Atmospheric Deposition Modeling of Oust®-Contaminated Dust in Southern Idaho during 1999-2001

Analyses Related to:

Adams, et al., v the United States of America,
Case No.:CIV 03-0049-E-BLW,
United States District Court, District of Idaho

Report Prepared by

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Prepared for

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Project: EC-11-001
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1 Introduction and Overview

The law firm Holland & Hart LLP[1] retained the services of Dr. Paolo Zannetti and his company EnviroComp Consulting, Inc.[2] (hereafter referred to as "EnviroComp") in this case.[3] Under this retention, Dr. Zannetti and his associates were asked to:

1. Interact and collaborate with scientists at Exponent, Inc.[4];
2. Simulate the transport and deposition of particles during dust episodes in Idaho in 1999-2001; and
3. Calculate deposition amounts of Oust®[5,6] in dust from different area sources and different episodes.

Dr. Zannetti is the principal author of this report. Dr. Zannetti has performed studies in atmospheric sciences for four decades. He has written more than 300 publications, including: (1) the book[7] "Air Pollution Modeling" completed in 1990, which was the first comprehensive book in the field and is still a widely used textbook today, and (2) the recent 4-volume book series[8] "Air Quality Modeling." Dr. Zannetti's CV is provided in Appendix A.[9]

Dr. Zannetti has investigated more than a hundred accidental releases caused by industrial and agricultural activities. In most of these cases, he simulated the ambient concentrations and depositions caused by chemical emissions using his own computer models and/or those developed and recommended by government agencies, such as the US Environmental Protection

1 http://www.hollandhart.com/
2 http://www.envirocomp.com
3 *Adams, et al., v the United States of America, Case No.: CIV 03-0049-E-BLW, United States District Court, District of Idaho.*
4 http://www.exponent.com
5 http://www2.dupont.com/Land_Management/en_US/products_services/herbicides/Oust_XP_herbicide.html
6 Throughout this report, the word "Oust" is used to represent the active ingredient (Sulfometuron methyl) of the Oust® XP herbicide.
7 Zannetti P (1990), *Air Pollution Modeling – Theories, Computational Methods, and Available Software,* Computational Mechanics Publications, Southampton, and Van Nostrand Reinhold, NY: 450 pp (http://www.ecampus.com/book/0442308051); this book is out of print but is freely available in PDF format (http://www.envirocomp.com/pops/airpollution.html).
8 A multi-volume, multi-author, comprehensive book series on air quality modeling published in 2003-2010 under Dr. Zannetti's direction and editorial management (http://www.envirocomp.org/aqm).
9 Most of Dr. Zannetti's publications are downloadable (http://www.envirocomp.com/zcv/zannetti.pdf).

Agency (US EPA). His testimony experience for the last four years is provided in Appendix B. His hourly rates as charged by his company (EnviroComp) are presented in Appendix C.

The work described in this report is a continuation of the work performed in 2008-2009 for this case. Dr. Zannetti's previous activities included:

1. Preparation of a Technical Memorandum,[10] submitted to Walter Shields,[11] PhD, CPSS of Exponent, and included as an appendix in Dr. Shields' report
2. Preparation of a Rebuttal Report[12]
3. Depositions, November 25, 2008[13] and February 3, 2009[14]
4. Trial testimony[15]

The opinions presented in these previous reports and testimonies are current and valid and should be considered incorporated here. This report presents the results of additional modeling work recently performed to simulate dust episodes in Idaho during 1999-2001 and the deposition of Oust®-contaminated dust in the region. Our modeling approach utilizes the CALPUFF modeling system[16] and is virtually identical to the CALPUFF modeling system applied in 2008-2009 and presented at the bellwether trial in August 2009.

10 "CALPUFF Modeling of Dust Episodes in Idaho during 1999-2001," Report: EC-08-007 – 08-08-29, dated 29 August 2008.

11 Principal Scientist, Director of Exponent's Environmental and Earth Sciences practice; 15375 SE 30th Place, Suite 250, Bellevue, WA.

12 "CALPUFF Modeling of Dust Episodes in Idaho during 1999-2001," Report: EC-08-007 – 09-01-19, dated 19 January 2009.

13 November 25, 2008, on behalf of Defendants, at Faegre & Benson, 1700 Lincoln Street, 3200 Wells Fargo Center, Denver, CO.

14 February 3, 2009; on behalf of Defendants, at EnviroComp Consulting, Inc., 2298 Ocaso Camino, Fremont, CA.

15 August 10 and 12, 2009, Boise, ID.

16 CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation, and removal. CALPUFF can be applied on scales of tens to hundreds of kilometers. It includes algorithms for subgrid scale effects (such as terrain impingement) as well as long-range effects (such as pollutant removal due to wet scavenging and dry deposition, chemical transformation, and visibility effects of particulate matter (PM) concentrations). The US EPA lists CALPUFF as a preferred/recommended model that can be applied for long-range transport and complex terrain (http://www.epa.gov/scram001/dispersion_prefrec.htm).

This report is prepared in compliance with Rule 26(a)(1)(B)[17] and presents the current results of our investigation and our opinions, based upon the materials reviewed, and the analyses performed to date. EnviroComp reserves the right to supplement this report in the event new information is presented. Any of the figures referenced in or attached to this report and accompanying model may be used as exhibits at trial.

[17] http://www.law.cornell.edu/rules/frcp/Rule26.htm

2 Information Reviewed

To date, we have received and reviewed the documents, data, and reports identified in Table 1.

Table 1. Information received and reviewed

Document	Source/Provider
Bureau of Land Management (BLM) fire records and spray dates	Exponent
BLM CALPUFF modeling files and reports for several non-Idaho burn events	Exponent
Meteorological data from surface stations, 1999-2001	Russ Qualls, University of Idaho and State Climatologist for Idaho
Geographic data: • All BLM sprayed areas • Generalized polygons of BLM sprayed areas of interest • Weather station locations • Soil sample data • Satellite imagery • Bellwether Plaintiff fields • Terrain elevation data • Major rivers and lakes	Kelly Hendrick, Remme Corporation
Time periods for modeling	Exponent
References for dust emission modeling	Exponent
Estimated hourly dust emission rates for 1999-2001	Exponent
Conversion factors to convert dust emissions to Oust® emissions	Exponent
Soil particle size data	Exponent
Representative receptor locations	Exponent
Findings of Fact & Conclusions of Law, Case No.: 4:03-CV-0049-BLW, Document 1681, filed 03/24/10	Holland Hart
CD containing: • Pictures (Plaintiff's Trial Exhibit 34378) • Pages 372-395 from Kurt Harman's testimony	Holland Hart

We have collected and examined the following documents and data as part of our project work:

- Terrain elevations (CALMET[18]-friendly format)[19]
- Land use data (CALMET[18]-friendly format)[20]
- Landsat7 satellite imagery

18 http://www.src.com/calpuff/calpuff1.htm
19 http://dds.cr.usgs.gov/srtm/version2_1/SRTM1/Region_01/
20 http://www.webgis.com/terr_pages/lulcutm_id.html

- USGS topographic maps
- Radiosonde upper-air meteorological data
- Wind roses for local airport meteorological stations, 2002-2006

3 Area of Interest and Surrounding Region

The area of interest is southern Idaho, the Snake River Valley. The counties involved are Twin Falls, Jerome, Lincoln, Blaine, Minidoka, Power, Cassia, Bannock, Bingham, and Oneida. Figure 1 shows these ten counties using Landsat7 satellite imagery.

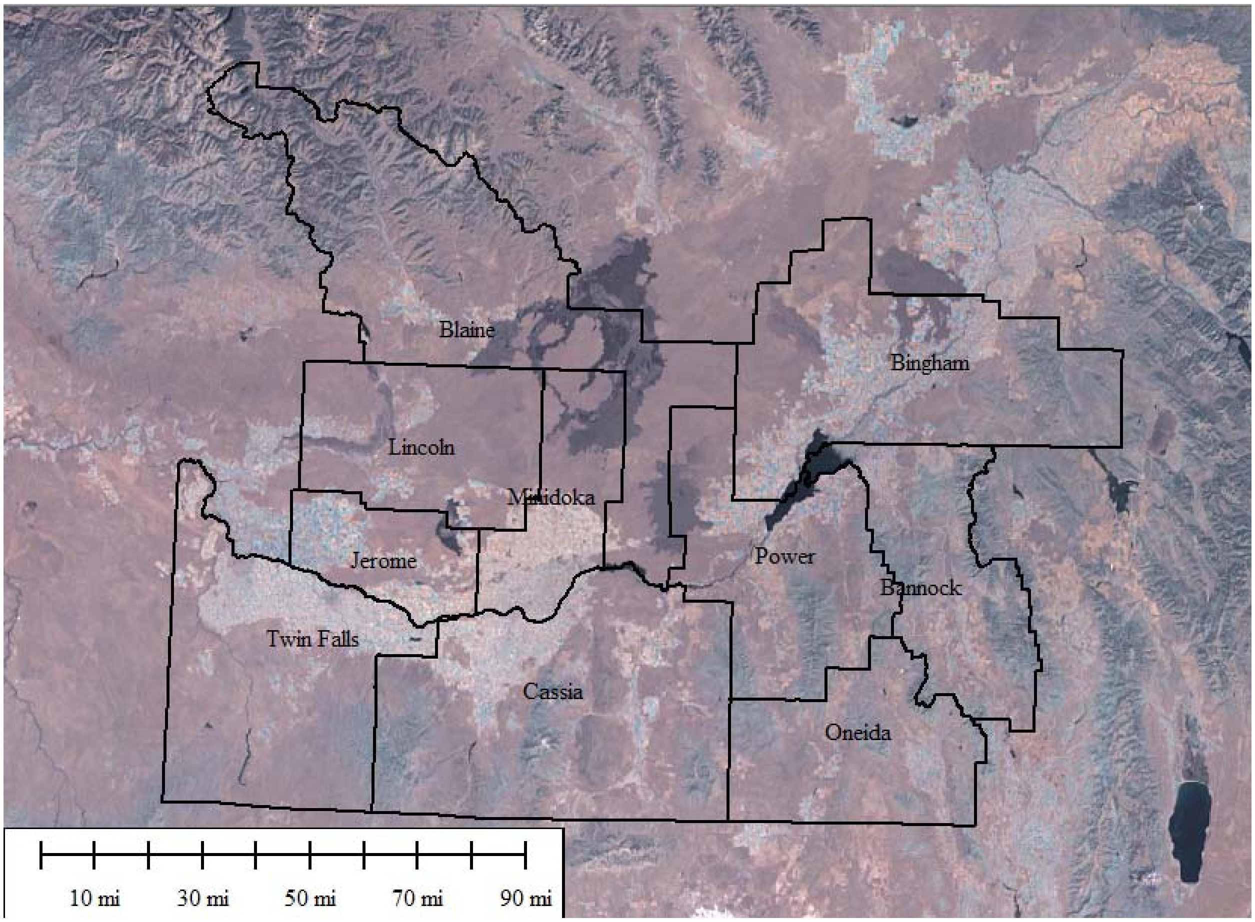

Figure 1. Landsat7 satellite image showing southern Idaho and the counties of interest.

The state of Idaho is very mountainous and the Rocky Mountains pass through the eastern portion of the state. The Snake River Valley cuts through the mountains in an arc from west to northeast and the surrounding plains are mostly rangeland and agricultural fields. Figure 2 shows the counties of interest along with local terrain elevations. The center of the valley is about 1,500 meters (m) above sea level (ASL) and the surrounding mountains reach 1,000 m and higher above the valley center. The lowest part of the valley is the western side.

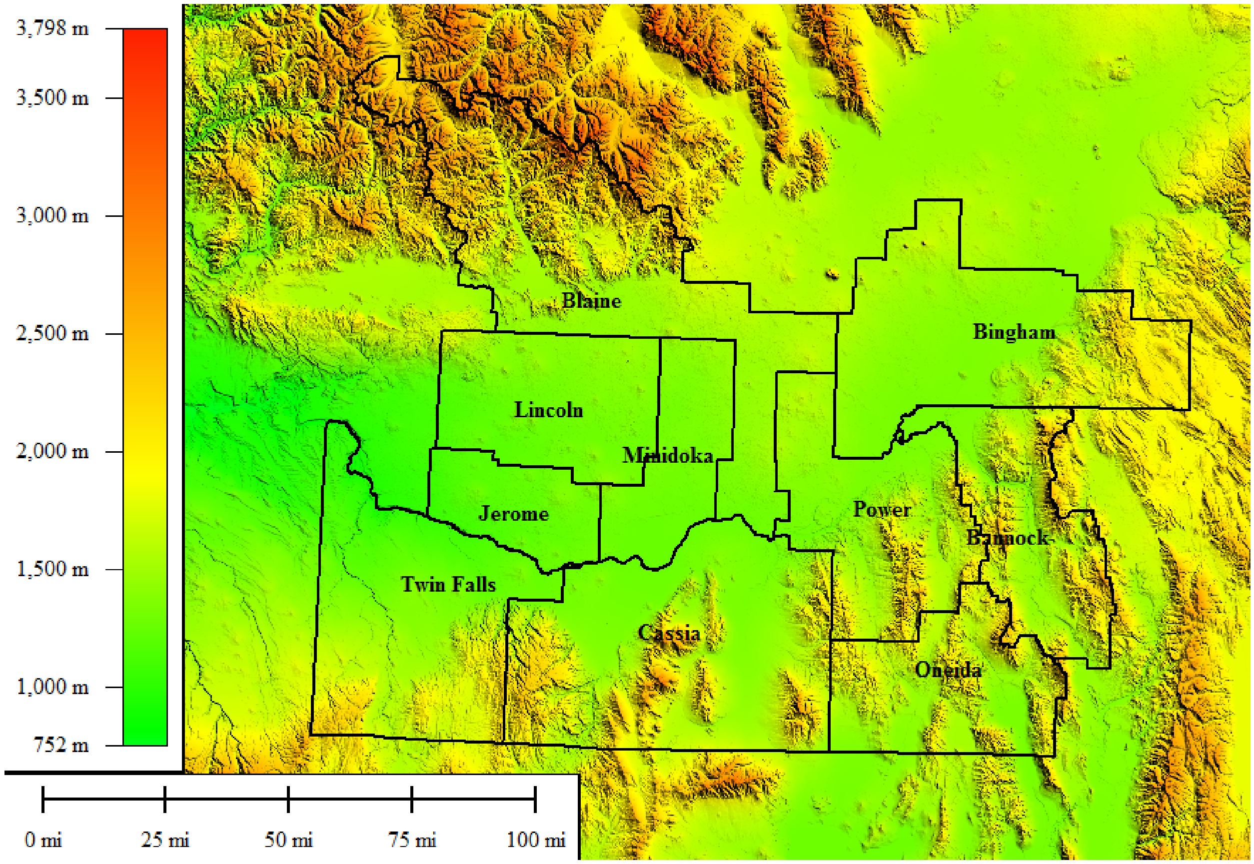

Figure 2. Southern Idaho with counties and terrain elevations of interest.

4 Meteorological Data

Meteorological data for the relevant surface stations were provided by Dr. Russ Qualls of the University of Idaho and the State Climatologist for Idaho. Figure 3 shows the local airports that report hourly weather conditions, along with parcels of BLM public domain land. The stations in the middle of the valley (KTWF, KJER, KBYI, and KPIH) are the same meteorological stations we used (with others) in our previous study for the bellwether 2009 trial.

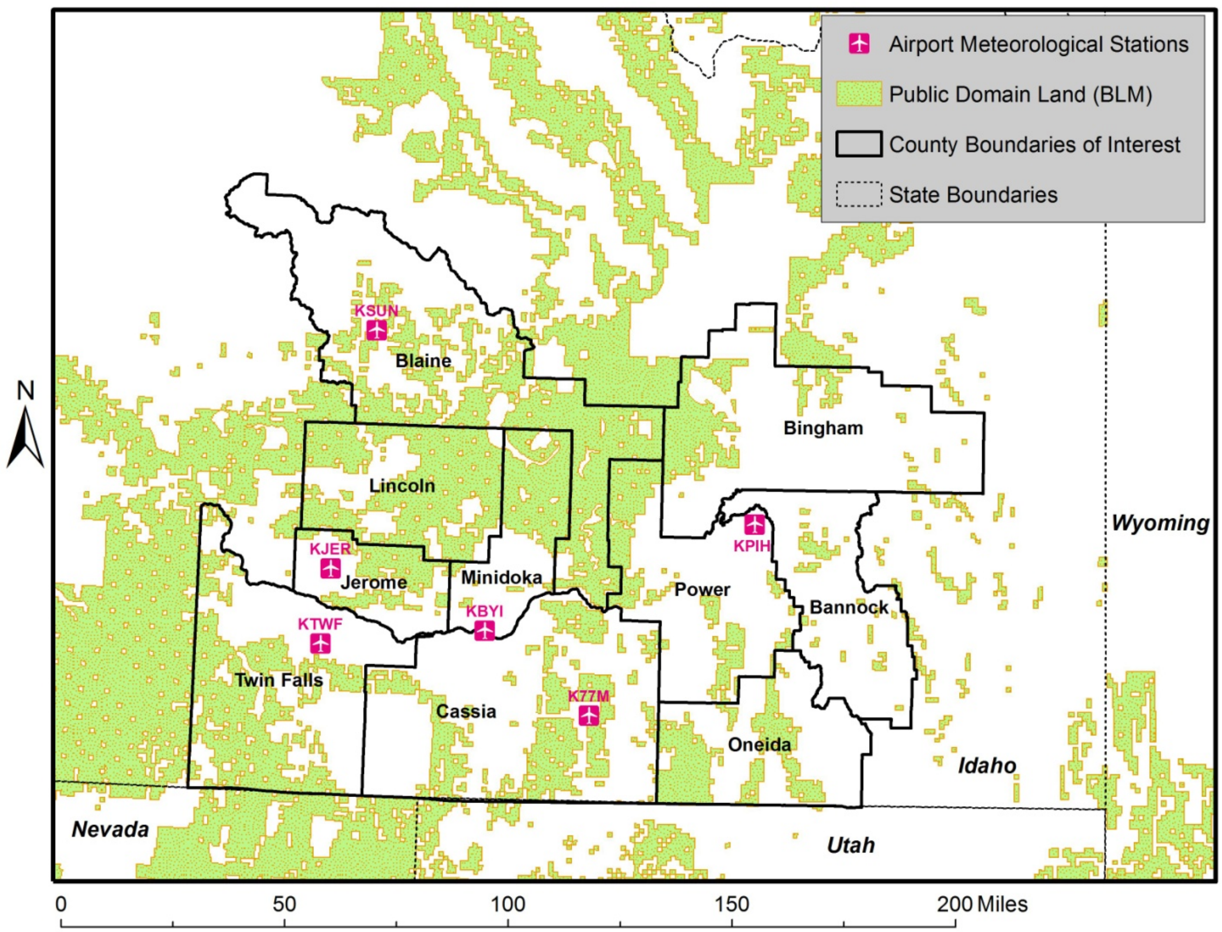

Figure 3. Southern Idaho with counties, local airports, and BLM public domain land of interest.

