Physikalisch-Meteorologisches Observatorium Davos
World Radiation Center

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Solar-C Science Definition Meeting
ISAS/JAXA, November 18-21, 2008
Sagamihara

# Solar Irradiance Observations

- for Solar-C Plan-A
- for Solar-C Plan B

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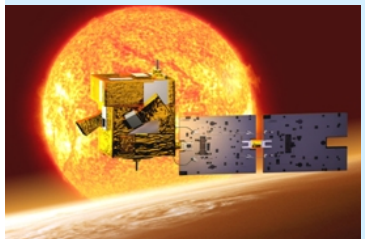

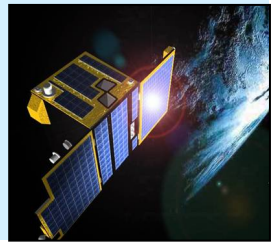

# Overview

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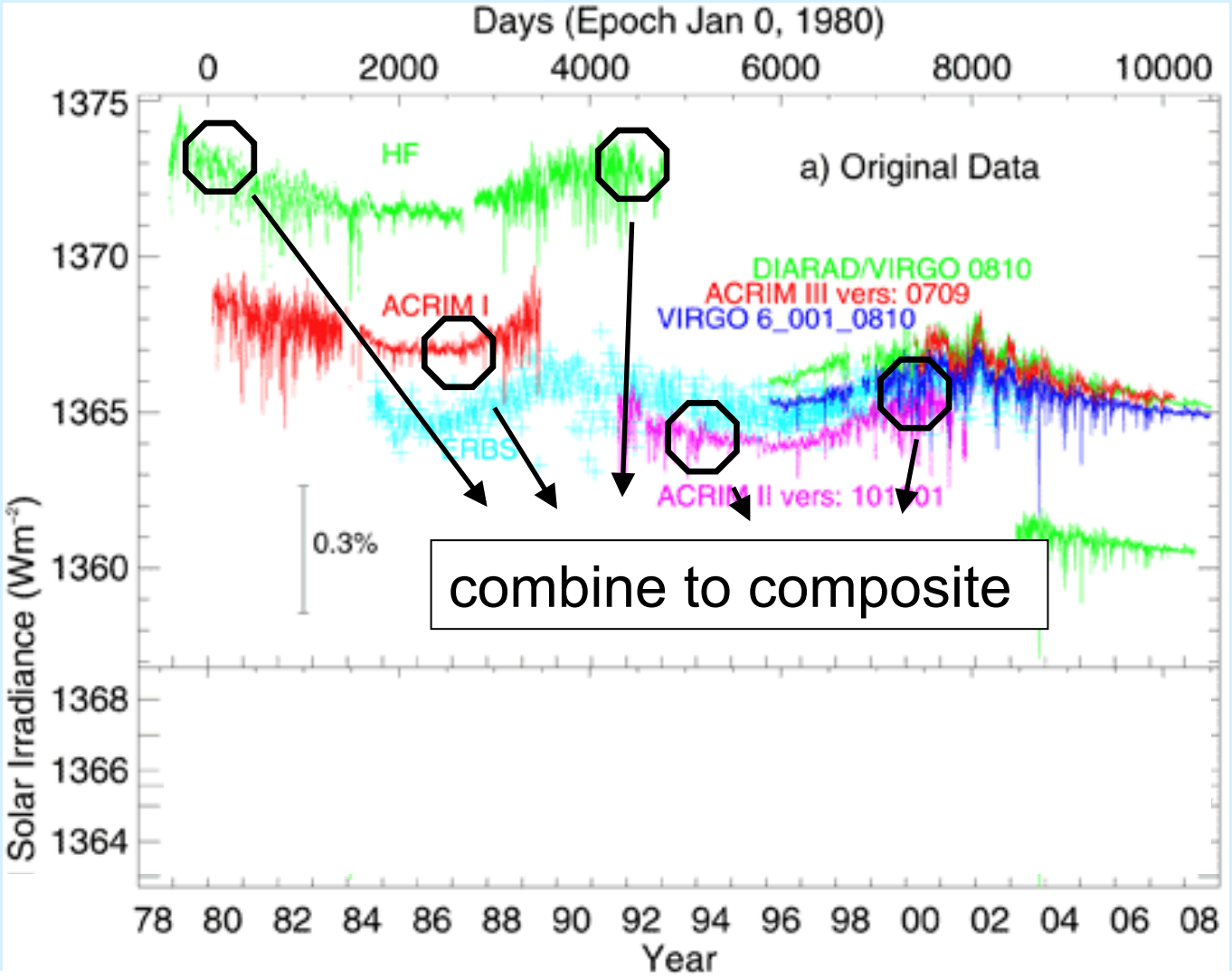
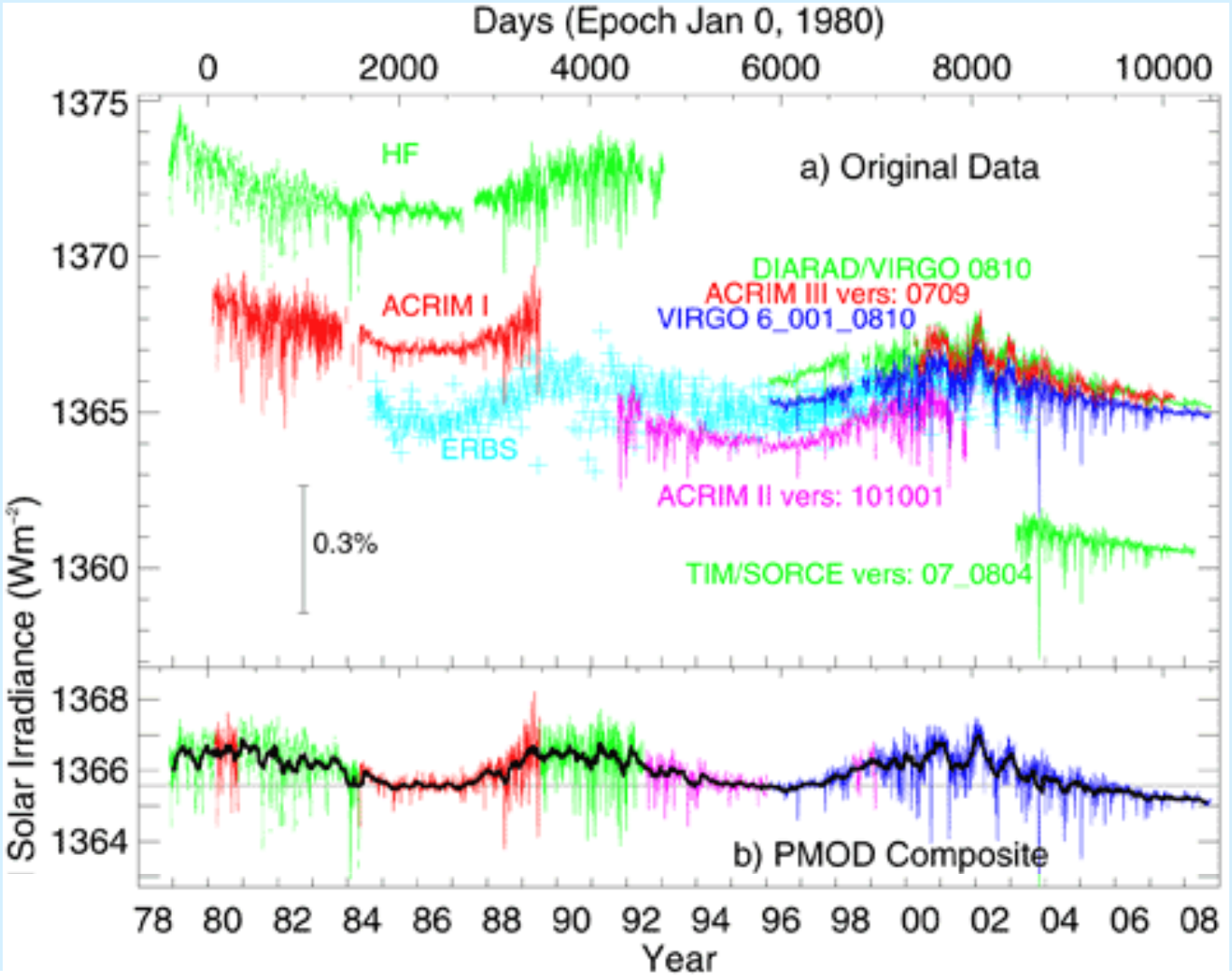
## Solar Irradiance Observations

