VARIATIONAL BIAS CORRECTION OF SURFACE PRESSURE OBSERVATIONS FROM SHIP

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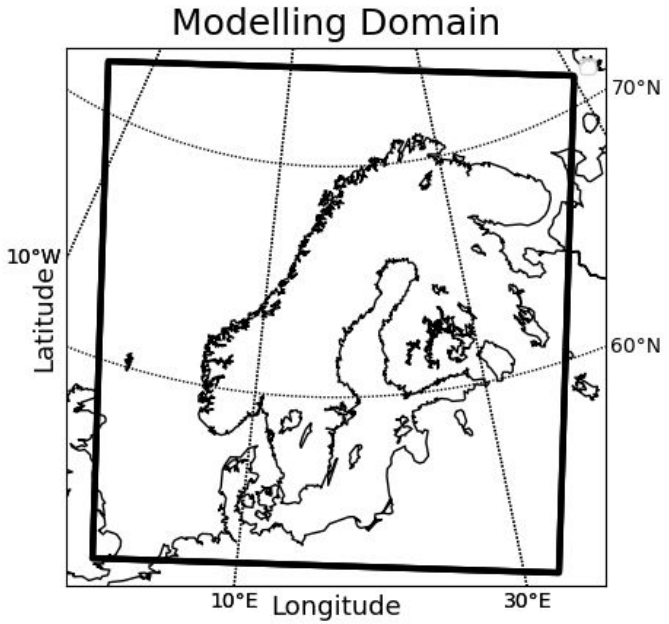
STRUCTURE

- MetCoOp's HARMONIE-AROME 43h2.1
- Variational Bias correction of surface pressure observations from ship
- Experimental design
- Evaluation of functionality
- Impact of VarBC ship Ps observations on the MetCoOp model bias and forecasts
- Conclusions

METCOOP model setup

- HARMONIE-AROME 43h2.1
- 2.5 km, Top 10 hPa, Coupled 3-hourly
- Non-hydrostatic
- Arome
- Canari + OI Main
- Conventional obs.: T2m, RH2m,
  SYNOP SHIP, AIRCRAFT, DRIBU, TEMP
- Unconventional obs.: AMSU A/B, MHS, IASI,
  ATMS, MWHS-2, SCATT



VarBC

Variational Bias Correction

Linear predictor model:

$$b(x,\beta)=\sum_{i=0}^{Np}\beta_i p_i(x)$$

Modified cost function:

$$J(x,\beta)=\frac{1}{2}(x-x^B)^T B^{-1}(x-x^B)+\frac{1}{2}(\beta-\beta^B)^T B_\beta^{-1}(\beta-\beta^B)+$$
$$\frac{1}{2}(Hx+b(x,\beta)-y)^T R^{-1}(Hx+b(x,\beta-y))$$

Predictor no.	Predictor
0	constant

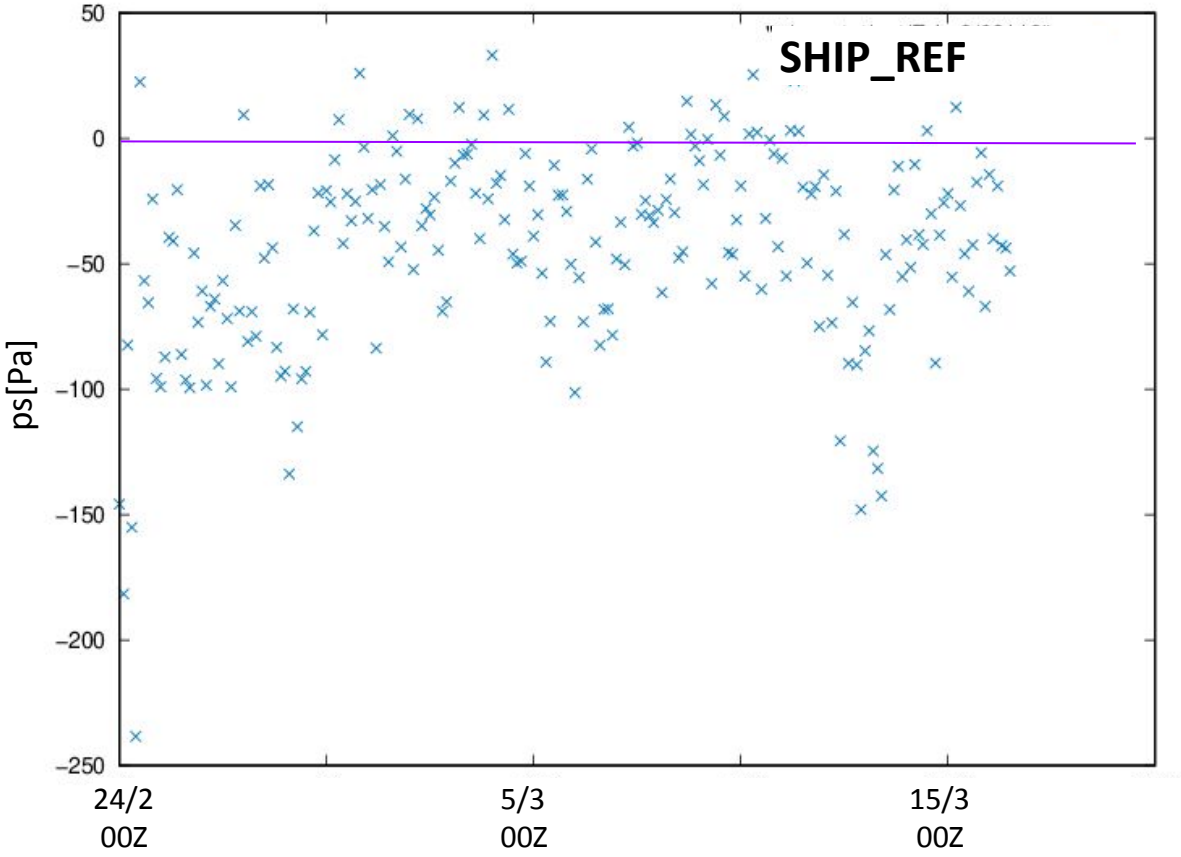
Dee, D., 2005: Bias and data assimilation. Quart. J. Roy. Meteor. Soc., 131, 3323–3343, doi:10.1256/qj.05.137.
Dee, D. and S. Uppala, 2009: Variational bias correction of satellite
radiance data in the ERA-Interim reanalysis. Quart. J. Roy. Meteor. Soc., 135, 1830–1841, doi:10.1002/qj.493.

Experimental design

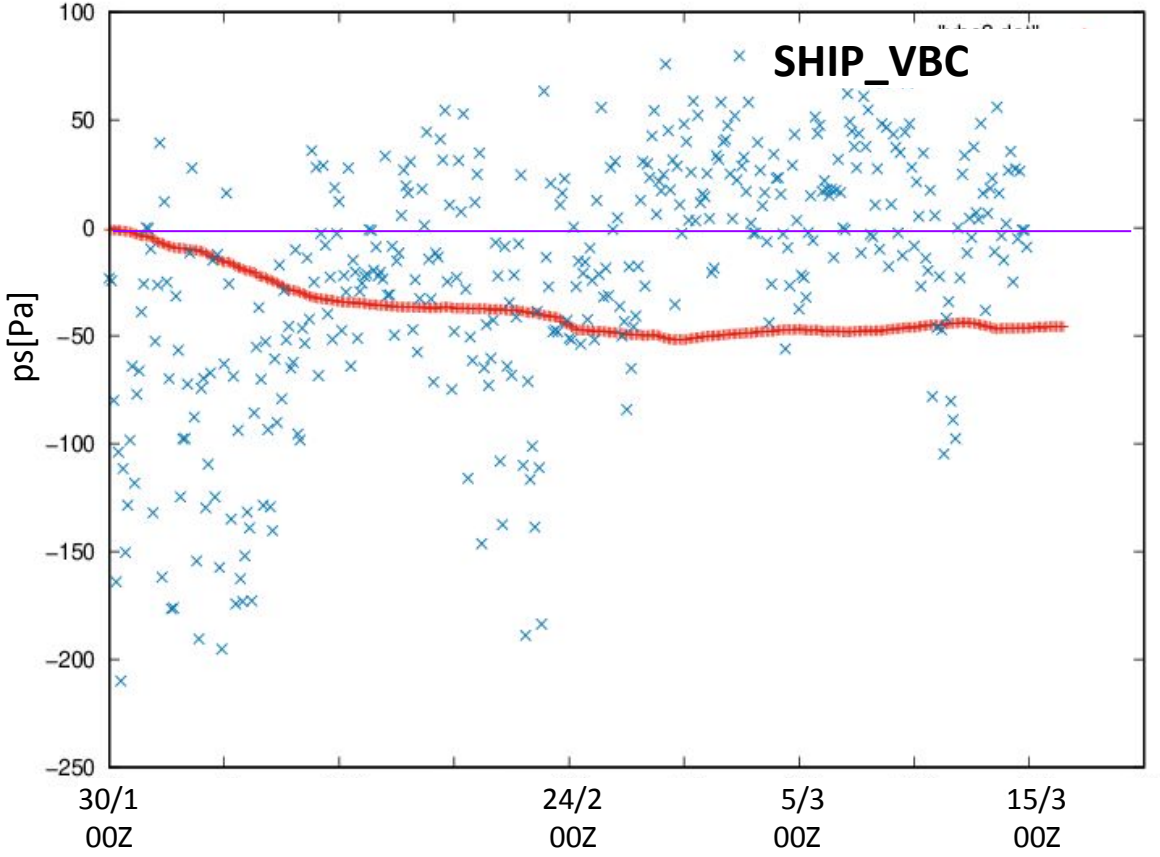
- Two experiments with VarBC of Ps obs (assimilated as ps not z) for ships has been achieved, in order to find the analysis and forecast impact on HARMONIE AROME
- 3 h cycling of VARBC coefficients with ‘Reimas’ proposed approach to update satellite coefficients once every 3 h. With 3 h cycling for SHIP VARBC we got faster convergence.

