Predictability of Long-lived of Rossby Wave Packets in S2S models during Southern Hemisphere Austral Summer

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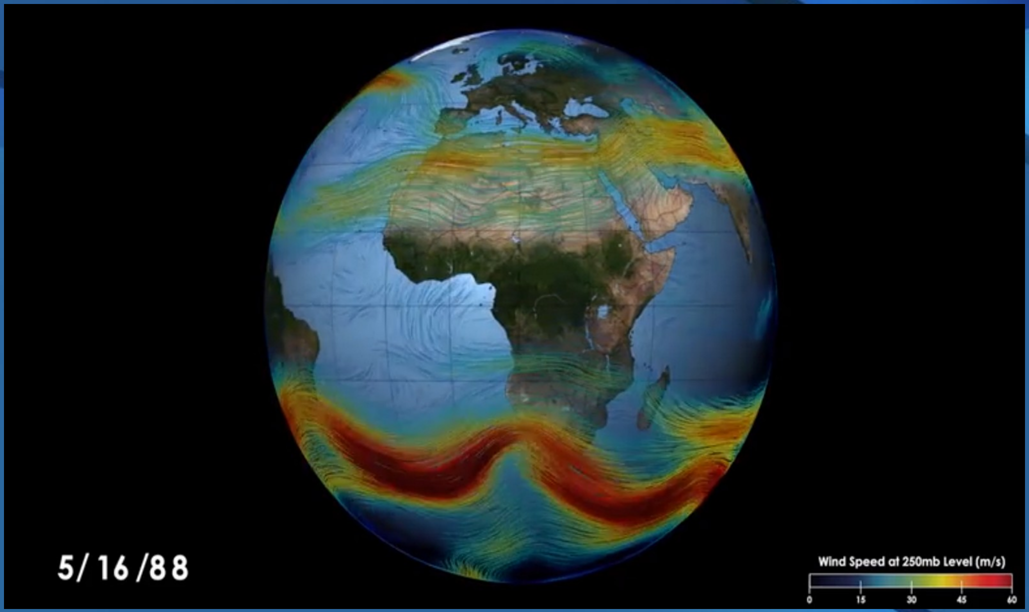
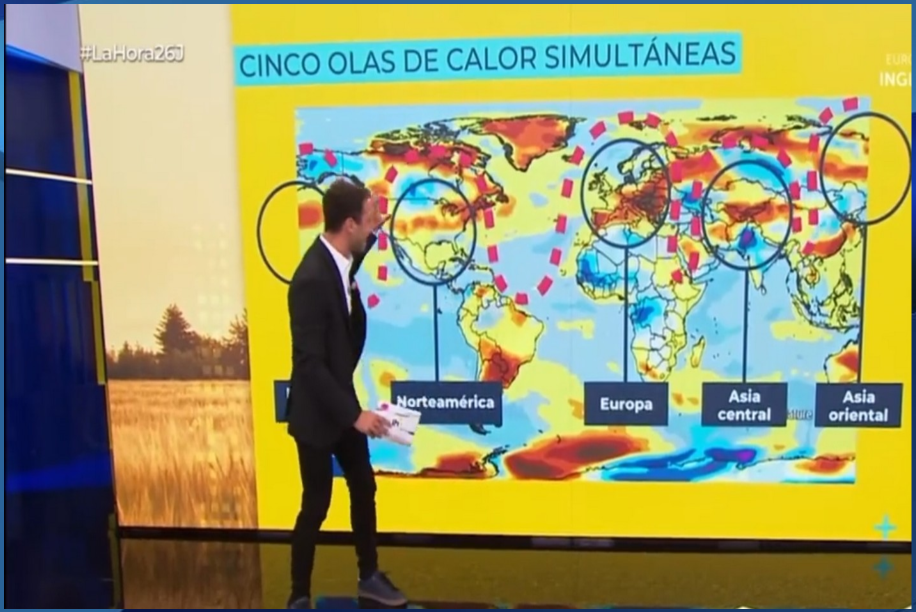
Rossby Wave Packets are deviations of the jet stream linked to extreme weather events



Source: pbslearningmedia.org/



Source: https://twitter.com/i/status1538941467686756352

The goal of the study is assessing the sub-seasonal forecast models skill at predicting LLRWPs

-We focus on the study of long-lived Rossby Wave packets or LLRWPs (duration>8 days) in NCEP and IAP-CAS forecast models.

