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Surface roughness variations control the regional atmospheric response to contemporary scale deforestation in Rondônia, Brazil

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The atmospheric response to deforestation is closely tied to the scale of the land cover change. In the Amazon, deforestation at small scale (≈1 km) has been observed to give rise to an increase in cloudiness and rain, triggered by horizontal thermal variations between forest and bare land. Large scale (hundreds of kms) Amazonian deforestation, on the other hand, has been predicted to cause warming and drying. Noticeably, our knowledge of the net atmospheric response to intermediate scale (tens of kms) deforestation in the Amazon is incomplete and so the scale dependence of the regional atmospheric response is not well understood. This mesoresolution case study of contemporary deforestation in Rondônia, Brazil aims at investigating the coupled dynamical and thermodynamical regional atmospheric response to intermediate scale deforestation. Our numerical simulations, conducted using the variable resolution Ocean-Land-Atmosphere-Model, show that the regional atmospheric response to intermediate scales of deforestation is dominated by surface roughness variations between forests and clearings. These variations trigger a mesoscale circulation which makes the atmosphere conducive to convection in the downwind side and suppresses convection in the upwind side of the deforested domain. Unlike the thermally generated mesoscale circulations, which occur only during the dry season, this dynamically generated circulation is present year round. Moreover, the atmospheric response is found to be strongest during the wet season marked by an ≈8% increase (compared to the control case) in the relative humidity in and around the upwelling branch of the circulation. Overall the study shows that the atmospheric response to contemporary intermediate scale deforestation in Rondônia is likely to be more influenced by differences in surface roughness between forest and forest clearings than by the differences in the surface energy partitioning.