

Ozone Modeling Study Over The Tri-Cities Area

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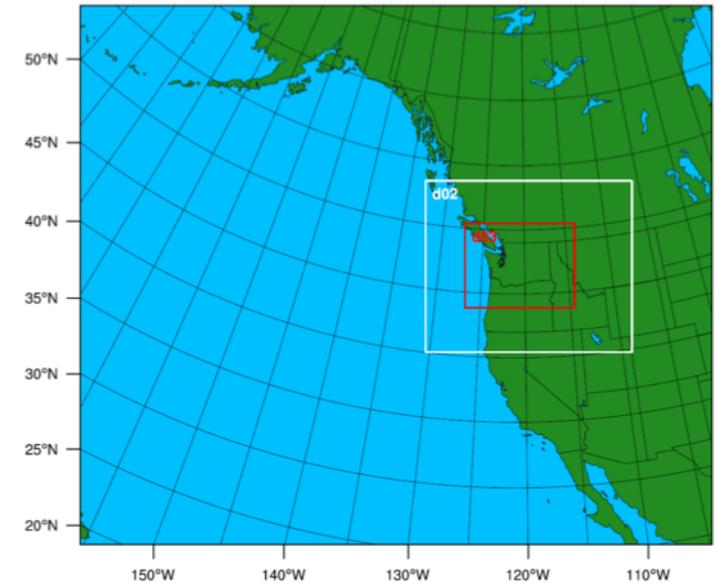
WA State Department of Ecology

NW-AIRQUEST Quarterly Meeting, Seattle - WA

Oct 04, 2018

Ecology In-House Model Setup

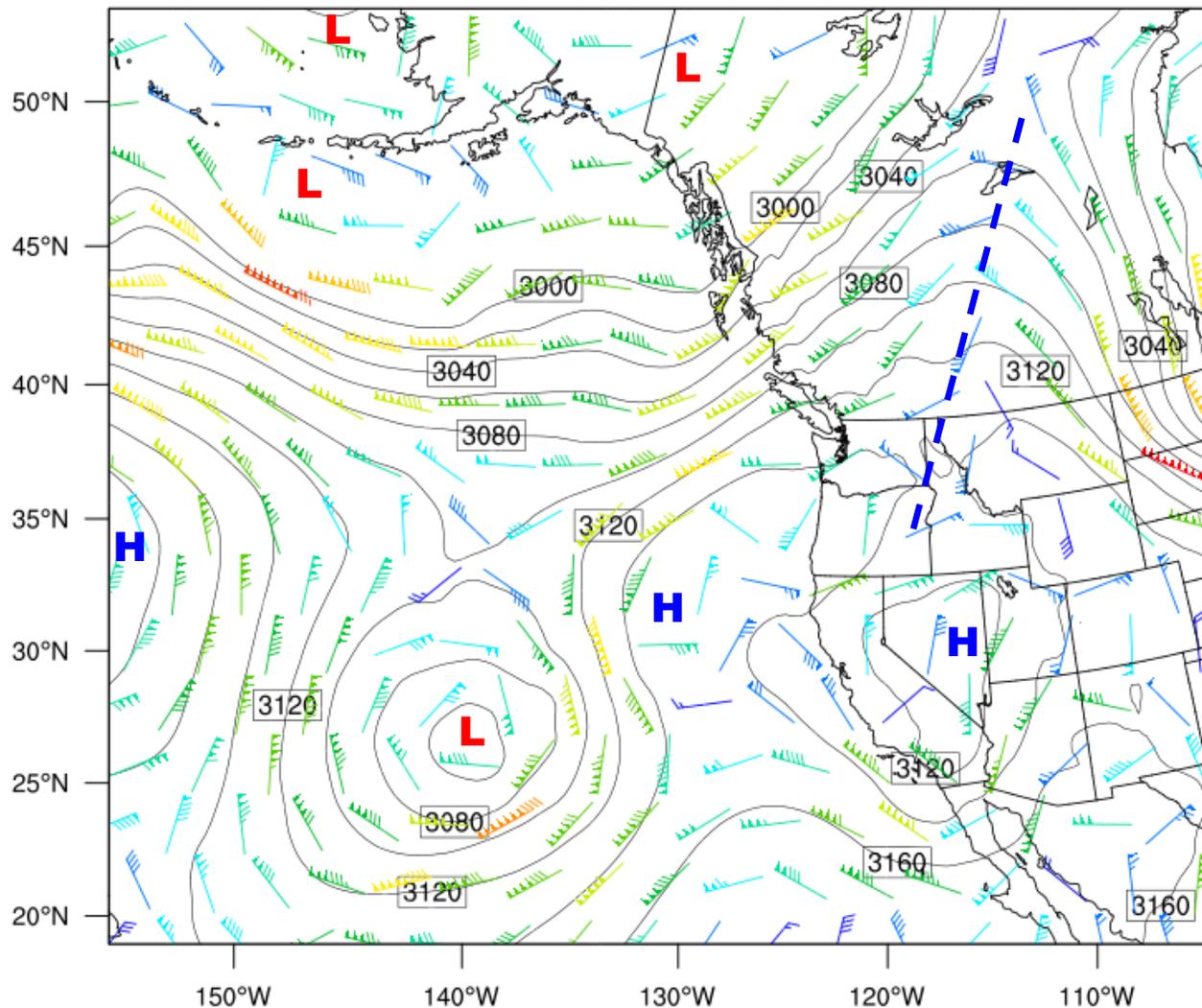
- WRF v3.7.1
 - 3-nested domains: 36, 12 & 4km
 - UW-Physics options: MP-Thompson; RRTMG; Revised M-O; Noah-MP; YSU; Grell-Freitas Ensemble
 - Analysis (Grid) nudging: GFS, NAM, RAP & OTISS-SST
 - **MCIP v4.4**
- SMOKE v4.5
 - 2014 NEI v2
 - BEIS 3.14 (with adjustment)
 - New SMOKE-MOVES from Wei (No Canada inputs yet)
 - Using spatial surrogates from AIRPACT-5 effort
- CMAQ v5.2
 - 3-D Emissions Input
 - CB05 Chemical Mechanism
 - BCON from AIRPACT MOZART archives
- Current Simulations Being tested (Kennewick ozone episodes):
 - June 3 – June 8, 2016
 - July 24 – July 31, 2017



36km Domain METGRID Data

Init: 2016-06-06_12:00:00

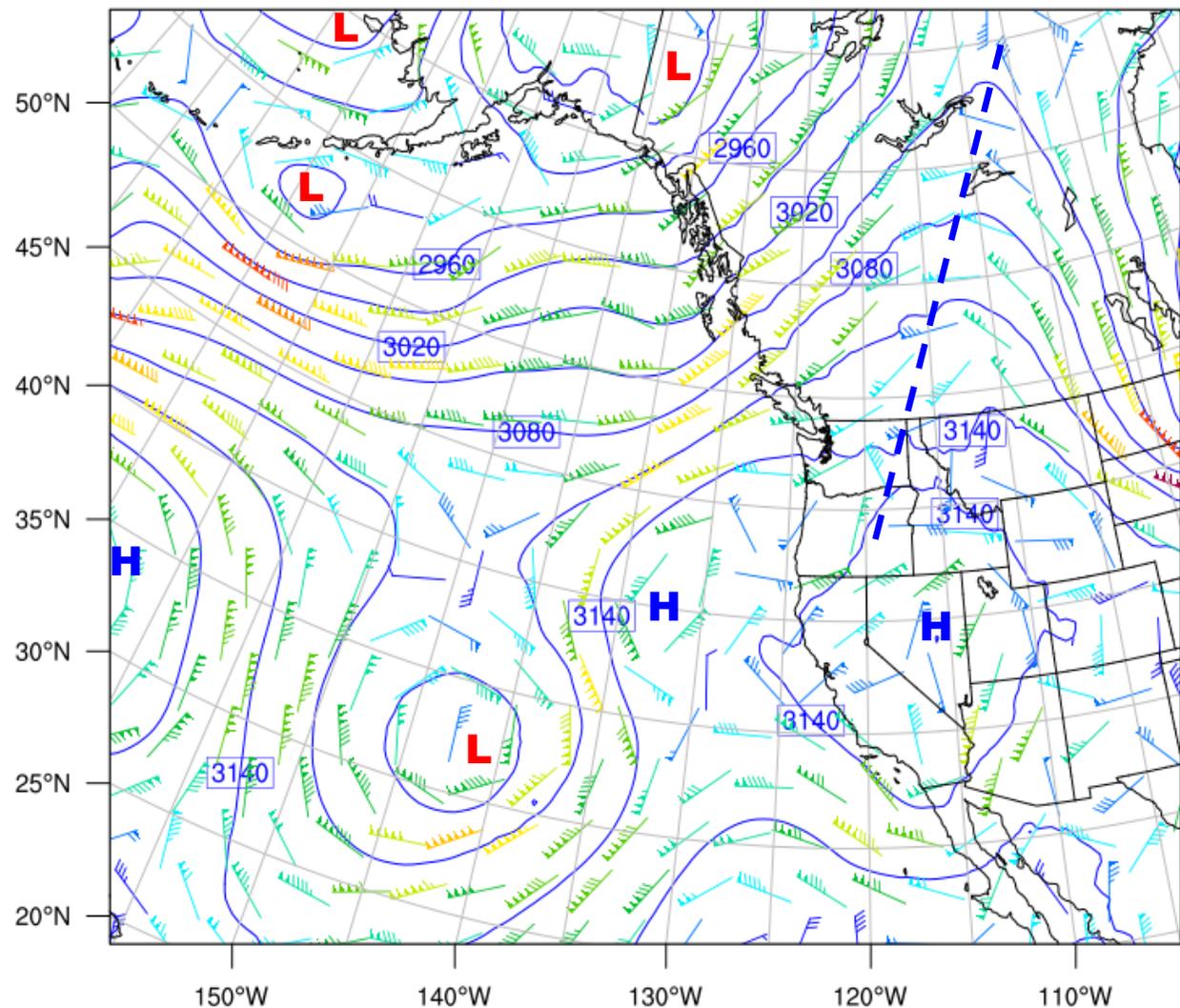
Height (m) at 700hPa
Wind (barb=1kts;flag=5) at 700hPa



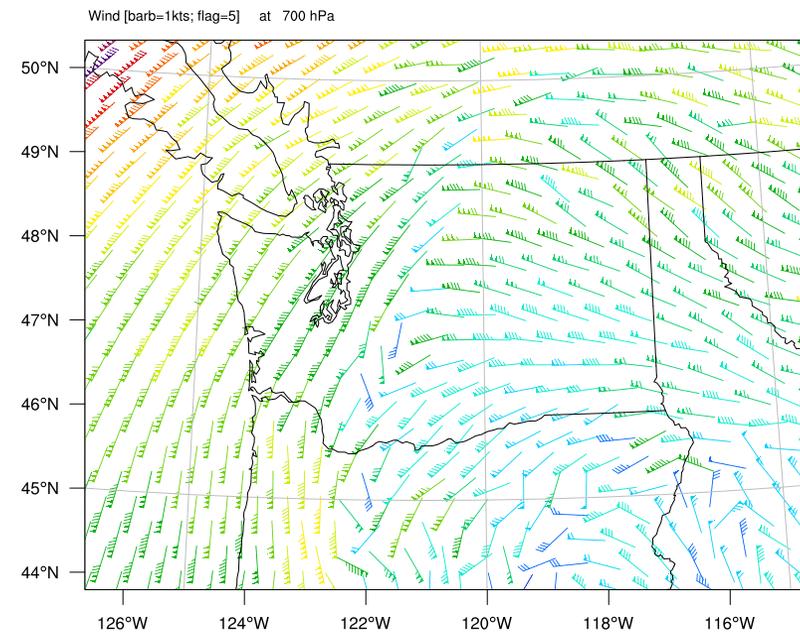
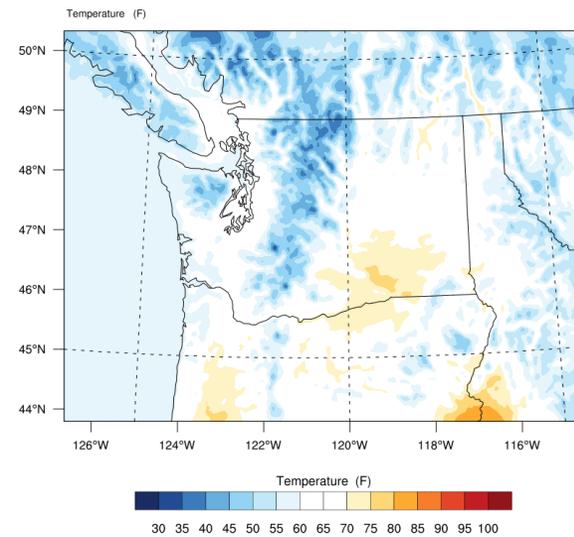
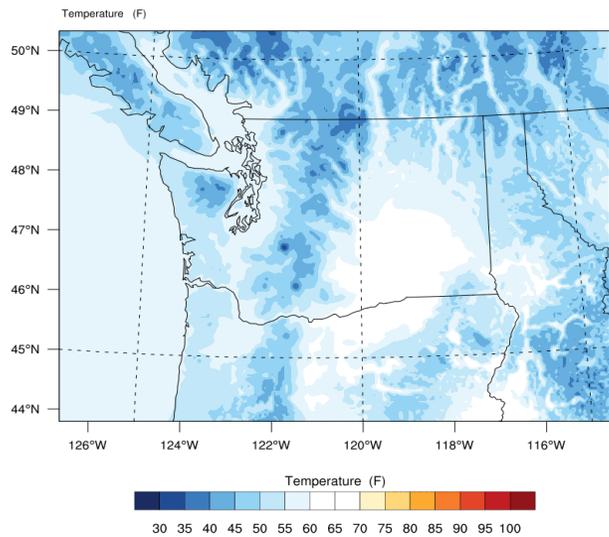
HINDCAST WRFv371

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Valid: 2016-06-06_12:00:00

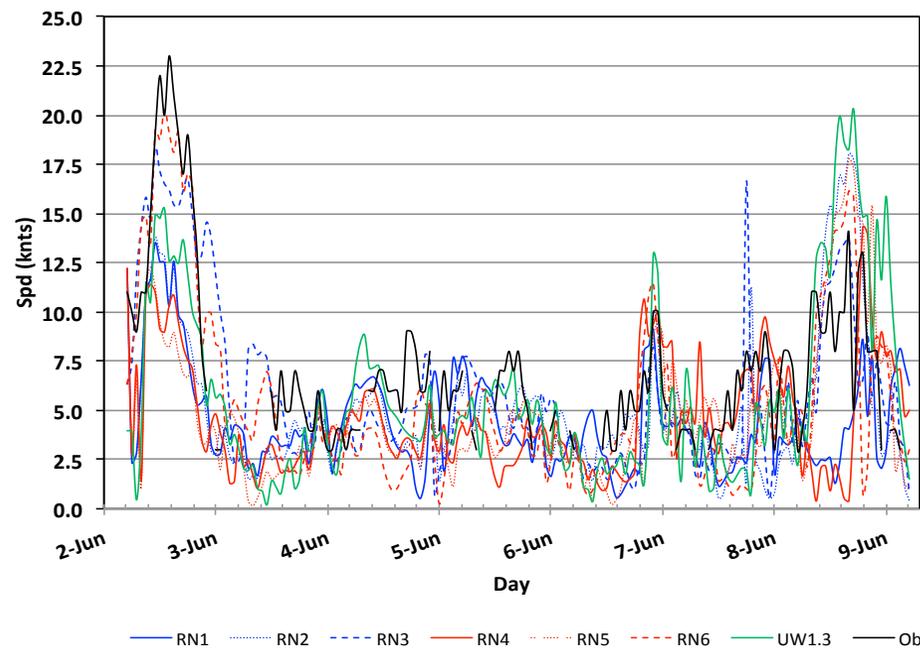
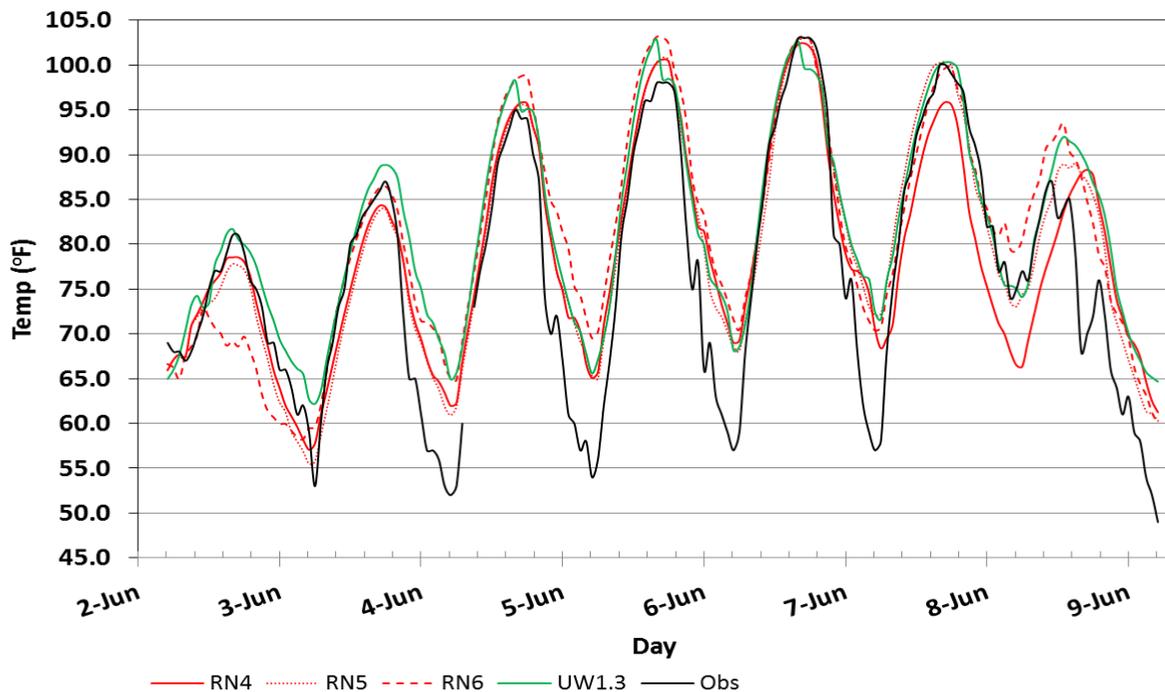
Height (m) at 700 hPa
Wind at 700 hPa



