
pyBELLA+: An idealised laboratory testbed for investigating novel NWP applications

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Abstract

pyBELLA+ is an innovative atmospheric flow solver and data assimilation engine designed to play a unique role in the landscape of numerical weather prediction (NWP) models. This project focuses on developing a compact, modular software package that adheres to modern scientific software development principles, enabling researchers to focus on addressing NWP modelling questions with analytical precision and dynamic consistency. Recently, pyBELLA+ has been successfully applied to advance scientific understanding in several key areas:

1. Seamless access to diverse dynamical regimes within a single simulation run.
2. Development of the first dynamically consistent balancing scheme for ensemble data assimilation.
3. Identifying and validating a novel atmospheric instability when incorporating the full Coriolis term.

Building on these achievements, pyBELLA+ offers potential for further exploration of the dynamical coupling of NWP model components, particularly in evaluating the effectiveness of emerging machine-learning emulators within a unified Python framework. Its ability to maintain near-machine-level accuracy in specific solution fields makes it ideal for characterising novel numerical methods. The solver's unique capability for seamless dynamics switching also presents opportunities to explore its applications to NWP.

During the presentation, we will delve into specific applications and ongoing investigations that underscore the potential of pyBELLA+ in advancing NWP research.

Keywords: idealised flow solver, blended dynamics, balanced dynamics, numerical laboratory

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