VOCALS cloud and surface flux observations for coupled model evaluation

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7 years of Stratus/VOCALS ship tracks

buoy

2001 Oct 22  Oct 24
2003 Nov 21  Nov 23
2004 Dec 10  Dec 07
2005 Oct 18  Oct 20
2006 Oct 20  Oct 22
2007 Oct 26  Oct 24
2008 Oct 27  Oct 30
2008 Nov 20  Nov 11

degrees latitude

degrees longitude
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.
  – Drizzle-sensitive Doppler radar (VOCALS 2008)
  – Column water vapor and liquid water path
  – Rawinsonde profiles
  – Aerosols
• Assess model and analysis fluxes from observations.
VOCALS 2008 20° S time series

- **Flux (W m⁻²)**
  - Solar
  - Sensible
  - Longwave
  - Evaporation

- **Temperature (°C)**
  - Sea
  - Air

- **Humidity (g kg⁻¹)**

- **Wind (m s⁻¹)**

**Month/Day**

10/26 11/2 11/9 11/16 11/23 11/30

20 19 18 17 16

85 75

10 9 8 7 6 5 4 3 2 1 0

0 5 10 15 20
diurnal cycle: 7-year surface heat budget, 20°S

\[ \rho C_p \frac{dT}{dt} = R_l + R_s + H + E + \text{residual} \]
Heat fluxes at 20°S

5 October ship sections

Model

WHOI ORS buoy

OAFlux (1984-2002)

CORE (1984-2004)

NOAA ship observations

west longitude
Surface heat balances

$40 \text{ W m}^{-2}$
20°S, 75-85°W October average

![Graph showing the relationship between insolation and thermal radiation. The correlation coefficient is r = -0.96. The slope equals -0.67.](image-url)
Cloud observations from the stratus region

- Rawinsondes: atmospheric profiles
- Lidar ceilometer: cloud base
- W-band radar: cloud and hydrometeors
- Boundary layer and cloud top
- Aerosols
- Surface meteorology

How do these measurable quantities regulate radiatively important clouds?

C-130 85° W sections can identify if this is synoptic variability.
- Lowest cloud base is 10% higher than lifting condensation level (LCL).
- Cloud base above 900 m decouples from surface layer.
- Cloud bases were higher and more decoupled in 2008.