climate change initiative

→ WATER VAPOUR

# Interannual and Decadal Changes in the Vertical Distribution of Stratospheric Water Vapour by ESA CCI, SWOOSH and GOZCARDS

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water vapour cci

BIRA•IASB

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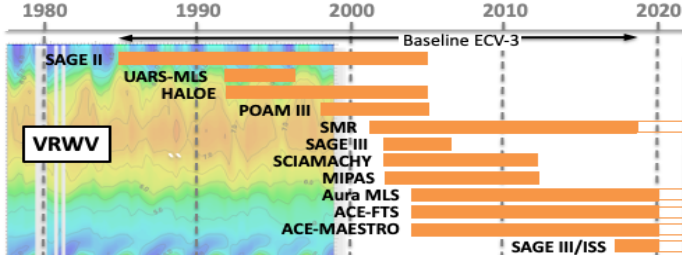
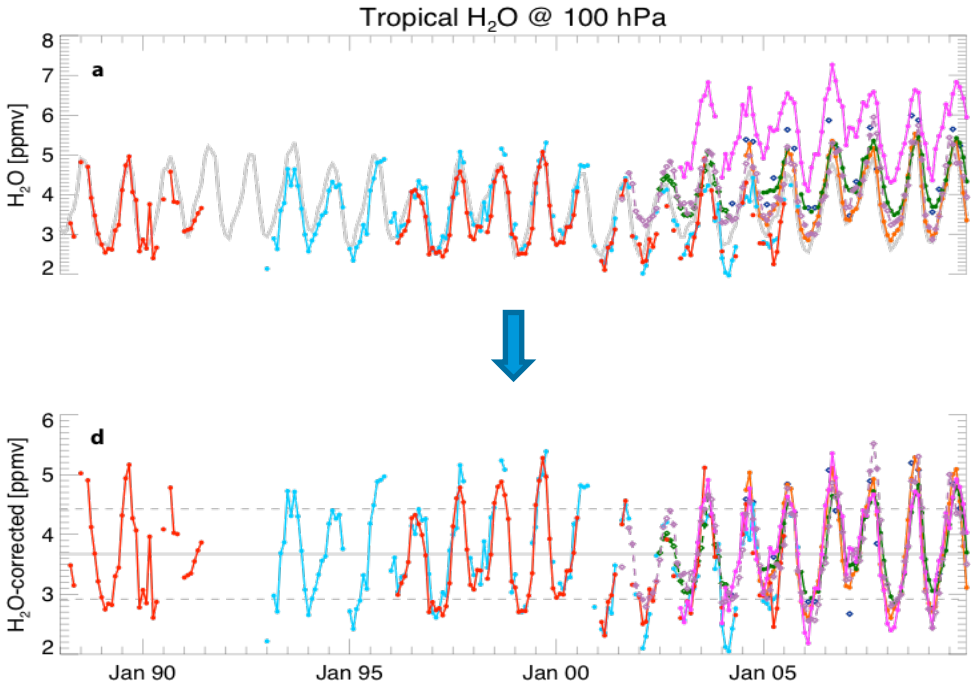
# ESA CCI VRWV-strato data product

- Input sensors (limb)




- Use CMAM chemistry-climate model as a transfer function between the different SPARC Data Initiative data to correct relative biases (Hegglin *et al.*, 2014)
- WV_cci improvements: outlier removal & optimal estimation method
- Specifications
  - 1985 - 2019, monthly
  - 90S - 90N, 5° latitude bins
  - 300 - 0.1 hPa, 28 levels
  - mean H2O VMR and uncertainty




