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WORKSHOP ON CLOUD PHYSICS AND CLIMATE

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CLOUD FREQUENCIES

(Preamble)

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PREAMBLE CLOUD FREQUENCIES

Cloud statistics are not commonly available, but some recent papers are providing helpful perspectives:

Warren et al, 1985 J. Climate Appl. Meteor
- example - zonal average distributions over land + ocean by cloud type

Hahn 1982 Reports from Natl Center for Atm. Res., Boulder
- analyses of surface observations to calculate conditional probabilities for simultaneous occurrences of different cloud types

Hughes and Henderson-Sellers, 1985, J. Climate. Appl. Meteor p. 664
- satellite data for mean cloud amount by month and for probabilities of coexistence of high and low clouds.

Precipitation statistics are better, but very sparse over oceans, and only daily totals are recorded most places.

Time-resolved rate measurements are needed

1

Warren et al. 1985 JCAM

2

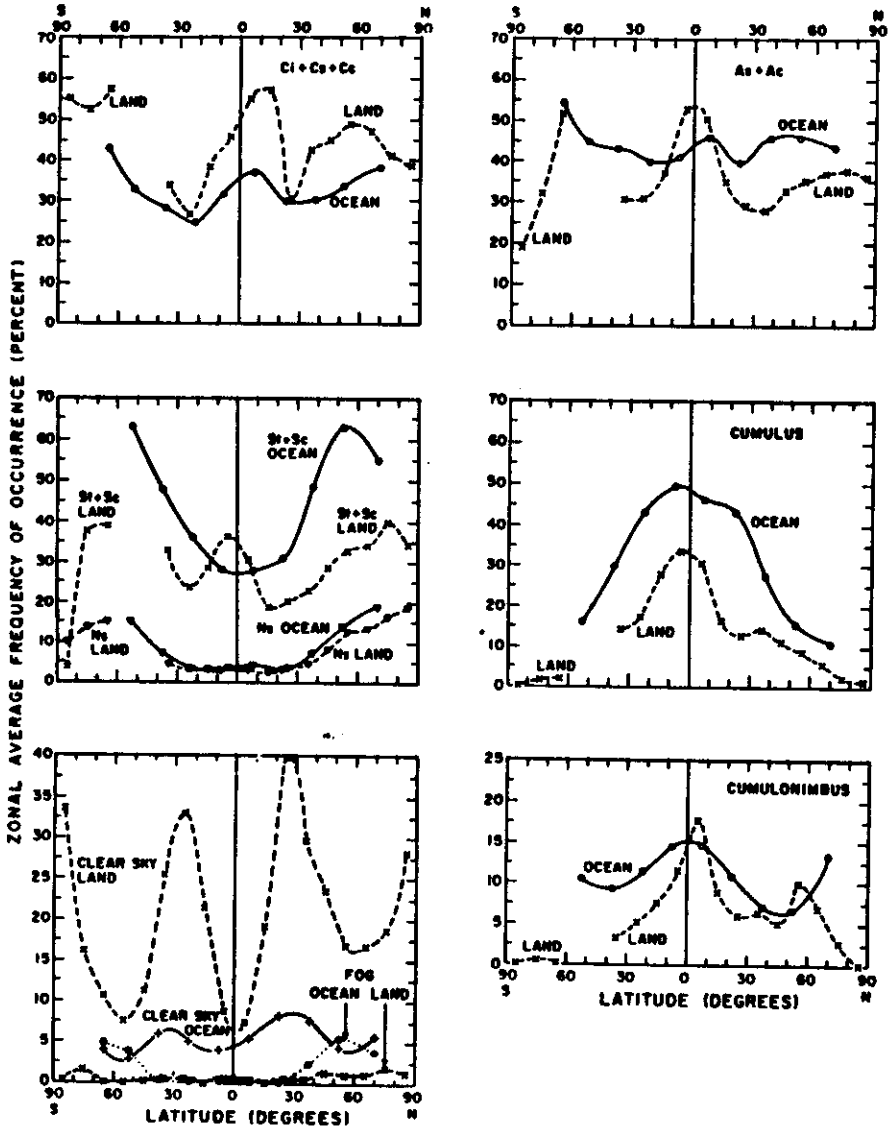

