

# HIRS Cloud Effective Emissivity

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**CO2 Slicing and Effective Emissivity**

**HIRS Reprocessing Results**

**Separating  $N$  and  $\epsilon$**

**Minimum HIRS Detectable Cloud Optical Depth**

**Summary**



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# CTPs using CO2 Slicing

Different ratios reveal  
cloud properties  
at different levels

hi - 14.2/13.9

mid - 13.9/13.6

low - 13.6/13.3

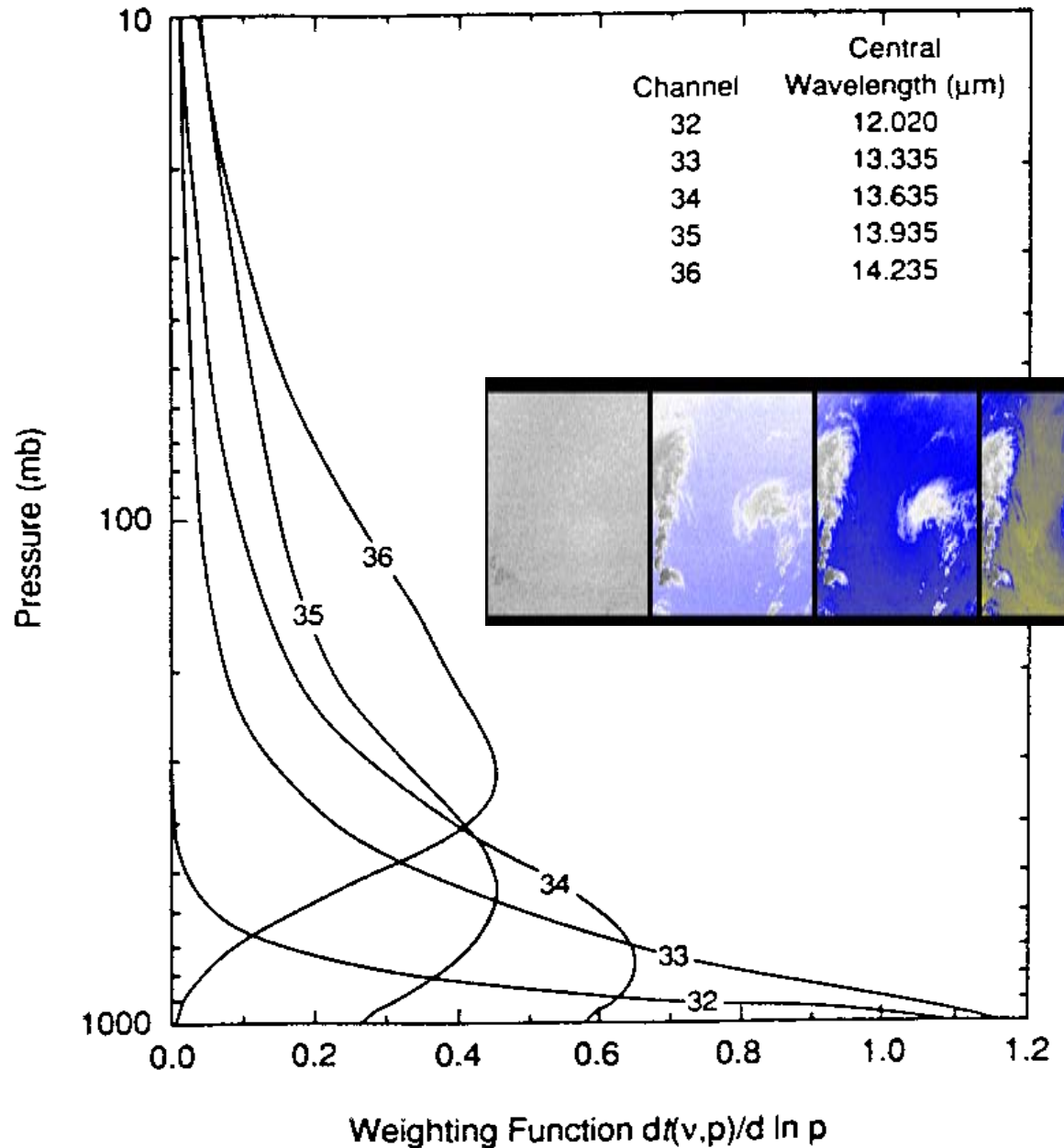
Meas

Calc

$$\frac{(I_{\lambda_1} - I_{\lambda_1}^{\text{clr}})}{p_s} = \frac{\eta \epsilon_{\lambda_1} \int \tau_{\lambda_1} dB_{\lambda_1} p_c}{p_s}$$