Height Contours: 2840 to 3230 by 30



Pasco Airport, 2-8 June 2016 Modeled v Obs Temperature (F)



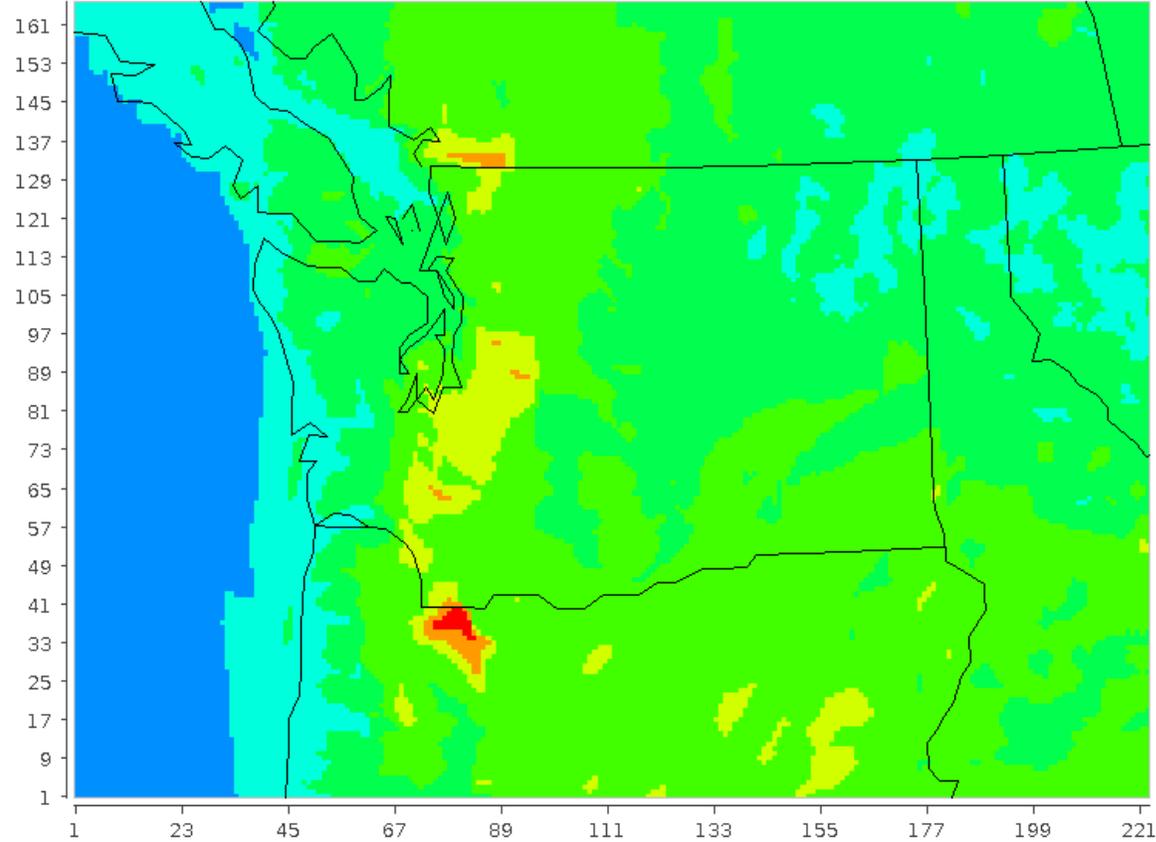
Vancouver, WA – Portland, OR area on 05 JUN @1400 PST
=> When prevailing winds from east and onshore NWly winds converge

HINDCAST WRFv371

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Valid: 2016-06-05_20:00:00

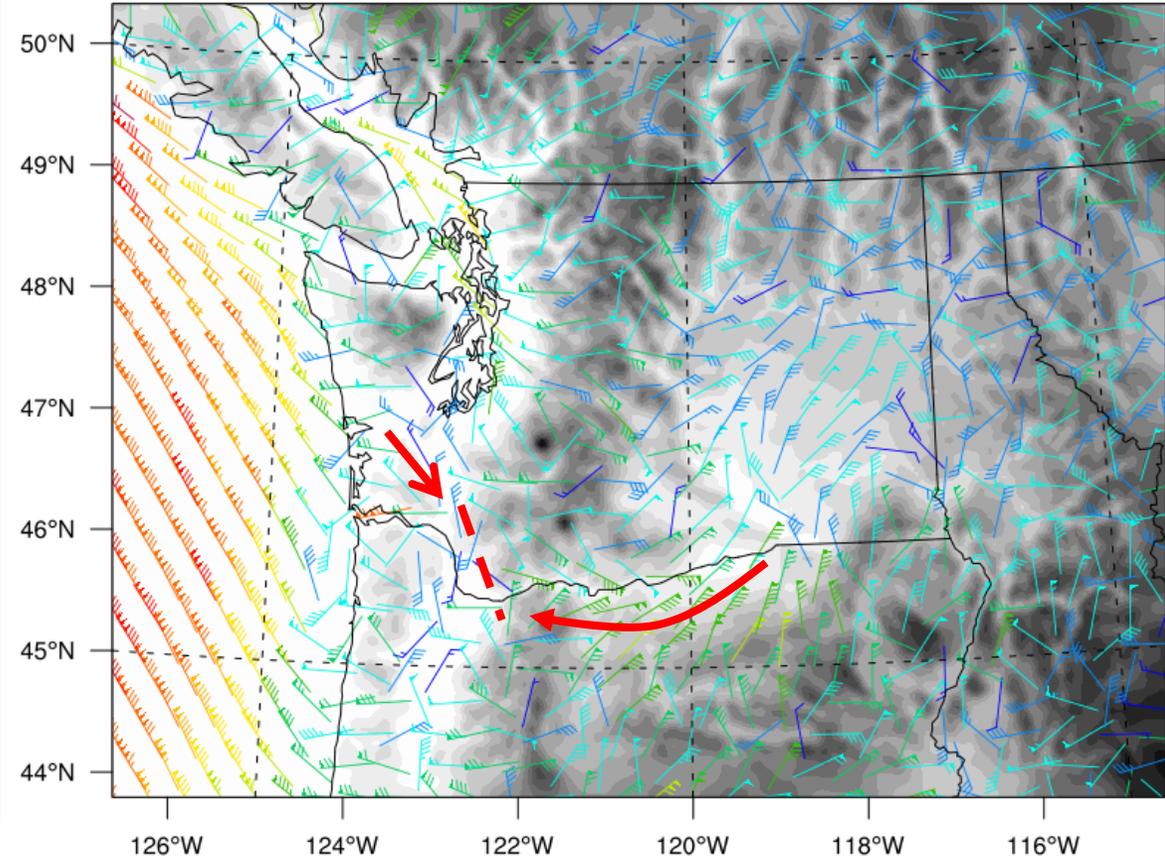
Layer 1 O3[hiVOC]

[5]=CCTM_ACONC_v52_gcc_ECY4km_20160605.nc



June 05, 2016 22:00:00 UTC
Min (5, 1) = 0.021, Max (81, 38) = 0.099

Terrain Height (m)
Wind at 10m Hgt [barb=1kts; flag=5]



Terrain Height (m)

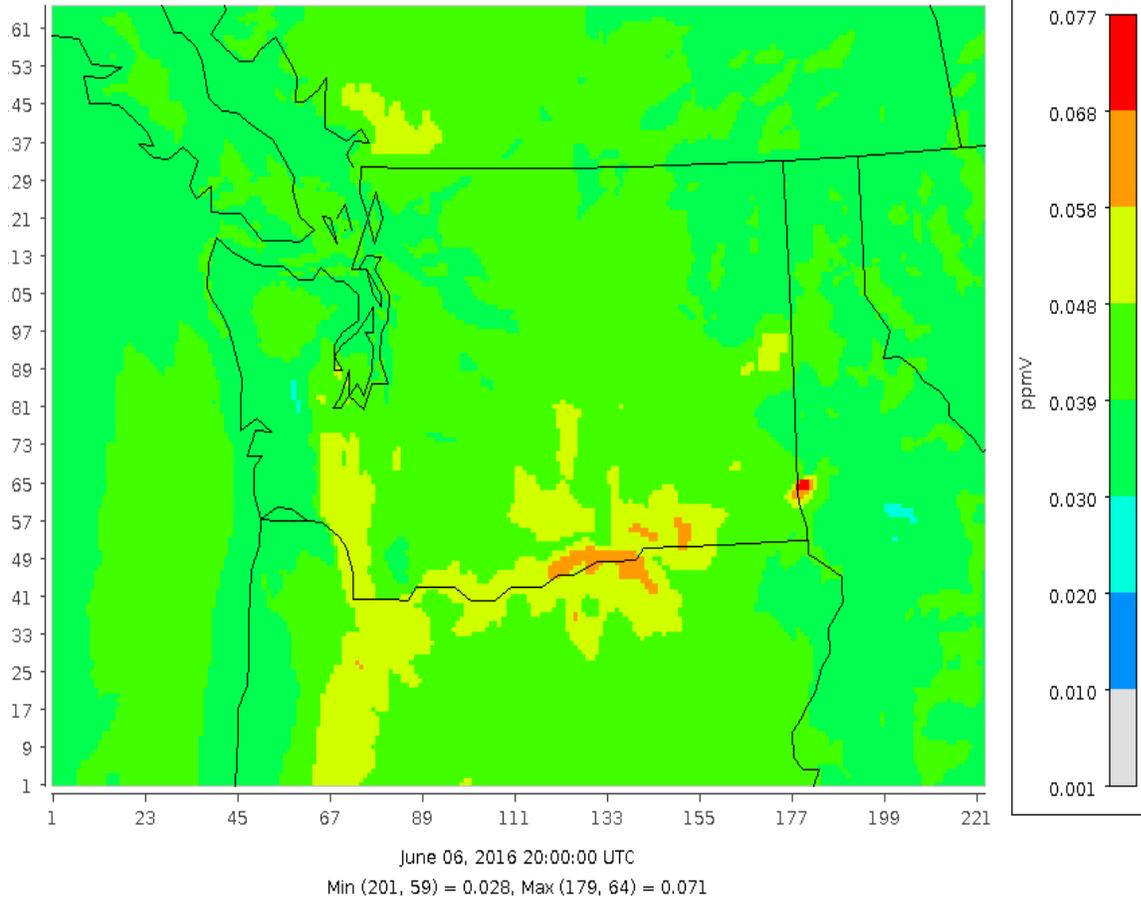


200 600 1000 1400 1800 2200 2600

- Hill tops serve as convergence zones during hot daytime -> transport precursors & O3 later in the day to the Columbia Air Basin
- Slower winds and hi Temps around the basin are conducive for O3 formation

Layer 1 O3[Base]

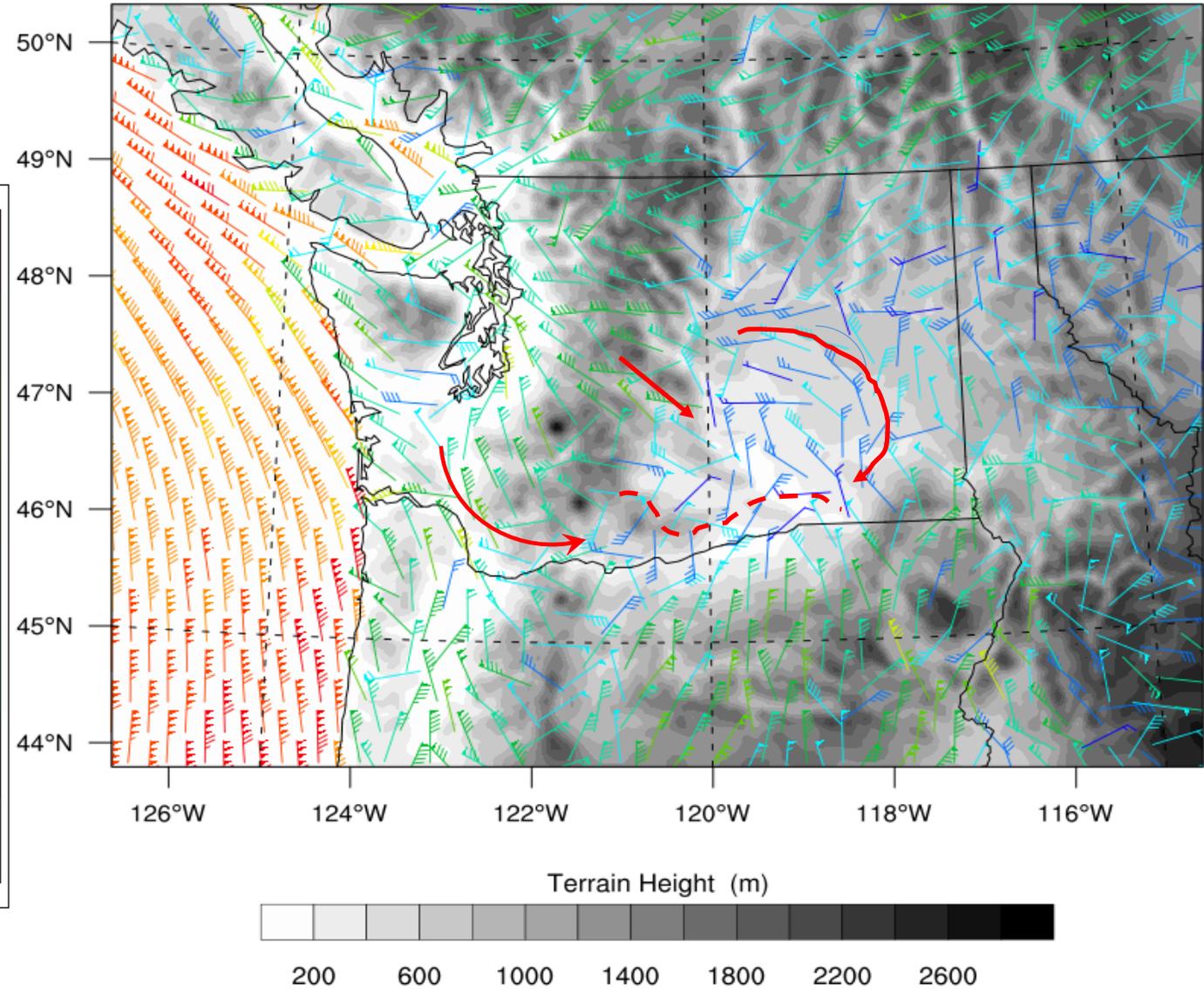
[2]=CCTM_ACONC_v52_gcc_ECY4km_20160606.nc



