Stratocumulus Cloud Modeling

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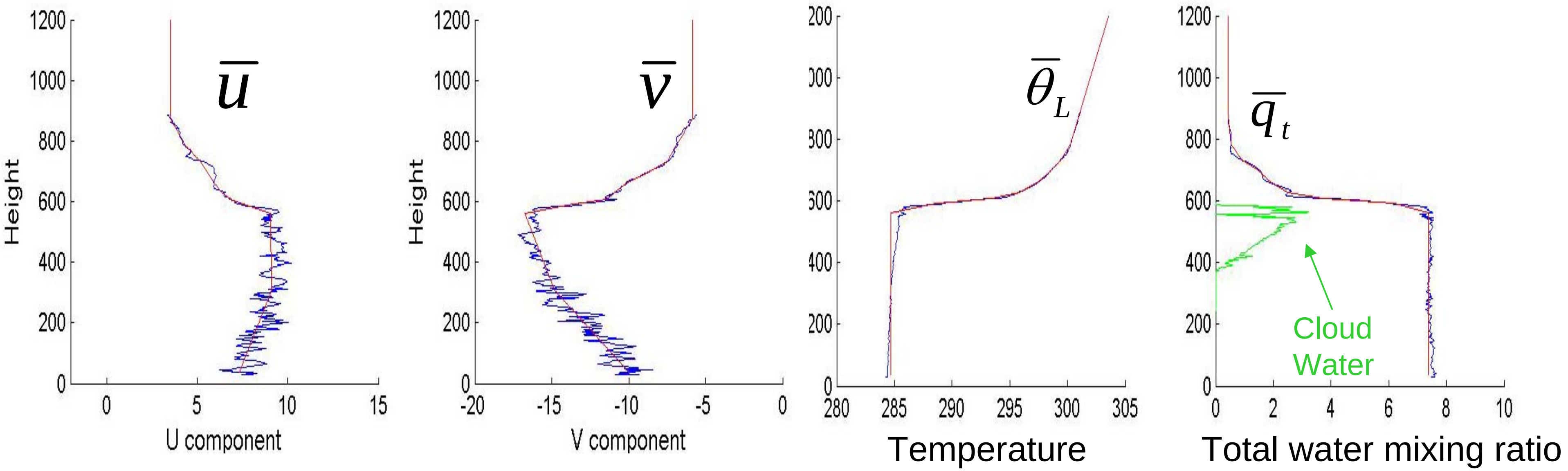
- **Research issues**
  - Wind shear impact on the entrainment and cloud structure
  - Stratocumulus cloud diurnal variation in Monterey Bay area
  - Evaluation and improvement of stratocumulus simulation of COAMPS
- **Approaches**
  - COAMPS-LES and COAMPS mesoscale modeling
  - Data analysis and comparison with model output
  - Close collaboration with other PIs.

