

# Nightglow background model - update

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# UV background model

- Goal is to obtain global picture of background
  - AURIC – UV nightglow source simulation
  - LibRadtran – radiative transfer calculation
    - Albedo map
    - Altitudes map (depth of atmosphere)
    - Type of atmosphere map
- 
- 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. Spect. Rad. Transfer, 62, 689, 1999.
  - LibRadtran reference: B. Mayer and A. Kylling, Technical note: The libRadtran software package for radiative transfer calculations - description and examples of use, doi:10.5194/acp-5-1855-2005

# LibRadtran – surface types

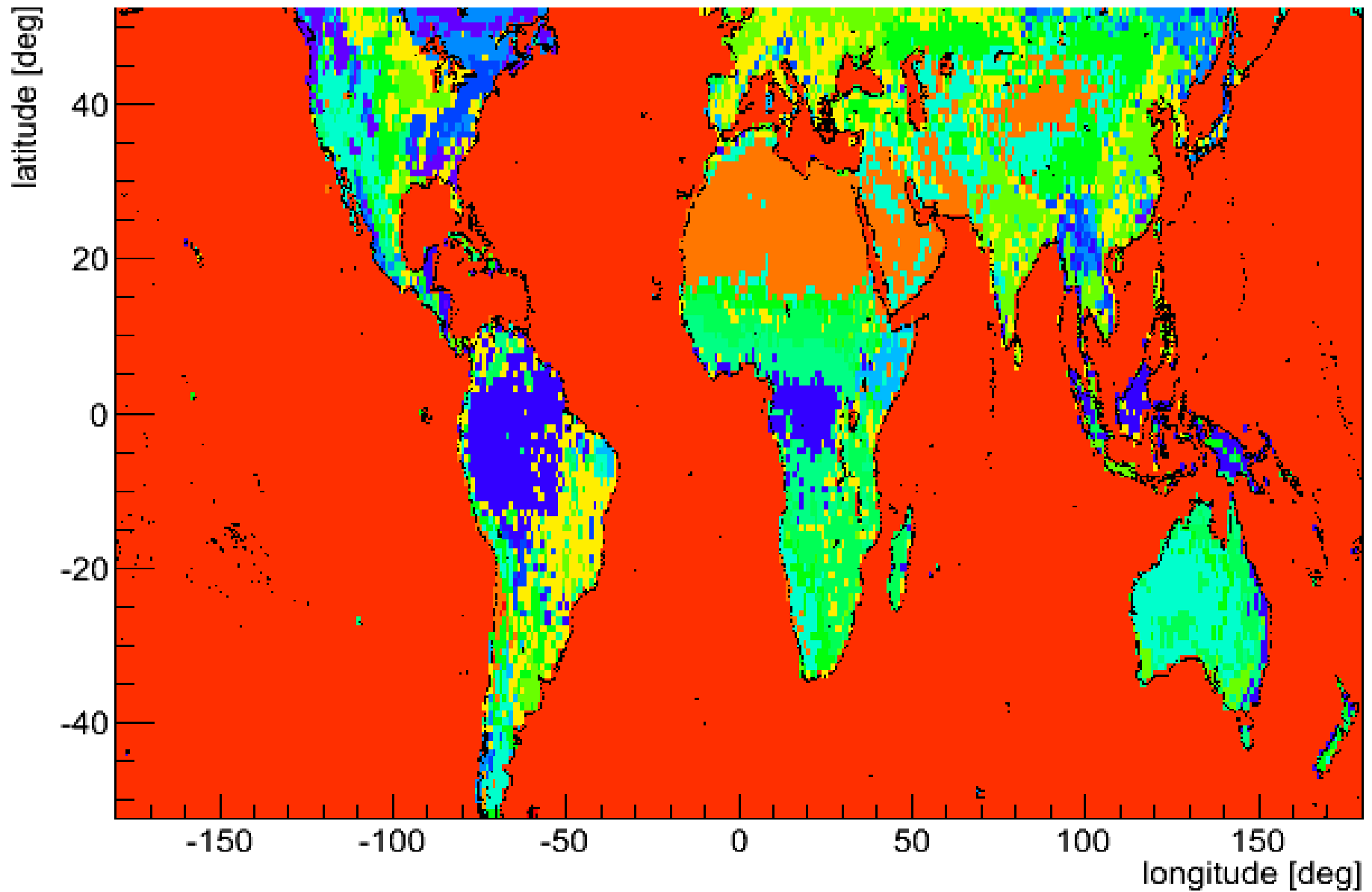
Contain 20 different surface types – albedo depend on wavelength in some cases