FIG. 1. Zonal, annual average frequency of occurrence of each cloud type, of clear sky, and of sky obscured due to fog, for land and ocean parts of each zone. ["Frequency of occurrence" is the fraction of weather observations in which a cloud type was reported present, given that it was possible to see whether it was present, irrespective of the fraction of the sky actually covered by that cloud.] A smooth curve is drawn through the points, which represent 10° zones over land and 15° zones over ocean (except for the high-latitude ocean zones 60°–80° N and 60°–70°S). The points are averages of all four seasons. Clear sky, fog, and cumulonimbus frequencies are plotted in the lower frames on an expanded scale. Gaps appear in most of the plotted values for land at 40°–60°S because the small amount of land there (less than 5%) often resulted in unrepresentative or meaningless zonal averages.

Hughes & Henderson-Sellers 1985 JCAM

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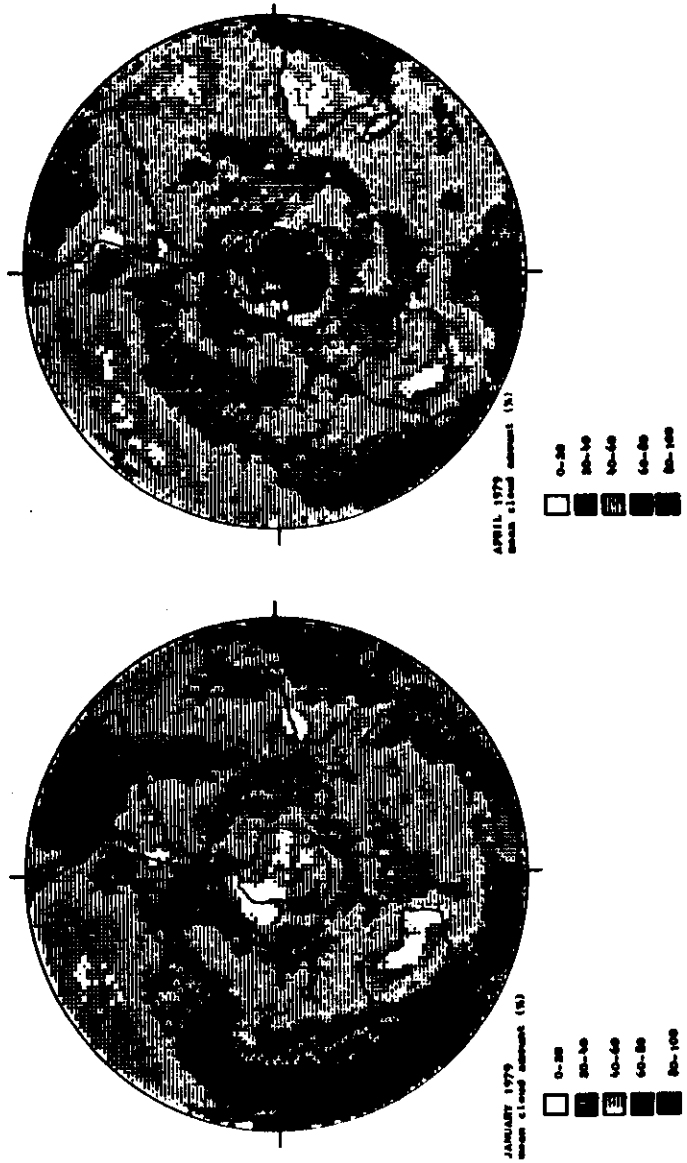

