Chandra's First Decade of Discovery

# Updating the ACIS Contamination model

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CXC

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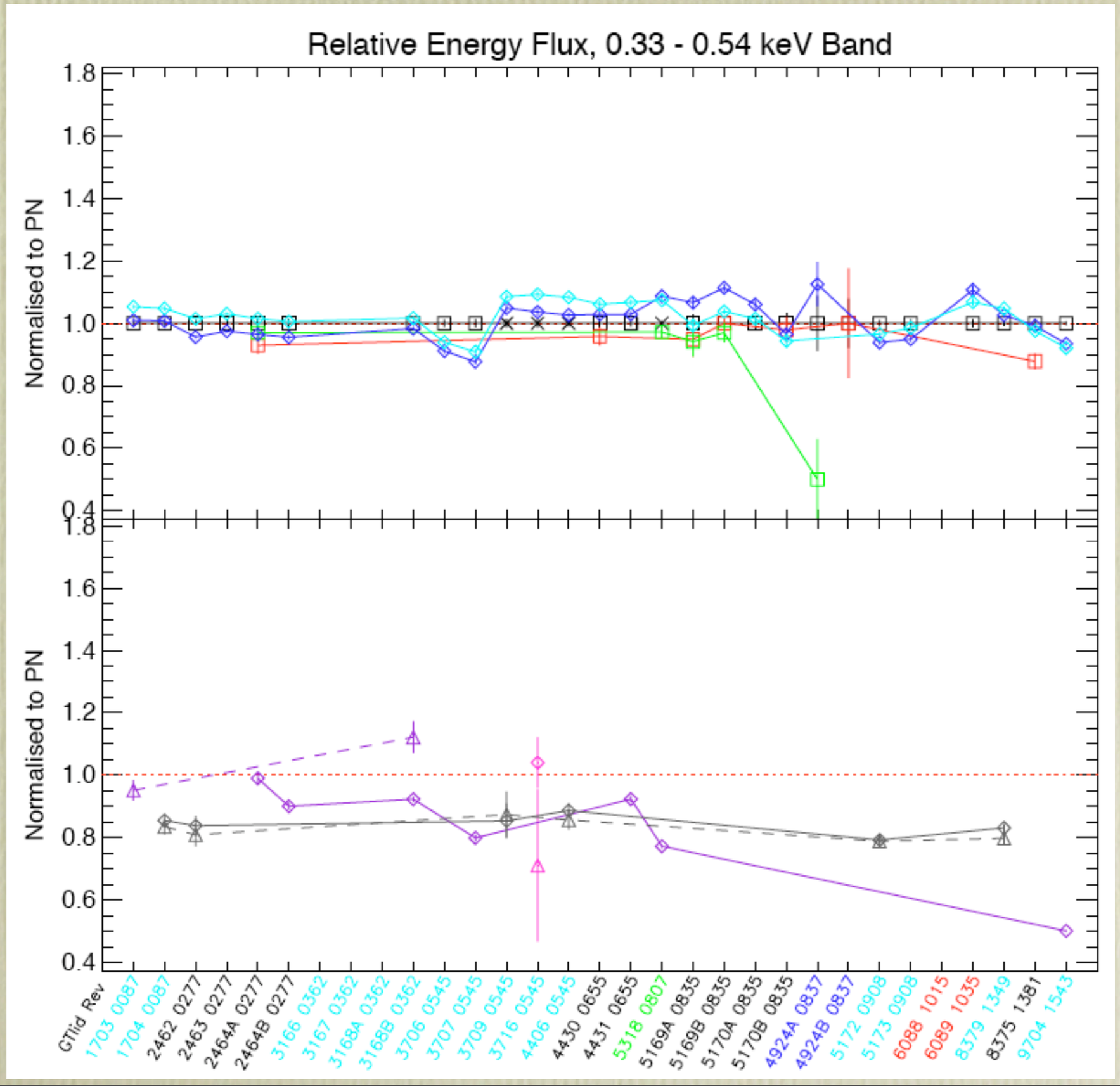
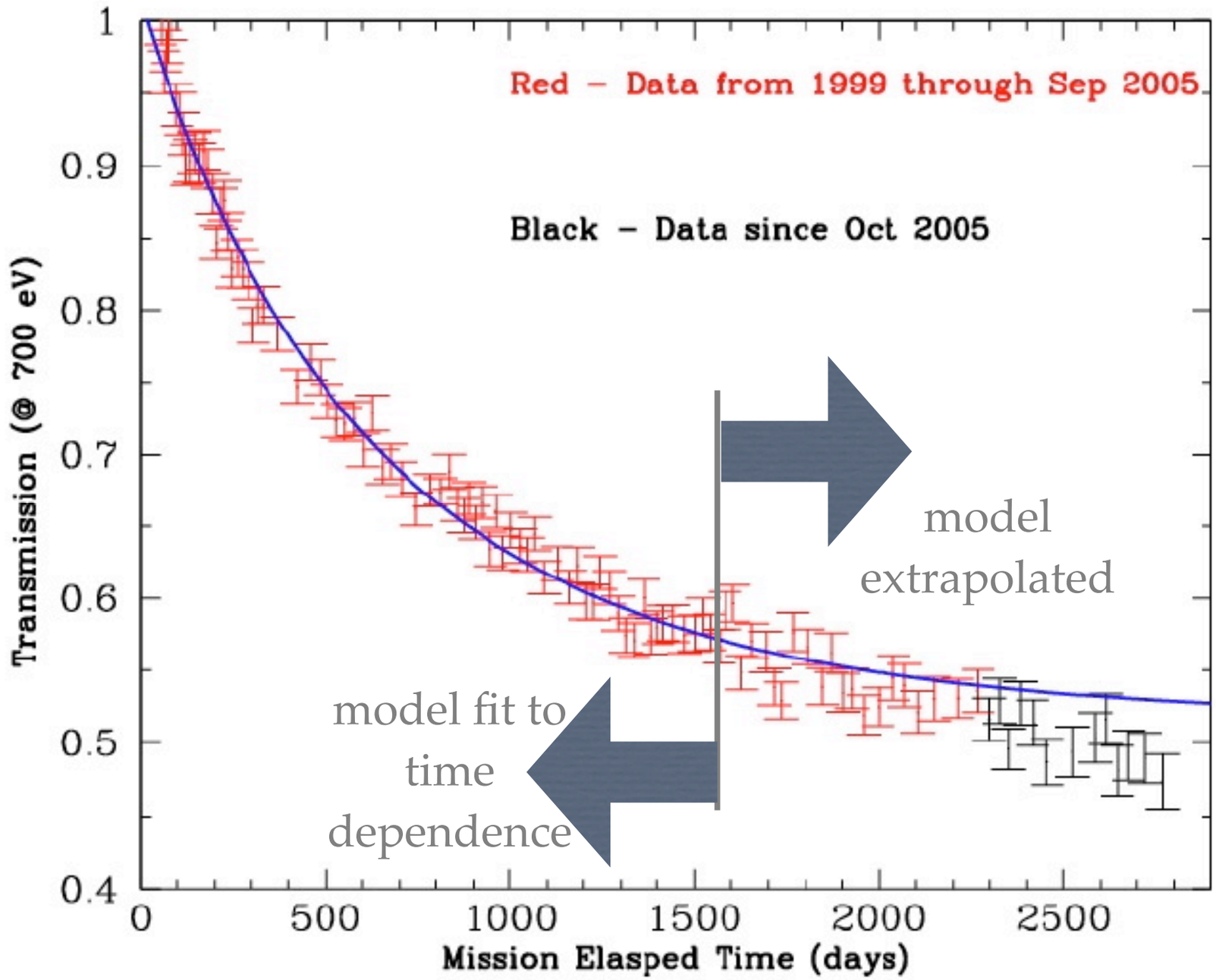
# Indications I