- Solar-C Plan B
  (can also be done with Plan B but out of ecliptic is not needed)
  → *Sun-Earth connection*
  - Long term TSI: *Space Climate*
    (High-time resolution: *Helioseismology)*
- Solar-C Plan A → *New Solar Physics*
  (can NOT be done with Plan B, out of ecliptic is needed)
  - Latitude dependence of the irradiance
    (Sun as a star)

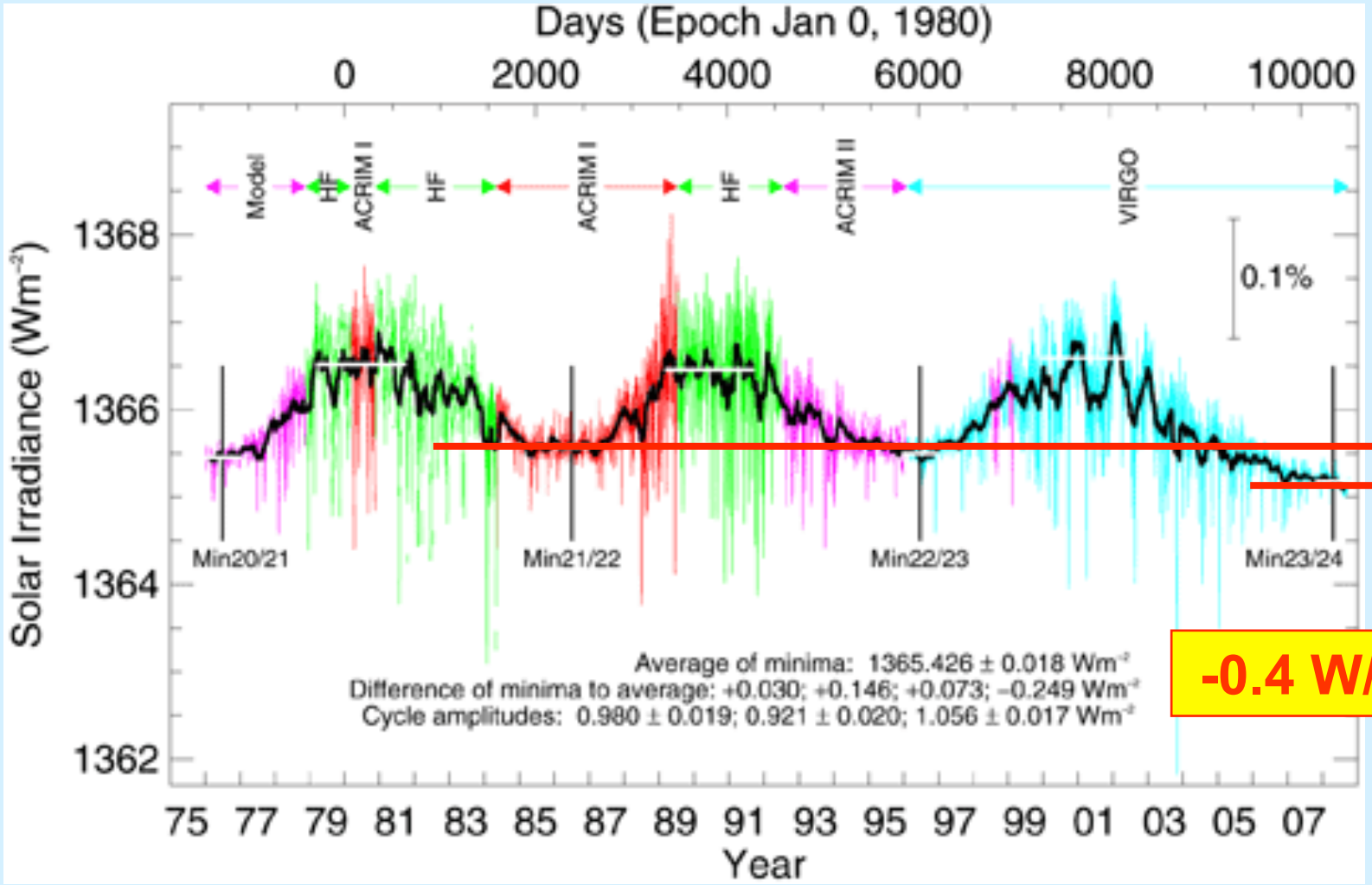
# Observed TSI



# Observed TSI

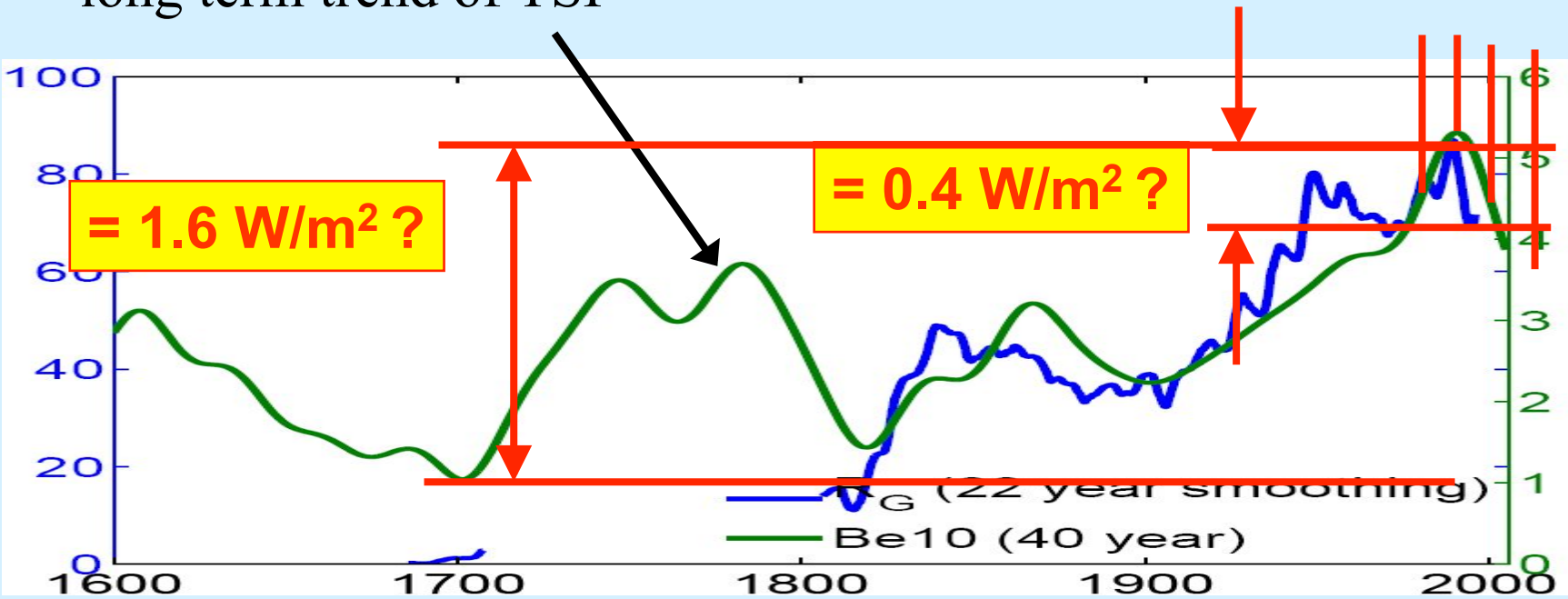


# TSI composite



# Long term trend

$^{10}$Be → open magnetic flux → proxy for the long term trend of TSI



# Conclusion: Plan B

- If we want to know how the irradiance influences the terrestrial climate then we have to continue measuring the Total Solar Irradiance