Cfr. previous talk by M. I. Hegglin

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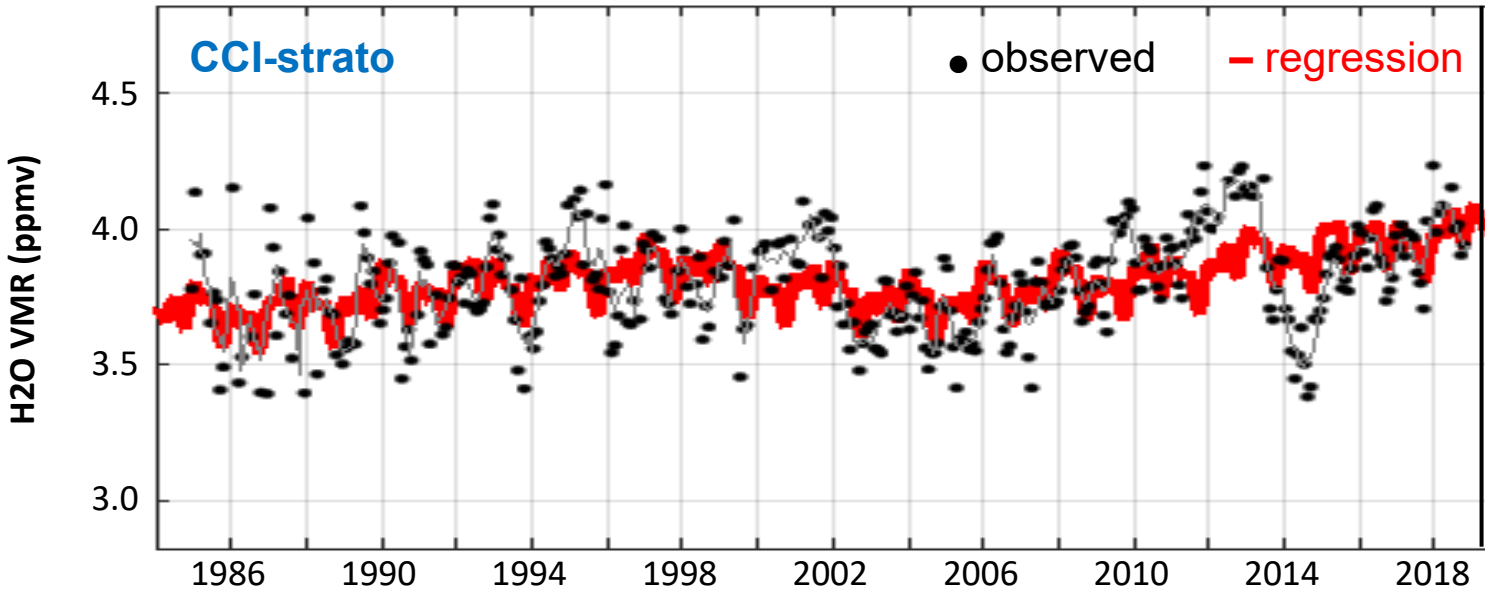
# Example : 0N-5N at 10 hPa

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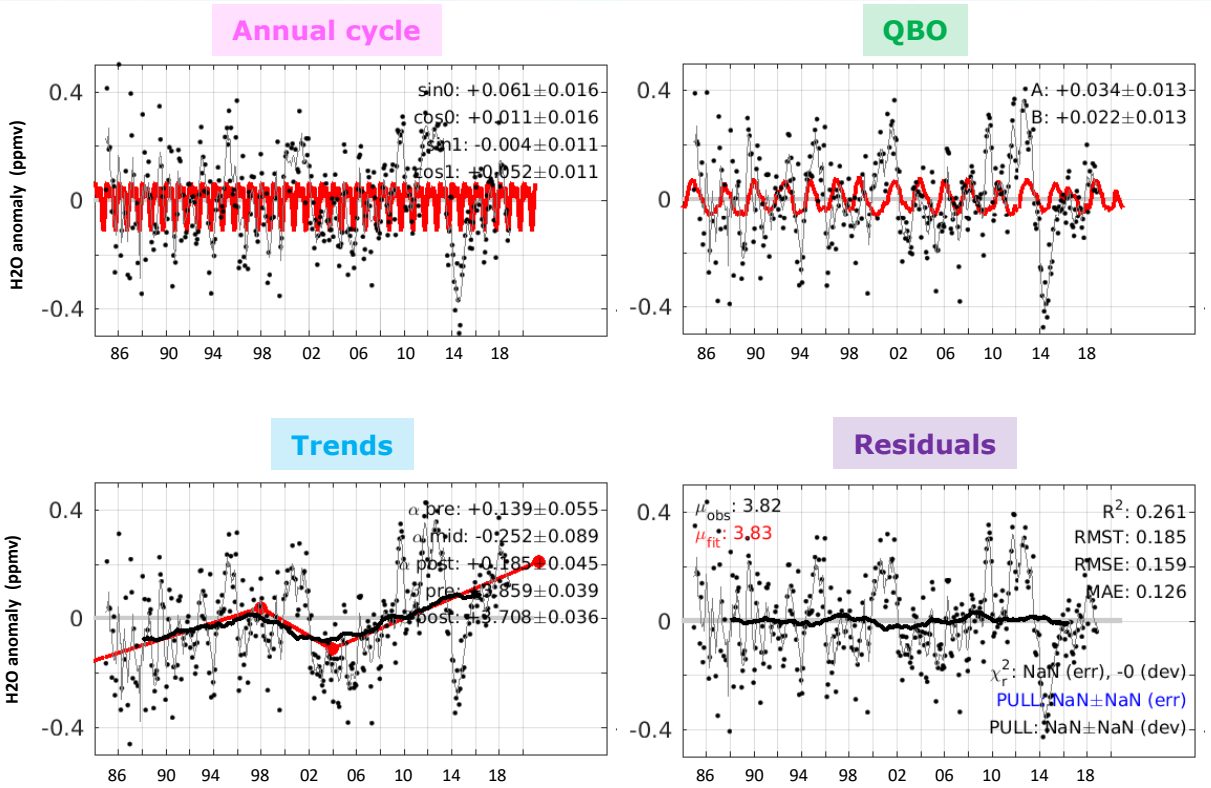
# Multiple Linear Regression




