

Physics Schemes in NCEP Operational HAFS v1 and the impacts of TC-specific modifications

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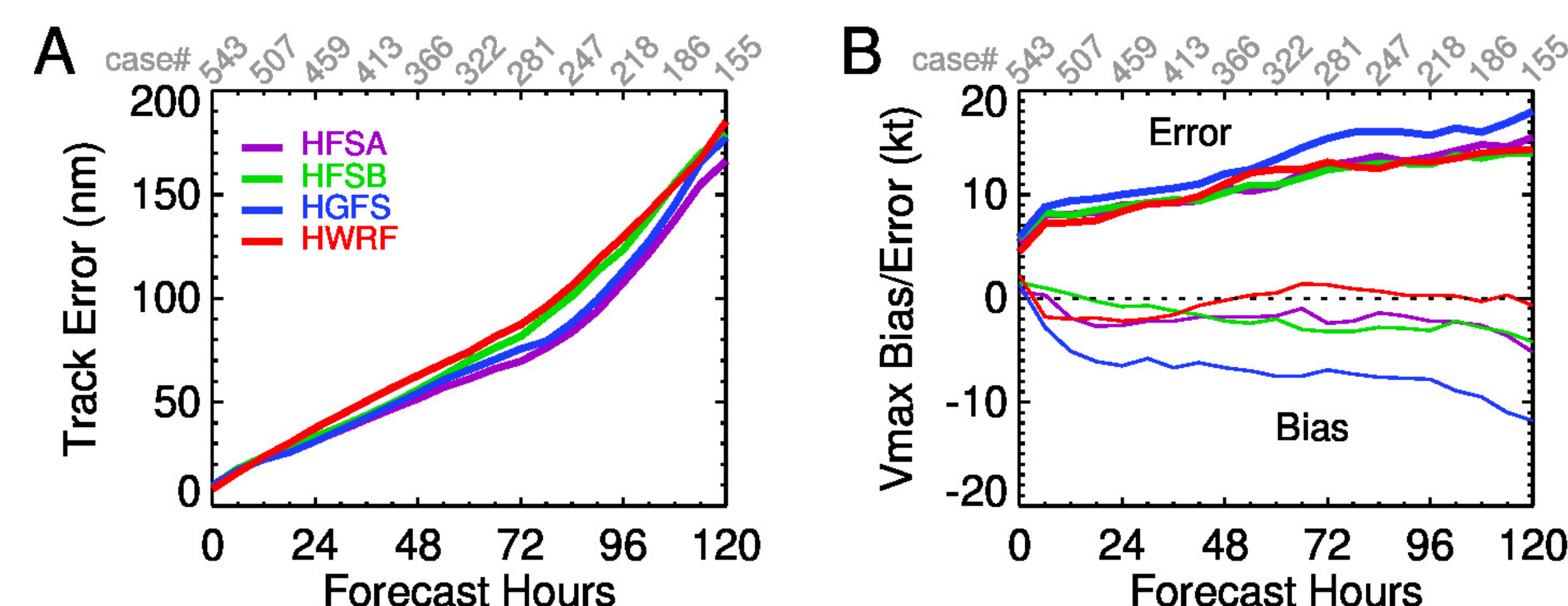
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Wang et al. (2024), Front. Earth Sci. 12:1379069. doi: 10.3389/feart.2024.1379069

Introduction

- Hurricane Analysis and Forecast System (HAFS) is an application of NOAA's unified forecast system, specialized in TC research and forecasting.
- First operational implementation of HAFS (HAFSv1) at NCEP in June 2023 replaces HWRF/HMON. It has two configurations (HFSA & HFSB).
- HAFSv1 physics schemes are the same as NCEP GFSv16 except for a few TC-specific modifications to improve intensity forecasts.

Why are modifications needed?



All HAFS runs have better track, while HAFS using GFS phys (HGFS, blue) has larger Vmax errors and biases than then-operational HWRF (red). HFSA/B (with modifications) have better Vmax results.

HFSA v1 and HFSB v1 phys

	HFSA	HFSB
Land/ocean Surface	NOAH LSM VIIRS veg type, HYCOM	NOAH LSM VIIRS veg type HYCOM
Surface Layer	GFS, HWRF TC-specific sea surface roughnesses	GFS, HWRF TC-specific sea surface roughnesses
Boundary Layer	Sa-TKE-EDMF, TC-related calibration, mixing length adjustments	Sa-TKE-EDMF, TC-related calibration, tc_pbl=1*, mixing length adjustments
Microphysics	GFDL single-moment	Thompson double-moment
Radiation	RRTMG Calling frequency 720 s	RRTMG Calling frequency 1800 s
Cumulus convection (deep & shallow)	Scale-aware-SAS, calibrated deep convection entrainment	Scale-aware-SAS
Gravity wave drag	Improved UGWPv1 (orographic on/convective off)	Improved UGWPv1 (orographic on/convective off)

