Zonal jets in the ocean: OFES vs observations

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¼-degree drifter ensemble mean zonal velocity
Eddy kinetic energy

From drifters

From altimeter
Correlation coefficient between $f \times V$ and $-g \ \text{grad}(h')$
Momentum equation in the upper ocean:

\[ \frac{dV}{dt} + f \times V - f \times V_{\text{ekman}} = - g \nabla <h> - g \nabla h' \]

drifters    wind    altimeter
NASA JPL mean sea level based on the GRACE geoid

Courtesy of Victor Zlotnicki
Blended mean sea level

Cost function

\[ \mathcal{E} = \int_{S} W_1 \cdot (h - H_{JPL})^2 \, ds + \int_{S} W_2 \cdot (\nabla h - \nabla H_{obs})^2 \, ds \rightarrow \text{min} \]

Large scale is controlled by \( H_{JPL} \) and small scale is defined by \( \nabla H_{obs} \)

The threshold scale is

\[ L \approx 2\pi \left( \frac{W_2}{W_1} \right)^{1/2} \approx 1000 \text{ km} \]
Hybrid decade-mean sea level: global map at mesoscale resolution
Mean sea level: OFES vs observations

(a) 1992-2002 DOT from observations

(b) Years 45-50 mean DOT from OFES climatological run

(b)-(a)
Mean sea level: OFES vs observations

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(a) 1992-2002 DOT from observations
(b) Years 45-50 mean DOT from OFES climatological run

(b)-(a)
1992–2002 mean near-surface zonal geostrophic velocity, cm/s

Ug40
Mean zonal geostrophic velocity: OFES vs observations

(a) 1992-2002 $<U_{\text{geostr}}>$ from observations

(b) Years 45-50 mean $<U_{\text{geostr}}>$ from OFES

(b)-(a)
Mean zonal geostrophic velocity: OFES vs observations

(a) 1992-2002 $<U_{\text{geostr}}>$ from observations

(b) Years 45-50 mean $<U_{\text{geostr}}>$ from OFES

(b)-(a)
Mean zonal geostrophic velocity: OFES vs observations

Southeastern Pacific

(a) 1992-2002 $\langle U_{\text{geost}} \rangle$ from observations

(b) Years 45-50 mean $\langle U_{\text{geost}} \rangle$ from OFES
Aviso: anomaly of zonal geostrophic velocity averaged over 18-weeks
OFES: 18-weeks averaged $U'$

C.c. = 0.67

1000 m

sea surface
18-weeks averaged anomaly of zonal geostrophic velocity
Latitude-time diagram of geostrophic vorticity anomaly at 140-150W: Aviso (a) and OFES (b,c)

pRossby waves = possibly Rossby … 😊
Conclusions

1. There are significant interactions between large scales and jets, i.e.
   - large-scale discrepancies between the nature and model configuration
     (e.g., forcing, topography, etc.) can result in mesoscale-jet differences
     between the reality and the model solution. (E.g., position of the
     Kuroshio Extention.)
   - mesoscale-jet discrepancies between the nature and model configuration
     can result in large-scale differences between the reality and the model
     solution. (E.g., effect of missing Azores Current.)

2. OFES seems to contain physics, which are adequate to the real ocean
   dynamics and not understood yet. (E.g., alternating zonal jets, pRossby
   waves, etc.)