$$H2O_t = \mu + A_t$$

https://arg.usask.ca/docs/lotus_regression

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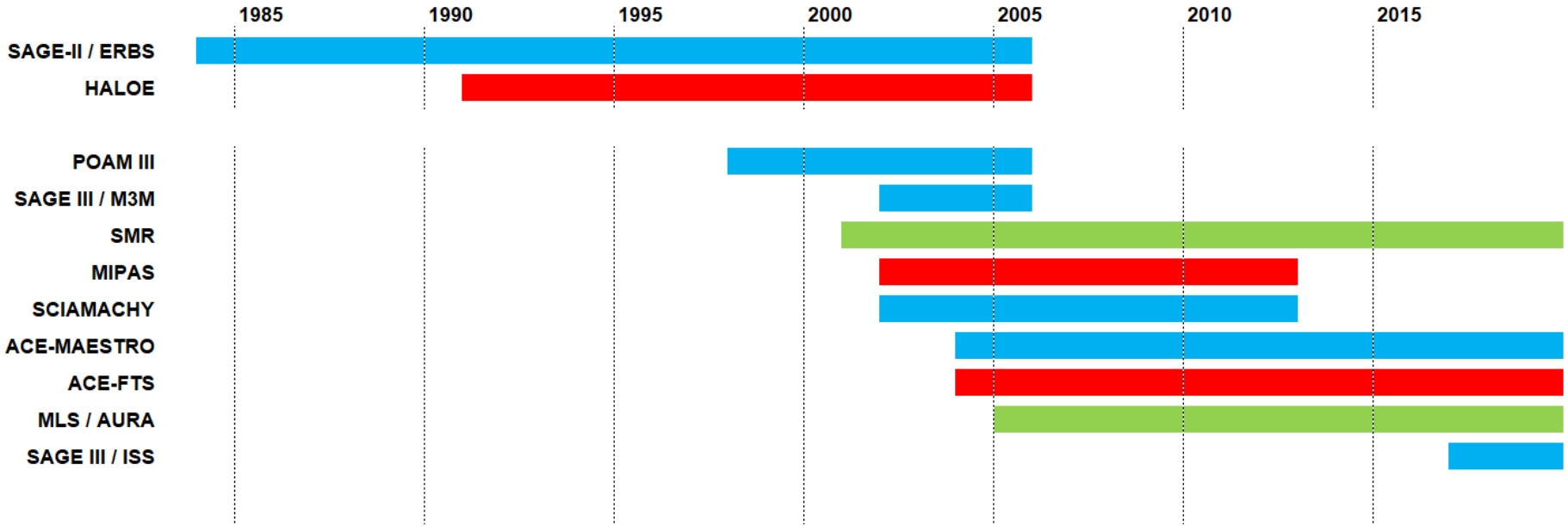
# Contributing limb/occultation sensors

