

# Air quality urban simulations using WRF-Chem: Urbanova project

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## Future works from the last AIRQUEST meeting

- ✓ Use CAM-Chem or WACCM global model as boundary condition (MOZART is discontinued)
- ✓ Improve urban canopy parameters using Spokane LIDAR data.
- ✓ Include “chemistry” in WRF-Urban over Spokane

# Model Configuration

- **Domain:** 221 X 181 grid cells
- **Resolution:** 800 m & 51 vertical layers
- **Boundary and initial conditions:** GFS-ANL (meteorological) and CAM\_CHEM(chemical) with 1 x 1 grade of resolution every 6 hours.
- **Chemistry:** MOZART & MOSAIC
- **Anthropogenic emissions:** NEI 2011

	WUDAPT case	BEP case	BULK case
Model	WRF	WRF-Chem	WRF-Chem
Coupled Option	Noah LSM Multi-layer BEP UCM	Noah LSM Multi-layer BEP UCM	Noah LSM Urban Bulk Parametrization
Land Use	WUDAPT & MODIS	MODIS	MODIS
Simulation period	August 29 <sup>th</sup> – September 6 <sup>th</sup> 2017	August 29 <sup>th</sup> – September 6 <sup>th</sup> 2017	August 31 <sup>th</sup> – September 6 <sup>th</sup> 2017

## WUDAPT vs BEP:

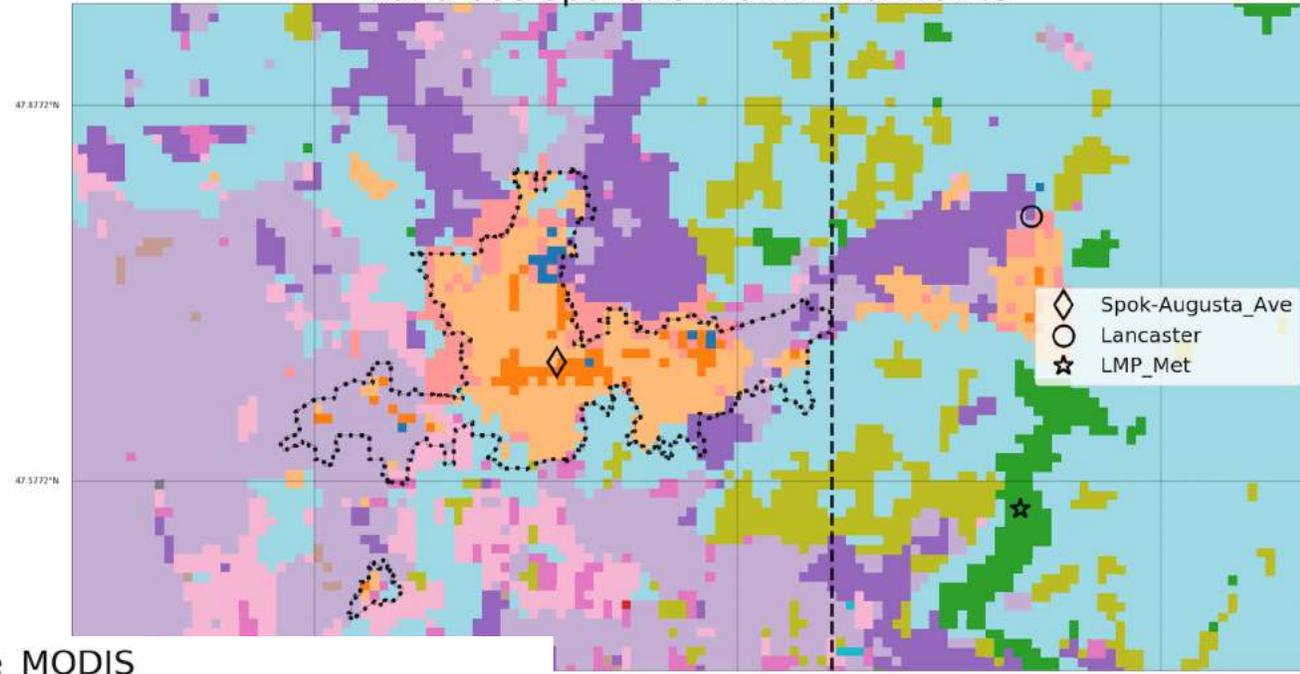
To investigate the impact of urban land use classification on urban weather over the Spokane area

