# The moisture, entropy and vorticity budgets in different stages of TC evolution

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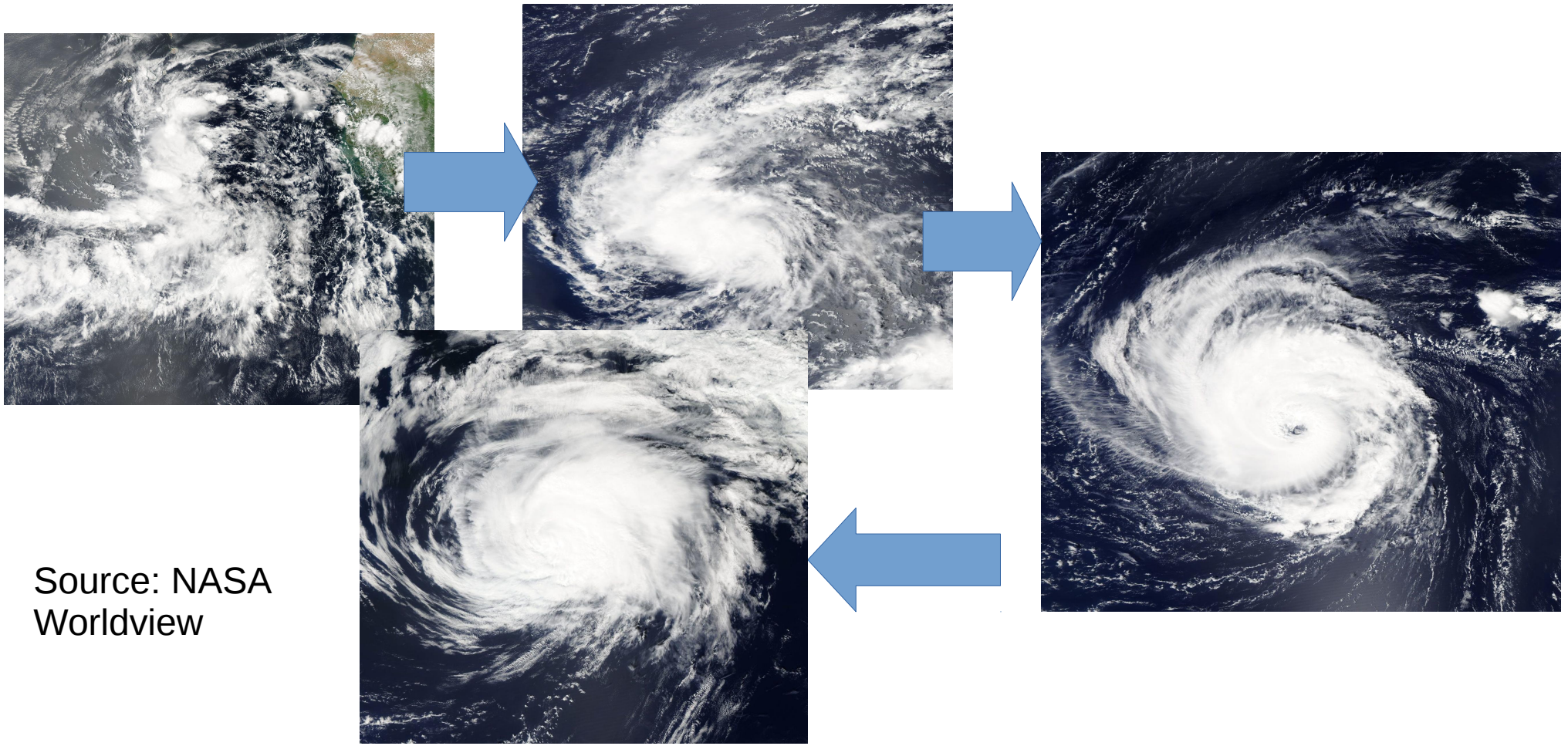
NASA Ames, CA

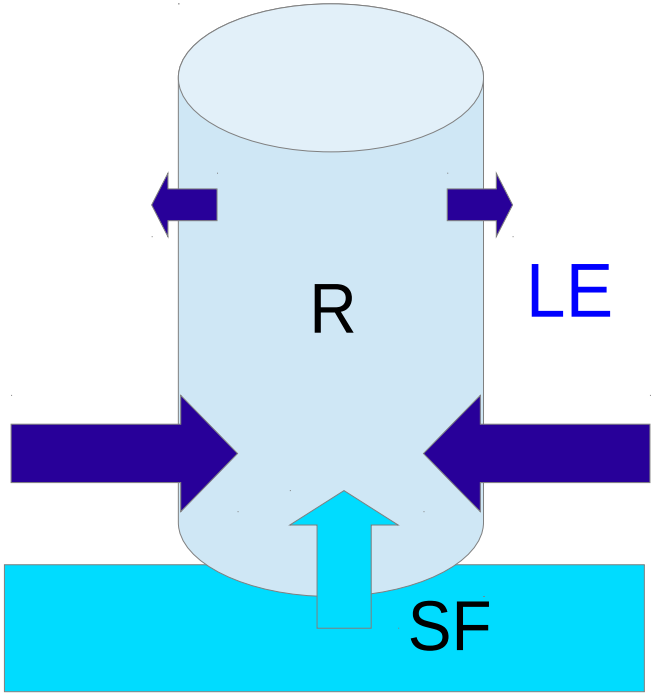
# How do changes in moisture, entropy and vorticity affect TC's evolution, especially during decay?



Source: NASA Worldview

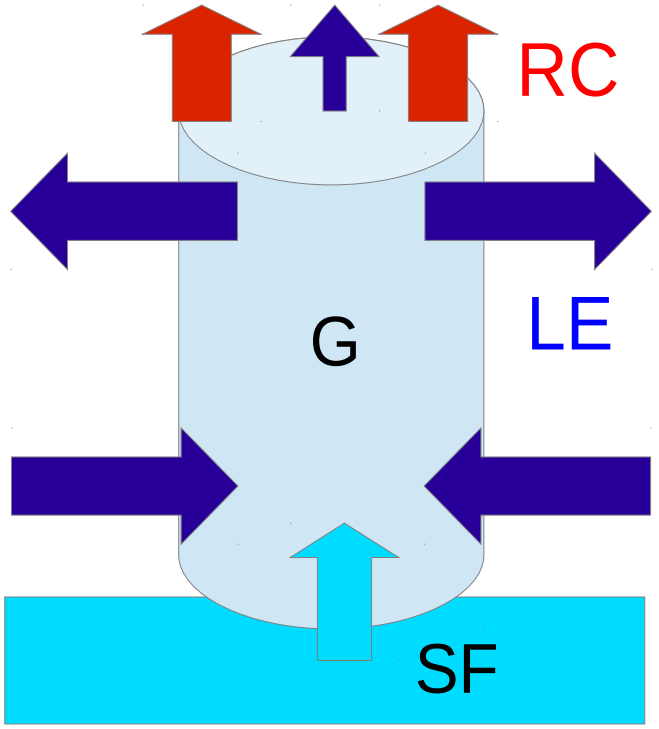
# Moisture budget

- Mixing ratio of water vapor
- Moisture flux/tendency = lateral entrainment (LE) + surface fluxes(SF) - net rainfall(R)



