Covariability Between the Surface Wind Divergence and Vorticity in the Pacific Ocean

Robert Jacobs & Larry O'Neill

Oregon State University

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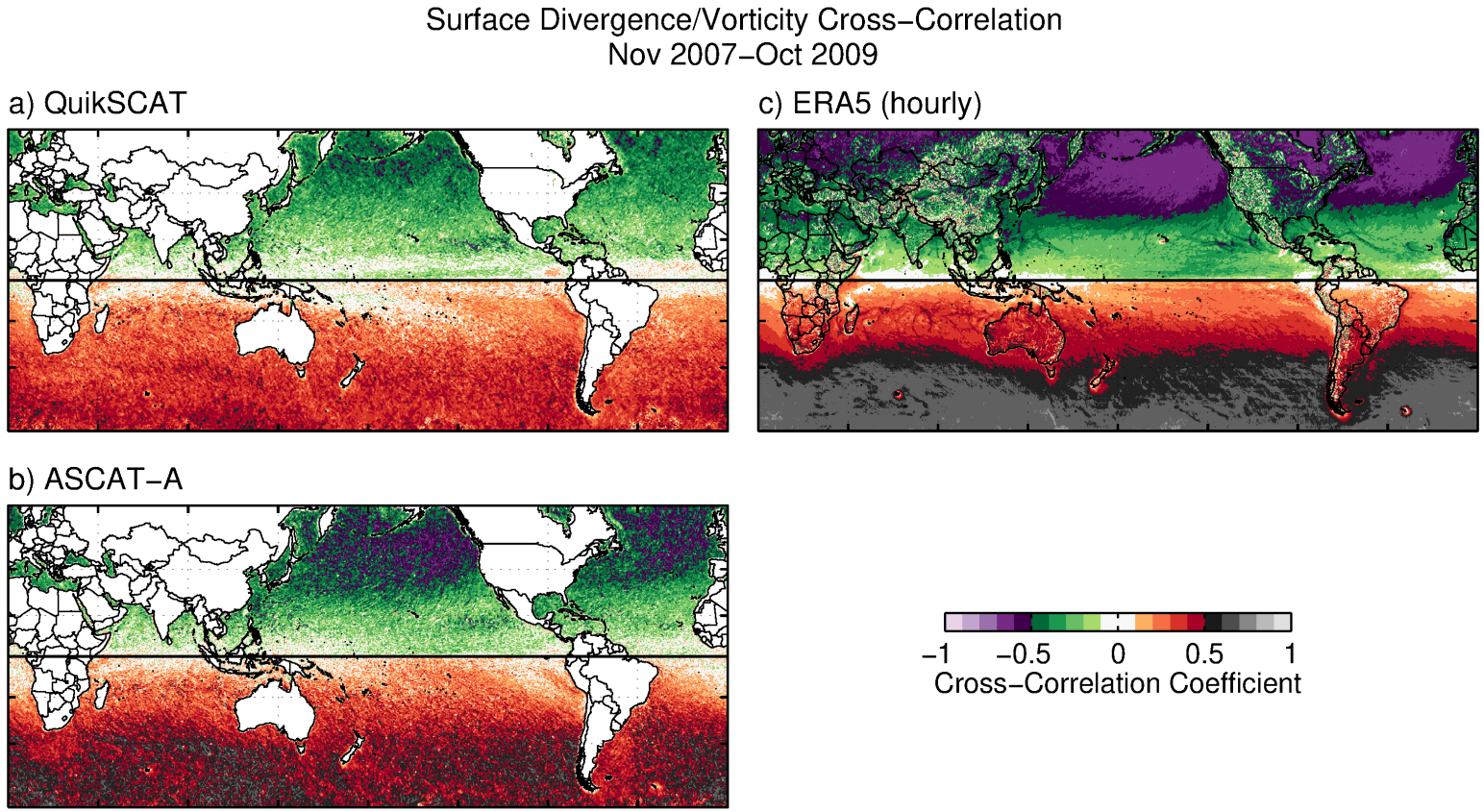
Oregon State University OSU College of Earth, Ocean, and Atmospheric Sciences

Divergence and Vorticity Cross-Correlation

- Highly correlated divergence and vorticity over most of the global ocean

- Why are they correlated?