## BEP vs BULK:

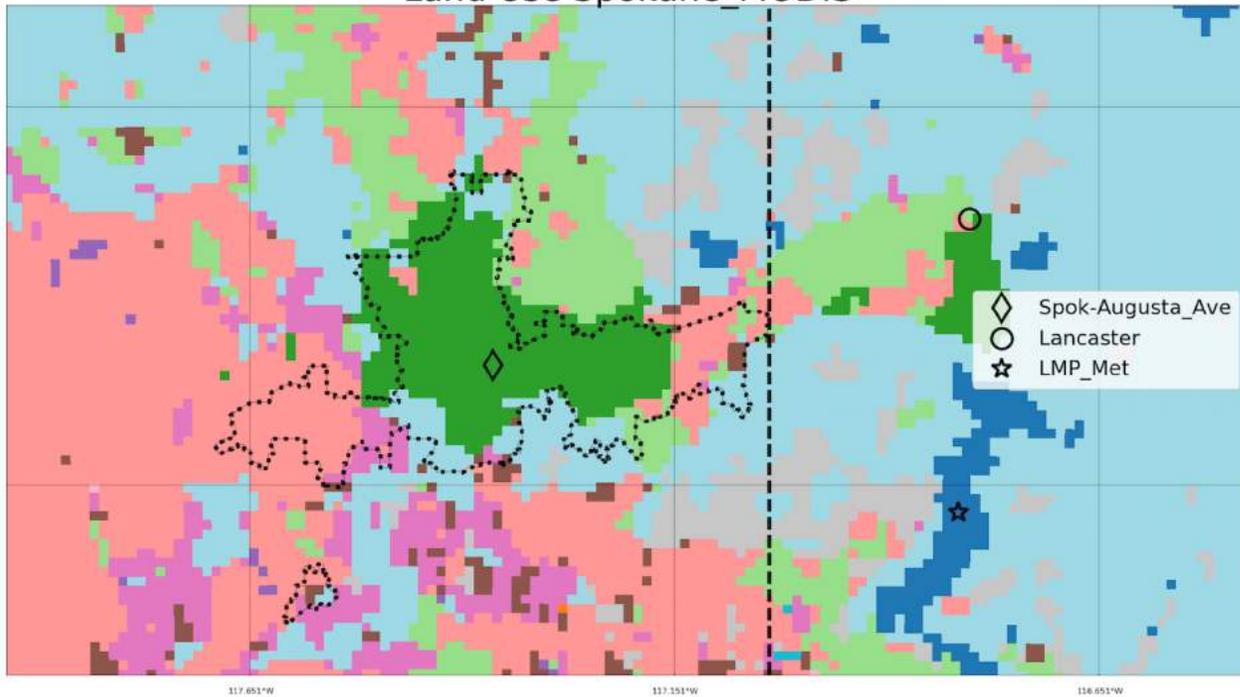
To investigate the effect of UCM on air quality over the Spokane area.

