CIRES

Implementing the RAP/HRRR orographic drag parameterization suite in the FV3GFS

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Introduction

- A suite of subgrid-scale orographic drag parameterizations have been implemented in the RAPv5/HRRRv4 by GSL
  - Such parameterizations have been used at coarse horizontal grid spacings (~100km) in the past
  - Benefits are seen at grid spacings of ~10km in the RAP/HRRR
- The suite is now available in the FV3GFS (global and regional) via the Common Community Physics Package (CCPP)

GSL orographic drag suite

Consists of four subgrid-scale drag parameterizations

Large horizontal scale processes

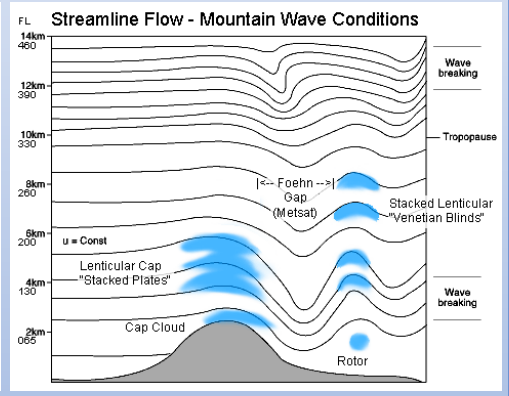
Small horizontal scale processes

Flow blocking drag

Kim and Doyle (2005)

Horizontal grids > 5km

Large-scale gravity wave drag



Kim and Doyle (2005)

Horizontal grids > 5km

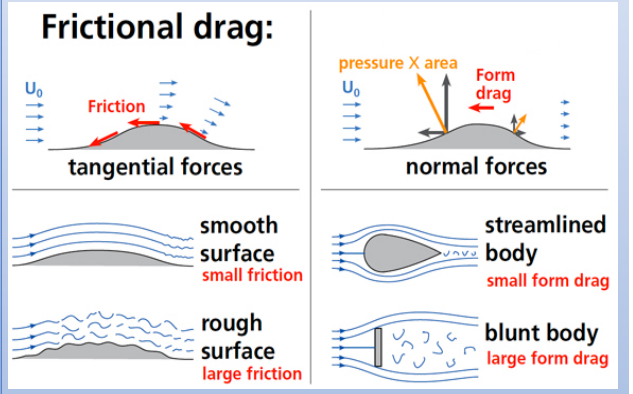
Small-scale gravity wave drag

Tsiringakis et al. (2017)

