Empirical Modeling and the Need for Accurate Measurements

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Outline

- Empirical Modeling
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  - Solar EUV irradiance models
- Results
  - FISM Fits
  - FISM results
- "Other Measurements"
  - Peterson et al.
  - LWS TR&T
- Conclusions

Empirical Modeling

- Making something out of nothing (well, almost nothing)
  - Use a small set of representative measurements, called 'proxies', to produce an full estimated spectrum.
- Need a base set of accurate measurements and co-temporal proxy measurements
  - Best if taken over the entire range of activity
- Make statistical relationships/fits of proxies to measurements.
  - If proxies are available, then can reproduce the measurements
- "My model is better than the measurements" – unknown

EUV Irradiance Models

- Flare Irradiance Spectral Model (FISM)
  - 0.1-190 nm, 1nm bins, 60 seconds, up to 5 proxies
- HEUVAC
  - 0.1 nm bins, daily, F10.7 and 81-day average F10.7
- NRLEUV
  - 0.1 nm bins, daily, F10.7 and MgII C/W (sometimes images)
- Solar Irradiance Platform (formerly Solar2000)
  - 0.1 nm bins, F10.7 or Lya
- VUV2002
  - 1 nm bins, F10.7, Lya, or Mg II C/W, daily

All use different Solar Minimum Spectra

FISM Main Algorithm

$$E(t_{UTC}) = E_{min} + \Delta E_{SC}(t_d) + \Delta E_{SR}(t_d) + \Delta E_{GP}(t_{UTC}) + \Delta E_{IP}(t_{UTC})$$

E_{min}: Solar minimum reference spectrum, FISMref, (Constant)

Daily Component Variations (Modeled on a daily basis):

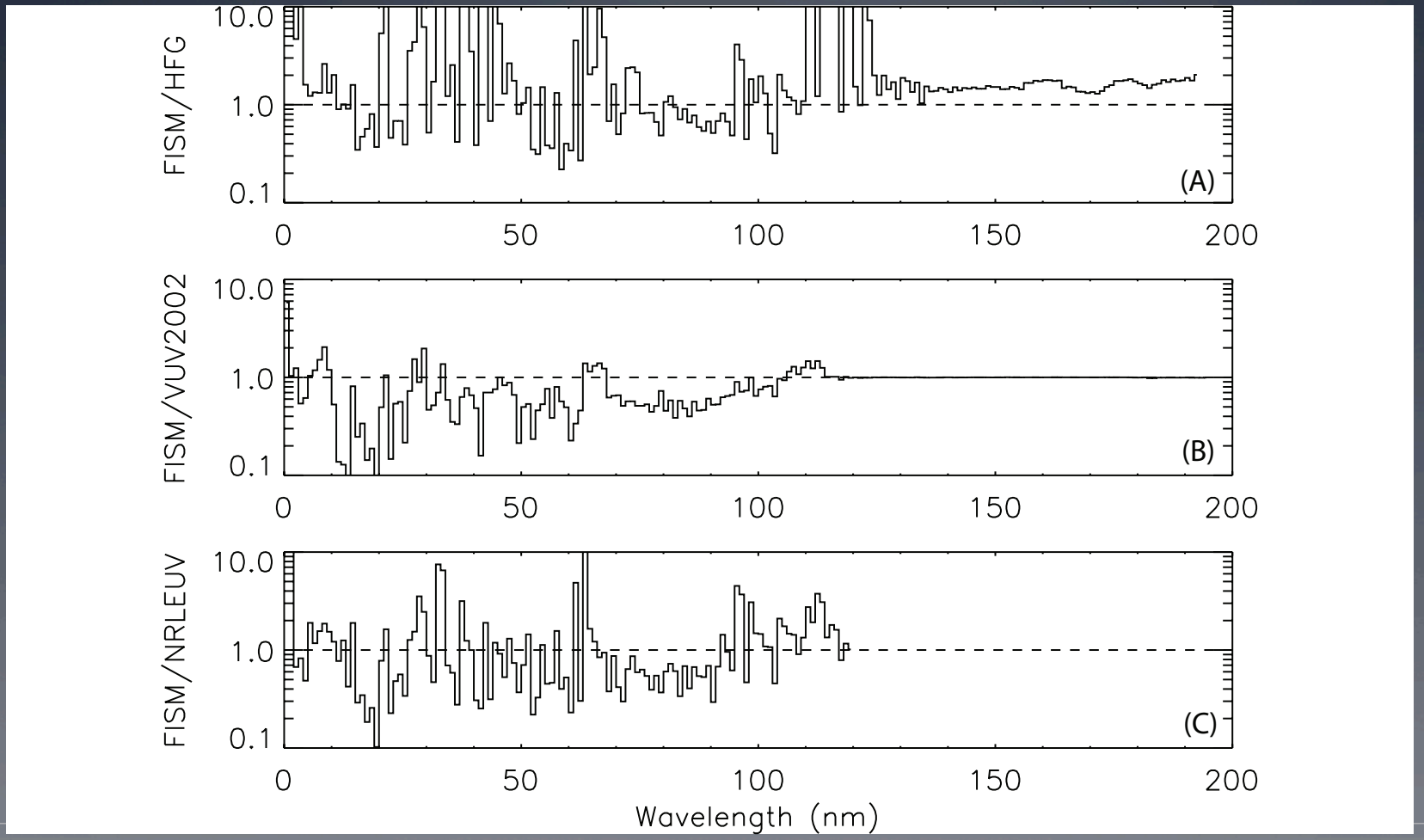
- Solar Cycle (SC) - linear with 108-day smoothed daily proxy
- Solar Rotation (SR) - linear with (daily proxy - SC proxy)

