Polar Auroras

How bad are they for astronomy at Dome C?

Figure 1.—Aurora borealis *taken in the Copper River Delta, Alaska; © 1990 by Dave Parkhurst, Alaska Naturally.*

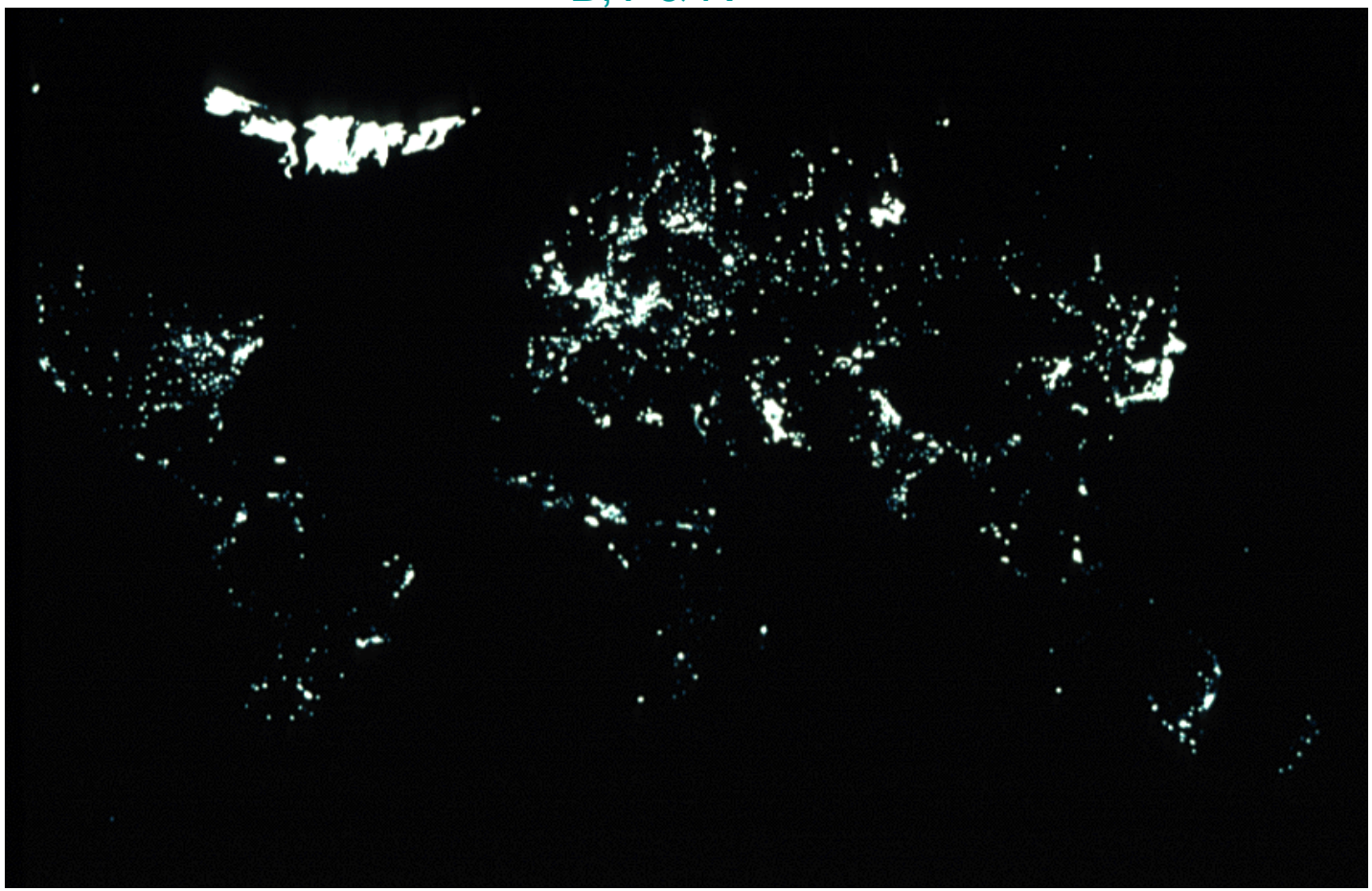
Prepared by Marc Sarazin (ESO) and Liviu Ivanescu (ESO)

Polar Auroras

South Pole Station

Polar Auroras

Auroras increase dramatically the sky background in B,V & R



Polar Auroras

Auroras occur when fast-moving solar particles trapped in Earth's magnetic field come crashing down into the gases of Earth's upper atmosphere.

