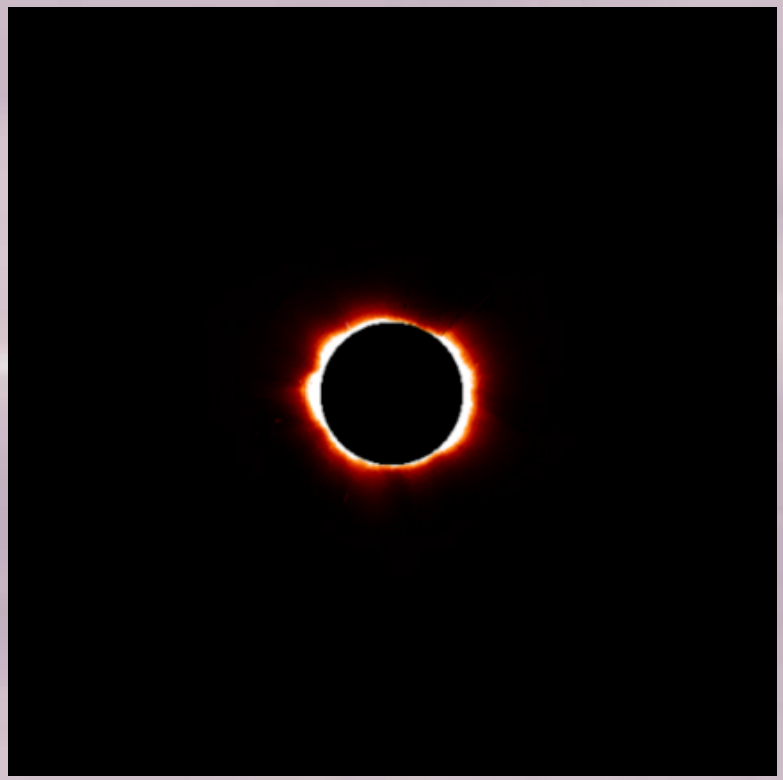
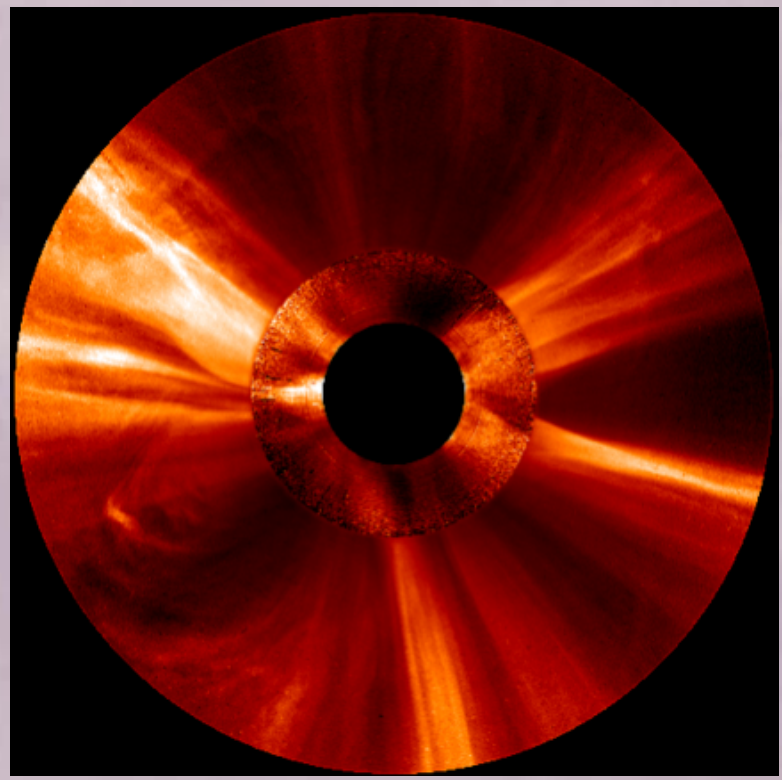
Coronal Image Processing

The Accurate Depiction of Structure
in Qualitative Images of the White Light Corona





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Outline

- Finding an unbiased radial graded filter using a model pB corona
- Apply to pB observations
- Compare results with standard LASCO images (made using division by a long term minimum method)
- Processing of white light images

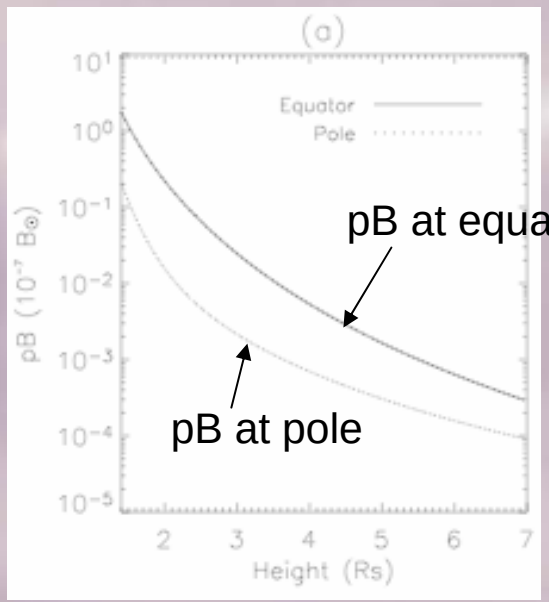
Synthetic Solar Minimum Corona

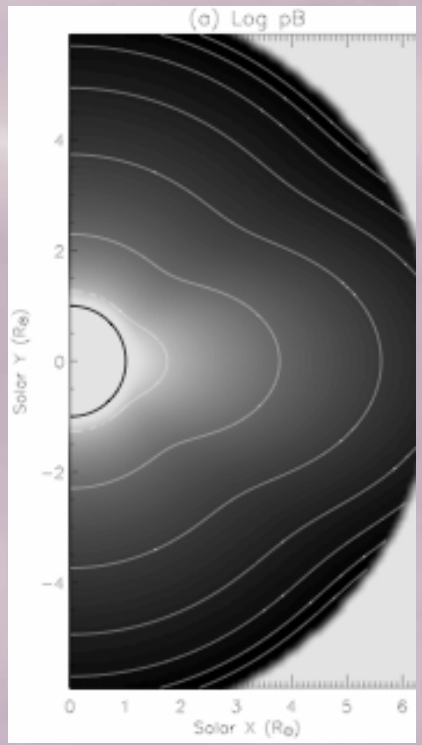
pB at pole pB at equator Current sheet width

