ESA Ozone Climate Change Initiative: combined use of satellite ozone profile measurements

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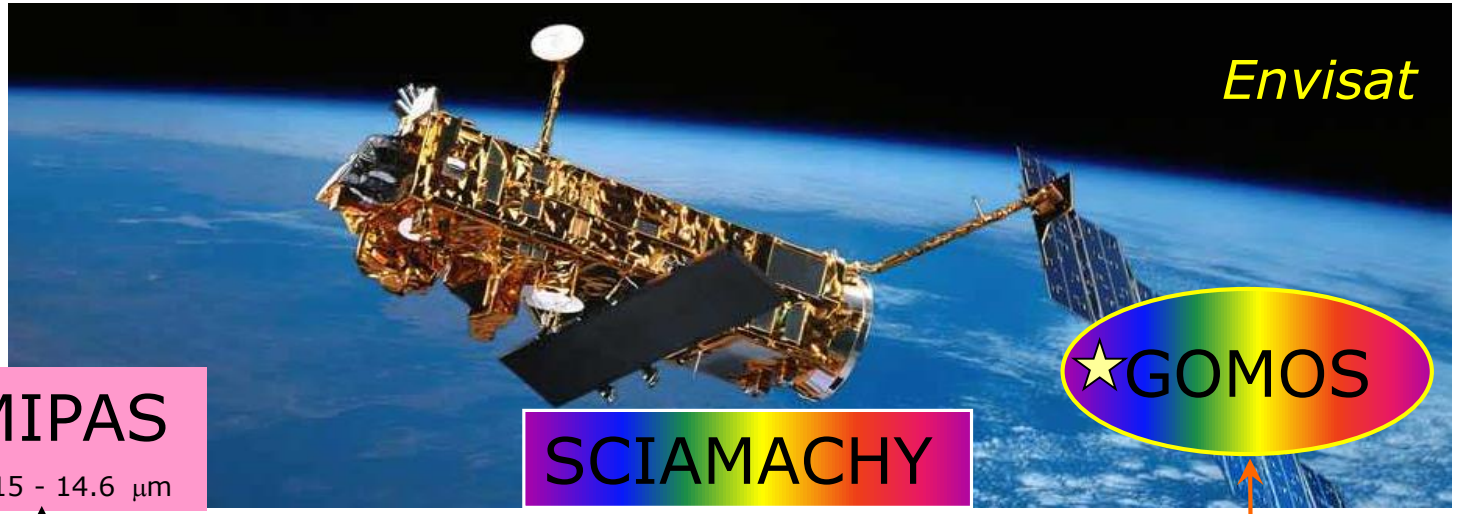
Ozone_cci limb profile instruments

Vertical resolution 2-4 km



MIPAS
4.15 - 14.6 μm

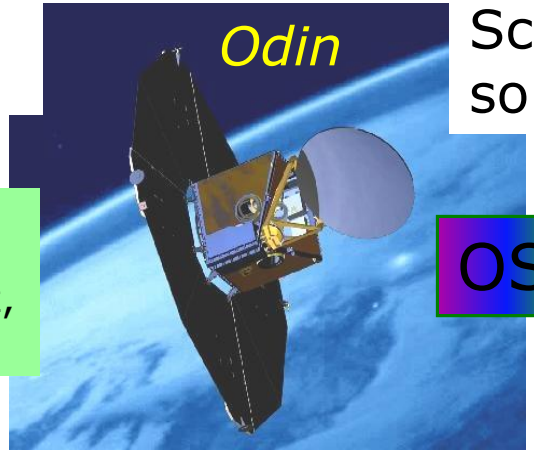
SCIAMACHY

GOMOS

Emission spectra

Scattered solar light

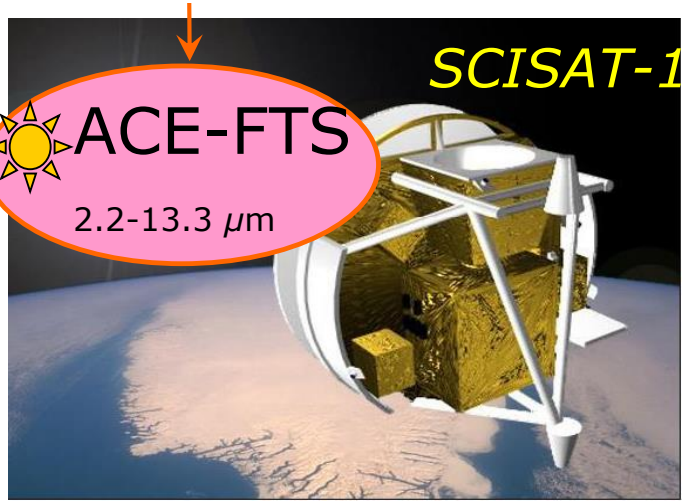
occultation



SMR
501.8GHz, ~0.6 mm

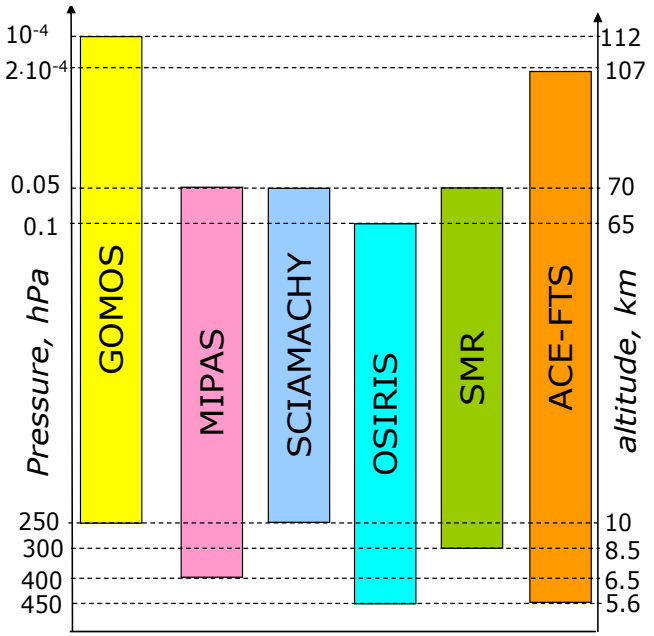
OSIRIS

ACE-FTS
2.2-13.3 μm



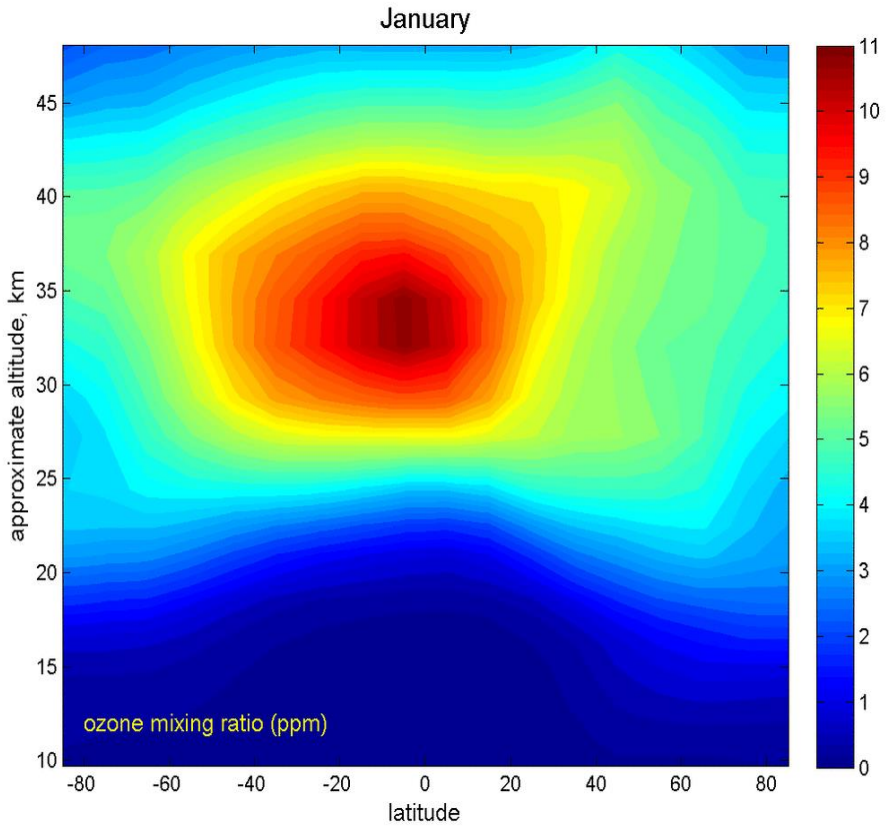
Harmonized dataset (HARMOZ), Level 2

- **Level 2 ozone profiles in the same vertical grid**
- **User-friendly: only valid data**
- **Data are in the same netcdf format**
  - Mandatory parameters, the same for all instruments
    - Ozone, uncertainties, vertical resolution, parameters for different representations
  - Optional parameters, specific for each instrument
    - Related to data quality and its characterization
- **Currently: on pressure grid**
- **Nearest future: also on altitude grid**
- **New datasets included**
  - GOMOS bright limb data
  - SMR 544 GHz
  - NASA& NOAA sensors: SAGE-II, HALOE, MLS, SABER
- **Relative biases and drifts, Rahpoe et al., 2015, AMT**



