Solar Activity Trending with OMI: Mg II and Ca II Indices

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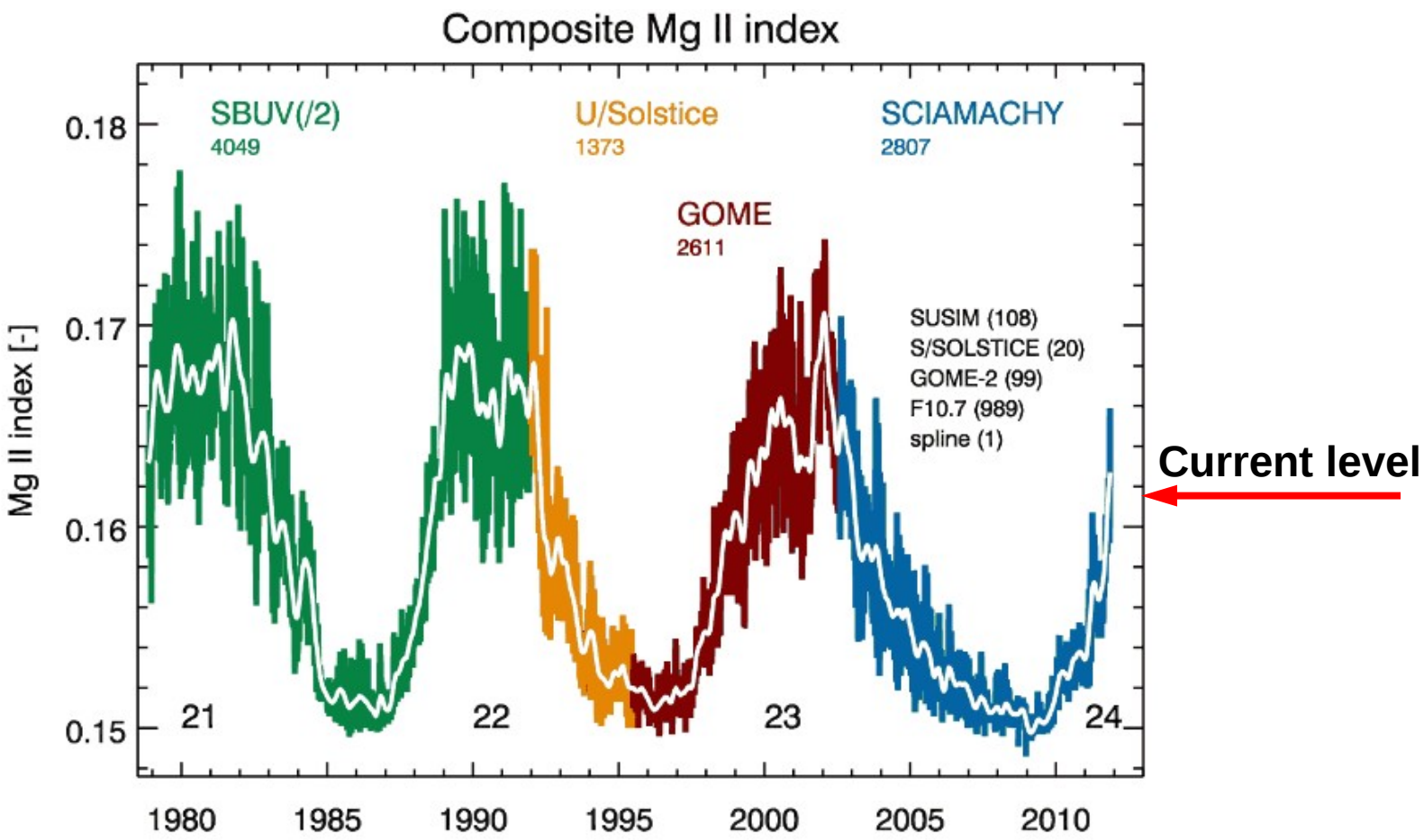
SSAI/GSFC

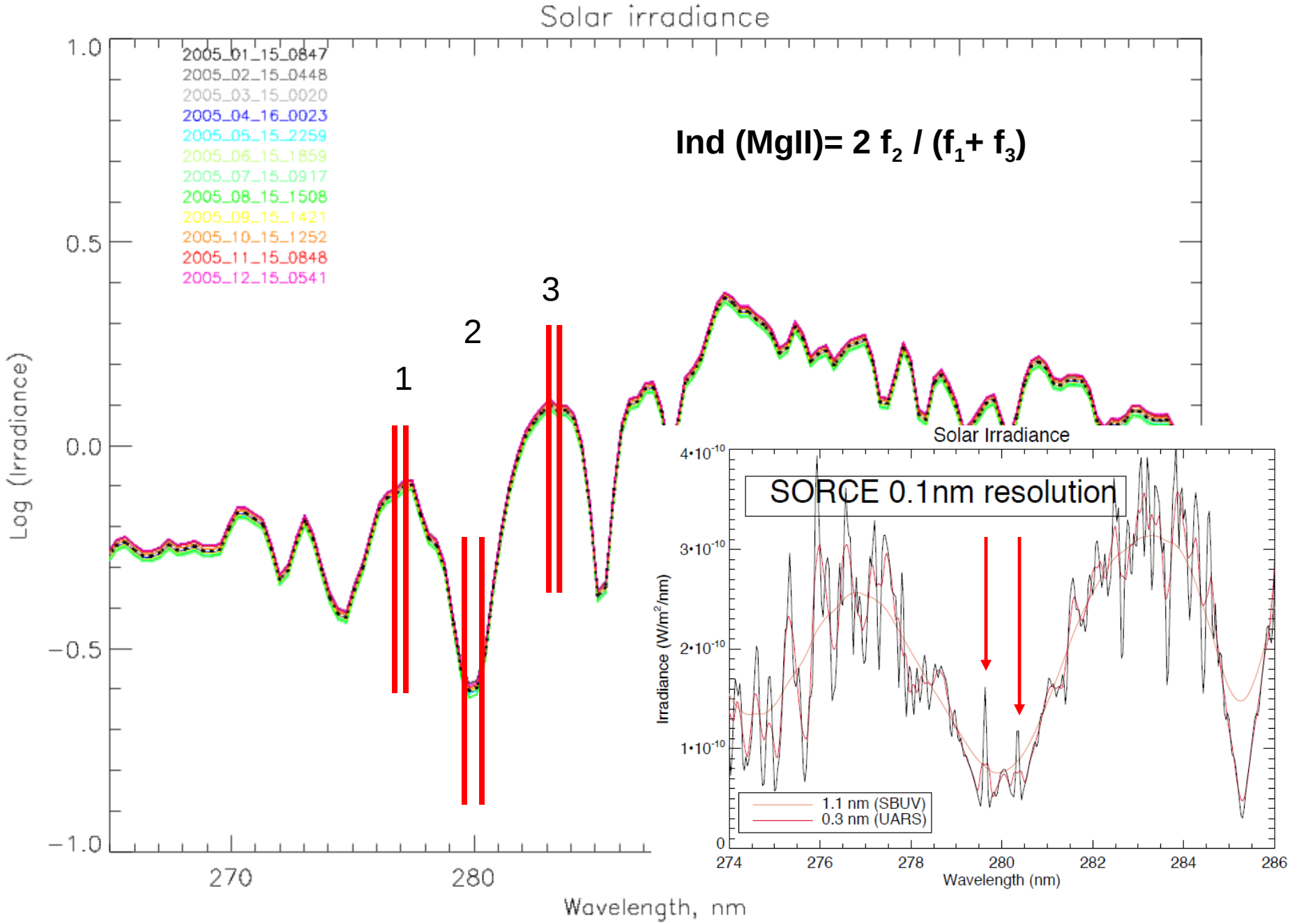
Aura STM, October 2012

Background

- **Solar UV radiation drives stratospheric photochemistry and heating.**
- **Solar Mg II and Ca II H, K indices are excellent indicators of solar UV activity that minimize instrument degradation issues.**
- **The initiation of the current Solar Cycle 24 was fairly unusual.**



Provided on-line by M.Weber (http://www.iup.uni-bremen.de/gome/gomemgii.html)



Snow & McClintock, 2006

Reviewed MgII and CaII Solar Indices

Mg II (280 nm)

OMI	(Δλ=0.6 nm)	(2004-present)
GOME/ERS2	(0.2 nm)	(1995-2011)
GOME-2/ENUMETSAT	(0.2 nm)	(2007-present)
SOLSTICE/SORCE	(0.1 nm)	(2003-present)
SCIAMACHY/ENVISAT	(0.2 nm)	(2002-2012)
SBUV2/NOAA-16	(1.1 nm)	(2001-present)
SBUV2/NOAA-17	(1.1 nm)	(2002-present)
SBUV2/NOAA-18	(1.1 nm)	(2005-present)

Ca II H,K (397, 393 nm)

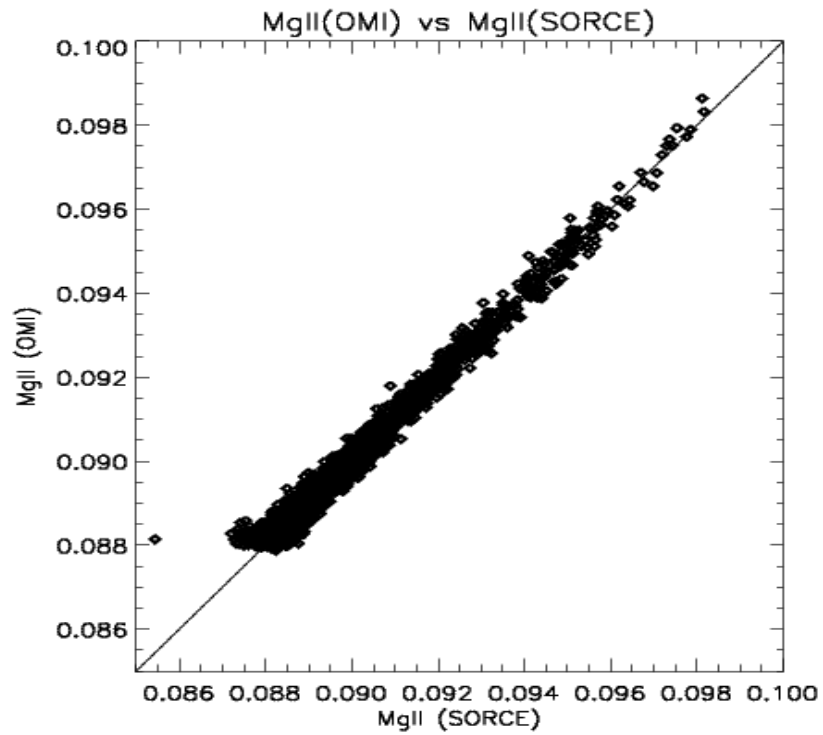
OMI	(Δλ=0.6 nm)	(2004-present)
ISS/NSO	(original 3-pix Δλ=0.0015 nm; 0.1nm used in this study)	(1974-present)
SBUV2/NOAA-17,18	(Δλ=1.1 nm)	(2002,2005-present)

Scaling:

$$Ind_{scaled} = a_0 + a_1 * Ind_{orig}$$

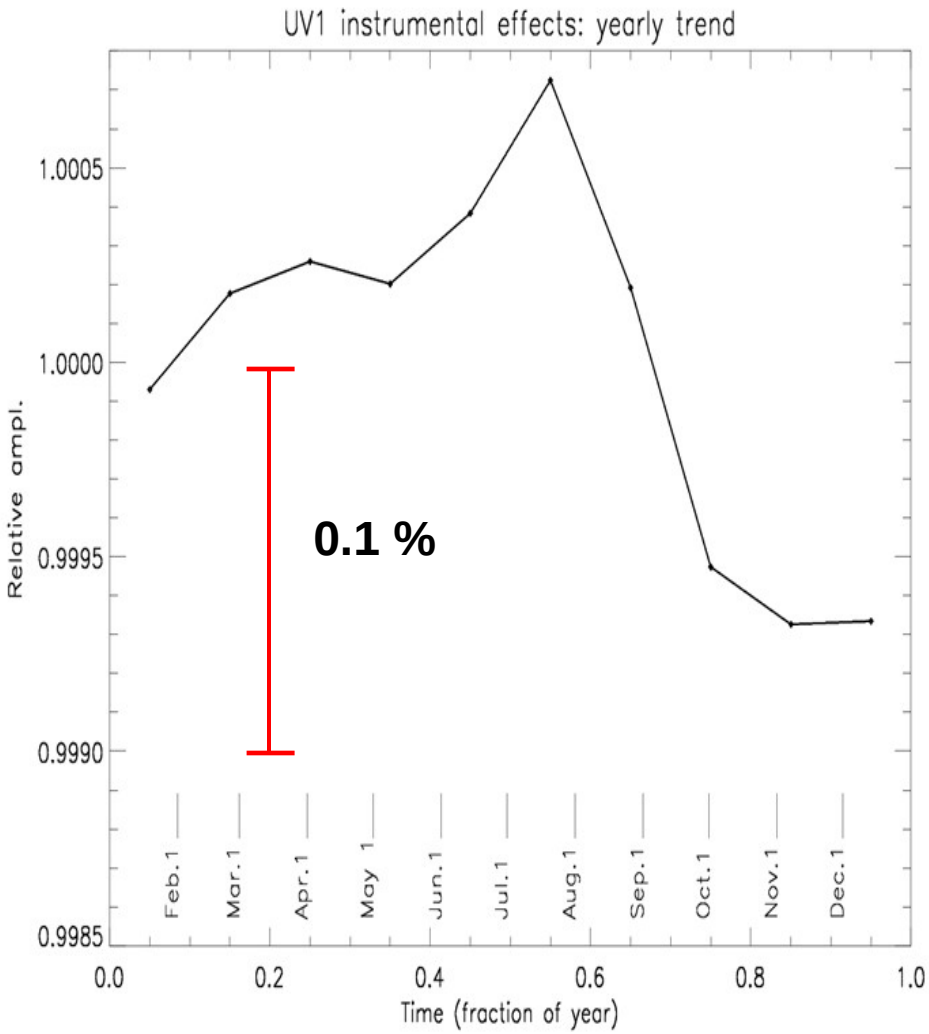
For all data subsets a_i were evaluated from the overlapping measurements (Sept. 2004 – present).