# WUDAPT & MODIS (WUDAPT) vs. MODIS land use (BEP)

Land Use Spokane WUDAPT & MODIS



Land Use Spokane MODIS

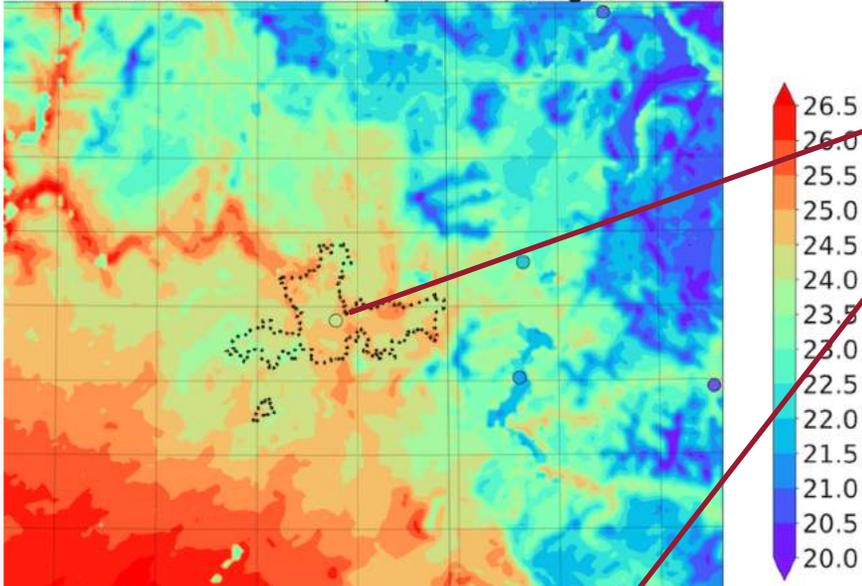


- Water
- Barren or Sparsely Vegetated
- Urban and Built-Up
- Croplands
- Grasslands
- Savannas
- Woody Savannas
- Open Shrublands
- Closed Shrublands
- Mixed Forests
- Deciduous Broadleaf Forest
- Evergreen Broadleaf Forest
- Evergreen Needleleaf Forest

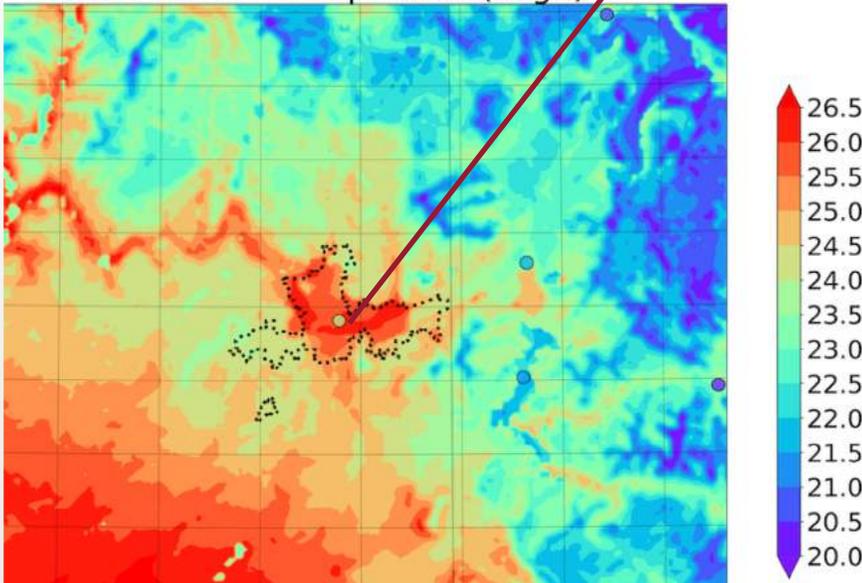
# Results

# WUDAPT vs. BEP

Mean WUDAPT 2m Temperature(degC)

