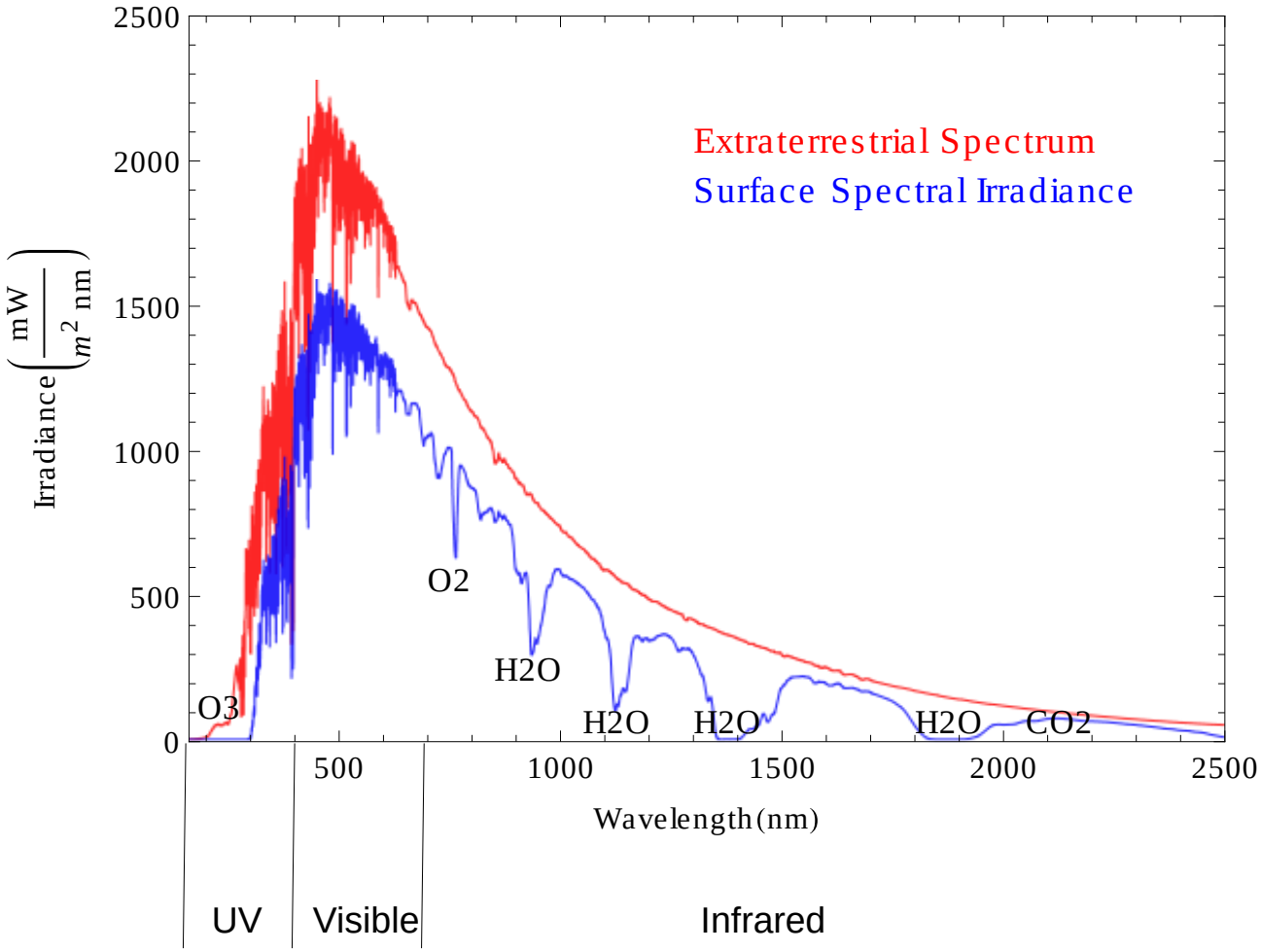
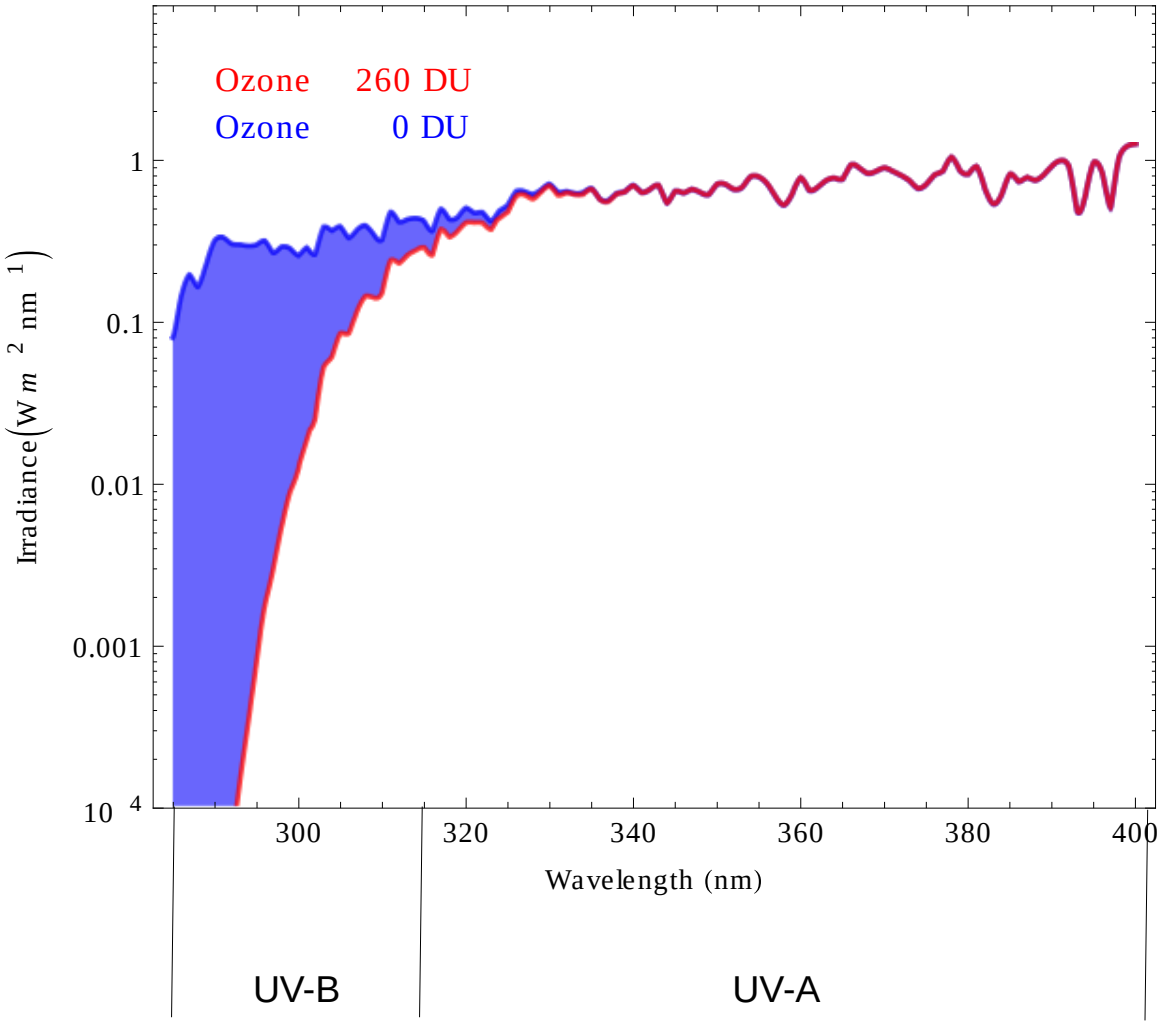
Detection of Atmospheric Composition Change

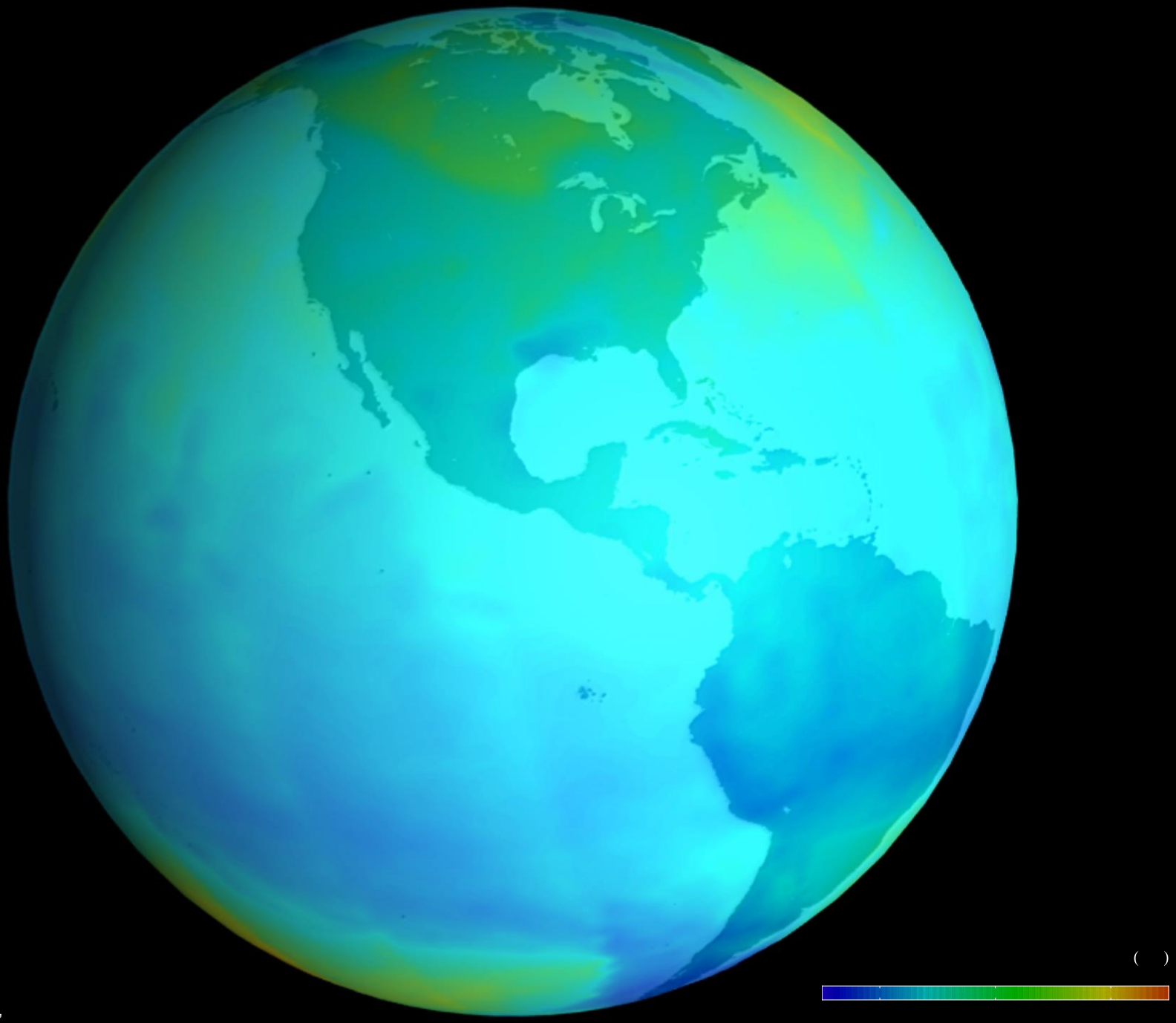
Standards for UV Radiation

Raul R. Cordero

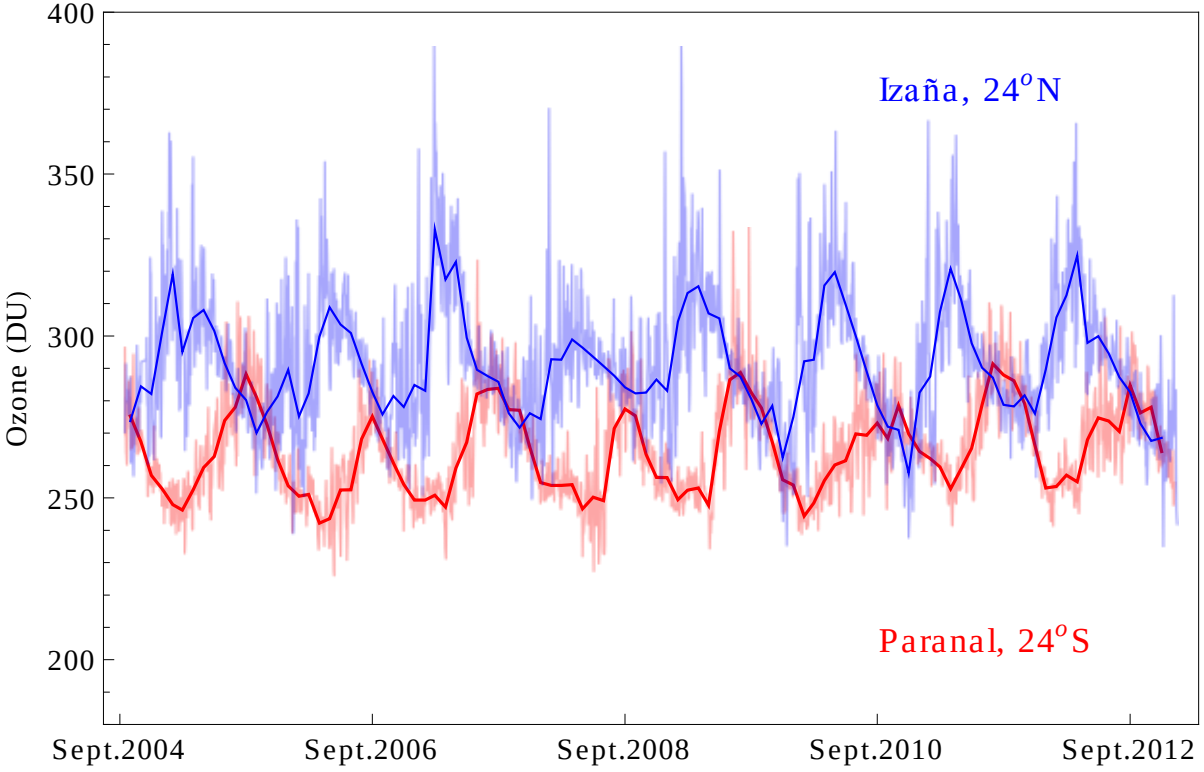
Universidad de Santiago de Chile


Extraterrestrial Spectrum
Surface Spectral Irradiance
Irradiance $\left(\frac{mW}{m^2\,nm}\right)$
2500
2000
1500
1000
500
0
500
1000
1500
2000
2500
Wavelength (nm)
O3
O2
H2O
H2O
H2O
H2O
CO2
UV
Visible
Infrared

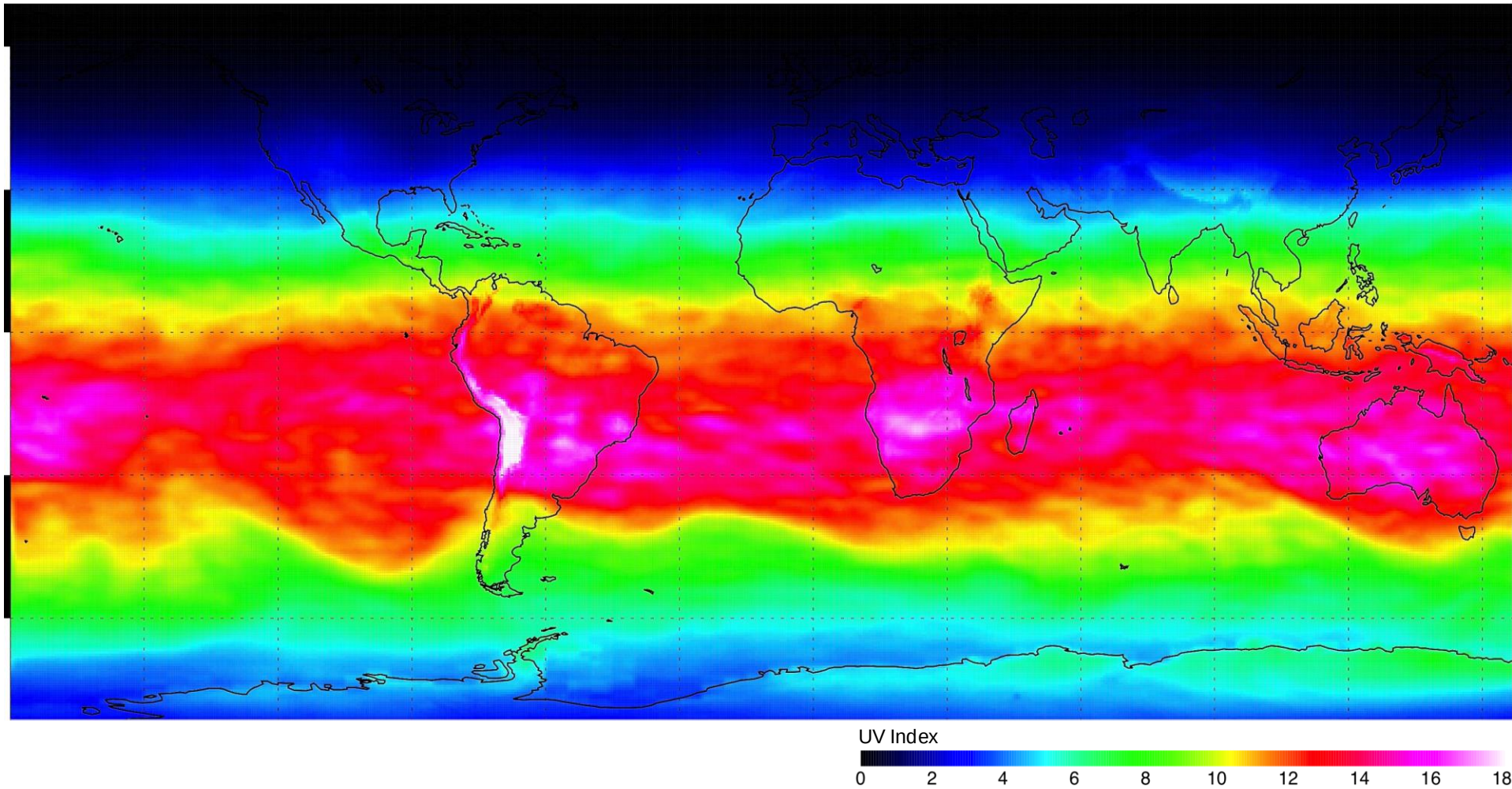

Ozone 260 DU
Ozone 0 DU
1
0.1
0.01
0.001
10 4
Irradiance (W m 2 nm 1)
300
320
340
360
380
400
Wavelength (nm)
UV-B
UV-A