# Indications II

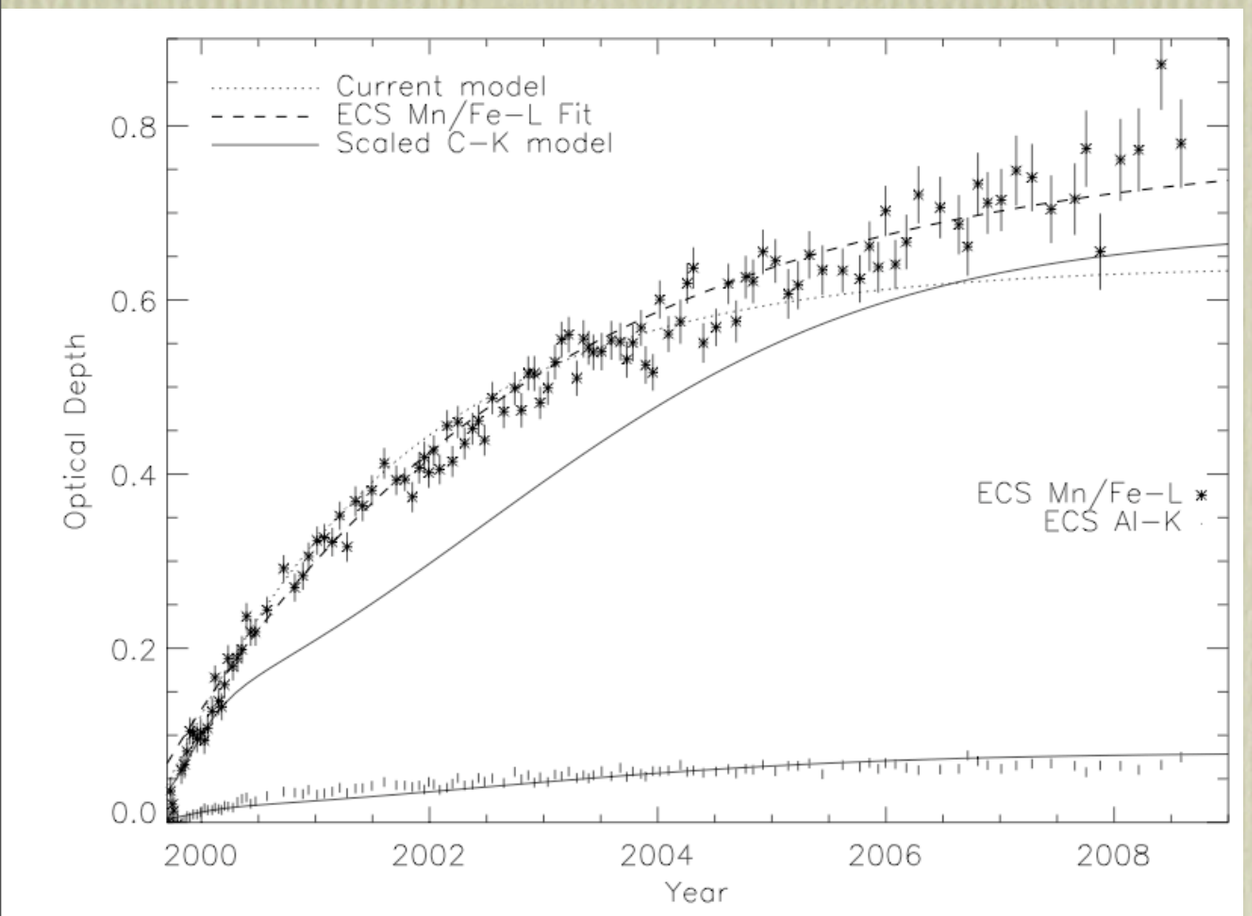
## Update on Contaminant Buildup



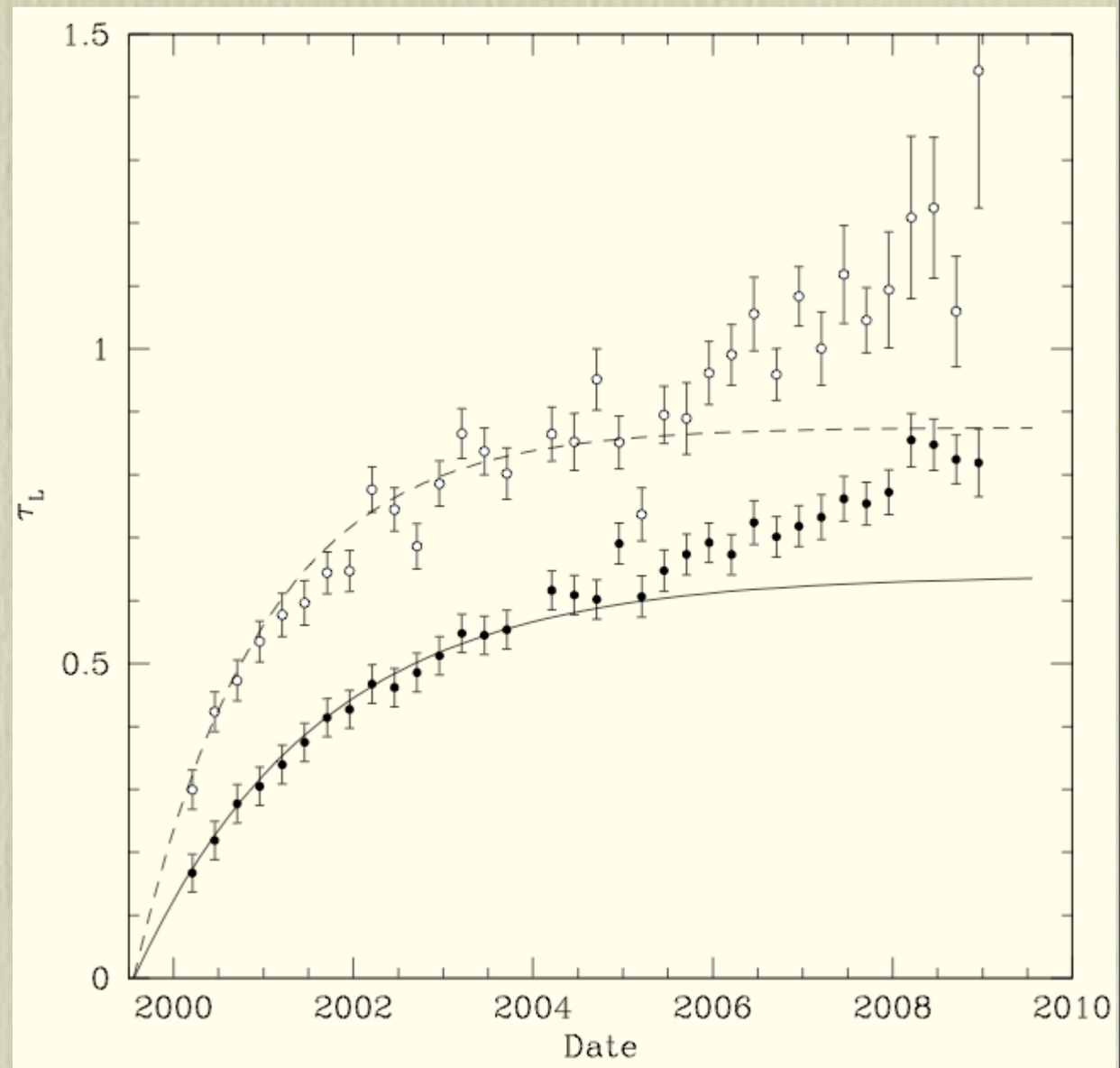

**Data for all Of S3: Grant (MIT)**

**Model: O'Dell & Tennant (MSFC) For middle of S3 Vikhlinin (SAO)**

# Why Now?




Model no longer fit ECS data (HLM, 12/08)

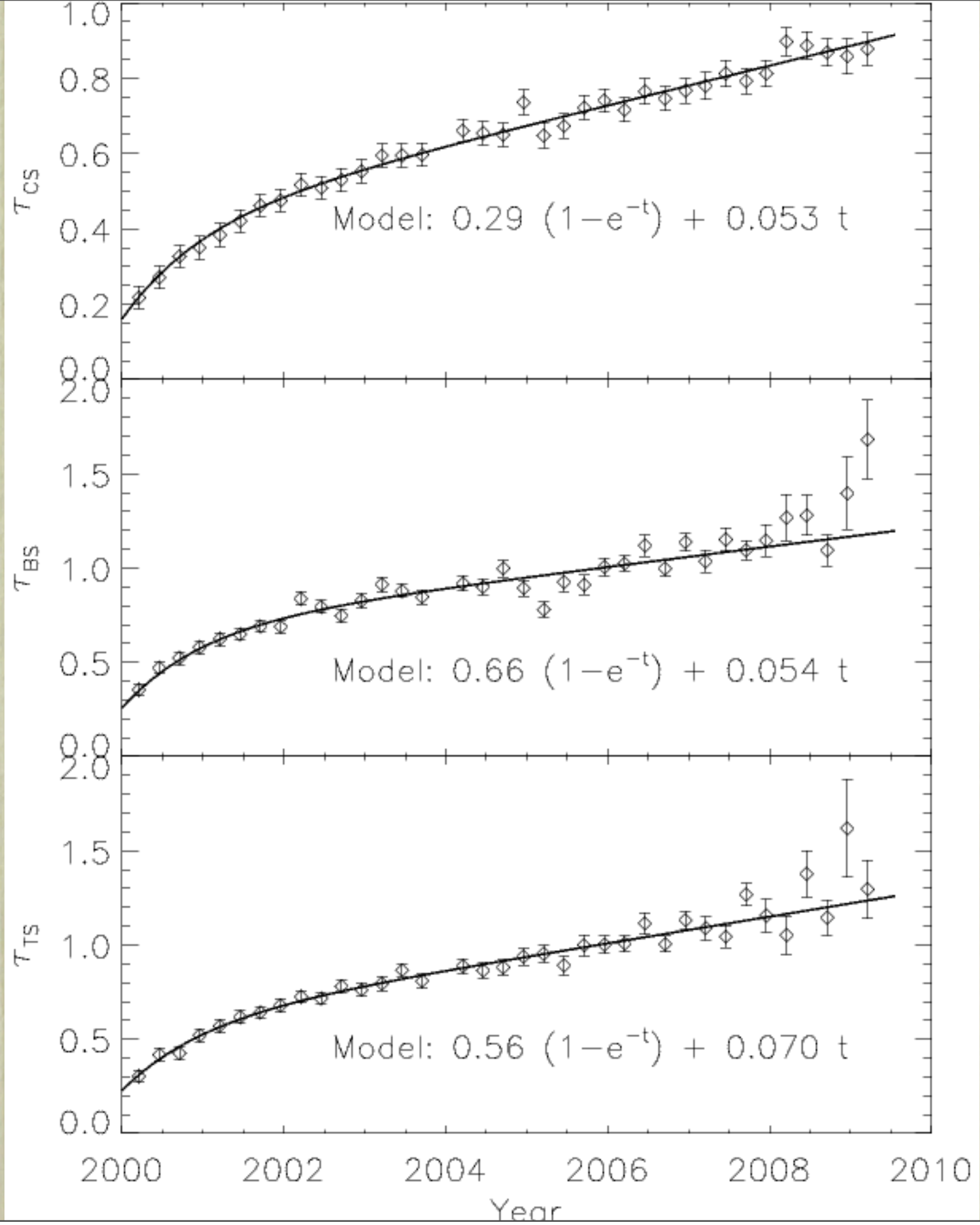



AV confirms, 3/09

# Approach

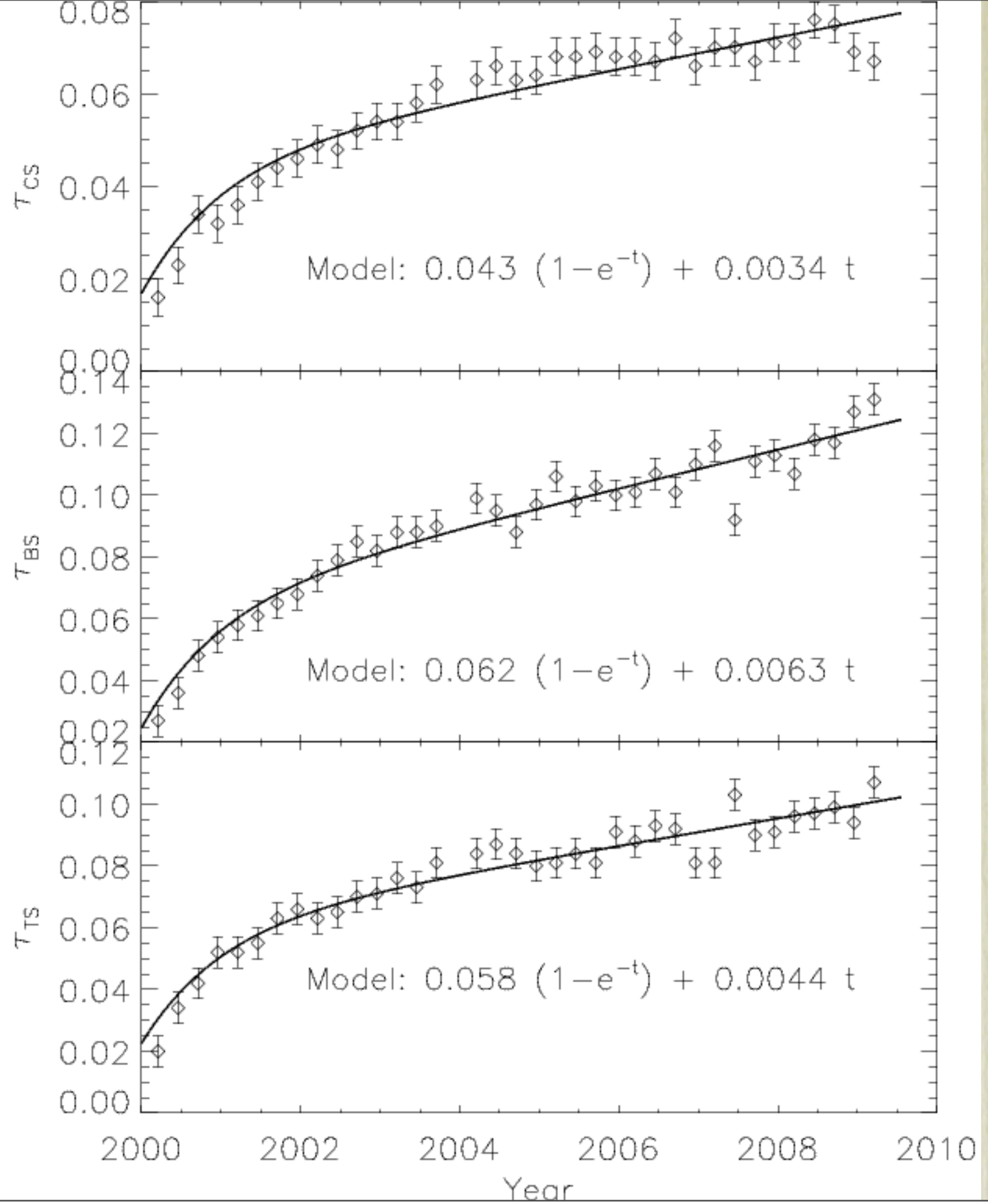
- Begin with fits to $\tau_{C\text{-}K}(t)$, $\tau_{O\text{-}K}/\tau_{C\text{-}K}$, $\tau_{F\text{-}K}/\tau_{C\text{-}K}$
  - Use LETG/ACIS blazar spectra
- Use $\tau_{O\text{-}K}/\tau_{C\text{-}K}$, $\tau_{F\text{-}K}/\tau_{C\text{-}K}$ to compute $\tau_{o.66}(t)$
  - Compare to external cal source (ECS)
  - Model excess opacity with "fluffium"
- Model $\tau_{C\text{-}K,\ edge}(t) - \tau_{C\text{-}K,\ center}(t)$
- Compute $\tau_{o.66,\ edge}(t) - \tau_{o.66,\ center}(t)$
  - Compare to ECS measurements
  - Model excess opacity with fluffium
- Adjust fluffium spectrum using ECS $\tau_{Al\text{-}K}(t)$
- Repeat for ACIS-I but without C-K

