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Drivers of the distribution and historical expansion of Australian rainforests

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The possible existence of alternative stable states in tropical vegetation, represented by closed canopy rainforest and savanna, driven by strong negative feedbacks between tree cover and fire activity, provides a tantalising explanation for the often inexplicable distribution of rainforests and savannas within a landscape. The potential instability of rainforest-savanna boundaries is reflected in widespread reports of rainforests expanding into adjacent savannas. Perhaps more than in any other region globally, rainforests appear to be expanding in monsoonal northern Australia. Little progress has been made in identifying the drivers of this trend, but possible explanations include a recent regional wetting trend, elevated atmospheric CO2 concentration, and changes to fire regimes. While the pattern is now well-documented in northern Australia, it is not clear whether it is also being borne out in the more extensive tracts of rainforest down Australia's eastern coast. We will present a synthesis of the results of a recent research program that aims to:
(1) Model the environmental drivers of rainforest distribution at a range of spatial scales in Australia, based on a number of high-resolution vegetation maps and GIS layers (including climate, topography and soils), to evaluate whether rainforest and fire-prone savanna vegetation types exist as alternative stable states; and
(2) Examine patterns and rates of rainforest expansion at a number of sites along the eastern coast of Australia, from tropical North Queensland to temperate Tasmania, in order to assess the hypothesis that rainforest expansion is being driven by a global, rather than local and regional, process.

Our results suggest that at a continental scale, rainforest distribution is very closely related to gross patterns of water availability. However, at a local scale, rainforest distribution is clearly related to fire activity, tending to occur in areas of topographic fire protection. While our results suggest strong environmental controls on rainforest distribution, they are consistent with rainforest and savanna communities existing as alternative stable states, mediated by a strong negative feedback between tree cover and fire activity. While it is clear that there is a general trend of rainforest expansion in much of northern and eastern Australia, rates of change are highly variable, with temperate rainforest boundaries appearing to be relatively stable. This finding is not entirely consistent with a global trend of increasing woody biomass and rainforest expansion and requires reconsideration of the likely drivers.