Wavelength (nm)	Antarctic snow	Closed shrubs	cropland	Crop mosaic	Deciduous broad forest	Deciduous needle forest	Desert
298.5 – 322.5	0.844	0.074	0.013	0.013	0.027	0.026	0.112
322.5 – 357.5	0.853	0.074	0.013	0.016	0.027	0.026	0.112
357.5 – 437.5	0.868	0.076	0.028	0.028	0.027	0.026	0.112
437.5 – 497.5	0.884	0.081	0.035	0.035	0.027	0.026	0.139
average	0.862	0.076	0.023	0.023	0.027	0.026	0.119

Wavelength (nm)	Evergreen broad forest	Evergreen needle forest	Fresh snow	Grassland	Mixed forest	Ocean water
298.5 – 322.5	0.034	0.025	0.900	0.013	0.028	0.057
322.5 – 357.5	0.034	0.025	0.902	0.015	0.028	0.064
357.5 – 437.5	0.034	0.025	0.906	0.027	0.028	0.073
437.5 – 497.5	0.034	0.025	0.909	0.033	0.028	0.071
average	0.034	0.025	0.904	0.022	0.028	0.066

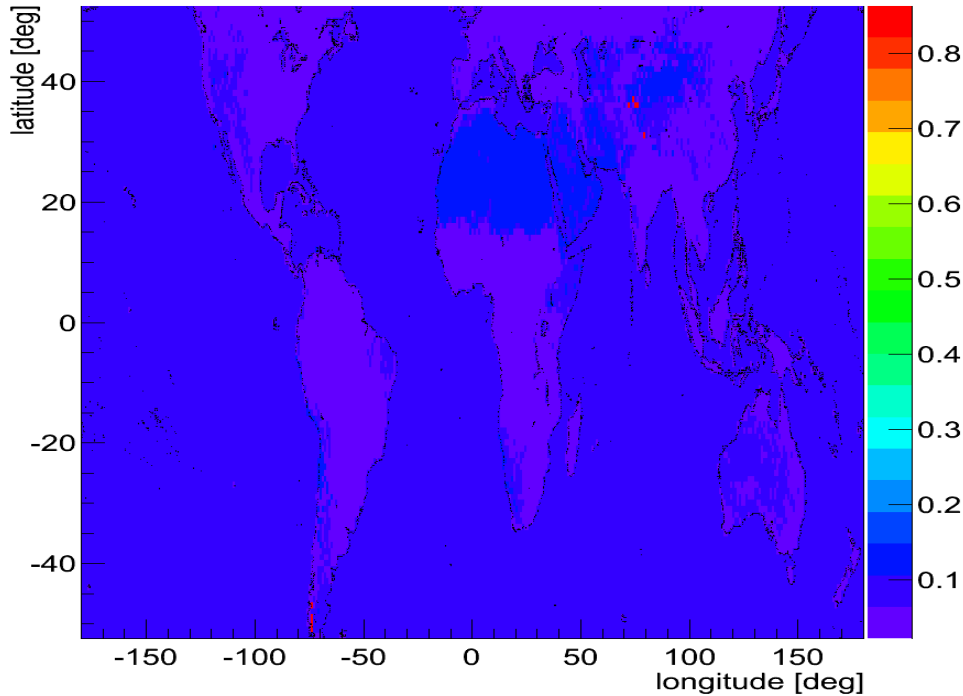
Wavelength (nm)	Open shrubs	savanna	Sea ice	tundra	urban	wetland	Woody savanna
298.5 – 322.5	0.074	0.013	0.713	0.012	0.048	0.031	0.018
322.5 – 357.5	0.074	0.015	0.713	0.015	0.048	0.031	0.020
357.5 – 437.5	0.076	0.027	0.713	0.026	0.048	0.031	0.027
437.5 – 497.5	0.081	0.033	0.713	0.033	0.061	0.031	0.031
average	0.076	0.022	0.713	0.022	0.051	0.031	0.024

