# The Martian ozone layer as seen by Mars Express and by MAVEN

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# Ozone on Mars

- **$O_3$ is a by-product of $CO_2$ photolysis and is destroyed by (H, OH, $HO_2$) radicals**

  → $O_3$ and $H_2O$ should be anticorrelated
  → $O_3$ key species for a quantitative understanding of the oxidizing capacity of Mars atmosphere

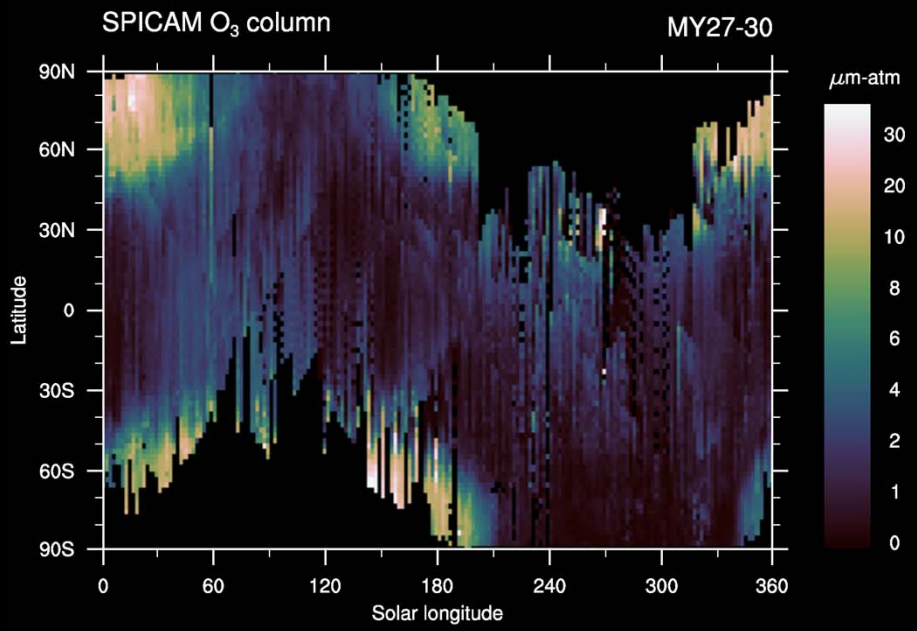
- **MEx/SPICAM observations: $O_3$**

  – SPICAM UV channel operational for four Martian years (2004-2011)
  – Various ozone observation modes:
    - stellar/solar occultations: $O_3$ vertical profile (*A. Piccialli, this morning; A. Määttänen, next talk*)
    - nadir viewing: $O_3$ integrated column

