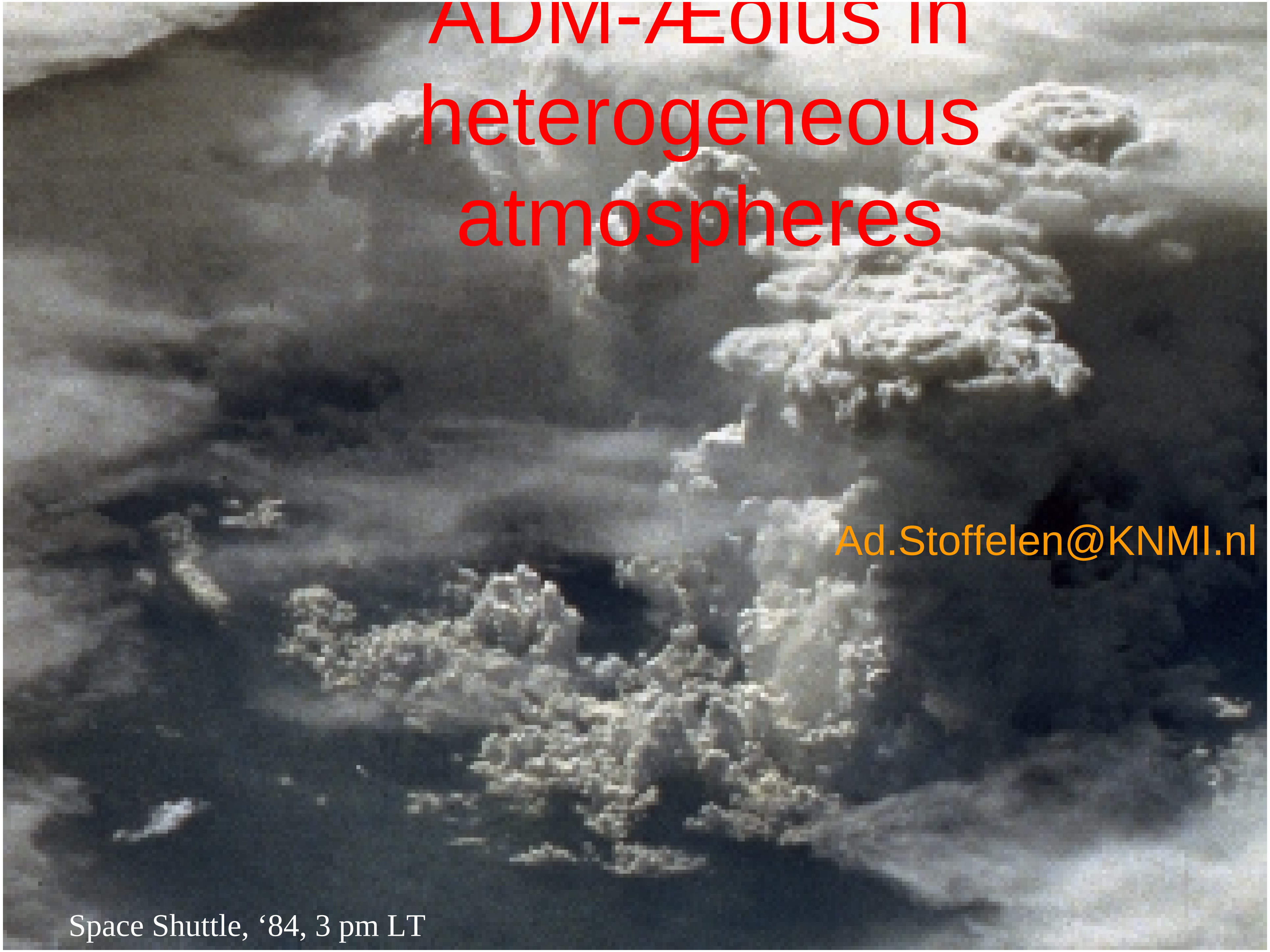
ADM-Æolus in heterogeneous atmospheres

Ad.Stoffelen@KNMI.nl



Space Shuttle, ‘84, 3 pm LT

Issues

- Atmospheric heterogeneity
- Cloud and aerosol stratification and signal height assignment
- Subcell wind variability or spatial representation of a NWP model grid cell wind
- Local vertical motion
- ADM capabilities

