STATUS OF NASA LANGLEY TRIANA RESEARCH

- **NISTAR CORRECTION FACTORS**
- **EPIC SIMULATIONS FOR CLOUD STUDIES**
- **CLOUD PHASE/SHAPE DETERMINATIONS**
- **MULTISATELITE, MULTIVIEW DATASETS**

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NISTAR CORRECTIONS FOR EACH OBSERVATION

OBJECTIVES

- **COMPUTE GLOBAL ALBEDO**
  - **ACCOUNT FOR ANISOTROPY (BRDF)**
  - **ACCOUNT FOR MISSING LIGHT**

- **COMPUTE GLOBAL LONGWAVE FLUX (OLR)**
  - **ACCOUNT FOR LIMB-DARKENING**
  - **ACCOUNT FOR DARK SIDE OF EARTH (OLR CORRECTION FACTOR)**

- **TO COMPUTE ERBE OLR AT TRIANA TIME FROM THE TWO CLOSEST ERBE OBSERVATIONS**

  LINEAR INTERPOLATION FOR OCEAN, SNOW AND COAST

  ERBE HALF SINE FIT FOR LAND AND DESERT

- **TRIANA REGIONAL (2.5°lat x 2.5°lon) OLR**

$$\mathbf{OLR}_{triana}(t_T) = \mathbf{OLR}_{erbe}(t_T)$$

- **TRIANA REGIONAL (2.5°lat x 2.5°lon) LONGWAVE RADIANCE**

$$\mathbf{RAD}_{triana}(t_T, vz_T, lat_T, season_T, scene_T) = \mathbf{OLR}_{erbe}(t_T)\,\gamma(t_T, vz_T, lat_T, season_T, scene_T)$$

$\gamma = \pi$ **RAD** / **OLR,** where $\gamma = 1$ for lambertion surface

• TRIANA GLOBAL OLR AND LONGWAVE RADIANCE

$$\mathbf{OLR}_{triana}(\mathbf{gmt}) = \sum_{earth}^{vz<90} \mathbf{OLR}_{triana}(\mathbf{t}_T)\cos(\mathbf{lat}_i) \Big/ \sum_{earth}^{vz<90} \cos(\mathbf{lat}_i)$$

$$\mathbf{RAD}_{triana}(\mathbf{gmt}) = \sum_{earth}^{vz<90} \mathbf{RAD}_{triana}(\mathbf{t}_T, \mathbf{vz}_T, \mathbf{lat}_T, \mathbf{season}_T, \mathbf{scene}_T)\cos(\mathbf{lat}_i) \Big/ \sum_{earth}^{vz<90} \cos(\mathbf{lat}_i)$$

$\cos(\mathbf{lat}_i)$ accounts for area weighting

• TRIANA GLOBAL LIMB DARKENING FACTOR

$$\gamma_{triana}(\mathbf{gmt}) = \mathbf{RAD}_{triana}(\mathbf{gmt}) \;/\; \mathbf{OLR}_{triana}(\mathbf{gmt})$$

• TRIANA GLOBAL NIGHT OLR CORRECTION FACTOR

$$\mathbf{OLR}_{FACTOR}(\mathbf{gmt}) = \Big[\sum_{earth} \mathbf{OLR}_{erbe}(\mathbf{t}_T)\cos(\mathbf{lat}_i) \Big/ \sum_{earth} \cos(\mathbf{lat}_i)\Big] \;/\; \big[\mathbf{OLR}_{triana}(\mathbf{gmt})\big]$$

- **TO COMPUTE ERBE ALBEDO AT TRIANA TIME FROM THE TWO CLOSEST ERBE OBSERVATIONS**

$$\alpha_{erbe}(\mu_T) = w_1 \sum_{i=1}^{4} \alpha_{erbe}(\mu_1)\, \delta_i(\mu_T)/\delta_i(\mu_1) + w_2 \sum_{i=1}^{4} \alpha_{erbe}(\mu_2)\, \delta_i(\mu_T)/\delta_i(\mu_2)$$

$$w_1 = (t_2 - t_T) / (t_2 - t_1),\ w_2 = (t_T - t_1) / (t_2 - t_1)$$

δ_i = ERBE SW directional model 1=clear, 2=partly cloudy, 3=mostly cloudy, 4=overcast

- **TRIANA REGIONAL ALBEDO (2.5°lat x 2.5°lon) REGION**

$$\alpha_{triana}(\mu_T) = \alpha_{erbe}(\mu_T)$$

- **TRIANA REGIONAL REFLECTANCE (2.5°lat x 2.5°lon) REGION**

$$\mathbf{REF}_{triana}(\mu_T, \mathbf{vz}_T, \mathbf{ra}_T, \mathbf{scene}_T) = \alpha_{erbe}(\mu_T)\, \chi(\mu_T, \mathbf{vz}_T, \mathbf{ra}_T, \mathbf{scene}_T)$$

• TRIANA GLOBAL ALBEDO AND REFLECTANCE

$$\alpha_{triana}(\mathbf{gmt}) = \sum_{earth}^{vz<90} \alpha_{triana}(\mu_i)\, \mu_i \cos(\mathbf{lat}_i) \Big/ \sum_{earth}^{vz<90} \mu_i \cos(\mathbf{lat}_i)$$

$$\mathbf{REF}_{triana}(\mathbf{gmt}) = \sum_{earth}^{vz<90} \mathbf{REF}_{triana}(\mu_T, \mathbf{vz}_T, \mathbf{ra}_T, \mathbf{scene}_T)\, \mu_i \cos(\mathbf{lat}_i) \Big/ \sum_{earth}^{vz<90} \mu_i \cos(\mathbf{lat}_i)$$

$\mu_i \cos(\mathbf{lat}_i)$ accounts for solar insolation and area weighting

• TRIANA GLOBAL BIDIRECTIONAL FACTOR

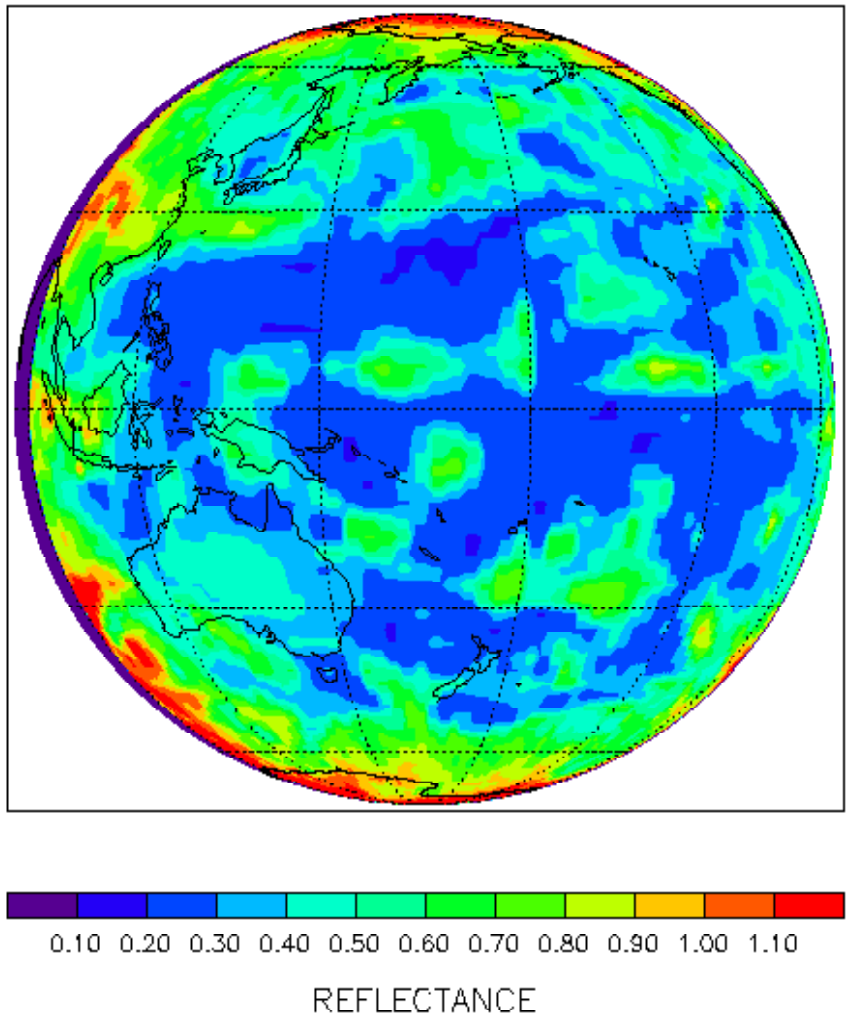
$$\chi_{triana}(\mathbf{gmt}) = \mathbf{REF}_{triana}(\mathbf{gmt}) \,/\, \alpha_{triana}(\mathbf{gmt})$$

• TRIANA GLOBAL MISSING LIGHT ALBEDO CORRECTION FACTOR

$$\alpha_{FACTOR}(\mathbf{gmt}) = \left[\sum_{earth} \alpha_{erbe}(\mu_i)\, \mu_i \cos(\mathbf{lat}_i) \Big/ \sum_{earth} \mu_i \cos(\mathbf{lat}_i) \right] \Big/ \left[\alpha_{triana}(\mathbf{gmt}) \right]$$

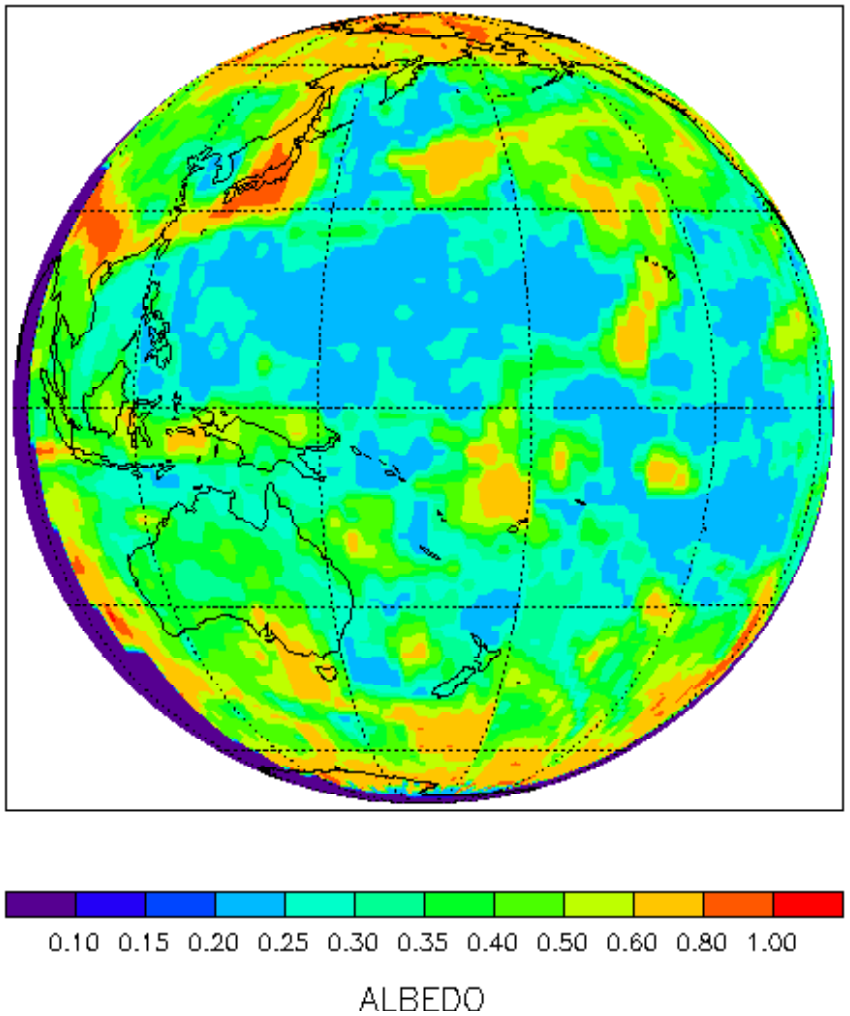
Triana Project

TRIANA VIEWED REFLECTANCE AT (−0.16,165) FOR March, 21,1986



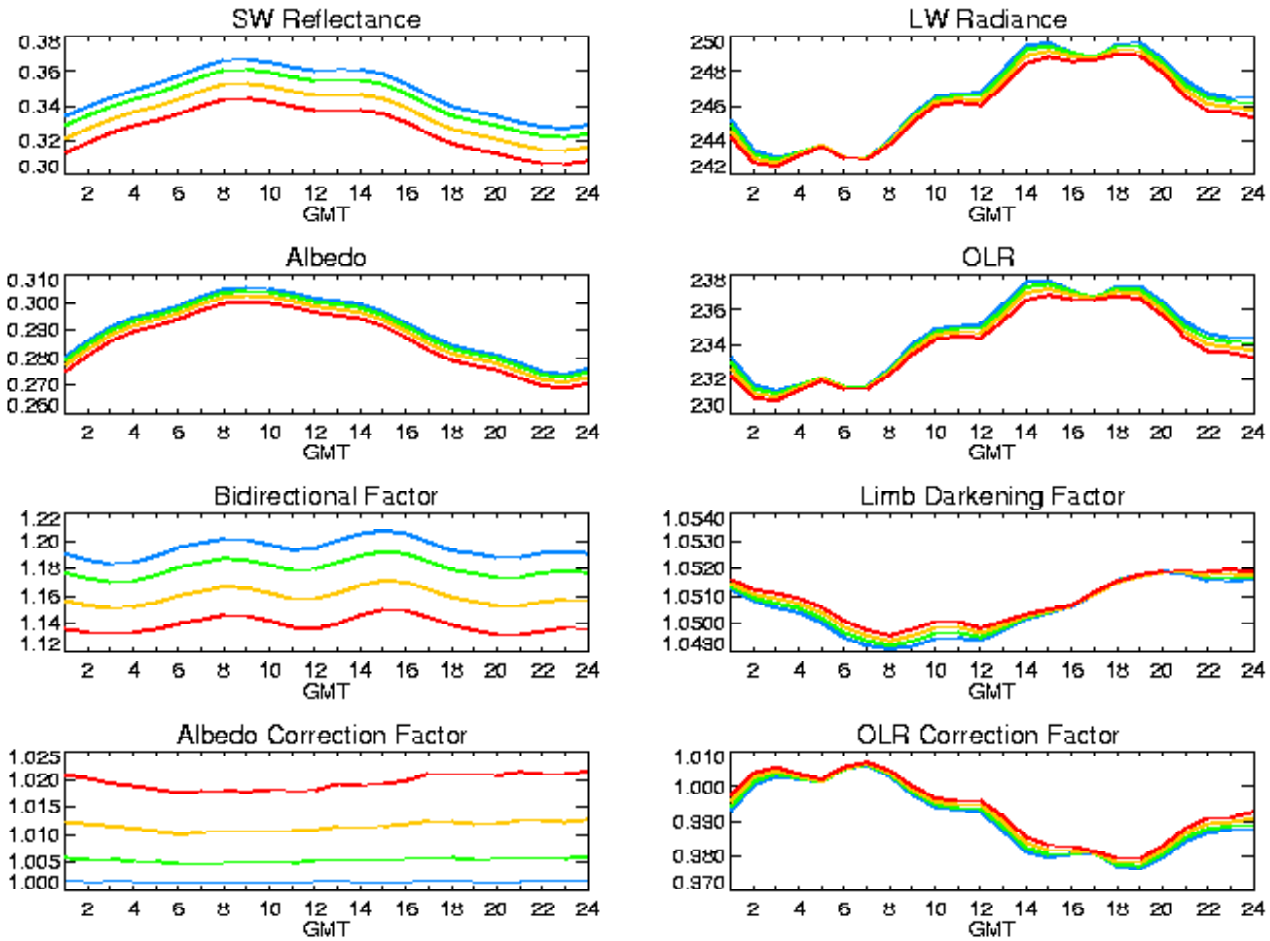
Triana Project

TRIANA VIEWED ALBEDO AT (9.08,164.81) FOR April. 15,1986



Triana Project

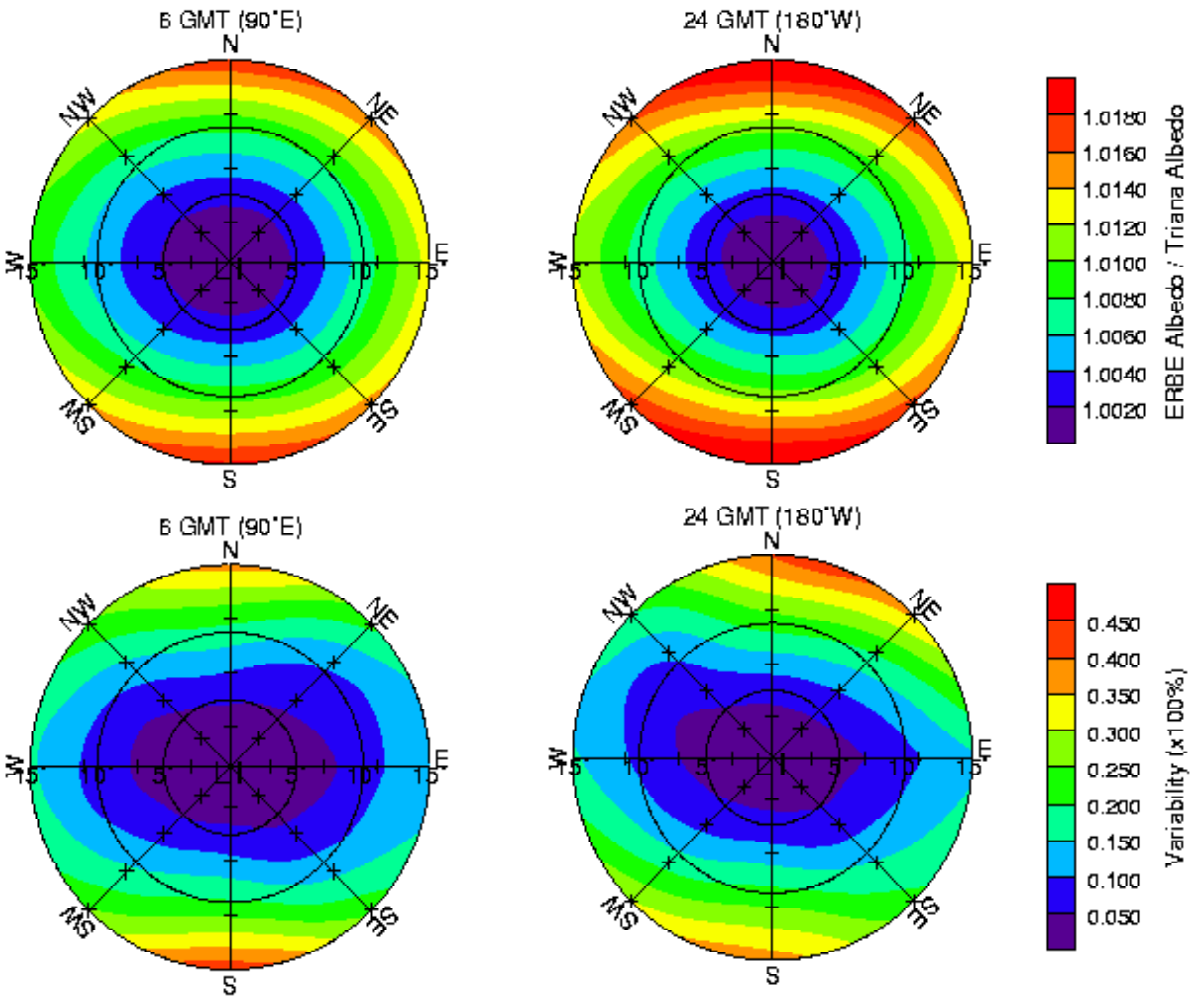
Diurnal variation of mean global Triana parameters as function of degrees North of L1 for March 1986



