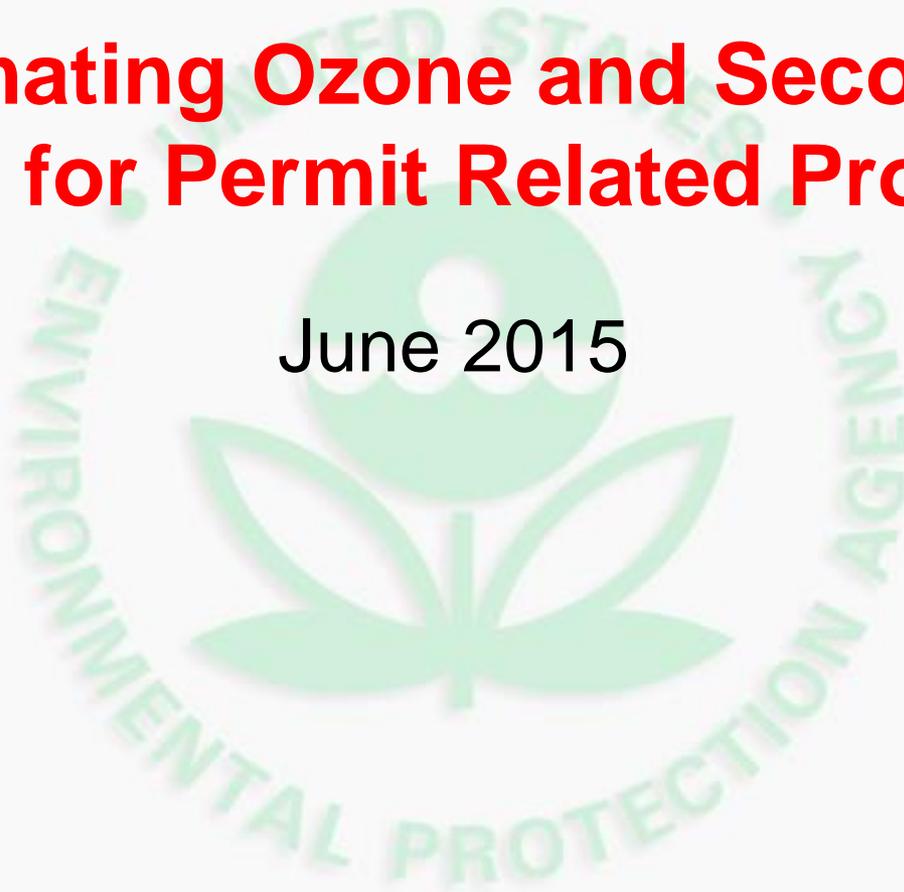


# Estimating Ozone and Secondary PM<sub>2.5</sub> for Permit Related Programs

June 2015





# Updates for Secondary Pollutants

- EPA granted Sierra Club petition (Jan 4, 2012) with commitment to update the Guideline on Air Quality Models (Appendix W) to address O<sub>3</sub> and secondary PM<sub>2.5</sub> impacts
- Appendix W currently provides little information about assessing single source secondary impacts (O<sub>3</sub> and secondary PM<sub>2.5</sub>)
- EPA's proposed revisions includes an entire chapter (5) on secondarily formed pollutants (O<sub>3</sub> and secondary PM<sub>2.5</sub>) and a chapter (6) focused on visibility, deposition (AQRVs)
- Intent for the regulatory revision to Appendix W and associated technical guidance is to develop appropriate detail that will be relevant over the long term
- Provides increasing technical detail and reflections of the current practice of model application in guidance documents which are more dynamic



## Process of updating Appendix W for single source secondary pollutant impacts

- Interagency Workgroup on Air Quality Modeling (IWAQM) has been a process historically used for Federal collaborations to update regulatory air quality modeling approaches
- IWAQM (phase 3) initiated in July 2013 to provide a mechanism for updating Appendix W and related guidance documents in partnership with the EPA Regional Offices and other federal agencies
- Goal is to understand and identify credible modeling techniques for single source secondary impacts for O<sub>3</sub> and secondary PM<sub>2.5</sub>
- IWAQM3 consists of 2 working groups
  - near-field impacts
  - long-range transport (most similar to past IWAQM phases)
- Technical reports and guidance were developed to support the proposed revisions to EPA's *Guideline on Air Quality Models*



