Analysis of the Tragas data for April 2015 events (DOY 96-120): geomagnetic field, neutrons and atmospheric parameters

1. Data sets and pre-processing

In this study the following data sets were used:

1. Tragaldabas data from April to October 2015 (issued by Georgy Kornakov in October 2015). Data are available for three multiplicities (M), five zenith angle (θ) and 8 azimuthal angle (φ) channels. Detector's frame is rotated by ~315º relative to geographic North (N).
   1.1. M: M1, M2, M3. ***Here only data for M1 are used***;
   1.2. θ: θ0 = 0-10º, θ1 = 10-20º, θ2 = 20-30º, θ3 = 30-40º, θ4 = 40-50º;
   1.3. φ (angle in the detector frame/in geographic coordinates): φ0 = -180 – -135º (SE), φ1 = -135 – -90º (S), φ2 = -90 – -45º (SW), φ3 = -45 – 0º (W), φ4 = 0 – 45º (NW), φ5 = 45 – 90º (N), φ6 = 90 – 135º (NE), φ7 = 135 – 180º (E).
   Data are of 5min time resolution, corrected for pressure (p) and temperature (T) measured in the Lab. Pressure and temperature data are also available. Here o***nly the data for DOY 96-120 were analysed***. The Tragas data were analyzed both in the form the data from the separate θ and φ channels and as sums of all φ channels (Σφ) separately for the four θ channels (zenith angle variations of the total particle flux).
2. Coimbra (COI) geomagnetic Obs. data for the horizontal (H) and vertical (Z) components of the geomagnetic field (GMF). Data are of the 1min time resolution.
3. CaLMa neutron monitor (NM) pressure and efficiency corrected data. Here I used 1h averaged data, but data with higher time resolutions are also available.

Since the Tragas 5min data are very noisy comparing to the COI and CaLMa data, I used hourly means for all parameters (Tragas, COI H and COI Z, CaLMa, p and T). Since the hourly means are still show high level of variability (see Fig. 1), the data were smoothed. I used 2 types of the smoothing procedures: adjacent (running, moving) averaging with a window of 25 points (1 day averaging) and a seasonal-trend decomposition (STL, in this case a "cycle length" parameter np was chosen in a way that the resulting STL trend component resemble adj. aver. curve) – see Fig. 1. I prefer the STL smoothing over the adj. averaging because in the second case the averaged series has a shorter length and this can affect calculation of the (e.g.) correlation coefficients. The smoothing was applied to all analyzed parameters. The Tragas data were also subjected to the principal component analysis (PCA) to extract the variability modes that are common to variations of all θ and φ channel.

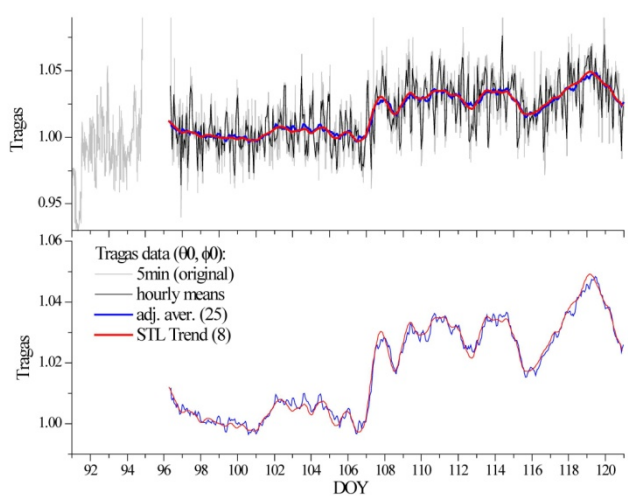
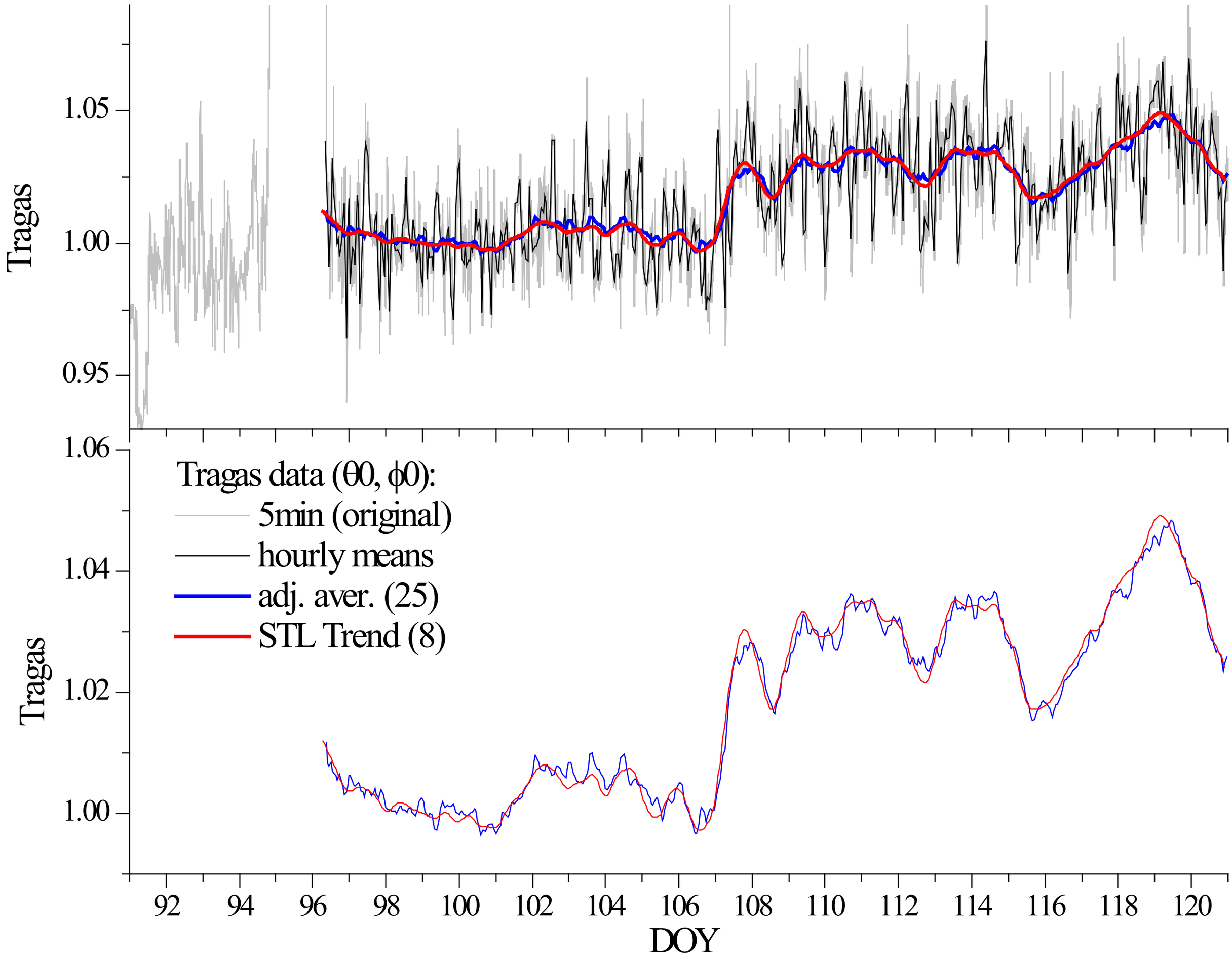


Fig. 1. Comparison of Tragas data (θ0, φ0) with different time resolution (smoothing levels): original (5min), hourly means, smoothed by the adjacent averaging (25 points window), smoothed by the STL decomposition (np=8).

Fig. 1


Tragas
1.05
1.00
0.95
1.06
1.04
1.02
1.00
Tragas data (θ0, ϕ0):
5min (original)
hourly means
adj. aver. (25)
STL Trend (8)
92
94
96
98
100
102
104
106
108
110
112
114
116
118
120
DOY

2. Comparison of Tragas data from different θ/φ channels (M1)

First of all, the data from all the θ/φ channels were compared between themselves. Fig. 2 shows data from all φ channels for each of the five θ channels and Fig. 3 shows data from all θ channels for each of the eight φ channels. As one can see, the 5th θ channel (θ4) shows highest, and the 1st and 2nd θ channels (θ0-θ1) show lowest levels of dispersion. The difference in the variability (or noise) level between the φ channels is seen only for the θ4 channel. These conclusions are supported by the correlations analysis. Fig. 4 shows correlation coefficients between the different φ channels for the same θ angle and Fig. 5 shows correlation coefficients between the different θ channels for the same φ angle. As one can see, the strongest inter-channel correlations for φ exist for θ1 and θ2, the weakest correlations are seen for θ4. Between the channels θ1 and θ2, the best correlations there are for φ2 (r = 0.77) and φ3, φ5, φ6 (r = 0.7-0.71) – W-SW and E-NE directions. Worst correlation between the θ channels are seen for channel θ4 vs other θs for φ0, φ4, φ3 and φ7 (E-SE and W-NW directions). I can't say for sure which of these correlations are related to the physical (a)symmetry of the particle flux and which are due to the building and detector room's properties.

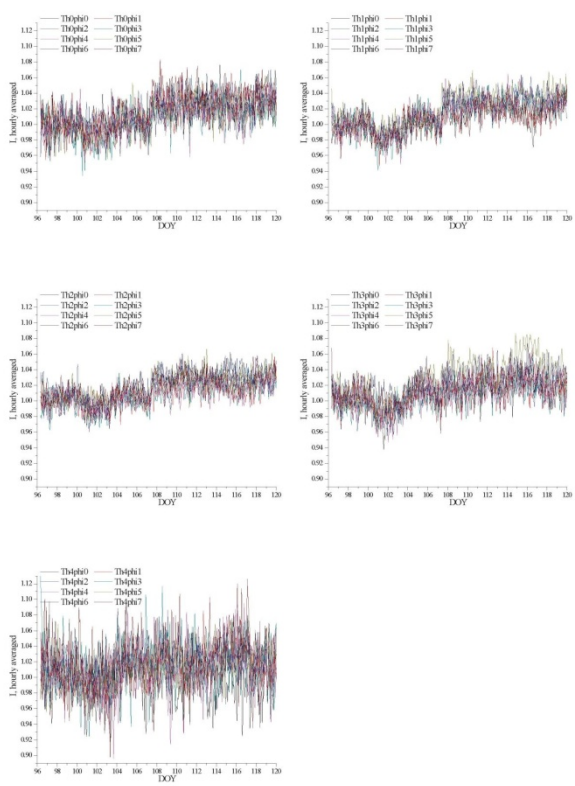


Fig. 2. All φ channels grouped by the θ channels: θ0, θ1 – top row, θ2, θ3 – middle row, θ4 – bottom row.

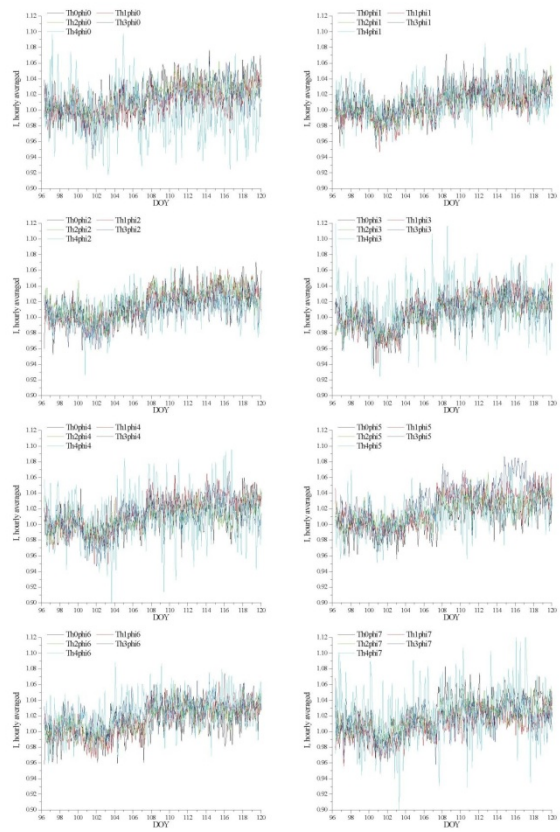


Fig. 3. All θ channels grouped by the φ channels: φ0, φ1 – top row, φ2, φ3 – second row, φ4, φ5 – third row, φ6, φ7 – bottom row.

