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.

TOTAL (mm/day)	**3.19**
CONVECTIVE (mm/day)	**1.24**
STRATIFORM (mm/day)	**1.11**
RATIO CONV/TOTAL (-)	**0.39**
RATIO STRAT/TOTAL (-)	**0.35**

The Partitioning in a GCM

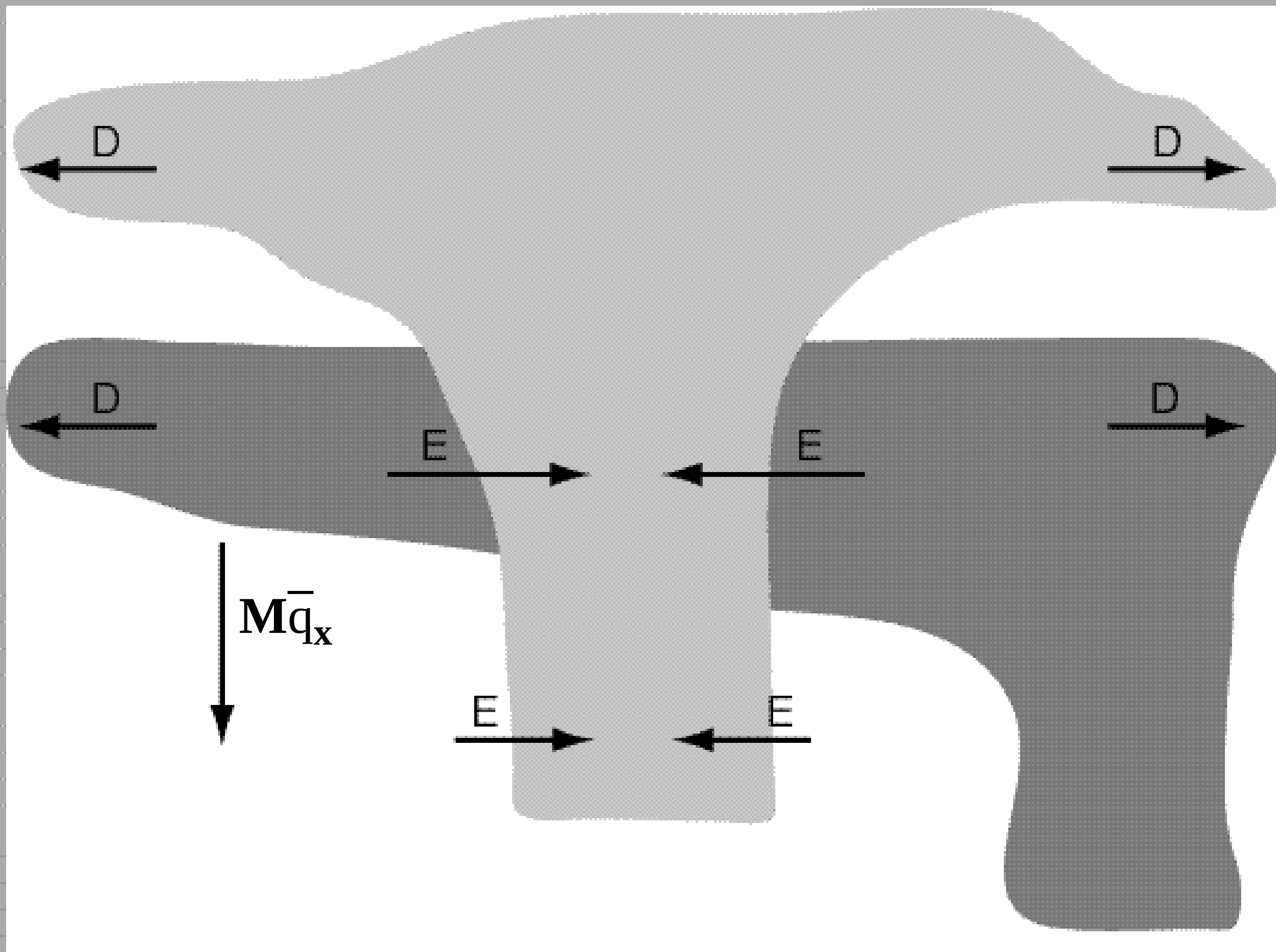
CONVECTIVE PRECIPITATION DEPENDS ON

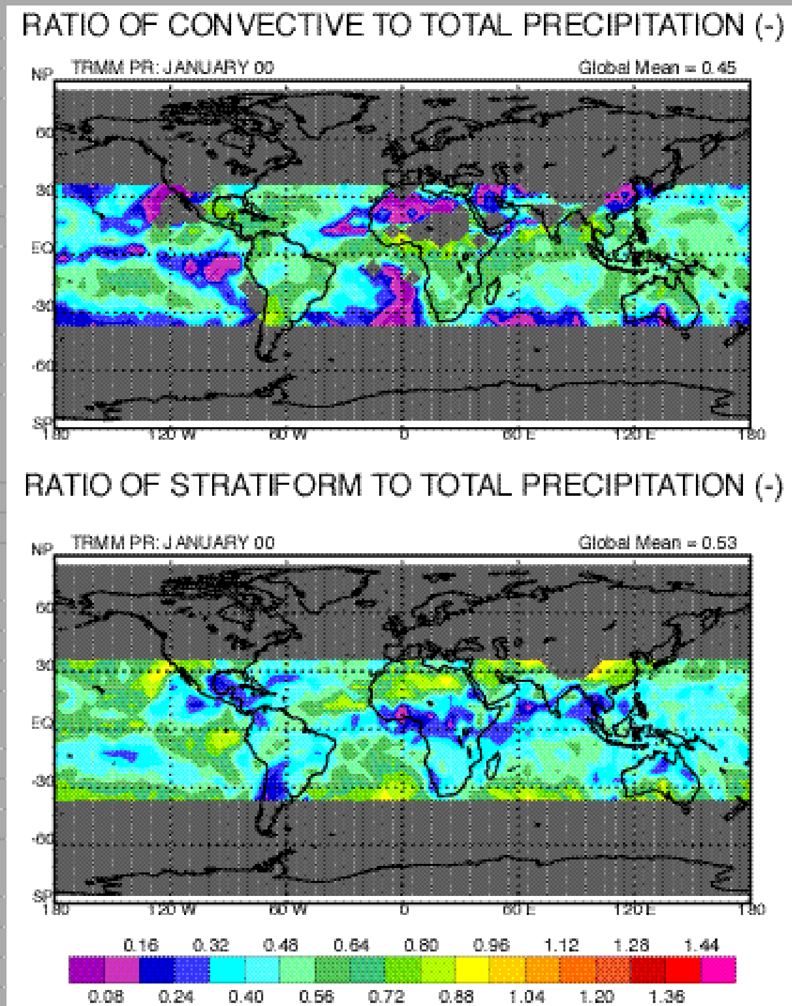
- The amount of water condensate formed in the convective updraft.
- The efficiency with which condensed water is converted into precipitation inside the cumulus clouds.
- How much condensed water is carried to and detrained from the tops of the updrafts, thus escaping precipitation.