5 Emission Characterization

This section is the same as Section 5 of our report[21] prepared for the bellwether 2009 trial.

[21] "CALPUFF Modeling of Dust Episodes in Idaho during 1999-2001," Report: EC-08-007 – 08-08-29, dated 29 August 2008.

6 EnviroComp Modeling

6.1 Methodology

Since we are interested in long-range atmospheric transport (over 100 miles) in a region with complex terrain, we used the CALPUFF[18] modeling system (version[22] 6.262) to simulate the emission, transport, and deposition of windblown dust.

Computer models for simulating air pollution phenomena have been successfully used for decades in the US and throughout the world. In the US, in particular, models have achieved an important status as official tools for regulatory applications,[23] such as State Implementation Plan (SIP) revisions for existing sources, and New Source Review (NSR) and Prevention of Significant Deterioration (PSD) Programs. Models approved by the US EPA (such as CALPUFF) go through a detailed peer-review and verification process and, in general, represent the best approximation of reality available through computational methods.

The CALPUFF modeling system has three components: CALMET, an advanced three-dimensional mass-consistent diagnostic meteorological model; CALPUFF, an advanced dispersion puff model; and CALPOST, a post-processor. The CALPUFF system is preferred by the US EPA for long-range transport of pollution and complex meteorological conditions. Our modeling runs were performed with the front-end software CALPUFF View 4.0.0 developed by Lakes Environmental.[24]

Windblown dust particles have a natural variation in size, so to accurately simulate this variation, the dust particles were modeled as four discrete categories representing aerosols with constant

22 http://www.src.com/calpuff/download/download.htm#MOD6_VERSION
This current version of the CALPUFF modeling system is slightly different from version 6.112, which was used in our previous study and whose results were presented at trial in 2009. In air pollution modeling, it is always preferred to use the most recent version of the software recommended and approved by the US EPA. However, the numerical results obtained with the two versions of CALPUFF are almost identical. For all practical purposes in this case, we verified there were no noticeable differences between the two versions of the program.

23 http://www.epa.gov/ttn/scram/guidanceindex.htm

24 http://www.lakes-environmental.com/calpuff/calpuff_overview.html

diameters of 2.5, 7.5, 24, and 50 microns, respectively. Exponent, based on empirical measurements at the site, estimated the proportion of dust emitted in each category. In this study, Exponent provided us with the emission rates already calculated[25] for Oust®.

The meteorology was based on the 14 surface meteorological stations in the valley, along with the three closest upper-air stations which give twice-daily radiosonde measurements. Figure 4 shows the locations of these three upper-air stations, which are Boise, ID (BOI), Salt Lake City, UT (SLC), and Elko, NV (LKN).

Since the terrains at the three upper-air stations are different from the terrain in the valley plains, these stations were not used to determine the valley's wind behavior. The wind data for the 14 surface meteorological stations were used to characterize the valley winds, up to 1,000 m above the valley floor. This is approximately the height of the surrounding mountains and the upper-air stations primarily determined the wind behavior above this level.

[25] In our previous study, whose results were presented at trial in 2009, we performed dispersion and deposition modeling of PM and, afterwards, Exponent post-processed our modeling results to extract the deposition values of Oust®. For this 2011 study, Exponent provided us directly with Oust® emission rates and therefore we were able to calculate directly the deposition values of Oust®. The two approaches provided nearly identical results.

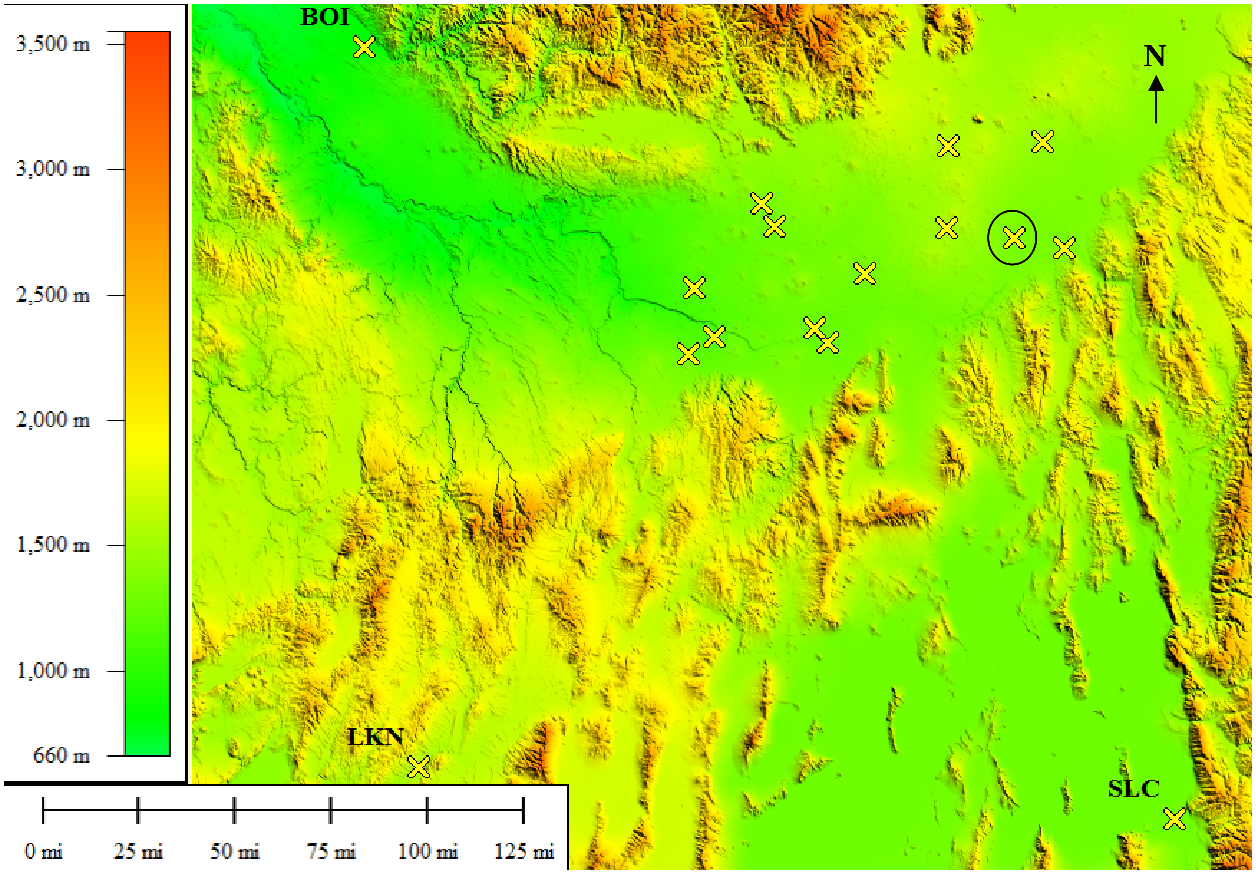

Figure 4. Snake River Valley and surrounding area in southern Idaho, with 14 surface meteorological stations and three upper-air stations (BOI, LKN, and SLC); the co-located stations ABE and ABEI are indicated (circle).

6.2 CALPUFF Simulations

To facilitate the simulation of dust emissions in CALPUFF, the irregular shapes of the BLM-sprayed areas were converted into rectangles which preserved surface area, centroid, and aspect ratio of the north-south to east-west extents of each spray area; these rectangles are shown in Figure 5 (white). This is the same methodology we applied in the study performed for the bellwether 2009 trial.

The centroid of each spray area was used as the center of a surface-based volume source in CALPUFF. The north-south and east-west extents of each rectangle determined the initial dimensions of each volume source. Since the dust emission episodes primarily involved winds from the west, the north-south extents were used to calculate an initial sigma-y (σ_y) by dividing[26] this dimension by 4.3. The east-west extents were used to determine an initial vertical dimension by using the Pasquill-Gifford sigma-z (σ_z) method in neutral conditions[27] for that horizontal extent, and then this vertical dimension was divided by 2.15 to derive an initial σ_z.[26] To achieve the recommended uniform vertical mixing of pollutant within the lower half of the initial source volume, the effective height of each volume source was set to one-half of the vertical dimension.

Our representation of the emission regions as ground-based volume sources was discussed at length in Section 2.1.3 of Dr. Zannetti's Rebuttal Report[12] and during the 2009 trail. Our volume-source approach provided a realistic simulation of the initial phase of a dust storm that best represents the nature of the mechanics of the plume and matches visual experience and testimony.

The domain in CALPUFF had dimensions of 168 km east-to-west, 104 km north-to-south, and up to 4,000 m above ground level and is shown in Figure 6. The horizontal grid spacing was 800 m and there were up to ten vertical cells that reached up to 4,000 m above ground level. Some runs had a lower vertical extent due to missing upper-air data. For each run, the total deposition of Oust® over the period was calculated at each of the 27,300 grid cells in the domain. Exponent also provided the locations of 16 representative receptors, which were used in our 2008-2009 study and are shown in Figure 7.

Since the horizontal grid spacing is 800 m, CALPUFF is not capable of simulating the effects of sub-grid phenomena, such as small turbulent atmospheric eddies, irregular topography, and uneven surface conditions. In other words, Oust® deposition amounts calculated by CALPUFF are more evenly distributed than what would be observed because the model does not account for small-scale variations.

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26 http://www.weblakes.com/guides/iscst3/section6/6_2_2.html

27 Equation 7-15, Zannetti P (1990), *Air Pollution Modeling – Theories, Computational Methods, and Available Software*," Computational Mechanics Publications, Southampton, and Van Nostrand Reinhold, New York, 450 pp, http://www.amazon.com/Pollution-Modeling-Theories-Computational-Available/dp/0442308051.

The density of particles simulated by CALPUFF has a default value of 1 g/cm^3 (water). In our simulations, we assumed the particles had a density of 2.65 g/cm^3 (quartz). To account for the particle's density, the aerodynamic diameter of each particle size was computed by multiplying the particle's physical diameter by the square root of this density of 2.65. The resulting number was entered into CALPUFF as the geometric mass mean diameter. Also, since we were simulating four distinct particle sizes, the geometric standard deviations were set to zero.

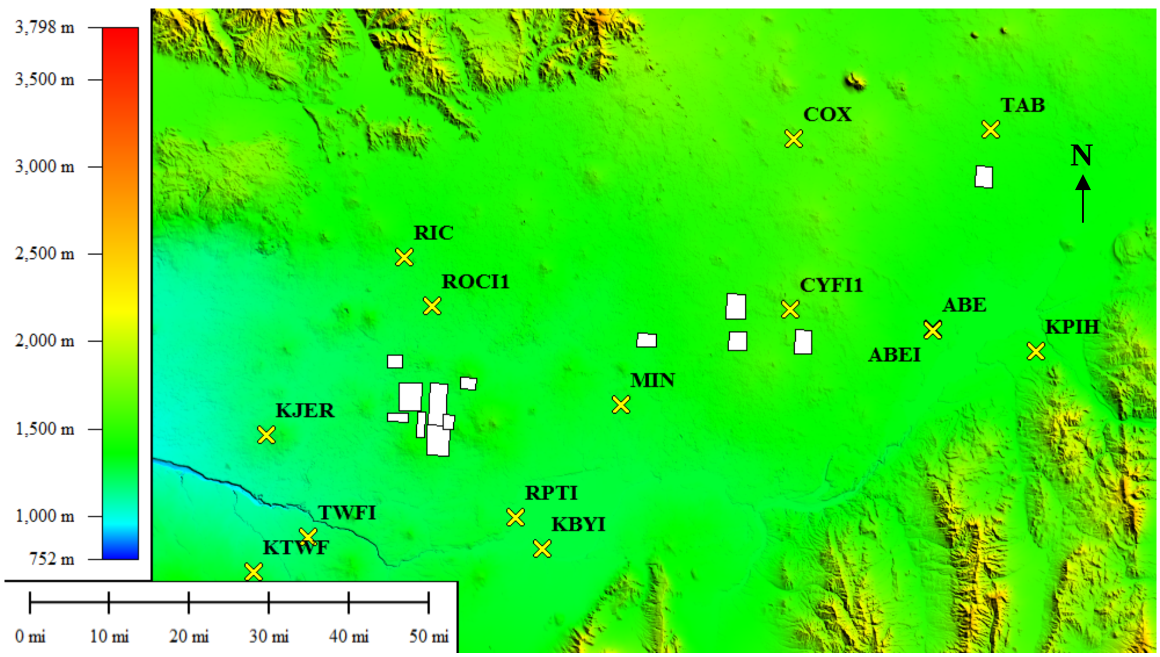

Figure 5. Snake River Valley with 14 surface meteorological stations (ABE co-located with ABEI) and 13 rectangles (white) representing BLM-spray areas of concern.

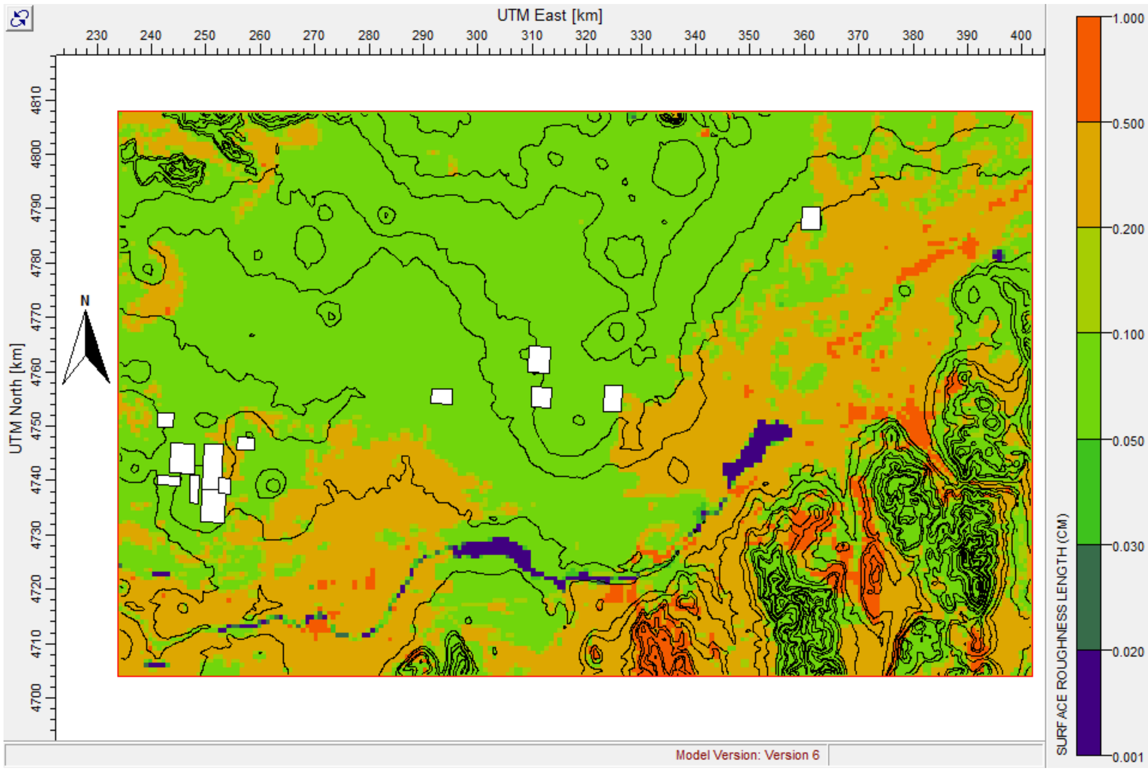

Figure 6. CALPUFF domain, with terrain contours, surface roughness lengths, and BLM-spray area rectangles (white).