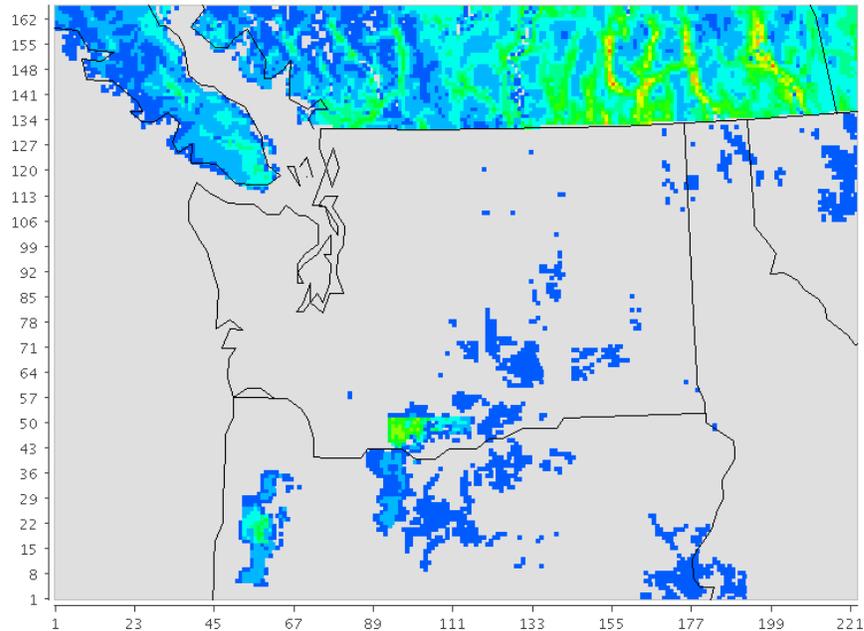
HINDCAST WRFv371

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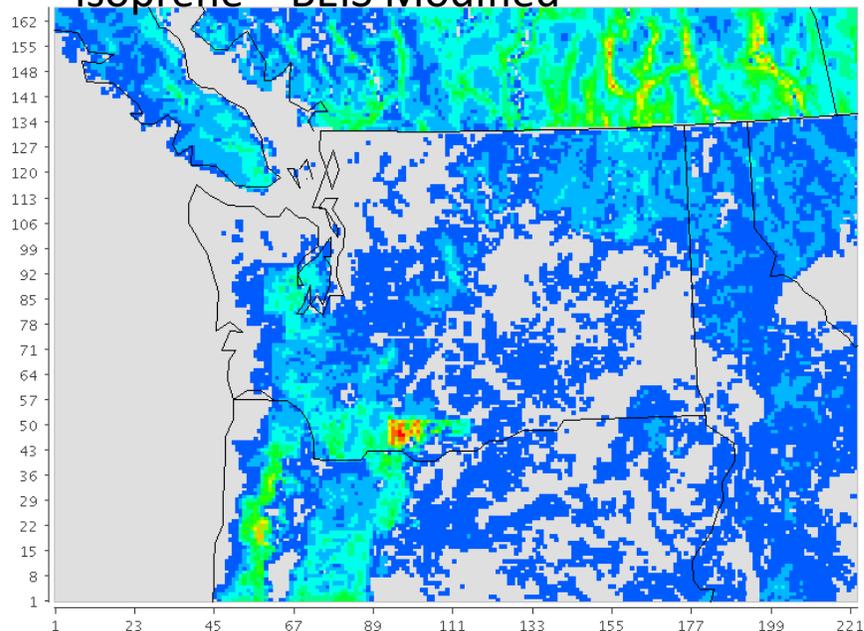
Terrain Height (m)
Wind at 10m Hgt [barb=1kts; flag=5]



Isoprene – BEIS Default



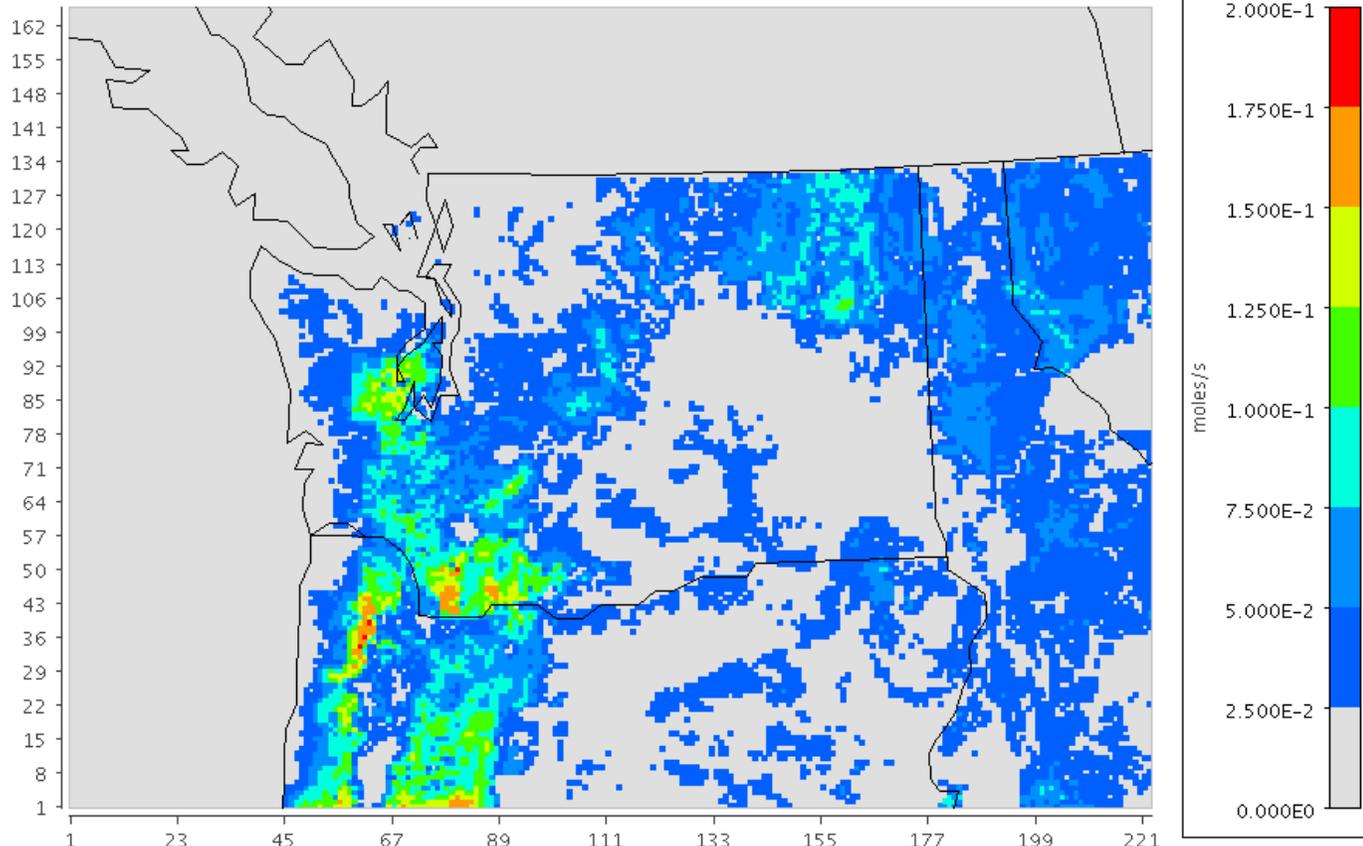
Isoprene – BEIS Modified



- However, CMAQ underestimated maximum O3
- So, biogenic emissions were modified to increase VOCs

Layer 1 ISOP[2]-ISOP[1] Isoprene Difference

[1]=b3gts_l.20160607.1.WA4km.AQP.ncf; [2]=b3gts_l.20160607.1.WA4km.AQP.ncf

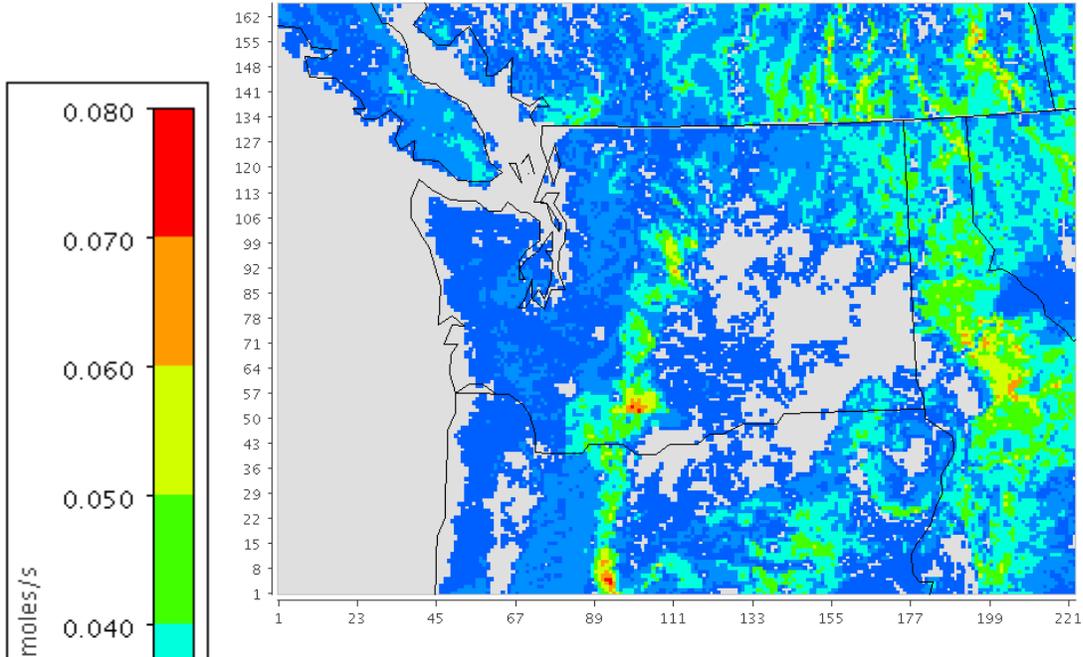


June 7, 2016 22:00:00 UTC

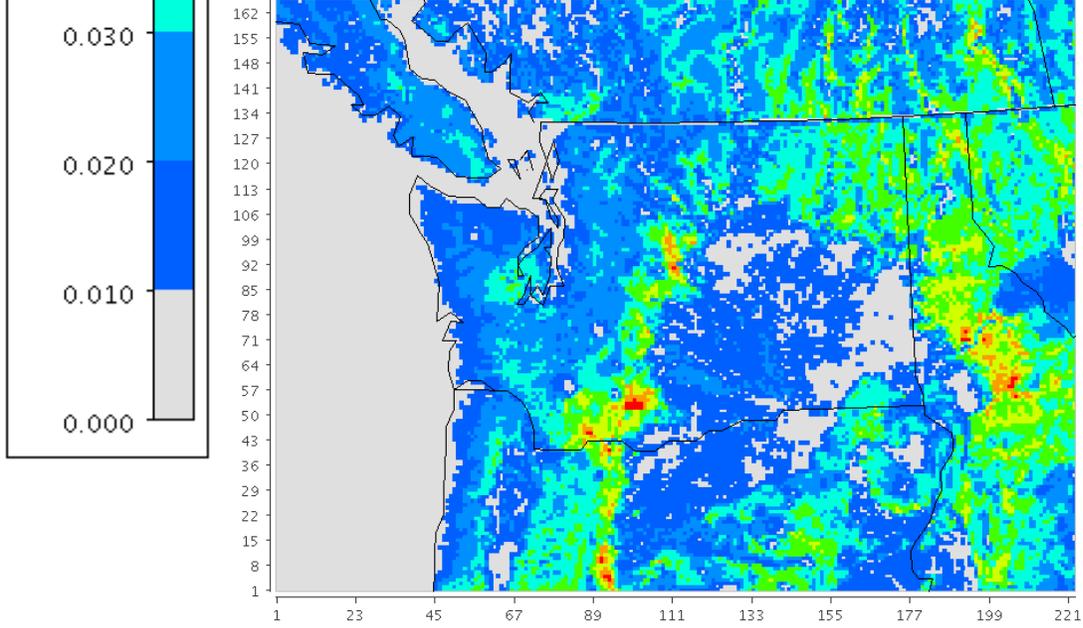
Min (1, 1) = 0.000E0, Max (61, 36) = 1.987E-1

Modified Douglas Fir (used Conifer)
Modified Misc Crops (used Shrubland)

