

Air Quality simulations using WRF-Chem

Ana Carla Fernandez, Amit Sharma, Yunha Lee

Laboratory for Atmospheric Research (LAR)
Civil and Environmental Engineering
Washington State University (WSU)

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Outline

- WRF-Chem: Western US simulations
 - Updates from last year's results
 - PM_{2.5} evaluation
 - O₃ evaluation
- WRF-Urban: Urbanova Project
 - Nesting domain
 - Spokane land use map: introduction of new land use classification (WUDAPT) into WRF
 - Evaluation of urban land use classes

WRF-Chem setup

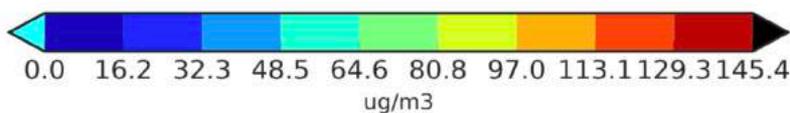
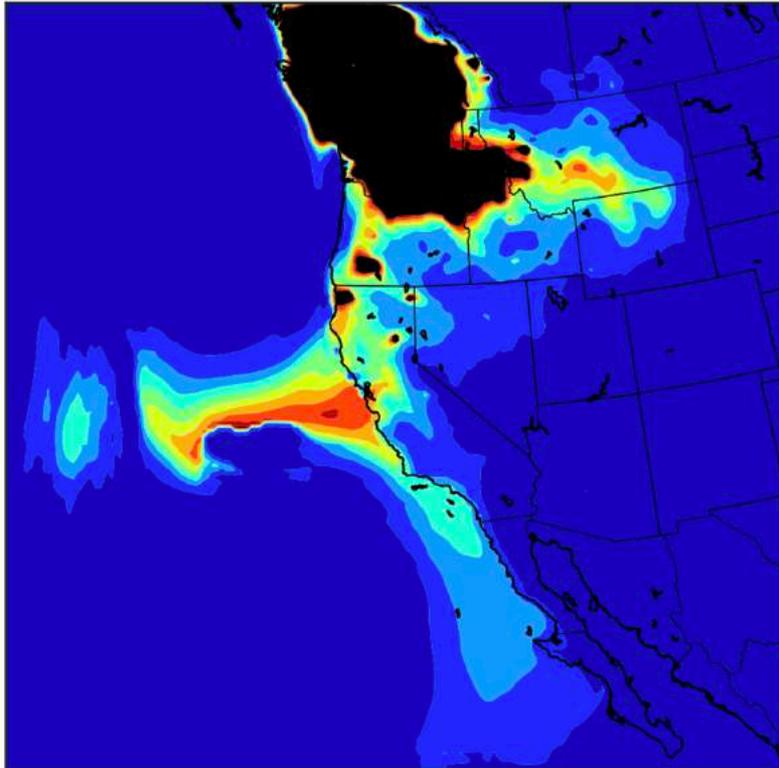
- WRF v3.9.1
- Resolution: 18 km
- Chemistry option: MOZART-MOSAIC_4bin_aq.
- Emissions:
 - MEGAN biogenic emissions.
 - FINN fire emissions.
 - NEI2011 anthropogenic emissions.

PM2.5 Mean concentration for Aug 05 2017

Previous results: overestimated concentrations

mean: 56.4354 ug m-3

PM25

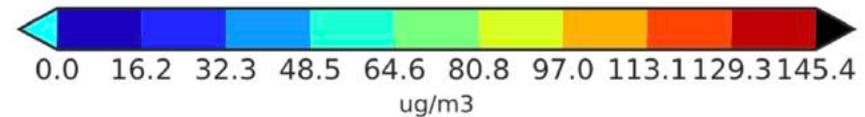
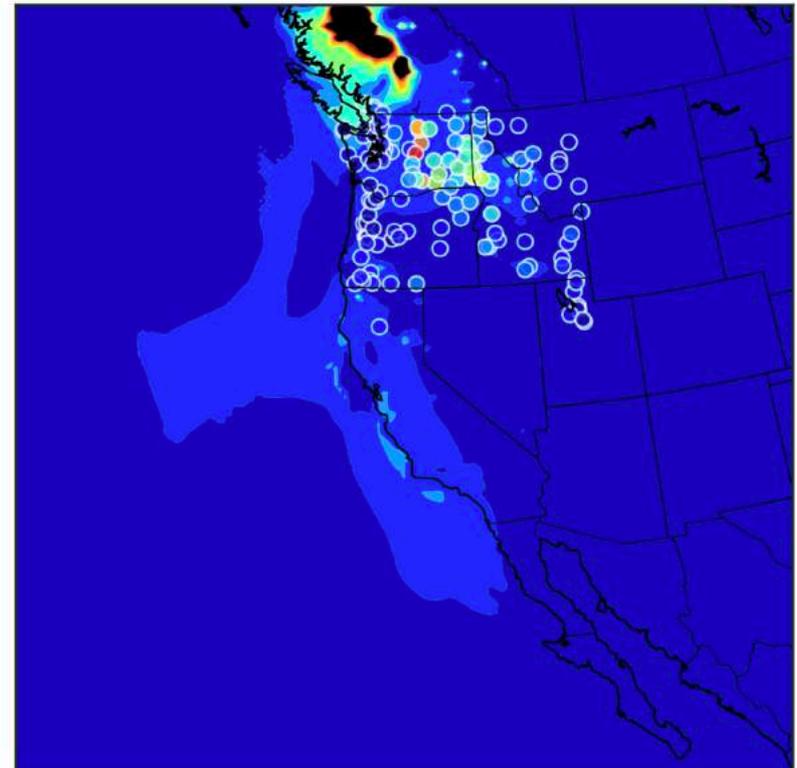