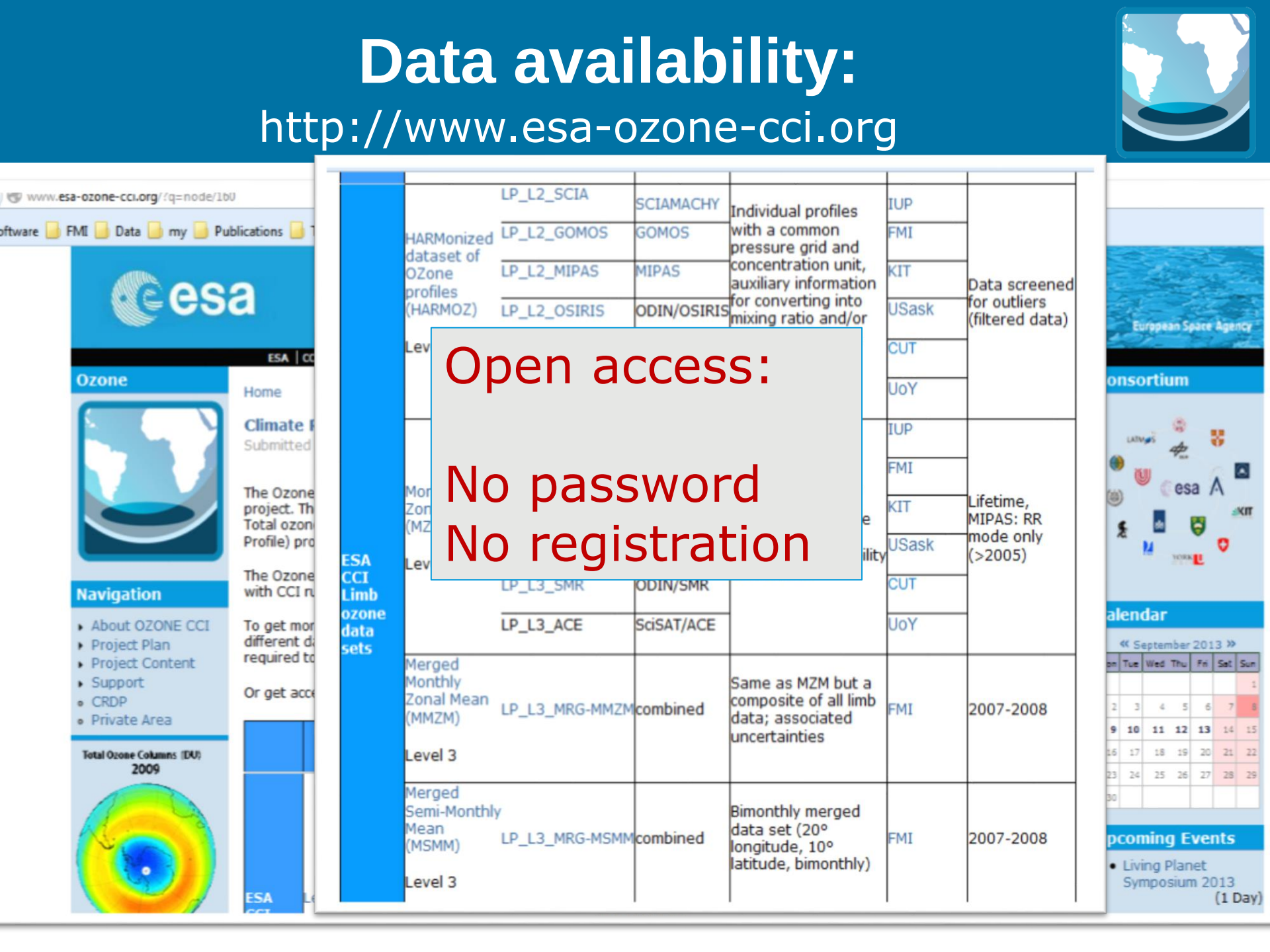
Level 3 data

- **Monthly zonal mean from individual sensors**
  - Uncertainty characterization including sampling uncertainty (Sofieva et al., 2014, AMT)
- **Merged monthly zonal mean**
- **Level 3 data with resolved longitudinal structure**
  - From individual sensors and merged
- **Mesospheric datasets**
- **Tropospheric ozone column from matched nadir-limb measurements**



Data availability:

http://www.esa-ozone-cci.org



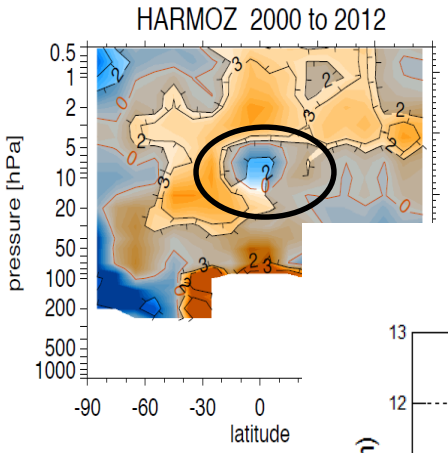
Open access:

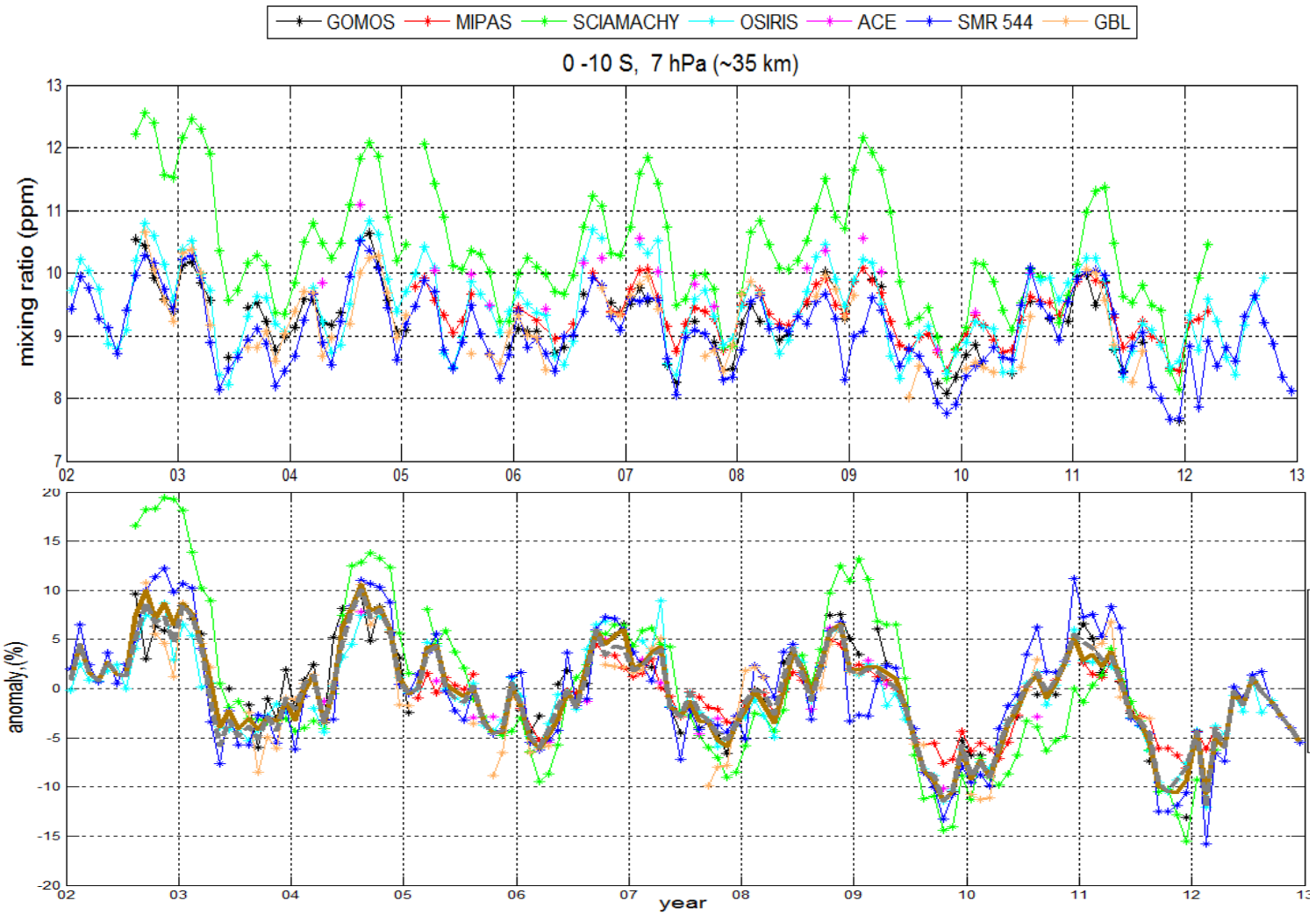
No password
No registration

ESA CCI Limb ozone data sets	HARMonized dataset of OZone profiles (HARMOZ) Level 3	LP_L2_SCIA	SCIAMACHY	Individual profiles with a common pressure grid and concentration unit, auxiliary information for converting into mixing ratio and/or	IUP
		LP_L2_GOMOS	GOMOS		FMI
		LP_L2_MIPAS	MIPAS		KIT
		LP_L2_OSIRIS	ODIN/OSIRIS		USask
					CUT
					UoY
	Mor Zon (MZ Lev	LP_L3_SMR	ODIN/SMR	ility	IUP
					FMI
					KIT
					USask
					CUT
		LP_L3_ACE	SciSAT/ACE		UoY
	Merged Monthly Zonal Mean (MMZM) Level 3	LP_L3_MRG-MMZM	combined	Same as MZM but a composite of all limb data; associated uncertainties	FMI
	Merged Semi-Monthly Mean (MSMM) Level 3	LP_L3_MRG-MSMM	combined	Bimonthly merged data set (20° longitude, 10° latitude, bimonthly)	FMI

