

Implementation Of The Novel Duo-Grid Within The GFDL FV3 Dynamical Core

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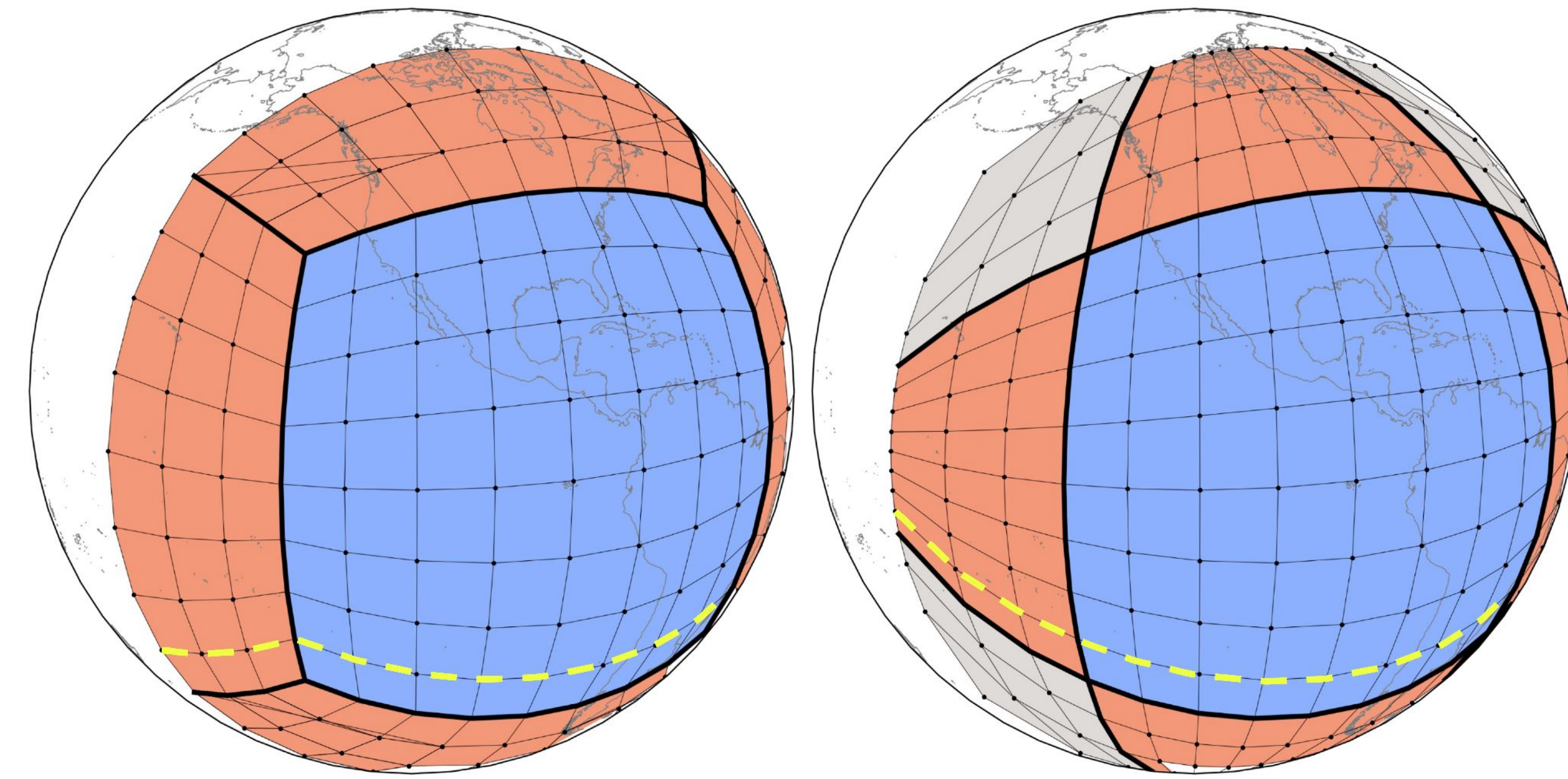
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Motivation

- In GFDL's dynamical core FV3, unphysical structures from the gnomonic cubed-sphere grid structure, such as edges and corners, can appear in the numerical solution especially at lower resolutions and in long climate simulations.
- This is known as grid imprinting which is due to errors in the assumed location of grid cells on opposing sides of a cube edge.
- We implement a new algorithm called Duo-Grid that corrects the location of the cross edge data, and eliminates grid imprinting in FV3. The increase in accuracy comes at the expense of additional computational complexity.

