Data Assimilation at NIWA

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National Institute of Water and

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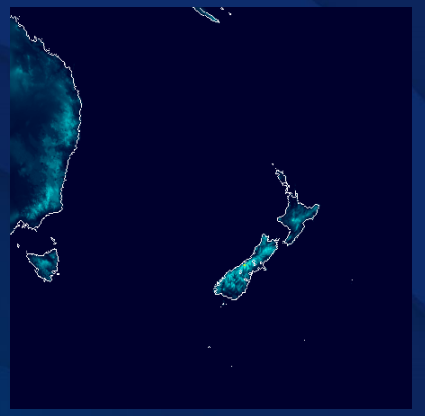
Climate, Freshwater & Ocean Science

Three Data Assimilating Models

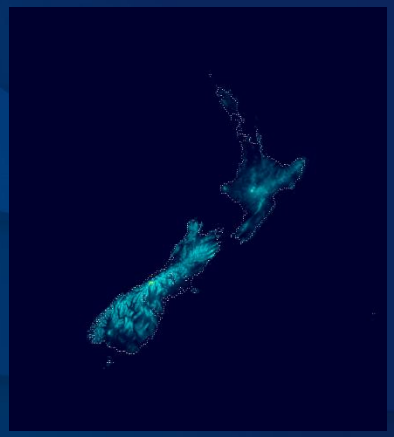
NZLAM

4·4km, 900x900 points.
Suppressed parametrised convection; PC2 largescale rain.
Boundaries come from the Met Office's global model.



NZCSM-DA

1·5km, 1200x1350 points.
Explicit convection; Smith largescale rain.
Boundaries come from the NZLAM.



NZENS-DA

Ensemble NZLAM; MOGREPS-G perturbations & boundaries.

The PS44 versions all use:

L70_80km vertical grid.
RA2M with gravity wave & orographic drag schemes switched on.
Unified global/UKV Jules settings.

Data Assimilation Methodology

Same for all the models

6 hourly cycling 3DVAR FGAT7.

A choice to put our computational resources into ensemble forecasting.

9km horizontal resolution VAR grid.

OPS apps and control files are from the Met Office's global model.

Most observations come from the Met Office as obstore files.

We add NIWA climate station synops to the surface obstore.

Currently OPS/VAR 2020.

Will be upgraded to OPS/VAR 2022.12.

Each model

Estimates its own satellite bias corrections.

Uses background error covariances estimated from its own forecasts.

Satellite Radiance Bias Correction

Hybrid VarBC/SatRad Scheme

SatRad provides scan position dependent bias coefficients; and predictor coefficients for passive channels.

VAR provides predictor coefficients for all other channels.

The biasses are updated after every analysis cycle

Run OPS & VAR using VarBC.

Repeat OPS using SatRad bias correction to produce Bstat files.

Calculate a new SatRad bias estimate from a 3 week rolling archive of Bstats files.

The SatRad biasses are then converted into to a VarBC file.