# Moist entropy budget

- The moist entropy flux/tendency = lateral entrainment(LE) + surface fluxes (SF) - radiative cooling (RC) + irreversible generation (G)



# Vorticity budget

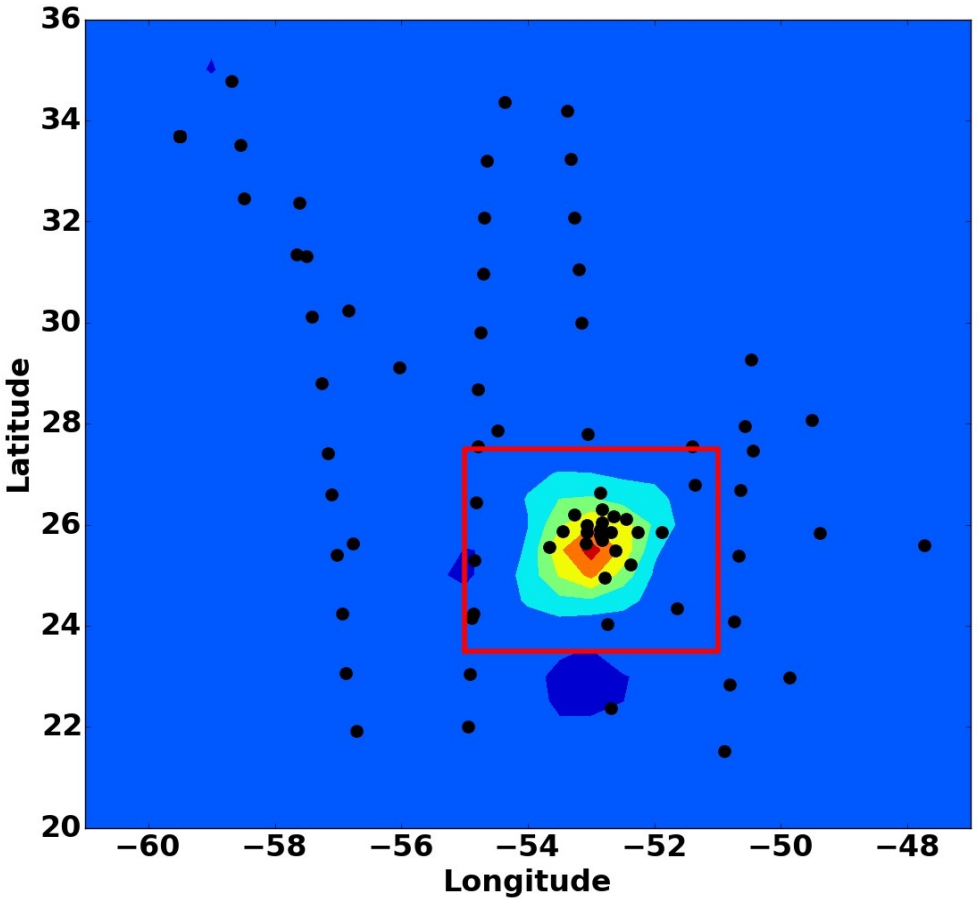
Vorticity tendency = stretching + tilting + surface friction

$$\frac{\partial \zeta_z}{\partial t} = -\vec{\nabla}\cdot\left(\hat{k}\,x\,\vec{F}\right) - \vec{\nabla}\cdot\left(\zeta_z \vec{v}_h\right) + \vec{\nabla}\cdot\left(\vec{\zeta}_h w\right)$$

$$Wind: \vec{v} = \left(\vec{v}_h, w\right)$$

$$Vorticity: \vec{\zeta} = \left(\vec{\zeta}_h, \zeta_z\right)$$

# 3D-Var analysis




Edouard, 09/14-15/2014

Vertical vorticity at 2 km

Dropsonde positions

Domain of interest – 'mask' (4ºx4º)