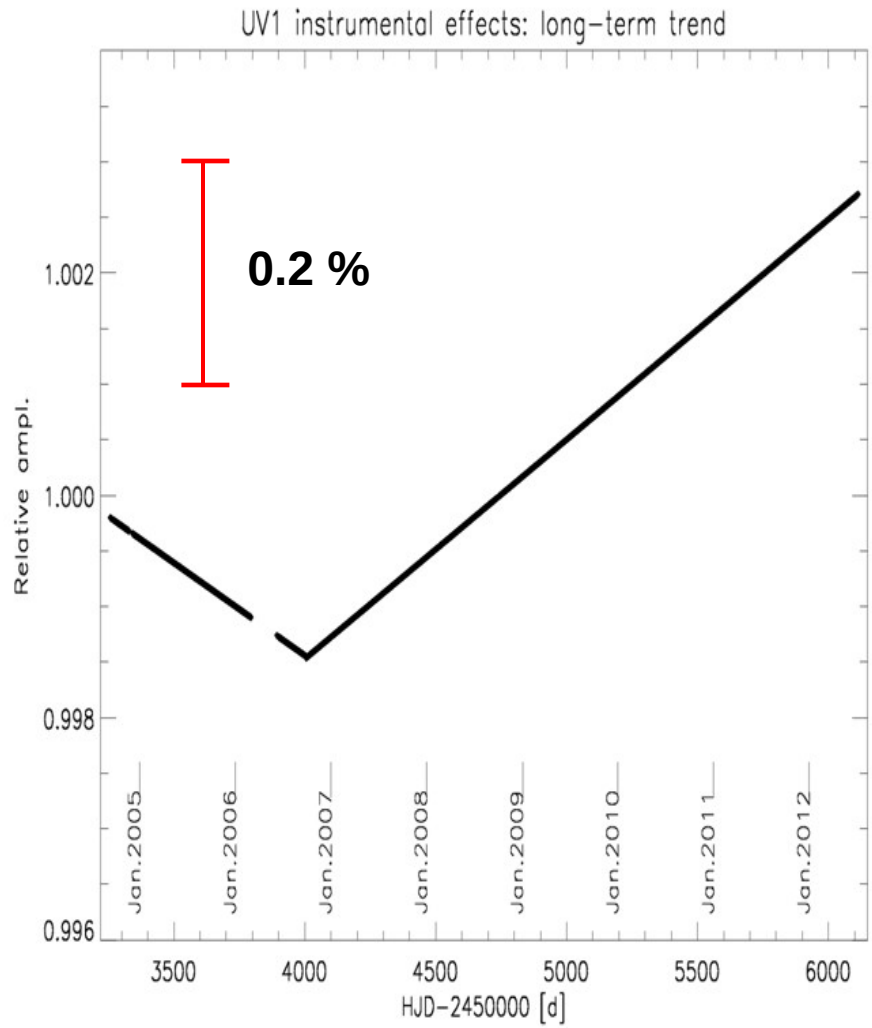
Mg II	a_0	a_1
NOAA-16	-0.016	1.070
NOAA-17	-0.013	1.070
NOAA-18	-0.016	1.070
SORCE	0.187	0.810
SCHIAMACHY	0.093	1.150
GOME	0.111	1.010
GOME-2	-0.024	~0.50(?)