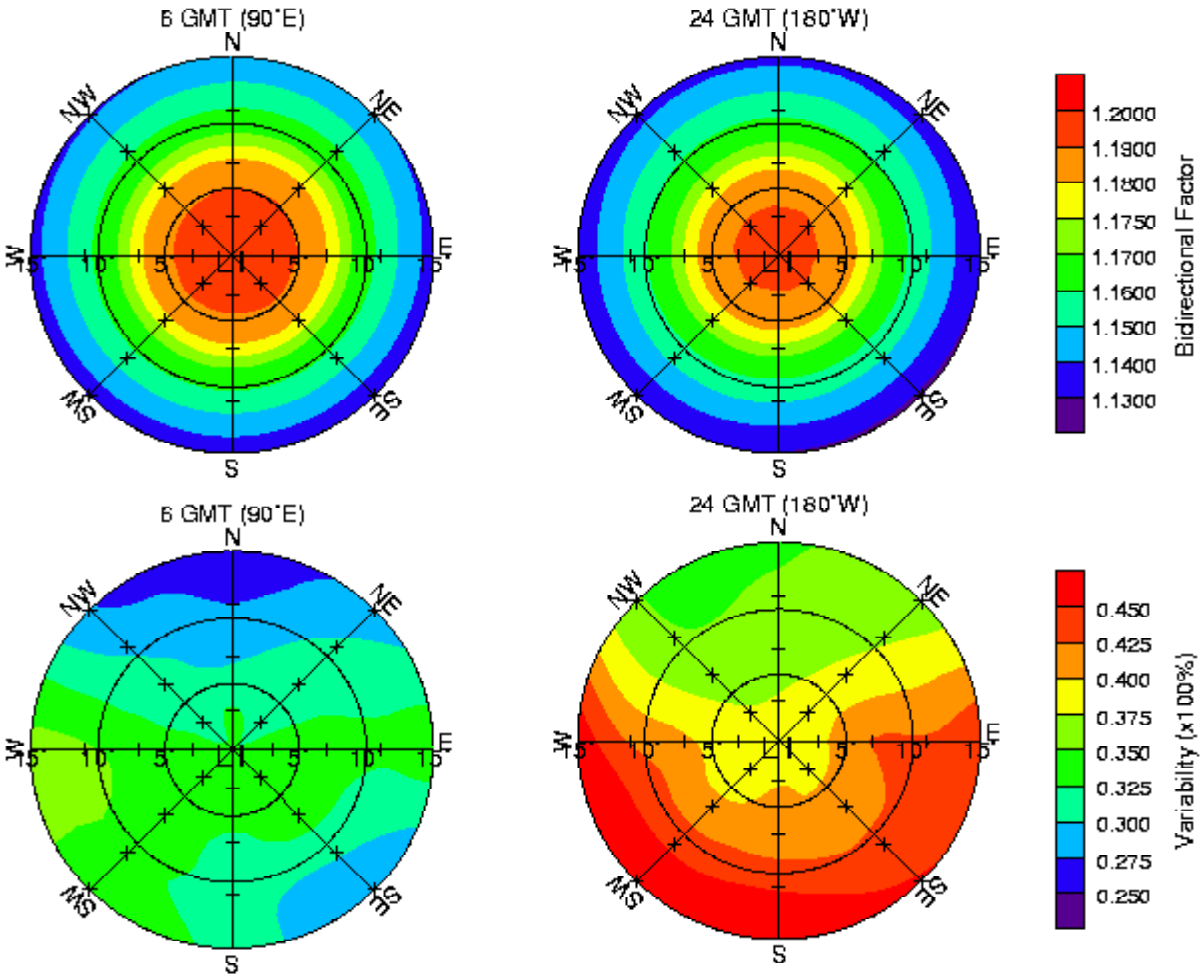
Red line =15.0, Yellow line =11.0, Green line =7.0 and Blue line =3.0

Triana Project

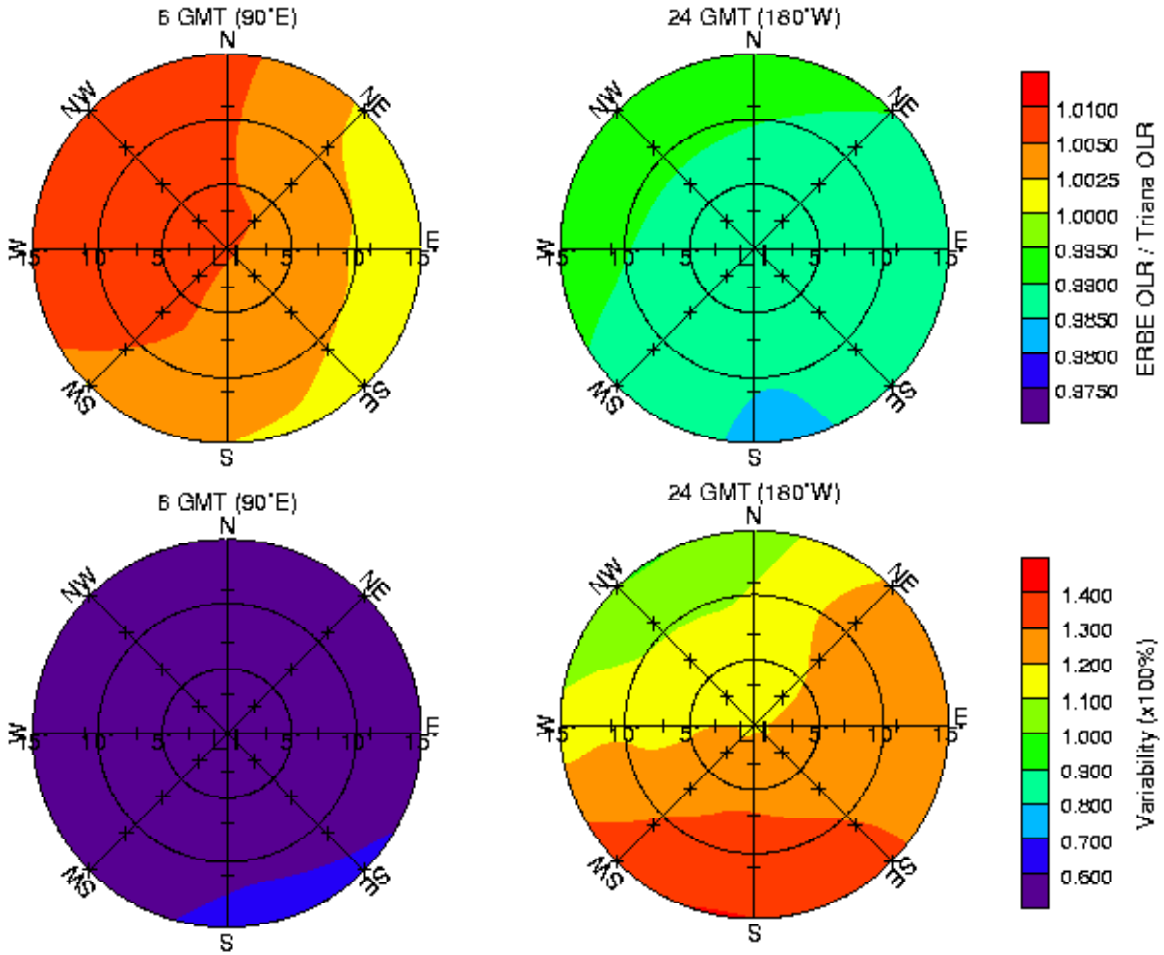
Mean and standard deviation of global missing light albedo correction factor as a function of GMT and degrees from L1 for March 1986



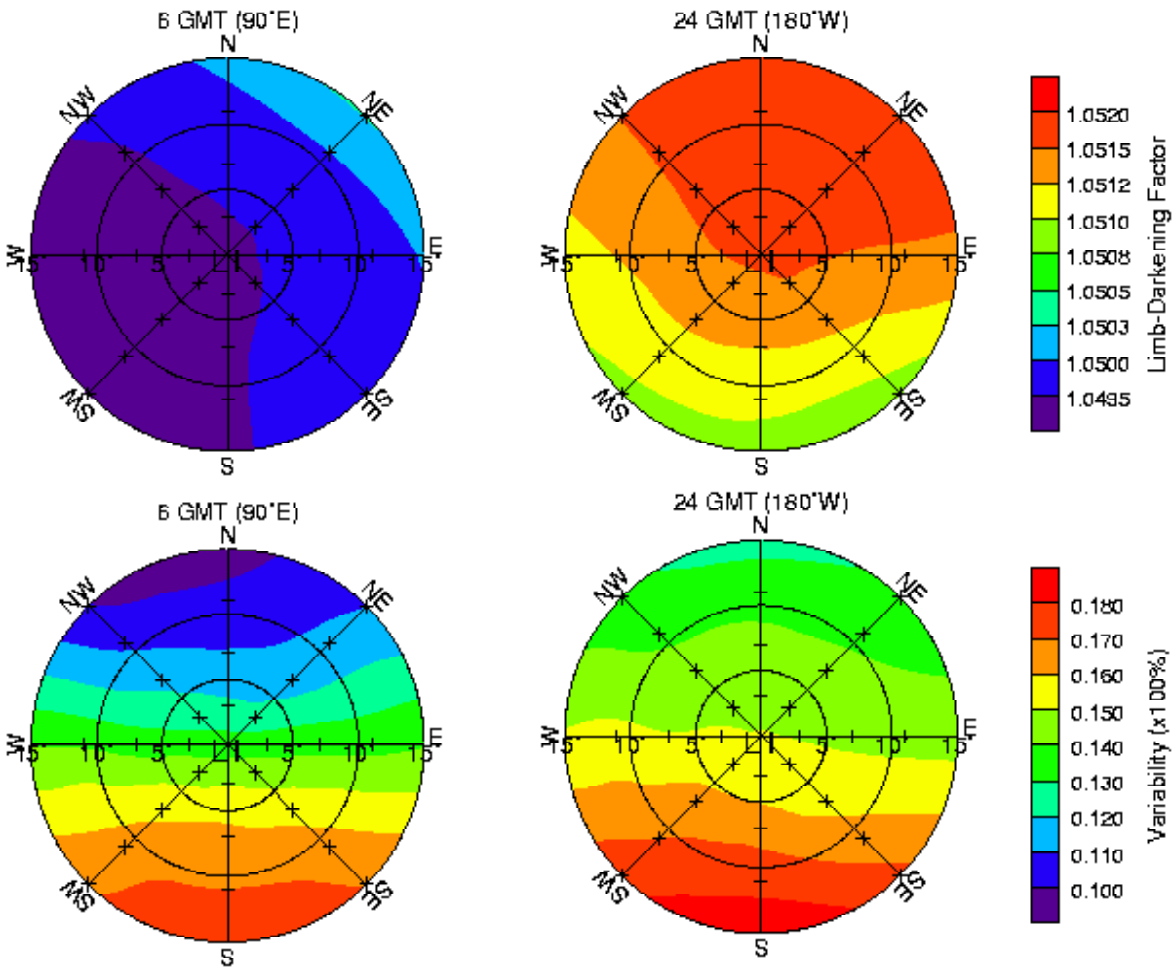
Mean and standard deviation of global bidirectional factor
as a function of GMT and degrees from L1 for March 1986

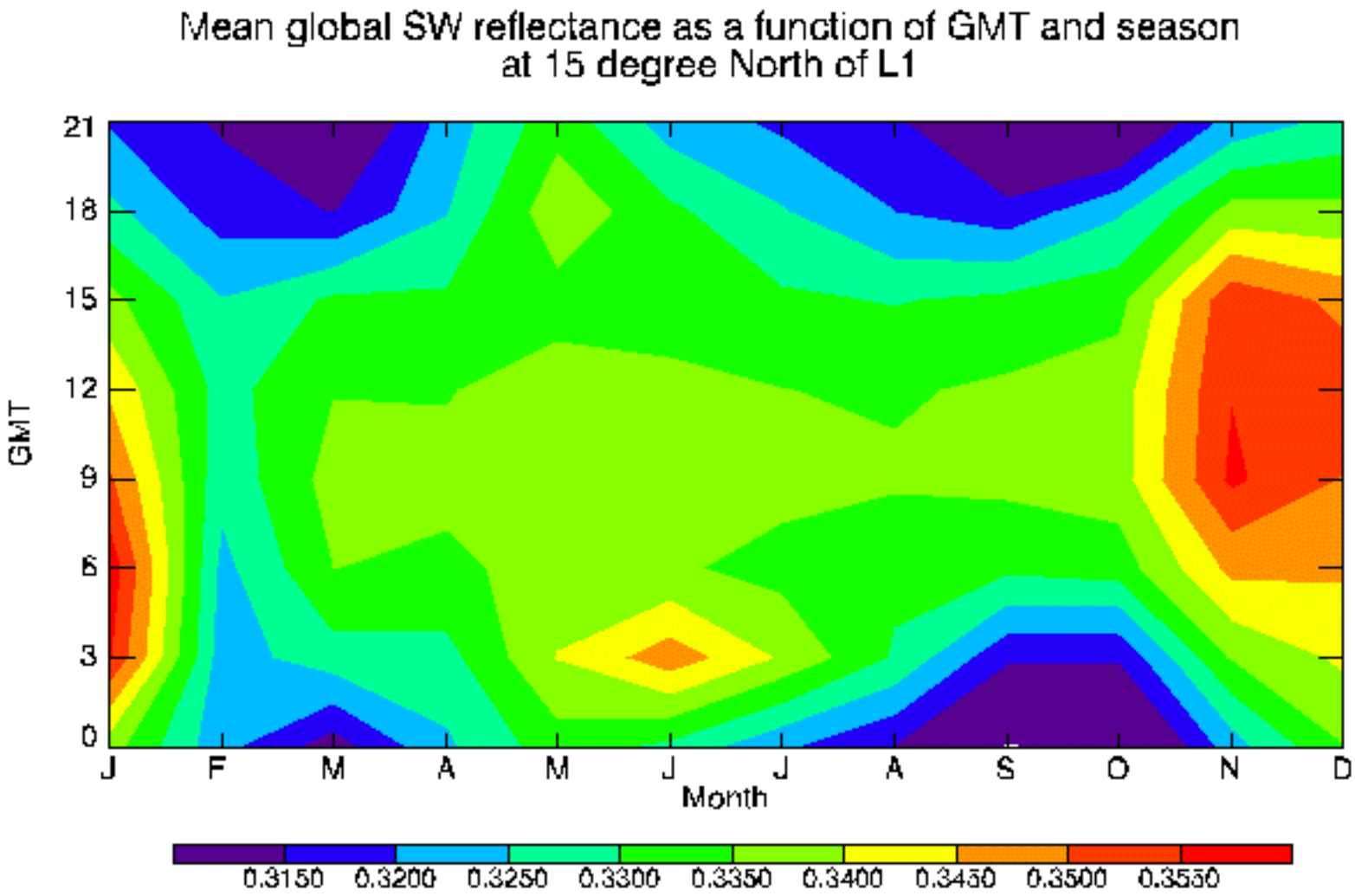


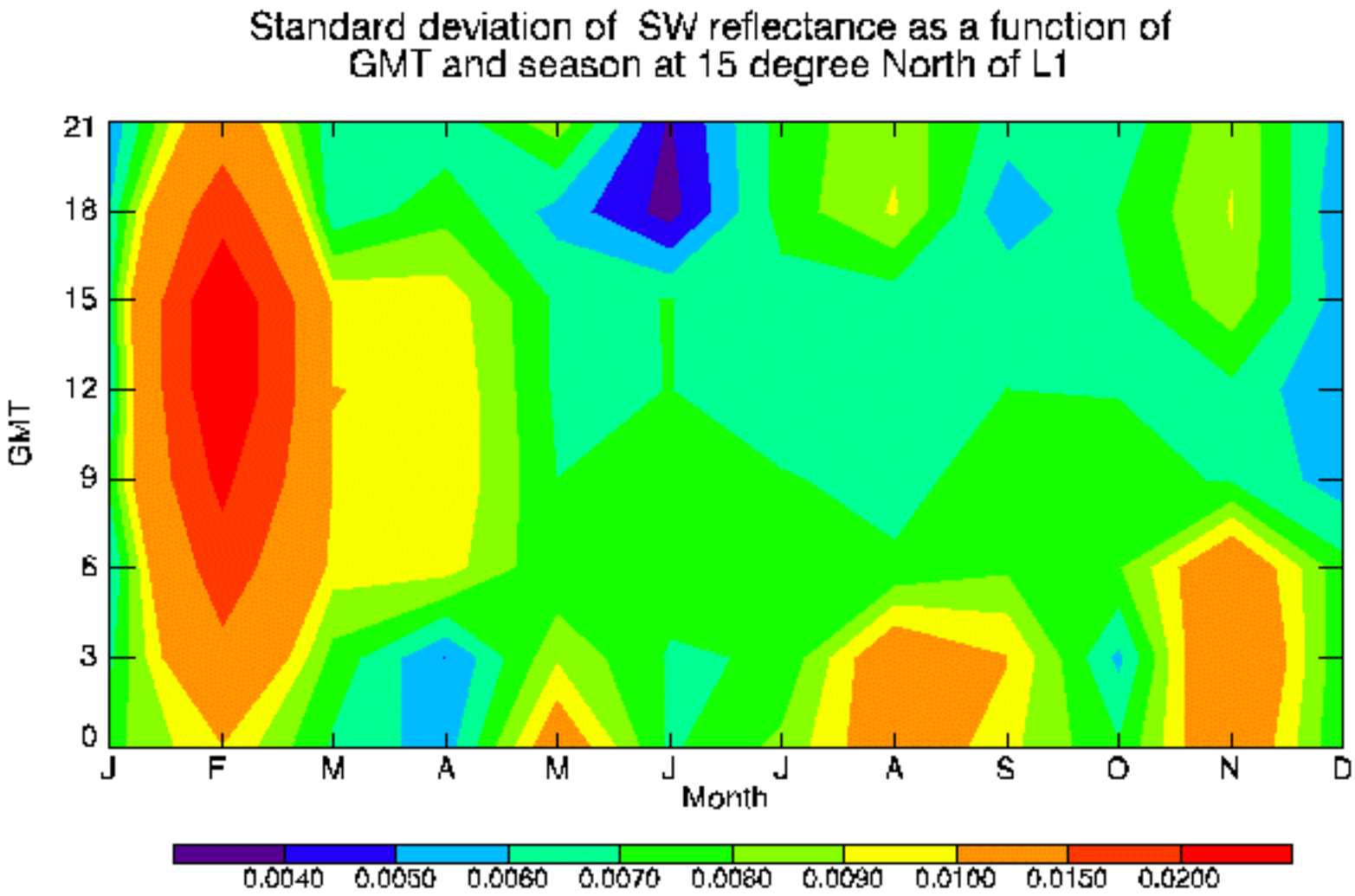
Mean and standard deviation of global OLR correction factor
as a function of GMT and degrees from L1 for March 1986

