Surface fluxes in the VOCALS region

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Physics of air-surface interactions and coupling to ocean-ice/atmosphere BL

**Aspects:**
- Emphasize surface fluxes
- Similarity Scaling
- Bulk Flux Parameterizations
- Surface/subsurface processes
- Improve Observing Technologies
- Flux climatologies

**Applications:**
- Model lower BC (PBL, Meso, NWP, GCM)
- Ocean budgets (stress, heat, waves, sea-ice)
- Carbon budgets
- Pollution deposition (particle, ozone)
- Cloud microphysics (aerosol source, DMS)
- Atmos Propagation ($C_n^2$, ducting, extinction)
- Hurricane intensity
Turbulence Measurements from Ships
Energy Budget

\[ Q_{\text{NET}} = Q_S^\uparrow + Q_S^\downarrow + Q_L^\uparrow + Q_L^\downarrow + H_S + H_L + \text{Storage} \]

Net at the surface
Shortwave up/down (albedo)
Longwave up/down
Sensible turbulent heat flux
Latent turbulent heat flux

\[ Q_L^\uparrow = \varepsilon(\sigma T^4 - Q_L^\downarrow) \]
Surface energy budget study from Stratus 2003
PACS cruise tracks

9 PACS Cruises Conducted Before Stratus Cruises
TAO/PACS
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 cruise tracks


2005, 2006, 2007 cruise tracks

degrees latitude

2001 Oct 22  Oct 24
2003 Nov 21  Nov 23
2004 Dec 10  Dec 07

degrees longitude

2005 Oct 18  Oct 20
2006 Oct 20  Oct 22
2007 Oct 26  Oct 24
Bulk Flux Parameterizations: COARE 3.0
Intercomparison of Fluxes and Context of VOCALS within the 2001-2007 Climatology

\[ H_L = \rho_a Le C_e U (q_{sat}(SST) - q_a) \]

Latent heat fluxes averaged in 10-m neutral wind speed bins:

**COARE3.0** (dashed line – median; x – mean) and Direct Measurements (solid line – median; circle – mean). Left panel is VOCALS and right panel is Stratus2007.
20°S surface heat budget

- **solar**
- **net**
- **sensible**
- **longwave**
- **latent**

Flux (W m\(^{-2}\)) vs. longitude
October heat fluxes at 20°S: assess analyses and models

![Graphs showing heat fluxes at 20°S for GFDL CM2.1 and IROAM models.](image)

- **Model**
- **WHOI ORS buoy**
- **WHOI (1984-2002)**
- **CORE (1984-2004)**
- **NOAA ship observations**