

*IGAG Symposium: Gravity, Geoid and Geodynamics, Banff, Alberta*

*July 31 - August 4, 2000*

*Time: 4:10 - 4:30, Aug. 4, Session 10: Geodesy and Geodynamics in Polar Regions*

## **On Modelling the Post-Glacial Rebound Geodetic Signature in Greenland and Antarctica**

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- **25 years of LAGEOS - class SLR data !**
  - **25 years + of mtn. glacier mass balance and sea level change records !**
  - **GRACE will "sharpen" the detail of long term gravity variability.**
  - **What might we learn quickly?**
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## OUTLINE

- **Background**
- **Employ "newest" zonal solutions to optimize a consistent set of model parameters**
  - I. **Mantle viscosity parameters**
  - II. **Last Glacial Maximum parameters**
  - III. **Sources of present-day sea-level change**
- **Consider an a posteriori  $\dot{m}$  (polar motion) bound.**
- **An emergence of consistent  $\dot{J}_1$  solutions!**
- **Antarctica may be in a negative mass balance state (?)**

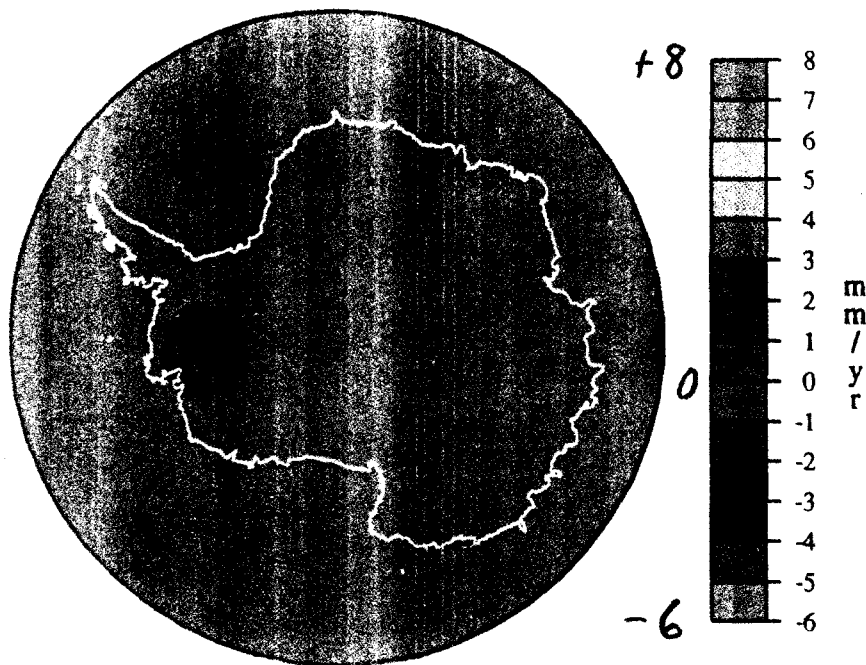
$$\dot{M}_A \approx - 235 \pm 360 \text{ Gt/yr}$$
$$\dot{\xi}_A \approx + 0.65 \pm 1.0 \text{ mm/yr}$$