Statistic	NMB	NME	RMSE	R ²
	1240.96	1246.69	236.66	0.29

Current results: Better agreement with observations

mean: 10.512354 ug m-3

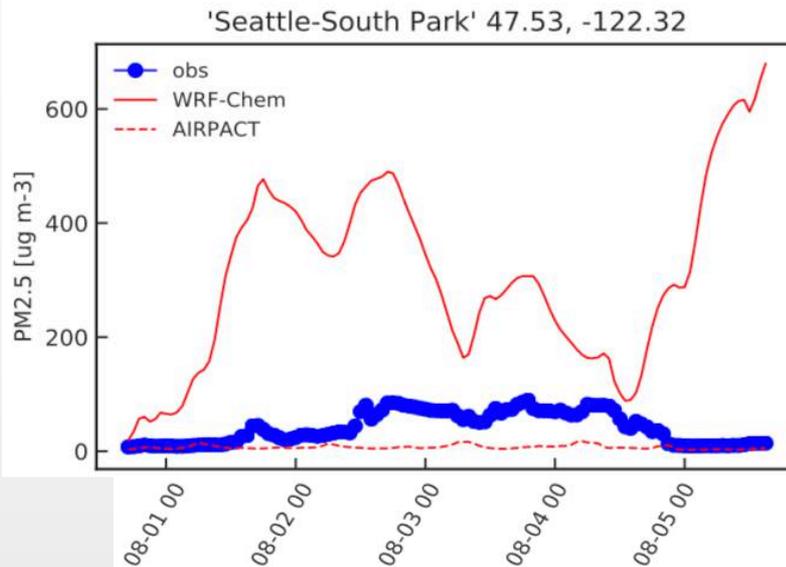
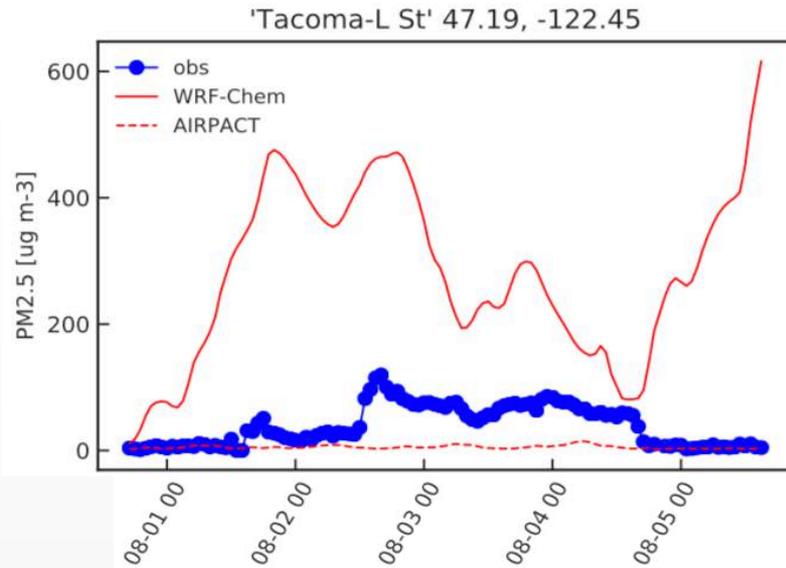
PM25



