Coupled Ocean-Atmosphere Interactions in the Southeast Pacific

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Scripps Coupled Ocean-Atmosphere Regional (SCOAR) Model

- **Atmosphere**
  - Regional Spectral Model (RSM)
  - Momentum, Heat and Moisture Fluxes
  - Flux-SST Coupler

- **Ocean**
  - Regional Ocean Modeling System (ROMS)
  - SST

- **NCEP/DOE Reanalysis (RA2)**
  - Monthly climatological SODA/ monthly OFES mean

Seo et al, 2006
- 88W to 68W, 8S to 38S
- Grid resolution:
  - horizontal = 20km
  - atmosphere = 28 layers
  - ocean = 30 layers
- Ocean spin up with NCEP forcing for 10 years
- Time periods: 1999-2007 10/1/08-12/14/08
- Atm. boundary downscaled from NCEP RA2
- Ocean boundary taken from monthly output of OFES and SODA clim.
Sea Surface Temperature (VOCALS-Rex Campaign)

TMI-AMSRE

SCOAR

ROMS-NCEP-soda

ROMS-NCEP-ofes
Sea Surface Height & Surface Current (VOCALS-Rex Campaign)
# Sensitivity Tests

<table>
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<th>Expt. Run</th>
<th>Boundary conditions</th>
<th>Forcing Wind</th>
<th>Forcing SST</th>
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<td>SCOAR-soda</td>
<td>SODA</td>
<td>RSM</td>
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<tr>
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<td>ROMS-NCEP-soda</td>
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<td>ROMS-QSCAT-ofes</td>
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<td>RSM-TMI_AMSRE</td>
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<td>Monthly SCOAR-soda</td>
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- **Atmospheric model:** separating out initial condition vs SST forcing impact on winds and atmospheric state
- **Ocean model:** choice of boundary conditions and its influence on ocean state
- **Ocean model:** momentum and heat fluxes contribution to SST distribution
SST-winds-upwelling

Mean winds (m/s) with SST contours

Mean surface wind stress (N/m²)

Ekman pumping velocity (m/day)

\[ w_{Ek} = \frac{\text{curl}(\tau)}{\rho f} \]
Scientific Questions

- How strongly do the coastal winds induce upwelling that cools SST off the coast of Peru and Chile?
- How does latent heat loss from the ocean over the VOCALS region covary with mesoscale ocean-atmosphere variables and influence the overall SST distribution?
- How does mesoscale SST impact the overlying PBL structure and thereby influencing the overall cloudiness of the Southeast Pacific region?
Proposed Experiments

**Hindcast 1:** Fully-coupled SCOAR run for 1999-2007.

**Hindcast 2:** Downscaled uncoupled RSM (atm.) runs for 1999-2007.
- Downscaled RA2 using monthly mean SST specified from Hindcast 1
- Downscaled RA2 using monthly mean SST prescribed from NCEP Analysis
- Downscaled RA2 using monthly mean SST specified from TMI-AMSRE Optimum Interpolated SST

**Hindcast 3:** Uncoupled ROMS (ocean) runs for 1999-2007.
- ROMS forced with monthly mean stresses and heat fluxes computed from Hindcast 1
- ROMS forced with wind stresses and heat fluxes from the coarse resolution NCEP RA2
- ROMS forced by satellite observations (QuikSCAT winds)
Championship Finals: Peru vs. Chile

Who will “SCOAR”???
Ocean Dynamics in the HCS

Figure from Samuel Hormazabal
Focus On Four Air-Sea Coupling Issues

- SST and wind stress coupling
- Upwelling and mixed layer depth (MLD) variability
- Latent heat flux over the ocean
- SST and planetary boundary layer (PBL) structure