Investigating the impact of surface drag parameterization schemes available in WRF on surface winds

Hongli Jiang[1,3], Michelle Harrold[2,3] and Jamie Wolff[2,3]

1: NOAA/ESRL/CIRA, Colorado State University

2: NCAR/Research Applications Laboratory

3: Developmental Testbed Center

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Surface drag parameterization

New topo_wind options to improve topographic effects on surface winds in YSU PBL scheme:

–*topo_wind*=1 (v3.4, Jimenez and Dudhia 2012)

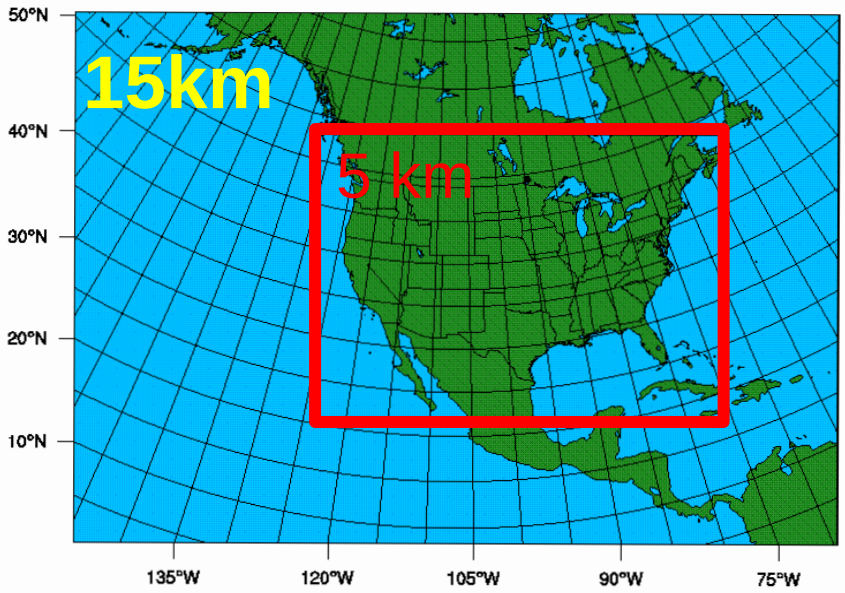
$$\frac{\partial u}{\partial t} = \cdots - C_t \frac{u_*^2 u}{\Delta z V}, C_t = fn(\Delta^2 h, \sigma_{sso})$$

- *h: topographic height*
- σ_{sso} *: Standard deviation of subgrid-scale orography*

–*topo_wind*=2 (v3.4.1+, Mass and Ovens 2010; 2011; 2012)

- *Enhancing:* u_* (~subgrid terrain variance)

Testing the New *topo_wind* Option



Physics Suite	Test Configuration
Microphysics	WRF Single-Moment 5
Radiation (SW/LW)	Dudhia/RRTM
Surface Layer	Monin-Obukhov similarity theory
Land Surface Model	Noah
PBL	Yonsei University (topo_wind=0,1,2)
Convection	Kain-Fritsch

