The Atmospheric Distribution of Molecular Hydrogen (H_2) During HIPPO

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The RAF team

Molecular Hydrogen (H_2)

- Tropospheric mixing ratio ~500 ppb
  - Produced from methane and VOCs; many sources in common with CO
  - Little or no trend in troposphere over 20 years
  - Lifetime ~2 years

Background literature:

Novelli et al., JGR, 1999

Price et al., JGR, 2007

Ehhalt and Rohrer, Tellus, 2009

Atmospheric H_2

- Sources:
  - CH_4 oxidation 23±8 Tg H_2/yr
  - Other VOCs 18±7 Tg H_2/yr
  - Fossil fuel use 11±4 Tg H_2/yr
  - Biomass burning 15±6 Tg H_2/yr
  - N_2 fixation 6±3 Tg H_2/yr (ocean)
  - N_2 fixation 3±2 Tg H_2/yr (land)
- Sinks:
  - OH oxidation 19±5 Tg H_2/yr
  - Soil uptake 60 (+30, -20) Tg H_2/yr

- Latitude distribution
  - Peak in tropics, minimum at NH high latitudes
  - More in SH than in NH
- Seasonal cycle
  - NH max (~540 ppb) in April/May
  - NH min (~440 ppb) in September
  - SH max (~550 ppb) in January
  - SH min (~520 ppb) in August/September

