

Forthcoming changes in ECMWF forecast system

Fernando Prates (& colleagues)

European Centre for Medium Range Weather Forecasts

fernando.prates@ecmwf.int

Outline

- 2021-22 Season
 - Forecast performance
- Model Cycle 48r1
 - Data Assimilation and Observation use
 - Model changes
 - Meteorological impact
 - Forecast System Configuration



New Data Centre in Bologna, Italy

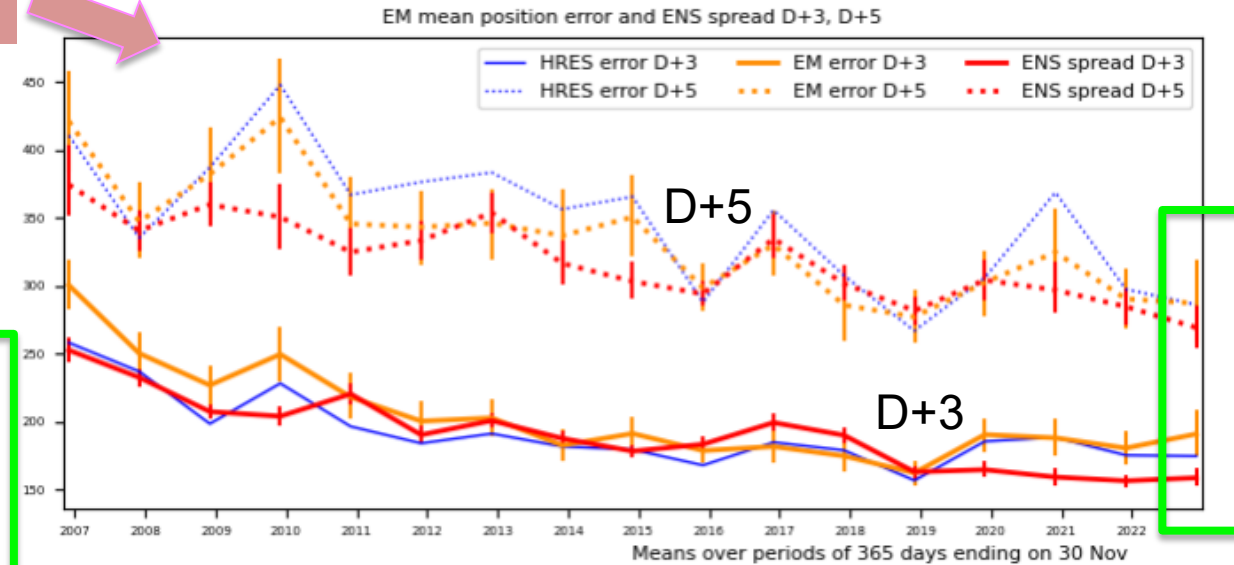
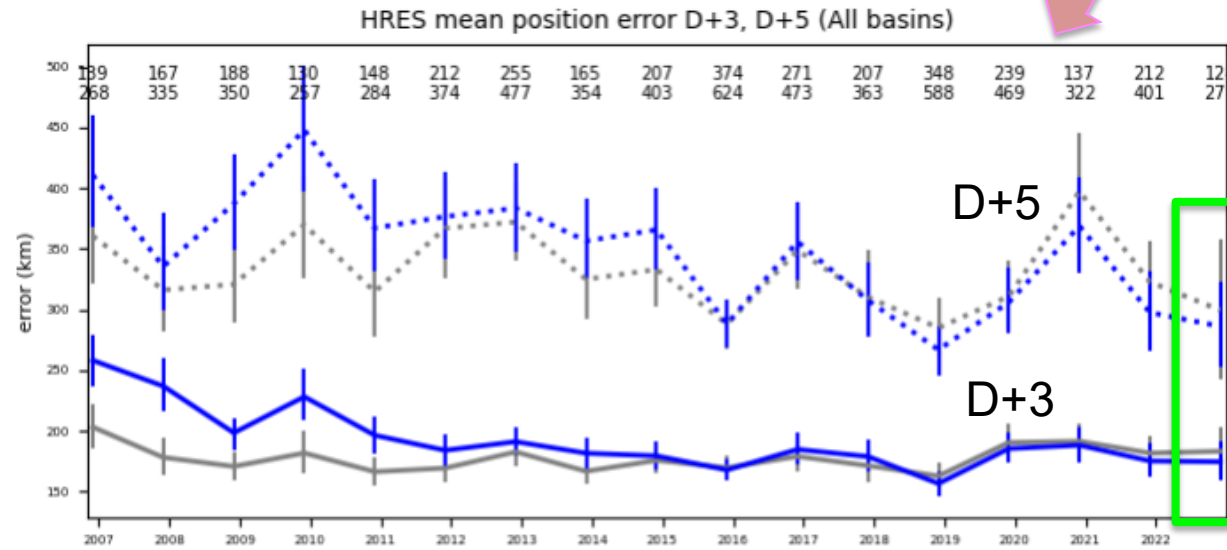
2021-2022: Tropical Cyclone Verification: HRES, ENS, ERA5

Verification Period
Dec 2021 – Nov 2022

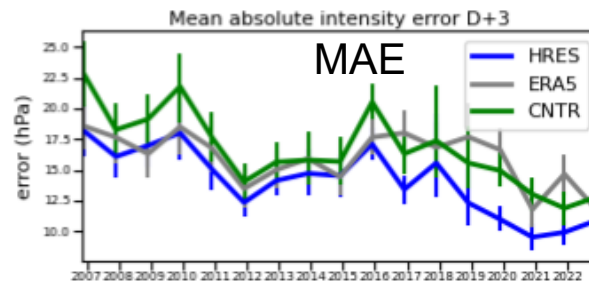
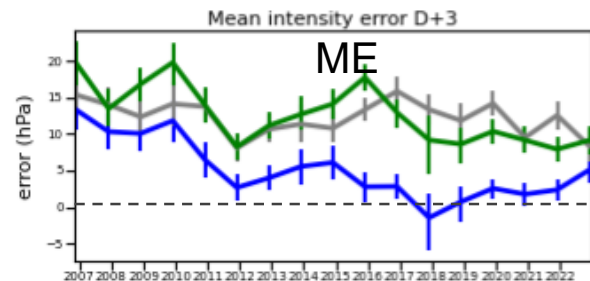
Position (ENS)