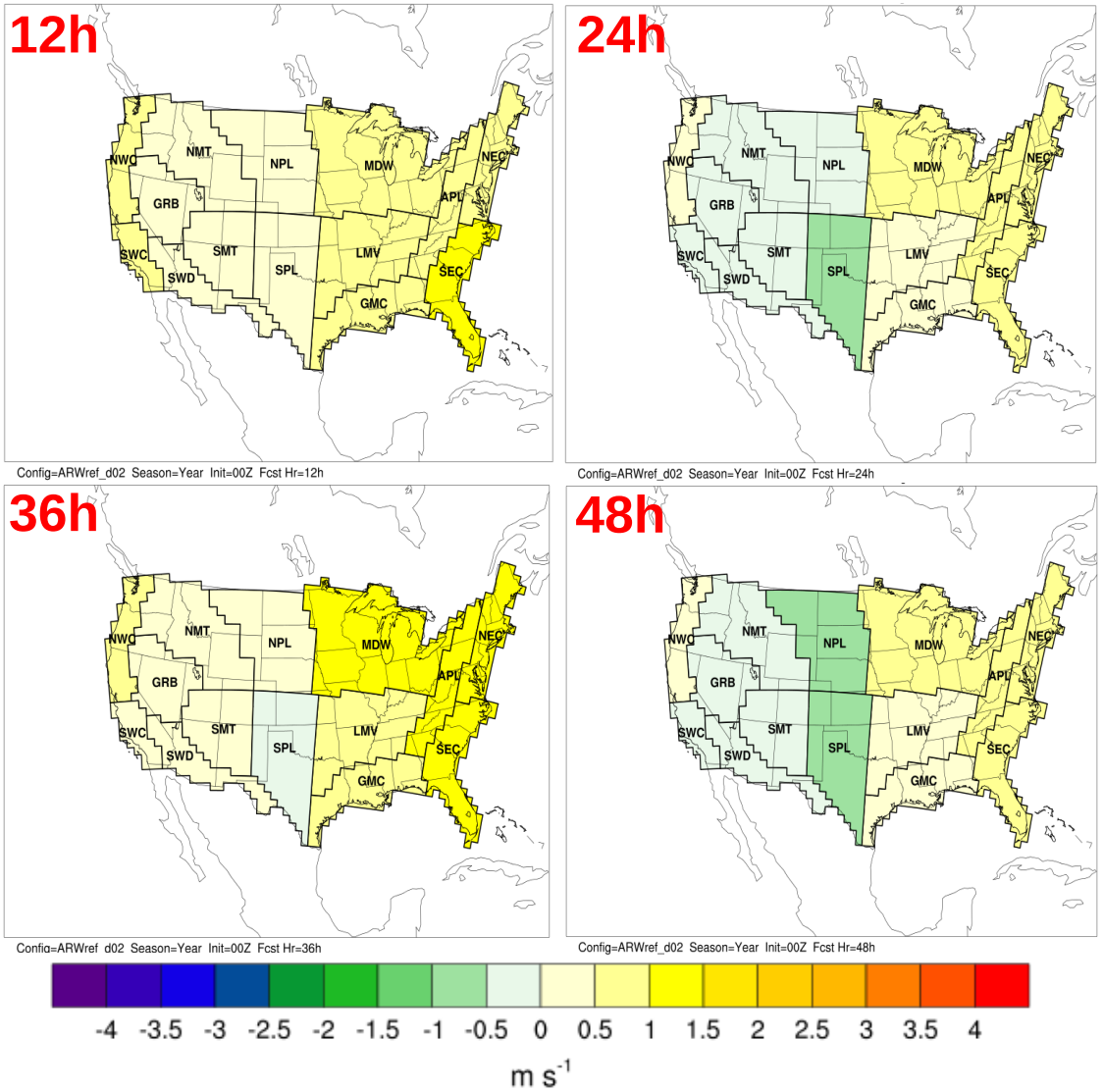
- Year-long simulations:1 July 2011 – 30 June 2012
- Initialized every 36 h, 48-h forecasts
- Domain: **15-km/5-km** nest
- **Focus on winds**

- Three configurations:
  - *topo_wind*=0 (twind0)
  - *topo_wind*=1 (twind1)
  - *topo_wind*=2 (twind2)

- Comparisons: (5-km domain only)
  - twind0 - twind1
  - twind0 - twind2
  - twind0, twind1,twind2
  - twind1 - twind2

Visit P67 by Harrold et al. for information regarding additional variables for twind0

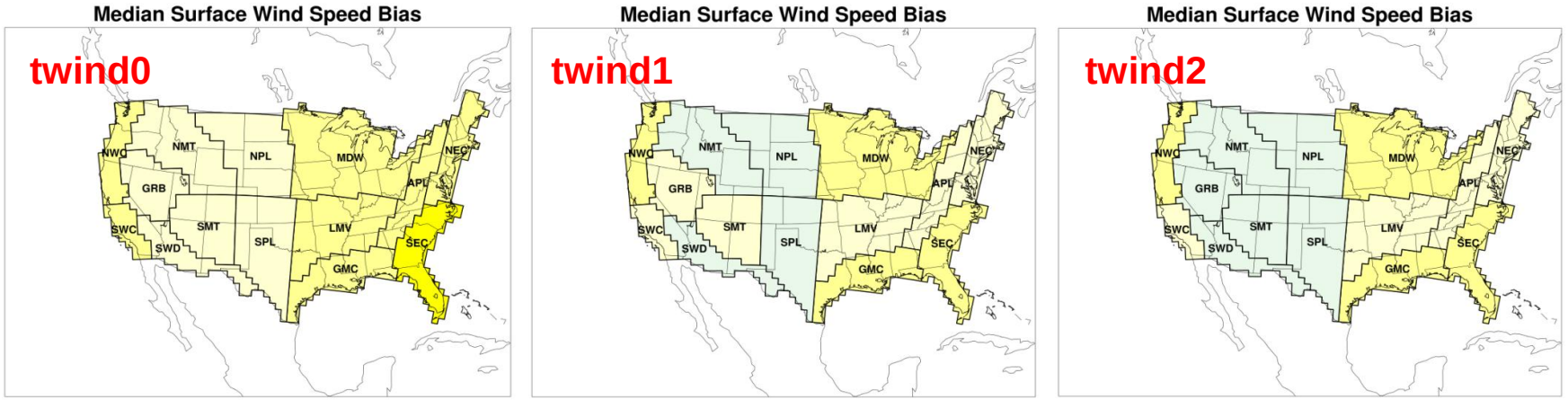
Surface wind speed bias (*twind0*), 00 UTC INIT

