Multi-angle Imaging SpectroRadiometer

EOS AM Spacecraft MISR

AEROSOL/SURFACE RETRIEVALS USING MULTIANGLE MEASUREMENTS FROM AIRMISR

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AirMISR Aerosol Retrieval

- **Prototype code to retrieve aerosol properties from AirMISR data in test phase**

  - uses the heterogeneous land (EOF) algorithm

- **Contributions from:**

  - Pranab Banerjee (HDFscan: visual display and interrogation routine for HDF image files)

  - Dave Diner (MSCAN: read/write routine for HDF files)

  - Matthieu Verstraete (integration of MSCAN routine into program input stream)

- **Performs radiative transfer calculations in real time**

Image #1 : Terrain Red
Line 118 Sample 816 Pixel value 0.000000e+00
Save
Quit

AirMISR Aerosol Retrieval

- **Investigated AirMISR dataset of Moffett field taken on 05 Nov 1997**
  - 2 runs were made: one flight north to south and 40 minutes later another flight from east to west
  - both runs were made within an hour before noon with a sun zenith angle of 53.5 deg
  - only Da camera view is not available as a resampled coregistered image
- **During this time sun photometry data and PARABOLA data were obtained**
  - target site was near runway
  - analysis of sun photometry data indicated that an aerosol amount of about 0.28 optical (green band) was present and optical depth decreased with increasing wavelength

AirMISR Aerosol Retrieval

- **Initial analysis of Moffett field data centered on quality of the resampled (27.5 m pixel) coregistered datasets**

  - found some misregistration (offset and scaling) effects between the various camera view images

  - scaling effects limited size of coregistered images to about 300x300 pixels

- **The nadir camera view images of the north -south run and the east-west run were compared for consistency**

  - radiance-averaged subregions (64x64 pixels in size) common to both runs were found to vary in brightness by up to 10 %

  - cause was traced to slightly different view geometries resulting in slightly different path radiances and surface BRFs.

  - concluded that the two runs were radiometrically consistent

AEROSOL RETRIEVAL ALGORITHM

- **TOA Radiance Equation**

$$L^{TOA}_{x,y}(-\mu, \mu_0, \phi-\phi_0) = L^{atm}(-\mu, \mu_0, \phi-\phi_0) + \exp(-\tau/\mu) \cdot L^{surf}_{x,y}(-\mu, \mu_0, \phi-\phi_0)$$
$$+ \int_0^1 \int_0^{2\pi} T(-\mu, -\mu', \phi-\phi') L^{surf}_{x,y}(-\mu', \mu_0, \phi'-\phi_0)\, d\mu' d\phi'$$

- **For heterogeneous land determine Empirical Orthogonal Functions (EOFs) which describe the surface reflectance angular variation for all pixels within the multi-angle image**
  - determined from pixel-dependent functions $L^{TOA}_{x,y} - \langle L^{TOA} \rangle$

- **For each aerosol model determine $\langle L^{TOA} \rangle - L^{atm}_{model}$ and expand in EOFs**

