Improved Long-Term Spectral Irradiance Record from *Aura/OMI*

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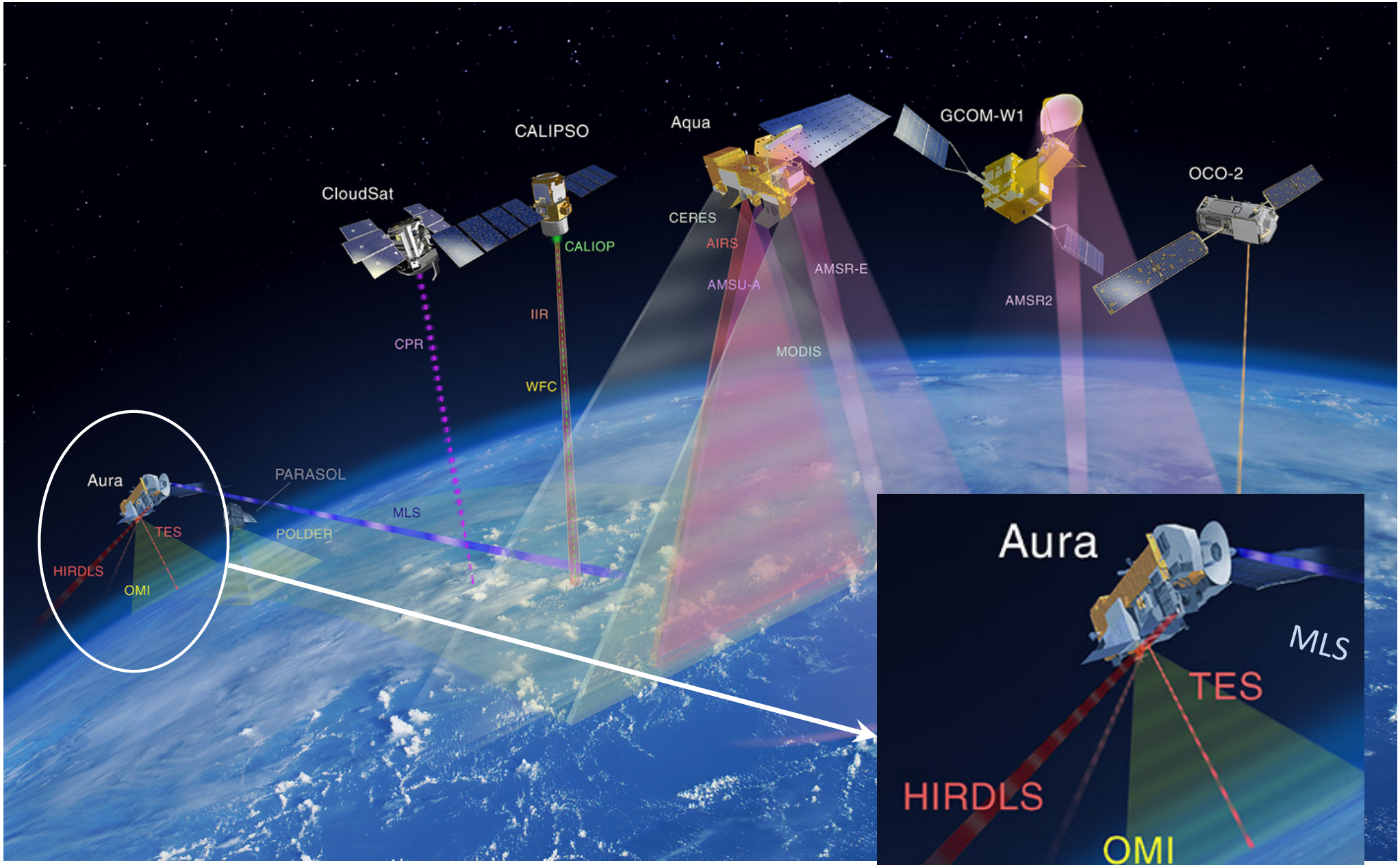


Aura, as part of the *"A-train"* constellation:

- launched July 15, 2004;
- lagging *Aqua* by 8-15 min;
- alt.=705 km sun-synchronous orbit, ~13:40 LST equator-crossing time

Ozone Monitoring Instrument (*OMI*)

- Main goal: atmospheric trace gases (O_3, SO_2, NO_2, etc.).

- Nadir-viewing, 'pushbroom' single monochromator with 2-D CCD detectors:
  - 264-504 nm spectral range (2 UV and 1 Vis channel);
  - 0.4-0.6 nm spectral resolution;
  - 30-60 simultaneous x-track FOVs.

- Once/day solar spectral irradiance (SSI) measurements.

- **Very stable instrument; over the mission lifetime (2004-present):**
  - **~ 4-10 % change in the optical throughput;**
  - **< 0.02 nm change in the wavelength registration.**

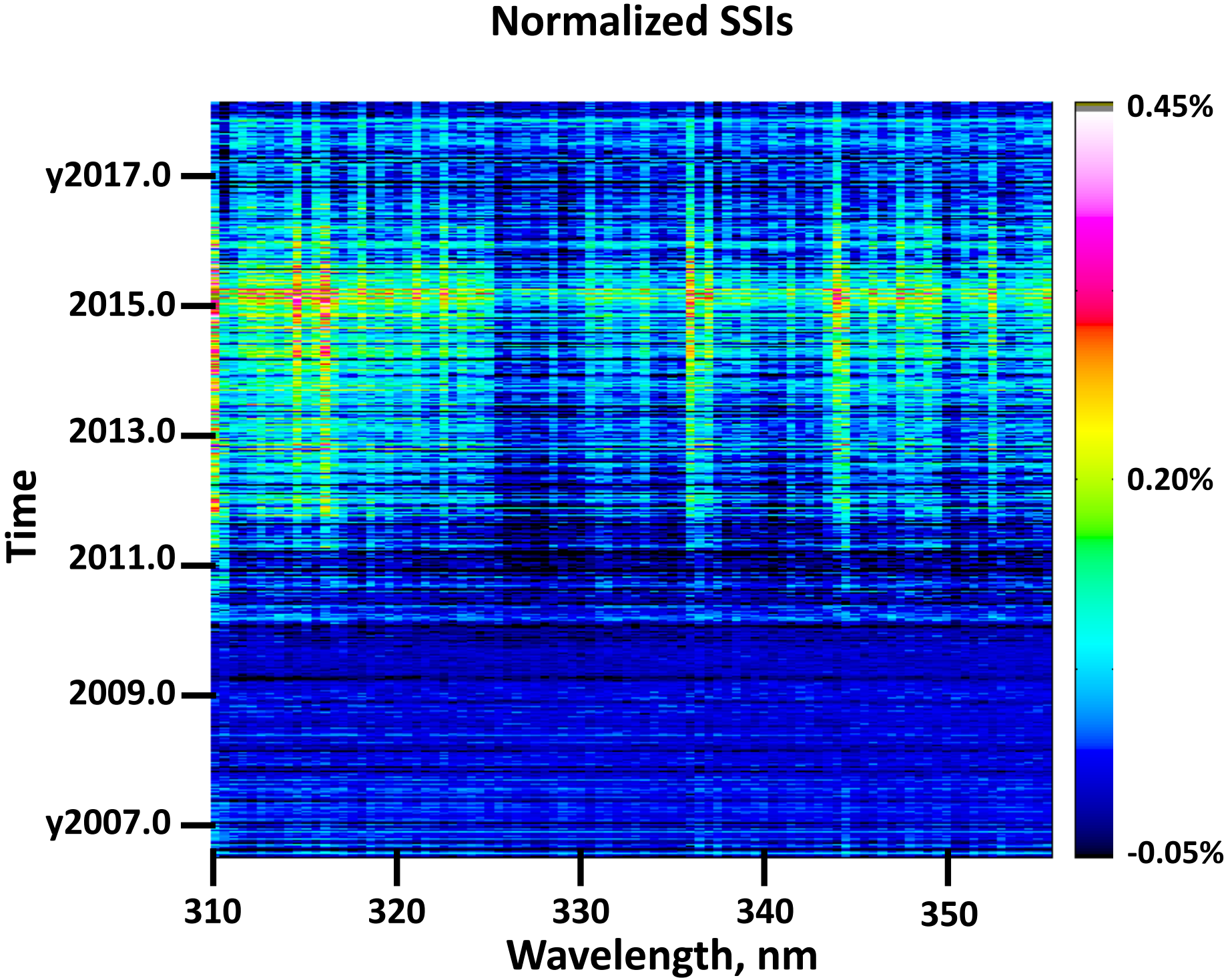
Upgrade of the OMI degradation model*; attempting to achieve <0.1% long-term (Solar cycle) SSI accuracy:

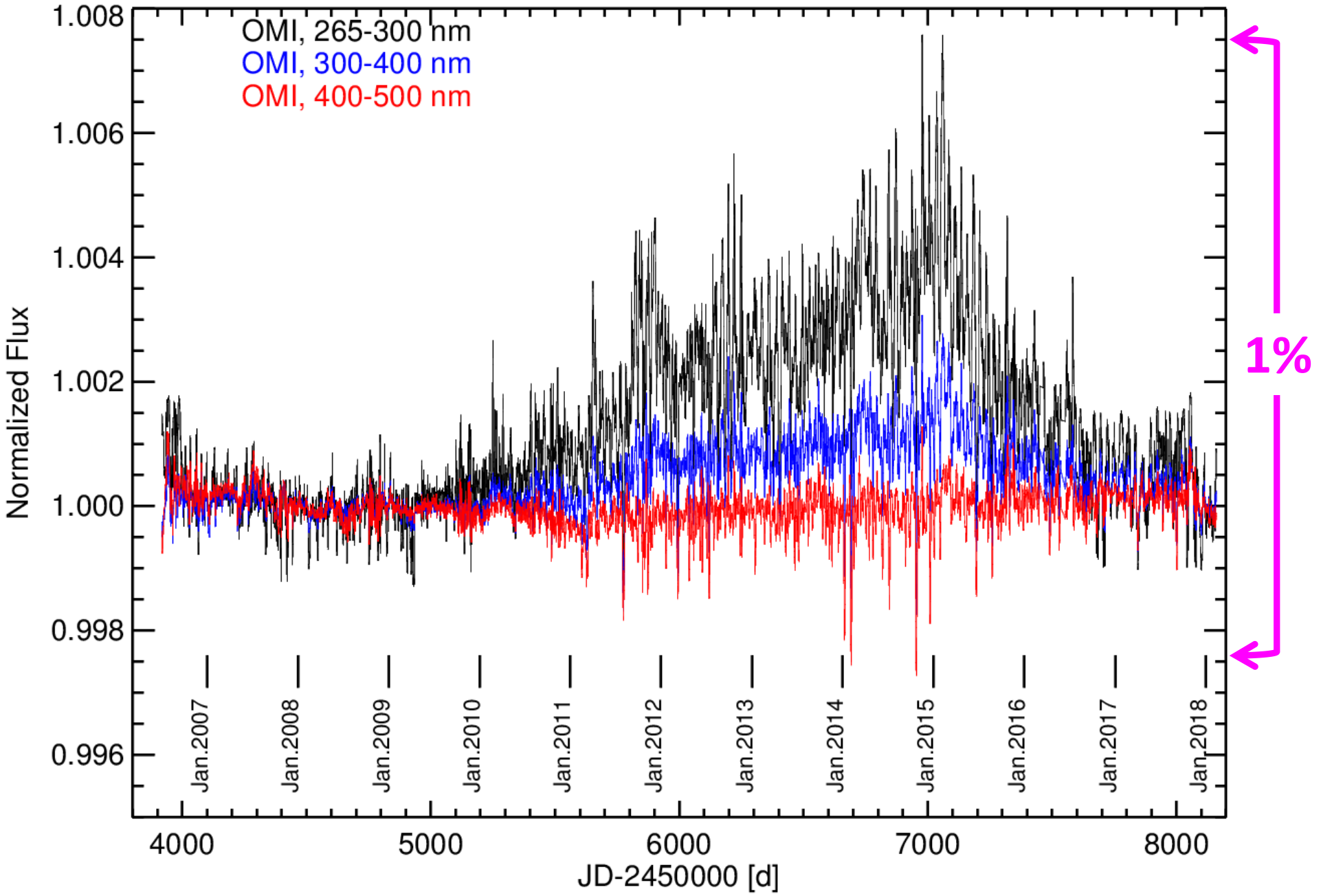
- Involving all available on-board calibration sources (two backup solar diffusors; weekly and monthly cadences)
- Better accounting for the goniometry-related changes
- Approximating the optical degradation by

