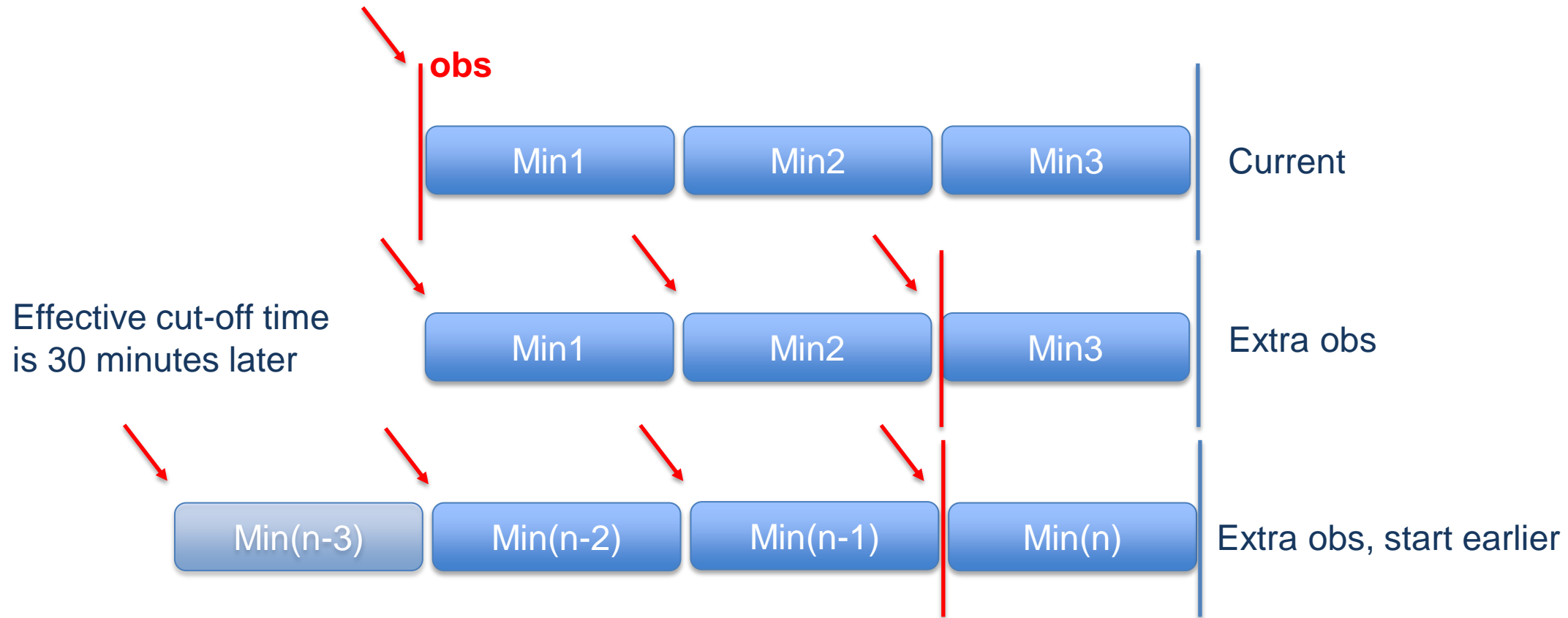


Key NWP and DA developments

NWP is using more observations, including FY => Better forecasts



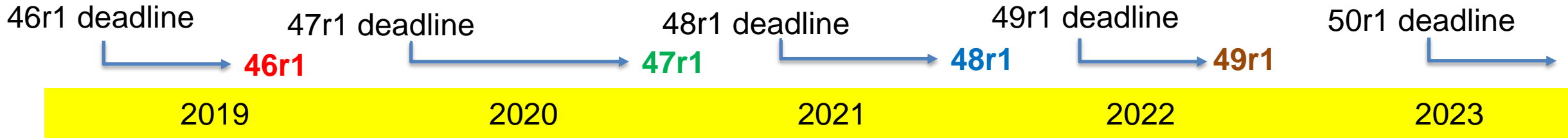
Continuous data assimilation (Peter Lean, Elias Holm, Massimo Bonavita)



Continuous Data Assimilation uses satellite observations much better than traditional DA with a data cut off

ECMWF cycles 2019-2023

New
Data
Centre
New
HPC



Continuous DA
50 member EDA



Large increase
in forecast skill
everywhere

New weak
constraint 4D-Var
Consistent timestep



Large increase in
forecast skill in
stratosphere

ENS resolution
change (vertical
and horizontal)



