



Observing System Simulation Experiment (OSSE) of future ALTIUS ozone profiles

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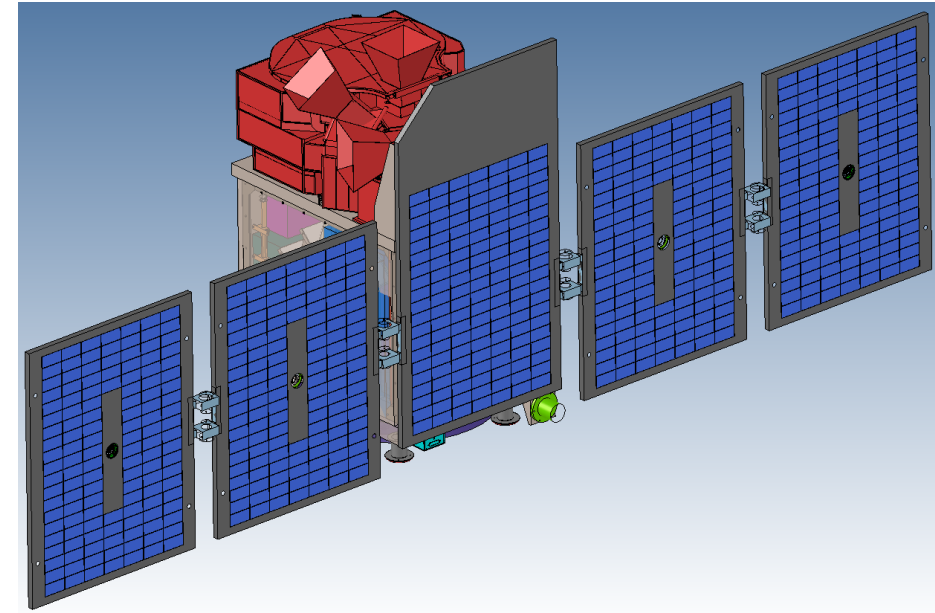


The ALTIUS mission

- The Atmospheric Limb Tracker for the Investigation of the Upcoming Stratosphere (ALTIUS) consists of three independent spectral imagers covering the UV–vis–NIR ranges
- It will operate on a PROBA micro-satellite on a low Earth polar orbit
- It is an element of the ESA Earth Watch programme
- Its launched is expected in 2024

