STEREO Space Weather Beacon:
December 2003

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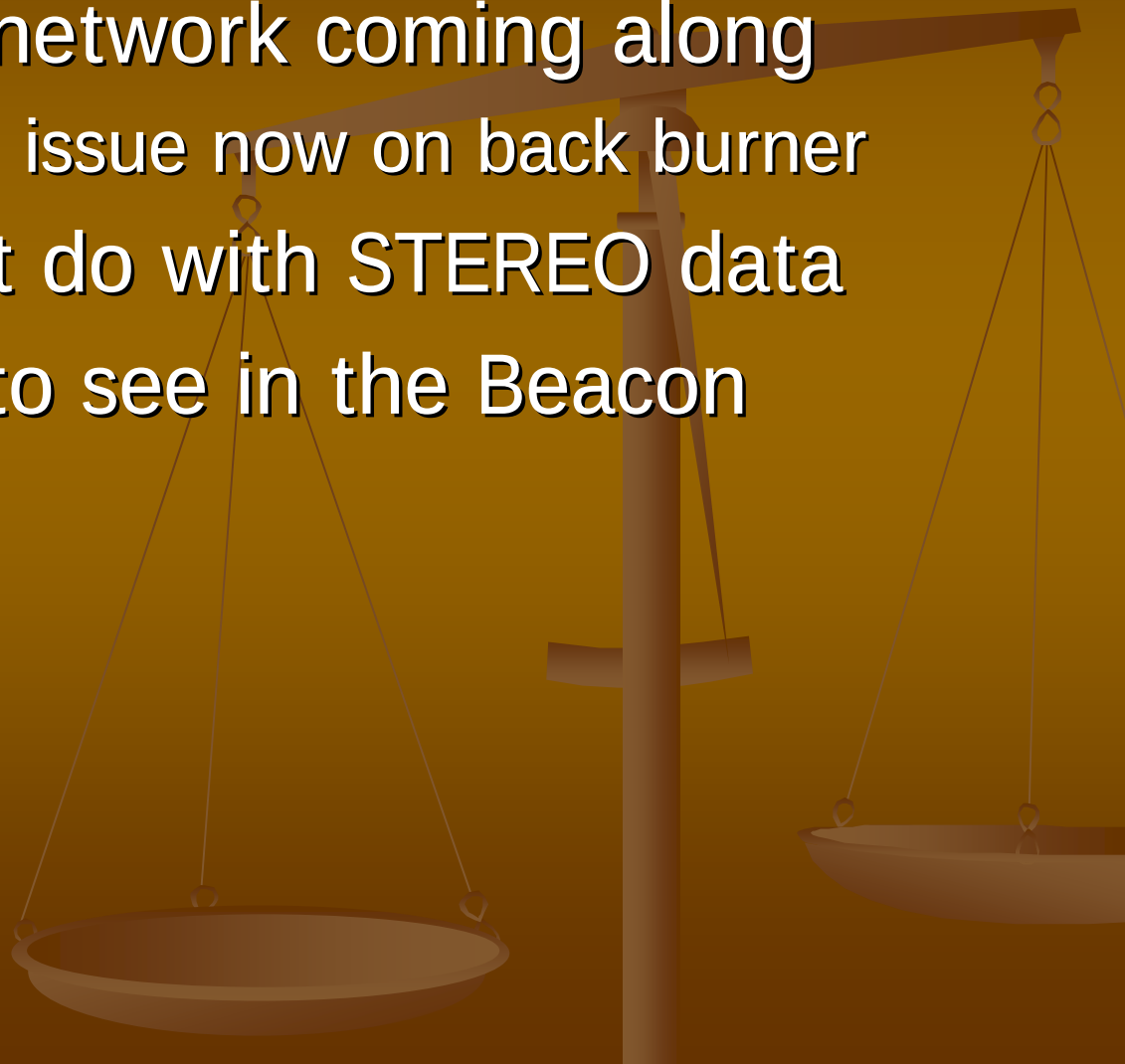
NOAA/SEC

Outline

- Ground station network coming along
  - Turbo encoding issue now on back burner
- What SEC might do with STEREO data
- What we'd like to see in the Beacon



Ground Station Partners

- None have yet signed on the bottom line
  - Moving along nicely, however
    - Ahead of ACE at this stage
    - The probables would give us the coverage we need
    - We are looking for redundancy wherever possible
  - Probables are NOAA (Fairbanks), NOAA (Wallops)*, RAL* (UK), CNES (France), and CRL (Japan)
  - Near probable is ACRES (Australia)
  - Possible is USAF (California), NOAA (Boulder)*
  - Others? Brazil, Canada ...

