Long-term Power Budget for the Upper Atmosphere

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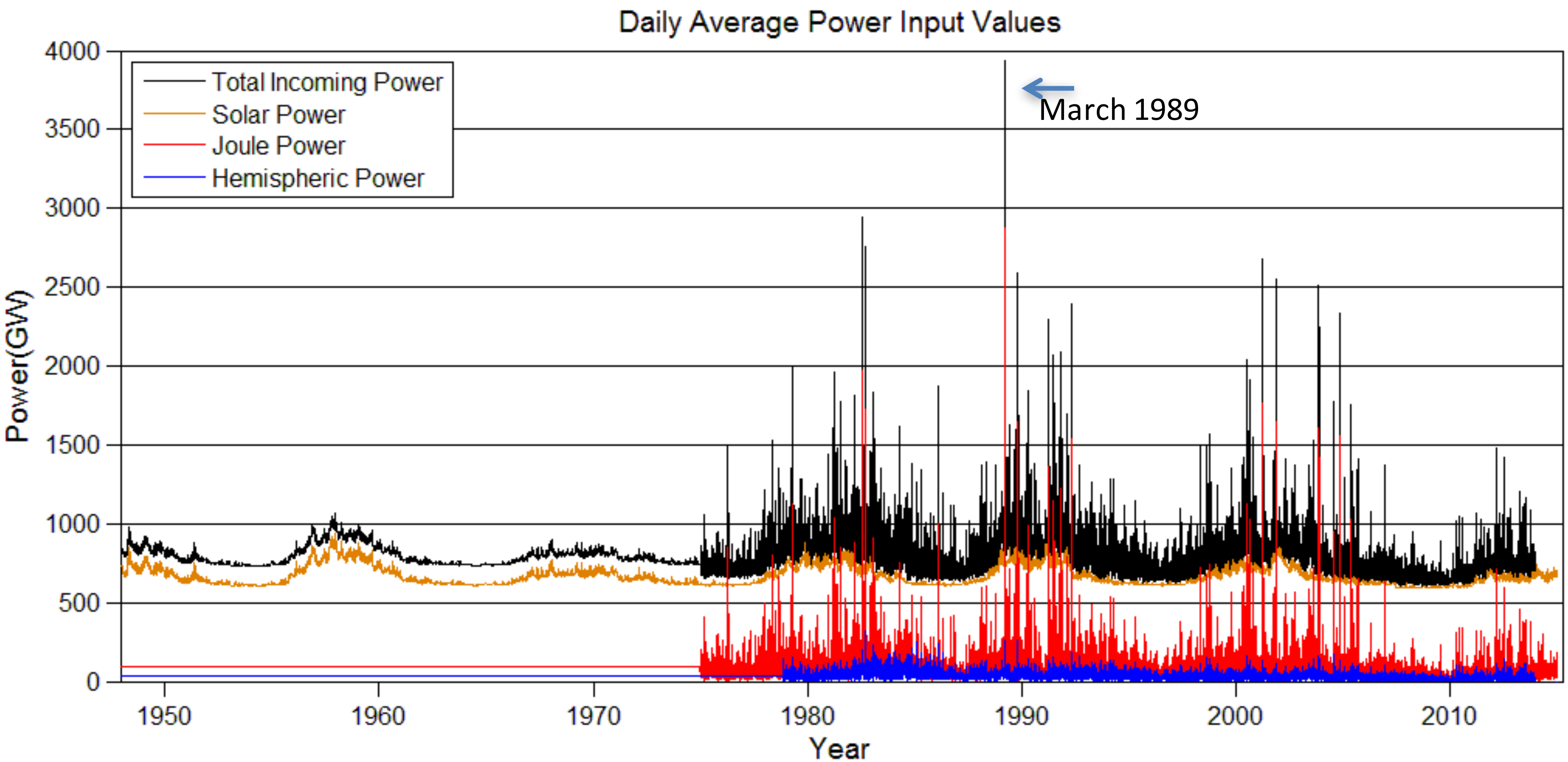
What is the daily average power input to the upper atmosphere?

a) Kilo Watts
b) Mega Watts
c) Giga Watts
d) Tera Watts
e) Peta Watts

Long-term Power Budget for the Upper Atmosphere

Solar	Magnetosphere	
EUV	Joule heating	Particle Precipitation
671 GW (85%)	91 GW (11%)	34 GW (4%)