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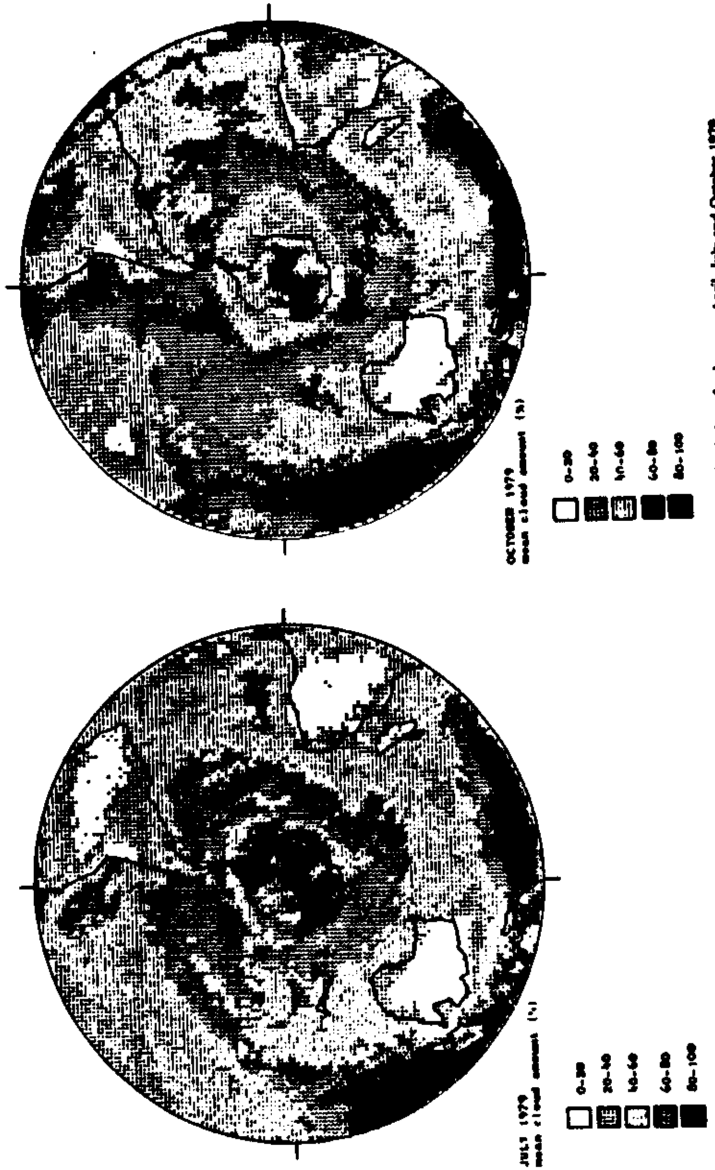

FIG. 2. (Continued) Monthly mean 3D-nephanalysis cloud amounts in the Southern Hemisphere for January, April, July and October 1979.