  → until the next minimum

# Solar-C Plan A

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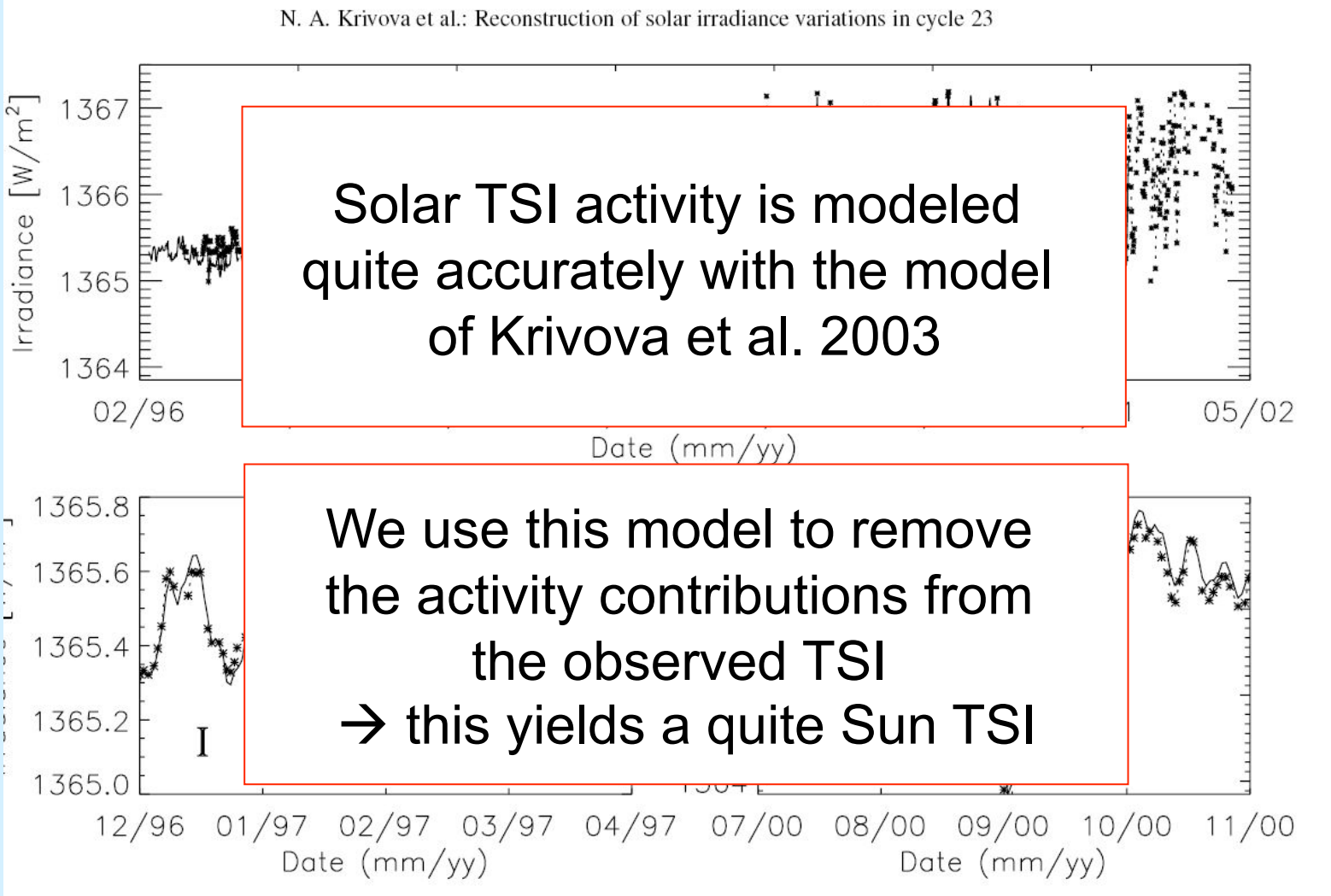
## Plan A: Solar-C out of the ecliptic

- What do we know about the latitude dependence of the irradiance?
  - Very little and very uncertain. Most recent paper:

    Rast et al. 2008 (based on PSPT) : *"We have found a weak enhancement of the mean continuum intensity at polar latitudes (continuum intensity enhancement 0.1%-0.2%, corresponding to a brightness temperature enhancement of 2.5 K)"*
  - Intensity at different view angle is NOT latitudional radiance variation!