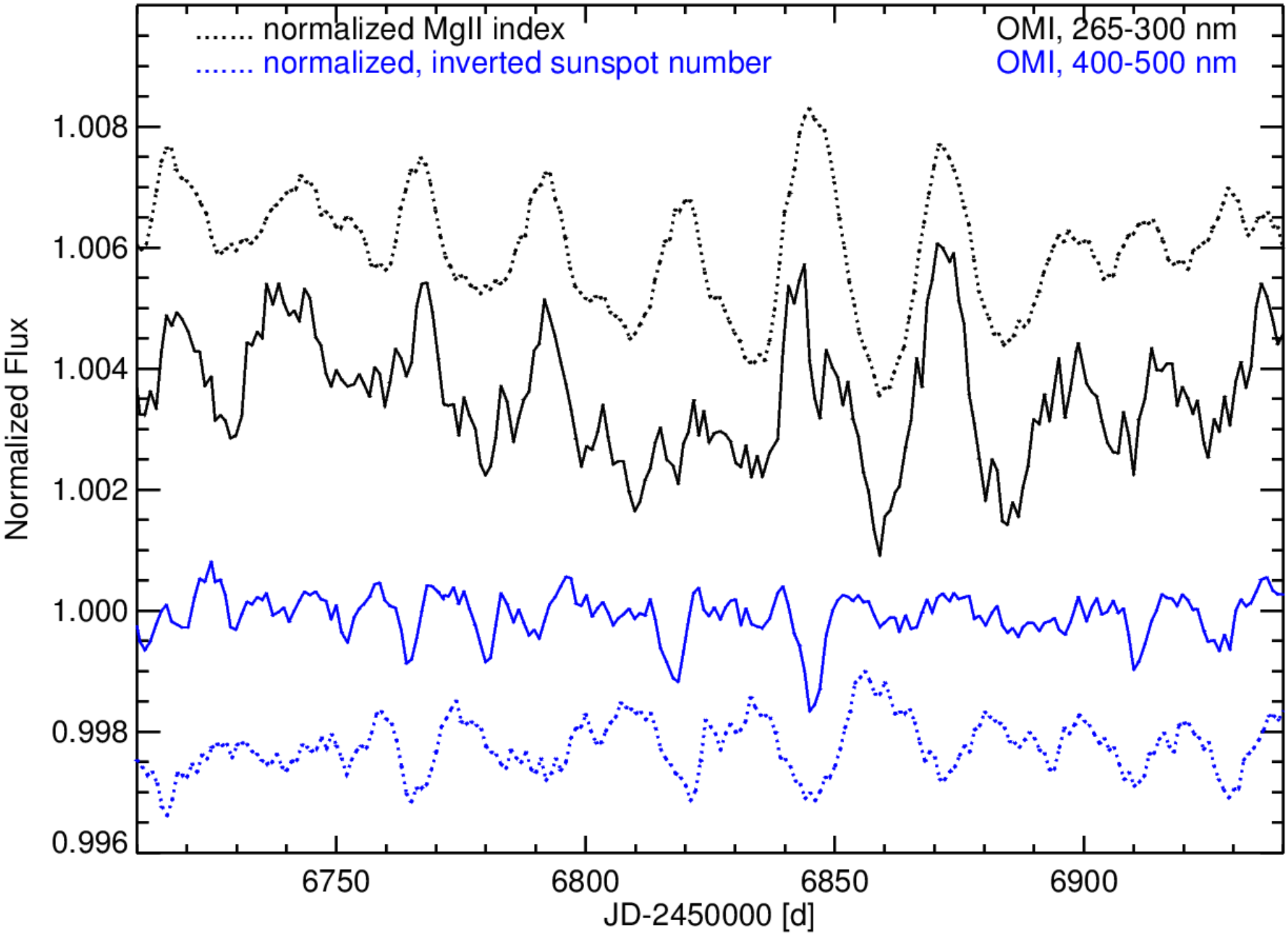
$$I(\lambda,t,VZA)=a_1(\lambda,VZA) \times \exp[-a_2(\lambda,VZA) \times t^{\,a3(\lambda,VZA)}]$$

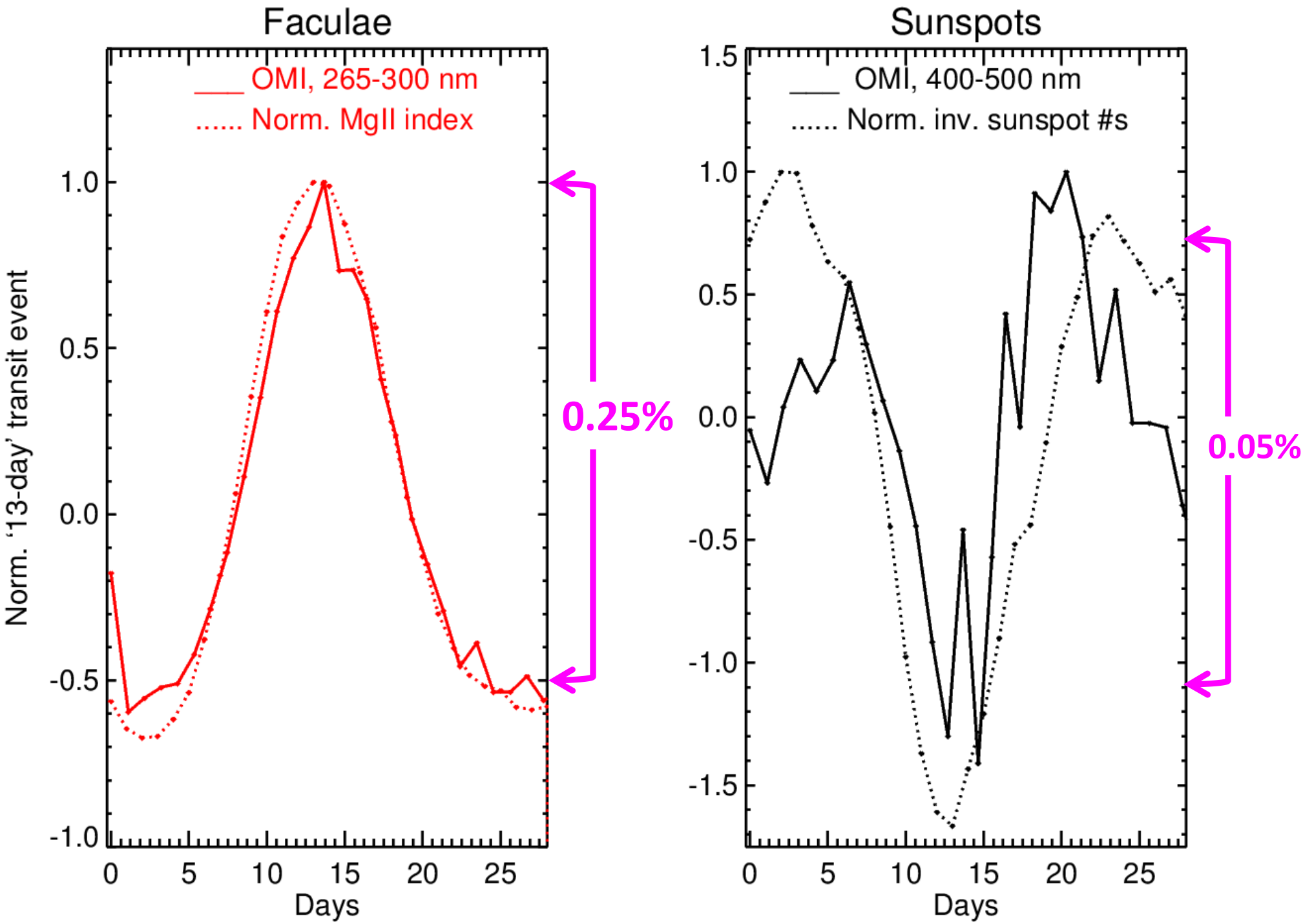
- Assuming consistent absolute irradiance levels at the minimum of Cycle 23 and Cycle 24. Otherwise, the model results in uncertainties comparable to the linear fit.*