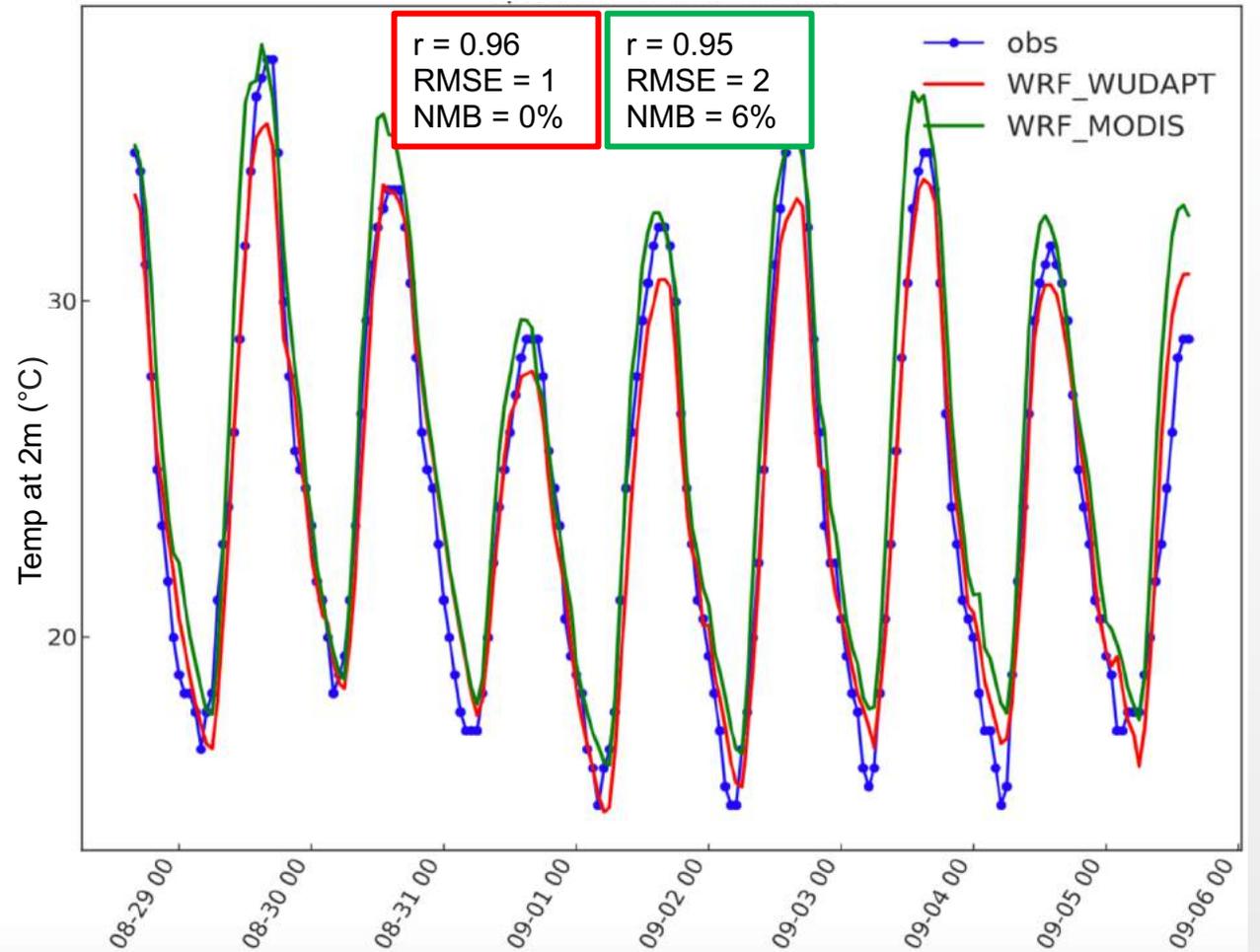


Mean BEP 2m Temperature(degC)



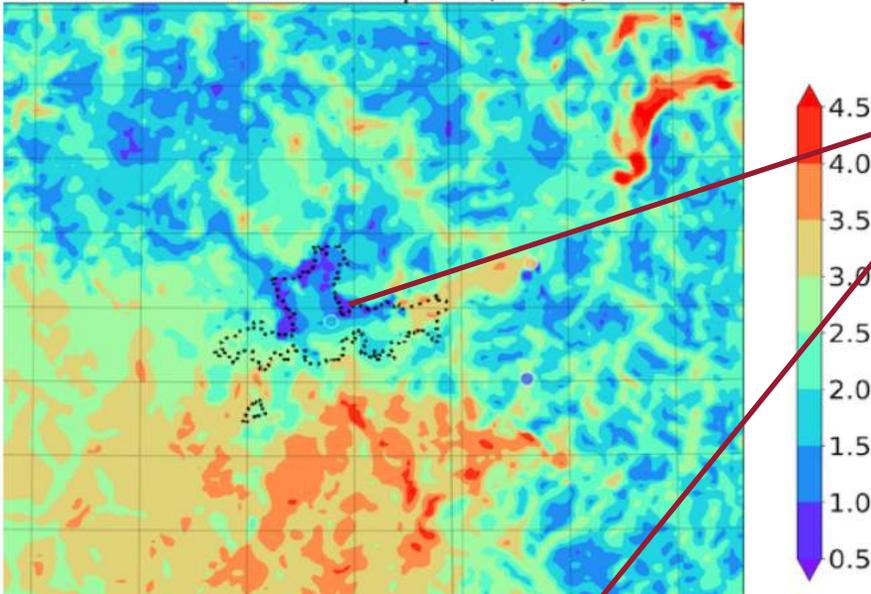
Over Spokane (dotted line), temp at 2 m in BEP is 1 °C higher than the one in WUDAPT.