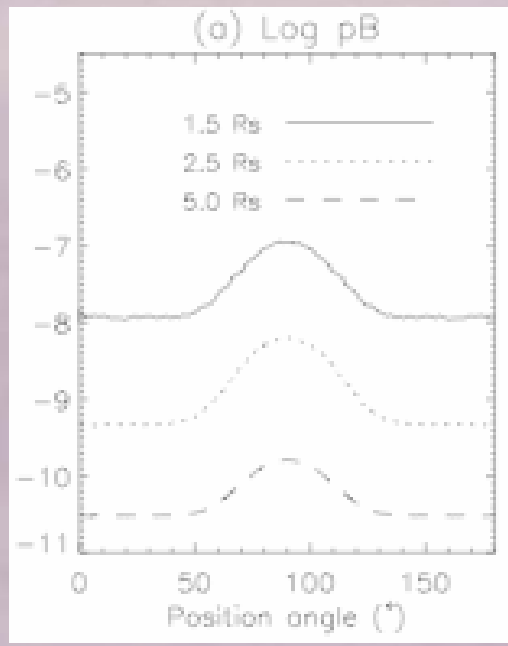
$$pB(r,\phi) = pB_p(r) + [pB_{cs}(r) - pB_p(r)]e^{-[(\phi-\phi_0)^2/w^2]}$$

w is constant so **RADIAL** corona

LOG pB







Simple Radial Graded Filter (RGF)

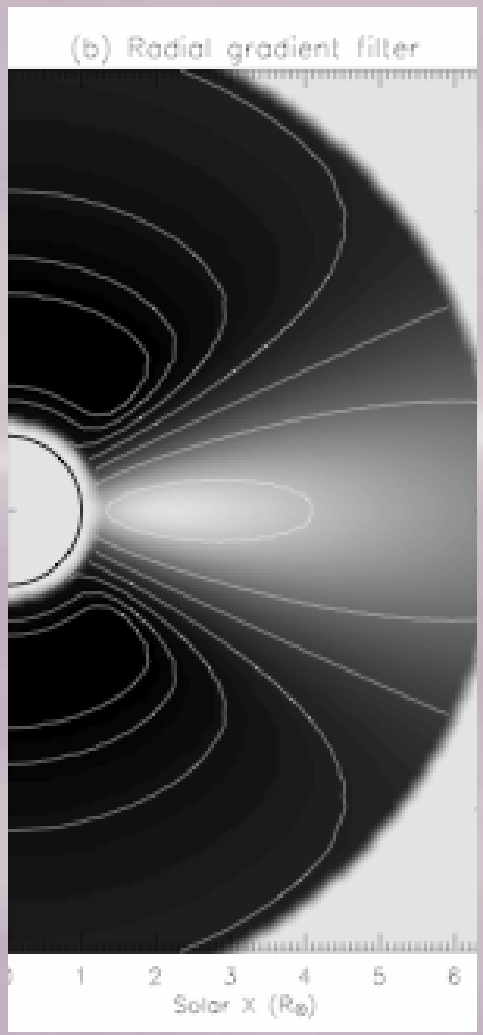
Processed intensity

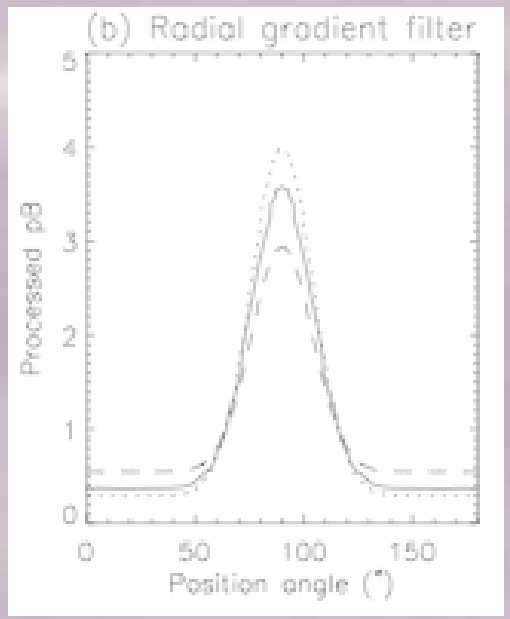
Original intensity

$$I'(r,\phi) = \frac{I(r,\phi)}{I(r)_{<\phi>}}$$

Intensity averaged over all latitudes at *r*

r height
ϕ latitude





WHY NOT RADIAL

????

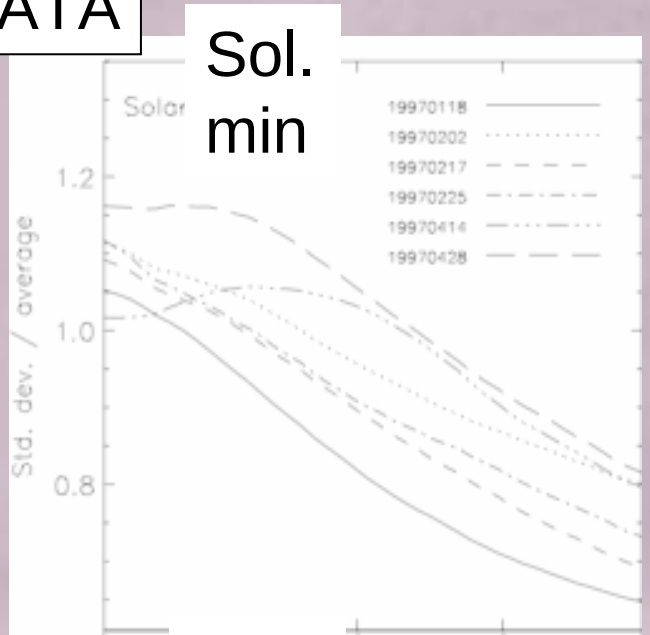
WHY NOT RADIAL?