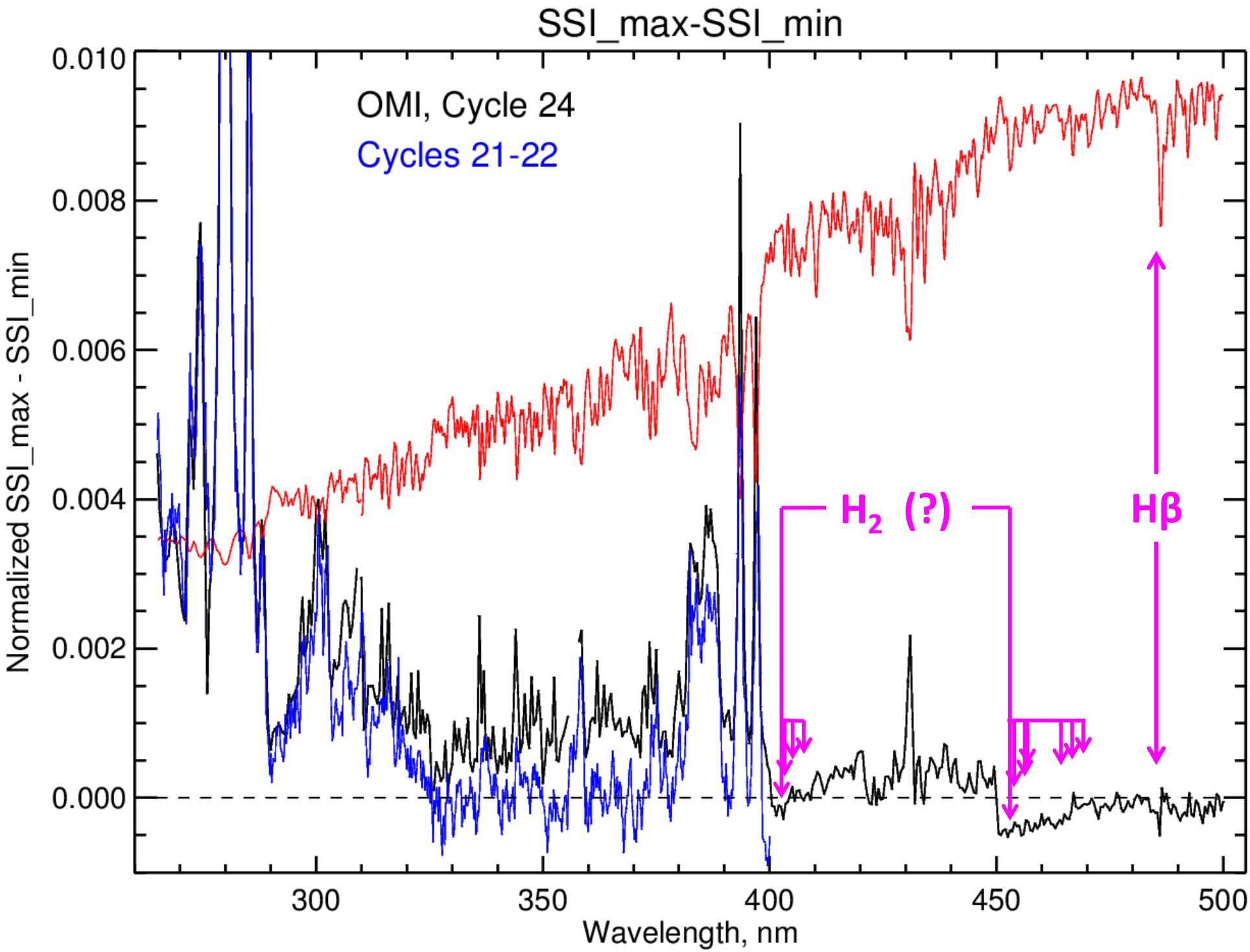
* Description of the previous approach: Marchenko & DeLand, 2014, ApJ,789, 117

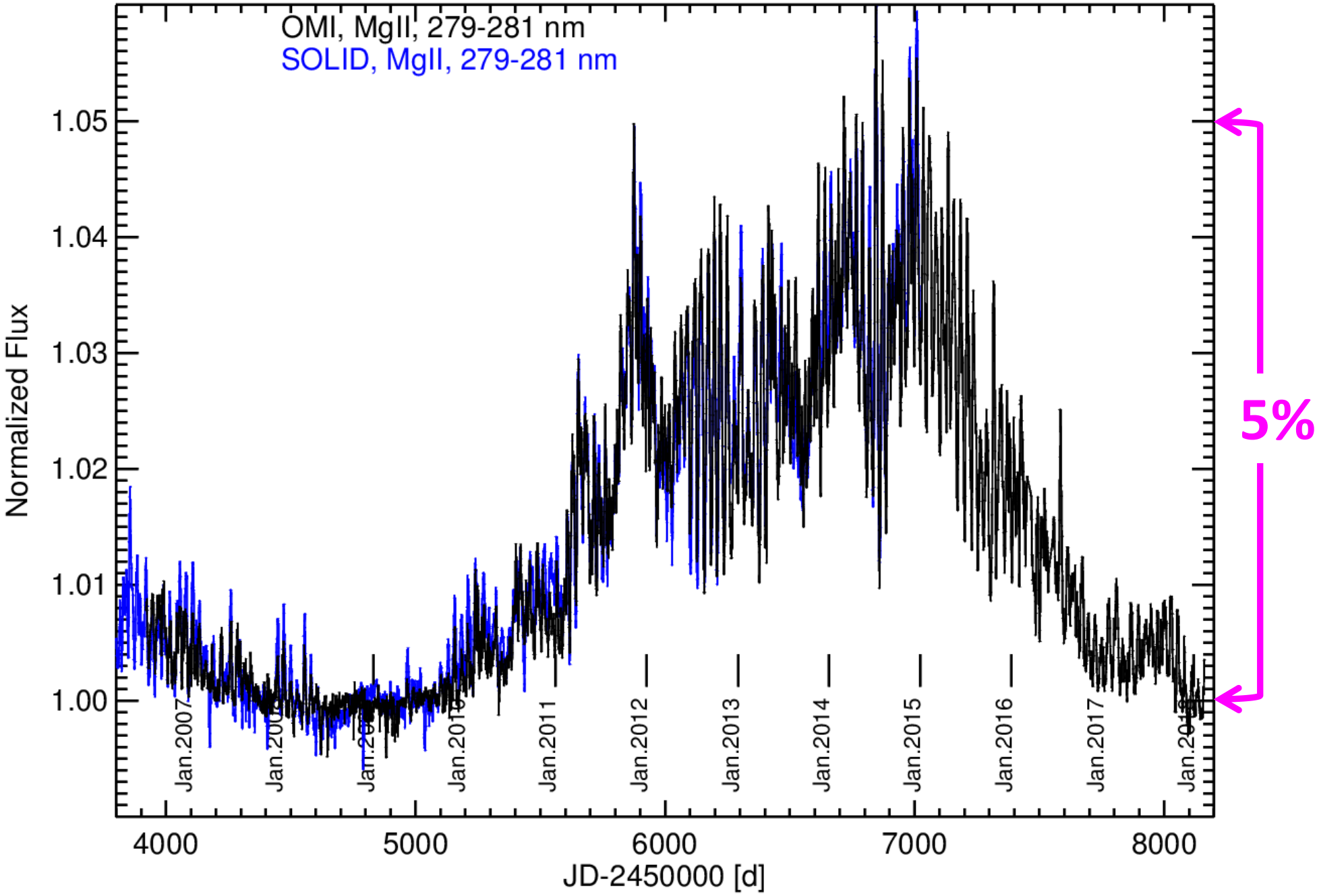

Normalized SSIs
y2017.0
2015.0
2013.0
2011.0
2009.0
y2007.0
Time
310
320
330
340
350
Wavelength, nm
0.45%
0.20%
-0.05%