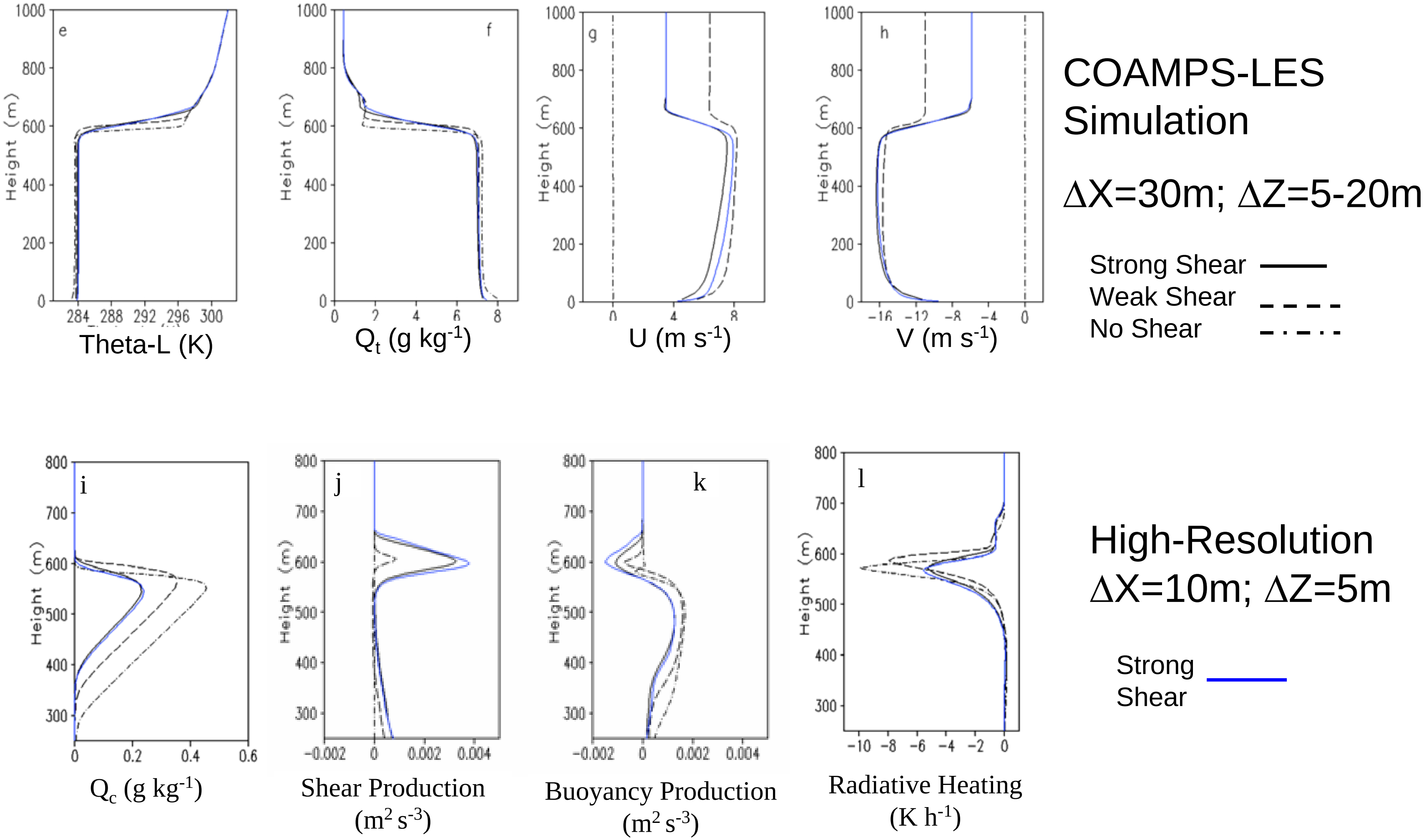
The Wind Shear Impact on the Entrainment and Cloud Structure

Aircraft observations on 8 July 1999 in Monterey Bay area in DECS (from Qing Wang)



- Strong wind shear exists at the top of clouds due to topography and land-sea contrast
- What is the effect of the intense wind shear on the entrainment?
- How does the wind shear affect the inversion structure?
- what is the response of turbulence and cloud structure to the wind shear?

The Wind Shear Impact on the Entrainment and Cloud Structure



- The intense wind shear enhances the TKE buoyancy consumption, decreases the liquid water content, and reduces the radiative cooling near the cloud top.