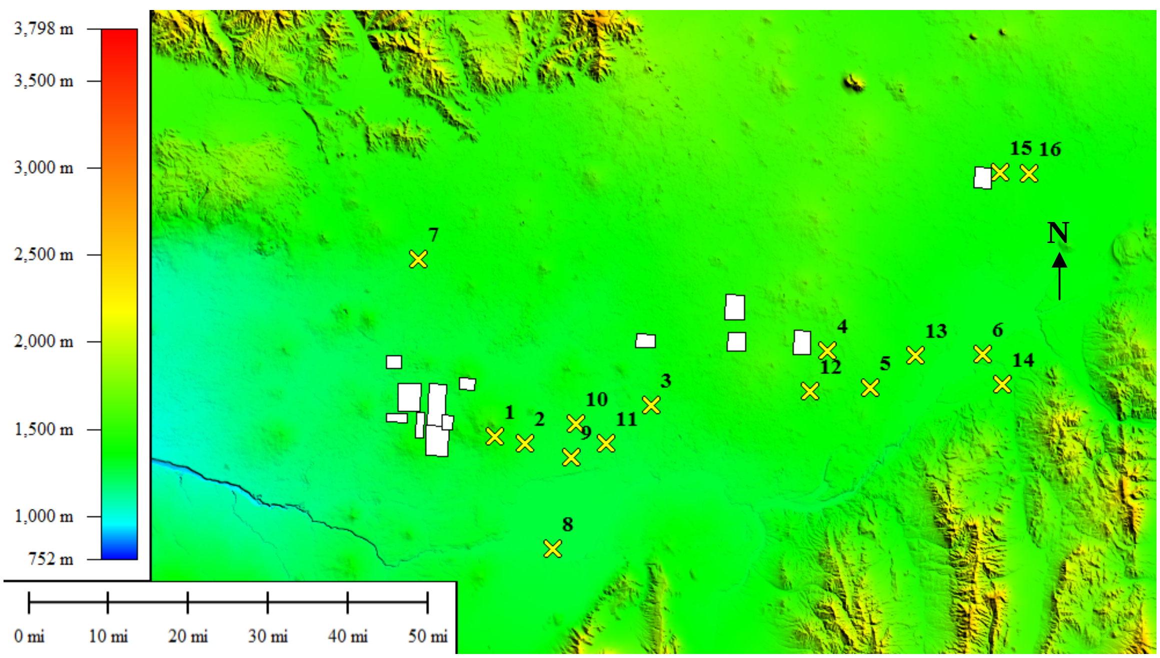

Figure 7. BLM-spray area rectangles with 16 representative receptors.

6.3 Results

Exponent identified 30 dust episodes from 1999 to 2001 to be simulated by CALPUFF. These dust episodes include the 25 episodes already simulated and presented at the bellwether trial in 2009, plus 5 additional episodes. Thirty-one (31) dust episode images (Figure 8 through Figure 38) show the total deposition of Oust® for each period in chronological order with one episode (June 12, 2001; Figure 36 and Figure 37) simulated using two different wind thresholds (15 and 20 mph) as requested by Exponent. Our Oust® deposition results were provided to Exponent for further analysis and calculations of Oust® impact assessment in the region.

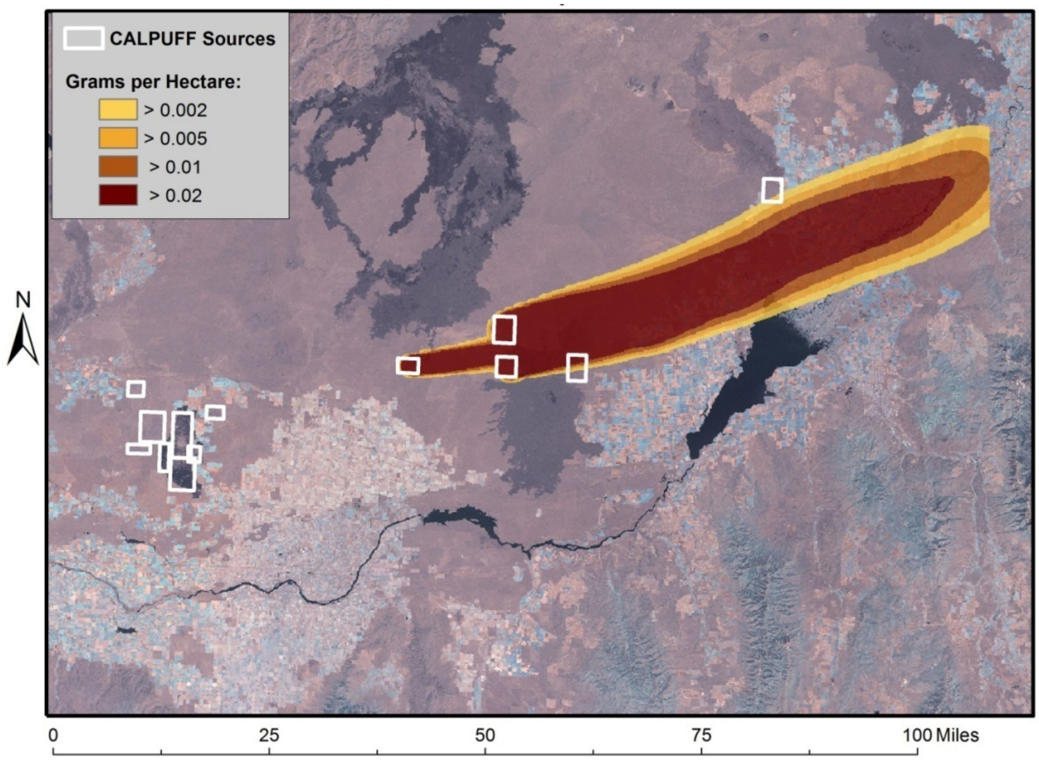

Figure 8. Oust® depositions for the October 14-16, 1999 dust episode (20-mph threshold).

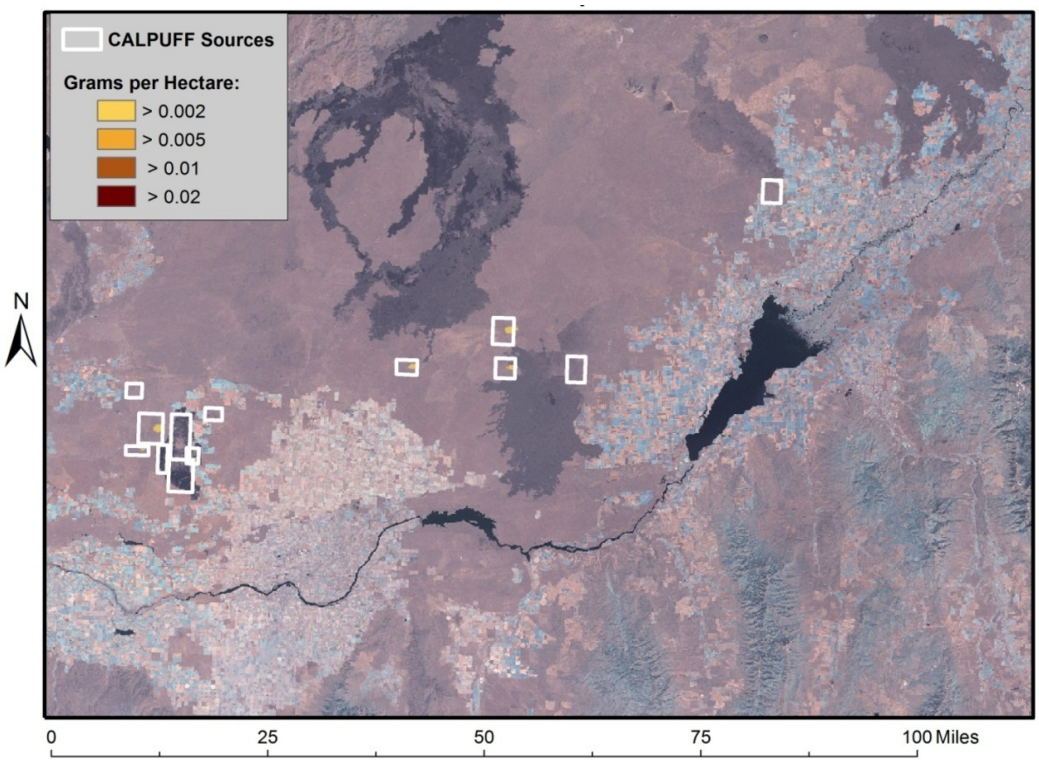

Figure 9. Oust® depositions for the November 17, 1999 dust episode (20-mph threshold).

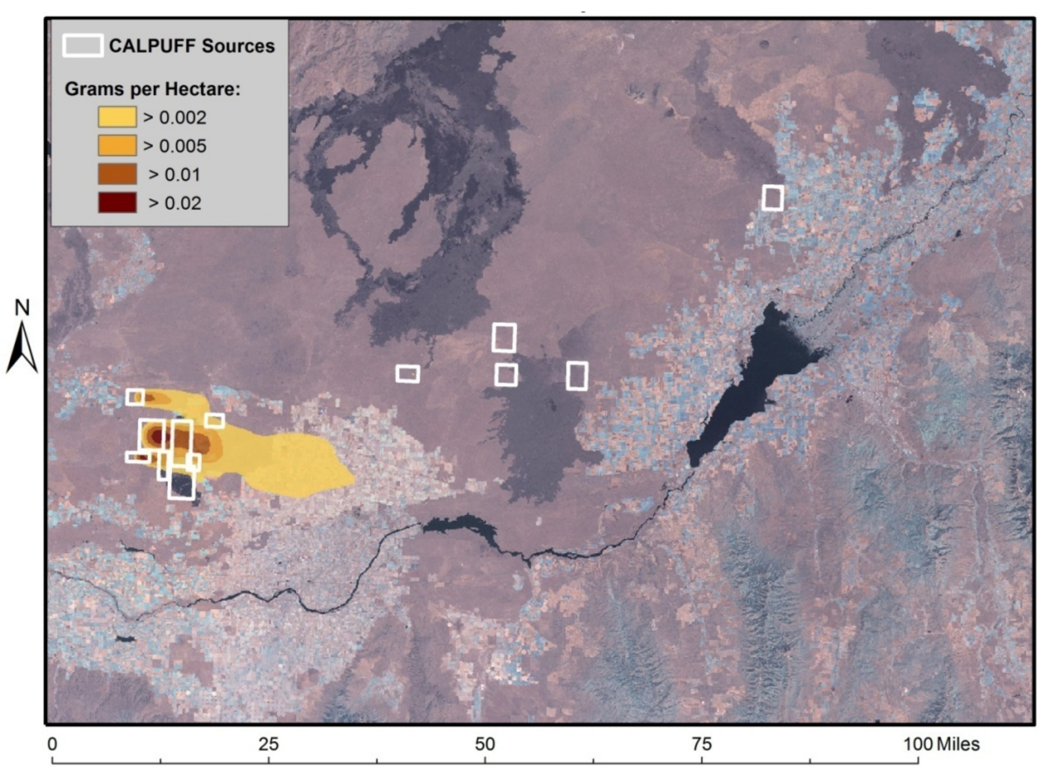

Figure 10. Oust® depositions for the December 18-20, 1999 dust episode (20-mph threshold).

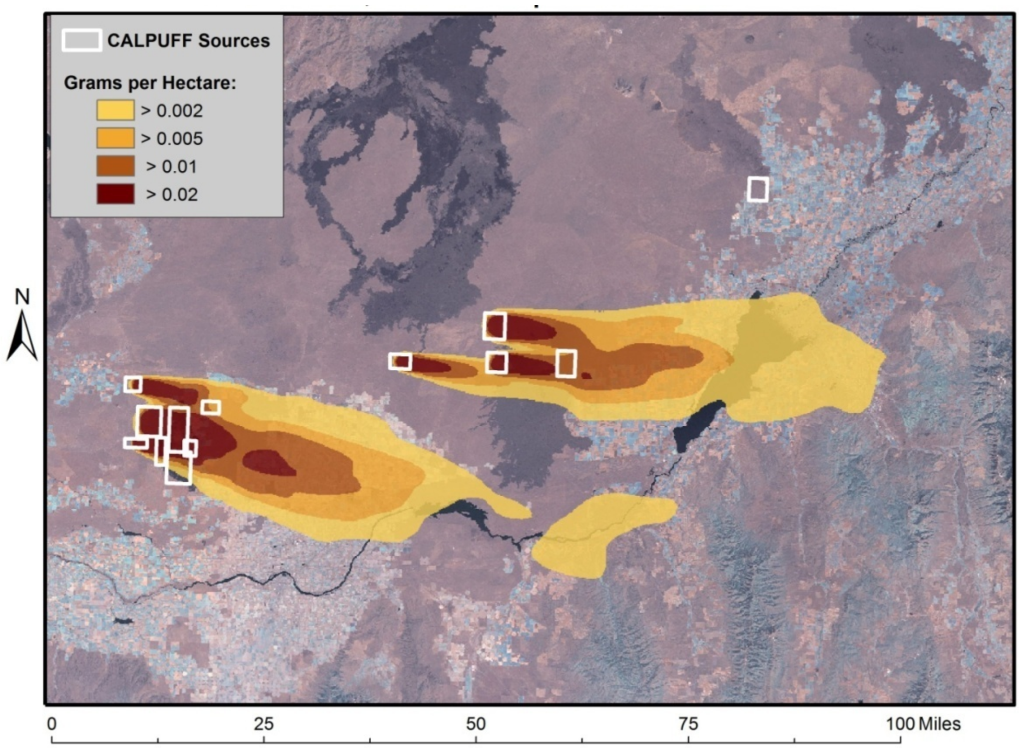

Figure 11. Oust® depositions for the March 14, 2000 dust episode (20-mph threshold).

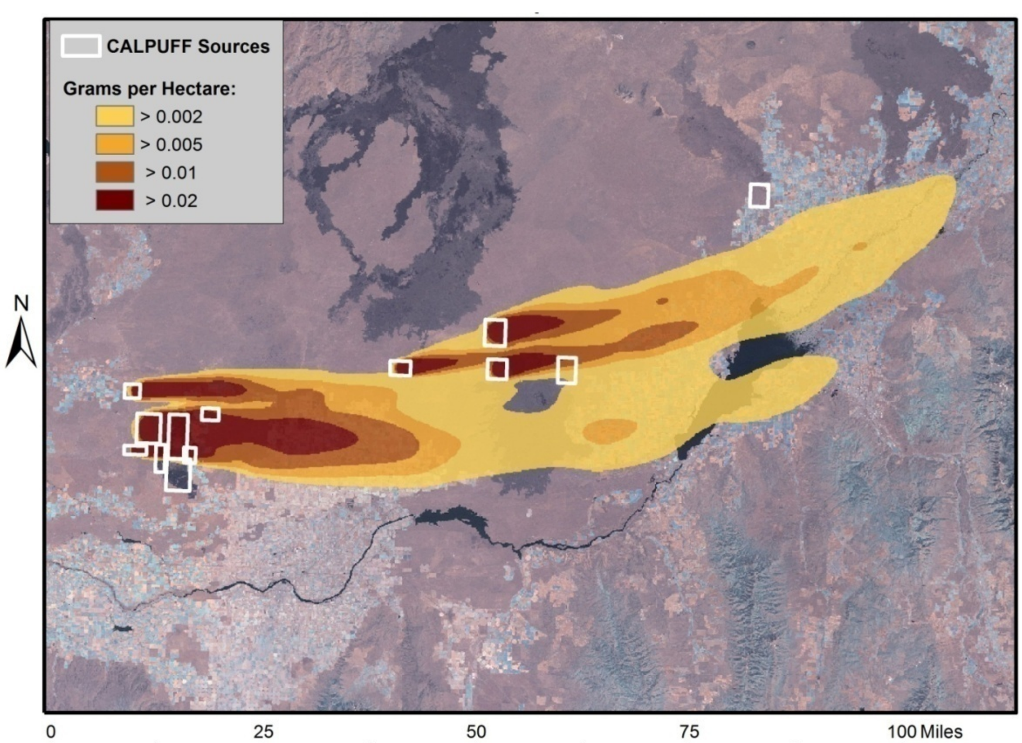

Figure 12. Oust® depositions for the March 23, 2000 dust episode (20-mph threshold).

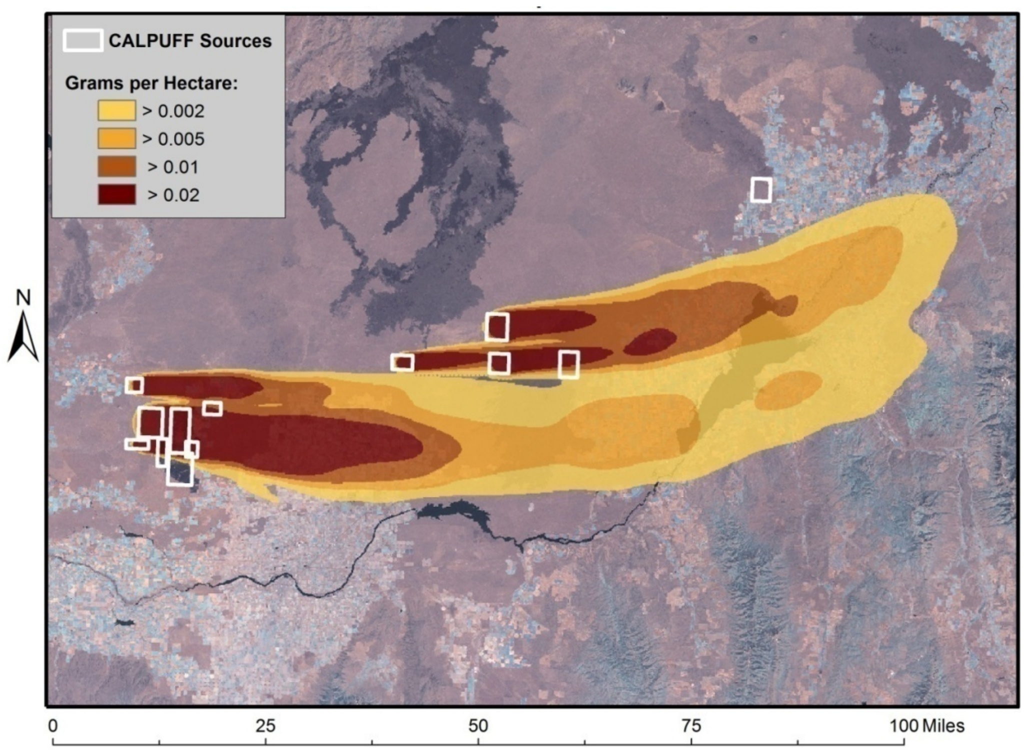

Figure 13. Oust® depositions for the March 28, 2000 dust episode (20-mph threshold).

