



July 13, 1994

TECHNICAL SUPPORT DOCUMENT

Section 182(f) Exemption Modeling

Section 182(f) of the Clean Air Act Amendments of 1990 requires the application of reasonably available control technology (RACT) and new source review (NSR) provisions to major stationary sources of oxides of nitrogen (NO_x). Such provisions, however, shall not apply:

- (1) if the net air quality benefits are greater in the absence of NO_x reductions from the sources concerned;
- (2) in nonattainment areas not within an ozone transport region, if additional NO_x reductions would not contribute to attainment of the ozone NAAQS; or
- (3) in nonattainment areas within an ozone transport region, if additional NO_x reductions would not produce net ozone air quality benefits.

The U.S. Environmental Protection Agency (USEPA) has issued guidance on how it expects to handle this exemption provision (see "Guideline for Determining Applicability of Nitrogen Oxides Requirements Under Section 182(f)", December 1993). The purpose of this document is to outline the procedures which were followed, in accordance with USEPA's guidance, for preparing an exemption petition for the Lake Michigan region.

BACKGROUND

The Lake Michigan Ozone Study (LMOS) was initiated by the States of Illinois, Indiana, Michigan, and Wisconsin, and USEPA to deal with the regional ozone problem in the Lake Michigan area. A major goal of the study is to develop a comprehensive modeling system for the States to use to support revisions to their ozone control plans. Preliminary control strategy simulations, consisting of across-the-board reductions in volatile organic compounds (VOC) and NO_x, were performed to provide information on the most effective control path (see "Emissions Sensitivity Tests - Set 2: September - November 1993", February 1, 1994). These modeling runs showed that reductions in NO_x emissions resulted in increases in the domain-wide peak ozone concentration, the areal coverage of hours greater than 120 ppb, and the number of hours greater than 120 ppb increase. NO_x reductions also increased hourly ozone concentrations within and immediately downwind of the major urban areas of Chicago, Milwaukee, Gary, and Grand Rapids. Additional model sensitivity tests involving alternative VOC:NO_x emissions ratios (see "Emissions Sensitivity Tests - Set 3: January - February 1994", April 1, 1994) and

alternative photolysis rates (see "Across-the-Board Emission Reductions, UAM-V v. UAM-IV Photolysis Rates", June 29, 1994) produced similar results. Independent analysis of the LMOS field data also concluded that NOx controls would increase ozone concentrations in and downwind of Chicago (see, for example, "List of Conclusions for LMOP Meeting, January 10, 1994"). Because the general application of NOx controls appears to be counter-productive, it is appropriate to seek an exemption from the NOx requirements of section 182(f).

PROPOSED METHODOLOGY

Of the three tests identified in the statute, the first two (i.e., net air quality benefits and not contribute to attainment) are relevant in the Lake Michigan region. The "net air quality benefits" test is based on a broad set of air quality impacts related to NOx emissions, including ozone, nitrogen dioxide, particulate matter, visibility impairment, acid deposition, air toxics, and nitrogen deposition in nutrient-sensitive areas. The "not contribute to attainment" test, on the other hand, only considers the effect of NOx emissions on ozone. Because only one test needs to be satisfied, we have elected to consider the "not contribute to attainment" test here.

The test involves application of a photochemical grid model. The modeling analysis used the UAM-V model (Fast Version 1.21) and LMOS Episodes 1, 2, and 4.¹ The model was run with both Grid A (outer grid with 16 km resolution), and Grid B (inner grid with 8 km resolution). Model inputs are as follows:

- Boundary Conditions: based on observations, with NOx measurements speciated as 0/90/10/0 (NO/NO₂/PAN/HNO₃), and aloft carbonyls from 100% aircraft data
- Wind Fields: CALRAMS winds (unadjusted)
- Emissions: Round 3, as developed by LADCO pursuant to the emissions reevaluation effort (see "Round Three Updates to the LMOS Regional Modeling Inventory", March 18, 1994)
- Vertical Diffusivity: KRAMS $K_v * 3$
- Deposition: Wesley (1989) algorithm
- Plume-in-Grid: applied to major NOx sources

¹ For further information concerning model performance see "Evaluation of the UAM-V Photochemical Grid Model in the Lake Michigan Region", Version 1.0, May 1994.

The steps of the analysis are as follows:

- (1) Project emissions to 1996 and 2007 conditions: Simple, region-wide adjustment factors were developed for point sources, area sources, and motor vehicles which account for both growth and known control (i.e., mandatory CAAA controls and 15% Reasonable Further Progress controls) - see Table 1. Biogenic emissions were assumed to be the same in the base year (1991) and the future years (1996 and 2007).
- (2) Model a substantial reduction in anthropogenic VOC emissions: USEPA's guidance suggests that a "substantial" reduction is the amount of VOC reduction needed to attain based on a modeling analysis. Although no attainment demonstration has been performed for the Lake Michigan area, the emissions sensitivity tests noted above indicate that VOC reductions on the order of 60% appear to be necessary to reduce modeled peak ozone concentrations to 120 ppb (assuming no change in boundary conditions). Given that some of this reduction is already accounted for in the control factors used to project emissions to 1996 and 2007 conditions, a reasonable level of additional reduction to assume for this analysis is about 40%. (This amount of reduction is also near the middle of the range of emission reduction expected from adoption of NOx RACT, as estimated by USEPA and NESCAUM.²)

Application of the 40% reduction factor was applied to all anthropogenic emissions located within Grid B of the UAM-V modeling domain for this simulation. (Note: Grid B includes all of the nonattainment areas classified as moderate [and above] in the Lake Michigan region.)

- (3) Model a substantial reduction in NOx emissions: The same 40% reduction level was assumed for this simulation in accordance with USEPA's guidance. The NOx reduction was applied to all emissions located within Grid B of the UAM-V modeling domain.

As a sensitivity test, the NOx reduction was also applied only to point sources for Episode 2 for 1996 conditions. The rationale for this alternative scenario is that the NOx RACT requirement would apply only to point sources.

- (4) Model a substantial reduction in NOx and anthropogenic VOC emissions: All NOx emissions and all anthropogenic VOC emissions for Grid B were

² See "Evaluation and Costing of NOx Controls for Existing Utility Boilers in the NESCAUM Region", December 1992, NESCAUM; and "Summary of NOx Control Technologies and their Availability and Extent of Application", February 1992, USEPA.

reduced by 40% for this simulation. USEPA's guidance recommends the use of the same level of VOC reduction assumed in Step 2 above, and a "similar" level of NOx reduction. Using the same percent reduction for both pollutants is consistent with USEPA's guidance.

As a sensitivity test, the NOx reduction was also applied only to point sources for Episode 2 for 1996 conditions (as discussed above).

- (5) Compare domain-wide peak 1-hour ozone concentration for three emission reduction cases: If the domain-wide peak ozone concentration under the VOC-only reduction case is less than the domain-wide peak ozone concentration under the other reduction cases for all modeled days (excluding ramp-up days), then USEPA's guidance states that the test is passed and the section 182(f) requirements would not apply. This exemption would apply region-wide within the nonattainment areas located in the Lake Michigan modeling domain.

MODELING RESULTS

The domain-wide peak ozone concentrations for the various modeling cases are presented in Table 2. Plots of the peak daily ozone concentrations are provided in Attachments 1 (1996 simulations), 2 (2007 simulations), and 3 (Sensitivity Test).

For Episodes 1 and 2, the table and plots demonstrate that:

- * the lowest domain-wide peak ozone concentrations occur under the VOC-only reduction case
- * the highest domain-wide peak ozone concentrations occur under the NOx-only reduction case
- * the area of 120 ppb (or greater) ozone concentrations is smallest under the VOC-only reduction case
- * the area of 120 ppb (or greater) ozone concentrations is largest under the NOx-only reduction case on most days

These results indicate that with respect to the domain-wide peak ozone concentrations and high ozone concentrations in general, across-the-board reductions in NOx emissions from the applicable upwind, local source regions for these episodes (i.e., NE Illinois, NW Indiana, and SE Wisconsin) would not contribute to attainment.

The results of the Episode 2 sensitivity test are similar to those noted above. This supports the finding that across-the-board reductions in point source NO_x emissions would not contribute to attainment.

For Episode 4, the highest predicted domain-wide peak ozone concentrations occur under the NO_x-only reduction case. The domain-wide peak ozone concentrations for the other cases are similar and, as seen in the plots, occur in the SE corner of the domain. It appears that this high value is due to either emissions from outside Grid B or boundary conditions. Given the focus of this analysis on Grid B, this value should be ignored and the high ozone concentrations farther inside the domain should be considered (i.e., in the area of highest observed ozone concentrations).

On June 20, the highest observed ozone concentrations occur in NE Illinois. The predicted ozone concentrations there are lowest under the VOC-only reduction case and highest under the NO_x-only reduction case.

On June 21, the highest observed ozone concentrations occur in NE Illinois and NW Indiana. Over this broad area, the highest predicted ozone concentrations occur under the NO_x-only reduction case. The predicted ozone concentrations there under the VOC-only reduction case are lower than under the basecase, but are similar to the concentrations under the combined VOC and NO_x reductions case. (In NE Illinois alone, the peak ozone concentrations under the VOC-only reduction case are lower than the other cases.)

The similarity in predicted peak ozone concentrations between the VOC-only reduction case and the combined VOC and NO_x reductions case suggests that NO_x reductions in the applicable upwind, local source region (W Michigan) may not be counterproductive (at least for Episode 4). Although these NO_x reductions do not appear to be detrimental, the analyses are too limited to determine whether the reductions are truly beneficial. Further analyses may show that selective (geographical) NO_x reductions, such as possibly in W Michigan for Episode 4, actually contribute to attainment. The information available at this time, however, clearly shows that general, across-the-board NO_x reductions throughout the Lake Michigan modeling domain will not contribute to attainment. Consequently, an exemption from the additional NO_x reductions required by section 182(f) is appropriate.

Table 1. Proposed Growth/Control Adjustment Factors to Baseyear Emission Estimates

	VOC		NOX	
	1996	2007	1996	2007
Point Sources	0.90	1.00	1.20	1.20
Area Sources	0.90	0.90	1.00	1.05
Motor Vehicles	0.50	0.30	0.85	0.80
Biogenics	1.00	1.00	---	---

Table 2. NOx Exemption Modeling Results

	Domain-Wide Peak Ozone Concentrations (ppb)			
	Episode 1	Episode 2	Episode 4	
	(June 26/June 27/June 28)	(July 17/July 18/July 19)	(June 20/June 21)	
Projected 1996 Results				
Base Case	134/121/117	132/117/136	112/119	
VOC Reductions	126/112/108	123/113/126	112/119	
NOx Reductions	140/134/135	165/151/144 138/123/141*	121/120	
VOC,NOx Reductions	133/124/125	148/130/135 123/116/130*	112/119	
* Sensitivity Test Results (NOx reduction only applied to point sources)				
Projected 2007 Results				
Base Case	133/120/116	131/116/134	110/118	
VOC Reductions	125/112/107	124/112/125	110/118	
NOx Reductions	138/132/133	163/149/143	116/122	
VOC,NOx Reductions	132/123/123	147/129/134	110/117	

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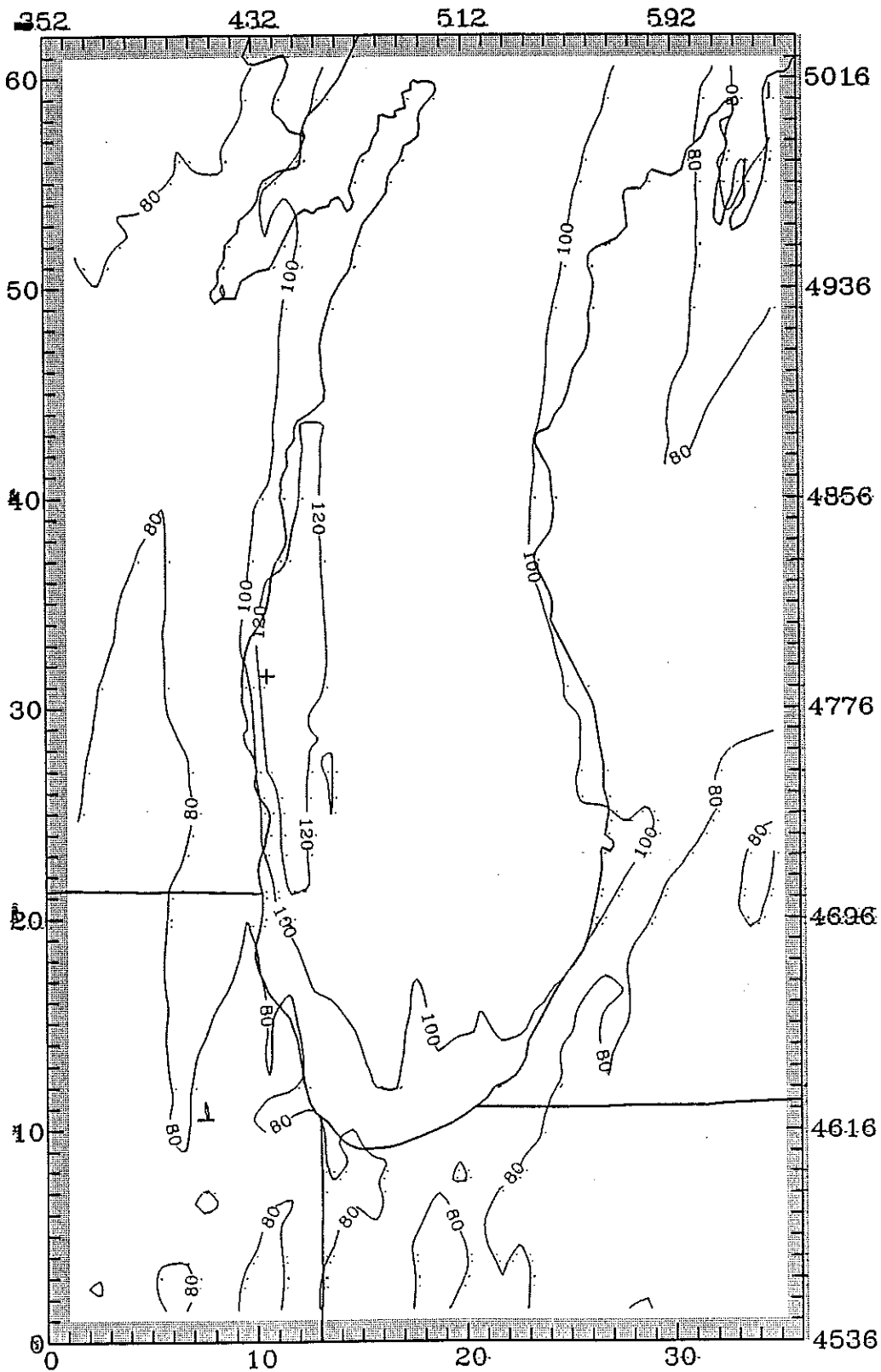
ATTACHMENT 1

Peak Daily Ozone Concentrations

Projected 1996 Conditions
Episodes 1, 2, and 4

LEVEL 1. Ozone. (ppb).
Time: 100-2400 June 26, 1991

+ MAXIMUM = 134.4 ppb
- MINIMUM = 59.2 ppb



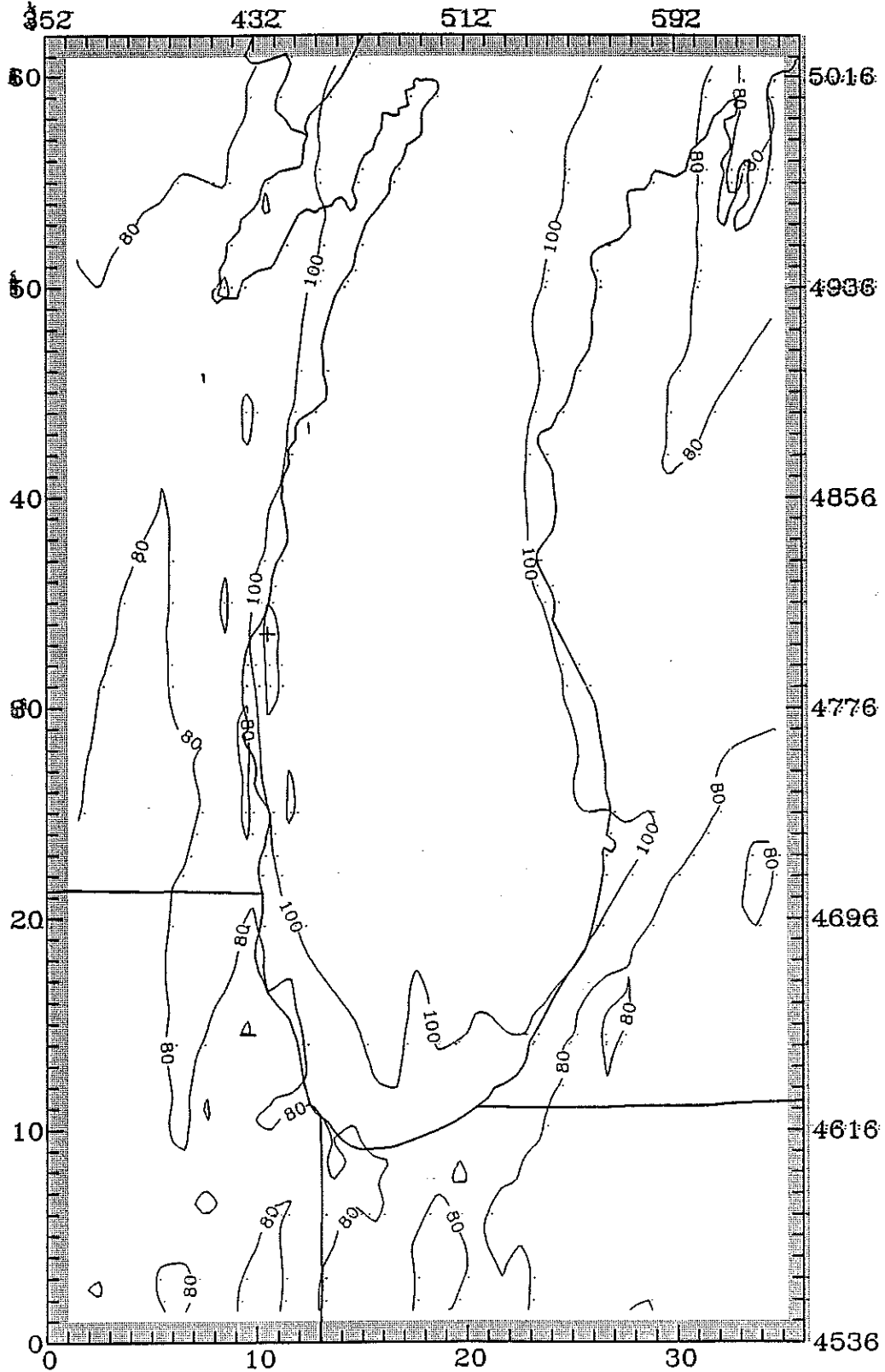
Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- June 26, 1991. (.24-28jun91.16-8km.96_base) (v1.21)

LEVEL 1 Ozone (ppb)

+ MAXIMUM = 125.5 ppb

Time: 100-2400 June 26, 1991

- MINIMUM = 58.1 ppb



Maximum Simulated Hourly Ozone Concentrations in the LMOs Region
8 km grid -- June 26, 1991. (.24-28jun91.16-8km.96_rhctrl) (v1.21)

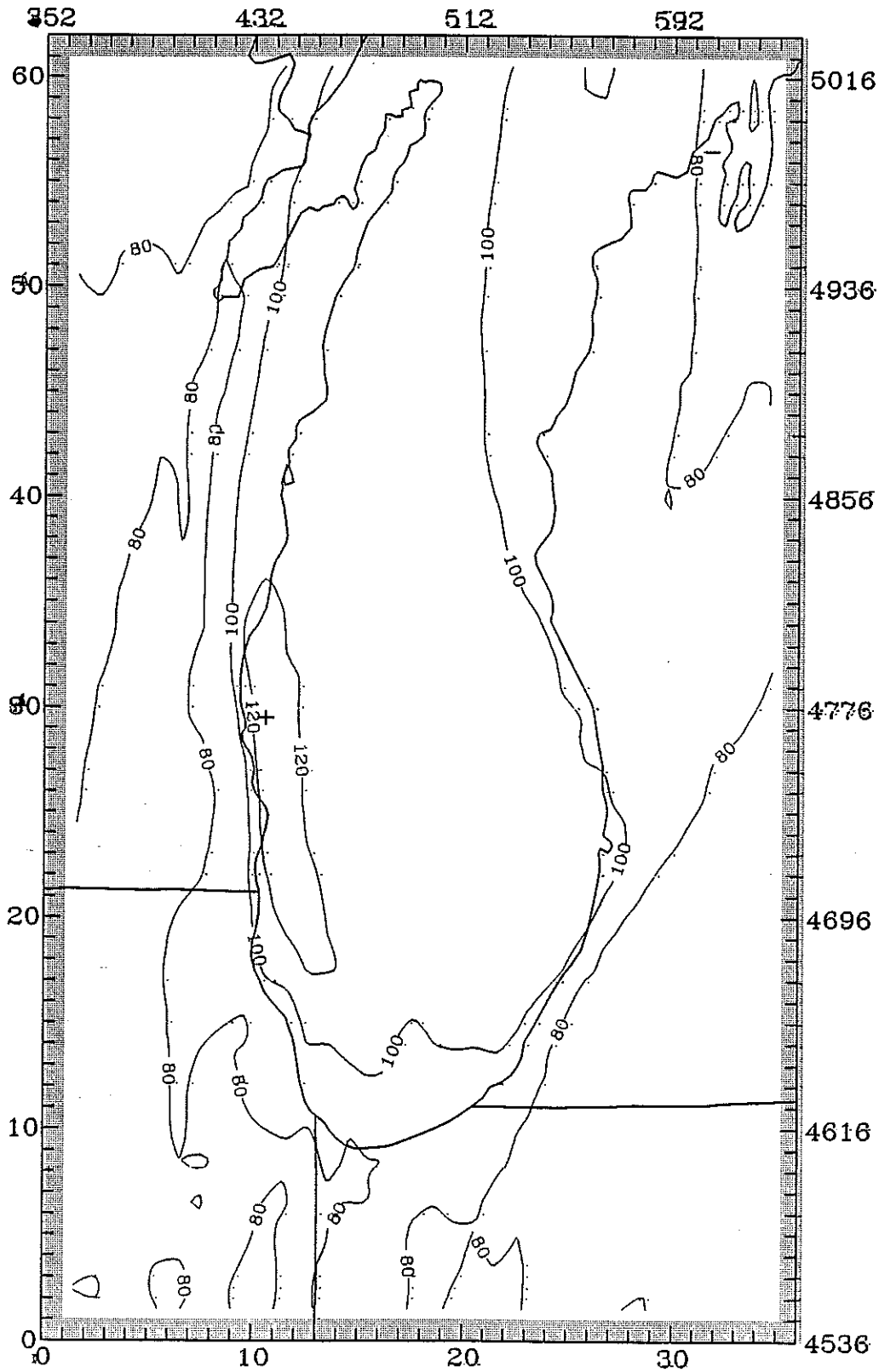
1996 Basecase with Grid B anthropogenic RHC emissions reduced by 40%.

LEVEL 1 Ozone (ppb)

Time: 100-2400 June 26, 1991

+ MAXIMUM = 139.8 ppb

- MINIMUM = 69.2 ppb

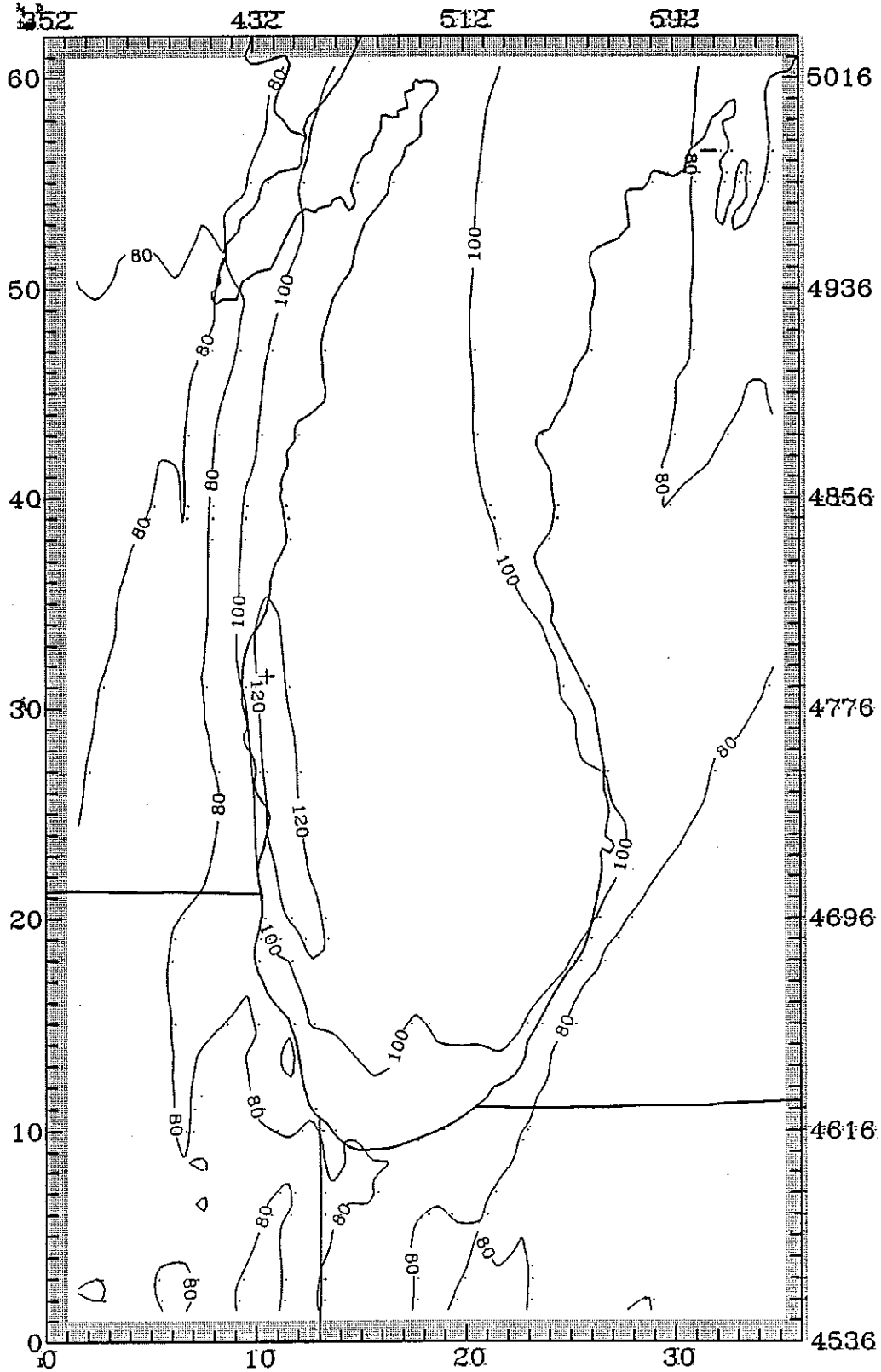


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- June 26, 1991. (.24-28jun91.16-8km.96_noxctrl) (v1.21)

1996 Basecase with Grid B NO_x emissions reduced by 40%.

LEVEL 1. Ozone (ppb):
Time: 100-2400 June 26, 1991

+ MAXIMUM = 133.1 ppb
- MINIMUM = 68.6 ppb

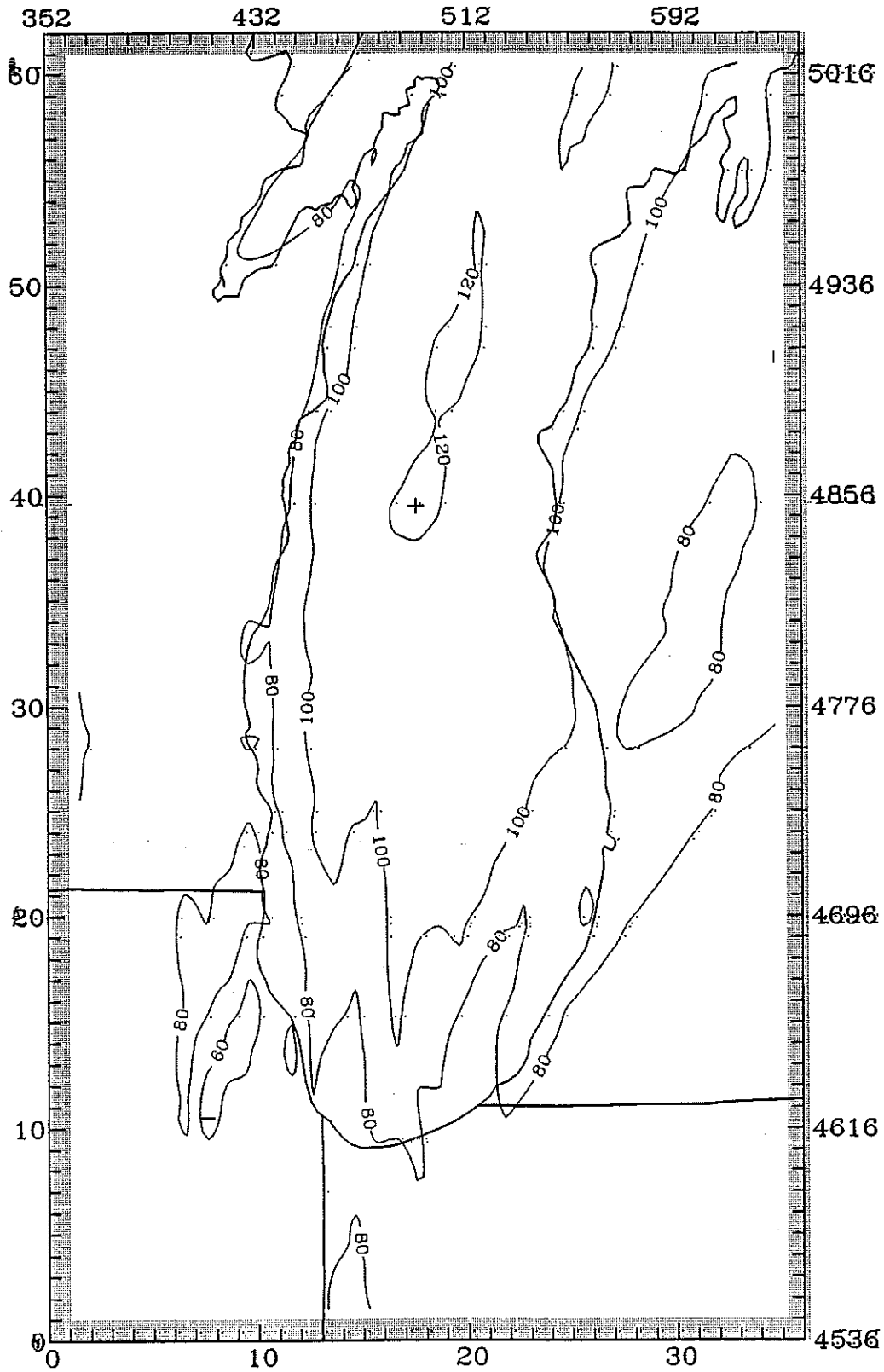


Maximum Simulated Hourly Ozone Concentrations in the LMOs Region.
8 km grid -- June 26, 1991. (.24-28jun91.16-8km.96_botlet1) (v1.21)

1996 Basecase with Grid B anthropogenic RHC & NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 June 27, 1991

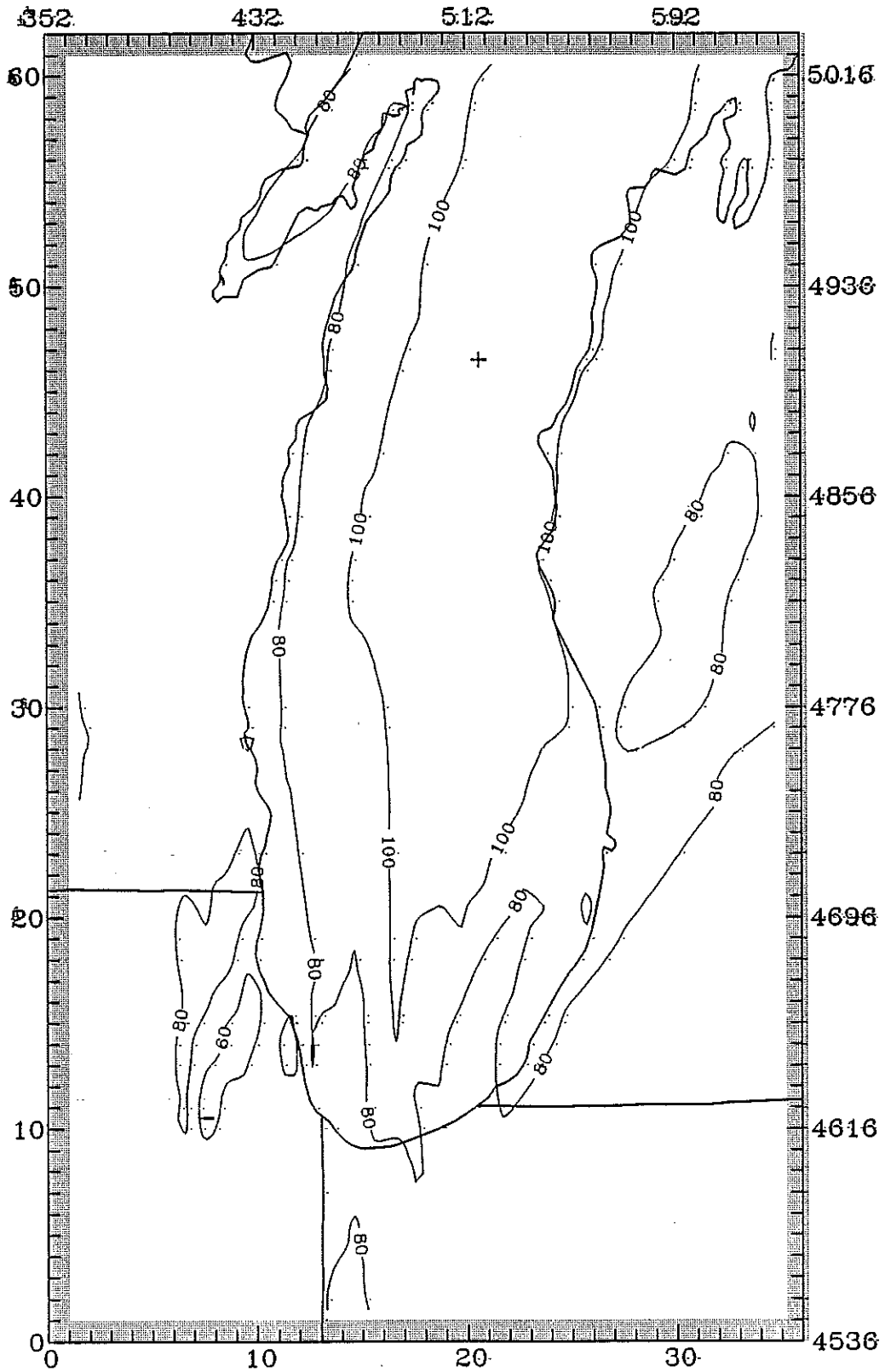
+ MAXIMUM = 121.4 ppb
- MINIMUM = 48.0 ppb



Maximum Simulated Hourly Ozone Concentrations in the LMQS Region
8 km grid -- June 27, 1991. (.24-28jun91.16-8km.96_base) (v1.21)

LEVEL 1 Ozone (pph).
Time: 0-2400 June 27, 1991

+ MAXIMUM = 112.2 ppb
- MINIMUM = 47.6 ppb

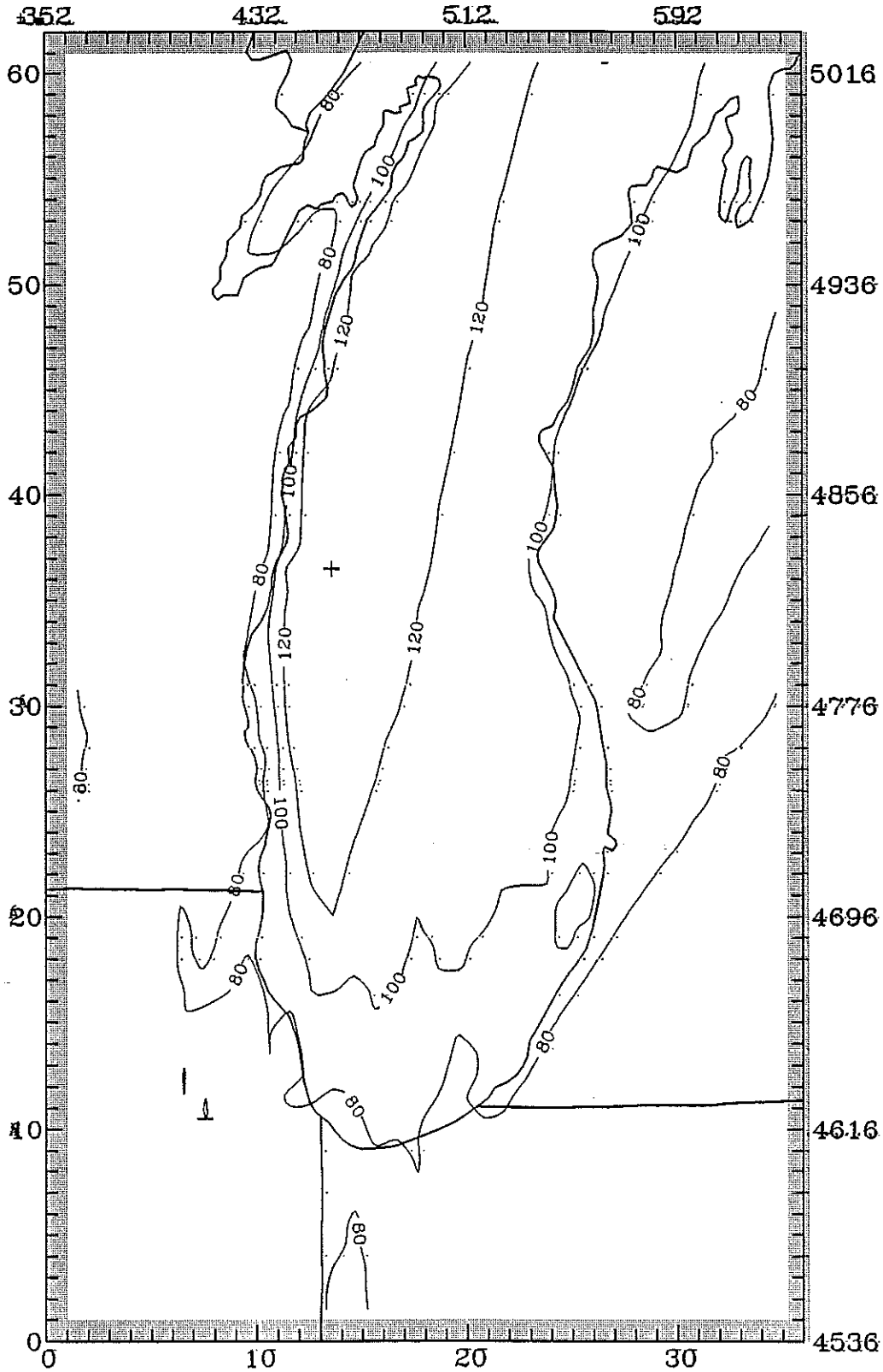


Maximum Simulated Hourly Ozone Concentrations in the LMOB Region.
8 km grid -- June 27, 1991. (.24-28jun91.16-8km.96_rhctrl). (v1.21)

