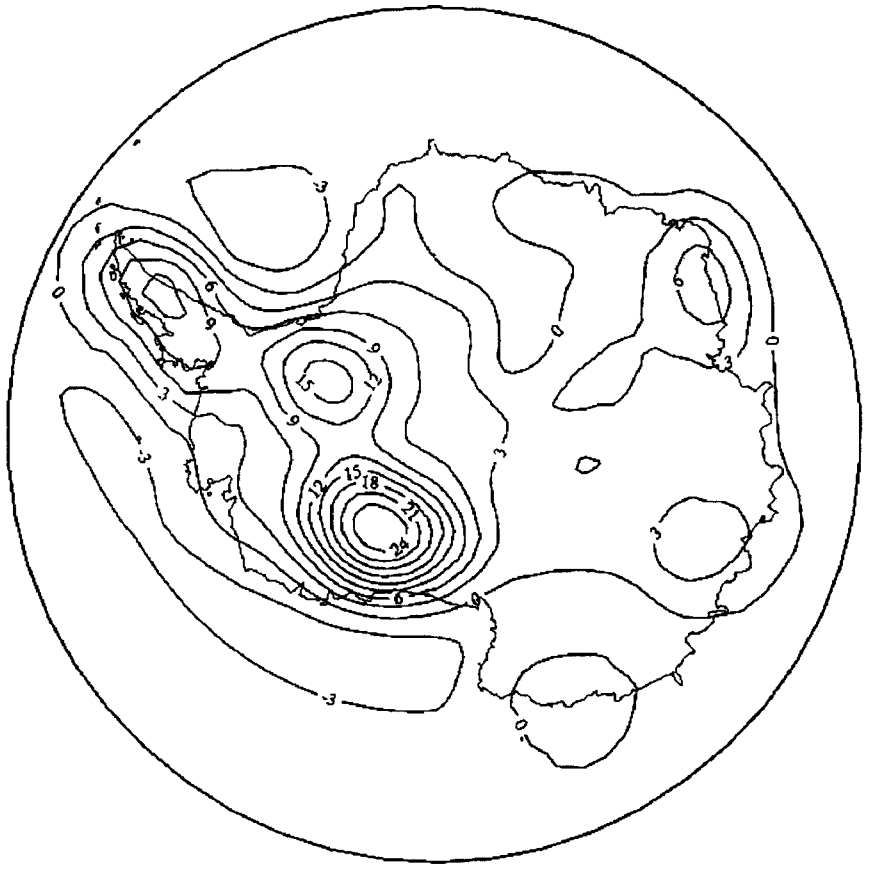
MODERN UPLIFT OF THE TRANSANTARCTIC MOUNTAINS: RESULTS OF AN AUTONOMOUS GPS ARRAY

SUMMARY

- *Predicted crustal motion signal from glacial isostasy*
- *GPS array in the Transantarctic Mountains*
- *Motion of the Antarctic lithosphere from GPS*
- *An integrated geophysical network for ice sheet mass balance studies*