- Large change in relative contrast between high and low intensity regions with height

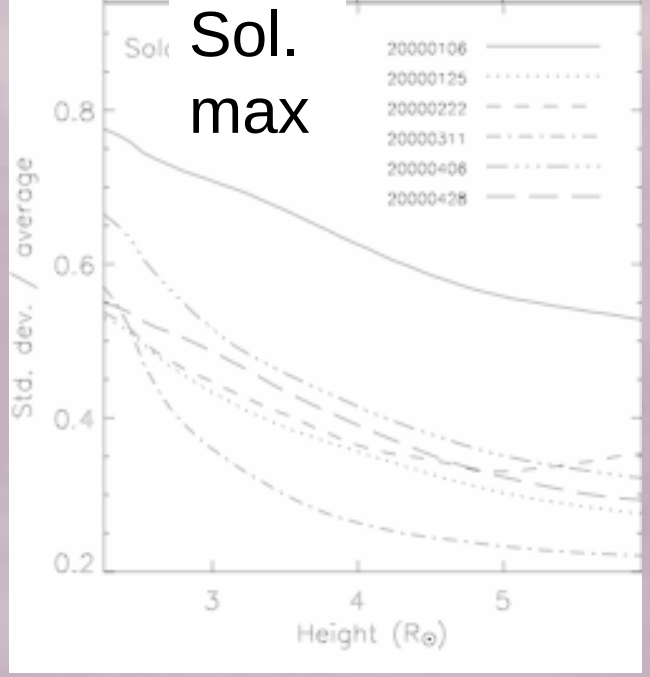
- RGF neglects the change in contrast so processed corona is distorted

DATA

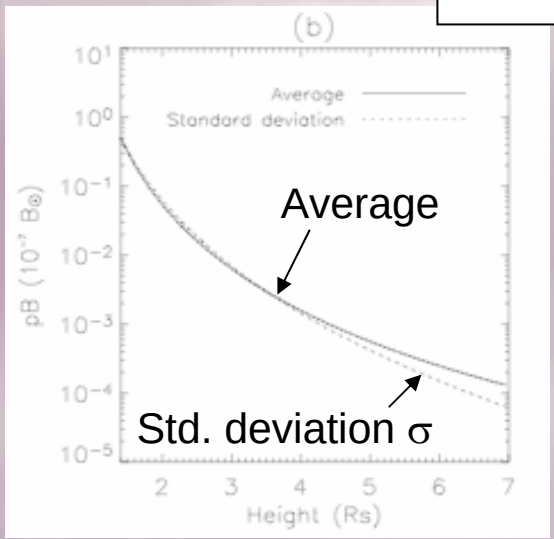
Sol. min

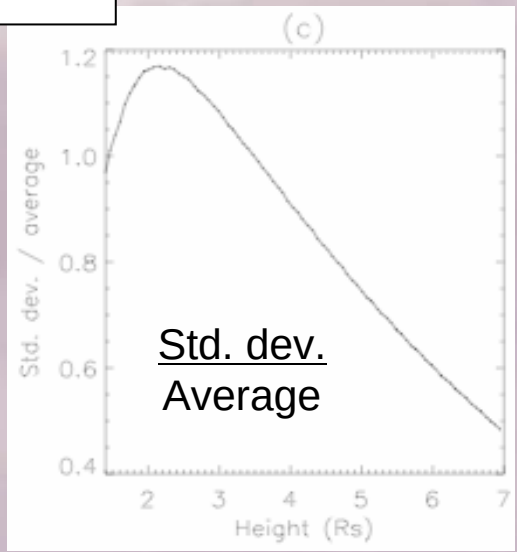


Sol. max



MODEL



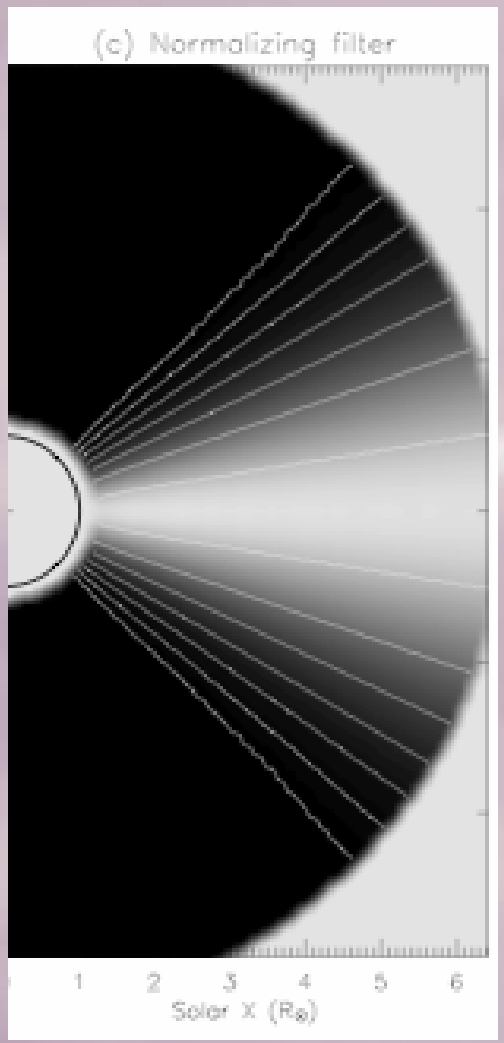


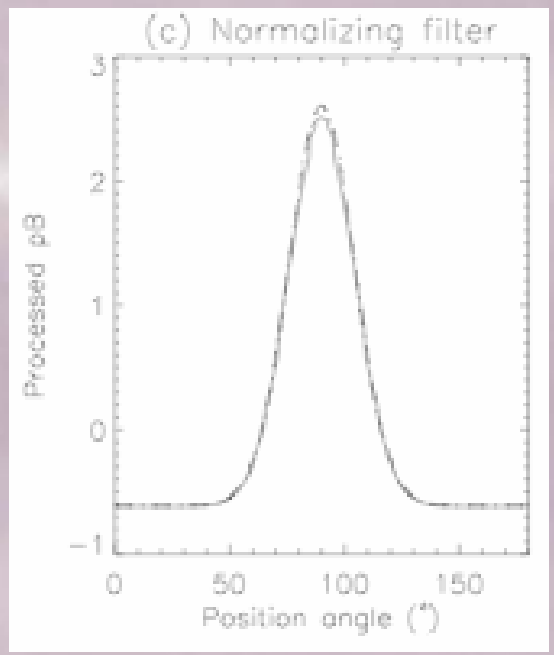
Normalizing Radial Graded Filter (NRGF)

