Predictability of Long lived Rossby Wave Packets During Southern Hemisphere Summer
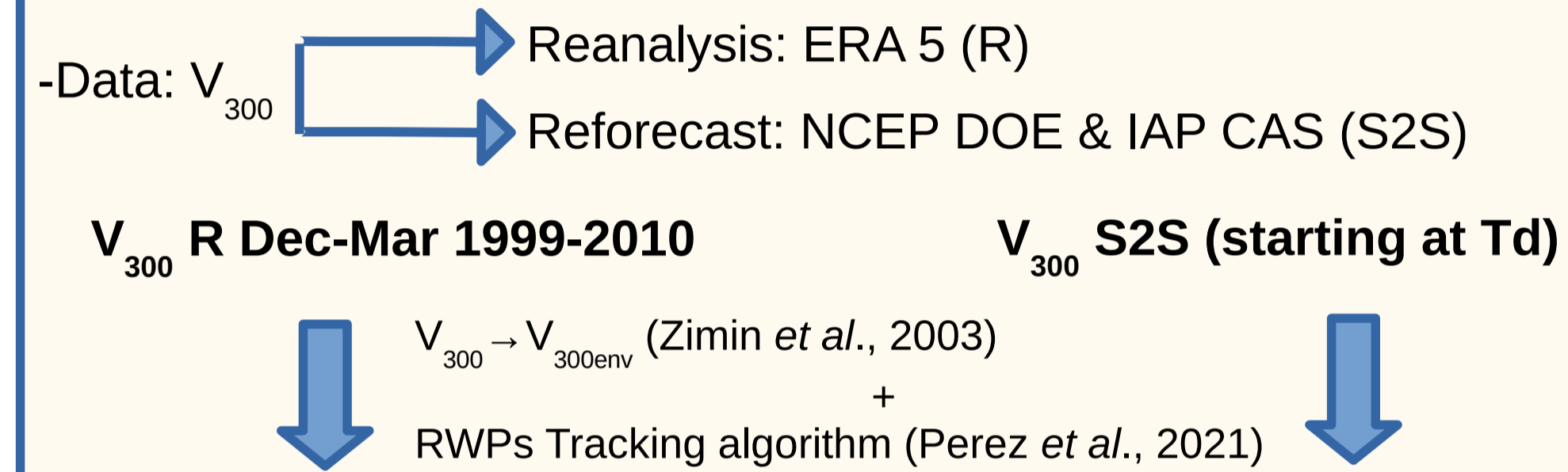
Email:iperez@fisica.edu.uy

@IagoPerezFern
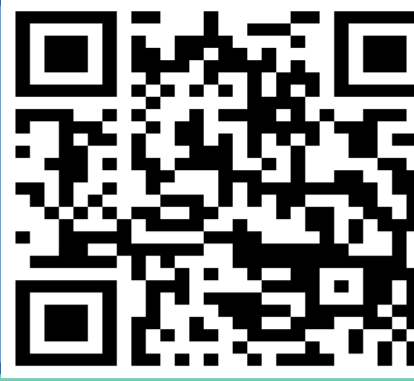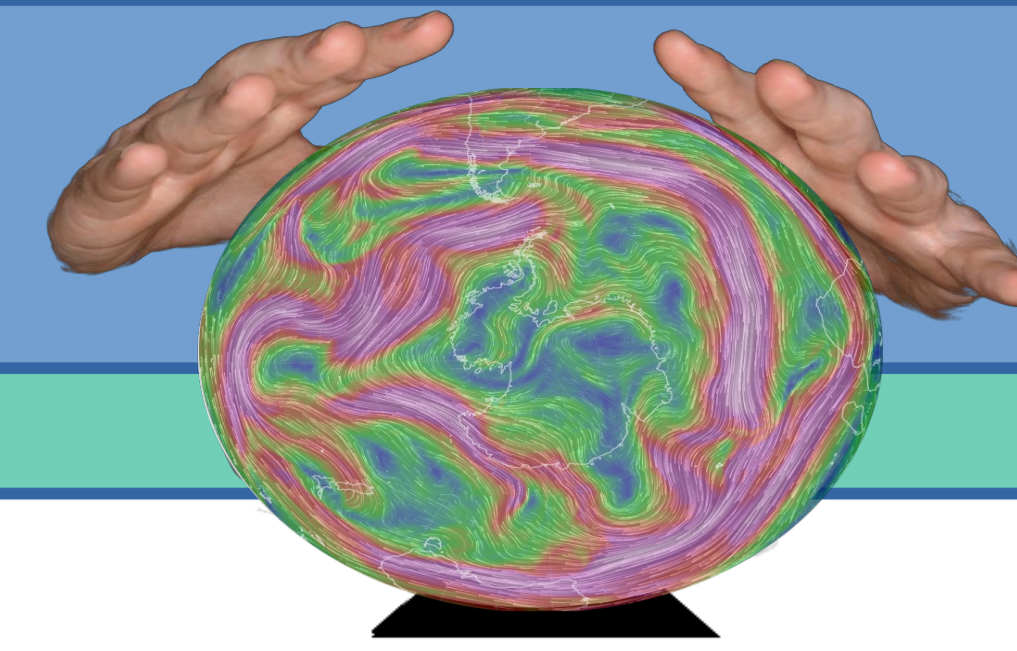
Pérez I [a] and Barreiro M [a]

