

The Impact of Different Satellite Altimeter Gravity Anomaly Data Sets on Geoid Height Models

by

Dru Smith, Ph.D.

National Geodetic Survey

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QUESTIONS LEADING TO THIS STUDY

1) What systematic differences exist between altimetric Δg data sets derived from identical altimeters?

2) What is the impact of those systematic Δg differences on geoid undulation models?

ALTIMETRIC DATA

Three Altimetric Gravity Anomaly Data Sets are investigated (All based on Geosat/ERS-1):

1) **Sandwell/Smith 6.2**, 1996, ~3' grid

(SS 6.2 grid currently unavailable publicly)

2) **Sandwell/Smith 7.2**, 1997, ~2' grid

(SS 7.2 grid at: ftp://baltica.ucsd.edu/pub/global_grav_2min)

3) **Kort & Matrikelstyrelsen**, 1997, ~4' grid

(KMS grid at : <ftp://www.kms.min.dk/incoming/GRAVITY>)

These are each separately combined with **terrestrial** and **ship** gravity measurements and gridded at 2' to form our three Δg test grids.

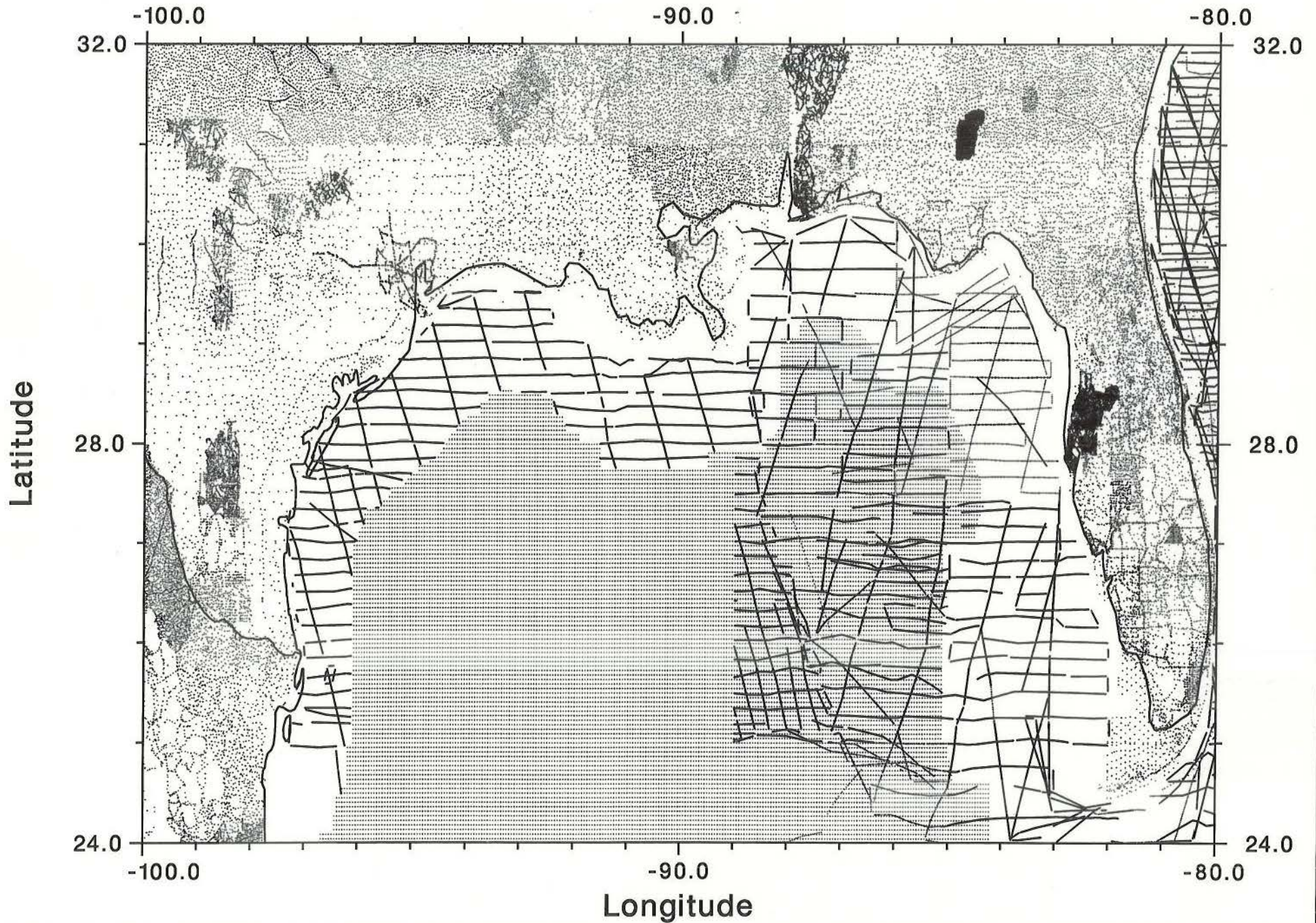
Altimetry was used only if the points were 100+ km from shore, and the depth exceeded 500 m.

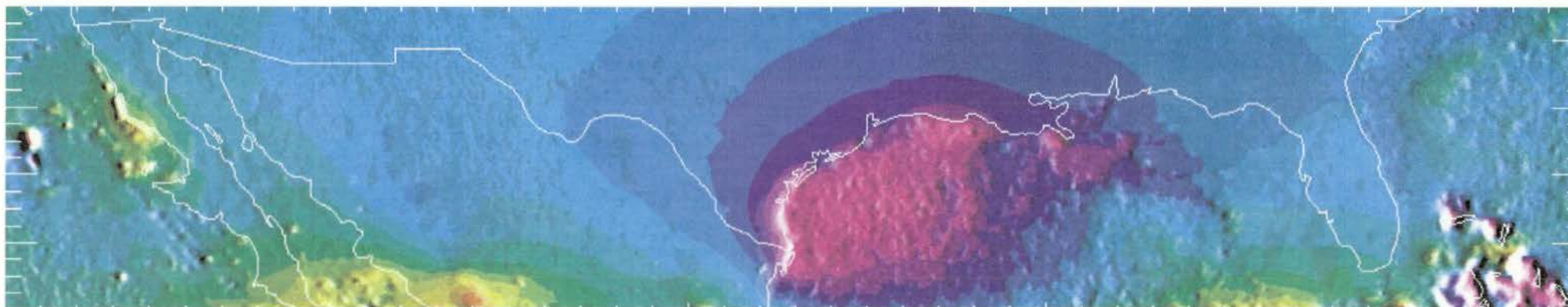
The final 2' grids were computed using 2-Dimensional splines in tension($T = 0.75$).

Due to a lack of reliable data in the Bahamas, all three Δg sets were given identical Δg values in the Bahamas.

Below: A sample of how altimetric Δg 's were combined with terrestrial/ship measurements.

Gravity/Altimetry coverage (SS 6.2)

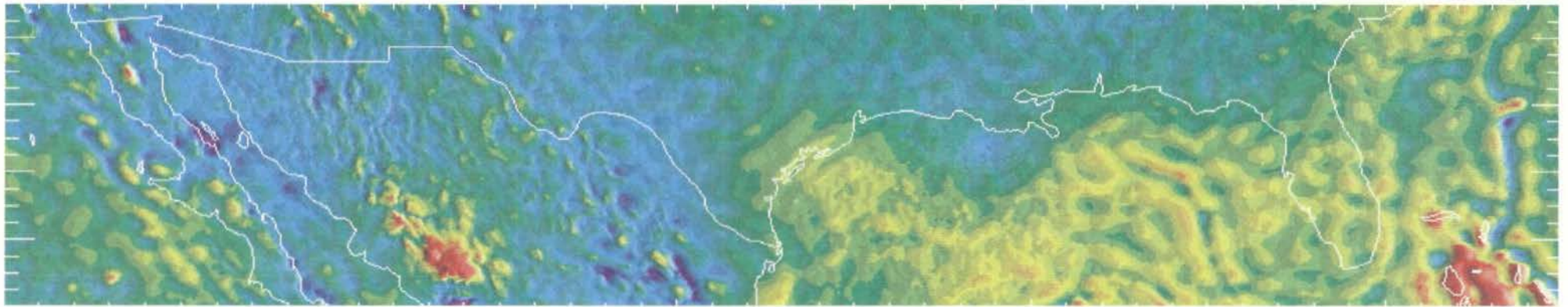




-2.266/+0.790

-25/+0.5
(-1/+1 delta)