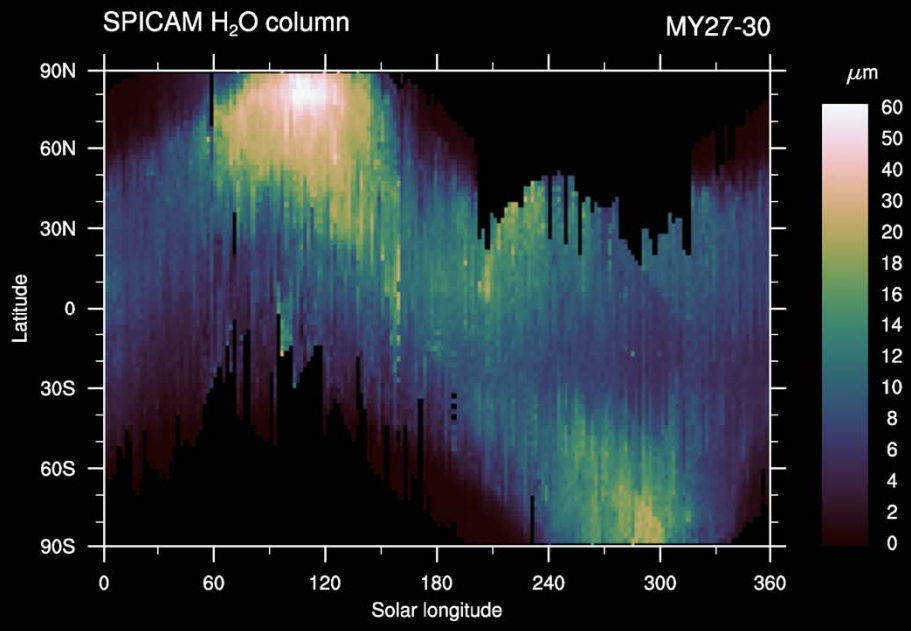
- **MEx/SPICAM observations: $H_2O$**

  – SPICAM IR channel (*Franck Montmessin, this morning; Anna Fedorova, tomorrow morning*)
  – Simultaneous $H_2O$ – $O_3$ measurement → unique to SPICAM (…and soon to TGO!)
  – Strong constraint for photochemical models