-If sub-season to seasonal forecast models (S2S) can correctly predict LLRWPs development.

Enhance extreme weather events prediction between 10-30 days

Tracking of Rossby Wave Packets in the reanalysis and S2S models

V_{300} ERA 5 Dec-Mar 1999-2010

V_{300} reforecast NCEP & IAP-CAS (starting at Td)

$V_{300} \rightarrow V_{300env}$ (Zimin *et al*., 2003)

+

RWPs Tracking algorithm (Perez *et al*., 2021)

Observed LLRWPs

- Date of beginning (Td).

VS

Forecasted LLRWPs

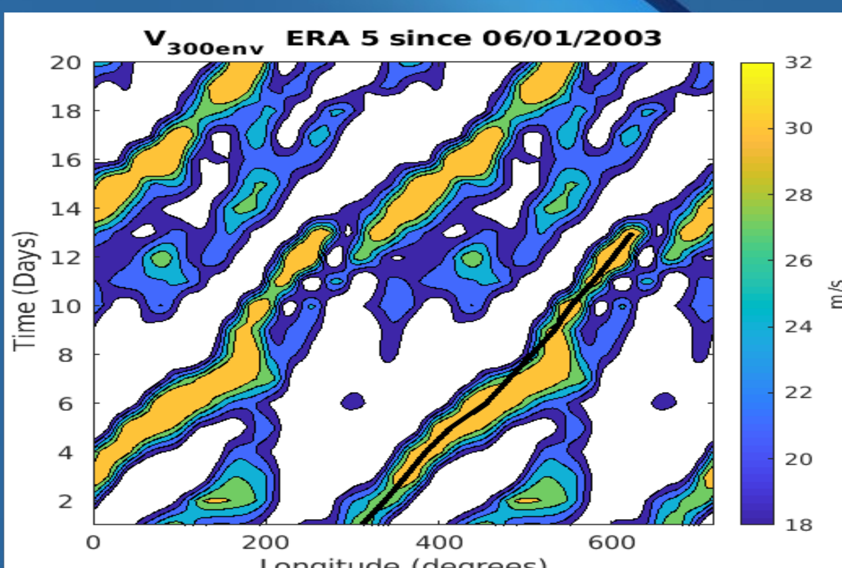


Fig 1. V_{300env} Hovmoller diagram when a LLRWPs was registered in the reanalysis dataset (black line).

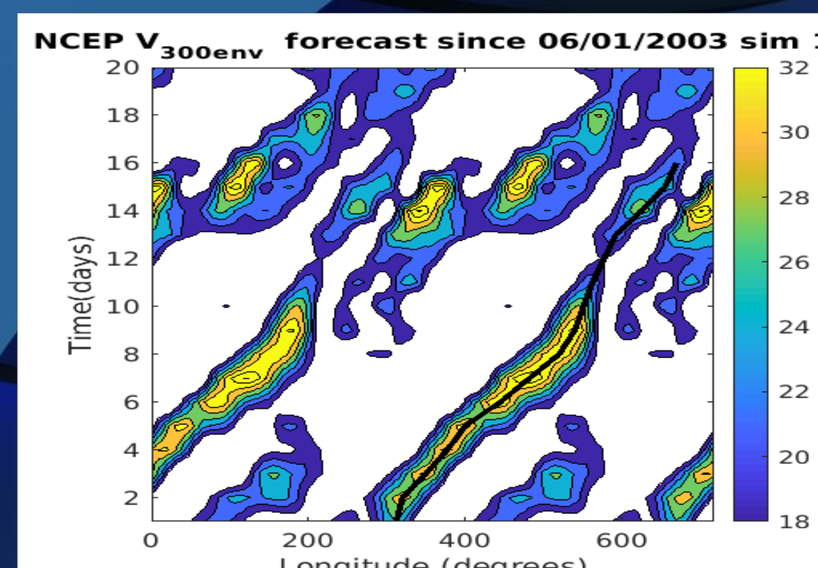


Fig 2. Forecasted evolution of V_{300env} from NCEP model since a LLRWPs was detected. Black line highlights the forecasted trajectory of a LLRWPs.

