New Mexico OAI Study Photochemical Modeling – 2nd Monthly Webinar June 2020

WESTAR and Ramboll

June 26, 2020

RAMBOLL Bright ideas. Sustainable change.

Content

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- Overview of NMED OAI Modeling Project
- Summary of May 28, 2020 Webinar
- NMED OAI Modeling Study Website
  - https://www.wrapair2.org/NMOAI.aspx
- 2014 and 2023 New Mexico Emissions
- 2014 36/12/4-km WRF Meteorological Modeling and Model Evaluation
- Next Steps
- Discussion

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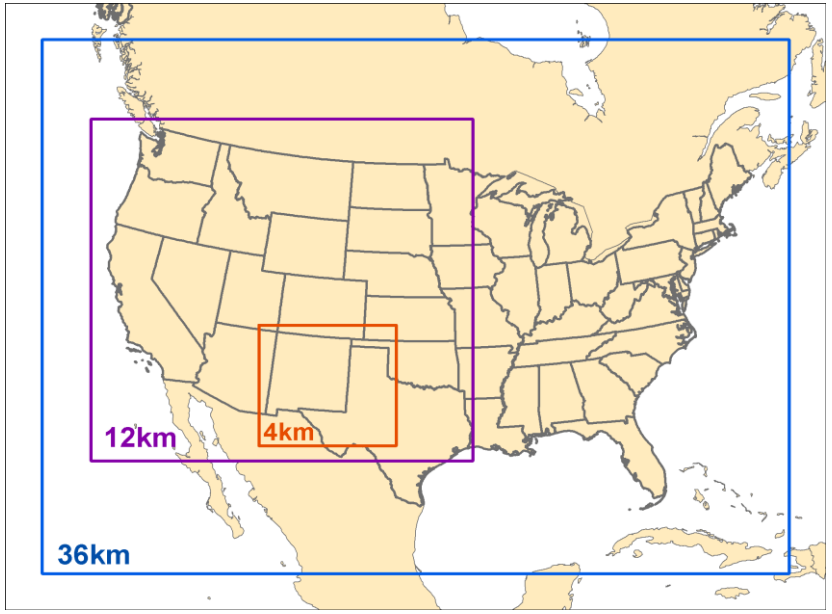
Overview of NMED OAI Modeling Study Tasks

- Task 1: Development Modeling Protocol/QAPP and Work Plan -- Completed
- Task 2: WRF Meteorological Modeling -- Completed
- Task 3: Evaluate Boundary Condition Inputs – Completed
- Task 4: 2014 and 2023 Emissions Development
  - Sources of 2014 and 2023 Emissions -- Completed
  - Sources of Mobile Source Emissions -- Completed
  - Natural Emissions; SMOKE Emissions Modeling; 2023 Controls
- Task 5: CAMx 2014 Base Case Modeling
  - Formal 2014 Base Case and MPE Report
- Task 6: 2023 Future Year CAMx Modeling
  - 2023 Base, Source Apportionment and Control Measure Evaluation
- Task 7: Air Quality Technical Support Document (AQTSD)
  - Formal AQTSD; Transfer Data and Results to IWDW



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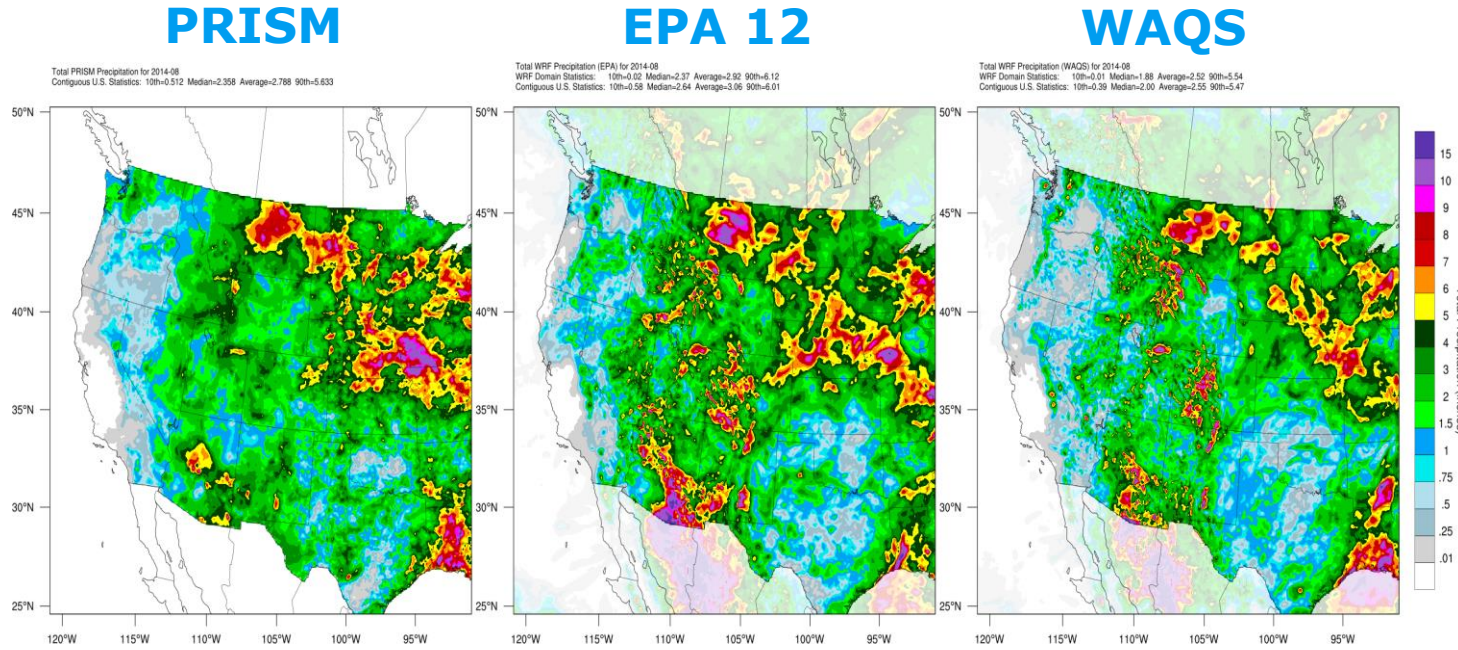
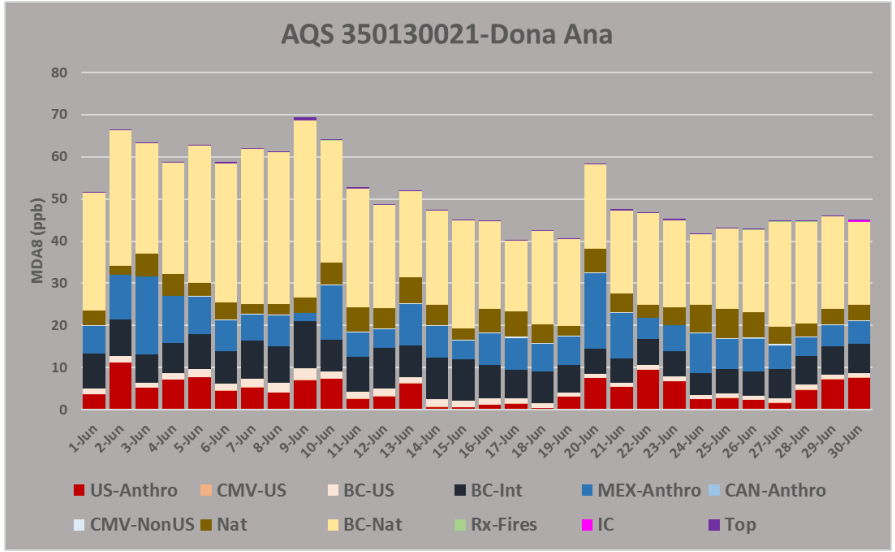
OVERVIEW OF MAY 26, 2020 WEBINAR

- Evaluation of Existing 2014 WRF Meteorological Modeling
  - EPA vs. WAQS 2014 WRF Modeling
  - NMED 2014 WRF following WAQS
- Evaluation of 2014 GEOS-Chem BCs
  - Deemed adequate
- Overview of Modeling Protocol and Work Plan
- 2014 and 2023 New Mexico Emissions
  - Request comments by June 12
- Next Steps





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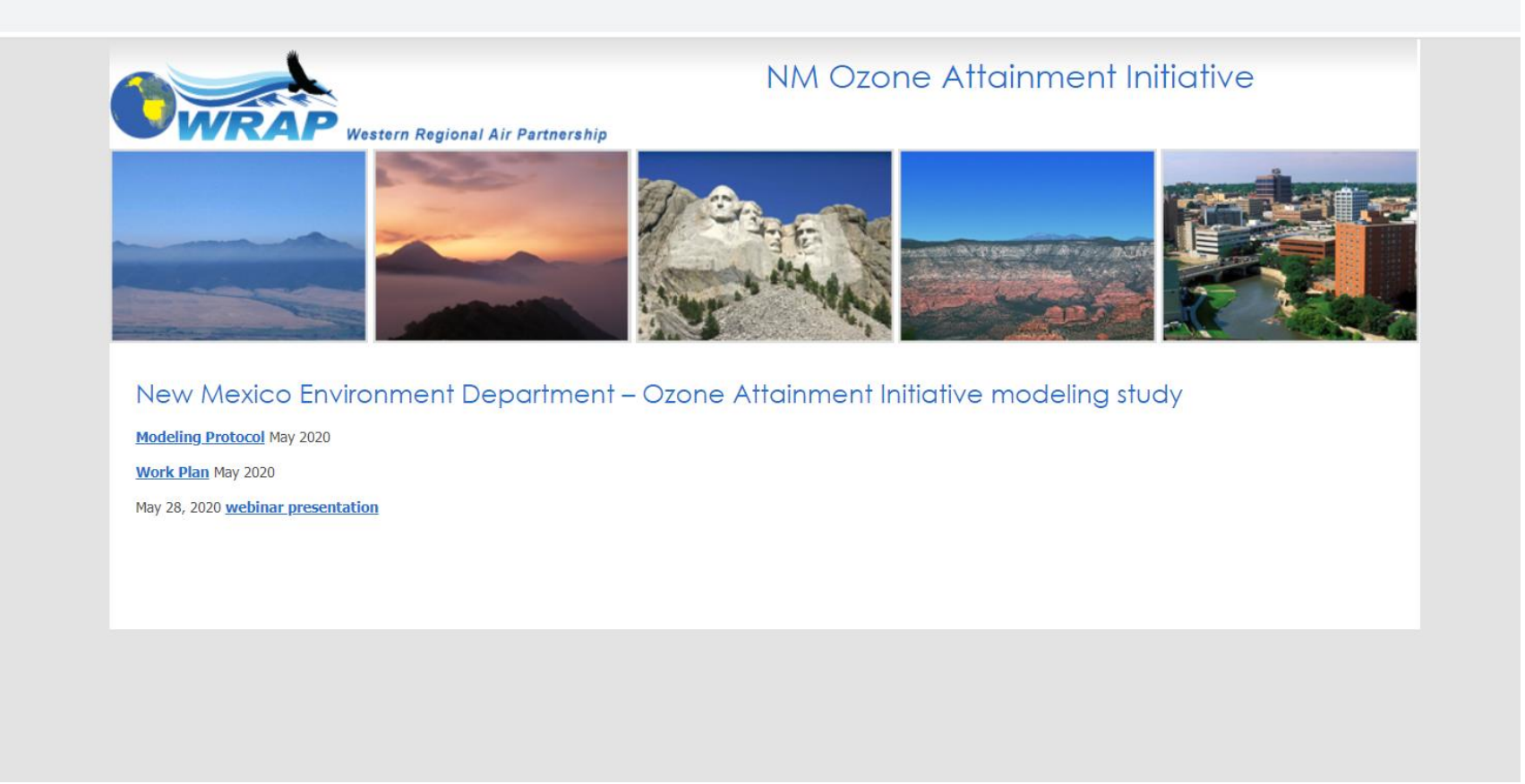
NMED OAI MODELING STUDY WEBSITE

- https://www.wrapair2.org/NMOAI.aspx



2014 AND 2023 EMISSIONS

New Mexico Emissions Data

- 2014 anthropogenic emissions are based on the WAQS 2014v2
  - NMED provided information on a piece of equipment missing from the inventory (NOx 94 TPY and VOC 1 TPY)
  - Consistent emissions between Regional Haze and OAI studies
- 2023 anthropogenic emissions are based on the EPA 2016v1 platform
  - NMED updates: some Title V facilities are duplicates in the pt_oilgas and ptnonipm sectors
  - Added Lordsburg Generating Station missing from the 2023 inventory
- On-Road emissions based on SMOKE-MOVES processing with 2014/2023 activity data and day-specific hourly gridded 2014 WRF meteorology
- O&G emissions based on state-of-the-science O&G emissions estimates from the IWDW-WAQS platform

2014 update

facility_name	sector	CO	NOX	PM10	PM25	SO2	VOC
Saunders Gas Plant	pt_oilgas	6	94	0	0	0	1

