TITLE: Determination of Rainfall and Condensational Heating in the South Pacific Convergence Zone During FGGE SOP-1

RESEARCH INVESTIGATOR:

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SIGNIFICANT ACCOMPLISHMENTS IN FY-84:

One of the primary objectives of this research, which began 15 October 1983, is to evaluate the role of cloud-related diabatic processesin maintaining the structure of the South Pacific Convergence Zone, SPCZ, (see Fig. 1). The method chosen to evaluate the condensational heating is a diagnostic cumulus mass flux technique which uses GOES digital IR data to characterize the cloud population. This method requires as input an estimate of time/area mean rainfall rate over the area in question. Since direct observation of rainfall in the South Pacific is not feasible, a technique using GOES IR data is being developed to estimate rainfall amounts for a 2.5 degree grid at 12h intervals. This resolution is consistent with the FGGE data set.

Estimating rainfall from space-based sensors involves numerous problems which are a function of temporal and spatial accuracy required. Although passive microwave techniques measure raindrop-sized hydrometeors, current observations are too infrequent (at best every 12h) to rely on this method alone. Instead we have opted for an IR method which, although providing only indirect rainfall estimates, can provide the near-continuous temporal coverage required. Since convective cloud clusters dominate the portion of the SPCZ near the Equator, observations approaching 1h frequency may be needed.

To date, IR schemes owe much of their success to their ability to identify raining vs. non-rainning areas (Lovejoy and Austin, 1979 MWR). Only limited skill has been demonstrated in providing rain rates on the scale of a few hours. The method developed in the present study incorporates not only IR temperature as a predictor, but expansion of cold cloud top area, IR cloud top morphology and environmental precipitable water. The cloud top expansion factor is based on a "floating" threshhold 10 C0 warmer than the time-mean minimum cloud top temperature within a 5.0° radius of the location in question. This feature allows the detection of of embedded convection in baroclinic waves, a situation that previous anvil expansion techniques are not designed to handle. Cloud top morphology in the form of the Laplacian of the temperature is used to identify regions of overshooting cells. Since the SPCZ extends from tropical to mid-latitude regions, the moisture available for precipitation production may vary considerably, even though the convective cloud structures may appear similar. To account for this, environmental precipitable water is used as an additional predictor.

During the first three months of this project a survey of existing IR and visible rainfall estimation techniques was conducted and the current methodology adopted. It was decided to develop the regression model on a set of hourly raingauge data in coastal regions of the U.S. and island stations in the western Pacific. Selection of cases was limited to those in which rain was produced by maritime synoptic systems moving on-shore. Both middle latitude baroclinic waves and convective disturbances in tropical air masses were included. At this time approximately one-half of these cases have been processed to derive the required statistical parameters.

CURRENT RESEARCH FOCUS:

Present work involves completing the tabulation of the data base required to develop the regression model. In the remainder of FY-84 we will 1) complete the statistical data base, 2) test an independent data set of varying synoptic regimes to demonstrate the generality and transferability (from one climate to another), 3) apply the scheme to the SPCZ region and 4) use the cumulus mass flux method along with the estimated precipitation to determine condensational heating in the SPCZ.

PLANS FOR FY-85:

The tasks for FY-85 include:

1) Application of the analysis to the full extent of the South Pacific Ocean and diagnosis of the corresponding heating.

2) Comparison of the satellite-derived precipitation to that obtained through moisture budgets constructed with the FGGE data base.

3) Application of the heating estimates to diagnosing energy transformations and frontogenetical forcing involved in maintaining the SPCZ.

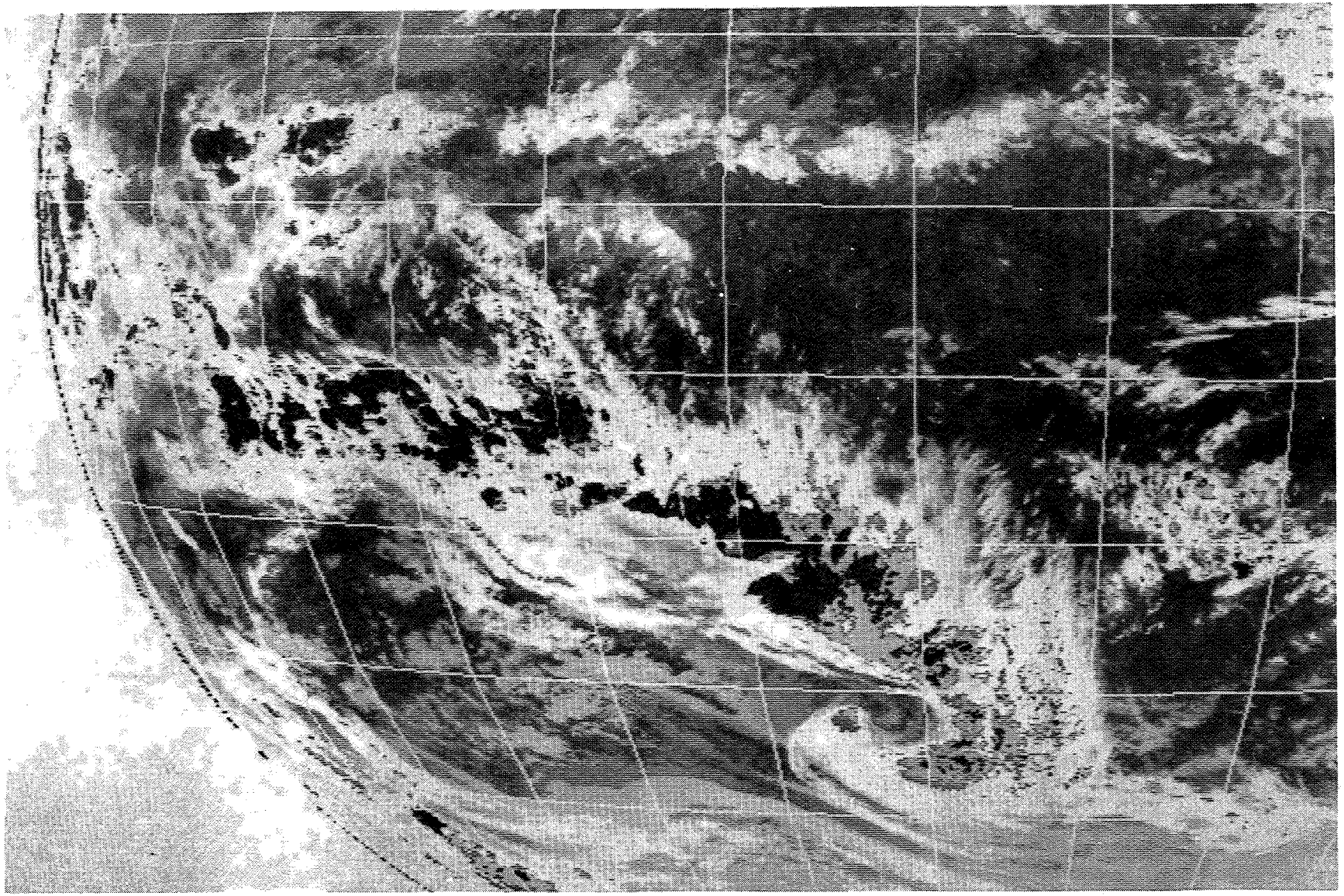

Figure 1. GOES West image at 1815Z 12 January 1979 showing the extent of the SPCZ cloud band. The image has been enhanced to emphasize the predominance of deep convection in the tropical portion and the existence of baroclinic waves at higher latitudes.