Eight years of BrO from OSIRIS: climatology, inferred Br_y, and trends

Chris McLinden[1], Doug Degenstein[2], and the OSIRIS Team

[1] Enivironment Canada (chris.mclinden@ec.gc.ca)
[2] University of Saskatchewan

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Introduction

Amount of bromine in the stratosphere remains uncertain:

- Estimates vary from 17 to 25 pptv
- Levels impacts role in mid-latitude ozone depletion
- If amount closer to 25 pptv, then what are the "missing" sources? Are they natural or anthropogenic? Do they have a trend?
- BrO remains only member of inorganic bromine family (Br_y) measured globally, on large scale (possible exception of $BrONO_2$ from MIPAS?)

OSIRIS BrO data product (1)

- Individual spectra lack sufficient SNR for BrO inversions (346 nm to 376 nm)
- Daily, zonal-mean level 1 spectra were created, averaged into 18 latitude x 2 local time bins on potential temperature levels
- Typically 10-25 spectra populate an averaging bin; 3-5 fold increase in SNR
- Spectral fit applied to daily, zonal-mean L1 product yielding BrO apparent slant column densities
- Slant columns inverted using optimal estimation (maximum a posteriori estimator)

OSIRIS BrO data product (2)

Current version: 4.0

August 2001 – July 2009, ~42,000 profiles

Altitude range: 16-36 km

18-36 km tropics; 16-34 km extra-tropics

Precision: ~30%

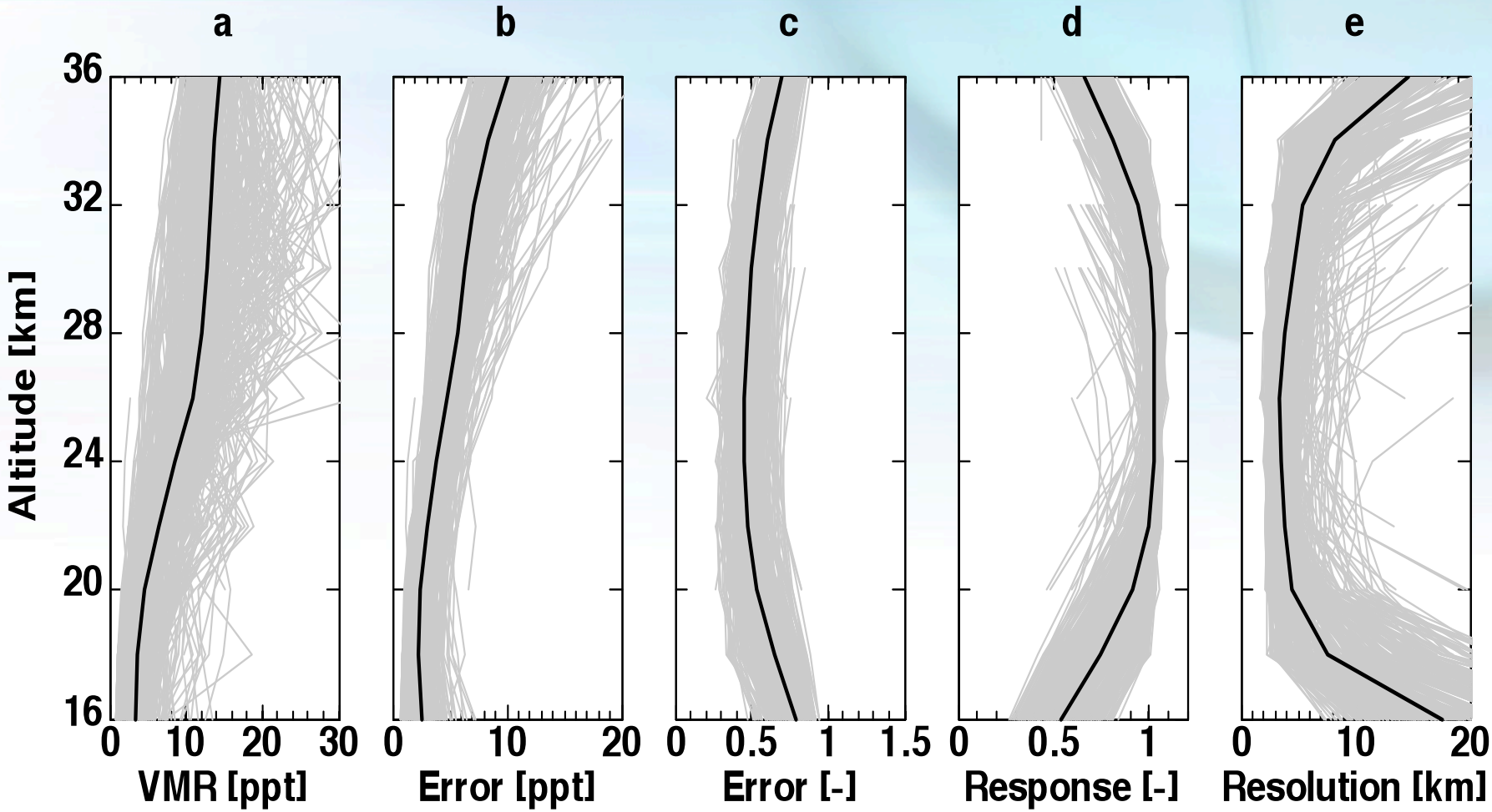
Accuracy: ~30%

Vertical resolution: 3-5 km between 20-32 km

Degrees of Freedom for Signal: ~5

Validation ongoing: general agreement within 30%

OSIRIS BrO data product (3)



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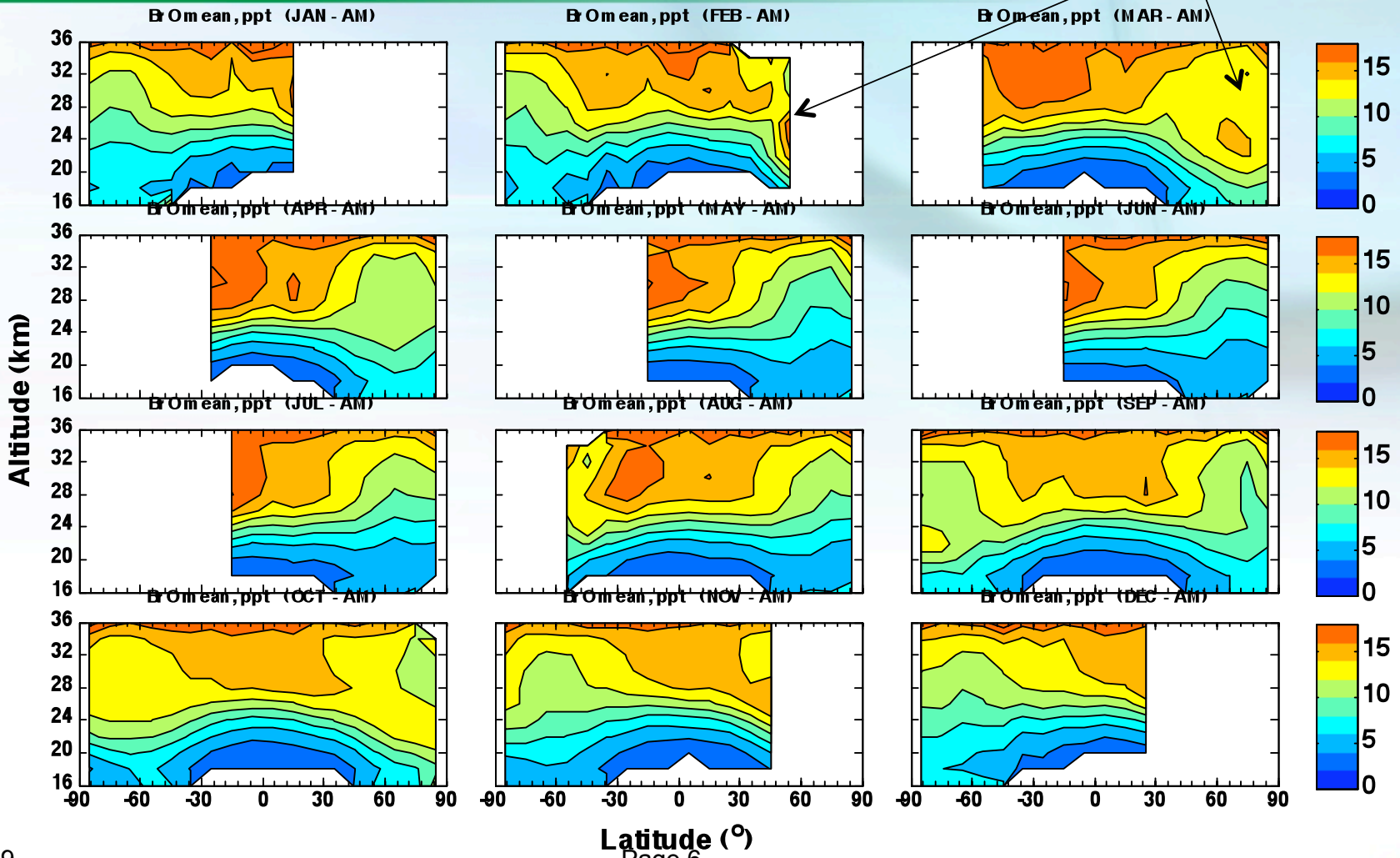
•every 100th profile plotted in grey
• black are median values