Horizontal grids > 1km

Active in stable (typically nocturnal) PBL

Turbulent Form Drag



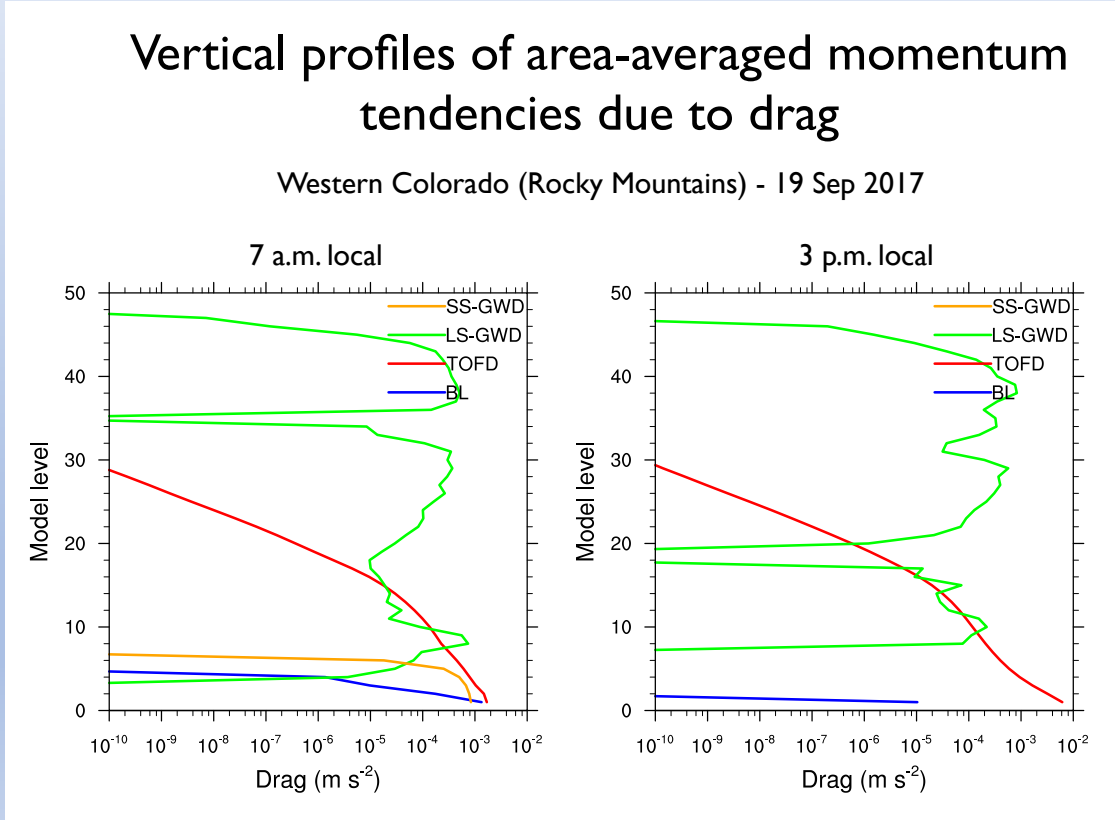
Beljaars et al. (2004)

Horizontal grids > 1km

With form drag parameterization, we can reduce z_0 in the PBL scheme to account only for surface roughness

Comparison of the four GSL drag schemes

Results from 13km RAP



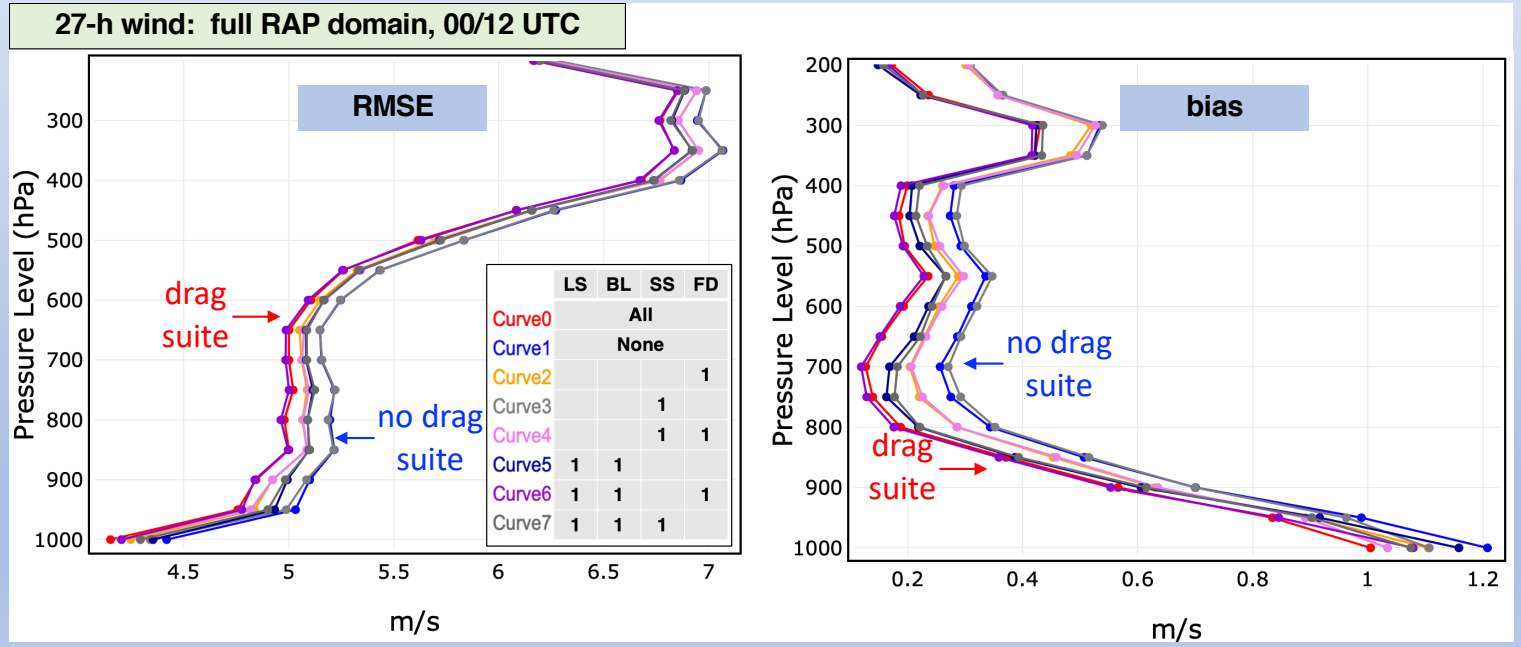
During the day:

