Interpretation of AUAV data with 3D radiative transfer models

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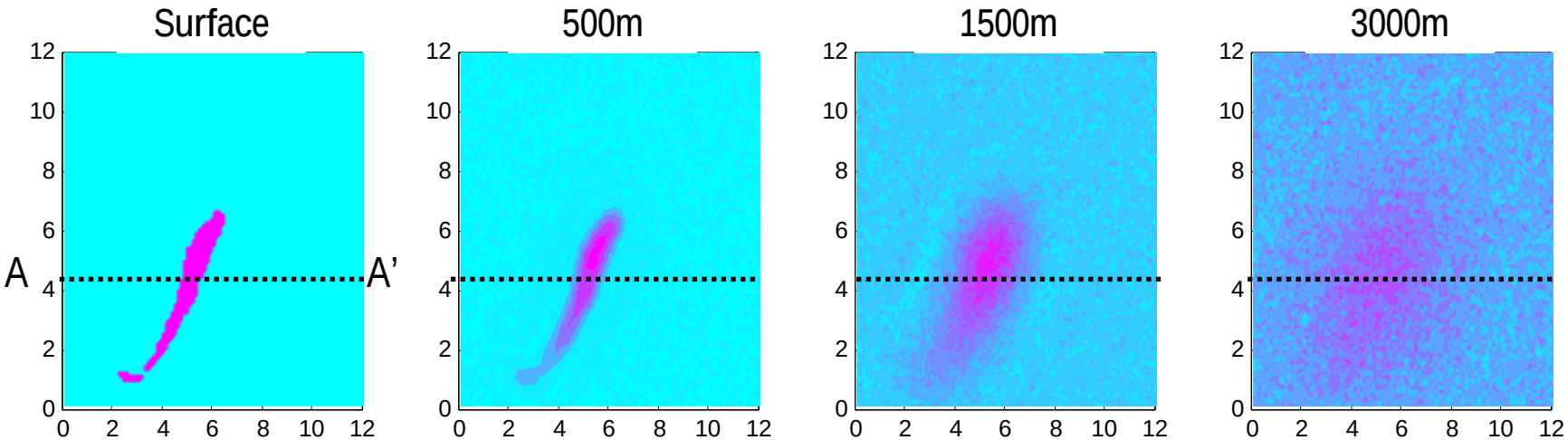
Objectives

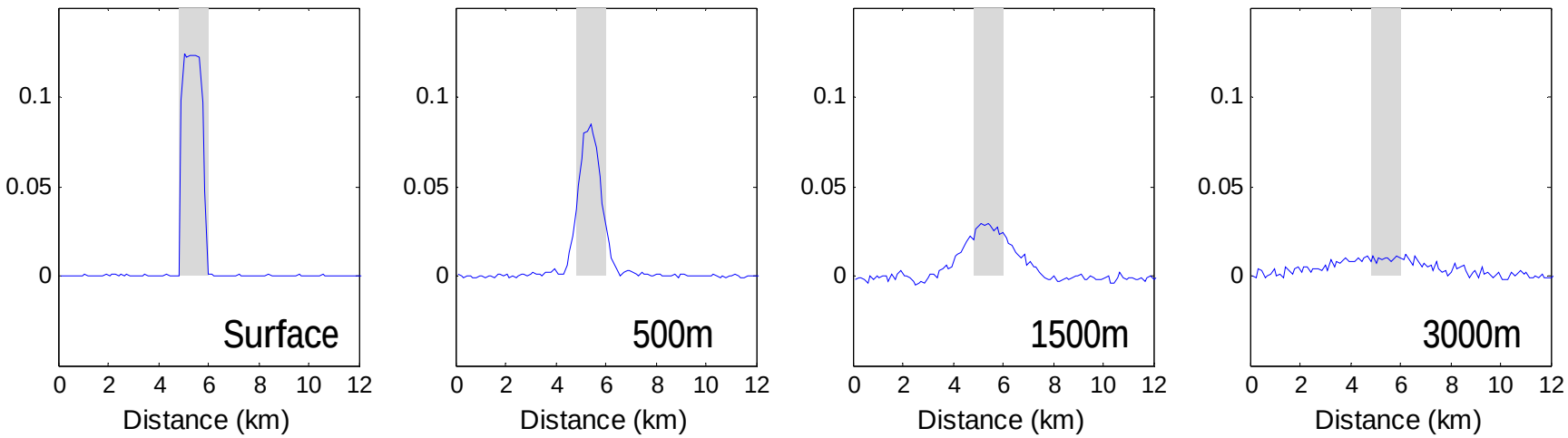
- Interpretation of UAV observation by 3-D model
  - ✓ *Investigation of island effect on UAV radiation measurements*
  - ✓ *Minimum distance from island to avoid possible contamination on UAV measurement*
  - ✓ *Simulation of observed flux by radiative transfer model*
    - Simulation of horizontal/ vertical albedo distribution
    - Effect of spectral dependence of island albedo (vegetation and sand)
    - Flux comparison between observations and calculations.
- Retrieval of atmospheric absorption and heating rate
  - ✓ *Estimate and comparison of atmospheric absorption and heating rate under clear and all sky conditions*

→ Improve the understanding of <u>atmospheric absorption.</u>

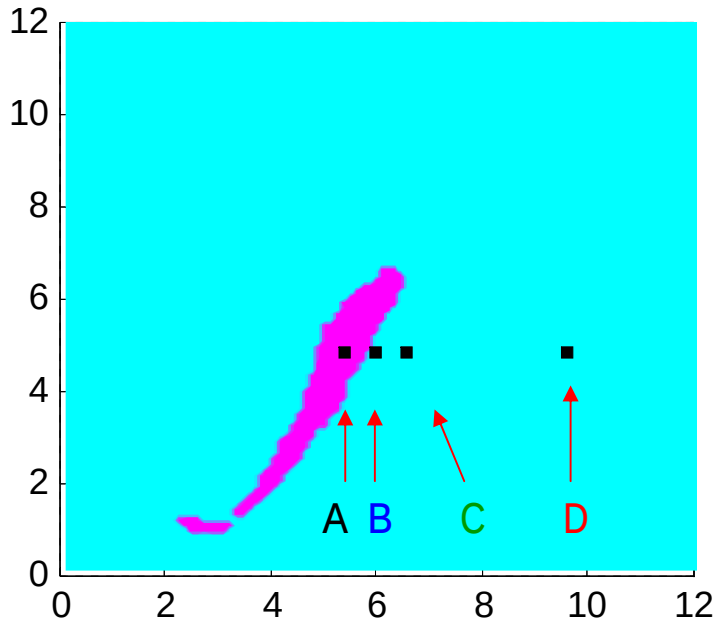
Horizontal distribution of albedo due to island effect