- **Caveats**

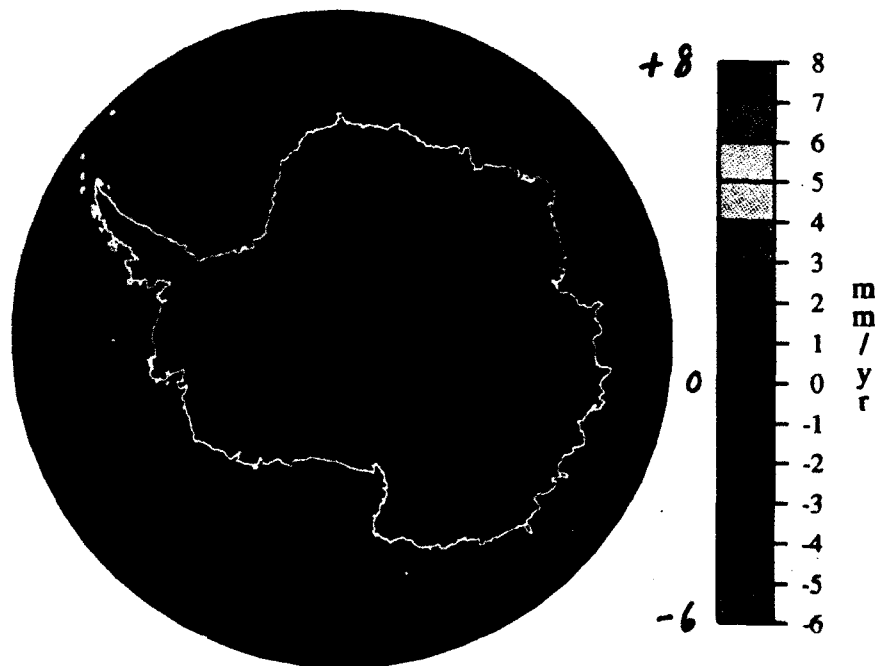
## PHYSICS

- **Deep mantle:  $\eta$**
- **Sources of present-day rate of sea-level rise:  $\dot{\xi}_{\text{Obs}}$ .**
- **Common thread: Polar Ice Sheets**