Flare Component Variations (Modeled on a 60 seconds basis):

- Gradual Phase (GP) - Power Law with GOES 0.1-0.8 nm
- Impulsive Phase (IP) - Power Law with d/dt GOES (Neupert Effect)

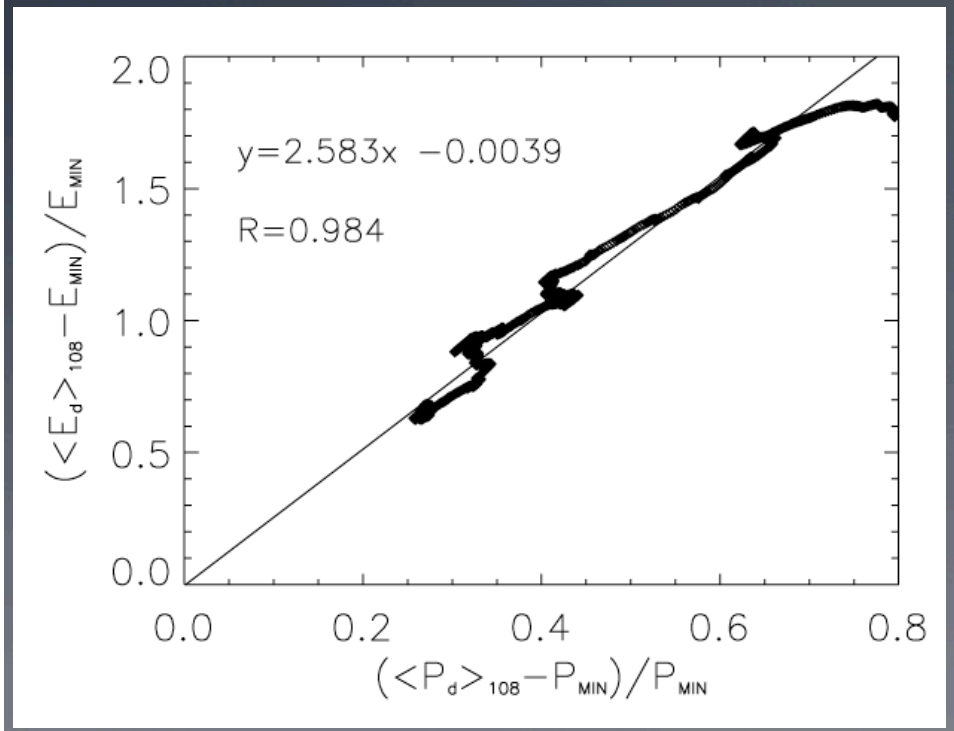
Center-to-Limb variations accounted for by representative proxies in daily component but must be corrected for in flare components

