Application of the time-lagged ensemble approach to the NCEP FV3GFS based new generation global weather prediction system at CWB

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109 年天氣分析與預報研討會

Introduction

- Increasing the size of the ensemble used in hybrid-variational assimilation methods has been shown to be beneficial, but is computationally expensive.

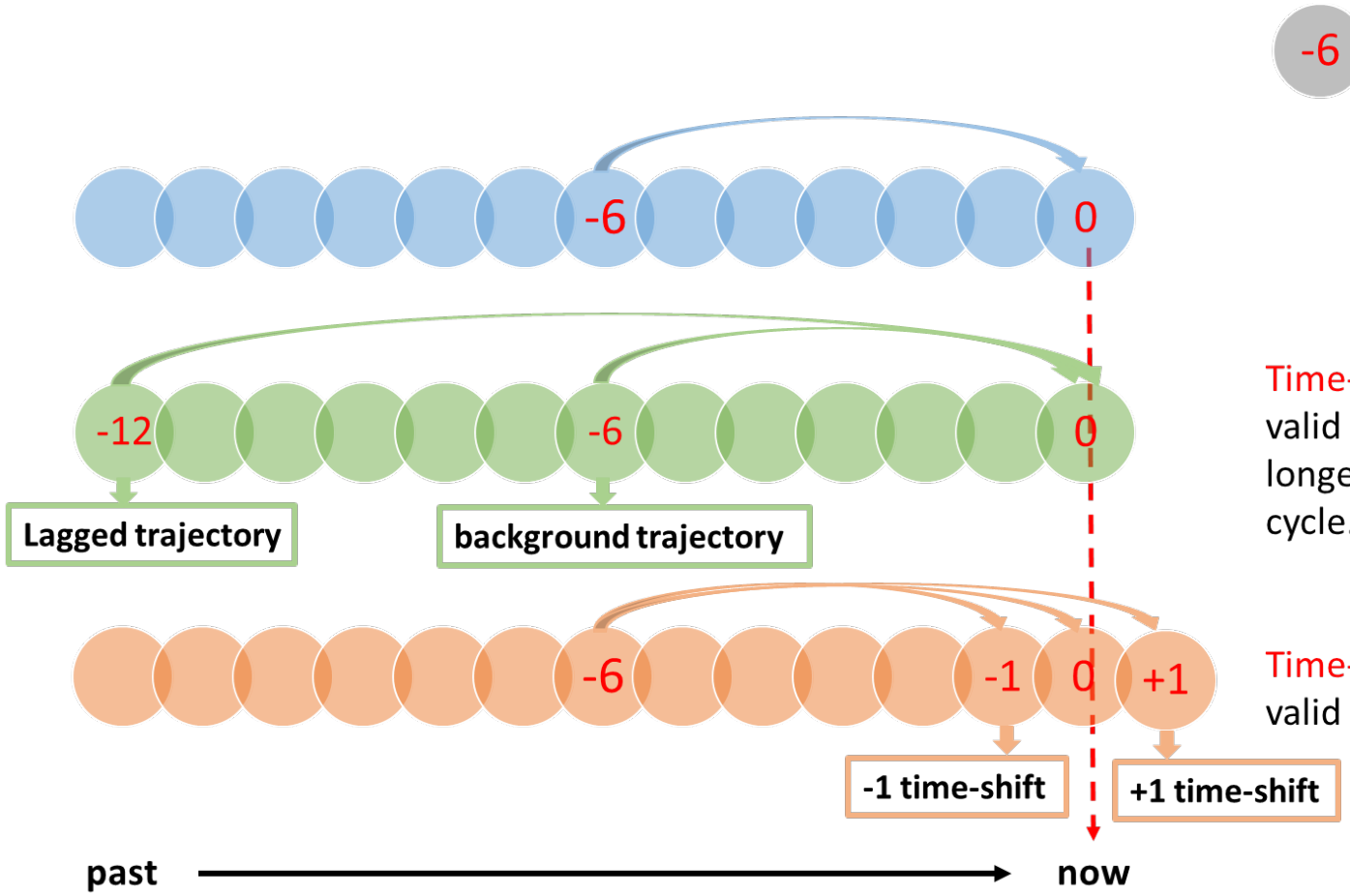
- This work sets out to see whether similar improvements can be obtained from a smaller ensemble by better estimation of ensemble covariances.

- The time-lagged method has been operated since Nov 2017.

- REFERENCES

趙子瑩、陳登舜、鄧雯心、曾建翰、陳建河、沈彥志、黃清勇，2017:使用時間延遲及偏移系集對中央氣象局全球資料同化系統的影響，天氣分析與預報研討會 A2-21

Time-shifted & lagged perturbations



Time-lagged uses perturbations valid at the correct time, from longer forecasts from the previous cycle.

Time-shifted uses perturbations valid at slightly different times.

Time-shifted & lagged ensembles In the CWBGFS

- **Experiment：**

ctrl:

Resolution: Main: T511L60 / Members: T319L60

36 EnKF members .

LAG :

