Himawari Radiance Integration in the Bureau Limited-Area Assimilation System: Impact of Assimilation, Error Diagnostics and Treatment

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1. Introduction

- This poster presents a practical investigation of introducing AHI clear-sky (AHICSR) data assimilation into the Bureau limited area model (LAM) ACCESS-C.
- This instrument provides good horizontal and temporal coverage over the Australian region, and a recent observation impact study by Samrat et al. (2025) shows denial of GEO CSR in the global model shows a forecast degradation of −0.55% over Australian regions (Figure 1).

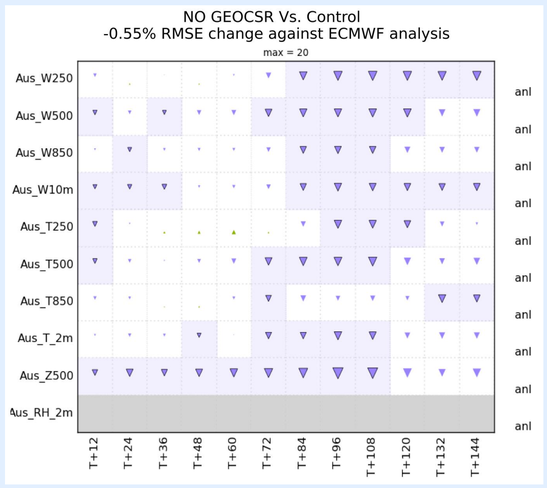


Figure 1: The percentage change in RMSE for NO-GEOCSR in the global model over the Australian region.

- Hence, assimilating AHICSR into ACCEESS-C aims to improve the analysis by resolving some smaller-scale features, especially for humidity, in the limited area model.

2. System Configuration & Data

The Bureau runs 7 LAM domains known as ACCESS-C, which are based on the Met Office UKV model. All ACCESS-C models have the following characteristics

- 1.5km model grid (fixed) with 4km variable outer grid (not shown here), ~892x744 grid points total.
- Hourly 4D-Var DA cycle with observation sources: AWS, METARs, ships, buoys, radiosondes, aircraft, radar, AMV, scatterometer, radar and satellite radiances from ATMS, AMSU-B/MHS, CrIS, IASI, AHI instruments.

Thinning and R–Matrix

- Current settings derive from the UKV model. Most were chosen independently when the instruments were first assimilated.
- Use diagonal R-matrix and assumed observation error is not correlated.

Instrument	Thinning distance
AHI (clear-sky)	12
AMSU-B	24
ATMS	5
CrIS	60
IASI	60

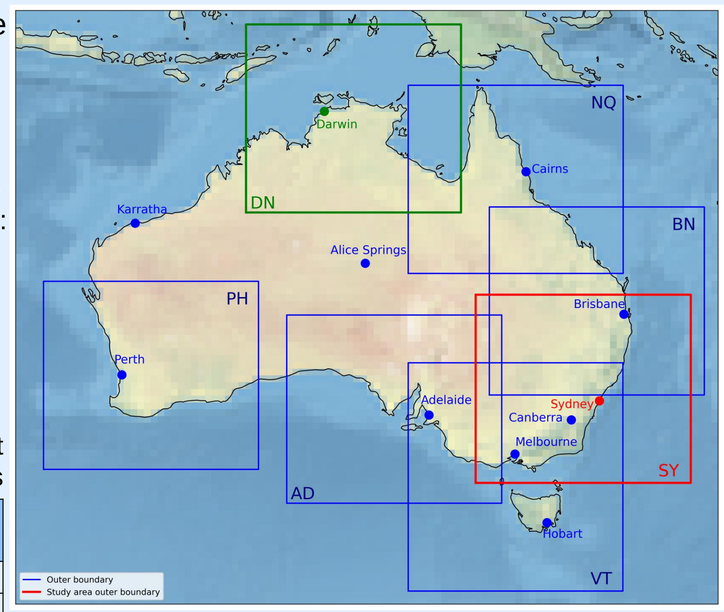


Figure 2: The Bureau ACCESS-C system domains (Samrat et al., 2022).