Ground Station Particulars

- NOAA/Wallops and NOAA/Fairbanks (13m)
  - Formal request not yet made
  - Informal contacts indicate antenna availability likely
- CNES (9m near Toulouse)
  - Should receive confirmation soon
- RAL (12m, 2.4m and 3.7m)
  - ACE is primary here
- CRL (6m)
  - Funding request for new antenna construction January, 2004. Highly rated.
- ACRES (9m in Alice Springs)
  - Lots of competing projects

Turbo vs Viterbi

- Telemetry encoding options in the beacon mode are rate 1/6 Viterbi, rate ½ Viterbi*, and Turbo encoding.
- Issues regarding Turbo were licensing and cost.
  - Licensing appears to not be a problem
  - JPL wants ~$56k for decoding software
- Turns out we can live without Turbo for at least 3 years: 6m good for 3 years; 9m for 4.9 years
- Turbo only gives about 1 additional year

Other beacon issues

- Ready for s/c beacon mode telecom testing – January 2004?
  - APL will record on DAT tape and send to SEC
- Software to decode Viterbi encoded data in work (Phil Karn)
  - May write software to decode Turbo

STEREO Science Relevant to SEC

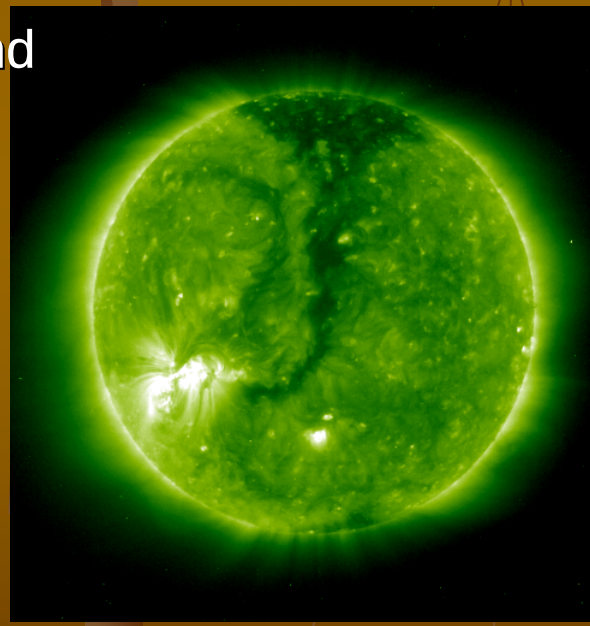
- Geomagnetic Storms
  - Coronal Mass Ejections
  - High speed streams
  - Solar Wind properties
- Long Term Forecasts
- Lots of other potential improvements

Coronal Mass Ejections

- Currently – SOHO/LASCO
  - Halo CME's
    - 1-3 day advance warning of geomagnetic storm
    - Uncertain hit/miss estimate for 'partial' halo CME's
    - error of ±11 hours in arrival time
    - rough estimate of intensity and duration
- STEREO
  - 3-d views of CME's
    - 1-3 day advance warning of geomagnetic storm
    - Continuous observations as CME propagates from Sun to Earth
    - Reliable hit/miss prediction
    - Potential for prediction of arrival time to within hours (or less?)
    - Improved estimate for storm duration

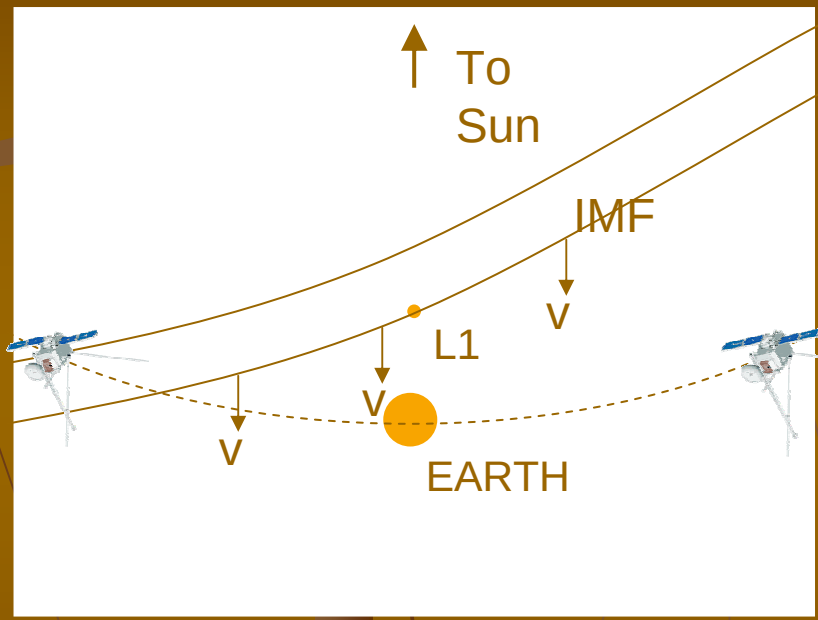
Recurring Solar Wind Streams

- Currently
  - For first time stream – estimate from longitude
  - Recurring stream – use previous occurrence and changes in coronal hole since then – 27 days
- STEREO – Lagging spacecraft
  - Use actual observation from ~few days earlier
  - Improved start time of high speed wind
  - Improved end time of high speed wind
  - Determination of high speed wind properties (*e.g.* velocity)



Solar Wind Discontinuities (and more)