see Fussen et al., JQSRT, 2020

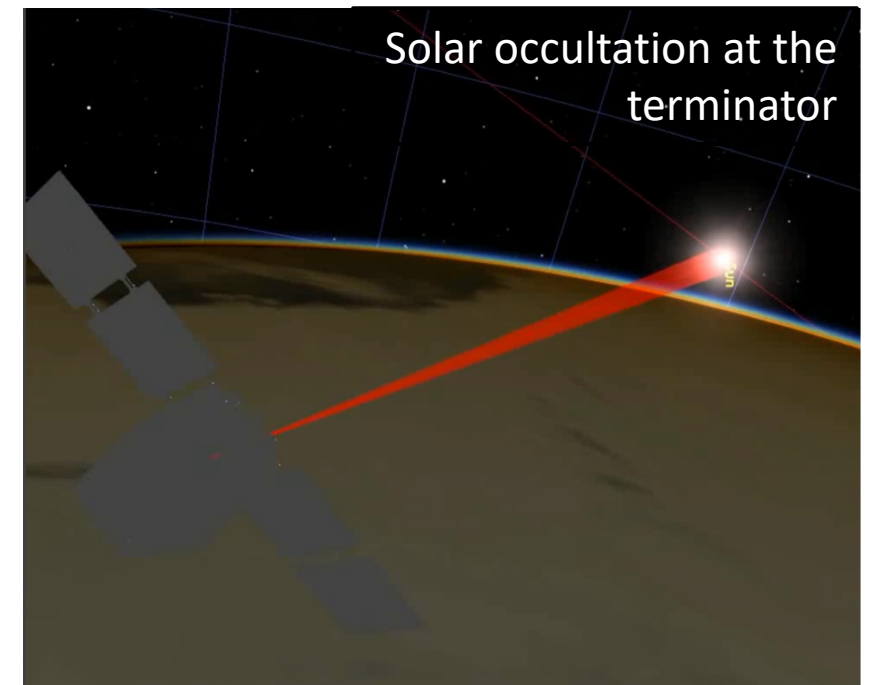
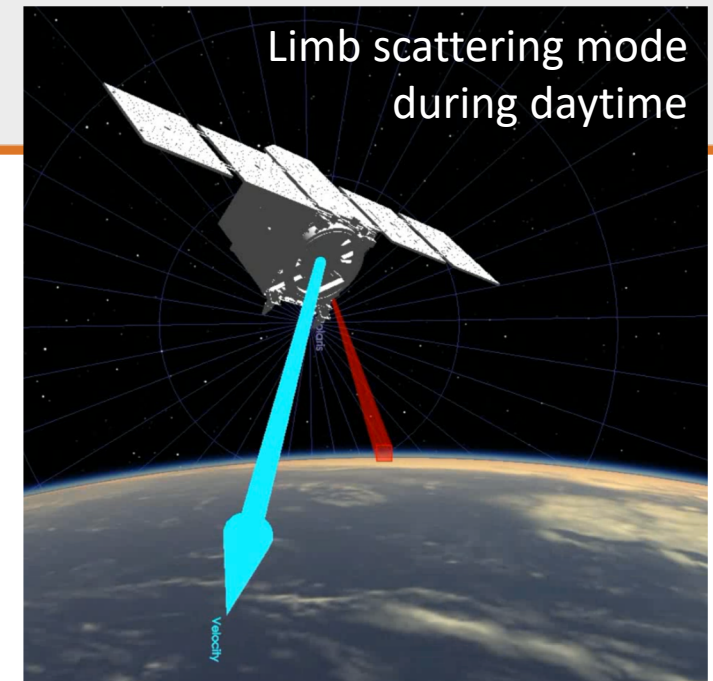
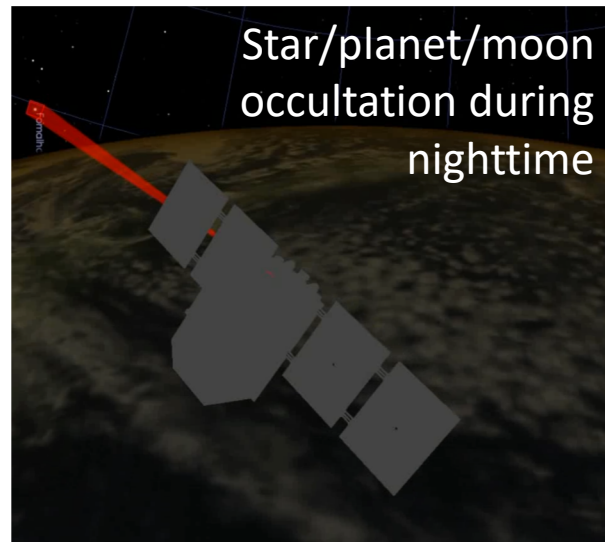
(<https://doi.org/10.1016/j.jqsrt.2019.06.021>)



mass	P/L: 57kg, S/C: 174kg
power	P/L + S/C on duty: 122W (avg)
orbit	650km LEO, 10:30 LTDN, 3±0.2 days revisit time
pointing	jitter: < 25μrad (2σ, over 5sec)

