



AURIC – UV background

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Basic notes

- Next slides contain results of AURIC calculations only for airglow emission in upward direction.
- There is no Albedo effect from - zodiac light, star light and airglow.
- All calculations was provided in altitude 400 km for nadir looking angle for night 20 – 21 of given month.
- Definition of night – zenith angle of sun is bigger than 110 degrees.
- Preliminary results – we need to compare our results with existing data.
- AURIC model provided by Computational Physics, Inc.
- AURIC reference: D. J. Strickland, J. E. Bishop, J. S. Evans, T. Majeed, P. M. Shen, R. J. Cox, R. Link, and R. E. Huffman, Atmospheric ultraviolet radiance integrated code (AURIC): theory, software architecture, inputs, and selected results, *J. Quant. Spectr. Rad. Transfer*, 62, 689, 1999.

AURIC - short introduction

- UV background in AURIC is produced by Herzberg I, II and Chamberlain emission inside range 300 - 400 nm.
- these emissions result from reactions involving downward diffusing atomic oxygen generated on the dayside by O_2 photodissociation.
- Recombination reaction:



- $M - O, O_2, N_2$
- Result of reaction is emission of photon

- Volume emission rate:

$$j_{\text{HzI}} = \frac{\varepsilon_{\text{HzI}} A_1 k_{43} [\text{O}]^2 [\text{M}]}{A_1 + k_{44}[\text{O}] + k_{45}[\text{O}_2] + k_{46}[\text{N}_2]},$$

$$j_{\text{Chm}} = \frac{\varepsilon_{\text{Chm}} A_2 k_{43} [\text{O}]^2 [\text{M}]}{A_2 + A_3 + k_{47}[\text{O}] + k_{48}[\text{O}_2]},$$

$$j_{\text{HzII}} = \frac{\varepsilon_{\text{HzII}} A_4 k_{43} [\text{O}]^2 [\text{M}]}{A_4 + k_{49}[\text{O}] + k_{50}[\text{O}_2]},$$

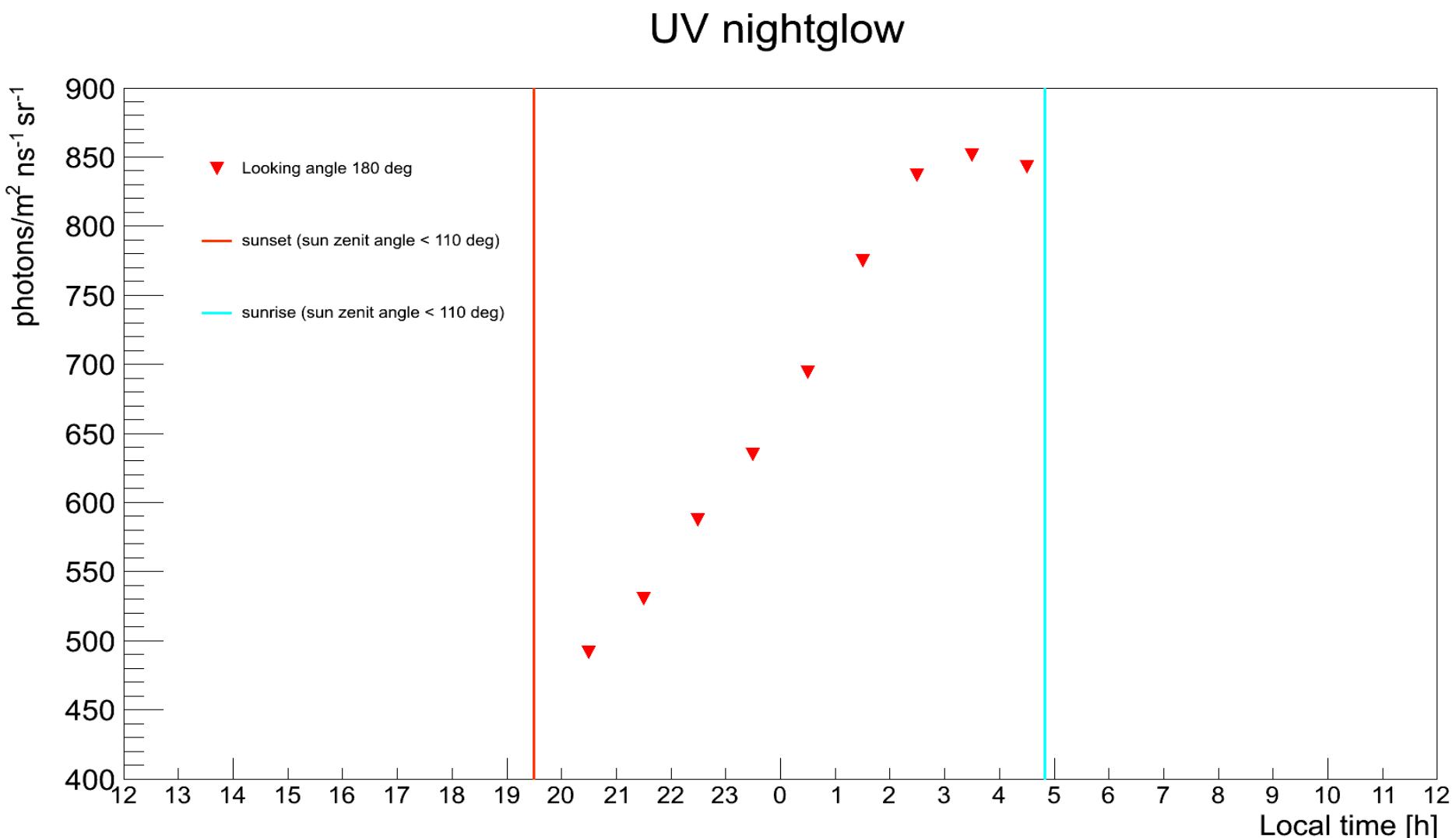
- $[\text{O}]$, $[\text{M}]$, $[\text{O}_2]$, $[\text{N}_2]$ – densities of corresponding atoms and molecules

$$k_{43} = 2.1 \times 10^{-32} (200/T_n)^2$$

- T_n - temperature
- $A_1, A_2, A_4, k_{44}, k_{45}, k_{46}, k_{47}, k_{48}, k_{49}, k_{50}$ - rate coefficients
- $\varepsilon_{\text{HzI}}, \varepsilon_{\text{Chm}}, \varepsilon_{\text{HzII}}$ production efficiencies

UV nightglow during one night

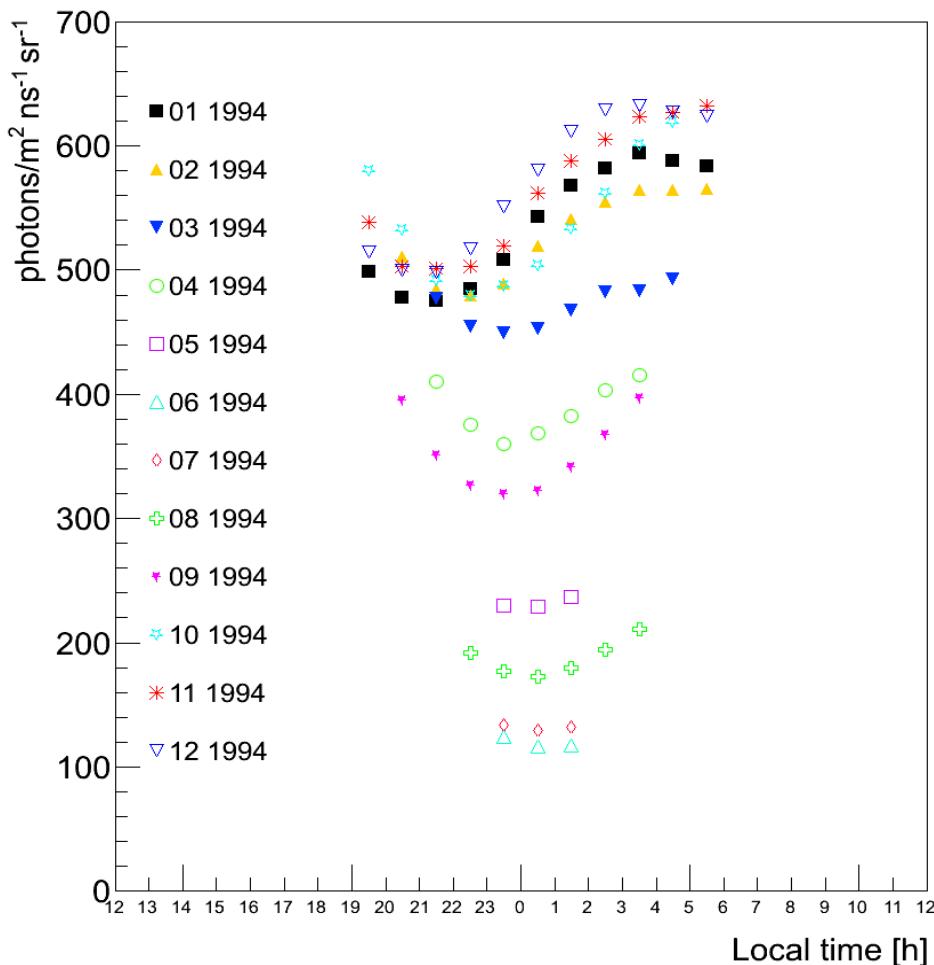
- Night 1994/03/20 – 21.
- Position: latitude – 0, longitude – 45.
- UV nightglow is not constant during night.



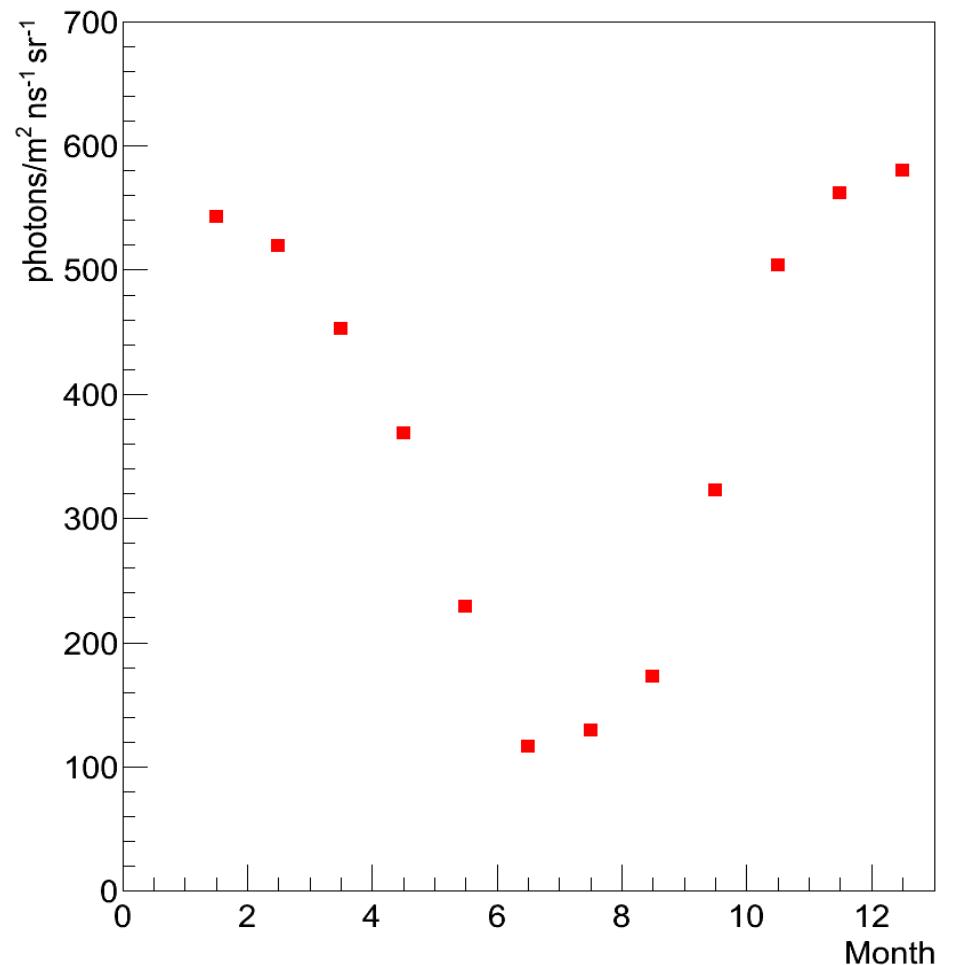
Seasonal dependence of UV nightglow

- Lat 45, long 45, 1994 – only one night (20-21) at each month.
- UV nightglow is not constant during night for most months.
- UV nightglow is seasonal dependent.

UV nightglow all night



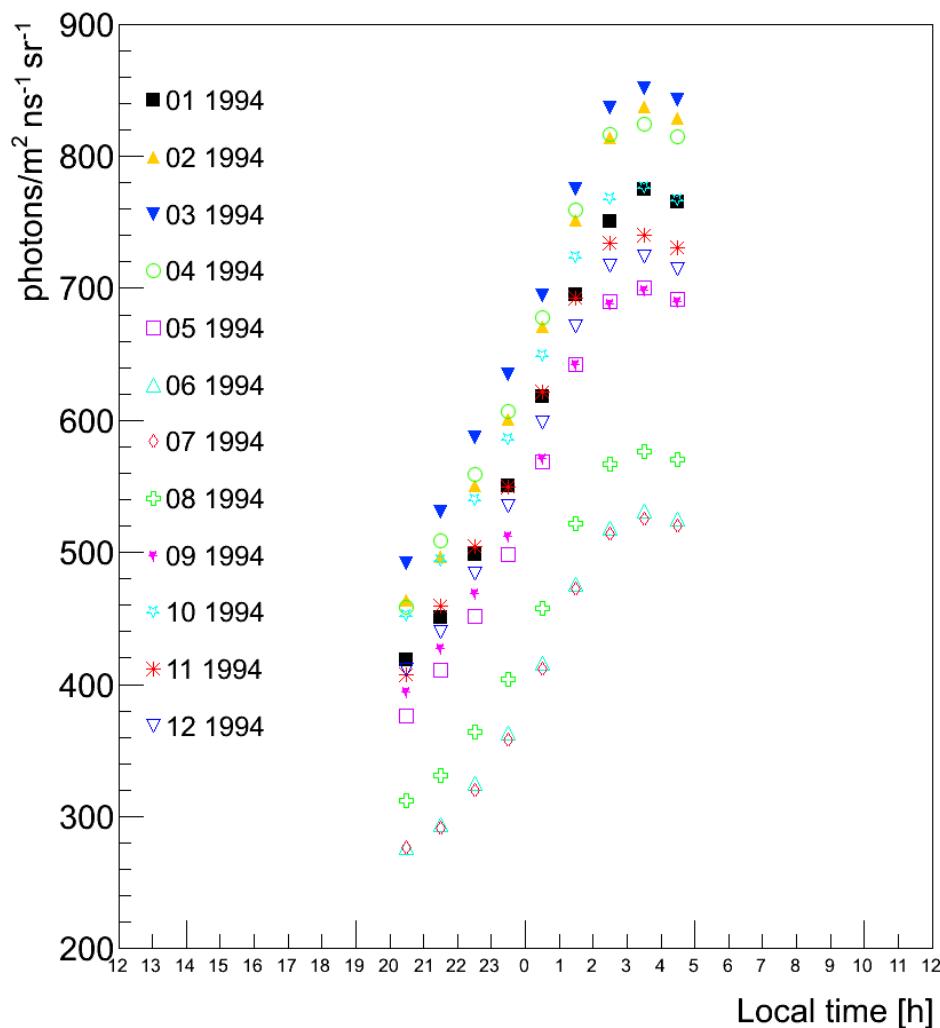
UV nightglow 00:00



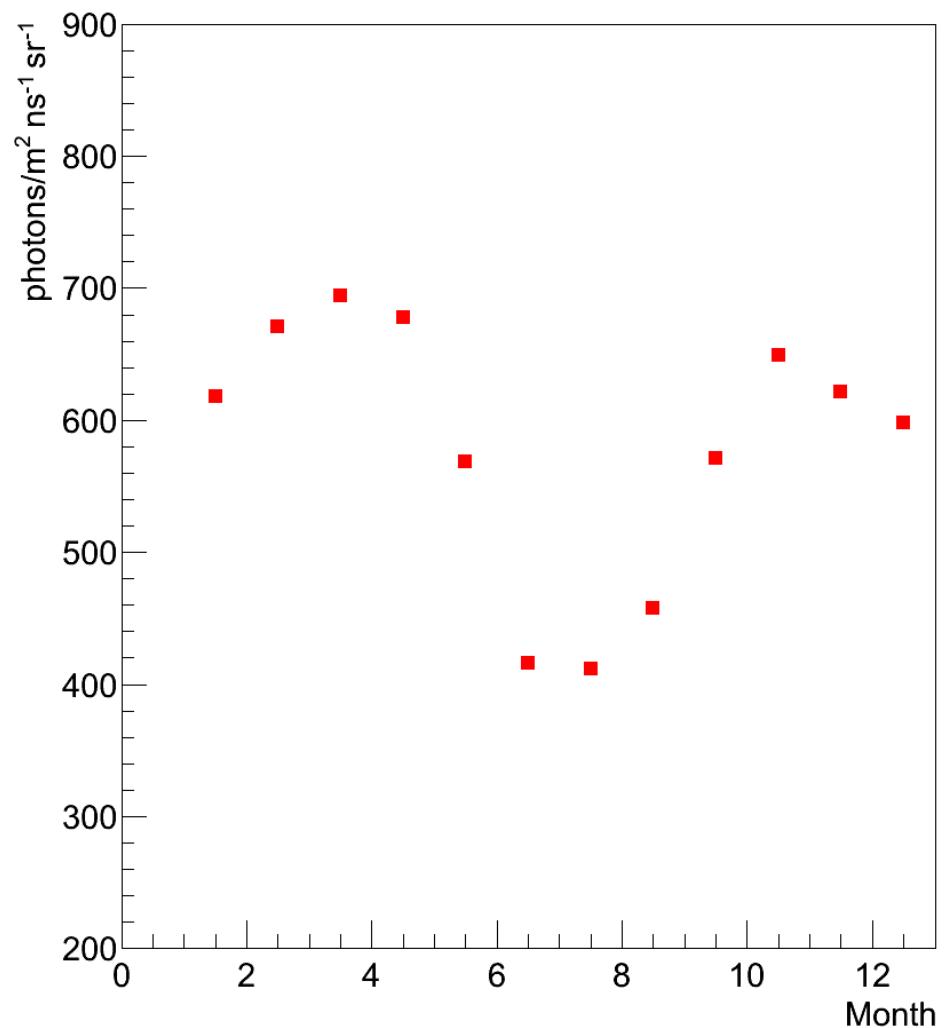
Seasonal dependence of UV nightglow

- Lat 0, long 45, 1994 – only one night (20-21) at each month.
- On equator – UV nightglow strongly increase.

UV nightglow all night



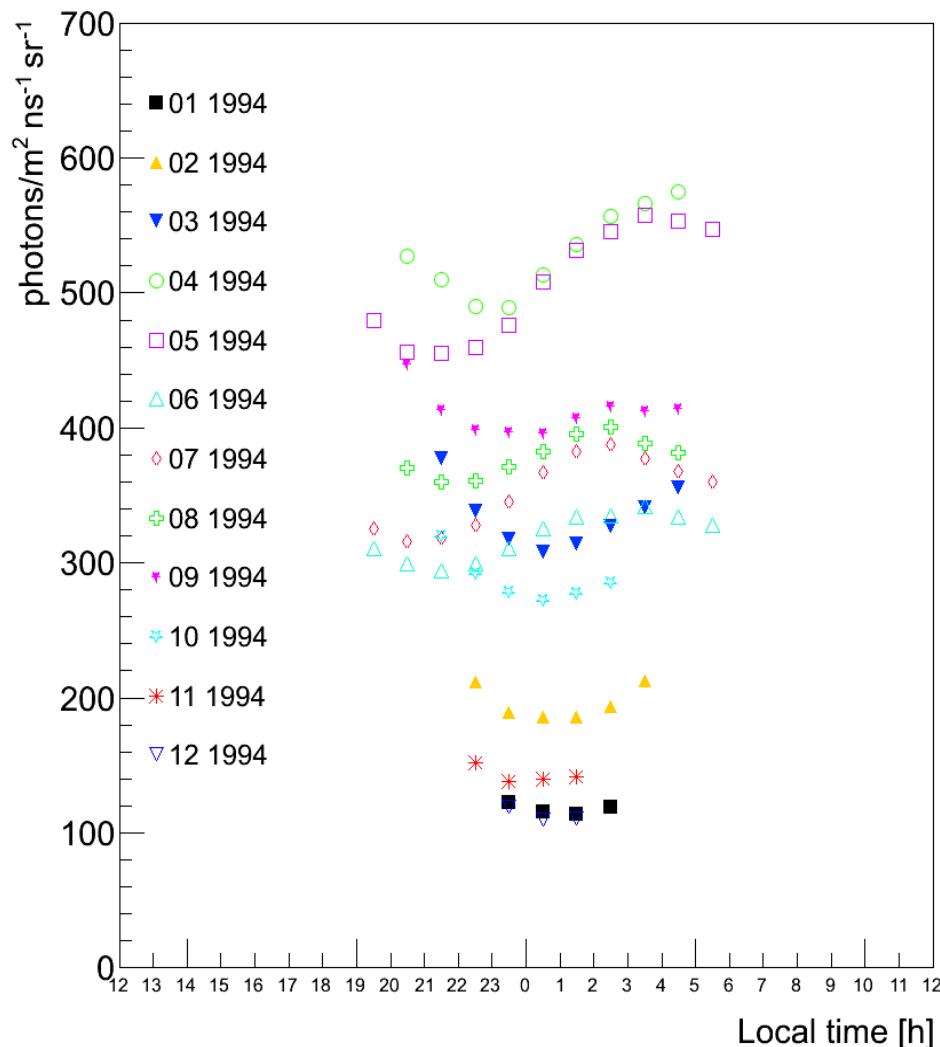
UV nightglow 00:00



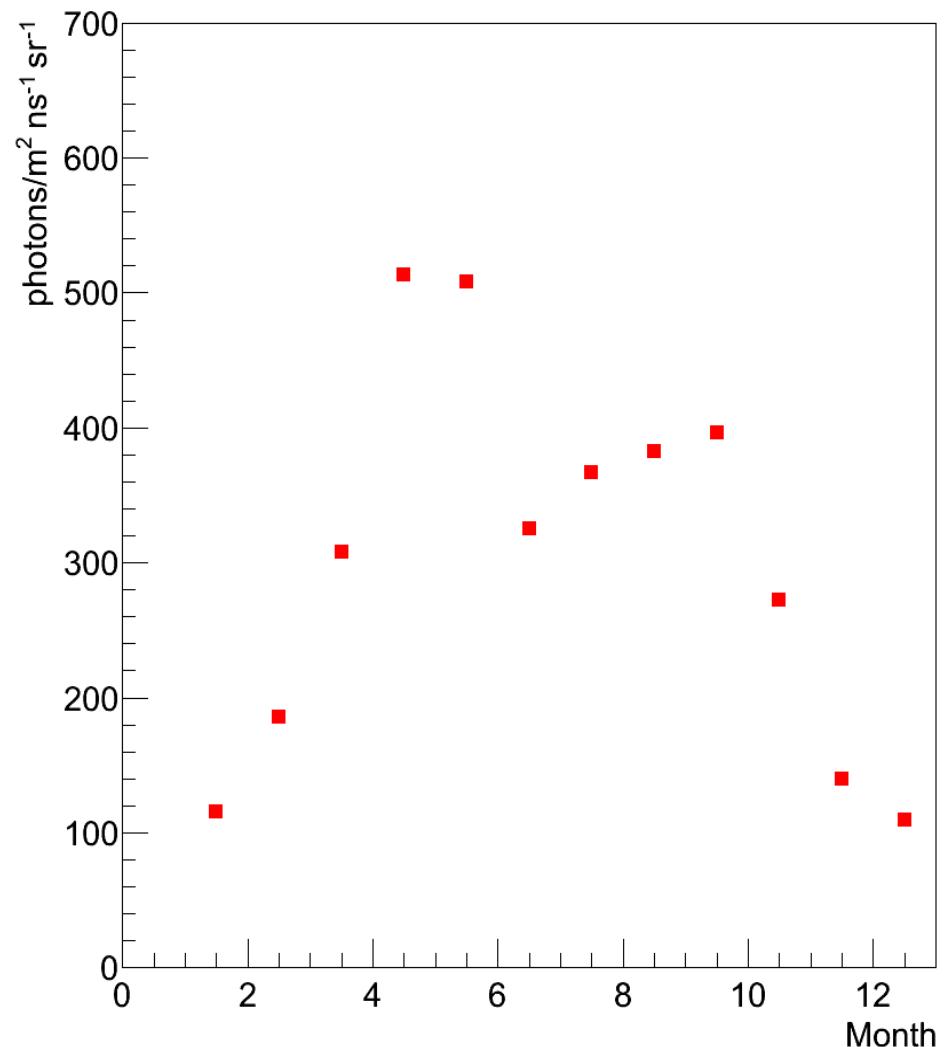
Seasonal dependence of UV background

- Lat -45, long 45, 1994— only one night (20-21) at each month.
- Opposite situation like on north hemisphere.

UV nightglow all night

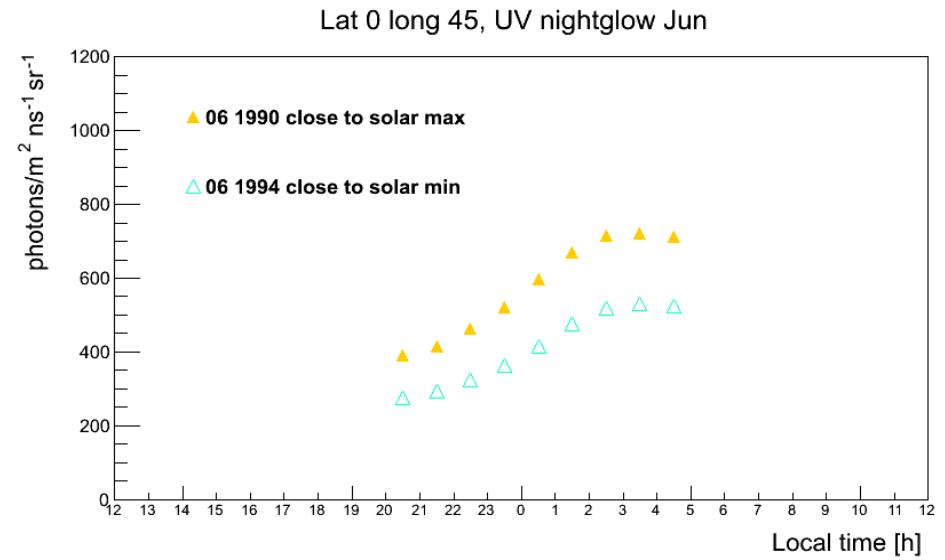
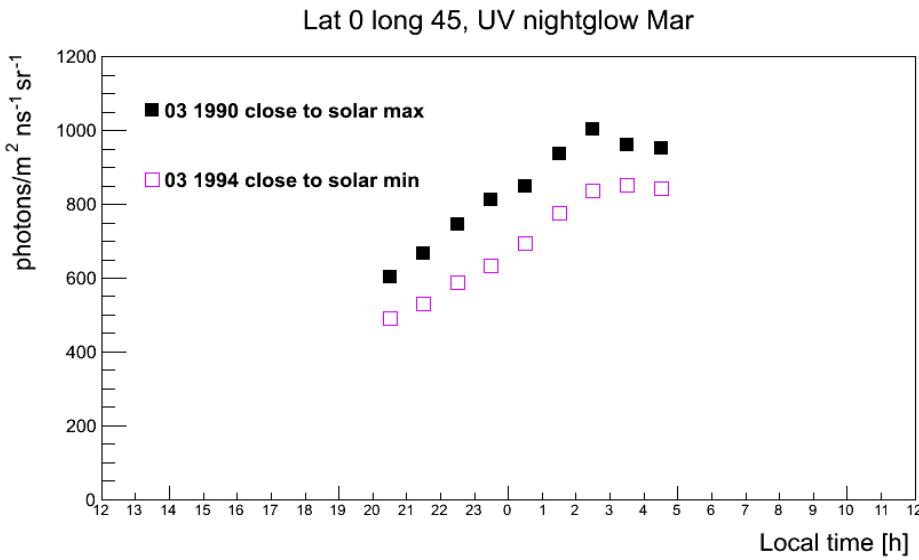


UV nightglow 00:00



Comparison of nightglow – 1990 (close to solar max) vs 1994 (close to solar min)

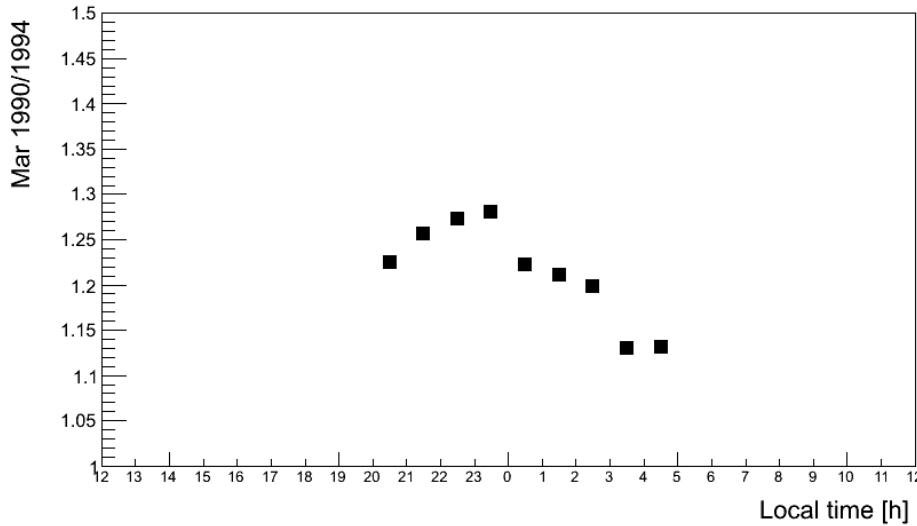
- 1990, 1994 – night from 20 -21 for March, Jun, September, December
- Dependence on solar activity.
- Bigger values close to solar maximum.