Fig. 2

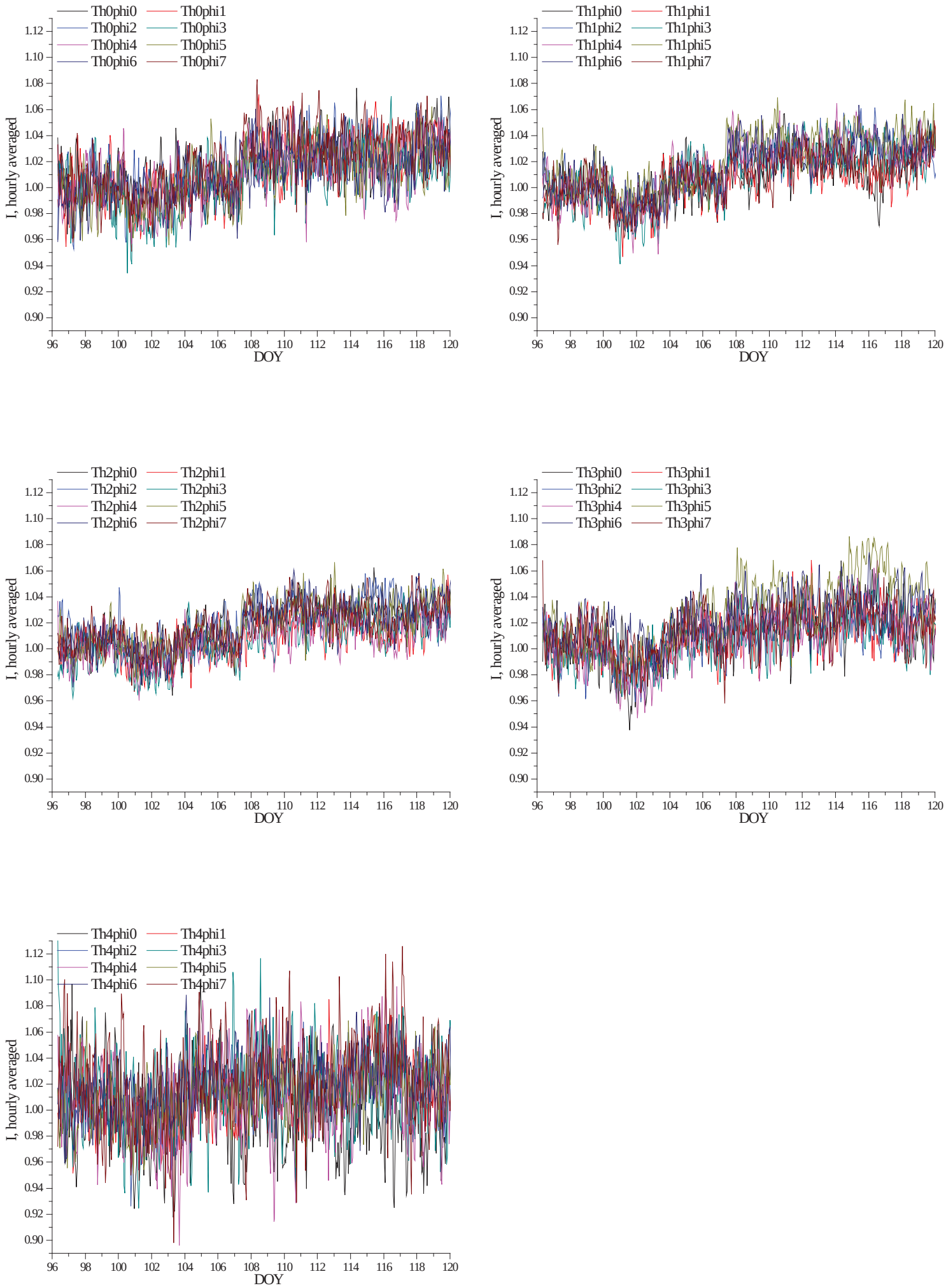
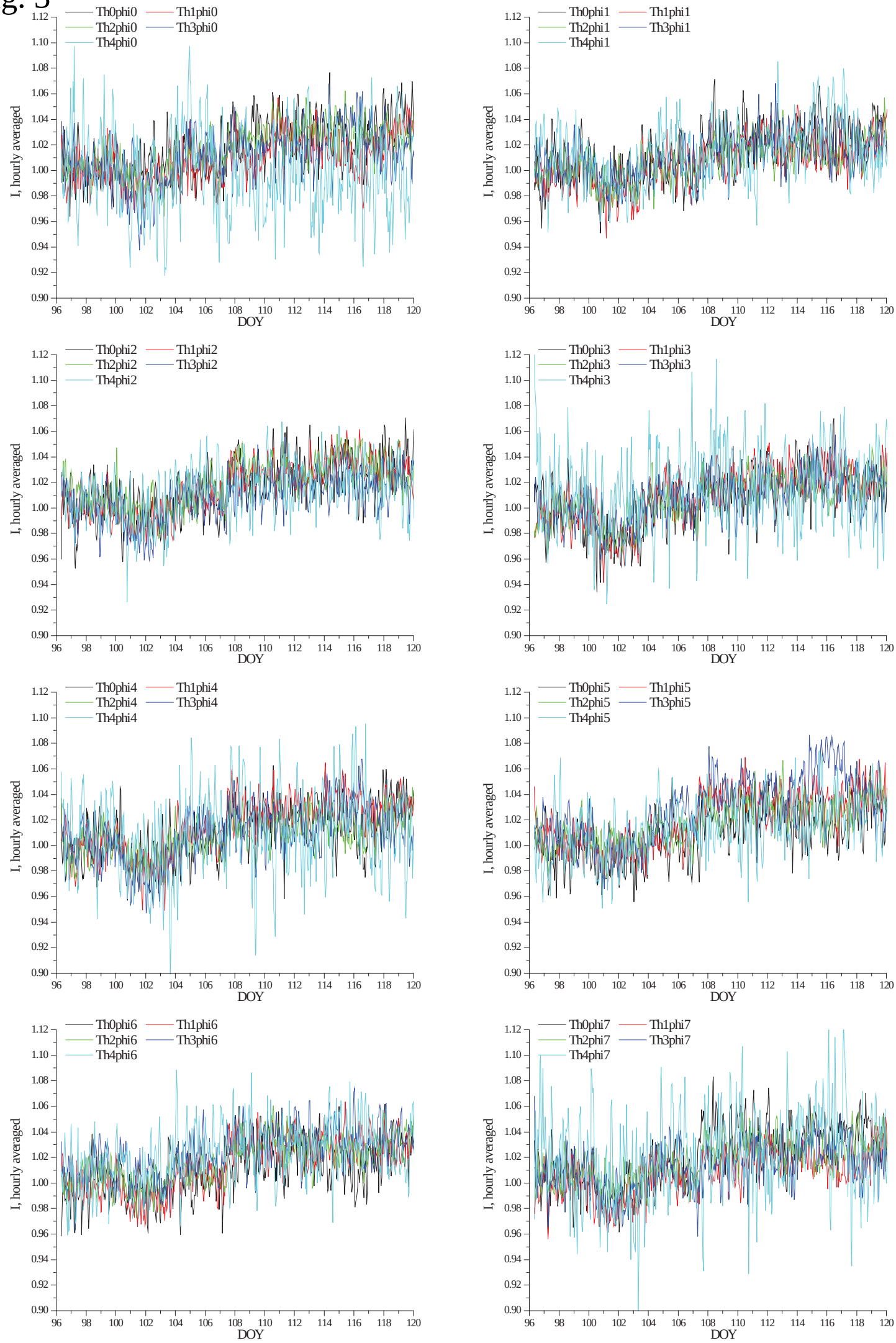

Th0phi0
Th0phi1
Th0phi2
Th0phi3
Th0phi4
Th0phi5
Th0phi6
Th0phi7
Th1phi0
Th1phi1
Th1phi2
Th1phi3
Th1phi4
Th1phi5
Th1phi6
Th1phi7
Th2phi0
Th2phi1
Th2phi2
Th2phi3
Th2phi4
Th2phi5
Th2phi6
Th2phi7
Th3phi0
Th3phi1
Th3phi2
Th3phi3
Th3phi4
Th3phi5
Th3phi6
Th3phi7
Th4phi0
Th4phi1
Th4phi2
Th4phi3
Th4phi4
Th4phi5
Th4phi6
Th4phi7
I, hourly averaged
DOY

Fig. 3


Th0phi0
Th1phi0
Th2phi0
Th3phi0
Th4phi0
Th0phi1
Th1phi1
Th2phi1
Th3phi1
Th4phi1
Th0phi2
Th1phi2
Th2phi2
Th3phi2
Th4phi2
Th0phi3
Th1phi3
Th2phi3
Th3phi3
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Th0phi4
Th1phi4
Th2phi4
Th3phi4
Th4phi4
Th0phi5
Th1phi5
Th2phi5
Th3phi5
Th4phi5
Th0phi6
Th1phi6
Th2phi6
Th3phi6
Th4phi6
Th0phi7
Th1phi7
Th2phi7
Th3phi7
Th4phi7
I, hourly averaged
DOY

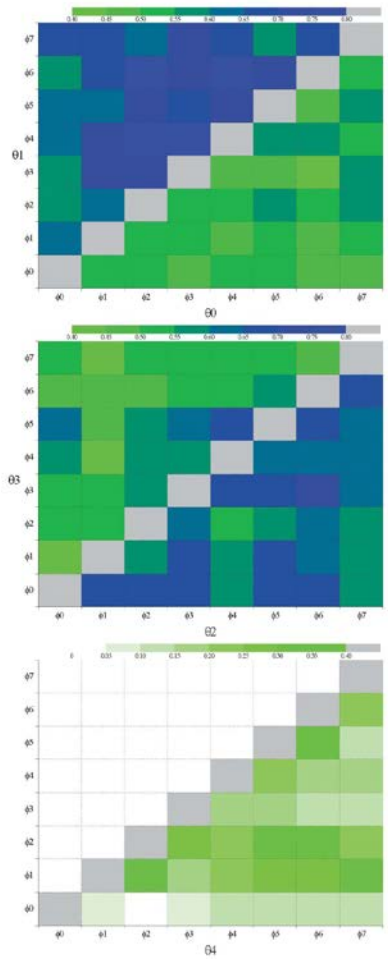


Fig. 4. Correlation coefficients between the φ channels for the same θ (above diagonal/bellow diagonal): top panel – θ1/θ0, middle panel – θ3/θ2, bottom panel – -/θ4.

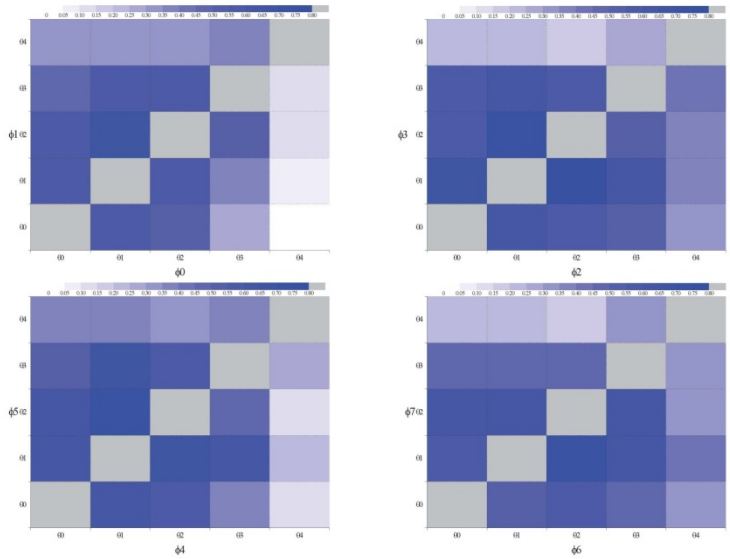
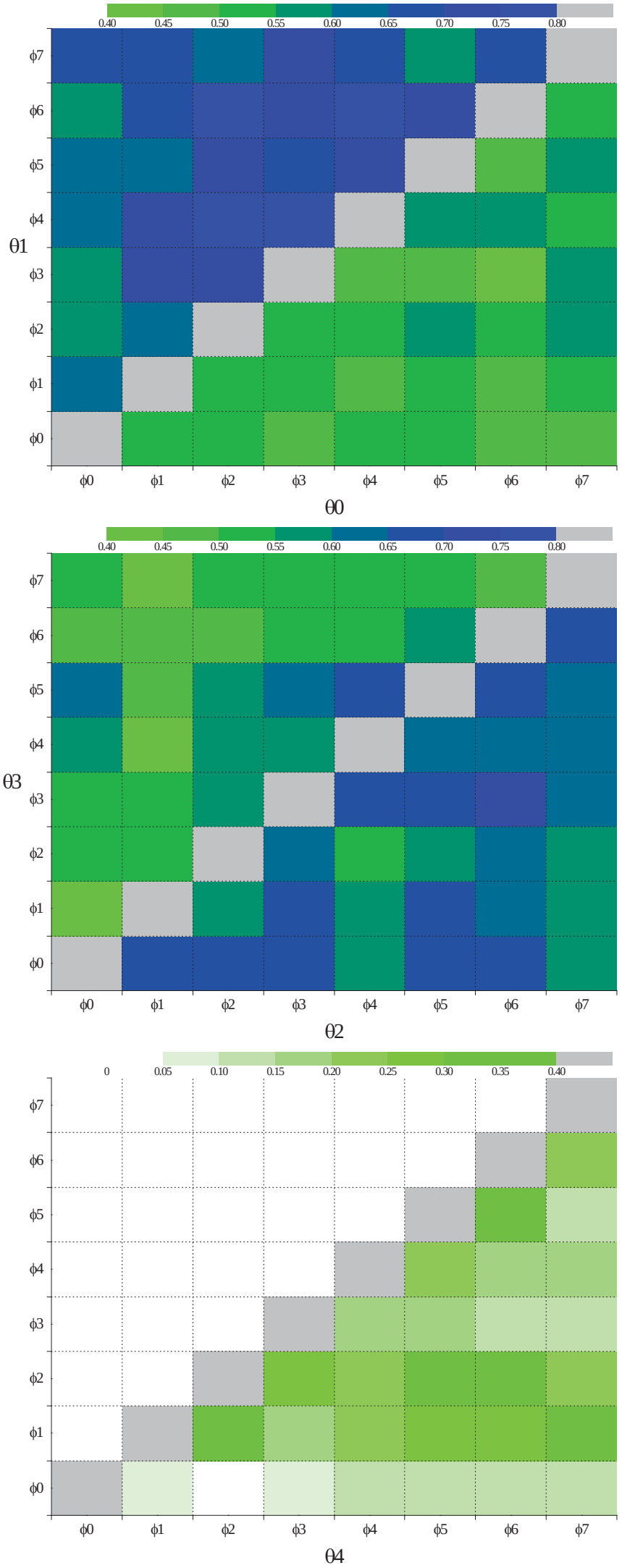


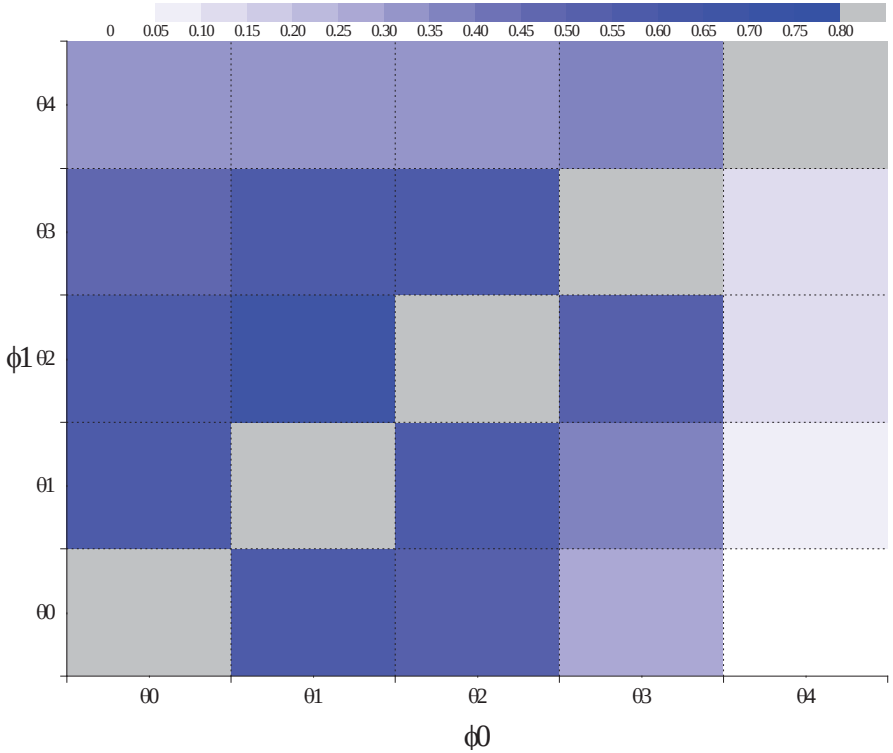
Figure 5. Correlation coefficients between the θ channels for the same φ: top left – φ1/φ0, top right – φ3/φ2, bottom left – φ5/φ4, bottom right – φ7/φ6.