All Basins

Position (HRES)



homogeneous
samples

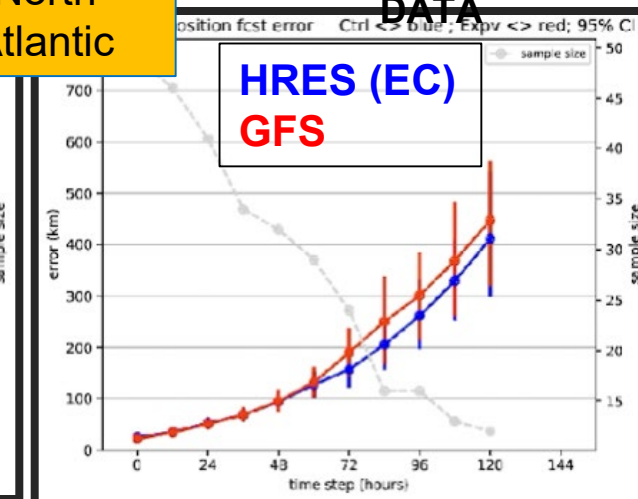
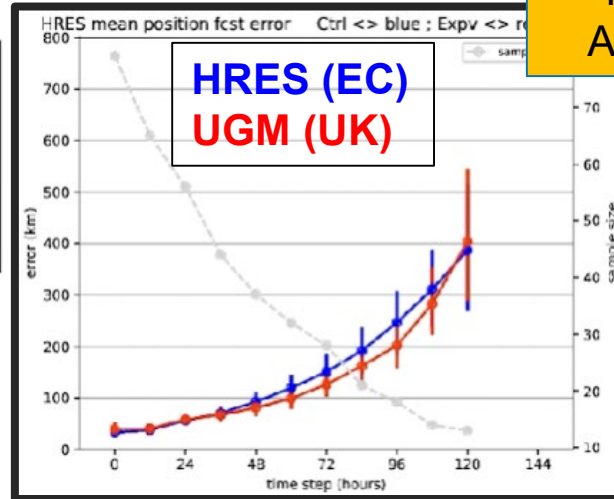


ERA5 fcst
in grey

Central pressure

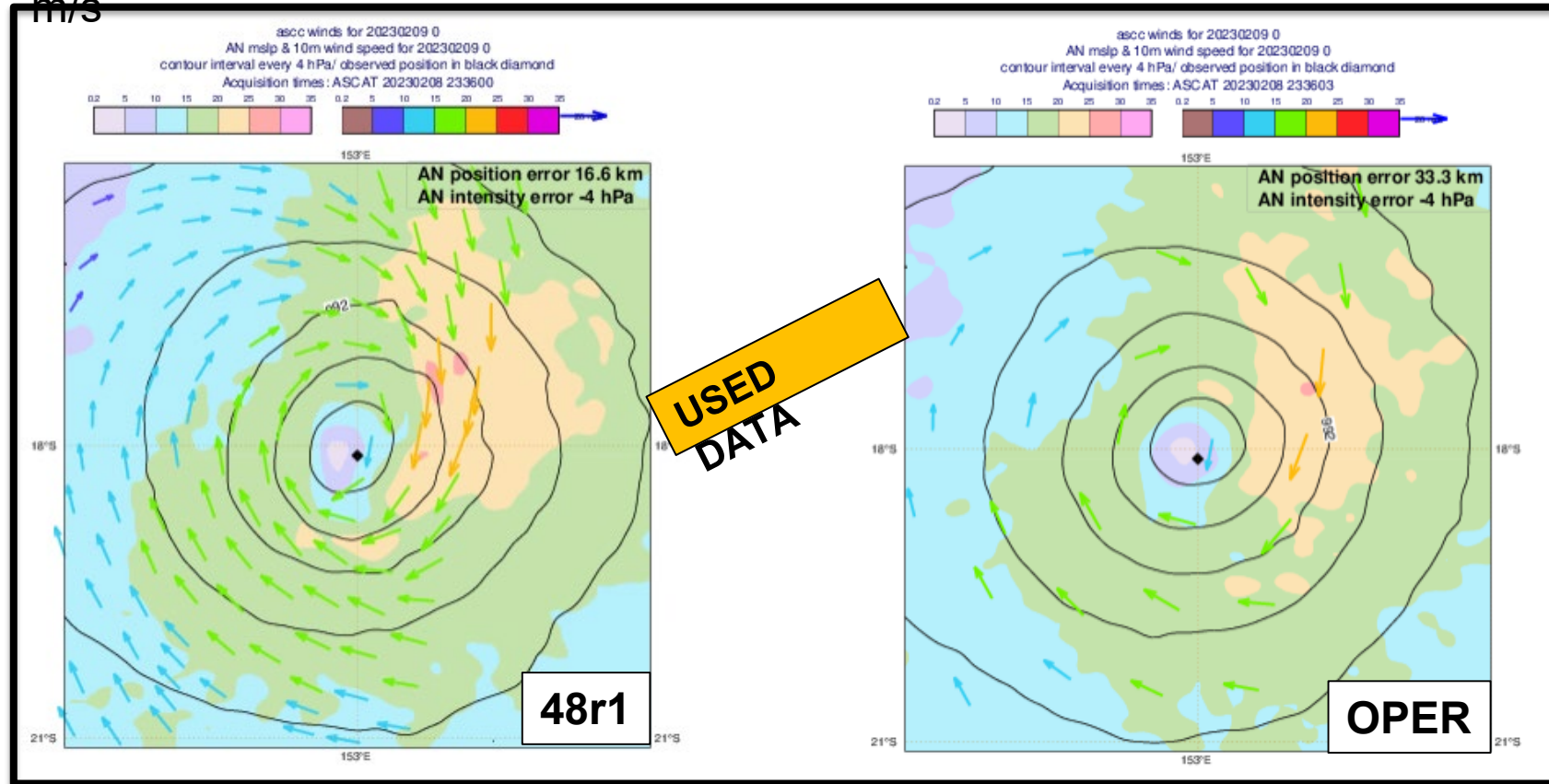
North
Atlantic

TIGGE
DATA



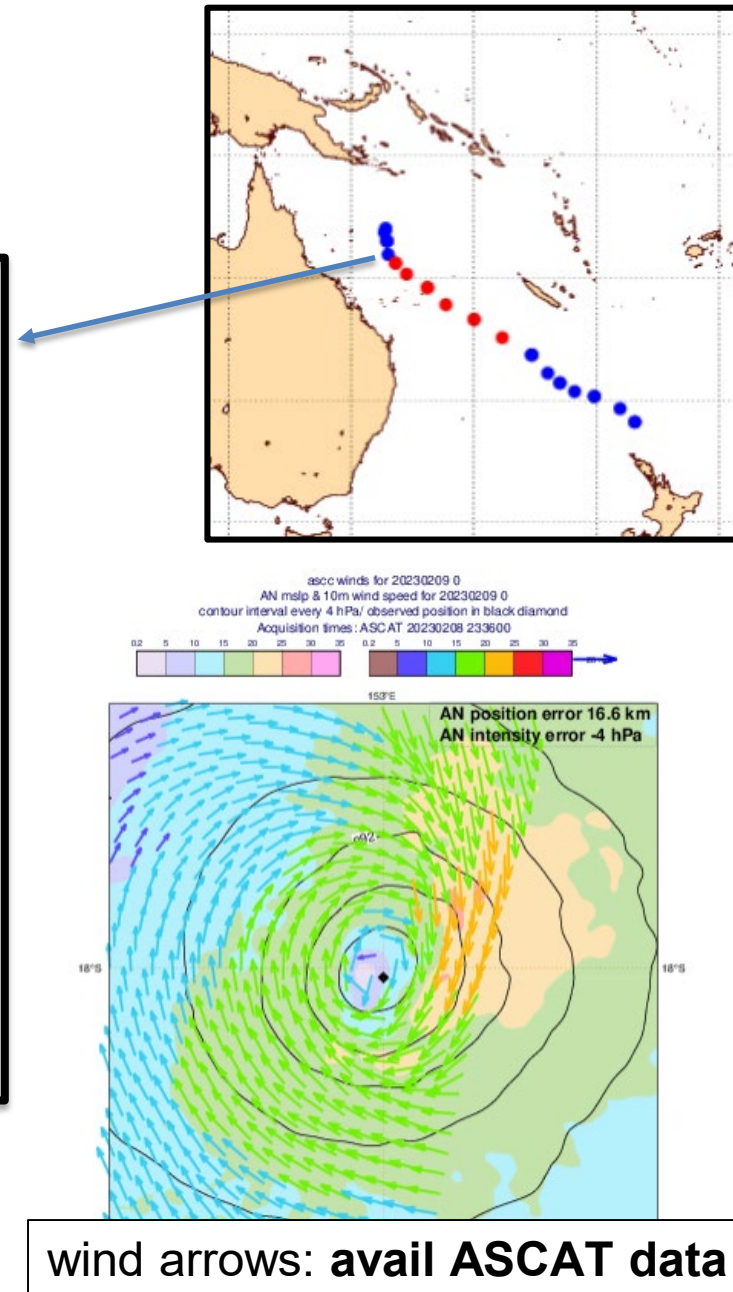
Higher density assimilation of ASCAT L2 winds – 48r1

