The importance of ocean mesoscale variability for air-sea interactions and upper ocean temperature flux in the Gulf of Mexico

Dian Putrasahan
Igor Kamenkovich and Ben Kirtman
Community Climate Systems Model (CCSM3.5)

Low resolution (LRC):
- 1° ocean, 0.5° atm
- Model years: 35-88
- Fixed forcing (1990)

High resolution (HRC):
- 0.1° ocean, 0.5° atm
- Model years: 102-155
- Fixed forcing (1990)
Community Climate Systems Model (CCSM3.5)

Low resolution (LRC):
• 1° ocean, 0.5° atm
• Model years: 35-88
• Fixed forcing (1990)

High resolution (HRC):
• 0.1° ocean, 0.5° atm
• Model years: 102-155
• Fixed forcing (1990)
Correlation between LHF and ocean variables (HRC)

\[ \nabla \cdot (\overline{uT'}) = \nabla \cdot (\overline{uT}) + \nabla \cdot (\overline{u'T'}) \]

Sea surface temperature

Divergence of total upper 200m temperature flux

Divergence of mean upper 200m temperature flux

Divergence of eddy upper 200m temperature flux
Magnitude of upper 200m temperature flux
<climatological 54-year mean>

\[
\langle (\bar{u}\bar{T}) \rangle = \langle \bar{u} \rangle \langle \bar{T} \rangle + \langle \bar{u}'\bar{T}' \rangle \\
\langle (\bar{u}'\bar{T}') \rangle = \langle \bar{u} \rangle \langle \bar{T} \rangle + \langle \bar{u}'\bar{T}' \rangle
\]
Divergence of upper 200m temperature flux
<climatological 54-year mean>

\[ \nabla \cdot \langle \mathbf{u} T \rangle = \nabla \cdot \langle \mathbf{u} \bar{T} \rangle + \nabla \cdot \langle \mathbf{u}' \bar{T}' \rangle \]

**Total**

**Mean**

**Submonthly**
Anticyclonic eddies in the Gulf of Mexico

- 1111 anticyclonic eddies based on SLA
- Average diameter: ~348km
Anticyclonic eddies in the Gulf of Mexico
(Atmospheric imprint)
SSTA composite (°C)

Full downwind SST gradient composite (°C/m)

Full wind divergence composite (s⁻¹)

Full Laplacian of SST composite (°C/m²)
Full moisture divergence composite (kg/kg/s)

Full convective precipitation composite (mm/day)
Magnitude of total upper 200m temperature transport (m-°C-m/s)

\[ \overline{uT} = \overline{uT} + \overline{u'T'} \]

- total
- mean
- submonthly

Magnitude of mean upper 200m temperature transport (m-°C-m/s)

Magnitude of submonthly upper 200m temperature transport (m-°C-m/s)
\[ \nabla \cdot (\overline{uT}) = \nabla \cdot (\overline{uT}) + \nabla \cdot (u'T') \]
Summary

- Positive correlation of latent heat flux with SST that indicates ocean forcing to the atmosphere (high ocean resolution case)

- This is supported by temperature flux divergence on a submonthly scale, even though magnitude of temperature flux vectors are larger in the mean

- Anticyclonic eddies from Loop current and rings have an imprint on the atmosphere in the northwest quadrant where warm anomalies reside
  - more LHF out of the ocean, deeper PBL, wind and moisture convergence, and more convective precipitation
  - warm SST anomalies are supported by submonthly divergence of temperature flux

Thank You!!!