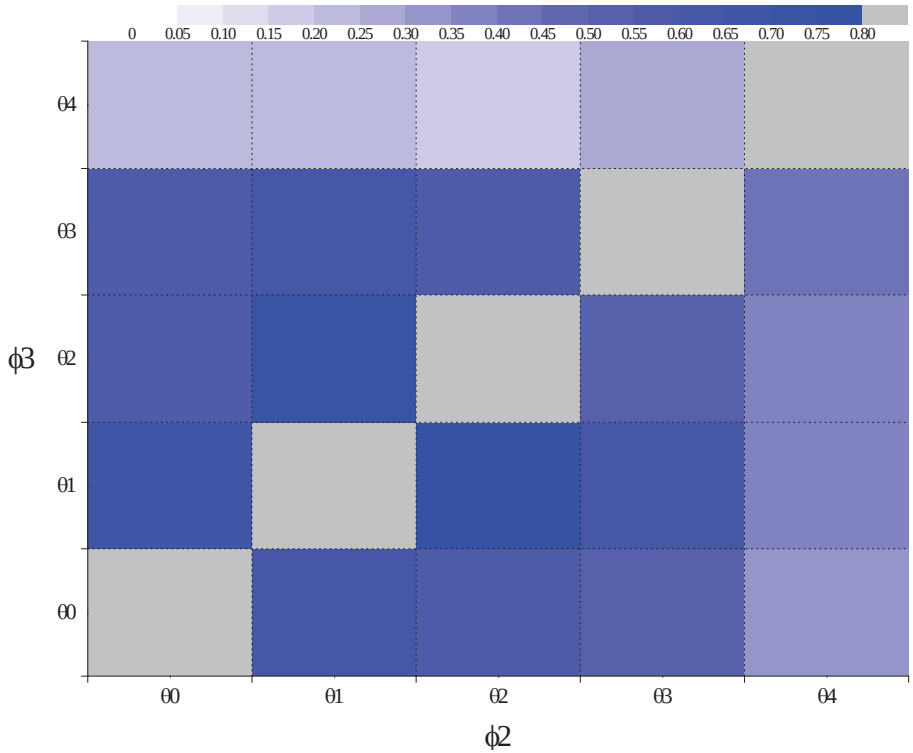
3. Comparison of the Tragas data to GMF and NM data

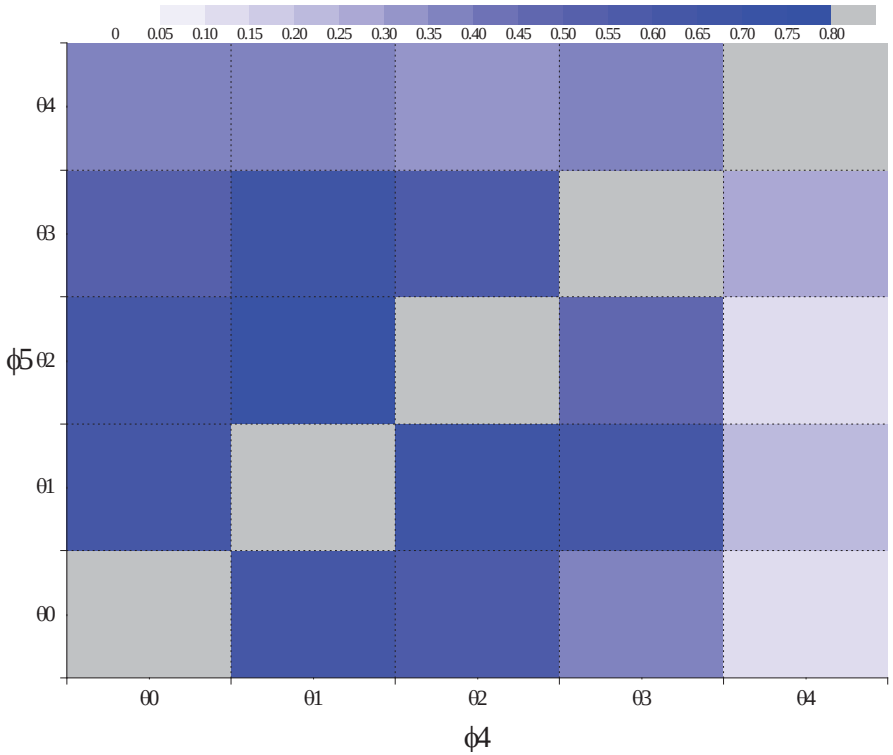
Figs. 6-7 show variations of COI H, COI Z, CaLMa and Tragas (θ0, φ0 as an example) data for the studied period and Fig. 8 show variations of GMF, NM data and Tragas Σφ for the different θ channels. First of all, the Tragas data quite well resemble CaLMa series variations (see e.g. Fig. 6 bottom left). Since the variations of GMF and cosmic ray (CR) flux measured by NM are coupled (to a certain degree), the Tragas data also show co-variations with both GMF components measured by COI (see e.g. Fig. 6 bottom right).

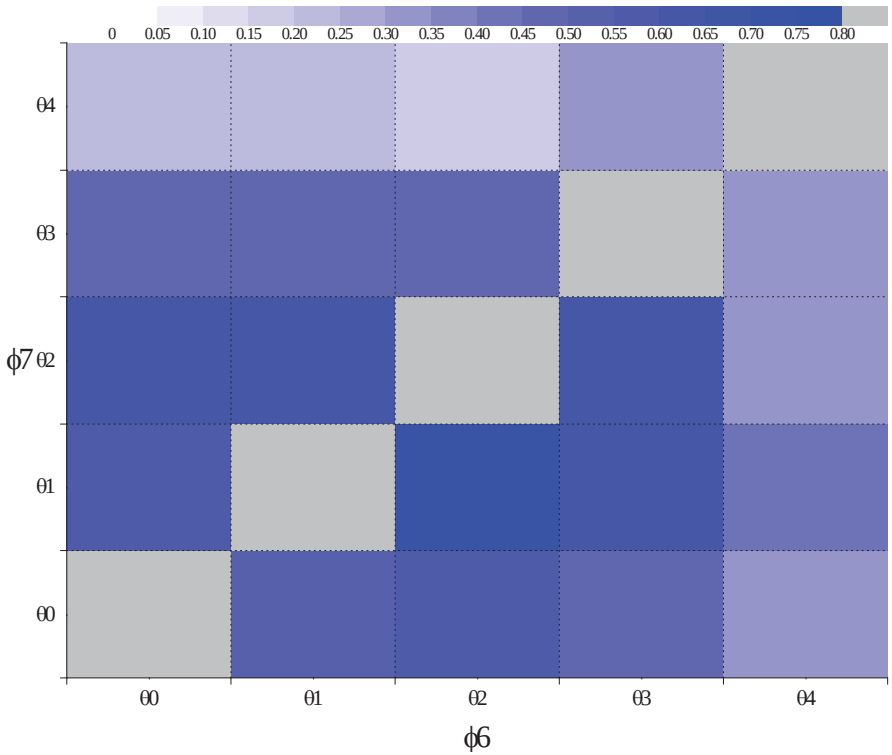
Fig. 4


0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80
θ1
ϕ7 ϕ6 ϕ5 ϕ4 ϕ3 ϕ2 ϕ1 ϕ0
ϕ0 ϕ1 ϕ2 ϕ3 ϕ4 ϕ5 ϕ6 ϕ7
θ0
0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80
θ3
ϕ7 ϕ6 ϕ5 ϕ4 ϕ3 ϕ2 ϕ1 ϕ0
ϕ0 ϕ1 ϕ2 ϕ3 ϕ4 ϕ5 ϕ6 ϕ7
θ2
0 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
ϕ7 ϕ6 ϕ5 ϕ4 ϕ3 ϕ2 ϕ1 ϕ0
ϕ0 ϕ1 ϕ2 ϕ3 ϕ4 ϕ5 ϕ6 ϕ7
θ4


0 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80
θ4
θ3
ϕ1 θ2
θ1
θ0
θ0 θ1 θ2 θ3 θ4
ϕ0


0 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80
θ4
θ3
ϕ3 θ2
θ1
θ0
θ0 θ1 θ2 θ3 θ4
ϕ2


0 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80
θ4
θ3
ϕ5 θ2
θ1
θ0
θ0 θ1 θ2 θ3 θ4
ϕ4


0 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80
θ4
θ3
ϕ7 θ2
θ1
θ0
θ0 θ1 θ2 θ3 θ4
ϕ6

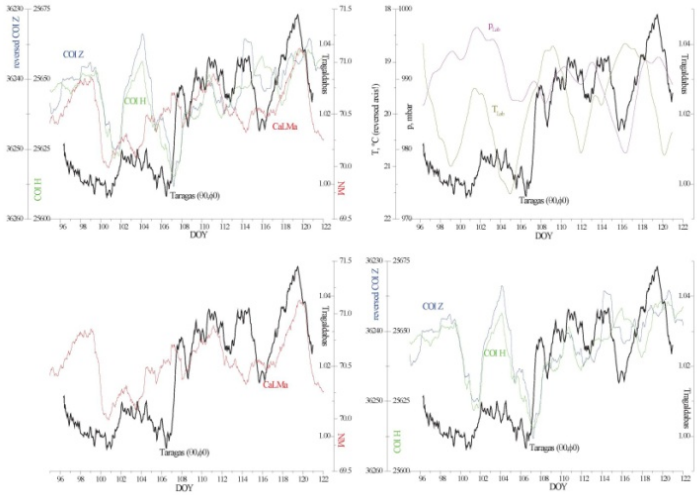


Fig. 6. Variations of COI H, COI Z, CaLMa and Tragas (θ0, φ0) for DOY 96-120. All GMF, NM and Tragas data – top left, atmospheric and Tragas data – top right, NM and Tragas data – bottom left, GMF and Tragas data – bottom right.

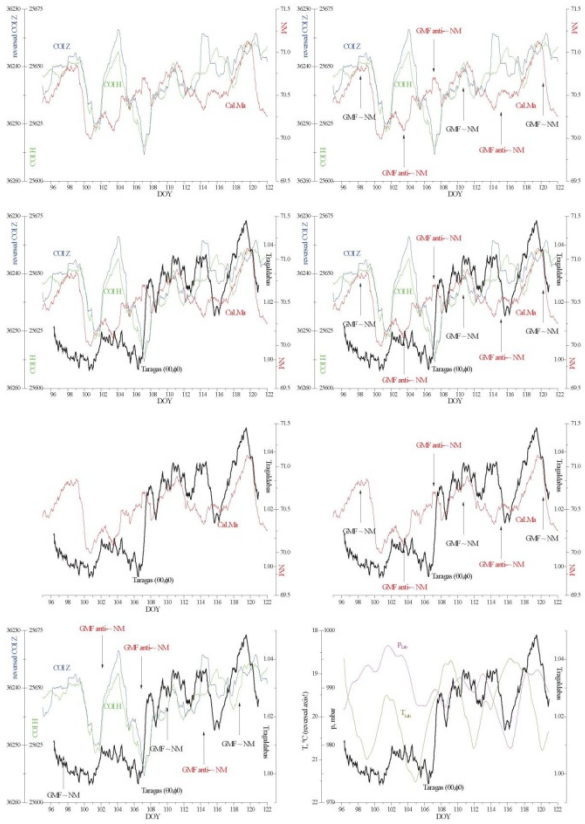


Fig. 7. Same as Fig. 6 but with marked periods of correlation/anti-correlations between the GMF and NM data.

Fig. 8. Variations of COI H, COI Z, CaLMa and Tragas (Σφ) for different θ (from top left to bottom right: all θs, θ0; θ1, θ2; θ3, θ4) for DOY 96-120.