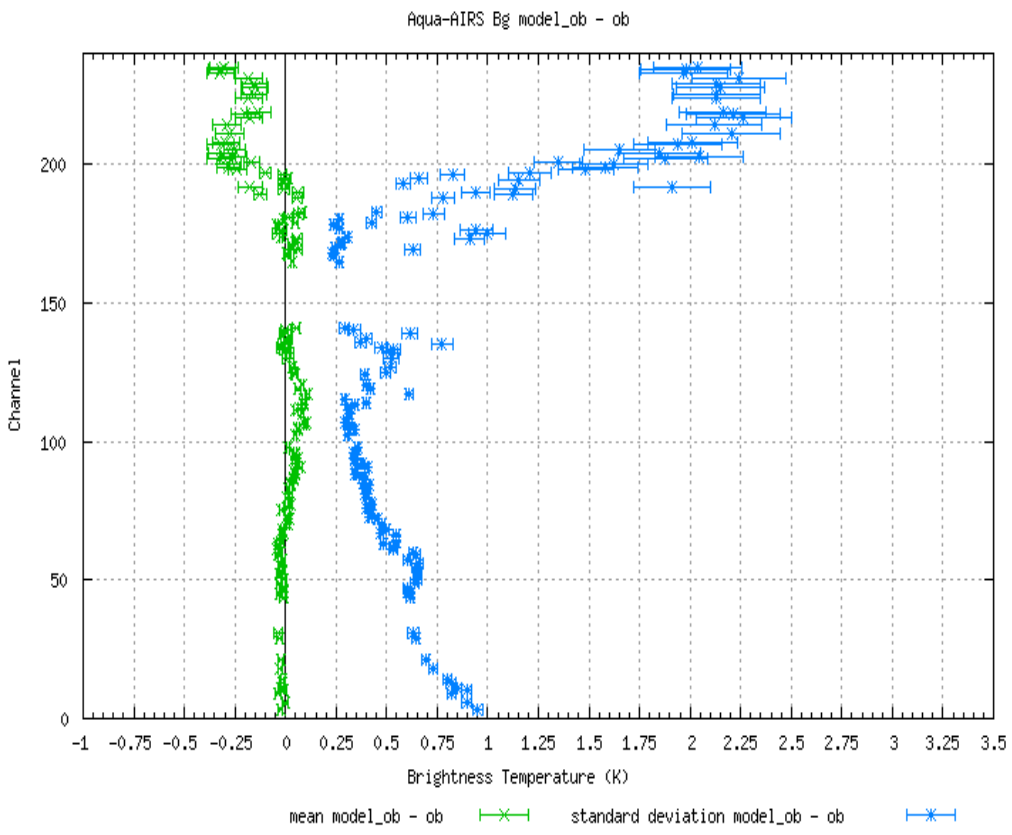
Using the OPS script, with a modified default value: Mmin = 110·70.

Prepare a VarBC file for the next cycle:

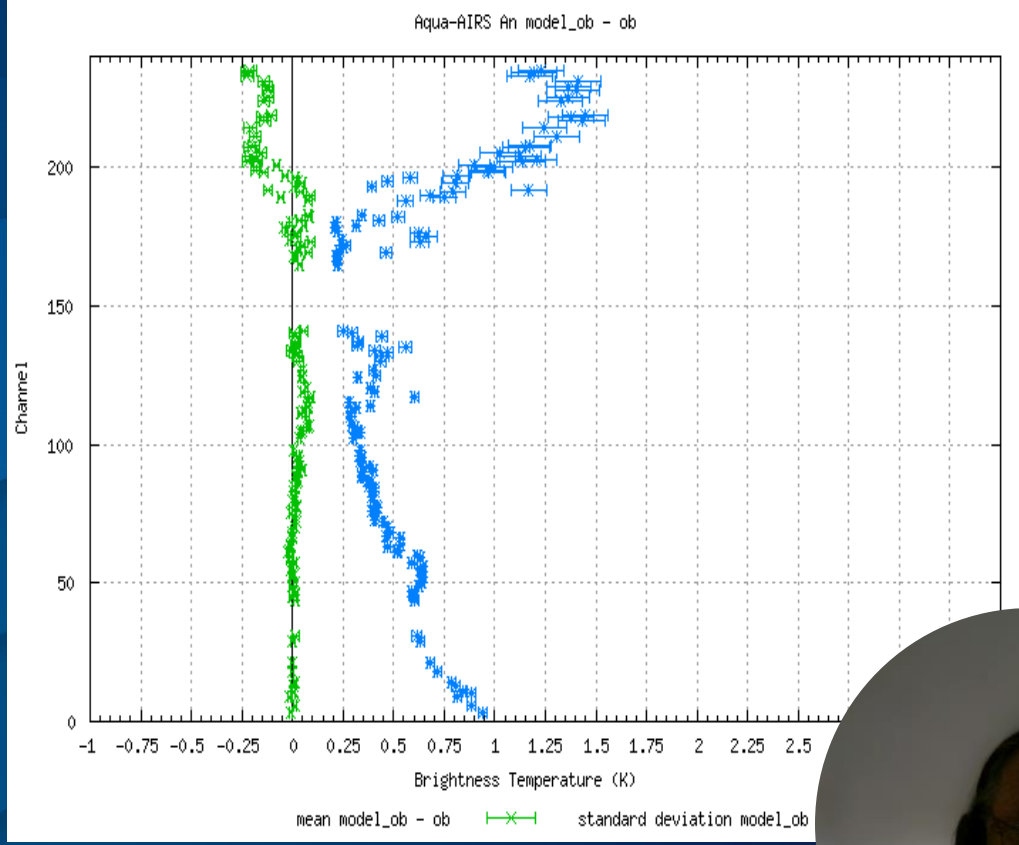
Merge the VarBC file converted from SatRad…