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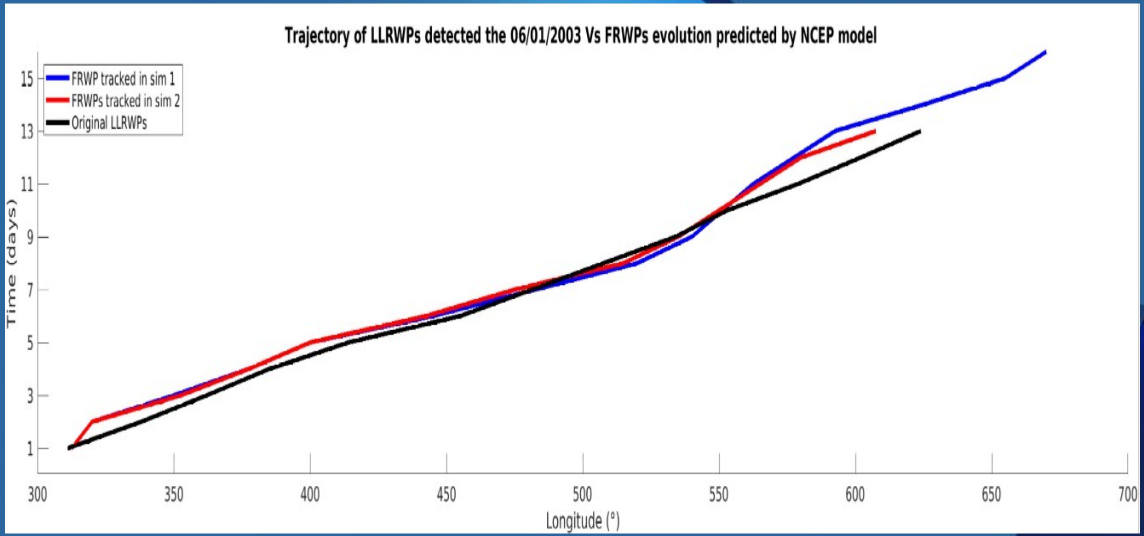

Fig 3. Spaghetti plot of the trajectory of an observed LLRWPs (black line) against its forecasted trajectory (coloured lines).

- -Displacement from original packet.
- -Lifespan.
- -Skill (% simulations that forecast a LLRWPs).

Circulation anomalies between the Indian-Pacific basin affects model´s LLRWPs forecast skill