Canada

Climatology (1)

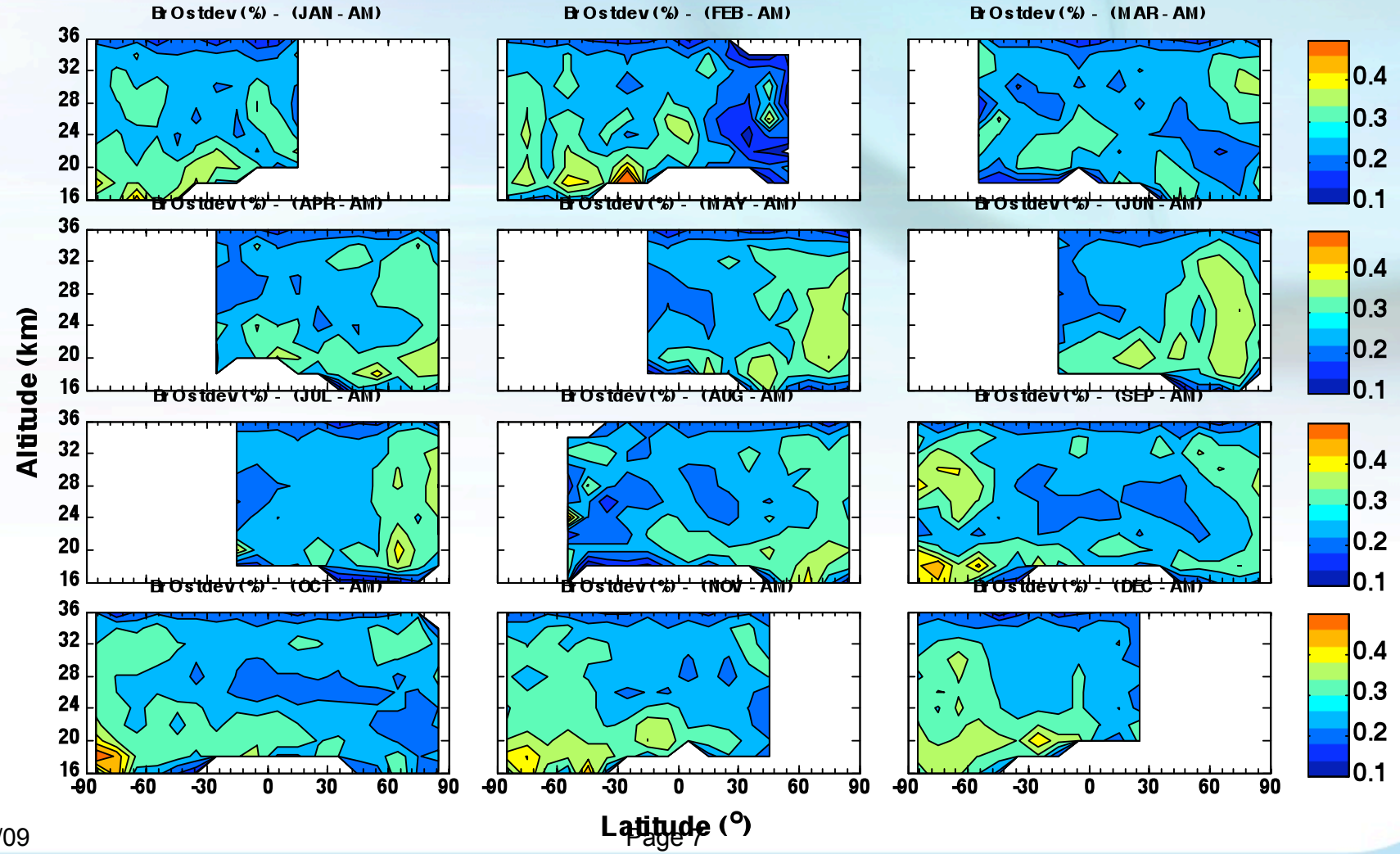
maximum corresponds to a minimum in NO_2