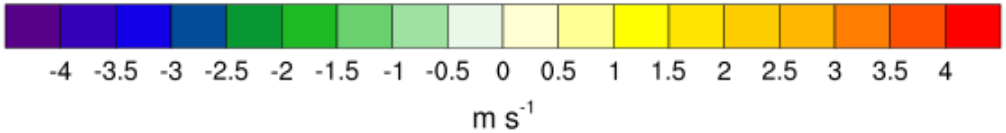


- High wind bias
- Diurnal variation
- Regional variation (East vs. West)
- **Yellow: 0.5 to 1.5 m/s**
- **Green: -0.5 to -1.5 m/s**

Comparison among three configurations

00f12





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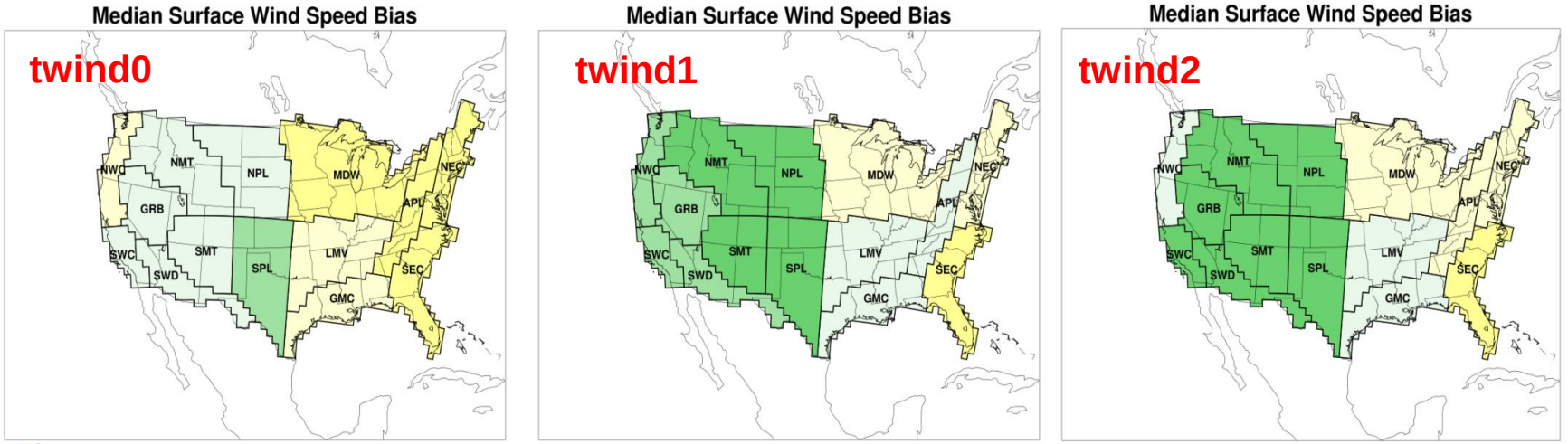
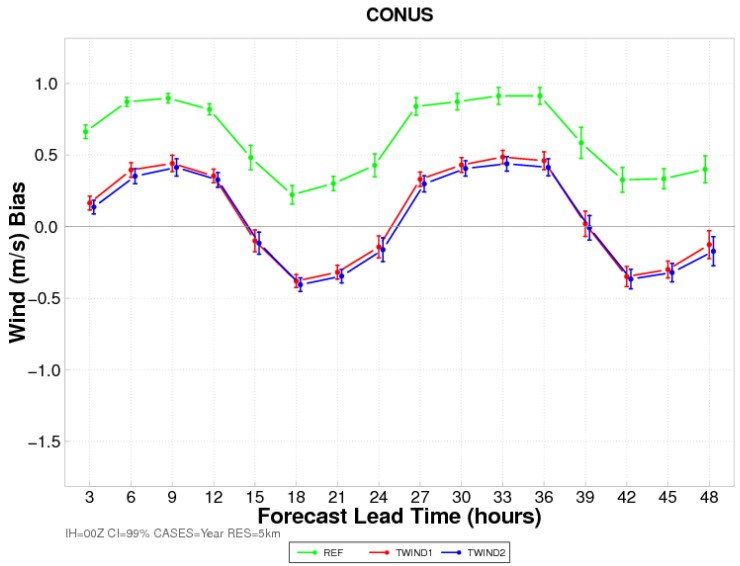
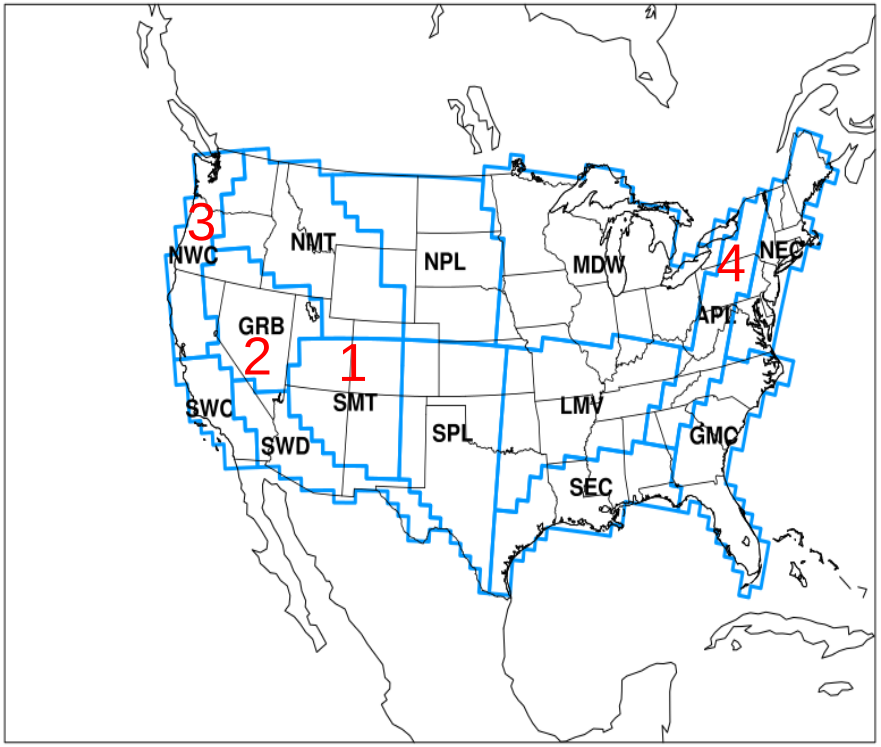