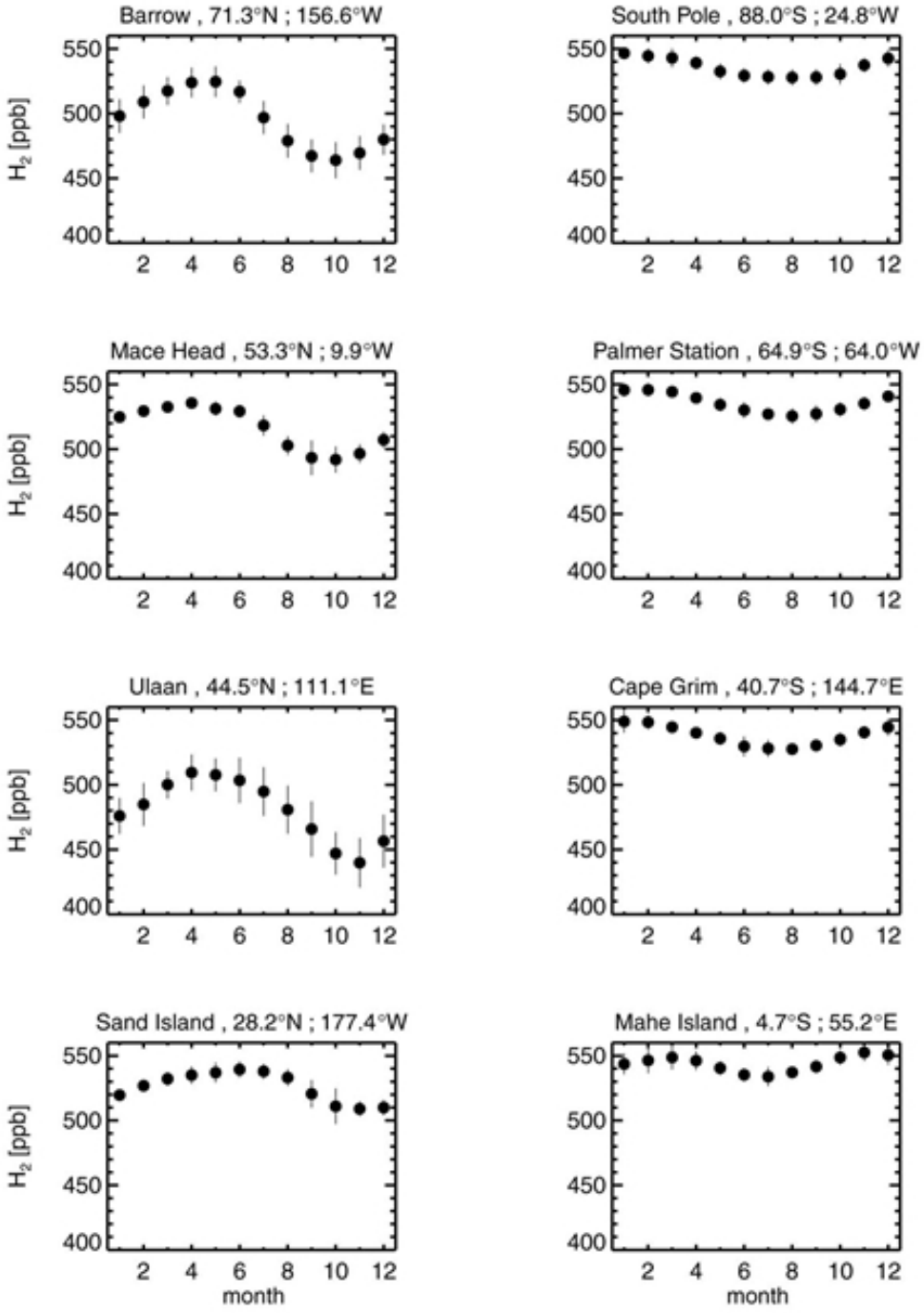


Fig. 2. Average seasonal variation of the H_2 mixing ratio at eight CMDL network sites between 1994 and 2003. Error bars represent the standard deviations (Adapted from fig. 7, Price et al., 2007; the data are from GMD, NOAA/ESRL).