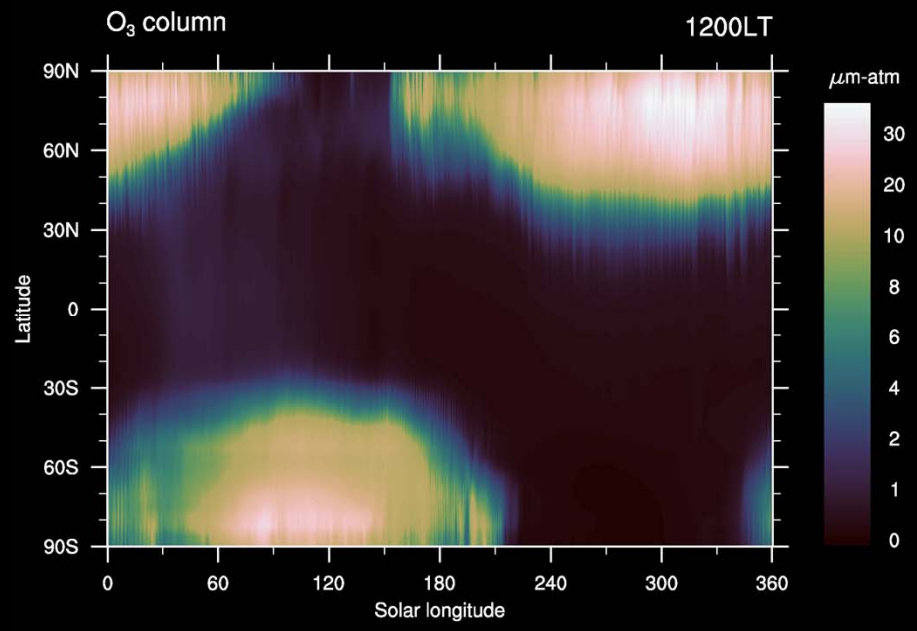
## SPICAM $O_3$ column



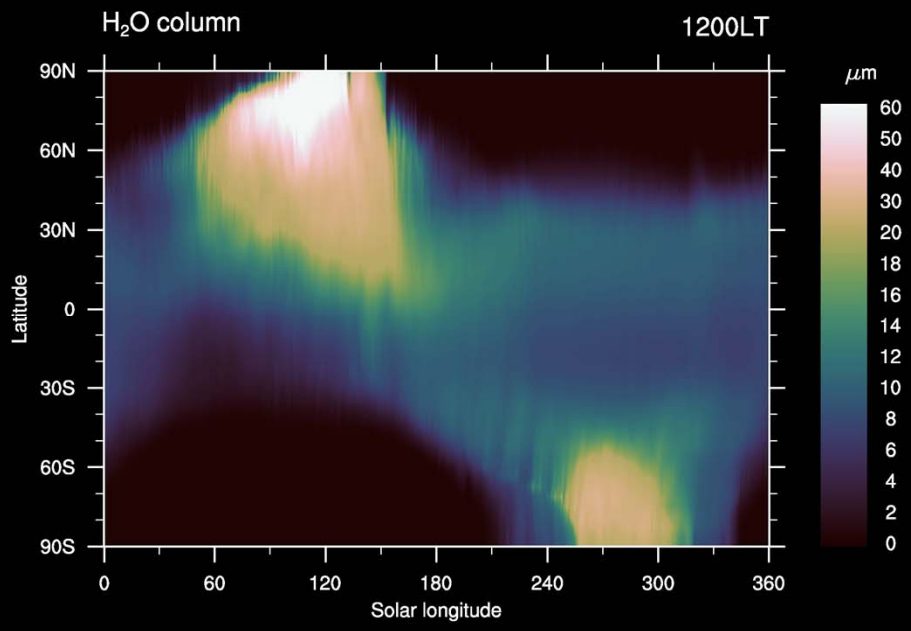

## SPICAM $H_2O$ column



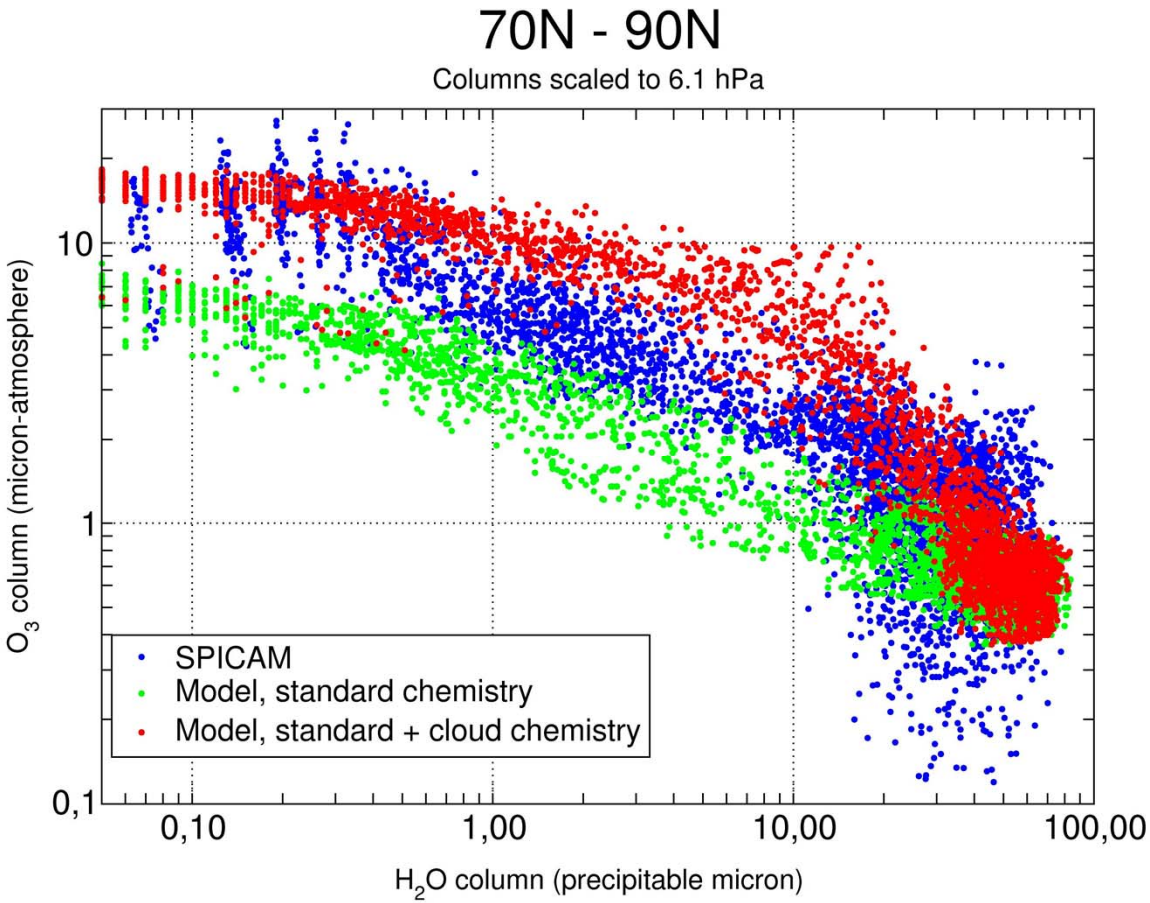