- Currently
  - In-situ observation at L1
  - ~1 hour warning of
    n, V, B

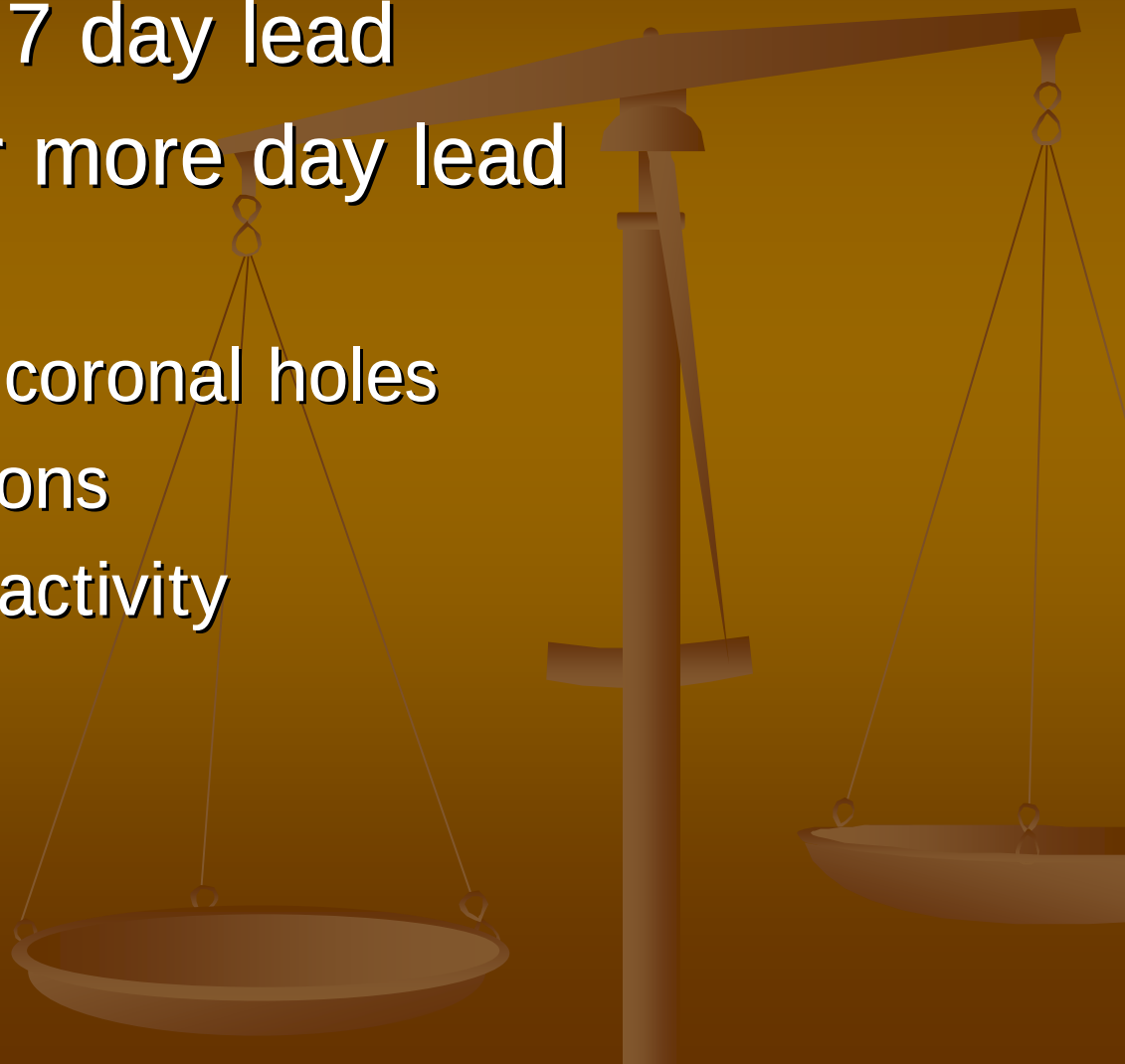


- STEREO
  - Either spacecraft, depending on heliosphere
    - May potentially provide ~ 1 day warning of V, B

Weimer *et al.* (2003)

Long-term Forecasts

- Current – up to 7 day lead
- STEREO – 14 or more day lead
  - EUV Flux
  - New equatorial coronal holes
  - New active regions
  - Level of flaring activity