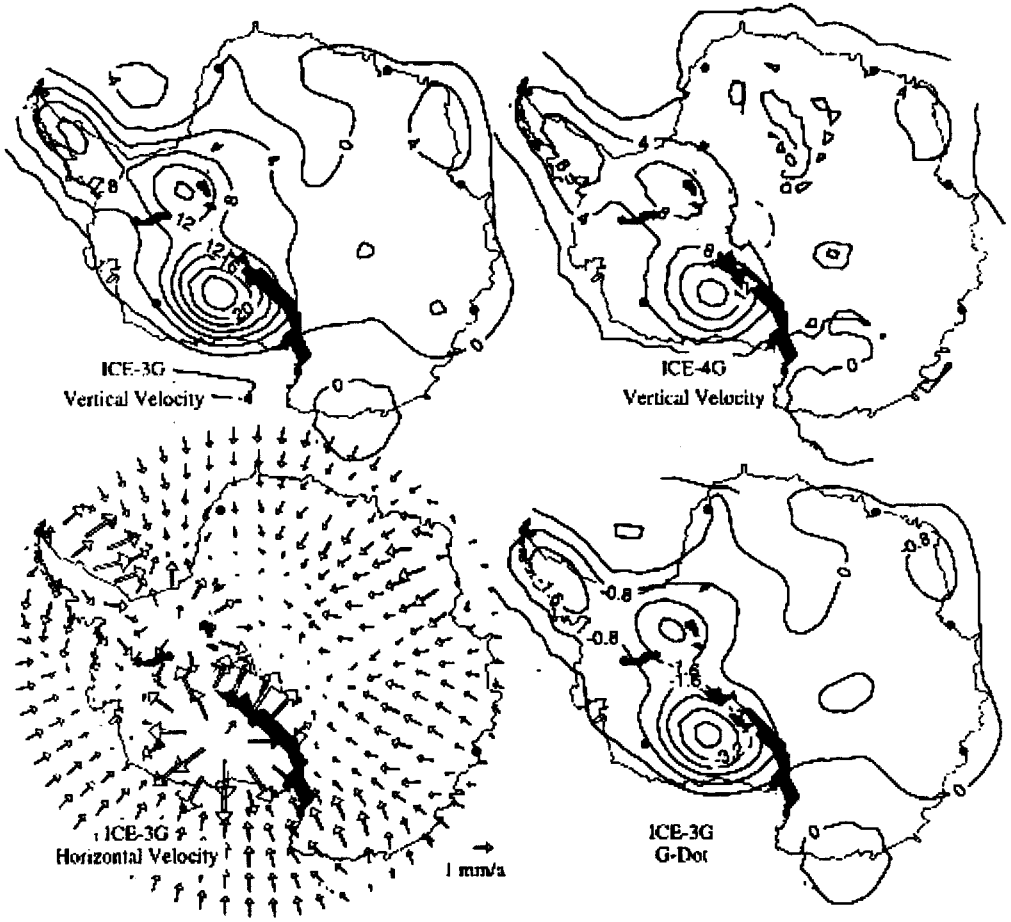
PREDICTED CRUSTAL MOTION FROM GLACIAL REBOUND

- *Uplift of 1-2 cm/yr predicted for the Ross Embayment and Ellsworth Mountains*
- *Various models have similar patterns, ICE-3G and D91 are end-members*
- *Present-day mass balance predicted to be small with some exceptions*
- *See James and Ivins, 1998, JGR for details*



ICE-3G

- Large late melt component (7-4 Ka)
- 25 m of RSL rise
- Constrained by northern hemisphere ice sheet history & relative sea level curves
- Uses 10^{21} Pa-s upper mantle viscosity
- James and Ivins, JGR, 1998



- ICE-4G closer to CLIMAP reconstruction
- ~25% lower predicted uplift rates
- Horizontal rates of several mm/yr predicted across West Antarctic Rift
- James and Ivins, JGR, 1998

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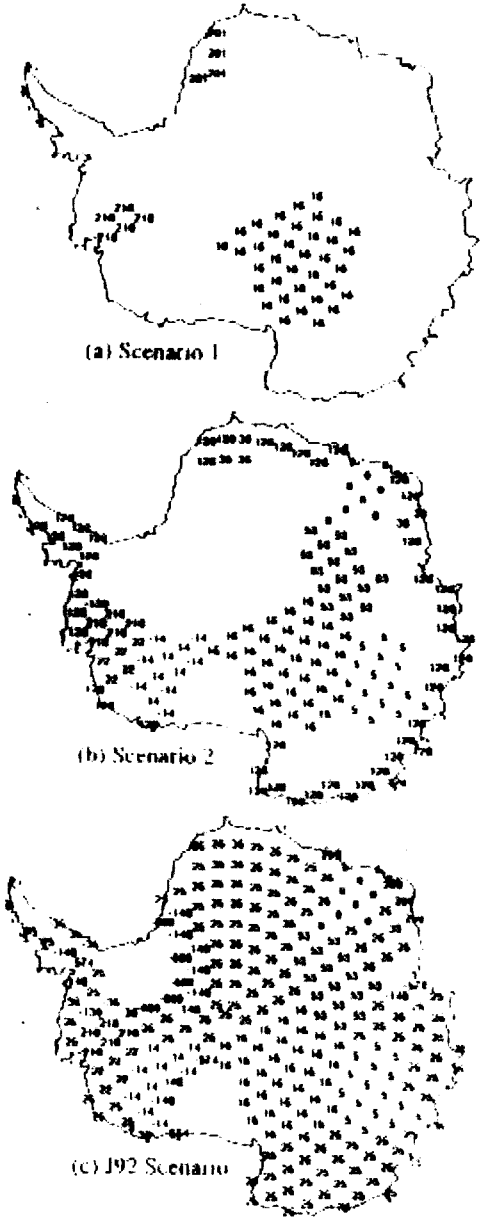
CAVEATS TO PREDICTIONS