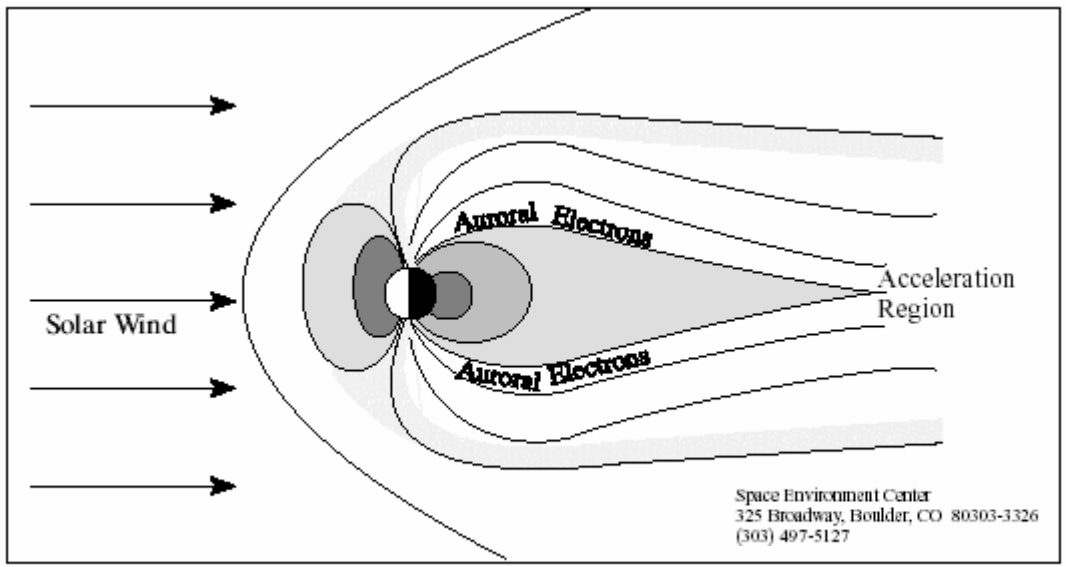


Figure 2.—A "side view" of the Earth and magnetosphere showing some of the important regions.

Polar Auroras

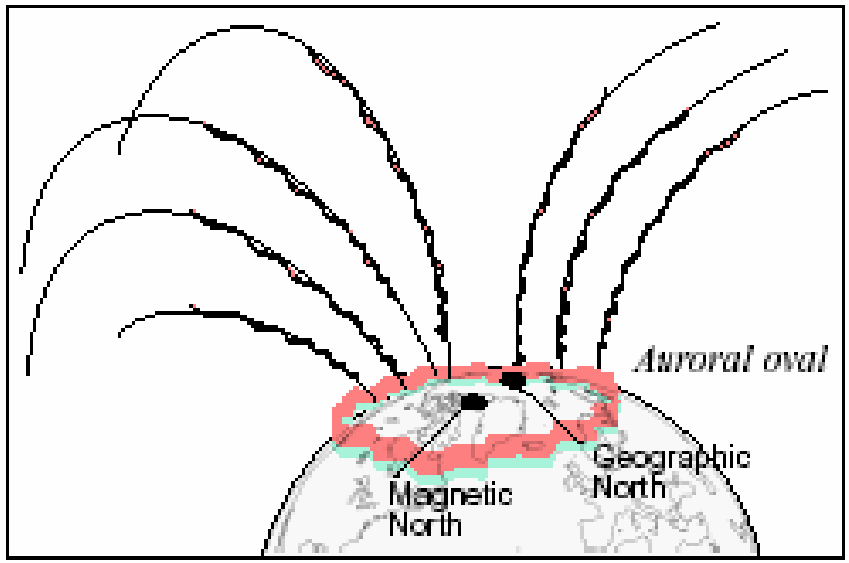


Figure 3. Energetic electrons spiral down the geomagnetic field lines towards the polar regions, striking the upper atmosphere, resulting in the display of auroral lights.