- Small-scale GWD not active
- Low-level blocking reduced

RAPv5 reforecast results

13km grid spacing

2-15 Feb 2019

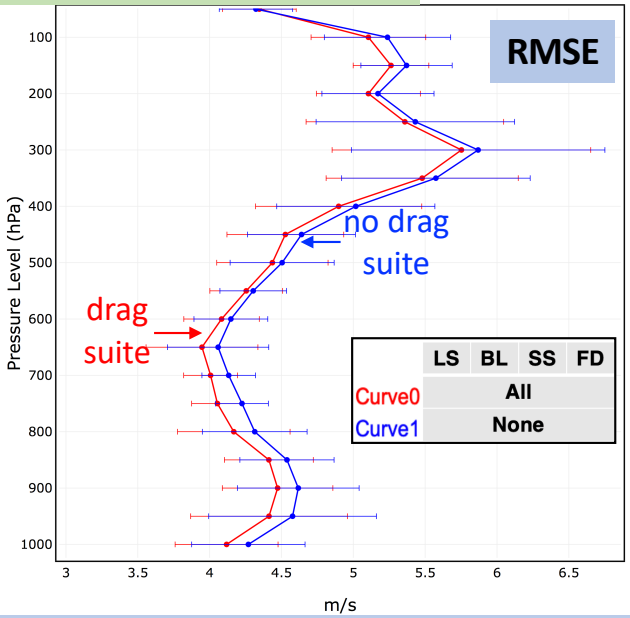


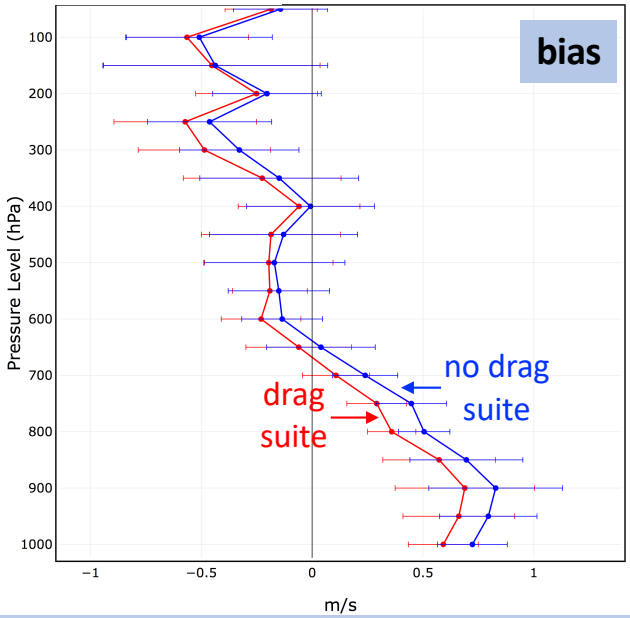
Global FV3GFS reforecast results

C768 grid (~13km grid spacing)