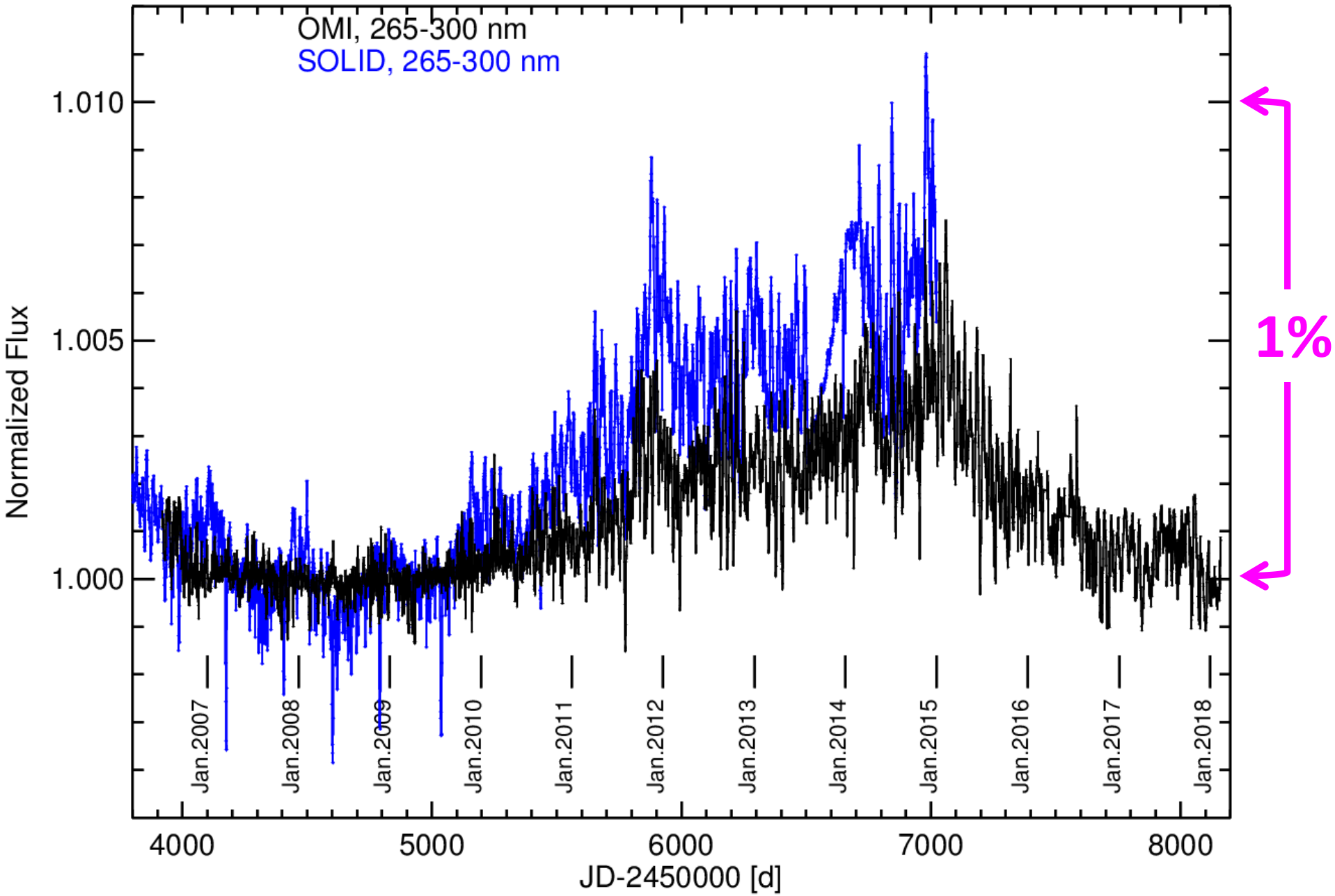

OMI, 265-300 nm
OMI, 300-400 nm
OMI, 400-500 nm
Normalized Flux
1.008
1.006
1.004
1.002
1.000
0.998
0.996
Jan.2007
Jan.2008
Jan.2009
Jan.2010
Jan.2011
Jan.2012
Jan.2013
Jan.2014
Jan.2015
Jan.2016
Jan.2017
Jan.2018
4000
5000
6000
7000
8000
JD-2450000 [d]
1%