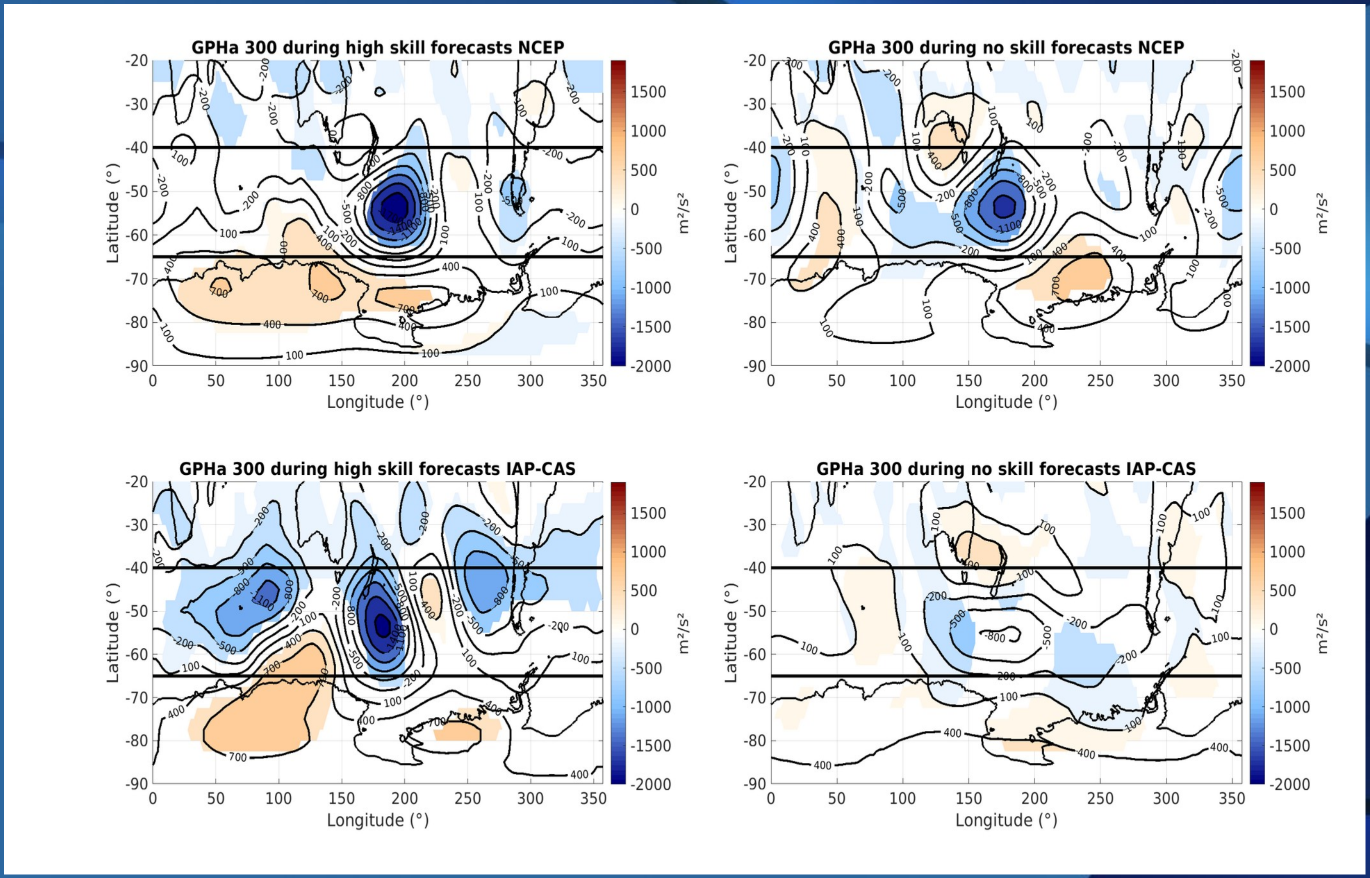

Figure 4: Z_{a300} anomalies during high and no skill LLRWPs forecast from NCEP (up) and IAP-CAS model retaining data from areas with at least 10 % of statistical significance. Orange (blue) areas signal positive (negative) anomalies.

-Development of strong cyclonic anomalies near NZ during high skill forecasts.

-Low skill simulations show a stationary wave packet in the same area.

An inactive Madden-Julian Oscillation favor the development of high skill forecasts