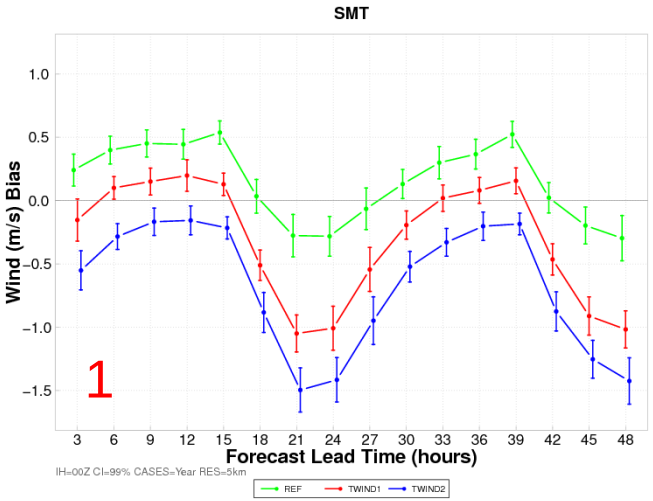
Breakdown by region: twind0, twind1, twind2

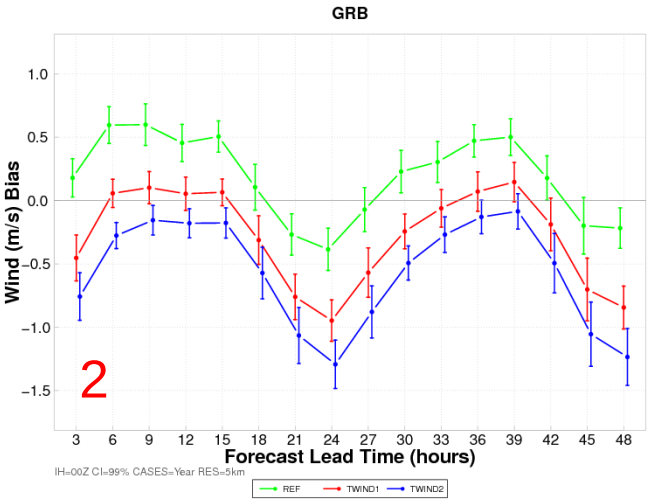


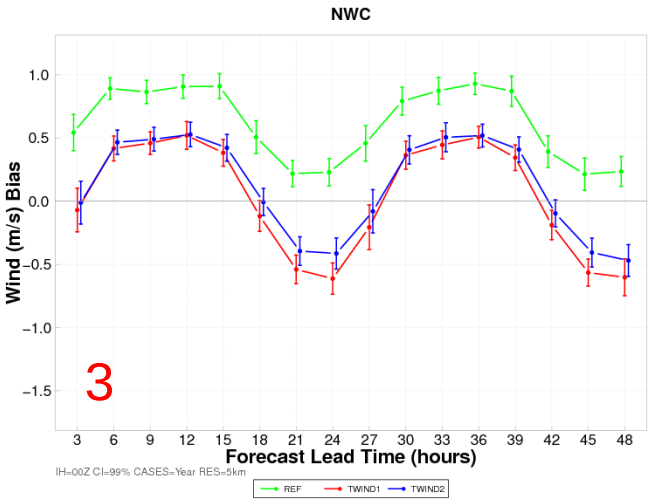
- twind0: high wind bias for all forecast lead times, maximum bias overnight and minimum during the day
- twind1, twind2: bias reduced over night, over-corrected during the day