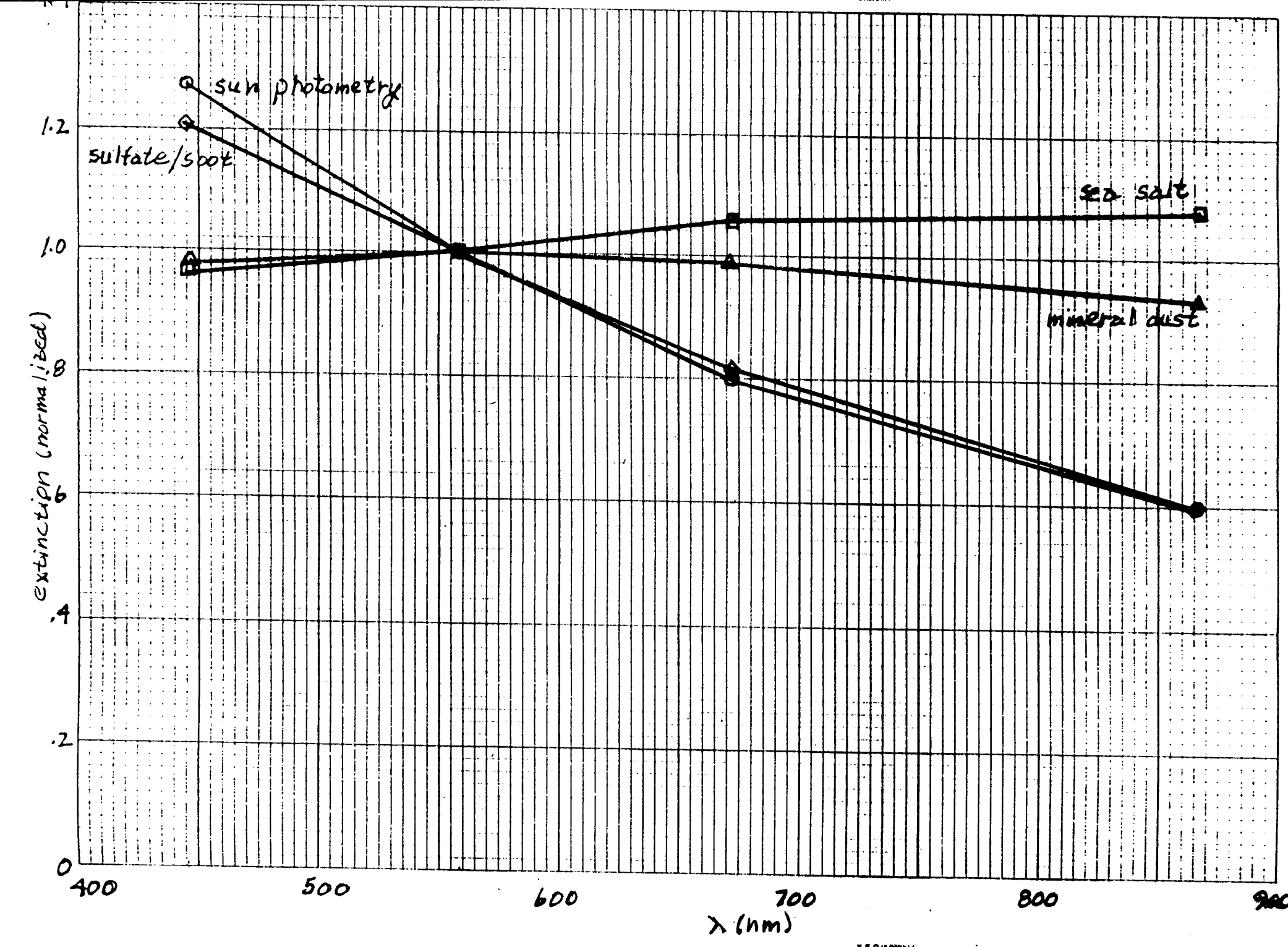
$$\langle L^{TOA}(-\mu, \mu_0, \phi-\phi_0) \rangle - L^{atm}_{model}(-\mu, \mu_0, \phi-\phi_0) \approx \sum_n C_n E_n(-\mu, \mu_0, \phi-\phi_0)$$