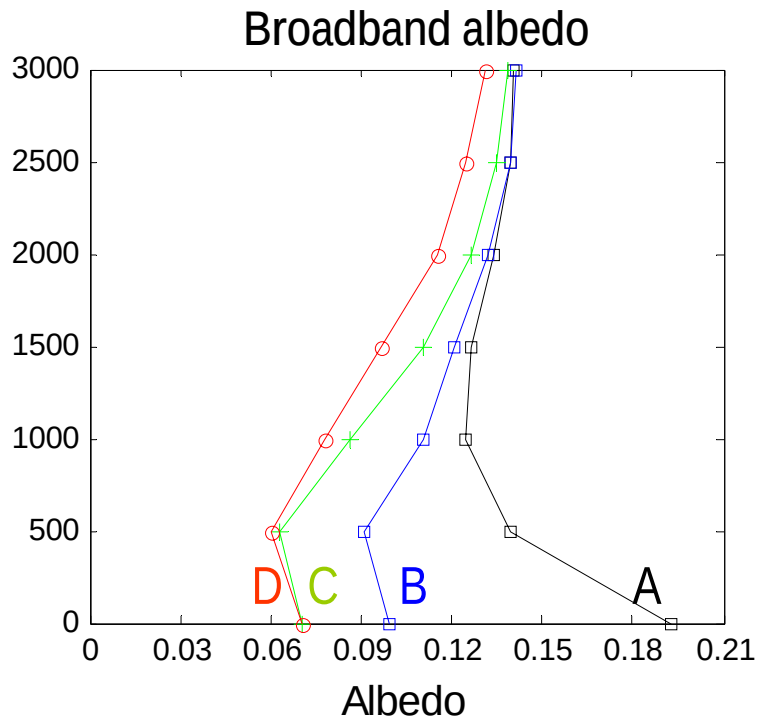


Removal of background albedo



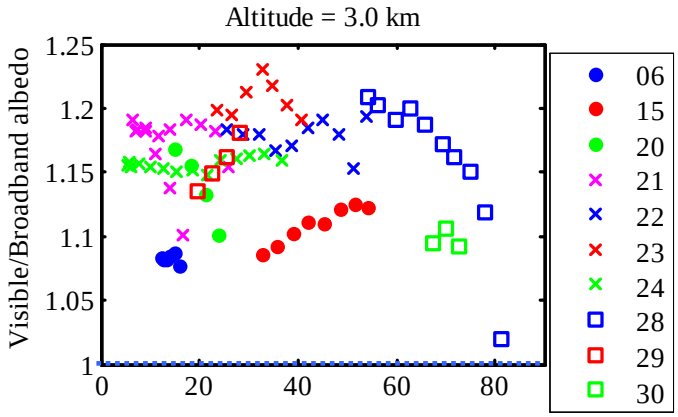
Vertical distribution of albedo due to island effect





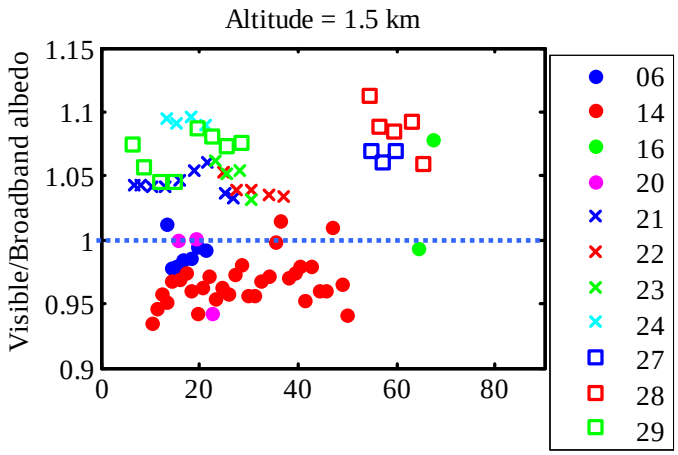
Vertical Albedo Ratios of α_{VI} vs α_{BB}:

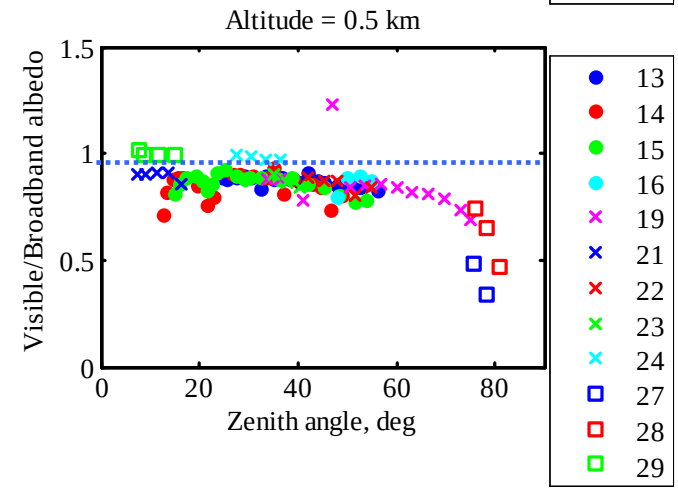
- Visible albedo (α_{VI}) *vs.* Broadband albedo (α_{BB})



