Precipitation Probability Distributions In Drought-prone regions

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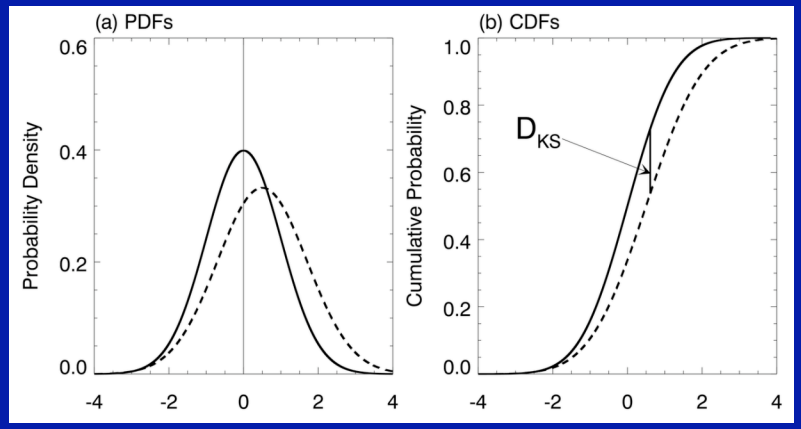
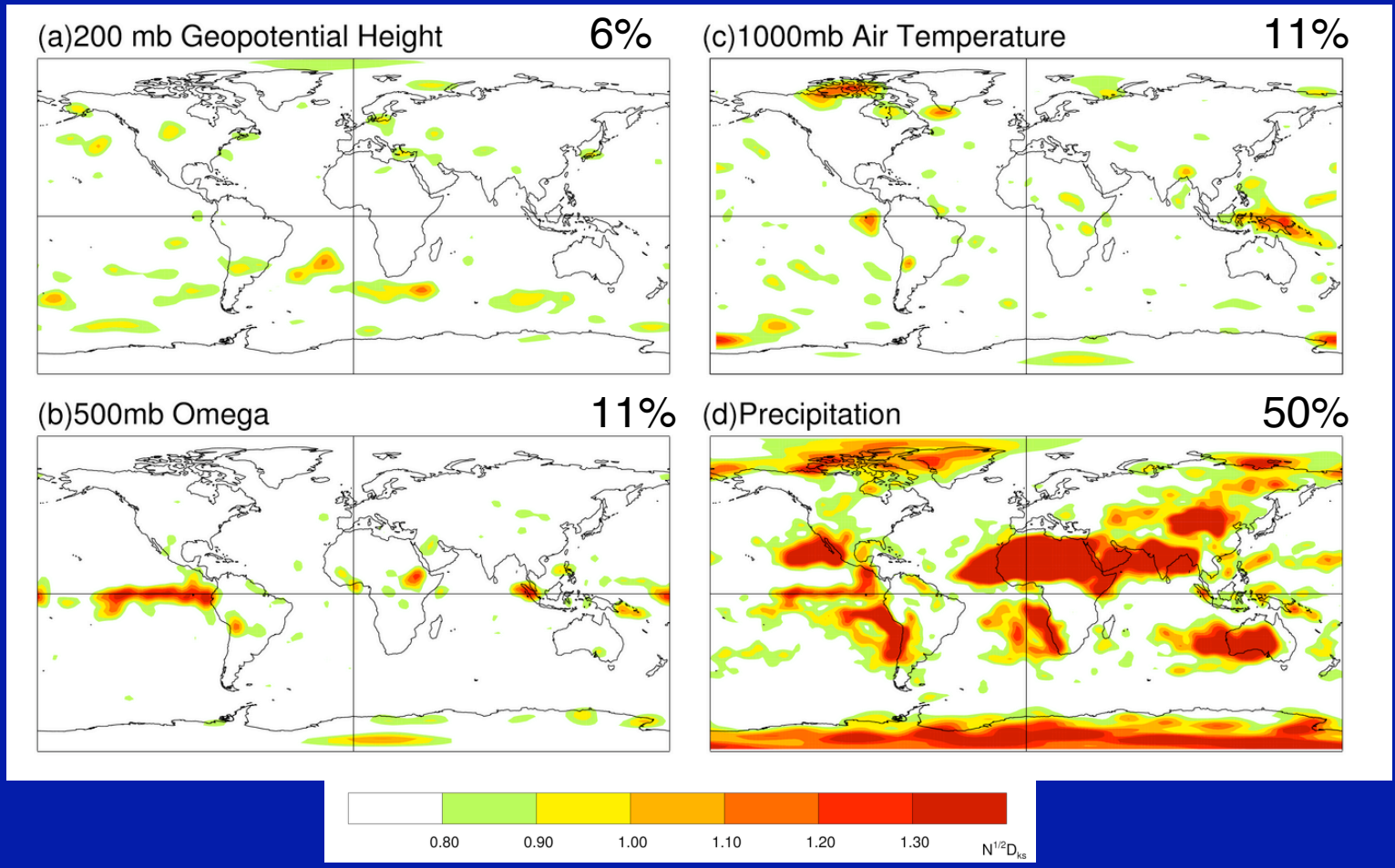
Introduction