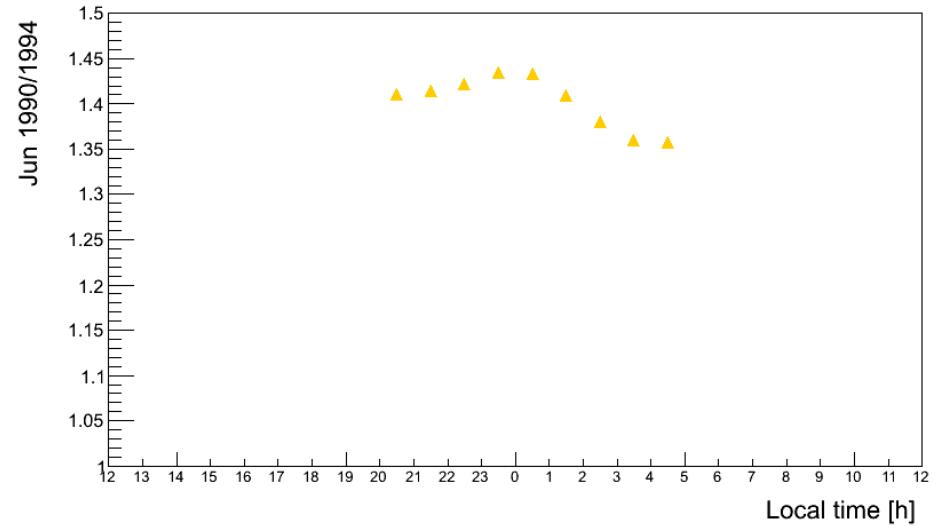
Ratio - 1990 vs 1994

- For March and September ~ 20-25%
- For Jun and December ~ 40-45 %

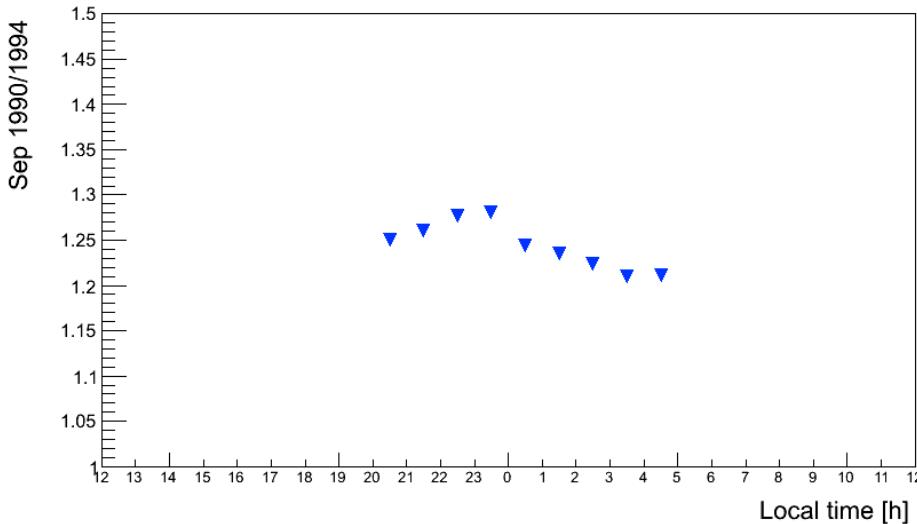
Lat 0 long 45, UV nightglow Mar, Ratio 1990/1994



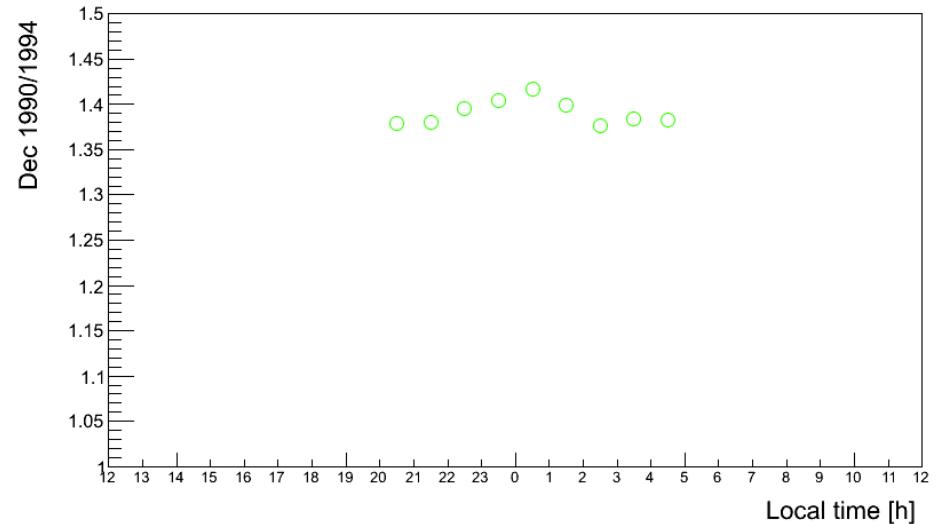
Lat 0 long 45, UV nightglow Jun Ratio 1990/1994



Lat 0 long 45, UV nightglow Sep Ratio 1990/1994

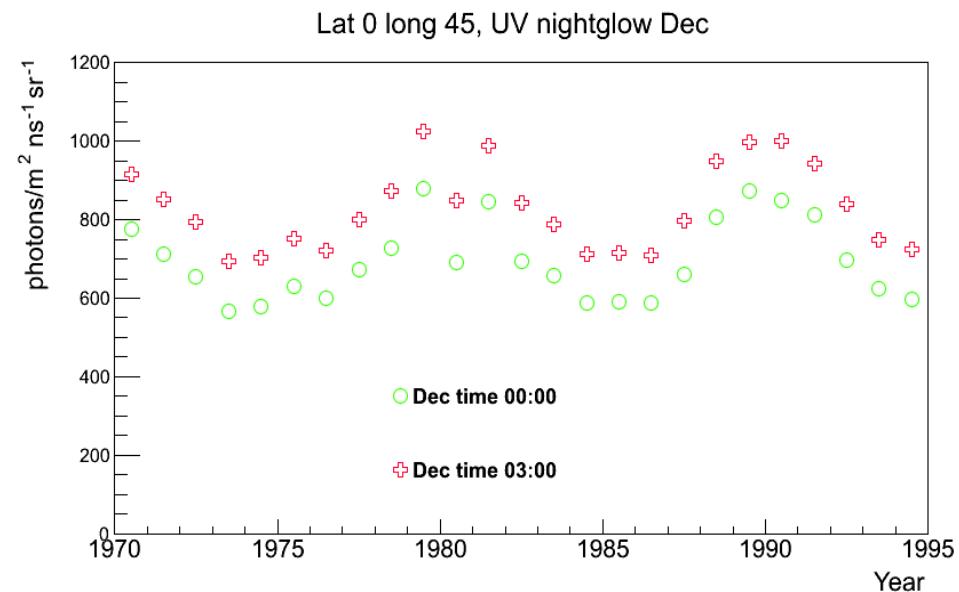
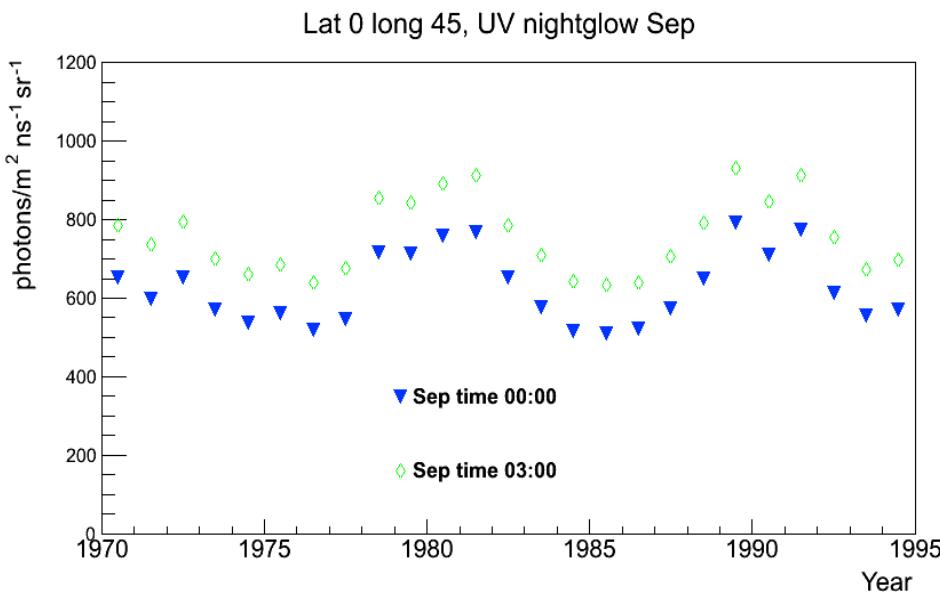
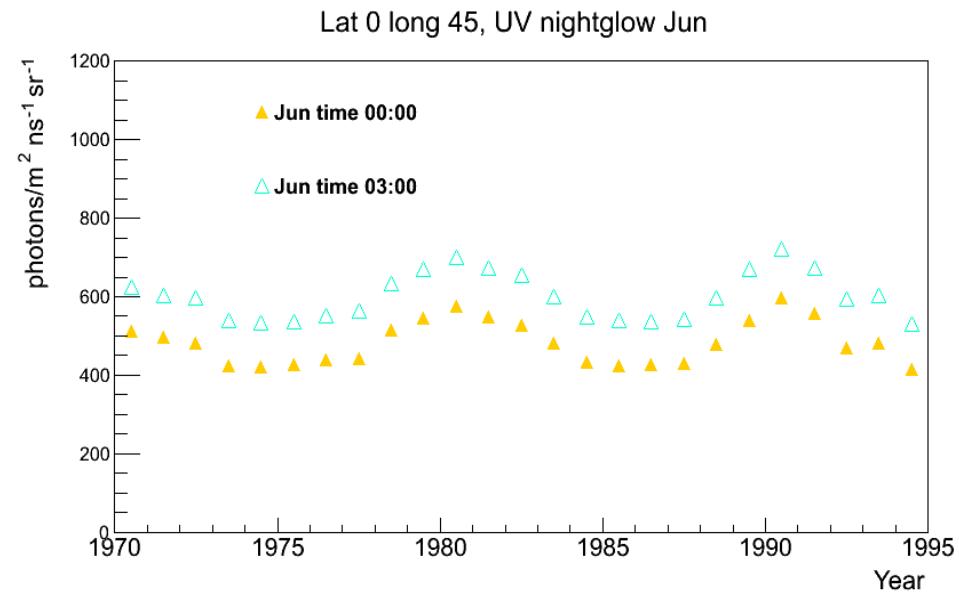
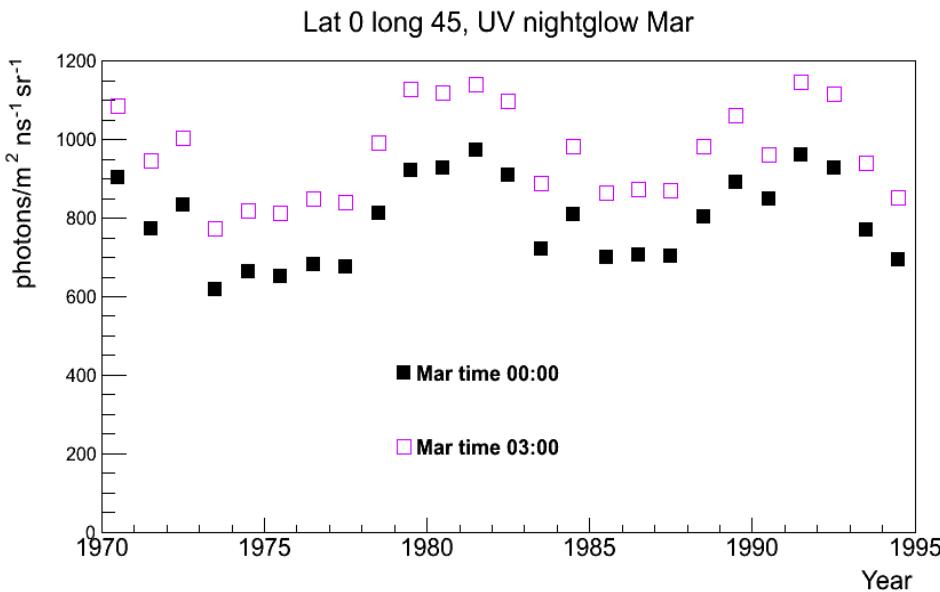


Lat 0 long 45, UV nightglow Dec Ratio 1990/1994



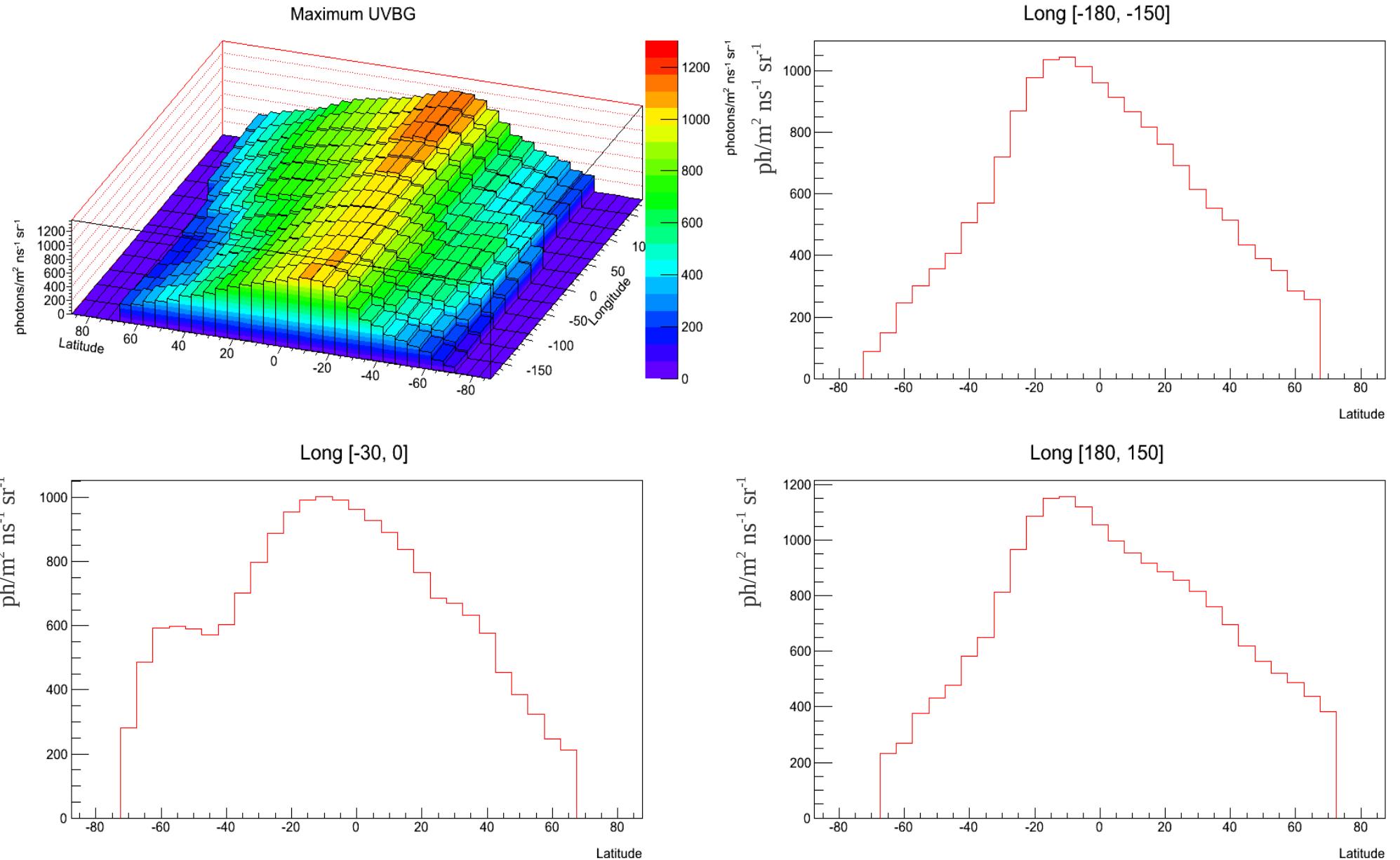
1970 – 1994 of solar activity

- Nightglow is correlated with solar activity.



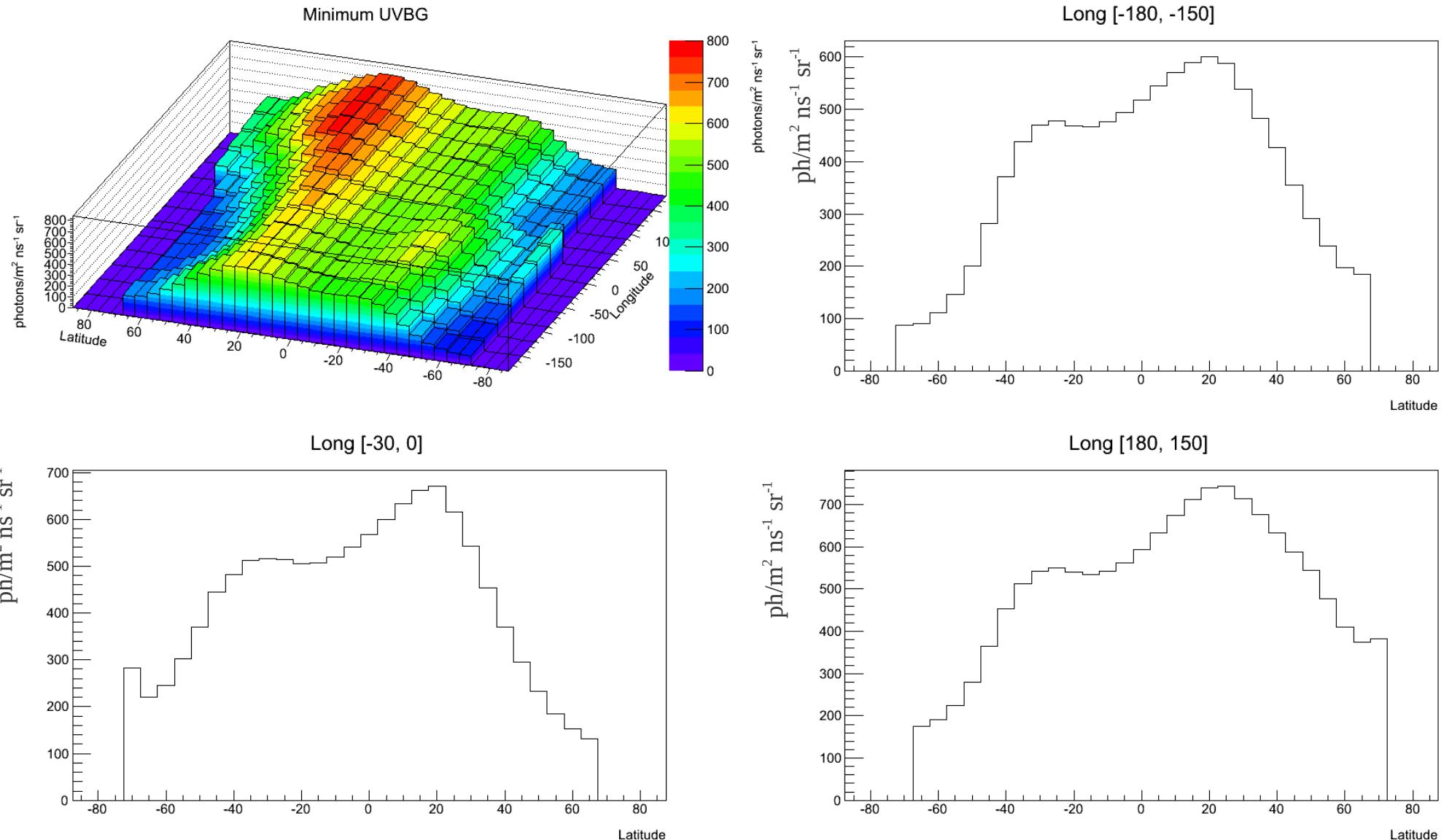
Map of maximal values of nightglow, 1990 (close to solar max), March 20-21

- Range of values $\sim (100 - 1200) \text{ ph/m}^2 \text{ ns}^{-1} \text{ sr}^{-1}$



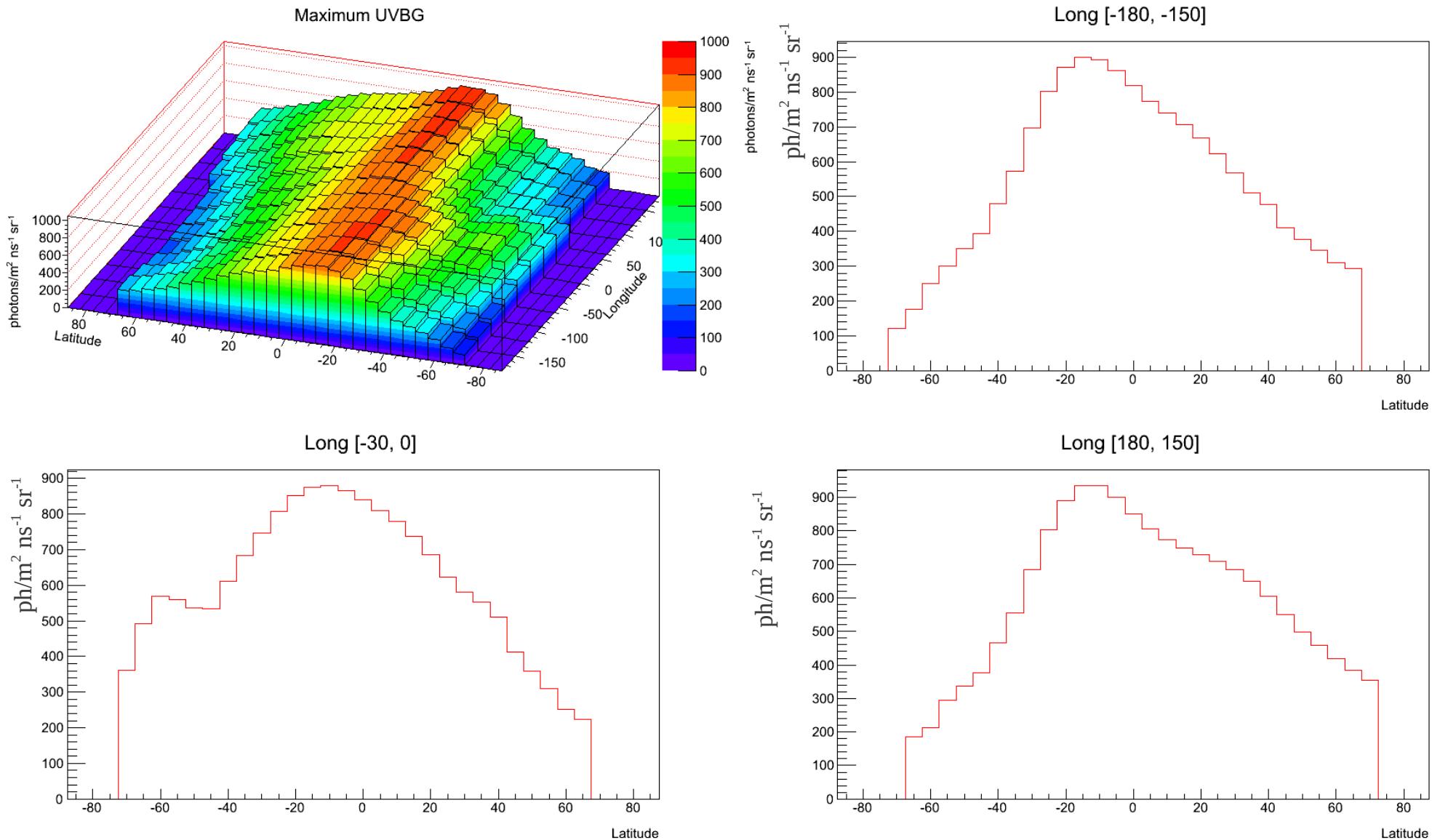
Map of minimal values of nightglow, 1990 (close to solar max), March 20-21

- Range of values $\sim (100 - 700)$ ph/m² ns⁻¹ sr⁻¹



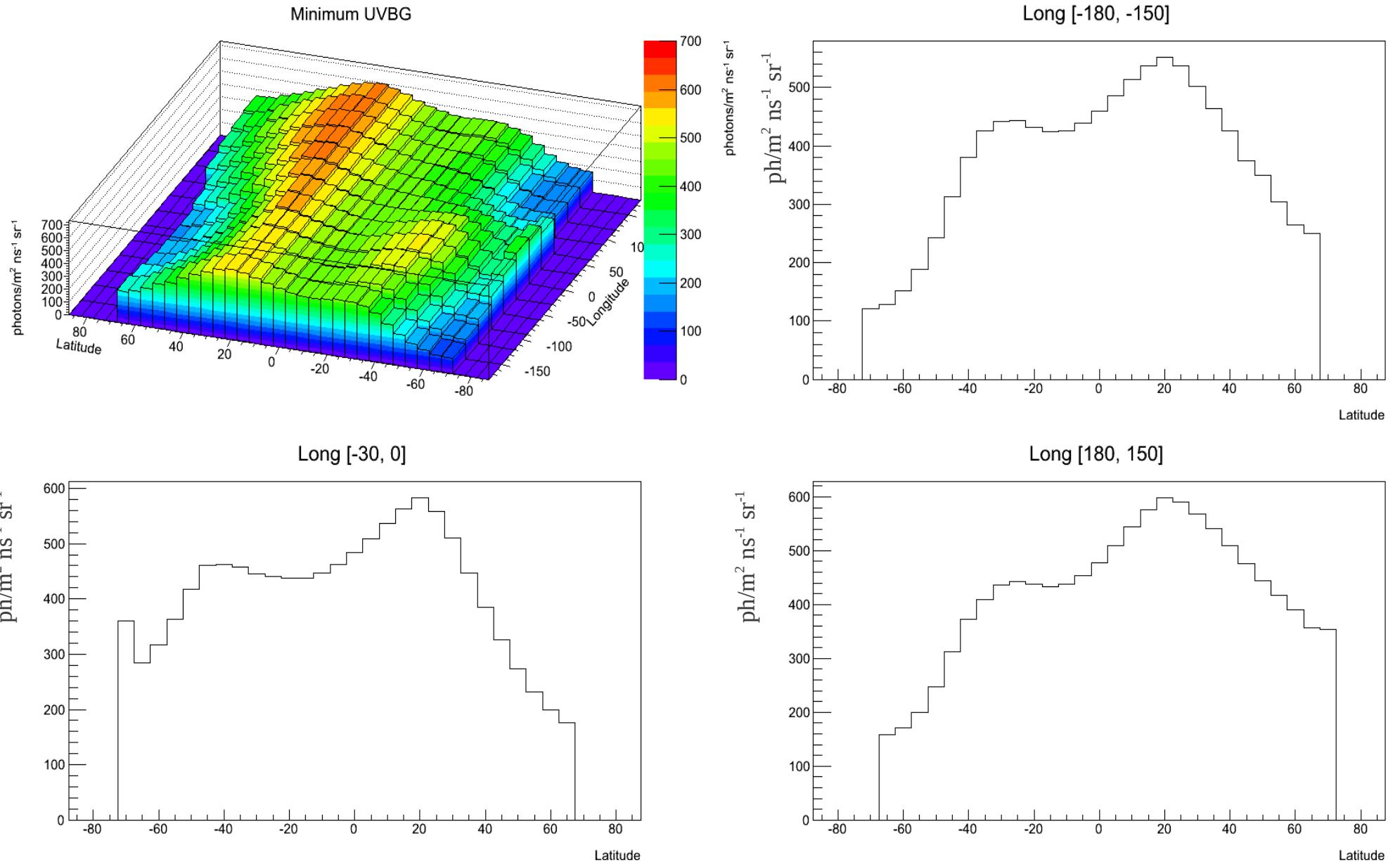
Map of maximal values of nightglow, 1994 (close to solar min), March 20-21

- Range of values $\sim (100 - 900) \text{ ph/m}^2 \text{ ns}^{-1} \text{ sr}^{-1}$



Map of minimal values of nightglow, 1994 (close to solar min), March 20-21

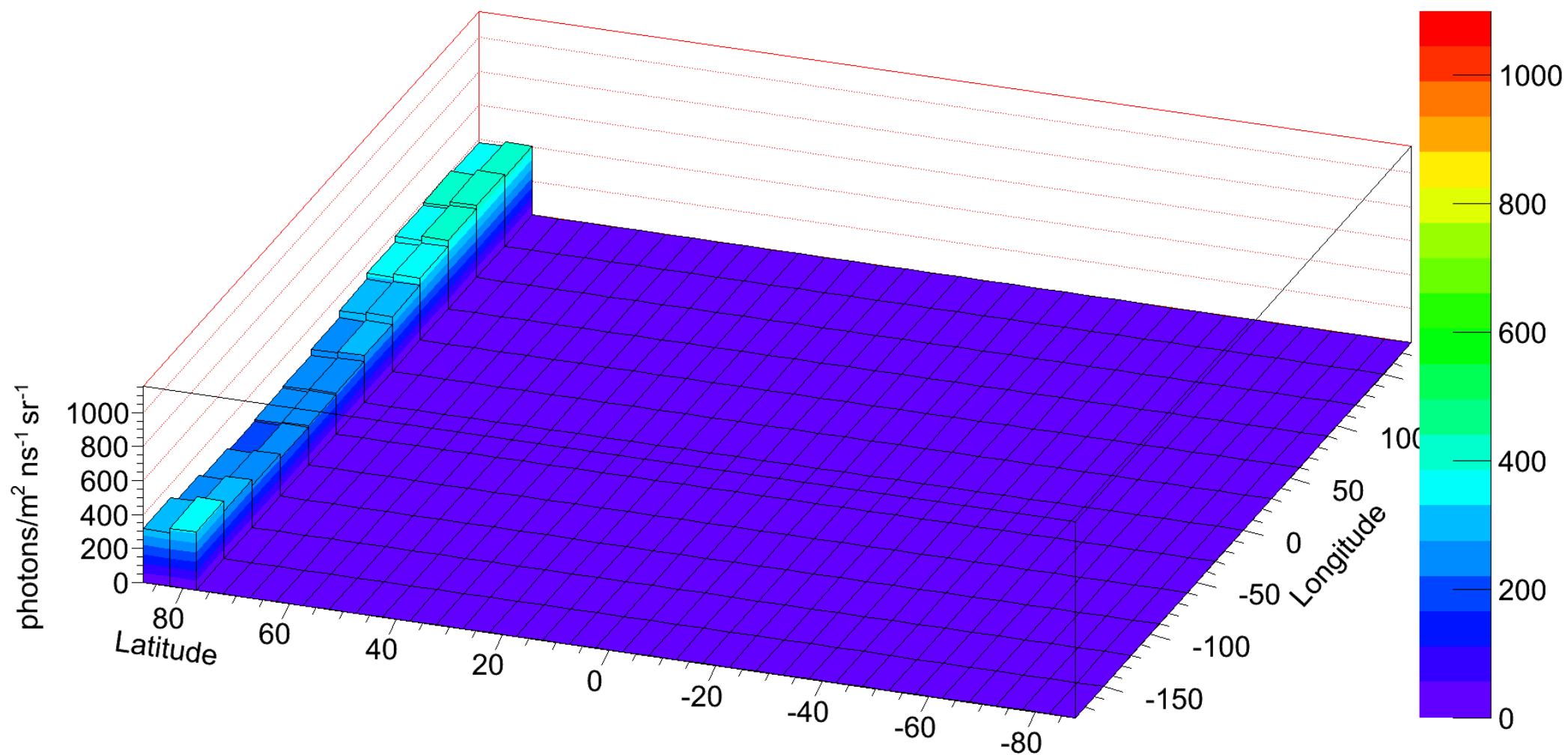
- Range of values $\sim (100 - 600) \text{ ph/m}^2 \text{ ns}^{-1} \text{ sr}^{-1}$



Slides 17 – 32 shows how UV nightglow is changing with local time on the whole Earth (one night 1994, Dec. 20 - 21).