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Target and signal variability

- Target is characterized by β and wind structures
  - Variability is induced by target heterogenity, i.e., convective clouds with associated dynamics, CAT, or aerosol or cloud stratification
  - Increased optical signal and/or wind variability gives larger spatial representativeness errors
  - Variable targets should be detected and classified, since different classes will be associated with different biases and uncertainties
- Signal determined by $\tau^2\beta$
  - Signal variability affects statistical considerations of processing algorithm, e.g., useful SNR ranges

Probability of target heterogeneities

Statistics of Global Cloud Presence

Latitude	> 60S	60-40S	40-20S	< 20	20-40N	40-60N	> 60N
% Cloudy	63	73	68	82	60	69	66

(after ECMWF)

- Cloud with respect to heterogeneity is an important ADM performance consideration
- Moreover, order of magnitude backscatter β_P vertical variability is common in clear air (Michael Vaughan, LITE)

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Does ADM provide the mean wind ?

- Great spatial β_P variability, horizontally and vertically (Mie)
- Great spatial α_P variability, horizontally and vertically (Rayleigh winds)
- Turbulent motion
- Up-/downward motions

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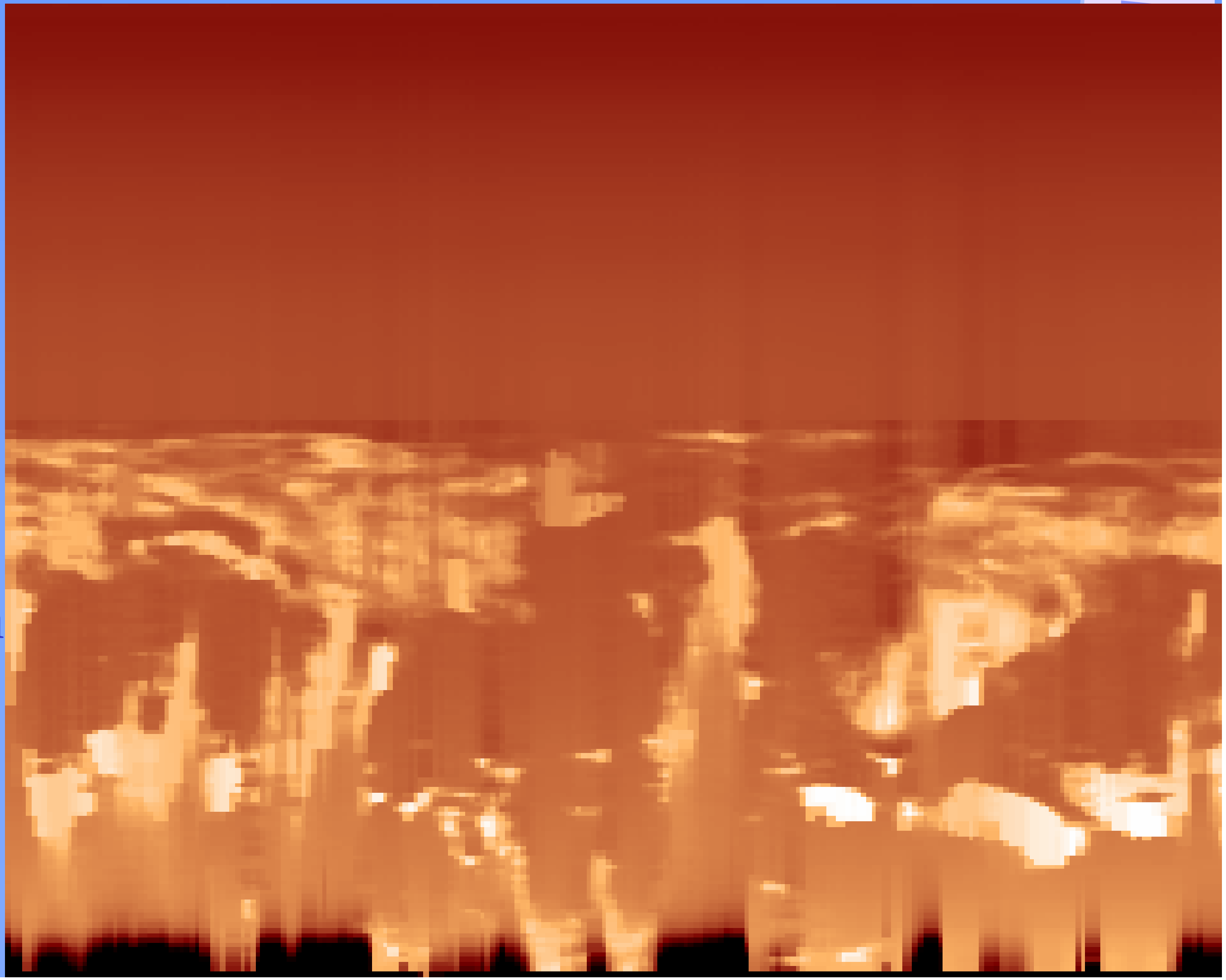
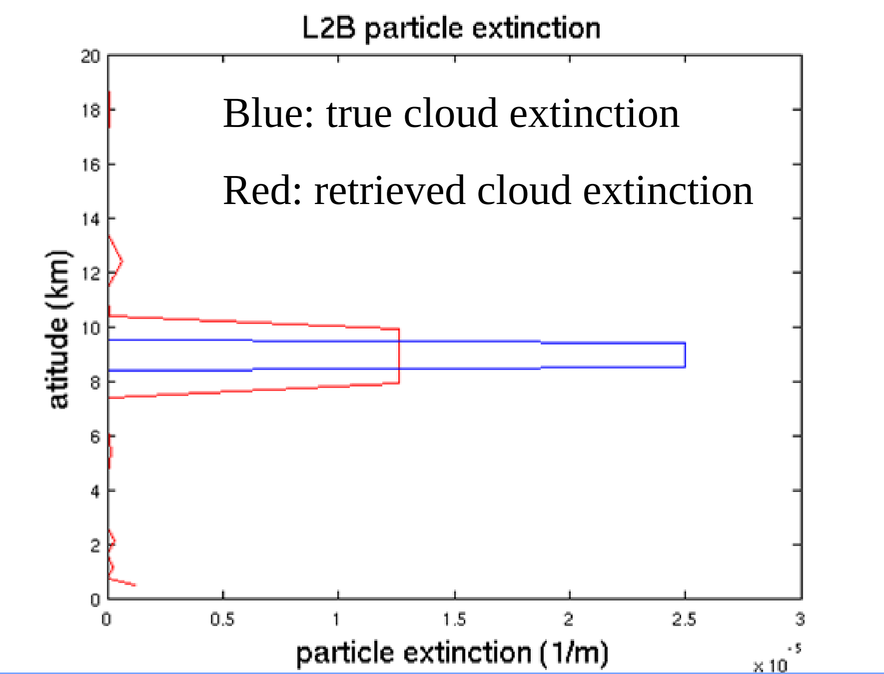
Cloudy β_P scene based on LITE in KNMI ADM database