Wind Shear Impact on the Entrainment and Cloud Structure

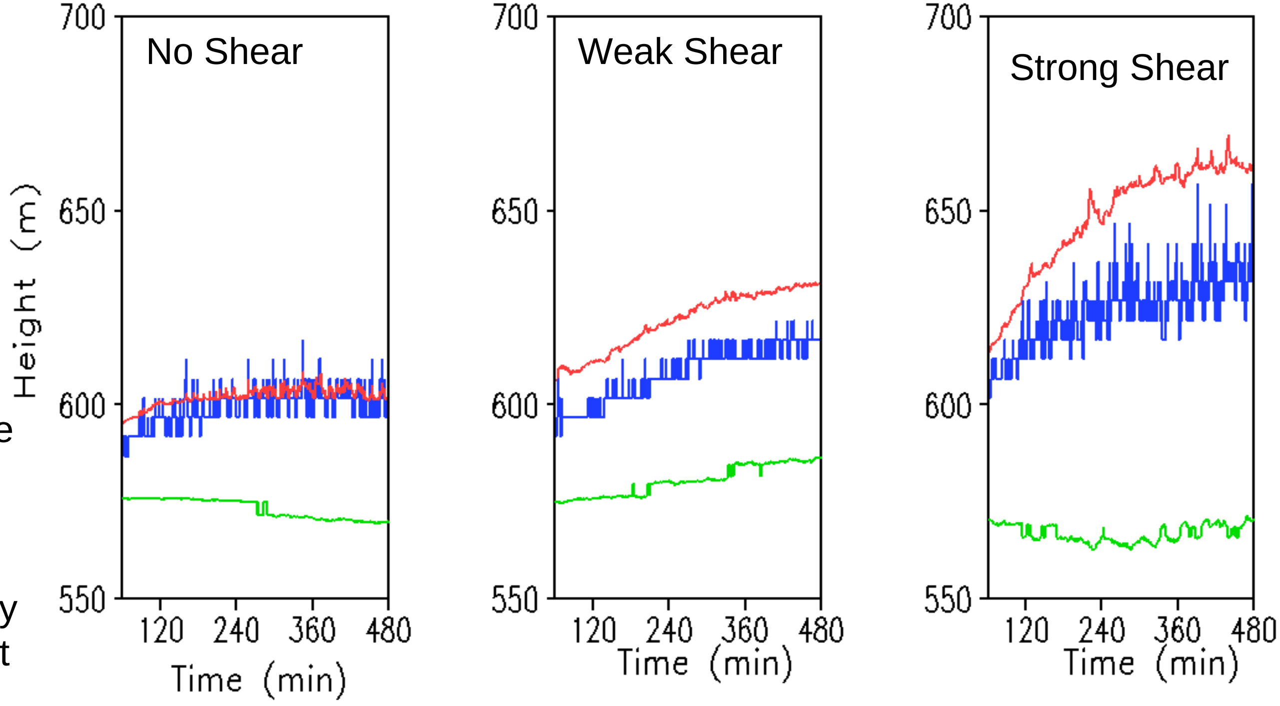
Wind shear across the inversion significantly change the inversion layer characteristics

