

Impact of Equatorial Atlantic Variability on ENSO Predictive Skill

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SUMMARY

Observations have shown that summer Atlantic Niños (Niñas) favor the development of Pacific Niños (Niños) the following winter¹. Here we examine how well climate models capture this teleconnection and its impact on the seasonal prediction skill of ENSO. We combine a multi-model analysis of 15 state-of-the-art prediction systems (NMME²) with a sensitivity study performed with EC-Earth, which applies a correction in SST mean state and variability in the equatorial Atlantic (between 5° S-5° N).

- Models have a substantial intermodel spread in late autumn ENSO prediction skill.
- An improved representation of equatorial Atlantic variability in summer and its teleconnection with the Pacific relates to enhanced skill of autumn/winter ENSO.
- The sensitivity study shows that correcting the SST in equatorial Atlantic improves forecast skill in the autumn/winter Tropical Pacific.
- **The equatorial Atlantic is affected by long-standing model biases that can deteriorate its prediction skill³. Reducing these biases offers the potential to increase the prediction skill of ENSO.**

2a. Sensitivity study

3 sets of seasonal predictions with EC-Earth (1981-2018):

1. **CTR** A baseline prediction.
2. **NUD-VAR** identical to CTR, but with observed SST prescribed in the equatorial Atlantic (5° S-5° N). The model runs freely elsewhere.
3. **NUD-JJAS**, same as 'NUD-VAR', but with SST nudging only from June to September. The model runs free afterwards.

