Evaluation of NWP Reanalysis against ARM Observations

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- **Part I: Long-Term Statistics**
- **Part II: March 2000 in Detail**
- **Evaluation variables: cloud fraction and effective albedo**

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See our poster for more on Part I

Part I: Long-Term Statistics

- **Objectives:**
  - **examine model bias in effective cloud albedo and cloud fraction**
  - **diagnose the causes of model bias**

- **Effective cloud albedo:**

Surface SW cloud forcing

All-sky Surface downwelling SW flux

Effective Cloud Albedo

$$\alpha_{cld}^{SRF} = \frac{F_{cld}}{F_{clr}^{dn}} = 1 - \frac{F_{all}^{dn}}{F_{clr}^{dn}}$$

Clear-sky Surface downwelling SW flux

Data & Methods

- **Surface data:**

  1) decade-long (1997-2008) ARM SGP observations

  - solar Infrared Radiation Station (SIRS), 15-min

  - surface Meteoro. Obs. System (SMOS), 30-min

  2) NCEP/NCAR Reanalysis I (T62 grid:210 km, 6h)

  3) NCEP/DOE Reanalysis II (T62 grid:210 km, 6h)

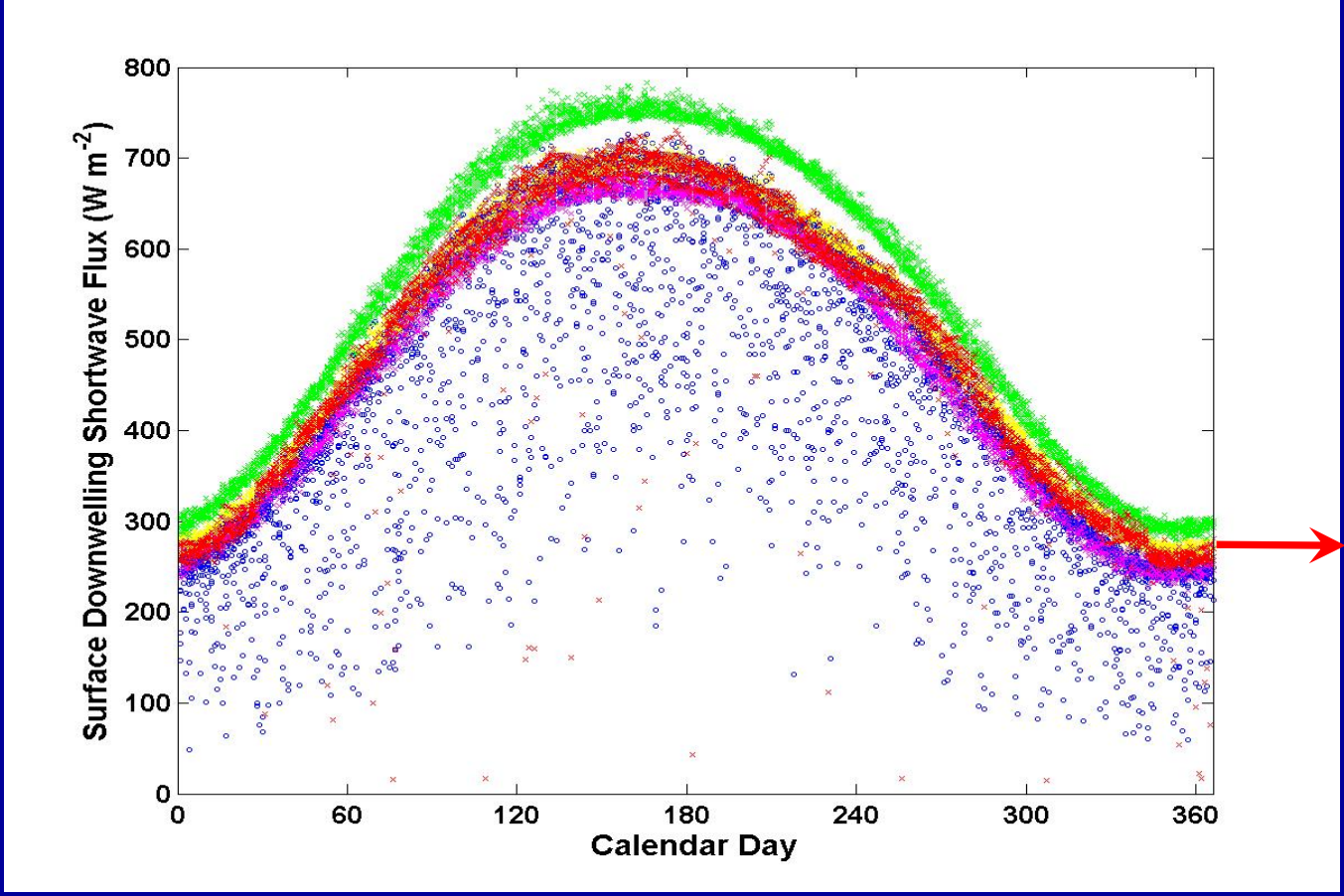
  4) ERA-Interim Reanalysis (T255 grid:80 km, 1h)

