Exospheric H density determined from GOES Lyman-α measurements

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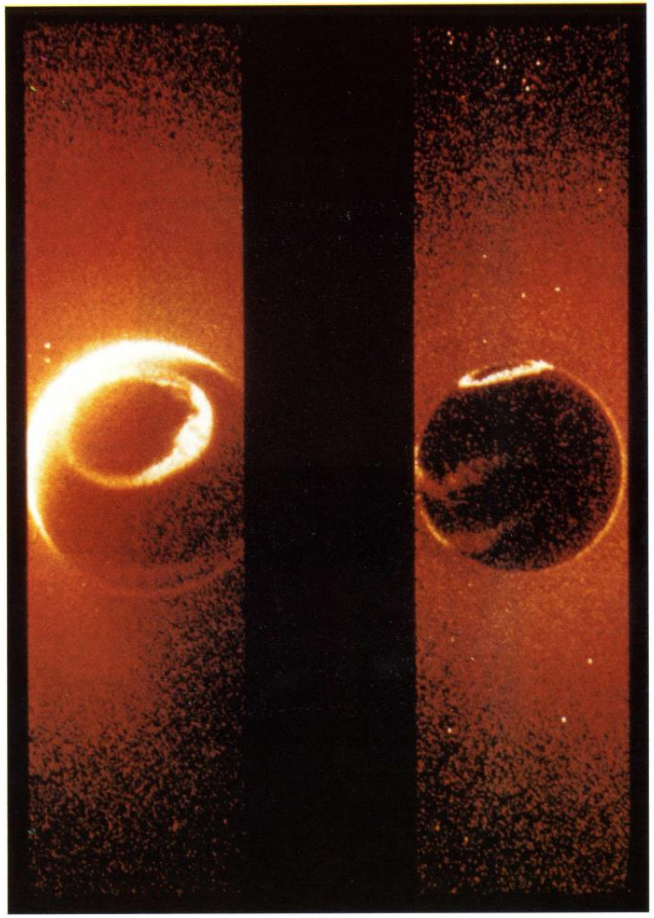
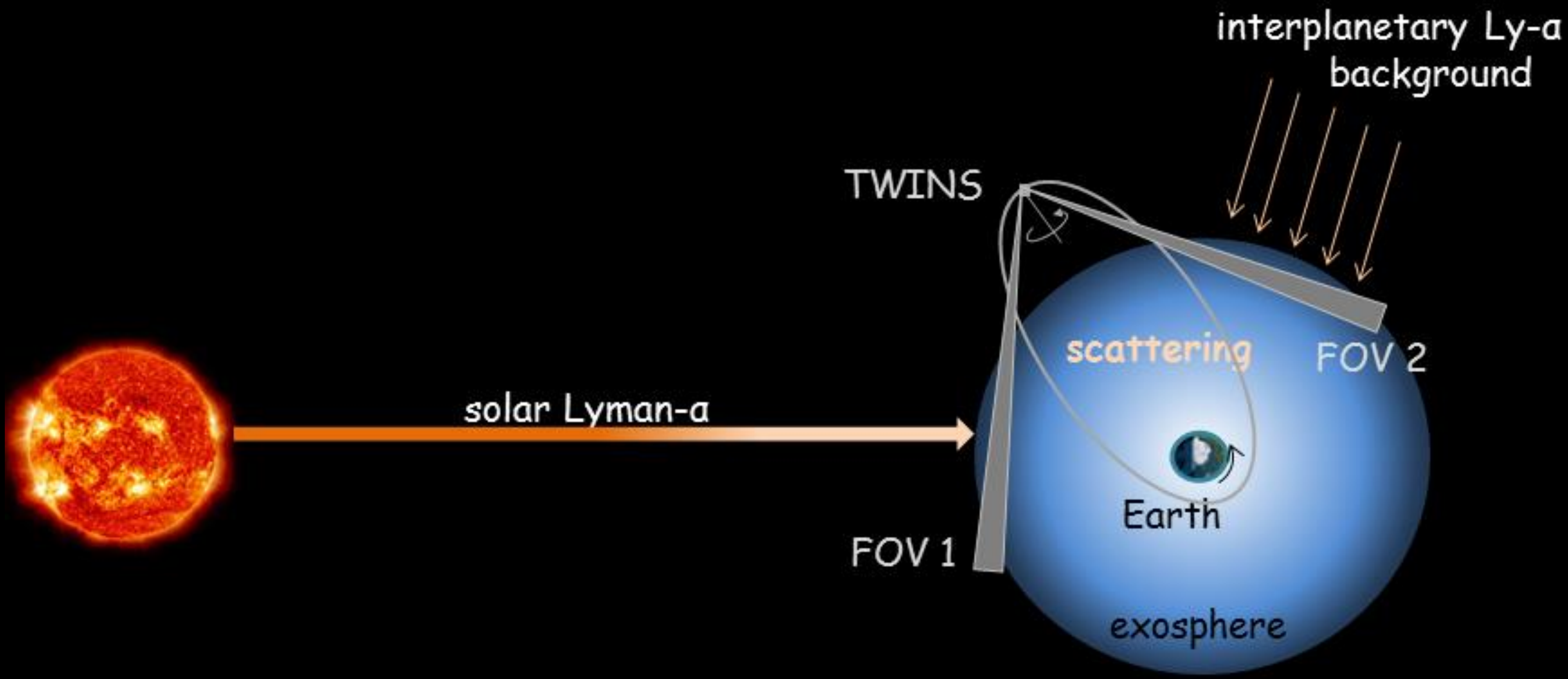


