	Operation Change Request	OCR No: 019
SCIAMACHY		Issue: A-2

Title: Replacement of eclipse nadir measurements by limb mesosphere measurements and modification of eclipse measurement timeline of the 'converted nadir orbits'

Description of Request:

The limb mesosphere measurements made during eclipse in the mesosphere/lower thermosphere have proven to be extremely valuable for the retrieval of mesopause temperatures from the hydroxyl Meinel band airglow emissions. Unfortunately, the number of available limb mesosphere measurements as well as the latitudinal coverage of the eclipse limb mesosphere measurements is far from its optimum. Particularly in the southern hemisphere, there are no measurements at mid and high latitudes.

Therefore, we request the following 2 changes:

a) In order to increase the number of limb mesosphere observations we request the eclipse nadir observations (performed every other orbit) be replaced by limb mesosphere measurements.
We think this request is justified for the following reasons:
- To date, nobody has looked at the nadir ecplipse data, whereas the limb mesosphere observations have shown great potential in monitoring the mesopause temperature.
- All potential applications of nighttime nadir observations related to terrestrial airglow emissions and Non-LTE processes can also be done with the limb mesosphere observations, since the emissions are also observed in the limb spectra. The limb mesosphere observations even have the advantage of a much longer path through the emitting layer leading to a significant improvement of the signal strength (by almost 2 orders of magnitude).
- A nadir nighttime data set of two years has been collected already, providing sufficient material for first scientific studies, if anyone should become interested in this data set. If the nadir nighttime observations should be given a higher scientific priority in the future (for whatever reason) the continuous collection of nadir eclipse measurements can always be resumed again.

b) In order to improve the latitudinal coverage of the limb mesosphere measurements we request to change the eclipse timeline for the orbits of the previous 'nadir orbits' (if they get converted to 'limb orbits' as requested in a)). So far the measurement timeline on the Earth's nightside starts with a block of dark current measurements (Measurement category 12), followed by a block of limb mesosphere measurements (Measurement category 26). Then again a sequence of dark current, limb, dark current measurements. We would like to replace the first dark current block with the first limb mesosphere measurement block in order to have nighttime limb measurements at higher southern latitudes.
The advantage of changing the timeline for the the converted 'nadir orbits' (see request a), is that the timeline for the existing 'limb orbits' remains unchanged.

Originator: Christian von Savigny, Heinrich Bovensmann	Date of Issue: 2004-06-16	Signature: CvS 2004-06-16

Assessment of SSAG (necessary for requests by scientists):
The OCR was discussed at the tiger team meeting and considered acceptable for implementation provided that the
- dark current measurements in eclipse are not endangered
- PI's accept the change in mission scenarios

SSAG: S. Noël, IFE	Date: 09/07/2004	Signature: via phone 09/07/2004

Classification of OCR: C

OCR Analysis (incl. Implementation Option) :

Part a) of the OCR is implemented by no longer using state nad09 in an eclipse timeline. Approval for this modification must bear in mind that this is equivalent to a permanent change in mission scenarios.

Part b) of the OCR requires to partially overwrite the accepted and implemented OCR_006 (*Increase of dark current blocks in the eclipse timeline*) since the modified eclipse timeline 44 (replace nad09 state by elimb01 state) must start and end with a sequence of limb_mesosphere states, i.e. not with a block of 5 dark current states. In addition, due to the limitation not to exceed a timeline duration of about 1250 sec, there are two consecutive dark current blocks. In case this is accepted by calibration experts, a new timeline 44 will be generated which fulfills the new requirement of OCR_019. Attached is an example (option 1) how this timeline will look like and the comparison to timeline 53 (limb_mesosphere) with the 2nd block of elimb01 states increased by 1 state (see figs 1 & 2).