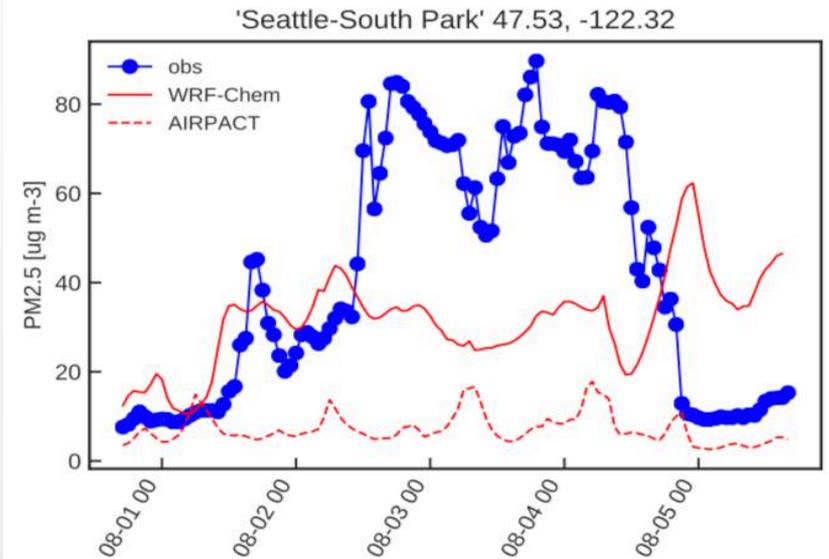
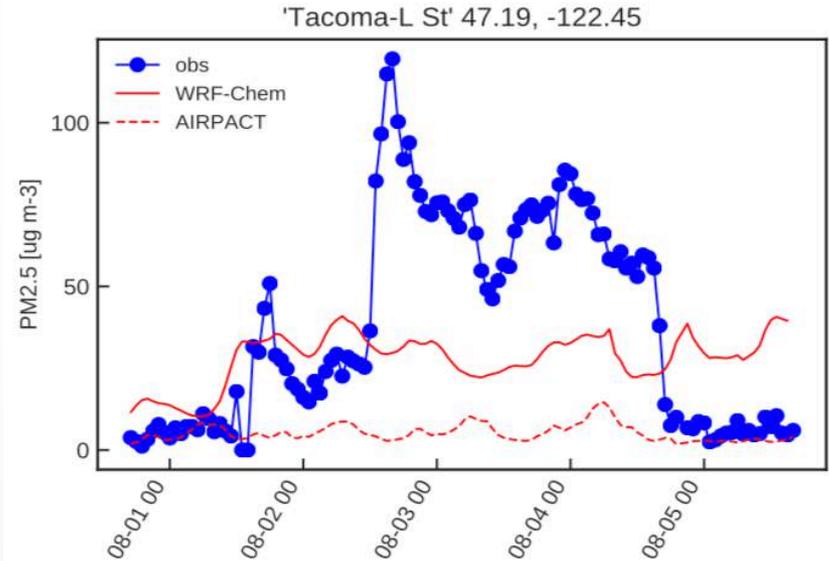
Statistic	NMB	NME	RMSE	R ²
	59.92	121.29	27.64	0.25

PM2.5 Evaluation

Previous results



Current results

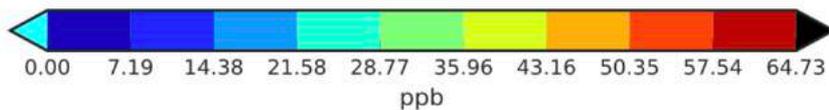
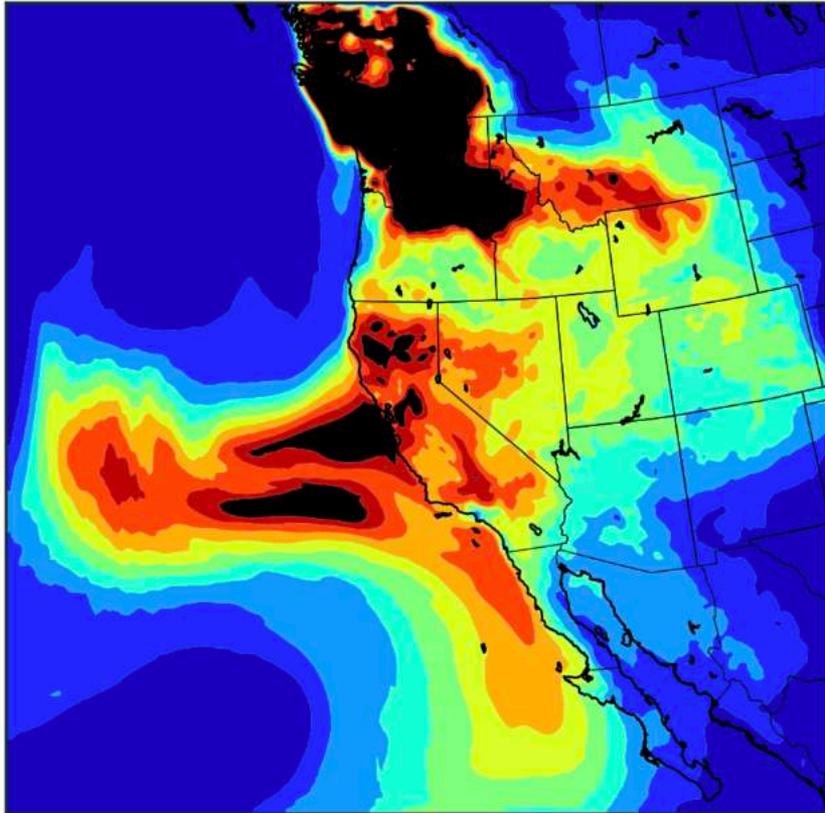