# Appendix W

## Chapters 5, 6, & preamble

### PM Modeling Guidance

Guidance on the use of models for assessing the impacts of emissions from single sources on the secondarily formed pollutants ozone and PM<sub>2.5</sub>

IWAQM Phase 3 Summary Report: Near-Field Single Source Secondary Impacts

Increasingly dynamic

Federal Land Managers' Air Quality Related Values Work Group (FLAG) Phase I Report - Revised 2010

IWAQM Phase 3 Summary Report: Long Range Transport and Air Quality Related Values

Other relevant internal and external technical reports, technical presentations, and literature

*\*blue color indicates development and/or revisions as part of current IWAQM3 process, other colors show documents outside of this process*



## Appendix W Chapter 5: Summary

- Totally new chapter in Appendix W
- Clear distinction between nonattainment planning for NAAQS (multi-source) vs. permit (single source) modeling requirements
- Emphasizes the importance to develop modeling protocols and consult with the reviewing authority
- Reflects a screening approach with no preferred model
- Outlines a multi-tiered approach for single source permit assessments
- Emphasis on use of chemical transport models (e.g. photochemical & Lagrangian models) or techniques that reflect state of science atmospheric chemistry for the less-anticipated situations where a refined assessment is necessary



## Guidance on the use of models for assessing the impacts of emissions from single sources on the secondarily formed pollutants ozone and PM<sub>2.5</sub>

- For **first tier assessments**, it is generally expected that applicants would use existing empirical relationships between precursors and secondary impacts based on modeling systems appropriate for this purpose as detailed in this guidance
- It is also possible screening approaches based on full science chemical transport modeling systems (e.g. reduced form models) could provide information to satisfy the first tier in some situations
- The use of pre-existing credible technical information or a screening model for the purposes of estimating single source secondary impacts will be considered on a case-by-case basis and should be done in consultation with the appropriate permitting authority
- Model Emissions Rates for Precursors (MERPs) are one type of Tier 1 demonstration tool



# Broader Considerations for O<sub>3</sub> and secondary PM<sub>2.5</sub> Permit Modeling

- Preamble for the Appendix W proposal refers to Model Emissions Rates for Precursors (MERPs) that would represent a level of emissions of precursors that is not expected to contribute significantly to concentrations of secondarily-formed PM<sub>2.5</sub> or ozone
- A MERP would neither replace the existing Significant Emissions Rates (SERs) for these pollutants nor serve as the basis for the applicability of PSD requirements to sources with emissions above the SER
- Thus, a source emitting above the SER but below the MERP would still need to follow administrative PSD requirements but may not need to do further technical demonstration to show impacts are below the appropriate SIL
- Our present understanding of the atmospheric science of ozone and secondary PM<sub>2.5</sub> formation indicates that MERP values will likely be higher than the SERs and more appropriate for evaluating the impacts of these criteria pollutants as precursors to PM<sub>2.5</sub> and ozone formation
- EPA expects to move forward here by releasing separate technical guidance to discuss Tier 1 demonstration tools in more detail and provide an illustrative example of MERPs as an appropriate Tier 1 demonstration tool under App W



## Guidance on the use of models for assessing the impacts of emissions from single sources on the secondarily formed pollutants ozone and PM<sub>2.5</sub>

- For **second tier assessments** (Sections 5.3.2.c and 5.4.2.c) when necessary, guidance is provided on the air quality models, inputs, run time options, receptor placement, and application approach for the purposes of estimating the impacts on ozone and secondarily formed PM<sub>2.5</sub> from single project sources
- Within the second tier described in Appendix W, applicants are provided flexibility in terms of the complexity of model application for comparison to both the SIL and NAAQS
- These sub-tiers allow for simpler approaches to be compared conservatively to the SIL and NAAQS and more sophisticated approaches could be applied to provide a more representative impact for a source's impact



## Guidance on the use of models for assessing the impacts of emissions from single sources on the secondarily formed pollutants ozone and PM<sub>2.5</sub>

- For **second tier assessments**, chemical transport models are recommended for estimating single source O<sub>3</sub> and secondary PM<sub>2.5</sub> impacts
- Chemical transport models include Lagrangian puff models and Eulerian grid (e.g. photochemical transport) models
- Lagrangian puff models need as input a realistic chemical environment
- Photochemical transport models typically estimate a realistic chemical environment
- Even though single source emissions are injected into a grid volume, comparisons with in-plume measurements indicate these types of models can capture downwind secondary pollutant impacts when applied appropriately for this purpose
- Further testing is needed for both types of chemical transport modeling systems (Lagrangian and Eulerian) to best understand the configurations appropriate for permit related assessments