For comparison, an alternatively modified timeline 44 (option 2a, fig.3) is presented, where throughout the timeline dark current states and limb_mesosphere states alternate. This can be regarded as a compromise both serving dark current calibration and limb_mesosphere needs. The total number of dark current and limb_mesosphere states is the same as in the option 1 timeline. Note that if this acceptable for both parties, one could expand on that approach even further and define a second eclipse timeline of this type but with dark current and limb_mesosphere states shifted by one state (option 2b, fig.3). Alternating scheduling of option 2a and 2b would then lead to a full coverage of the eclipse phase with limb_mesosphere measurements in two consecutive orbits. The option 2b timeline would be used instead of timeline 53.

Since the modification impacts the final flight timeline set, where a new set 33 will be in preparation soon as a consequence of OCR_017, it is suggested to include OCR_019 in this timeline set as well – provided the OCR is accepted. Otherwise maintenance of final flight timelines in the ground segment becomes more and more complex. Thus acceptance of OCR_019 (part a and b) should be finalised until about July 10th when timeline set 33 generation will start.

Modified implementation option following discussions with Q. Kleipool, H. Bovensmann (20/07/2004):

The implementation of OCR_019 has to comply with the requirements of dark current measurements. These can be summarized as follows:

- all 5 dark current states in a block must not be separated by other states
- there must be at least one complete block of dark current states finished in eclipse before ANX

Thus option 2 as described above cannot be realized (violating the first requirement). Option 1 as described above can also not be implemented because due to the seasonal variation in December (see fig. 4) dark current block 1 of the modified timeline 44 would fall onto ANX and no complete dark current block would be established in eclipse at the end of an orbit (violating the second requirement).

It is therefore proposed to alter option 1 slightly by shortening the limb_mesopshere block at the start of timeline 44. The modified option 1 is referred here as option 1a. In option 1a 3 limb_mesosphere states are executed in timeline 44 before the first dark current block. This moves the dark current block by 132 sec towards ANX as compared to the current timeline 44. December 26th, when eclipse start is closest to ANX, the first dark current block will be scheduled at 5799 sec elapsed time in an orbit. With a duration of about 208 sec, the first block will stop about 30 sec before ANX (see fig. 7). Thus both requirements for the dark current measurements are satisfied. The rest of timeline 44 is filled with dark current states and limb_mesosphere states as listed in fig. 5. The coverage with limb_mesosphere states in eclipse, when executing timelines 53 and 44 (option 1a) consecutively, is displayed in fig. 6. Except of a small gap of 75 sec in the early phase of the eclipse timelines an almost complete coverage can be realized.

SOST: M. Gottwald, DLR-IMF (ESA, Industry if necessary)	Date: 21/06/2004 & 21/07/2004	Signature: via e-mail 21/06/2004 & 21/07/2004

Approval of Proposed Implementation:		
Originator Approval: Christian von Savigny, Heinrich Bovensmann	Date: 21/07/2004	Signature: via e-mail 21/07/2004

SSAG Approval: Heinrich Bovensmann	Date: 21/07/2004	Signature: via e-mail 21/07/2004

Decision / Approval:
The modified option 1, as described in the attachment, shall be implemented. Calibration experts (Q. Kleipool) have also agreed to the proposed approach since the dark current requirements are fully maintained. PI's (e-mails July 19th and 28th) support the change as well.

DLR Approval: (if necessary NIVR, SPEC) C. Chlebek, DLR	Date: 30/07/2004	Signature: via phone 30/07/2004

Implementation by SOST:
The modified option 1 is implemented by generating a new timeline 44 in set 33 (required by OCR_017) which contains a state sequence as listed in the attachment. All nadir_eclipse states are replaced by limb_mesosphere states. It is ensured that the first dark current block ends prior to ANX throughout the year.

Timeline 53 in set 33 was increased by 1 state. Thus both eclipse timelines are now of identical duration (1288 sec).

The new timeline set 33 will be uploaded in orbit 13172 (September 6th). From that orbit onwards there are only limb_mesosphere measurements in eclipse.