The ALTIUS mission

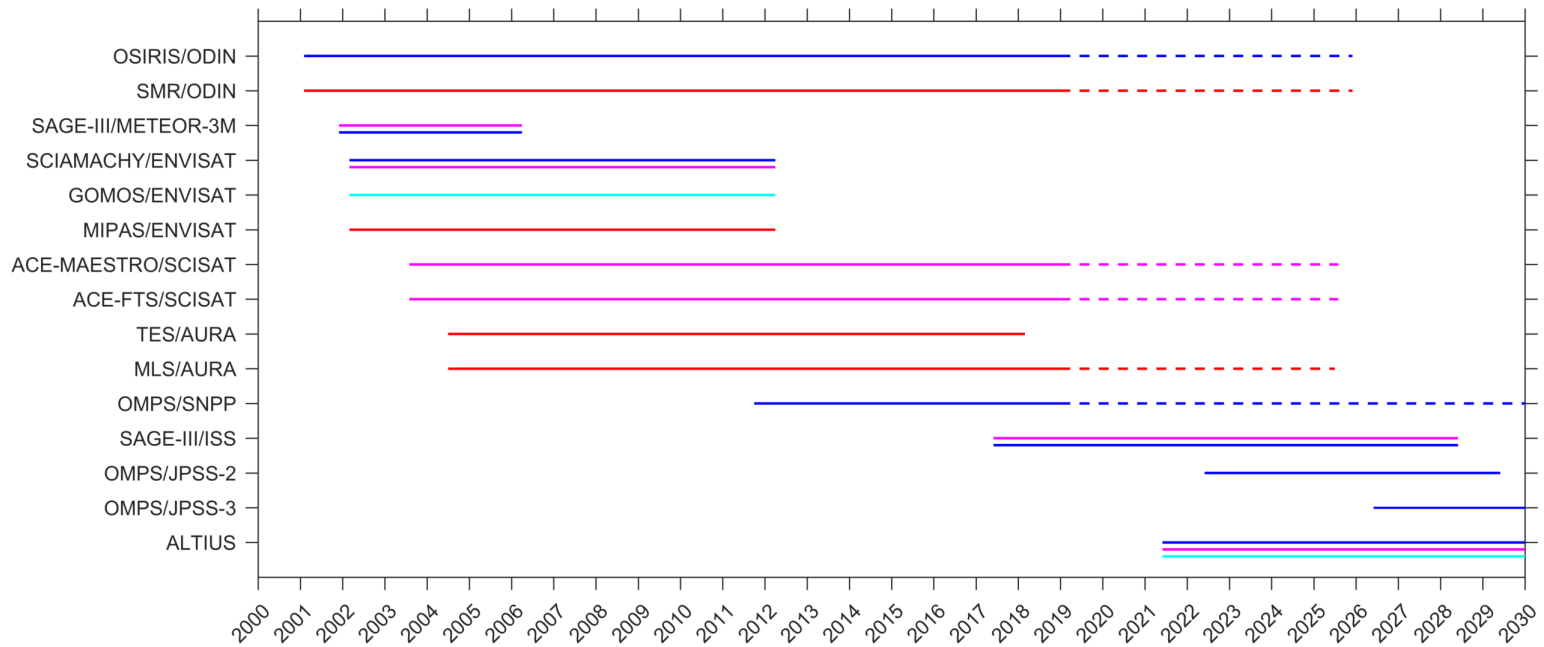
- During daytime, the instrument will scan limb scattered light
- At the terminator, it will make a solar occultation measurement
- During nighttime, it will make stellar/planets/ Moon occultations



The ALTIUS mission

- Until recently, and despite GCOS recommendations, limited limb sounder instruments are planned
- Only recently, the Swedish space agency recently selected a MW limb sounder proposal to measure middle atmosphere composition and winds to be launched in 2023

Limb sounders since 2000, according to the WMO's OSCAR database (OSCAR, 2016). The colours represent the measurement techniques: **limb scattering**, **emission**, **solar occultation**, and **stellar occultation**. The dashed lines illustrate the potential extended lifetime of missions currently operating beyond their nominal lifetime. From Fussen et al., JQSRT, 2019.