**CCI-strato**

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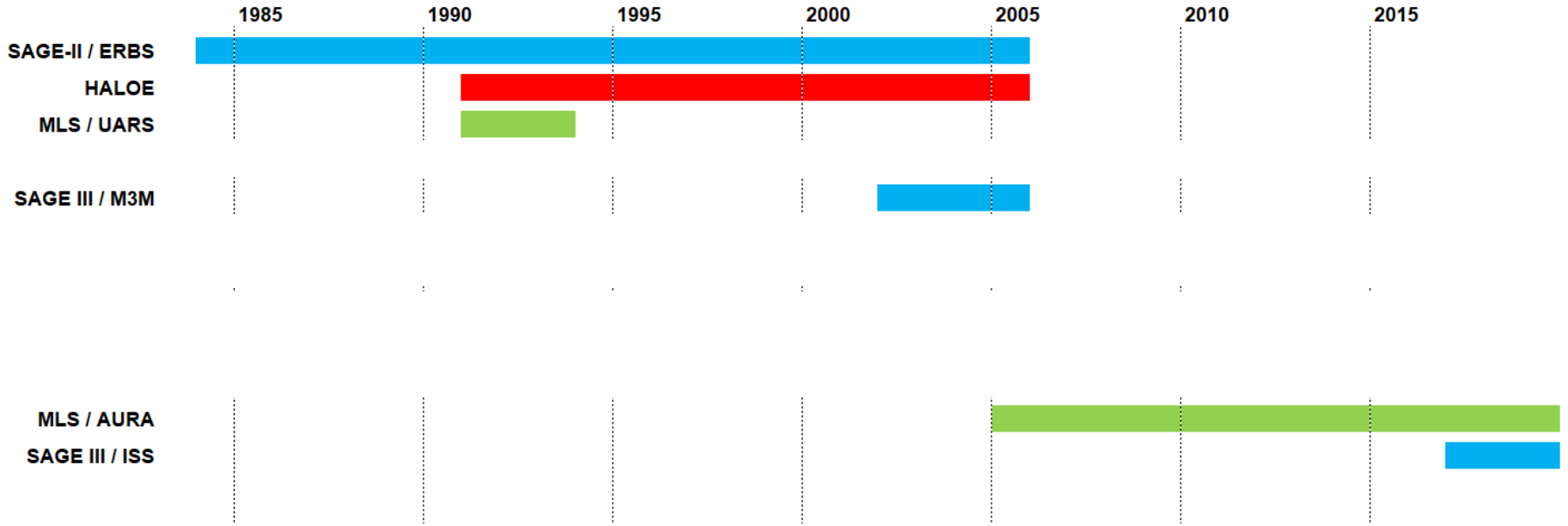
# Contributing limb/occultation sensors

**SWOOSH**

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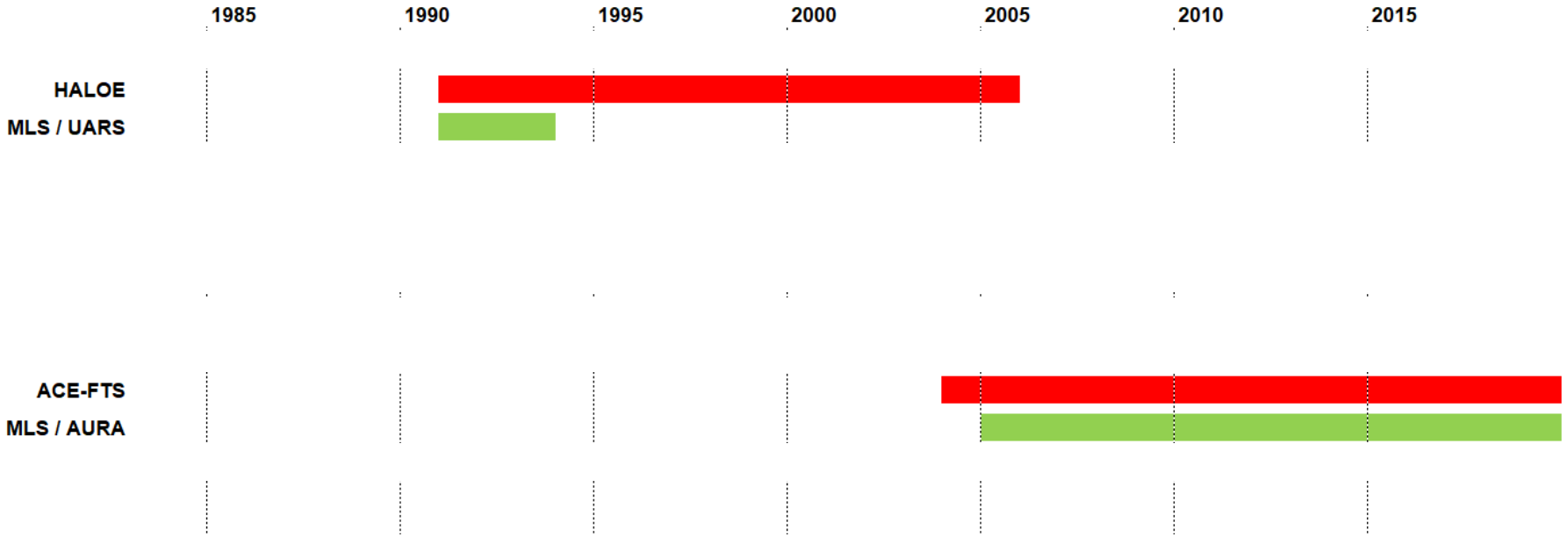
# Contributing limb/occultation sensors

