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

Number of satellite data products operationally monitored at ECMWF
(Weather and Composition configurations)
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**

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- Continuous DA
  - 50 member EDA

- New weak constraint 4D-Var
  - Consistent timestep

- ENS resolution change (vertical and horizontal)

- OOPS and COPE

- Key infrastructure developments

- Large increase in forecast skill everywhere
- Large increase in forecast skill in stratosphere
- Large increase in forecast skill expected
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
FY4A: Correcting the spectral shift improves the agreement with RT simulations

This has been fed back to CMA.

A recent change to the processing has an improved spectral calibration.
Very preliminary 4D-Var assimilation experiment

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.

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

Departure histogram narrower for AN than for FG
$\Rightarrow$ OK
Future perspectives
Doppler wind lidar: evidence from ESA Aeolus mission

RMSE in vector wind

RMSE in temperature

+10%

-10%

worse

better

+10%
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

a) b)
Inspirational case study! ....
Dorian genesis...to first strike on Windward Islands

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...

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

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!