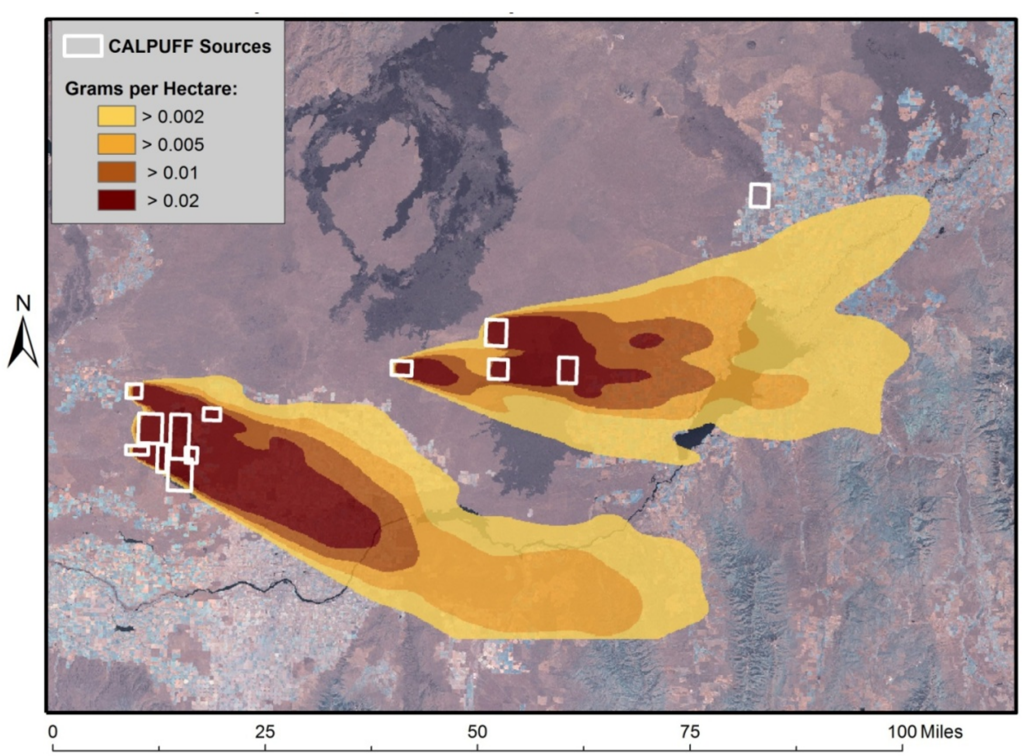

Figure 14. Oust® depositions for the April 5-7, 2000 dust episode (20-mph threshold).

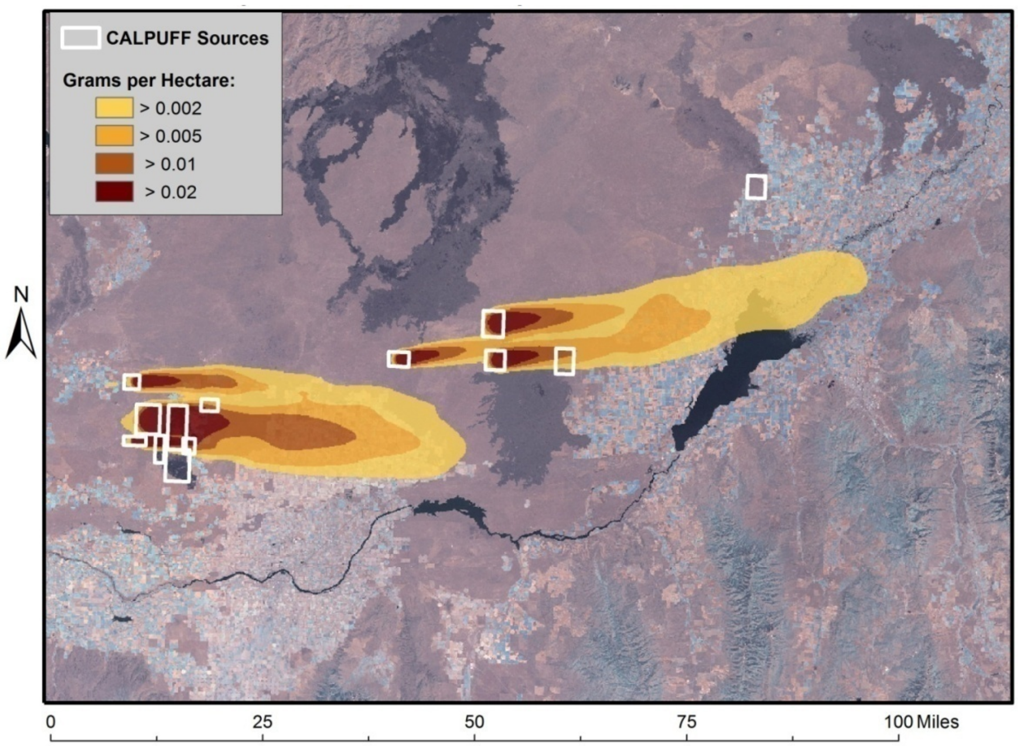

Figure 15. Oust® depositions for the April 27-29, 2000 dust episode (20-mph threshold).

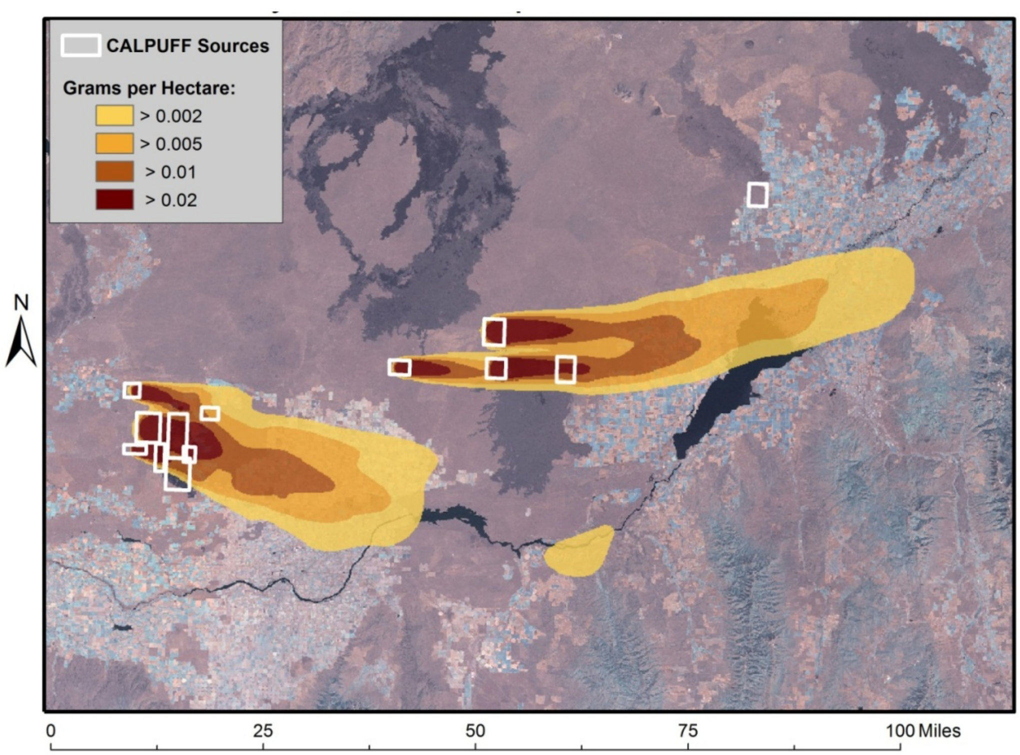

Figure 16. Oust® depositions for the May 23, 2000 dust episode (20-mph threshold).

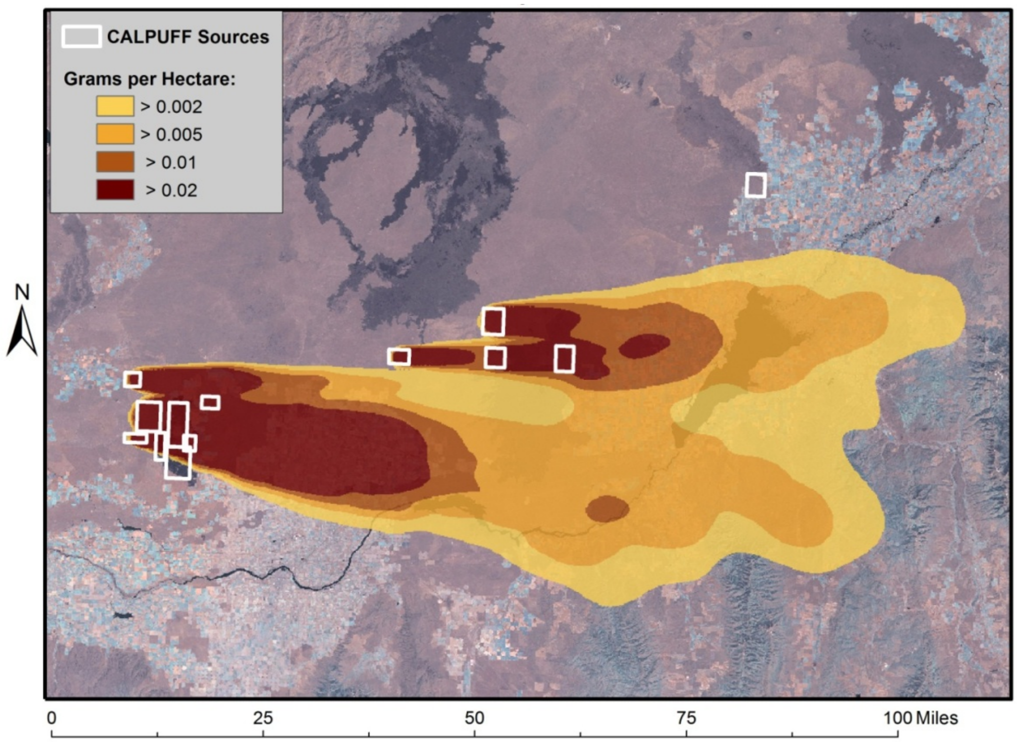

Figure 17. Oust® depositions for the June 14-16, 2000 dust episode (20-mph threshold).

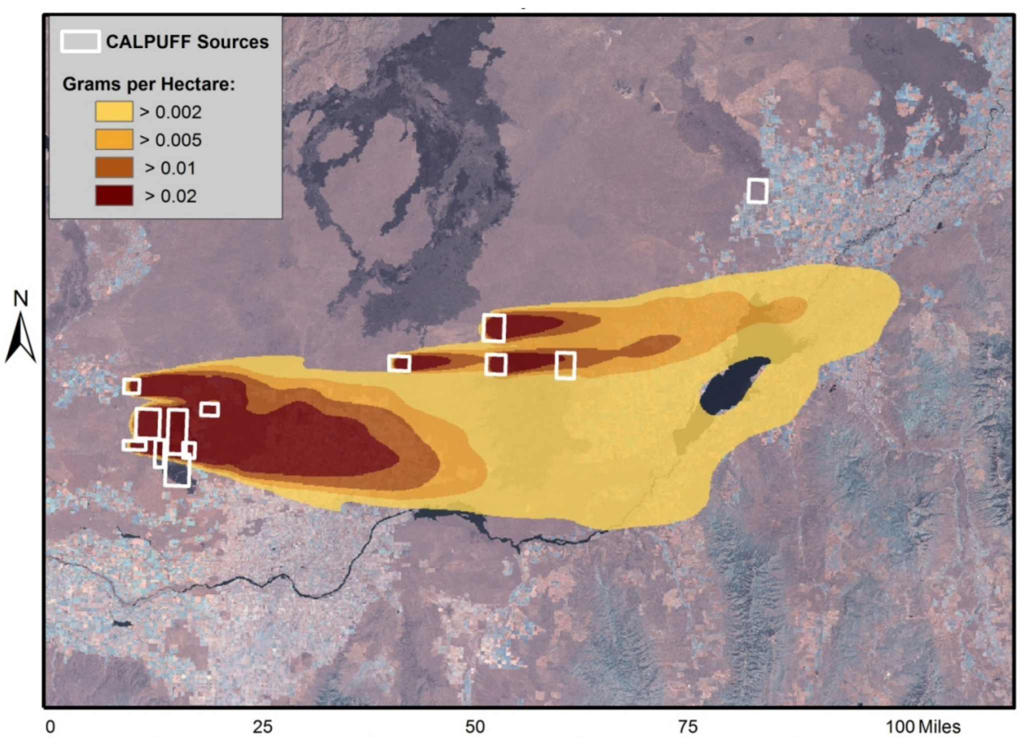

Figure 18. Oust® depositions for the June 19-20, 2000 dust episode (20-mph threshold).

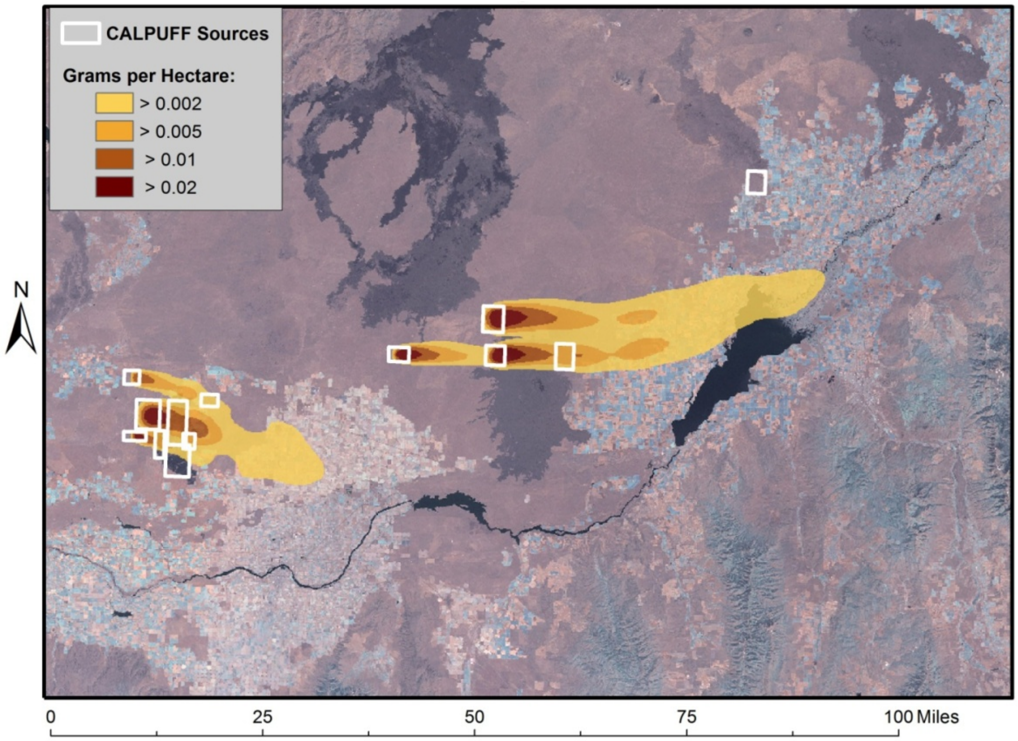

Figure 19. Oust® depositions for the June 24, 2000 dust episode (20-mph threshold).

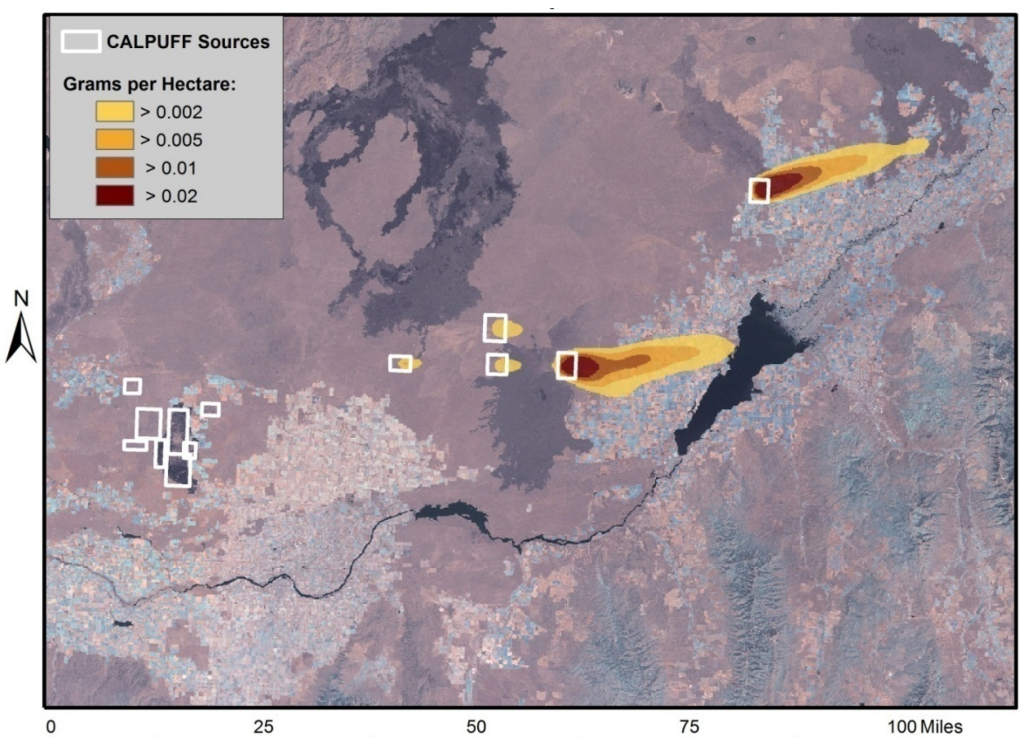

Figure 20. Oust® depositions for the October 20-21, 2000 dust episode (20-mph threshold).