Data screened for outliers (filtered data)	
Lifetime, MIPAS: RR mode only (>2005)	
2007-2008	
2007-2008	

Usefulness of intercomparisons



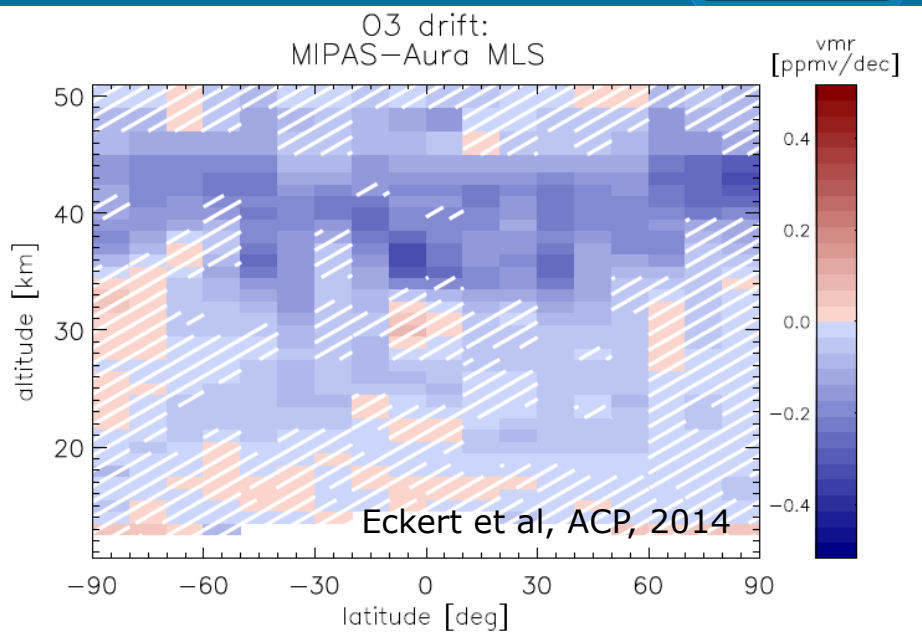


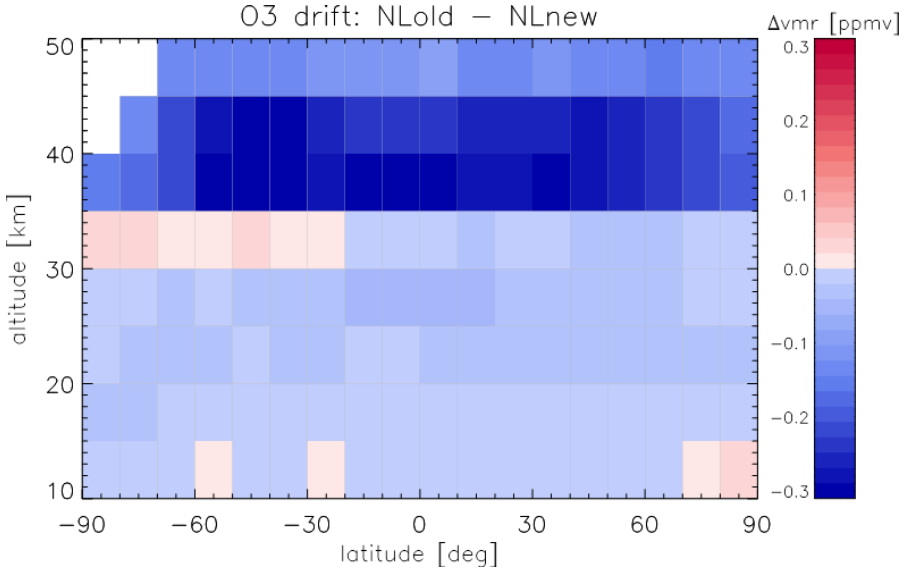
- **The data with strong drifts can be removed from the ensemble**
- **Even in the very problematic case in the illustration, the merged time series follows the majority of the data**
- **Negative trend ~35 km is observed in several datasets**

Strong SCIAMACHY bias and drift : local feature → will be improved in the next data version (processing)

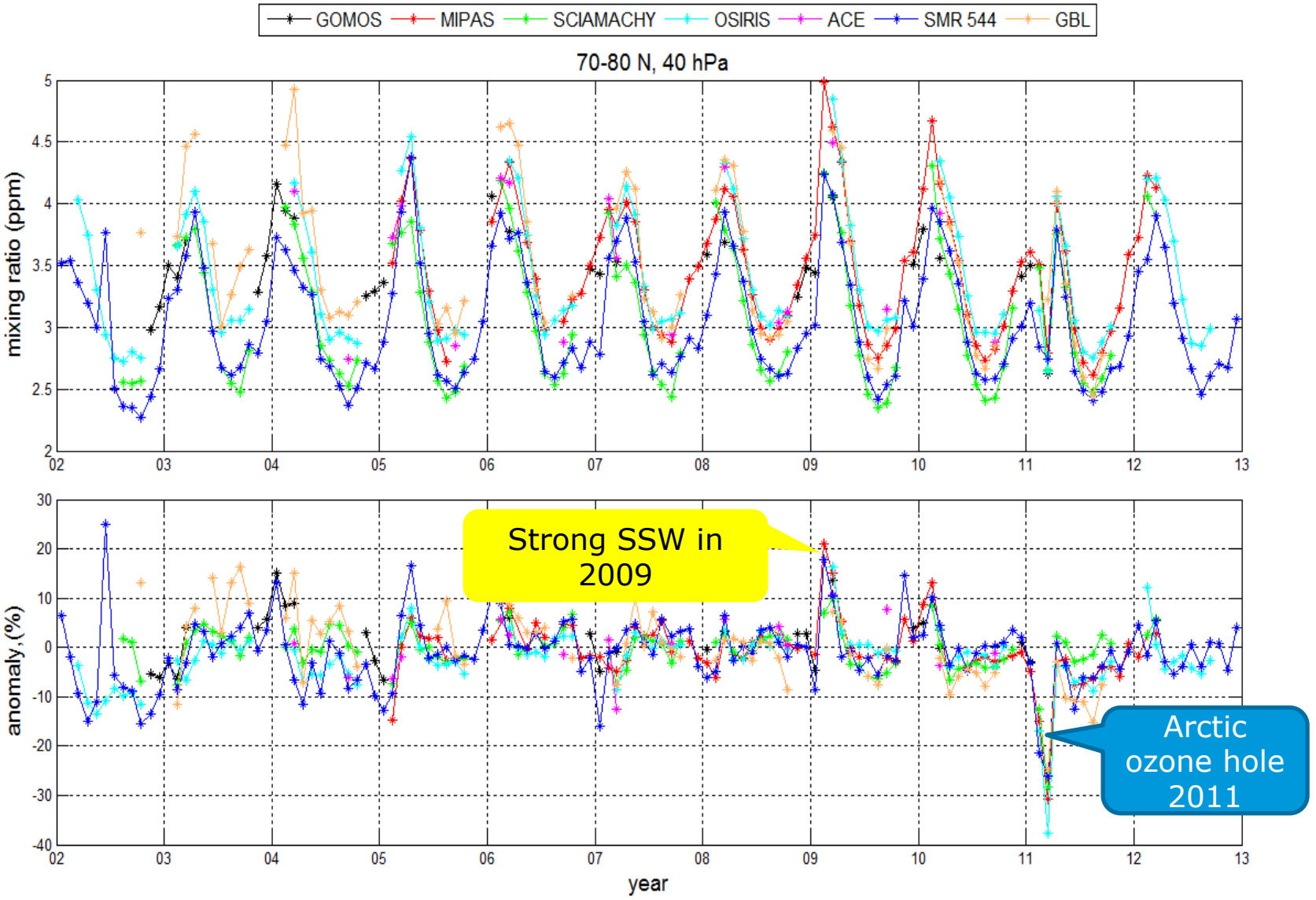
New data versions

- **ACE-FTS v.3.5**
- **GOMOS ALGOM 2s:**
  - improved UTLS ozone
  - More accurate filtering of invalid data
- **MIPAS IMK v7**
  - time-dependent non-linearity correction: removed drift
- **SCIAMACHYv3.5**
  - Inversion using continuous spectrum in VIS
  - More accurate reference and advanced aerosol modelling
- **OSIRIS**
  - Altitude registration correction (better stability at upper altitudes)
- **SMR**
  - correction of corrupted data