## LMD GCM $O_3$ column



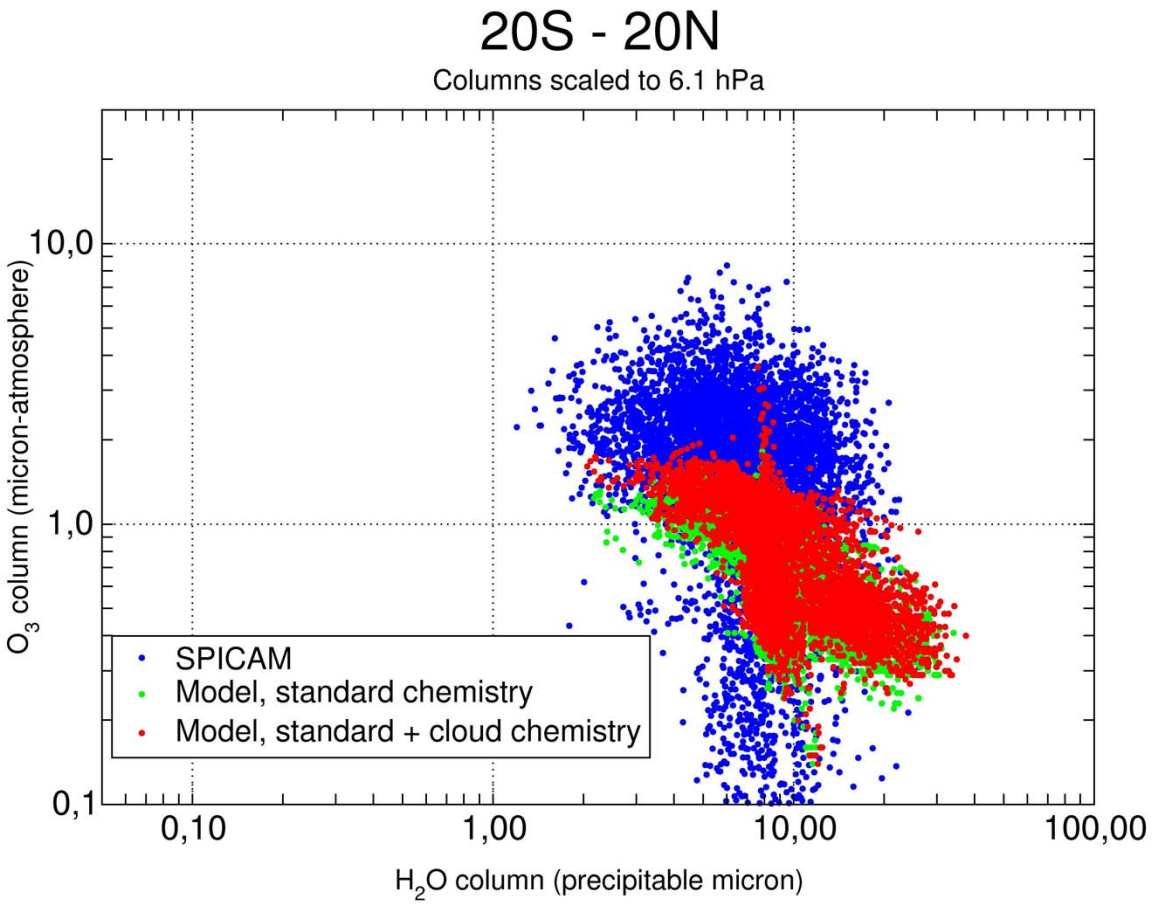

## LMD GCM $H_2O$ column



# Ozone/Water vapour simultaneous observations



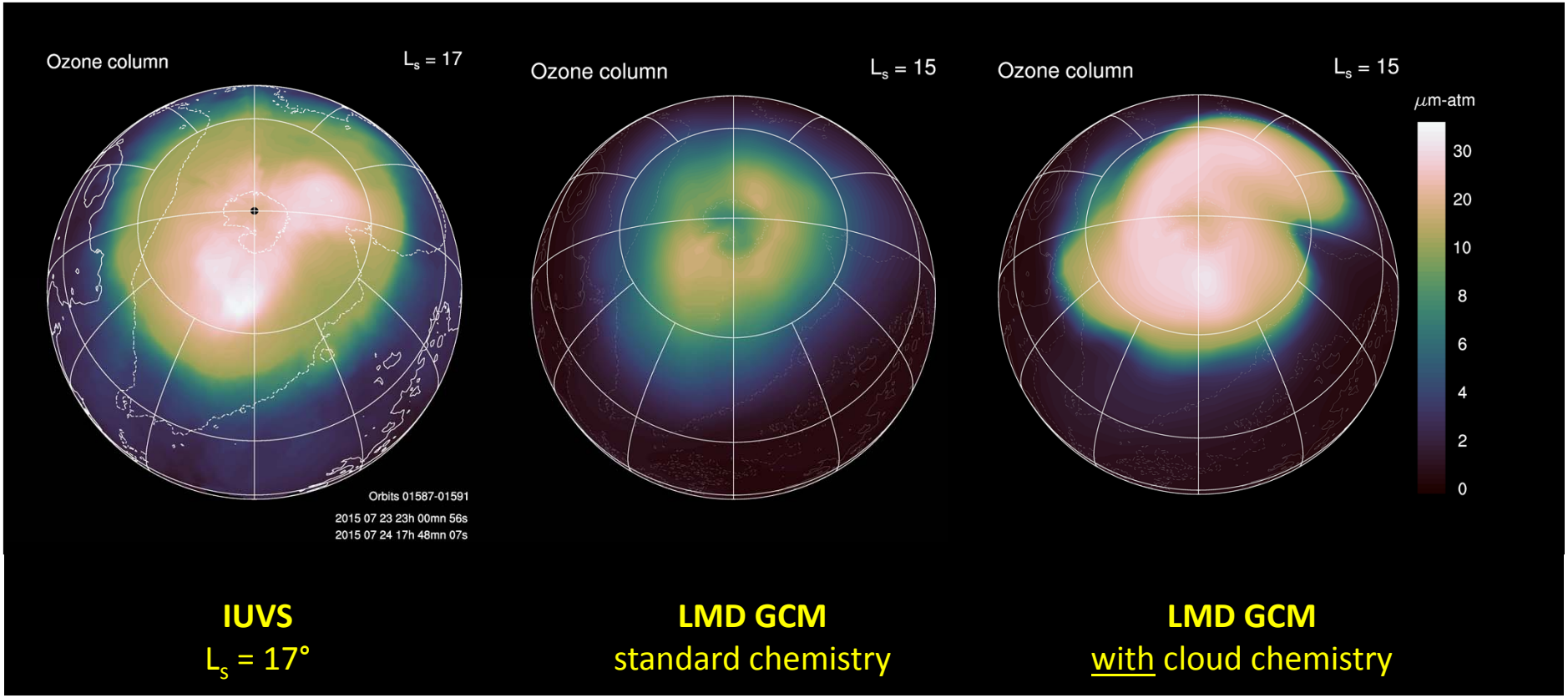
# Ozone/Water vapour simultaneous observations



# MAVEN/IUVS ozone observations

- IUVS: FUV/MUV spectrometer 110-340 nm
- $O_3$ retrieval algorithm identical to SPICAM
- Daily ozone mapping since October 2014