The studied period can be divided into a number of short time intervals (of ~1-3 days long) during which GMF and NM series are correlated or anti-correlated (Fig. 7, top right). During the events of April 2015 the variations of GMF show the first geomagnetic storm (GS) on DOY 100-101 that is followed by a fast recovering of GMF on DOY 104. However, the new storm (or it can be considered as the second phase of the 1st storm) is observed on DOY 107, and GMF slowly recovers until DOY 116-120. As one can see from Fig. 7 (top right), the variations of CR

Fig. 6

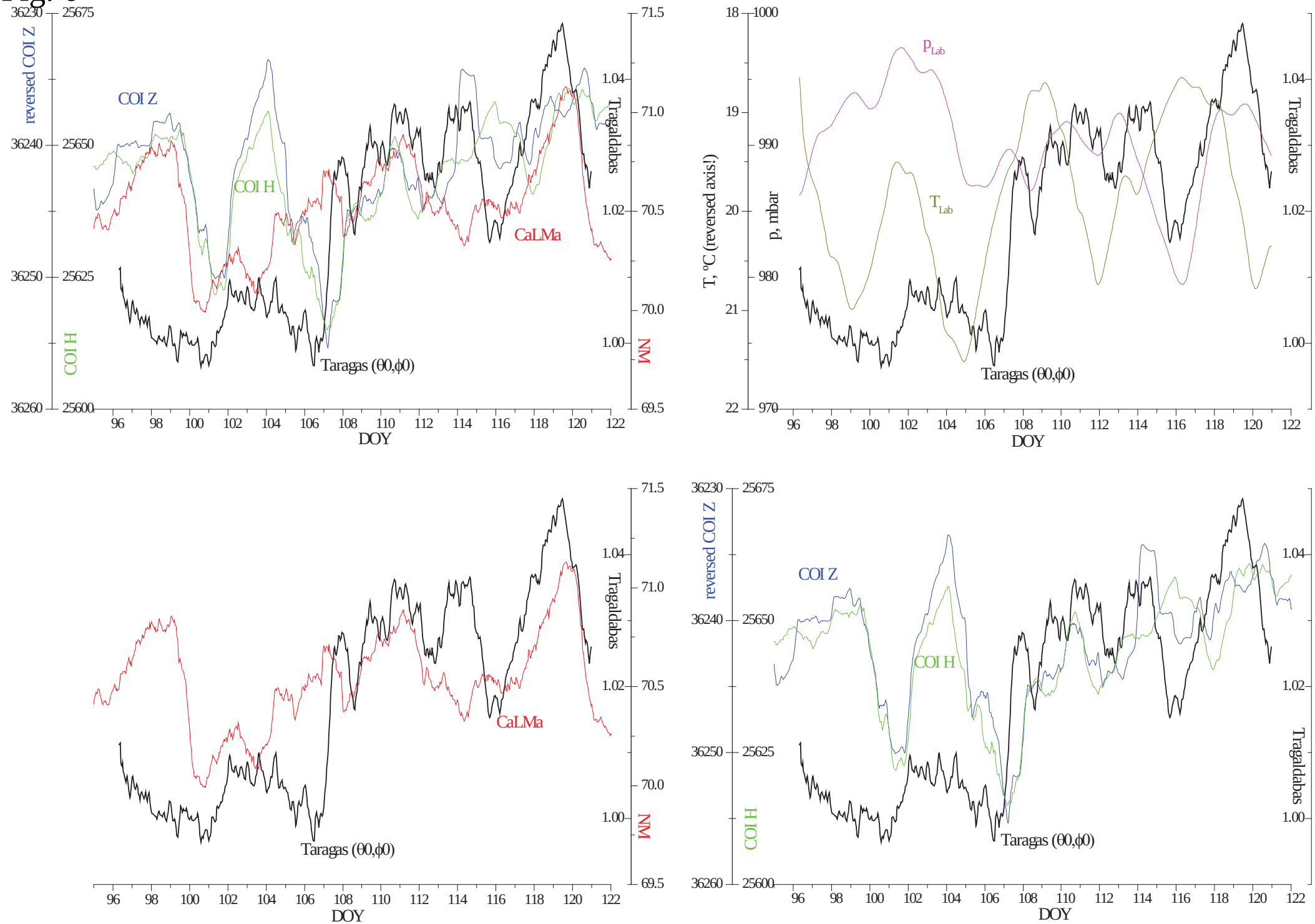

reversed COI Z
COI H
COI Z
COI H
CaLMa
Taragas (θ0,ϕ0)
Tragaldabas
NM
DOY
T, °C (reversed axis!)
p, mbar
p_{Lab}
T_{Lab}
Taragas (θ0,ϕ0)
Tragaldabas
DOY
CaLMa
Taragas (θ0,ϕ0)
Tragaldabas
NM
DOY
reversed COI Z
COI Z
COI H
COI H
Taragas (θ0,ϕ0)
Tragaldabas
DOY

Fig. 7

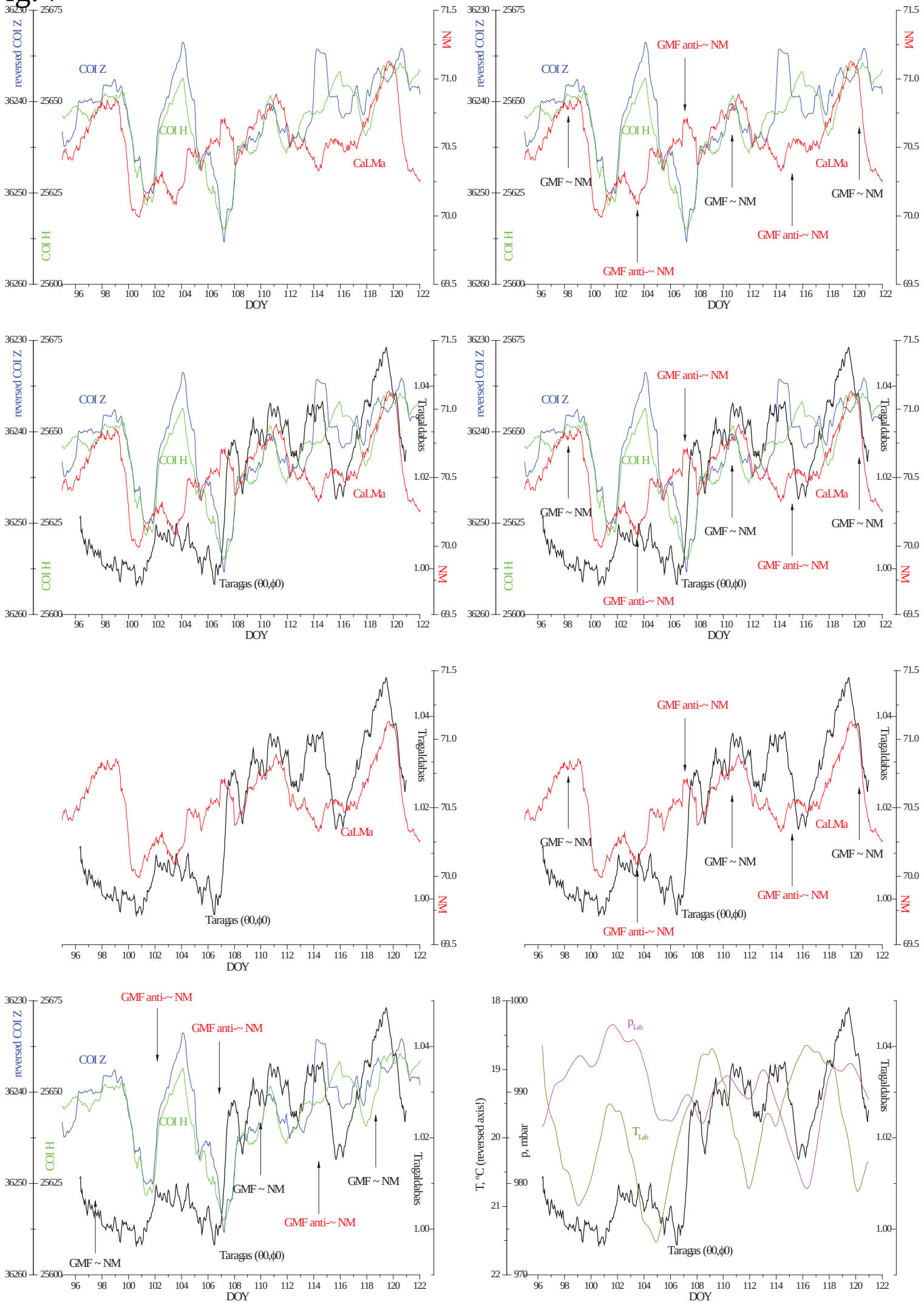

reversed COI Z
COI H
COI Z
COI H
CaLMa
NM
DOY
GMF anti-~ NM
GMF ~ NM
Taragas (θ0,ϕ0)
Tragaldabas
T, °C (reversed axis!)
p, mbar
p_{Lab}
T_{Lab}

Fig. 8


COI Z
COI Z reversed
COI H
CaLMa
NM
Tragaldabas
Taragas (Σϕ: θ0, θ1, θ2, θ3, θ4)
DOY

measured by NM show significant decrease (FD) on DOY 100-104 (coincides with the first GS), then the CR flux gradually increases to the undisturbed level with another (smaller) FD on DOY 112-116 (no GS at this moment!). The second GS wasn't accompanied by FD. Comparison of the variations of the Tragas data with GMF and NM data during these time intervals (Fig. 7, right panels) shows that the differences between the variations of the Tragas and CaLMa series are not linked (at least on first site) to these intervals of correlation/anti-correlation between the GMF and CR time variations. However, one can see that the 2nd GS (DOY 107) was accompanied by a decrease of the Tragas particle flux (but not the neutron flux). On the other side, the 2nd FD (DOY 112-116), that took place without GS, is seen in the Tragas data quite well (with a delay of ~2 days). It is interesting to note that during this event the geomagnetic components (H and Z) showed different behaviour: while COI H was gradually increasing from DOY 112, COI Z showed sudden increase (***H and Z components anti-correlate!***) on DOY ~116 which is correlated with the decrease of the Tragas data.

To my mind, all these mean that the Tragas measured particle variations are due to the (1) variations of the CR flux similar to ones measured by NM and (2) variations of GMF (with variations of the different components taken into account!). It could even be said that (during this particular series of events!) the 1st decrease of the Tragas particles is more related to FD of other CR particles, but following variations of the Tragas series are more correlated with the GMF variations. The detailed analysis of Fig. 8 allows me even to conclude that (during April 2015 events!) particles arriving from different zenith angles co-vary with different GMF components. As one can see comparing Fig. 8 bottom panels (θ3-θ4) with middle (θ1-θ2) and top right (θ0) panels, particles arriving with close to zenith angles (θ0-θ2) follow rather variations of COI Z and ones arriving with the low zenith angles (θ3-θ4) follow rather variations of COI H. This is clearly seen during DOY 112-116. However, we have to keep in mind that the data from the θ4 channel are very noisy and, probably, not as reliable as data from other zenith angles.

The correlation analysis of the Tragas vs geomagnetic and CR series shows (Fig. 9) that for all θ (except θ4) the Tragas series
– correlate very well with CaLMa data;
– correlate relatively well with COI H series and anti-correlate with COI Z series.
There is no specific azimuthal direction(s) that are better correlated with NM or GMF data for all the θ channels (maybe, after analysis of other events, such directions can be found), however the Σφ series for θ2 channel show slightly higher correlations (both with CaLMa and COI data) than Σφ series for θ0-θ1 channels.

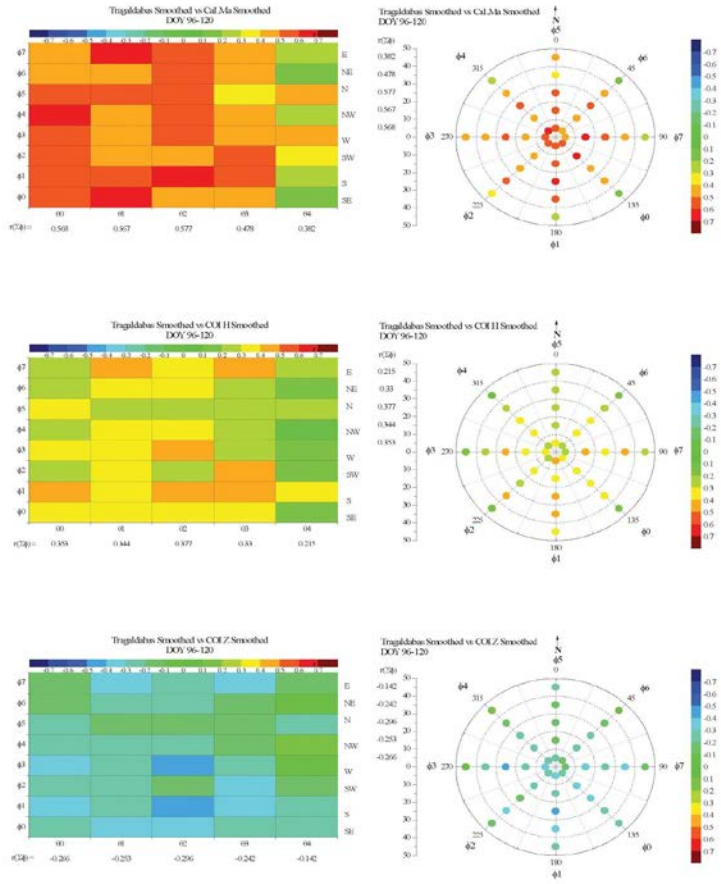
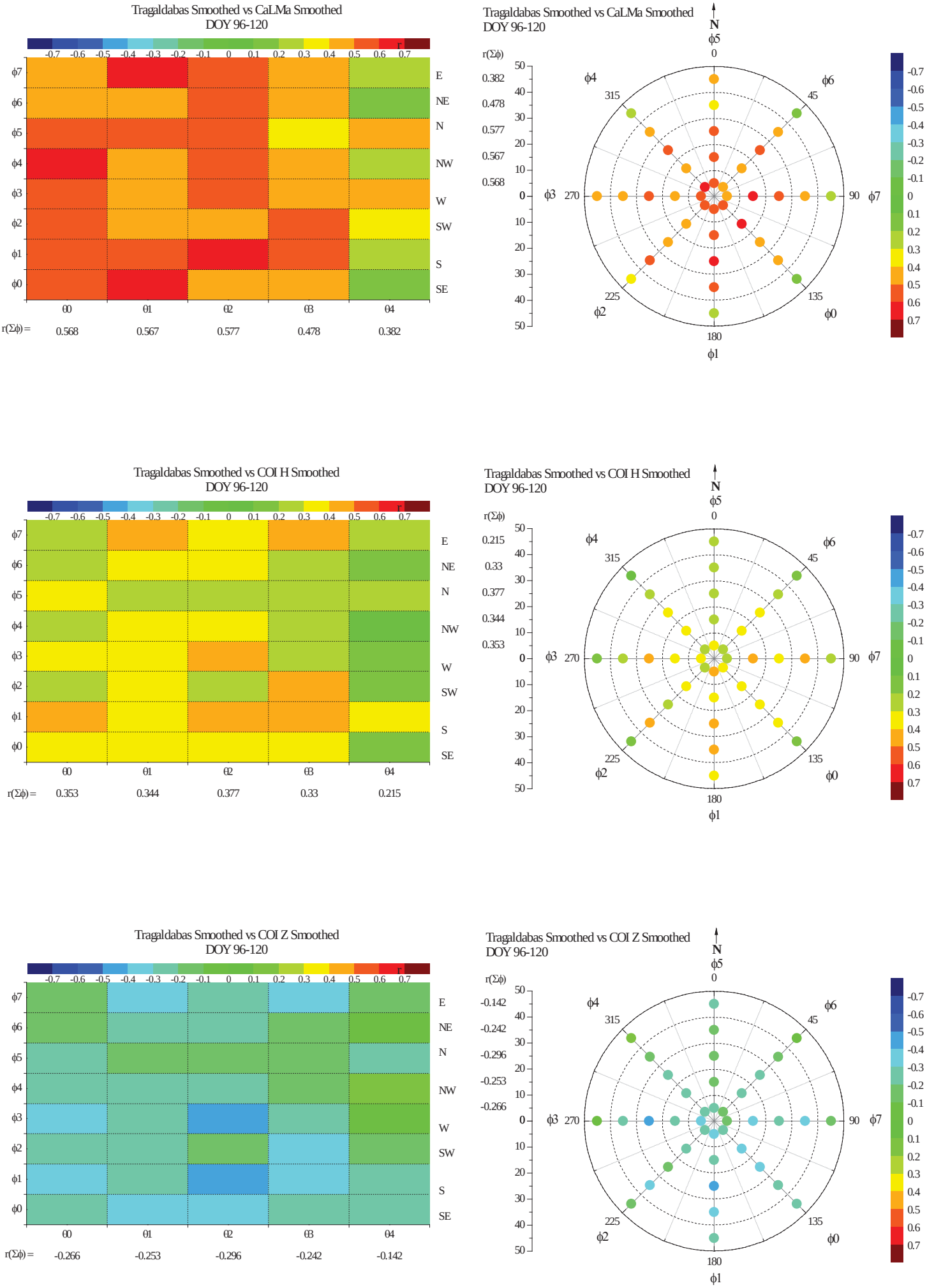