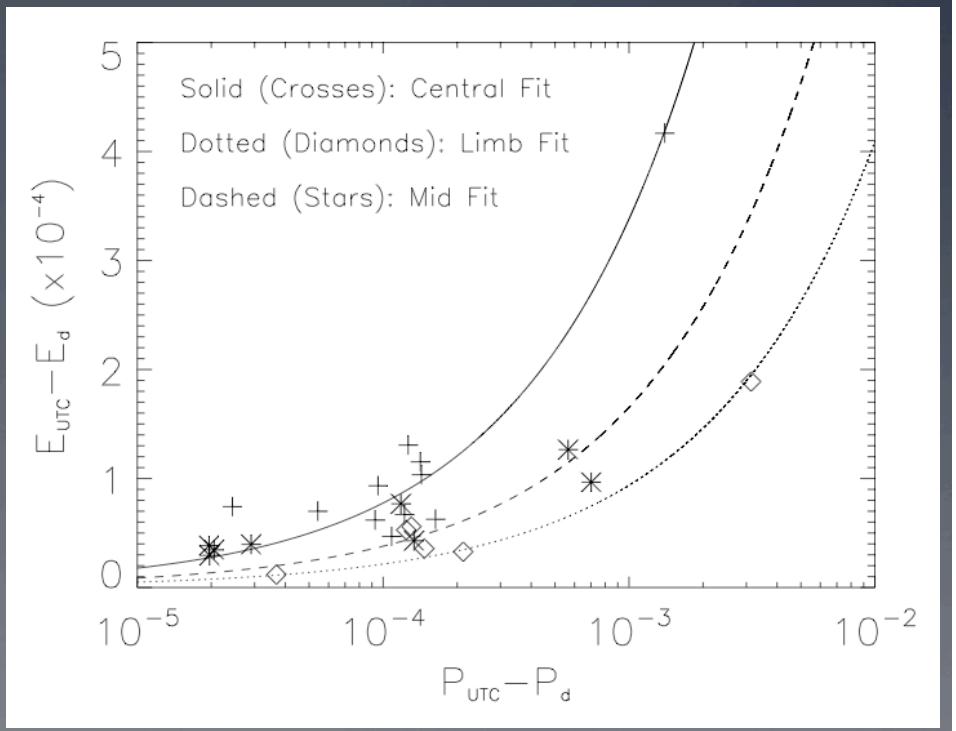
Solar Minimum 'Reference'



