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Interactive Comment

Interactive comment on “Reply to: "Tropical cirrus and water vapor: an effective Earth infrared iris feedback?"” *by* M.-D. Chou et al.

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Abstract
Chou et al (2002) have criticized our results on the change in net TOA radiative fluxes that would be associated with a decrease of the cloudy moist areas of the tropics, an essential part of the atmospheric iris feedback proposed by Lindzen et al (2001) (LCH). We show that our results are in much better agreement with observations than are the earlier results by LCH.

Introduction
Lindzen et al (2001) (hereafter LCH) suggested that the result of an increase in tropical sea surface temperature would be (i) a decrease in f_{cloudy}, the fraction of the tropical area covered by upper-level cirrus with high upper level humidity (the 'cloudy moist '

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region (LCH)), and (ii) a decrease in f_{moist}, the fractional area of the region characterized by low-level clouds and high upper level humidity, (their 'clear moist' region). These would be compensated for by an increase in $f_{dry} = 1 - f_{cloudy} - f_{moist}$, the fraction of the tropical area characterized by low-level clouds and low upper level humidity.

These changes would produce a change in R_{net}, the overall net incoming TOA radiative flux in the tropics, due to the decrease in high clouds and areas with high upper level moisture, and the increase in exposed low-level clouds. If the net incoming TOA radiative fluxes are R_{cloudy}, R_{moist} and R_{dry} in the three regions, then

$$R_{net} = R_{cloudy} f_{cloudy} + R_{moist} f_{moist} + R_{dry} f_{dry} \quad (1)$$

so that if $f_{cloudy} \to f_{cloudy} - \Delta f_{cloudy}, f_{moist} \to f_{moist} - \Delta f_{moist}$, then

$$\Delta R_{net} = (R_{cloudy} - R_{dry}) \Delta f_{cloudy} \quad (2)$$
$$+ (R_{moist} - R_{dry}) \Delta f_{moist} \quad (3)$$

The magnitude of the proposed atmospheric iris feedback is proportional to ΔR_{net}.

The first term on the RHS of equation (3) is the change in TOA flux due to the decrease in high clouds and in upper level water vapor when the convective region is replaced by the drier one, and the second term on the RHS is due to the decrease in upper level water vapor alone, because we assume the low-cloud cover is the same in the dry and in the clear moist region, as did LCH. We return to this point below.

Conclusions

The physics of this model lies in the choices of parameters used to calculate the terms on the RHS of equation (3). LCH chose these parameters within loose constraints provided from overall ERBE tropical budgets. They calculated

$R_{cloudy} - R_{dry} = 110 W/m^2; R_{moist} - R_{dry} = 40 W/m^2$.

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Fu et al (hereafter, FBH) used the LCH model structure but used realistic temperature and humidity profiles to calculate $R_{moist} - R_{dry}$ and ERBE observations of cloud radiative forcing for the cloudy moist region. Their results are as follows:

$R_{cloudy} - R_{dry} = 49W/m^2; R_{moist} - R_{dry} = 25W/m^2$.

The contributions to ΔR_{net} calculated by LCH and by FBH can be compared with data. Point values of the net TOA fluxes in the tropics (10S-10N), based on ERBE data, range from about 85 W/m^2 at 130 E (comparable to the 'cloudy moist' region) to about 50 W/m^2 at 260 E, near the coast. Thus the maximum observed magnitude of $R_{cloudy} - R_{dry}$ is actually less than $35W/m^2$; smaller than that calculated by FBH and much smaller than that calculated by LCH. Examination of net TOA fluxes along any constant latitude bane in the tropics (see, for example, Figure 2.11, hartmannbook) shows that the magnitude of $R_{cloudy} - R_{dry}$ is never more than about 40 W/m^2.

The LCH value is incompatible with observed behavior of the tropical atmosphere and the LCH iris feedback factor (proportional to ΔR_{net}) is significantly exaggerated.

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