Priority	Observable	Vertical range	Vertical res. [km]	Horizontal res. along parallels [km]	Horizontal res. along meridians [km]	Total error [%]	Coverage	Photo-chemistry [day/night]
A	O ₃	UT-LS	1	10	500	5	global	d/n
A	O ₃	US	1	10	500	5	global	d/n
A	O ₃	MS	1	50	500	20	polar	n
B	NO ₂	LS-US	2	50	500	30	global	d/n
B	H ₂ O	UT-LS	2	50	500	20	global	d/n
B	CH ₄	UT-LS	2	50	500	20	global	d/n
B	aerosol	UT-LS	1	20	500	25	global	d/n
B	PSC	UT-LS	1	20	500	25	polar	d/n
C	PMC	MS	1	20	500	50	polar	d/n
C	OCIO	LS-US	1	50	500	25	global	n
C	BrO	UT-LS	1	50	500	20	global	d
C	NO ₃	LS-US	1	50	500	25	global	n
C	T°	LS-MS	2			2	polar	
C	gradients	LS-US	1	10	10	30	global	d/n

ALTIUS vs requirements of the user community (Operoz)

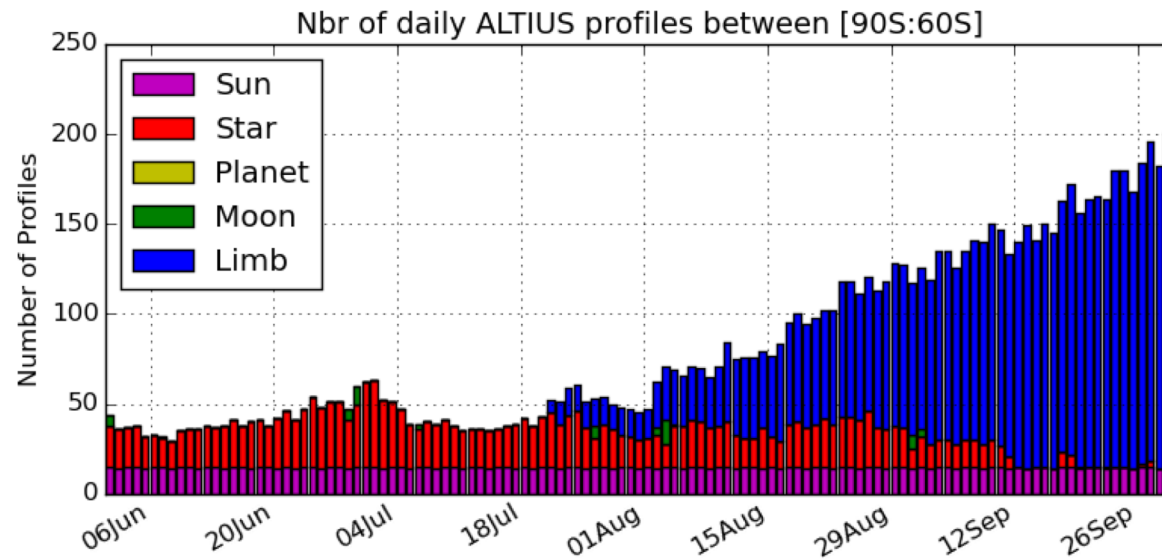
ESA Operoz report providing minimum requirements from the user community (operational services and long-term monitoring)

Summary of Observational Requirements Table , adapted form the ESA <i>Operoz</i> report					
Operational services (U1) and Long-term monitoring (U2) <i>Minimum Mission ('Priority A')</i>				<i>Timeliness: < 3h (LS, MS)</i> <i>Long-term stability:</i> <i>1% / 3% per decade</i>	
Observable	Along-track sampling (km)	Horizontal coverage	Vertical resolution (km)	Update frequency	Uncertainty
<i>LS O₃</i>	<i>100 / 200</i>	<i>Global (incl. polar night)</i>	<i>1/2</i>	<i>12h / 24h</i>	<i>8% / 16%</i>
<i>MS O₃</i>	<i>100 / 200</i>	<i>Global (incl. polar night)</i>	<i>1/2</i>	<i>12h / 24h</i>	<i>4% / 8%</i>
<i>US O₃</i>	<i>200 / 400</i>	<i>Global (incl. polar night)</i>	<i>2/4</i>	<i>Daily/weekly</i>	<i>4% / 8%</i>