Empirical Fit Example

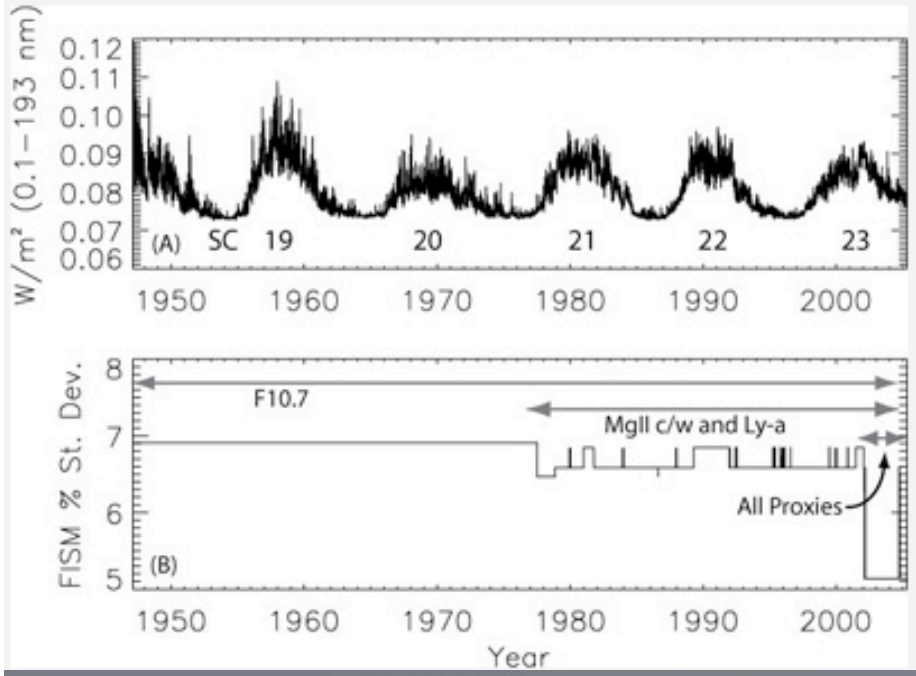
- Daily and Flare 'Modeling' is a relationship between some form of proxy and some form of a measurement

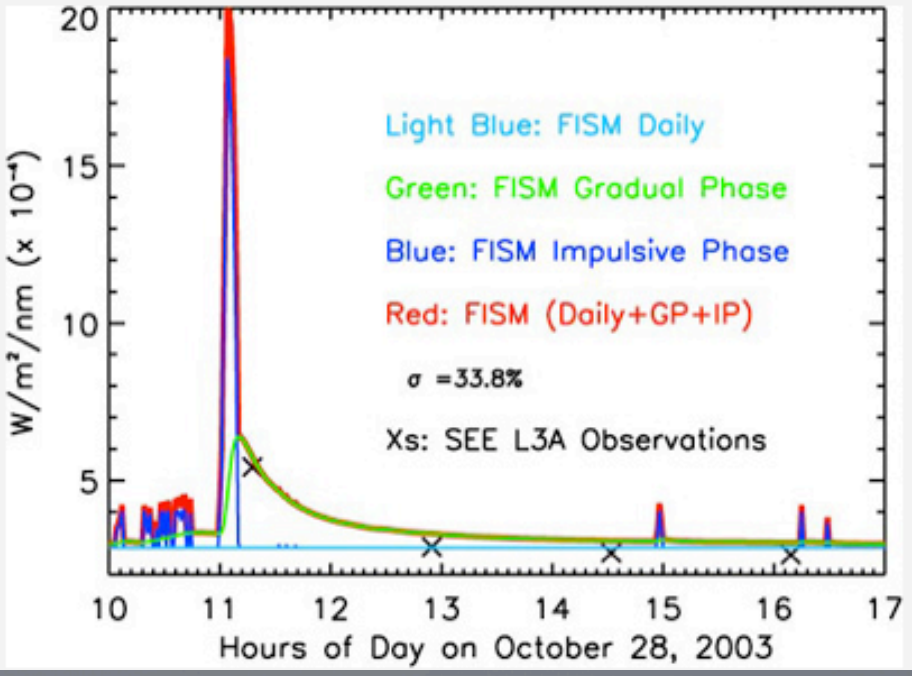




Models Depend on Data

- Empirical models are dependent on both the accuracies of the measurements as well as the precision of the proxies