Large increase
in forecast skill
expected

OOPS and
COPE



Key
infrastructure
developments

FY status and evaluation at ECMWF

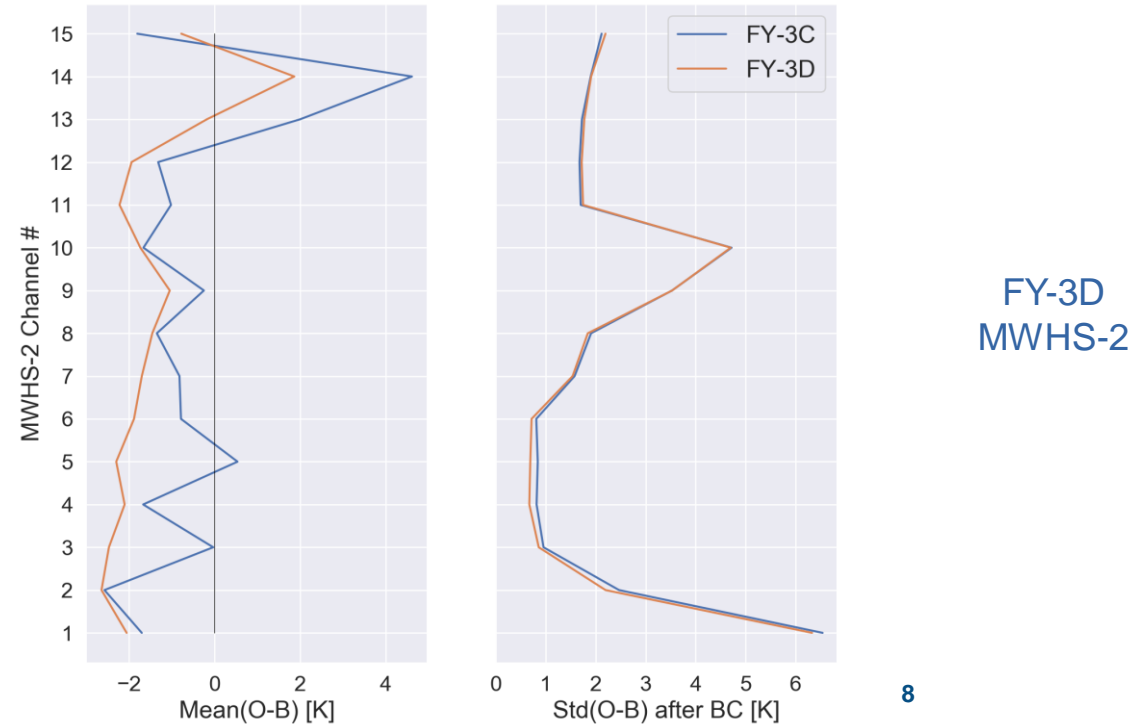
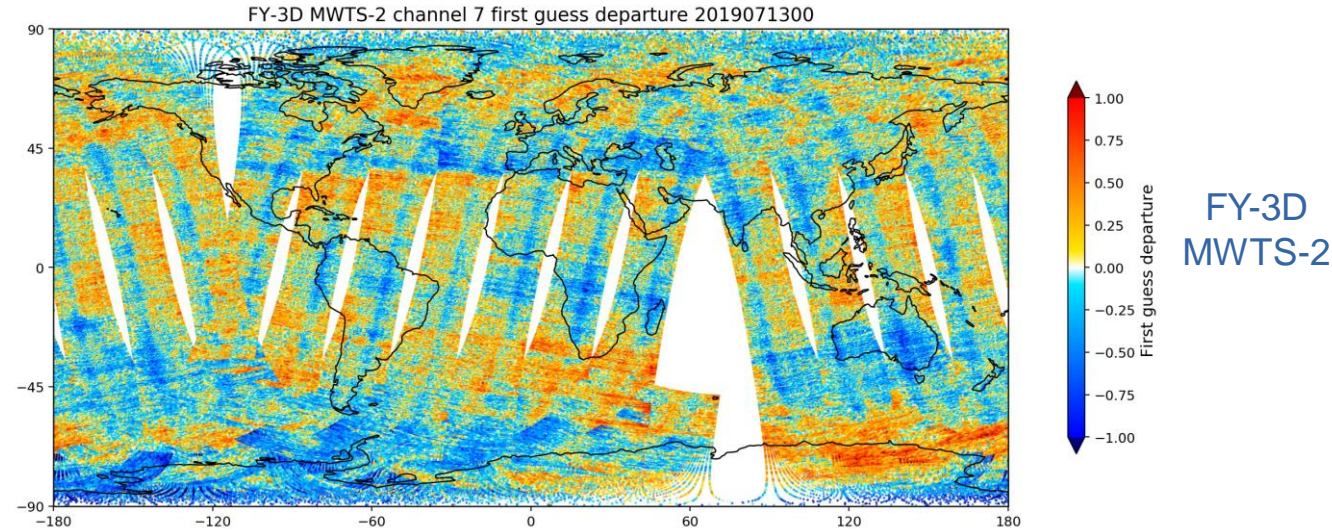
Part of ECMWF-CMA Collaboration Agreement

FY-3D Microwave

ECMWF already use data operationally from FY3A, B, C in operations and re-analysis.

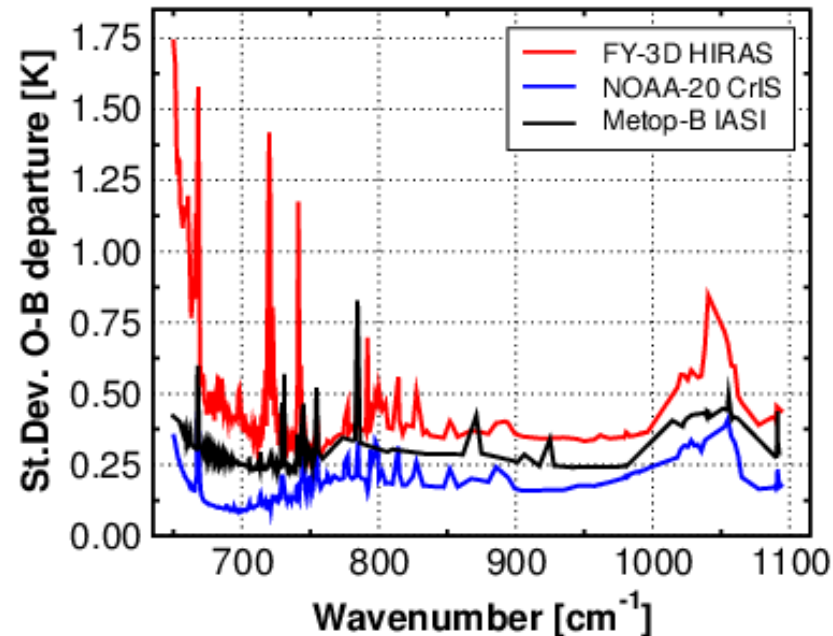
What about FY3D?

- MWRI testing is on-going, results not yet conclusive
- MWTS-2: higher std(O-B) than exhibited by AMSU-A or ATMS, plus significant striping and across scan biases not fixed by varBC
- MWHS-2: performance for FY-3D is similar to FY-3C, departures appear quite like MHS for similar channels. **READY!**
- GNOS: Small residual biases, but good enough to use. **READY!**



FY-3D Infrared

- HIRAS: early results based on a 2-month offline sample
- Spectral characteristics and orbit parameters like those of CrIS – except for instrument noise
- Encouraging, still some issues to resolve – strong collaboration with CMA/NSMC by ECMWF

