Trends in Southern Hemisphere Albedo using a 27-yr Composite TOMS/SBUV(/2)/OMI Dataset of UV Lambertian Equivalent Reflectivity

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Composite Dataset for 60°S to 60°N

Linear Increase in Lambertian Equivalent Reflectivity (LER) at 331 nm is 0.0061 per decade

Mean Albedo = 0.262
Nimbus 7 Comparison

Monthly Mean Tropical Albedo (25°S to 25°N)

Mean Difference = 0.0003
Max Difference = ± 0.015

Compare with: Herman and Celarier, JGR, 102 (D23), 28,003, 1997.
The composite albedo dataset is the average of the available near-UV (331 nm) Lambertian Equivalent Reflectivity (LER) data from eight similar satellites from November 1978 to the present, binned into 5° latitude (zonal) bands by month.
Comparison with ERBE

Nov. 1984 to Sept. 1999

60°S-25°S
Mean Ratio = 0.921

25°S-25°N
Mean Ratio = 0.918

25°N-60°N
Mean Ratio = 0.926

On average, ERBE is 7-8% higher than the TOMS/SBUV reflectivities.

ERBE S10N WFOV
Edition 3

5° zonal monthly means of daily mean total sky short-wave (0.2-5.0 μm) albedo
Comparison with ERBE

Monthly Mean Tropical Albedo (25°S to 25°N)

- **ERBE**
- **TOMS/SBUV**

Mean increase in TOMS/SBUV LER = 0.023

Mt. Pinatubo Eruption
15 June 1991, 15°N Latitude
Comparison with ERBE

Monthly Mean Tropical Albedo (25°S to 25°N)

Trend = -0.007 per decade

Mt. Pinatubo Eruption, June

Trend = +0.011 per decade
Comparisons with CERES

March 2000 to Dec. 2005 for Albedo=0.0-0.5:

- $90^\circ$S-$25^\circ$S: Mean Ratio = 0.958
- $25^\circ$S-$25^\circ$N: Mean Ratio = 0.940
- $25^\circ$N-$90^\circ$N: Mean Ratio = 0.927

Terra FM1, Terra FM2, Aqua FM3, Aqua FM4, NOAA-14 SBUV/2, EarthProbe TOMS, NOAA-16 SBUV/2, NOAA-17 SBUV/2, Aura OMI, CERES ES4 Edn. 1-CV

5° zonal monthly means of daily mean total sky short-wave (0.2-5.0 μm) albedo.
Comparisons with CERES

March 2000 to Dec. 2005
for Albedo=0.0-1.0:

$90^\circ$S-25°S
Mean Ratio = 1.047

$25^\circ$S-25°N
Mean Ratio = 0.940

$25^\circ$N-90°N
Mean Ratio = 1.048

NOAA-14 SBUV/2
EarthProbe TOMS
NOAA-16 SBUV/2
NOAA-17 SBUV/2
Aura OMI

CERES ES4 Edn. 1-CV
5° zonal monthly means of
daily mean total sky short-
wave (0.2-5.0 μm) albedo
## Comparisons with ERBE and CERES

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<th>Dataset</th>
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</table>
Comparison with Earth Shine Data

Monthly data have been deseasonalized.

Seasonality of LER

Seasonality of LER

Monthly Mean Albedo (area weighted over 25°S to 25°N)

ERBE measures from 0.2-5.0 μm
TOMS/SBUV measures at 331 nm

ERBE (1990-94, Mean=0.231)
TOMS/SBUV (1990-94, Mean=0.222)
Seasonality of LER

Monthly Mean Albedo
(area weighted over 25°S to 25°N)

- ERBE (pre-Pinatubo, Mean=0.231)
- ERBE (post-Pinatubo, Mean=0.231)
- TOMS/SBUV (pre-Pinatubo, Mean=0.204)
- TOMS/SBUV (post-Pinatubo, Mean=0.227)

Mean increase in TOMS/SBUV Lambertian Effective Reflectivity (LER) is 0.023

ERBE measures over 0.2-5.0 μm
TOMS/SBUV measures at 331 nm
Increase in Lambertian Equivalent Reflectivity (LER) at 331 nm is 0.020 per decade

55°S to 50°S

January, February and March

June

Mean Albedo = 0.384
What can cause a large increase in albedo at mid- to high Southern Latitudes?

- Land use changes?  X
- Snow cover changes?  X
- Sea ice changes?  X
- Ocean changes?  X
- Cloud cover changes?  √
Deseasonalized “Trends” at 20°S to 20°N

Decadal Trends in Albedo

Decadal Trends in LER in the Southern Hemisphere
$R^2 = 0.98$ for the inverse correlation between the reflectivity trend and the surface temperature anomaly trend in the Southern Hemisphere ($60^\circ$S-10$^\circ$S).
1978-2005
Increasing Albedo, Aerosol Index and Temperature Anomalies
Conclusions

• A 27-year Composite dataset of near-global UV Lambertian Equivalent Reflectivities (LER) at 331 nm has been compiled from eight satellite instruments (TOMS, SBUV(/2) and OMI) using the same TOMS Version 8 retrieval algorithm

• Accuracy and precision of the dataset is estimated to be ~0.01 (1%)

• ERBE is on average 7-8% higher than the TOMS/SBUV(/2) Composite

• For albedo<0.5, CERES is on average 4-7% higher than the Composite

• Seasonality of the albedo agrees reasonably well with model estimates (esp. GISS Model E20/H)

• Seasonality of the albedo has changed over the past three decades!

• TOMS/SBUV(/2)/OMI Composite agrees very well with Earth shine data

• Decadal trends in albedo are: near zero in the Tropics slightly negative at high NH latitudes large and positive at high SH latitudes

• Decadal trends are significant and should be included in climate models!