

H4. SMR/1247
Lecture Note: 15

**WORKSHOP ON PHYSICS OF
MESOSPHERE-STRATOSPHERE-TROPOSPHERE
INTERACTIONS WITH SPECIAL EMPHASIS ON MST
RADAR TECHNIQUES**

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**PROBING THE TROPICAL ATMOSPHERE:
WIND OBSERVATIONS**

Prof. K. S. Gage

National Oceanic and Atmospheric Administration (Noaa)
Aeronomy Laboratory
Boulder, Colorado
United States of America

Probing the Tropical Atmosphere: Wind observations.

Lecture Notes:

This lecture contains highlights of Pacific profiler observations made with the NOAA/CU Trans-Pacific Profiler Network. Most of the observations are drawn from over a decade of observations with the 50 MHz profiler at Christmas Island. Zonal wind variability shows a clear annual signal and interannual variability related to the Southern Oscillation. Meridional winds show mostly southward winds that are strongest when the ITCZ is well developed to the north of Christmas Island. Vertical motions are for the most part downward except near the tropopause and when convection is active during ENSO warm events. Some evidence of equatorial waves is also seen in observations at Christmas Island.

1. Trans-Pacific Profiler Network (TPPN):

The Trans-Pacific Profiler Network was constructed in the late 1980's and early 1990's to provide wind observations from a data sparse region of the equatorial Pacific. The TPPN is comprised of sites that span the equatorial Pacific: Biak, Indonesia; Manus Island, PNG; Nauru, Tarawa, Kiribati; Christmas Island, Kiribati; San Cristobal in the Galapagos Islands of Ecuador; and Piura, Peru. 50 MHz profilers are located at Biak, Indonesia; Christmas Island and Piura. 915 MHz profilers are located at Biak, Manus, Nauru, Tarawa, Christmas Island and San Cristobal.

Near real time observations from the TPPN are transmitted via geostationary satellite and placed on the GTS for global distribution. The observations are used in analyses and forecasts of centers such as NCEP and ECMWF. More complete data are recorded on site and mailed back to the Aeronomy Laboratory for processing and archival.

2. Zonal Wind Variability and ENSO as seen from Christmas Island:

A clear annual signal is seen in the zonal winds observed at Christmas Island. Lower tropospheric easterlies are present most of the time but upper tropospheric westerlies are observed during northern winter. This annual cycle is modulated by ENSO. The upper tropospheric westerlies are most pronounced during cold events and are very weak during warm events. As a consequence the 'envelope' of zonal winds through the troposphere show a clear ENSO signal. Multiple height time series of zonal winds show strong shear during cold events and weak shear during ENSO.

3. Meridional Winds seen at Christmas Island:

Meridional winds observed at Christmas Island exhibit an annual cycle and a distinct vertical structure that varies through the year. Meridional winds are characterized by northerlies in the upper troposphere consistent with the local Hadley circulation associated with the ITCZ that lies to the north of Christmas Island. The northerlies are strongest in the May - October time period when the ITCZ is most active. There is also a secondary maximum in northerlies observed at Christmas Island in the 4 - 6 km height range. These northerlies are also quite pronounced during the same time period when the ITCZ is most pronounced north of Christmas Island.

4. Vertical Motions observed at Christmas Island:

Vertical velocities observed at Christmas Island show a long-term subsidence of a fraction of 1 cm s^{-1} . The magnitude of the subsidence is about what is required to balance radiational cooling to space. There is also evidence of a diurnal cycle in the vertical motions that can be characterized by strongest subsidence at night. Above about 14 km the vertical motion becomes upward and maximizes near the tropopause. The magnitude of the vertical motion requires a heat source near the tropopause which could be accounted for if subvisible cirrus is common at the tropopause.

5. Comparisons of Observations with Analyses and Reanalyses:

Comparisons of observed winds at Christmas Island with the NCEP and ECMWF analysis/reanalysis products show good agreement and improvement after the profiler winds are included in the analyses. Zonal winds appear to agree well at all heights but there are important differences that show up in the lower troposphere. It appears that the analyses do not simulate the tropical boundary layer very well at least over the central equatorial Pacific.

6. Equatorial Waves Observed in Profiler Observations

Both Kelvin waves and Mixed Rossby Gravity waves have been identified in Christmas Island winds. As expected the zonal winds exhibit the Kelvin wave behavior and the meridional winds exhibit the mixed Rossby gravity wave behavior.