Marine Boundary-Layer and Cloud Analysis Using the ESRL EPIC/VOCALS East Pacific Ship Observation Database

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Results from NOAA Cruises

• PACS/EPIC 1999-2004 Enhanced Monitoring
  – 9 cruises
  – 6 cruises
• VOCALS 2008 REALLY big field program
Fig. 1. Annual mean climatology of downward surface radiation (W m\(^{-2}\)) from SRB satellite observation (top), CFS CMIP simulations (middle), as well as their differences (bottom).
“If you get the clouds right, chances are you get the feedbacks right” – John Mitchell, Chair WCRP Working Group on Coupled Modeling

OBSERVATION APPROACHES

• DOE/ARM CART sites: surface-based measurements, cloud profiling – comprehensive, expensive & a few fixed LAND sites

• Intensive ship-based field campaigns: similar to ARM but short duration – comprehensive and expensive
  – Example: Tropic Eastern Pacific PACS/Monitoring project
  – 1999-2004
  – Fairall et al. 2007

• Buoys
  – Much better spatial distribution/sampling
  – Full annual cycle
  – Much more limited in measured variables
  – Cronin et al. 2006a, 2006b
Observation Systems
Air-sea Fluxes, Clouds, Precipitation

Cloud Radar and Microwave Radiometer
Measurement Systems for Stratus Cruises

<table>
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<tr>
<th>Instrument/Variable</th>
<th>Oct 01</th>
<th>Nov 03</th>
<th>Dec 04</th>
<th>Oct 05</th>
<th>Oct 06</th>
<th>Oct 07</th>
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<td>X</td>
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<td>X</td>
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<td>Sonde</td>
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PACS:
Spring 2000-2002
Fall 1999 - 2004

Cruise Tracks

Creation of Synthesis Data Sets:

- PACS/EPIC 1999-2004 Enhanced Monitoring, 10 cruises
  - Flux, Microwave, Ceilometer data in 3 separate files
  - Software to read, merge, process, plot the files

  - Merging already done for list of spiffy variables
PACS Synthesis Examples
ftp://ftp.etl.noaa.gov/user/cfairall/EPIC/epicmonitor/combined_files
PACS
October heat fluxes
95 & 110°W

- Model
- TAO buoy
- CORE (1984-2004) [Large and Yeager 2004]
- NOAA ship observations (1999-2002) [Fairall et al. 2008]
Stratus Synthesis Data
http://psd.etl.noaa.gov/psd/psd3/synthesis/

• Fall 2001, 2003-2007 (6 years) 20°S, 75-85°W.

• **Observe:** (10-min or Hourly time resolution)
  – Surface meteorology
  – Turbulent and radiative fluxes
  – Cloud vertical structure: top, base, and LCL.
  – Rawinsonde profiles
  – Column water vapor and liquid water path
  – Aerosols

• **Assess fluxes from ground**
Stratus Example: Buoy IR Flux Observations Used to Deduce Cloud Fraction

\[
\text{CloudFraction} = \frac{Rl_{\text{meas}} - Rl_{\text{clear}}}{Rl_{\text{overcast}} - Rl_{\text{clear}}}
\]
Stratus
October
heat fluxes
20°S

Model

WHOI ORS buoy
WHOI (1984-2002)
analysis
CORE (1984-2004)

NOAA ship observations