Exp. name	Warming of Bias corr.	VarBC & CONTROL period start from same time
SHIP_VBC	30.01.2022-23.02.2022	24.02.2022-30.04.2022
SHIP_REF		24.02.2022-30.04.2022

functionality[1]: VarBC coef without/with VarBC



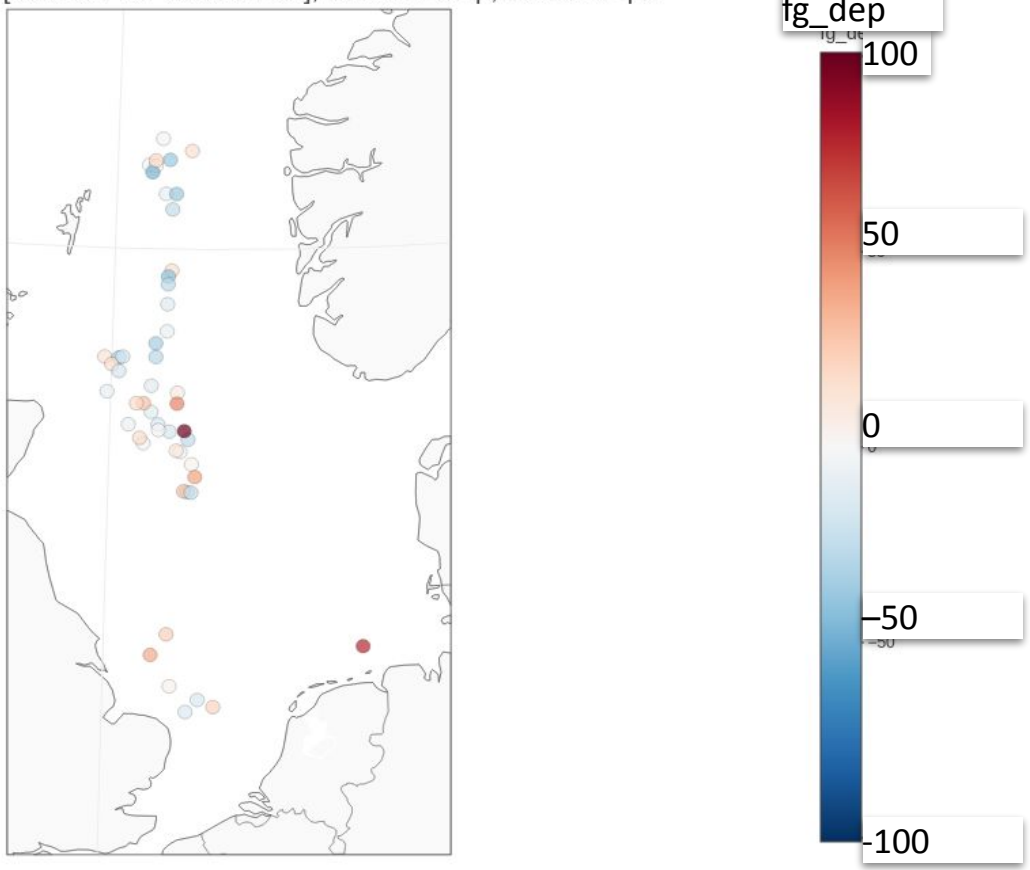
SHIP_REF: 3 h cycling, station=63112 & STARTDATE = 2022022400
This station showed large negative bias during the simulation time.



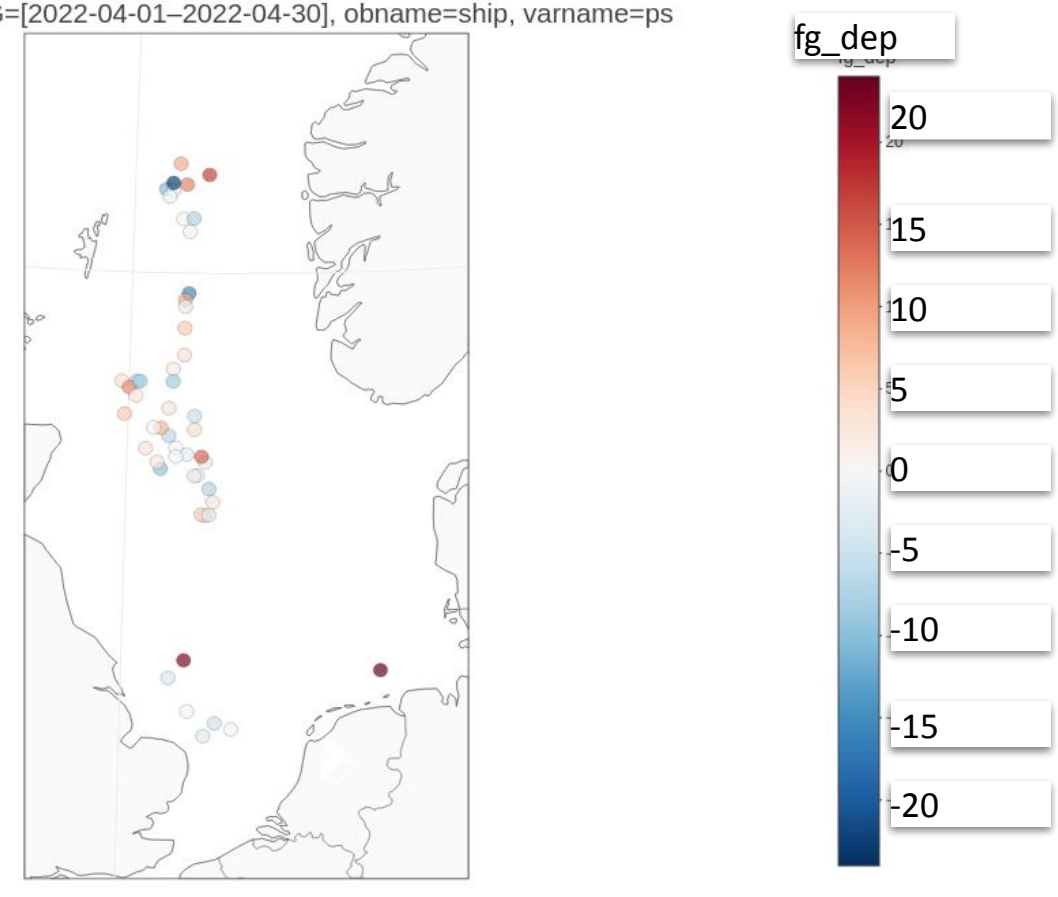
The bias (analysis departure, x) received from the odb files has decreased to ca. zero at 24/2 and remained low during the simulation time. The VarBC coefficient (red line) reached balance near -50 Pa at February 24.

functionality[2]: without/with VarBC [2]

SHIP_REF Average First Guess Departure Map
station=[62010, 62102, ..., 63117, LF3I]
db=ccma, DTG=[2022-04-01–2022-04-30], obname=ship, varname=ps