  - determine least squares residuals

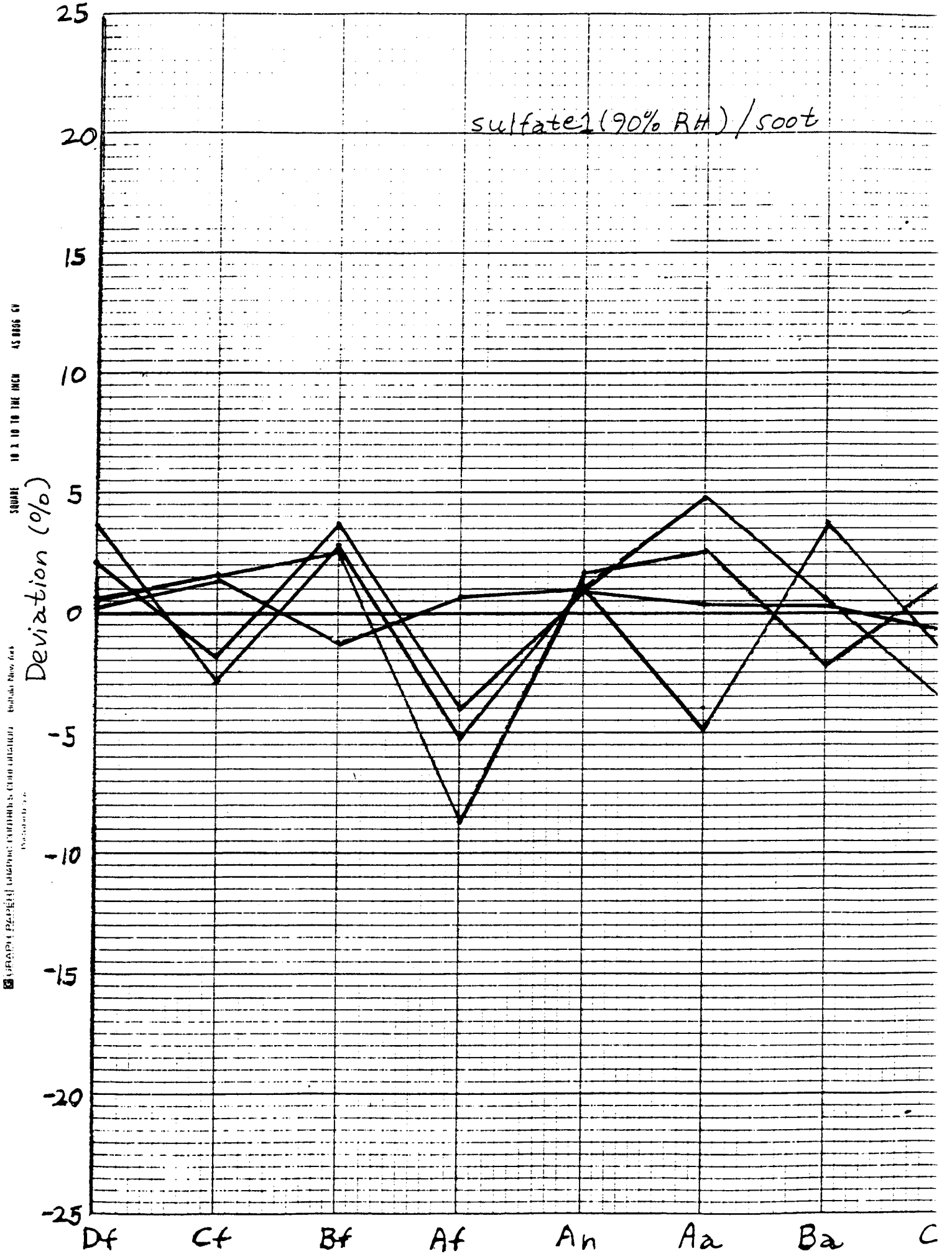
- **Aerosol model which produces minimum residuals is best estimate of atmospheric state**