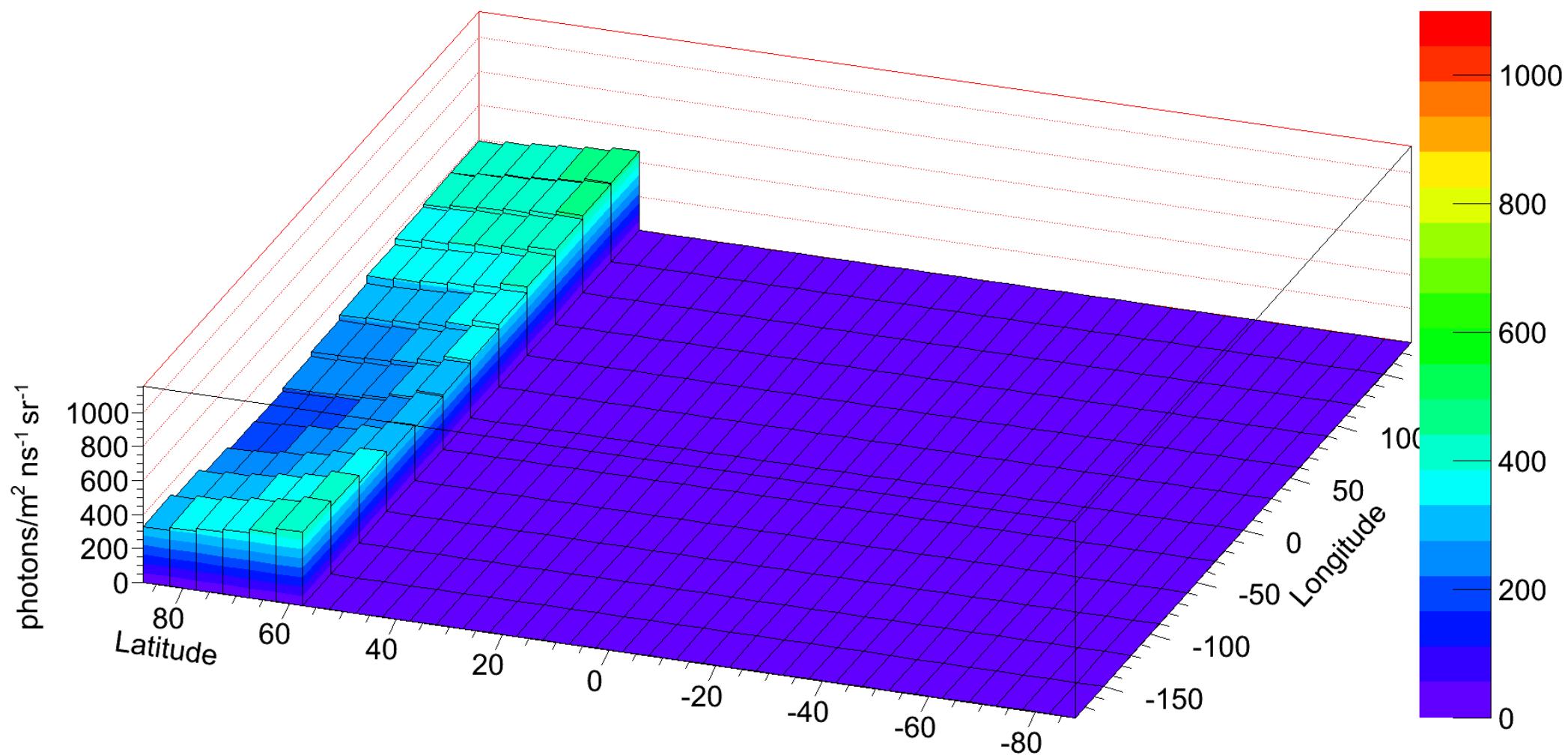
1994, 20 - 21 Dec, Local time

17 hour UVBG



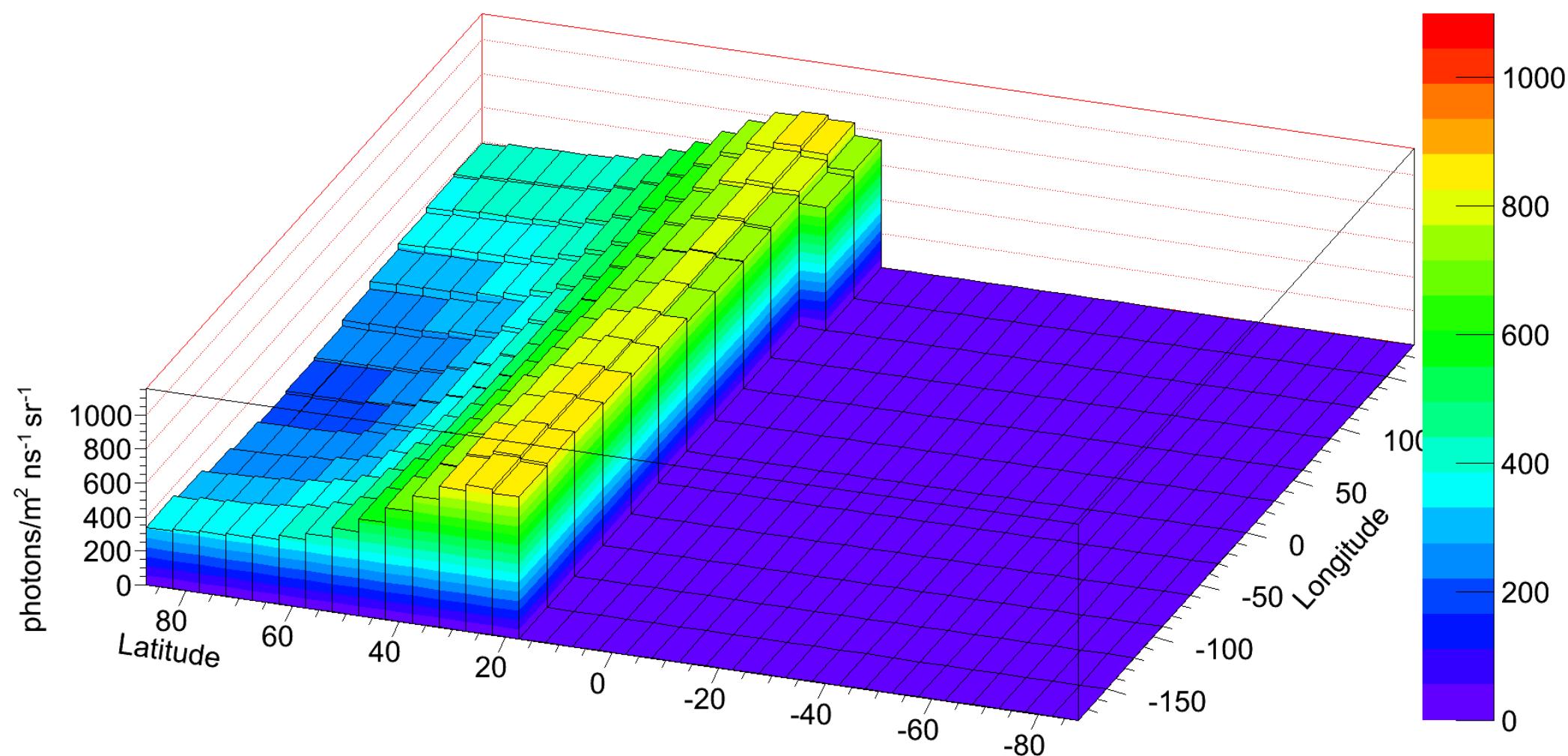
1994, 20 - 21 Dec, Local time

18 hour UVBG



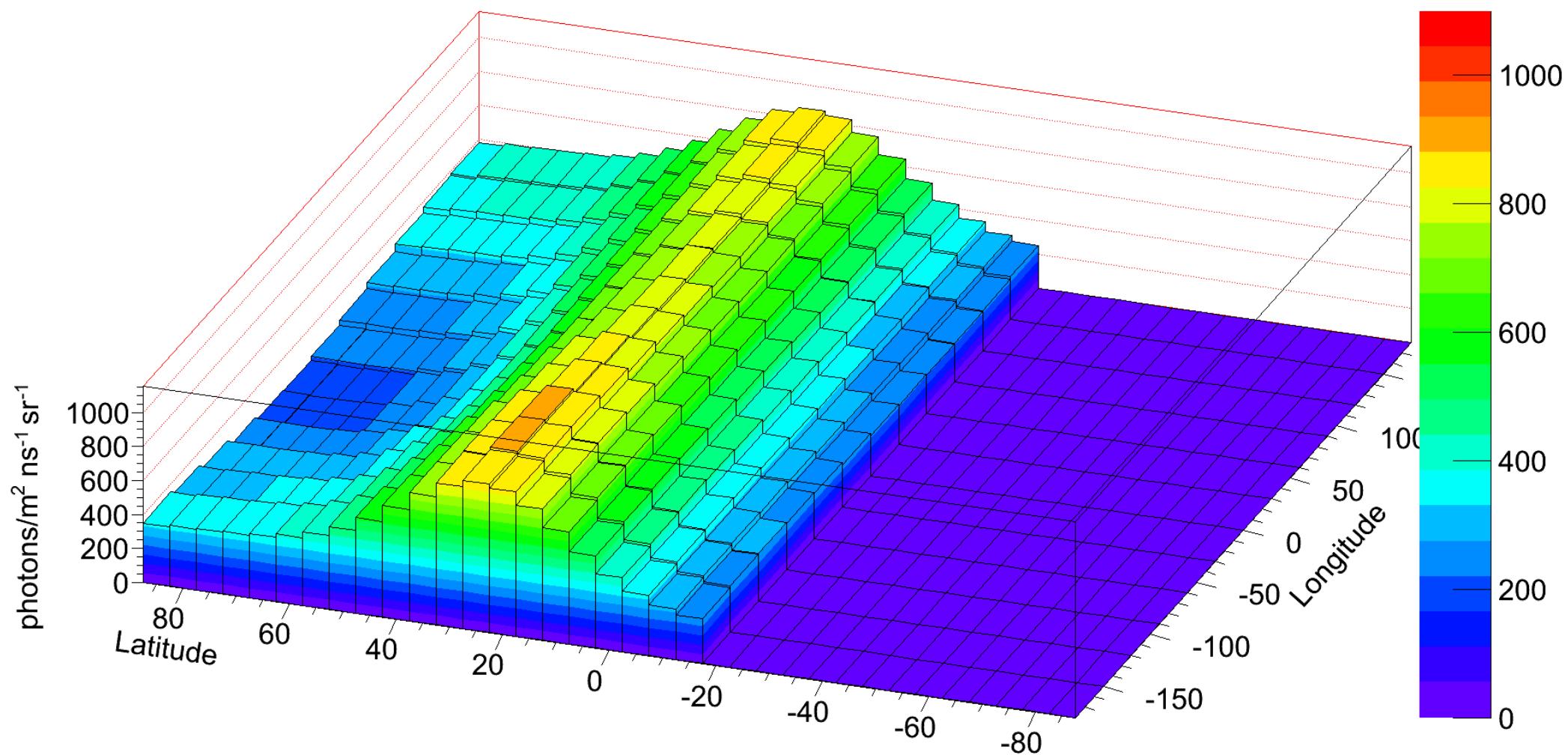
1994, 20 - 21 Dec, Local time

19 hour UVBG



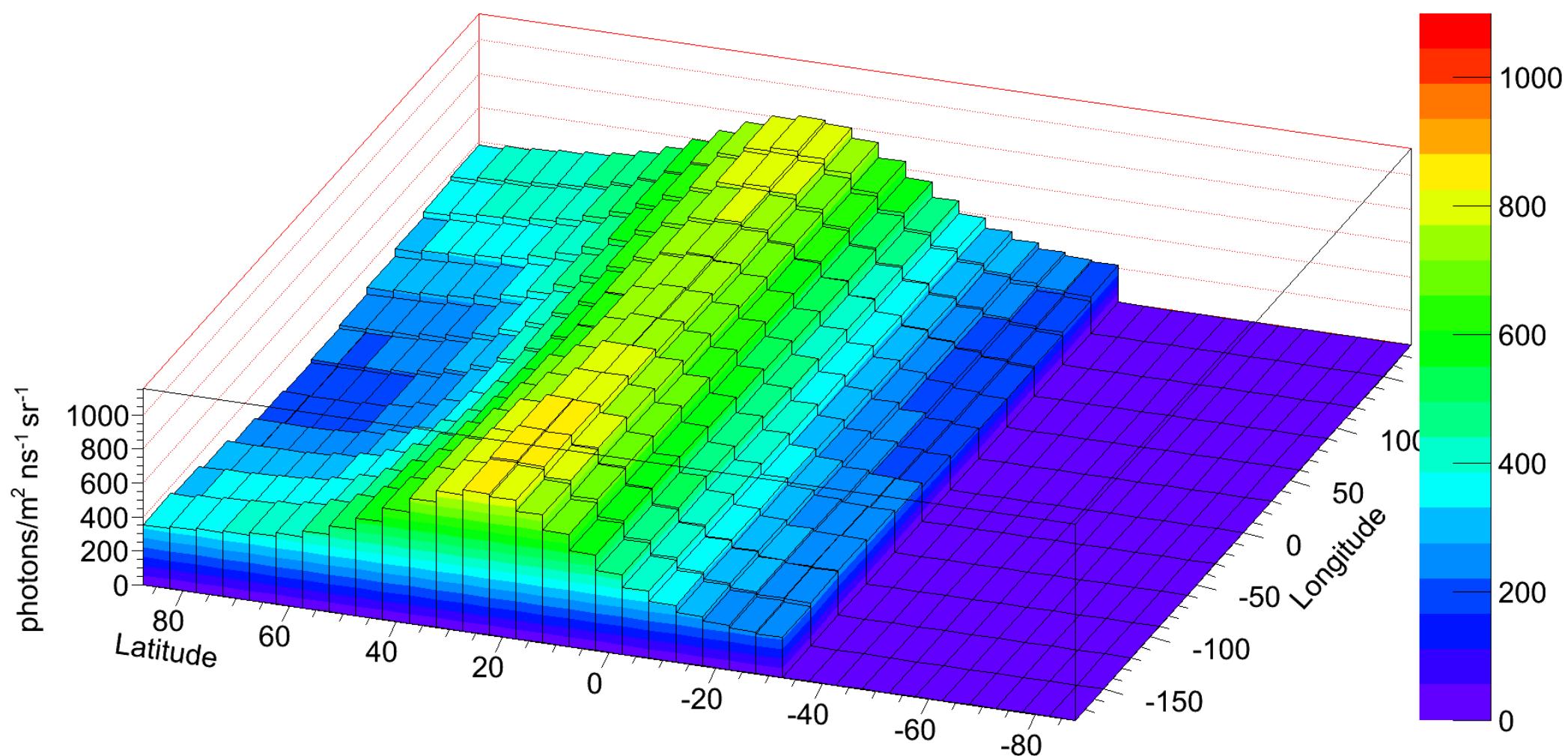
1994, 20 - 21 Dec, Local time

20 hour UVBG



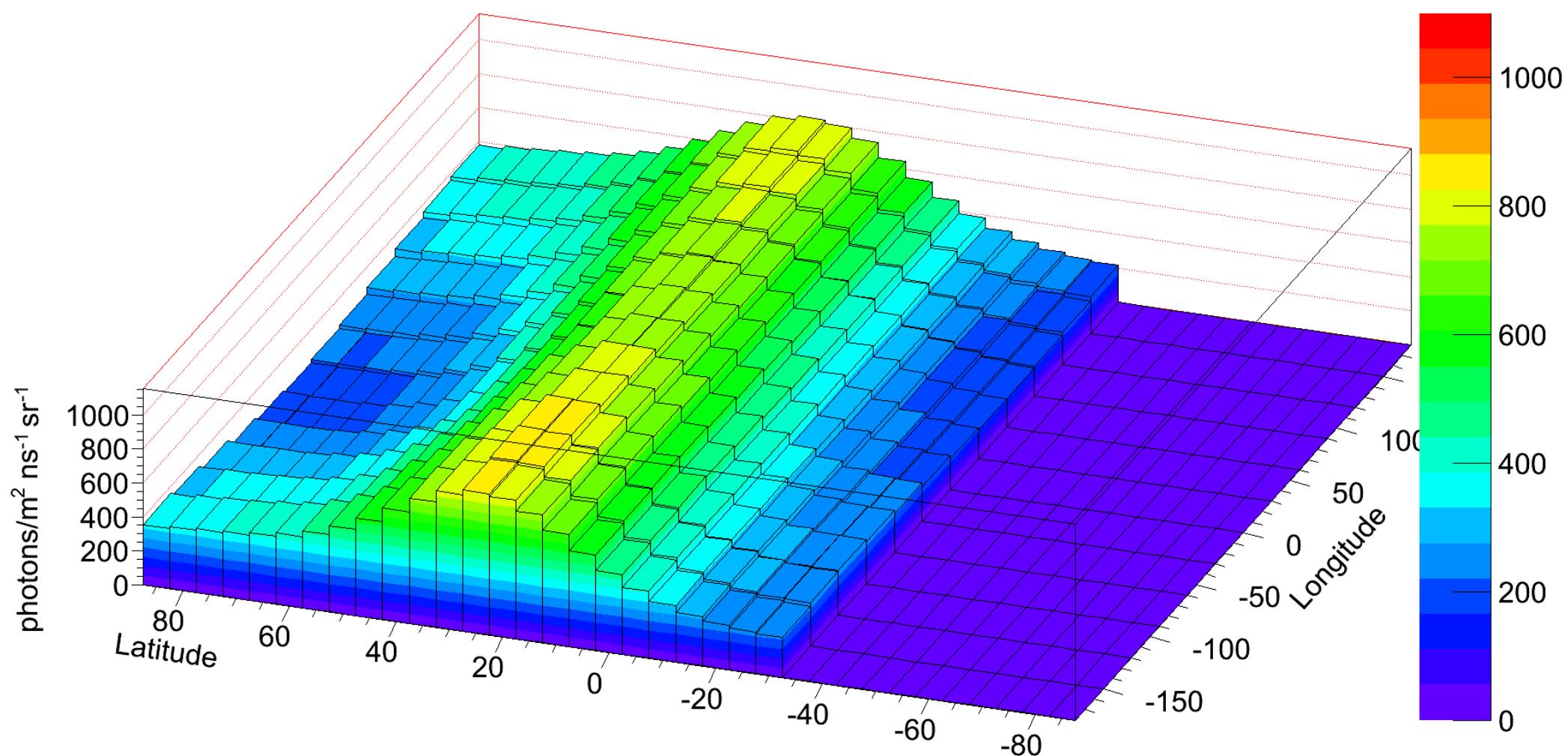
1994, 20 - 21 Dec, Local time

21 hour UVBG



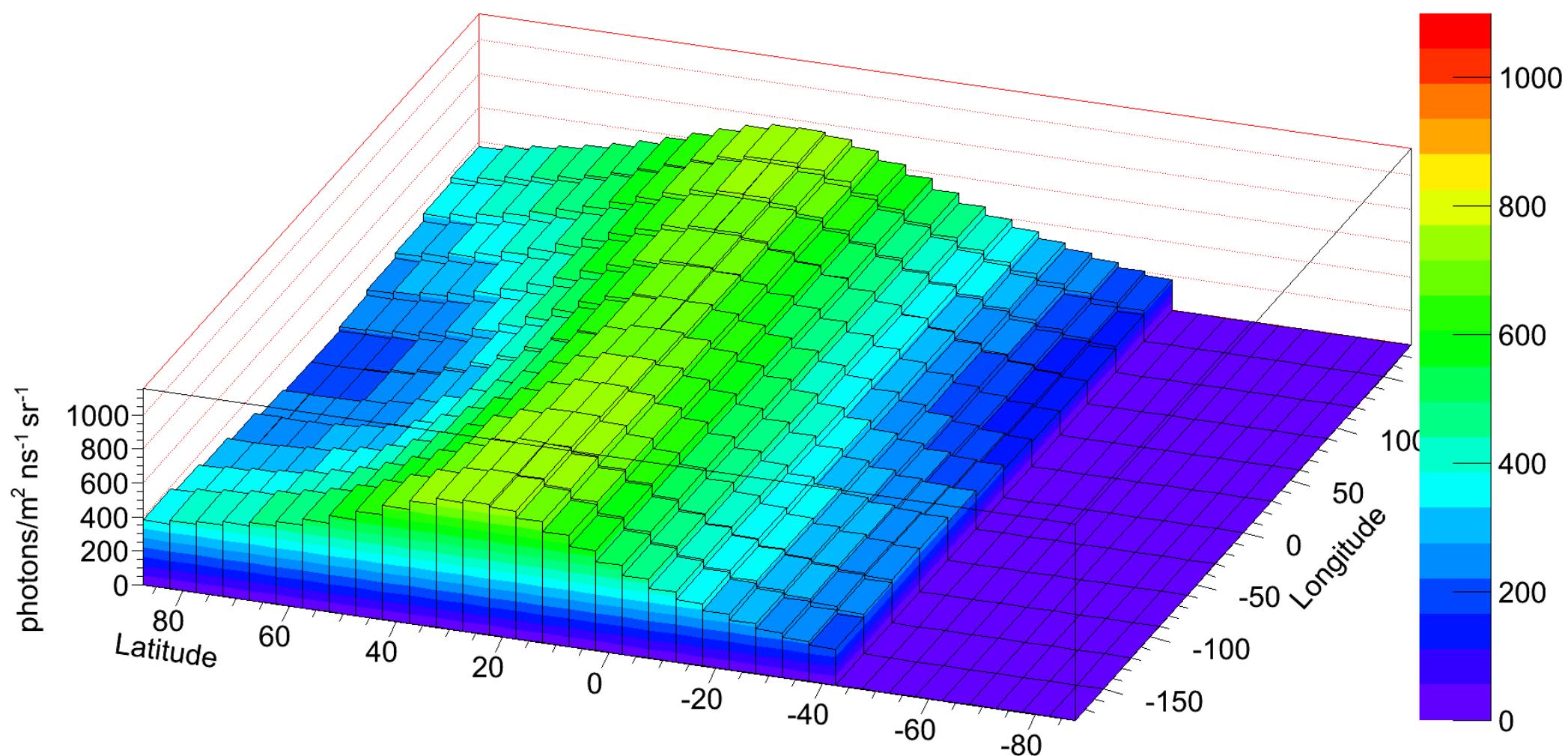
1994, 20 - 21 Dec, Local time

21 hour UVBG



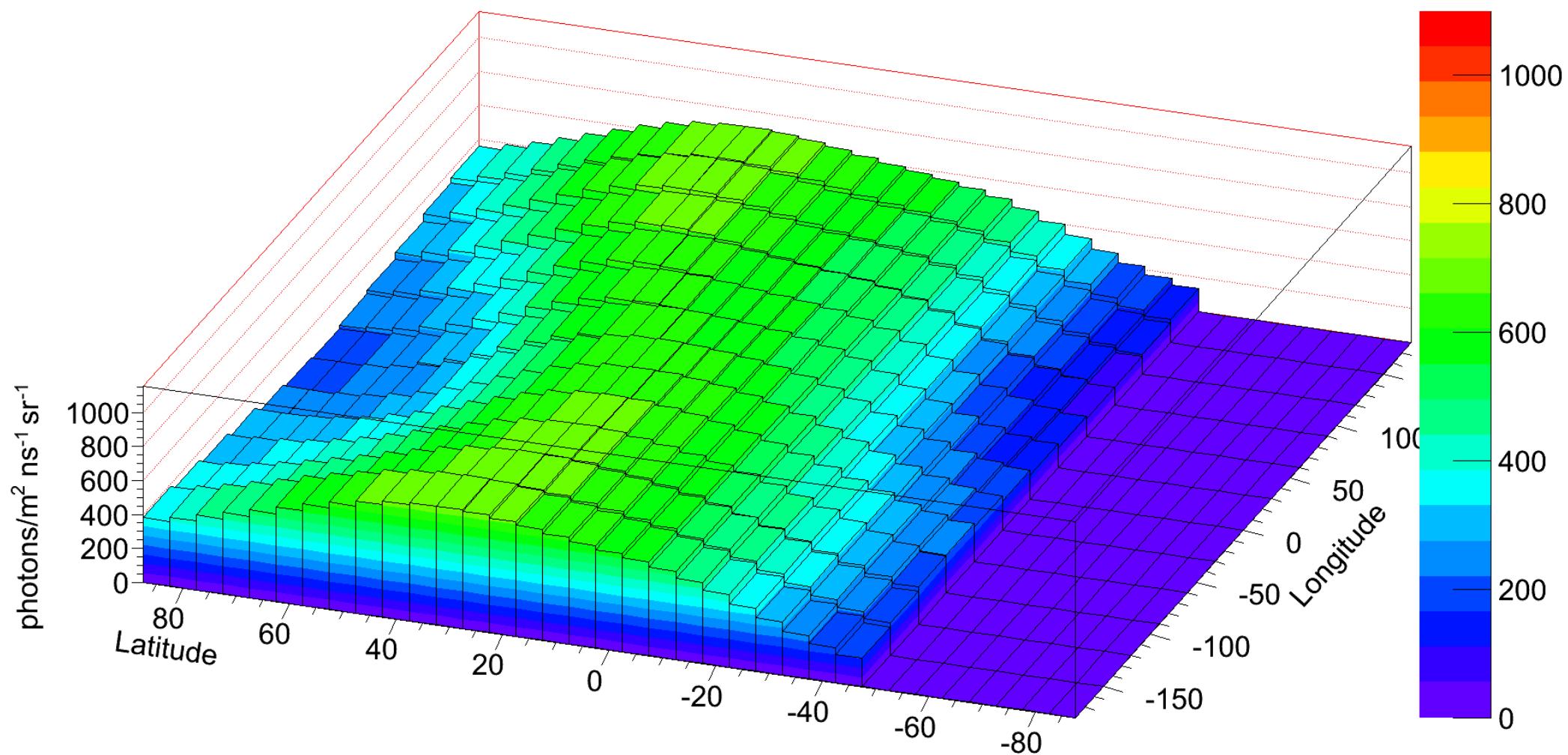
1994, 20 - 21 Dec, Local time

22 hour UVBG



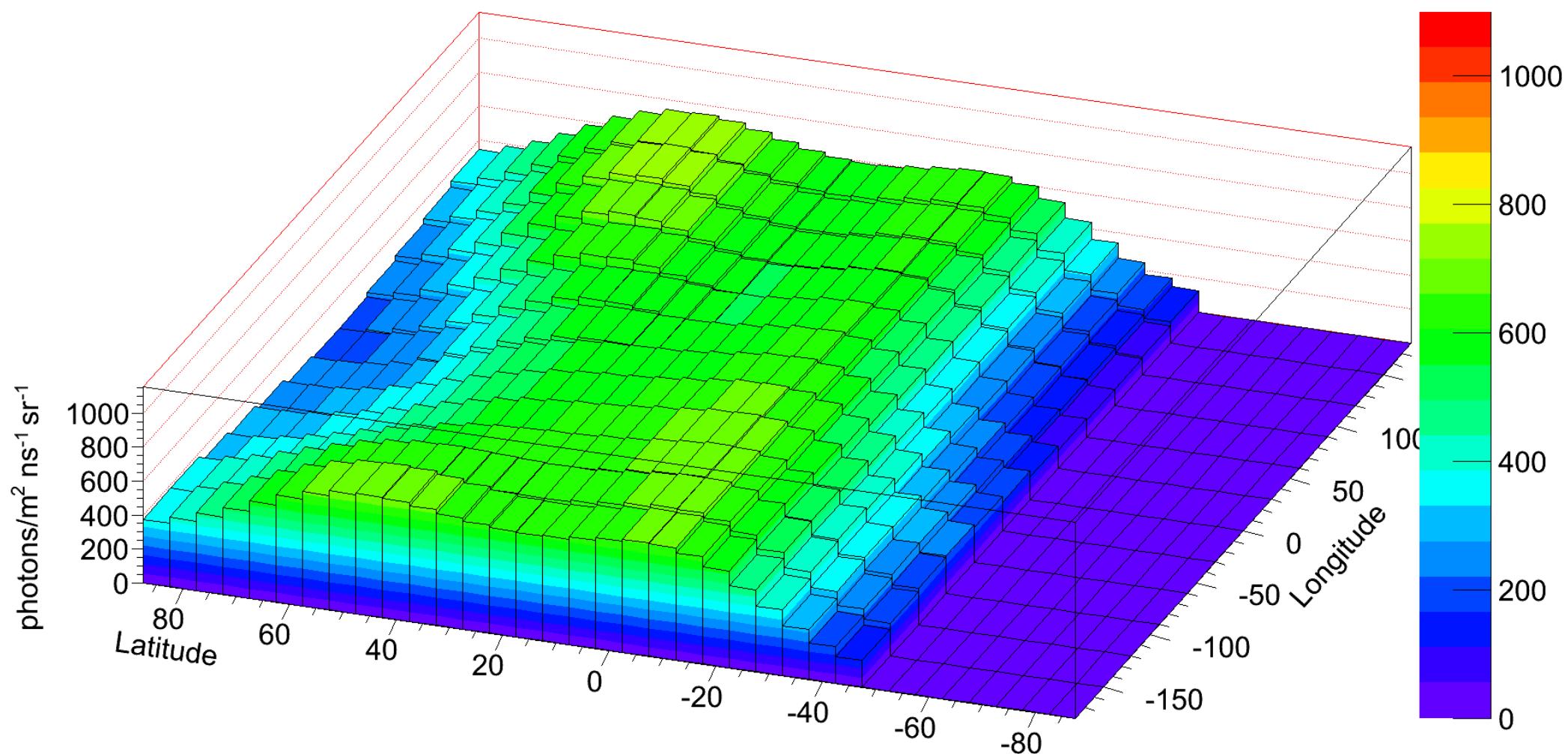
1994, 20 - 21 Dec, Local time