[a]Departamento de Ciencias de la Atmósfera y Física de los Océanos , Facultad de Ciencias ,Universidad de la República, Montevideo, Uruguay

Motivation

-Rossby Wave Packets or RWPs are linked to the apparition of extreme weather events such as heatwaves among other phenomena.

-If forecast models represent correctly the propagation of RWPs with lifespan >8 days (LLRWPs) we can improve extreme weather events prediction.

-This study aims to measure how skillful are NCEP and IAP CAS forecast models at predicting LLRWPs development and the conditions that favours the development of simulations with high/low LLRWPs forecast skill.

Methodology

-Area of study: 40-65ºS.

-Data: V_{300}
- Reanalysis: ERA 5 (R)
- Reforecast: NCEP DOE & IAP CAS (S2S)

V_{300} R Dec-Mar 1999-2010 V_{300} S2S (starting at Td)

$V_{300} \rightarrow V_{300env}$ (Zimin et al., 2003)
+
RWPs Tracking algorithm (Perez et al., 2021)

Observed LLRWPs   VS   Forecasted LLRWPs (FRWPs)

- Formation and trayectory.
- V_{300env} at the RWPs center.
- **Date of beginning (Td).**

- Forecasted packet propagation.
- Predicted evolution of $V_{300env.}$
- % of simulations that forecast LLRWPs (skill).