SOST: M. Gottwald, DLR-IMF	Date: 03/08/2004	Signature: via e-mail 03/08/2004

State Index	T/L 53				Option 1: T/L 44 modified (OCR_019)			
	State ID	State	State Start (sec)	State Stop (sec)	State ID	State	State Start (sec)	State Stop (sec)
1	8	dcc05	2,77	46,33	27	elimb01	2,77	46,83
2	26	dcc04	46,33	79,89	27	elimb01	46,83	90,89
3	46	dcc01	79,89	93,45	27	elimb01	90,89	134,95
4	63	dcc02	93,45	127,00	27	elimb01	134,95	179,00
5	67	dcc03	127,00	210,57	27	elimb01	179,00	223,06
6	27	elimb01	210,57	254,63	8	dcc05	223,06	266,62
7	27	elimb01	254,63	298,68	26	dcc04	266,62	300,18
8	27	elimb01	298,68	342,74	46	dcc01	300,18	313,74
9	27	elimb01	342,74	386,80	63	dcc02	313,74	347,30
10	27	elimb01	386,80	430,86	67	dcc03	347,30	430,86
11	27	elimb01	430,86	474,92	8	dcc05	430,86	474,42
12	27	elimb01	474,92	518,98	26	dcc04	474,42	507,98
13	27	elimb01	518,98	563,04	46	dcc01	507,98	521,54
14	8	dcc05	563,04	606,59	63	dcc02	521,54	555,09
15	26	dcc04	606,59	640,15	67	dcc03	555,09	638,66
16	46	dcc01	640,15	653,71	27	elimb01	638,66	682,71
17	63	dcc02	653,71	687,27	27	elimb01	682,71	726,77
18	67	dcc03	687,27	770,83	27	elimb01	726,77	770,83
19	27	elimb01	770,83	814,89	27	elimb01	770,83	814,89
20	27	elimb01	814,89	858,95	27	elimb01	814,89	858,95
21	27	elimb01	858,95	903,01	8	dcc05	858,95	902,51
22	27	elimb01	903,01	947,07	26	dcc04	902,51	936,07
23	27	elimb01	947,07	991,13	46	dcc01	936,07	949,63
24	27	elimb01	991,13	1035,18	63	dcc02	949,63	983,18
25	27	elimb01	1035,18	1079,24	67	dcc03	983,18	1066,75
26	8	dcc05	1079,24	1122,80	27	elimb01	1066,75	1110,80
27	26	dcc04	1122,80	1156,36	27	elimb01	1110,80	1154,86
28	46	dcc01	1156,36	1169,92	27	elimb01	1154,86	1198,92
29	63	dcc02	1169,92	1203,48	27	elimb01	1198,92	1242,98
30	67	dcc03	1203,48	1287,04	27	elimb01	1242,98	1287,04