O₃ Mean concentration for Aug 05 2017

Previous results: overestimated concentrations

mean: 25.2928 ppb

o3

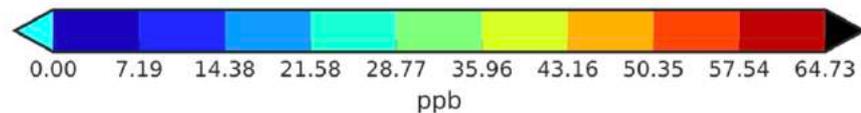
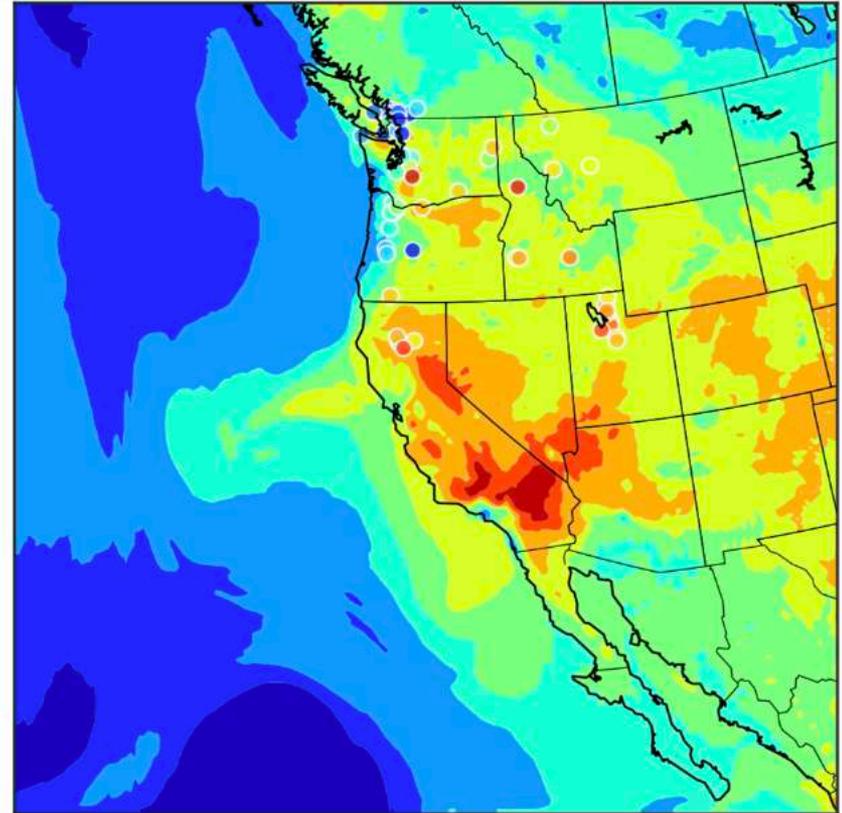