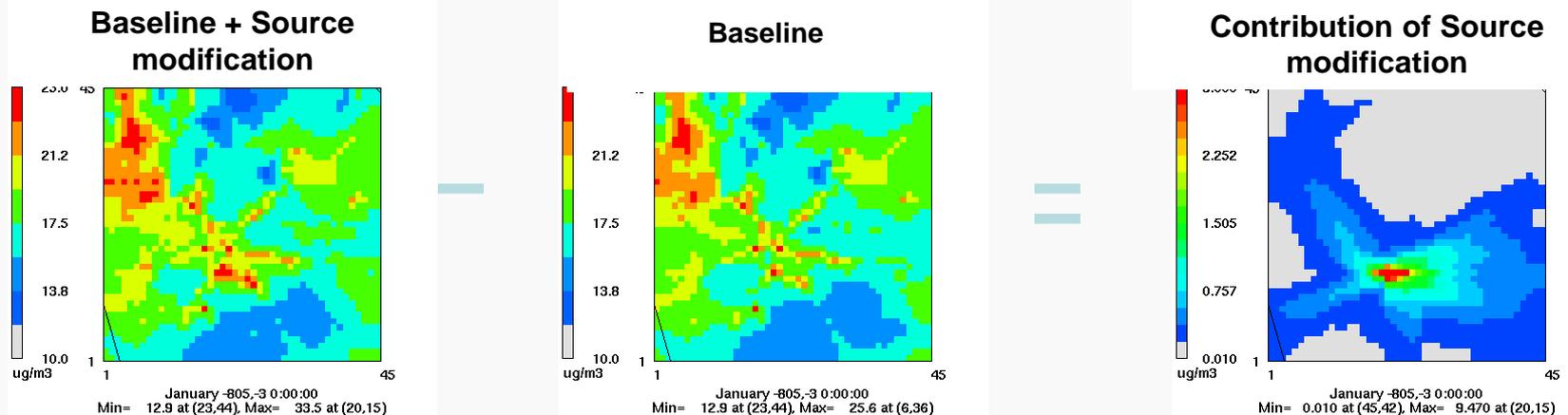
## IWAQM3: Near-Field Impacts Workgroup

- Updates to preamble & Chapter 5: Ozone and Secondary PM<sub>2.5</sub>
- New guidance document: Guidance on the use of models for assessing the impacts of emissions from single sources on the secondarily formed pollutants ozone and PM<sub>2.5</sub> (available in docket)
- IWAQM Phase 3 Summary Report: Near-Field Single Source Secondary Impacts (available in docket)
  - What do we know about the relationships between single source precursors and secondary impacts?
  - Overview of published emissions and secondary impacts from single sources to provide context for expected impacts
  - Recommended models, approaches, screening tools, etc.



# Estimating Source Contribution with Chemical Transport Models

- Lagrangian puff models output single source impacts
- Single source impacts estimated by photochemical grid models can be done by comparing a 1) model simulation with all sources and the project source at pre-construction levels and 2) model simulation with all sources and the project source at post-construction levels
- Alternatively, post-construction emissions could be tracked with photochemical grid model source apportionment or source sensitivity model extensions





## What tools exist for single source secondary impacts?

- Chemical transport models; photochemical grid models & Lagrangian puff models
- Photochemical models treat ozone and PM<sub>2.5</sub>
- Can a single source impact be realistically estimated with a grid model?
- What methods are appropriate to differentiate the single source secondary impacts in a photochemical grid model?