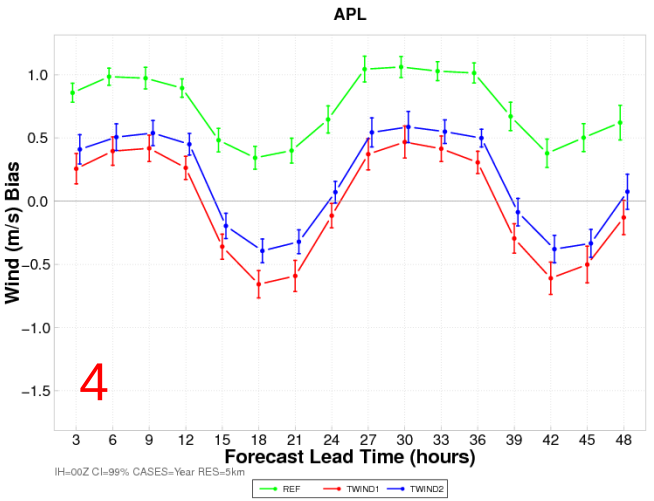


Breakdown by region: twind0, twind1, twind2



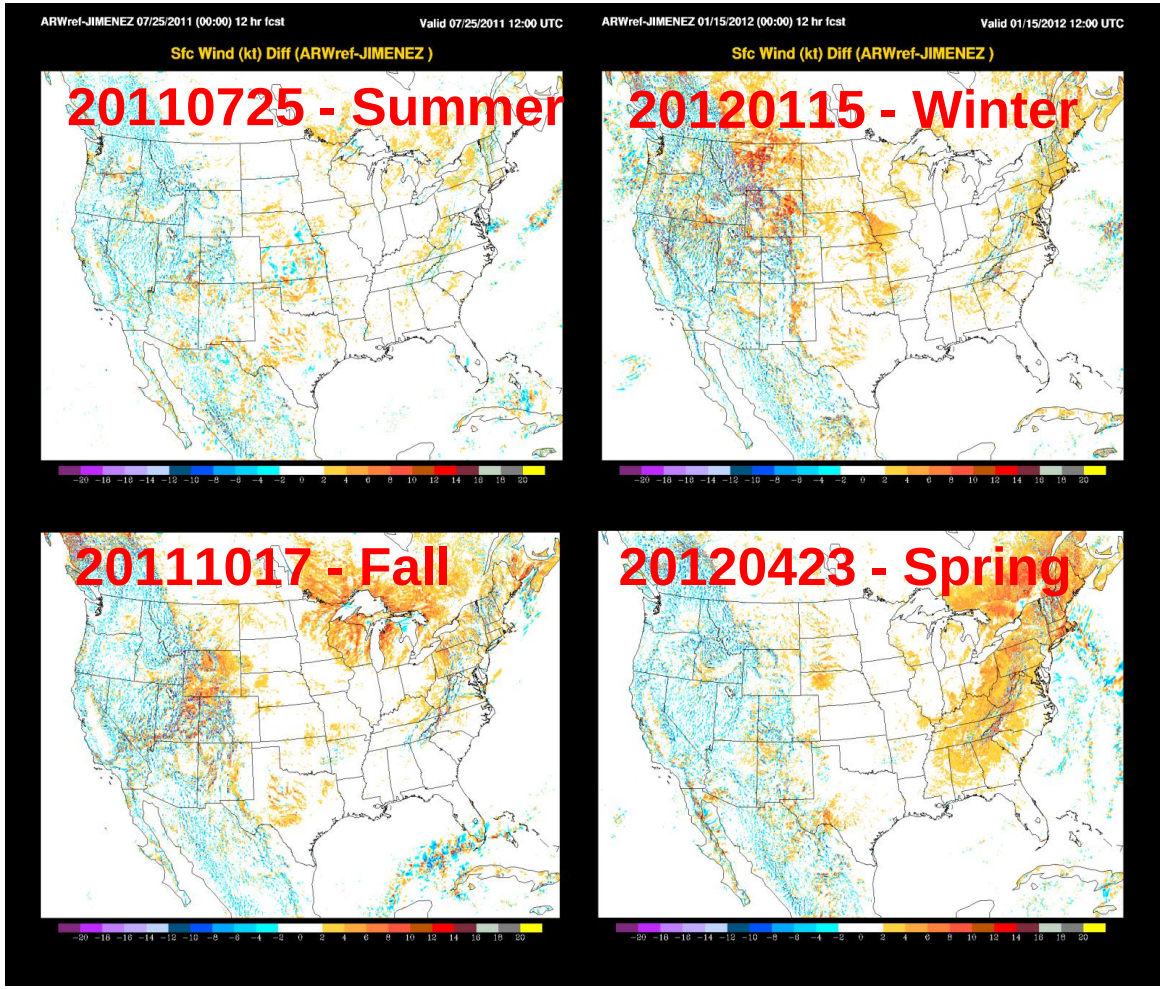






Breakdown by season: twind0 - twind1

00f12h



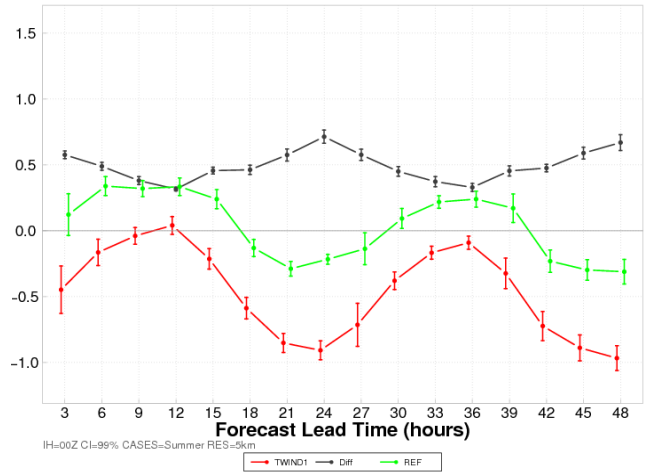
- **Very complex pattern for any given day**
- **Blue: twind1 stronger – generally over Mountain West**