maximum in winter/spring



Climatology (2)

- generally in 0.25-0.35 range, can be taken as a measure of the precision of a single profile
- larger values in SON at south pole, <20 km, due to variability of detnitification



standard deviation, expressed as fraction of the mean

Inferred Br_y (1)

$$Br_y = BrO_{OS} / [BrO/Br_y]_{model}$$

where BrO_{OS} is OSIRIS monthly-mean

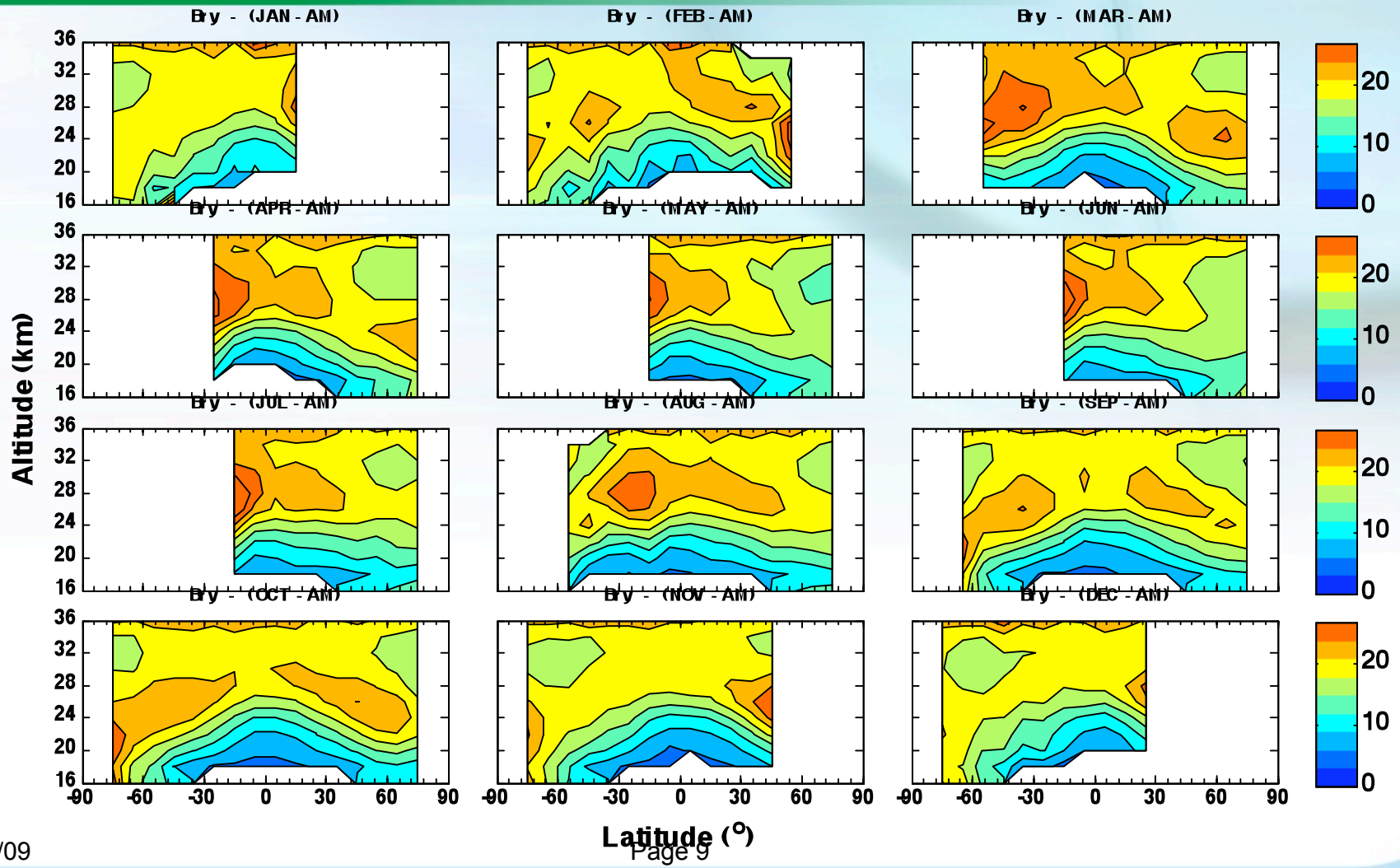
The University of California, Irvine photochemical box model is used to calculate the BrO/Br_y ratio, and is constrained with monthly-mean:

