Variability and trend of the stratospheric subtropical barrier

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PROBLEM STATEMENT

- Variability and trends in the dynamical barrier located in the subtropical stratosphere.

- The barrier or edge region separates inner tropical region from mid-latitudes and act as border of the tropical pipe

- Probability Density Functions of long-lived tracers allow to estimate the position of the region of minimum gradient (i.e. the edge of the dynamical barrier) merging different observations and model data

Questions:

- Annual variability of the "edge" region in the stratosphere ?

- Interannual variaiblity and impact of the QBO ?

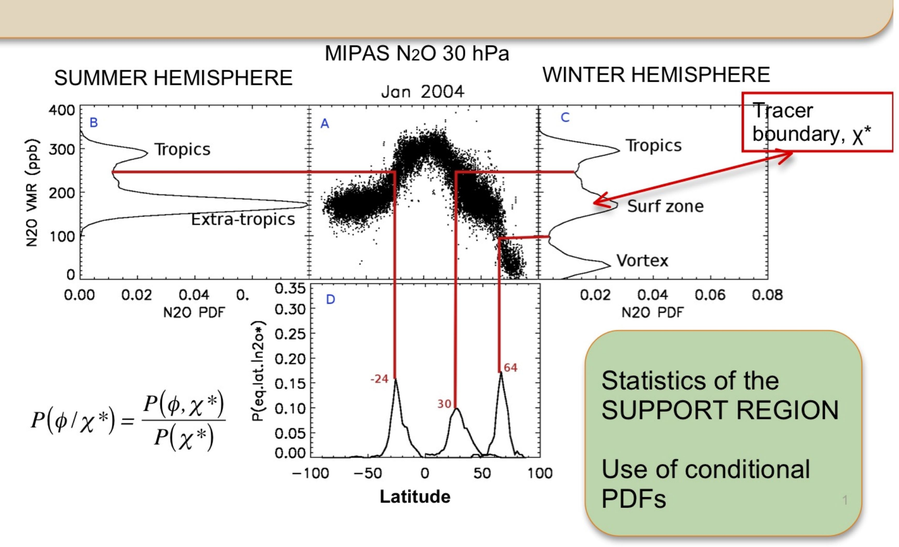
- Trends in position and intensity ?

- How it compares to state-of-the art climate models ?

- Probability Distribution Functions (PDFs) of long-lived tracers

- Estimate mixing and barrier regions

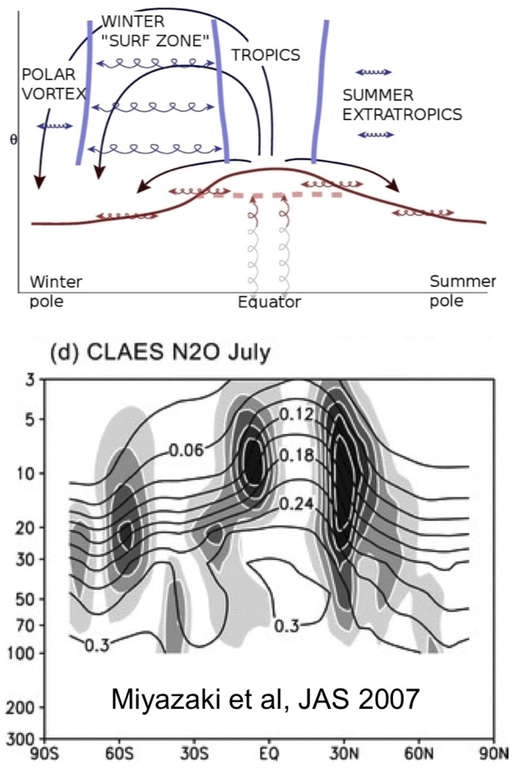
- In principle not dependant from latitudinal distribution and species