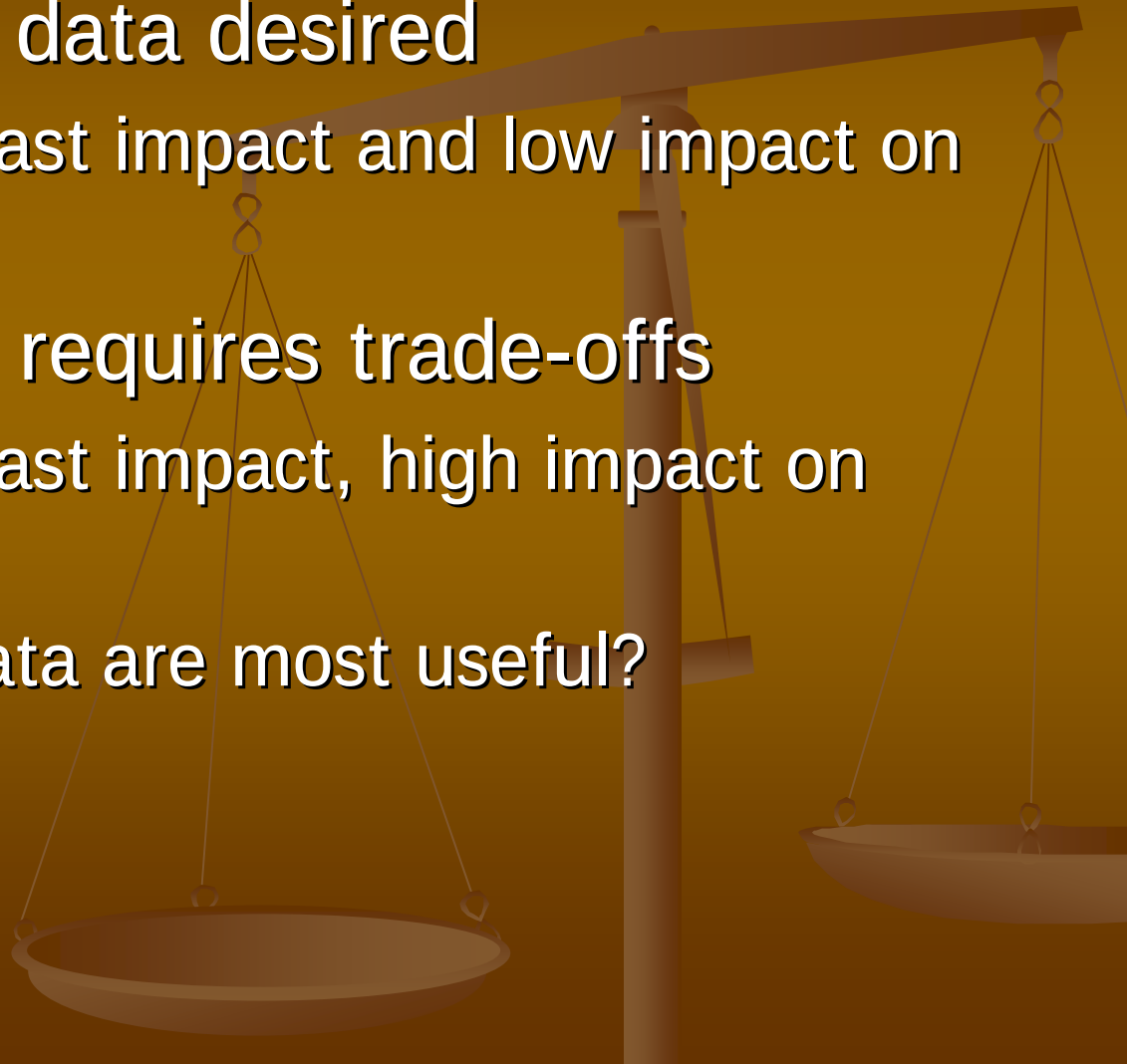


The Far Future

- STEREO will be of ‘limited’ use in forecasting – due to short mission lifetime
- I think of it as a proof of concept for space/solar monitors of the future.
  - When technologies such as solar sails are mature, missions like this could be common.
  - STEREO needs to show that highly accurate, and useful forecasts can be made.
    - What’s the $$$ impact?

Space Weather Beacon Data

- All non-imaging data desired
  - High SWx forecast impact and low impact on telemetry
- The image data requires trade-offs
  - High SWx forecast impact, high impact on telemetry
  - Which image data are most useful?