Daily Upper-Atmosphere Power Input

Knipp et al., manuscript in prep

Global- scale Historical Record of Power to/from the Upper Atmosphere

- Solar power from wavebands 25-105 & 125-175 nm
  - from the Solar Irradiance Platform [Tobiska and Bouwer, 2006], multiplied by their respective heating efficiency factors, 0.35 and 0.32, [Stolarski et al., 1975]
- NOAA POES hemispheric power [HP]
- - Joule heating (JH) proxy derived by
  - Regressing the revised Polar Cap Index [Troshichev et al., 1988, and Janzhura and Troshichev, 2011] and Dst [Sigiura, 1964]
    - NASA OMNIWeb
  - Against 16 years of NGDC SPIDR AMIE JH estimates [Ridley and Kihn, 2004]
    - TIMED/SABER [Mlynczak, 2010] IR cooling record 2002-present

New Joule Heat Proxy Index

- Based only on PCI and Dst Indices
  - 16 years of NGDC SPIDR AMIE JH estimates
    - Suspect spike data eliminated
  - Winter (Oct 21 – Feb 20) :

$46.86\ |PC| + 4.91\ PC^2 - 0.279\ |DST| + 0.019\ DST^2$

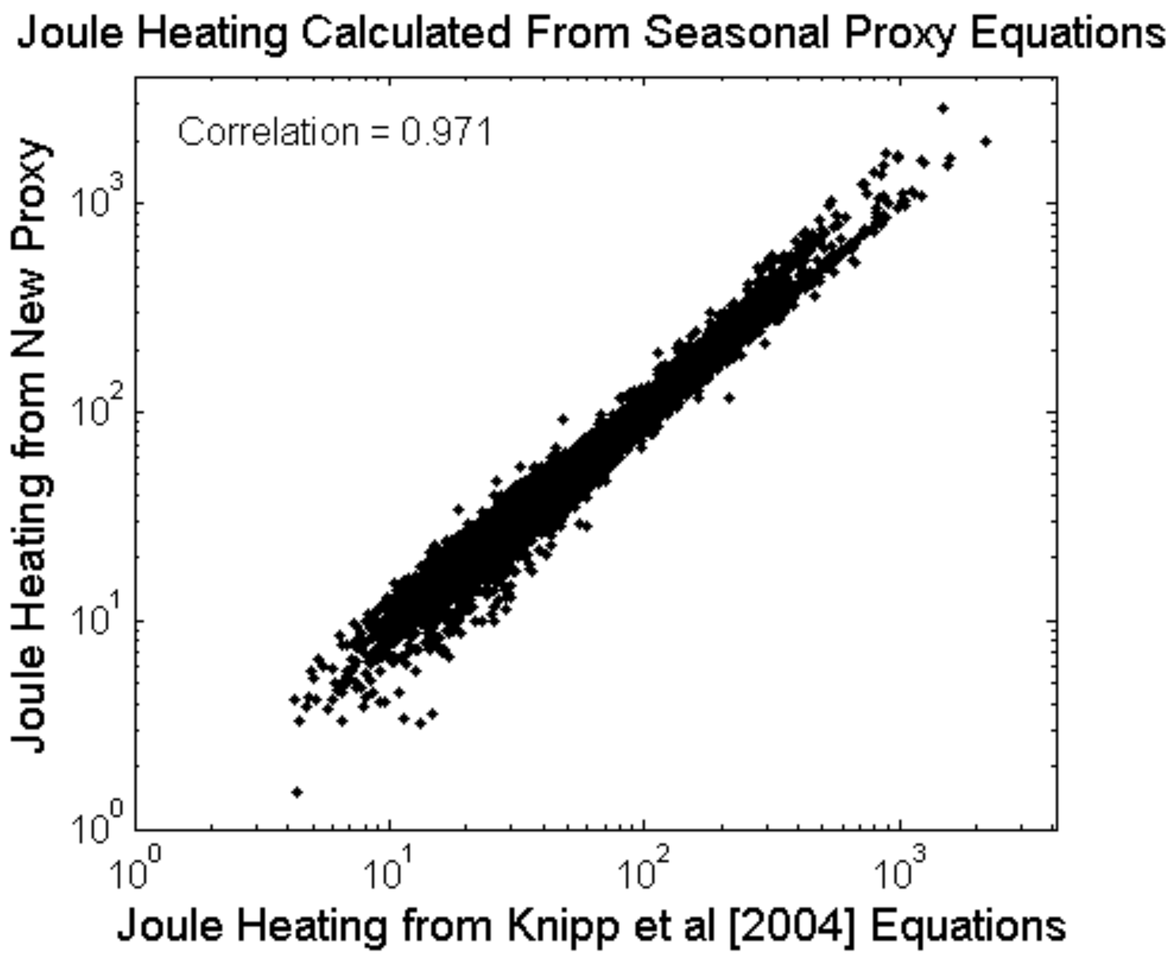
  - Summer (Apr 21 – Aug 20) :