Good agreement: the Arctic stratosphere

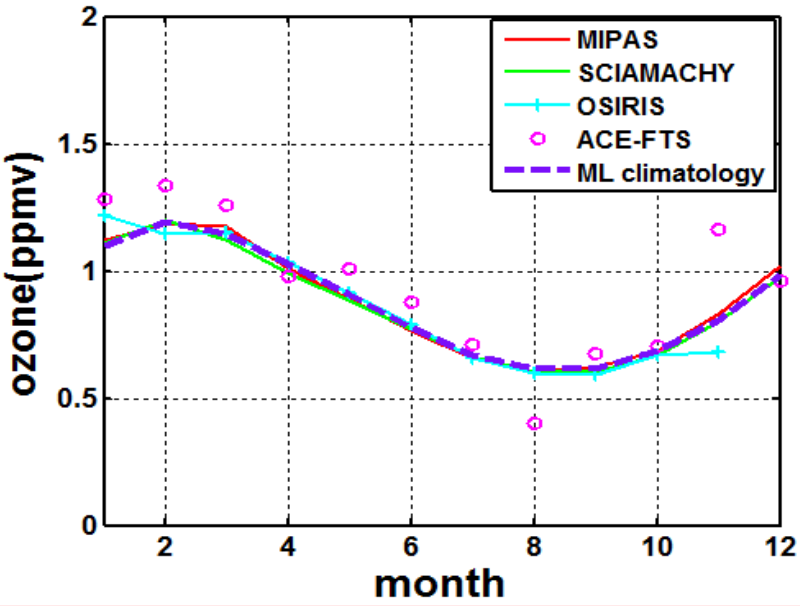


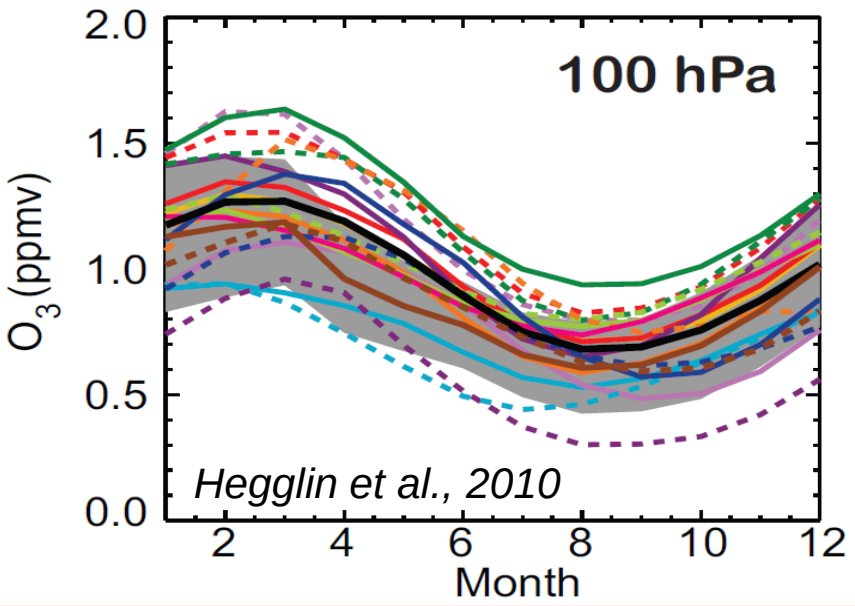
Ozone seasonal cycle in the extra-tropical UTLS

Ozone_cci limb instruments

Climate models

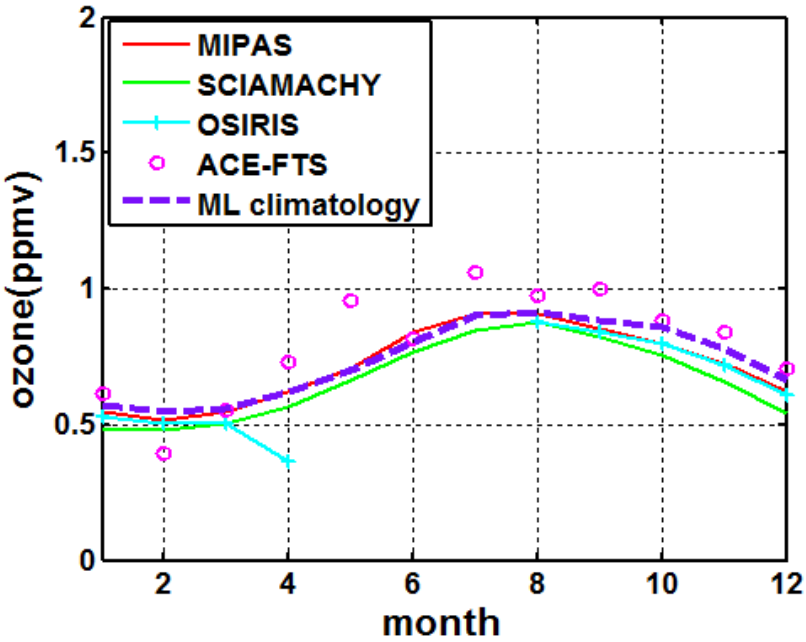
40- 60 N

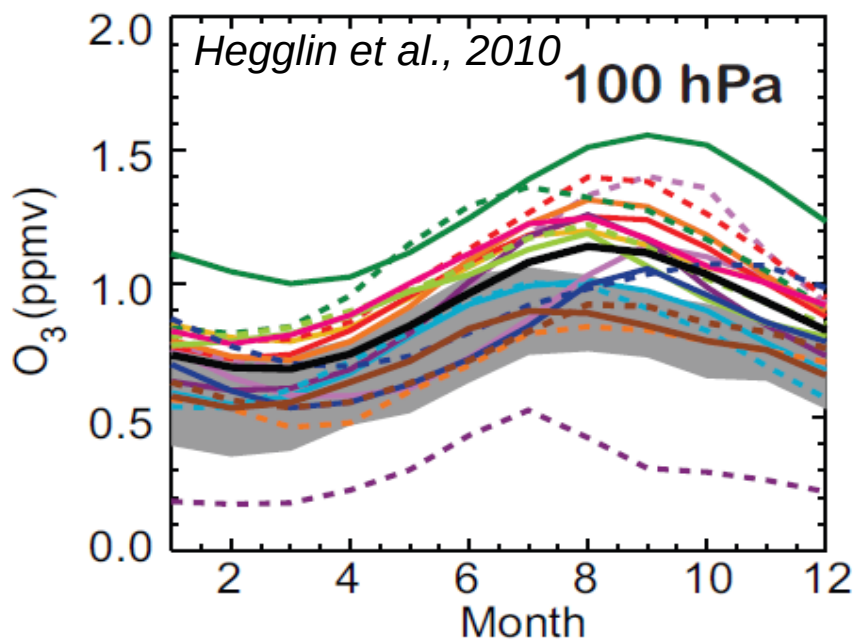




Hegglin et al., 2010

40- 60 S

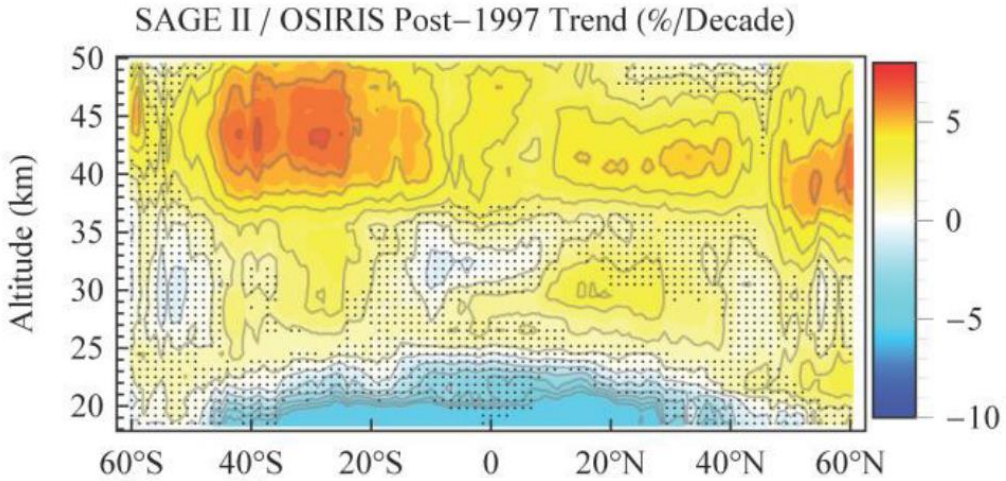




Trends in vertical ozone distribution

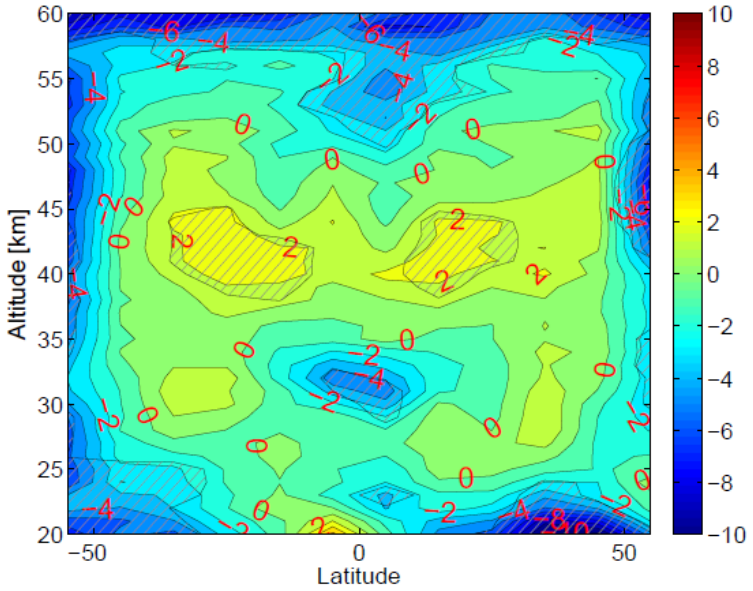
Trends in qualitative good agreement but there are differences between datasets