1996 Basecase with Grid B anthropogenic RHC emissions reduced by 40%.

LEVEL 1 Ozone (ppb):
Time: 0-2400 June 27, 1991

+ MAXIMUM = 133.8 ppb
- MINIMUM = 59.9 ppb

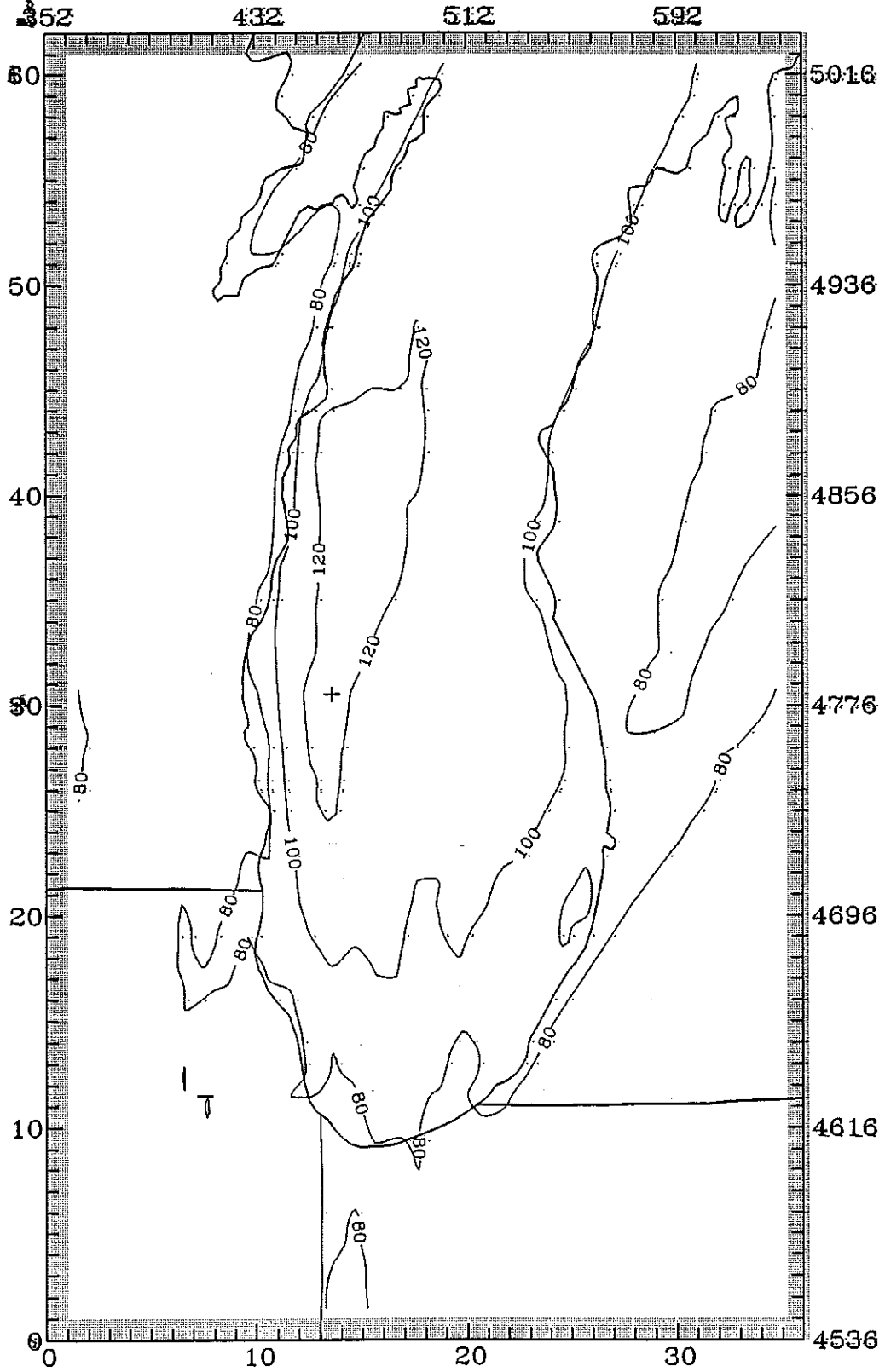


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region.
8 km grid -- June 27, 1991. (.24-25jun91.16-8km.96_noxctri) (v1.21)

1996 Basecase with Grid B NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 June 27, 1991

+ MAXIMUM = 123.6 ppb
- MINIMUM = 59.3 ppb

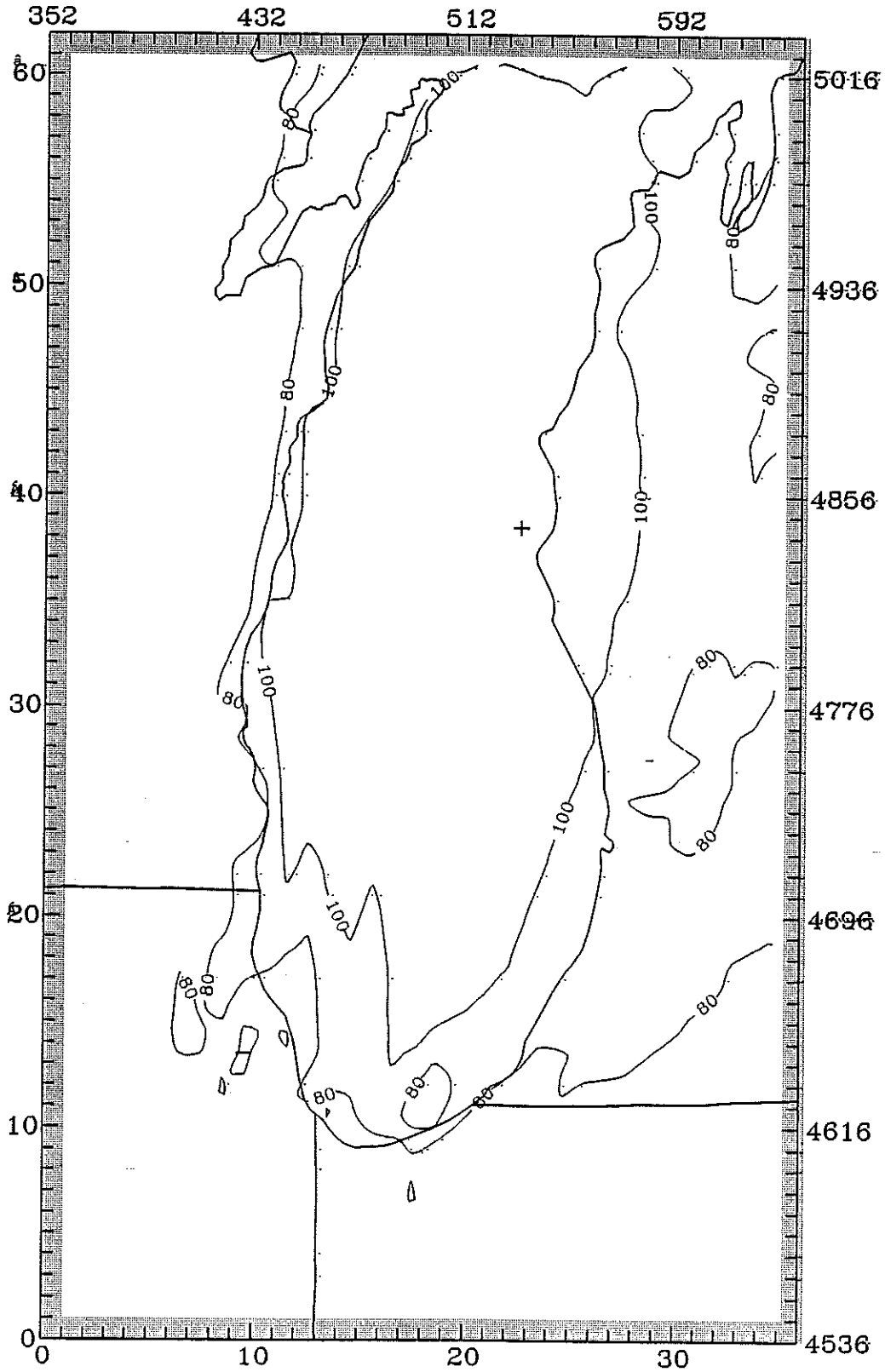


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- June 27, 1991. (.24-28jun91.16-8km.96_botfictf) (v1.21)

1996 Basecase with Grid B anthropogenic RHC & NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 June 28, 1991

+ MAXIMUM = 117.0 ppb
- MINIMUM = 57.1 ppb

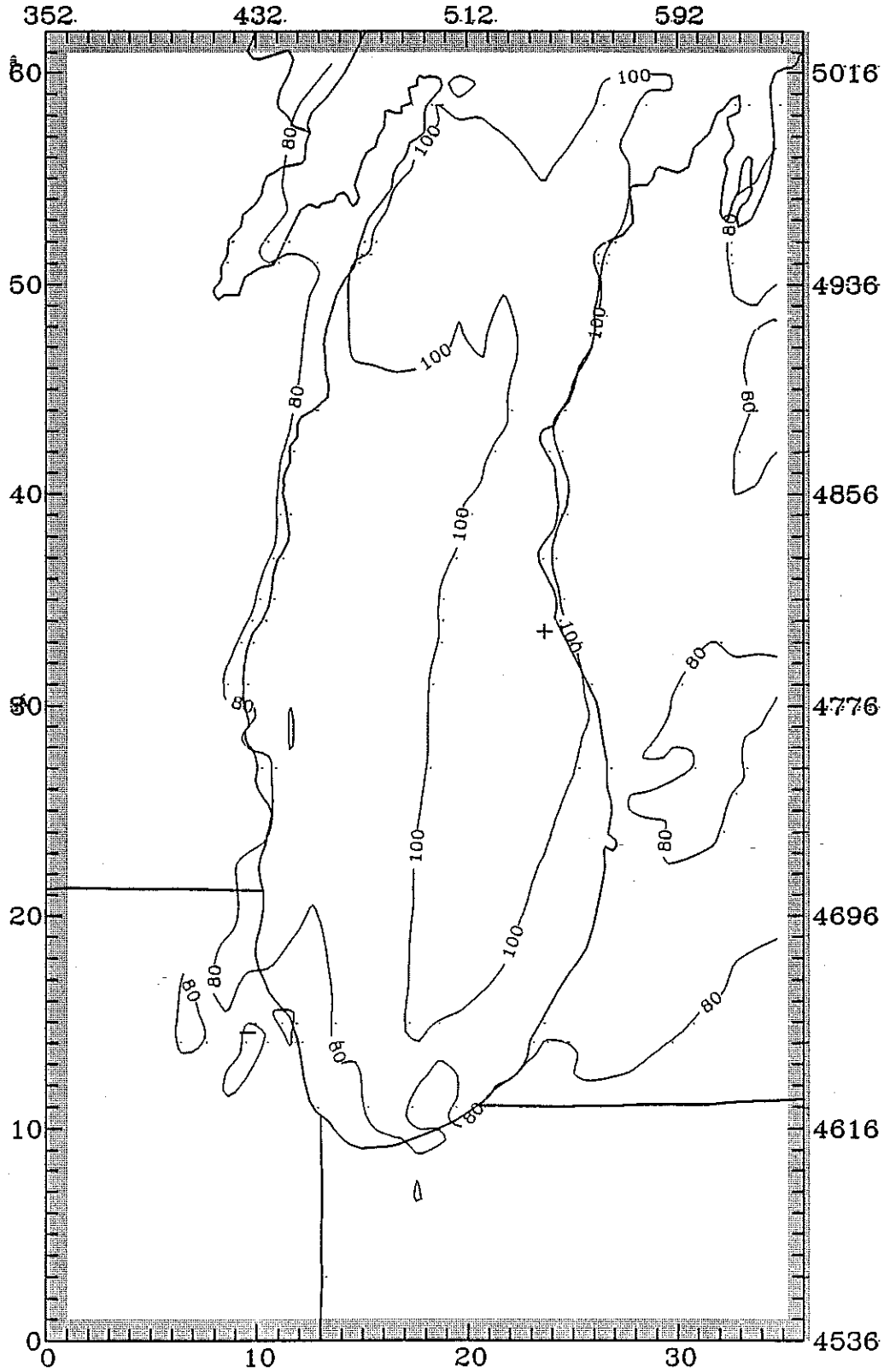


Maximum Simulated Hourly Ozone Concentrations in the LMQS Region.
8 km grid -- June 28, 1991. (.24-28jun91.16-8km.96_base) (v1.21)

1996 Basecase

LEVEL 1 Ozone (ppb)
Time: 0-2400 June 28, 1991

+ MAXIMUM = 107.9 ppb
- MINIMUM = 55.3 ppb



Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- June 28, 1991. (.24-28jun91.16-8km.96_rhcctrl) (v1.21)

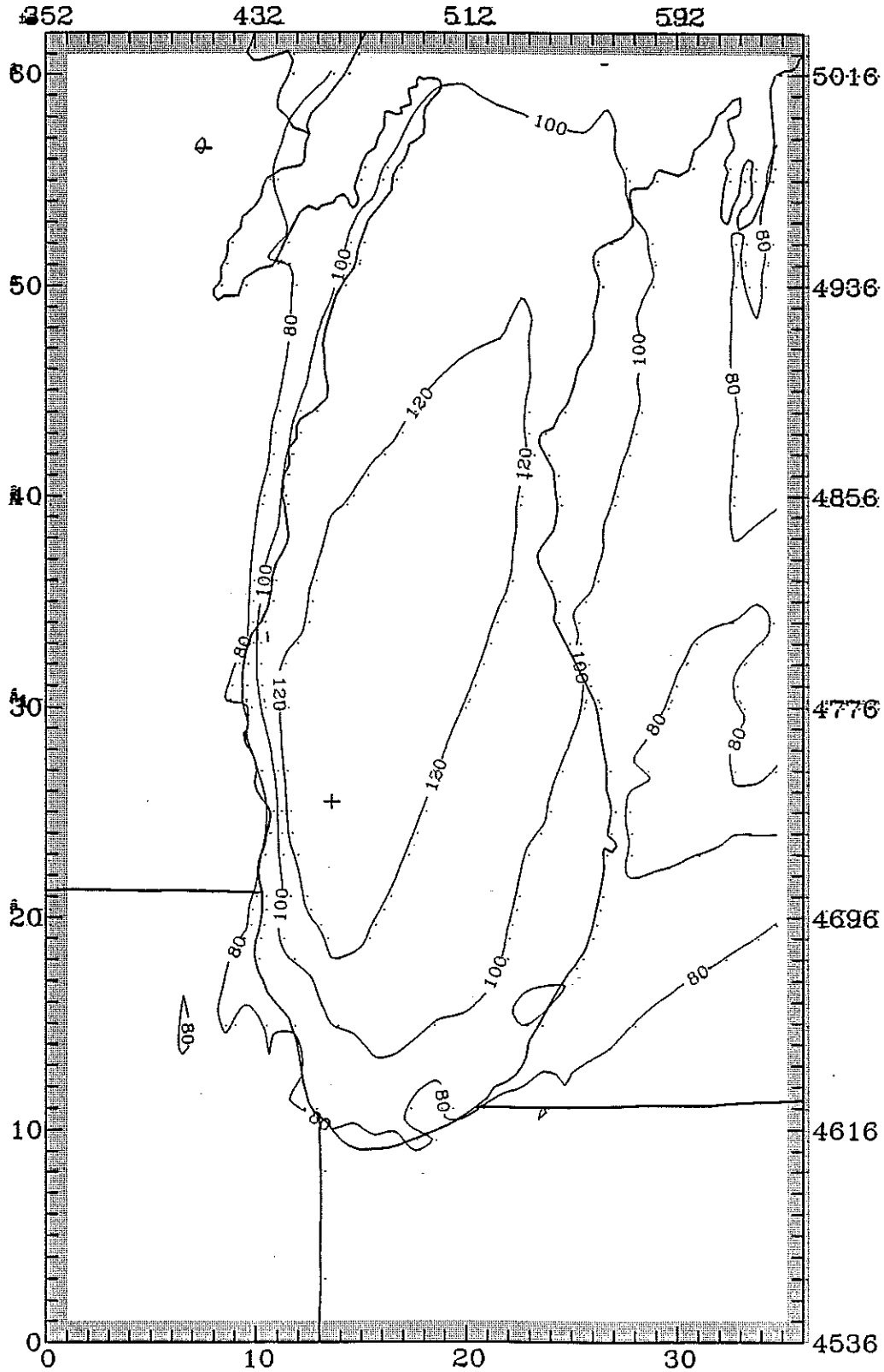
1996 Basecase with Grid B anthropogenic RHC emissions reduced by 40%.

LEVEL 1. Ozone. (ppb).

+ MAXIMUM = 134.6 ppb

Time: 0-2400 June 28, 1991

- MINIMUM = 59.7 ppb

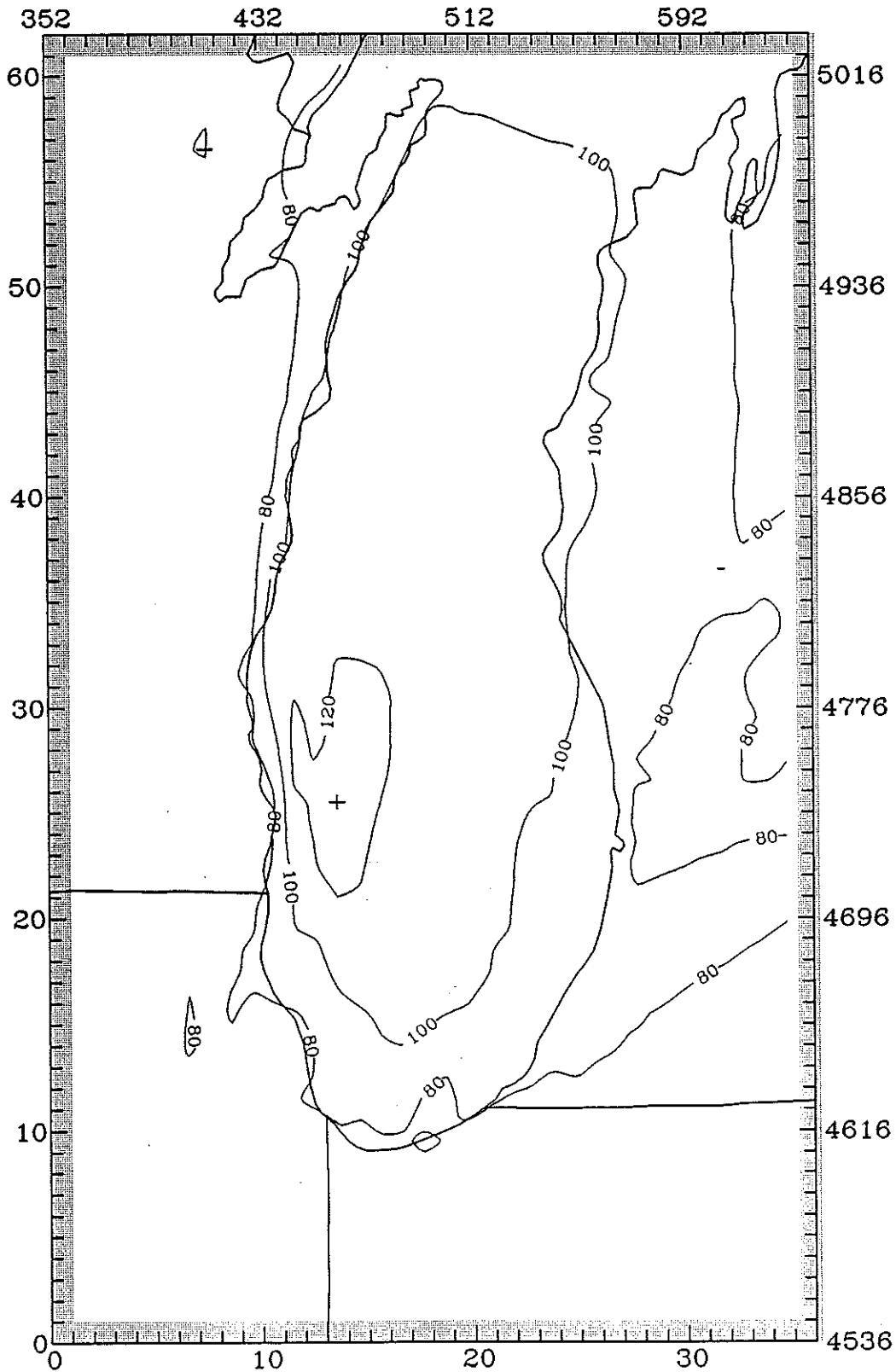


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- June 28, 1991. (.24-28jun91.16-8km.96_noxatrl). (v1.21)

1996 Basecase with Grid B NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 June 28, 1991

+ MAXIMUM = 124.7 ppb
- MINIMUM = 59.6 ppb



Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- June 28, 1991. (.24-28jun91.16-8km.96_bothctrl) (v1.21)

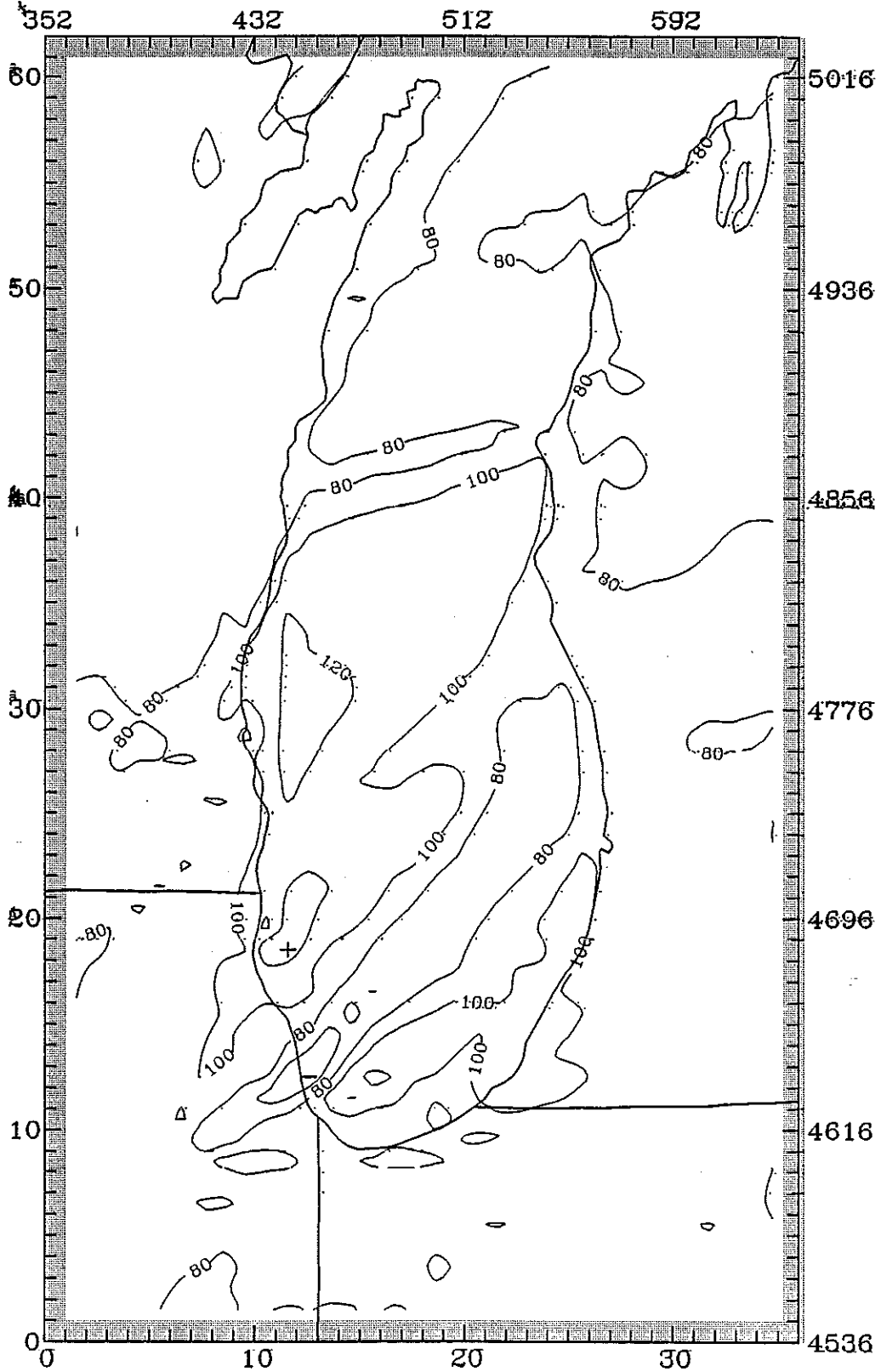
1996 Basecase with Grid B anthropogenic RHC & NOx emissions reduced by 40%.

LEVEL 1: Ozone (ppb):

+ MAXIMUM = 131.6 ppb

Time: 100-2400 July 17, 1991

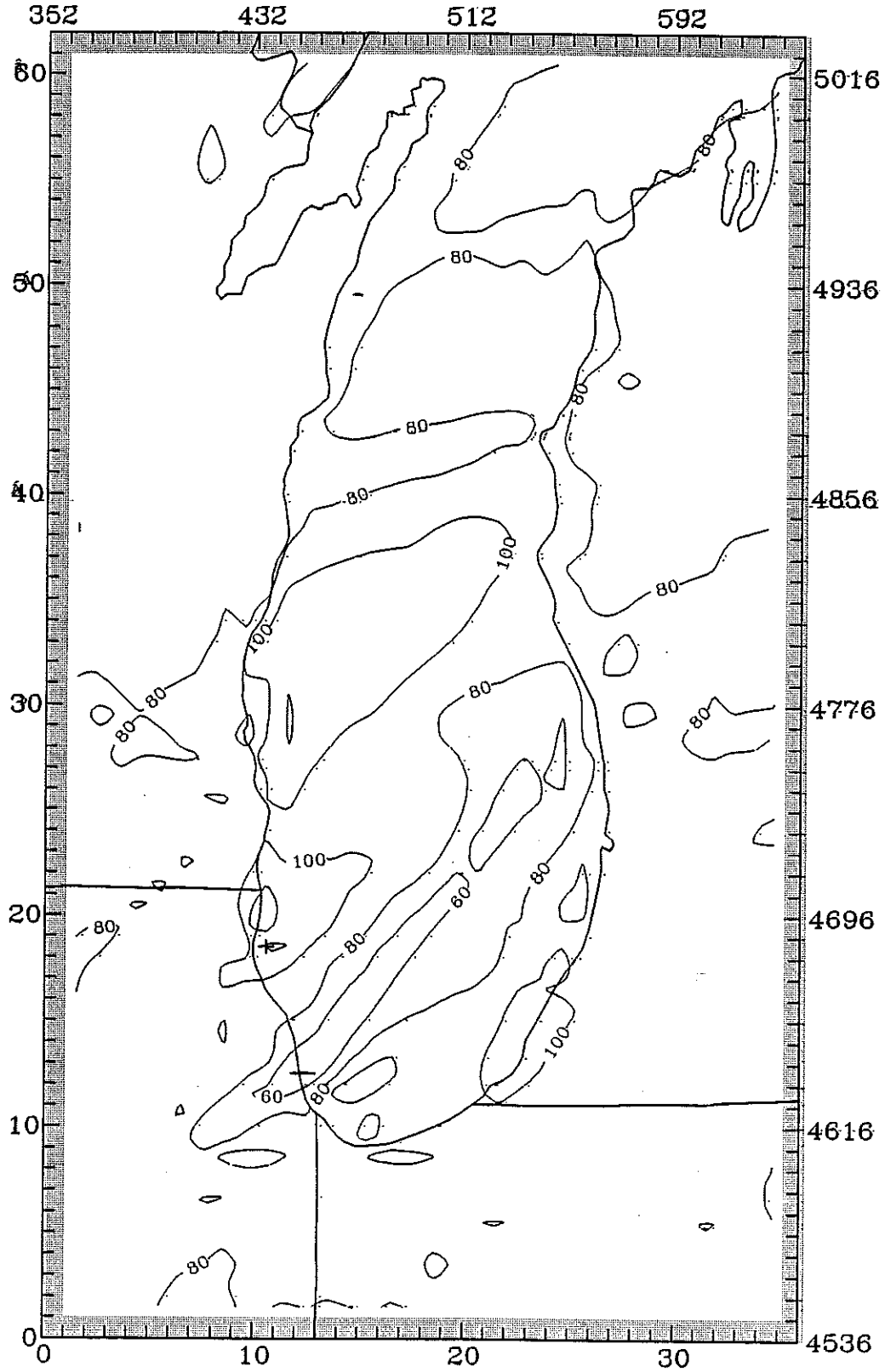
- MINIMUM = 41.4 ppb



Maximum Simulated Hourly Ozone Concentrations in the LMO Region
8 km grid -- July 17, 1991. (.15-19jul91.16-8km.96_base) (v1.21).

LEVEL 1 Ozone (ppb)
Time: 100-2400 July 17, 1991

+ MAXIMUM = 123.4 ppb
- MINIMUM = 38.3 ppb



Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- July 17, 1991. (.15-19jul91.16-8km.96_rhcctri) (v1.21)

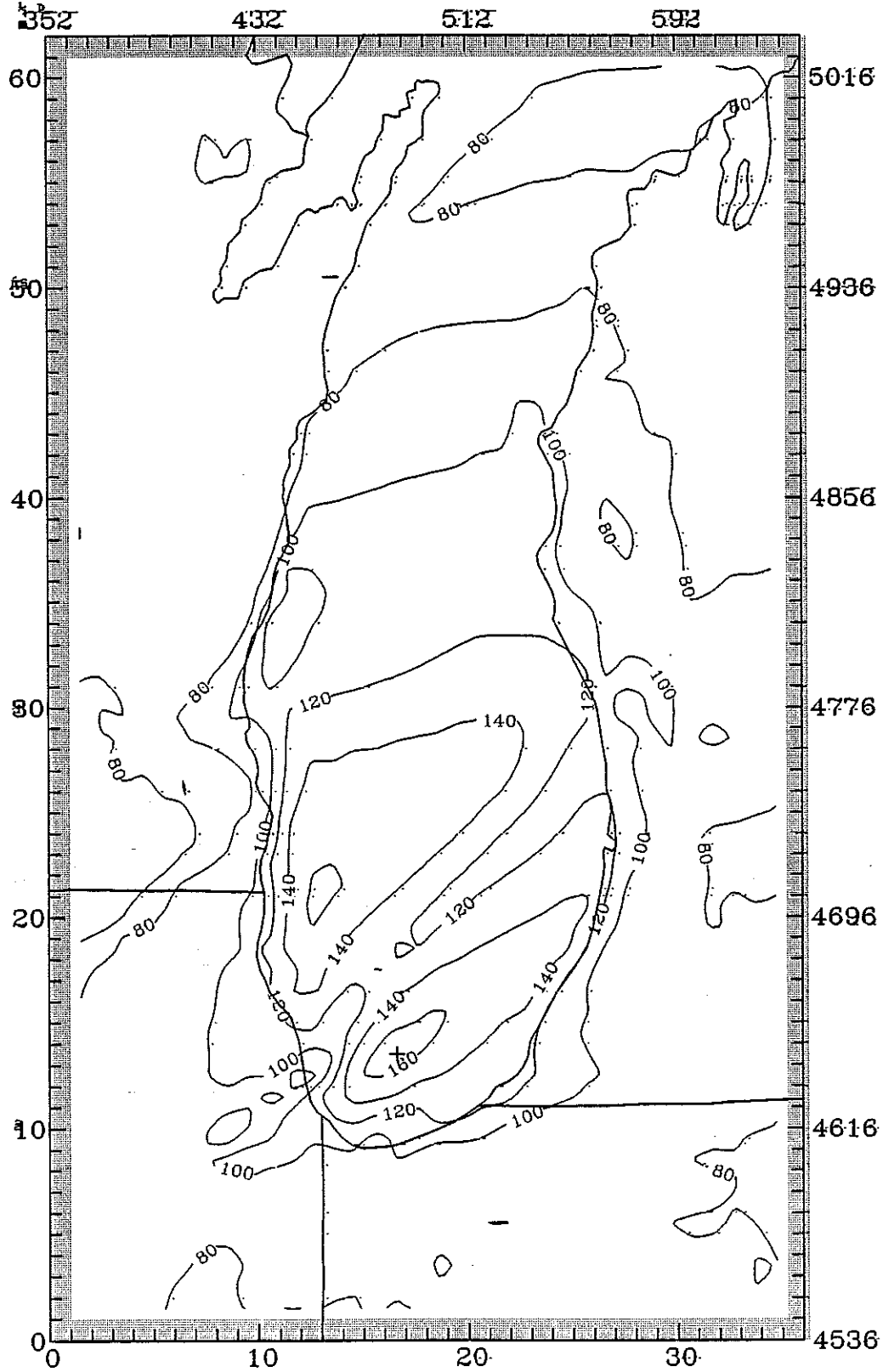
1996 Basecase with Grid B anthropogenic RHC emissions reduced by 40%.

LEVEL 1 Ozone (ppb)

Time: 100-2400 July 17, 1991

+ MAXIMUM = 164.6 ppb

- MINIMUM = 59.2 ppb

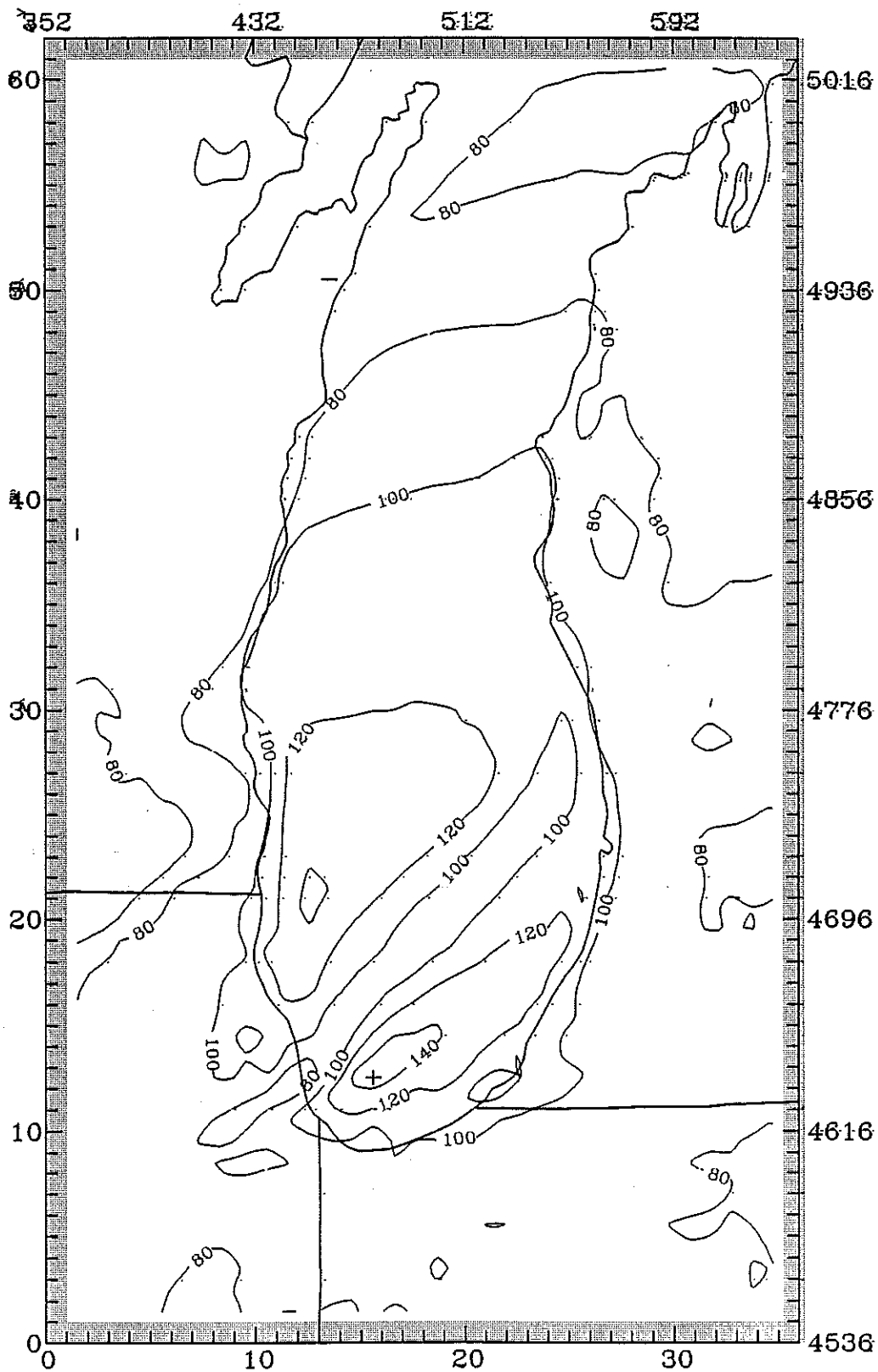


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region:
8 km grid -- July 17, 1991. (.15-19jul91.16-8km.96_noxctrl) (v1.21)

1996 Basecase with Grid B anthropogenic NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 100-2400 July 17, 1991

+ MAXIMUM = 148.1 ppb
- MINIMUM = 59.1 ppb



Maximum Simulated Hourly Ozone Concentrations in the IMOS Region.
8 km grid -- July 17, 1991. (.15-19jul91.16-8km.96_bothctrl) (v1.21)

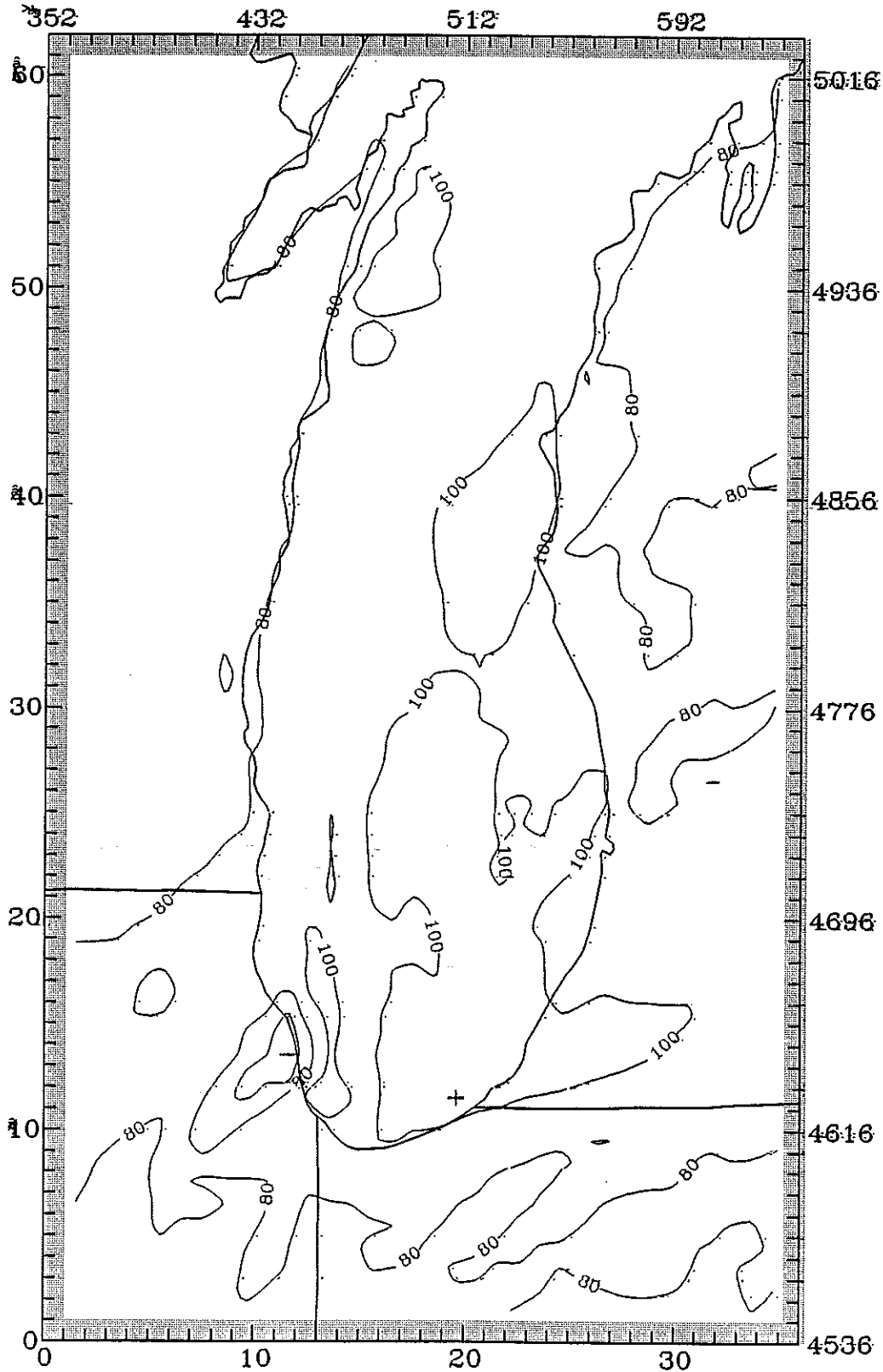
1996 Basecase with Grid B anthropogenic RHC & NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)