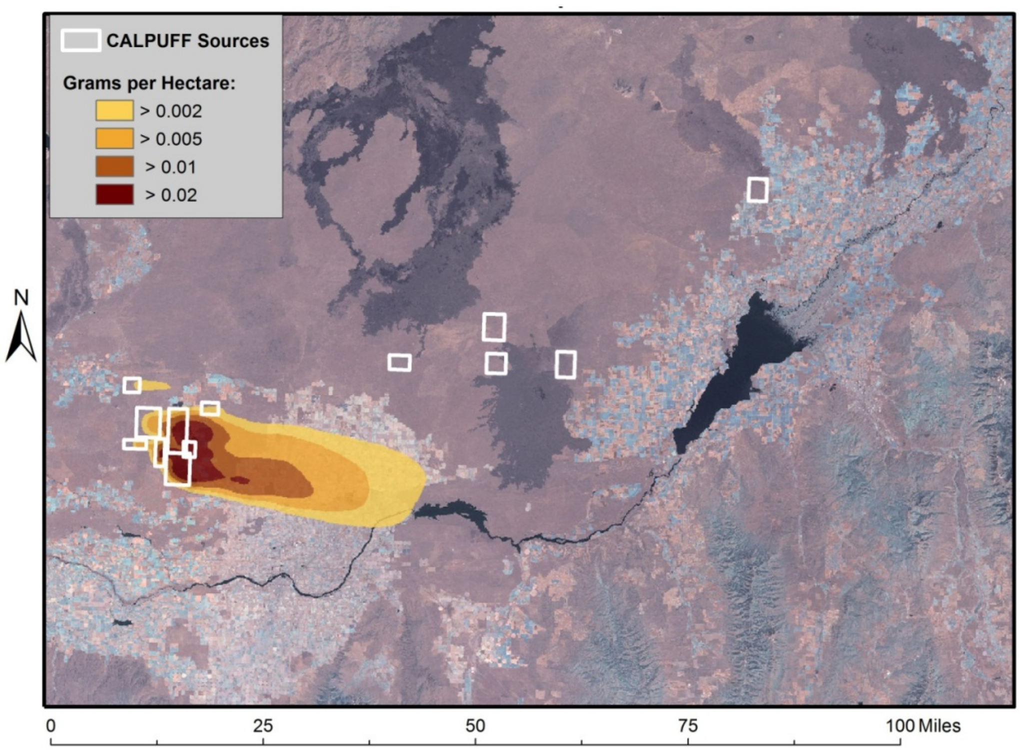

Figure 21. Oust® depositions for the November 1-2, 2000 dust episode (20-mph threshold).

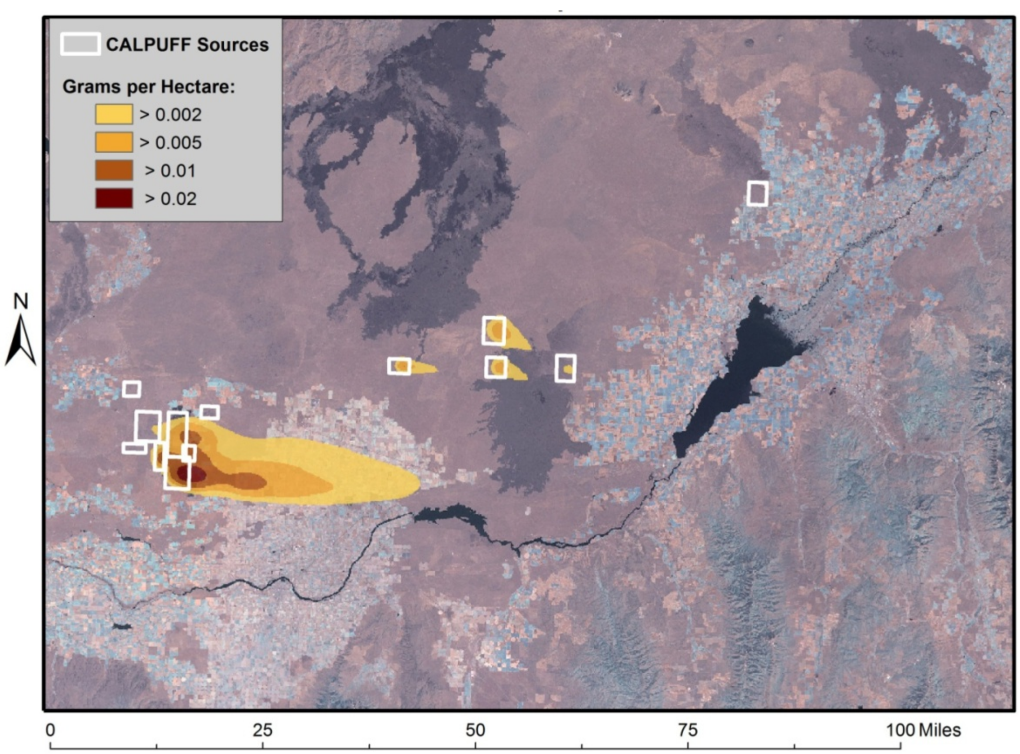

Figure 22. Oust® depositions for the November 4-5, 2000 dust episode (20-mph threshold).

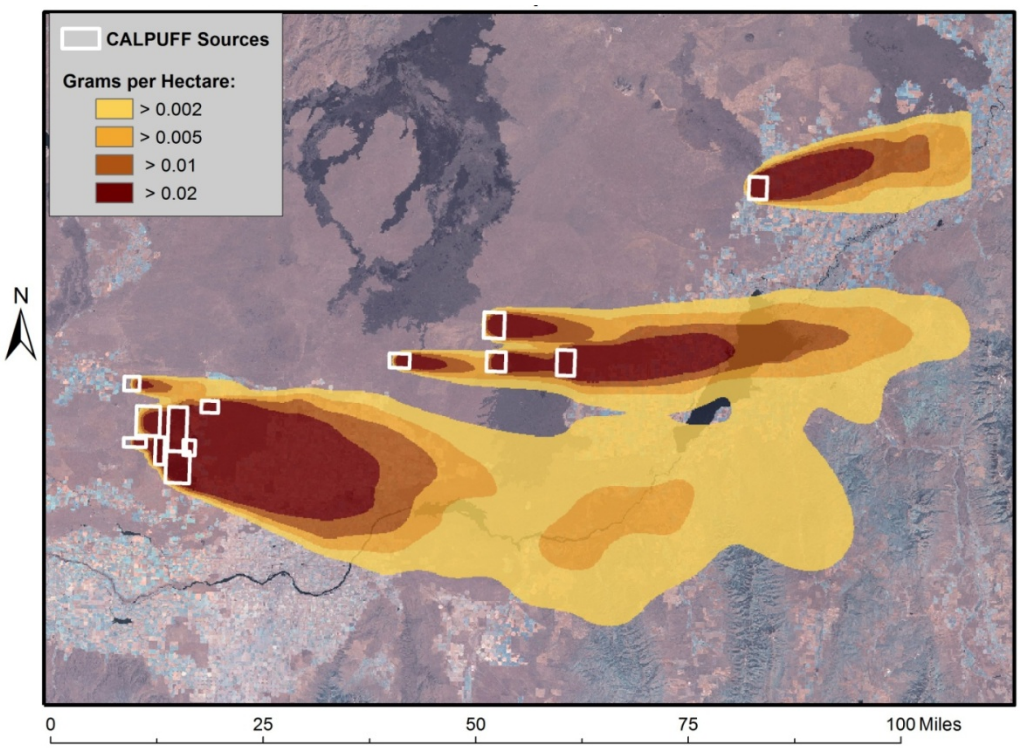

Figure 23. Oust® depositions for the March 25-27, 2001 dust episode (20-mph threshold).

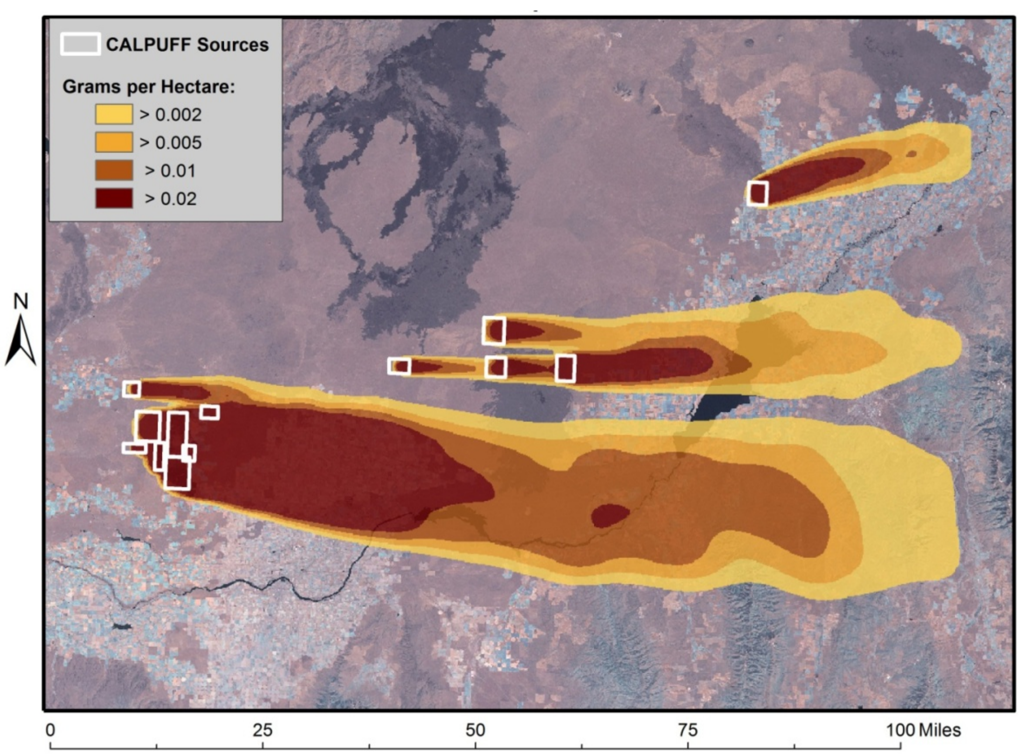

Figure 24. Oust® depositions for the March 30-31, 2001 dust episode (20-mph threshold).

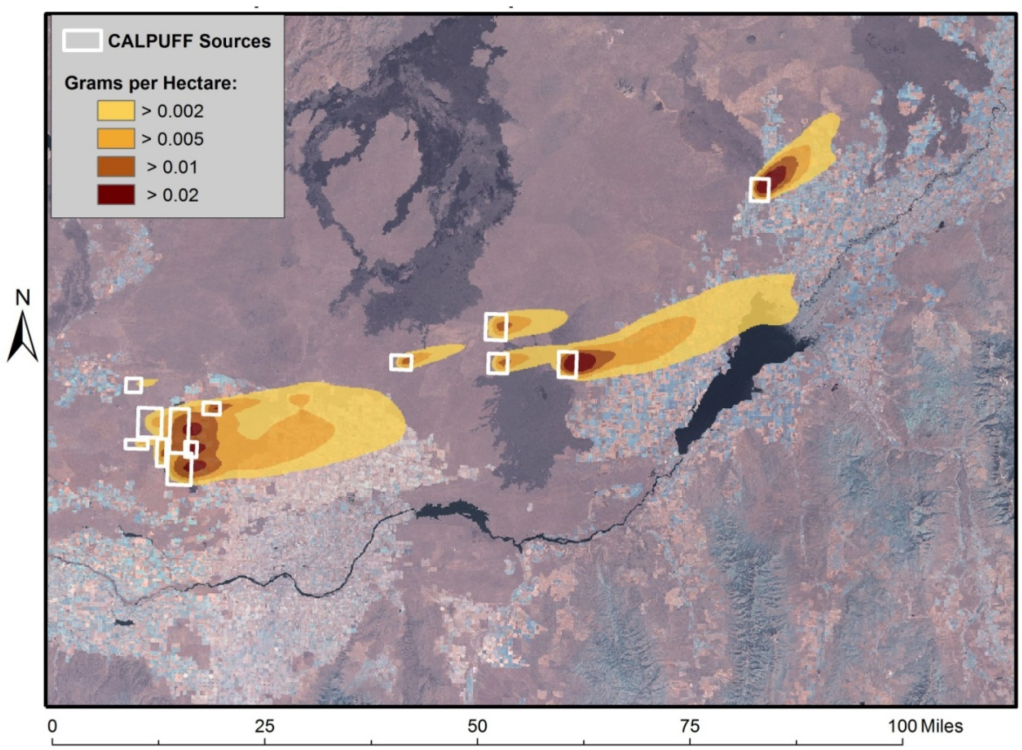

Figure 25. Oust® depositions for the April 1, 2001 dust episode (20-mph threshold).

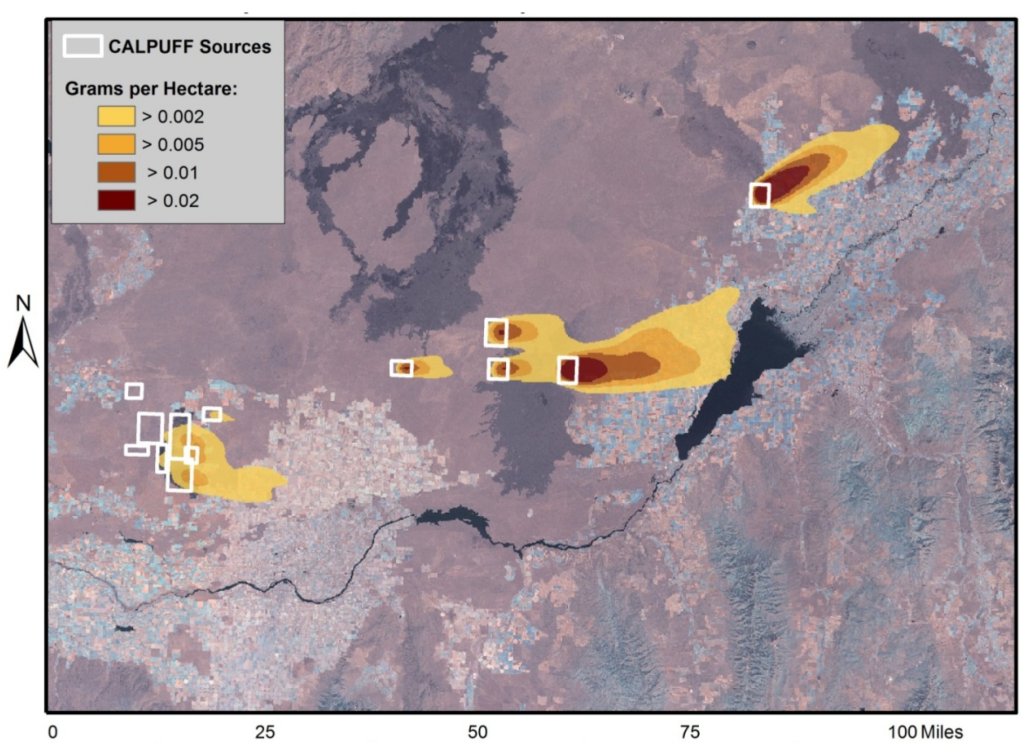

Figure 26. Oust® depositions for the April 28-30, 2001 dust episode (20-mph threshold).

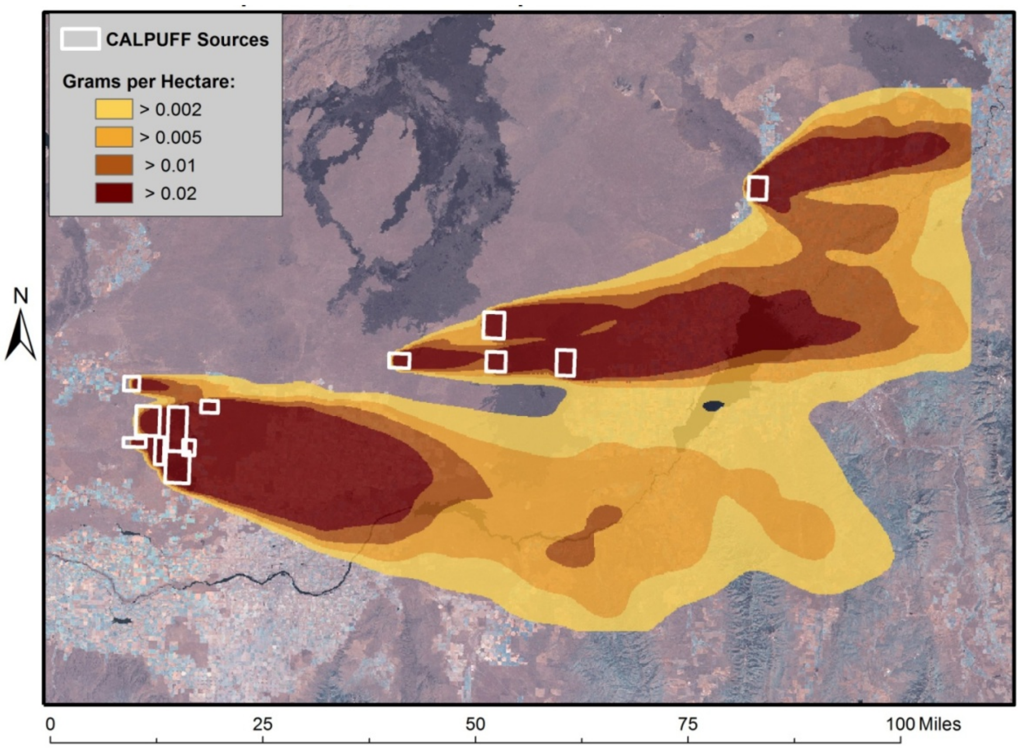

Figure 27. Oust® depositions for the April 30-May 2, 2001 dust episode (20-mph threshold).