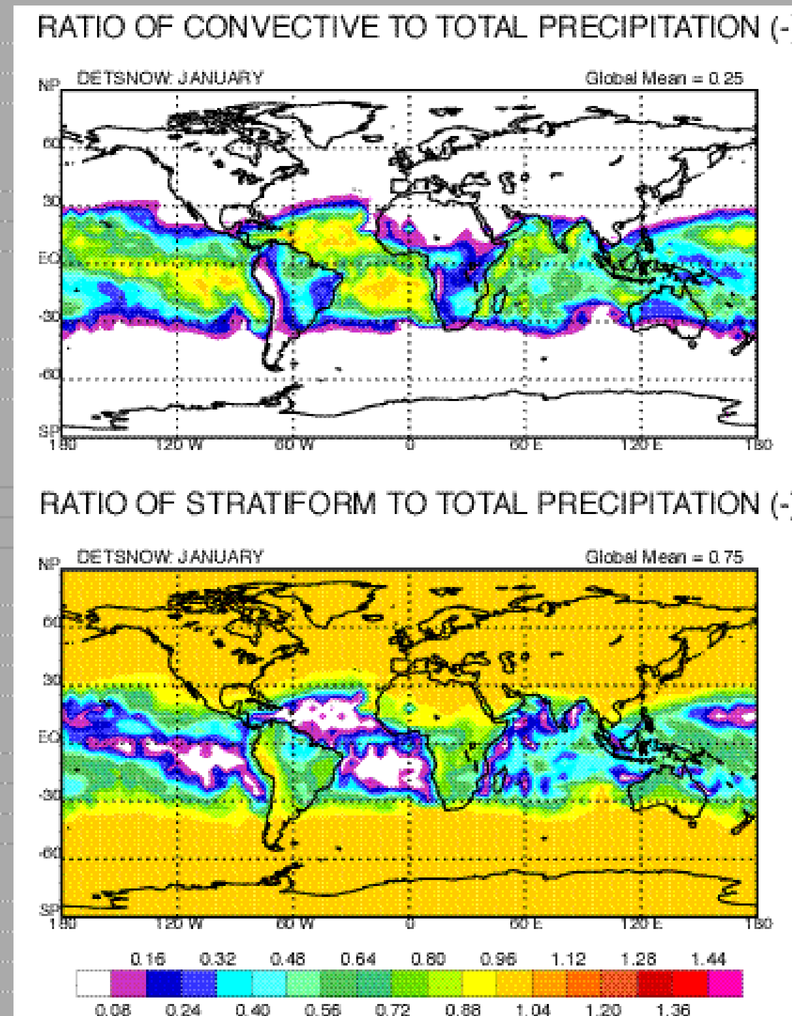
LARGE-SCALE PRECIPITATION DEPENDS ON

- 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




RATIO OF CONVECTIVE TO TOTAL PRECIPITATION (-)
TRMM PR: JANUARY 00
Global Mean = 0.45
RATIO OF STRATIFORM TO TOTAL PRECIPITATION (-)
TRMM PR: JANUARY 00
Global Mean = 0.53
180 120 W 60 W 0 60 E 120 E 180
0.16 0.32 0.48 0.64 0.80 0.96 1.12 1.28 1.44
0.08 0.24 0.40 0.56 0.72 0.88 1.04 1.20 1.36


RATIO OF CONVECTIVE TO TOTAL PRECIPITATION (-)
DETSNOW: JANUARY
Global Mean = 0.25
RATIO OF STRATIFORM TO TOTAL PRECIPITATION (-)
DETSNOW: JANUARY
Global Mean = 0.75
180 120 W 60 W 0 60 E 120 E 180
0.16 0.32 0.48 0.64 0.80 0.96 1.12 1.28 1.44
0.08 0.24 0.40 0.56 0.72 0.88 1.04 1.20 1.36