COAMPS-LES Simulations:

Inversion top
Inversion base
Cloud top

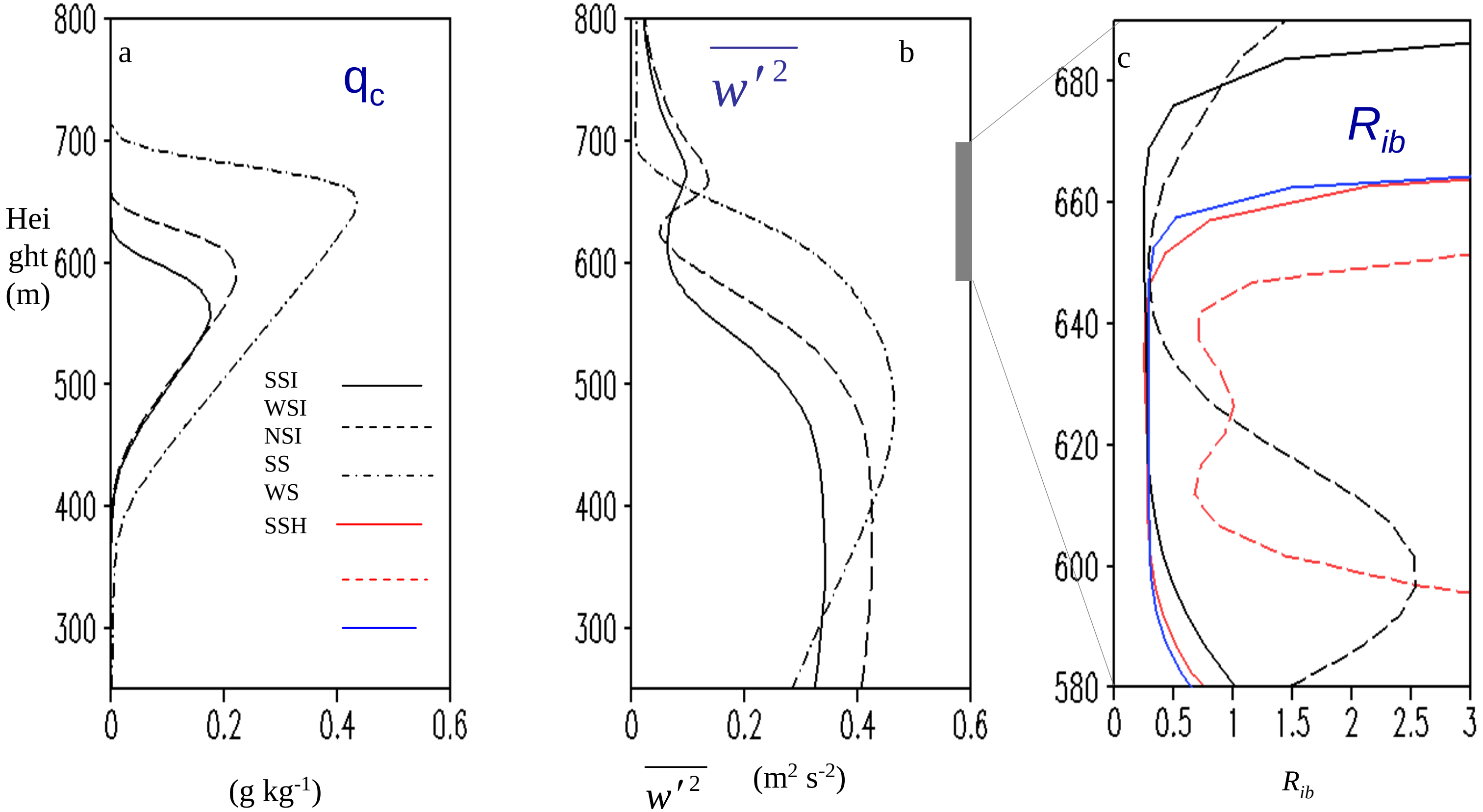
Inversion top and base are defined by $\overline{\theta_l'^2}$