- **Methods: (only daytime: 6am to 6pm)**

  1) multiscale variations & co-variations

  2) low-order statistics (mean, std, correlation, rms)

Clear-sky Surface Downwelling SW Flux



Reanalysis II

=0.92x Reanalysis I

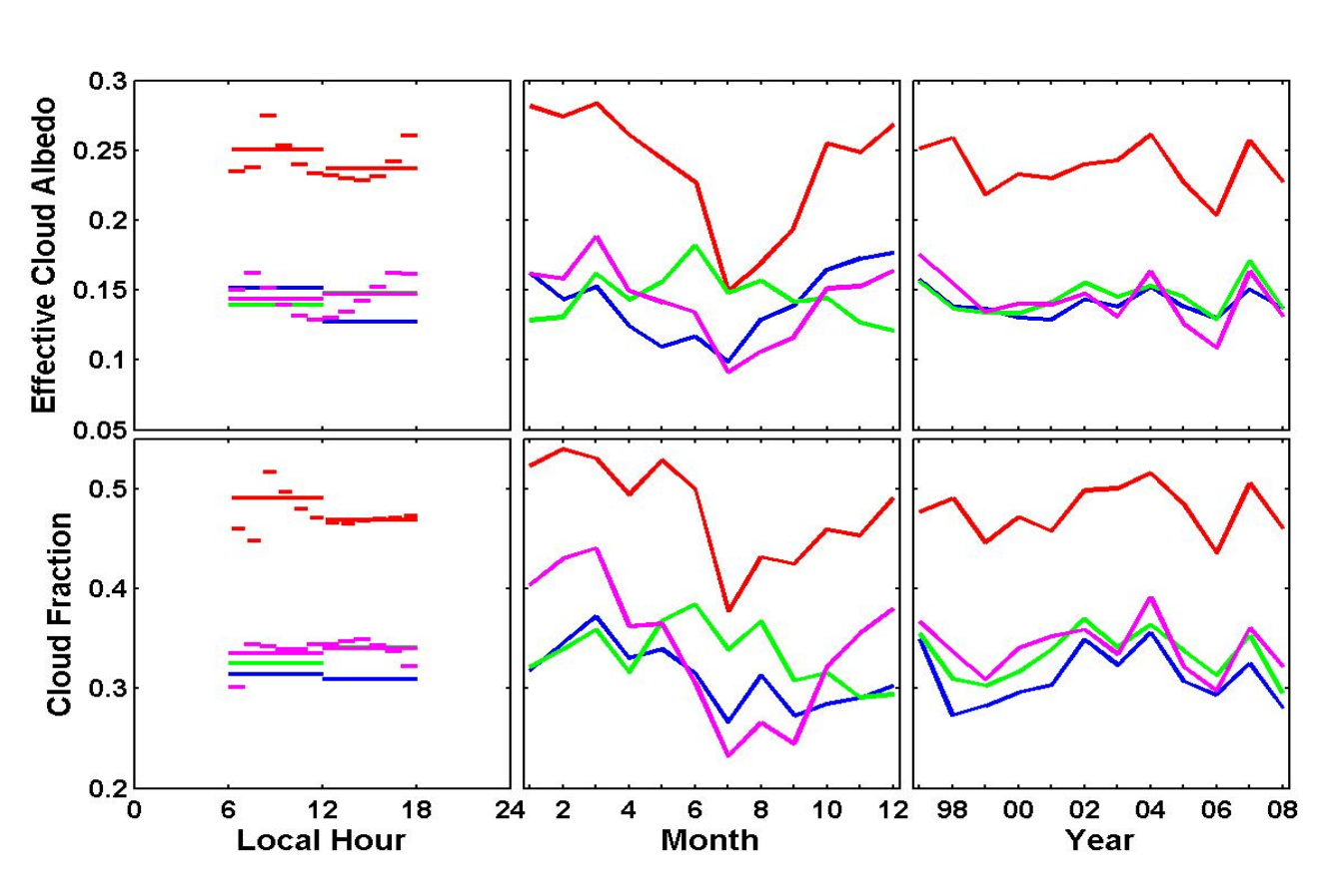
(by the best fit)