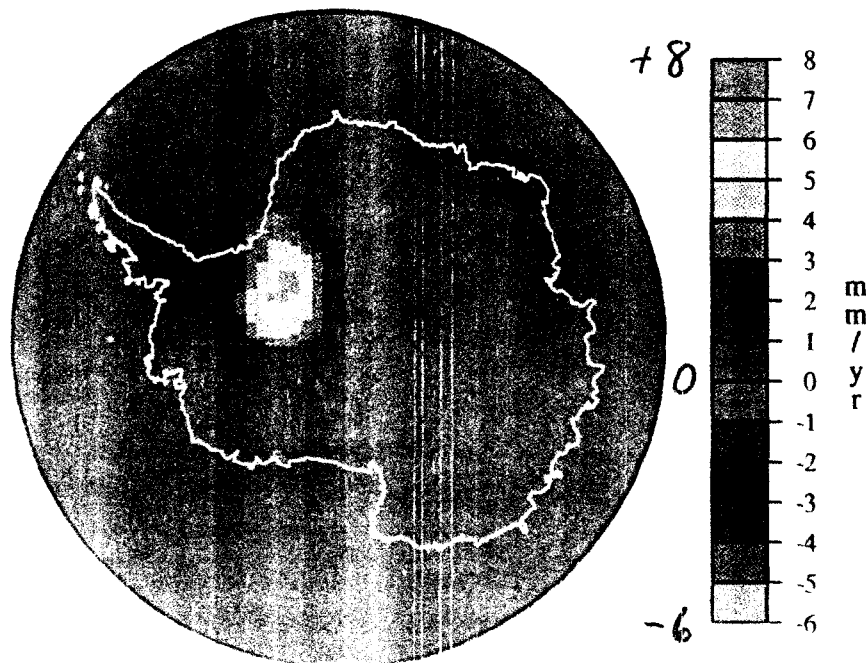
Scenario 1; Vertical Velocity



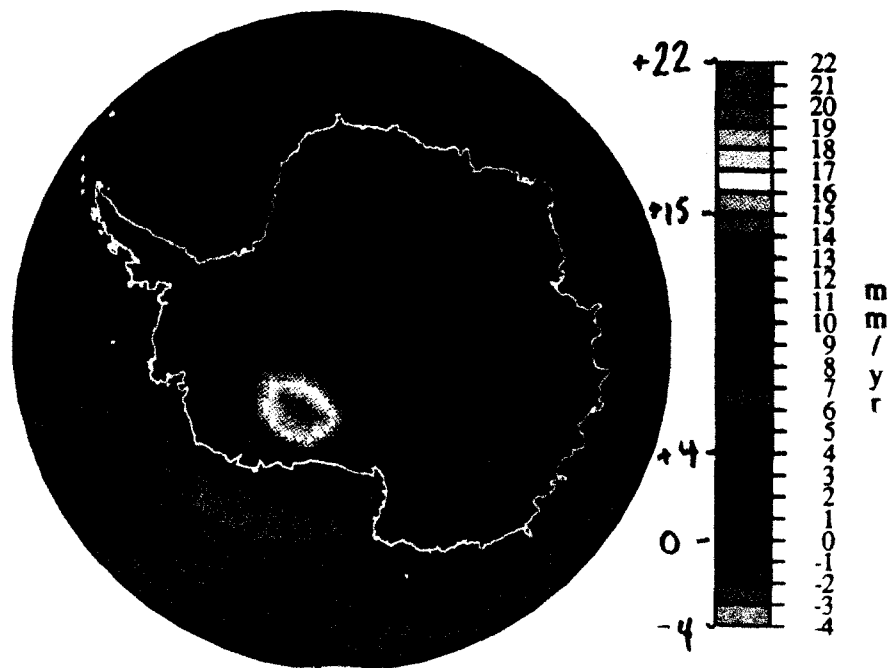
Scenario 2; Vertical Velocity