The Duo-Grid



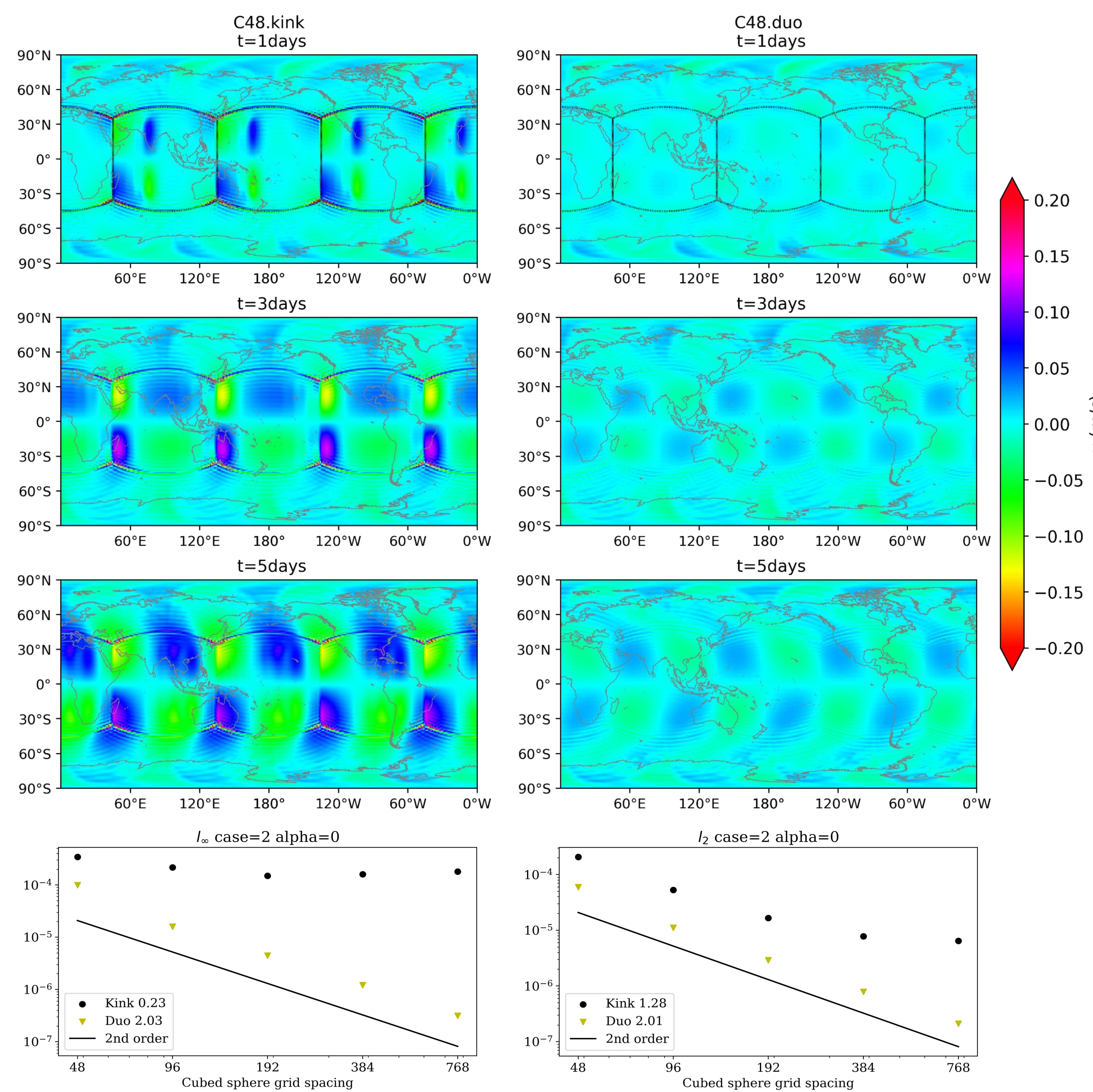
- The Duo-Grid extension supports all grid staggers and the corner region.
- Continuous integration along great circle lines => No other edge/corner handling code is required!
- The halo remapping algorithm and Duo extension are directly implemented into tiles' halo update message passing calls.
- Minimize data movement on CPU/GPU hybrid systems => Stepping stone for future FV3 developments on GPUs.