Data → **OBS, Reanalysis I, Reanalysis II (blue: all-sky surface SW), ERA-Interim**

Model Bias → **Reanalysis I (high bias), up to 50 W m^{-2}**

ERA-Interim (slightly low bias)

Multiscale Variations of Cloud Properties

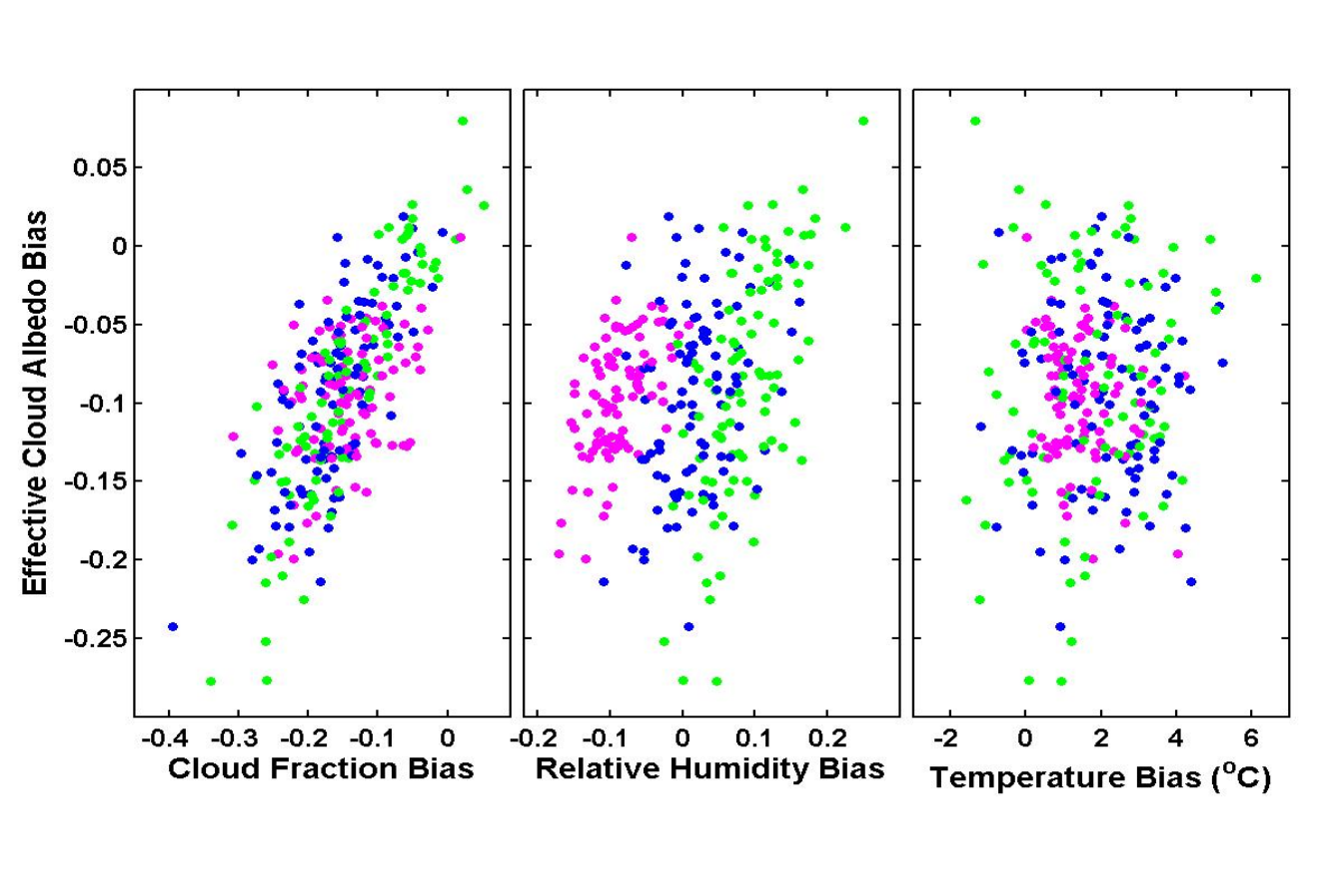


Data → OBS, Reanalysis I, Reanalysis II, ERA-Interim

Model Bias → phase: Reanalysis I (poor), Reanalysis II (good), ERA-Interim (best)

magnitude: systematically underestimate OBS !! (ECA~ 50%, CF~40%)

Co-variations of Different Model Biases



Data (monthly as an example) ⇒ Reanalysis I, Reanalysis II, ERA-Interim

Model-Bias Time Series ⇒ between ECA and CF (or RH): positive, ~ linear

between ECA and Temp: vague positive!!

