Mission Plan Rationale

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Basic Assumptions

Launch: 1 March 2002
Duration of Commissioning Phase: 9 months
Start of measurement programme: after commissioning phase
Mission lifetime: 4 "operational" years

Basic Requirements

The mission plan is based on the Observation Modes as modified by the SAG at the 37th SAG meeting.

The basic requirements are:

- The nominal mode (N) shall be executed for at least 90% of the time during the first year of operation after the end of the Commissioning Phase. This shall allow the coverage of a complete seasonal cycle on a global scale with as little gaps in space and time as possible. This period will cover the December 2002 to November 2003 period. The bulk of the engineering tests should have been successfully completed before starting this first year of N.

- The various non-nominal observation modes (Special Observation Modes S1 to S6, Upper Atmosphere Modes UA1 to UA4) shall be tested as early as possible if this is without risk for the instrument and does not interrupt the nominal mode too much. This procedure shall ensure that the various groups that are supposed to utilize data of those modes will be able to test their scientific concepts and the associated retrieval algorithms. If necessary, the non-nominal observation modes can then be adjusted according to the findings of the scientific teams in time before the regular execution of those modes will be started in the 2nd year of the mission. The non-nominal observation modes have been distributed over time such that the interruption of the nominal mode N is minimised. A duration of each 1 or 2 days for these test runs should be sufficient, in general (with some exceptions that need to be discussed). It is proposed to do these tests globally even if this is not requested for a later execution of all non-nominal modes. Preferentially, the tests shall be carried out during two different geophysical conditions, the first period covering approximately the solstice case, the second one covering roughly the equinox case. A total of about 25 days (i.e. less than 10% of the whole period) had to be spent for testing the non-nominal modes during the first mission year, if this outline was followed. This strategy also has the positive side effect of having collected data of all modes already within the first year of the mission in case the expected mission lifetime cannot be fully achieved.

- Intensive validation campaign phases have been assigned tentatively in the mission plan. Ideally, the test of the various modes should be executed within the validation campaign periods and coordinated with the validation experiments. For some validation experiments, even a close coordination between the Envisat and the validation experiment measuring scenarios might be useful (i.e. in order to match measured air volumes best possible). However, during the first validation campaign priority should be given to the nominal mode. Details have to be elaborated in the MIPAS validation plan that is available as first draft. The baseline behind the distribution of the intensive validation measurement phases over time and latitudes was to cover both the various geophysical conditions (i.e. mid latitudes, high latitudes summer and winter, tropical latitudes) as well as the whole ENVISAT lifetime (long term validation phases are not yet included in the present mission plan).

- The mission plan is rather detailed for the first 2 years but is getting more and more vague afterwards as later phases will have to be adjusted to experience made during the early mission period.

- A high degree of flexibility is needed during the mission to be able to adjust the mission plan in case of special events (proposal: two days in advance) or in case it turns out that the initial mission plan does not match sufficiently well with the scientific objectives (that also will have to be adjusted) and/or the data quality (proposal: one week in advance). The process of decision-making and the responsibilities have still to be defined.

Choices and scientific justifications for special and upper atmosphere modes

- S1 – Polar Chemistry and Dynamics

(This mode shall be executed in combination with the nominal mode N during the 2nd year of the mission, i.e. from T0+1.5y to T0+2.5y. The S1 modes enables a higher vertical and horizontal resolution than N. This is justified by the fact that the spatial variability of the tracers and the chemical constituents is higher than in the more quiet summer hemisphere. The switch between N and S1 should be at about 40° latitude in the winter hemisphere. The N/S1 combination shall cover a whole seasonal cycle.)
Following discussions at SAG meetings #32 and 33 the combination of modes N and S1 has been abandoned. Instead, a latitude dependant offset shall be applied to the scan for optimisation of vertical coverage. Mode S1 shall be executed for one full northern polar winter.

- S2 – Troposphere and strat-trop exchange mode

This mode is dedicated to study upper troposphere and troposphere/stratosphere exchange processes. Spatial, mainly vertical, resolution should be maximised for this mode. The current baseline is to run this mode in the 2nd year during six bi-monthly periods lasting each several days. As studying UTLS issues from space-borne sensor data is a very challenging task this baseline will have to be carefully assessed with data recorded during the test phases.

- S3 – Impact of aircraft emissions

Cross-track observations are preferred for this mode as most air traffic corridors are oriented east-west. Altitude coverage and sampling are supposed to be similar to that in S2. Current baseline is to execute this mode once per season (each 2 to 3 days) in the 3rd year of the mission.