OSIRIS O_3, ECMWF T, Odin NO_y, SMR N_2O (for tracer correlations)

Obtain monthly Br_y maps

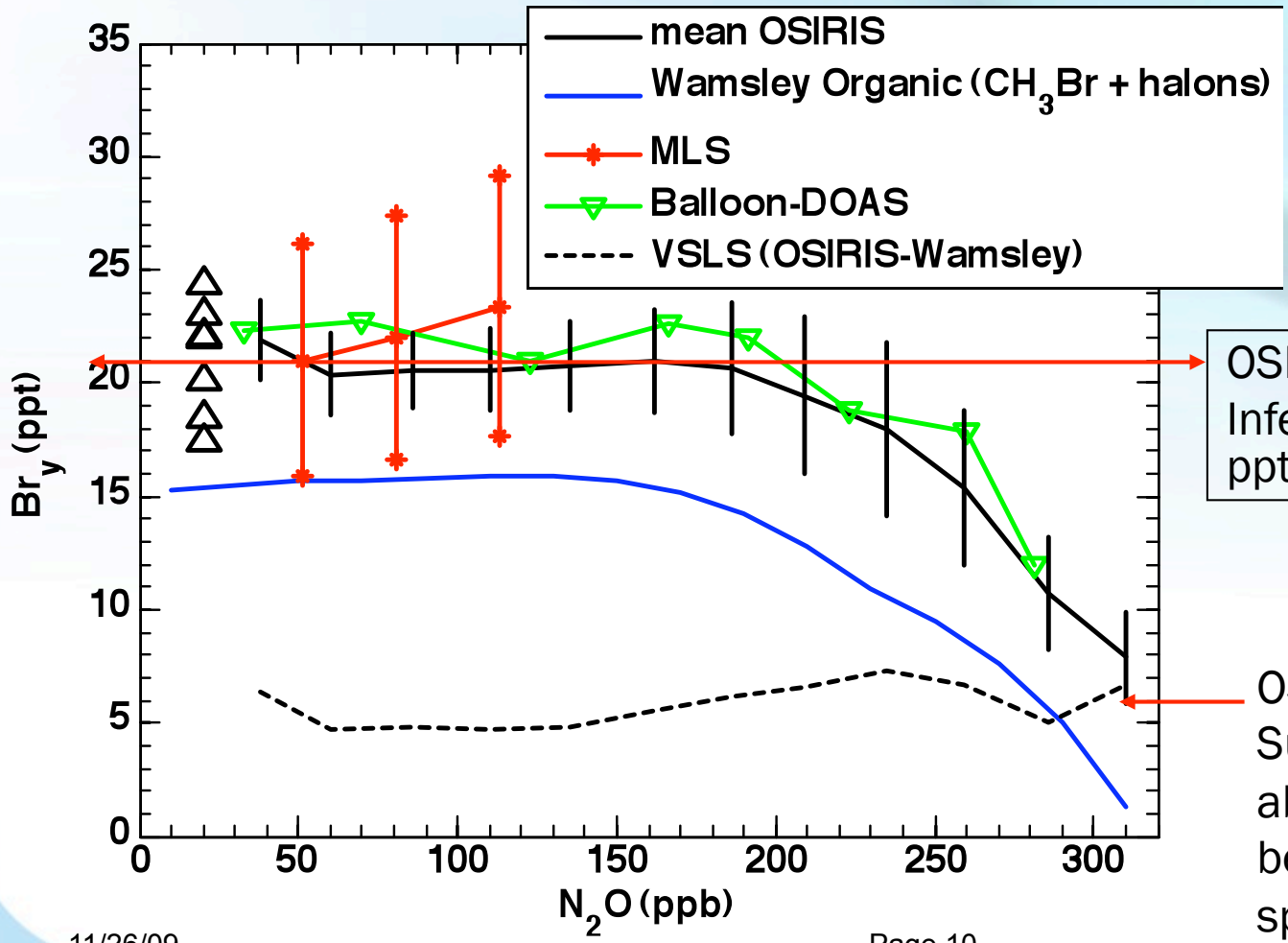
Inferred Bry (2)