3. Addition of AHI & Thinning Trial Results

Impact of AHICSR & VarBC testing

Experiment	Details
Control	All observations currently used operationally (Section 2)
AHICSR_G	Control + AHICSR + VarBC from ACCESS-G
AHICSR_C	Control + AHICSR + VarBC from ACCESS-C
Trial Period	01/02/20- 15/04/ 2020
Domain	Sydney (Red in Fig.2)

Positive ΔRMSE (positive impact).
Negative ΔRMSE (negative impact).

The size of each triangle represents the magnitude of each value and solid black line means statistically significant.

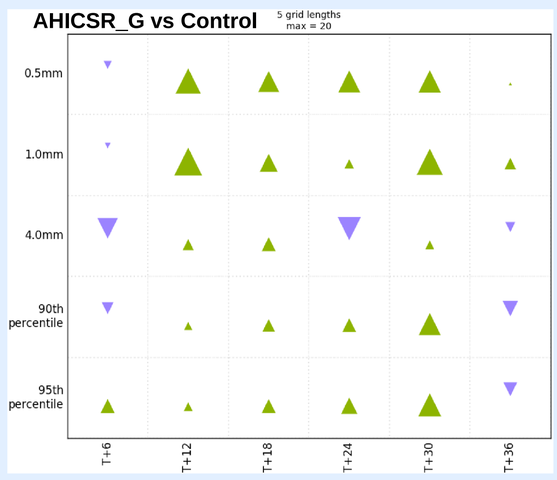


Figure 3: ΔFSS for 1-hr precipitation accumulation.

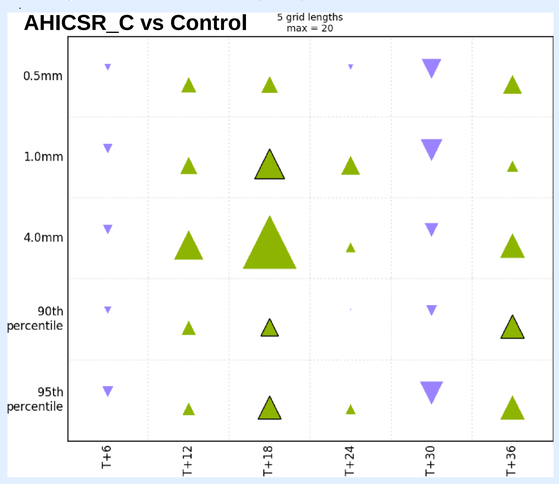


Figure 4: ΔFSS for 1-hr precipitation accumulation.

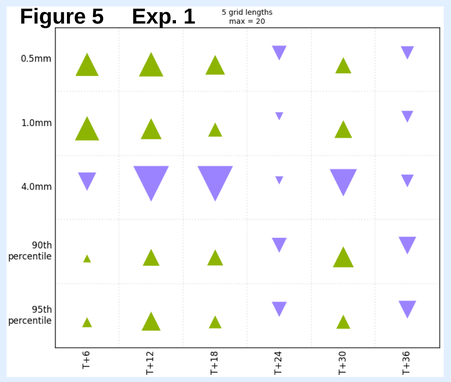
- The Fractions Skill Score (FSS) for precipitation indicated mixed impacts for adding AHICSR to ACCESS-C (Figure 3).
- The ΔFSS in Figure 4 improves when running for AHICSR_C.
- No significant change to other radiances from running VarBC in ACCESS-C (not shown).
- O-B distributions of AHICSR water vapour channels are similar for AHICSR_G and _C (not shown)

