CW 06

November 8, 1994

TECHNICAL SUPPORT DOCUMENT

Modeling Demonstration to Support an Attainment Date Extension for the Western Michigan Moderate Ozone Nonattainment Areas

Pursuant to Section 181 of the Clean Air Act Amendments of 1990 ("the Act"), USEPA has classified portions of western Michigan as moderate nonattainment areas for ozone. These areas are as follows:

Michigan: Grand Rapids Area (Kent and Ottawa Counties)

Muskegon Area (Muskegon County)

Section 182(b)(1)(A) of the Act requires each state in which all or part of an ozone moderate nonattainment area exists to submit by November 15, 1994 a revision to its implementation plan which provides for sufficient reductions in emissions of volatile organic compounds (VOC) and oxides of nitrogen (NOx) as necessary to attain the national ambient air quality standard (NAAQS) for ozone by the statutory attainment date.

According to section 181 of the Act, moderate nonattainment areas for ozone are required to attain as expeditiously as practicable, but not later than November 15, 1996. Because there is overwhelming transport of ozone into these LMOS moderate nonattainment areas from nearby upwind (severe) nonattainment areas, and because severe nonattainment areas have a later statutory attainment date (i.e., November 15, 2007, in this case), the western Michigan moderate nonattainment areas may not be able to: (a) submit a demonstration by November 1994 that the areas will attain by 1996, or (b) actually demonstrate attainment through monitoring data by 1996.

To resolve these conflicting provisions of the Act, USEPA has issued guidance on attainment dates for ozone nonattainment areas affected by overwhelming transport (see "Ozone Attainment Dates for Areas Affected by Overwhelming Transport", September 1, 1994). This guidance allows such areas to suspend temporarily the original attainment date without "bumping" them up to a higher classification. For the purposes of developing their attainment demonstration, Michigan can use the upwind areas' attainment date (i.e., 2007) in the absence of any analyses from the upwind areas. When later information becomes available from the upwind areas, USEPA may require additional analysis by the downwind moderate nonattainment areas to determine if an adjustment of the 2007 date is necessary.

METHODOLOGY

According to USEPA's guidance, to qualify for an extension, it must demonstrate that emissions reduction measures contained in the SIP would be, at a minimum, sufficient to achieve attainment by the date generally applicable for the area's classification but for the overwhelming amount of transported pollutants into the area from the upwind area. This demonstration for the Lake Michigan area will be performed using the UAM-V model (Standard Version 1.11). The model will be run with both Grid A (outer grid with 16 km resolution), Grid B (inner grid with 8 km resolution), and Grid C (innermost grid with 4 km resolution); and 8 vertical layers. Model inputs are as follows:

Boundary Conditions:based on observations, with surface data used to set layer 1-2 values and aircraft data used to set layer 3-8

(Note: future year [1996] boundary conditions were assumed to be the same as base year [1991] boundary conditions.)

Wind Fields: based on the CALRAMS prognostic meteorological model

Emissions: based on the LMOS Round 3a modeling inventory (see "Modeling Inventory for the Lake Michigan Region", August 1994)

Vertical Diffusivity: based on KRAMS preprocessor, w/ LADCO modifications

Chemical Mechanism: USEPA's recommended CB-IV mechanism (with UAM-IV photolysis rates)

Plume-in-Grid: applied to top 50 NOx point sources

For more information concerning these model inputs, see "Evaluation of the UAM-V Photochemical Grid Model in the Lake Michigan Region", Version 2.0, September 1994.

The modeling analysis consists of the following steps:

(1) Demonstrate Effectiveness of Mandatory Control Measures: LMOP Strategy 1 (1996 scenario reflecting growth and mandatory Clean Air Act controls) was modeled for LMOS Episodes 1 - 4 (see Table 1). A summary of the Strategy 1

VOC and NOx emissions is presented in Table 2.

(2) Demonstrate Overwhelming Transport: If the Strategy 1 results do not show attainment in the moderate nonattainment areas, then it is necessary to determine whether overwhelming transport is responsible for preventing attainment in these areas. To determine the contributions of the moderate nonattainment areas and the upwind nonattainment areas, an additional simulation must be performed in which the NOx and anthropogenic VOC emissions in the moderate nonattainment counties are zeroed-out. (Note: pursuant to USEPA guidance, this demonstration need only be made for one episode. This is appropriate given that attainment must be shown for all episodes and the inability to show attainment for one episode due to overwhelming transport would prevent a State from preparing a complete attainment demonstration.)

MODELING RESULTS

The Strategy 1 peak ozone concentrations (domain-wide and at ambient monitoring sites in the western Michigan moderate nonattainment areas) are presented in Table 3. Plots of the peak daily ozone concentrations are provided in Attachment 3.

The highest predicted (and observed) ozone concentrations in western Michigan occur during Episode 2. To determine whether overwhelming transport is responsible for preventing attainment in these areas, an additional simulation was performed where all anthropogenic emissions in the moderate nonattainment counties were eliminated (see Figure 1 for the area where emissions were zeroed-out). The peak ozone concentrations (domain-wide and at ambient monitoring sites in the western Michigan moderate nonattainment counties) for this simulation are also presented in Table 3. Plots of the peak daily ozone concentrations are provided in Attachment 3.

As can be seen, the elimination of all local anthropogenic ozone precursor emissions has no affect on the domain-wide peak ozone concentration. Furthermore, the peak ozone concentration at ambient monitoring sites in the western Michigan moderate nonattainment counties also shows no significant change. (Note, the slight increase in these peak ozone concentrations is probably due to the elimination of NOx emissions which serve to titrate ozone concentrations locally.) This additional run shows that during Episode 2: (a) the air entering these counties is above the NAAQS, and (b) the local contribution is very small. It is, therefore, apparent that the moderate nonattainment areas would be able to attain the ozone NAAQS, but for the overwhelming transport from nearby upwind severe nonattainment areas (and from areas outside the modeling domain). The showing of overwhelming transport for one episode (Episode 2) is sufficient to justify a later attainment date, especially given that Episode 2-type conditions are

responsible for most of the exceedances which occur in western Michigan.[1]

Marginal modeled exceedances also occur in western Michigan during Episode 4 (June 21).[2] Comparison of the concentration plots in Attachment 3 (Basecase C v. Strategy 1 for June 21) shows that the Strategy 1 emission reductions in the three moderate nonattainment counties are effective in reducing the magnitude of predicted peak ozone concentrations and the spatial extent of area above 120 ppb in western Michigan. The remaining nonattainment problem can be attributed to high boundary conditions (i.e., the modeled boundary conditions on this day were 90 - 100 ppb). Recent analyses have demonstrated the need for lower boundary conditions in order to demonstrate attainment in the Lake Michigan region.[3] Preliminary modeling has shown that as little as a 15% reduction in boundary conditions is sufficient to show modeled attainment for Episode 4.[4] It is, therefore, clear that transport is a problem for both LMOS episodes with predicted exceedances in western Michigan.

In summary, this modeling analysis has demonstrated that the western Michigan moderate nonattainment counties cannot attain by the statutory attainment date due to overwhelming transport from nearby upwind severe nonattainment areas (and from areas outside the modeling domain). In accordance with USEPA policy, these moderate nonattainment counties qualify for a temporary suspension of the original attainment date. While the policy does not allow for final approval of an attainment date extension (with a

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1 See "Ozone Air Quality Study for the Lower Lake Michigan Air Quality Region", September 1989, Systems Applications International; "Representativeness of 1991 LMOS Ozone Episodes and Relations Between Ozone Episodes and Meteorological Variables in the Lake Michigan Area", January 1993, Sigma Research Corporation; and "Frequency of Ozone Episodes with Northeasterly Winds", April 1994, Lake Michigan Air Directors Consortium.

2 The National Ambient Air Quality Standard for ozone is defined as 0.12 ppm. In a memorandum dated December 15, 1992, USEPA stated that the target model attainment level is 0.120 ppm (see "The Ozone Attainment Test in the State Implementation Plan (SIP) Modeling Demonstrations", from Joseph Tikvart, USEPA, OAQPS to Brenda Johnson, USEPA, Region IV). Thus, a prediction of 123 ppb constitutes a modeled exceedance.

3 Emissions and boundary condition sensitivity tests for the latest model basecase (Basecase C) found that reductions in boundary conditions were more effective in decreasing peak modeled ozone concentrations than reductions in local ozone precursor emissions. Consequently, it was concluded that the regional attainment demonstration must include lower boundary conditions (e.g., on the order of 15 - 30%), as well as lower local emissions. (See "Model Sensitivity Tests - Set 5", October 28, 1994, Lake Michigan Air Directors Consortium)

4 See "Control Strategy Modeling, Strategies 1 and 2", DRAFT, November 9, 1994, Lake Michigan Air Directors Consortium.

newly specified attainment date), it does allow the downwind area (in this case, western Michigan) to use the upwind area's (in this case, Chicago) attainment date (i.e., 2007) for the purpose of developing an attainment demonstration, given that the upwind area's analysis and attainment demonstration are not yet available. This means that the Lake Michigan regional planning effort can move forward assuming a 2007 attainment date for the region. (If it is later found that a sooner attainment date is achievable for the Chicago severe nonattainment area, then it will be necessary to adjust the attainment date for western Michigan accordingly.)

The new temporary attainment date applies also to the requirement to show attainment based on actual ambient monitoring data. Consequently, the policy would preclude USEPA from "bumping" the moderate nonattainment counties up to a higher nonattainment classification in the event that ambient monitoring data does not show attainment by November 15, 1996.

Table 1. Strategy 1 Control Measures

General Description of Strategy

Mandatory Clean Air Act control measures to be implemented by 1996

Other State-specific control measures in the 15% plans to be implemented by 1996

Stationary Sources

Point Source Measures (New CTGs, RACT tightening, major source non-CTG, RACT fix-ups and catch-ups, Title III MACT, and Title IV NOx-Phase 1)

Area Source Measures (Stage II, Architectural and Industrial Maintenance Coatings)

State-Specific 15% Measures (e.g., IL - bakeries, IN - coke battery shutdowns, WI-yeast manufacturing)

Transportation

Current State transportation implementation plans (build scenario)

Employee Commute Options Program (partial implementation)

Motor Vehicle

Tier I standards

Enhanced I/M in severe nonattainment areas

Clean Fuel Fleets Program

Fuel

Reformulated Gasoline - Phase I (Class C) in severe nonattainment areas

Table 2. Strategy 1 Emissions - Grid B (TPD)

	Point Sources	Area Sources	Motor Vehicles	Biogenics	Total
VOC					
Base	637	1193	917	1100	3847
Strat.1	590	1146	584	1100	3396
NOx					
Base	1079	478	928	------	2485
Strat.1	1116	512	752	------	2380

Table 3. Predicted Ozone Concentrations

	Episode 1 (June 26/June 27/June 28)			Episode 2 (July 17/July 18/July 19)			Episode 3 (Aug 25/Aug 26)		Episode 4 (June 20/June 21)	
Domain-wide Peak										
Base	165	151	142	148	162	160	128	158	137	126
Strategy 1	158	143	134	151	157	155	127	150	132	123
Strategy 1 (Zero-out MI)	---	---	---	151	157	155	---	---	---	---
MI Moderate NA Peak										
Strategy 1	95[1]	103[2]	111[2]	110[2]	108[2]	138[2]	91[3]	114[2]	96[4]	108[5]
Strategy 1 (Zero-out MI)	---	---	---	111[2]	109[2]	140[2]	---	---	---	---

[1] Holland

[2] Muskegon

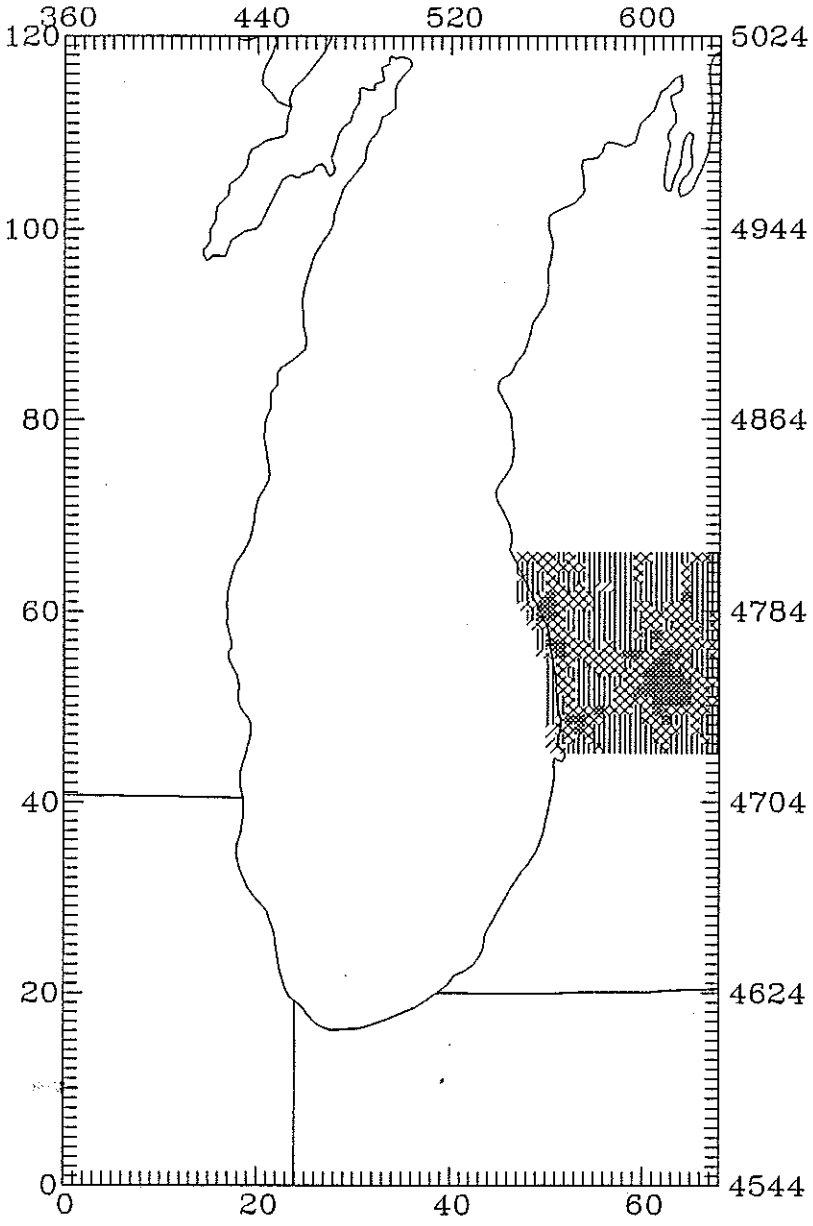
[3] South Haven

[4] Parnell

[5] Jenison

FIGURE 1

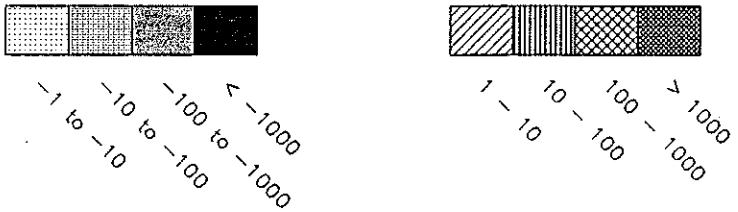
Max difference:	6927.7 (kg/day) at (63, 52)
Avg difference:	356.2 (kg/day), non-zero cells only.



7/18 Total Low emissions (Strategy 1 vs. Bumpup 1)

RHC

Total difference: 154938 (Kg/day)



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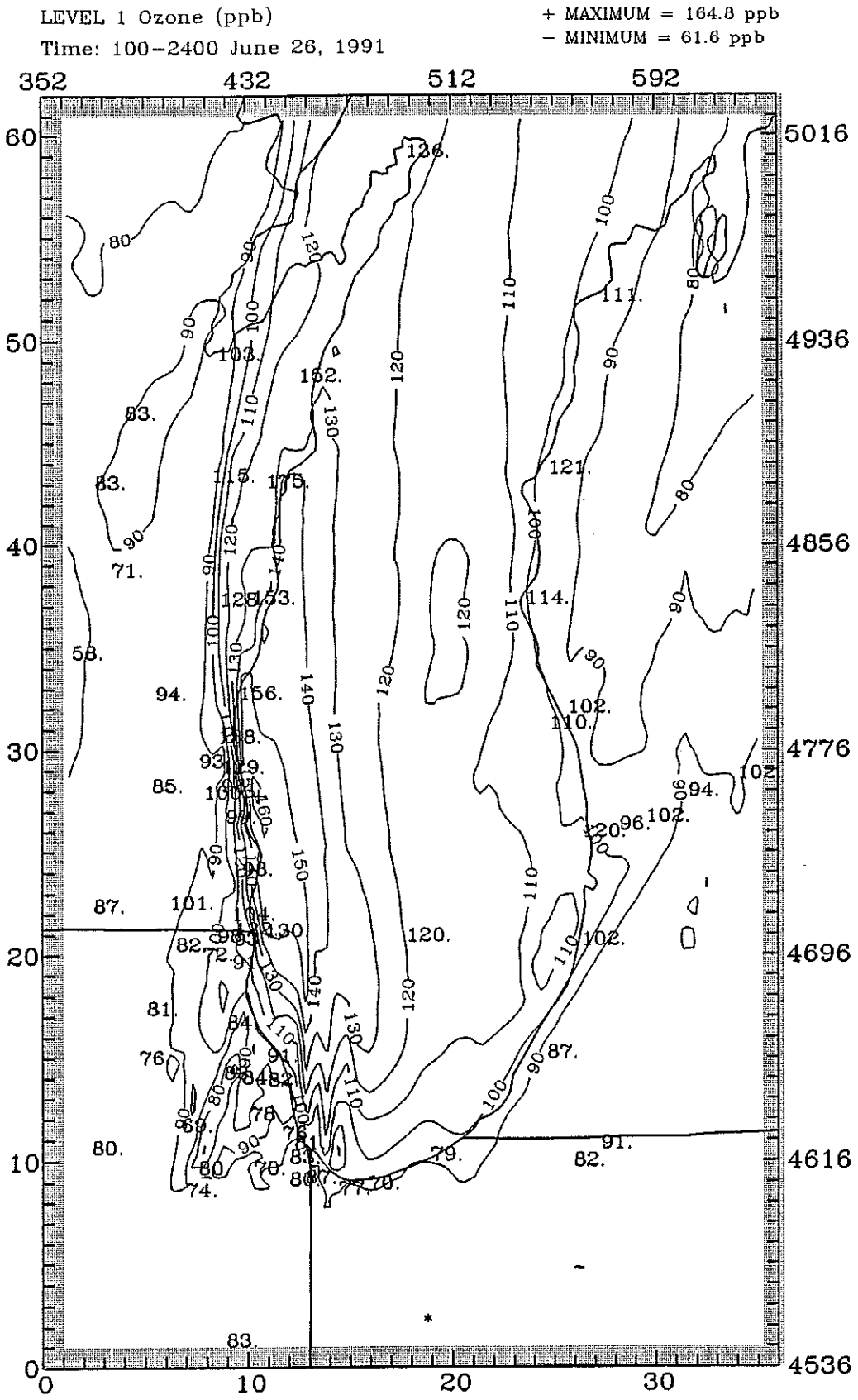
ATTACHMENT 1