Conclusions

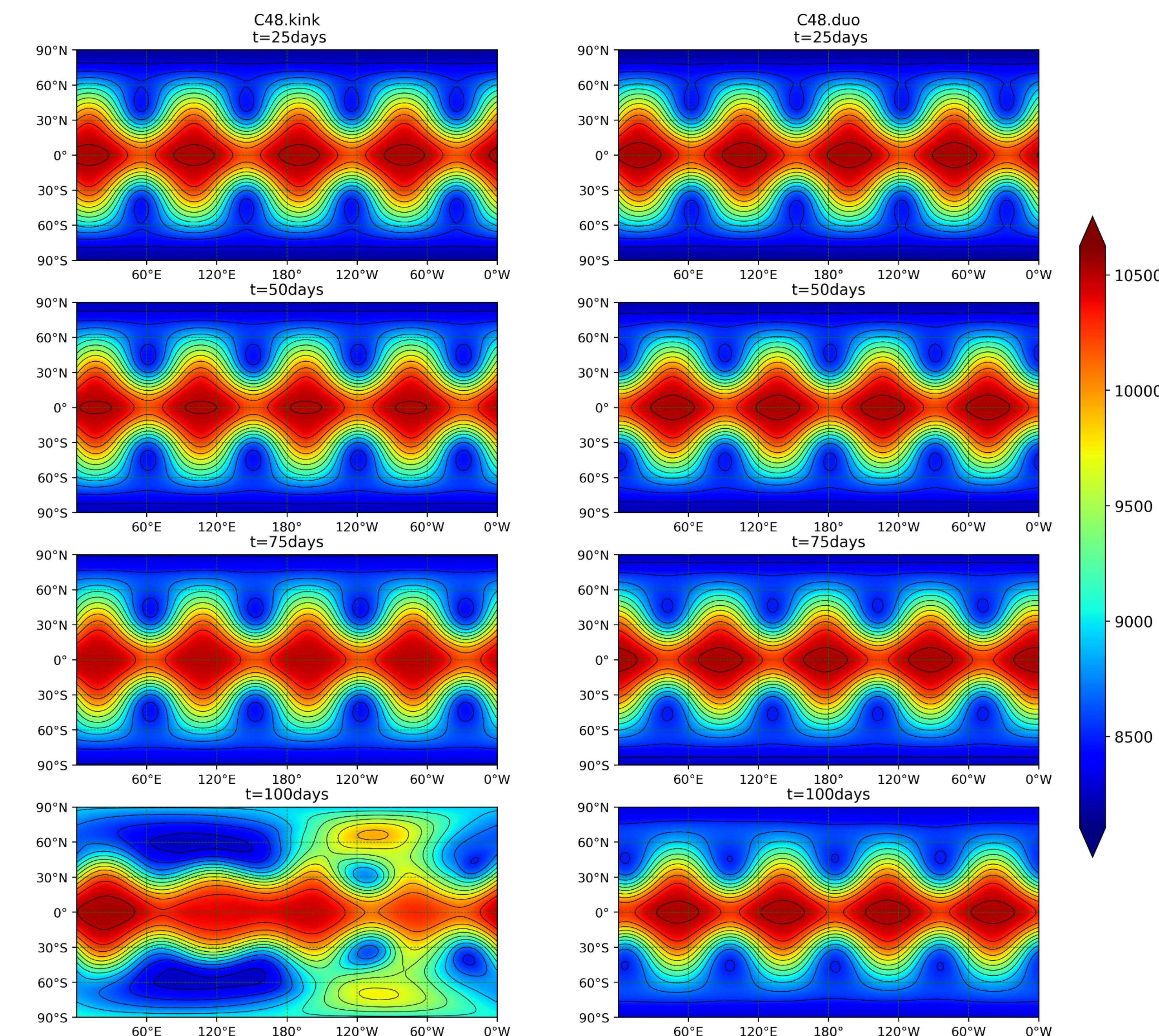
- Grid imprinting is greatly reduced in idealized tests and practically eliminated.
- The true order of accuracy of FV3's horizontal discretization is restored.
- Dispersion and dissipation properties are identical to those of the original FV3 algorithm.
- **FV3's robustness and accuracy have increased.**