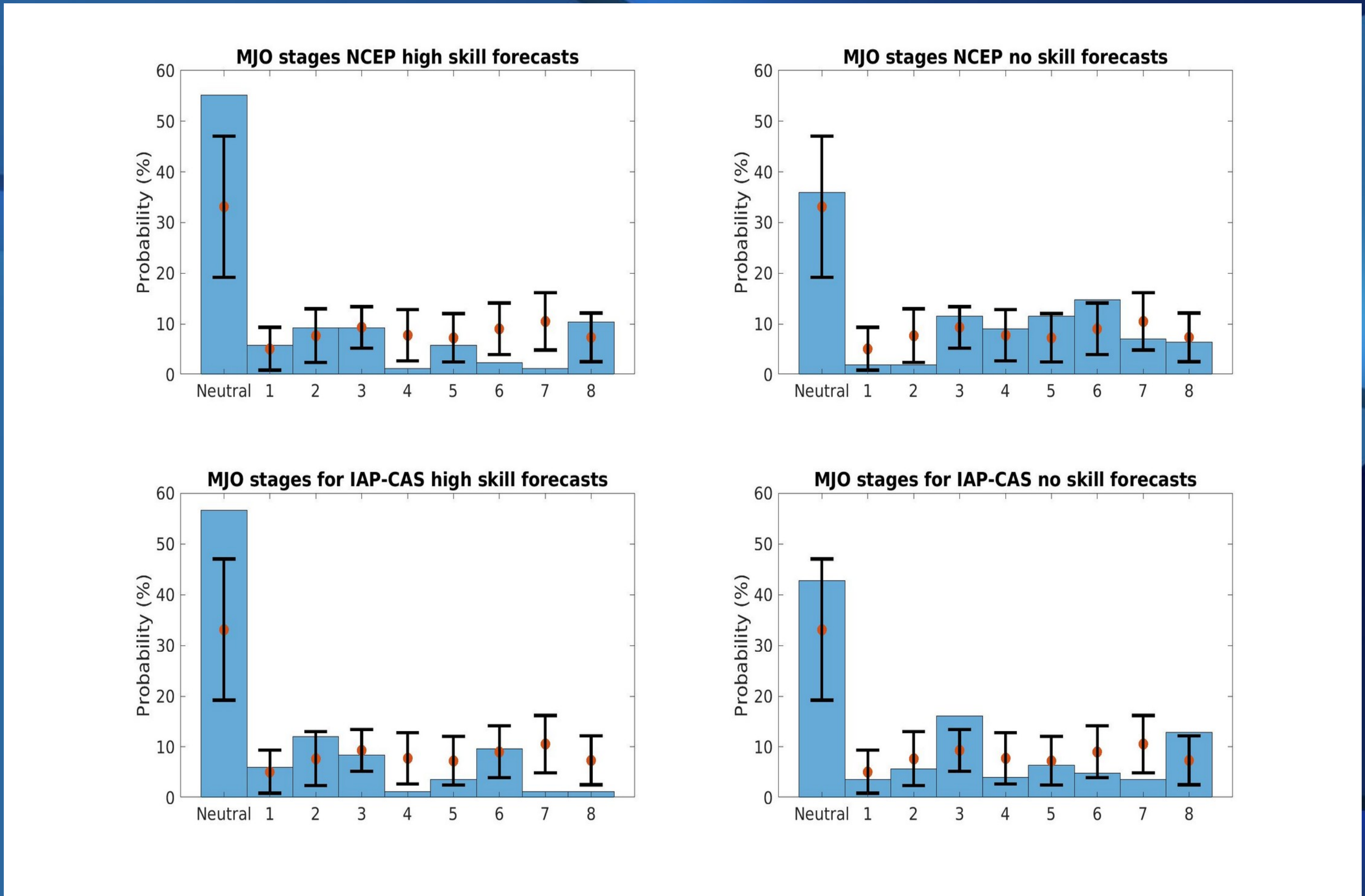

Figure 5. Relative frequency of the MJO phases detected during high skill (left figures) and no skill (right figures) LLRWPs forecasts in NCEP and IAP-CAS models. Orange dots signal the mean climatological probability of finding the MJO in a specific phase (C) and black lines show the range between C ± its standard deviation.

-Skillful forecasts show a unusually inactive MJO.

-Low skill forecasts display different distributions among models.

Summary

-In this study we assessed if NCEP and IAP-CAS models can forecast the development of long-lived Rossby Wave packets, and identified which conditions favor the development of skillful/not skillful forecasts.

-When both models forecast a strong cyclonic circulation near the western Indian basin, they show high predictive skill.

-An inactive Madden-Julian Oscillation favor the development of skillful forecasts.

References

-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, https://doi.org/10.1029/2021JD035467

-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. https://doi.org/10.1175/15200493(2003)131<1011:EEORWP>2.0.CO;2

Extra Slide: RWPs Tracking algorithm

Methodology of the tracking algorithm based in the maximum envelope method:

- 1.-Detection the highest value of the amplitude in the longitudinal axis (x_n) in day t.
- 2.- Search for the position of the maximum amplitude the next day eastward (x_{n+1}).
- 3.-If the distance between points x_n and x_{n+1} is in the range 15-45º, x_n and x_{n+1} are registered as part of the same trajectory. Steps 2 and 3 are repeated in the following days.
- 4.- When a maximum x_m is not within the range specified in step 3, the trajectory is saved and we resume the tracking from the last day we detected the start of a trajectory.
- 5.-Application of proximity criteria (Sagarra and Barreiro 2020) to link interrupted trajectories.