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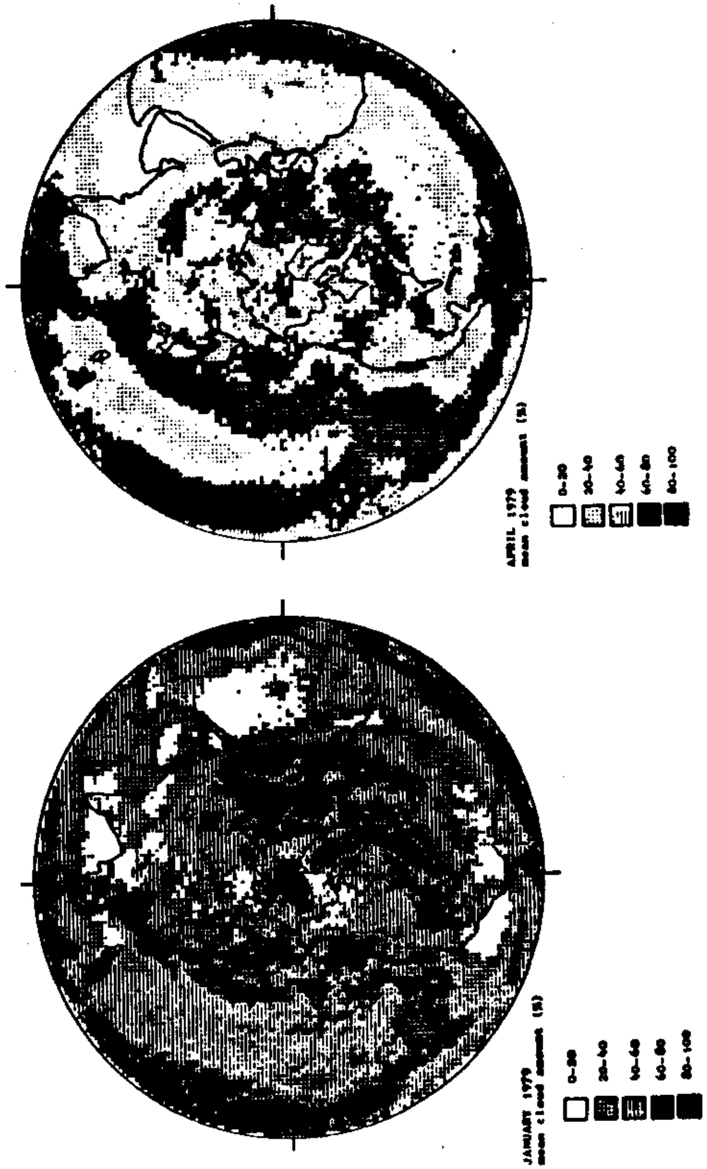

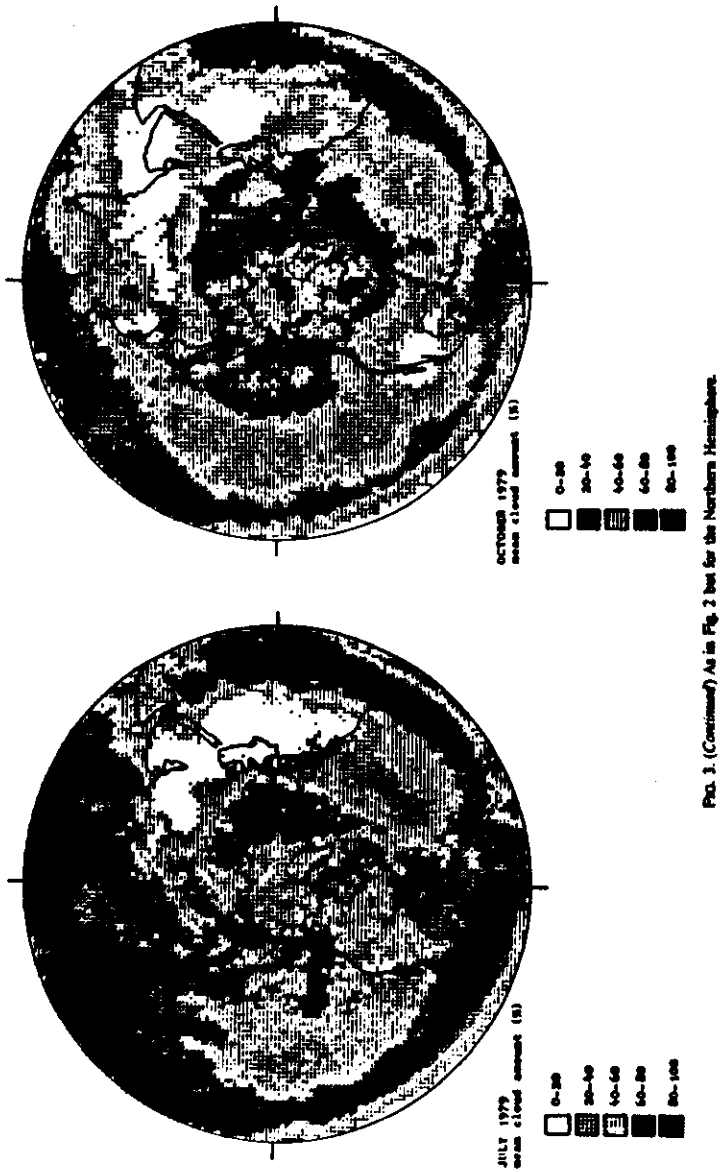

FIG. 3. (Continued) As in Fig. 2 but for the Northern Hemisphere.