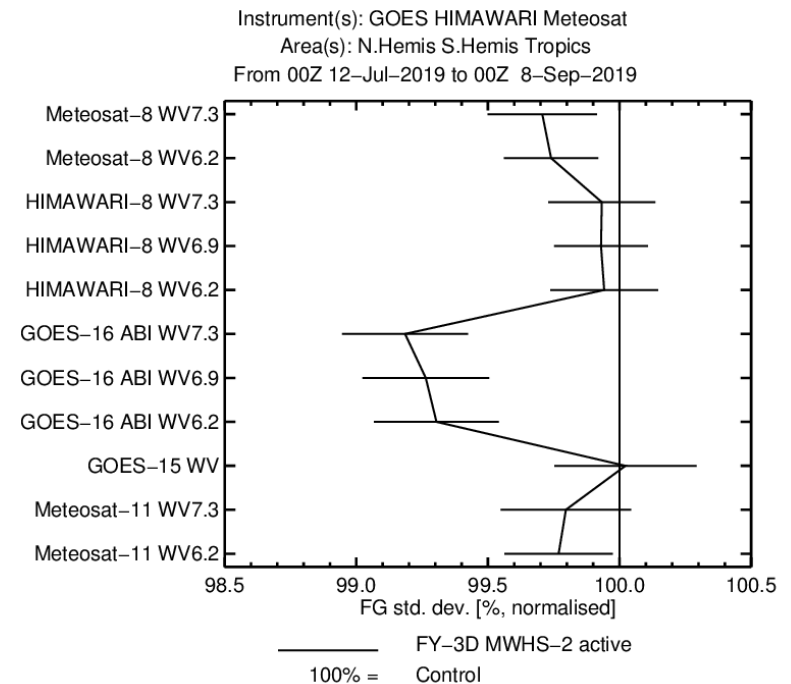


FY-3D Pre-Operational tests

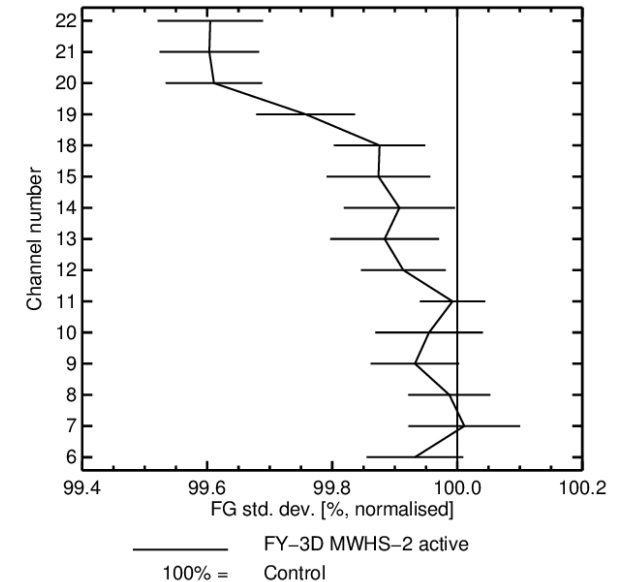
2 month experiment of FY-3D MWHS-2 assimilation shows:

- Stable instrument performance
- Improved fits seen from ATMS and GOES WV channels
- Similar performance to MHS and FY-3C MWHS-2

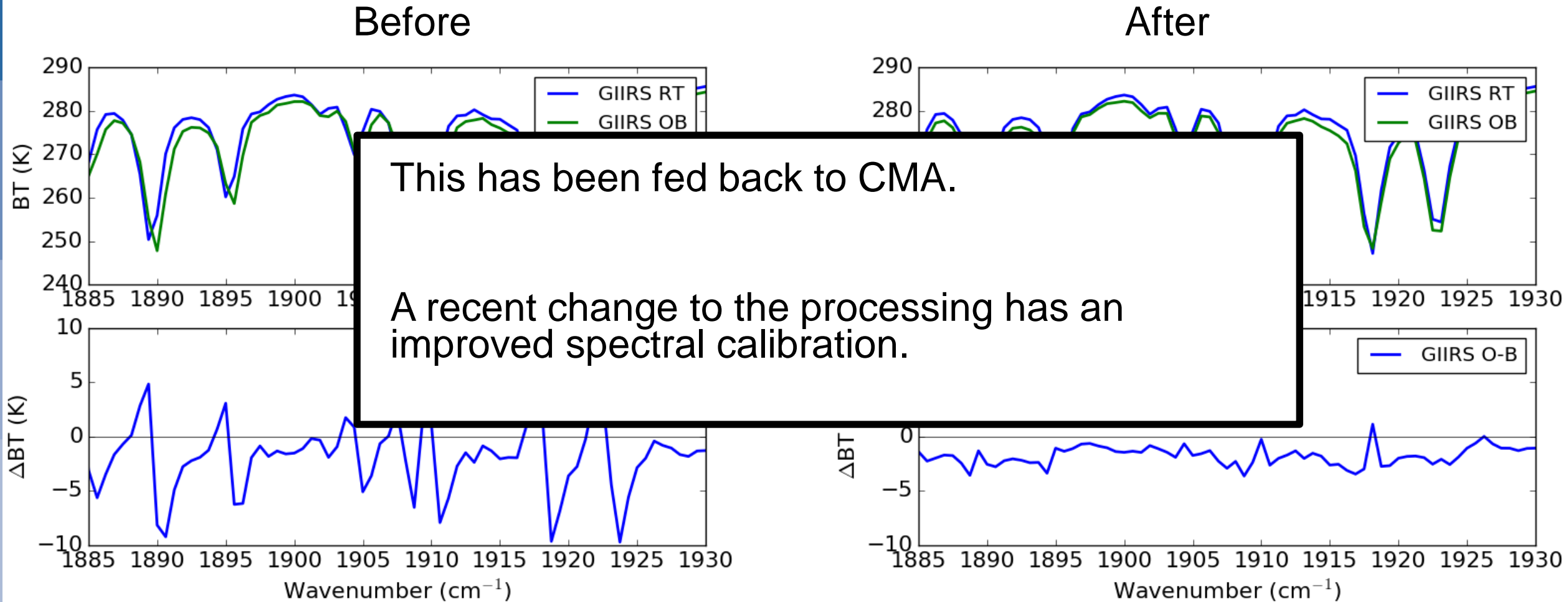
Other experiments are ongoing to use more MWHS-2 channels over sea ice



Instrument(s): NOAA-20 ATMS Tb NPP ATMS Tb Area(s): N.Hemis S.Hemis Tropics
From 00Z 12-Jul-2019 to 00Z 8-Sep-2019



FY4A: Correcting the spectral shift improves the agreement with RT simulations



Very preliminary 4D-Var assimilation experiment

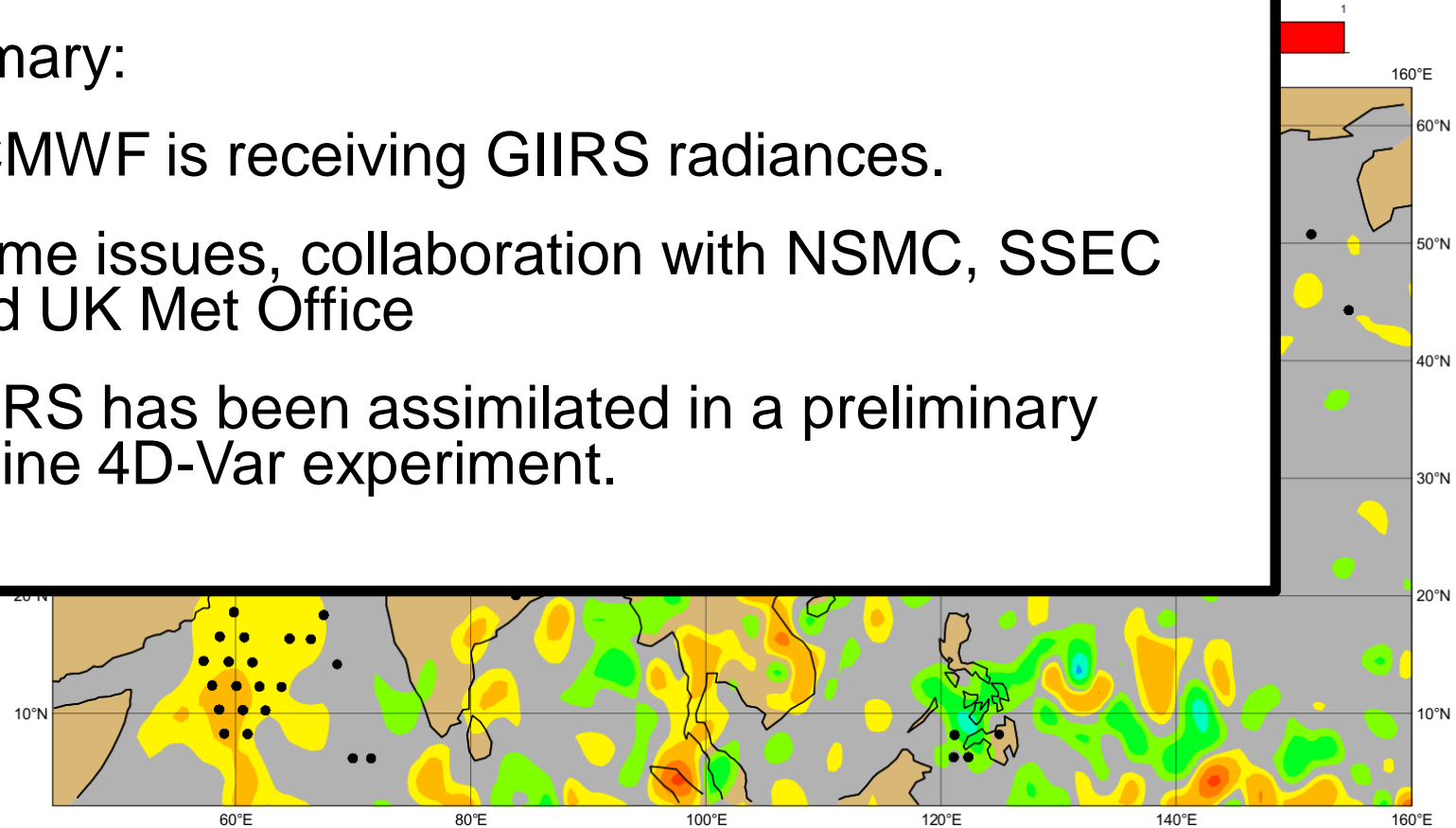
OdbDatabase: /var/tmp/tmpdir/dam/jtmp.17737/mv.27171.dam/marsDyF402
Min: -6.99212 Max: 7.9609 (4875 points)
Tuesday 20 August 2019 21 UTC cont 400 hPa Temperature