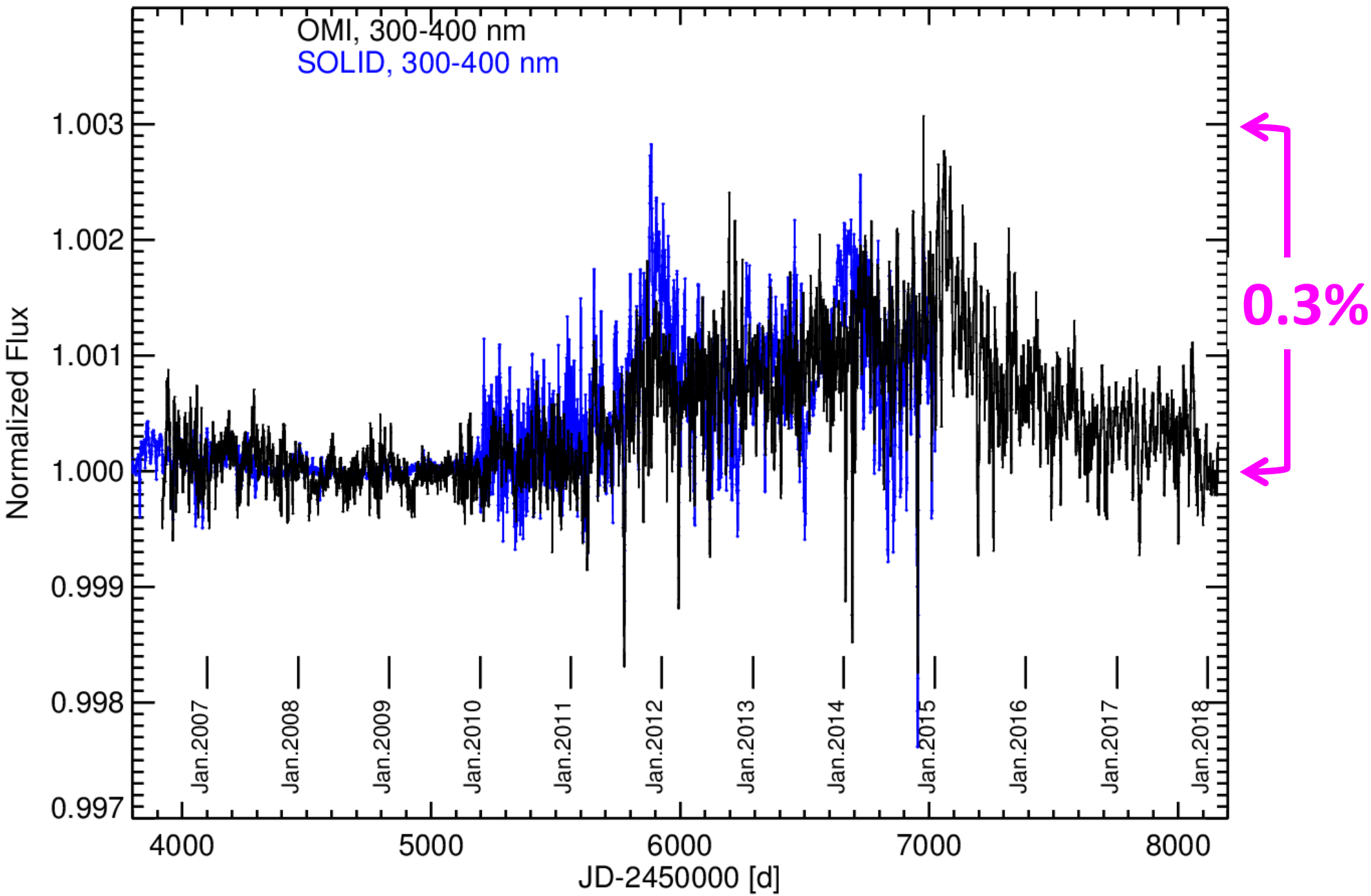

..... normalized MgII index
..... normalized, inverted sunspot number
OMI, 265-300 nm
OMI, 400-500 nm
Normalized Flux
1.008
1.006
1.004
1.002
1.000
0.998
0.996
6750
6800
6850
6900
JD-2450000 [d]

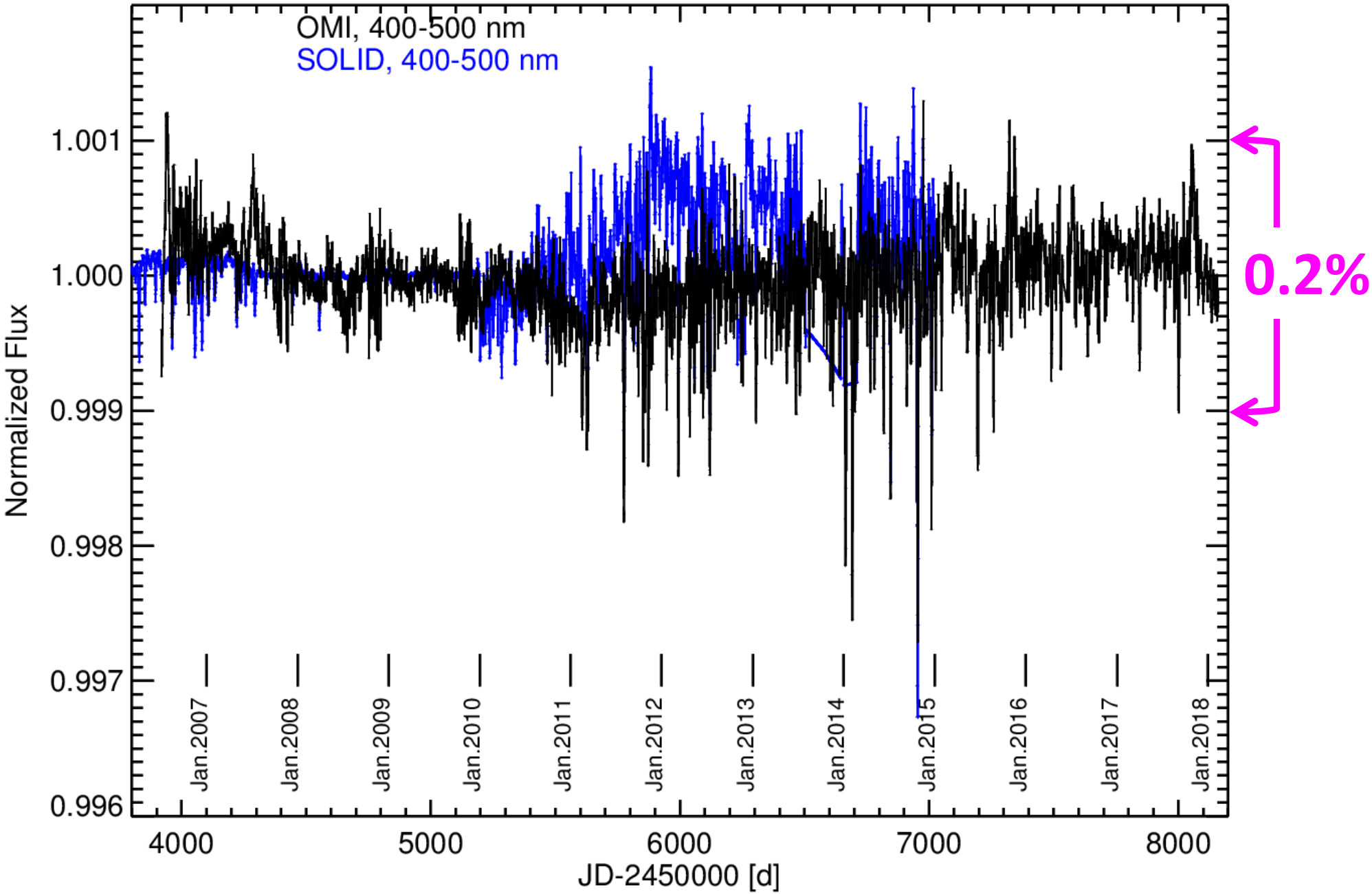

Faculae
OMI, 265-300 nm
Norm. MgII index
Norm. '13-day' transit event
1.0
0.5
0.0
-0.5
-1.0
0
5
10
15
20
25
Days
0.25%
Sunspots
OMI, 400-500 nm
Norm. inv. sunspot #s
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
0
5
10
15
20
25
Days
0.05%

