Finite Cloud Effects at the ACRF TWP Site
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Introduction:
- Most GCMs use a cloud amount weighted average to calculate upward and downward fluxes, Eq. (1).
- Eq. (1) neglects (See Fig. 1):
  - Inhomogeneity of Cloud Microphysical Properties
  - 3D Cloud Field Bulk Geometry
  - Varying Cloud Thermodynamic Properties
- The difference in surface longwave forcing due to finite 3D clouds when compared to infinite clouds, referred to as (CSE) cloud side effect (i.e. (A) - (B) from Fig. 1), has been measured to be as much as 15 W m⁻² (Heidinger and Cox 1996).

Fig 1. This schematic illustrates the contributions to the surface flux from (A) a realistic non-isothermal cloud field with inhomogeneous optical properties and 3D geometry and (B) considering a Plane Parallel cloud field with homogeneous optical properties.

Data:
- Observations are taken at the ACRF TWP Site from June 1999 through May 2003 and obtained from the ARM Data Archive.
- These instruments are used to extract cloud field parameters using the frozen turbulence approximation. The cloud parameters are used as input in to the PCLoS Models to determine $N_e$.

<table>
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<tr>
<th>Instrument</th>
<th>Observations</th>
<th>Parameter(s) Extracted</th>
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<tr>
<td>Ceilometer</td>
<td>Cloud Base Height</td>
<td>Cloud Base Height, Cloud Base Length, N</td>
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<td>ARSCL</td>
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<td>Pyrgeometer</td>
<td>Longwave Diffuse Downwelling Flux</td>
<td>$N_e$</td>
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Summary and Conclusions:
- 62 two-hour intervals of single-layer cumulus clouds are studied at the ACRF TWP site.
- The effective cloud fraction can be calculated using the PCLoS inferred from the Whole Sky Imager with some skill.
- The mean cloud side effect (CSE) in the longwave at the surface is 7.15 W m⁻² at Manus and 11.50 W m⁻² at Nauru. The larger observed CSE at Nauru coincides with a larger mean aspect ratio. The mean CSE at the ACRF TWP considering all cases is 8.07 W m⁻².
- The cloud side effect reported by Heidinger and Cox (1996) is very similar to the results presented here, despite the appearance of larger clouds at TWP. This is a result of two competing effects: (1) increased CSE with increased aspect ratio and (2) decreased CSE with smaller differences between clear and overcast downwelling fluxes.

Results:
- Mean Flux from Cloud Side Emission:
  - 7.15 Wm⁻² at Manus
  - 11.50 Wm⁻² at Nauru
- The effective cloud fraction is determined using PCLoS from the WSI. Pyrgeometer data and MDTERP longwave radiative transfer model are used to validate the PCLoS effective cloud fractions.
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