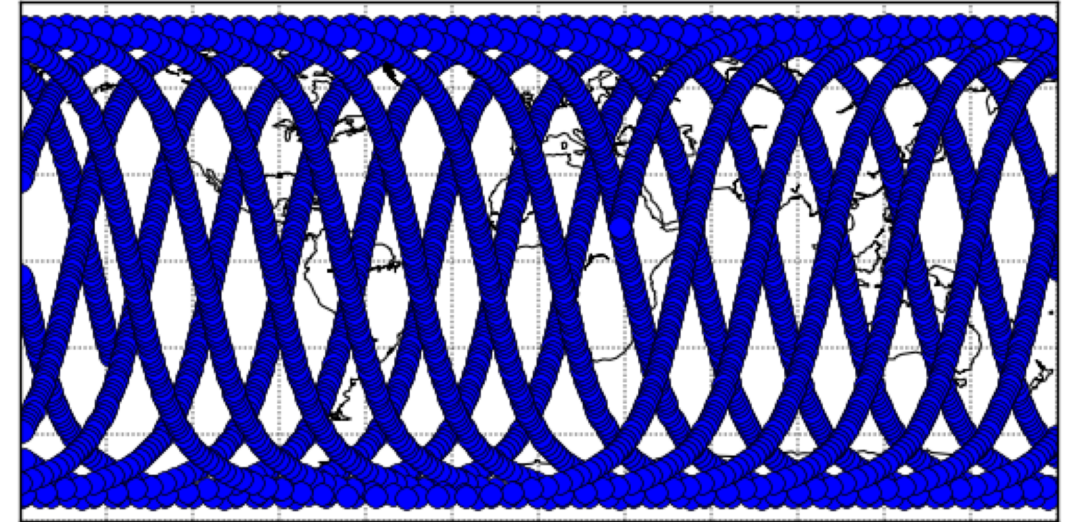
Breakthrough/Threshold

ALTIUS Observation System Simulation Experiment (OSSE)

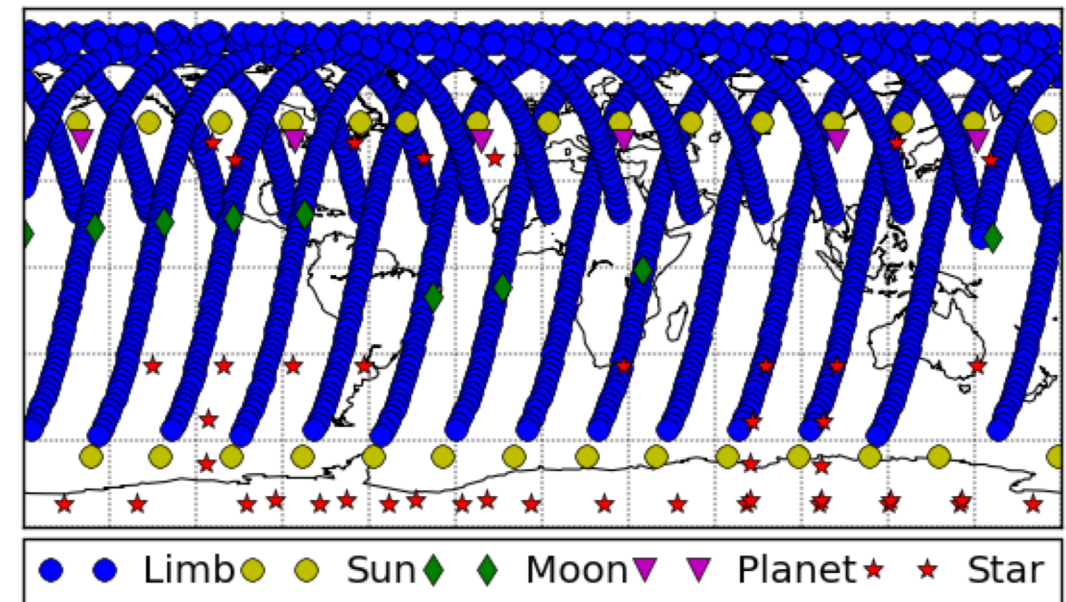
- Does the relatively small number of occultations in polar night sufficient to constraint polar ozone?