Single cycle first
departures (char

400hPa tempera
increments.

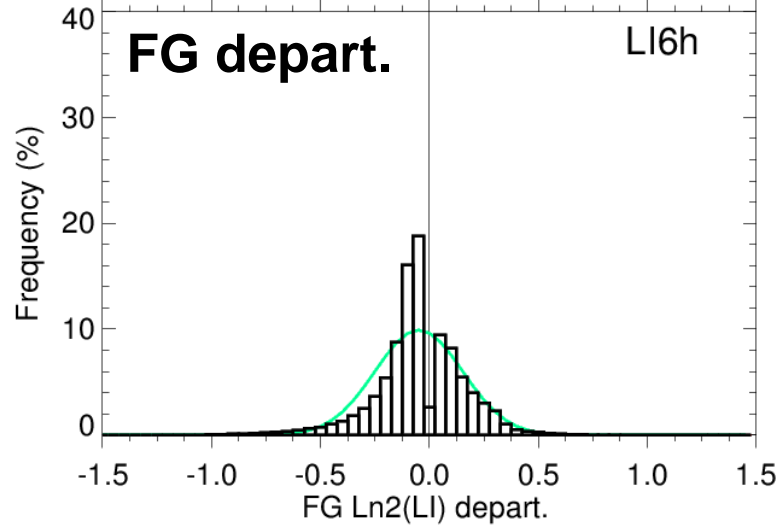
Summary:

- ECMWF is receiving GIIRS radiances.
- Some issues, collaboration with NSMC, SSEC and UK Met Office
- GIIRS has been assimilated in a preliminary offline 4D-Var experiment.

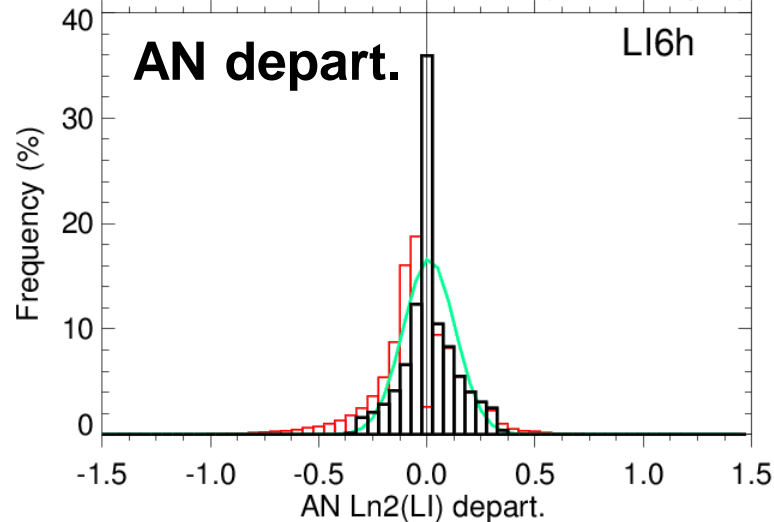


4D-Var assimilation of GOES-16 GLM lightning flash densities: First long experiment.

FG Ln2(LI) depart. 2018060100-2018071512
Mean = -0.049, $\sigma = 0.201$ (740841 pts)

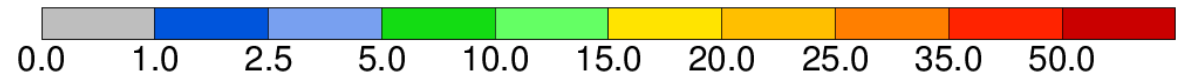
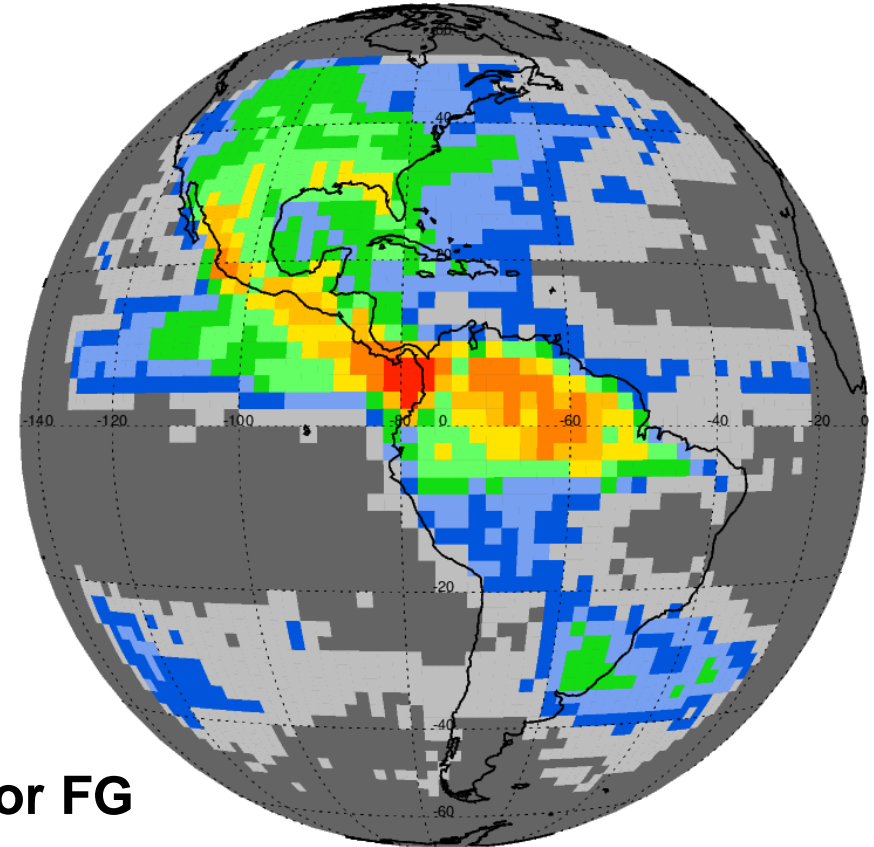