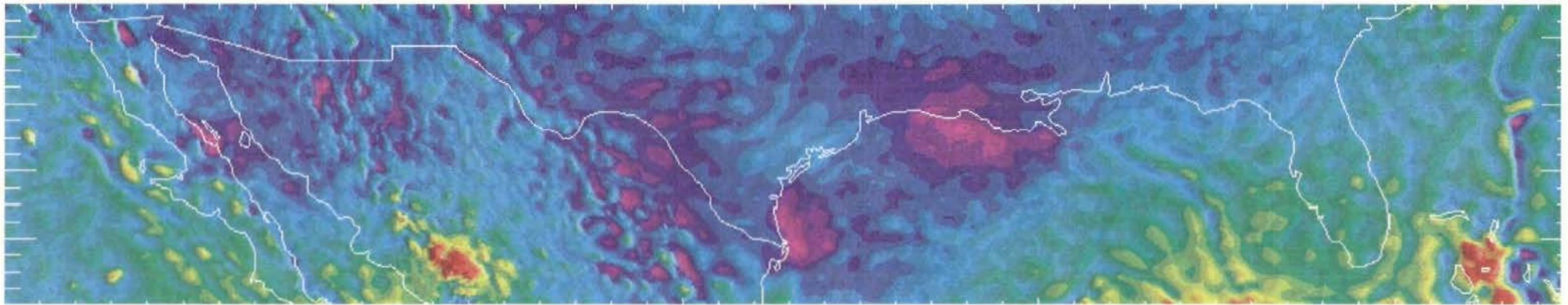
dif. max 97-99.555. overlap. 2.b



-1.322 / +3.344

$\pm 1.5, \pm 0.7$

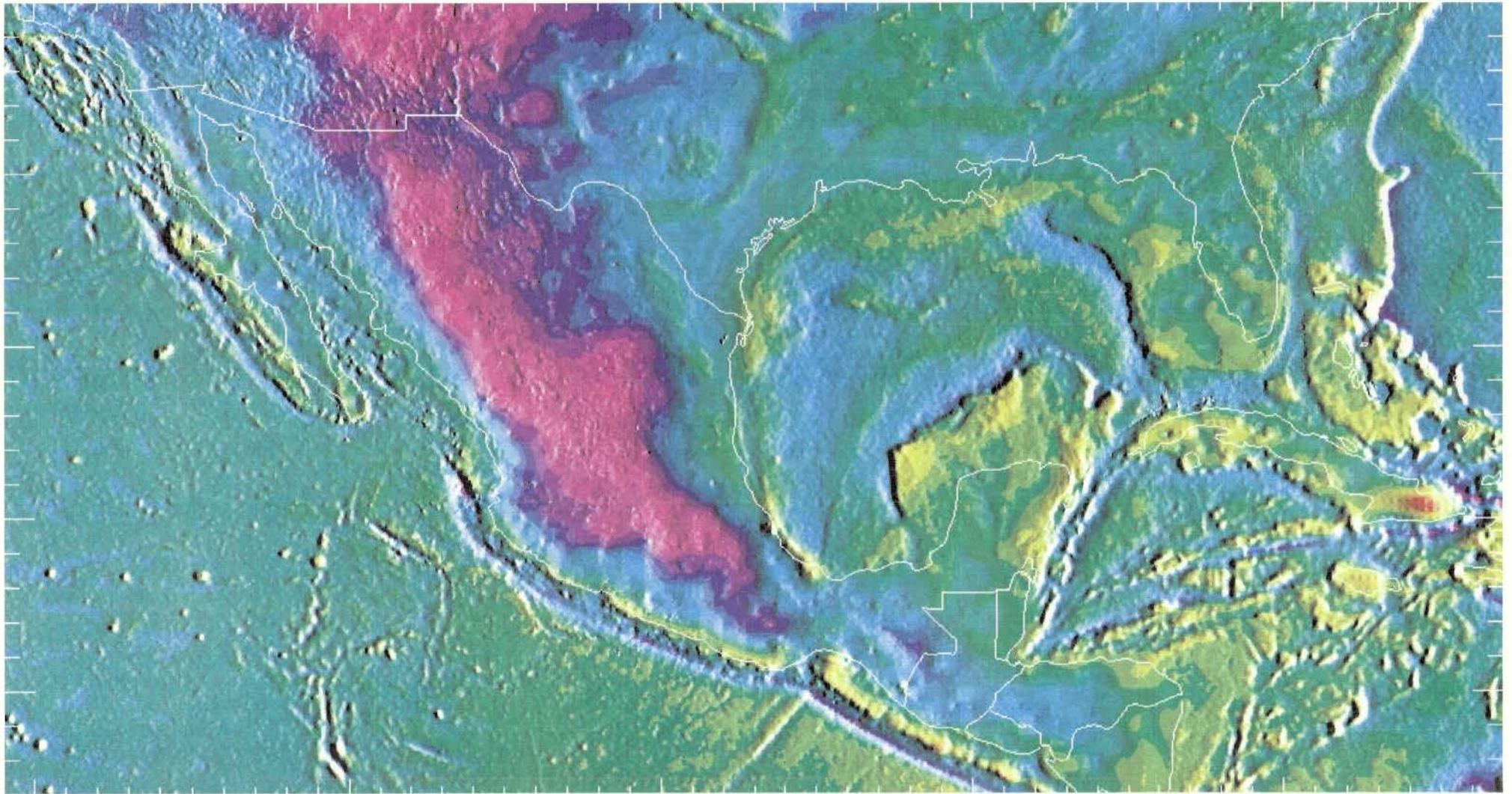
grav96.undres.overlap. b



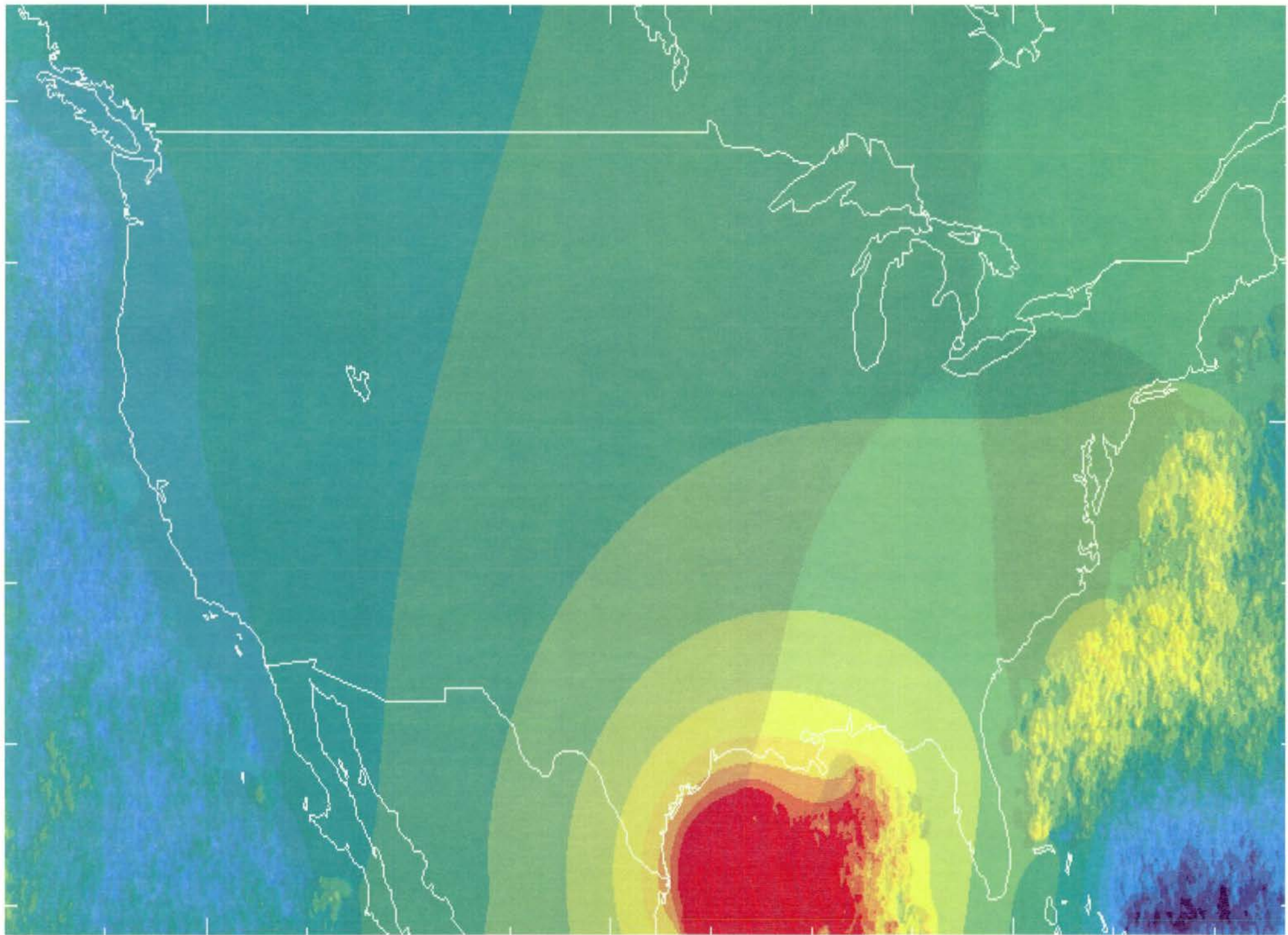
-1.457 / +2.791

± 1.5
(± 0.7 delta)