Time series at Spokane 47.83, -117.27



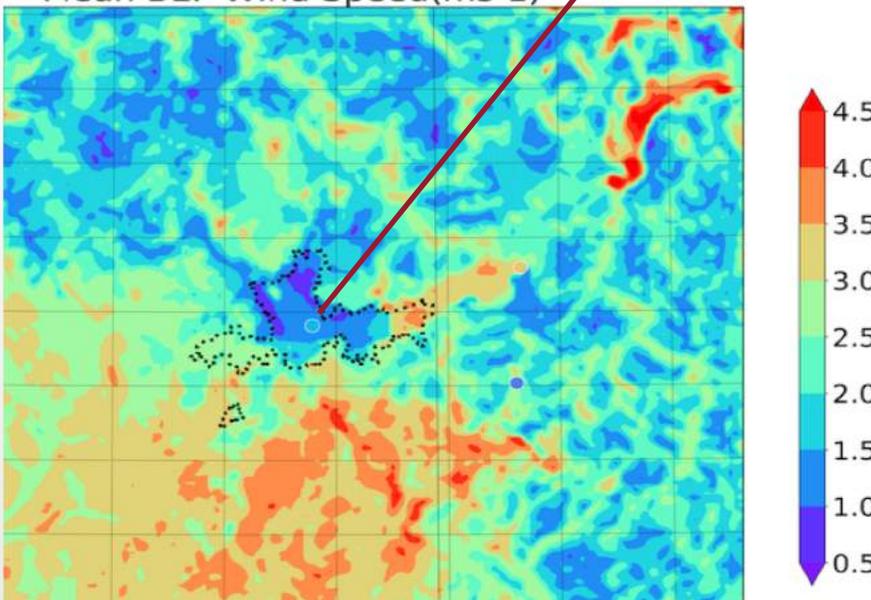
# WUDAPT vs. BEP

Mean WUDAPT Wind Speed(ms-1)

