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Timescales of Seasonal ITCZ Transitions in an Aquaplanet Model

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In this poster, we investigate the controls on the rate of movement of the ITCZ over the seasonal cycle using a range of idealised experiments. In aquaplanet simulations with a slab ocean surface condition, the seasonal cycle of the ITCZ has been observed to exhibit behaviour similar to the sudden onset of the Asian monsoon. For a sufficiently shallow ocean mixed layer depth, fast transitions are observed between two regimes of the overturning circulation: an equinoctial regime, where the ITCZ is near the Equator, and the Hadley cells and associated precipitation are weaker, and a 'monsoon' regime, with the ITCZ off the Equator, a strong cross-equatorial winter hemisphere Hadley cell, and enhanced precipitation.

Even in these simple experiments, multiple different processes, working on different timescales, control the onset and withdrawal of this 'aquaplanet monsoon'. Here, we investigate this further using idealised experiments, including simulations in which the length of the seasonal cycle, the planetary rotation rate, and the surface conditions are varied. Our goals are to examine the roles of dynamics internal to the atmosphere and of interactions with the surface, to identify the timescales on which these processes act, and to determine their consequent effects on the regime transitions.

We find that in experiments in which the length of the seasonal cycle is doubled and halved, the rate of change of ITCZ latitude over monsoon onset is unchanged, indicating that this is primarily controlled by dynamical feedbacks, rather than being simply determined by the rate of movement of the peak insolation. Additionally, we observe that varying the rotation rate of the aquaplanet alters the ITCZ latitude at which the transition occurs. This is consistent with the presence of a feedback relating to a rapid reduction in upper level absolute vorticity due to vortex stretching.