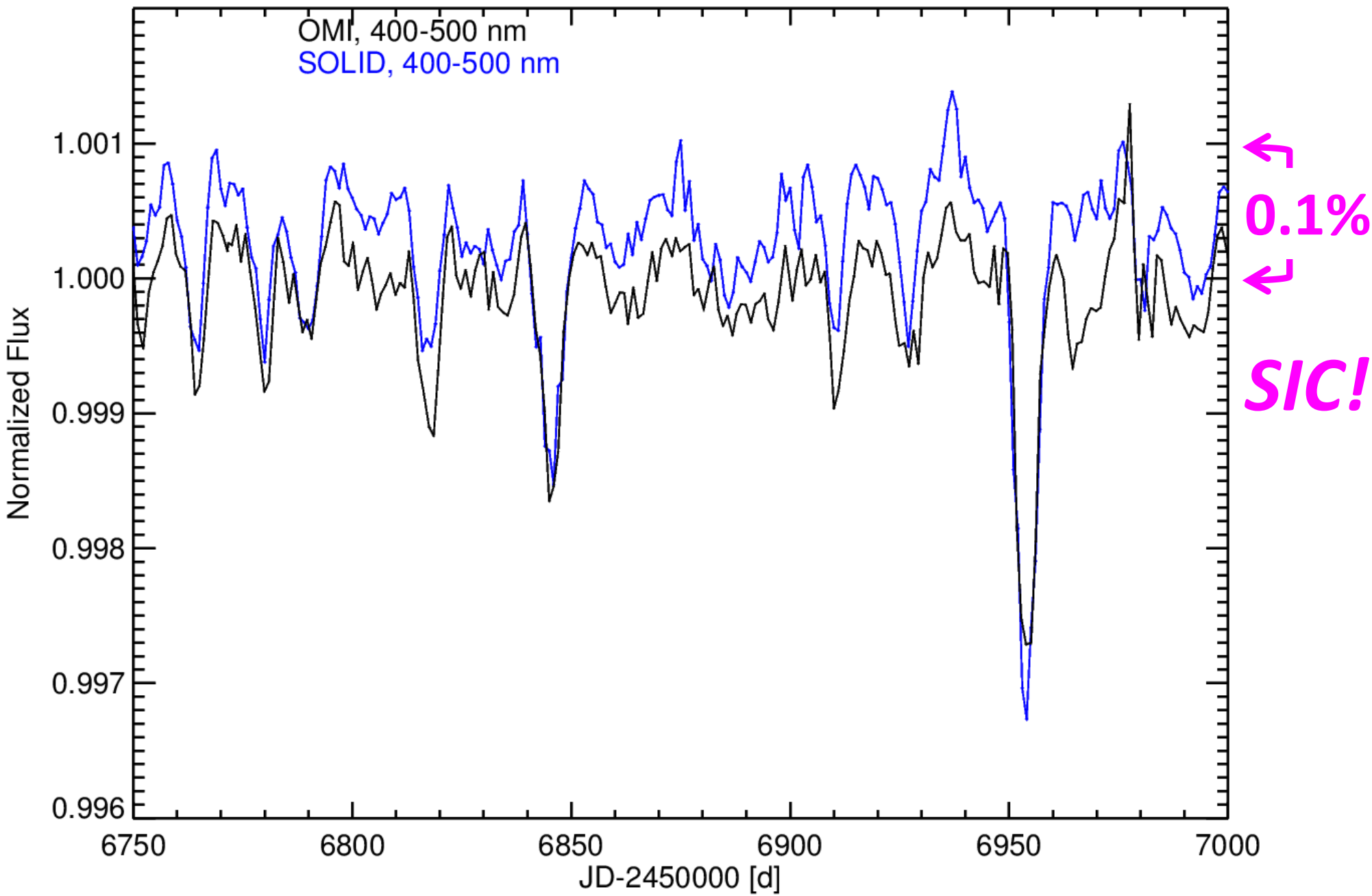

SSI_max-SSI_min
OMI, Cycle 24
Cycles 21-22
H2 (?)
Hβ
Normalized SSI_max - SSI_min
Wavelength, nm
0.010
0.008
0.006
0.004
0.002
0.000
300
350
400
450
500

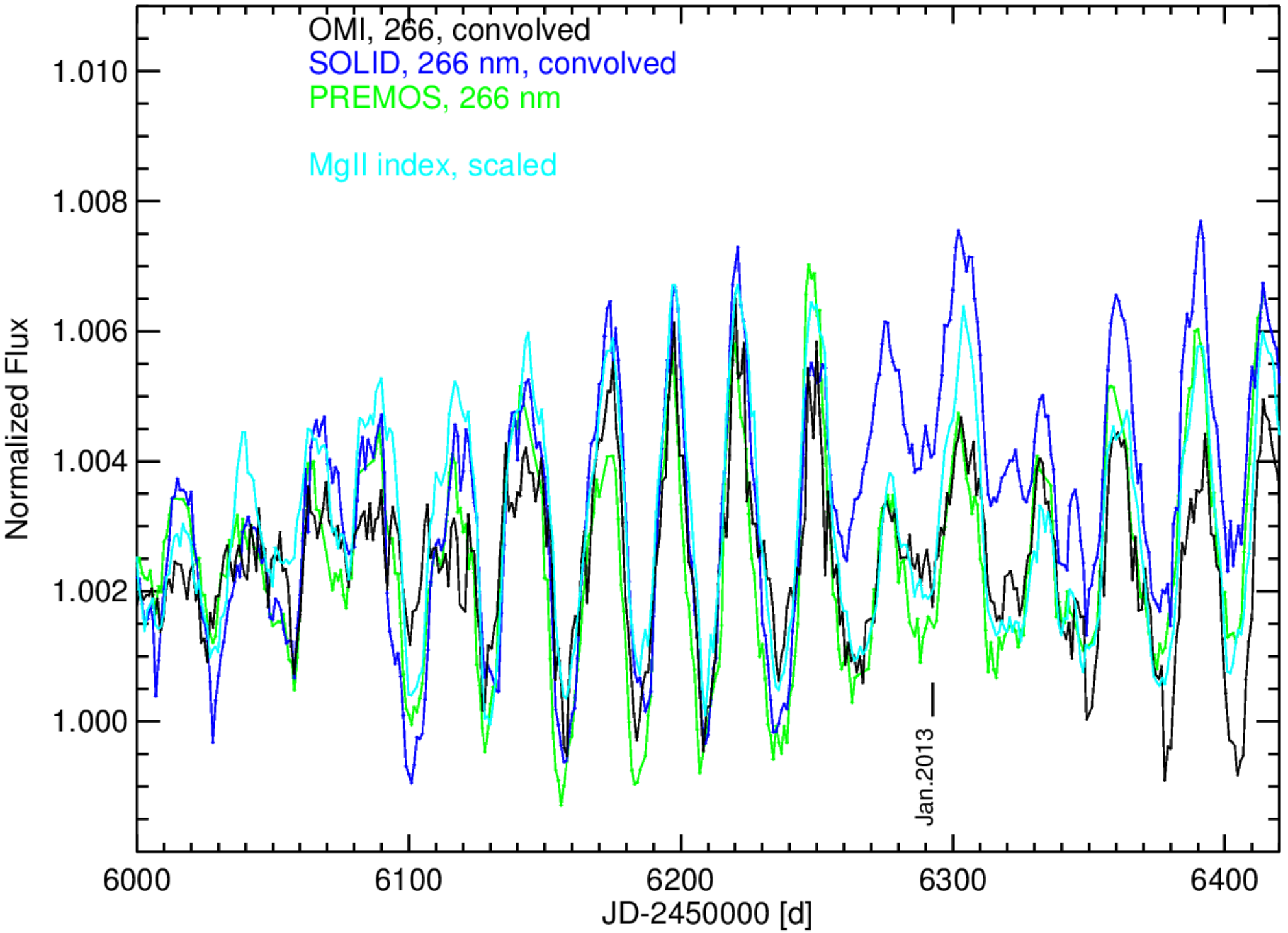

OMI, MgII, 279-281 nm
SOLID, MgII, 279-281 nm
Normalized Flux
1.05
1.04
1.03
1.02
1.01
1.00
5%
Jan.2007
Jan.2011
Jan.2012
Jan.2013
Jan.2014
Jan.2015
Jan.2016
Jan.2017
4000
5000
6000
7000
8000
JD-2450000 [d]