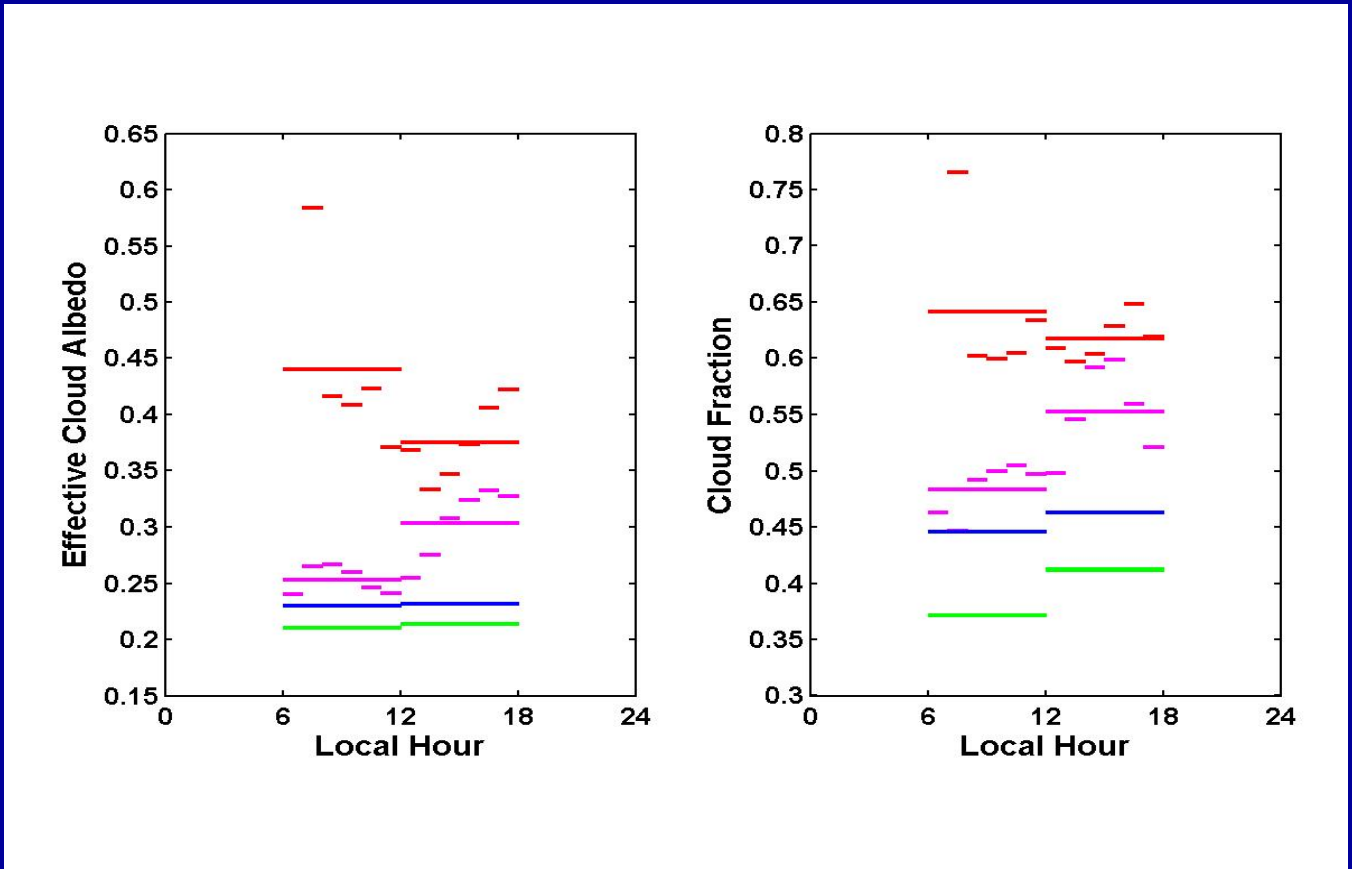
Summary of Part I

- Systematic underestimation on effective cloud albedo
- Bias: related to cloud fraction & relative humidity
- Performances: ERA-Interim (best), Reanalysis I (worst)