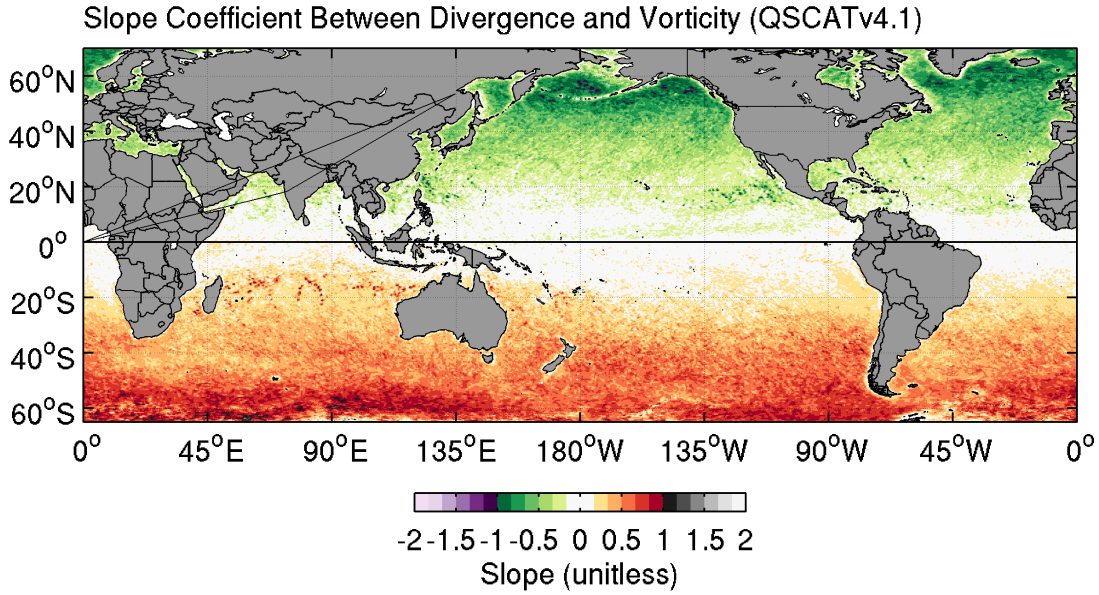
Divergence and Vorticity Correlation

- Ekman dynamics predicts a correlation between surface divergence and vorticity

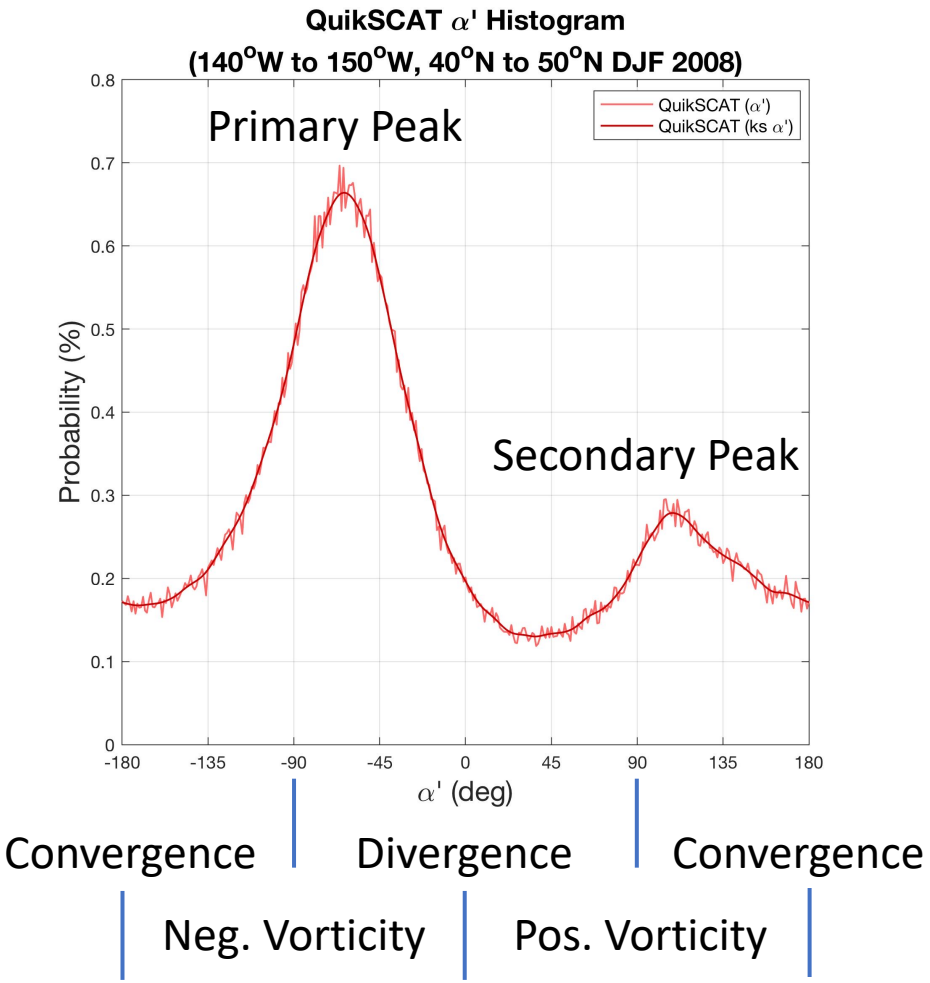
$$-\frac{f}{a}\left(\vec{\nabla}\cdot\vec{V}\right)=\hat{k}\cdot\left(\vec{\nabla}\times\vec{V}\right)$$