1 Jan – 2 Mar 2016

24-h wind: CONUS, 00/12 UTC





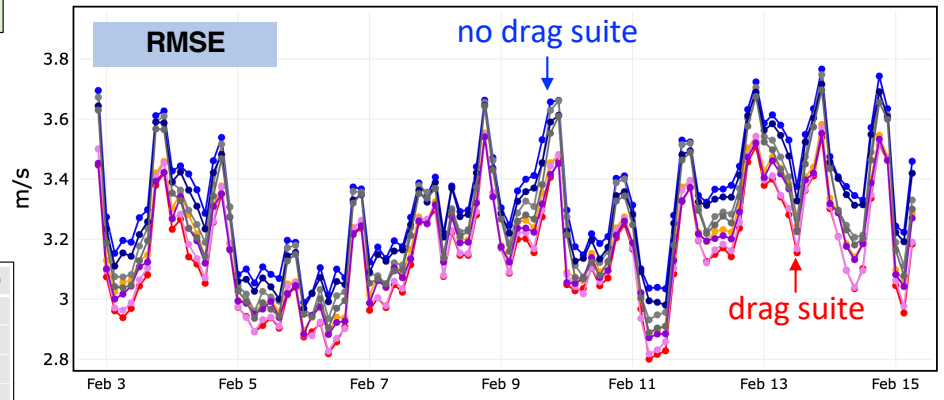
RAPv5 reforecast results

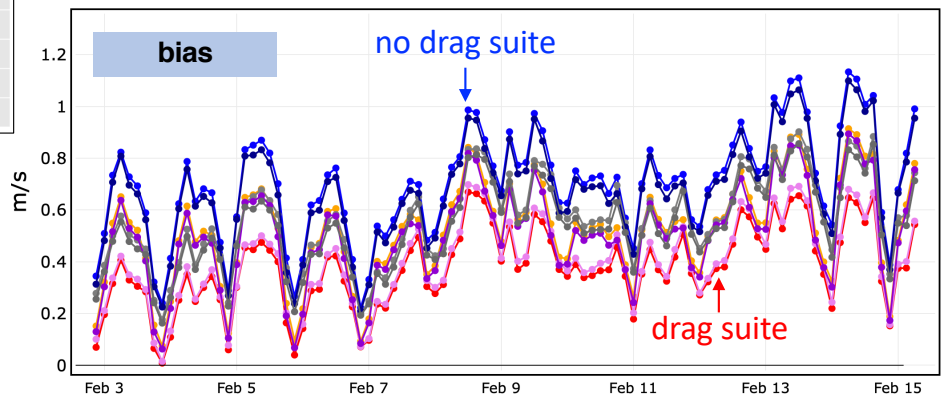
13km grid spacing

2-15 Feb 2019

21-h 10-m wind: full RAP domain

	LS	BL	SS	FD
Curve0	All			
Curve1	None			
Curve2				1
Curve3			1	
Curve4			1	1
Curve5	1	1		
Curve6	1	1		1
Curve7	1	1	1	





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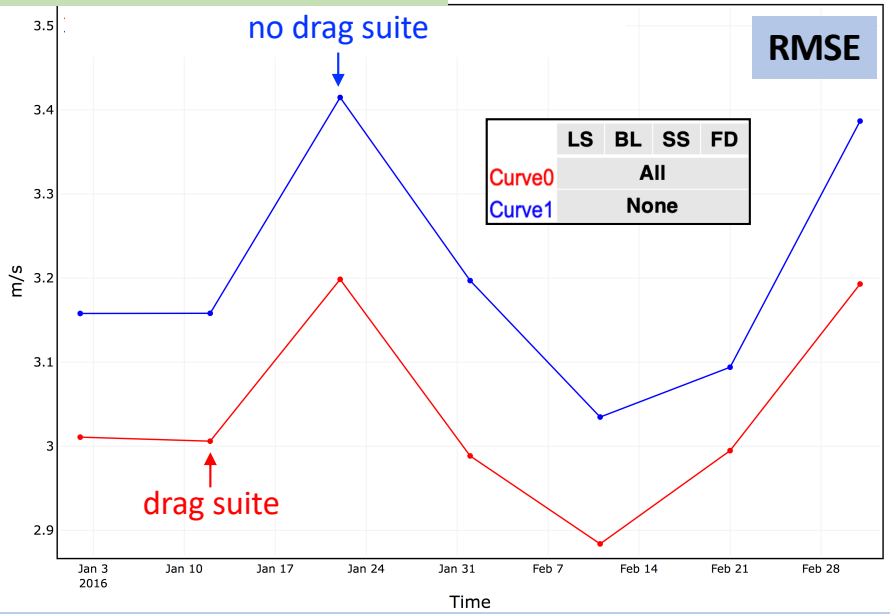