ECS fits 660 eV

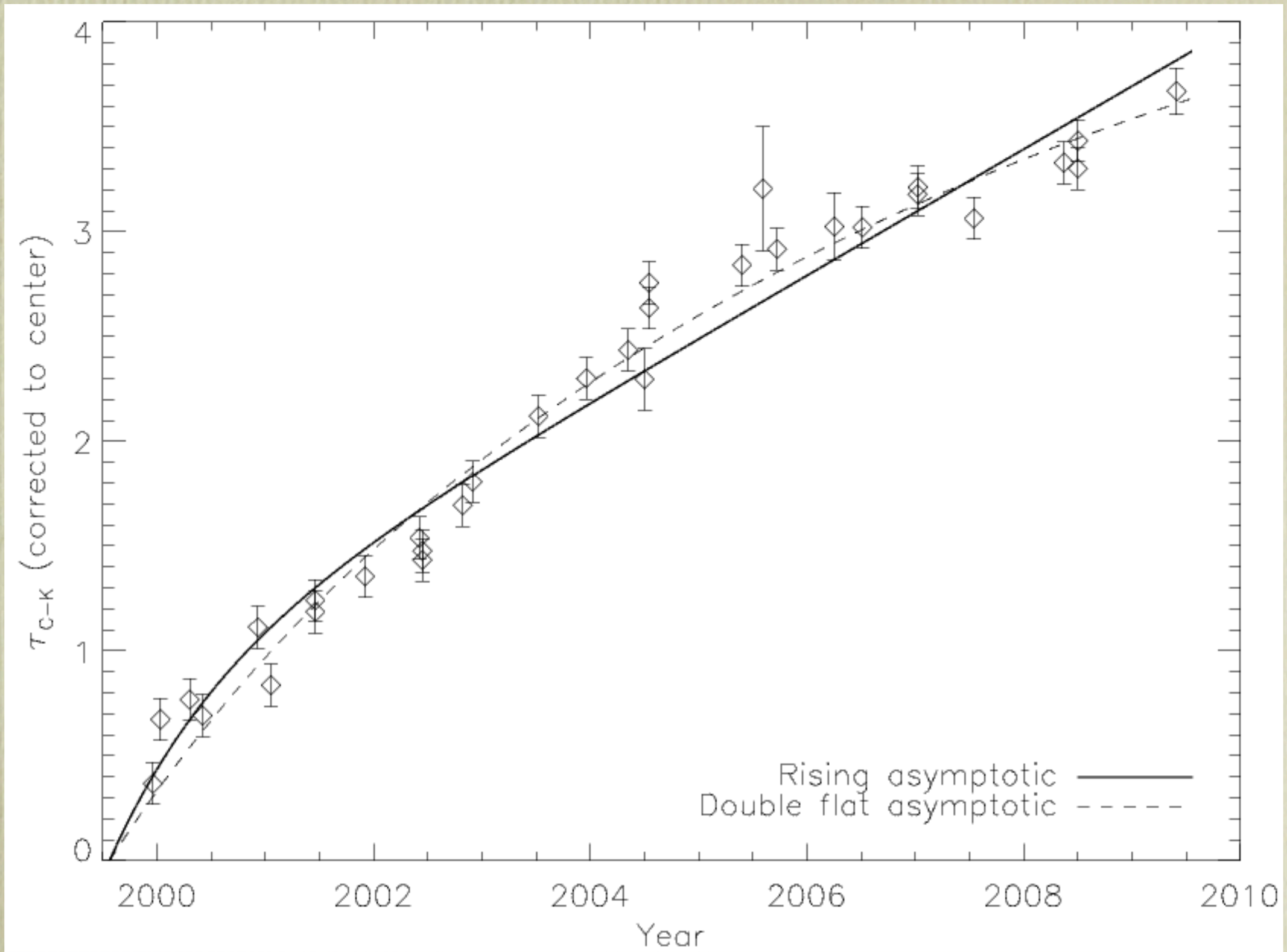



Data from Alexey Vikhlinin

ECS fits 1.486 keV

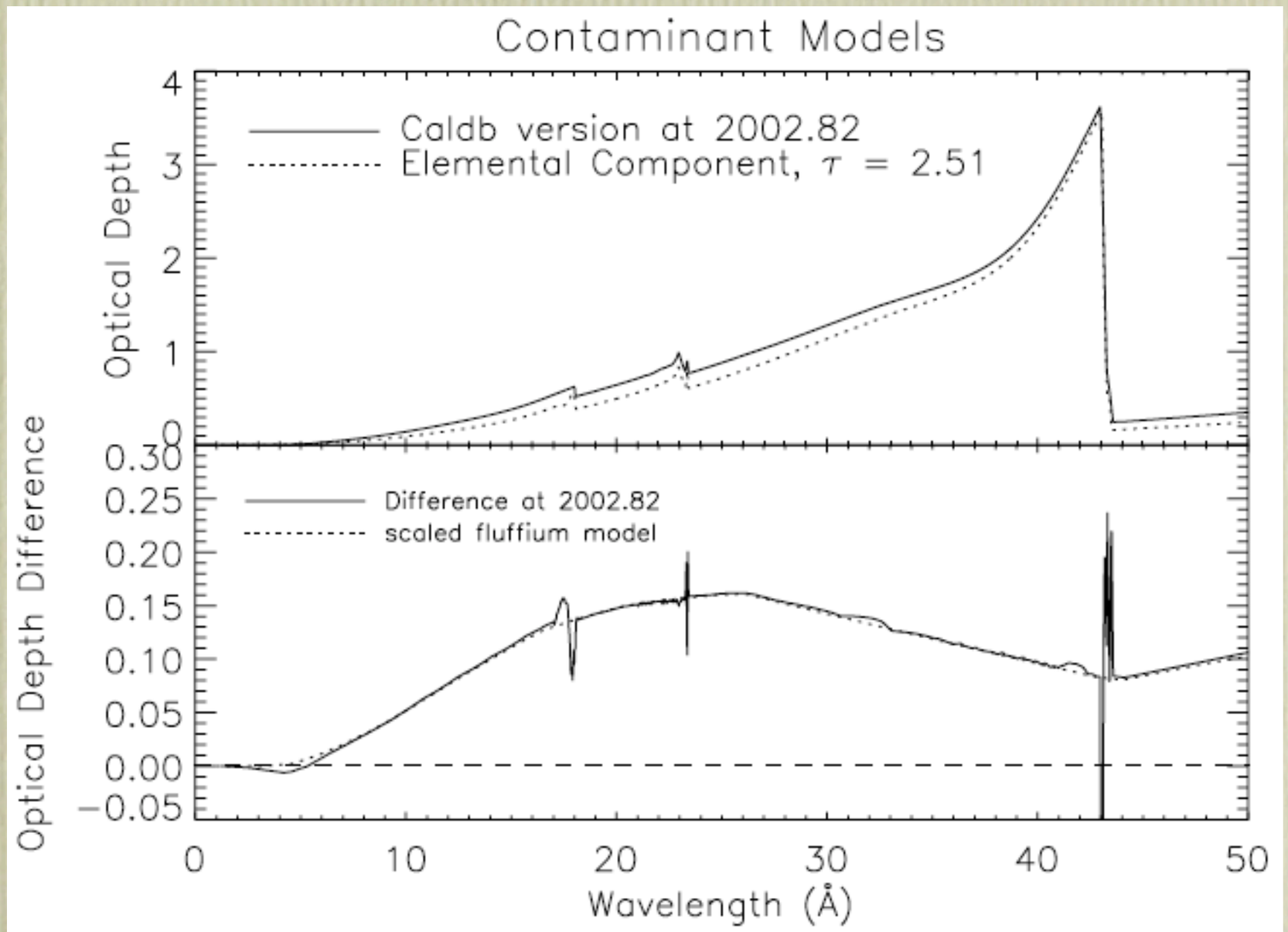



Data from Alexey Vikhlinin

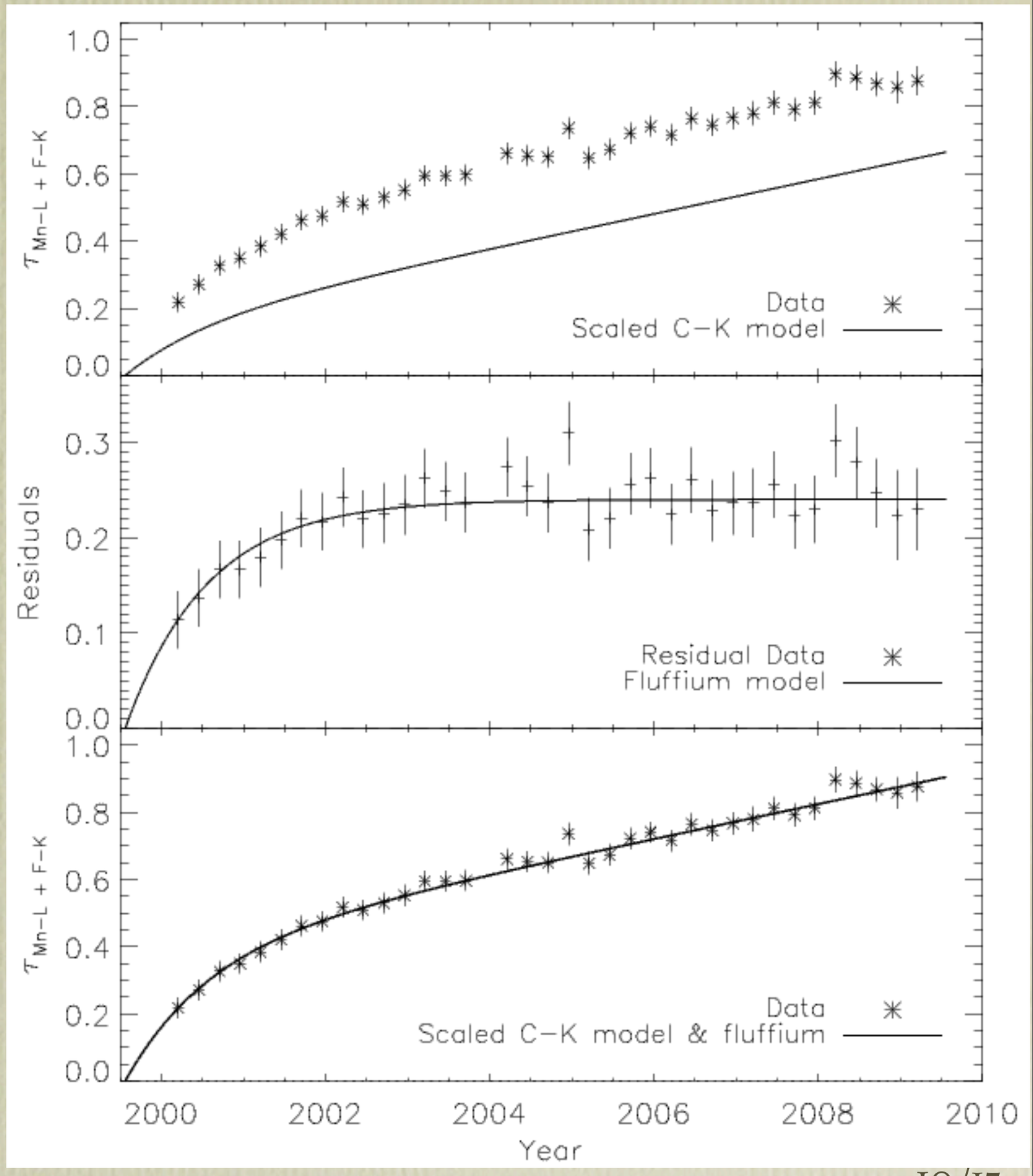