23 hour UVBG



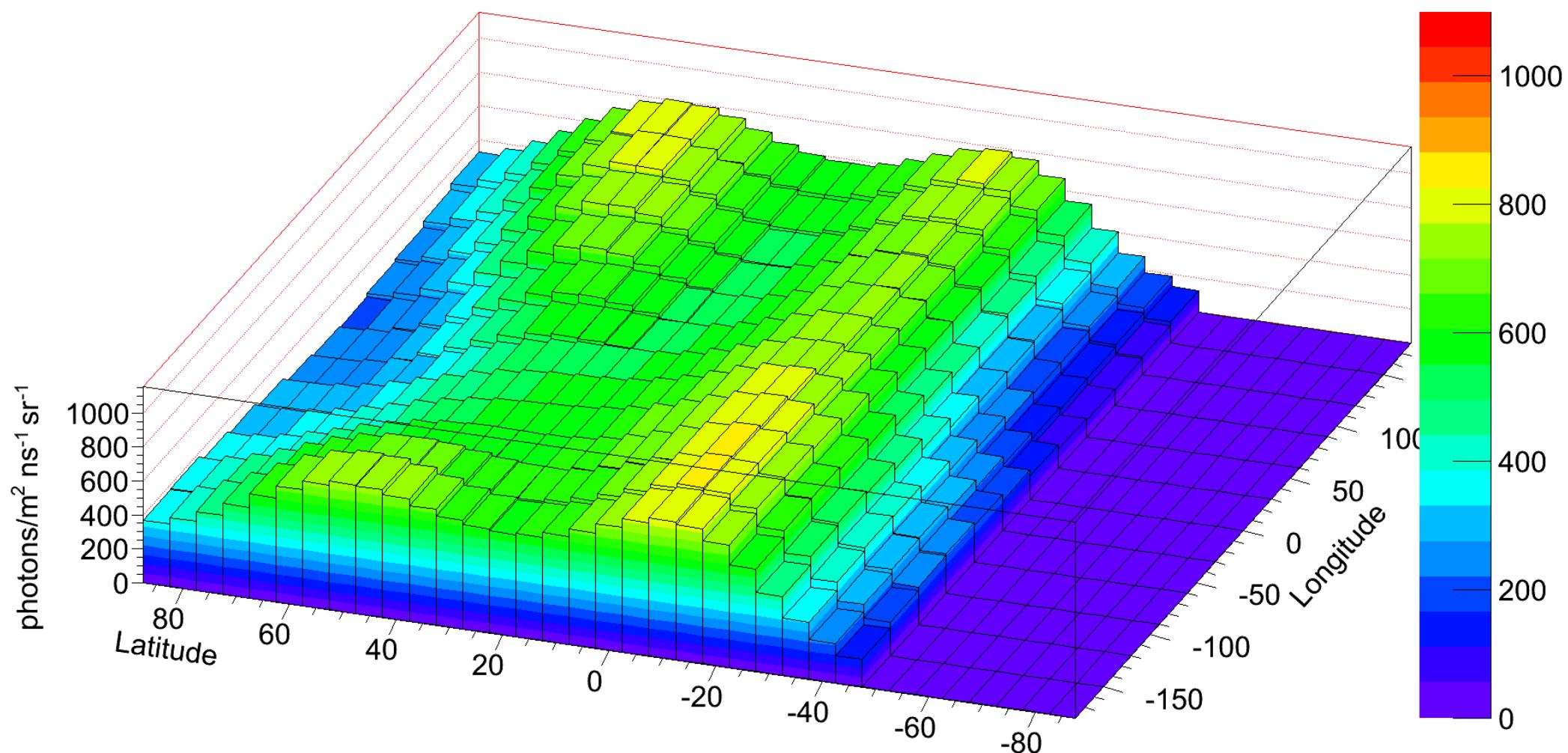
1994, 20 - 21 Dec, Local time

0 hour UVBG



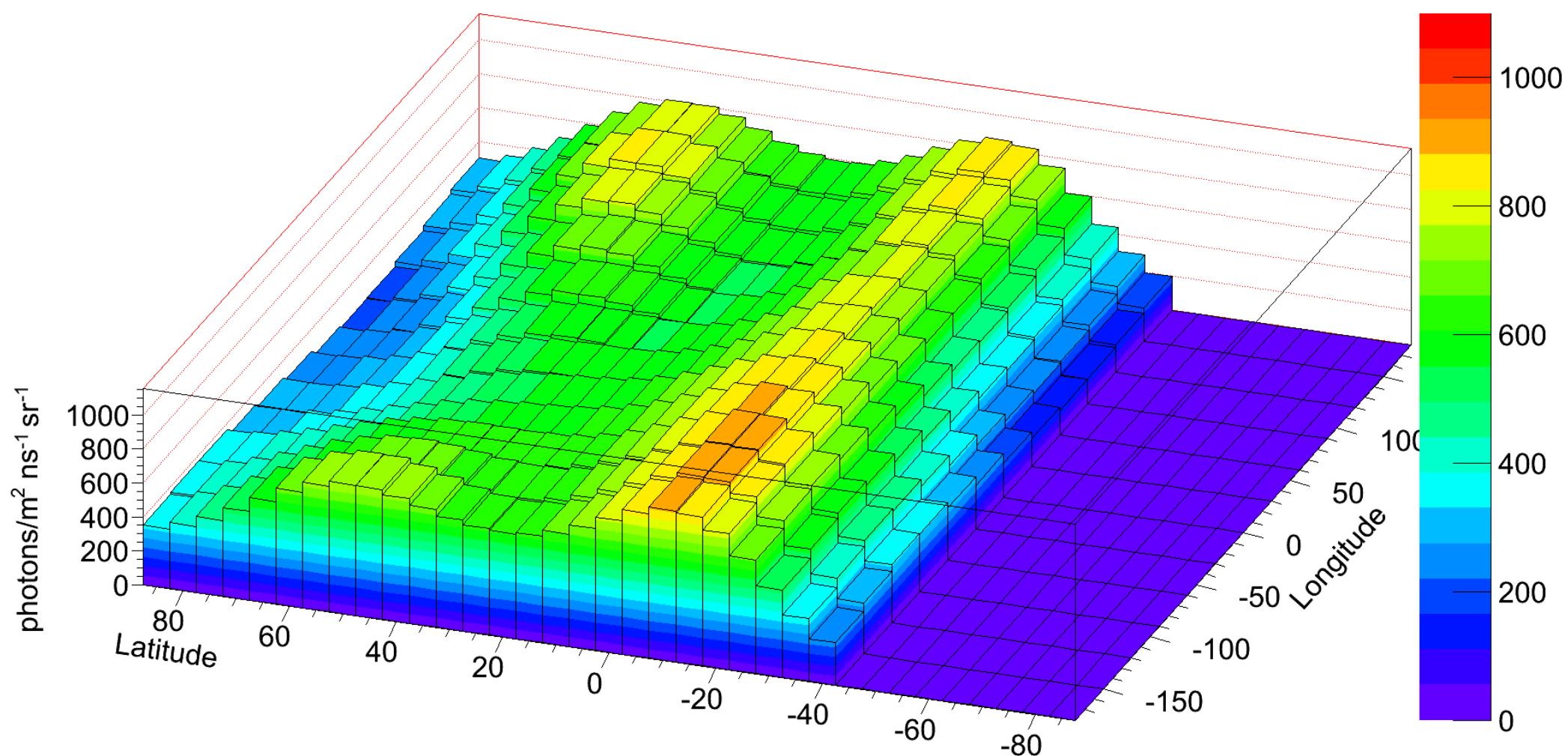
1994, 20 - 21 Dec, Local time

1 hour UVBG



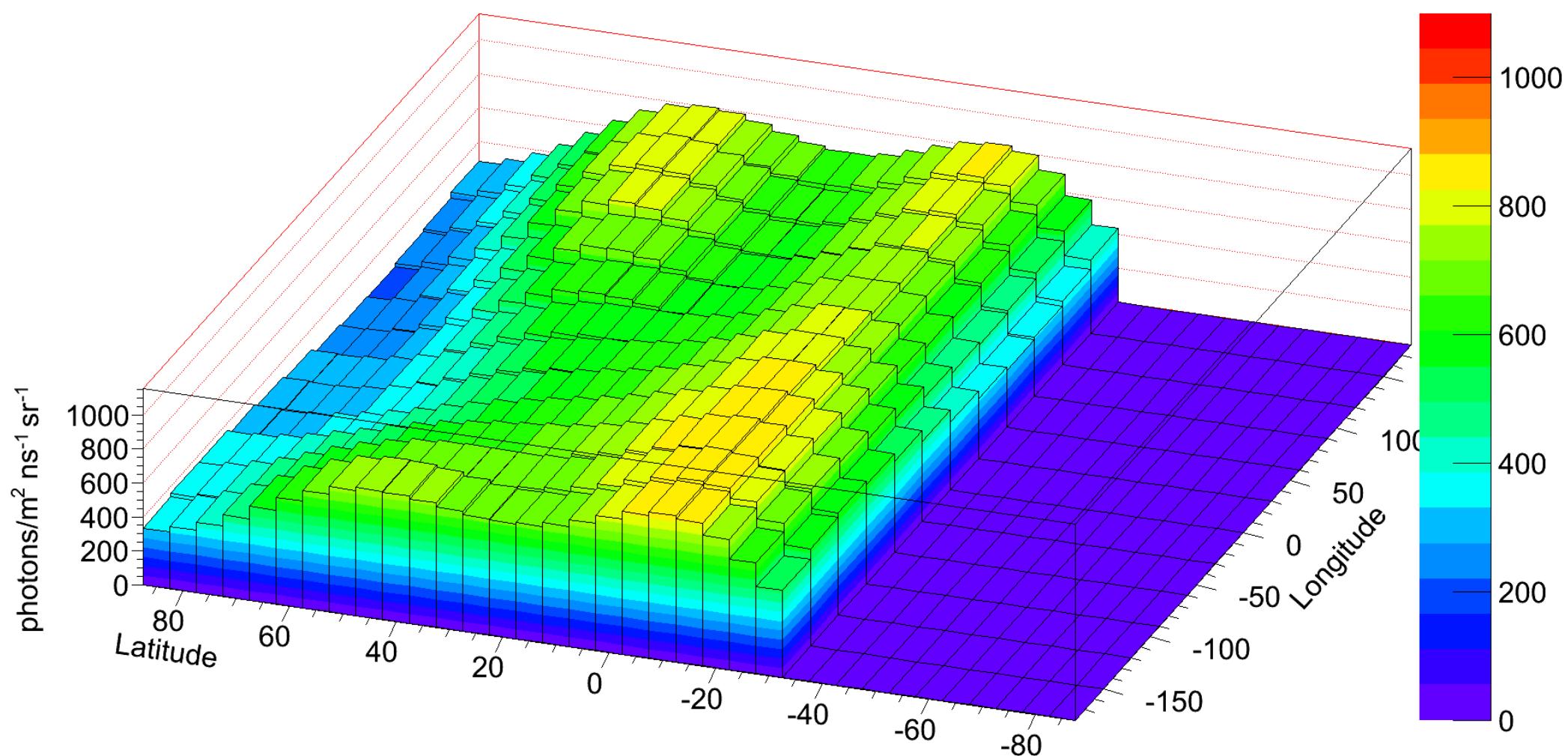
1994, 20 - 21 Dec, Local time

2 hour UVBG



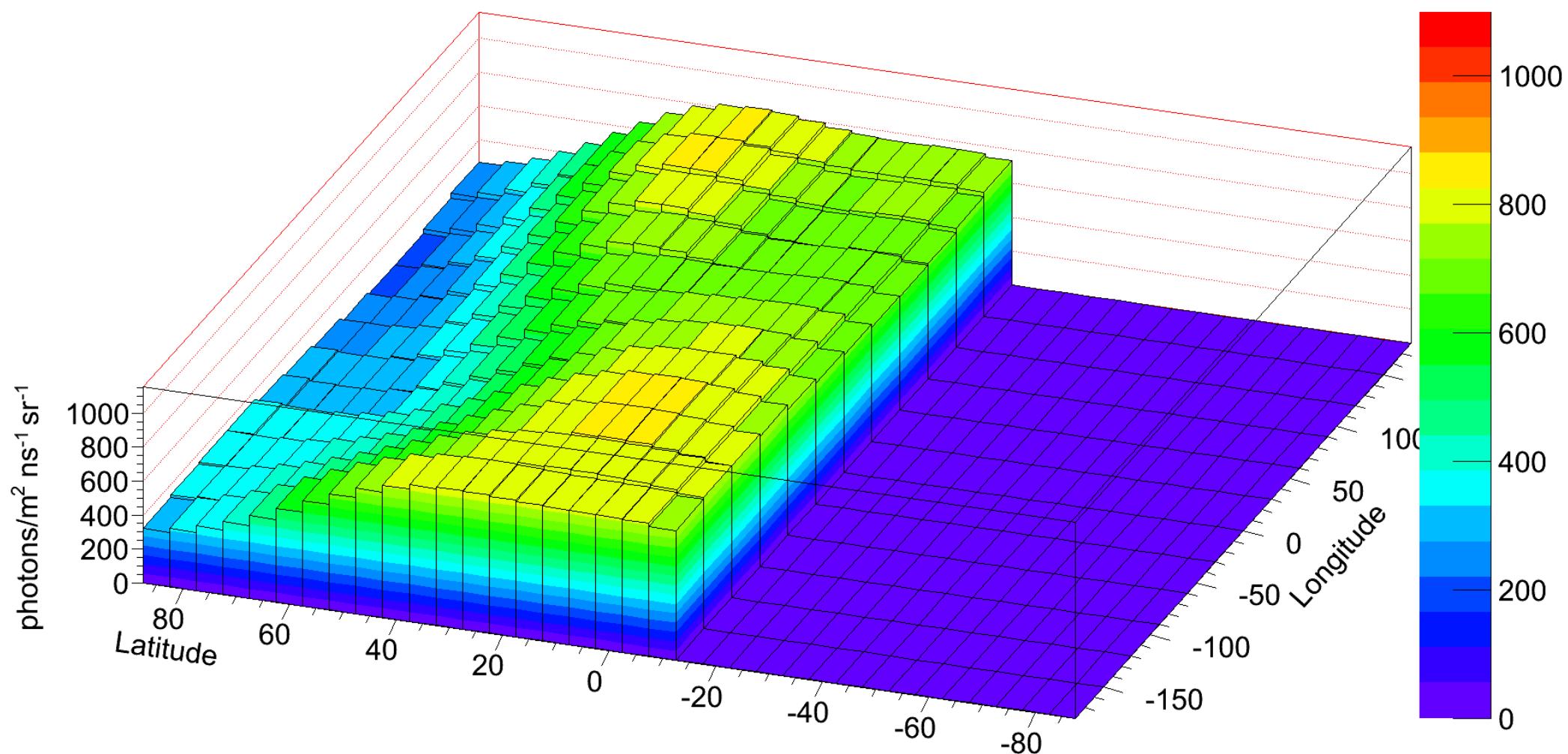
1994, 20 - 21 Dec, Local time

3 hour UVBG



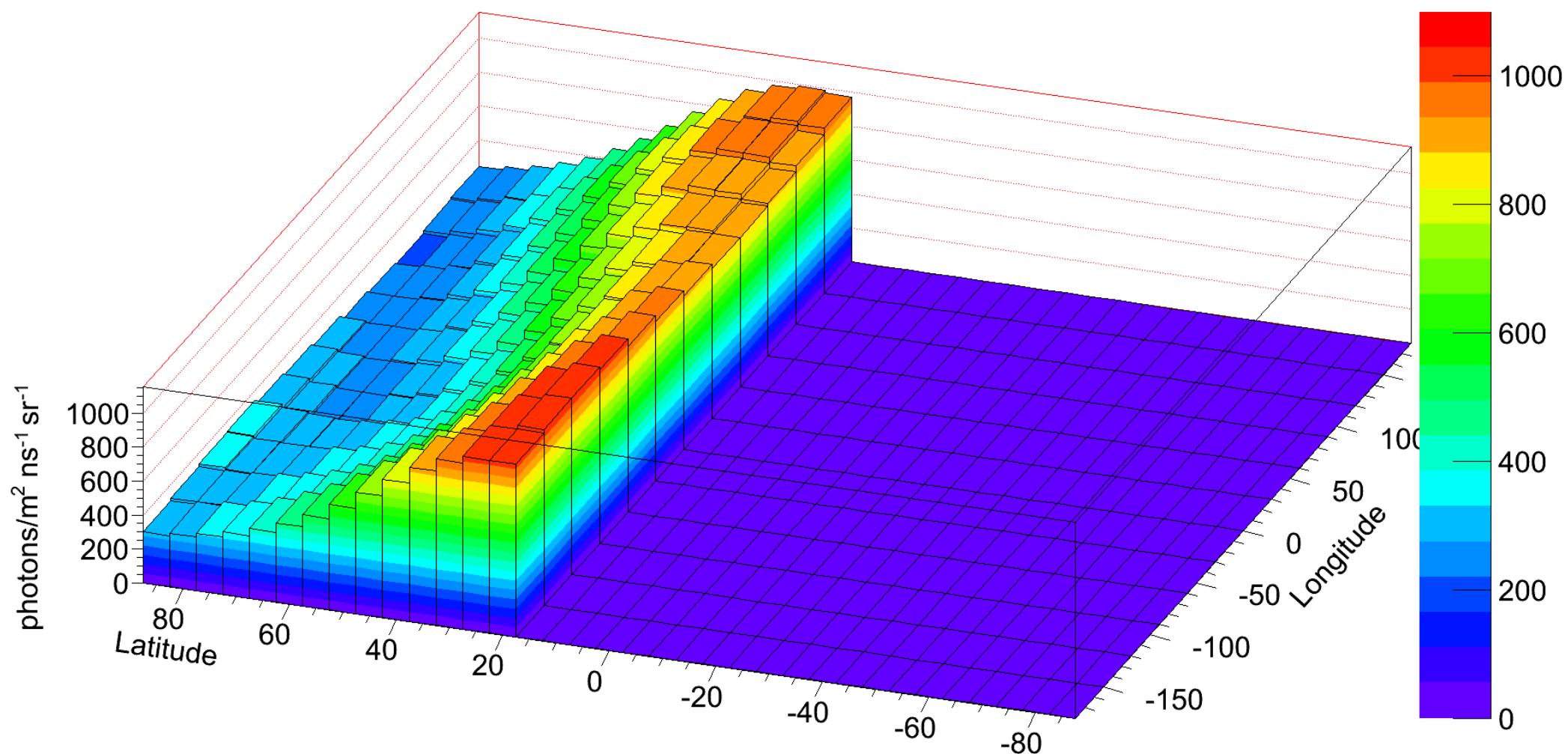
1994, 20 - 21 Dec, Local time

4 hour UVBG



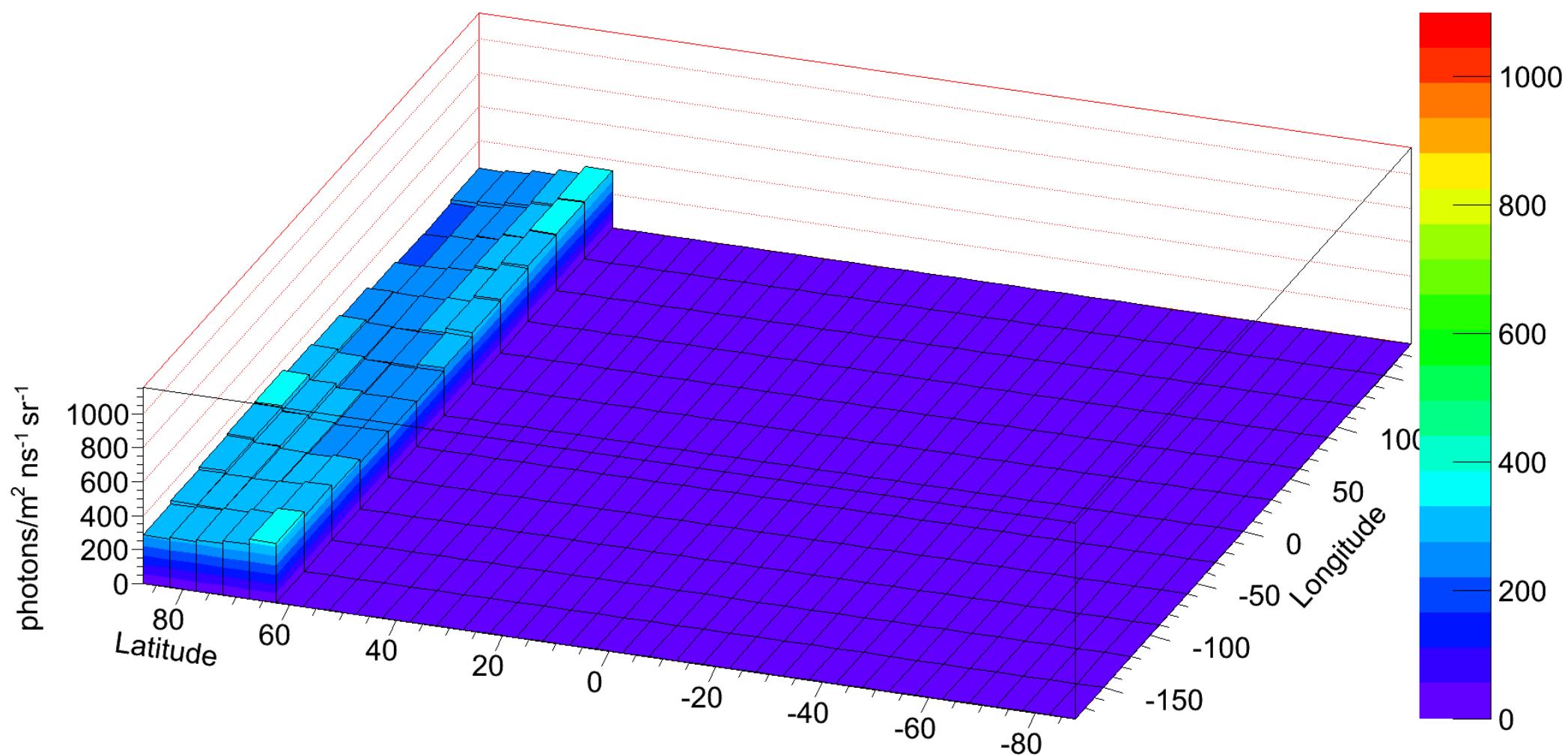
1994, 20 - 21 Dec, Local time

5 hour UVBG



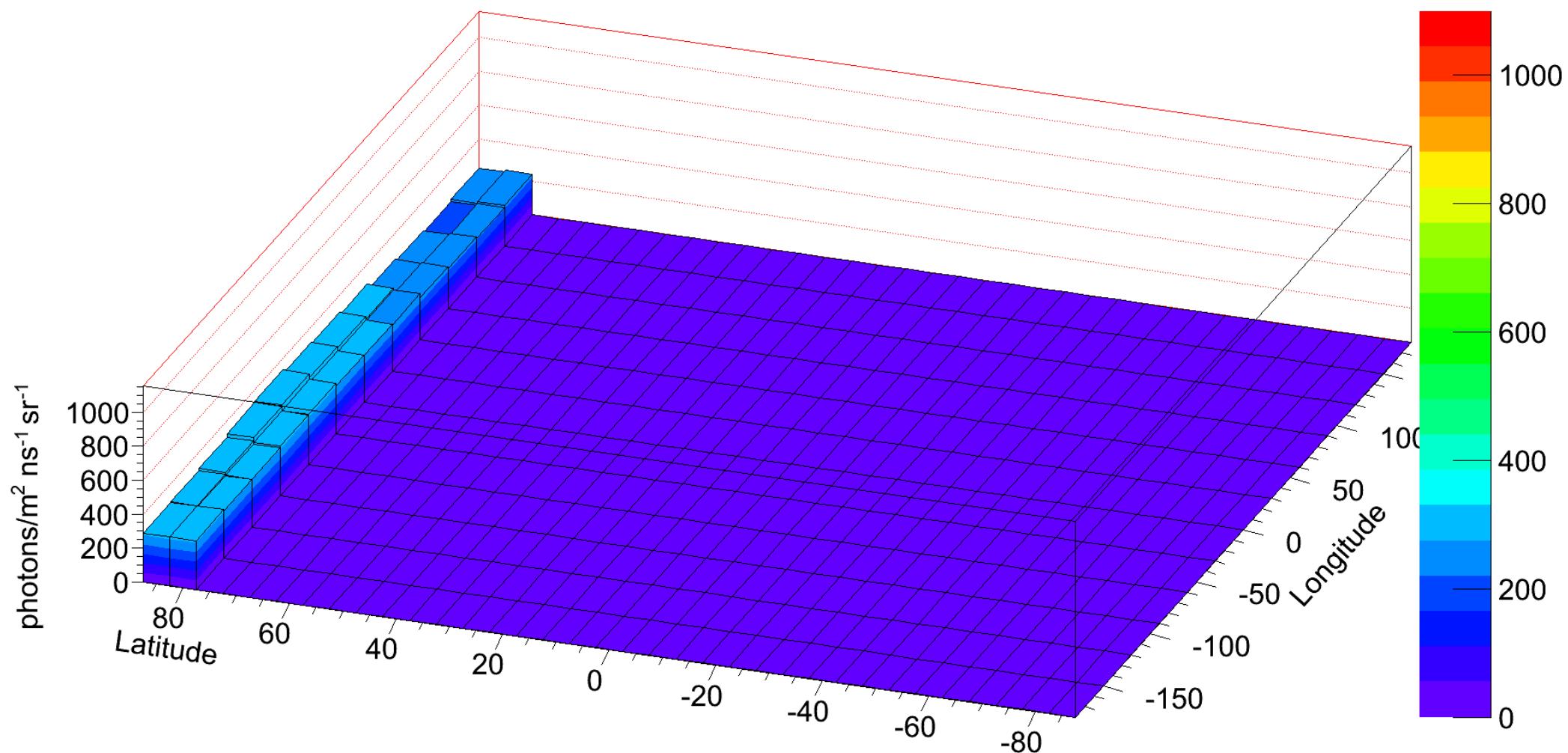
1994, 20 - 21 Dec, Local time

6 hour UVBG

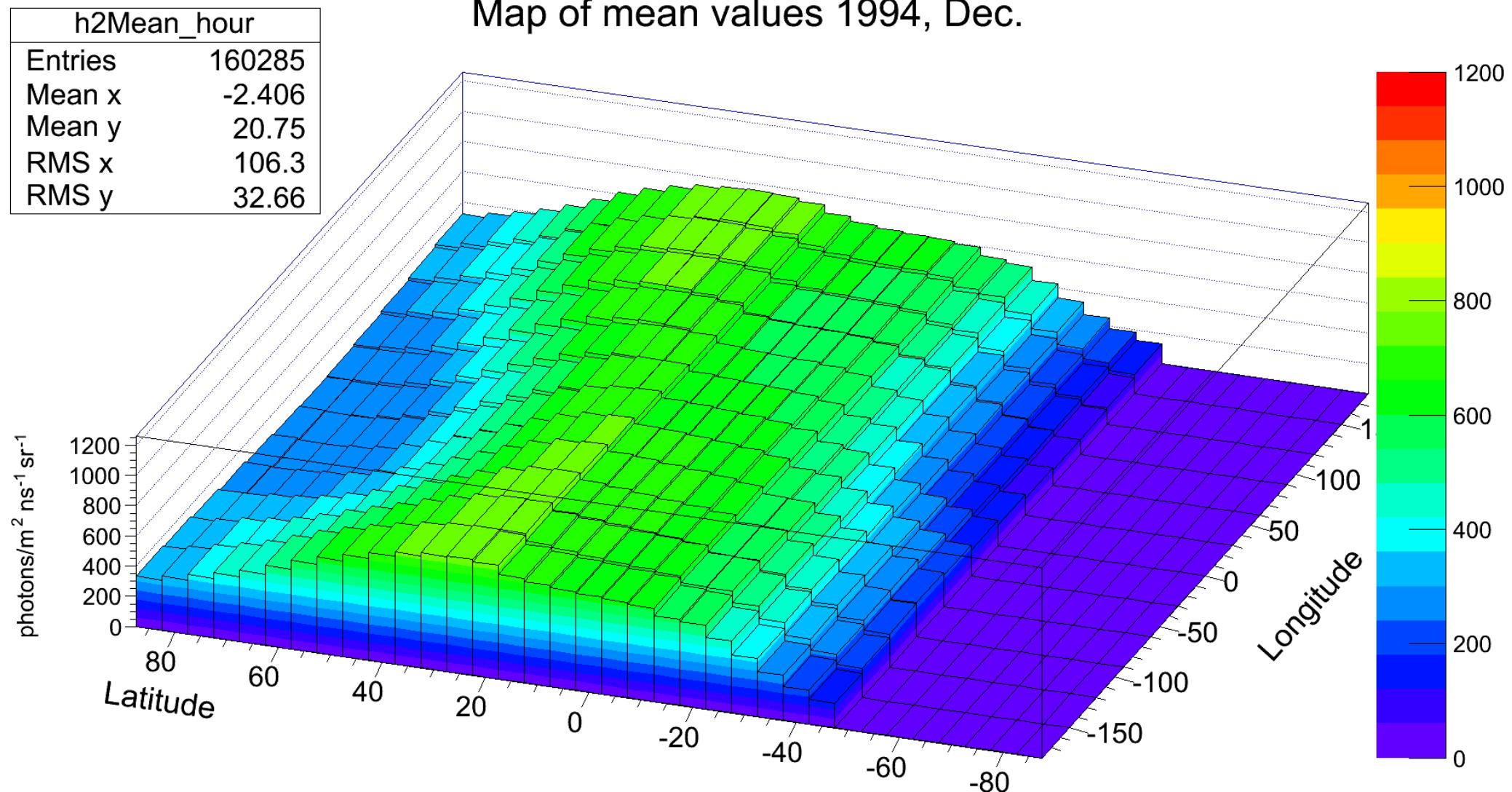


1994, 20 - 21 Dec, Local time