Time: 0-2400 July 18, 1991

+ MAXIMUM = 116.8 ppb

- MINIMUM = 43.9 ppb

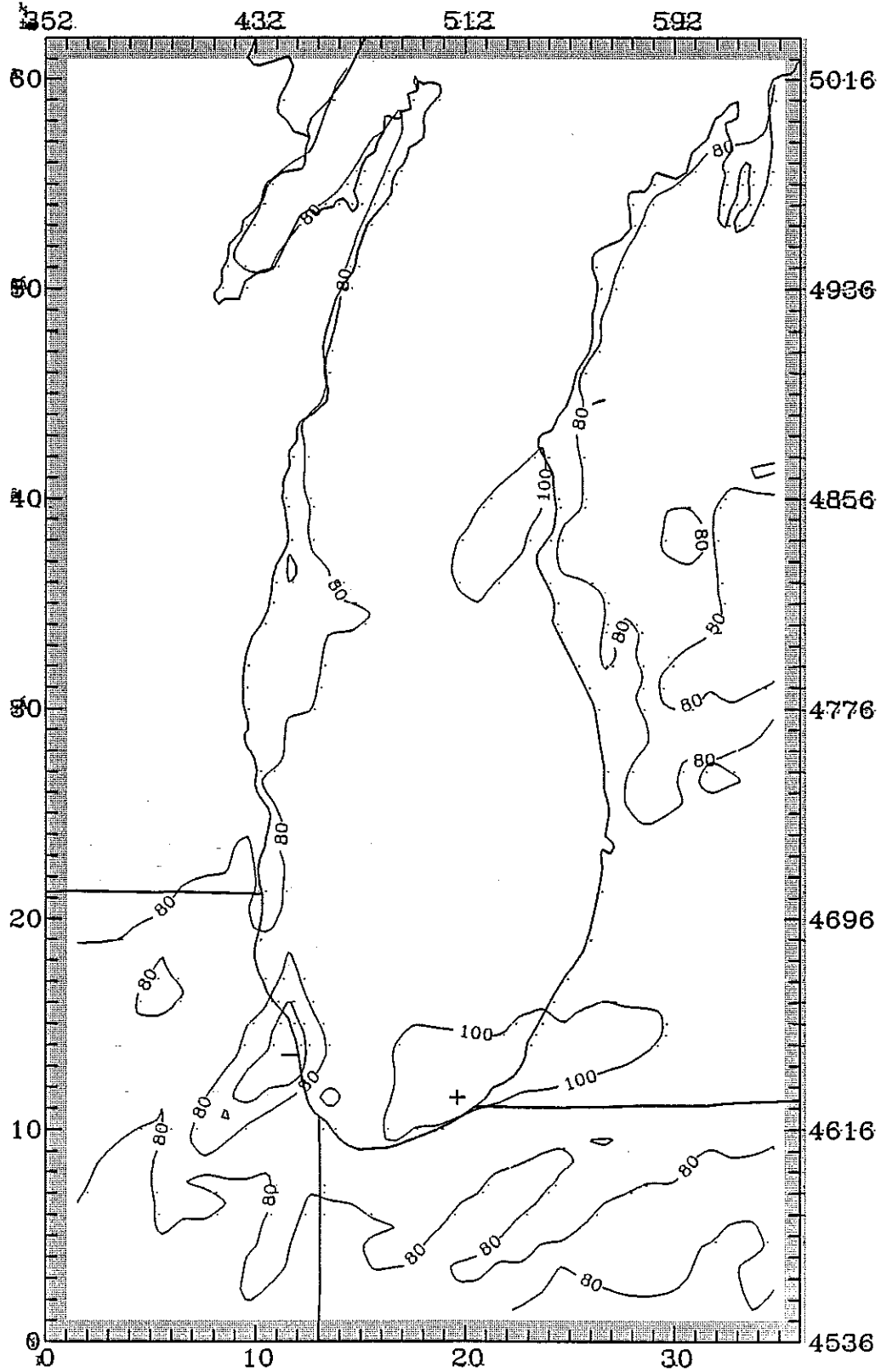


Maximum Simulated Hourly Ozone Concentrations in the LMOB Region.
8 km grid -- July 18, 1991. (.15-19jul91.16-8km.96_base) (v1.21):

1996 Basecase

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 18, 1991

+ MAXIMUM = 112.8 ppb
- MINIMUM = 39.8 ppb

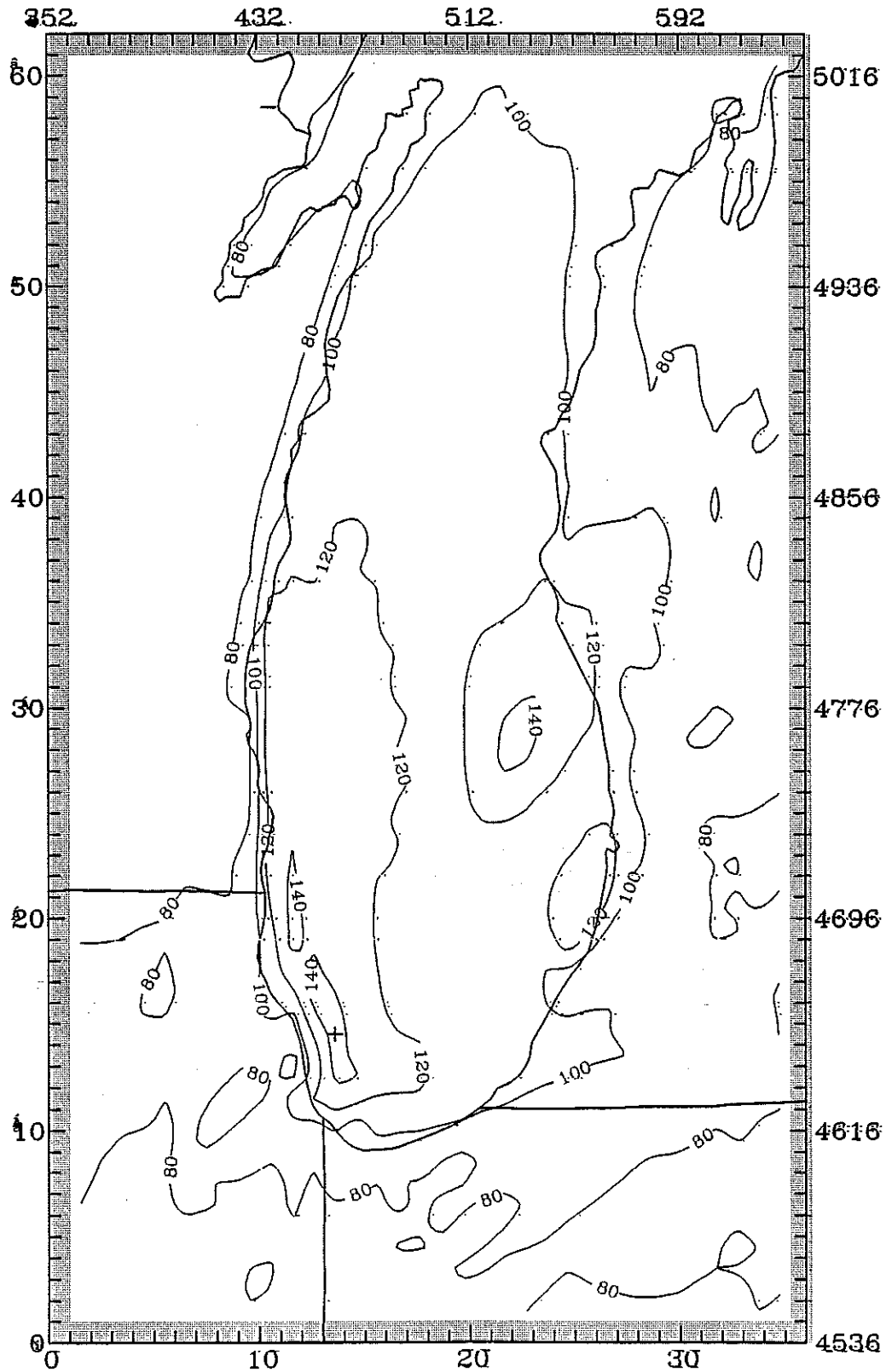


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- July 18, 1991. (.15-19jul91.16-8km.96_rhcont) (v1.21)

1996 Basecase with Grid B anthropogenic RHC emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 18, 1991

+ MAXIMUM = 151.2 ppb
- MINIMUM = 63.2 ppb

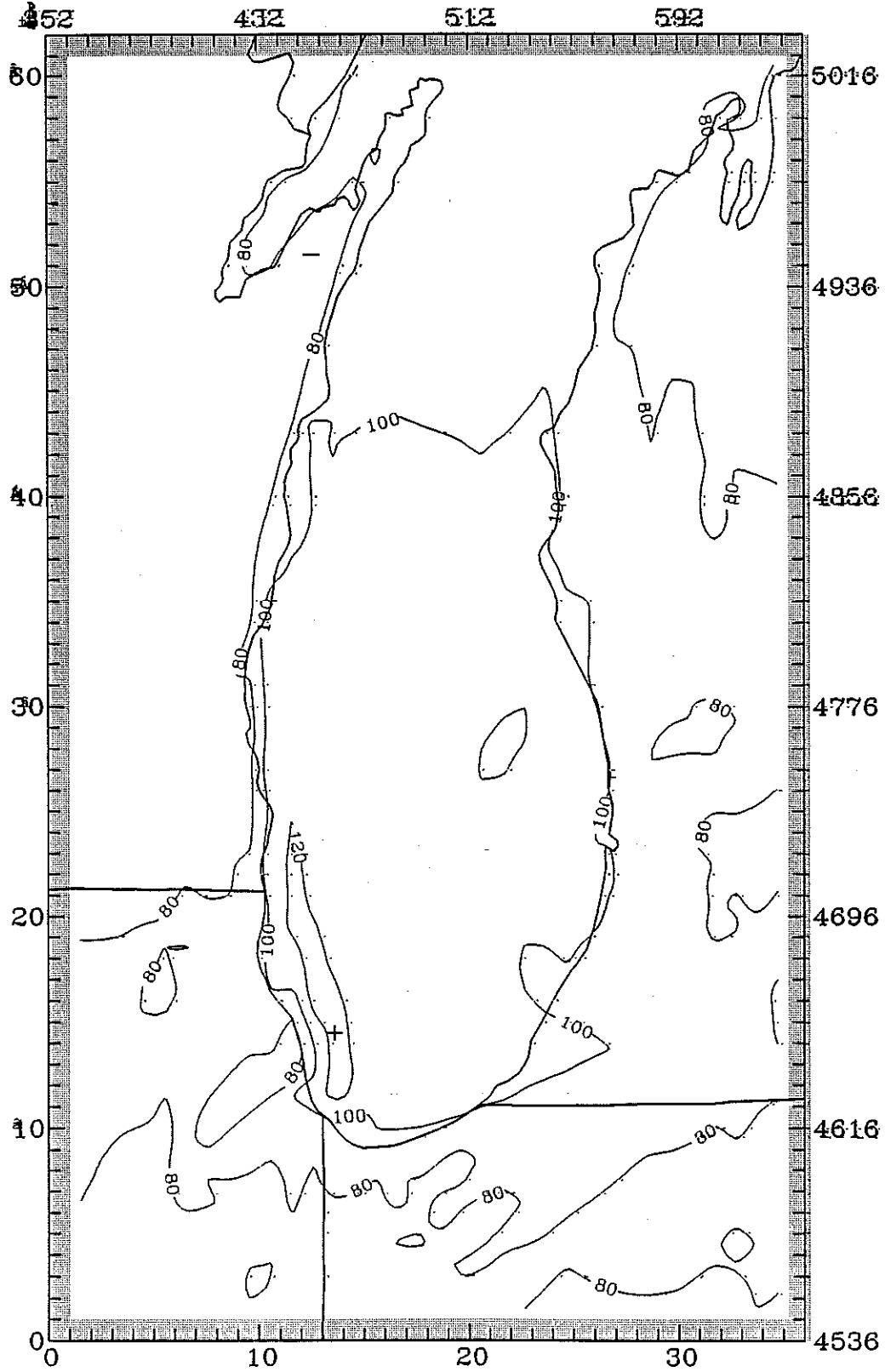


Maximum Simulated Hourly Ozone Concentrations in the LMQS Region.
8 km grid -- July 18, 1991. (.15-19jul91.16-8km.96_noxctrl) (v1.21)

1996 Basecase with Grid B NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 18, 1991

+ MAXIMUM = 129.8 ppb
- MINIMUM = 61.8 ppb

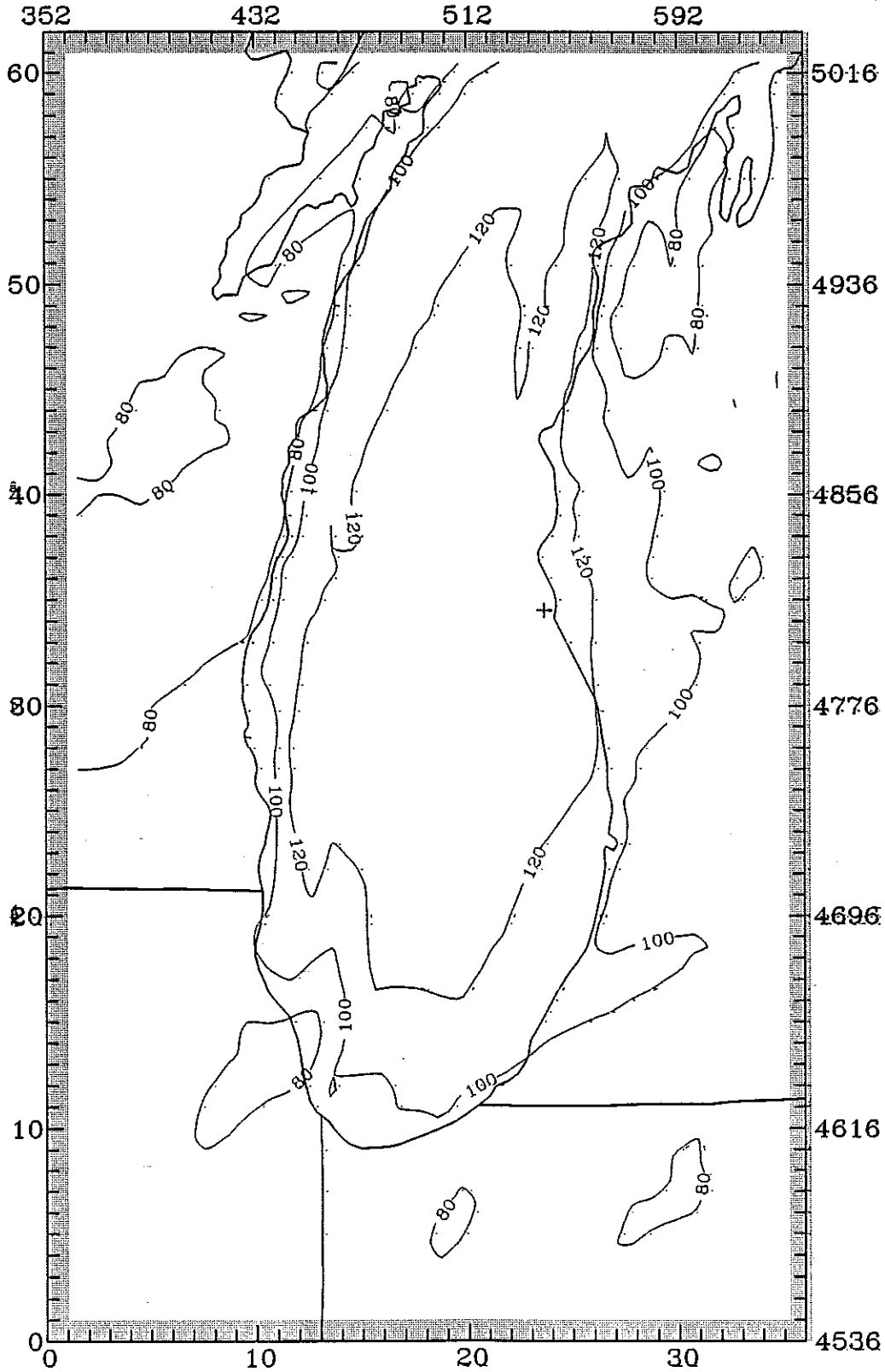


Maximum Simulated Hourly Ozone Concentrations in the LMO Region:
8 km grid -- July 18, 1991. (.15-19jul91.16-8km.96_basecase): (v1.21)

1996 Basecase with Grid B anthropogenic RHC & NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb).
Time: 0-2400 July 19, 1991

+ MAXIMUM = 135.6 ppb
- MINIMUM = 57.4 ppb



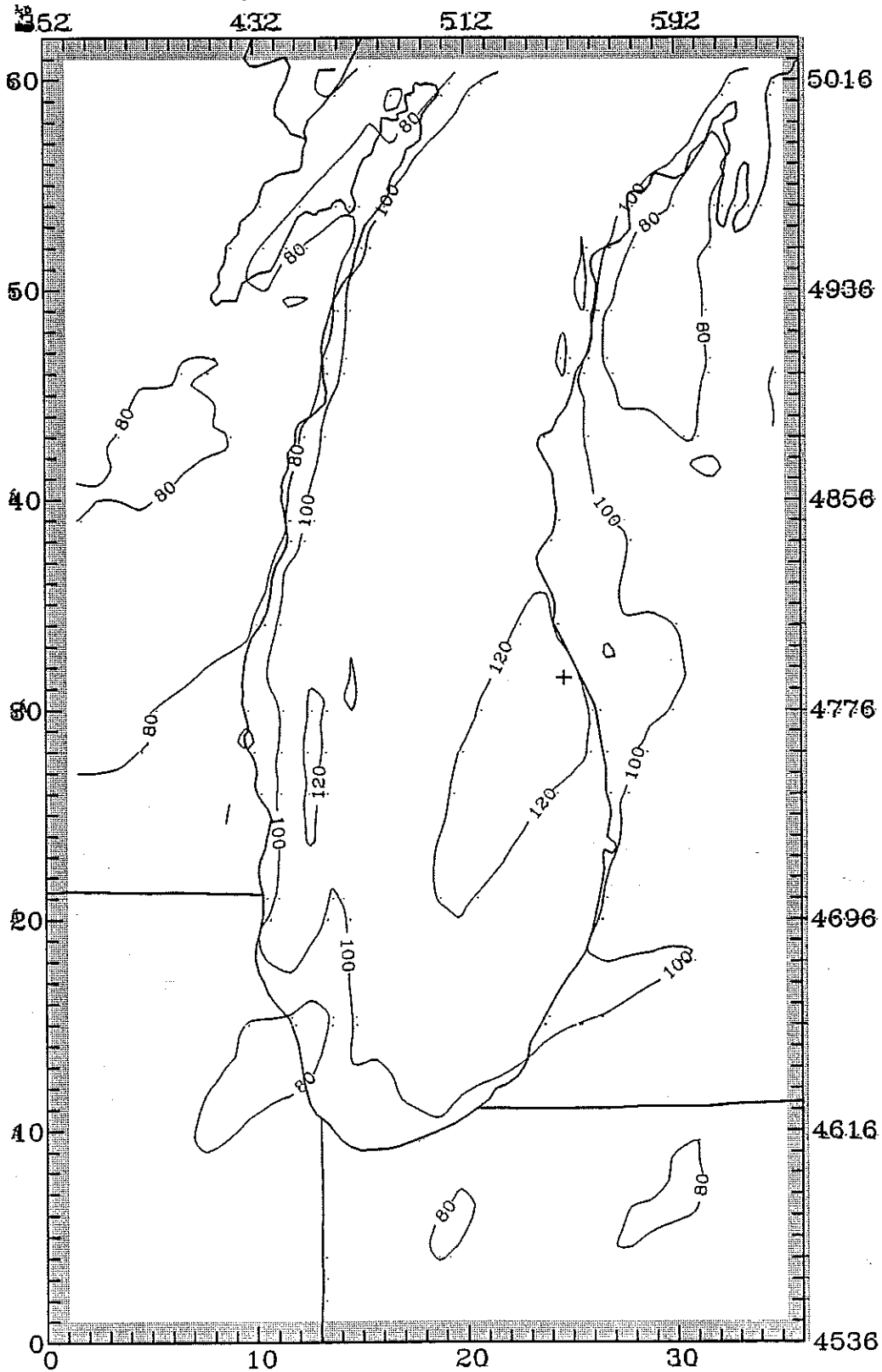
Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- July 19, 1991. (.15-19jul91.16-8km.96_base) (v1.21)

LEVEL 1 Ozone (ppb):

Time: 0-2400 July 19, 1991

+ MAXIMUM = 125.9 ppb

- MINIMUM = 57.4 ppb

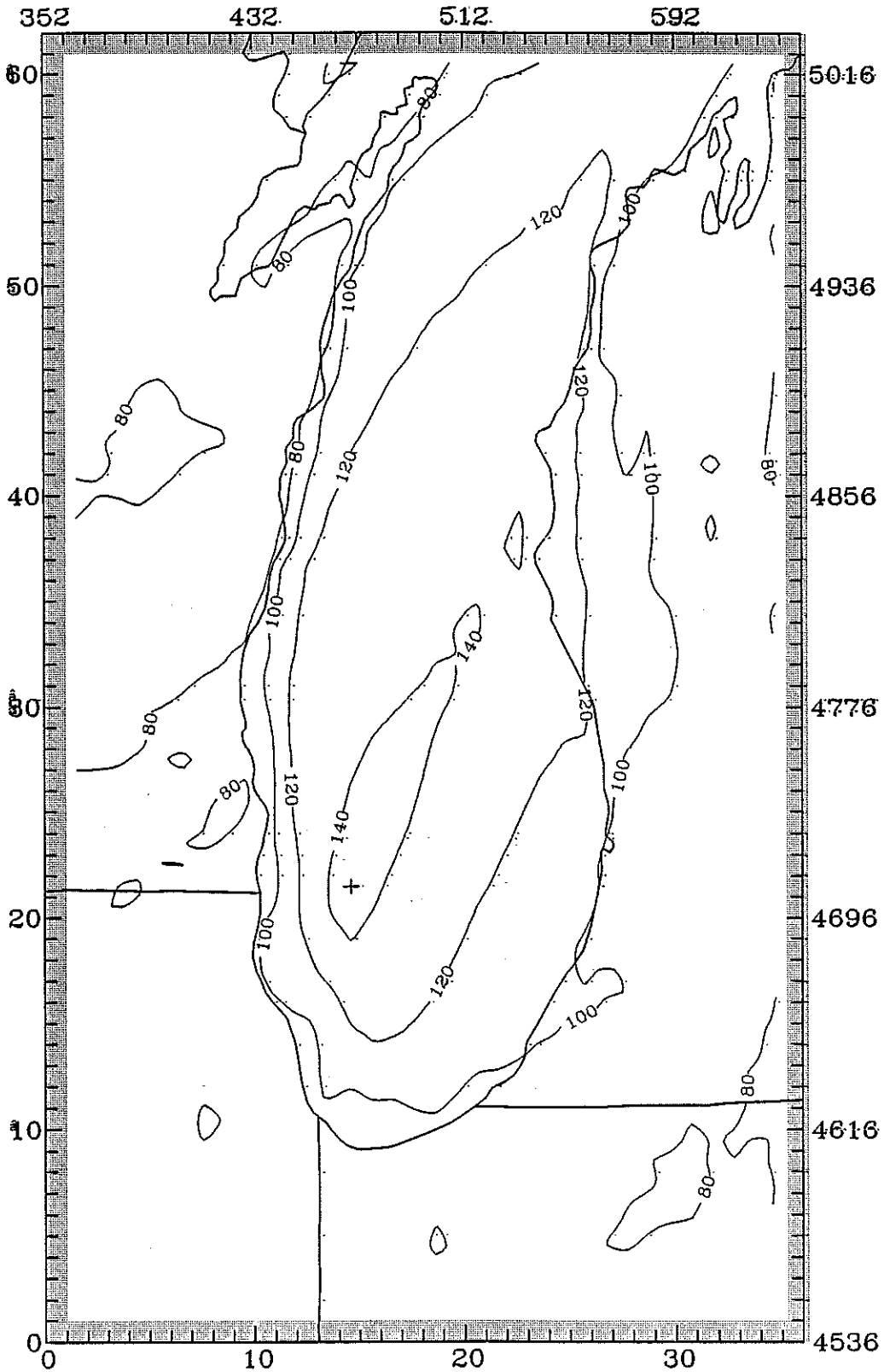


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- July 19, 1991. (.15-19jul91.16-8km.96_rhctrl) (v1.21)

1996 Basecase with Grid B anthropogenic RHC emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 19, 1991

+ MAXIMUM = 144.4 ppb
- MINIMUM = 58.5 ppb

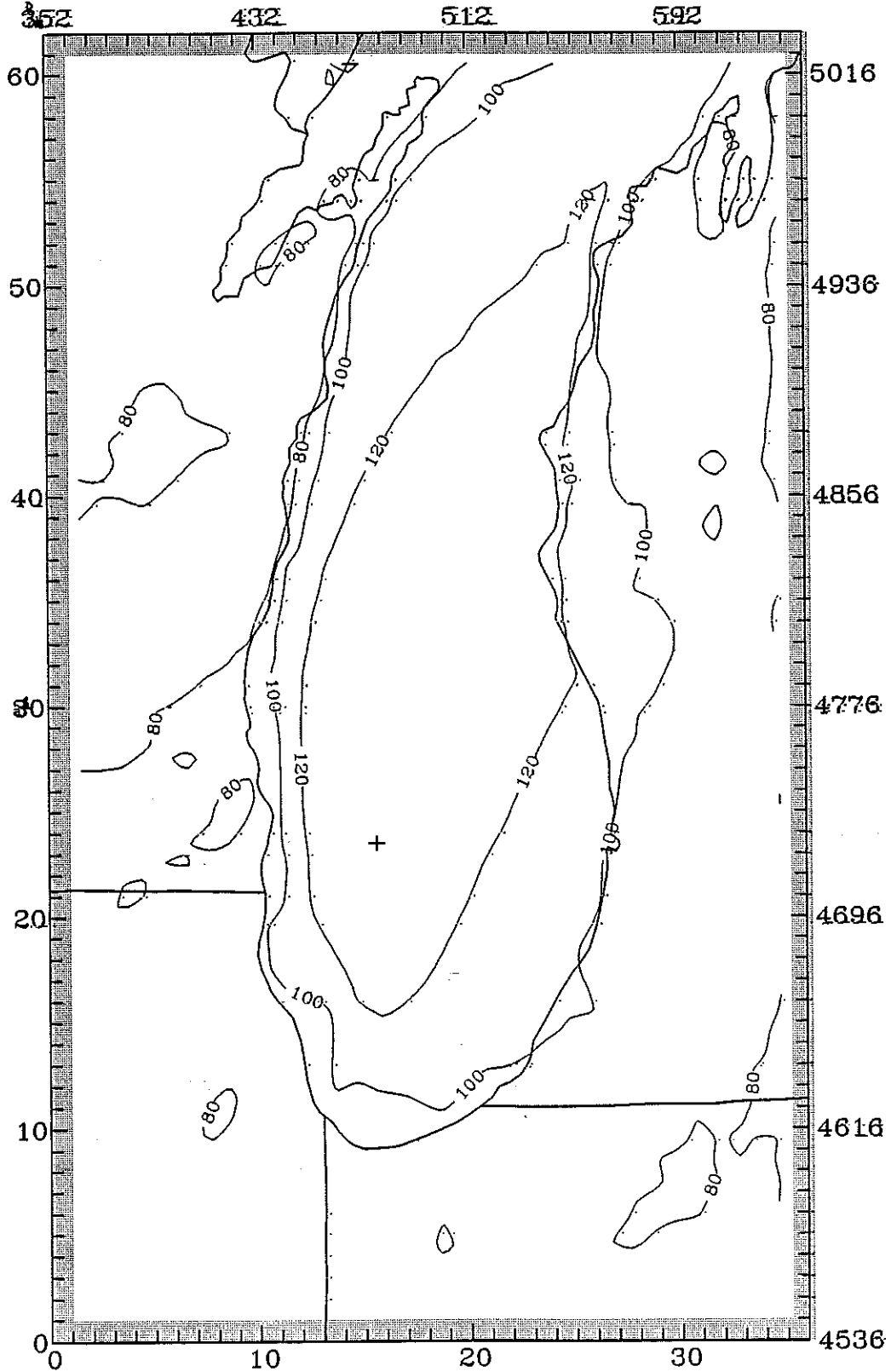


Maximum Simulated Hourly Ozone Concentrations in the LMOs Region
8 km grid -- July 19, 1991. (.15-19jul91.16-8km.96_noxctrl) (v1.21)

1996 Basecase with Grid B anthropogenic NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 19, 1991

+ MAXIMUM = 134.8 ppb
- MINIMUM = 58.7 ppb

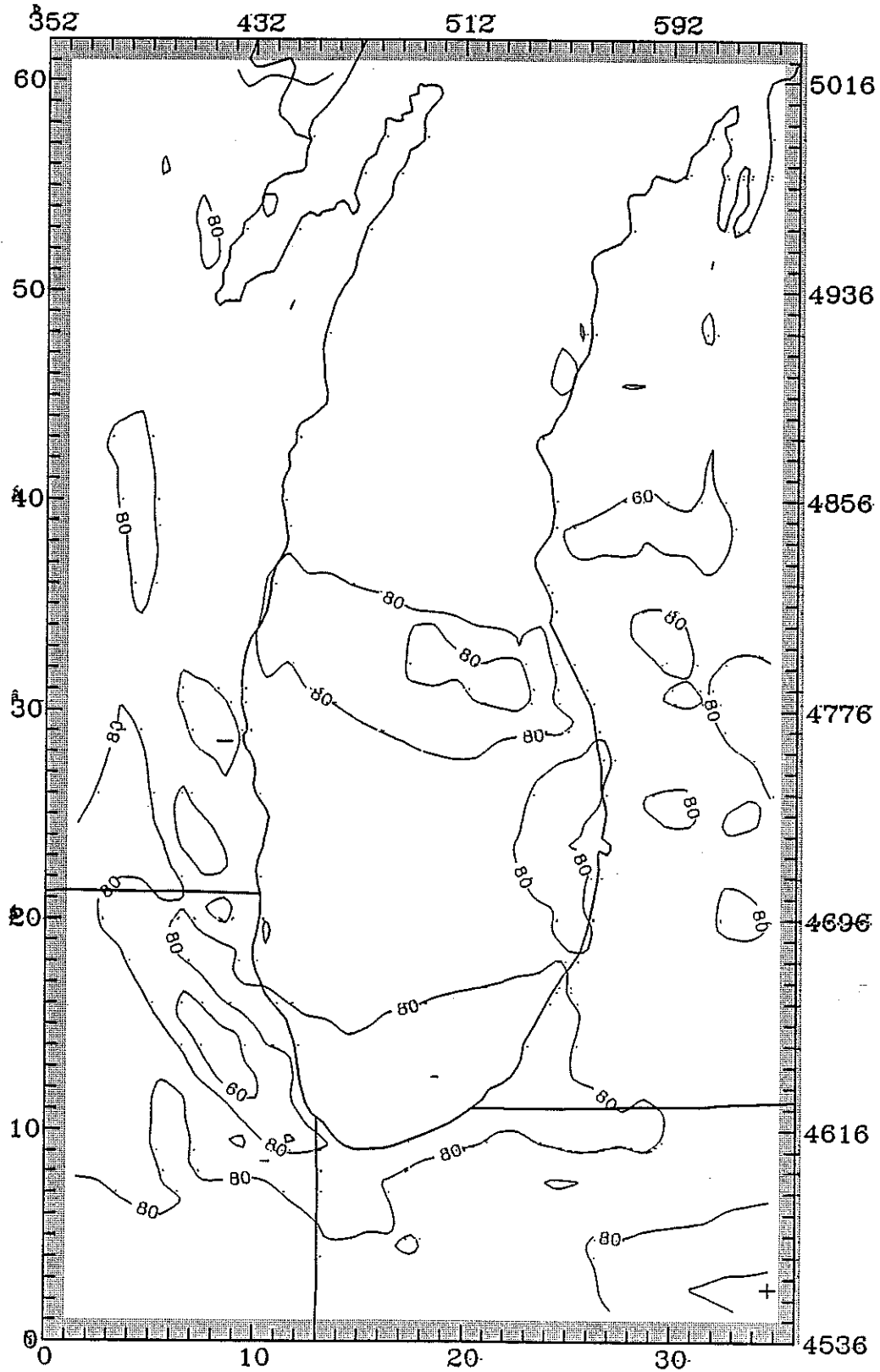


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- July 19, 1991. (.15-19jul91.16-8km.96_bothctrl) (v1.21)

1996 Basecase with Grid B anthropogenic RHC & NO_x emissions reduced by 40%.

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

+ MAXIMUM = 111.5 ppb
- MINIMUM = 46.1 ppb

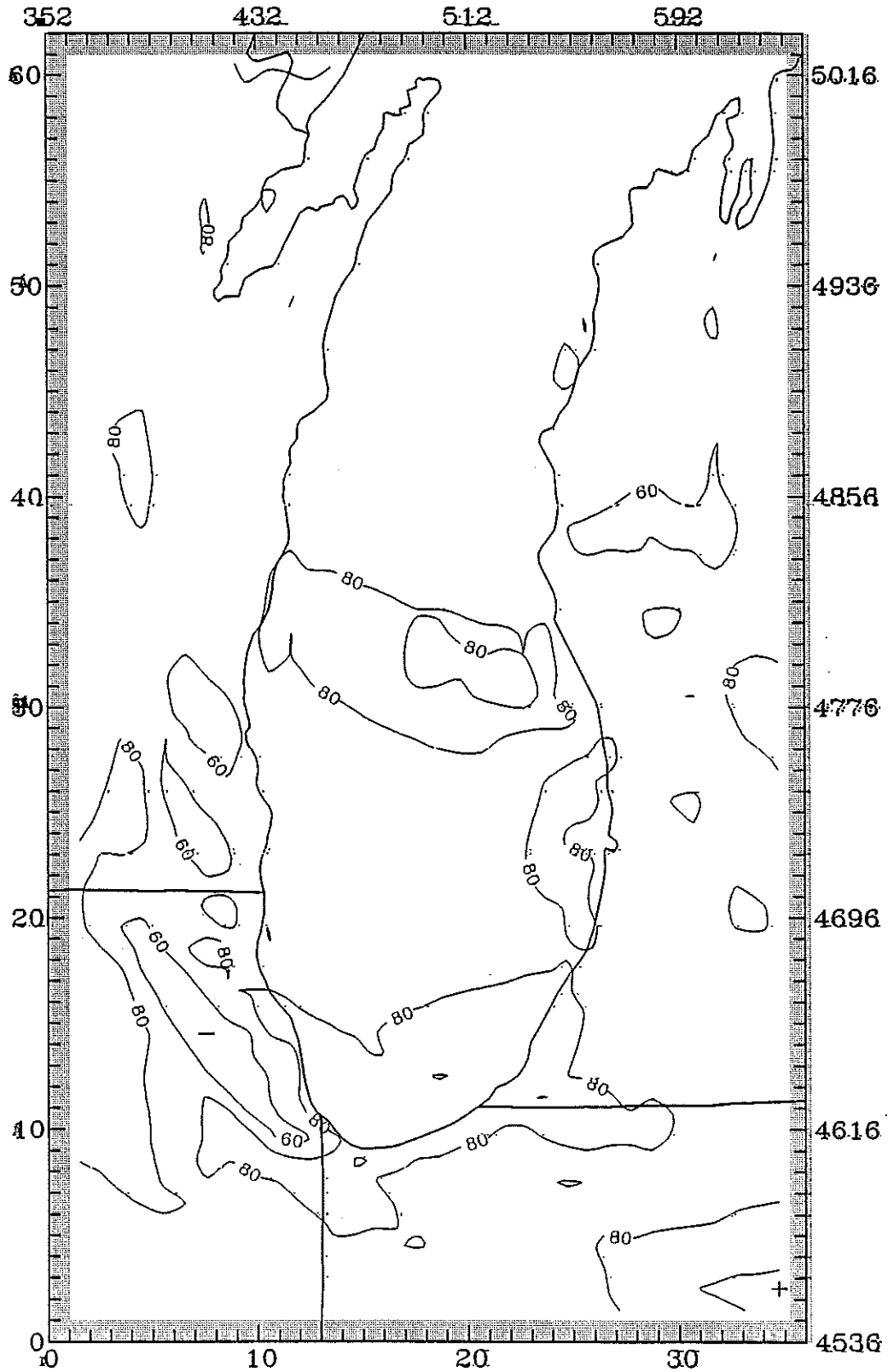


Maximum Simulated Hourly Ozone Concentrations in the LMOs Region
8 km grid -- June 20, 1991. (.18-21jun91.16-8km.96_base) (v1.21)

1996 Basecase

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

+ MAXIMUM = 111.5 ppb
- MINIMUM = 38.0 ppb

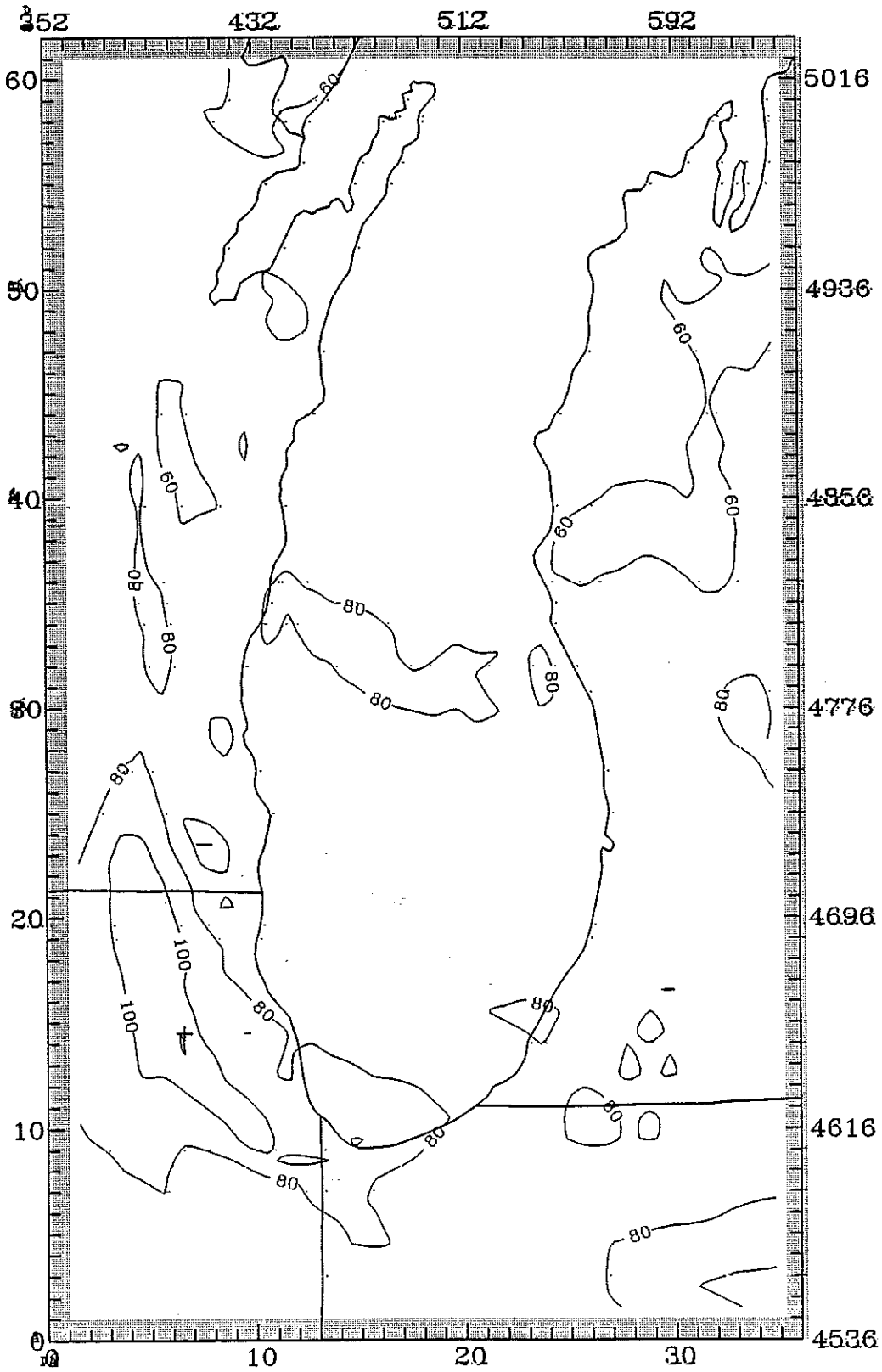


Maximum Simulated Hourly Ozone Concentrations in the LMOs Region
8 km grid -- June 20, 1991. (.18-21jun91.t6-8km.96_chart): (vL2L)