Statistic	NMB	NME	RMSE	R ²
	321.39	340.47	56.43	0.54

Current results: Better agreement with observations

mean: 25.818047 ppb

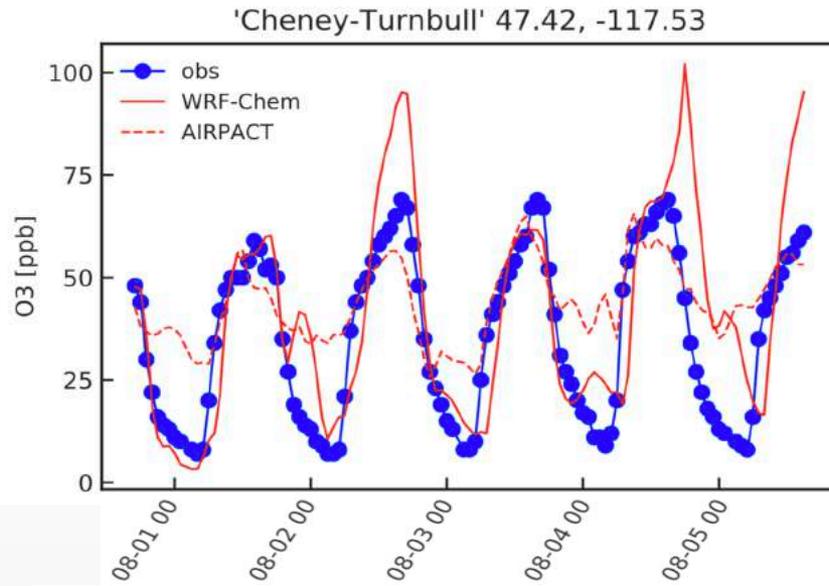
o3



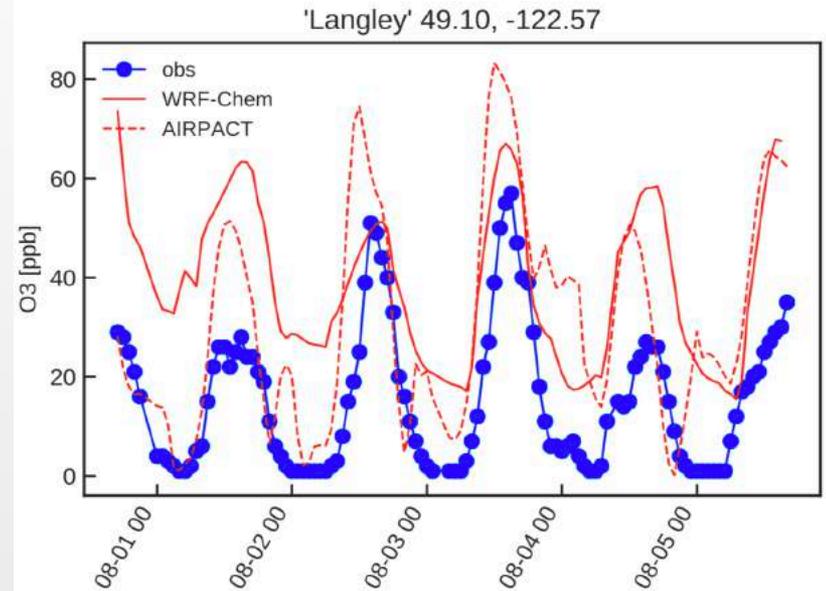
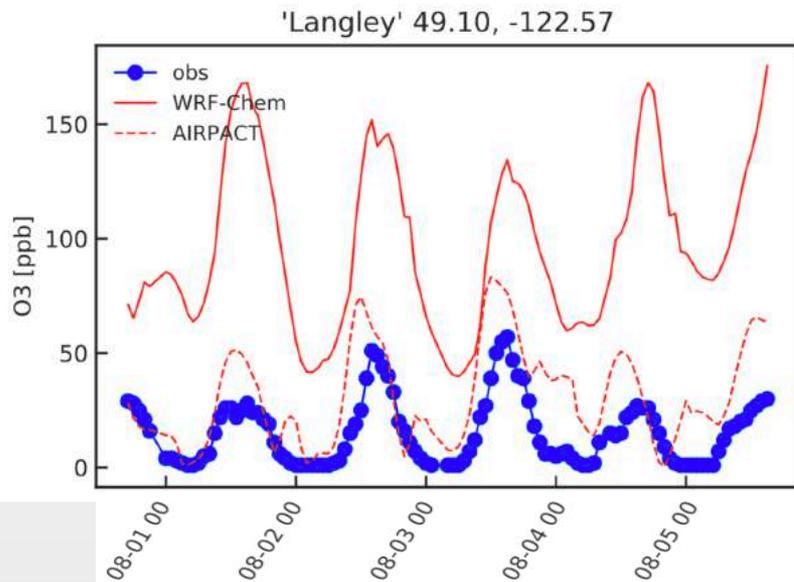
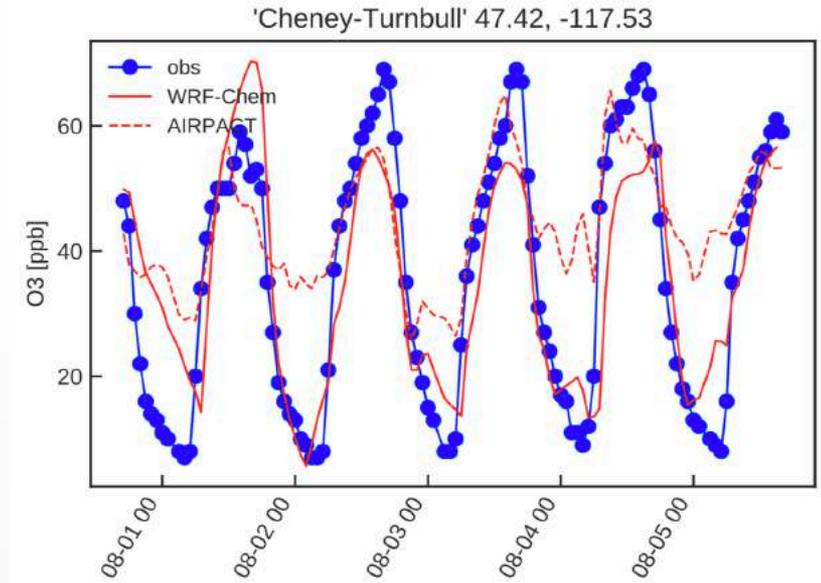
Statistic	NMB	NME	RMSE	R ²
	63.98	89.24	16.84	0.57

O₃ Evaluation

Previous results



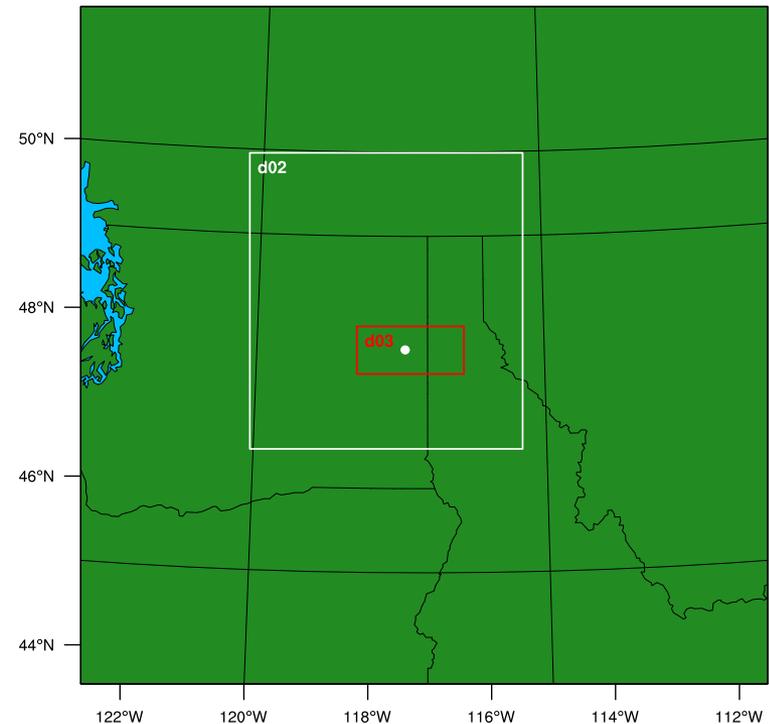
Current results



WRF_Urban: Urbanova project

- Domain_3= 280 x 127 grid cells
- Grid spacing = 500 m
- Simulation date: 08/4-5/2017
- No Chemistry included
- Urban canopy model (UCM): Built Environment Parametrization (BEP)

WPS Domain Configuration



Urban land cover data

- **World Urban Database and Access Portal Tools (WUDAPT)**

- Use the **Local Climate Zone (LCZ)** classification framework.
- High resolution Global Data Base containing information about urban form and function.