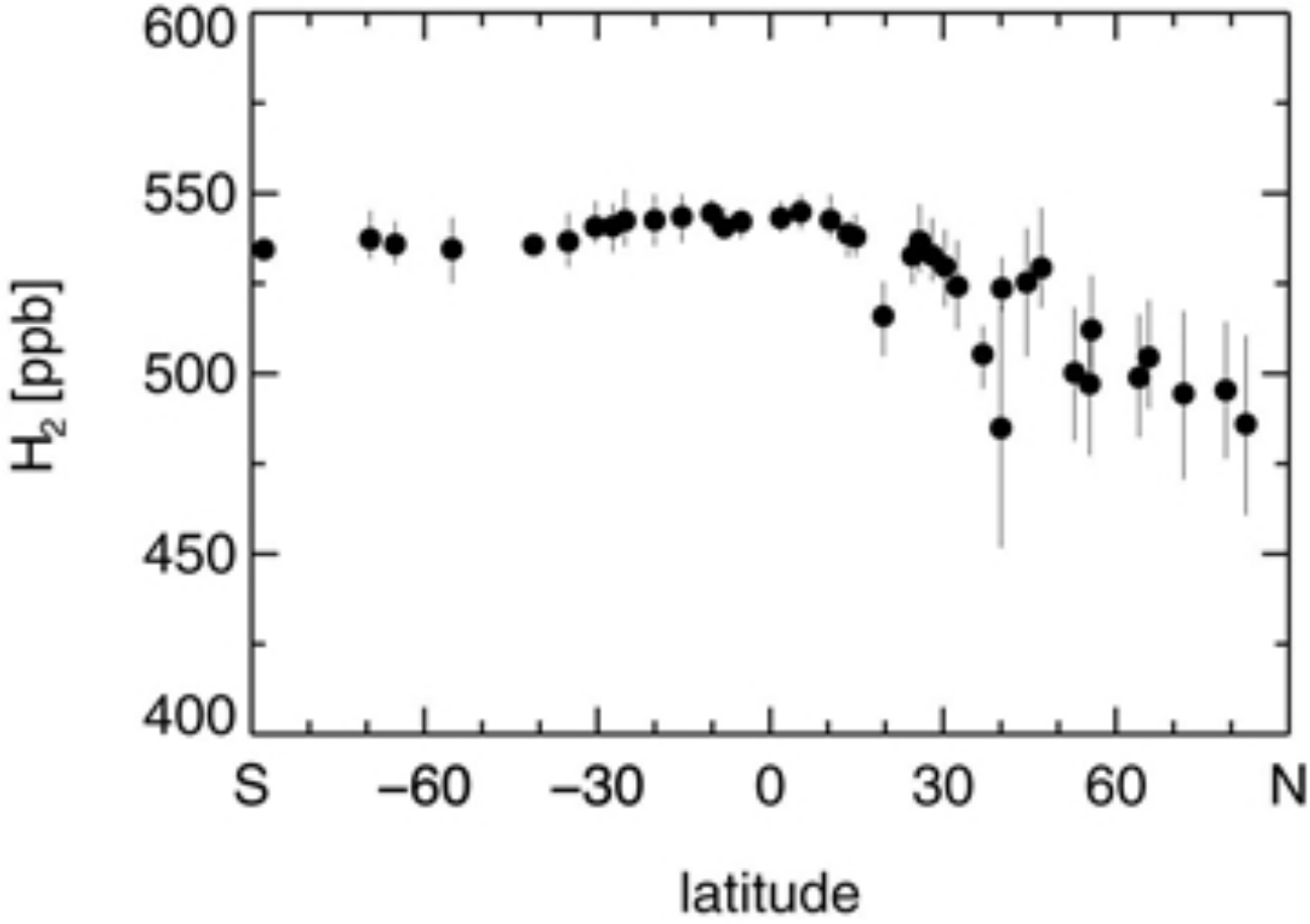


Fig. 3. Average latitudinal distribution of the H_2 mixing ratio between 1994 and 2003 derived from the CMDL surface network sites. Error bars represent the standard deviations (Adapted from fig. 6, Price et al., 2007; the data are from GMD, NOAA/ESRL).