1996 Basecase with Grid B anthropogenic RHC emissions reduced by 40%.

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

+ MAXIMUM = 121.0 ppb
- MINIMUM = 54.3 ppb

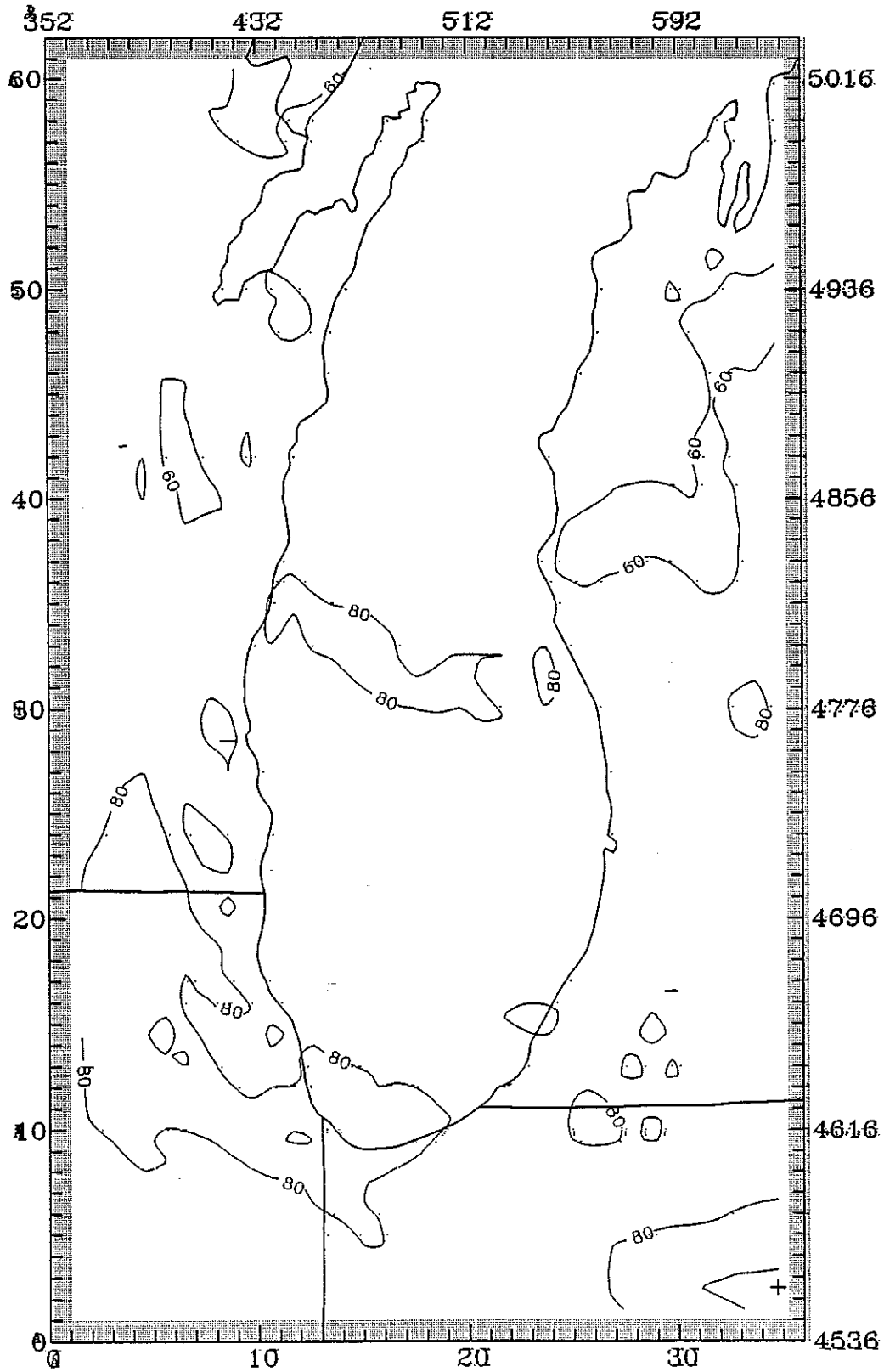


Maximum Simulated Hourly Ozone Concentrations in the LMOB Region.
8 km grid -- June 20, 1991. (.18-21jun91.16-8km.96_max.txt) (v1.21)

1996 Basecase with Grid B NOx emissions reduced by 40%.

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

+ MAXIMUM = 111.6 ppb
- MINIMUM = 53.3 ppb

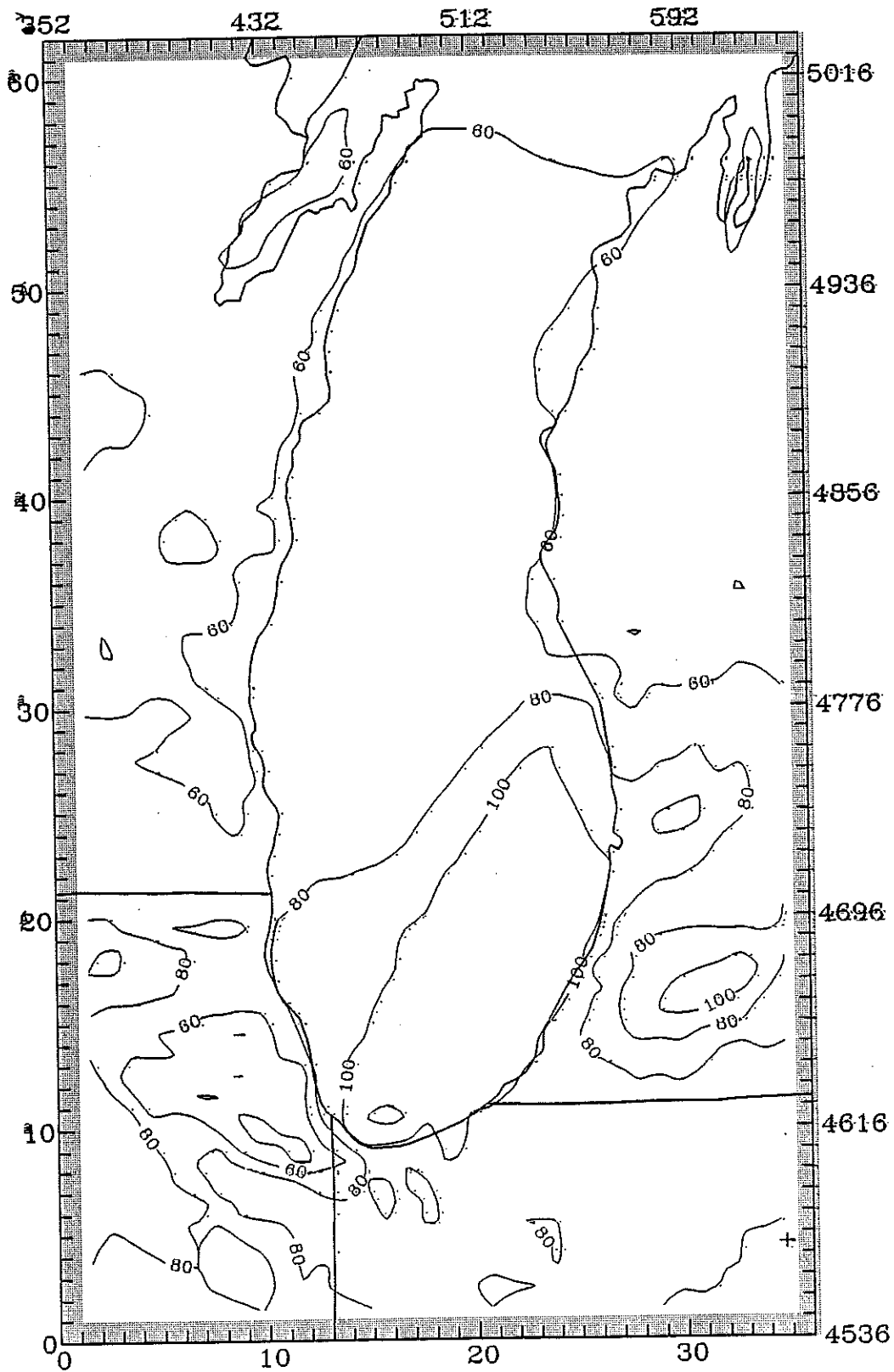


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- June 20, 1991. (.18-21jun91.16-8km.96_bothctrl) (v1.21)

1996 Basecase with Grid B anthropogenic RHC and NOx emissions reduced by 40

LEVEL 1 Ozone (ppb)
Time: 0-2400 June 21, 1991

+ MAXIMUM = 119.2 ppb
- MINIMUM = 34.3 ppb

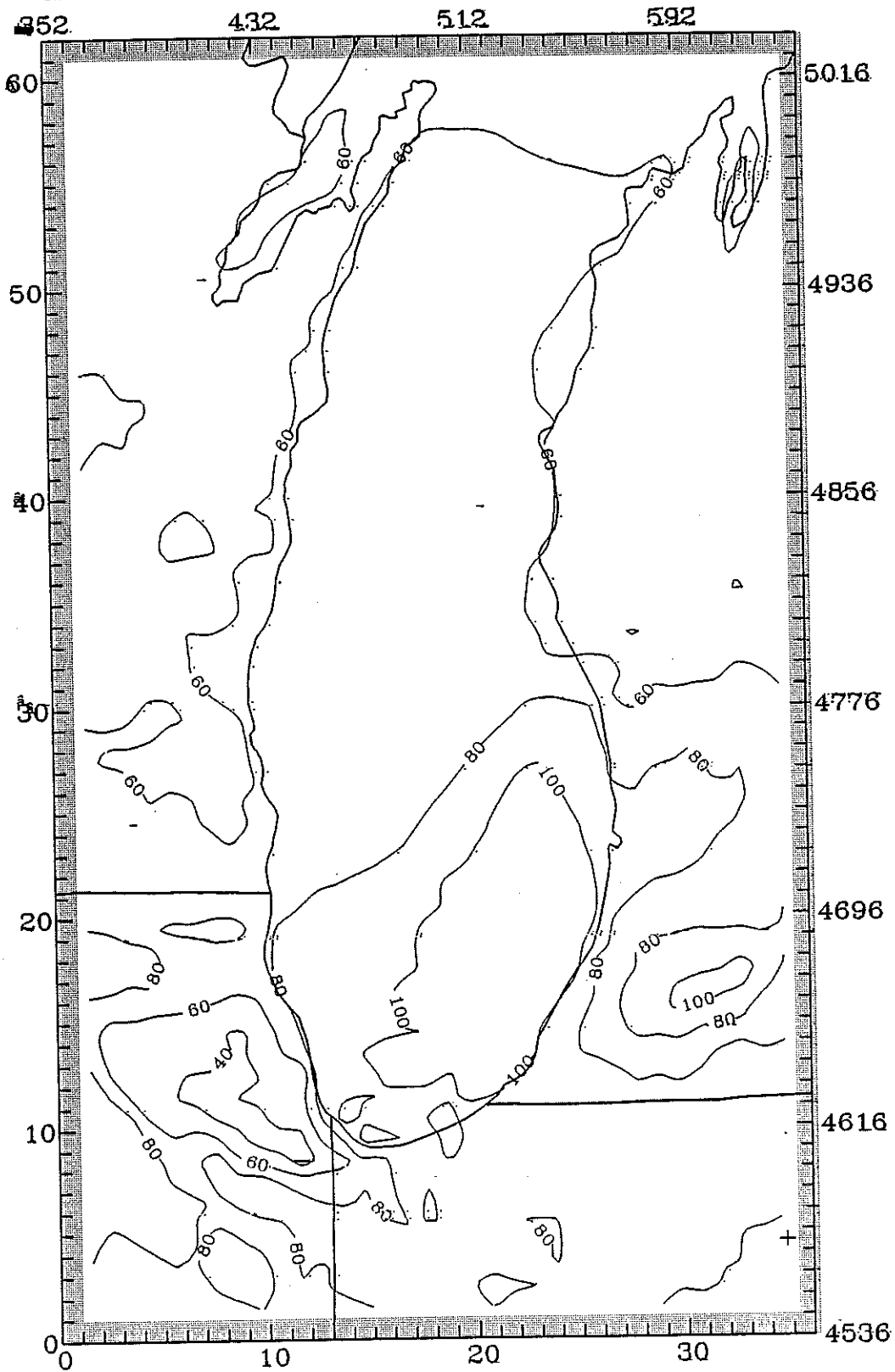


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- June 21, 1991. (.18-21jun91.16-8km.96_base) (v1.21)

1996 Basecase

LEVEL 1 Ozone (ppb)
Time: 0-2400 June 21, 1991

+ MAXIMUM = 119.2 ppb
- MINIMUM = 30.4 ppb



Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- June 21, 1991. (.18-21jun91.16-8km.96_rhcctrl) (v1.21)

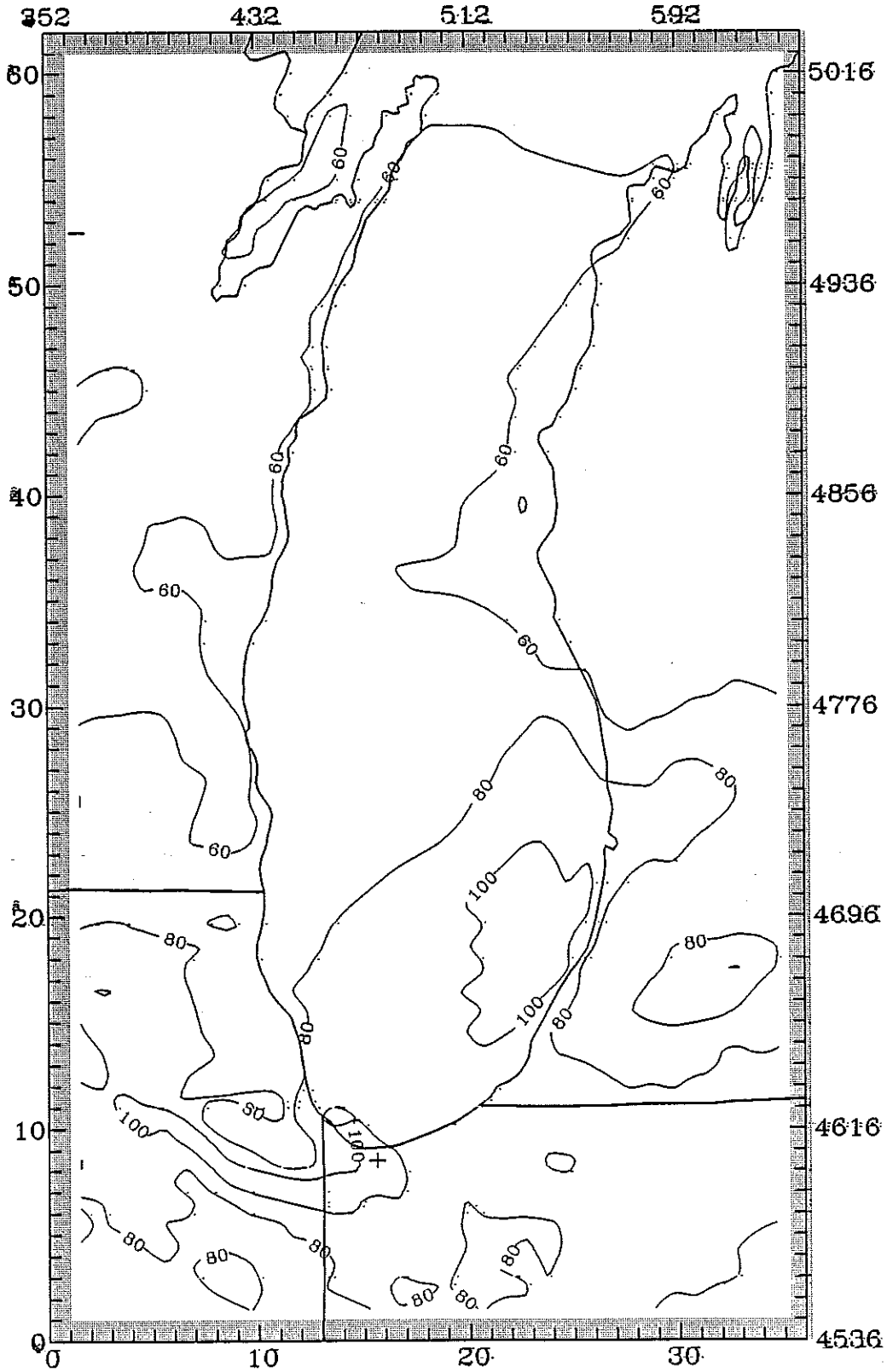
1996 Basecase with Grid B anthropogenic RHC emissions reduced by 40%.

LEVEL 1 Ozone (ppb):

Time: 0-2400 June 21, 1991

+ MAXIMUM = 119.7 ppb

- MINIMUM = 40.2 ppb

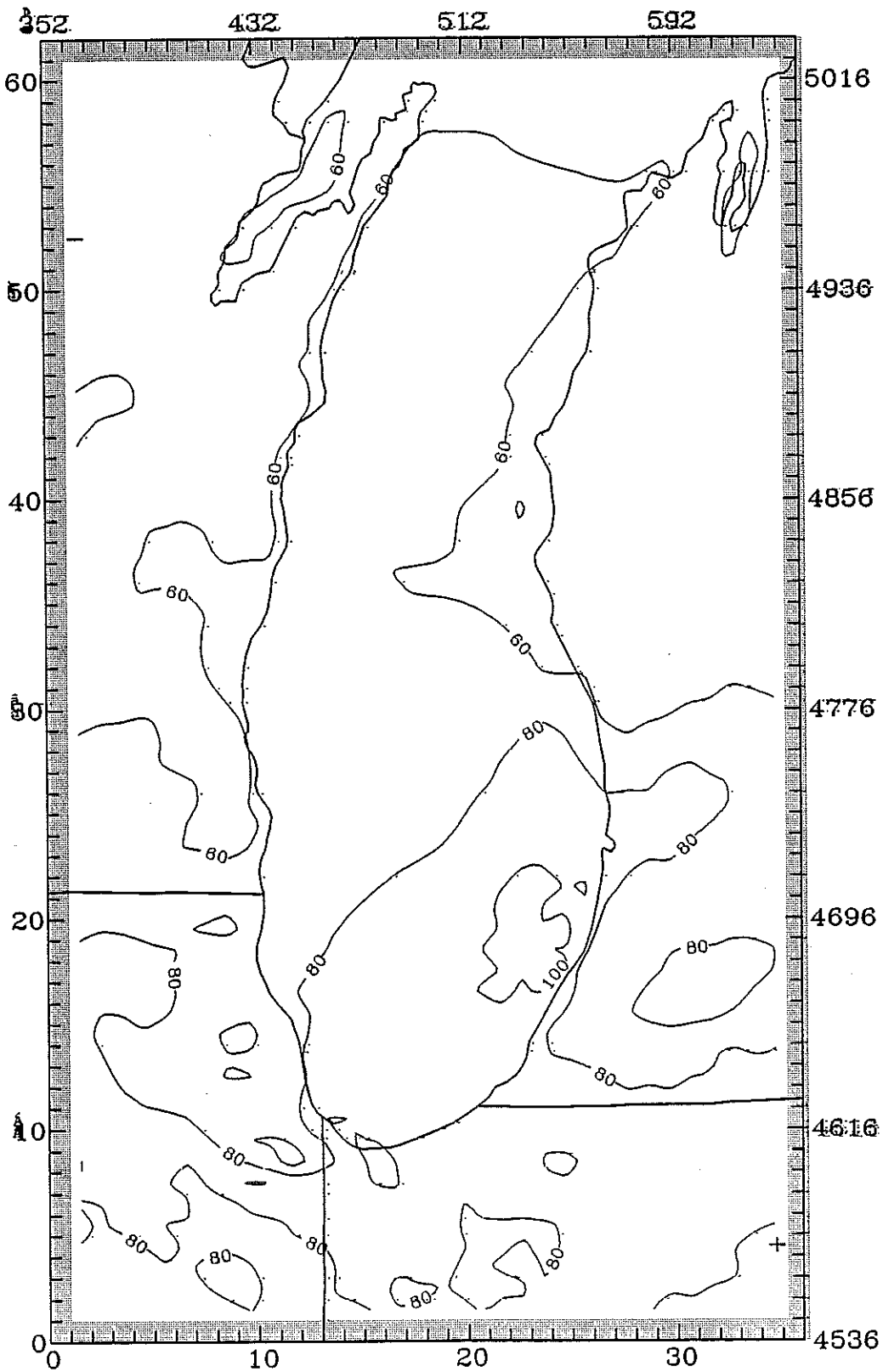


Maximum Simulated Hourly Ozone Concentrations in the IMOS Region.
8 km grid -- June 21, 1991. (.18-21jun91.16-8km.96_noxctrl). (v1.21)

1996 Basecase with Grid B NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 June 21, 1991

+ MAXIMUM = 118.5 ppb
- MINIMUM = 40.2 ppb



Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- June 21, 1991. (.18-21jun91.16-8km.96_bothictri) (v1.21)

1996 Basecase with Grid B anthropogenic RHC and NOx emissions reduced by 40

July 13, 1994

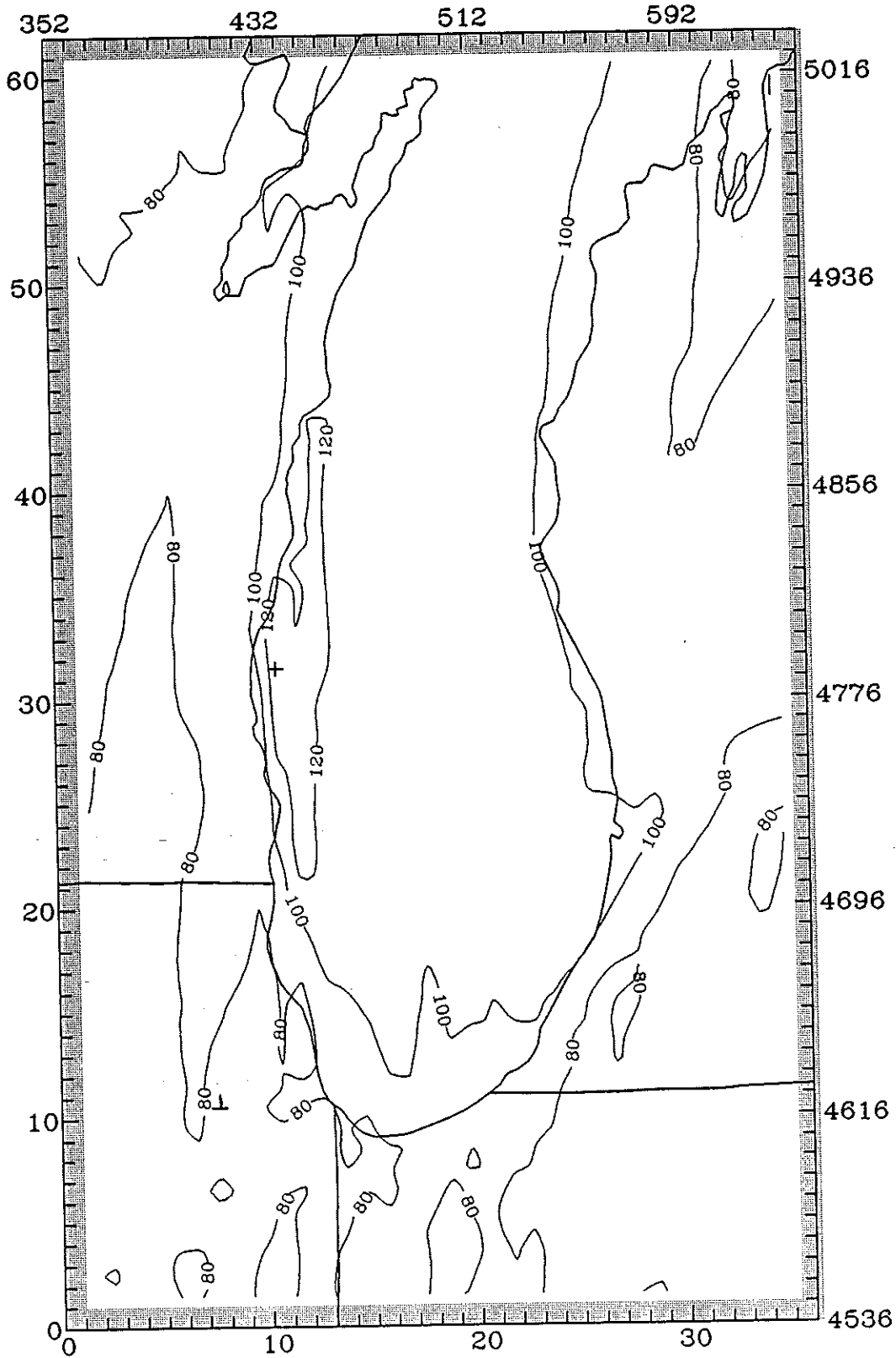
ATTACHMENT 2

Peak Daily Ozone Concentrations

Projected 2007 Conditions
Episodes 1, 2, and 4

LEVEL 1 Ozone (ppb)
Time: 100-2400 June 26, 1991

+ MAXIMUM = 133.0 ppb
- MINIMUM = 59.3 ppb

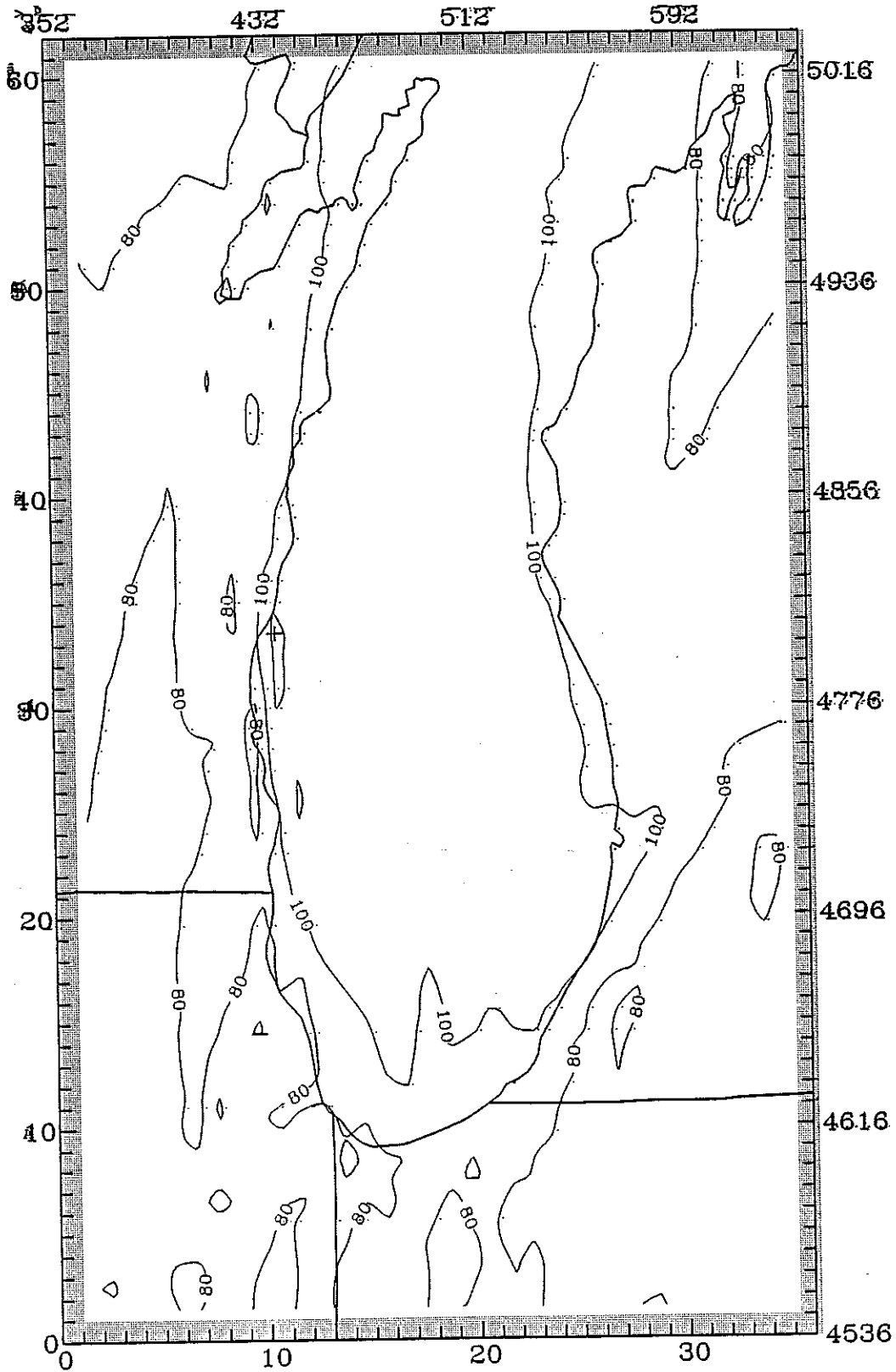


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- June 26, 1991. (.24-28jun91.16-8km.07_base) (v1.21)

2007 Basecase

LEVEL 1 Ozone (ppb)
Time: 100-2400 June 26, 1991

+ MAXIMUM = 124.9 ppb
- MINIMUM = 58.0 ppb

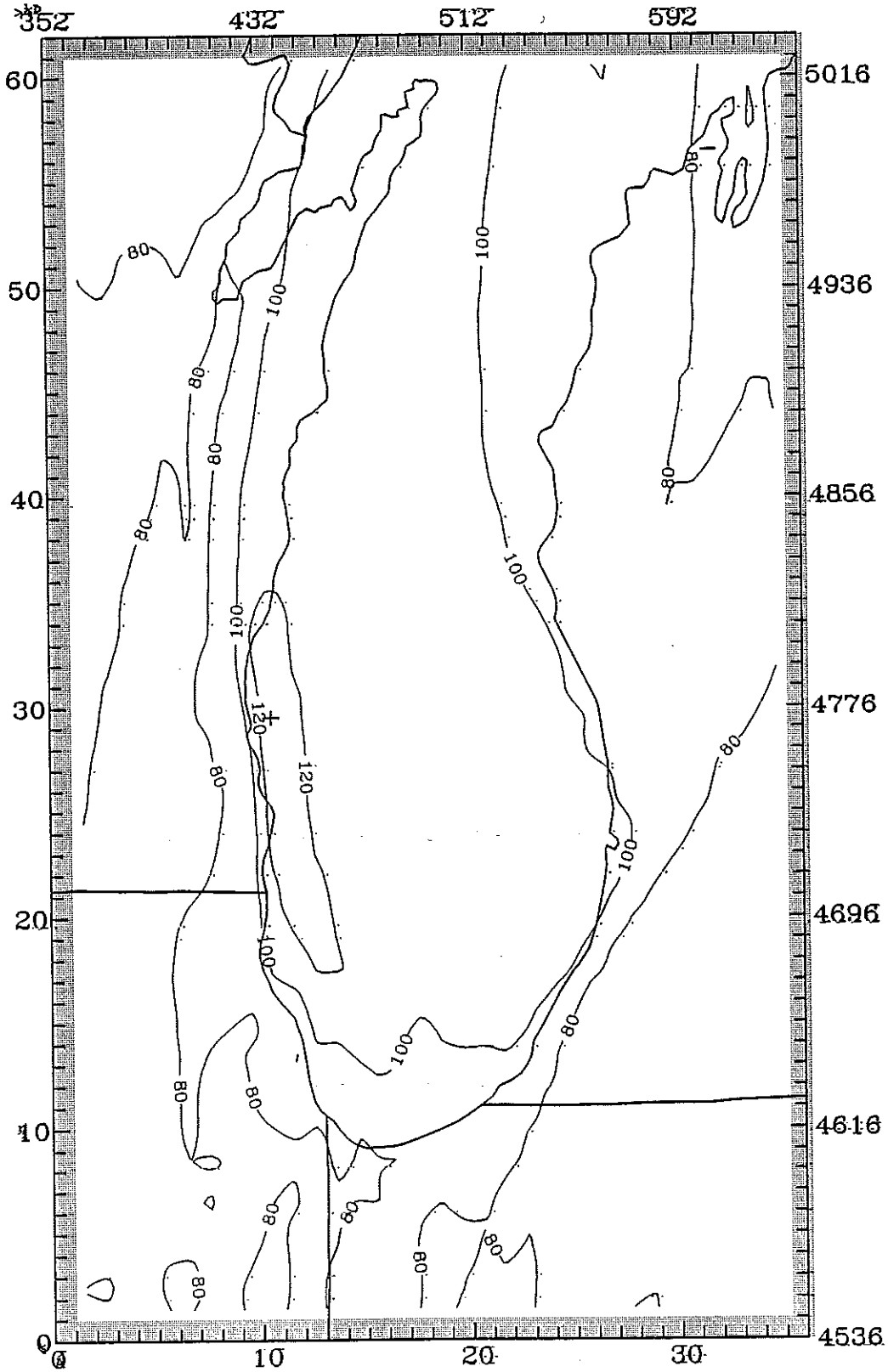


Maximum Simulated Hourly Ozone Concentrations for the LMQS Region.
8 km grid -- June 26, 1991. (.24-25jun91.16-8km.07_rfictr1) (v1.21)

2007 Basecase with Grid B anthropogenic RHC emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 100-2400 June 26, 1991

+ MAXIMUM = 138.3 ppb
- MINIMUM = 69.1 ppb



Maximum Simulated Hourly Ozone Concentrations in the LMOS Region:
8 km grid -- June 26, 1991. (.24-28jun91.16-8km.07_noxctrl) (v1.21)

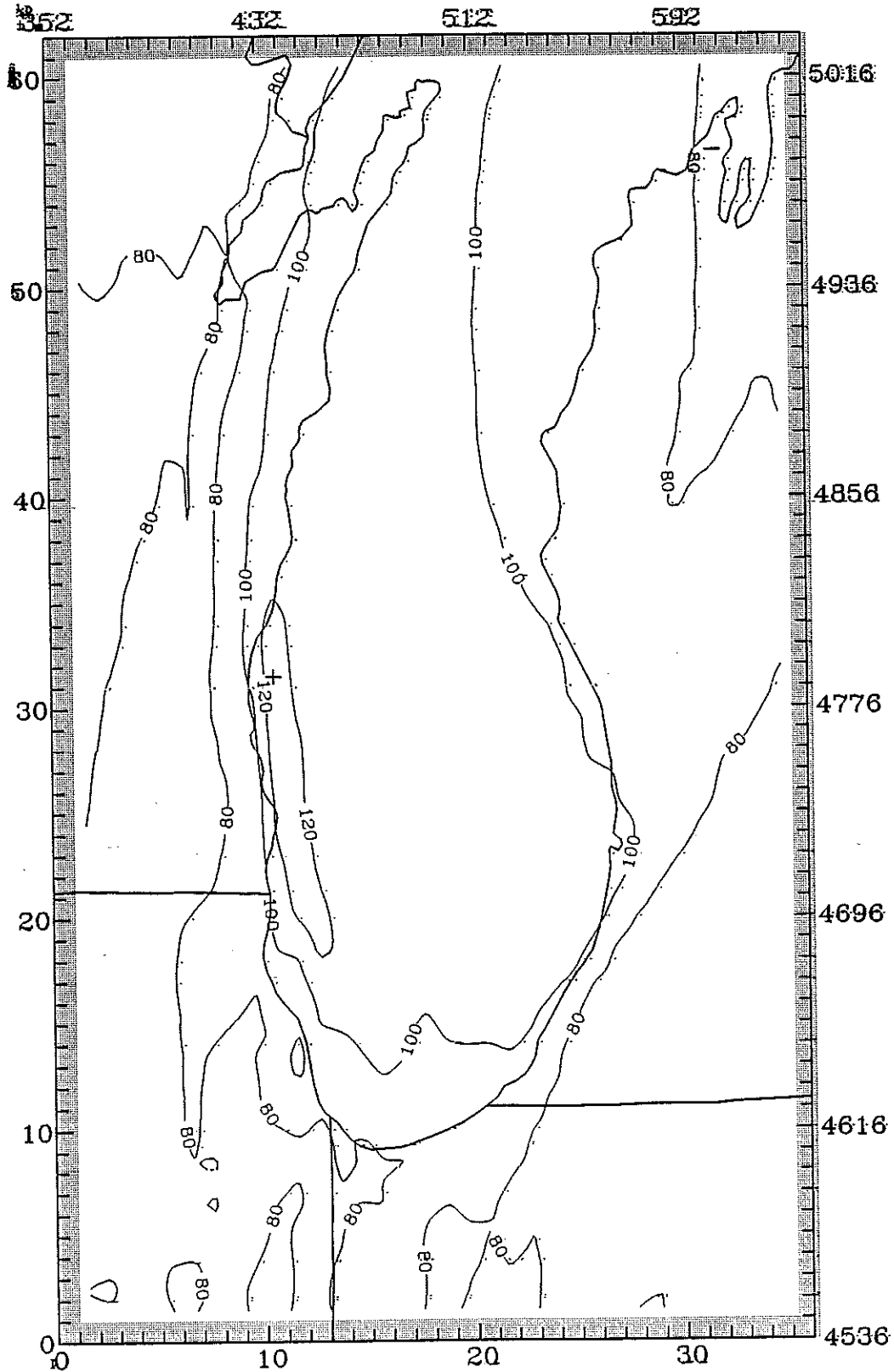
2007 Basecase with Grid B NOx emissions reduced by 40%.

LEVEL 1. Ozone. (pph).

