VOCALS Winds, Clouds and the Surface Heat Budget

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Ocean Vector Winds Science Team meeting

Boulder, CO
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7 years of Stratus/VOCALS cruises

- 2003 Nov 21: Nov 23
- 2004 Dec 10: Dec 07
- 2005 Oct 18: Oct 20
- 2006 Oct 20: Oct 22
- 2008 Oct 27: Oct 30
- 2008 Nov 20: Nov 11, Nov 28

WHOI buoy
Stratus synthesis of NOAA ship observations

http://www.esrl.noaa.gov/psd/psd3/synthesis

- Fall 2001, 2003-2008 (7 years) 20°S, 75-85°W.
- Integrate measurements of
  - Surface meteorology
  - Turbulent and radiative fluxes
  - Cloud vertical structure: top, base, and LCL.
  - Doppler cloud radar (VOCALS 2008)
  - Column water vapor and liquid water path
  - Rawinsonde profiles
  - Aerosols

- Assess model and gridded products from in situ observations.
VOCALS ship/QuikSCAT comparison

• 132 QuikSCAT independent wind pixel retrievals from 10 hours fall within 100 km of the ship.
• Do ship and QuikSCAT agree?
  – systematic differences
• How representative are ship-QuikSCAT coincidences?
VOCALS ship observations compared with QuikSCAT gridded wind

Wind speed agrees well.

Wind direction agrees poorly.

Larry O’Neill
VOCALS ship observations compared with QuikSCAT gridded wind

Wind speed agrees well.

Wind direction correction not understood.

Larry O’Neill
VOCALS IMET buoy observations compared with QuikSCAT gridded wind.

Wind speed and direction agree well.

Larry O’Neill
Fluxes in the surface heat budget

(a) turbulent flux
WHOI OAFlux

(b) net radiative flux
ISCCP FD

(c) ocean residual
WHOI OAFlux

(d) UW Hybrid
latitude

(e) ISCCP FD

(f) UW Hybrid

(g) NCAR CORE

(h) NCAR CORE

(i) NCAR CORE

W m$^{-2}$
Surface heat balances along 20°S

W m\(^{-2}\)

-200  -150  -100  -50   0    50    100   150   200   250   300

NCAR CORE  WHOI OAFlux  UW Hybrid  PSD ship  NCAR CCSM3.0  IROAM  INM CM3.0  CSIRO Mk3.0  MRI CGCM2.3.2A  GFDL CM2.1  UKMO HadCM3  IAP FGGE1.0g  NCAR PCM1  GFDL CM2.0  MIROC3.2.hires  CNRM CM3  MIROC3.2.medres  CCCMA CGCM3.1  IPSL CM4  MPI ECHAM5

solar
residual
genesis
latent
QuikSCAT wind stress divergence

Peter Gaube
TMI cloud liquid water

C-130 85° W sections can identify if this is synoptic variability.
Ship-based 3.2-mm cloud radar
Doppler vertical velocity
Divergence and CLW vs. SST

10-m Wind Divergence
Annual Averages over 10°x10° Box Centered at 85°W, 20°S

SST Anomaly

Paulson and Wijesekera
Summary

• Flux and cloud model errors in the southeast Pacific
• VOCALS REx ship, buoy, aircraft observations
• Diagnose surface heat budget
• Challenge: upscale fine in situ observations to regional and global scales.
• Satellite observations for VOCALS
  Wind agrees with buoy; speed agrees with ship.
• Synoptic variability in wind, cloud, & SST:
  weak divergence $\rightarrow$ convective cloud
  strong divergence $\rightarrow$ stratiform cloud
VOCALS ship wind and coincident QuikSCAT swath observations

![Diagram showing wind observations in various locations with overlaid vectors indicating wind direction and speed.](image)
Direct measurement of turbulent stress components

Jeff Hare
October balance

- Combine turbulent fluxes.
- Combine radiation.
- Subtract mean observed fluxes \( \rightarrow \) anomalies.
Satellite data support for VOCALS Regional Experiment at http://numbat.coas.oregonstate.edu/vocals/

QuikSCAT wind stress

Peter Gaube
Synoptic atmospheric variability in VOCALS REx

75-90W, 15-25S

Rob Wood
Synoptic atmospheric variability in VOCALS REx

75-90°W, 15-25°S

**Clouds**

MODIS Terra Cloud Fraction, liquid clouds (solid); ice (dashed)

**W_850**

$w_{850}$ [cm s$^{-1}$]

Rob Wood
Time-longitude plots of high-pass filtered SSH and SST along 20S

cyclonic...........
anticyclonic___

• Eddies transport heat
• Wind-SST coupling