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

**SIGNIFICANT ACCOMPLISHMENTS IN FY 91/92:**

1. Satellite forecast applications.

A case study in which additional signals were extracted from TOVS and inserted into the NMC Global Spectral Model is complete. A report has been submitted to NMC for evaluation and a manuscript has been submitted for publication. The key results are that modest improvements in tropical analysis and forecasting on the synoptic scale can be achieved by making use of horizontally coherent temperature and moisture signatures currently available in operational TOVS observations.

2. Satellite data analysis.

i. A draft of a thesis by Fink intercomparing SMMR, TOVS, OLR and ECMWF estimates of tropical oceanic column precipitable water is being prepared for publication. The key results are that infrared observations have a positive impact on estimated precipitable water by ECMWF analysis, even when moisture retrievals from TOVS are used as estimators in the ECMWF analyses. The infrared information is merged with ECMWF through simple regression and the results are compared with SMMR estimates (assumed as a ground truth). Negative results are that most of the predictability seems to appear on the large scale in association with climatological features. Impact on analyzed synoptic structure appears to be minimal.

ii. Fink's study is the basis for extending interpretive analysis of infrared precipitable water estimation. A study has been initiated using many of the TOVS channels (including MSU, window channels, and channels in the 14 micron band) to estimate precipitable water. Sensitivity of precipitable water to sea surface temperatures and atmospheric stability is also being considered. A new data set is being used and ground truth will be raobs and SSM/I estimates. At this point, planning is complete and two tasks have been completed:

- a. A radiative model has been used to define and quantify the sensitivity of numerous TOVS channels to vertical moisture structure.
- b. Data sets of several hundred pairs of observations have been constructed for collocated SSM/I-TOVS observations, TOVS-Raob observations and SSM/I-Raob observations.

Interpolations of OLR and ECMWF fields are also being prepared.

### 3. Tropical plume mechanisms.

iii. Interpretation of the kinetic energy calculations of Lee is continuing. He has computed kinetic energy budgets comparing 1983 (El Nino) and 1984 (El Nino cold phase) in both the NMC and ECMWF analyses. He intercompares regional energetics over the eastern Pacific during tropical plume events and hemispheric wide tropical spectral energetics. He finds systematic biases in the two analyses which change as climate conditions (El Nino) change. Local random wind differences exceeding 20 m/s occur almost daily. Important findings are:

- a. During ENSO, source regions of KE move dramatically.
- b. During plume events, barotropic and baroclinic processes suggest stability, although locally, generation of KE by cross contour flow is large.
- c. Spectrally, planetary waves dominate, especially during ENSO. During most plume events, there is a transfer of KE from the planetary scale to the synoptic scale.

iv. Development of a spherical global model and a two layer baroclinic model, appropriate for tropical plume diagnostics and study of tropical/extratropical interaction continues. Tropical plume simulation during ENSO continues. There are no results yet beyond Askue's modelling of normal mode interaction and Blackwell's modelling of tropical plumes forced by subsidence.

### **FOCUS OF CURRENT RESEARCH AND PLANS FOR FY 92/93:**

1. Completion of the prediction of precipitable water from ECMWF analysis and infrared observations is anticipated (ii above). The long range goal is to document a technique for retrieving daily precipitable water fields for the decade of the 1980's from infrared based techniques. From 1987 onward, SSM/I has solved much of this problem (except vertical moisture structure and structure between tropical DMSP passes).

2. We anticipate revisiting the estimation of TOVS radiances from ECMWF and NMC analyses. This procedure is to be used as a diagnostic tool of the operational analyses.

3. Finally, interpretive modelling of tropical mid latitude interactions with barotropic and simple baroclinic models will continue (item iv). Expected results are a description of the interaction of baroclinic and barotropic fields in synoptic systems forced diabatically. Also of interest is the correspondence between satellite observations (OLR, TOVS 11 and 12, and SSM/I fields) and dynamically predicted quantities in simple models (related to focus 2).

**PUBLICATIONS (since July 1991):**

Refereed:

McGuirk, J.P., 1992: Impact of increased TOVS signal on the NMC global spectral model: A tropical plume case study, submitted to *Weather and Forecasting*, April 1992.

\_\_\_\_\_, and J.D. Fink: Tropical precipitable water estimates from SMMR, TOVS, OLR and ECMWF analysis, to be submitted to *J. Applied Meteorology*, July 1992.

Blackwell, K.G., and J.P. McGuirk, 1992: Sensitivity of TOVS moisture channels to upper tropospheric moisture, to be submitted to *J. Applied Meteorology*, August 1992.

Presentations:

-----, 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:

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., (December 1991).

[Totaling 10 refereed publications, 35 conference papers, 11 MS. theses, 6 PhD. dissertations under 8 yrs. of NASA sponsorship, commencing April 1983.]