1. What governs the PDF of seasonal mean precipitation?
2. Using GCM and reanalysis data, *Sardeshmukh, Compo, and Penland* (2000) suggested that the PDF is non-Gaussian in regions of large-scale tropospheric descent.
3. Descending areas are also drought-prone areas. Need to understand the shape of the PDF in these areas in particular.
4. As a first step, we have computed frequency of scant precipitation, skewness, and the fit to a Gaussian using the Kolmogorov-Smirnov (Lillifoer's) distance D_{ks}.



Non-Gaussian regions for January-March Seasonal Means

(NCEP-NCAR Reanalysis, 1948-2004)

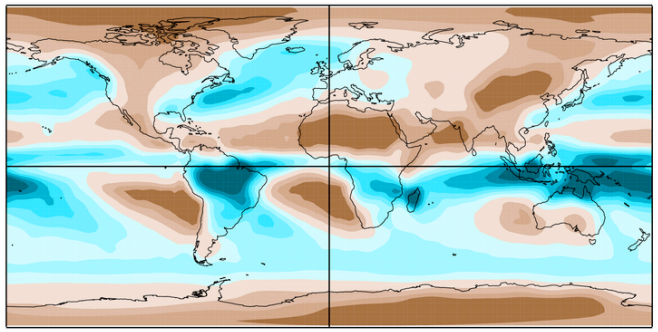


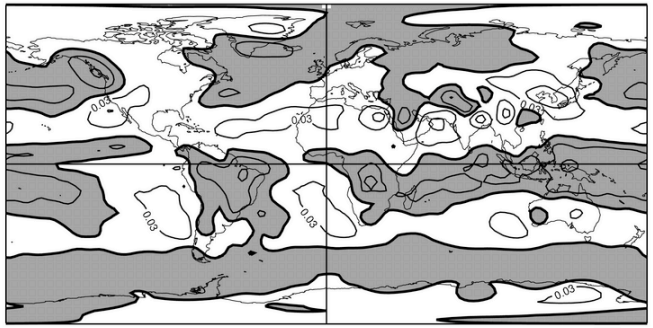
While many variables are Gaussian, precipitation is not, over 50% of the globe.

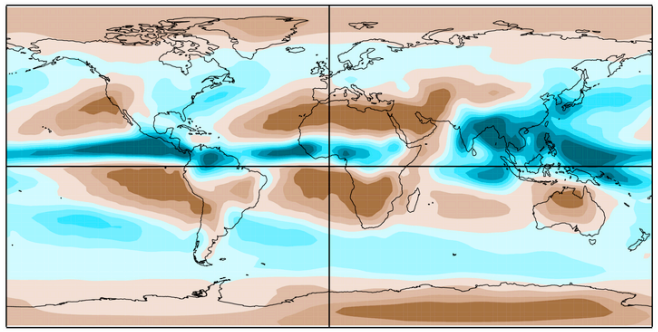
Climatology of Seasonal Mean Precipitation and 500 mb Vertical Velocity

