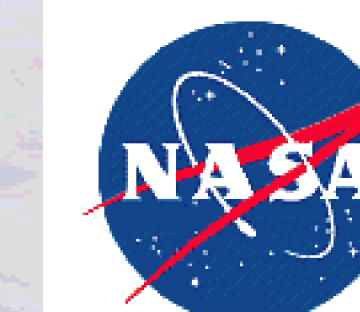


# Clear-column closure studies of aerosol extinction and optical depth aboard the NCAR C-130 in ACE-Asia, 2001

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## Introduction

The Spring 2001 phase of the Asian Pacific Regional Aerosol Characterization Experiment (ACE-Asia), studied aerosol outflow from the Asian continent to the Pacific basin. It was designed to integrate suborbital and satellite measurements and models so as to reduce the uncertainty in calculations of the climate forcing due to aerosols. In order to assess whether or not the in situ instrumentation aboard the various participating aircraft measured an adequate representation of the ambient aerosol, extinction and optical depth closure studies need to be carried out. This paper describes closure studies based on instrumentation flown aboard the NCAR C-130 aircraft.

In ACE-Asia, the 6-channel NASA Ames Airborne Tracking Sunphotometer (AATS-6) operated on 15 of the 19 research flights of the NCAR C-130. AATS-6 measured solar beam transmission at 6 wavelengths (380-1021 nm), yielding aerosol optical depth (AOD) spectra and column water vapor (CWV). Vertical differentiation in profiles yields aerosol extinction spectra and water vapor concentration.

Aerosol extinction can also be derived from airborne in situ measurements of scattering (nephelometers) and absorption (particle soot/absorption photometer, PSAP) or calculated from particle size distribution measurements (mobility analyzers and optical particle counters). Subsequent integration of in situ derived extinction with respect to altitude yields aerosol optical depth.