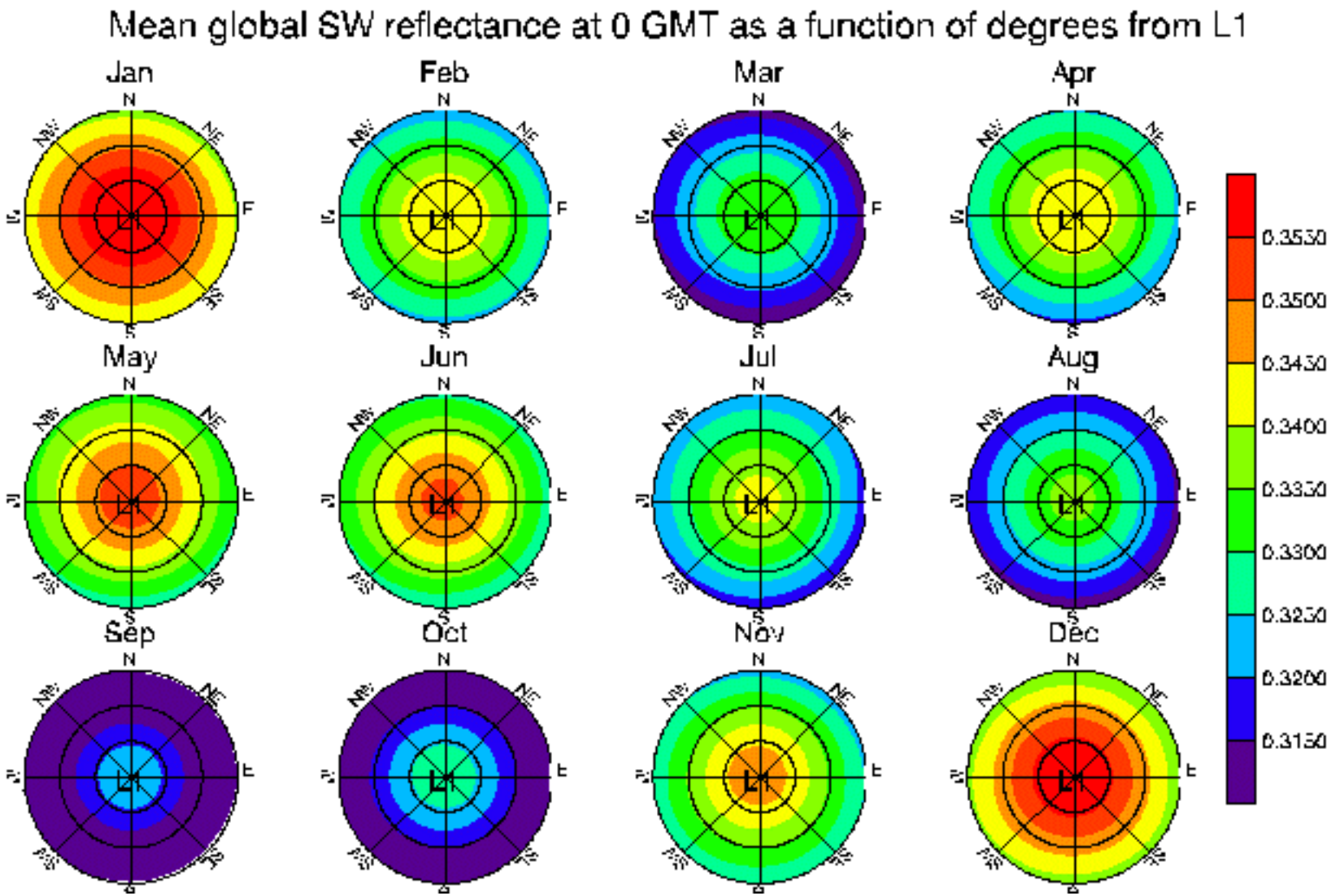


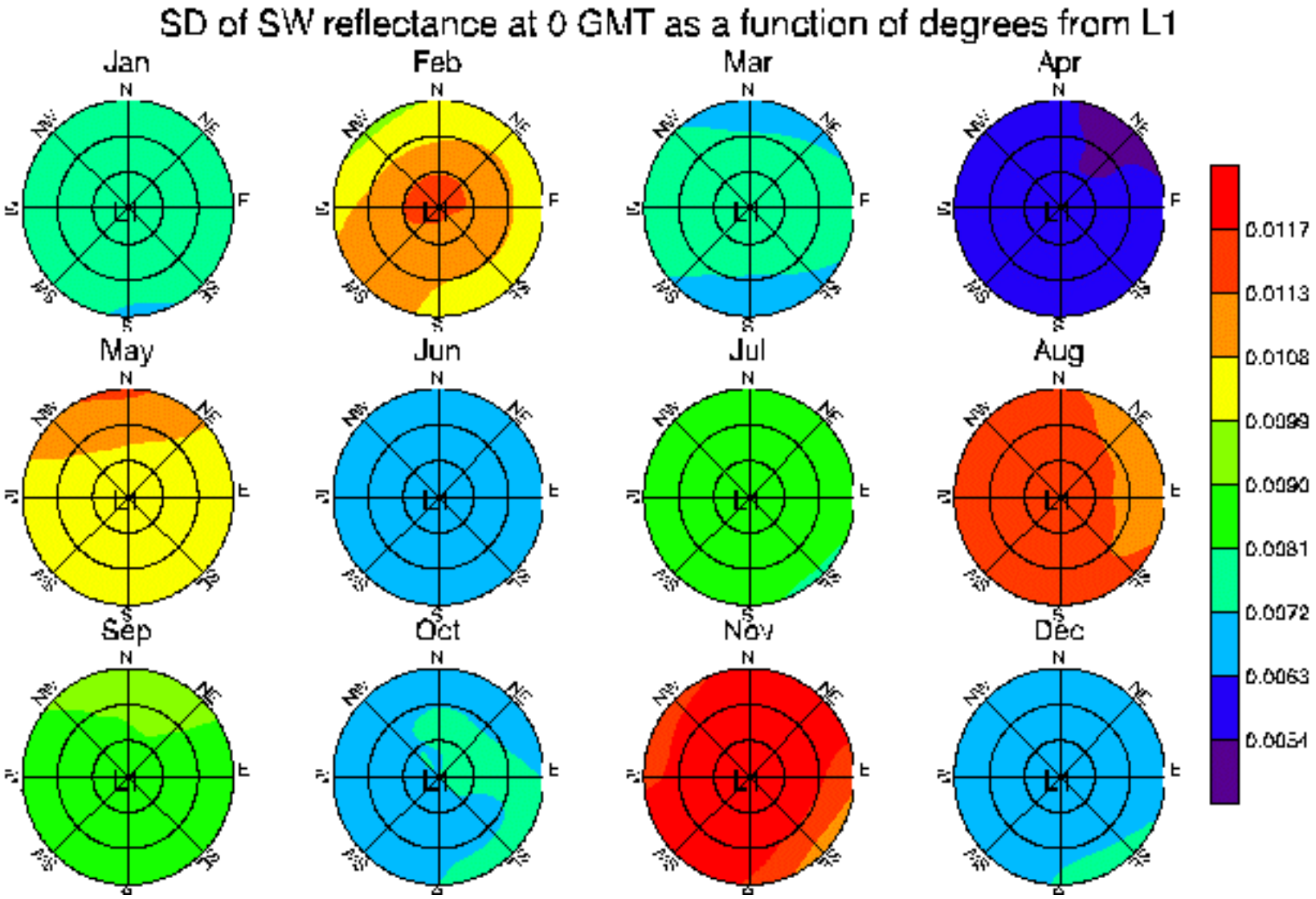
Mean and standard deviation of global Limb-Darkening factor
as a function of GMT and degrees from L1 for March 1986

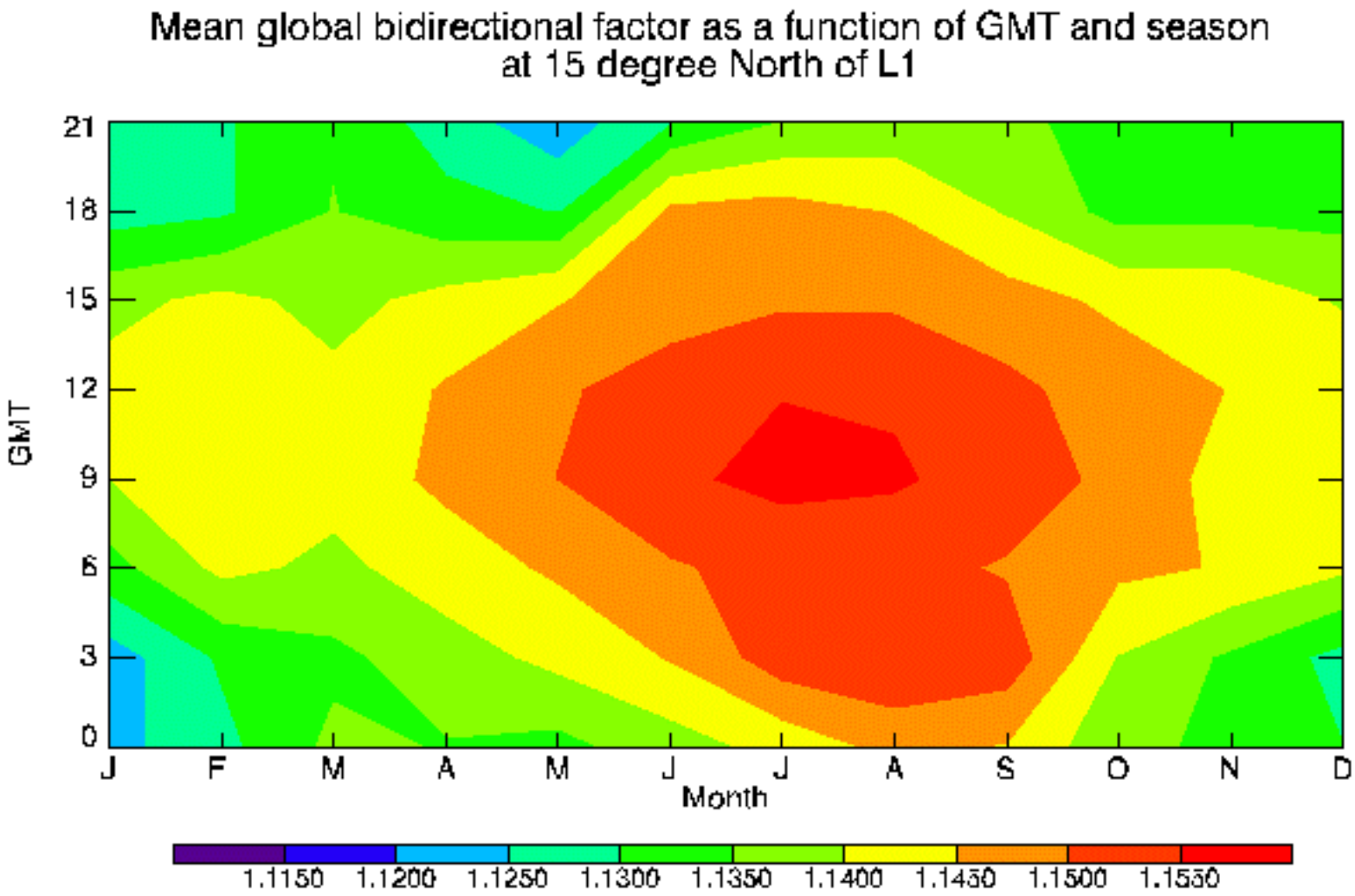


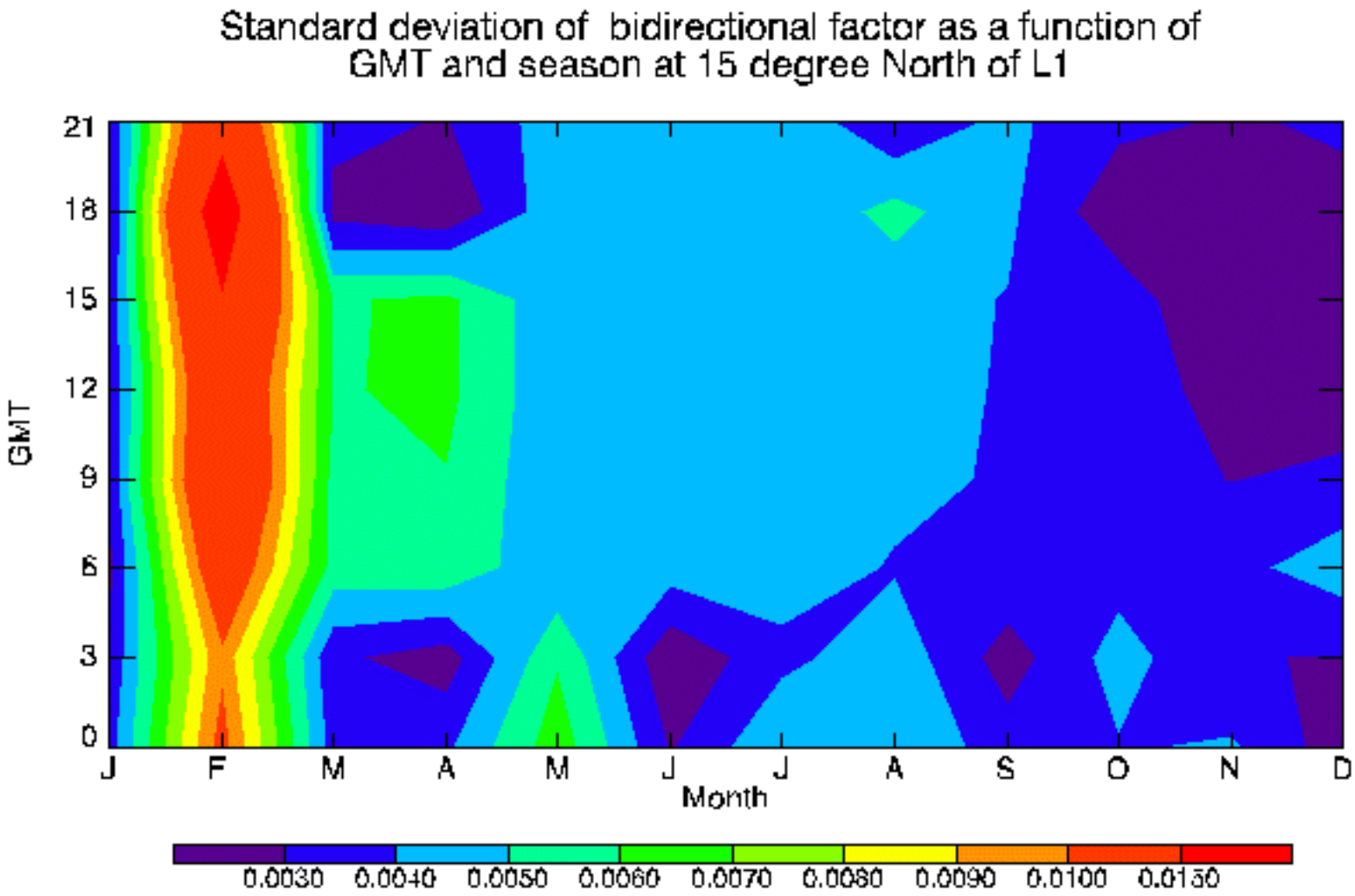

Mean global SW reflectance as a function of GMT and season
at 15 degree North of L1
GMT
21
18
15
12
9
6
3
0
J
F
M
A
M
J
J
A
S
O
N
D
Month
0.3150
0.3200
0.3250
0.3300
0.3350
0.3400
0.3450
0.3500
0.3550

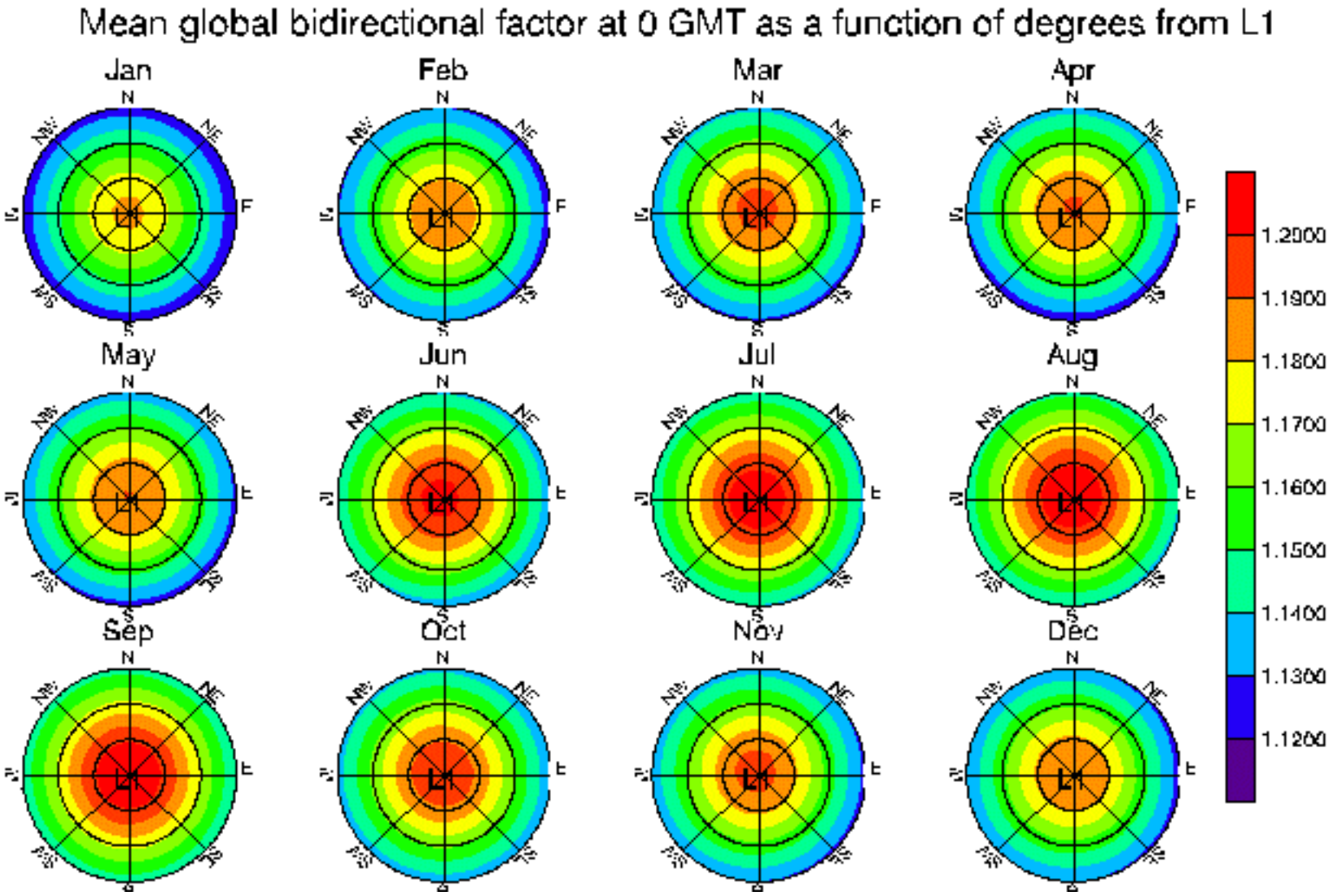

Standard deviation of SW reflectance as a function of
GMT and season at 15 degree North of L1
GMT
21
18
15
12
9
6
3
0
J
F
M
A
M
J
J
A
S
O
N
D
Month
0.0040
0.0050
0.0060
0.0070
0.0080
0.0090
0.0100
0.0150
0.0200

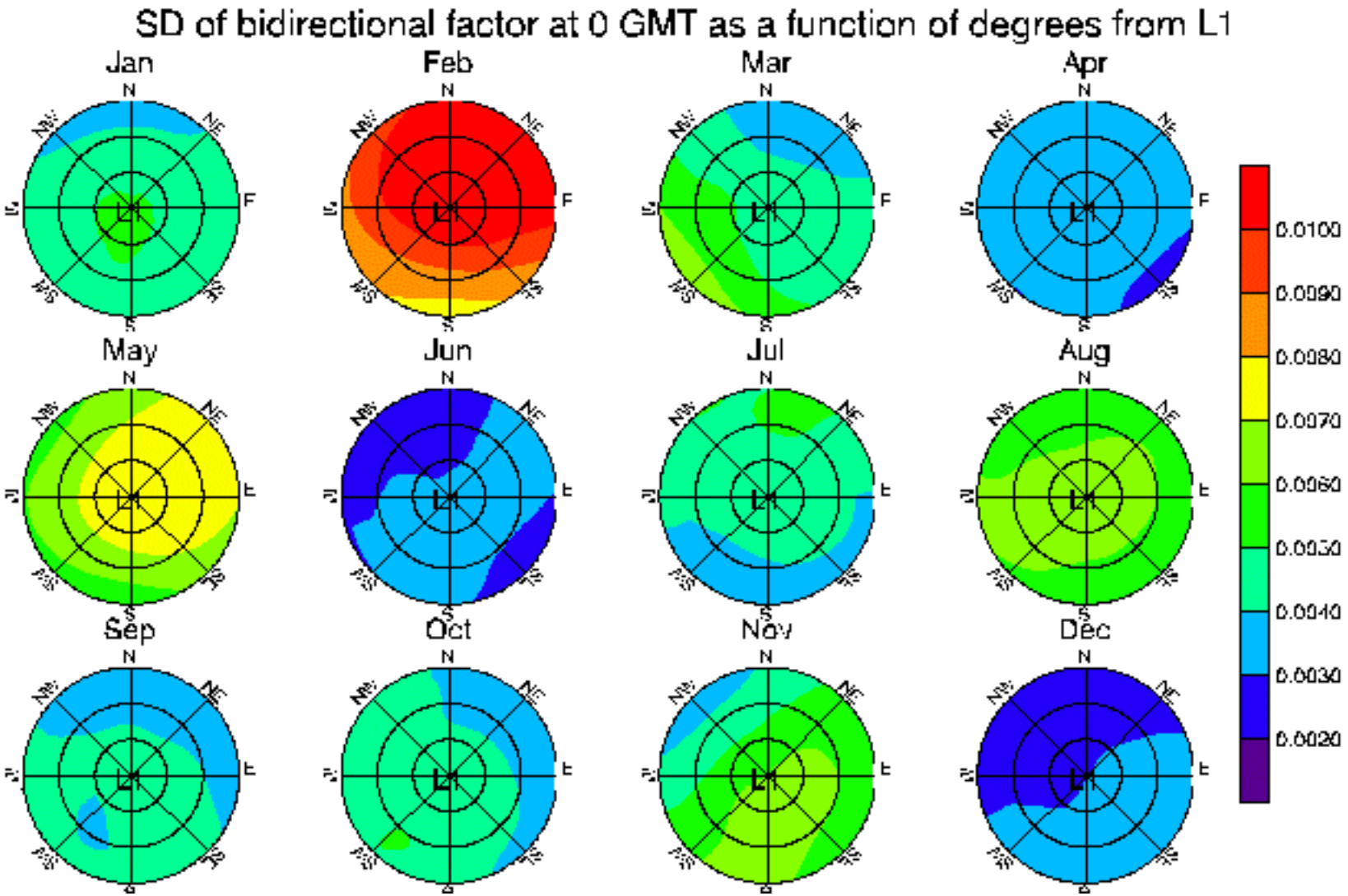

Mean global SW reflectance at 0 GMT as a function of degrees from L1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
N
NE
E
SE
S
SW
W
NW
L1
0.3550
0.3500
0.3450
0.3400
0.3350
0.3300
0.3250
0.3200
0.3150