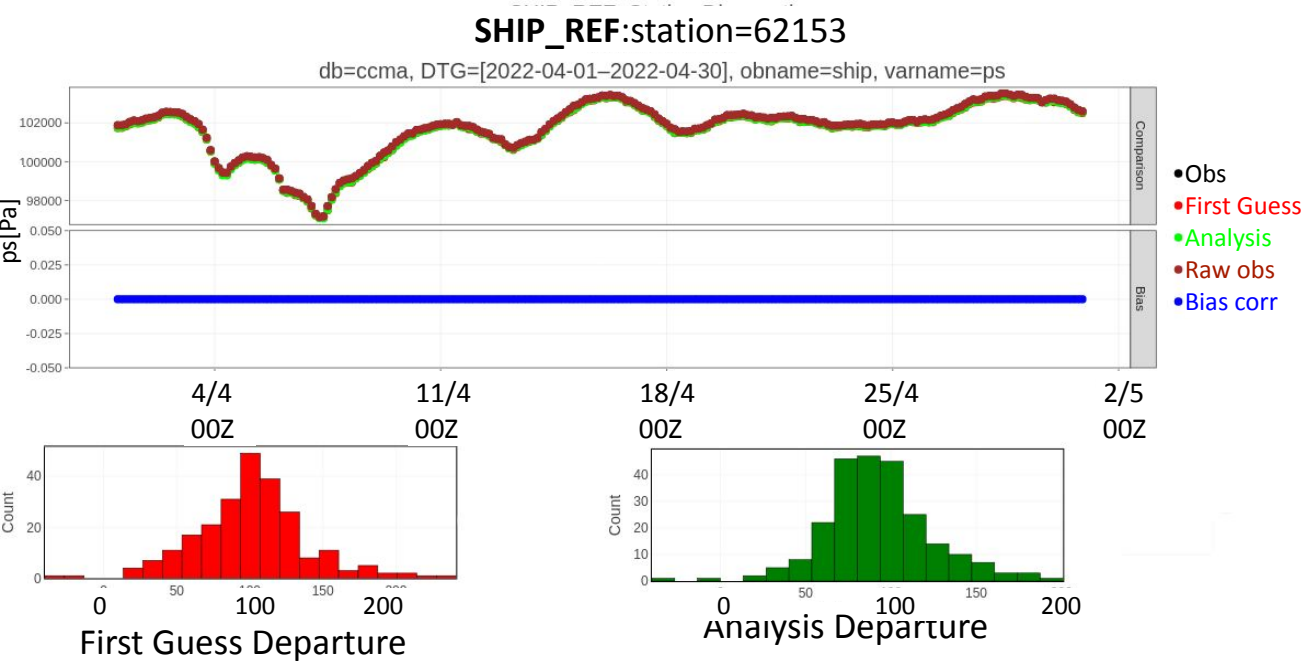


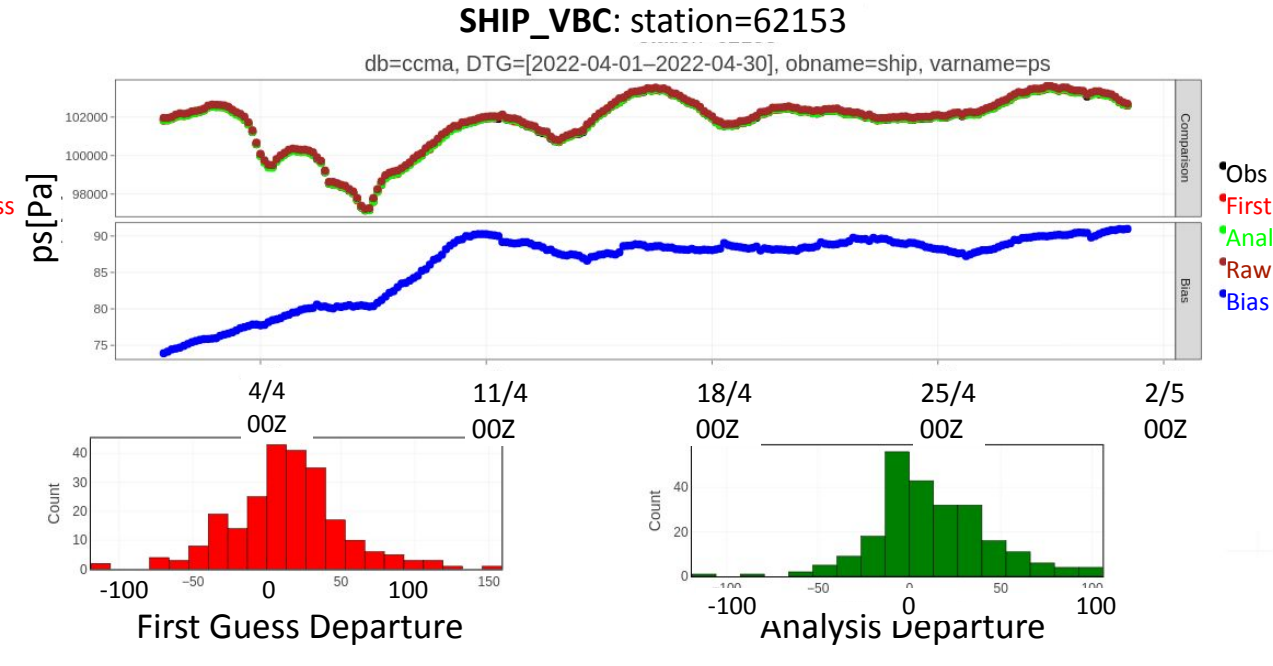
SHIP_VBC Average First Guess Departure Map
station=[62010, 62102, ..., 63117, LF3I]
db=ccma, DTG=[2022-04-01–2022-04-30], obname=ship, varname=ps



Note the different scaling of the fg_dep in the two experiments. April period

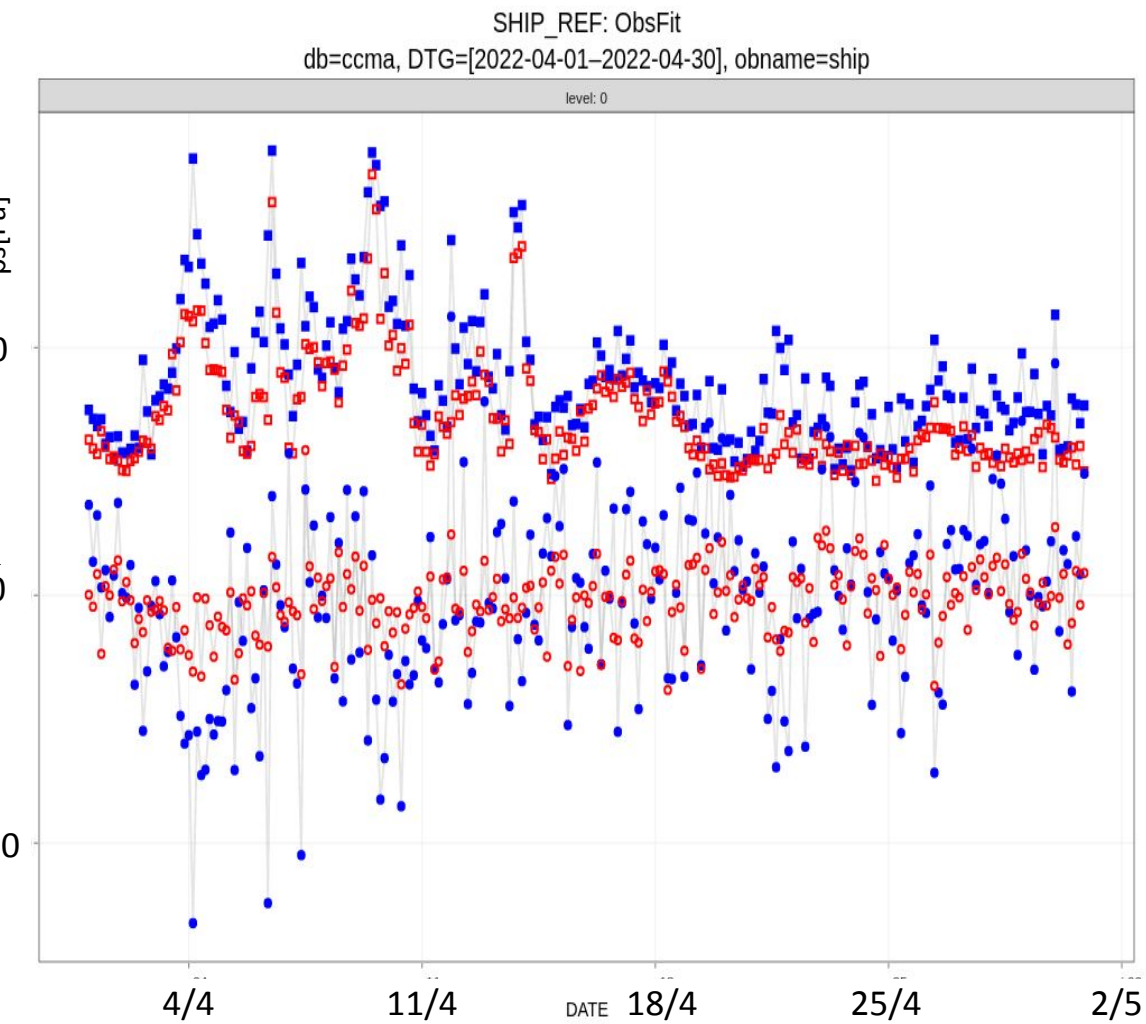
functionality [3]: bias without/with VarBC