$$-f\hat{k}\times\vec{V}-\frac{1}{\rho_o}\vec{\nabla}p-a\vec{V}=0$$

$$a=\frac{C_d\left|\vec{V}\right|}{h}$$

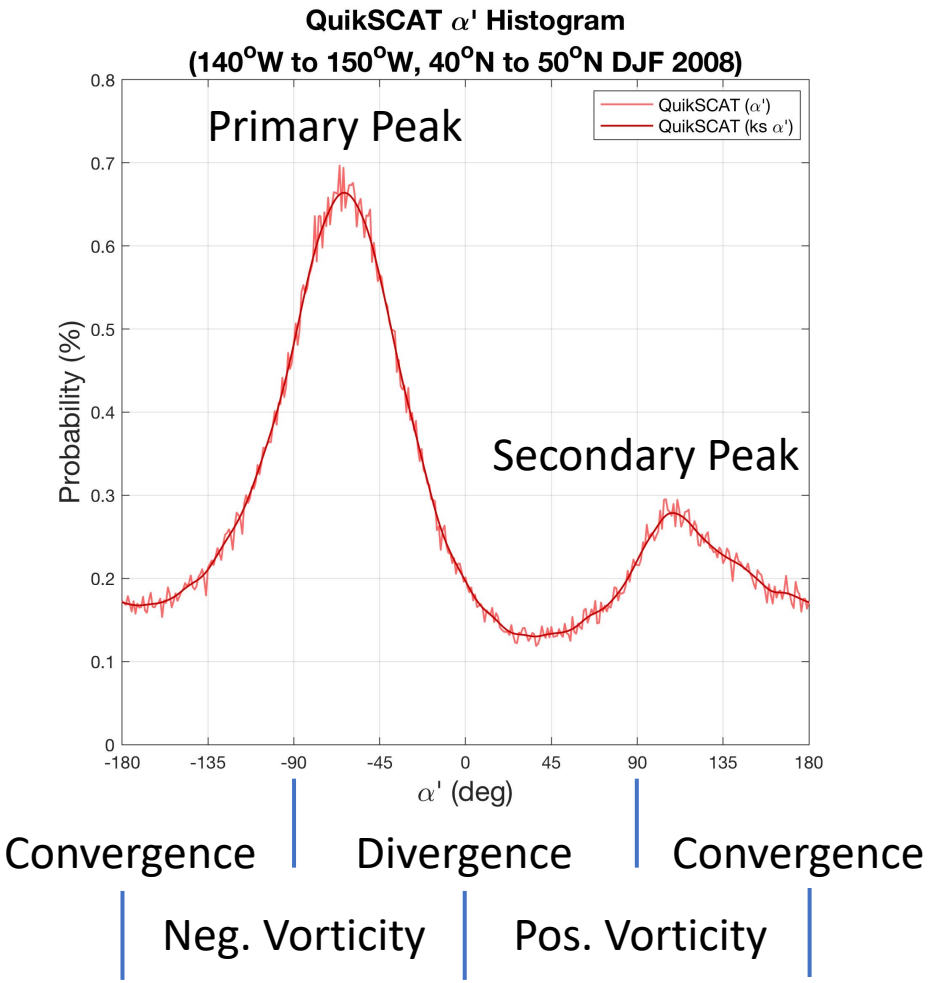


QuikSCAT Univariate α' PDF



- $\alpha' = \tan^{-1}\left(\frac{\hat{k}\cdot(\vec{\nabla}\times\vec{V})}{(\vec{\nabla}\cdot\vec{V})}\right) = \tan^{-1}\left(\frac{-f}{a}\right)$

QuikSCAT Univariate α' PDF

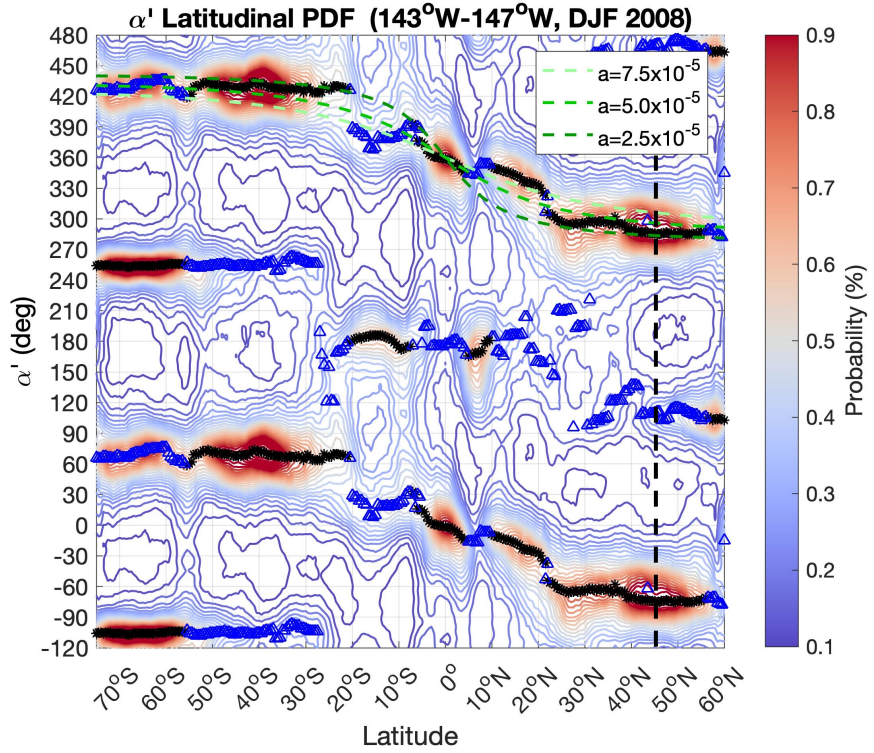


- $\alpha' = \tan^{-1}\left(\frac{\hat{k}\cdot(\vec{\nabla}\times\vec{V})}{(\vec{\nabla}\cdot\vec{V})}\right) = \tan^{-1}\left(\frac{-f}{a}\right)$

- Primary Peak (Northern Hemisphere)
  - Positive Divergence with Negative Vorticity (anti-cyclonic)
  - Ekman Balance requires:
    $-90° \leq \alpha' < 0°$
  - $\alpha' = -64°$

- Secondary Peak (Northern Hemisphere)
  - Convergence with Positive Vorticity (cyclonic)
  - $\alpha' = 108°$