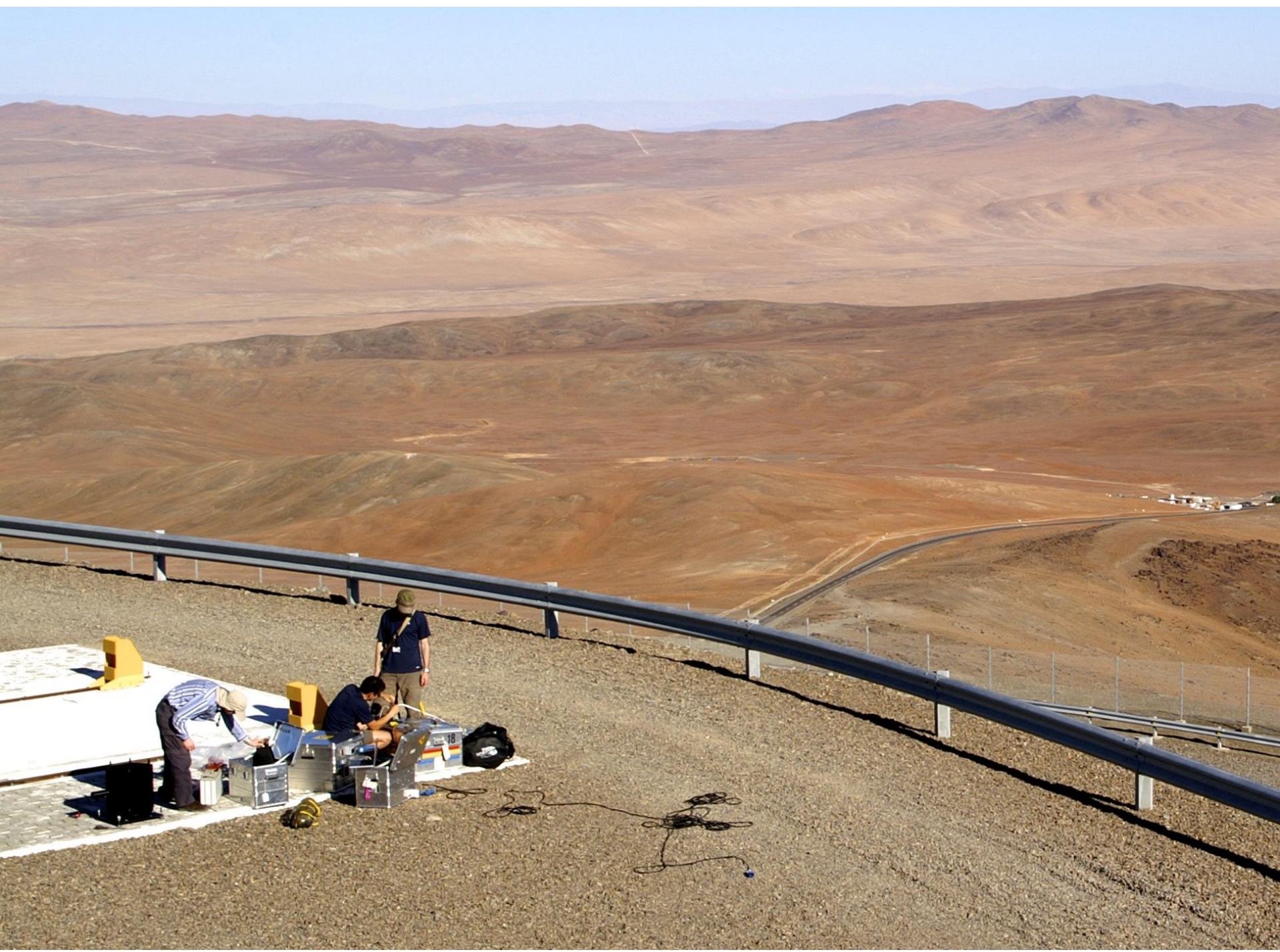
“NASA Ozone Watch”,
http://ozonewatch.gsfc.nasa.gov/