first global maps of Br_y (in pptv)



Inferred Br_y (3)

- OSIRIS data from previous plot averaged over N_2O-bins and compared with other measurements of Br_y
- the blue line is from bromine source gases (methyl bromine + halons)
- their difference is a measure of the missing source



OSIRIS Total Bry 21±5 pptv
Inferred "extra" source of 5 pptv

OSIRIS minus Wamsley: Suggests 5-6 pptv of Bry above tropopause, this must be from short-lived bromine species

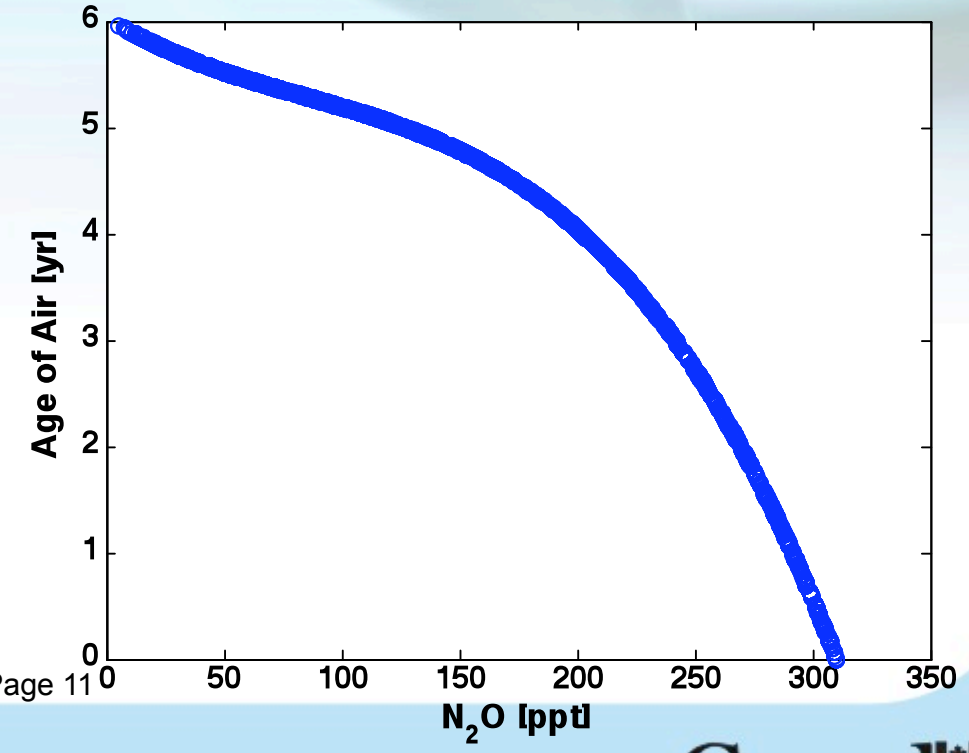
Br_y Time Series (1)

Each OSIRIS monthly-mean can be assigned an age-of-air based on its abundance of N_2O (from SMR monthly-means)