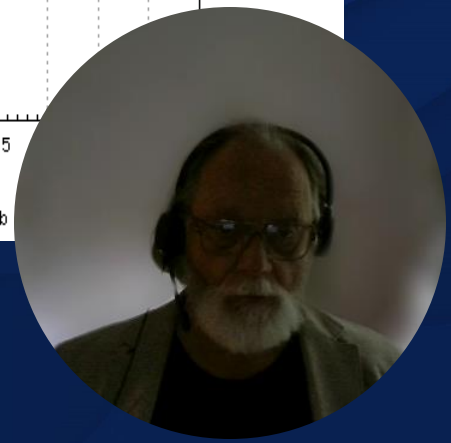
…with the VarBC file produced by VAR.

NZENS-DA Member 0



NZENS-DA Member 0





Background Error Covariance

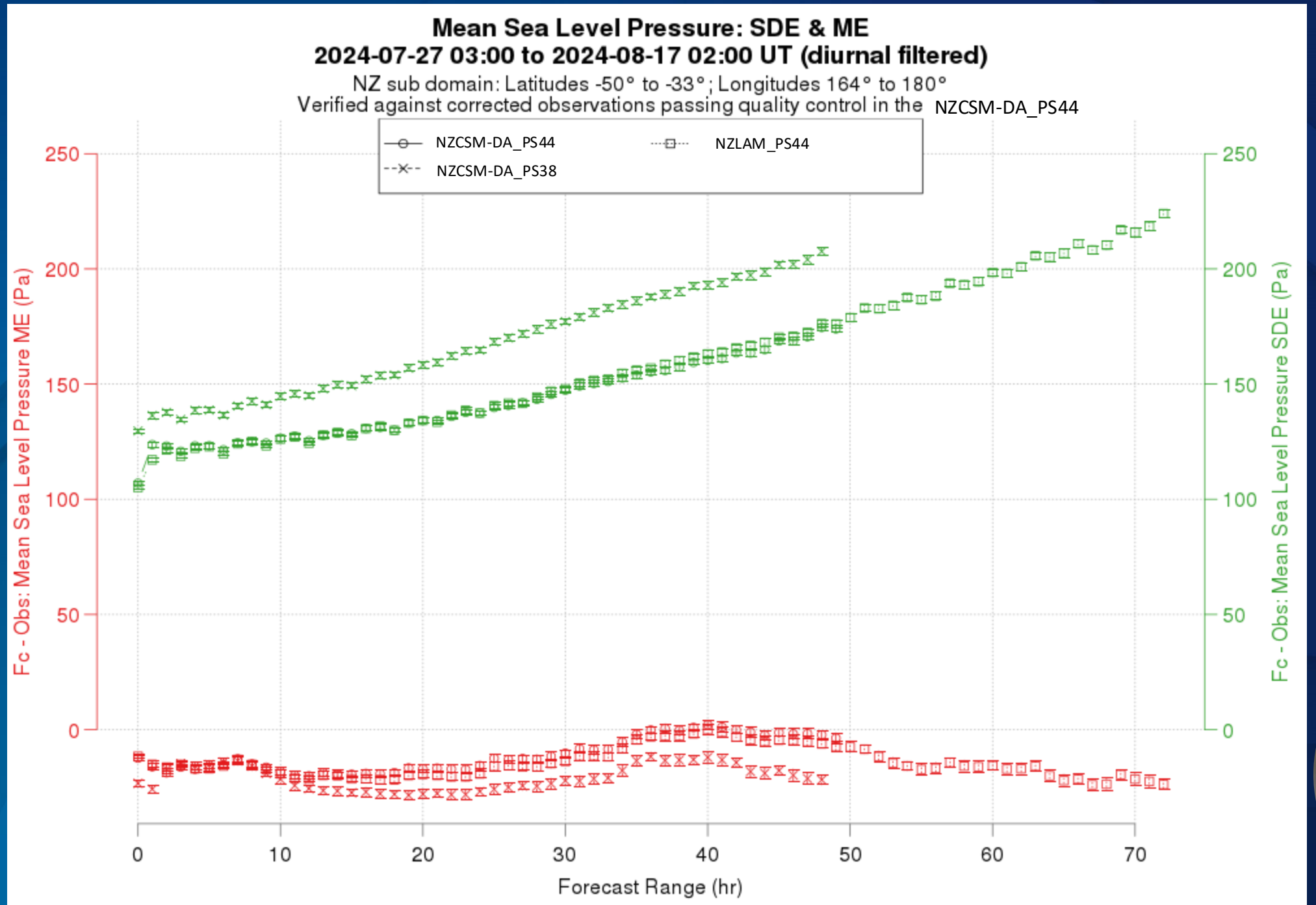
Our aim is to allow the estimate to track changes in the statistics on monthly and longer timescales.