Part II: March 2000 in Detail

- Data: ARSCL and Merged Sounding (hourly)
- Objectives:
  - examine model bias in vertical structures
  - diagnose the causes from parameterizations

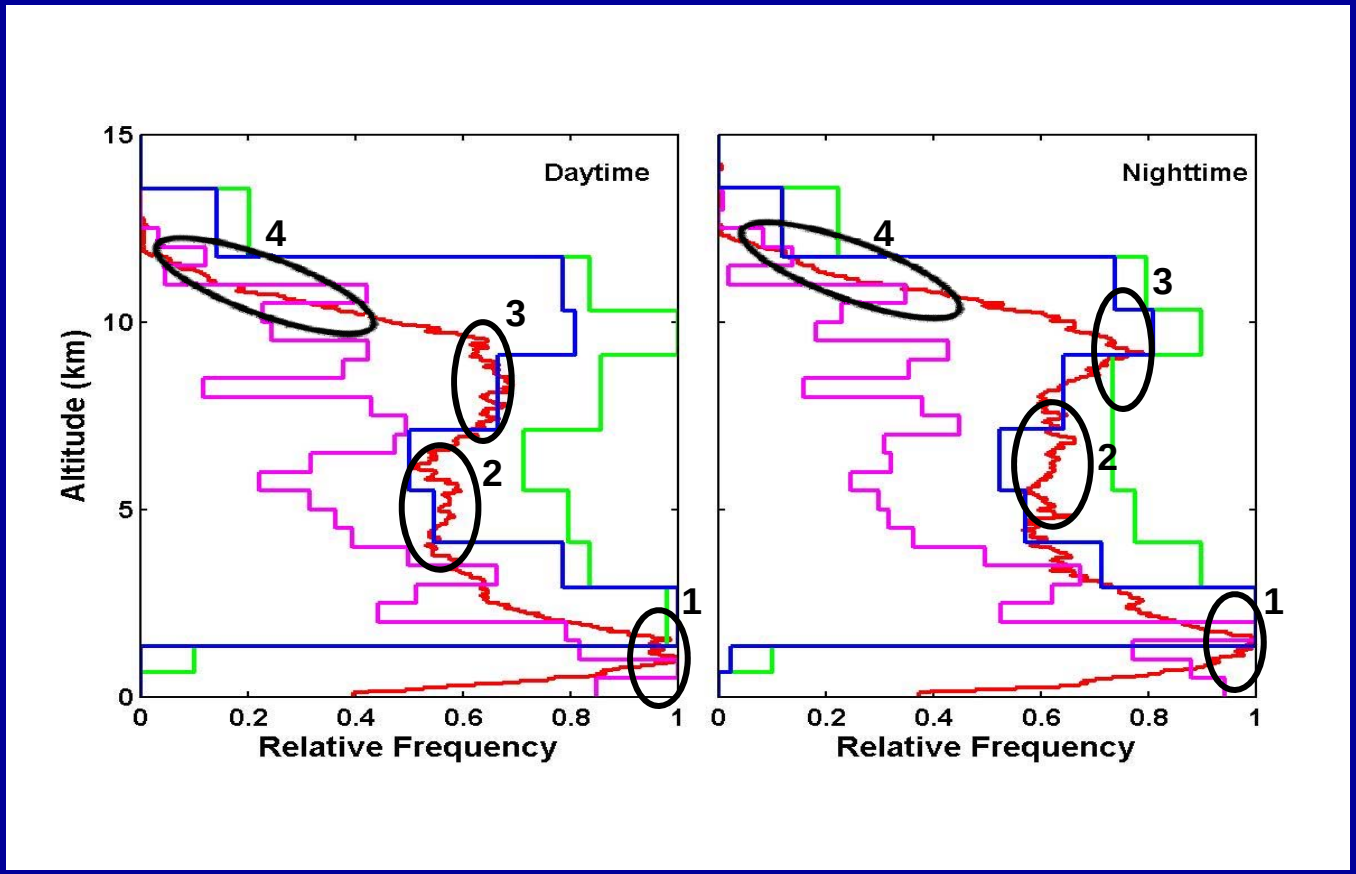
Part II: Cloud Properties (March 2000)



Data → OBS, Reanalysis I, Reanalysis II, ERA-Interim

Model Bias → underestimate OBS, but not as significant as climatological means!!