# Model: $0.86(1-e^{-t}) + 0.301t$

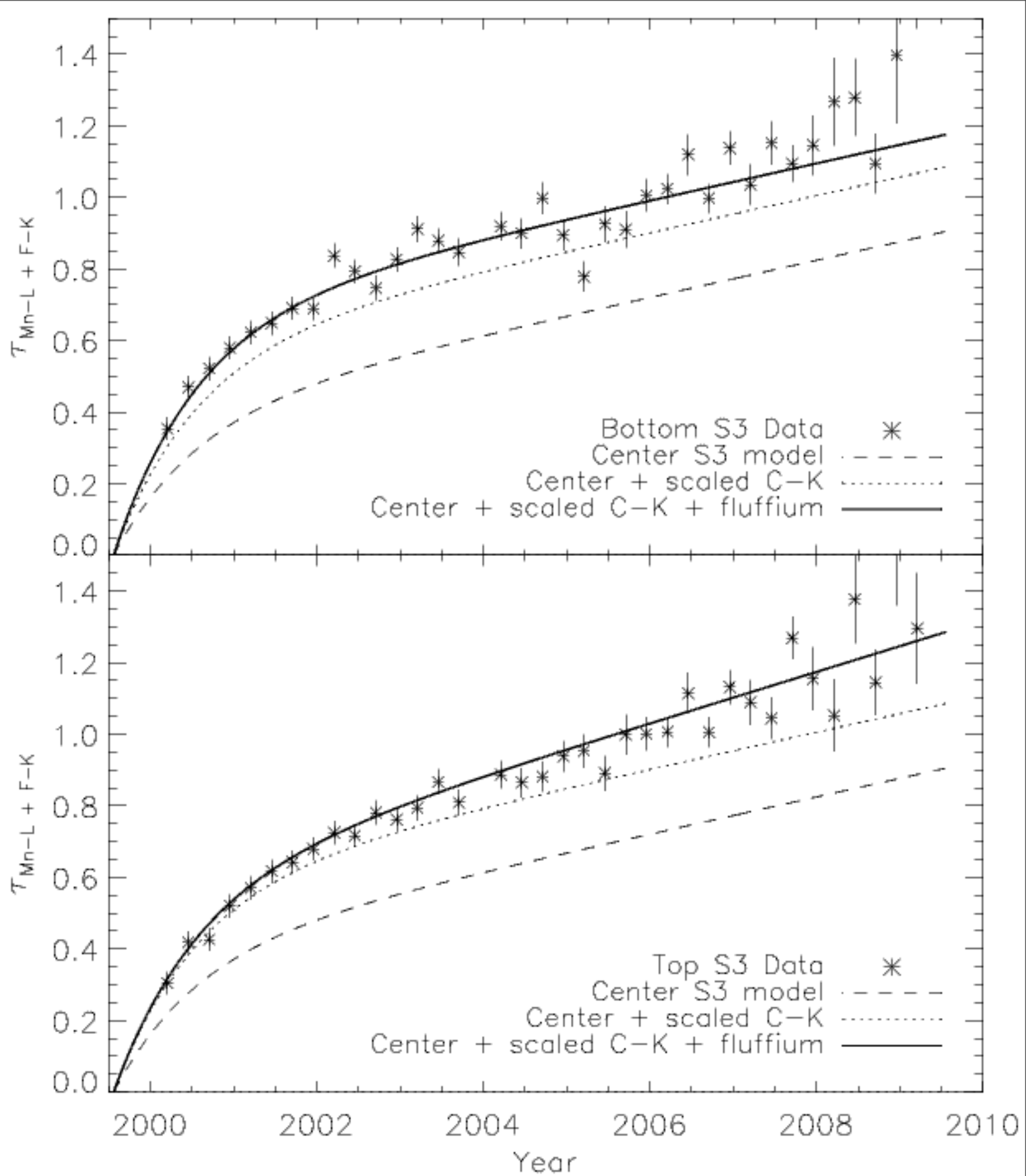
# Spectral model



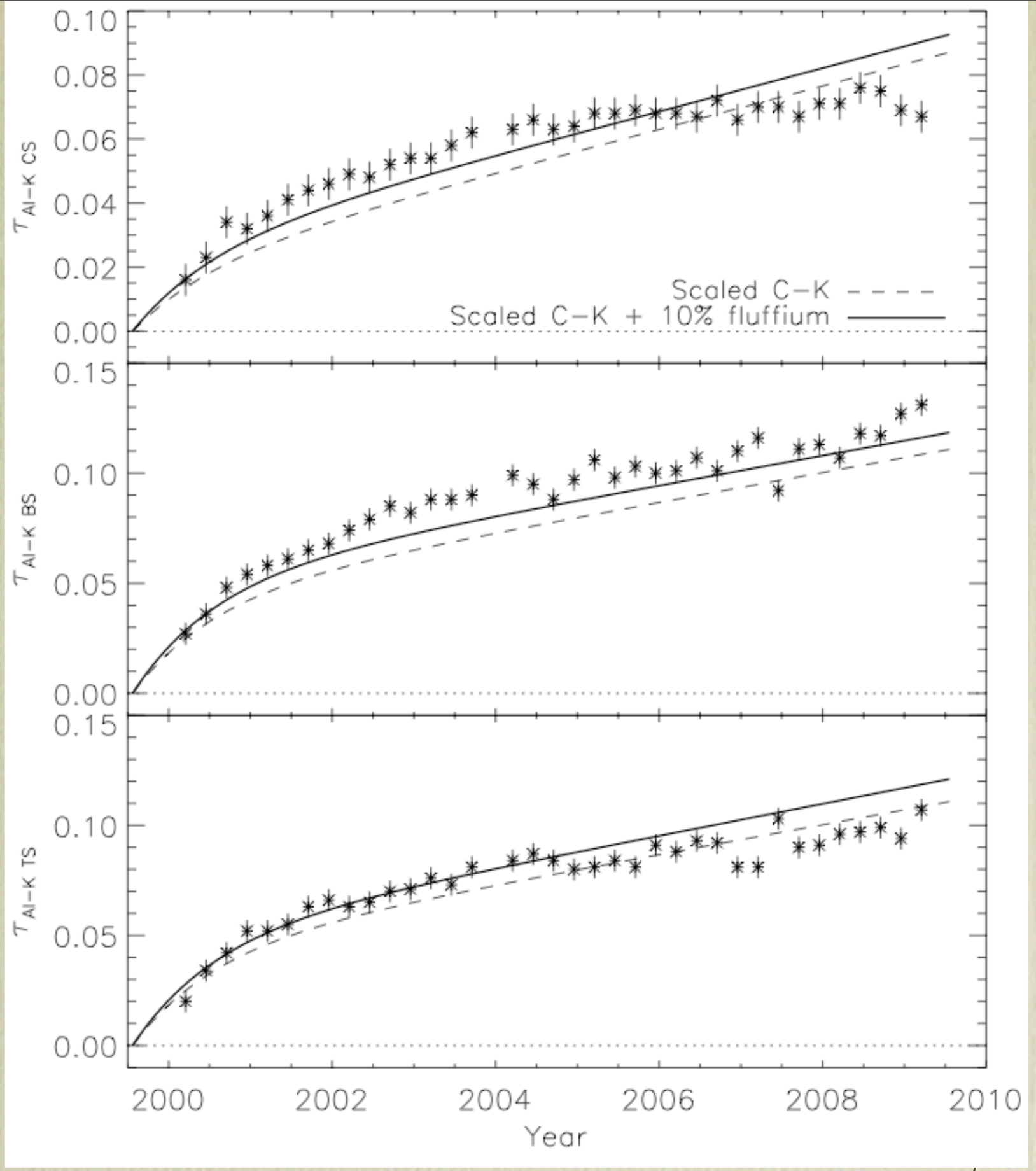
- Scale C-K model to 660 eV
- Subtract from CS data
- Fit to rising expoential
- Assign difference to fluffium