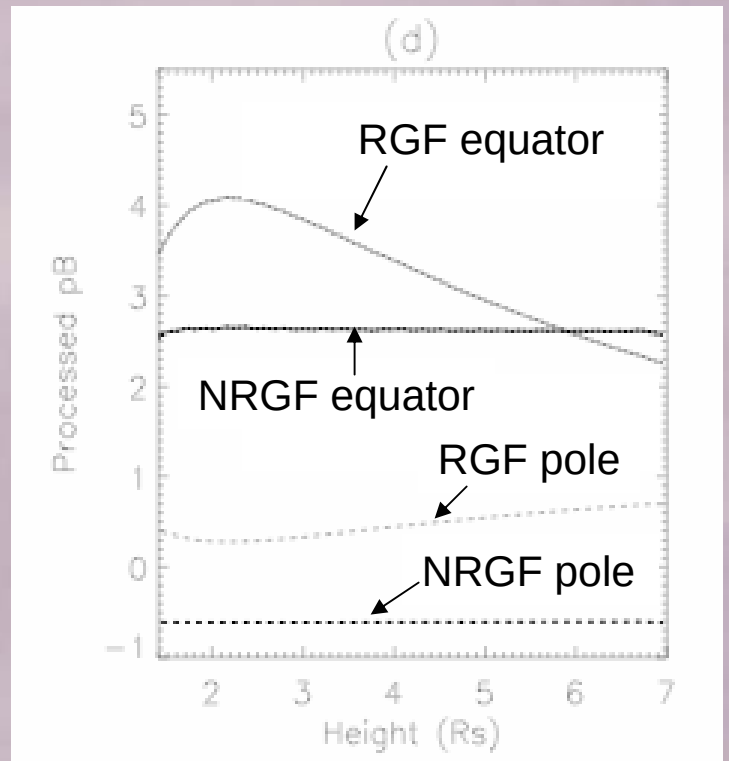
Processed — Original — Average

$$I'(r,\phi) = \frac{[I(r,\phi) - I(r)_{<\phi>}]}{\sigma(r)_{<\phi>}}$$

Std. dev.