Fig. 9. Correlation analysis of the variations of the Tragas data (different θ/φ – colours, and different θ/Σφ – numbers) vs CaLMa (top row), COI H (middle row) and COI Z (bottom row). Correlation coefficients are shown both as θ vs φ coloured maps and as polar plots (φ – polar angles, θ – radius – see left axes).

4. PCA of the Tragas series

The Tragas hourly averaged data (for DOY 96-120) for all the θ and φ channels were submitted to PCA to find time patterns common to all channels. The first four principal components (PCs) – time functions, and empirical orthogonal functions (EOFs) – distribution between the θ/φ channels, are shown in Fig. 10 (left panels, black lines). As one can see, only first three PCs have time variations different from white noise. The amplitudes (EOFs) of these time variations change from one θ/φ channel to another. Mode 1 (PC1+EOF1) is significant for all θ and φ channels, mode 2 has higher amplitudes for θ0 and θ3-θ4, mode3 is relatively small for all channels except θ4. On the whole, channel θ4 shows highest level of uncertainty (as was already mentioned before). Therefore, I repeated PCA using the data from only θ0-θ3 channels (red lines in left panels in Fig. 10). As one can see, the main trends of the first three PCs remain the same (there are point-to-point variations due to the high level of noise of the hourly averaged data). The smoothed series of PC1-PC3 are shown in Fig. 10 (left panels) as blue lines and in top right panel as black, red and blue lines (correspondingly). These PCs explains 44-59%, 5-8% and 3-6% of the variability, correspondingly, of the Tragas data set (see Fig. 10, tip right panel).

Fig. 1


Tragaldabas Smoothed vs CaLMa Smoothed
DOY 96-120
r
-0.7 -0.6 -0.5 -0.4 -0.3 -0.2 -0.1 0 0.1 0.2 0.3 0.4 0.5 0.6 0.7
ϕ7 ϕ6 ϕ5 ϕ4 ϕ3 ϕ2 ϕ1 ϕ0
E NE N NW W SW S SE
θ0 θ1 θ2 θ3 θ4
r(Σϕ) = 0.568 0.567 0.577 0.478 0.382
Tragaldabas Smoothed vs CaLMa Smoothed
DOY 96-120
N
ϕ5
0
r(Σϕ)
0.382
0.478
0.577
0.567
0.568
ϕ4 315
ϕ6 45
ϕ3 270
90 ϕ7
225 ϕ2
135 ϕ0
180
ϕ1
Tragaldabas Smoothed vs COI H Smoothed
DOY 96-120
r(Σϕ) = 0.353 0.344 0.377 0.33 0.215
Tragaldabas Smoothed vs COI H Smoothed
DOY 96-120
r(Σϕ)
0.215
0.33
0.377
0.344
0.353
Tragaldabas Smoothed vs COI Z Smoothed
DOY 96-120
r(Σϕ) = -0.266 -0.253 -0.296 -0.242 -0.142
Tragaldabas Smoothed vs COI Z Smoothed
DOY 96-120
r(Σϕ)
-0.142
-0.242
-0.296
-0.253
-0.266

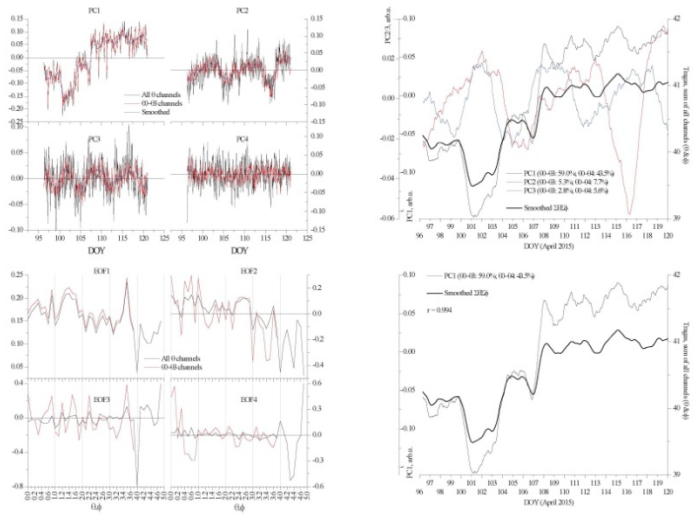


Fig. 10. Left panels – First 4 PCs and EOFs from PCA of the Tragas data set (DOY 96-120). Black lines show results for the whole Tragas data set (θ0-θ4) and red lines show results of PCA for the first three θ channels. Blue lines (tope left panel) show smoothed PCs. Right panels – comparison of the first three PC (for θ0-θ3 data set) with a smoothed sum for all θ and φ channels (total measured flux).

As one can see PC1 represent the main trend of the Tragas measured flux (Fig. 10, right panels) during the events of April 2015. As expected, it shows the same correlations (Fig. 11-12) with GMF and NM series as the data from the θ/φ channels shown in Figs. 7-9. The other two PCs show no significant correlation with GMF and NM series. I suppose PC1 can be used to further analysis of the variations of the particle flux measured by Tragas in relation to space weather events (GS, FD, solar wind structures etc.). The origin of PC2 and PC3, on other hand, need special attention. These PCs explain quite a part of the whole Tragas flux variations (~10% in sum). While these PCs do not correlate with GMF and NM series, as is seen in Figs. 11-12, some specific pattern are seen in their time variations. The origin of these PCs is discussed in the next section.

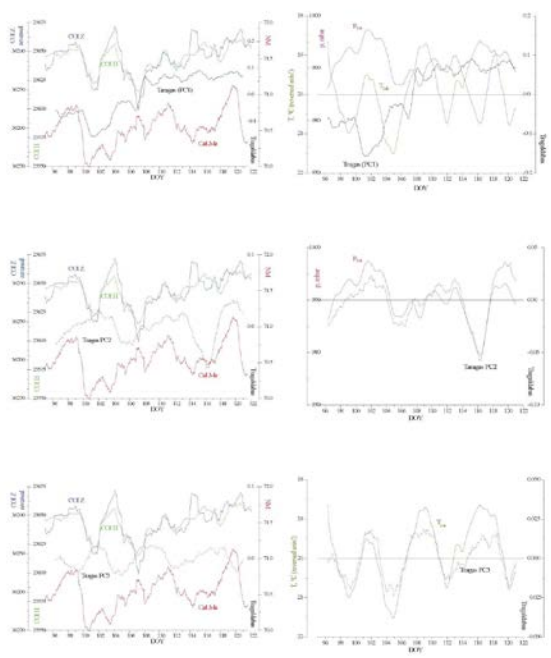


Fig. 11. Variations of PC1-PC3 comparing to the variations of COI H and COI Z, and CaLMa (left panels) and p and T in the Lab (right panels).

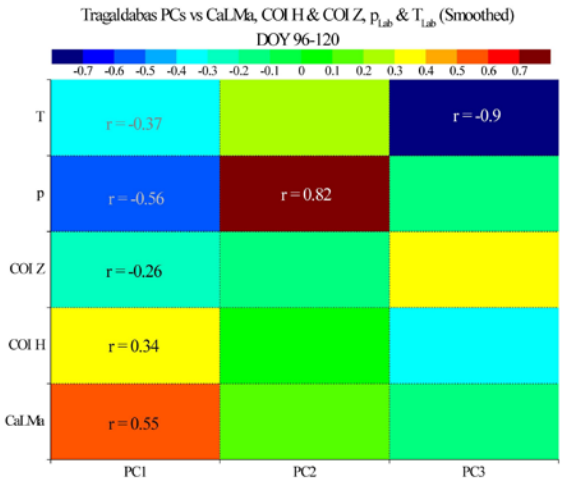
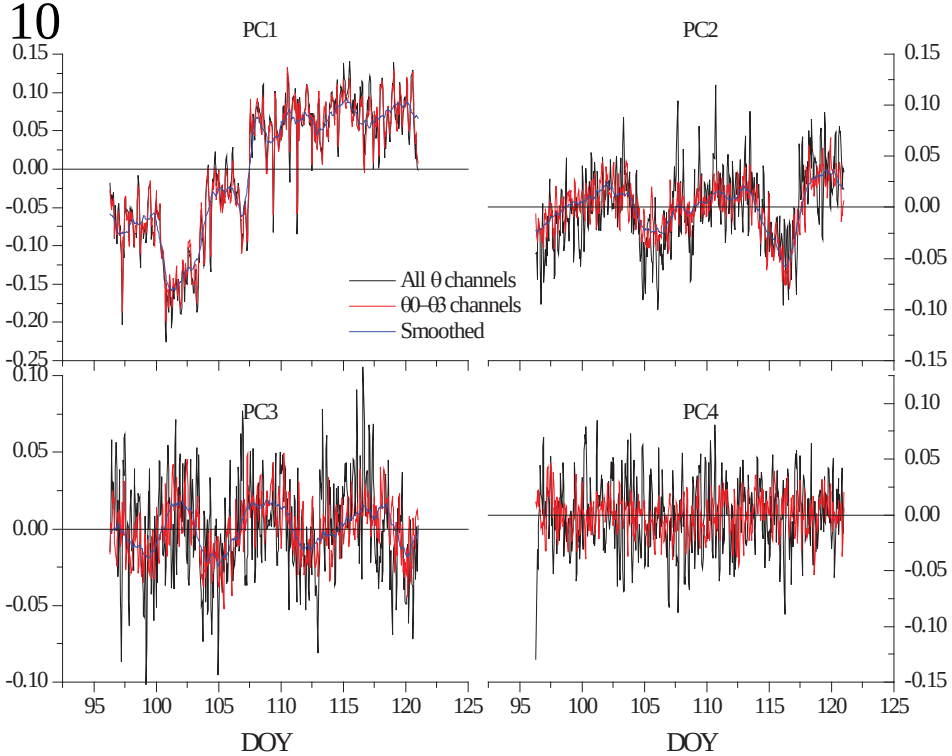
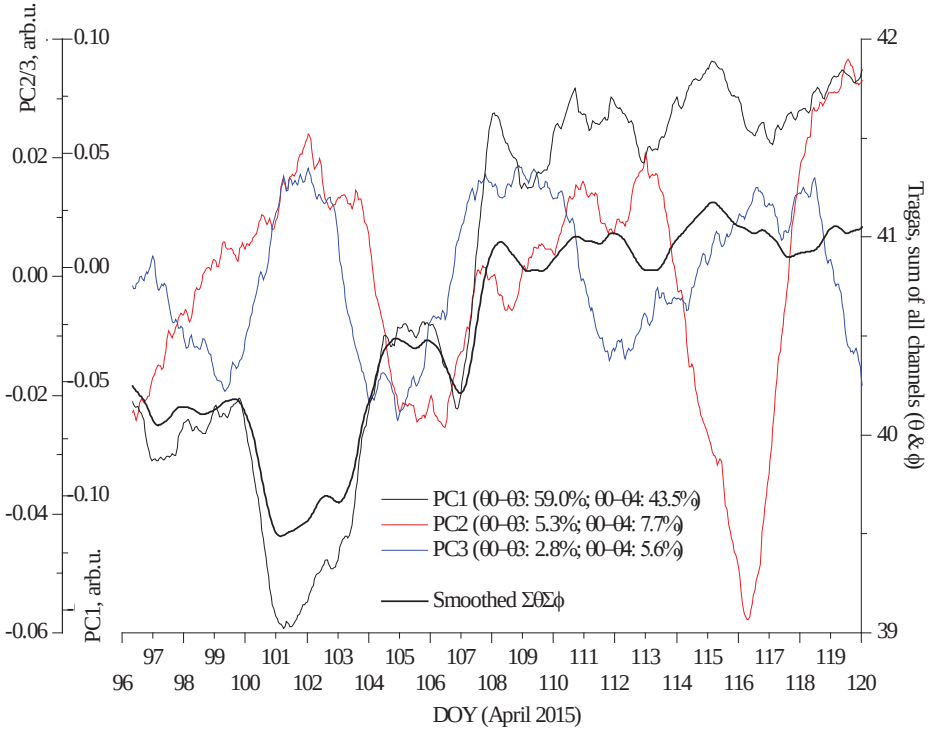
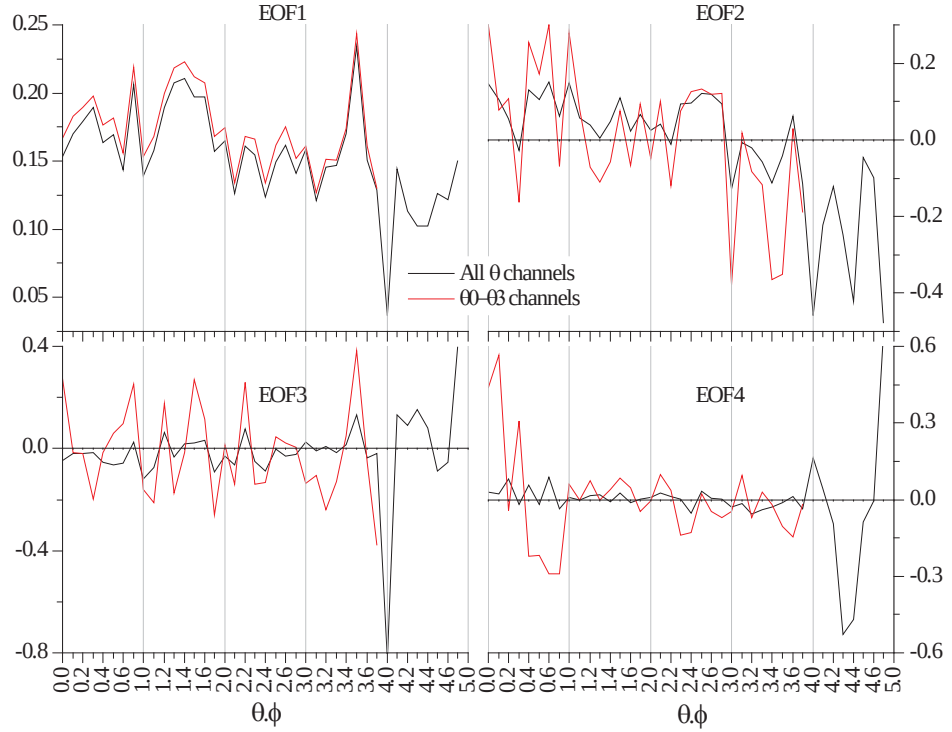