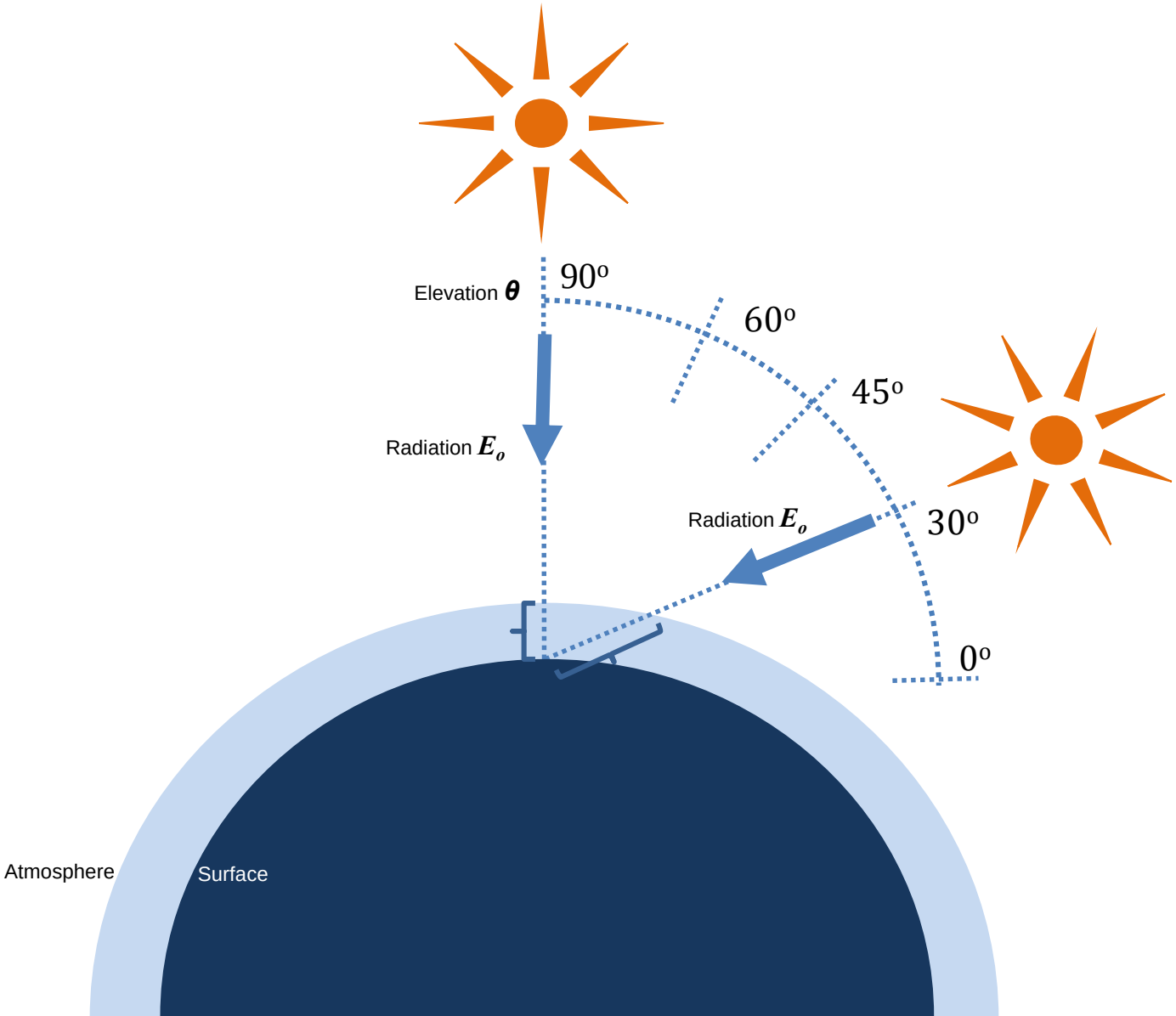


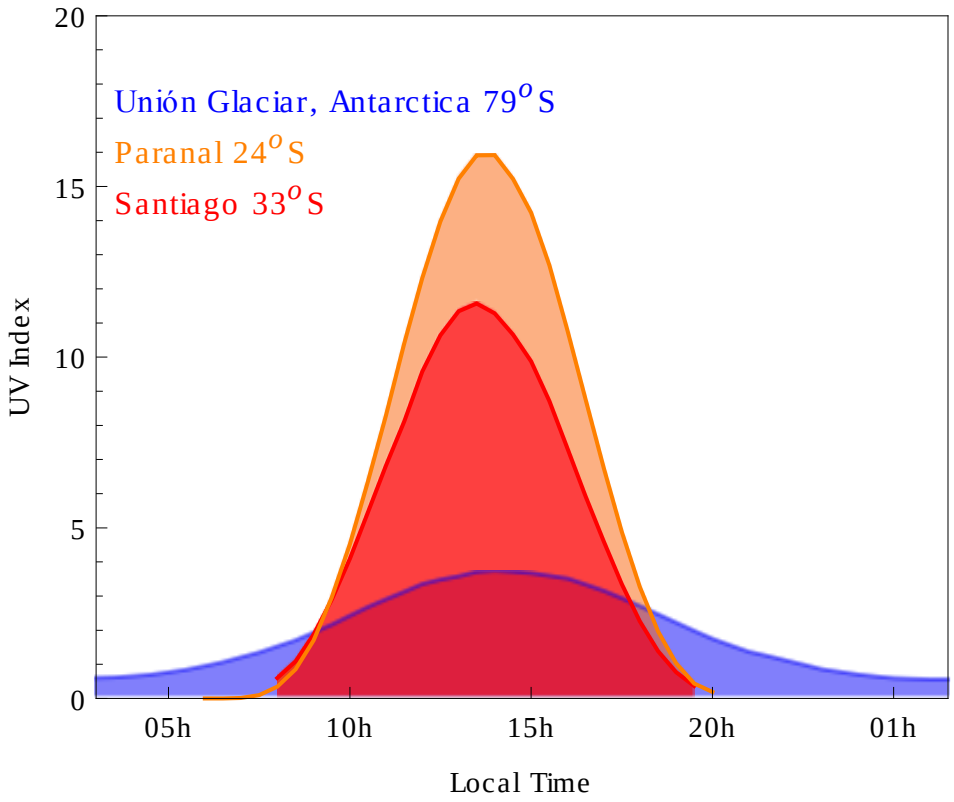
Quoted from Cordero et al 2014



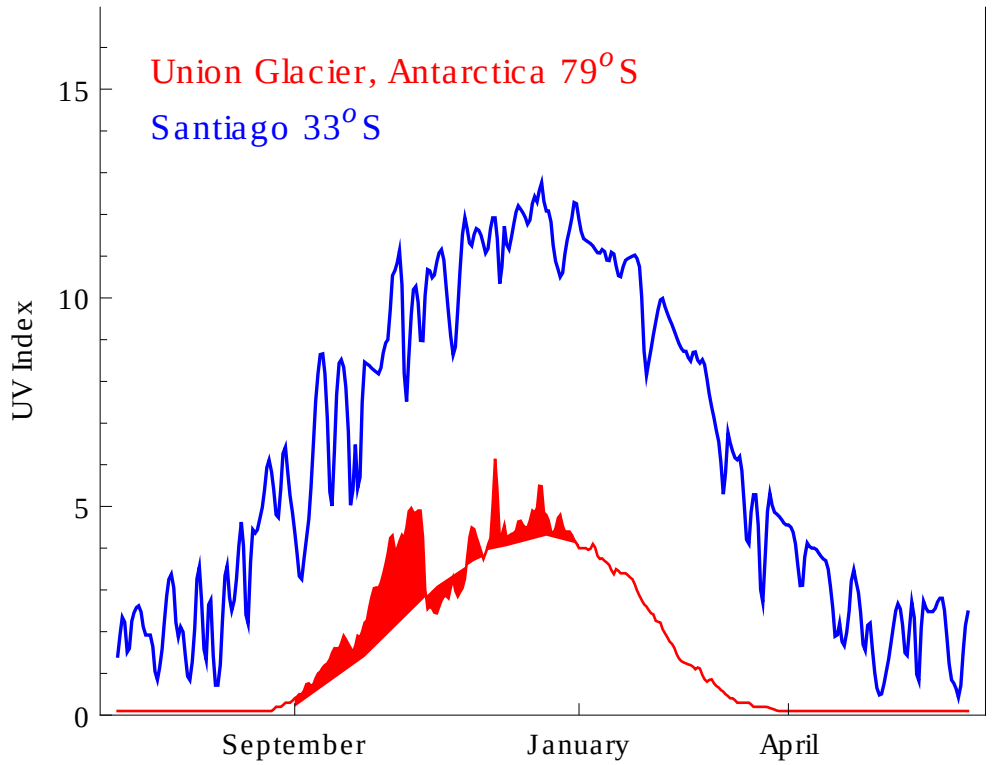
January 4, 2014



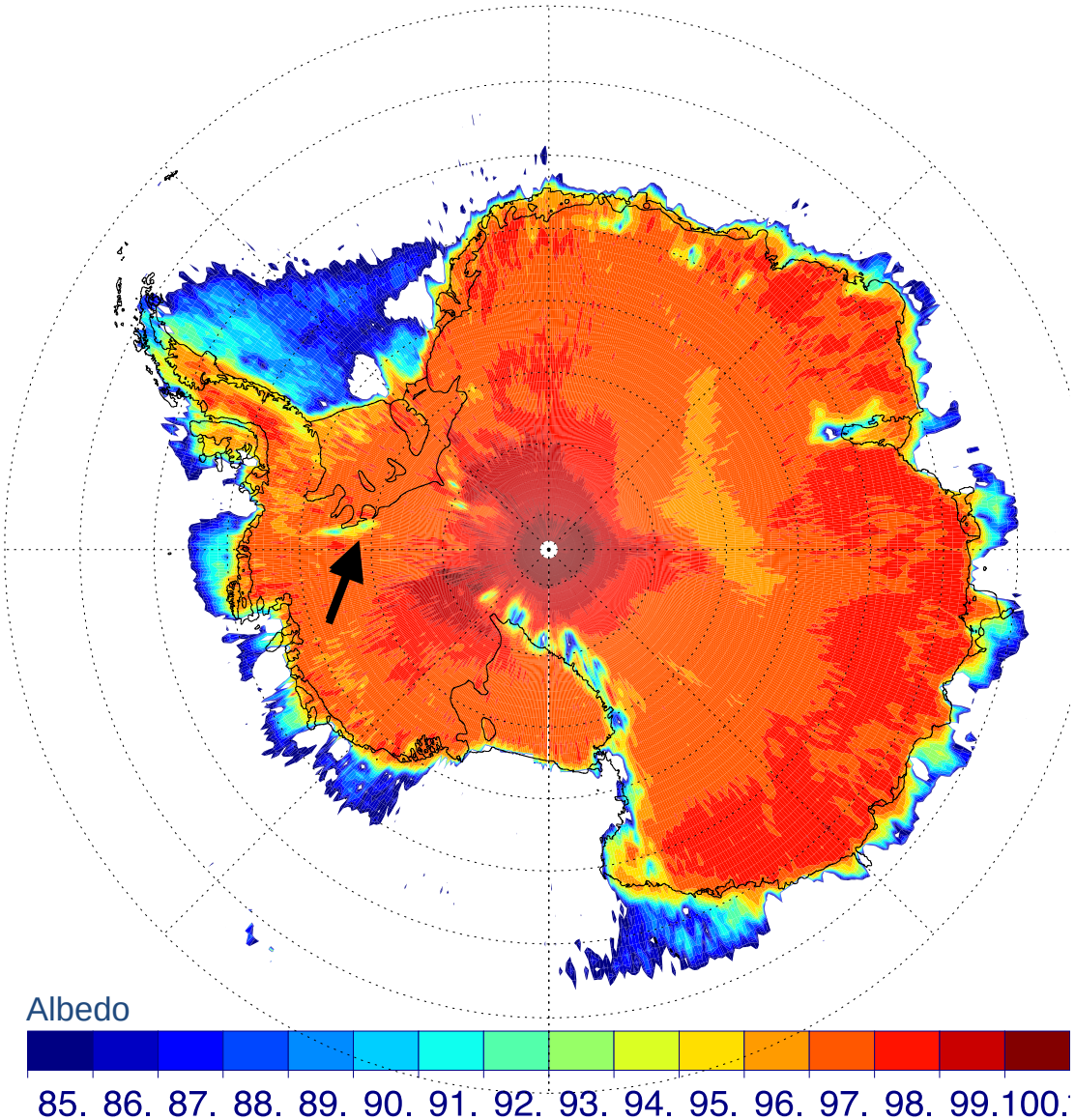

Elevation θ
90º
60º
45º
30º
0º
Radiation E_o
Radiation E_o
Atmosphere
Surface



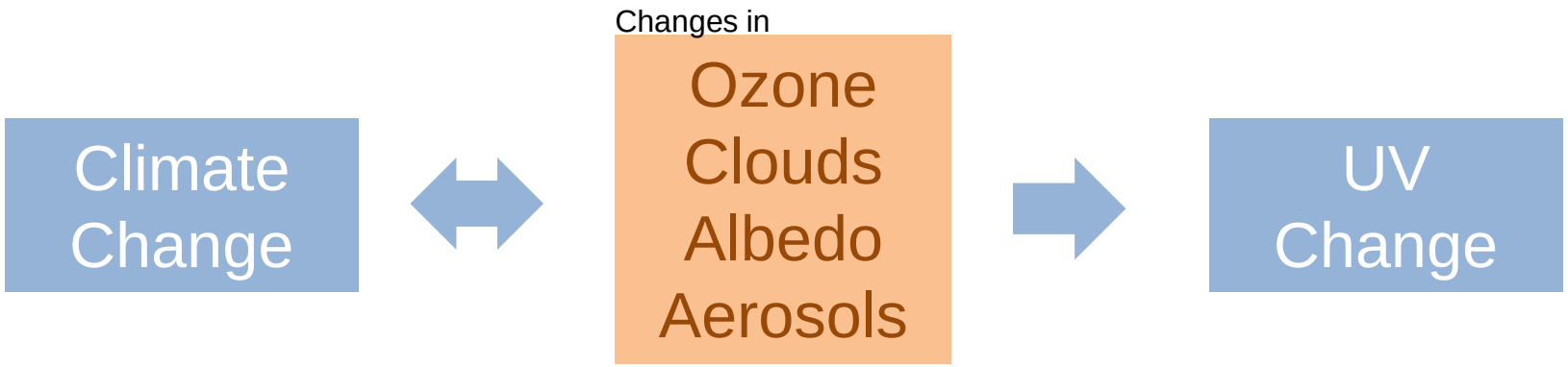
Quoted from Cordero et al 2014



Quoted from Cordero et al 2014

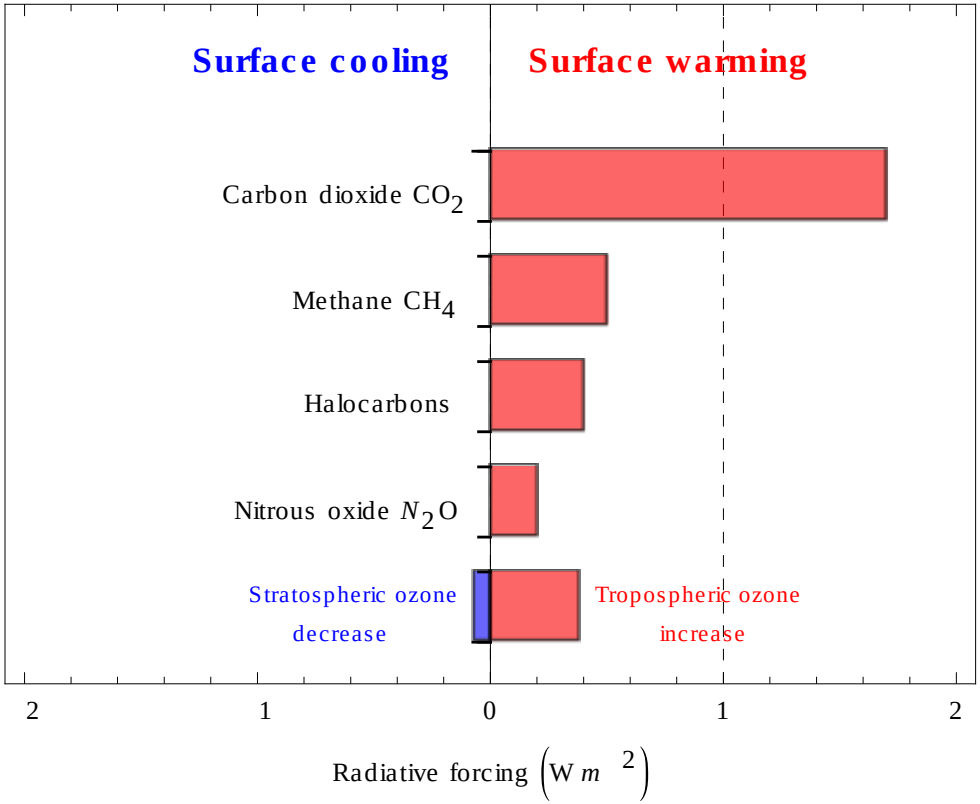


Quoted from Cordero et al 2014.


Climate Change
Changes in
Ozone
Clouds
Albedo
Aerosols
UV Change

Radiative Forcing of Climate Change

from changes in greenhouse gases caused by human activities between 1750 and 2005



Douglass, A., et al. Global Ozone Research and Monitoring Project-Report No. 52, 516 pp., Ginebra, Suiza, 2011

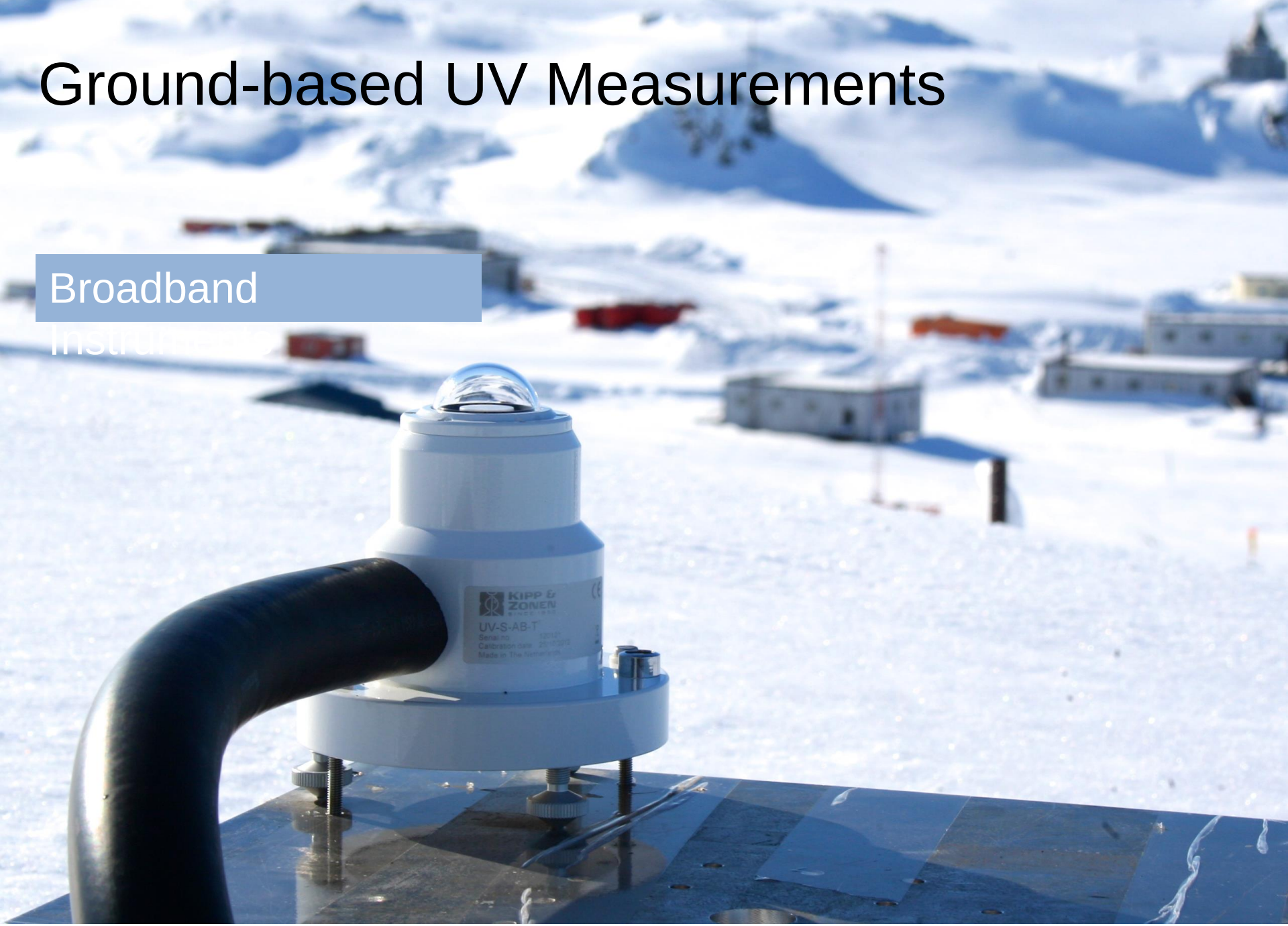
Ground-based UV Measurements

Broadband

Spectroradiometers

Ground-based UV Measurements

Broadband Instruments



King George Island, October 2013

Broadband Instruments

Characterizatio

Calibration

WORLD METEOROLOGICAL ORGANIZATION
GLOBAL ATMOSPHERE WATCH

No. 164

Instruments to Measure Solar Ultraviolet Radiation

Part 2: Broadband Instruments Measuring Erythemally Weighted Solar Irradiance

Lead Author: G. Seckmeyer

Co-authors: A. Bais, G. Bernhard, M. Blumthaler, C.R. Booth, K. Lantz, R.L. McKenzie

Contributors: P. Disterhoft, A. Webb

WMO TD-No. 1289

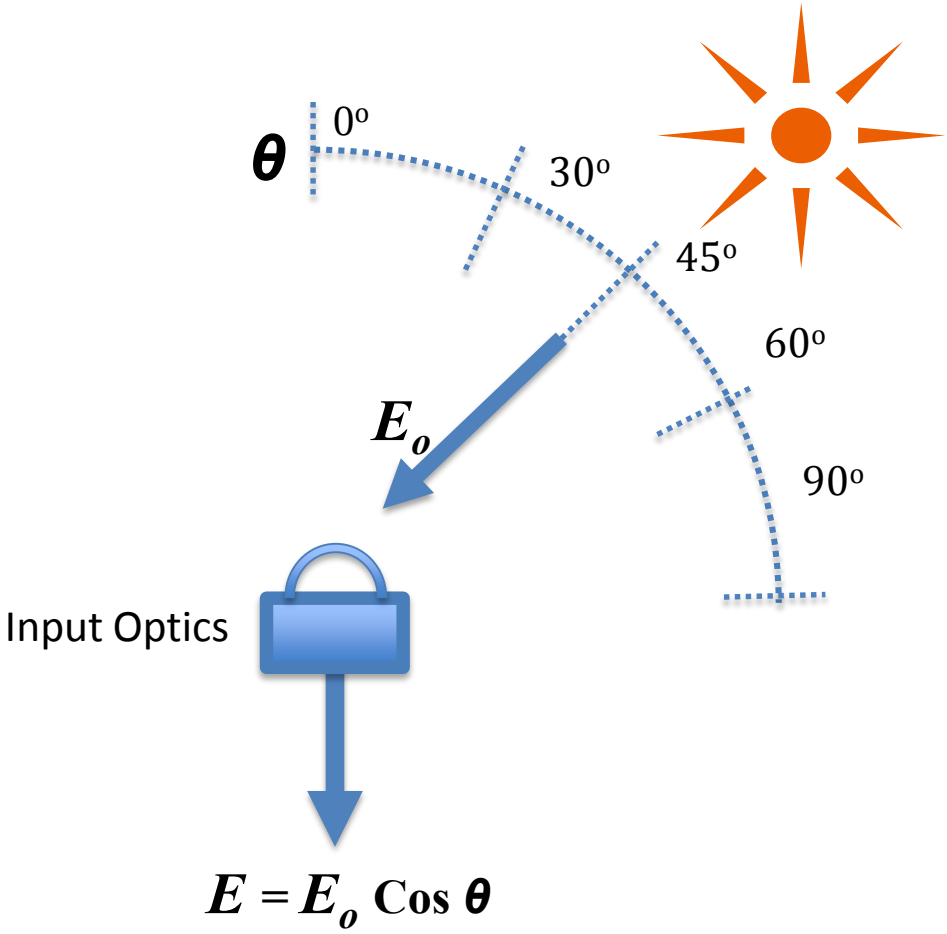
Broadband Instruments

Characterizatio

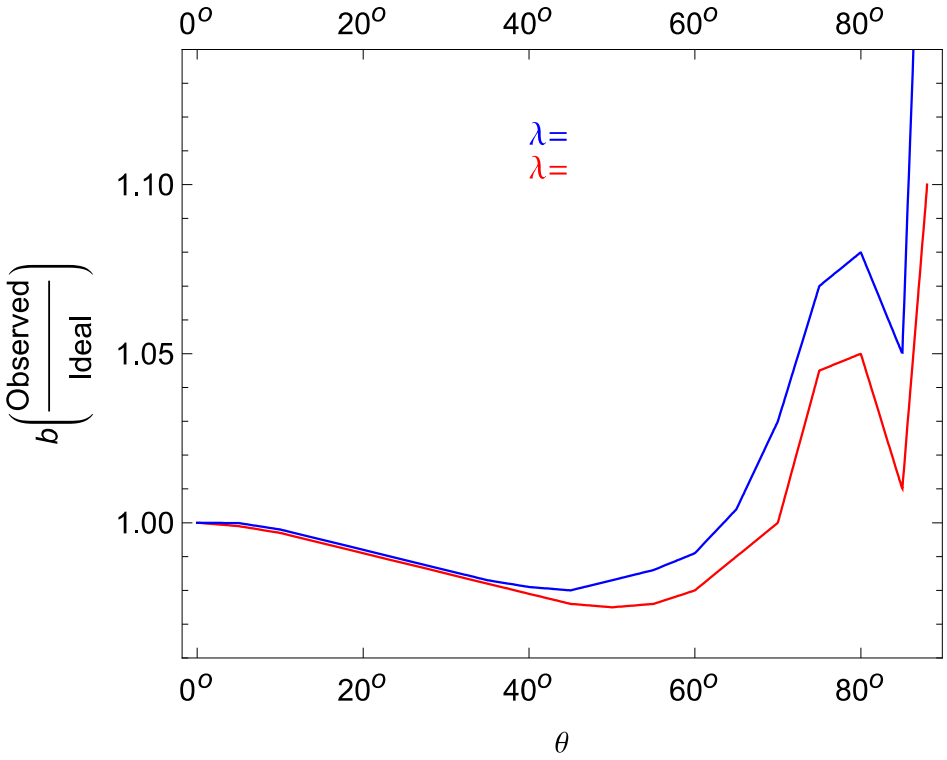
- Angular Response
- Spectral Responsivity

Calibration

Angular Response



Cosine Error (*b*)