# Photochemical Models and Source Impact Estimation Approaches

- Multiple photochemical models
  - CMAQ
  - CAMx
- Source sensitivity approaches
  - Brute-force difference
  - HDDM
- Source apportionment approaches
  - ISAM
  - OSAT/APCA & PSAT

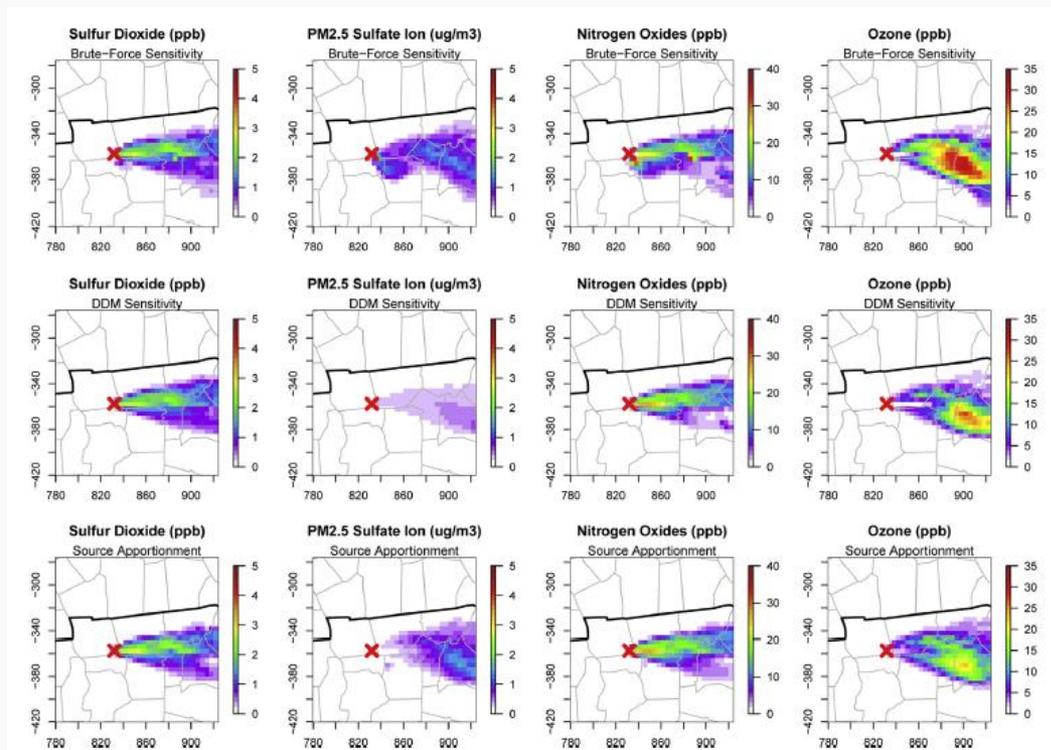
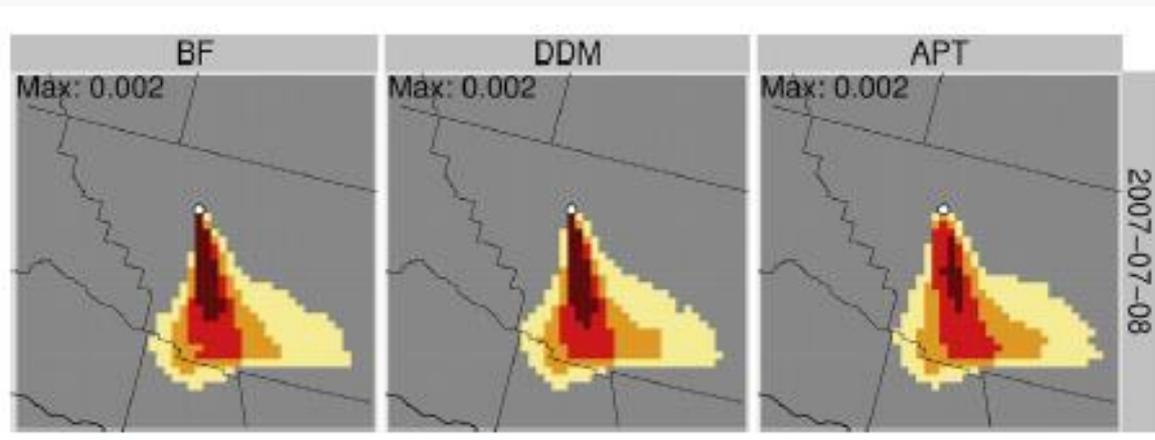


Fig. 6. Spatial extent of model predicted maximum  $\text{SO}_2$ ,  $\text{PM}_{2.5}$  sulfate ion,  $\text{NO}_x$ , and  $\text{O}_3$  contribution from TVA Cumberland for daytime July 6, 1999 using brute force difference (top row), DDM (middle row), and source apportionment (bottom row).