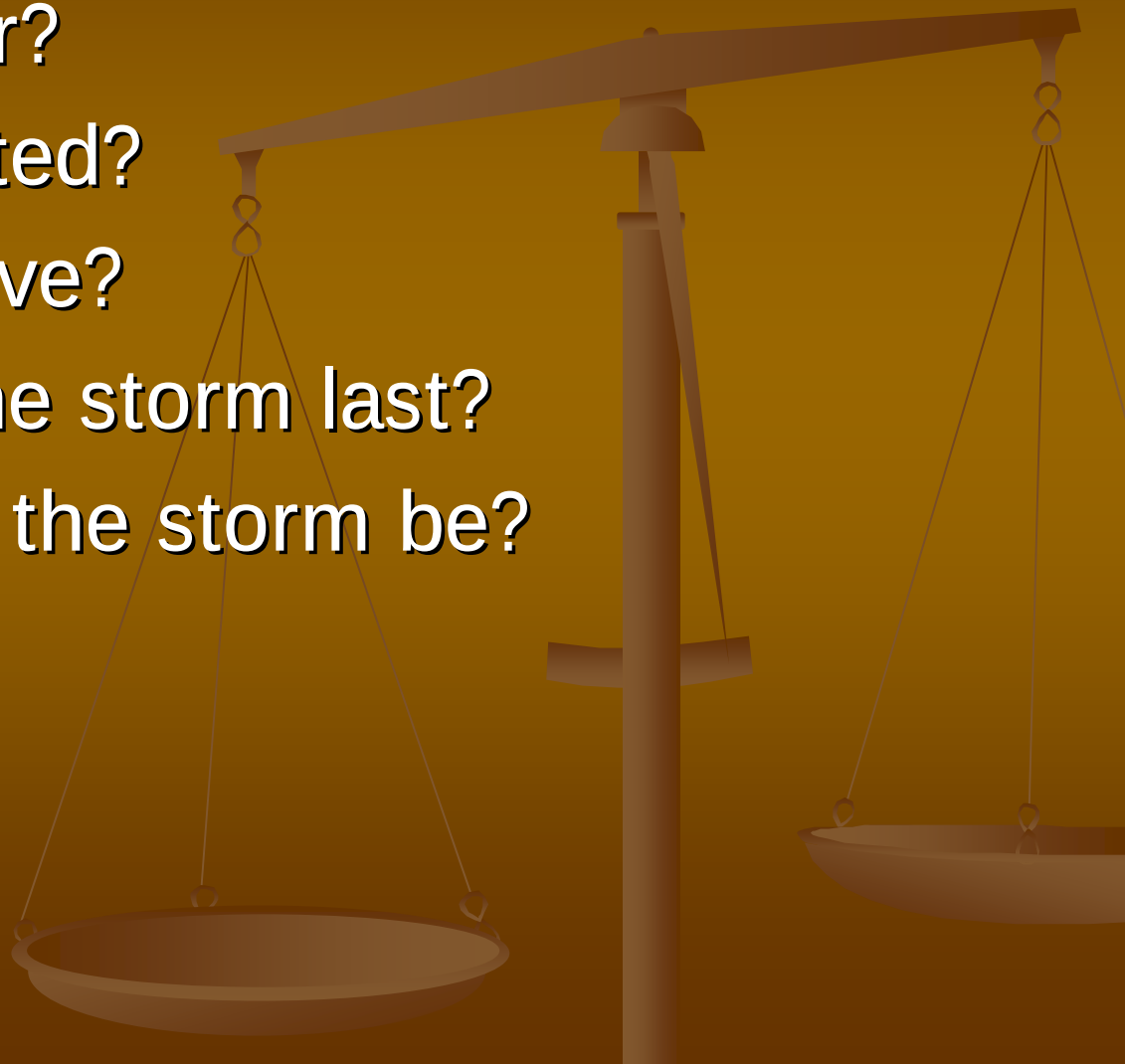


SECCHI Proposed Beacon Content

- SECCHI Space Weather Channel – 500 bits/s
- Original CCD image is 2048 x 2048 pixels
- 6-7 lossy (5x compressed) 256 x 256 pixel images per hour
- 2 lossless (2.3x compressed) 256 x 256 pixel images per hour
- 4x cadence with 128 x 128 pixel images

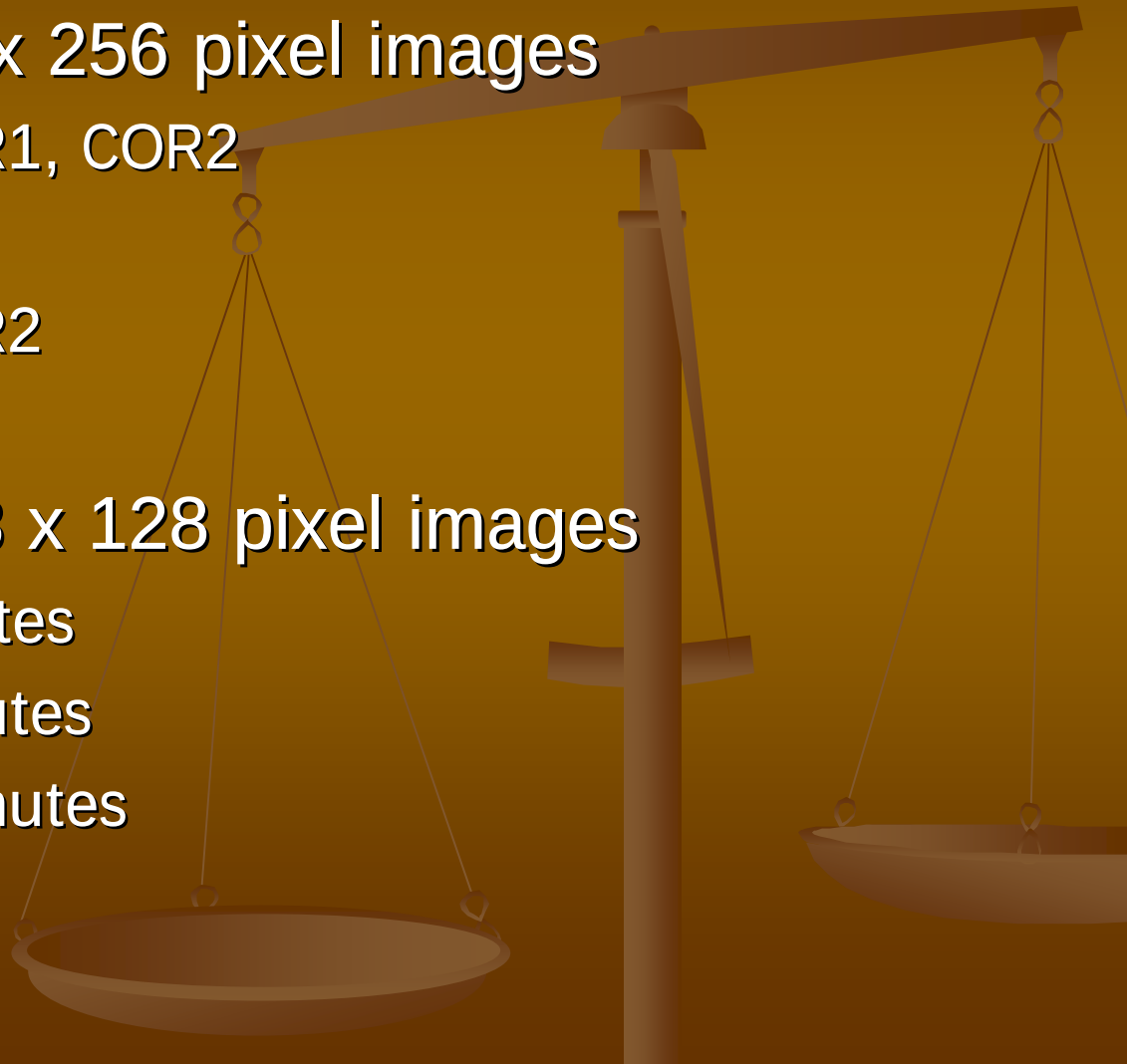
e.g. CME related geomag storm

- Did a CME occur?
- Is it Earth directed?
- When will it arrive?
- How long will the storm last?
- How strong will the storm be?