# LibRadtran: Map of surface types

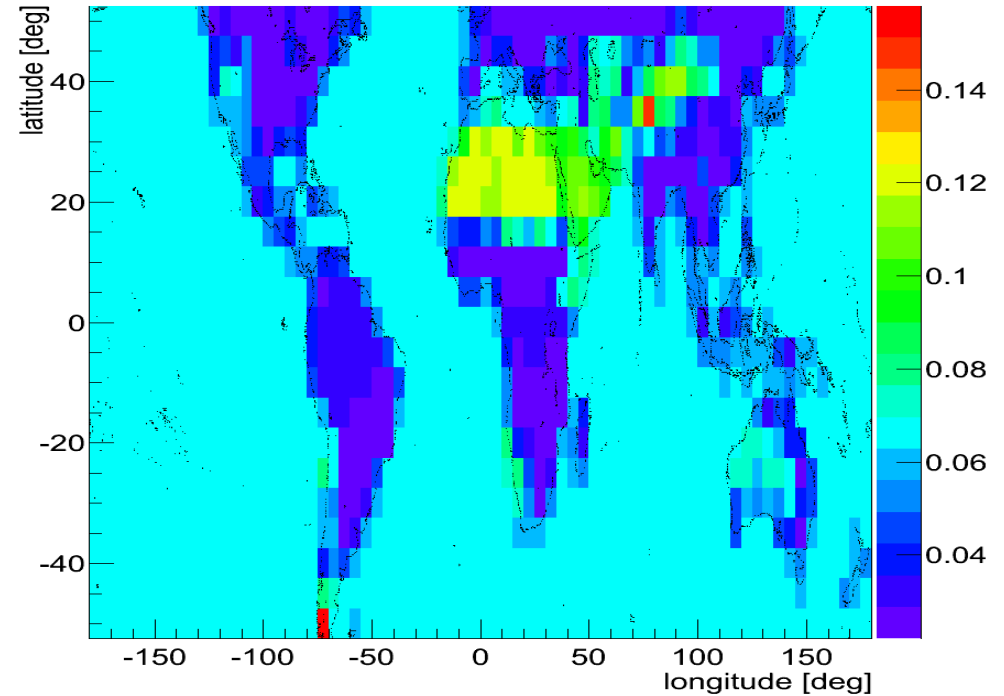


# LibRadtran: Albedo map – summer, north hemisphere

Albedo map summer for 37800 points



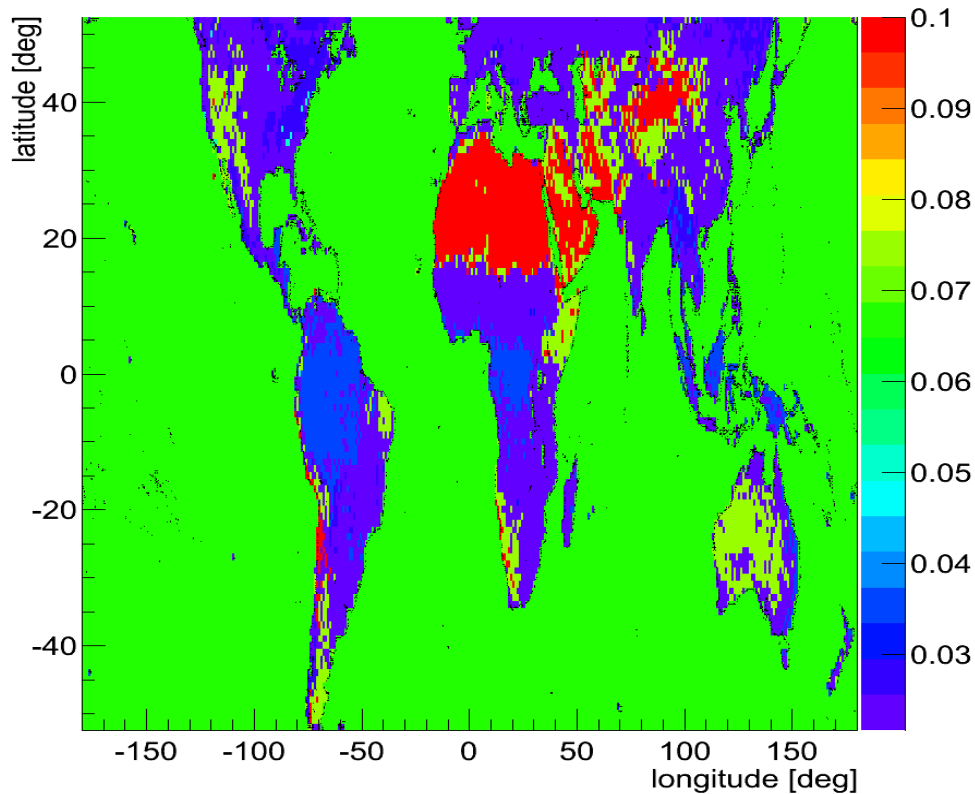
Albedo map summer for 1512 points



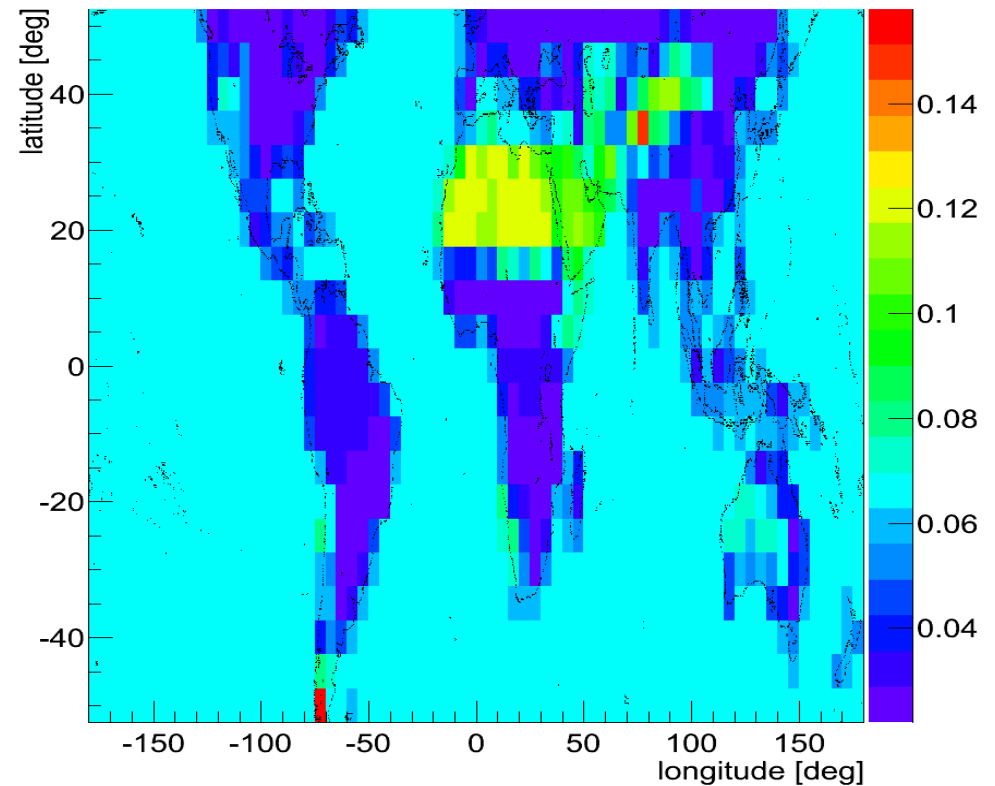
- Most of values are less than 0.1
- Only ice, snow, desert  $> 0.1$
- Right picture: value at one cell is average of 25 points from left picture
- Belward, A. and Loveland, T.: The DIS 1-km land cover data set, GLOBAL CHANGE, The IGBP Newsletter, 27, 1996.