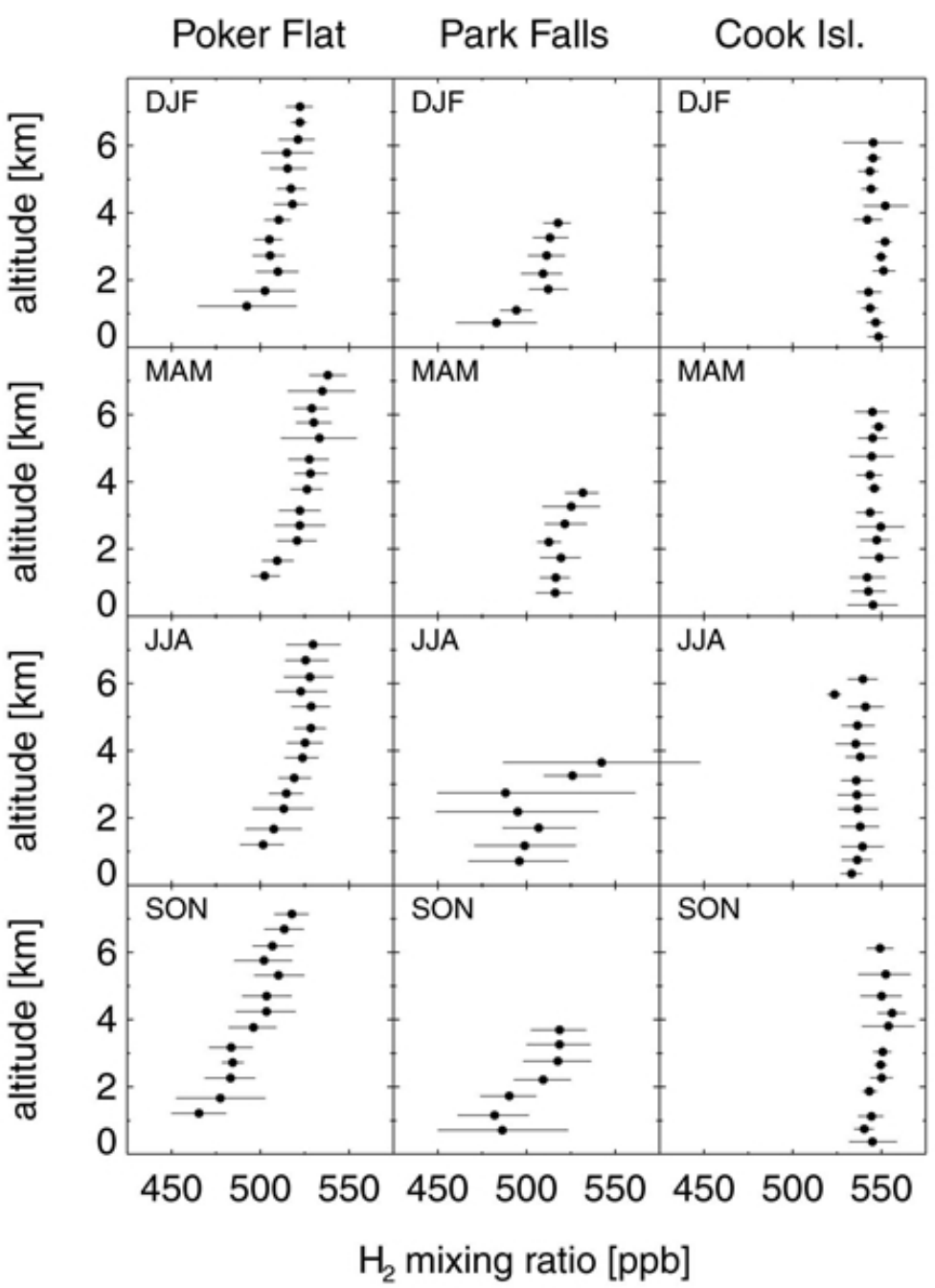
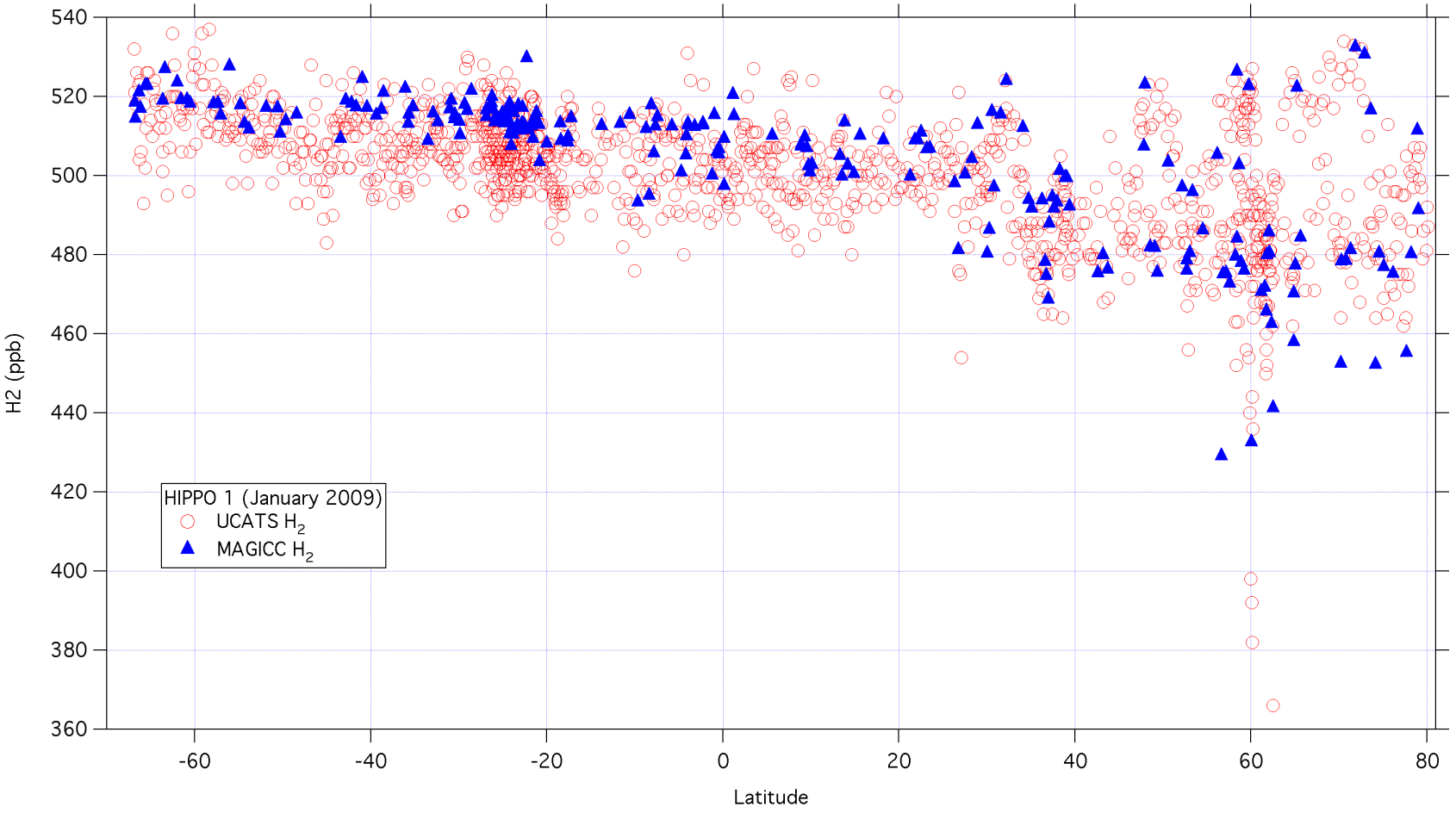


Fig. 4. Seasonally averaged vertical profiles of the H_2 mixing ratio over Poker Flat, 65.1°N, 147.3°W (2002–2004); Park Falls, 45.9°N, 90.3°W, (2002–2004) and Cook Island, 21.4°N, 160.4°E (2003–2004). Error bars represent the standard deviation (Adapted from fig. 8, Price et al., 2007; the data are from GMD, NOAA/ESRL).