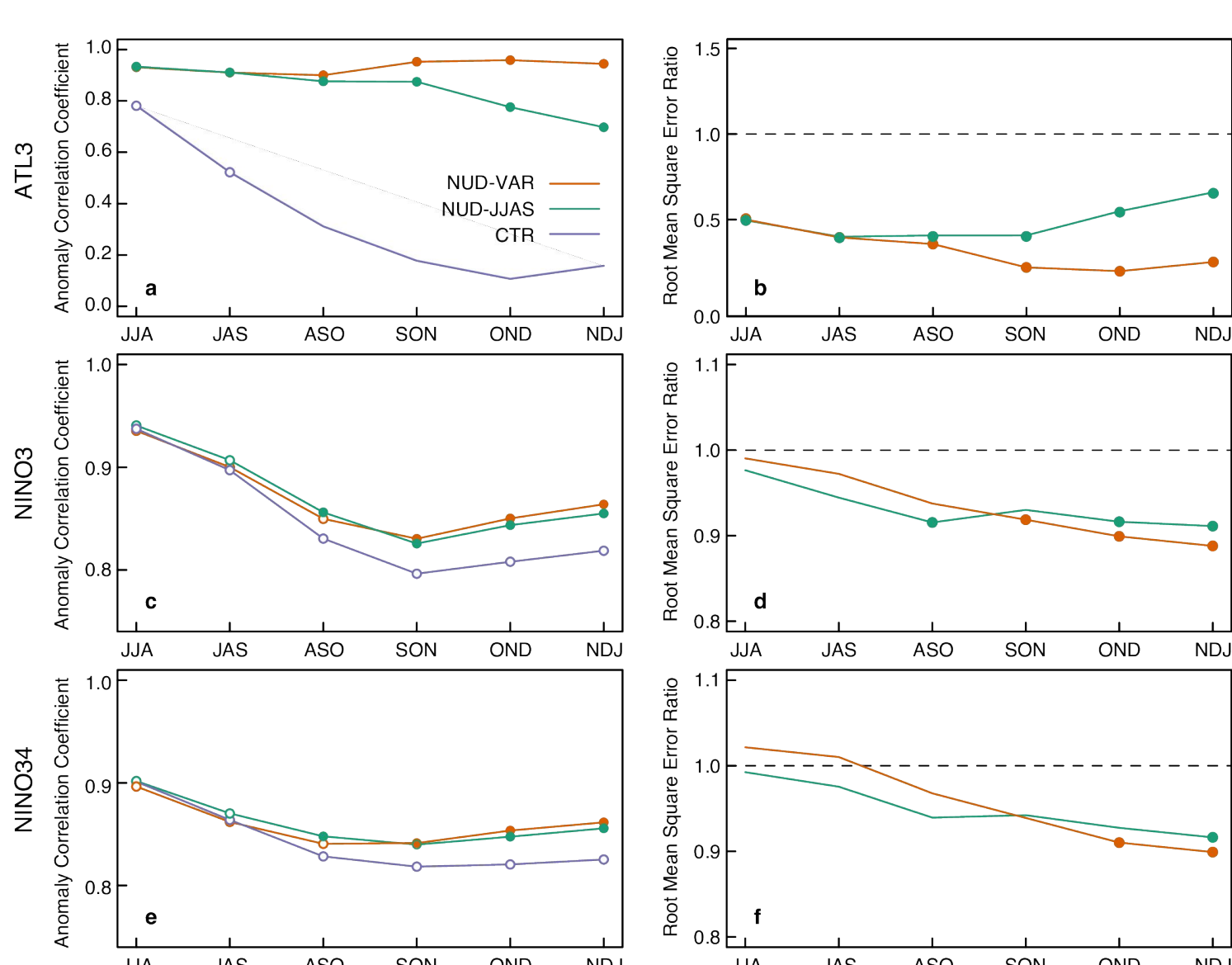


Fig 3: a) Skill for the ATL3 SST index. Empty circles when $p < 0.05$. Full circles when NUD-JJAS or NUD-VAR have significantly higher skill than CTR ($p < 0.05$). b) Ratio between RMSE of ATL3 in the ATL3-nudged forecasts and the corresponding RMSE in the CTR. c-f) Same as in panels a, b but for the Niño3 and Niño3.4 indices. All metrics are evaluated against HadISSTv1.1, over the 1981-2018 period.