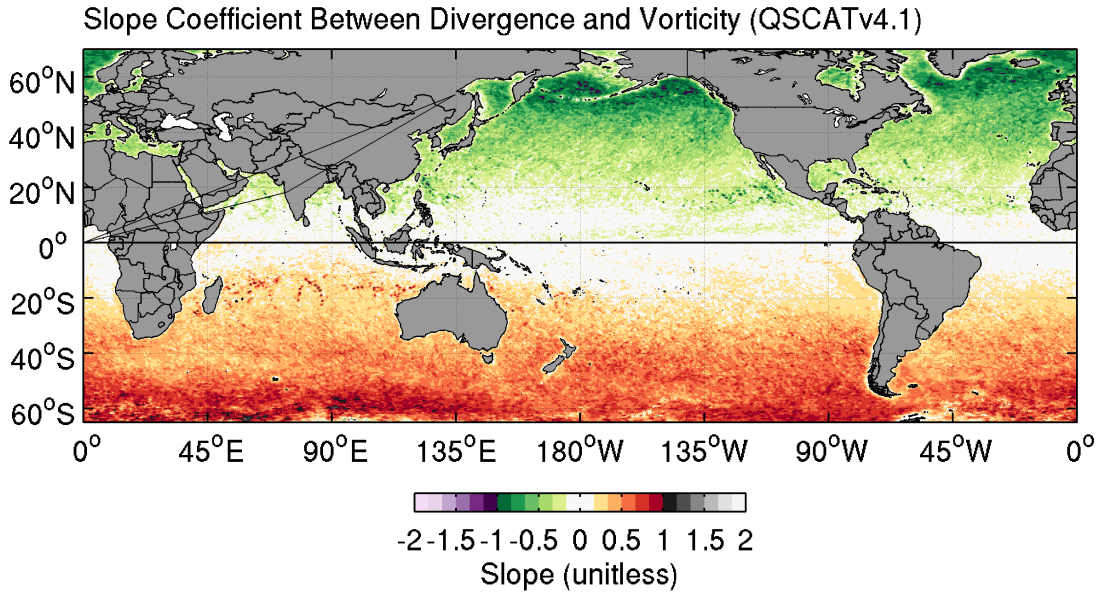
ERA5 Latitudinal PDF Variation

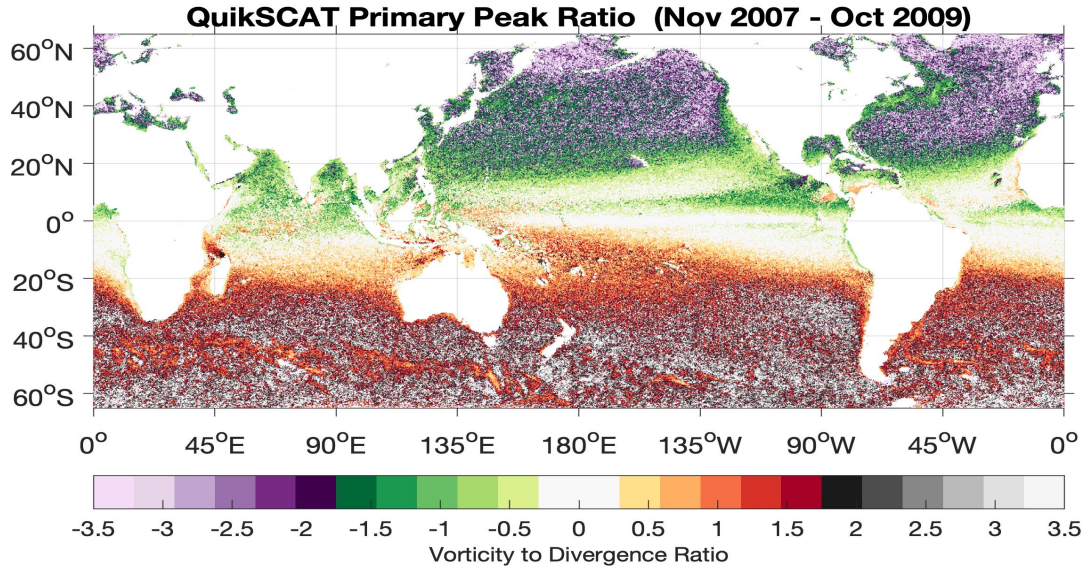


$$\alpha' = \tan^{-1}\left(\frac{\hat{k}\cdot(\vec{\nabla}\times\vec{V})}{(\vec{\nabla}\cdot\vec{V})}\right) = \tan^{-1}\left(\frac{-f}{a}\right)$$

- Primary Peak follows the expected inverse tangent function
- Secondary Peak follows a step function

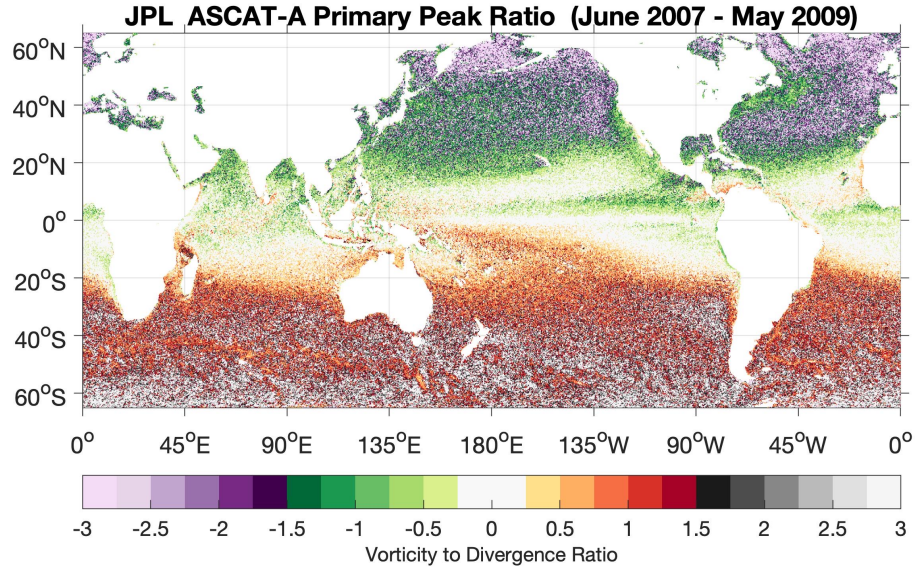
Divergence and Vorticity Cross-Correlation