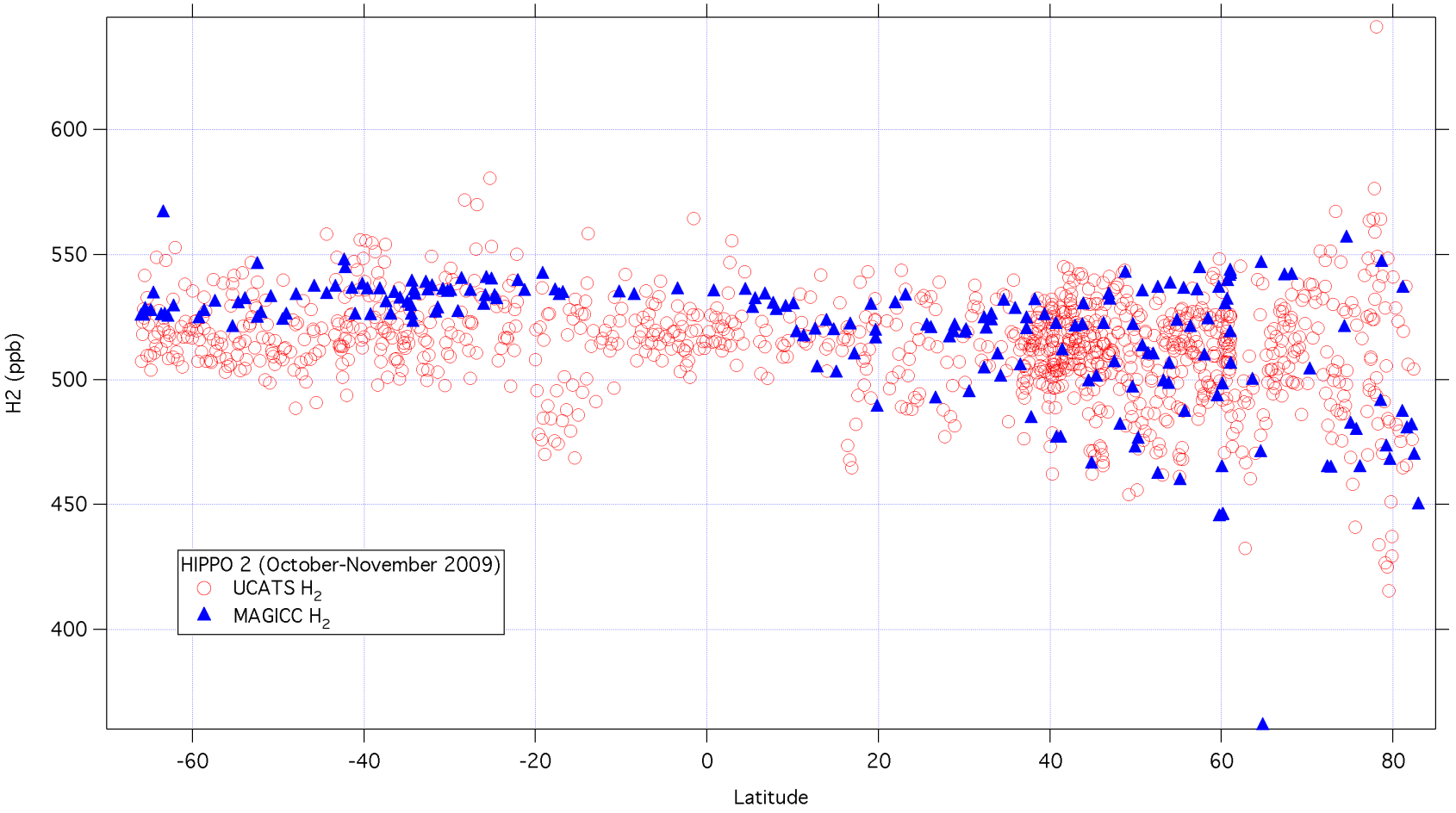
H_2 data in HIPPO

- UCATS GC
- PANTHER GC (ECD)
- NWAS flasks
- Accuracy ≅ 5 ppb (largely from uncertainty in standards)