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2023 NEW MEXICO EMISSIONS – DUPLICATE EMISSIONS

facility_name	sector	CO	NH3	NOX	PM10	PM25	SO2	VOC
Hope Pump Station	pt_oilgas	48	0	204	0	0	0	10
NuStar Logistics Operation LP - Hope Pump Station	ptnonipm	4	0	101	0	0	0	0
Durango Midstream - Empire Abo Gas Plant - CS	pt_oilgas	142	0	546	20	20	1,184	623
Empire Abo Gas Plant/Compressor Station	ptnonipm	12	0	84	0	0	162	42
Durango Midstream - Maljamar Gas Plant	pt_oilgas	239	0	305	14	14	417	250
Maljamar Gas Plant	ptnonipm	50	0	87	7	7	213	57
DCP - Linam Ranch Gas Plant	pt_oilgas	345	0	547	23	19	300	163
Linam Ranch Gas Plant	ptnonipm	449	0	692	28	28	109	103
DCP - Eunice Gas Plant	pt_oilgas	183	0	526	7	6	1,585	67
DCP Midstream - Eunice Gas Plant	ptnonipm	224	0	606	11	11	1,437	70
Mid-America Pipeline - San Luis Pump Station	pt_oilgas	4	0	8	0	0	0	8
San Luis Pump Station	ptnonipm	2	0	3	0	0	0	1
Huerfano Pump Station	ptnonipm	10	0	25	1	1	0	23
Mid-America Pipeline - Huerfano Pump Station	pt_oilgas	5	0	14	1	1	0	16
Lordsburg Generating Station	ptegu	2	0	3	0	0	0	1

Some O&G sources not classified as O&G and incorrectly placed in Non-EGU Point Source Sector in EPA's 2023fh emission projections so got double counted when EPA 2023 O&G was replaced by WRAP 2023 O&G

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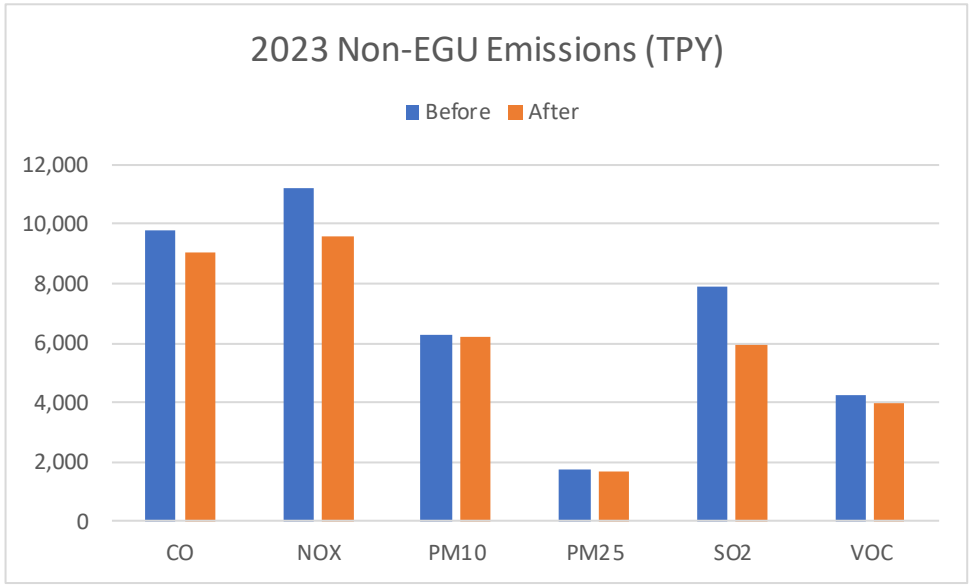
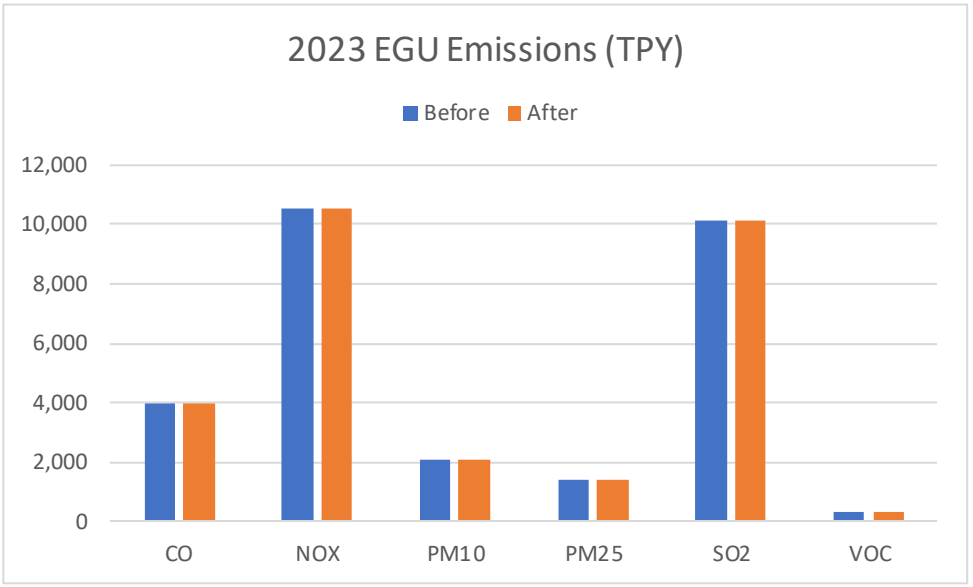
2023 NM EMISSIONS UPDATES

Duplicate Sources						
	CO	NOX	PM10	PM25	SO2	VOC
Ptnonipm	751	1,599	48	48	1,921	297
Original inventory (total emissions)						
	CO	NOX	PM10	PM25	SO2	VOC
Pt_oilgas	38,732	44,062	1,150	1,104	12,864	32,934
Ptnonipm	9,774	11,208	6,273	1,744	7,881	4,232
Ptegu	3,963	10,516	2,040	1,365	10,122	312
Updated total emissions (removing duplicates)						
	CO	NOX	PM10	PM25	SO2	VOC
Pt_oilgas	38,732	44,062	1,150	1,104	12,864	32,934
Ptnonipm	9,023	9,609	6,225	1,696	5,960	3,936
Ptegu	3,965	10,519	2,040	1,365	10,122	312





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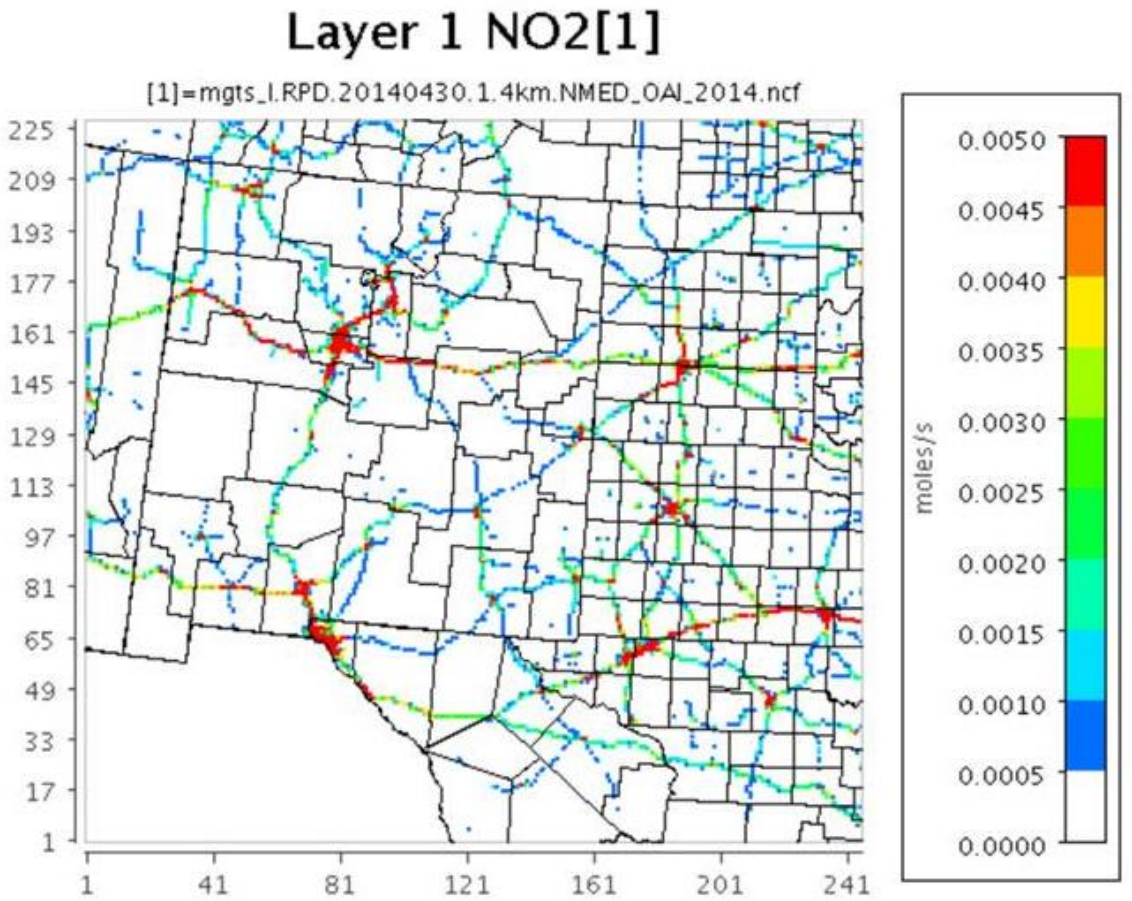
SMOKE PROCESSING

- SMOKE version 4.7

- Process 4 km emissions using spatial surrogates from EPA's emission modeling platform

- Began processing SMOKE-MOVES with 4-km MCIP data and 2014 MOVES lookup tables
  - rate-per-distance (RPD) (30 mins per day)
  - rate-per-vehicle (RPV) (10 mins per day)
  - rate-per-profile (RPP)
  - rate-per-hour (RPH)



Emission Modeling Sector Description

Separate SMOKE emissions modeling of each Source Sector

Sector	Description
afdust_adj	Area fugitive dust
ag	Agricultural ammonia sources
cmv_c1c2	Category 1 & 2 Marine Vessels
cmv_c3	Category 3 Marine Vessels
nonpt	Other nonpoint sources
np_oilgas	Non-point Oil and Gas
nonroad	Non-road mobile
onroad	On-road mobile
ptegu	EGU point sources
ptnonipm	Non-EGU point sources
pt_oilgas	Point Oil and Gas
rail	Locomotive
rwc	Residential Wood Combustion

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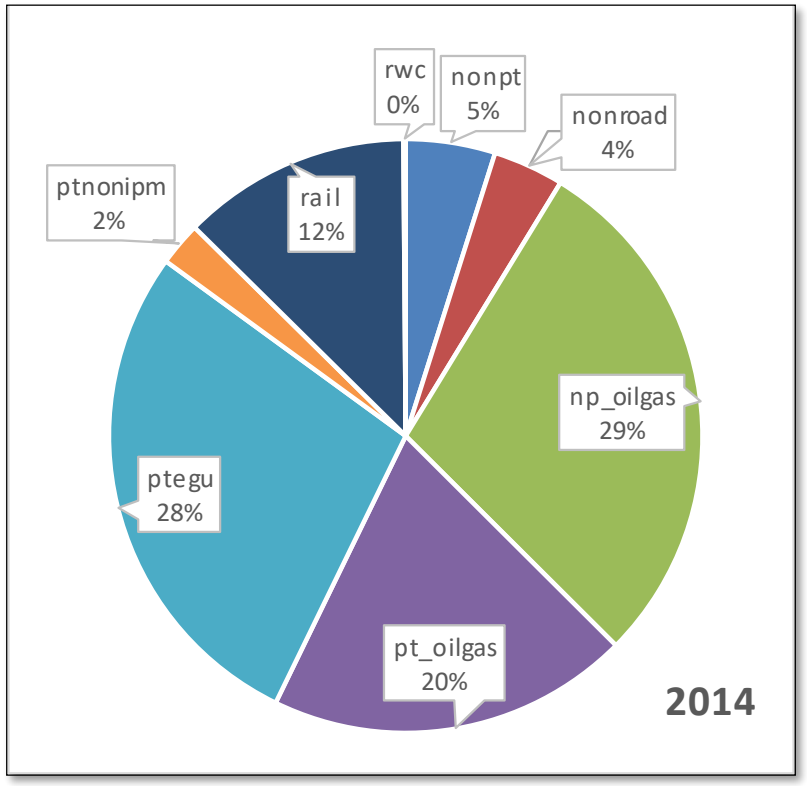
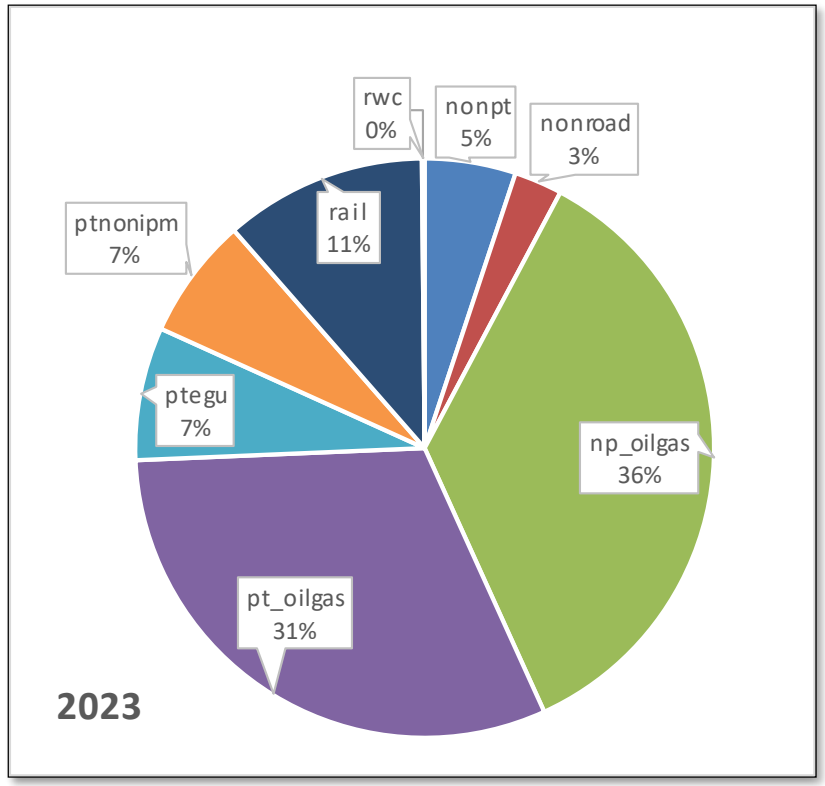
Updated New Mexico Emissions: 2023 vs. 2014 NOx