Height assignment errors



L2B Fabry-Perot cloud layer retrieval

- 1 km cloud covers two range bins
- Correct retrieval of cloud optical thickness (transmission)
- However, distribution over two 1 km range gates

- Shear in cloud over 1 km layer will be spread over 2 km in Mie channel
- Wind signal from upper half of range gate will dominate in molecular return due extinction losses in lower parts

Height assignment errors

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- Aerosol and clouds are often stratified vertically
- LITE indicates Mie mean signal height SDE of 100 m for 1 km range gates
- Wind shear maximum is at 50 m/s per km, implying a max. 5 m/s wind SDE
- This is probably often vertically correlated error leading to large shear errors

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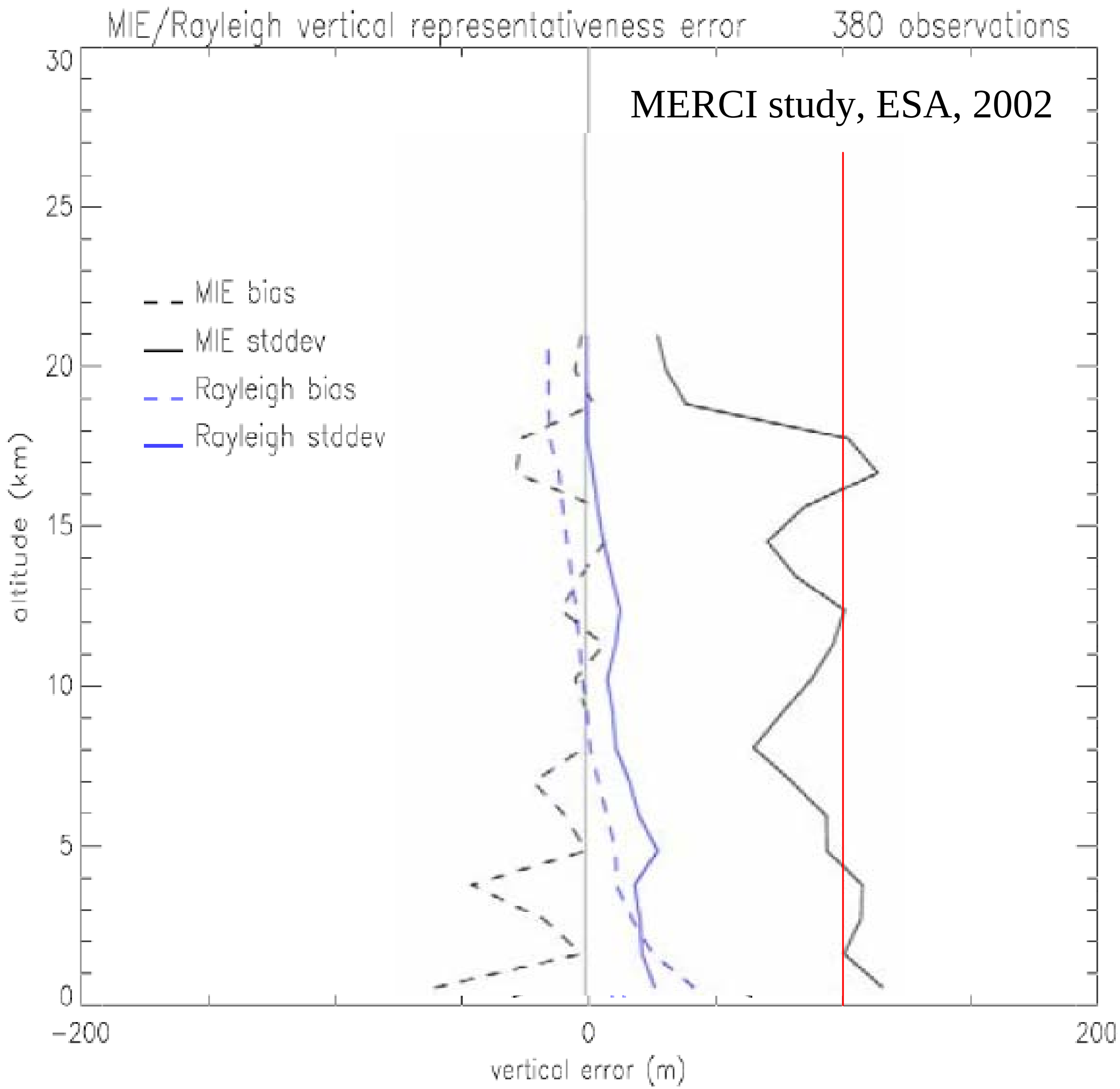

Height assignment errors

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- Wind generally increases with height (positive shear)
- Extinction and β_P generally decrease with height
- Errors tend to be systematic, i.e., Mie tends to be slower than Rayleigh at the same height, since signal originates lower down
- Intercalibration ?