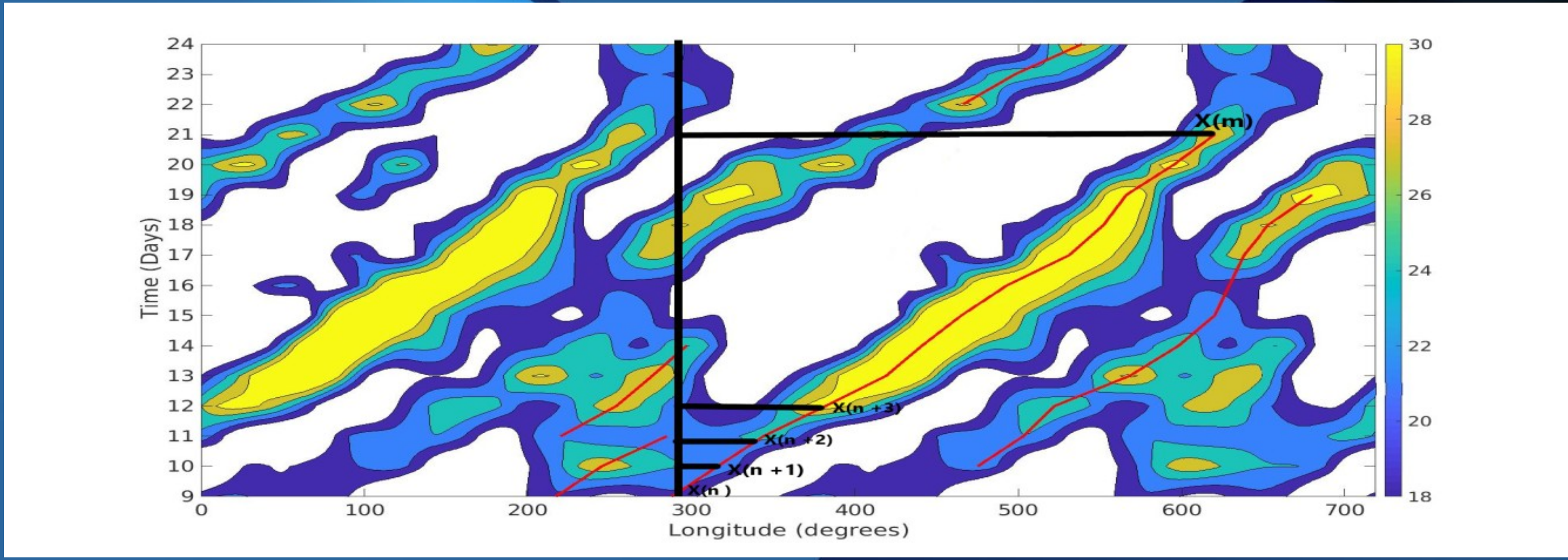

Fig E1: Performance of the tracking algorithm detecting a LL RWPs detected at 09/12/1979.

