

EEMS Test Case Model Description

TC_Chapra_33-2

1 Overview

This model replicates Example 33.2 from Stephen C. Chapra's book "*Surface Water-Quality Modeling*" [1]. The objective is to use EFDC+ Explorer (EE) and EFDC+ to simulate algal/nutrient interactions with light limitation through the three solar radiation options (IWQSUN) available in EFDC+. The test case provides a controlled, analytically verified benchmark for understanding how different solar radiation settings influence algal growth dynamics in EFDC+.

2 Demonstration Feature

This test case demonstrates the Water Quality module in EFDC+, specifically its ability to simulate algal and nutrient dynamics under varying solar radiation conditions. The three IWQSUN options explored in this test case are:

- IWQSUN = 0 – Constant solar radiation
- IWQSUN = 2 – Hourly solar radiation read from the ASER.INP input file
- IWQSUN = 3 – Computed daily average solar radiation derived from the ASER.INP input file

By replicating Chapra's Example 33.2, this test case illustrates how the choice of solar radiation option affects the simulated chlorophyll a concentration over time, and how closely each EFDC+ configuration reproduces the analytical solution provided in the reference. This is particularly useful for users seeking to understand the sensitivity of algal growth simulations to solar radiation input methods. The theoretical foundations of the EFDC+ water-quality module are detailed in the [EFDC+ Theory Document](#) [2].

3 Model Description

The model configuration is summarized in Table 1. The model domain, shown in Figure 1, consists of 3 horizontal grid cells and 1 vertical layer, representing the simplified water body used in Chapra's Example 33.2. The following EFDC+ modules are activated in this test case:

- Hydrodynamics – provides the flow field for the simplified model domain
- Temperature – simulates water temperature dynamics, which influence algal growth rates
- Dye / Age – used as a supplementary tracer for transport verification
- Water Quality – the primary module of interest, simulating algal biomass (chlorophyll a) and nutrient interactions under light limitation with three different solar radiation configurations

Table 1 Model configuration summary

Dimensions	Horizontal cells	Vertical cells	Activated modules
2D	3 cells	1 layer	• Hydrodynamics • Temperature • Dye / Age • Water Quality

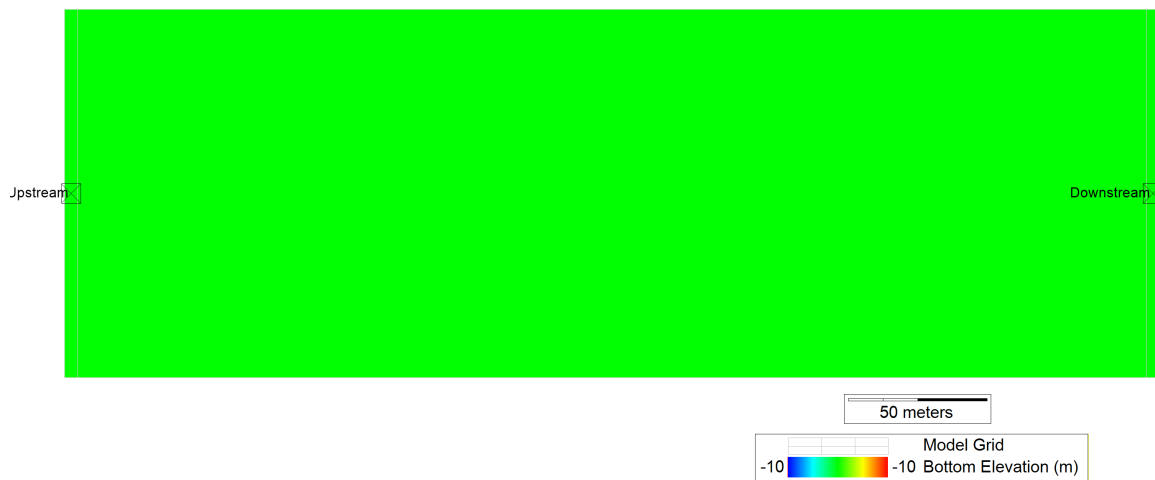


Figure 1 Model domain

4 Model Results

Figures 2–4 show depth-averaged chlorophyll a for each IWQSUN option, highlighting differences in algal growth dynamics driven by the choice of solar-radiation input. Observational values are taken from Chapra [1]. Across all three configurations, EFDC+ reproduces the analytical solution from Chapra [1] with good agreement.