All anthro source categories except onroad



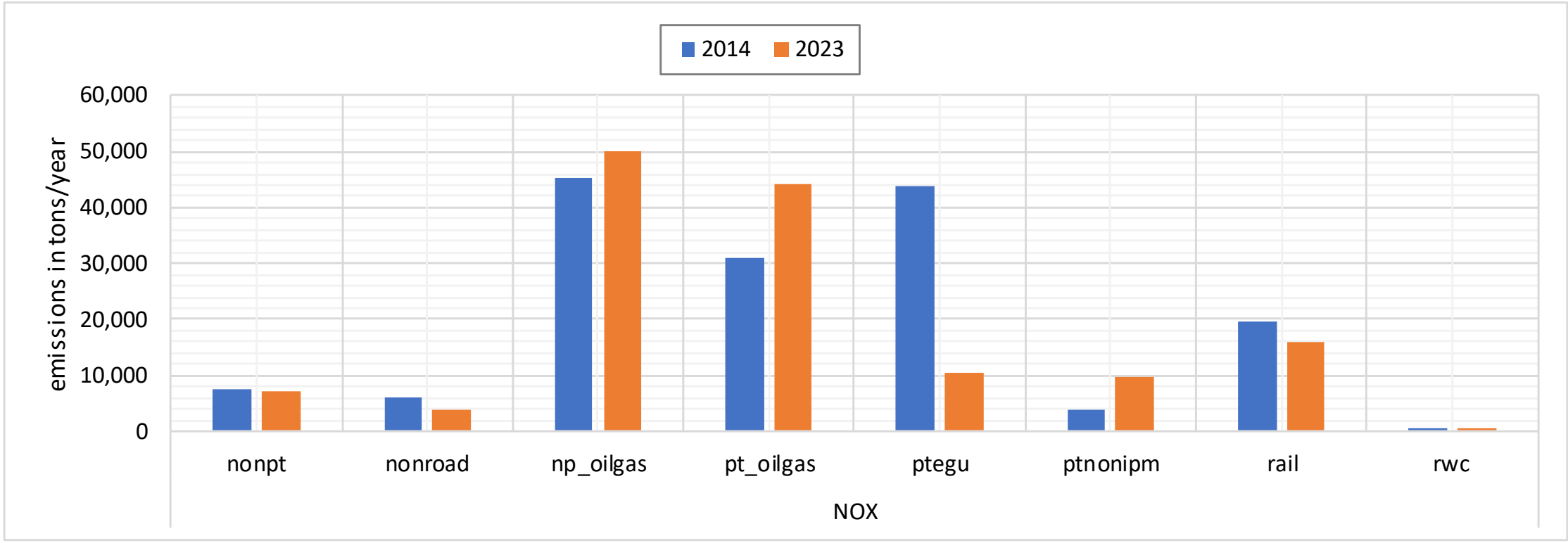


157,534 TPY

141,606 TPY

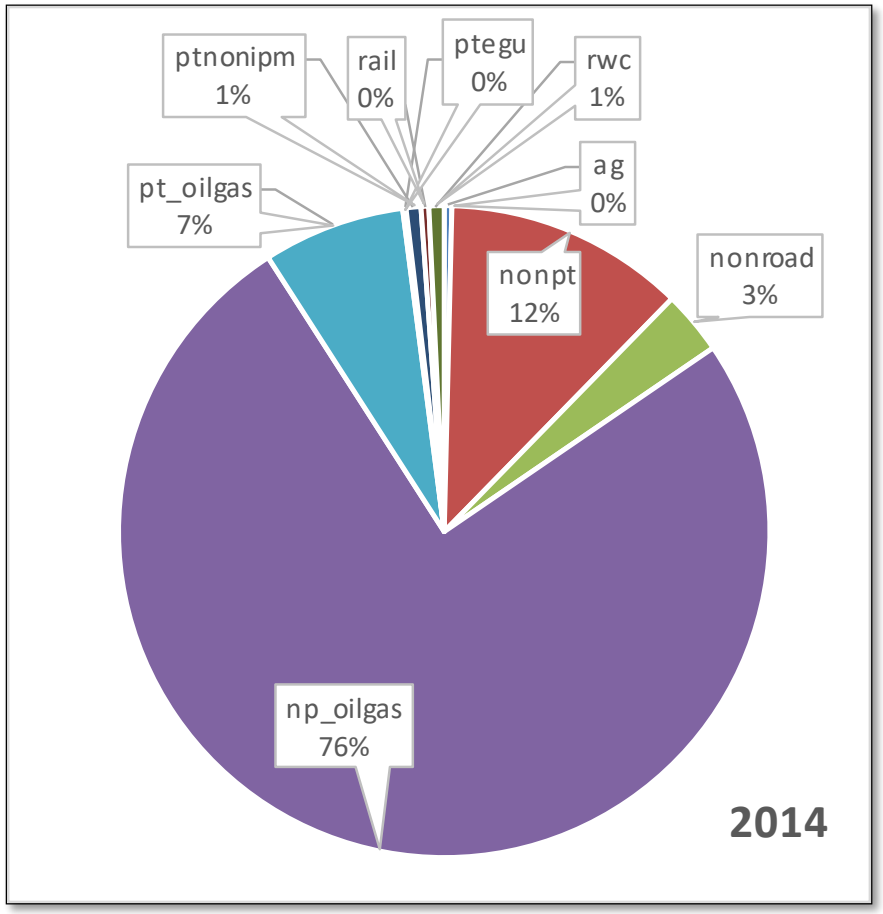
-15,928 TPY (10%) Reduction

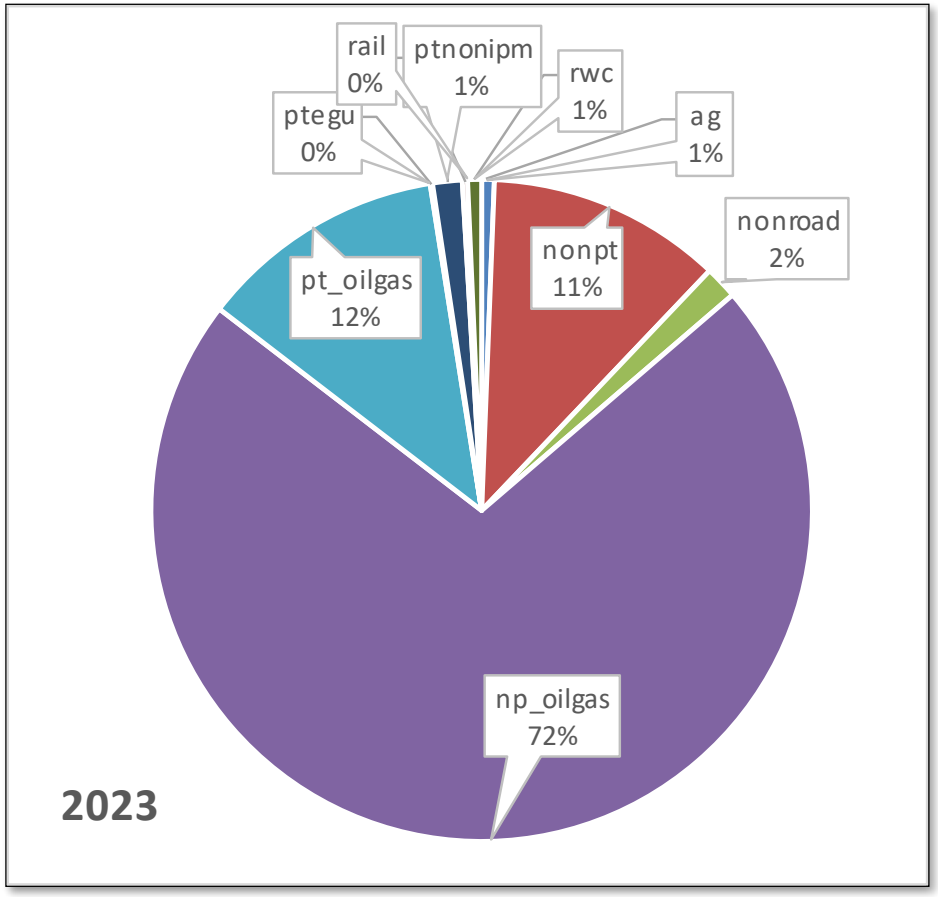
Updated New Mexico Emissions: 2023 vs. 2014 NOx by Source Category