Jacobs et al.; Vertical Velocity

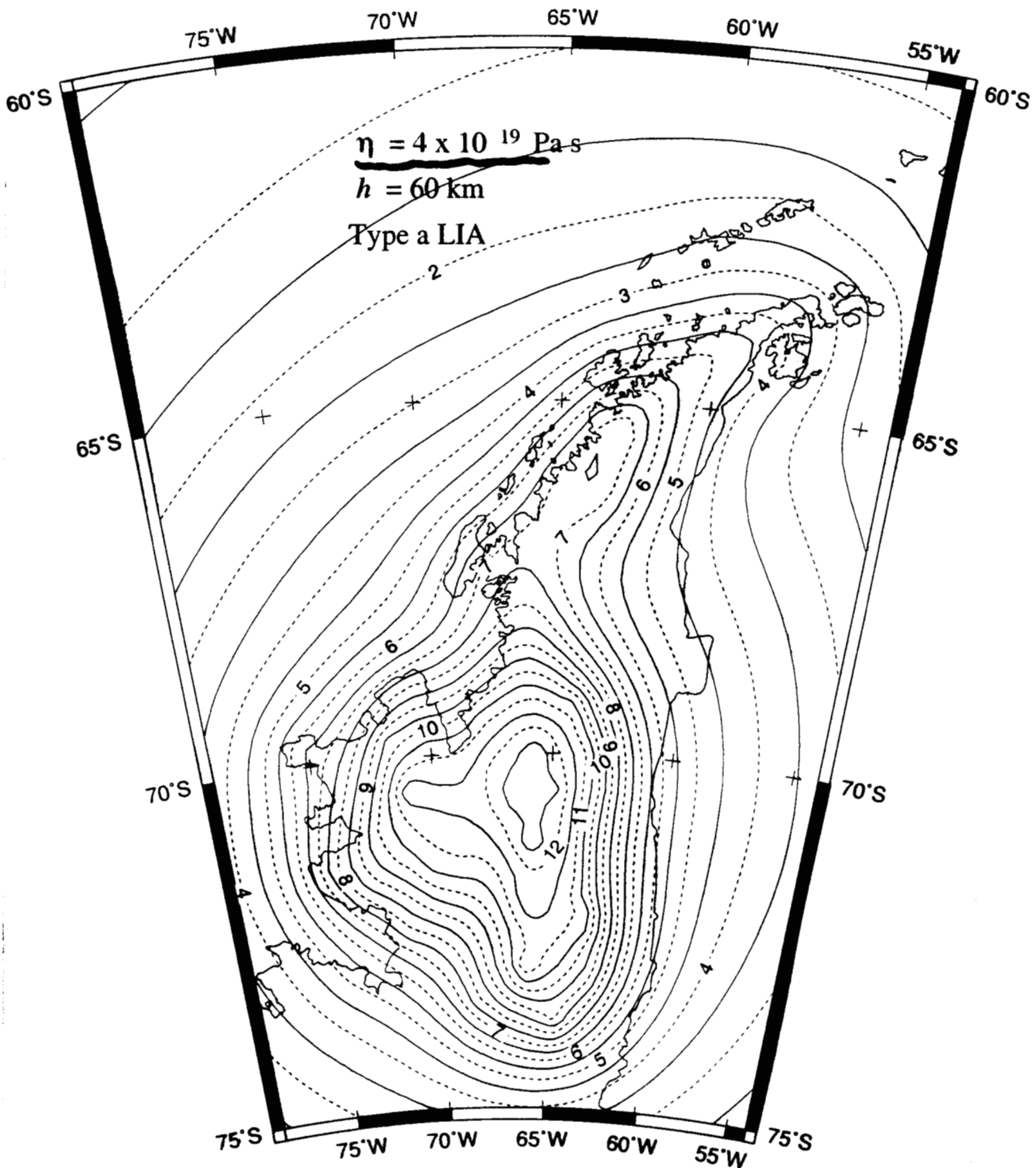


ICE-3G



uplift rate (mm/a) 4650 yr. growth phase (LIA only)