# LibRadtran: Albedo map – summer, north hemisphere

Albedo map summer for 37800 points



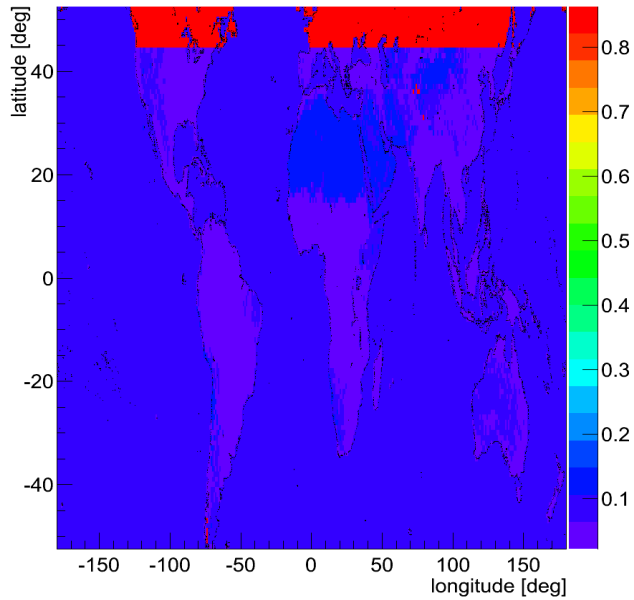
Albedo map summer for 1512 points



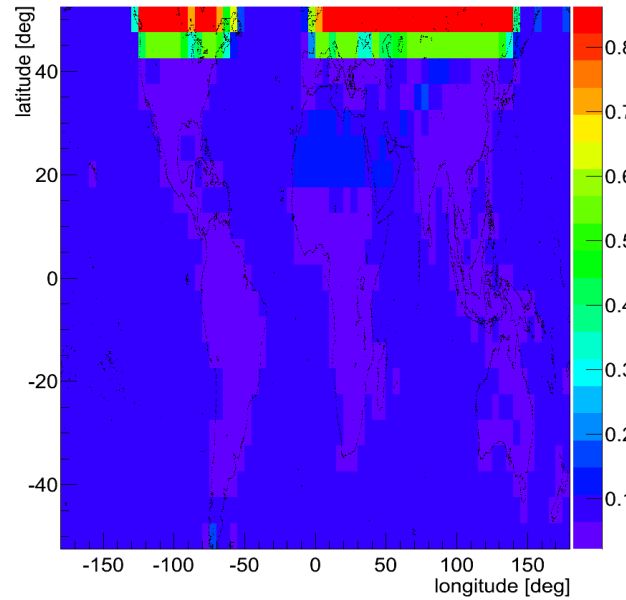
- Zoom of z axis – left picture

# LibRadtran: Albedo map – winter, north hemisphere

Albedo map winter for 37800 points

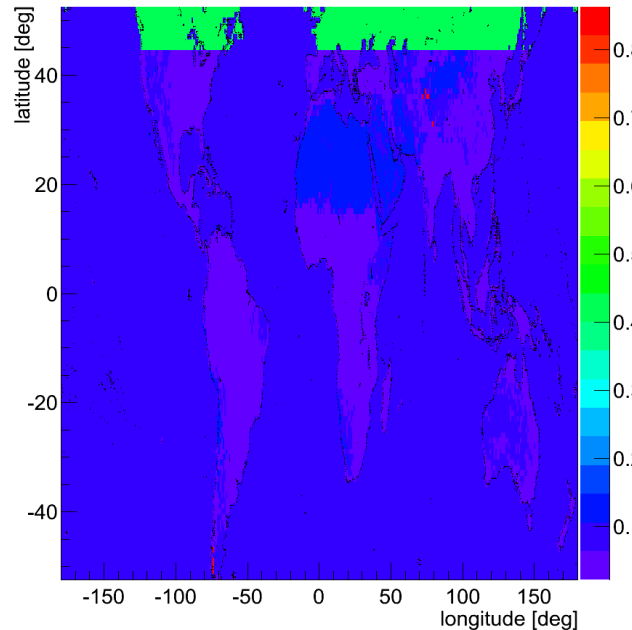


Albedo map winter for 1512 points

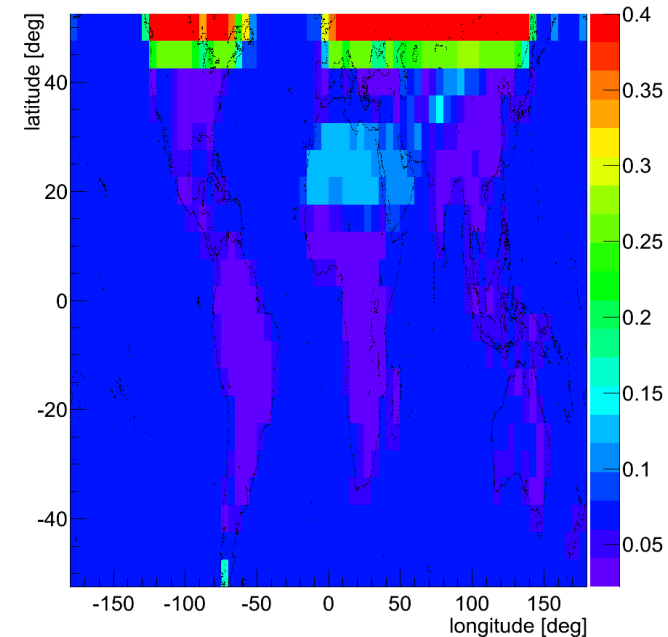


- Pessimistic scenario - fresh snow for latitude  $> 44.5$  deg