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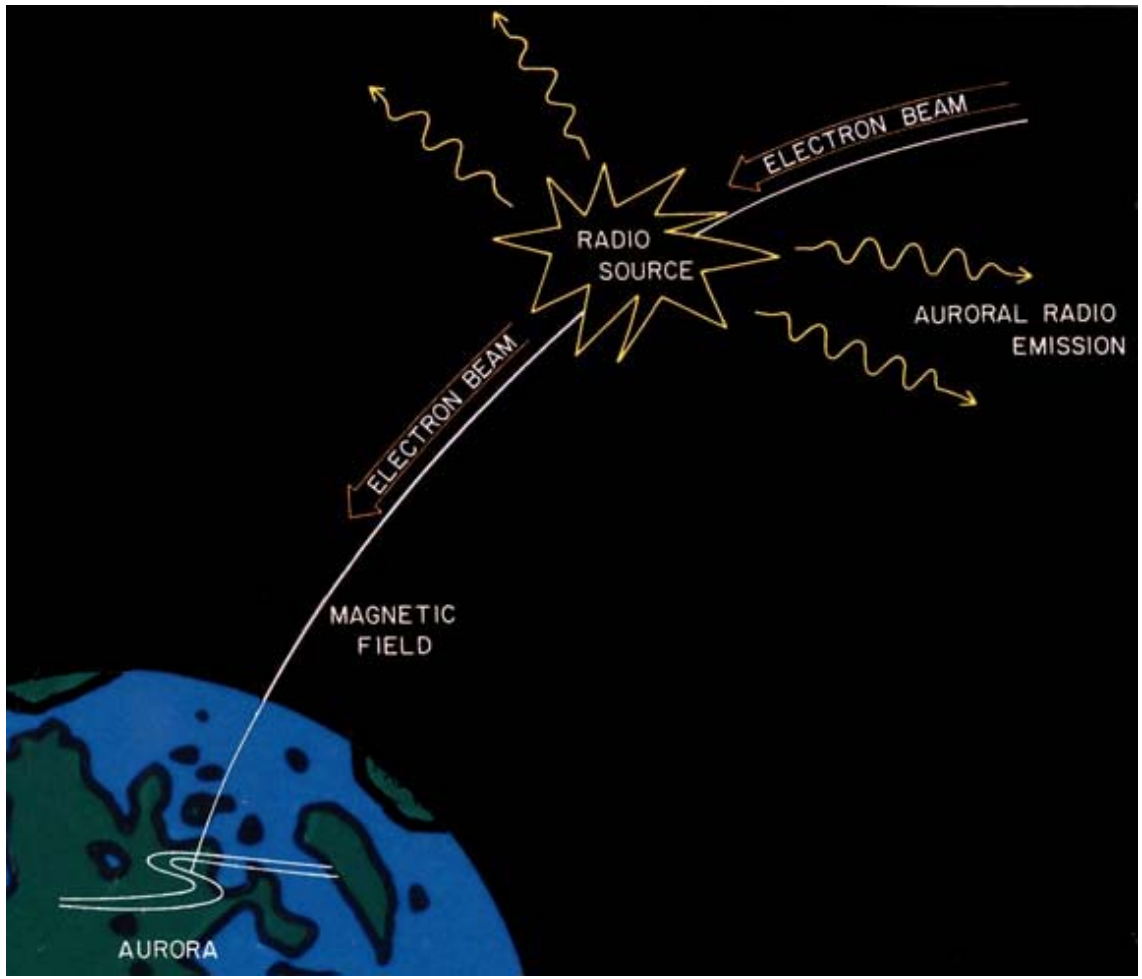
Polar Auroras

These same electrons generate intense radio emissions most intense over a frequency range about 100 to 500 kHz but also extending below 20kHz.