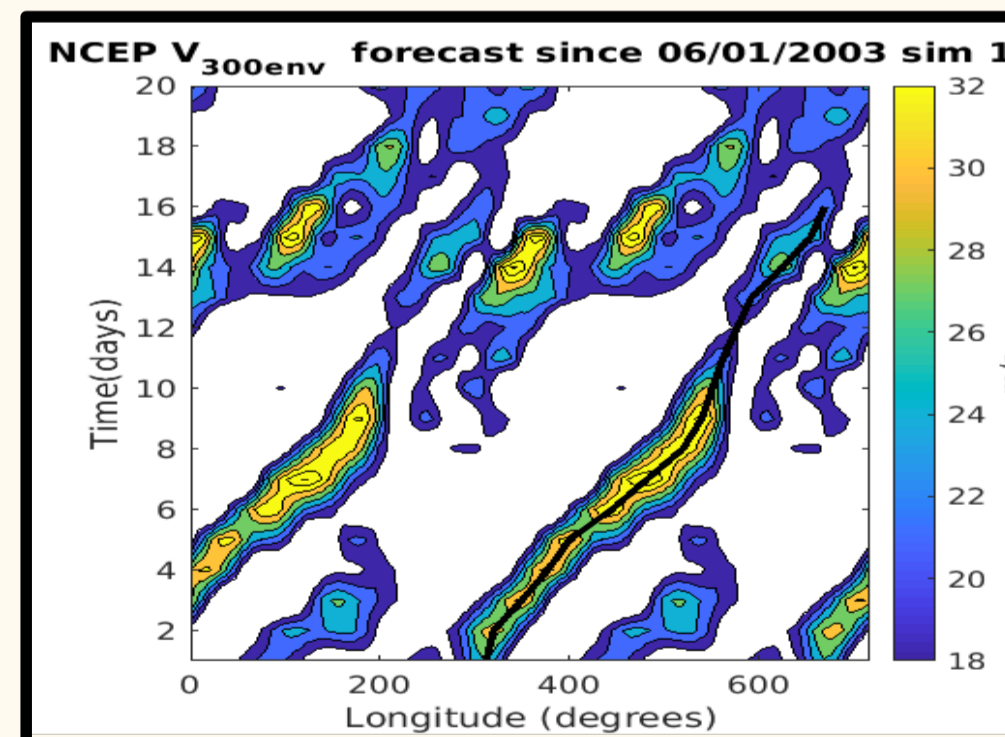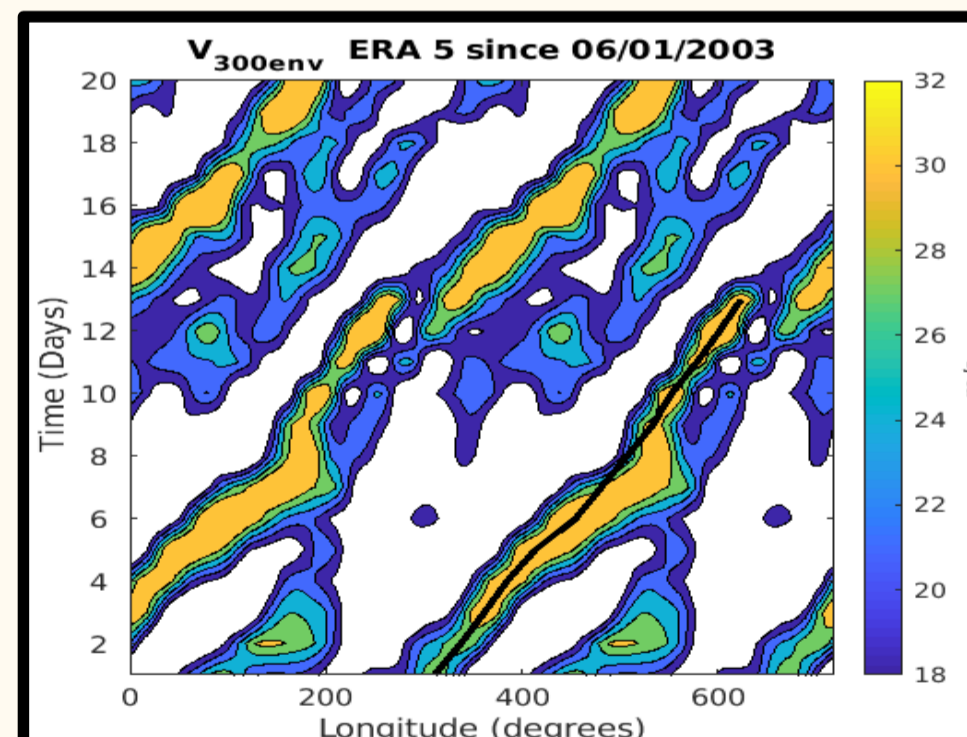
Fig 1. V_{300env} Hovmoller diagram when a LLRWPs was registered in the reanalysis dataset (black line).