## Preliminary findings

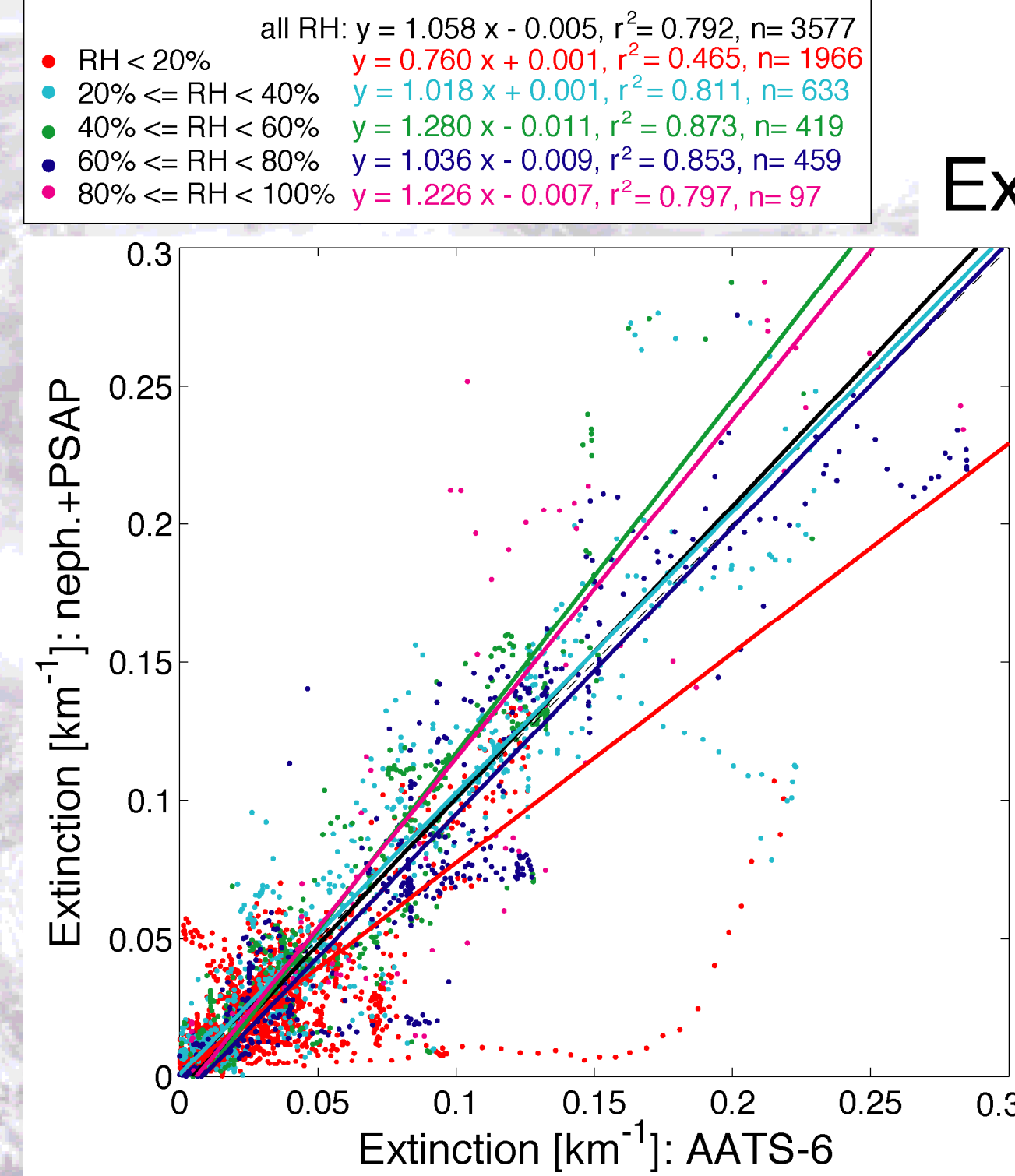
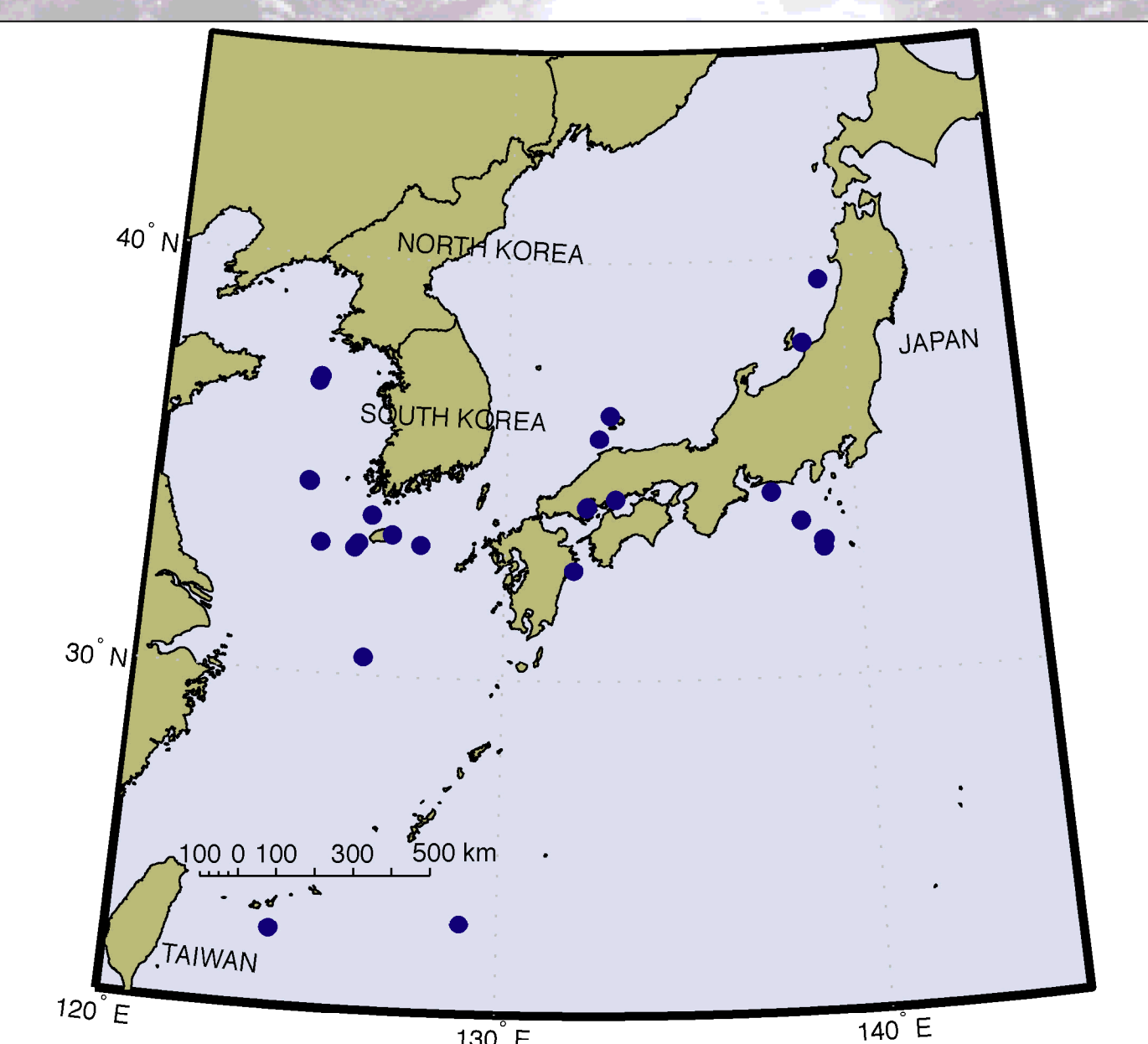
- 1) Comparison of AOD's derived using the combination of nephelometer scattering and PSAP-derived absorption to AATS-6 derived AOD in a linear regression of 28 profiles yields a slope of 0.946, an offset of 0.004 and a correlation coefficient of 0.74. The slope and offset of the regression line were calculated using the "Least-Squares-Bisector"-method (i.e., slope of line is determined by bisecting the two model 1 regression lines, Y-on-X and X-on-Y).
- 2) Interpolating the AATS-6 derived aerosol extinctions to the altitudes at which the in situ extinction data are presented and performing a linear regression on the resulting 3577 data pairs we found a slope of 1.058, a negligible offset of -0.005 and a correlation coefficient of 0.79. We found no clear dependence in the level of agreement between the two methods on the ambient relative humidity, RH.
- 3) From 1) and 2) above we conclude that the aerosol taken in by the NCAR C-130 LTI can account for all the ambient aerosol extinction within the in situ and sunphotometer measurement uncertainties. Remaining differences are small and may be due to spatial inhomogeneity in aerosol properties which affect the sunphotometer-derived aerosol optical depth.
- 4) From a stratification of the extinction data with particle size (as indicated by the Angstrom parameter) not presented here we conclude that in general, the aerosol taken in by the NCAR C-130 LTI can account for all the ambient aerosol extinction within the measurement uncertainties. Further from the AOD comparisons, there seem to be no significant differences when comparing the LTI performance in the boundary layer vs. the free troposphere (although there is a tighter correlation in the PBL AOD comparison). However, for the free trop. layer with dust, our comparisons show a slight tendency of the LTI to oversample large particles (as expected).
- 5) Similar analysis between AATS-6 derived columnar water vapor (CWV) and water vapor density to the NCAR RAF reference humidity measurements (with Lyman-alpha hygrometers and thermoelectric instruments) yields very good agreement, illustrated in part by high correlation coefficients of 0.989 and 0.955 respectively.