- Albedo 0.904

Albedo map winter for 37800 points



Albedo map winter for 1512 points

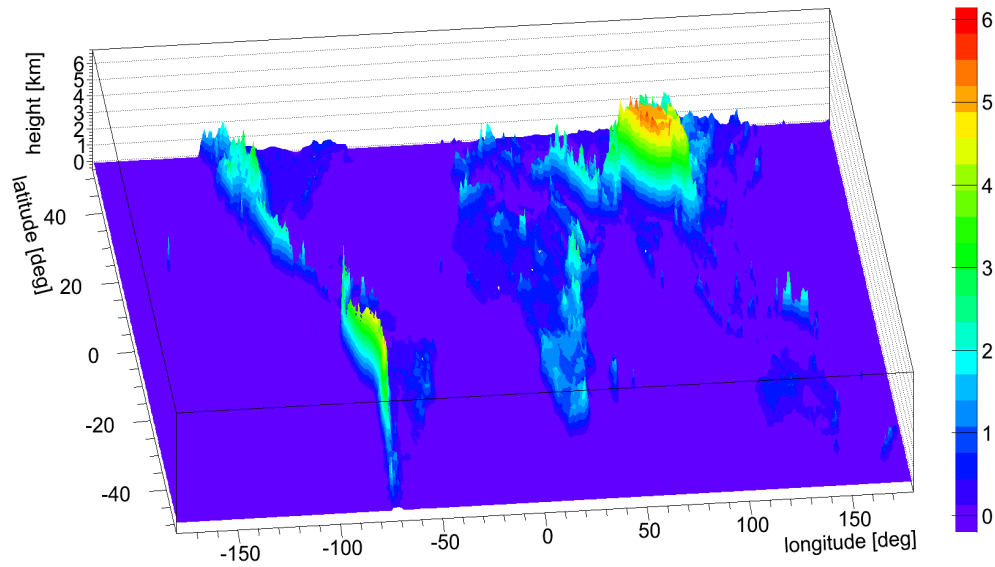


- Fresh snow reflectance is reduced by vegetation and terrain is not flat.
- Reduction of albedo by  $\sim 50\%$
- More real scenario: albedo  $\sim 0.4$
- Renata Chadyšien, Aloyzas Girgždys, ULTRAVIOLET RADIATION ALBEDO OF NATURAL SURFACES, Journal of Environmental Engineering and Landscape Management, DOI: 10.3846/1648-6897.2008.16.83-88