Broadband Instruments

Characterizatio

Angular Response

Spectral Responsivity

Radiometry Lab

Calibration

Broadband Instruments

Characterizatio

Angular Response

Spectral Responsivity

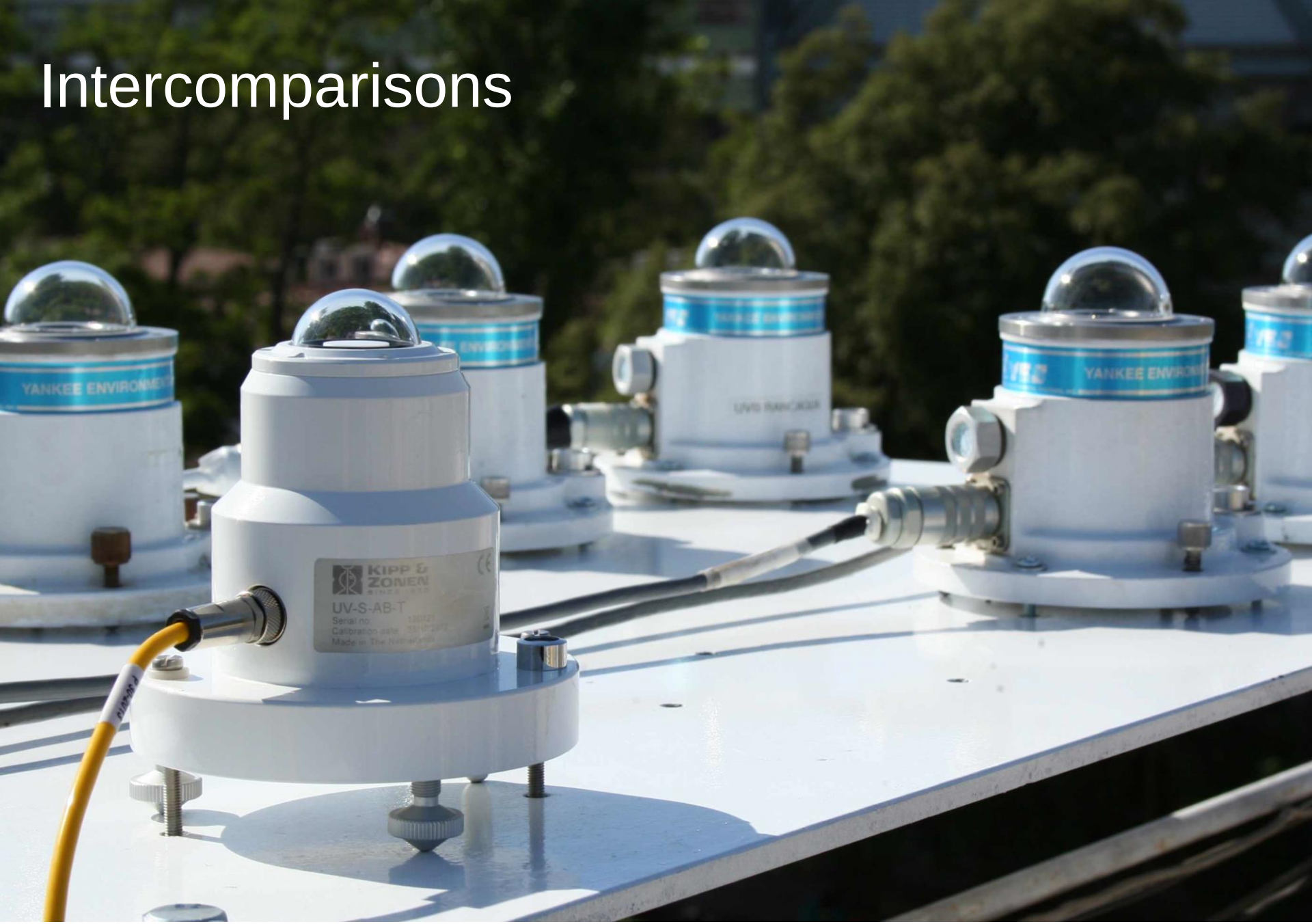
Radiometry Lab

Calibration

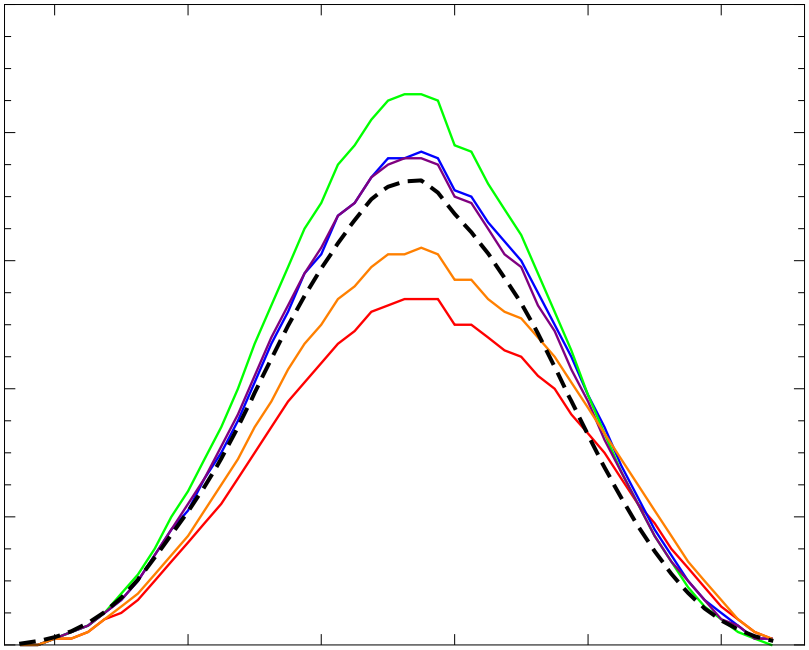
Intercomparisons

Campaigns

Intercomparisons



Intercomparisons



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Spectroradiometers

Characterizatio

Calibration

WORLD METEOROLOGICAL ORGANIZATION
GLOBAL ATMOSPHERE WATCH

No. 125

Instruments to measure solar ultraviolet radiation

Part 1: Spectral instruments

Lead Author: G. Seckmeyer

Co-authors: A. Bais, G. Bernhard, M. Blumthaler, C.R. Booth, P. Disterhoft, P. Eriksen, R.L. McKenzie,
M. Miyauchi, C. Roy

Contributors: K. Dehne, U. Feister, B. Mayer, P. Taalas, E. Weatherhead, A. Webb

WMO TD No. 1066

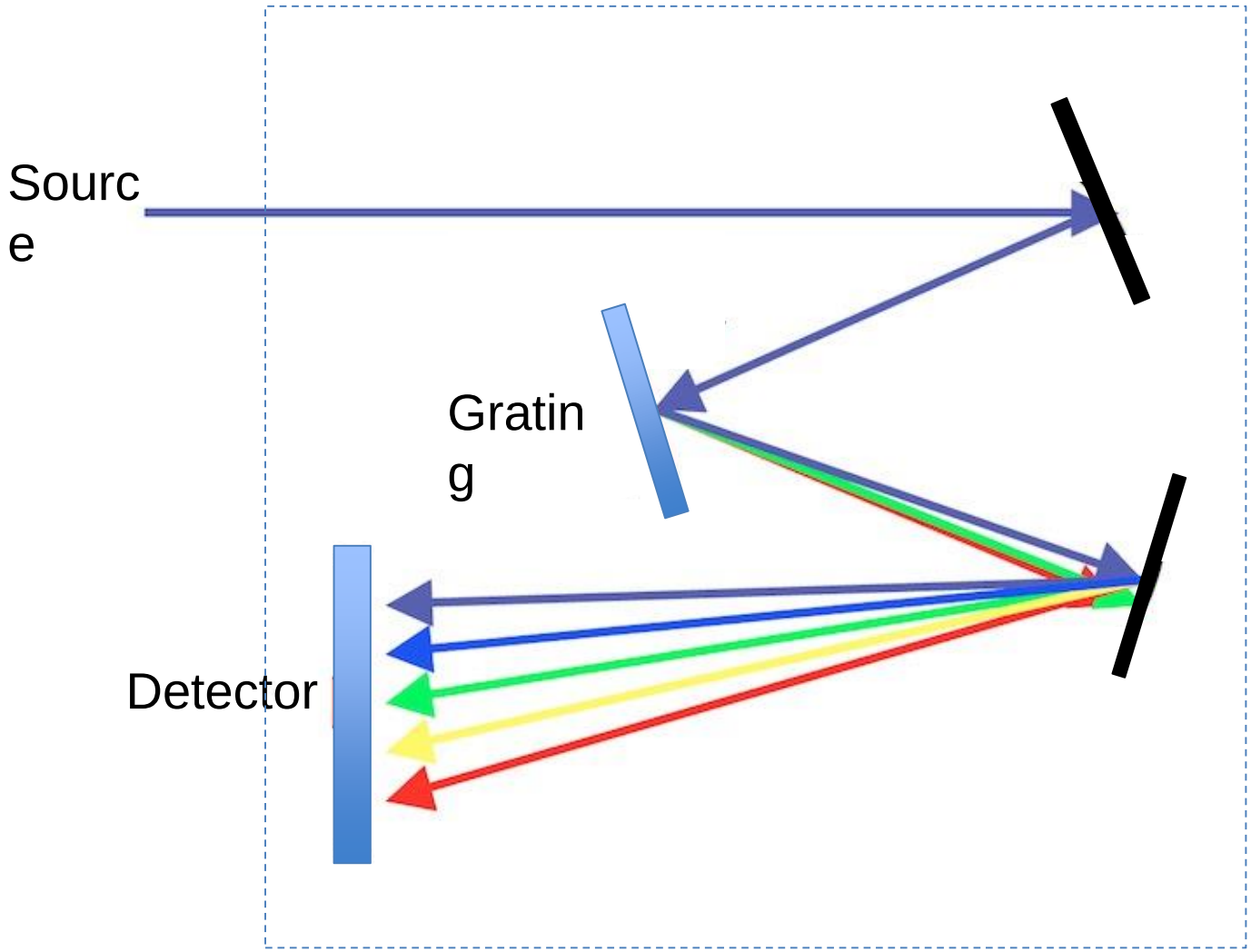
Spectroradiometers

Characterizatio

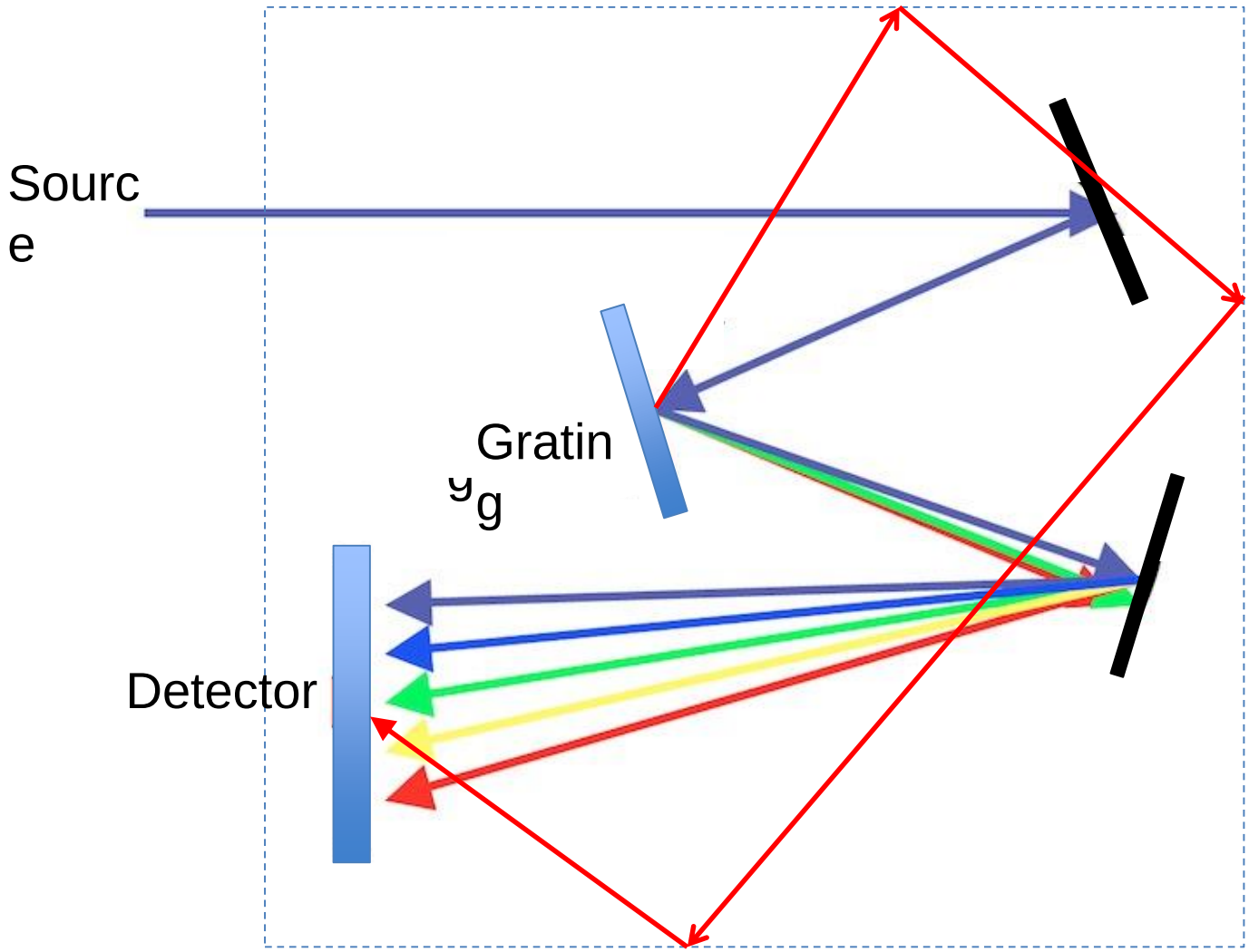
- Angular Response
- Noise
- Stray Light