3000m

$\alpha_{VI} > \alpha_{BB}$



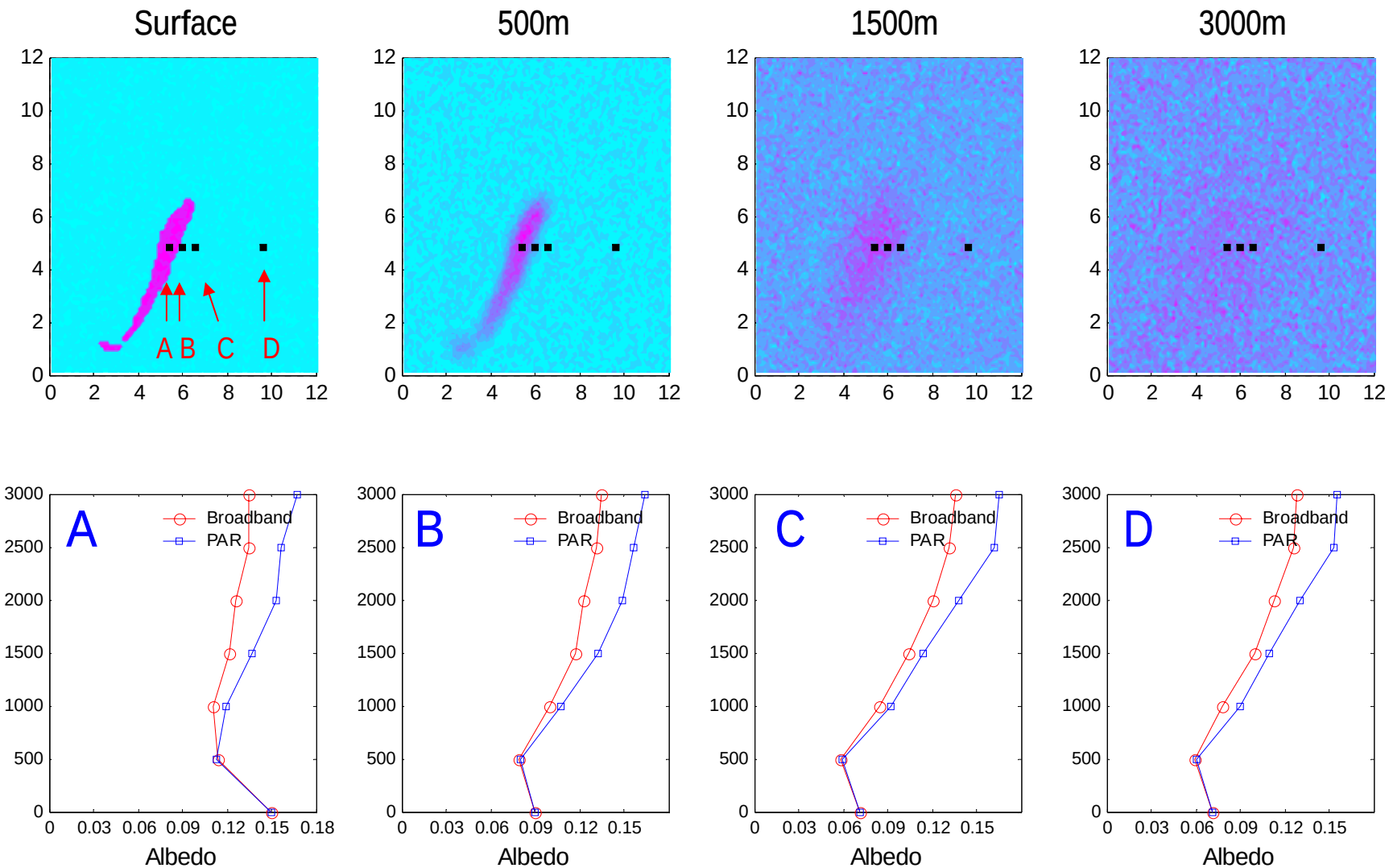


500m

$\alpha_{VI} < \alpha_{BB}$

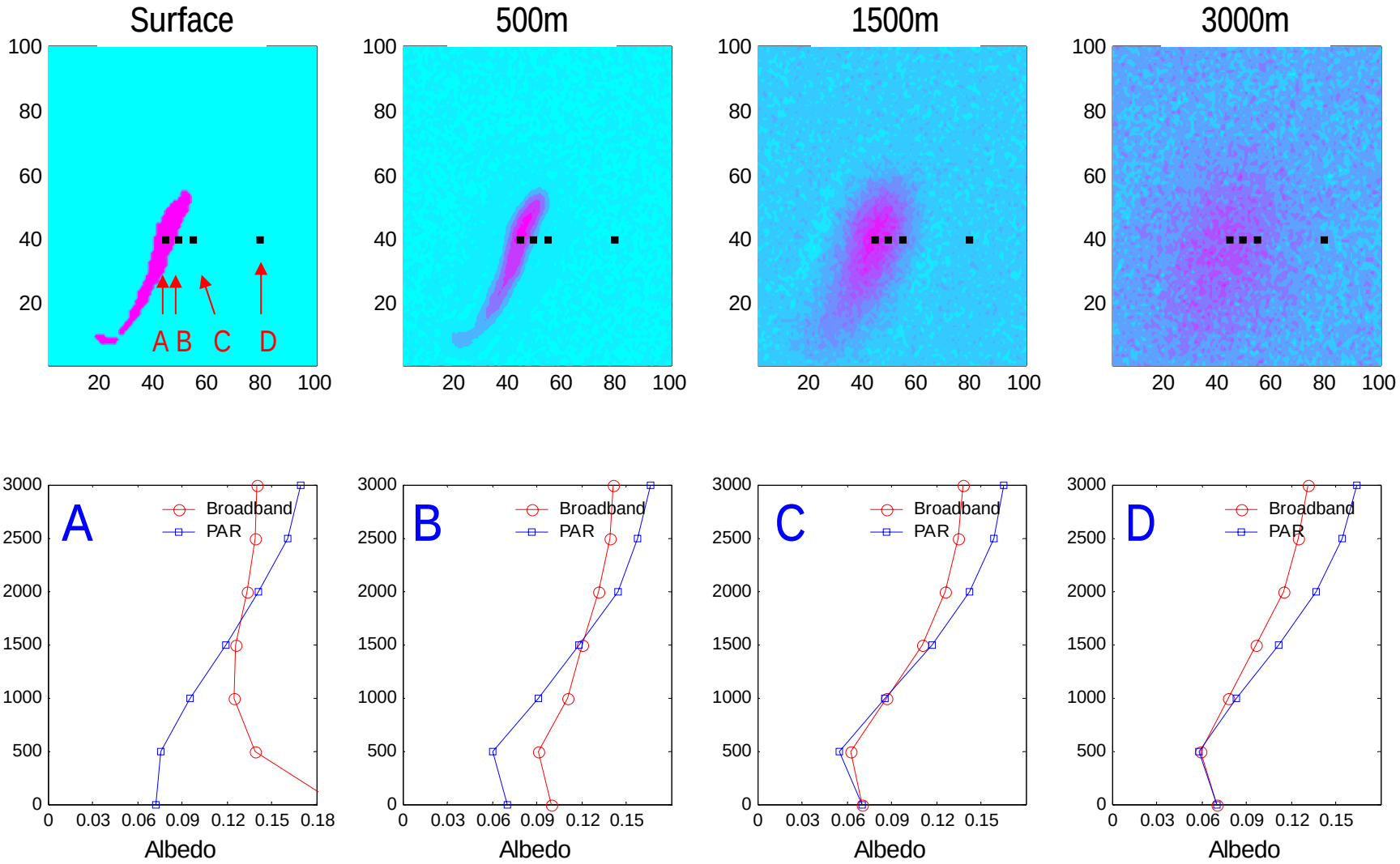
Vertical Island (Vegetation) albedo

: *without wavelength dependence*



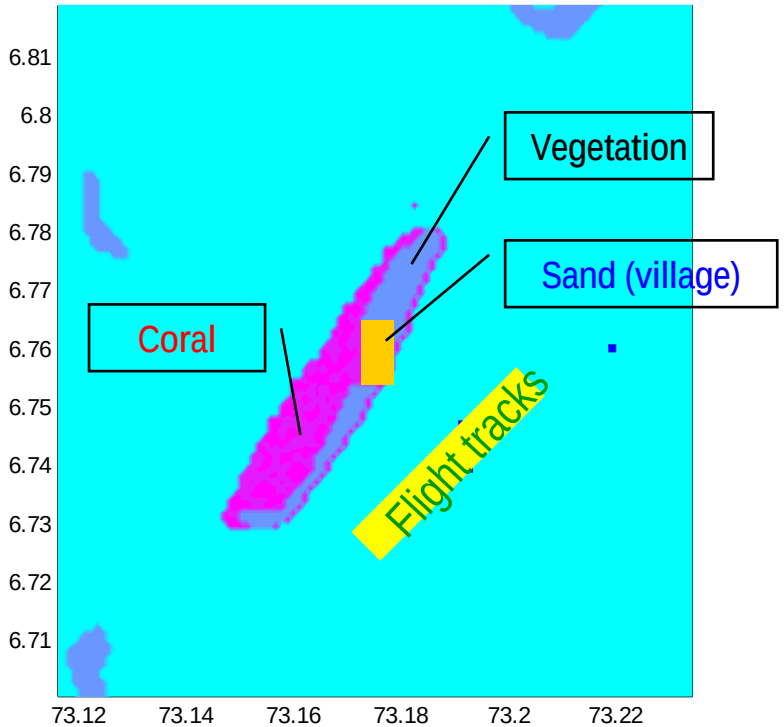
Vertical Island (Vegetation) albedo