Resolution: Main: T511L60 / Members: T319L60

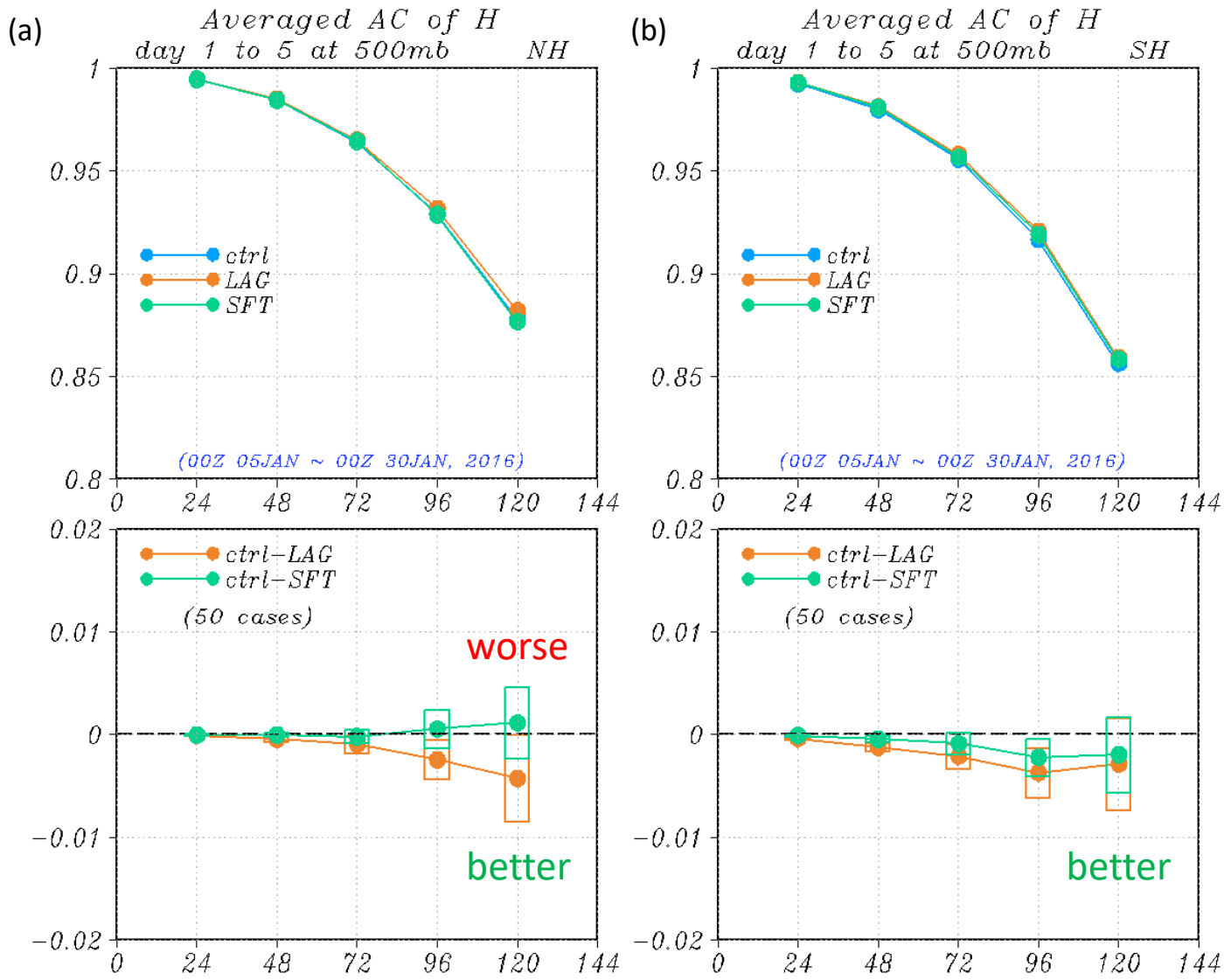
72 members（36 EnKF members, 36 12-hour-lag members）.

SFT :

Resolution: Main: T511L60 / Members: T319L60

108 members（36 EnKF members, 72 1-hour-shift members）.

1st to 5th day forecast against NCEP analysis (2016010100--2016013000) NH, SH ACH



The average 500-hPa geopotential height anomaly correlation scores by forecast day for ctrl(blue)、LAG(Orange) and SFT(green) forecasts (a) Northern and (b) Southern Hemispheres.
The error bars represent the significance of the difference between the two runs at the 95% confidence level.

Time-lagged ensembles In the FV3GFS

- **Experiment：**

CTRL :

Resolution: Main: C384L64 / Members: C192L64

32 EnKF members .

TIMELAG :

Resolution: Main: C384L64 / Members: C192L64

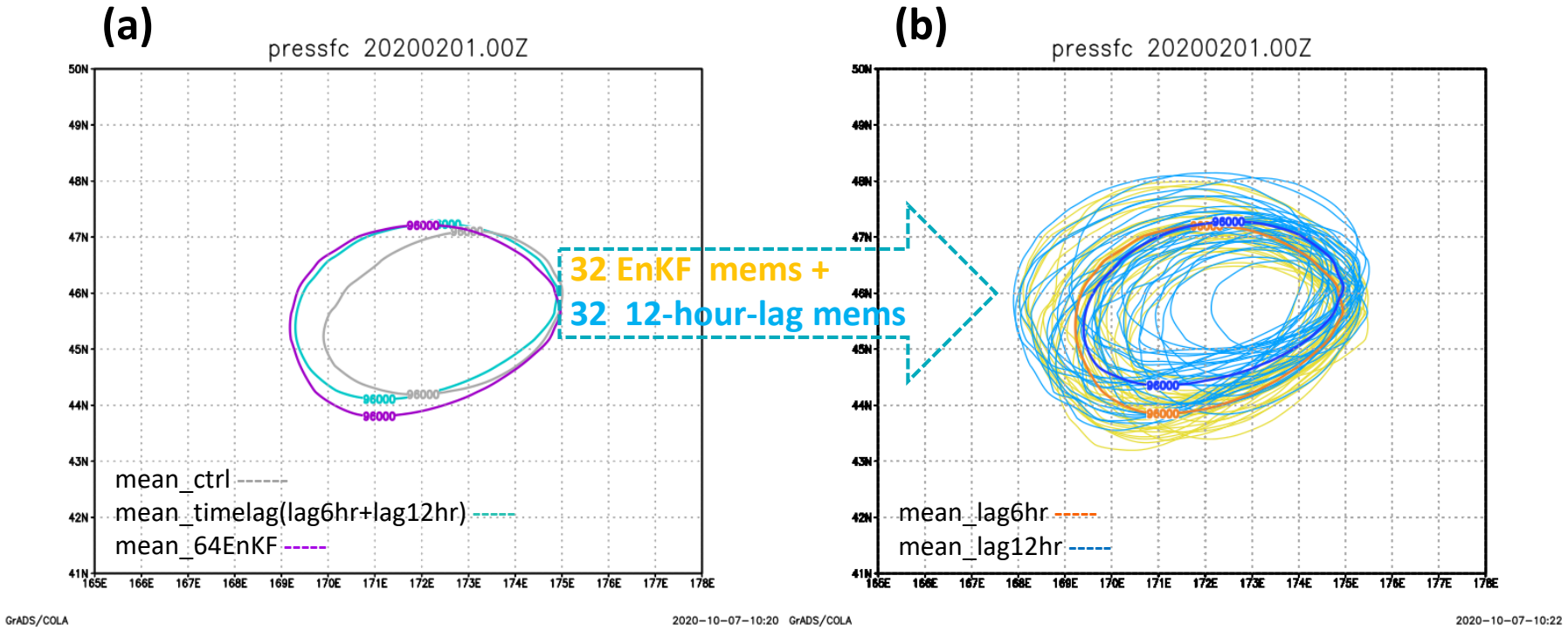
64 members（32 EnKF members, 32 12-hour-lag members）.