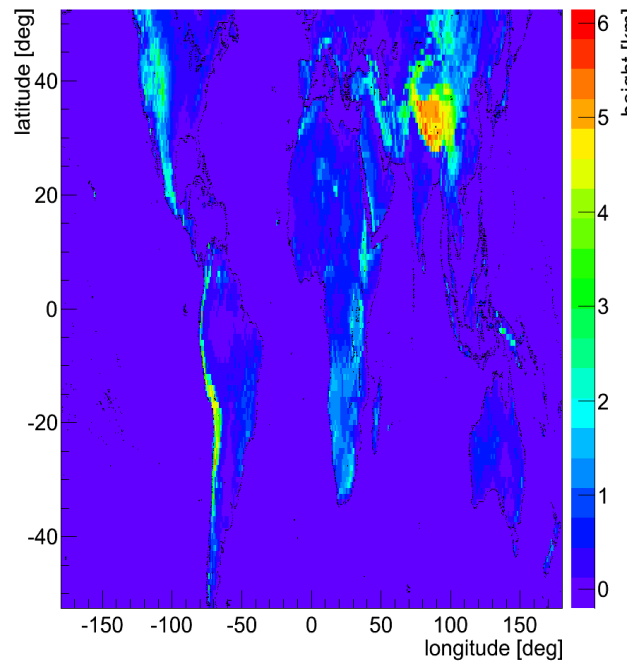
# LibRadtran: Altitude map

Altitude map for 37800 points

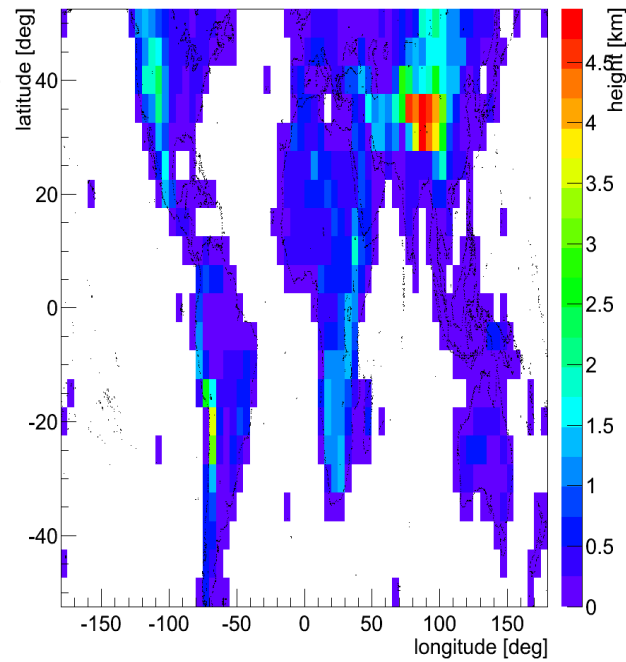


Altitude map – different positions have different atmosphere depth

Altitude map for 37800 points



Altitude map for 1512 points



# LibRadtran: Type of atmosphere

- 6 types of atmosphere: tropical, midlatitude summer, midlatitude winter, subarctic winter, subarctic summer, US standard
- in range from -52.5 deg to 52.5 deg of latitude:  
(-22.5 to 22.5) tropical, midlatitude summer and midlatitude winter for rest
- Anderson, G., Clough, S., Kneizys, F., Chetwynd, J., and Shettle, E.: AFGL atmospheric constituent profiles (0-120 km), Tech. Rep. AFGL-TR-86-0110, Air Force Geophys. Lab., Hanscom Air Force Base, Bedford, Mass., 1986.