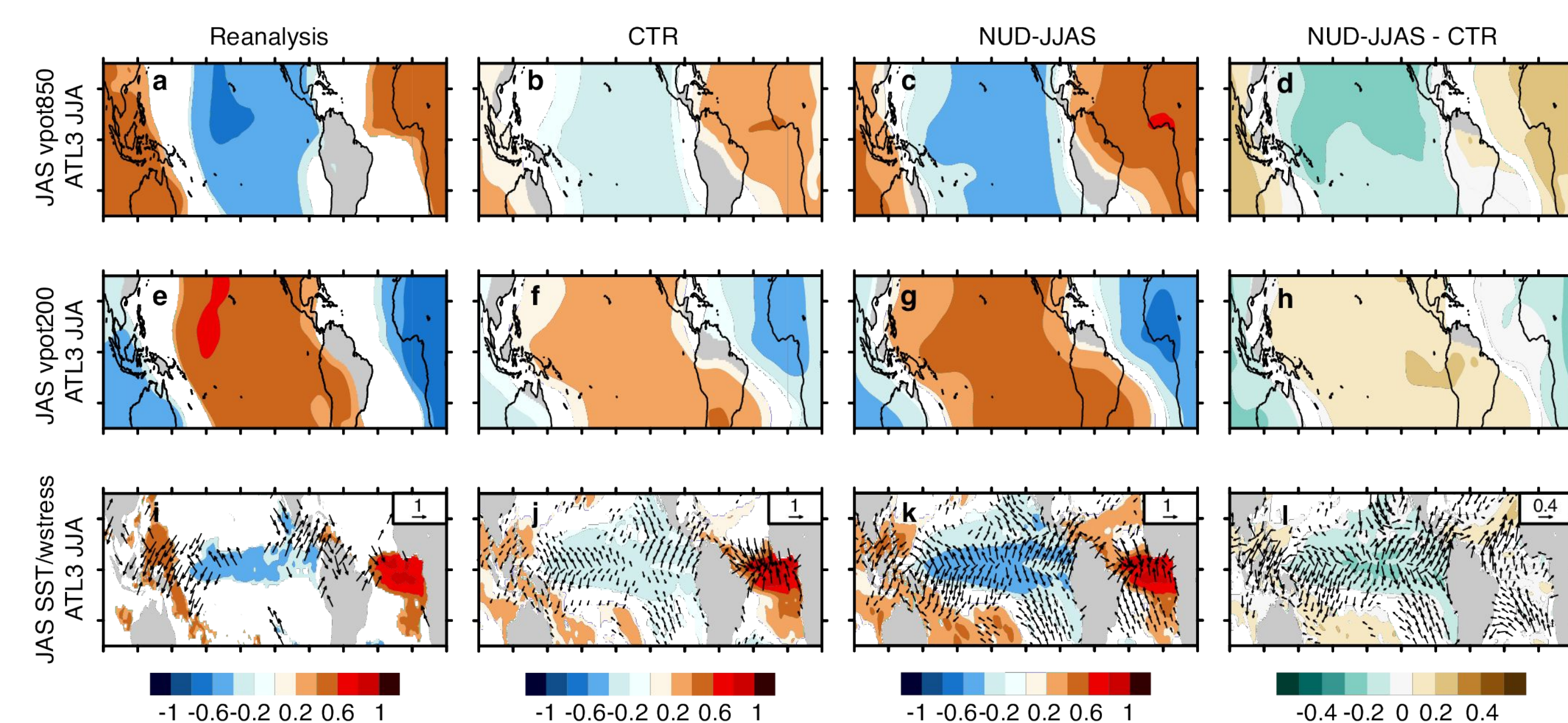


Fig 4. a-c) Correlation pattern between JJA ATL3 index and the JAS velocity potential at 850 hPa for ERA-interim (1st column), CTR (2nd column) and NUD-JJAS (3rd column). Only significant values at a 95% confidence level are shown. d) Differences between the correlations in panels c-b. Only significant differences at the 95% confidence level are shown. e-h) The same as in a-d) but against the velocity potential at 200 hPa. i-l) As in a-d) but for the SSTs (in shaded colors) and the surface winds (in vectors).

1. Multi-model ensemble

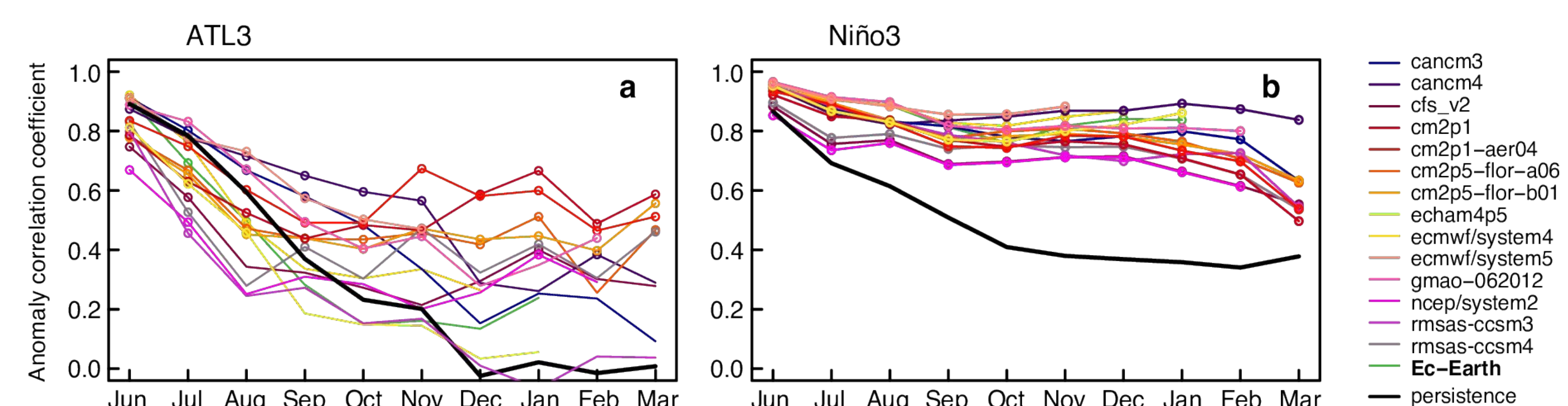


Fig 1: a) Prediction skill (ACC) of ATL3 SST in each prediction system (reference is HadISSTv1.1) for 1981-2011. The black line indicates the persistence b) The same but for the prediction skill of Niño3 SST. Empty circles where $p < 0.05$.