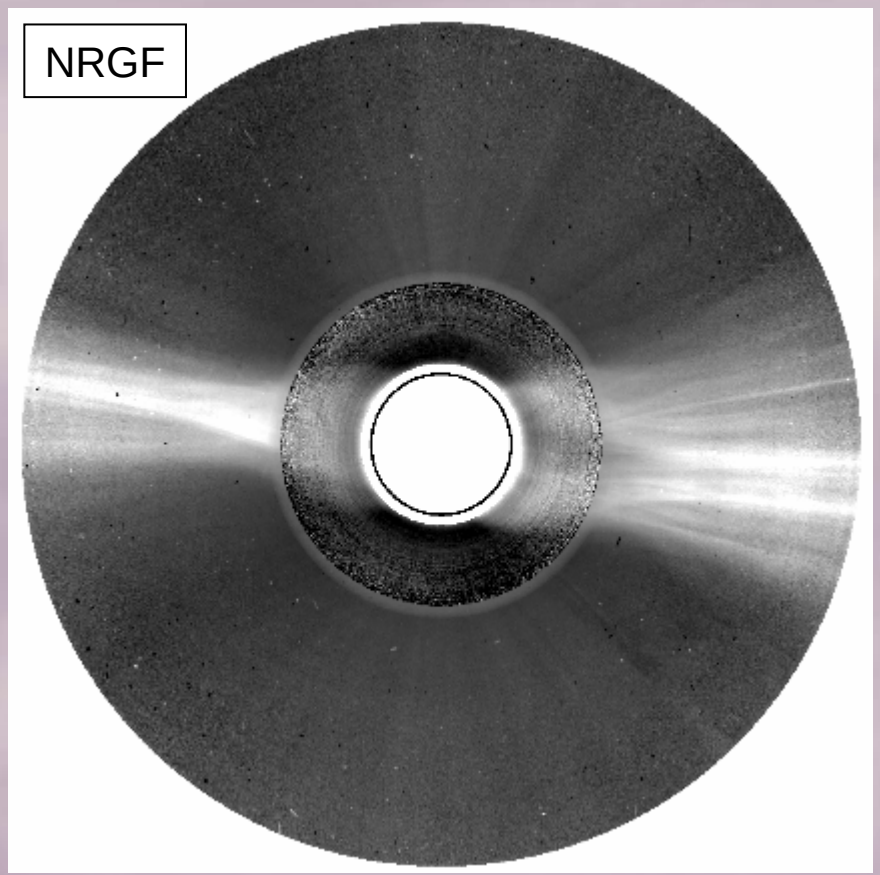


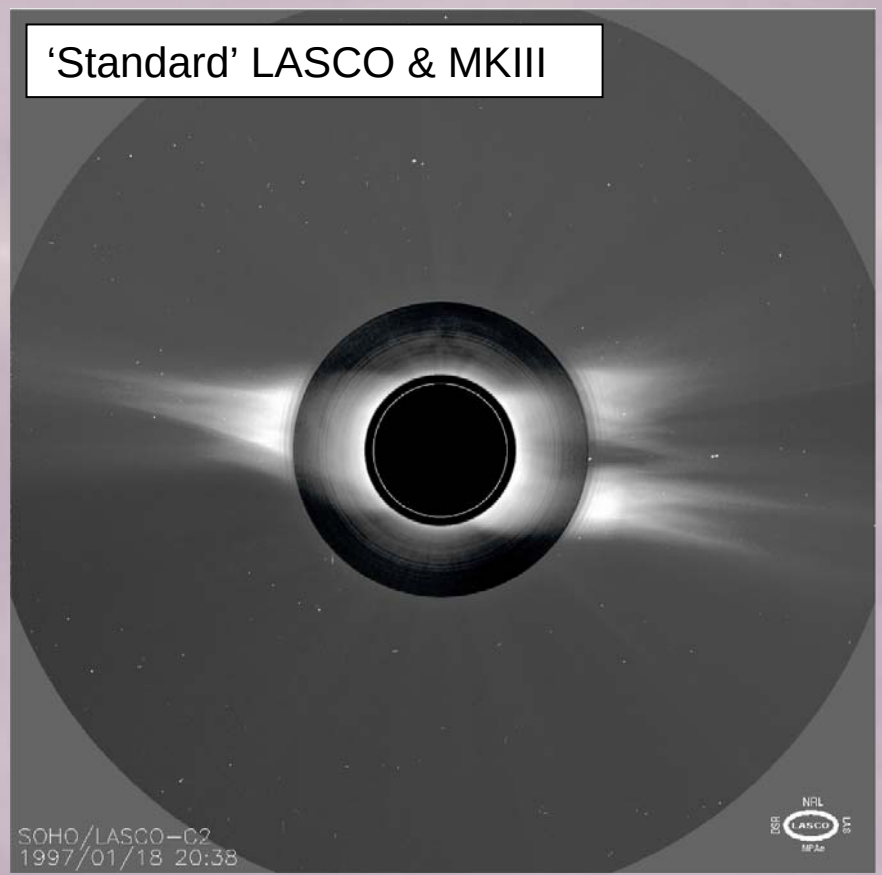




Application to pB observations - Solar Minimum January 18 1997

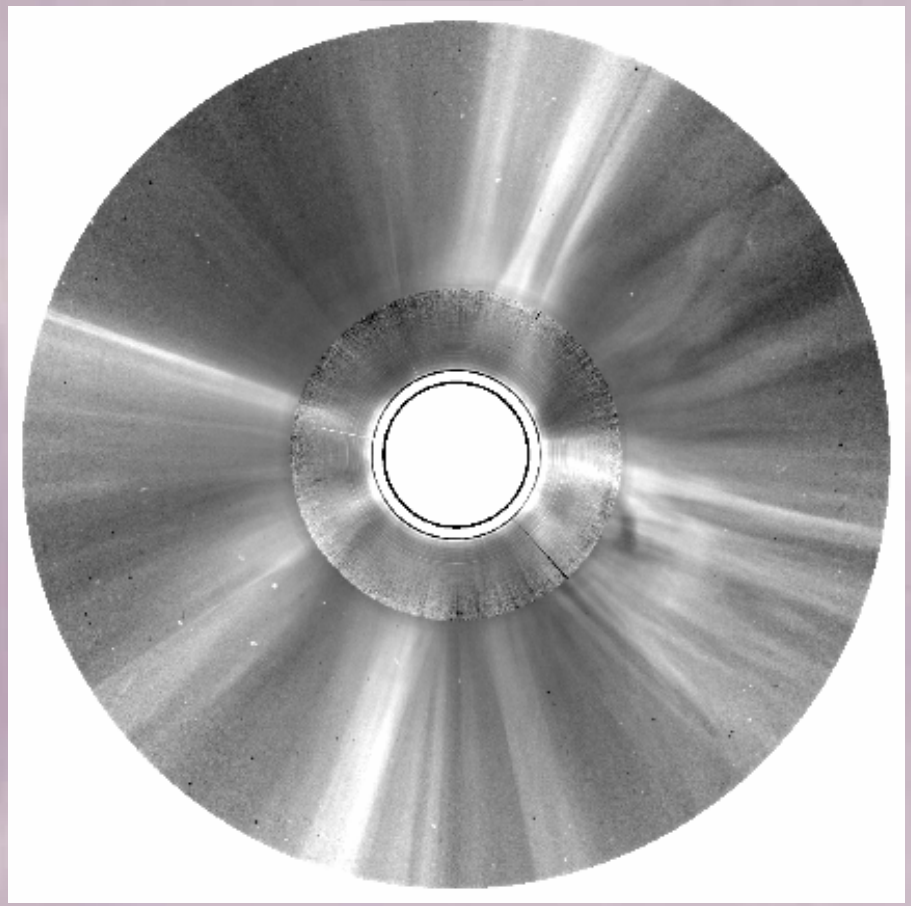
- MLSO MKIII & MKIV coronameters - 1.15-2.28 R_s
- LASCO (SOHO) C2 coronagraph - 2.28-6.2 R_s





Application to pB observations - Solar Maximum (June 21 2000)

NRGF



‘Standard’ LASCO & MKIII

LASCO ‘standard’ images or the NRGF - which gives the true picture?