Cloud-top is defined by the level of the highest cloudy grid point.



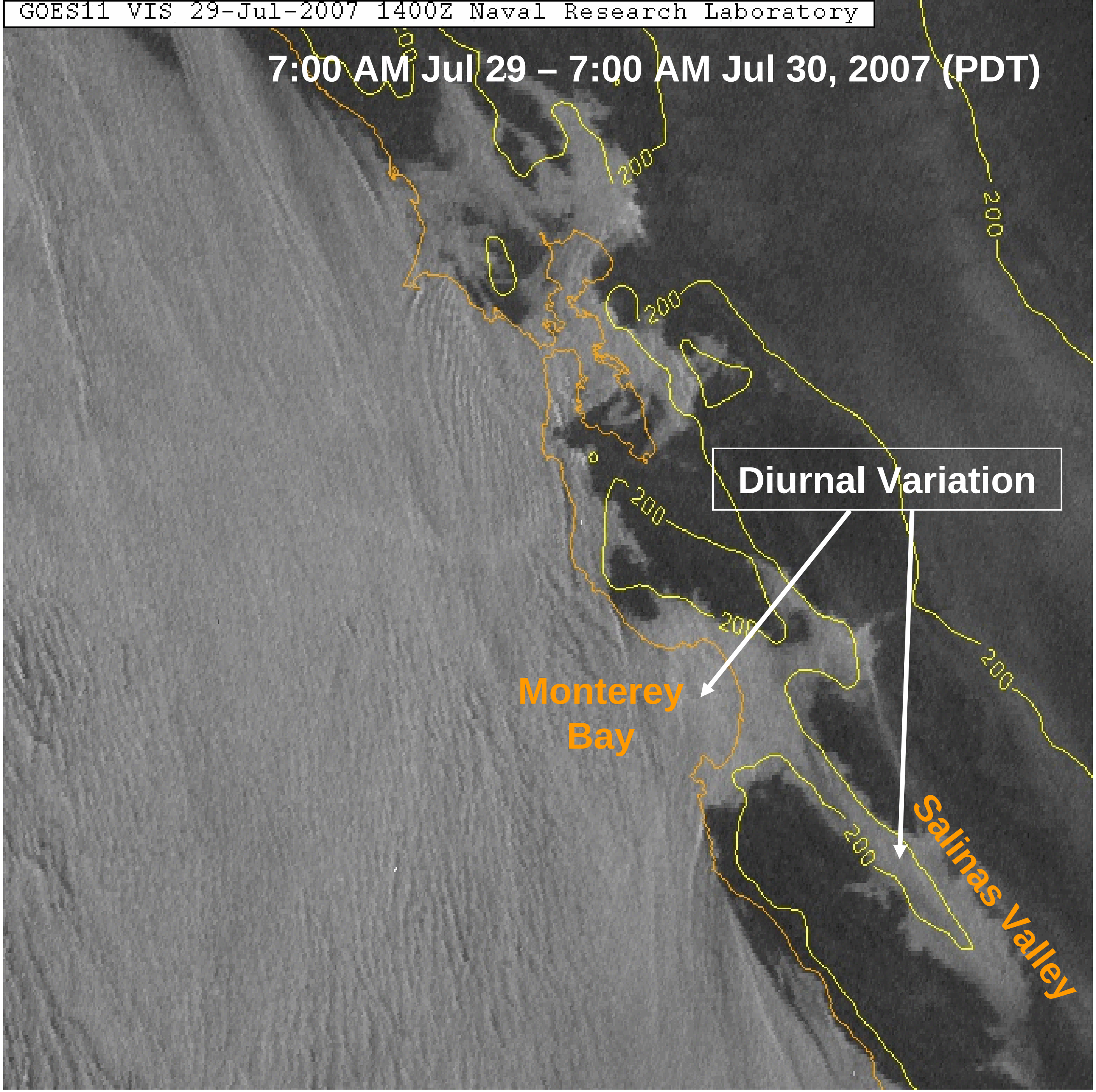
- The entrainment mixing is enhanced by the wind shear;
- A separation between the cloud top and inversion top is produced;
- This separation layer thickness is proportional to the intensity of the wind shear.
- Data need: soundings, entrainment zone, surface and cloud layer turbulence and cloud microphysics.