Aura MLS Geolocation on 20080705

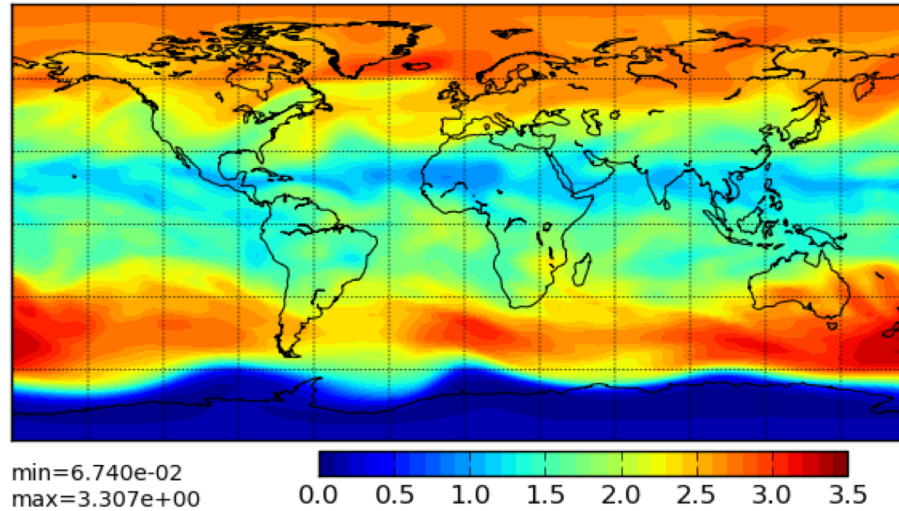


ALTIUS Geolocation on 20080705

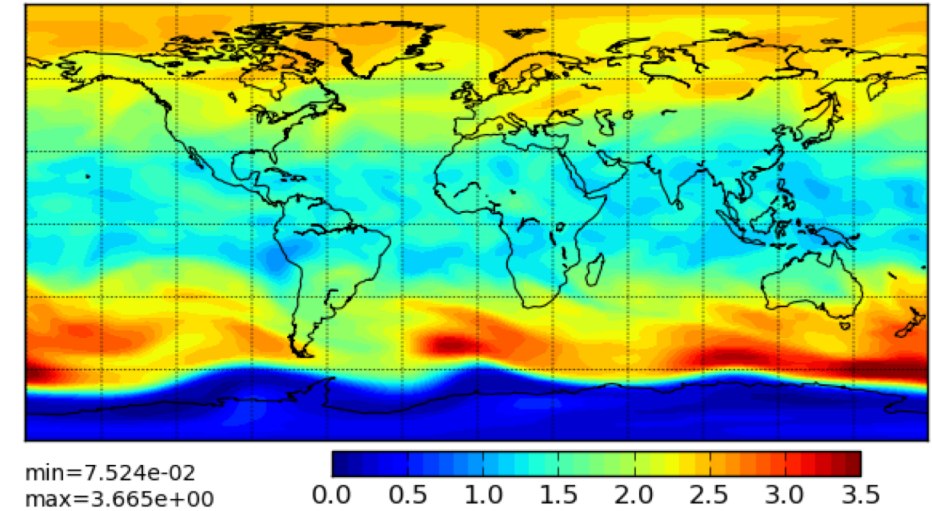


- Geolocation of ALTIUS profiles calculated for July-October 2008 with an orbital model (including an occultation event predictor)
- The nature run:
 - BASCOE Assimilation of MLS, saved in ALTIUS space
 - BASCOE_MLS@ALTIUS perturbed according to ALTIUS error bars (dependent on observation mode) providing ALTIUS synthetic observations
 - No bias added synthetic observations
- OSSE runs: assimilation of different combinations of ALTIUS measurements
- BASCOE Free model run also performed