Mass loss rate = 48 Gt/a begins at 1850 AD

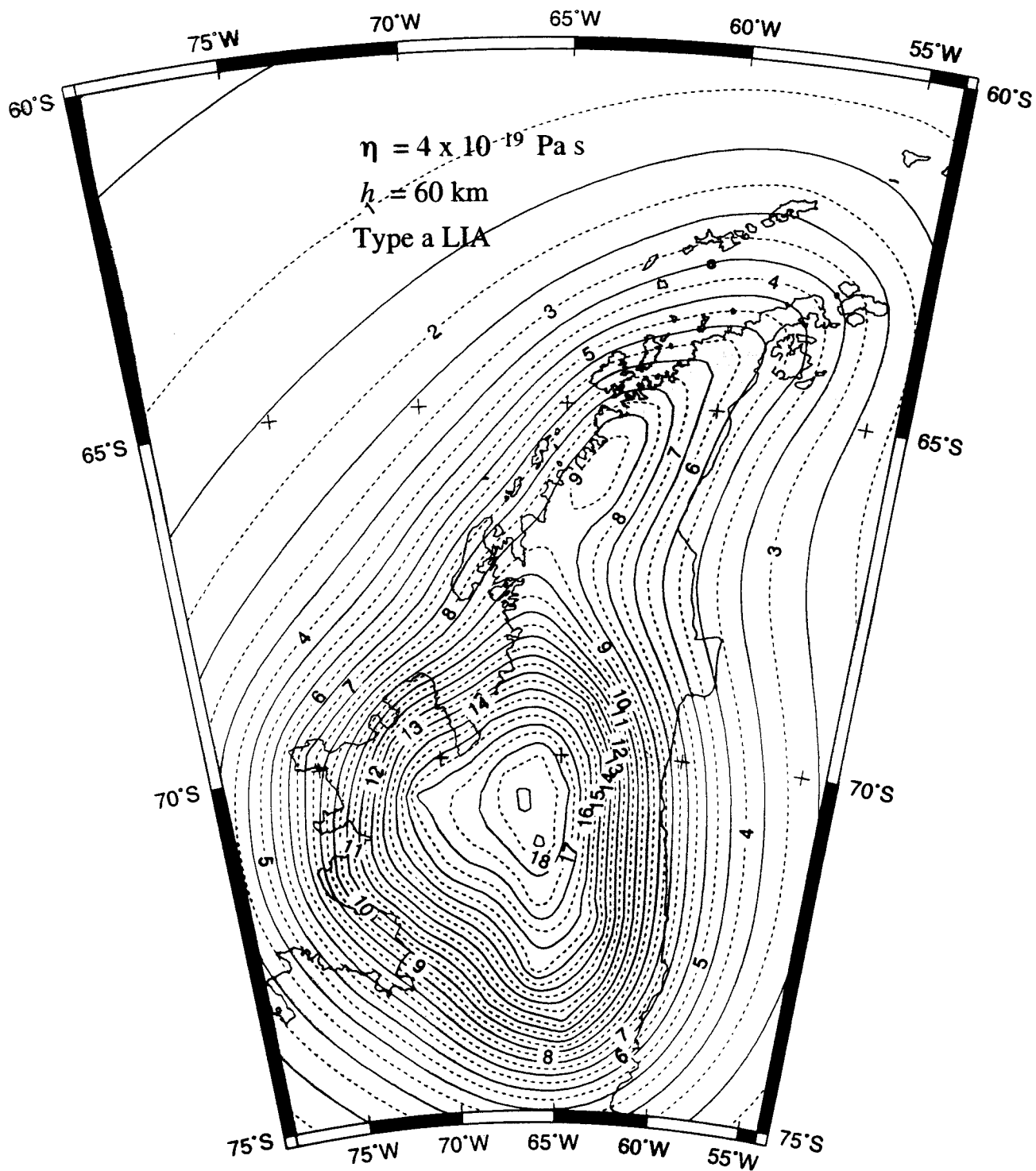


uplift (mm/a) 0.72 meter e.s.l. LGM & continuous draw-down

$\Delta s_{LGM} \sim 0.72 \text{ m}$