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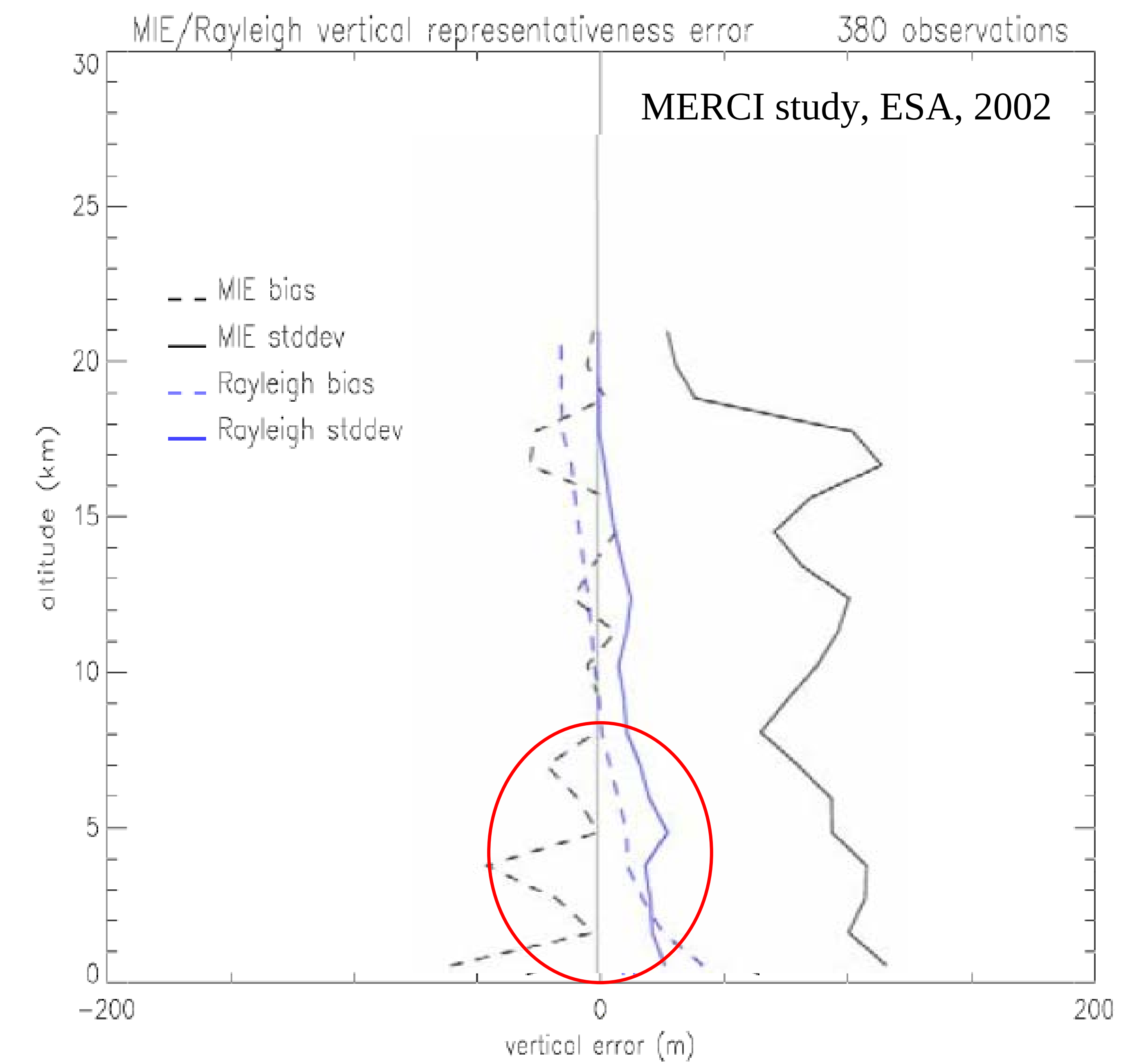
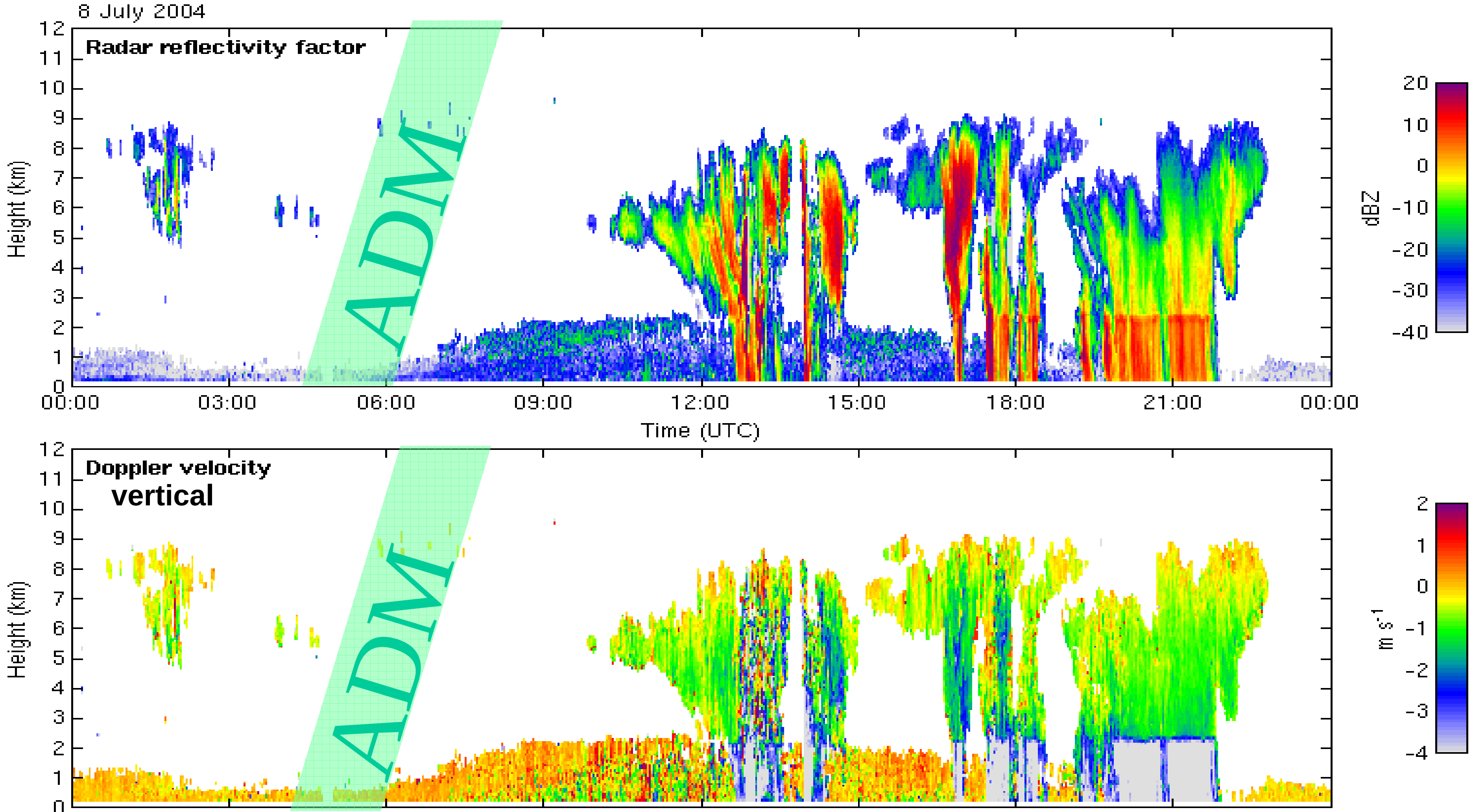