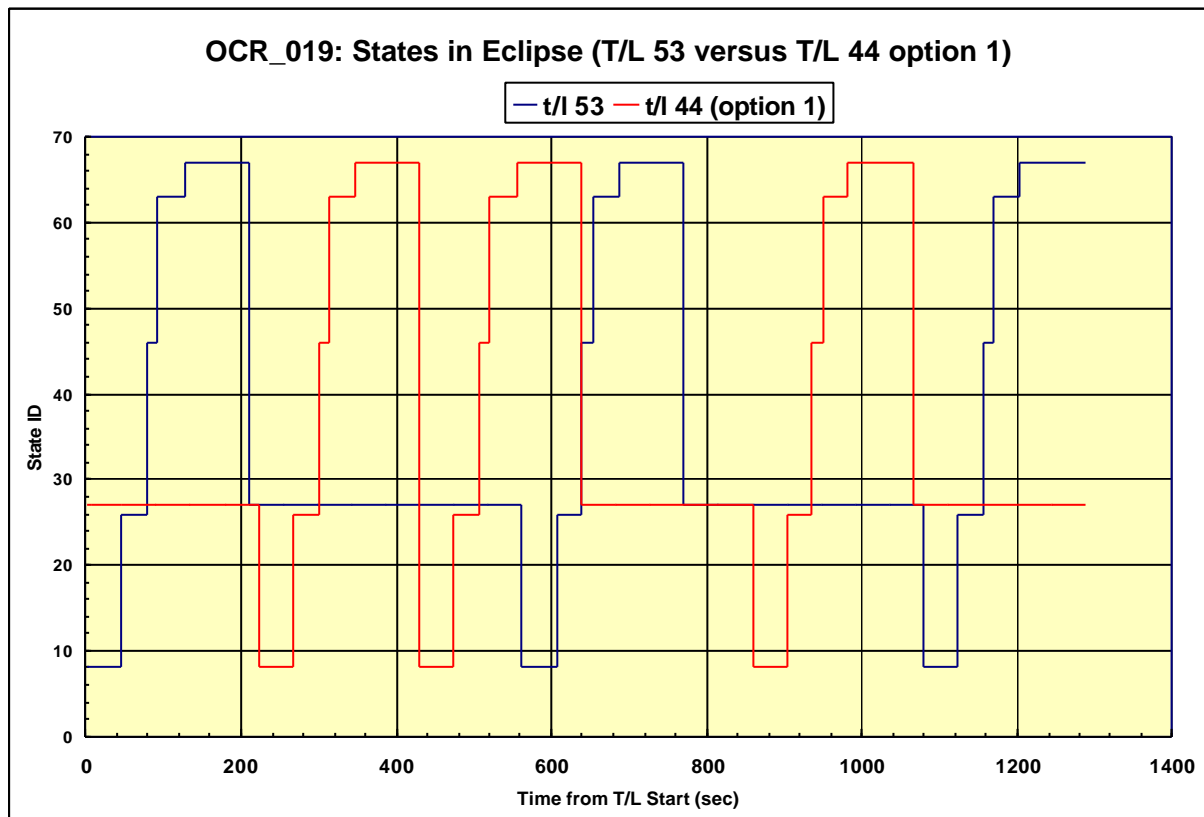Fig. 1: Eclipse timelines 53 and 44 (modified to comply with OCR_019)

Fig. 2: Execution of dark current states (ID 8,26,46,63,67) and limb_mesosphere states (ID 27) as a function of time elapsed since start of eclipse timelines 53 and 44 (modified to comply with OCR_019)

State Index	Option 2a: alternative T/L 44 (seq. 1)				Option 2b: alternative T/L (seq. 2)			
	State ID	State	State Start (sec)	State Stop (sec)	State ID	State	State Start (sec)	State Stop (sec)
1	8	dcc05	2,77	46,33	27	elimb01	2,77	46,83
2	27	elimb01	46,33	90,39	8	dcc05	46,83	90,39
3	26	dcc04	90,39	123,95	27	elimb01	90,39	134,45
4	27	elimb01	123,95	168,00	26	dcc04	134,45	168,00
5	46	dcc01	168,00	181,56	27	elimb01	168,00	212,06
6	27	elimb01	181,56	225,62	46	dcc01	212,06	225,62
7	63	dcc02	225,62	259,18	27	elimb01	225,62	269,68
8	27	elimb01	259,18	303,24	63	dcc02	269,68	303,24
9	67	dcc03	303,24	386,80	27	elimb01	303,24	347,30
10	27	elimb01	386,80	430,86	67	dcc03	347,30	430,86
11	8	dcc05	430,86	474,42	27	elimb01	430,86	474,92
12	27	elimb01	474,42	518,48	8	dcc05	474,92	518,48
13	26	dcc04	518,48	552,04	27	elimb01	518,48	562,54
14	27	elimb01	552,04	596,09	26	dcc04	562,54	596,09
15	46	dcc01	596,09	609,65	27	elimb01	596,09	640,15
16	27	elimb01	609,65	653,71	46	dcc01	640,15	653,71
17	63	dcc02	653,71	687,27	27	elimb01	653,71	697,77
18	27	elimb01	687,27	731,33	63	dcc02	697,77	731,33
19	67	dcc03	731,33	814,89	27	elimb01	731,33	775,39
20	27	elimb01	814,89	858,95	67	dcc03	775,39	858,95
21	8	dcc05	858,95	902,51	27	elimb01	858,95	903,01
22	27	elimb01	902,51	946,57	8	dcc05	903,01	946,57
23	26	dcc04	946,57	980,13	27	elimb01	946,57	990,63
24	27	elimb01	980,13	1024,18	26	dcc04	990,63	1024,18
25	46	dcc01	1024,18	1037,74	27	elimb01	1024,18	1068,24
26	27	elimb01	1037,74	1081,80	46	dcc01	1068,24	1081,80
27	63	dcc02	1081,80	1115,36	27	elimb01	1081,80	1125,86
28	27	elimb01	1115,36	1159,42	63	dcc02	1125,86	1159,42
29	67	dcc03	1159,42	1242,98	27	elimb01	1159,42	1203,48
30	27	elimb01	1242,98	1287,04	67	dcc03	1203,48	1287,04