$50.15\ |PC| + 15.89\ PC^2 + 0.347\ |DST| + 0.024\ DST^2$

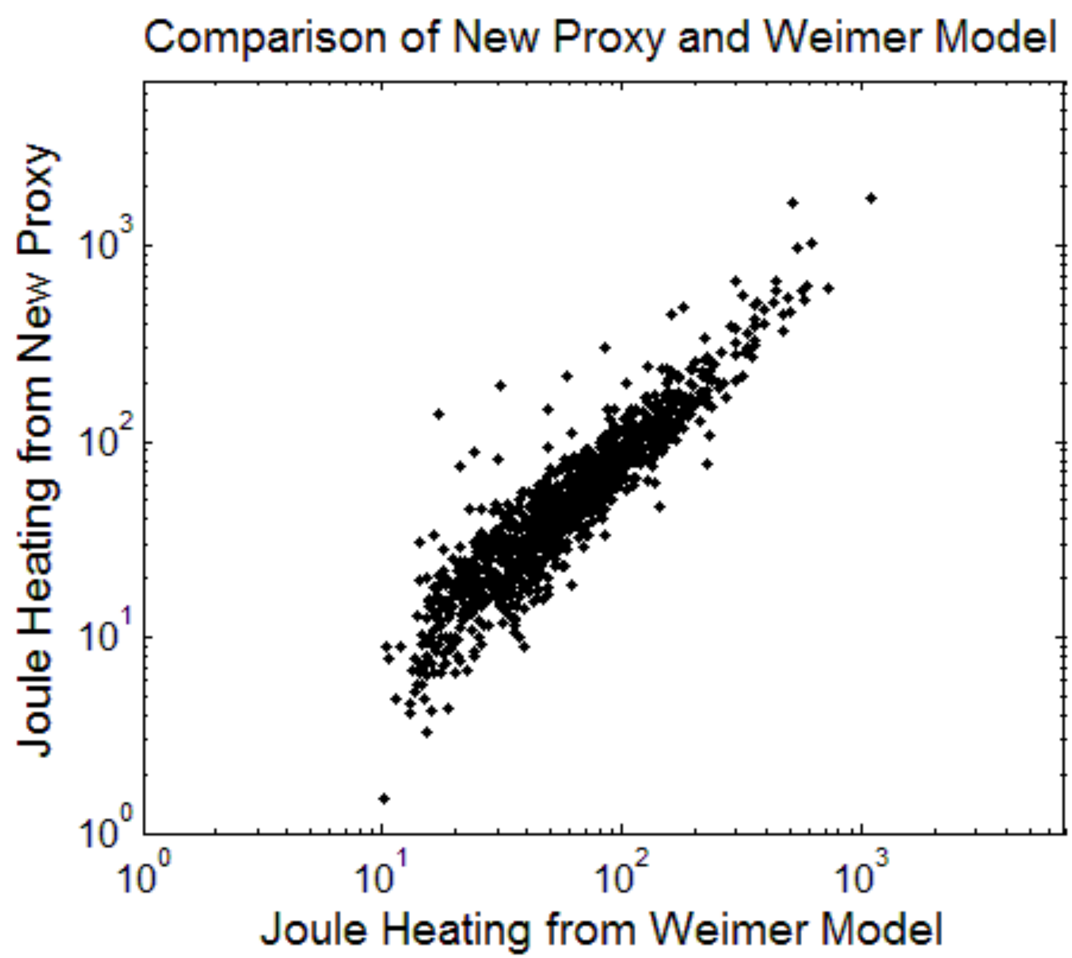
  - Equinox (Feb 21 – Apr 20, Aug 21 – Oct 20) : $53.43\ |PC| + 9.36\ PC^2 + 0.031\ |DST| + 0.018\ DST^2$