Time: 100-2400 June 26, 1991

+ MAXIMUM = 132.3 ppb

- MINIMUM = 68.5 ppb

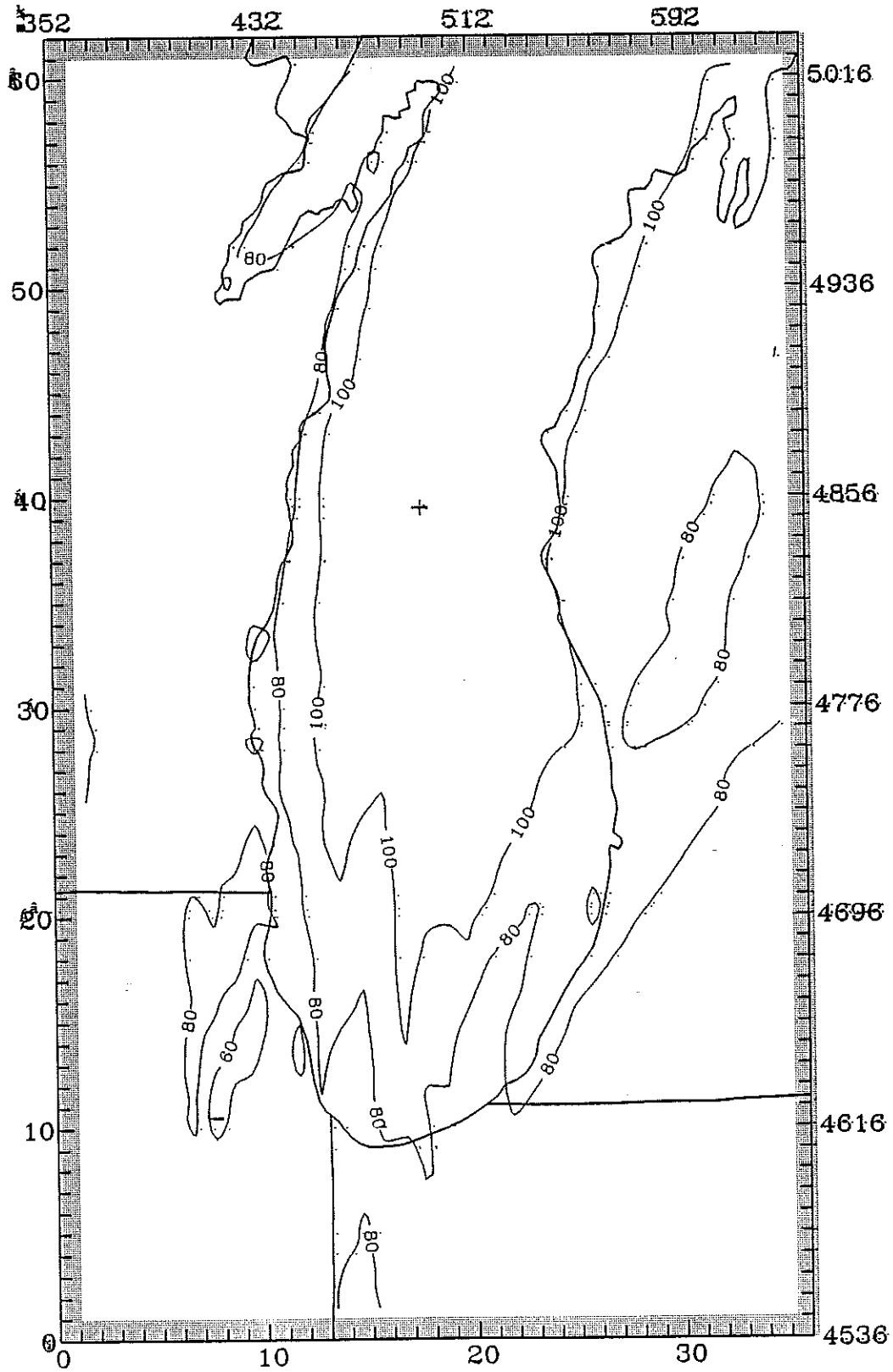


Maximum Simulated Hourly Ozone Concentrations in the LMQS Region.
8 km grid -- June 26, 1991. (.24-28jun91.16-8km.07_bothctrl) (v1.21)

2007 Basecase with Grid B anthropogenic RHC & NOx emissions reduced by 40%.

LEVEL 1. Ozone (ppb)
Time: 0-2400 June 27, 1991

+ MAXIMUM = 119.9 ppb
- MINIMUM = 48.1 ppb



Maximum Simulated Hourly Ozone Concentrations in the LMOB Region
8 km grid -- June 27, 1991. (.24-28jun91.16-8km.07_base) (v1.21)

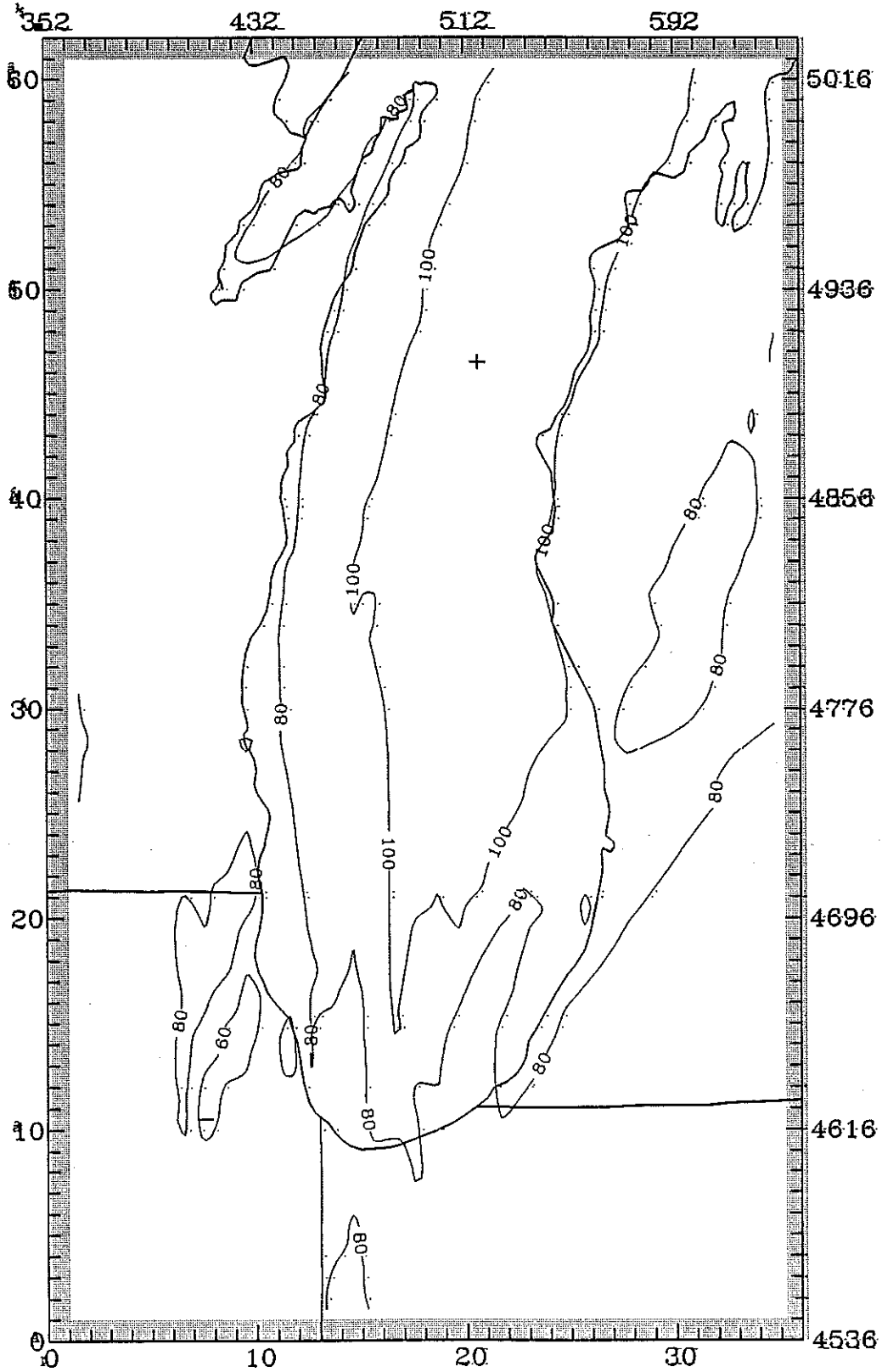
2007 Basecase

LEVEL 1 Ozone (ppb):

Time: 0-2400 June 27, 1991

+ MAXIMUM = 111.5 ppb

- MINIMUM = 47.7 ppb

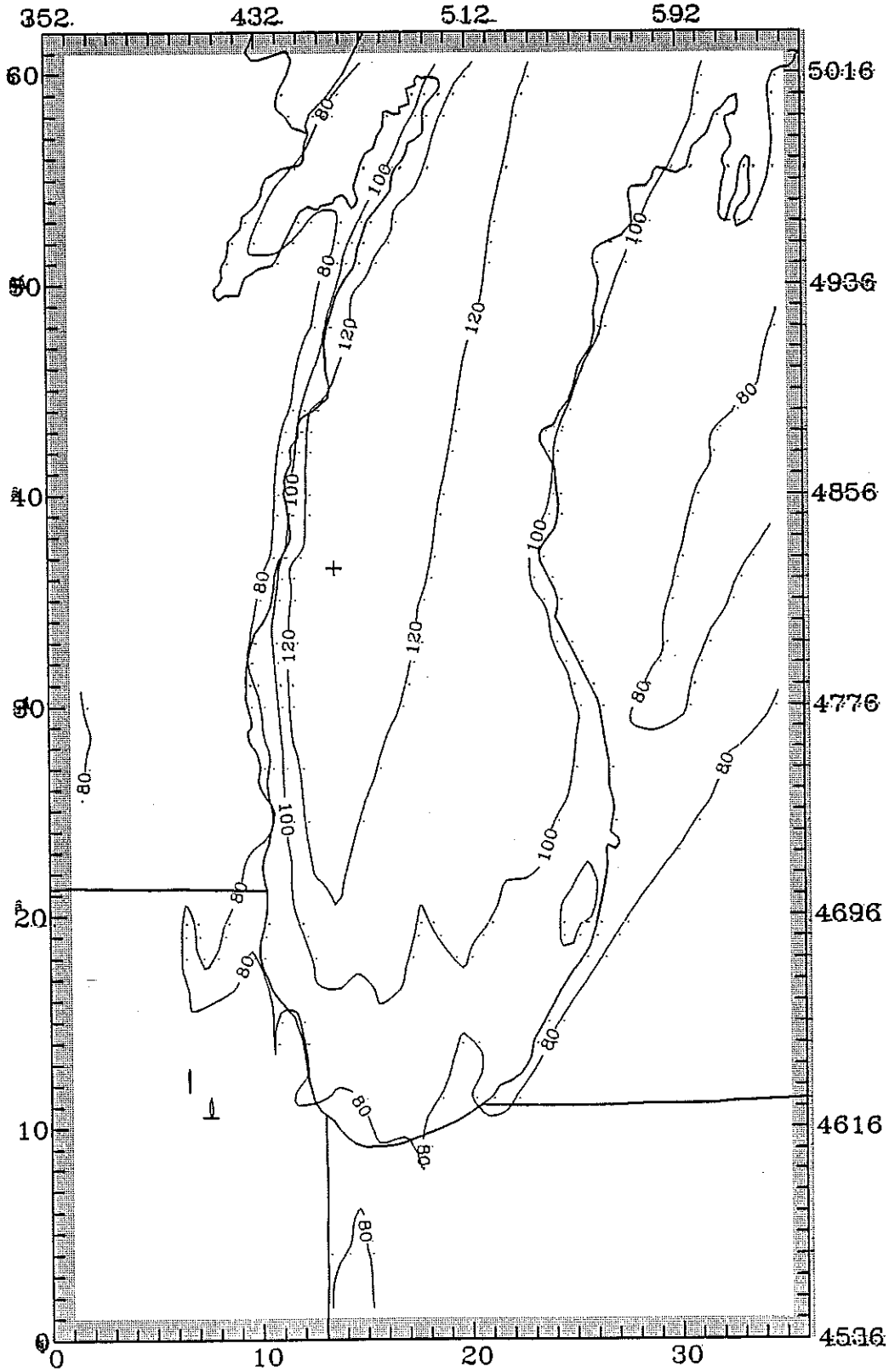


Maximum Simulated Hourly Ozone Concentrations in the LMQS Region.
8 km grid -- June 27, 1991. (.24-28jun91.16-8km.07_rhcctrl) (v1.21)

2007 Basecase with Grid B anthropogenic RHC emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 June 27, 1991

+ MAXIMUM = 131.9 ppb
- MINIMUM = 60.0 ppb

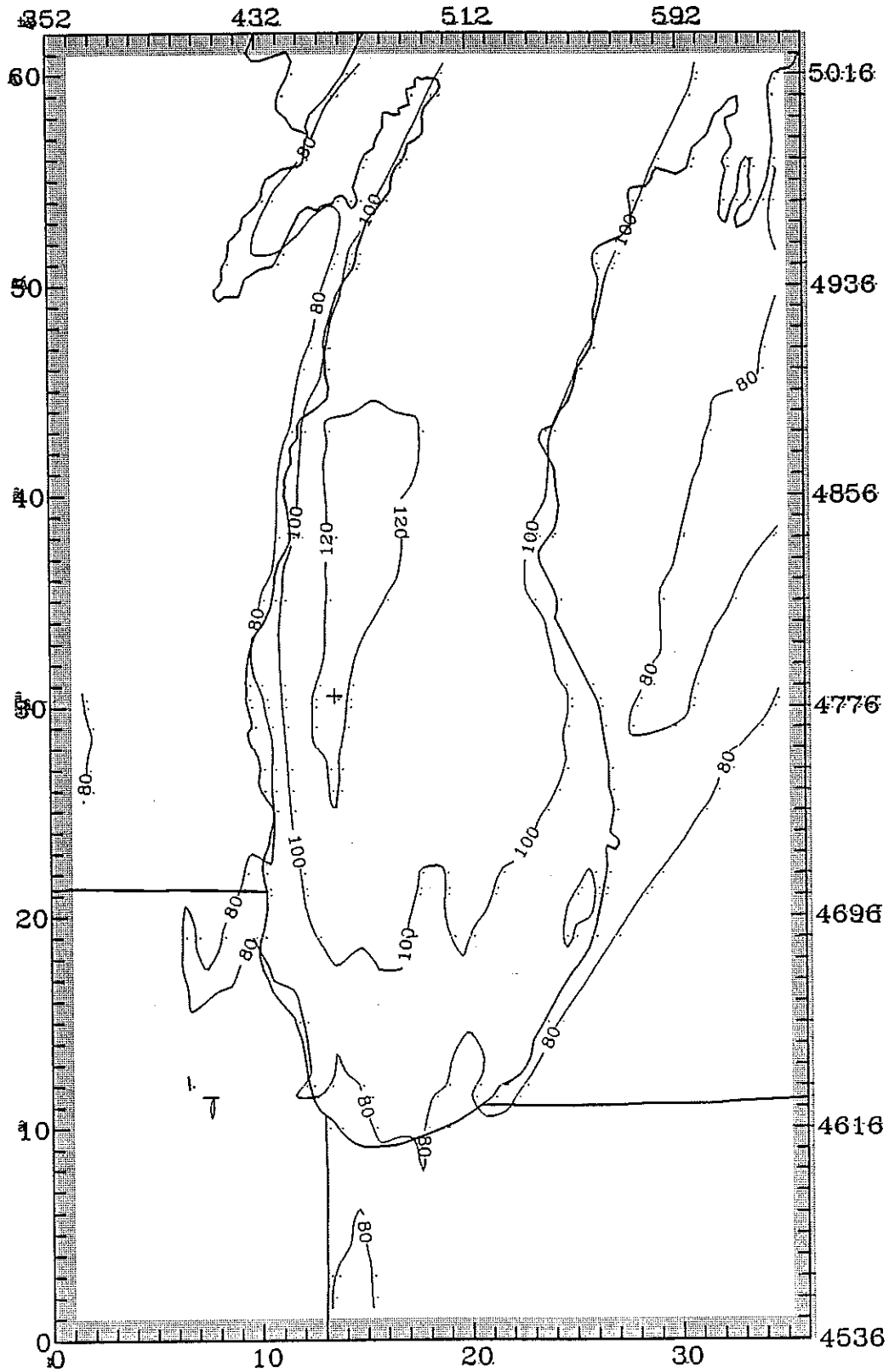


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- June 27, 1991. (.24-28jun91.16-8km.07_noxctrl) (v1.21)

2007 Basecase with Grid B NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 June 27, 1991

+ MAXIMUM = 122.5 ppb
- MINIMUM = 59.3 ppb

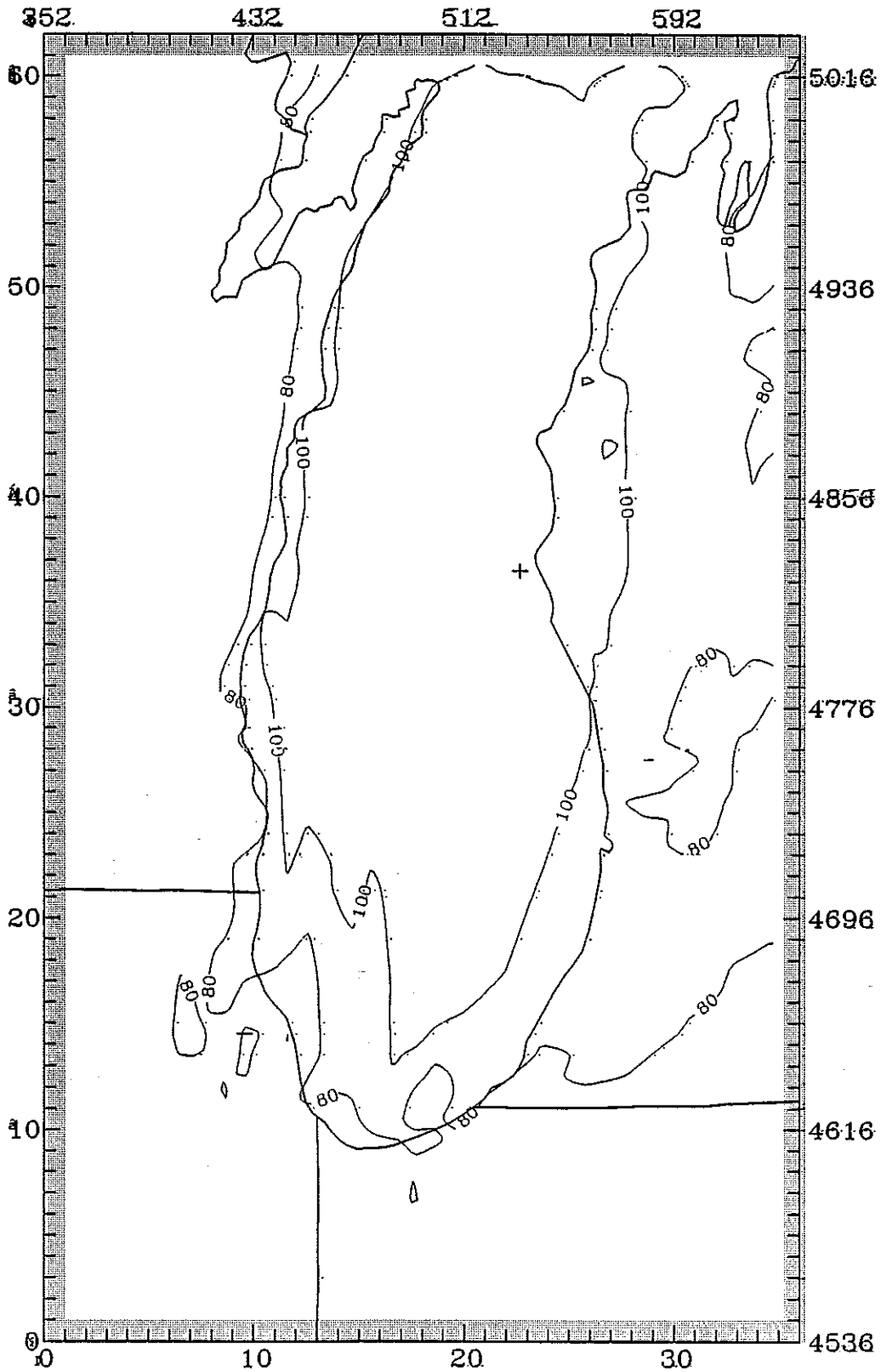


Maximum Simulated Hourly Ozone Concentrations in the LMO5 Region
8 km grid -- June 27, 1991. (.24-28jun91.16-8km.07_bothctr1) (v1.21)

2007 Basecase with Grid B anthropogenic RHC & NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 June 28, 1991

+ MAXIMUM = 115.6 ppb
- MINIMUM = 56.9 ppb



Maximum Simulated Hourly Ozone Concentrations in the IMOS Region
8 km grid -- June 28, 1991. (.24-28jun91.16-8km.07_base) (v1.21)

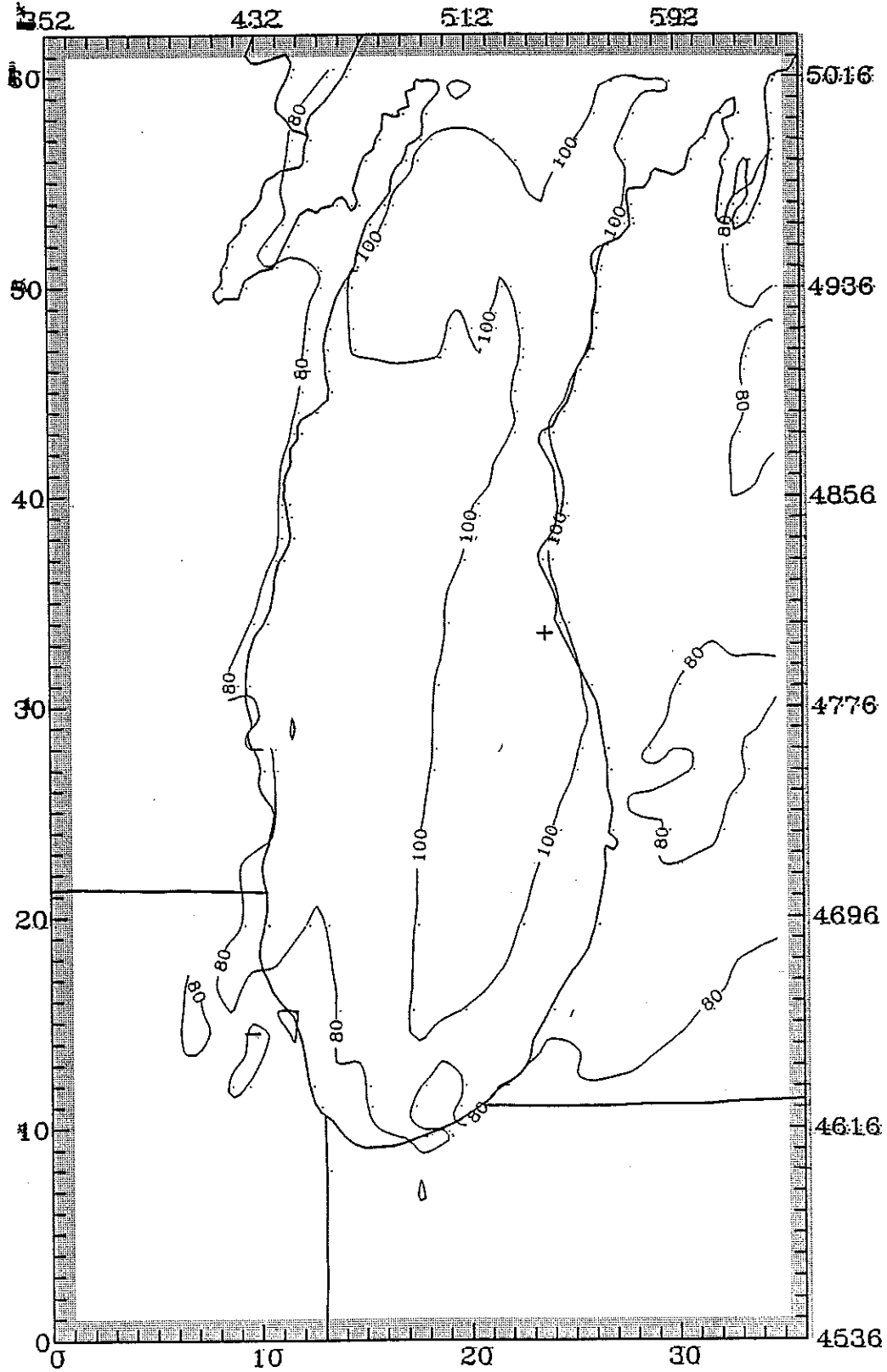
2007 Basecase

LEVEL 1 Ozone (ppb)

Time: 0-2400 June 28, 1991

+ MAXIMUM = 107.4 ppb

- MINIMUM = 55.1 ppb

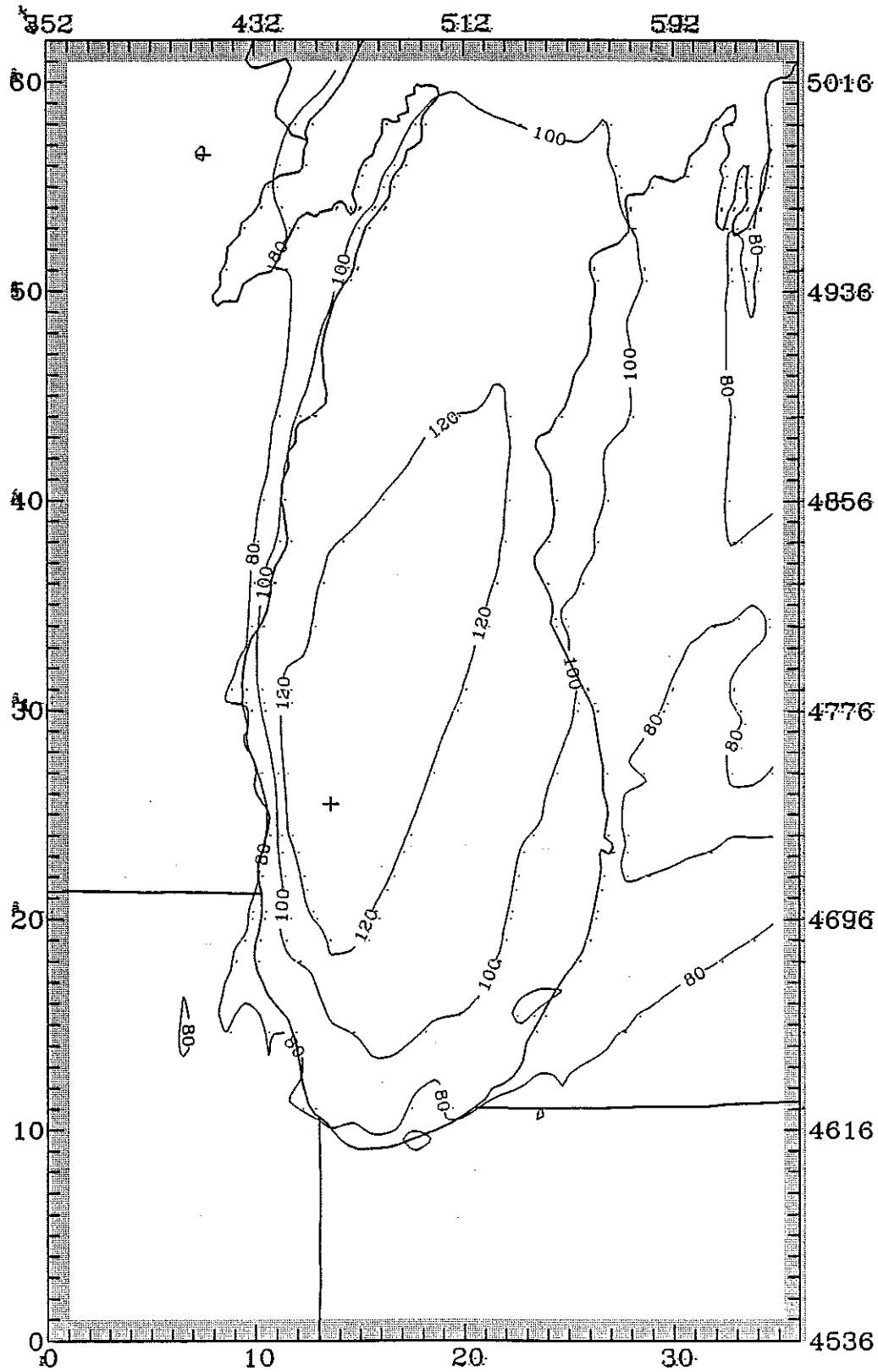


Maximum Simulated Hourly Ozone Concentrations in the LMOs Region
8 km grid -- June 28, 1991. (.24-28jun91.16-8km.07_rhctrl). (v1.21).

2007 Basecase with Grid B anthropogenic RHC emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 June 28, 1991

+ MAXIMUM = 132.6 ppb
- MINIMUM = 59.7 ppb

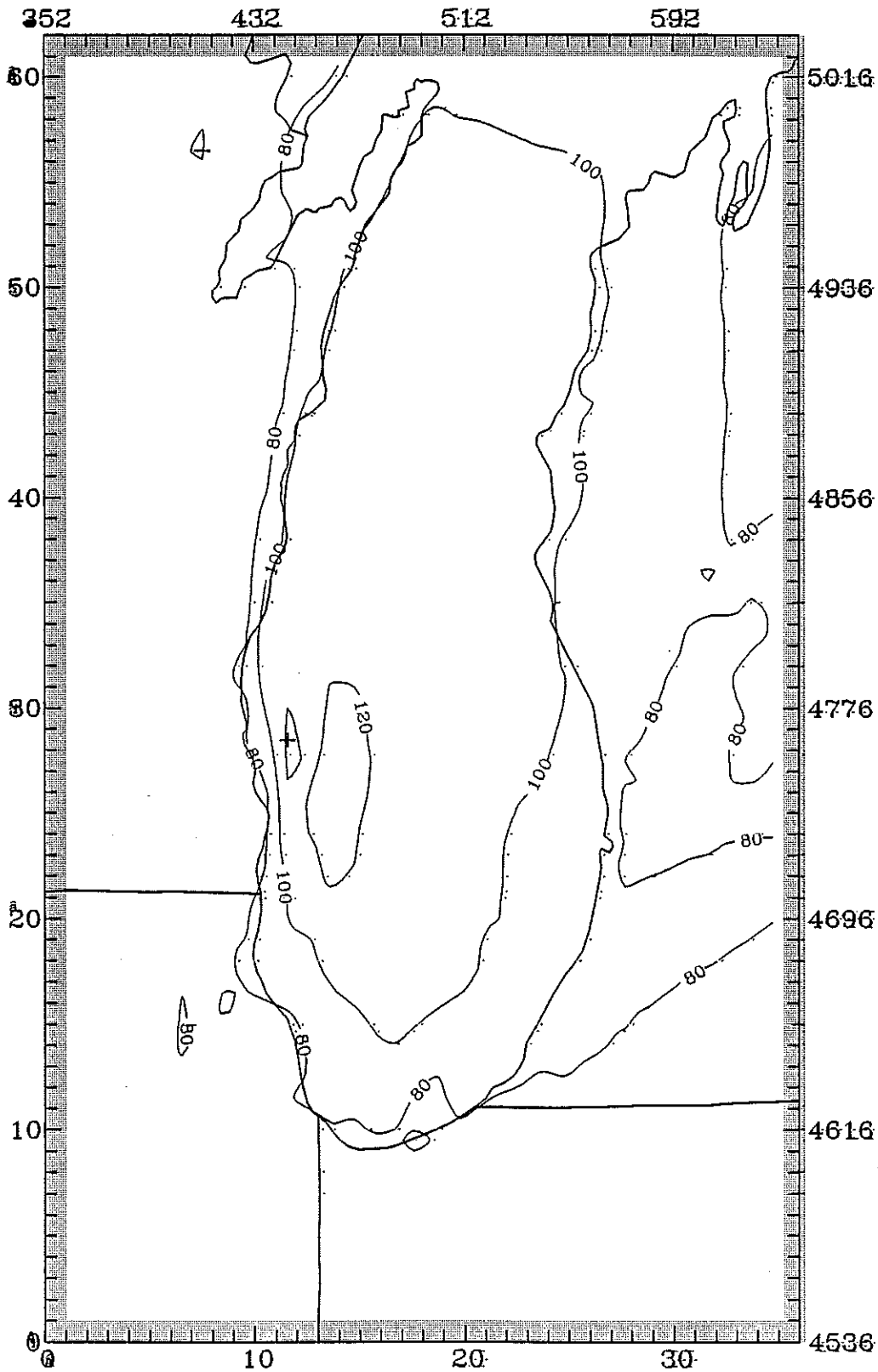


Maximum Simulated Hourly Ozone Concentrations in the LMOB Region.
8 km grid -- June 28, 1991. (.24-28jun91.16-8km.07_noxctrl) (v1.21)

2007 Basecase with Grid B NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 June 28, 1991

+ MAXIMUM = 123.5 ppb
- MINIMUM = 59.6 ppb

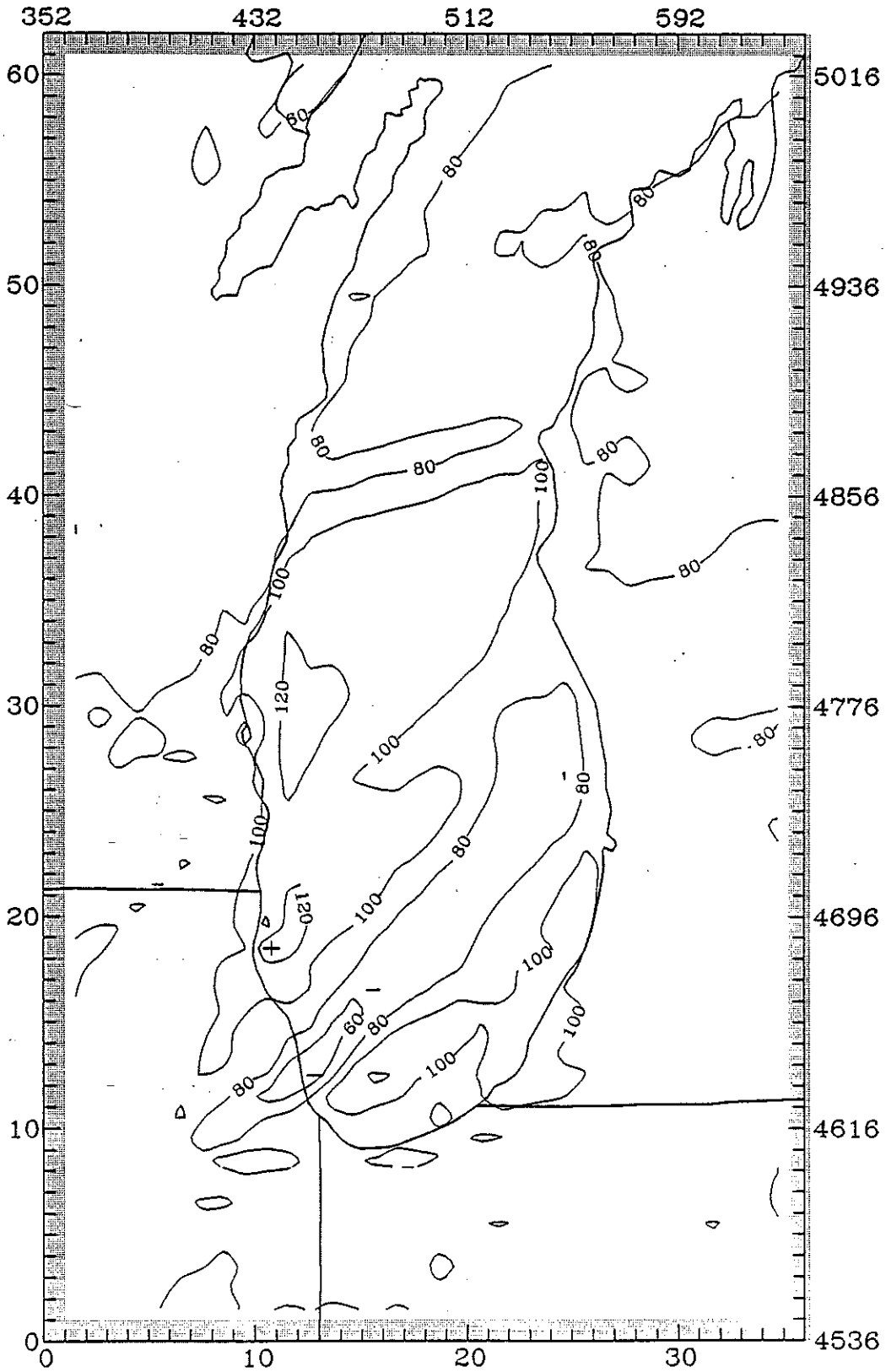


Maximum Simulated Hourly Ozone Concentration in the LMOS Region.
8 km grid -- June 28, 1991. (.24-28jun91.16-8km.07_botlicri) (v1.21)

2007 Basecase with Grid B anthropogenic RHC & NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 17, 1991

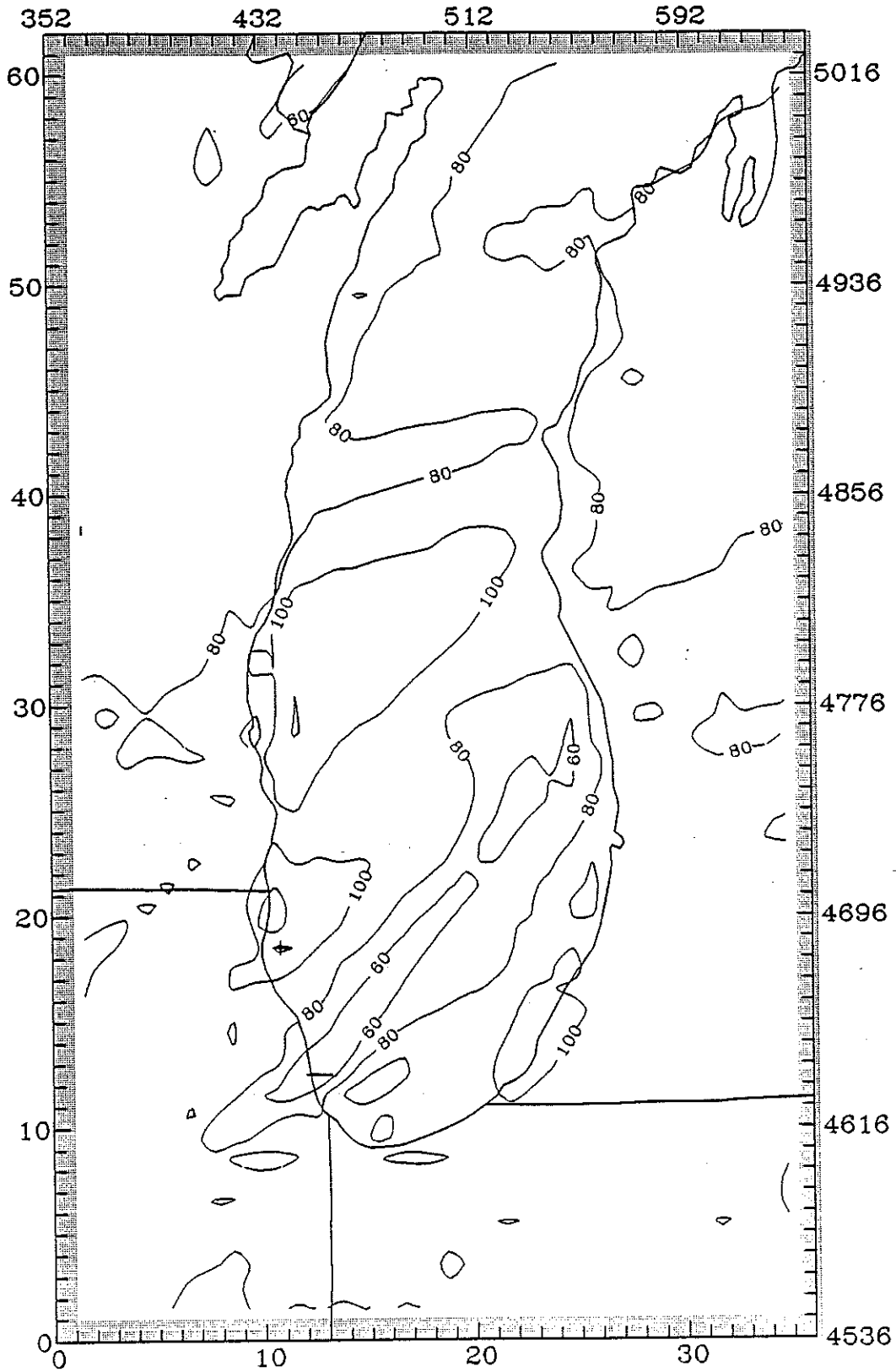
+ MAXIMUM = 131.4 ppb
- MINIMUM = 41.5 ppb



Maximum Simulated Hourly Ozone Concentrations in the LMOs Region
8 km grid -- July 17, 1991. (.15-19jul91.16-8km.07_base) (v1.21)