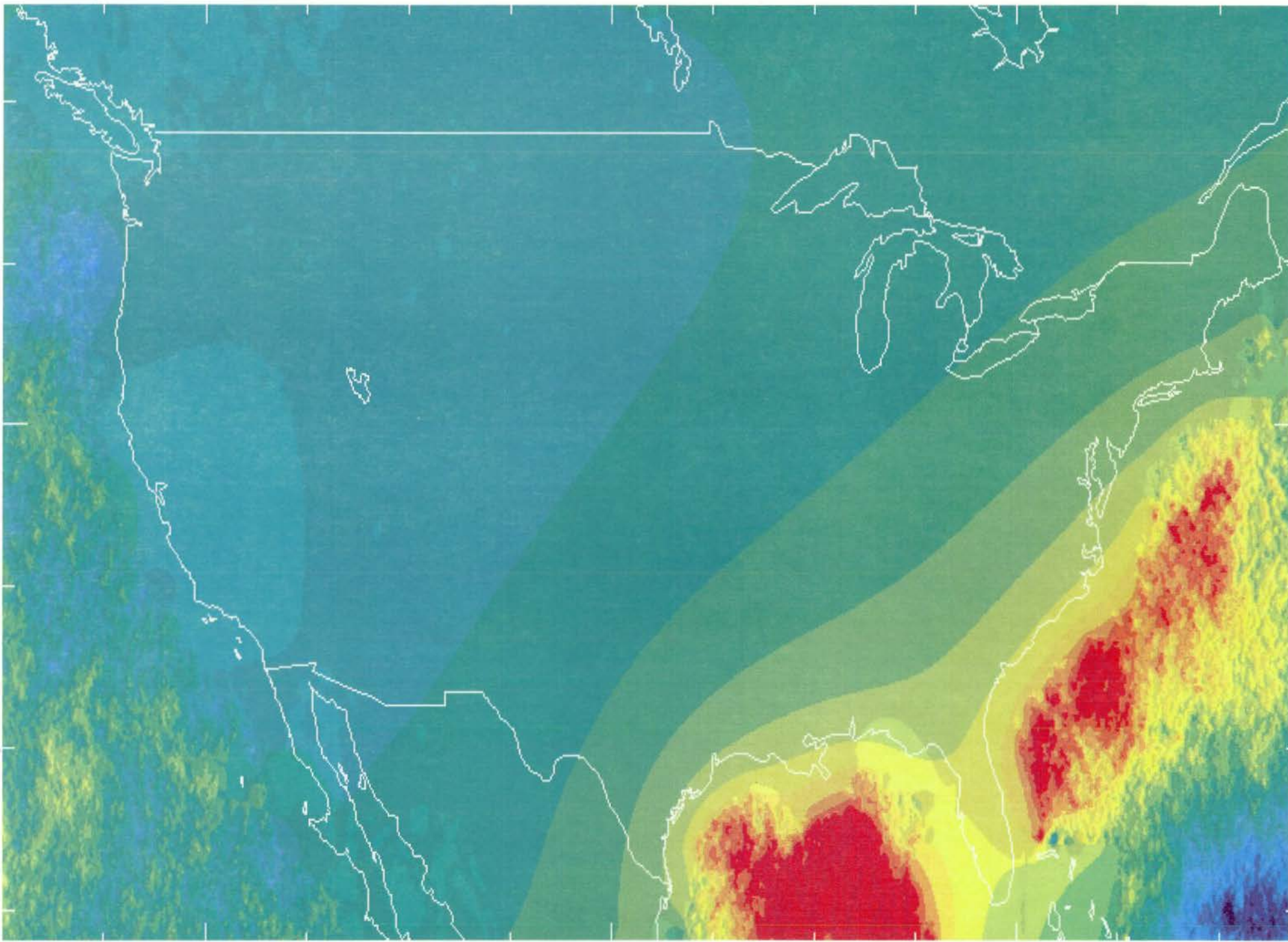
max97, undres22-overlap.cps



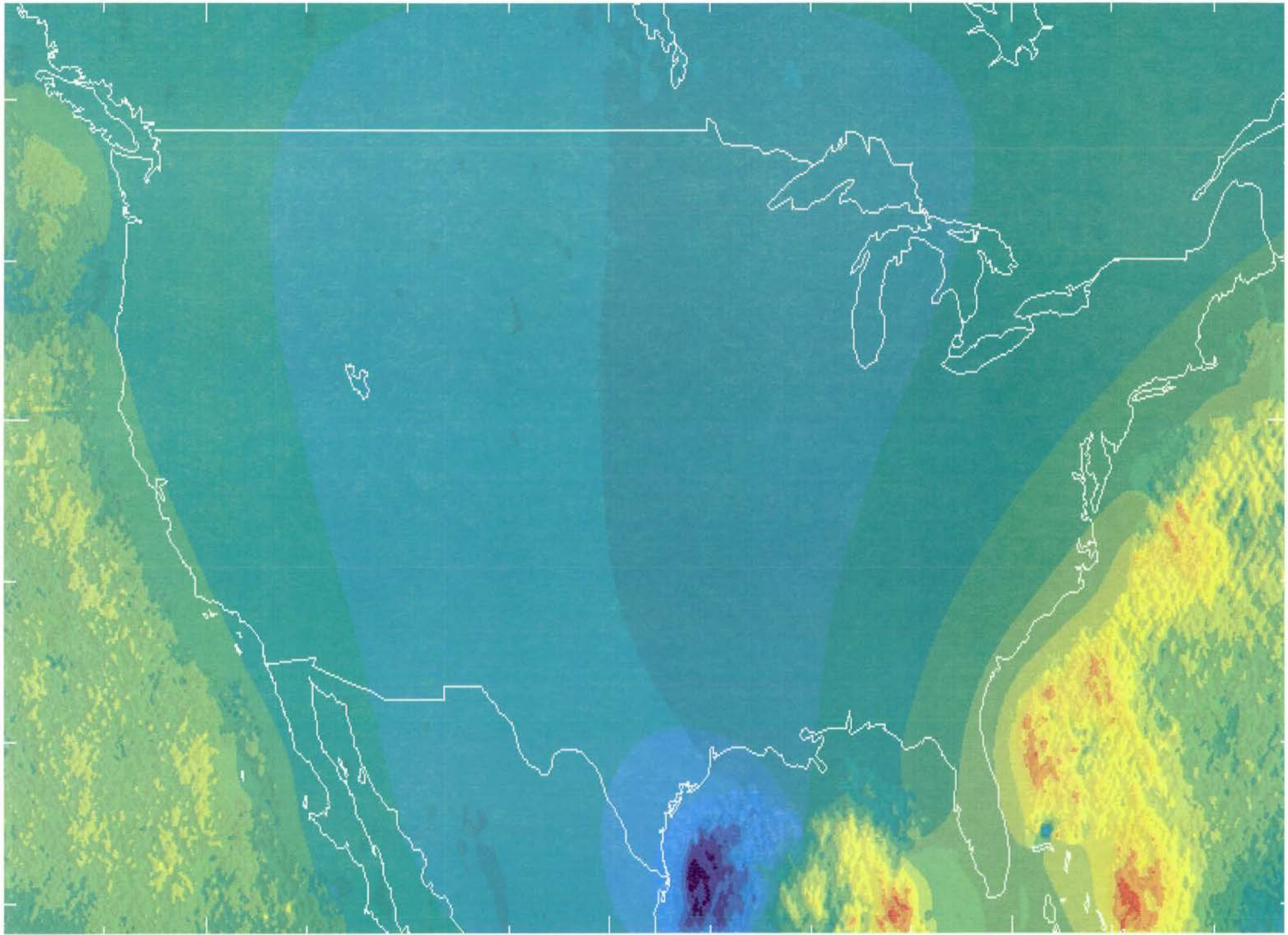
N: 556.2 - 55 7.2 ±50 cm



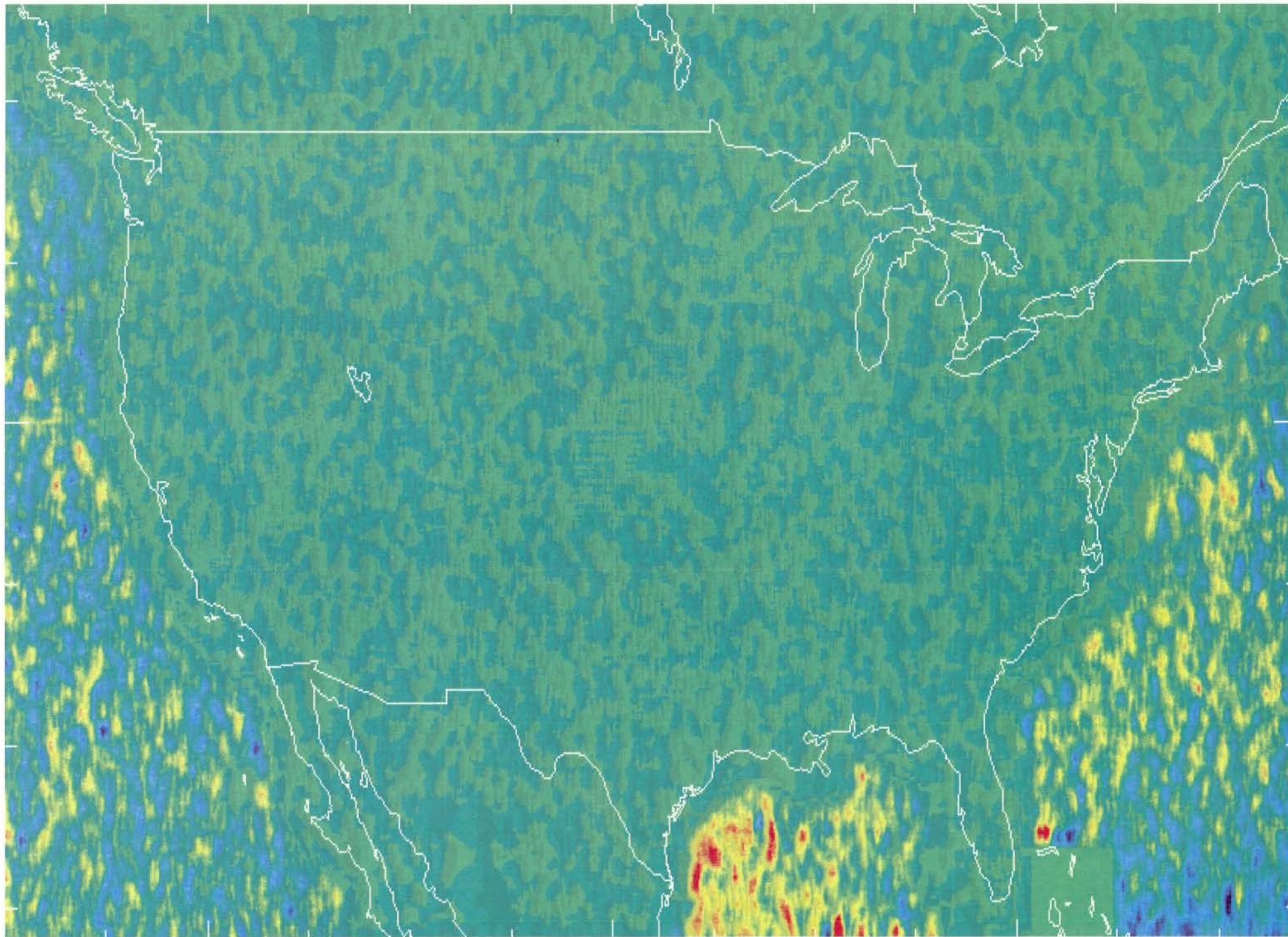
Ni SS 6.2 - KMS ± 50 cm



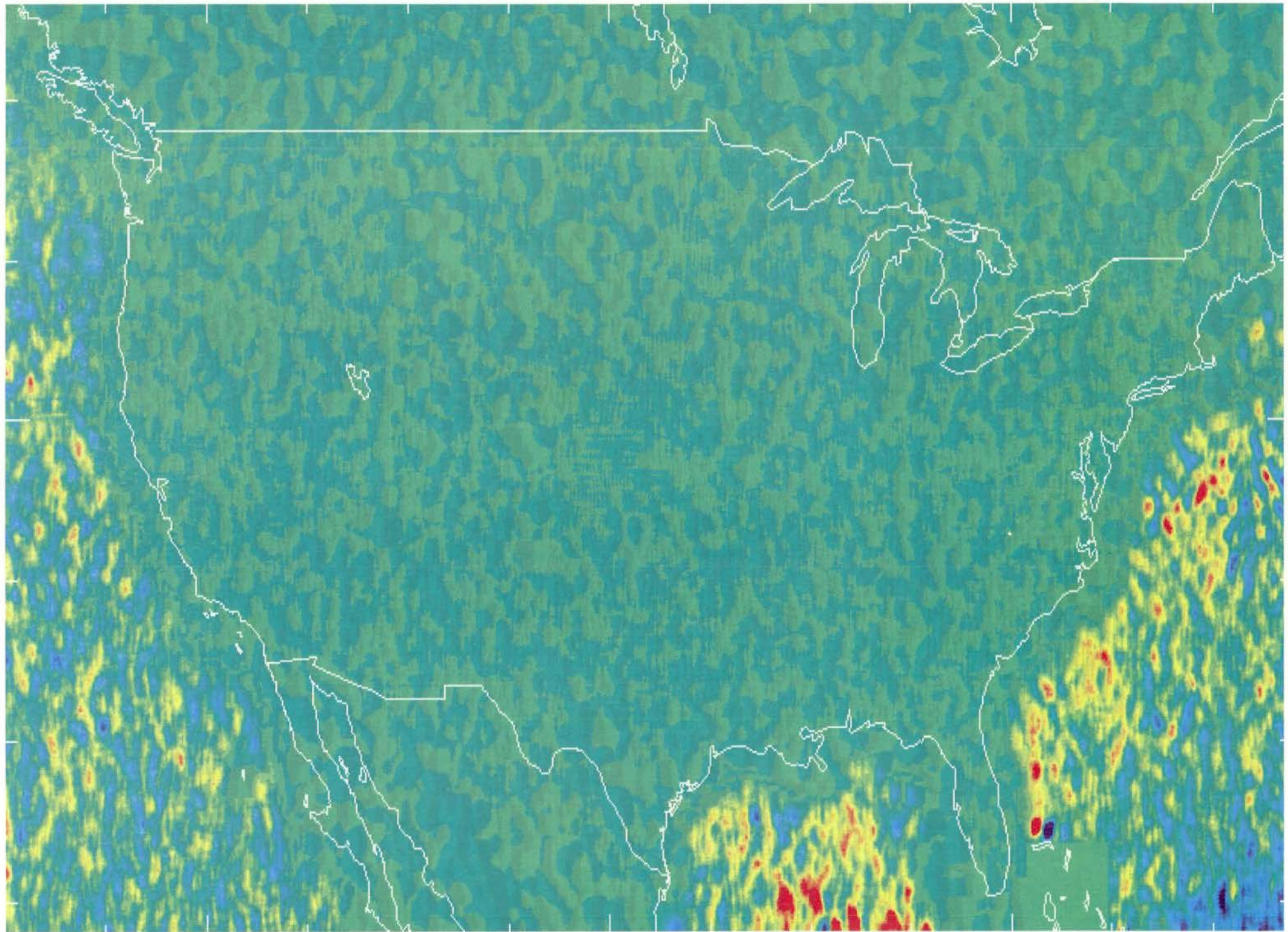
N: ss 7.2 - KMS ± 50 cm



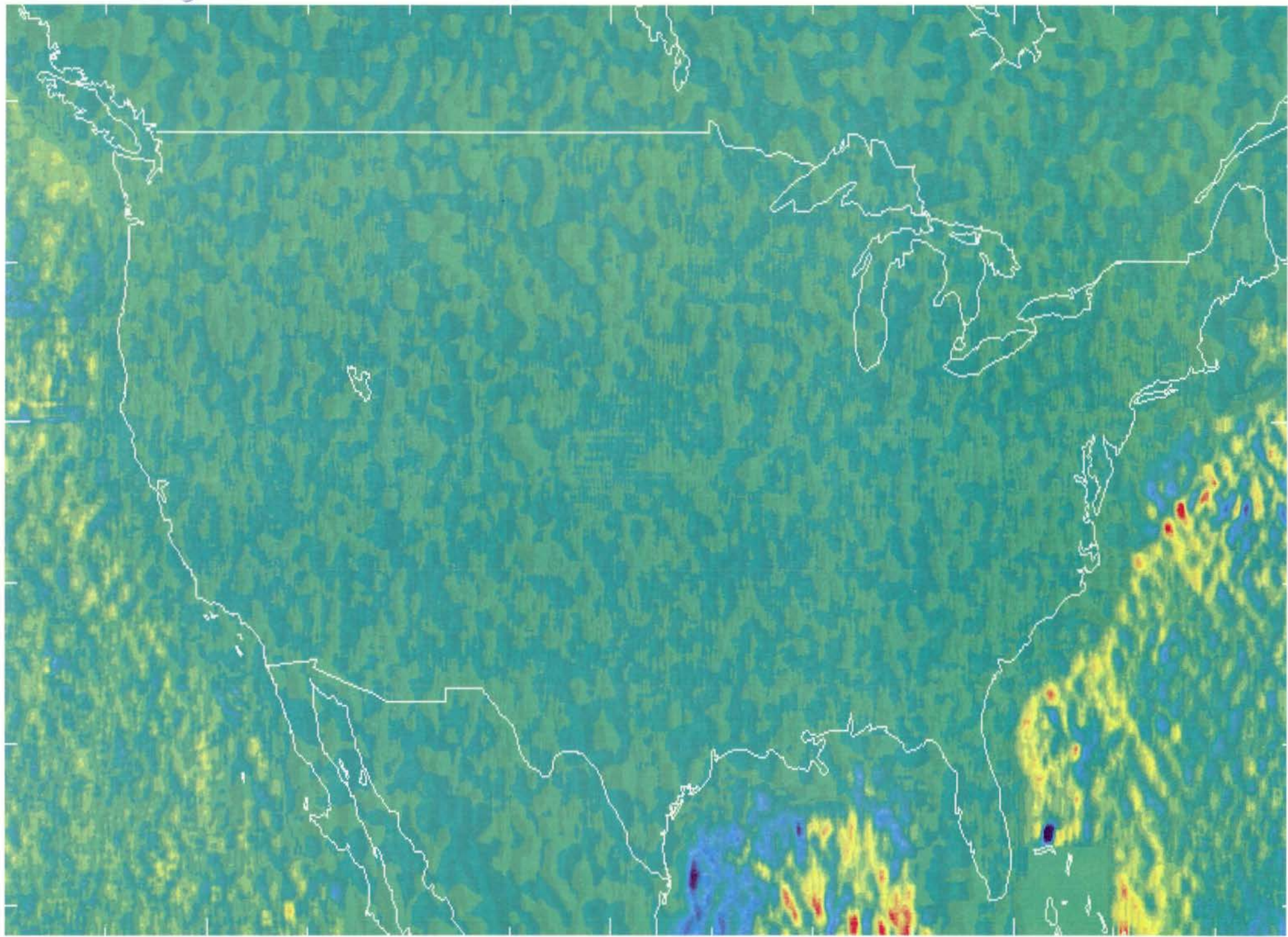