Fig 2. Forecasted evolution of V_{300env} from the NCEP model since a LLRWPs was detected. Black line highlights the forecasted trajectory of a LLRWPs.
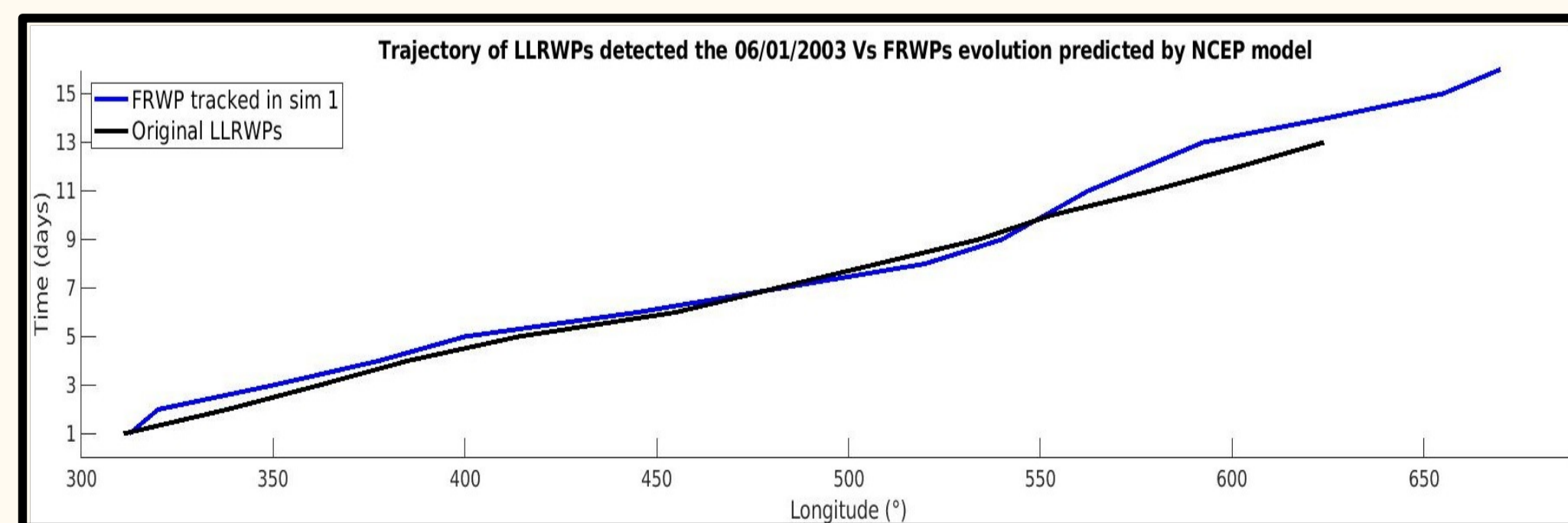