Fig. 3: Two eclipse timelines which ensure full eclipse coverage with limb_mesosphere states in consecutive orbits. Dark current measurements are still executed in blocks of 5 states but between individual dark current states a limb_mesosphere state is planned. This could be an alternative to the modification of timeline 44 as required in OCR_019.
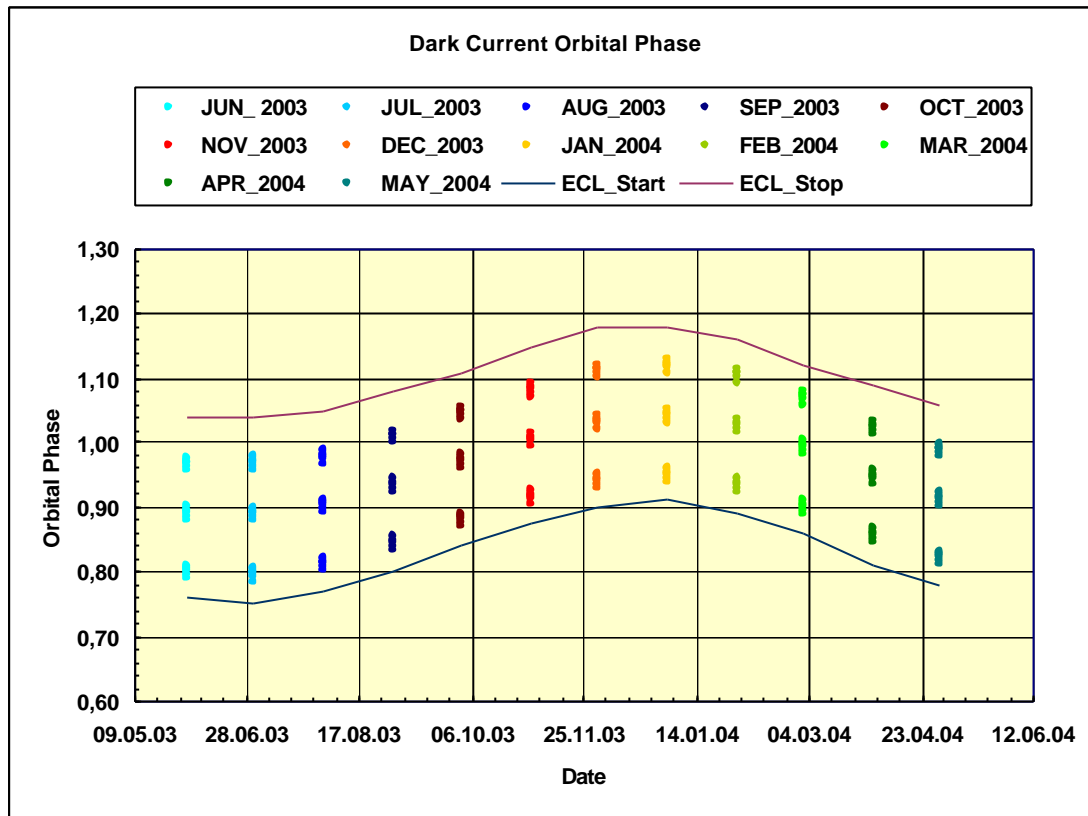
Fig. 4: Dark current block (5 dcc states each) start location in eclipse for a complete year showing the seasonal variation. Only a single orbit at the start of a month is displayed. Each of the 3 dark current blocks consists of 5 dark current states. The blocks are executed at the beginning, in the middle and at the end of the eclipse timeline. Orbital Phase is derived from the time elapsed since ANX (phase 0 and 1 correspond to ANX). Eclipse starts when the solar elevation is 28.5°, i.e. just below the horizon seen from the ENVISAT orbit. Eclipse stops when the first limb state in the Sun occultation timeline starts. The gaps between the dark current blocks are filled with either nadir_eclipse or limb_mesopshere states. The gap before the first block is required for ADC calibration and potential engineering activities. The gap after the third block is required for potential CTI/timeline uploads. These two cannot be overwritten by measurement states.