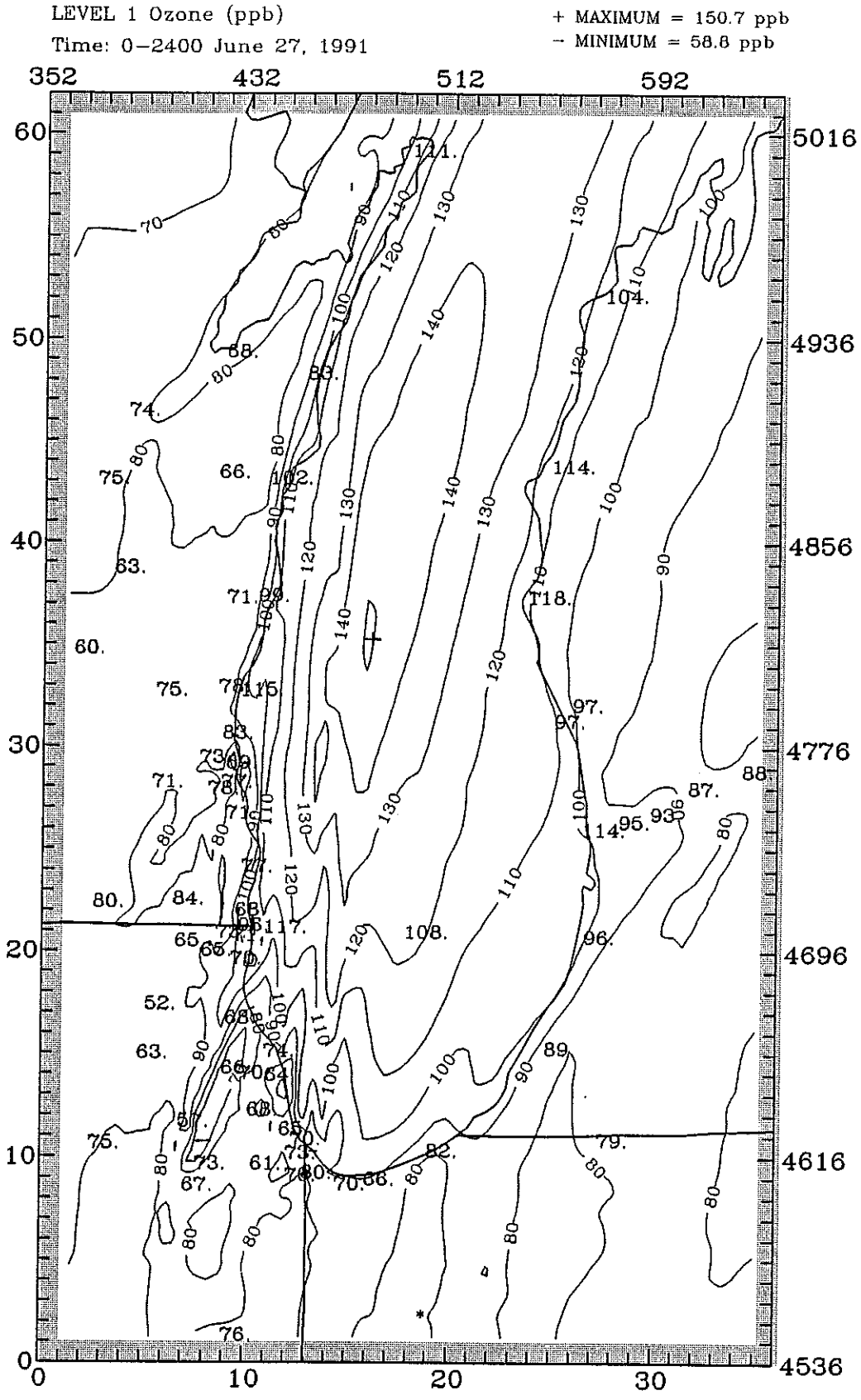
Peak Daily Ozone Plots

* Basecase C
* Strategy 1
* Zero-Out Western Michigan



LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
XY Map -- June 26, 1991 -- Grids B & C

(.24-28jun91.16-8-4km.basecasec) (V1.11a)



LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
XY Map -- June 27, 1991 -- Grids B & C

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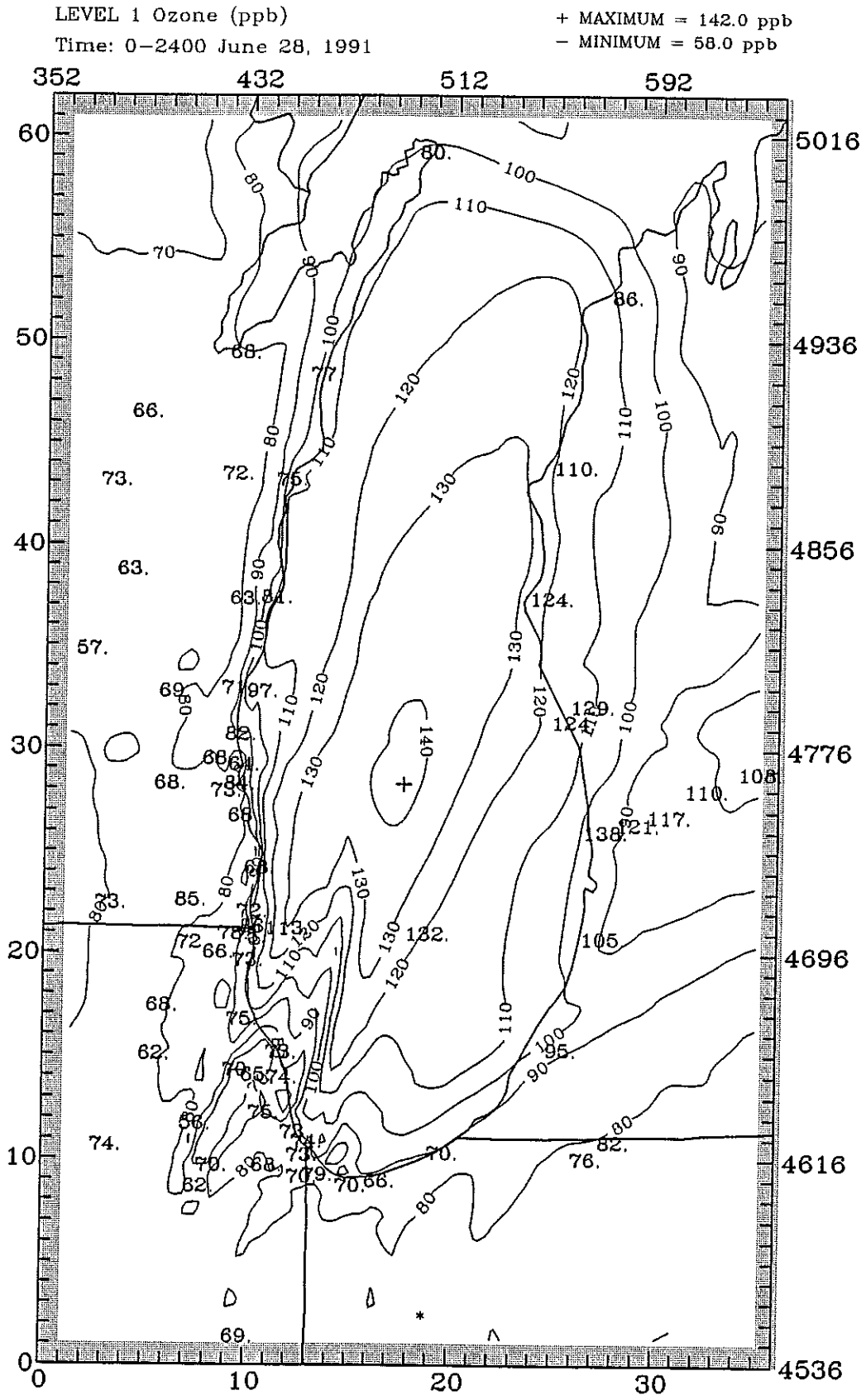

LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
XY Map -- June 28, 1991 -- Grids B & C

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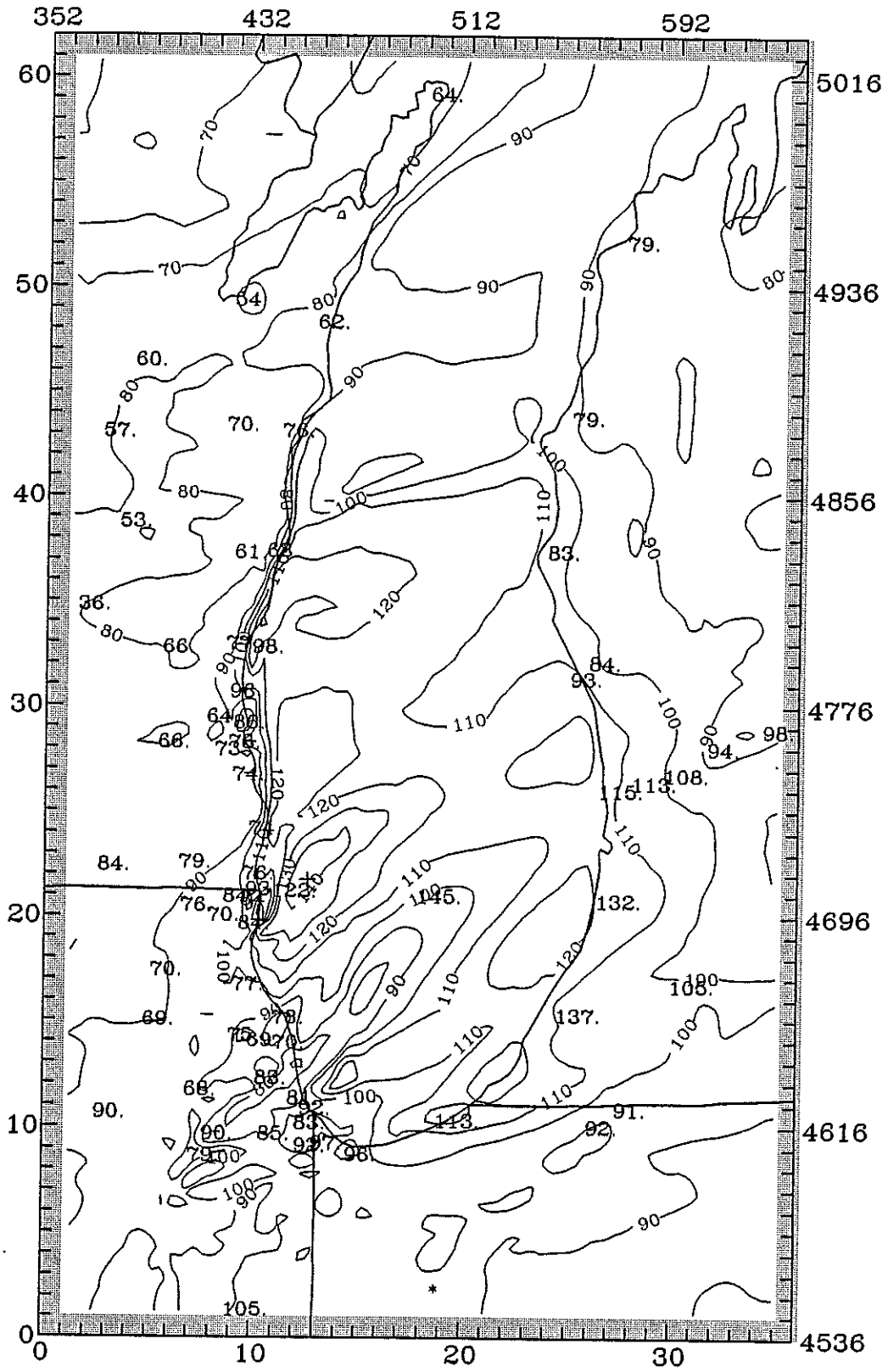

LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
XY Map -- July 17, 1991 -- Grids B & C

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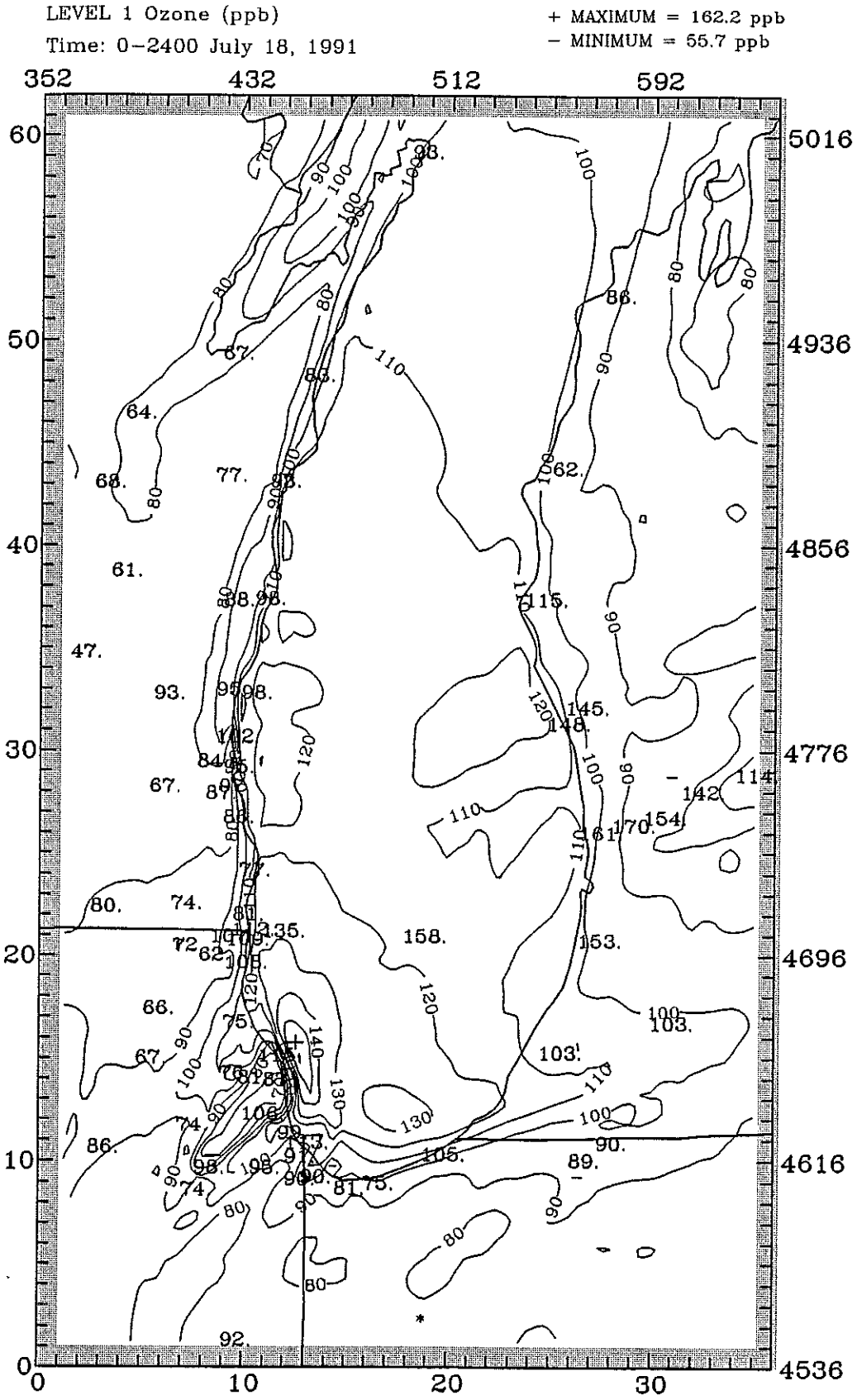

LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
XY Map -- July 18, 1991 -- Grids B & C

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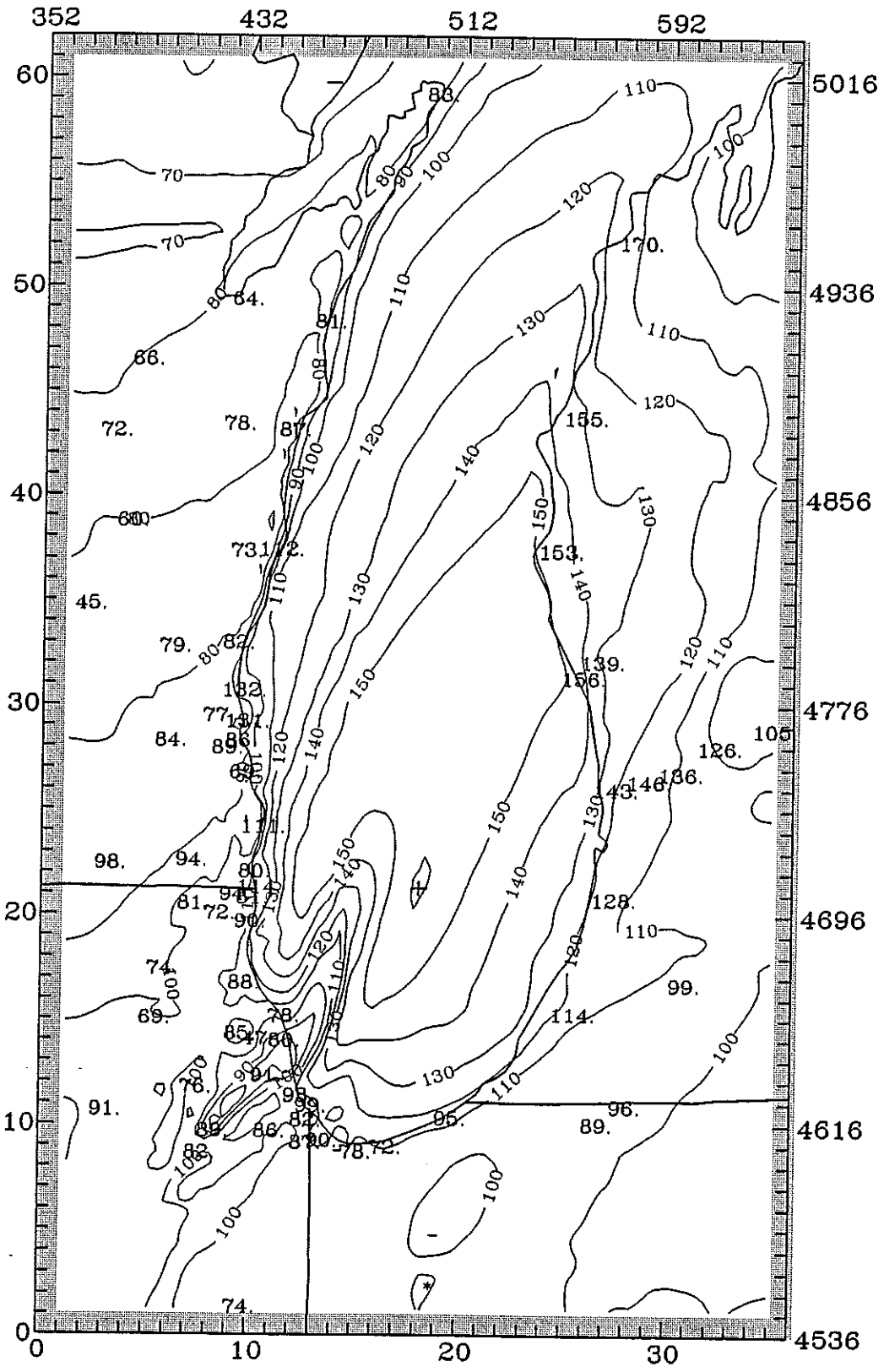

LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
XY Map -- July 19, 1991 -- Grids B & C