Fig 3. Spagetti plot of the trajectory of an observed LLRWPs (black line in Fig 1) against its forecasted trajectory (black line in Fig 2)
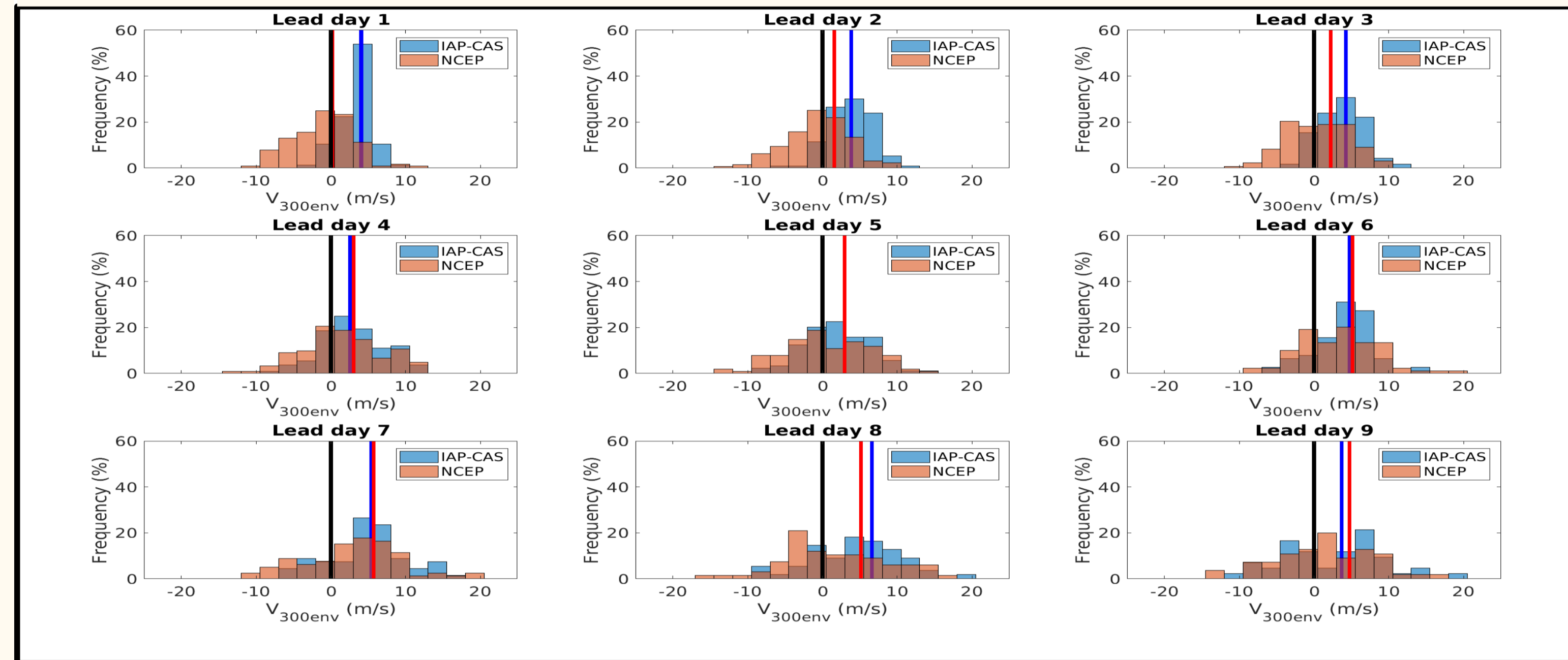
Results

