The Moist Entropy Change in Hurricane Nadine

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The Entropy Change

- Moist entropy, s

- 3-D divergence of entropy flux: includes input/output on the sides + at the top

  ➢ Positive = export

  ➢ Negative = import

- Only one part of entropy budget
  - No surface or radiative fluxes
  - No irreversible generation of entropy
- Contains information about moistening/drying of the system
- Raymond et al. (2011) – if entropy export is small or negative – potential for development

Data

- QC dropsonde data from HS3 missions into Nadine

- Good data coverage – vertical and horizontal

- Covers the entire system

- Problem: some data missing close to the surface – those drops not used

- 4 missions (2012) used in analysis:

    1. September 14: TS becoming a hurricane

    2. September 19: TS, intensified later

    3. September 22: low becoming TS again

    4. September 26: TS, became a hurricane 2 days later

Methods

- Data interpolated onto regular grid: 3D-VAR analysis

- Mass continuity imposed

- Grid points distance:
  - ➢Horizontal: 0.5°x0.5°
  - ➢Vertical: 0.625 km

- Vertical domain: 0-17 km

- Horizontal domain: specific area selected, to cover the storm – from vorticity field

Methods – calculating the entropy change

- Divergence of moist entropy flux:

$$\vec{\nabla}\cdot\left(\rho\,\vec{v}\left(s-s_0\right)\right)$$

$\rho =$ density

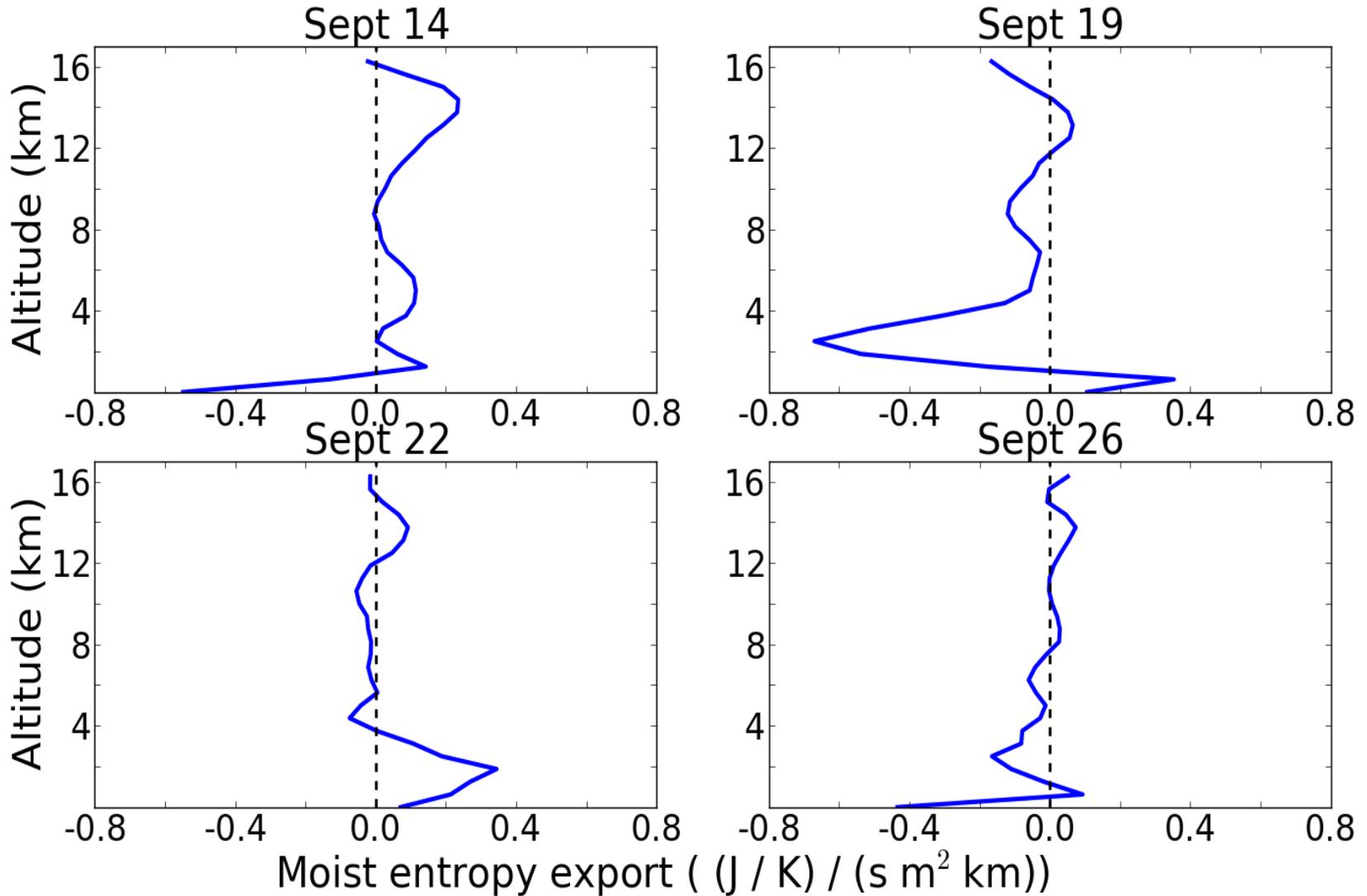$s\text{-}s_0 =$ moist entropy perturbation (per unit mass)