7 hour UVBG

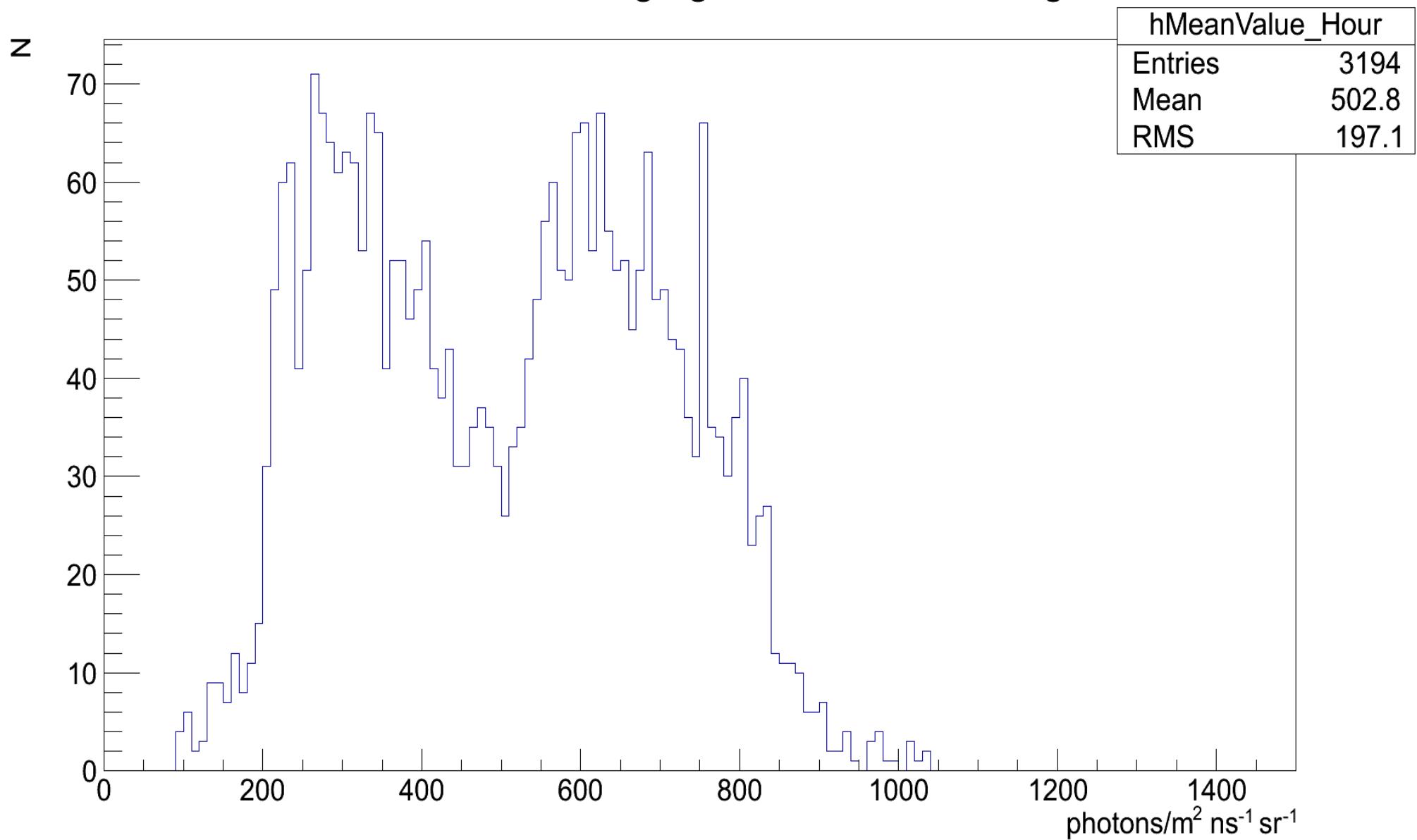


Map of mean values 1994, 20 - 21 Dec.



Histogram of nightglow 1994, 20 - 21 Dec

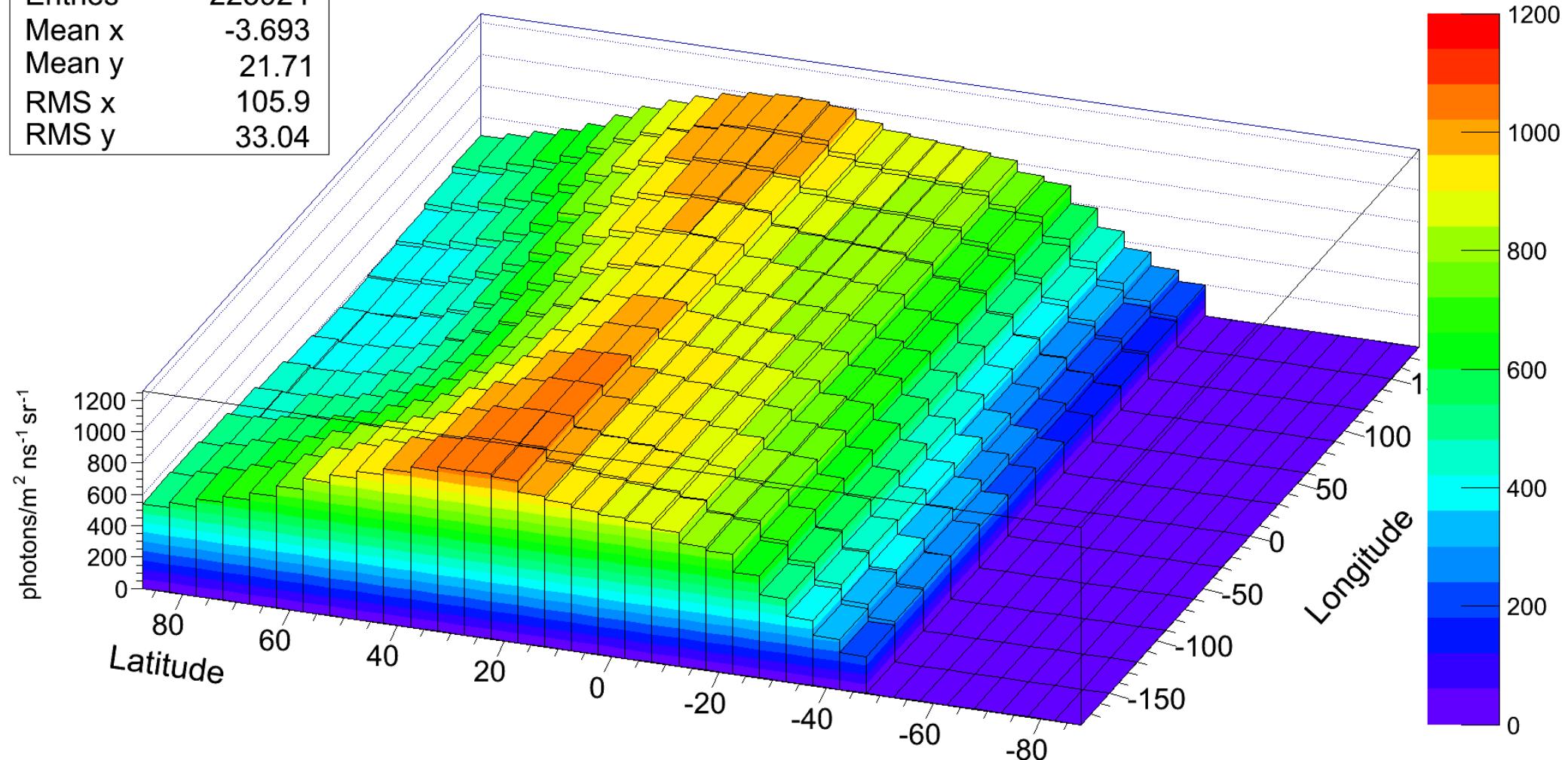
Distribution of UV nightglow values for all night



Map of mean values 1990, 20 - 21 Dec

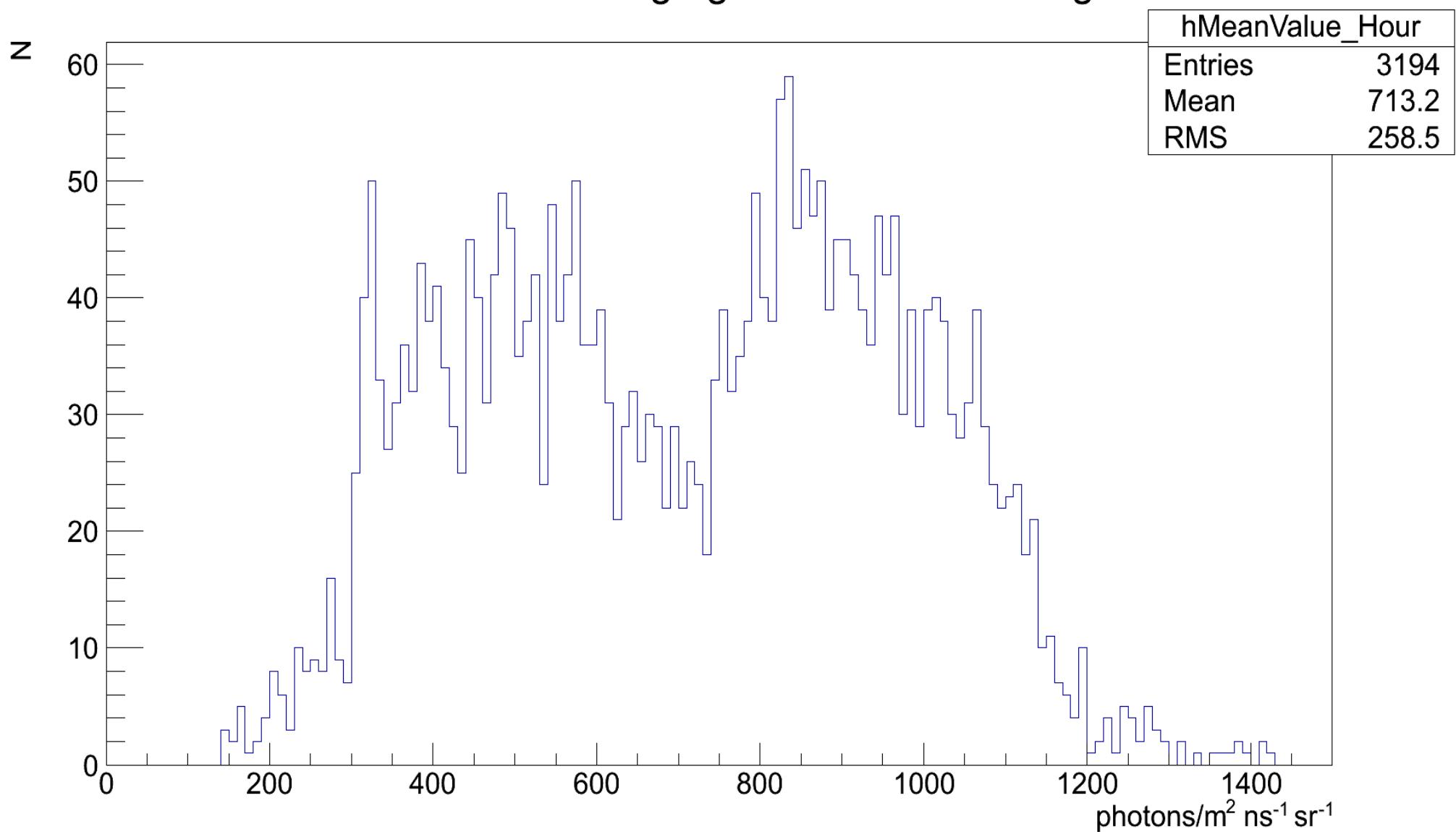
h2Mean_hour	
Entries	225924
Mean x	-3.693
Mean y	21.71
RMS x	105.9
RMS y	33.04

Map of mean values 1990, Dec.



Histogram of nightglow 1990, 20 - 21 Dec

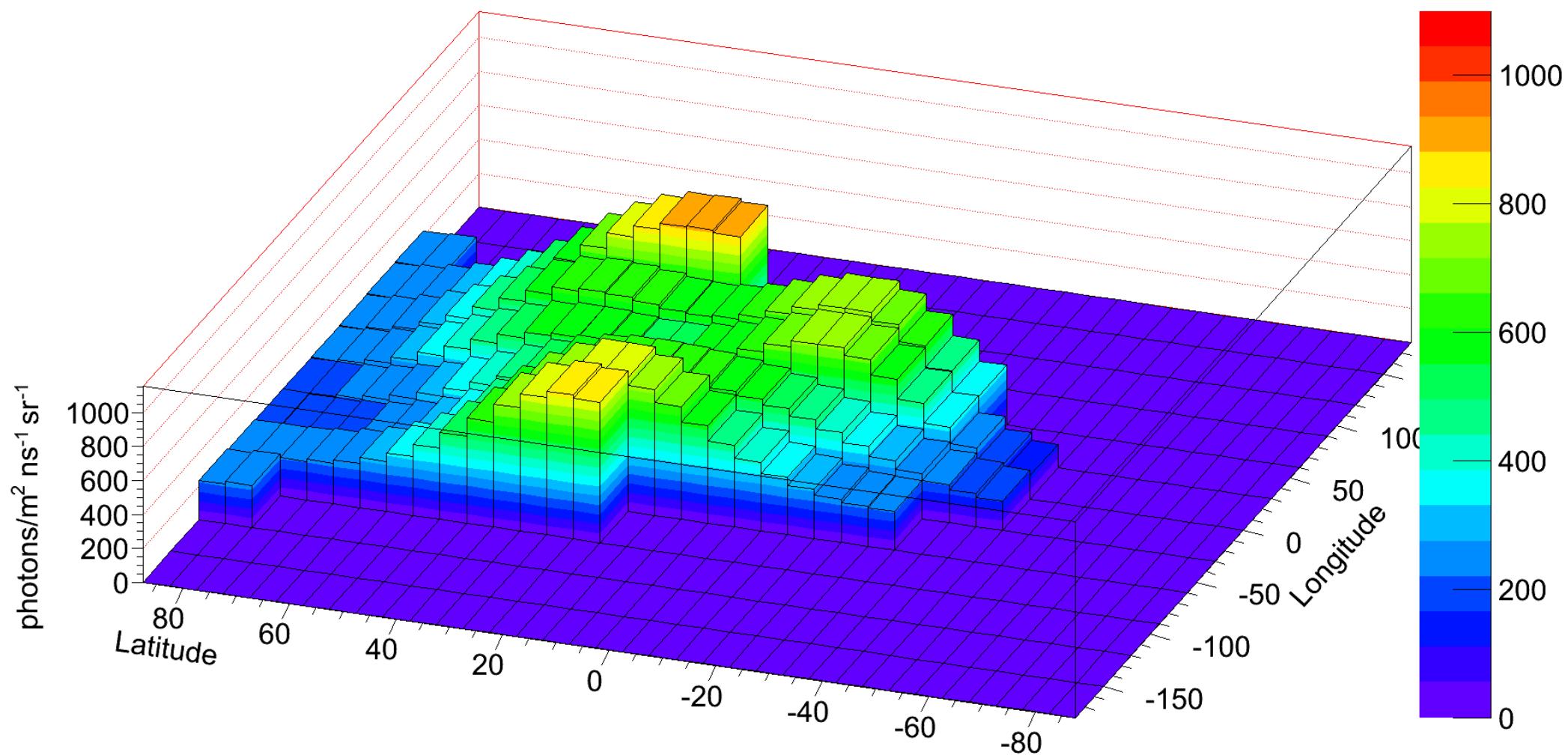
Distribution of UV nightglow values for all night



Slides 38 – 61 shows how UV nightglow is changing with UTC time on the whole Earth (one night 1994, Dec. 20 - 21).