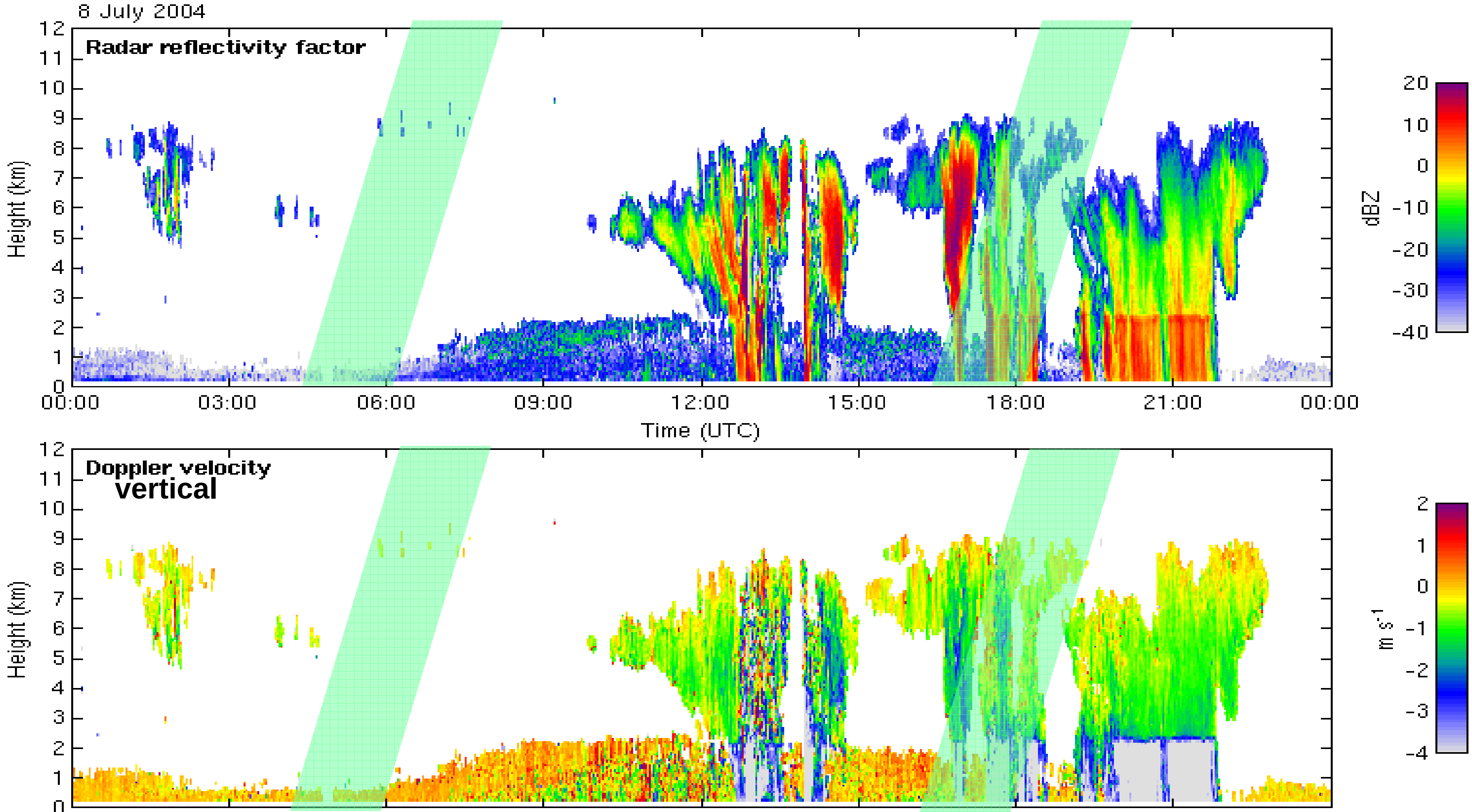