TWINS

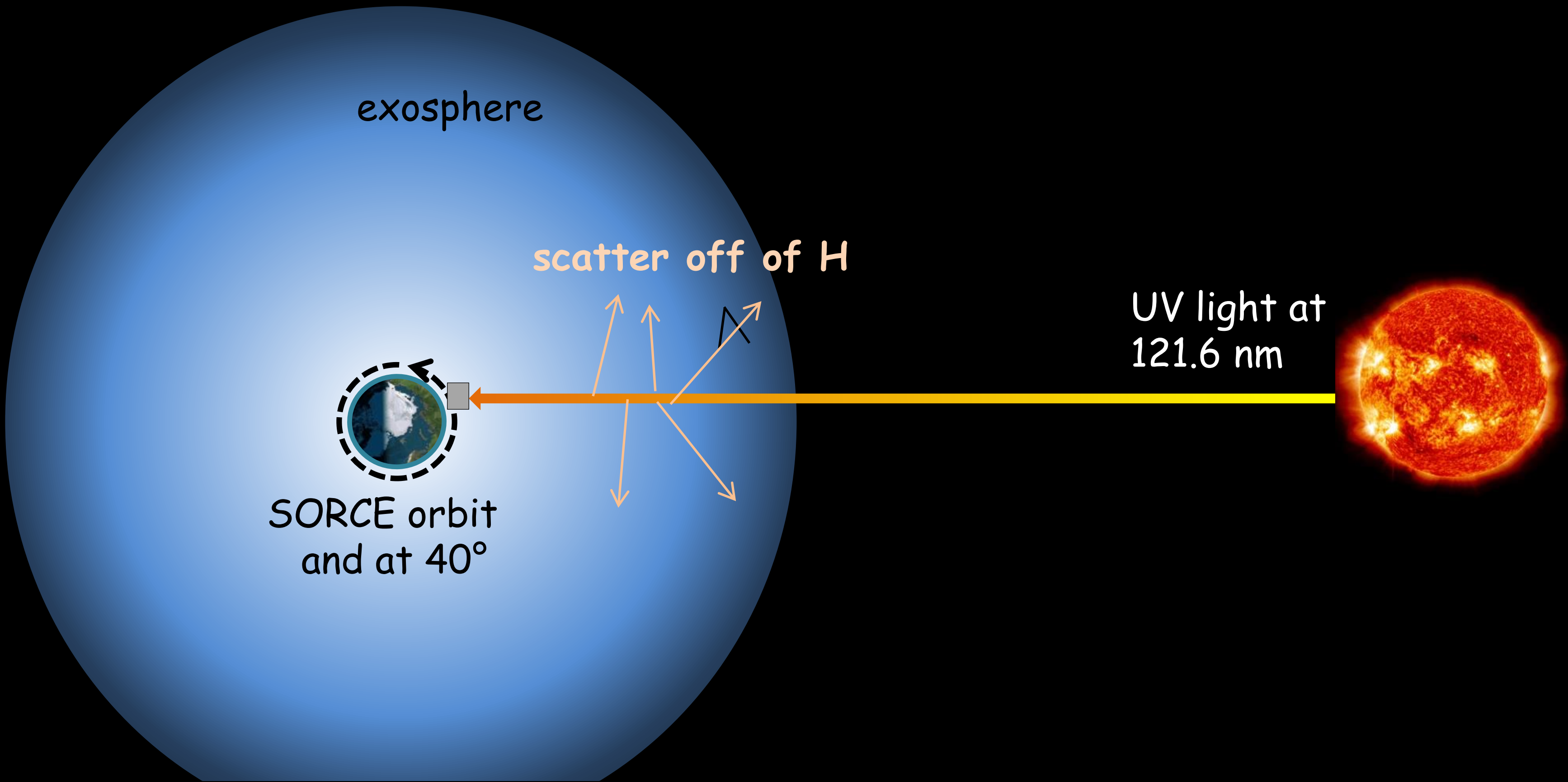
Measurement from Ly-a Scatter



+ 3D over time

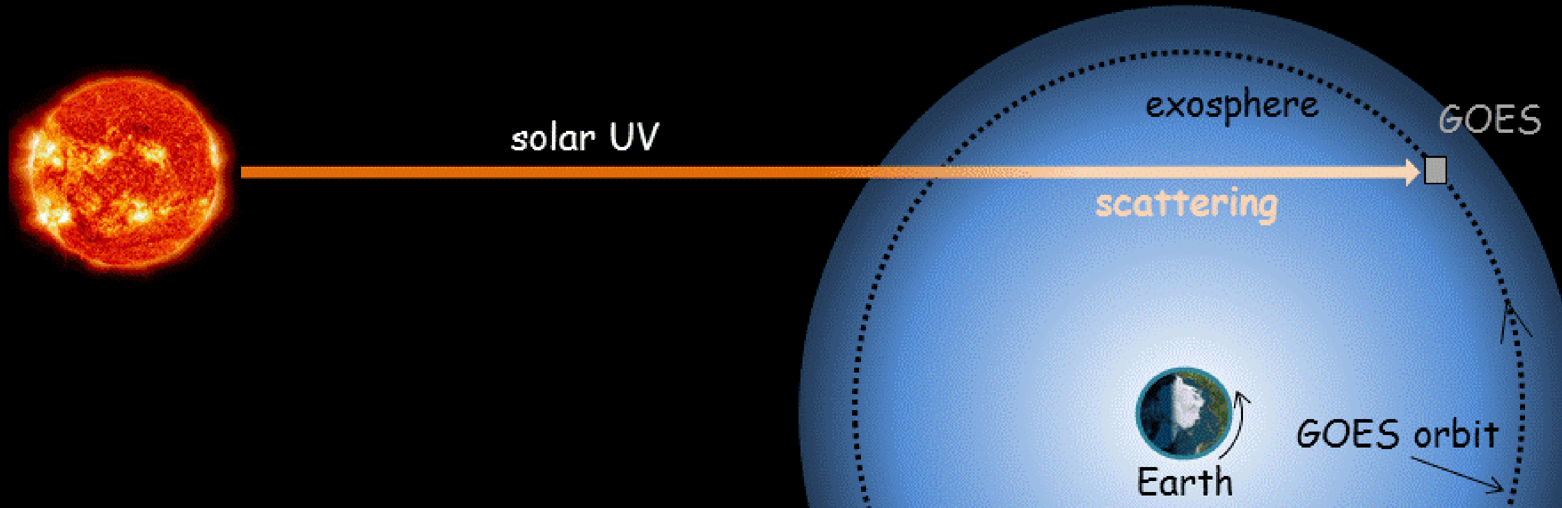
- Small signal, high background, multiple scattering <3 RE