AN Ln2(LI) depart. 2018060100-2018071512
Mean = 0.011, $\sigma = 0.120$ (740841 pts)



Departure histogram
narrower for AN than for FG
→ OK

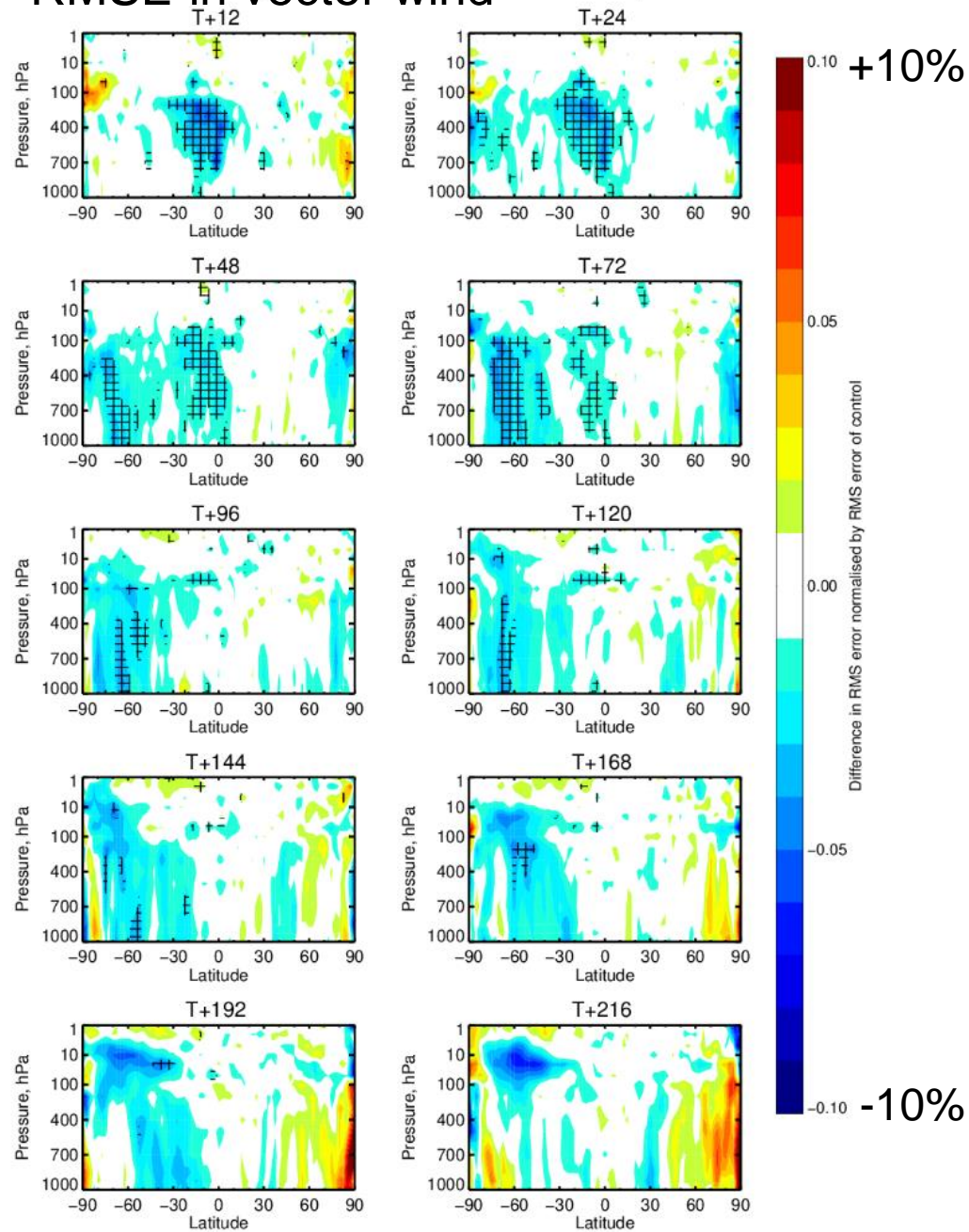
Mean number of obs per $2^\circ \times 2^\circ$ box
1 June – 15 July 2018 (CY46R1; TCo399 \approx 28 km)