Updated New Mexico Emissions: 2023 vs. 2014 VOC

All anthro source categories except onroad



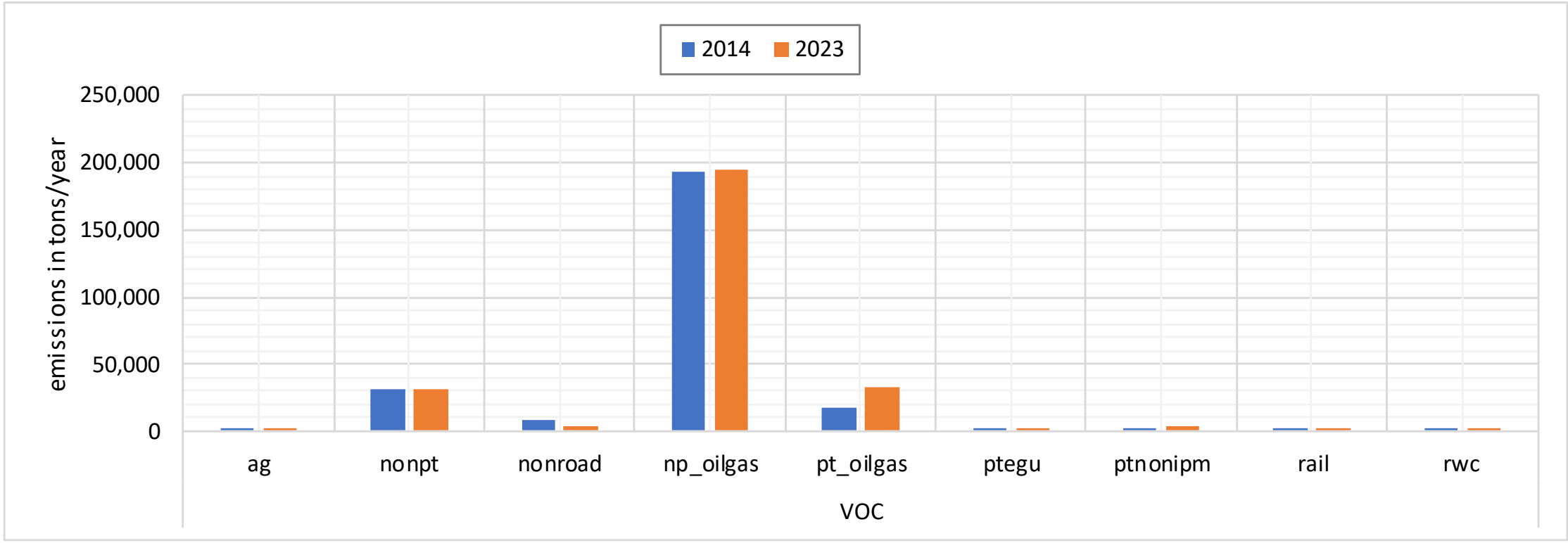


255,765 TPY

272,492 TPY

+16,727 TPY (7%) Increase

Updated New Mexico Emissions: 2023 vs. 2014 VOC by Source Category



2014 36/12/4-KM WRF METEOROLOGICAL MODELING

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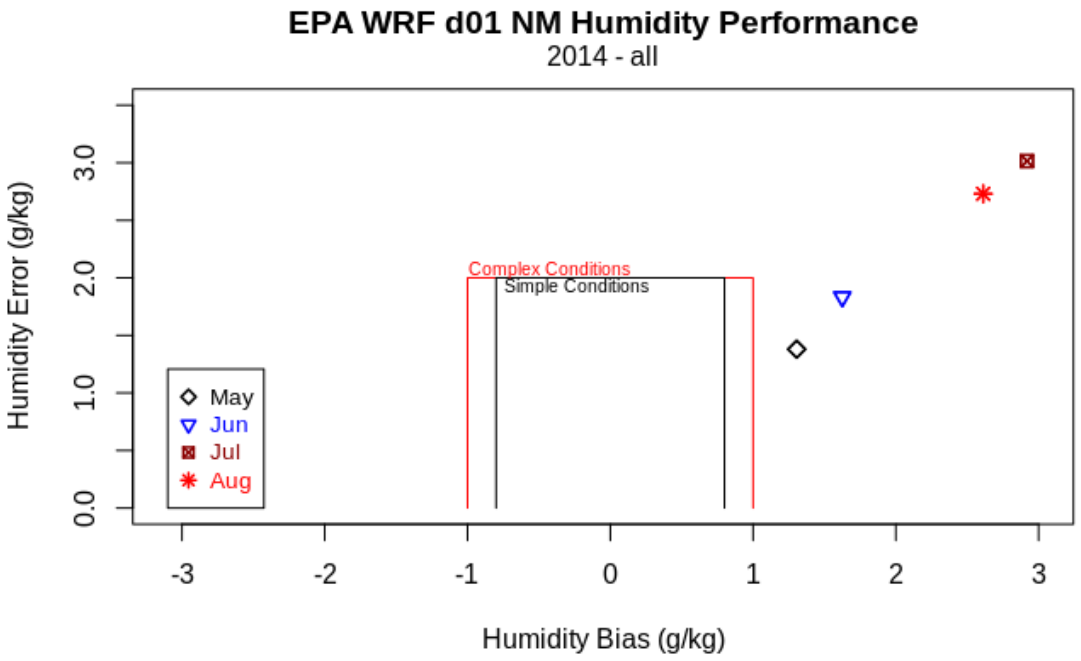
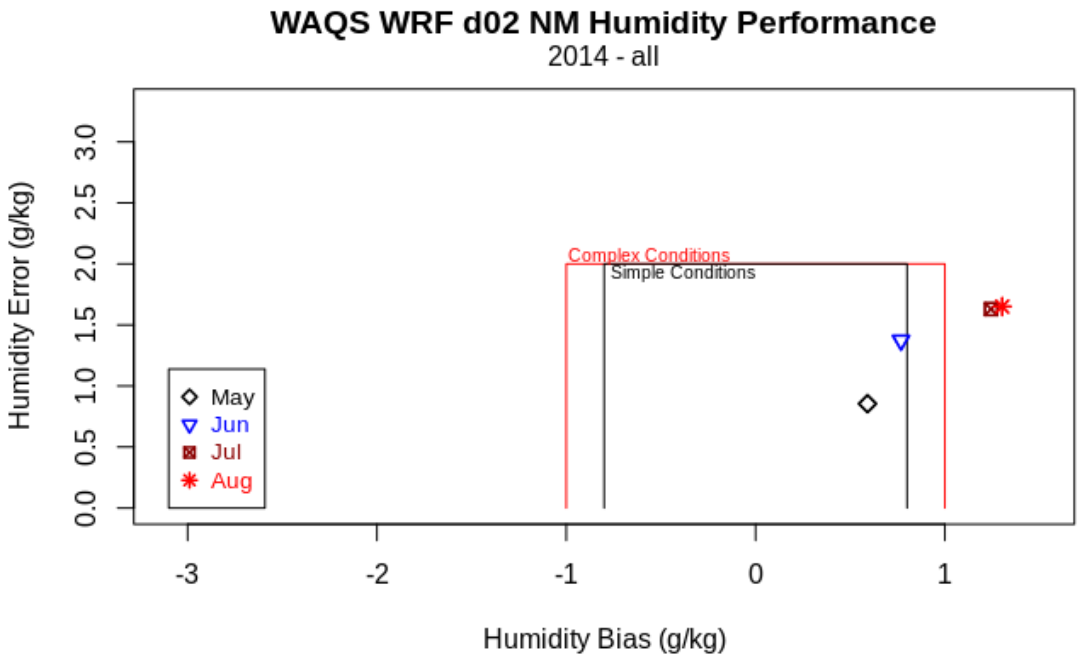
RECAP OF EPA/WAQS WRF EVALUATION

- Evaluated EPA 12US1 and WAQS 12WUS2 for May-August 2014
- EPA wet bias in summer months associated with overactive summer convection
- WAQS smaller wet bias

EPA 12 km



WAQS 12 km



RECAP OF NM OAI WRF SETUP AND PROCEDURE

- NM OAI proposed WRF configuration aligns closely with WAQS to reduce overactive summertime convection in New Mexico, with these differences
  - Reposition 4 km domain to encompass all of New Mexico
  - Use hybrid vertical coordinate to improve representation of upper troposphere/lower stratosphere
  - Add second simulation driven by ERA5 analysis
  - No observation nudging
- Two NM OAI WRF simulations (NAM12/ERA5) completed and evaluated
- Present evaluation of these two simulations for this webinar

NM OAI VS WAQS WRF CONFIGURATION

WRF Option	NM OAI	2014 WAQS
Vertical Coordinate	hybrid sigma-pressure	sigma
Domains run	36/12/4-km	36/12/4-km
Microphysics	Thompson	Thompson
LW Radiation	RRTMG	RRTMG
SW Radiation	RRTMG	RRTMG
LSM	Noah	Noah
PBL scheme	YSU	YSU
Sfc Layer Physics	MM5 similarity	MM5 similarity
Cumulus	36/12/4-km Multi-scale Kain Fritsch	36/12-km Multi-scale Kain Fritsch
BC, IC Analysis Nudging Source	12-km NAM/ERA5	12-km NAM
Analysis Nudging Grids	36/12-km	36/12-km
Obs Nudging	None	4-km
Sea Sfc Temp	FNMOC	FNMOC

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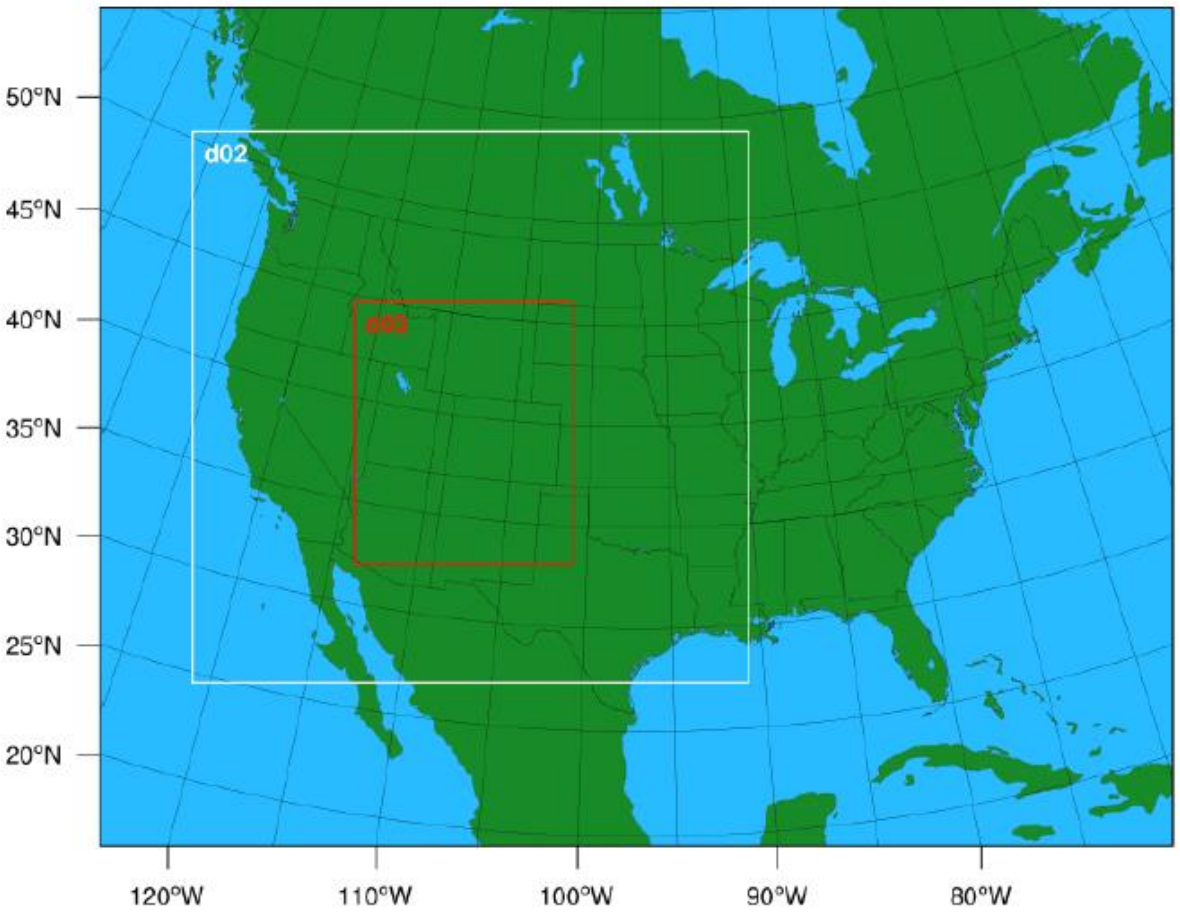
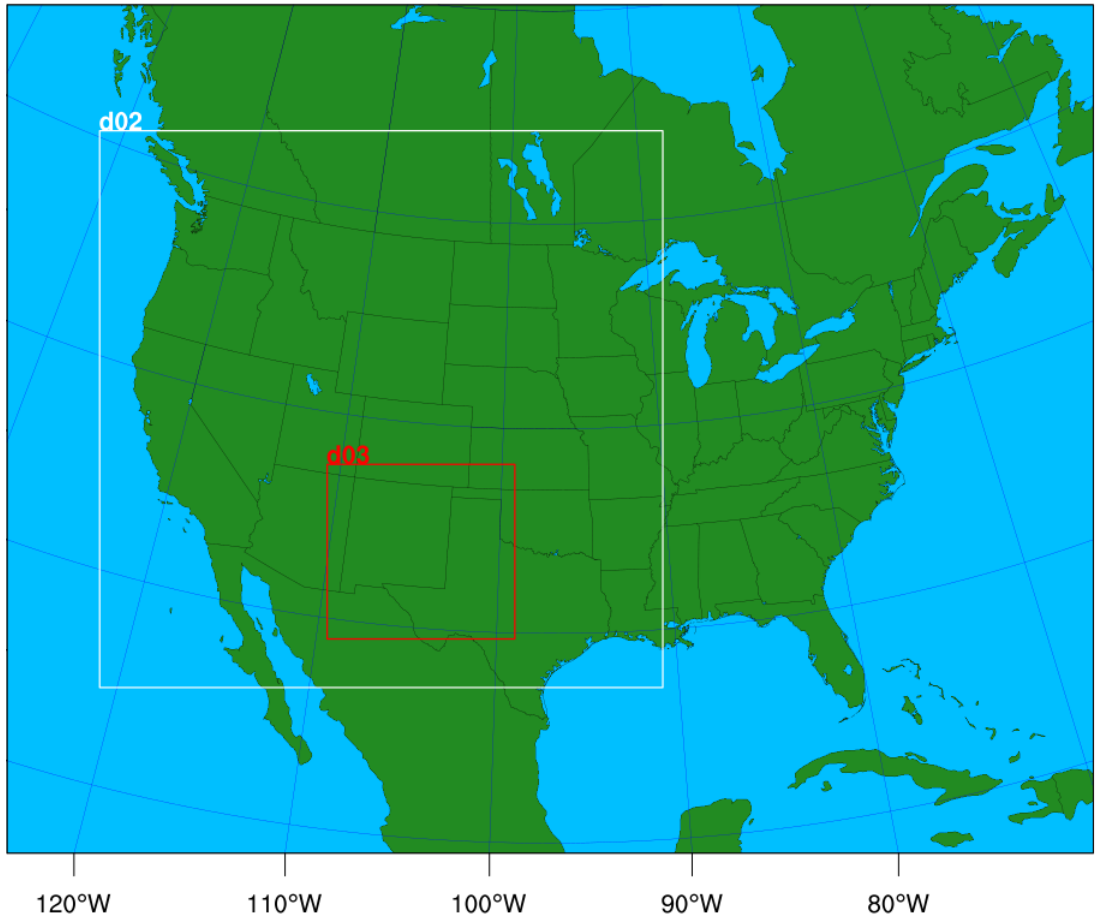
NM OAI VS WAQS WRF DOMAINS

WAQS 36/12/4 km



NM OAI 36/12/4 km



ERA5 VS NAM WRF MPE APPROACH

- Evaluate ERA5 and NAM WRF simulations for May-August 2014
  - ERA5 and NAM analysis field inputs are critical inputs to a WRF simulation as they define initial and boundary conditions (IC and BC) and are used in the Four Dimensional Data Assimilation (FDDA) to continuously nudge the WRF predictions to the analysis fields
  - Evaluation include observation sites within New Mexico only
- Quantitative Evaluation
  - METSTAT – model/obs pairing, bias/error statistics against NCAR ds3505 observations
    - Soccer plots – monthly stats
    - Time series – hourly and daily
    - Plots for all sites in NM, and each individual site within NM
- Qualitative Evaluation
  - PRISM precipitation spatial maps
    - Monthly and daily