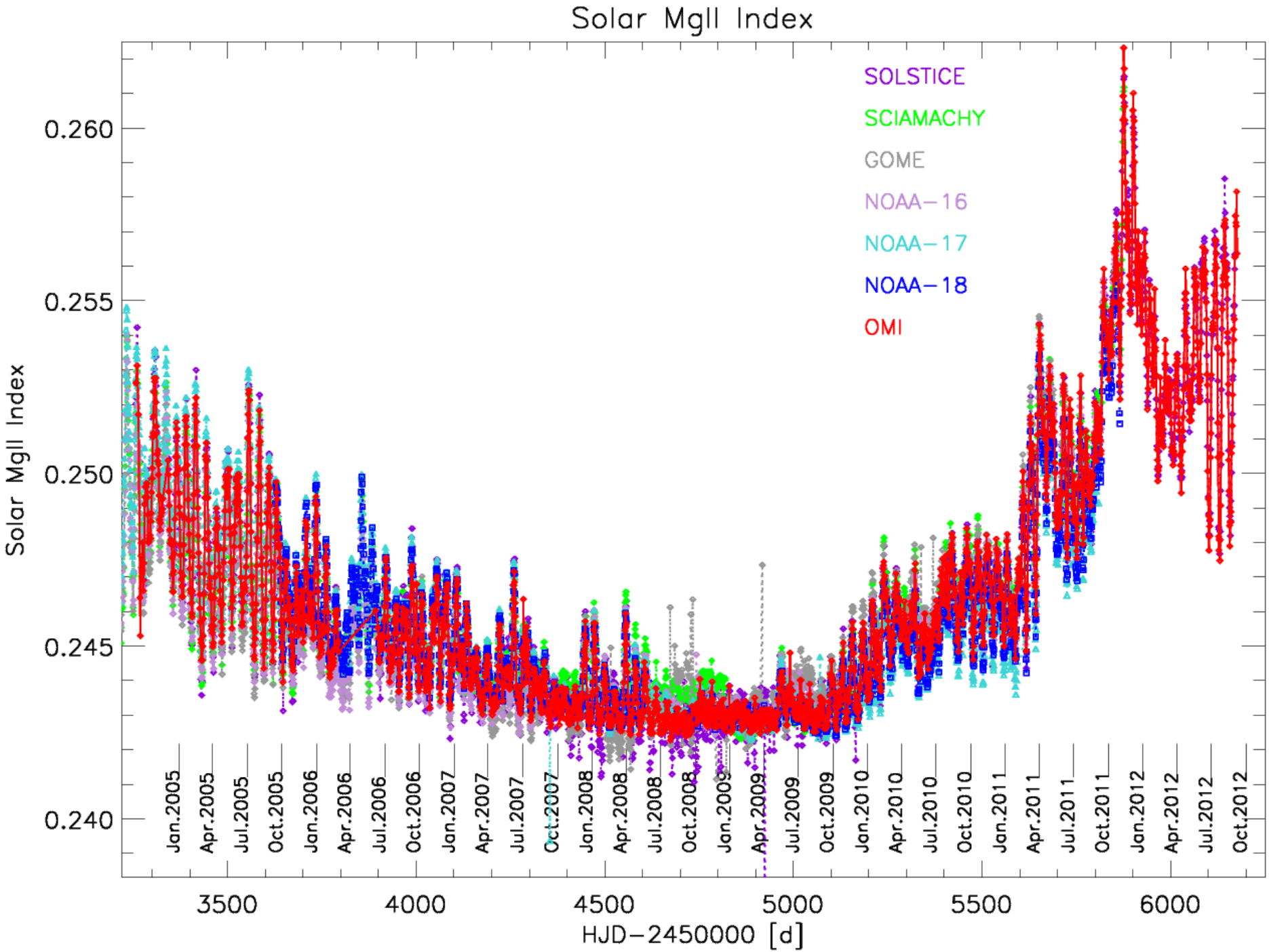


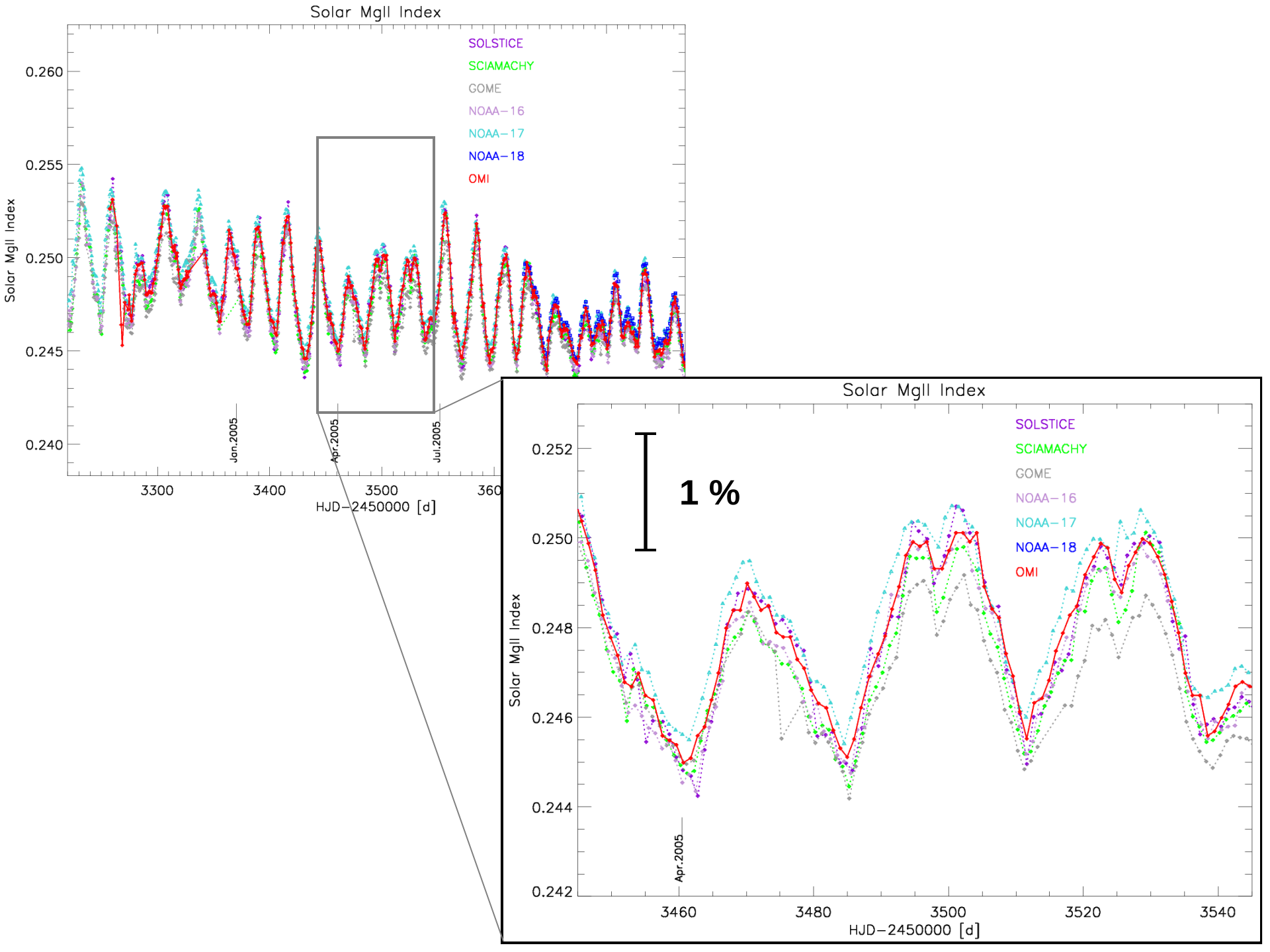
OMI vs. SORCE

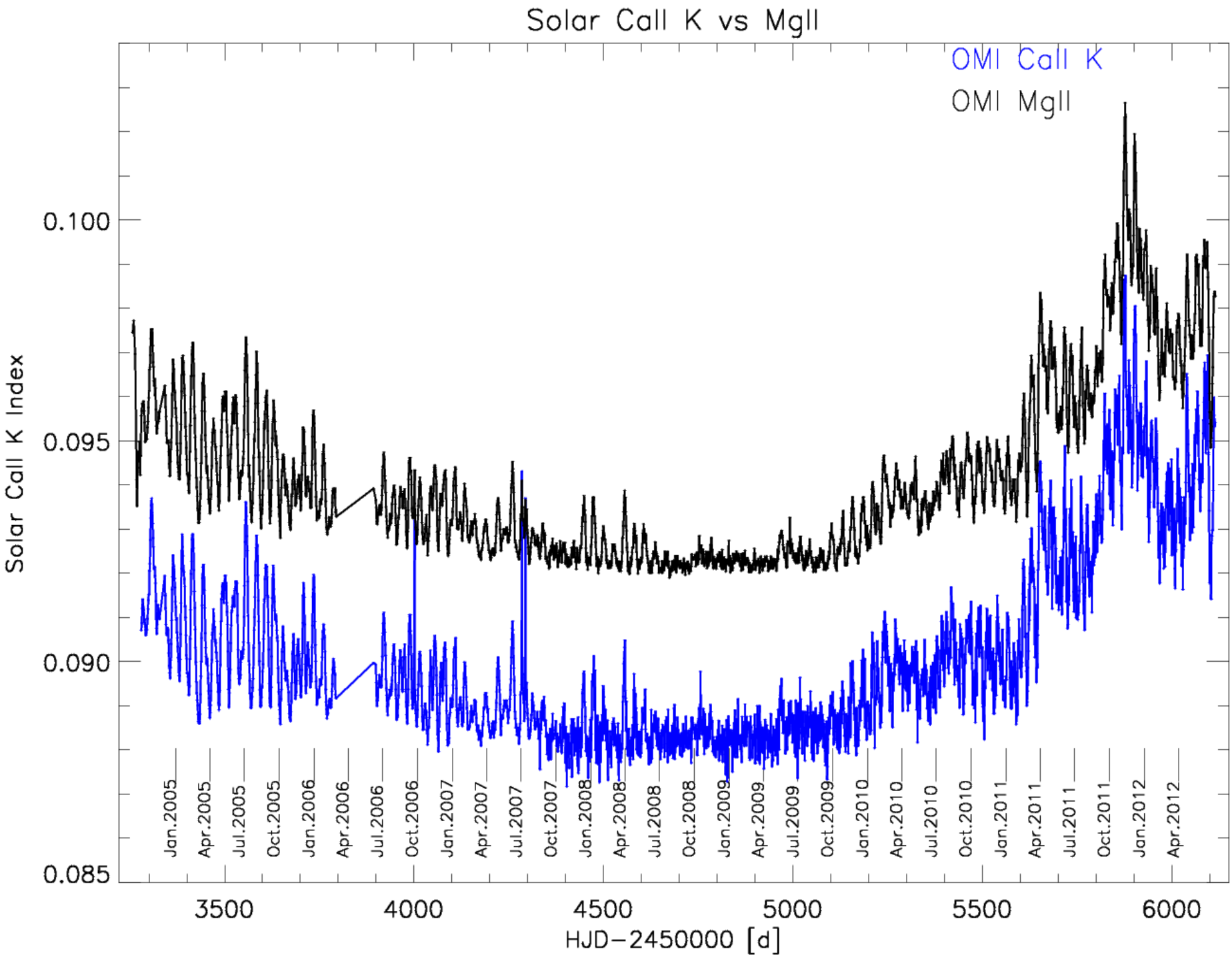
UV1 instrumental effects

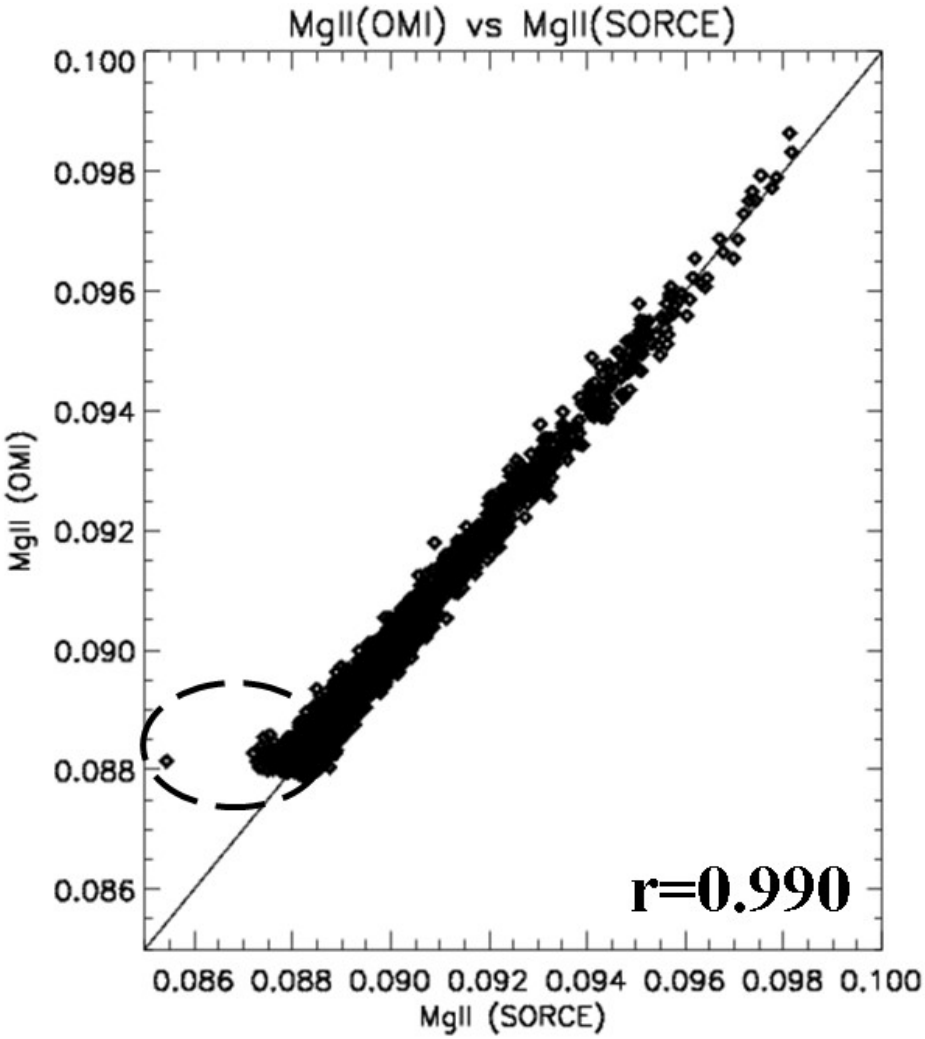




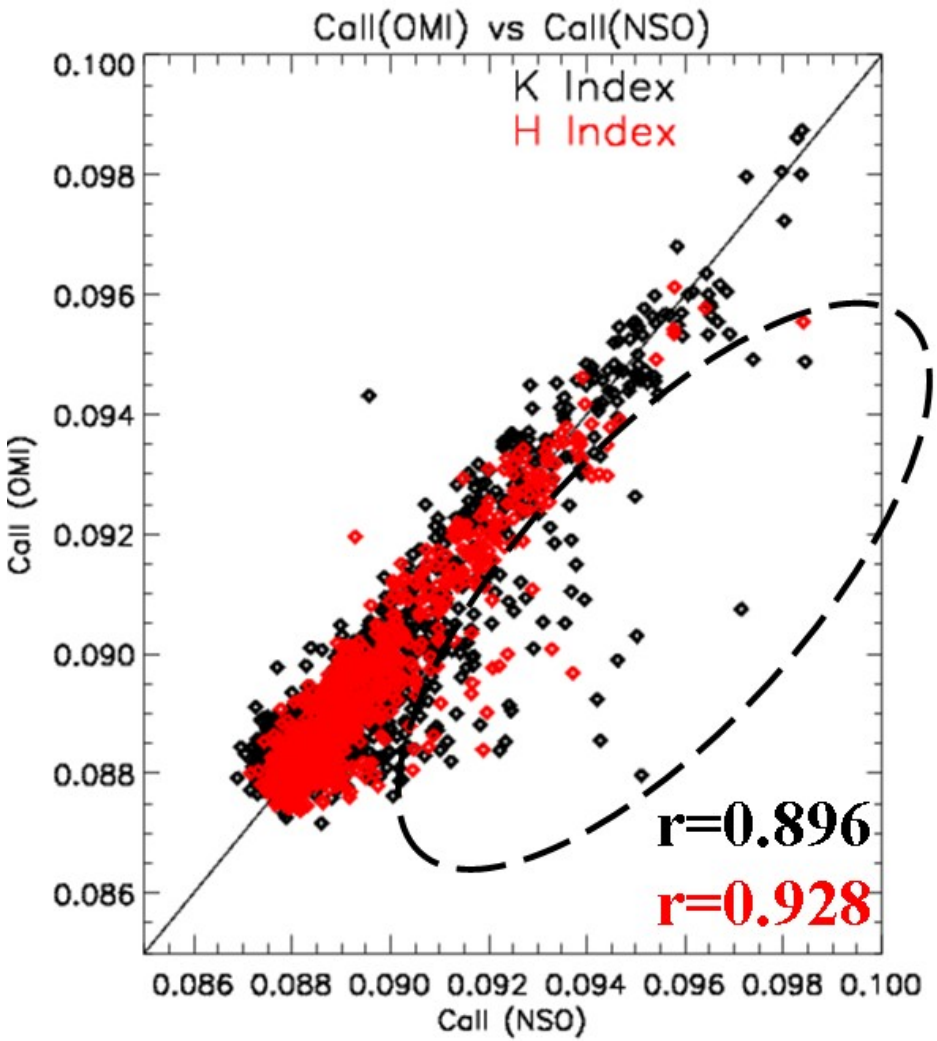

Solar MgII Index
SOLSTICE
SCIAMACHY
GOME
NOAA−16
NOAA−17
NOAA−18
OMI
0.260
0.255
0.250
0.245
0.240
Solar MgII Index
Jan.2005
Apr.2005
Jul.2005
Oct.2005
Jan.2006
Apr.2006
Jul.2006
Oct.2006
Jan.2007
Apr.2007
Jul.2007
Oct.2007
Jan.2008
Apr.2008
Jul.2008
Oct.2008
Jan.2009
Apr.2009
Jul.2009
Oct.2009
Jan.2010
Apr.2010
Jul.2010
Oct.2010
Jan.2011
Apr.2011
Jul.2011
Oct.2011
Jan.2012
Apr.2012
Jul.2012
Oct.2012
3500
4000
4500
5000
5500
6000
HJD−2450000 [d]


Solar MgII Index
SOLSTICE
SCIAMACHY
GOME
NOAA−16
NOAA−17
NOAA−18
OMI
Solar MgII Index
0.260
0.255
0.250
0.245
0.240
Jan.2005
Apr.2005
Jul.2005
3300
3400
3500
HJD−2450000 [d]
Solar MgII Index
1 %
0.252
0.250
0.248
0.246
0.244
0.242
Apr.2005
3460
3480
3500
3520
3540
HJD−2450000 [d]

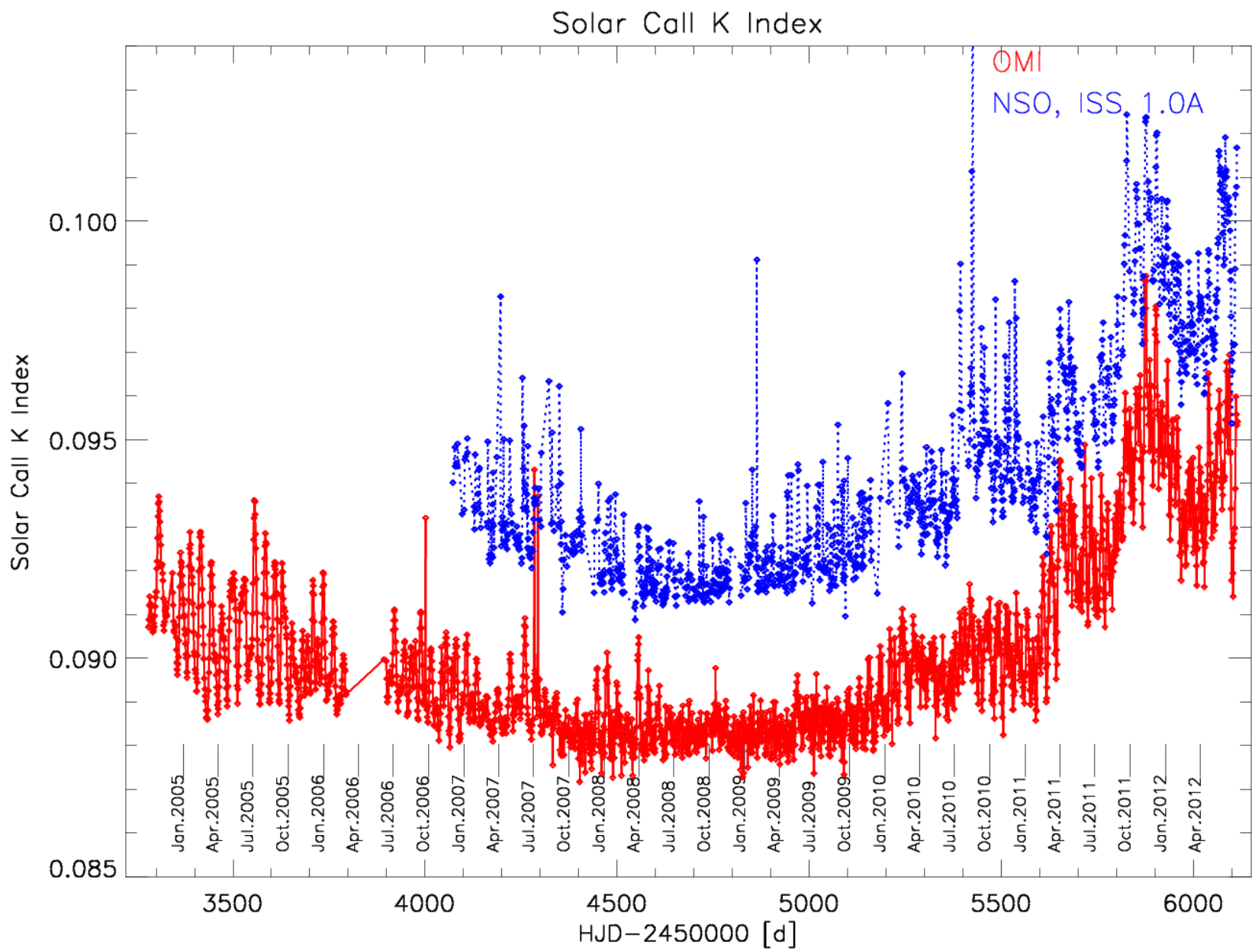

Solar CaII K vs MgII
OMI CaII K
OMI MgII
Solar CaII K Index
0.100
0.095
0.090
0.085
Jan.2005
Apr.2005
Jul.2005
Oct.2005
Jan.2006
Apr.2006
Jul.2006
Oct.2006
Jan.2007
Apr.2007
Jul.2007
Oct.2007
Jan.2008
Apr.2008
Jul.2008
Oct.2008
Jan.2009
Apr.2009
Jul.2009
Oct.2009
Jan.2010
Apr.2010
Jul.2010
Oct.2010
Jan.2011
Apr.2011
Jul.2011
Oct.2011
Jan.2012
Apr.2012
3500
4000
4500
5000
5500
6000
HJD−2450000 [d]

