CALIOP recalibration for studying tropical stratospheric aerosols

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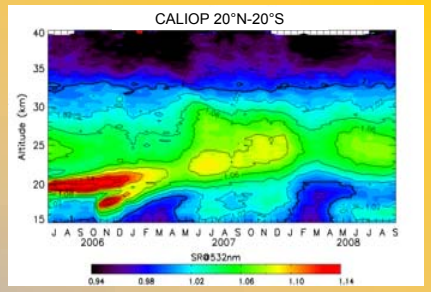
1 Stratospheric aerosols from level 1 products

- Total & perpendicular attenuated backscatter 532nm (β'_{532} & $\beta'_{\perp,532}$)
- Nighttime only
- 1 degree latitude average along orbit, 16-day averaging (CALIPSO repeat cycle)
- Correction of two-way transmission (T^2) for molecular attenuation and ozone absorption : $\beta_{532} = \frac{\beta'_{532}}{T^2}$
- « Clouds » (no spherical particles) removed with volume depolarization ratio threshold of 5%
- Molecular backscatter(β_m) with air density from GEOS-5 model
- Scattering Ratio : $SR = \beta_{532} / \beta_m$



Assumption : pure molecular backscatter at 30-34km (SR=1)

$$C(z_c) = \frac{X(z_c)}{\beta_m(z_c) SR(z_c) T^2(z_c)}$$

Results

✓ Slow ascent of volcanic plumes, apparent seasonal clean air injection from the troposphere

BUT

✓ SR< 1 above 34km and below 20km in Feb-Mar

✓ Meaningless simultaneous changes at all altitudes

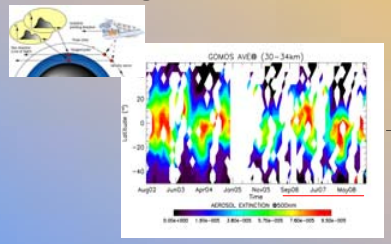
Limits

→ presence of aerosols up to 35 km in the tropics

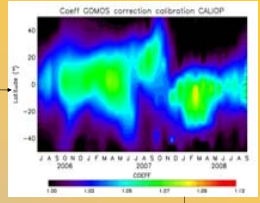
→ acccuracy of GEOS 5 density at high altitude

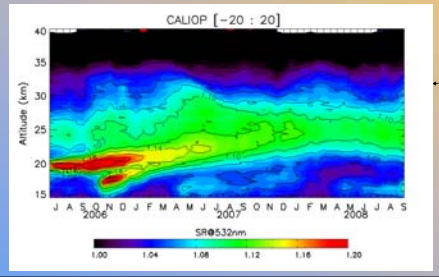
Conclusion: adjustment of calibration required

2 First method : Adjustment with GOMOS/ENVISAT extinction



- Conversion from 500 nm to 532 nm using Angstrom coeff (Jager et al., 1995,2002)
- Conversion into SR using backscatter-to-extinction coefficient k=0.017+/- 0.002 sr-1 (Chazette et al., 1995)
- Missing observations replaced by interpolation





$$SR_{ad} = SRxC$$

Results

- No more SR<1+/-0.01
- Minima more pronounced in the LS
- Second maximum in 2007 between 25-30 km largely disappeared

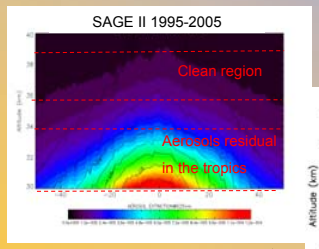
Limits

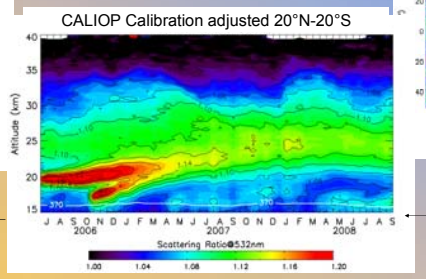
- Uncertainty on lidar ratio
- Periods of missing GOMOS data

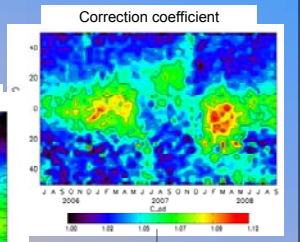
Aknowledgments

The SCOUT-O3 balloon flights in Brazil and Niger have been performed with the help of the CNES, the Institut de Recherche pour le Développement (IRD) and the AMMA Operational Committee (AOC). The CALIOP data are those made available at the ICARE data centre. The project was supported by the SCOUT-O3 EU project, CNES and the LEFE-CHAT Tropical UTLS programme. They are all gratefully acknowledged

3 Second method: Adjustment of calibration at aerosol free higher altitude



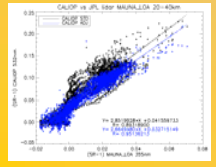




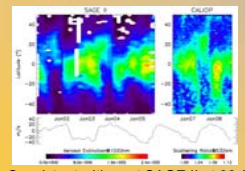
$$C = \frac{1}{SR_{36-39km}}$$

$$SR_{ad} = SRxC$$

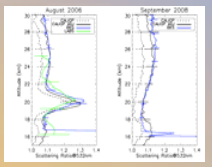
- No more SR<1+/- 0.01
- Better continuity
- But still signs of simultaneous changes at all altitude, e.g. 3_4% in Jan-Feb 2008



Consistent with Nasa JPL lidar in Mauna Loa (19°N,155°W)



Consistent with past SAGE II at 30-34km

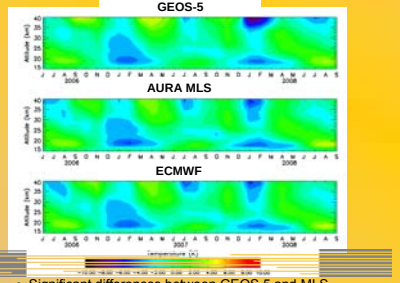


Consistent with SCOUT-AMMA BKS sondes in Niger (12°N, 2°E)

Reference: Vernier at al.,2009 JGR Calipso special issue, in revision

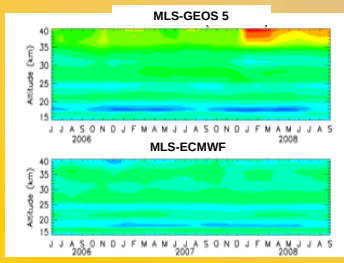
4 Impact of atmospheric model

Mean temperature anomaly 20°N-20°S



- Significant differences between GEOS 5 and MLS, ECMWF temperature at high altitude

Diffference



- GEOS-5 6-8K colder above 36 km in Jan-Feb 08 than MLS and ECMWF not seen when comparing MLS and ECMWF, resulting in a 3-4% SR ncrease

5 Conclusions

- CALIOP standard level 1 calibration in the tropics impacted by aerosols in the 30-34 km altitude range (typically 6%)
- Improved results with use of GOMOS extinction (ECMWF density) but limited by assumption on lidar ratio and periods of GOMOS missing data (still 2% anomalies)
- Recalibration at aerosol free altitude at 36-39km : results consistent with past SAGE II, ground-based lidar and in situ backscatter sonde in the tropics, but still anomalies of up to 3-4%
- Remaining anomalies due to GEOS 5 temperature difference at high altitude compared to MLS and ECMWF
- Further work: recalibration at aerosol free altitude at 36-39km with ECMWF temperature