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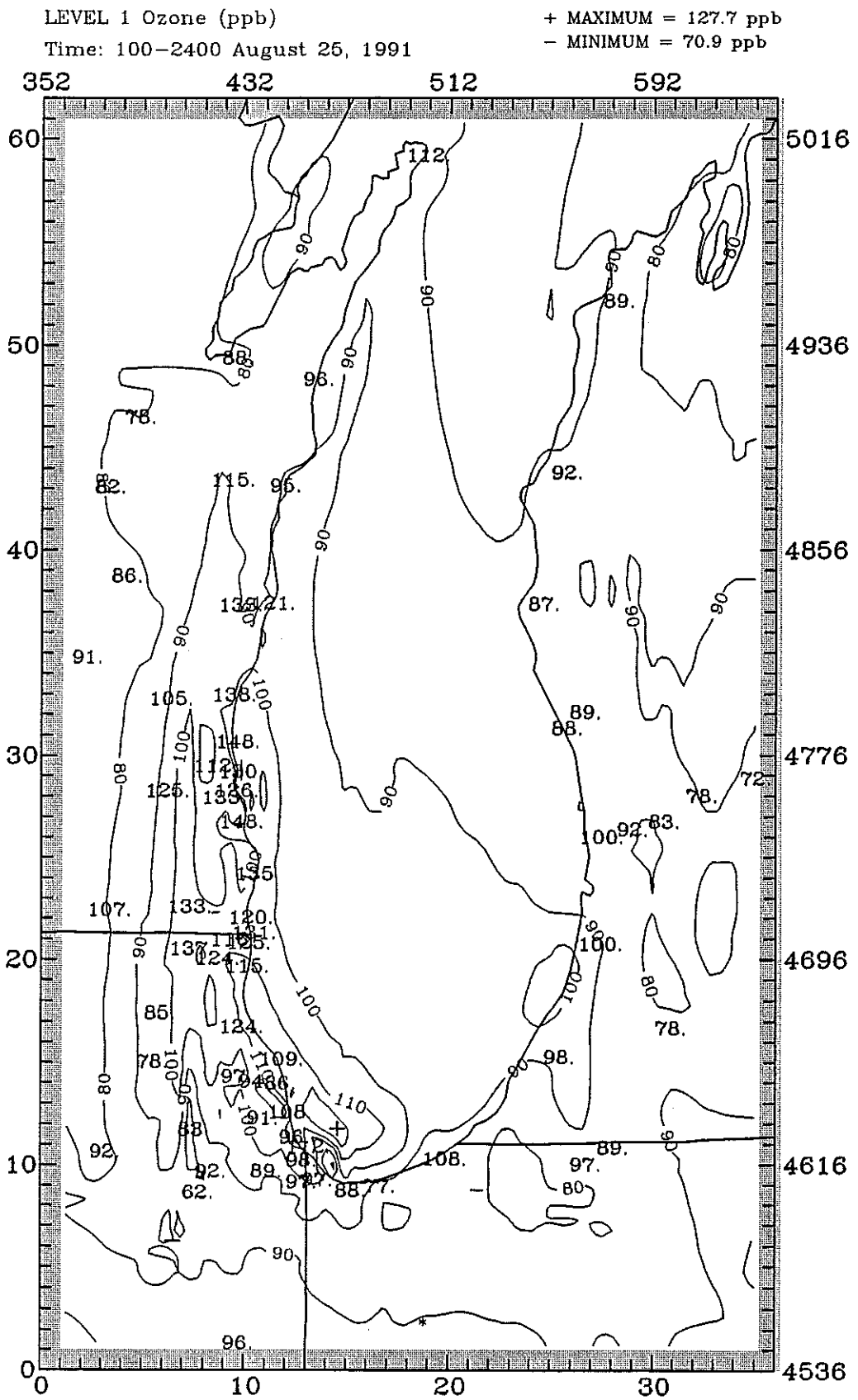

LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
XY Map -- August 25, 1991 -- Grids B & C

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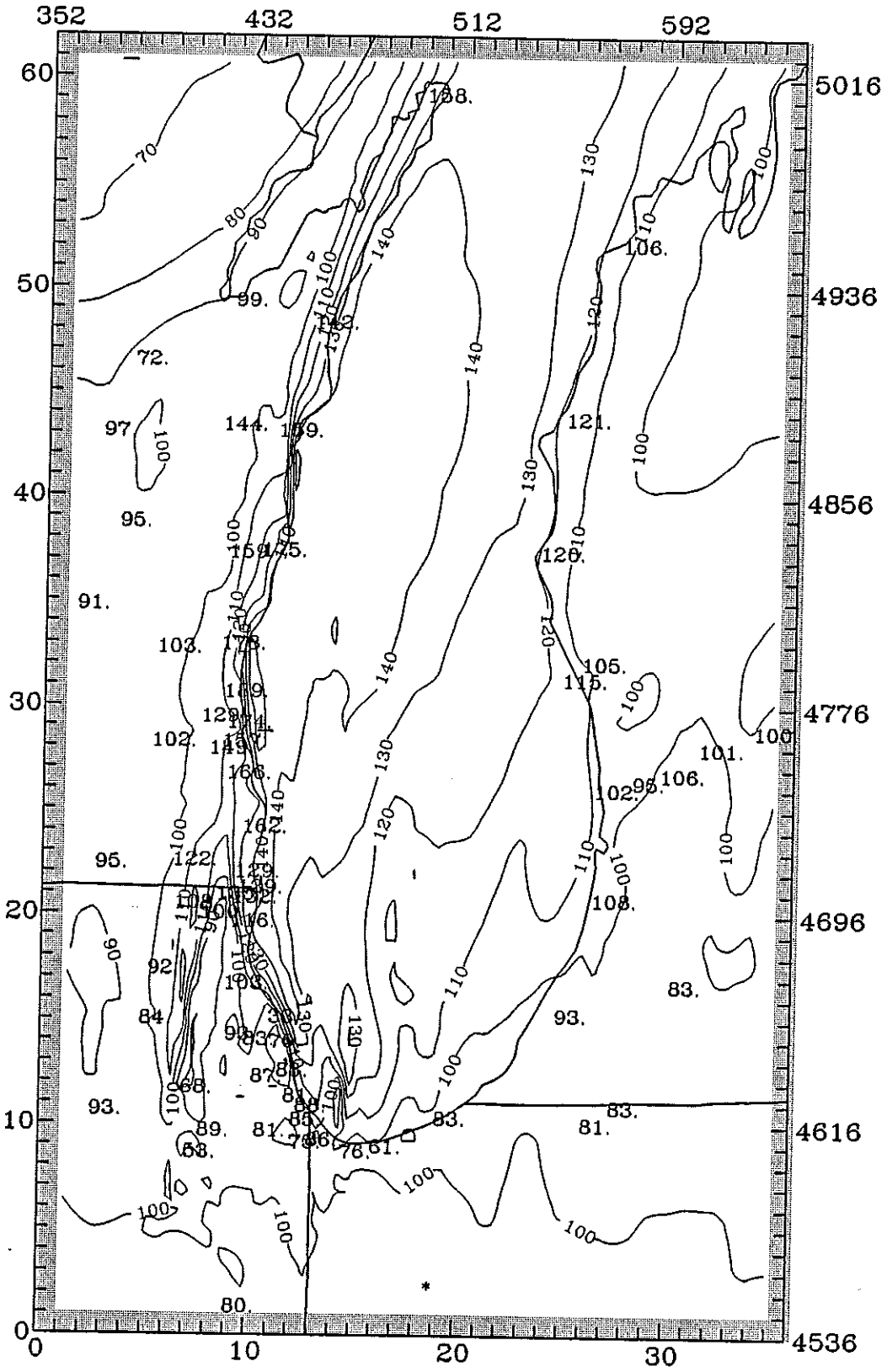

LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
XY Map -- August 26, 1991 -- Grids B & C

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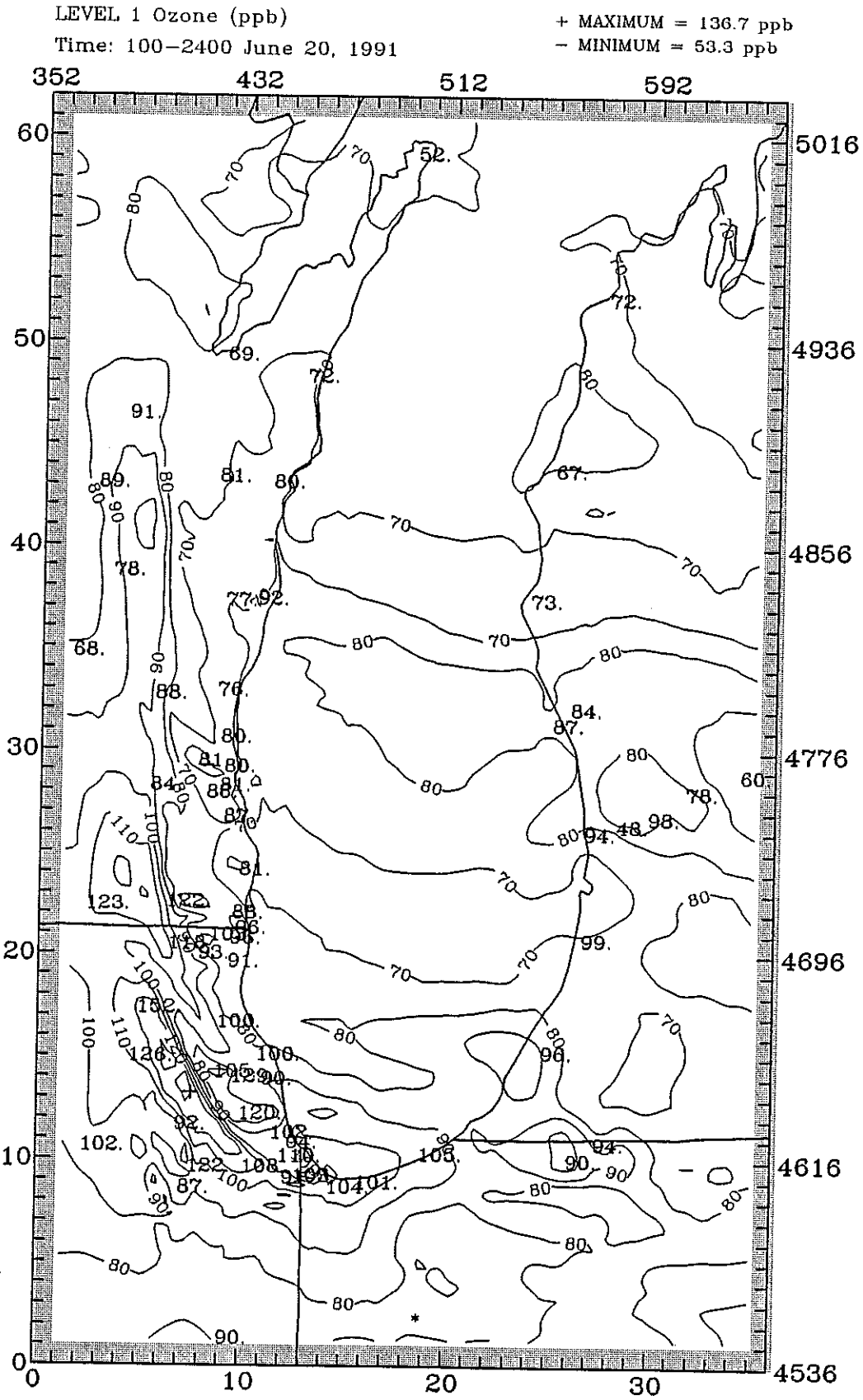

LMOS UAM–V Model Predictions of Maximum Hourly Ozone:
XY Map -- June 20, 1991 -- Grids B & C

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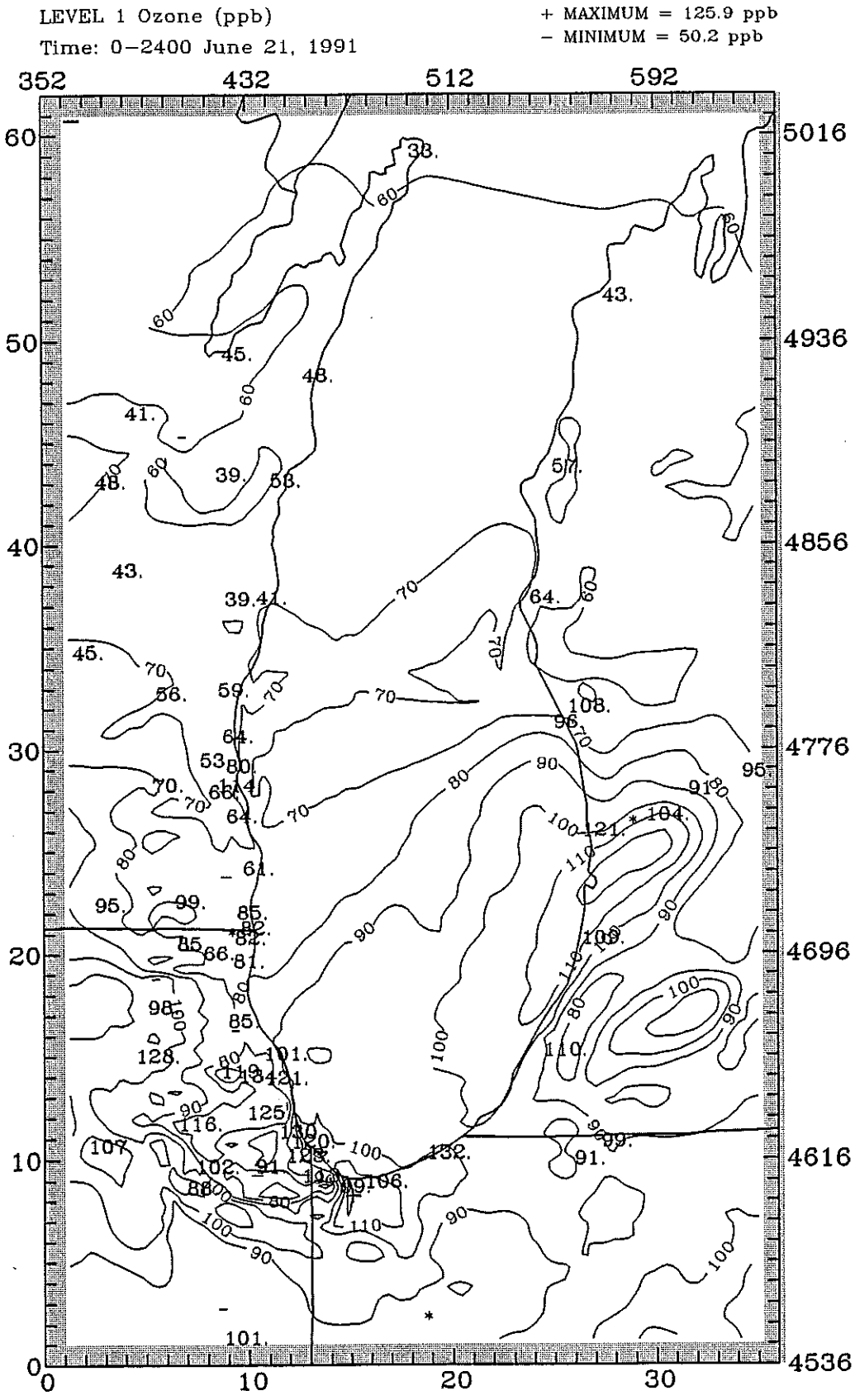

LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
XY Map -- June 21, 1991 -- Grids B & C

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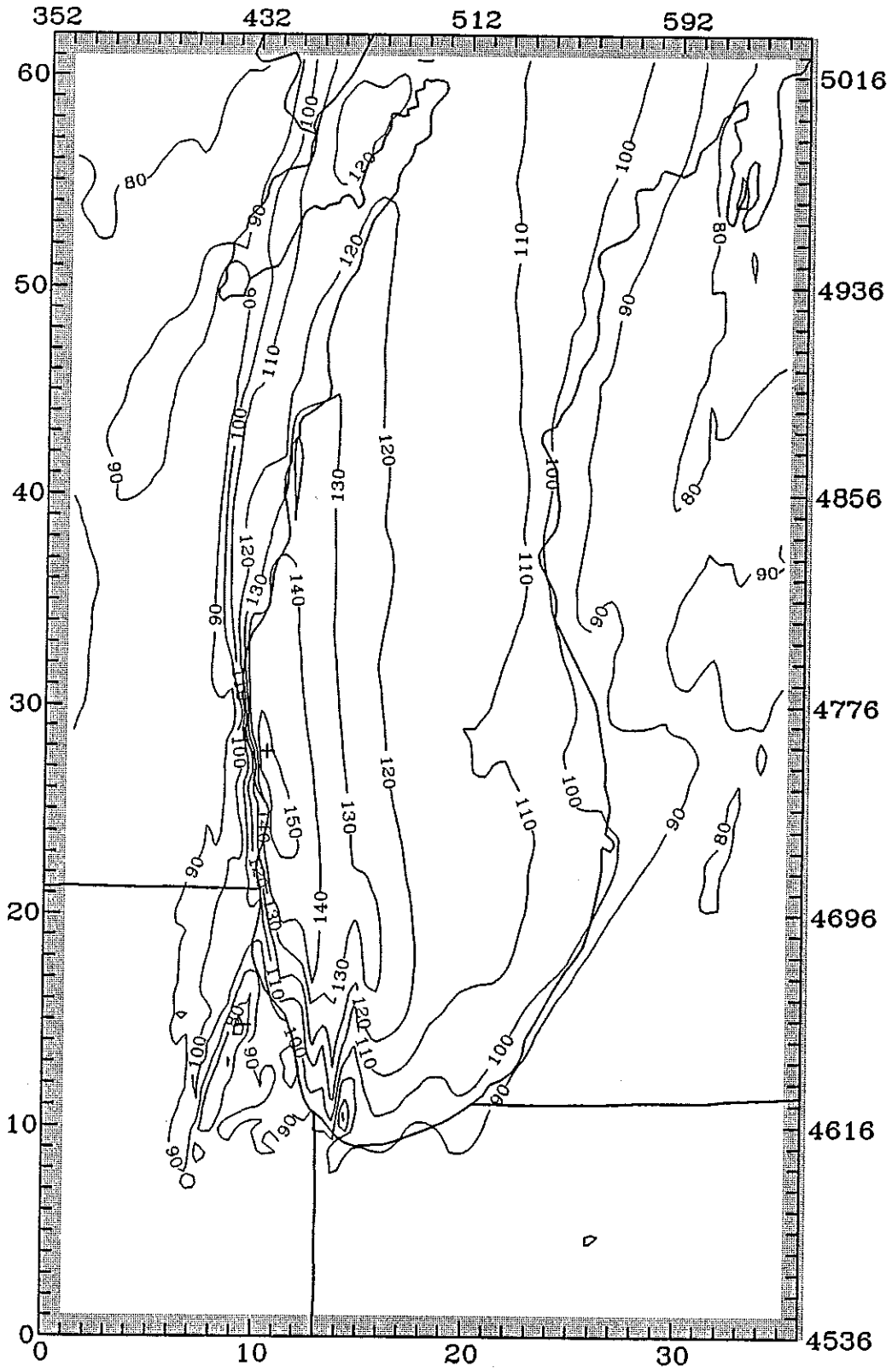
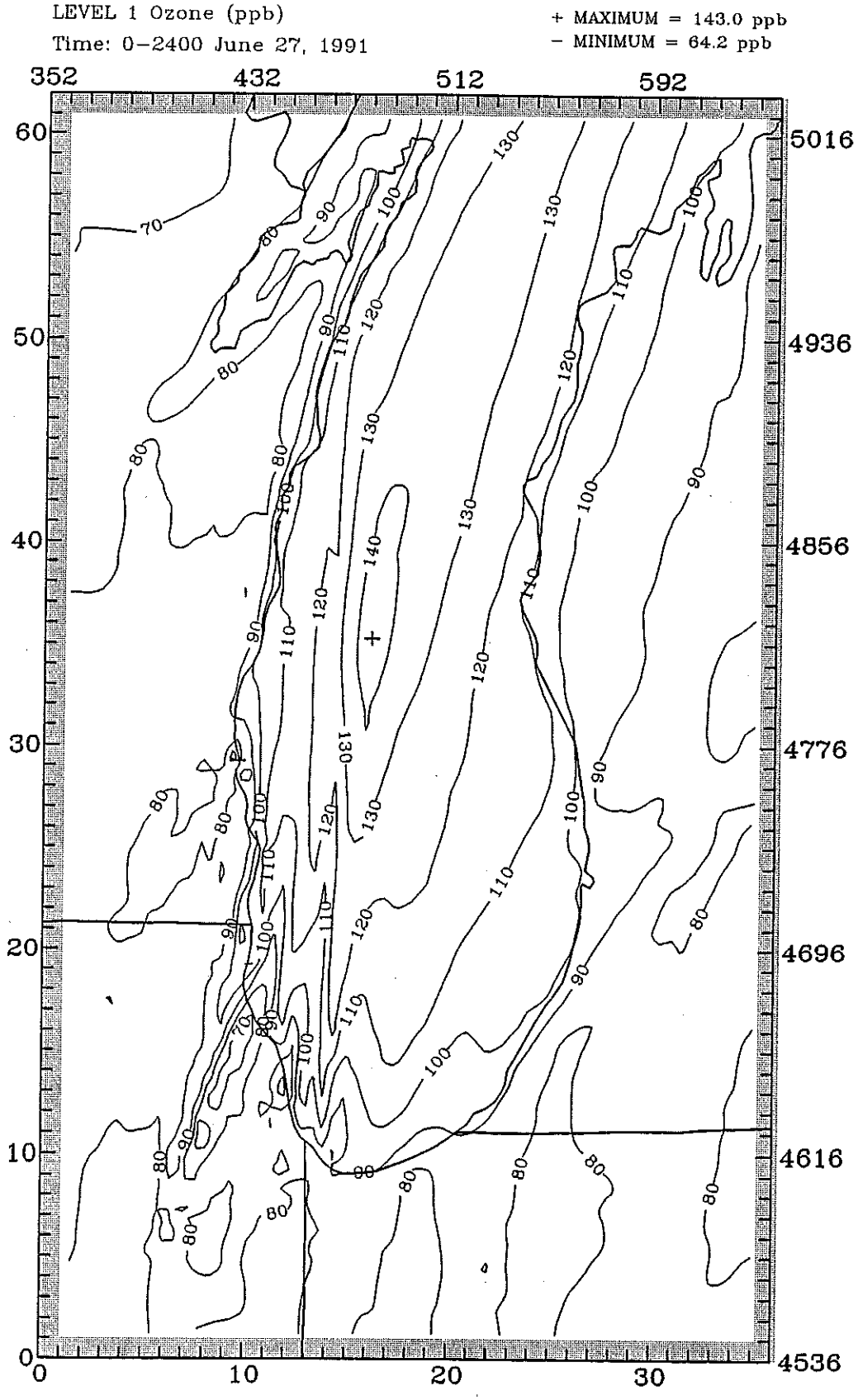