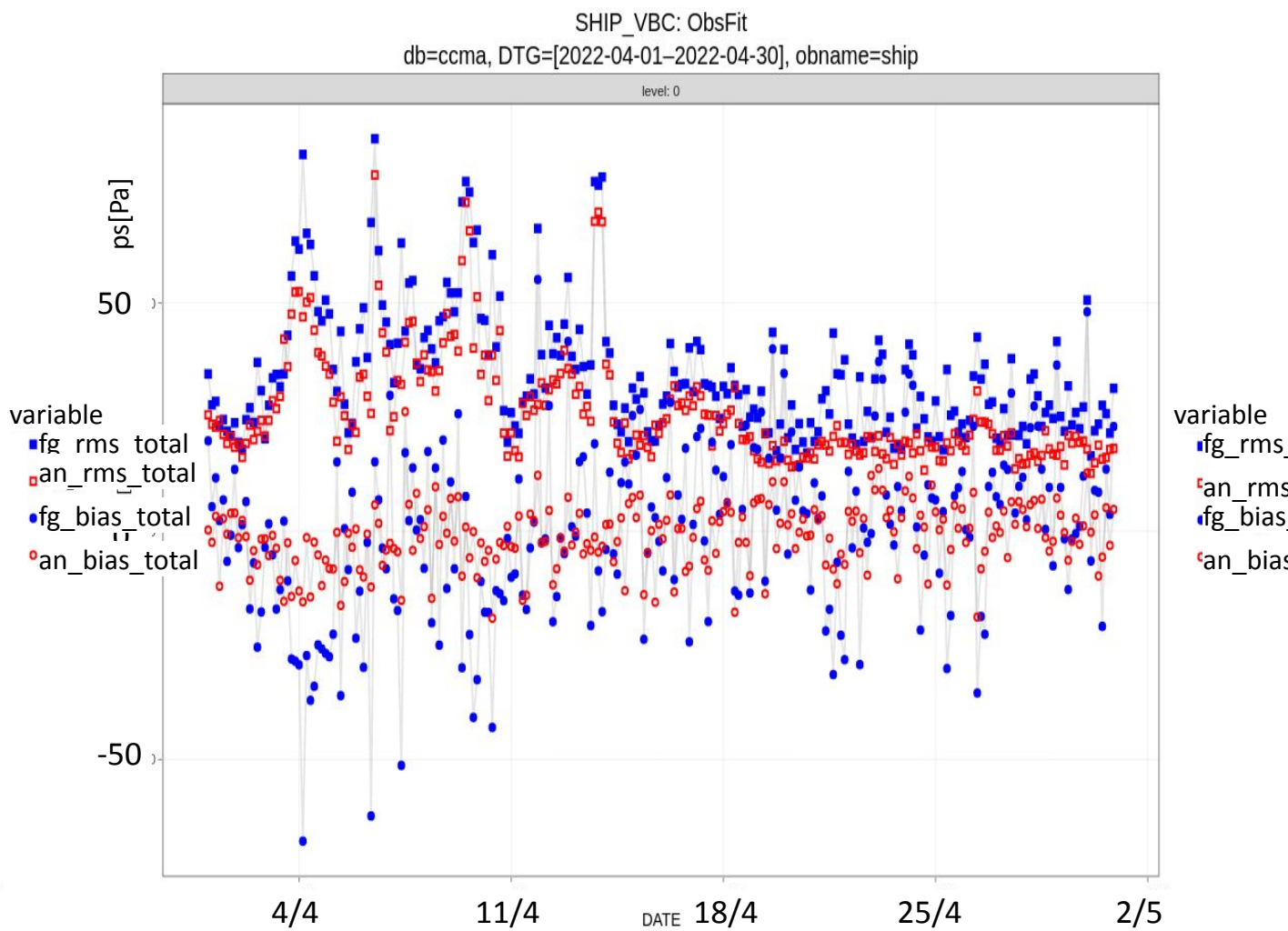




First guess and analysis departures for station=62153 shown for April for SHIP_REF (no VarBC; Left) and SHIP_VBC (with VarBC; Right). Despite the bad First Guess Departures, SHIP_VBC still provides good analyses with less bias. We scaled with 3D-Var the mean daily bias. The day/night variation in bias, if it exists, can be reached with 4D-Var.