Mass loss rate = 48 Gt/a begins at 1850 AD

$\dot{s}_{\text{present-day}} \sim 0.1 \text{ mm/a}$

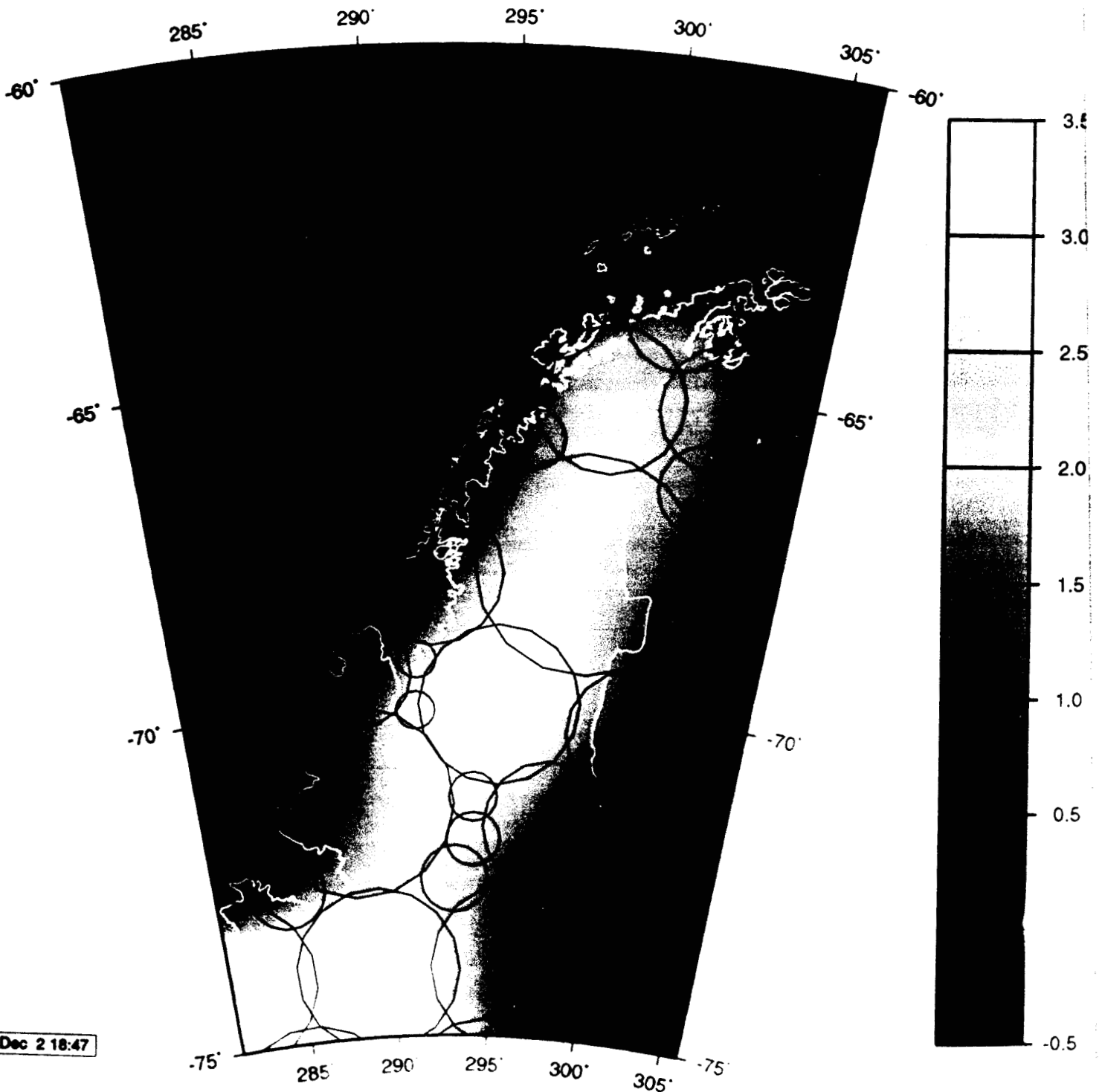


D91 modified after Payne, Sugden and Clapperton (1989)