**GOZCARDS**

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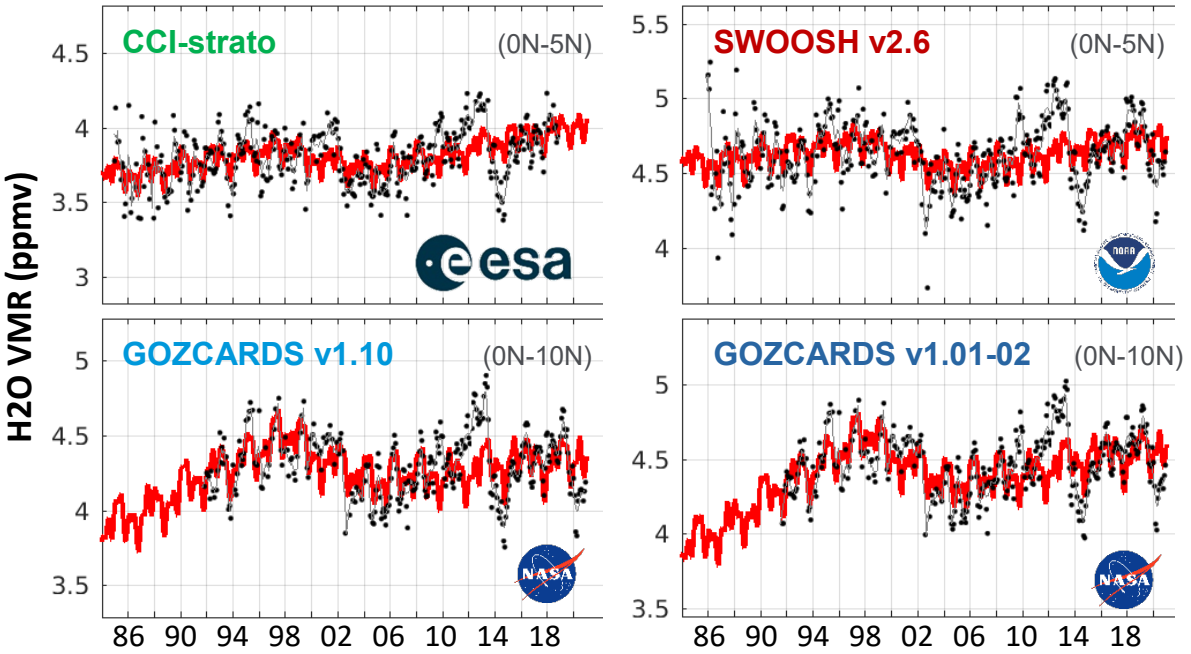
# Assessment of four H2O CDRs




## Differences between Climate Data Records

- Sampling resolution
- Coverage
- Sensors
- Data version
- Auxiliary data
- Offset correction method
- Reference
- Merging method
- Uncertainty budget