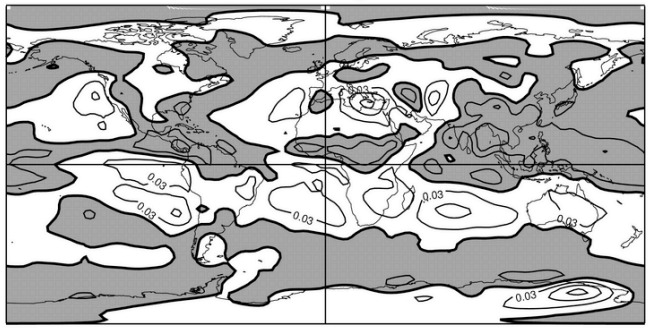
JFM

JJA









0.0 0.25 0.5 1.0 1.5 2.0 3.0 4.0 5.0 6.0 7.0 8.0 mm/day

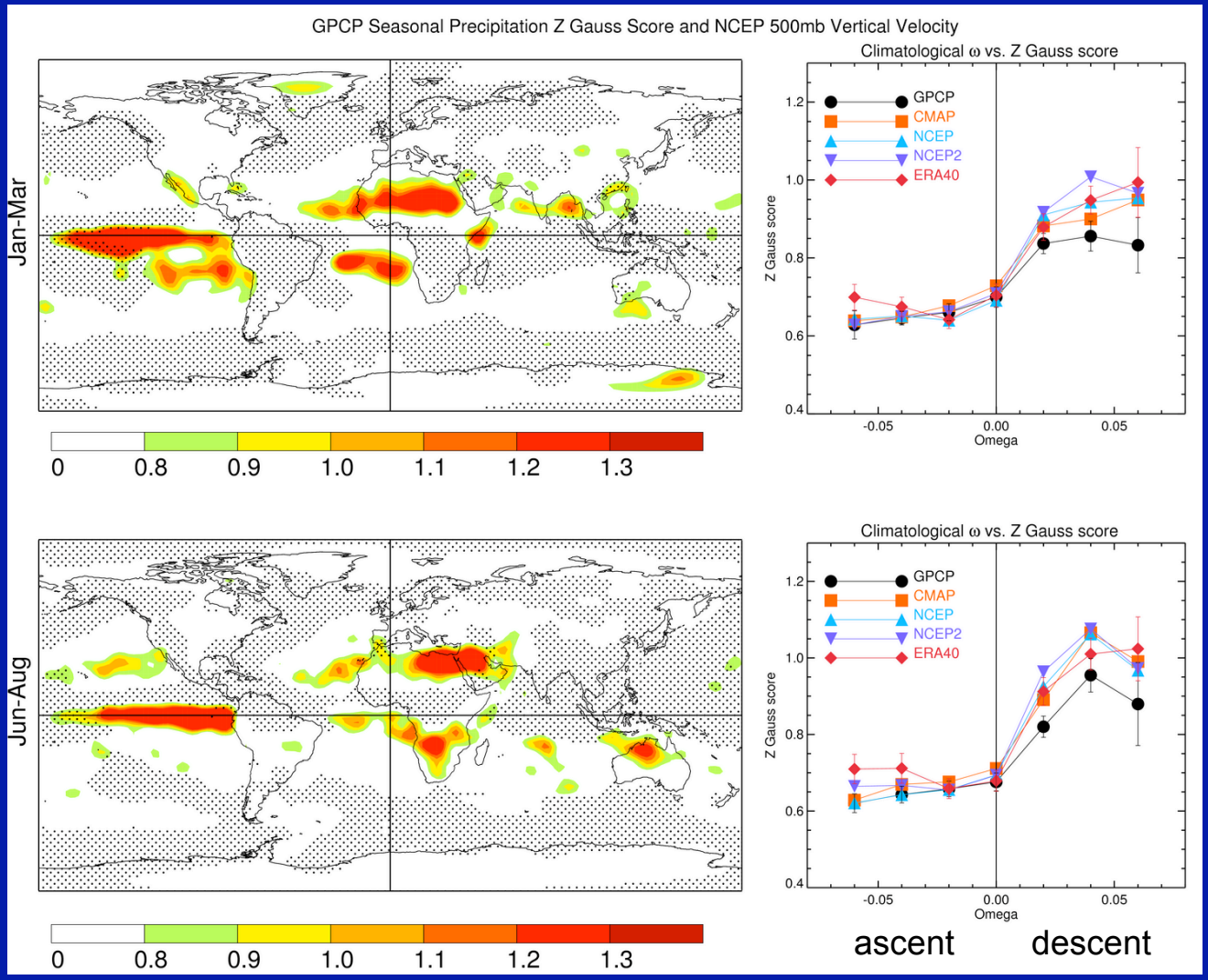
Shading indicates mean ascent

Global Precipitation Climatology Project

NCEP-NCAR Reanalysis

Precipitation is non-Gaussian in colored areas.
These are also areas of mean descent (right panels).