Differences shown in colors

Modifications

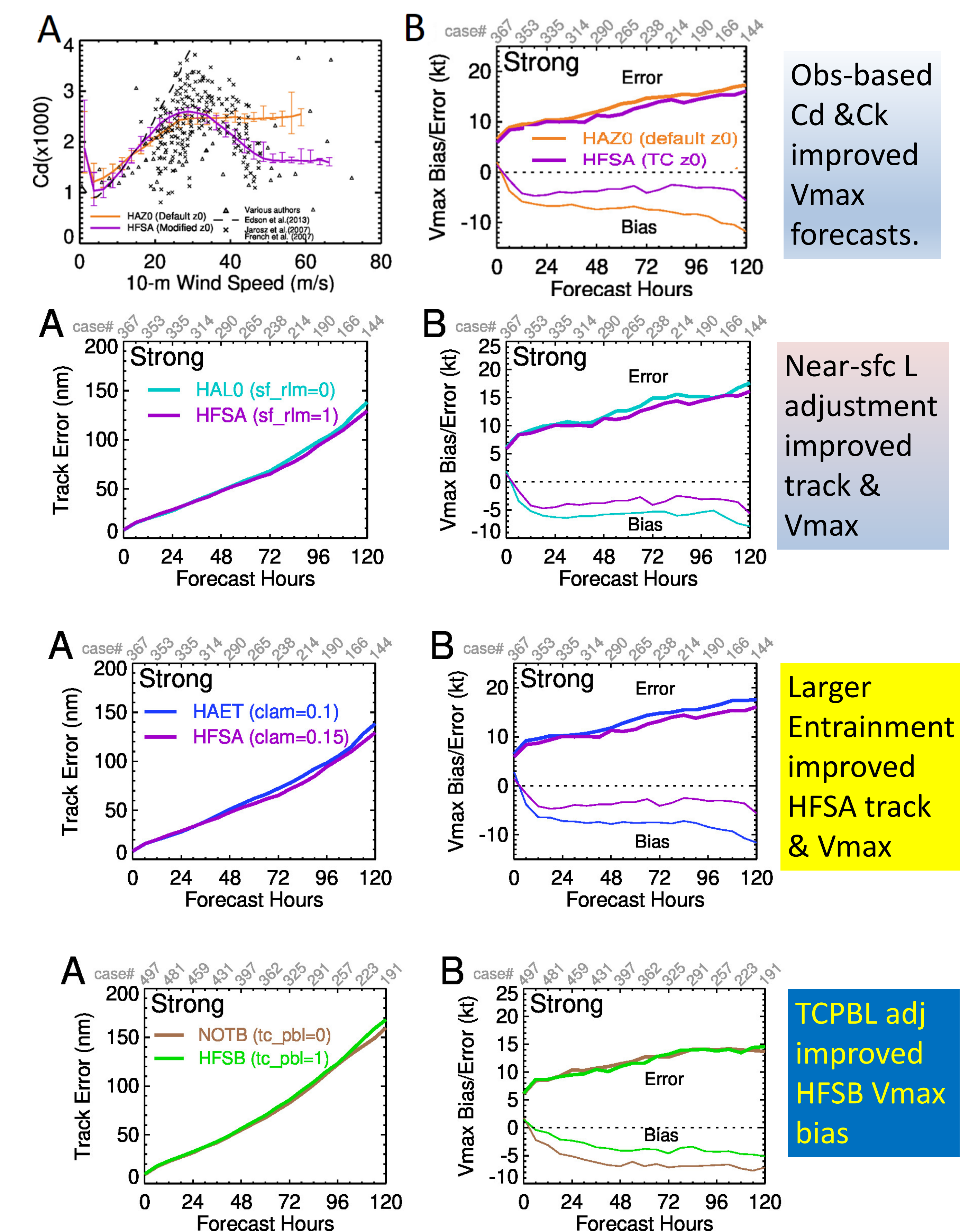
- Observation-based Surface momentum and enthalpy exchange coefficients (both HFSA and HFSB).
- Adjustment of near-surface mixing length in HFSA.
- Enhanced entrainment rate in convection scheme in HFSA.
- TCPBL adjustment in HFSB, including model coefficients, max allowed mixing length, mass flux, and PBLH

Experiments

Simulate NATL storms in 2021&2022 using HAFSv1 **with and without** those modifications, respectively, to highlight their impacts.

Impacts of modifications

Improved strong storms (Max>64kt)



Challenges/future

Unify physics schemes over parent/nest domains and basins; test model parameters and other physics options of microphysics & convection.