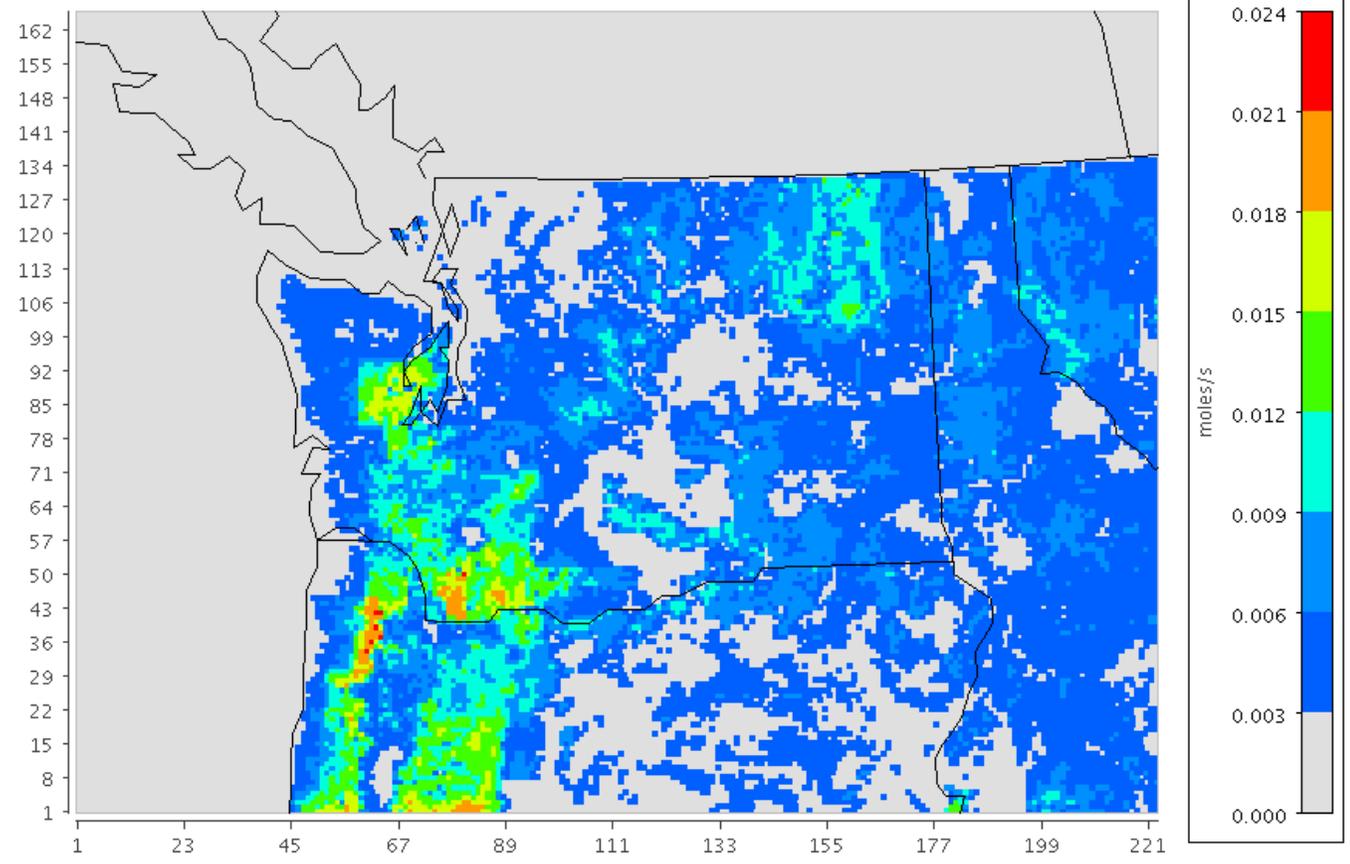
Terpenes – BEIS Default



Terpenes – BEIS Modified



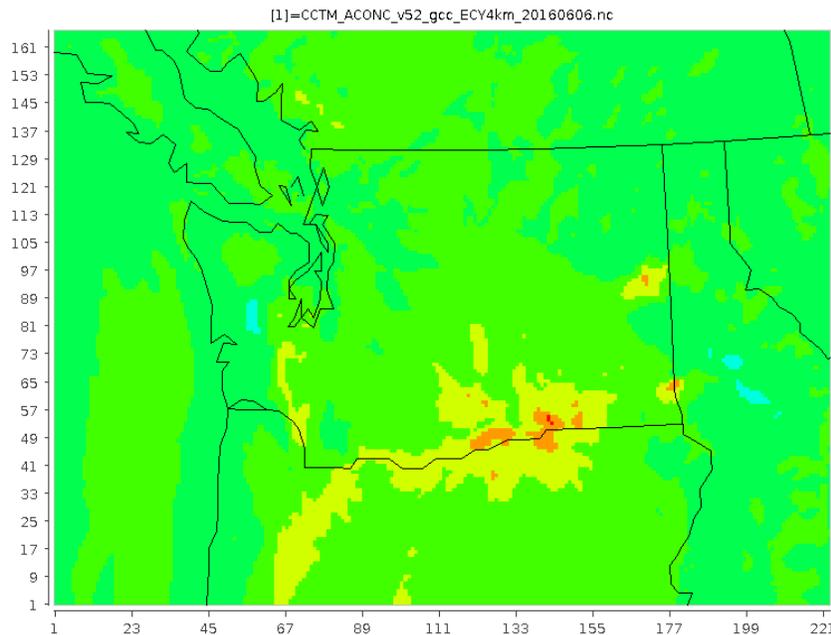
Terpene Difference



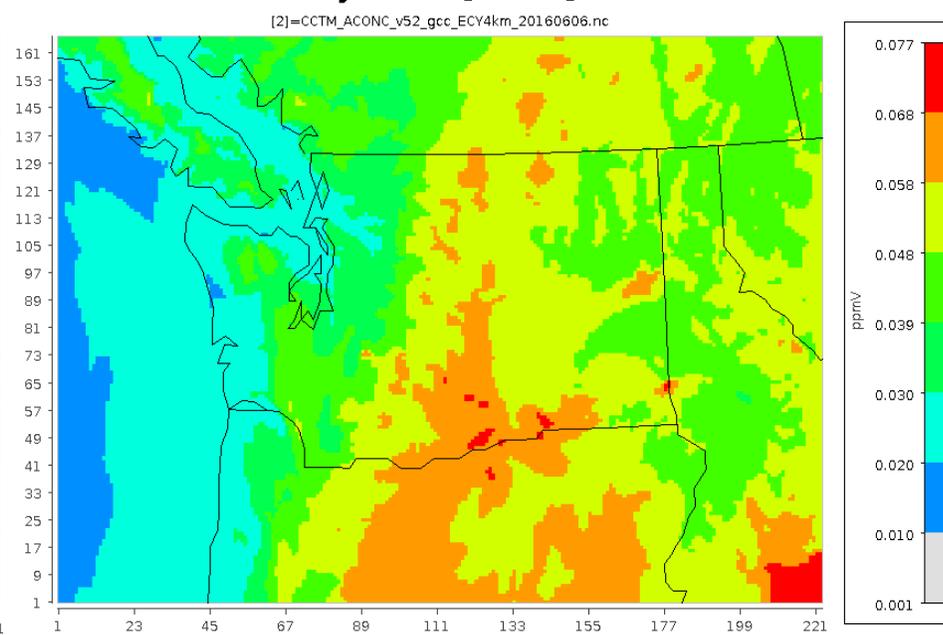
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Min (1, 1) = 0.000, Max (61, 36) = 0.024

Modified Douglas Fir (used Conifer)
Modified Misc Crops (used Shrubland)

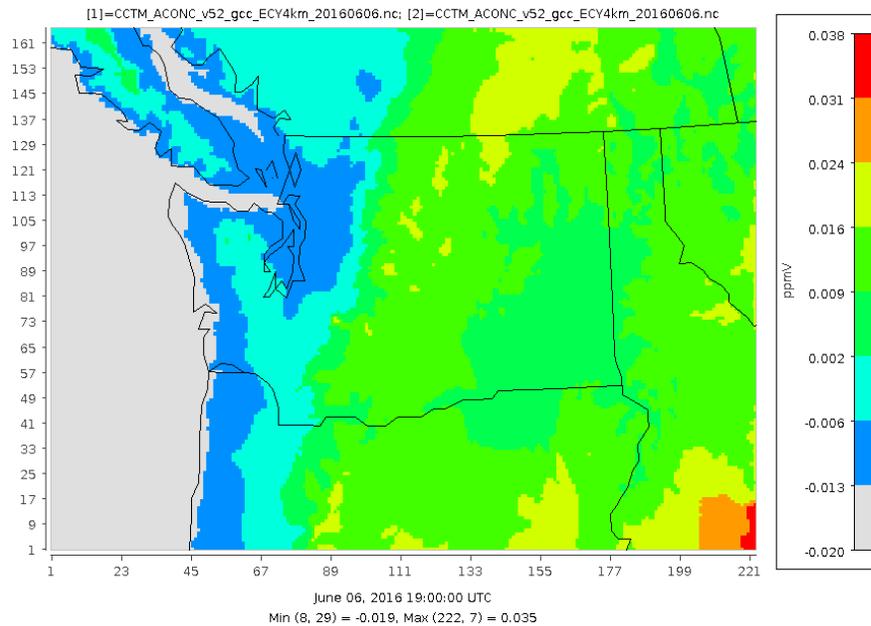
Layer 1 O3[Base]



Layer 1 O3[hiVOC]



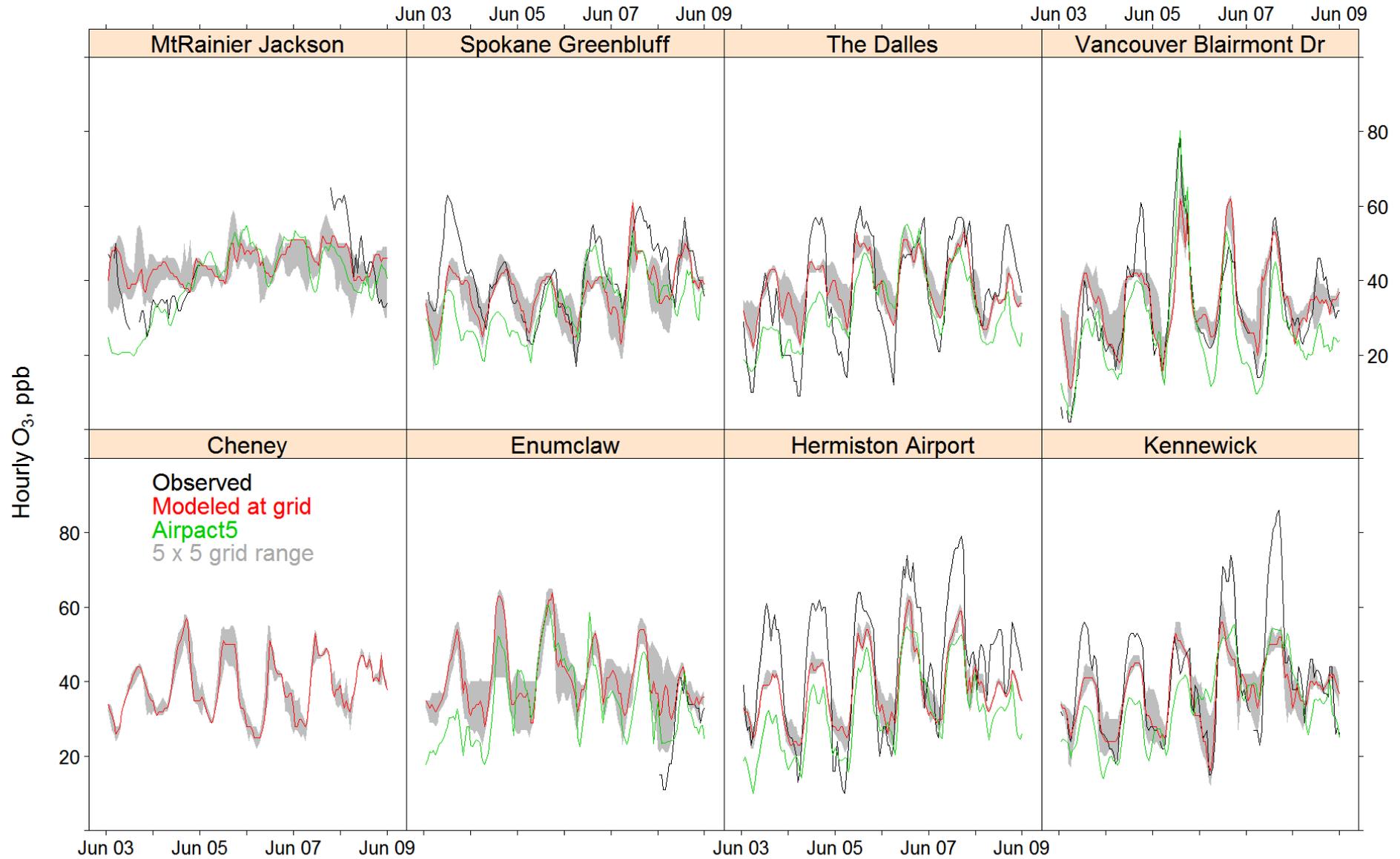
Layer 1 O3[hiVOC] - O3[Base]



Tri-Cities area on 06 JUN @1100 PST
=> 2 - 9ppb O3 increase

➤ Some O3 production improvement (Columbia Basin 2-9ppb more O3)

Jun 2016 episode simulation basecase

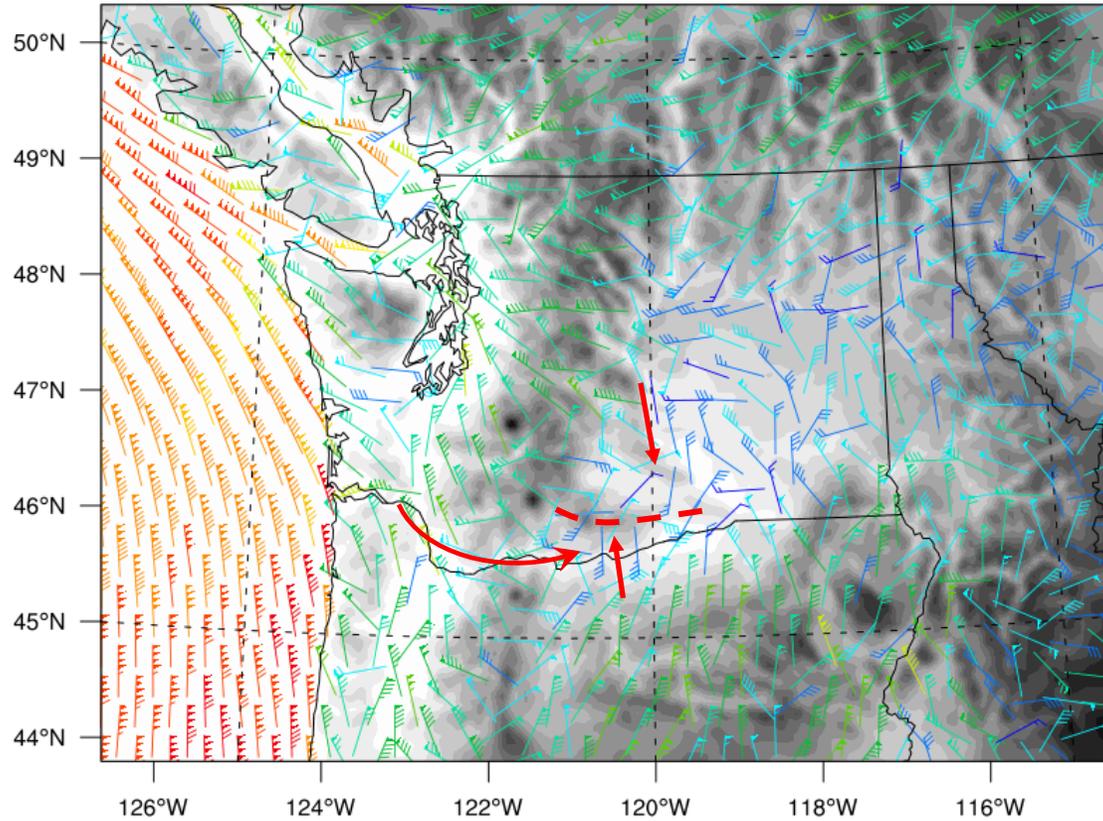


06 JUN @1200 PST

HINDCAST WRFv371

Init: 2016-06-02_12:00:00
Valid: 2016-06-06_20:00:00

Terrain Height (m)
Wind at 10m Hgt [barb=1kts; flag=5]

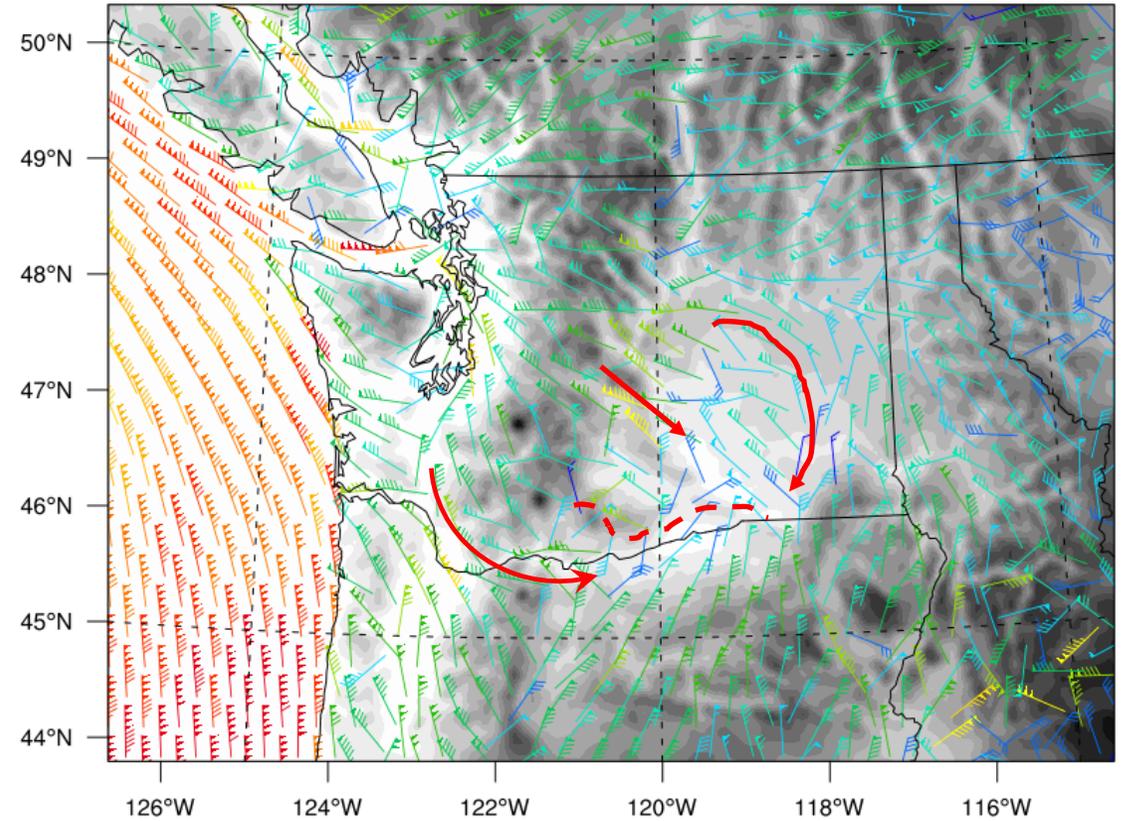


06 JUN @1600 PST

HINDCAST WRFv371

Init: 2016-06-02_12:00:00
Valid: 2016-06-07_00:00:00

Terrain Height (m)
Wind at 10m Hgt [barb=1kts; flag=5]