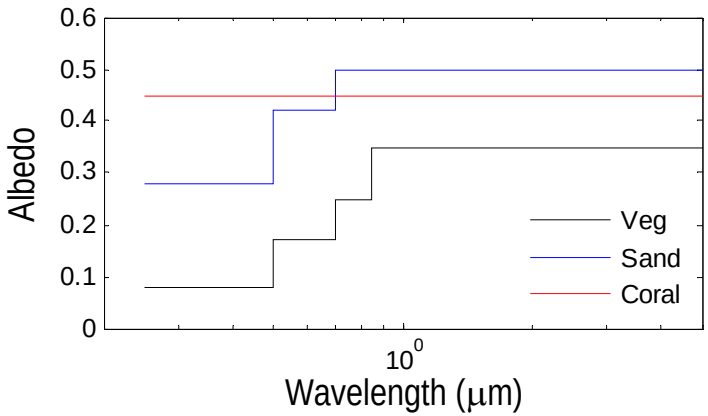
: *with wavelength dependence*



Ref: Briegleb and Ramanathan (1982)

Island surface albedo





Ref: Briegleb and Ramanathan (1982)

Simulation of UAV observed radiation by 3D MACR

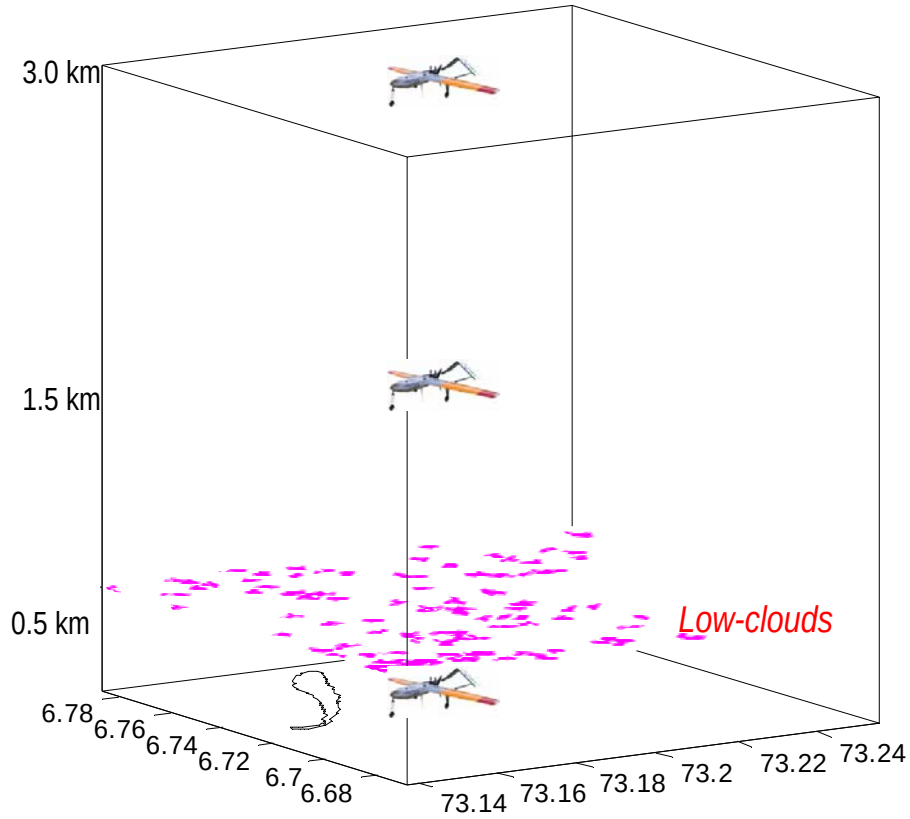
Monte-Carlo Aerosol-Cloud Radiation (MACR) Model

