

Appendix A: Model sensitivity

Analysis of model sensitivity was performed was to test the effect of uncertainty on the initial nutrient status and future precipitation level (Figure A1), 9 scenarios were created based on a combination of 3 initial CN ratio scenarios and 3 precipitation scenarios for the years 2020-2090. The sensitivity reveals that both water and nutrient availability regulates carbon dynamics. The higher NCB at the end of the simulation is associated to the high nutrient high precipitation scenario while the lower NCB is associated to the low nutrient low precipitation scenario. Given that the ICS is the time integrated NCB, the sensitivity analysis also reveals negative ICS across all scenarios.

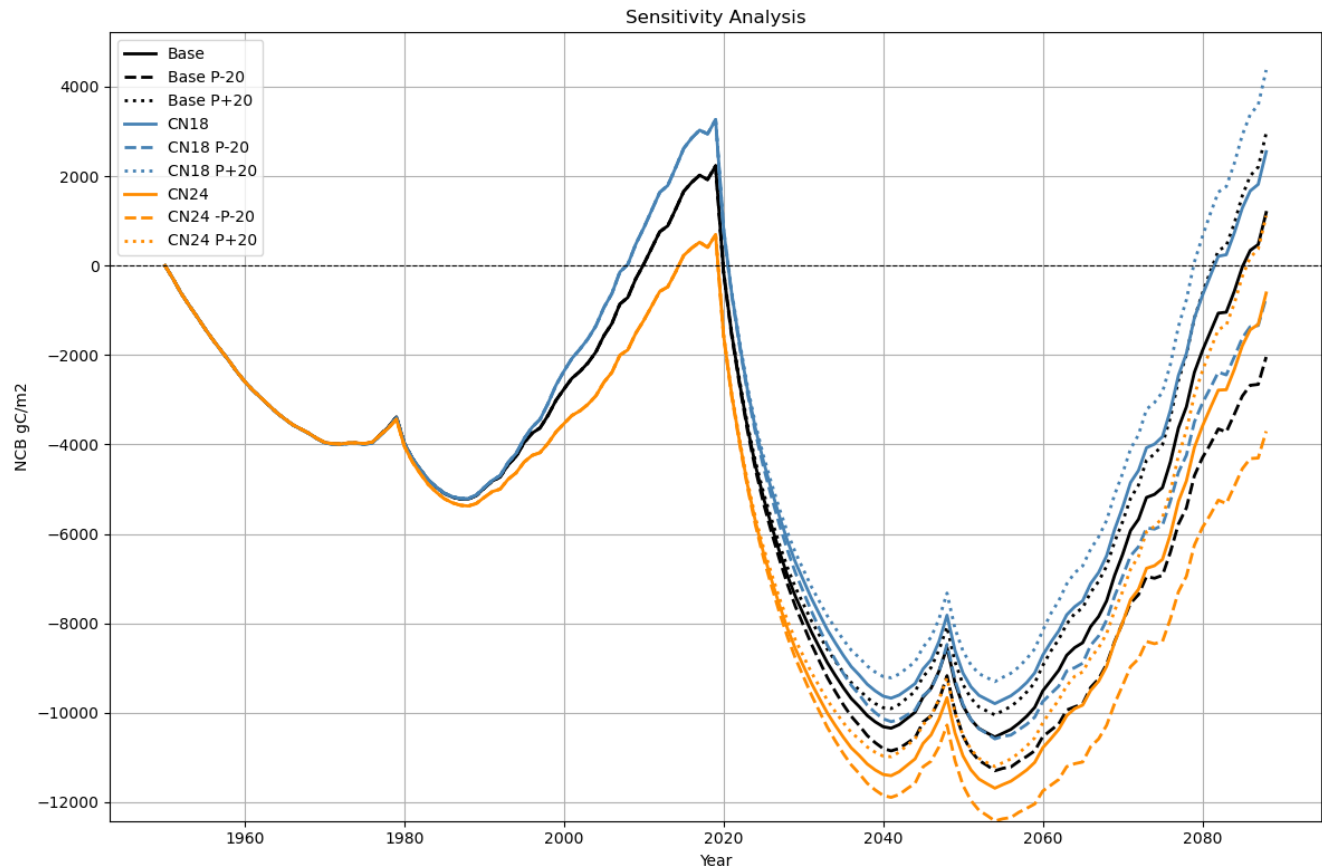


Figure A1. Sensitivity analysis of net carbon balance (NCB) for the Ecosystem+HWP boundary: Each colour represents a different C:N ratio, and each line style indicates a specific future precipitation scenario. The black lines correspond to a C:N ratio of 21, used in the primary simulation of this study (Base). Blue lines represent a C:N ratio of 18, while orange lines represent a C:N ratio of 24. Dotted lines indicate a scenario with 20% higher precipitation from 2020–2090 compared to the main simulation, while dashed lines represent a scenario with 20% lower precipitation during the same period. This analysis highlights the effects of nutrient availability and climate variability on NCB projections.

15 Within the model formulation, nitrogen and water directly influence carbon dynamics, as reflected in the behaviour shown in
Figure A1. Nutrient content in soil organic matter regulates the nitrogen mineralization rate, which, in turn, controls nitrogen
uptake by trees. This uptake determines leaf nitrogen content, ultimately affecting gross photosynthesis. On the other hand,
precipitation governs soil water content, influencing both water uptake by trees and decomposition rates. At higher growth
levels, associated with improved nutrient conditions, water availability can become a limiting factor. This is evident from the
20 similar NCB values at the end of the simulation for the scenario combining a C:N ratio of 21 with 20% higher precipitation
and the scenario combining a C:N ratio of 18 with precipitation levels matching the main simulation.