Calibration

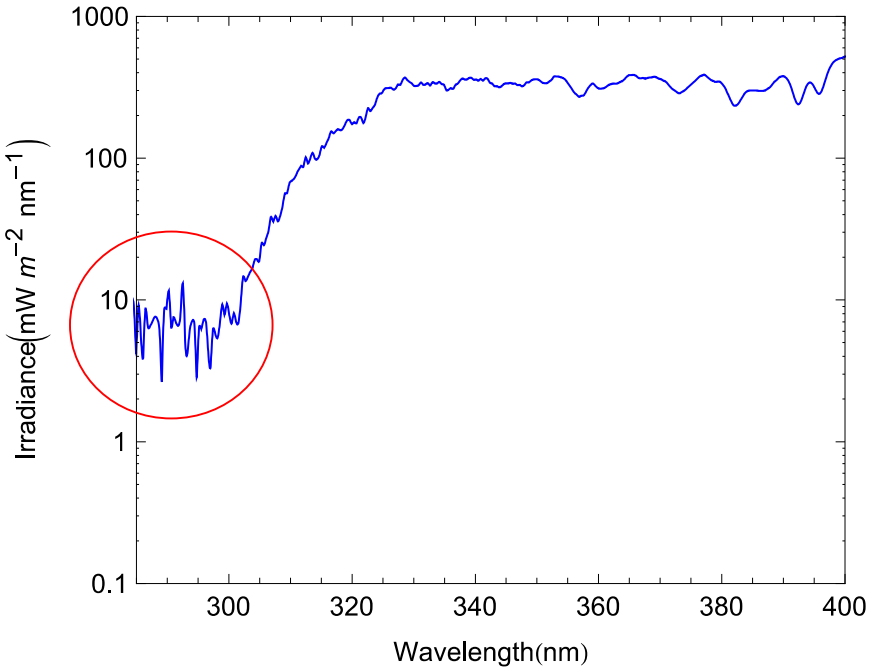
Stray Light

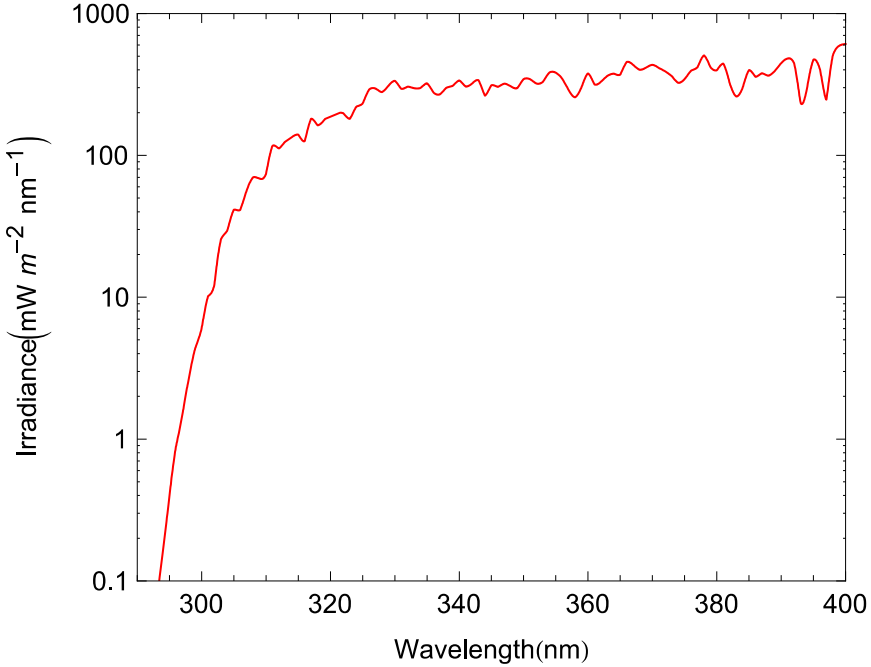


Stray Light

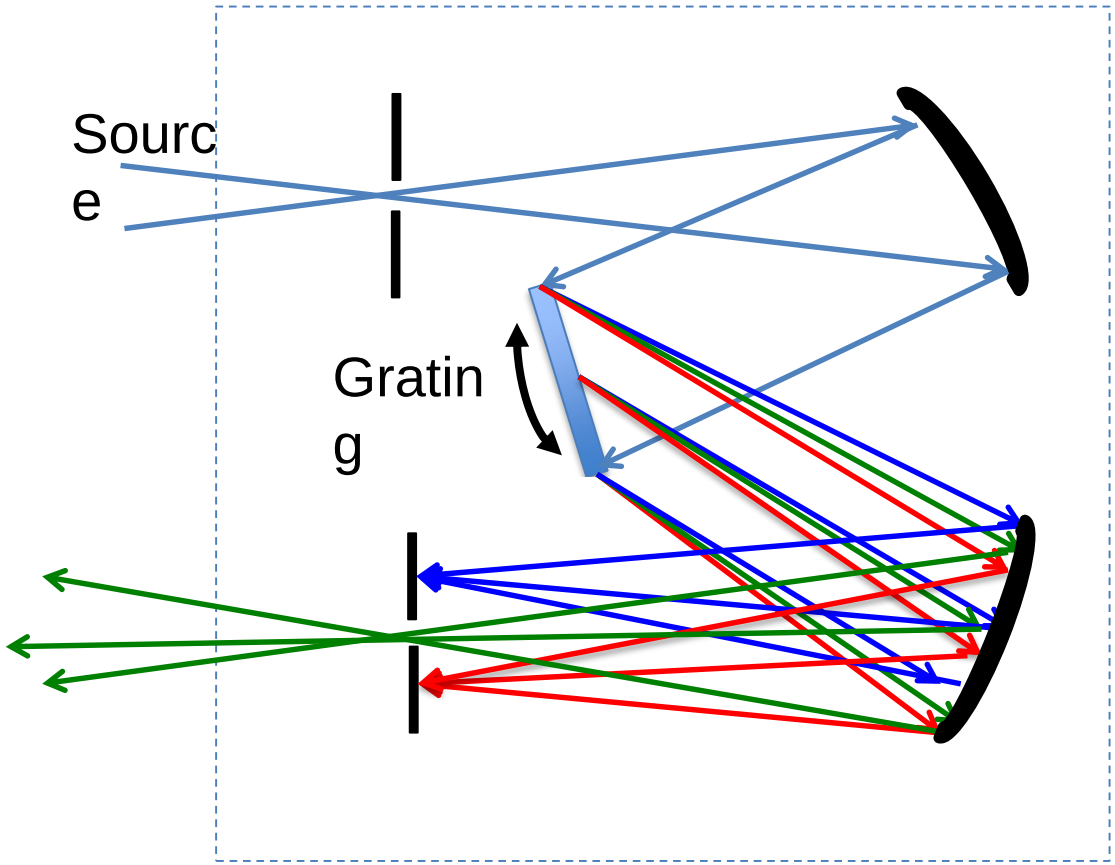


Stray Light Effect

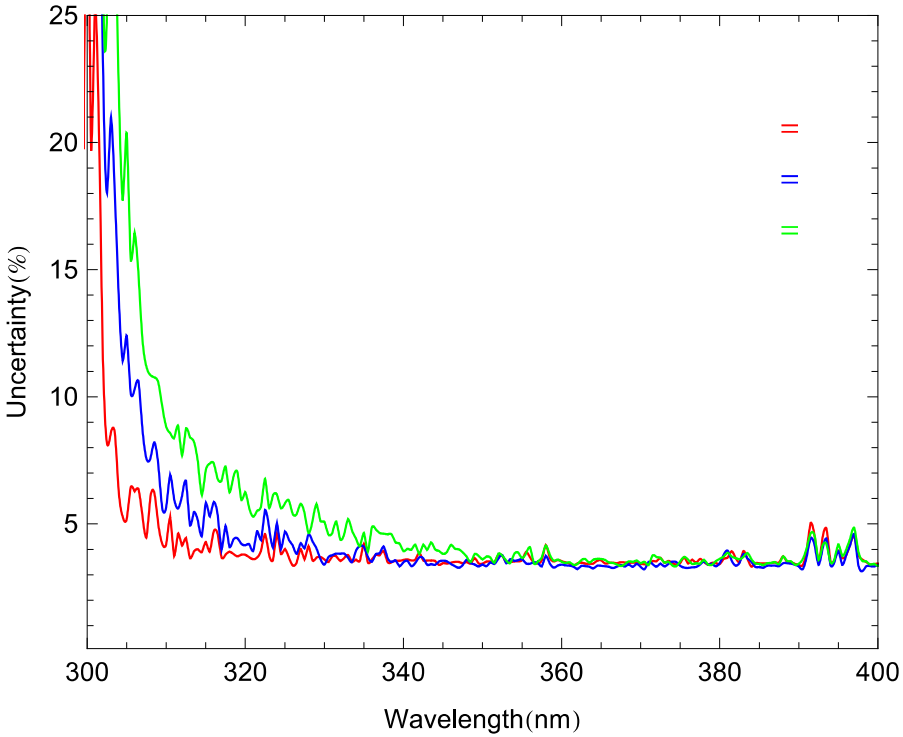




Czerny-Turner Monochromator



Noise Effect



Quoted from Cordero et al 2012

Double Monochromator

King George Island (62º S, January, 2011)

Spectroradiometers

Uncertainty

Angular Response

Noise

Stray Light

Radiometry Lab

Accuracy

Spectroradiometers

Uncertainty

- Angular Response
- Noise
- Stray Light

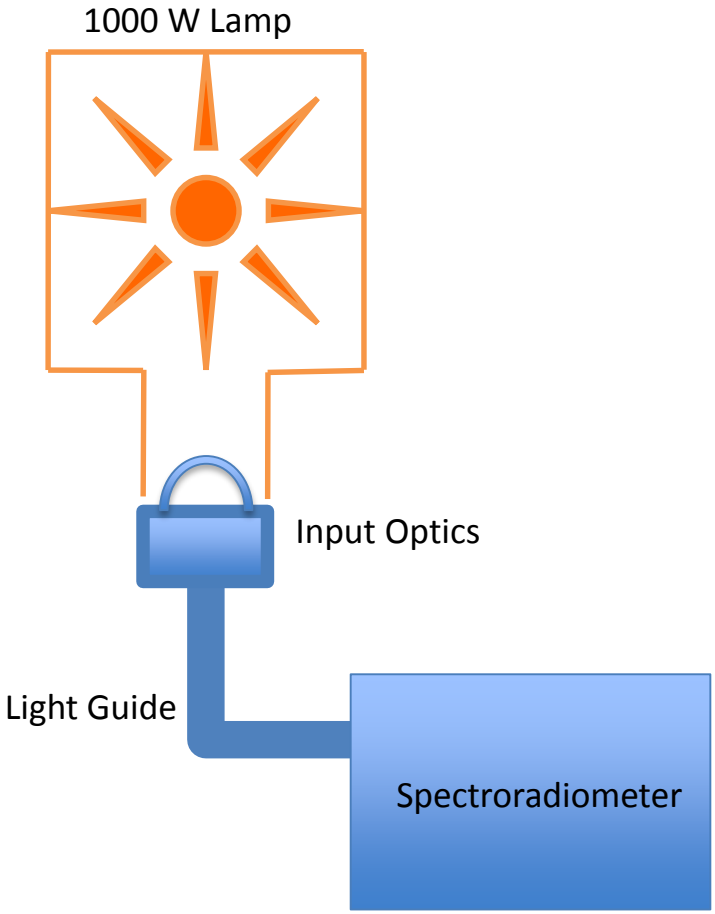
Radiometry Lab

Accuracy

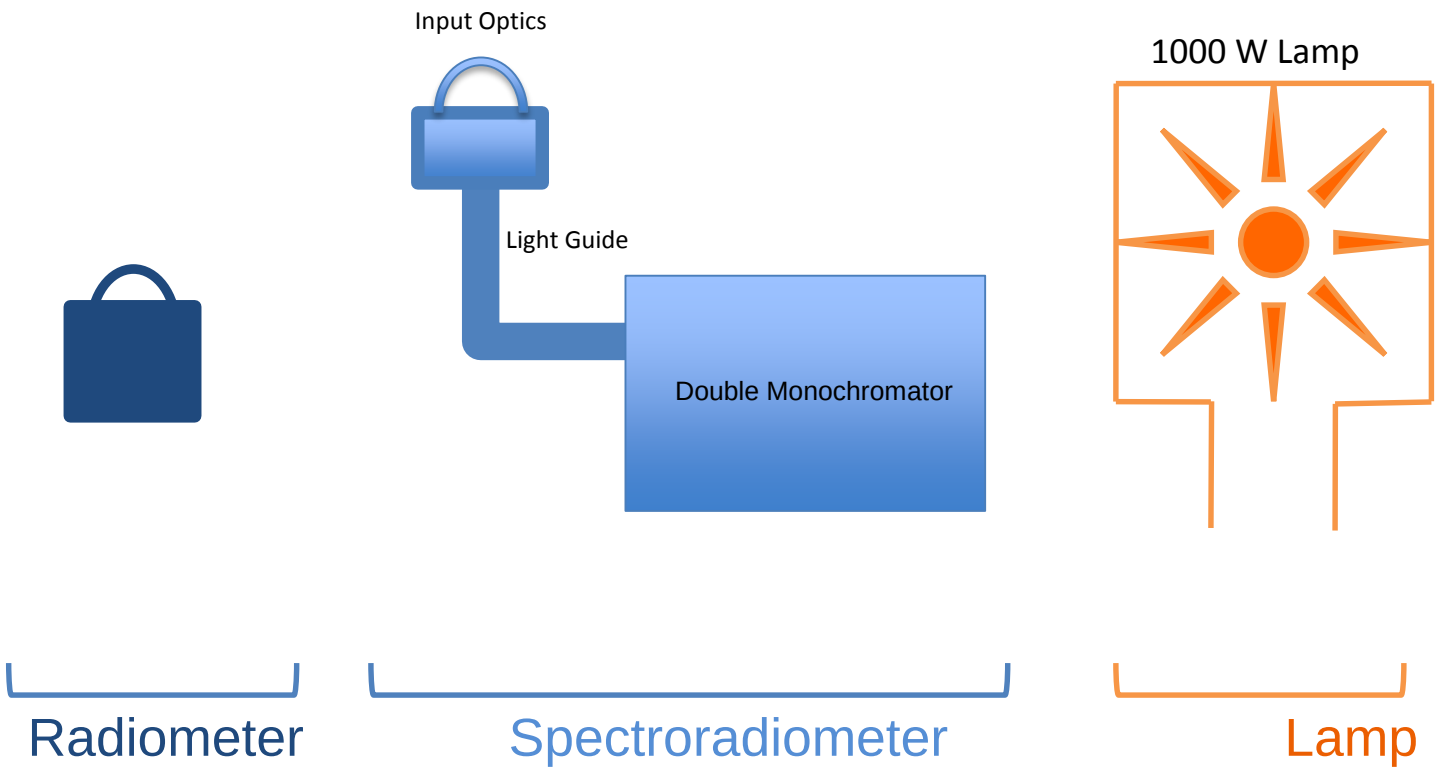
- Stabilized Lamps

Radiometry Lab

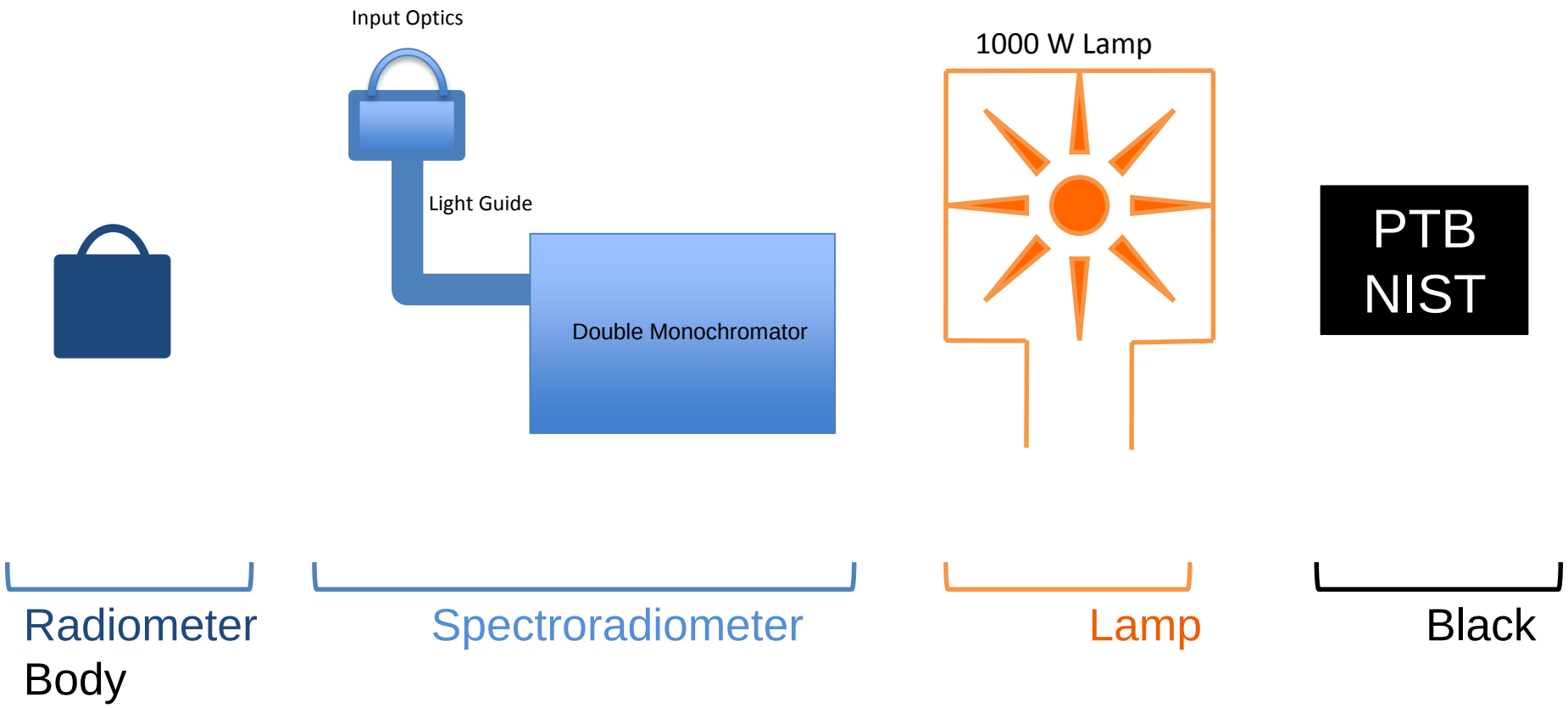
Absolute Calibration



Traceability



Traceability

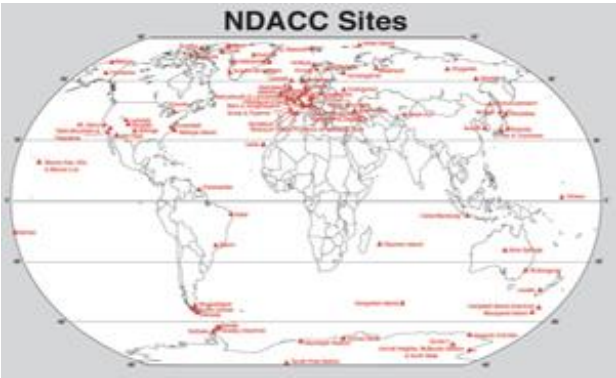


Network for the Detection of Atmospheric Composition Change (NDACC)

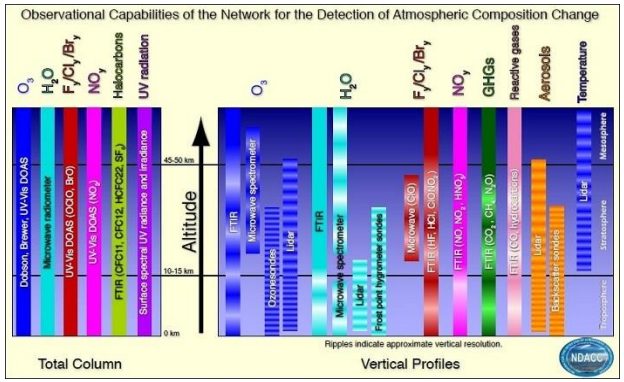
Newsletter
Goals and Organization
Instruments
Protocols
M&A Directory
Measurement Stations
NDACC Data&Formats
Working Groups:
- Dobson/Brewer (@CHMI)
- FTIR (@NCAR)
- Lidar (off site)
- Microwave (@U Bern)
- Satellite (@BIRA)
- Sondes (U Wyoming)
- Theory (@U Leeds)
- UV/Vis (@BIRA)
- Spectral UV
- Water Vapor (@U Bern)

Cooperating Networks
NDACC News
Ozone Q&A (@ESRL)
Related Links
Featured Link:
- SPARC Report on Halogen/O3 Initiative

SC Resource Page
Contact Us



Clickable map. Click on sitenames to access public data.