Developed by the Center for Clouds, Chemistry and Climate (C4), UCSD

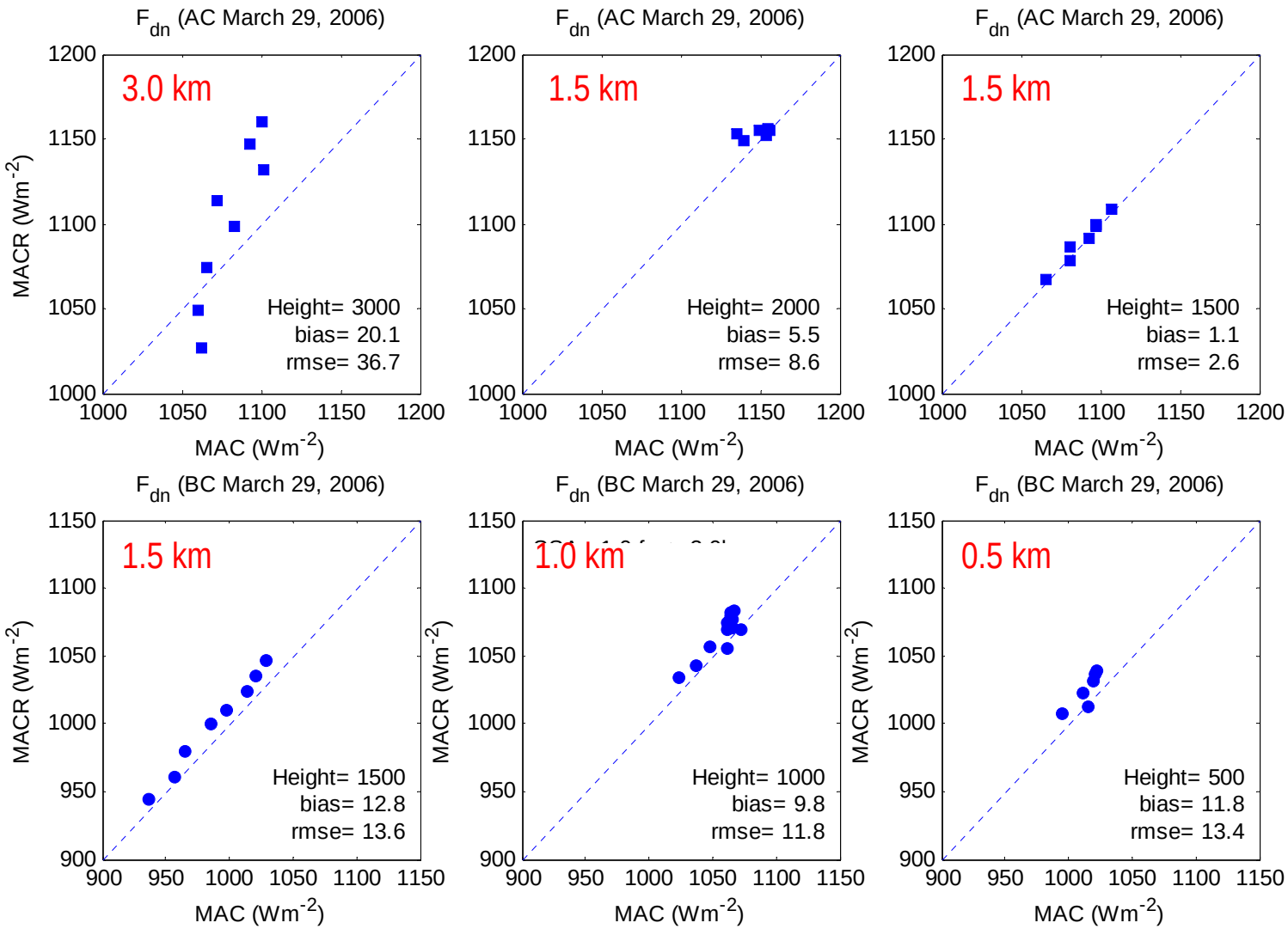
Inputs for flux calculation

- Aerosol properties→ *AERONET*
  - ✓ Aerosol optical depth (AOD)
  - ✓ Single scattering albedo (SSA)
  - ✓ Asymmetry factor
  - ✓ Wavelength dependence of AOD and SSA (Angstrom exponent)
- Ozone and water vapor amount:
  - ✓ Precipitable water
  - ✓ Total ozone amount
- Surface albedo (ocean, land)
  - ✓ Land surface albedo
  - ✓ Ocean albedo (Briegleb et al., 1986)
- *MAC observations:*

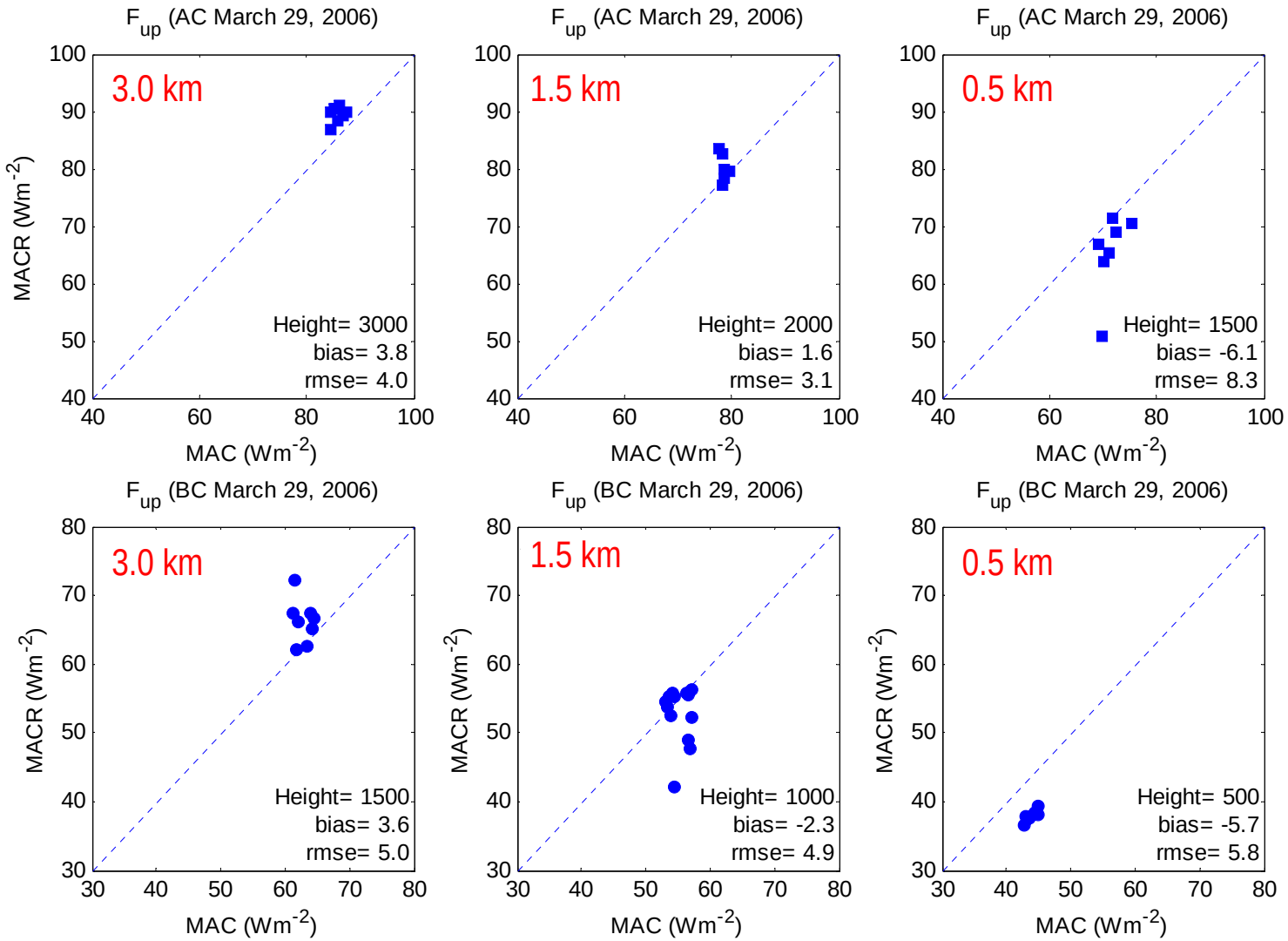
  Aerosol number conc (#/m3); Relative Humidity (%); Temperature profiles