    Rast et al. investigated the equator to pole difference of the limb darkening function, which reflects essentially the solar structure in height.
  - We have one more piece of evidence ….

# Model of TSI

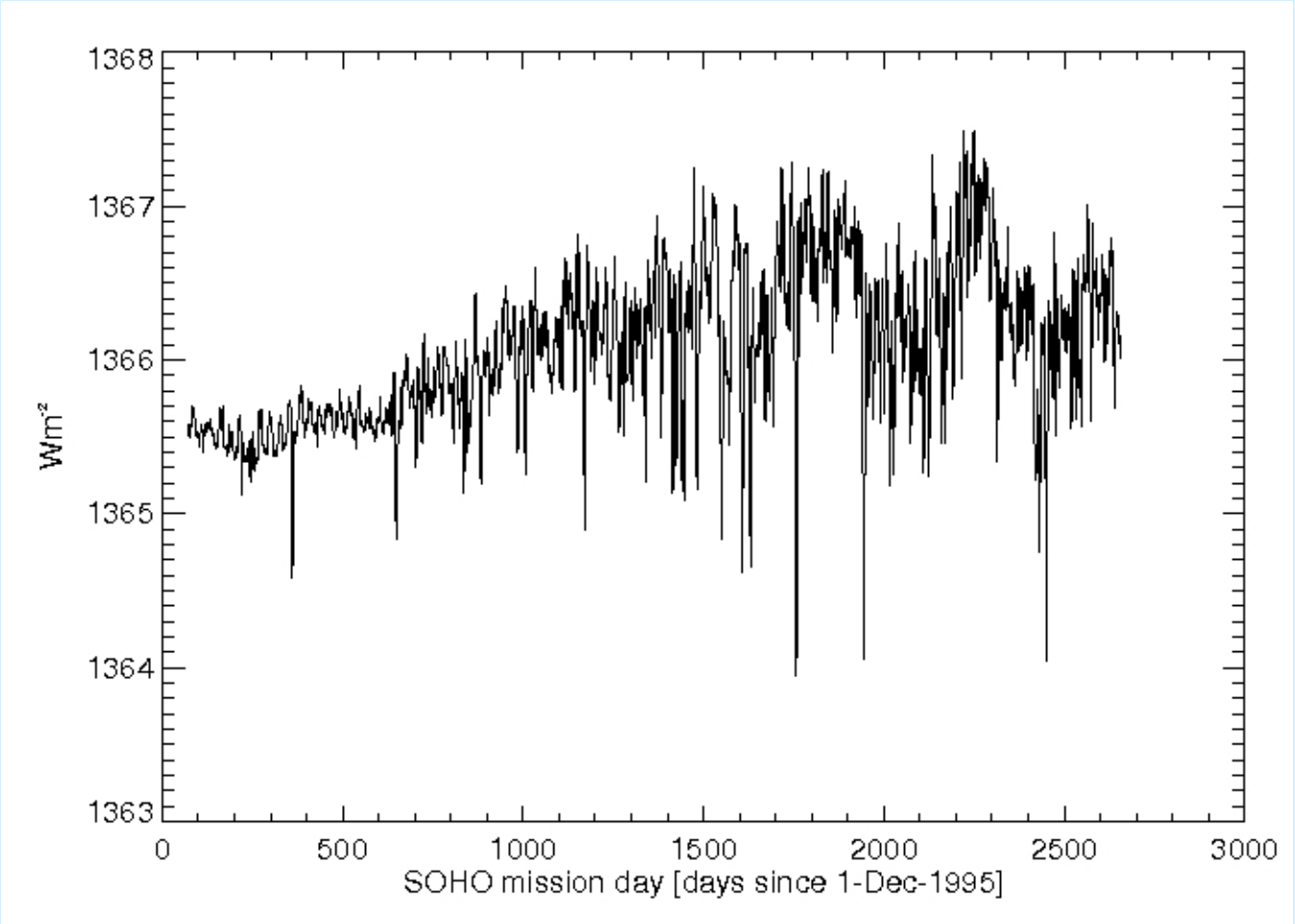



Solar TSI activity is modeled quite accurately with the model of Krivova et al. 2003