## NASA Ames Airborne Tracking Sunphotometer: AATS-6

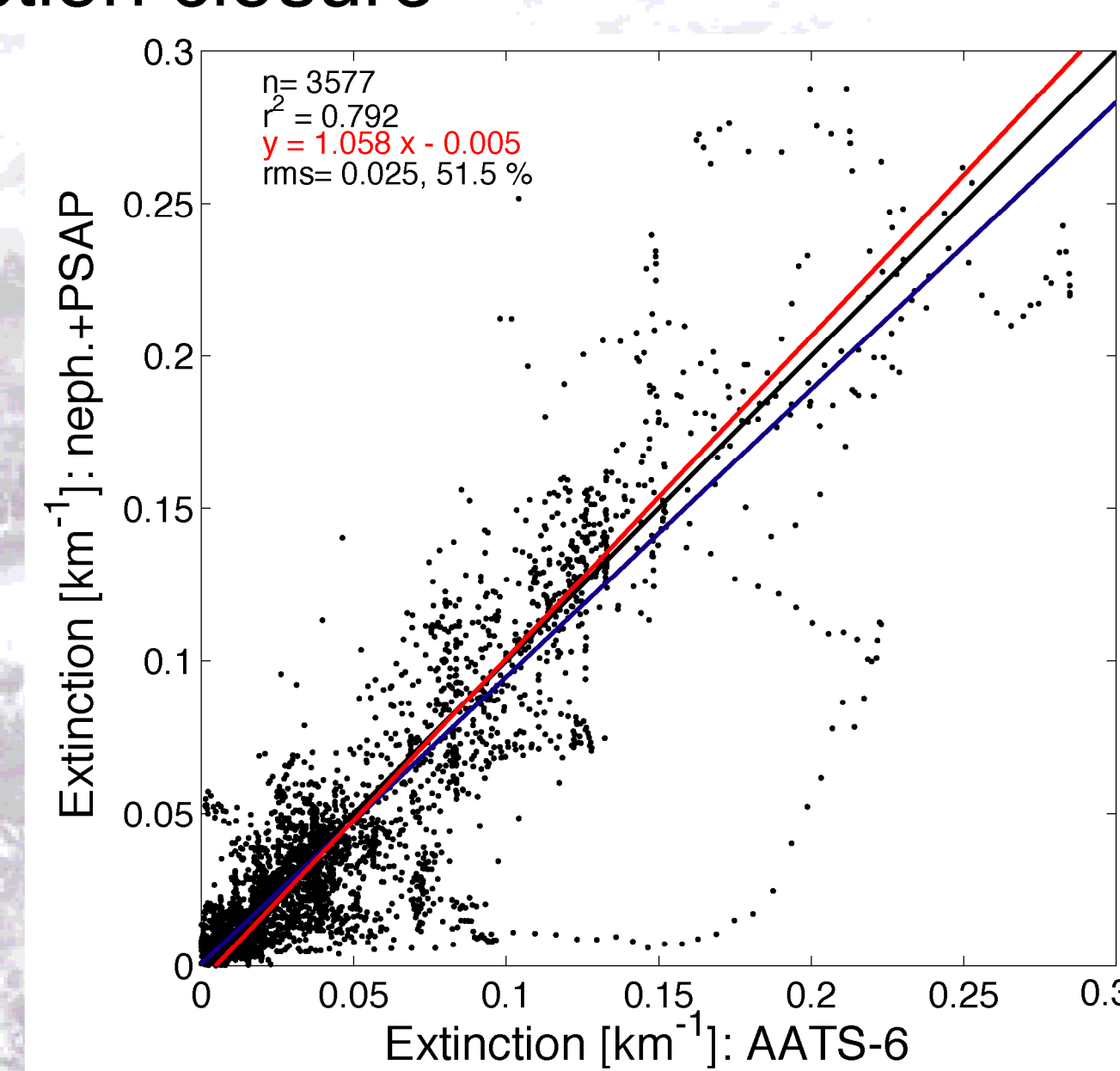


- Measures direct solar beam transmission @:  
380.1 450.9 525.7 864.5 941.9 1021.3 nm
- Yields:  
aerosol optical depth + aerosol extinction when A/C files profiles  
columnar water vapor + water vapor conc. when A/C files profiles
- Size:  
Telescope dome 8" OD x Overall telescope height ~15"  
Extends ~6" above A/C skin, 9" below
- Weight:  
62 lbs. (+39 lbs control system)