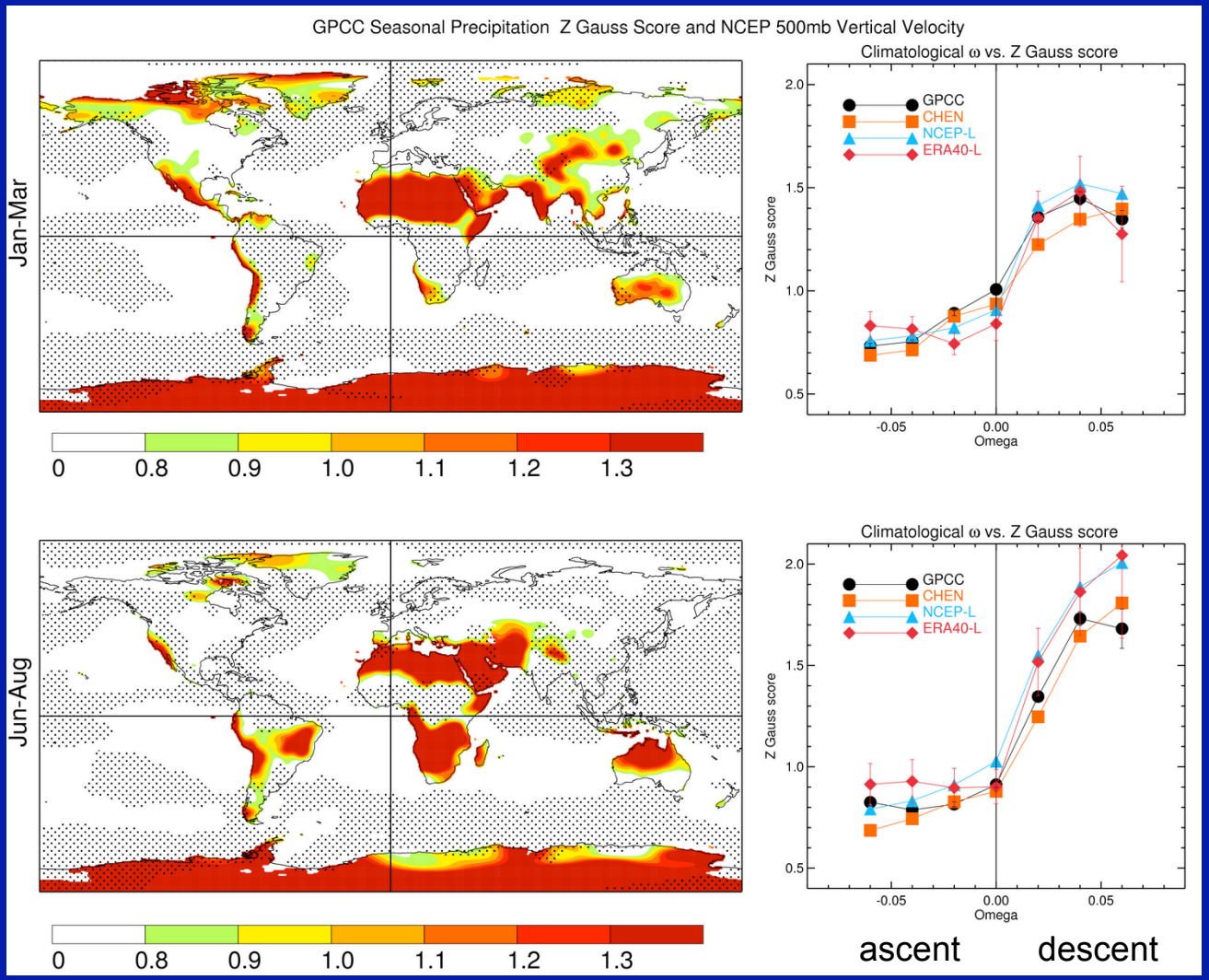
GPCP Precipitation, NCEP-NCAR 500 mb Vertical Velocity (1979-2004)



Stippled areas show regions of climatological mean ascent

Precipitation is non-Gaussian in colored land areas.
These are also areas of mean descent (right panels).