Urban Climates Zones (UCZ)

Stewart and Oke (2012)

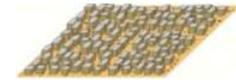
LCZ 1: Compact high-rise



LCZ 4: Open high-rise



LCZ 7: Lightweight low-rise



LCZ 2: Compact mid-rise



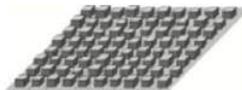
LCZ 5: Open mid-rise



LCZ 8: Large low-rise



LCZ 3: Compact low-rise



LCZ 6: Open low-rise



LCZ 9: Sparsely built



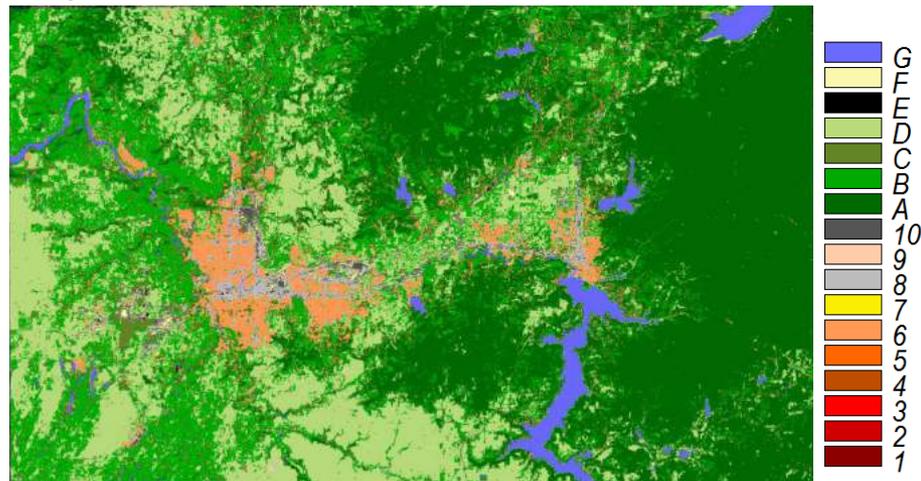
LCZ 10: Heavy industry



- **Incorporated urban land use in WRF:**

- 10 Urban Classes from WUDAPT data
- Combined with MODIFIED_IGBP_MODIS_N OAH for non-urban classes.
- Resulting in 40 land use classes.