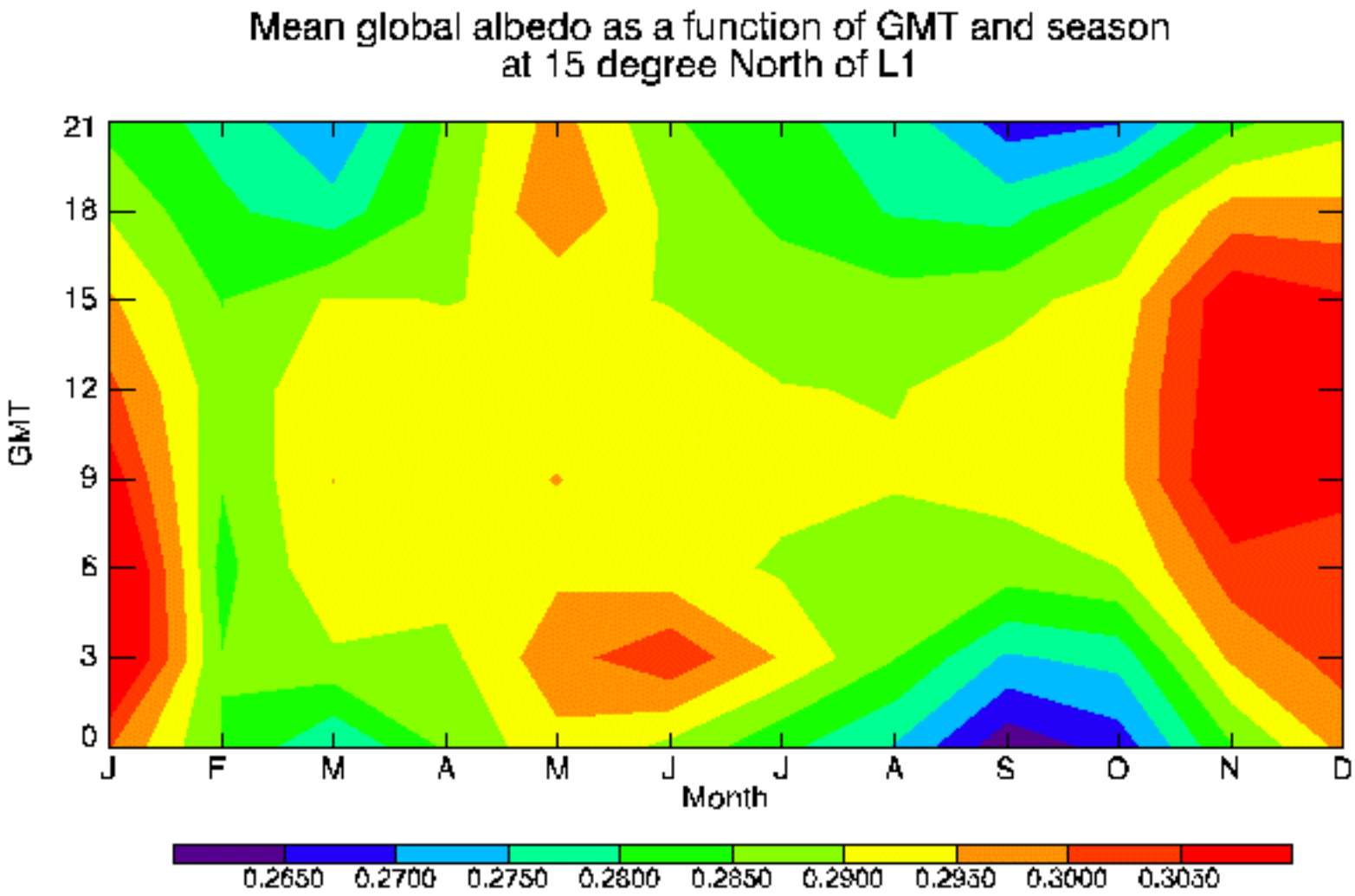

SD of SW reflectance at 0 GMT as a function of degrees from L1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
N
NE
E
SE
S
SW
W
NW
L1
0.0117
0.0113
0.0108
0.0099
0.0090
0.0081
0.0072
0.0063
0.0054

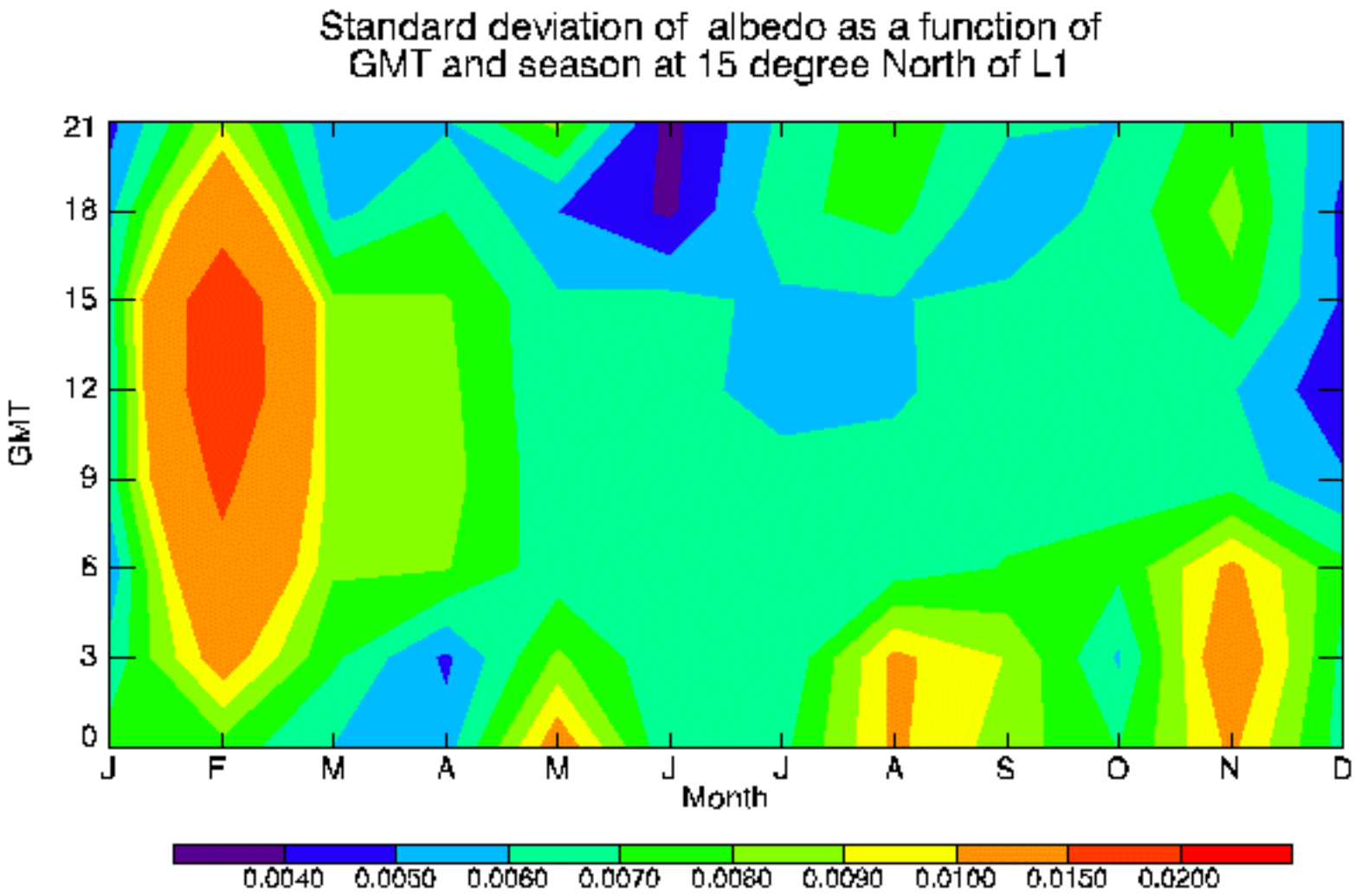

Mean global bidirectional factor as a function of GMT and season
at 15 degree North of L1
GMT
21
18
15
12
9
6
3
0
J
F
M
A
M
J
J
A
S
O
N
D
Month
1.1150
1.1200
1.1250
1.1300
1.1350
1.1400
1.1450
1.1500
1.1550

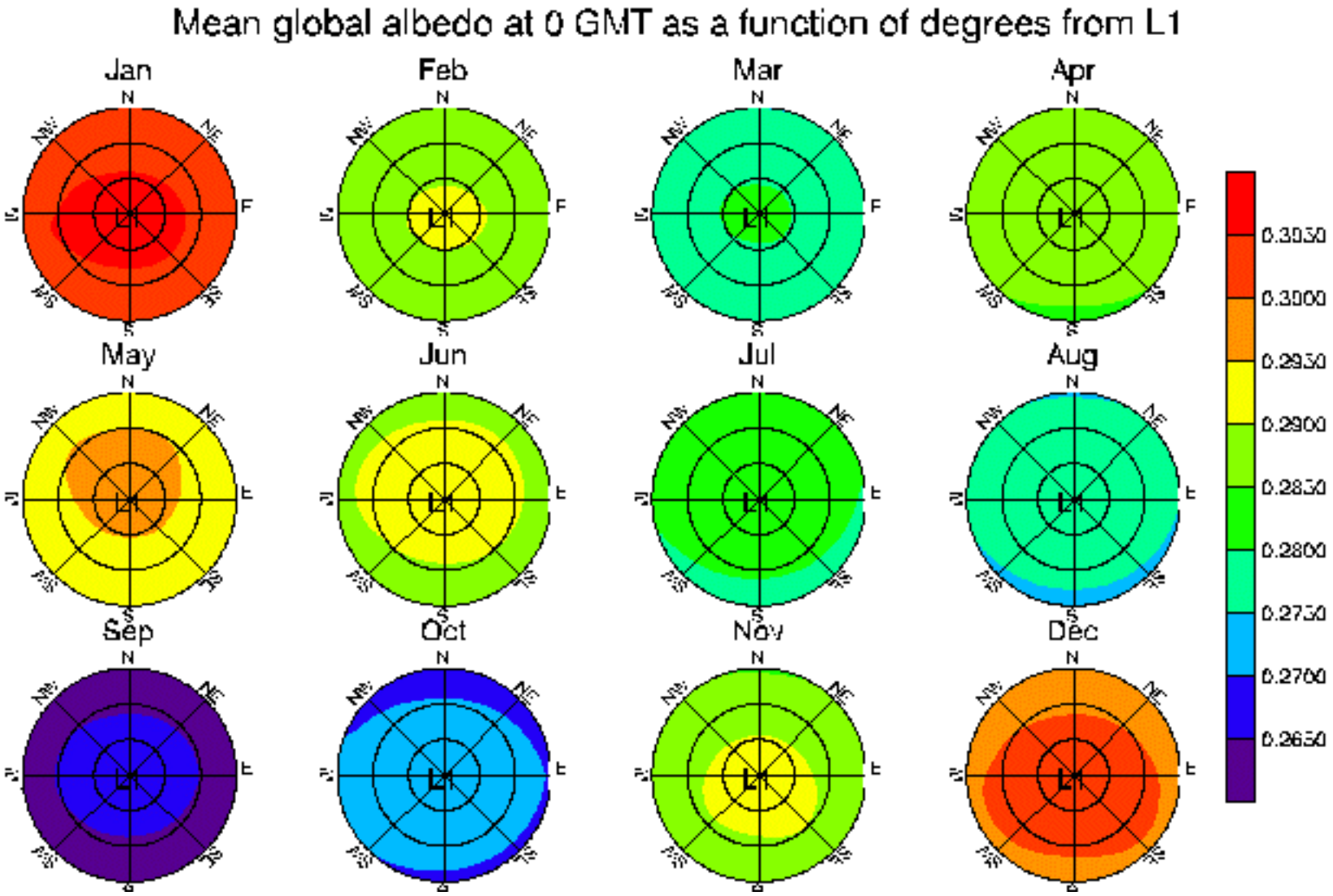

Standard deviation of bidirectional factor as a function of
GMT and season at 15 degree North of L1
GMT
21
18
15
12
9
6
3
0
J
F
M
A
M
J
J
A
S
O
N
D
Month
0.0030
0.0040
0.0050
0.0060
0.0070
0.0080
0.0090
0.0100
0.0150

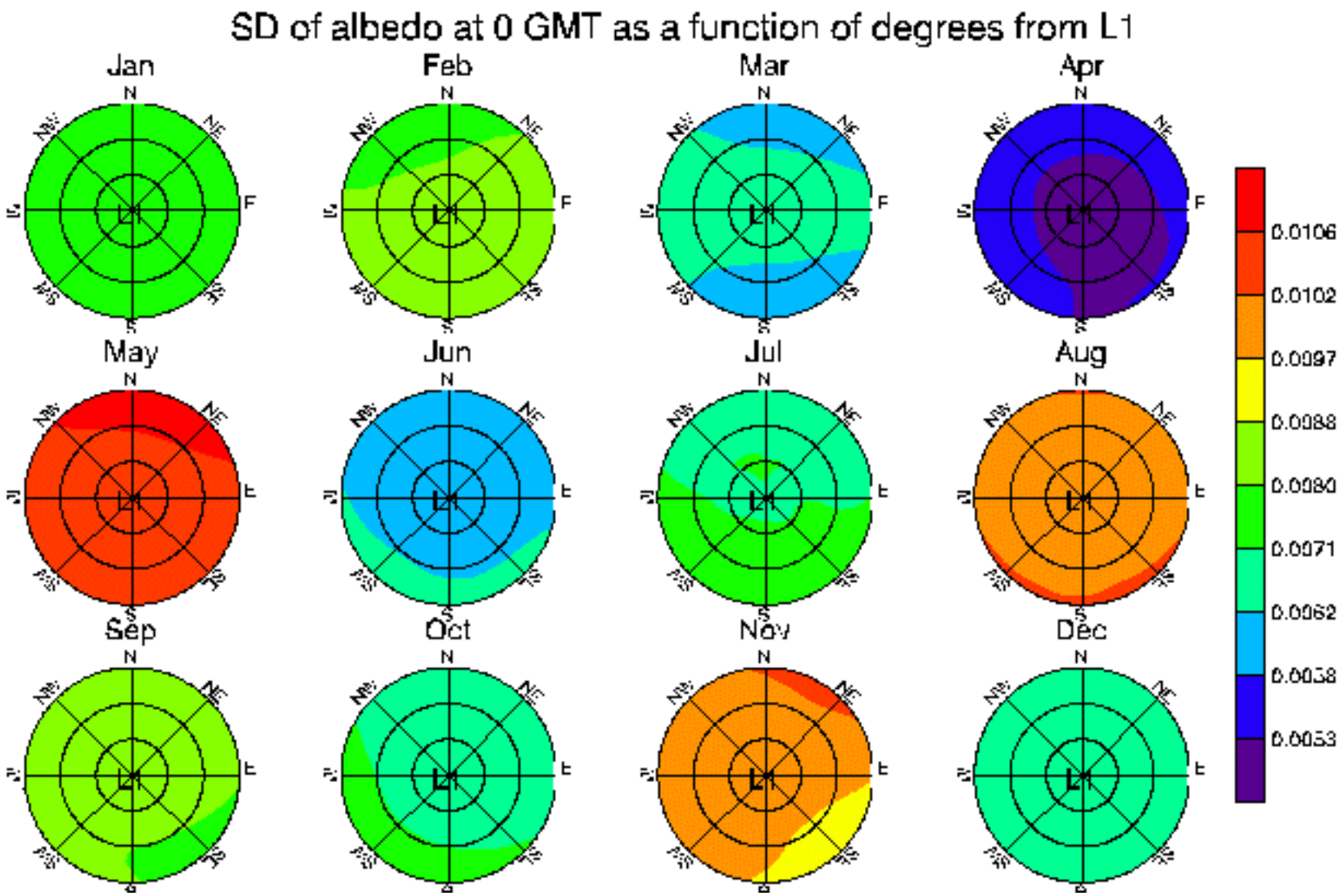

Mean global bidirectional factor at 0 GMT as a function of degrees from L1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
N
NE
E
SE
S
SW
W
NW
L1
1.2000
1.1900
1.1800
1.1700
1.1600
1.1500
1.1400
1.1300
1.1200

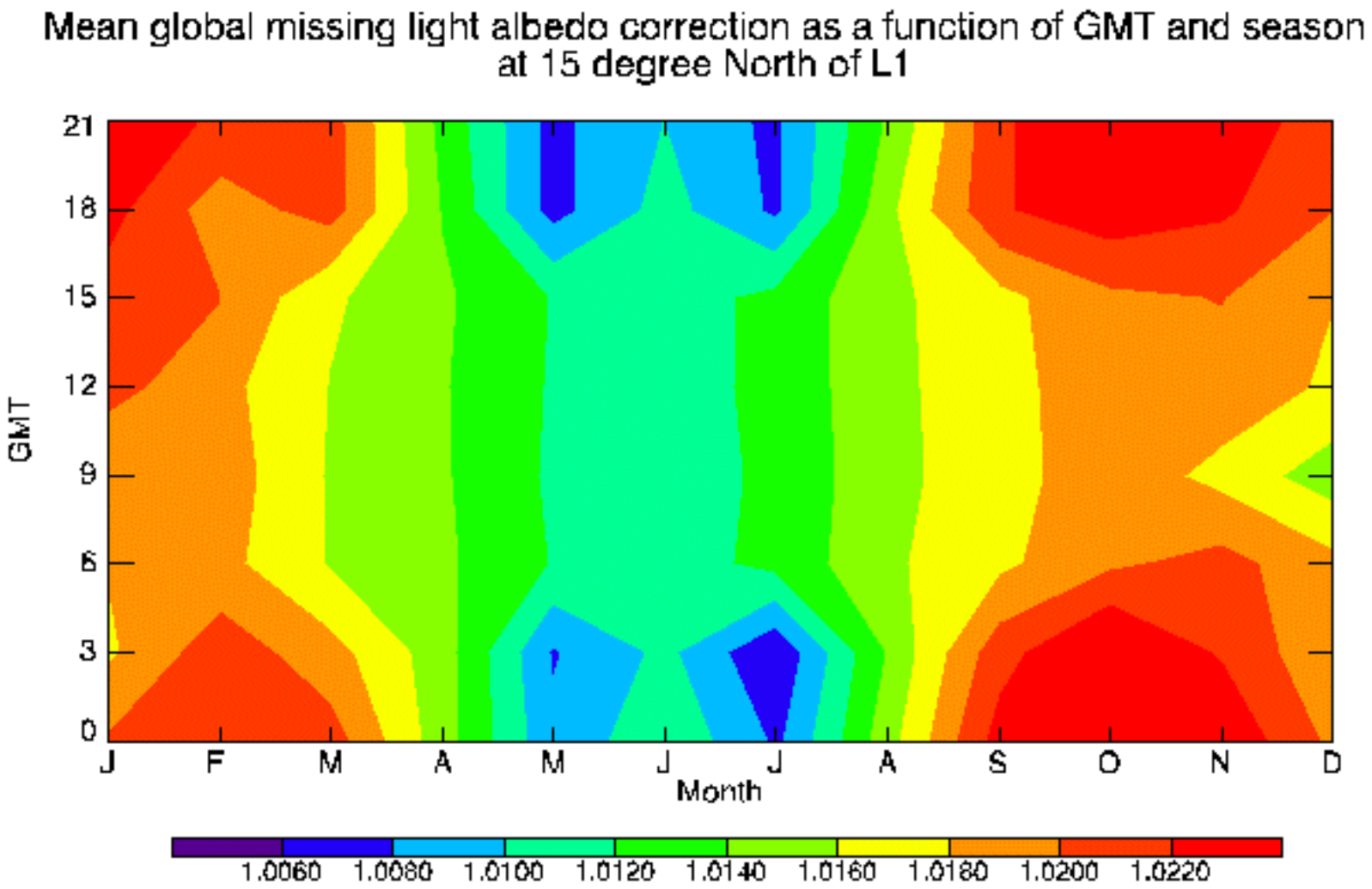

SD of bidirectional factor at 0 GMT as a function of degrees from L1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
N
NE
E
SE
S
SW
W
NW
L1
0.0100
0.0090
0.0080
0.0070
0.0060
0.0050
0.0040
0.0030
0.0020

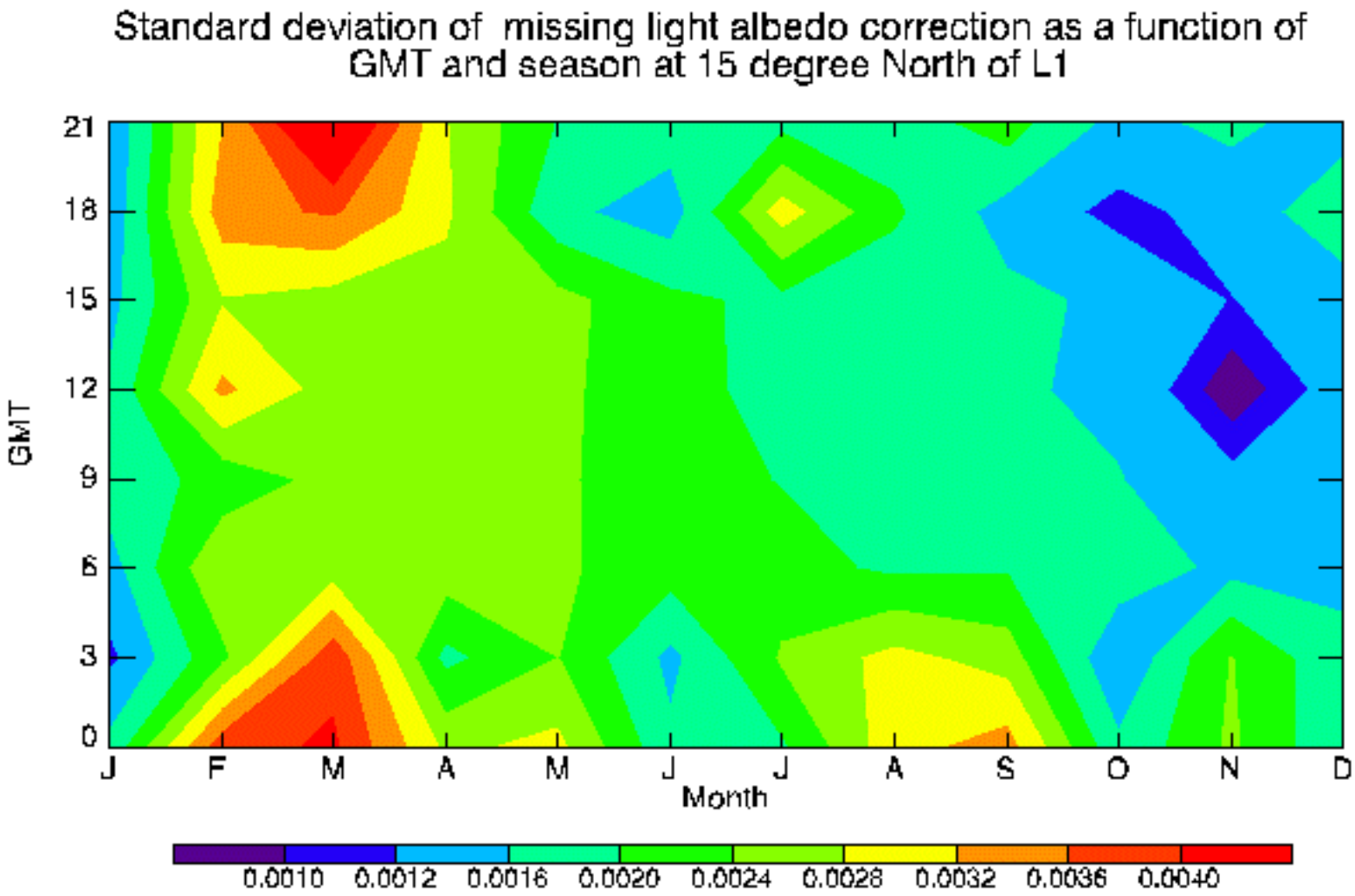

Mean global albedo as a function of GMT and season
at 15 degree North of L1
GMT
21
18
15
12
9
6
3
0
J
F
M
A
M
J
J
A
S
O
N
D
Month
0.2650
0.2700
0.2750
0.2800
0.2850
0.2900
0.2950
0.3000
0.3050