Latitudinal profiles at 3 heights

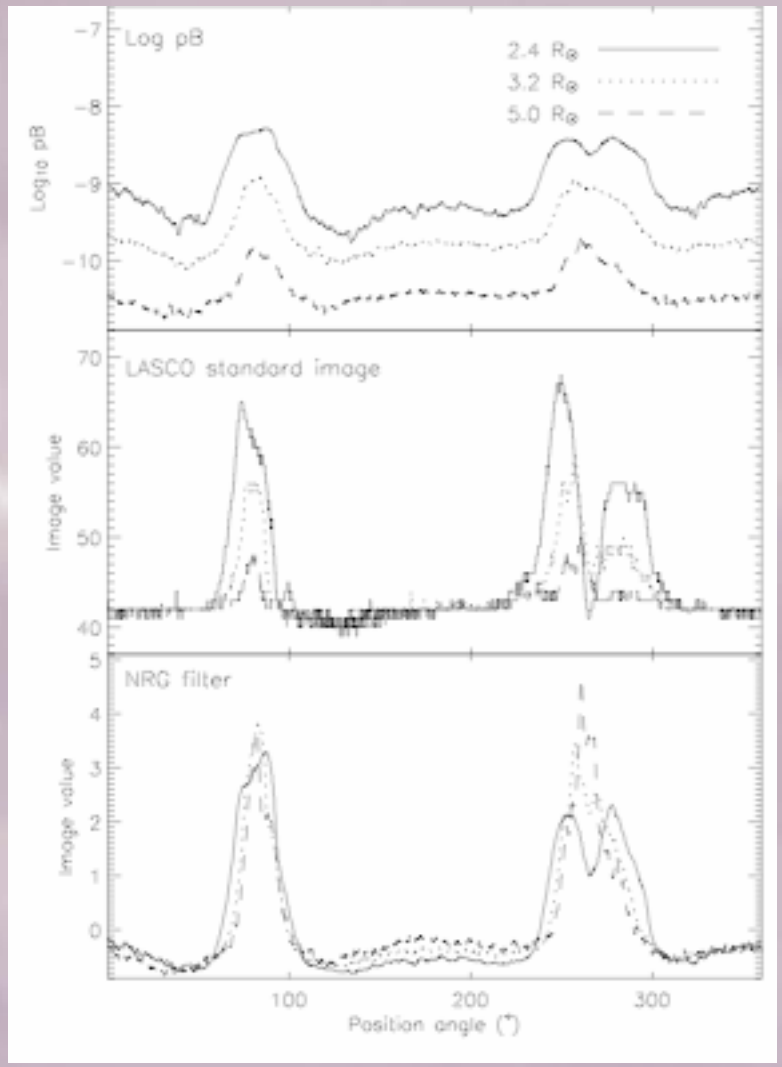
Solar min

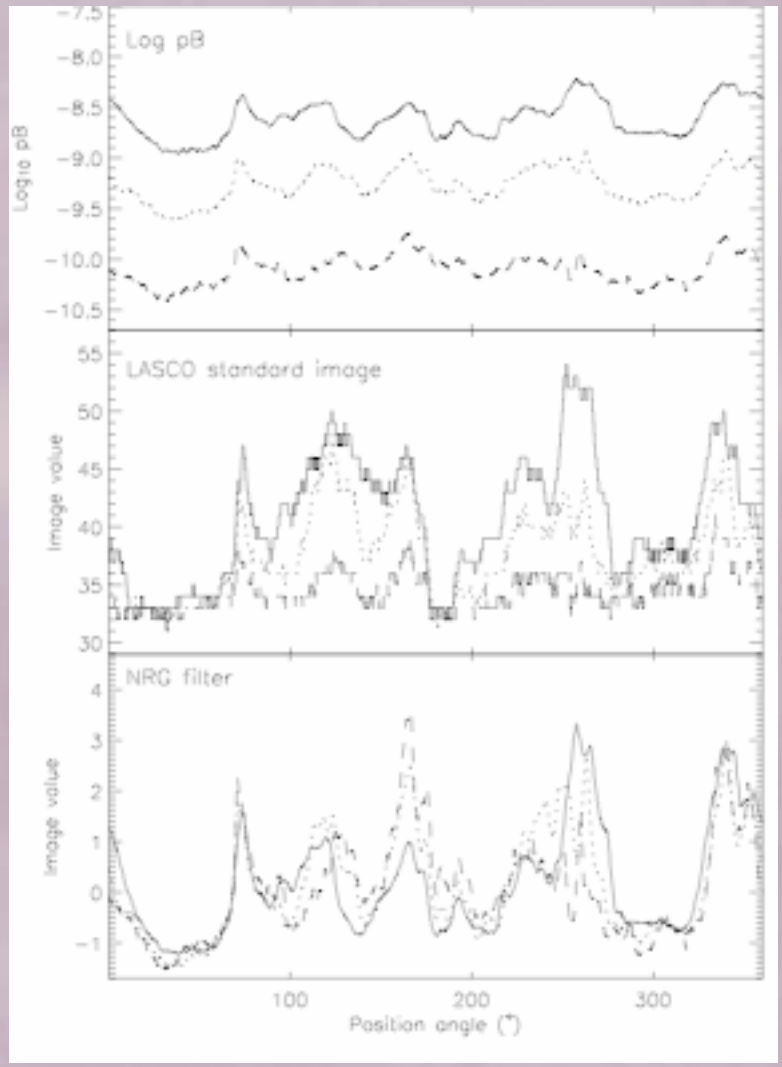
Solar max

LOG

Standard

NRGF



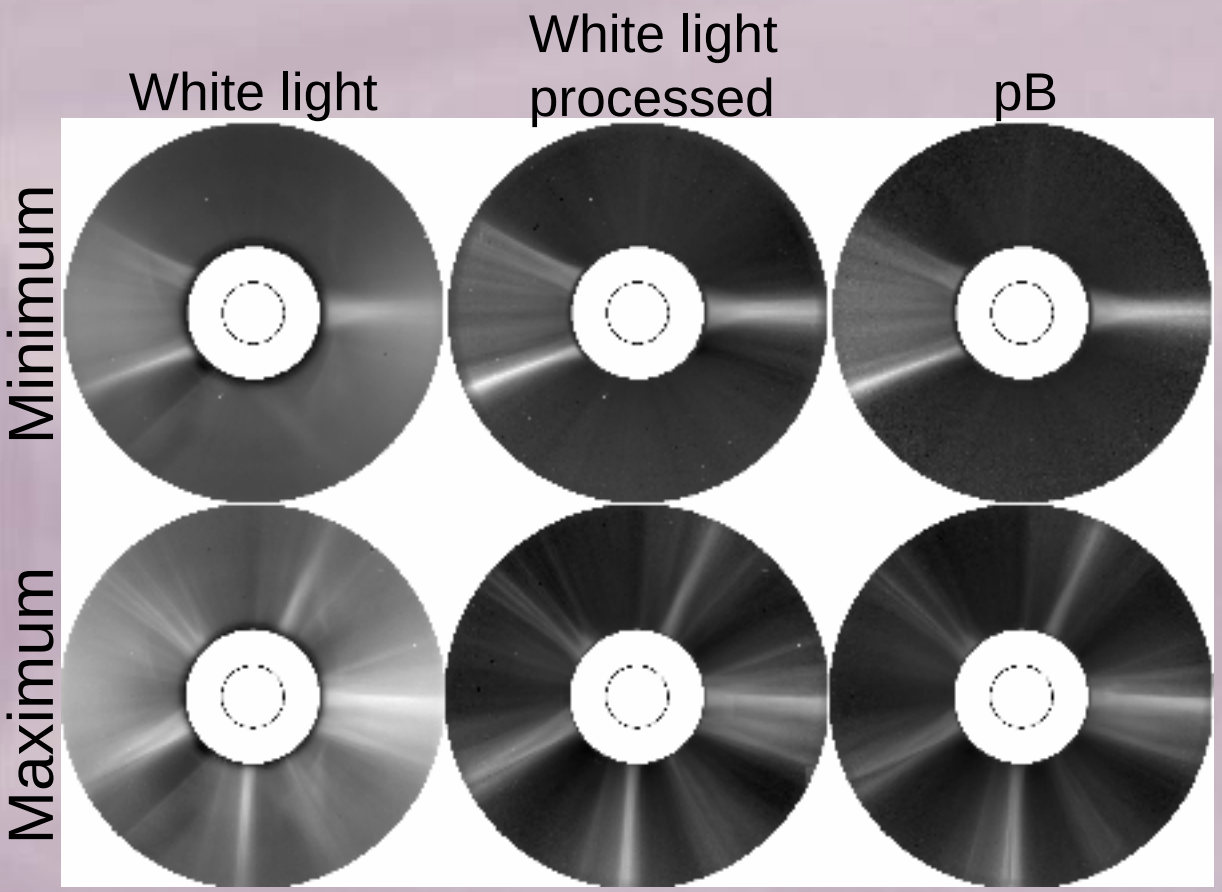


Application to white light (WL)...