ASCAT thinning reduction (100km $\square$ 50km); Observation error 1.5 $\square$ 2.25 m/s



GABRIELLE (12P) ANALYSIS
09th Feb 2023 00Z

◆ position fix
wind arrows: used data
shades: AN wind speed
Contours: AN MSLP

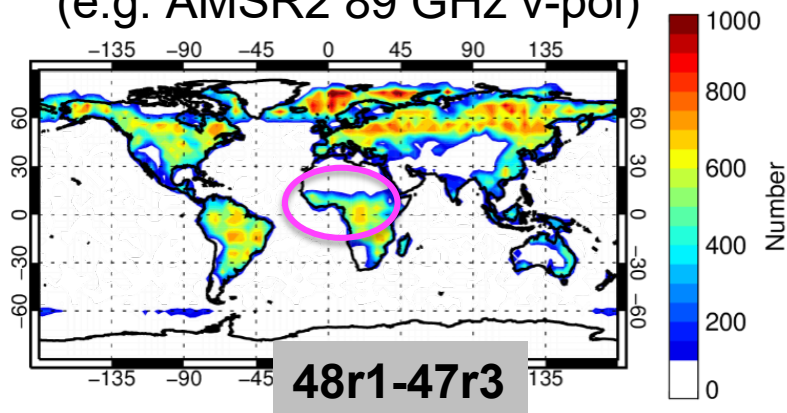


All-sky all-surface: more microwave observations over land surfaces – 48r1

Provide additional information on rain & cloud liq. Water over land

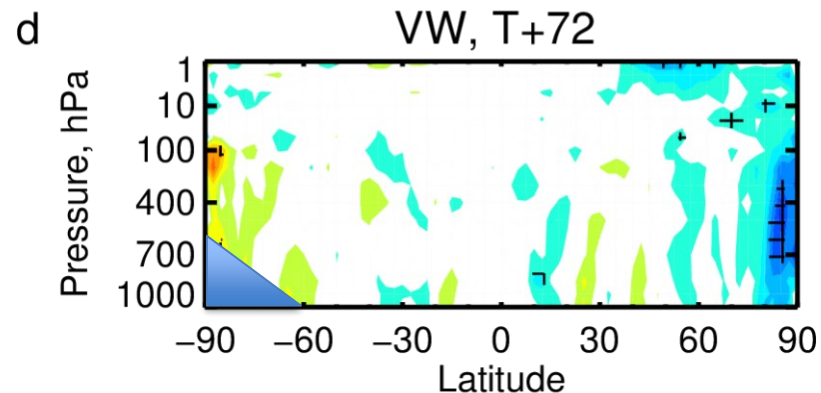
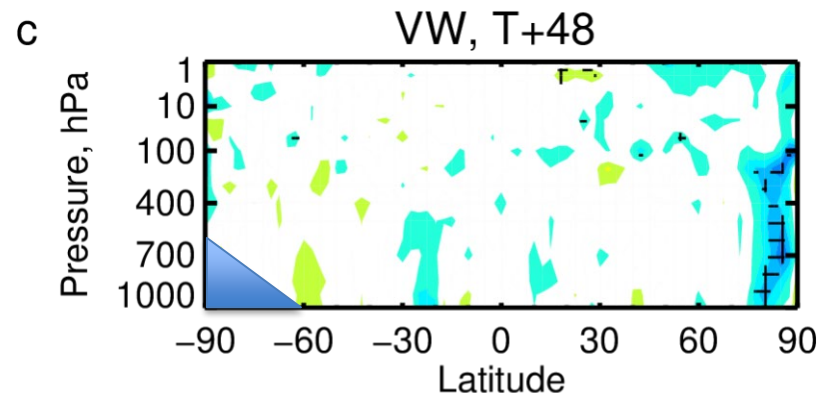
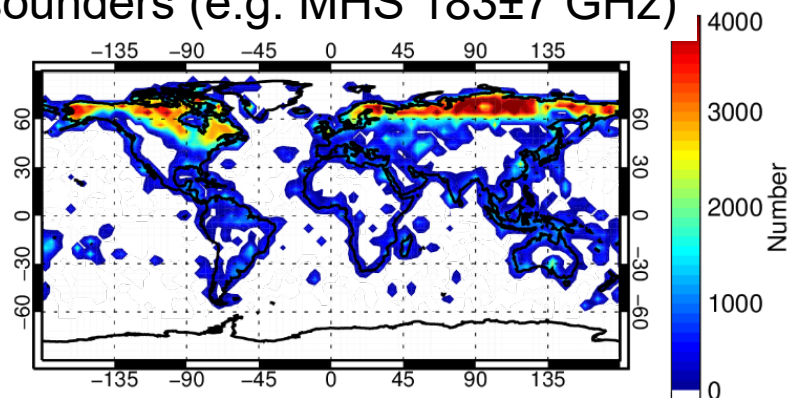
Increased use of MW imagers
(e.g. AMSR2 89 GHz v-pol)

Observations
used over land
surfaces and polar
oceans for the first time



Increased use of MW humidity
sounders (e.g. MHS 183±7 GHz)

Observations used
over polar land and
mixed scenes (e.g.
coasts, lakes) for the
first time