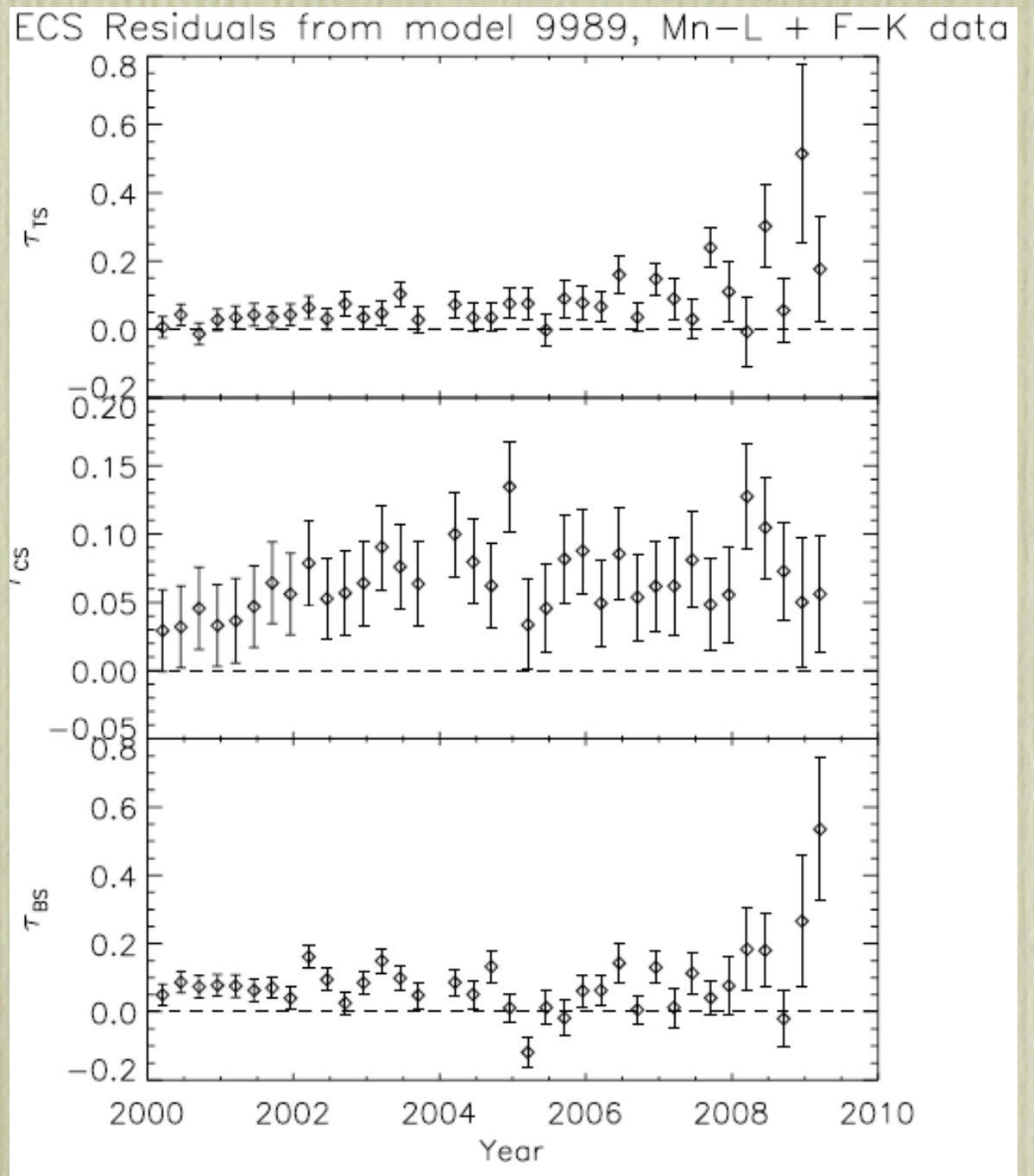
- Offset from center of S array
- Scale from C-K edge-center model
- Assign remainder to fluffium
- Fluffium now has spatial-temporal model

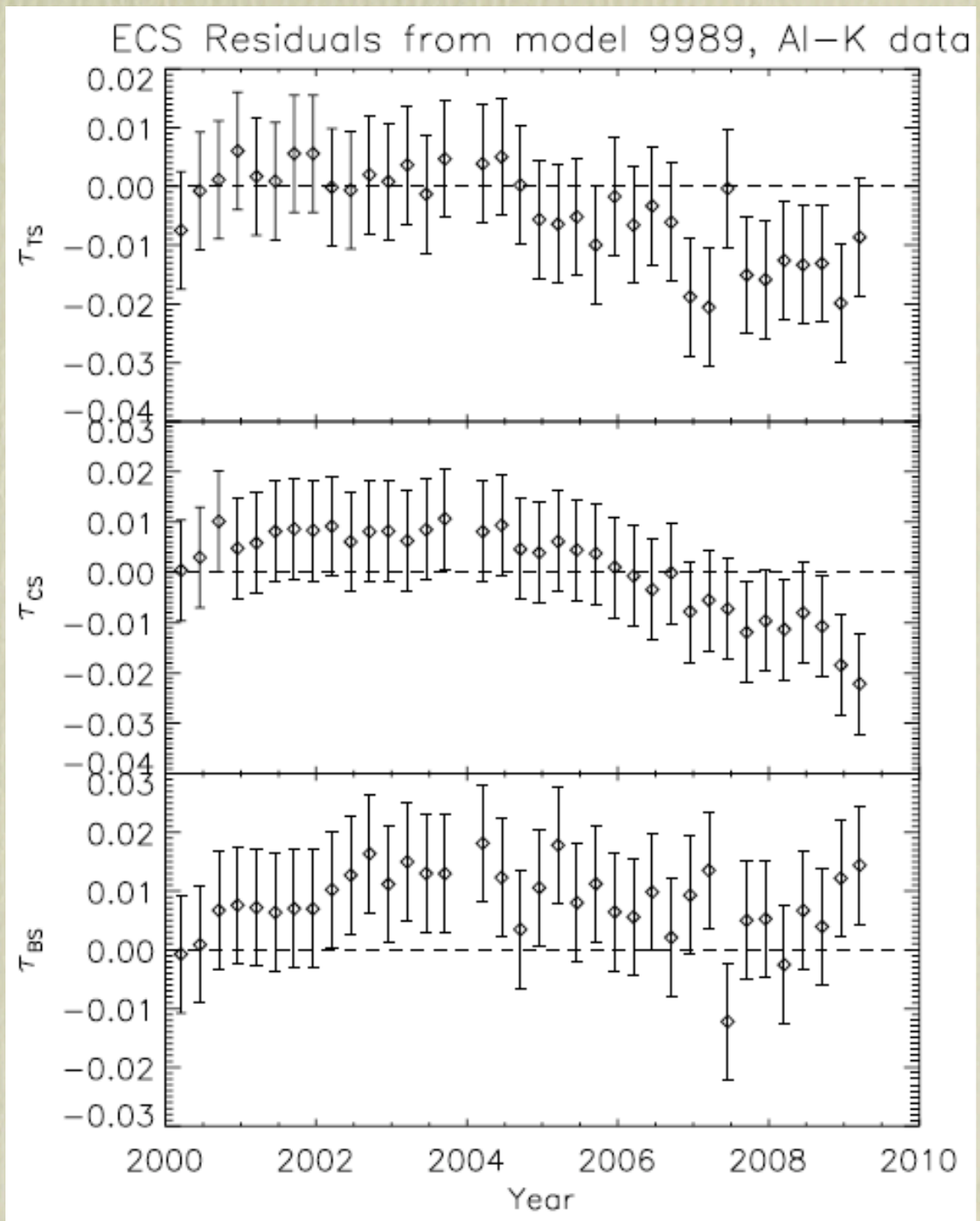


- Predict Al-K optical depths
- One free parameter: $\tau_{Al\text{-}K,\ fluff}$
- Error bars set at 0.05