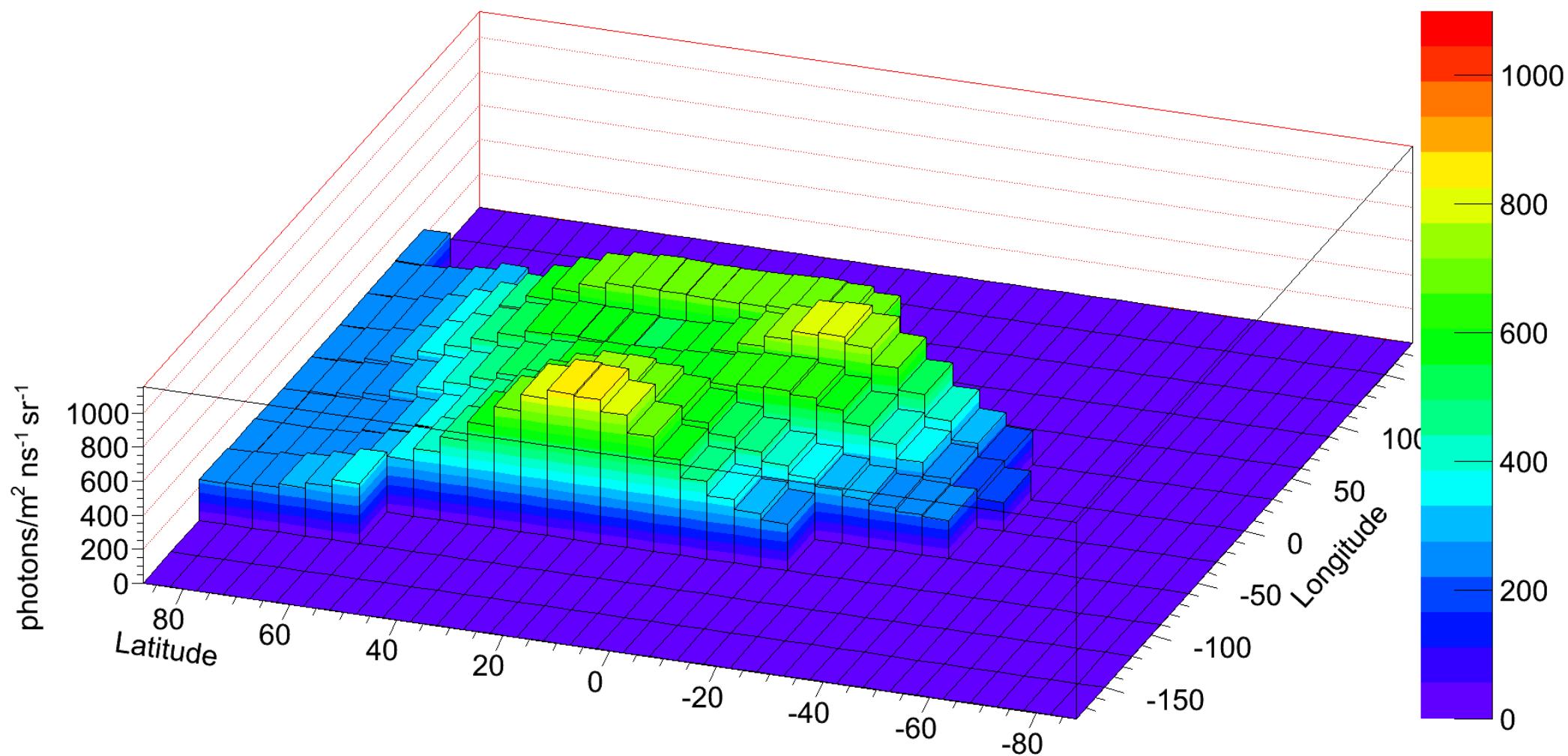
1994, Dec, UTC time

0 UTC UVBG



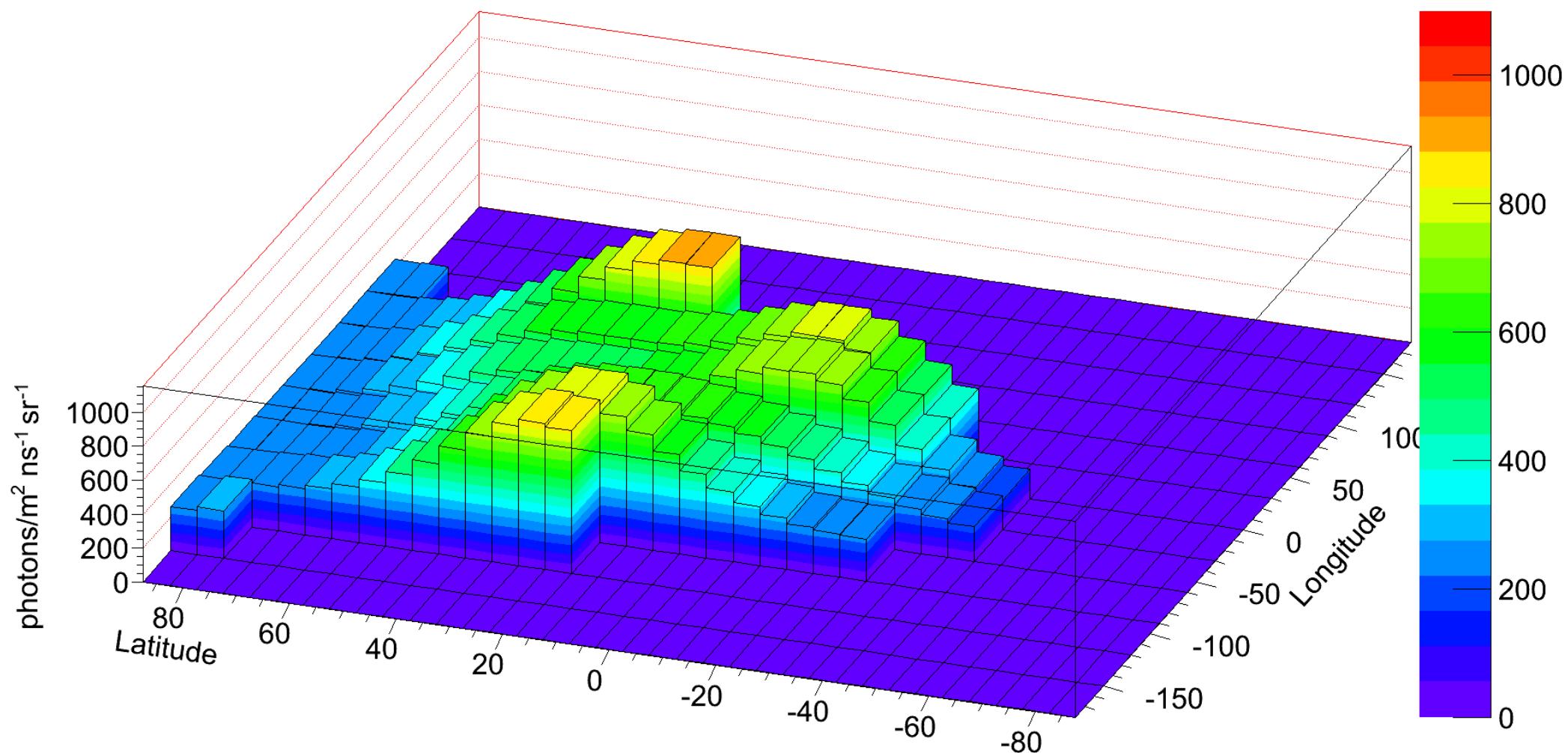
1994, Dec, UTC time

1 UTC UVBG



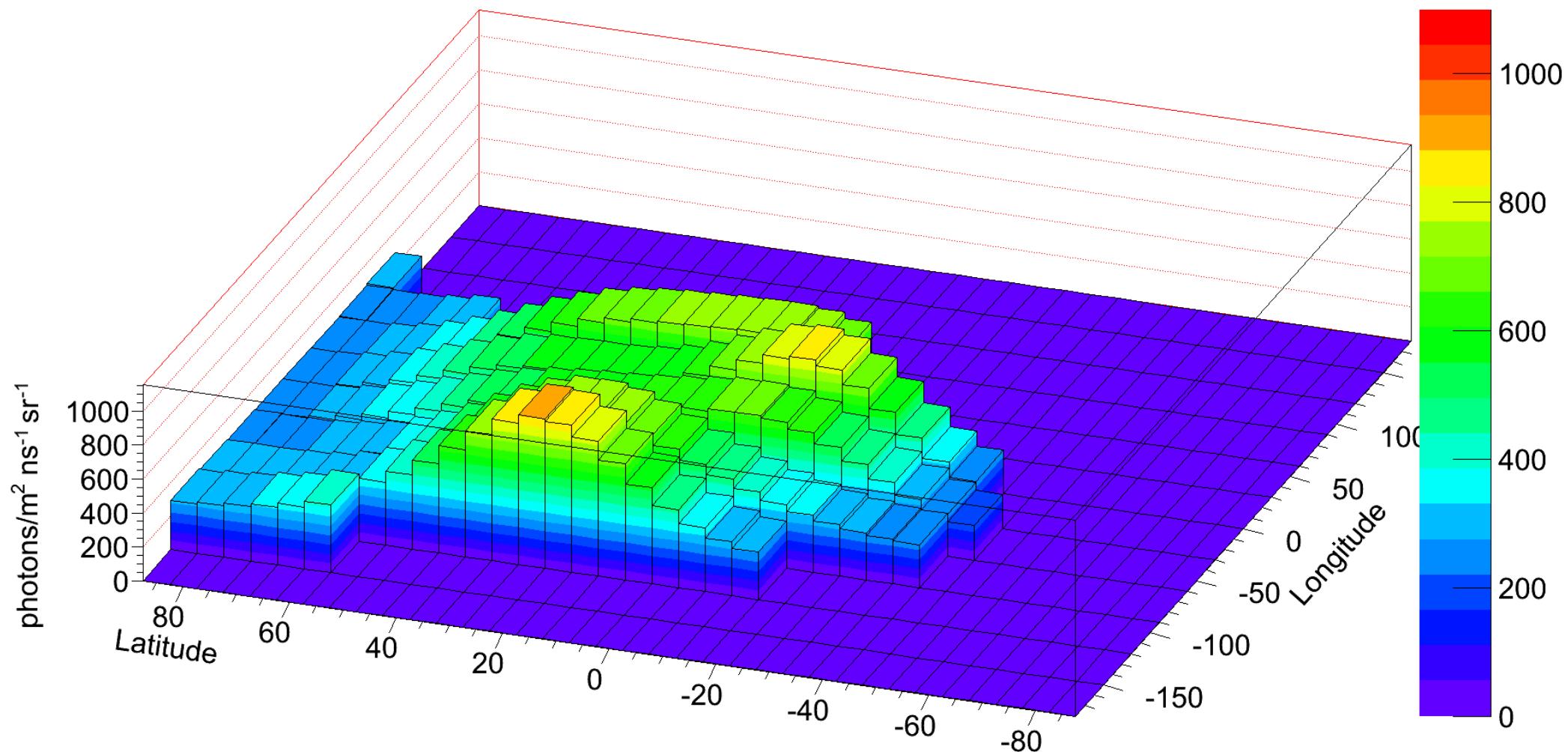
1994, Dec, UTC time

2 UTC UVBG



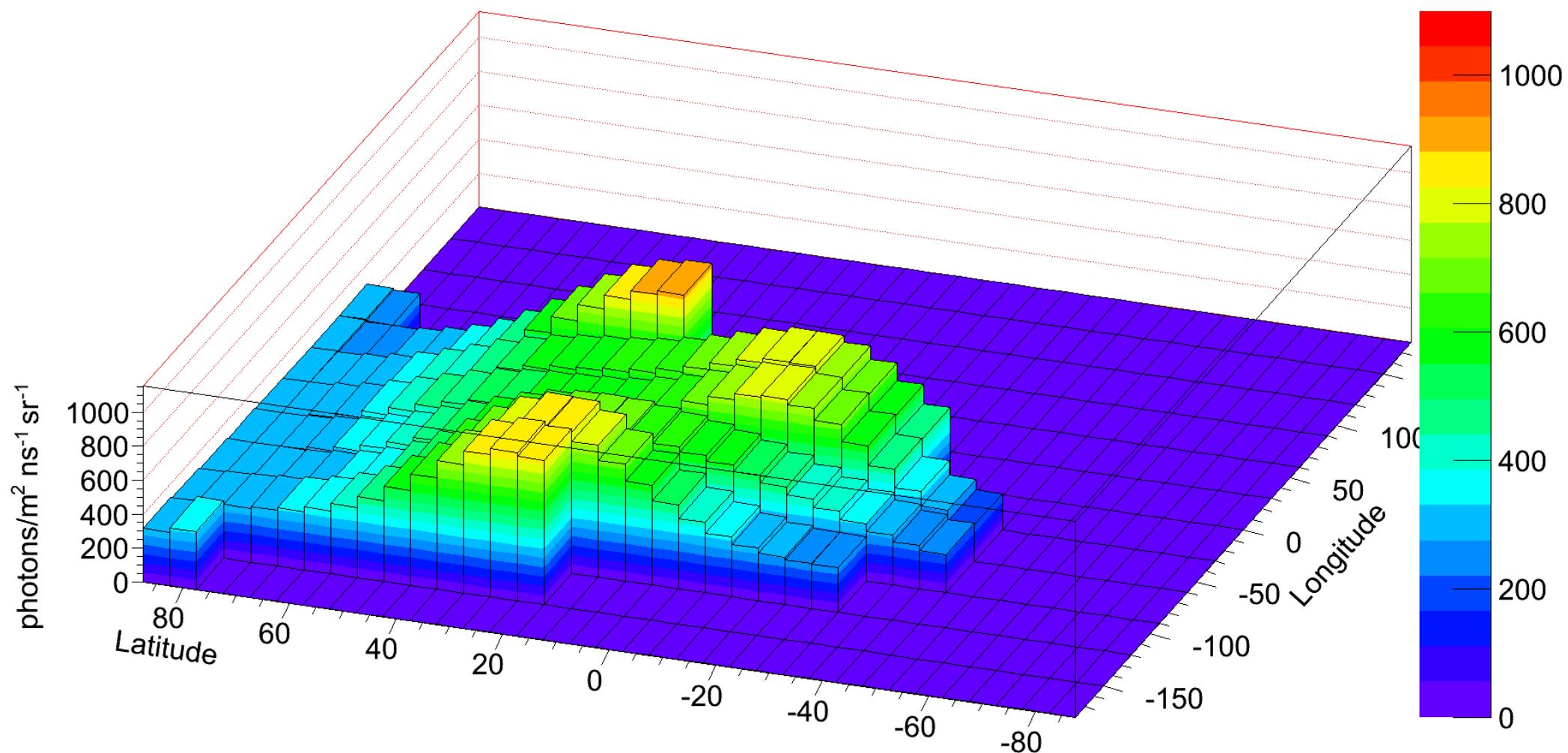
1994, Dec, UTC time

3 UTC UVBG



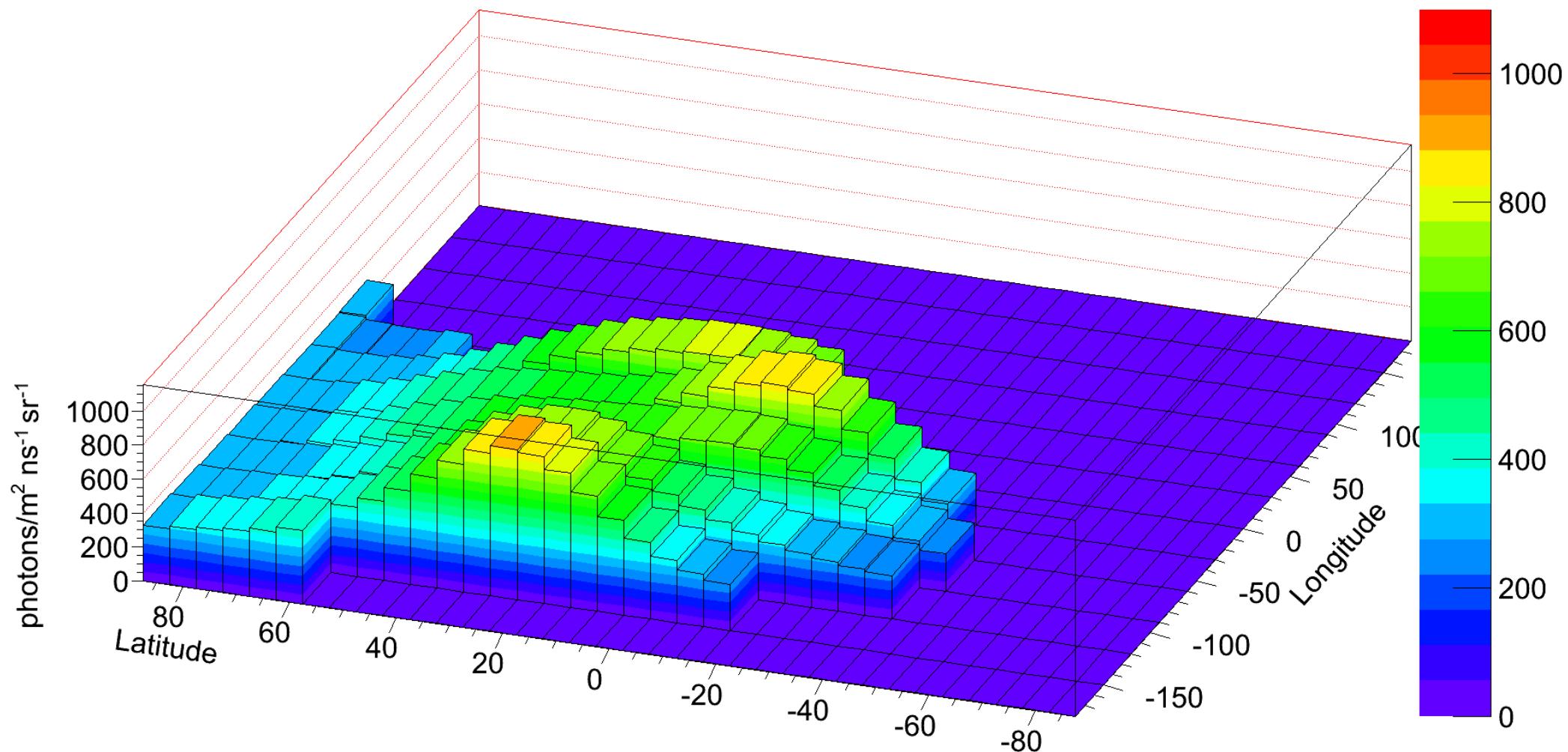
1994, Dec, UTC time

4 UTC UVBG



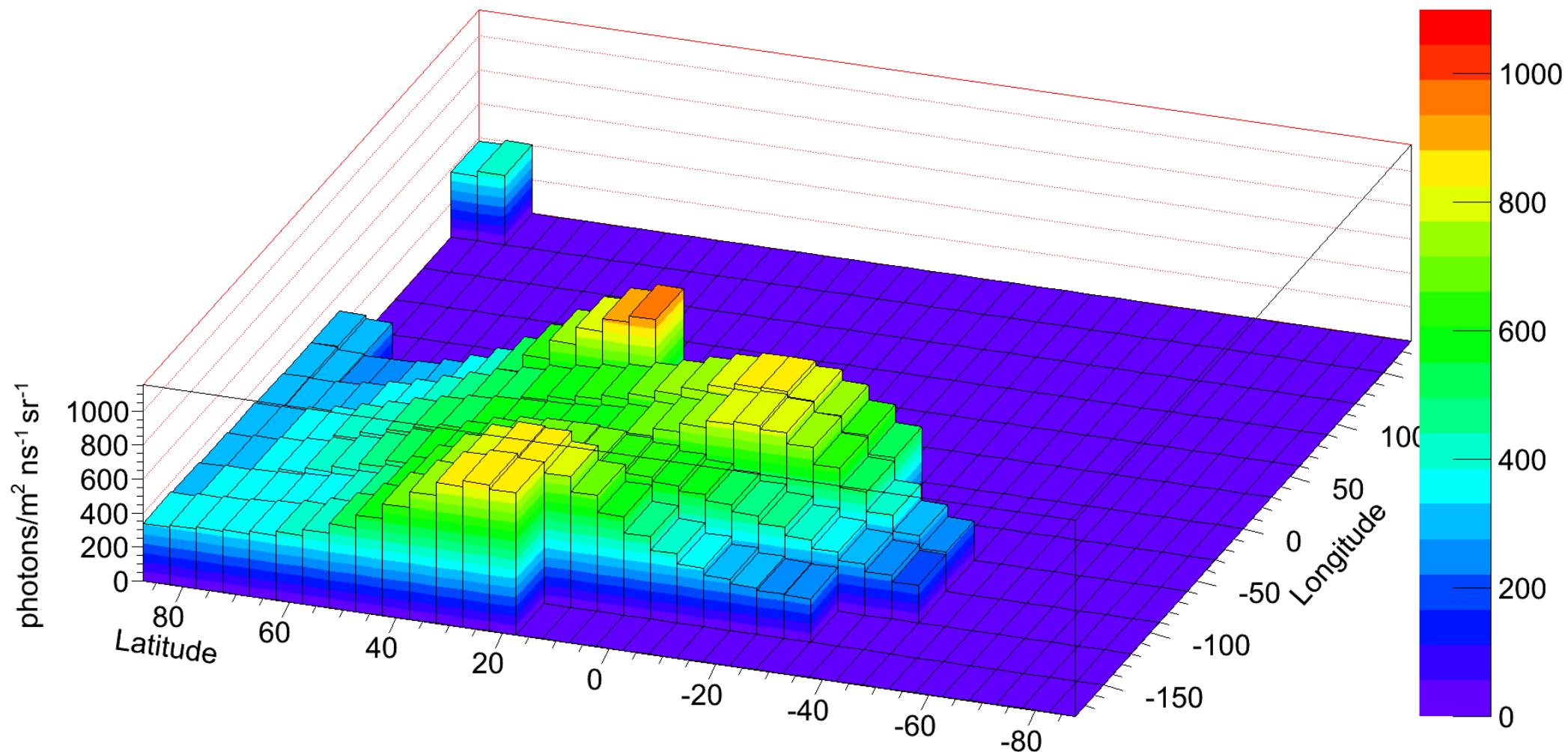
1994, Dec, UTC time

5 UTC UVBG



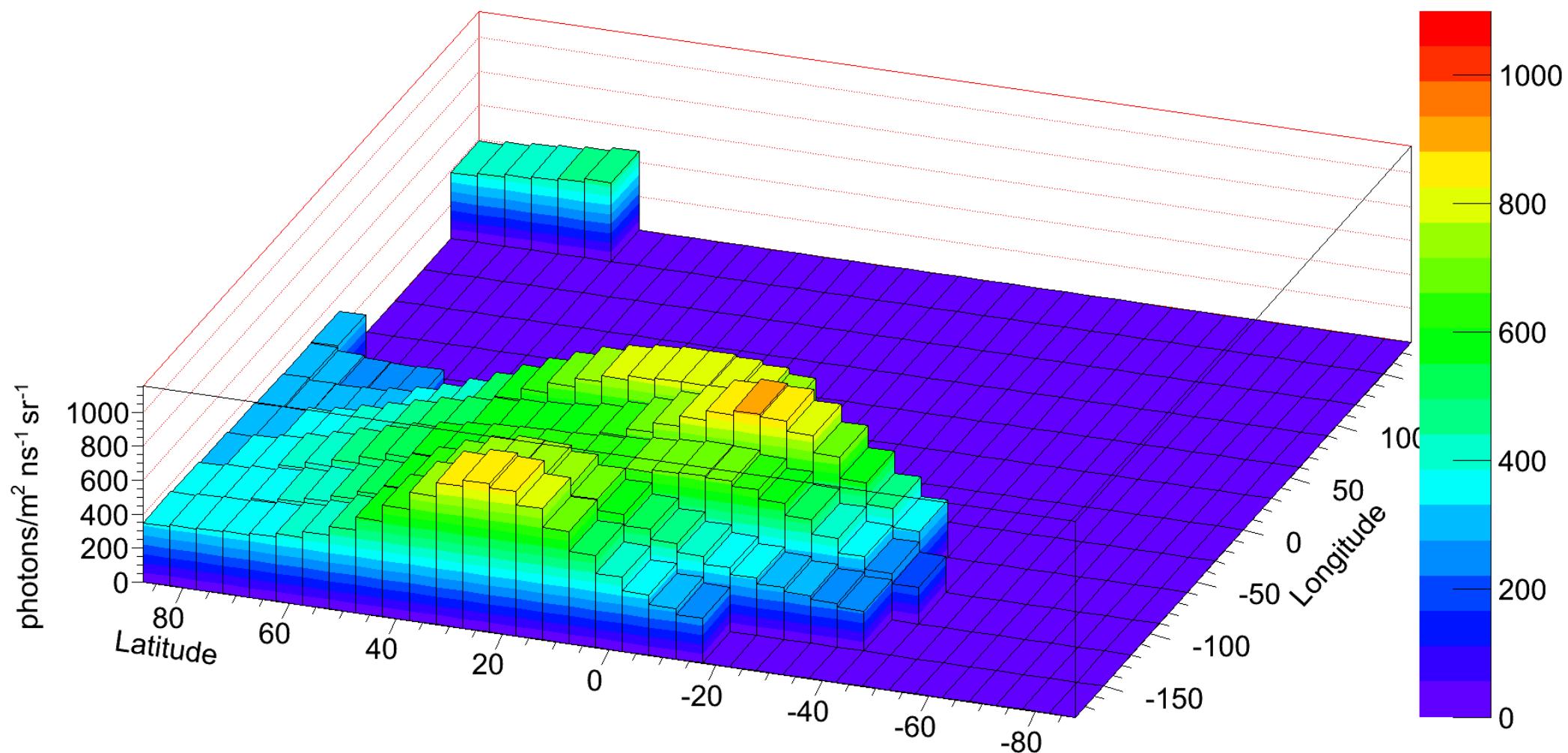
1994, Dec, UTC time

6 UTC UVBG



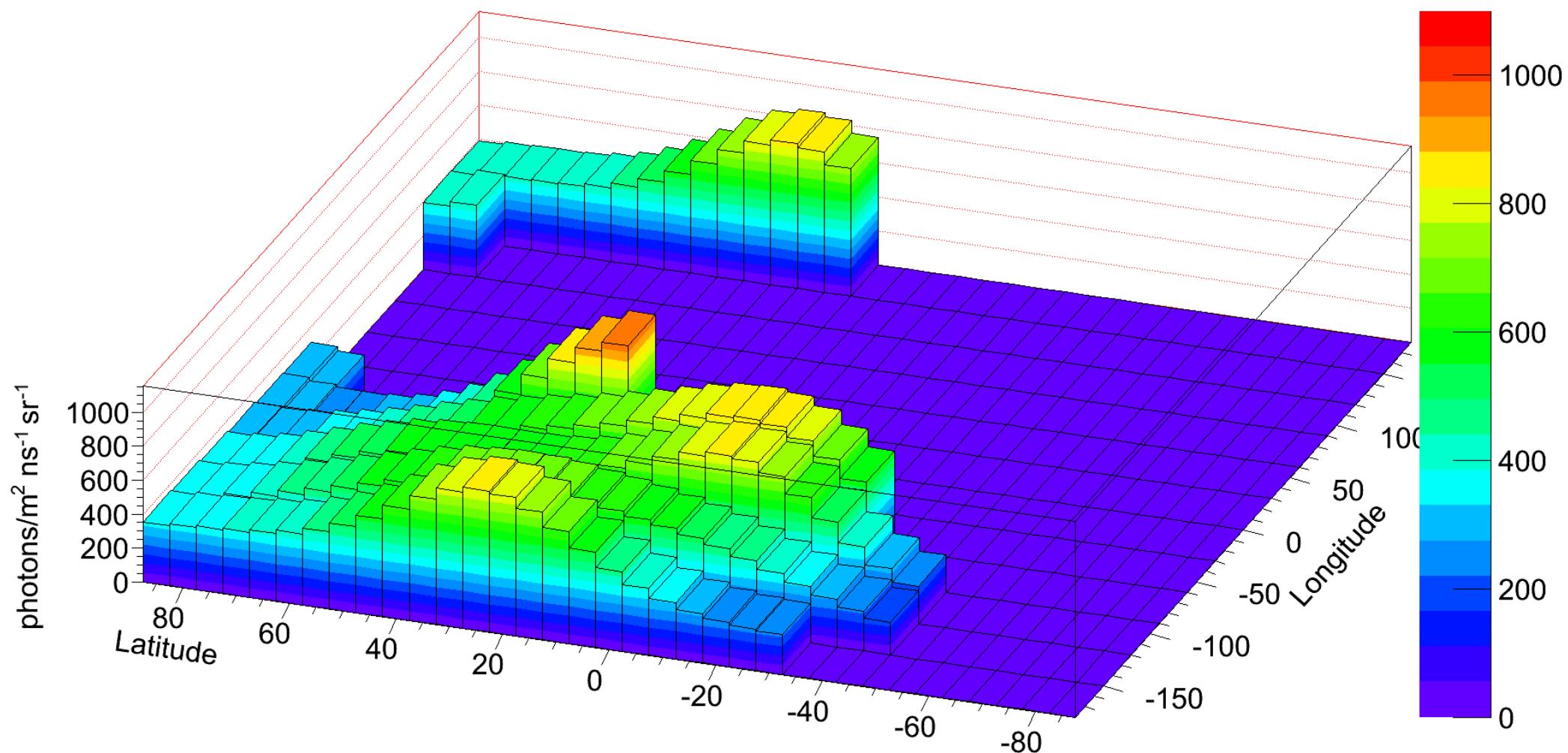
1994, Dec, UTC time

7 UTC UVBG



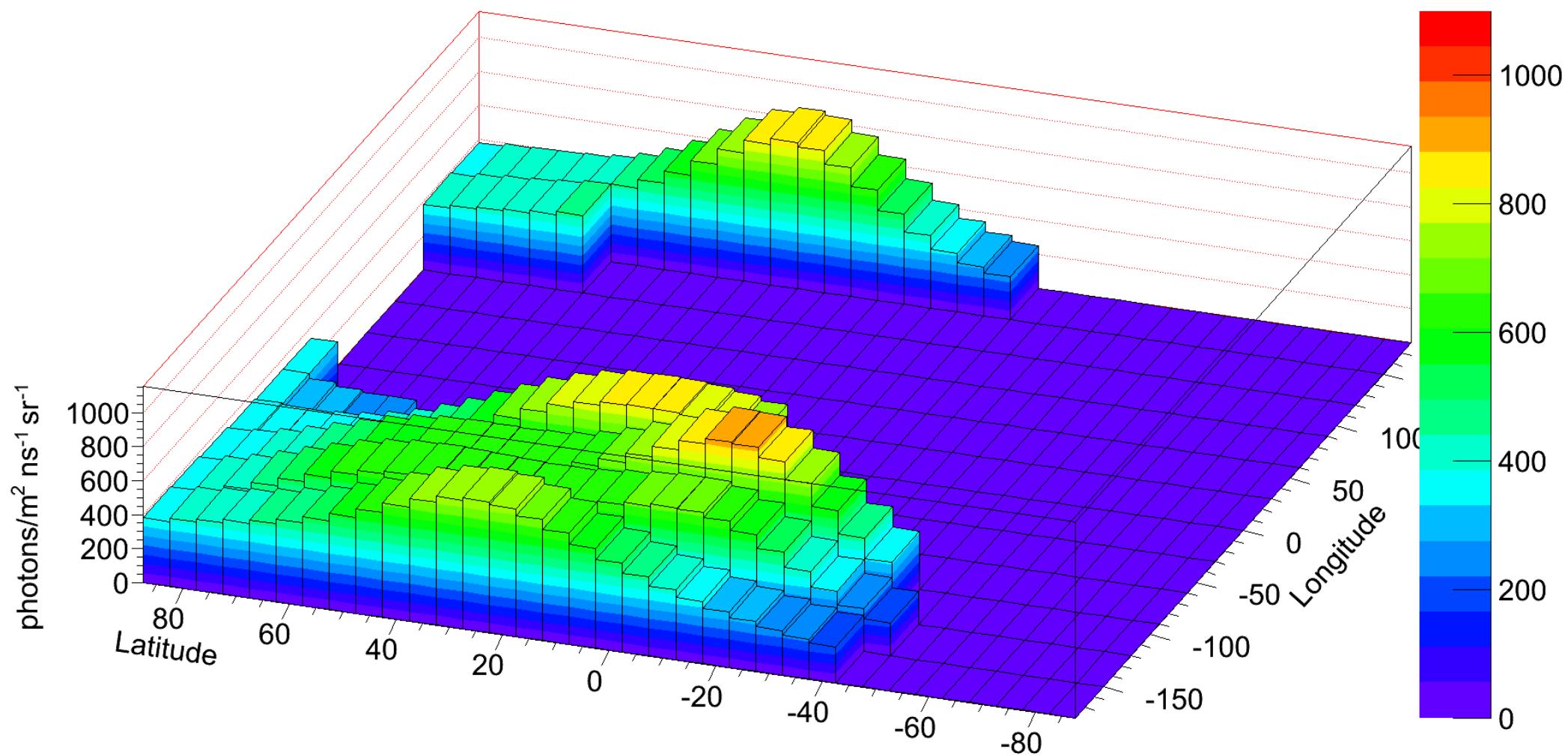
1994, Dec, UTC time

8 UTC UVBG



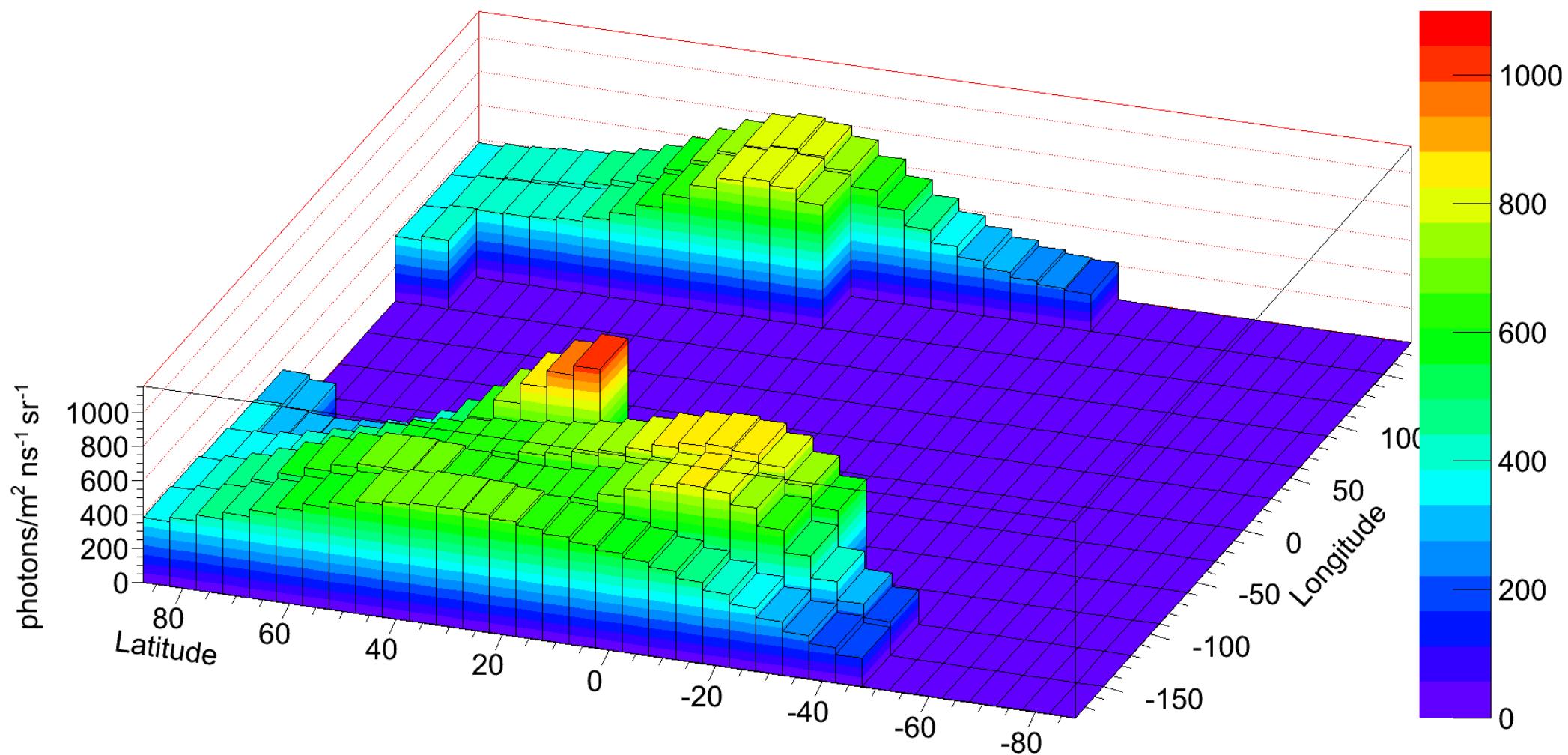
1994, Dec, UTC time

9 UTC UVBG



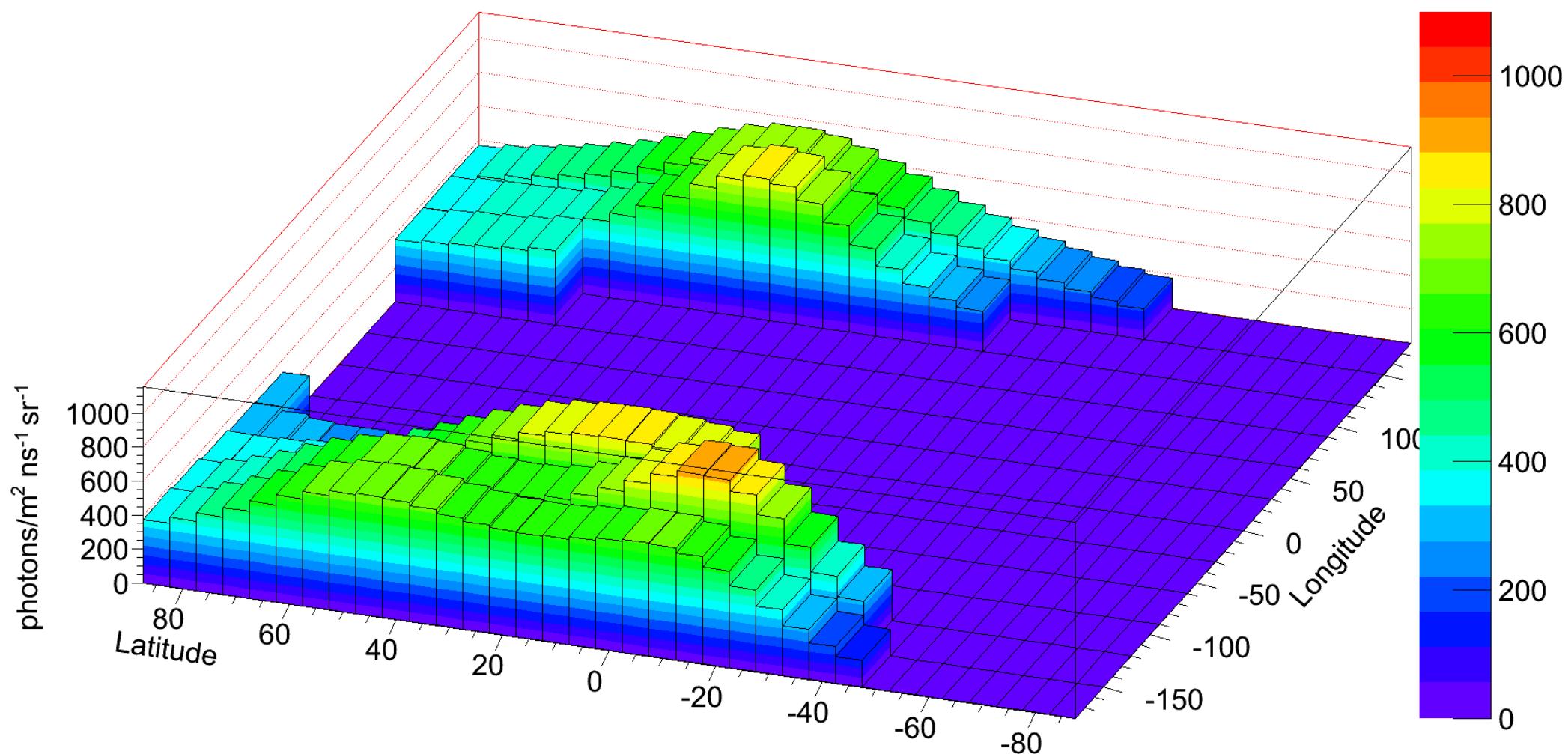
1994, Dec, UTC time

10 UTC UVBG



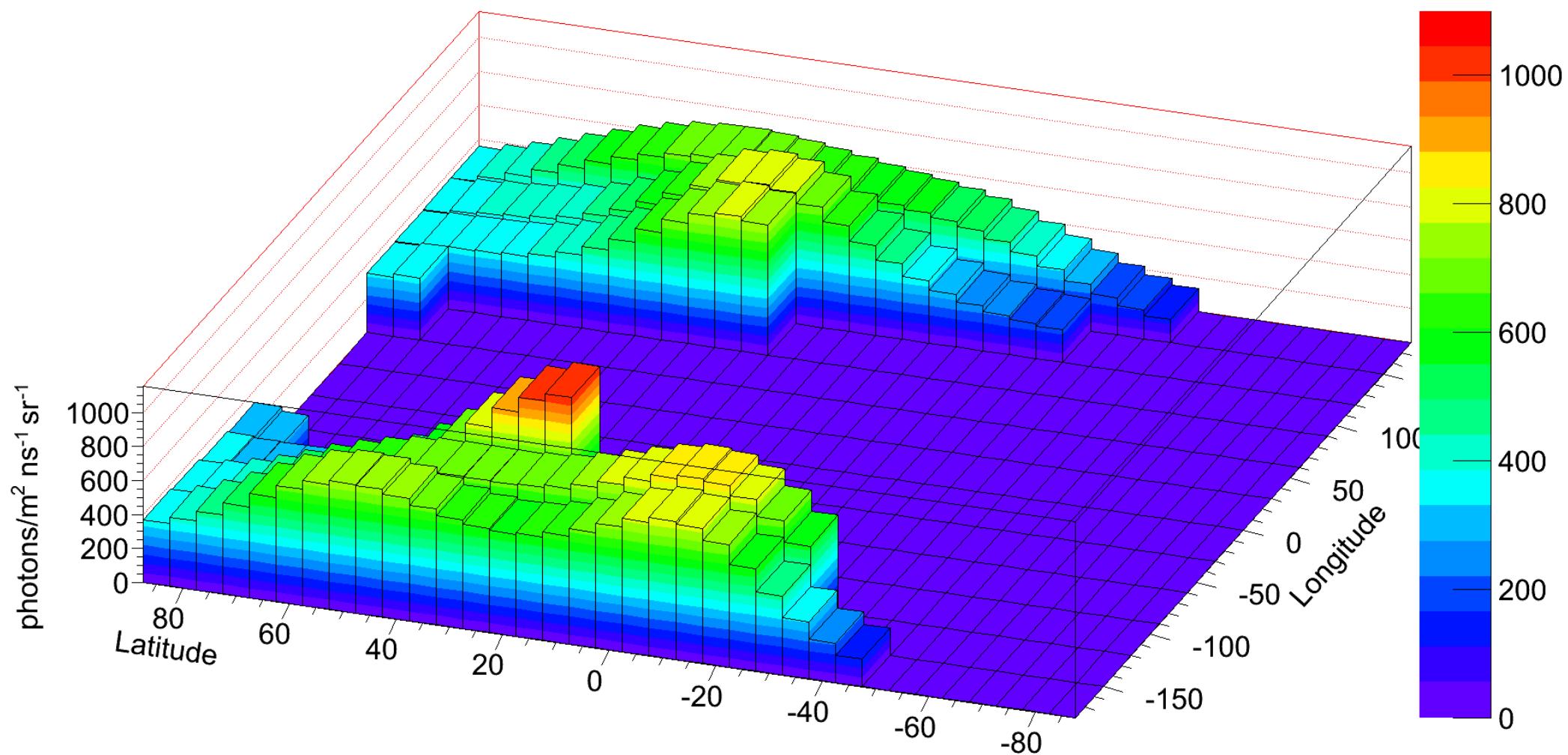
1994, Dec, UTC time

11 UTC UVBG



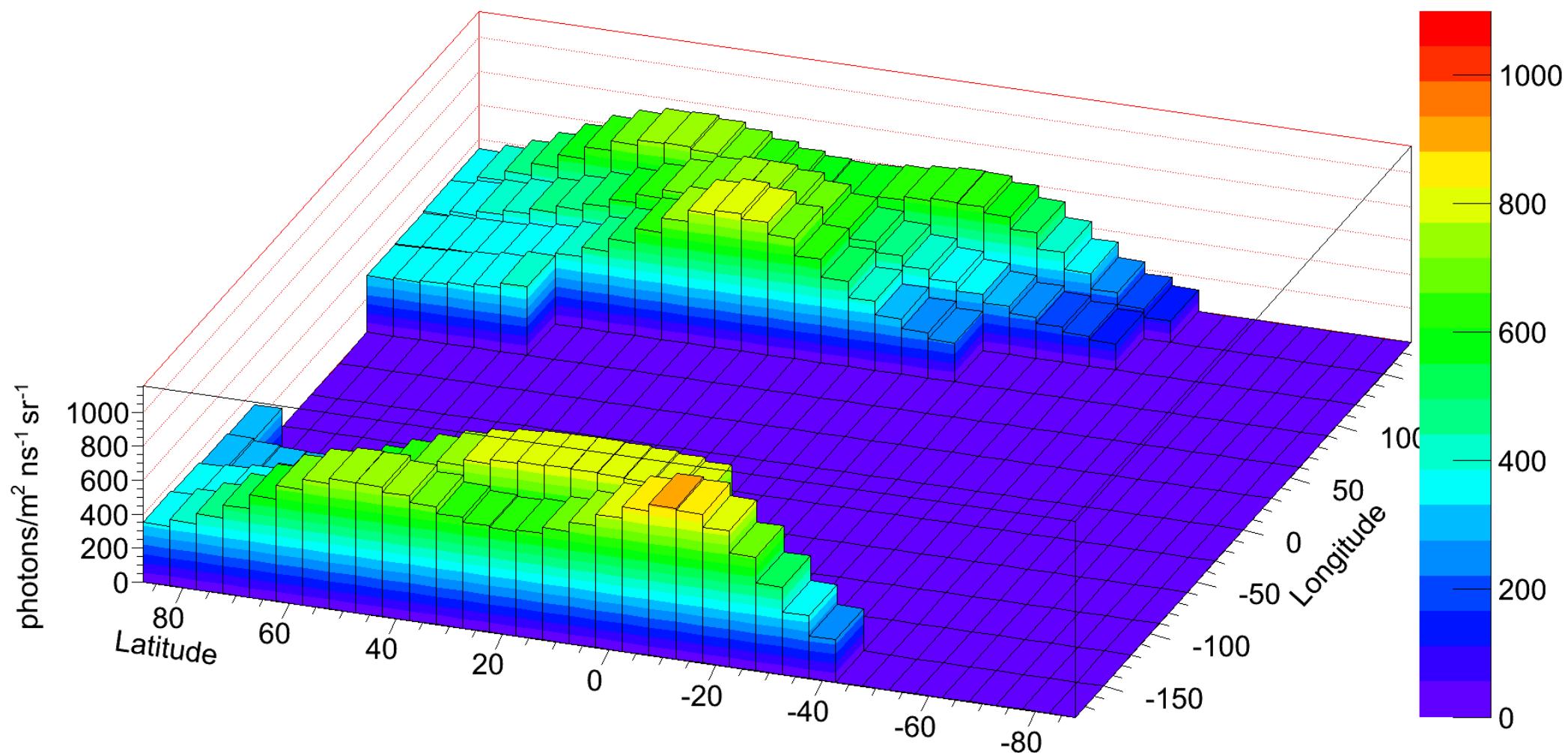
1994, Dec, UTC time