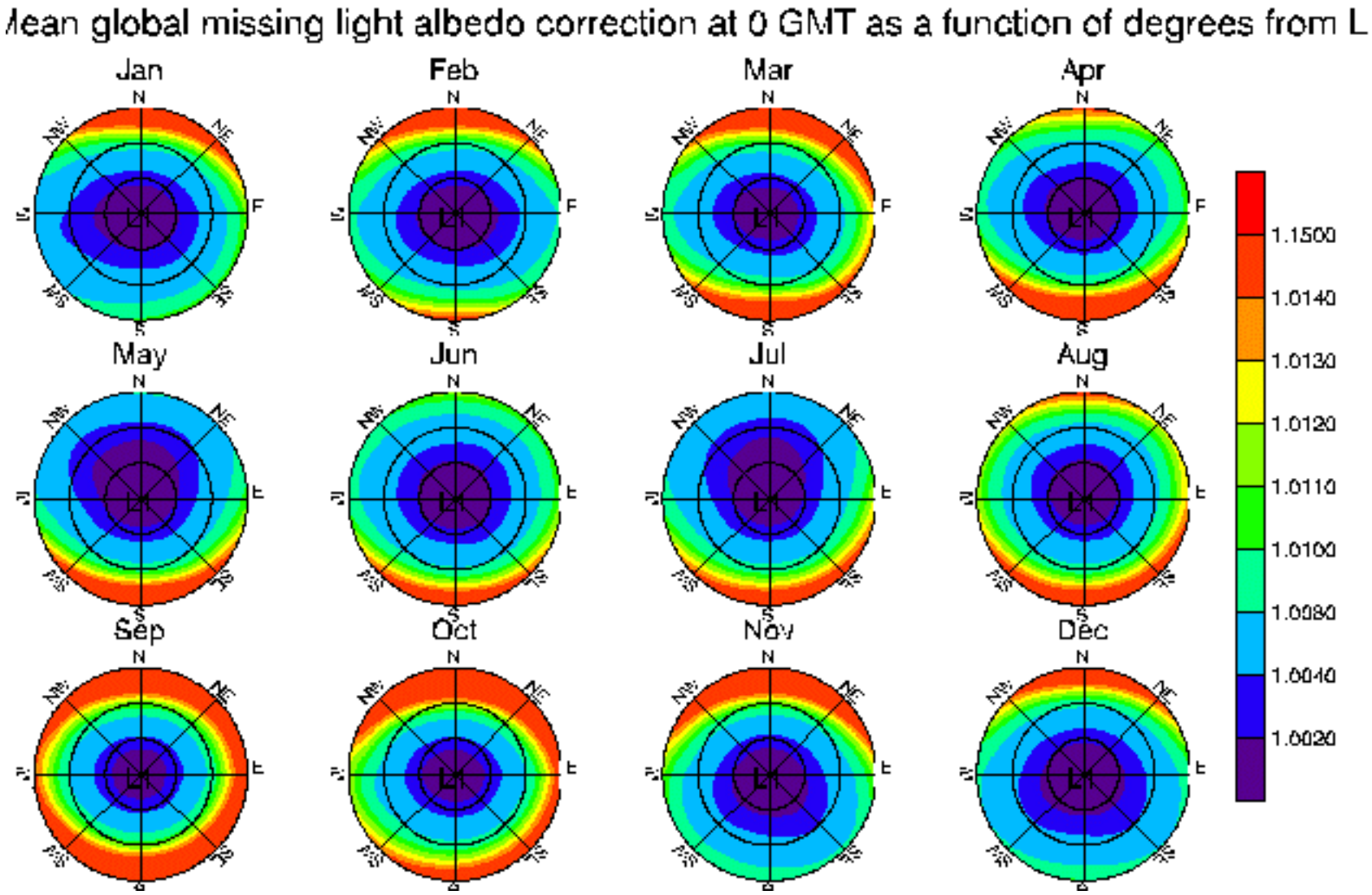

Standard deviation of albedo as a function of
GMT and season at 15 degree North of L1
GMT
21
18
15
12
9
6
3
0
J
F
M
A
M
J
J
A
S
O
N
D
Month
0.0040
0.0050
0.0060
0.0070
0.0080
0.0090
0.0100
0.0150
0.0200

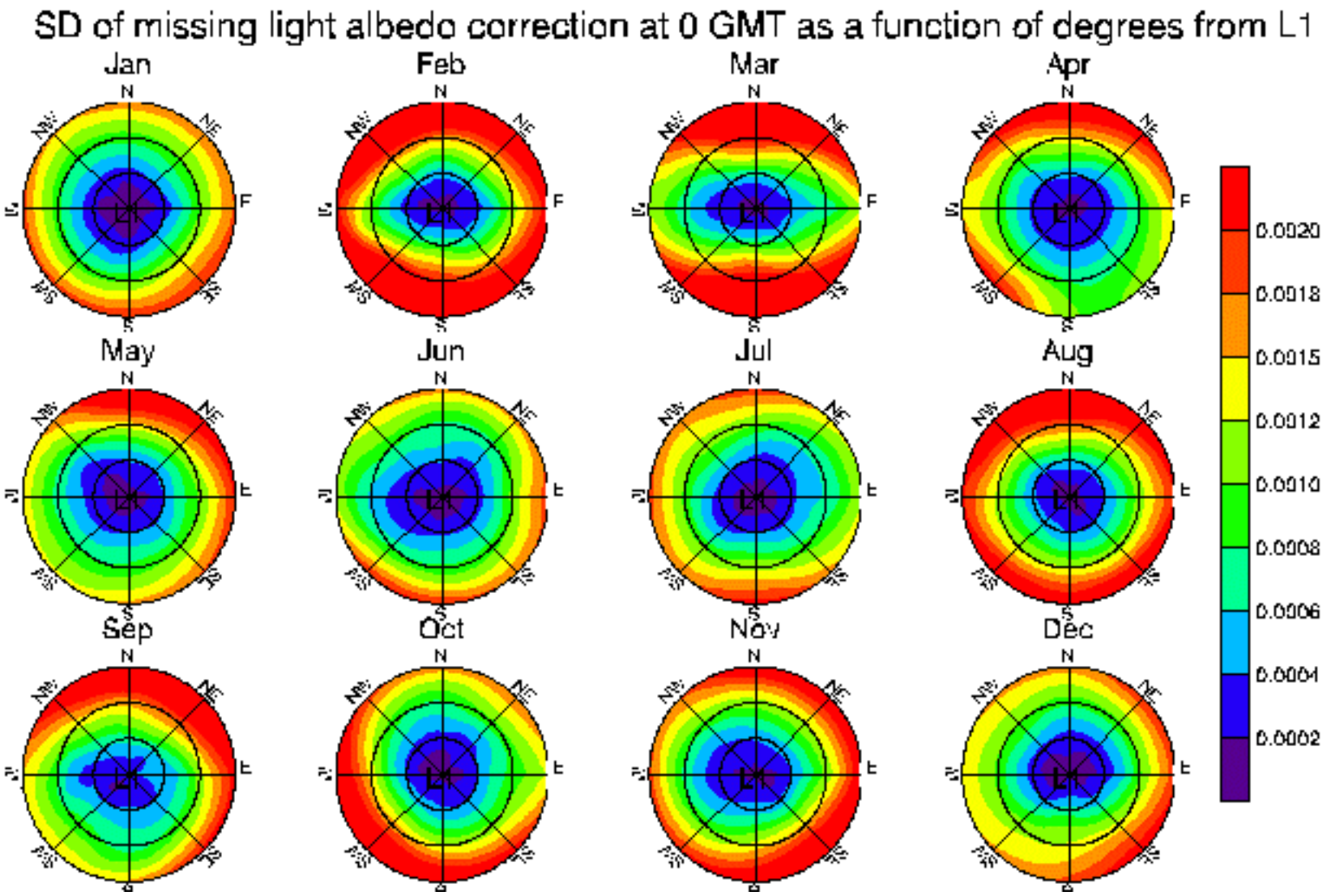

Mean global albedo at 0 GMT as a function of degrees from L1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
N
NE
E
SE
S
SW
W
NW
L1
0.3050
0.3000
0.2950
0.2900
0.2850
0.2800
0.2750
0.2700
0.2650

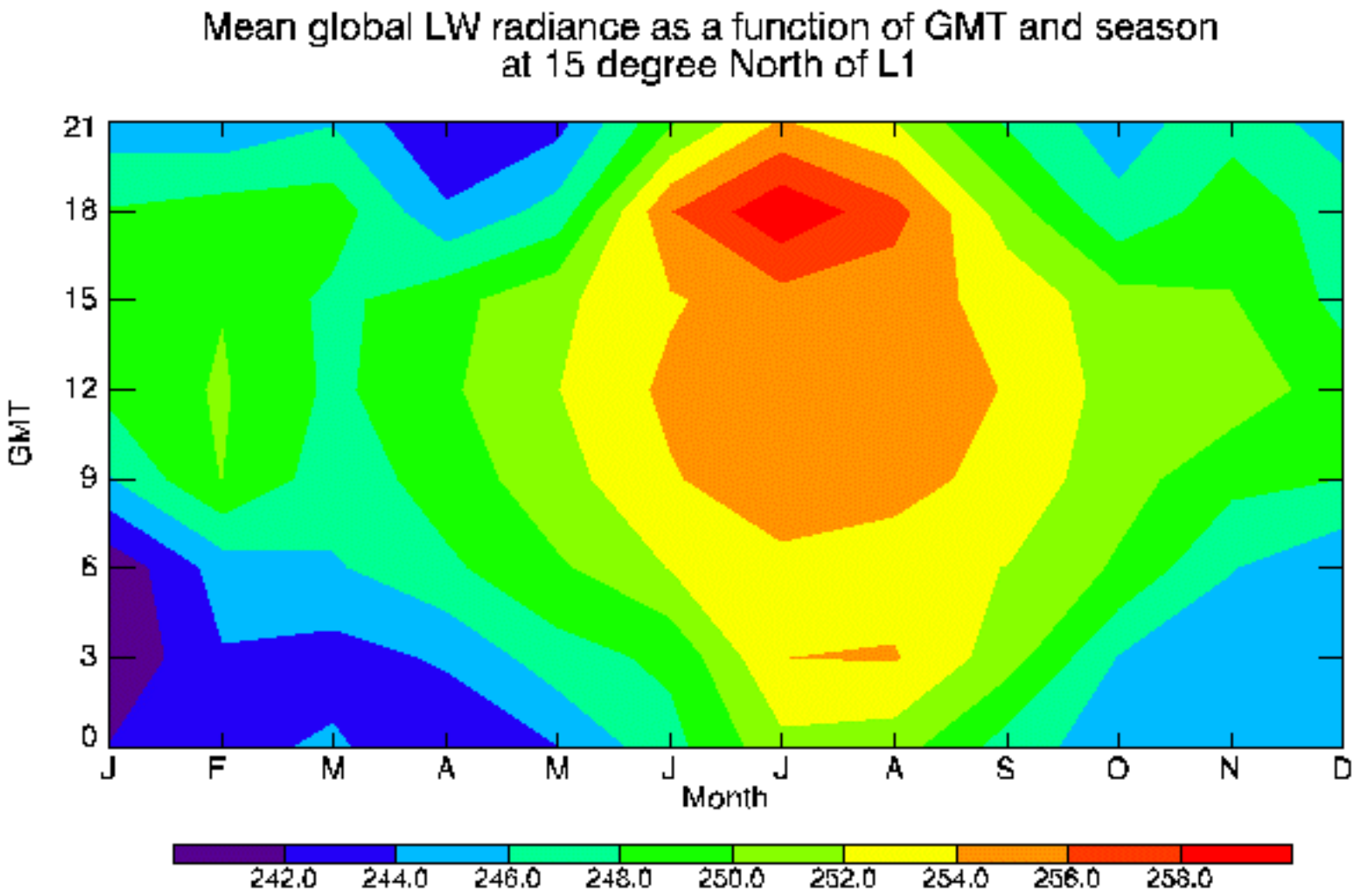

SD of albedo at 0 GMT as a function of degrees from L1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
N
NE
E
SE
S
SW
W
NW
L1
0.0106
0.0102
0.0097
0.0088
0.0080
0.0071
0.0062
0.0058
0.0053

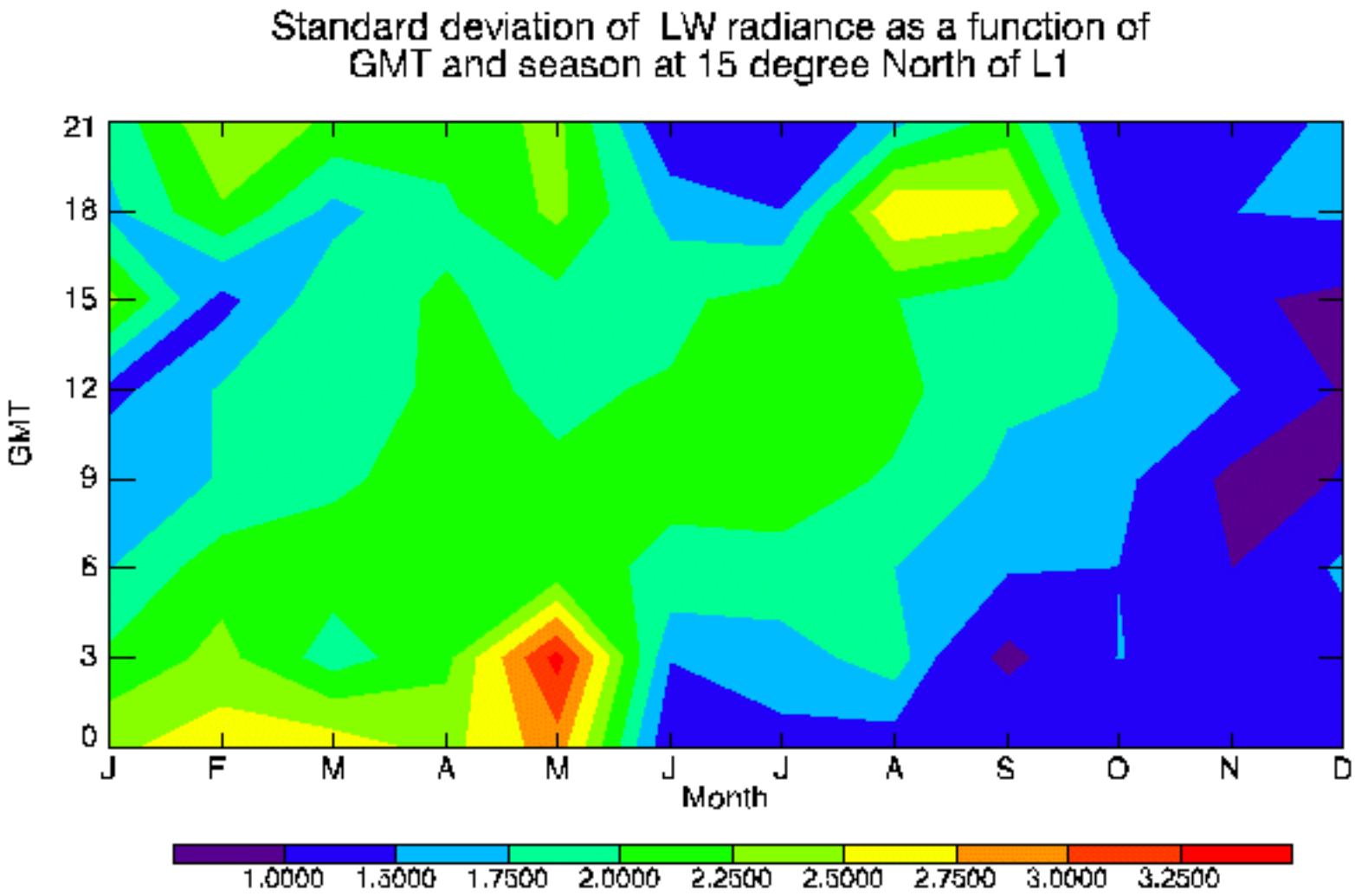

Mean global missing light albedo correction as a function of GMT and season
at 15 degree North of L1
GMT
21
18
15
12
9
6
3
0
J
F
M
A
M
J
J
A
S
O
N
D
Month
1.0060
1.0080
1.0100
1.0120
1.0140
1.0160
1.0180
1.0200
1.0220

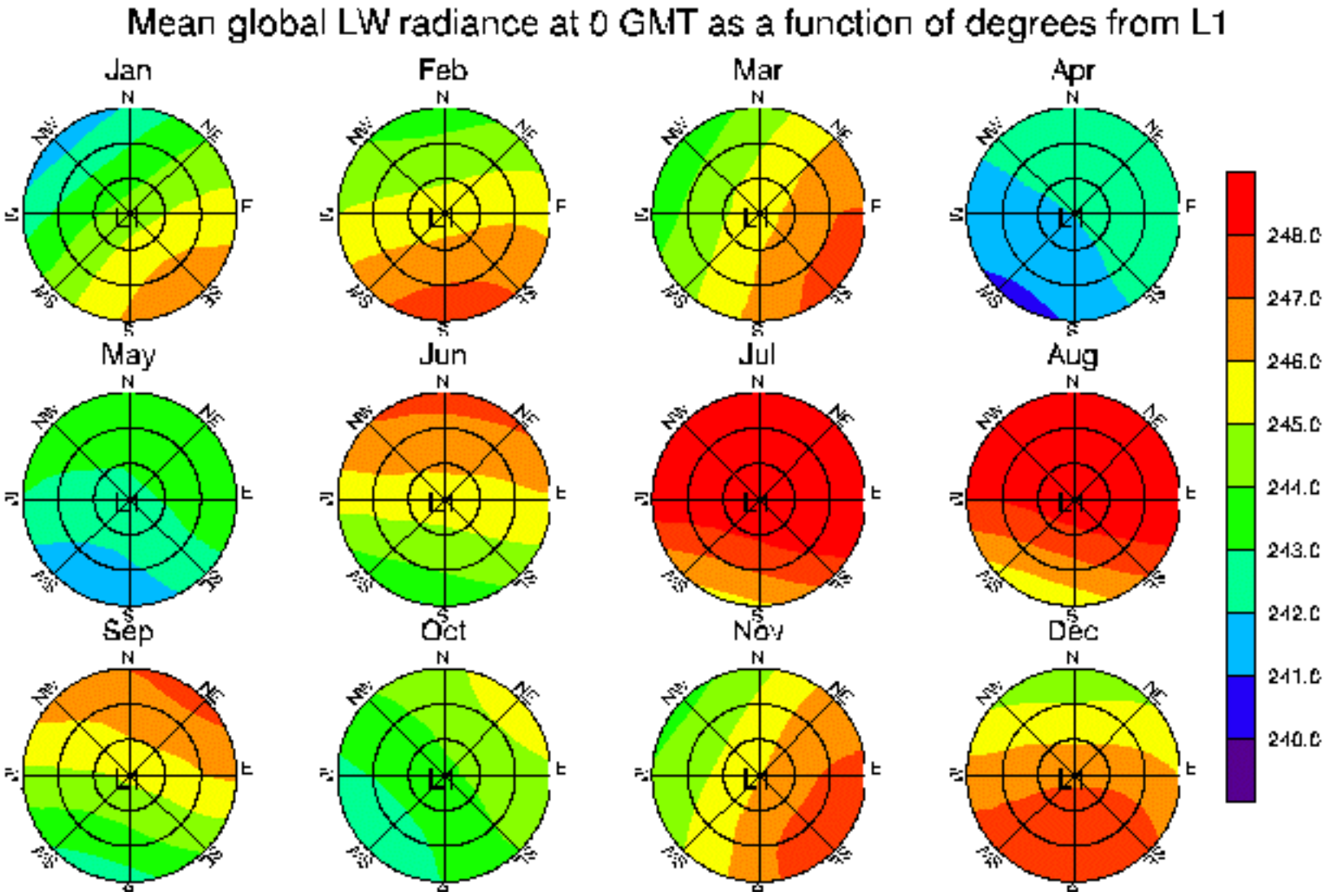

Standard deviation of missing light albedo correction as a function of GMT and season at 15 degree North of L1
GMT
21
18
15
12
9
6
3
0
J
F
M
A
M
J
J
A
S
O
N
D
Month
0.0010
0.0012
0.0016
0.0020
0.0024
0.0028
0.0032
0.0036
0.0040