Bourassa et al., 2014

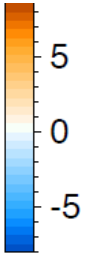


SAGE II/GOMOS 1997-2011

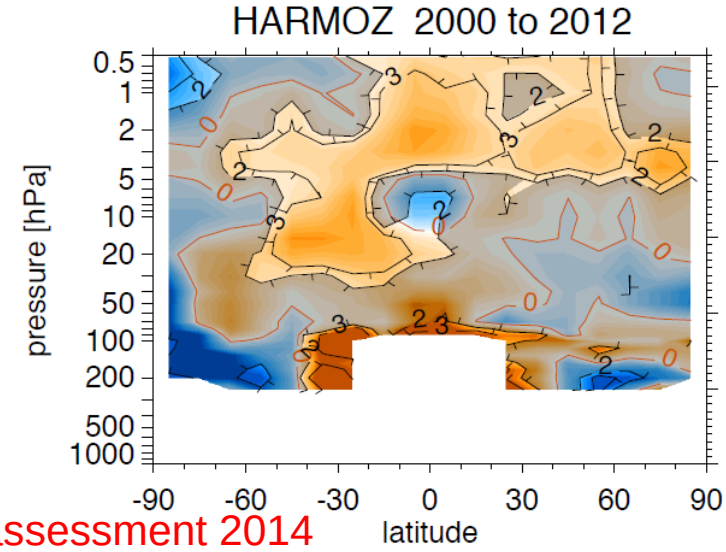
Kyrölä et al., 2013



O_3 trend %/dec

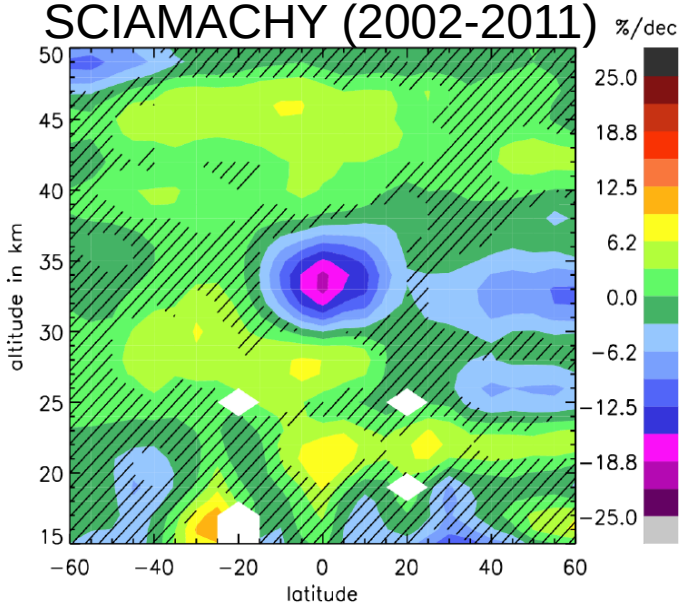


HARMOZ 2000 to 2012



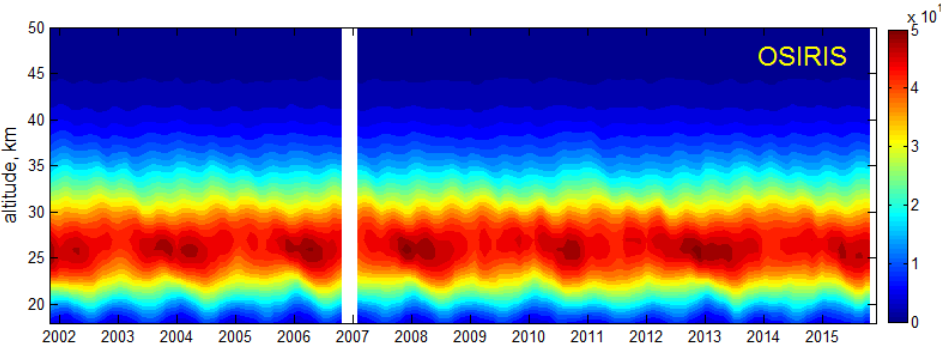
SCIAMACHY (2002-2011)