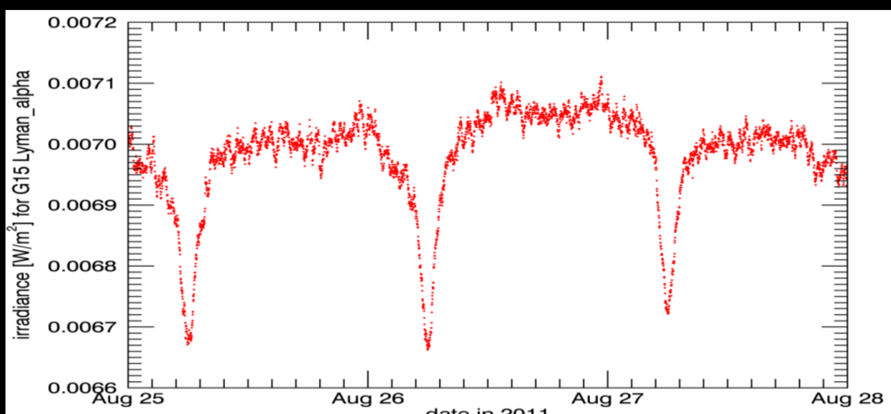
SORCE SOLSTICE + Exosphere



+ Long record (SOLSTICE)
- Limited coverage
- Small signal (<5%)

Exospheric H from GOES Lyman-α

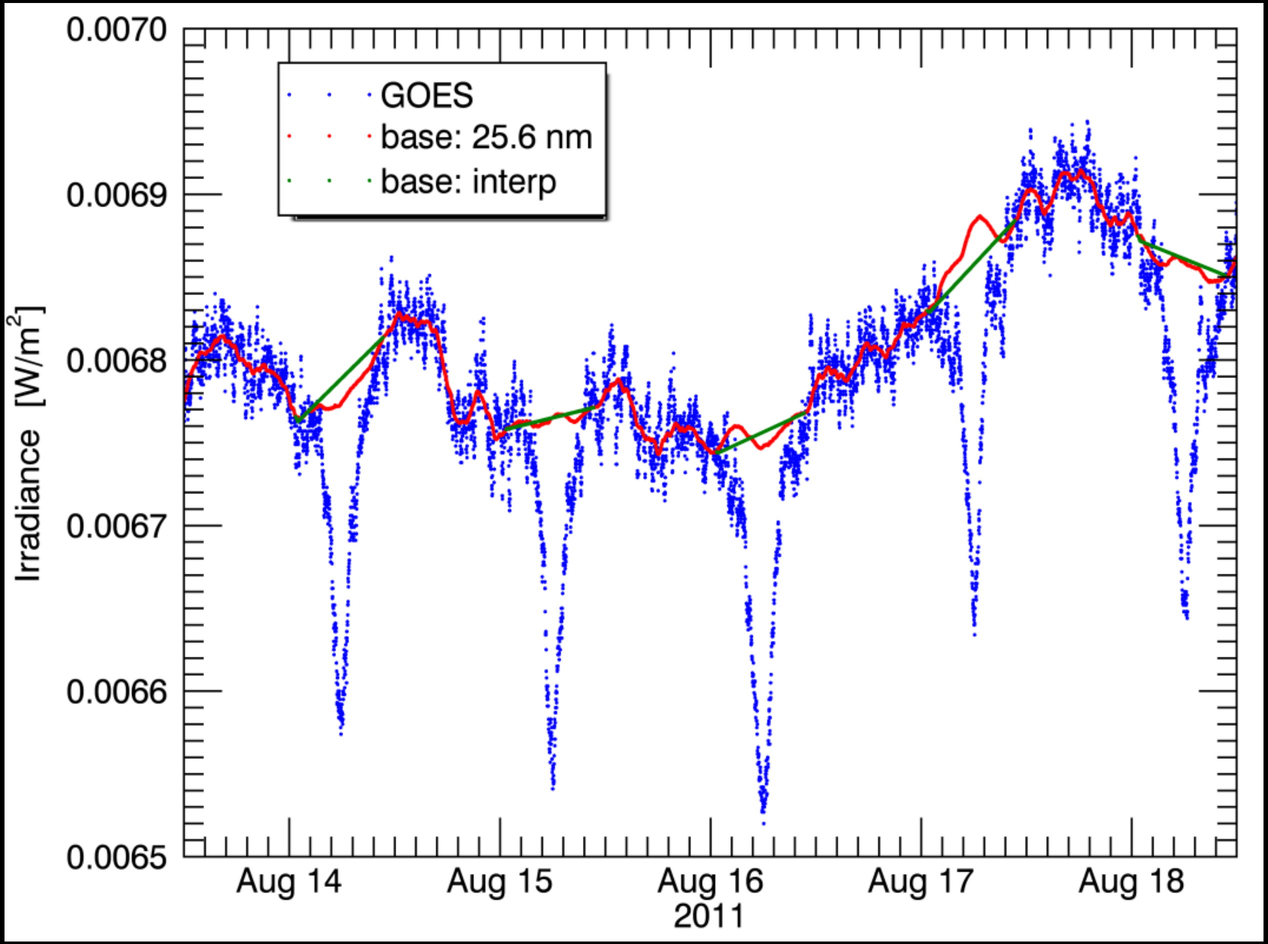




+ Absolute measurement
+ Global coverage… but only every 6 months
- Signal contamination (solar variability and instrument "noise")