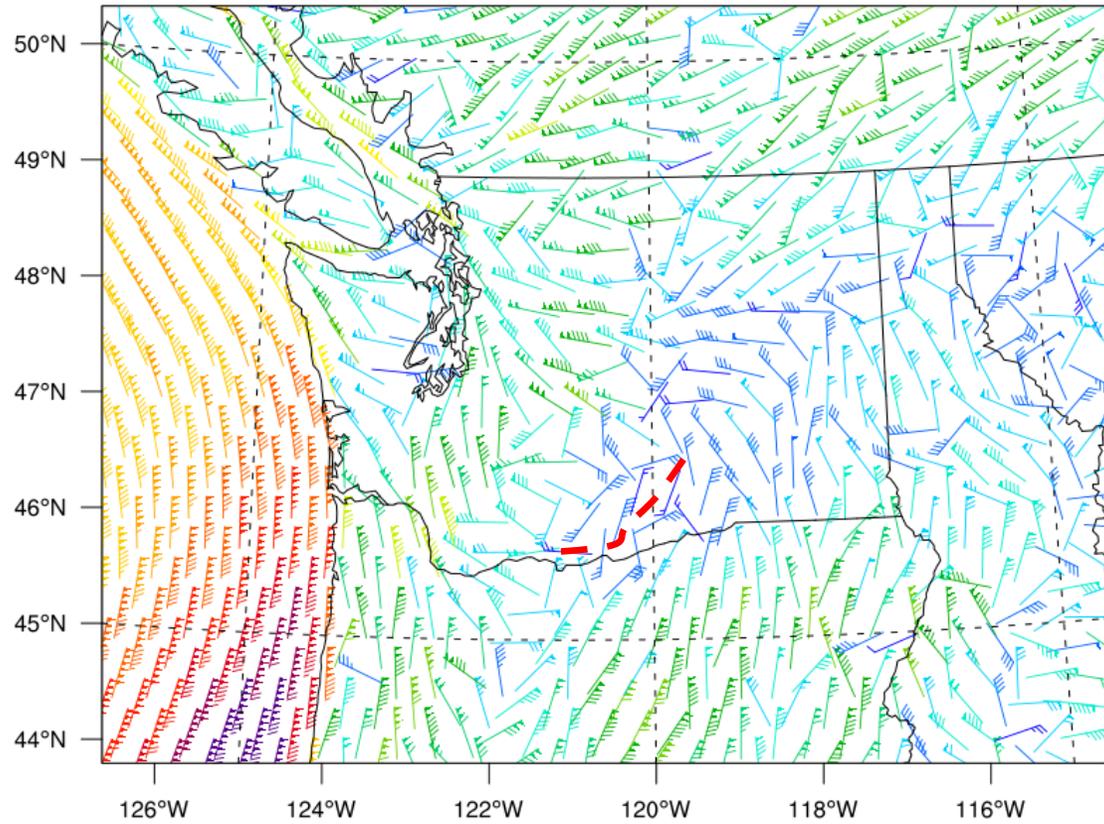


06 JUN @1200 PST

HINDCAST WRFv371

Init: 2016-06-02_12:00:00
Valid: 2016-06-06_20:00:00

Wind at 350m Hgt [barb=1kts; flag=5]

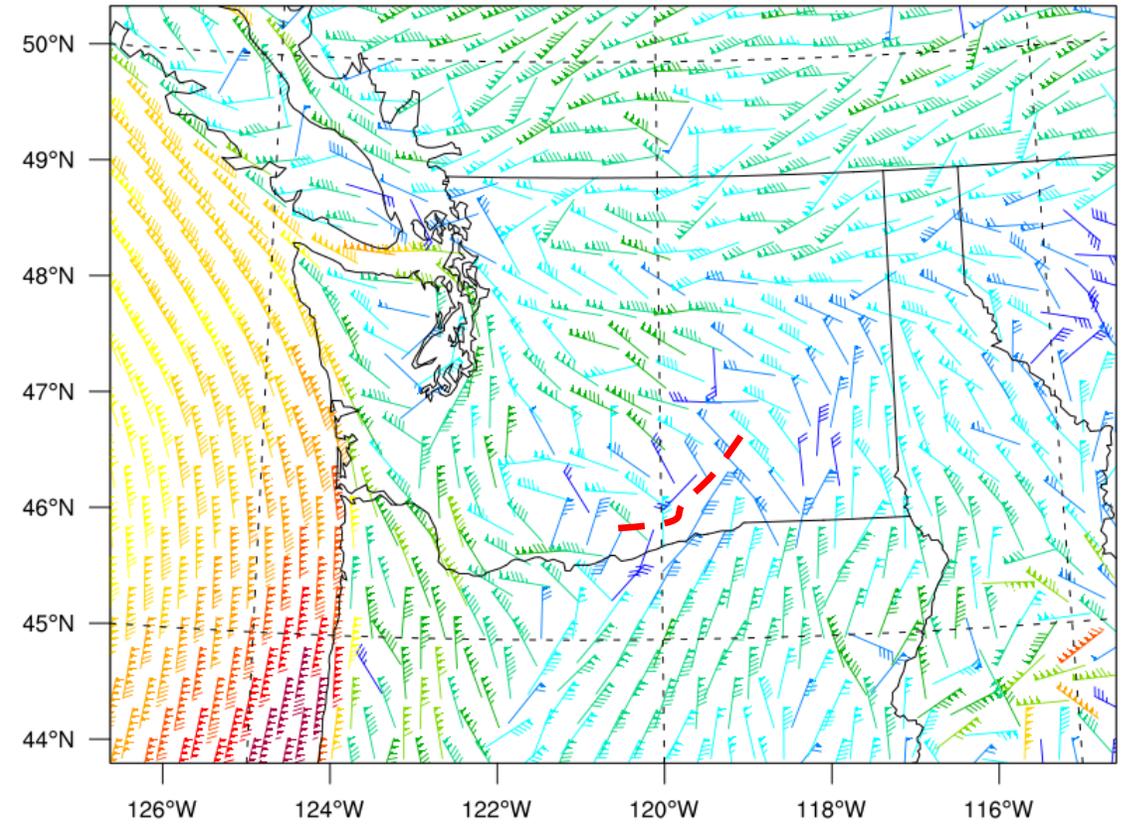


06 JUN @1600 PST

HINDCAST WRFv371

Init: 2016-06-02_12:00:00
Valid: 2016-06-07_00:00:00

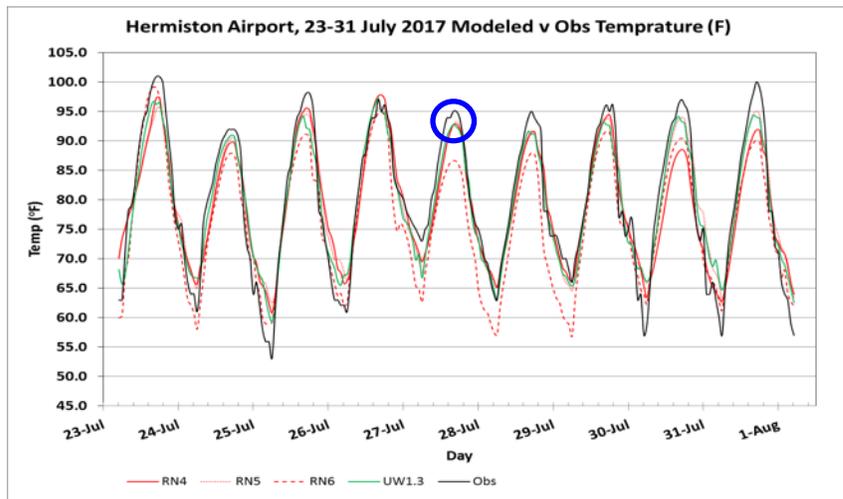
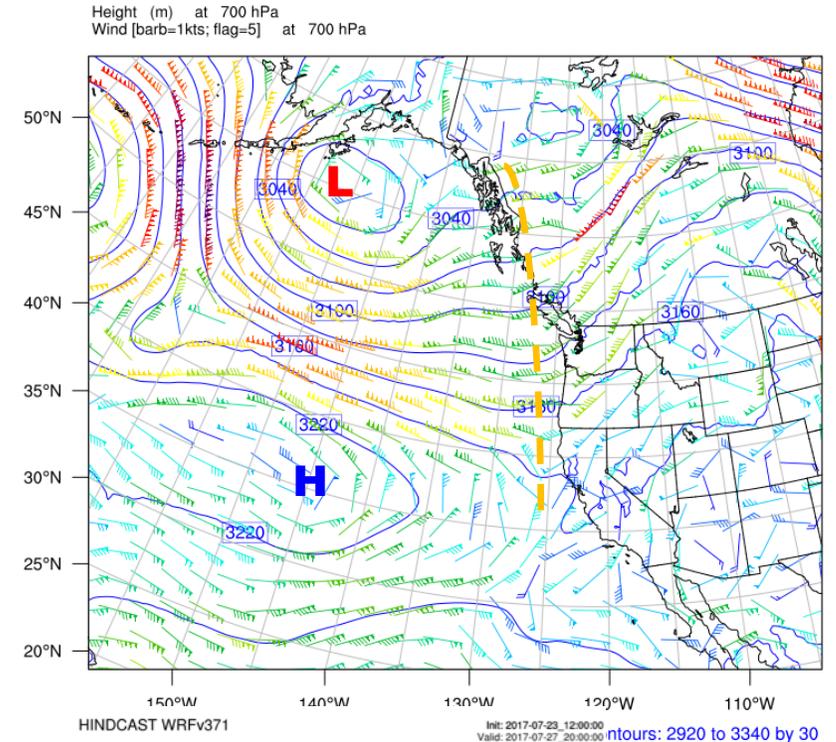
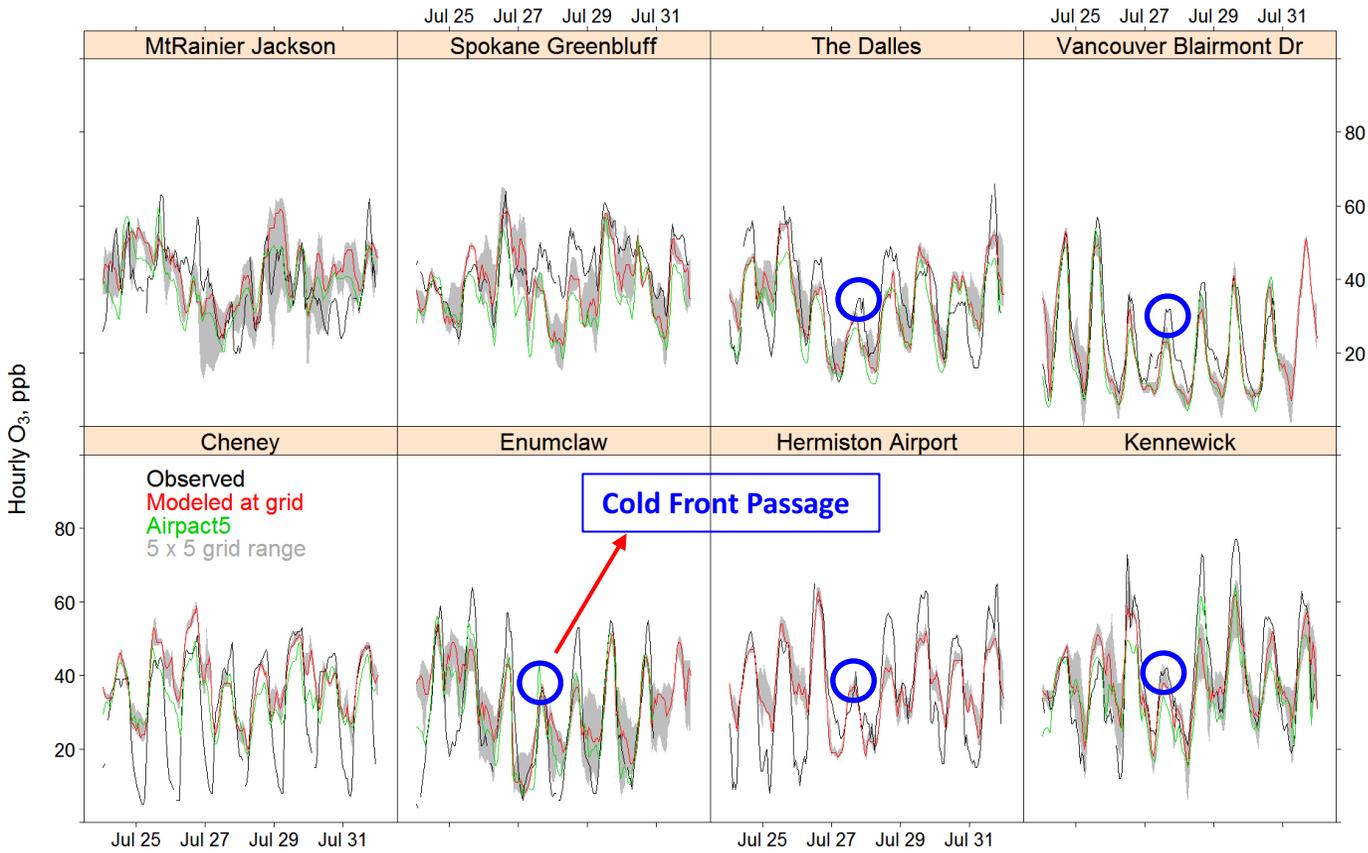
Wind at 350m Hgt [barb=1kts; flag=5]



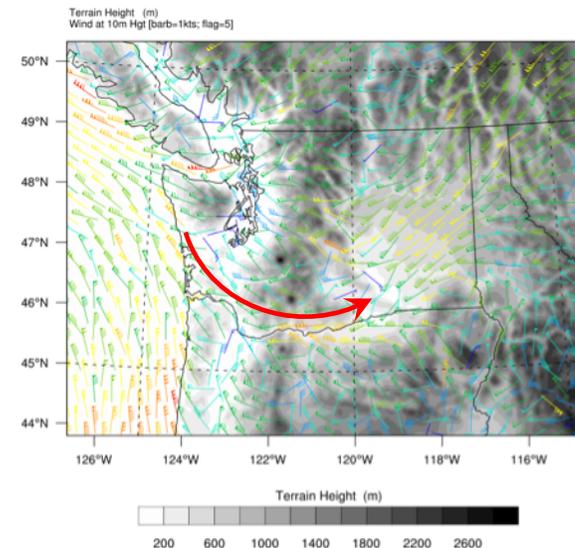
Jul 2017 episode simulation basecase

HINDCAST WRFv371

Init: 2017-07-23_12:00:00
Valid: 2017-07-27_12:00:00



➤ Despite Temp dropped only slightly on Jul 27th, cold front passage provided transport (i.e., ventilation)

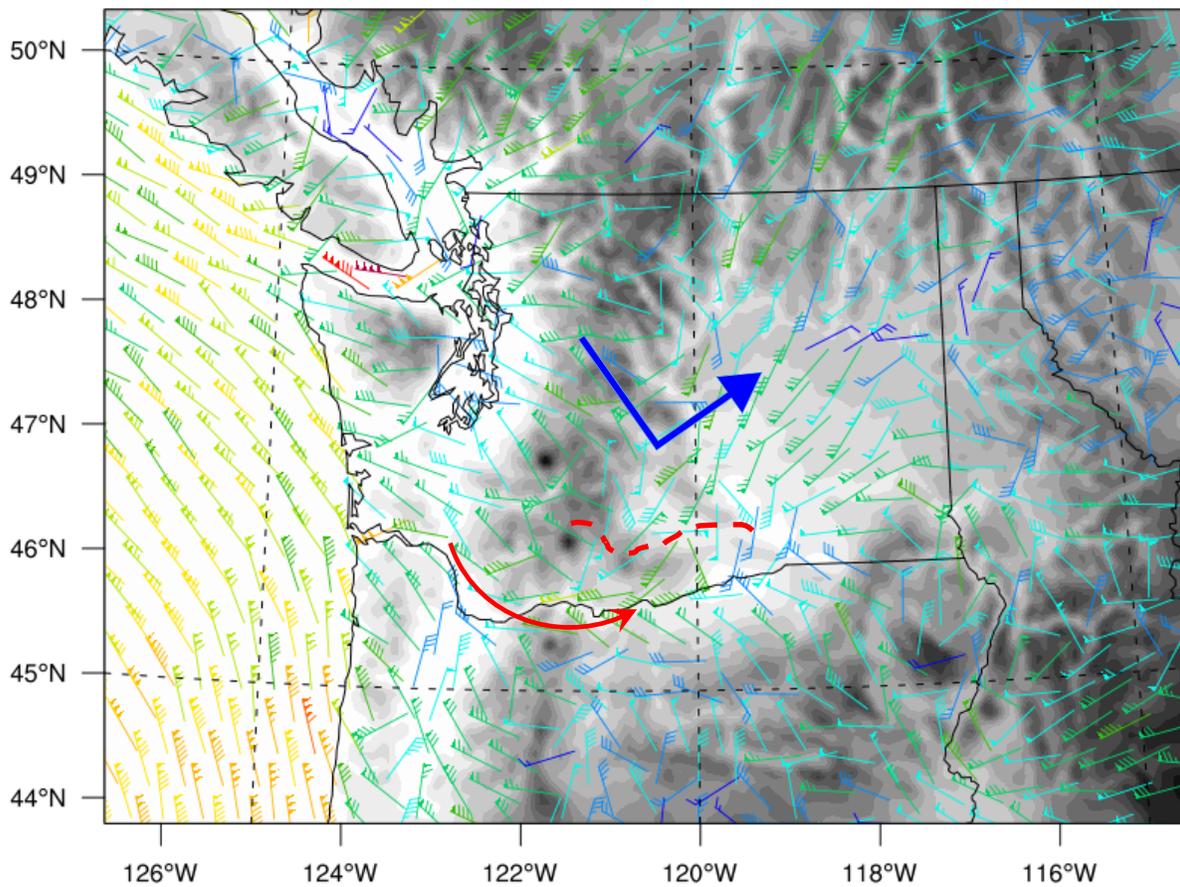


26 JUL @1200 PST

HINDCAST WRFv371

Init: 2017-07-23_12:00:00
Valid: 2017-07-26_20:00:00

Terrain Height (m)
Wind at 10m Hgt [barb=1kts; flag=5]