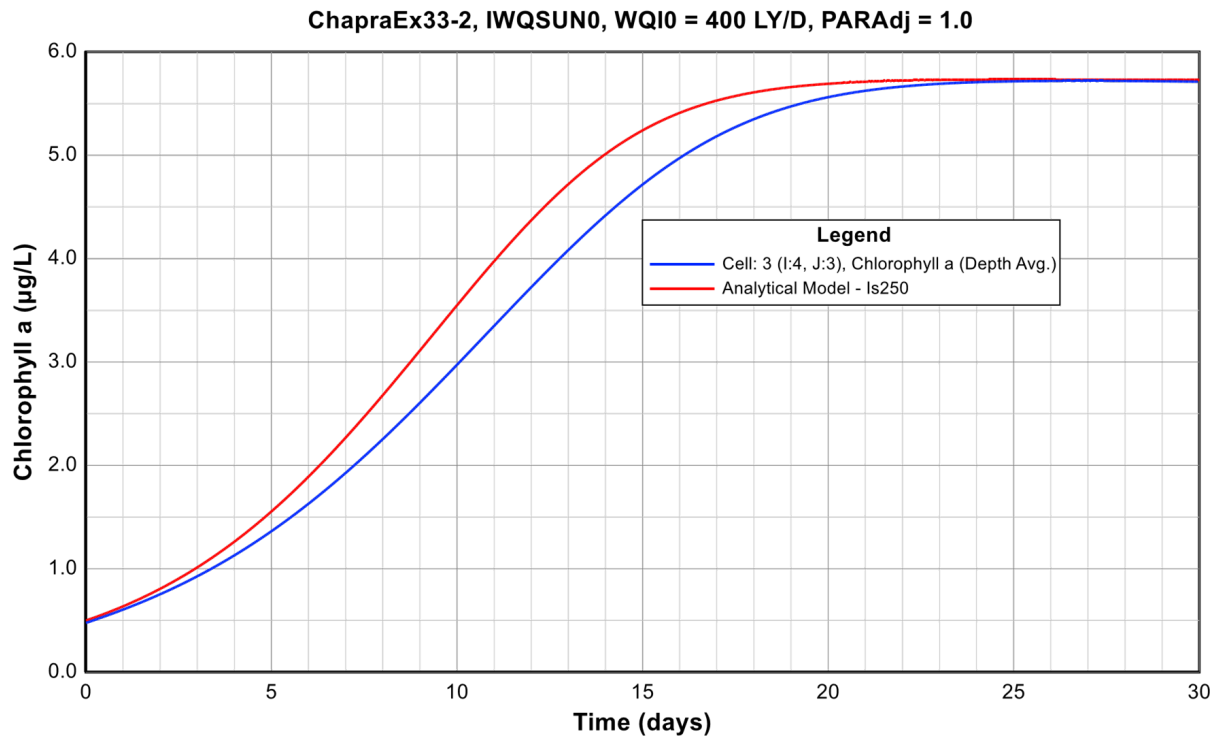


Figure 2 Time series of observed and simulated chlorophyll a for the constant solar radiation approach

