The Influences of Geocoronal Variability

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To Do List

- Background
  - Geocorona
  - What is airglow?
- Instrumentation
  - SORCE
  - SOLSTICE
- Methods of interpreting the data
- Data Analysis
- Conclusion
The Geocorona

Photo taken with a UV filter by Apollo 16 commander John Young. April 21, 1972
The Geocorona

- Composed of neutral hydrogen atoms
- Hydrogen $\rightarrow$ since it has a small mass, its scale height is larger than for heavier atoms.
- When solar UV radiation impacts the geocorona, it is either scattered or absorbed.
- Extends to about 15 Earth radii
Airglow

- Lyman-α (121.5 nm)
- This scattered radiation is known as airglow.
Naturally, this occurs on both sides of the Earth (dayglow on the sunlit side and nightglow in the shadow region).

Instruments are only measuring airglow in the shadow if the Earth.
This instruments responsible for supplying the data for this project were designed and built at the Laboratory for Atmospheric and Space Physics (LASP).

They are also controlled here by scientists and students from the University of Colorado at Boulder.
NASA sponsored satellite used to measure x-ray, ultraviolet, visible, near-infrared, and total solar radiation.
Launched on January 25, 2003 and continues to return data.
Orbits at ~600km above the surface of the Earth.
SORCE (cont.)

- Four instruments on board including, Spectral Irradiance Monitor (SIM), Total Irradiance Monitor (TIM), XUV Photometer System (XPS), and Solar Stellar Irradiance Comparison Experiment (SOLSTICE).
SOLar STellar Irradiance Comparison Experiment: SOLSTICE

- Makes daily measurements of solar ultraviolet irradiance (115 – 325 nm).
- I primarily used SOLSTICE B data.
- Solar and Stellar mode.
How SOLSTICE operates
Interpreting the data

- Not all of the data we receive from SOLSTICE is straightforward.
- We need to work with parameters to determine information about the mission to obtain reliable results.
- There were already written procedures and functions to use but it took awhile to learn how to use them and that they actually exist.
- Astronomy lesson
Optical Thickness

- **Optical Depth**: A measure of transparency, the fraction of radiation that is not scattered or absorbed along a path.
- One key aspect we need to determine is whether the geocorona is optically thick or thin.
- If the geocorona is optically thick, there will be no dependence on look direction or orbit location.
Where is the Spacecraft?

- There are IDL procedures to provide Earth-Sun and Earth-spacecraft vectors.
Where is the Spacecraft? (cont.)

- Calculated $\theta$ is between $0^\circ$ and $180^\circ$.
- This doesn’t help much with determining which side of the Earth (dawn or dusk) the spacecraft is located.
  - Spacecraft is moving in the same direction as the Earth.
  - Decide where angles $>180^\circ$ will be located.
Airglow Observations at location of the spacecraft
Airglow Observations at location of the spacecraft
Target Location

SOLSTICE Targets

Declination

Right Ascension
Stellar Companion Observation

companion_stellar_observation
Look Direction

- There is also an IDL procedure to determine the vector from Earth to the Target.
- The difference between the Earth-target and Earth-spacecraft vectors is the look direction.
- We can use these vectors to calculate how the angle between the anti-sunward vector and look direction changes.
Look Direction (cont.)

\[ \vec{T} - \vec{SC} = \vec{L} \]
Lyman-α Flux

- Have to (un)adjust for Sun-Earth distance (6%)
Lyman-$\alpha$ Flux

- A way to measure solar cycle
Lyman-α Flux (cont.)

What a nice fit!
Recall..
Solar Cycle Adjusted

Airglow Observations with Lyman-α Flux removed

Orbit Location=130–135 degrees

Normalized Countrate

Recall...
Solar Cycle Adjusted

Airglow Observations with Lyman-α Flux removed

Orbit Location=130-135 degrees
Optical Thickness Results

- The corrected airglow signal shows a substantial change as a function of both orbit location and look direction.
- We can conclude that at the altitude of SORCE the geocorona is optically thin.
Geomagnetic Activity
I was unable to make any concrete conclusions on whether or not the influences of geomagnetic activity play a roll in impacting the geocorona.

Why?

- The geocorona is comprised of neutral hydrogen atoms.
- Time...
Final Thoughts...

- I would like to explore other factors effect the geocorona (27 day cycle)
- By being able to model the airglow signal in the geocorona, we can learn more about its physical state.
- If we can model, we can then remove it from other observations (stellar and lunar).
QUESTIONS?

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