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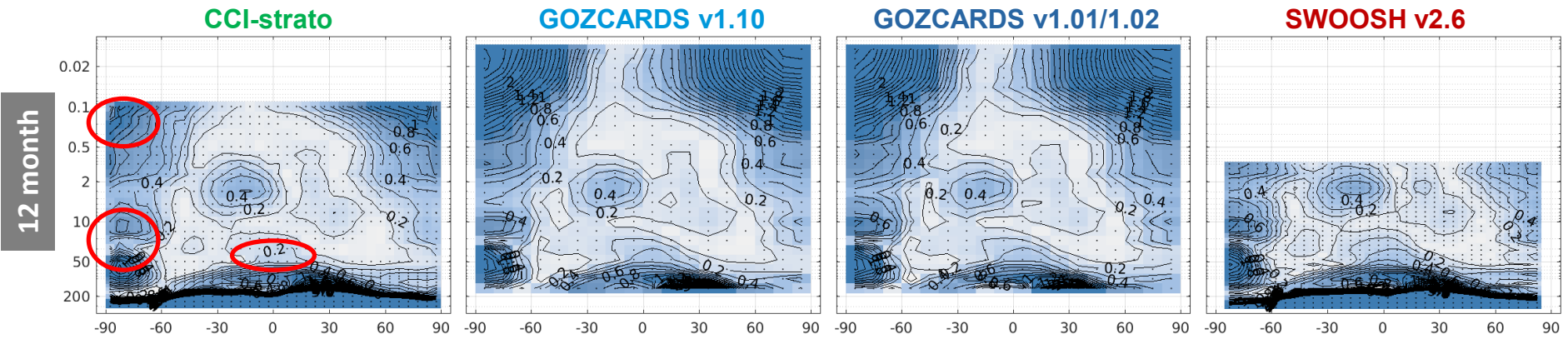
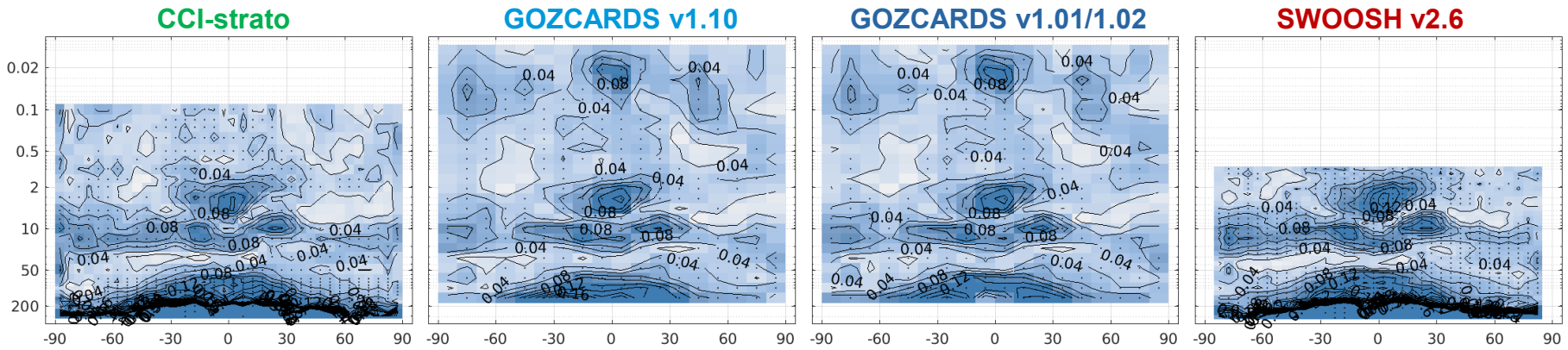
# Amplitude annual cycle (*ppmv*)




- Good agreement in magnitude & spatial structure.
- (Small) low bias of CCI-strato in tropical LS & polar LS/LM (0.1-0.2 ppmv, ~2%)

# Amplitude QBO (*ppmv*)




Excellent agreement in magnitude and structure

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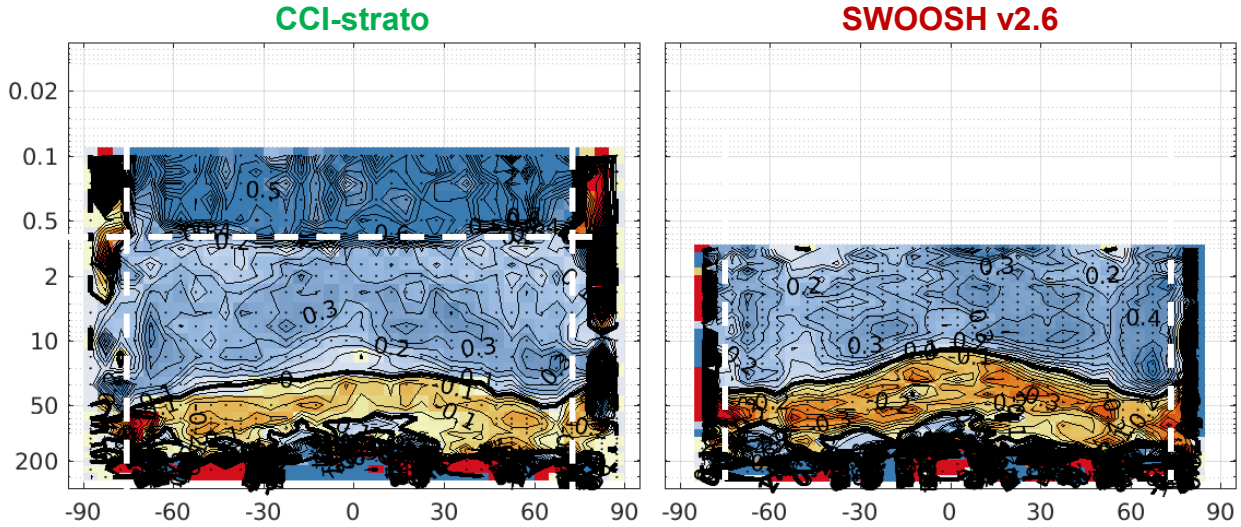
# Trend prior to Jan 1998 (*ppmv/dec*)