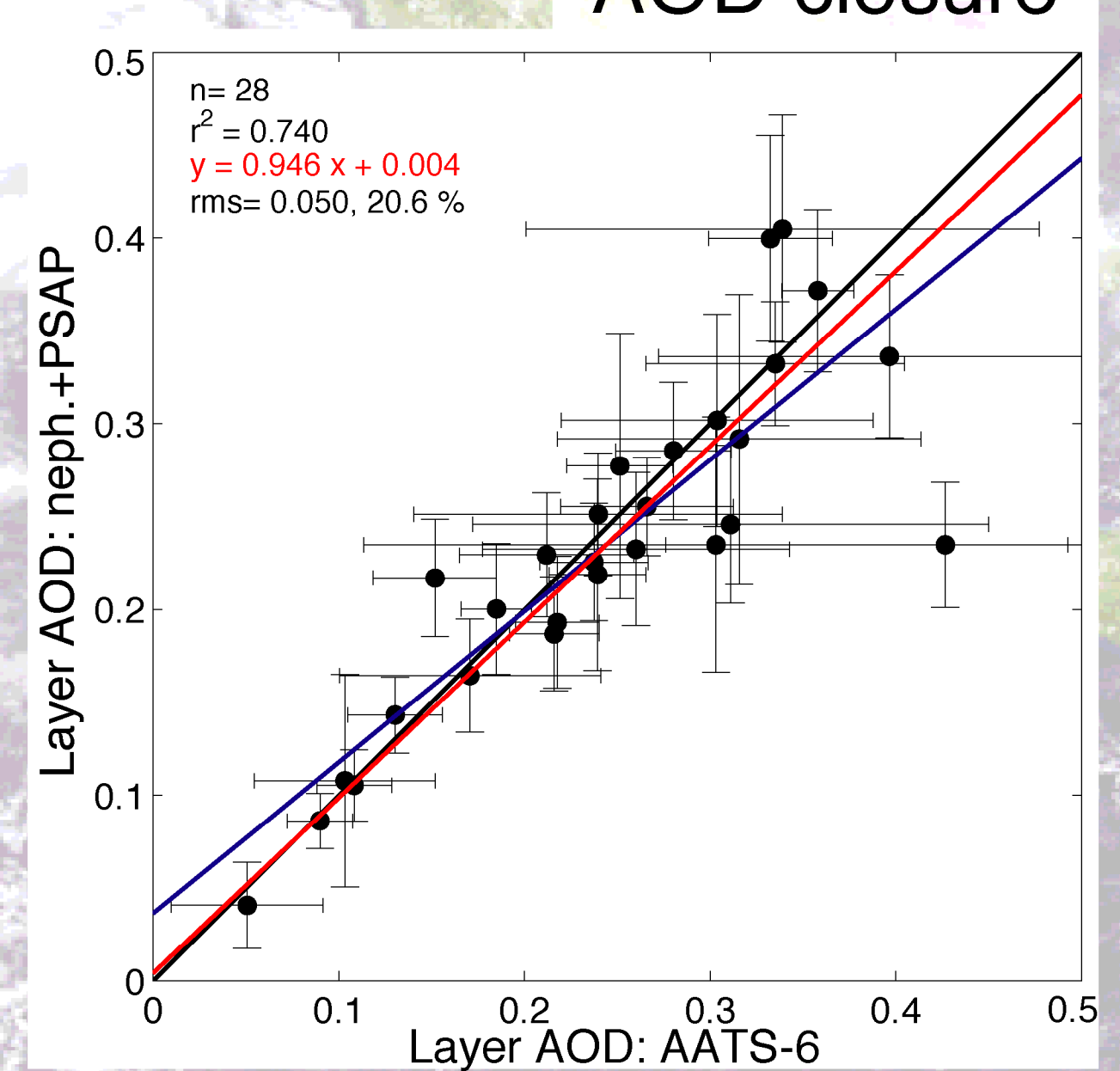
## Location of C-130 profiles for closure studies presented here