- **Orange: twind1 weaker – generally over East Plains**

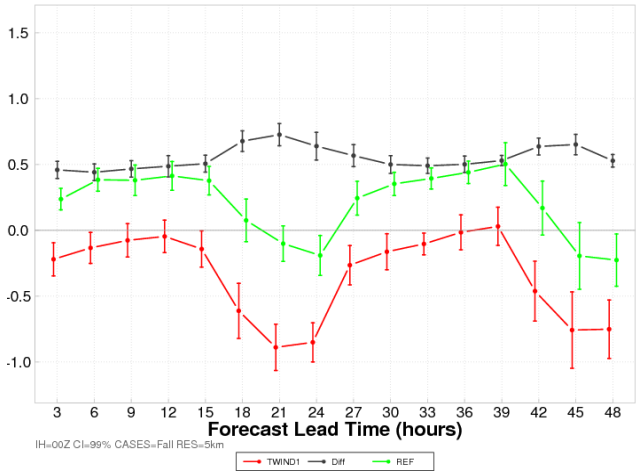
Breakdown by season/region: twind0, twind1

Wind (m/s) Bias

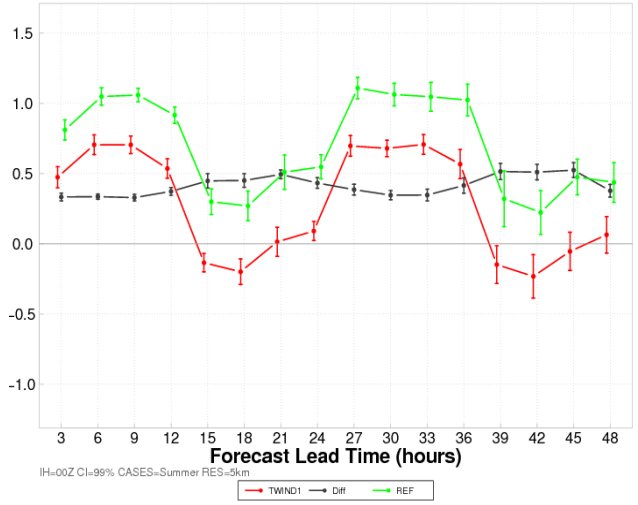
Summer | **Fall**

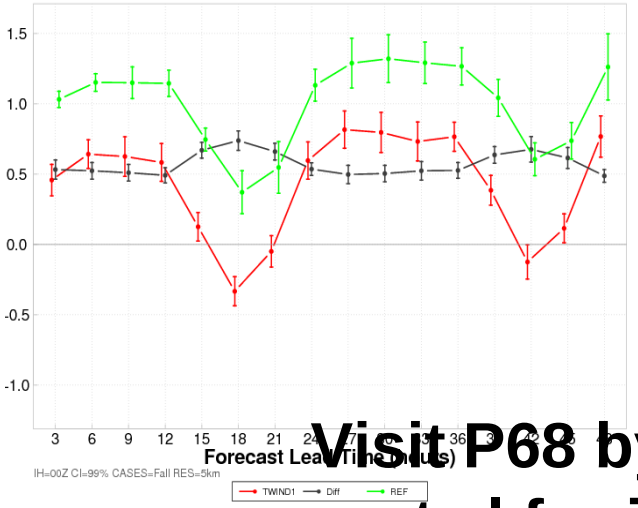
West





East





West region:

- **twind1 reduces bias to near zero 12h, 36h**
- **Over corrected during the day**

East region:

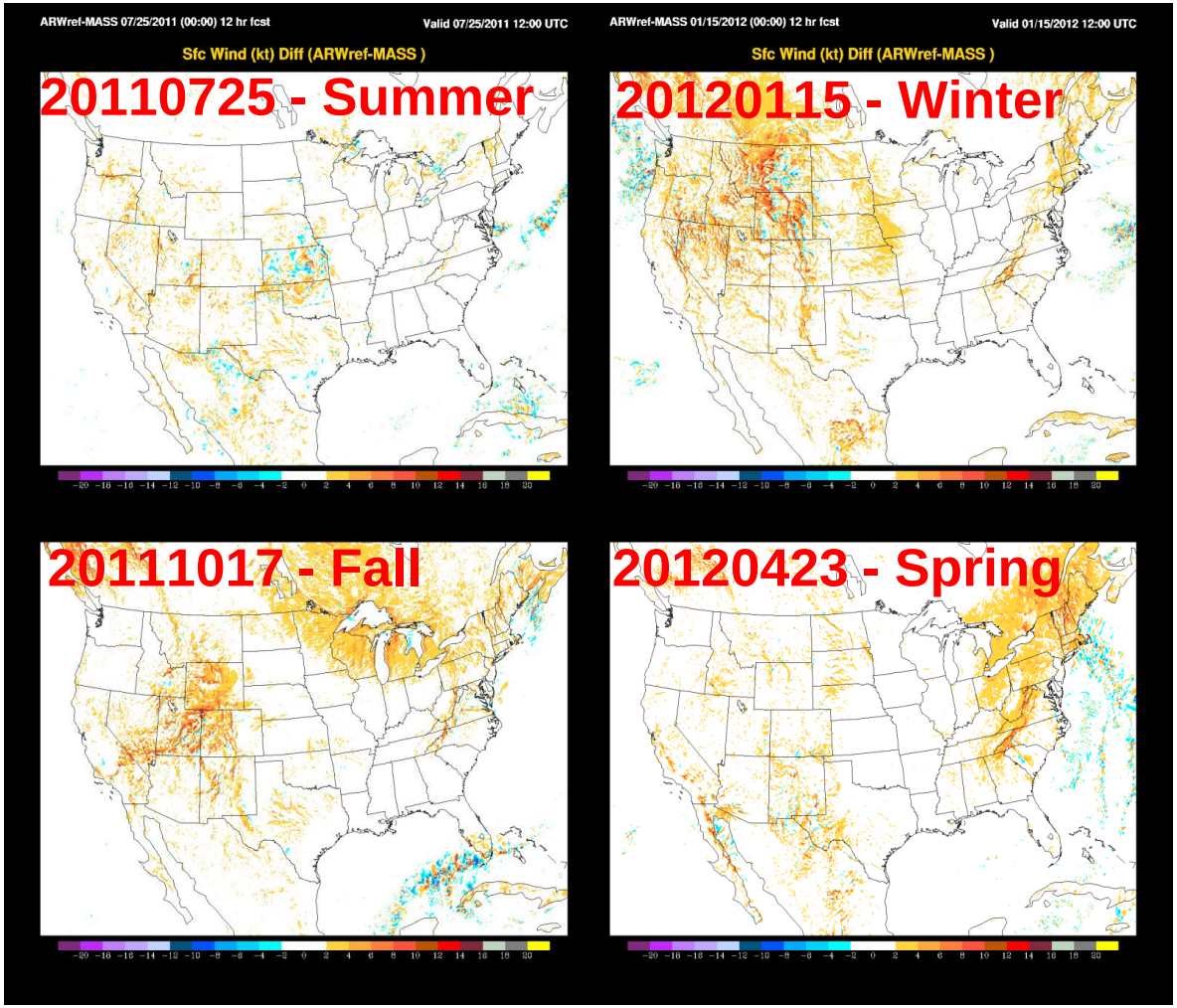
- **twind1 shifts bias downward**
- **bias still high overnight**