Δg : SS 6.2 - SS 7.2 ± 5 mgals



Δg : SS 6.2 - KMS ± 5 mgals



$\Delta g: SS 7.2 - KMS \pm 5 \text{ mgals}$

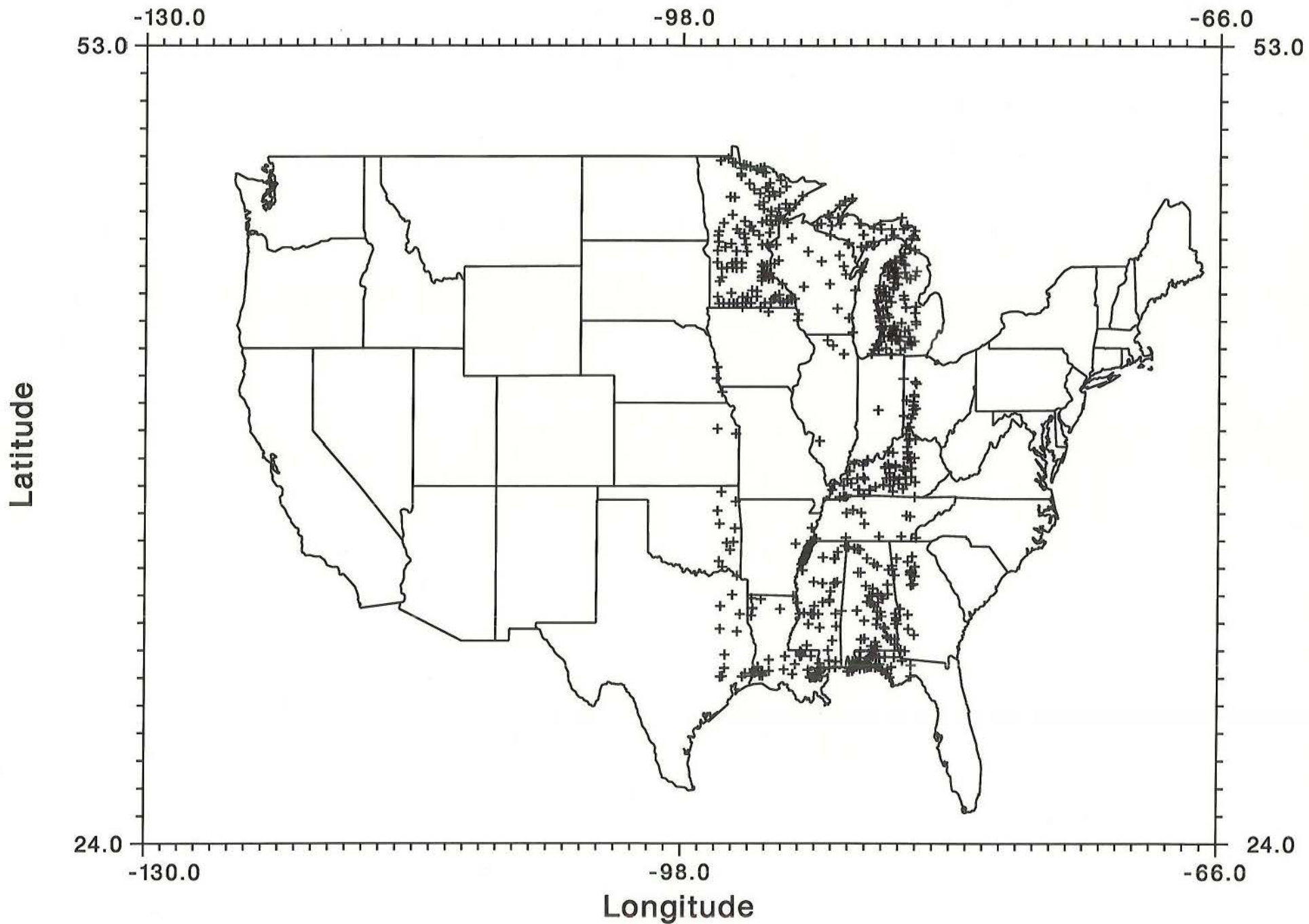


SYSTEMATIC DIFFERENCES

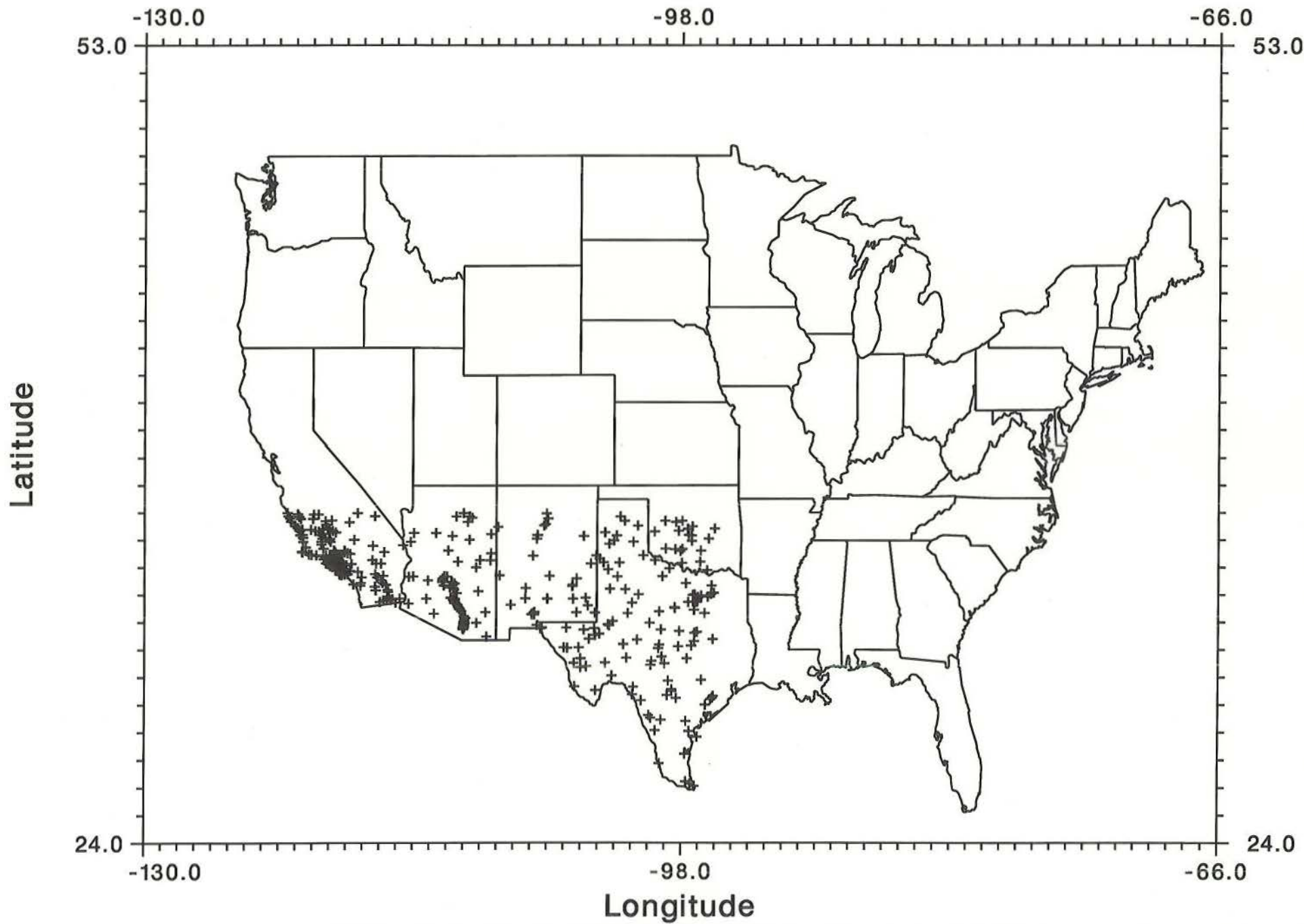
Above: Δg differences using S/S 6.2 vs. S/S 7.2 *appear* as noise at the 2' grid level.