ENKF64 :

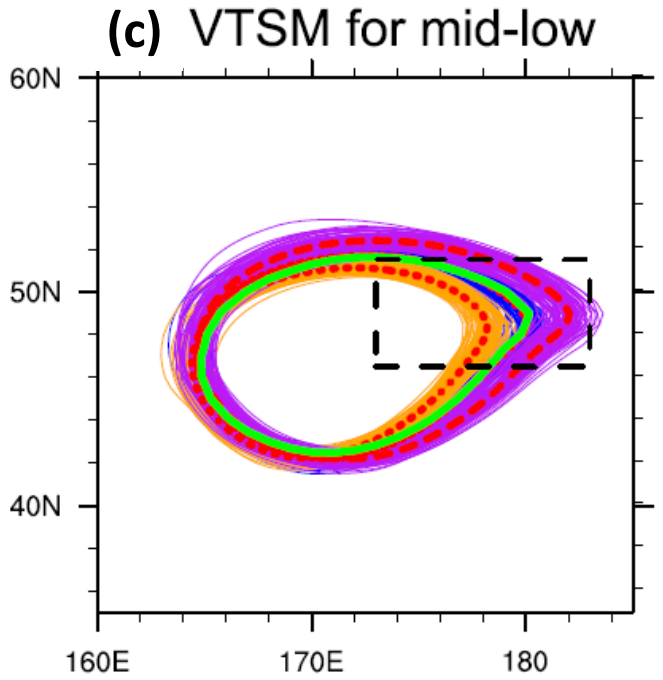
Resolution: Main: C384L64 / Members: C192L64