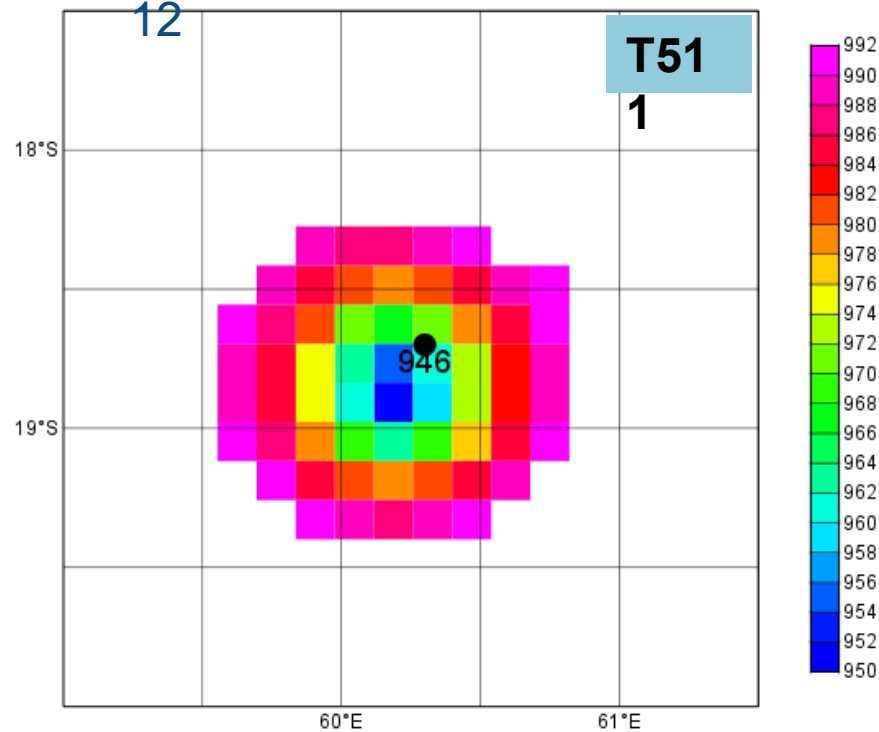


Reduced rmse vector wind forecast
errors to day 3 in northern polar regions

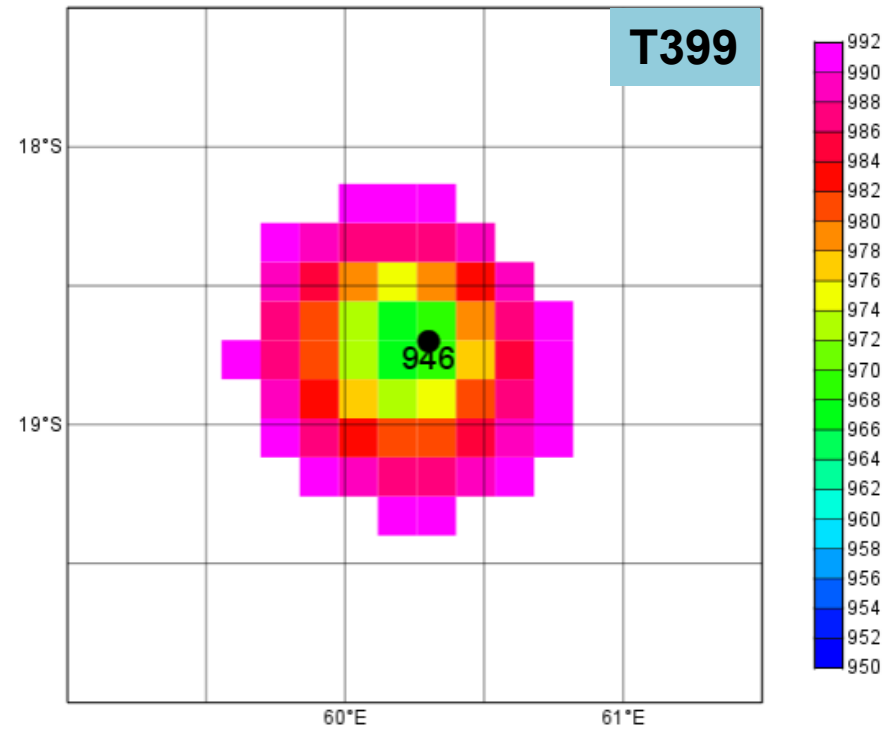
Increase of final 4D-Var inner-loop resolution TL399 □ TL511 – 48r1

Increasing inner loop resolution from TL399 (~50 km) to T511 (~40km) improves the extraction of finer scale observation information in the 4D-Var analysis.

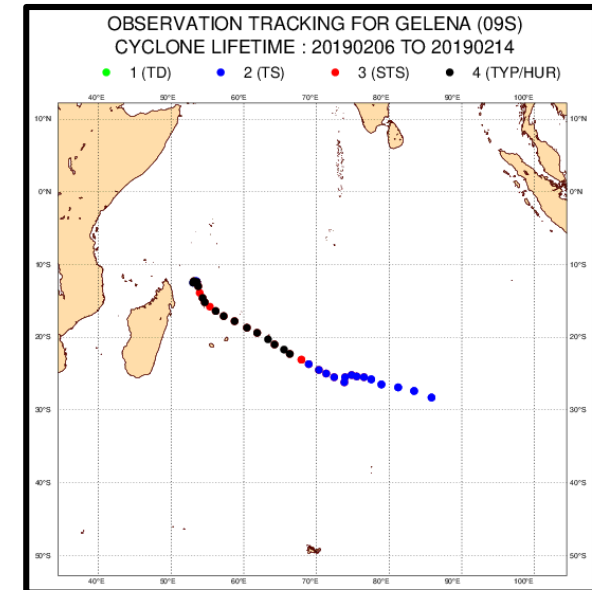
Tropical Cyclone GELENA (09S) ANALYSIS MSLP VT: 2019-02-09-12



~40km Inner loop: 951.4 hPa=Obs+5.4hPa



~50km inner loop: 967.1 hPa=Obs+21.1 hPa



48r1: Selection of model contributions

- **9 km ensemble**
 - Tracer mass fixer applied to moist species
 - Moist physics changes (saturation adjustment, ice fall speed)
 - Stochastic physics (saturation adjustment tendency excluded from SPPT)
- Improved drag representation
- Revised computation of Semi-Lagrangian advection departure points
- New model top sponge layer formulation
- Consistent physics-dynamics interface across non-linear/tangent-linear/adjoint model
- Radiatively interactive prognostic ozone using new HLO scheme + tuned Semi-Lagrangian vertical filter (significant impact in the Stratosphere for the Extended & Long Range Forecasts)
- Multi level snow scheme (improved 2mTMIN over snow sfc; snow depth reduces for increased forecast range)
- Revised climate fields (inclusion seasonal lakes)
- New representation of freezing drizzle and more precipitation type parameters (new product)

Meteorological Impact of 48r1

SCORECARD TROPICS (20N-20S)

RD Esuite (00Z runs only) verified against own analysis.