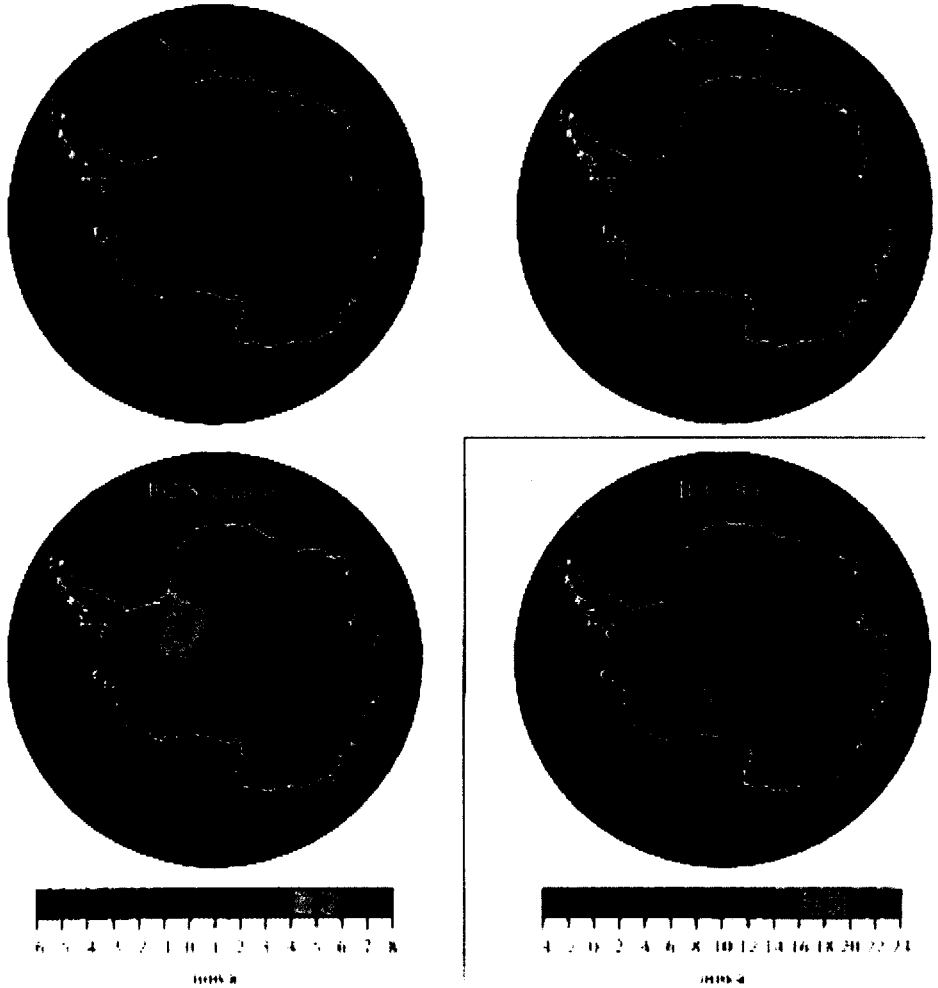
- *Mantle viscosity is key parameter controlling reponse of lithosphere to glacial loading and unloading*
- *Viscosities below 5 x 10^{20} Pa-s result in decreasing memory of LGM and enhanced sensitivity to Late Holocene history*
- *Constraints on viscosity and neoglacial history will reduce the ambiguity in the interpretation of crustal motion data*

PREDICTED CRUSTAL MOTION (mm/yr)

James & Ivins, 1998

Syowa	0.7	0.8	1.6	1.1
Davis	2	2.7	2	1
Casey	4.3	2.8	1.9	3.4
Mt Melbourne	0.6	-2	-1	4.6
McMurdo	6.9	-0.1	0.2	3.7
Prince Olav Mtns	**17.2**	**16.9**	**11.9**	**6.5**
Exec. Comm. Range	3.7	4.4	4.2	7.6
Mt. Ulmer	**2.1**	**4.4**	**2.5**	**12**
Independence Hills	8.5	11.2	7.5	9.5
O'Higgins	6.7	3.6	4	-1.8
Dufek Massif	**19.8**	**14.6**	**8.6**	**8.4**
Basen	-0.1	-0.1	1	6.6