University of Iowa instrumentation also revealed that similar radio emissions occur in association with aurora at Jupiter, Saturn, Uranus, and Neptune.

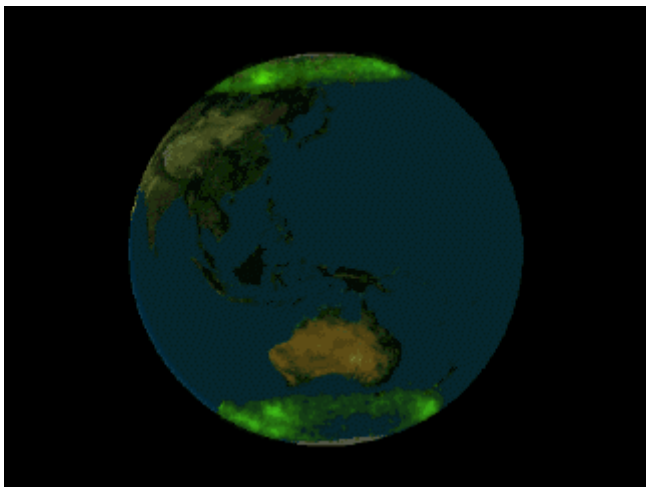


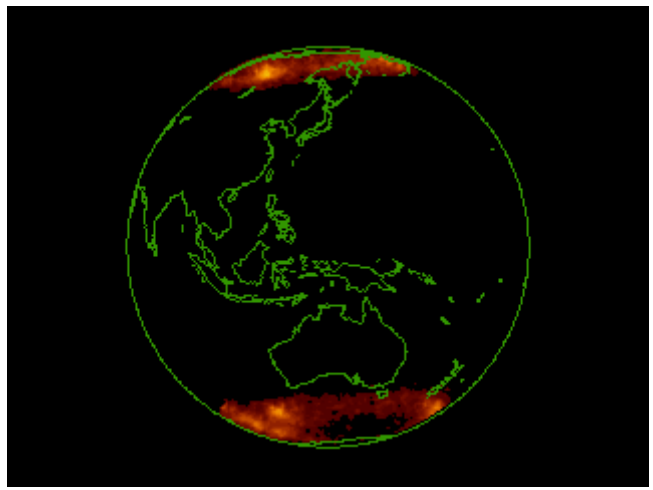
http://www-pw.physics.uiowa.edu/space-audio/sounds/EarthAKR/earthakr-png.html

Polar Auroras

Brightness Variability scales from hours to days

Disturbances in the Earth's magnetosphere are called geomagnetic storms. These, in turn, can produce sudden changes in the intensity of radio emissions, the brightness and motion of the aurora called auroral substorms.





Coupling of North/South Polar aurora activity
http://www.gsfc.nasa.gov/topstory/20011025aurora.html

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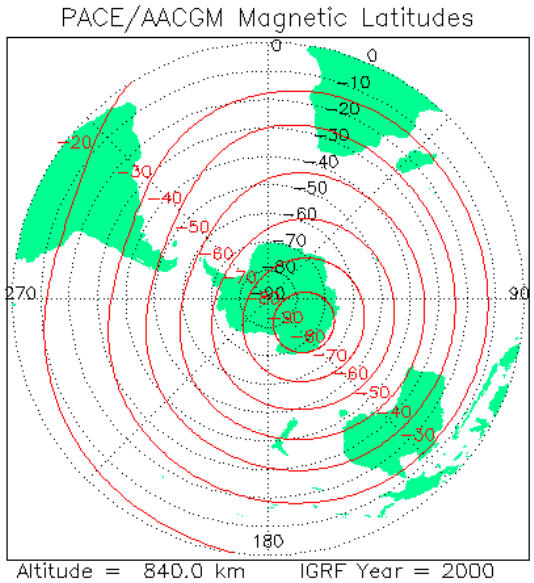