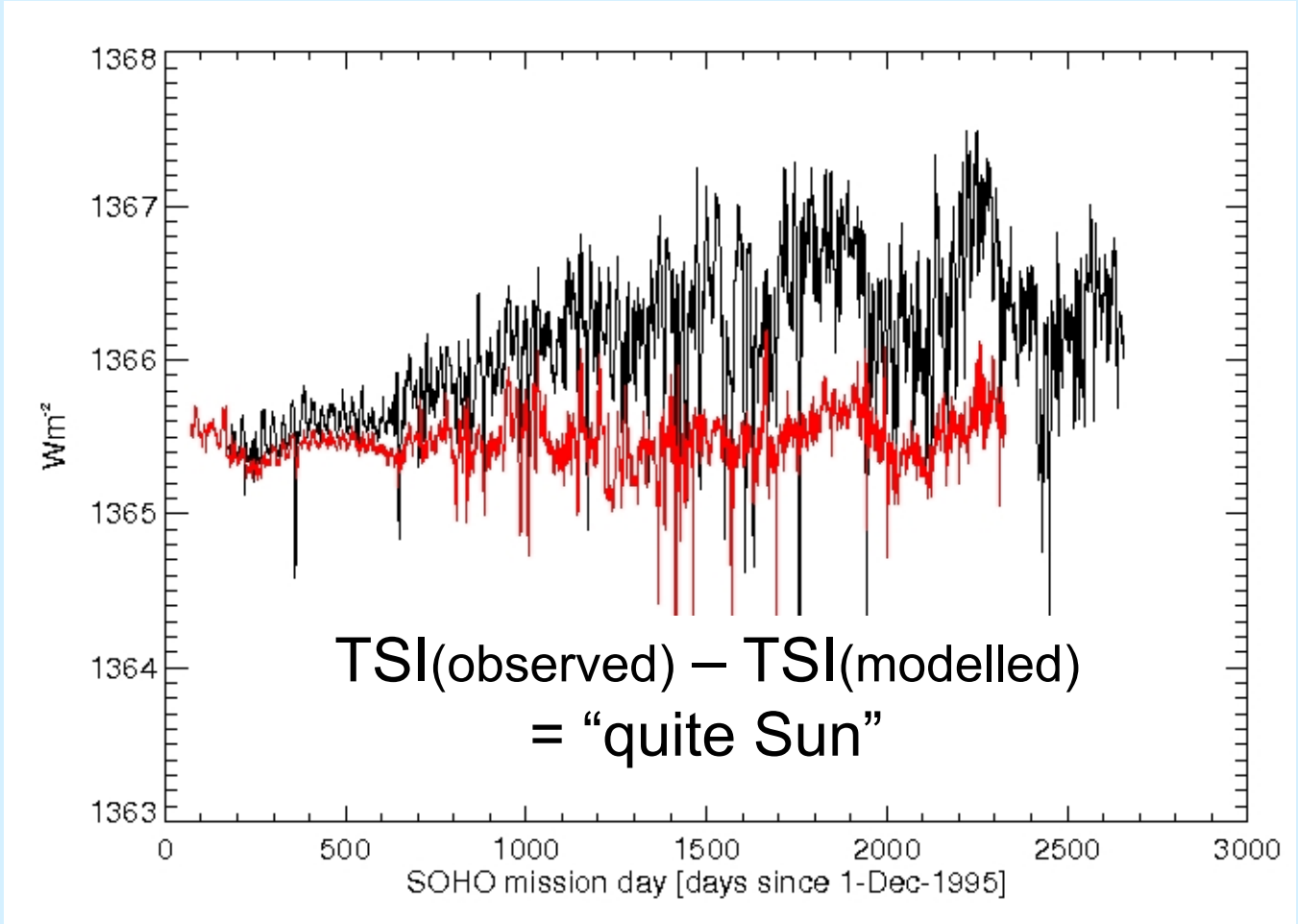
We use this model to remove the activity contributions from the observed TSI
→ this yields a quite Sun TSI