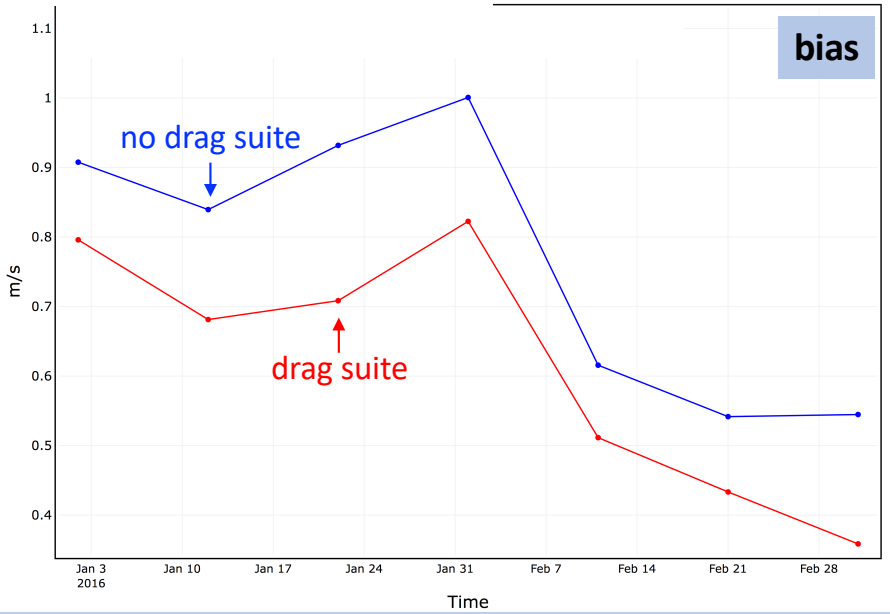

Accessing the code and what's ahead

- The GSL drag suite is available at:
  - https://github.com/NOAA-GSD/ufs-weather-model (gsd/develop branch)
  - https://github.com/NCAR/ccpp-physics (master and dtc/develop branches)
- In CCPP Suite definition file, include the line:
  `<scheme>drag_suite</scheme>`
- Static files containing statistics of subgrid topography, e.g., standard deviation of subgrid topographic height
  - For now, custom made for each grid
  - Planning to make it generated automatically on initialization
- Namelist option: `gwd_opt = 3`
- The GSL drag suite will soon be merged with the Unified Gravity Wave Physics

References

Beljaars, A. C. M., A. R. Brown, and N. Wood, 2004: A new parametrization of turbulent orographic form drag. *Q. J. R. Meteorol. Soc.,* **130,** 1327-1347.

Kim, Y.-J., and J. D. Doyle, 2005: Extension of an orographic-drag parametrization scheme to incorporate orographic anisotropy and flow blocking. *Q. J. R. Meteorol. Soc.,* **131,** 1893-1921.

Tsiringakis, A., G. J. Steeneveld, and A. A. M. Holtslag, 2017: Small-scale orographic gravity wave drag in stable boundary layers and its impact on synoptic systems and near-surface meteorology. *Q. J. R. Meteorol. Soc.,* **143,** 1504-1516.