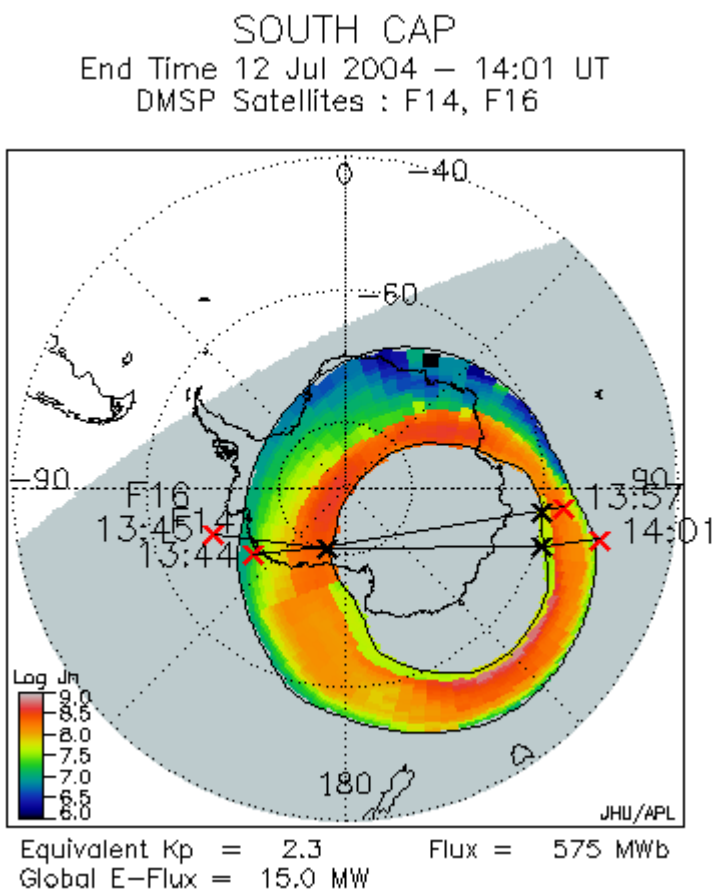

Variability of the Position of the Auroral Oval

Average diameter 4000km

(larger during solar maximum(

http://sd-www.jhuapl.edu/Aurora/ovation_live/

Altitude 90-150km (V,R), 1000km (B)

http://members.aardvark.net.au/jacksonsalter/ast/aurorobs.html

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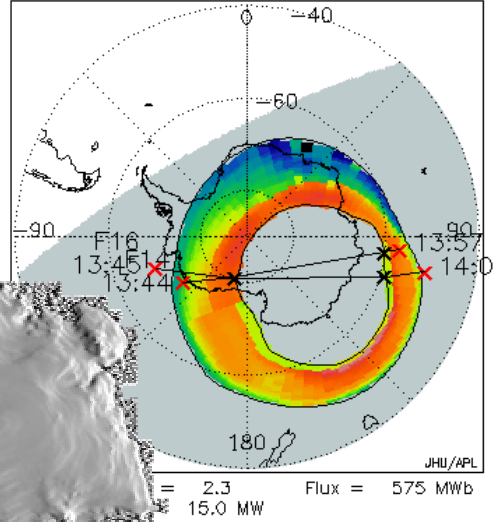