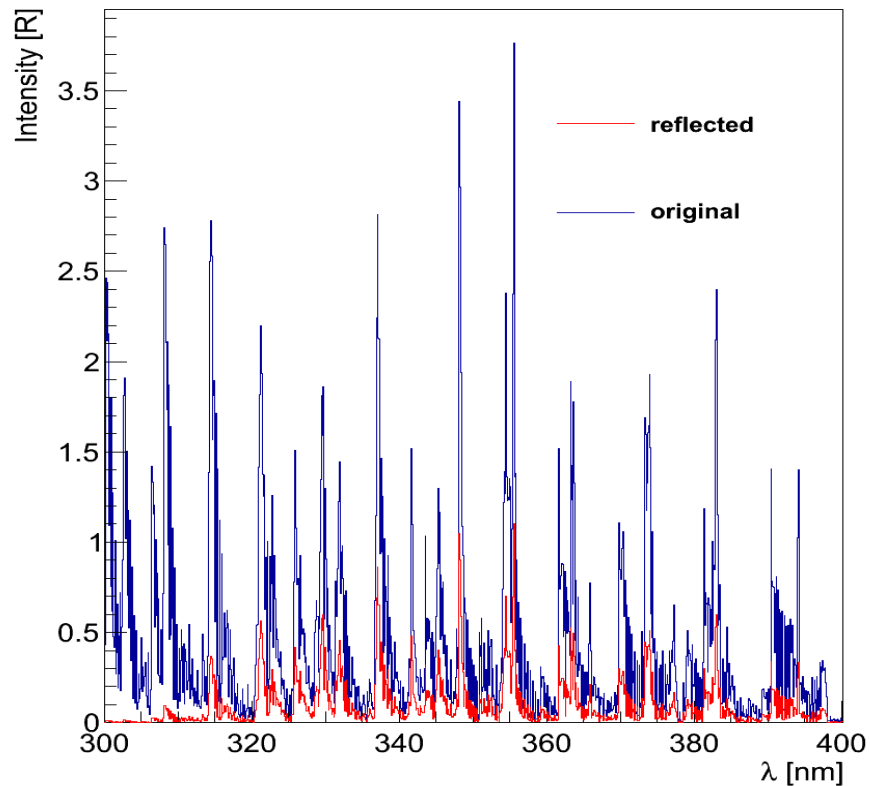
# Radiative transfer example - libRadtran

- No clouds
- Albedo 0.119 (desert)
- US standard atmosphere
- Input spectrum – AURIC (300 – 400 nm)
- Altitude of final (reflected) spectrum 120 km
- Two options in libRadtran:
  - BEAM – source is infinitely wide beam
  - FISOT – diffuse source

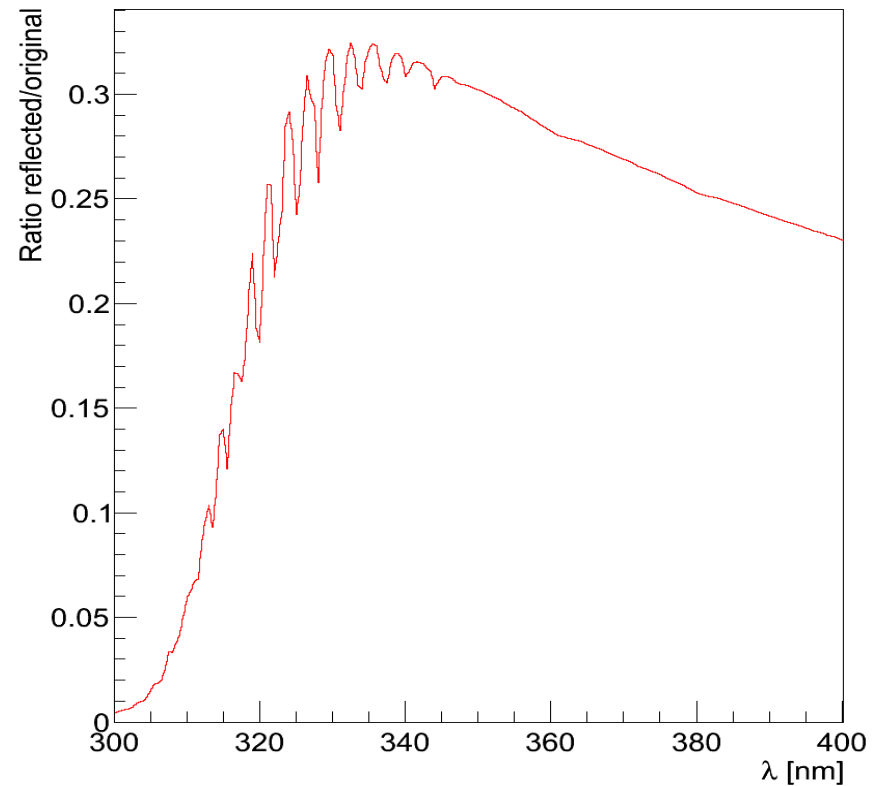
# FBEAM – beam source

- ratio is  $\sim 0.25 - 0.33$  in range  $\sim 330 - 400$  nm
- In range  $300 - 330$  nm – strong absorption