Fig 4. Frequency histogram of the difference of V_{300env} in the center of the wave packets between observed LLRWPs minus the FRWPs. Positive (negative) values signal that the FRWPs forecasted by the model are less (more) energetic compared to the observed LLRWPs. Black lines signals the area of 0 bias whereas red (blue) lines show the median location of the distribution.
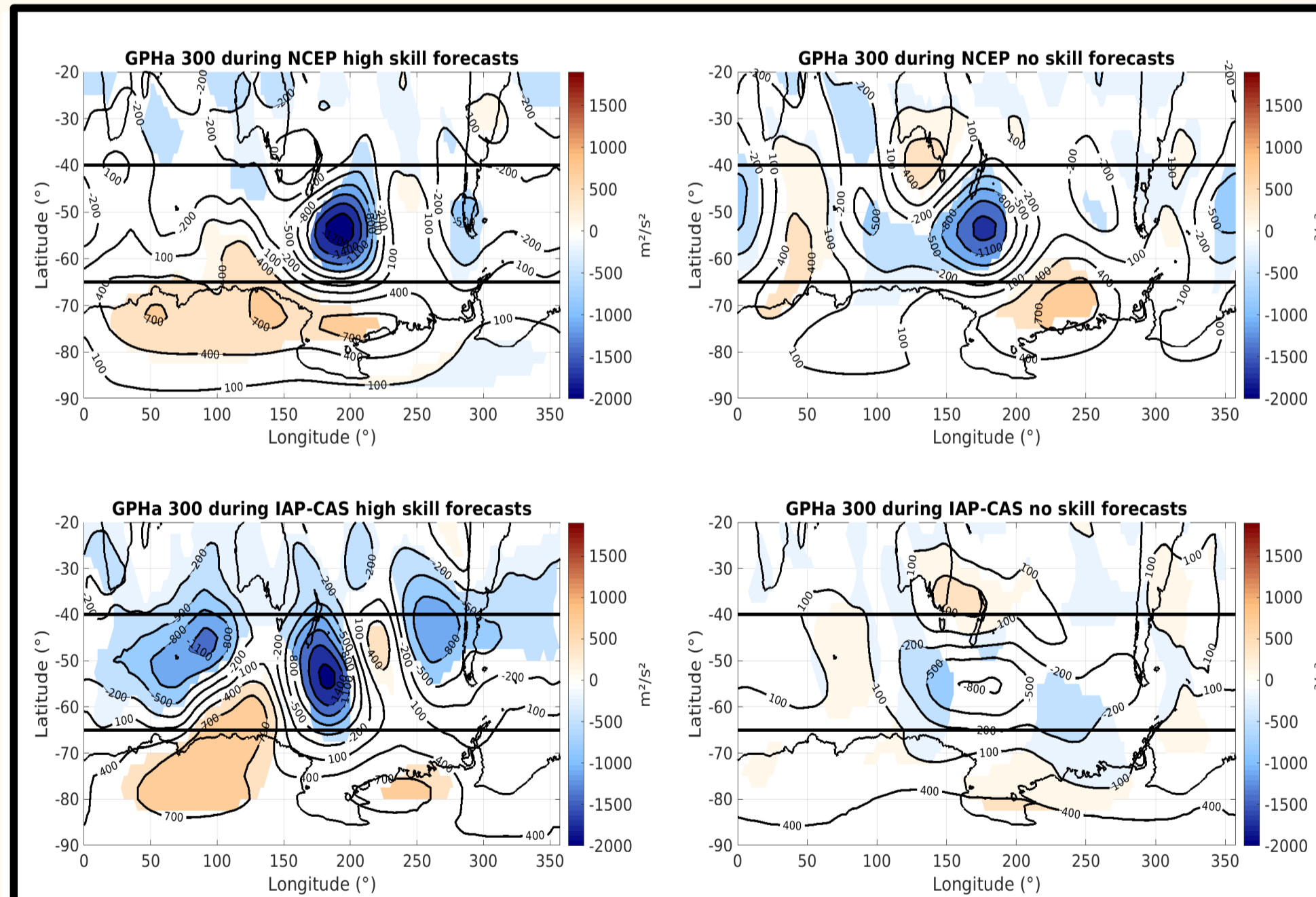