Free Model Run

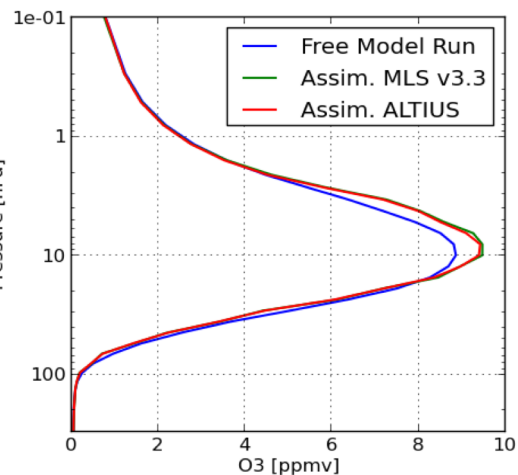


MLS Analysis

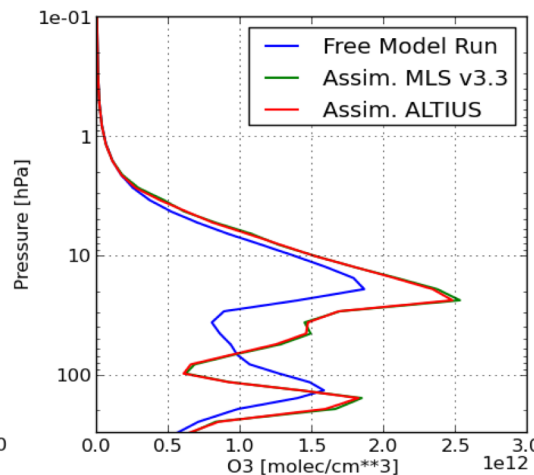


Ozone at 55 hPa on
30-Sep-2008 from
BASCOE Free Model
Run, MLS and ALTIUS
assimilation