Easy to apply NRGF to pB observations since pB does not contain F corona and stray light. Why bother with WL?

•LASCO makes ~30 WL obs./day, compared with ~2 pB.

•LASCO WL observations have 12” resolution (1024x1024 pix). LASCO pB have half this resolution.



How we do it...

•Calculate WL-pB for many days surrounding observation, and average.

•Subtract this average from desired observation

$$B' = B - \frac{1}{n}\sum_{i=1}^{n}(B_i - pB_i)$$

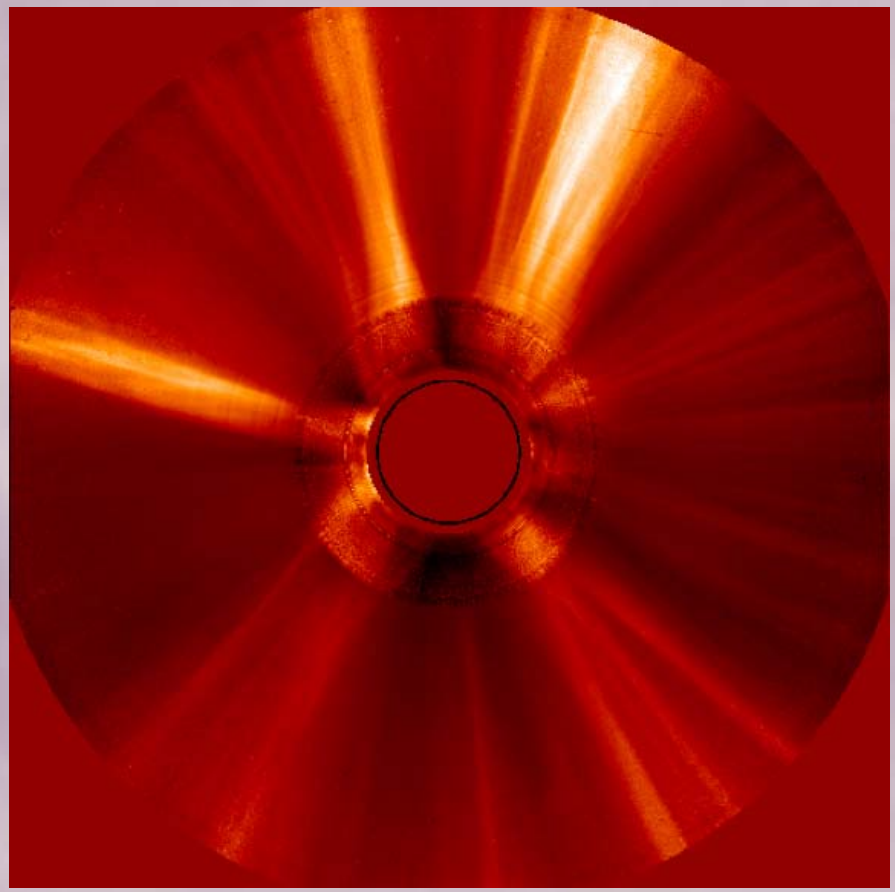
$$B' = B_K + B_F - \frac{1}{n}\sum_{i=1}^{n}(B_{Ki} + B_{Fi} - pB_i)$$