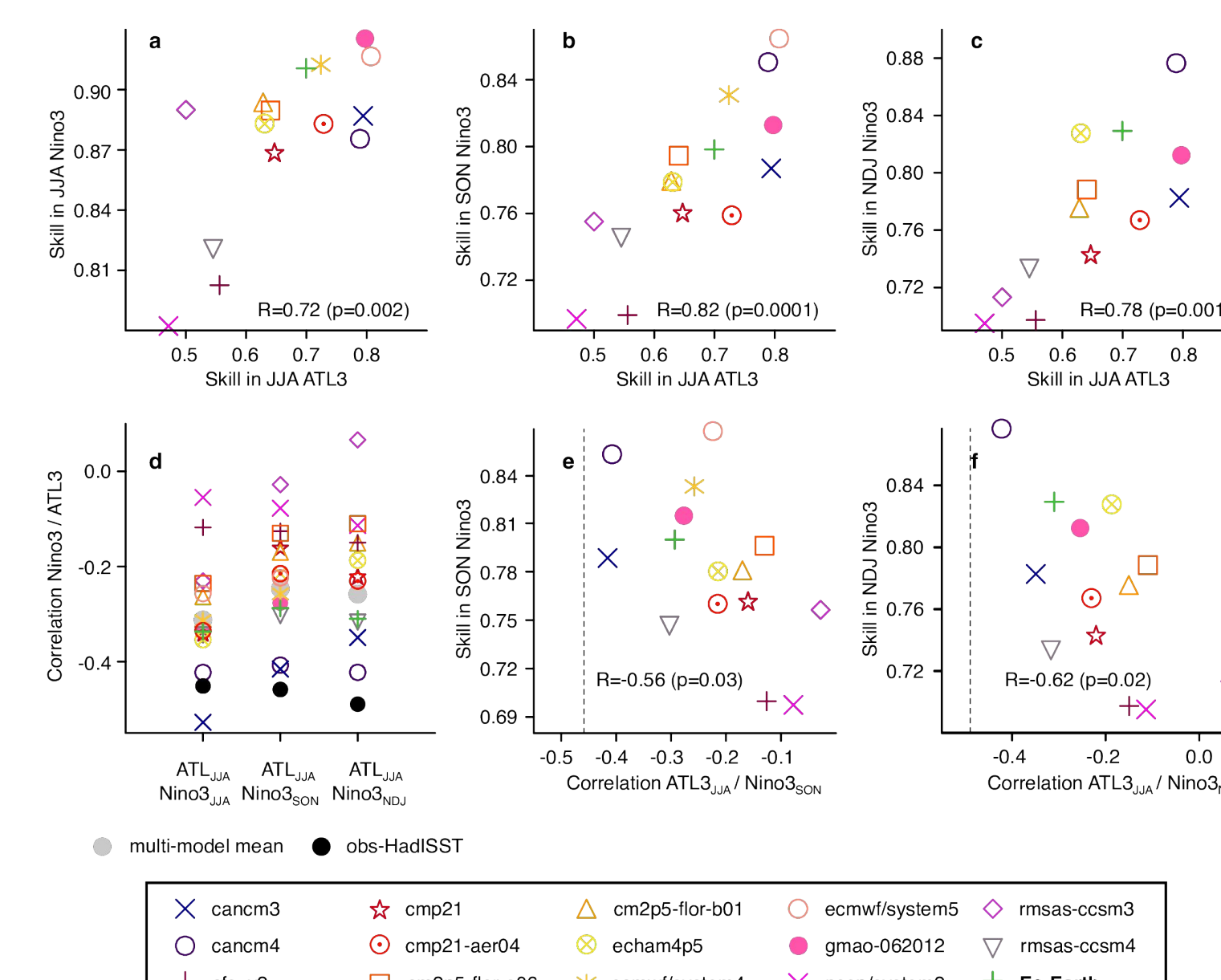


Fig 2: a-c) Scatter plots of skill in JJA ATL3 against the skill of Niño3 SST in JJA, SON and NDJ. d) Teleconnection Strength, evaluated by the correlation coefficient of ATL3 SST in JJA and Niño3 SST in JJA, SON and NDJ. Black dots are for HadISSTv1.1. e-f) Scatter plots of the skill in SON/NDJ Niño3 SST against the strength of the teleconnection between JJA ATL3 SST and SON/NDJ Niño3 SST.

- ATL3 has comparatively lower skill and a large inter-model spread. Niño3 is highly predictable, but with an inter-model spread that increases with forecast time (Fig 1).
- SON/NDJ Niño3 skill is linearly related with both ATL3 JJA skill and the strength of the teleconnection (Fig 2). The higher the ENSO skill is, the stronger (and therefore more realistic) the teleconnection tends to be.