30°S-30°N

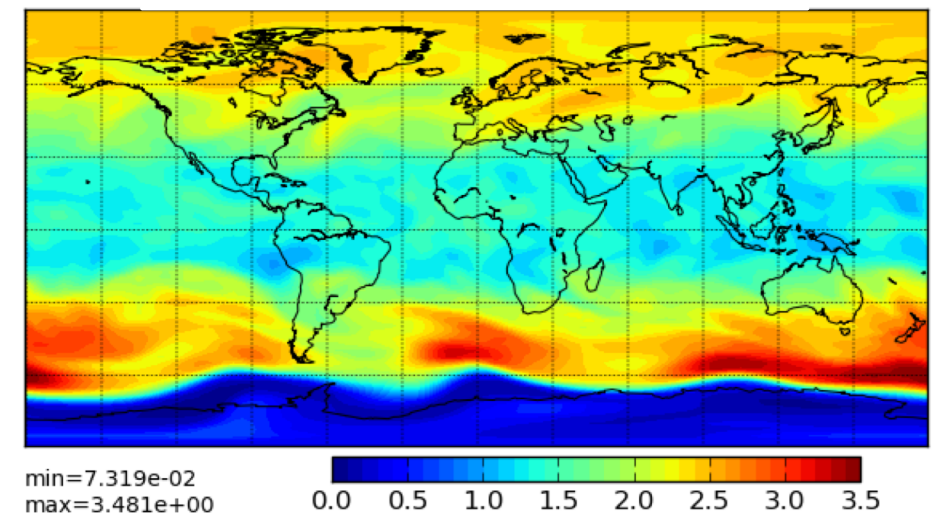


90°S-60°N



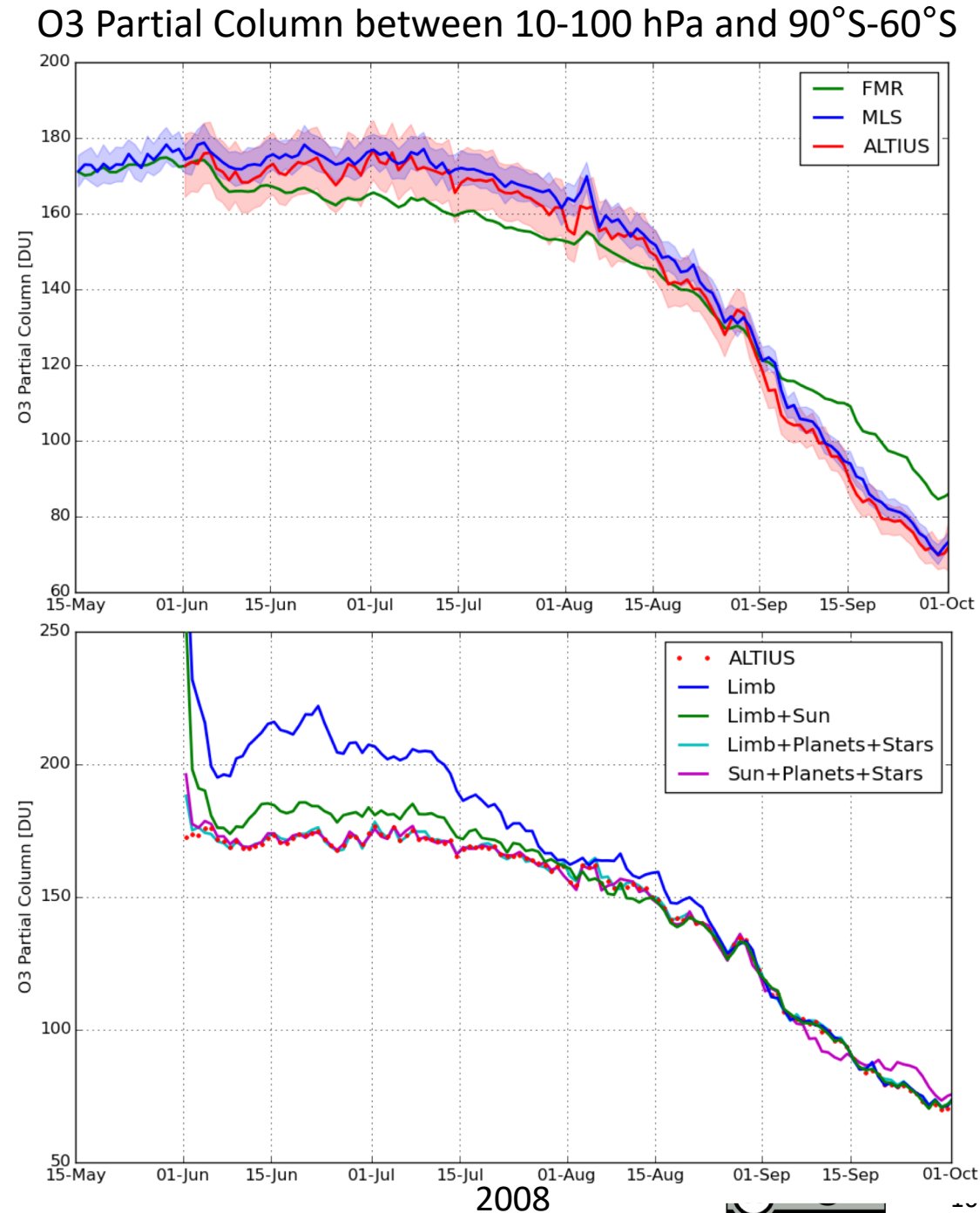
BASCOE Ozone
mean profiles on
30-Sep-2008

ALTIUS Analysis



ALTIUS OSSE

- (Top): ALTIUS data provides sufficient information to capture the development of the ozone hole
- (Bottom): OSSE of different modes of ALTIUS observations shows that all modes are necessary to capture the development of the ozone hole.
 - Here, OSSE experiments performed with BASCOE chemistry turned off and 2 x init. cond.



- Despite the limited number of profiles during nighttime, ALTIUS measurements will be able to constrain ozone during polar winters/springs
- This goal is achieved thanks to the different mode of ALTIUS where:
 - Solar/Planet/Stellar occultations are essential during the polar night
 - Limb scattered measurements are essential in spring