functionality [4]: Obsfit without/with VarBC

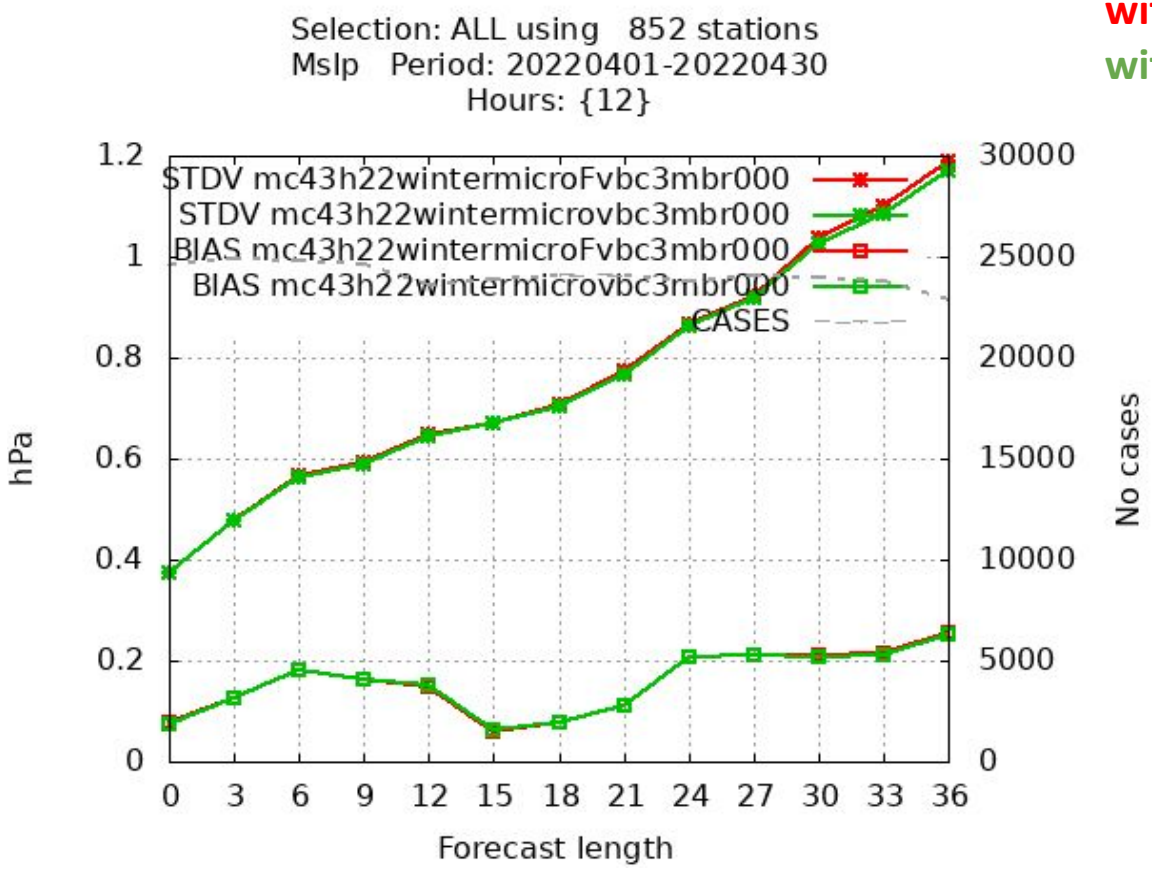




Both exp. pulls well for the observations, otherwise neutral

Results [1]: Obs. verifications without/with VarBC

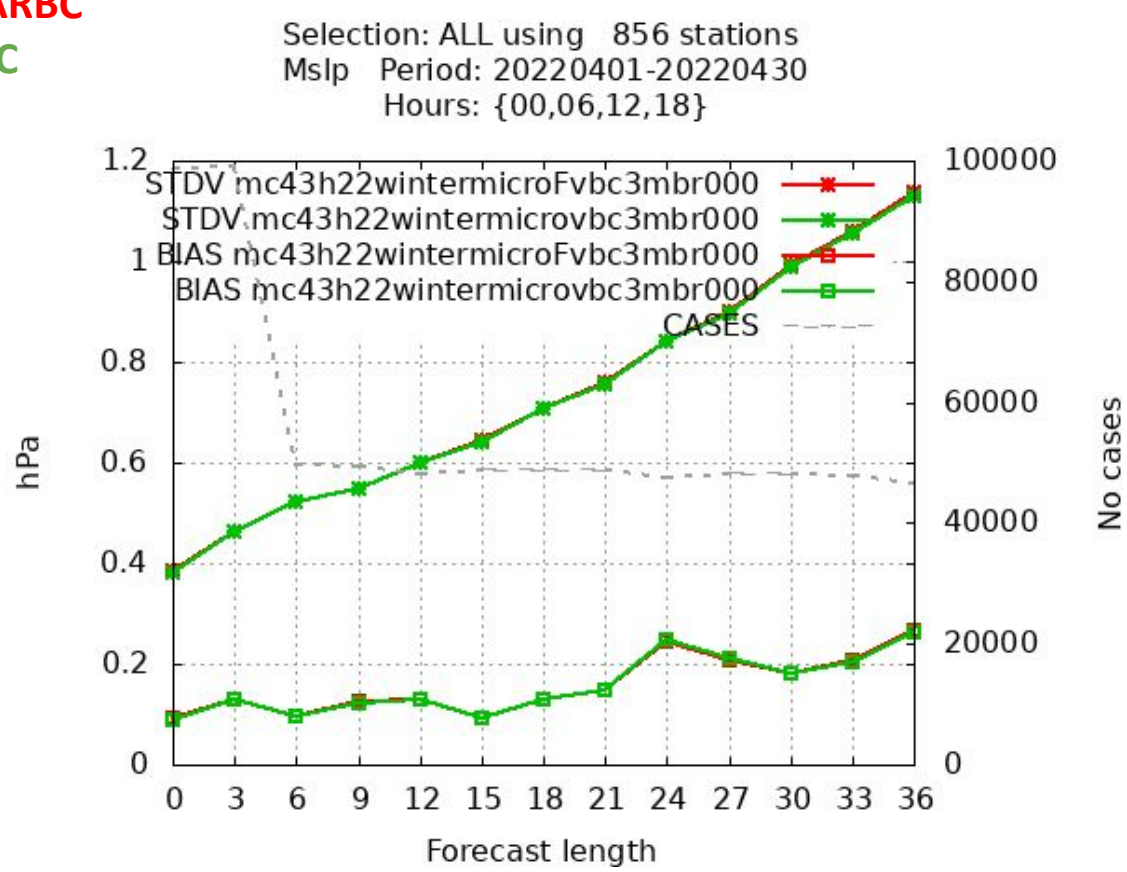
Mslp at 12 UTC



without VARBC

with VARBC

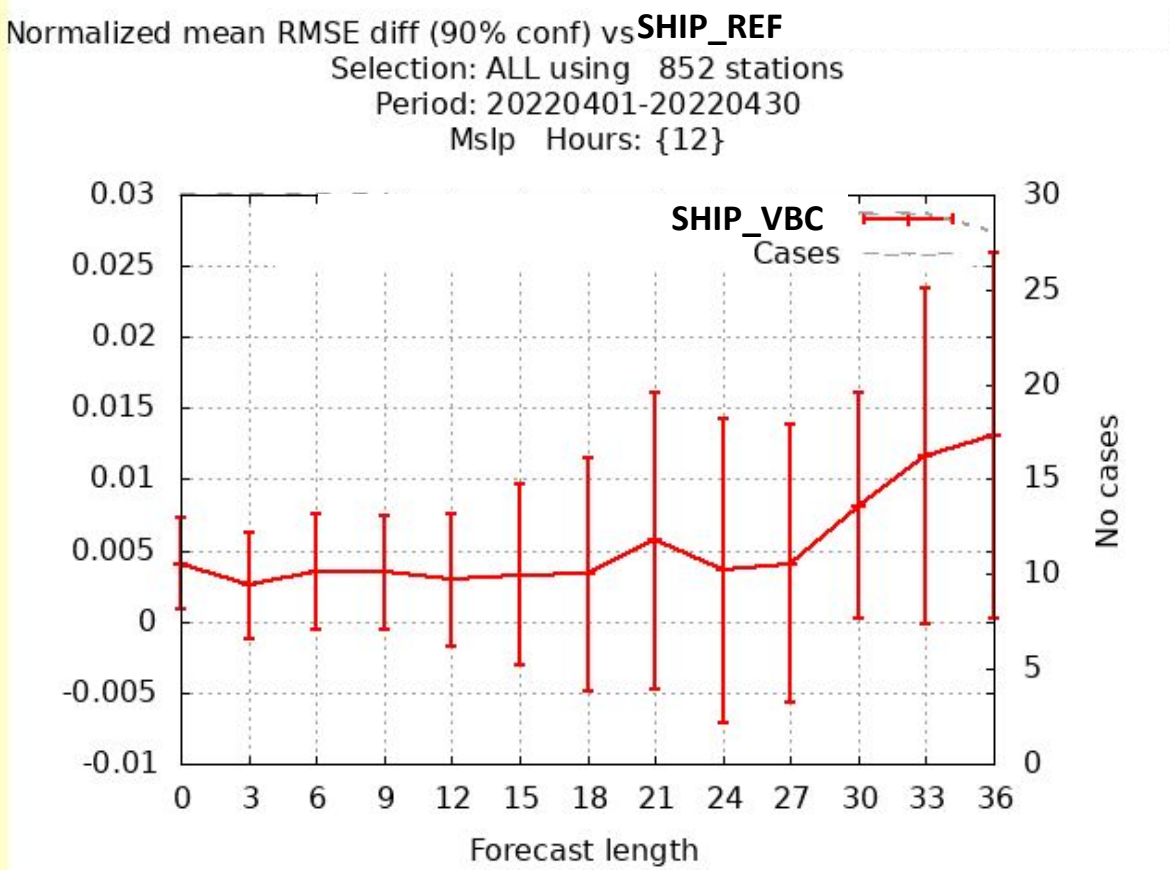
Mslp at 00,06, 12, 18



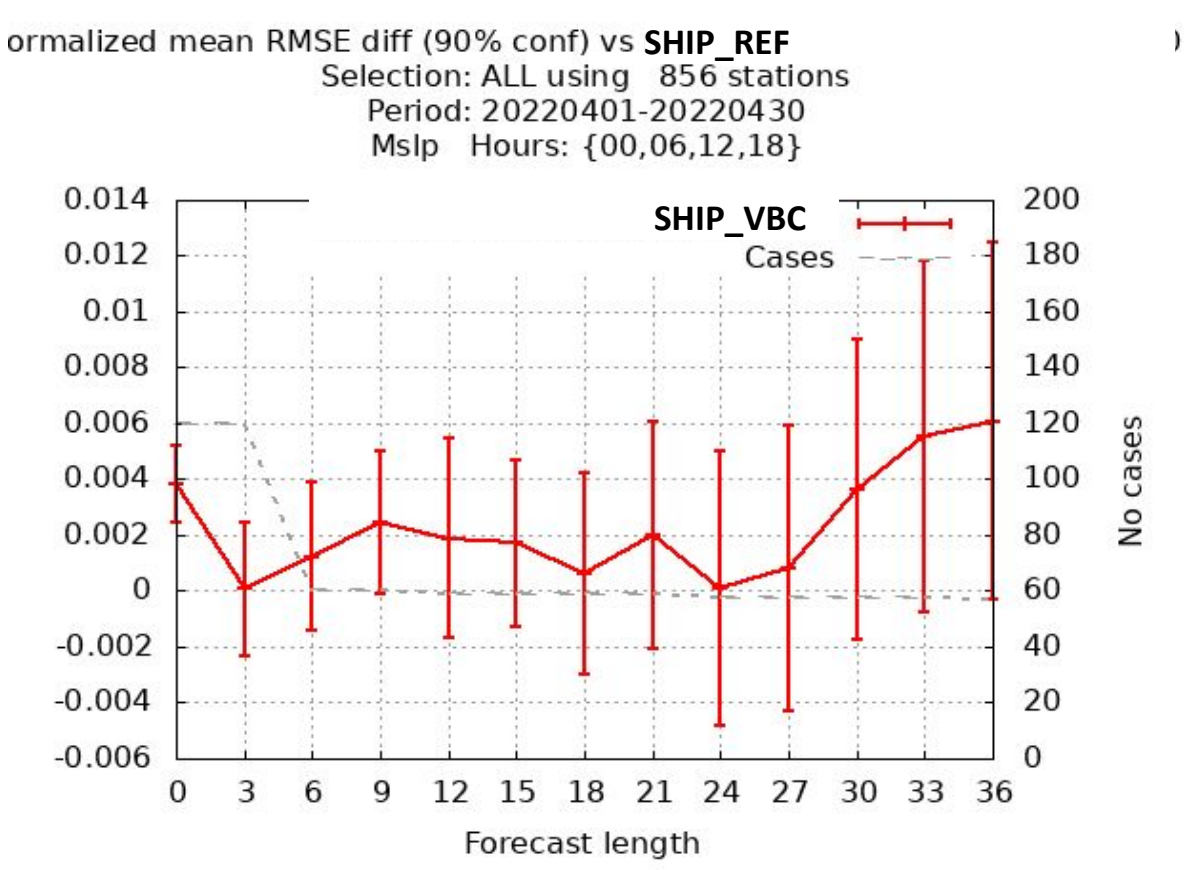
Test the use of VarBC Ps for ship observations over the METCOOP domain show rather neutral impact