VT: 2020-06-03 to 2020-08-16 &

2020-12-03 to 2021-02-13

ENSEMBLE (~9km)

1..... 15 days

temperature

wind

humidity

ENS mean position error (km)

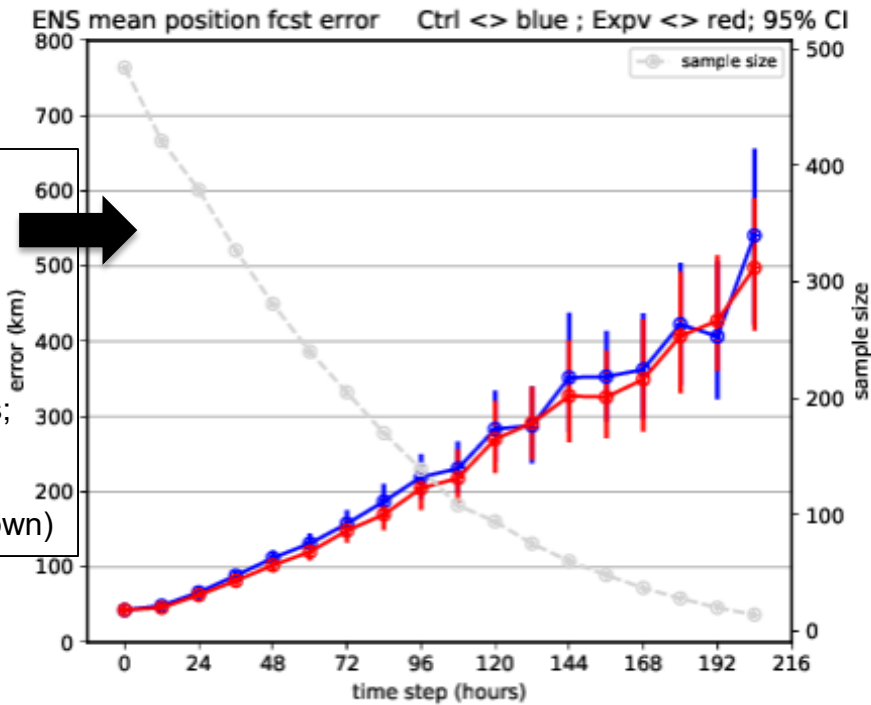
48r1/47r3

Homogeneous samples;

All basins;

95% CI bootstrapping

- ~7% reduction EM mean track errors;
- Good EM error/spread relation up to t+120h (not shown);
- overspread t+144h onwards (not shown)



ccaf=anomaly correlation

crps=Continuous ranked probability score

spread=Ensemble spread

red = the experiment (esuite) **is worse** than the control

blue = the experiment (esuite) **is better** than control.

purple = the experiment is **more active** than the control.

green = the experiment is **less active** than control.

Meteorological impact of 48r1 (TC intensity)

ENS mean absolute intensity error (hPa)

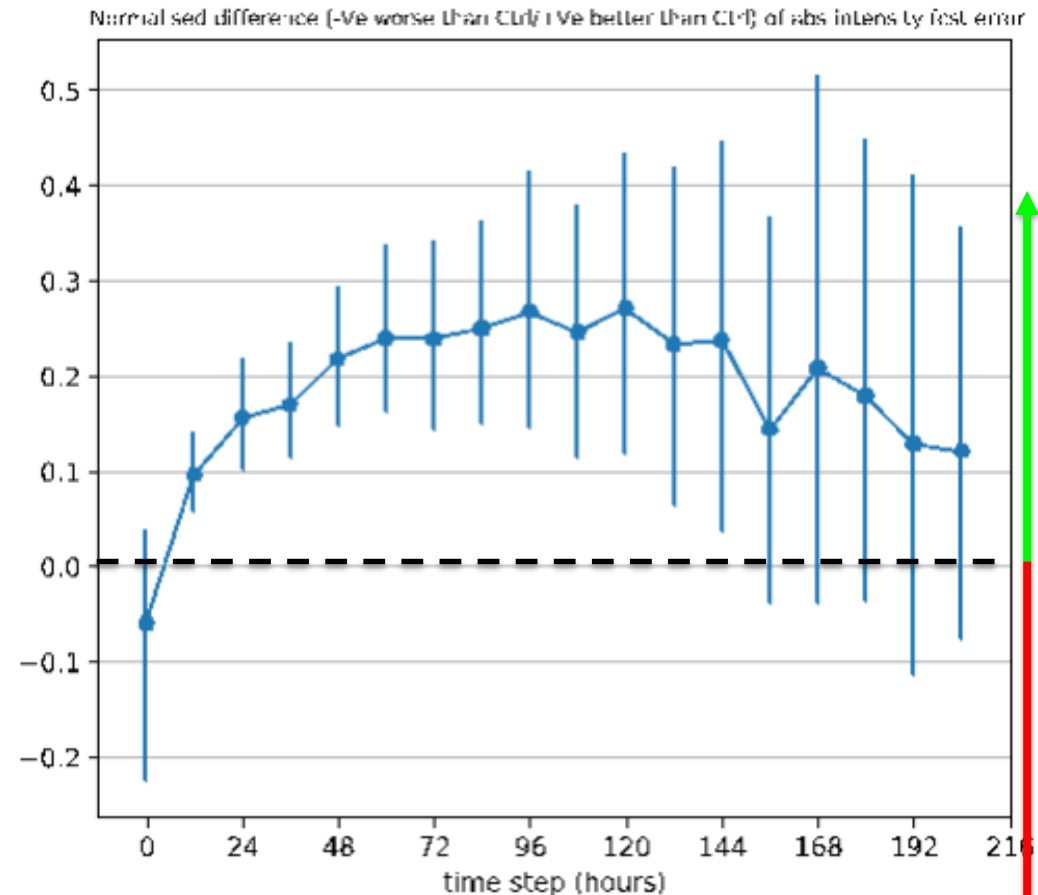
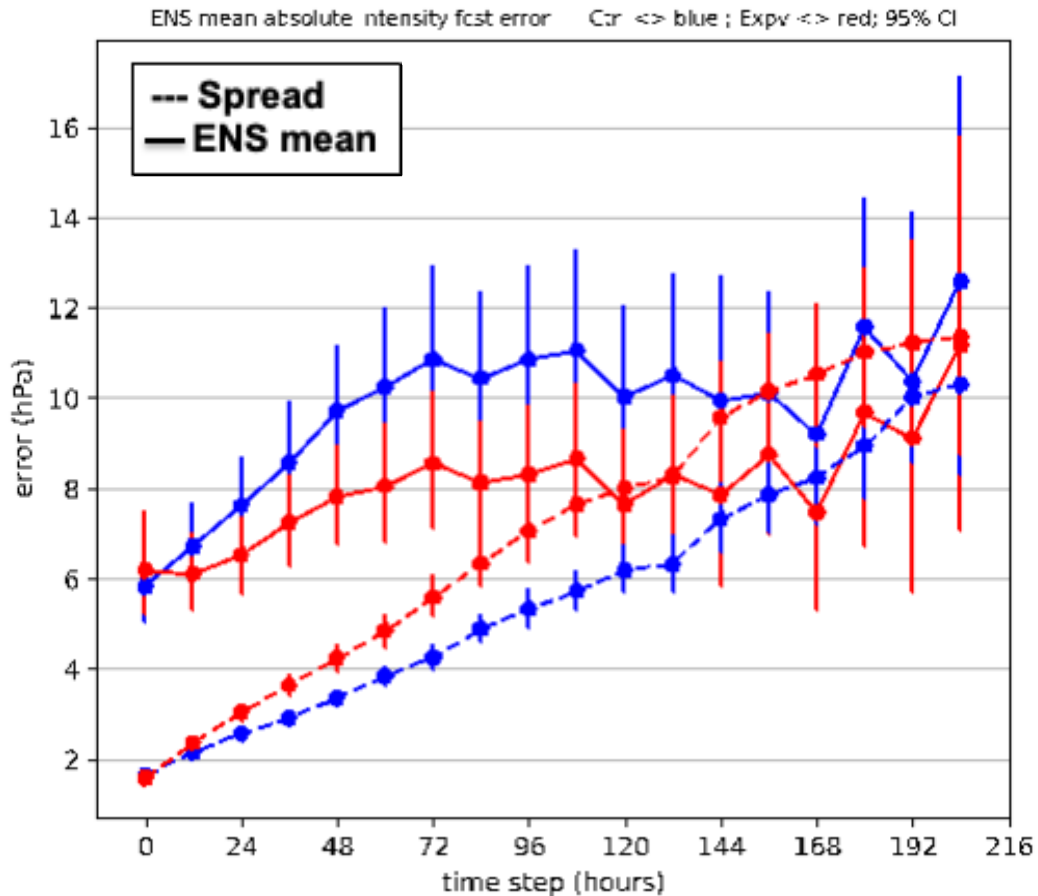
48r1/47r3