Extra slide 2: Data processing

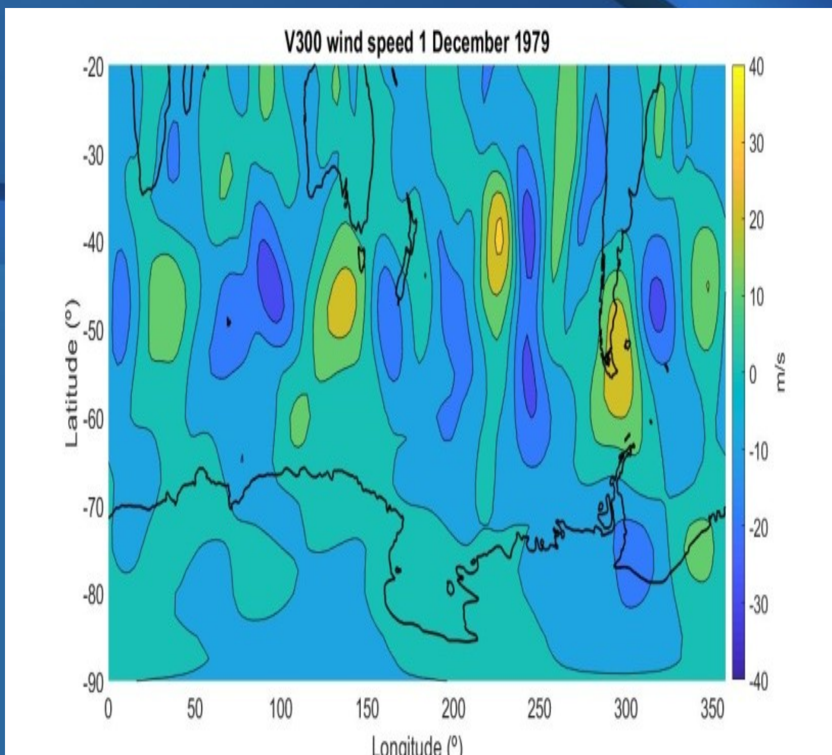

Figure E1: V_{300} anomalies from NCEP dataset.

$$H(u)(t) = \frac{1}{\pi} \, \mathrm{p.v.} \int_{-\infty}^{+\infty} \frac{u(\tau)}{t-\tau} \, d\tau$$

Hilbert transform

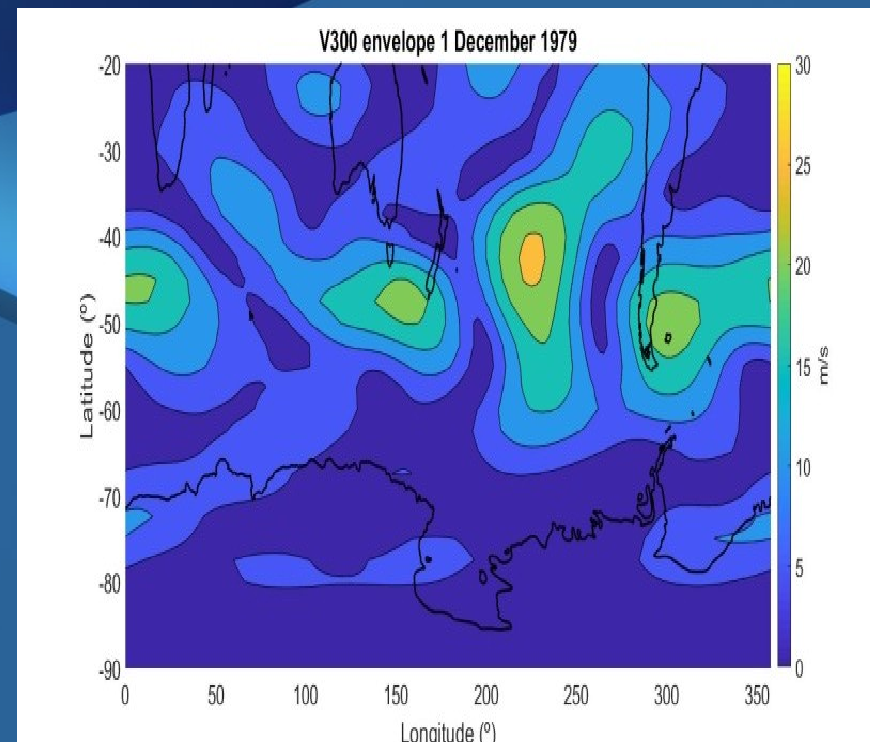

Figure E2: V_{300env} a from NCEP dataset.