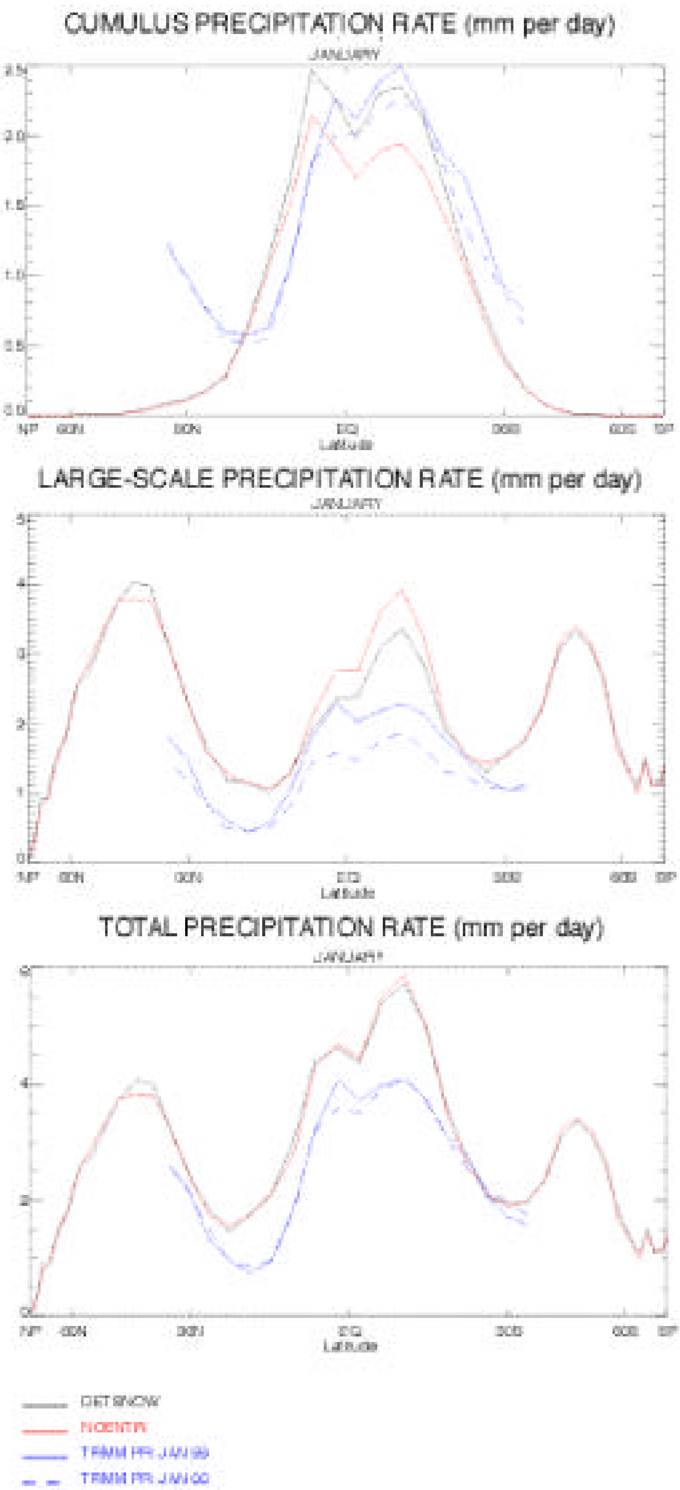
The NOENTR Experiment

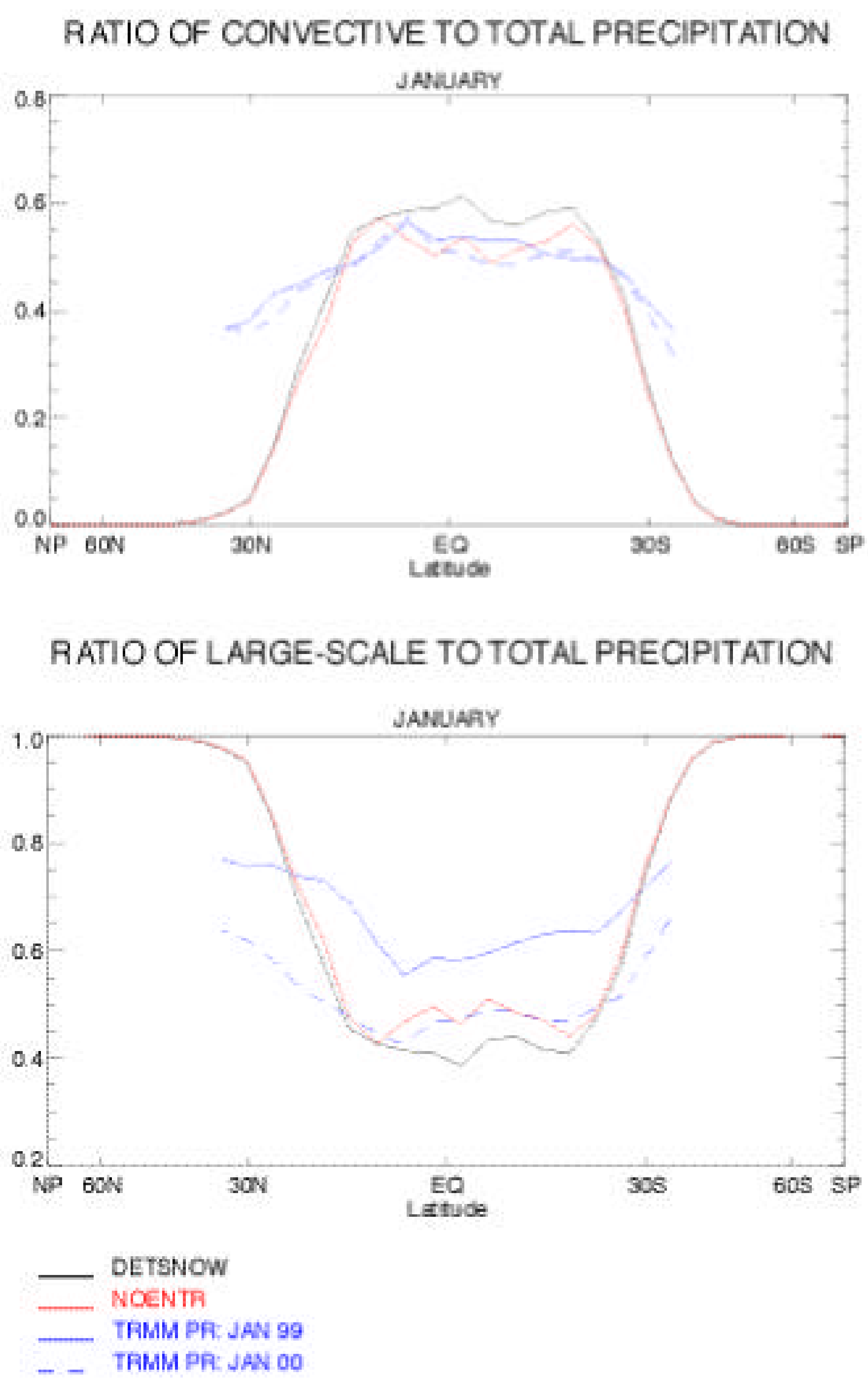
- **Disable entrainment of cloud water and cloud ice from stratiform clouds into cumulus clouds.**

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.


CUMULUS PRECIPITATION RATE (mm per day)
JANUARY
Latitude
LARGE-SCALE PRECIPITATION RATE (mm per day)
JANUARY
Latitude
TOTAL PRECIPITATION RATE (mm per day)
JANUARY
Latitude
NP 60N 30N EQ 30S 60S SP


RATIO OF CONVECTIVE TO TOTAL PRECIPITATION
JANUARY
0.8
0.6
0.4
0.2
0.0
NP
60N
30N
EQ
30S
60S
SP
Latitude
RATIO OF LARGE-SCALE TO TOTAL PRECIPITATION
JANUARY
1.0
0.8
0.6
0.4
0.2
NP
60N
30N
EQ
30S
60S
SP
Latitude
DETSNOW
NOENTR
TRMM PR: JAN 99
TRMM PR: JAN 00

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.