Mapping plant phenological traits at fine resolution continentally by combining process-based modelling and remote sensing

Jinyan Yang[1,2], Karel Mokany[2]

[1] *Agriculture & Food, CSIRO, Canberra, ACT, 2601, Australia*
[2] *Environment, CSIRO, Canberra, ACT, 2601, Australia*
Email: jinyan.yang@csiro.au

Abstract: Plant phenological traits control plant functional and structural responses to environmental fluctuations and thus have been widely adopted in vegetation modelling and monitoring. Although various approaches have been proposed to map plant phenological traits, they generally rely on statistical relationships that disregard ecological processes resulting in difficulties generalising the pixel-based information across large spatial extents. The potential for linking multi-decadal Earth Observation data with ecological theory to map plant phenological traits across large regions remains largely unexplored. We used 40 years of remotely sensed vegetation indices to parameterise a process-based vegetation model in a differential evolution algorithm. The process derived 14 plant phenological traits and seven ancillary plant functional traits for 14,774 sites with minimal known human disturbance. Further analysis showed that plant phenological traits are clearly linked to environmental drivers indicating that the phenological traits are optimised for the growing environmental conditions. We then provided gridded maps of the plant phenological traits at 100m resolution for Australia. The mapping was based on the environmental drivers using a neural network model while accounting for the correlation between the traits. Our approach illustrated an alternative approach to existing mapping methods by combining remotely-sensed vegetation indices and process-based modelling. The plant phenological trait maps could be readily used for parameterisation of land surface and hydraulic models. The process-based approach offers a practical solution to project potential vegetation indices under climate change and thus could help quantify the impacts of human land use change on terrestrial vegetation.

Keywords: *Process-based model, plant phenological traits, remote sensing, differential evolution algorithm*

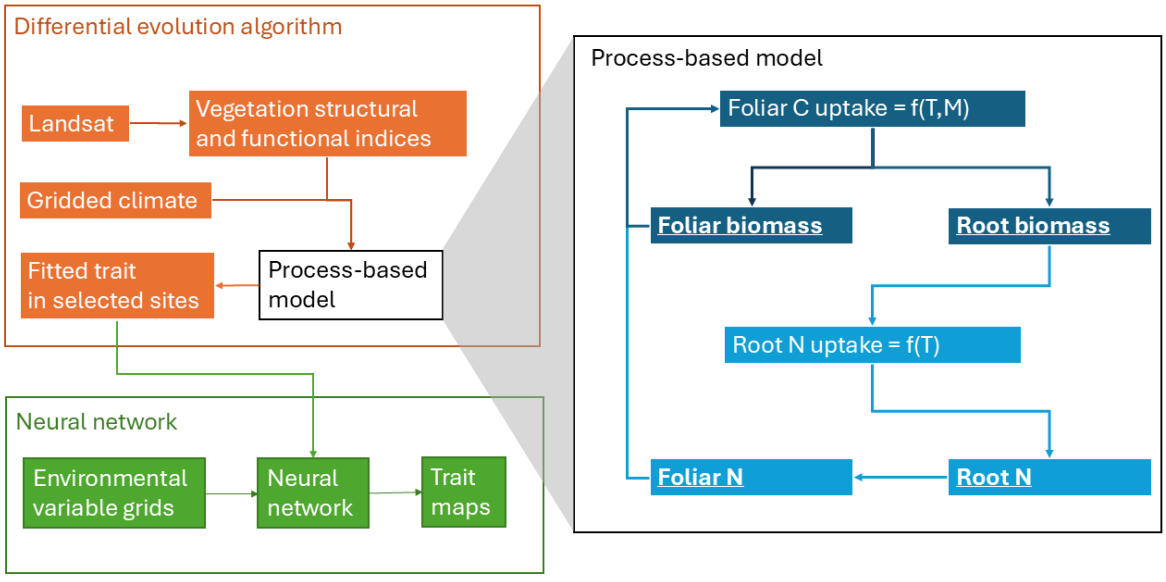

Fig 1. Conceptual workflow. The orange box shows the differential evolution algorithm workflow; the neural network workflow is shown in the green box. Processes considered in the model are listed in the black box with dark blue showing the carbon related processes and light blue showing nitrogen related processes. T means monthly mean air temperature; M means monthly mean soil moisture. The underlines highlight the state variables.