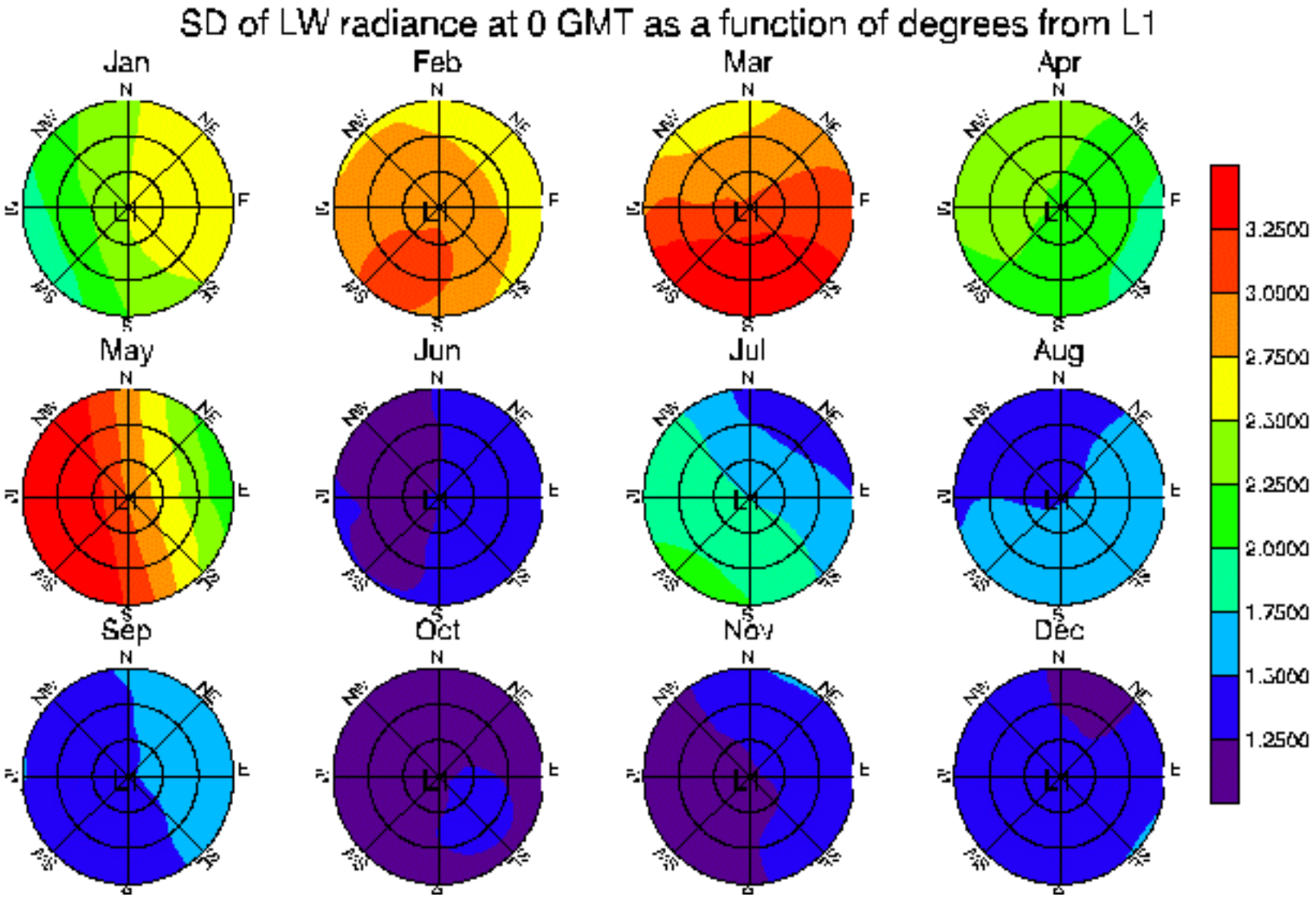

Mean global missing light albedo correction at 0 GMT as a function of degrees from L
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
N
NE
E
SE
S
SW
W
NW
L1
1.1500
1.0140
1.0130
1.0120
1.0110
1.0100
1.0080
1.0040
1.0020


SD of missing light albedo correction at 0 GMT as a function of degrees from L1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
N
NE
E
SE
S
SW
W
NW
L1
0.0020
0.0018
0.0016
0.0014
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002


Mean global LW radiance as a function of GMT and season
at 15 degree North of L1
GMT
21
18
15
12
9
6
3
0
J
F
M
A
M
J
J
A
S
O
N
D
Month
242.0
244.0
246.0
248.0
250.0
252.0
254.0
256.0
258.0


Standard deviation of LW radiance as a function of
GMT and season at 15 degree North of L1
GMT
21
18
15
12
9
6
3
0
J
F
M
A
M
J
J
A
S
O
N
D
Month
1.0000
1.5000
1.7500
2.0000
2.2500
2.5000
2.7500
3.0000
3.2500


Mean global LW radiance at 0 GMT as a function of degrees from L1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
N
NE
E
SE
S
SW
W
NW
L1
248.0
247.0
246.0
245.0
244.0
243.0
242.0
241.0
240.0


SD of LW radiance at 0 GMT as a function of degrees from L1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
N
NE
E
SE
S
SW
W
NW
L1
3.2500
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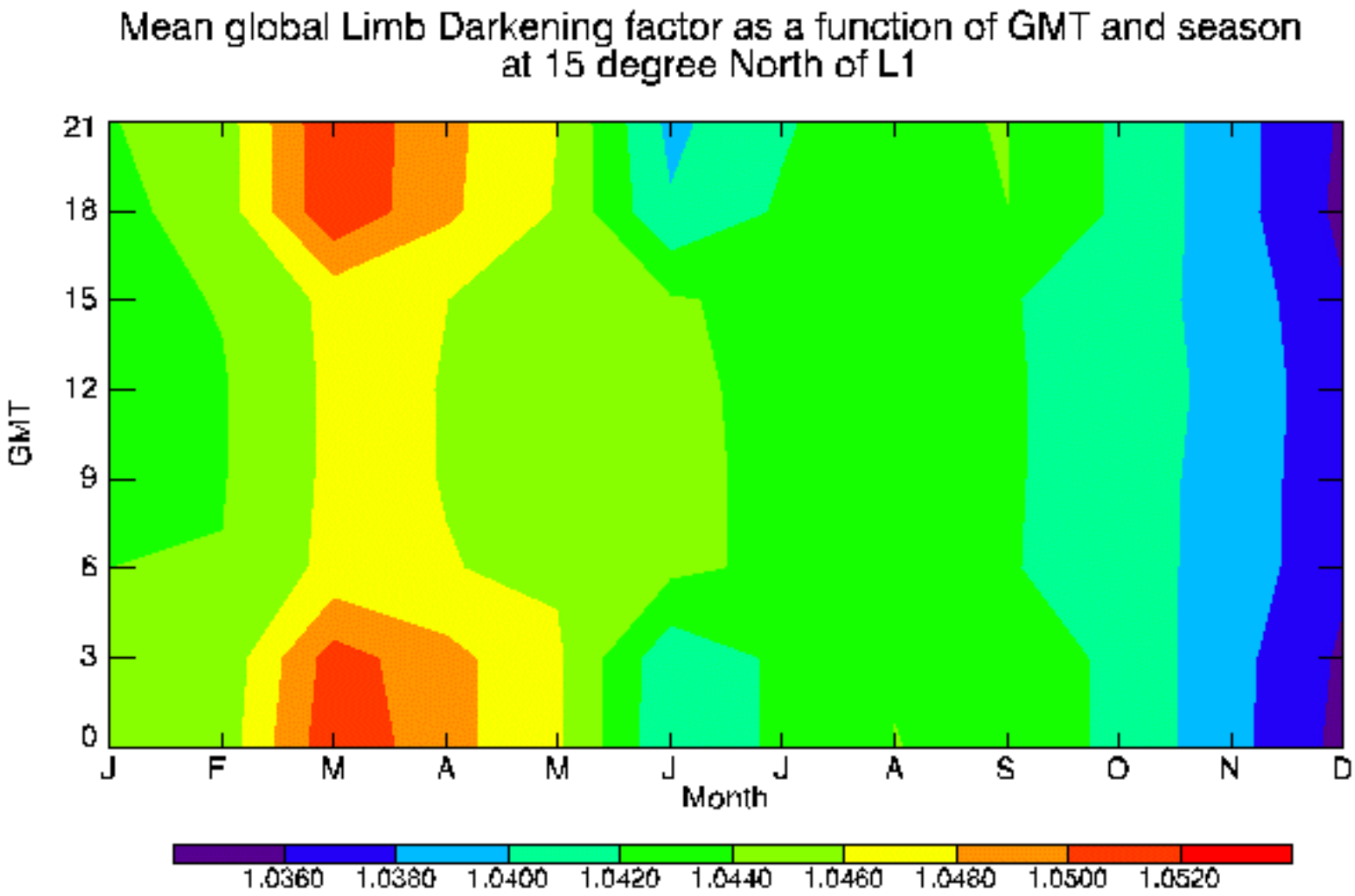
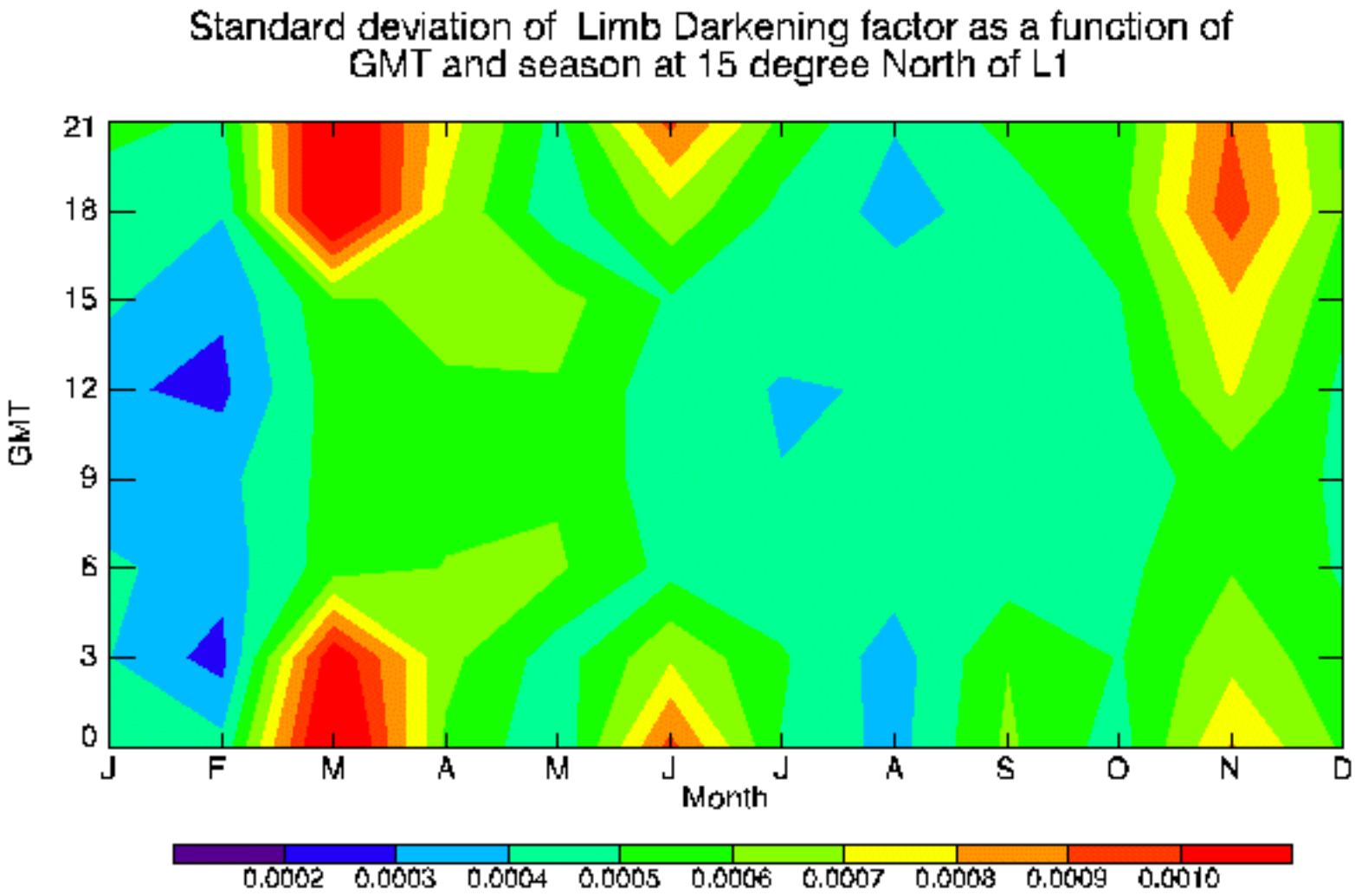
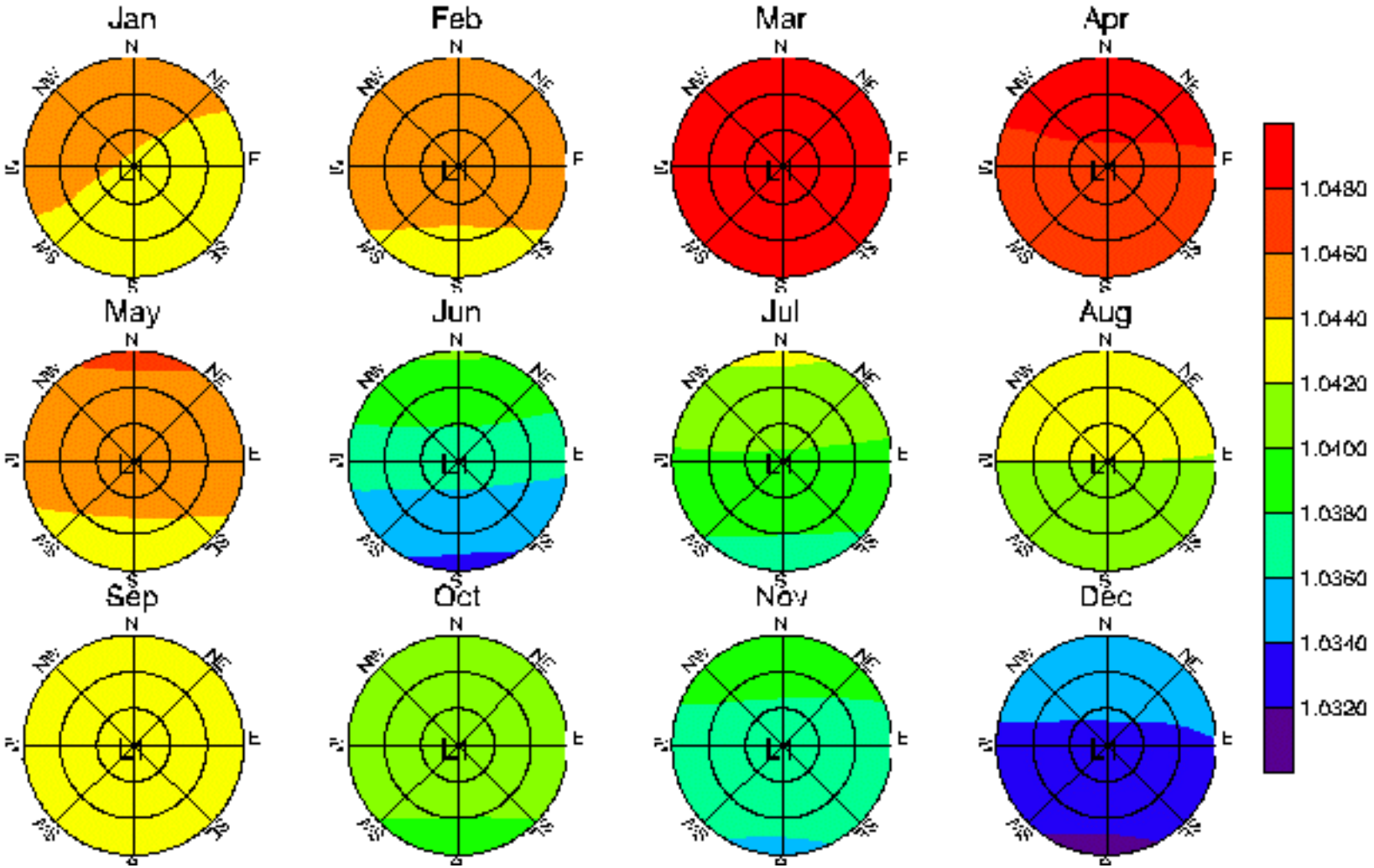
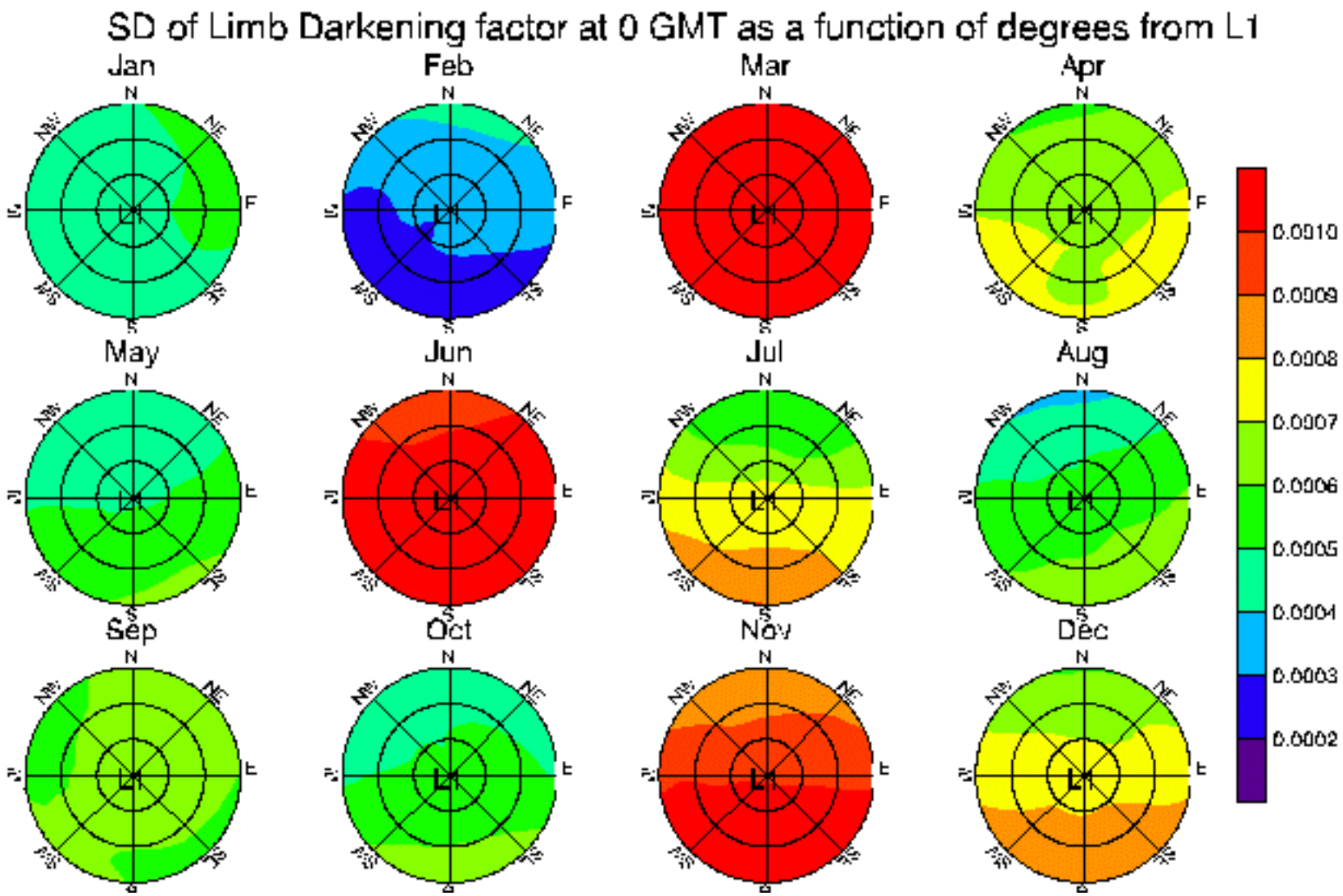
2.0000
1.7500
1.5000
1.2500