- Positive trends in MS & US (+0.35 ppmv/dec, +8%/dec), negative trends in LS (-0.2 ppmv/dec, -6%/dec)
- CCI & SWOOSH agree within < 0.1 ppmv/dec
- Discontinuity for CCI-strato @ 0.7 hPa, due to change in input sensors
- Limited confidence in high-latitude results, due to limited sampling

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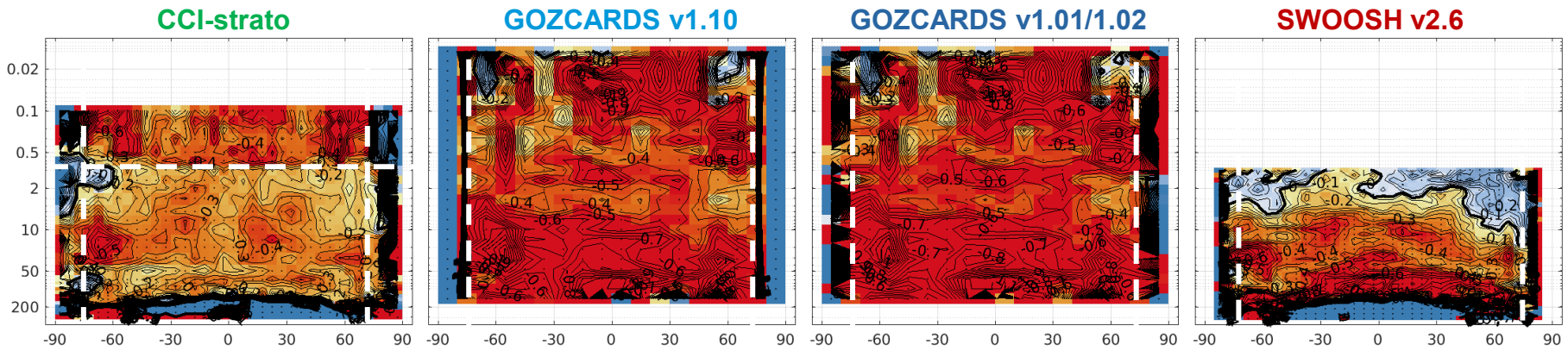
# Trend 1998-2003 (*ppmv/dec*)




- Overall agreement in sign of trend : negative
- Significant disagreement in trend magnitude, up to ±0.4 ppmv/dec
- Discontinuity for CCI-strato @ 0.7 hPa, due to change in input sensors
- Limited confidence in high-latitude results, due to limited sampling

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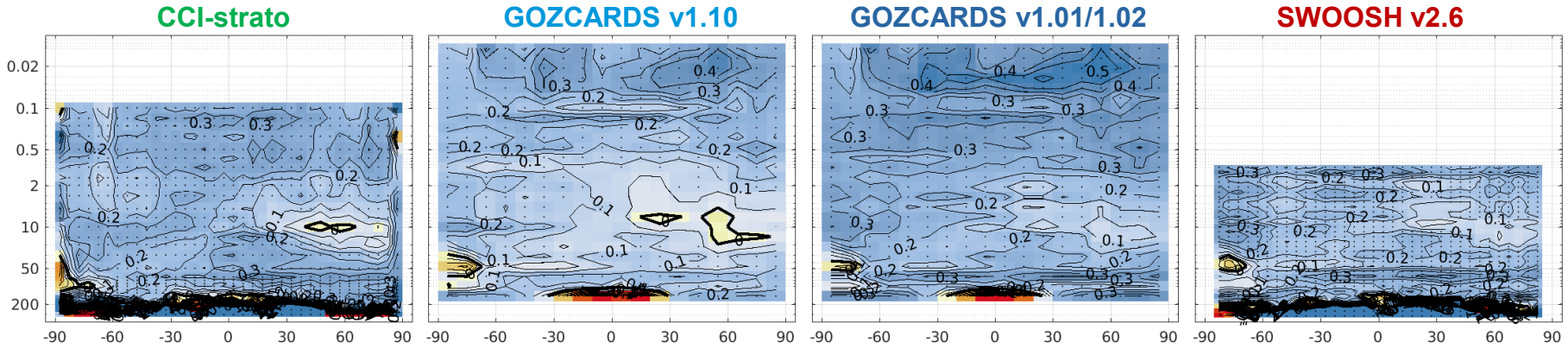
# Trend since Jan 2004 (*ppmv/dec*)