Below: Δg differences for all three data combinations, *smoothed using a 30' running average filter* show more clearly the systematic differences between data sets (predominantly in the Gulf of Mexico and Gulf Stream regions).

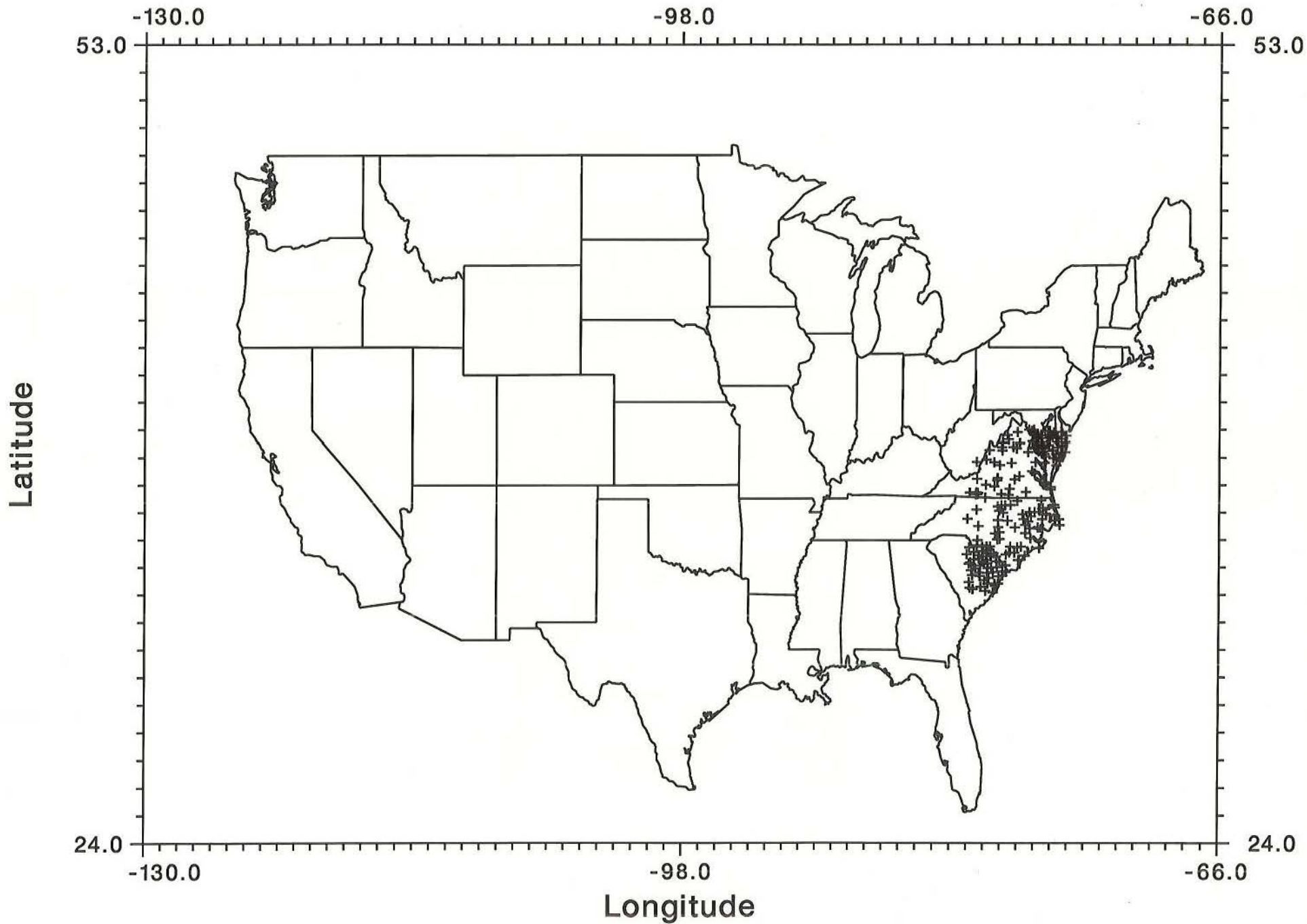
res_t1.flmn.t



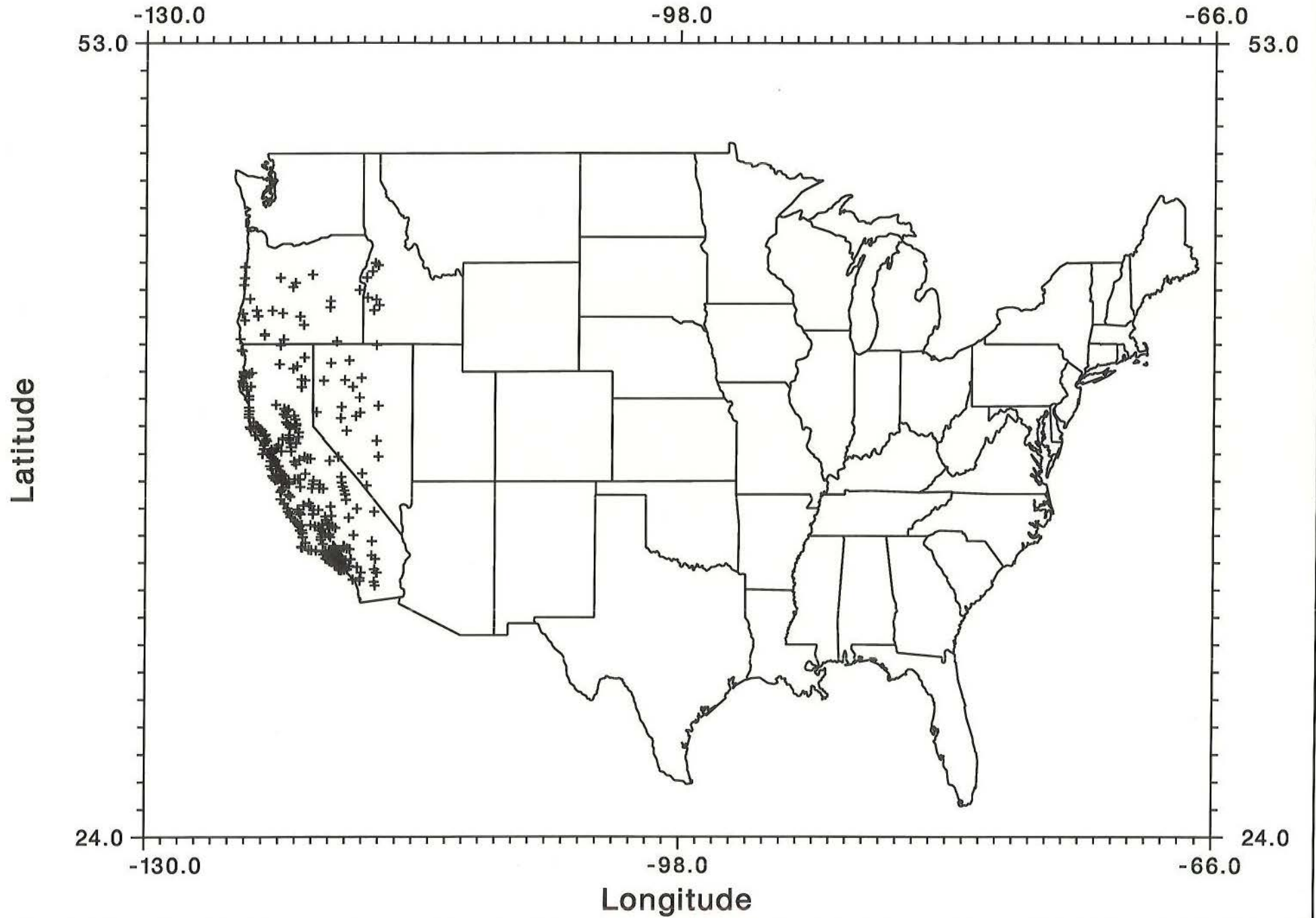
res_t1.txca.t



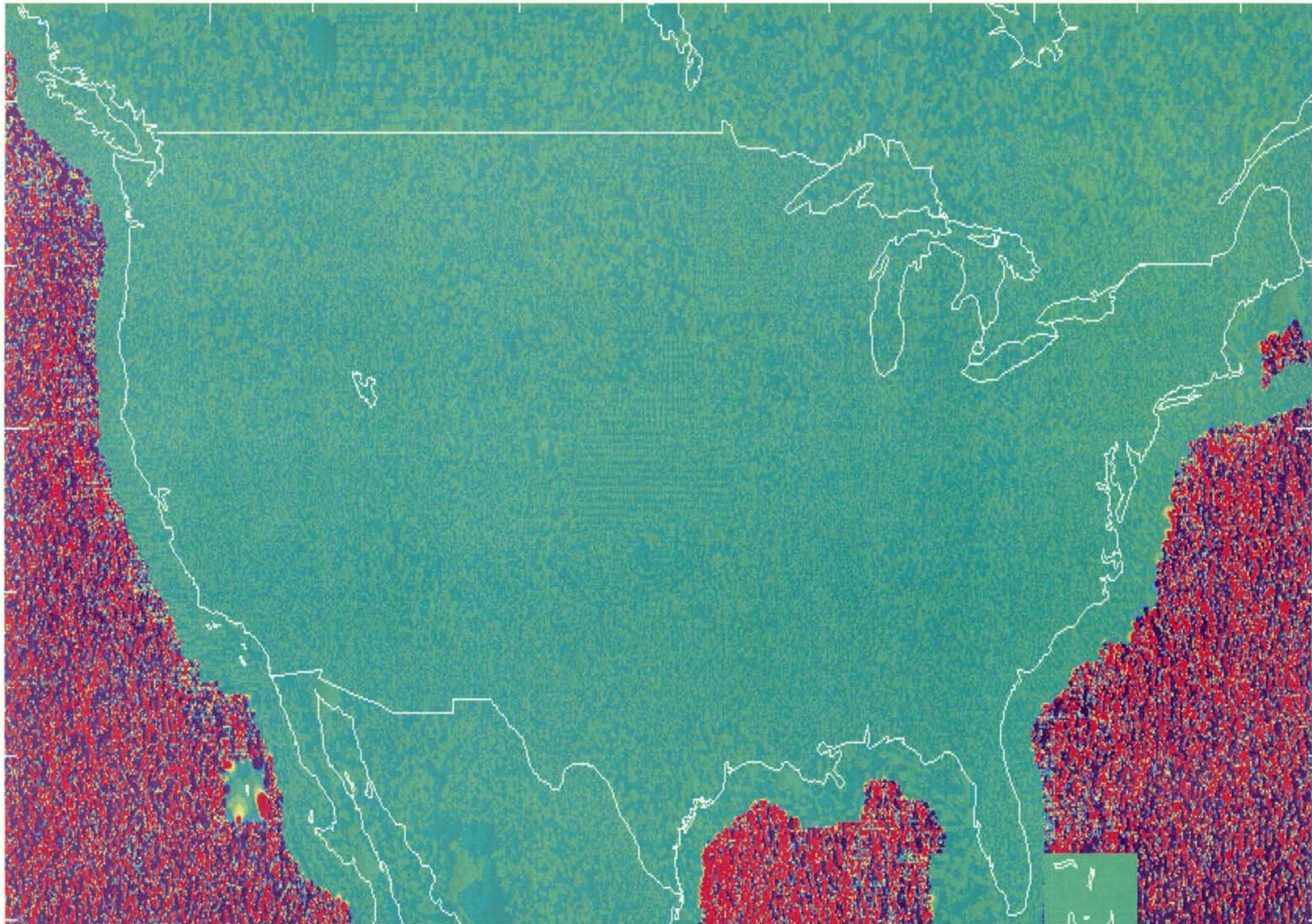
res_t1.ecoast.t



res_t1.wcoast.t



$\Delta g(\text{S/S } 6.2)$ minus $\Delta g(\text{S/S } 7.2)$