Terrain Height (m)



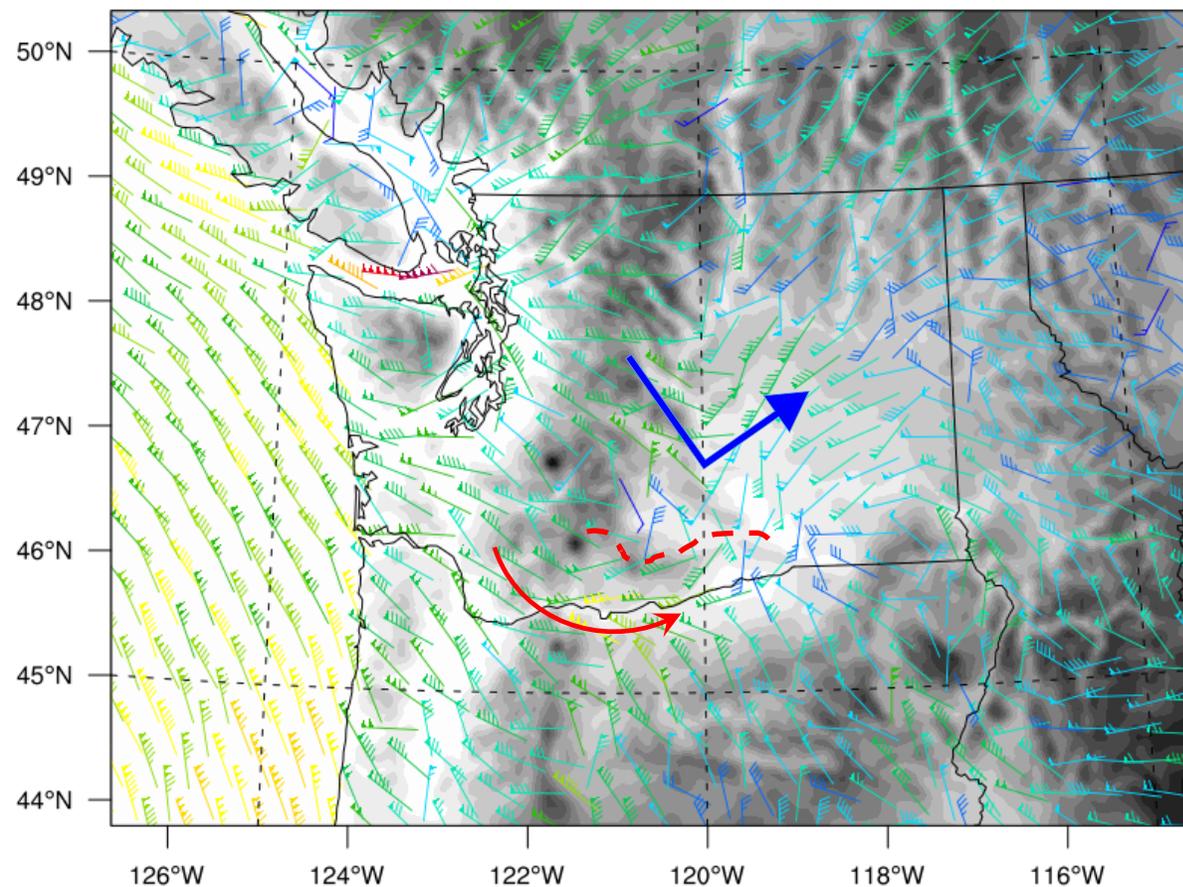
200 600 1000 1400 1800 2200 2600

26 JUL @1600PST

HINDCAST WRFv371

Init: 2017-07-23_12:00:00
Valid: 2017-07-27_00:00:00

Terrain Height (m)
Wind at 10m Hgt [barb=1kts; flag=5]



Terrain Height (m)



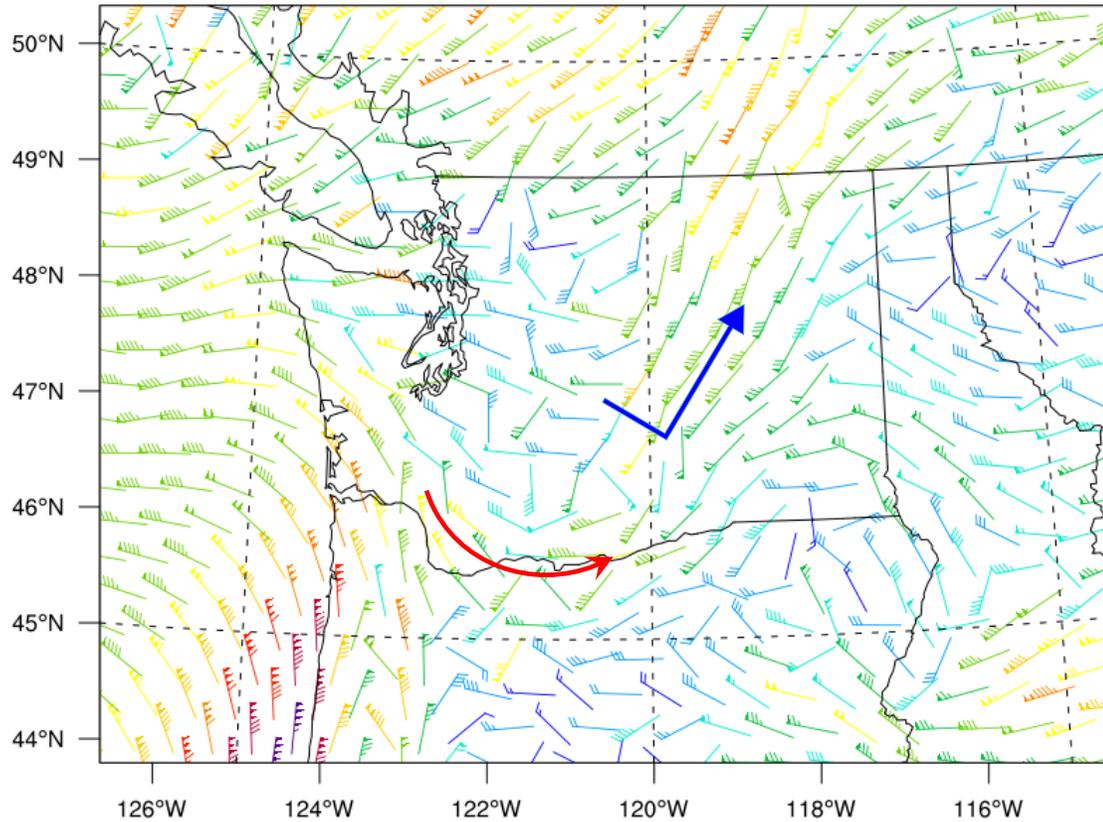
200 600 1000 1400 1800 2200 2600

26 JUL @1200 PST

HINDCAST WRFv371

Init: 2017-07-23_12:00:00
Valid: 2017-07-26_20:00:00

Wind at Hgt=350m [barb=1kts; flag=5]

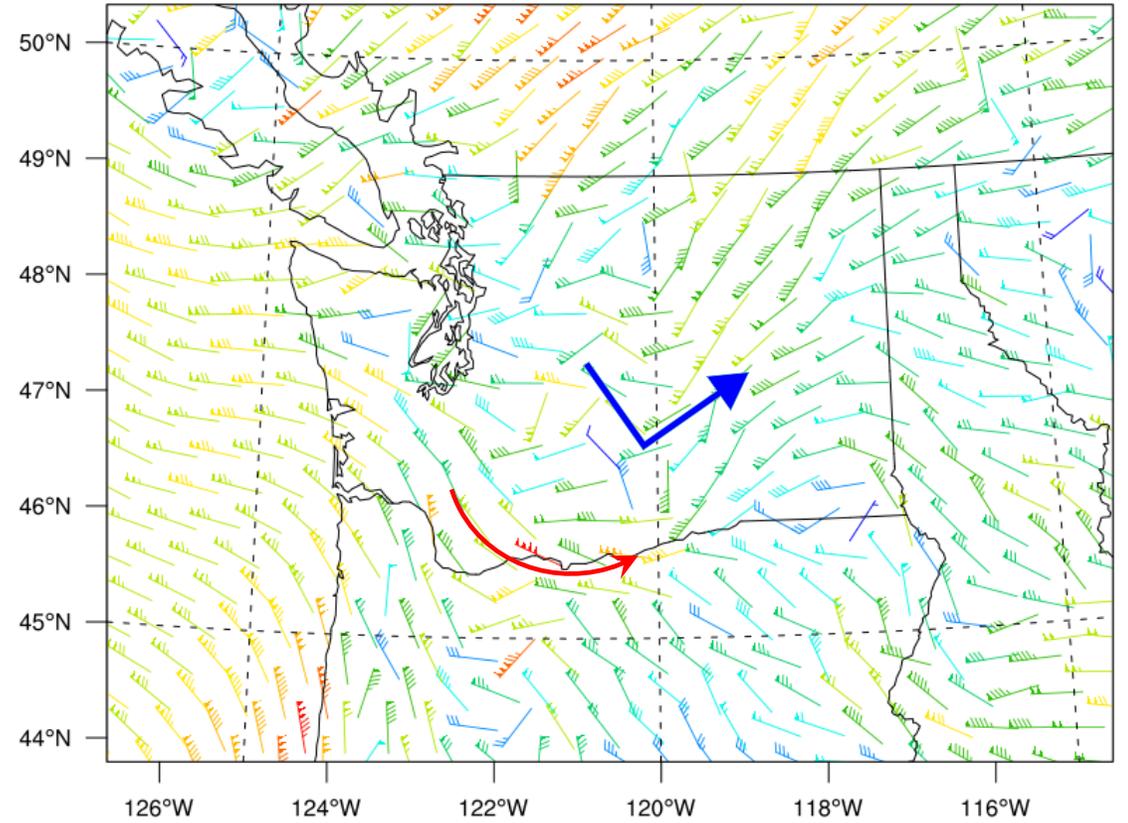


26 JUL @1600PST

HINDCAST WRFv371

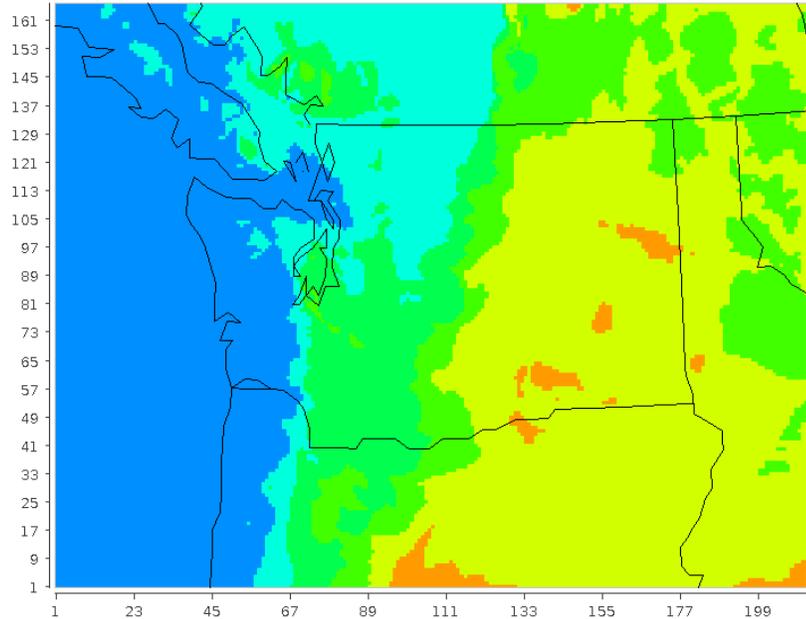
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Wind at Hgt=350m [barb=1kts; flag=5]



Layer 1 O3[Base]

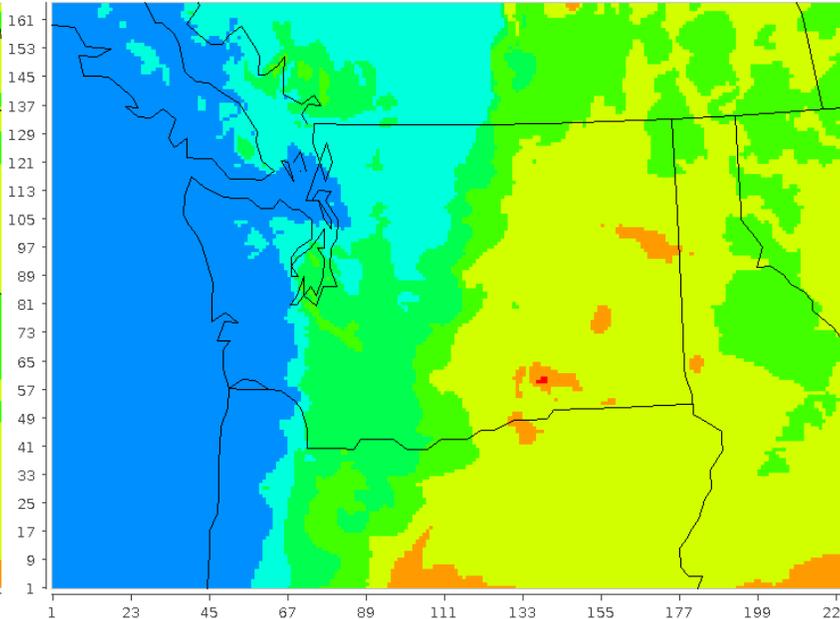
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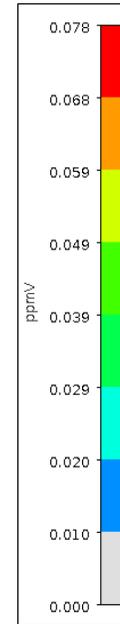
July 26, 2017 20:00:00 UTC
Min (52, 65) = 0.012, Max (138, 59) = 0.068

Layer 1 O3[hiVOC]