LMOS UAM–V Model Predictions of Maximum Hourly Ozone:
XY Map -- June 26, 1996 -- Grids B & C

(.24–28jun96.16–8–4km.strat1) (V1.11) [LMOP Strategy 1 -- 1996]



LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
XY Map -- June 27, 1996 -- Grids B & C

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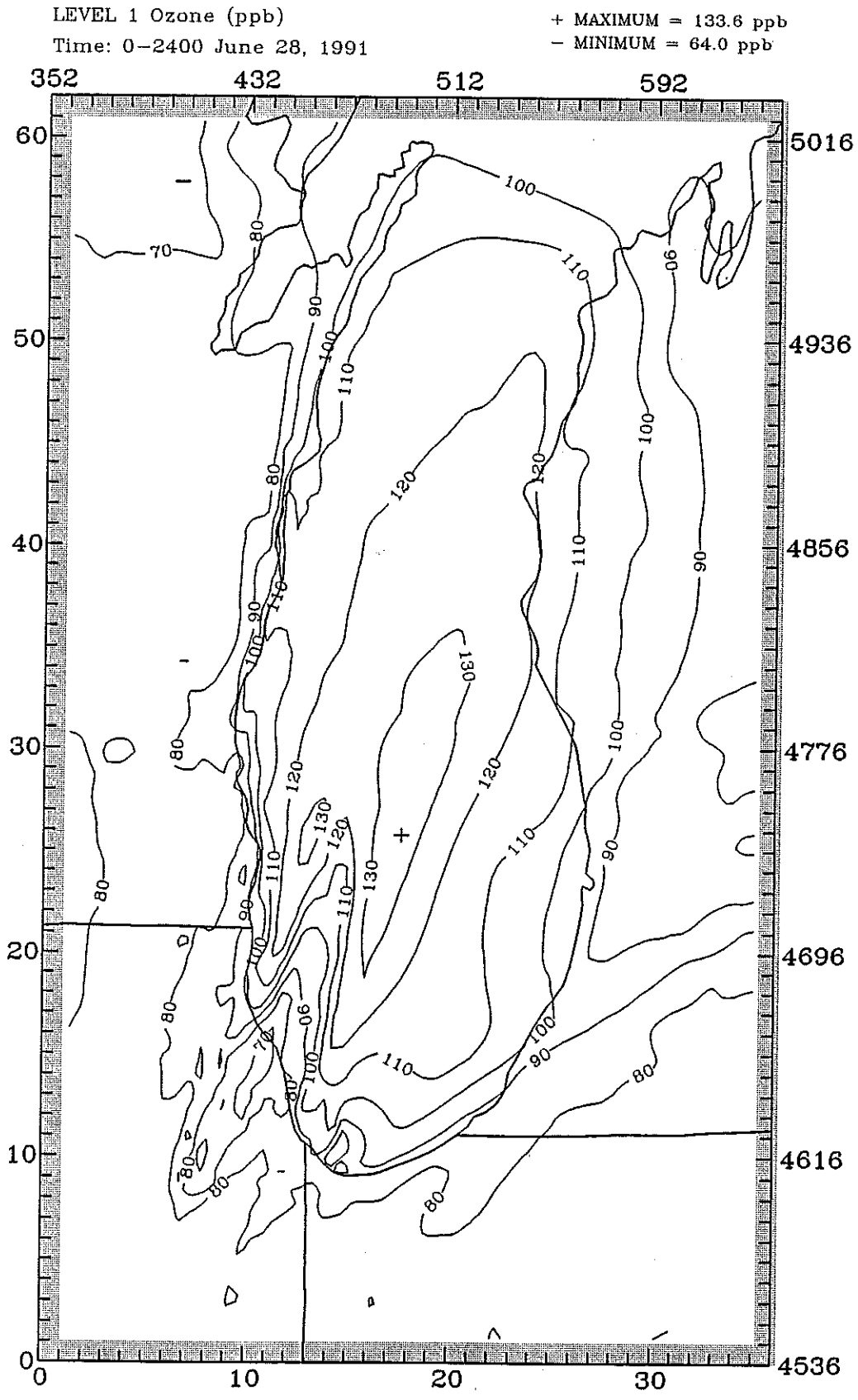

LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
XY Map -- June 28, 1996 -- Grids B & C

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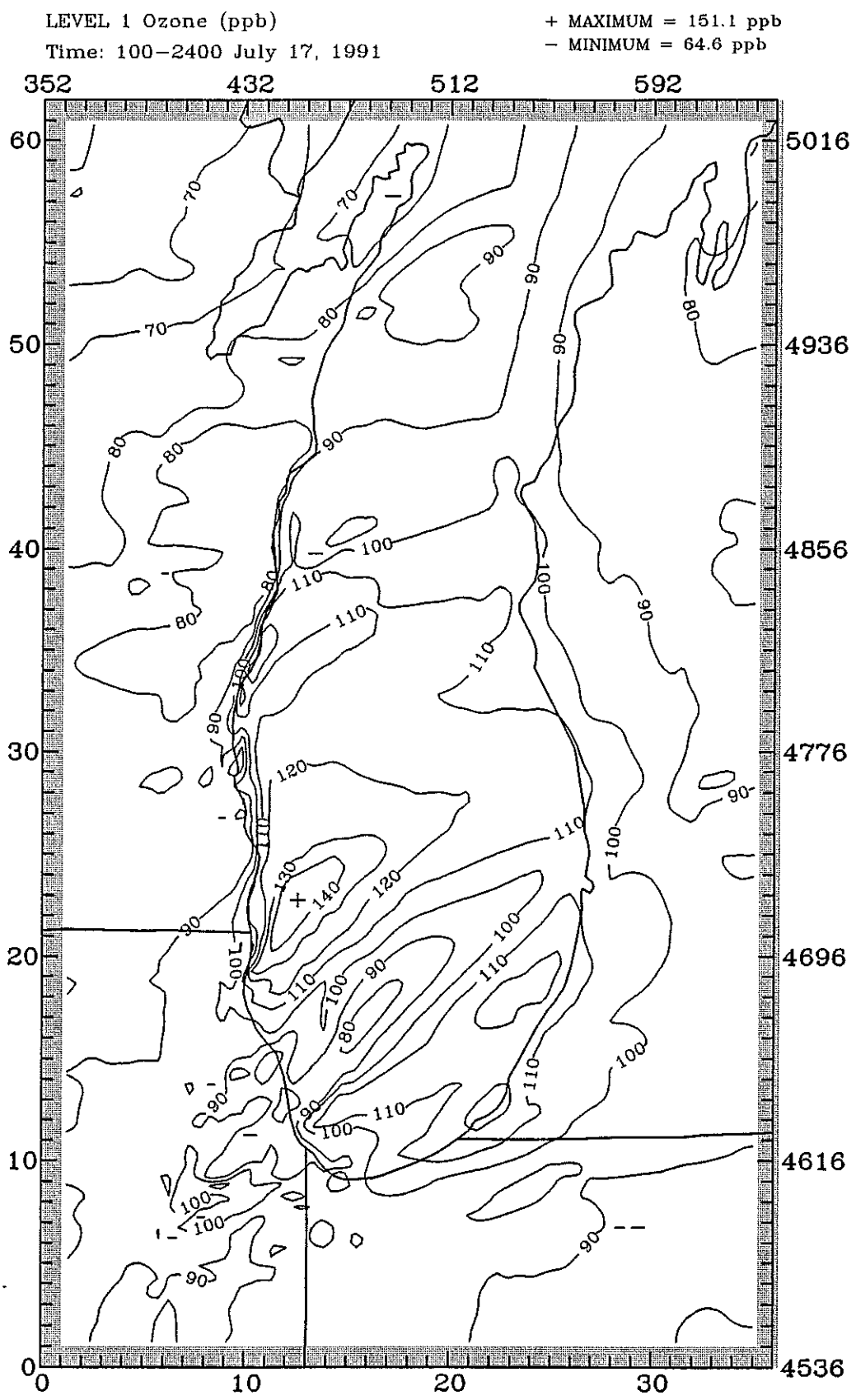
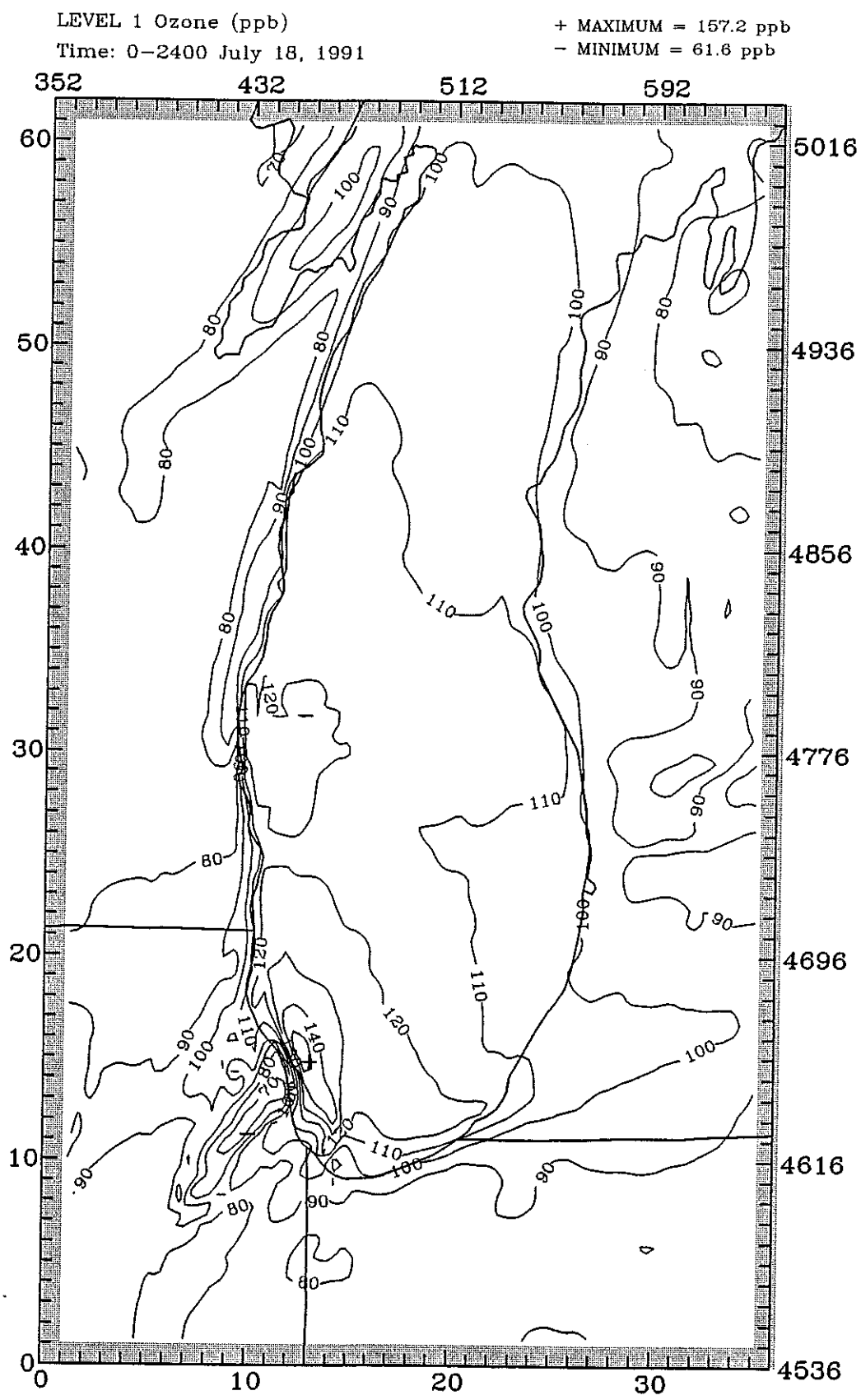


LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
XY Map -- July 17, 1996 -- Grids B & C

(.15-19jul96.16-8-4km.strat1) (V1.11) [LMOP Strategy 1 -- 1996]



LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
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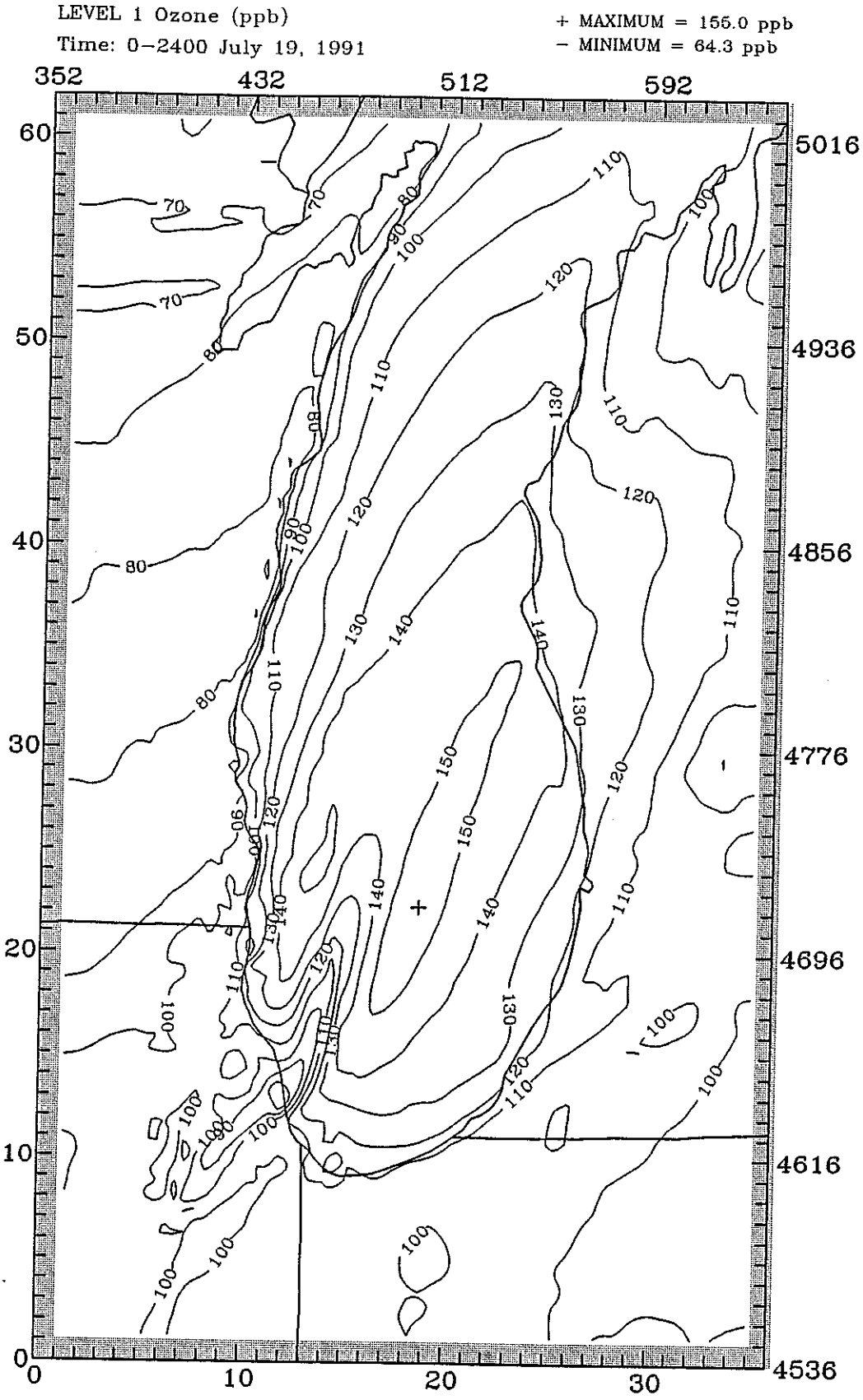

LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
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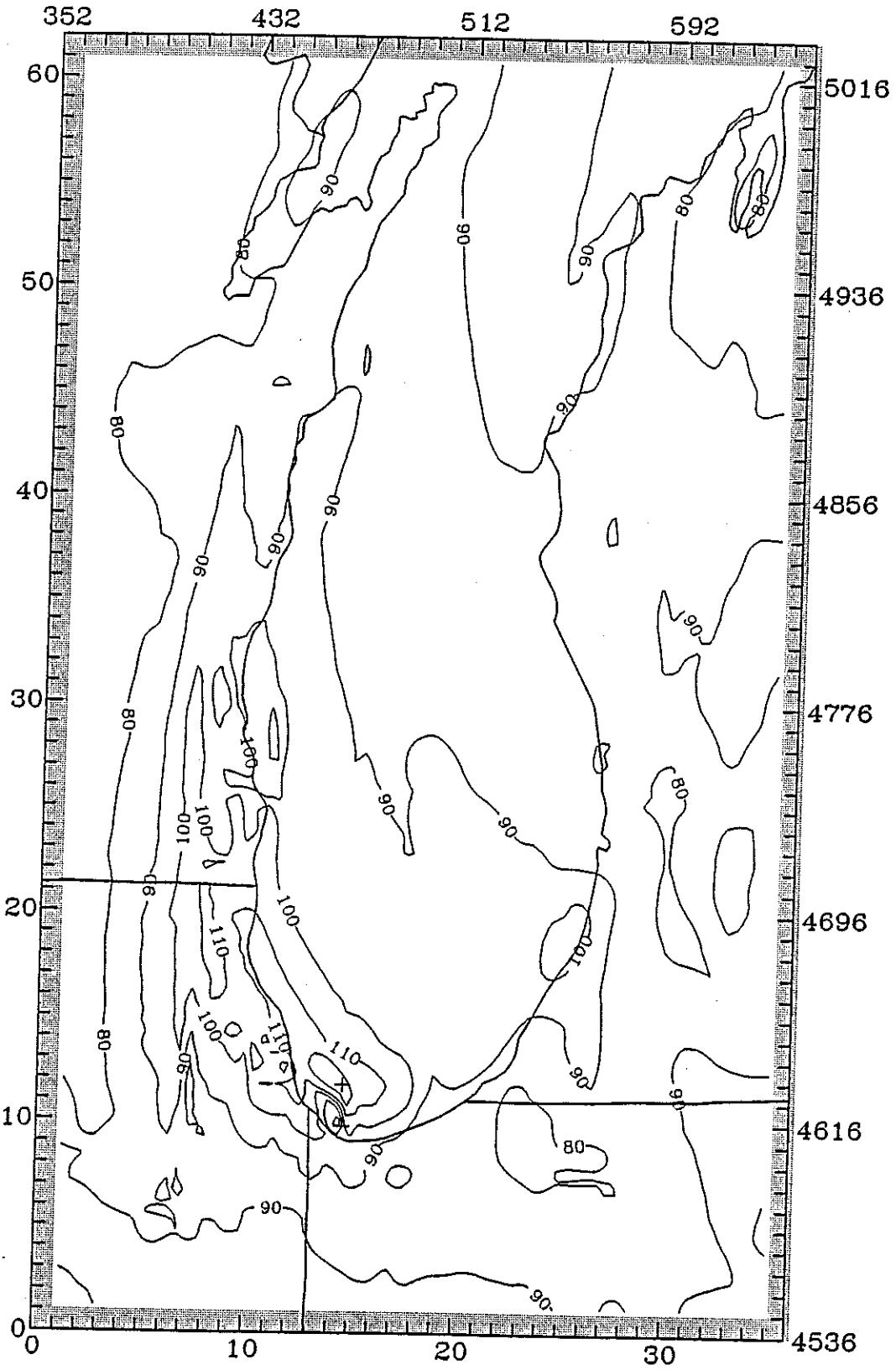

LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
XY Map -- August 25, 1996 -- Grids B & C

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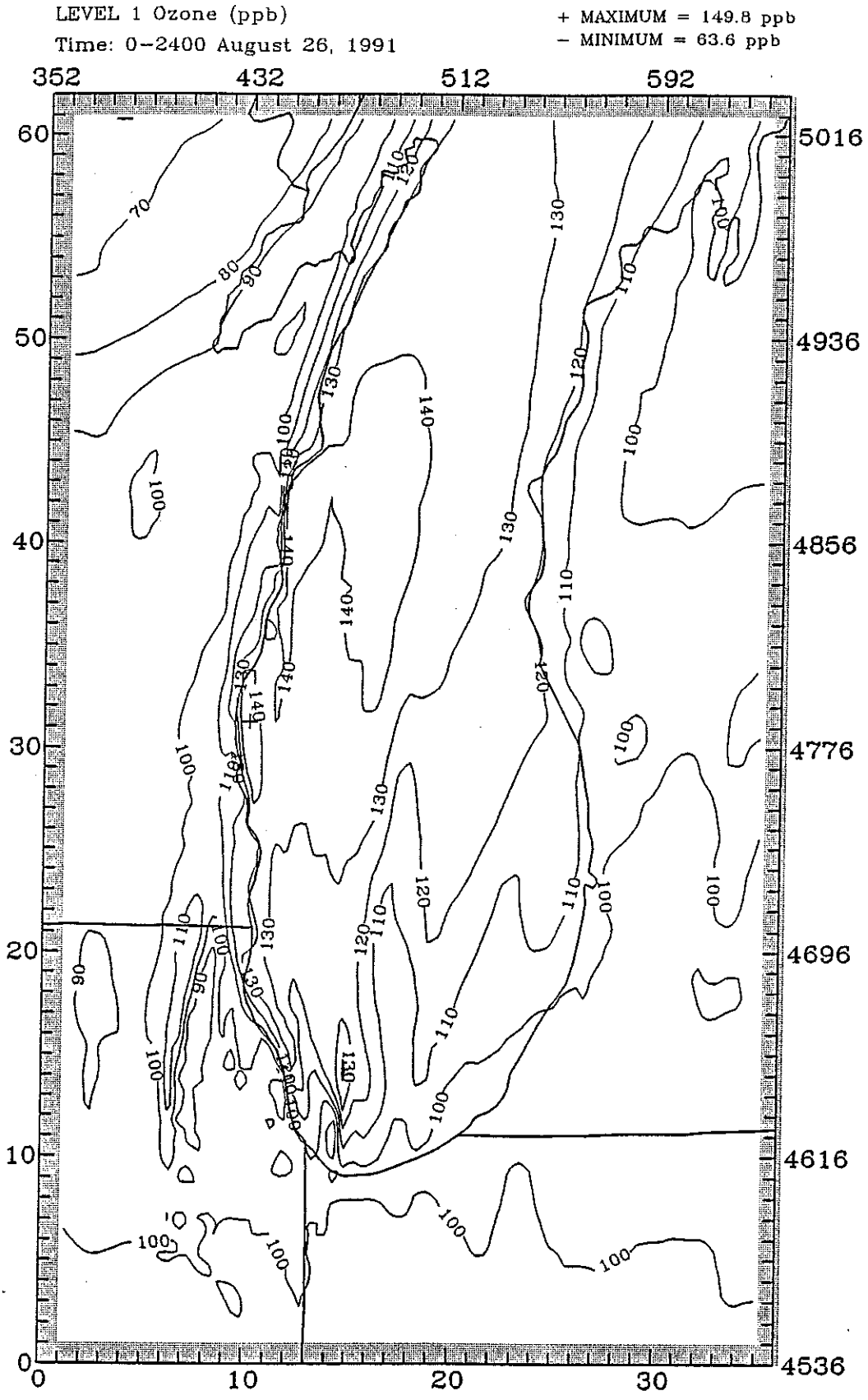

LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
XY Map -- August 26, 1996 -- Grids B & C

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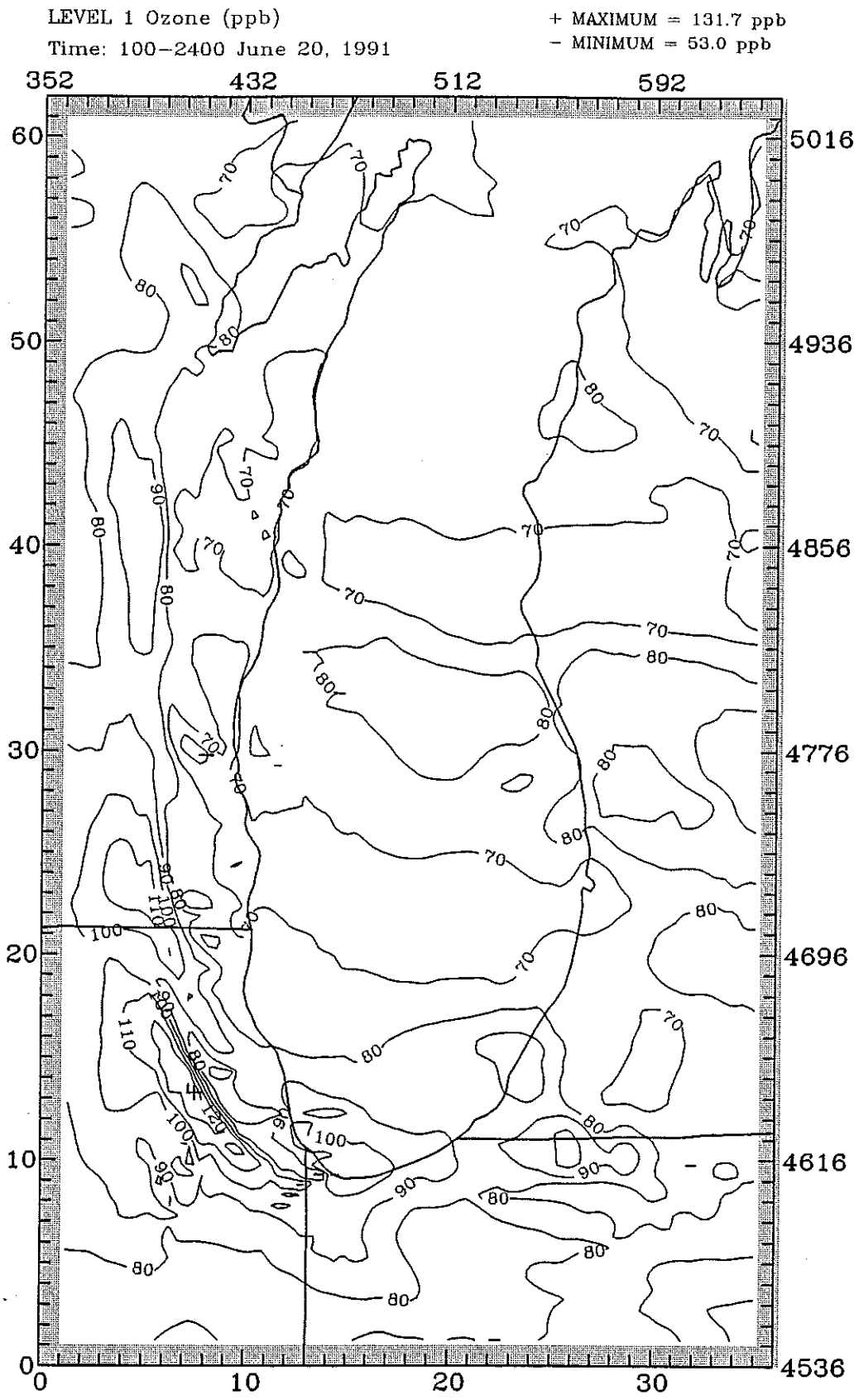

LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
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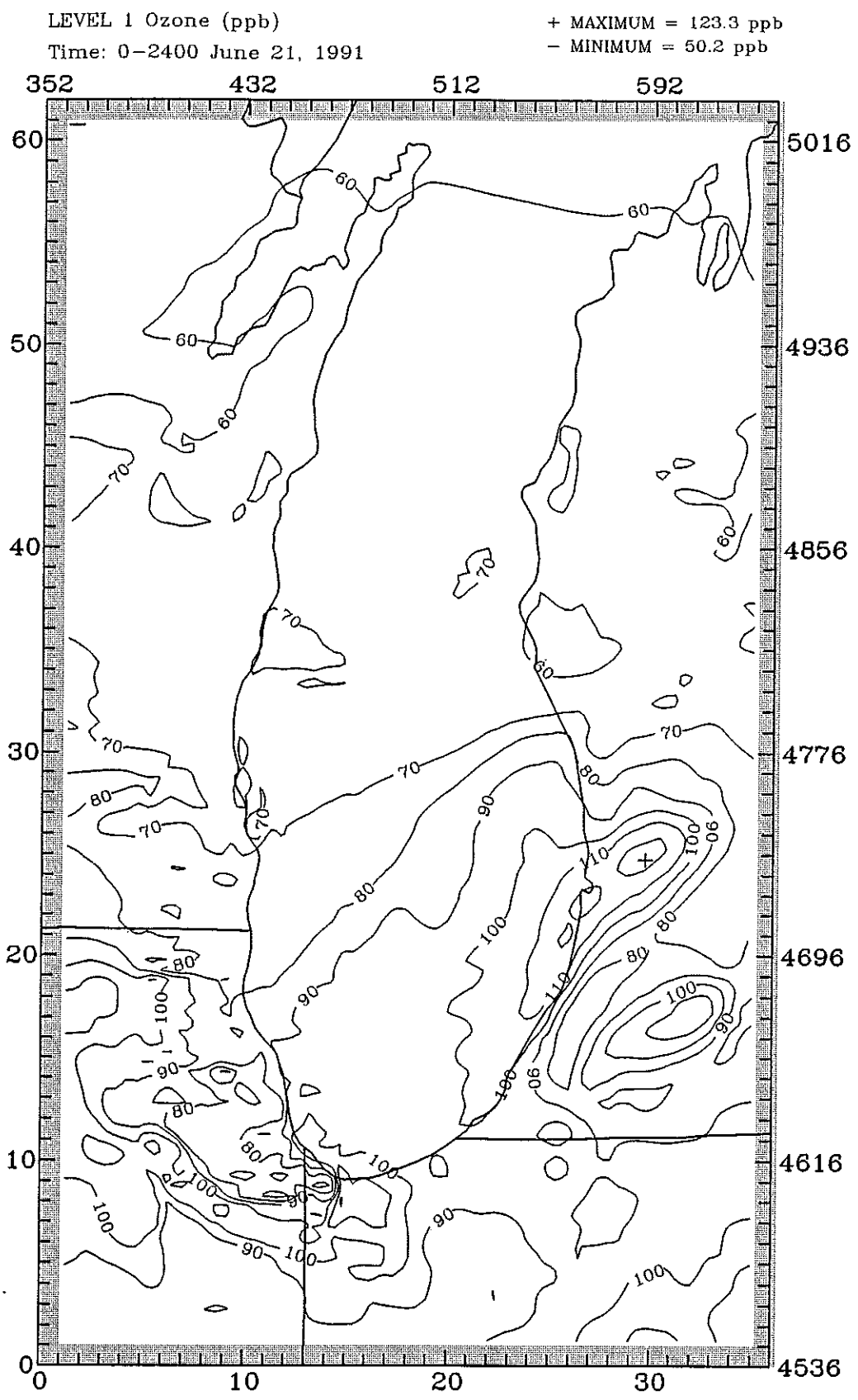

LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
XY Map -- June 21, 1996 -- Grids B & C

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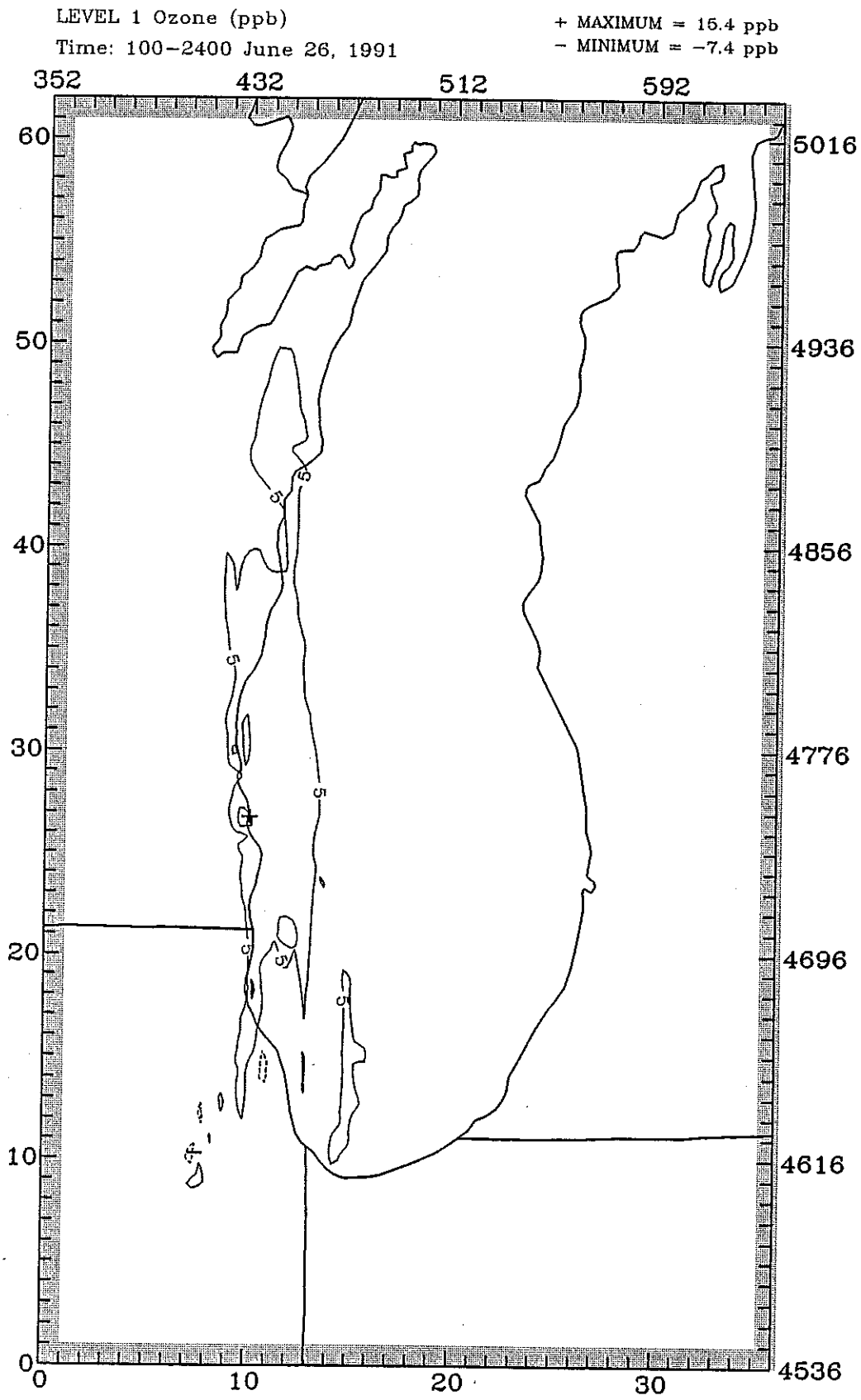
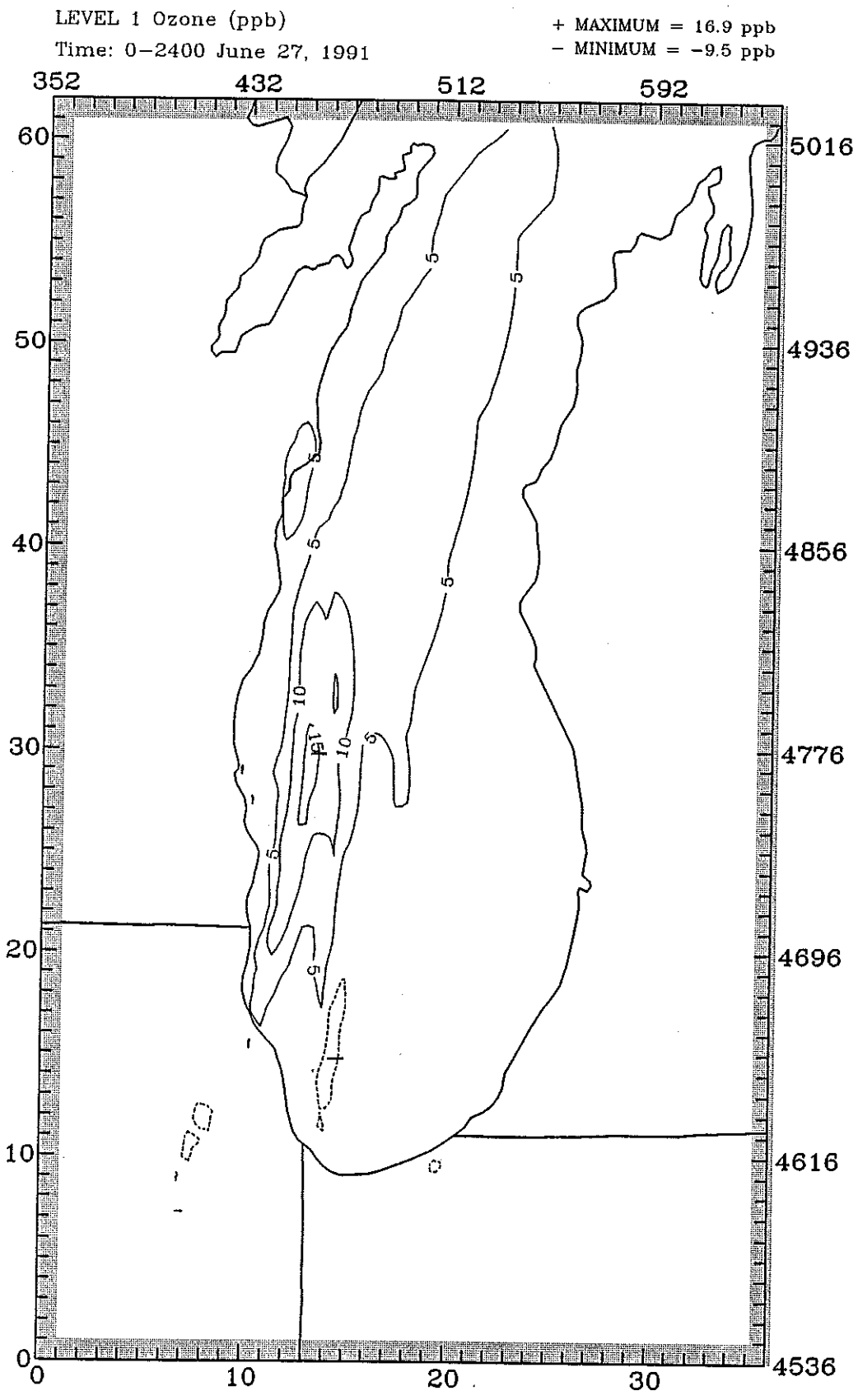