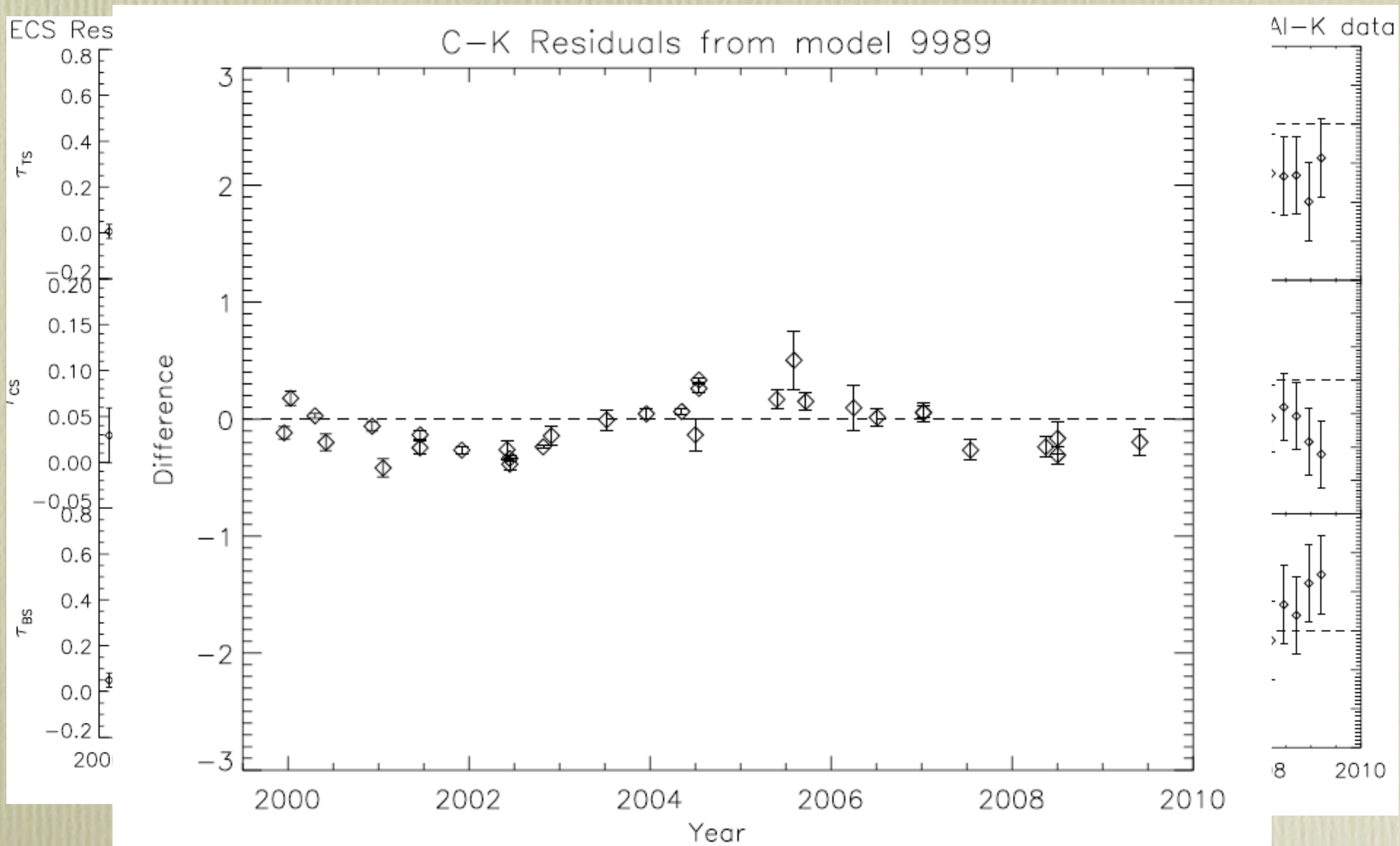


# Testing I

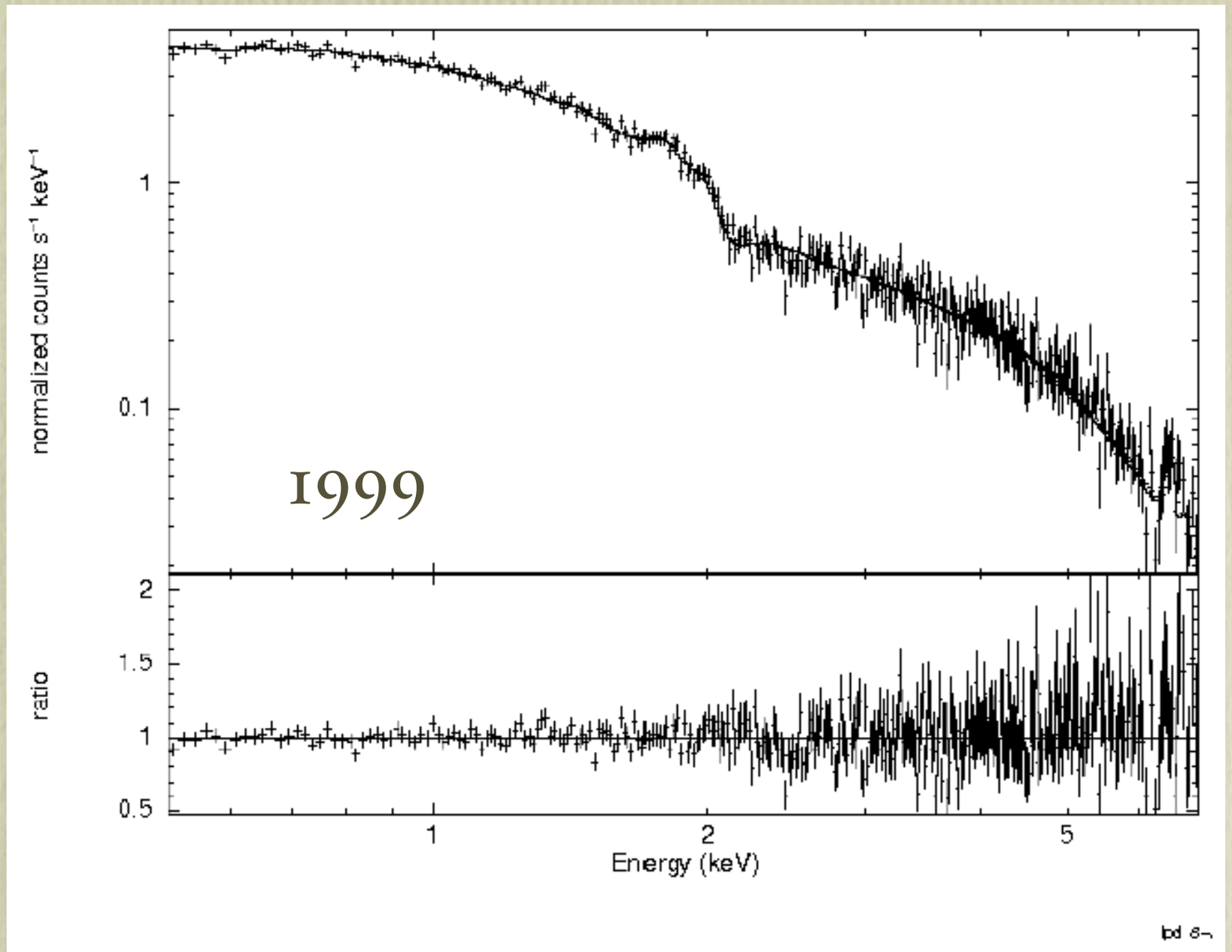

ECS Residuals from model 9989, Mn−L + F−K data
$\tau_{TS}$
$\tau_{CS}$
$\tau_{BS}$
Year


ECS Residuals from model 9989, Al−K data
$\tau_{TS}$
$\tau_{CS}$
$\tau_{BS}$
Year

# Testing I

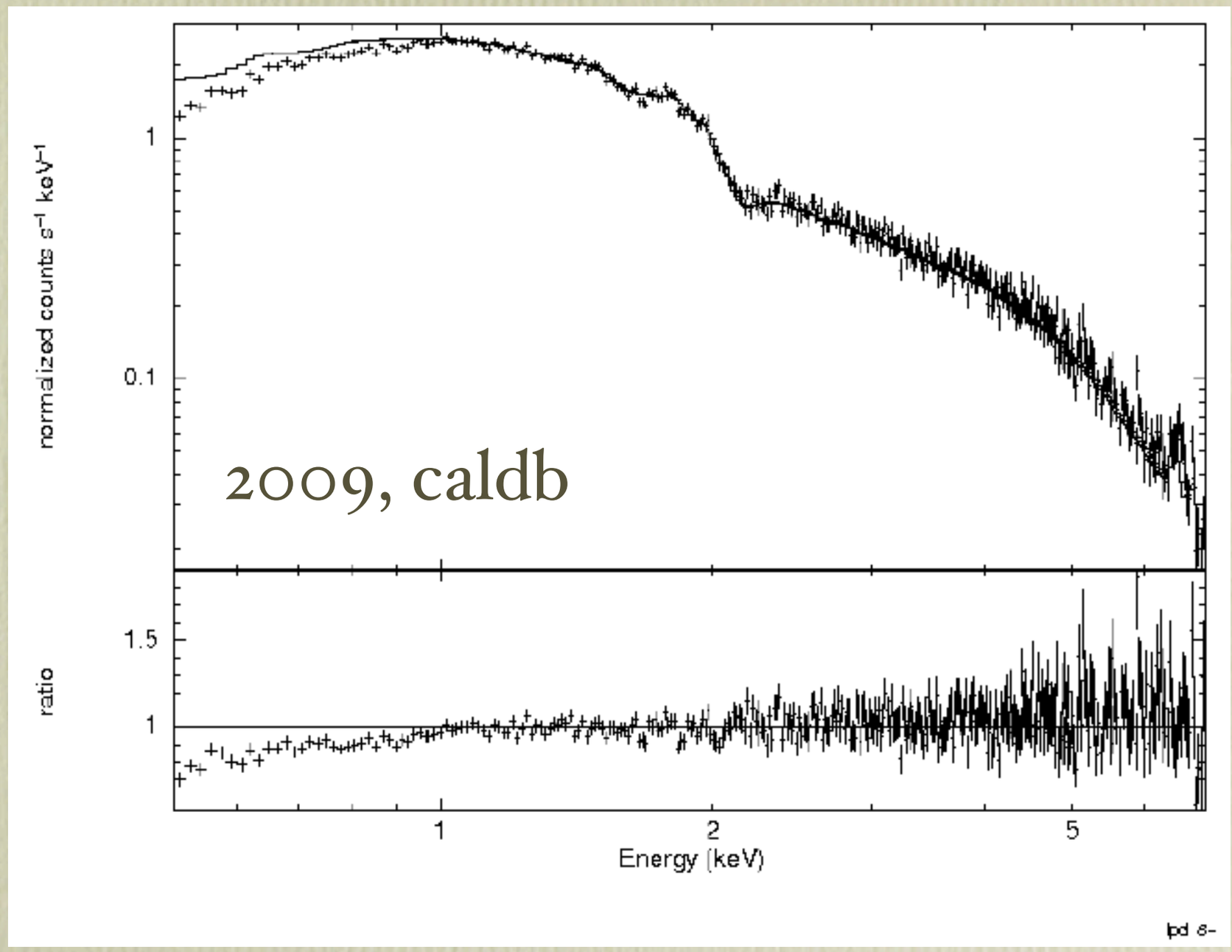

ECS Res
C−K Residuals from model 9989
Al−K data
Difference
Year
2000
2002
2004
2006
2008
2010