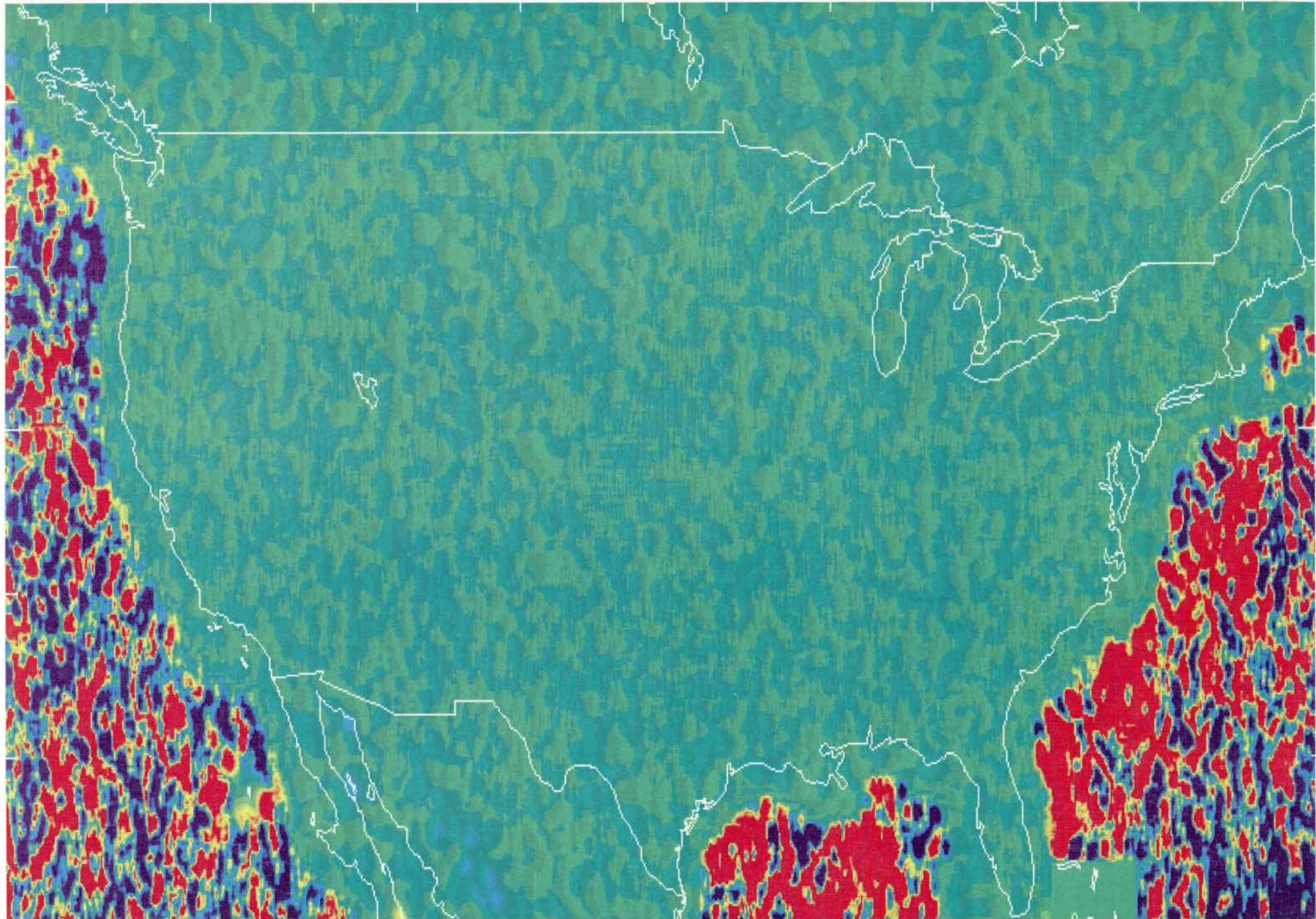


SYSTEMATIC DIFFERENCES

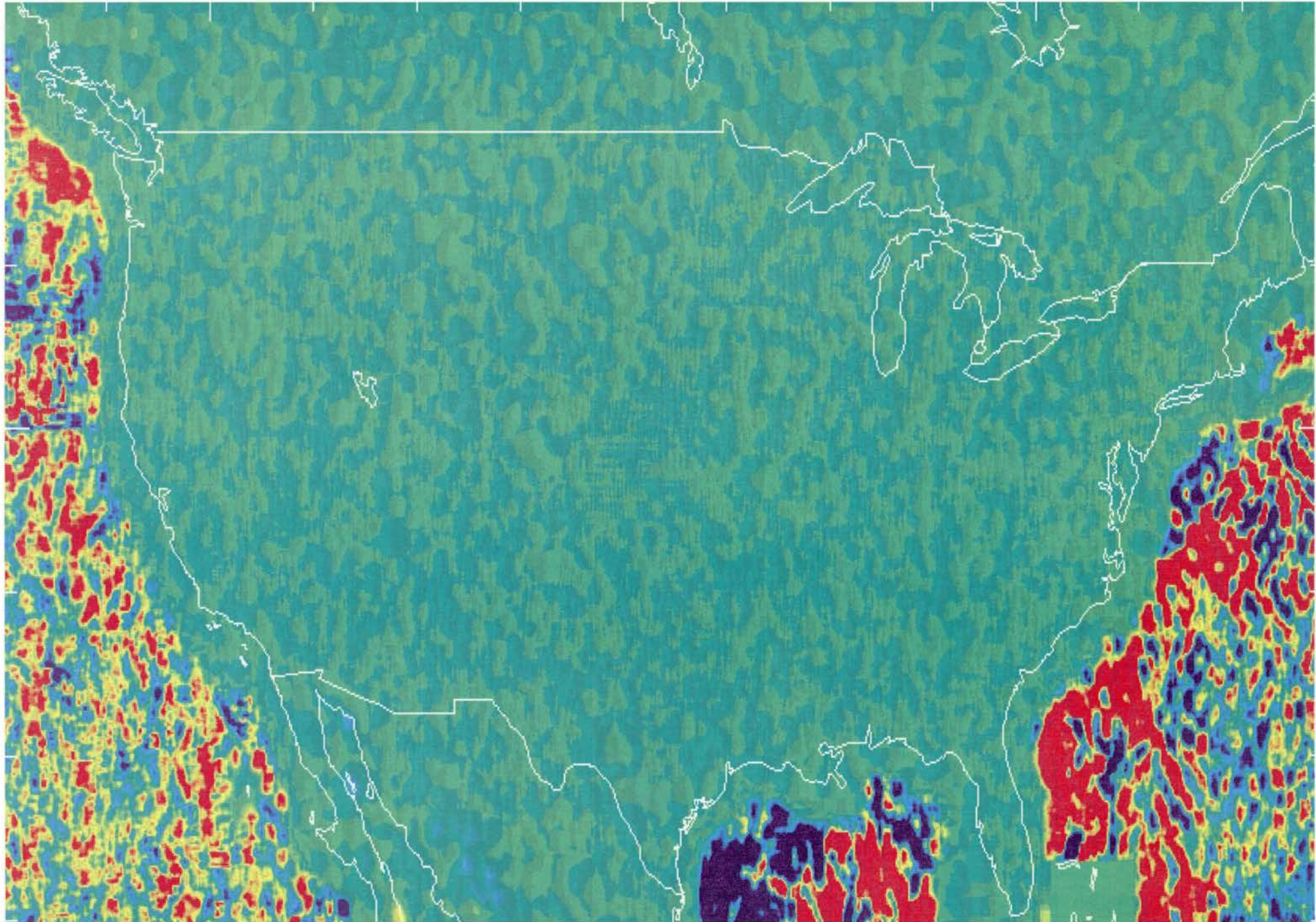
Left: Δg differences using S/S 6.2 vs. S/S 7.2 *appear* as noise at the 2' grid level.

Below: Δg differences for all three data combinations, *smoothed using a 30' running average filter* show more clearly the systematic differences between data sets (predominantly in the Gulf of Mexico and Gulf Stream regions).