James and Ivins, GRL, 1995
Bentley and Giovenetto, 1991
Jacobs et al., 1992

GPS IN ANTARCTICA

- ***Permanent IGS sites*** *at O'Higgins, Casey, Davis, McMurdo*

- ***'Other' permanent sites*** *at Mawson, Syowa, Palmer, etc. but data not in public domain*

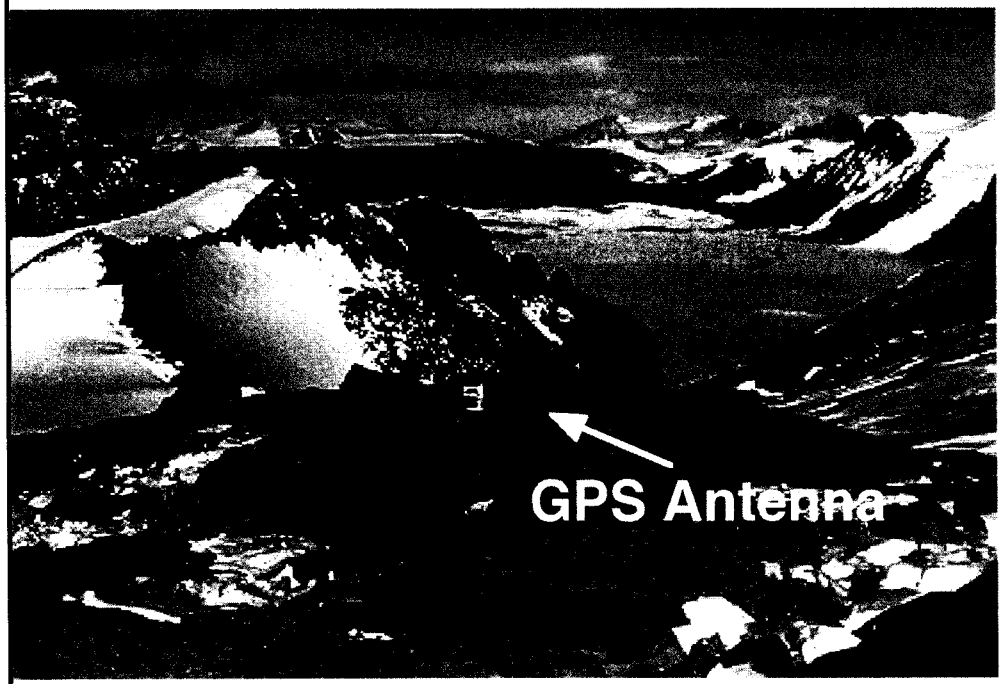
- ***Networks (campaign meas.)*** *in Northern TAM (Willis, Wilson, Whillans, Hothem) and Antarctic Peninsula (Dietrich et al.; Bevis et al.)*

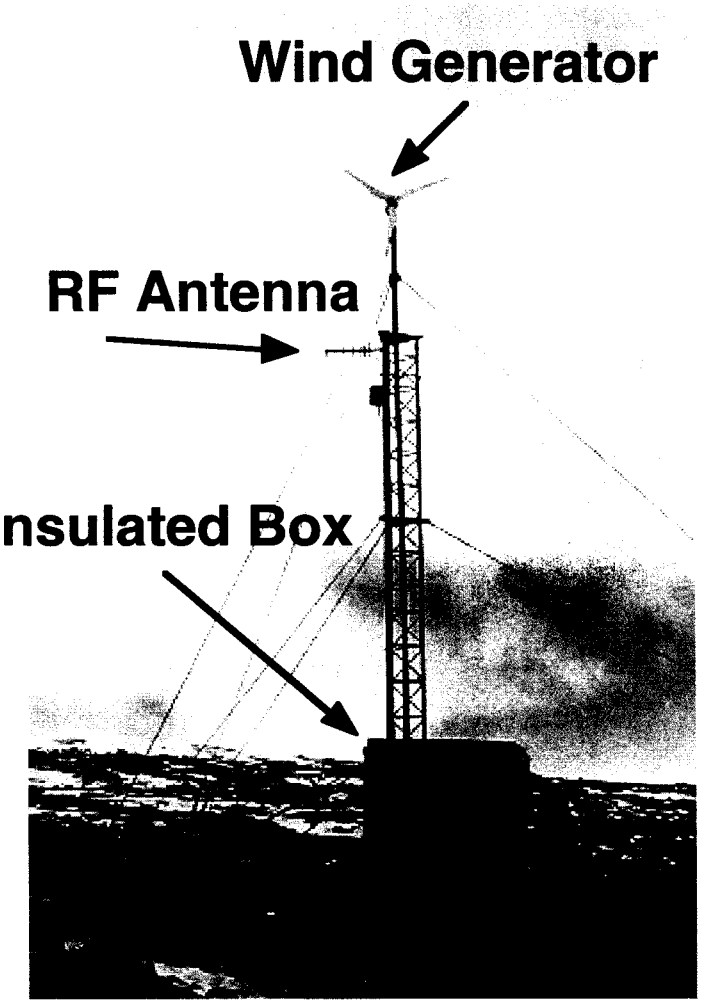
- ***"Permanent" arrays*** *in the TAM (these authors), MBL (Donnellan & Luyendyk) and DML (Zwartz)*