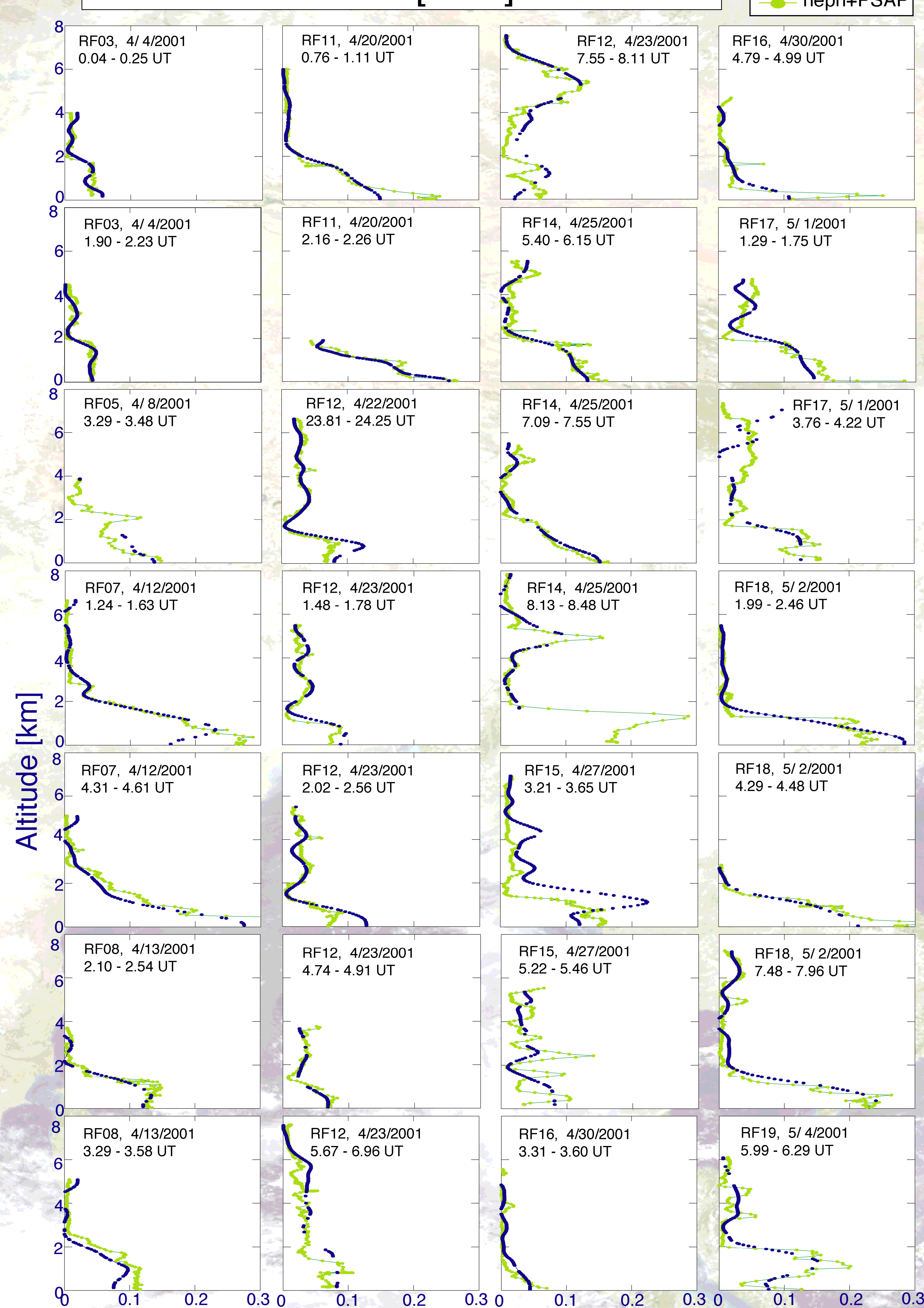
## Extinction closure



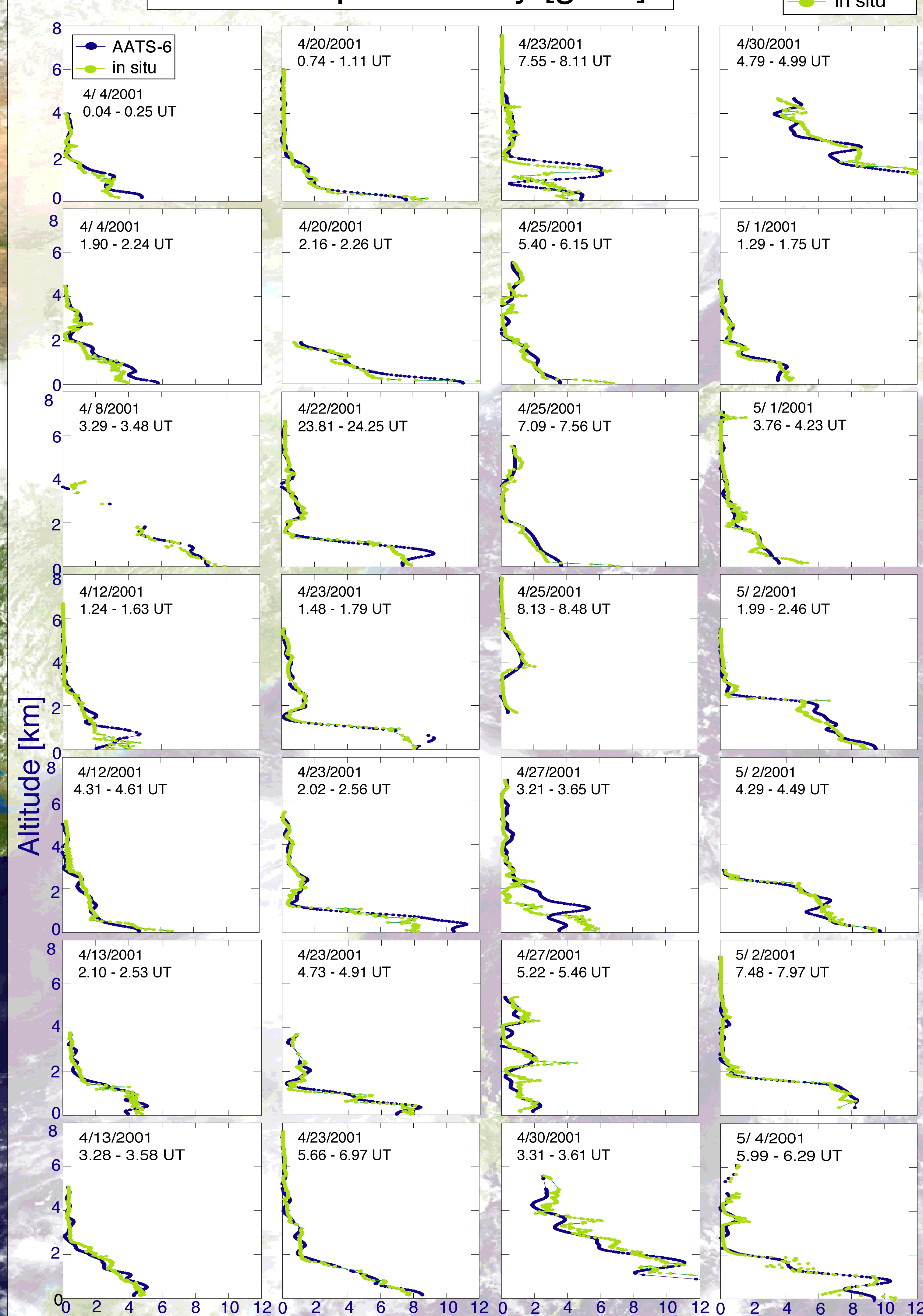
