Variability of UVB and global cloud cover

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Abstract. The role of Dimethyl Sulphide (DMS) in regulating climate has been the focus of much research in the last 20 years. In particular, that warmer ocean temperatures might increase the production of DMSP and subsequent flux of DMS to the atmosphere, increasing the number of cloud condensation nuclei and so cloud albedo and duration. In turn this could act to reduce solar heating of the surface, and such a negative feedback would act as a natural thermostat.

However, temperature is not the only environmental variable that may affect the production of DMS. Another forcing factor is the flux of ultraviolet (UV) light into the oceans, Larsen (2005). It is hypothesised that increased UV decreases the flux of DMS to the atmosphere. In which case, cloud cover is reduced, further enhancing the flux of UV into the ocean, and vice versa. In this case a positive feedback would result.

The oceans most likely to be susceptible to such a forcing are those where the mixing depth is lowest, and incoming solar-UV flux greatest. These include the subtropics (and higher latitude oceans in summer). The effect of variations in the solar flux on any DMS-climate link are therefore more complex - enhanced solar heating potentially having a negative feedback, but the simultaneously enhanced solar-UV flux having a positive feedback.

In order to test this hypothesis, UVB data were compared with Earthshine data (a measure of the Earth's albedo) over the Pacific and Atlantic oceans. Significant negative correlations were obtained, especially in the northern hemisphere Pacific and Atlantic in the summer half of the year.

Introduction

This presentation reports on the initial results of a test of the hypothesis of Larsen (2005) that the climatic system may be sensitive to variations in UV flux through DMS mediated changes in cloud properties.

Data

Two data sets have been constructed. The first are zonal means of monthly UVB (280-320 nm) for the Pacific (150° E – 120° W) and the Atlantic (15° W – 60° W) at 1° resolution, from 60° N – 60° S, based on the dataset of Bodeker *et al.* (2001).

A spurious correlation is possible between UVB and cloud. This may occur due to changes in the height of the tropopause from changes in mean sea level pressure (MSLP). Under conditions of low MSLP (eg a cyclonic system), which also tend to be cloudy, a lowered tropopause, with enhanced ozone would result in a lower predicted tropospheric flux of UVB. Higher MSLP (eg an anticyclonic system), which tend to have less cloud, would be associated with an elevated tropopause, a reduced depth of ozone, and so a higher tropospheric flux of UVB. In order to avoid this effect, the stratospheric ozone amount were corrected for variations in MSLP, and these data were then used to calculate the tropospheric UVB flux.

The second data set are monthly Earthshine data from the Big Bear Solar Observatory. These cover the Atlantic and Pacific ocean, Pallé *et al.* (2004). Earthshine measures the brightness of the "dark" portion of the crescent moon which is illuminated by light reflected from the Earth, and provides a reliable method of determining the global albedo.

Results

Correlating the Earthshine data for each oceanic region yields statistically significant correlations of up to -0.67 in the north Atlantic. In both the Atlantic and Pacific of the northern hemisphere, these are most pronounced in summer.

In the southern Atlantic and Pacific oceans, the correlations are weaker and less consistent. Averaging the results of both oceans together, the northern hemisphere displays a statistically significant inverse correlation from July to late September at midlatitudes. In the southern hemisphere, significant correlations occur at higher latitudes centred around March and September. These are both periods when the cyclonic systems of the southern westerlies expand equator-ward as a result of the semi-annual oscillation of MSLP, and at these times, the associated clouds will contribute more to the earthshine signal.

Conclusions

These results suggest that the climate system may be sensitive to changes in the flux of UVB into the troposphere. Further work is now in progress to correlate the observed correlations with satellite derived cloud data from the International Satellite Cloud Climatology Program (ISCCP).

References

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