Simulation of UAV Flux: Downward flux



Simulation of UAV Flux: Upward flux

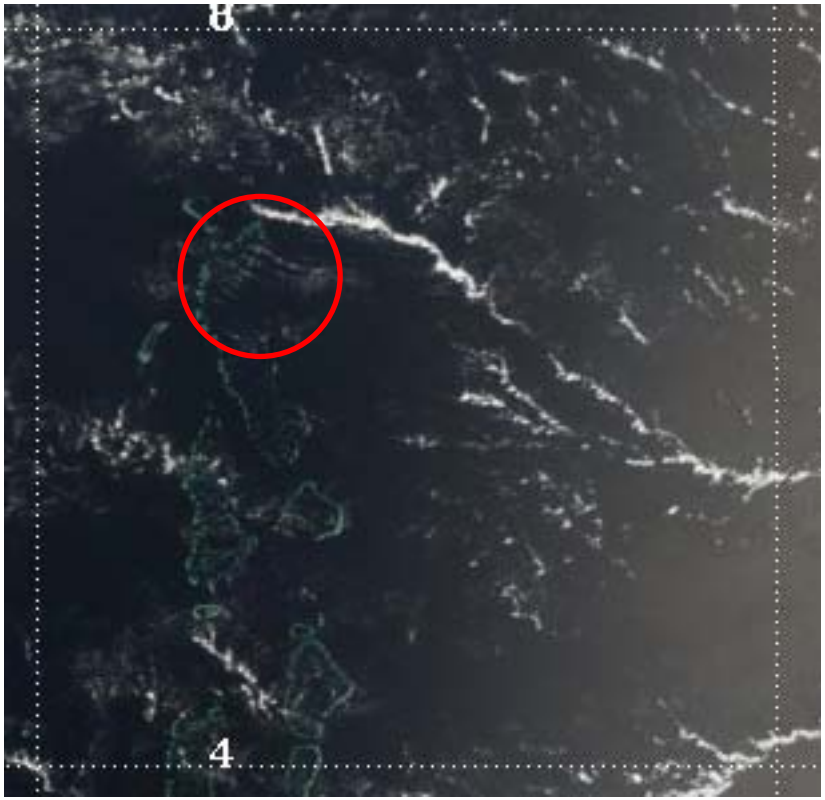


Simulation of UAV observed radiation by 3D MACR

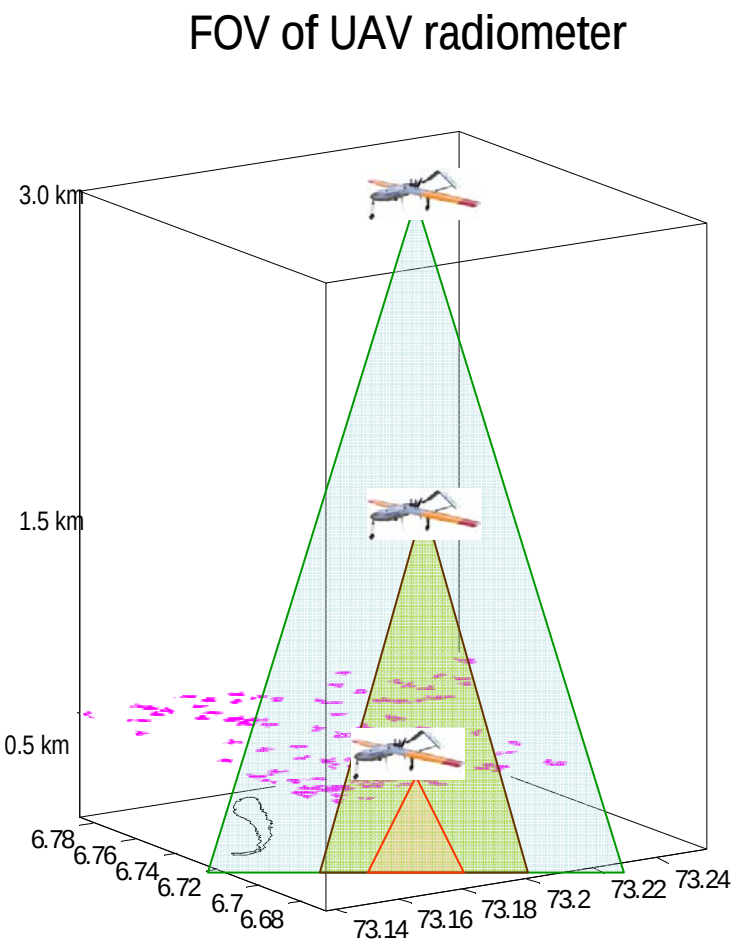
: cloudy sky conditions

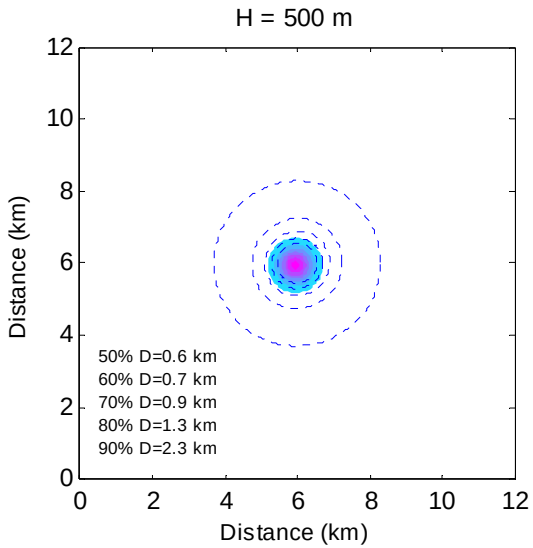
Sky picture at MCOH (10:30 LST)

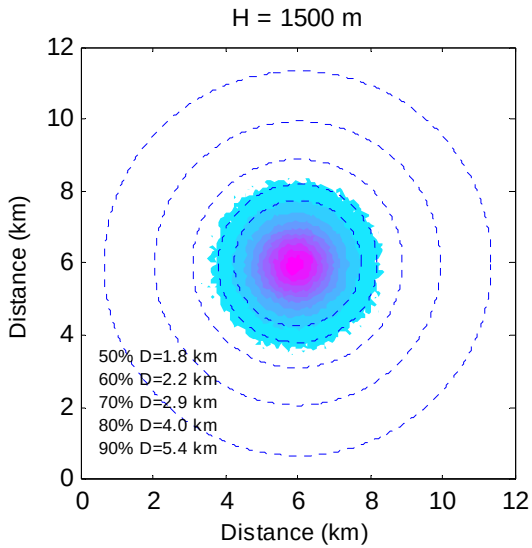
MODIS Image (10:35 LST)

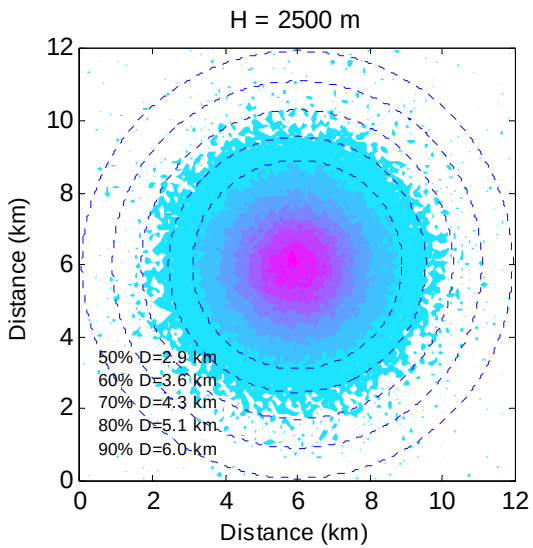


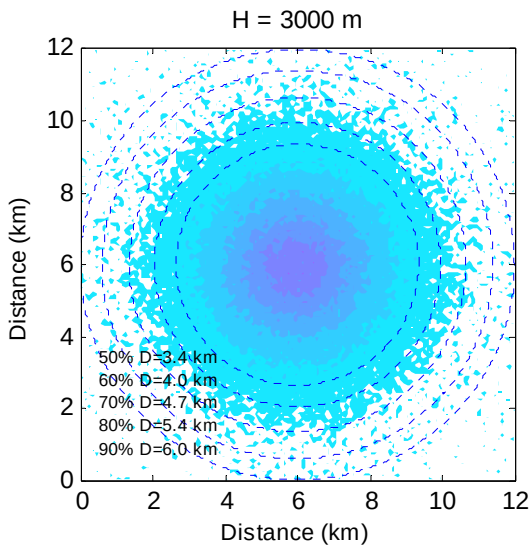
Surface contributions to radiation at UAV altitude