$$P(\phi/\chi^*) = \frac{P(\phi,\chi^*)}{P(\chi^*)}$$

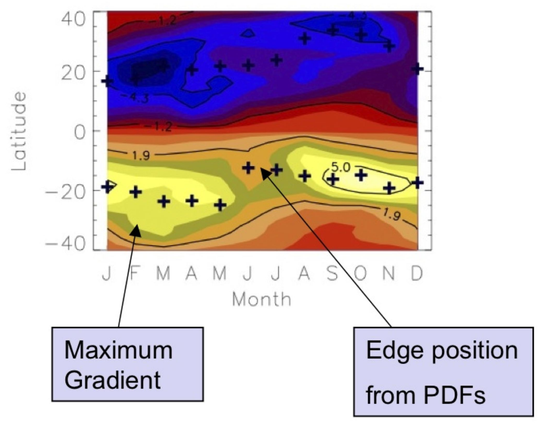
Statistics of the SUPPORT REGION

Use of conditional PDFs



Average gradient PDF Edge position

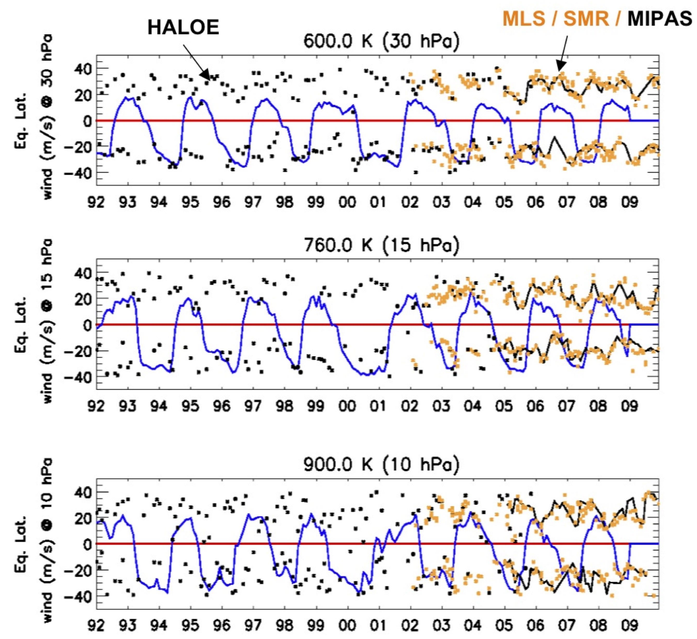
20 hPa (690 K)



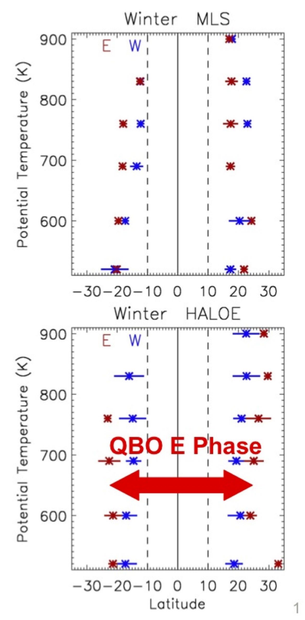
$$\frac{d\chi}{d\phi} = \cos\phi \times \frac{1}{P(\chi)}$$