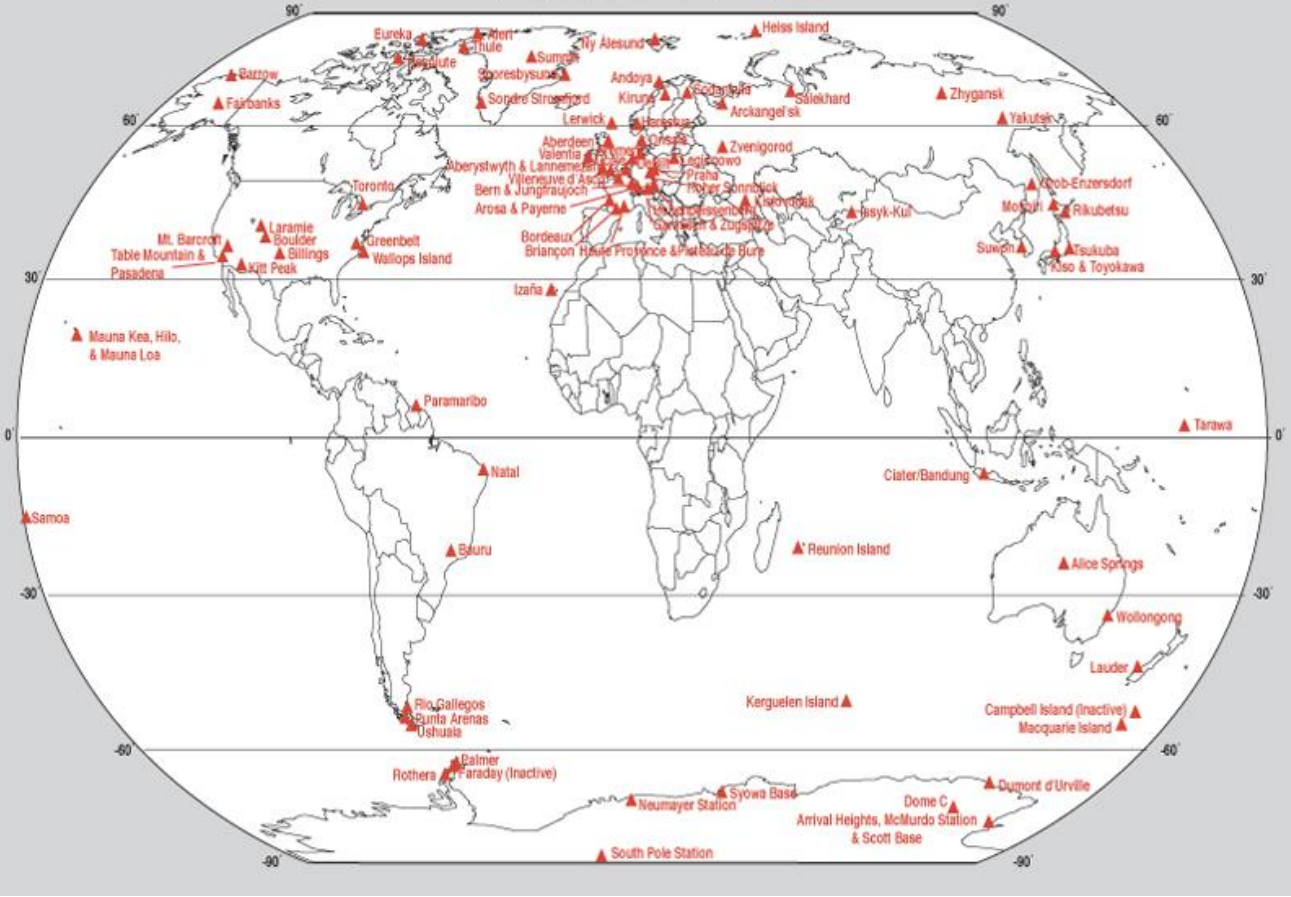
NDACC Observation Capabilities.

The international **Network for the Detection of Atmospheric Composition Change (NDACC)** is composed of more than 70 high-quality, remote-sensing research stations for observing and understanding the physical and chemical state of the stratosphere and upper troposphere and for assessing the impact of stratosphere changes on the underlying troposphere and on global climate.

While the NDACC remains committed to monitoring changes in the stratosphere with an emphasis on the long-term evolution of the ozone layer, its priorities have broadened considerably to encompass issues such as the detection of trends in overall atmospheric composition and understanding their impacts on the stratosphere and troposphere, and establishing links between climate change and atmospheric composition.

Following five years of planning, instrument design and implementation, the NDACC began network operations in January 1991.

NDACC Sites



90°
60°
30°
0°
-30°
-60°
-90°
Eureka
Alert
Thule
Ny Ålesund
Heiss Island
Barrow
Fairbanks
Andoya
Kiruna
Salekhard
Zhygansk
Yakutsk
Arckangel'sk
Lerwick
Aberdeen
Valentia
Zvenigorod
Aberystwyth & Lannemezan
Villeneuve d'Ascq
Praha
Bern & Jungfraujoch
Arosa & Payerne
Toronto
Issyk-Kul
Rikubetsu
Laramie
Boulder
Billings
Greenbelt
Wallops Island
Mt. Barcroft
Table Mountain &
Pasadena
Kitt Peak
Bordeaux
Briançon
Tsukuba
Kiso & Toyokawa
Izaña
Mauna Kea, Hilo,
& Mauna Loa
Paramaribo
Tarawa
Natal
Ciater/Bandung
Samoa
Bauru
Reunion Island
Alice Springs
Wollongong
Lauder
Rio Gallegos
Punta Arenas
Ushuaia
Kerguelen Island
Campbell Island (Inactive)
Macquarie Island
Palmer
Rothera
Faraday (Inactive)
Syowa Base
Neumayer Station
Dumont d'Urville
Dome C
Arrival Heights, McMurdo Station
& Scott Base
South Pole Station

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Final Remarks

1) Detection of Atmospheric Composition Change requires Spectral Measurements of the Solar Radiation.

2) Monitoring stations in the southern hemisphere are underrepresented in the existing networks.

3) Part of the Problem is the Lack of Radiometric Calibration Facilities.

Positive Forcing

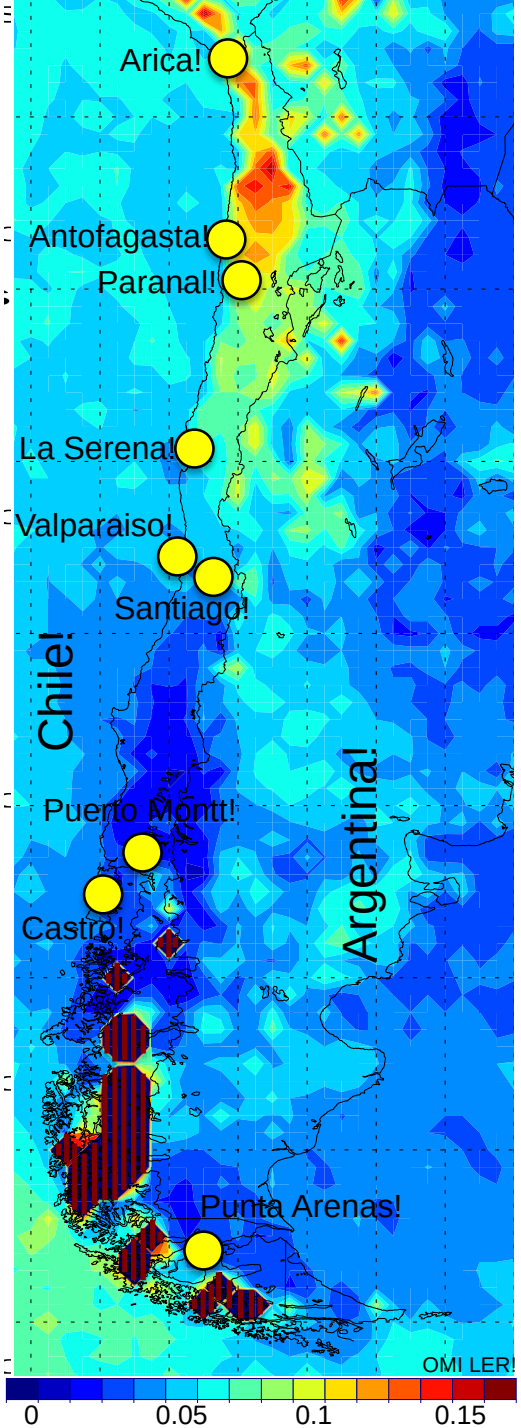
Carbon dioxide,
Methane,
Tropospheric Ozone,
Nitrous oxide

Climate Change

Negative Forcing

Stratospheric
Ozone depletion

WP3
Snow Reflection Properties

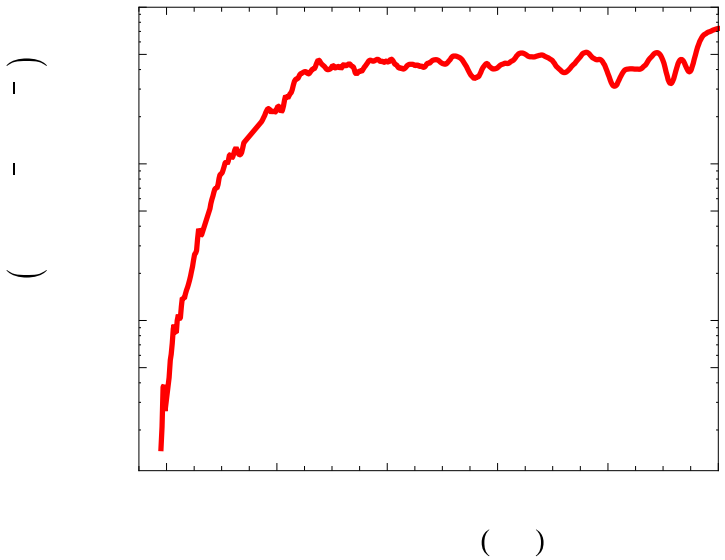


Lambertian equivalent reflectivity (LER) data represents the combined cloud, aerosol and surface scene reflectivity as observed from space. Quoted from Damiani, Cordero et al 2014.

UV Index

40(m²/w)

$$A = \int_{250}^{400} W(\lambda)\, I(\lambda)\, d\lambda$$

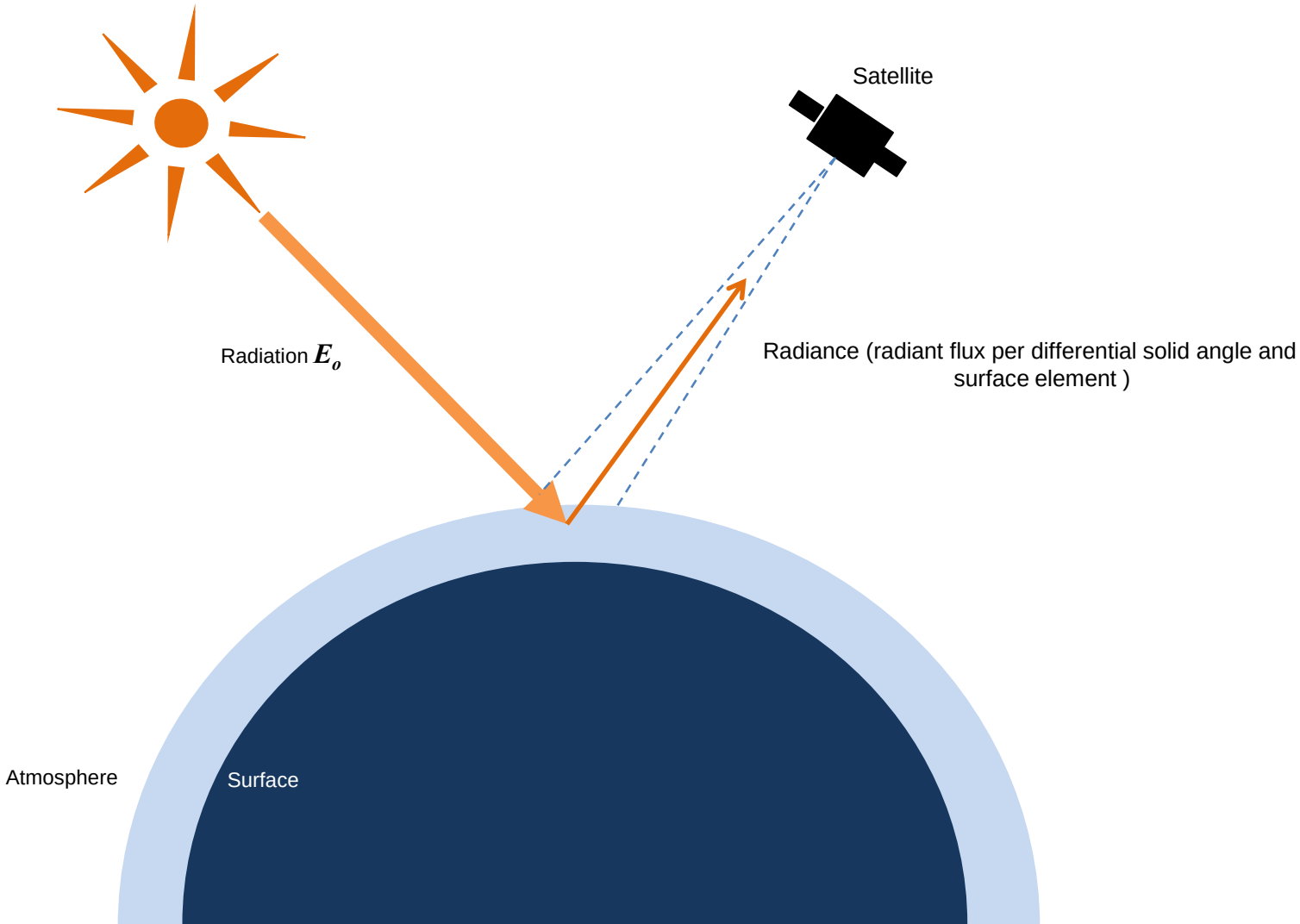


McKinlay-Diffey Erythema action spectrum

$$W(\lambda) = \begin{cases} 1 & 250 \le \lambda \le 298 \\ 10^{0.094(298-\lambda)} & 298 < \lambda \le 328 \\ 10^{0.015(139-\lambda)} & 328 < \lambda \le 400 \end{cases}$$