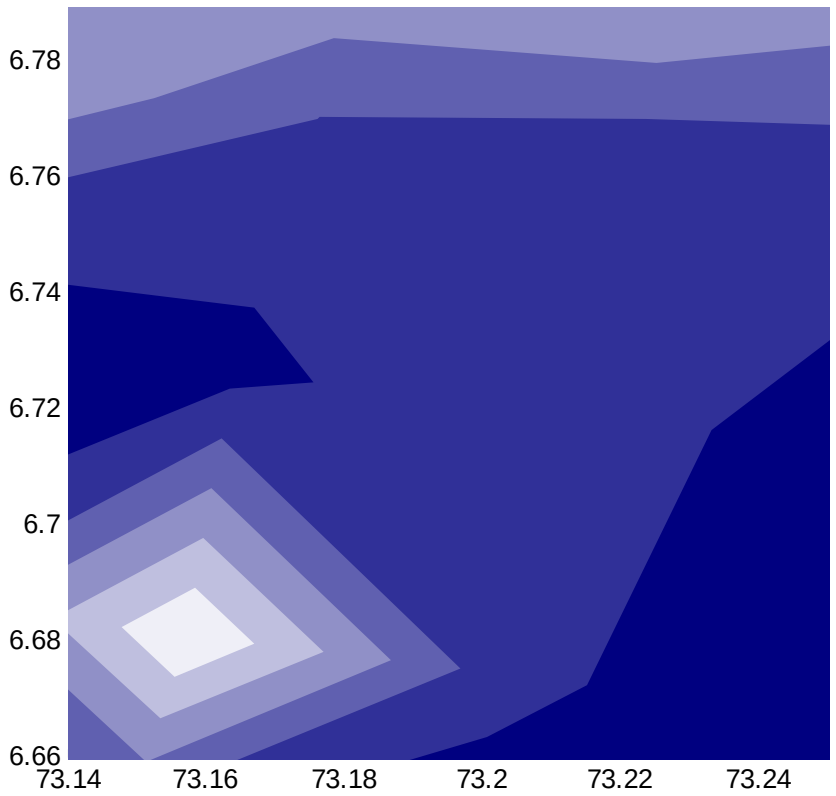




Simulation of UAV observed radiation by 3D MACR

: cloudy sky conditions

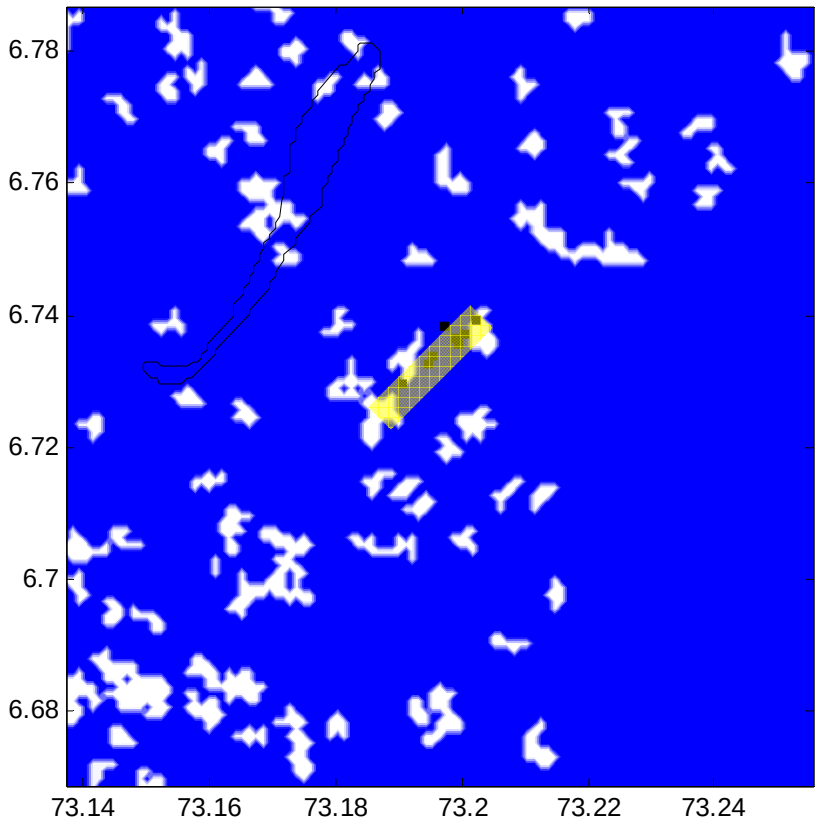
MODIS Cloud fraction (*MOD06_L2, 5km)*
1035 LST, March 24, 2006