We achieve this by updating daily, using the CVT package, from a rolling archive of 84 forecast pairs.

The forecast pairs are 6 & 12 hour forecasts to the same validity time, using the same boundary conditions. One pair is produced every analysis cycle.

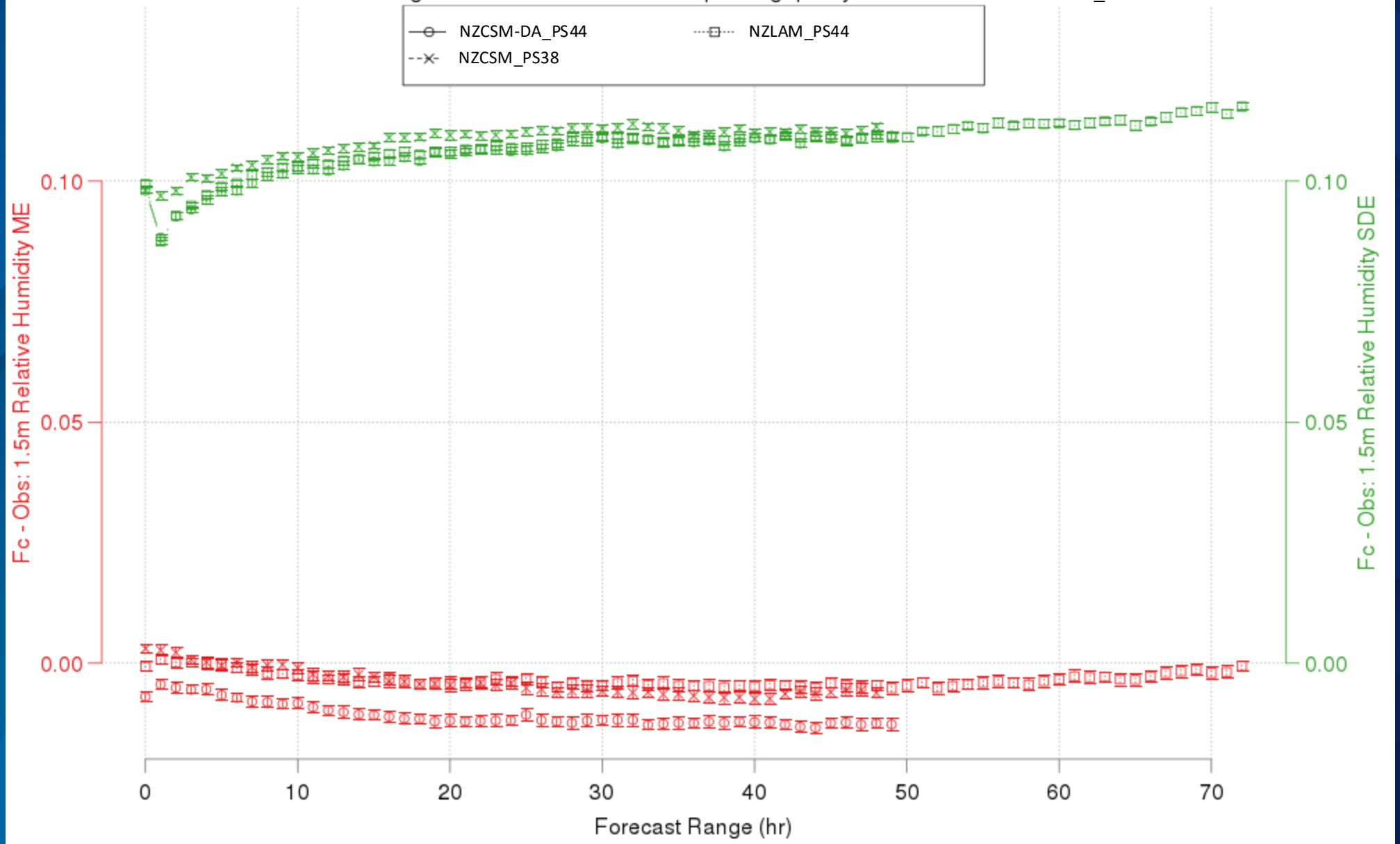
In CVT we average over all horizontal points, except for a region near the lateral boundaries.

