COR1 CURRENT STATUS AND FUTURE PLANS

Joseph Davila¹, O. C. St. Cyr¹
William Thompson²

¹NASA Goddard Space Flight Center,
²Adnet Systems, Inc.
COR1 Status

• COR1-A and COR1-B are both observing regularly as part of the synoptic program
  • Both are returning scientifically-useful images!

• First light:
  • COR1-A  -- December 4, 2006
  • COR1-B  -- December 13, 2006

• COR1-B has lower stray light than COR1-A
  • COR1-B objective lens changed at KSC
COR1 Performance
Running Difference  25 Jan 2007

• Coronal streamers visible to edge of the FOV
• Dynamics and evolution of the low corona
• CME events
  – Speed, Location, acceleration, etc
• Background stars (5th magnitude)
There are four parameters that are critical to understanding the origins of CMEs and the forces acting on them. But these are difficult to measure above 2 $R_S$ (depicted by white circle).

- initial acceleration
- non-radial motions
- transverse (latitudinal) expansion
- initial radial expansion
All refractive design in axial package
Seven spherical lenses, rad-hard material
(1 singlet, 3 cemented doublets)
1.2 meters long

Three cascaded imaging systems:
• Objective lens forms a solar image at the occulter
• Field lens images front aperture onto the Lyot Stop
• Pair of doublets relay coronal image onto the CCD
Concept of Operations

- Three images are taken at polarizer positions of 0°, 120°, and 240°.
- Combining the three images allows one to derive both the polarized brightness \((pB)\) and the total brightness \((B)\).
- The polarized brightness calculation rejects most of the stray light.

*Image showing 3 separate polarization components*
Inflight Comparison

- Scattered light unchanged (A), or better (B) than pre-flight level
- B (refurbished at the Cape) is slightly better than A
- Both are below $10^{-6}$ requirement
• The field is highly flat, with discrete areas of vignetting near the occulter and camera aperture edges.

• The flat field is monitored in flight with the diffuser window mounted in the door.
Linearity

Detectors on both COR1A and COR1B are slightly non-linear

- IP-summed
  ~1%
- CCD-summed
  ~3%
- Measured with two separate techniques
- Exposure time of 1.7 seconds chosen to keep well within linear range.

**Graph:**
- Sensitivity (DN/sec)
- Ahead
- Behind
- CCD-summed
- IP-summed

STEREO SWG
Stability

• Both COR1A and COR1B have shown decreases in the scattered light since their doors were opened, by about 15%.

• Only the diffuse scattered light shows a decrease—the discrete features remain constant.

• COR1B shows some evolution between the 3 polarizer components.
Compression

- Image compression is required to be able to bring down data with sufficient cadence to see all CMEs.
- ICER is limited to a dynamic range of just over 13 bits.
- Dynamic range in COR1 is limited by scattered light
  - Top end limited by brightest part of the image, near occulter.
  - Bottom end limited by Poisson noise in fainter outer regions.
  - Resulting dynamic range is less than 13 bits for 2x2 binning for both COR1A and COR1B
- Strategy is to select a compression mode that keeps the digital noise below the Poisson noise.
  - Binning to 1024x1024 first improves statistics
    • Optics designed for 1024x1024 operation
  - Selected ICER 05 compression mode
  - Space weather: 128x128 binned with ICER 11
Removing Scattered Light

- Polarized brightness ($pB$) calculation removes much of the scattered light.
  - Still some residual scattered light
- Running and base difference movies also work well
  - Jitter sensitivity less for $B$ than for $pB$
- Other strategies include:
  - Removing model derived from calibration rolls
    - Works well for $pB$
    - Instrument evolution limits effectiveness for $B$
  - Monthly minimum image technique
    - Effect of instrument evolution not yet clear
  - Daily minimum image technique
    - Mainly effective for CMEs
- Above models are applied to each polarization component before combining into $pB$
Without Background Subtraction

Most of the scattered light is removed by the $pB$ calculation.

$pB$

Behind       Ahead

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Roll Maneuvers

- Roll maneuvers allow the separation of instrumental and coronal effects.
  - Coronal hole assumed to be zero intensity
- Derived scattered light suitable for extracting $pB$
  - $B$ affected more by instrumental evolution
  - Behind evolution also affecting $pB$ calculation
- There are several roll maneuvers now on each spacecraft.
COR1 “B” (24-Jan-2007)
Subtracting Rotation Model

- Most representative of corona.
COR1 “B” (24-Jan-2007)
Subtracting Daily Minimum

Behind
Ahead

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Observing Plans

• Three polarizer positions (0°, 120°, 240°) taken in rapid sequence
• All images binned to 1024x1024 resolution
• Currently planning on IP-binning for better linearity
  – May need to go to CCD-binning to reduce radiation-induced noise
• Images scaled to 13 bits and compressed with ICER 05
• Complete polarizer sequence repeated every 10 minutes
  – SSR2 data decreases cadence to 5 minutes for few hours
Jitter Sensitivity

• Spacecraft jitter affects COR1 scattered light pattern.

• Spacecraft jitter greatly improved after 23 Jan (Ahead) and 24 Jan (Behind).

• Still studying how to model jitter effects in data.
COR1 "B" (24-Jan-2007)
running difference median
COR1 Event
25 Jan 2007

from James McAteer

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First CME Height-time Plot

\[ \langle V \rangle = 200 \text{ km/s} \]
\[ a = 5.9 \text{ m/s/s} \]

2006/12/30

Gopalswamy and Yashiro

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# Events List

15-Jan to 18-Feb-2007

<table>
<thead>
<tr>
<th></th>
<th>COR1-A</th>
<th>COR1-B</th>
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<tbody>
<tr>
<td>Observing [Days]</td>
<td>31</td>
<td>35</td>
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<td>Data Gaps [Days]</td>
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<td>Average [Images/Day]</td>
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<td>Cadence [min]</td>
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<td>CMEs Detected</td>
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<td>Questionable CMEs</td>
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<td>Stars Detected</td>
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<td>Debris Sightings</td>
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<td>2</td>
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</table>
Background Stars

- Stars passing through FOV provide an opportunity to verify alignment and may be useful for intensity calibration
- Four stars observed during last week of January
- Solar pointing determined from stars (A) and Moon (B)
Tomographic Modeling

3D Density Determination

- Combination of rotation and views from A and B to reconstruct 3D corona
- Regularization parameter $\mu$ controls smoothness

\[ F = |A \cdot X - Y|^2 + \mu |R \cdot X|^2 \]

from Shaela Jones and Maxim Kramar
COR1 Work-in-Progress

• Several people working on different methods to remove stray light pattern
  • Dynamic versus static

• Using stars to determine COR1 intensity calibration and Sun location
  • Stars identified in both A and B

• Preliminary event list started (duty cycle, CMEs, stars, space debris, etc...)

• Modeling the 3D corona
COR1 Science Team

- J. M. Davila, O. C. St. Cyr, B. Thompson, J. Gurman, N. Gopalswamy, and W. Thompson (SECCHI co-I’s)
- S. Jones (graduate student)
- Undergraduate students at MLSO (J. Burkepile)
- Image enhancement at Mees (Huw Morgan)

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COR1-B Lunar Transit Movie

Base difference in B

2007-02-24 00:13