Impacts of Inversion Stability and Wind Shear



- Increased wind shear with reduced inversion stability leads to a significant reduction in cloud water and top height.
- It significantly thickens the inversion layer
- Bulk Richardson number of in the inversion approaches to 0.3 with increased instability

07Z29-
07Z30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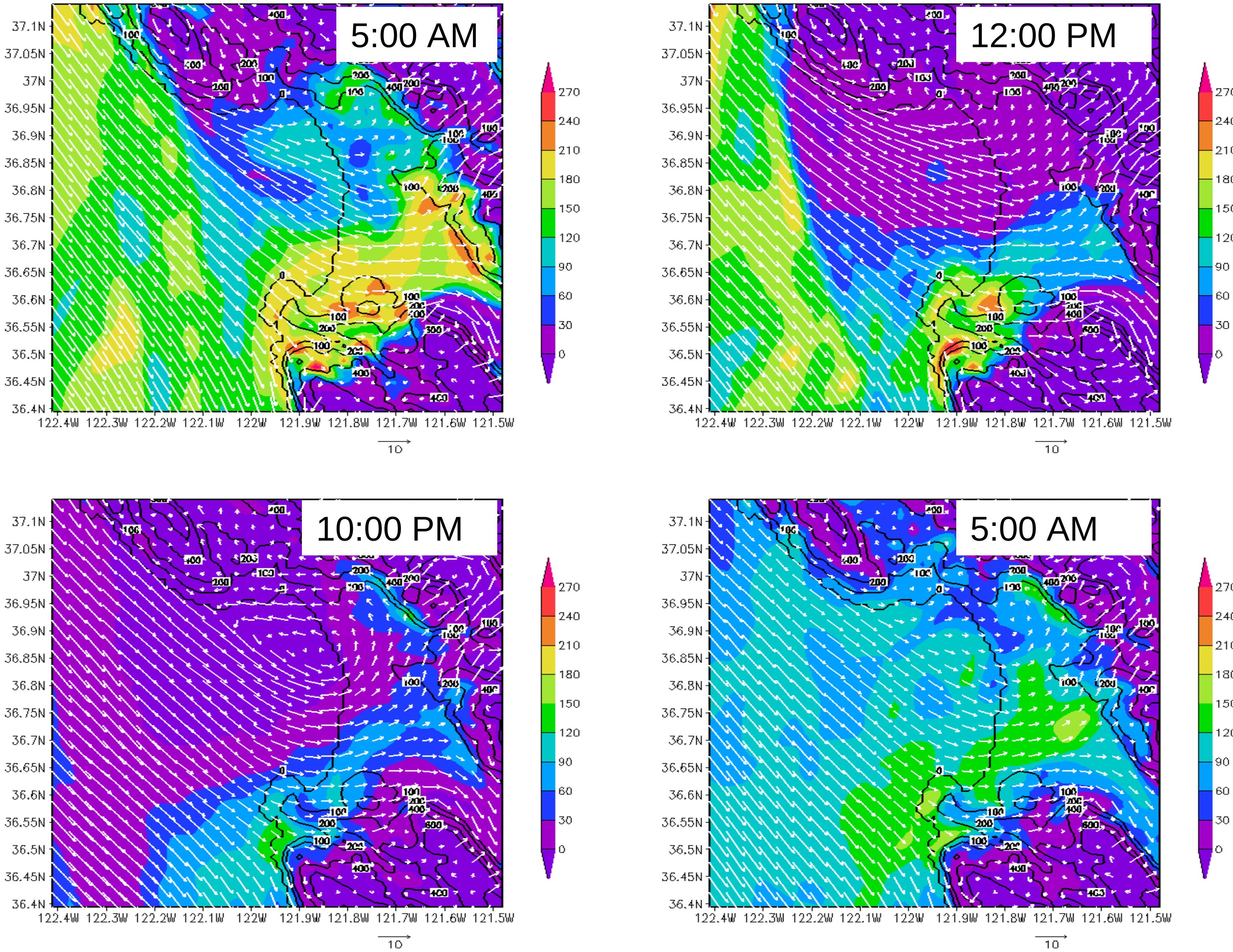
Diurnal Variation
Monterey Bay
Salinas Valley