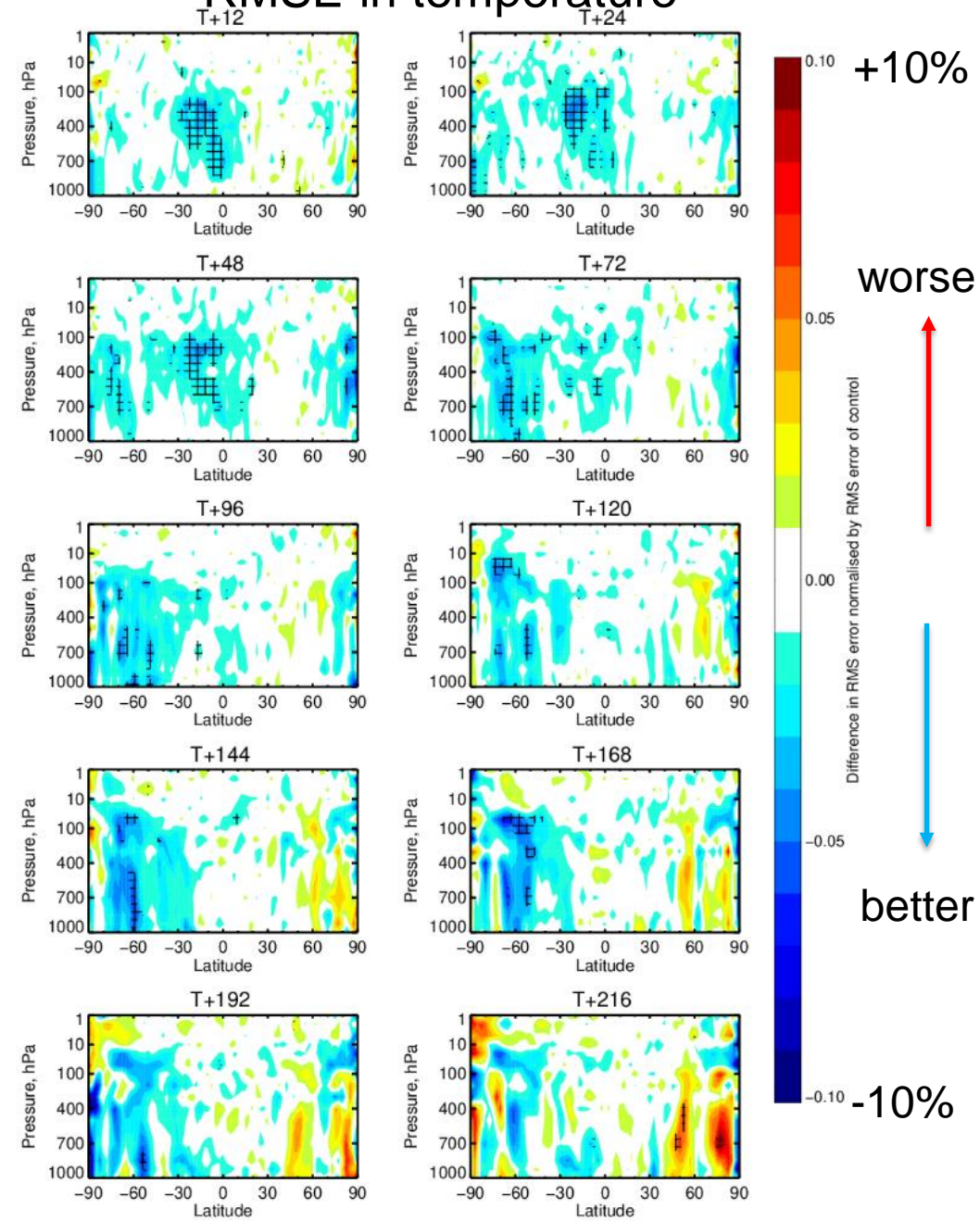
Future perspectives

Doppler wind lidar: evidence from ESA Aeolus mission

RMSE in vector wind

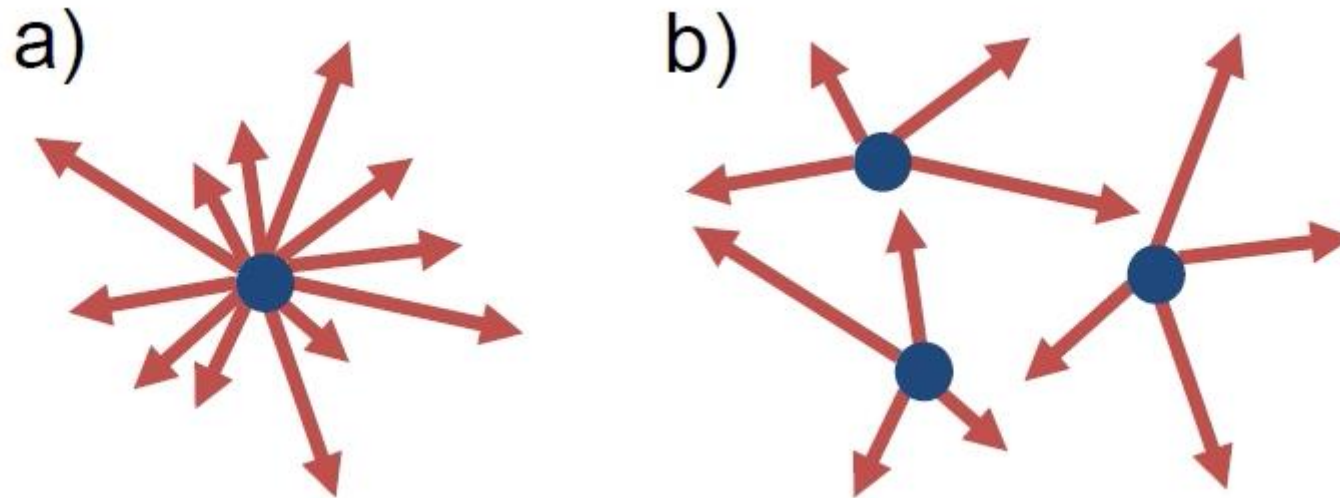


RMSE in temperature



Future EDA initialisation – multiple high resolution analyses (Elias, Massimo)

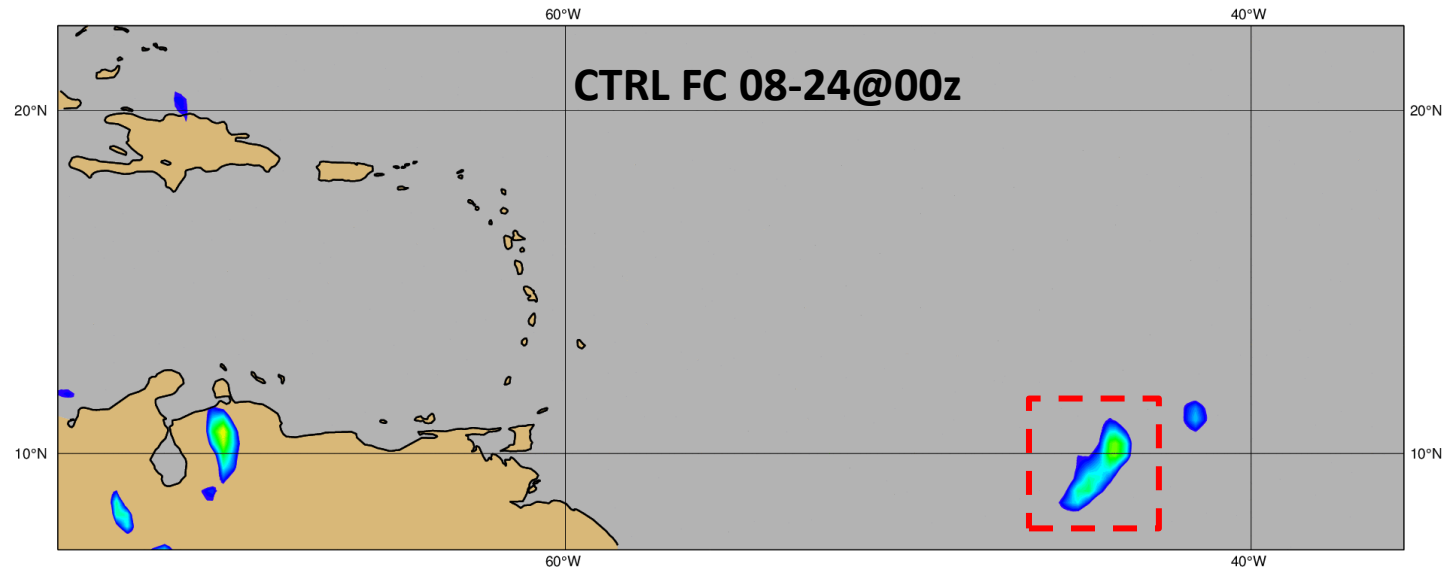
- Satellite observations dominate NWP skill so.....
- Do NWP centres fully utilise current satellite observations?
- No – e.g. 3% of hyperspectral IR due to spectral and spatial thinning
- Exploring distributing observations across Ensemble Forecast members to initialise Ensemble forecasts better and use all observations