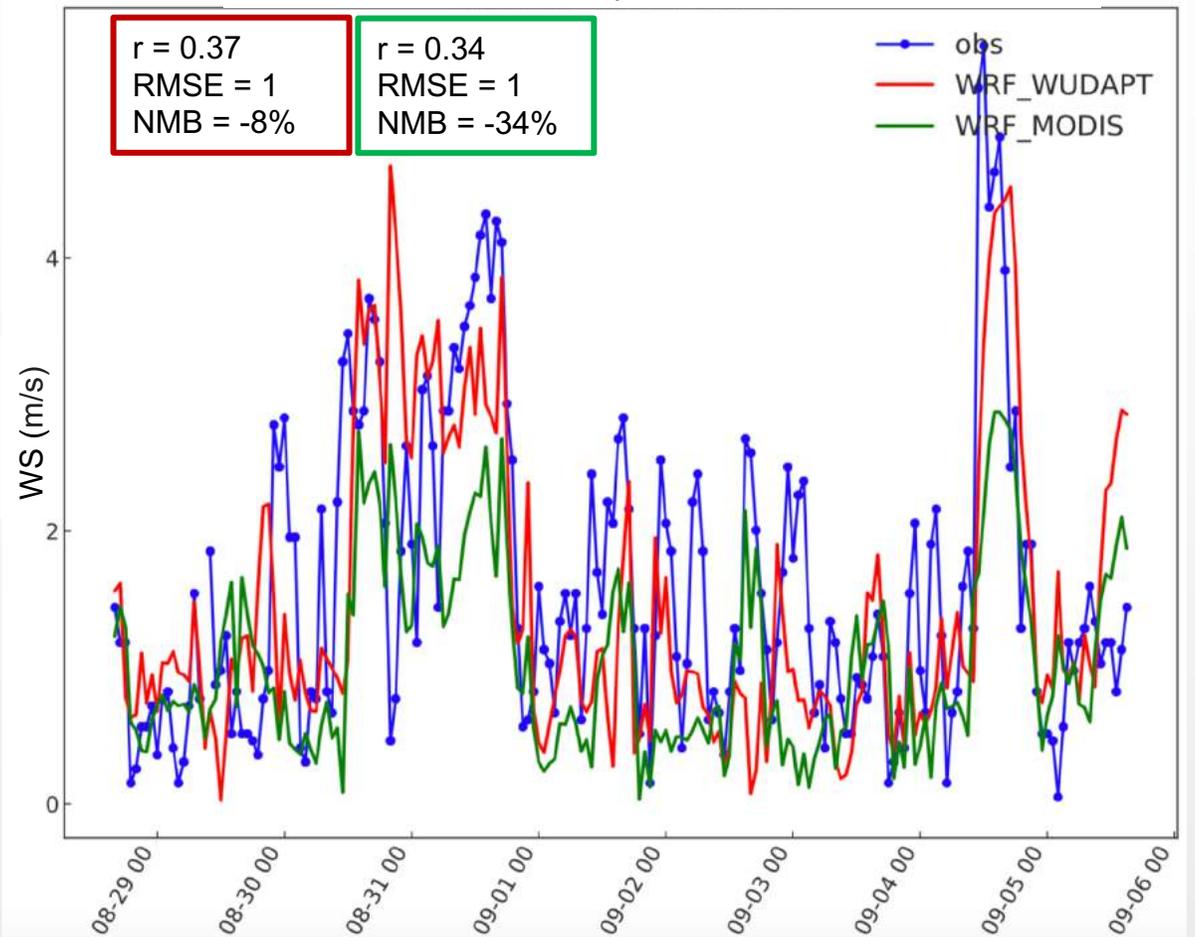


WUDAPT shows higher wind speeds in most of the city center in comparison to the BEP results.

Mean BEP Wind Speed(ms-1)



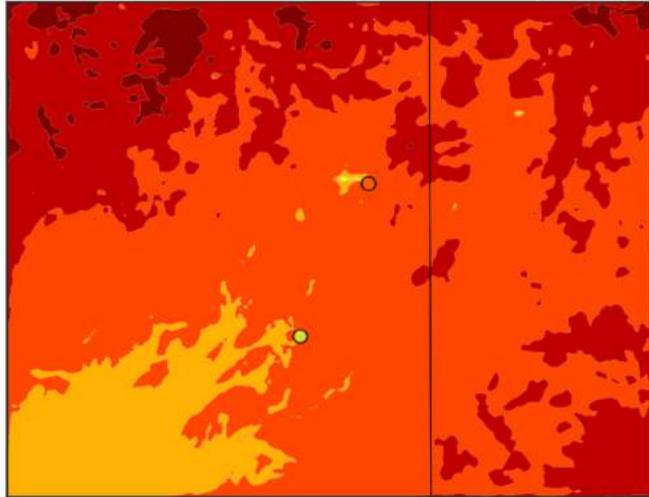
Time series at Spokane 47.67, -117.36



# BEP vs BULK

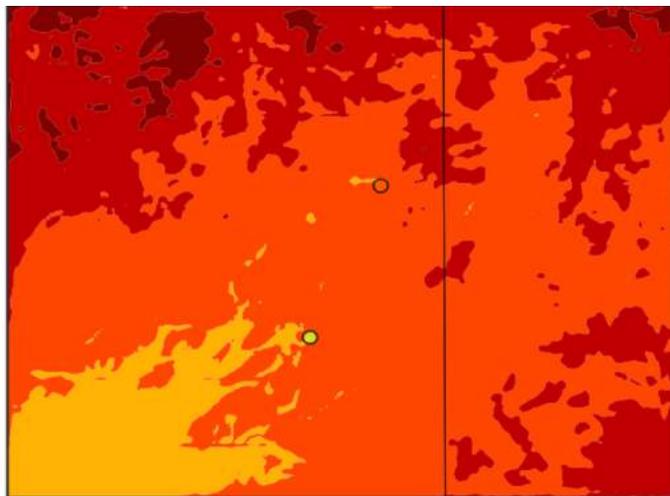
No significant difference in the O<sub>3</sub> distributions between BEP and BULK

Mean BEP O<sub>3</sub> Concentration (ppbv)