Fig 5. Z_{a300} during the first 10 days of LLRWPs propagation in high and no skill forecasts from NCEP (up) and IAP-CAS (down) model, retaining data with at least 10 % of statistical significance. Orange (blue) areas signal positive (negative) anomalies.
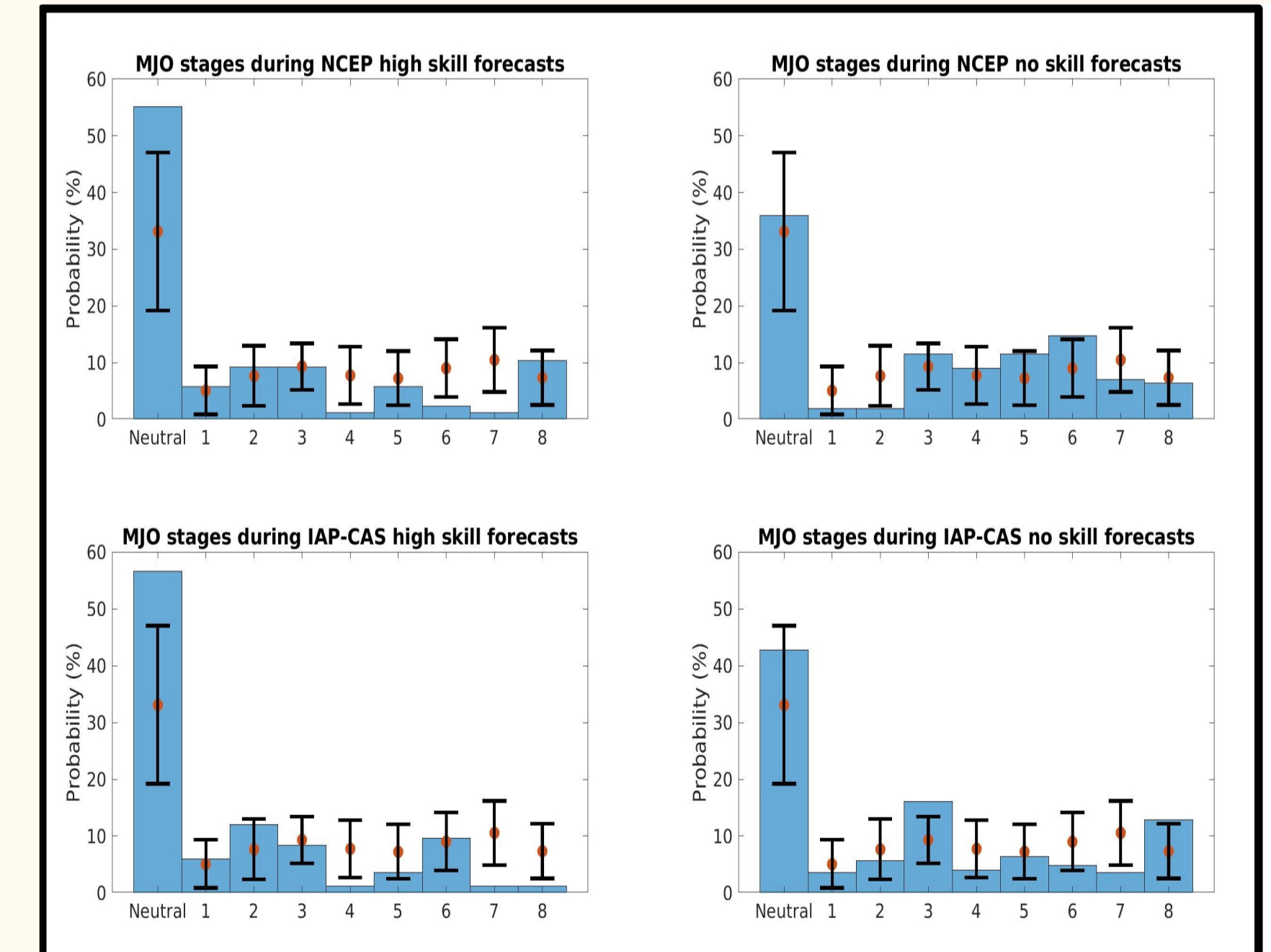

Fig 6. Frequency of the Madden Jullian Oscillation (MJO) phases during LLRWPs propagation in high (left) and no forecast skill (right) in both models. Orange dots signal the mean probability of having the MJO in a certain phase (C) while black lines show the range between C ± its standard deviation.

Conclusions

-Long-lived RWPs forecast is limited to the sinoptic time scale due to a strong drop in the RWPs energy after the 1st week of simulation.

-Simulations with high skill are characterized by the development of a strong cyclonic circulation at the southeast of new Zealand.

-An Inactive Madden Jullian Oscillation favors the development of skillful LLRWPs forecast.

References:
Grazzini, F and Vitart F. 2015 Atmospheric predictability and Rossby wave packets. International Journal. of the Royal . Meteorological. Society, 141(692), 2793-2802. Zimin, V. A., Szunyogh, I., Patil, J. D., Hunt, R. B., & Ott, E. (2003). Extracting envelopes of Rossby Wave Packets. Monthly Weather Review, 131(5), 1011–1017.
Pérez, I., Barreiro, M., & Masoller, C. (2021). ENSO and SAM influence on the generation of long episodes of Rossby Wave Packets during southern hemisphere summer. Journal of Geophysical Research: Atmospheres, 126, e2021JD035467