Ground-based cloud radar



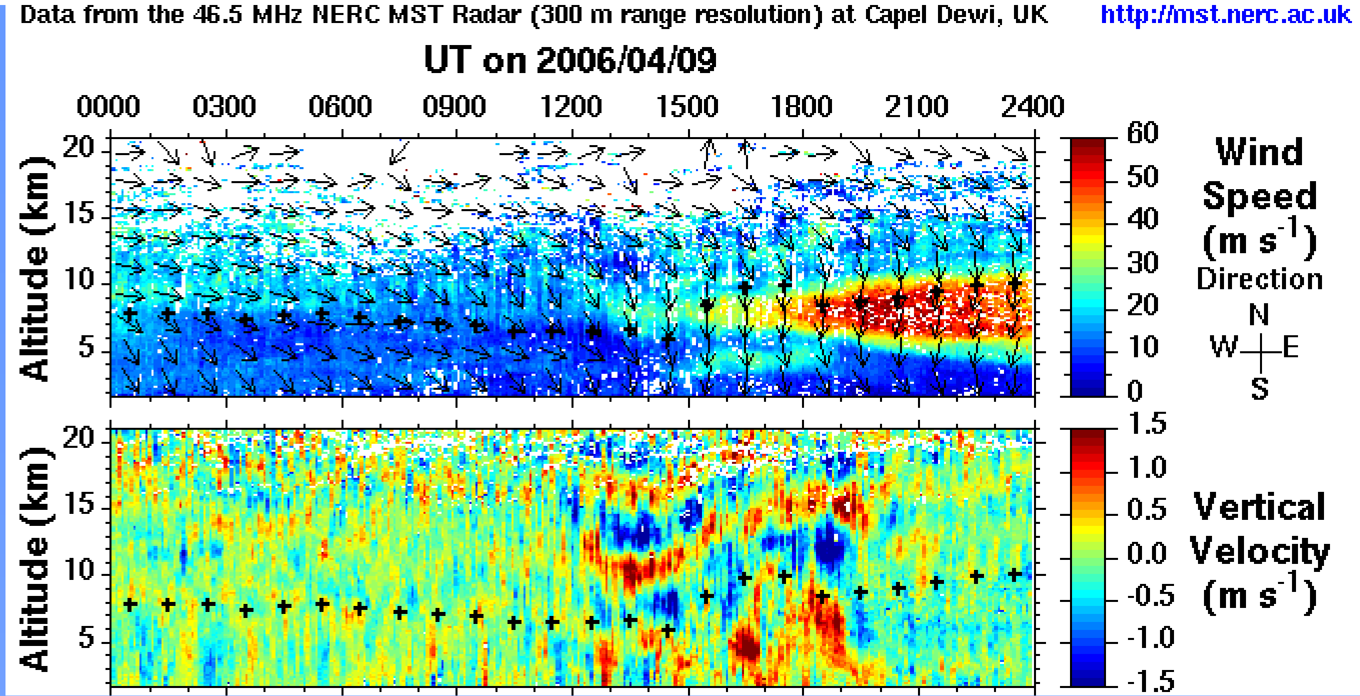
- Summer scene Cabauw, Netherlands

Heterogeneous scenes



- Spatial representativeness? QC by signal variability?

•••• All-weathe r vertical motion and shear



- Horizontal wind variability may be controlled by oversampling, scene classification and QC in L2Bp
- Vertical wind variations can be substantial within a km and further control may be needed

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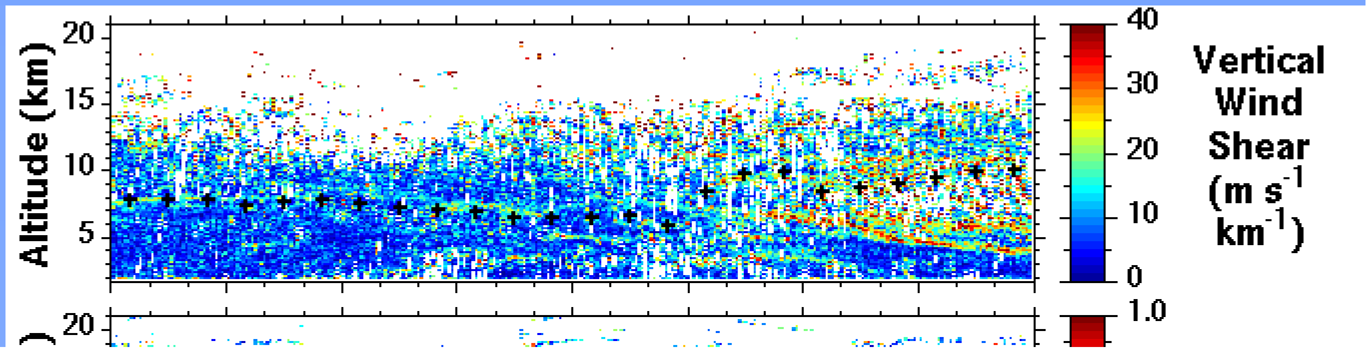

Mie channel oversampling

- Better vertically resolved particle backscatter
- Height error reduced due to better vertical resolution of particle backscatter and extinction
- Better intercalibration Mie and Rayleigh channels
- Better QC of vertically variable scenes

but

- Rayleigh-only capability in UT/LS needs further testing
- Geographically dependent vertical sampling?
- How many Mie range gates should be dedicated to ground speed calibration and at what geographical locations?

Concluding

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- ADM's design takes account of atmospheric heterogeneity by horizontal oversampling of cloud structures allowing classification in profiles and measurement weighting.
- An atmospheric data base and E2S exists to test such cases through the L0p, L1Bp, L2Bp and L2Ap, which is ongoing.
- In a year time an ADM-Æolus aircraft campaign will be dedicated to heterogeneous atmospheric cases.
- For ADM advanced vertical sampling scenarios need to be elaborated in order to optimally exploit the limited number of vertical range gates for accurate winds.
- Issues of instrument wind calibration, zonal wind variability climate, atmospheric heterogeneity, expected beneficial impact, and data assimilation method are all at interplay.
- Several options remain open, which will be studied in more detail to provide guidance before the launch in 2008.

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