Cone Model for Storms: A Sensitivity Study Using ENLIL Solar Wind + Cone CME Model

Christina O. Lee

with C. Nick Arge
Dusan Odstrcil, and Janet G. Luhmann

Special thanks to Vic Pizzo
Introduction
Initial parameters used for our CME cloud and ambient solar wind

**CME cloud:**
- Launch speed: 700, 800, …1200 km/s
- Density: 2, 3, …6 times the fast speed stream density
- Radius ($\omega$): 15°, 30°, 45°, 60°

We use each of the above values for the numerical runs we make.

**Default solar wind at 0.1 AU:**
- Fast (slow) stream: 600 (300) km/s
- Fast (slow) density: 1200 (300) per cc
- $B_r$ for fast & slow streams: 150 nT
- Inclination of streamer belt: 30°
- Width of streamer belt: 20°
Launching CME clouds at various latitudes and longitudes

Within cluster, each launch location is separated by 16° (4 grid cells for low resolution). A few are separated by 4°.
Launch locations around central meridian, within streamer belt

<table>
<thead>
<tr>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>160</td>
</tr>
<tr>
<td>90</td>
<td>164</td>
</tr>
<tr>
<td>90</td>
<td>196</td>
</tr>
<tr>
<td>90</td>
<td>200</td>
</tr>
<tr>
<td>74</td>
<td>180</td>
</tr>
<tr>
<td>106</td>
<td>180</td>
</tr>
<tr>
<td>79</td>
<td>169</td>
</tr>
<tr>
<td>101</td>
<td>191</td>
</tr>
</tbody>
</table>
An example: Evolution of a ICME launched at central meridian

Low resolution run

90° Latitude, 180° Longitude

\( v_c = 900 \text{ km/s}, \ d_c = 4x, \ r_c = 45° \)
Vary launch speeds: Comparing time profiles at 1 AU for CMEs launched at west limb (left) and central meridian (right)

Cloud launched at 270 longitude, 90 latitude
Viewing angle at 270 longitude
Launch speed = 700 km/s
Density = 4x fast stream
Radius = 45 degrees
Shock arrival at 2.15470 days

Cloud launched at 180 longitude, 90 latitude
Viewing angle at 180 longitude
Launch speed = 700 km/s
Density = 4x fast stream
Radius = 45 degrees
Shock arrival at 2.71050 days

700 km/s
800 km/s
900 km/s
1000 km/s
1100 km/s
1200 km/s
Vary densities: Comparing time profiles at 1 AU for CMEs launched at west limb (left) and at central meridian (right)
Shock arrival times at 1 AU vs. CME launch speed (central meridian group)

Spread of values for each given launch speed ranges roughly between 1.6 to 2 hours.
Shock arrival times at 1 AU vs. CME density (central meridian group)

Spread of values for each given launch speed ranges roughly between 1 to 2 hours.
Vary cloud sizes: Velocity (left) and density (right) time profiles at 1 AU

Cloud launched at 164 longitude, 090 latitude
Viewing angle at 182 longitude

Launch speed = 900 km/s
Density = 2x fast stream
Radius = 15 degrees
Shock arrival at 3.4961769 days

15 deg

30 deg

45 deg

60 deg

15 deg

30 deg

45 deg

60 deg
Shock arrival times (speed) at 1 AU vs. CME cloud size

Spread of values for each given launch speed ranges roughly between 0.5 to 5.5 hours
Shock arrival times (density) at 1 AU vs. CME cloud size

Spread of values for each given launch speed ranges roughly between 0.5 to 6.5 hours
Future work:
Compare properties from different vantage points (longitude)

Creating multipoint observations for each run
Future work:
Launch CMEs into trailing stream, eastward of streamer belt
In addition, do the following:

- Compare shock strengths
- Sensitivity of our results to the different grid resolution used (low resolution vs. medium resolution)
- Compare results using different ambient solar wind conditions
  - fast/slow stream speeds and densities
  - streamer belt thickness and tilt angle
Other suggestions are welcomed!