# Testing II



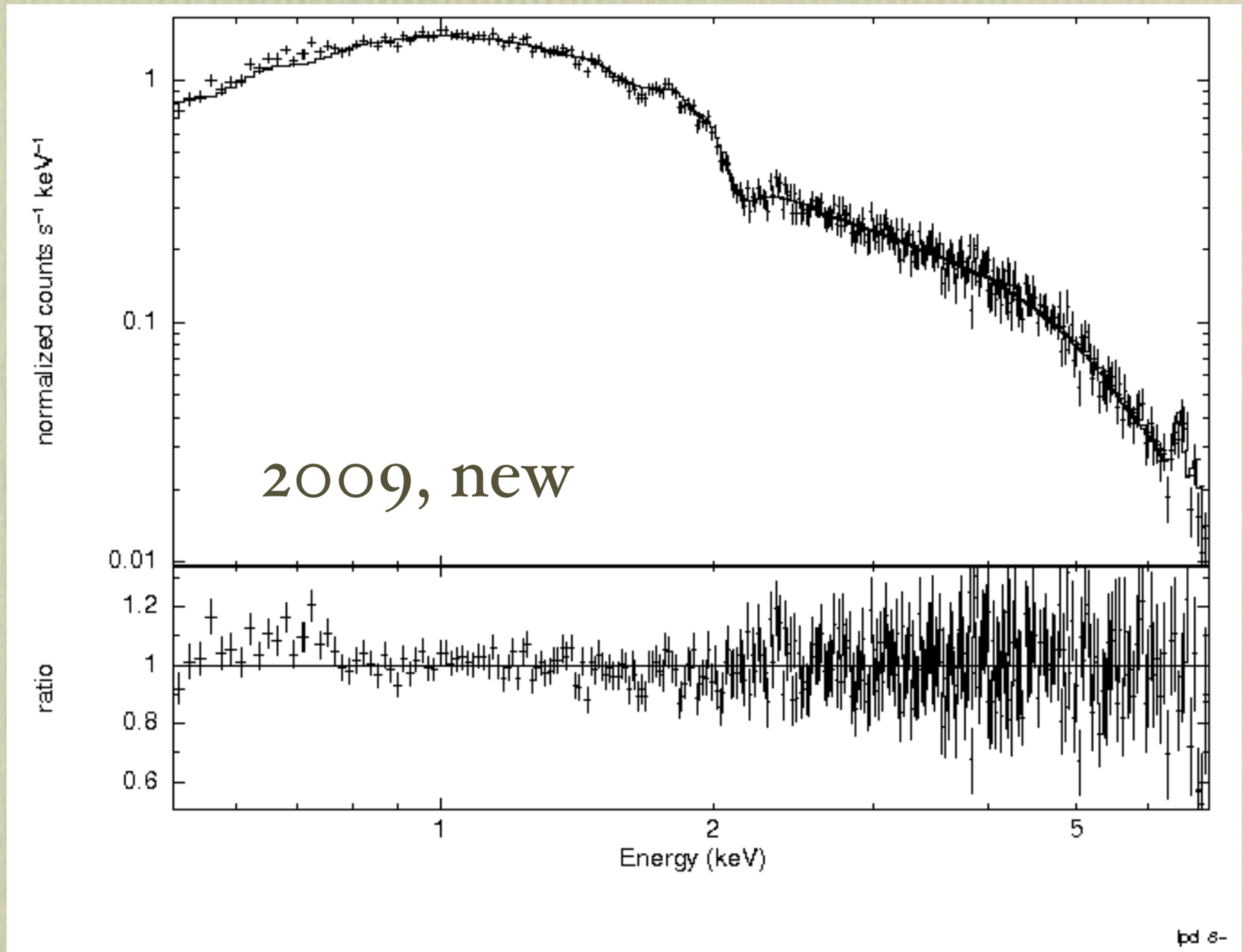

# ACIS observations of Coma (Larry David)

# Testing II



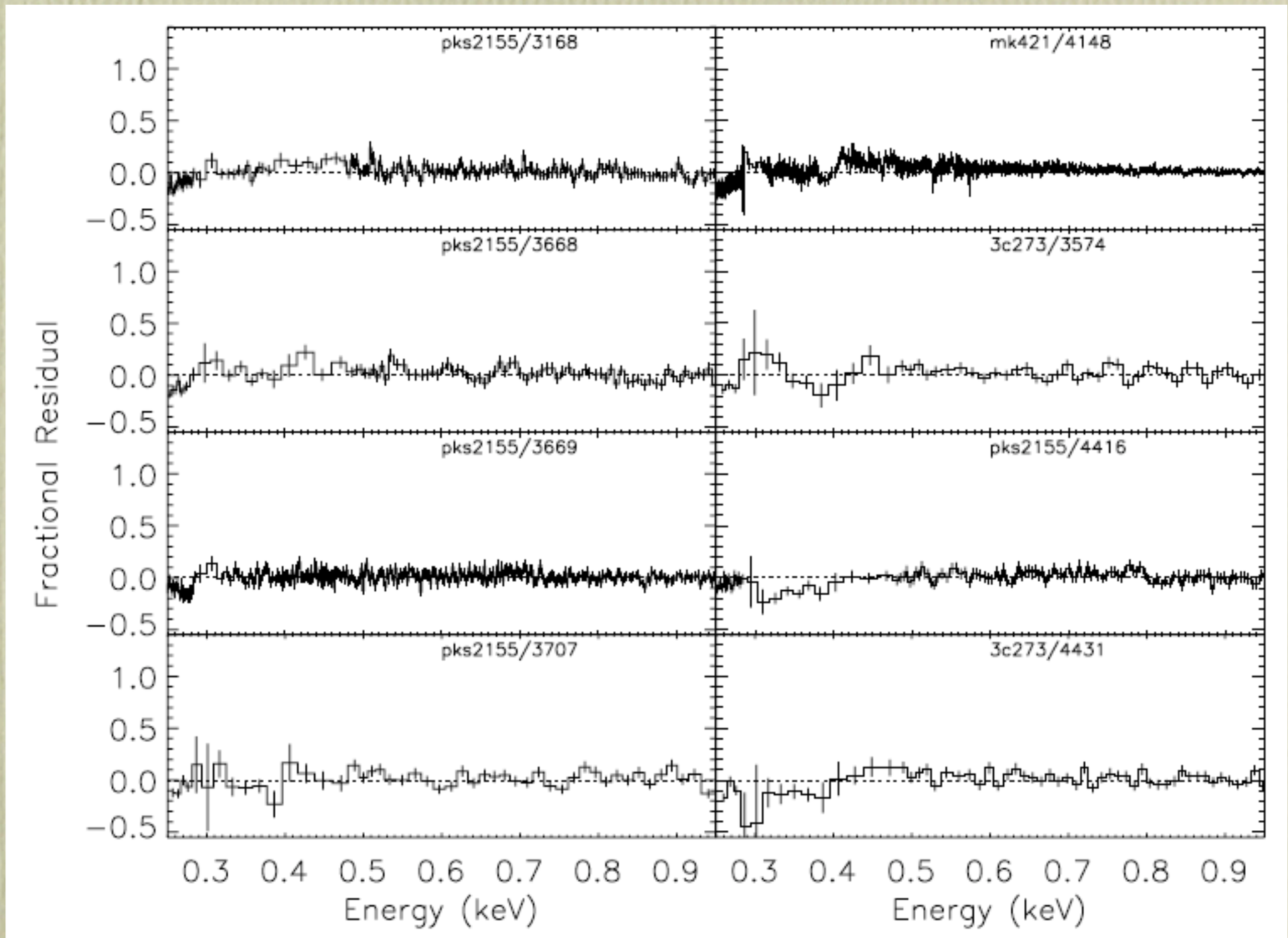

ACIS observations of Coma (Larry David)

# Testing II

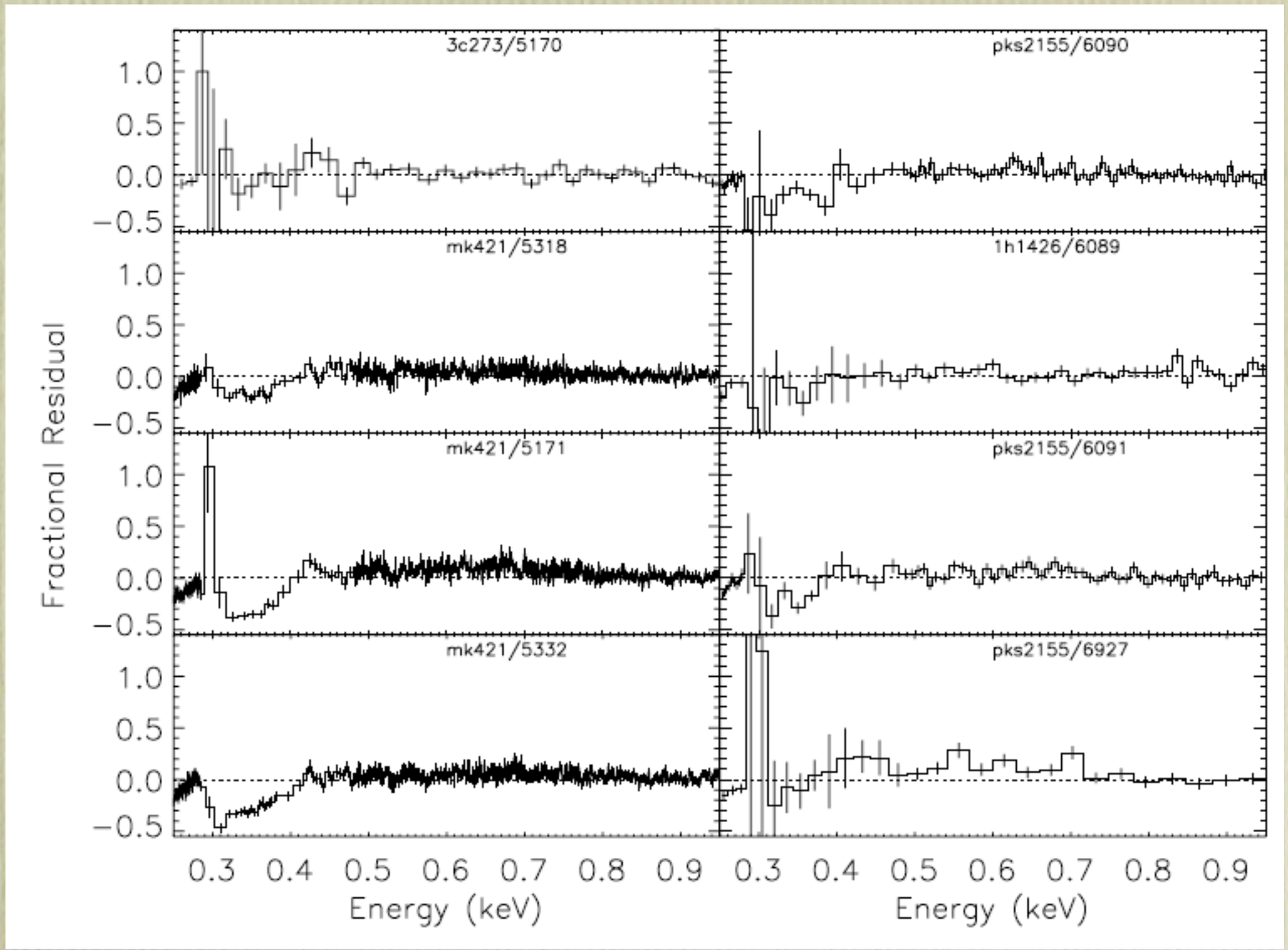



ACIS observations of Coma (Larry David)