Krivova et al. 2003, A&A 399 L1

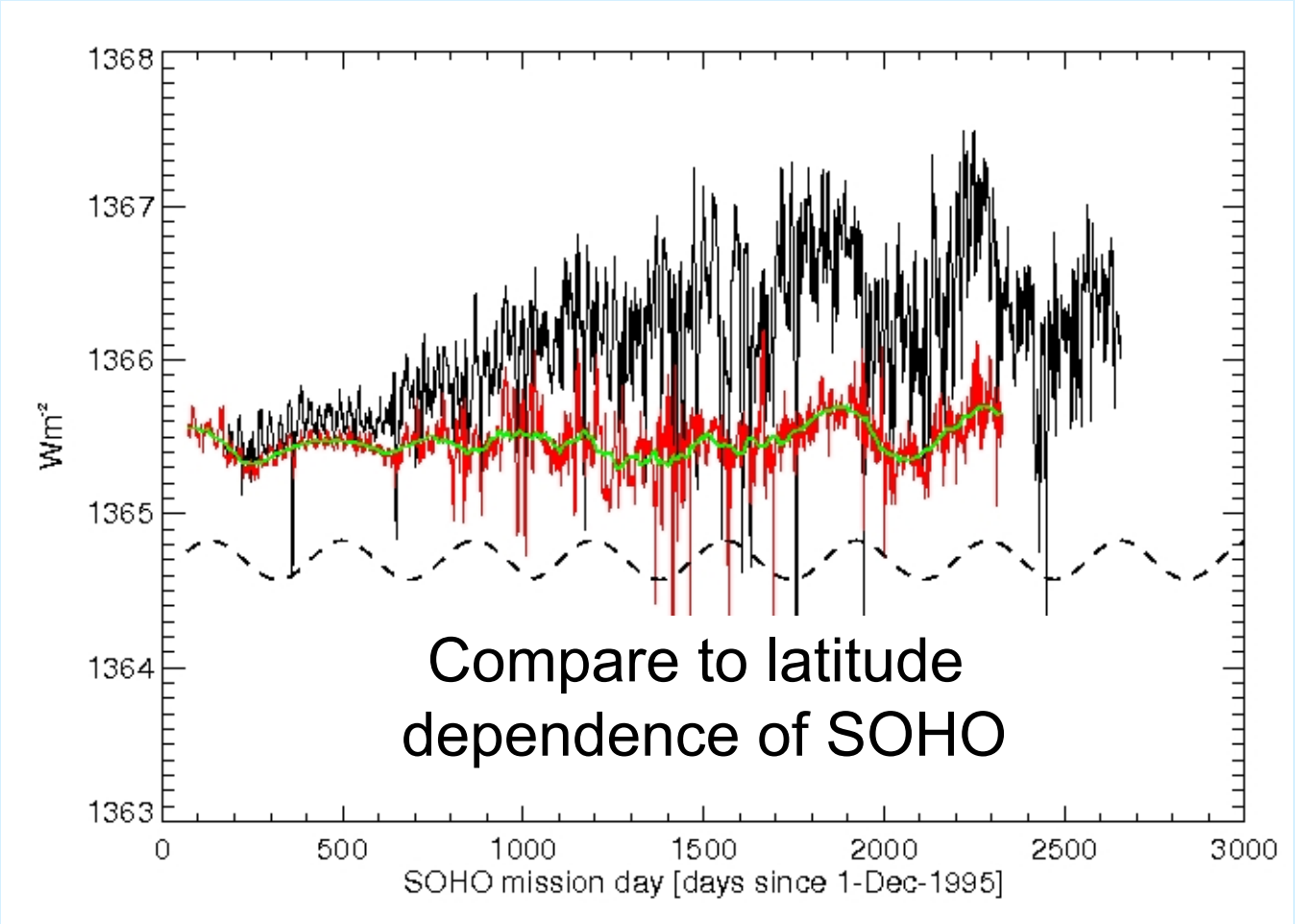
# TSI: Time dependence



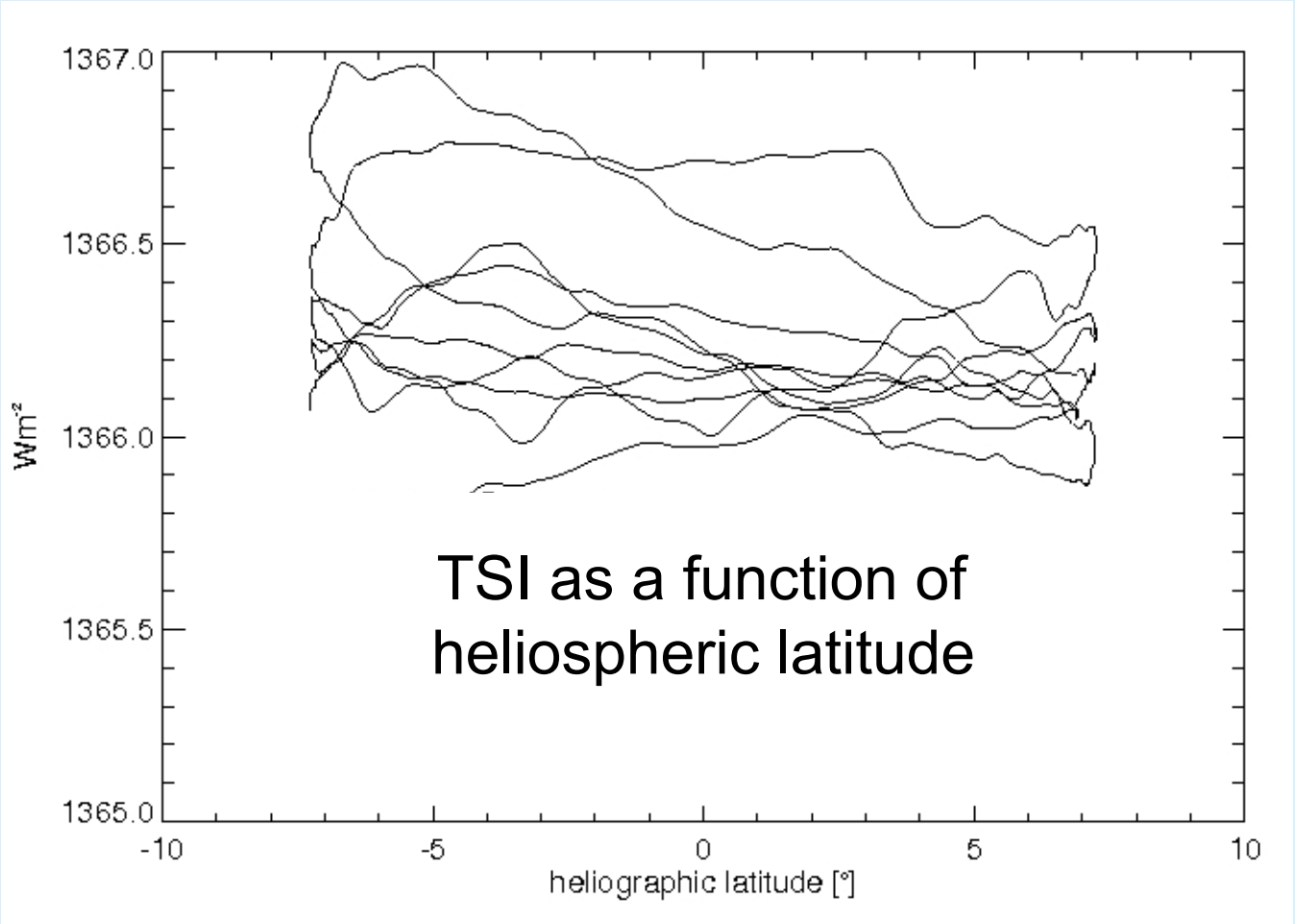
# TSI: Time dependence



# TSI: Time-latitude dependence

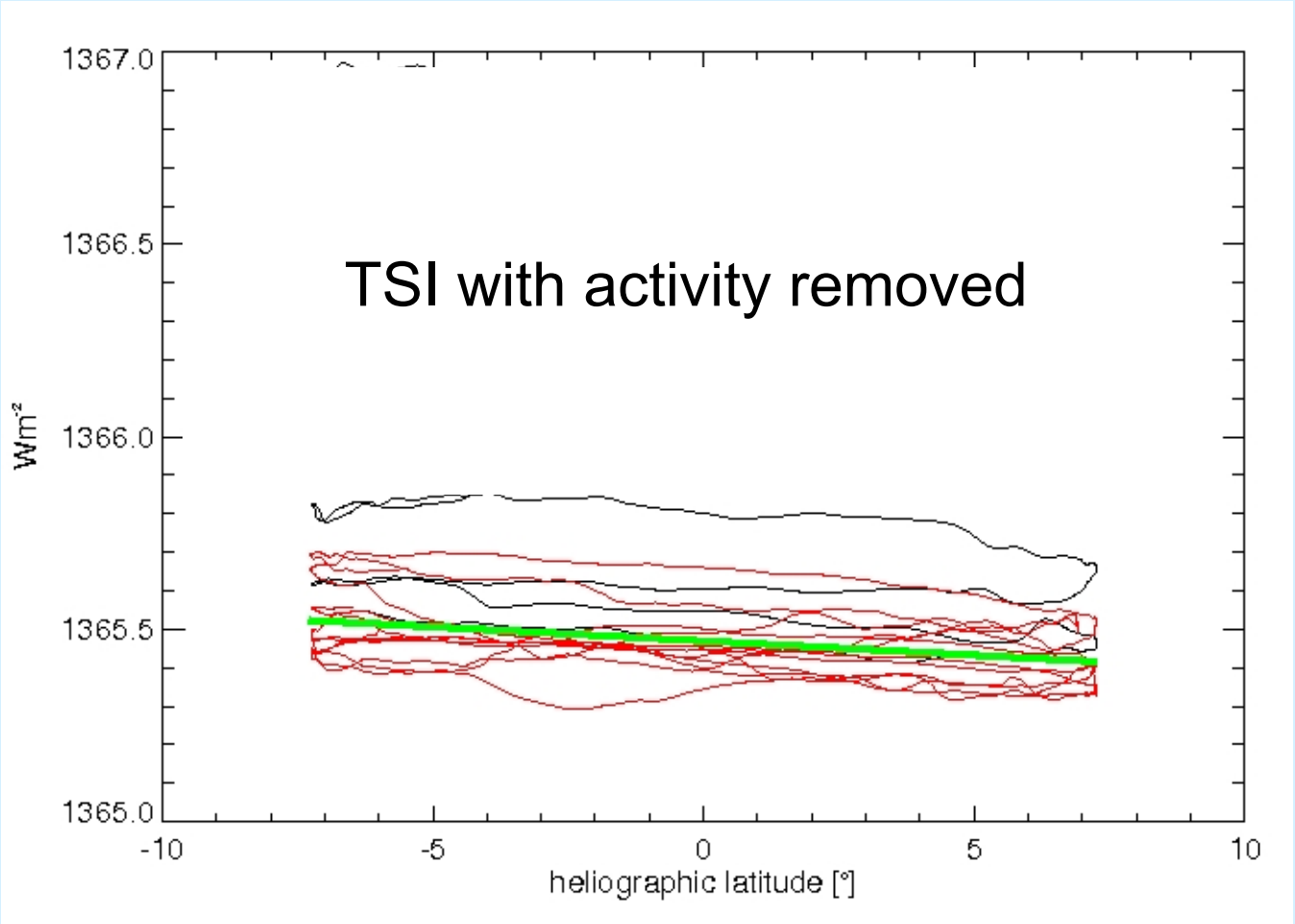


# TSI: Latitude dependence




TSI as a function of heliospheric latitude

# TSI: Latitude dependence



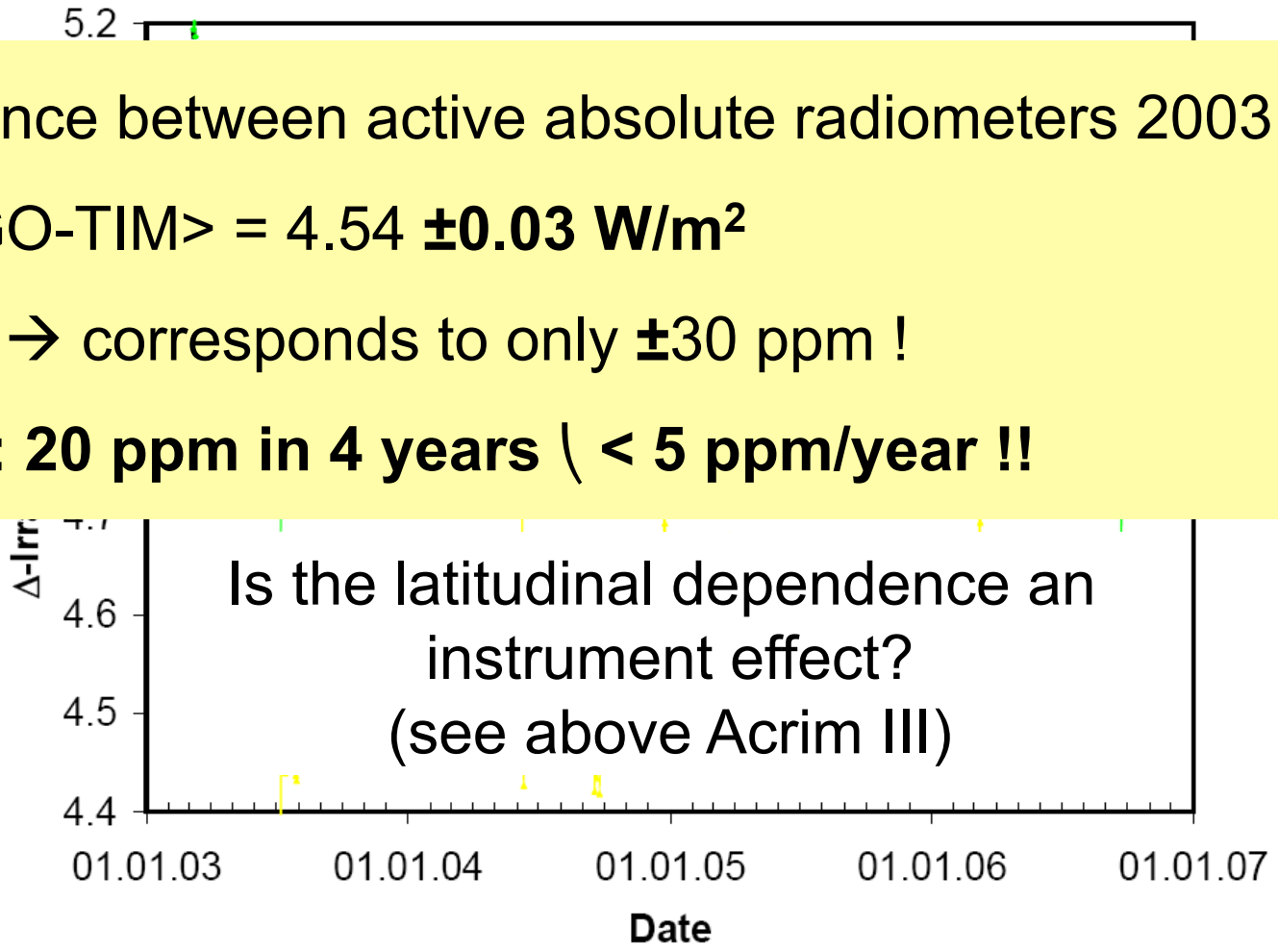
# Empirical TSI accuracy

Difference between active absolute radiometers 2003 – 2006

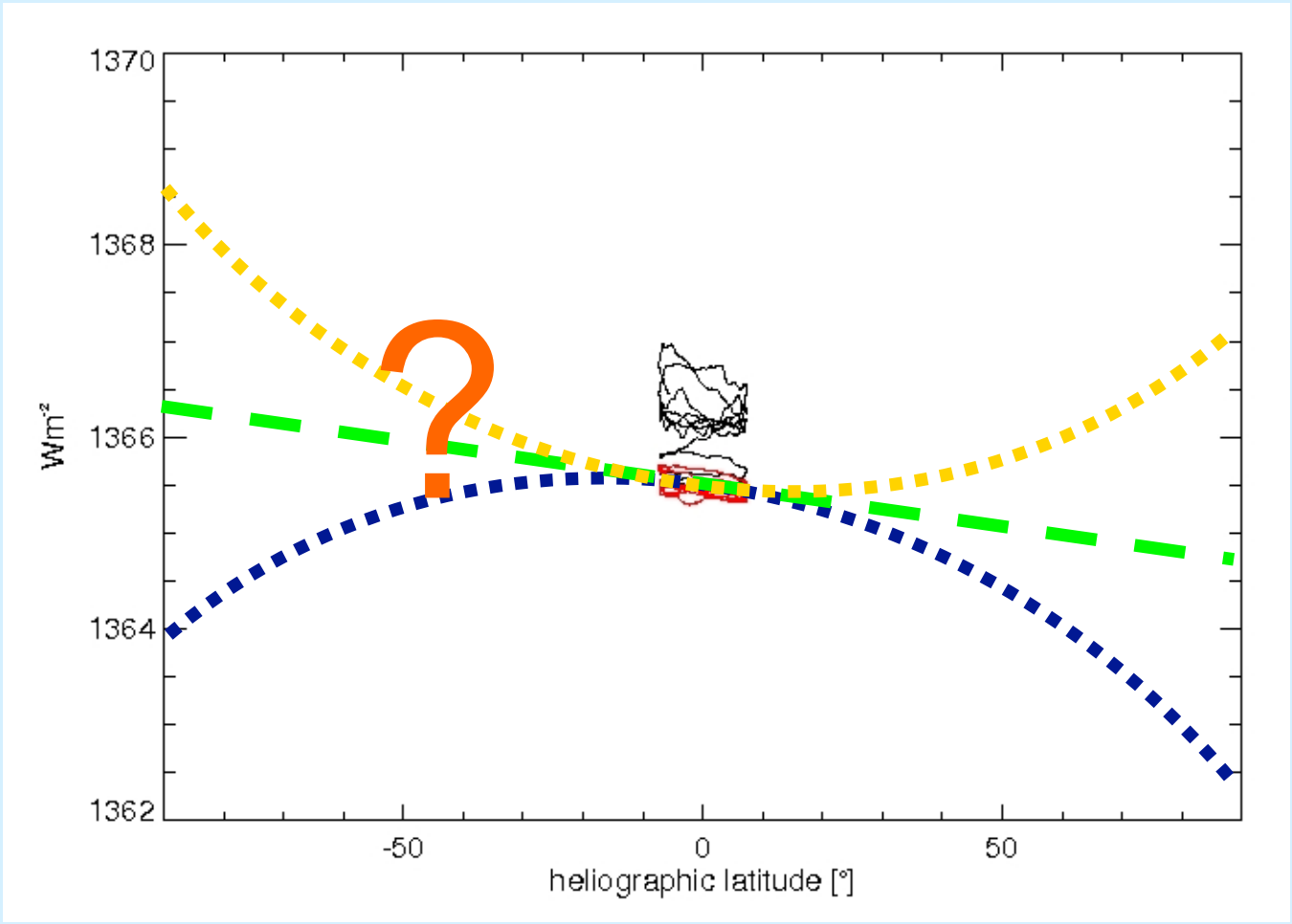
<VIRGO-TIM> = 4.54 **±0.03 W/m²**

→ corresponds to only **±**30 ppm !