Hahn 1982

Oceans

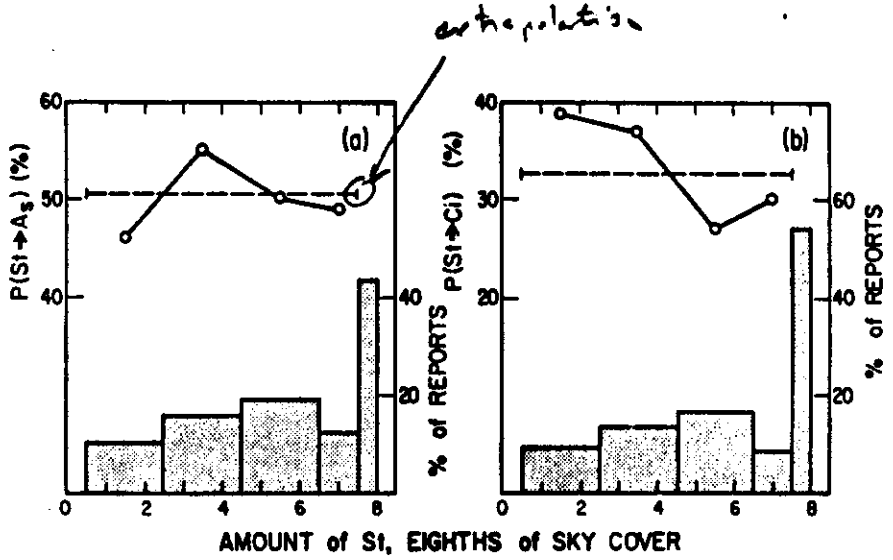

Fig. 1. Probability of occurrence of As(a) and Ci(b) with given amounts of St. Bars indicate the relative number of reports that contributed to each point. Dashed line represents the mean value of all reports contributing to the four points. (For Northern Hemisphere, MAM 1971)

Hahn 1982

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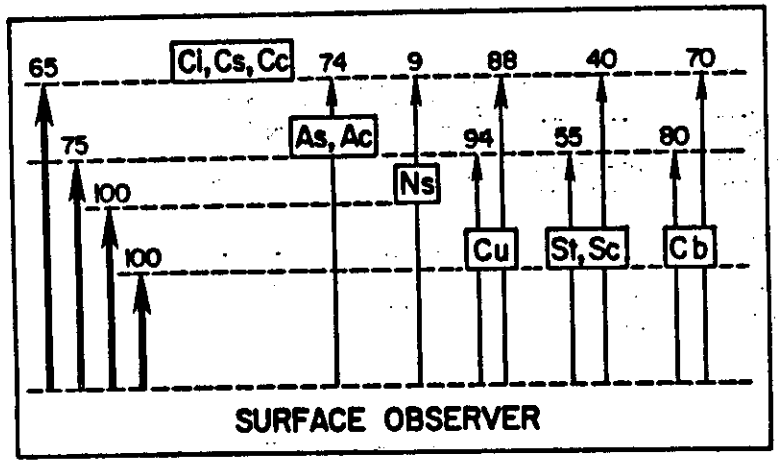

Fig. 2. Percent frequency with which observers reported upper levels seen through lower cloud types. Thick arrows on left give overall frequency of report of the *level* at head of arrow as seen through any (or no) lower cloud; on right is frequency of report of upper *levels* seen (whether an upper *cloud* was present or not) through particular lower cloud types. (Average of all seasons 1965–1976, global average).