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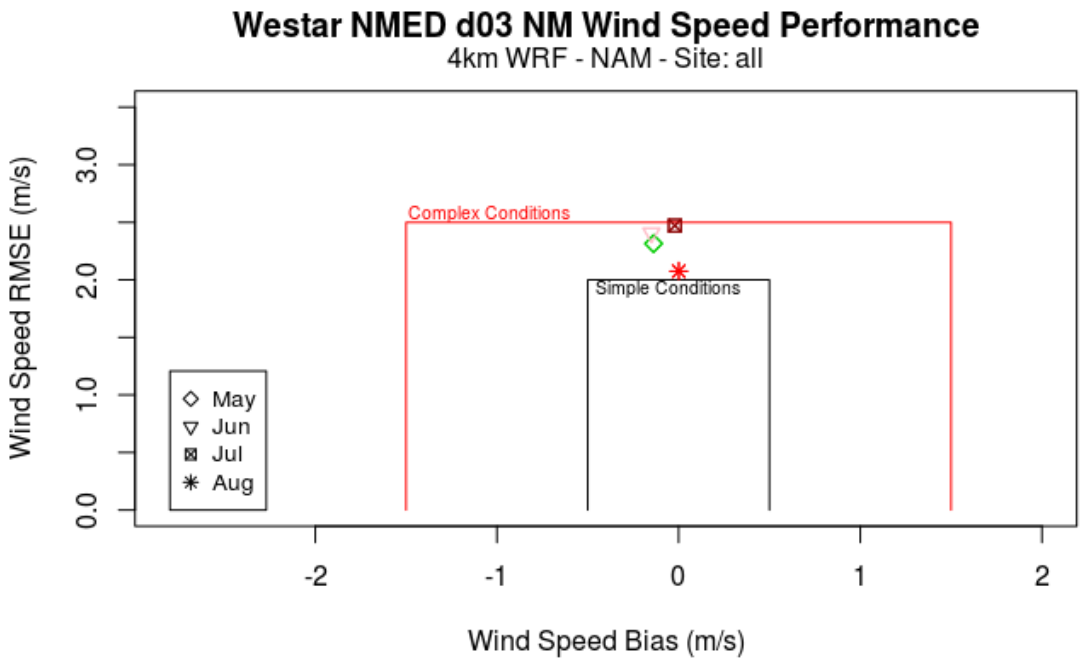
WRF STATISTICAL BENCHMARKS

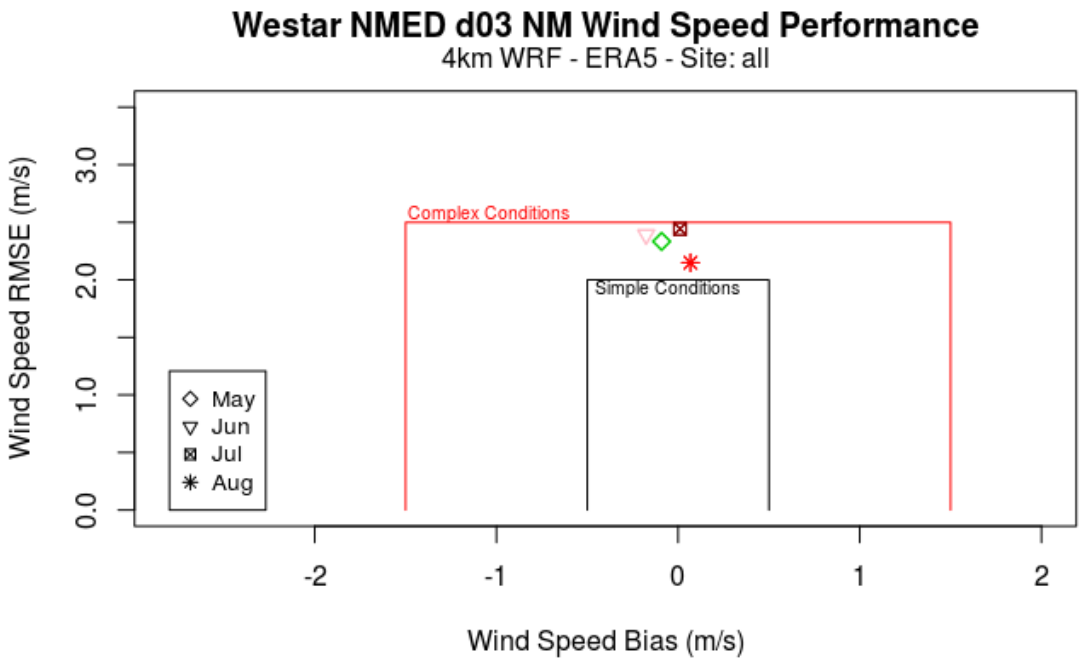
Meteorological Variable	Simple Conditions		Complex Conditions	
	Bias	Error	Bias	Error
Temperature	< ±0.5 °C	< 2.0 °C	< ±2.0 °C	< 2.5 °C
Wind Speed	< ±0.5 m/s	< 2.0 m/s (RMSE)	< ±1.5 m/s	< 2.5 m/s (RMSE)
Wind Direction	< ±10 degrees	< 30 degrees	< ±10 degrees	< 50 degrees
Humidity	< ±0.8 g/kg	< 2.0 g/kg	< ±1.0 g/kg	< 2.0 g/kg

SOCCER PLOTS – WIND SPEED FOR ALL NM SITES

NAM



ERA5

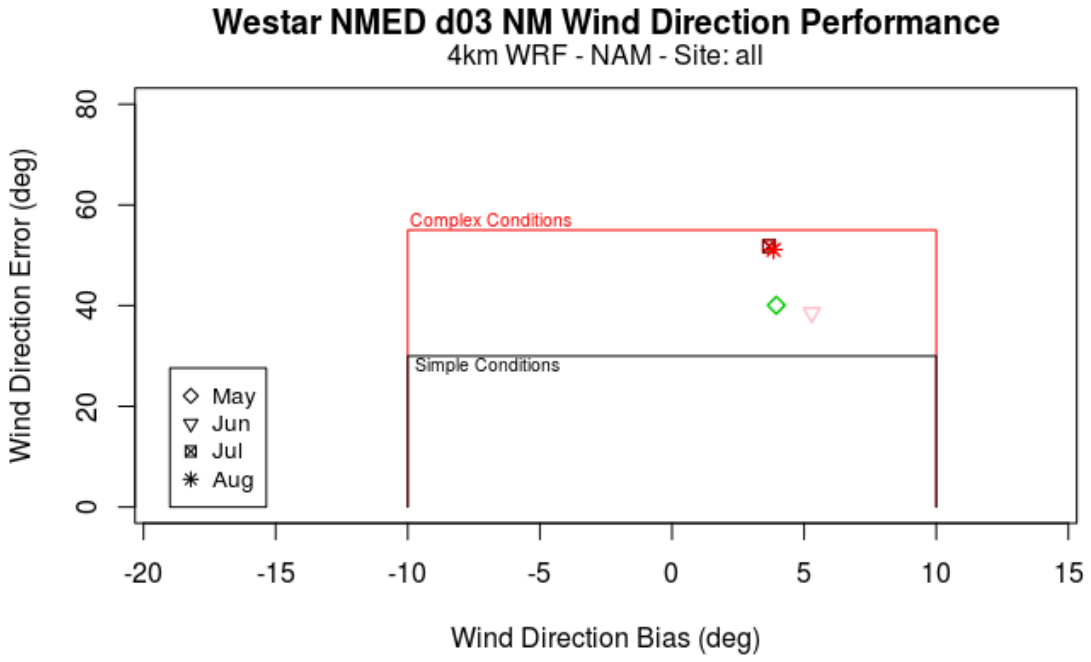


All months within complex conditions goal for both runs

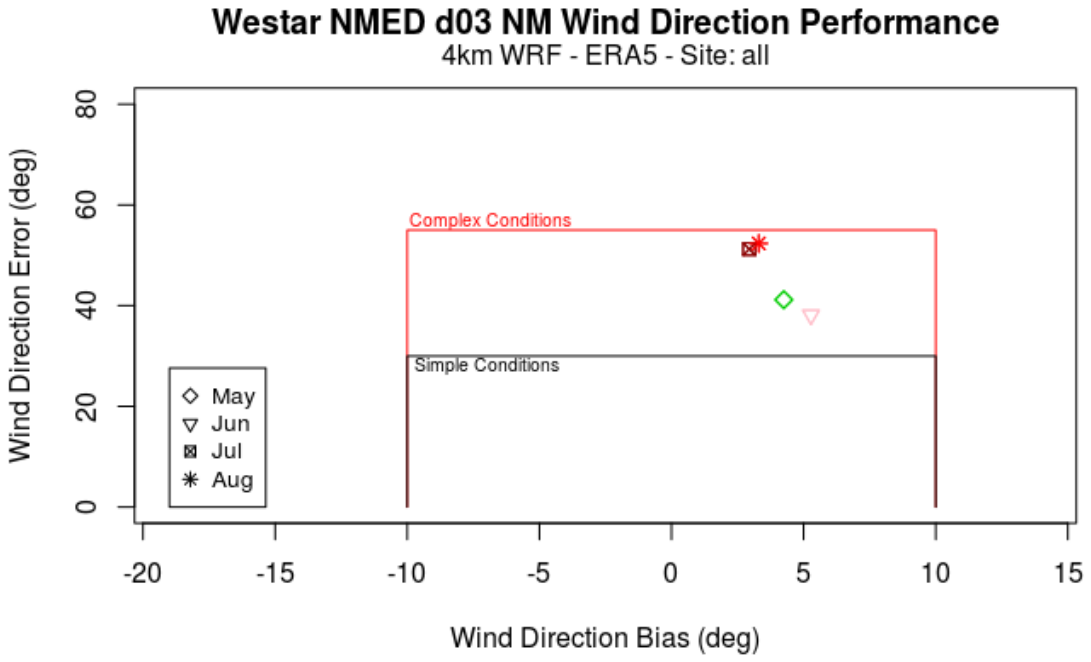
NAM and ERA5 very similar; both runs' RMSE outside simple conditions goal for all months

SOCCER PLOTS – WIND DIRECTION FOR ALL NM SITES

NAM



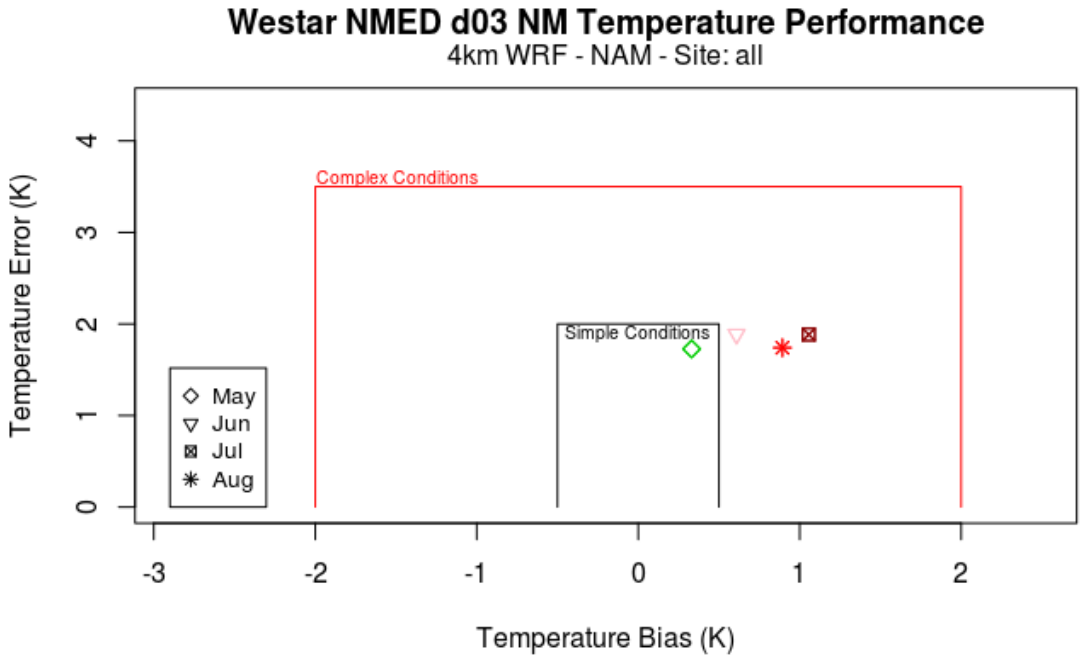
ERA5



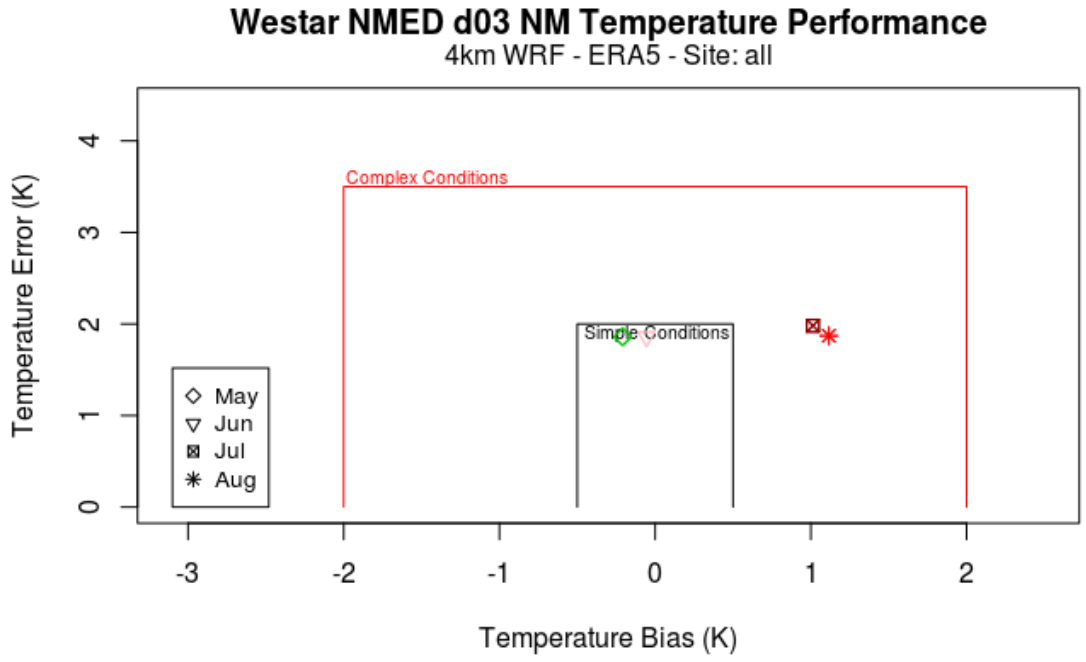
NAM and ERA5 performance nearly identical