- S4 – Stratospheric dynamics

This mode is dedicated to study medium-scale dynamical features like filaments, vortex erosion patterns, and streamers. Previous studies based on results from European campaigns for the high to middle latitudes and CHRISTA observations for the middle to low latitudes suggest that the lifetime of those structures is in the order of at least a couple of days. Hence, the baseline for this mode is to cover the four seasons by each 2-weeks periods during the 2nd, 3rd and 4th year of the ENVISAT mission lifetime.

- S5 – Diurnal changes

Cross track observations are envisaged to study the evolution of photo-chemically driven short-lived species near the terminator. Only few observations will be needed to cover this objective in restricted areas of the globe. Currently, four days are planned for this task distributed over the four seasons during the 2nd mission year. These exercises may be complemented in conjunction to intensive validation campaigns.

- S6 – UTLS

This mode is optimised for high spatial resolution measurements of the UTLS in order to test primarily tomographic observation of H_2O in the upper troposphere. The feasibility of retrieving high vertical resolution profiles has to be tested with real data.

- UA1 – non-LTE validation

This mode is to verify/falsify the predicted non-LTE effects on the on-line/off-line retrievals and hence it is essential to execute this during the Commissioning and Core Validation Phases. This task should be completed as soon as possible by covering conditions that are close to equinox and solstice (both hemispheres), respectively. For each case global observations lasting 1 day are envisaged. Tight coordination of these measurement periods with independent (non-LTE free) correlative observations is envisaged.

- UA2 – Upper polar vortex dynamics and stratosphere/mesosphere exchange processes

To achieve the expected scientific objectives 2 days of global measurements/month plus 3 additional days at late March/early April and at late September/early October coinciding with the reversal of the meridional circulation and possibly the breaking of the polar vortex. This programme is envisaged for the 2nd operational year and corresponds to a total of 28 days.

- UA3 – Energy budget, non-LTE studies and budgets of hydrogen, nitrogen and carbon in the upper atmosphere

Four periods lasting each three days are planned for this major upper atmosphere (mesosphere and thermospere) mode are planned within the 2nd operational year of the mission. In addition, each one week per season is envisaged in the 4th operational year.

- UA4 – Non-LTE studies related to NO specifically

This mode is dedicated to precise retrievals of NO that should also account for the thermospheric emission of NO. It will extend the limb sequence up to 170 km. The current baseline is to cover the four seasons which each a couple of days of global measurements in the 3rd operational year.

- Special event modes

Related scientific objectives may be auroral effects, volcano eruptions, and so on. Aurora events can be predicted about three days in advance. The measurement scenario (in terms of vertical sampling and coverage as well as in terms of the azimuth scan) will have to be carefully defined when the spatial extent and the location of the aurora will be forecasted. Similar constraints hold for volcano eruptions in terms of the measurement scenarios. However, as those cannot be forecasted reliably, some alert strategy has to be prepared to enable rapid programming, decision-making and commanding.

Nominal Observation Mode

(V3.2, January 2002)

No.	Scientific Objectives	Primary Target Parameters/Gases	Altitude Range	Vertical Spacing	Horizontal Spacing	Azimuth Mode	Coverage	Frequency of Observations (prelimin.)
N	• Stratospheric Chemistry and Dynamics • Applications in Climatology • Applications in Medium Range Forecasts	p,T, O3, N2O, CH4, H2O, HNO3, NO, NO2, N2O5, ClONO2, CFCs, CO, aerosol, PSCs	68 - 6 km	68, 60, 52, 47km, 42 to 6 km in 3 km steps	~510 km (17 angles per limb sequence)	RW[1]	global	90% within the first full seasonal cycle, at least 50% afterwards

[1] rearward view, azimuth angle dependent on orbit position to permit full global coverage

Special Observation Modes

(V3.8, June 2002)