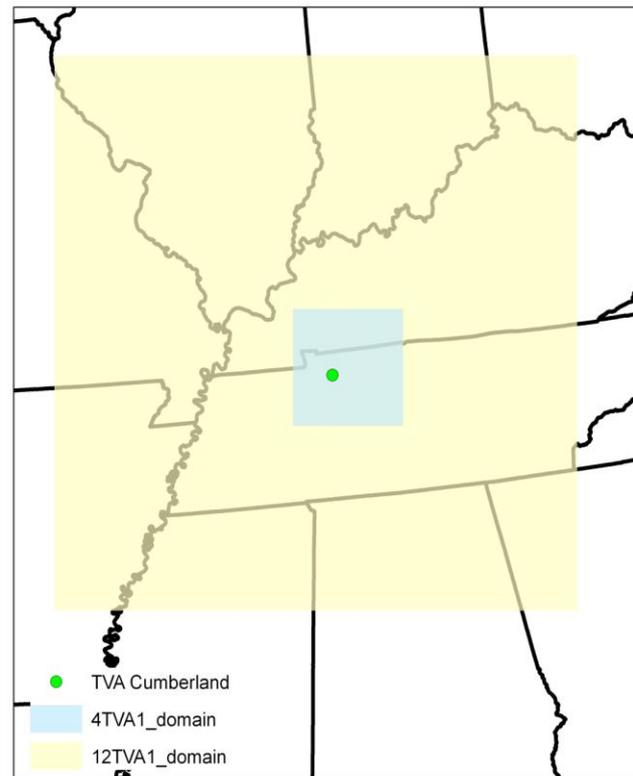
# Single Source Application & Evaluation

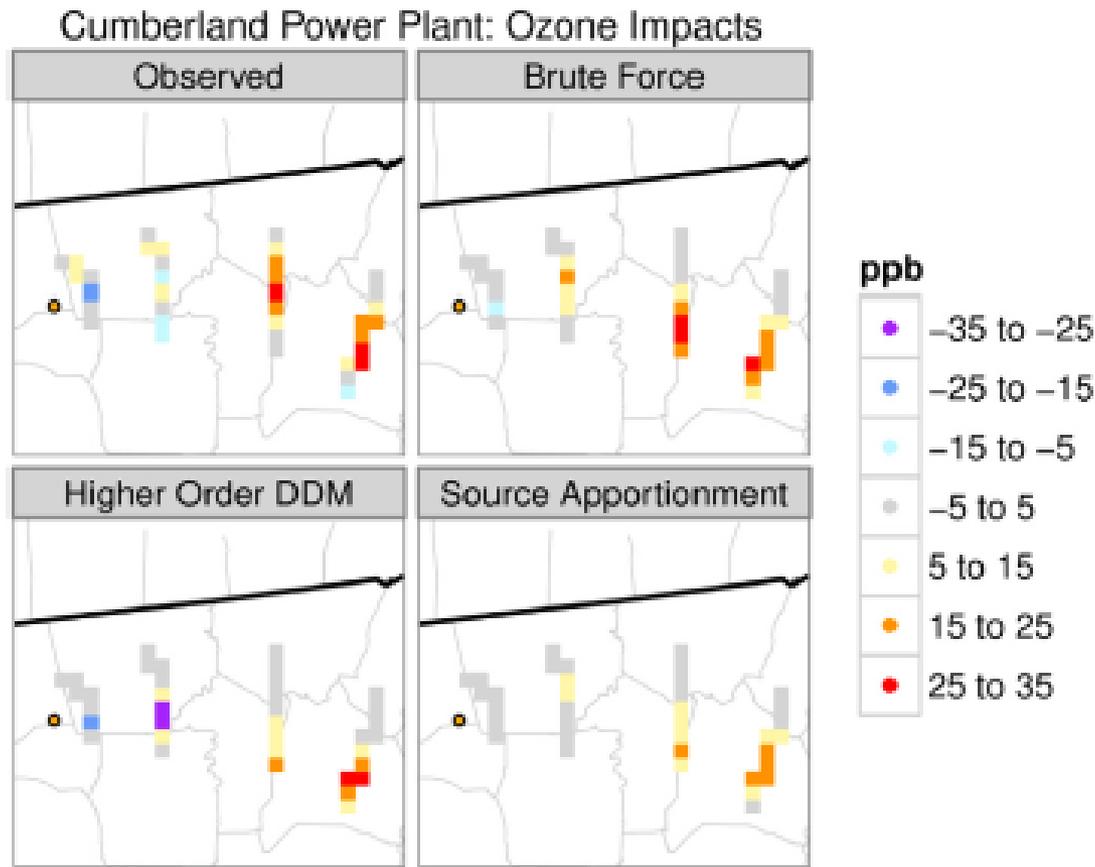
- Multiple studies modeling single source O<sub>3</sub> and secondary PM<sub>2.5</sub> with multiple photochemical grid model approaches
- In-plume measurements of TVA power plant in 1999 used to evaluate O<sub>3</sub> single source estimates
- Need for additional O<sub>3</sub> evaluations and for the first time to include secondary PM<sub>2.5</sub> assessment