64 EnKF members .

Time-shifted & lagged perturbations



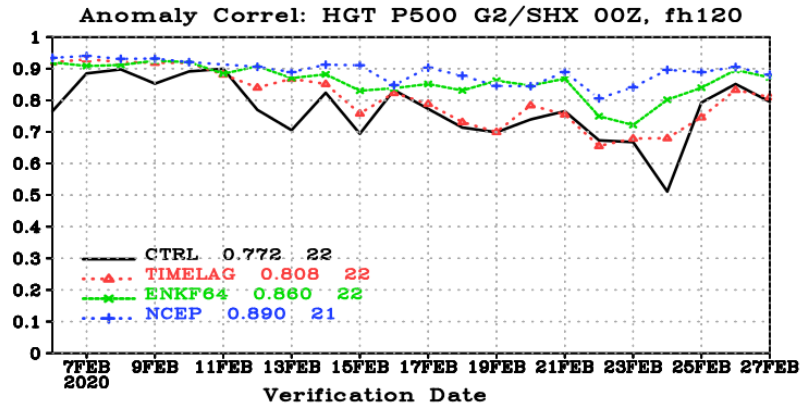
(a)(b)sea level pressure

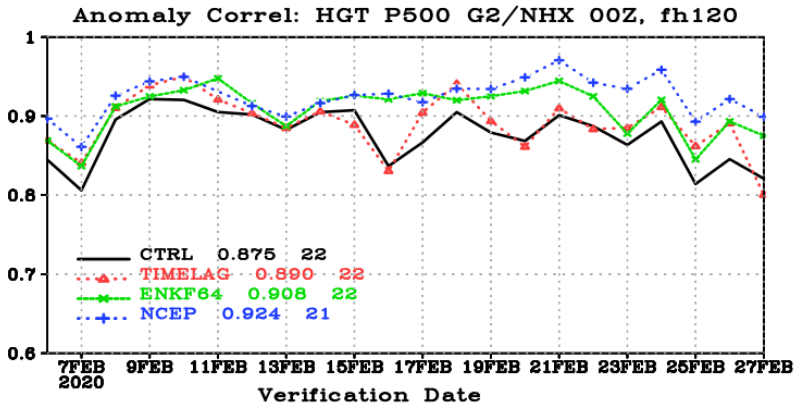


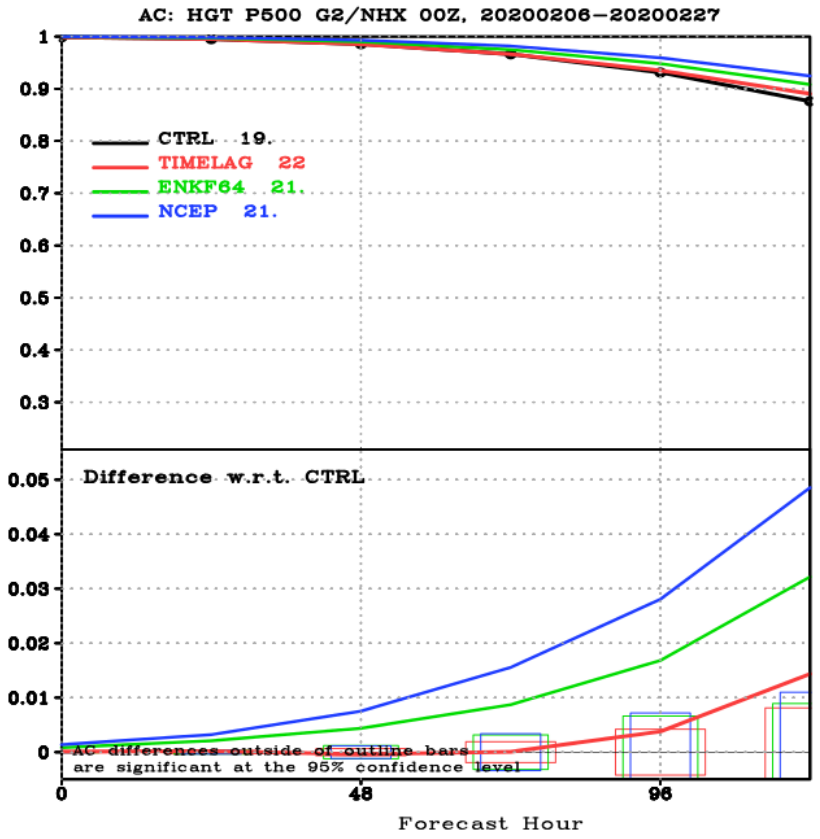
B. Huang, and X. Wang, 2018

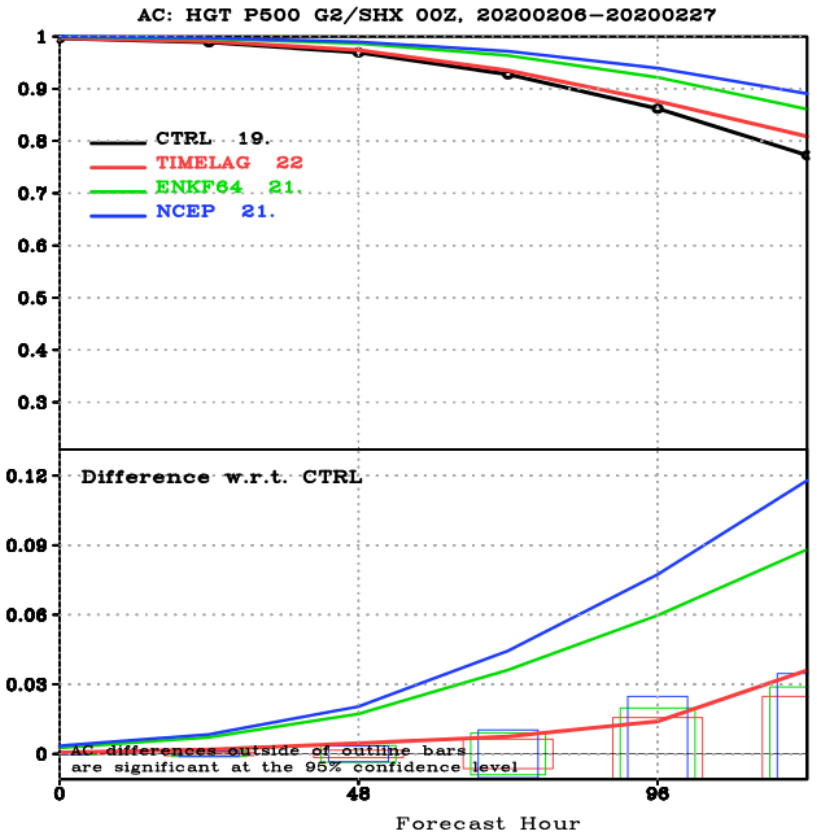
Spaghetti-contour plots of (c) the 1400-gpm geopotential height at 850 hPa in a midlatitude closed low.

1st to 5th day forecast against NCEP analysis (2020020600--2020022700) NH, SH ACH