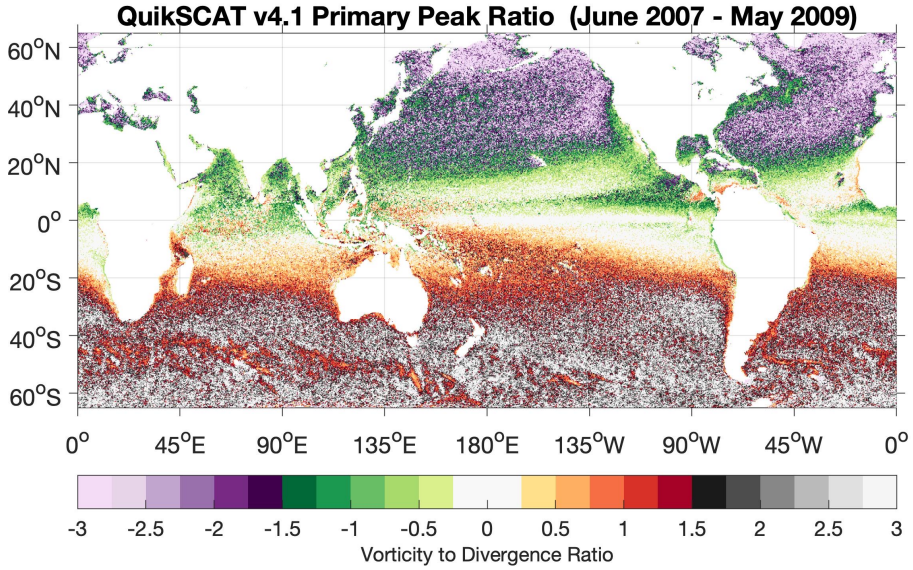


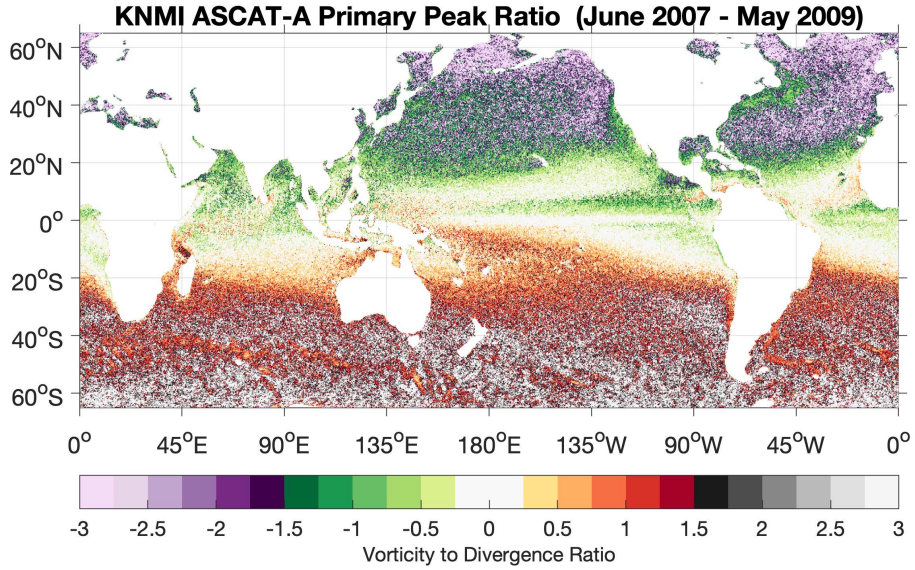


$$\tan(\alpha') = \frac{-f}{a} = \frac{\hat{k} \cdot (\vec{\nabla} \times \vec{V})}{(\vec{\nabla} \cdot \vec{V})}$$

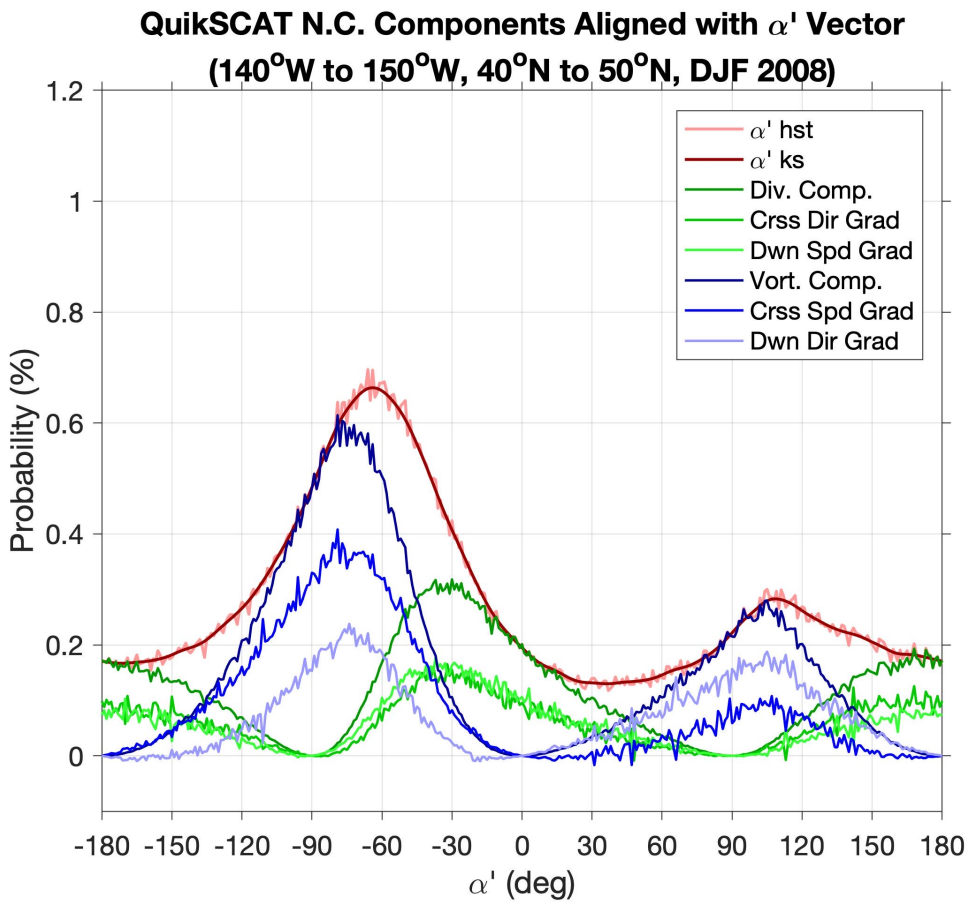
Divergence and Vorticity Cross-Correlation