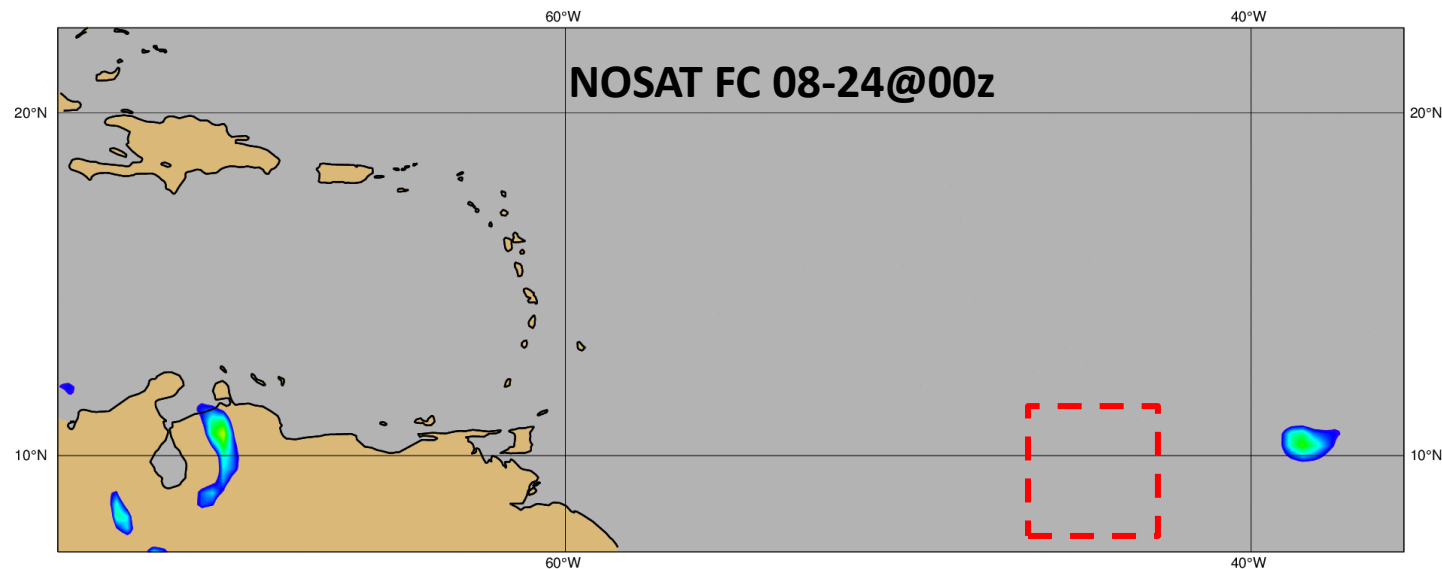
Inspirational case study!

Dorian genesis...to first strike on Windward Islands

Saturday 24 August 2019 00 UTC ecmf 850 hPa Vorticity (relative)

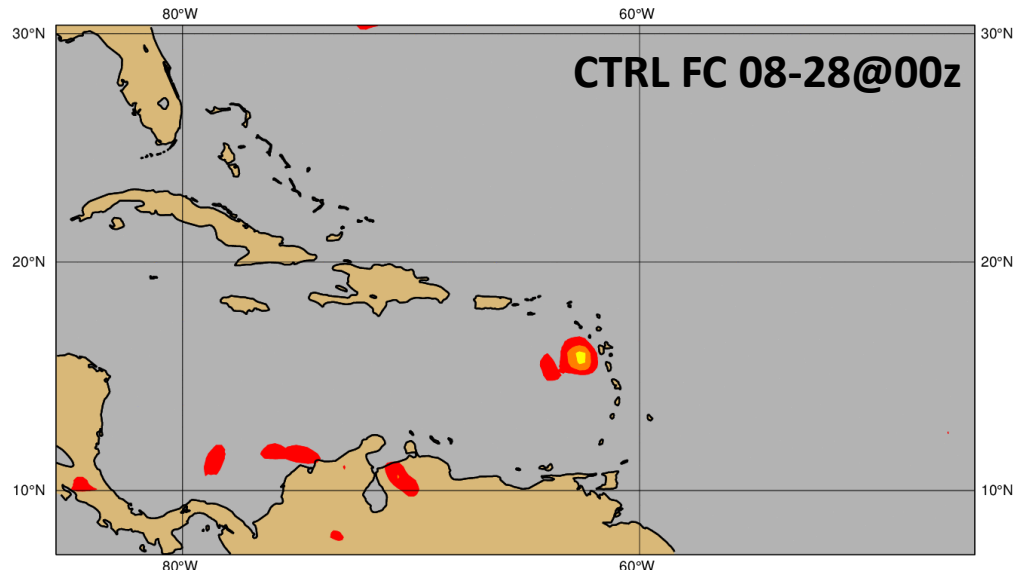


Control system with satellites identifies storm genesis on 24th August and provides 4 days warning of direct strike on Windward Islands



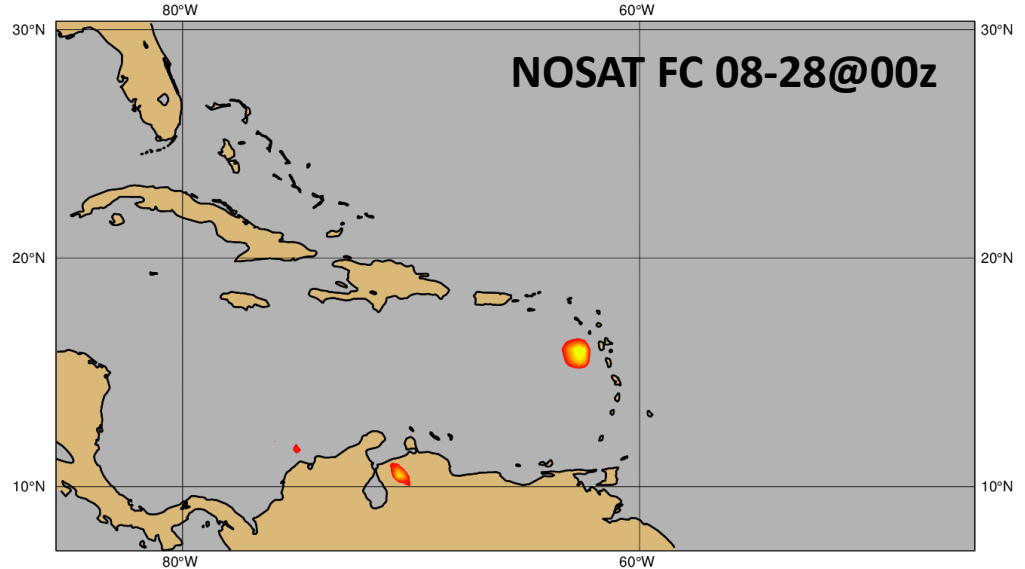
System with satellites denied (for 36hrs prior to forecast) misses the storm genesis and provides no warning of strike on Windward Islands

Transition from Windward Islands ...to Bahamas...