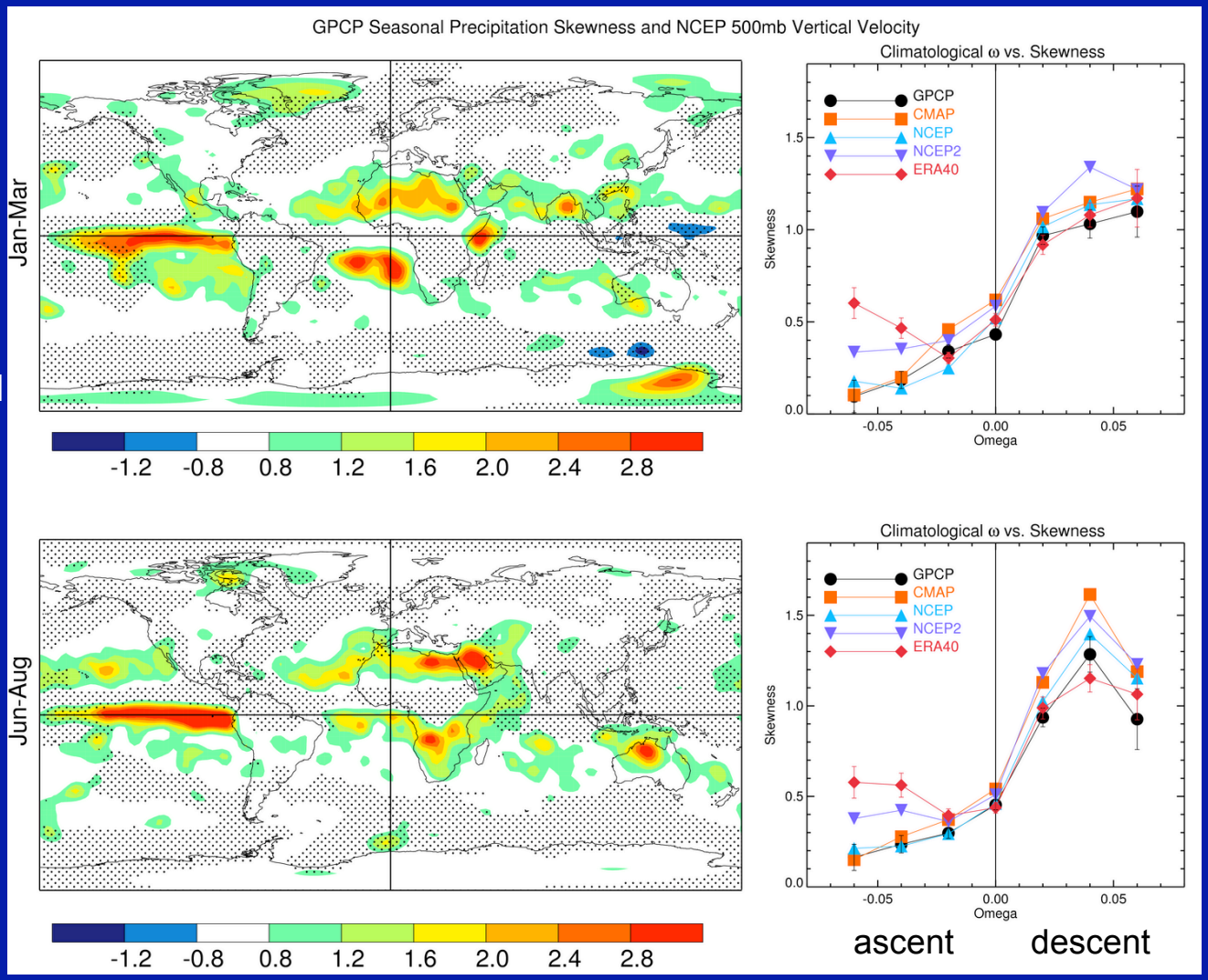
GPCC Precipitation, NCEP-NCAR 500 mb Vertical Velocity (1951-2004)



Stippled areas show regions of climatological mean ascent

Precipitation is skewed in colored areas.
Positive skew occurs in regions of mean descent (right panels).