$$\frac{(I_{\lambda_2} - I_{\lambda_2}^{\text{clr}})}{p_s} = \frac{\eta \epsilon_{\lambda_2} \int \tau_{\lambda_2} dB_{\lambda_2} p_c}{p_s}$$

if  $(I_{\lambda}^{\text{clr}} - I_{\lambda}) < \Delta$   
then IRW is used



# From CTP infer $N\varepsilon$

$$(I_{\text{IRW}} - I_{\text{IRW-clr}}) = \eta \varepsilon_{\text{IRW}} \int_{\text{ps}}^{\text{pc}} \tau_{\text{IRW}} \, dB_{\text{IRW}}$$

or

$$[I_{\text{IRW}} - I_{\text{IRW-clr}}] / [B(\text{IRW}, T(\text{pc})) - I_{\text{IRW-clr}}] = \eta \varepsilon_{\text{IRW}} =$$

[observed cloud forcing / opaque cloud forcing]

**UW HIRS global cloud statistics  
from December 1978 through December 2009**

	<b>All Clouds</b>	<b>Thin Clouds NE&lt;0.5</b>	<b>Thick Clouds</b>	<b>Opaque Clouds NE&gt;0.95</b>
<b>IR Optical Depth</b>	<b>0.05&lt;</b>	<b>&lt;0.7</b>	<b>&lt;3</b>	<b>&gt;3</b>
<b>High (&lt;440 hPa)</b>	<b>40%</b>	<b>22%</b>	<b>15%</b>	<b>3%</b>
<b>Mid (440 → 680 hPa)</b>	<b>12%</b>	<b>5%</b>	<b>6%</b>	<b>1%</b>
<b>Low (&gt;680 hPa)</b>	<b>21%</b>	<b>1%</b>	<b>2%</b>	<b>18%</b>
<b>All Clouds</b>	<b>73%</b>	<b>28%</b>	<b>23%</b>	<b>22%</b>

**UW HIRS global cloud statistics**  
**from December 1978 through December 2009**  
**(corrected for higher cloud obstruction of lower clouds using**  
**random overlap assumption)**

	<b>All Clouds</b>	<b>Thin Clouds NE&lt;0.5</b>	<b>Thick Clouds</b>	<b>Opaque Clouds NE&gt;0.95</b>
<b>IR Optical Depth</b>	<b>0.05&lt;</b>	<b>&lt;0.7</b>	<b>&lt;3</b>	<b>&gt;3</b>
<b>High (&lt;440 hPa)</b>	<b>40%</b>	<b>22%</b>	<b>15%</b>	<b>3%</b>
<b>Mid (440 → 680 hPa)</b>	<b>20%</b>	<b>8%</b>	<b>10%</b>	<b>2%</b>
<b>Low (&gt;680 hPa)</b>	<b>52%</b>	<b>2%</b>	<b>5%</b>	<b>45%</b>
<b>Clear</b>	<b>27%</b>			

# Inferring IR Optical Depth

Cloud optical depths can be estimated from the effective emissivity ( $N_{\varepsilon}$ ) derived from the HIRS data. By assuming that transmission is the complement of emission without scattering, the infrared window optical depth is given by

$$\tau(\text{IRW}) = -\ln(1 - N_{\varepsilon}).$$

Cloud Amounts from HIRS and Collocated AVHRR Data  
 Cloud Heights < 700 mb from 20-40 N Latitude  
 July 1994