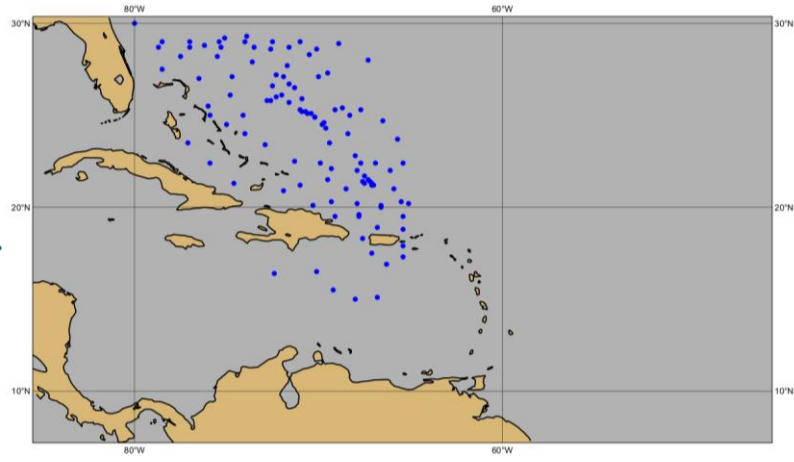


Wednesday 28 August 2019 00 UTC ecmf 850 hPa Vorticity (relative)

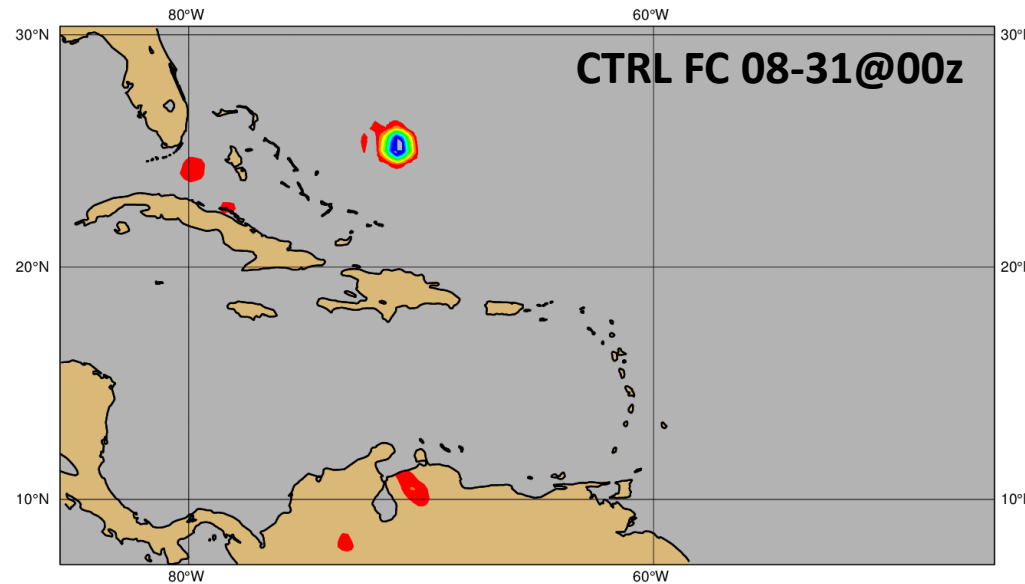
Control system with satellites correctly predicts the storm's transition to hit on the Bahamas 4 days later



System with satellites denied wrongly predicts a near miss for the Bahamas, despite the availability of extensive US drop-sonde activity.

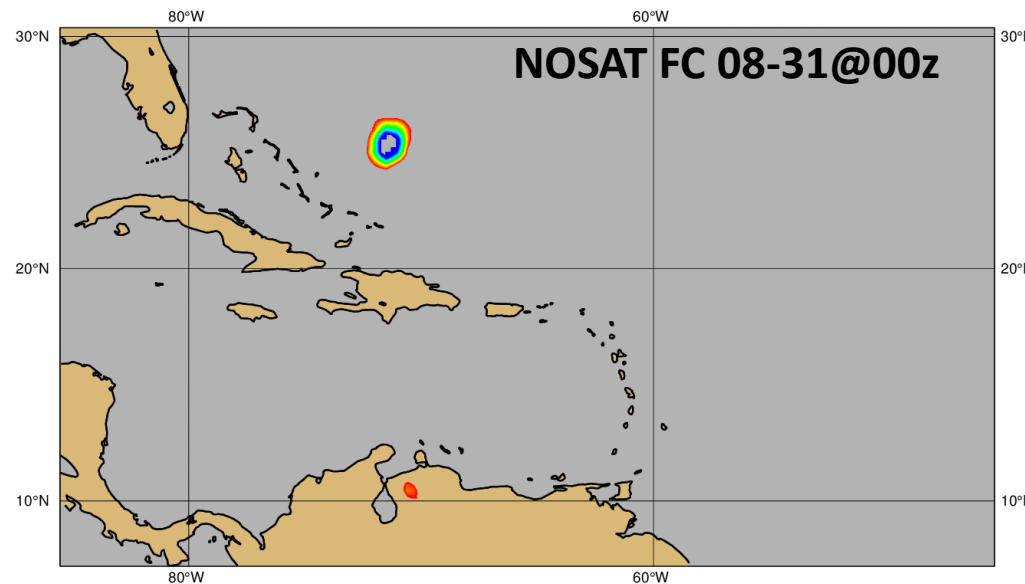


Stall over Bahamas ...no Florida land-fall



Saturday 31 August 2019 00 UTC ecmf 850 hPa Vorticity (relative)

Control system with satellites correctly predicts the storm's stall over the Bahamas and no land-fall on Florida



System with satellites denied fails to predict the stall and wrongly forecasts a direct hit on Florida (like many earlier CTRL forecasts!)

Conclusions

- Good year for new observations:
 - FY-3D and FY-4A hyperspectral, RO and MW instruments being evaluated, FY-3D MWHS-2 and GNOS already good enough to use operationally, HIRAS close, MWTS-2 and MWRI more work needed;
- Good recent years for Data Assimilation
 - New continuous DA concept at ECMWF has improved skill very much, one of biggest skill jumps for many years;
 - Earth System Data Assimilation progressing fast
- The future is exciting too!
 - Distributed obs in EDA may improve ENS initialisation and use investment in satellites more fully;
 - Aeolus: ready for operational implementation at ECMWF, confirms NWP models need more 3D wind observations

Use of FY observations by Global NWP centres like ECMWF bring additional benefits of investment in satellite programmes to the whole world, including China and Belt and Road countries!