Results [2]: Point verification without/with VarBC

Mslp from 12



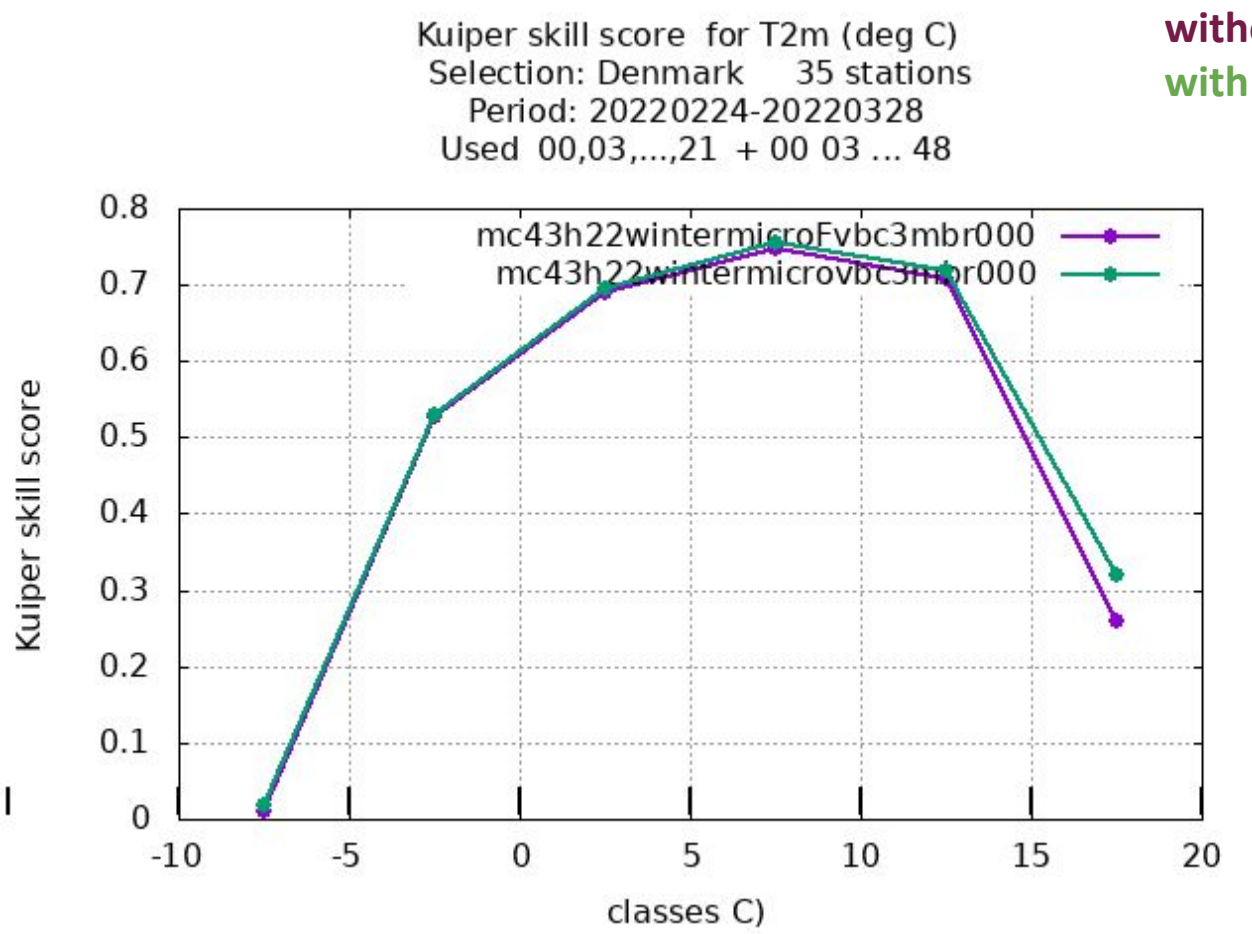
Mslp from 00, 06 12, 18

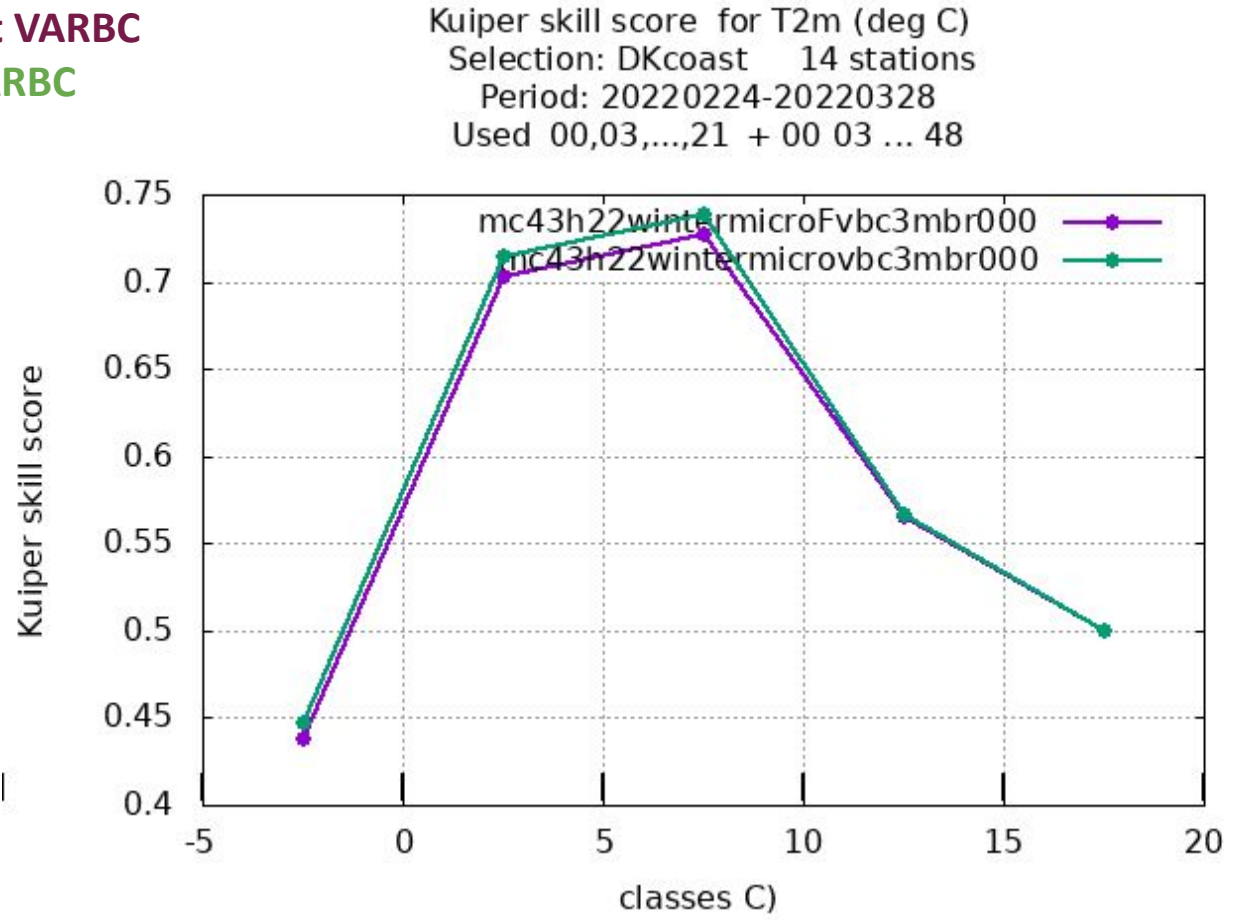


Results showing more positive than neutral significant impact of use of VarBC Ps observations for ships. Note the greater impact at 12 UTC, perhaps because of more satellite observations then. They may affect Ps weakly through multivariate B in a suboptimal way, that improves so none biased ship observations.

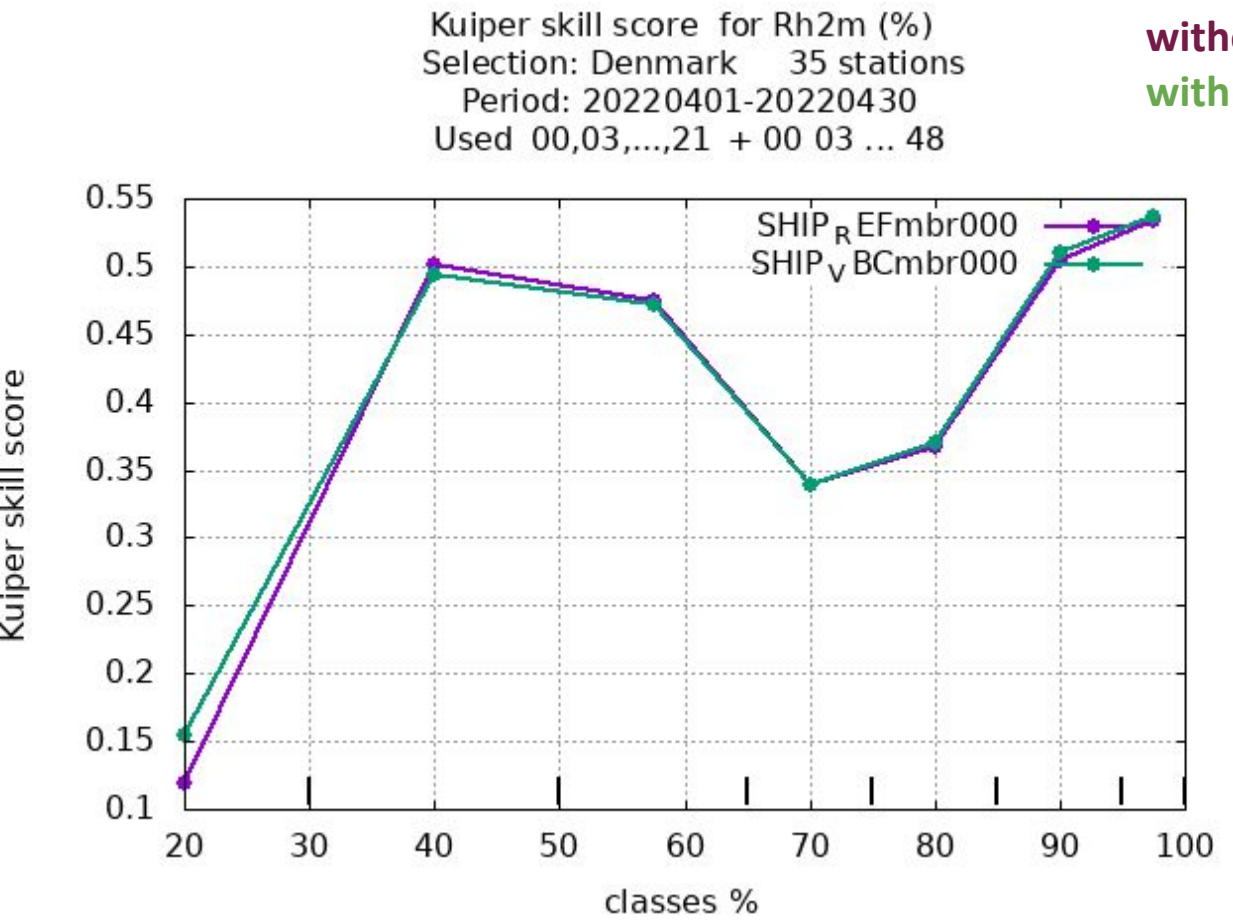
Results [3a]: Kuiper skill scores for T2m

