Developing diagnostics for evaluation & real-time monitoring of tropical waves

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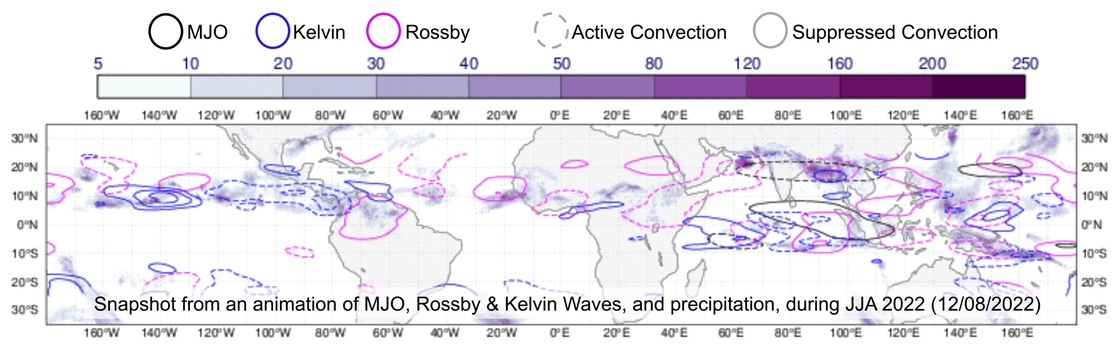
Tropical Waves: Predictability & Diagnostics

- Tropical disturbances such as the Madden Julian Oscillation (MJO) and equatorial waves (including Kelvin waves, equatorial Rossby waves, mixed Rossby-Gravity waves and African easterly waves) play a **major role in organising tropical convection**
- They also influence synoptic-scale features and **high-impact weather** events, within and beyond the tropics
- These tropical waves are an important **source of predictability**, so it is useful to **understand how well we represent them** in NWP models

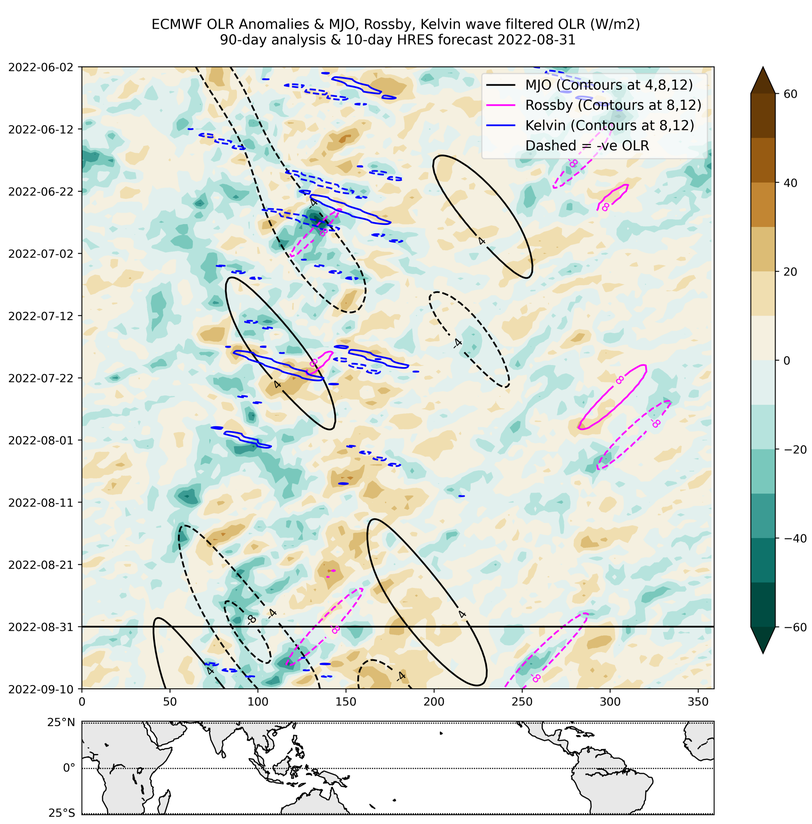
- At ECMWF, we are undertaking evaluation & developing diagnostics to better understand tropical waves in the IFS
- Here we highlight some examples developed for **real-time monitoring of tropical waves**, and **preliminary diagnostics** for evaluation of tropical waves in the IFS
- **Future work** will examine links to predictability of high-impact weather and teleconnections