Spokane local climate zone classification

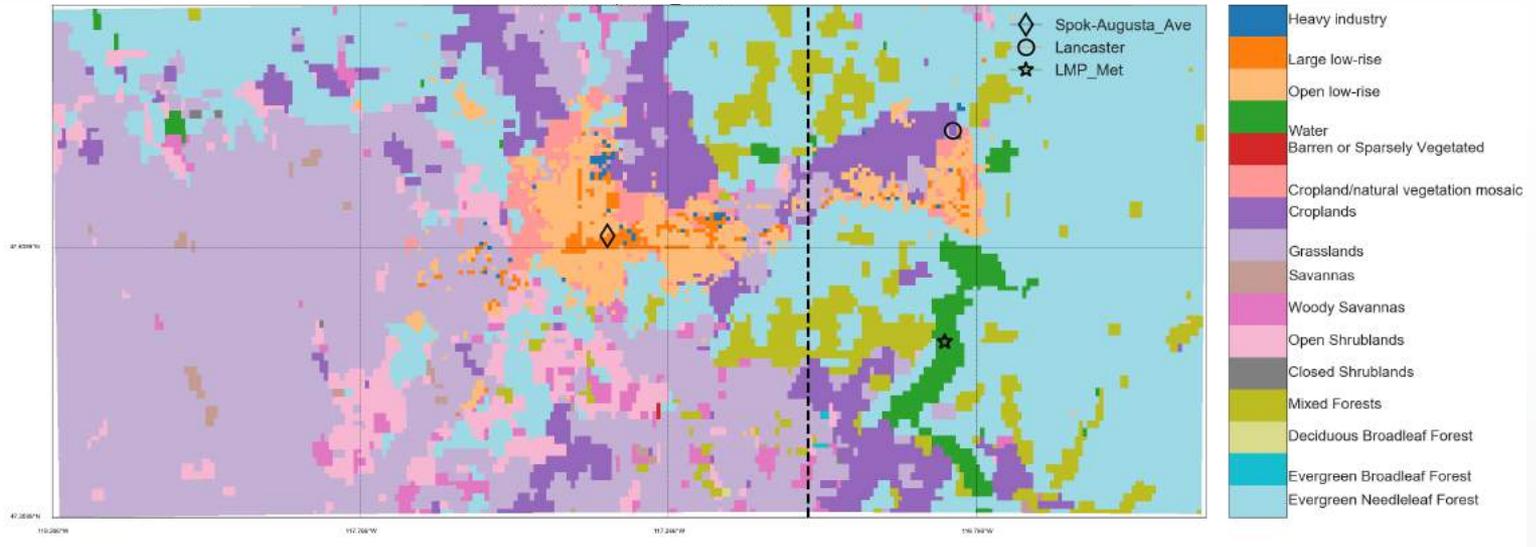


Alex Schmies

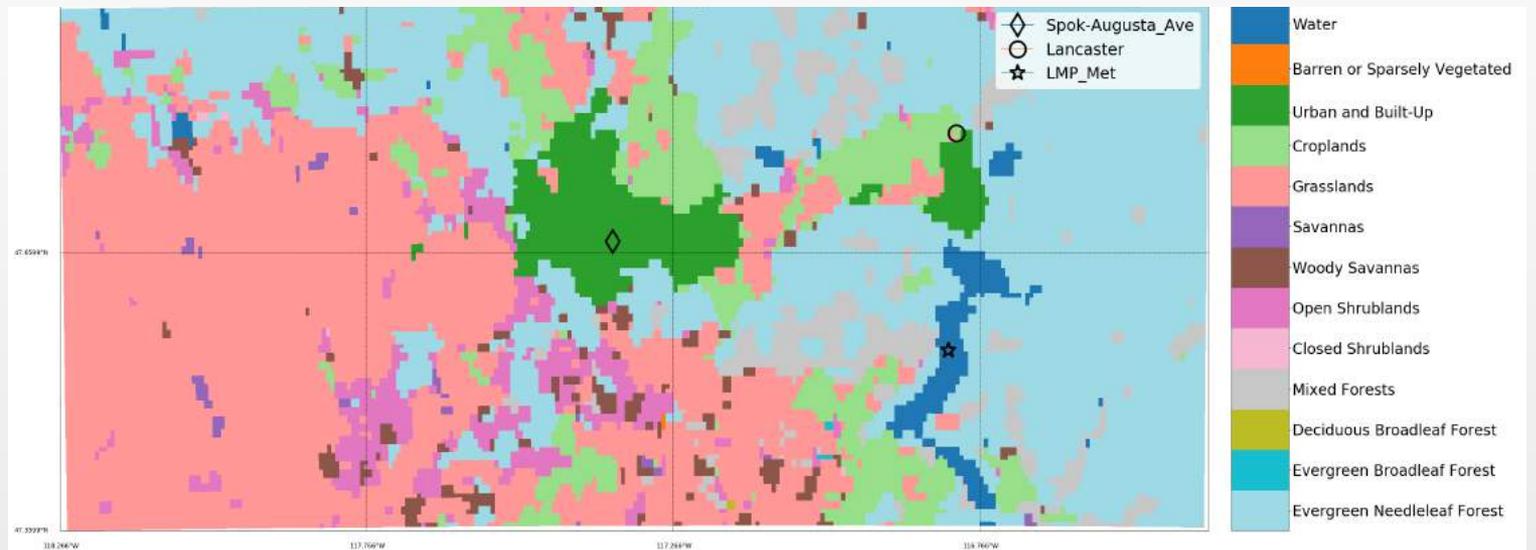


Comparison of land use classification over Spokane

UCZ
&
MODIS



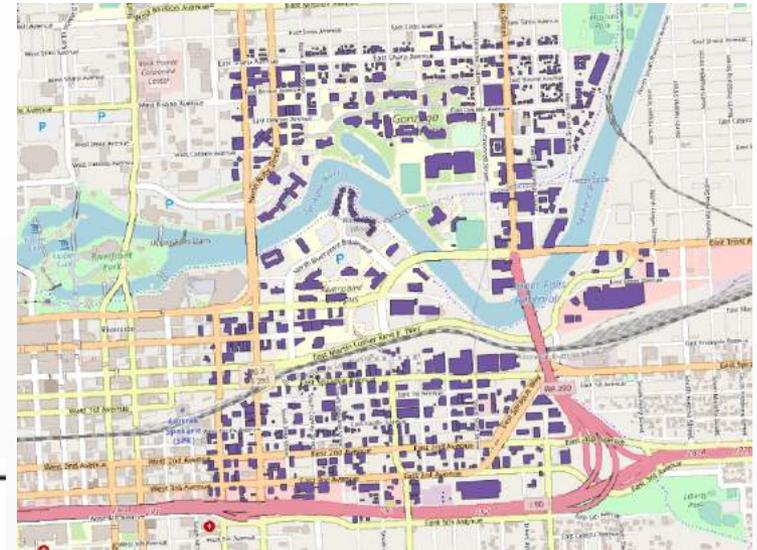
MODIS



WUDAPT land use classification assessment

Acknowledge to Dr. Kerry Brooks
from Eastern Washington University

- Post-processed LIDAR data from Urbanova district was used to assess land use class building heights.
- 752 buildings were analyzed.