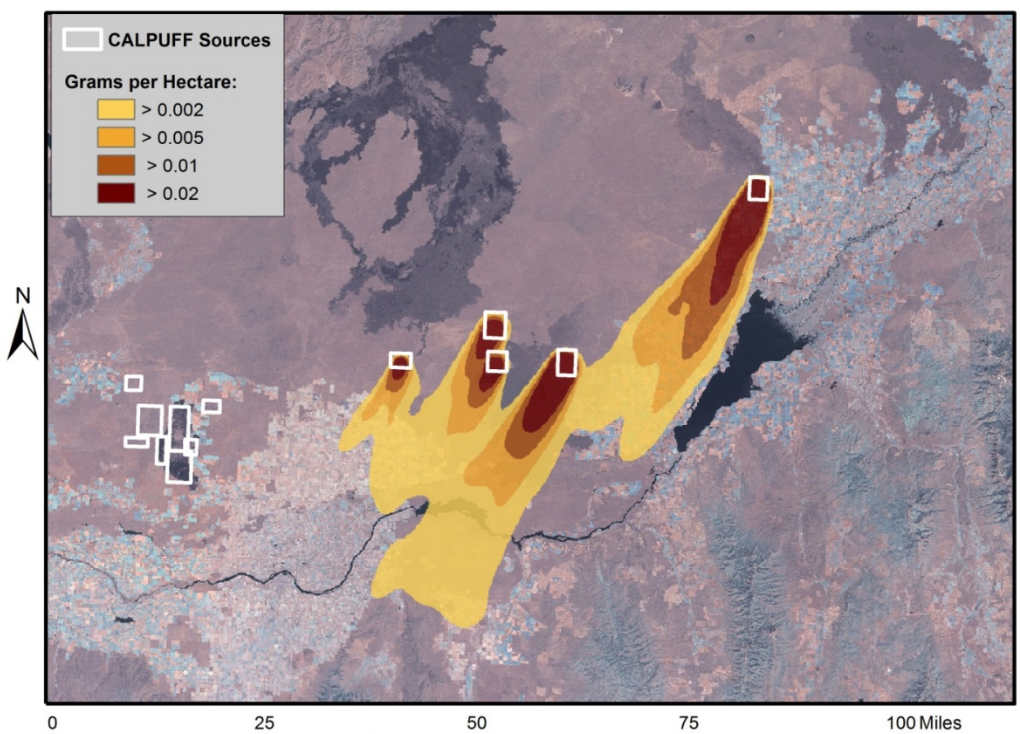

Figure 28. Oust® depositions for the May 2-4, 2001 dust episode (20-mph threshold).

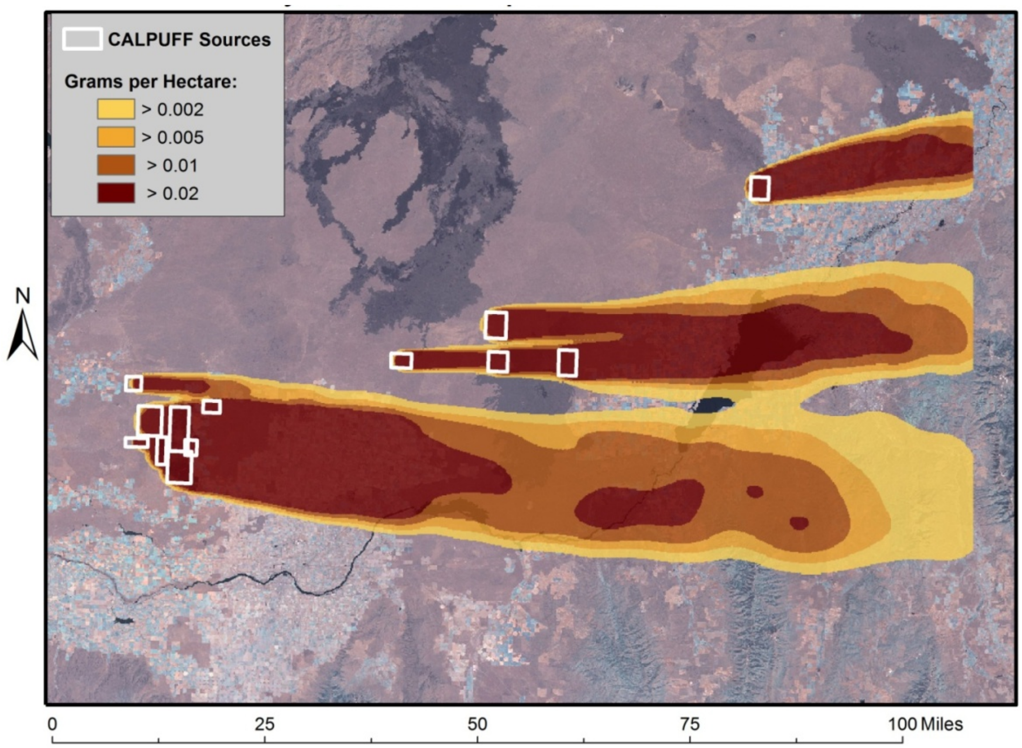

Figure 29. Oust® depositions for the May 5-6, 2001 dust episode (20-mph threshold).

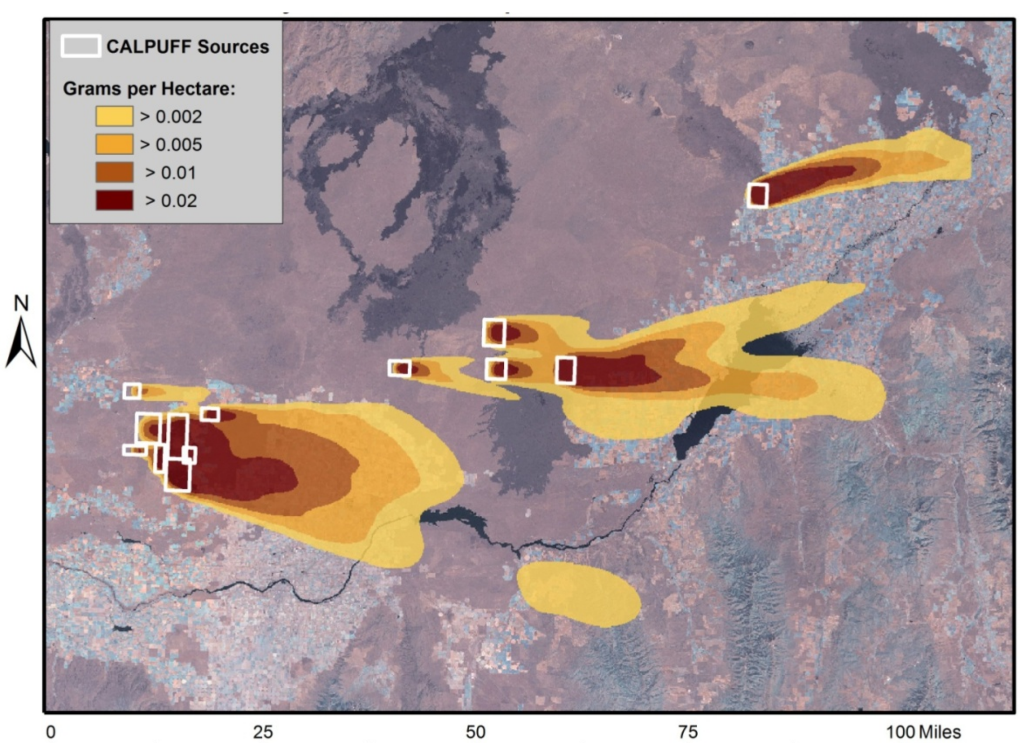

Figure 30. Oust® depositions for the May 9-11, 2001 dust episode (20-mph threshold).

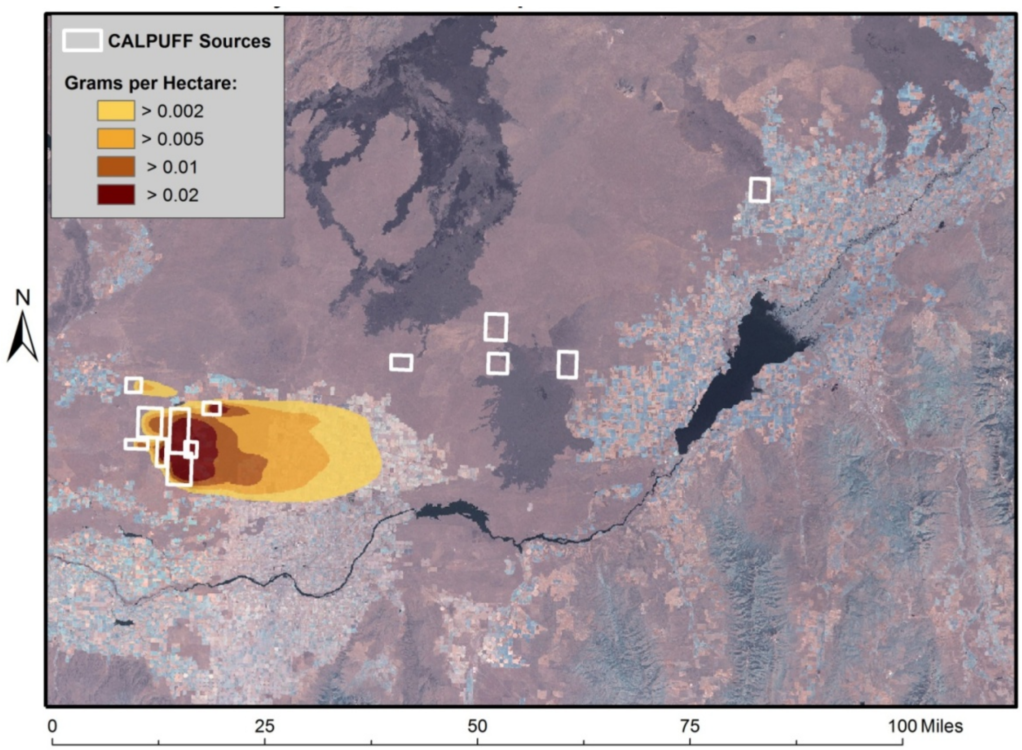

Figure 31. Oust® depositions for the May 12-13, 2001 dust episode (20-mph threshold).

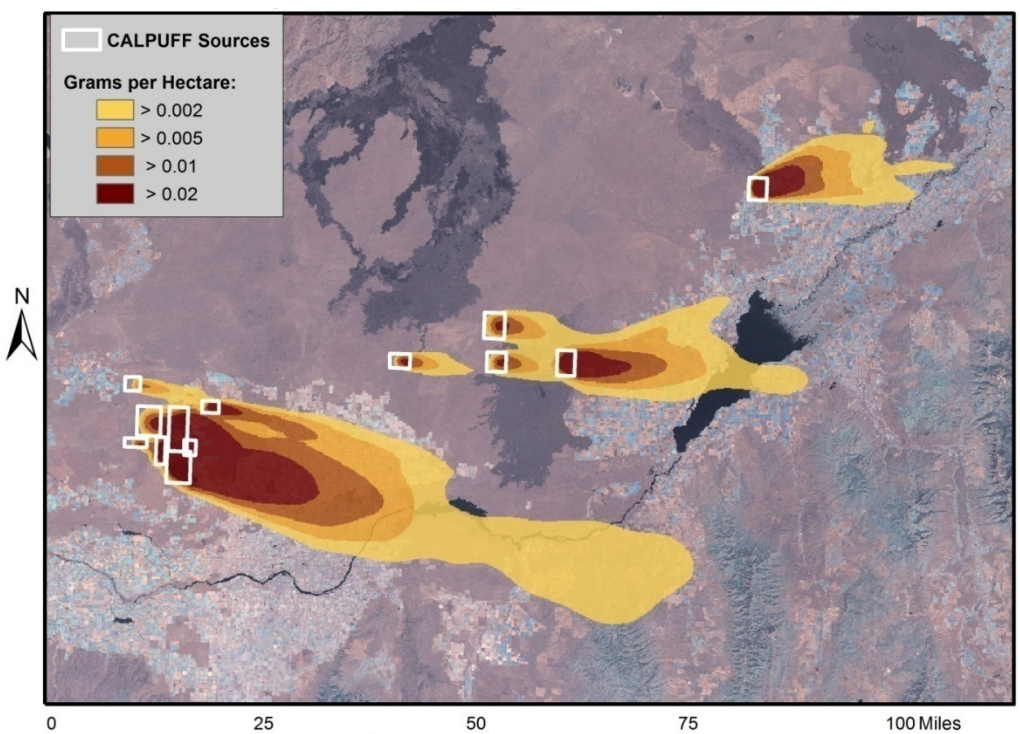

Figure 32. Oust® depositions for the May 14-15, 2001 dust episode (20-mph threshold).

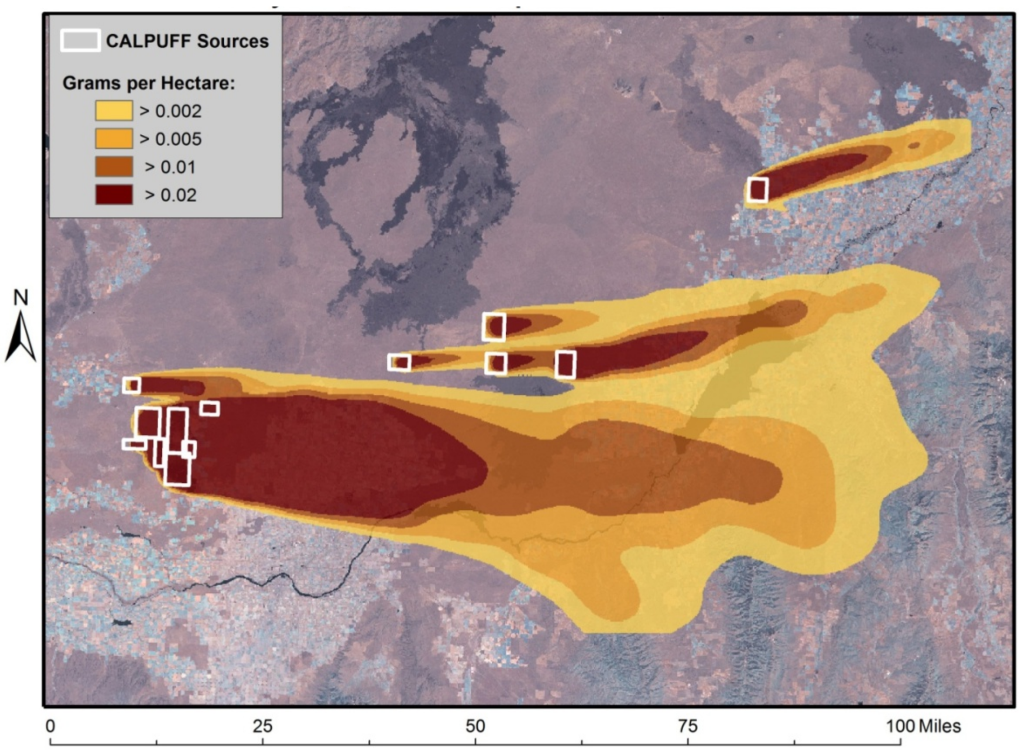

Figure 33. Oust® depositions for the May 19-21, 2001 dust episode (20-mph threshold).

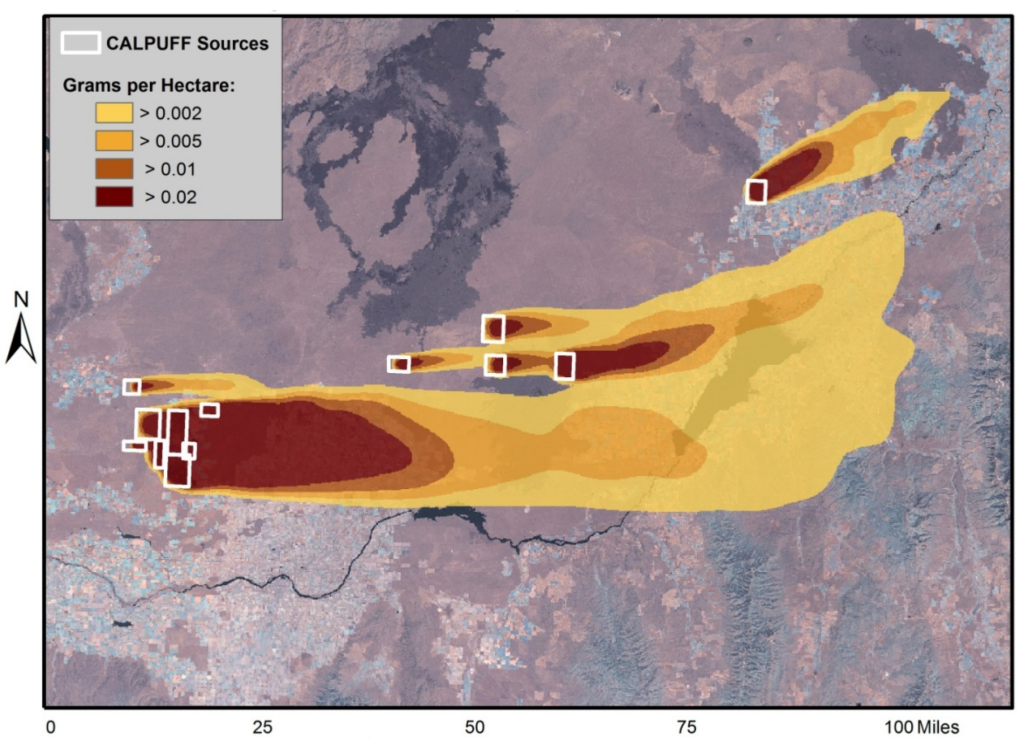

Figure 34. Oust® depositions for the May 29-30, 2001 dust episode (20-mph threshold).