12 UTC UVBG



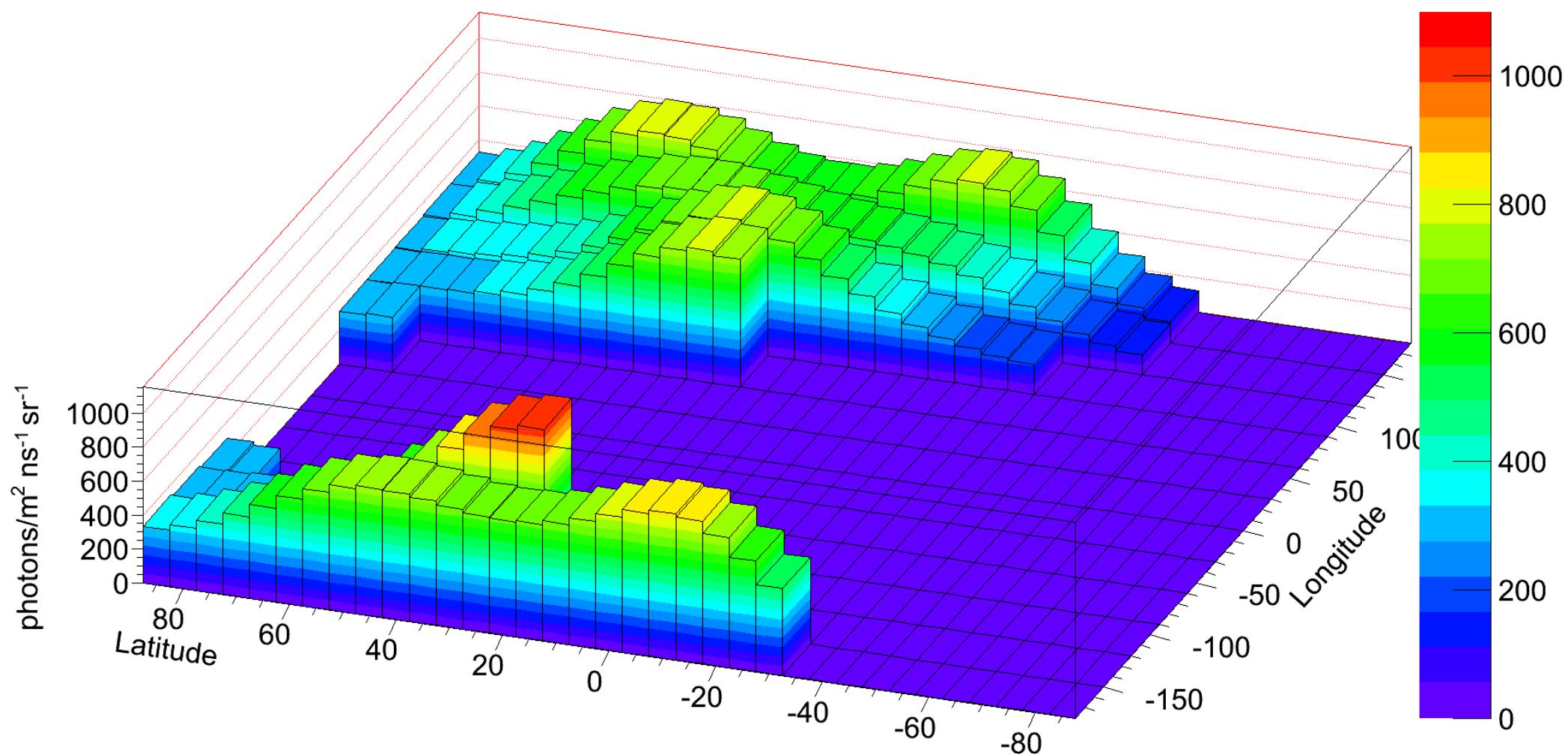
1994, Dec, UTC time

13 UTC UVBG



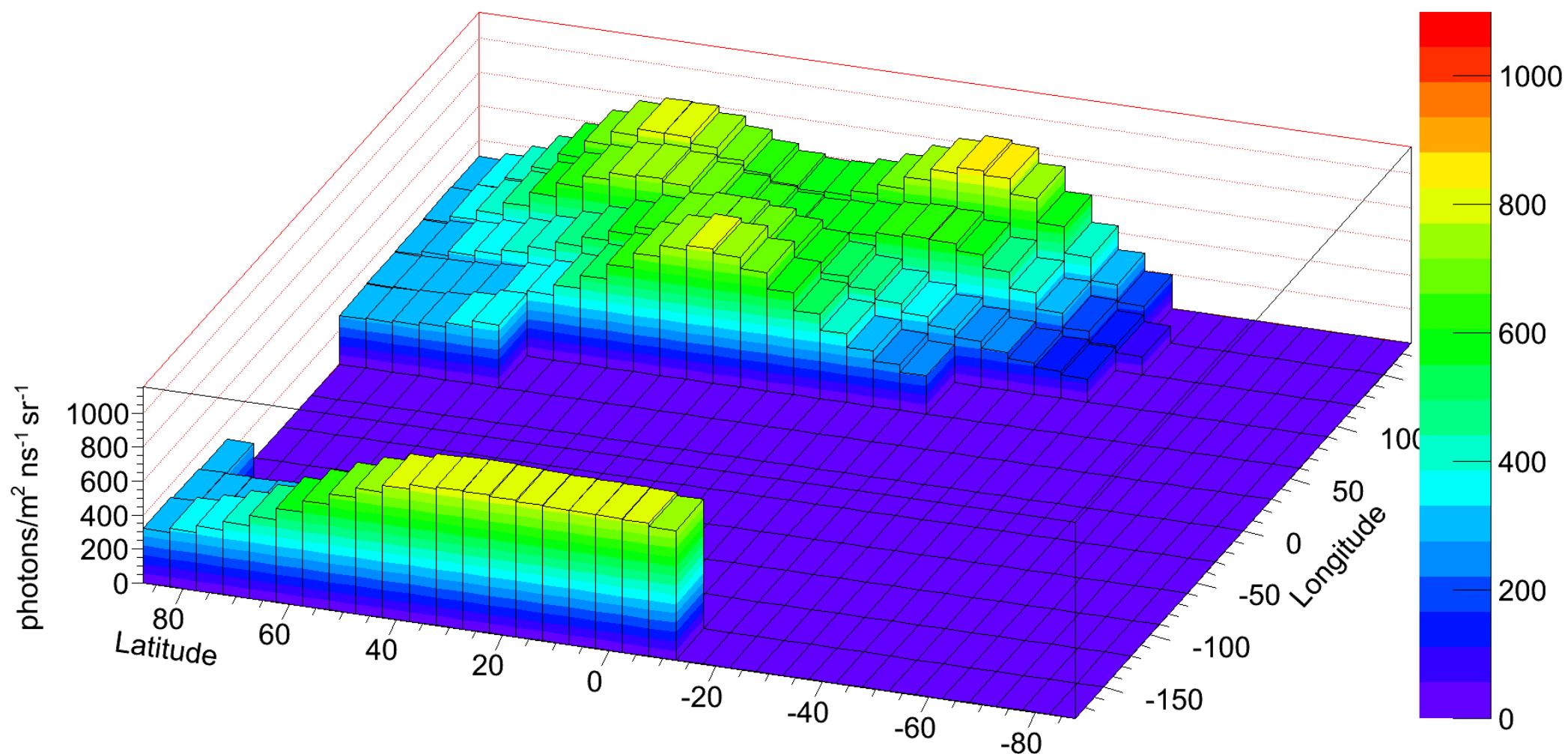
1994, Dec, UTC time

14 UTC UVBG



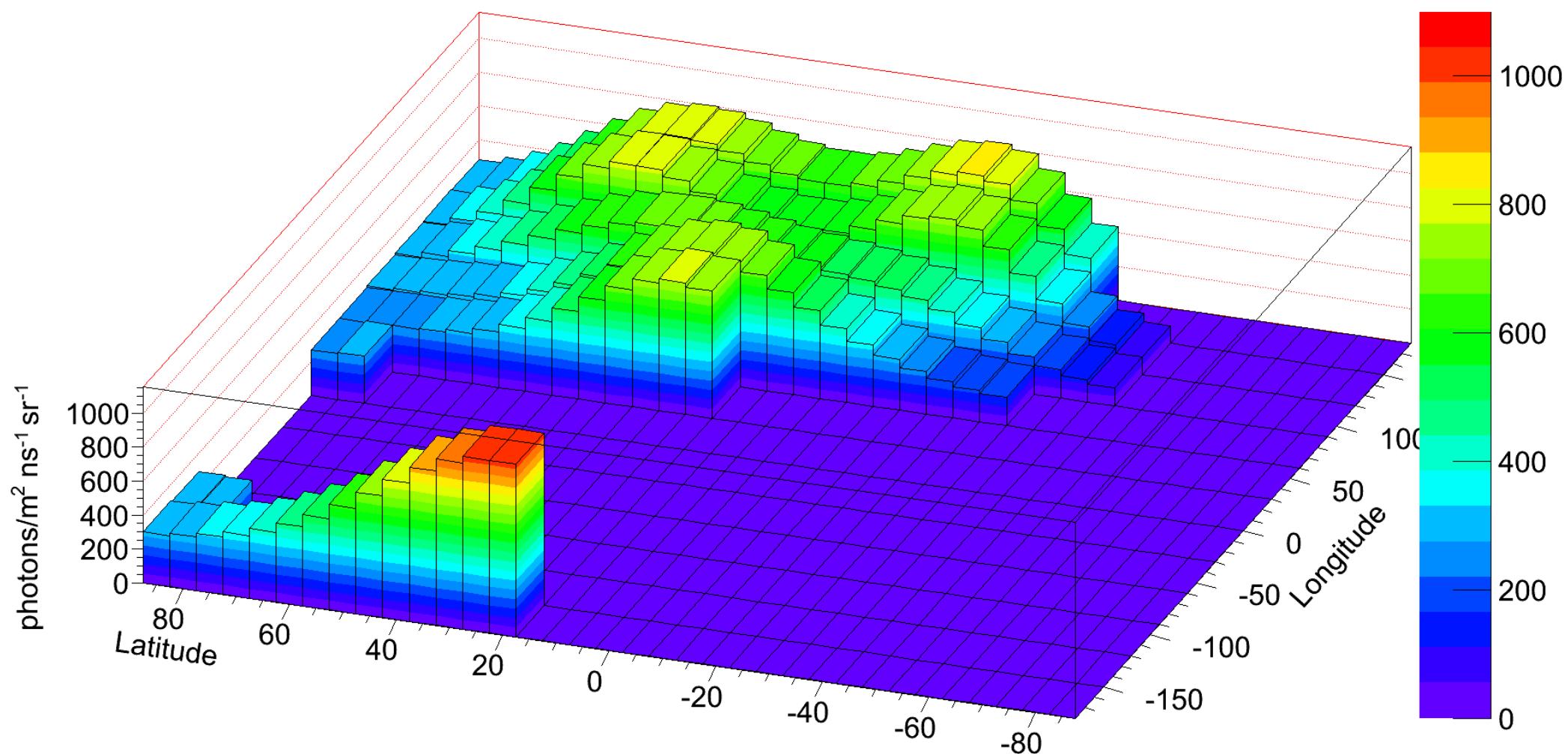
1994, Dec, UTC time

15 UTC UVBG



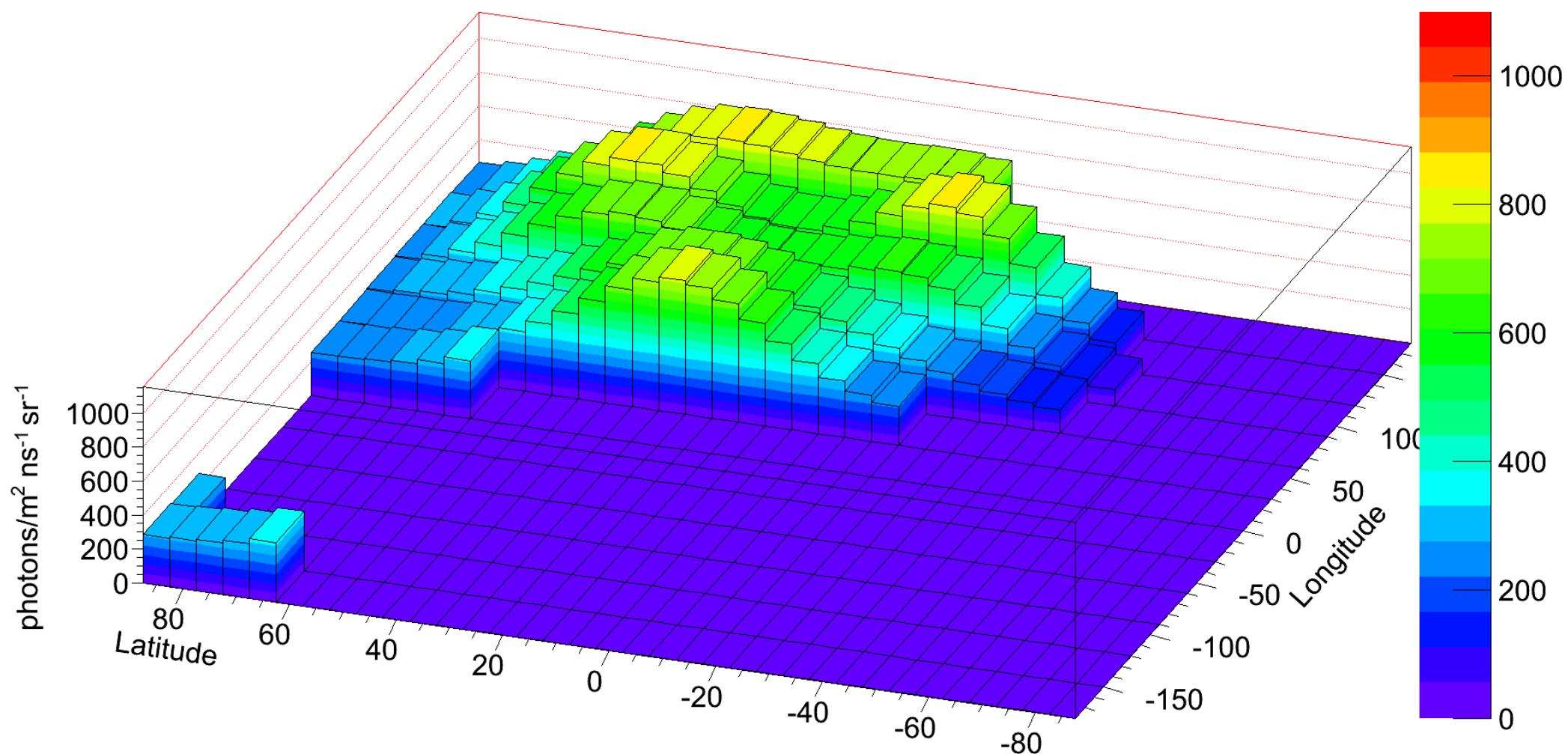
1994, Dec, UTC time

16 UTC UVBG



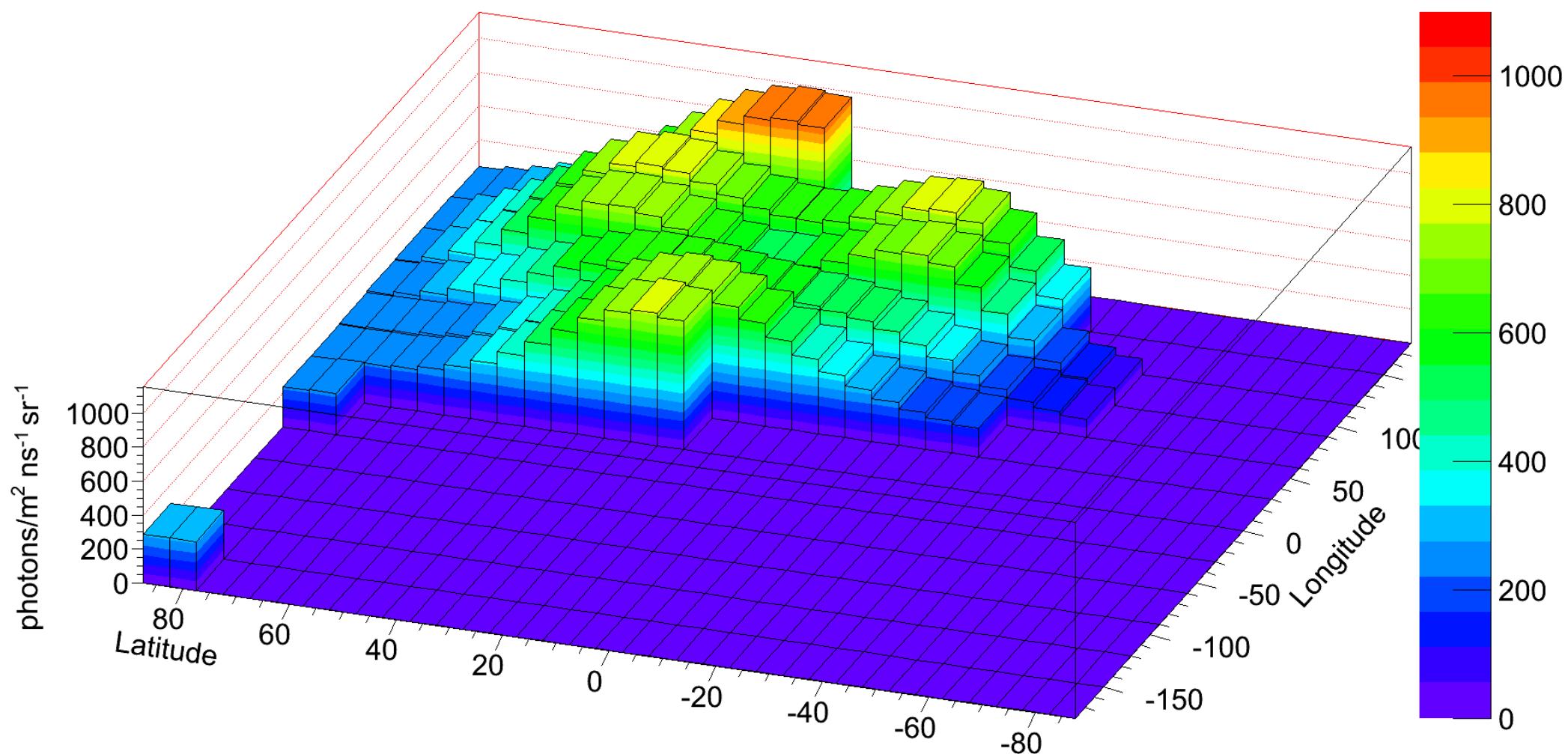
1994, Dec, UTC time

17 UTC UVBG



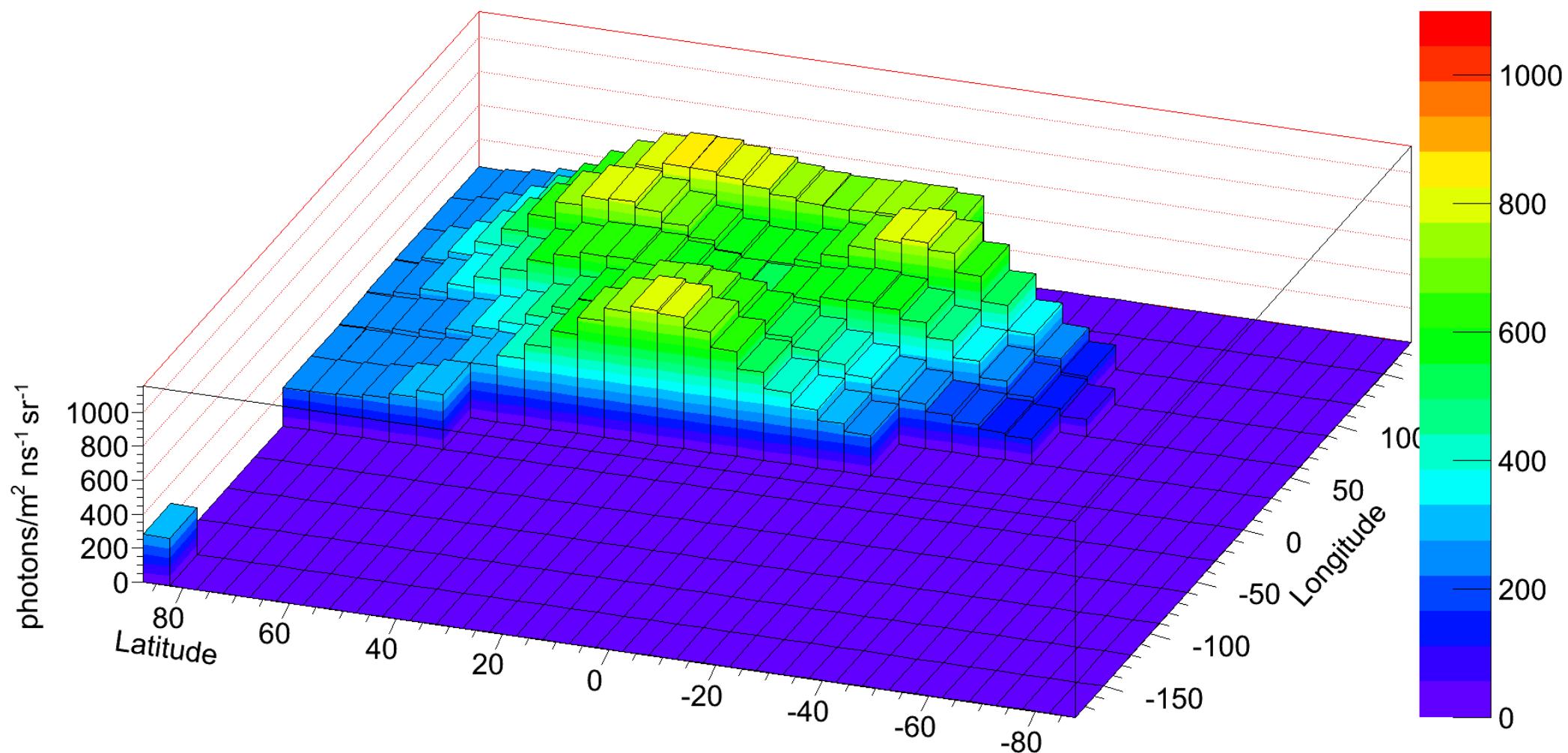
1994, Dec, UTC time

18 UTC UVBG



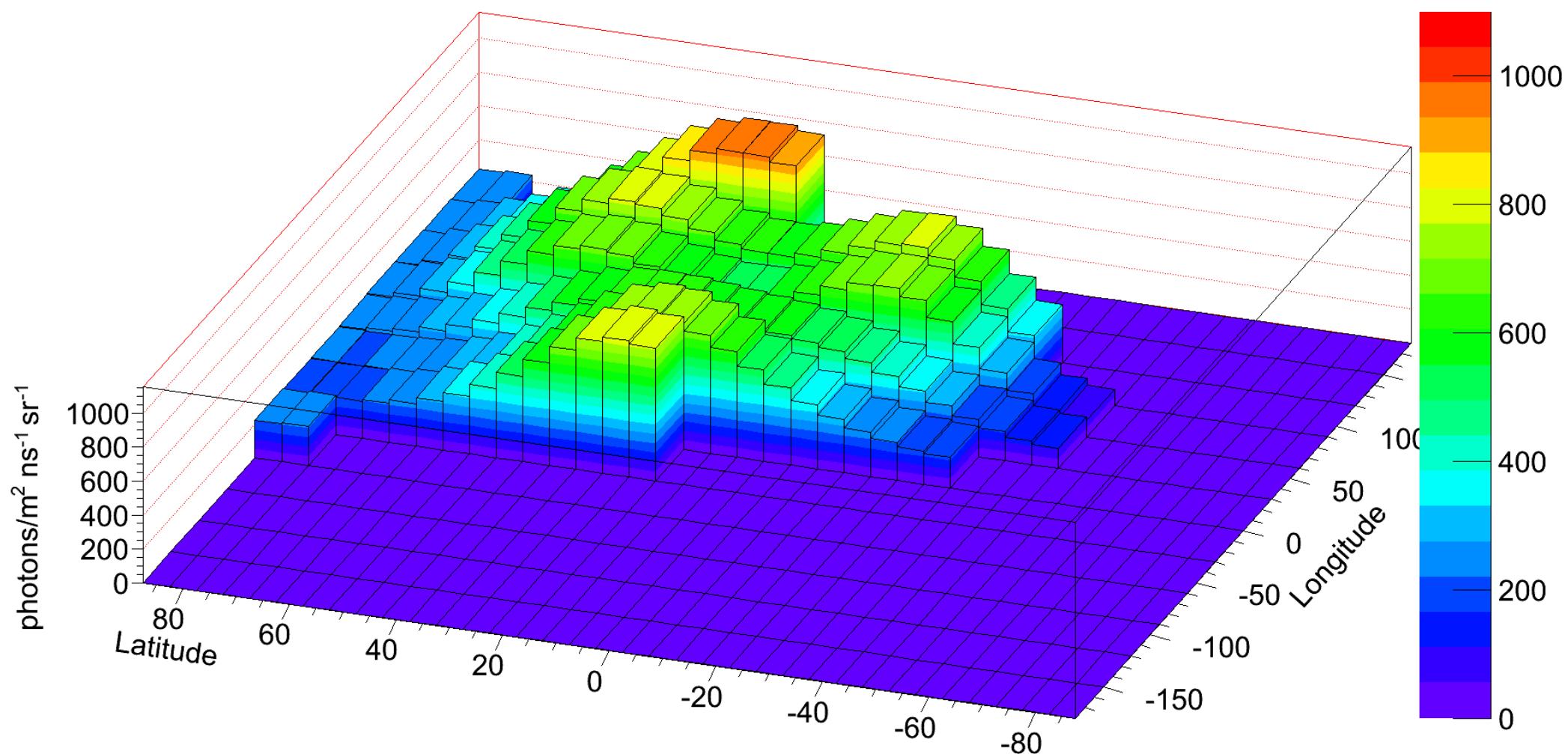
1994, Dec, UTC time

19 UTC UVBG



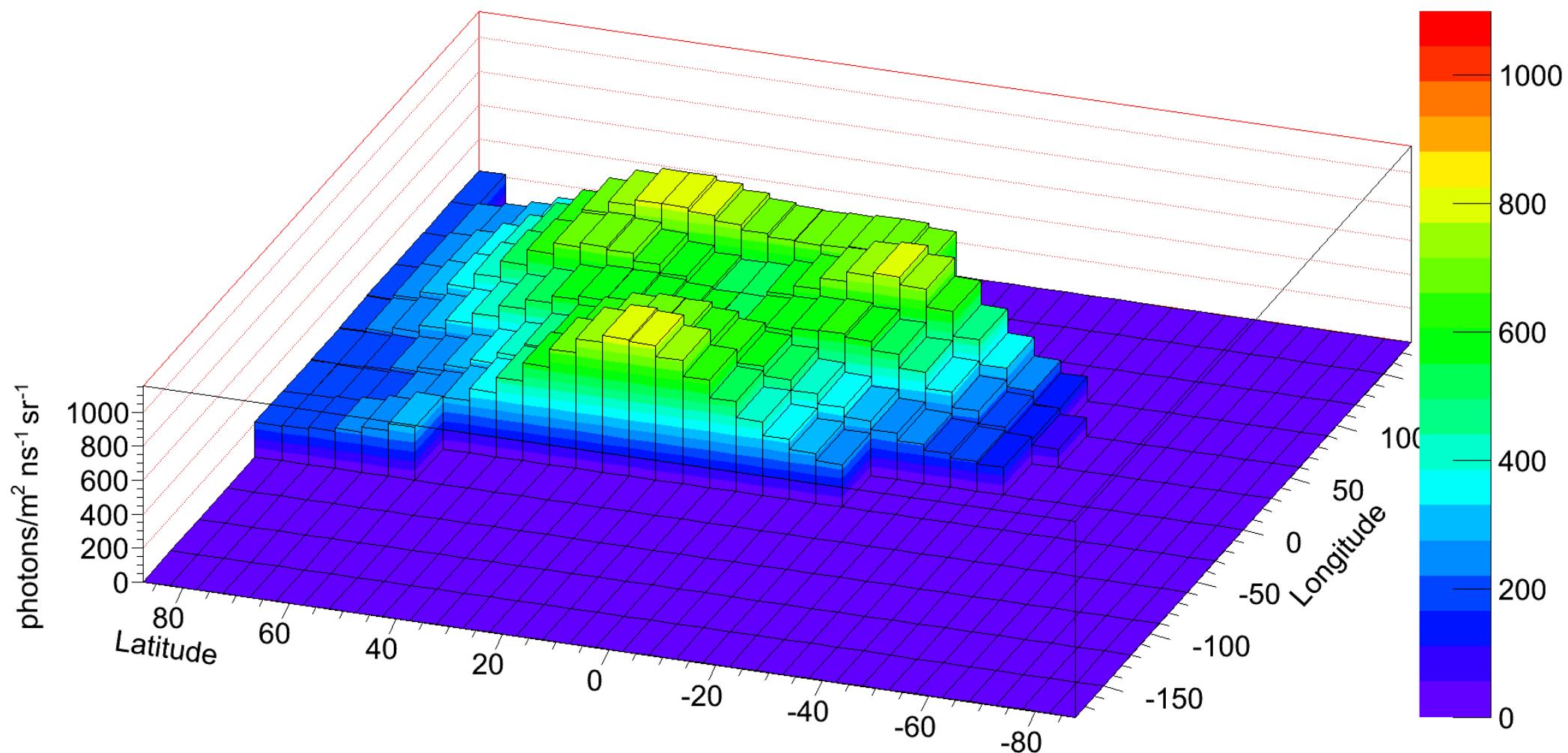
1994, Dec, UTC time

20 UTC UVBG



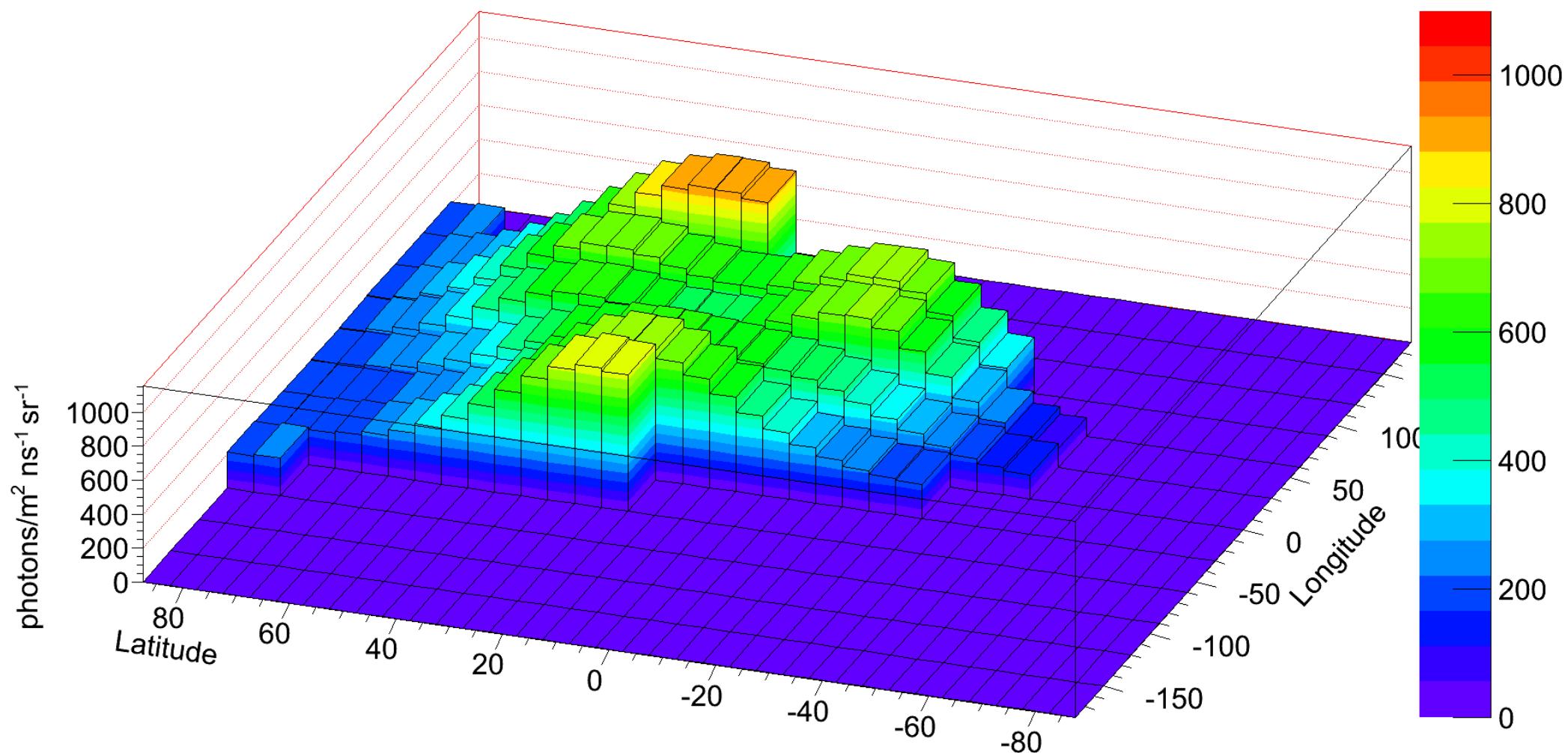
1994, Dec, UTC time

21 UTC UVBG



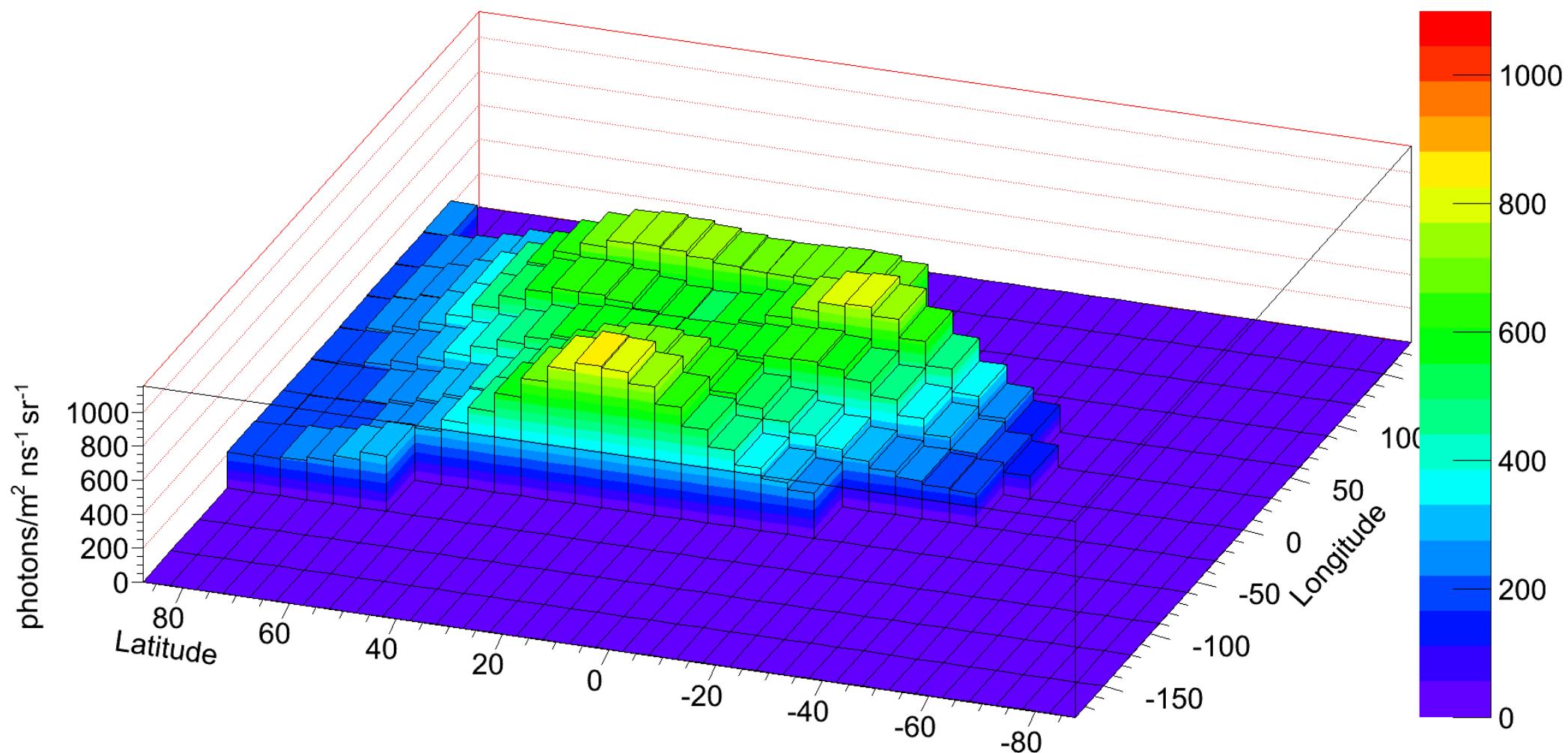
1994, Dec, UTC time

22 UTC UVBG

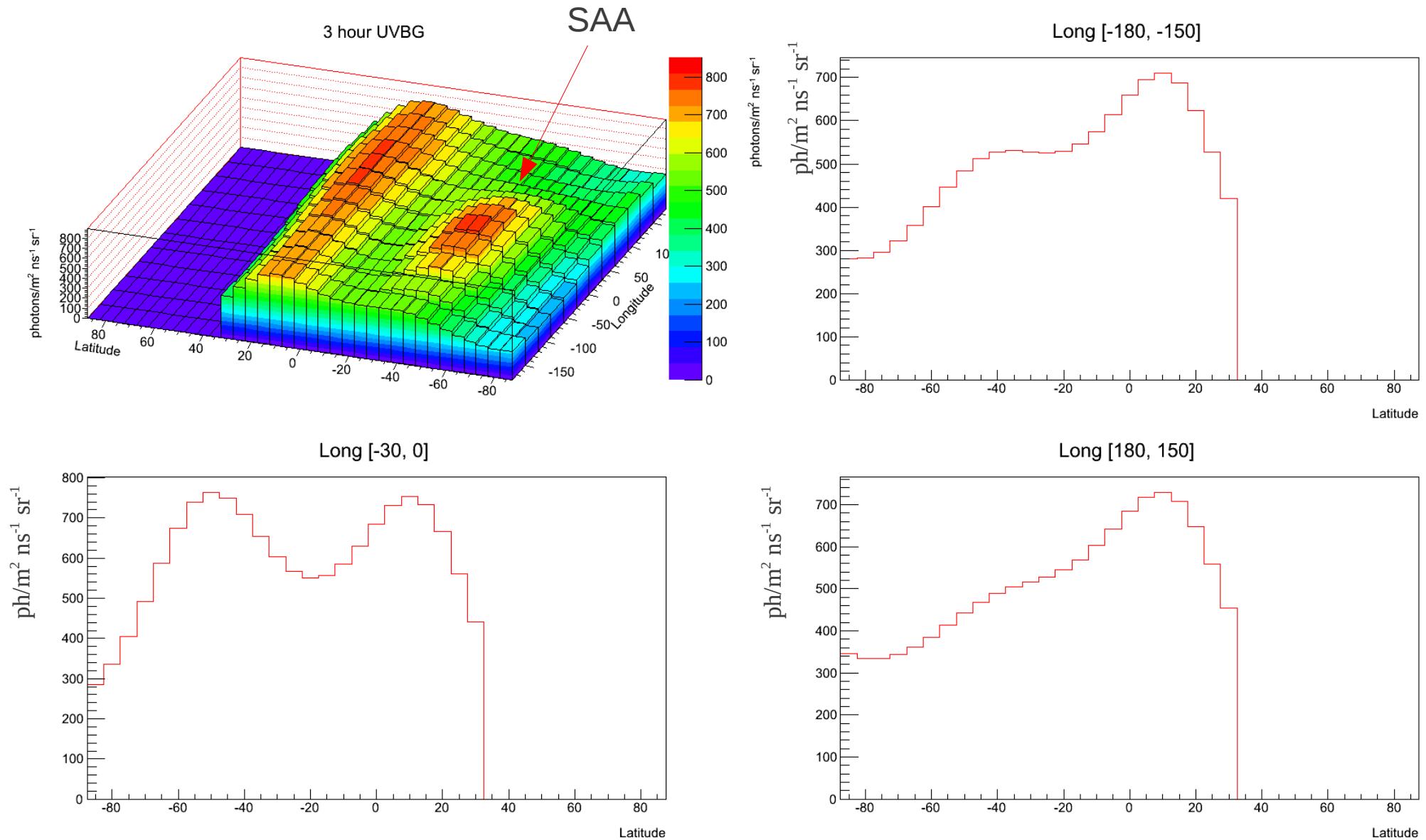


1994, Dec, UTC time

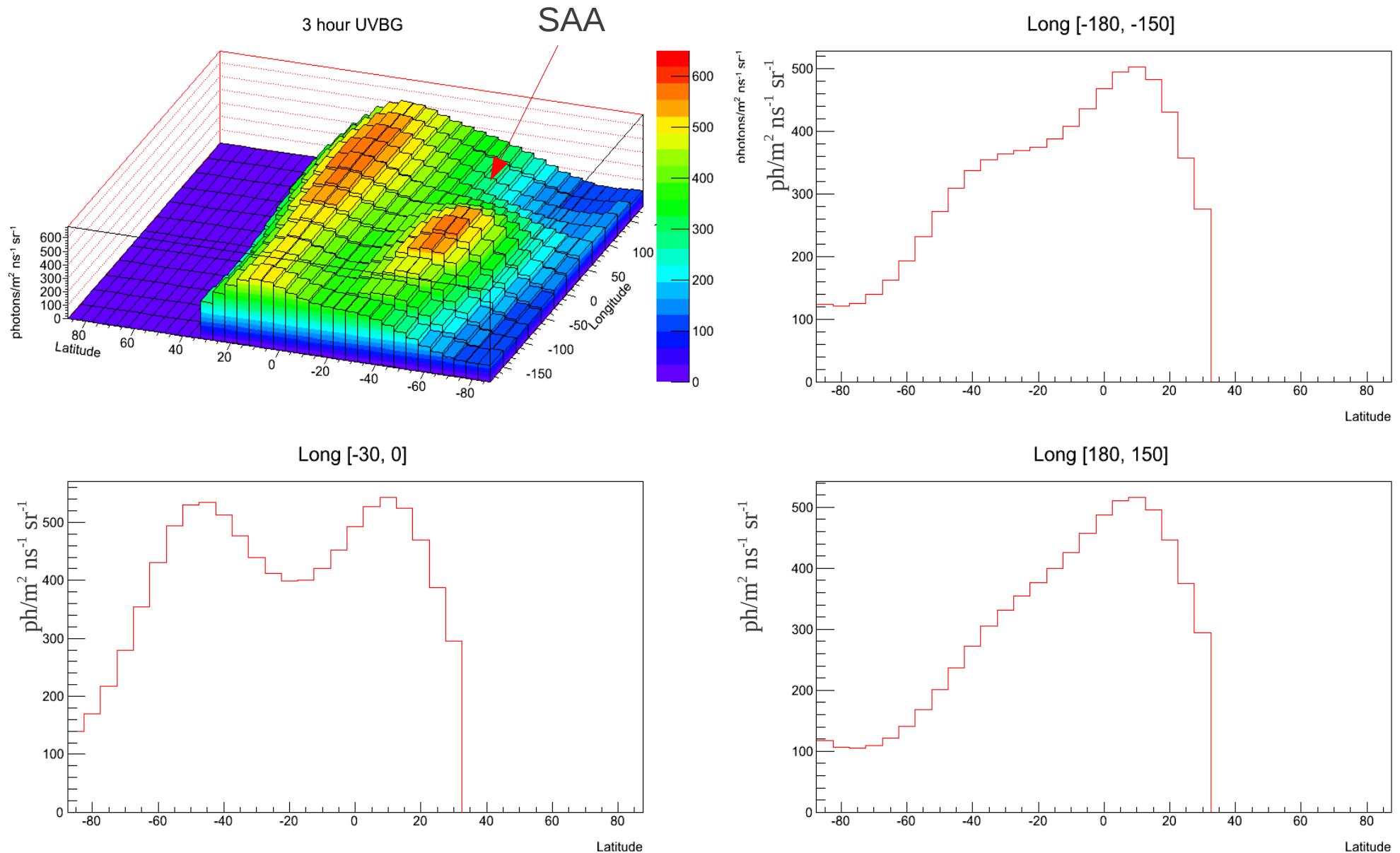
23 UTC UVBG



South Atlantic Anomaly, Map of UV nightglow, 1990, 20 -21. Jun, Local time 03:00