$\Delta g(\text{SS } 6.2)$ minus $\Delta g(\text{KMS})$ [filtered]



$\Delta g(\text{SS } 7.2)$ minus $\Delta g(\text{KMS})$ [filtered]

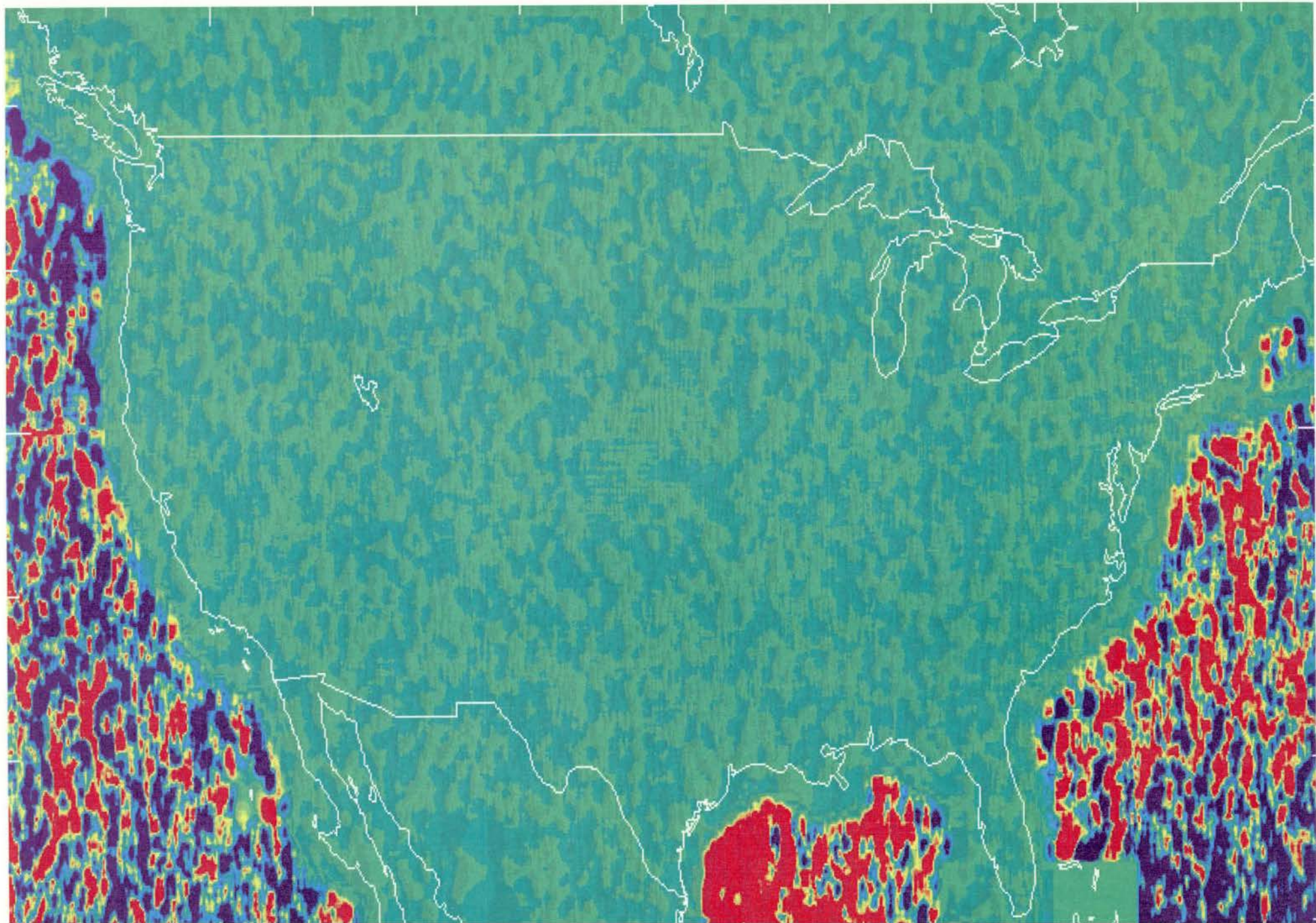


CONVERSION TO GEOID UNDULATIONS

Δg values are converted to geoid undulations (N) using a Fourier based Stokes' integration. EGM96 is used in the remove-compute-restore procedure.

Below: Differences between the three geoid models (from the the three Δg sets) are shown. Note especially the significant *tilts* between the models, deep inside the continent, as a result of *only* changing the altimetric gravity anomalies. (Remember, all three Δg sets come from Geosat/ERS-1).

$\Delta g(\text{SS } 6.2)$ minus $\Delta g(\text{SS } 7.2)$ [filtered]