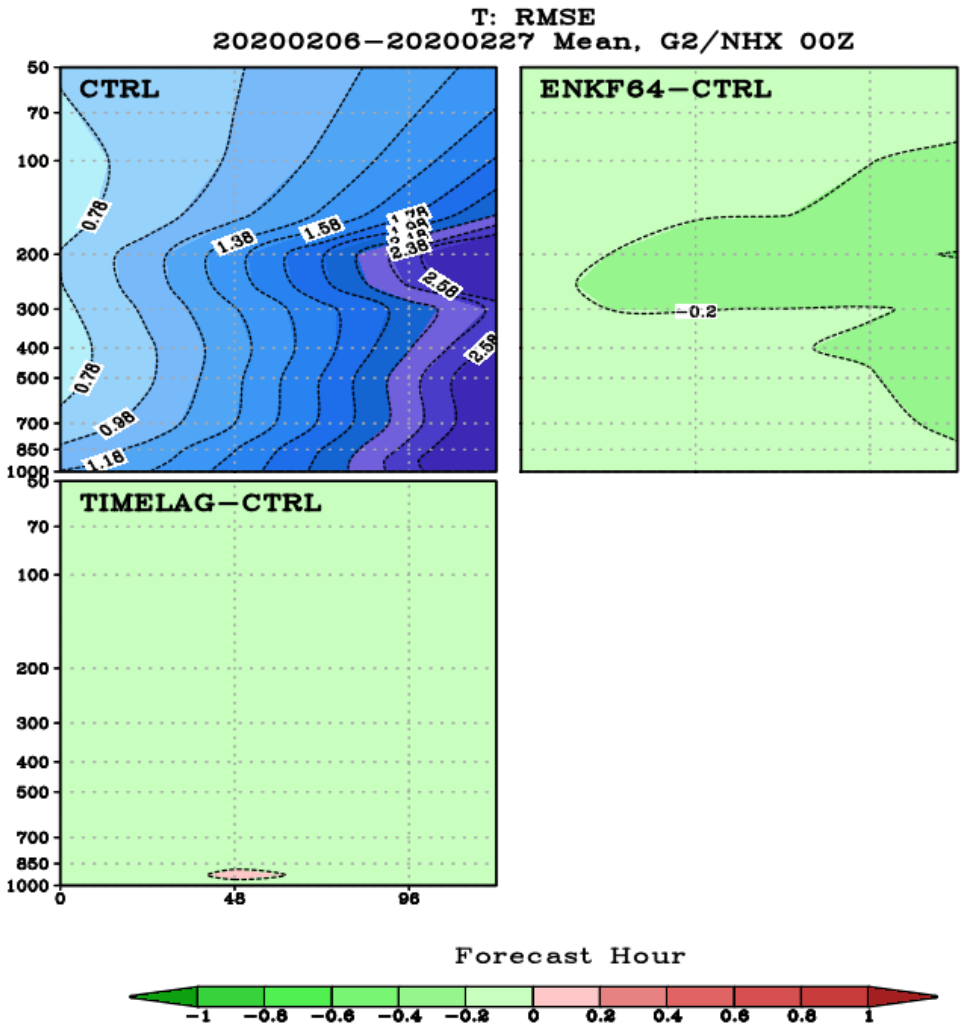


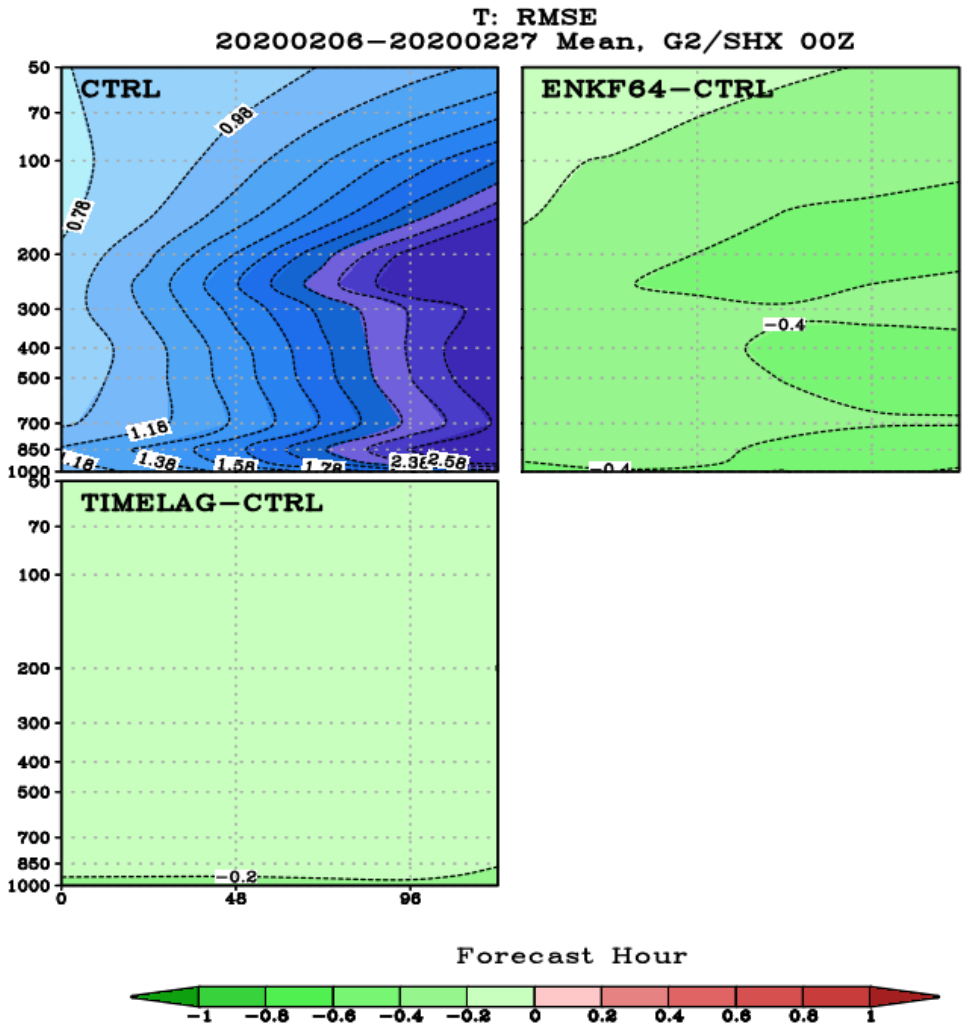




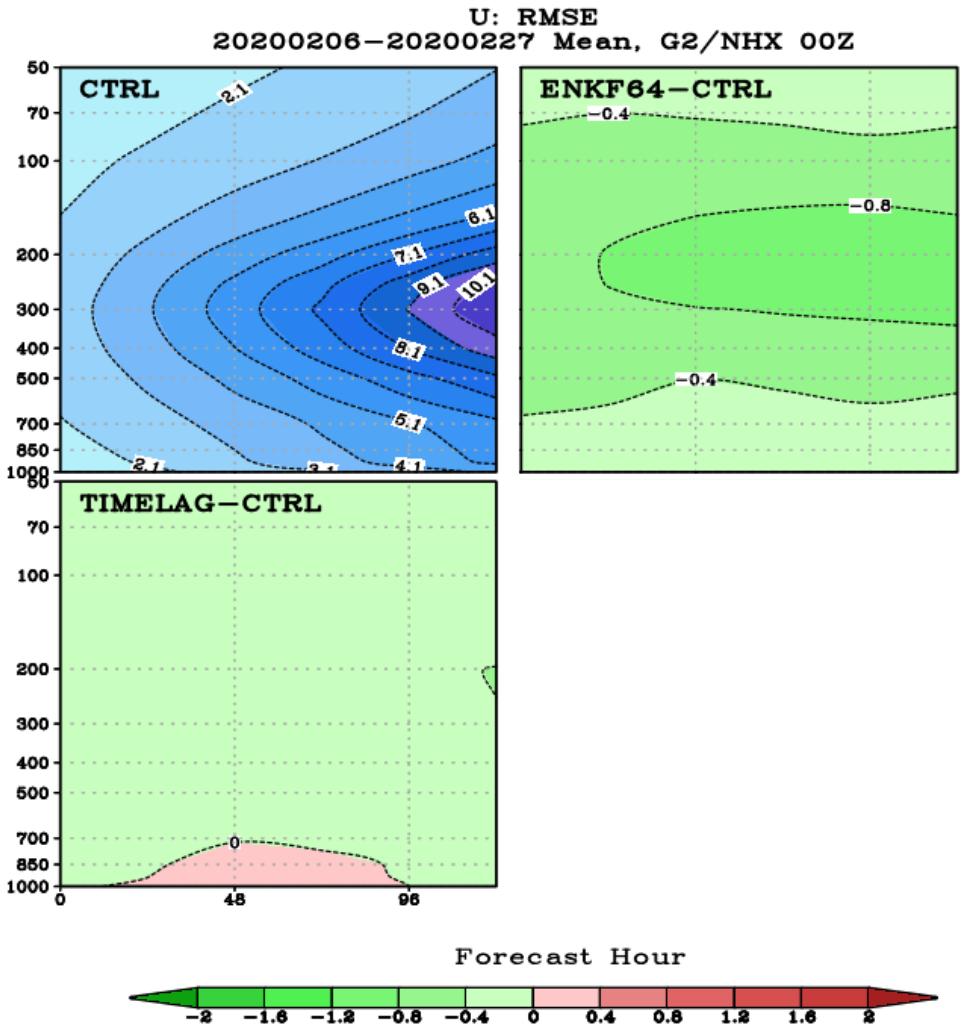


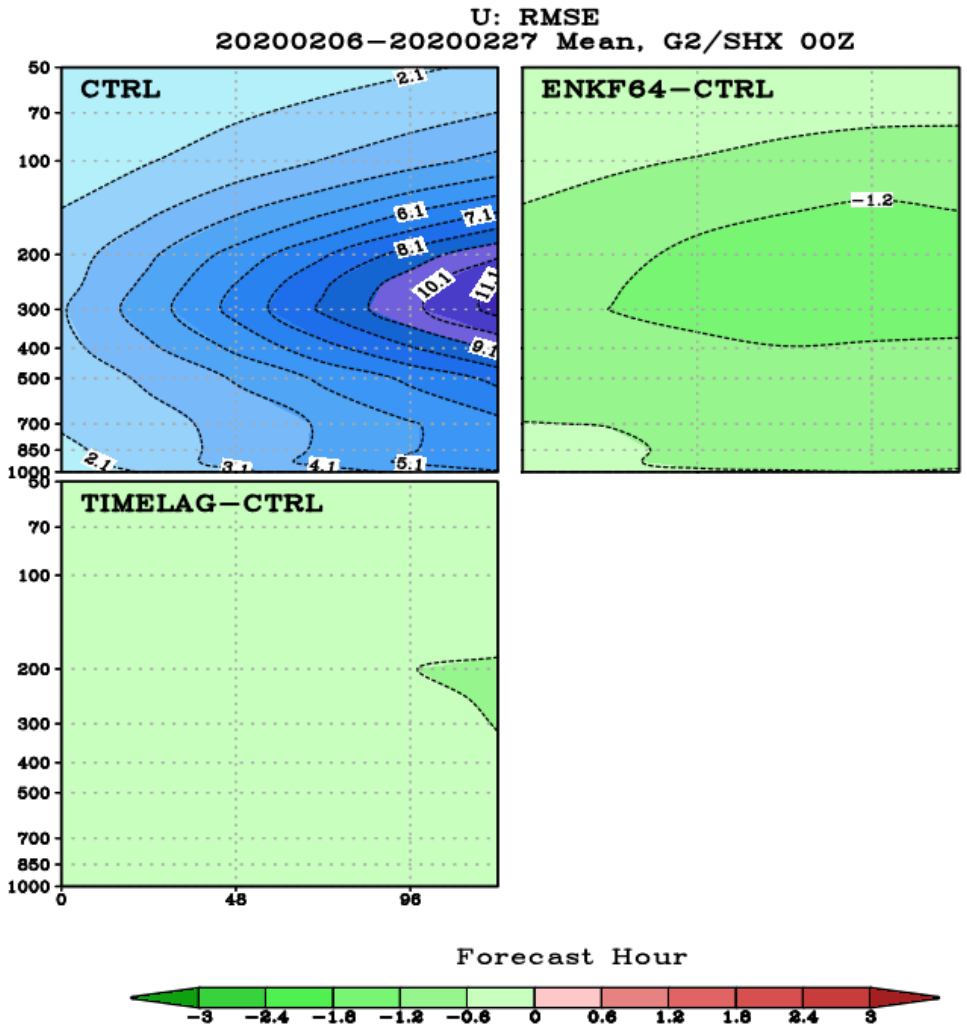
1st to 5th day forecast against NCEP analysis (2020010120--2020022300) NH, SH RMS temperature error





1st to 5th day forecast against NCEP analysis (2020010120--2020022300) NH, SH RMS wind error





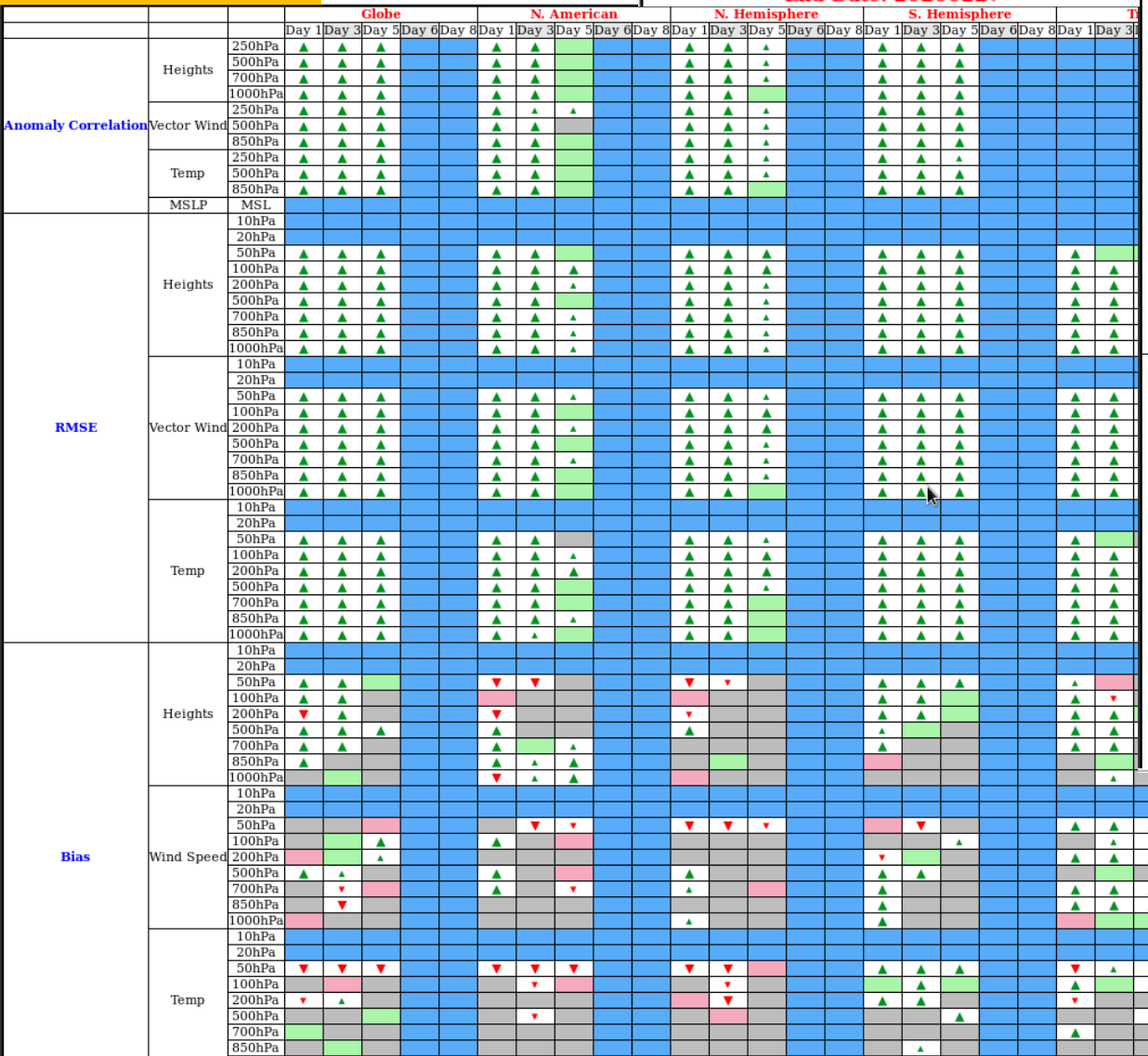
2020020600 ~ 2020022700

ENKF64-TIMELAG

EMC Verification Scorecard
Symbol Legend

- ▲ ENKF64 is better than TIMELAG at the 99.9% significance level
- ▲ ENKF64 is better than TIMELAG at the 99% significance level
- ENKF64 is better than TIMELAG at the 95% significance level
- No statistically significant difference between ENKF64 and TIMELAG
- ENKF64 is worse than TIMELAG at the 95% significance level
- ▼ ENKF64 is worse than TIMELAG at the 99% significance level
- ▼ ENKF64 is worse than TIMELAG at the 99.9% significance level
- Not statistically relevant