GPCP Precipitation, NCEP-NCAR 500 mb Vertical Velocity (1979-2004)



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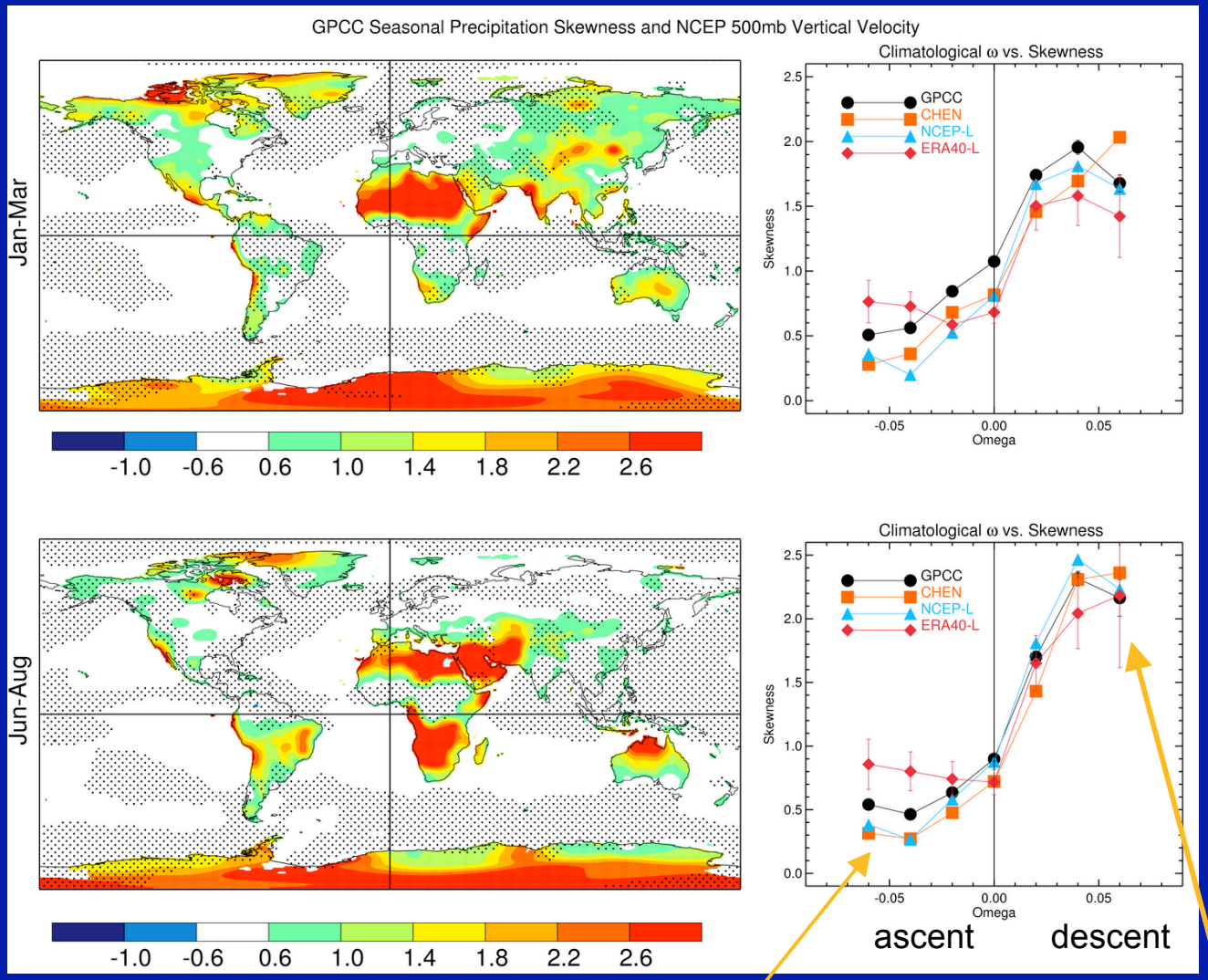
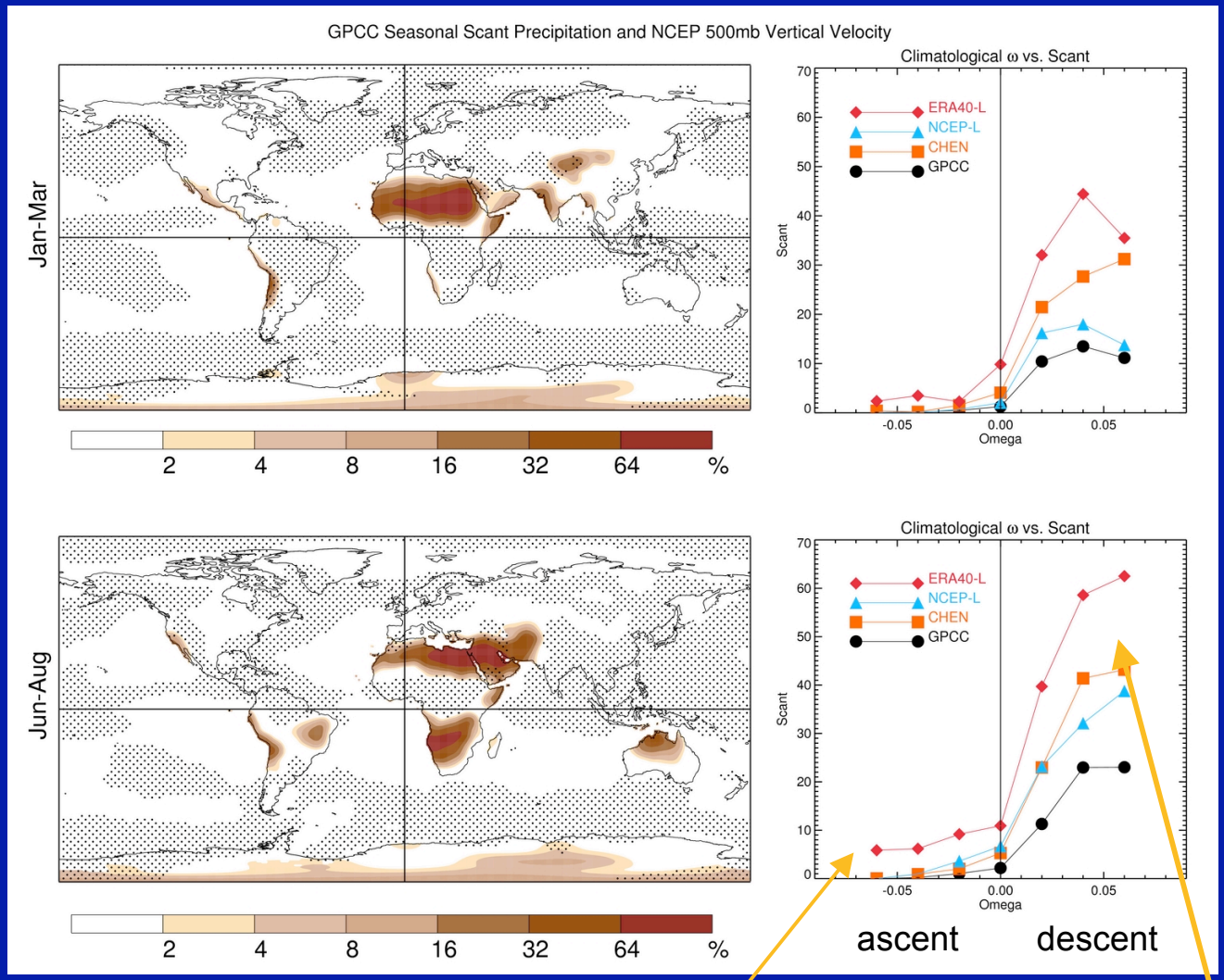


3 to 4 times more skewed in regions of mean descent

Precipitation is frequently scant (< 0.01mm/day) in colored land areas.
Frequent scant precipitation occurs in regions of mean descent (right panels).

GPCC Precipitation, NCEP-NCAR 500 mb Vertical Velocity (1951-2004)



2 to 4 times more frequent scant in regions of mean descent

Conclusions

1. Even seasonal mean precipitation is significantly non-Gaussian in semi-arid regions of descent.

2. The precipitation PDF is strongly controlled by the PDF of tropospheric vertical velocity in regions of descent, and therefore, precipitation variability in these regions is a passive response to dynamical remote teleconnections.