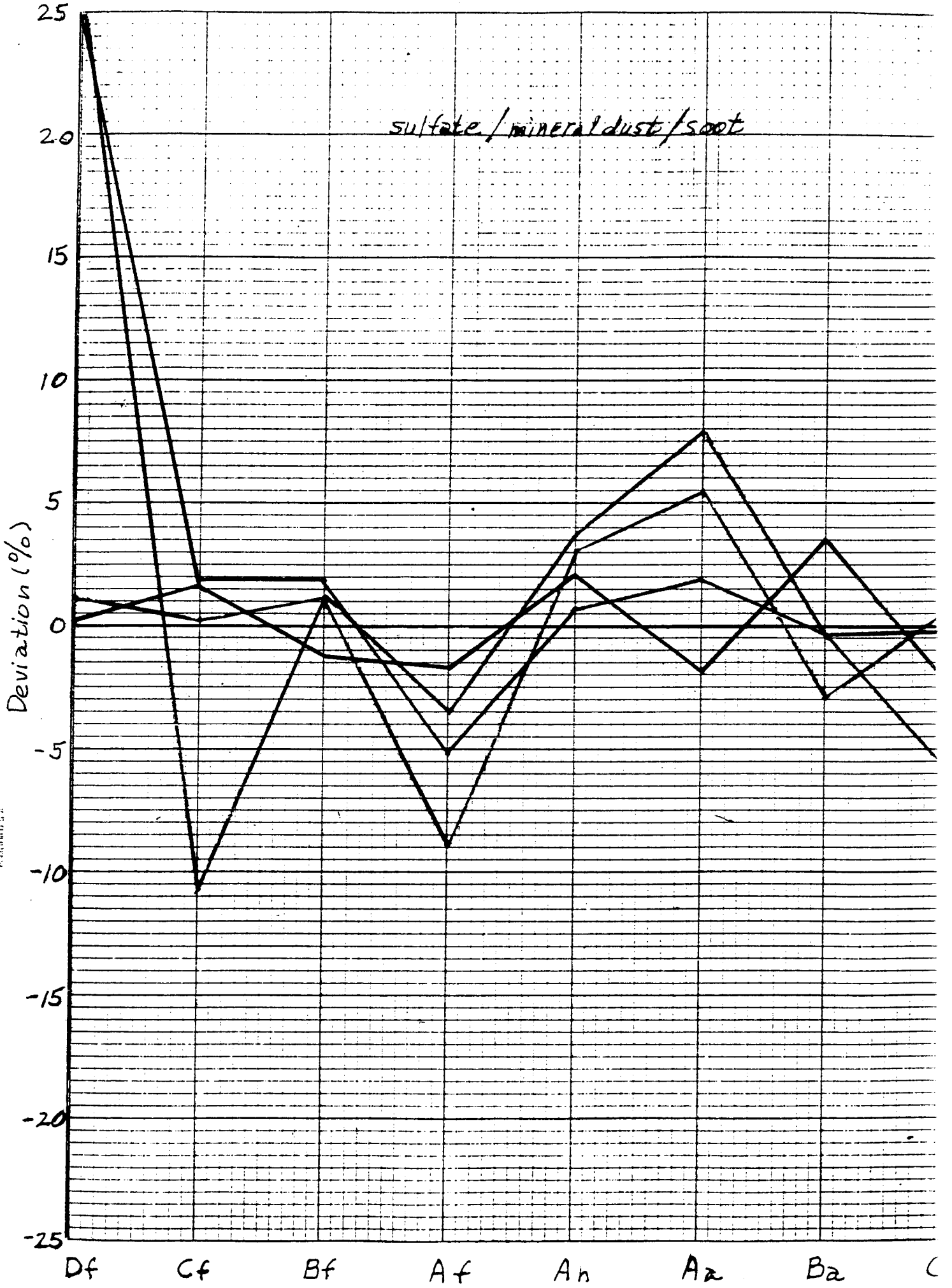
Table 3: Pure particle types in the ACP

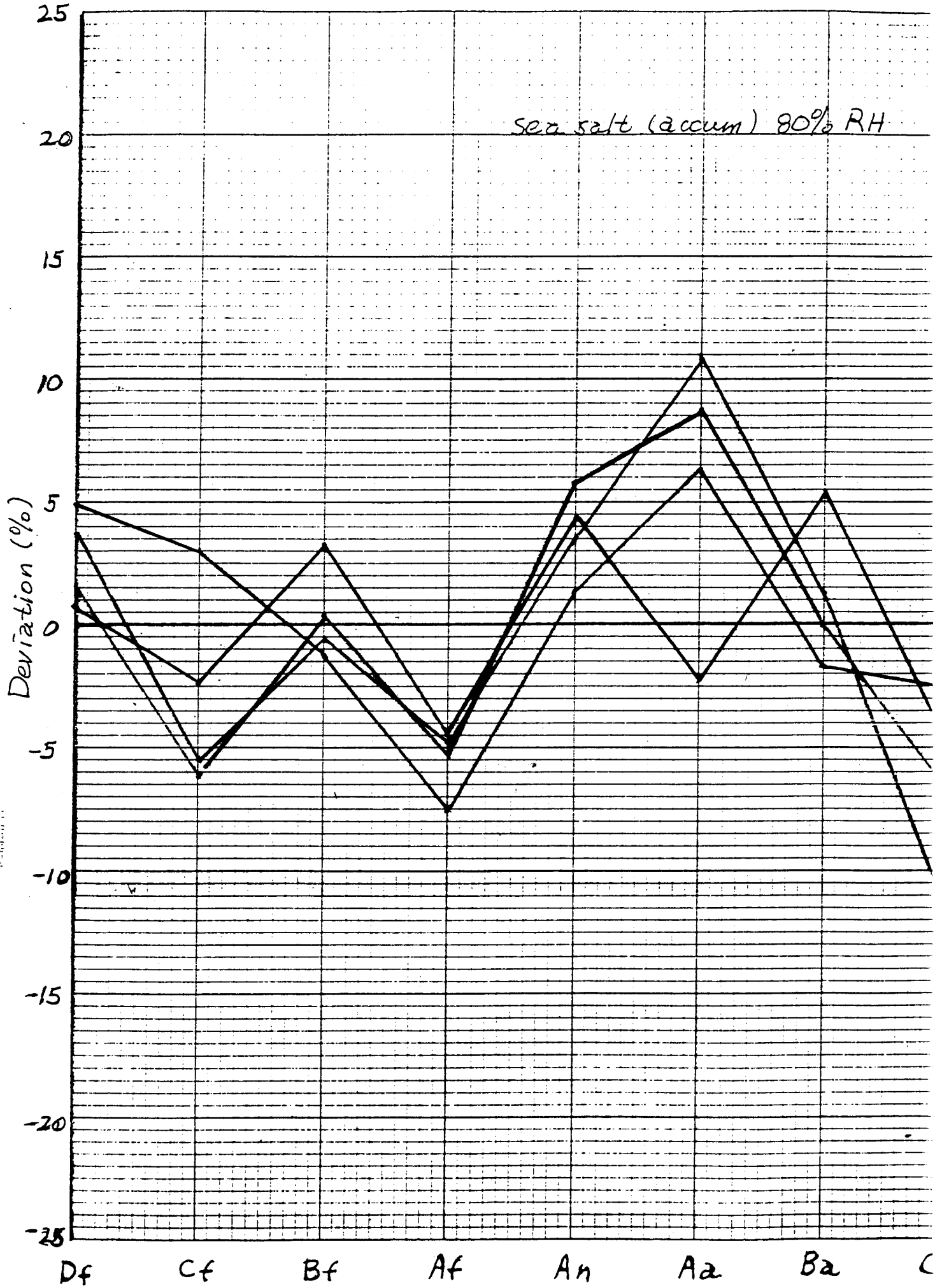
Aerosol	r_1 (μm)	r_2 (μm)	r_c (μm)	σ	α	n_r	n_i (band)	ξ (g / cm^3)	RH (%)	Vary with RH?	Shape
Sulfate/ nitrate 1 (Accum.)	0.007	0.7	0.07	1.86	n/a	1.53	0.0 (all)	1.7	0	Yes	Spheres
Sulfate/ nitrate 2 (Accum.)	0.05	2.0	0.45	1.30	n/a	1.43	0.0 (all)	1.7	Amb	No	Spheres
Mineral dust (Accum.)	0.05	2.0	n/a	n/a	3.0	1.53	0.0085(1) 0.0055(2) 0.0045(3) 0.0012(4)	2.6	0	No	Prolate/ oblate spheroids
Mineral dust (Coarse)	0.5	15.0	n/a	n/a							
Sea salt (Accum.)	0.1	1.0	0.35	2.51	n/a	1.50	0.0 (all)	2.2	0	Yes	Spheres
Sea salt (Coarse)	1.0	20.0	3.30	2.03							
Urban soot	0.005	20.0	0.012	2.00	n/a	1.75	0.455(1) 0.440(2) 0.435(3) 0.430(4)	2.3	0	No	Spheres
Biomass burning	0.007	2.0	0.40	1.80	n/a	1.43	0.0035 (all)	1.8	97	No	Spheres
Near-surface fog	0.5	50.0	n/a	n/a	2.5	1.33	0.0 (all)	1.0	100	No	Spheres
Thin cirrus	10.0	500.0	see text	see text	see text	1.31	0.0 (all)	1.0	100	No	Equidim. hexag. prisms