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 17, 1991

+ MAXIMUM = 123.5 ppb
- MINIMUM = 38.9 ppb

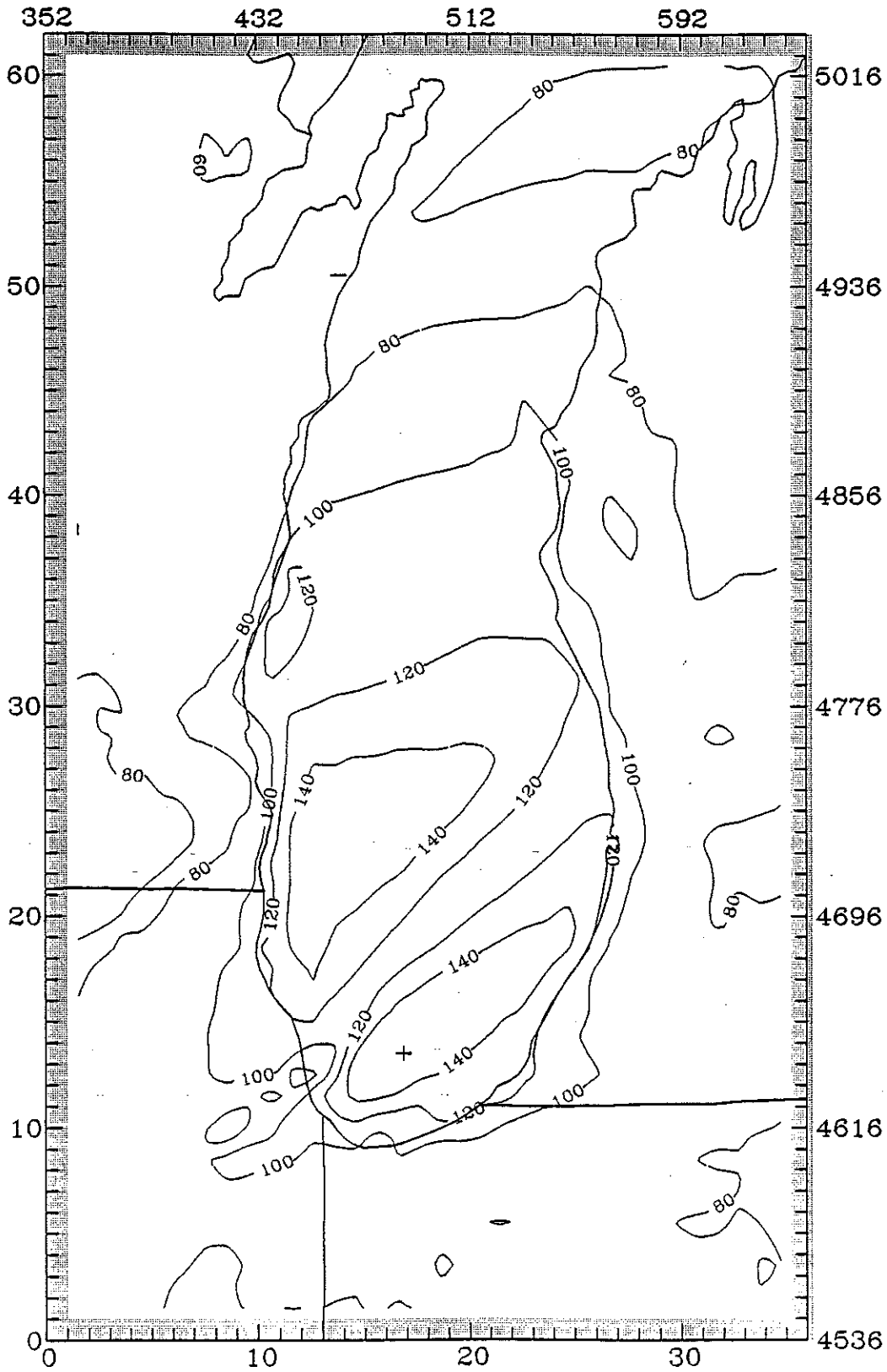


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- July 17, 1991. (.15-19jul91.16-8km.07_rhcctrl) (v1.21)

2007 Basecase with Grid B anthropogenic RHC emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 17, 1991

+ MAXIMUM = 162.7 ppb
- MINIMUM = 59.2 ppb

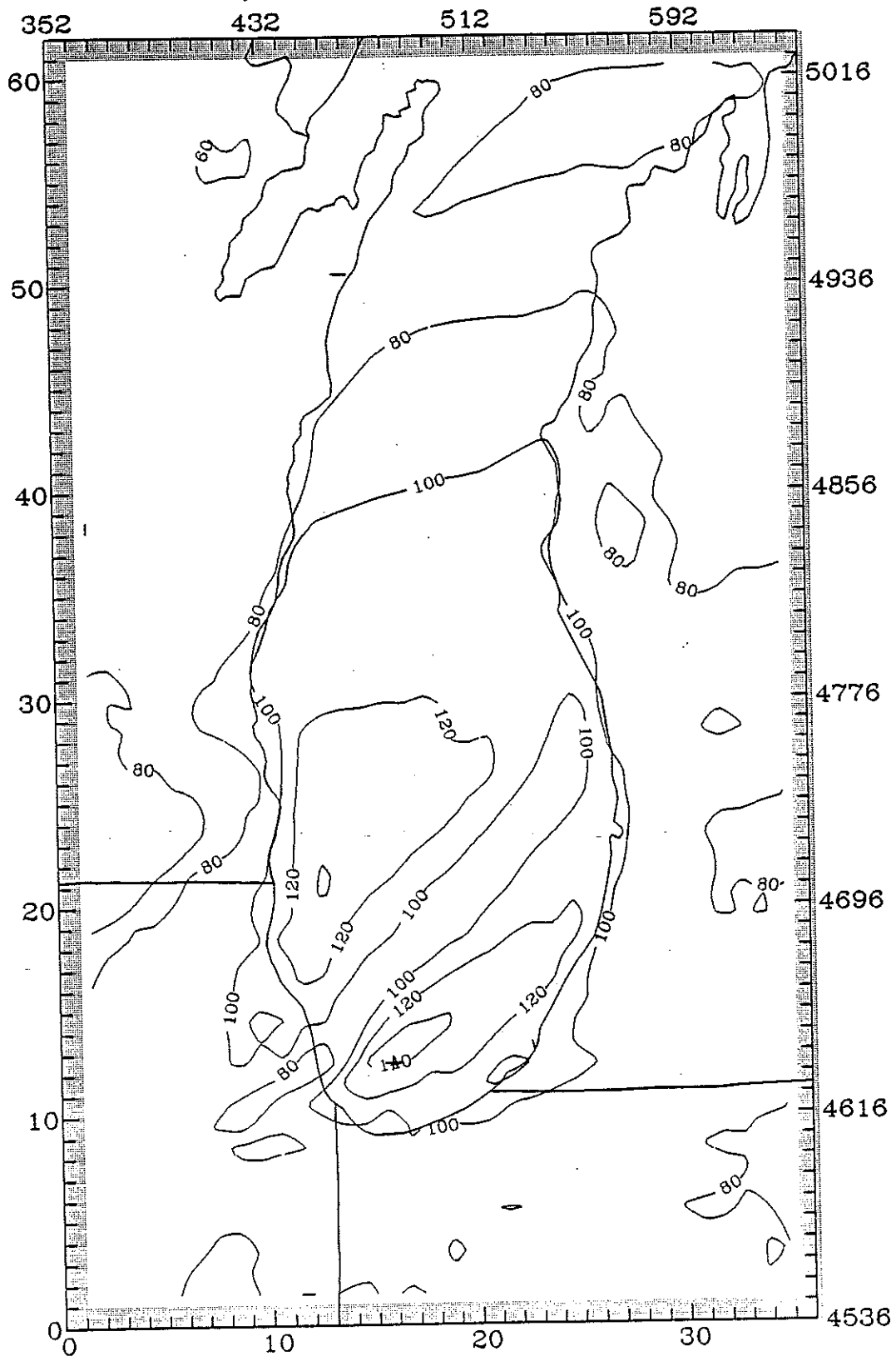


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- July 17, 1991. (.15-19jul91.16-8km.07_noxctrl) (v1.21)

2007 Basecase with Grid B anthropogenic NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 17, 1991

+ MAXIMUM = 147.2 ppb
- MINIMUM = 59.2 ppb



Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- July 17, 1991. (.15-19jul91.16-8km.07_bothctrl) (v1.21)

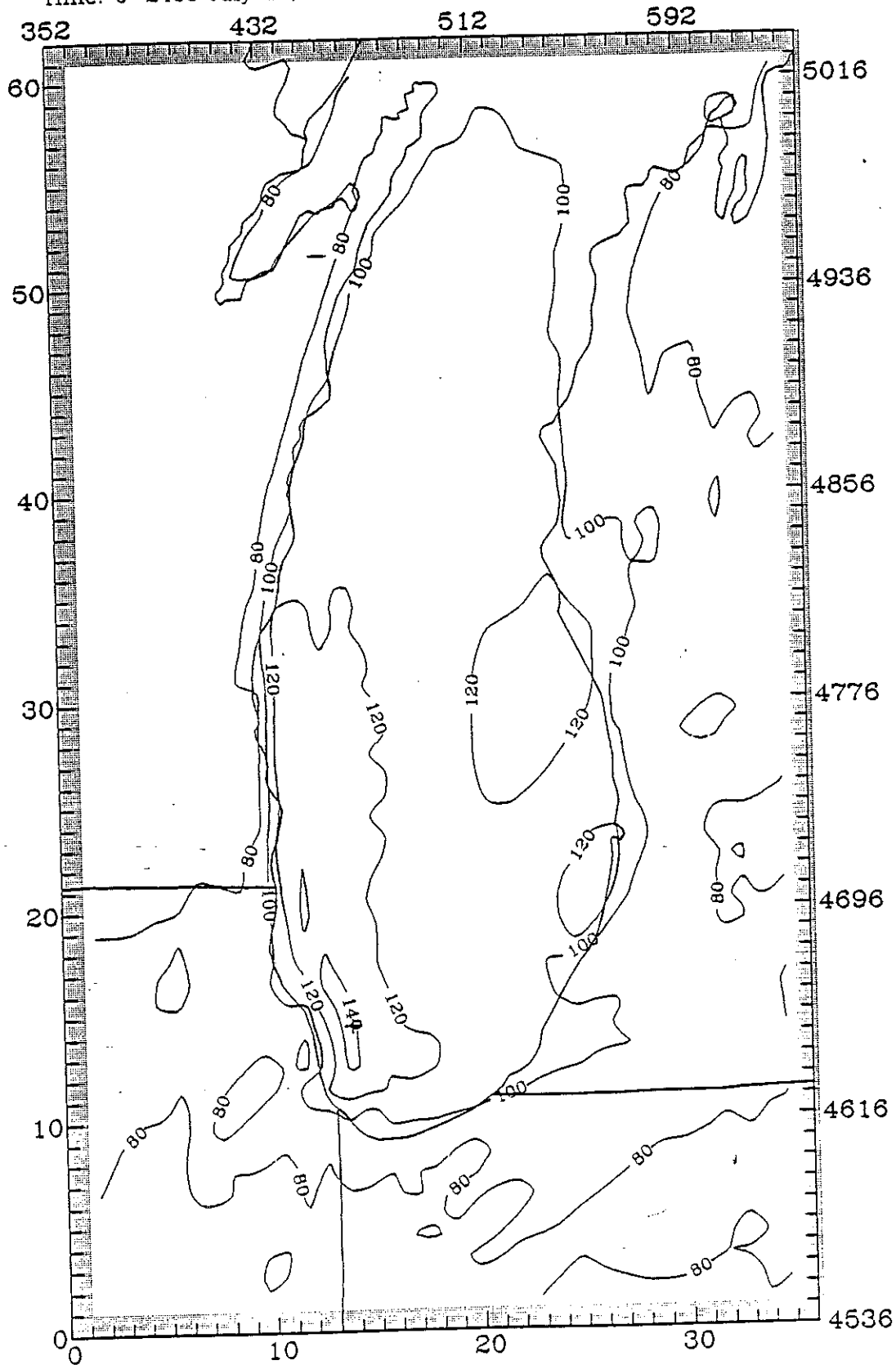
2007 Basecase with Grid B anthropogenic RHC & NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)

Time: 0-2400 July 18, 1991

+ MAXIMUM = 149.1 ppb

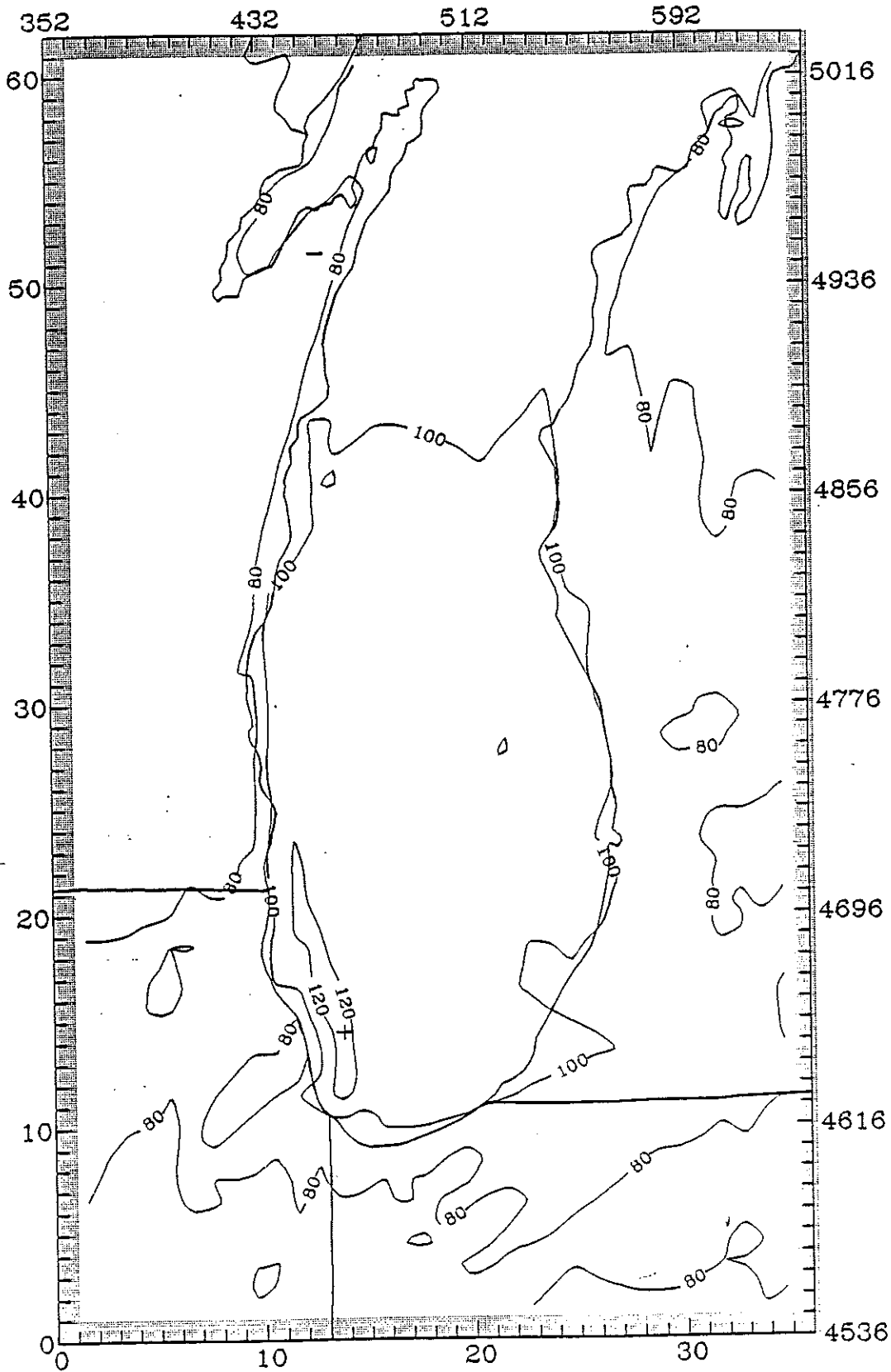
- MINIMUM = 63.1 ppb



Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- July 18, 1991. (.15-19jul91.16-8km.07_noxctrl) (v1.21)

2007 Basecase with Grid B anthropogenic NO_x emissions reduced by 40%.

Time: 0-2400 July 18, 1991

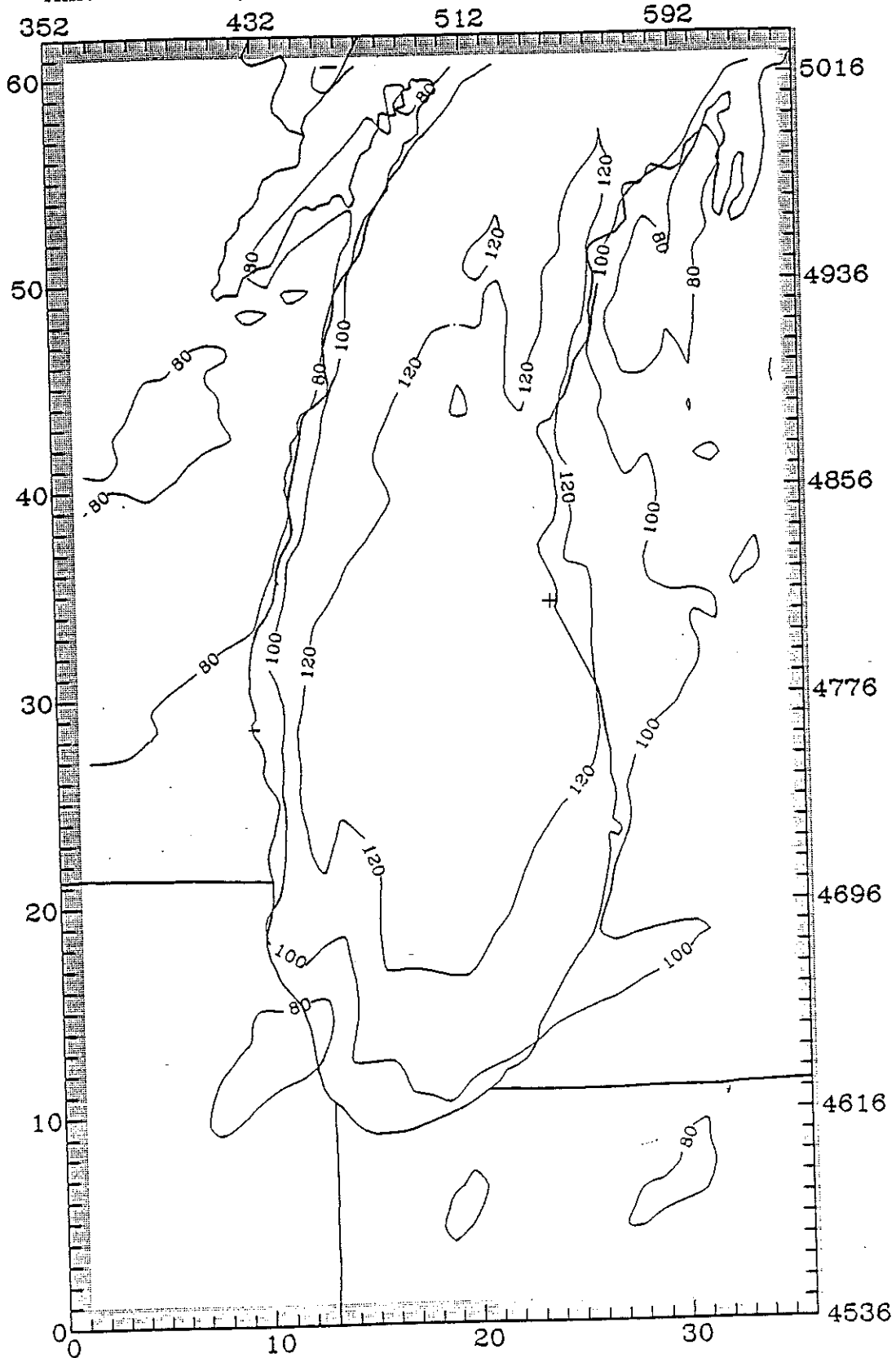


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- July 18, 1991. (.15-19jul91.16-8km.07_bothctrl) (v1.21)

2007 Basecase with Grid B anthropogenic RHC & NOx emissions reduced by 40%

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 19, 1991

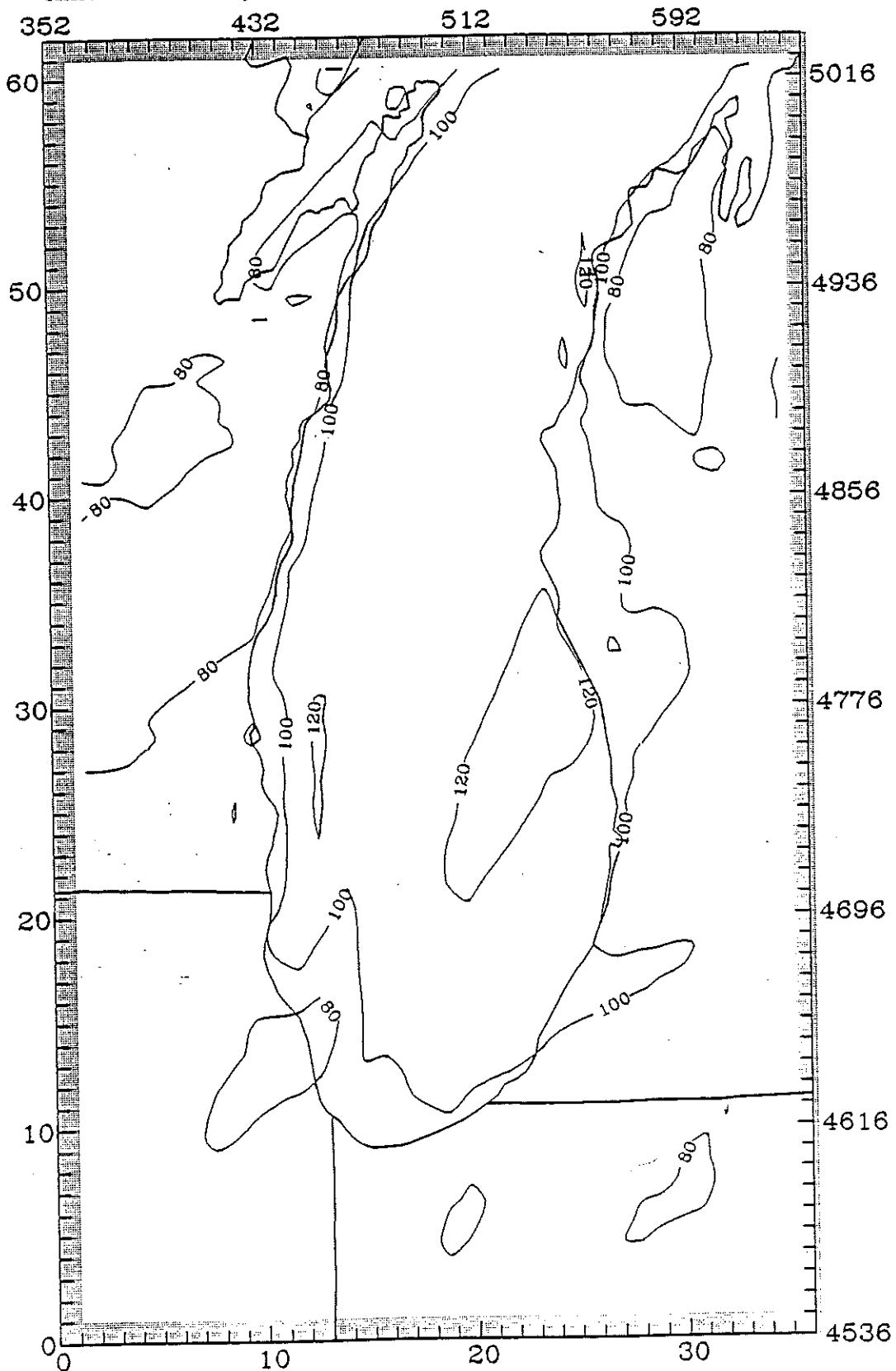
+ MAXIMUM = 134.1 ppb
- MINIMUM = 57.4 ppb



Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- July 19, 1991. (.15-19jul91.16+8km.07_base) (v1.21)

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 19, 1991

+ MAXIMUM = 125.4 ppb
- MINIMUM = 57.4 ppb

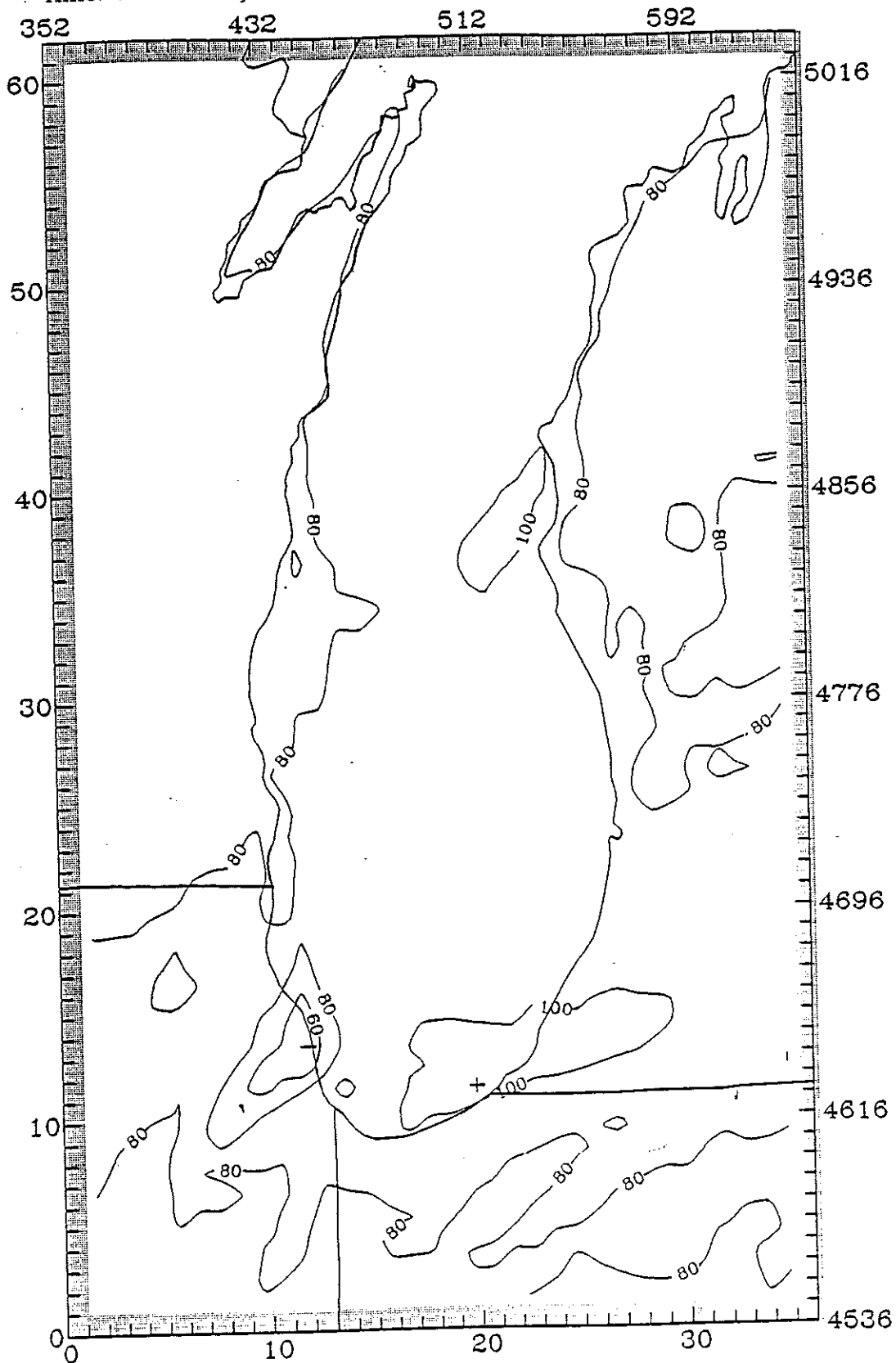


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- July 19, 1991. (.15-19jul91.16+8km.07_rhcctrl) (v1.21)

2007 Basecase with Grid B anthropogenic RHC emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 18, 1991

+ MAXIMUM = 112.2 ppb
- MINIMUM = 40.3 ppb

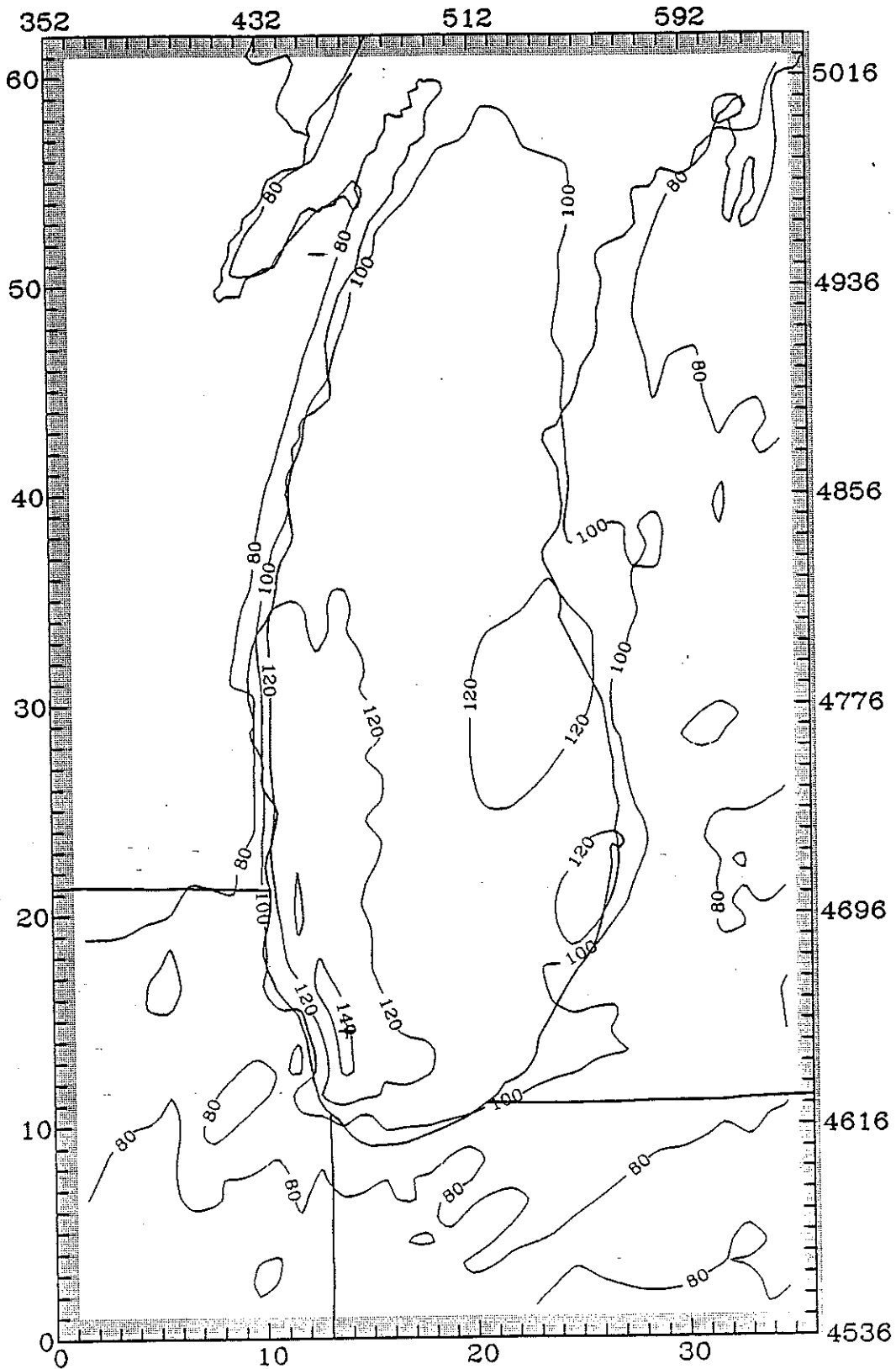


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- July 18, 1991. (.15-19jul91.16-8km.07_rhctrl) (v1.21)

2007 Basecase with Grid B anthropogenic RHC emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 18, 1991

+ MAXIMUM = 149.1 ppb
- MINIMUM = 63.1 ppb

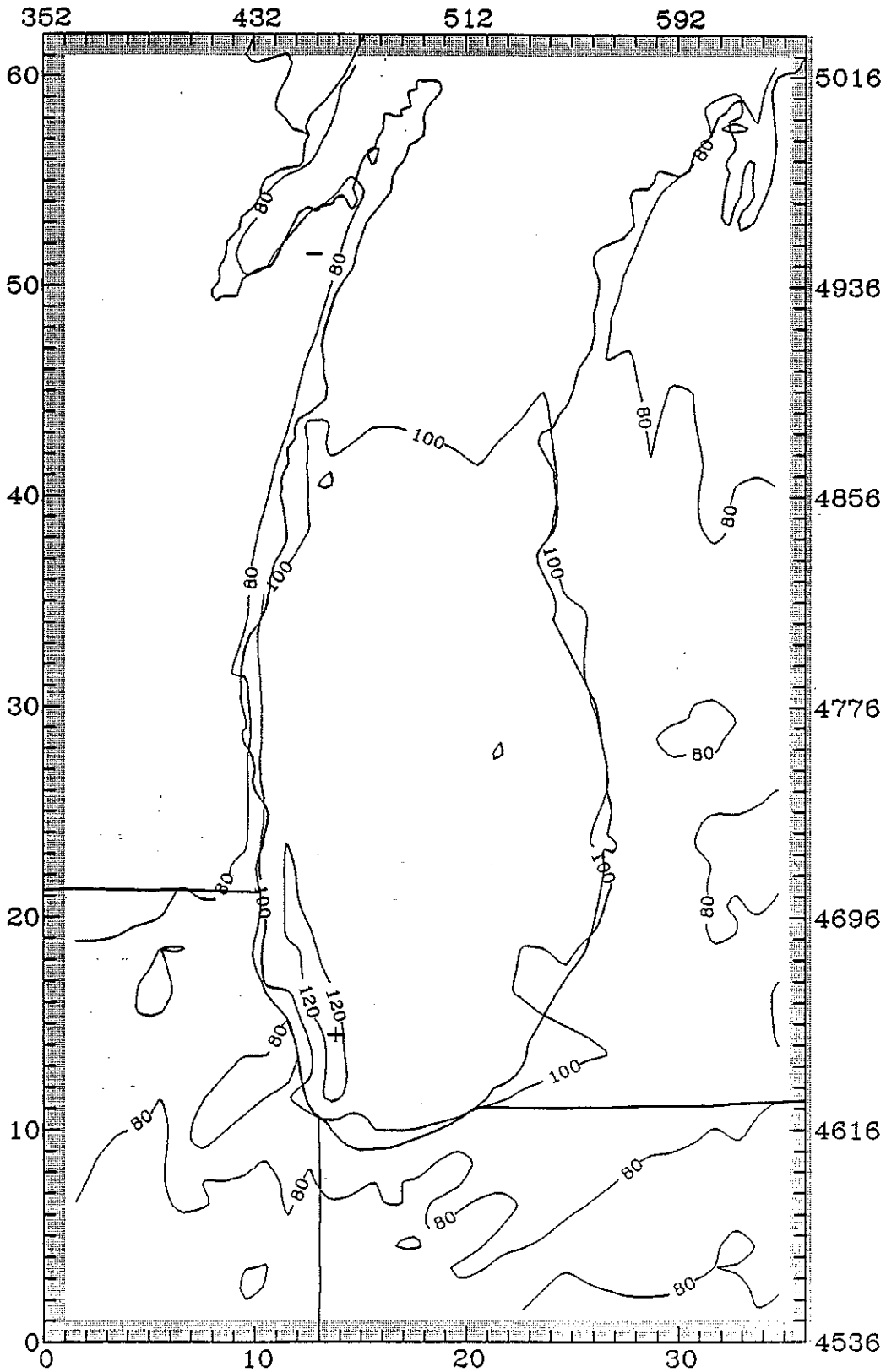


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- July 18, 1991. (.15-19jul91.16-8km.07_noxctrl) (v1.21)

2007 Basecase with Grid B anthropogenic NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 18, 1991

+ MAXIMUM = 128.7 ppb
- MINIMUM = 61.8 ppb

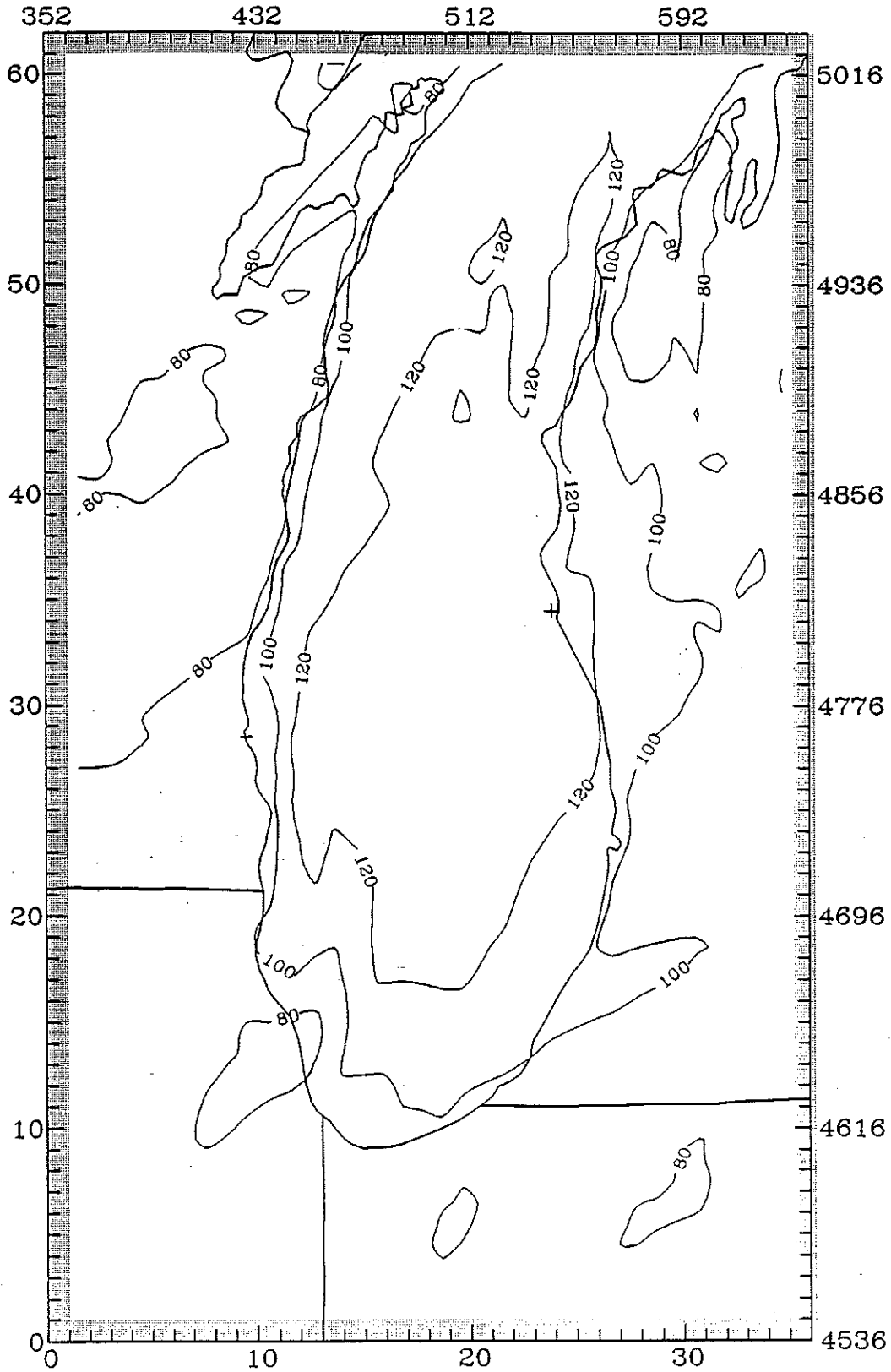


Maximum Simulated Hourly Ozone Concentrations in the LMOs Region
8 km grid -- July 18, 1991. (.15-19jul91.16-8km.07_bothctrl) (v1.21)