- Positive trends (+0.1-0.3 ppmv/dec, +2-6 %/dec) across almost entire stratosphere
- CCI, SWOOSH & GOZCARDS v1.01/1.02 agree within < 0.1 ppmv/dec
- Difference (0.1 ppmv/dec) between GOZCARDS versions due to change in Aura MLS (Livesey et al., 2021)
- Reasonable confidence in high-latitude results

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# Conclusions

**Assessment of geophysical cycles and long-term changes**

- Structure & magnitude of annual cycle & QBO agree well for all CDRs
- Structure and sign of trends generally agree well
  - Largest disagreement in 1998-2003 period
  - Trends since 2004 depend on Aura MLS version & data sets included

**CCI-strato includes more sensors** → more independent from other CDRs

# Backup

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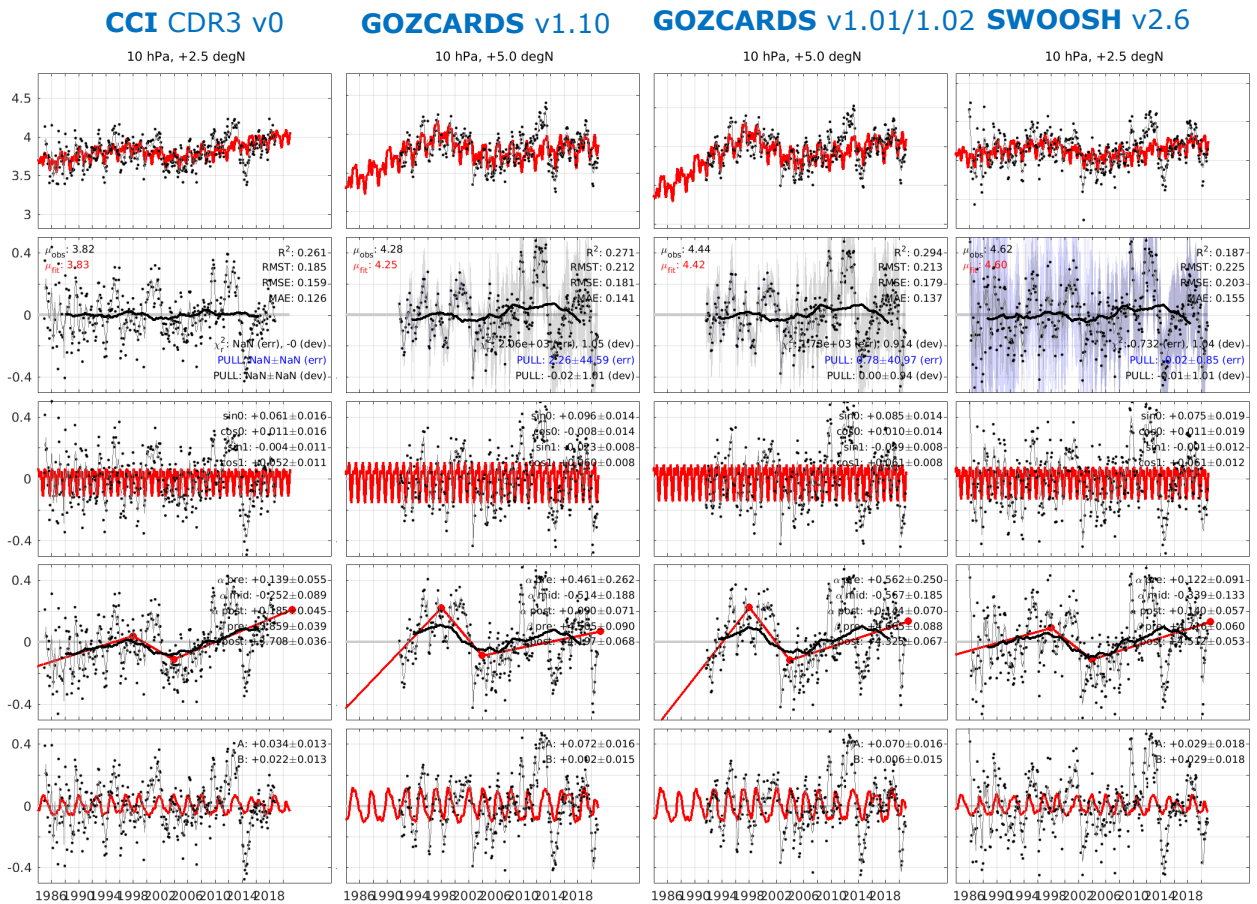
# Example time series (~5N, ~10 hPa)