Start Date: 20200206
End Date: 20200227



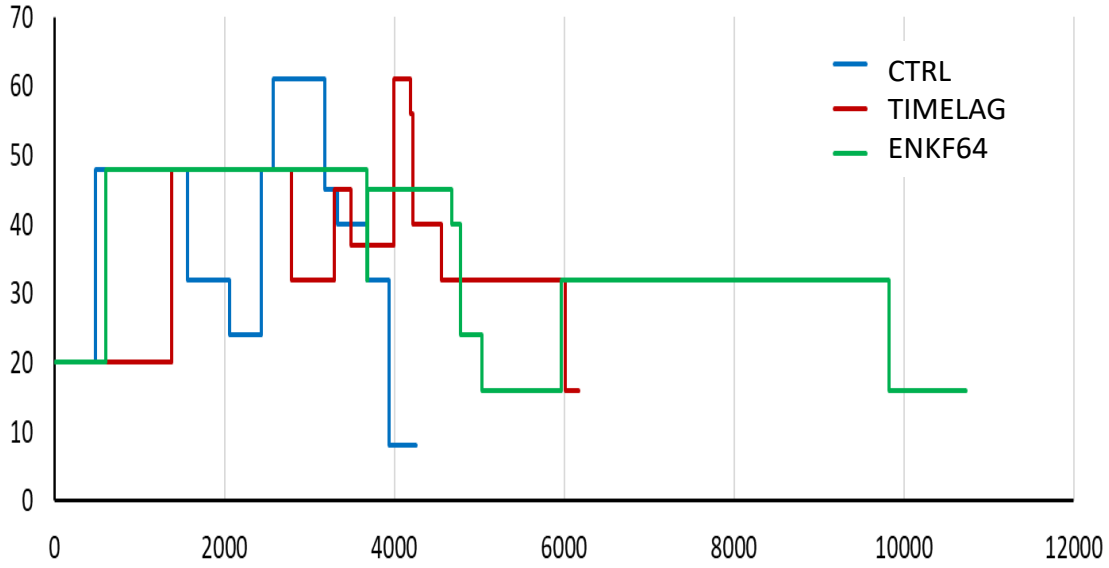
TIMELAG-CTRL

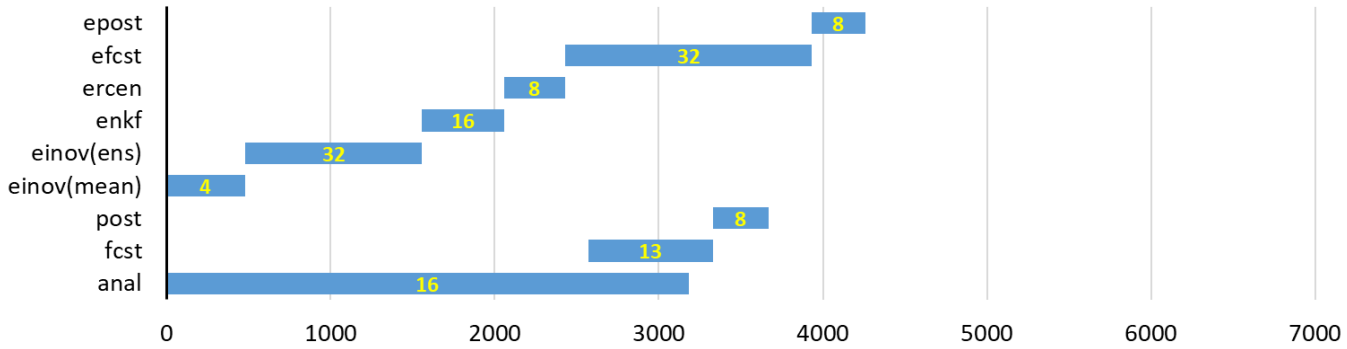
EMC Verification Scorecard
Symbol Legend

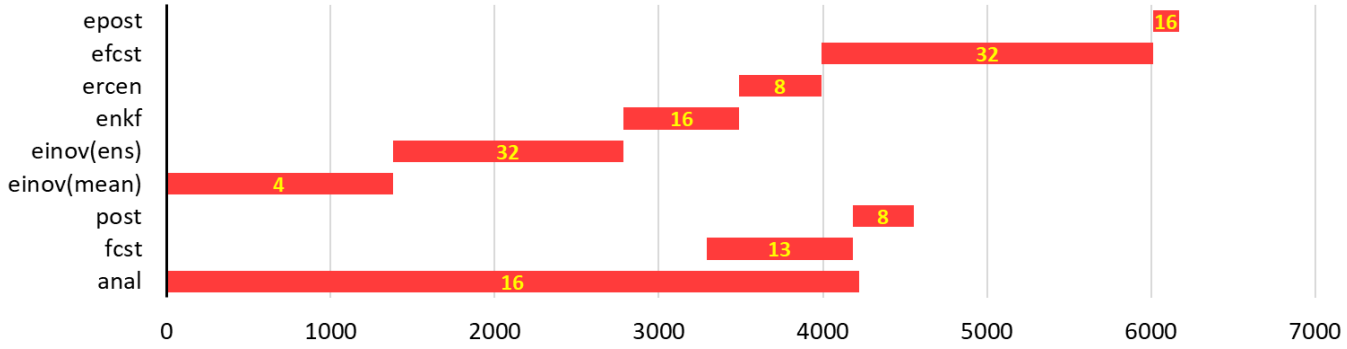
- ▲ TIMELAG is better than CTRL at the 99.9% significance level
- ▲ TIMELAG is better than CTRL at the 99% significance level
- TIMELAG is better than CTRL at the 95% significance level
- No statistically significant difference between TIMELAG and CTRL
- TIMELAG is worse than CTRL at the 95% significance level
- ▼ TIMELAG is worse than CTRL at the 99% significance level
- ▼ TIMELAG is worse than CTRL at the 99.9% significance level
- Not statistically relevant