- Compare against
  - Joule heat model [Weimer, 2005]
  - Ovation Prime [Newell et al., 2010]

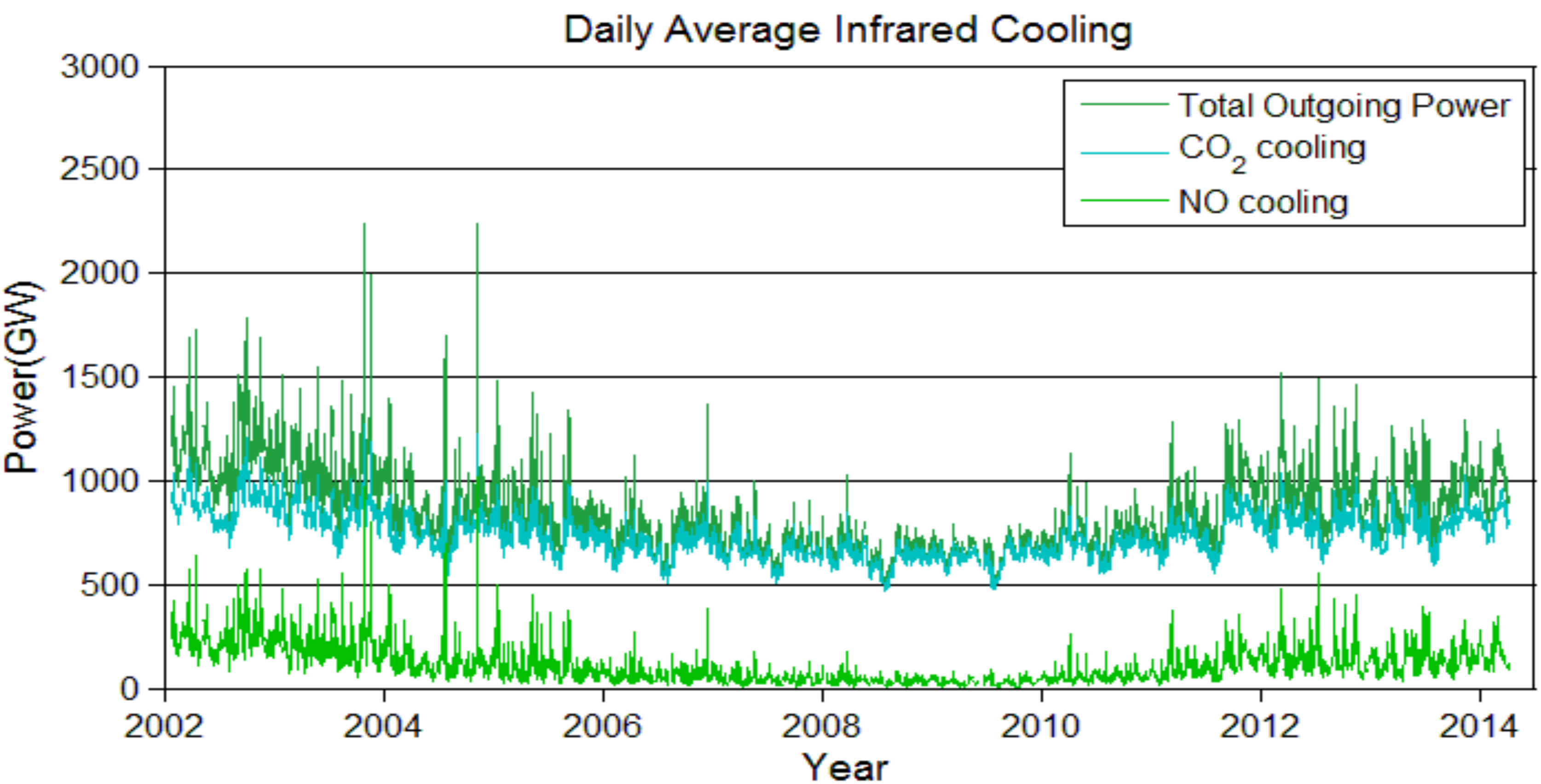