SOCCER PLOTS – TEMPERATURE FOR ALL NM SITES

NAM



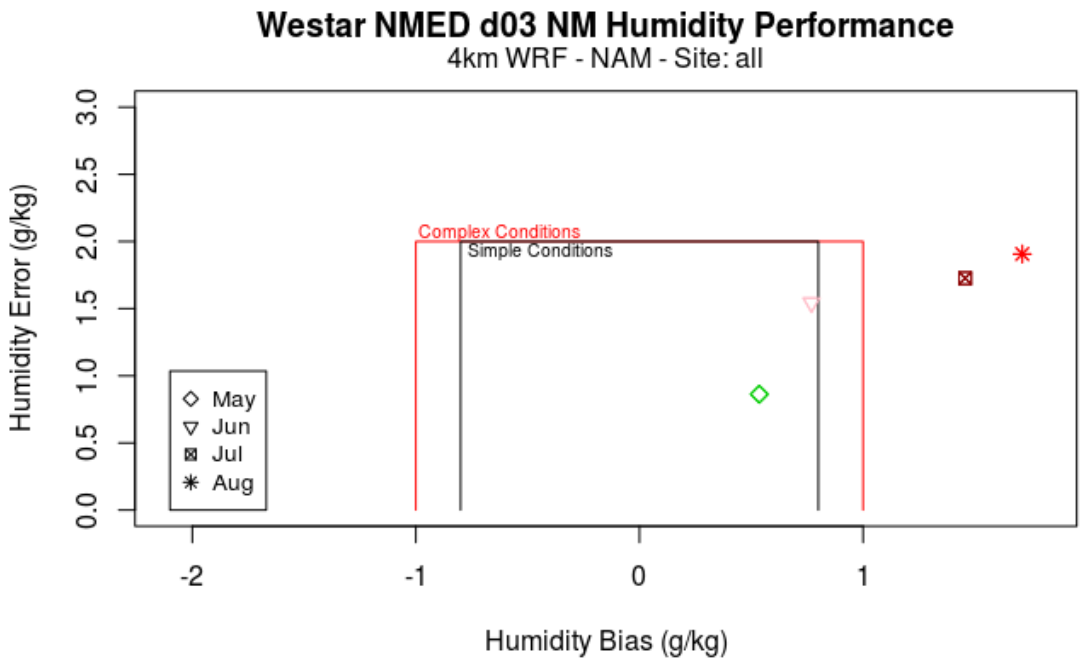
ERA5



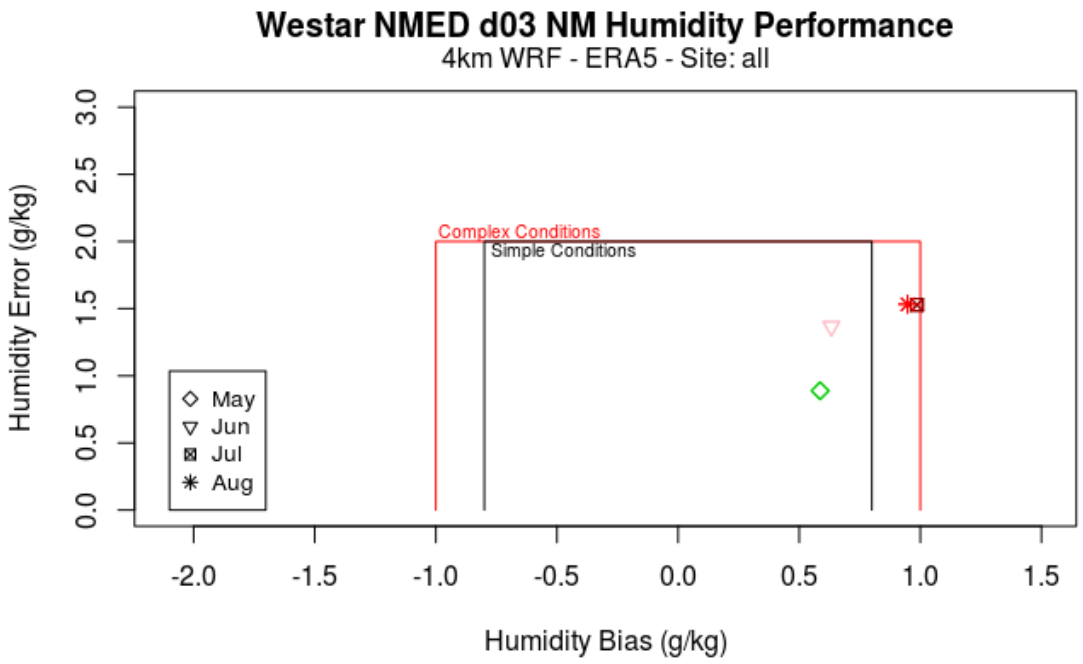
ERA5 run outperforms NAM for May-Jun; similar performance for Jul-Aug

SOCCER PLOTS – HUMIDITY FOR ALL NM SITES

NAM



ERA5

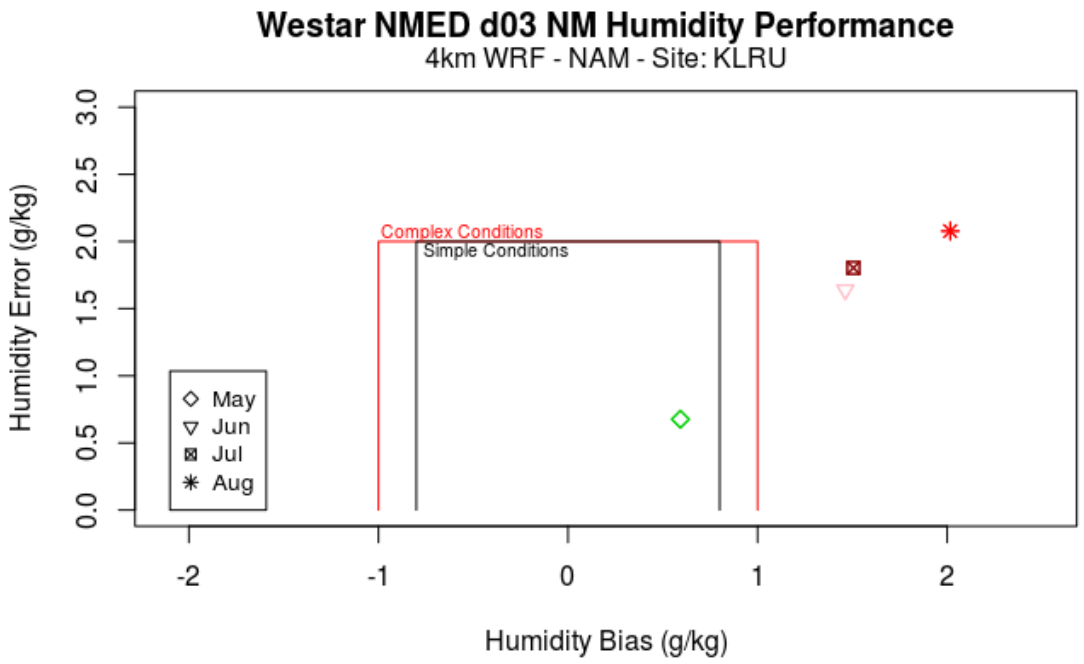


ERA5 run outperforms NAM; both runs have positive (wet) bias for all months

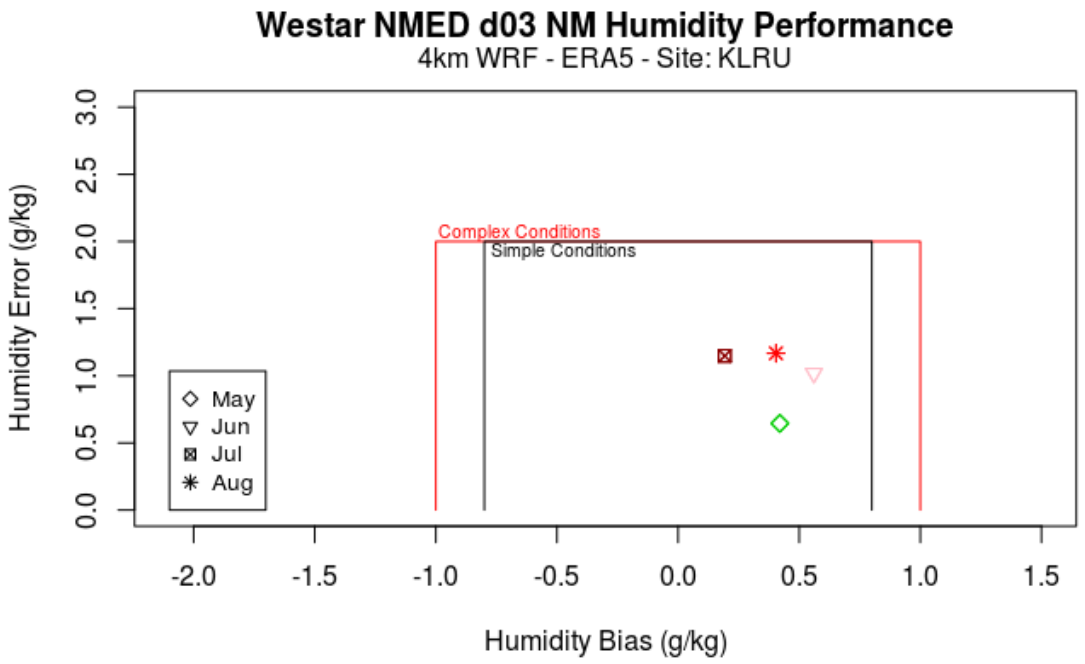
ERA5 considerably better performance for Jul-Aug