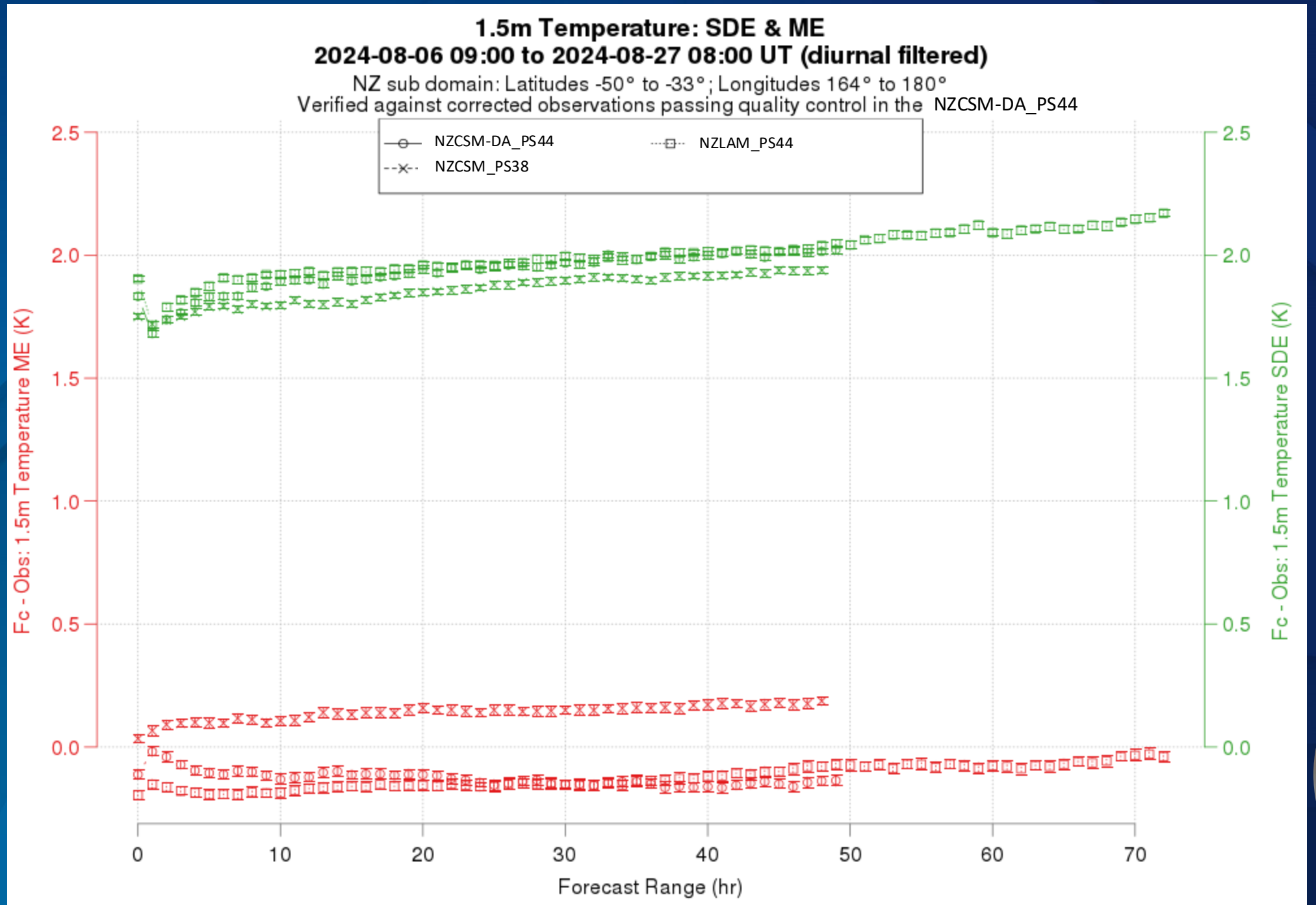
After completion, we reset any zeroes in the M_inc_StdDev_binned field of the CovStats_VAR.nc file to 0·000001 (to remove artifacts from high level theta fields).