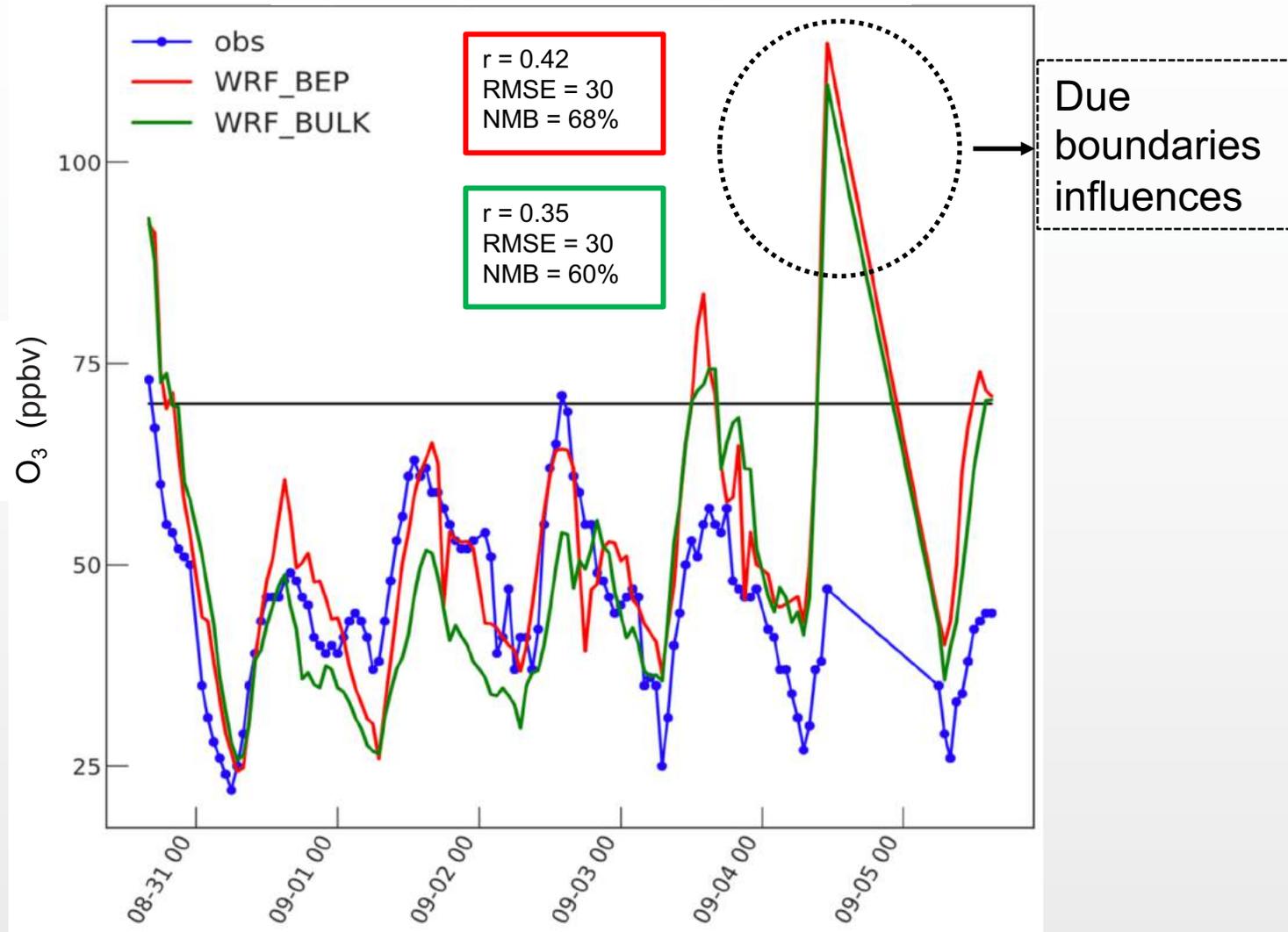
0.0 6.5 13.0 19.5 26.0 32.4 38.9 45.4 51.9 58.4

Mean BULK O<sub>3</sub> Concentration (ppbv)



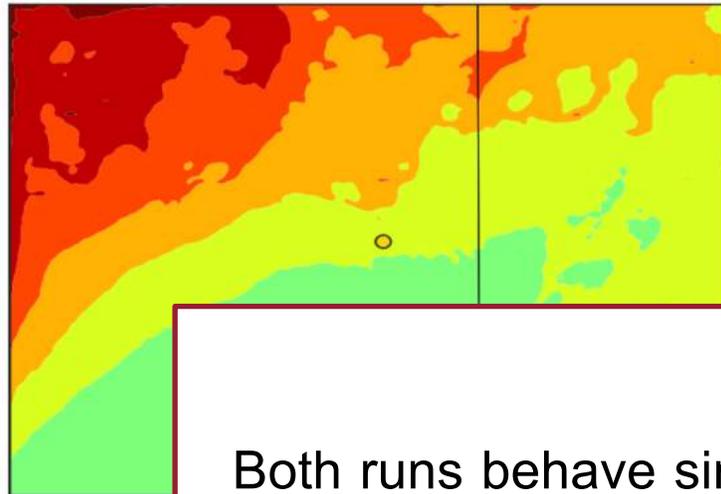
0.0 6.5 13.0 19.5 26.0 32.5 38.9 45.4 51.9 58.4