SOCCER PLOTS – HUMIDITY FOR KLRU

NAM

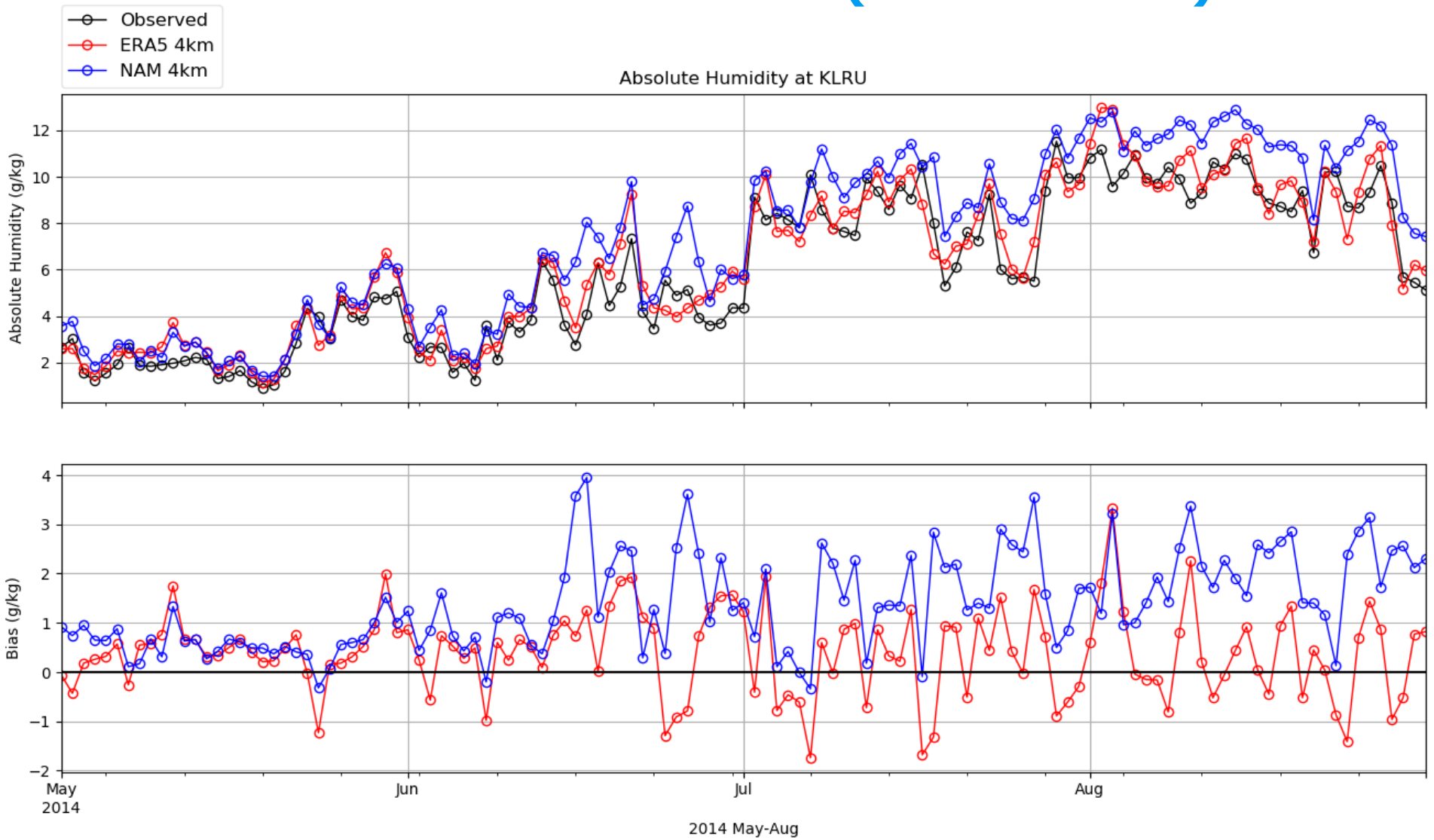


ERA5



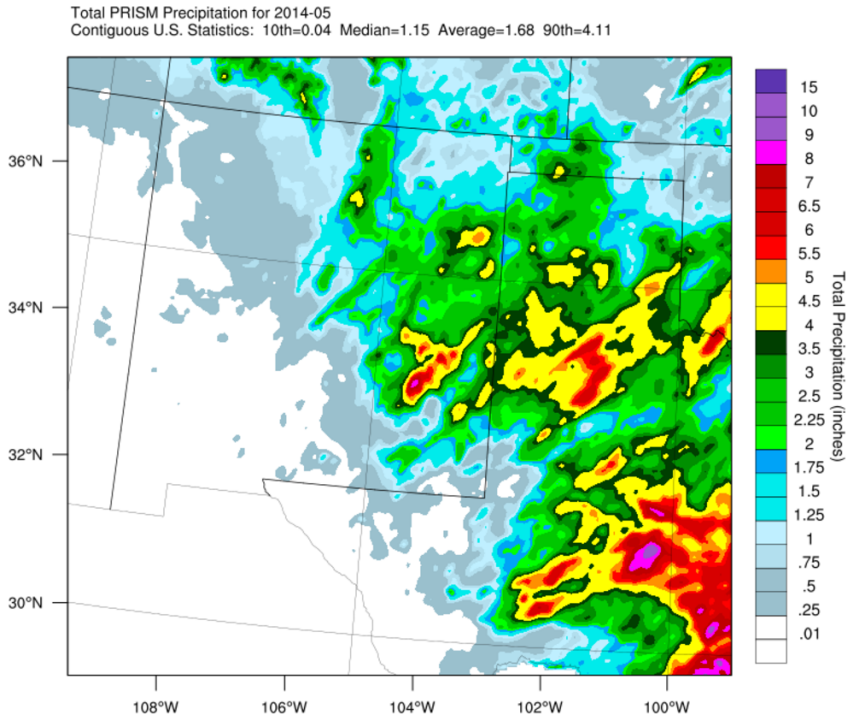
ERA5 run outperforms NAM for all months

TIME SERIES – HUMIDITY AT KLRU (LAS CRUCES)



MONTHLY PRECIPITATION PLOTS – MAY 2014

PRISM Obs



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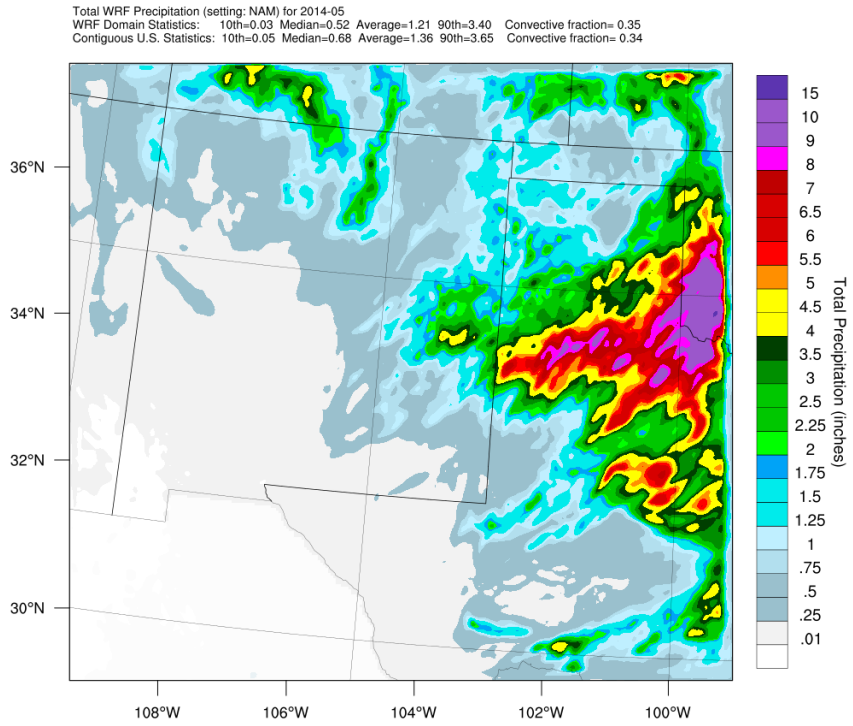
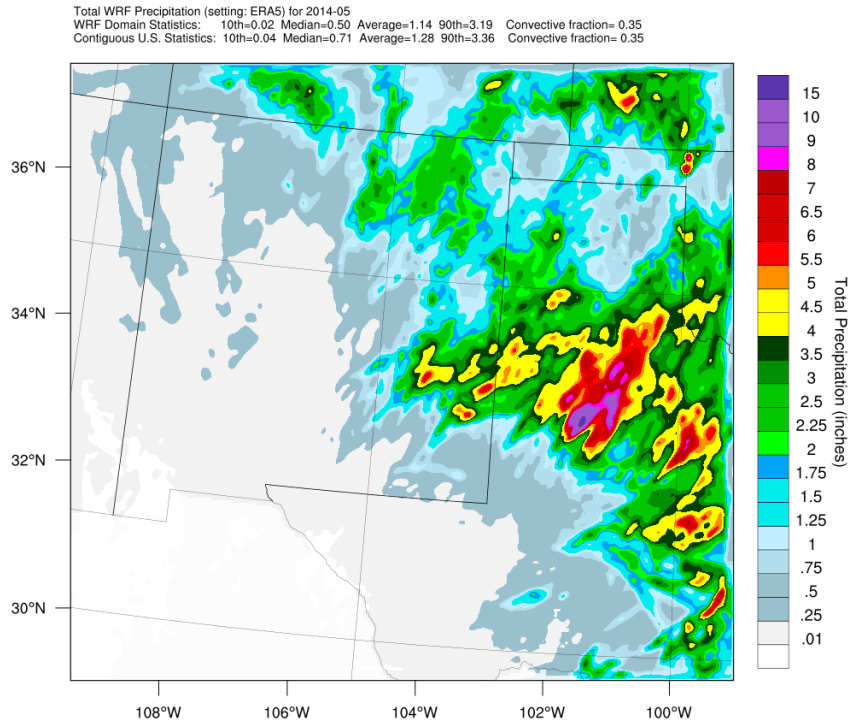


ERA5



NAM and ERA5 are similar over New Mexico

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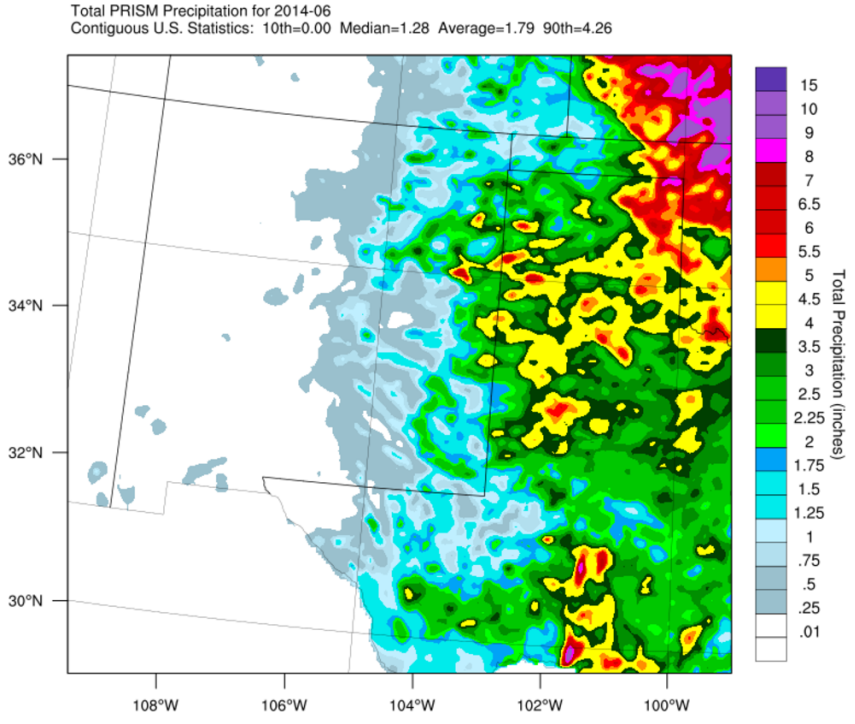
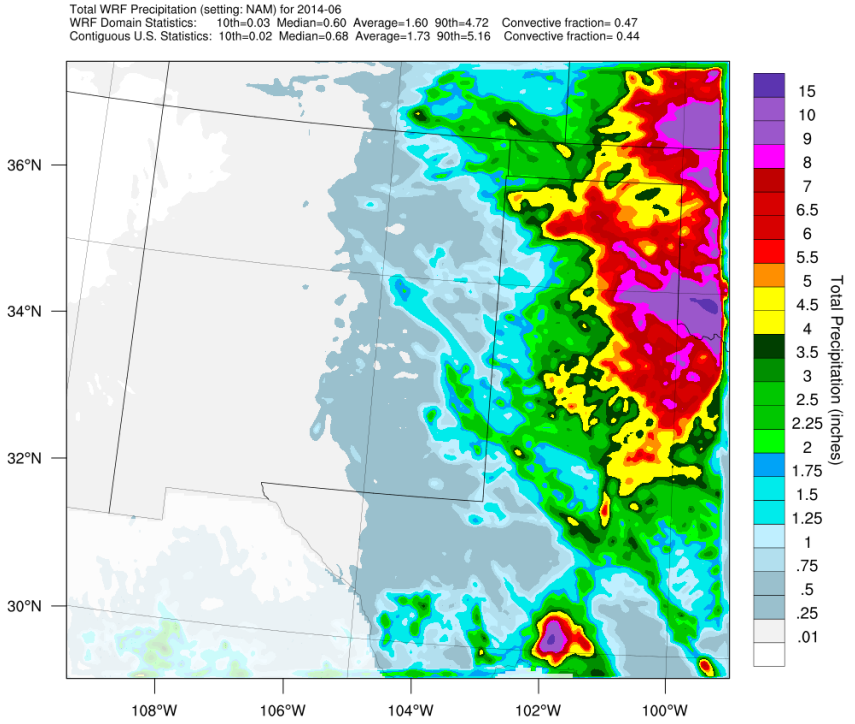
MONTHLY PRECIPITATION PLOTS – JUNE 2014

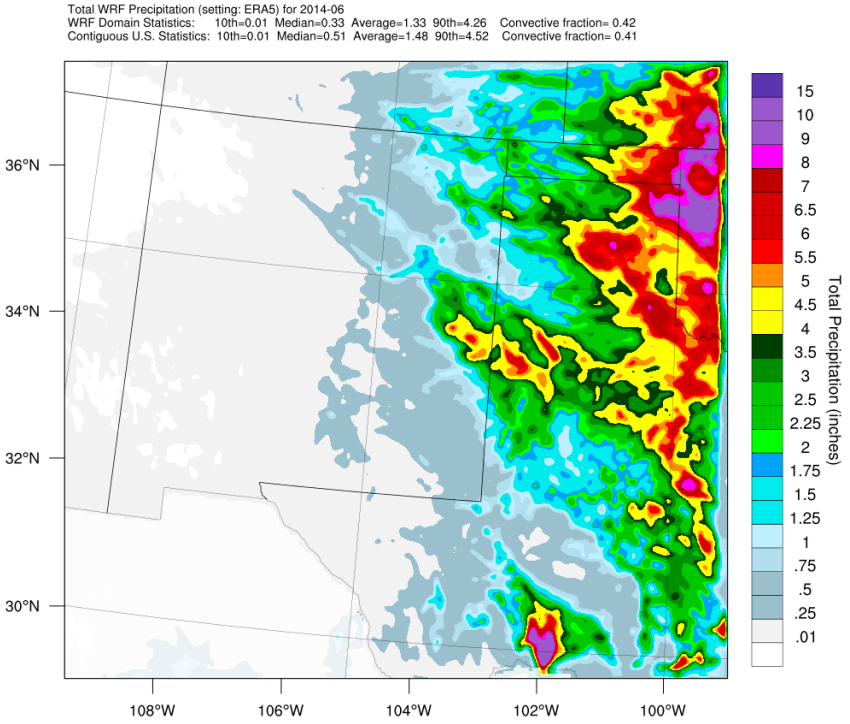
PRISM Obs



NAM



ERA5



Both NAM and ERA5 are reasonable over NM; NAM overpredicts over North Texas

ERA5 slightly better

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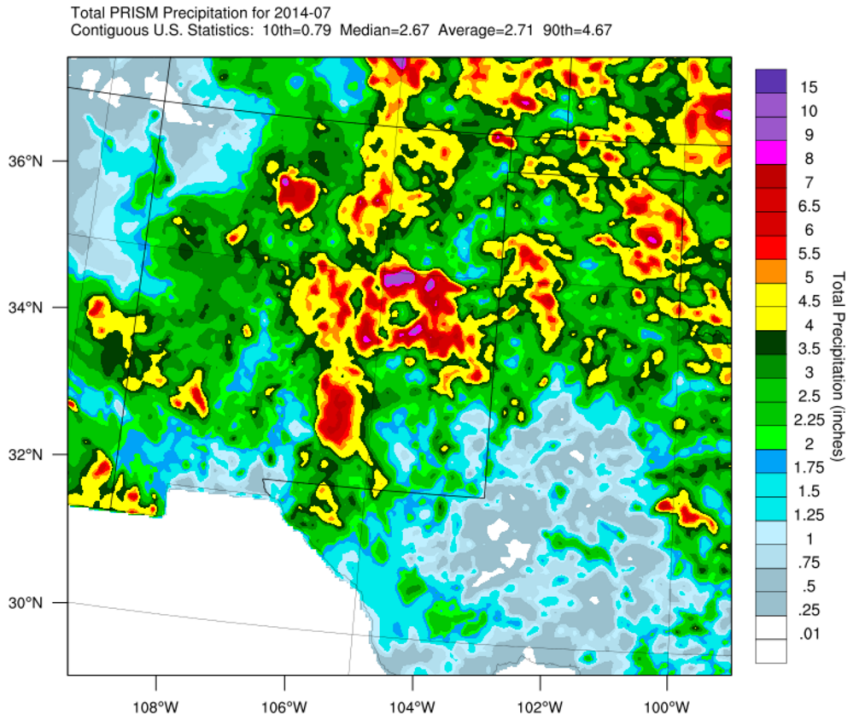
MONTHLY PRECIPITATION PLOTS – JULY 2014