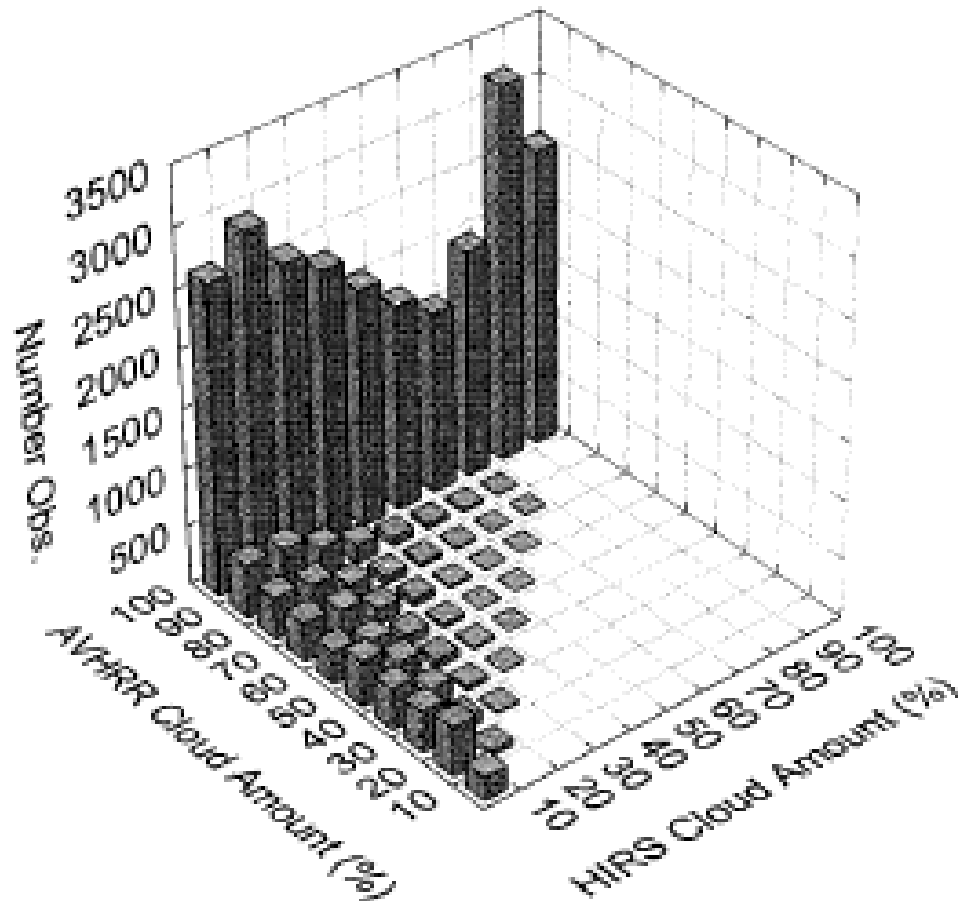


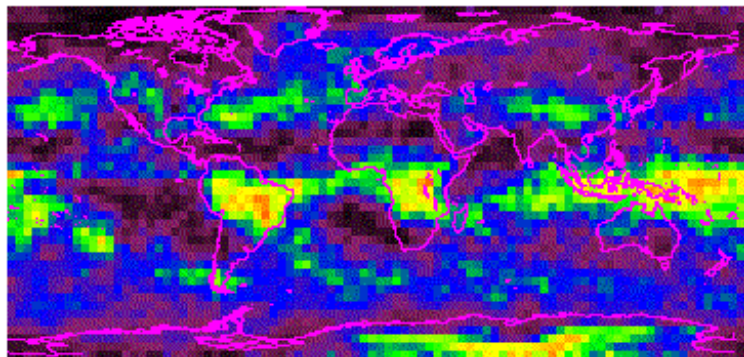
FIG. 1. AVHRR cloud coverage within a HIRS FOV plotted against HIRS effective emissivity (effective cloud amount) for clouds above 700 hPa in the tropical oceans from 20° to 40°N lat for July 1994.

For  $N\varepsilon < 0.5$   
 average  $N = .72$

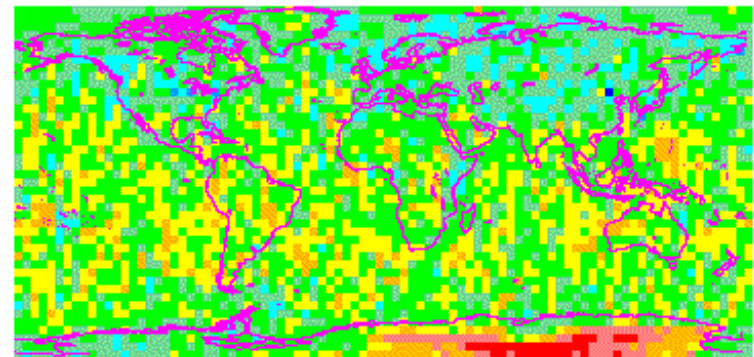
For  $N\varepsilon > 0.5$   
 roughly  $N=1.00$   
 $\varepsilon = (N\varepsilon)$