Method

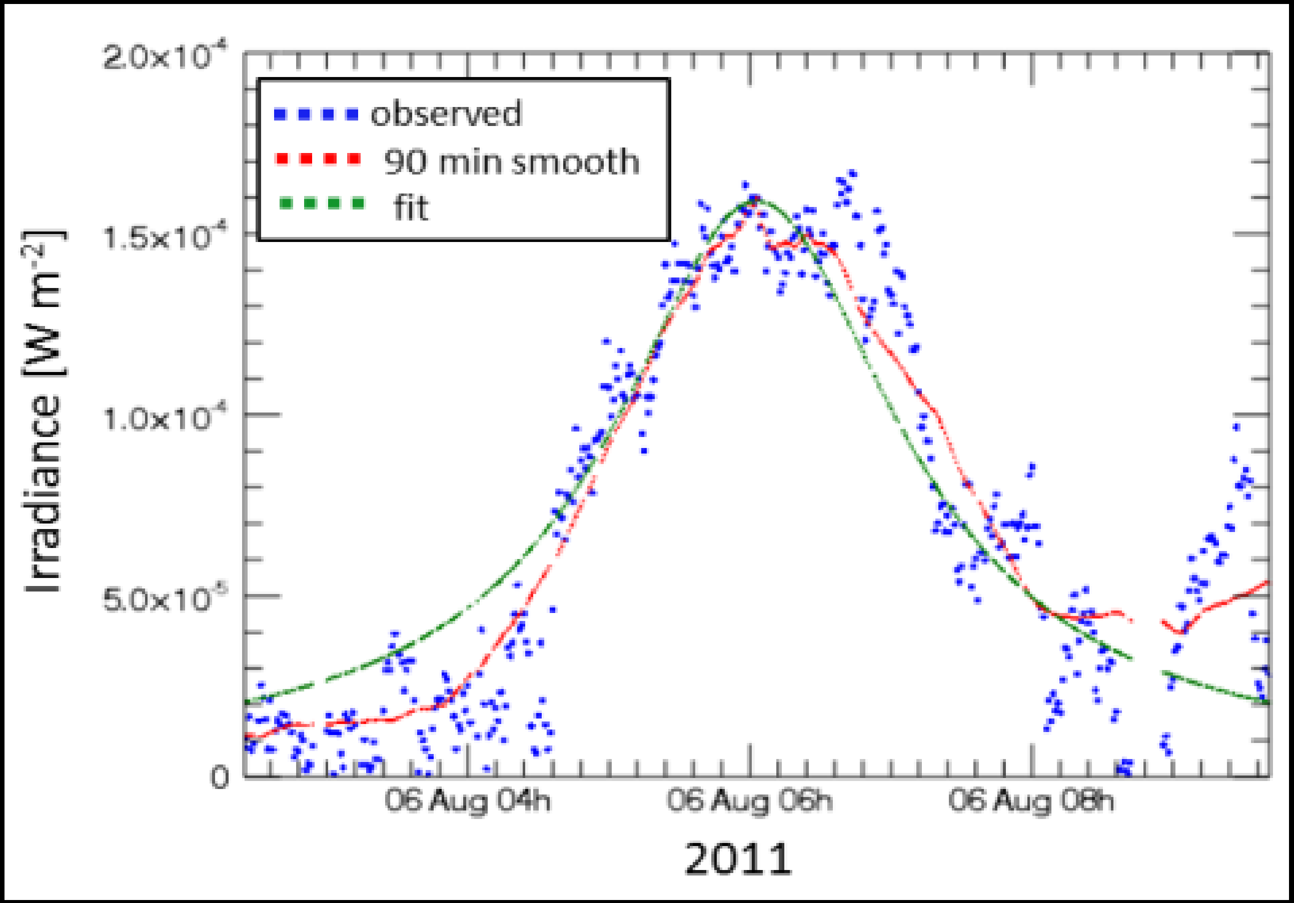
1. **Define a baseline to extract dips due to scattering loss.**



Method

1. **Define a baseline to extract dips due to scattering loss.**

2. **Extract scattering loss.**



Method

1. **Define a baseline to extract dips due to scattering loss.**

2. **Extract scattering loss.**

3. **Solar irradiance loss** along the line of sight:

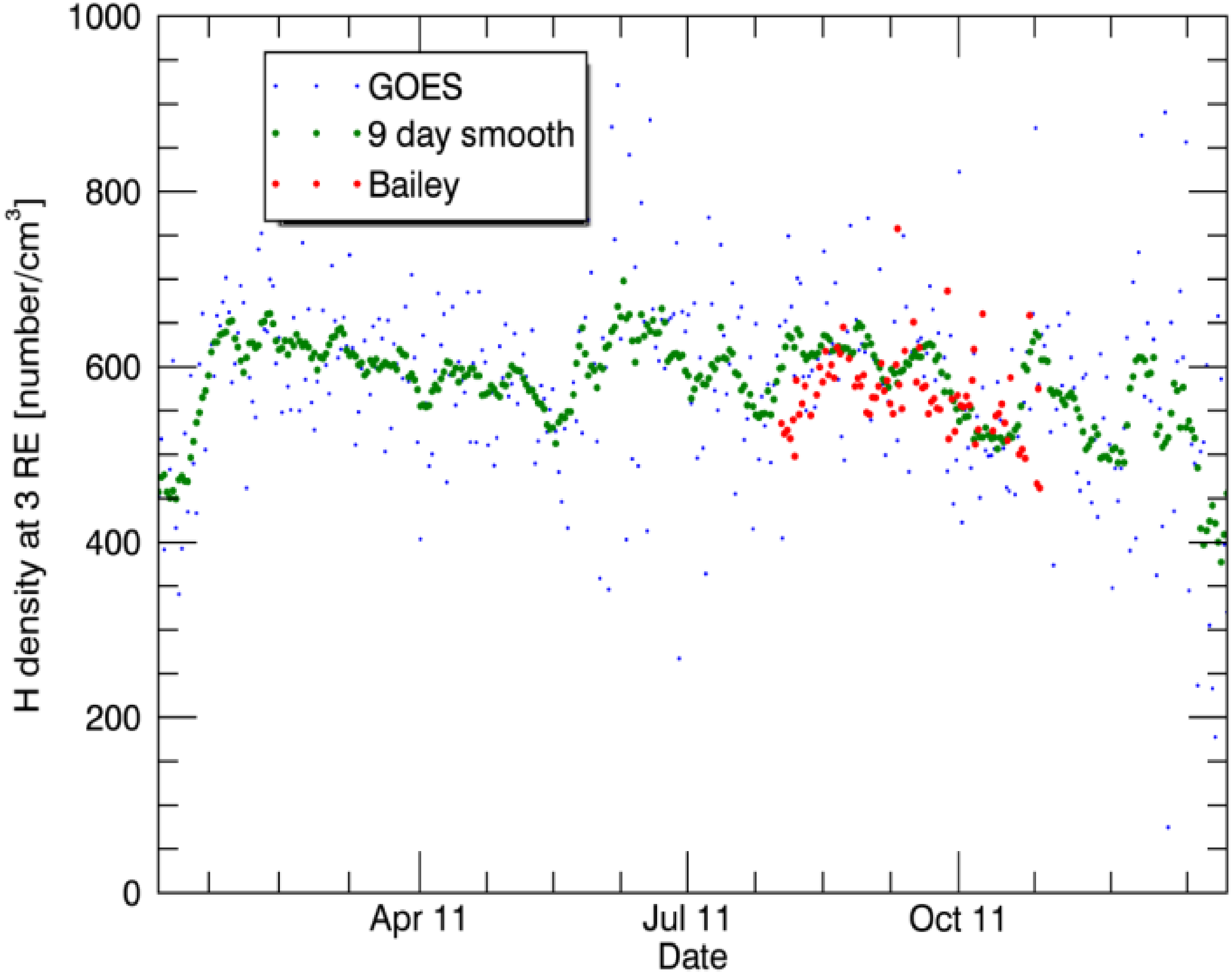
   $I_{loss} = g^* \int n_H(x)\, dx$ (*g** = local scattering rate)

4. **Assume a power law H density**: $n_H(r) = a\, r^{-k}$

5. **Fit I_{loss} integral** to find *a* and *k* values for each dip,

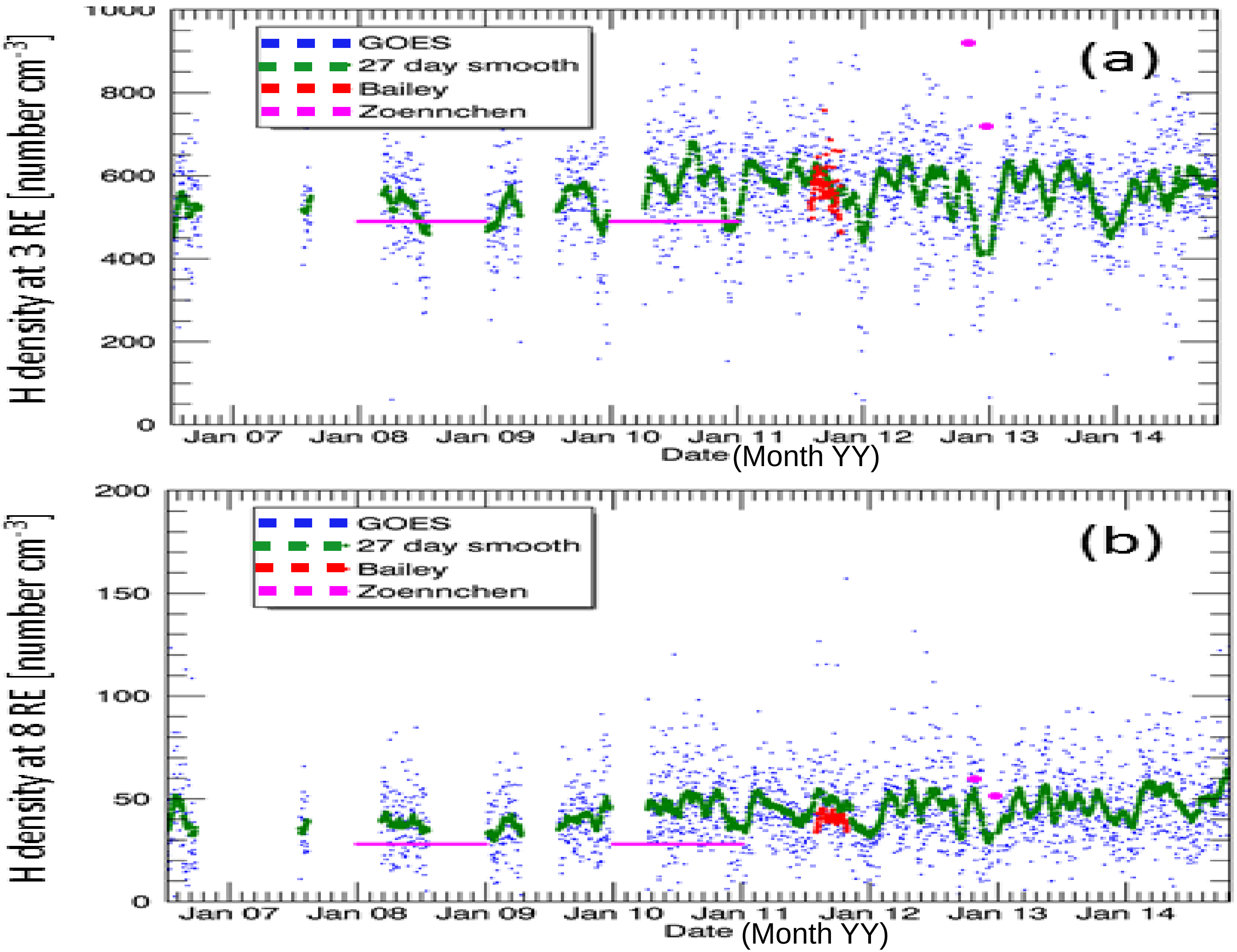
   thus deriving n_H for each day.