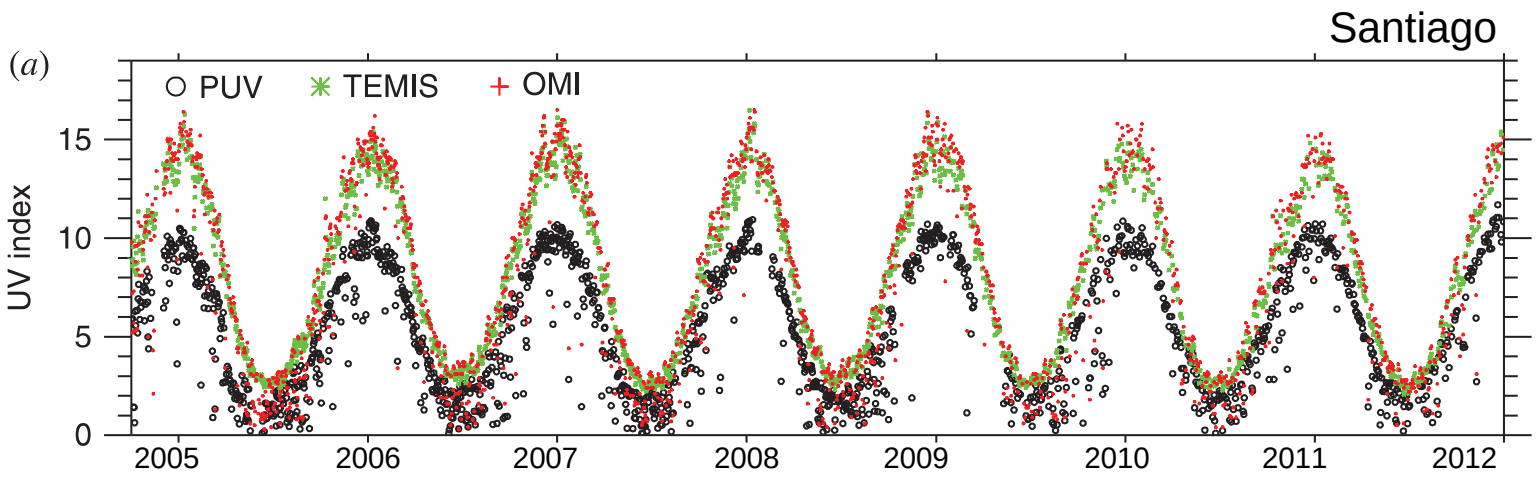
UV Assessment

Satellite Estimates



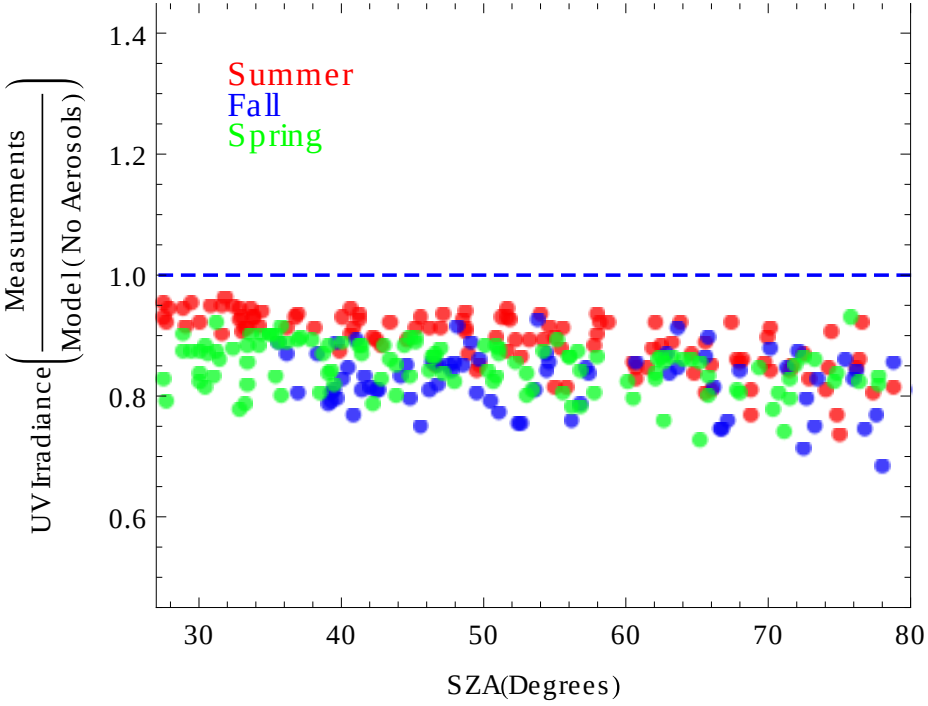
UV Assessment

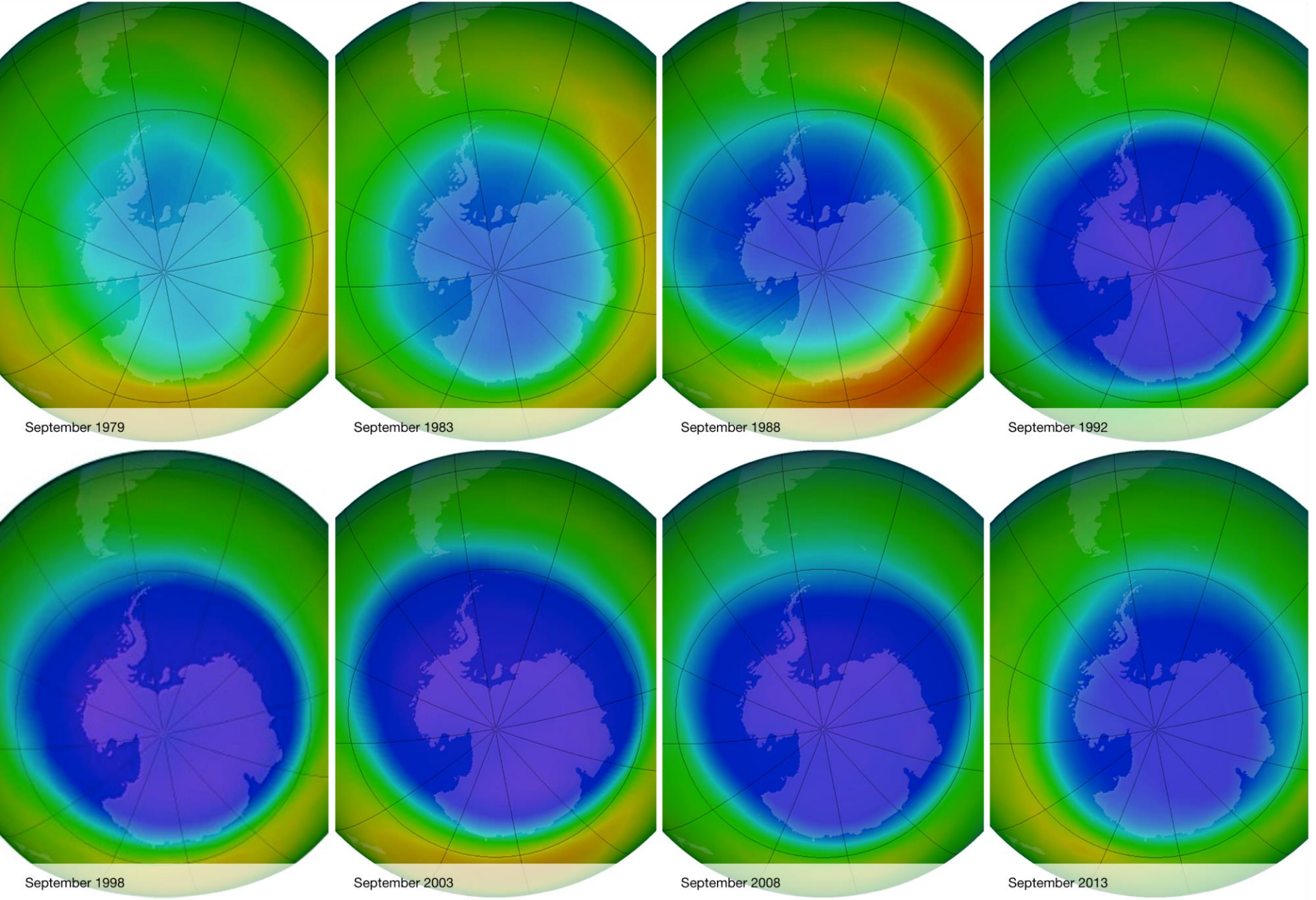
Satellite Estimates



Quoted from Damianii, Cordero et al 2013.

Aerosol Attenuation





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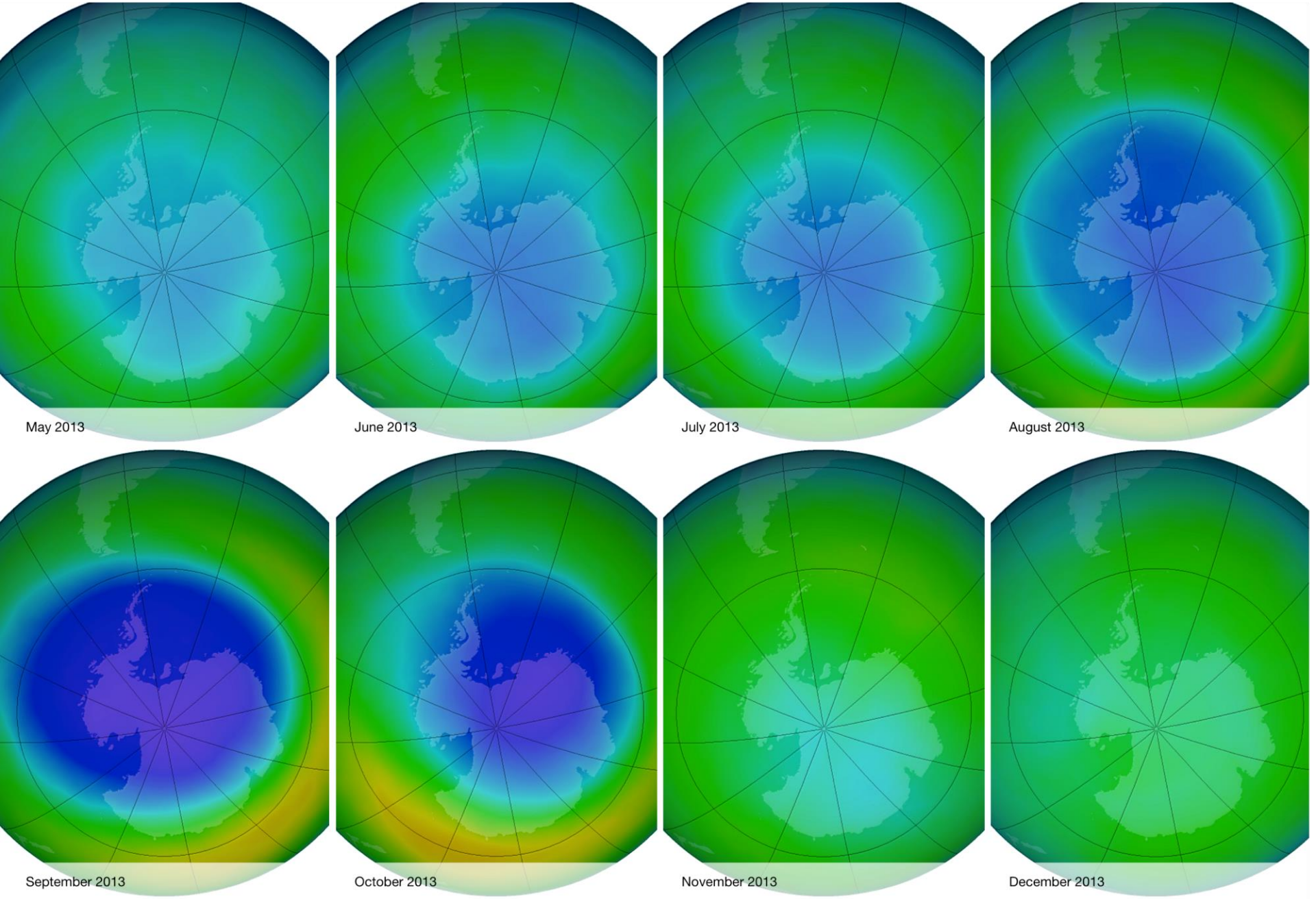
“NASA Ozone Watch”, http://ozonewatch.gsfc.nasa.gov/



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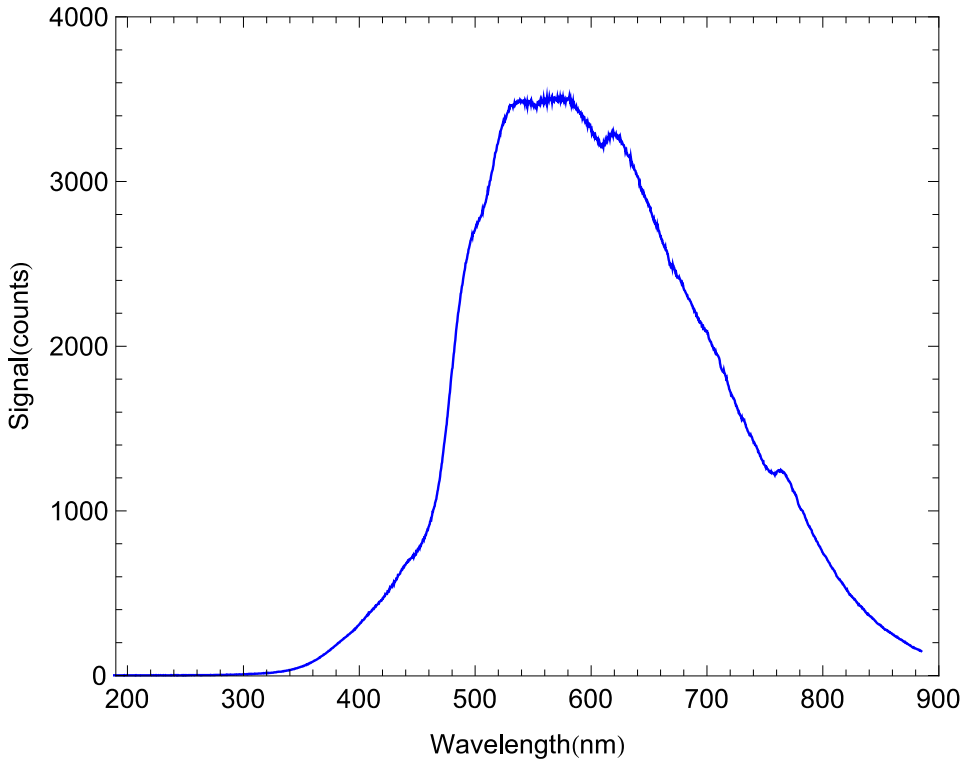
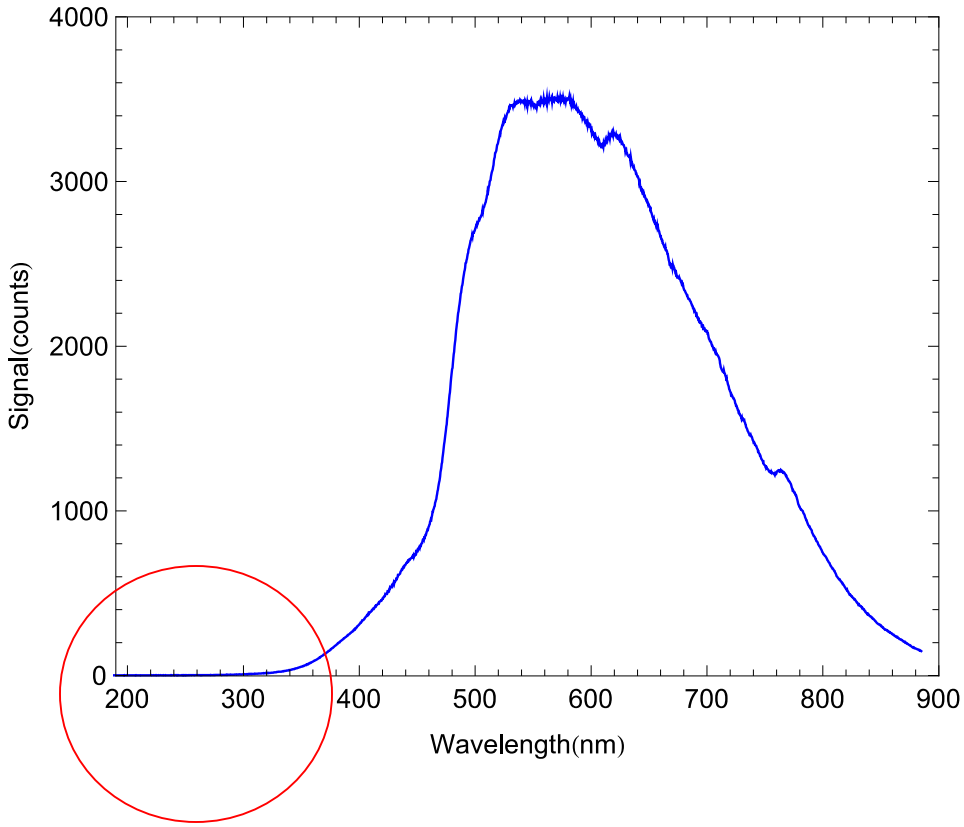
“NASA Ozone Watch”, http://ozonewatch.gsfc.nasa.gov/

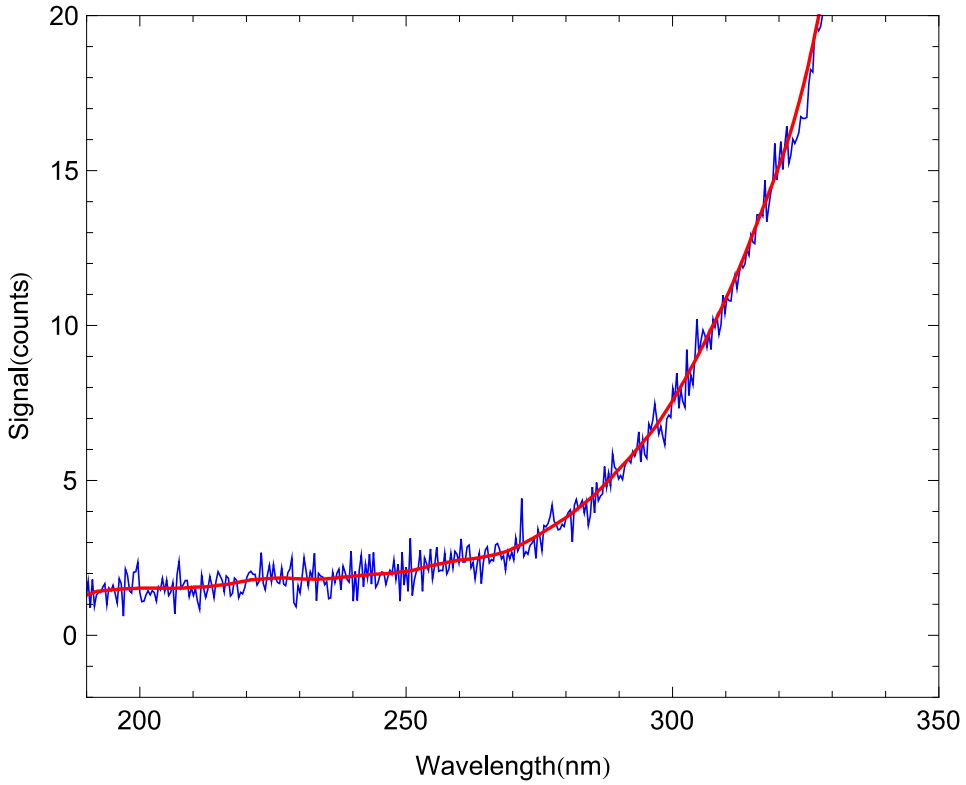
Stray Light


4000
3000
2000
1000
0
Signal(counts)
200
300
400
500
600
700
800
900
Wavelength(nm)