New vs Old Joule Heating Index



New JHI vs Weimer Model



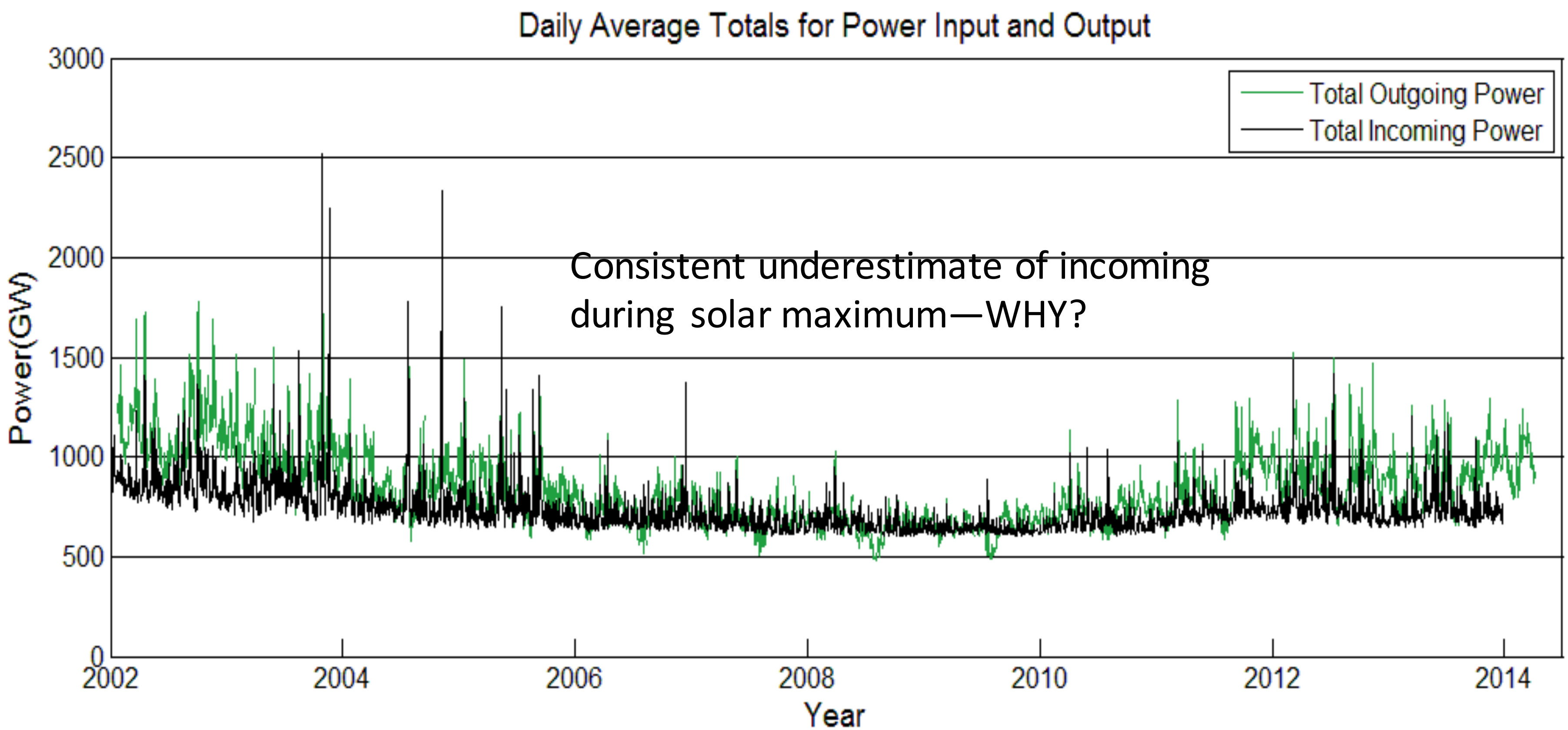
SABER IR Radiative Power to Space CO_2 and NO