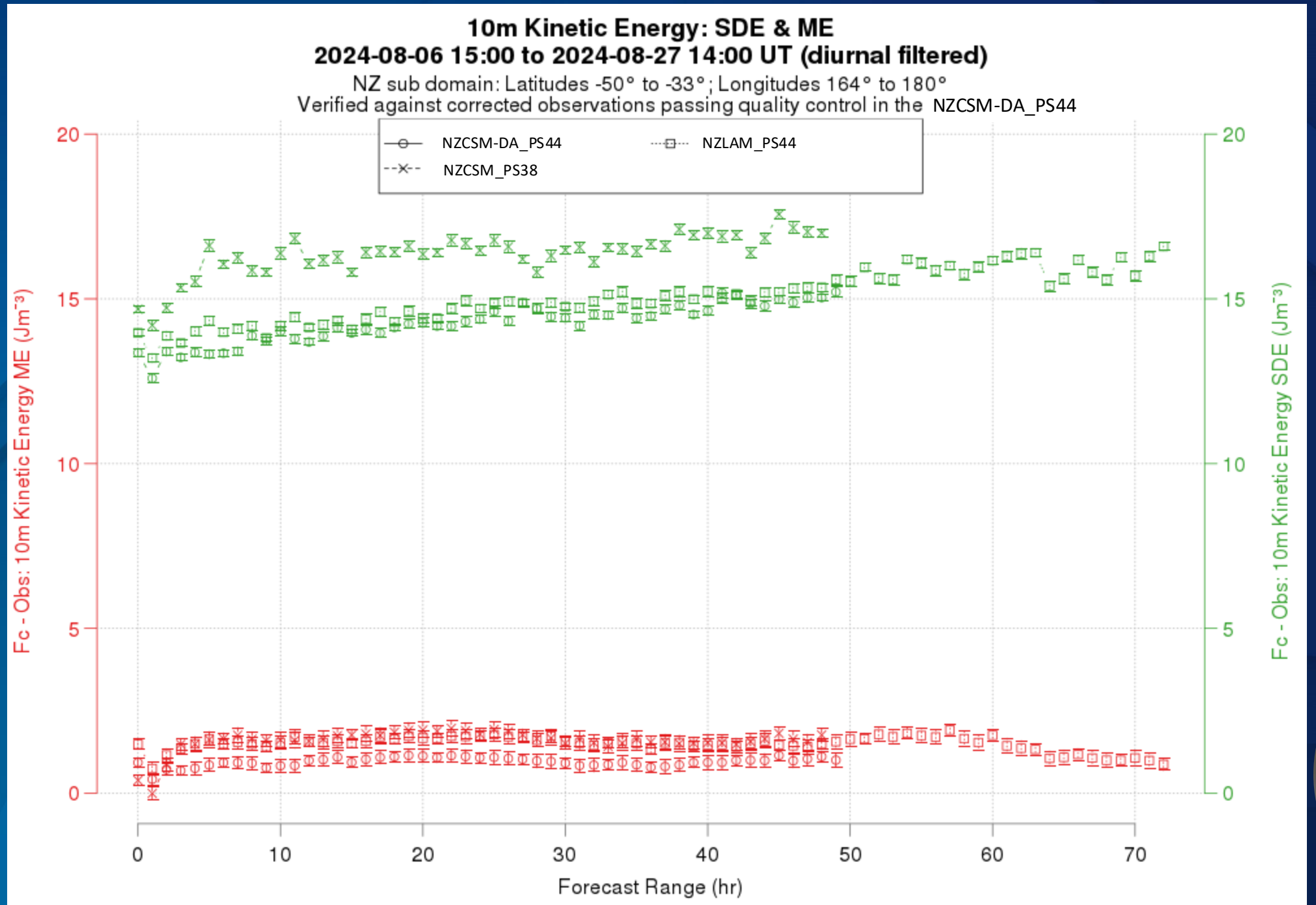

Mean Sea Level Pressure: SDE & ME
2024-07-27 03:00 to 2024-08-17 02:00 UT (diurnal filtered)
NZ sub domain: Latitudes -50° to -33°; Longitudes 164° to 180°
Verified against corrected observations passing quality control in the NZCSM-DA_PS44
NZCSM-DA_PS44
NZLAM_PS44
