TITLE SEARCH FOR SOLAR SIGNALS IN GOES IMAGERY
and
CLOUD CLIMATOLOGY ANALYSIS

PRINCIPAL INVESTIGATOR RALPH J MARKSON
AIRBORNE RESEARCH ASSOCIATES, INC
46 KENDAL COMMON ROAD
WESTON, MASSACHUSETTS 02193
(617) 899-1834

A SIGNIFICANT ACCOMPLISHMENTS TO DATE IN FY-84

I GOES COMPUTER IMAGE ANALYSIS SYSTEM

Our project involves digitizing and analyzing 16 mm GOES IR imagery (Northern Hemisphere--1/2 hour resolution) to identify spatial and temporal variations in the clouds which may be related to solar variability Inherent in the investigation is a cloud climatology analysis For diagnostic purposes we initially have been examining diurnal variations

During the past year an Interactive Graphics Package (IGP) has been added to our Computer Image Analysis System (CIAS) The overall system now includes (1) a 16mm analyst projector which projects an image into, (2) a G E video camera with a 128 X 128 charge injection device array to digitize the image, (3) a custom built interface which controls the digitized image transfers to the direct memory accesss of the PDP-11/23 computer, (4) a dual double density disk drive, (5) a Raster Technologies monitor controller, (6) a VT 103 video terminal which encases the PDP-11/23 CPU (7) a Conrac color video monitor (8) a Digipad 5 graphics tablet with 16 function button cursor (9) an IDS Prism dot matrix printer, (10) and a Tektronix oscilloscope which is used for previewing pictures from the G E camera

The IGP was designed by three of the personnel responsible for the hardware and software at the MCIDAS facility at the Air Force Geophysics Lab (AFGL· Hanscom Field Bedford, Massachusetts The software that was developed contains many features that have been quite useful in analyzing the GOES imagery One of those is the ability to display up to 4 images at a time on the Conrac monitor The 4 images may be viewed simultaneously or individually while zoomed to 2, 4, or 8 times their normal resolution A single button enables the programmer to step through each picture creating a miniature movie loop effect A rectangular cursor can be sized to any dimension and moved to any location in the monitors display area by either program control or by the 16 function button cursor and the Digipad 5 cursor tablet The mini array can then be read back into the DEC PDP-11/23 to be analyzed The intensity level of specific pixels may be read quickly using a cross hair pointer controlled by the cursor and tablet A color enhancement program enables the programmer to set up as many as 64 intervals of different colors

II VERIFICATION OF THE SYSTEM AND INTERIMAGE NORMALIZATION

Using the current CIAS we redid our original pilot study using Western GOES data which had been done by hand This was an analysis of overall light intensity variations in six 10 degree square boxes across the intertropical convergence zone (ITCZ) during our test period (May-July 1976) The ability to reproduce the origional analysis was a criterion that the CIAS was working properly Initially 2 different analyses were performed on the stored data, the first

examined the thresholded average intensity levels of each of 6 boxes in the ITCZ, the second examined the percentage of clouds greater than a threshold value in each area

In both analyses the time of occurance of minimum intensity in boxes 1 - 6 follows local time from east to west across the Pacific This is an important result implying that we are measuring real changes in the clouds and not artifacts arising from the preparation of the film data base or analysis procedures (which affect all areas of the image simultaneously) Anomalies occuring at 0515 and 1015 UT, apparent universal time variations, (i e , simultaneous brightness changes in all the boxes) are probably not representative of real phenomena but arise from the way the films were produced

Similarly, the data at times have discontinuous variations between frames A special series of analyses were conducted to determine a method for normalizing the data First, changes of intensity in the white border surrounding the images were studied Intensity variations of less than 1 % were found, implying that the film was overexposed in the outer border and therefore not sensitive to the fluctuations observed in the global part of the image Next an analysis was made of the darkest 5 % of pixels in an eastern mid-latitude area of the global image The assumption was that at least that percentage of the area should be cloud free at all times, and therefore the intensities that are observed should be representative of the ocean (which is assumed to be at a constant temperature for periods of at least several days) Variations observed in the mid-latitude band were highly correlated with the sudden discontinuities in intensity observed in the ITCZ The discontinuities are non-linear with intensity, i e the greater the intensity, the smaller the change Using this information a curve will be determined which will normalize the light intensity variations between images This is necessary before proceeding with additional analysis

III PRELIMINARY ANALYSIS OF UNNORMALIZED DATA

Preliminary correlations of the GOES images have been made between what is assumed to be the most important solar modulated parameter, the Cosmic Ray Index (CRI), as well as the Vorticity Area Index (VAI), which has been reported to vary with aspects of solar variability Our results indicate a significant relationship between the changes in CRI to the changes in GOES intensity levels in all 6 boxes for one of the 3 test months The high noise levels that are the result of intensity discontinuities may be responsible for the lack of similar results in the other 2 test months or this result may be a statistical accident Once a normalization curve has been determined and used to improve the data, the correlations will be recalculated Needless to say, if the possible relationship between cosmic radiation and cloudiness is real, this would be of considerable significance

Spatial and temporal autocorrelations which were performed on the GOES imagery showed decreasing correlation as the lag times increased as would be expected

B FOCUS OF CURRENT RESEARCH ACTIVITIES

Currently we are working on developing normalizing proceedures that will minimize the noise levels previously discussed Once this is accomplished we will expand our data base from 3 months to 1 and then 3 years and proceed with the analyses of various measures of solar variability versus the spatial and temporal changes in clouds (particularly deep convection)

In conjunction with Prof Peter Stone head of the Center for Meteorology and Physical Oceanography at MIT who has provided support for a student, we are putting the CIAS to use in a new project This is to relate variations in ionospheric potential (from aircraft and balloon measurements) to tropical convection (as determined by the CIAS) Since this convection drives the Hadley Cell (and thus the general circulation), and since the deep convection in the tropics is probably correlated with ionospheric potential, this research may lead to a means of quantifying the driving force for the general circulation with fine time resolution through ionospheric potential measurements as well as through analysis of satellite imagery

C PLANS FOR FY-85

We hope in 1985 to expand our data base to include imagery from the Eastern GOES (which we already have acquired) plus the European METEOSAT, and the Japanese weather satellite in a continuation of the investigation

D RECOMMENDATIONS FOR NEW RESEACH

The possibility of measuring the Hadley Cell intensity through analysis of satellite imagery and testing whether ionospheric potential measurements can be used for this purpose is recommended as an extension of the ongoing project

E LIST OF PUBLICATIONS PREPARED SINCE JUNE 1983 by Ralph Markson

1 Comments on Measurement of the Global Circuit and the Hy-Wire Potential Variations at Wallops Island, J Geophys Res , 89 (in press)

2 Measurement of the Global Circuit, to be presented at VIIth International Conference on Atmospheric Electricity, Albany, N Y , June 1985 (preprint form now--to be published)