[6]=CCTM_ACONC_v52_gcc_ECY4km_20170726.nc

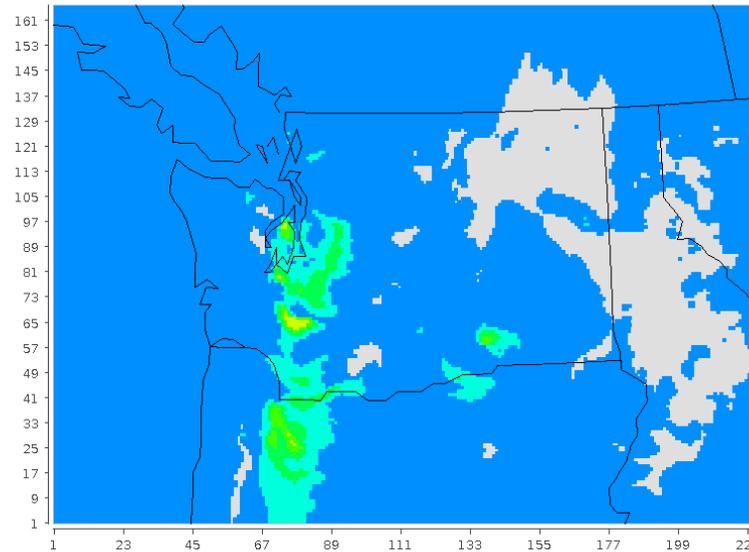


July 26, 2017 20:00:00 UTC
Min (52, 65) = 0.012, Max (138, 59) = 0.069

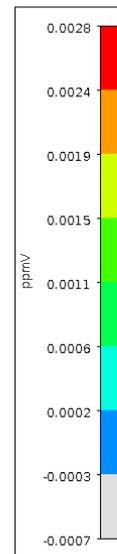


Layer 1 O3[hiVOC] - O3[Base]

[2]=CCTM_ACONC_v52_gcc_ECY4km_20170726.nc; [6]=CCTM_ACONC_v52_gcc_ECY4km_20170726.nc



July 26, 2017 20:00:00 UTC
Min (136, 112) = -0.0005, Max (77, 64) = 0.0019



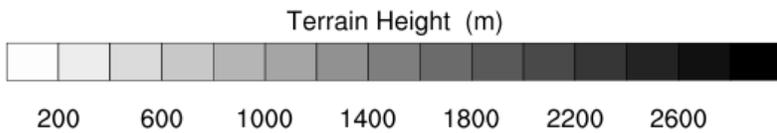
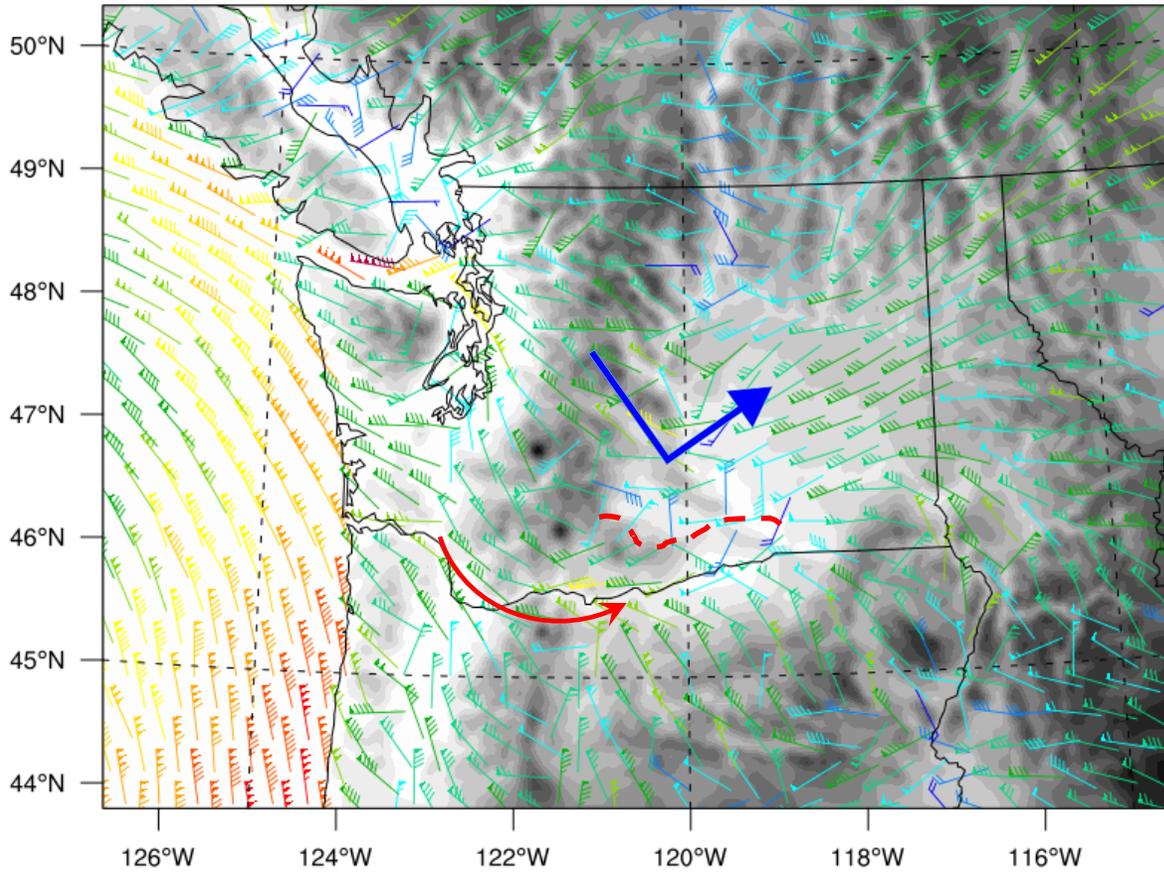
Tri-Cities area on 26 JUL @1200 PST
=> 0.2 – 0.6ppb O3 increase

28 JUL @1600 PST

HINDCAST WRFv371

Init: 2017-07-23_12:00:00
Valid: 2017-07-29_00:00:00

Terrain Height (m)
Wind at 10m Hgt [barb=1kts; flag=5]

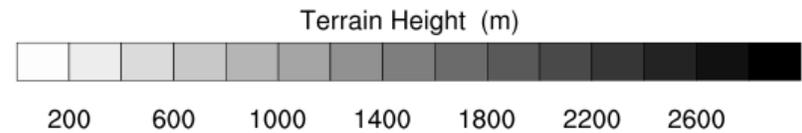
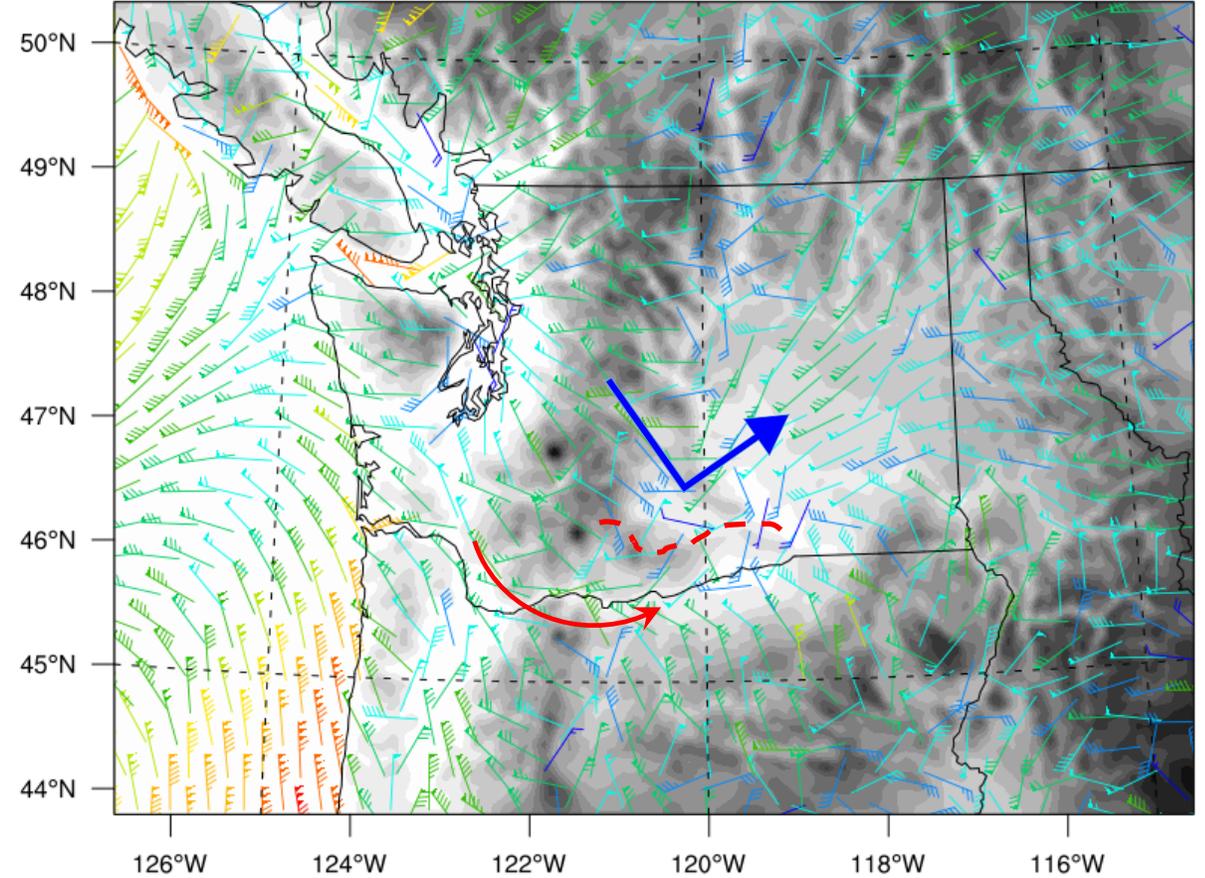


29 JUL @1200 PST

HINDCAST WRFv371

Init: 2017-07-23_12:00:00
Valid: 2017-07-29_20:00:00

Terrain Height (m)
Wind at 10m Hgt [barb=1kts; flag=5]

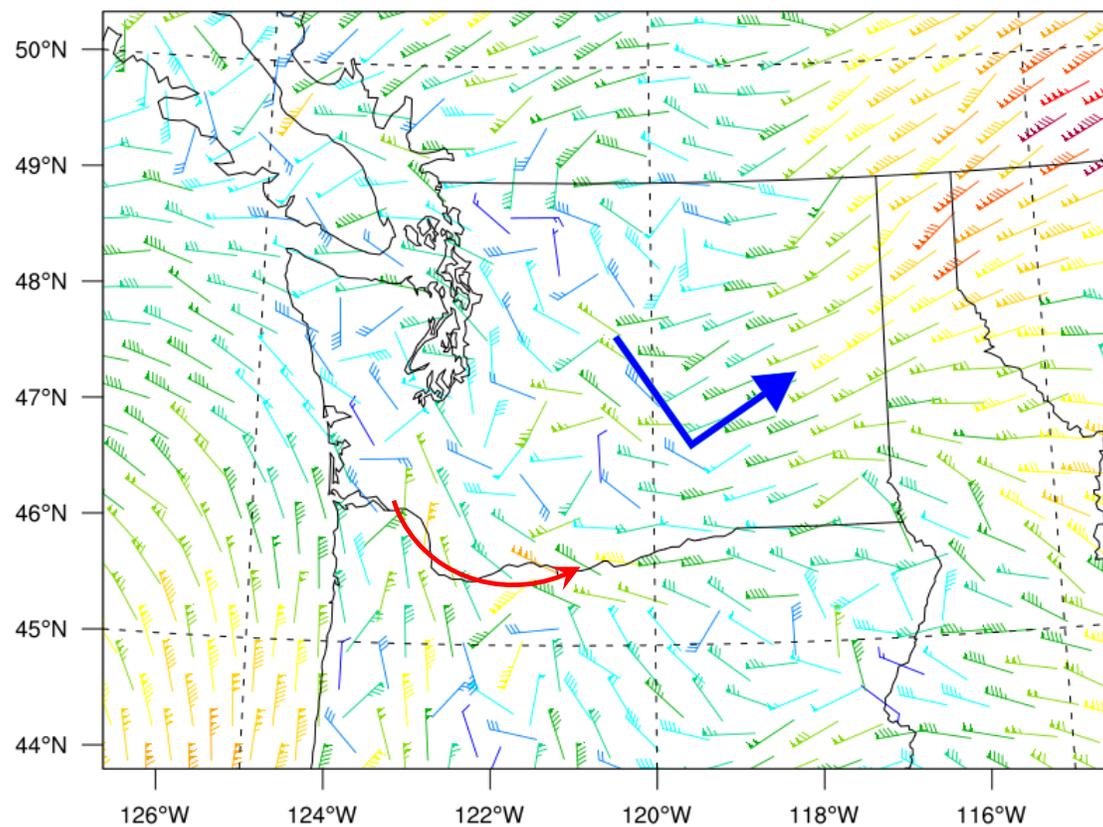


28 JUL @1600 PST

HINDCAST WRFv371

Init: 2017-07-23_12:00:00
Valid: 2017-07-29_00:00:00

Wind at Hgt=350m [barb=1kts; flag=5]

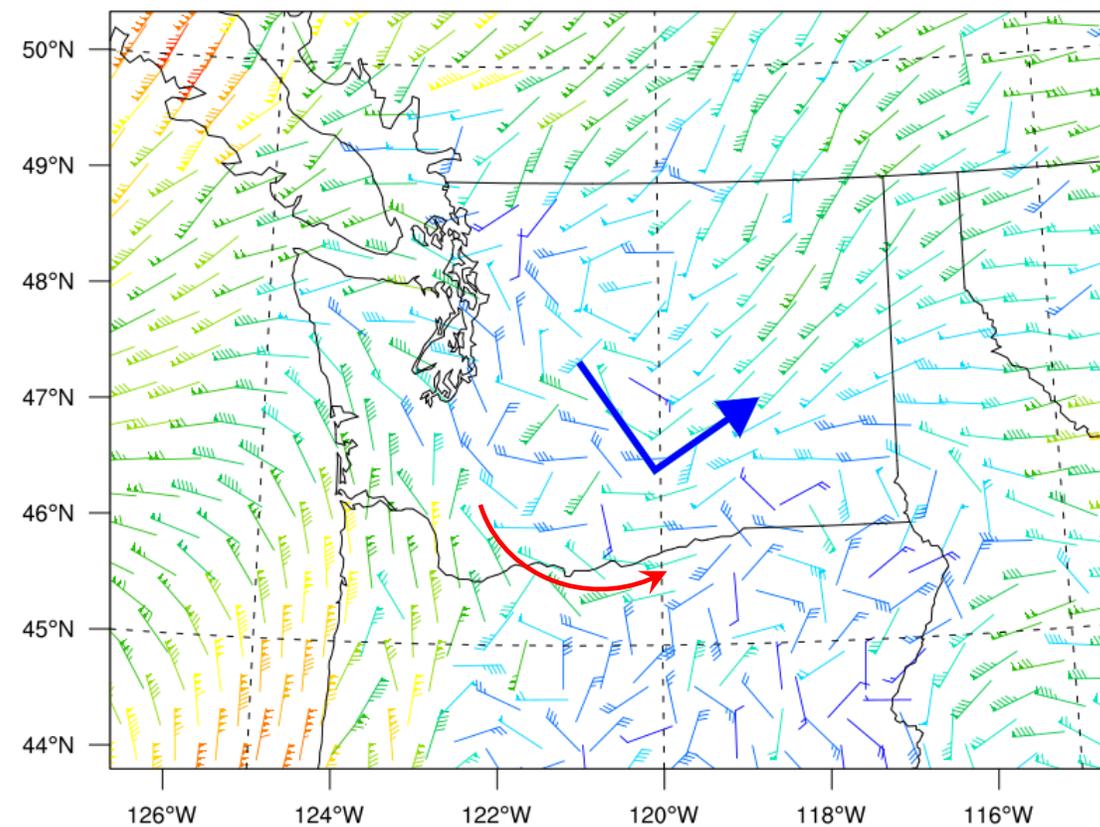


29 JUL @1200 PST

HINDCAST WRFv371

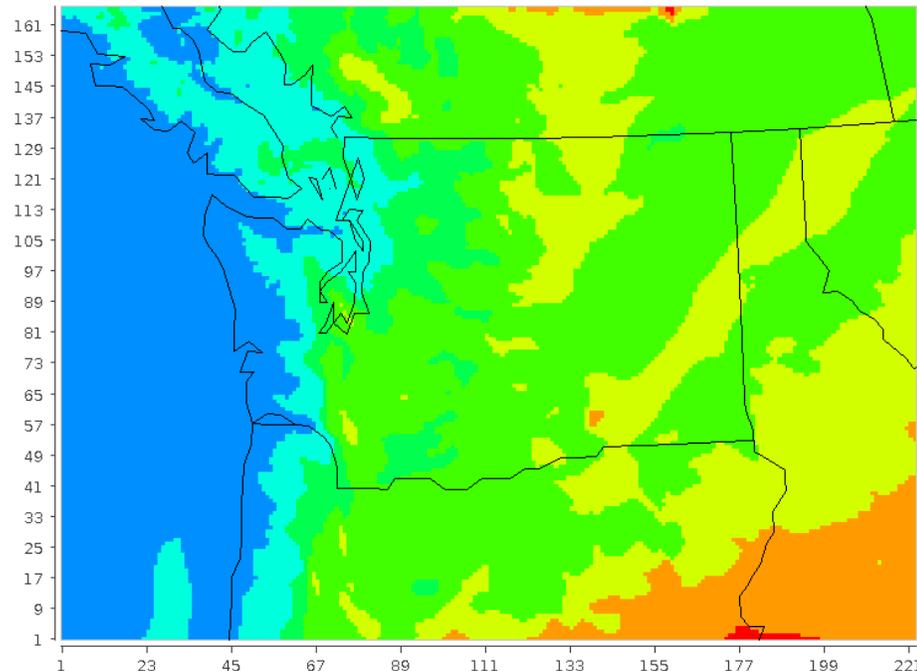
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Valid: 2017-07-29_20:00:00