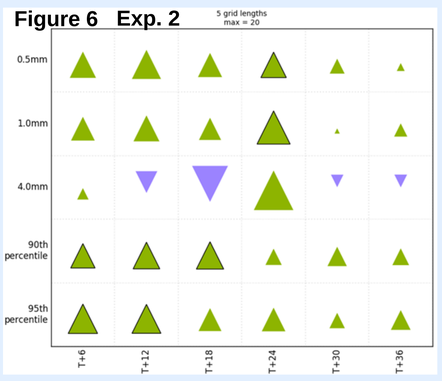
Thinning Trials

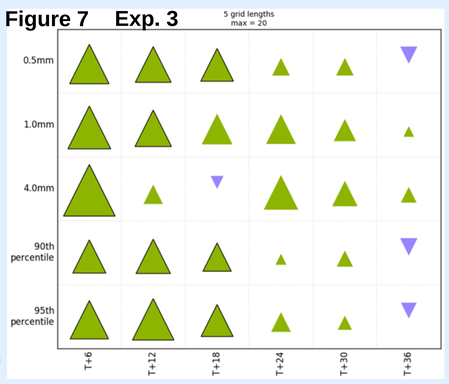
- Aim: trial short, medium and long thinning distances selected after literature review.

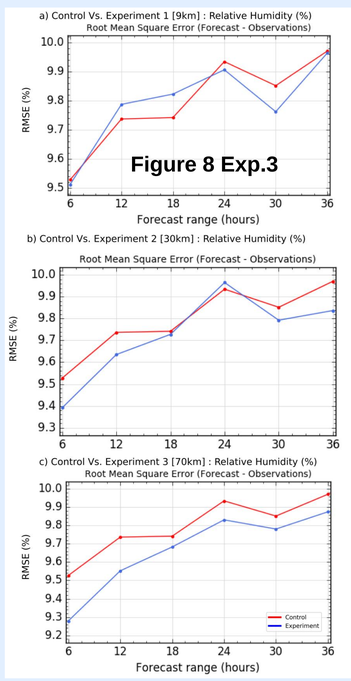
Experiment	Thinning distance (km)
Control	Current (see System Configuration)
Exp1	9km (2x DA grid length)
Exp2	30km (> 6x DA grid length)
Exp3	70km (suggested for convective models)
Trial Period	25/11/2021 – 31/01/2022
Domain	Darwin(Green in Fig.2)

- Exp. 1 Summary: Mixed positive and negative signals with low significance. (Figure 5).
- Exp. 2 Summary: Mostly positive but with low significance (Figure 6).
- Exp. 3 Summary: Mostly positive with high significance up to T+18 Figure (7)
- See Samrat et al.(2024) for further details.