Extra slide 2: Data processing

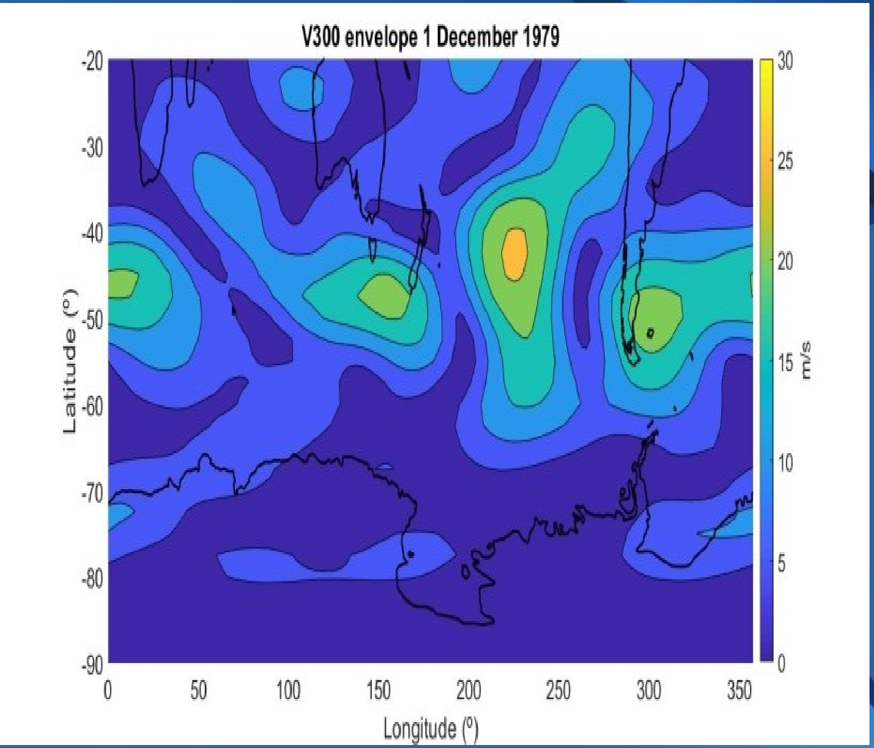

Figure E2: V_{300env} a from NCEP dataset.

Mean between 40-65ºS
+
Filtering data below a threshold

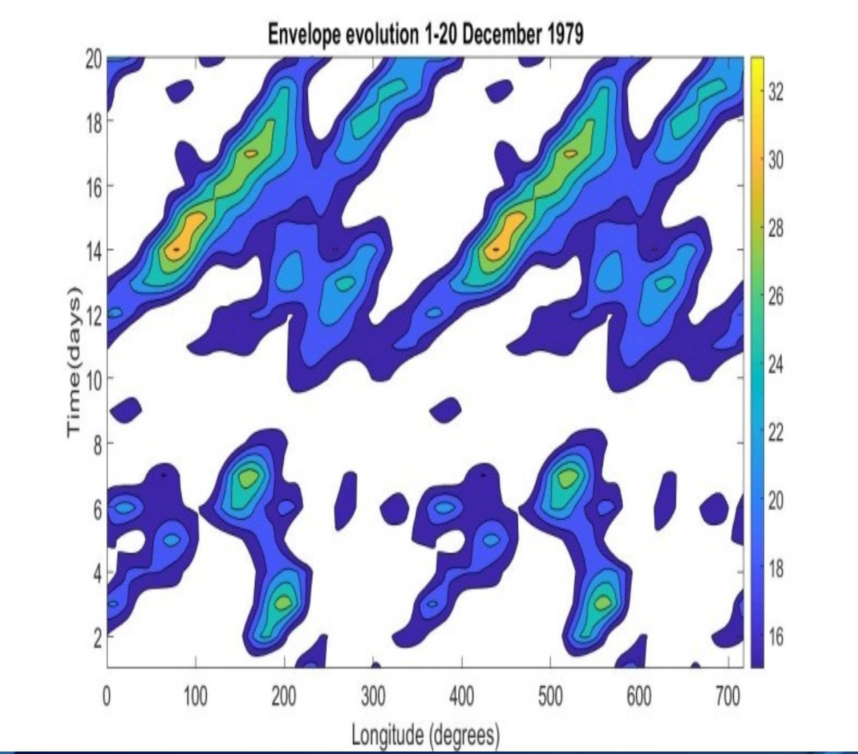

Figure E3: Hovmoller diagram of the envelope evolution between 1-20 December of 1979.