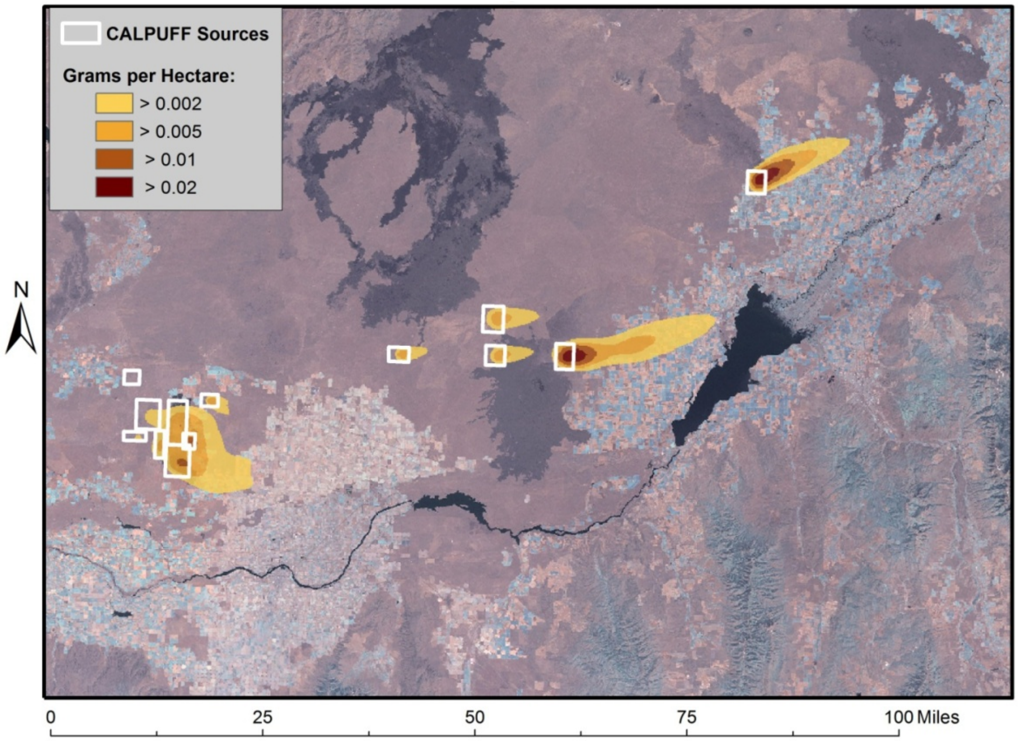

Figure 35. Oust® depositions for the June 9-10, 2001 dust episode (20-mph threshold).

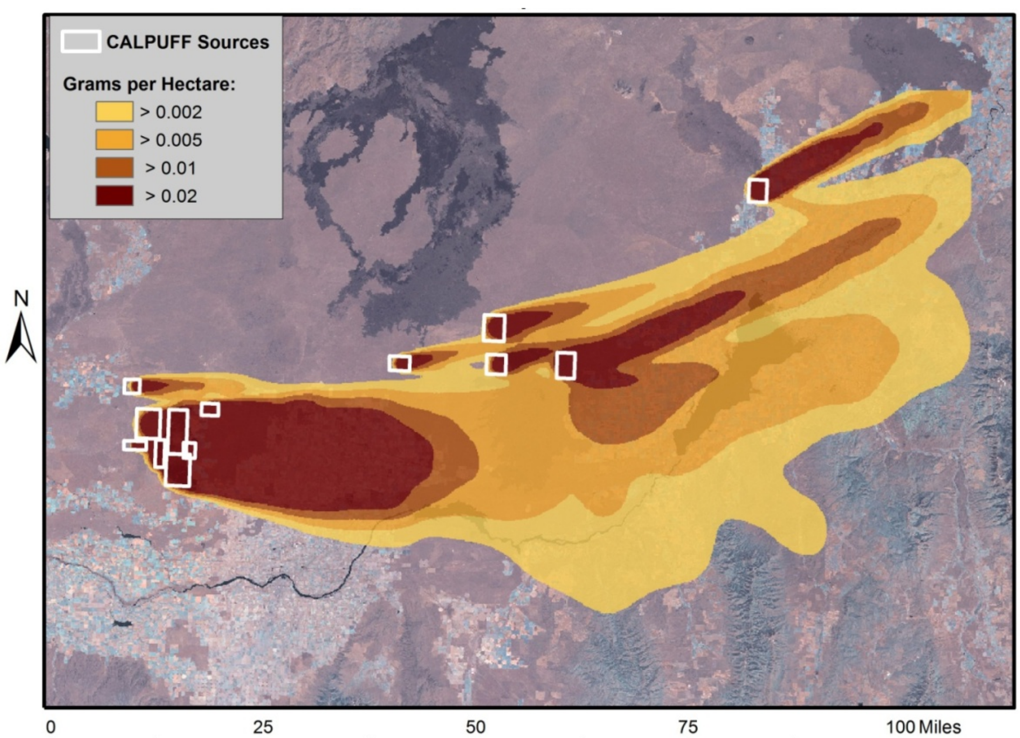

Figure 36. Oust® depositions for the June 12-13, 2001 dust episode (20-mph threshold).

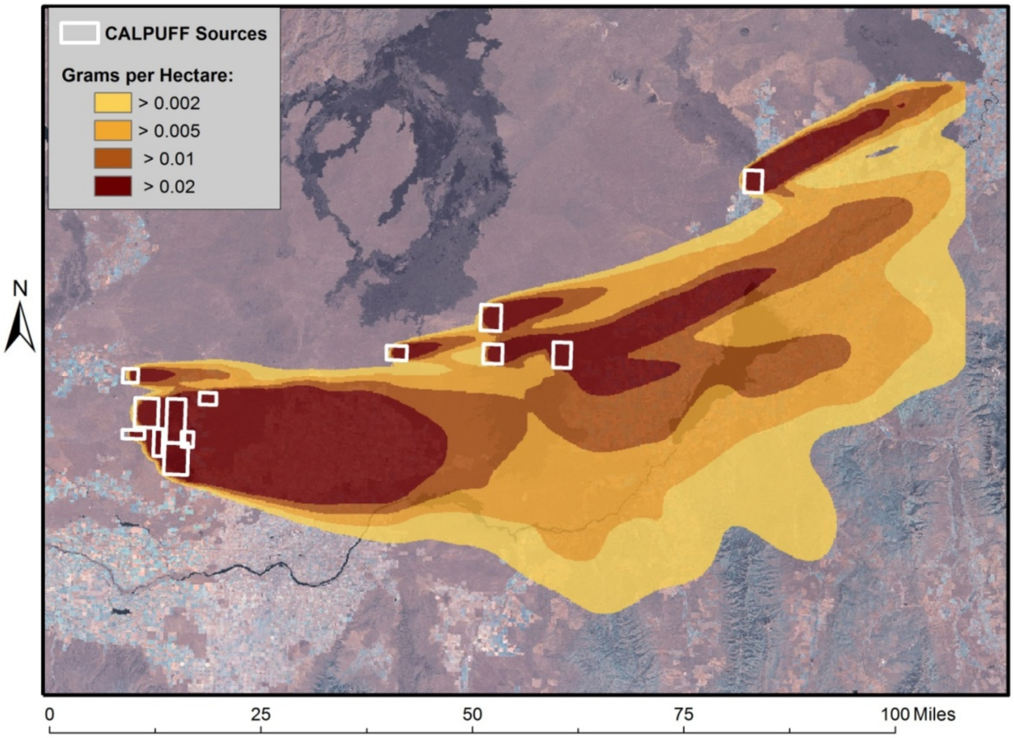

Figure 37. Oust® depositions for the June 12-13, 2001 dust episode (15-mph threshold).

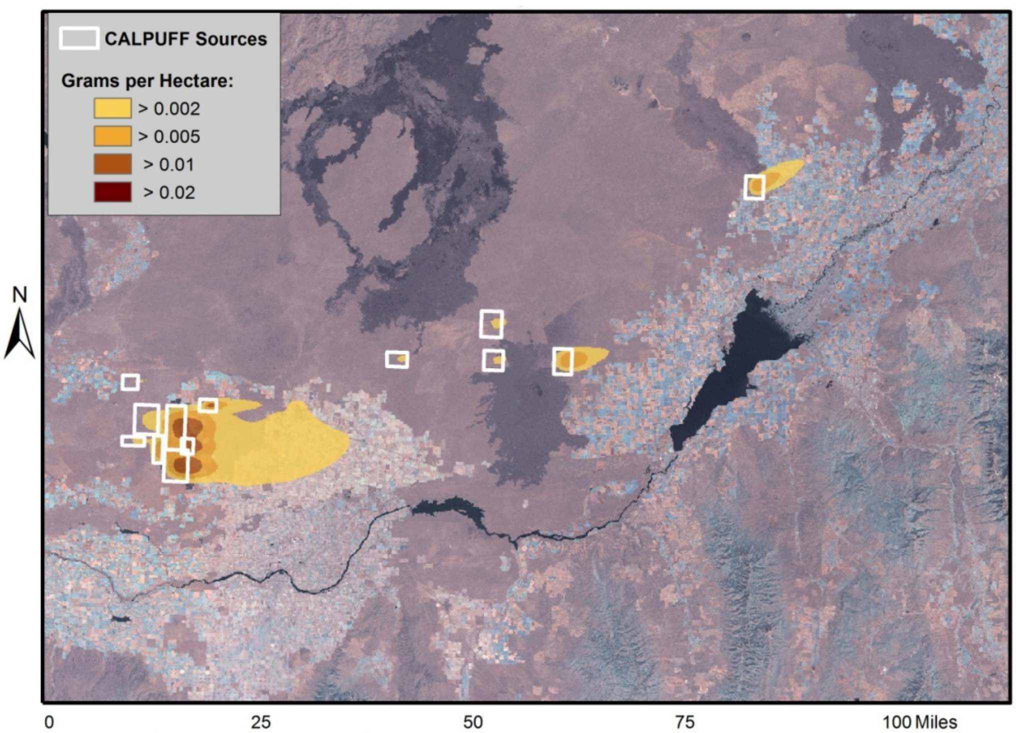

Figure 38. Oust® depositions for the June 15-16, 2001 dust episode (20-mph threshold).

Finally, we present in Figure 39 and Figure 40 the total deposition for all the 30 episodes (with 20-mph threshold) during the two periods of concern: October 1999 – June 2000 and October 2000 – June 2001.

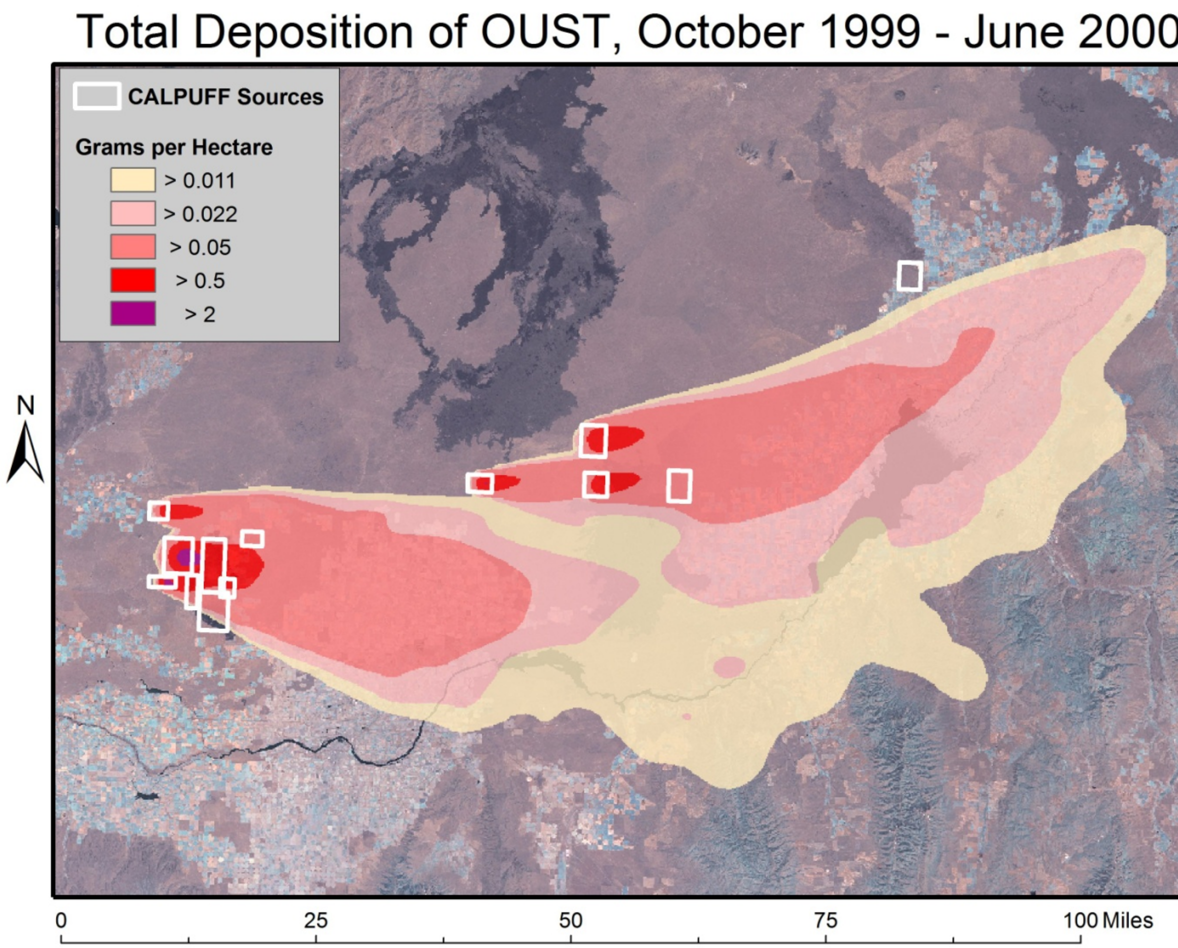

Figure 39. Total Oust® deposition for the first growing season (October 1999 – June 2000).

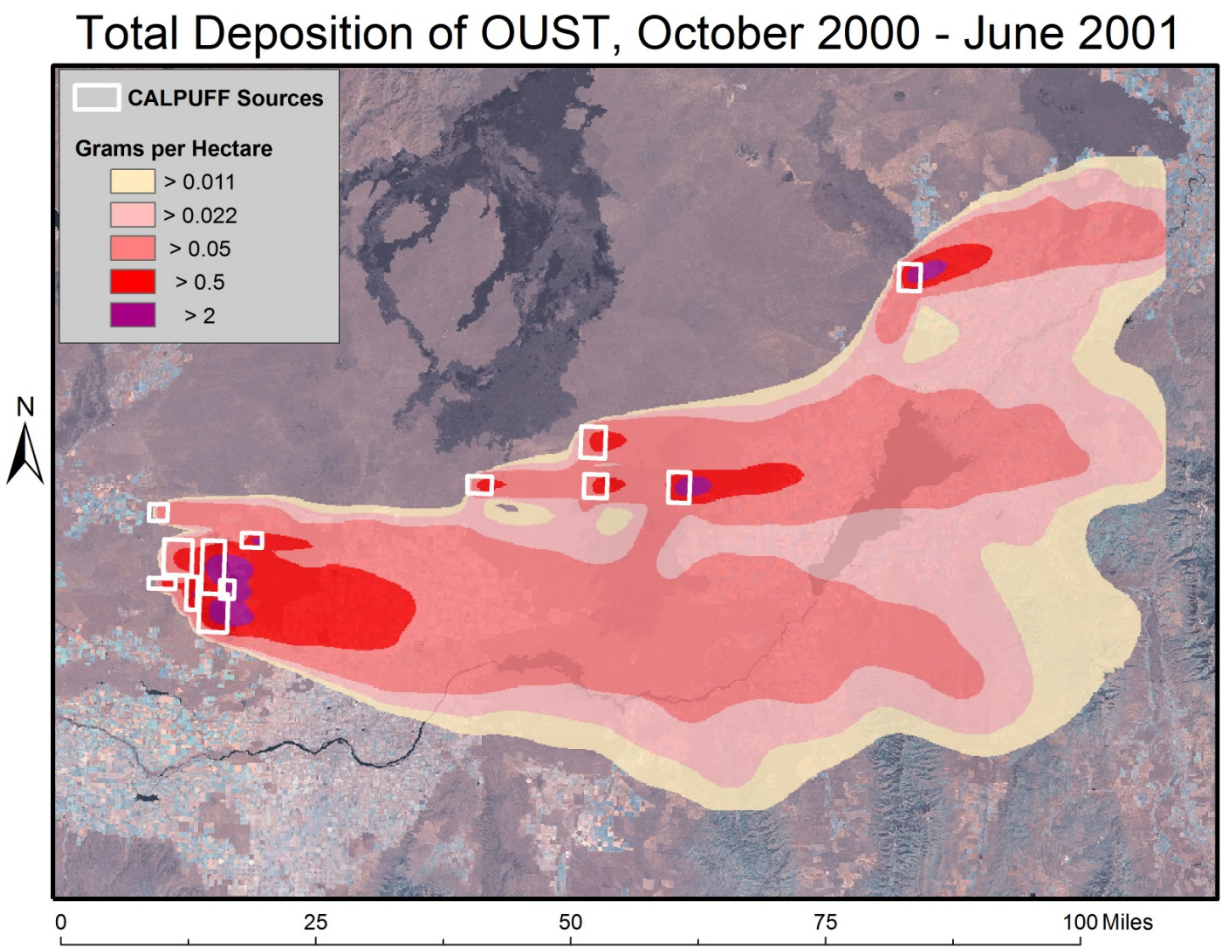

Figure 40. Total Oust® deposition for the second growing season (October 2000 – June 2001).