No.	Scientific Objectives	Primary Target Parameters/Gases	Altitude Range	Vertical Spacing	Horizontal Spacing	Azimuth Mode	Coverage	Frequency of Observations (prelim.)/ Remarks
S1	Polar Chemistry and Dynamics (perturbed chemistry at increased spatial resolution, denitrification, vortex erosion, transport of vortex air)	p,T, O3, N2O, CH4, H2O, HNO3, NO, NO2, N2O5, ClO, HOCl, ClONO2, aerosol, PSCs	55 – 7 km	55, 45, 35, 30, then 27 to 13 km in 2km steps, 10, 7	~420 km (14 angles per limb sequence)	RW[1]	global	regularly from 2nd year on. Latitude dependent altitude offset following: Minimum tangent altitude = 8km + 2km* cos(2*tangent point latitude)
S2	• Troposph./Stratosph. Exchange Processes (upward/downward transport, altitude of hygropause/tropop.) • Tropospheric Chemistry;	p,T, O3, N2O, CH4, H2O, CO, CFCs, SF6, C2H2, C2H6, HNO3, (NO2), (NO), others (tbd), cirrus clouds	40 – 5 km	40, 30, 25 km, then 20 to 5 km in 1.5 km steps	~420 km (14 angles per limb sequence)	RW[1]	global	Several days every other month over one year
S3	Impact of Aircraft Emissions	p,T, O3, H2O, HNO3, NO, NO2, ClONO2, N2O, CH4, aerosol, PSCs	40 -6 km	40, 30, 23, 18 km, then 15 to 6 km in 1.5 km steps	~330 km (RW option) (11 angles per limb sequence)	RW[1] or CT[2] (tbd)	primarily north of 25° N latitude	a few days in summer and winter sideways option preferred

Special Observation Modes (cont.)

(V3.8, June 2002)

No.	Scientific Objectives	Primary Target Parameters/Gases	Altitude Range	Vertical Spacing	Horizontal Spacing	Azimuth Mode	Coverage	Frequency of Observations (preliminary)/ Remarks
S4	Stratospheric Dynamics, Transport Processes (medium scale structures, ozone laminae, …)	p, T, O3, N2O, CH4, H2O, HNO3, CFC-11	53, 47 - 8 km	3 km (3 x 15 angles)	along track: ~390 km cross track: ~550 km	RW 3 'parallel' swaths at 170, 180, and 190° azimuth	global	each one week per season; spectral resolution reduced by a factor of 4
S5	Diurnal Changes	short-lived species like NO, NO2, N2O5	60 - 15 km	3 km	~480 km (16 angles per limb sequence)	CT[2] adjusting of azimuth angle during limb scanning sequence	near the terminator	each one week per season
S6	Upper Troposphere / Lower Stratosphere	H2O, O3	35 – 6km	35, 28, then 24 to 6km in 2km steps	~120 km (12 angles per limb sequence)	RW	global	2 test periods, 1-2 days each spectral resolution reduced by a factor of 4 Latitude dependent altitude offset following: Minimum tangent altitude = 8km + 2km* cos(2*tangent point latitude)

[2] cross track (side view)

Upper Atmosphere Observational Scenarios

(V1.5 April 2001)

No.	Scientific Objectives	Primary Target Parameters/Gases	Altitude Range	Vertical Spacing	Horizontal Spacing	Azimuth Mode	Coverage	Frequency of Observations (prelim.)
UA1	Validation (Confirmation of predicted non-LTE effects on the retrieval of p-T and target species)	p,T, O3, N2O, CH4, H2O, HNO3	102-18 km	3 km in stratosphere (42-18km), 5 km above (102-47km)	~630[(1)] km	-	Global	Commissioning phase. At least 1/2 week each in solstice and equinox.
UA2	• Upper polar vortex dynamics • Stratosphere mesosphere exchange and dynamics	CO, NO, NO2, H2O, O3	90-30 km	3 km in stratosphere (51-30km), 4 km in mesosphere (90-54km).	~540[(1)] km		**Global**	2 days/month (mid month) + 3 days at end March-early April + 3 days at end Spet.-early Oct. During 1 year.
UA3	• Radiative energy budget of the mesosphere and lower thermosphere • Hydrogen, nitrogen and carbon budgets in the upper atmosphere. • Mesospheric dynamic • Non-LTE studies	• CO2 (4.3 and 15µm) NO, O3 • CO2 , CO, NO, NO2, N2O, H2O, CH4, OH? • All above	130-40 km	5 km	~570[(1)] km		Global (Day and Night, different SZAs)	Each one week during equinox and solstice per year (alternating for summer and winter)
UA4	• Non-LTE studies of NO • Radiative cooling of the thermosphere	NO vibrational and rotational.	170-42 km	170 to 90km in 5km steps, 82 to 42km in 8km steps	~450[(1)] km		Global	Each one week during equinox and solstice per year.
Special Event	Auroral effects	NO, NO+, CO2 , O3, OH	160-40 km	5 km	~750[(1)] km		Polar winter regions	Several days/year (preferably following to aurora alerts).

[1]Reduced in a factor of ~1.8 if spectral resolution reduced in a factor of 2.