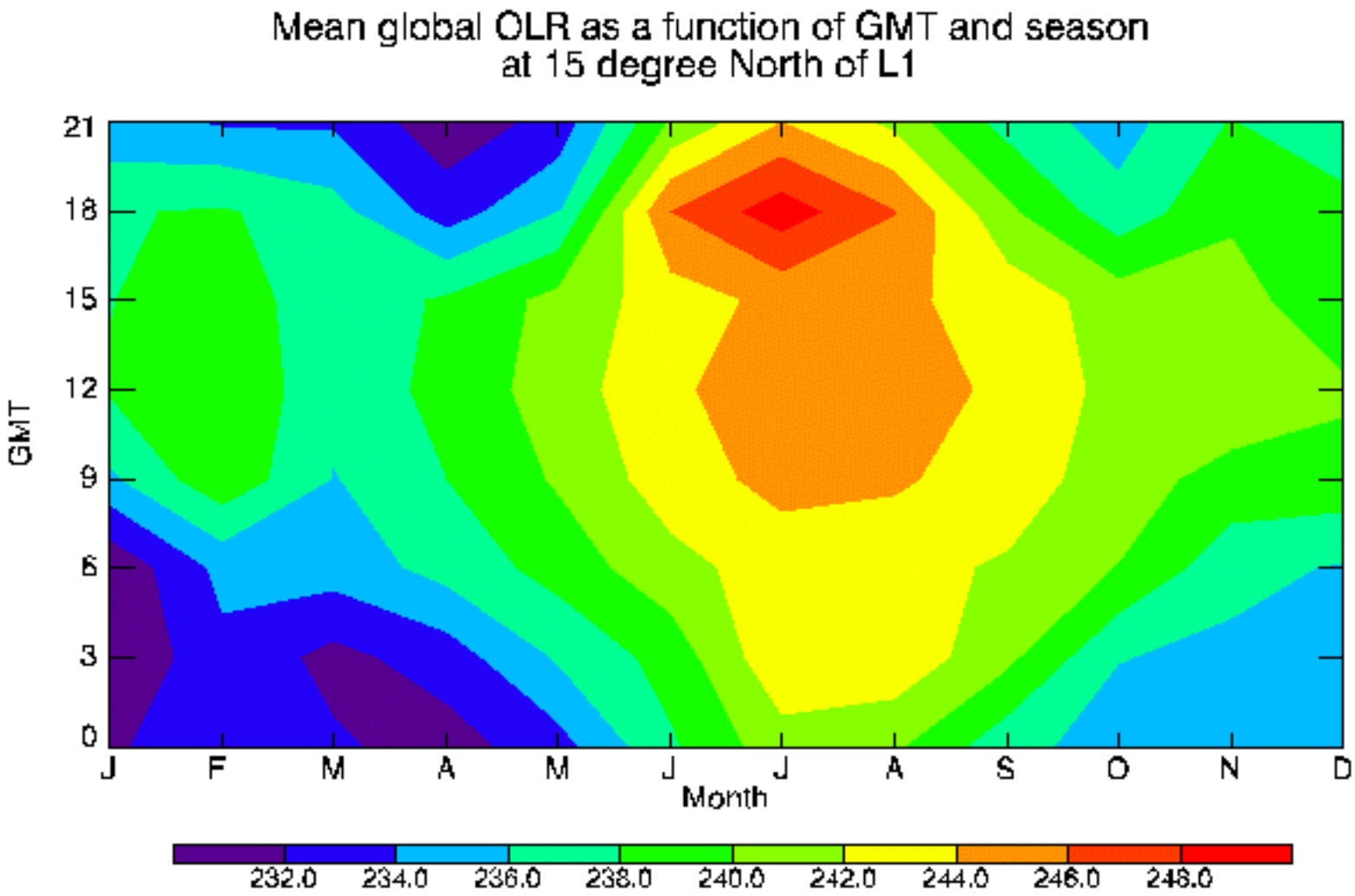

Mean global Limb Darkening factor as a function of GMT and season
at 15 degree North of L1
GMT
21
18
15
12
9
6
3
0
J
F
M
A
M
J
J
A
S
O
N
D
Month
1.0360
1.0380
1.0400
1.0420
1.0440
1.0460
1.0480
1.0500
1.0520

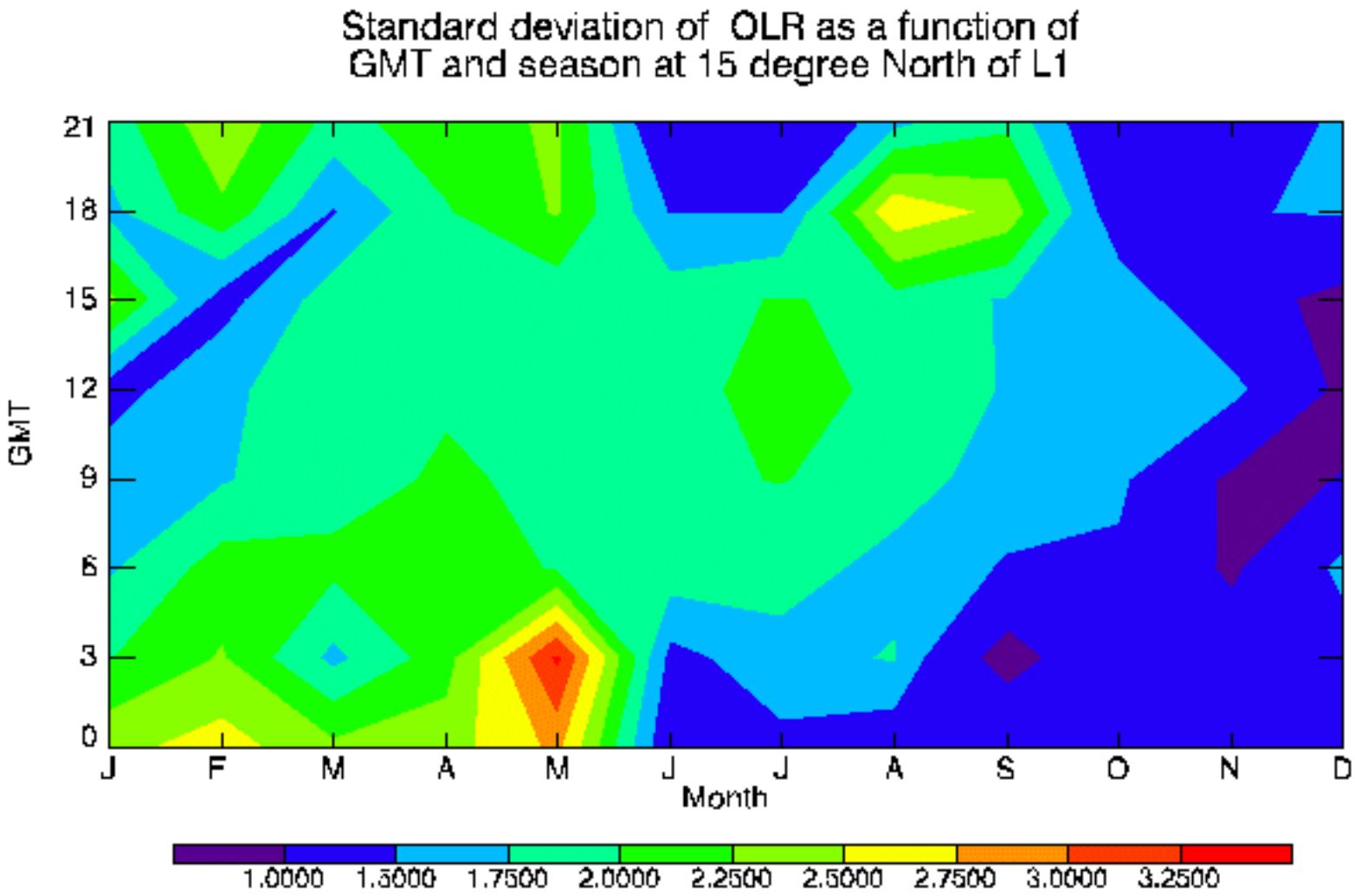

Standard deviation of Limb Darkening factor as a function of
GMT and season at 15 degree North of L1
GMT
21
18
15
12
9
6
3
0
J
F
M
A
M
J
J
A
S
O
N
D
Month
0.0002
0.0003
0.0004
0.0005
0.0006
0.0007
0.0008
0.0009
0.0010

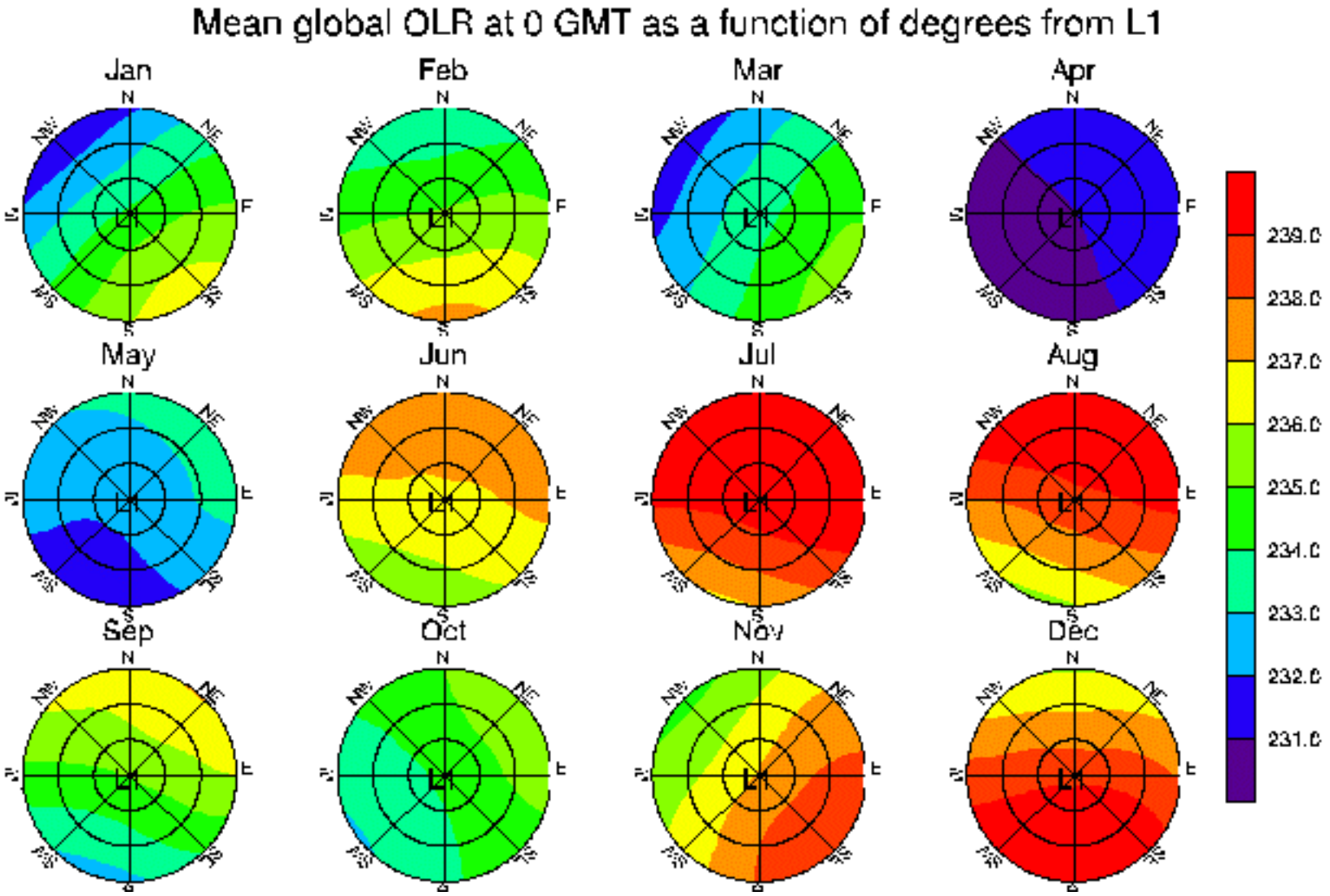
Mean global Limb Darkening factor at 0 GMT as a function of degrees from L1

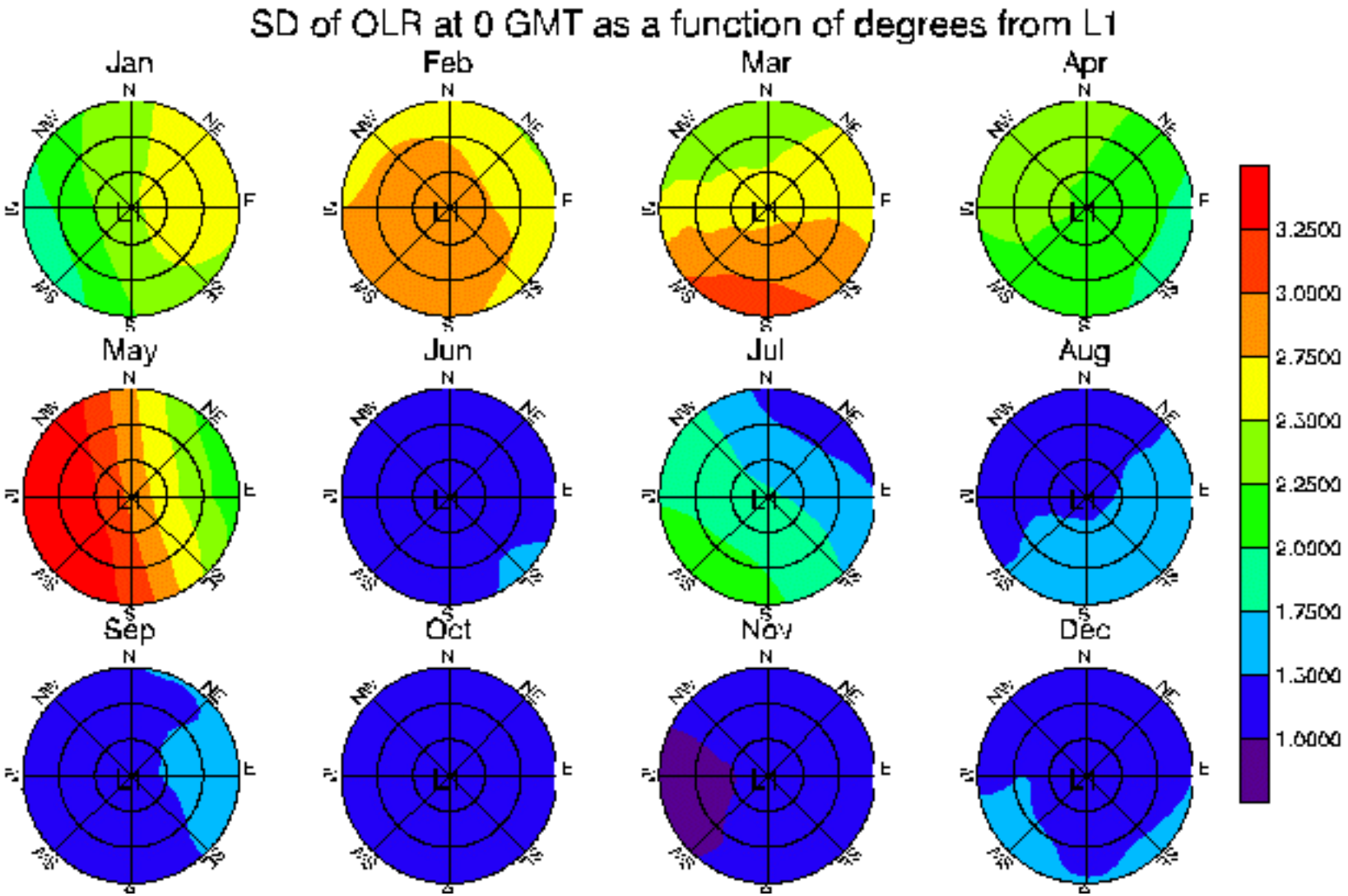


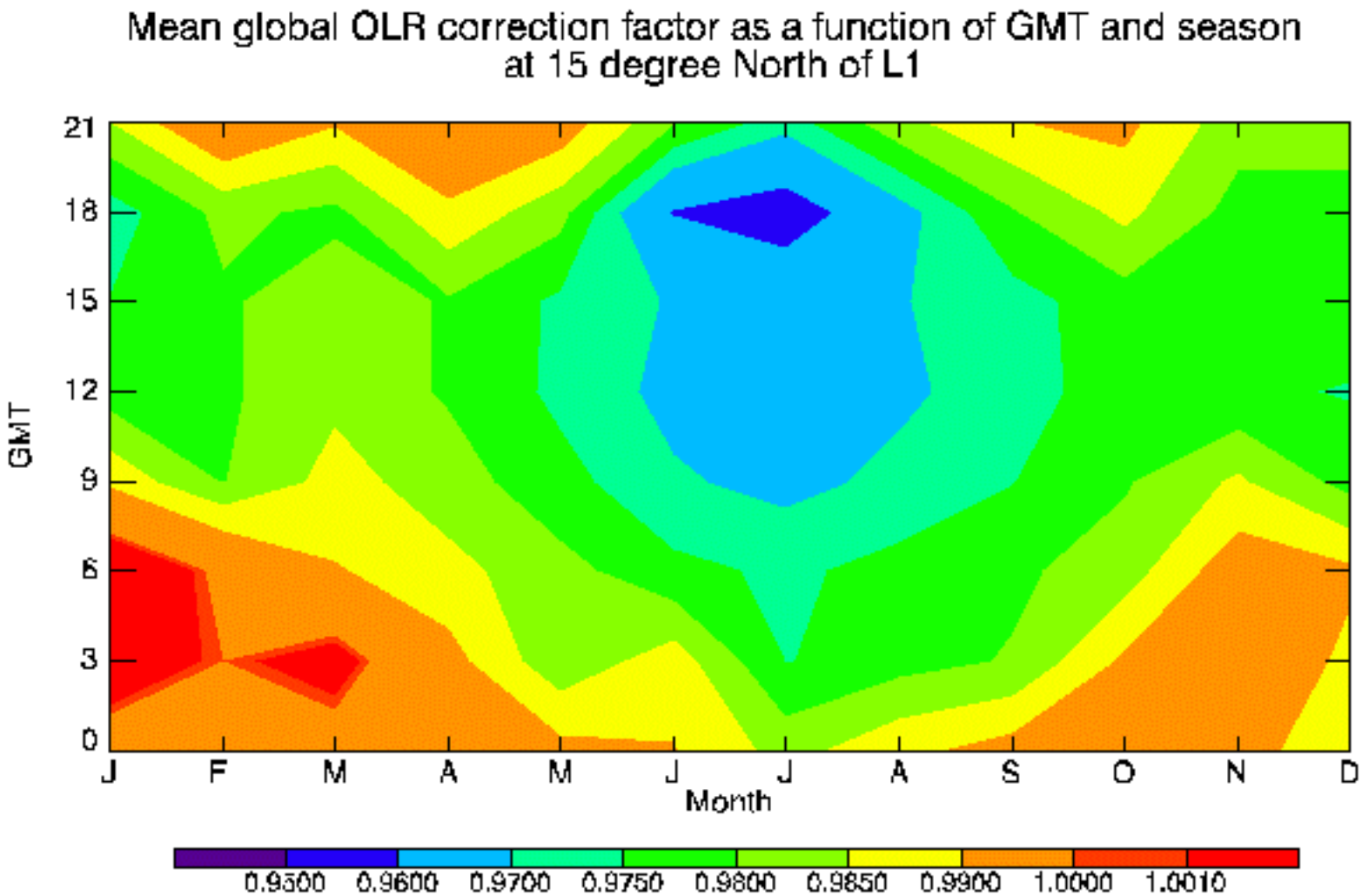

SD of Limb Darkening factor at 0 GMT as a function of degrees from L1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
N
NE
E
SE
S
SW
W
NW
L1
0.0010
0.0009
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002