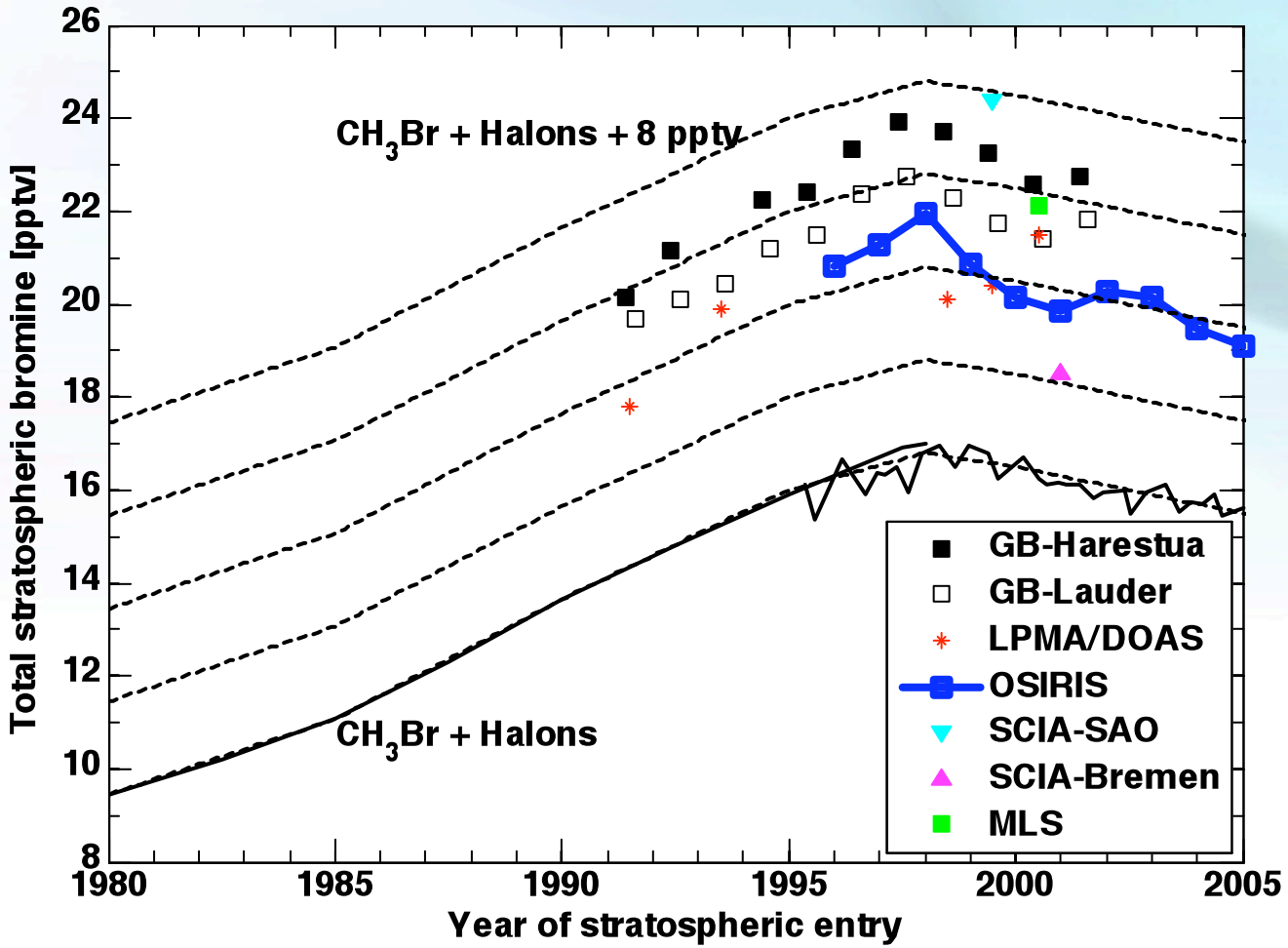
From this based on time of OSIRIS measurement and the age of air, the year of stratospheric entry can be calculated:

Year of stratospheric entry =
time of measurement – age of air

OSIRIS 1-year averages calculated



Br_y Time Series (2)



In this representation OSIRIS most consistent with +4-4.5 pptv of Bry

Summary

- 8+ years of OSIRIS BrO processed and available
- OSIRIS measures about 21 pptv of Br_y, with ~5 pptv estimated to be from short-lived bromine-bearing species
- OSIRIS sees a late-1990s maximum in stratospheric input, followed by a slow decline
- Trend studies currently underway

Please contact Chris.McLinden@ec.gc.ca for additional information

http://osirus.usask.ca/ for data access

Thank you!