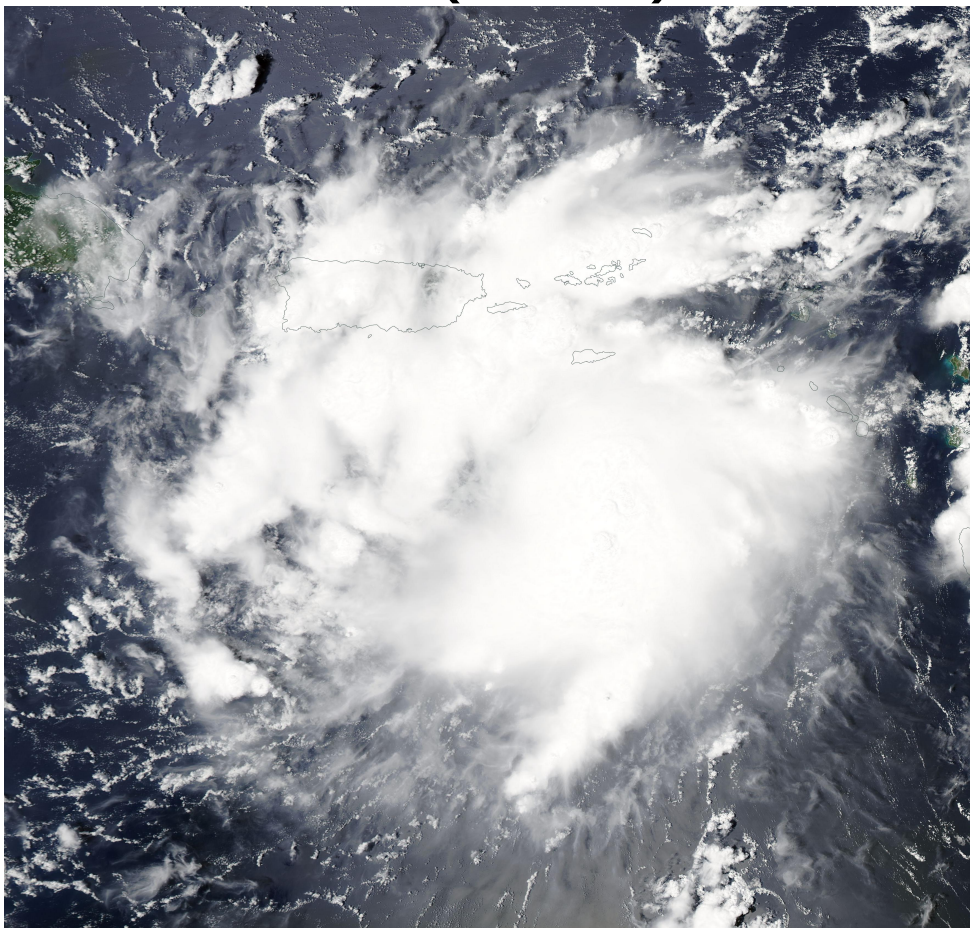
Storm-relative ref. frame

Grid: 0.5ºx0.5º

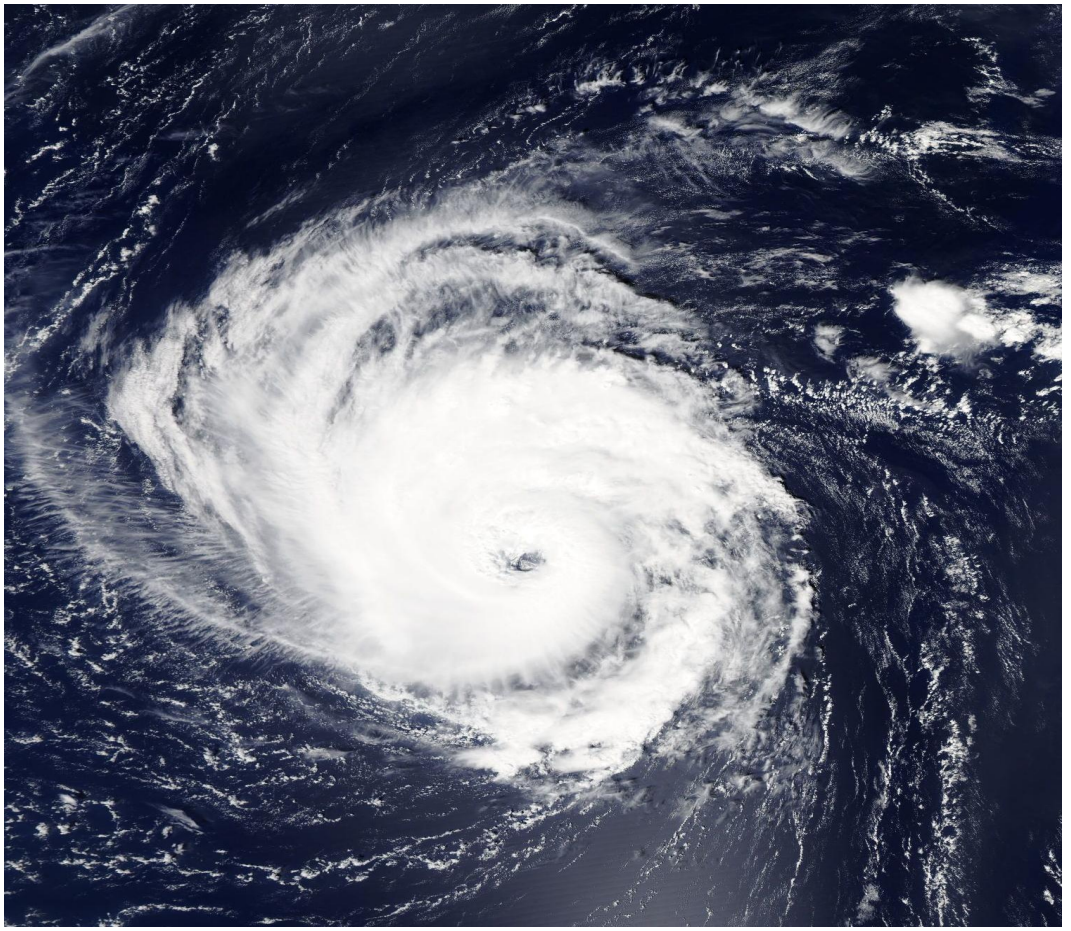
Vertical: 0-16km, 0.2km resolution

# Case studies

## Gabrielle (2013)

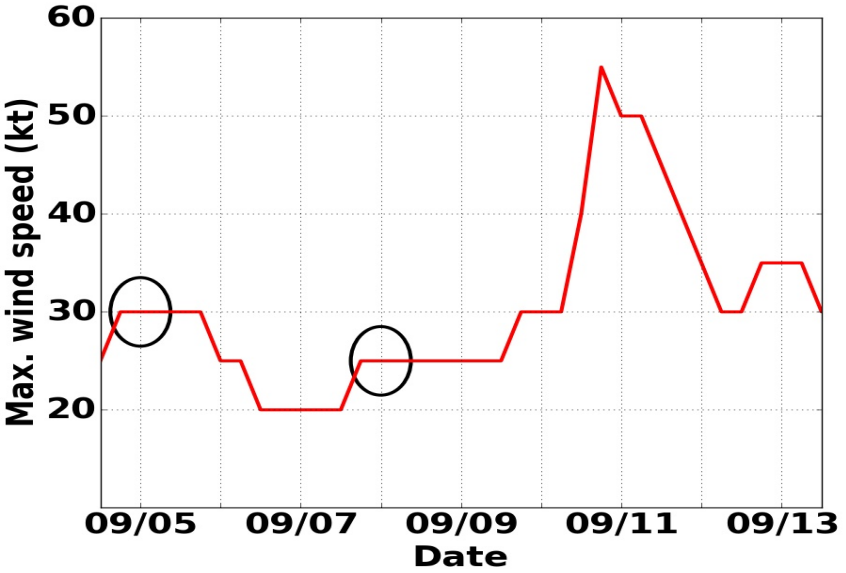