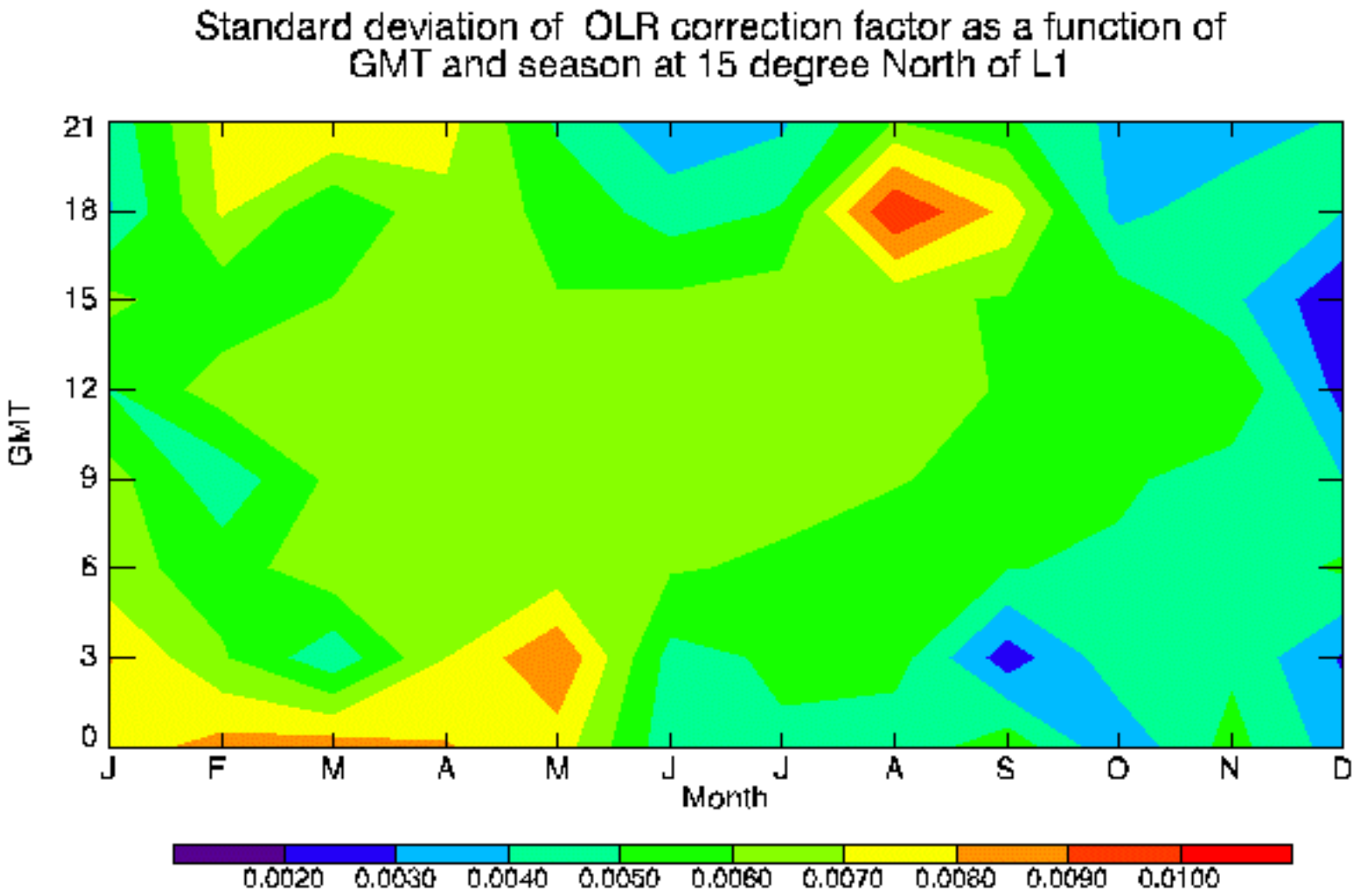

Mean global OLR as a function of GMT and season
at 15 degree North of L1
GMT
21
18
15
12
9
6
3
0
J
F
M
A
M
J
J
A
S
O
N
D
Month
232.0
234.0
236.0
238.0
240.0
242.0
244.0
246.0
248.0


Standard deviation of OLR as a function of
GMT and season at 15 degree North of L1
GMT
21
18
15
12
9
6
3
0
J
F
M
A
M
J
J
A
S
O
N
D
Month
1.0000
1.5000
1.7500
2.0000
2.2500
2.5000
2.7500
3.0000
3.2500

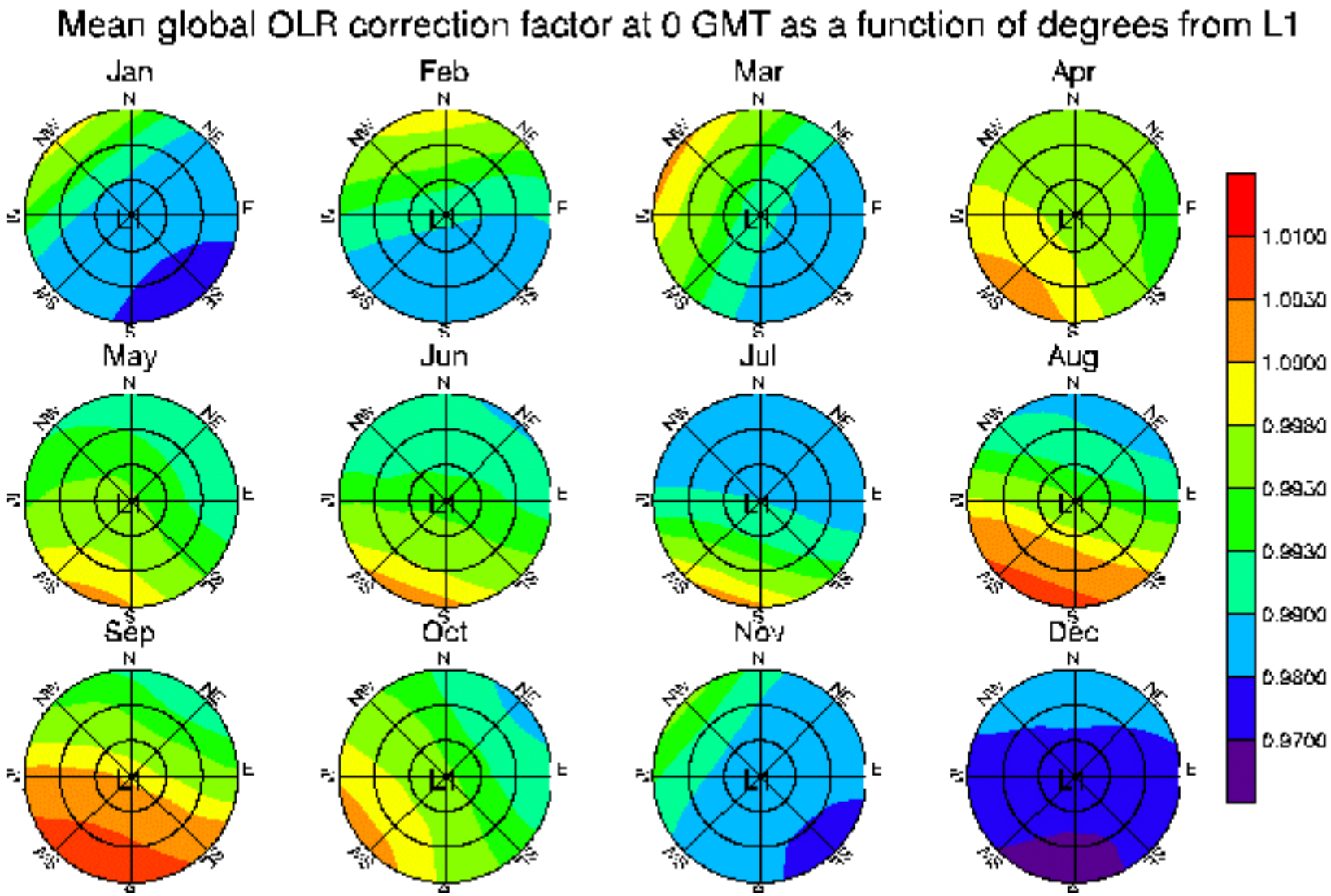

Mean global OLR at 0 GMT as a function of degrees from L1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
N
NE
E
SE
S
SW
W
NW
L1
239.0
238.0
237.0
236.0
235.0
234.0
233.0
232.0
231.0

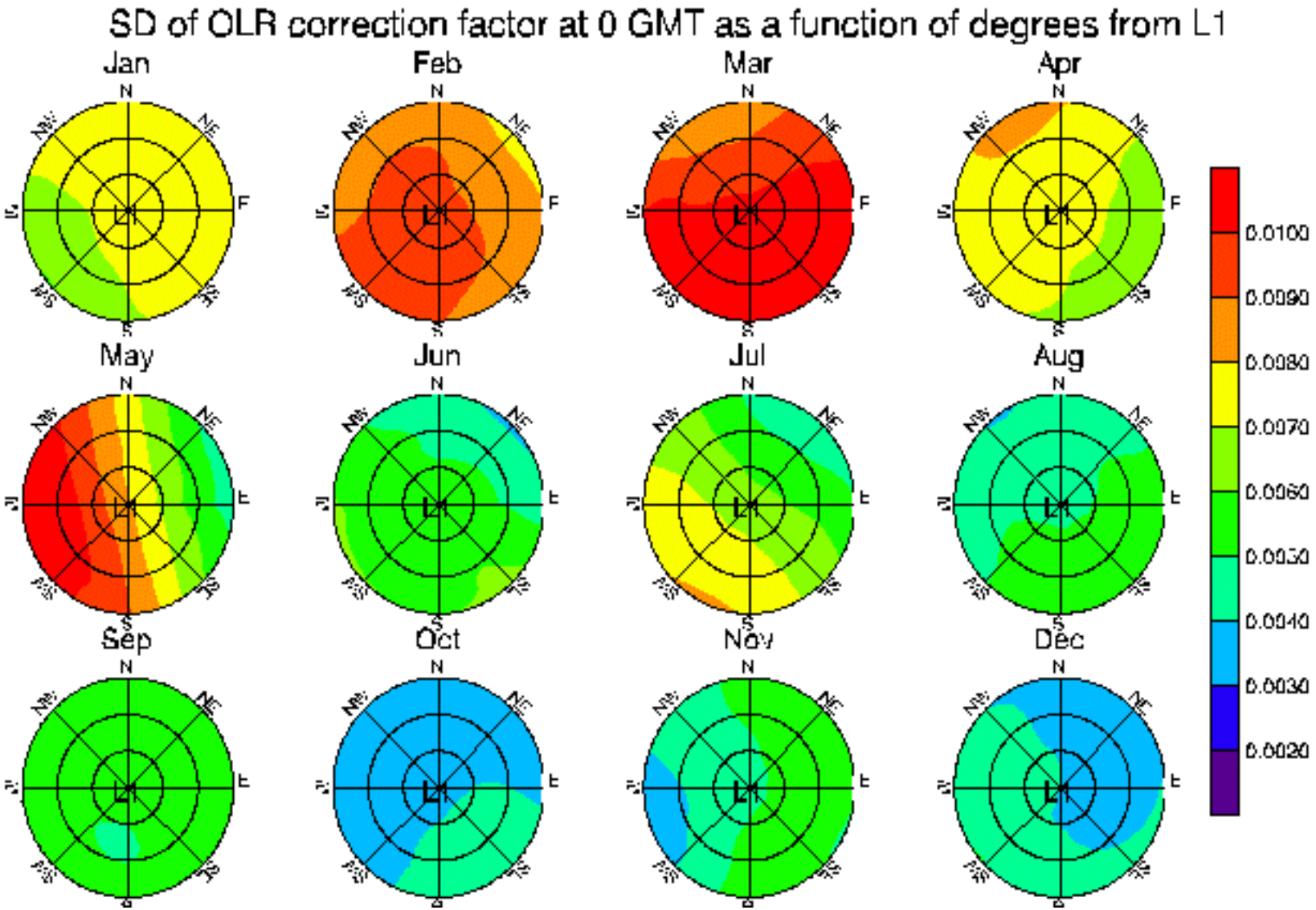

SD of OLR at 0 GMT as a function of degrees from L1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
N
NE
E
SE
S
SW
W
NW
L1
3.2500
3.0000
2.7500
2.5000
2.2500
2.0000
1.7500
1.5000
1.0000

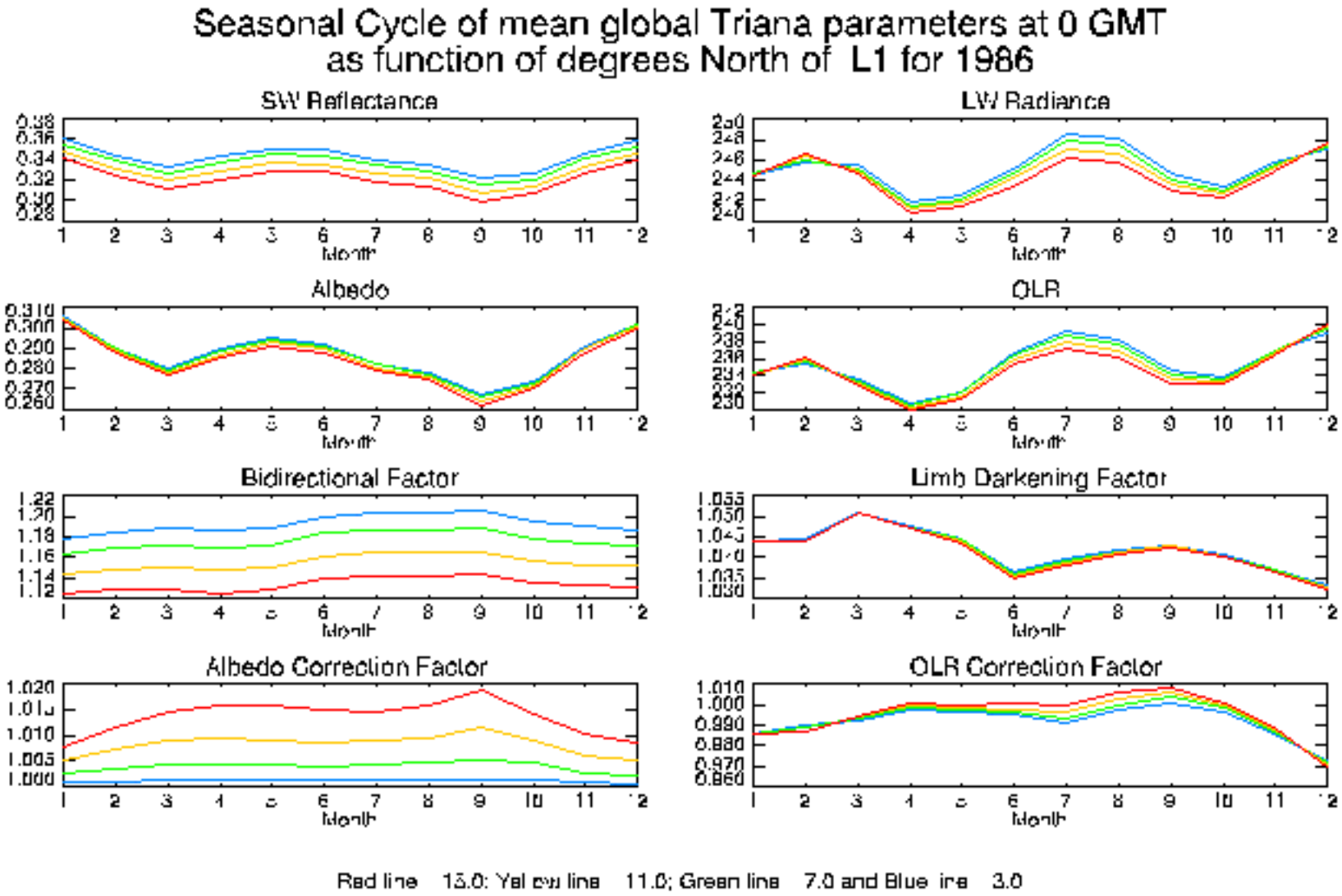

Mean global OLR correction factor as a function of GMT and season
at 15 degree North of L1
GMT
21
18
15
12
9
6
3
0
J
F
M
A
M
J
J
A
S
O
N
D
Month
0.9500
0.9600
0.9700
0.9750
0.9800
0.9850
0.9900
1.0000
1.0010


Standard deviation of OLR correction factor as a function of
GMT and season at 15 degree North of L1
GMT
21
18
15
12
9
6
3
0
J
F
M
A
M
J
J
A
S
O
N
D
Month
0.0020
0.0030
0.0040
0.0050
0.0060
0.0070
0.0080
0.0090
0.0100

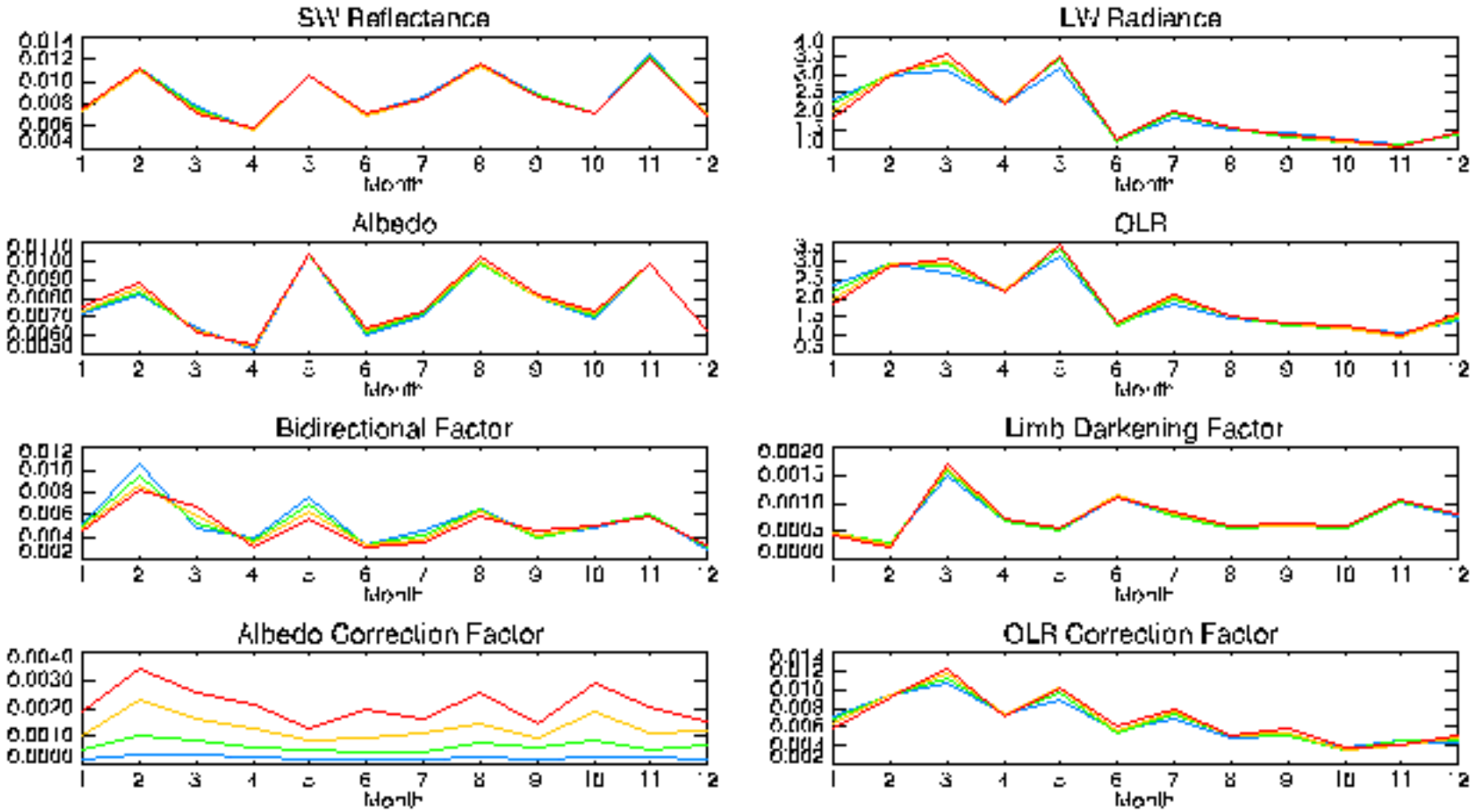
Triana Project




SD of OLR correction factor at 0 GMT as a function of degrees from L1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
N
NE
E
SE
S
SW
W
NW
L1
0.0100
0.0090
0.0080
0.0070
0.0060
0.0050
0.0040
0.0030
0.0020


Seasonal Cycle of mean global Triana parameters at 0 GMT
as function of degrees North of L1 for 1986
SW Reflectance
LW Radiance
Albedo
OLR
Bidirectional Factor
Limb Darkening Factor
Albedo Correction Factor
OLR Correction Factor
Month
Red line 15.0; Yellow line 11.0; Green line 7.0 and Blue line 3.0

Seasonal Cycle of standard deviation of Triana parameters at 0 GMT as function of degrees North of L1 for 1986



Red line 15.0; Yellow line 11.0; Green line 7.0 and Blue line 3.0

Conclusions and Discussions

- Both diurnal and seasonal variabilities are significant for all Triana correction parameters.
- The variability is also sensitive to the Triana offset phase angle (away from L1).
- One year correction factors computed:
  - **BRF 1.1216 -- 1.1616 SD 0.0018 -- 0.0176 (1.5%)**
  - **ACF 1.0063 -- 1.0259 SD 0.0008 -- 0.0048 (0.5%)**
  - **LDC 1.0354 -- 1.0519 SD 0.0002 -- 0.0012 (0.2%)**
  - **OCF 0.9448 -- 1.0083 SD 0.0021 -- 0.0106 (1.1%)**
- Due to diurnal and seasonal cycle, we must establish some method of characterizing the temporal structure of correction factors, such as Fourier spectral estimation; empirical orthogonal representation.

Future Work

- Simulate Triana viewed albedo/radiance with the combination of ISCCP and ERBE data.
- Future compute mean correction factors with estimate of variance.
- Analysis of the inter-annual and intra-seasonal fluctuation variability and estimate of the contribution to total variance by analysis of year 1985-1989.
- Design the correction model based on the above-mentioned simulation results.