Original and reflected spectrum



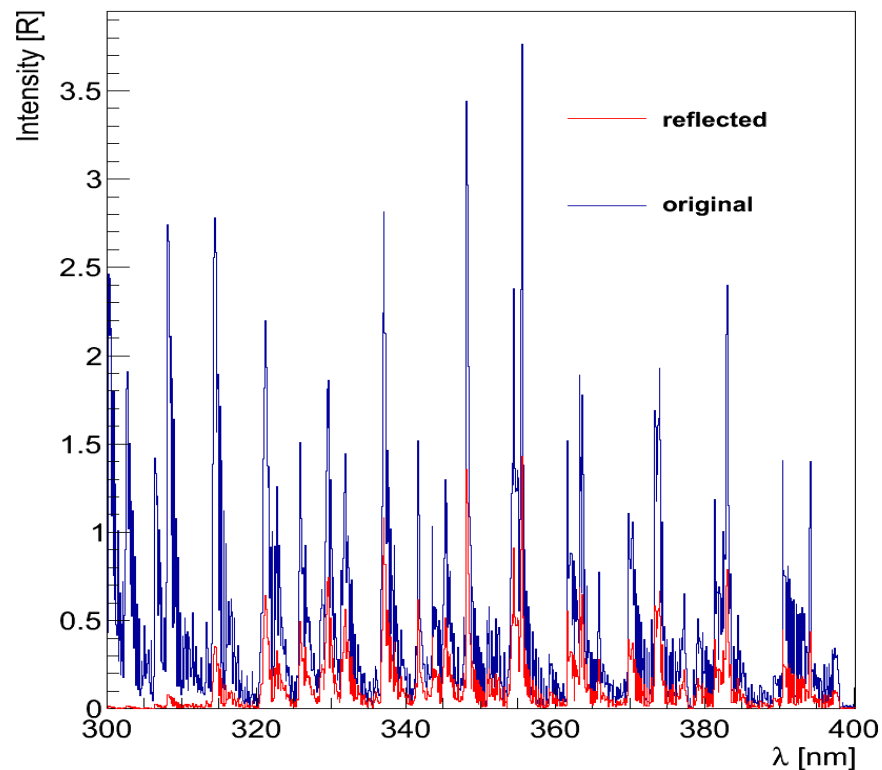
Ratio reflected/original



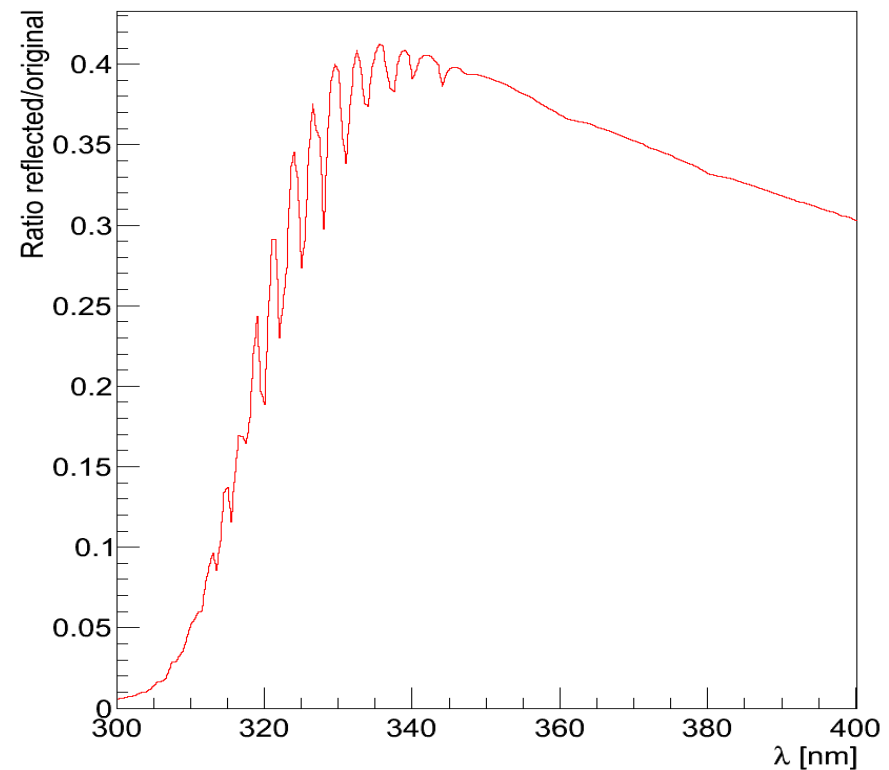
# FISOT – diffuse source – emission from atmosphere layer

- ratio is  $\sim 0.3 - 0.42$  in range  $\sim 330 - 400$  nm
- In range  $300 - 330$  nm – strong absorption
- Diffuse source results in bigger values with respect to beam source

Original and reflected spectrum



Ratio reflected/original



# Next steps

- Prepare reflected spectra for different
  - time and space coordinates
  - types of atmosphere
  - Albedo
- Effect of clouds
- Finally prepare complete model of night background
- Balloon and TA EUSO data will be very useful