Results



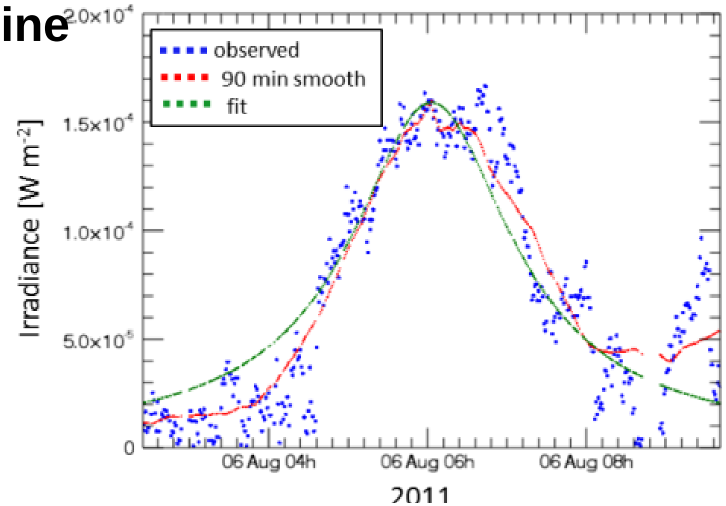
GOES
9 day smooth
Bailey
H density at 3 RE [number/cm^3]
1000
800
600
400
200
0
Apr 11
Jul 11
Oct 11
Date

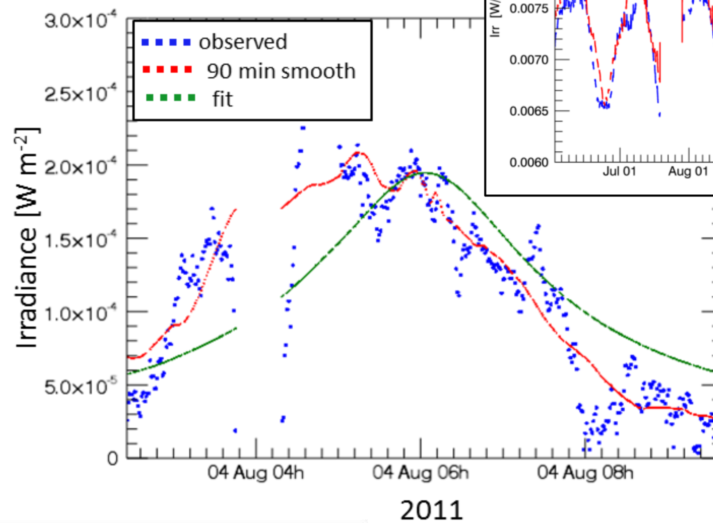
Results

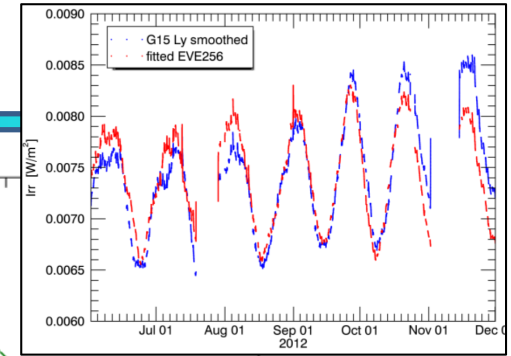

H density at 3 RE [number cm^{-3}]
GOES
27 day smooth
Bailey
Zoennchen
(a)
0
200
400
600
800
1000
Jan 07 Jan 08 Jan 09 Jan 10 Jan 11 Jan 12 Jan 13 Jan 14
Date (Month YY)
H density at 8 RE [number cm^{-3}]
GOES
27 day smooth
Bailey
Zoennchen
(b)
0
50
100
150
200
Jan 07 Jan 08 Jan 09 Jan 10 Jan 11 Jan 12 Jan 13 Jan 14
Date (Month YY)