Vertical Isostatic Response at Present-day (0 ka B.P.) in mm/yr

$$h = 70 \text{ km} \quad \eta = 4.0 \times 10^{20} \text{ Pa s}$$

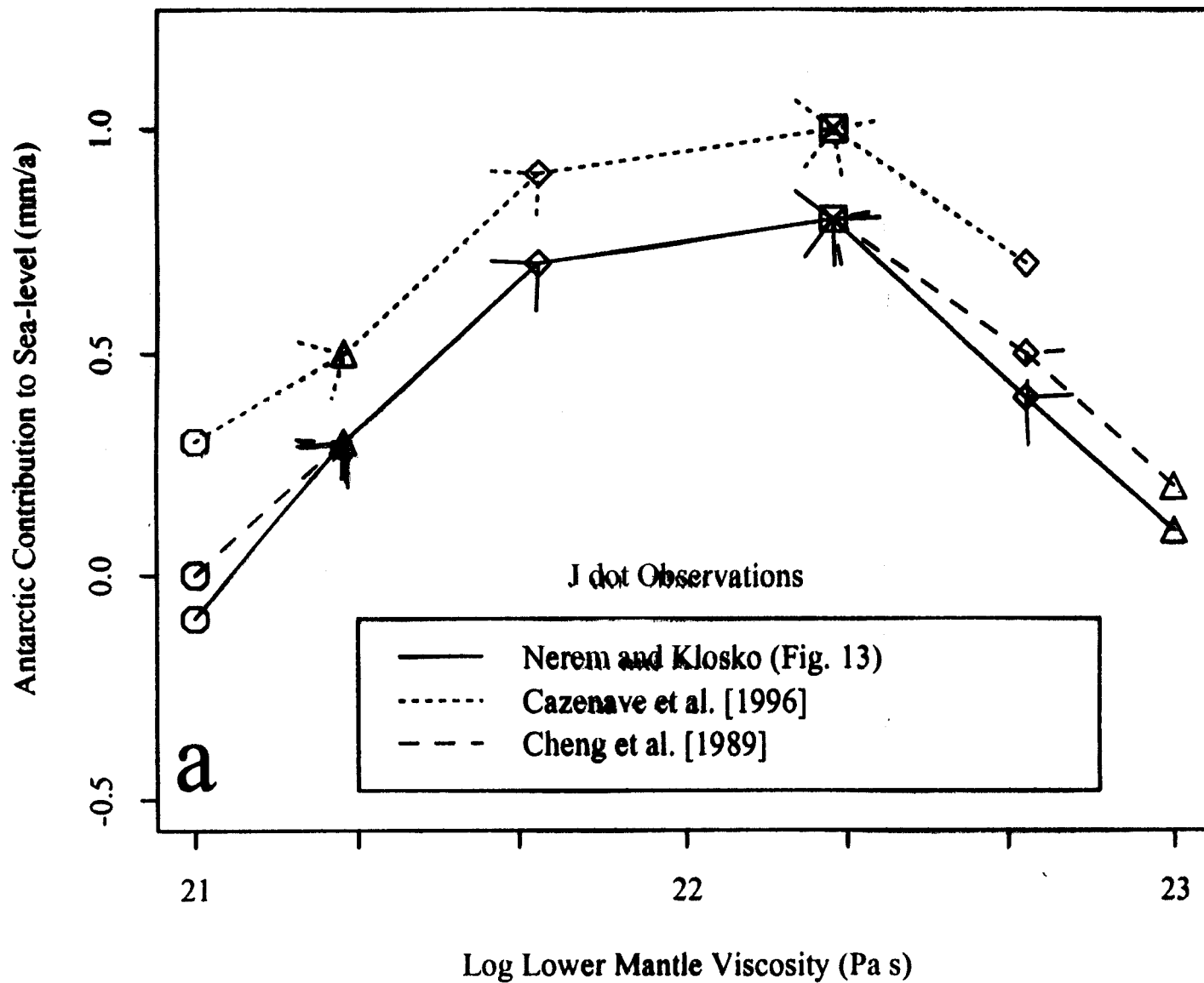
Total Antarctic contribution to eustatic sea-level rise = 20 meters





$\dot{J}_l$  Satellite Solutions, in  $10^{-12}$  /a.

Author	$J_2$	$J_{3L}$	$J_3$	$J_4$	Var
<i>Nerem and Klosko</i> [1996]	-27.7 $\pm 2.5$	15.7 $\pm 3.5$		2 $\pm 14.6$	6.9
<i>Cazenave et al.</i> [1996]	-30 $\pm 3$		-17 $\pm 1$	-8 $\pm 15$	11.4
<i>Cheng et al.</i> [1989]	-25 $\pm 3$		-1 $\pm 3$	3 $\pm 6$	4.8
<i>Eanes and Bettadpur</i> [1996]	-25.6 $\pm 3.4$			-9 $\pm 13$	5.3



## **PROSPECTS & CAVEATS**

- **Confirm odd-chain  $J_1$  solutions.**
- **GRACE (2001 - 2005) and follow-on missions.**
- **Antarctic LGM reconstructions.**

# Conclusions and Future Considerations

- SLR determinations of  $\dot{J}_3$  are crucial to ice sheet mass balance studies.  
(Lageos-1 Lageos-2 Starlette Ajisai)

- How good are Antarctic deglaciation reconstructions?

1. ICE-3G & -4G    2. ANT-    3. Univ. Maine    4. Bremerhaven

- Land-based GPS experiment in Antarctic interior initiated Dec. 1996

( C. Raymond - B. Kamb - A. Donnellan - M. Smith)

+ ( I. Whillans - T. Wilson )