Homogeneous samples;

All basins;

95% CI bootstrapping

- >20% improvement of EM mean abs errors;
- Underspread ENS for intensity



48r1 better

48r1 worse

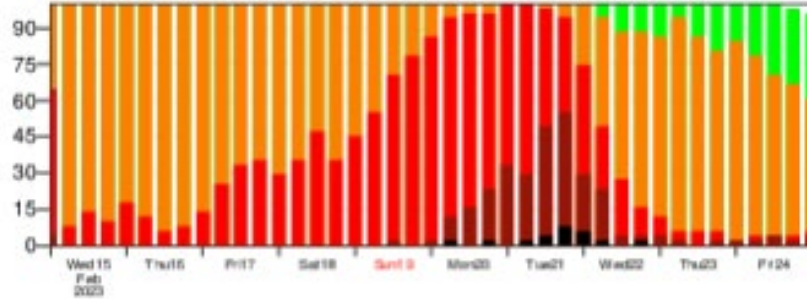
OPER

FREDDY (07S) Forecast 15th Feb 2023 00Z

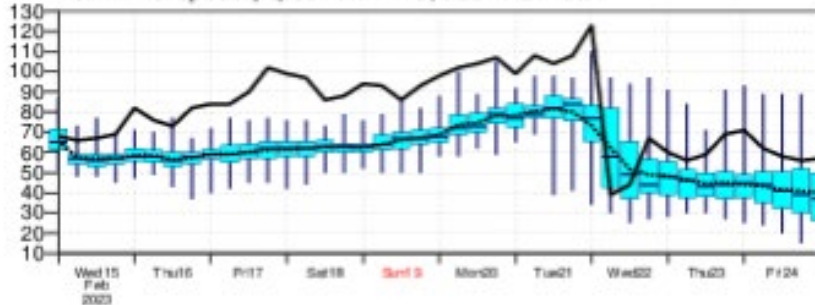
48r1

Probability (%) of Tropical Cyclone Intensity falling in each category

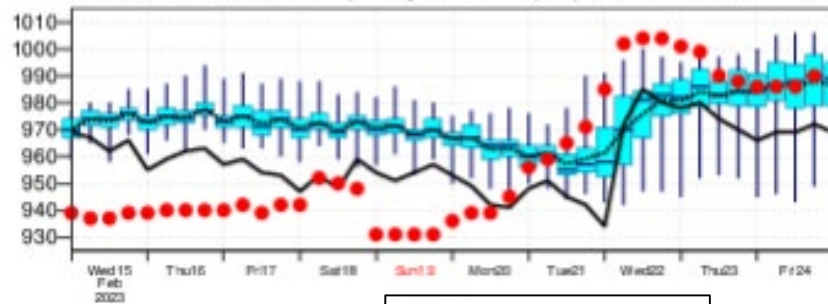
TD [up to 33] TS [34-63] HR1 [64-82] HR2 [83-95] HR3 [> 95 kt]



10m Wind Speed (kt) solid=HRES; dot=Ens Mean



Mean Sea Level Pressure in Tropical Cyclone Centre (hPa) solid=HRES; dot=Ens Mean

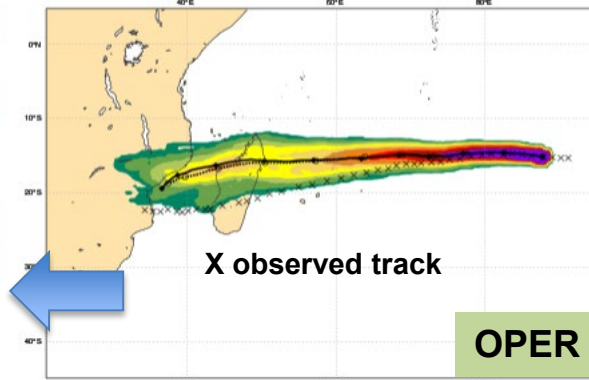


● reported pressure

Date 20230215 00 UTC @ECMWF

Probability that **FREDDY** will pass within 120 km radius during the next 240 hours
tracks: solid=HRES; dot=Ens Mean [reported minimum central pressure (hPa) 939]

5-10 10-20 20-30 30-40 40-50 50-60 60-70 70-80 80-90 > 90%



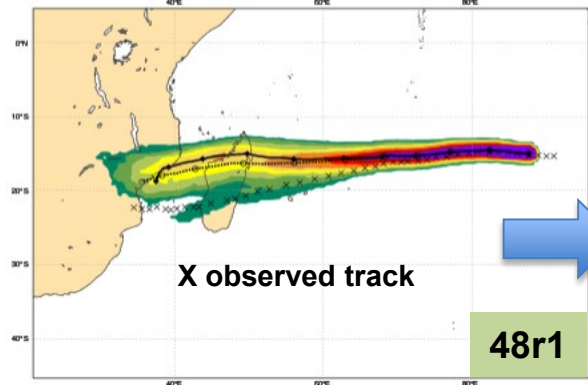
X observed track

OPER

Date 20230215 00 UTC @ECMWF

Probability that **FREDDY** will pass within 120 km radius during the next 240 hours
tracks: solid=HRES; dot=Ens Mean [reported minimum central pressure (hPa) 939]