## AOD closure



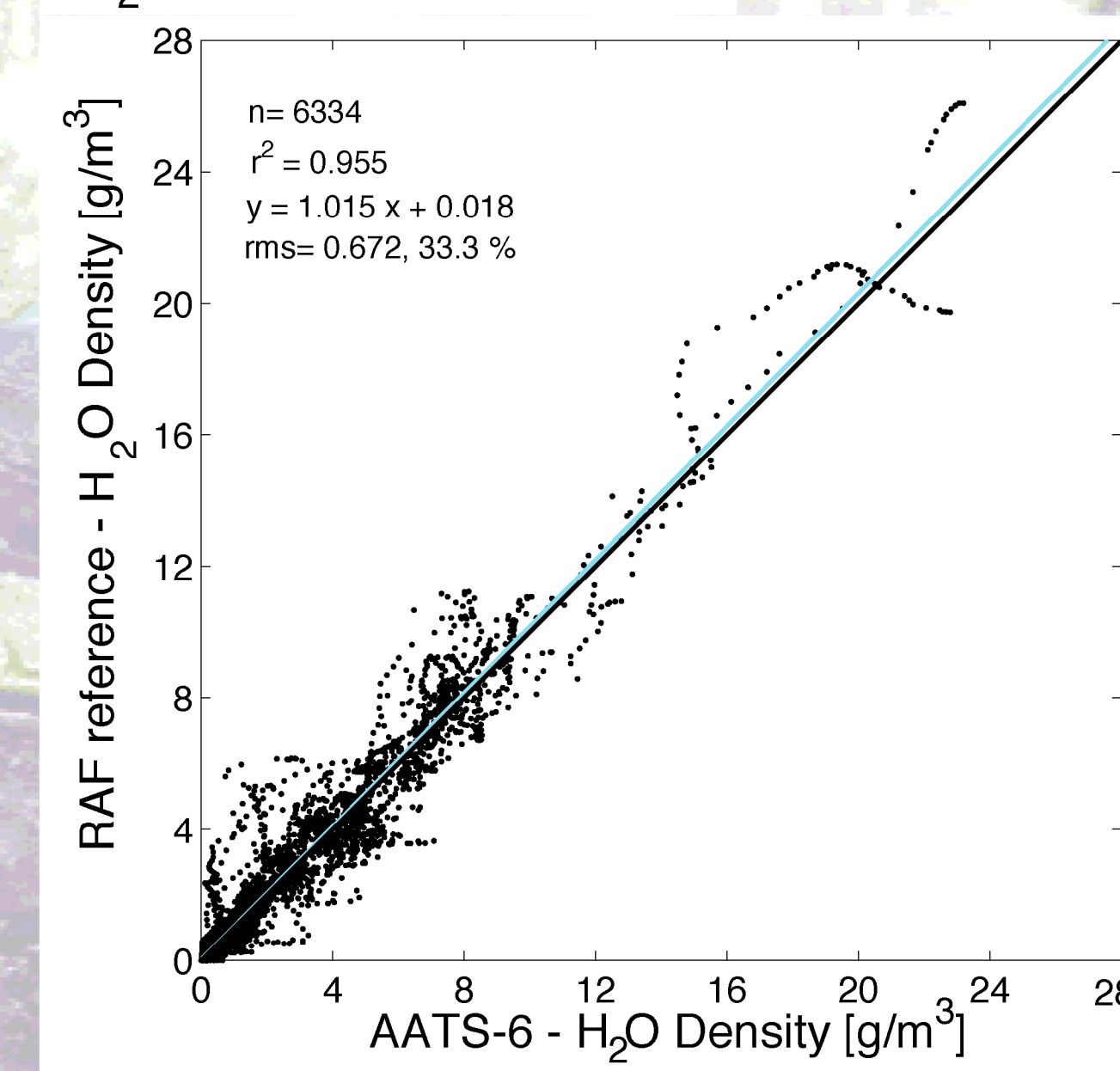
## Aerosol Extinction [km<sup>-1</sup>] at 550 nm