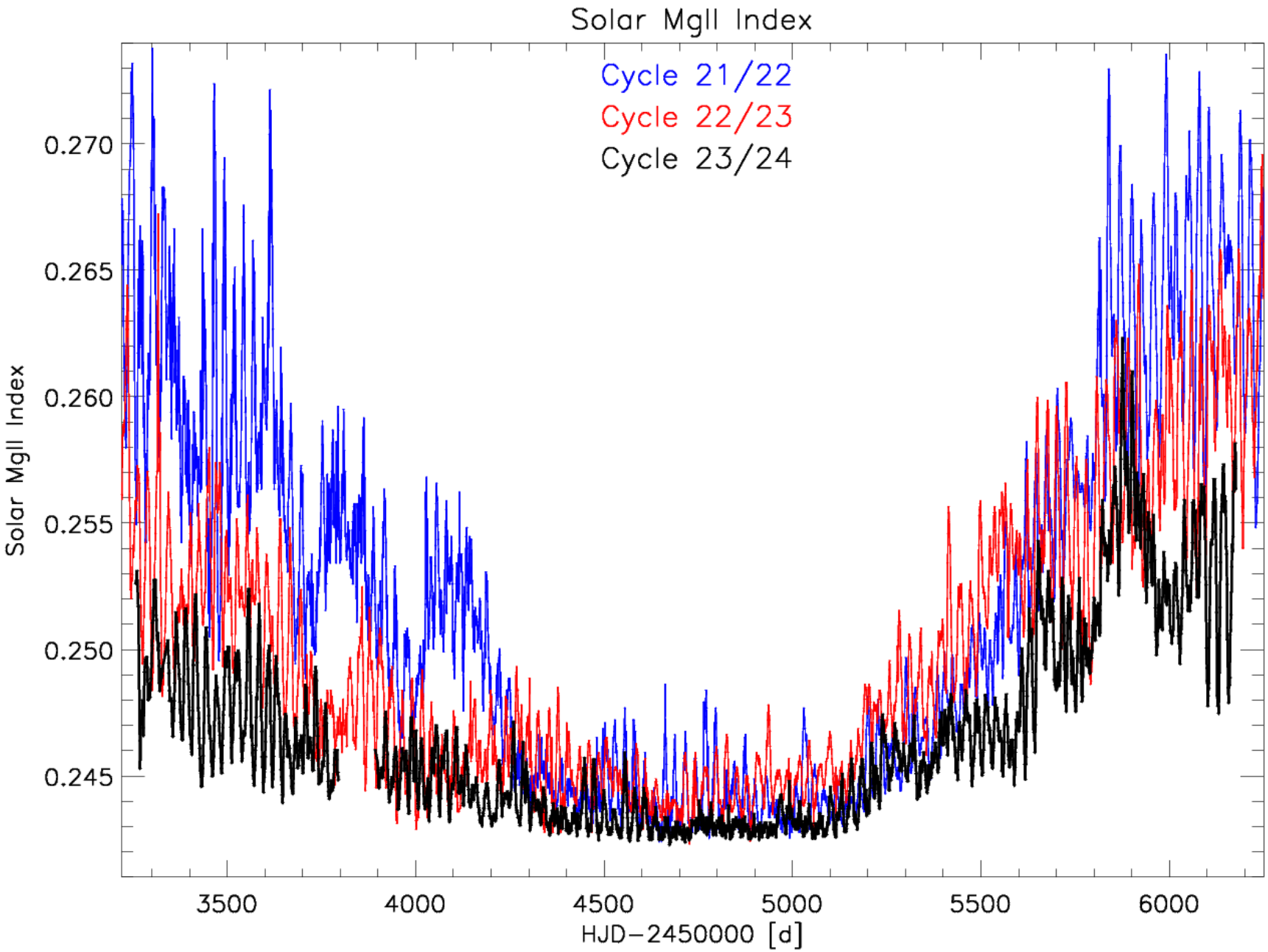


OMI vs SORCE



OMI vs NSO


Solar Call K Index
OMI
NSO, ISS, 1.0A
Solar Call K Index
0.100
0.095
0.090
0.085
Jan.2005
Apr.2005
Jul.2005
Oct.2005
Jan.2006
Apr.2006
Jul.2006
Oct.2006
Jan.2007
Apr.2007
Jul.2007
Oct.2007
Jan.2008
Apr.2008
Jul.2008
Oct.2008
Jan.2009
Apr.2009
Jul.2009
Oct.2009
Jan.2010
Apr.2010
Jul.2010
Oct.2010
Jan.2011
Apr.2011
Jul.2011
Oct.2011
Jan.2012
Apr.2012
3500
4000
4500
5000
5500
6000
HJD−2450000 [d]

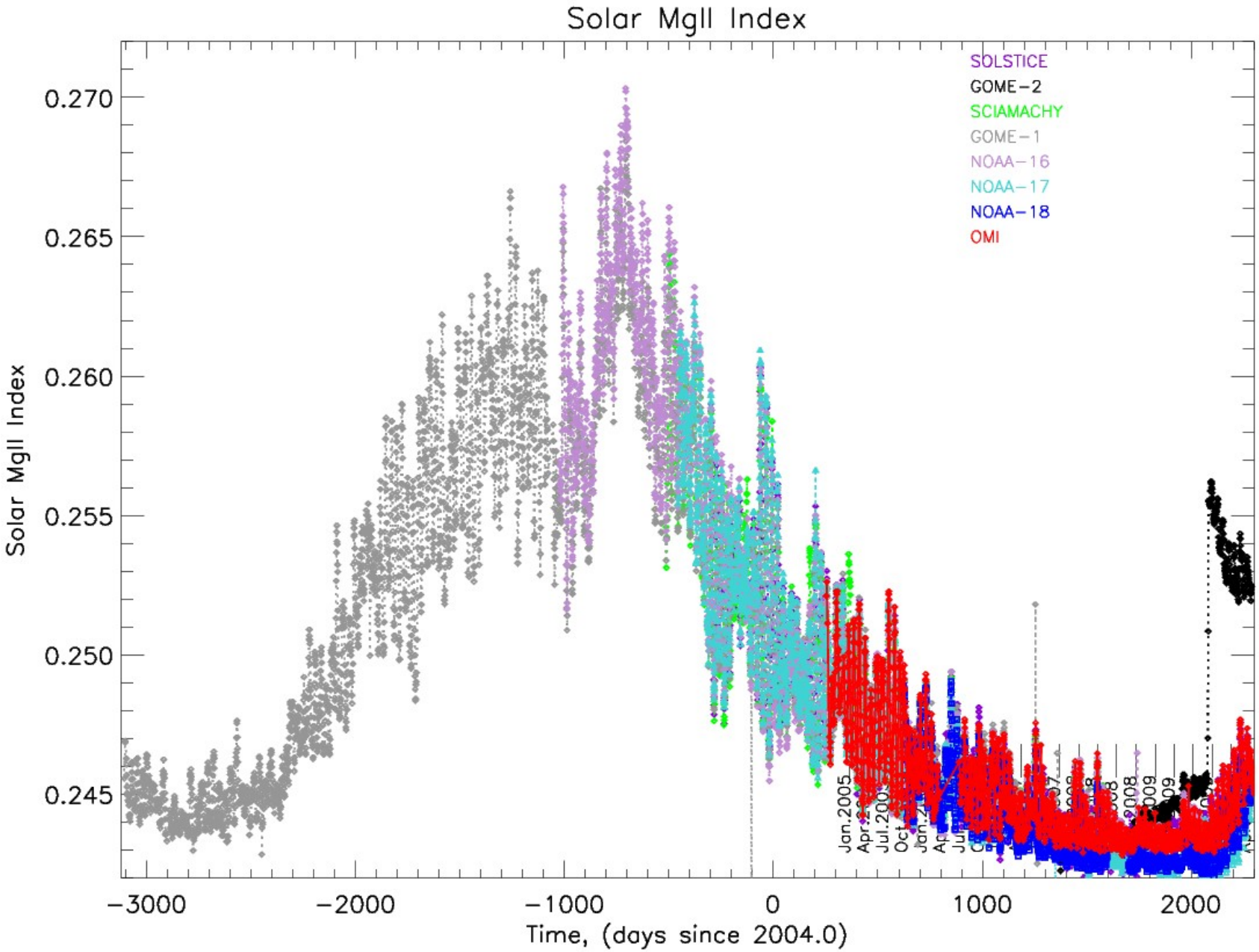


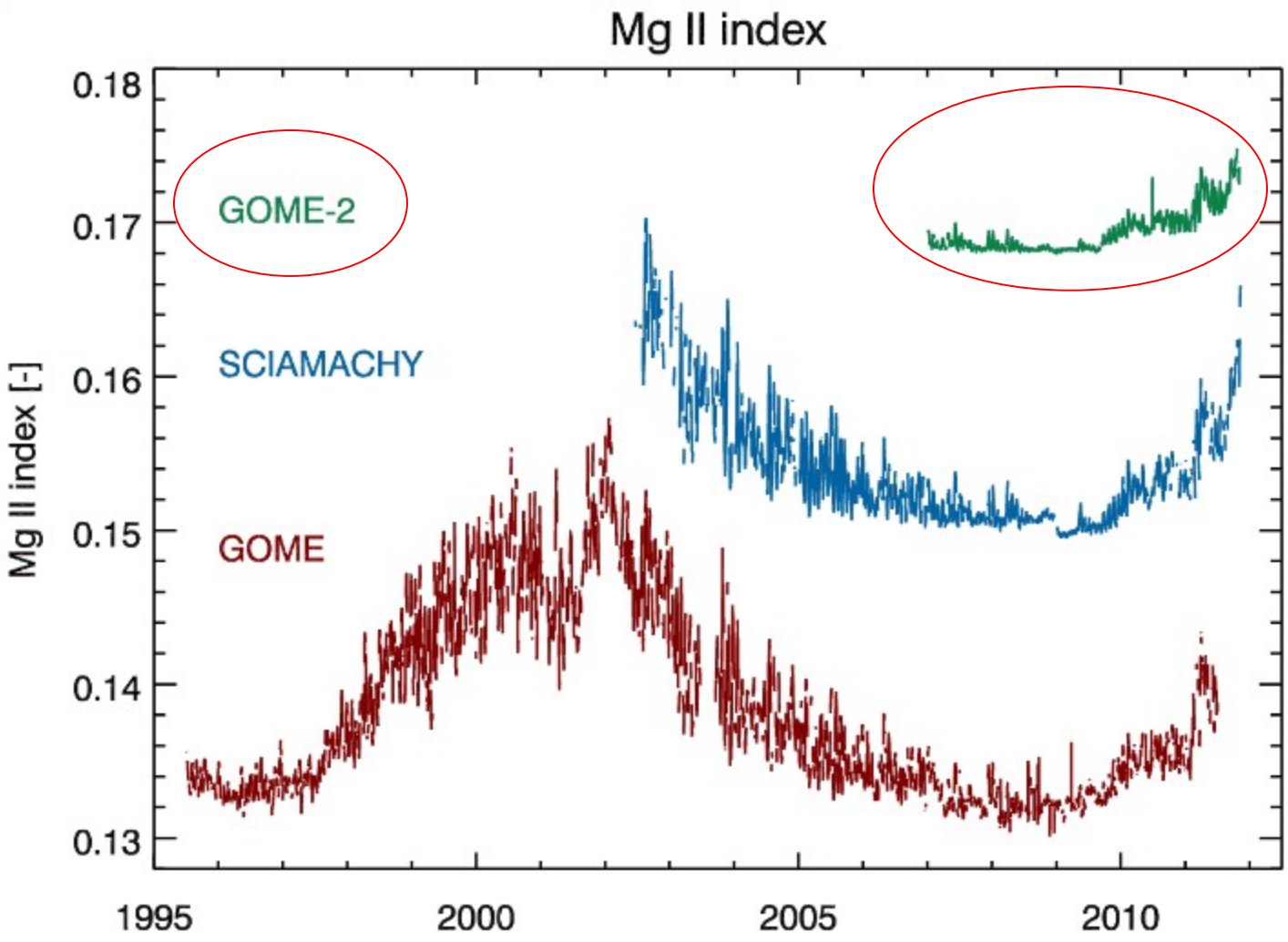
The Solar Cycle 21-23 data were taken from: http://www.iup.uni-bremen.de/gome/gomemgii.html