Wind at Hgt=350m [barb=1kts; flag=5]



Layer 1 O3[Base]

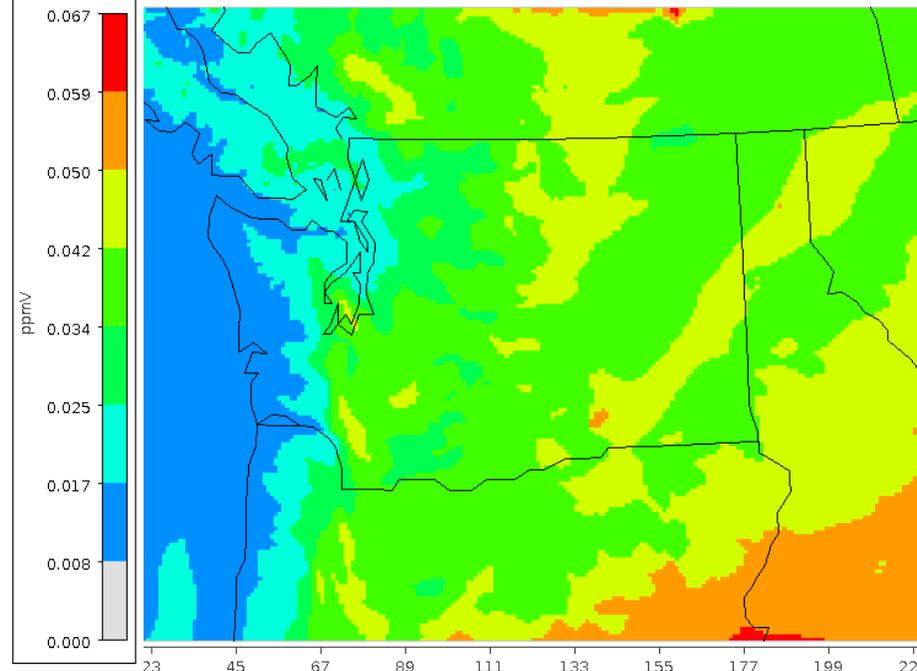
[3]=CCTM_ACONC_v52_gcc_ECY4km_20170728.nc



July 28, 2017 22:00:00 UTC
Min (45, 88) = 0.013, Max (179, 1) = 0.062

Layer 1 O3[hiVOC]

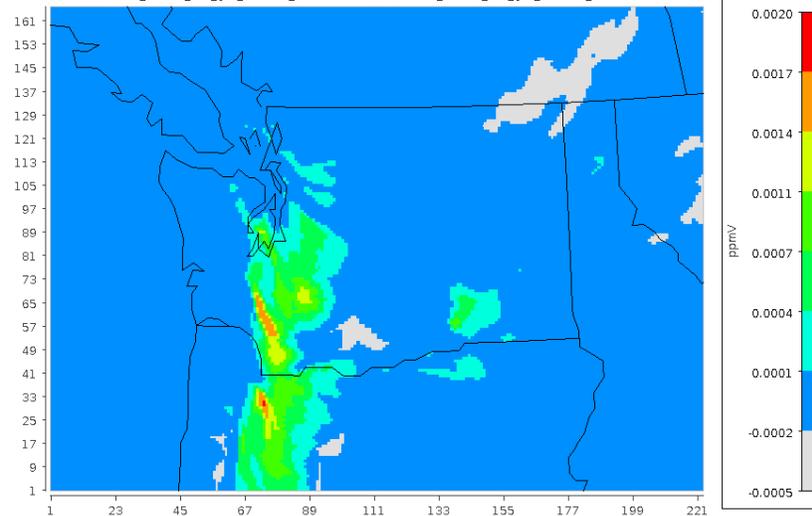
[7]=CCTM_ACONC_v52_gcc_ECY4km_20170728.nc



July 28, 2017 22:00:00 UTC
Min (45, 88) = 0.013, Max (179, 1) = 0.062

Layer 1 O3[hiVOC] - O3[Base]

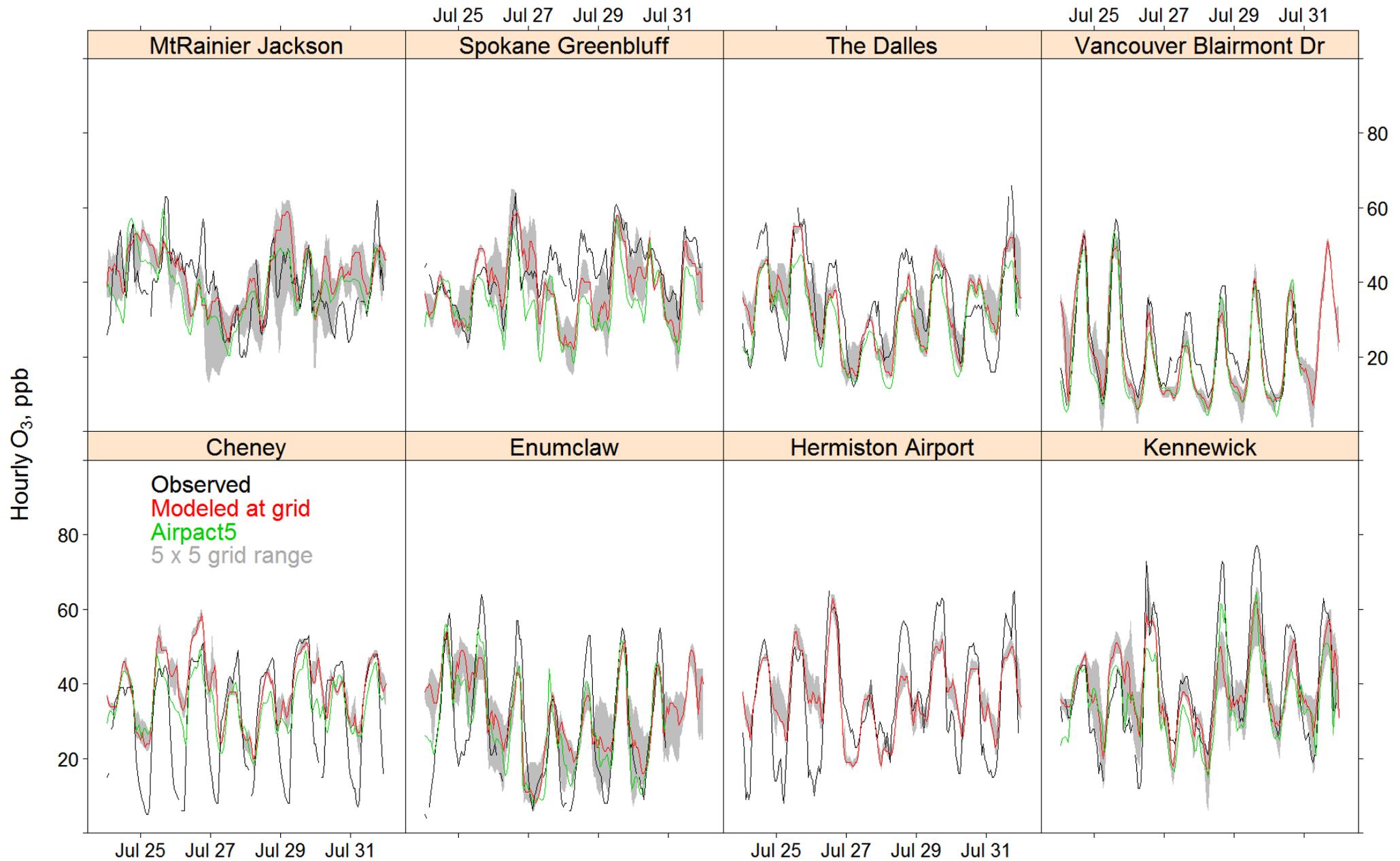
[3]=CCTM_ACONC_v52_gcc_ECY4km_20170728.nc; [7]=CCTM_ACONC_v52_gcc_ECY4km_20170728.nc



July 28, 2017 22:00:00 UTC
Min (162, 135) = -0.0004, Max (73, 30) = 0.0018

Tri-Cities area on 28 JUN @1400 PST
=> 0.1 – 0.4ppb O3 increase

Jul 2017 episode simulation basecase



Summary

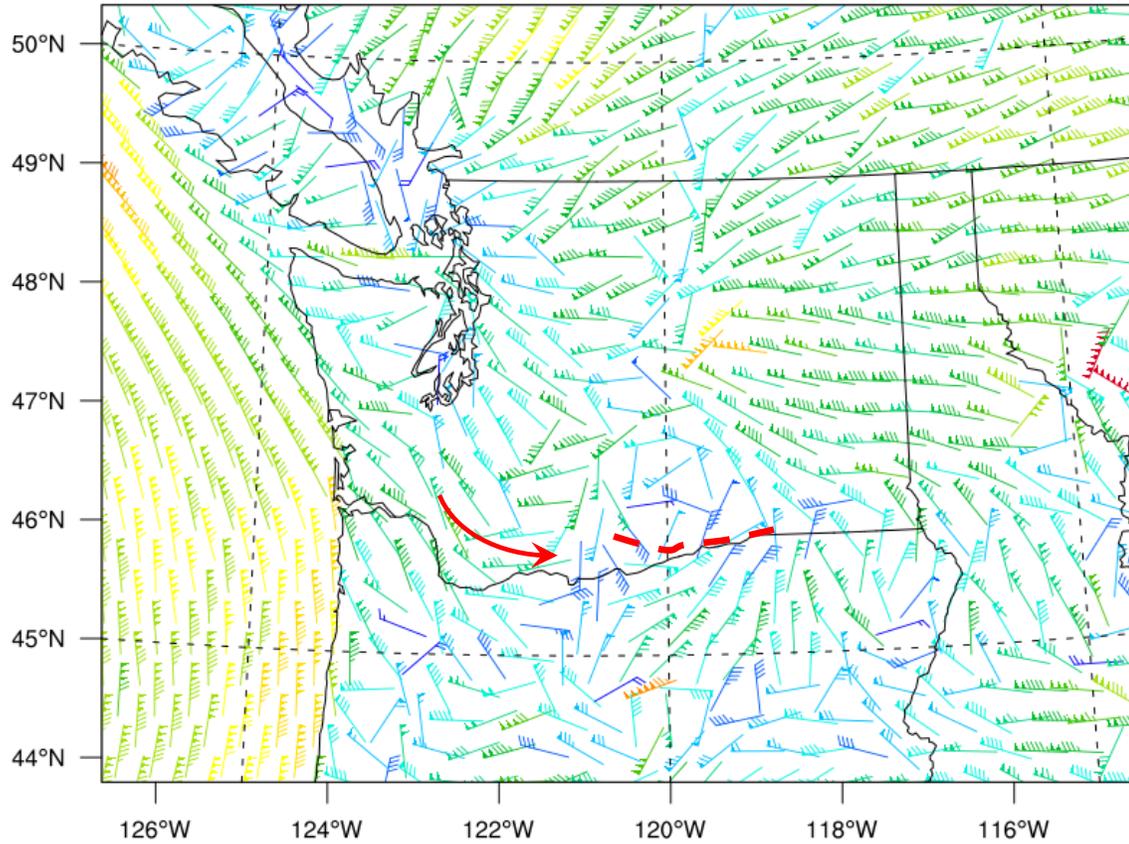
- Generally, the CMAQ modeling system captured the qualitative patterns of the photochemistry over the Tri-Cities area. However, it underestimated O₃ maxima especially during peak O₃ days.
- Increase in biogenic emissions increased O₃ (by 2-9ppb) when winds from forest area flow towards the Columbia Basin.
- ECY-CMAQ performed better than AIRPACT5 in certain instances, probably due to better reanalyzed “first-guess” input data to WRF as a hind-cast modeling.
- While more episodic tests are necessary, high O₃ formation over the Tri-Cities area seems to peak when westerly winds from the Vancouver area and northwesterly flow from Wenatchee converge over the Heaven House Hills tops as well as the Columbia Basin.
- Future work includes possible bias reduction tests and examination of other O₃ episodes over the Columbia Air Basin.

07 JUN @1400 PST

HINDCAST WRFv371

Init: 2016-06-02_12:00:00
Valid: 2016-06-07_22:00:00

Wind at 350m Hgt [barb=1kts; flag=5]

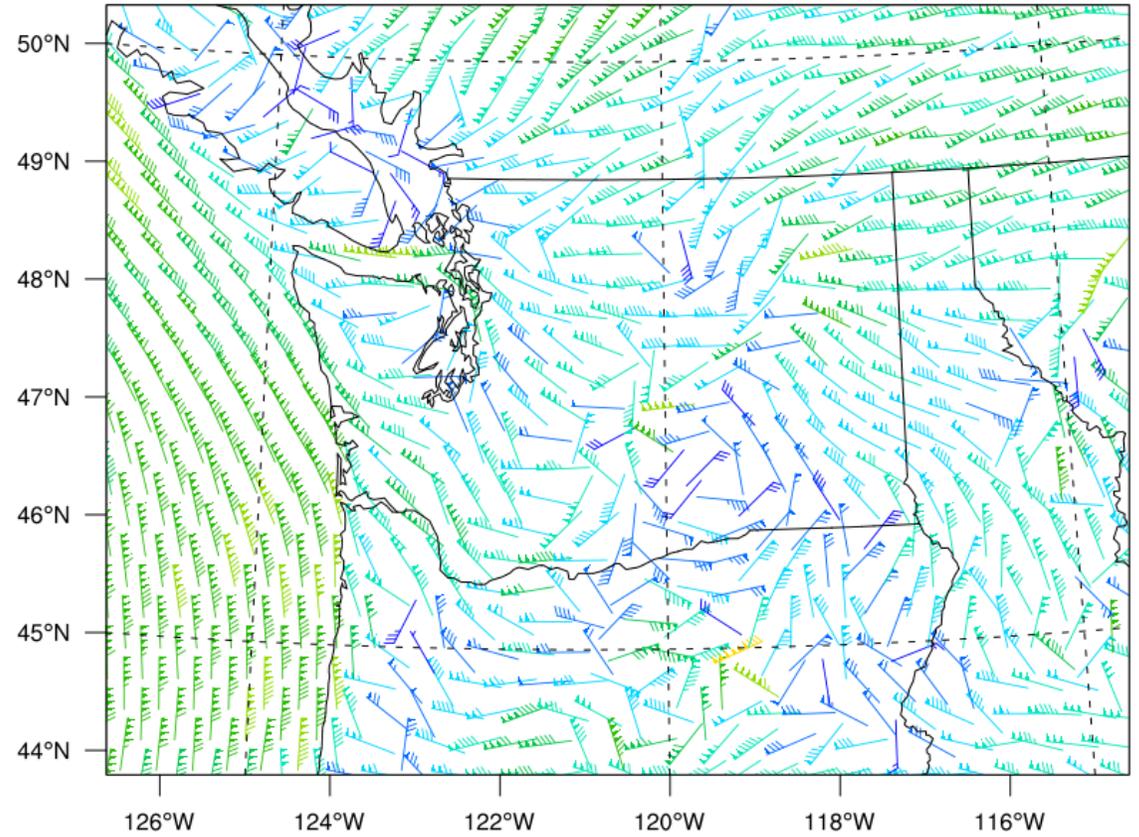


07 JUN @1600 PST

HINDCAST WRFv371

Init: 2016-06-02_12:00:00
Valid: 2016-06-08_00:00:00

Wind at 350m Hgt [barb=1kts; flag=5]



Jul 2017 episode simulation hiVOC