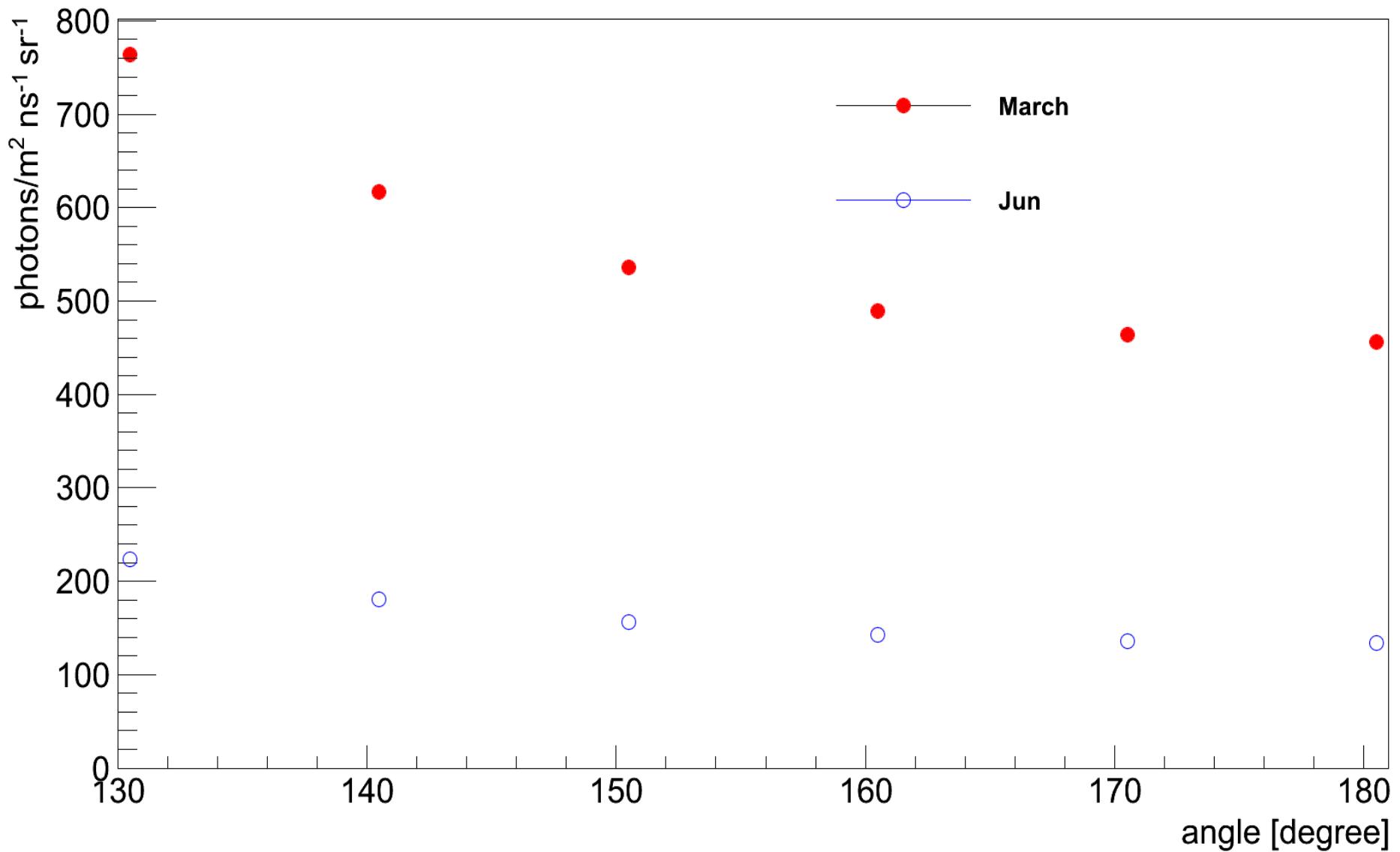


South Atlantic Anomaly, Map of UV nightglow, 1994, 20 -21. Jun, Local time 03:00

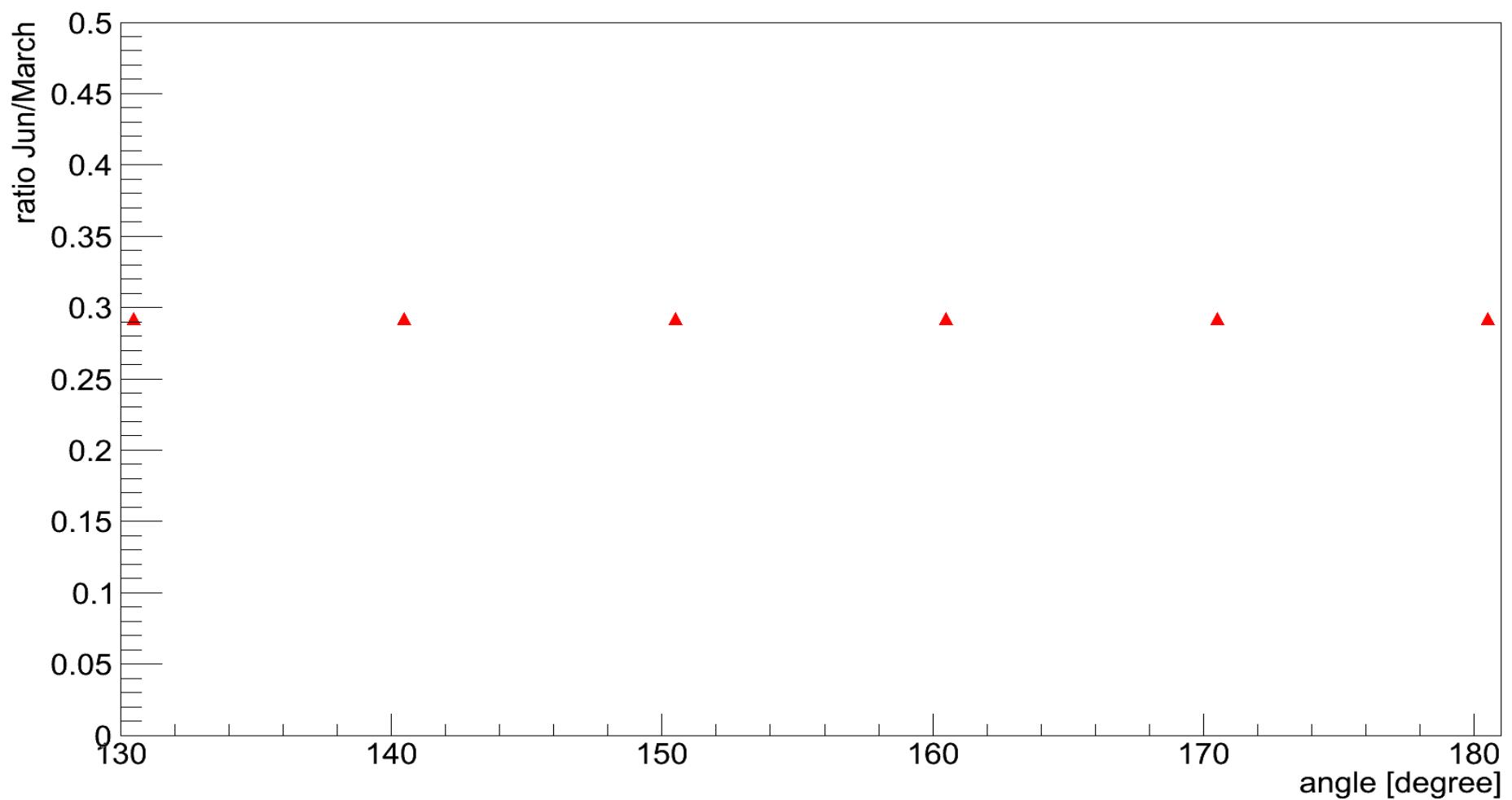


Looking angle dependence

UVBG for different looking angles, Year: 1994, time: 00:00, position: Lat 40, Long 20



- Ratio Jun/March – constant
- Some “simple function” scaling radiation from nadir looking angle.



Conclusion

- UV nightglow in AURIC is produced by Herzberg I, II and Chamberlain emission inside range 300 - 400 nm.
- UV nightglow depend on O, O₂, N₂ densities and on temperature.
- UV nightglow depend on:
 - local time – consequence of density and temperature change during the night,
 - season of year,
 - solar activity,
 - position on Earth.
- Values are in interval $\sim 100 - 1400 \text{ ph/m}^2 \text{ ns}^{-1} \text{ sr}^{-1}$
- Dependence on looking angle in AURIC: Some “simple function” scaling radiation from nadir looking angle. There is no special simulation procedure for this.