Globally, and in the tropics in particular, how much precipitation falls from convection, and how much from stratiform clouds?

David A. Randall and Laura D. Fowler
Convective and Stratiform Clouds--Not Black and White

• Many stratiform clouds are produced through convective detrainment.

• Virtually all stratiform clouds contain convective turbulence.

• Strong convective rain events are usually (always?) accompanied by stratiform rain in comparable amounts.
A Cloud is a Cloud

- Existing climate models use separate parameterizations for convective and stratiform clouds. Stratiform clouds are “resolved” (at least partly). Cumulus clouds are not resolved.

- In nature, cumulus and stratiform clouds strongly interact, and these interactions are included in modern parameterizations.

- At sufficiently high resolution convective clouds must be explicitly resolved. Such models are coming.

- Is it possible to develop a single parameterization to represent both kinds of clouds in both high- and low-resolution models?
What does TRMM say?

- Partitioning between convective and stratiform precipitation is a function of the intensity, and horizontal and vertical polarizations of the radar reflectivity. There is a third category called “other”.

- Partitioning is about 50 - 50 in regions of deep convective activity.

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<tbody>
<tr>
<td>TOTAL (mm/day)</td>
<td>3.19</td>
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<tr>
<td>CONVECTIVE (mm/day)</td>
<td>1.24</td>
</tr>
<tr>
<td>STRATIFORM (mm/day)</td>
<td>1.11</td>
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<tr>
<td>RATIO CONV/TOTAL (-)</td>
<td>0.39</td>
</tr>
<tr>
<td>RATIO STRAT/TOTAL (-)</td>
<td>0.35</td>
</tr>
</tbody>
</table>
The Partitioning in a GCM

**CONVECTIVE PRECIPITATION DEPENDS ON**

- The amount of water condensate formed in the convective updraft.
- The efficiency with which condensed water is converted into precipitation inside the cumulus clouds.
- How much condensed water is carried to and detrained from the tops of the updrafts, thus escaping precipitation.

**LARGE-SCALE PRECIPITATION DEPENDS ON**

- The amount of convective condensate (cloud water, cloud ice, snow) detrained at the tops of the convective updrafts.
- The parameterized conversion of cloud water/cloud ice to rain/snow.
CLOUDS IN THE CSU GCM

\[ \overline{M_{q_x}} \]
The NOENTR Experiment

- Disable entrainment of cloud water and cloud ice from stratiform clouds into cumulus clouds.  
  **Vapor and temperature are still entrained.**

- Disable the effects of “compensating subsidence” on cloud water and cloud ice only.  
  **Compensating subsidence still warms and dries.**
Conclusions

• Convective and stratiform clouds are closely linked and should not be parameterized separately as “plug-compatible modules”.

• The partitioning between stratiform and convective precipitation depends on microphysical processes in both cloud types.

• The total precipitation rate is much less sensitive to the details of the model.

• Future cloud parameterizations should address convective and stratiform clouds as endpoints along a continuum, rather than as discrete types.

A cloud is a cloud.