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.
4. To synthesize knowledge gained from satellite observations through diagnosis and numerical models.

SIGNIFICANT ACCOMPLISHMENTS IN FY 90/91:

1. <u>Satellite data analysis.</u> Three significant tasks were accomplished this past year. Additionally, a nearly complete study of the accuracy of ECMWF and NMC tropical analyses compared to observed satellite radiance fields has been put on hold while its author was assigned to Operations Desert Shield and Desert Storm.

   a. Comparisons of upwelling radiance fields for 1983 and 1984 were completed for the purpose of testing the sensitivity of water vapor/ greenhouse feedback to local sea surface temperature variations.

   b. The interaction between tropical plumes, wave features over Central America, travelling waves in the upper tropospheric tropics and the tropical interseasonal oscillation was examined in OLR and TOVS tropopause level channels. Generally, little interaction occurs between these features (Winton's thesis).

   c. Planning and early efforts on construction of a model and infrared based climatology of daily precipitable water are completed. Methodology includes the split window technique, differential absorption, statistical regression and sensitivity testing using radiative transfer models.

2. <u>Tropical plume mechanisms.</u> Satellite data have been used over the last several years to improve classical diagnosis and modelling of tropical synoptic systems.

   a. Computations of the kinetic energy budget over a limited domain surrounding tropical plumes and for a global tropical strip reveal that global barotropic mechanisms and tropical-midlatitude interactions increase significantly, particularly at synoptic scales, when tropical plumes erupt in only a limited domain. NMC and ECMWF analyses are not adequate to resolve baroclinic mechanisms within plumes.

   b. A barotropic model, developed to examine wave-wave interaction of tropical normal modes, has been extended to run with a realistic upper tropospheric basic state. Forcing, simulating midlatitude troughs and surges in the tropical Walker circulation, generates many of the

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observed features within tropical plumes. Pressure-work terms dominate the development, but the atmospheric source of the work term cannot be identified in a barotropic model.

c.   Results of integrations of the NMC Medium Range Forecast Model, using satellite enhanced initial conditions demonstrate the sensitivity to the basic state of the evolution of tropical synoptic scale waves. In two cases, tropical plume and vortex evolution were predicted more realistically using additional available TOVS observations. Model performance was improved only when the moisture field was adjusted in conjunction with height/temperature changes.

FOCUS OF CURRENT RESEARCH AND PLANS FOR FY 91/92:

1. Full documentation of tropical plume mechanisms   (2a, 2b, and 2c) will take most of the next 6 months.

2. Barotropic model development and experimentation will continue. Design of a realistic El Nino-type basic state has commenced to examine ENSO/non-ENSO differences. Linearized and two-layer baroclinic versions of the model will be developed to resolved tropical plume mechanisms more precisely.

3. The major focus will be observation and analysis of tropical moisture fields from space. Item 1c above will near completion. Results will be a better understanding of the sensitivity of satellite infrared observations to tropical moisture fields and the reconstruction of historical precipitable water fields for comparison with SSM/I and future data sets.

4. Aspects of WetNet research (by McGuirk and Zipser) will be merged to examine the synoptic structure of tropical systems (plumes and cold surges) as viewed by SSM/I-derived moisture fields.

PUBLICATIONS (since August 1990):

Refereed:

McGuirk, J.P., and D.J. Ulsh, 1990: Evolution of tropical plumes in VAS water vapor imagery, Mon. Wea. Rev., 118, 1758-1766.

Presentations:

McGuirk J.P., and D.E.W. Smith, 1990: TOVS channel radiances as a "ground truth" for ECMWF analysis, Accepted for 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.

_____, 1991:   Long term climatology of precipitable water from space, WetNet Science and Analysis Colloquium, Santa Barbara, February 1991.

-----, 1991: Transient tropical-extratropical interaction observed and simulated in a barotropic model, Accepted at the IUGG/IAMAP Symposium on Large-Scale Atmospheric Flow and Variability, Vienna, Austria, August 1991.

-----, 1991: Improved satellite signals in tropical forecasts in the NMC Medium Range Forecast Model, submitted to the AMS 9th Conf. on Numerical Weather Prediction, Denver, October 1991.

-----, K.G. Blackwell and Y. Zhang, 1991: Divergently-forced transient tropical response in a shallow water model with a realistic basic state, submitted to the AMS 8th Conf. on Atmospheric and Oceanic Waves and Stability, Denver, October 1991.

Theses/ Dissertations:

Blackwell, K.G., 1990: Transient synoptic forcing of tropical plumes in a barotropic model with a realistic basic state, PhD., Texas A&M Univ., 269pp.

Lee, J.G., 1991: Comparative tropical synoptic scale kinetic energy budgets, PhD., Texas A&M Univ., (August 1991).

Winton, S.E., 1991: Eastern Pacific and Central American tropical systems as viewed from satellite, MS., Texas A&M Univ., (August 1991).

[Totaling 7 refereed publications, 35 conference papers, 11 MS. theses, 6 PhD. dissertations under 8 yrs. of NASA sponsorship, commencing April 1983.]