SECCHI Draft Observing Plans

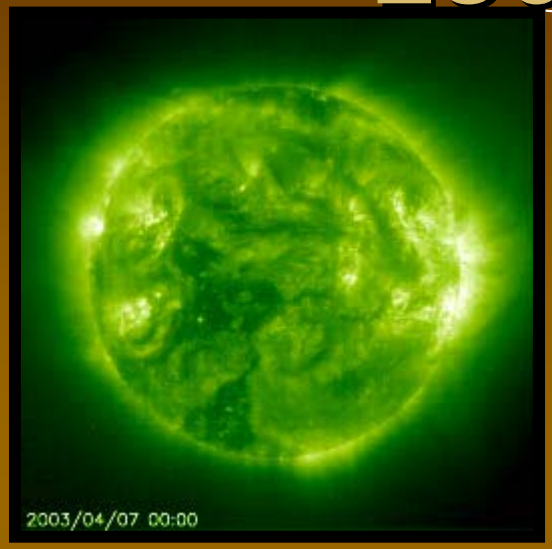
- Hourly Plan 7 256 x 256 pixel images
  - 00 mins EUVI, COR1, COR2
  - 15 mins COR2
  - 30 mins EUVI, COR2
  - 45 mins COR2
- Hourly Plan 28 128 x 128 pixel images
  - EUVI every 5 minutes
  - COR1 every 6 minutes
  - COR2 every 10 minutes



SEC Preferred Observing Plans

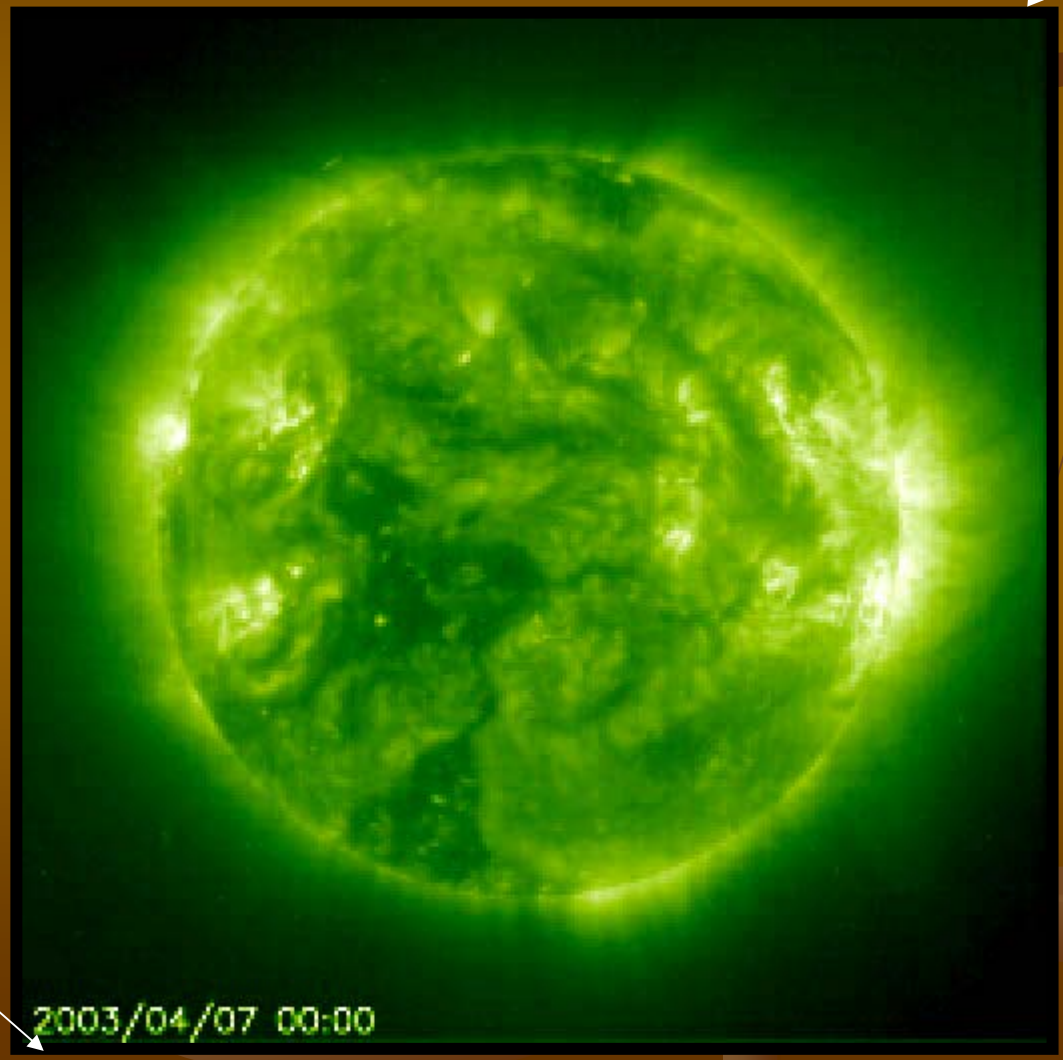
- Hourly Plan 7 256 x 256 pixel images
  - 00 mins COR2, HI1 or HI2
  - 15 mins COR2
  - 30 mins COR2
  - 45 mins COR2
- Provides 4 images of 2500 km/s CME (fastest)
  - ‘Reliable’ velocity and acceleration determination