PDF and gradient are inversely proportional

Position Time series

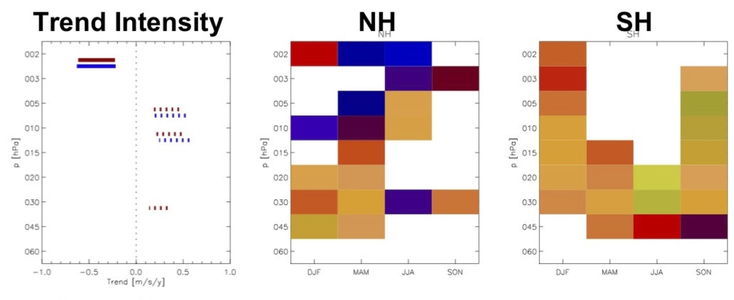


Effect of QBO

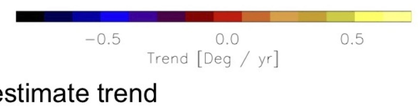


Less visible in MLS NH

TRENDS IN THE BARRIER POSITION

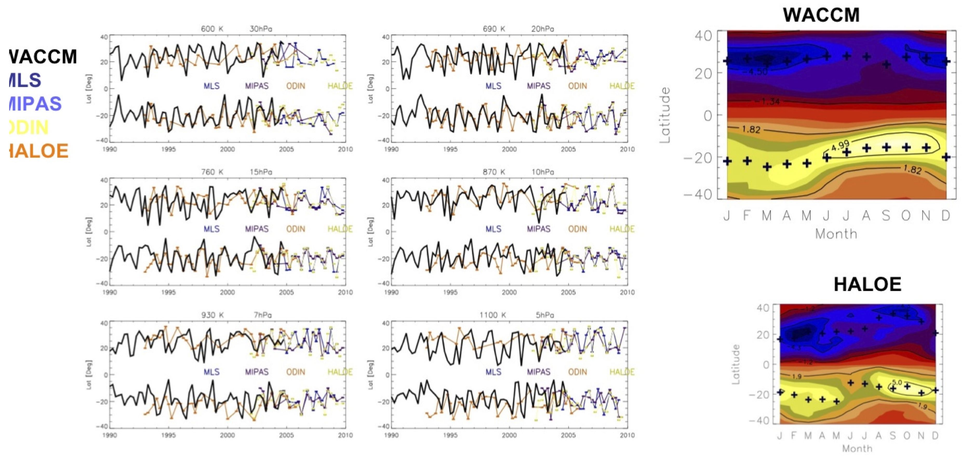


Regress and multi regression analysis
Correction for AR(1)
t-student=2 (96 %)
Positive in the SH = 0.3 deg/yr (equatorward)



Impact of the database
- HALOE data necessary to estimate trend
- Similar results using only 2/3 sensors (but with lower confidence)

Comparison with WACCM CCMVAL REF-2 simulations



Agreement on annual and interannual variability of position and intensity
QBO effect clearly visible in WACCM (SH)

CONCLUSIONS

- Annual variability of the "edge" region in the stratosphere ?

- QBO modulates the position through planetary waves

Equator (pole) ward in W (E) phase

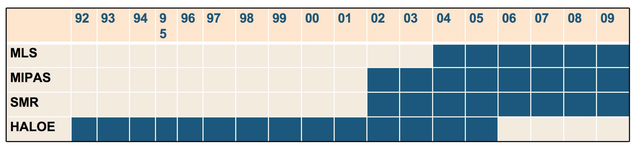
- Observations show significant trend in position in the SH stratosphere but no trend in intensity

Role of v* EP flux ?

- WACCM is in very good agreement

SATELLITE DATA SETS

global coverage
measurement continuity
unprecedented long data series
PDF helps in merging different sensors



MIPAS/Envisat SMR/Odin MLS/Aura HALOE/UARS

Table 2. Mean and standard deviation values of the histogram distributions of the differences between the barrier latitude calculated from each pair of sensors shown in Fig. 5.

		MLS-MIP	MLS-HAL	MLS-SMR	MIP-HAL	MIP-SMR	HAL-SMR
# hist	NH	76	22	104	27	110	67
	SH	85	36	123	37	118	79
Mean (°)	NH	0.9	−2.9	0.9	−3.4	−1.2	3.8
	SH	−1.1	−0.3	−1.1	1.8	0.9	−2.2
STD (°)	NH	3.8	4.7	4	5.4	4	6
	SH	4	5	4	4.2	3.7	4.3

Bias among different sensors < 1°

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Atmospheric Chemistry and Physics Discussions

This discussion paper is/has been under review for the journal Atmospheric Chemistry and Physics (ACP). Please refer to the corresponding final paper in ACP if available.

Probability density functions of long-lived tracer observations from satellite in the subtropical barrier region: data intercomparison

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