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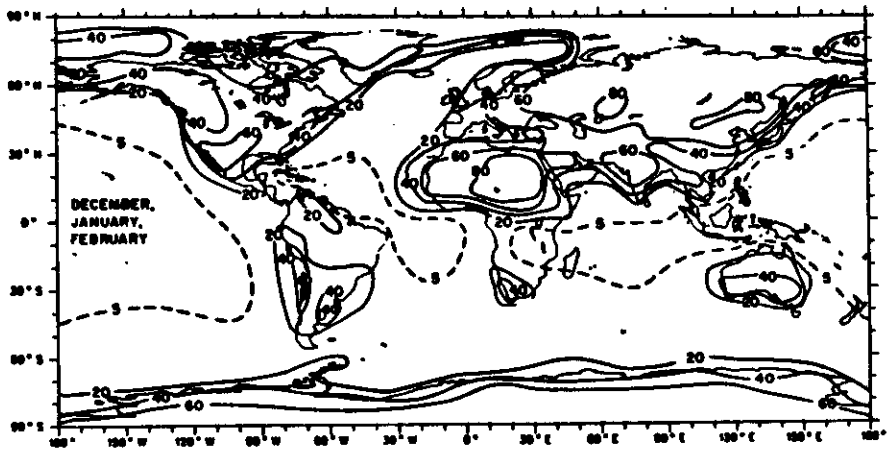
quantities, and which is discussed elsewhere (Hahn *et al.*, 1982, 1984).

If the contingency probability $P(A \rightarrow B)$ is greater than $f(B)$, then one may say that A and B tend to be meteorologically associated [whereas if $P(A \rightarrow B)$ equals $f(B)$, this means that B is just as likely to occur whether or not A is present]. The tables show for example that $P(As \rightarrow Ci)$ generally exceeds $f(Ci)$. These two types actually exhibit the strongest association of any two of the six types, particularly over the ocean. By contrast, As and Cu tend to be somewhat mutually exclusive. This is likely due to the fact



Given Ci/Cs/Cc, Probability (Percent) That No Other Cloud Is Present

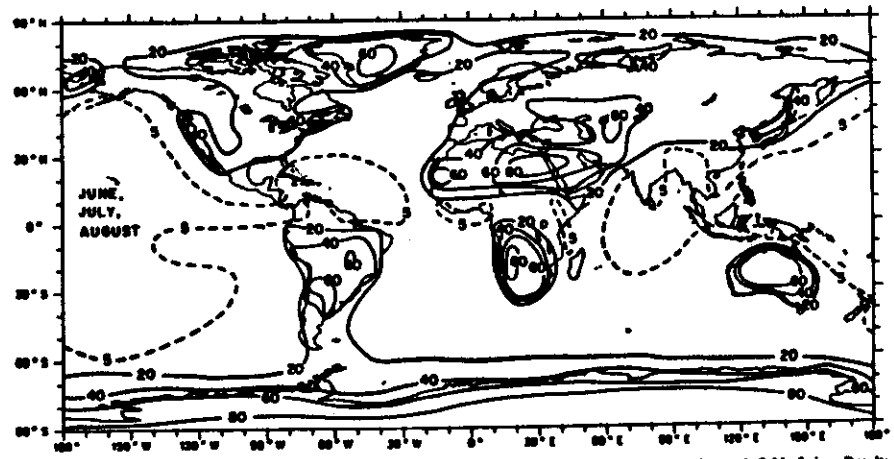


FIG. 2. Given that cirrus is present, this is the probability that no other cloud is present in the ground-observer's field of view. Results from Maps 12 of both the land and ocean atlases (Hahn *et al.*, 1982; 1984) were merged and contoured. Some smoothing of the point values was done for the purpose of contouring.

NORMAL MONTHLY TOTAL PRECIPITATION (Inches)