Real-time Monitoring: MJO, Kelvin, Rossby

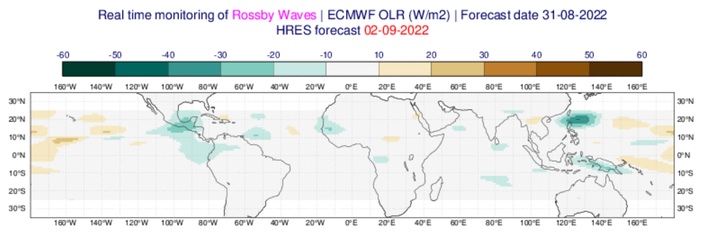


Wave identification software is used to track tropical waves in ECMWF analysis and forecast OLR data, for real-time monitoring

- The wave identification is based on the methodology of Wheeler and Weickmann (2001), with modifications to use ECMWF forecast data out to 10 & 30 days beyond the last available analysis. This allows forecast skill to be maintained beyond a strict truncation of the data and zero padding described by Wheeler and Weickmann
- **Animations and Hovmöller diagrams are produced routinely**, **showing wave progression over the past 90 days (using analysis data) and in the 10-day high resolution (HRES) & 30-day control forecasts**
- Produced for individual waves, with animations showing combined waves + precipitation (snapshot ↑), and Hovmöller diagrams showing OLR anomalies + combined waves (example ↓)

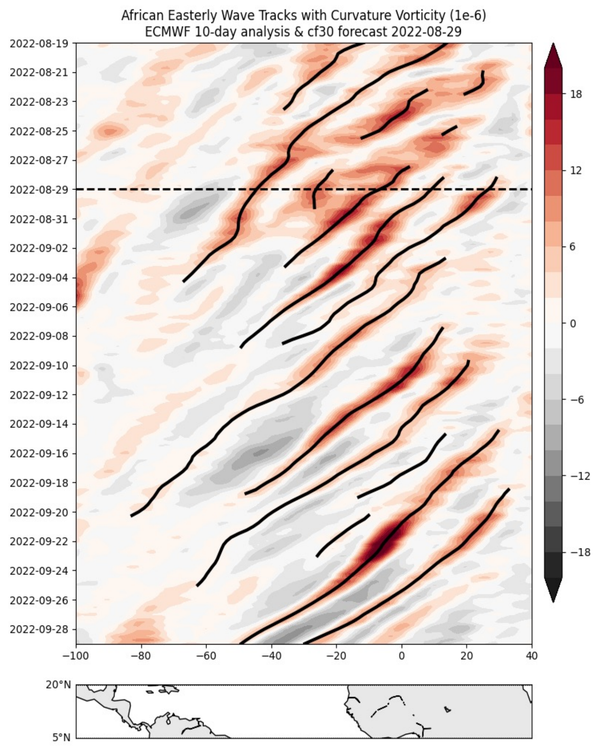


- This real-time monitoring can be used as a tool to assess causes of particular **weather features** in real-time, and to help **diagnose forecast busts**, for example
- Future plans include extending the monitoring to include more wave types, and to run the identification software for the full forecast ensemble (medium- & extended-range)



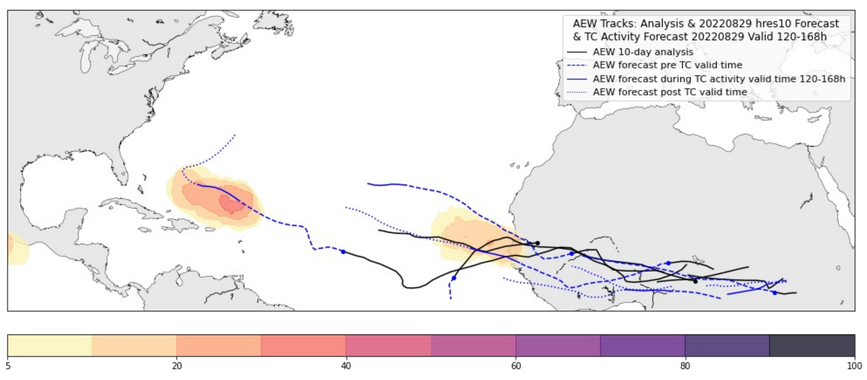
Scan the code to view some animations and leave comments →