Challenges

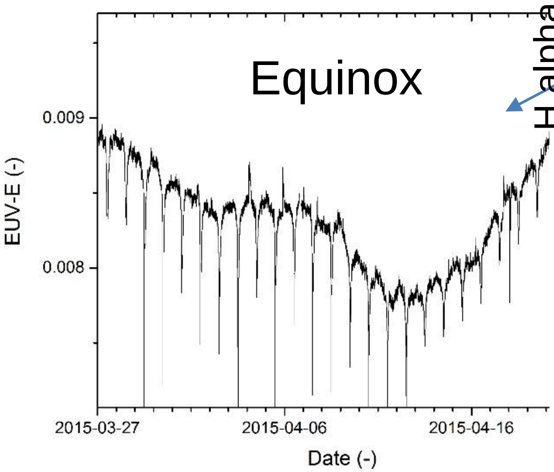
Baseline

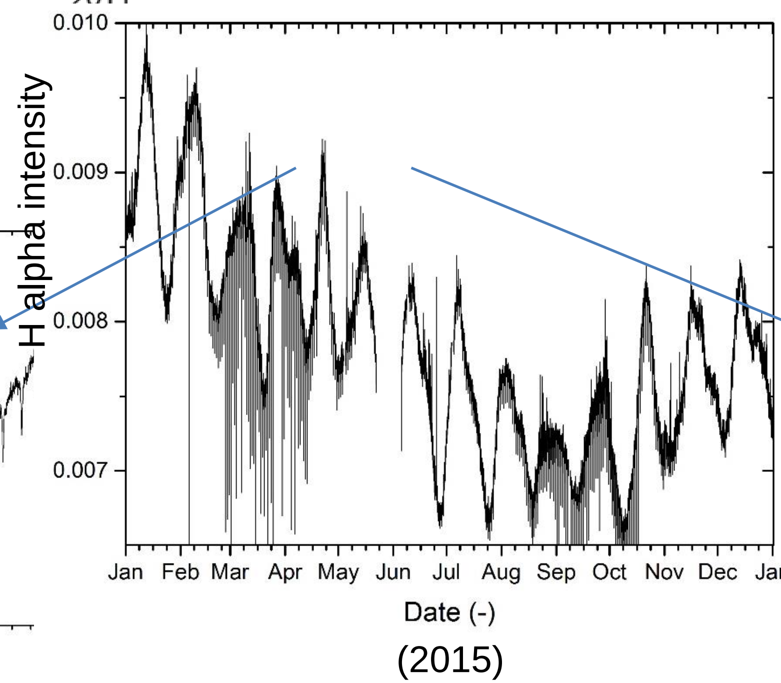


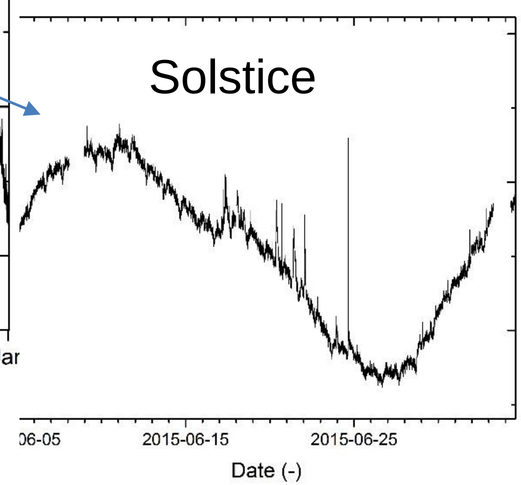




Smaller scattering during solstices







Conclusions

- Initial results are reasonably consistent with other measurements.

- Need to find a better way to correct for solar variability.

- Advantages
  - Absolute measure of density
  - Height profiles
  - Long (multi year) record

- Disadvantages:
  - Signal is small relative to other variations
    - Solar
    - Instrumental
  - Only one slice through the exosphere per day.
    - Takes 6 months to assemble a full map.

- GOES-R
  - Higher spectral resolution
  - Full spectral measurements
    - 25.6 (and 140 nm) will be provided for baseline

Backup slides

Scattering Rate

$$g^{*}[photons\ s^{-1}] = A_{10}^{21} \cdot \frac{\lambda^3}{4\pi c} f_\lambda = 3.47\ 10^{-4} \left(\frac{I_{Ly}[W/m^2]/C_{\gamma\rightarrow W}}{10^{11}\ m^{-2}\ s^{-1}}\right)^{1.21}\ s^{-1}$$