2007 Basecase with Grid B anthropogenic RHC & NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 19, 1991

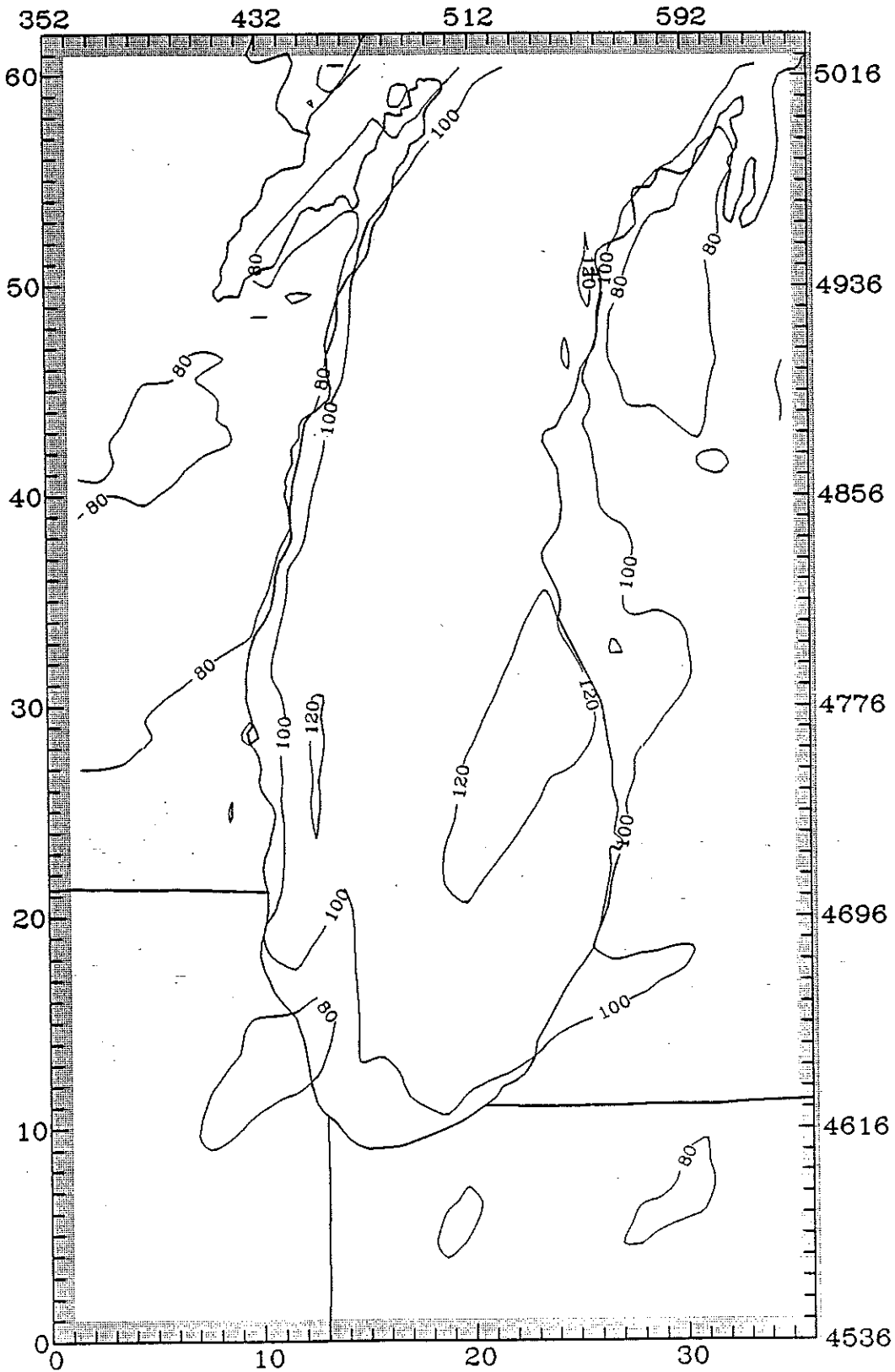
+ MAXIMUM = 134.1 ppb
- MINIMUM = 57.4 ppb



Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- July 19, 1991. (.15-19jul91.16-8km.07_base) (v1.21)

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 19, 1991

+ MAXIMUM = 125.4 ppb
- MINIMUM = 57.4 ppb

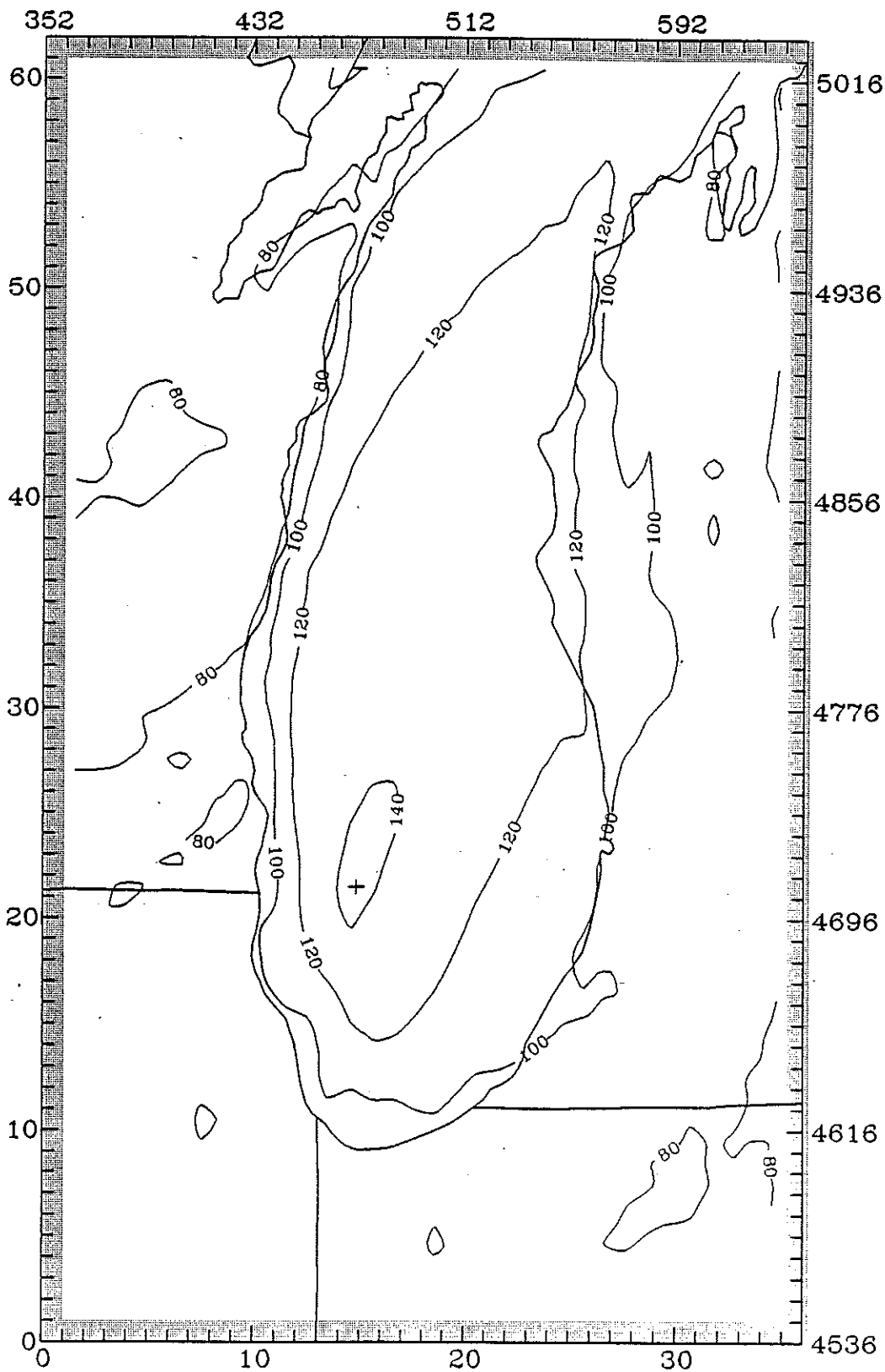


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- July 19, 1991. (.15-19jul91.16-8km.07_rhcctrl) (v1.21)

2007 Basecase with Grid B anthropogenic RHC emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 19, 1991

+ MAXIMUM = 142.5 ppb
- MINIMUM = 58.6 ppb

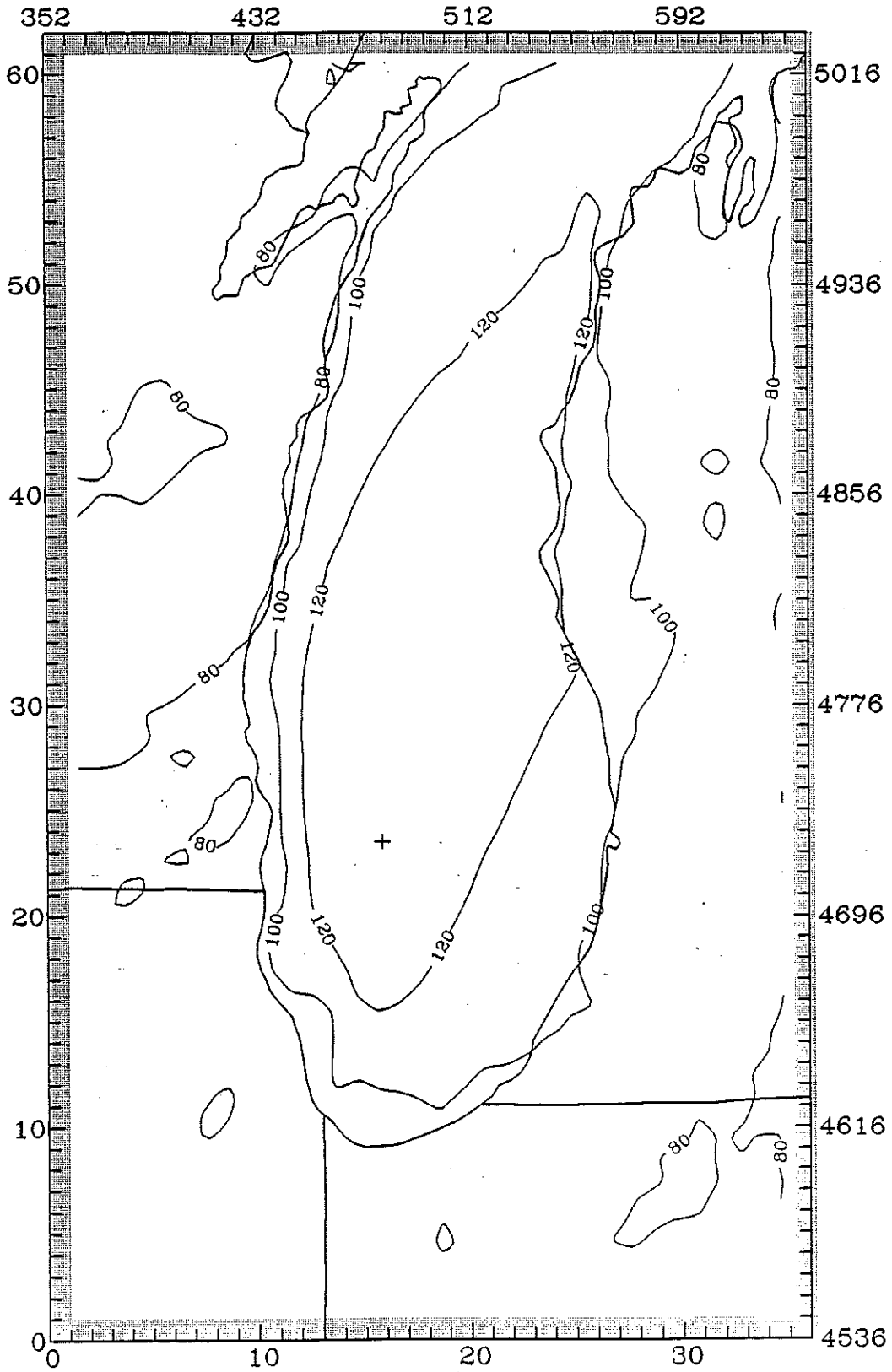


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- July 19, 1991. (.15-19jul91.16-8km.07_noxctrl) (v1.21)

2007 Basecase with Grid B anthropogenic NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 19, 1991

+ MAXIMUM = 133.5 ppb
- MINIMUM = 58.7 ppb

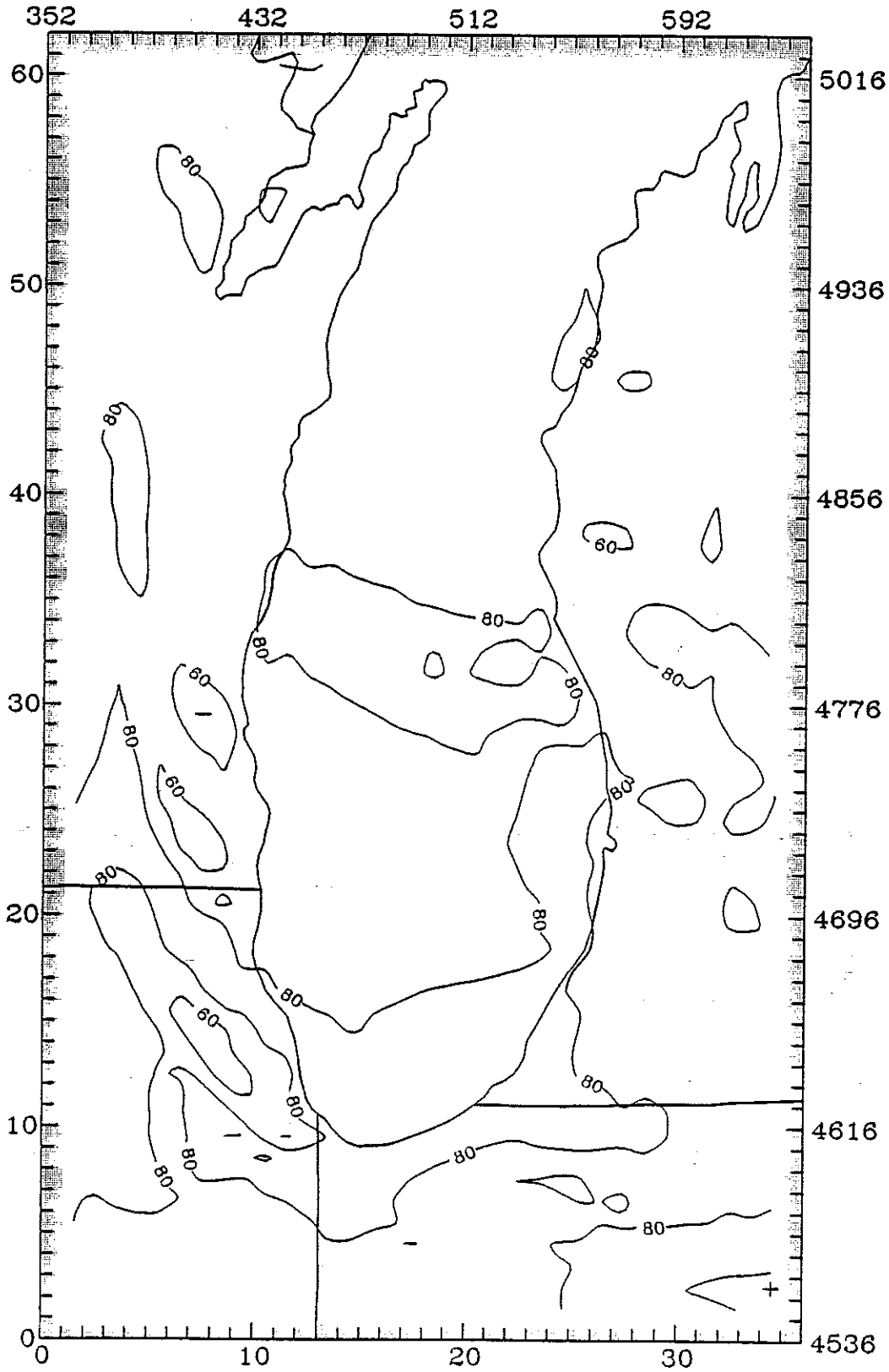


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- July 19, 1991. (.15-19jul91.16-8km.07_bothctrl) (v1.21)

2007 Basecase with Grid B anthropogenic RHC & NOx emissions reduced by 40%.

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

+ MAXIMUM = 110.3 ppb
- MINIMUM = 46.2 ppb

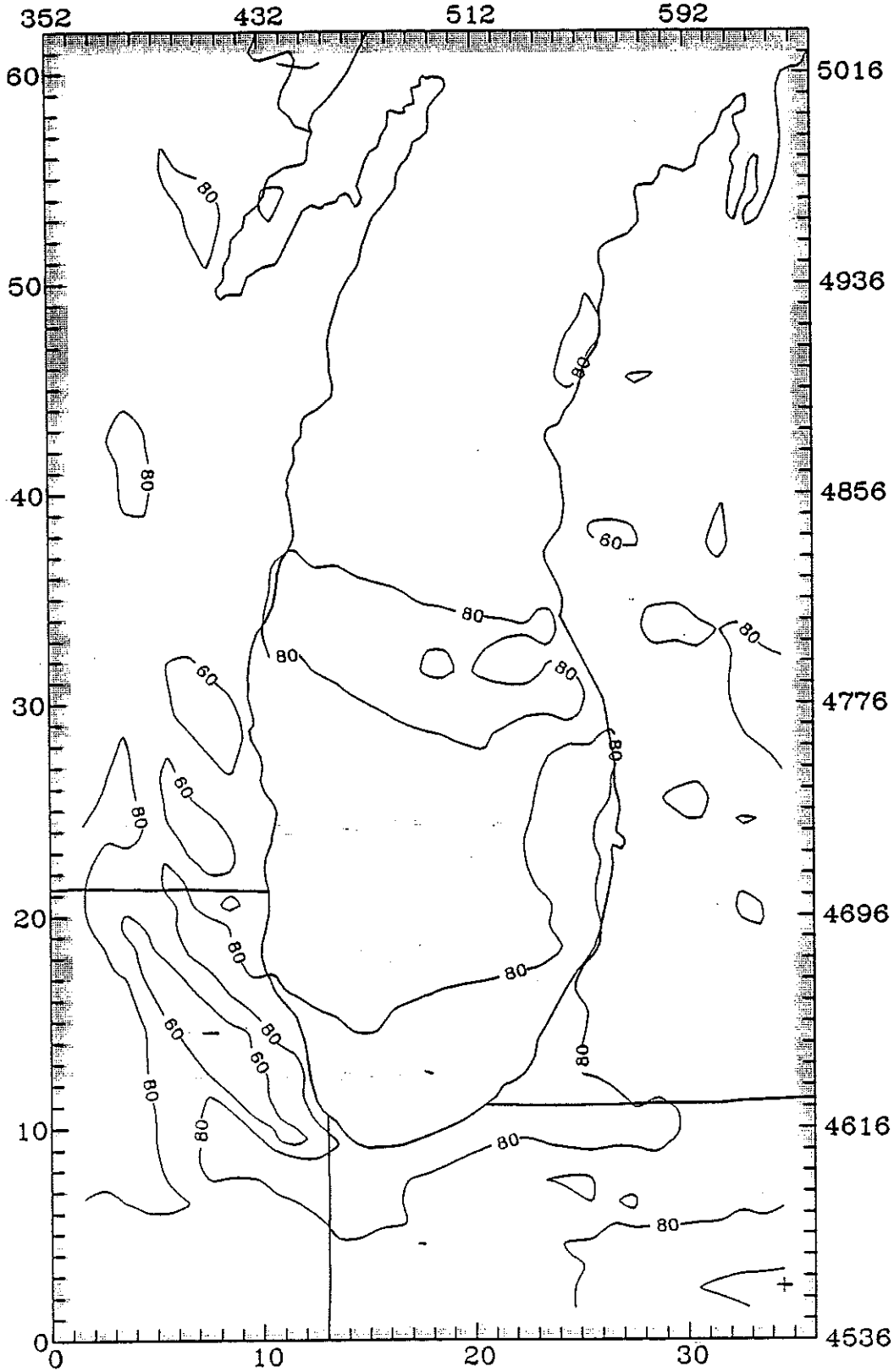


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8km grid -- June 20, 1991. (18-21jun91.16-8km.07_base) (v1.21)

2007 Basecase

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

+ MAXIMUM = 110.3 ppb
- MINIMUM = 42.7 ppb

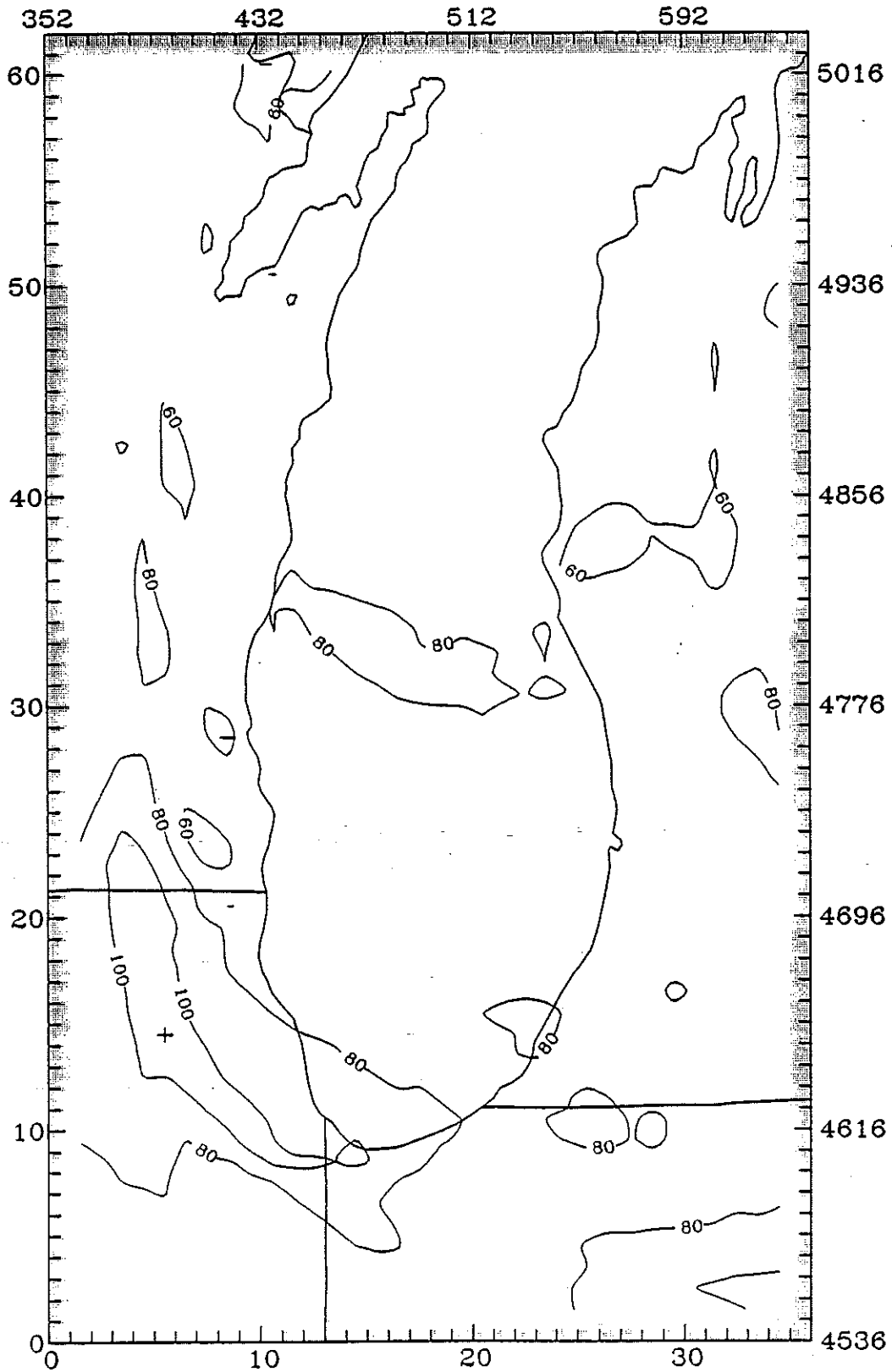


Maximum Simulated Hourly Ozone Concentrations in the LMOs Region
8km grid -- June 20, 1991. (18-21jun91.16-8km.07_rhctrl) (v1.21)

2007 Basecase with Grid B RHC emissions reduced by 40%.

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

+ MAXIMUM = 116.1 ppb
- MINIMUM = 55.5 ppb

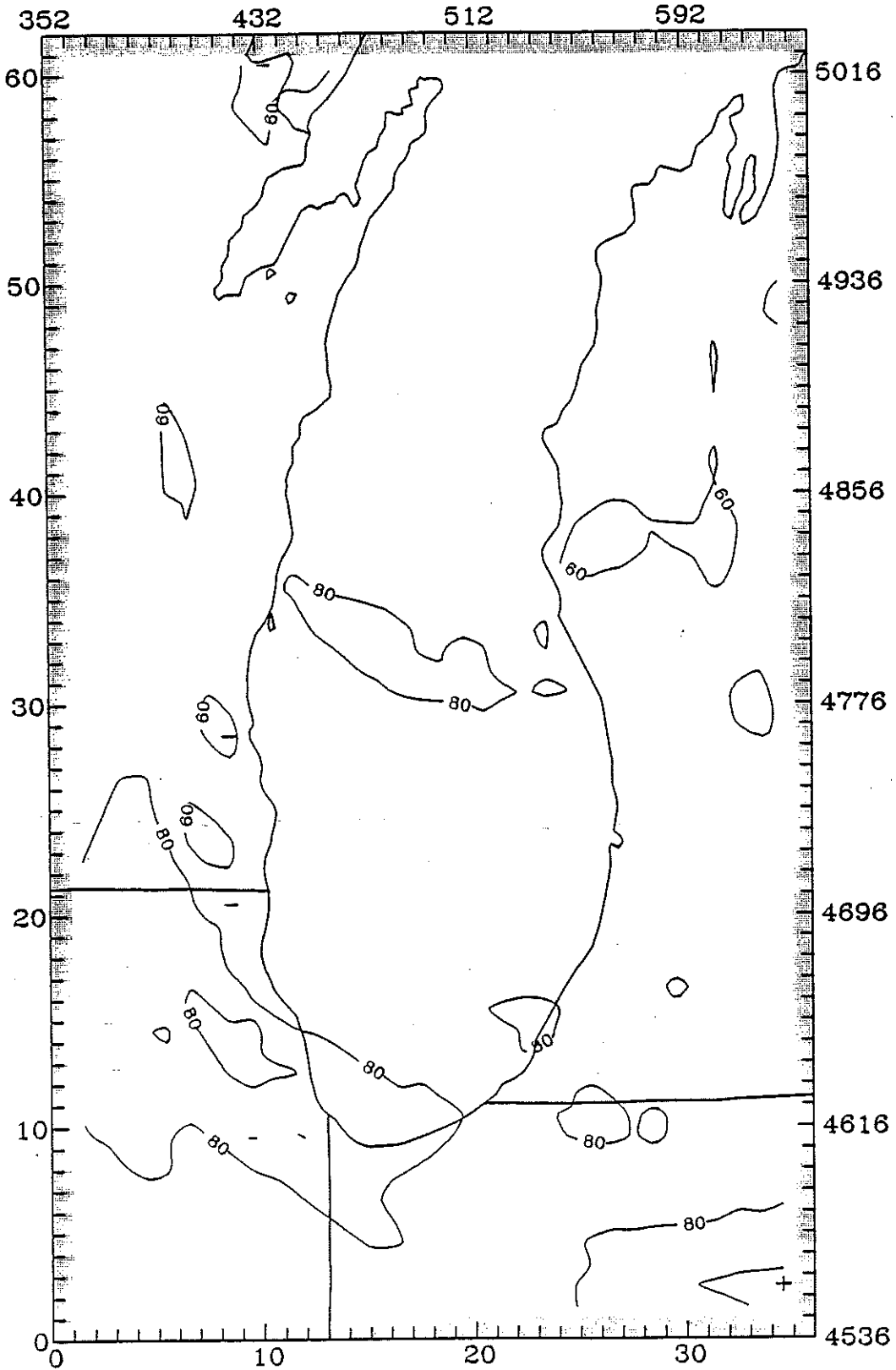


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8km grid -- June 20, 1991. (18-21jun91.16-8km.07_noxctrl) (v1.21)

2007 Basecase with Grid B NOx emissions reduced by 40%.

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

+ MAXIMUM = 110.4 ppb
- MINIMUM = 54.6 ppb

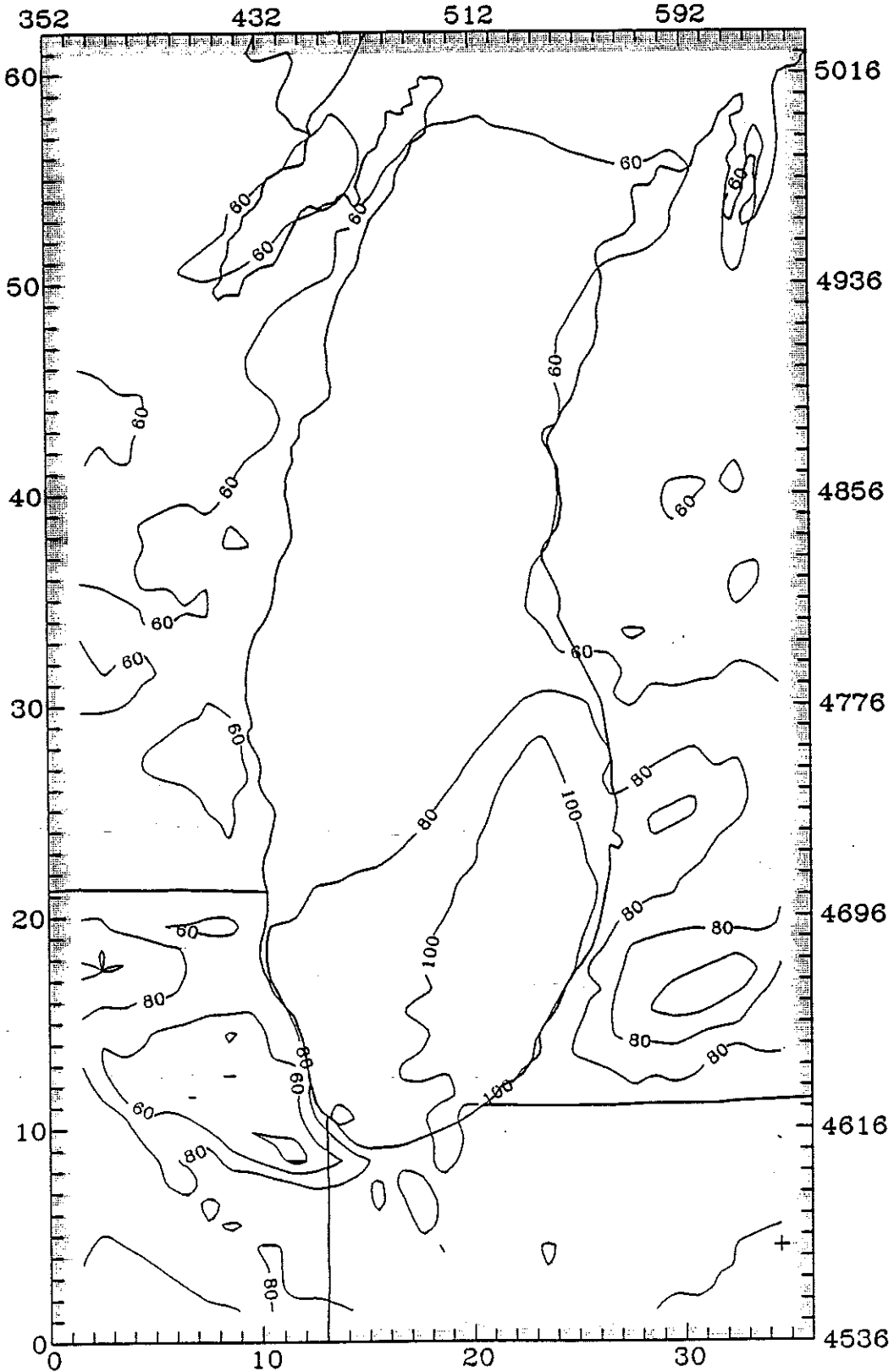


Maximum Simulated Hourly Ozone Concentrations in the LMOs Region
8km grid -- June 20, 1991. (18-21jun91.16-8km.07_rhctrl) (v1.21)

2007 Basecase with Grid B NOx and RHC emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 June 21, 1991

+ MAXIMUM = 117.8 ppb
- MINIMUM = 33.9 ppb



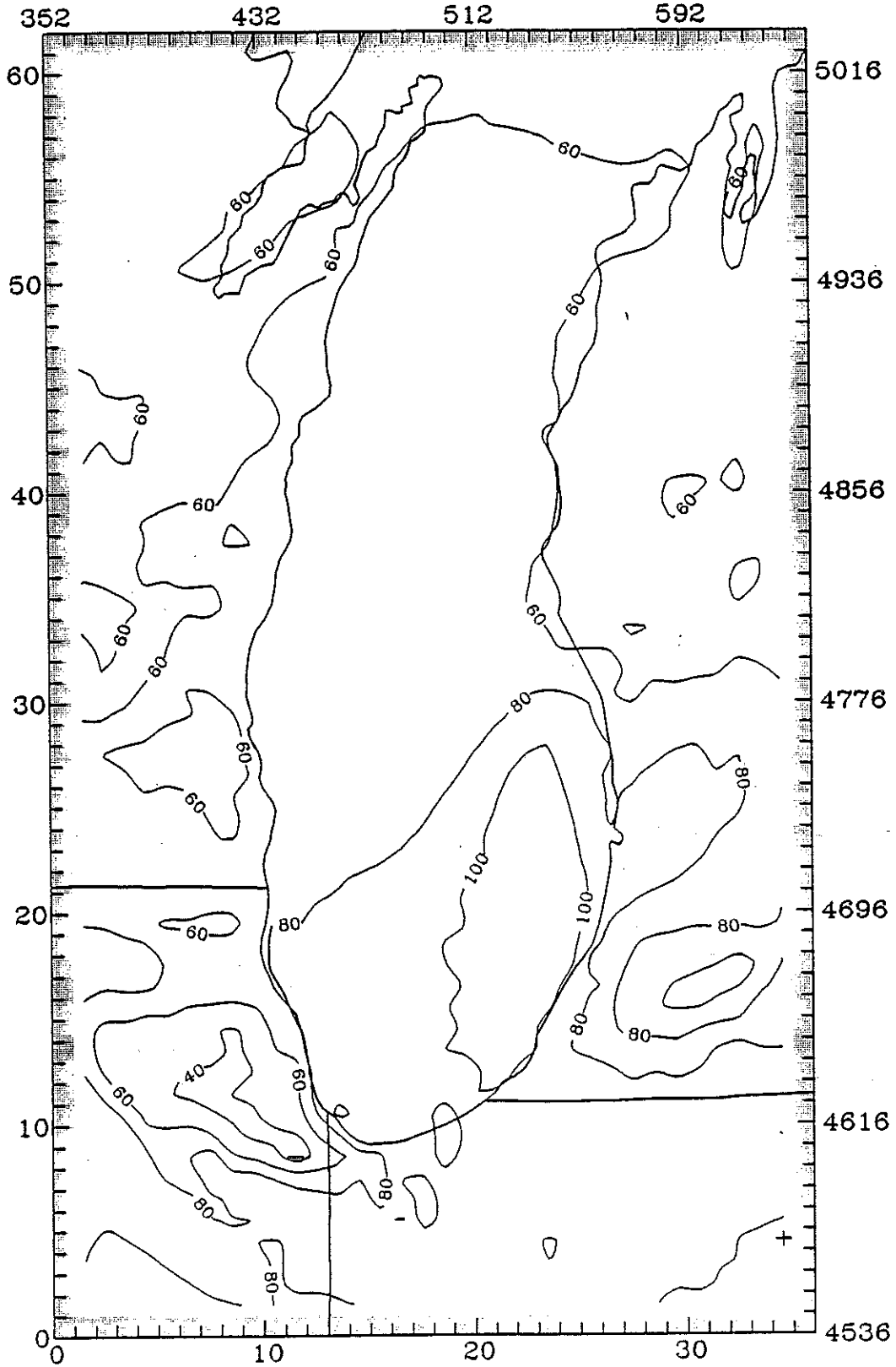
Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8km grid -- June 21, 1991. (18-21jun91.16-8km.07_base) (v1.21)

LEVEL 1 Ozone (ppb)

Time: 0-2400 June 21, 1991

+ MAXIMUM = 117.8 ppb

- MINIMUM = 30.8 ppb

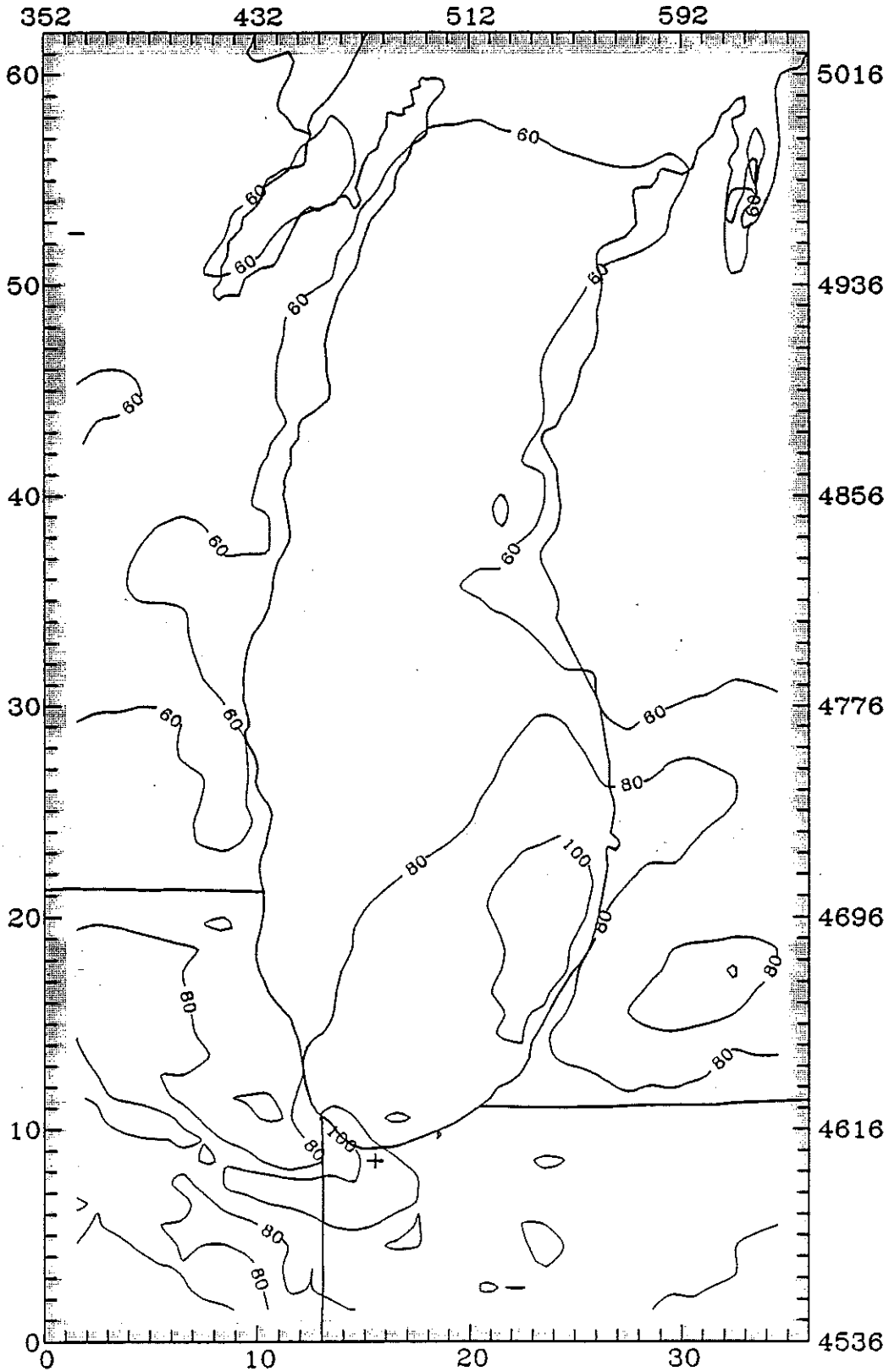


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8km grid -- June 21, 1991. (18-21jun91.16-8km.07_rhctrl) (v1.21)