Fig. 12. Correlation coefficients between PC1-PC3 and GMF, NM and atmospheric series.

Fig. 10


PC1
PC2
PC3
PC4
All θ channels
θ0–θ3 channels
Smoothed
DOY
DOY


PC2/3, arb.u.
PC1, arb.u.
Tragas, sum of all channels (θ & ϕ)
PC1 (θ0–θ3: 59.0%; θ0–θ4: 43.5%)
PC2 (θ0–θ3: 5.3%; θ0–θ4: 7.7%)
PC3 (θ0–θ3: 2.8%; θ0–θ4: 5.6%)
Smoothed ΣθΣϕ
DOY (April 2015)


EOF1
EOF2
EOF3
EOF4
All θ channels
θ0–θ3 channels
θ.ϕ
θ.ϕ

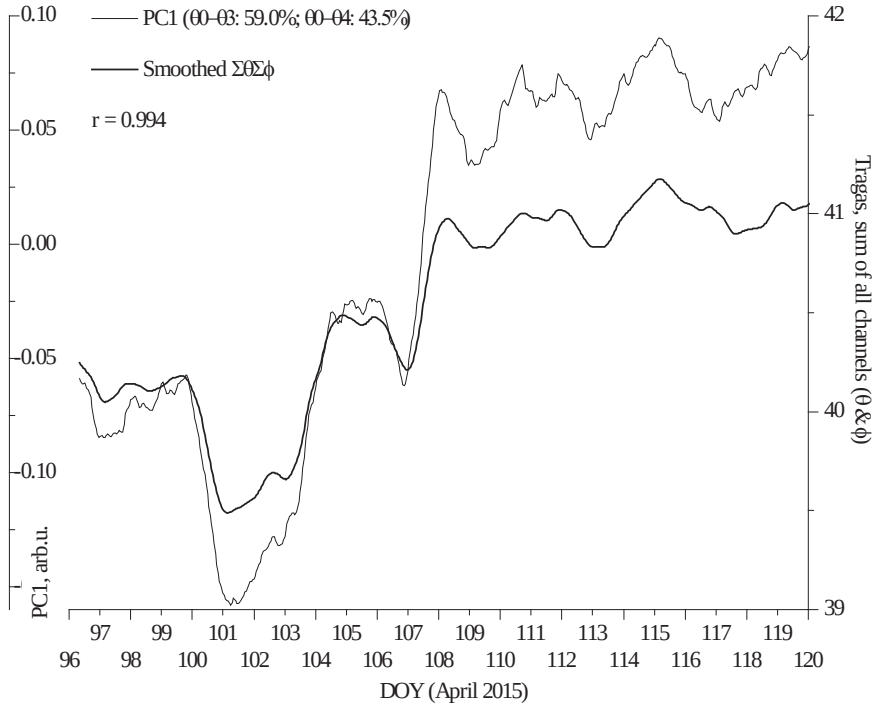
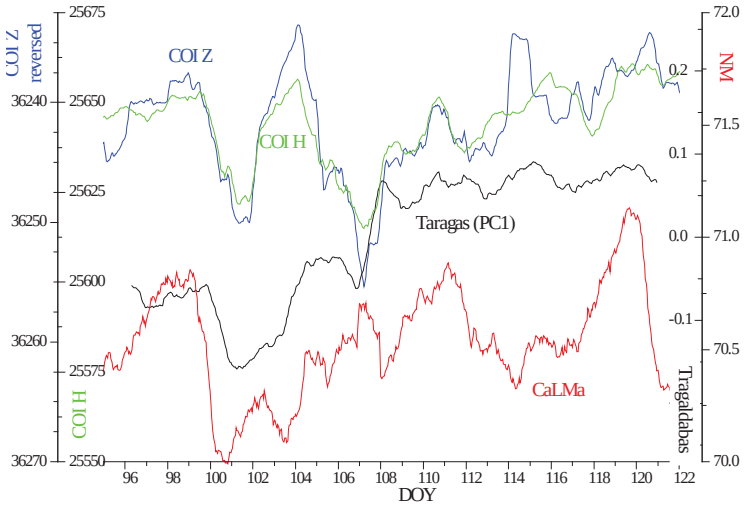
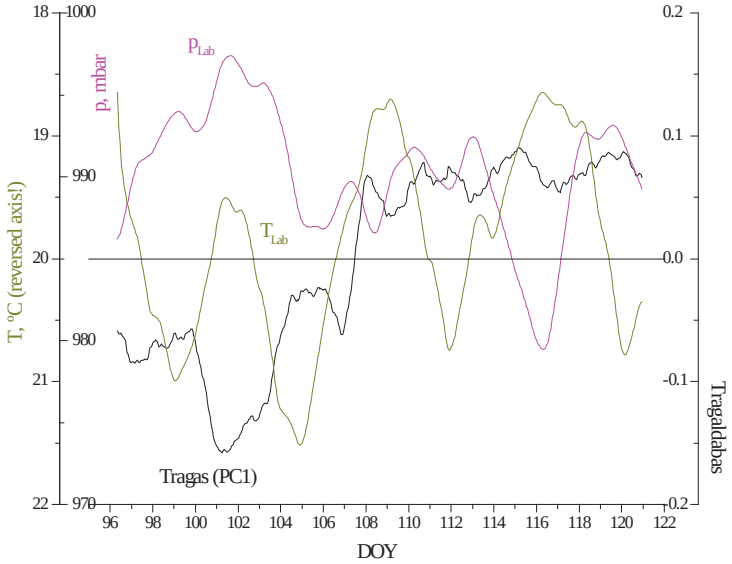
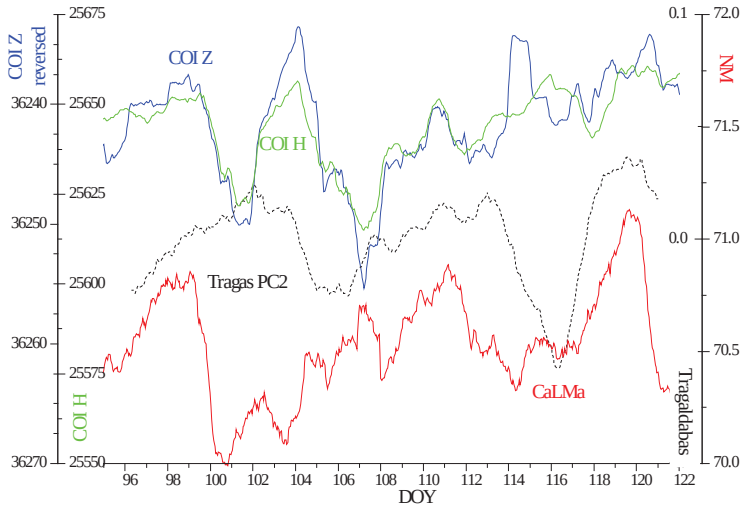
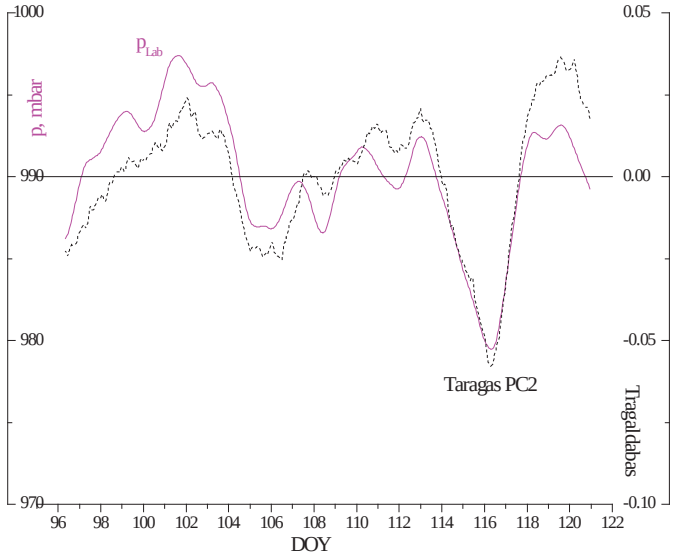

PC1 (θ0–θ3: 59.0%; θ0–θ4: 43.5%)
Smoothed ΣθΣϕ
r = 0.994
PC1, arb.u.
Tragas, sum of all channels (θ & ϕ)
DOY (April 2015)