Local climate
zone (LCZ)

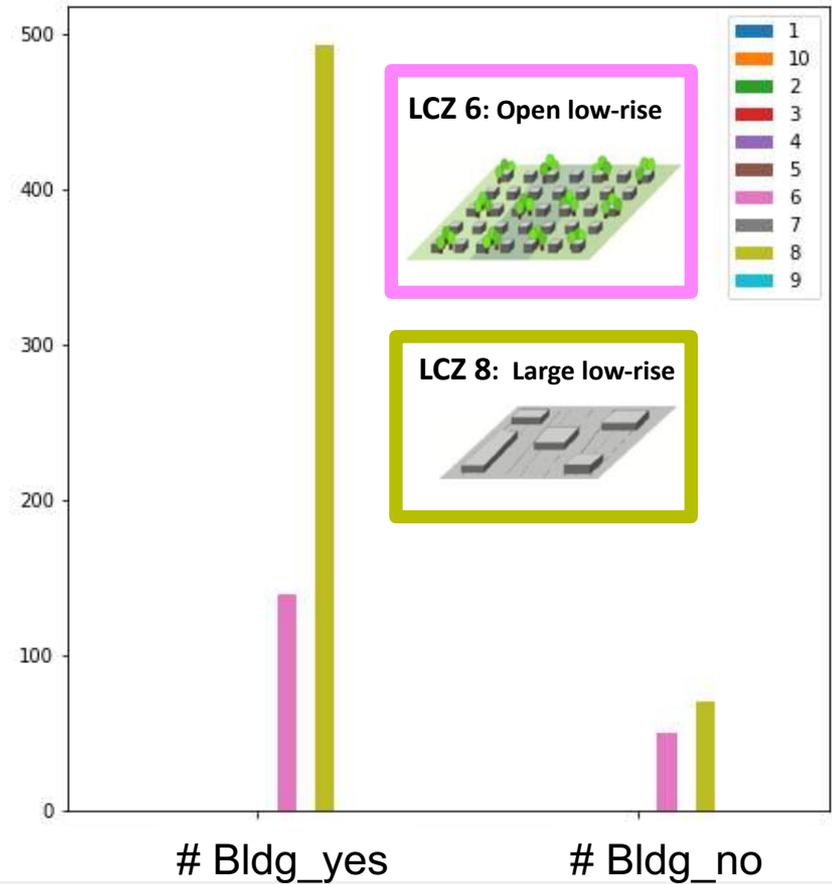
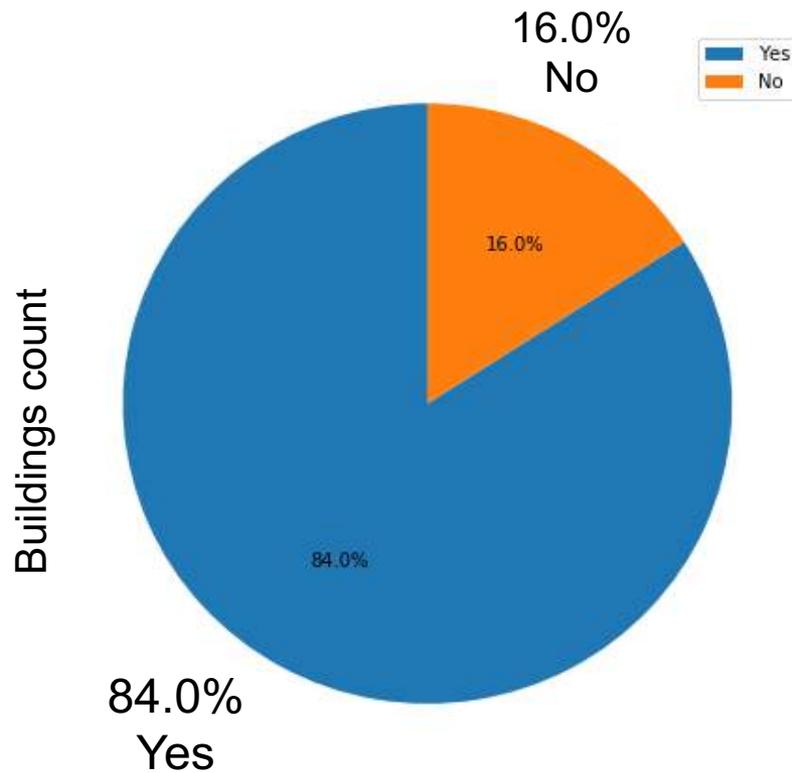
Height of
roughness
elements^e

<i>LCZ 1</i> Compact high-rise	>25
<i>LCZ 2</i> Compact mid-rise	8–20
<i>LCZ 3</i> Compact low-rise	3–8
<i>LCZ 4</i> Open high-rise	>25
<i>LCZ 5</i> Open mid-rise	8–20
<i>LCZ 6</i> Open low-rise	3–8
<i>LCZ 7</i> Lightweight low-rise	2–4
<i>LCZ 8</i> Large low-rise	3–10
<i>LCZ 9</i> Sparsely built	3–8
<i>LCZ 10</i> Heavy industry	5–15

- Each building height was compared to the corresponding land use height interval.

WUDAPT land use classification assessment

Agreement between UD buildings height and urban land use class height



Next step

- Incorporate Bluesky emissions instead of FINN
- 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

Thank you !

WRF-Chem setup

- WRF v3.9.1
- Chemistry option: MOZART-MOSAIC_4bin_aq.
- Emissions:
 - MEGAN biogenic emissions.
 - FINN fire emissions.
 - NEI2011 anthropogenic emissions.

Processes:

- **Microphysics:** Morris 2-moment
- **Radiation:** Rapid radiative transfer model (RRTM)
- **Surface layer physics:** Monin-Obukhov (Janjic Eta) Similarity scheme.
- **Land-surface Physics:** Noah LSM.
- **PBL physics:** Bougeault and Lacarrere (BouLac).
- **Cumulus:** Grell 3D
- **Urban Canopy Model:** no UCM