When examining the Oust® deposition plots presented in the figures above, one should remember that model results always possess some moderate degree of variance based on wind direction and other factors. Other scientific evidence (e.g., observations of crop damage) should be used to support the model results and confirm final opinions and interpretations.

Our current results are virtually identical to those presented at the bellwether trial in 2009. The only changes made to our CALPUFF simulations were:

1. Use of the most recent version of the CALPUFF software;
2. Slightly changed simulation region to accommodate more Plaintiff fields;
3. Use of emission rates directly expressed for Oust®;

4. Running five additional episodes (for a total of 30 episodes); and,
5. Addition of a new area source.[28]

As a validity check, Exponent successfully verified our simulations matched the deposition results at the 16 representative receptors used in our 2008-2009 study.

Our CALPUFF simulations are a component of the three-part model Dr. Shield presented at trial in 2009. The Court determined that the model we used in trial in 2009 was reliable; in fact, the Court[29] stated the following while describing our methodology:

> *175. Using CALPUFF, a wind modeling program endorsed by the EPA, and the data that Dr. Shields provided, Dr. Zannetti modeled the amount of dust that would be deposited at certain down wind locations called "receptors." See Transcript at p. 2315.*

plus:

> *158. To reach these conclusions, Dr. Shields performed a three-part analysis: (1) emission (how much dust blew off the BLM application sites and how much Oust was in that dust); (2) transport (how far the wind-borne Oust contaminated dust traveled), and (3) deposition (how much Oust would be expected to land on the farms of the bellwether plaintiffs under this model). See Transcript at p. 2167.*

and concluded:

> *159. This three-part analysis is explained further below. The Court finds that it is based on sufficient facts or data, is the product of reliable principles and methods, and that Dr. Shields has applied the principles and methods reliably to the facts of the case. See Fed.R.Civ.P. 702.*

[28] The total number of area sources is now 13 (versus 12 used in the 2009 trial), since a new source (Mallard Lake) has been added. The emission rate of this new source is equivalent to that of Wilson Ridge 2 (personal communication from Exponent)

[29] Findings of Fact & Conclusions of Law, Case No. 4:03-CV-00049-BLW, Document 1681, filed 03/24/10.

7 Conclusions

This report presents the current results of our investigation and our opinions, based upon the materials reviewed so far, in relation to the case: *Adams, et al., v the United States of America, Case No.: CIV 03-0049-E-BLW, United States District Court, District of Idaho*. We reserve the right to perform additional simulation modeling and develop further opinions to supplement this report in the event new information is presented. Any of the figures referenced in or attached to this report and accompanying model may be used as exhibits at trial.

Dr. Paolo Zannetti, QEP
President
EnviroComp Consulting, Inc.

Appendix A

CV of Dr. Paolo Zannetti, QEP

CURRICULUM VITAE OF PAOLO ZANNETTI

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EDUCATION AND TITLES

- *Qualified Environmental Professional (QEP),* Institute of Professional Environmental Practice (IPEP) (www.ipep.org)
  Certificate #029440029 (2/1994) – Recertified on 7/2007

- *Doctoral Degree in Physics*, University of Padua, Italy (12/1970) (www.unipd.it)

- *Diploma of Maturita' Scientifica*, Scientific Lyceum Degree, Ippolito Nievo, Padua, Italy (7/1965)

PROFESSIONAL EXPERIENCE

- ***President*, EnviroComp Consulting, Inc. (4/2001 – present)** (www.envirocomp.com)
    - *President and Founder*, EnviroComp Institute (10/1996 – present) (www.envirocomp.org)
    - *Regional Coordinator* for the Institute of Professional Environmental Practice (IPEP) in the San Francisco Bay Area (9/1997 – present) (www.ipep.org)
    - *Visiting Professor,* Wessex Institute of Technology, Southampton, UK (1991 – present) (www.wessex.ac.uk)
    - *Visiting Professor*, Polytechnic University of Bari-Taranto, Italy (1999 – present) (www.poliba.it/Taranto/TARAS_1.htm)
    - *Peer-Reviewer*, Kuwait Institute of Scientific Research, Kuwait, Wessex Institute of Technology, Southampton, UK (2002-present) (http://www.kisr.edu.kw/)

- ***Principal Scientist,* Exponent, Inc., Menlo Park, CA (11/1991-4/2001)** (www.exponent.com)
    - *Instructor,* University Extension, University of California, Berkeley (10/1992 – 7/1997) (www.unex.berkeley.edu:4243)

- ***Department Manager*, AeroVironment, Inc., Pasadena/Monrovia, CA (10/1979 – 11/1991)** (www.aerovironment.com)
    - *Consultant*, IBM Semea, Milan, Italy (1/1991 – 10/1991; on leave of absence from AeroVironment)
    - *Head, Environmental Sciences*, IBM Scientific Center, Bergen, Norway and *Leader*, *Environmental Sciences Activities of IBM Europe* (3/1990 – 12/1990; on leave of absence from AeroVironment)
    - *Consultant*, Research Center of the Italian National Electric Power Company (CRTN/ENEL), Milan, Italy (3/1984 – 10/1984; on leave of absence from AeroVironment)
    - *Project Manager*, Kuwait Institute for Scientific Research (KISR), Kuwait (2/1982 – 2/1984; on leave of absence from AeroVironment) (www.kisr.edu.kw)

- ***Researcher*, IBM Scientific Center, Venice, Italy (8/1971 – 10/1979)**
    - *Visiting Scientist*, Department of Statistics, Stanford University, California (1/1978 – 3/1979; on assignment from IBM Italy)
    - *Visiting Scientist,* IBM Scientific Center, Palo Alto, CA (1/1978 – 3/1979; on assignment from IBM Italy)
    - *Assistant Professor,* Department of Civil Engineering, University of Padua, Italy (1974 – 1978) (www.unipd.it)

- ***Systems Analyst*, UNIVAC/Sperry Rand, Milano, Italy (3/1971 – 7/1971)**

EDITORIAL RESPONSIBILITY

- Editor, Book Series, "Environmental Sciences and Environmental Computing". Three published volumes (www.envirocomp.org/esec)

- Editor and Co-Author, Book Series, "Air Quality Modeling – Theories, Methodologies, Computational Techniques, and Available Databases and Software". Three published volumes (www.envirocomp.org/aqm)

- Editor, Book Series, "Environmental Modeling". Computational Mechanics Publications. Three published volumes (http://www.witpress.com/978-1-85312-281-1.html)

- Member, Editorial Board, "Environmental Forensics" (AEHS) (2003 – present)

- Founder and President, The EnviroComp Institute – The International Institute of Environmental Sciences and Environmental Computing (since 1996) (www.envirocomp.org)

- Founder and Editor-in-Chief (1986 – 1993), quarterly journal *Environmental Software*, Computational Mechanics Publications (since June 1986) and Elsevier Applied Science (since September 1991); currently Founding Editor

- Founder and Co-Director (until 1998), biennial ENVIROSOFT Conference – Computer Techniques in Environmental Studies (conferences held every two years since 1986)

- Founder and Co-Director, first two AIR POLLUTION Conferences – Computer Techniques in Environmental Studies (1993 – 1994); currently Member, Conference Board

- Associate Editor/Member, Editorial Board, *Atmospheric Environment*, Pergamon Press (1987 – 1999)

- Member, Editorial Board, *Ecological Modeling*, Elsevier Applied Science (1992 – 2007)

- Member, Editorial Board, *ENVIRONews*, FiatLux Publications (1993 – 1998) (www.envirocomp.org/html/news/flpub.htm)

MEMBERSHIPS

- Member, International Scientific Advisory Committee, AIR POLLUTION Conference Cycle, Wessex Institute of Technology, UK (since 2000)

- Member, "SATURN Specialist Group" (http://aix.meng.auth.gr/lhtee/saturn.html), subproject of EUROTRAC-2 (http://www.gsf.de/eurotrac) dealing with urban air pollution (since 1998)

- San Francisco Bay Area Regional Coordinator for the Institute of Professional Environmental Practice (IPEP) (since 1997) (www.ipep.org)

- Athens 2004 Committee (1997 – 2000)

- Reviewer Group, Center for Indoor Air Research (CIAR) (1995 – 1999)

- International Scientific Advisory Committee, Environmental Engineering and Management Conference, Barcelona, Spain (October 1998)

- International Scientific Advisory Committee, Environmental Engineering, Education and Training Conference (EEET96), Southampton, UK (April 1996)

- Scientific Advisory Board, International Congress on Modeling and Simulation (MODSIM 93 and MODSIM 95), Modeling and Simulation Society of Australia, Inc.

- International Federation for Information Processing (IFIP), Working Group WG 5.11 (Computers and Environment) (1992 – 1997)

- ISATA Programme Committee (1992 – 1994)

- Scientific Committee of the Technological Consortium THETIS (Venice, Italy) (1991)

- Board of Directors, MONDOMETANO, RES Editrice srl (1989 – 1992)

- European Association for the Science of Air Pollution (EURASAP) (1987 – 1994)

- EPA-ASRL pool for the review of U.S. Environmental Protection Agency publications (1987 – 1996)

- American Meteorological Society (AMS) (1978 – 1985)

- Air & Waste Management Association (A&WMA) (originally Air Pollution Control Association, APCA) (since 1978)

MISCELLANEA

- Italian Citizen by birth; U.S. Citizen since 1989
- Languages: English, Italian, French, plus understanding of Spanish

HONORS

- Medal award from Computational Mechanics, Ashurst, UK, in recognition of contribution to the development of Environmental Modeling (11/1994)

- Plaque award from the South Coast Air Quality Management District, in recognition of contribution to the Toxic Symposium at Caltech, Pasadena, CA (7/1986)

PUBLICATIONS (**DL** indicates downloadable publications[1])

Books

B.25 Zannetti, P. (ed) (2008) Air Quality Modeling – Theories, Methodologies, Computational Techniques, and Available Databases and Software, Vol. III – Special Issues, Book Series, The EnviroComp Institute and the Air & Waste Management Association (www.envirocomp.org/aqm)

B.24 Zannetti, P., S. Elliott, and D. Rouson (eds) (2007) Environmental Sciences and Environmental Computing, Vol. III, Electronic book (on CD-ROM), The EnviroComp Institute (www.envirocomp.org/esec)

B.23 Zannetti, P., D. Al-Ajmi, and S. Al-Rashied (eds) (2007) Ambient Air Pollution, The Arab School for Science and Technology (ASST) and The EnviroComp Institute (www.envirocomp.org/asst)

B.22 Zannetti, P. (ed) (2005) Air Quality Modeling – Theories, Methodologies, Computational Techniques, and Available Databases and Software, Vol. II – Advanced Topics, Book Series, The EnviroComp Institute and the Air & Waste Management Association (www.envirocomp.org/aqm)

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B.19 Brebbia, C.A. and P. Zannetti (eds) (2002) Development and Application of Computer Techniques to Environmental Studies IX, WIT Press (www.witpress.com)

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[1] Available at http://www.envirocomp.com/people1/CV/zannetti.pdf

B.18 Ibarra-Berastegi, G., C.A. Brebbia, and P. Zannetti (eds) (2000) Development and Application of Computer Techniques to Environmental Studies VIII, WIT Press (www.witpress.com)

B.17 Zannetti, P. and Y.Q. Zhang (eds) (1998) Environmental Sciences and Environmental Computing, Vol. I, Electronic book (on CD-ROM), FiatLux Publications and EnviroComp Institute (www.envirocomp.org/esec)

B.16 Pepper, D.W., C.A. Brebbia, and P. Zannetti (eds) (1998) Development and Application of Computer Techniques to Environmental Studies, Proceedings, ENVIROSOFT 98 Conference, Las Vegas, NV, November, WIT Press – Computational Mechanics Publications, Southampton

B.15 Zannetti, P. (ed) (1996) Environmental Modeling – Computer Methods and Software for Simulating Environmental Pollution and its Adverse Effects – Vol. III, Computational Mechanics Publications, Southampton

B.14 Zannetti, P. and C. Brebbia (eds) (1996) Development and Application of Computer Techniques to Environmental Studies VI, Proceedings, ENVIROSOFT 96 Conference, Como, Italy, September, Computational Mechanics Publications, Southampton

B.13 Zannetti, P. (ed) (1994) Pollution Modeling, Vol. I, Proceedings, ENVIROSOFT 94 Conference, San Francisco, CA, November, Computational Mechanics Publications, Southampton

B.12 Zannetti, P. (ed) (1994) Environmental Systems, Vol. II, Proceedings, ENVIROSOFT 94 Conference, San Francisco, CA, November, Computational Mechanics Publications, Southampton

B.11 Baldasano, J.M., C.A. Brebbia, H. Power, and P. Zannetti (eds) (1994) Computer Simulation, Vol. I, Proceedings, Second International AIR POLLUTION Conference, Barcelona, Spain, September 1994, Computational Mechanics Publications, Southampton

B.10 Baldasano, J.M., C.A. Brebbia, H. Power, and P. Zannetti (eds) (1994) Pollution Control and Monitoring, Vol. II, Proceedings, Second International AIR POLLUTION Conference, Barcelona, Spain, September 1994, Computational Mechanics Publications, Southampton

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B.8 Zannetti, P., C.A. Brebbia, J.E. Garcia Gardea, and G. Ayala Milian (eds) (1993) Air Pollution, First International Conference on Air Pollution, Monterrey, Mexico, February, Computational Mechanics Publications, Southampton, and Elsevier Science Publishers, London

B.7 Zannetti, P. (ed) (1993) Environmental Modeling – Computer Methods and Software for Simulating Environmental Pollution and its Adverse Effects – Vol. I, Computational Mechanics Publications, Southampton, and Elsevier Science Publishers, London

B.6 Zannetti, P. (ed) (1992) Computer Techniques in Environmental Studies IV, Proceedings, Fourth International Conference ENVIROSOFT 92, Computational Mechanics Publications, Southampton, and Elsevier Applied Science, London

B.5 Melli, P. and P. Zannetti (eds) (1992) Environmental Modeling, Computational Mechanics Publications, Southampton, and Elsevier Applied Science, London

B.4 Zannetti, P. (1990) Air Pollution Modeling – Theories, Computational Methods and Available Software, Computational Mechanics Publications, Southampton, and Van Nostrand Reinhold, New York, 450 pp (http://www.amazon.com/Pollution-Modeling-Theories-Computational-Available/dp/0442308051) **DL**

B.3 Zannetti, P. (ed) (1990) Computer Techniques in Environmental Studies III, Proceedings, Third International Conference ENVIROSOFT 90, Computational Mechanics Publications, Southampton, UK

B.2 Zannetti, P. (ed) (1988) Computer Techniques in Environmental Studies, ENVIROSOFT 88, Second International Conference, Porto Carras, Greece, September, Ashurst, UK, Computational Mechanics Publications

B.1 Zannetti, P. (ed) (1986) ENVIROSOFT 86, Proceedings, International Conference on Development and Application of Computer Techniques to Environmental Studies, Los Angeles, CA, USA, November 1986, Ashurst, UK, Computational Mechanics Publications

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BC.15 Zannetti, P. (2008) Air Quality Modeling Resources on the Web, Chapter 27, Air Quality Modeling – Theories, Methodologies, Computational Techniques, and Available Databases and Software, Vol. III – Special Issues, P. Zannetti (ed), The EnviroComp Institute and the Air & Waste Management Association (www.envirocomp.org/aqm) **DL**

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BC.4 Zannetti, P. (1993) Numerical Simulation Modeling of Air Pollution: An Overview, Section of Ecological Physical Chemistry, L. Bonati, U. Cosentino, M. Lasagni, G. Moro, D. Pitea, and A. Schiraldi (eds), Elsevier Science Publishers, London; also Air Pollution, P. Zannetti, C.A. Brebbia, J.E. Garcia Gardea, and G. Ayala Milian (eds), First

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JA.23 Zannetti, P. (1996) Modeling Danger – Computer Simulations Analyze Pollution Effects, Forecast Problems, Contingency Magazine, (March/April):73-75 **DL**

JA.22 Boybeyi Z., S. Raman, and P. Zannetti (1995) Numerical Investigation of Possible Role of Local Meteorology in Bhopal Gas Accident, Atmospheric Environment (Urban Atmosphere), **29**(4):479-496 **DL**

JA.21 Zannetti, P., I. Tombach, S. Cvencek, and W. Balson (1993) Calculation of visual range improvements from SO_2 emission controls – II: An application to the Eastern United States, Atmospheric Environment, **27A**:1479-1490 **DL**

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JA.18 Brusasca, G., G. Tinarelli, D. Anfossi, and P. Zannetti (1987) Particle modeling simulation of atmospheric dispersion using the MC-LAGPAR package, Environmental Software, **2**(3):15l-158 **DL**

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JA.15 Tirabassi, T., M. Tagliazucca, and P. Zannetti (1986) KAPPA-G, a non-Gaussian plume dispersion model: description and evaluation against tracer measurements, Journal of the Air Pollution Control Association, **36**:592-596 **DL**

JA.14 Zannetti, P. (1984) New Monte Carlo scheme for simulating Lagrangian particle diffusion with wind shear effects, Applied Mathematical Modeling, **8**:188-192 **DL**

JA.13 Zannetti, P. (1982b) Il "Controlled Trading" negli Stati Uniti [Controlled Trading of pollution emissions in the US], Note di Inforrnatica, **1**:71-83, IBM Italia; also in Inquinamento, **25**(7/8):61-64, Etas Kompass, 1983 **DL**

JA.12 Zannetti, P. (1981b) Scommessa con il sole [Solar Challenger], Scienza e Vita Nuova, **3**(7):16-21, Rusconi Editore **DL**

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