5-10 10-20 20-30 30-40 40-50 50-60 60-70 70-80 80-90 > 90%

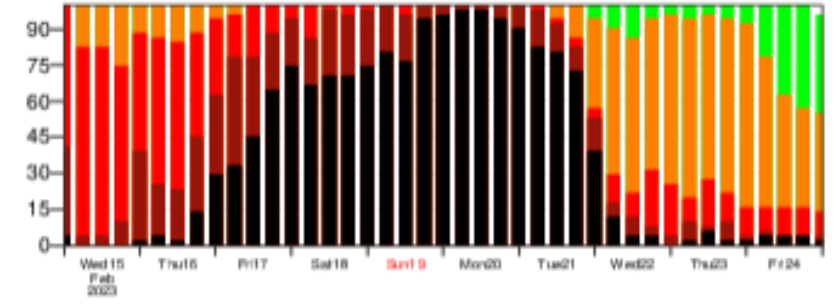


X observed track

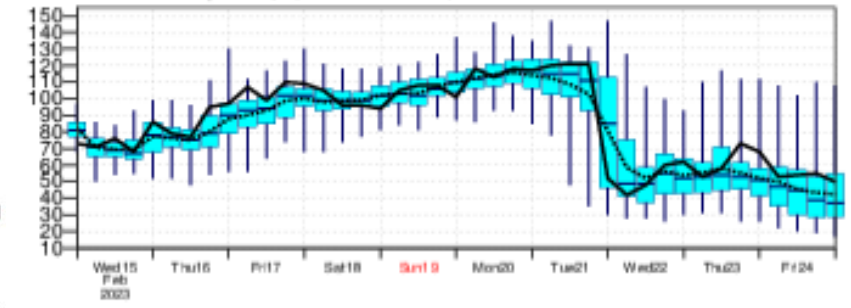
48r1

Probability (%) of Tropical Cyclone Intensity falling in each category

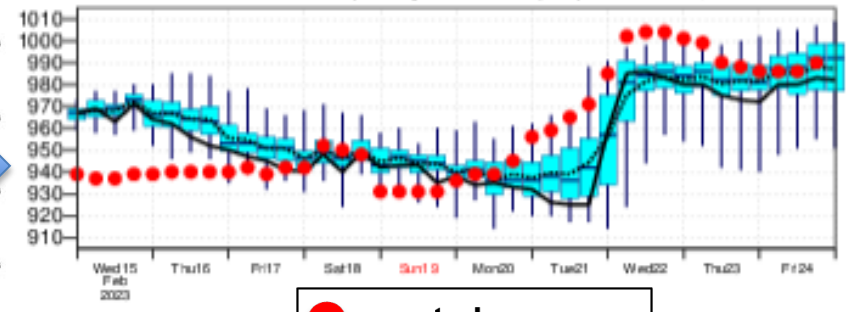
TD [up to 33] TS [34-63] HR1 [64-82] HR2 [83-95] HR3 [> 95 kt]



10m Wind Speed (kt) solid=HRES; dot=Ens Mean

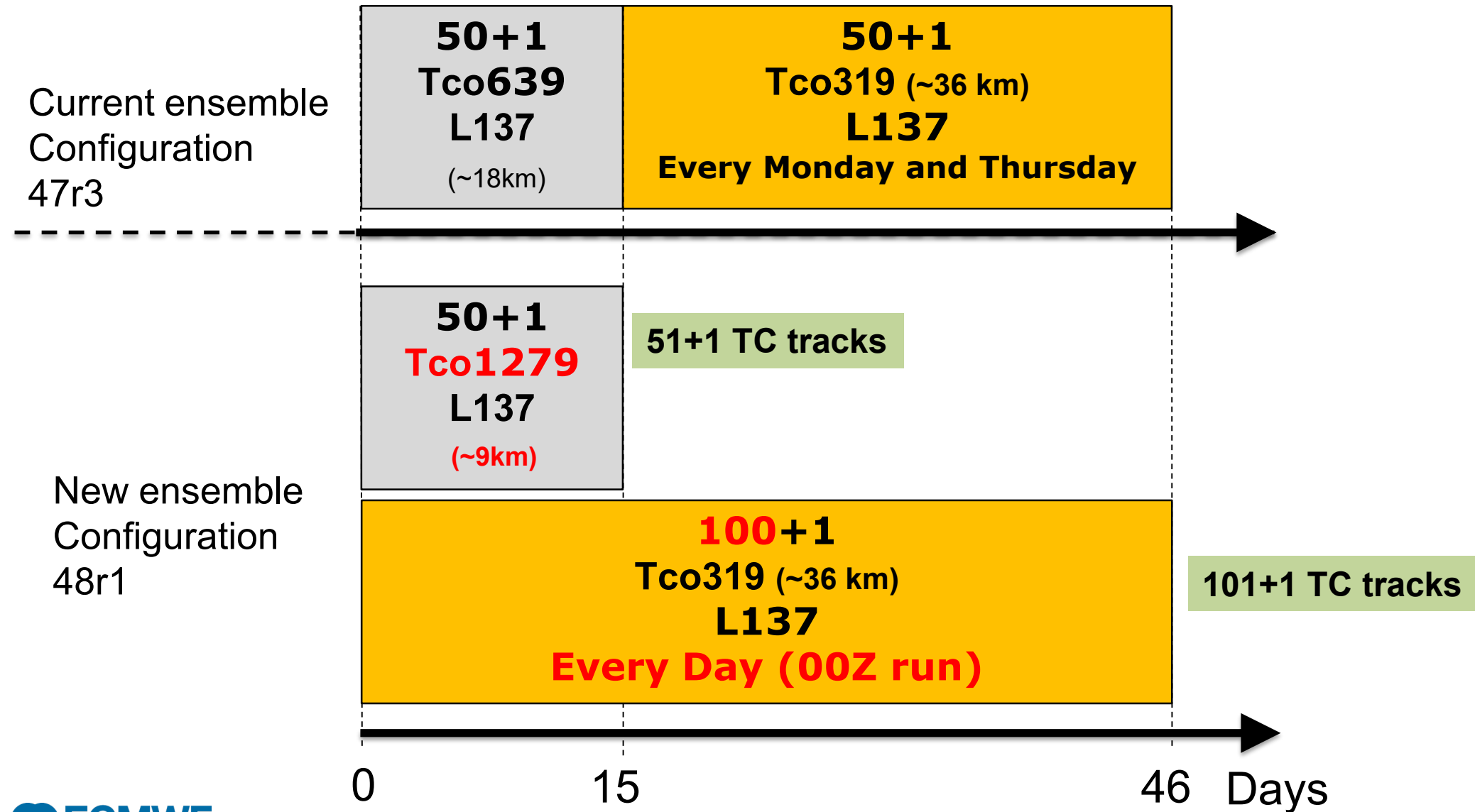


Mean Sea Level Pressure in Tropical Cyclone Centre (hPa) solid=HRES; dot=Ens Mean