# Single Source Application

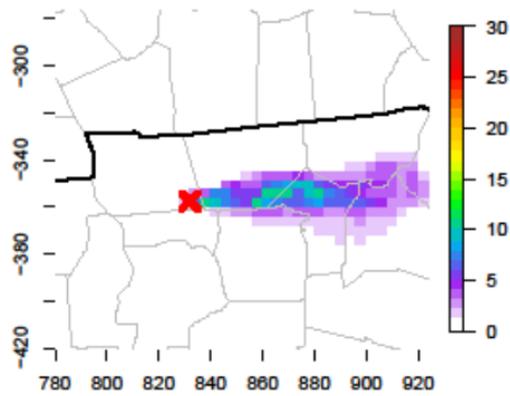
- 1999 TVA in-plume transect measurements compared with model estimates of TVA impacts
- Used photochemical grid model (CMAQ)
- Used multiple approaches to differentiate source impact from other sources



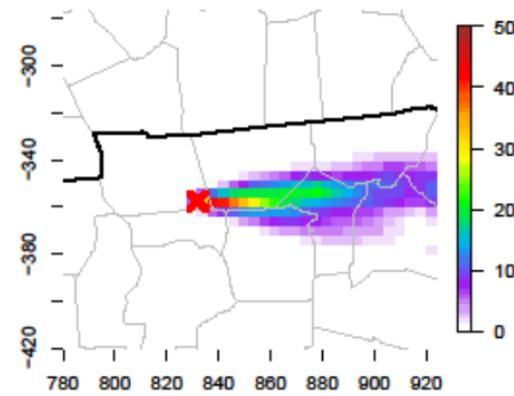


**Fig. 4.** Spatial plots of observed and modeled  $O_3$  mixing ratios. Modeled source impact shown using source apportionment, HDDM, and brute force difference. Observations are aggregated to match model grid structure.

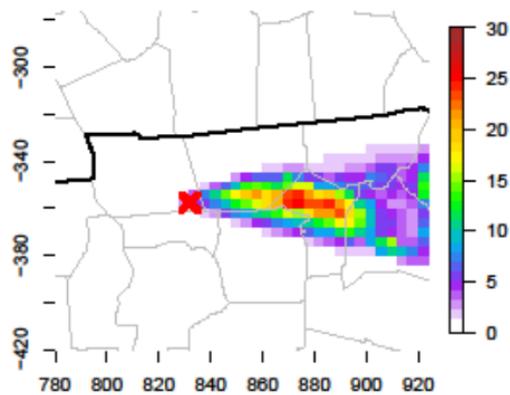
**SO<sub>2</sub> Deposition (g/ha)**



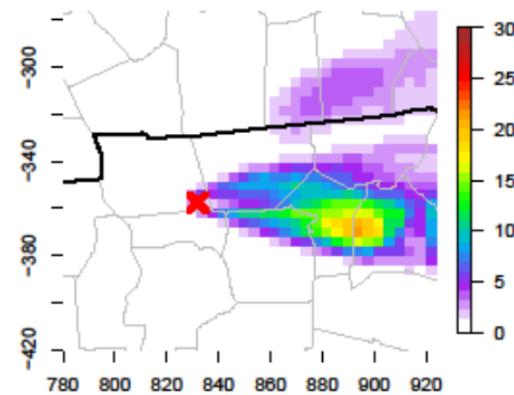
**NO<sub>x</sub> Deposition (g/ha)**



**HNO<sub>3</sub> Deposition (g/ha)**



**Ozone Deposition (g/ha)**





# Working towards a windows based single source assessment tool (alpha)