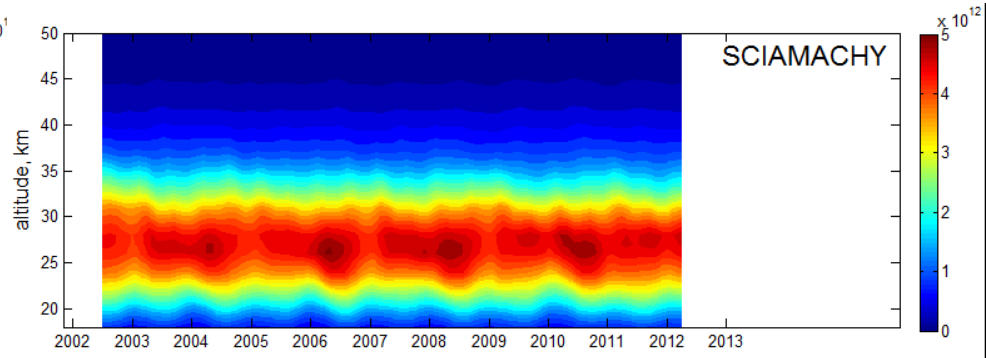
Gebhardt et al., 2014

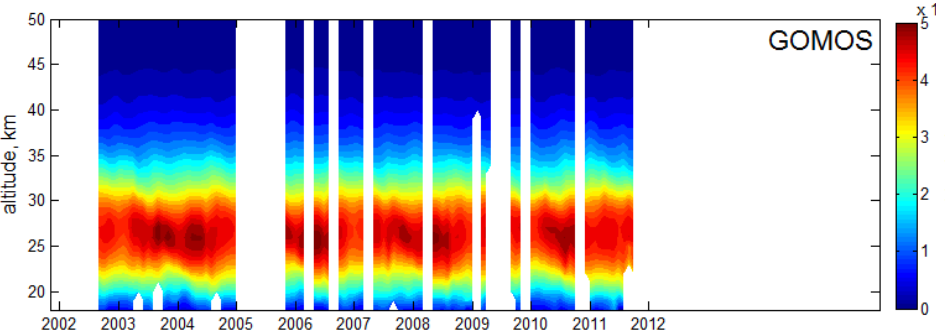


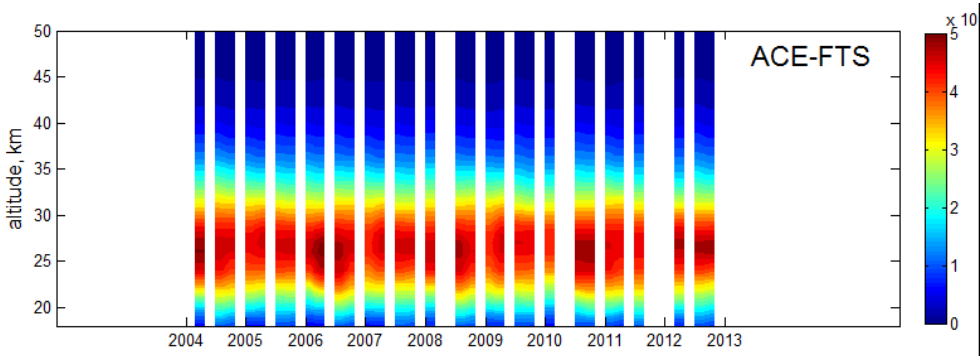
WMO ozone assessment 2014

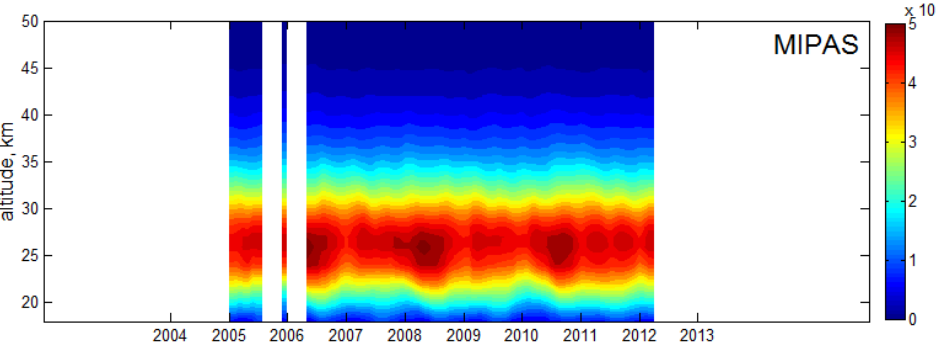
From individual time series

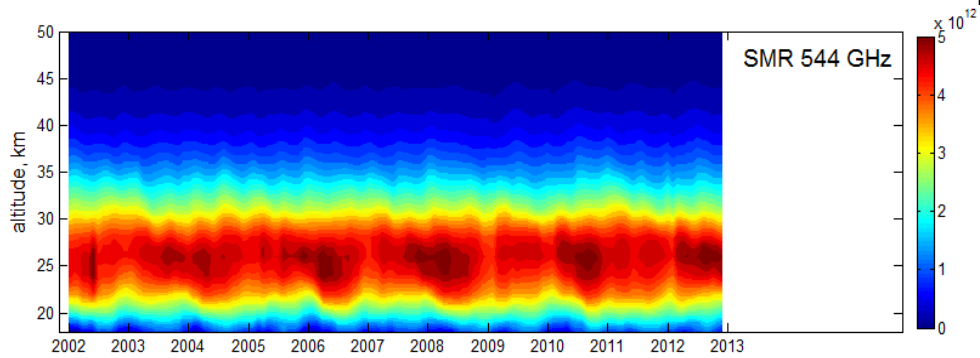






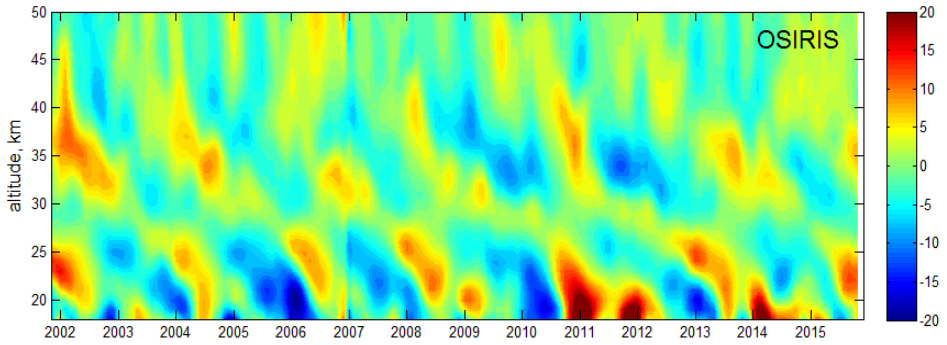


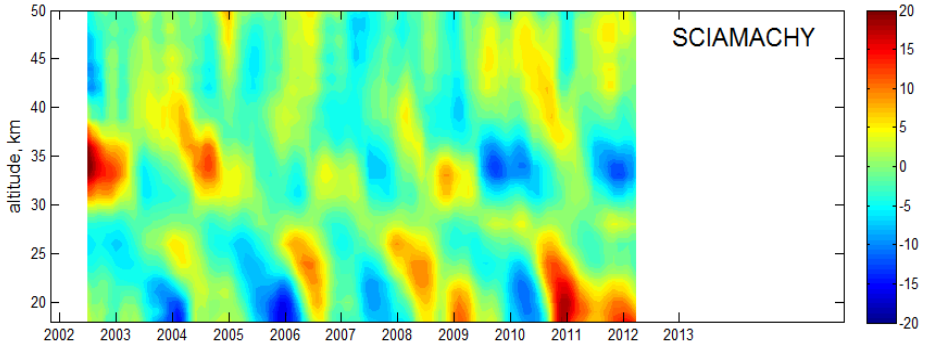


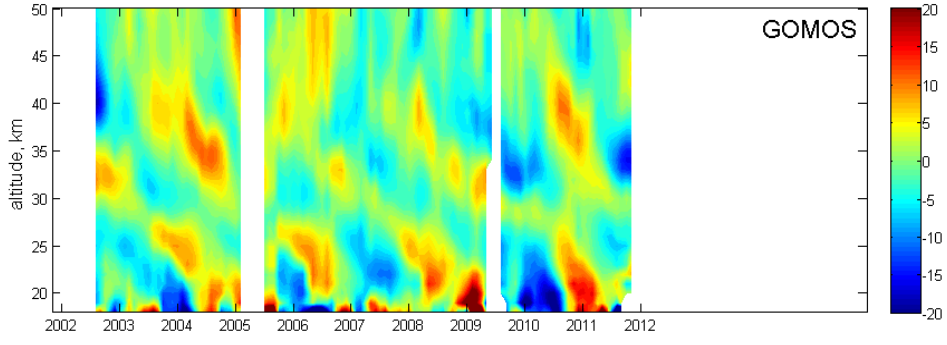


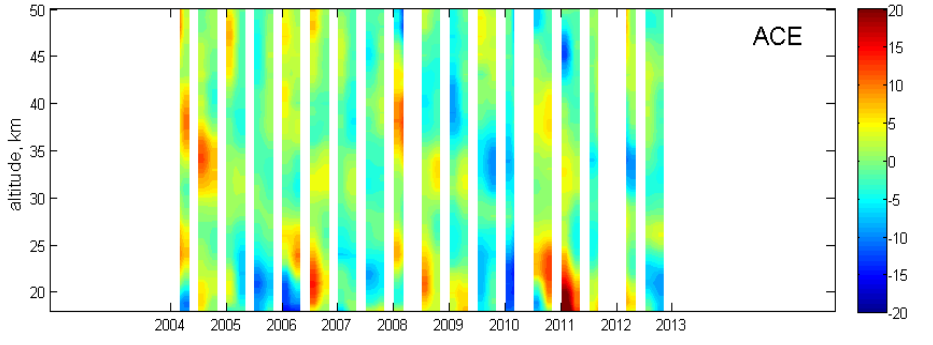
through individual deseasonalized anomalies