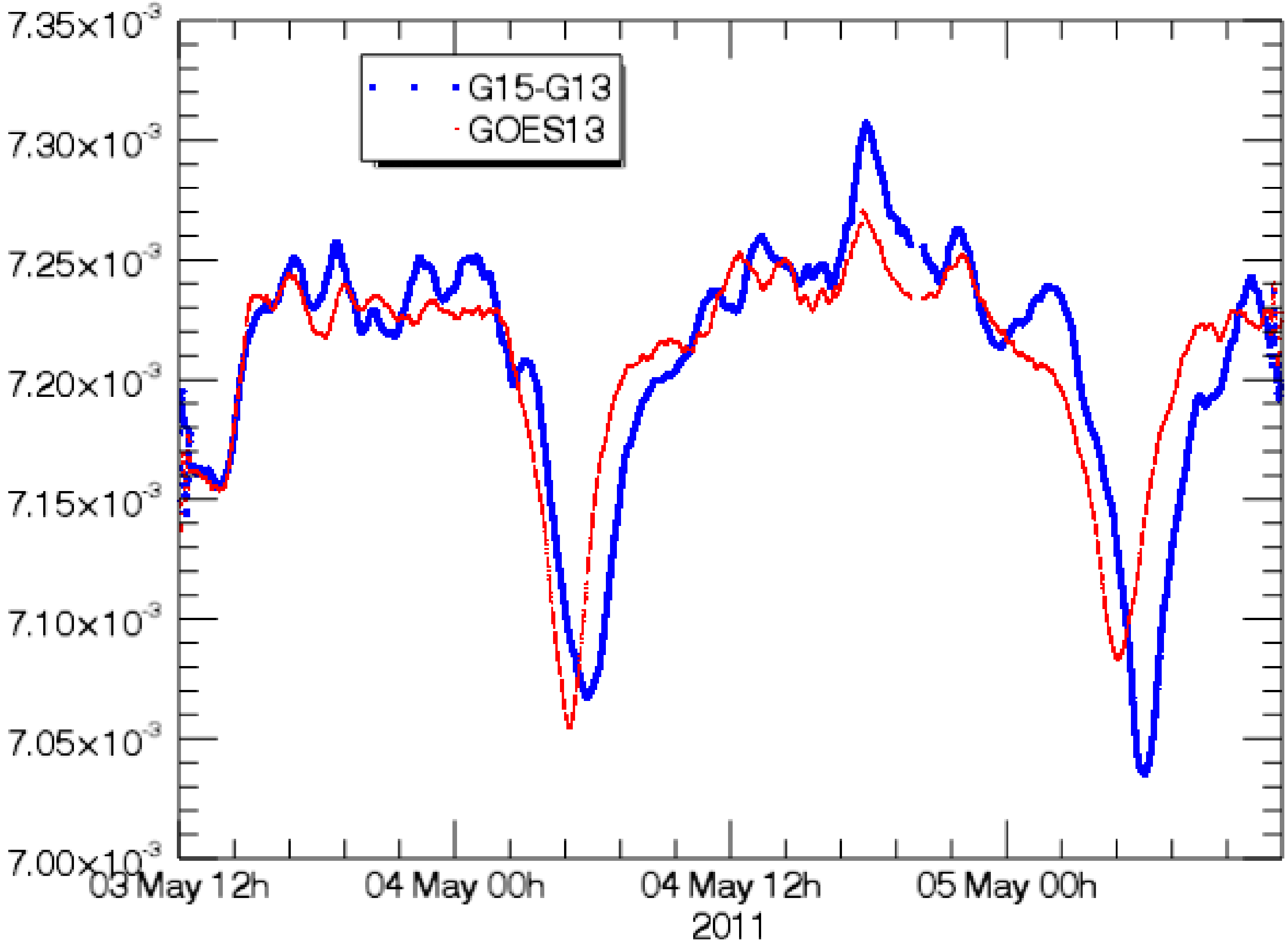
A_{10}^{21} is the transition probability between the H ground state and the lowest level excited state

f_λ is the irradiance at the center of the Lyman-α line

I_{Ly} is the full irradiance of the solar Lyman-α line

$C_{\gamma\rightarrow W}$= 1.988e-12 / λ[nm] for wavelength λ=121.6 nm is the unit conversion factor from [photons/(cm^2 s)] to [W/m^2].

GOES 15 and GOES 13

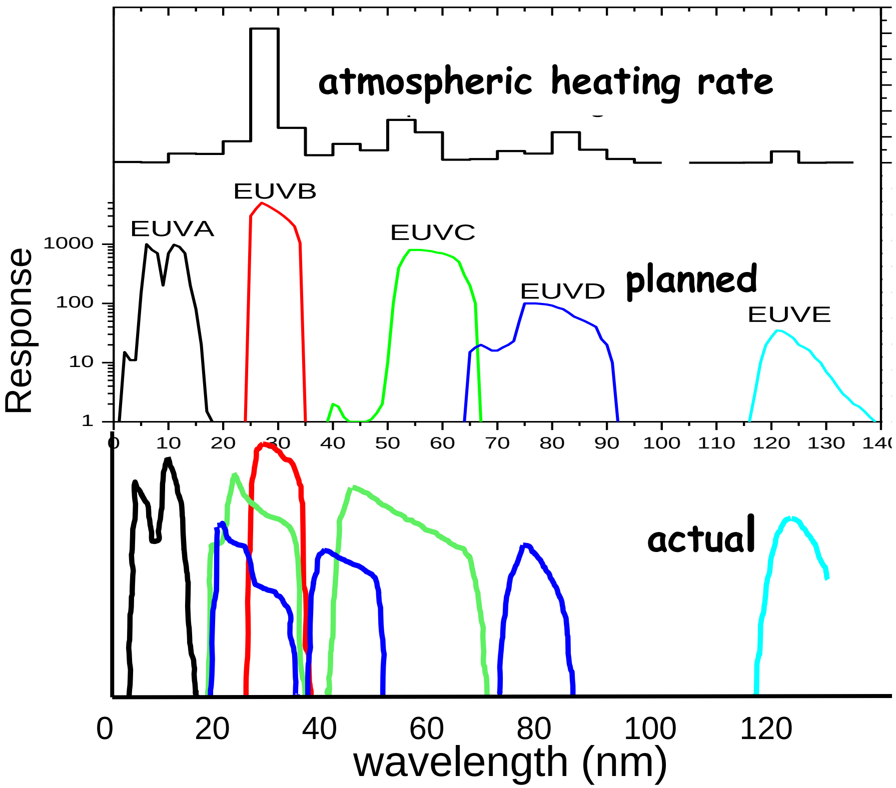


Methods to remove background

- Smoothing.
- Selecting only lowest values.
- Single or linear combinations of GOES channels A (17 nm) and B (30.4 nm), MEGS-P, SORCE SOLSTICE, EVE 25.6 nm.
- Average GOES 13 and 15 with time offset.
- Average pre and post midnight data.
- GOES-15 minus GOES13

EUVS on GOES 13-15

5 EUV bands, 5-127 nm,
10-s sample rate, 15% uncertainty



Channels A, B and E are most useful.

C and D are too complicated and have multiple peaks due to filter issues.

Channel E covers the Lyman-alpha line at 121 nm.

All channels have some thermal issues.

Only Channel E appears to have degradation. This is corrected by scaling to *daily* SORCE SOLSTICE values.