Conclusions

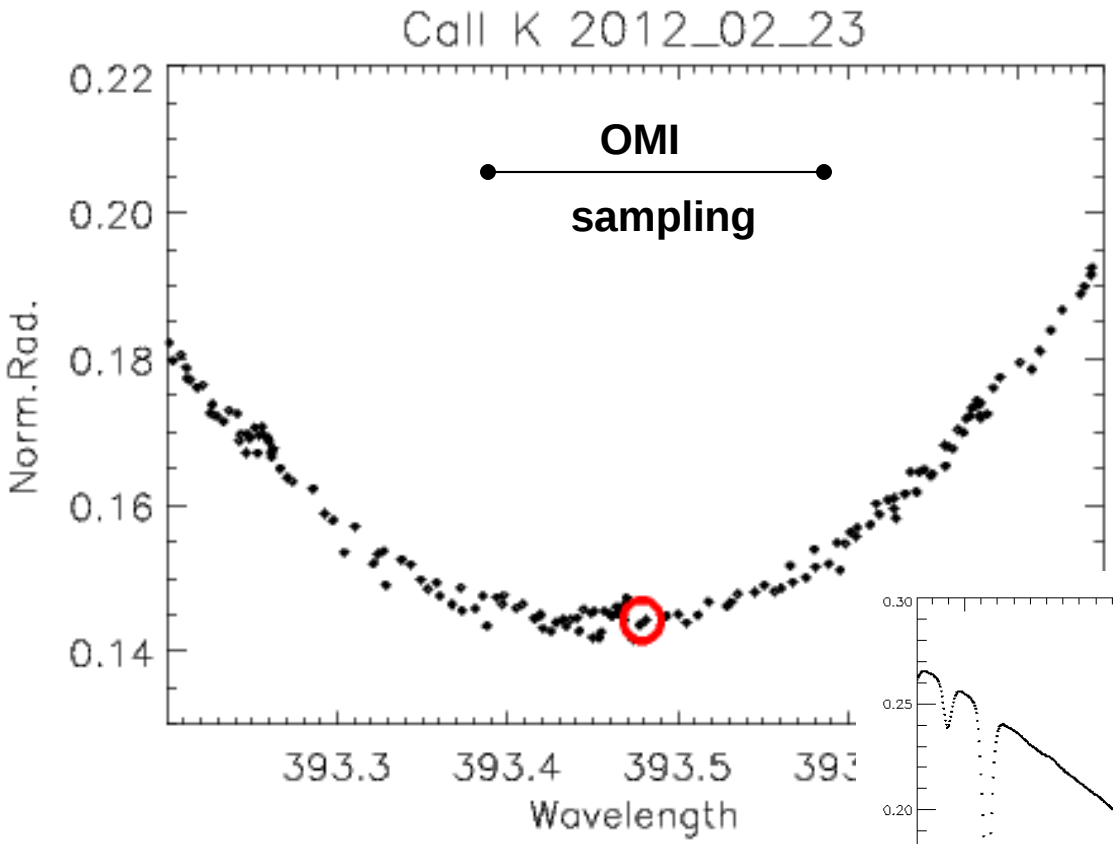
- ❖OMI solar measurements can produce high-quality data for long-term monitoring of solar UV activity.
- ❖Excellent instrument performance provides the unique combination of four indexes (Mg II, Mg I, Ca II K, Ca II H) on a daily basis.
- ❖OMI Ca II H & K index data can identify anomalous data points in ground-based solar measurements typically considered to be a reference standard.
- ❖OMI will continue to observe the unusual behavior of solar cycle 24.

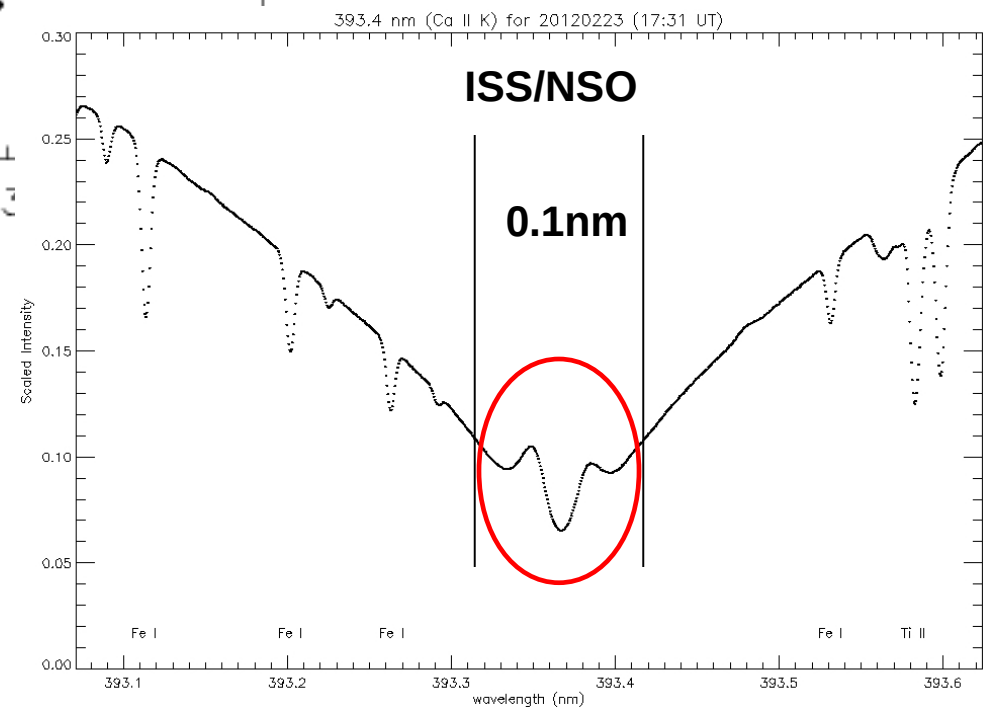
BACKUP


Solar MgII Index
SOLSTICE
GOME−2
SCIAMACHY
GOME−1
NOAA−16
NOAA−17
NOAA−18
OMI
0.270
0.265
0.260
0.255
0.250
0.245
Solar MgII Index
−3000
−2000
−1000
0
1000
2000
Time, (days since 2004.0)
Jan.2005
Jul.2005

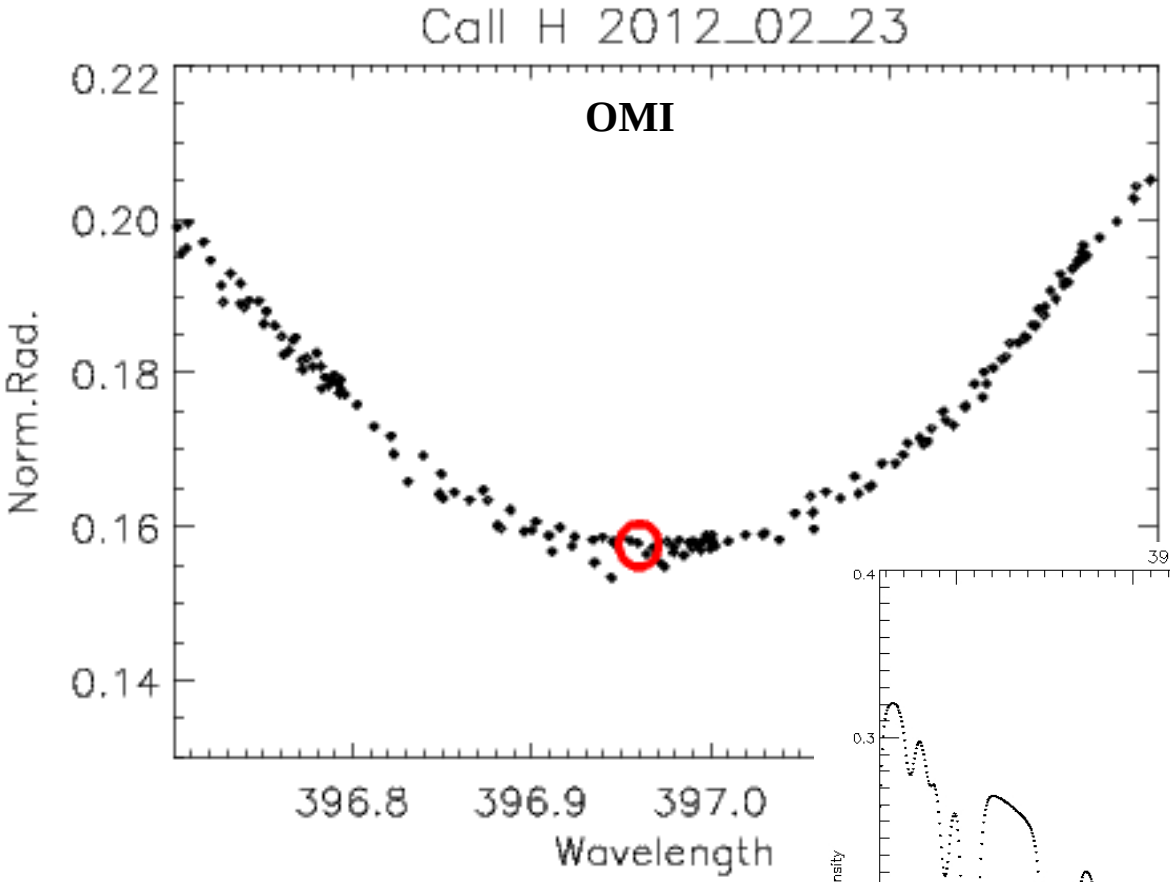


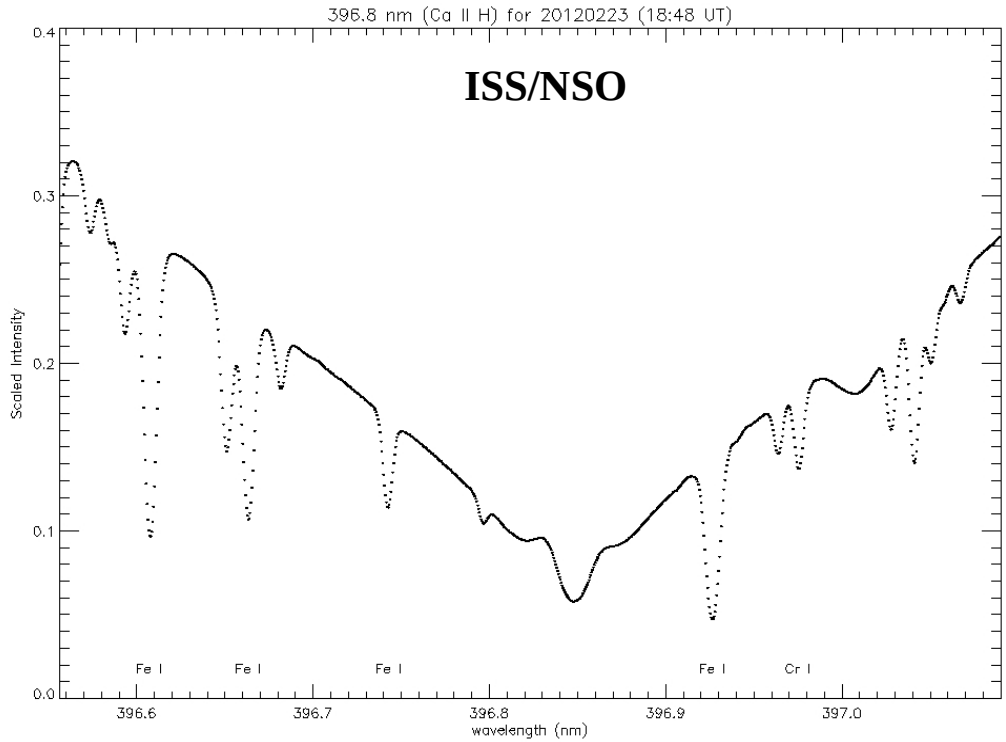
Provided on-line by M.Weber (http://www.iup.uni-bremen.de/gome/gomemgii.html)