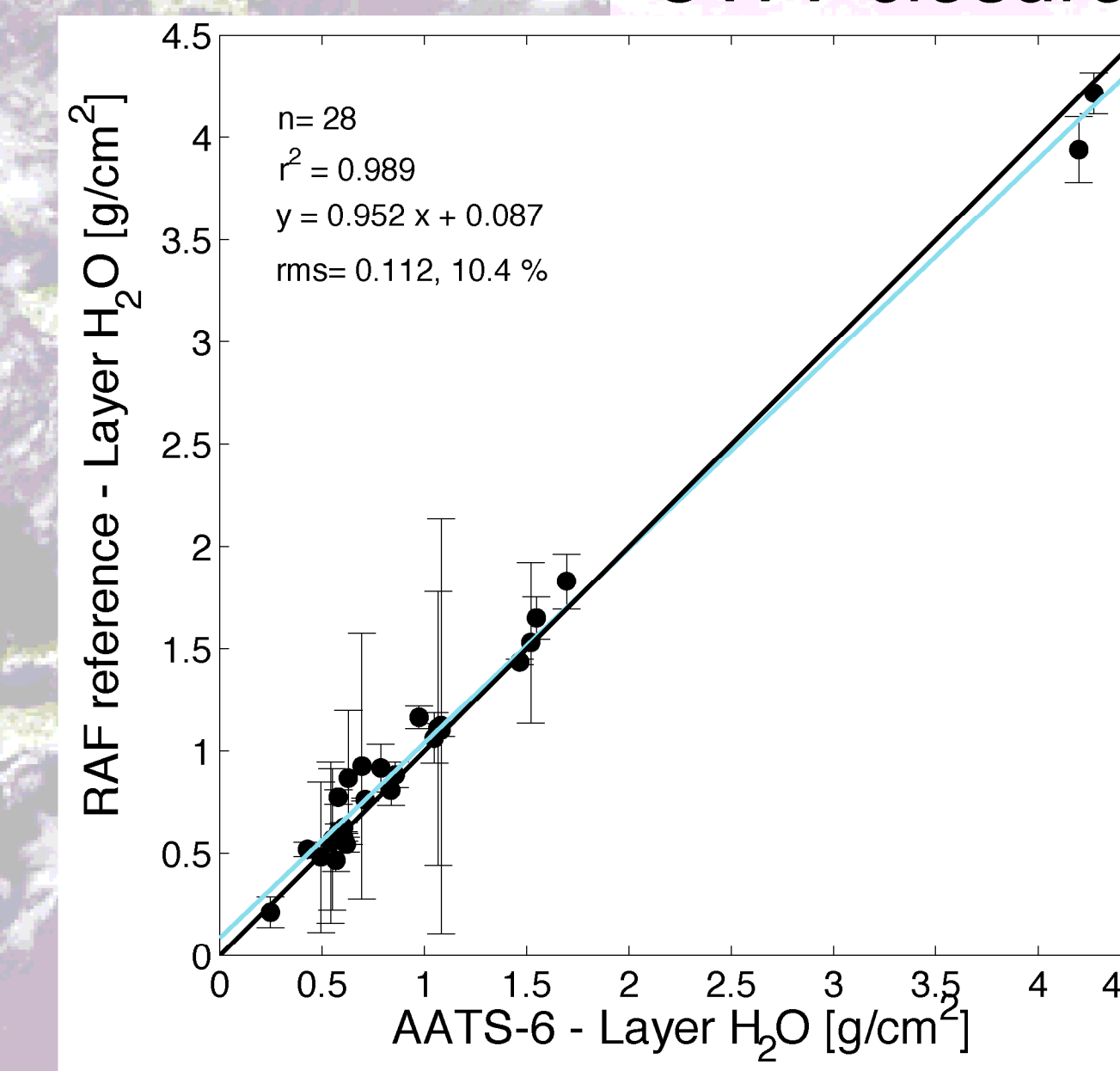
## Water Vapor Density [g/m<sup>3</sup>]