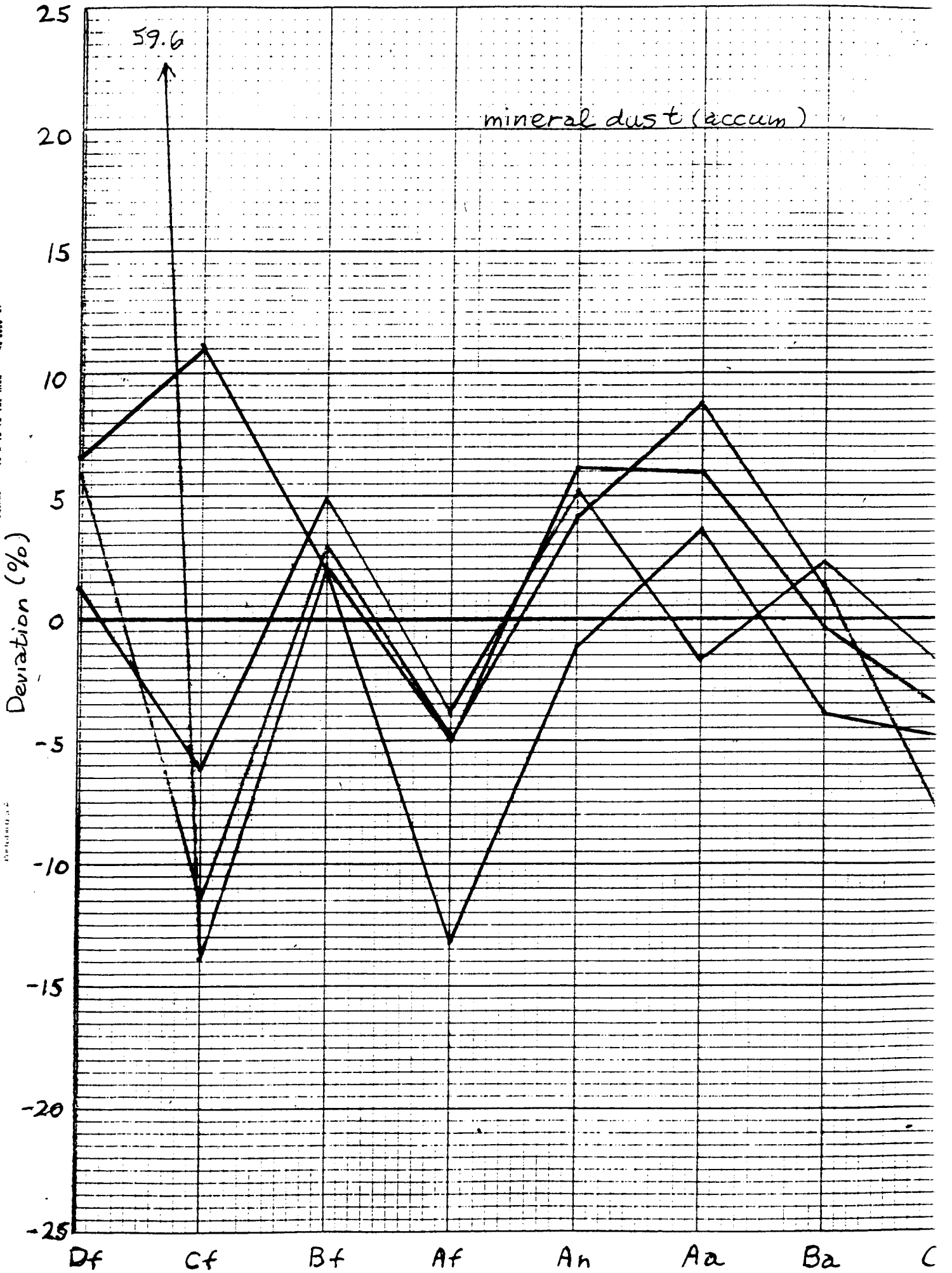


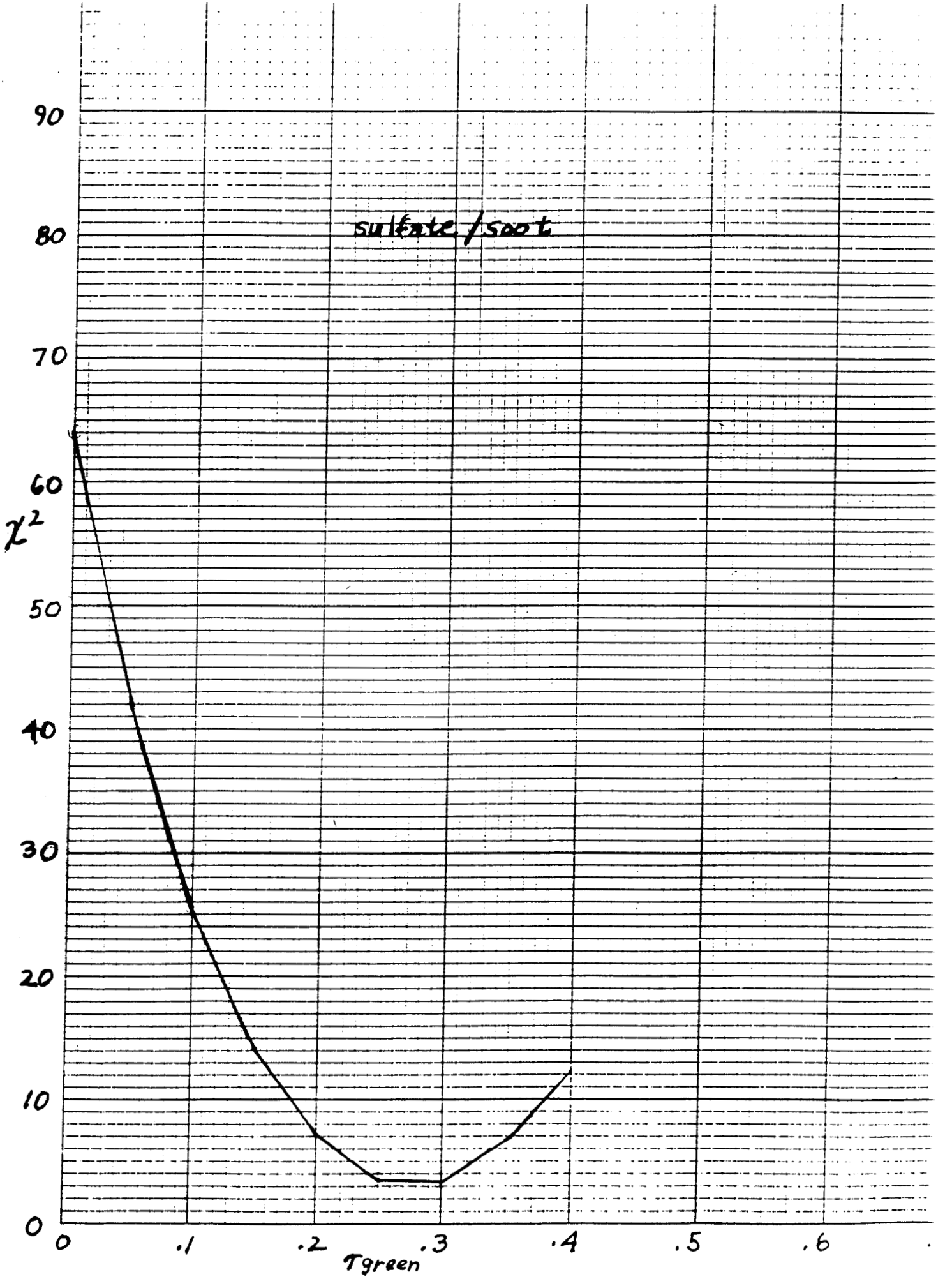
GRAPH PAPER GRAPHIC CONTROLS CORPORATION Buffalo, New York PRINTED IN U.S.A. SQUARE 10 X 10 TO THE INCH AS 0006 GY