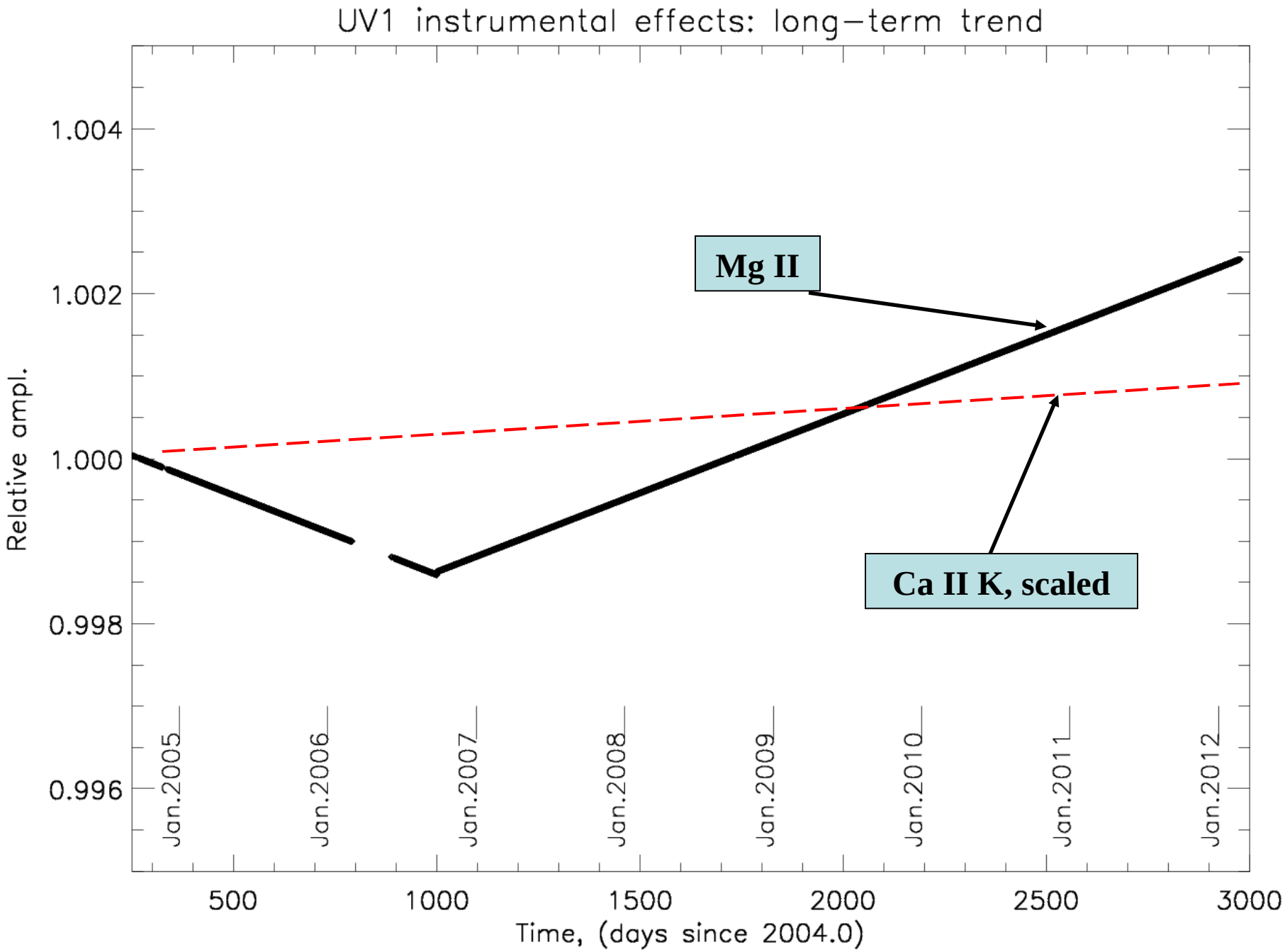


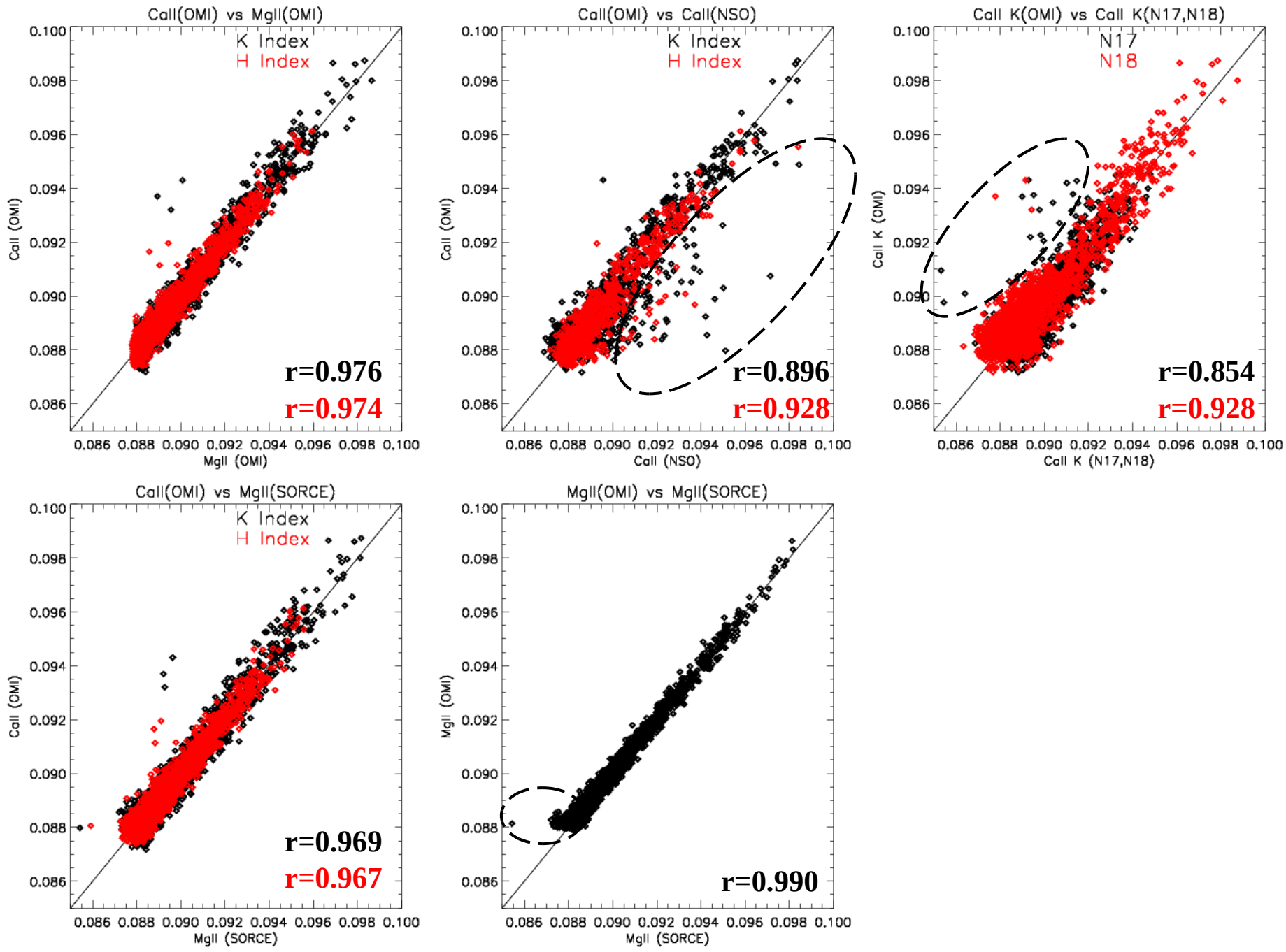
The NSO profile is provided at: http://solis.nso.edu/iss/