● reported pressure

New Extended Range configuration – 48r1

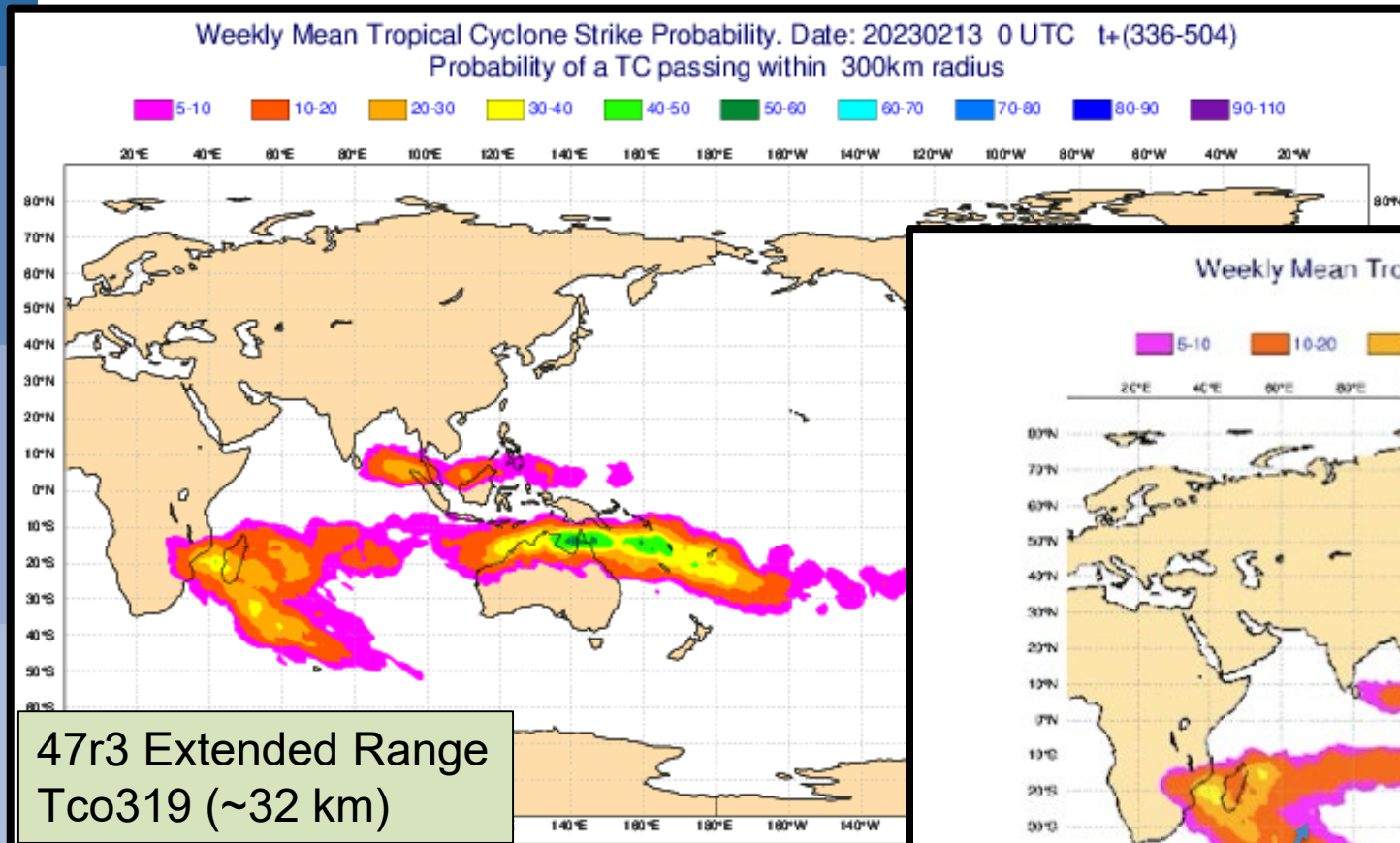


Increasing the Ensemble Size

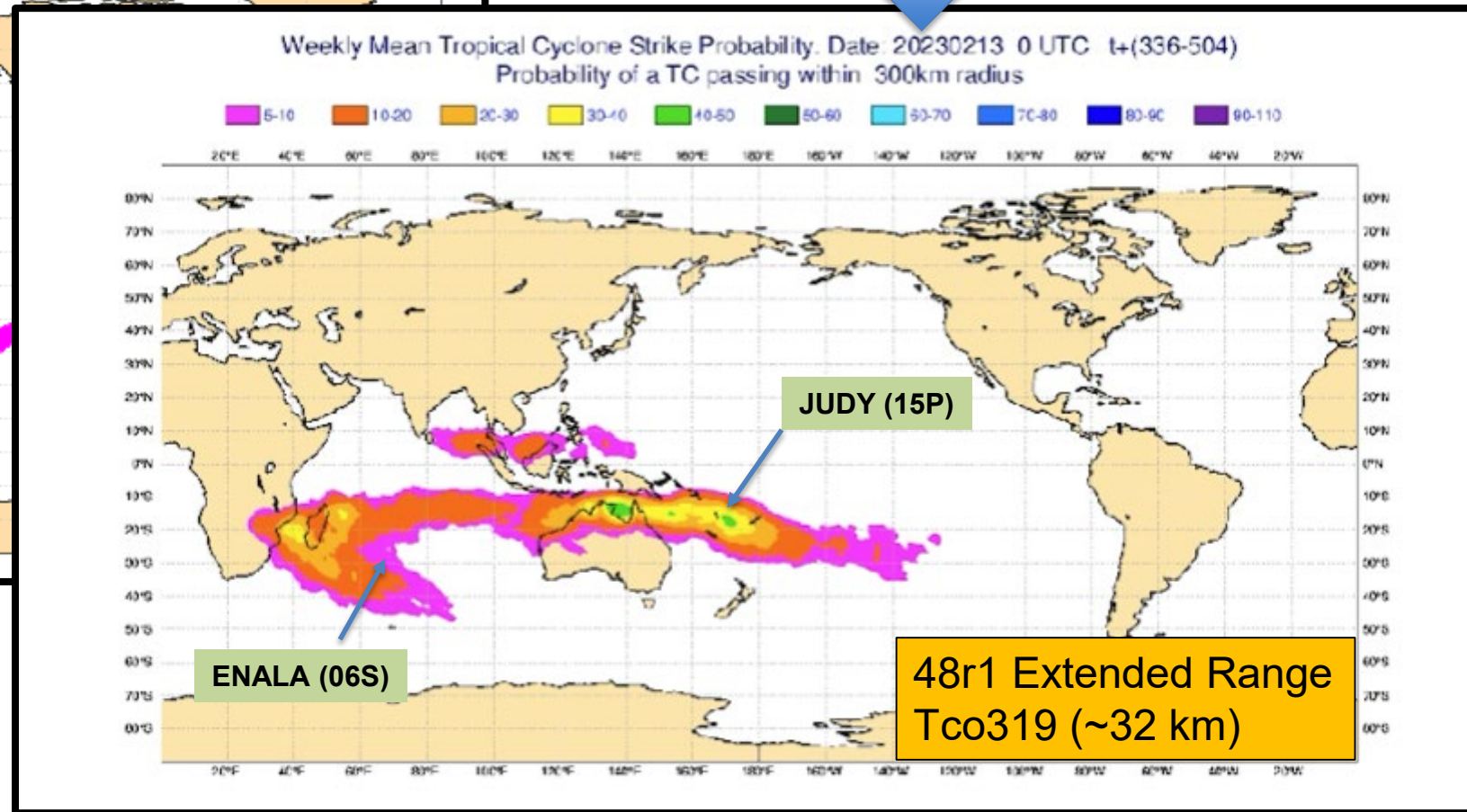
VT: 27Feb-05Mar 2023

Forecast week 3 (t+336-504h)

101 ENS members



51 ENS members



Summary

- 2021-22 Season: reduction of the TC position errors (HRES & ENS) at D+5 for all basins compared w/ previous season ;
- Increase of TC intensity errors;
- Cycle 48r1:
 - Increase resolution of ENS system from ~18 km to ~9 km (15 days forecast);
 - Improved TC position errors and a sig. improvement of intensity errors;
 - Reduced thinning of ASCAT L2 winds in DA;
 - Increase of final 4D-Var inner loop iteration;
 - Parallel stream of daily 100+1 members Extended

Range Forecast up to 46 days at lower resolution
For more information and further updates watch
<https://confluence.ecmwf.int/display/FCST/Implementation+of+IFS+Cycle+48r1>