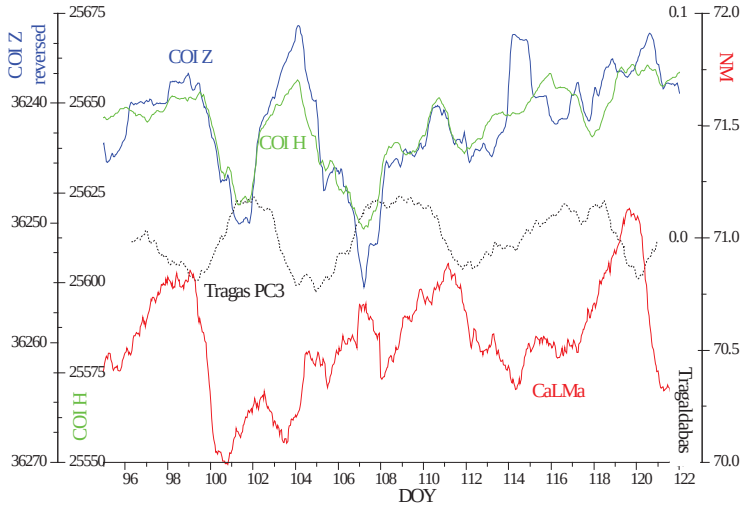
Fig. 11


COI Z reversed
COI H
COI Z
COI H
Taragas (PC1)
CaLMa
NM
Tragaldabas
DOY


p, mbar
T, °C (reversed axis!)
p_{Lab}
T_{Lab}
Tragas (PC1)
Tragaldabas
DOY


COI Z reversed
COI H
COI Z
COI H
Tragas PC2
CaLMa
NM
Tragaldabas
DOY


p, mbar
p_{Lab}
Taragas PC2
Tragaldabas
DOY


COI Z reversed
COI H
COI Z
COI H
Tragas PC3
CaLMa
NM
Tragaldabas
DOY

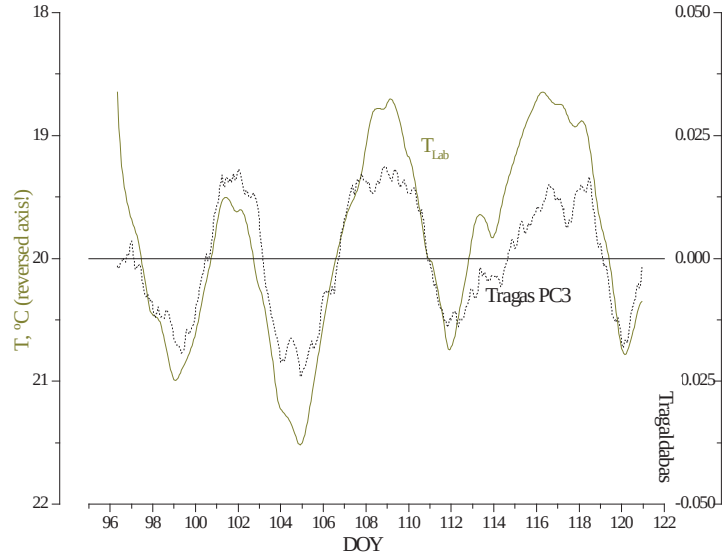
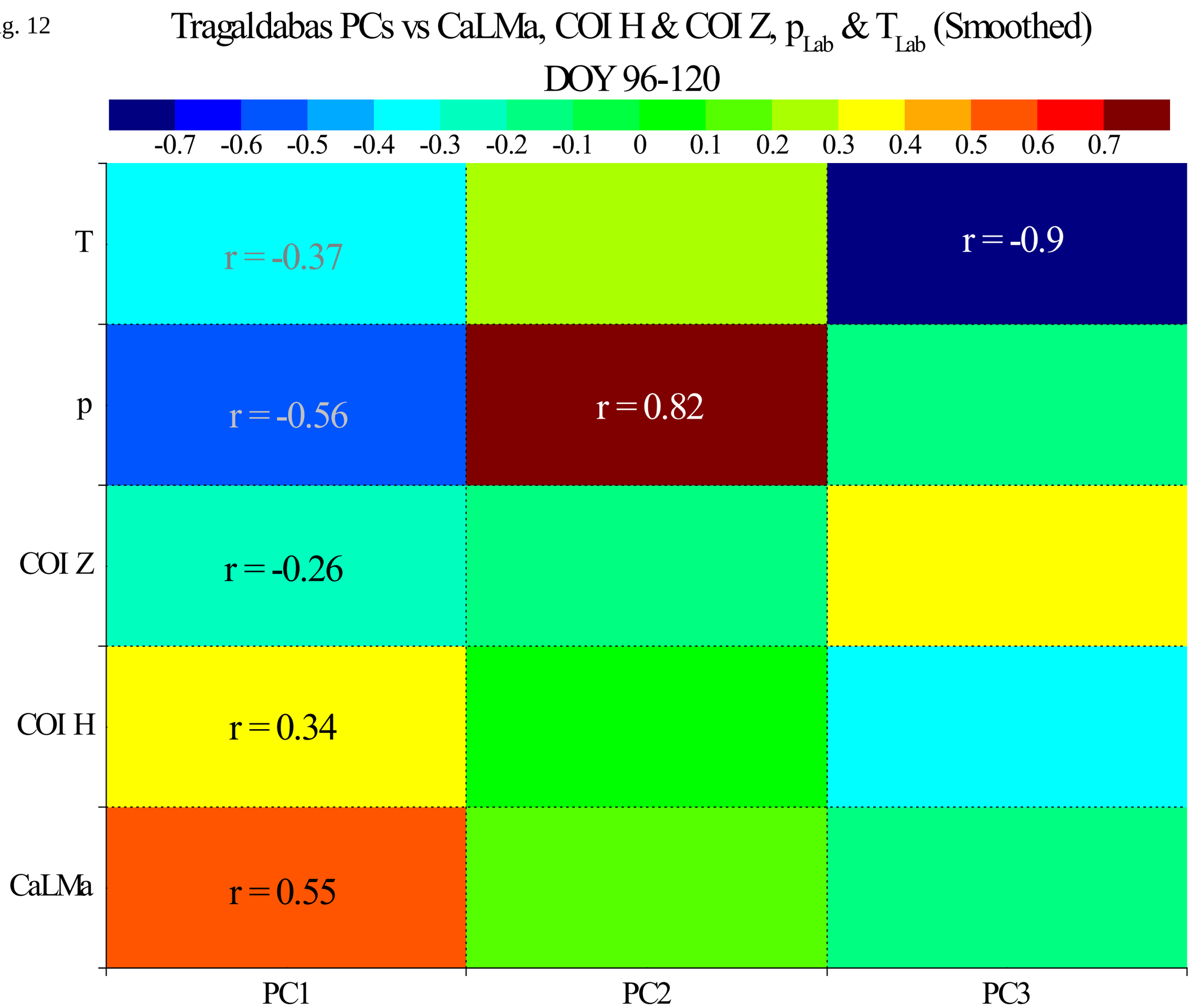

T, °C (reversed axis!)
T_{Lab}
Tragas PC3
Tragaldabas
DOY

Fig. 12


Tragaldabas PCs vs CaLMa, COI H & COI Z, p_{Lab} & T_{Lab} (Smoothed)
DOY 96-120
-0.7 -0.6 -0.5 -0.4 -0.3 -0.2 -0.1 0 0.1 0.2 0.3 0.4 0.5 0.6 0.7
T
p
COI Z
COI H
CaLMa
r = -0.37
r = -0.9
r = -0.56
r = 0.82
r = -0.26
r = 0.34
r = 0.55
PC1
PC2
PC3

5. Atmospheric component in the Tragas data

It was tempting to think that the variations related to PC2 and PC3 come from the effect of atmospheric parameters in the tropopause and stratosphere on the CR flux. Unfortunately, this is not the case. As one can see in Fig. 13, there are no straightforward similarities between these two PCs of the Tragas data and atmospheric parameters at tropopause and stratospheric levels. On the other hand, when these PCs are compared to the p and T measured in the Lab (Fig. 11, right panels), it is absolutely clear that PC2 arises from the Tragas detector response to the pressure variations and PC3 results from the effect of the temperature in the Lab. These conclusions are confirmed by the correlation analysis (Fig. 12). Moreover, the correlation analysis shows that PC1 is also not free from the environmental effect.

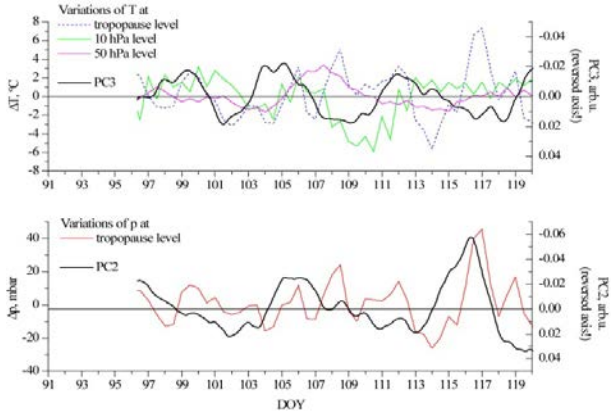
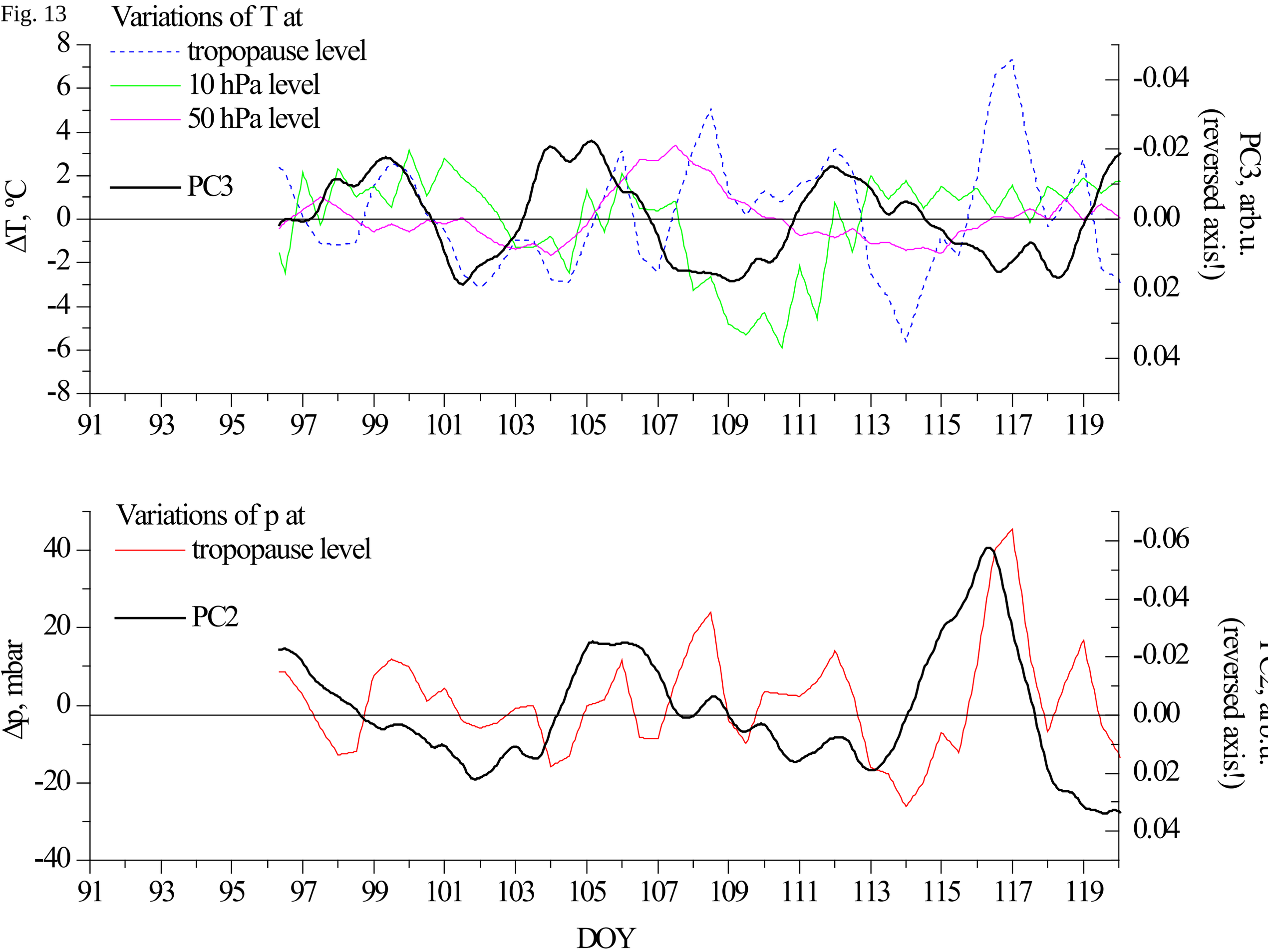


Fig.13. Comparison of PC3 and tropopause and stratospheric temperatures (top panel) and comparison of PC2 and tropopause pressure (bottom panel).

The co-variations between the Lab's p and T series and Tragas data from different θ/φ channels are shown in Fig. 6 (top right), Fig. 7 (bottom right) and Fig. 14. As one can see from Fig.14 the strength of the dependence of the Tragas data on the atmospheric parameters increases with zenith angle: channels θ3 and θ4 shows higher level of correlations than θ0-θ2 channels. Also, the dependence on p is stronger than on T (this is also seen in the PCA results – PC2 explain more of the input data set variations than PC3). Taking into account that the Tragas data used in the analysis are already (!) p and T corrected, this is not a good newst and, I suppose, <u>a new procedure to correct the Tragas data for the atmospheric conditions in the Lab is needed</u>. Please also remember that PC1 is also show correlations with p and T series. These correlation coefficients are, of course, much smaller than ones for PC2 and PC3, but, on the other hand, on the <u>same level as the correlations coefficients between PC1 and COIH, COIZ and CaLMa series.</u> Of course, one can say that these correlations are not from the under-correction of the Tragas data but from the effect of CR and GS on the weather... But I think this is a very lame excuse. ☺

Fig. 13


Variations of T at
tropopause level
10 hPa level
50 hPa level
PC3
ΔT, °C
PC3, arb.u.
(reversed axis!)
8
6
4
2
0
-2
-4
-6
-8
-0.04
-0.02
0.00
0.02
0.04
91
93
95
97
99
101
103
105
107
109
111
113
115
117
119
Variations of p at
tropopause level
PC2
Δp, mbar
PC2, arb.u.
(reversed axis!)
40
20
0
-20
-40
-0.06
-0.04
-0.02
0.00
0.02
0.04
DOY

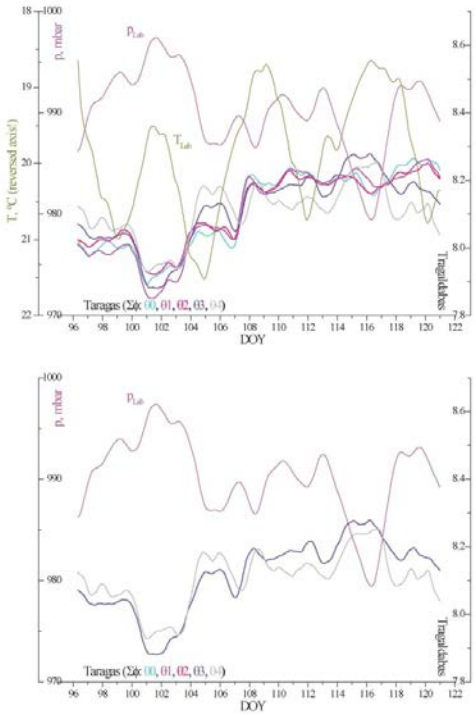


Fig. 14. Tragas Σφ series for different θ channels and p and T series (top panel). p_{Lab} and Tragas Σφ series for θ3 and θ4 channels.

