Animation: Introducing the MJO

Voiceover: (00:05)
The Madden-Julian Oscillation (MJO) is a variability in a tropical atmosphere, which happens on the weekly to monthly timescale.

Voiceover: (00:13)
This intra-seasonal phenomenon was first described in the 1970s by Rol Madden and Paul Julian and research continues today. The MJO is a large region of enhanced rainfall moving slowly, eastwards near the equator, most pronounced over the Indian Ocean and Western Pacific. The large area of enhanced convection, which can be 2000 kilometres across, is preceded and followed by an area of suppressed rainfall. When this dipole passes over a location, it typically leads to increased rainfall followed by a drier period. The MJO recurs on a timescale of about 30 to 60 days, but it varies in strength and frequency. An important consequence of the MJO is that tropical cyclones are more likely to develop within and immediately after the enhanced convection phase of a strong MJO. And we'll come back to this shortly.

Voiceover (01:07):

To quantify the MJO an index is used, which plots the daily location, or phase, of the enhanced convection and its strength, or amplitude. The lifecycle of the MJO is divided into eight phases, from phase one developing over Africa and the Western Indian Ocean to decaying in phases seven and eight after moving through the Pacific.

Voiceover (01:26):

Forecasting centres plot the phase and amplitude for the previous weeks and months. And some also forecast the index. The index itself is based on the near-equator, 850hPa zonal wind, 200 hPa zonal wind, and satellite observed outgoing longwave radiation (OLR).

Voiceover (01:47):

Whilst each individual event can vary, the MJO phases are:

Voiceover (01:51):

Phase 1, some convection can develop over the western Indian Ocean, but this first phase is not always observed.

Voiceover (01:56):

Phase 2 and 3, a developed area of enhanced convection moves slowly eastwards over Southeastern Africa and the Indian Ocean, including Mozambique, Madagascar, and Seychelles, and parts of the Indian sub-continent. Meanwhile, convection is suppressed over the Western Pacific.

Voiceover (02:13):

Phase 4 and 5, the enhanced convection reaches the Maritime Continent of Indonesia and the West Pacific.

Voiceover (02:21):

Phase 6, 7 and 8, the enhanced rainfall moves further over the Western Pacific, eventually dying out in the central Pacific. And meanwhile, convection is suppressed over the Indian Ocean.

Voiceover (02:32):

And then the next MJO cycle begins.

Voiceover (02:37):

So what about cyclones? Most cyclones in the Southwest Indian Ocean form in the enhanced convection of phases, 2 to 4, and in the immediate wake of the enhanced convection in phase 5. The MJO increases moisture and promotes convection, which helps tropical cyclone formation. The MJO is also a source of vorticity and Rossby waves, which can spin up into cyclones as they move away from the equator.

Voiceover (03:06):

Cyclones are also more likely to be intense or to rapidly intensify when they form in phases 2 to 6, although many cyclones in phases 3 to 5 form further east away from the African continental landmass. And exceptions are always possible. For example, cyclone Idai in 2019 was the first storm to reach tropical cyclone strength in the Mozambique Channel in phases 3 to 5.

Voiceover (03:30):

And conversely, the suppressed phase of the MJO is typically associated with below average tropical cyclone frequency. For the Southwest Indian Ocean there are approximately three times as many,24 hour rapid intensifications in the active convection of MJO phases 2 to 5 than there are in the more locally suppressed phases of 7, 8 and 1.

Voiceover (03:52):

The phase of the MJO can be used as a guide for tropical cyclone development. But tropical cyclones might form in any phase or when there's no apparent MJO. The MJO is weak when the amplitude or strength is less than one.

Voiceover (04:09):

And what about the rest of the world? Firstly, for the tropics, the enhanced rainfall phase can bring the onset of the monsoon and the suppressed phase can delay the onset of the monsoon. Secondly, the MJO can be affected by El Niño or La Niña. El Niño years have more MJO activity in the Pacific and La Niña years have more MJO activity in the Indian Ocean. And finally, the enhanced and suppressed area of rainfall near to the equator can propagate changes into higher latitudes, altering the path and intensity of synoptic waves and thereby affecting the weather at mid-latitudes.