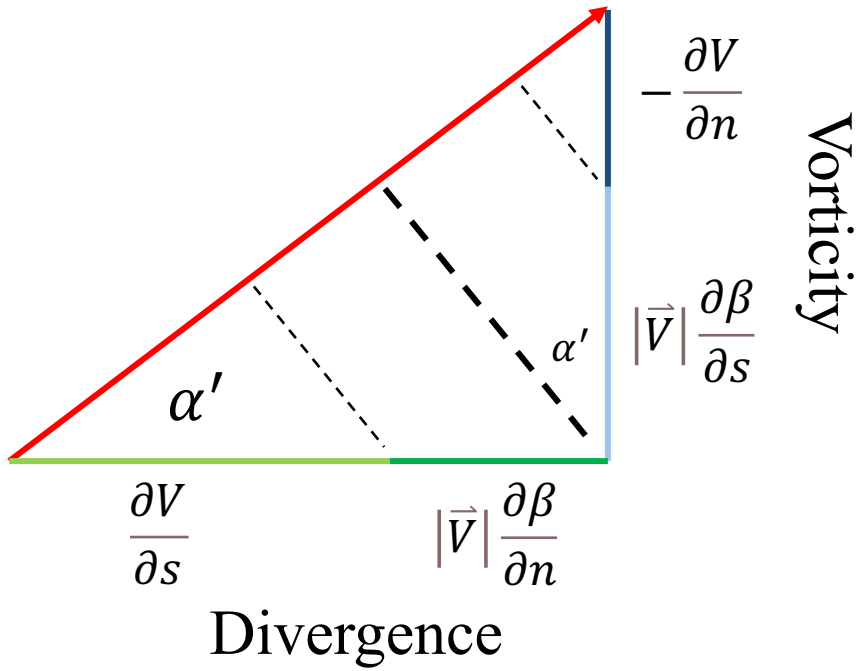




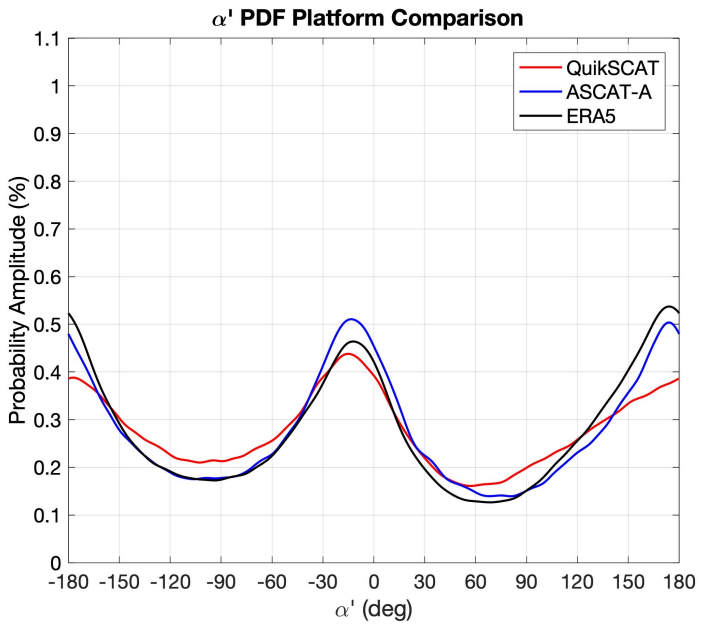


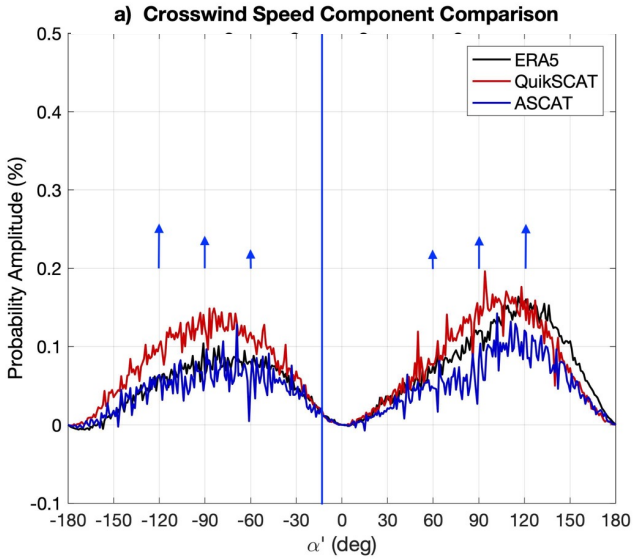
Natural Coordinate Composition

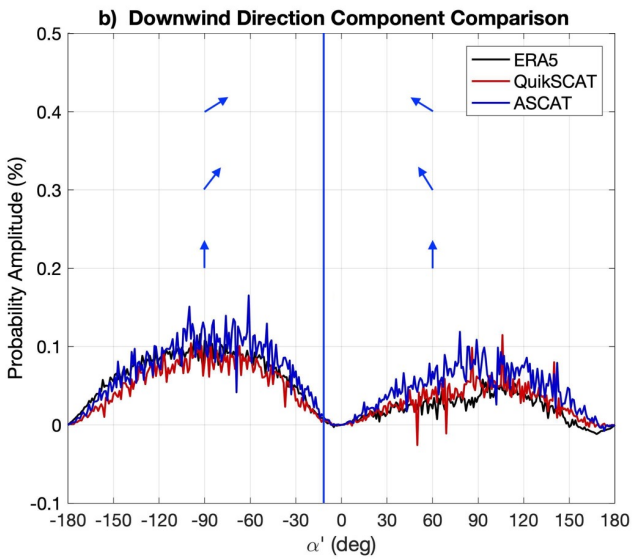


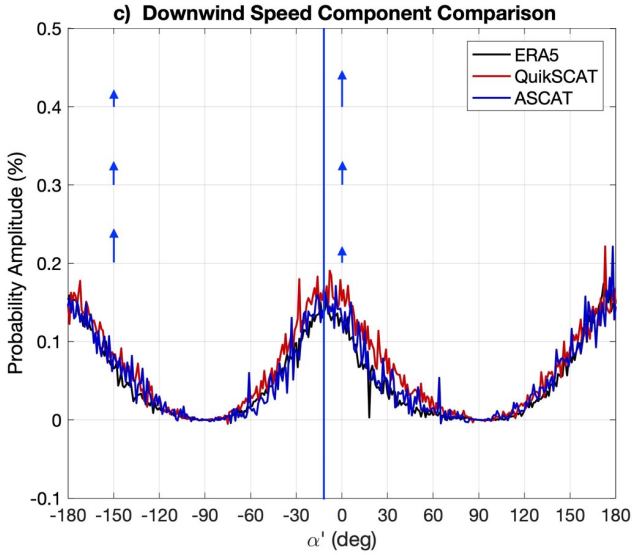


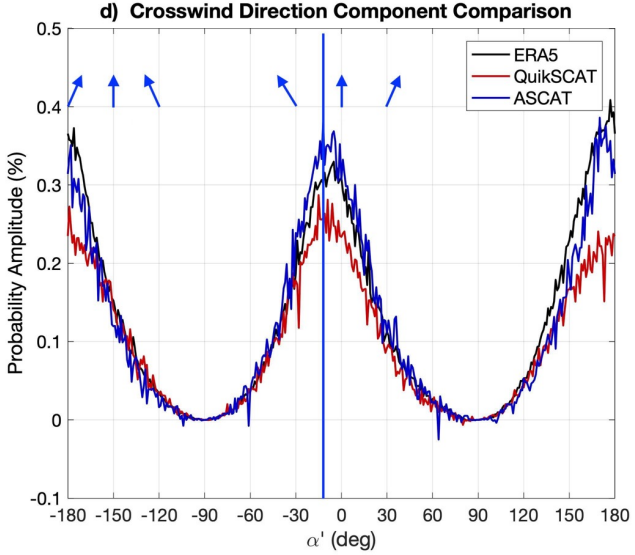