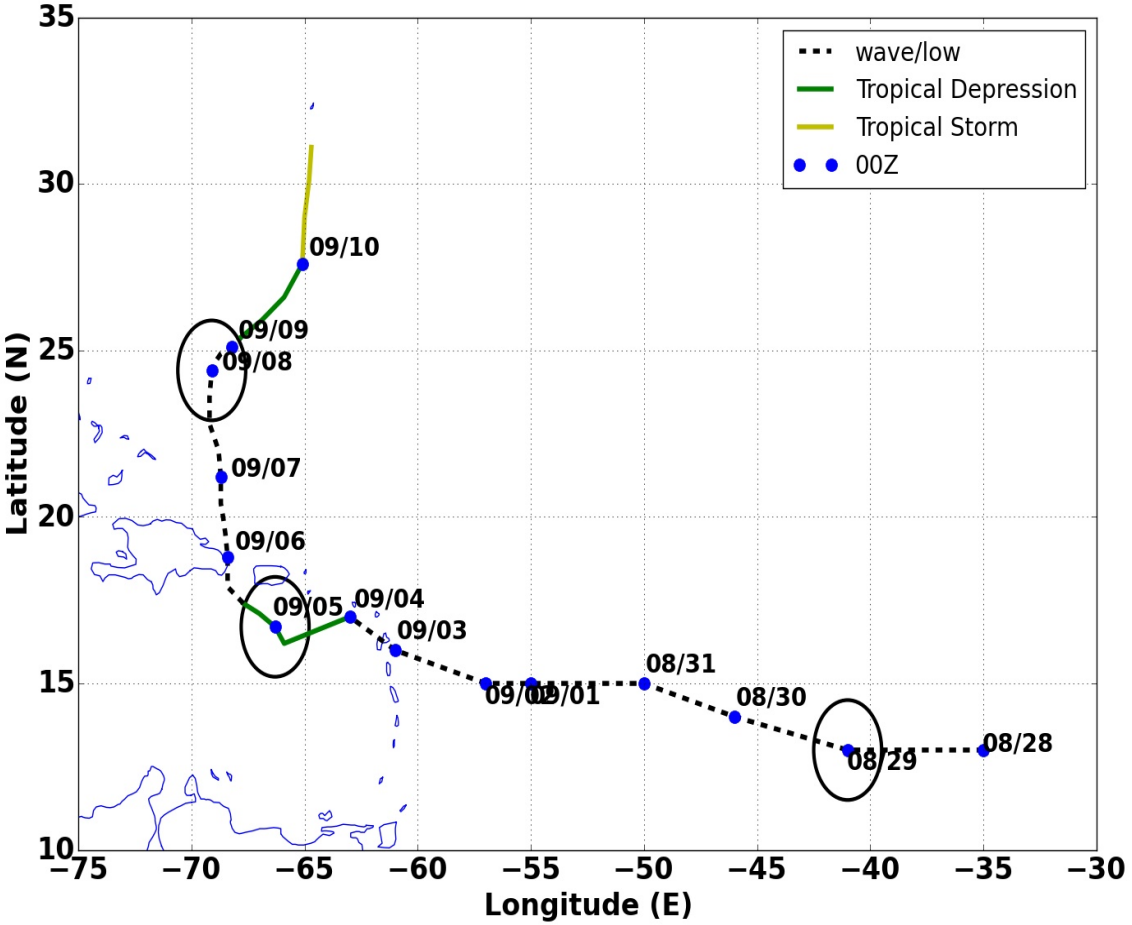
## Edouard (2014)



Source: NASA Worldview (Aqua)

# Gabrielle (2013)

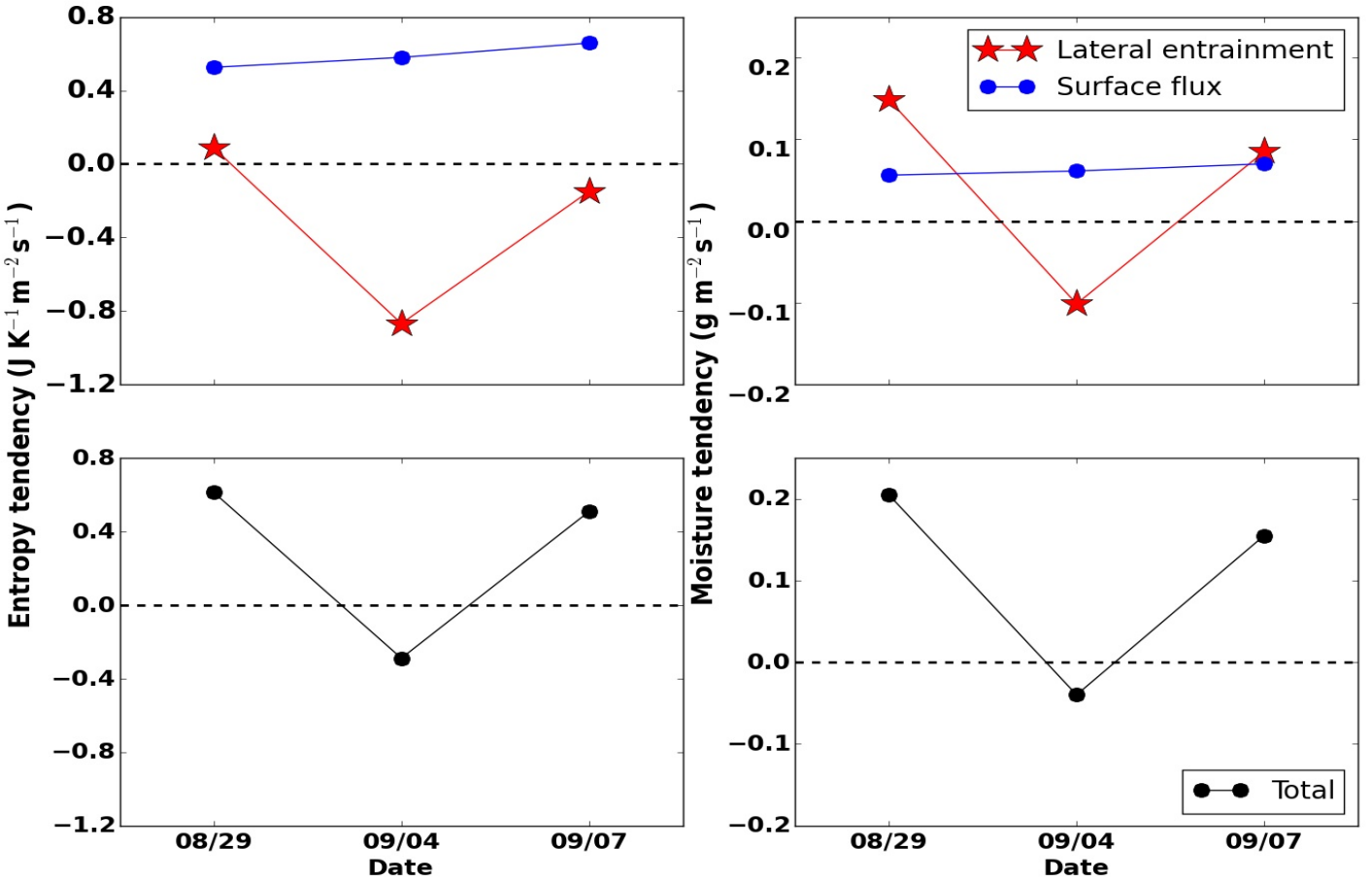


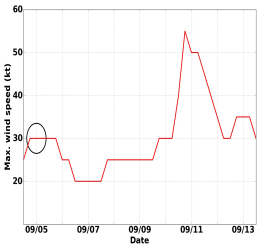
# Gabrielle: Entropy and moisture tendencies