$\vec{v} = (u,v,w) =$ wind vector

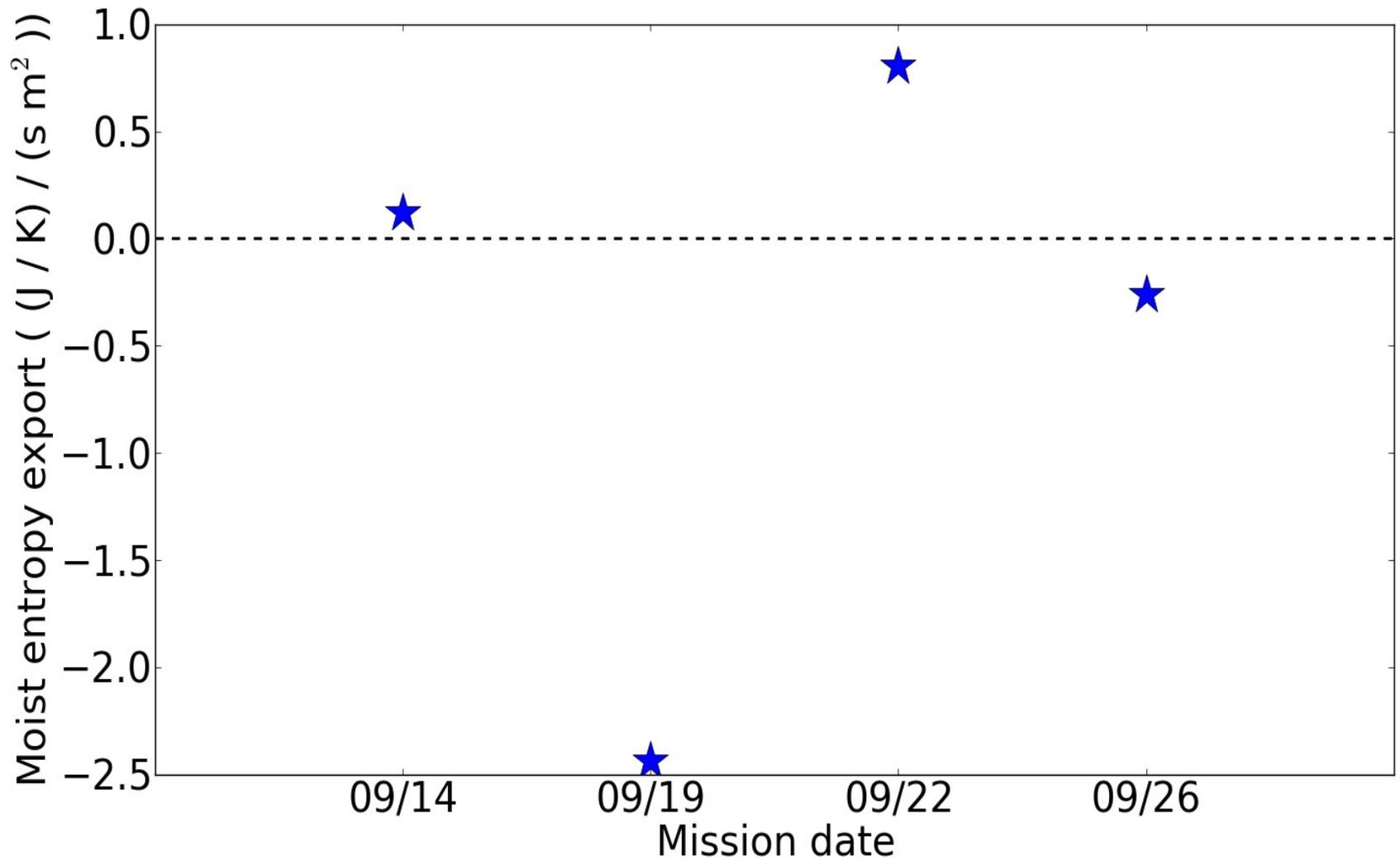- Horizontally averaged and vertically integrated → Entropy export
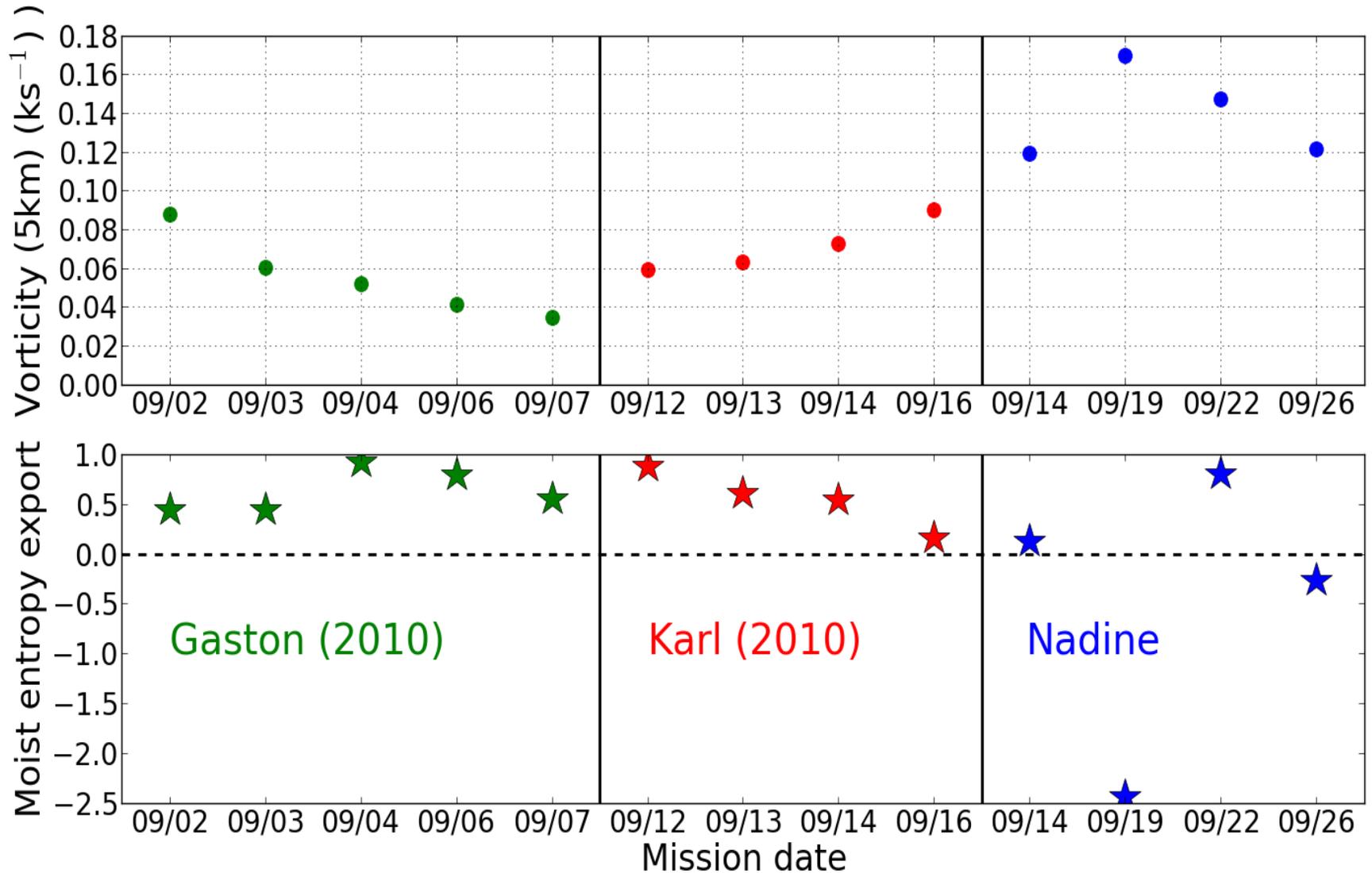
Results

Vertical profiles of horizontal export (Nadine)

Moist Entropy Export (Nadine)

Comparison to other cases

Conclusion

- During 2 missions into Nadine (Sept 19 and Sept 26) moist entropy increased due to overall import

- At the time of other 2 missions (Sept 14 and Sept22) moist entropy slightly decreased due to overall export

- Agrees with the assumption that the moist entropy export should be small or negative to strengthen the storm (except Sept 22)

- However, other parameters need to be considered as well

Thank you!