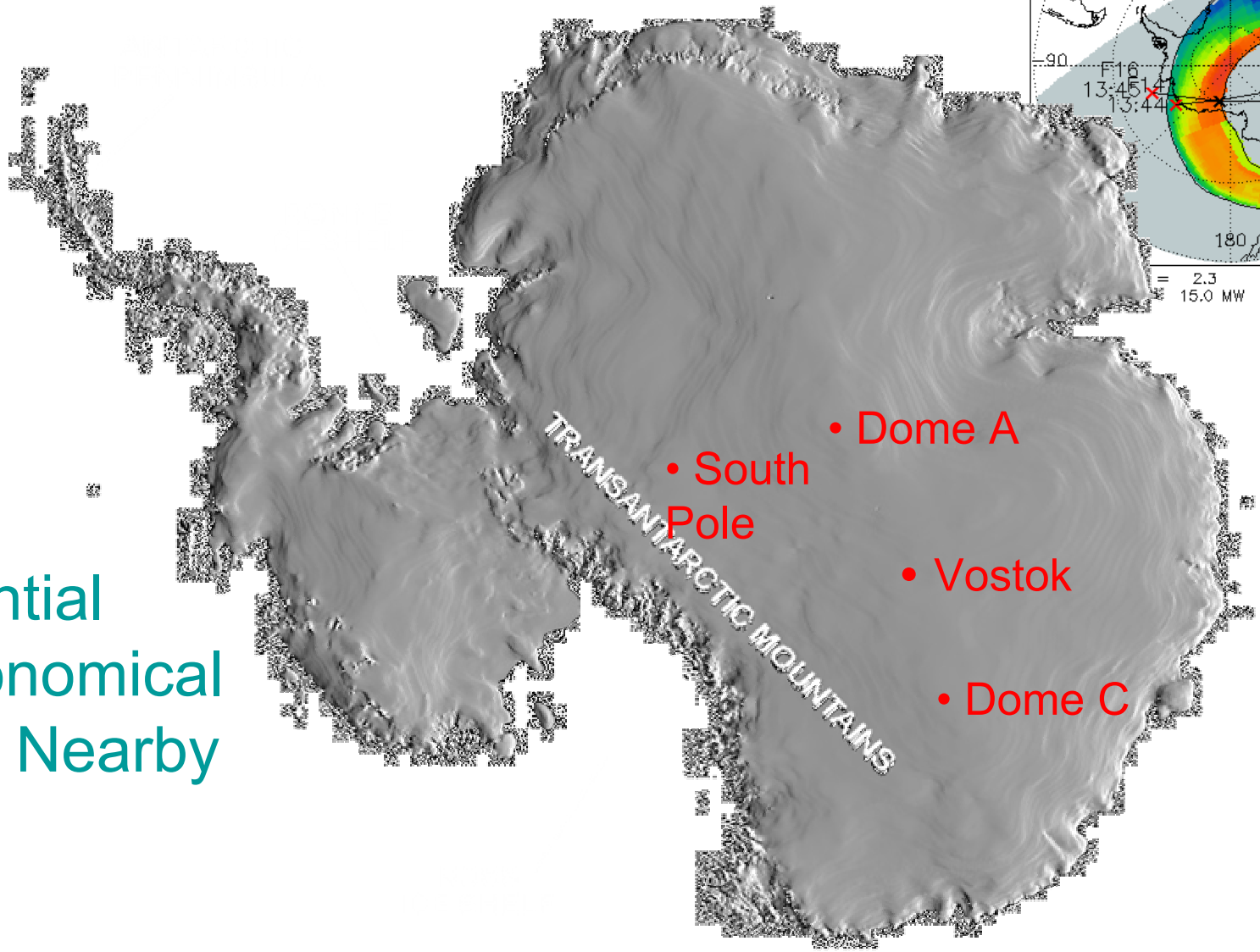

Potential Astronomical Sites Nearby

Storey, J.W.V., 'The Owl and the Penguin: why we should build an Extremely Large Telescope in Antarctica', Australia Telescope National Facility and Anglo Australian Observatory joint colloquium, Epping, Sydney, 11/06/03

Polar Auroras

Potential Astronomical Sites Nearby

Site	Latitude (deg,min)	Longitude (deg, min)	Geomagnetic Latitude (deg min)	Geomagnetic Longitude (deg, min)	Horizontal distance from oval (km)
South Pole	-90	0	-76 13	11 53	0
Dome C	-75 06 S	123 23 E	-89 10	264 56	2000
Dome A	-81	81 E	-81 58	51 10	300

Minimum zenith angle of the auroral arc (degree)
V & R: 0 at South Pole, 64 at Dome A, 86 at Dome C
B : 0 at South Pole, 27 at Dome A, 64 at Dome C

J.T. Dempsey, J.W.V. Storey, *Auroral contribution to Sky Brightness on the Antarctic Plateau*

Polar Auroras

Diurnal Variations (+/-30 from zenith)

Table 10: Relative sky background contribution by aurora (B magnitudes) at Dome C and Dome A with respect to South Pole. Values are calculated as a function of magnetic local time, for an average level of auroral activity.