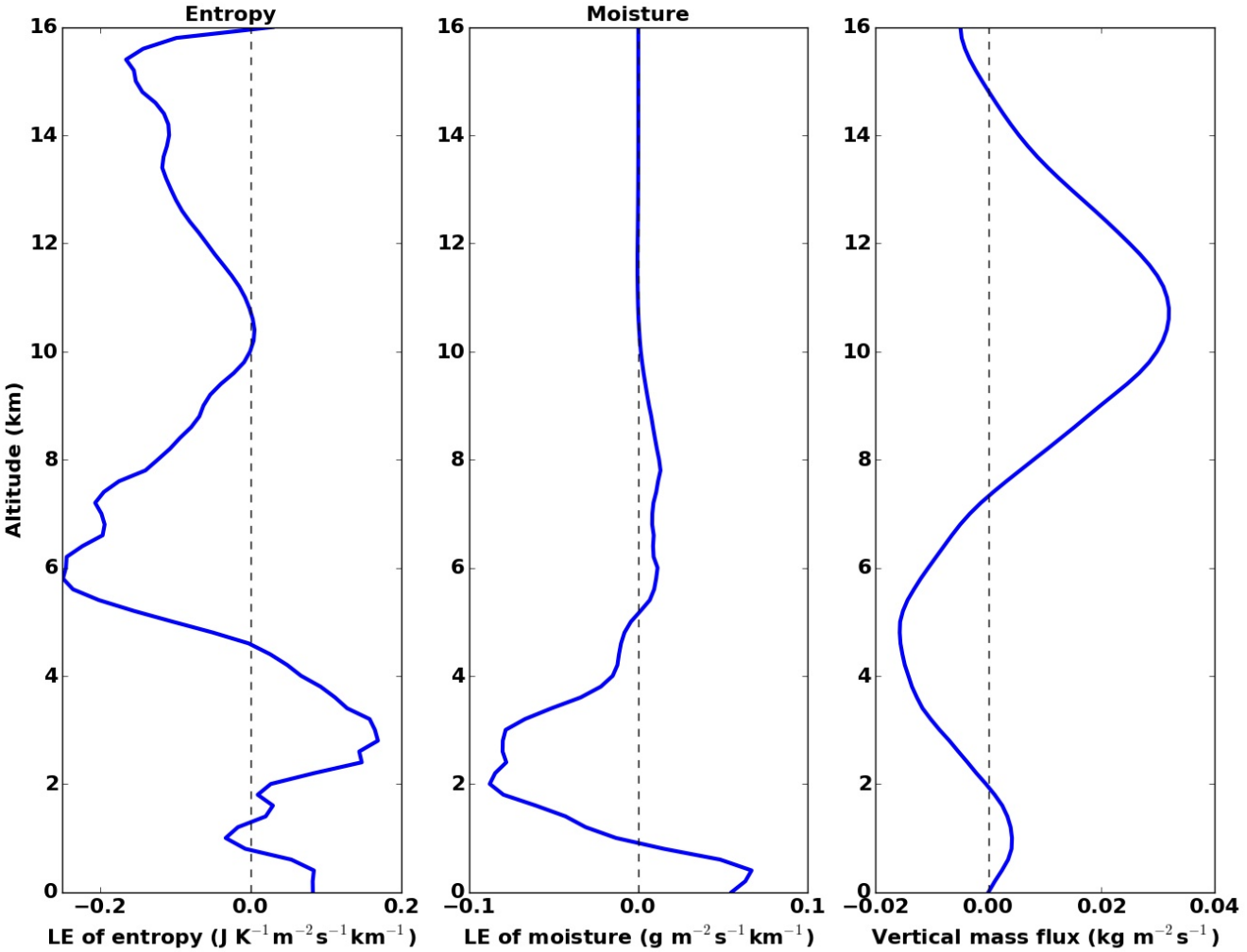
Entropy

Moisture

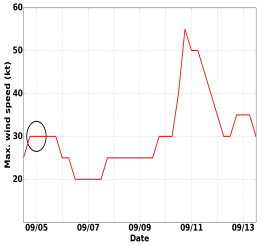


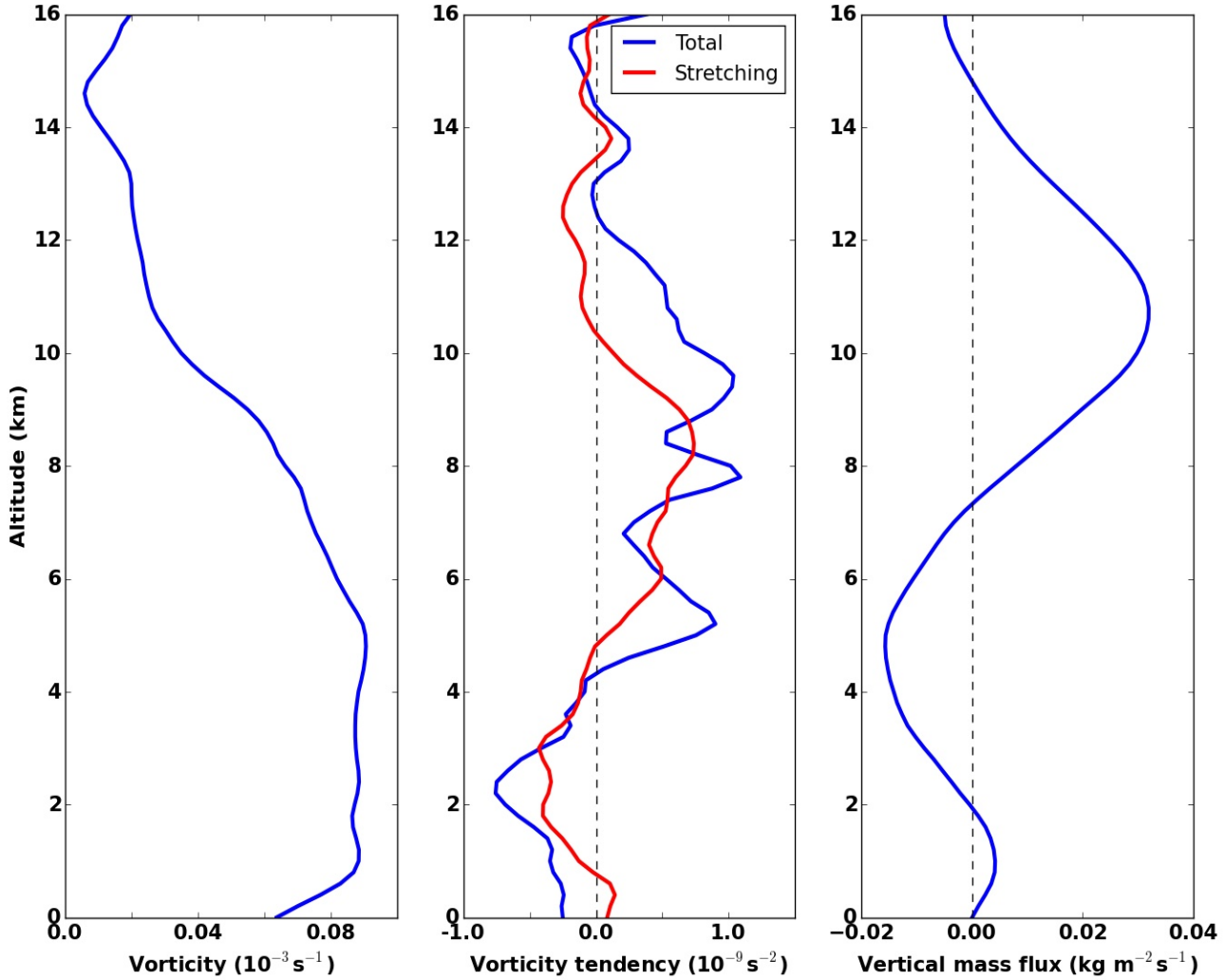
# Lateral entrainment (LE) of moisture and entropy, vertical mass flux
# Gabrielle (09/04-05/2013), decaying case