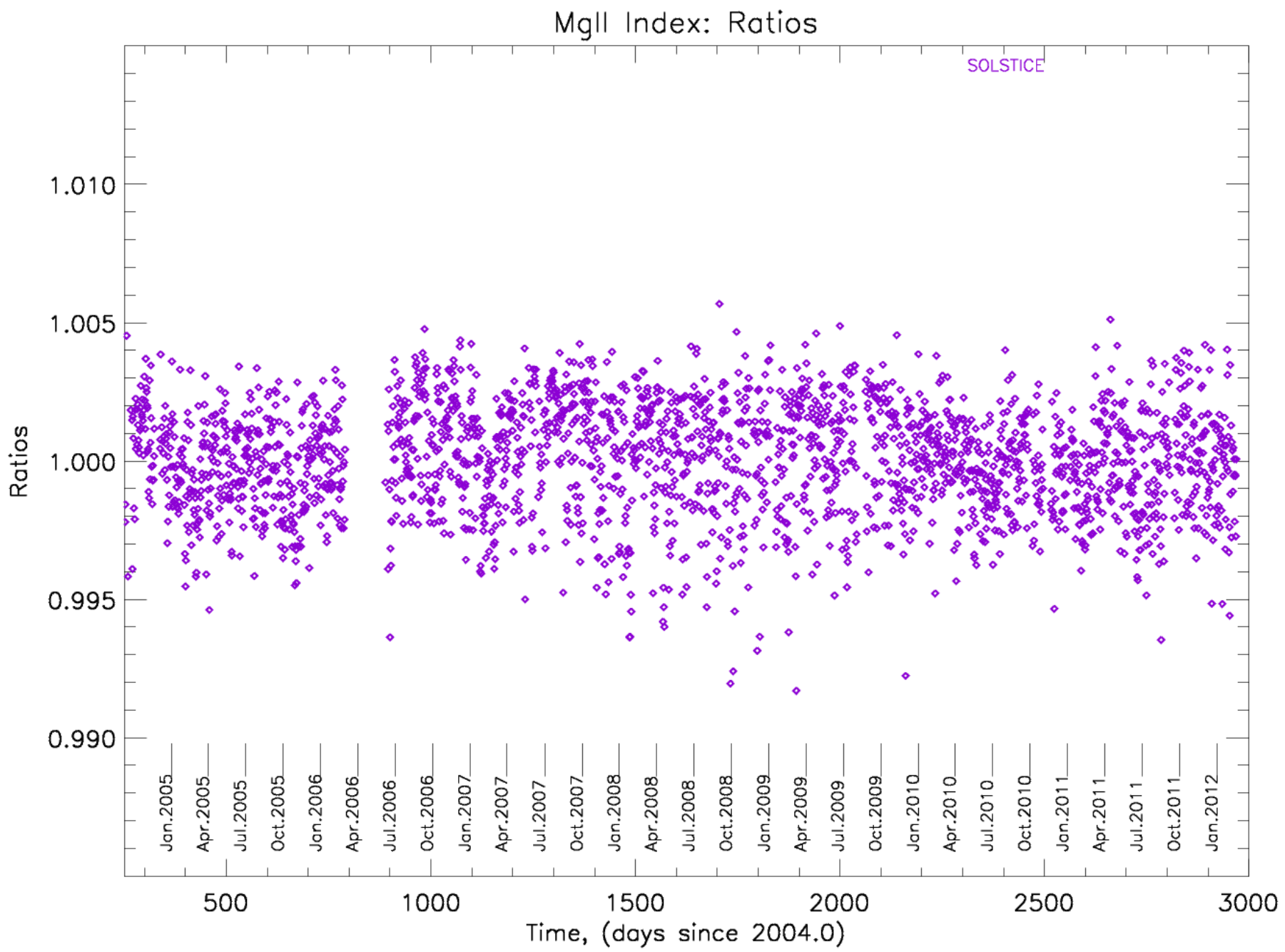


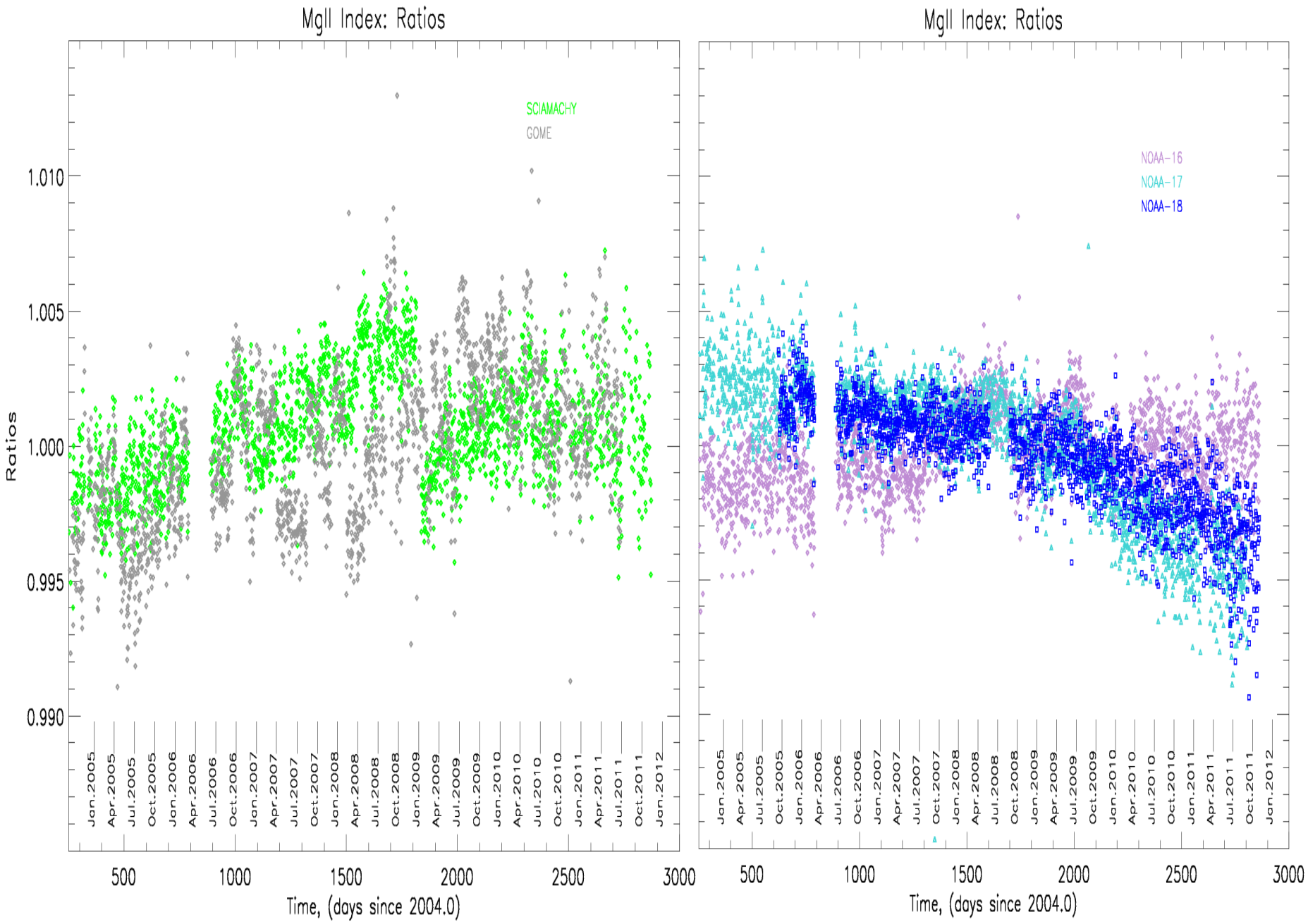


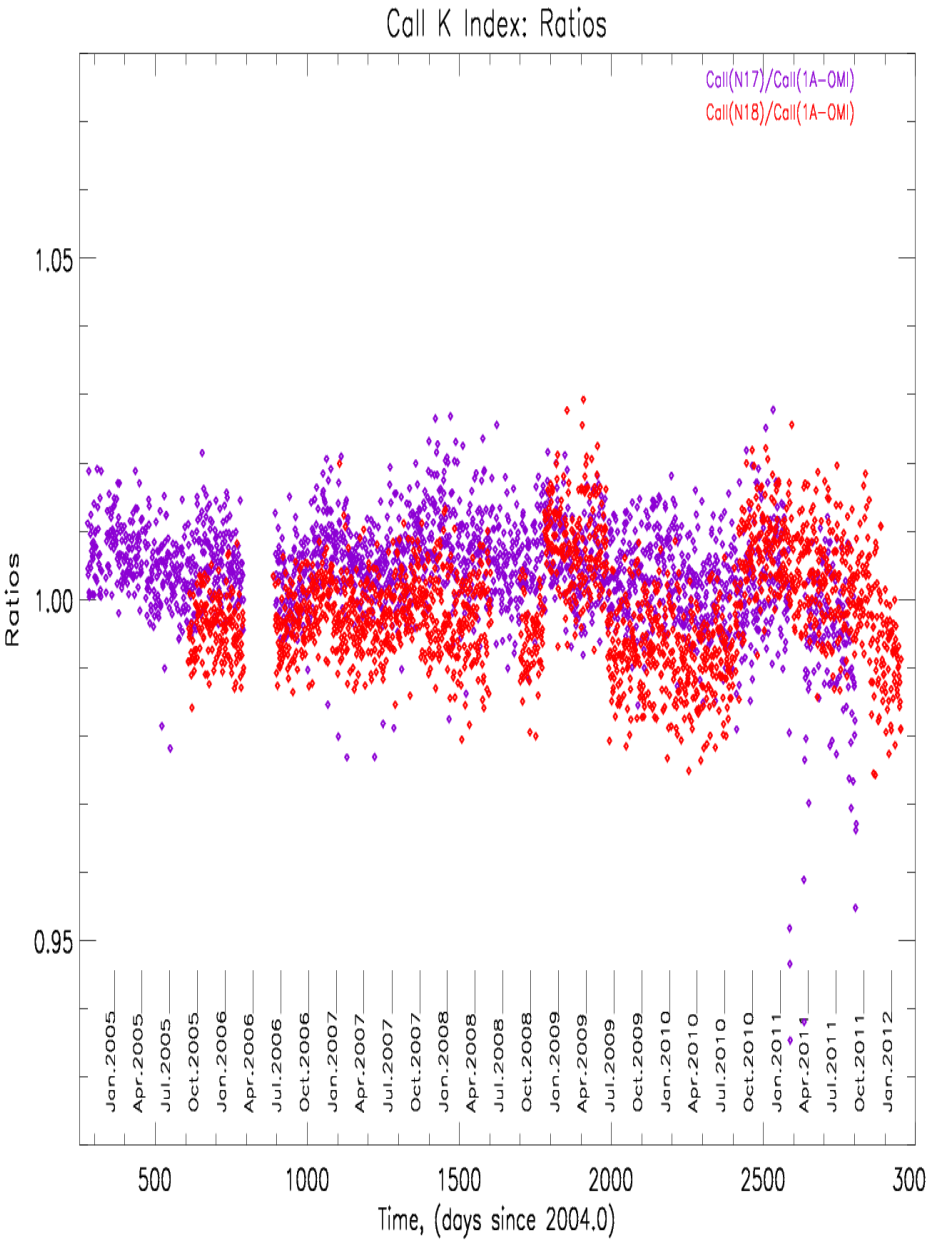
Copied from: http://solis.nso.edu/iss/

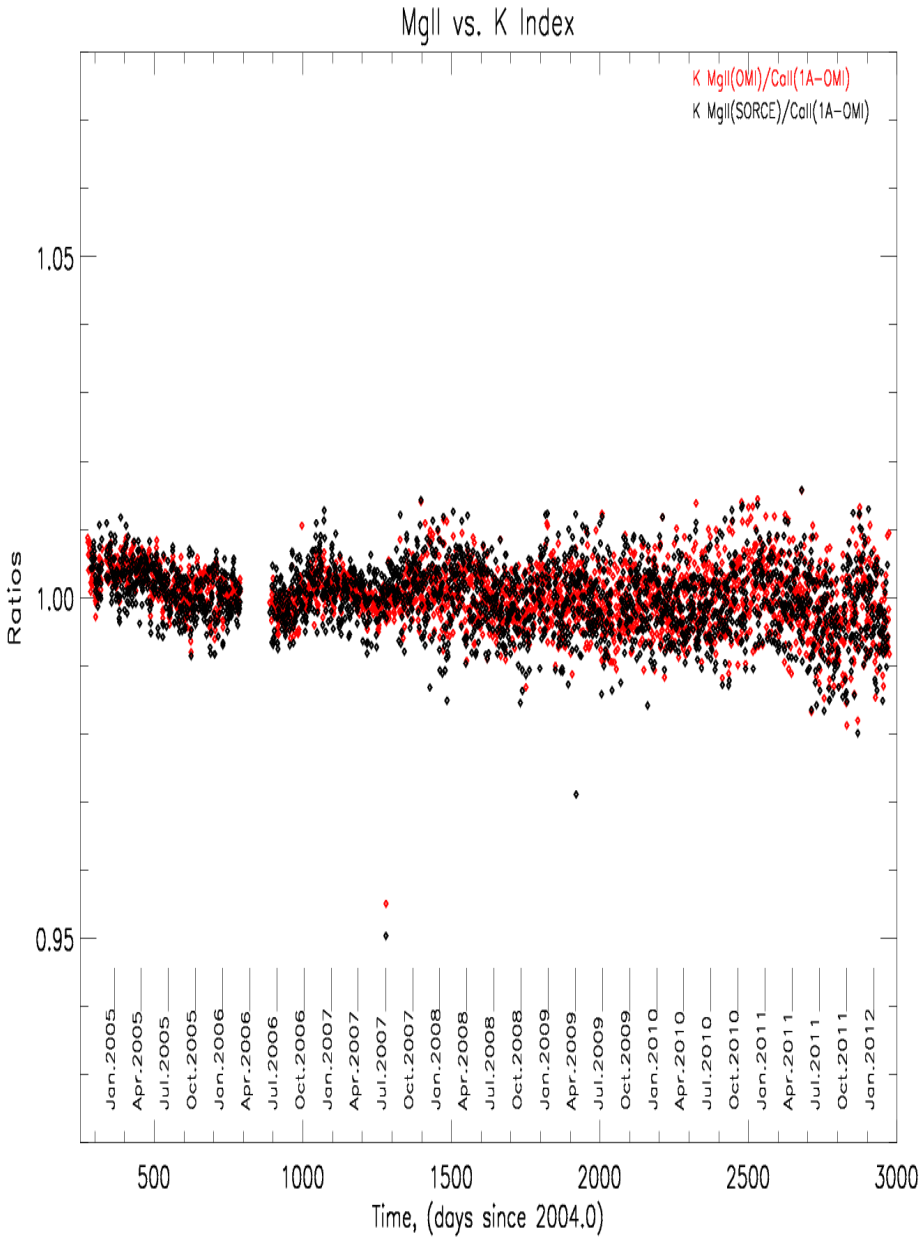

UV1 instrumental effects: long−term trend
Mg II
Ca II K, scaled
Relative ampl.
1.004
1.002
1.000
0.998
0.996
Jan.2005
Jan.2006
Jan.2007
Jan.2008
Jan.2009
Jan.2010
Jan.2011
Jan.2012
500
1000
1500
2000
2500
3000
Time, (days since 2004.0)

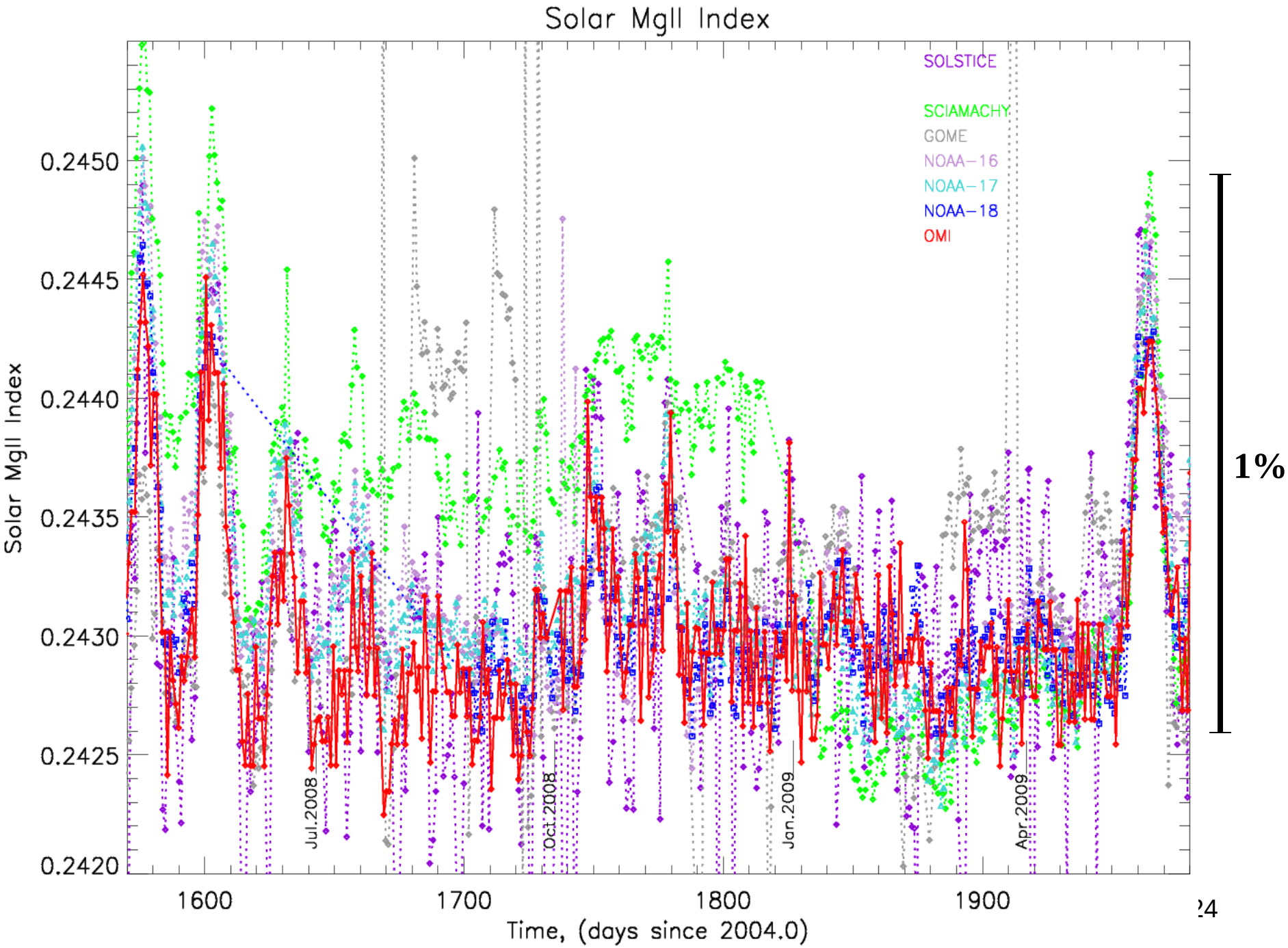

CaII(OMI) vs MgII(OMI)
K Index
H Index
r=0.976
r=0.974
CaII (OMI)
MgII (OMI)
CaII(OMI) vs CaII(NSO)
K Index
H Index
r=0.896
r=0.928
CaII (OMI)
CaII (NSO)
CaII K(OMI) vs CaII K(N17,N18)
N17
N18
r=0.854
r=0.928
CaII K (OMI)
CaII K (N17,N18)
CaII(OMI) vs MgII(SORCE)
K Index
H Index
r=0.969
r=0.967
CaII (OMI)
MgII (SORCE)
MgII(OMI) vs MgII(SORCE)
r=0.990
MgII (OMI)
MgII (SORCE)
0.086 0.088 0.090 0.092 0.094 0.096 0.098 0.100