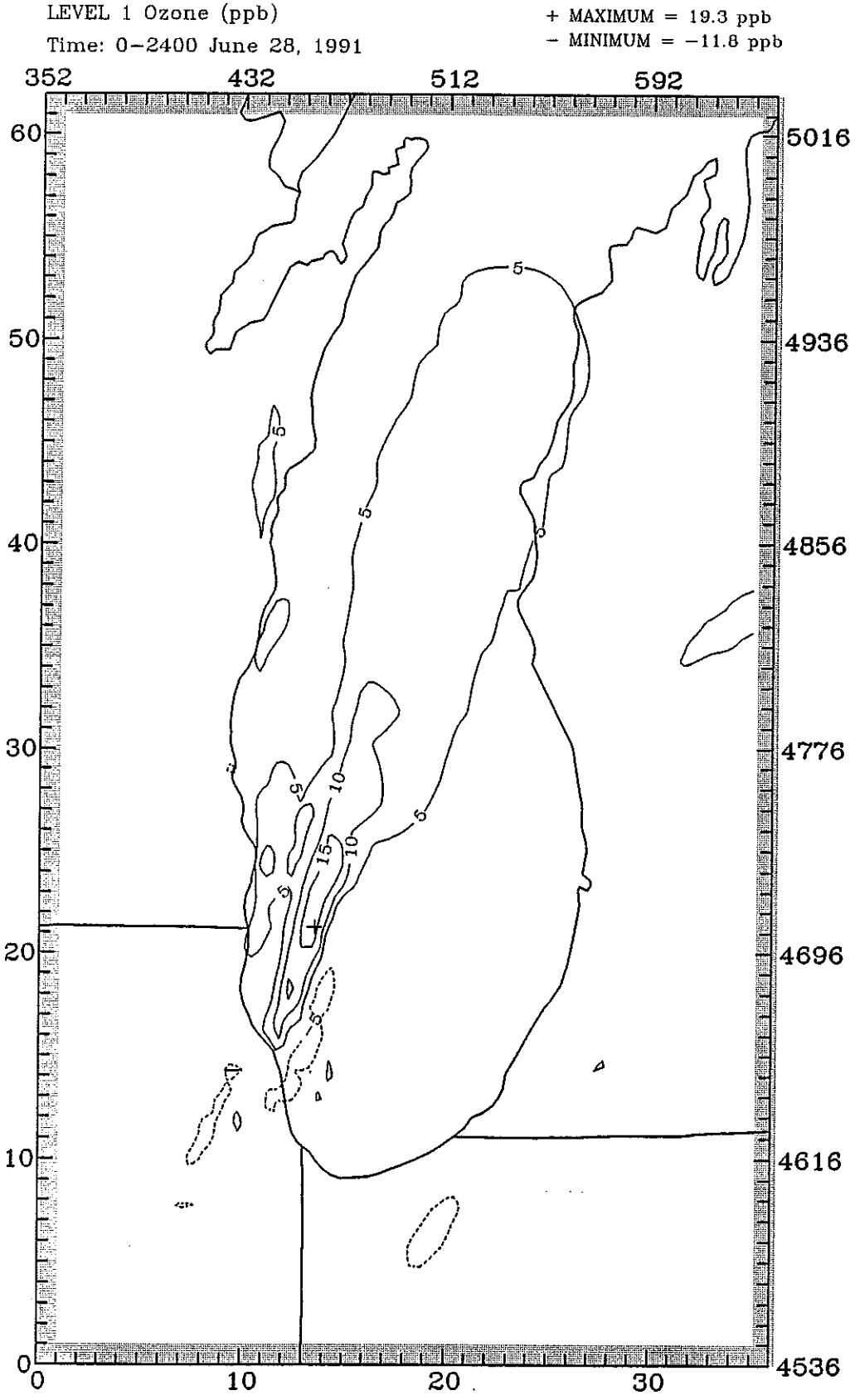
LMOS UAM-V Model Predictions of Differences in Maximum Hourly Ozone:
XY Map -- June 26, 1996 -- Grids B & C

(Basecase C - Strategy 1) [effect of LMOP Strategy 1 by 1996]



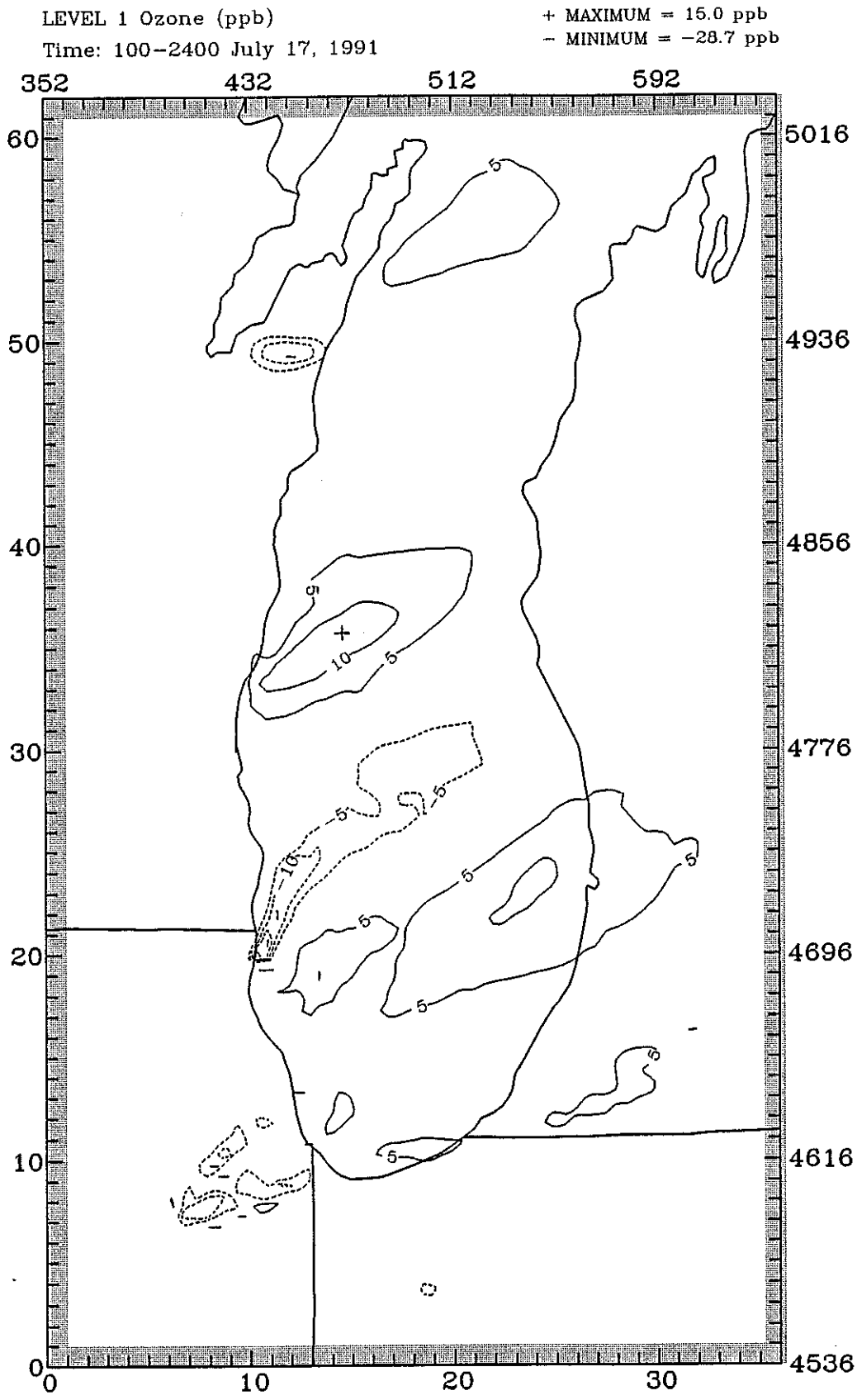
LMOS UAM–V Model Predictions of Differences in Maximum Hourly Ozone:
XY Map –– June 27, 1996 –– Grids B & C

(Basecase C – Strategy 1) [effect of LMOP Strategy 1 by 1996]



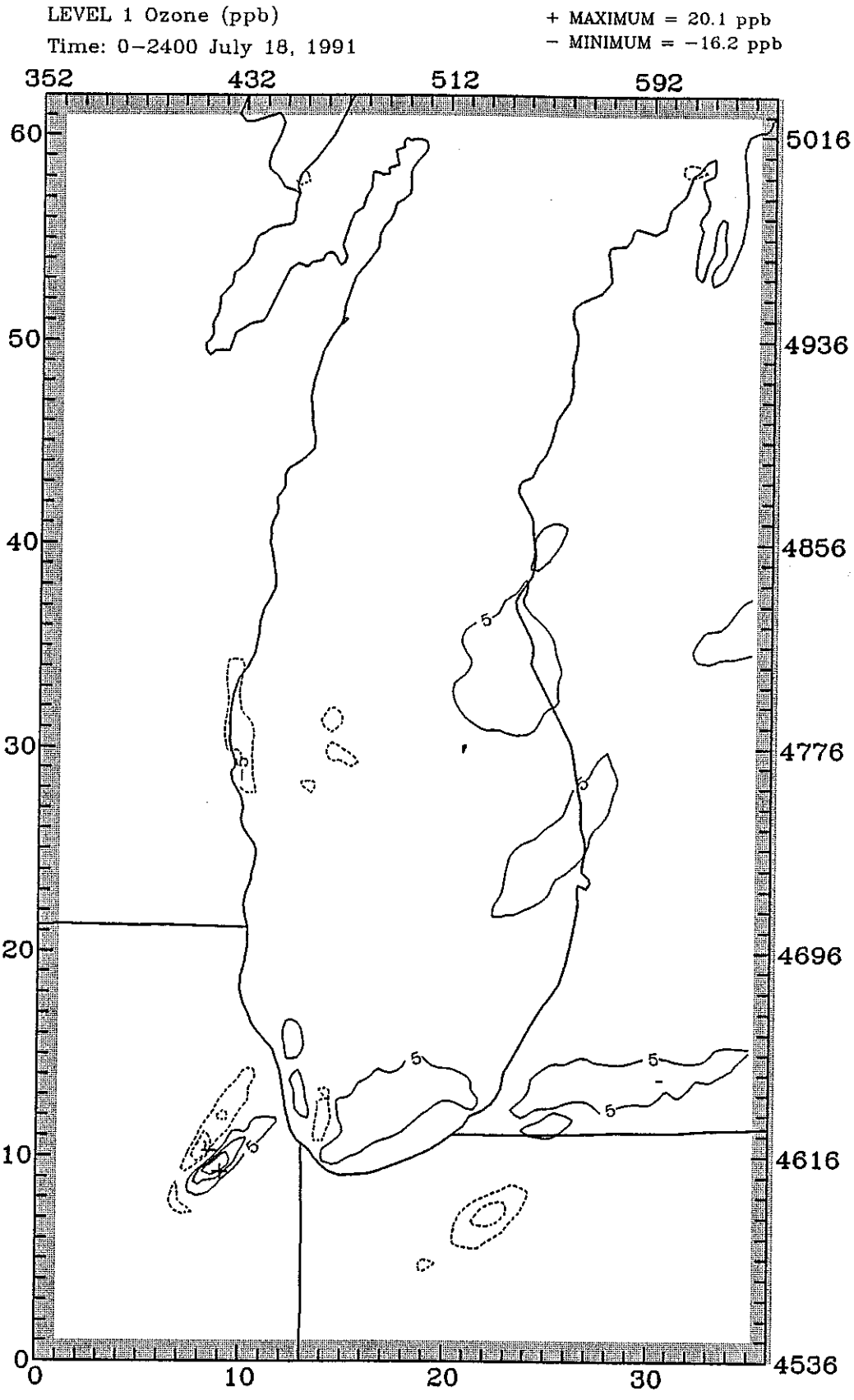
LMOS UAM-V Model Predictions of Differences in Maximum Hourly Ozone:
XY Map -- June 28, 1996 -- Grids B & C

(Basecase C - Strategy 1) [effect of LMOP Strategy 1 by 1996]



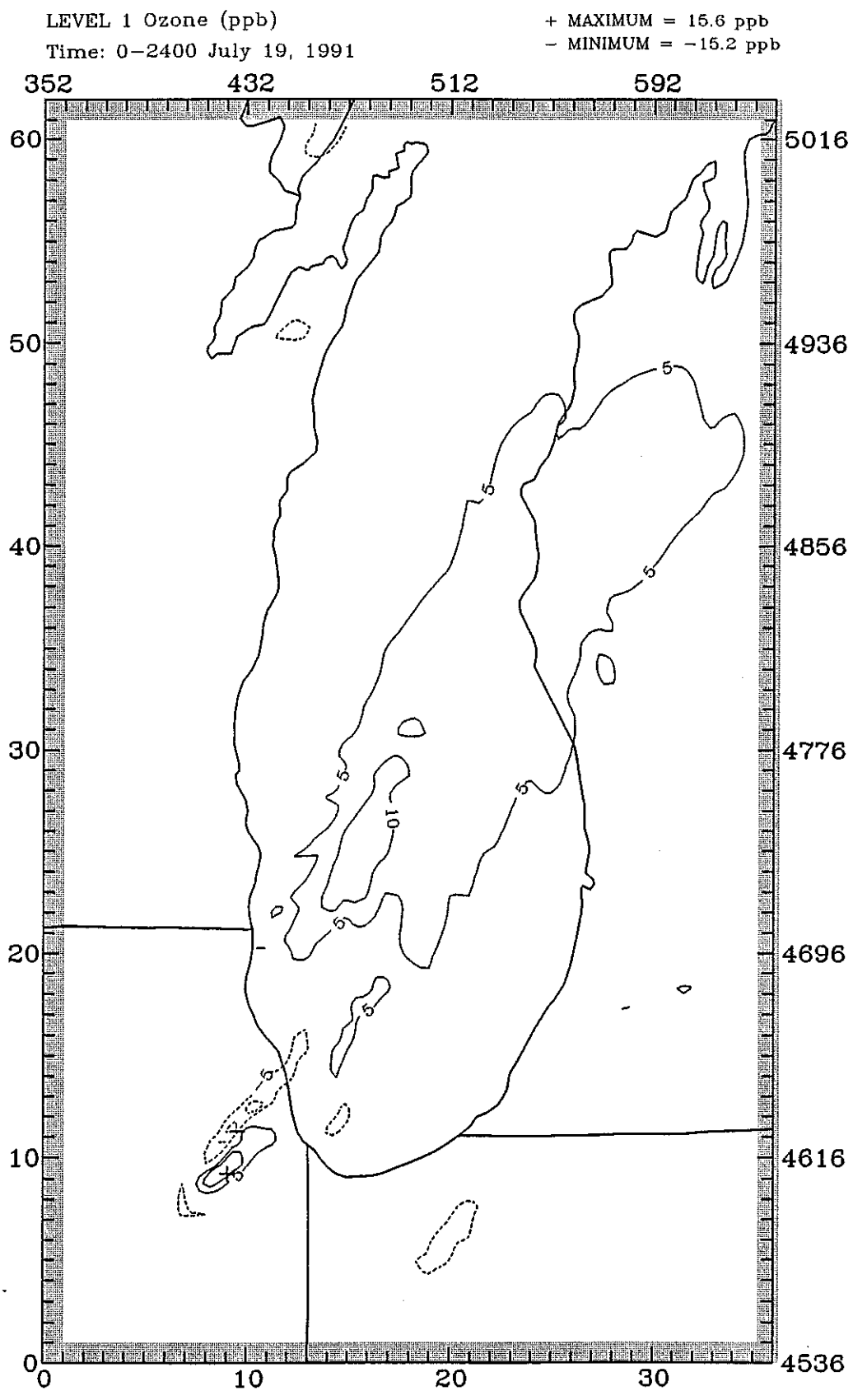
LMOS UAM-V Model Predictions of Differences in Maximum Hourly Ozone:
XY Map -- July 17, 1996 -- Grids B & C

(Basecase C - Strategy 1) [effect of LMOP Strategy 1 by 1996]