# Vertical profiles of vorticity, vorticity tendency and vertical mass flux
# Gabrielle (09/04-05/2013), decaying case



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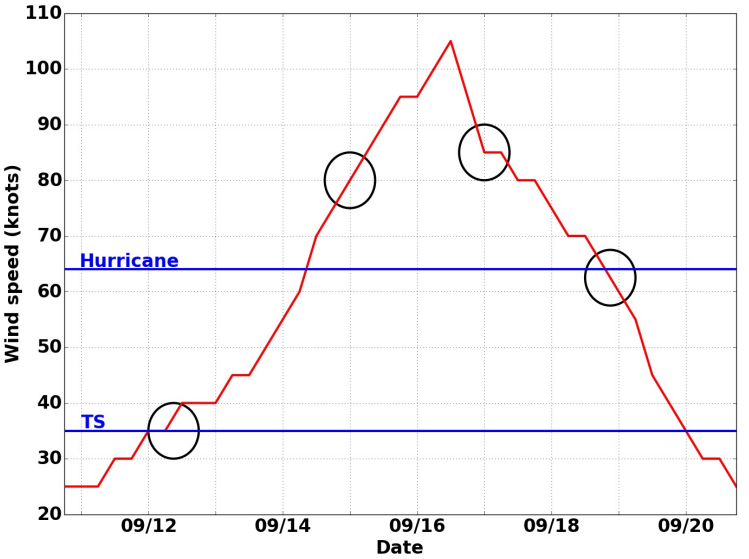