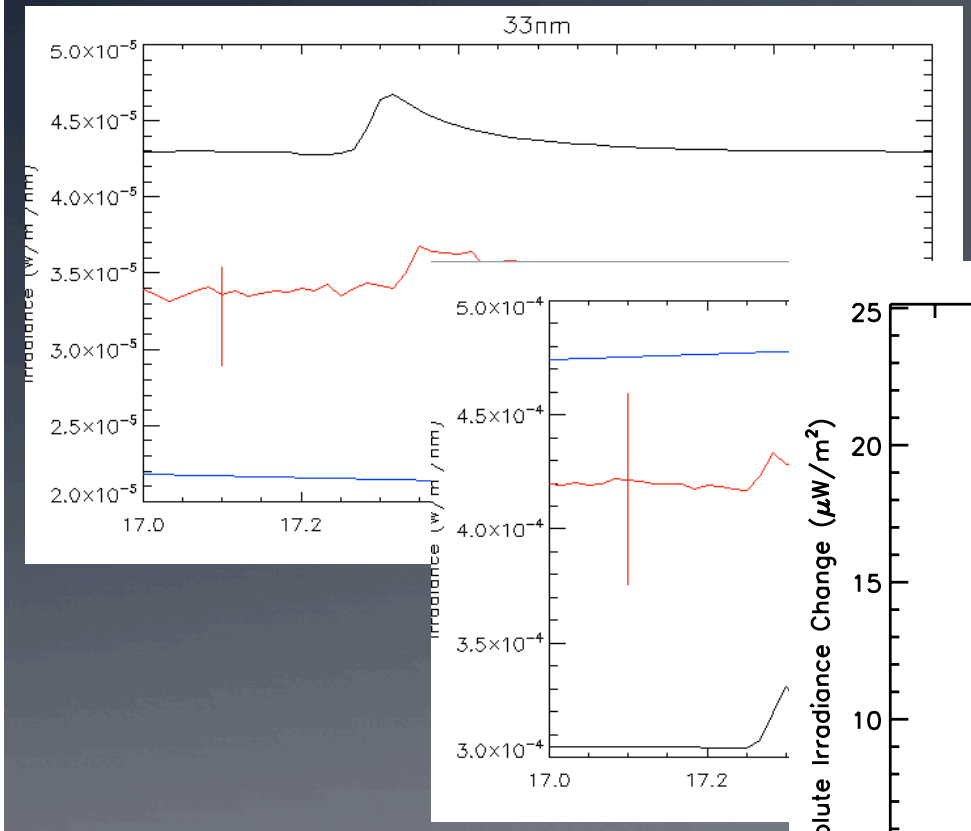


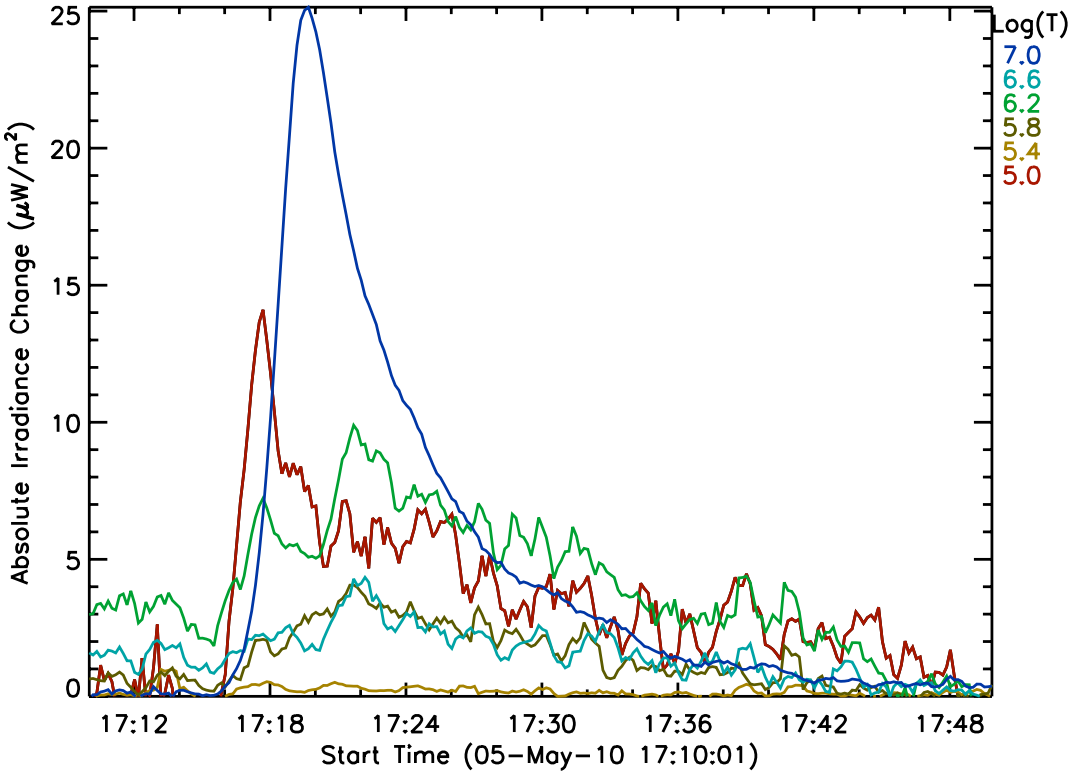
FISM Results

FISM v1 (based on see v10)