State Index	T/L 53				Option 1a: T/L 44 modified (OCR_019)			
	State ID	State	State Start (sec)	State Stop (sec)	State ID	State	State Start (sec)	State Stop (sec)
1	8	dcc05	2,77	46,33	27	elimb01	2,77	46,83
2	26	dcc04	46,33	79,89	27	elimb01	46,83	90,89
3	46	dcc01	79,89	93,45	27	elimb01	90,89	134,95
4	63	dcc02	93,45	127,00	8	dcc05	134,95	178,50
5	67	dcc03	127,00	210,57	26	dcc04	178,50	212,06
6	27	elimb01	210,57	254,63	46	dcc01	212,06	225,62
7	27	elimb01	254,63	298,68	63	dcc02	225,62	259,18
8	27	elimb01	298,68	342,74	67	dcc03	259,18	342,74
9	27	elimb01	342,74	386,80	8	dcc05	342,74	386,30
10	27	elimb01	386,80	430,86	26	dcc04	386,30	419,86
11	27	elimb01	430,86	474,92	46	dcc01	419,86	433,42
12	27	elimb01	474,92	518,98	63	dcc02	433,42	466,98
13	27	elimb01	518,98	563,04	67	dcc03	466,98	550,54
14	8	dcc05	563,04	606,59	27	elimb01	550,54	594,60
15	26	dcc04	606,59	640,15	27	elimb01	594,60	638,66
16	46	dcc01	640,15	653,71	27	elimb01	638,66	682,71
17	63	dcc02	653,71	687,27	27	elimb01	682,71	726,77
18	67	dcc03	687,27	770,83	27	elimb01	726,77	770,83
19	27	elimb01	770,83	814,89	27	elimb01	770,83	814,89
20	27	elimb01	814,89	858,95	27	elimb01	814,89	858,95
21	27	elimb01	858,95	903,01	8	dcc05	858,95	902,51
22	27	elimb01	903,01	947,07	26	dcc04	902,51	936,07
23	27	elimb01	947,07	991,13	46	dcc01	936,07	949,63
24	27	elimb01	991,13	1035,18	63	dcc02	949,63	983,18
25	27	elimb01	1035,18	1079,24	67	dcc03	983,18	1066,75
26	8	dcc05	1079,24	1122,80	27	elimb01	1066,75	1110,80
27	26	dcc04	1122,80	1156,36	27	elimb01	1110,80	1154,86
28	46	dcc01	1156,36	1169,92	27	elimb01	1154,86	1198,92
29	63	dcc02	1169,92	1203,48	27	elimb01	1198,92	1242,98
30	67	dcc03	1203,48	1287,04	27	elimb01	1242,98	1287,04