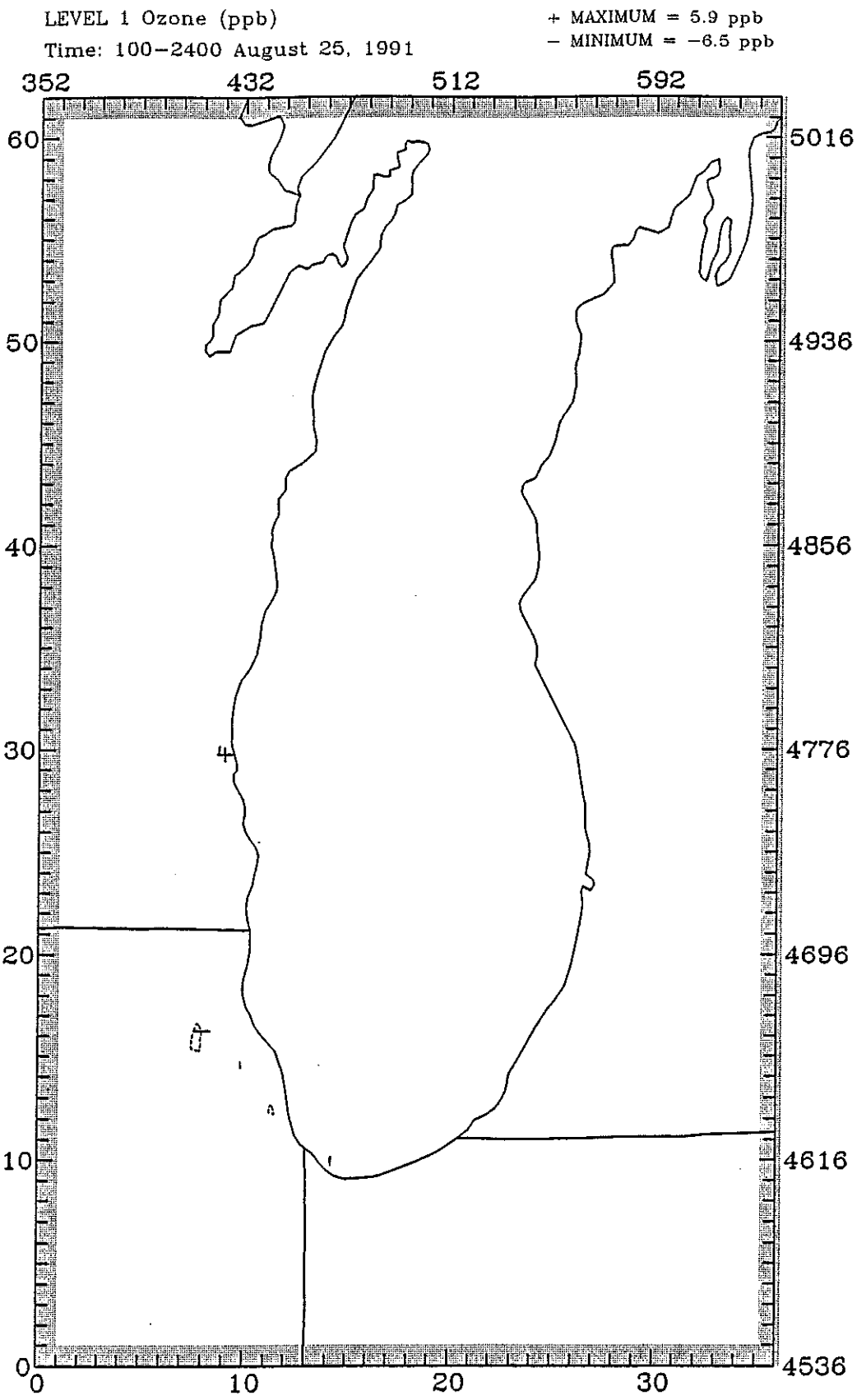
LMOS UAM-V Model Predictions of Differences in Maximum Hourly Ozone:
XY Map -- July 18, 1996 -- Grids B & C

(Basecase C - Strategy 1) [effect of LMOP Strategy 1 by 1996]



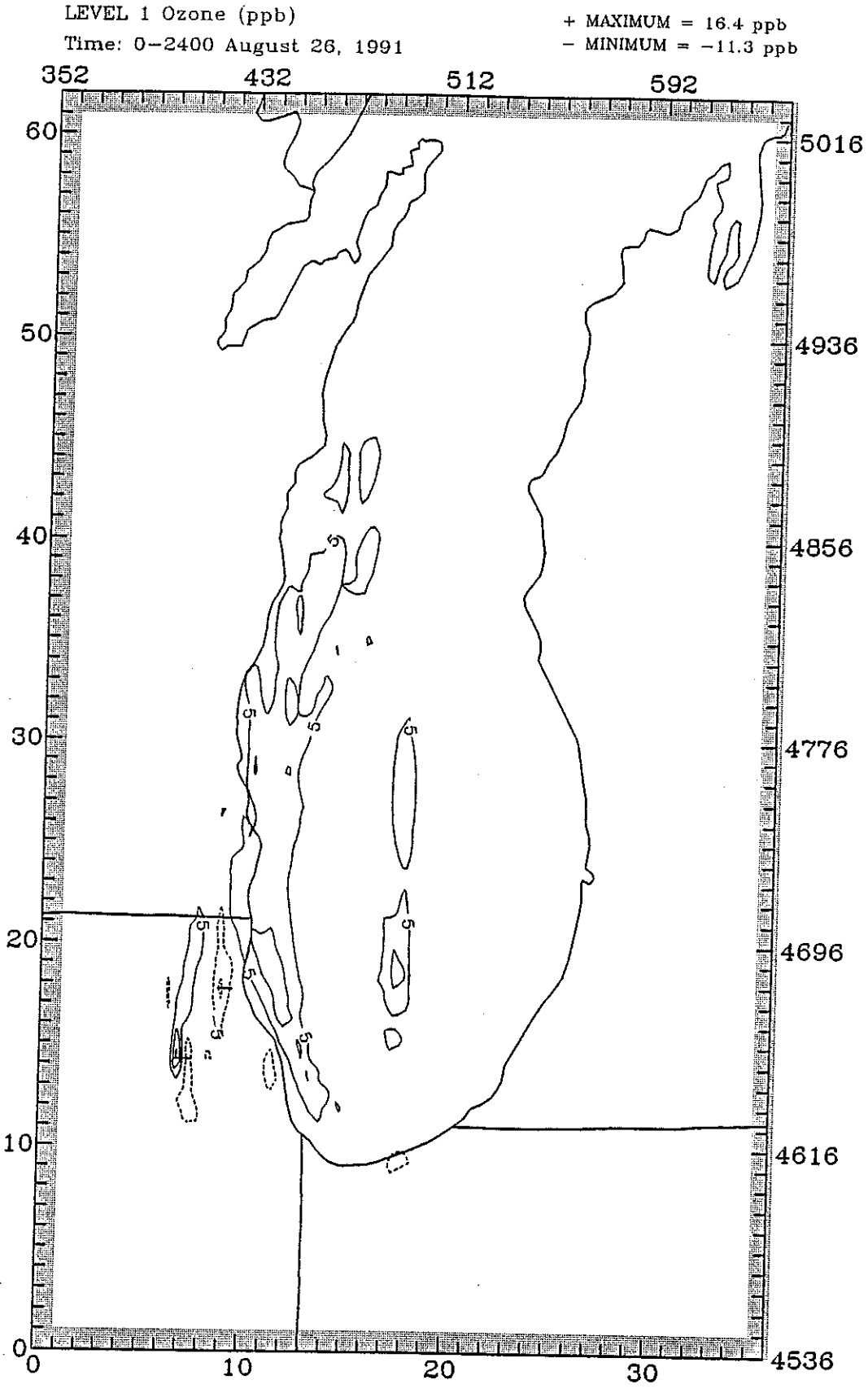
LMOS UAM-V Model Predictions of Differences in Maximum Hourly Ozone:
XY Map -- July 19, 1996 -- Grids B & C

(Basecase C - Strategy 1) [effect of LMOP Strategy 1 by 1996]



LMOS UAM-V Model Predictions of Differences in Maximum Hourly Ozone:
XY Map -- August 25, 1996 -- Grids B & C

(Basecase C - Strategy 1) [effect of LMOP Strategy 1 (1996)]

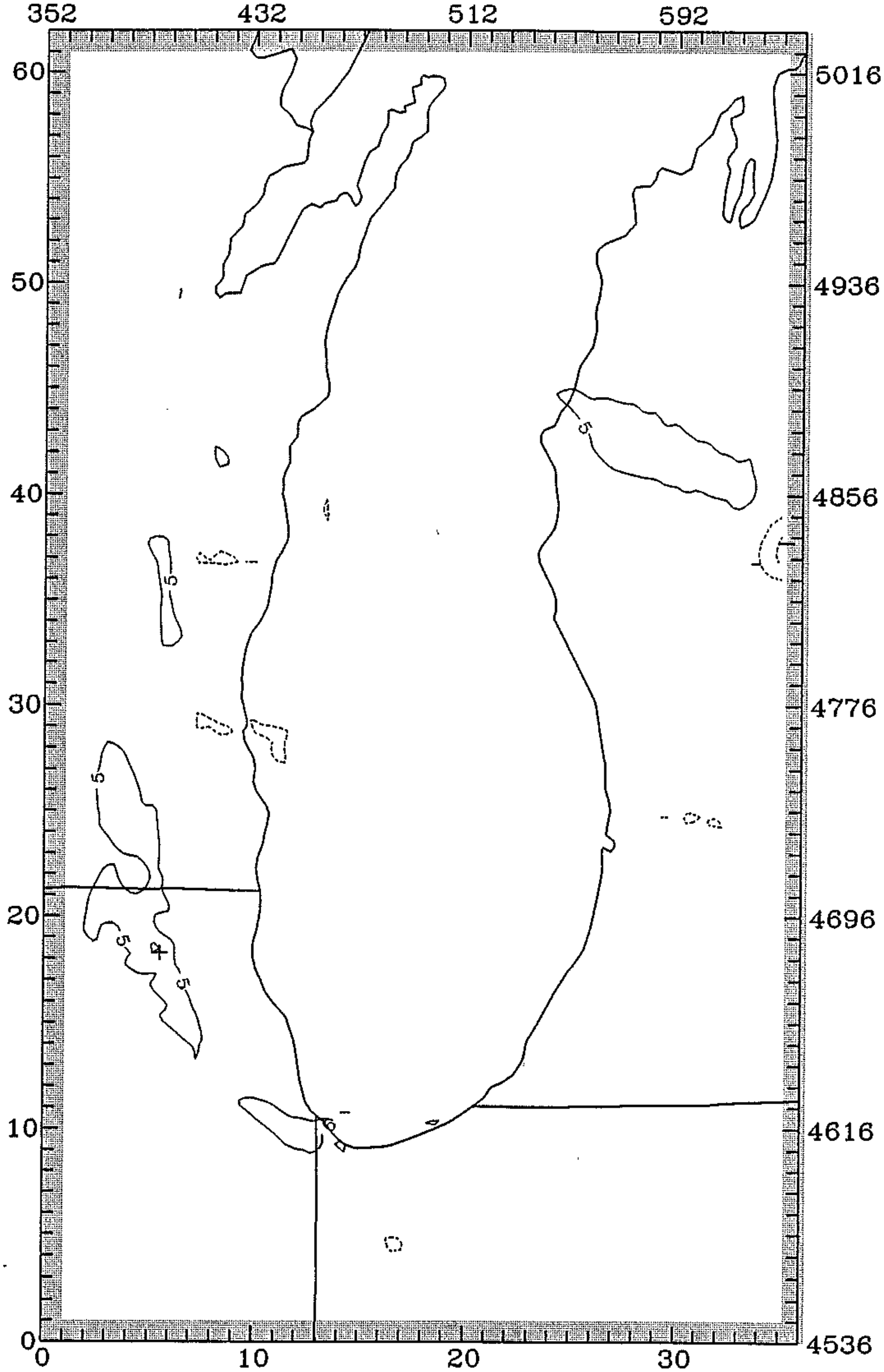


LMOS UAM-V Model Predictions of Differences in Maximum Hourly Ozone:
XY Map -- August 26, 1996 -- Grids B & C

(Basecase C - Strategy 1) [effect of LMOP Strategy 1 (1996)]

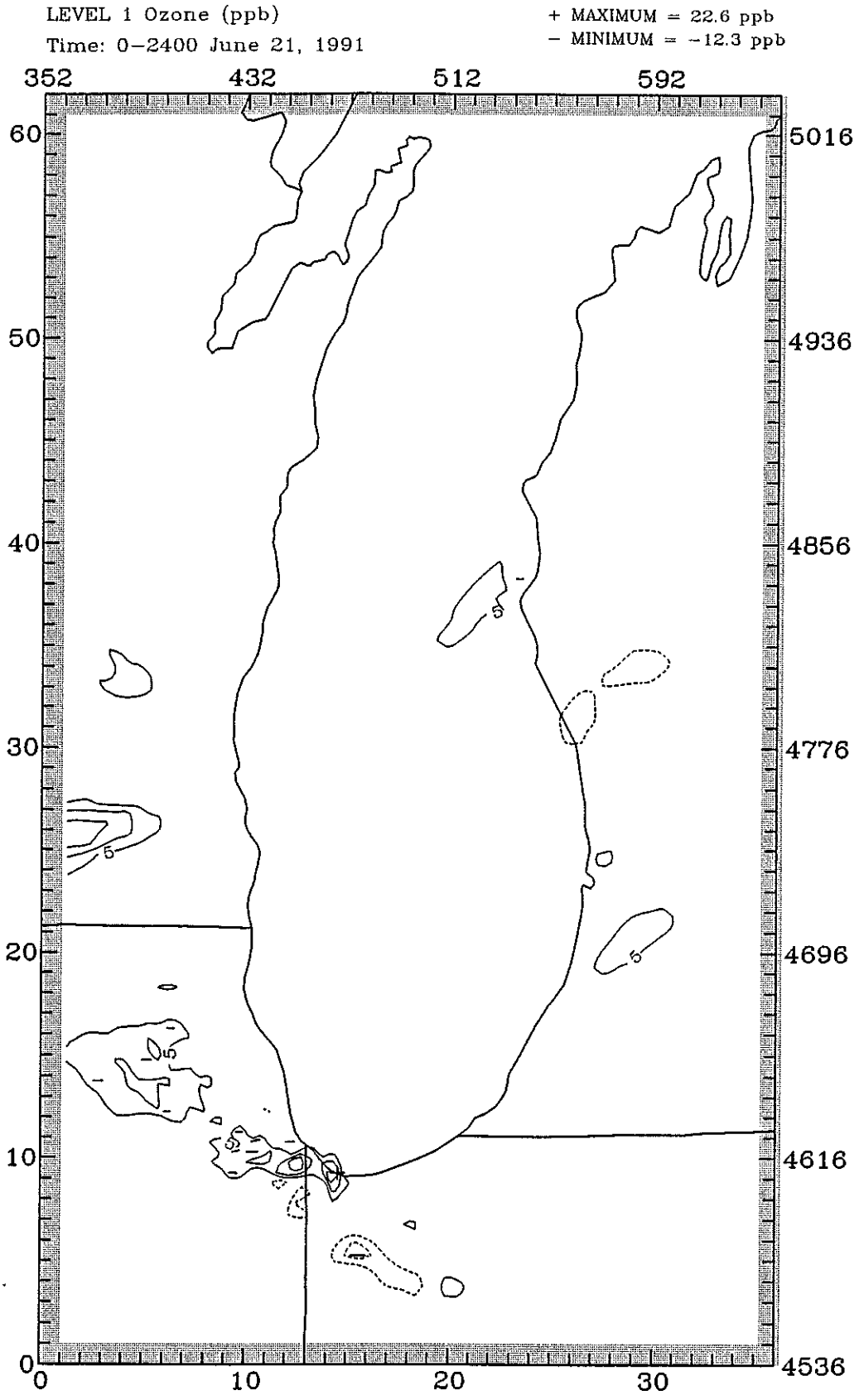
LEVEL 1 Ozone (ppb)
Time: 100–2400 June 20, 1991

+ MAXIMUM = 11.0 ppb
– MINIMUM = –11.0 ppb



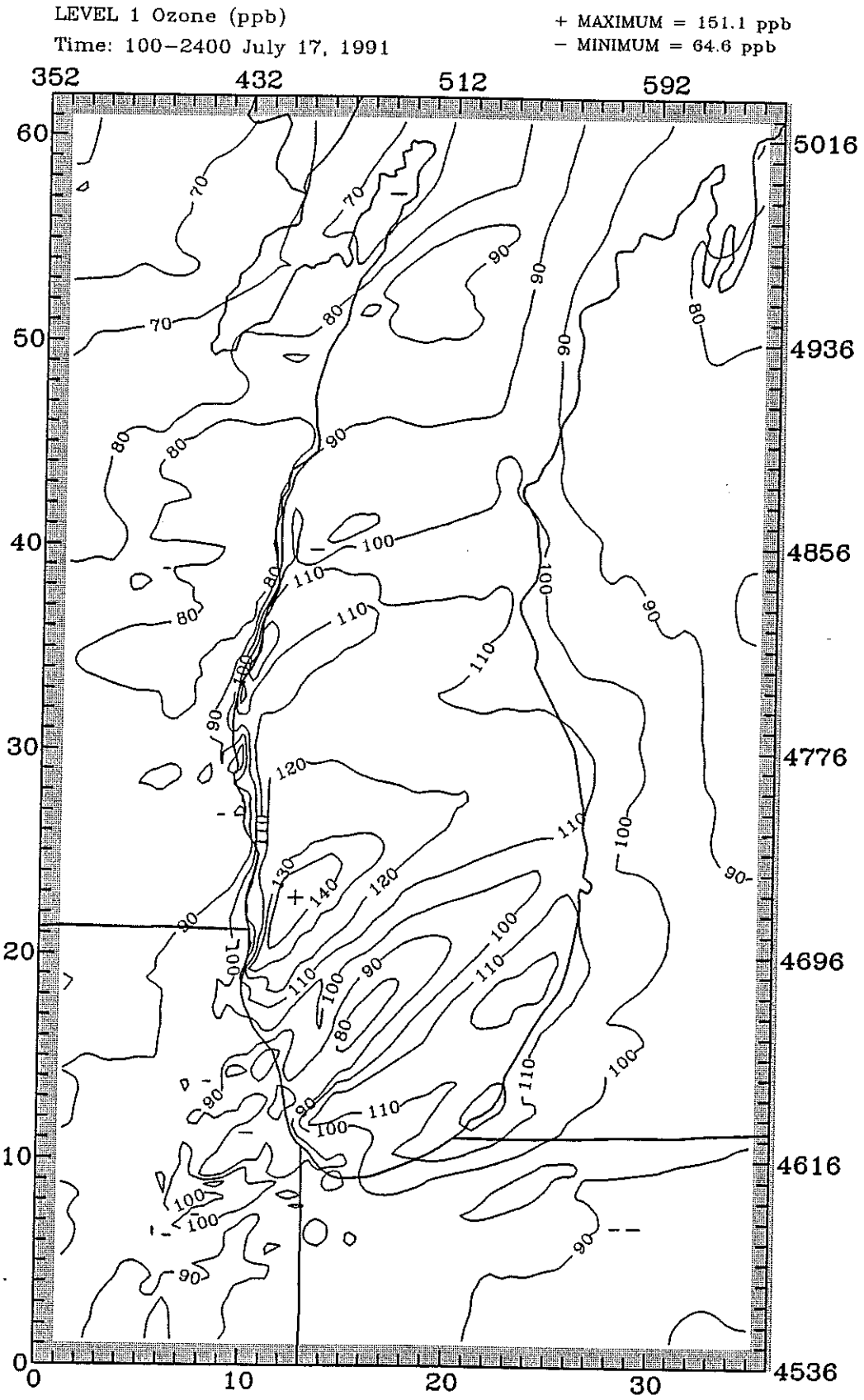
LMOS UAM–V Model Predictions of Differences in Maximum Hourly Ozone:
XY Map –– June 20, 1996 –– Grids B & C

(Basecase C – Strategy 2) [effect of LMOP Strategy 1 by 1996]