ESP (using FISM wv) with +/- 10% error shown

SEE Level 3A version 11

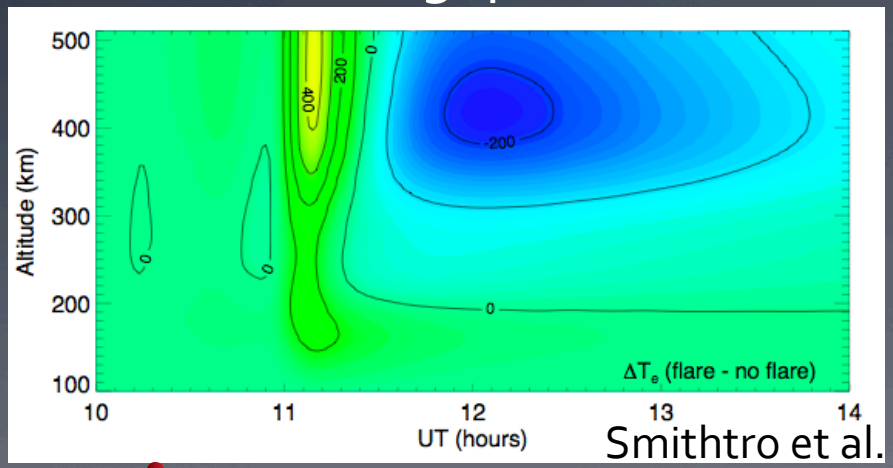




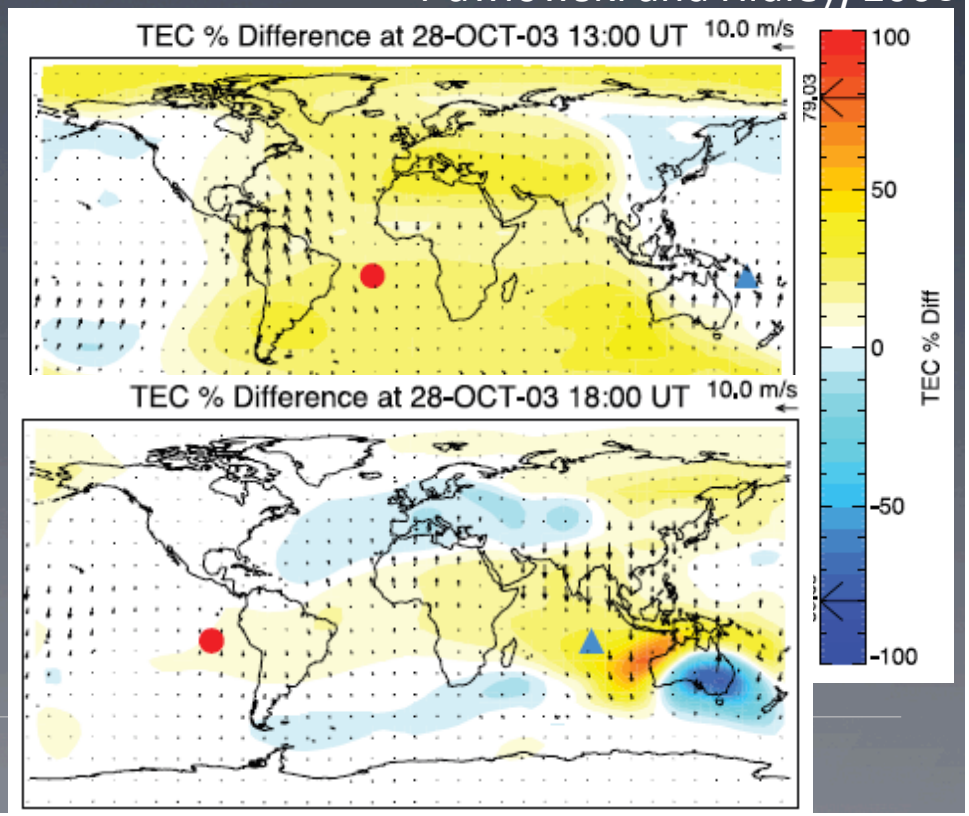
FISM Results

- Fill in 'data' when measurements aren't available
- Extend back (and forward) when needed as well as fill in the data gaps between measurements

Pawlowski and Ridley, 2008



Smithtro et al.

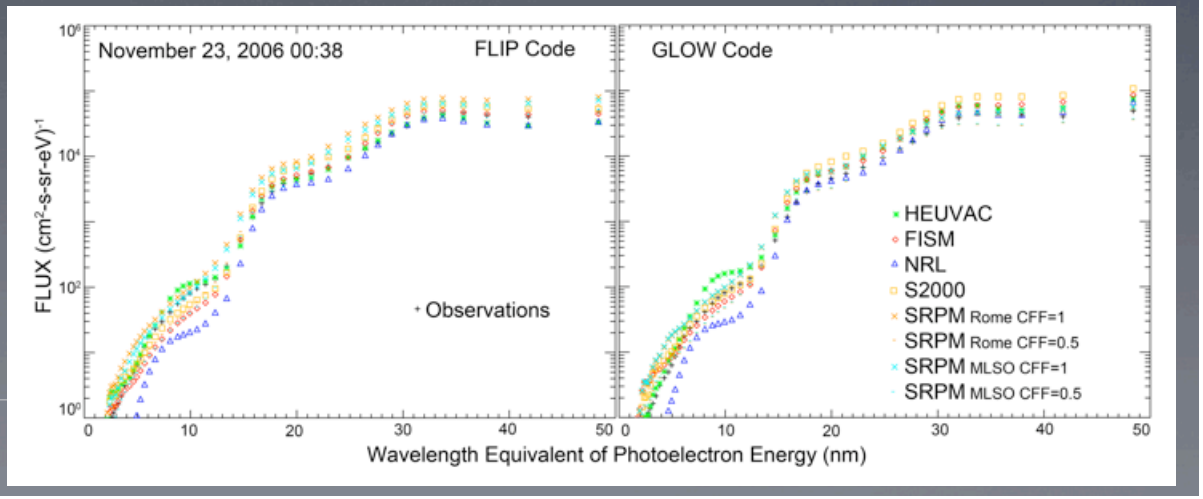


MAVEN

CU/LASP • GSFC • UCB/SSL • LM • JPL

Other Validation

- Peterson et al. papers using multiple solar irradiance models and measurements in multiple ionospheric models to compare photoelectron production to FAST.
- LWS TR&T Focus Science Topic: Use FISM and EVE as input to multiple I/T models to compare solar min, solar max, and flare to each other as well as to measurements (e.g. ionosonds, TEC)



Conclusions

- Models are nice, but are only as good as the data
  - Please use data when available!
  - Will be new versions when new data (e.g. SDO/EVE) becomes available
- Wide range of uses from science to instrument design
- Rely on precise proxies in the past and future
  - Also need in respective temporal resolution
  - GOES XRS/EUV are great!
- A lot of work to do to update models with new measurements and proxies – this workshop is critical.