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Predicting mangrove forest dynamics across a soil salinity gradient using an individual-based vegetation model linked with plant hydraulics

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Abstract. In mangrove forests, soil salinity is one of the most significant environmental factors determining mangrove forest distribution and productivity as it limits plant water uptake and carbon gain. However, salinity control on mangrove productivity through plant hydraulics has not been investigated by existing mangrove models. Thus, we present a new individual-based model linked with plant hydraulics to incorporate physiological characterization of mangrove growth under salt stress. Plant hydraulics was associated with mangroves nutrient uptake and biomass allocation apart from water flux and carbon gain. The developed model was performed for two-coexisting species of *Rhizophora stylosa* and *Bruguiera gymnorrhiza* in a subtropical mangrove forest in Japan. The model predicted that the productivity of both species was affected by soil salinity through downregulation of stomatal conductance, while *B. gymnorrhiza* trees grow faster and suppress the growth of *R. stylosa* trees by shading that resulted in a *B.gymnorrhiza*-dominated forest under low soil salinity conditions (< 28‰). Alternatively, the increase in soil salinity significantly reduced the productivity of *B. gymnorrhiza* compared to *R. stylosa*, leading to an increase in biomass of *R. stylosa* despite the enhanced salt stress (> 30‰). These predicted patterns in forest structures across soil salinity gradient remarkably agreed with field data, highlighting the control of salinity on productivity and tree competition as factors that shape the mangrove forest structures. The model reproducibility of forest structures was also supported by the predicted self-thinning processes, which likewise agreed with field data. In addition, the mangroves morphological adjustment to increasing soil salinity – by decreasing transpiration and increasing hydraulic conductance – was reasonably predicted. Aside from the soil salinity, seasonal dynamics in atmospheric variables (solar radiation and temperature) was highlighted as factors influencing mangrove productivity in a subtropical region. The physiological principle-based improved model has the potential to be extended to other mangrove forests in various environmental settings, thus contributing to a better understanding of mangrove dynamics under future global climate change.