256 x 256 EIT Images

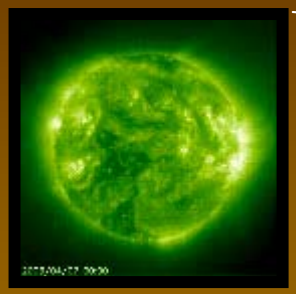


12 min cadence
10.4”/pixel

2x Enlargement

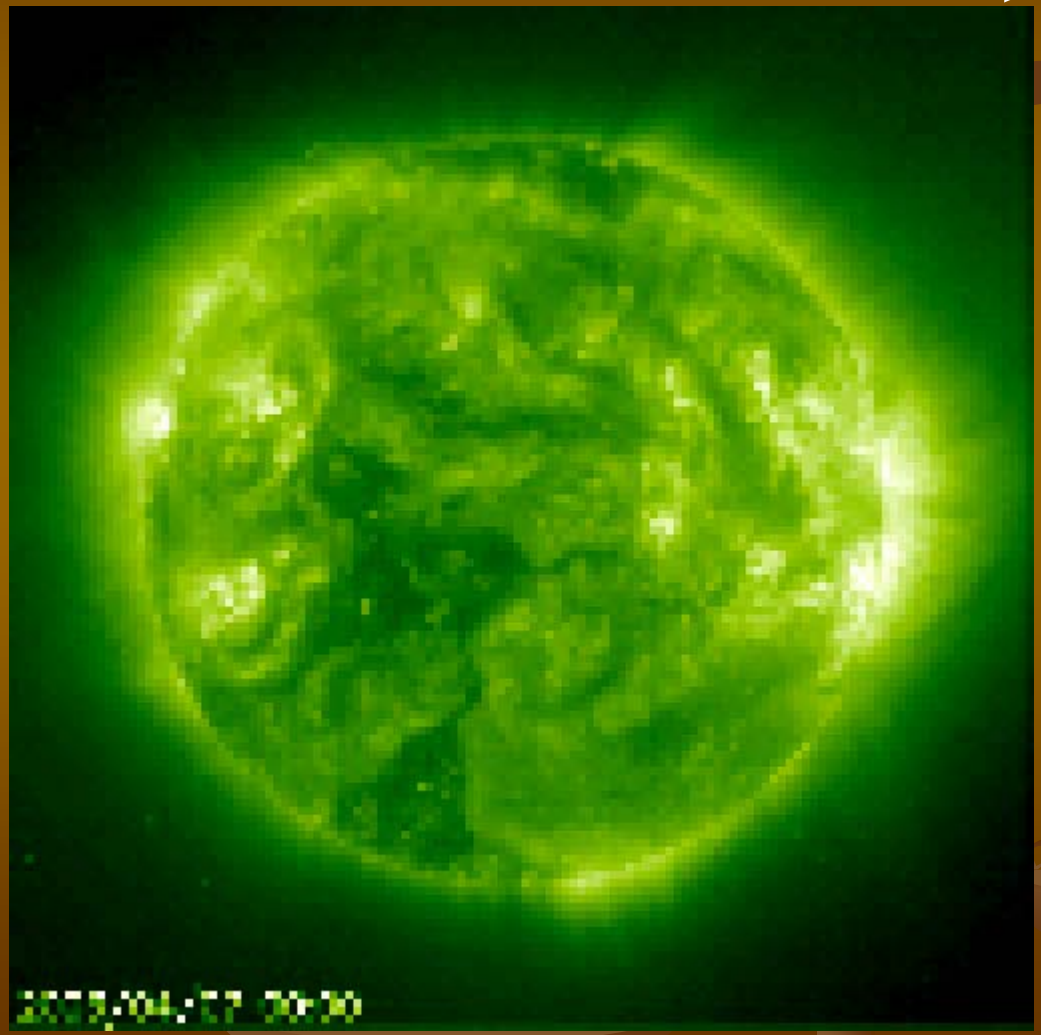


128 x 128 EIT Images

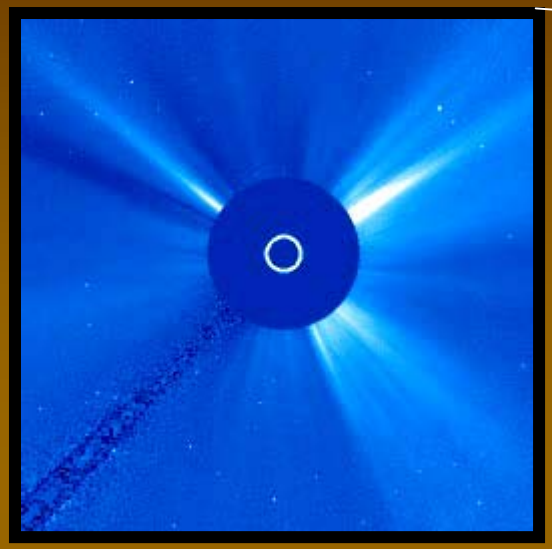


12 min cadence
20.8”/pixel

4x enlargement



256 x 256 LASCO C3 Images



~30 min cadence
224”/pixel

2x Enlargement

128 x 128 LASCO C3 Images

~30 min cadence
448”/pixel

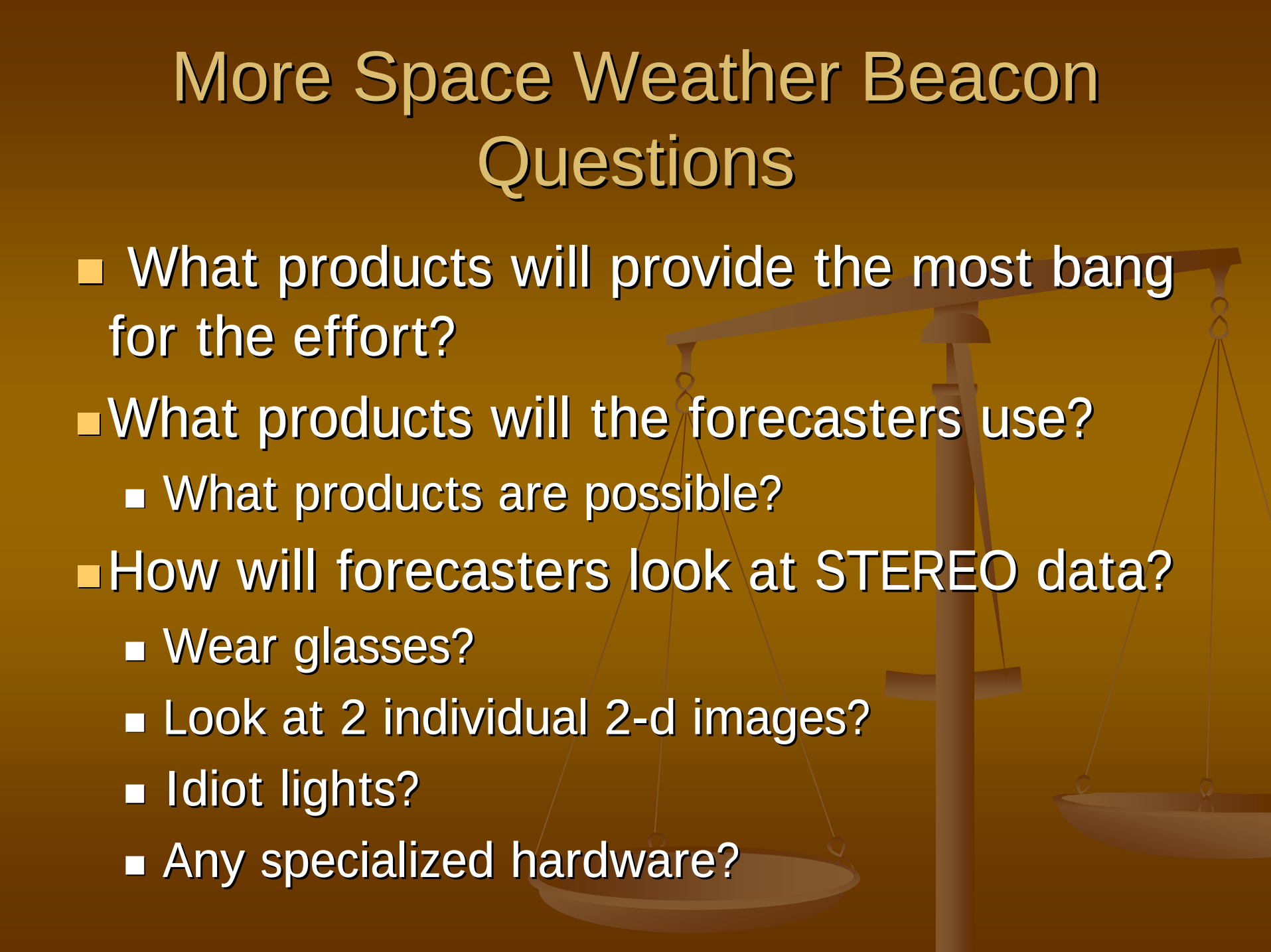
4x enlargement

Space Weather Beacon Questions

- Observing plan
  - Piggyback on full resolution observing plan or some space weather beacon only images?
  - Brightness or polarized images?
  - EUVI wavelength scan?
  - HI-1 or HI-2 data?
- Non-image data?
  - Brightest pixel in each 64 x 64 pixel block (32 x 32 pixel image)
  - Cosmic Ray Counts from HI Scrubbing
- Do we generate SW Beacon images when we don’t know someone is listening ?

More Space Weather Beacon Questions

- What products will provide the most bang for the effort?
- What products will the forecasters use?
  - What products are possible?
- How will forecasters look at STEREO data?
  - Wear glasses?
  - Look at 2 individual 2-d images?
  - Idiot lights?
  - Any specialized hardware?



Draft Space Weather Beacon Images

Telescope	FOV (Rsun)	256 x 256 Resolution Cadence CME Speed	128 x 128 Resolution Cadence CME Speed
EUVI	Disk – 1.7	12.8” 30 min 271 km/s	25.6” 5 min 1624 km/s
COR1	1.28 - 4	30” 60 min 526 km/s	60” 6 min 5259 km/s
COR2	2 - 15	240” 15 min 10053 km/s	480” 10 min 15080 km/s