**Trend: 20 ppm in 4 years \ < 5 ppm/year !!**



# What do we expect?



# Hardware option 1

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As: PREMOS/PICARD
launch June 2009

TSI radiometer
+ 6 (x 2) (UV) filter channels
(replaces a full Sun spectrograph)

Advantage:
high speed sampling
TSI: 0.1 Hz
filter channels 30 Hz

- MASS: 11 kg
- Overall Dimensions:
  270 x 327 x 160 mm
- Power Requirement
  13 W nominal

# Hardware option 2

As: DARA/PROBA3
(phase A study)

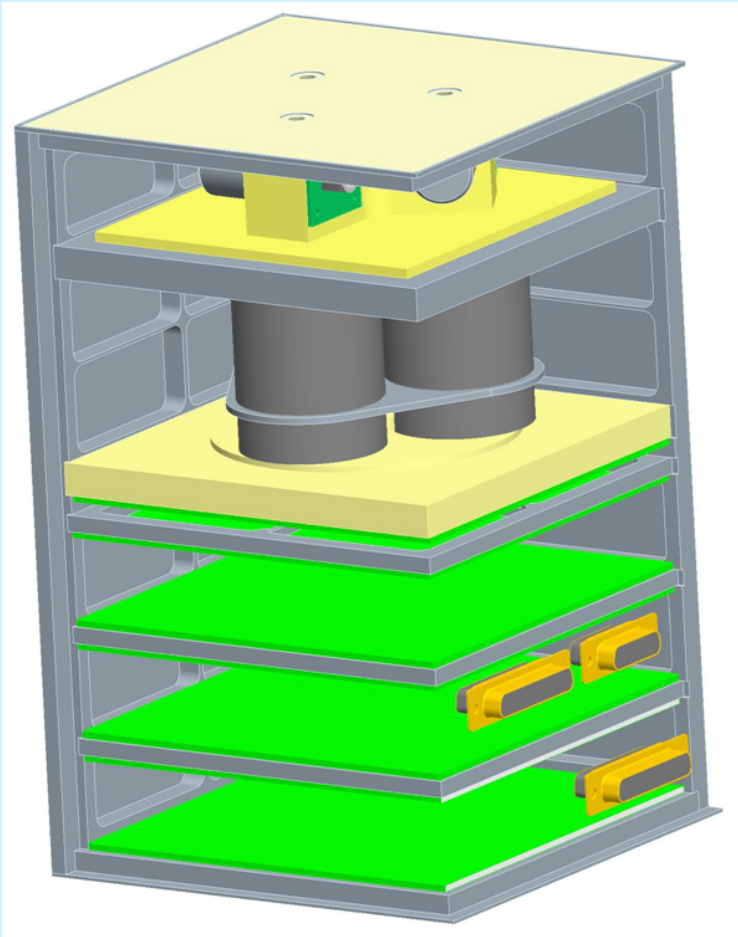
TSI 3-channel radiometer

Advantage:
- long-term stability
- high speed sampling: 0.1 Hz

- MASS: 4 kg

- Overall Dimensions:
  156 mm x 182 mm x 228 mm

- Power Requirement
  3.5 W nominal



# Conclusions

Solar-C Plan A:

Total Irradiance Radiometer (4 kg):

- Latitude dependence of irradiance ***(Now unknown!)***
  → boundary condition to meridional circulation
  → true luminosity of the Sun

# Conclusions

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Solar-C Plan A:

Total Irradiance Radiometer (4 kg):

- Latitude dependence of irradiance ***(Now unknown!)***

  → boundary condition to meridional circulation

  → true luminosity of the Sun

Solar C Pan B:

Total Irradiance Radiometer (4 kg)

- High temporal resolution (full Sun)

option (+7 kg): 6-channel filter radiometer

→ allows FUV + UV spectral reconstruction (10 to 300 nm)