2007 Basecase with Grid B RHC emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 June 21, 1991

+ MAXIMUM = 121.6 ppb
- MINIMUM = 41.3 ppb

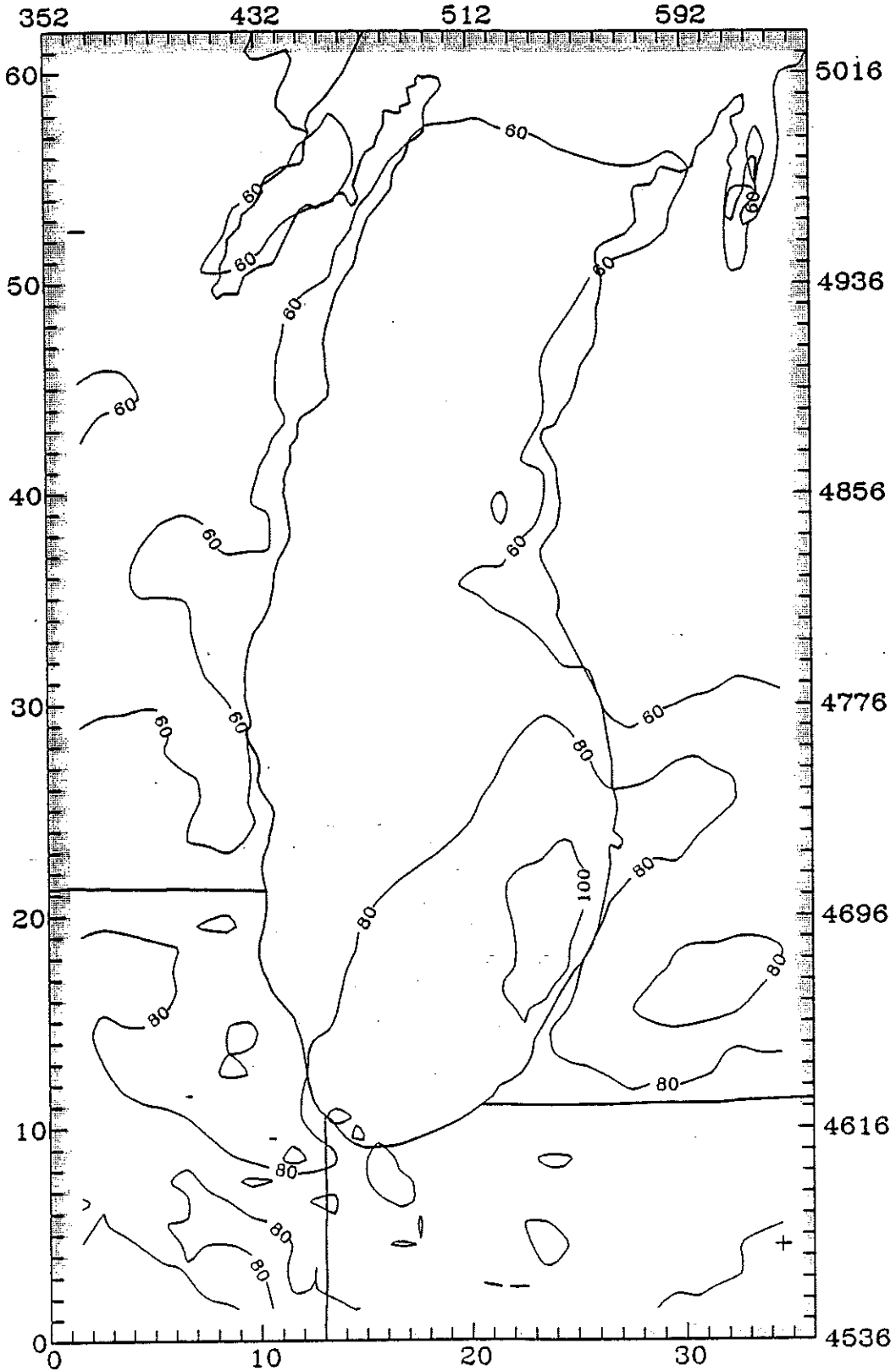


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8km grid -- June 21, 1991. (18-21jun91.16-8km.07_noxctrl) (v1.21)

2007 Basecase with Grid B NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 June 21, 1991

+ MAXIMUM = 117.1 ppb
- MINIMUM = 41.4 ppb



Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8km grid -- June 21, 1991. (18-21jun91.16-8km.07_bothctrl) (v1.21)

2007 Basecase with Grid B NOx and RHC emissions reduced by 40%.

July 13, 1994

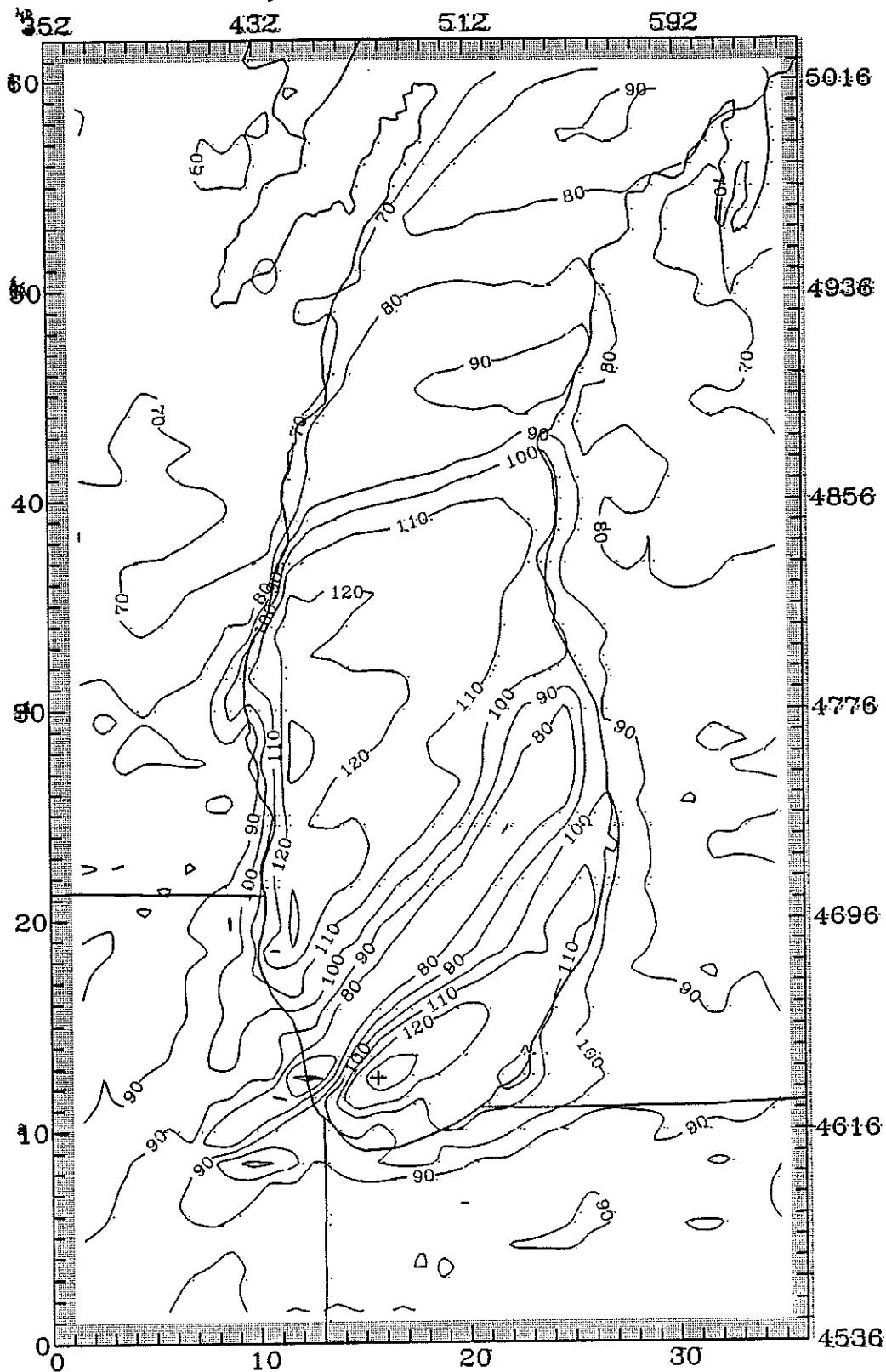
ATTACHMENT 3

Peak Daily Ozone Concentrations

Sensitivity Test (Point Source NO_x Reductions)
Projected 1996 Conditions
Episode 2

LEVEL 1 Ozone (ppb)
Time: 100-2400 July 17, 1991

+ MAXIMUM = 137.7 ppb
- MINIMUM = 54.5 ppb

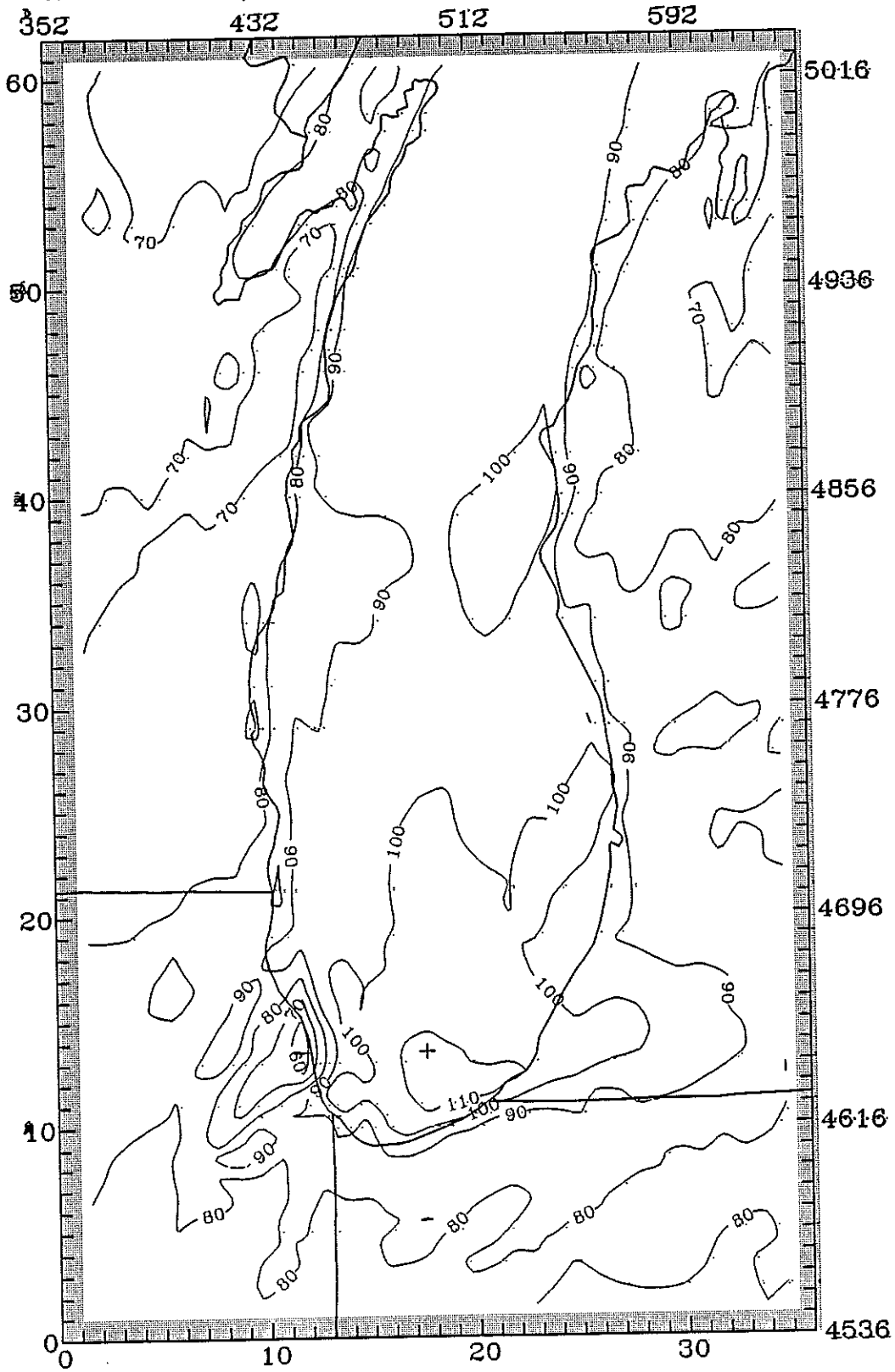


Maximum Simulated Hourly Ozone Concentrations in the LMOB Region.
8 km grid -- July 17, 1991. (.15-19jul91.16-8km.96_noxctrl2). (v1.2t)

1996 Basecase with Grid B Point Source NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 18, 1991

+ MAXIMUM = 115.5 ppb
- MINIMUM = 52.7 ppb

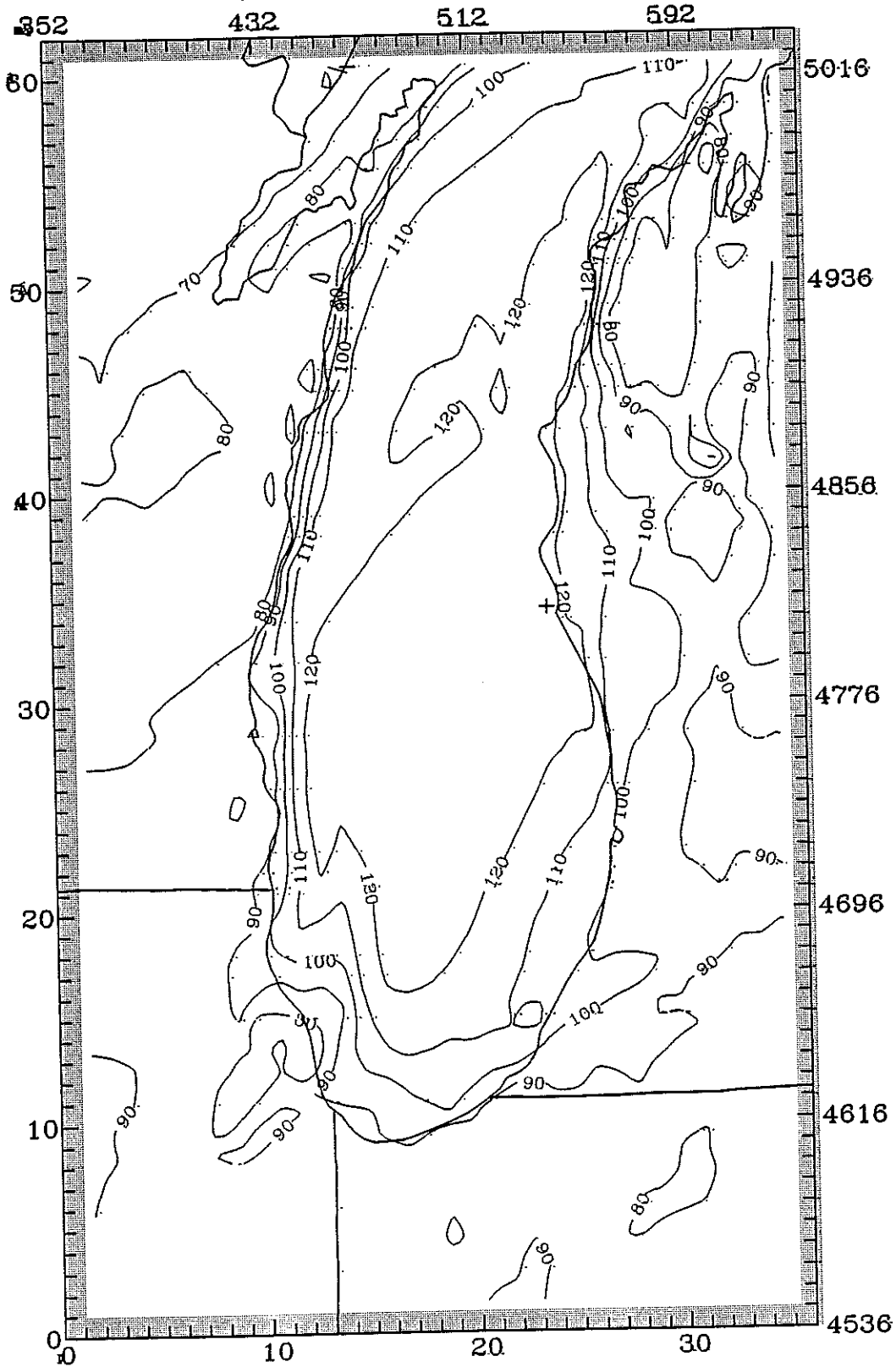


Maximum Simulated Hourly Ozone Concentrations in the LMS Region.
8 km grid -- July 18, 1991. (.15-19jul91.16-8km.96_bothctr12) (v1.21)

1996 Basecase with Grid B aRHC & Point Source NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 19, 1991

+ MAXIMUM = 130.4 ppb
- MINIMUM = 58.6 ppb

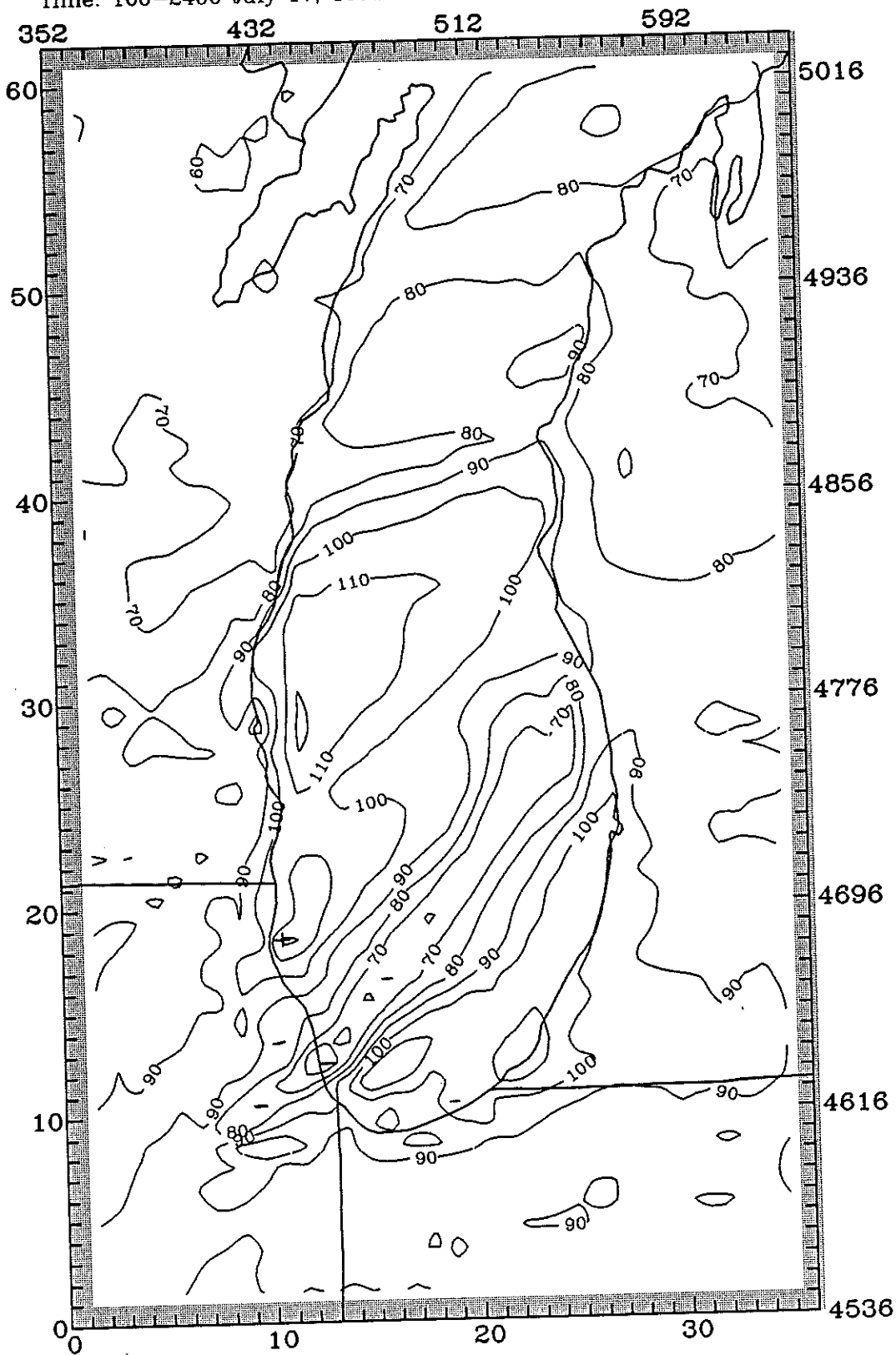


Maximum Simulated Hourly Ozone Concentrations in the LMQS Region.
8 km grid -- July 19, 1991. (.15-19jul91.16-8km.96_bothctr12) (v1.21)

1996 Basecase with Grid B aRHC & Point Source NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 100-2400 July 17, 1991

+ MAXIMUM = 123.2 ppb
- MINIMUM = 49.1 ppb

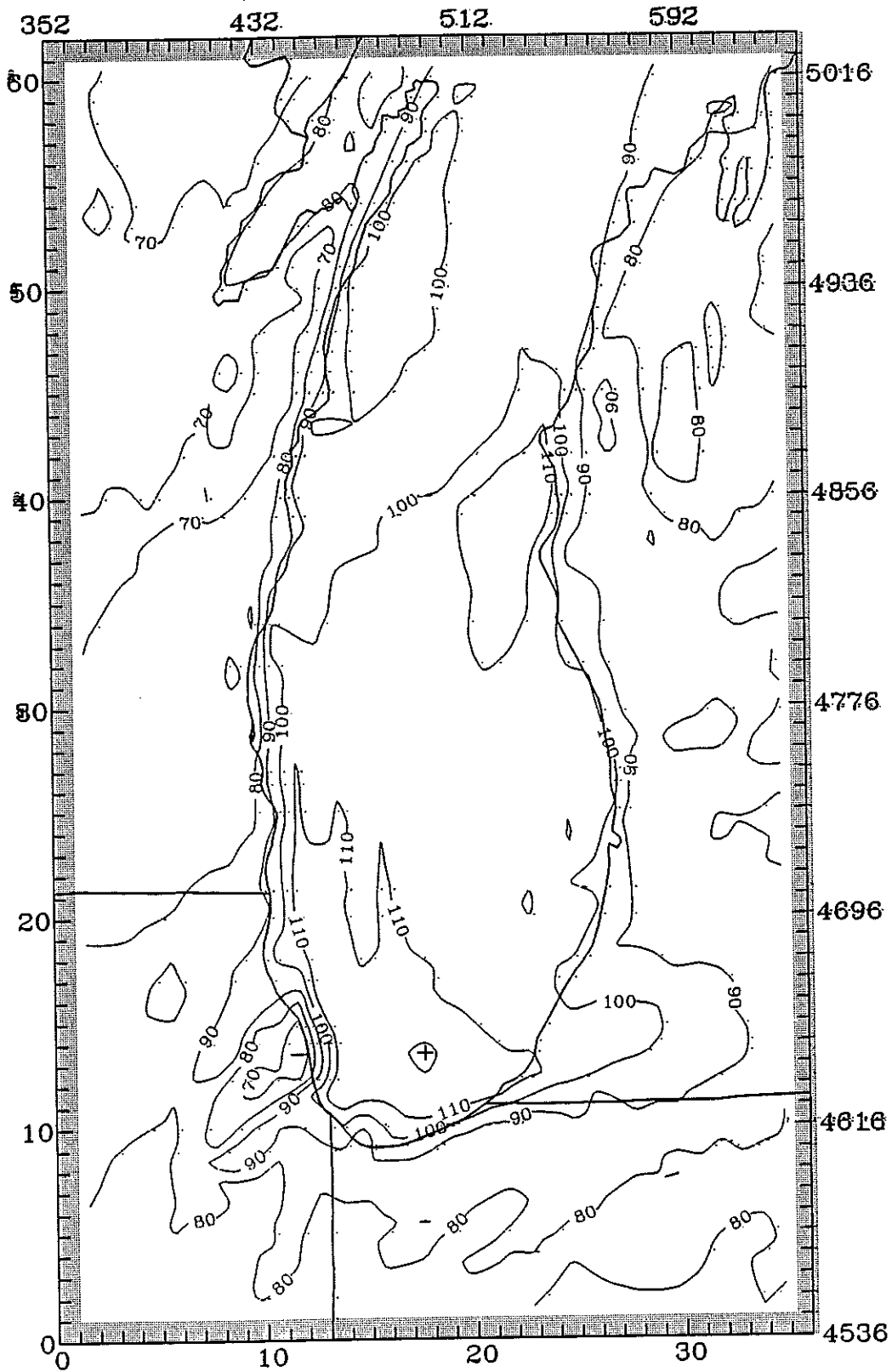


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- July 17, 1991. (.15-19jul91.16-8km.96_bothctrl2) (v1.21)

1996 Basecase with Grid B aRHC & Point Source NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb).
Time: 0-2400 July 18, 1991

+ MAXIMUM = 123.2 ppb
- MINIMUM = 59.1 ppb

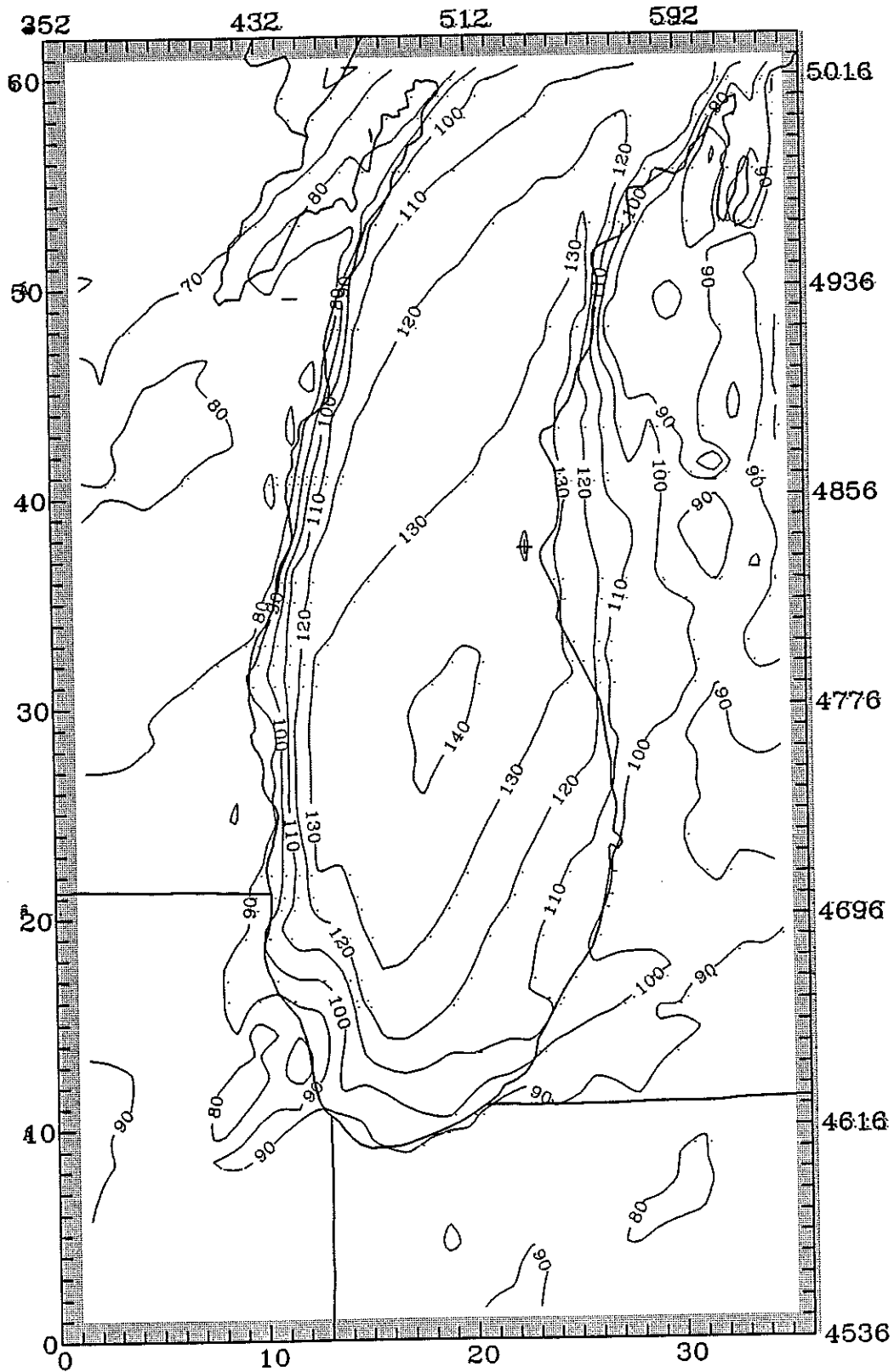


Maximum Simulated Hourly Ozone Concentrations in the LMOS Region
8 km grid -- July 18, 1991. (.15-19jul91.16-8km.96_noxctl2). (v1.21).

1996 Basecase with Grid B Point Source NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
 Time: 0-2400 July 19, 1991

+ MAXIMUM = 141.1 ppb
 - MINIMUM = 58.5 ppb

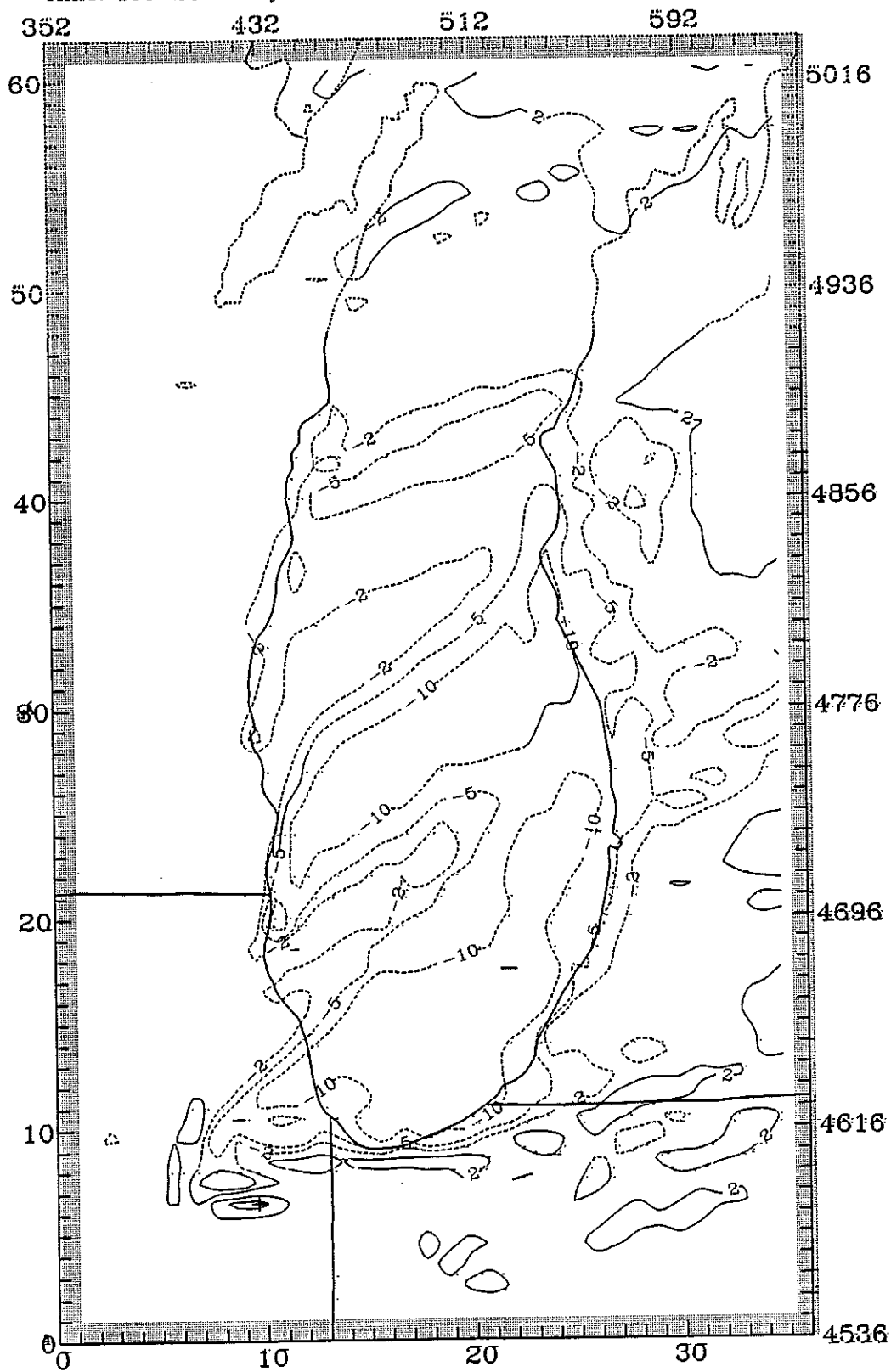


Maximum Simulated Hourly Ozone Concentrations in the LMS Region.
 8 km grid -- July 19, 1991. (.15-19jul91.16-8km.96_max.tr12): (v1.21)

1996 Basecase with Grid B Point Source NOx emissions reduced by 40%.

LEVEL 1 Ozone (ppb)
Time: 100-2400 July 17, 1991

+ MAXIMUM = 6.4 ppb
- MINIMUM = -19.9 ppb



Simulated Maximum Ozone Differences: XY map
in the LMOS Region (8 km grid) on July 17, 1991.

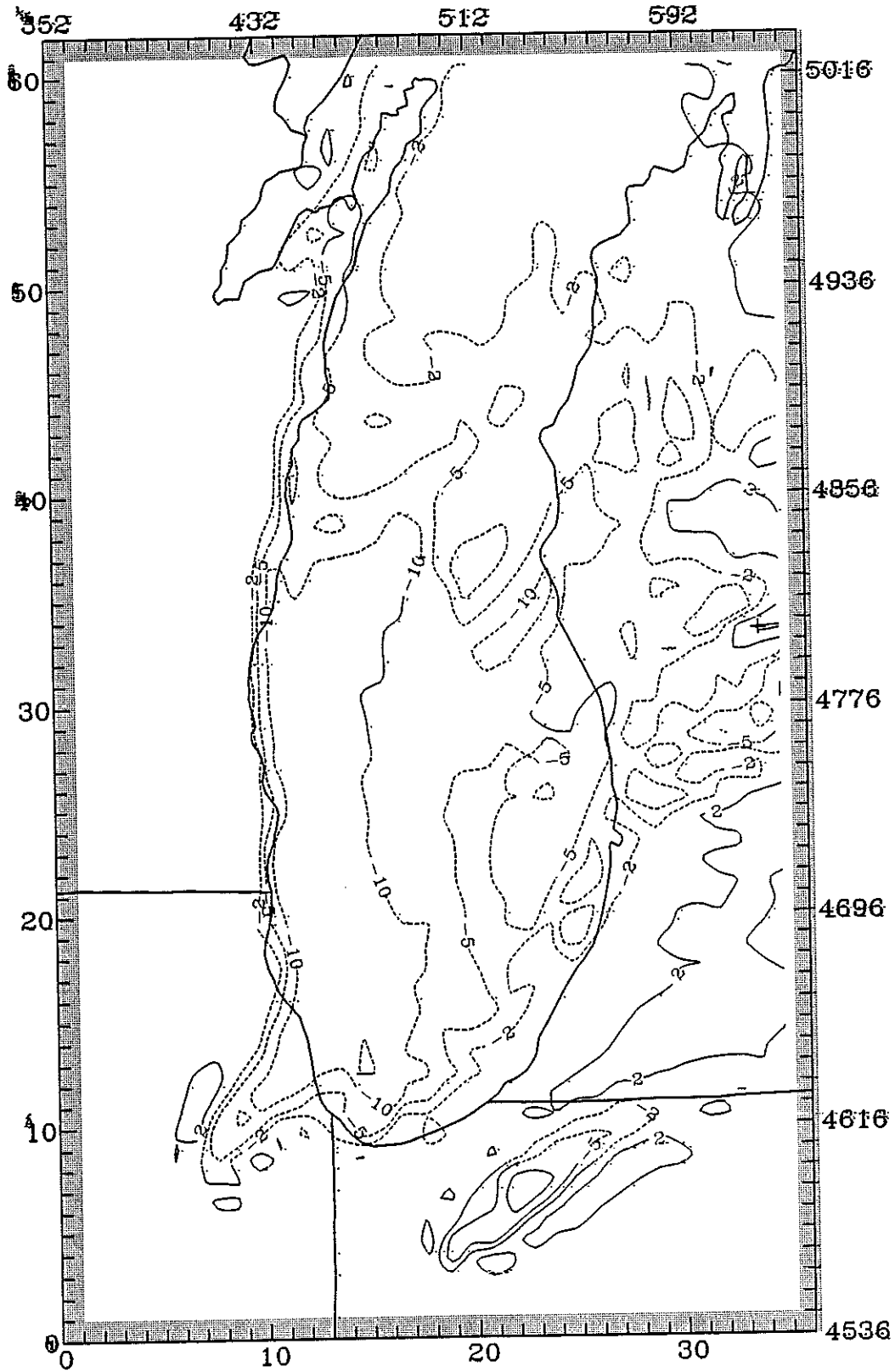
(96_base - 96_noxctr12) [effect of 40% Grid B Point Source NOx control]

LEVEL 1 Ozone (ppb)

Time: 0-2400 July 18, 1991

+ MAXIMUM = 5.8 ppb

- MINIMUM = -22.4 ppb

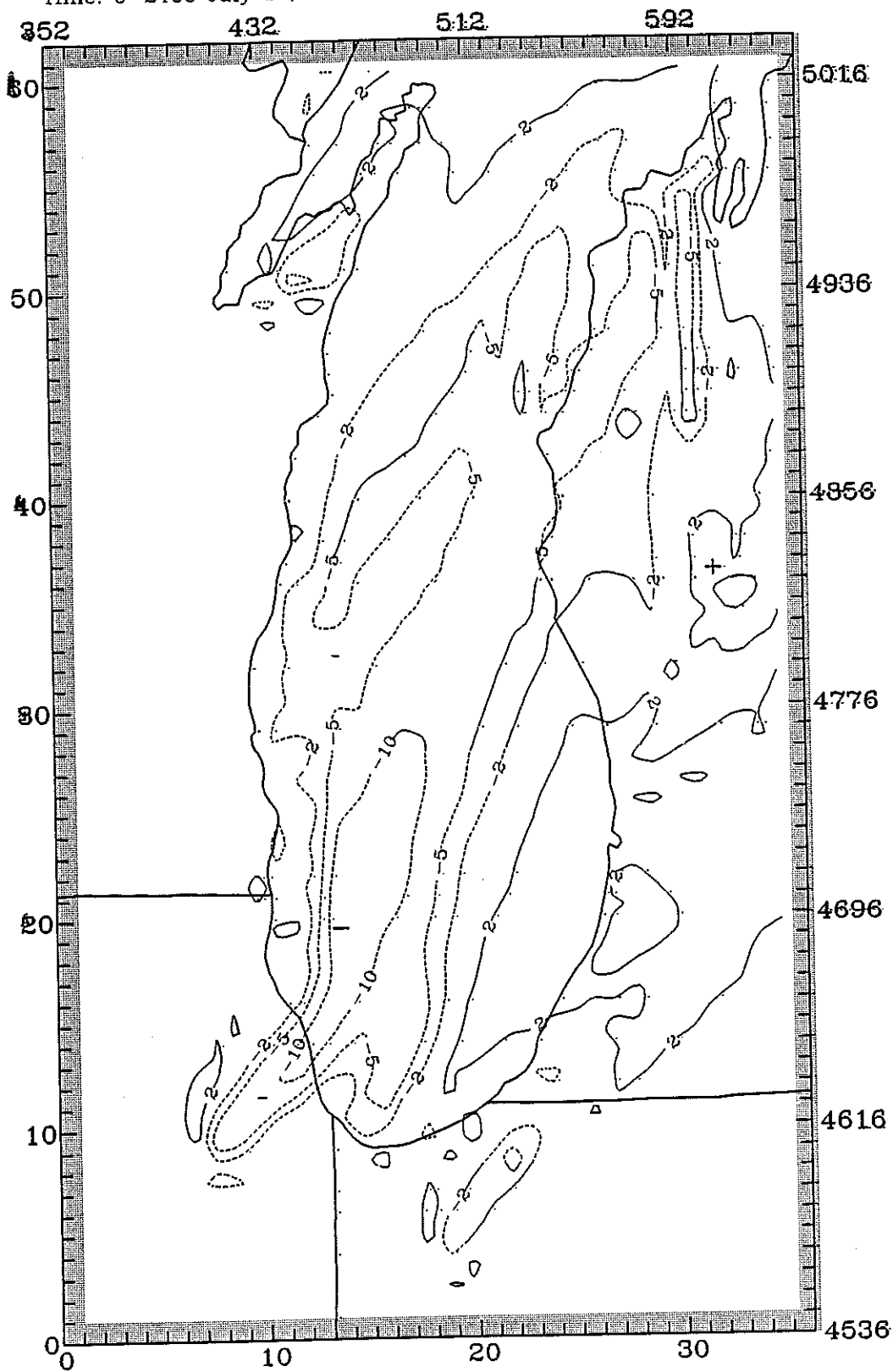


Simulated Maximum Ozone Differences: XY map
in the LMOS Region (8 km grid) on July 18, 1991.

(96_base - 96_noxctrl2) [effect of 40% Grid B Point Source NOx control]

LEVEL 1 Ozone (ppb)
Time: 0-2400 July 19, 1991

+ MAXIMUM = 5.3 ppb
- MINIMUM = -16.1 ppb



Simulated Maximum Ozone Differences: XY map
in the LMOS Region (8 km grid) on July 19, 1991.

(96_base - 96_noxctrl2) [effect of 40% Grid B Point Source NOx control]