200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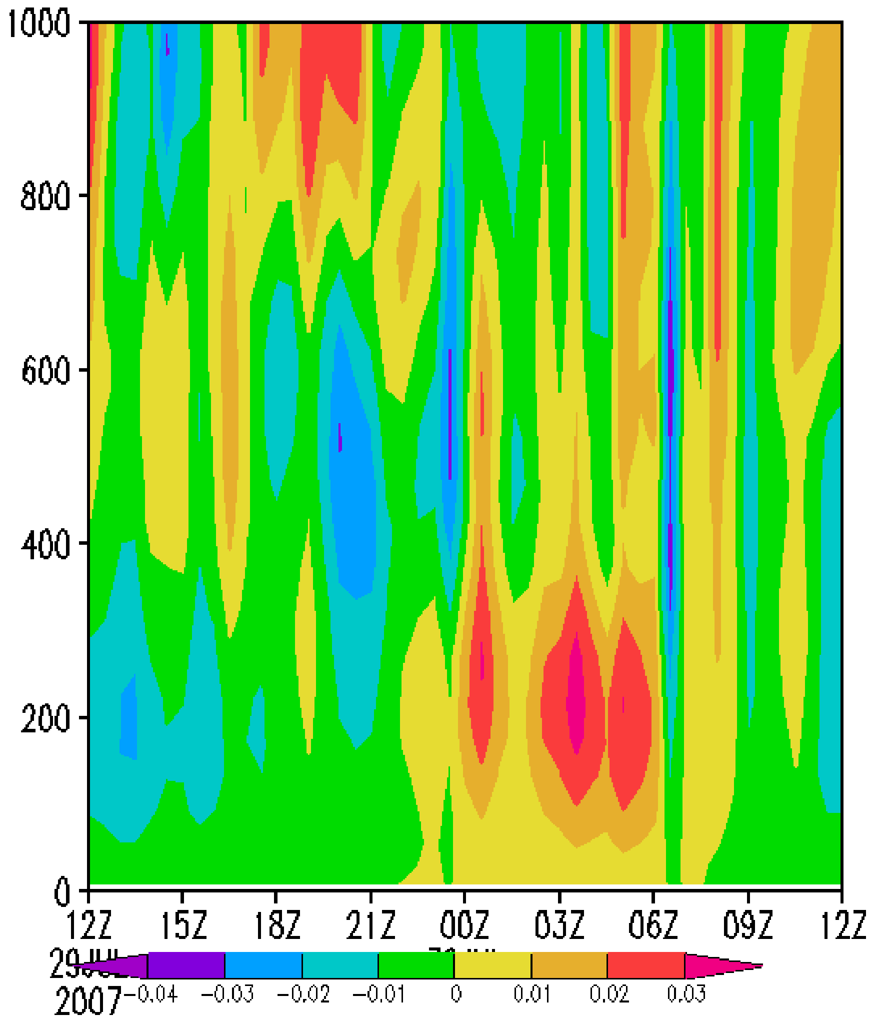
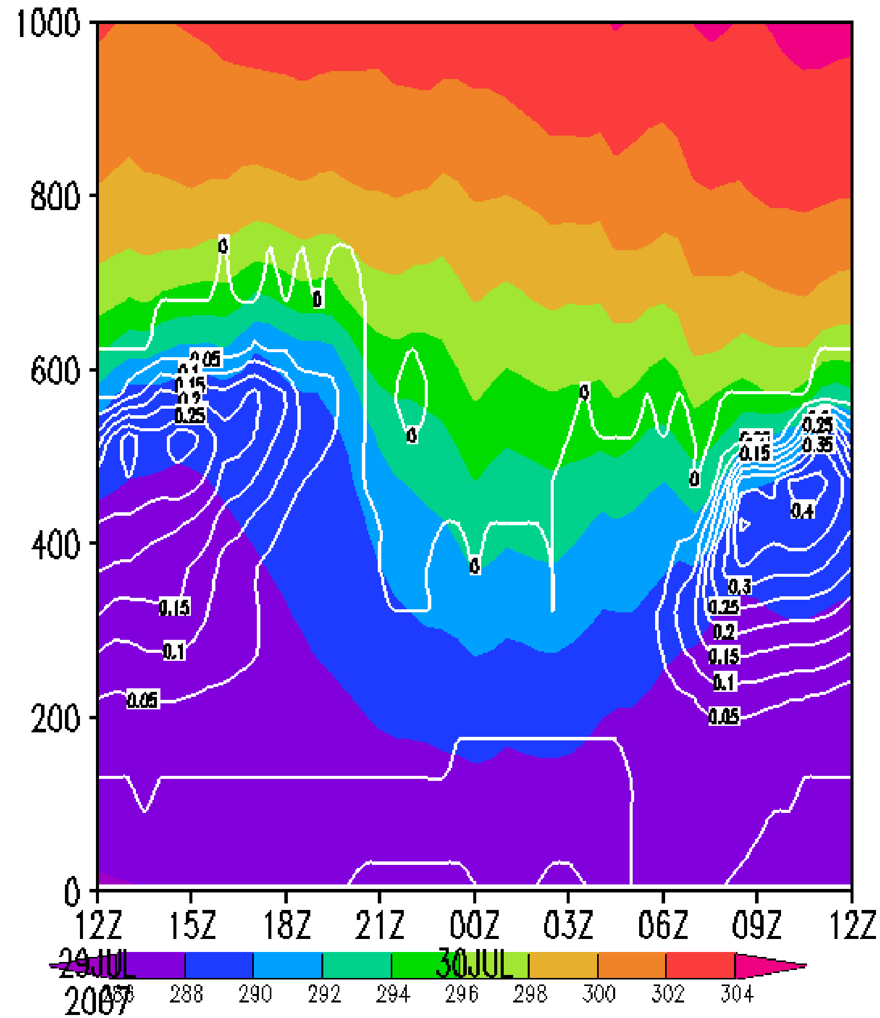
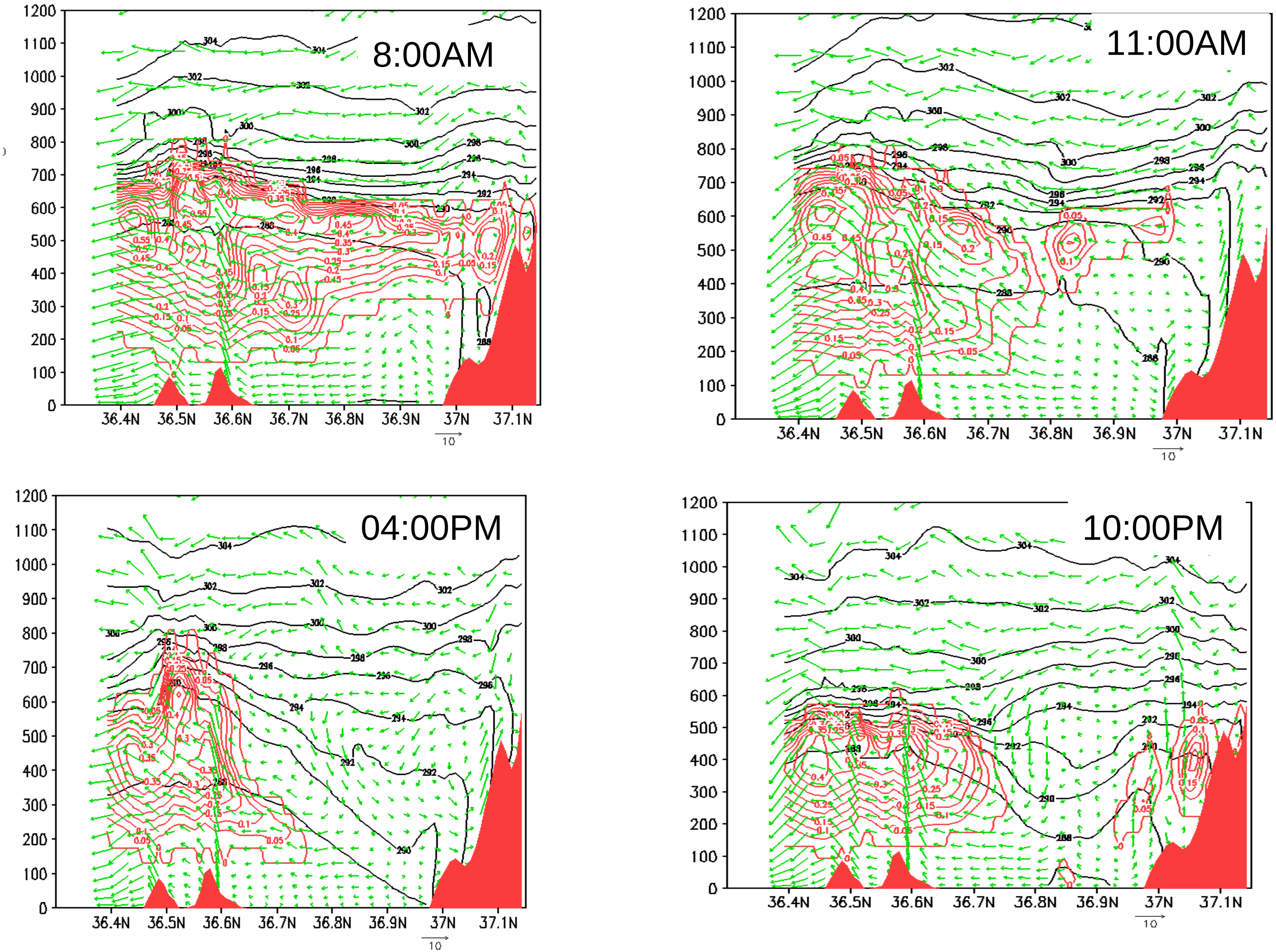
Diurnal Variation of Stratocumulus Clouds in Monterey Bay

Mbay area averaged vertical motion



Mbay area averaged θ and q_c

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Collaborations

- Anthony – COAMPS radiation evaluation, simple scheme for LES
- Qing – Shear COAMPS-LES case studies
- CIRPAS, and UCI – COAMPS forecast evaluation and mesoscale processes (Sounndings)
- Other modeling groups on some case studies (Intercomparison case?)
- COAMPS mesoscale forcing

Scientific Questions

- What is the local wind shear effect vs. mean shear on the entrainment
- How significant is the effect of wind shear mixing in reducing buoyancy driven entrainment?
- What is the role of critical Richardson number?
- How to represent the shear driven entrainment in a mesoscale model