PRISM Obs



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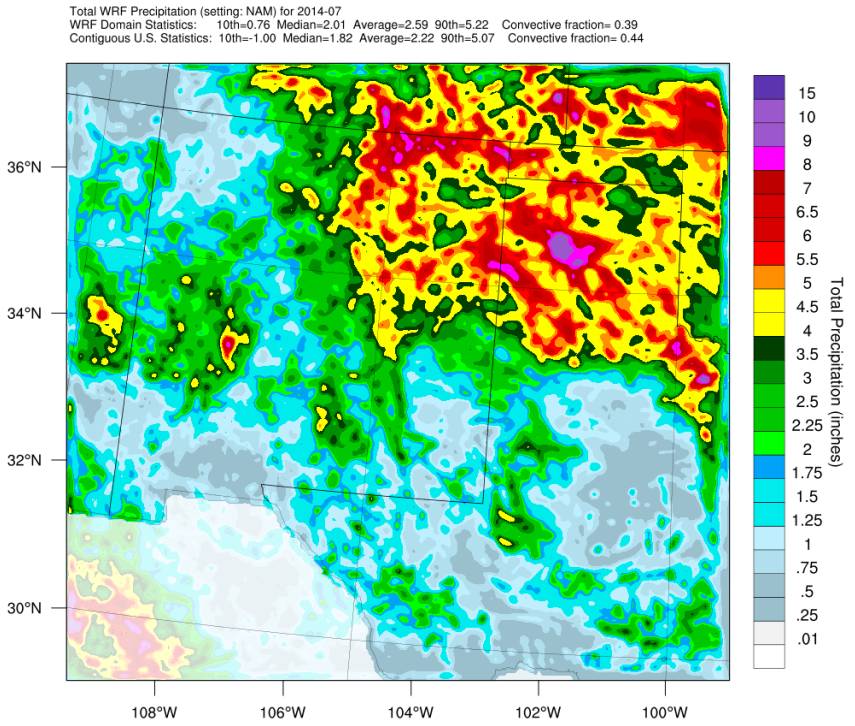
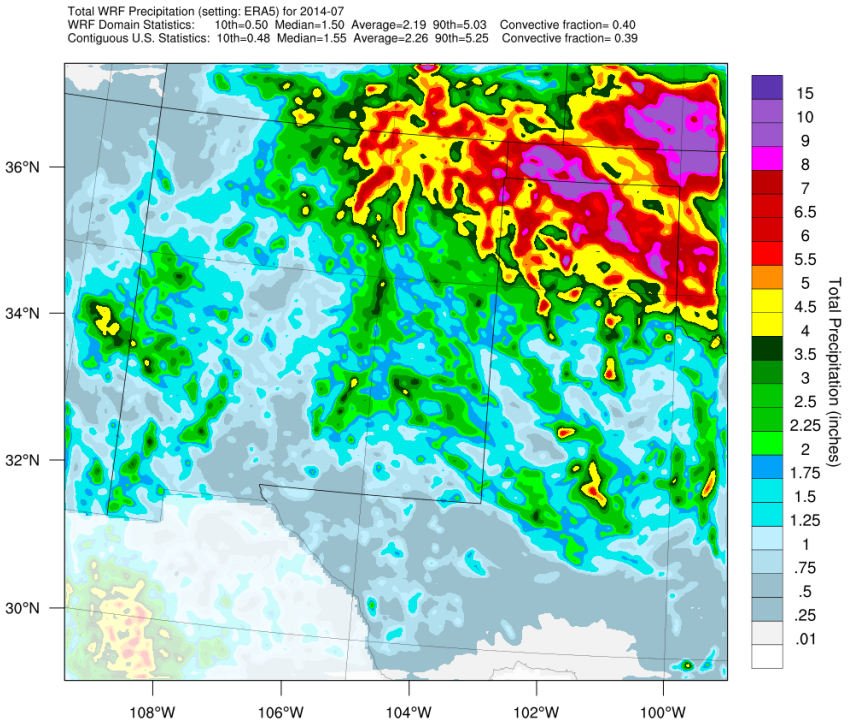


ERA5



NAM overpredicts over NE New Mexico; both NAM and ERA5 show dry bias elsewhere in NM

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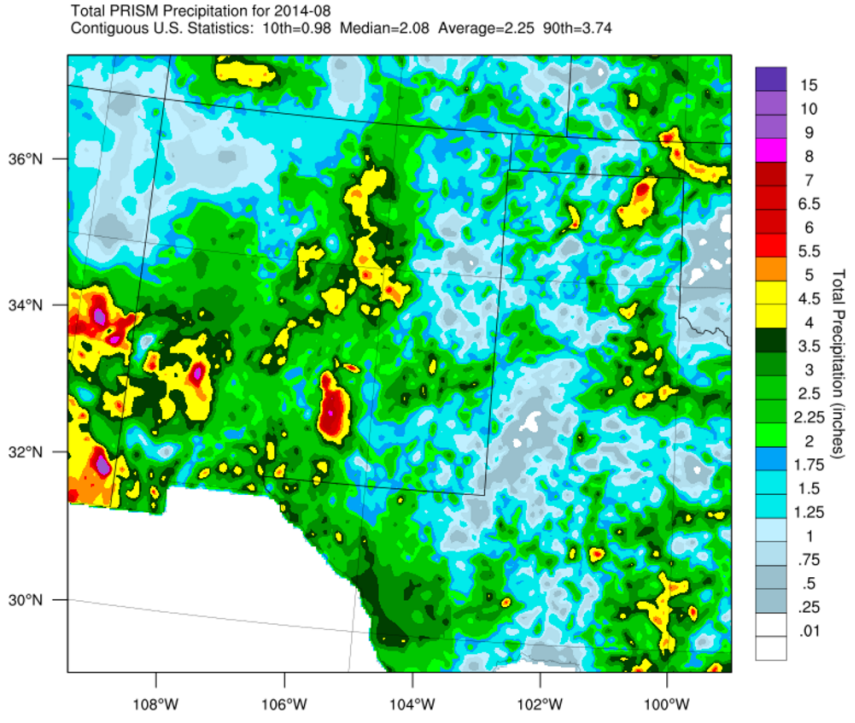
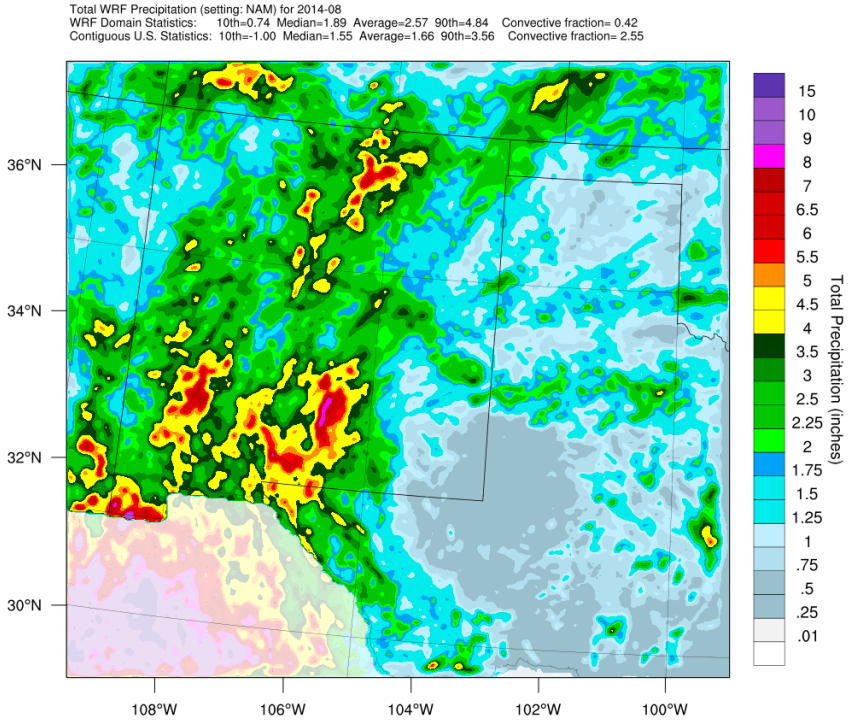
MONTHLY PRECIPITATION PLOTS – AUG 2014

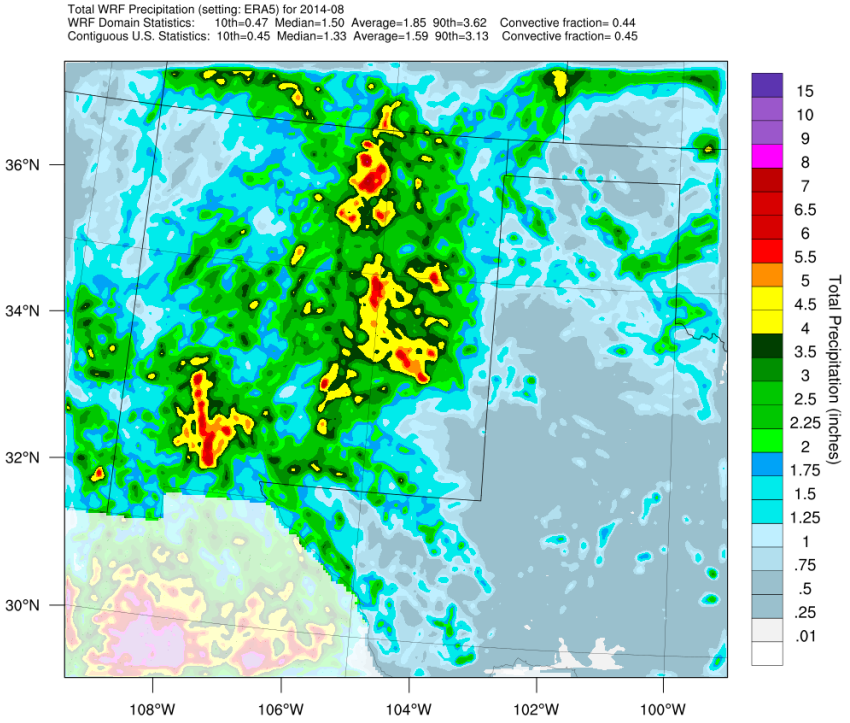
PRISM Obs



NAM



ERA5



ERA5 slightly better than NAM in matching location and magnitude of PRISM observations

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2014 WRF SUMMARY AND CONCLUSIONS

- WRF performance reasonable for both NAM and ERA5 simulations
- Differences between NAM and ERA5 are smaller in comparison to EPA/WAQS
- NAM wet bias in June-August may be partly associated with overactive summer convection
- ERA5 has smaller wet bias
- Not possible to know which WRF simulation will result in better in CAMx ozone performance
  - Relative performance varies across parameters/seasons/locations
  - Best (or worst) performing WRF days may have small (or large) influence on AQ concentrations
  - Other meteorological variables (vertical diffusion, PBL heights, etc.) may be more important than the ones we can easily evaluate (T, Q, winds, precip)
- Proceed with both WRF simulations through CAMx and select best ozone performance for final CAMx configuration

NM OAI Study Next Steps

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Next Up in July 2020

- July 2020: Task 4 -- 2014 and 2023 Emissions
  - 2014 SMOKE-MOVES and SMOKE for 4-km New Mexico Domain
  - 2014 36/12/4-km MEGAN biogenic and LNOx emissions modeling
  - Start 2023 SMOKE modeling
- July 2020: Task 5 – CAMx 2014 36/12/4-km Base Case Modeling
  - CAMx meteorological input sensitivity modeling
    - May 1 – June 16, 2014; 4 configurations: WRF/NAM and WRF/ERA5 using CMAQ/YSU vertical diffusivities (Kv)
  - Start CAMx 2014 36/12/4-km final base case May - August
- July 2020: NMED OAI Webinar
  - 2014 SMOKE Results for 4-km New Mexico domain (Anthro & Natural)
  - CAMx WRF meteorology sensitivity modeling
  - CAMx 2014 36/12/4-km final base case configuration
- Expected progress in August 2020
  - 2014 CAMx base case and MPE Report
  - 2023 Base and Control Strategy SMOKE Modeling and 2023 CAMx base case

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DISCUSSION