Relative Frequency of Cloud Occurrence (March 2000)

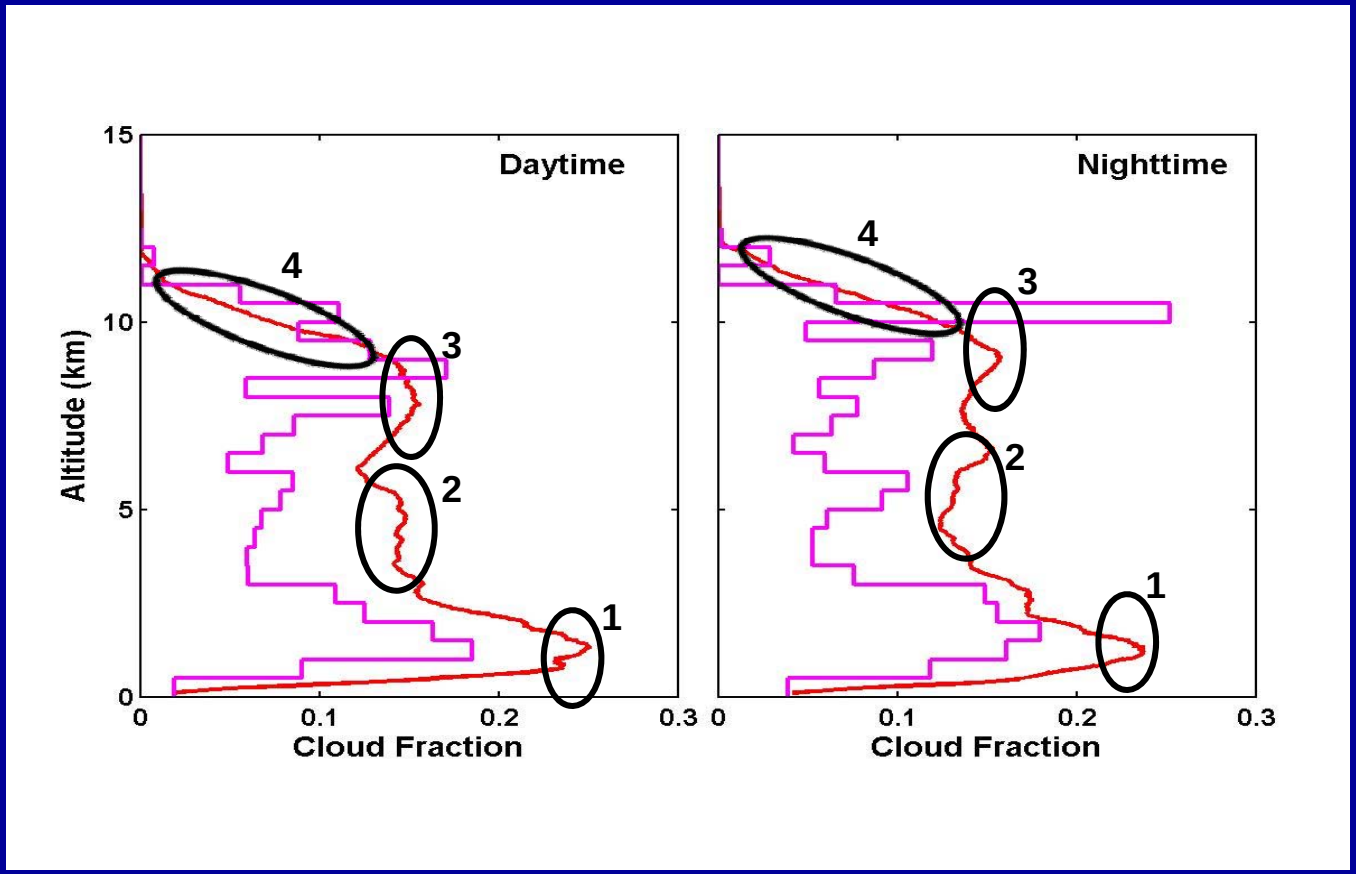


Data → OBS, Reanalysis I, Reanalysis II, ERA-Interim

Model Bias → cloud regimes 1 and 4: ERA-Interim (best)

cloud regimes 2 and 3: Reanalysis II (best)

Vertical Cloud Fraction (March 2000)



Data → OBS, ERA-Interim

Model Bias → cloud regimes 3 and 4: good

cloud regimes 1 and 2: underestimated OBS!!