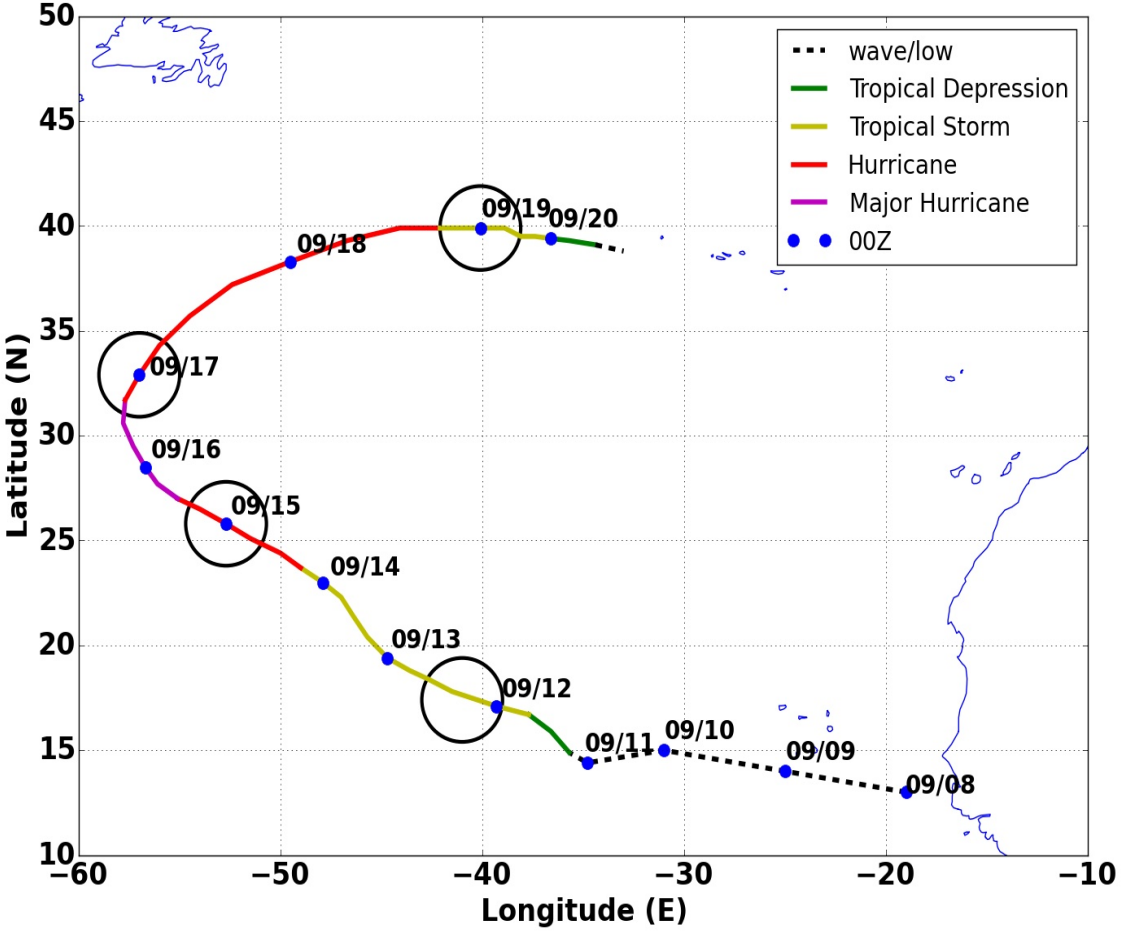

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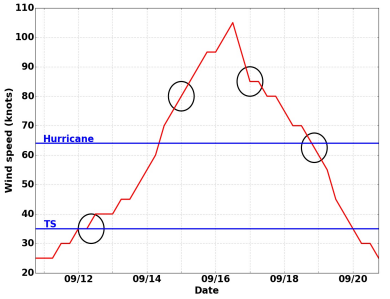
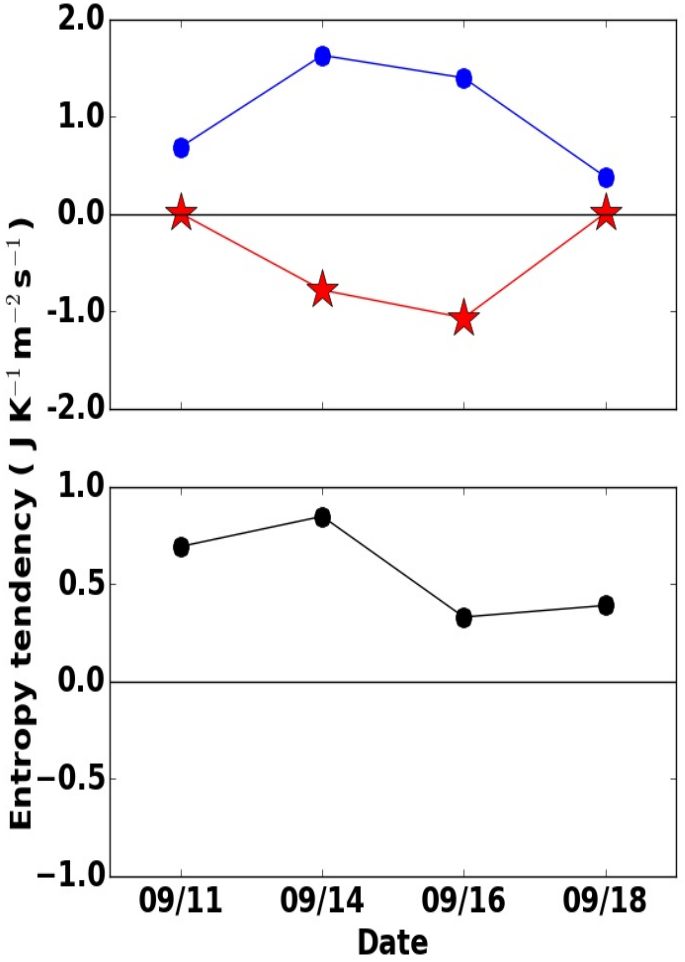
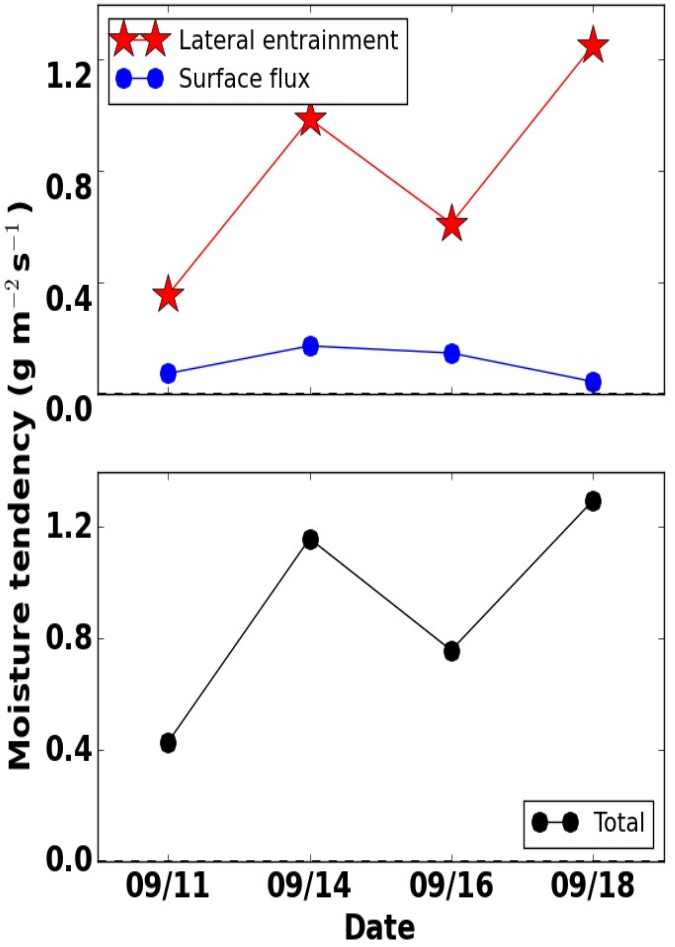



Entropy

Moisture



# Lateral entrainment of moisture and entropy, vertical mass flux
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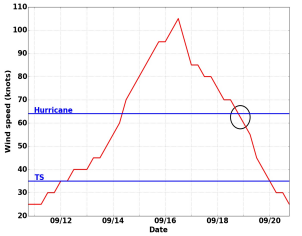