DJF 2008
Lat: 5°N to 15°N
Long: 140°E to 150°E





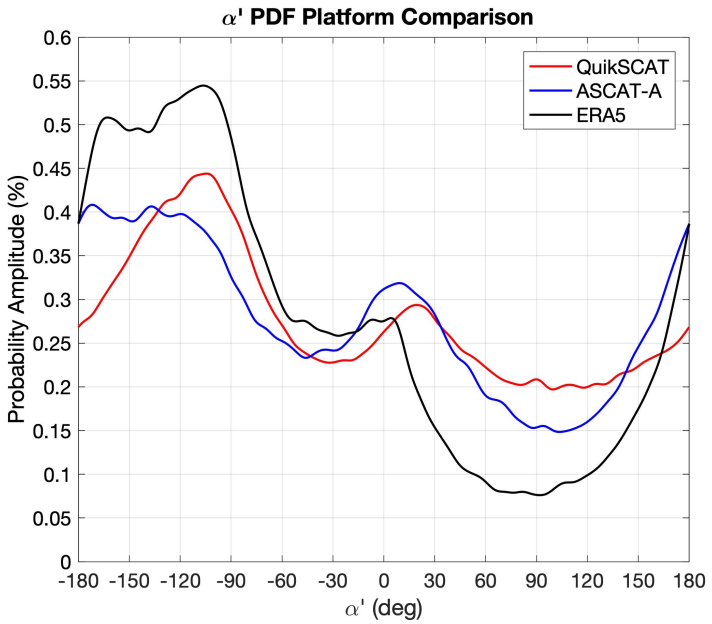




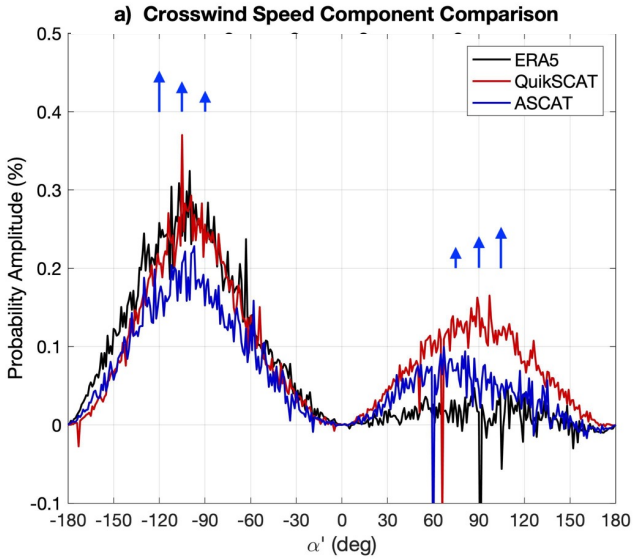


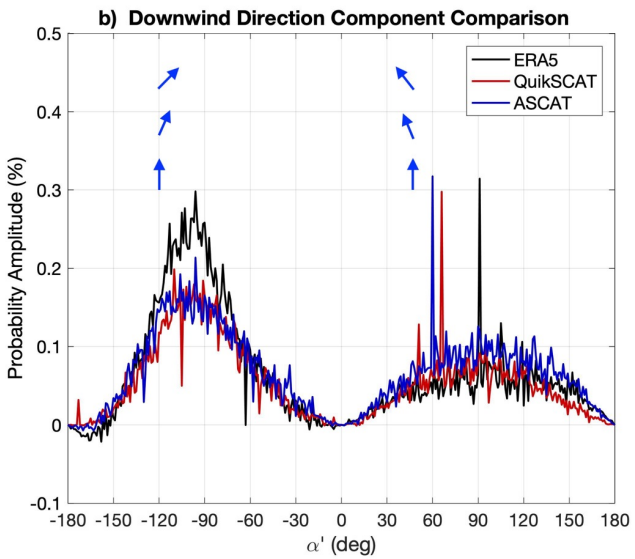
- Good derivative field correlation in most of the Pacific Ocean
- What components differ in the α' PDFs?