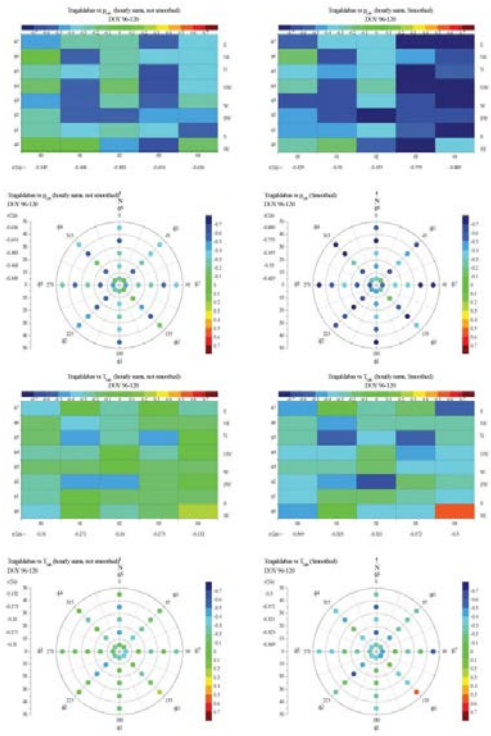
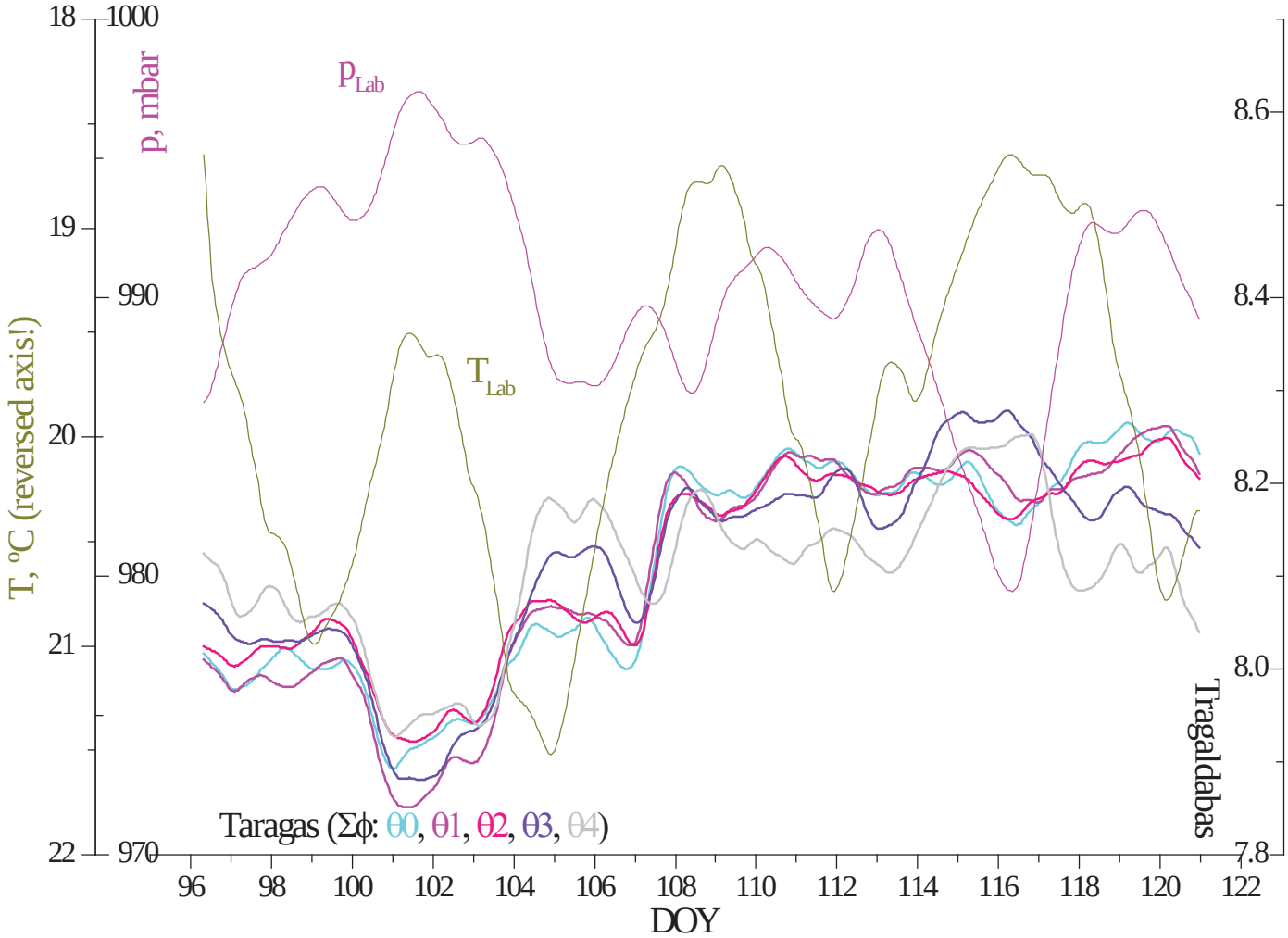


Fig. 15. Correlation coefficients between the Tragas series (for different θ and φ channels) and p (top) and T (bottom) series. Left panels are for the hourly means, right panels are for the smoothed series. Both colour maps and polar plots are shows.

6 Conclusions

1. Tragas data from the different φ and θ channels are inter-correlated. Best correlations are found for φ channels from θ1 and θ2 channels. The data from the θ4 channel show highest level of dispersion and lowest correlation to other θ/φ channels.
2. Main trend of the Tragas series during the events of April 2015 follows quite well the variations of CR particles measured by NM. On the other side, more short-term variations (~1-3 days long) are rather correlated with GMF variations. There is a tendency for Tragas data from θ0-θ2 channels to follow COI Z component variations, while Tragas series for θ3-θ4 channels rather follow changes of the COI H component.
3. Principal component analysis helps to extract three main modes of the Tragas variations. Together they explain ~50-70% of the Tragas data set variability. It's possible to use for PCA only θ0-θ3 channels (since θ4 data are very noisy). The first PC (PC1) represent main trend of the Tragas variations during a series of events in April 2015. It correlates with CaLMa and COI series. Other two PCs result from the atmospheric effect of the detector environment: pressure (PC2) and temperature (PC3) in the Lab. These two PCs are responsible for ~10% of the Tragas data variations (at least, during April 2015) and show that a new procedure for the atmospheric corrections of the Tragas measurements is needed. Besides, PC1 also shows correlation with these p and T series.

Fig. 14


p, mbar
T, °C (reversed axis!)
p_{Lab}
T_{Lab}
Taragas (Σϕ: θ0, θ1, θ2, θ3, θ4)
Tragaldabas
DOY
18
19
20
21
22
1000
990
980
970
8.6
8.4
8.2
8.0
7.8
96
98
100
102
104
106
108
110
112
114
116
118
120
122

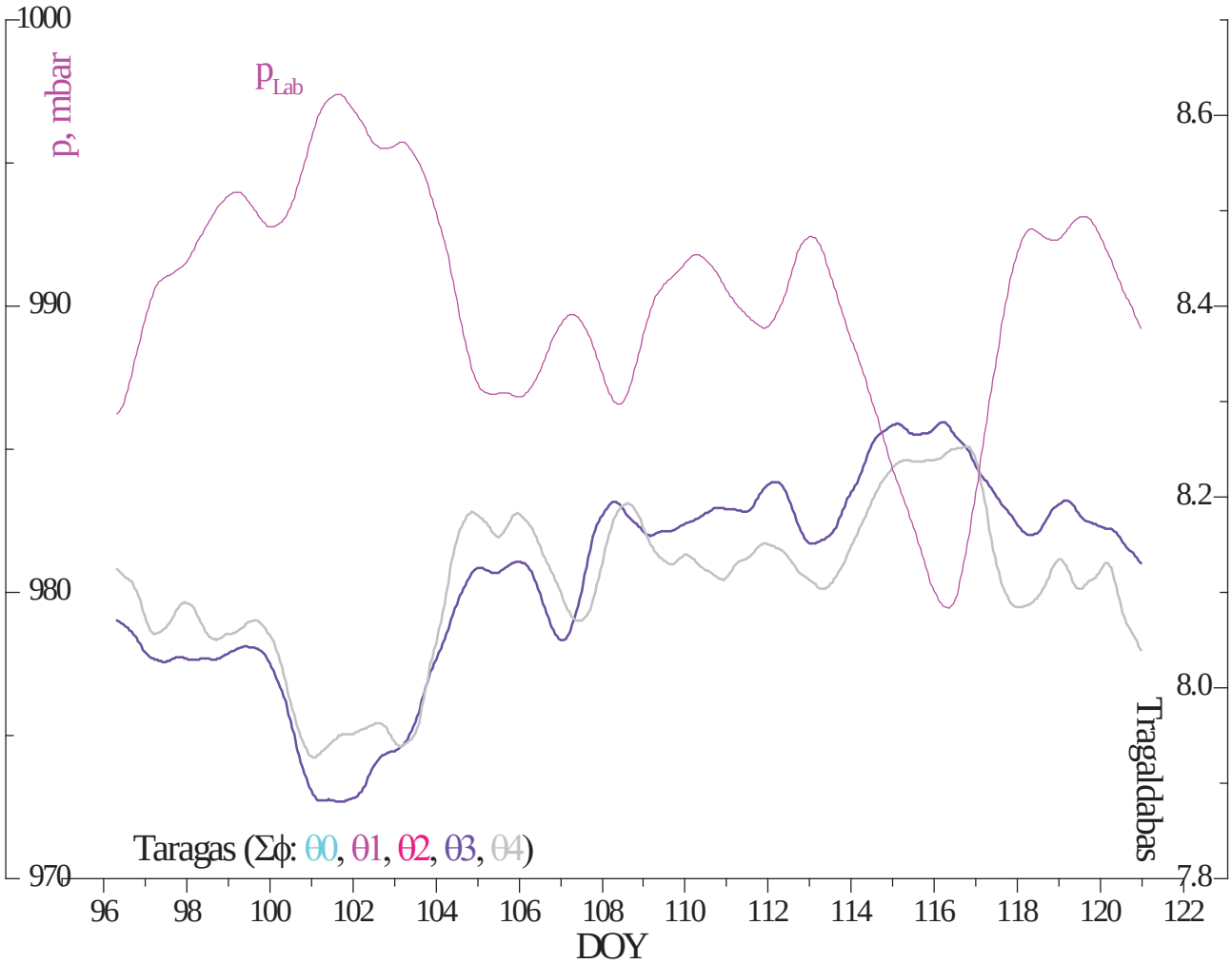
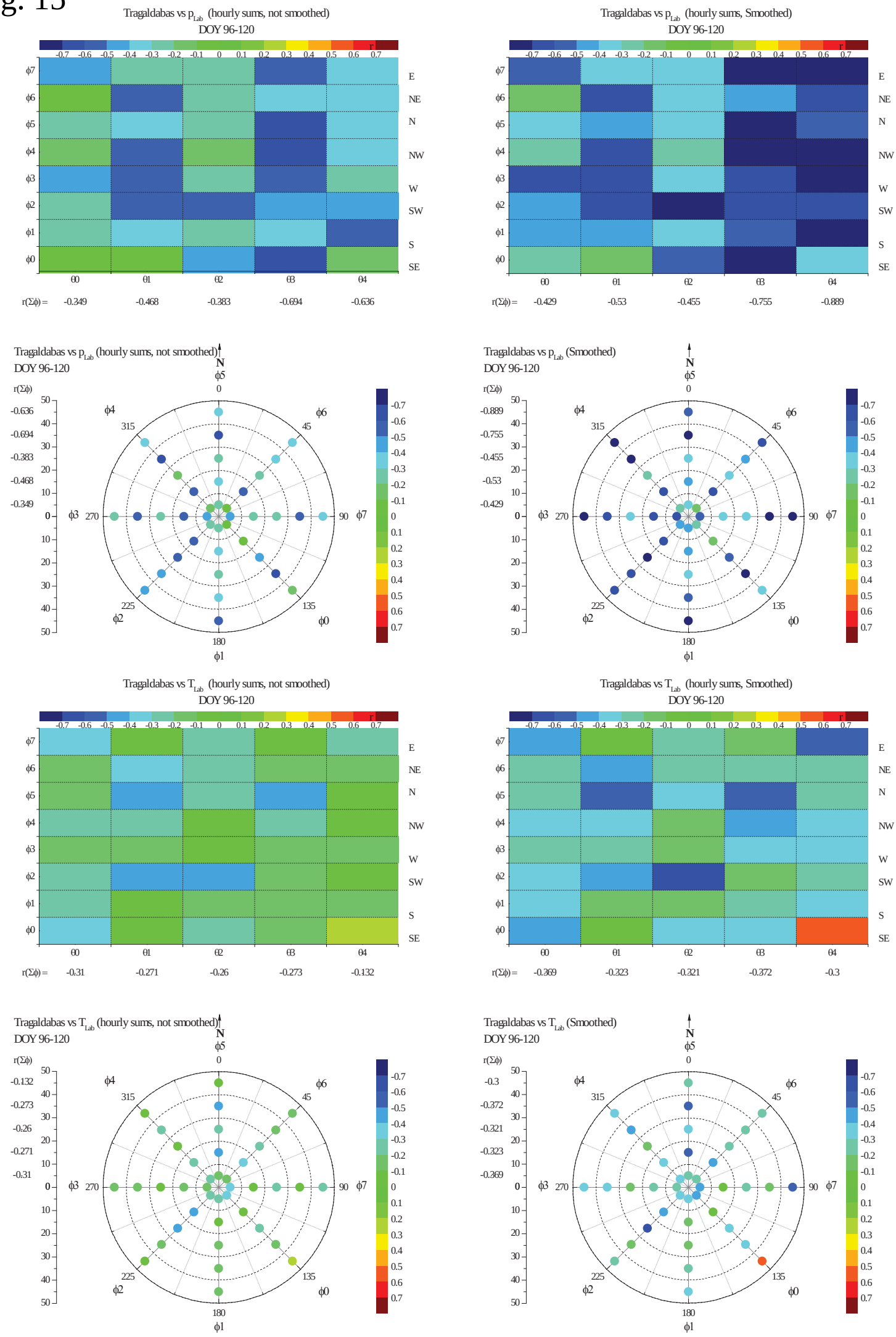

p, mbar
p_{Lab}
Taragas (Σϕ: θ0, θ1, θ2, θ3, θ4)
Tragaldabas
DOY
1000
990
980
970
8.6
8.4
8.2
8.0
7.8
96
98
100
102
104
106
108
110
112
114
116
118
120
122

Fig. 15


Tragaldabas vs p_{Lab} (hourly sums, not smoothed)
DOY 96-120
r(Σϕ) = -0.349 -0.468 -0.383 -0.694 -0.636
Tragaldabas vs p_{Lab} (hourly sums, Smoothed)
DOY 96-120
r(Σϕ) = -0.429 -0.53 -0.455 -0.755 -0.889
Tragaldabas vs p_{Lab} (hourly sums, not smoothed)
DOY 96-120
Tragaldabas vs p_{Lab} (Smoothed)
DOY 96-120
Tragaldabas vs T_{Lab} (hourly sums, not smoothed)
DOY 96-120
r(Σϕ) = -0.31 -0.271 -0.26 -0.273 -0.132
Tragaldabas vs T_{Lab} (hourly sums, Smoothed)
DOY 96-120
r(Σϕ) = -0.369 -0.323 -0.321 -0.372 -0.3
Tragaldabas vs T_{Lab} (hourly sums, not smoothed)
DOY 96-120
Tragaldabas vs T_{Lab} (Smoothed)
DOY 96-120