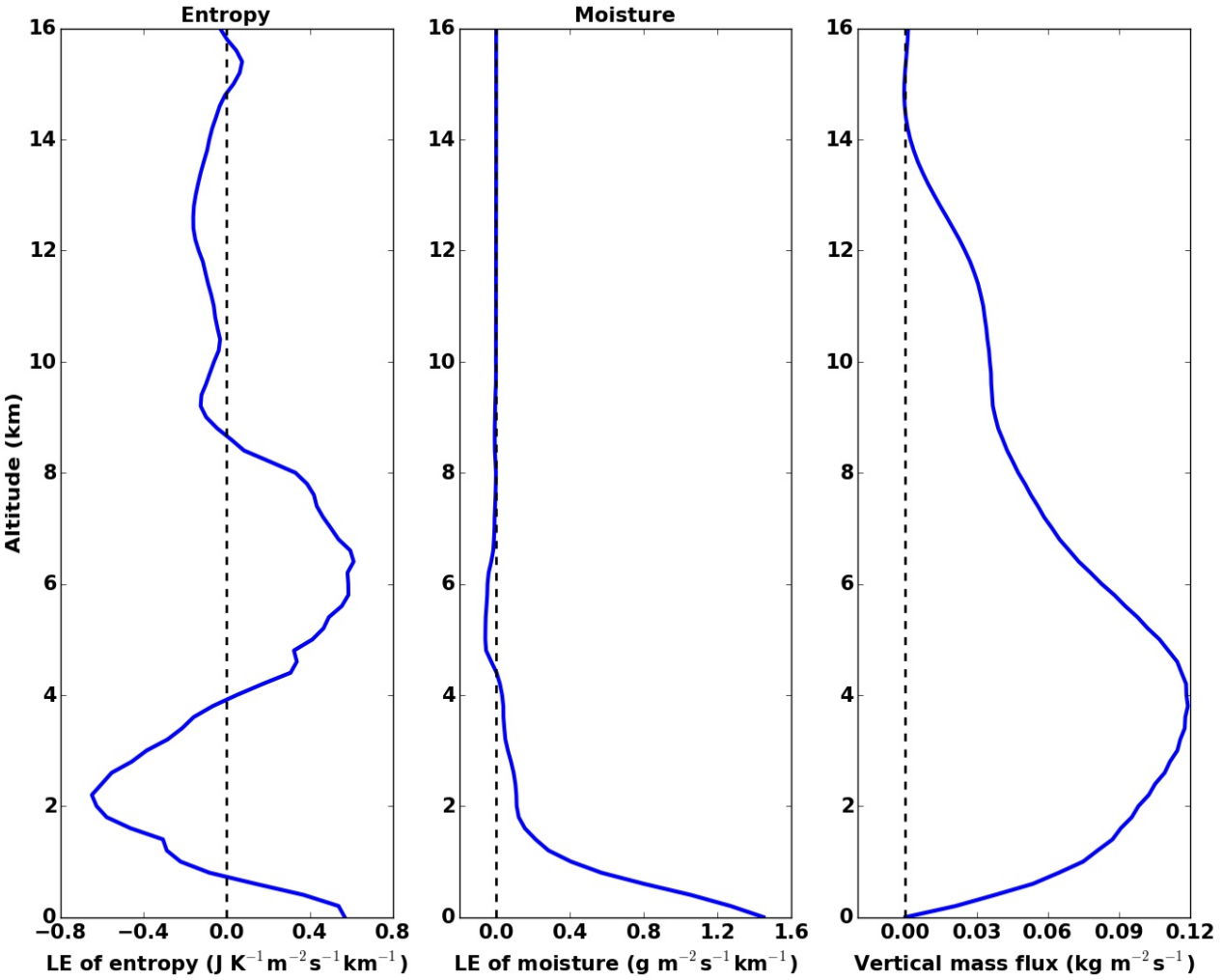

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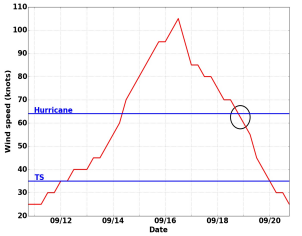


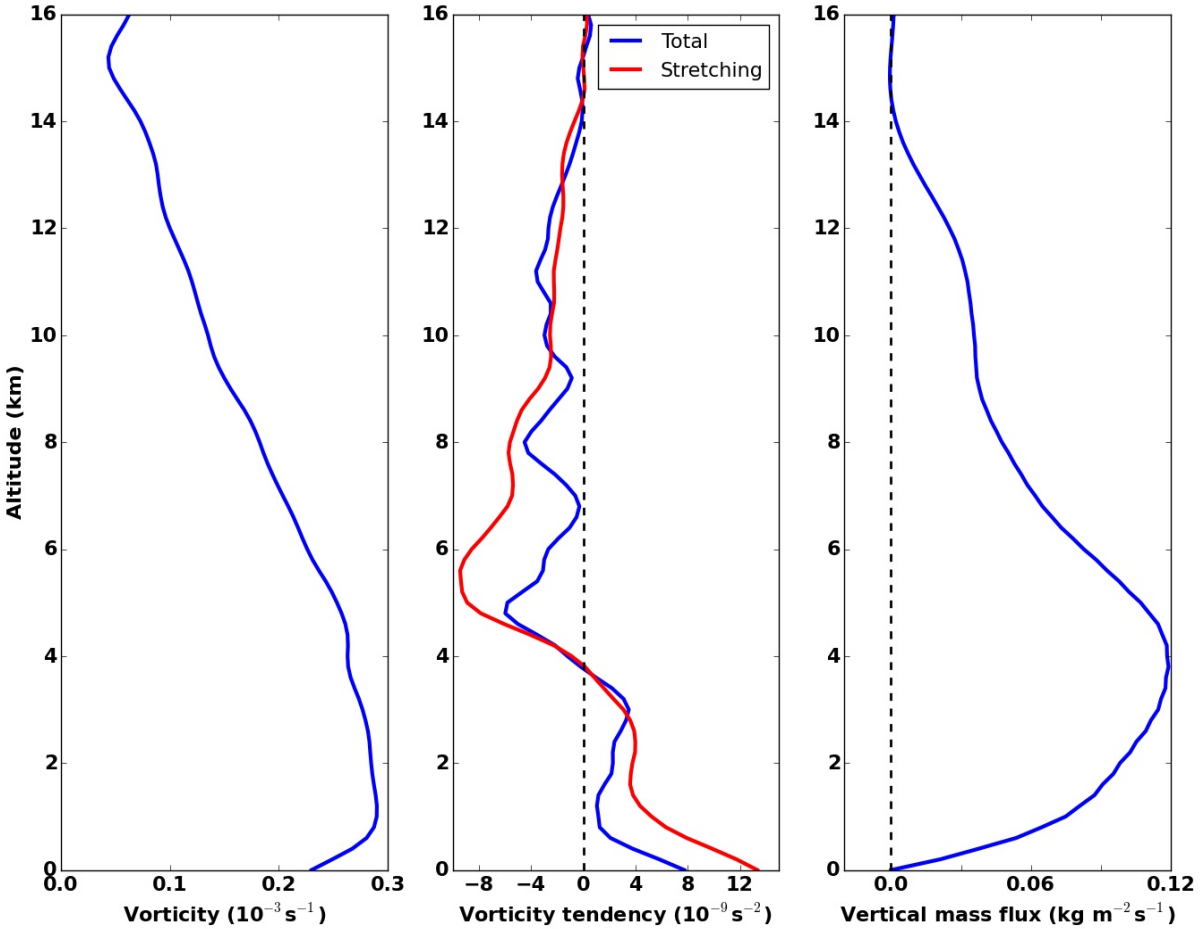

# Conclusions

- Moist entropy tends to increase more in developing cases
- Surface fluxes are counteracting the loss due to lateral detrainment, which grows with increasing intensity
- On 09/04/2013 Gabrielle had subsidence and strong dry air intrusion at 2-4 km
- Edouard's decay on 09/18-19/2014 partially due to strong divergence at 4-8 km