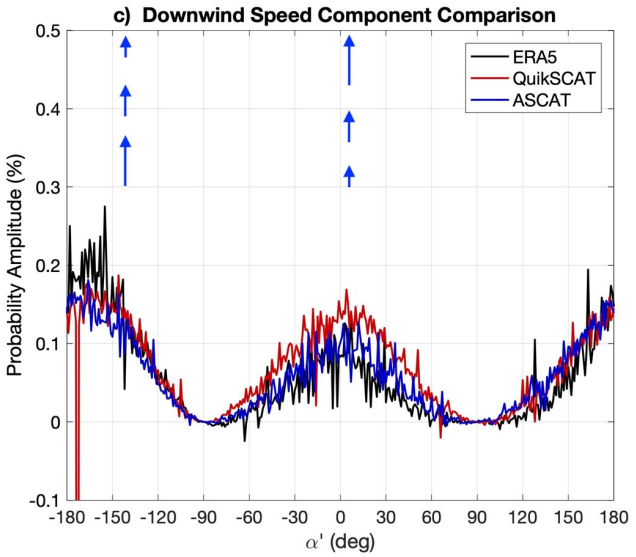
DJF 2008
Lat: 5°S to 15°S
Long: 80°E to 90°E

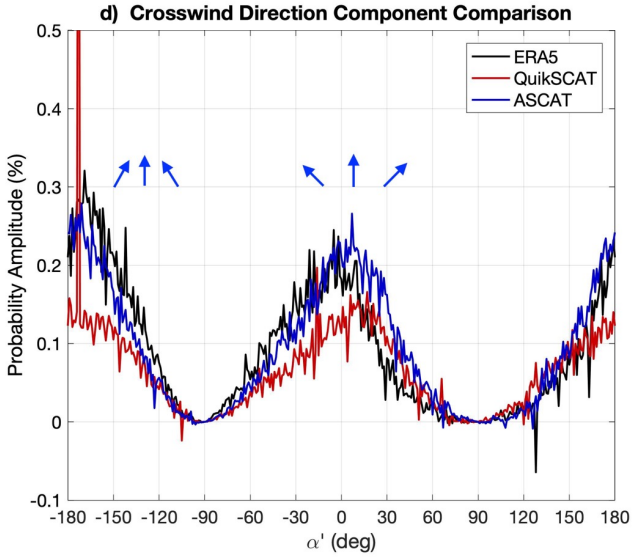


- Poor derivative field correlation in the Indian Ocean



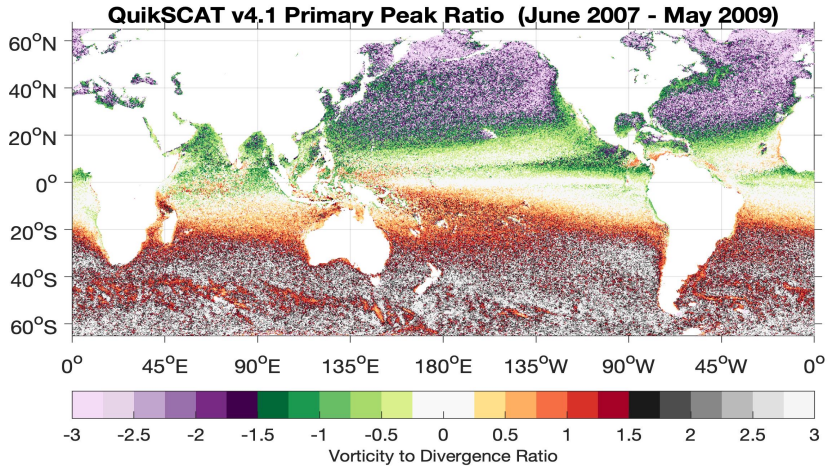


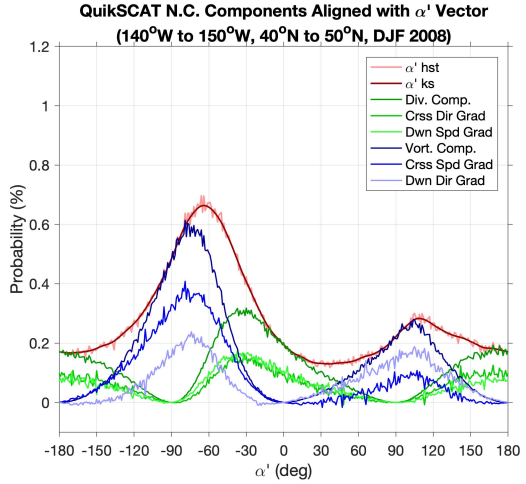


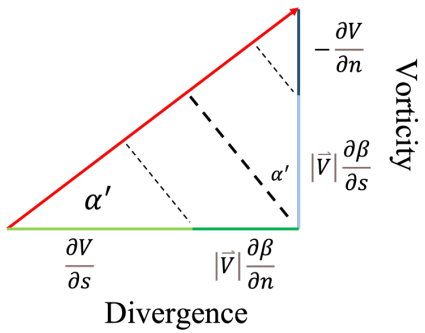


Summary

- Divergence and vorticity are highly correlated. This new result shows strong latitudinal structure
- Steady-state Ekman dynamics can explain much of the divergence and vorticity co-variability through the α' metric
- Utilize the α' metric and natural coordinates to determine the composition of the derivative wind fields







Thank You

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jacobrob@oregonstate.edu