Random distributed low clouds

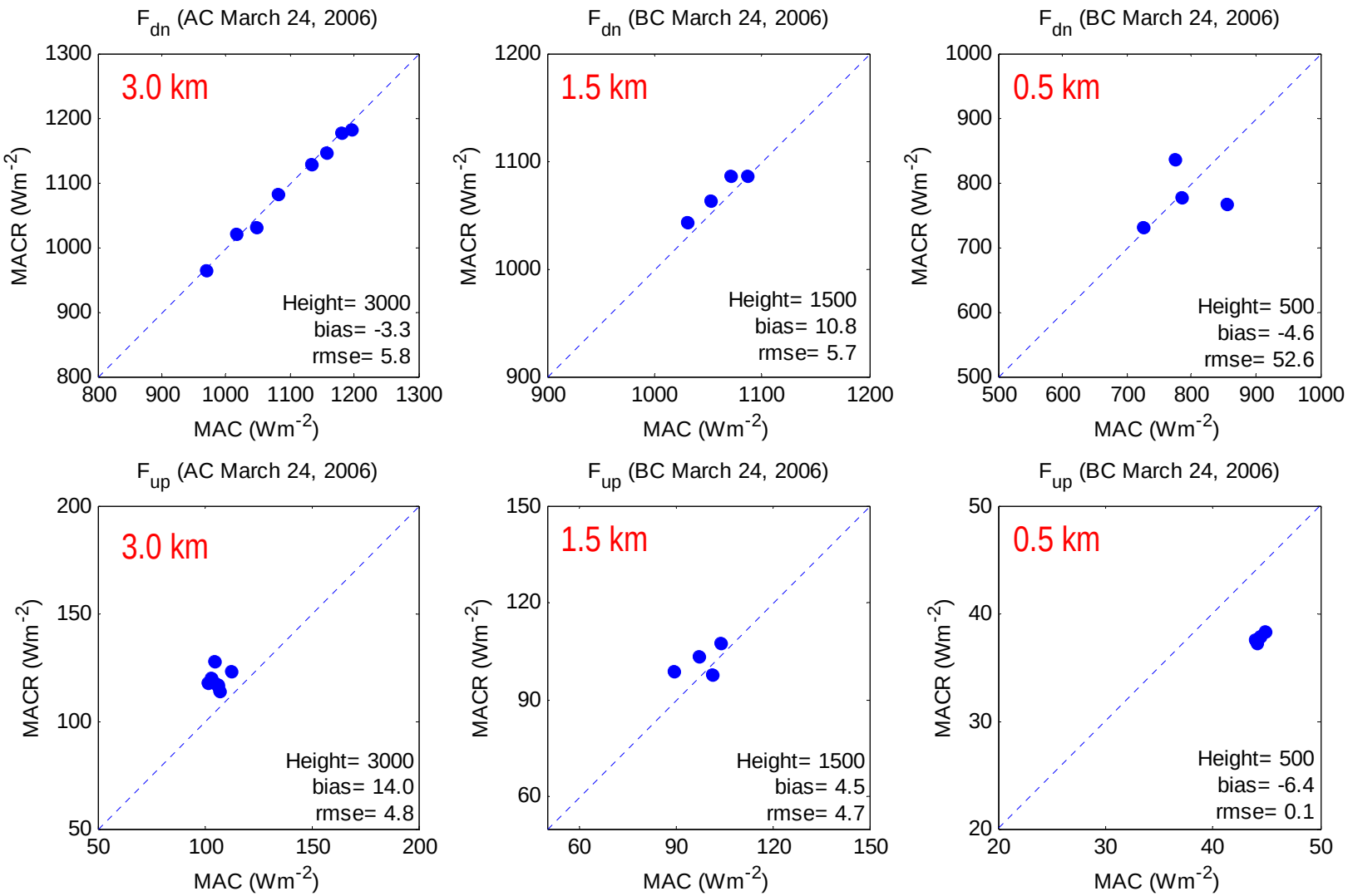
Input from measurements:

- Cloud fraction (MODIS)
- Cloud size (UAV)
- Probability function of cloud size

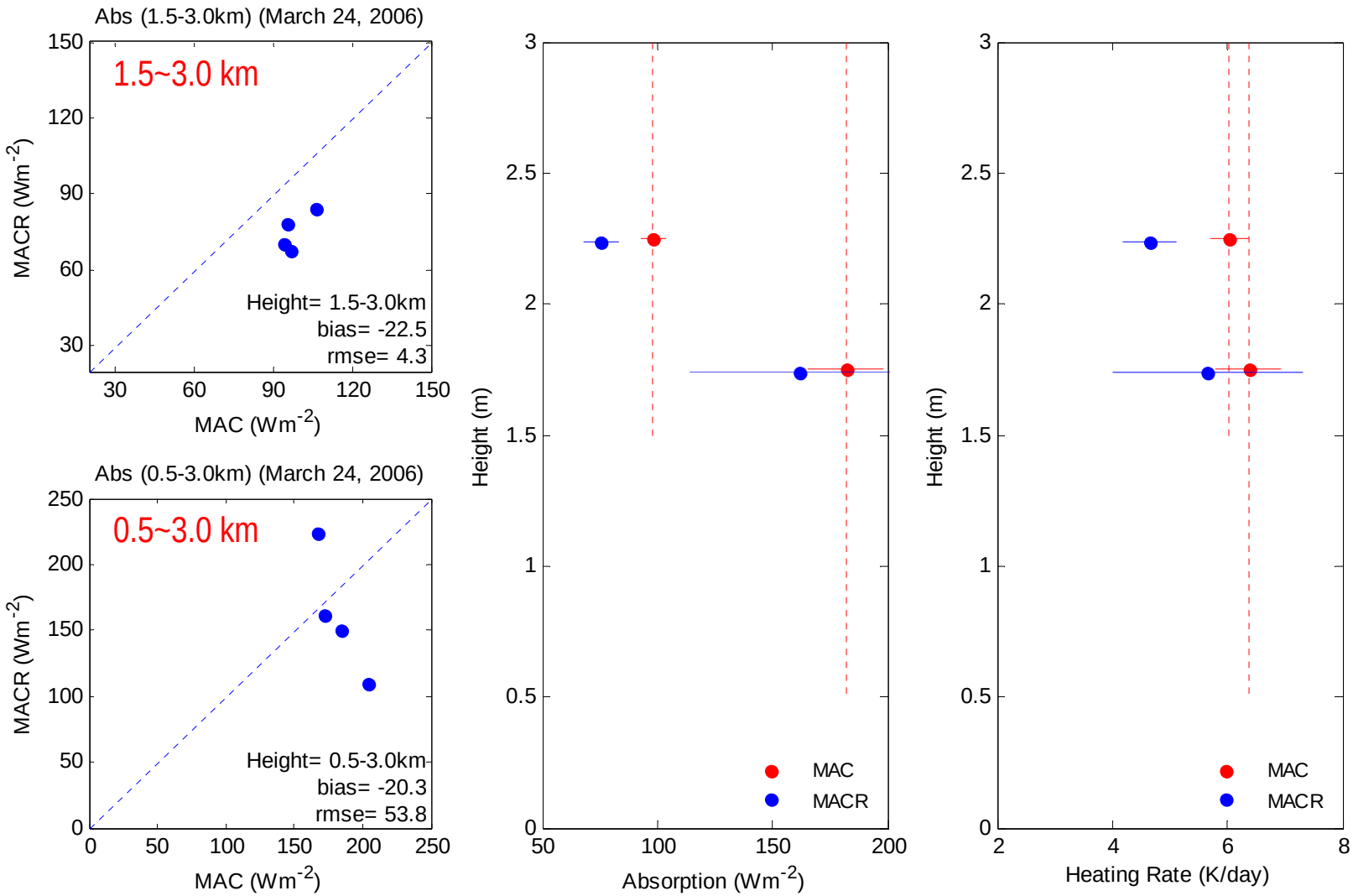


Flux comparison: UAV observation vs. MACR

MODIS retrieved cloud fraction



Absorption and Heating rate: UAV observation vs. MACR



Summary

- Interpretation of UAV observation by 3-D model
  - ✓ *Small island (including coral surrounding island) effect should be considered in UAV radiation measurements.*
  - ✓ *Minimum distance from island to avoid possible contamination on UAV measurement is about 2-5 km depending on UAV altitude.*
  - ✓ *MACR model can simulate UAV observed flux at different altitude with instrumental uncertainty range.*
- Retrieval of atmospheric absorption and heating rate
  - ✓ *Calculated heating rate (flux divergence) relatively smaller than observed values under clear and all sky conditions.*