## H<sub>2</sub>O-dens. closure

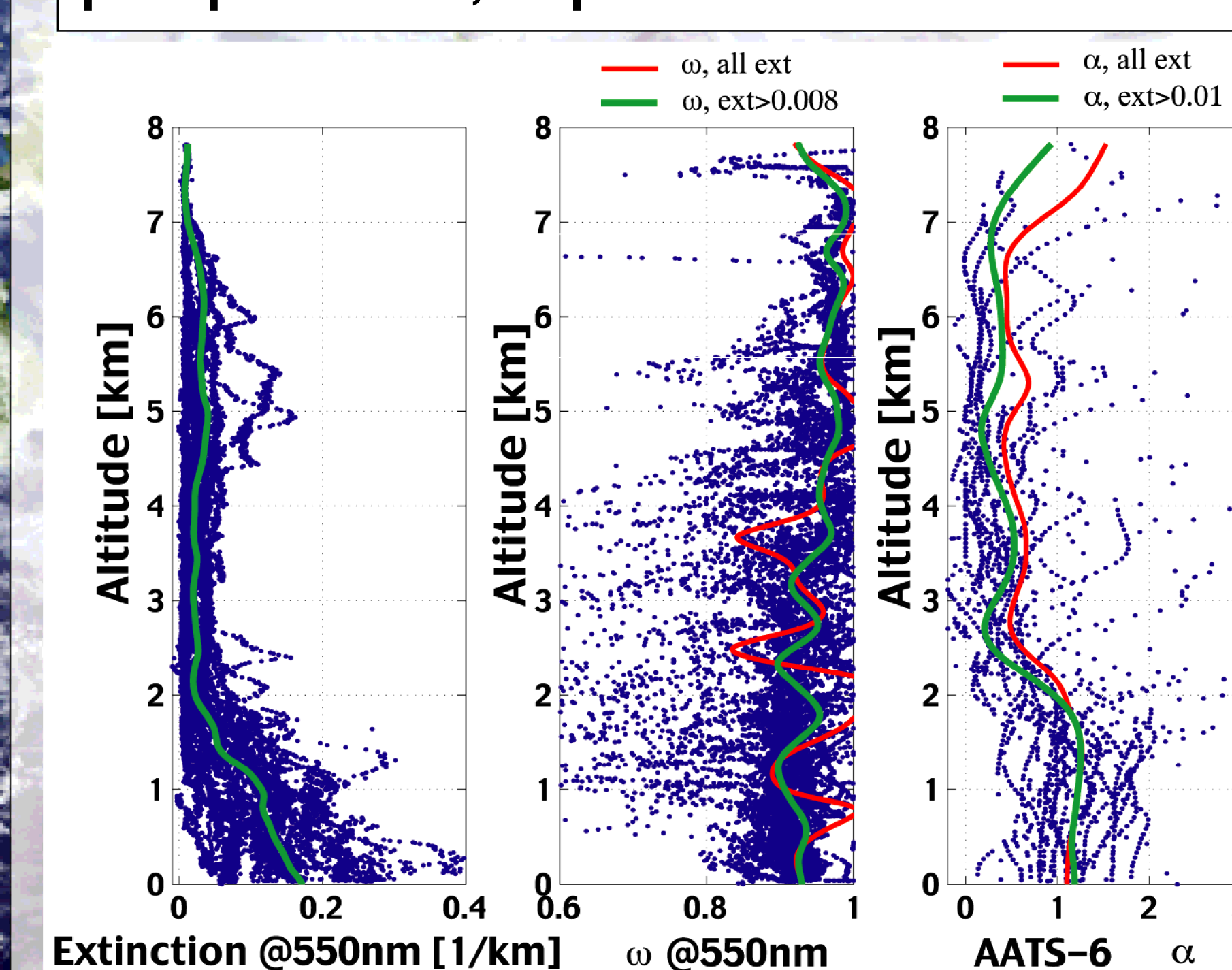


## Water Vapor Density [g/m<sup>3</sup>]

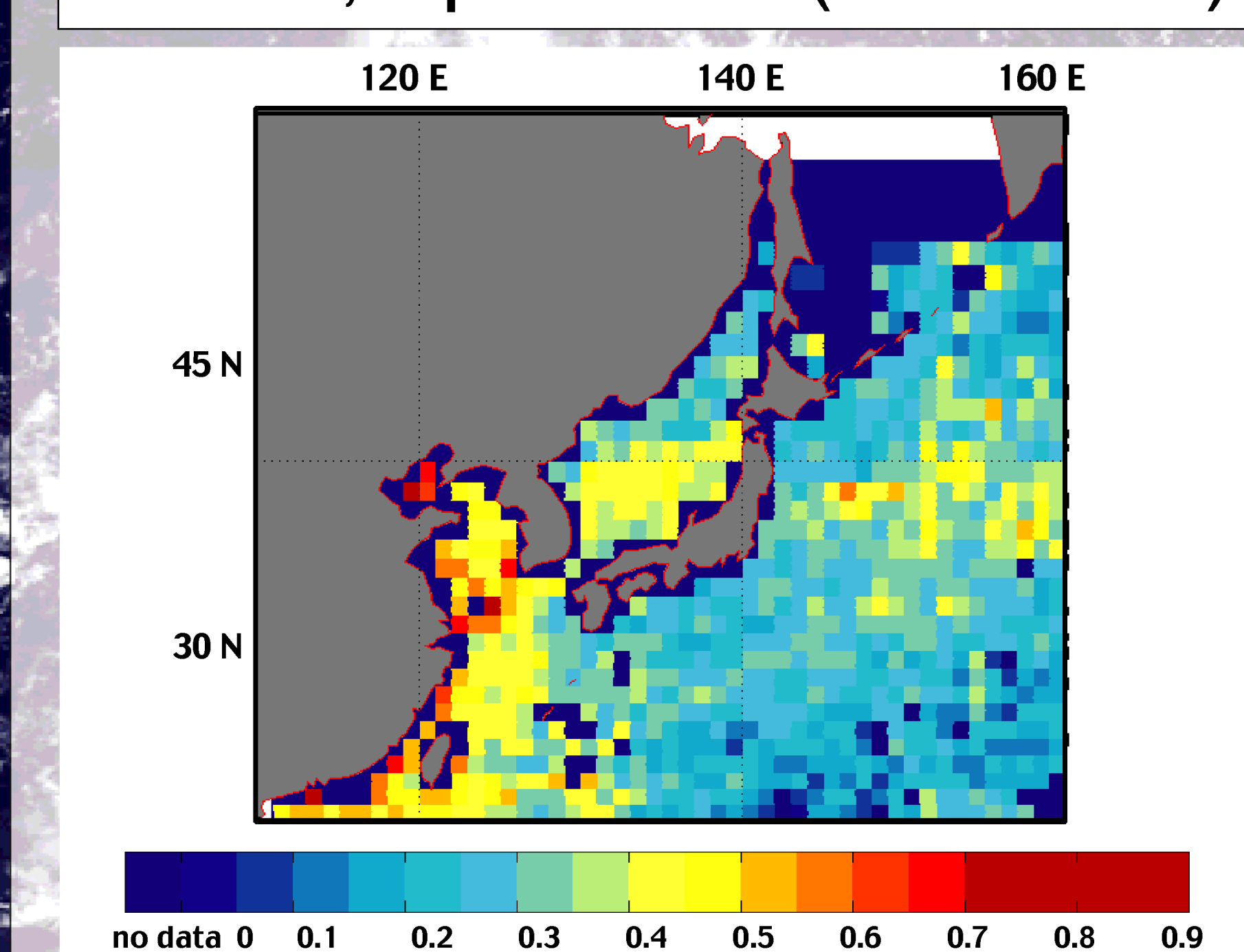


## CWV closure

## ACE-Asia (NCAR C-130) closure study derived aerosol properties, April 2001



## SeaWiFS-derived mean aerosol optical depth at 550nm, April 2001 (Hsu et al.)



## 24h-avg. direct clear-sky aerosol radiative forcing at the surface [Wm<sup>-2</sup>], April 2001