RMSE results (Figure 8 shows 1.5 m RH) for each experiment**:**

Exp. 1: Slightly worse overall, particularly for 1.5 m T

Exp. 2 : Improvement to T+18 for both 1.5 m T and 1.5 m RH

Exp. 3: Improvement at all ranges for both 1.5 m T and 1.5 m RH

4. Error Diagnostics

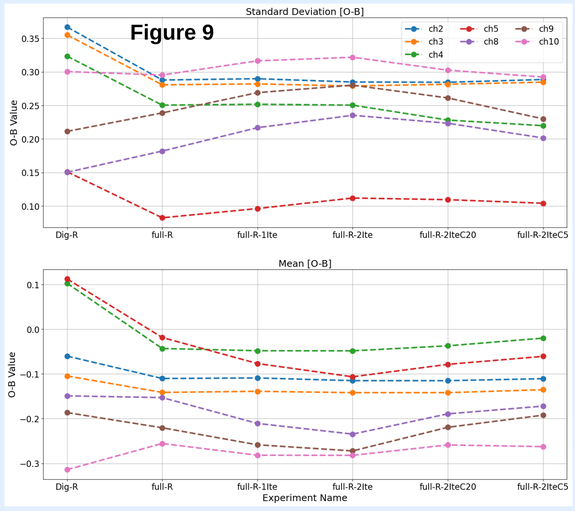
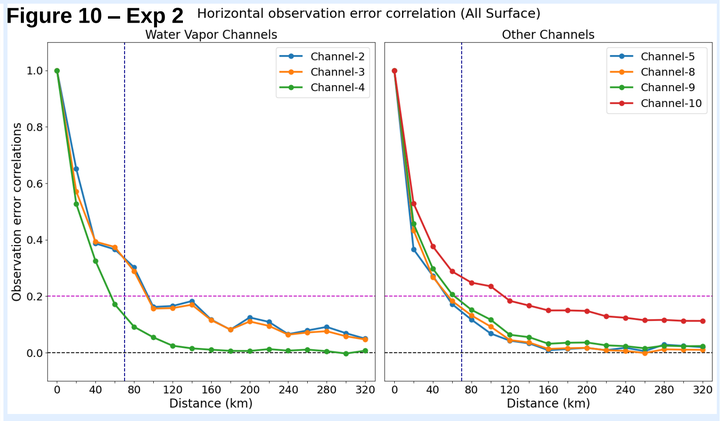
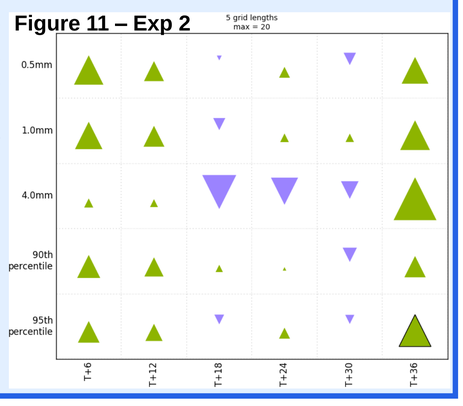


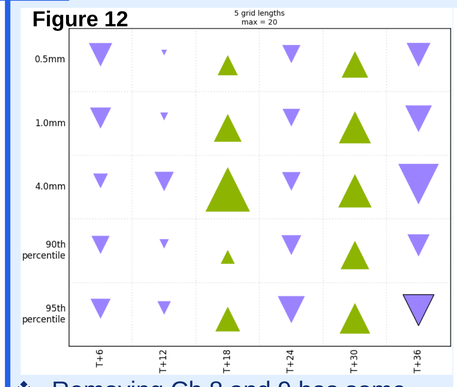
Figure 9 Experiments	Details
Control	Exp3 (Thinning Exp. Only AHI Setting) [Section3], Diagonal R
Exp1	Full- R (estimated based on Desroziers et al. (2005)
Exp2, Exp3, Exp4 and Exp5	**Full R Ite. 1**, Full R Ite.2, Full R Ite.2 Condition Number 20 and Full R Ite.2 Condition Number 5



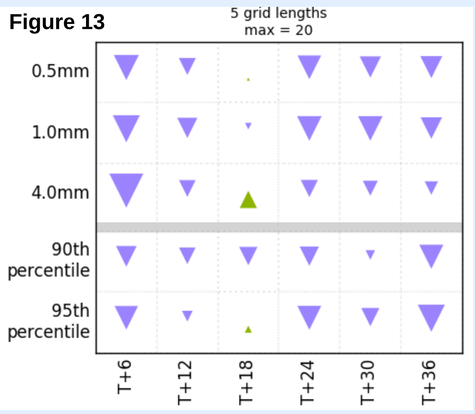
- O-B Summary: Testing of Full-R matrix shows good agreement. (Figure 9).
- The horizontal error correlations in Figure 10 shows our choice to use a 70 km thinning distance and Full R is reasonable
- Figure 11 shows neutral impact of Exp 2.



5. Additional Experiments



- Removing Ch 8 and 9 has some negative impacts.(Figure 12)



- Adding Ch 10 over land shows mostly negative impact (Figure 13), we plan to start a few new experiments in this topic.

6. Conclusions

- Integrating AHICSR into Bureau LAM with UKV settings has a neutral impact on precipitation forecasts.
- Increasing spatial thinning of satellite radiance observations to 70 km can improve forecast skill up to 18 hours ahead.
- Testing Full R for AHICSR shows neutral impact and good horizontal correlations.
- Future work will focus on assimilating AHI data over land.
- More investigation is required to see if these results will be consistent when tested in the future configuration of the regional ACCESS model which includes large-scale blending.

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