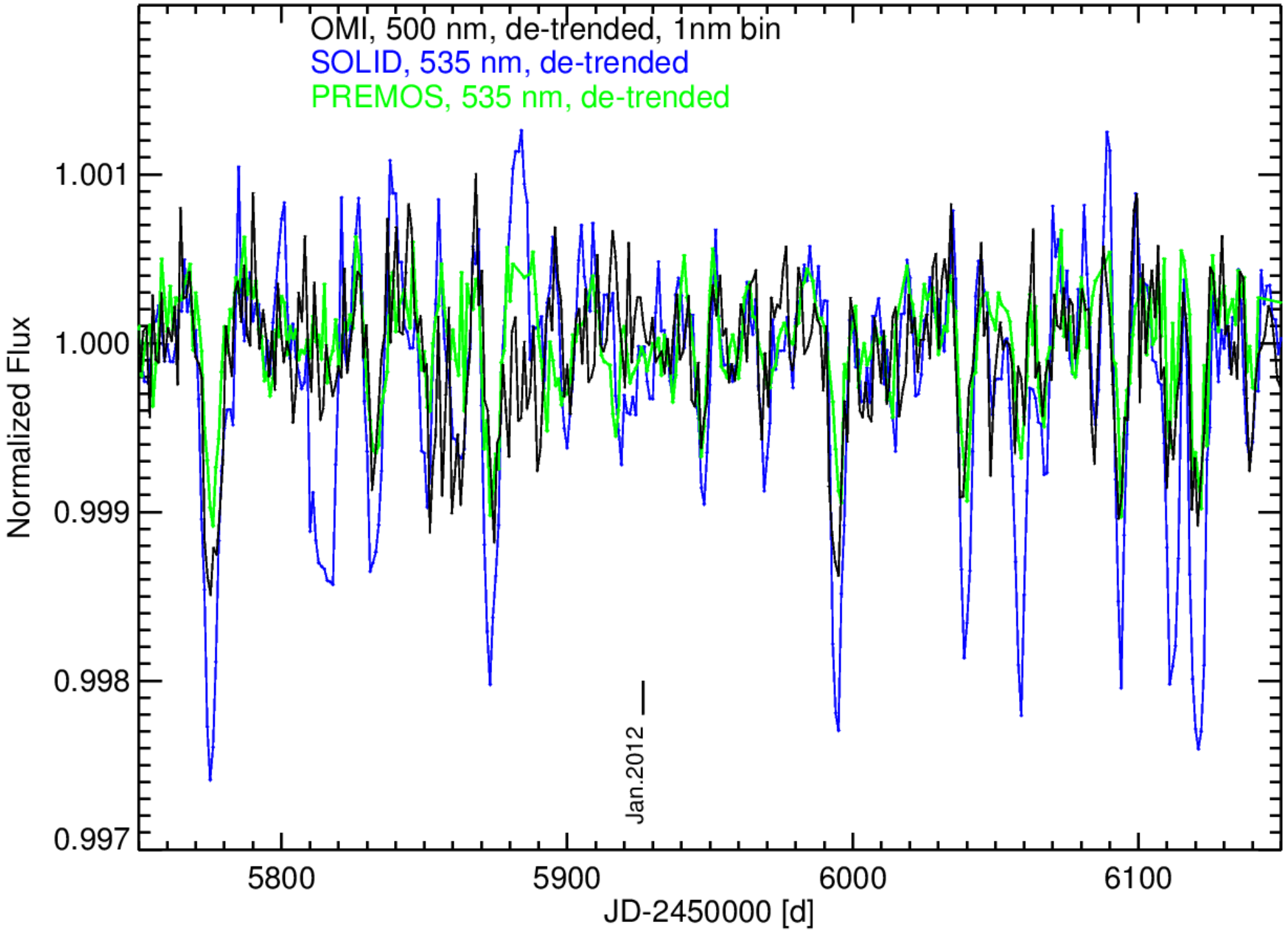

OMI, 265-300 nm
SOLID, 265-300 nm
1.010
1.005
1.000
Normalized Flux
1%
Jan.2007
Jan.2008
Jan.2009
Jan.2010
Jan.2011
Jan.2012
Jan.2013
Jan.2014
Jan.2015
Jan.2016
Jan.2017
Jan.2018
4000
5000
6000
7000
8000
JD-2450000 [d]


OMI, 300-400 nm
SOLID, 300-400 nm
Normalized Flux
1.003
1.002
1.001
1.000
0.999
0.998
0.997
0.3%
Jan.2007
Jan.2008
Jan.2009
Jan.2010
Jan.2011
Jan.2012
Jan.2013
Jan.2014
Jan.2015
Jan.2016
Jan.2017
Jan.2018
4000
5000
6000
7000
8000
JD-2450000 [d]


OMI, 400-500 nm
SOLID, 400-500 nm
Normalized Flux
1.001
1.000
0.999
0.998
0.997
0.996
0.2%
Jan.2007
Jan.2008
Jan.2009
Jan.2010
Jan.2011
Jan.2012
Jan.2013
Jan.2014
Jan.2015
Jan.2016
Jan.2017
Jan.2018
4000
5000
6000
7000
8000
JD-2450000 [d]


OMI, 400-500 nm
SOLID, 400-500 nm
1.001
1.000
0.999
0.998
0.997
0.996
Normalized Flux
6750
6800
6850
6900
6950
7000
JD-2450000 [d]
0.1%
SIC!


OMI, 266, convolved
SOLID, 266 nm, convolved
PREMOS, 266 nm
MgII index, scaled
Normalized Flux
1.010
1.008
1.006
1.004
1.002
1.000
6000
6100
6200
6300
6400
JD-2450000 [d]
Jan.2013


OMI, 500 nm, de-trended, 1nm bin
SOLID, 535 nm, de-trended
PREMOS, 535 nm, de-trended
Normalized Flux
1.001
1.000
0.999
0.998
0.997
Jan.2012
5800
5900
6000
6100
JD-2450000 [d]

- OMI provides accurate daily solar irradiances spanning all Cycle 24.
- Wavelength coverage: 265-500 nm.
- ~0.5 nm spectral resolution.
- The typical point-to-point uncertainties in the wavelength-binned data are close to 0.05% (k=1), with occasional goniometry-related ~0.1-0.2% spikes.
- OMI data compare well (at ~0.1% level) with SOLID composite and PREMOS measurements.
- Take a look at:

  https://sbuv2.gsfc.nasa.gov/solar/omi/

  coming to LISIRD soon, http://lasp.colorado.edu/lisird/