without VARBC
with VARBC



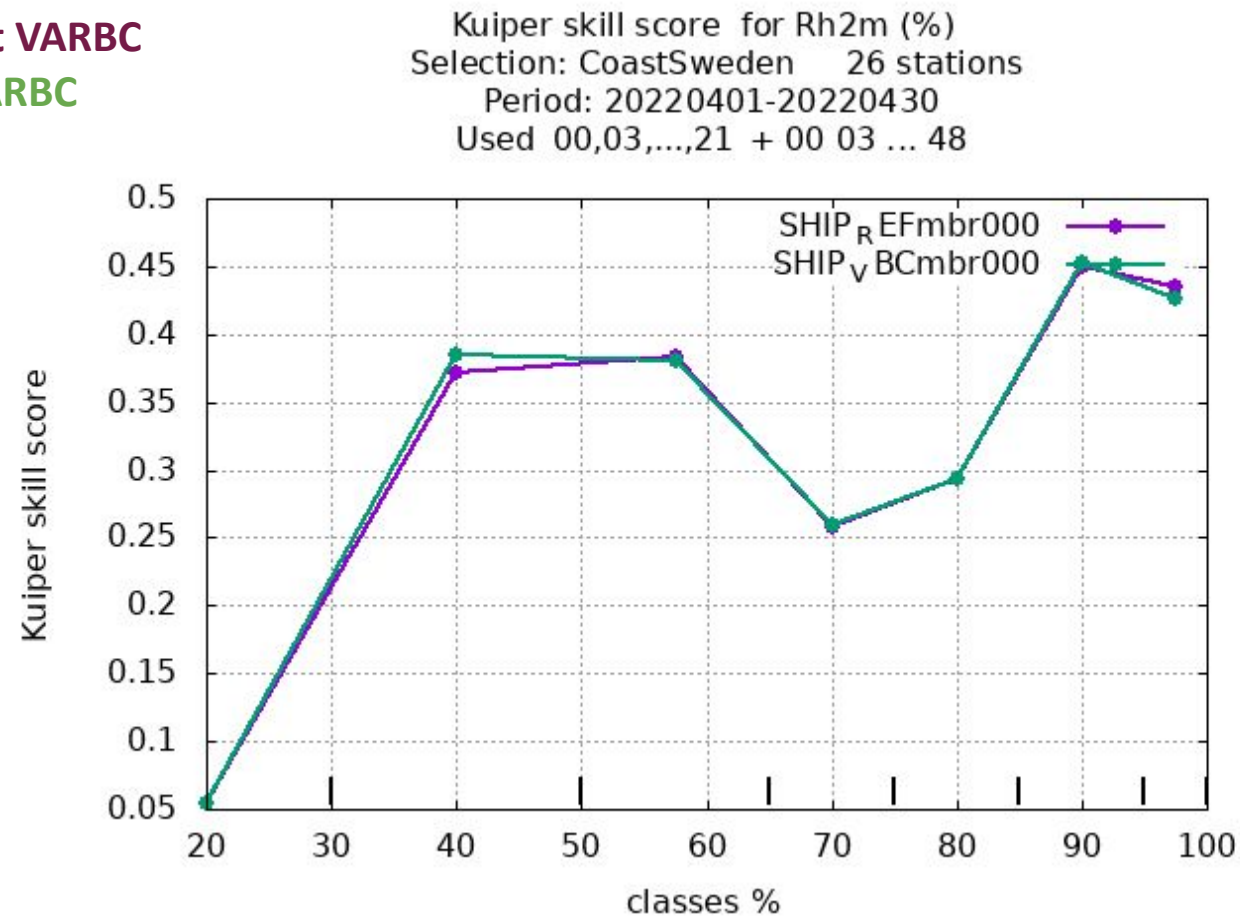


Results [3b]: Kuiper skill scores for Rh2m

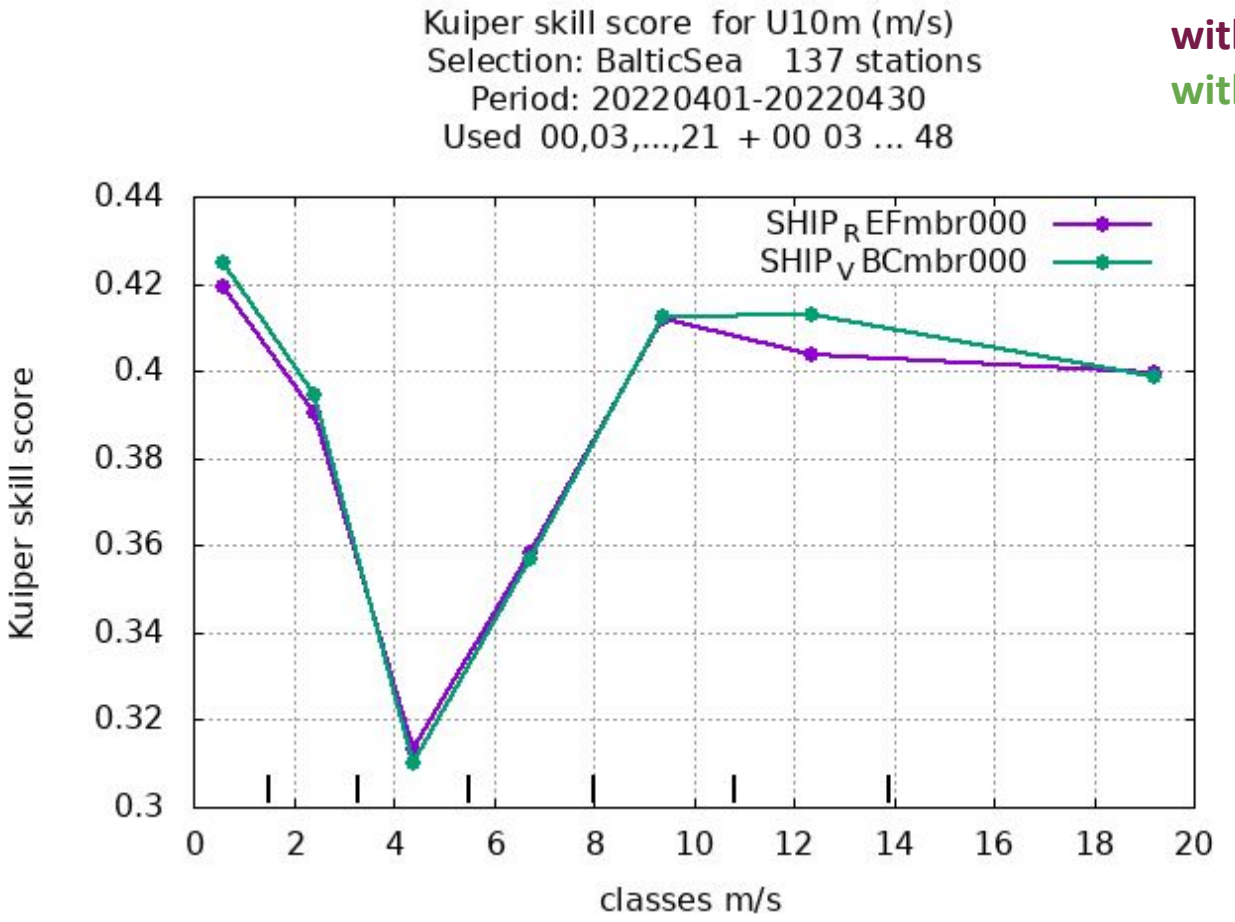


without VARBC

with VARBC

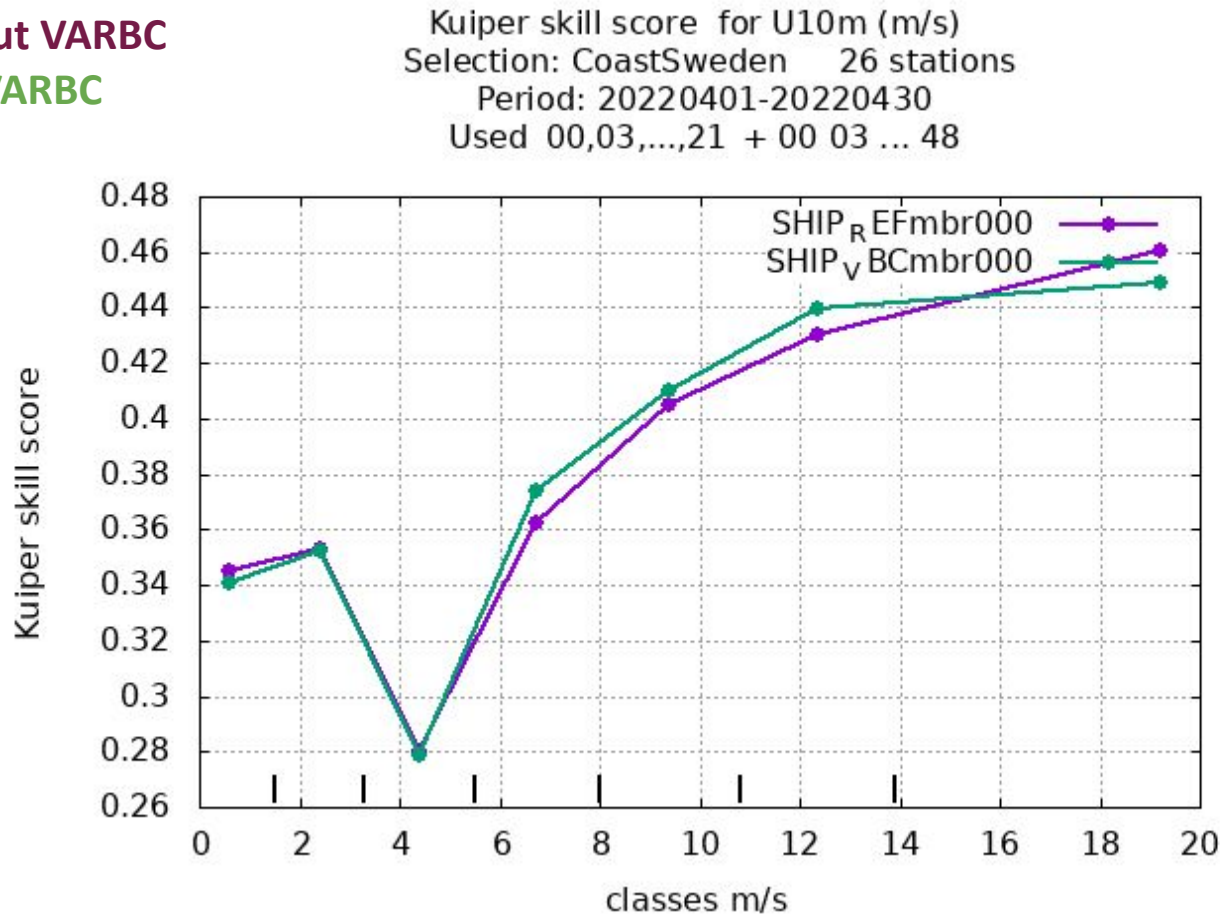


Results [3c]: Kuiper skill scores for U10m

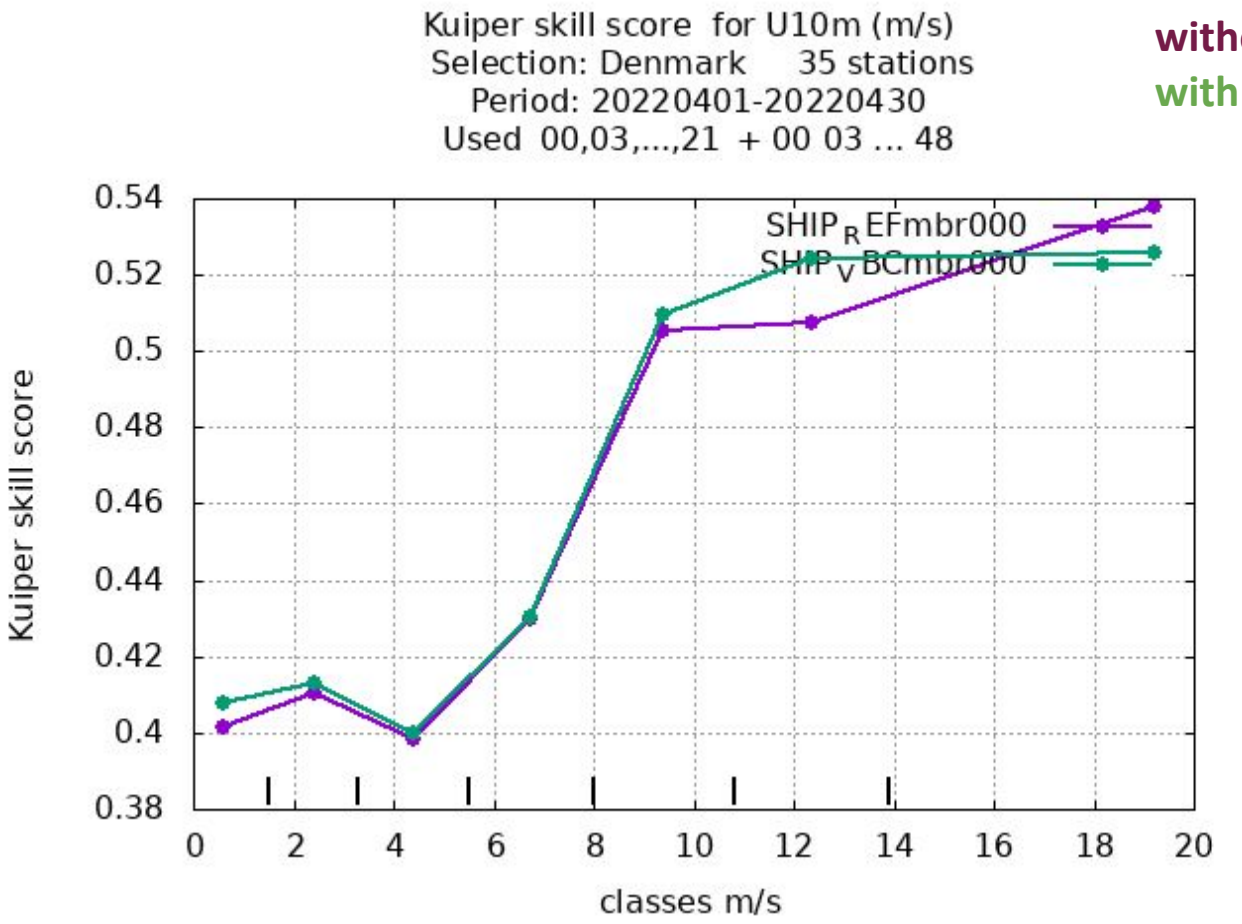


without VARBC

with VARBC

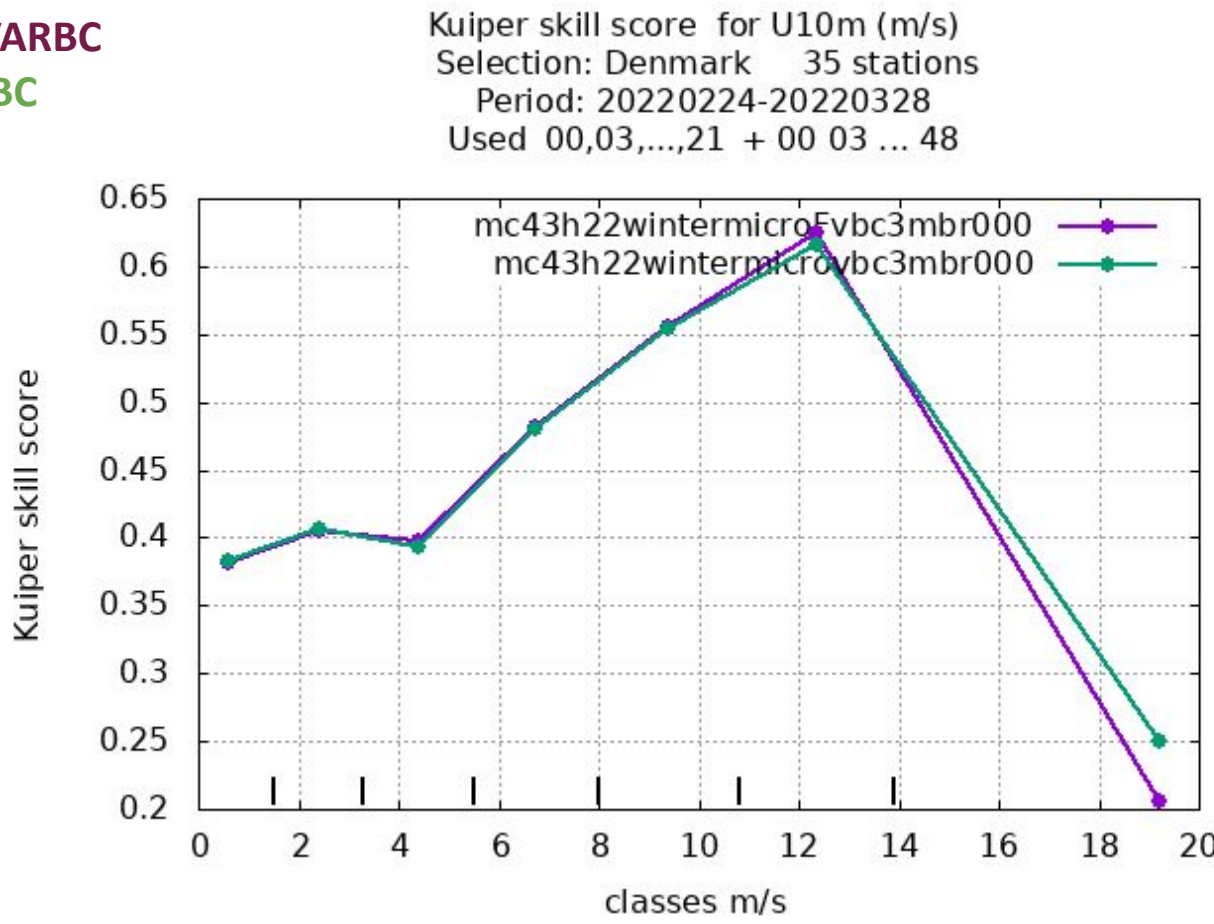


Results [3d]: Kuiper skill scores for U10m



without VARBC

with VARBC



Conclusions

- VarBC of Ps observations for ships has been setup and evaluated
- The functionality slides show that the VarBC princip works perfectly to reduce the bias. Radiances and truely also radar need to be good lower-air observations to be effectively assimilated in regional models. Good active SHIP data coverage is needed.
- The forecasts show small impact over the whole METCOOP domain
- More positive impact is shown in part sea and coastal areas, through through multivariate B on for example T2m, Rh2m and especially U10m
- The results indicate that it is important to increase again number of ships observations