(*Mike Chaffin, this morning)*




**IUVS**
$L_s$ = 17°

**LMD GCM**
standard chemistry

**LMD GCM**
with cloud chemistry

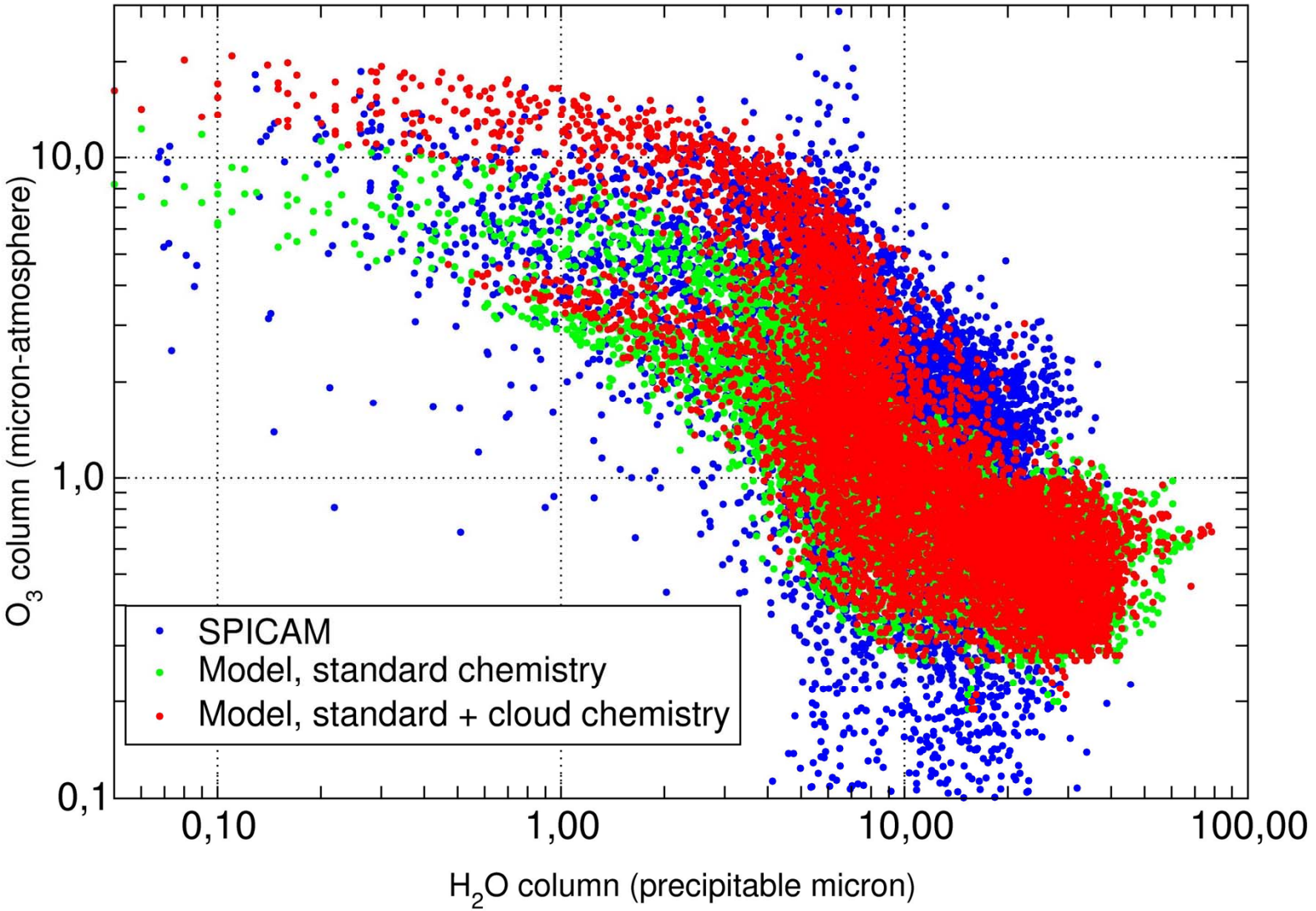
# Summary

- At mid-to-high latitudes, there is an exponential anticorrelation between the $O_3$ and $H_2O$ columns.
- At low latitudes, the $O_3$ and $H_2O$ columns are little anticorrelated . $O_3$ variations occur higher in the atmosphere *(next talk by Anni Määttänen)*
- For a given $H_2O$ amount, the $O_3$ amount is underestimated by the LMD GCM with conventional chemistry.
- This suggests that Mars atmosphere is <u>less oxidizing</u> than predicted by current chemical models
  - Consistent with low CO bias (factor 2 to 4) in all models
- Solutions ?
  - Problems with gas-phase $HO_x$ kinetics ? … but Earth models show <u>a lack</u> of $HO_x$ (Li et al., 2017)
  - Heterogeneous sink of $HO_x$ improves the model/data agreement ($HO_x$ uptake on clouds is one possibility)

# One intriguing question whose answer I would like to know

What drives the apparent fast variations of martian $CH_4$?

# backup


30N - 60N
Columns scaled to 6.1 hPa
10,0
1,0
0,1
$O_3$ column (micron-atmosphere)
0,10
1,00
10,00
100,00
$H_2O$ column (precipitable micron)
SPICAM
Model, standard chemistry
Model, standard + cloud chemistry