Results

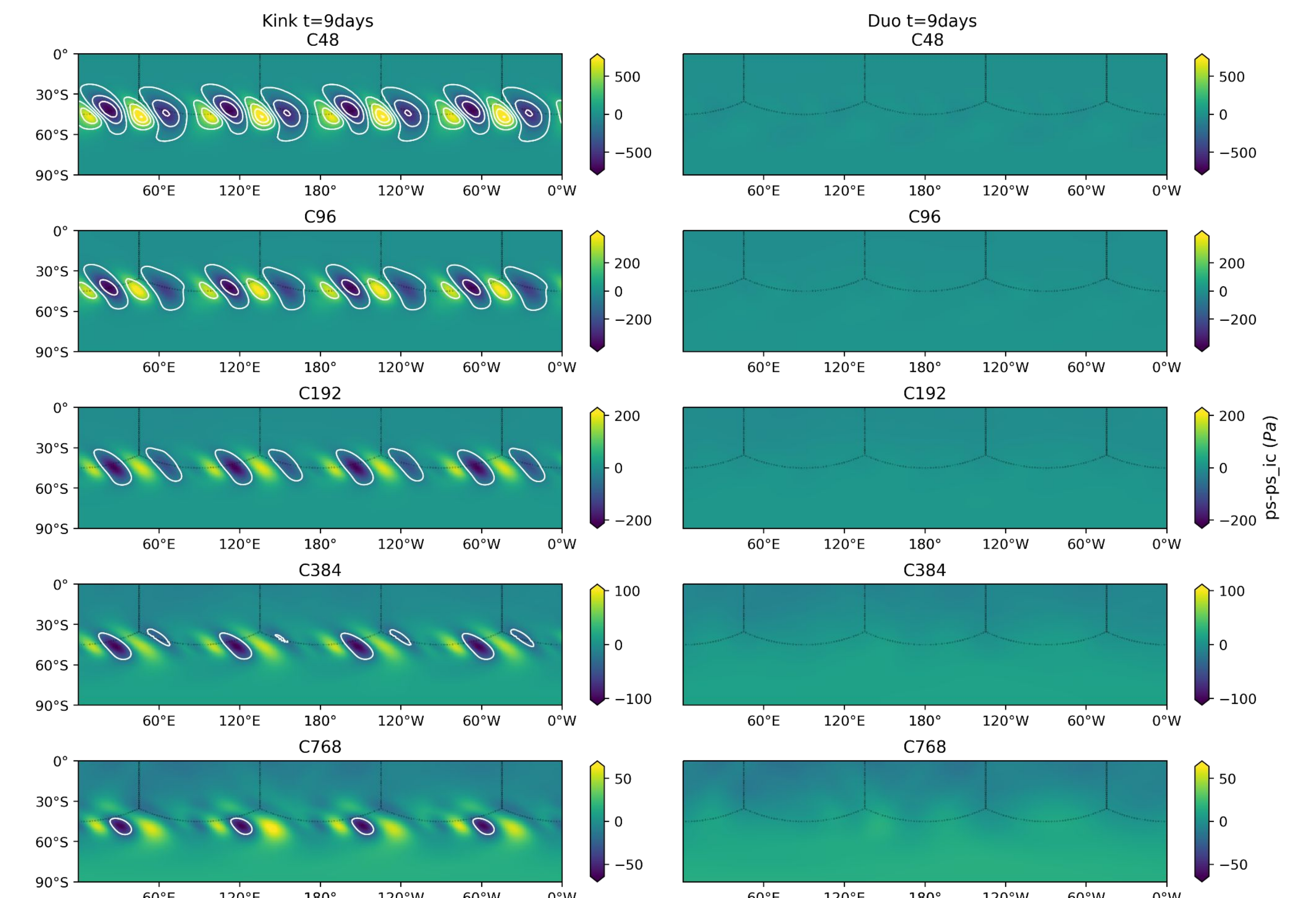
Steady state geostrophic balance



Rossby-Haurwitz wave



Baroclinic wave



References

1. Mouallem, J., Harris, L. and Chen, X. (2023) 'Implementation of the novel Duo-Grid in GFDL's FV3 dynamical core' *Journal of Advances in Modeling Earth Systems*, Accepted, November 2023
2. Chen, X. (2021) 'The LMARS based shallow-water dynamical core on generic gnomonic cubed-sphere geometry' *Journal of Advances in Modeling Earth Systems*, 13, 1-31. doi: 10.1029/2020MS002280