GPS ARRAY IN THE TRANSANTARCTIC MOUNTAINS

- *Two stations established at Mt Coates and Mt Cocks*
- *High precision geodetic GPS receiver (TurboRogue)*
- *Hybrid wind/solar power system*
- *Data telemetry to McMurdo via radio modems*
- *Met instrument package*

Remote GPS Station, Coates, in the Dry Valleys, Antarctica





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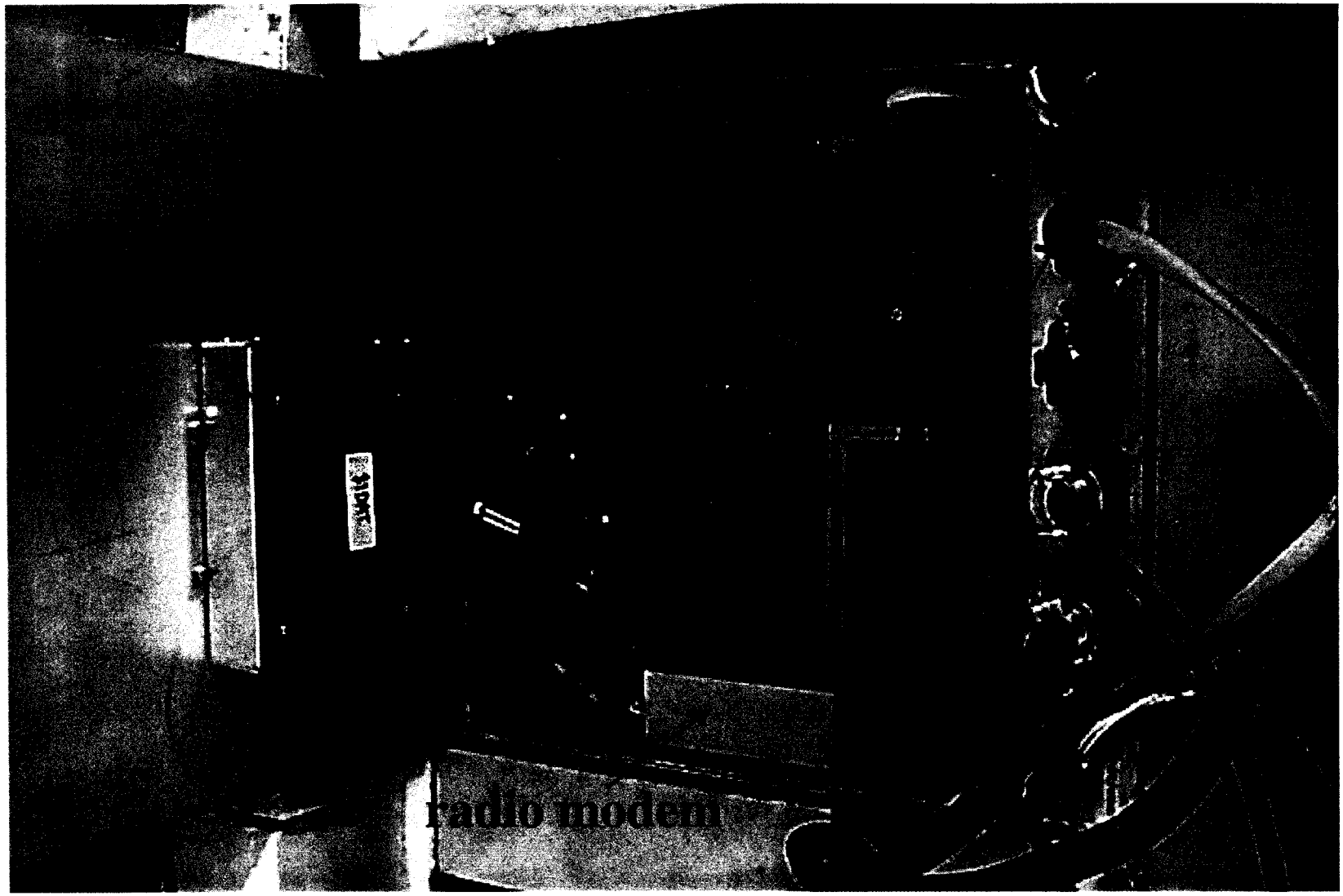
EQUIPMENT ENCLOSURE AT MT COATES 1998