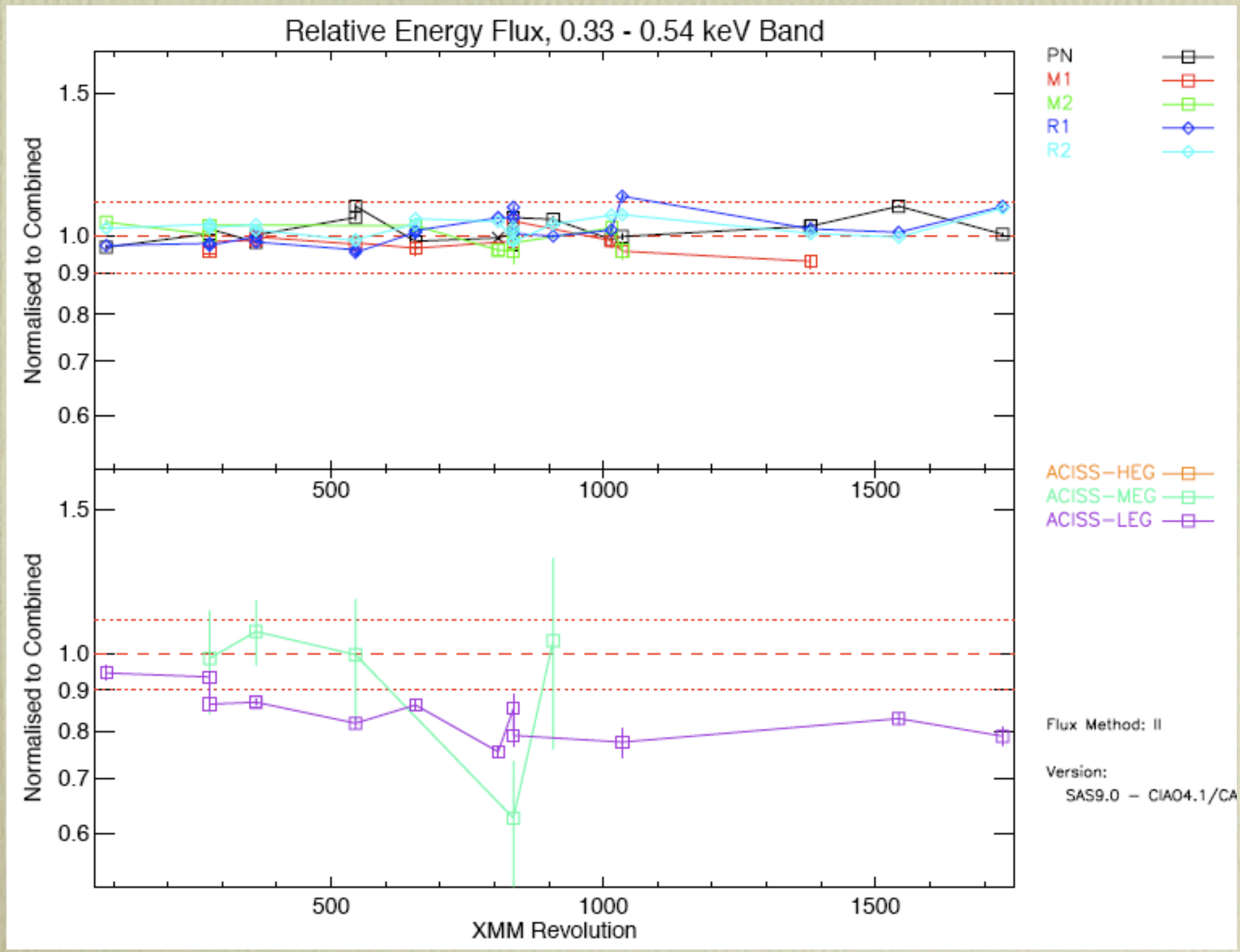
# Testing III


pks2155/3168
mk421/4148
pks2155/3668
3c273/3574
pks2155/3669
pks2155/4416
pks2155/3707
3c273/4431
Fractional Residual
1.0
0.5
0.0
−0.5
0.3 0.4 0.5 0.6 0.7 0.8 0.9
Energy (keV)

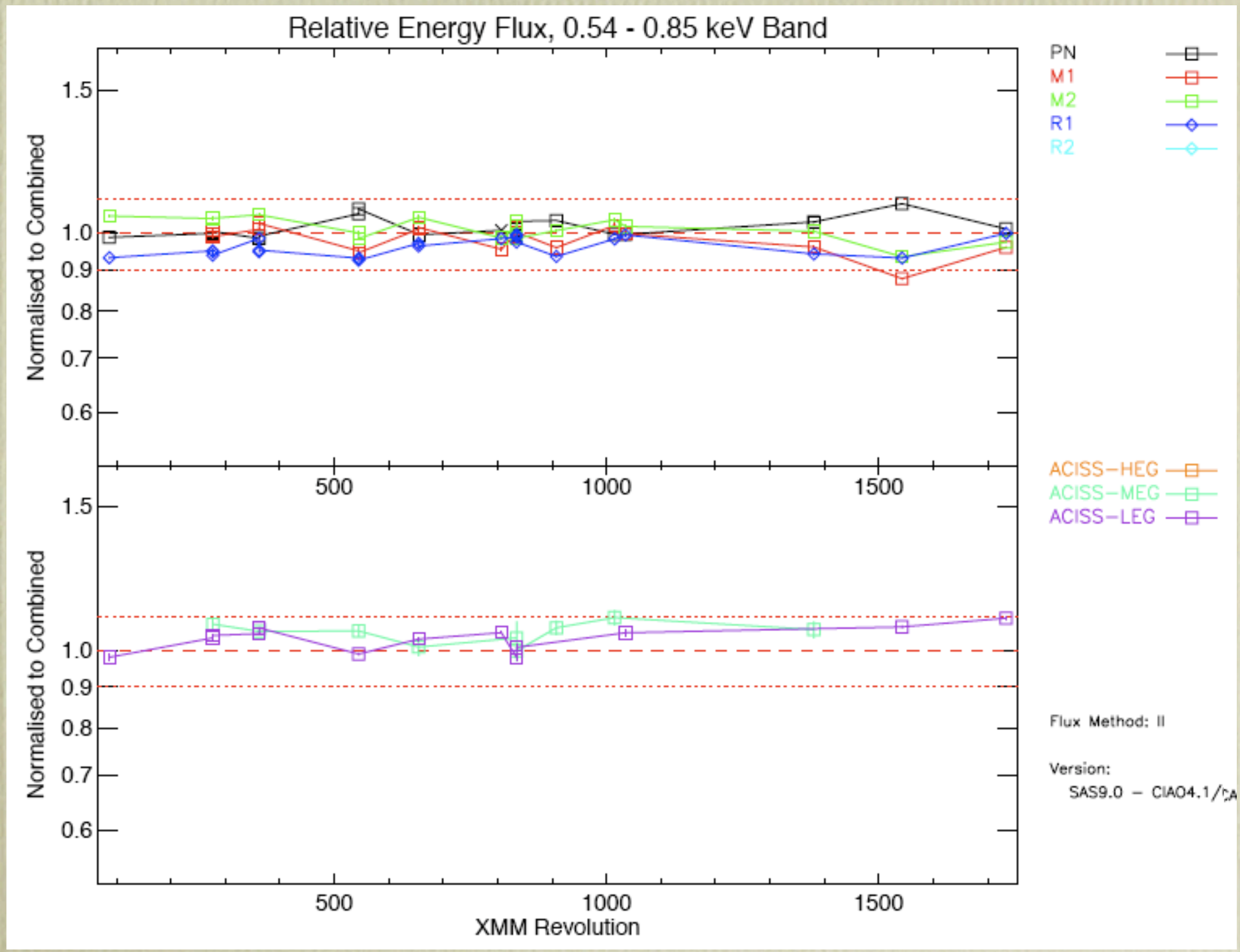
# Testing III


3c273/5170
pks2155/6090
mk421/5318
1h1426/6089
mk421/5171
pks2155/6091
mk421/5332
pks2155/6927
Fractional Residual
1.0
0.5
0.0
−0.5
0.3 0.4 0.5 0.6 0.7 0.8 0.9
Energy (keV)

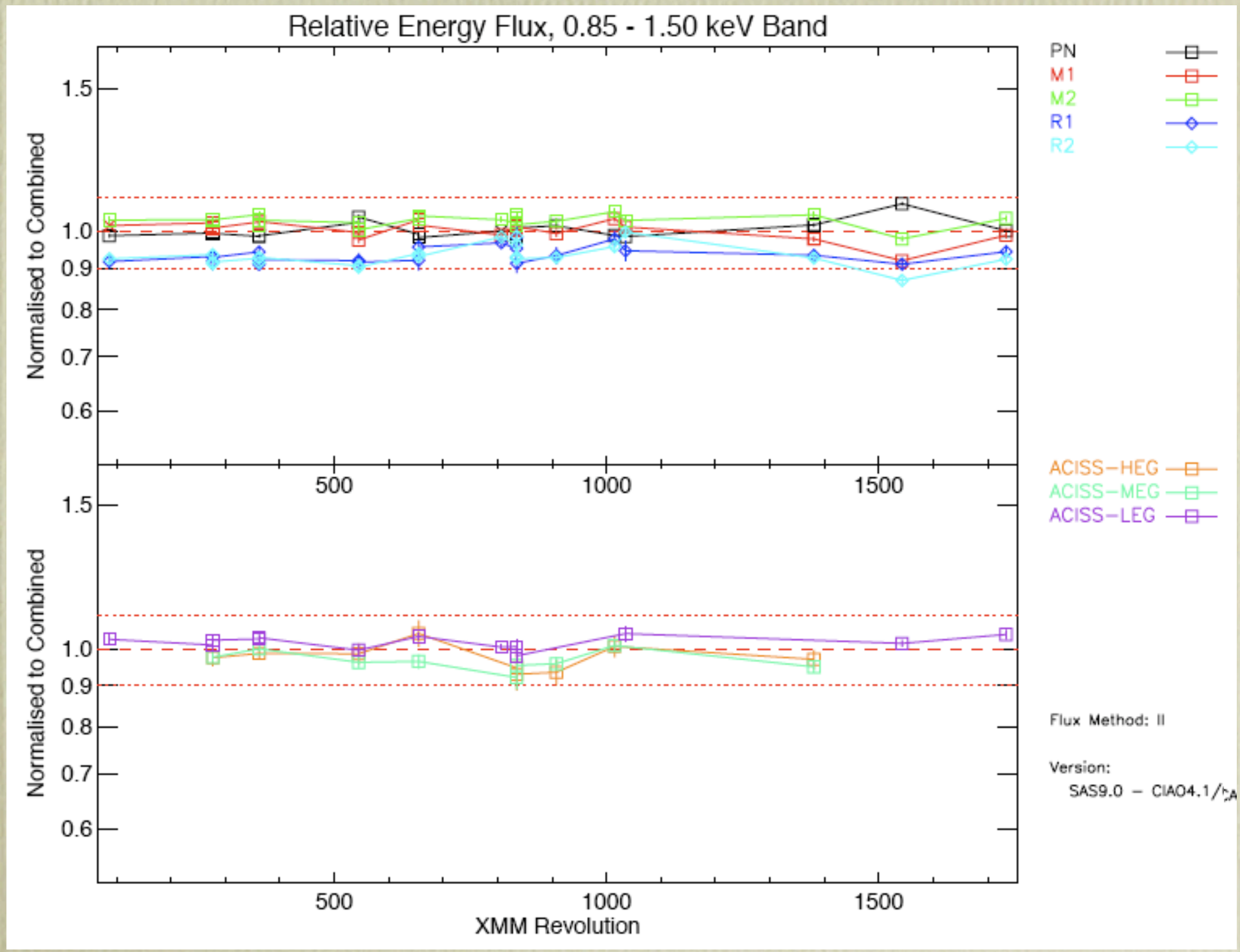
# Testing IV


Relative Energy Flux, 0.33 - 0.54 keV Band
Normalised to Combined
1.5
1.0
0.9
0.8
0.7
0.6
500
1000
1500
XMM Revolution
PN
M1
M2
R1
R2
ACISS-HEG
ACISS-MEG
ACISS-LEG
Flux Method: II
Version:
SAS9.0 – CIAO4.1/CA

# Testing IV


Relative Energy Flux, 0.54 - 0.85 keV Band
Normalised to Combined
1.5
1.0
0.9
0.8
0.7
0.6
500
1000
1500
PN
M1
M2
R1
R2
ACISS-HEG
ACISS-MEG
ACISS-LEG
Flux Method: II
Version:
SAS9.0 - CIAO4.1/CA
XMM Revolution

# Testing IV


Relative Energy Flux, 0.85 - 1.50 keV Band
Normalised to Combined
1.5
1.0
0.9
0.8
0.7
0.6
500
1000
1500
PN
M1
M2
R1
R2
ACISS-HEG
ACISS-MEG
ACISS-LEG
Flux Method: II
Version:
SAS9.0 - CIAO4.1/
XMM Revolution

# Summary

- A new contamination correction will soon be available
  - Still testing on flight data
  - An alternative model from AV is being tested

- Fluffium component is not understood
  - Physical basis is untenable
  - Approach breaks down if ECS Al-K data are reliable
  - Alternative models will be explored