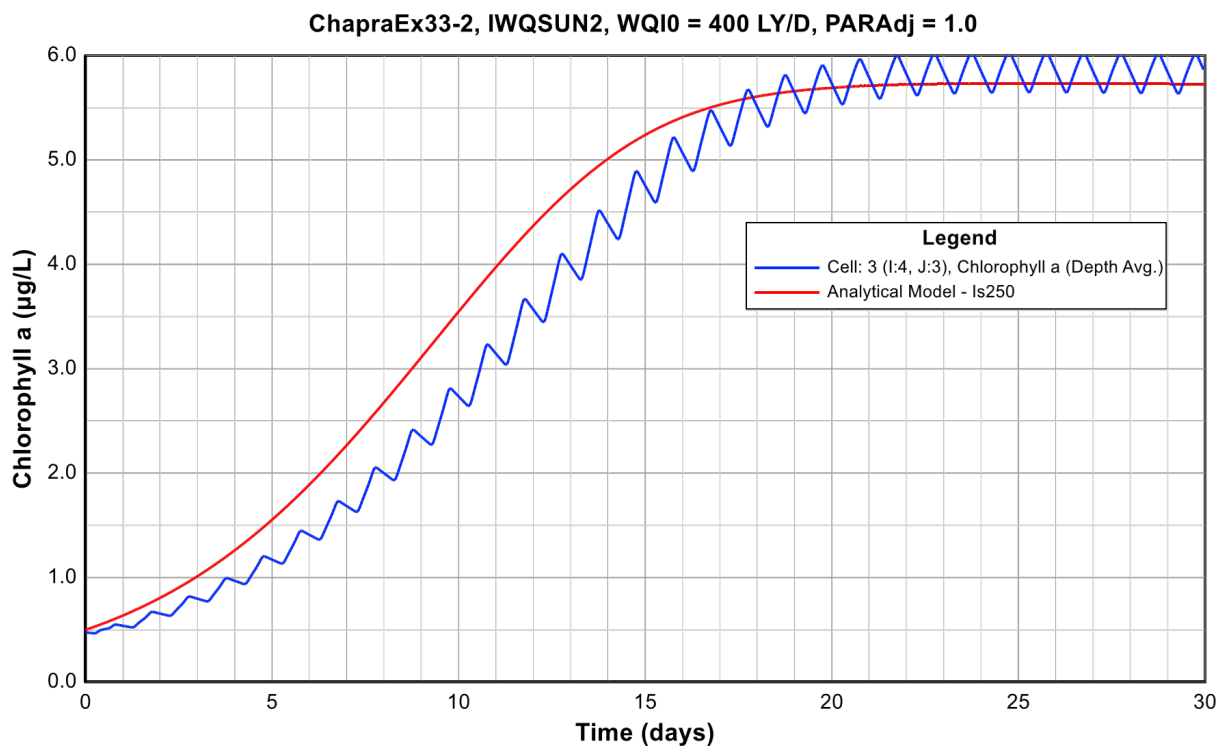


Figure 3 Time series of observed and simulated chlorophyll a for the hourly solar radiation approach

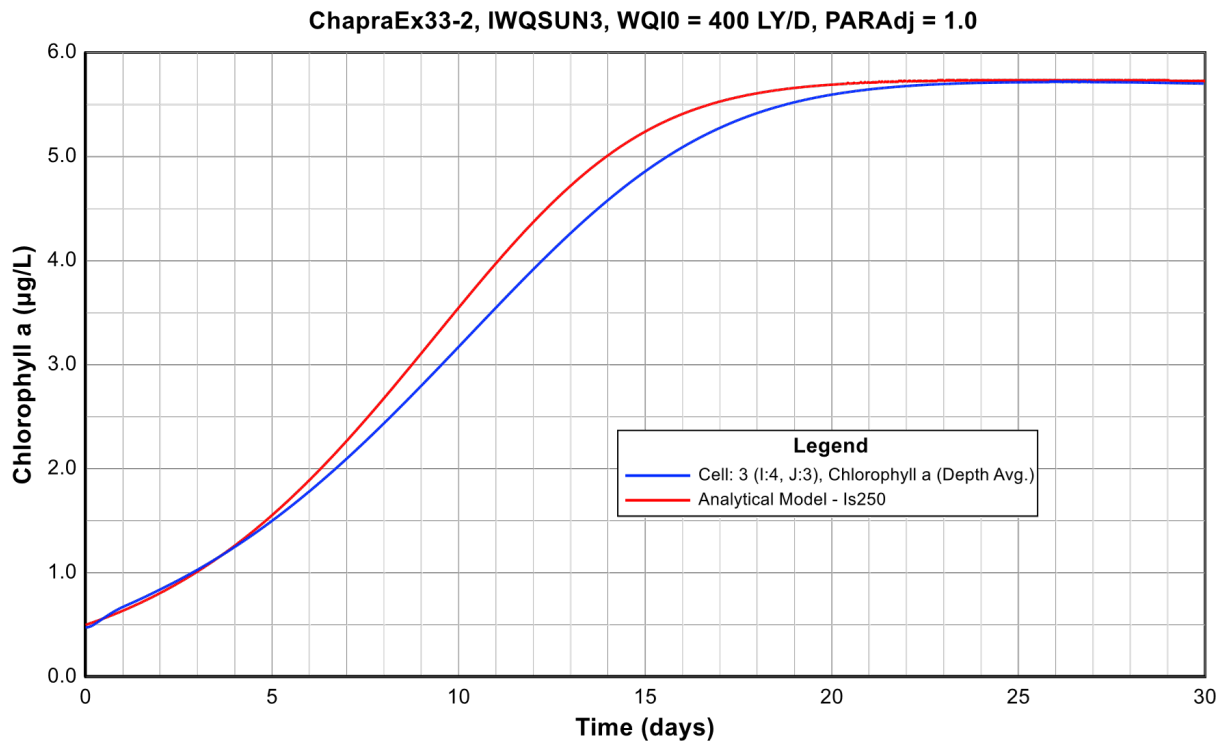


Figure 4 Time series of observed and simulated chlorophyll a for the daily computed solar radiation approach

References

- [1] Chapra, S. C. (2008). *Surface Water-Quality Modeling*. Waveland Press, Long Grove, IL. Published December 31, 2008.
- [2] DSI LLC (2024). *EFDC+ Theory: Version 12*. DSI LLC, Edmonds, WA, USA. Accessed: 2026-04-06.

Disclaimer: This model is provided to demonstrate that EFDC+ Explorer and EFDC+ can be used to better understand how to build this kind of model. The model is running as expected; however, it should not be considered final, as it can be modified and refined to obtain improved results.