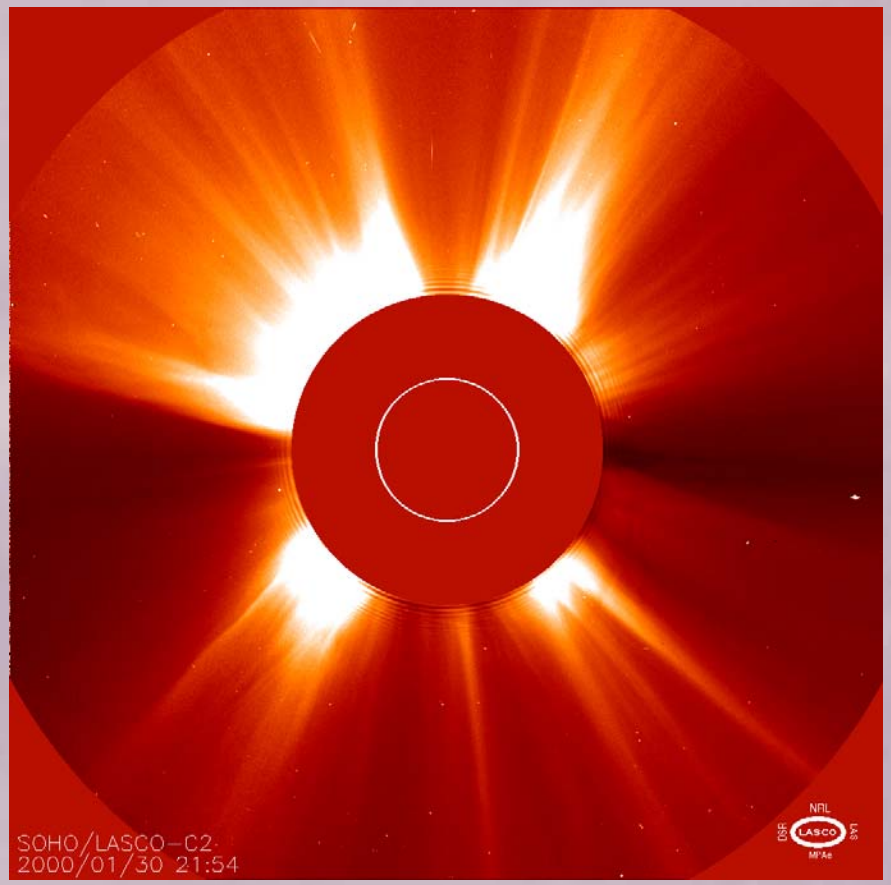
$$B' = B_K - \delta,$$

$$\delta = \frac{1}{n}\sum_{i=1}^{n}(B_{Ki} - pB_i)$$

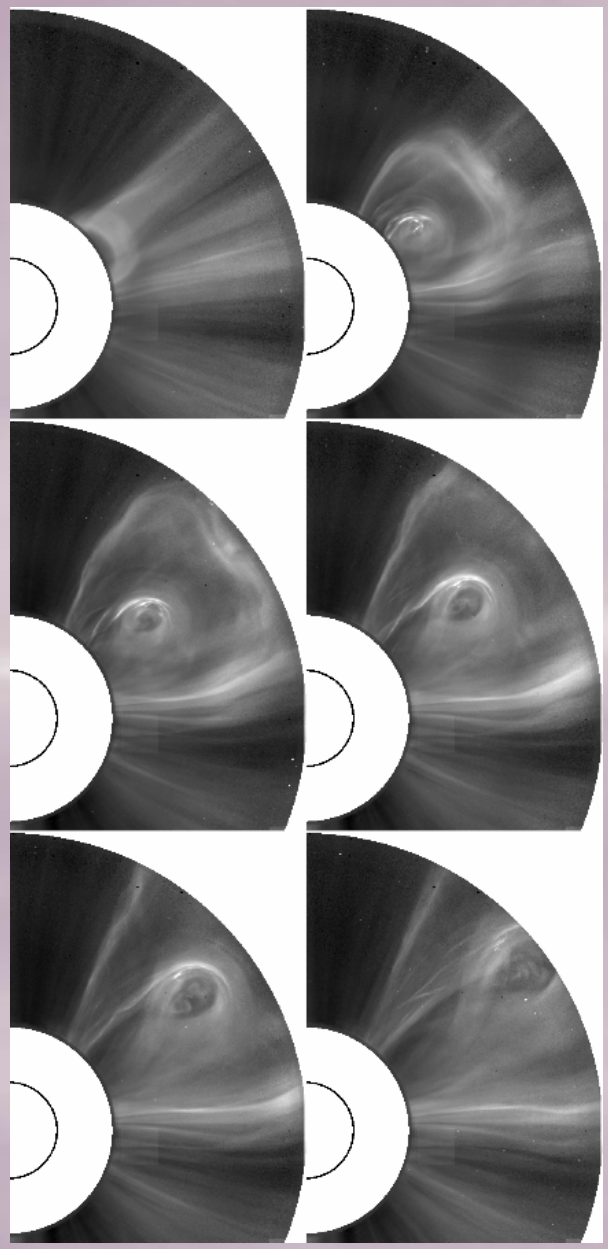
•This method provides excellent qualitative images of coronal structure after final processing with NRGF

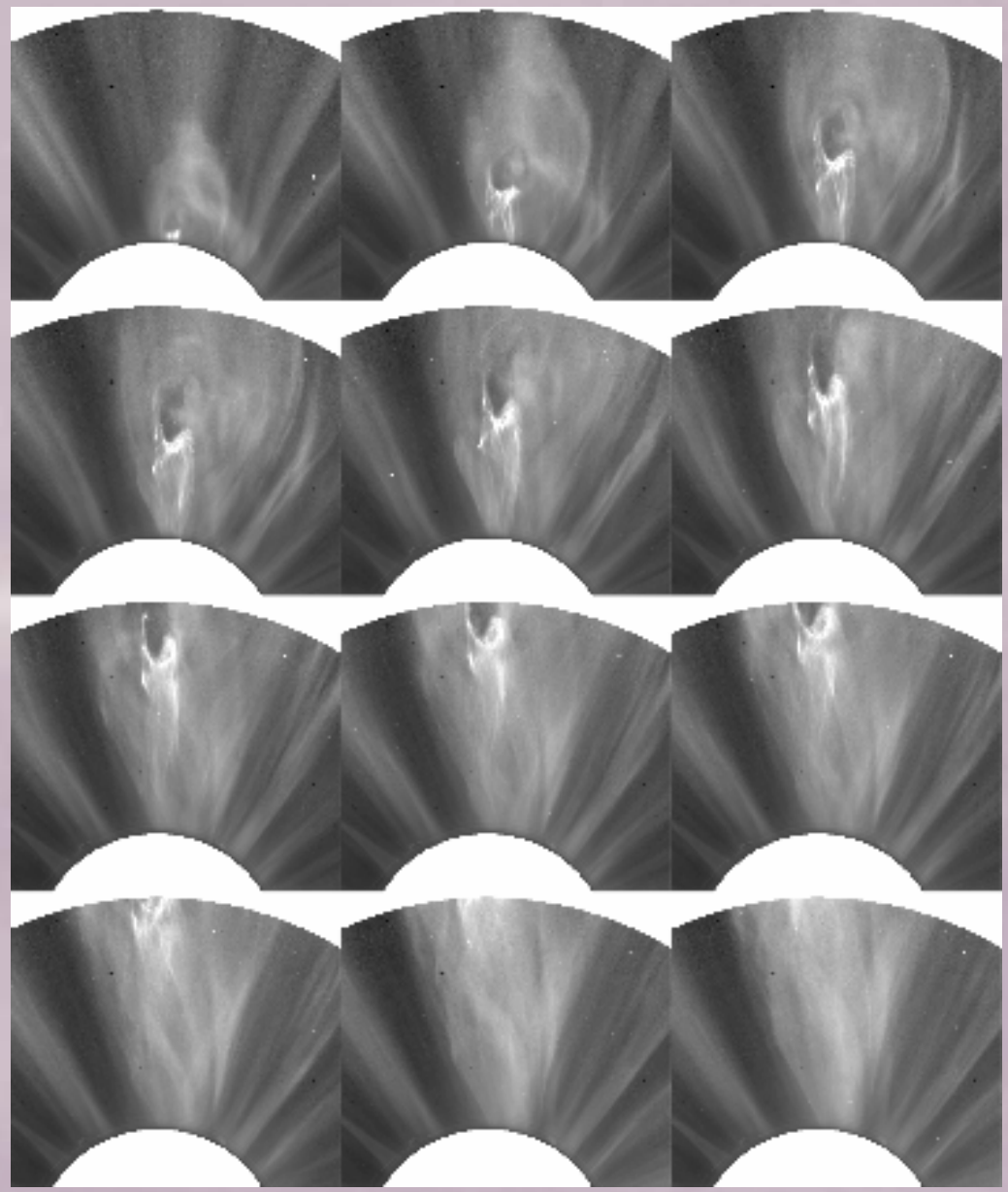
Application to WL - comparison with LASCO standard images





Application to WL - CME





Conclusions

•The NRGF is a correct method for removing radial gradient from coronal images

•Division by a long term minimum almost invariably leads to a misleading depiction of structure

•A new method for processing white light images provides good results with LASCO C2 observations (C3 needs more work - due to polarization of F corona?)

•Using the NRGF, we can avoid saturating the image to see structure, and finer detail can be seen at all heights in the corona.