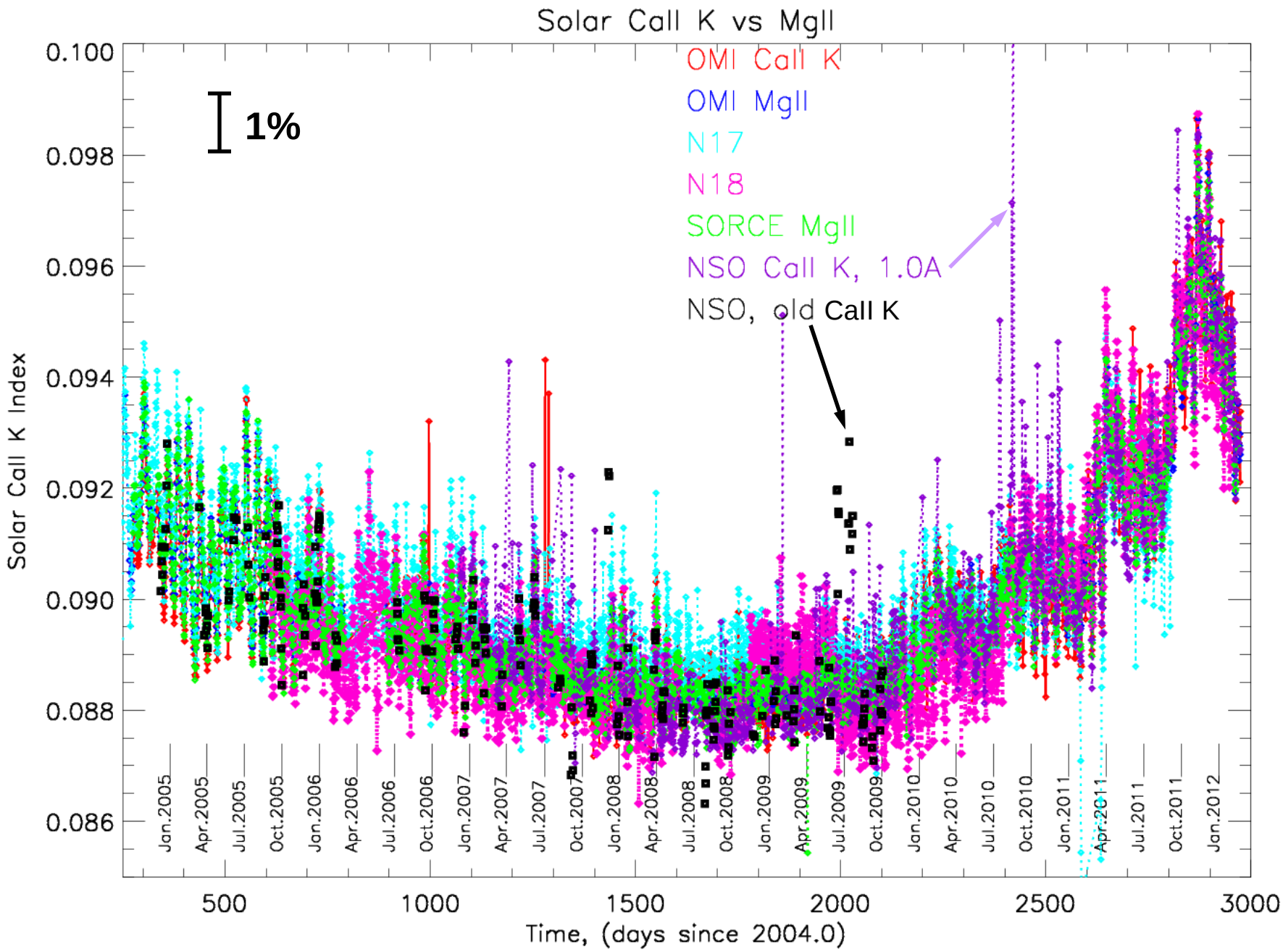

MgII Index: Ratios
SOLSTICE
Ratios
1.010
1.005
1.000
0.995
0.990
Jan.2005
Apr.2005
Jul.2005
Oct.2005
Jan.2006
Apr.2006
Jul.2006
Oct.2006
Jan.2007
Apr.2007
Jul.2007
Oct.2007
Jan.2008
Apr.2008
Jul.2008
Oct.2008
Jan.2009
Apr.2009
Jul.2009
Oct.2009
Jan.2010
Apr.2010
Jul.2010
Oct.2010
Jan.2011
Apr.2011
Jul.2011
Oct.2011
Jan.2012
500
1000
1500
2000
2500
3000
Time, (days since 2004.0)

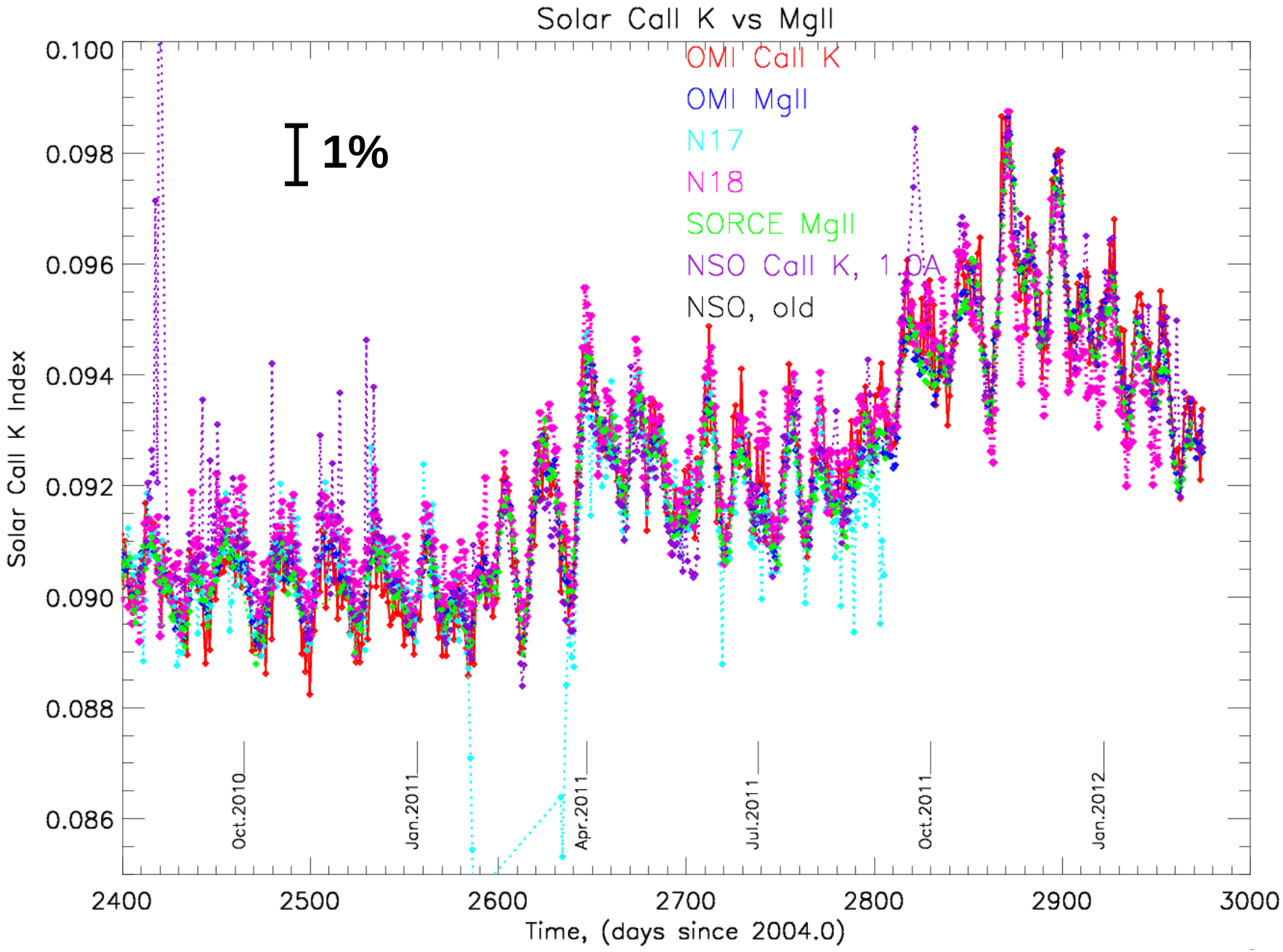

MgII Index: Ratios
SCIAMACHY
GOME
Ratios
1.010
1.005
1.000
0.995
0.990
Jan.2005
Apr.2005
Jul.2005
Oct.2005
Jan.2006
Apr.2006
Jul.2006
Oct.2006
Jan.2007
Apr.2007
Jul.2007
Oct.2007
Jan.2008
Apr.2008
Jul.2008
Oct.2008
Jan.2009
Apr.2009
Jul.2009
Oct.2009
Jan.2010
Apr.2010
Jul.2010
Oct.2010
Jan.2011
Apr.2011
Jul.2011
Oct.2011
Jan.2012
500
1000
1500
2000
2500
3000
Time, (days since 2004.0)
MgII Index: Ratios
NOAA-16
NOAA-17
NOAA-18
Time, (days since 2004.0)


CaII K Index: Ratios
CaII(N17)/CaII(1A-OMI)
CaII(N18)/CaII(1A-OMI)
Ratios
1.05
1.00
0.95
Jan.2005
Apr.2005
Jul.2005
Oct.2005
Jan.2006
Apr.2006
Jul.2006
Oct.2006
Jan.2007
Apr.2007
Jul.2007
Oct.2007
Jan.2008
Apr.2008
Jul.2008
Oct.2008
Jan.2009
Apr.2009
Jul.2009
Oct.2009
Jan.2010
Apr.2010
Jul.2010
Oct.2010
Jan.2011
Apr.2011
Jul.2011
Oct.2011
Jan.2012
500
1000
1500
2000
2500
300
Time, (days since 2004.0)


MgII vs. K Index
K MgII(OMI)/CaII(1A-OMI)
K MgII(SORCE)/CaII(1A-OMI)
Ratios
1.05
1.00
0.95
Jan.2005
Apr.2005
Jul.2005
Oct.2005
Jan.2006
Apr.2006
Jul.2006
Oct.2006
Jan.2007
Apr.2007
Jul.2007
Oct.2007
Jan.2008
Apr.2008
Jul.2008
Oct.2008
Jan.2009
Apr.2009
Jul.2009
Oct.2009
Jan.2010
Apr.2010
Jul.2010
Oct.2010
Jan.2011
Apr.2011
Jul.2011
Oct.2011
Jan.2012
500
1000
1500
2000
2500
3000
Time, (days since 2004.0)


Solar MgII Index
SOLSTICE
SCIAMACHY
GOME
NOAA−16
NOAA−17
NOAA−18
OMI
0.2450
0.2445
0.2440
0.2435
0.2430
0.2425
0.2420
Solar MgII Index
Jul.2008
Oct.2008
Jan.2009
Apr.2009
1600
1700
1800
1900
Time, (days since 2004.0)
1%


Solar CaII K vs MgII
OMI CaII K
OMI MgII
N17
N18
SORCE MgII
NSO CaII K, 1.0A
NSO, old CaII K
1%
Solar CaII K Index
0.100
0.098
0.096
0.094
0.092
0.090
0.088
0.086
Jan.2005
Apr.2005
Jul.2005
Oct.2005
Jan.2006
Apr.2006
Jul.2006
Oct.2006
Jan.2007
Apr.2007
Jul.2007
Oct.2007
Jan.2008
Apr.2008
Jul.2008
Oct.2008
Jan.2009
Apr.2009
Jul.2009
Oct.2009
Jan.2010
Apr.2010
Jul.2010
Oct.2010
Jan.2011
Apr.2011
Jul.2011
Oct.2011
Jan.2012
500
1000
1500
2000
2500
3000
Time, (days since 2004.0)


Solar CaII K vs MgII
OMI CaII K
OMI MgII
N17
N18
SORCE MgII
NSO CaII K, 1.0A
NSO, old
1%
Solar CaII K Index
0.100
0.098
0.096
0.094
0.092
0.090
0.088
0.086
Oct.2010
Jan.2011
Apr.2011
Jul.2011
Oct.2011
Jan.2012
2400
2500
2600
2700
2800
2900
3000
Time, (days since 2004.0)