Daily Upper-Atmosphere Power Output

Courtesy M. Mlynzack, L. Hunt

Net Power



Net Daily Upper-Atmosphere Power Output

Minding the Power Gap

- Parameterization for JH is ‘crude’
  - AMIE maps used in regression
- Not accounting for small scale variability
- Not properly accounting for dayside JH
- Particle input is also crudely parameterized
- Interaction between particles and JH lacking
- COMING SOON: Improved AMIENext Particles and JH

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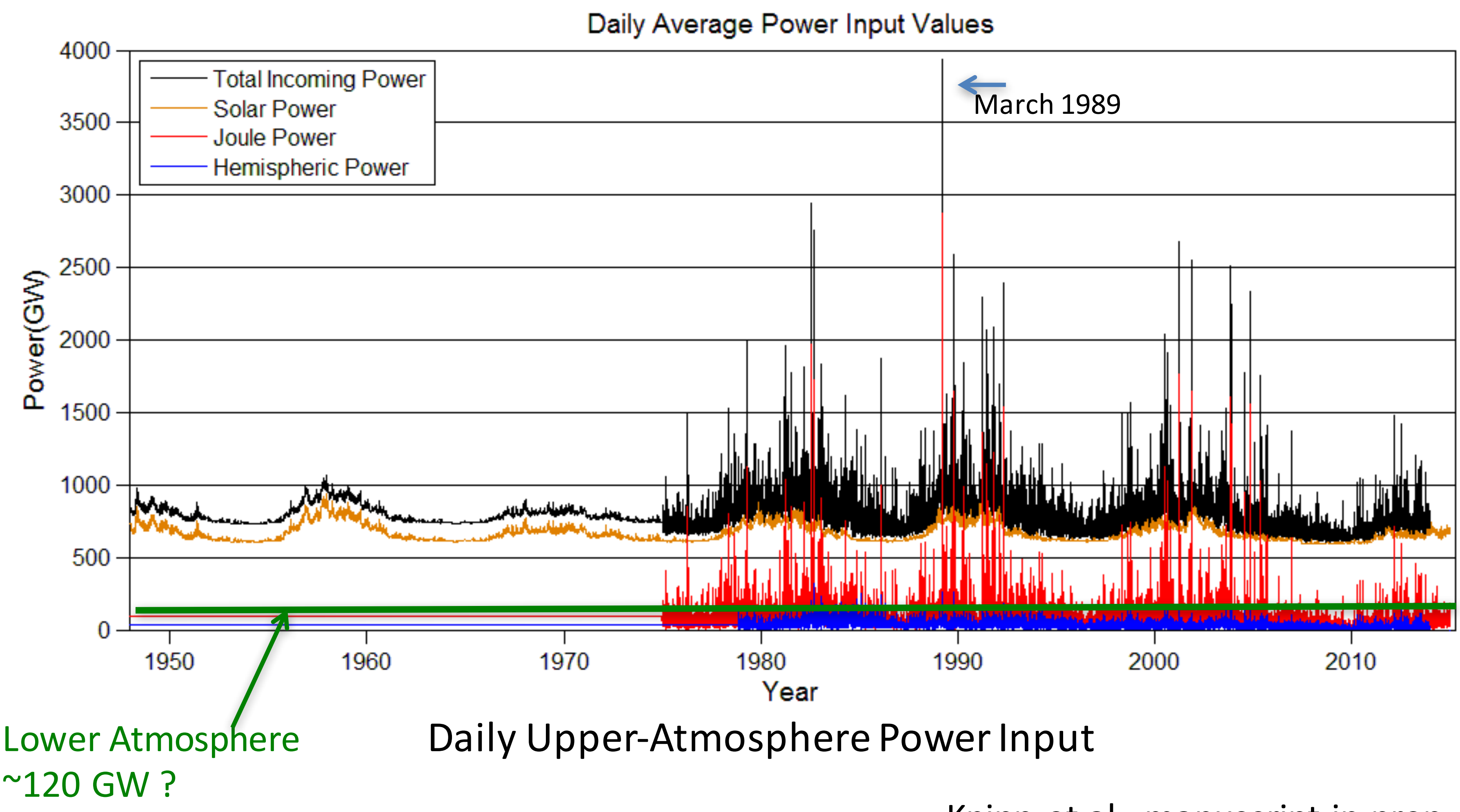
Solar | Magnetosphere

EUV — 671 GW (85%)

Joule heating — 91 GW (11%)