Fig. 5: Eclipse timelines 53 and 44 (option 1a - modified to comply with OCR_019 and to fulfill the requirements for dark current measurements in eclipse)
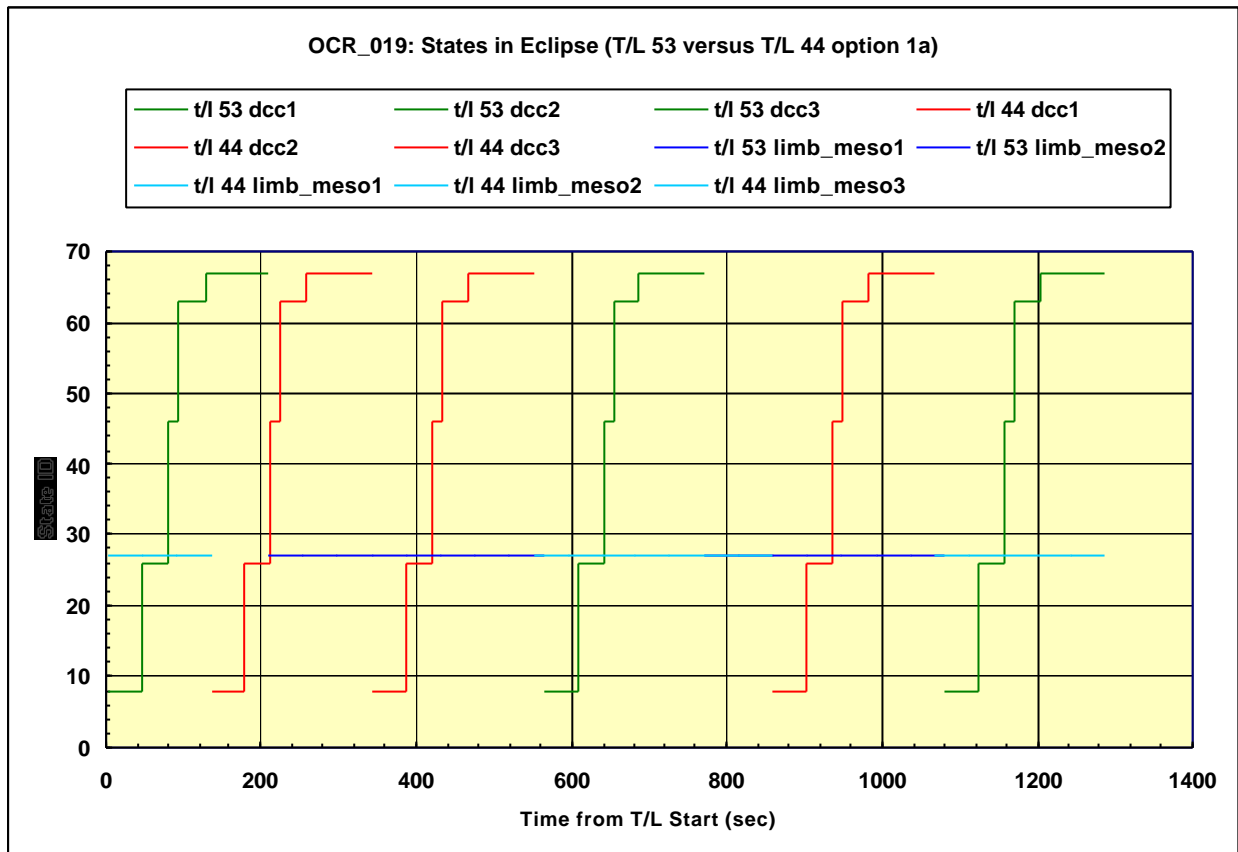
Fig. 6: Execution of dark current states (ID 8,26,46,63,67) and limb_mesosphere states (ID 27) as a function of time elapsed since start of eclipse timelines 53 and 44 (option 1a - modified to comply with OCR_019 and dark current requirements). In timeline 53 3 dark current blocks (dcc1-dcc3) and 2 limb_mesosphere blocks (limb_meso1, limb_meso2) are defined. Timline 44 (option 1a) consists of 3 dark current blocks and 3 limb mesosphere blocks. Alternating