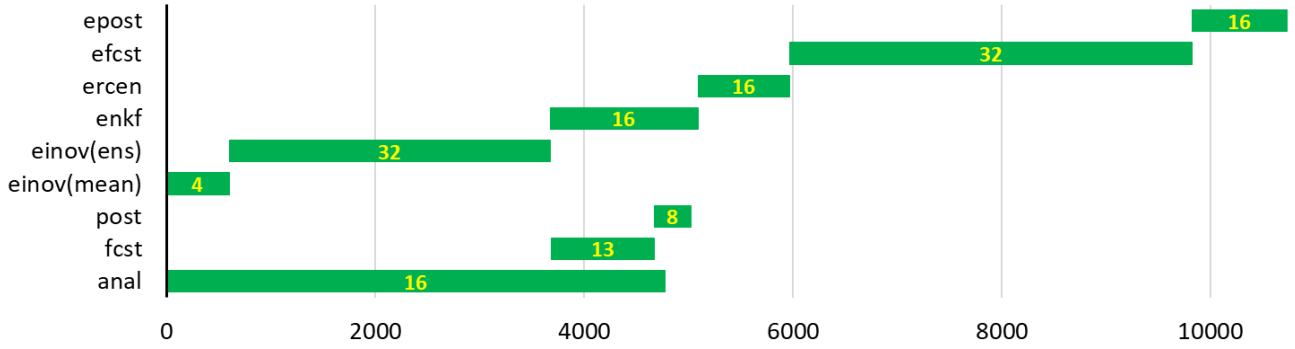
Start Date: 20200206
End Date: 20200227

Cost comparison between CTRL , TIMELAG and ENKF64

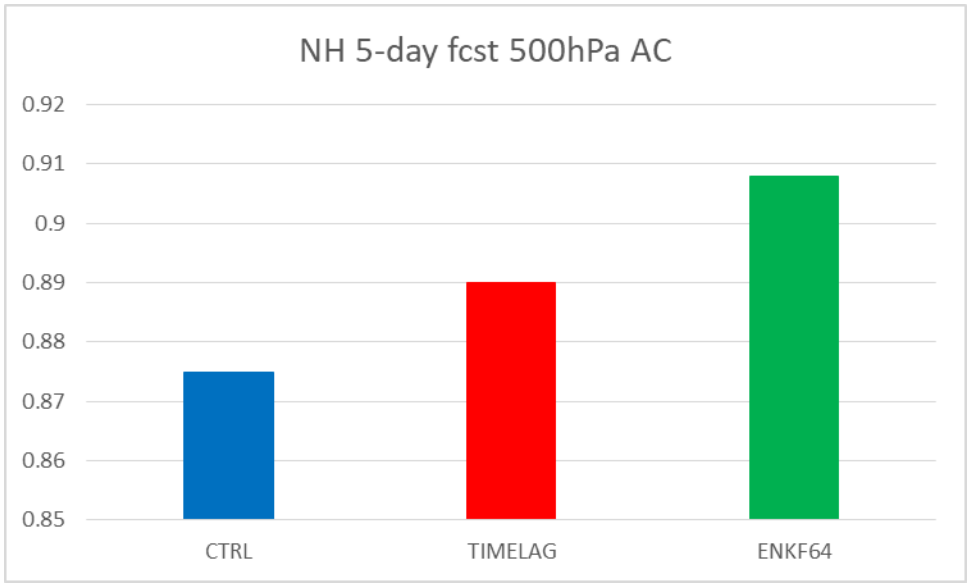


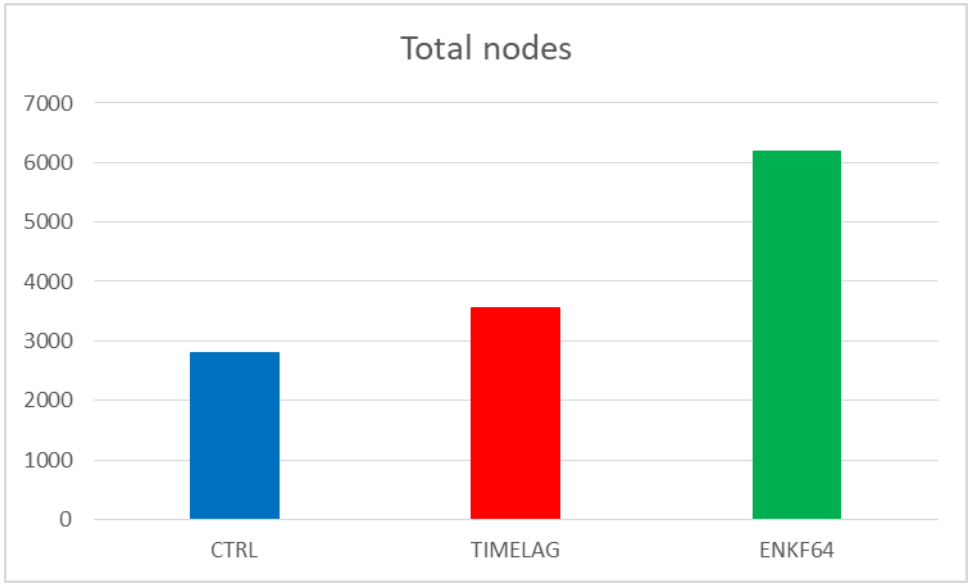






Relative skill and cost





1.7%

3.7%

27%

120%

Summary

- Using additional time-lagged members in hybrid-3DEnVar shows better results in 5-day forecast than the pure hybrid-3DEnVar in FV3GFS, similar to the results in CWBGFS.

- The analysis fields of TIMELAG and ENKF64 show similar pattern for a mid-latitude low in both phase and structure.

- Compared to CTRL, ENKF64 increase its cost by 120%, while TIMELAG experiment shows only 27% increase on its cost.

The End

- Thank you for your attention

	CTRL			Time-Lag			64 EnKF		
	node	Time(min)	Node-hour	node	Time(min)	Node-hour	de	Time(min)	Node-hour
anal	16							80	1280
fcst	13							16	208
post	8							6	48
einov(mean)	4							10	40
einov(ens)	4*8						8	51	1632
enkf	16							24	448
ercen	8							15	240
efcst	4*8						8	64	2048
epost	8							15	240
Total Node-hour									6184