Analysis of a 2012 Ozone Episode in Spokane –Coeur d’Alene Using AIRPACT-5 and HYSPLIT

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Methods
To identify ozone episodes of regulatory significance which were not largely influenced by regional wildland fires, all episodes from 2007-2015 were compared with historical fire occurrences (2). One episode from July 1st - 14th, 2012, with peak ozone occurring on the 9th through the 13th, was chosen due to a lack of wildland fires in the area. Modeling results were extracted for the Spokane area from a rerun of AIRPACT-5, the air quality forecasting model for the region. AIRPACT-5 uses meteorological fields from the Weather and Research Forecasting (WRF) model, with chemical boundary conditions from MOZART, a global chemistry model, and dynamic emissions processed using SMOKE to drive the CMAQ photochemical air quality model to simulate trace gas and aerosol concentrations. Figure 3 shows a schematic of how the system works.

Transport Path
• HYSPLIT back trajectories demonstrate meandering paths characteristic of stagnant conditions on July 9th - 13th.
• Ozone along the trajectories (not shown) seems to fluctuate, as does the rate of change in ozone.

VOC/NOx Limited Conditions
• At Augusta and Greenbluff, indicator ratios suggest ozone formation is VOC limited.
• At Cheney, ratios suggest a transitional regime where it may be dominated by either depending on time and emissions.

Conclusions
The high ozone associated with southwesterly flows at Greenbluff suggests a connection to downwind emissions from the Spokane urban center. The lack of a dominant direction for Augusta and Cheney along with the meandering back trajectories with no particular ozone concentration or production pattern and lingering concentrations of ozone after the daily peak suggest stagnant summertime meteorological conditions allowed precursors in ozone production to remain in the area and build up over several days. The VOC limited regime of ozone production suggests that urban emissions of nitrogen oxides during the stagnant condition were prevalent and extended beyond the urban area to Greenbluff and even Cheney. However, further work using emissions reduced runs of AIRPACT is needed to confirm the VOC/NOx limited regimes. AIRPACT-5 ozone concentrations were over-predicted with a 3% fractional bias and a 7% fractional error on average over all 3 sites. NOx at Augusta Ave was also over-predicted by 8% with a fractional error of 18%.

Introduction
Due to a recent reduction in the National Ambient Air Quality Standard for daily maximum 8-hour ozone, the Spokane Regional Clean Air Agency (SCAA) requested assistance with an analysis of ozone production and transport in the Spokane –Coeur d’Alene corridor (Figures 1 and 2). This investigation was intended to seek underlying factors for ozone production and transport in the area in order to explain elevated levels of ozone observed at three monitoring sites over the last few years which have reached regulatory significance under the new standard. Specific questions to address include: 1) what are the daily ozone and precursor concentration patterns at Spokane area monitoring sites? 2) what are the transport paths for ozone production during typical episodes? 3) Is the area generally VOC or NOx limited? Observed O3 and NOx concentrations along with output from the AIRPACT-5 air quality modeling system (1) were used to address these questions.

Daily Ozone Patterns
• Peak ozone occurred on July 12th or 13th depending on the site.
• Figure 4 shows that the model under-predicted some peak days, namely 7/11.
• O3 observed concentrations remain elevated into the nighttime.
• Concentration roses in Figure 5 show that elevated ozone occurred at the urban Augusta and rural Cheney sites for both NE and SW winds.
• Greenbluff sees high ozone with southwesterly flow (Figure 5).

Acknowledgments
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