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TITLE: Tropical Pacific Moisture Variability

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RESEARCH OBJECTIVES:

1. To describe synoptic scale variability of moisture over the tropical Pacific Ocean and the systems leading to this variability.
2. To implement satellite analysis procedures to accomplish (1).
3. To incorporate additional satellite information into operational analysis/forecast systems at NMC.

SIGNIFICANT ACCOMPLISHMENTS IN FY-88/89:

JPM spent eight months of FY-88/89 at NMC's Development Division under joint sponsorship of UCAR/NMC/NASA; this leave stretched out funding of the NASA contract with concomitant reduction in effort.

1. Modification of NMC models with satellite data. Composite satellite radiance patterns describe features detectable well before the development of synoptic scale tropical plumes. These typical features were extracted from historical files of TOVS radiance observations for a pair of tropical plumes which developed during January 1989. Signals were inserted into the NMC operational medium range forecast model and a suite of model integrations were conducted. Many of the 48 h model errors of the historical forecasts were eliminated by the inclusion of more complete satellite observations.

2. Satellite radiance analysis. Three studies progressed:

a. Fink completed an analysis which blended TOVS moisture channels, OLR observations and ECMWF model analysis to generate fields of total precipitable water comparable to those estimated from SMMR μ -wave observations. This study demonstrated that a 10 y climatology of precipitable water over the oceans is feasible, using available infrared observations (OLR and TOVS) and model analysis (ECMWF, NMC or similar quality). The estimates are sensitive to model quality and the estimating model must be updated with operational model changes.

b. Coe developed a set of tropical plume and ITCZ composites from TOVS observations, and from NMC and ECMWF analyses which had been passed through a radiative transfer model to simulate TOVS radiances. The composites have been completed as well as many statistical diagnostics of individual TOVS channels. Analysis of the computations is commencing.

c. Chung has initiated a study of the differences between TOVS observed vapor structure during ENSO (1983) and non-ENSO (1984) years. Preliminary diagnosis demonstrates gross moisture changes between warm and cold sea surface temperature episodes.

3. Tropical plume mechanisms.

- a. Askue constructed a shallow-water model to measure barotropic tropical wave interaction. We hypothesized that tropical plumes, as described by TOVS radiance composites, could result from instabilities associated with wave-wave interaction. Although plume-like wave growth could be induced, instability due to triad interaction or linearized wave-wave interaction is not sufficiently vigorous to explain completely plume evolution.
- b. Lee is nearing completion of an energetics study to describe plume behavior and environment in ENSO and non-ENSO years with both ECMWF and NMC analyses. Instability processes are different in the two analyses, although gross environmental behaviors are similar. Important differences are associated with the steady equatorial convection of ENSO events.

FOCUS OF CURRENT RESEARCH AND PLANS FOR FY 90/91:

This year's focus will continue to be the understanding and utilization of satellite radiance data, directed particularly at the moisture fields of synoptic-scale systems, a problem currently not well understood. An additional focus is the modelling and understanding of tropical synoptic scale dynamics, as revealed from the last six years of satellite data analysis.

1. The NMC model diagnosis, Coe's composited radiation simulation, and Lee's energy study will be completed.
2. Chung's study of moisture structure over the Pacific Ocean and its observation and statistical properties will continue throughout the year. More tasks may be initiated if additional Air Force graduate students are identified.
3. Three modelling studies will be initiated, or continued:
 - a. A global barotropic model, with a realistic 200 mb basic state will be initialized with typical divergent forcing to trigger tropical plumes.
 - b. The same model will be run with ENSO-like basic state to examine tropical plume suppression and Walker circulation dynamics.
 - c. The barotropic model will be used as the basis for a baroclinic model to attempt to develop tropical plumes without arbitrary forcing.

PUBLICATIONS (since July 1989):

Refereed:

McGuirk, J.P., and D.J. Ulsh, 1989: Evolution of tropical plumes in VAS water vapor imagery, Mon. Wea. Rev. (To be published, August 1990)

Presentations:

McGuirk, J.P., J.R. Schaefer, D.E.W. Smith and G.A. White, 1990: Effects of satellite observational characteristics of EOF structure, AMS 11th Conf. on Probability and Statistics in Atmospheric Sciences, Monterey CA, October, 1989.

_____, and D.E.W. Smith, 1990: TOVS channel radiances as a "ground truth" for ECMWF analysis, AMS 5th Conf. on Satellite Meteorology and Oceanography, London, September 1990.

_____, 1990: Use of satellite-derived spatial patterns in synoptic-scale numerical forecasts, op. cit.

Theses/ Dissertations:

Askue, C.A., 1989: Barotropic mechanisms associated with tropical plume formation, Ph.D., 188pp.

[Totaling 7 refereed publications, 31 conference papers, 10 MS. theses, 4 Phd. dissertations under 7 yrs. of NASA sponsorship, commencing April 1983.]

