Investigations of Arc Cloud Lines

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Research Objectives

This research is designed to provide in depth understanding of the natural mechanisms that lead to the development of deep convective storms through the integration of rapid scan satellite data with research aircraft observations. Previous research has shown that arc cloud lines and their associated convective scale interactions are of primary importance in determining the development and evolution of deep convection. In order to bring into sharper focus the dynamical and thermodynamical features of these arc clouds and convective interactions that lead to the development of deep (and often severe) convection, research aircraft flights were undertaken in Florida in the late summer of 1983. The aircraft measurements were designed to provide detailed air motion and thermodynamic data near and within the arc cloud line region at the same time GOES rapid scan data was being taken.

Significant Accomplishments

Seven research flights were made on five separate flight days. Each flight lasted between three and four and one half hours. On all but one of the flights, well-defined arc cloud lines were encountered, and penetrations were made within the density surge line (DSL) region from approximately 120 meters AGL to 650 meters AGL.

Preliminary inspection of the data (support was provided only for the flight phase) indicates:

1) Arc cloud lines are important in both the (a) production of convergence and vorticity, and (b) in the interaction with intense thunderstorms which may act to trigger tornado activity.

2) The lateral extent of the vertical motion field compared to the cloud scale indicates that the main driving force for the initial cloud development along the arc-line is controlled by the thunderstorm outflow (s) interacting with the convectively unstable air of the environment. The individual cumulus cloud scale motions along the arc line can then be visualized as being superimposed on this somewhat larger-scale, initiating process.

3) Arc cloud lines and their associated DSL region can pose extreme hazards to aircraft operations. Depending on aircraft speed prior to its descent into the DSL, the loss of relative flow across the wing in the DSL can cause critical sink rates which may lead to an aircraft accident.

4) An arc cloud line's major threat to space shuttle operations lie in its ability to generate new thunderstorm activity along the shuttle glide path in time frames that occur after the decision for reentry has been made. Additionally, lateral wind shears across the runway could exceed shuttle landing requirements in either an arc cloud DSL environment or the environment of the thunderstorm it might have triggered.

Future Plans

1) Funding is needed to analyze the data sets so that the preliminary results indicated above may be quantified and the various convective scale interactions better defined.

2) The meteorological community is coming to realize the importance of outflow (arc cloud lines) in the production of rainfall as well as tornadic storm development. Scientists have proposed that the NASA Convair 990 equipped with a doppler lidar be used to investigate outflow and arc cloud lines. Our past experience in arc cloud investigations, as well as our ability to place an in situ platform in the region being sampled by the doppler lidar should be utilized in such an effort.

3) Investigations such as these should be included as a major part of SPACE.

List of Publications - "Conference"

Sinclair, P.C. and J.F.W. Purdom, 1984: Aircraft penetrations of arc cloud lines, 1st Conference on Satellite Meteorology/Remote Sensing and Applications, Clearwater, FL, Amer. Meteor. Soc., June 25-29, 4 pp.