# HIRS minus GLAS High Cloud Difference

## HIRS Frequency of High Cloud



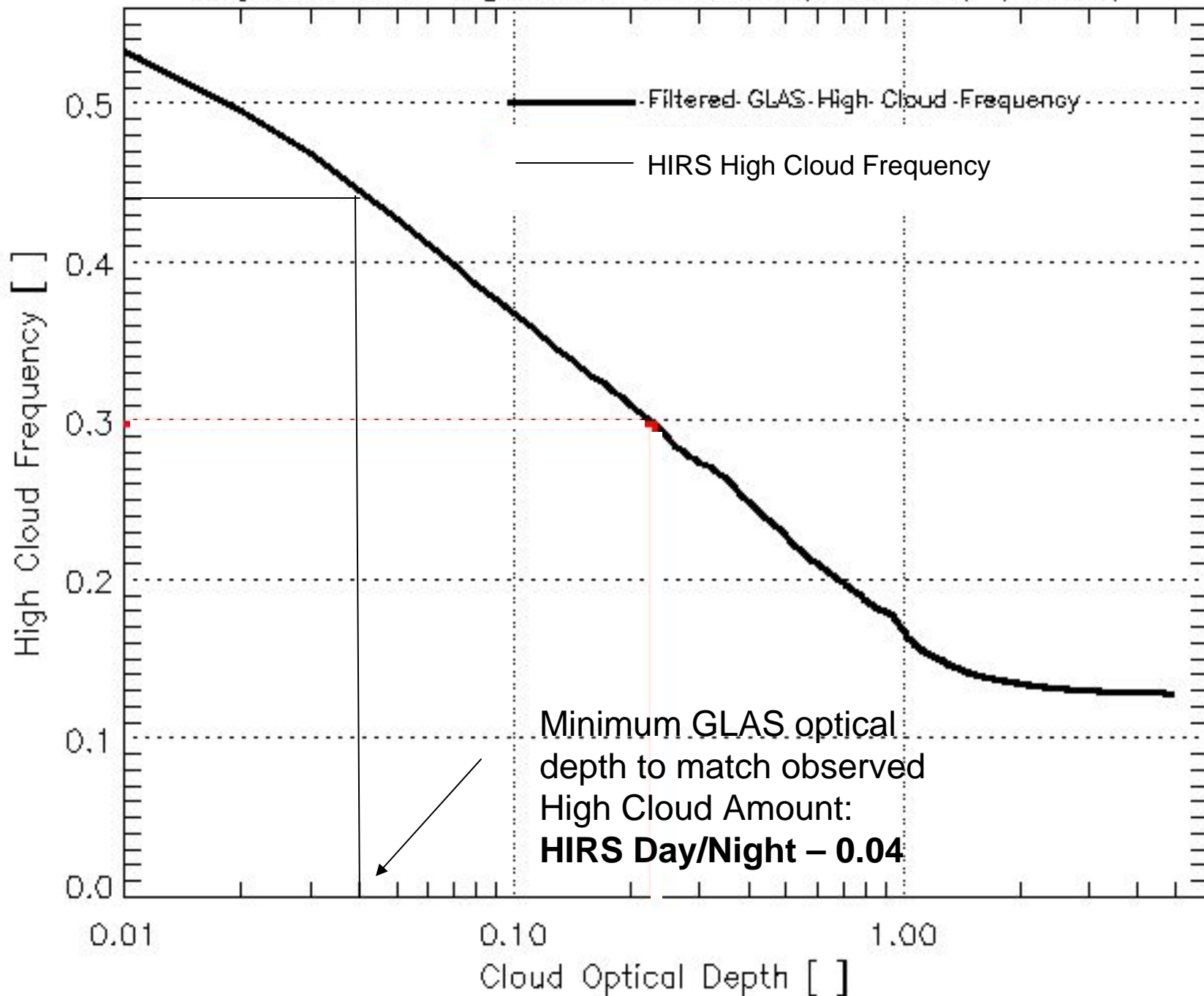
## HIRS – GLAS Difference



HIRS reports more high clouds in parts of tropics and southern hemisphere, but areas of differences are scattered and not meteorologically organized.



# Adjusted GLAS High Cloud Amounts (20S-20N) (Conv+)



# Summary

- \* Cloud effective emissivity retrieval compares observed cloud forcing to opaque cloud forcing given the cloud top pressure
- \*  $N\varepsilon = 0.5$  converts to  $COD(IR) = 0.7$
- \* For high clouds detected in 40% of HIRS observations, 22% (18%) have  $COD(IR) < (>) 0.7$
- \* For  $N\varepsilon < 0.5$ , on average  $\varepsilon = 1.4 (N\varepsilon)$  and for  $N\varepsilon > 0.5$ , roughly  $\varepsilon = (N\varepsilon)$
- \* comparison of tropical cloud detection with GLAS suggests that HIRS is detecting clouds with  $COD(vis) > 0.04$