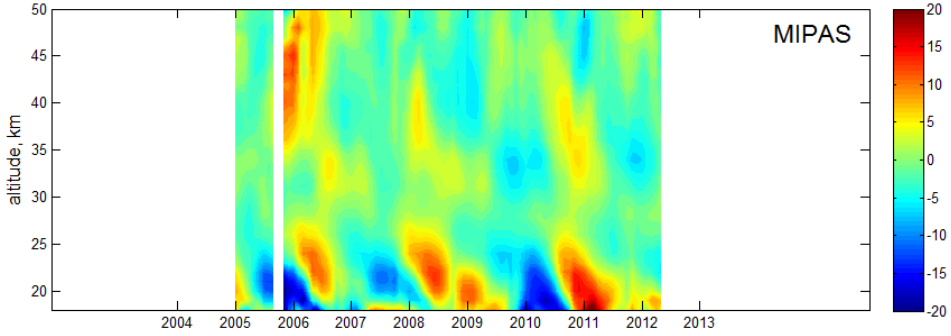
Deseasonalized ozone anomalies in %

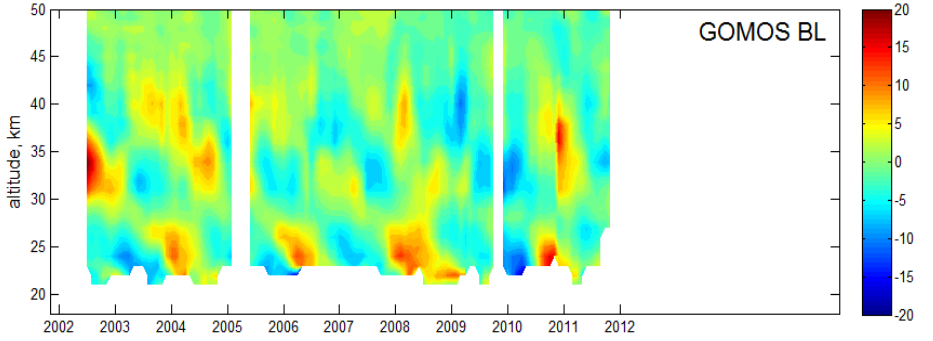




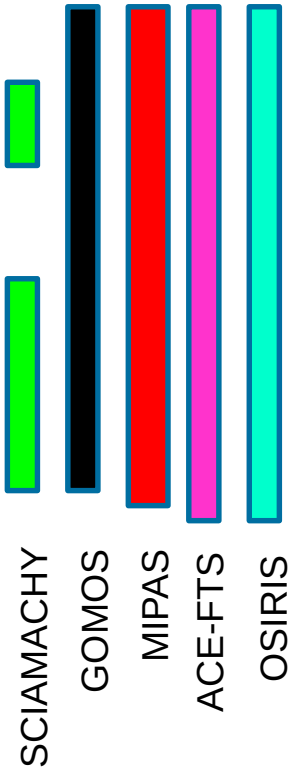


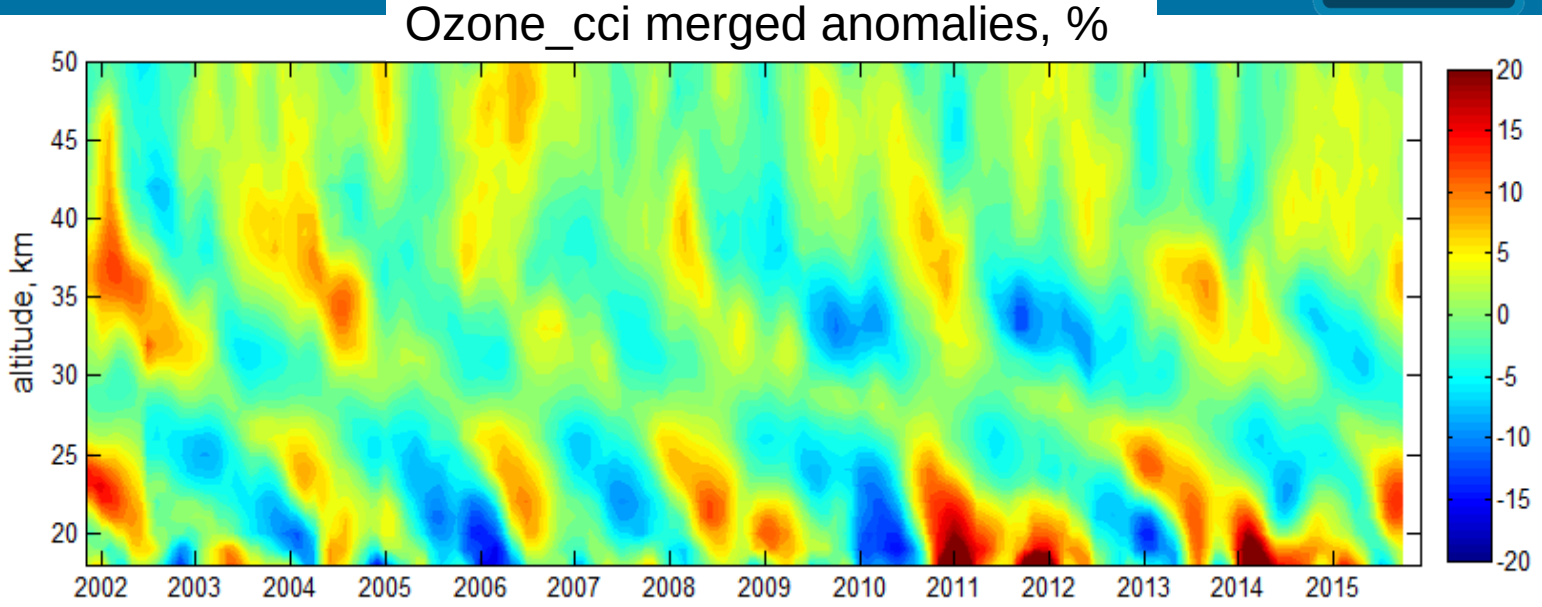


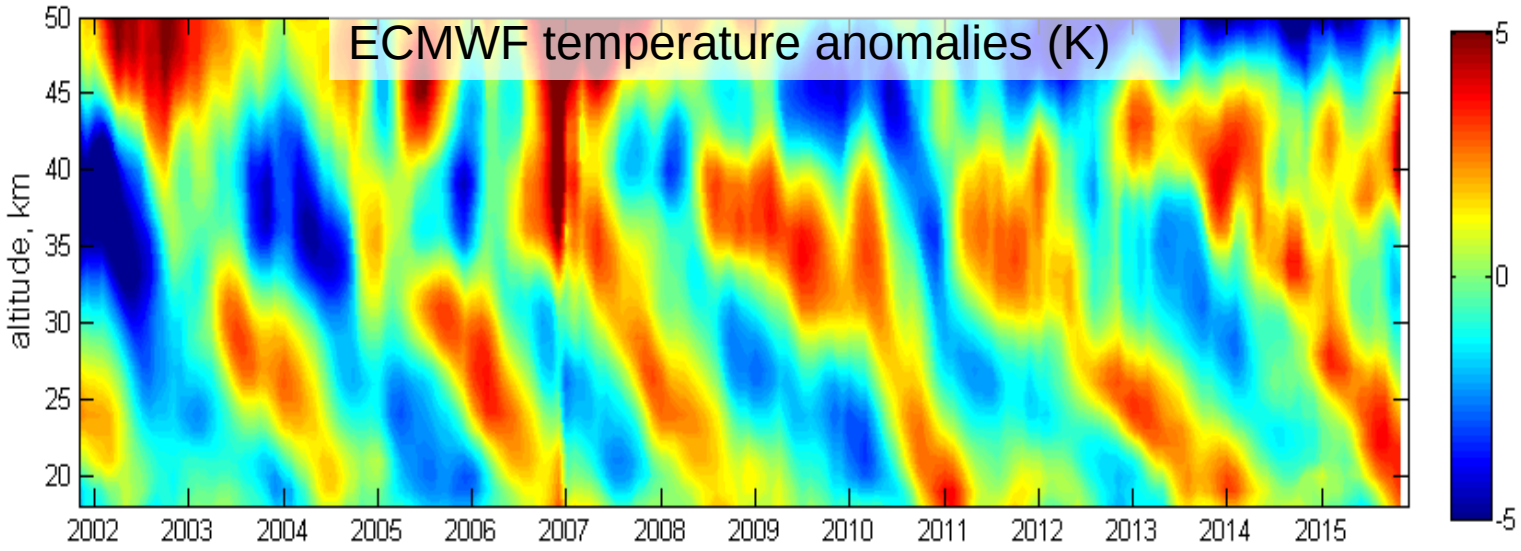




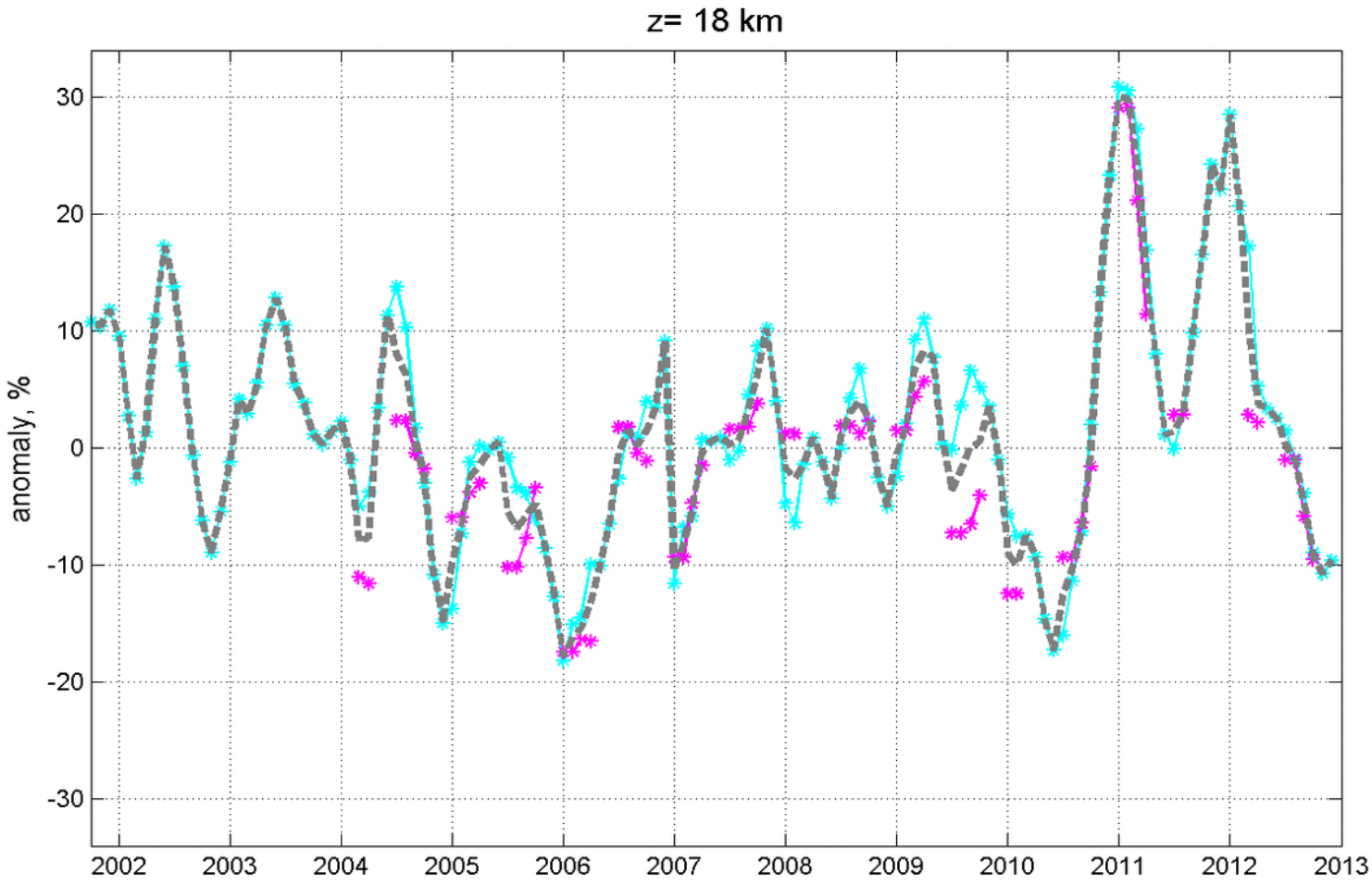
….to merged dataset







Examples of time series in the equatorial LS



OSIRIS

ACE-FTS

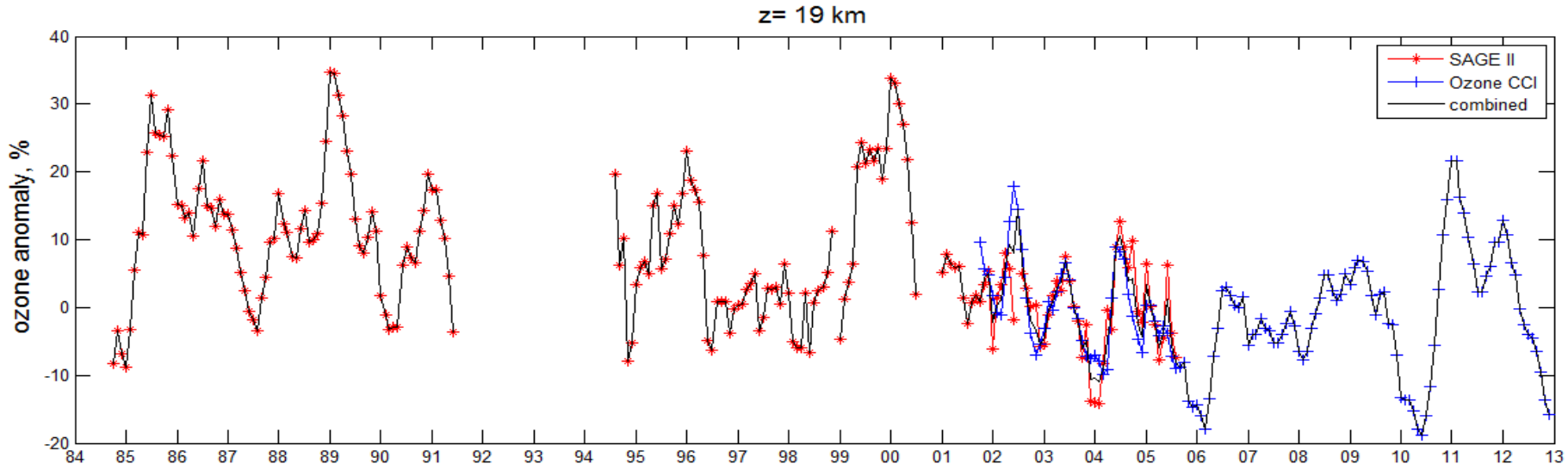
MIPAS

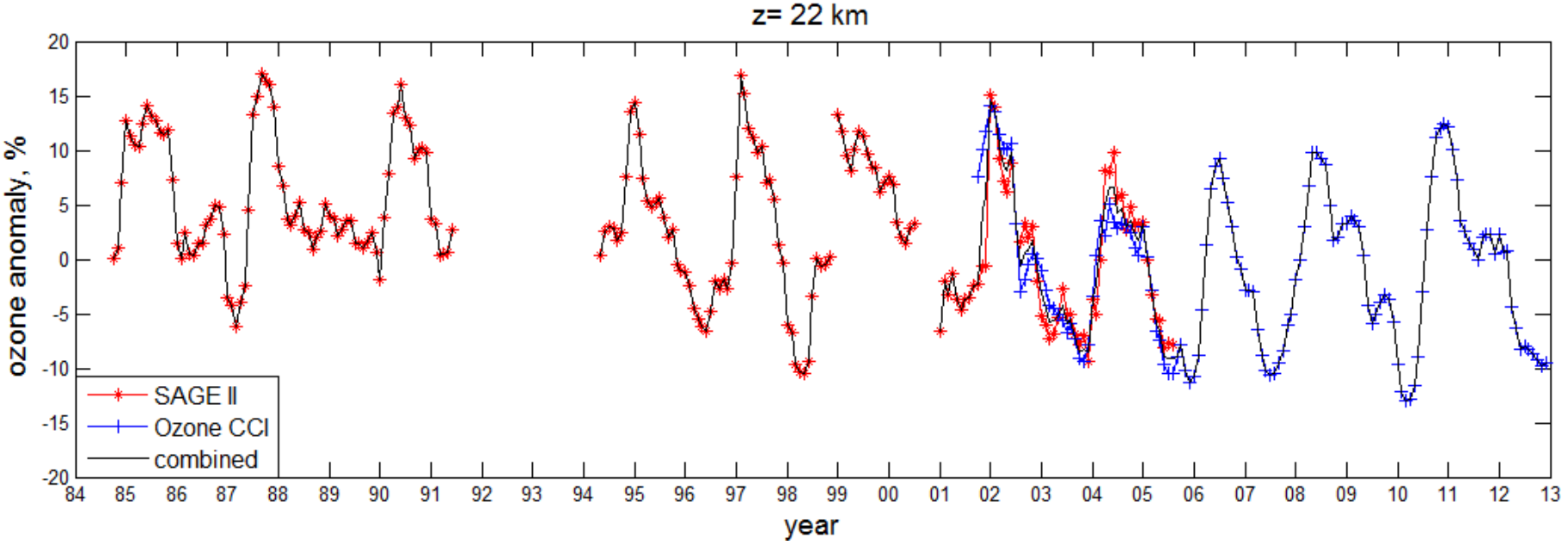
GOMOS

SCIAMACHY

- - merged

Combination with SAGE II



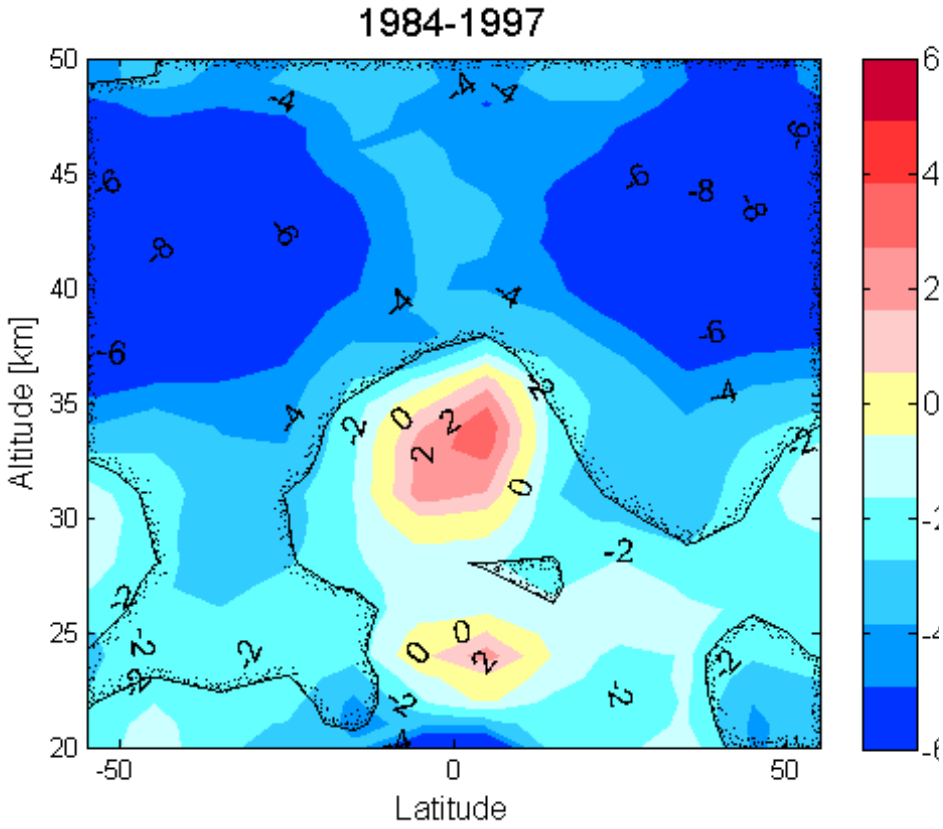


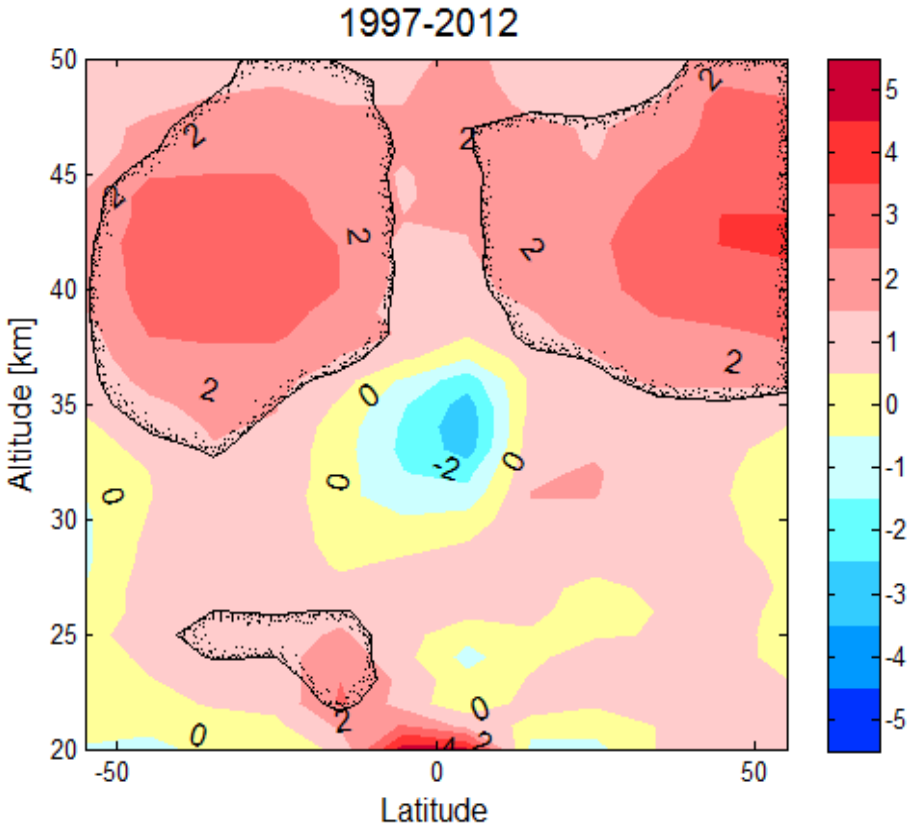
Preliminary assessment of ozone trends

Merged SAGE II & Ozone_cci data set 1984 – 2012

Ozone_cci:

- ACE-FTS v 3.5, OSIRIS V5.07R, MIPAS IMK V7, GOMOS ALGOM2s, SCIAMACHY v 2.9
- Removing anomalies with drifts or with excessive variability





Piece-wise linear trend, solar flux , QBO, ENSO

On-going work, nearest plans

- Creating Level 3 datasets (after new versions are ready)
- Revised ozone trend analyses (together with historical datasets), SAGE II- Ozone_cci- (OMPS)
- Contribution to Obs4MIPs
- Contribution to next WMO ozone assessment and related SPARC activity (Long-term Ozone Trends and Uncertainties in the Stratosphere, LOTUS)

Further extension

- **Currently operating :OMPS**
- **Future: SAGE III/ISS, ALTIUS (occultation ja limb measurements)**
- **All these instruments use UV-VIS wavelength range for ozone retrievals (number density on altitude grid)**
- **Climate data record can be continued**
- **Furthermore, it can be made even more consistent (e.g., all limb-scatter data processed with one processor, occultation data etc)**
- **Important to have more than one dataset**
  - For quality assessment
  - For confidence in observed phenomena