MLT	6hrs	12hrs	18hrs	24hrs
SP	0.0	0.00	0.00	0.00
Dome C	1.88	2.94	1.98	1.75
Dome A	0.73	1.00	1.17	1.30

J.T. Dempsey, J.W.V. Storey, *Auroral contribution to Sky Brightness on the Antarctic Plateau*

Polar Auroras

Sky Background

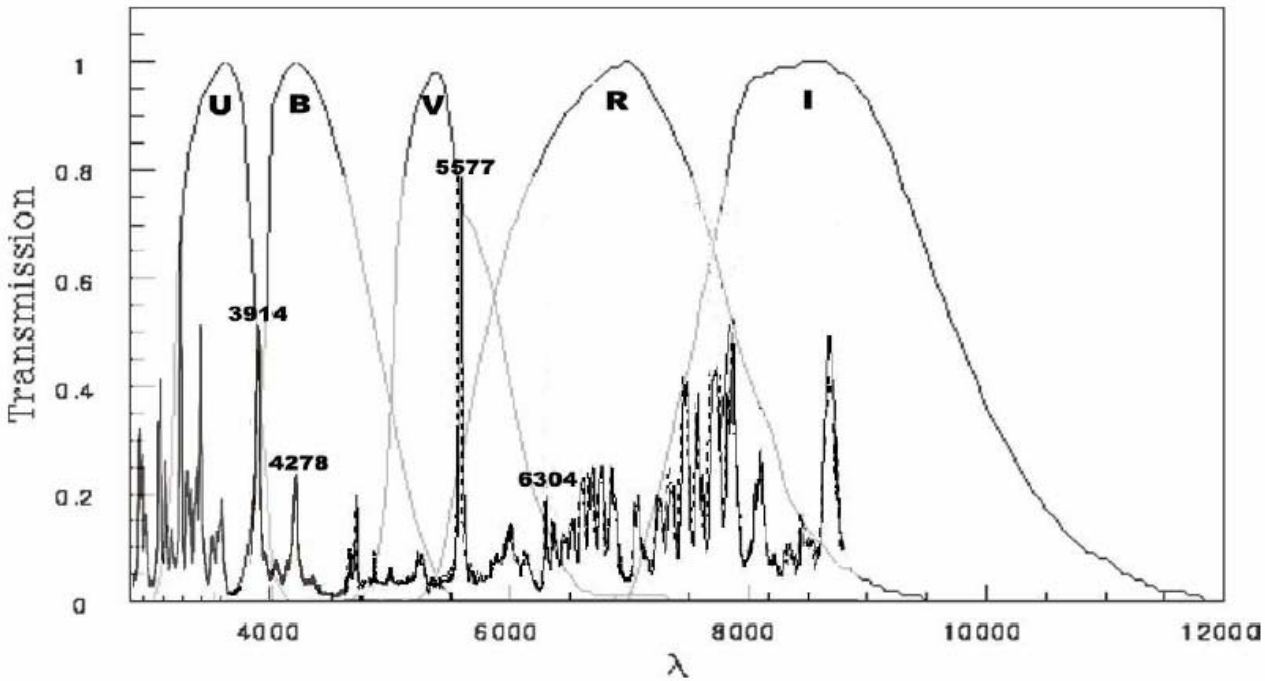

Figure 9: The position of the visible auroral lines in respect to the *UBVRI* passbands. Auroral spectrum is from 300mm to 890mm (Paxton & Meng 1999; Swenson et.al. 1998).

Polar Auroras

Zenith Brightness Contribution of the Aurora

% time brighter than Paranal (Solar Min-Max)	South Pole	Dome C	Paranal (Magnitude, full band)
B (427.8 removed	60-40	8-2	22.64
V (557.7 removed)	10-2	0	21.61
R (630.0 only)	0	0	20.87

J.T. Dempsey, J.W.V. Storey, *Auroral contribution to Sky Brightness on the Antarctic Plateau*