NZCSM-DA_PS38
Fc - Obs: Mean Sea Level Pressure ME (Pa)
Fc - Obs: Mean Sea Level Pressure SDE (Pa)
Forecast Range (hr)
0
50
100
150
200
250
0
10
20
30
40
50
60
70

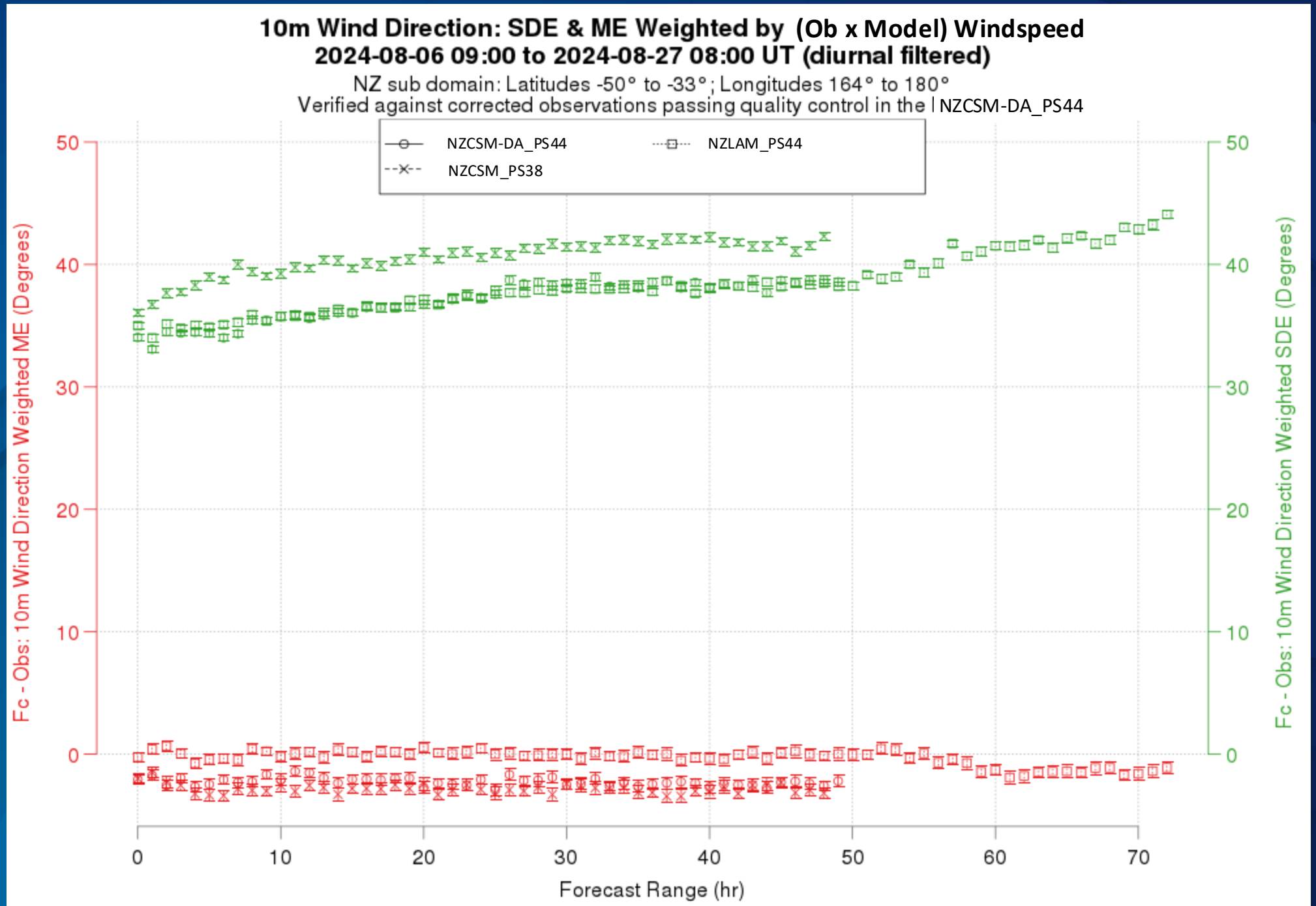
1.5m Relative Humidity: SDE & ME
2024-08-06 09:00 to 2024-08-27 08:00 UT (diurnal filtered)