2b. Sensitivity study

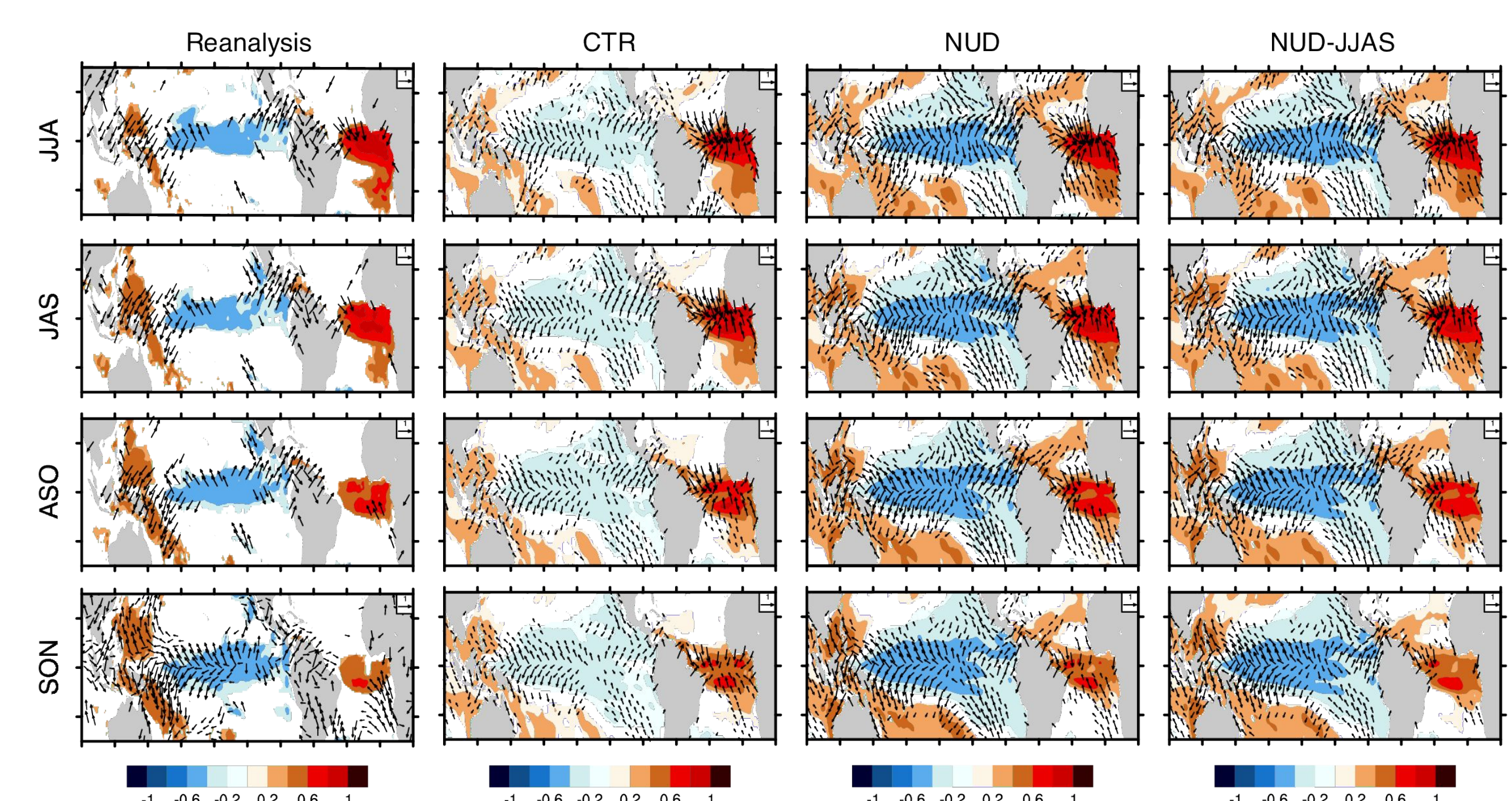


Fig 5. As in Fig 4i-l but for JJA, JAS, ASO and SON.

- NUD-VAR & NUD-JJAS show significant improvements in skill (ACC) and RMSE in Niño3/Niño3.4 in autumn and winter (Fig 3).
- NUD-VAR & NUD-JJAS show improvement in the representation of the teleconnection, evaluated with the lagged correlation between the JJA ATL3 SST index and SST/velocity potential at 200/850 hPa (Figs 4 & 5).

1. Rodríguez-Fonseca, B. et al. Are Atlantic Niños enhancing Pacific ENSO events in recent decades? Geophys. Res. Lett. 36, L20705 (2009).
2. Kirtman, B. P. et al. The North American multimodel ensemble: phase-1 seasonal-to-interannual prediction; phase-2 toward developing intraseasonal prediction. Bull. Am. Meteorol. Soc. 95, 585–601 (2014).
3. Richter, I. et al. An overview of coupled GCM biases in the tropics. Indo-Pacific Clim. Var. Predict. 7, 213 (2015).