<-1

>+1

mgal

mgal



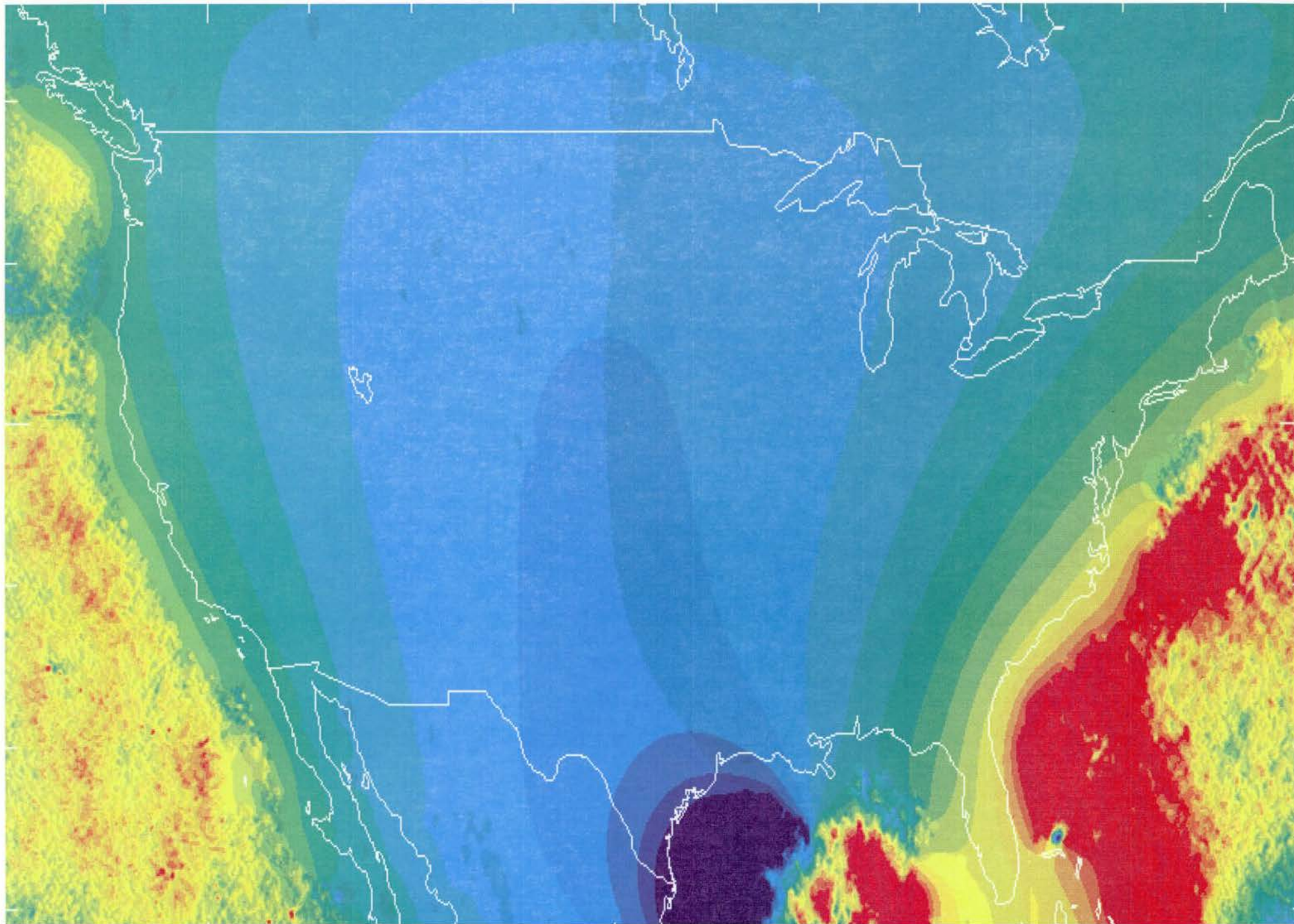
<-20

>+20

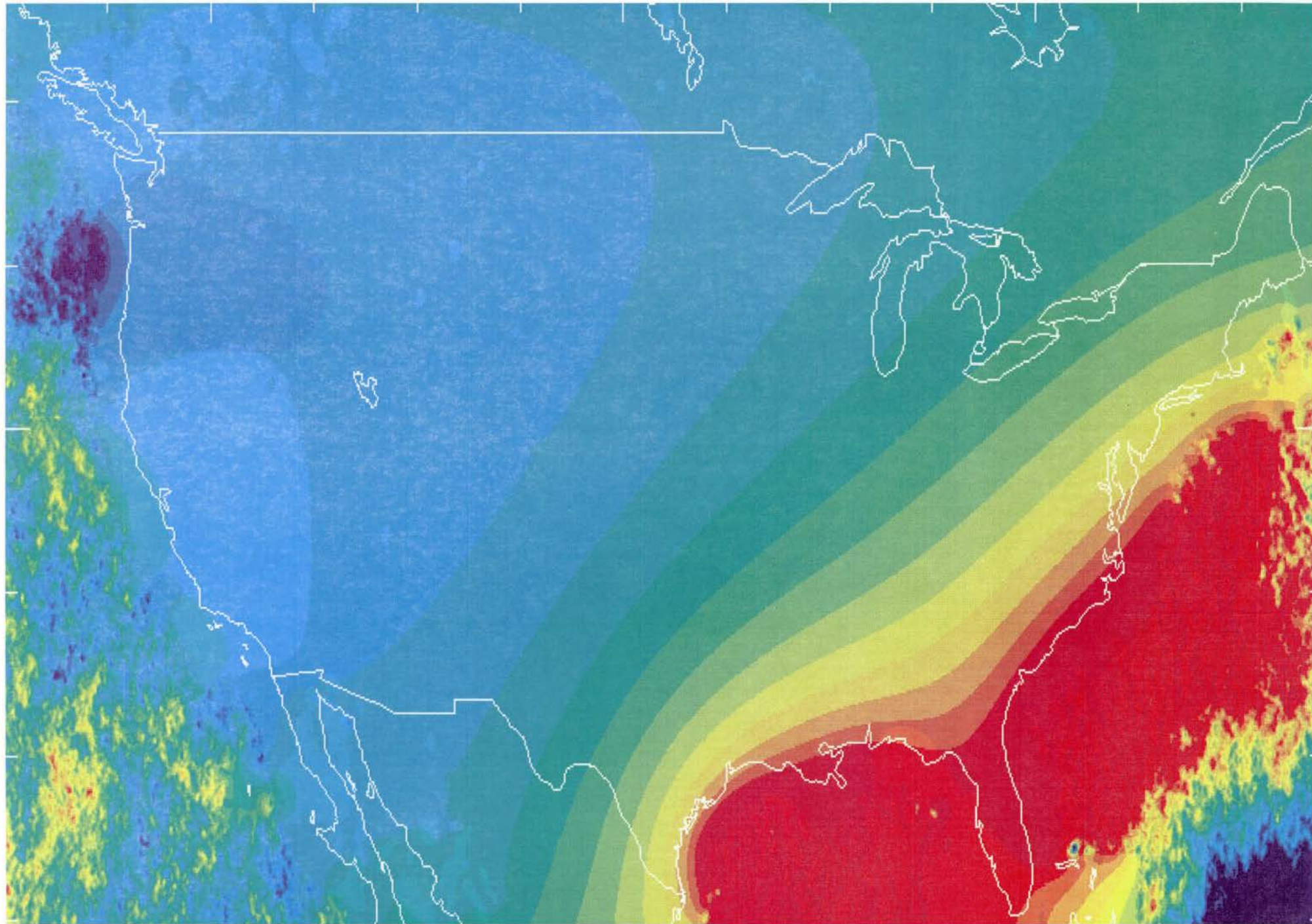
cm

cm

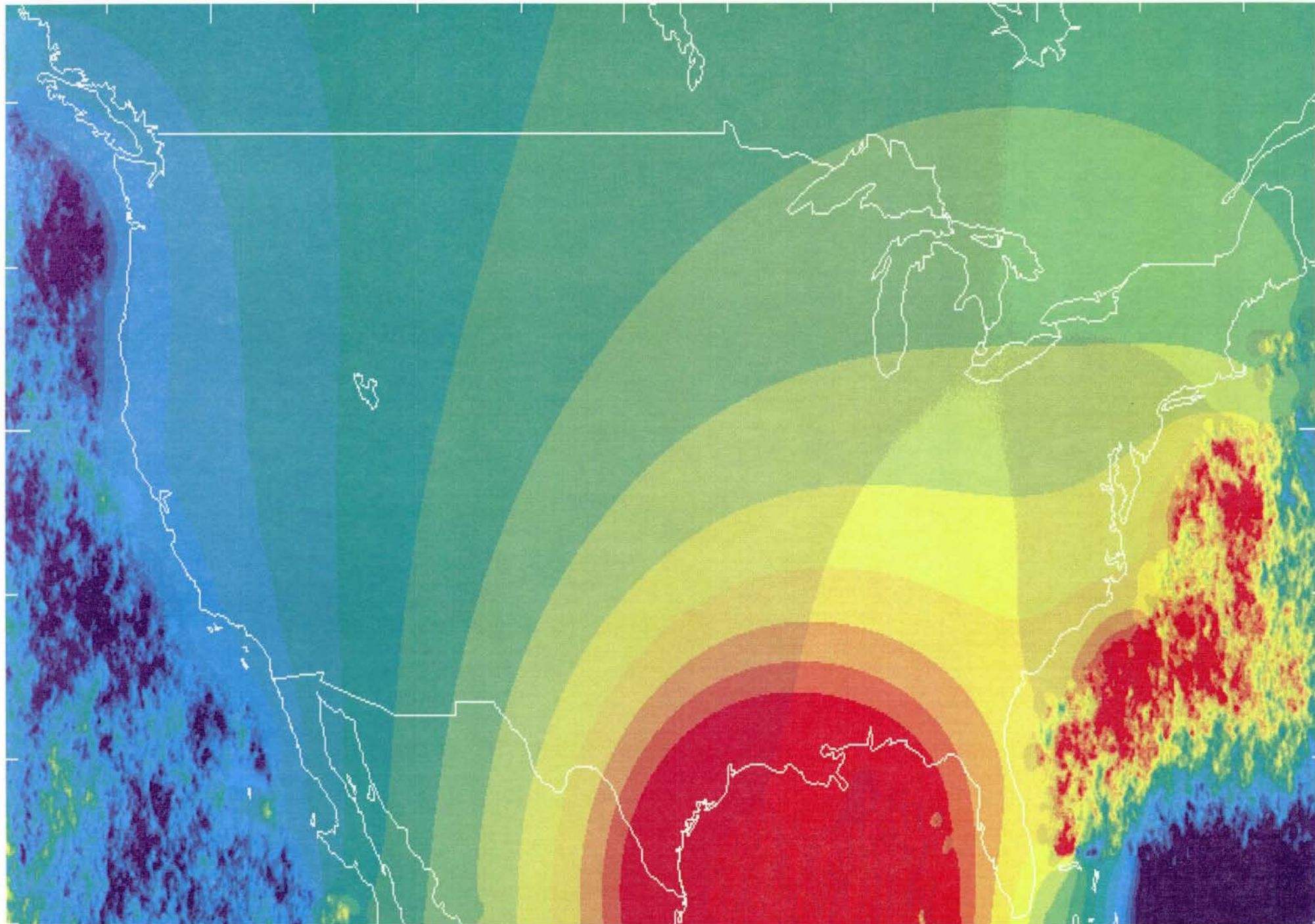
$N(\text{SS } 7.2) \text{ minus } N(\text{KMS})$



$N(\text{SS } 6.2) \text{ minus } N(\text{KMS})$



$N(SS\ 6.2)$ minus $N(SS\ 7.2)$



MAGNITUDE OF TILTS (ppm/azimuth)

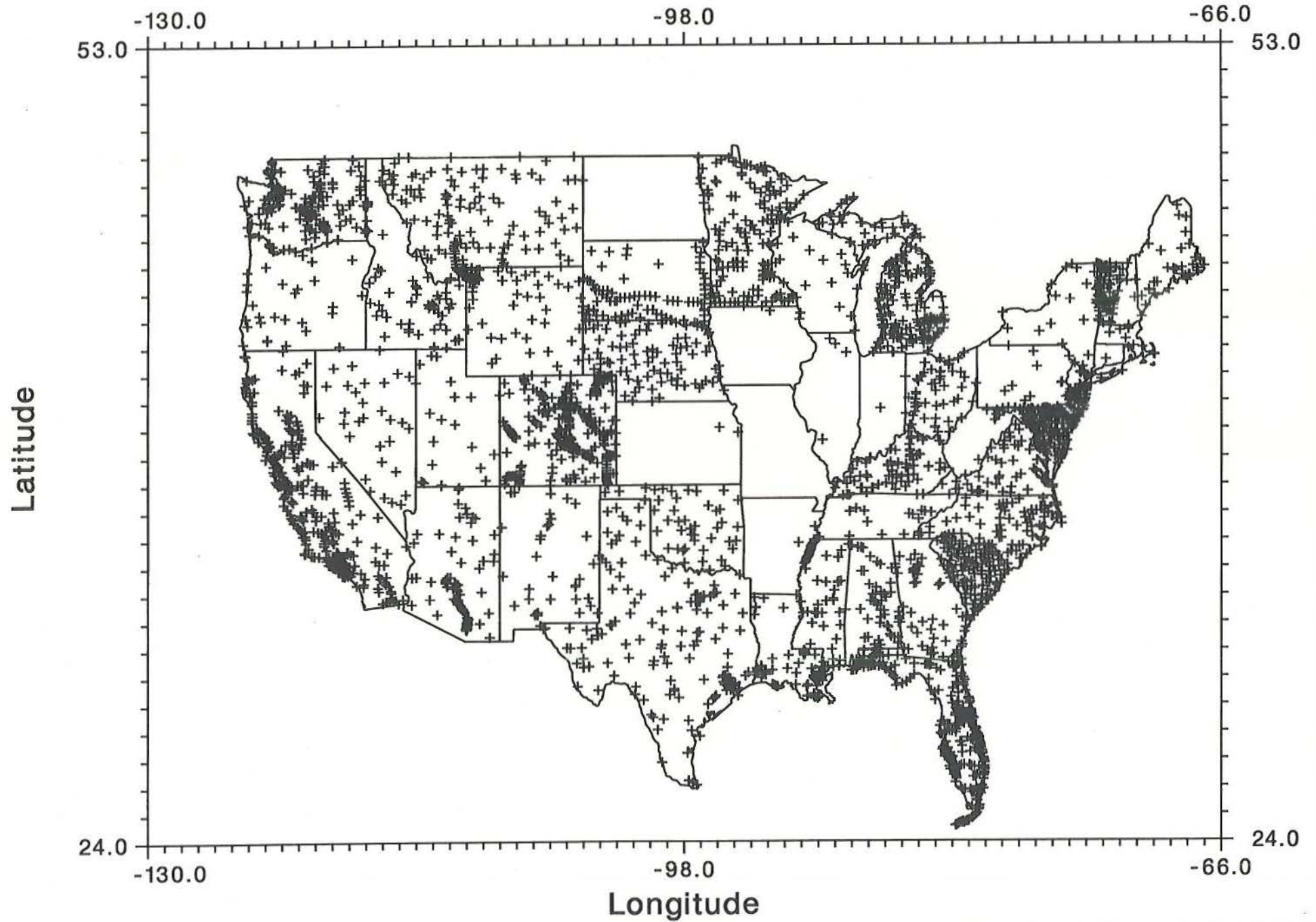
	<u>SS6.2</u> <u>- SS7.2</u>	<u>SS6.2</u> <u>- KMS</u>	<u>SS7.2</u> <u>- KMS</u>
TX to CA	0.16/105°	0.07/143°	0.11/259°
FL to MN	0.07/179°	0.09/143°	0.05/095°
E. Coast	0.12/148°	0.40/138°	0.28/134°
W. Coast	0.13/076°	0.04/207°	0.16/244°

ACCURACY CHECK WITH GPS/ BENCHMARKS

Using 3742 benchmarks with NAVD 88 leveled heights and ITRF94 GPS heights, we have an independent check on the N values at those locations. This provides an excellent way to determine if a tilt is improving or degrading the geoid model.

Below: The location of 3742 GPS Benchmarks in the NGS database.

GPS/Benchmarks, 3742 pts, 8/5/1997



**GEOID MODEL TILT, RELATIVE TO
GPS/BENCHMARKS (ppm/azimuth)**

(RED=best model for that area)

	<u>SS6.2</u>	<u>SS7.2</u>	<u>KMS</u>
TX to CA	0.21/358°	0.35/343°	0.30/350°
FL to MN	0.13/003°	0.23/009°	0.25/355°
E. Coast	0.95/134°	0.88/133°	0.64/132°
W. Coast	0.52/264°	0.60/263°	0.49/266°

CONCLUSIONS

- 1) The Sandwell/Smith 6.2 data set appears best for the Gulf of Mexico.**
- 2) The KMS data set appears best for the East and West coasts.**
- 3) Some combination of these two sets might yield an even better geoid model.**
- 4) One mgal systematic errors are a significant drawback to altimetrically derived Δg sets.**

**I will be here from 9:00 to 11:00,
Monday December 8th**