NZ sub domain: Latitudes -50° to -33°; Longitudes 164° to 180°
Verified against corrected observations passing quality control in the NZCSM-DA_PS44




1.5m Temperature: SDE & ME
2024-08-06 09:00 to 2024-08-27 08:00 UT (diurnal filtered)
NZ sub domain: Latitudes -50° to -33°; Longitudes 164° to 180°
Verified against corrected observations passing quality control in the NZCSM-DA_PS44
NZCSM-DA_PS44
NZLAM_PS44
NZCSM_PS38
Fc - Obs: 1.5m Temperature ME (K)
Fc - Obs: 1.5m Temperature SDE (K)
Forecast Range (hr)
0.0
0.5
1.0
1.5
2.0
2.5
0
10
20
30
40
50
60
70


10m Kinetic Energy: SDE & ME
2024-08-06 15:00 to 2024-08-27 14:00 UT (diurnal filtered)
NZ sub domain: Latitudes -50° to -33°; Longitudes 164° to 180°
Verified against corrected observations passing quality control in the NZCSM-DA_PS44
NZCSM-DA_PS44
NZLAM_PS44
NZCSM_PS38
Fc - Obs: 10m Kinetic Energy ME (Jm⁻³)
Fc - Obs: 10m Kinetic Energy SDE (Jm⁻³)
Forecast Range (hr)
0
5
10
15
20
0
10
20
30
40
50
60
70


10m Wind Direction: SDE & ME Weighted by (Ob x Model) Windspeed
2024-08-06 09:00 to 2024-08-27 08:00 UT (diurnal filtered)
NZ sub domain: Latitudes -50° to -33°; Longitudes 164° to 180°
Verified against corrected observations passing quality control in the NZCSM-DA_PS44
NZCSM-DA_PS44
NZLAM_PS44
NZCSM_PS38
Fc - Obs: 10m Wind Direction Weighted ME (Degrees)
Fc - Obs: 10m Wind Direction Weighted SDE (Degrees)
Forecast Range (hr)
0
10
20
30
40
50
60
70

Data Assimilation in the NZENS-DA Ensemble

Used for 3 purposes:

Recentring the ensemble around our analyses.

Which includes local observations.

Reducing spinup.

Compared to our current NZENS, which cold starts each member each cycle from reconfigured MOGREPS-G T+3 dumps.

Adding small scale perturbations.

Experience shows that multiple NZLAM's never converge at small scales, because these are not fully constrained by the data assimilation.

This requires each member to perform its own data assimilation cycling.

NZENS-DA Ensemble Design

Each ensemble member runs two forecasts

First Forecast (T-1 to T+9): data assimilation cycling.

Updates are applied to start dumps including SST; soil moisture; soil temperature; and snow cover.

Outputs a dump at T+3 to start the main ensemble forecast.

Second Forecast (T+3 to T+120): main ensemble forecast

Add MOGREPS-G perturbations to the start dump.

Only the unperturbed member:

Calculates SatRad biasses, used by all members.
Produces forecast pairs for CVT.

Data Assimilation at NIWA

END

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