General offset of ~0.5 m/s between the two configurations

Visit P68 by Lorente-Plazas et al for improvement

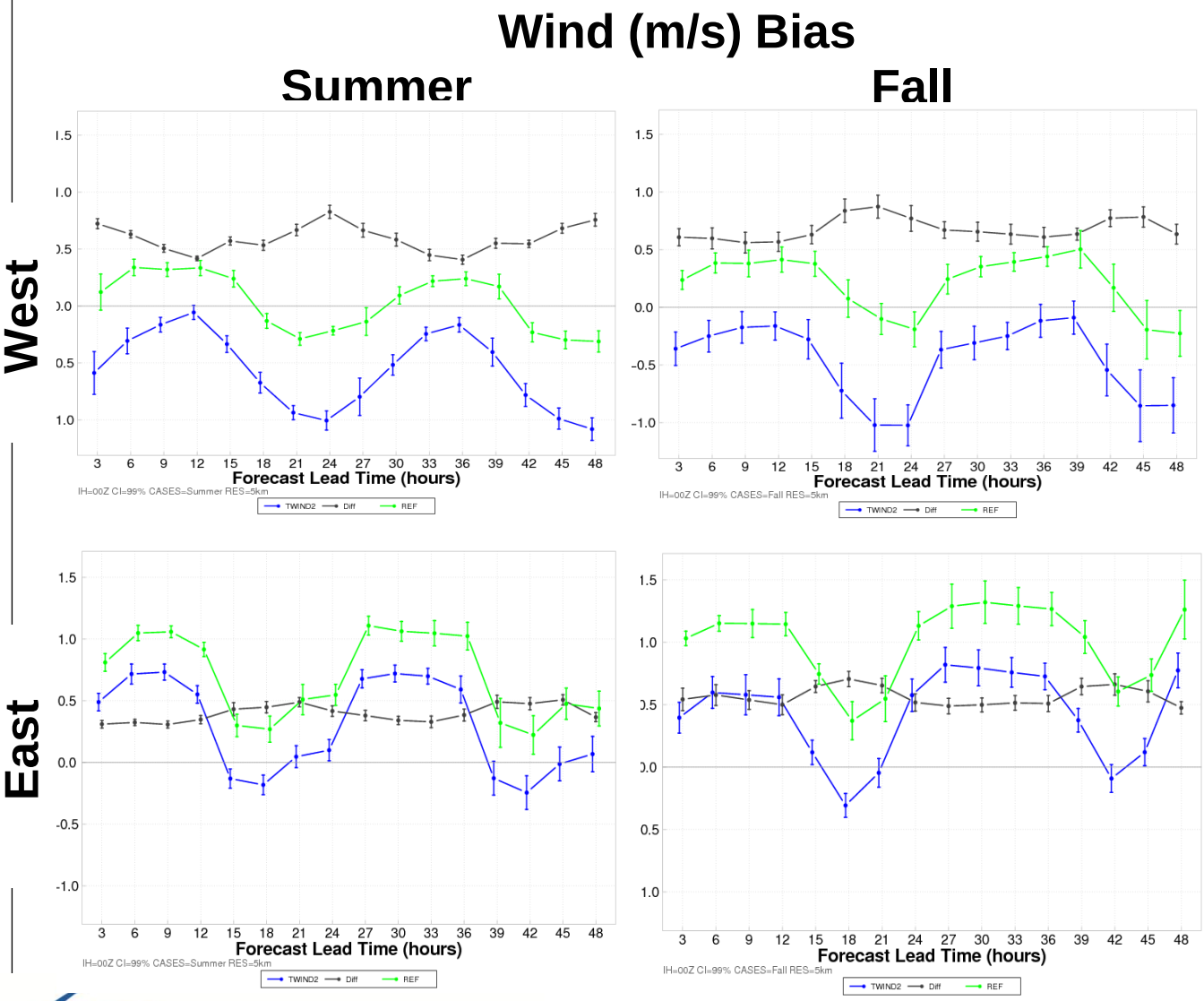
Breakdown by season: twind0 - twind2

00f12h



- Orange: twind2 weaker

Breakdown by season/region: twind0, twind2



West region:

- **twind2 reduces bias to below zero 12h, 36h**
- **over corrected during the day**

East region:

- **bias reduced**
- **higher than the West**

General offset of ~0.5 m/s between the two configurations

Summary

topo_wind=0:

- High surface wind bias (known issue)
  - –maximum at 12 h and 36 h
  - –minimum at 24 h
- Higher bias over East, Lower over West (for all seasons)
  - –unresolved subgrid topography
  - –smoother or flatter topography used in the model
  - –absence of topographic drag

topo_wind=1, 2:

- Overall high bias reduced in both options
  - –at night: improvement
  - –during the day: over-corrected
- Other factors
  - –fewer stations over West/Mountains, Hills
  - –representativeness error over West
  - –is subgrid topograph correctly resolved? at what resolution?