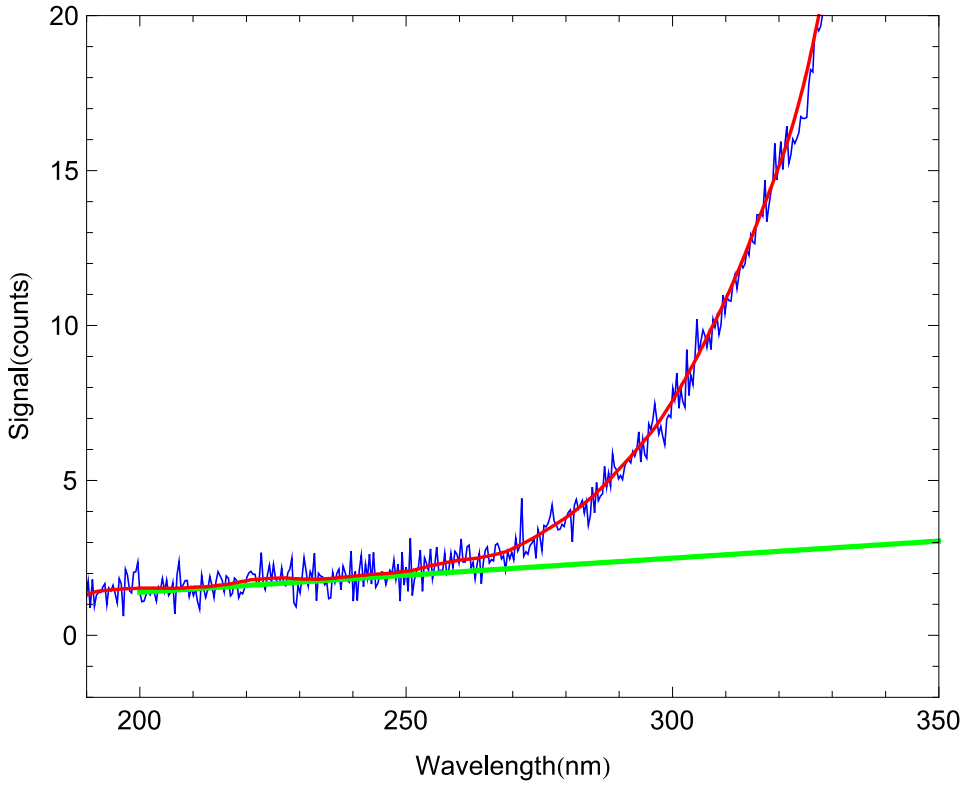
Stray Light


4000
3000
2000
1000
0
Signal(counts)
200
300
400
500
600
700
800
900
Wavelength(nm)

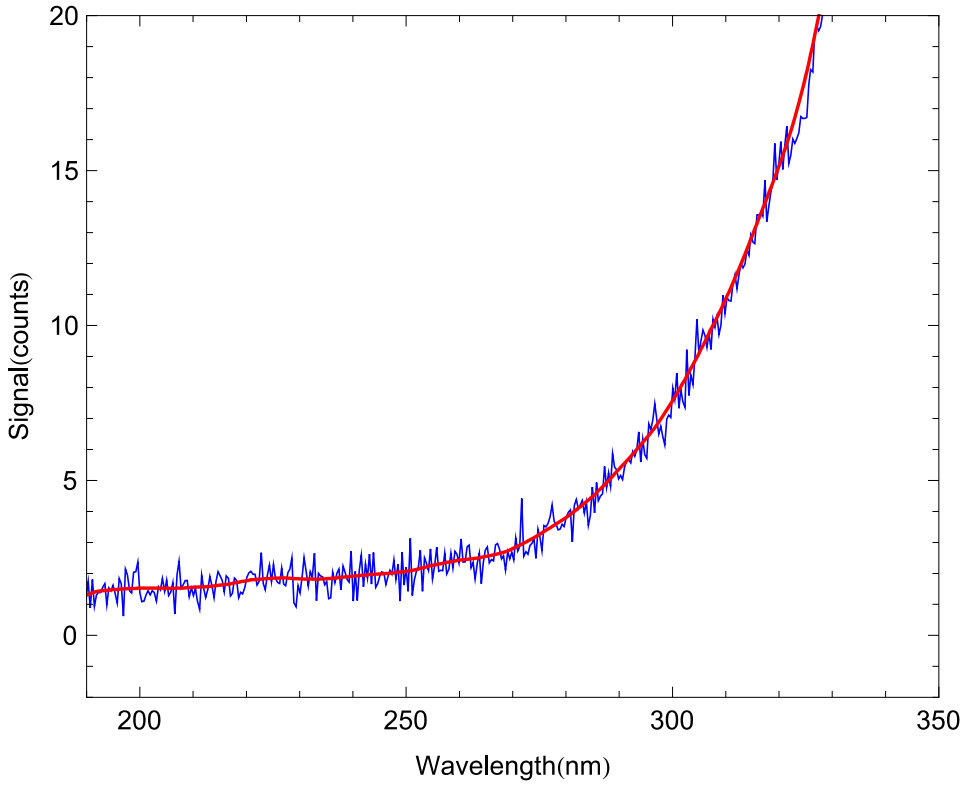
Stray Light



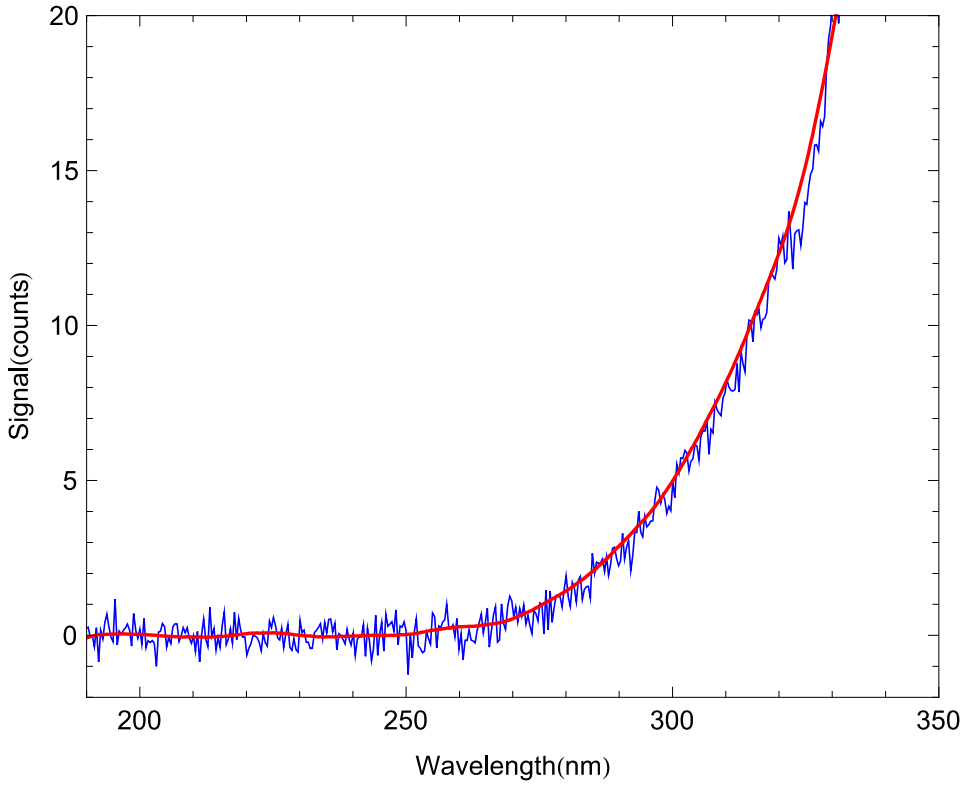
Stray Light



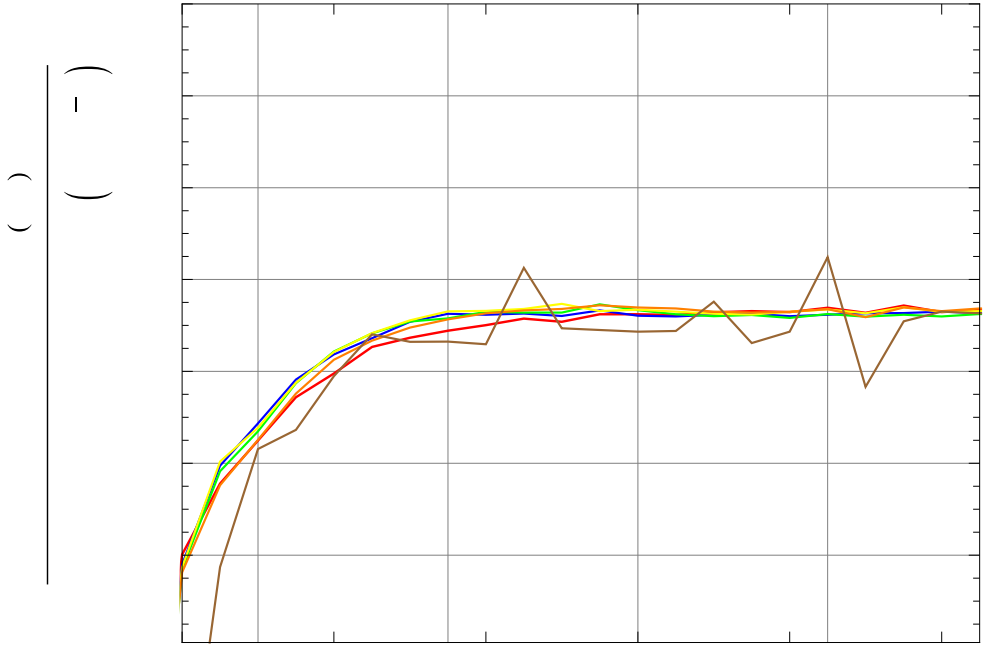
Stray Light

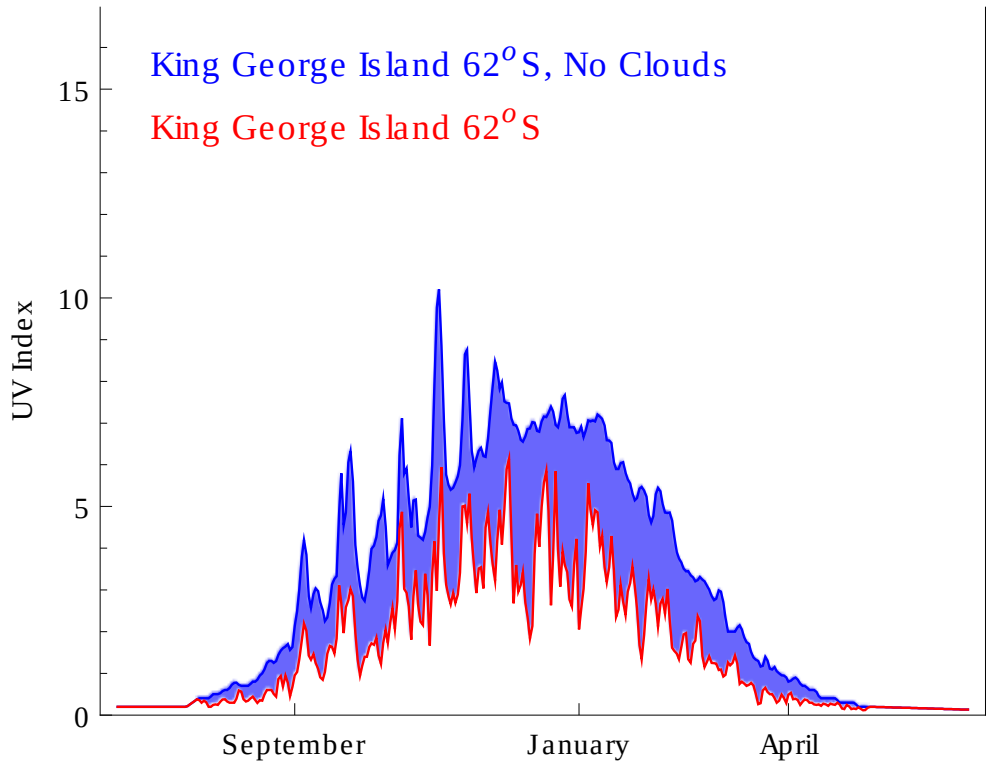


Stray Light



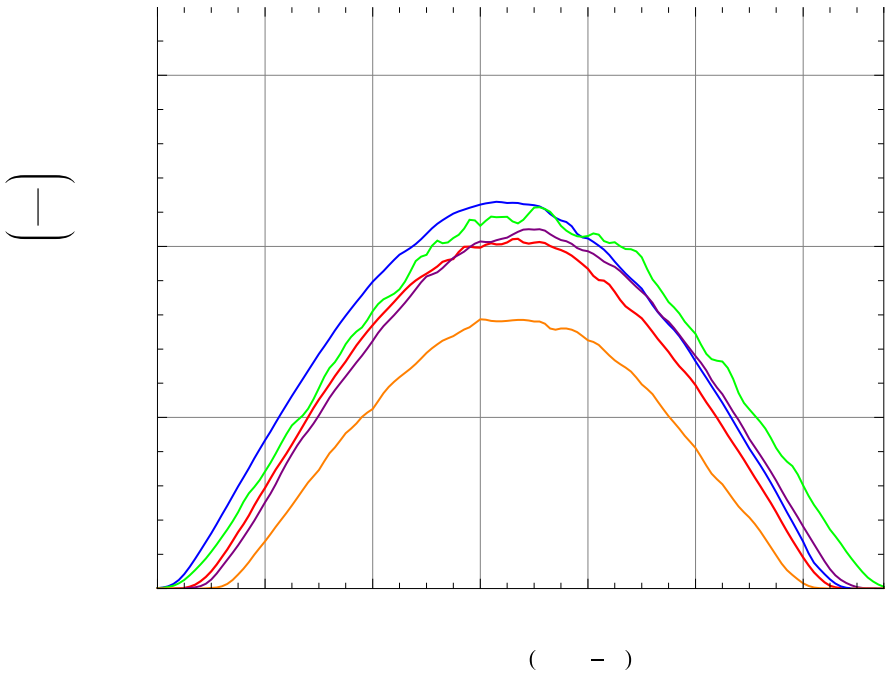
Intercomparisons

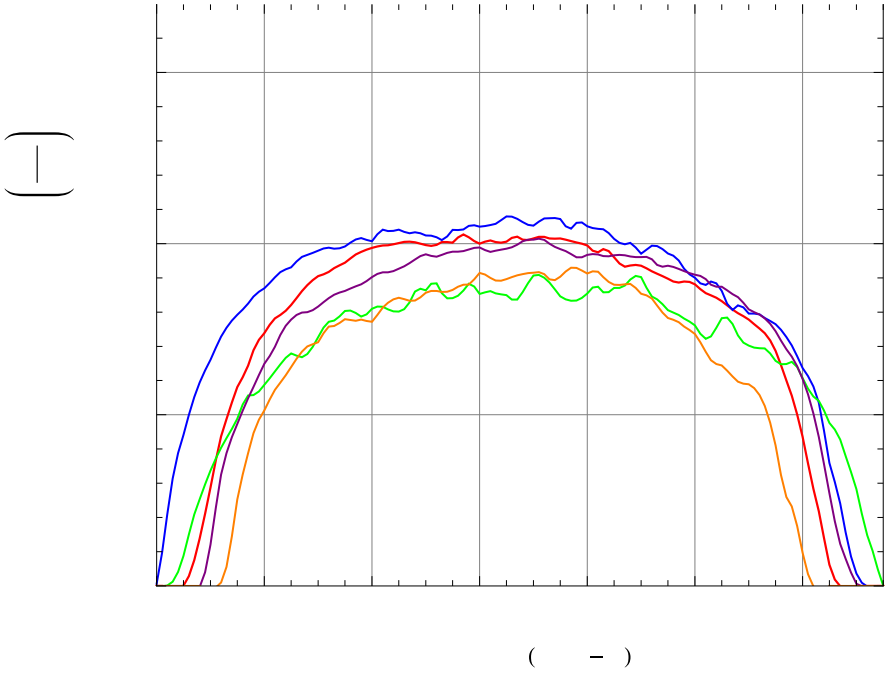



King George Island 62°S, No Clouds
King George Island 62°S
UV Index
15
10
5
0
September
January
April

Izaña, Tenerife
Paranal
Santiago
King George Island
Union Glacier

Total Irradiance





Northern Chile