execution of timelines 53 and 44 leads to an almost complete coverage of the eclipse phase with limb_mesosphere states (dark and pale blue line).
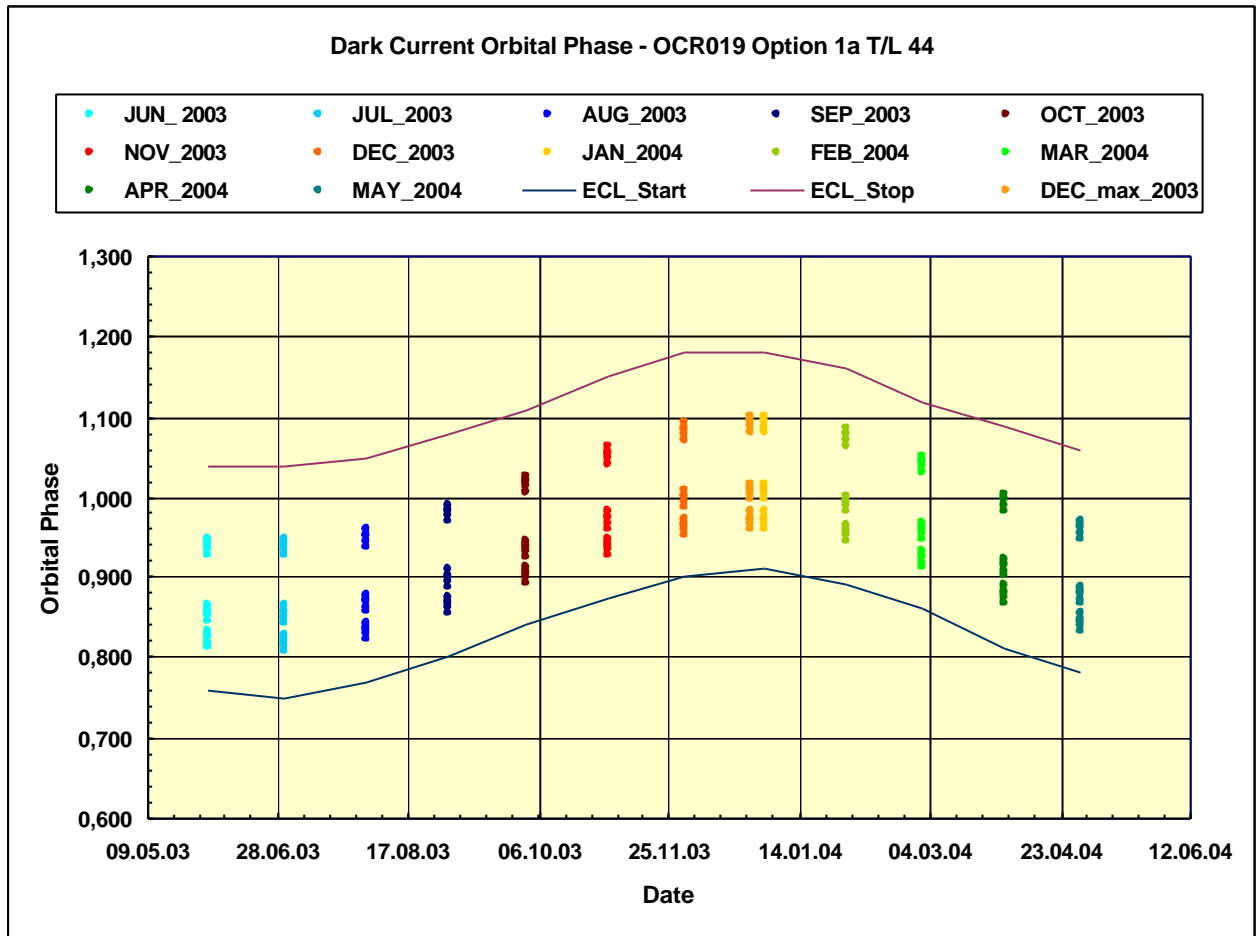
Fig. 7: Dark current block (5 dcc states each) start location in eclipse for the modified timeline 44 (option 1a) for a complete year showing the seasonal variation. For details see figure 4. Even when shifting the first block by a total of 3 limb_mesosphere states towards ANX, this block ends before ANX on December, 26th when the time intervall between eclipse start and ANX is shortest. This day is indicated as an additional data point close to the January 1st data point.