Particle Precipitation — 34 GW (4%)



Daily Upper-Atmosphere Power Input

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Open Issues

- Distribution of Power
  - Latitude and longitude
  - Altitude
- Power from Below
- Heat Conduction Downward
- Non linear effects
  - Particle precipitation modifies how Joule Heating is distributed.
  - Neutral winds

Questions

Backup

Comparison Data

- Previous Joule heat proxy [Knipp et al., 2004]

  Winter (Oct 21 – Feb 20) :

  $$13.36\ |PC| + 5.08\ PC^2 + 0.47\ |DST| + 0.0011\ DST^2$$

  Summer (Apr 21 – Aug 20) :

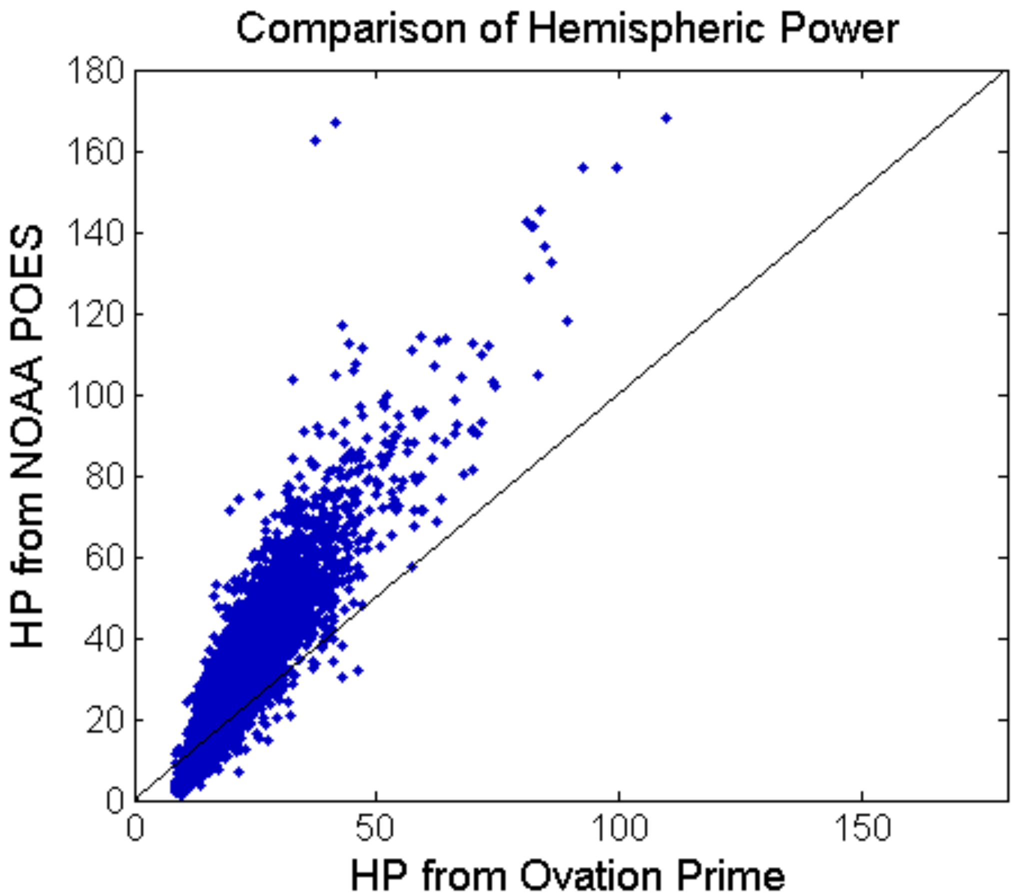
  $$29.27\ |PC| + 8.18\ PC^2 - 0.04\ |DST| + 0.0126\ DST^2$$

  Equinox (Feb 21 – Apr 20, Aug 21 – Oct 20) :

  $$29.14\ |PC| + 2.54\ PC^2 + 0.21\ |DST| + 0.0023\ DST^2$$

- Joule heat model [Weimer, 2005]
- Ovation Prime [Newell et al., 2010]

Comparison of old and new NOAA Hemispheric Power



- Challenges
  - Move away from parameterizations
  - AMIENext
  - HP from conductance re-estimates
  - SDO data