Real-time Monitoring: African Easterly Waves



Tracking African Easterly Waves in ECMWF's forecasts

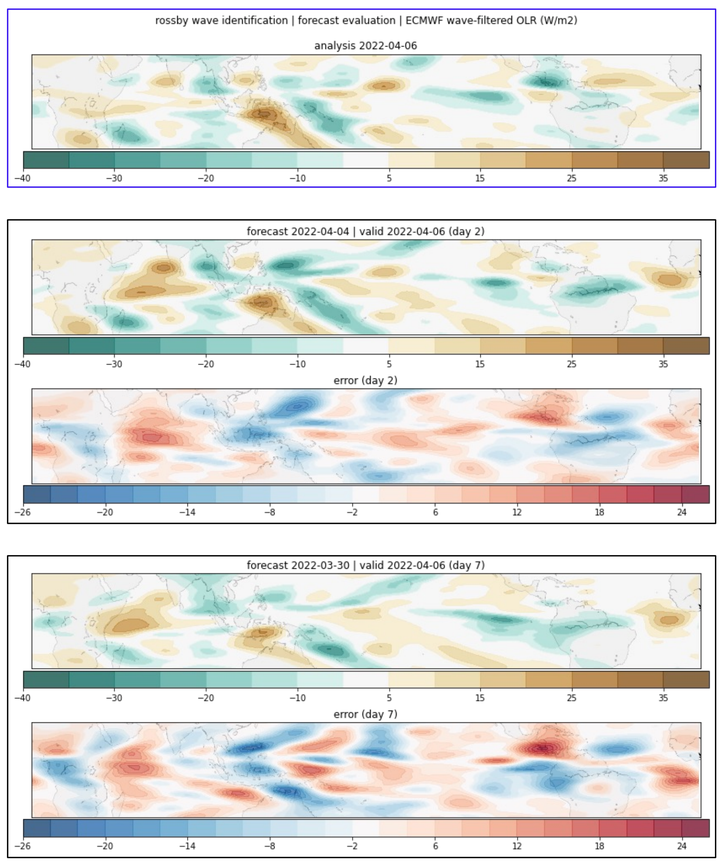
- African Easterly Waves (AEWs) are important for **tropical cyclone genesis** in the Atlantic, and for rainfall and **high-impact weather** over West Africa
- Real-time monitoring diagnostics under development for **tracking and monitoring AEWs in ECMWF forecasts**
- Hovmöller diagrams display AEW tracks over the past 10 days based on analysis data, followed by the 10-day high resolution forecast, or the 30-day control forecast (example ←)
- Maps of AEW tracks combined with ECMWF tropical cyclone activity forecasts under development (example ↓)
- Plans to extend range of diagnostic tools, including ensemble forecasts
- Methodology & tracking software developed by Quinton Lawton @ University of Miami (see Lawton et al., 2022)



Evaluation of Tropical Waves in the IFS

- This work aims to **provide an overview of the skill** of ECMWF's Integrated Forecasting System (IFS) in representing and predicting tropical waves
- Dataset of MJO, Rossby and Kelvin waves in analysis & forecast data produced for cycle 47r3 of the IFS (October 2021 – August 2022; HRES & extended-range control)

- Preliminary results assess the consistency of the wave identification software, and skill of individual forecasts (e.g. →)
- **Examples show Rossby waves identified in the ECMWF analysis data** (wave-filtered OLR) for a given date (06/04/2022; top panel), followed by the **2-day-ahead HRES forecast** and the corresponding error compared to the analysis (centre), and the **7-day-ahead HRES forecast** and **corresponding error** (bottom)
- **Planned applications** include monitoring prediction skill for tropical waves in future versions of the IFS, and assessing predictability of tropical precipitation and high-impact weather related to tropical waves and their teleconnections



References & Further Reading

- Wheeler, M. and Weicknann, K. M. (2001): **Real-time Monitoring and Prediction of Modes of Coherent Synoptic to Intraseasonal Tropical Variability**, Monthly Weather Review, 129, 2677-2694, https://doi.org/10.1175/1520-0493(2001)129<2677:RTMAPO>2.0.CO;2
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- Ferrett, S., et al., (2020): **Linking extreme precipitation in Southeast Asia to equatorial waves**, QJRMS, 146, 665-684, https://doi.org/10.1002/qj.3699
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