sulfate1 (90% RH) / soot
Deviation (%)
25
20
15
10
5
0
-5
-10
-15
-20
-25
Df
Cf
Bf
Af
An
Aa
Ba
C


sulfate / mineral dust / soot
Deviation (%)
25
20
15
10
5
0
-5
-10
-15
-20
-25
Df
Cf
Bf
Af
An
Az
Ba


sea salt (accum) 80% RH
Deviation (%)
25
20
15
10
5
0
-5
-10
-15
-20
-25
Df
Cf
Bf
Af
An
Aa
Ba
C


59.6
mineral dust (accum)
Deviation (%)
25
20
15
10
5
0
-5
-10
-15
-20
-25
Df
Cf
Bf
Af
An
Aa
Ba
C


sulfate/soot
χ^2
90
80
70
60
50
40
30
20
10
0
0
.1
.2
.3
.4
.5
.6
τ_{green}

AirMISR Aerosol Retrieval

soot/sulfate ratio (blue)	retrieved τ (green)	maximum τ (green)	BHR (green)
0.0	0.186	0.173	0.108
0.05	0.197	0.184	0.110
0.10	0.207	0.195	0.116
0.25	0.256	0.230	0.124
0.30	0.273	0.248	0.127
0.50	0.348	0.301	0.148
sea salt	0.204	0.227	0.103
mineral dust	0.249	0.209	0.104
sulfate/mineral dust/soot	0.197	0.180	0.110

measured τ (green) = 0.28

AirMISR Aerosol/Surface Retrieval

- **Need to provide an input aerosol model loop to current program**
  - will be able to investigate about 120 - 150 models / hour
- **The DDV aerosol retrieval algorithm is almost ready for use with AirMISR data**
- **Ready to test surface retrieval algorithm on AirMISR data**
  - produces HDRFs, BHRs, BRFs, DHRs, and RPV BRF model parameters
  - additional code needed to produce PAR integrated BHRs and DHRs
  - when prototyped LAI/FPAR code is ready it will also be added
- **The EOF/DDV aerosol retrieval algorithms and the surface retrieval algorithm will be able to verify MISR Level 2 aerosol/surface products**