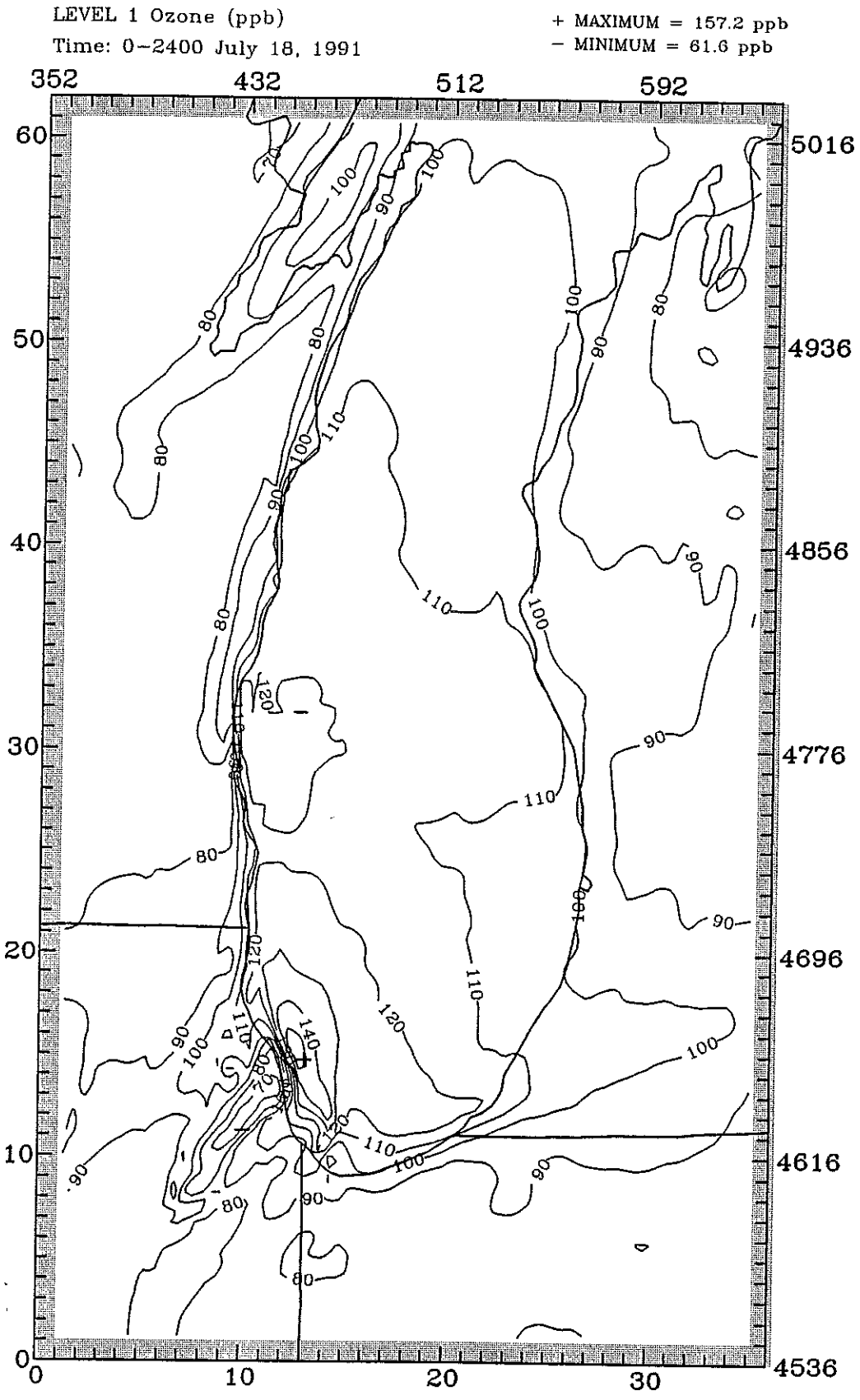
LMOS UAM-V Model Predictions of Differences in Maximum Hourly Ozone:
XY Map -- June 21, 1996 -- Grids B & C

(Basecase C - Strategy 1) [effect of LMOP Strategy 1 by 1996]



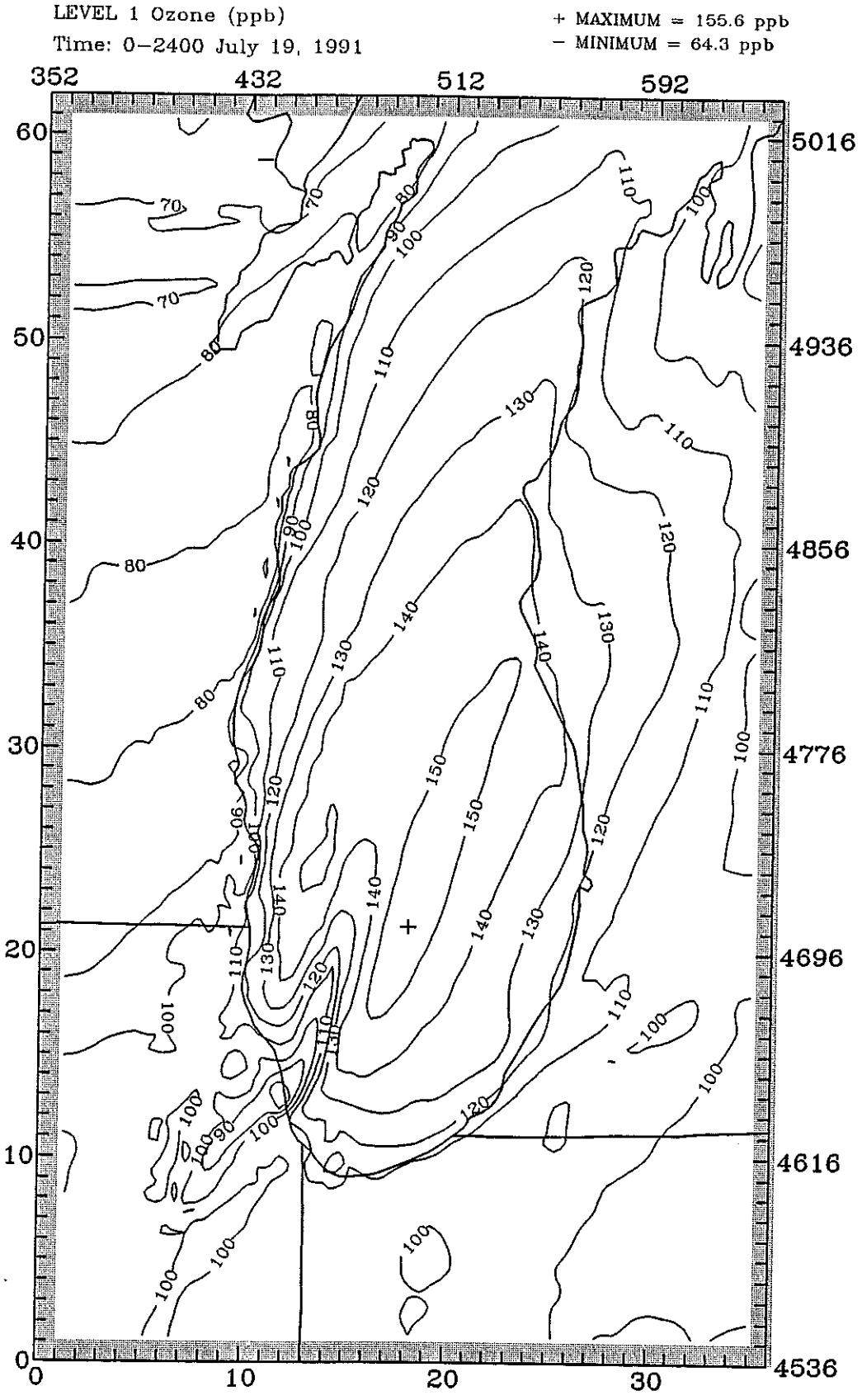
LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
XY Map -- July 17, 1996 -- Grids B & C

(.15-19jul96.16-8-4km.bumpup1) [Strategy 1 (1996): zero MI moderate emissio



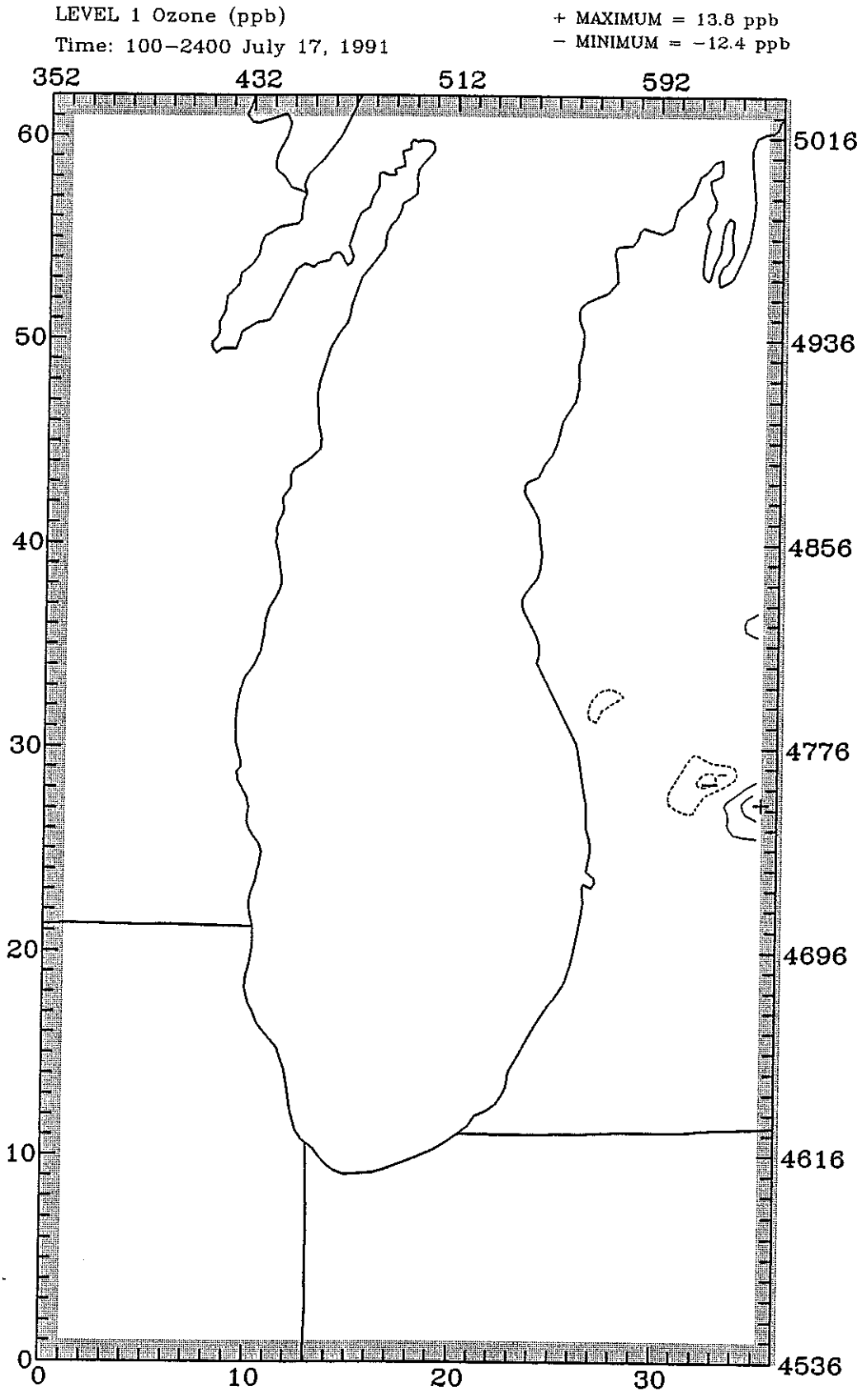
LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
XY Map -- July 18, 1996 -- Grids B & C

(.15-19jul96.16-8-4km.bumpup1) [Strategy 1 (1996): zero MI moderate emissio



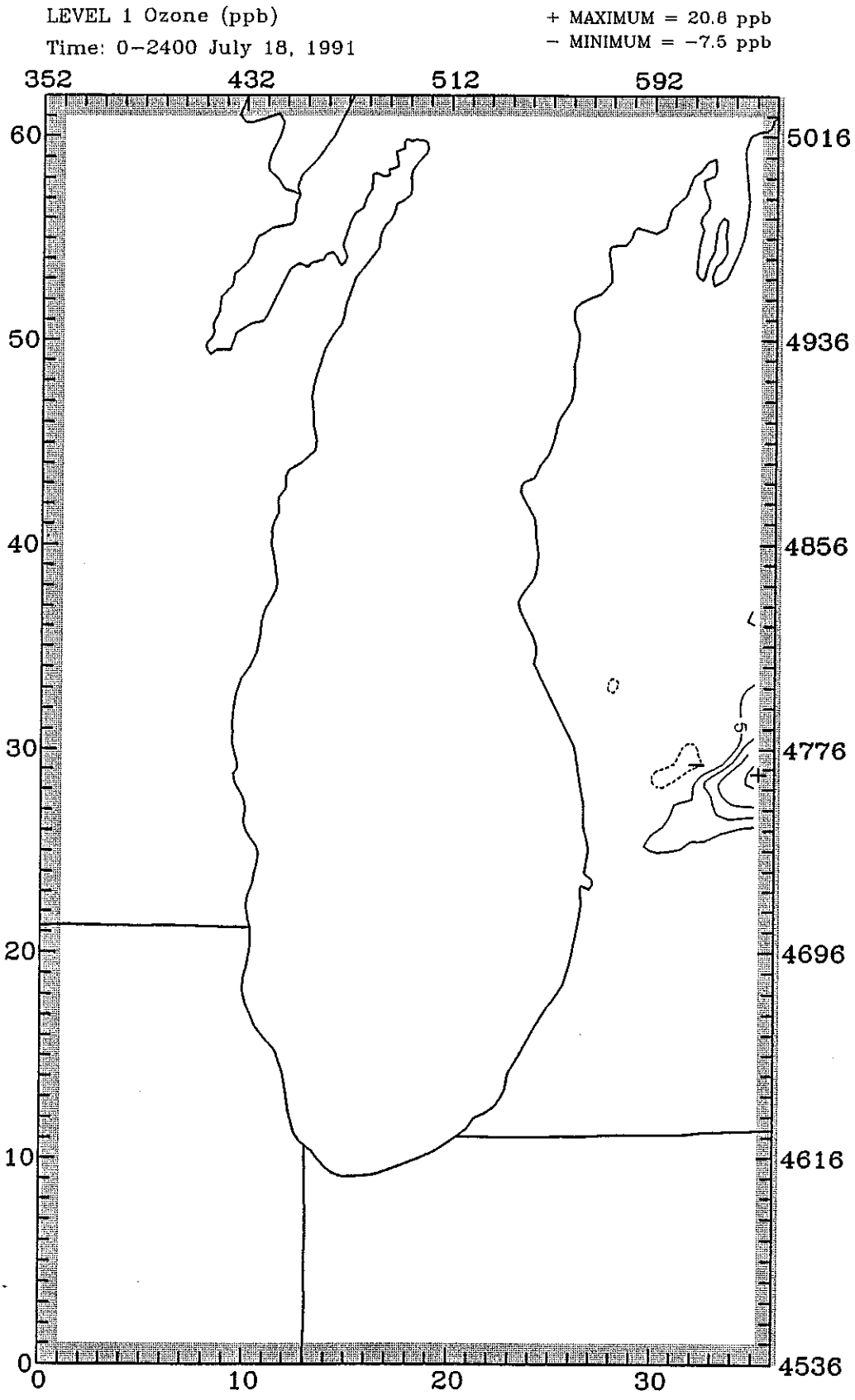
LMOS UAM-V Model Predictions of Maximum Hourly Ozone:
XY Map -- July 19, 1996 -- Grids B & C

(.15-19jul96.16-8-4km.bumpup1) [Strategy 1 (1996): zero MI moderate emissio



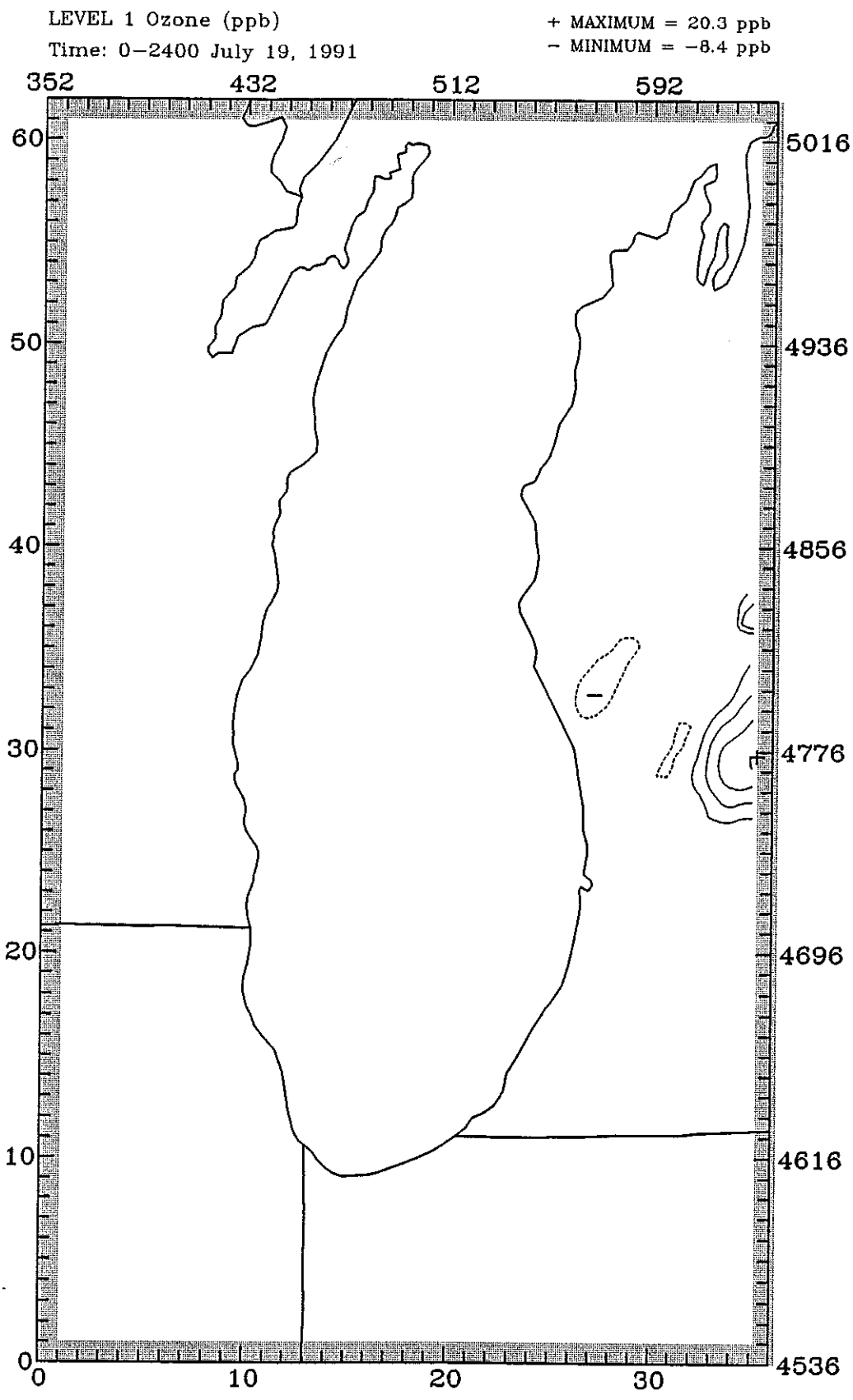
LMOS UAM–V Model Predictions of Differences in Maximum Hourly Ozone:
XY Map –– July 17, 1996 –– Grids B & C

(Strategy 1 – Bumpup 1) [effect of zero MI moderate emissions (1996 – Strate



LMOS UAM-V Model Predictions of Differences in Maximum Hourly Ozone:
XY Map -- July 18, 1996 -- Grids B & C

(Strategy 1 - Bumpup 1) [effect of zero MI moderate emissions (1996 - Strate



LMOS UAM–V Model Predictions of Differences in Maximum Hourly Ozone:
XY Map –– July 19, 1996 –– Grids B & C

(Strategy 1 – Bumpup 1) [effect of zero MI moderate emissions (1996 – Strate