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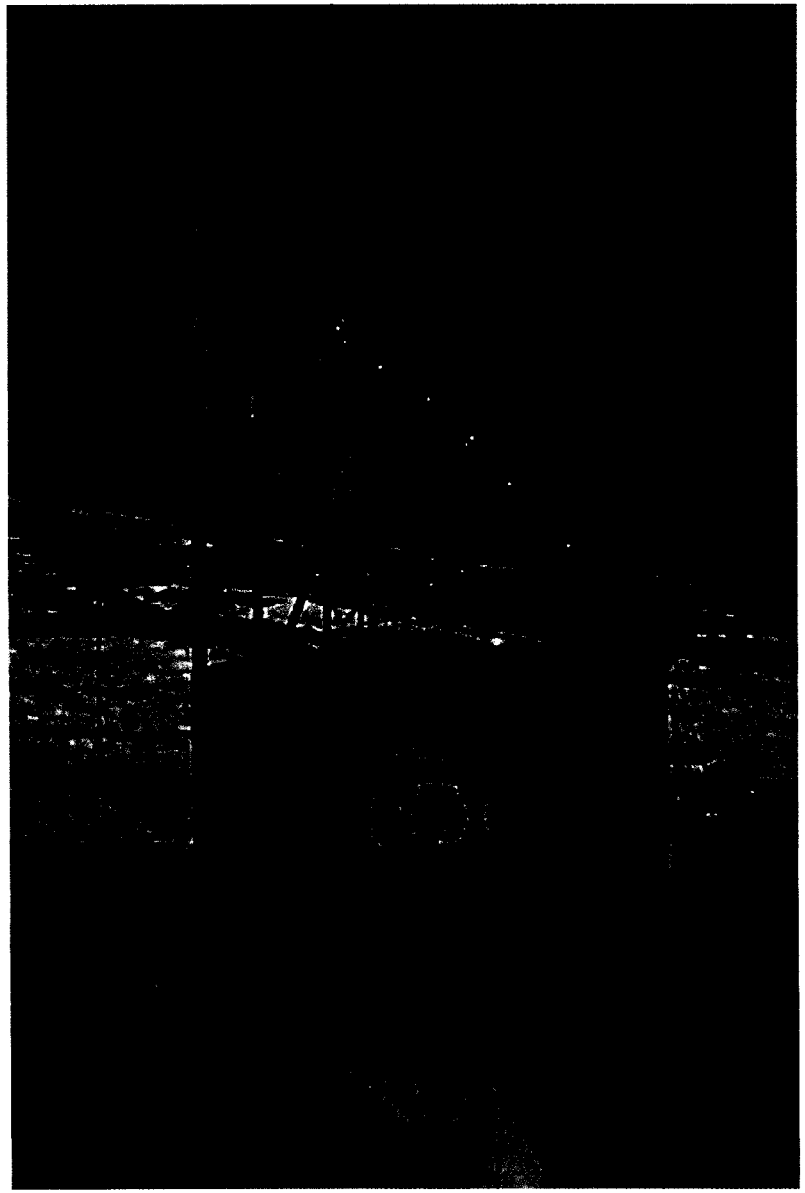
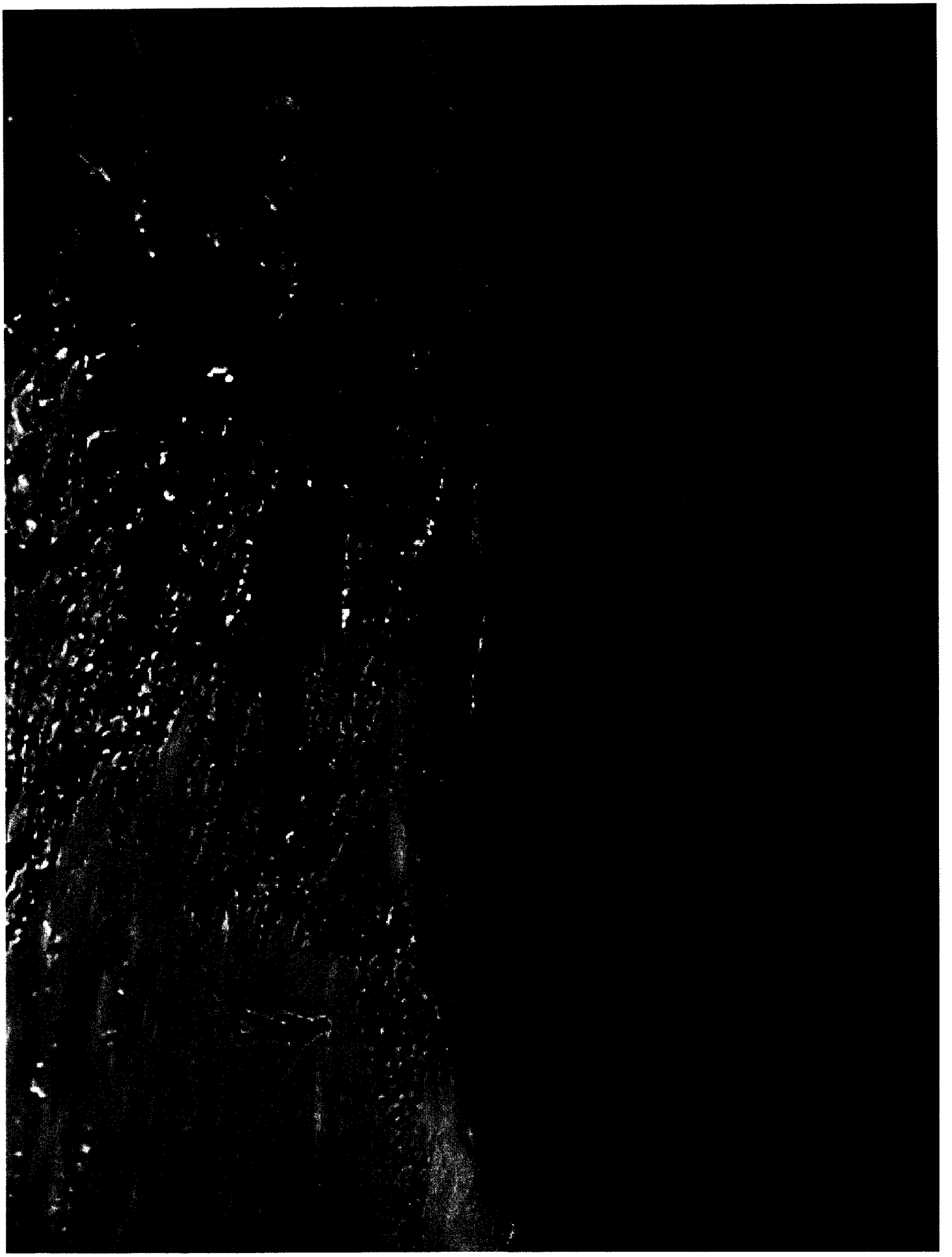


Coates box showing wind monitor and temperature sensor



INTEGRATED GEOPHYSICAL MEASUREMENTS OF ICE SHEET MASS BALANCE

- *Gravity Recovery and Atmospheric Change Experiment (GRACE) to measure mass redistribution*
- *Geoscience Laser Altimeter System on ICESat to measure surface accumulation*
- *Geodetic GPS to constrain viscous and elastic rebound*
- *Interferometric Synthetic Aperture Radar to measure glacier mass balance and crustal motion*

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VISION

- ***Coordinated, strategically located GPS measurements will provide geodetic constraints on present and past ice sheet mass balance within five years***

- ***Correlative satellite and ground measurements will define present-day mass balance***

- ***Seismological and ice core (accumulation history) data will further constrain past ice sheet history***

- ***Unattended autonomous stations will enable this vision***