Time series at Spokane 47.83, -117.27

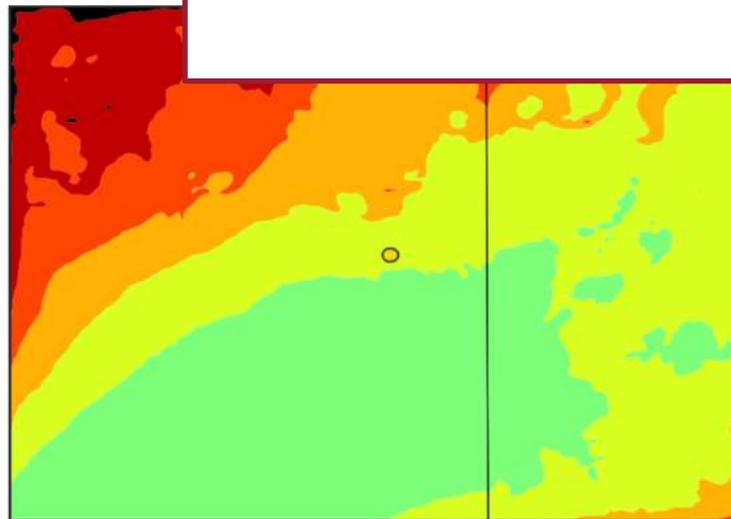


# BEP vs BULK

Mean BEP PM<sub>2.5</sub> Concentration (ug/m<sup>3</sup>)



0.0 3.1 6.1  
Mean B



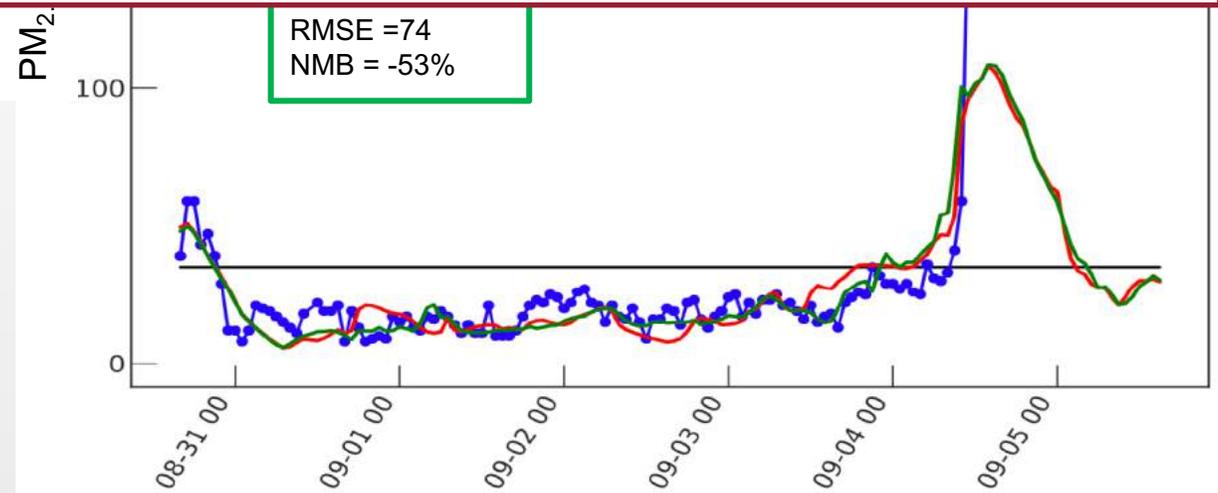
0.0 3.1 6.1 9.2 12.2 15.3 18.3 21.4 24.4 27.5

No significant difference in the PM<sub>2.5</sub> distributions between BEP and BULK

Time series at Spokane 47.67, -117.36



Both runs behave similarly compared to observations such as it captures the observed O<sub>3</sub> but underestimates PM<sub>2.5</sub>



# Conclusions

- Switching from the MODIS urban land use to the WUDAPT urban land use in WRF over Spokane results in:
  - lower mean temperature at 2 m, although the WUDAPT case performed better compared to observations.
  - higher wind speeds, which make the predictions closer to the observations.
  - larger variability on both temperature at 2 m and wind speed around city center, which means that WUDAPT urban land use better accounts for the spatial morphologic and thermal differences.
- Air quality predictions over our study domain do not change significantly with or without UCM in WRF-Chem.

## Future Works

- Explore the impact of UCM and WUDAPT land use on air quality over Spokane: Run WRF-Chem BEP UCM with WUDAPT classification
- Apply Ndown or nested domains to avoid unrealistic boundary influences on the model domain
- Explore other seasons