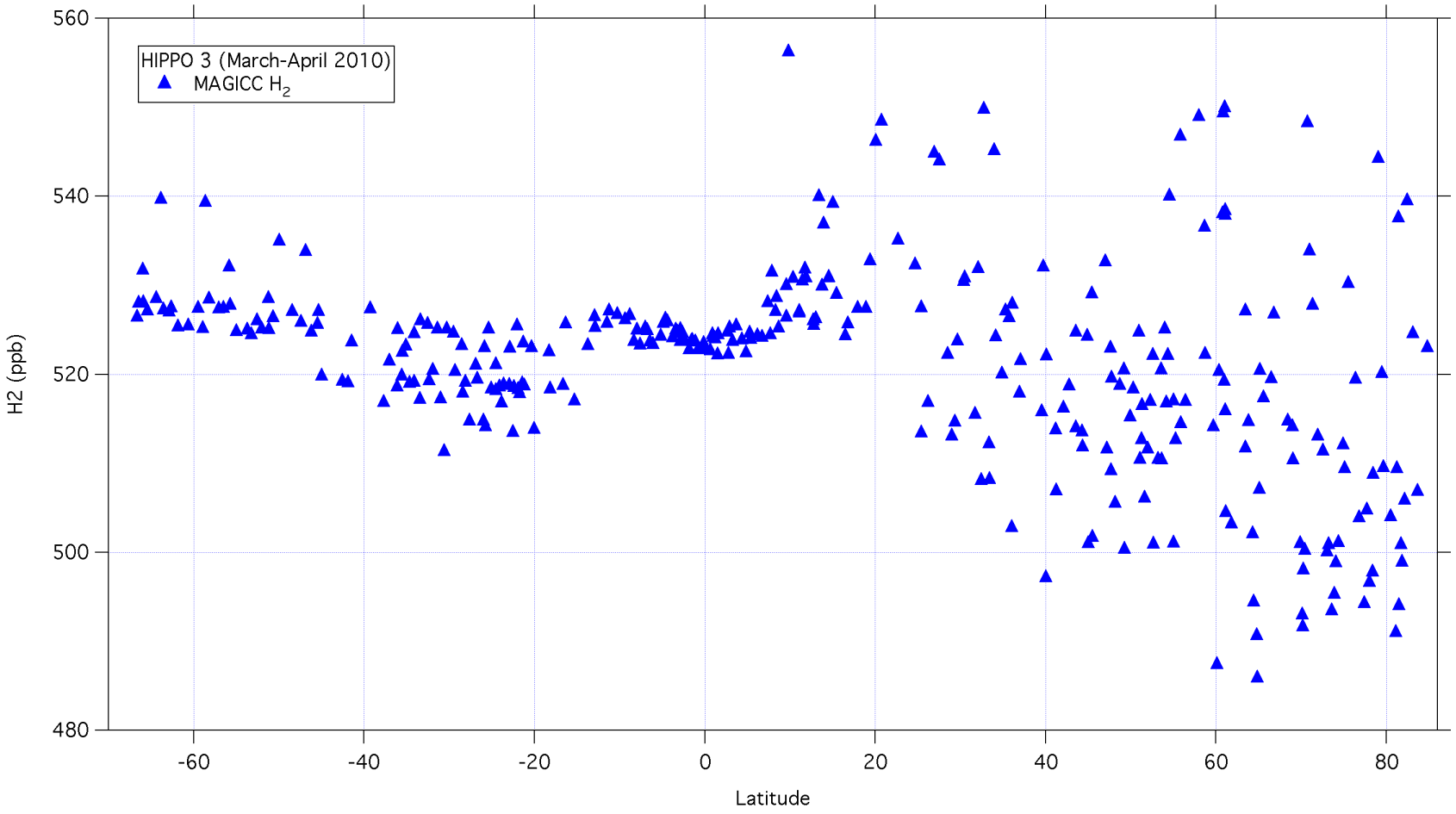
HIPPO 1


540
520
500
480
460
440
420
400
380
360
H2 (ppb)
-60
-40
-20
0
20
40
60
80
Latitude
HIPPO 1 (January 2009)
UCATS H_2
MAGICC H_2

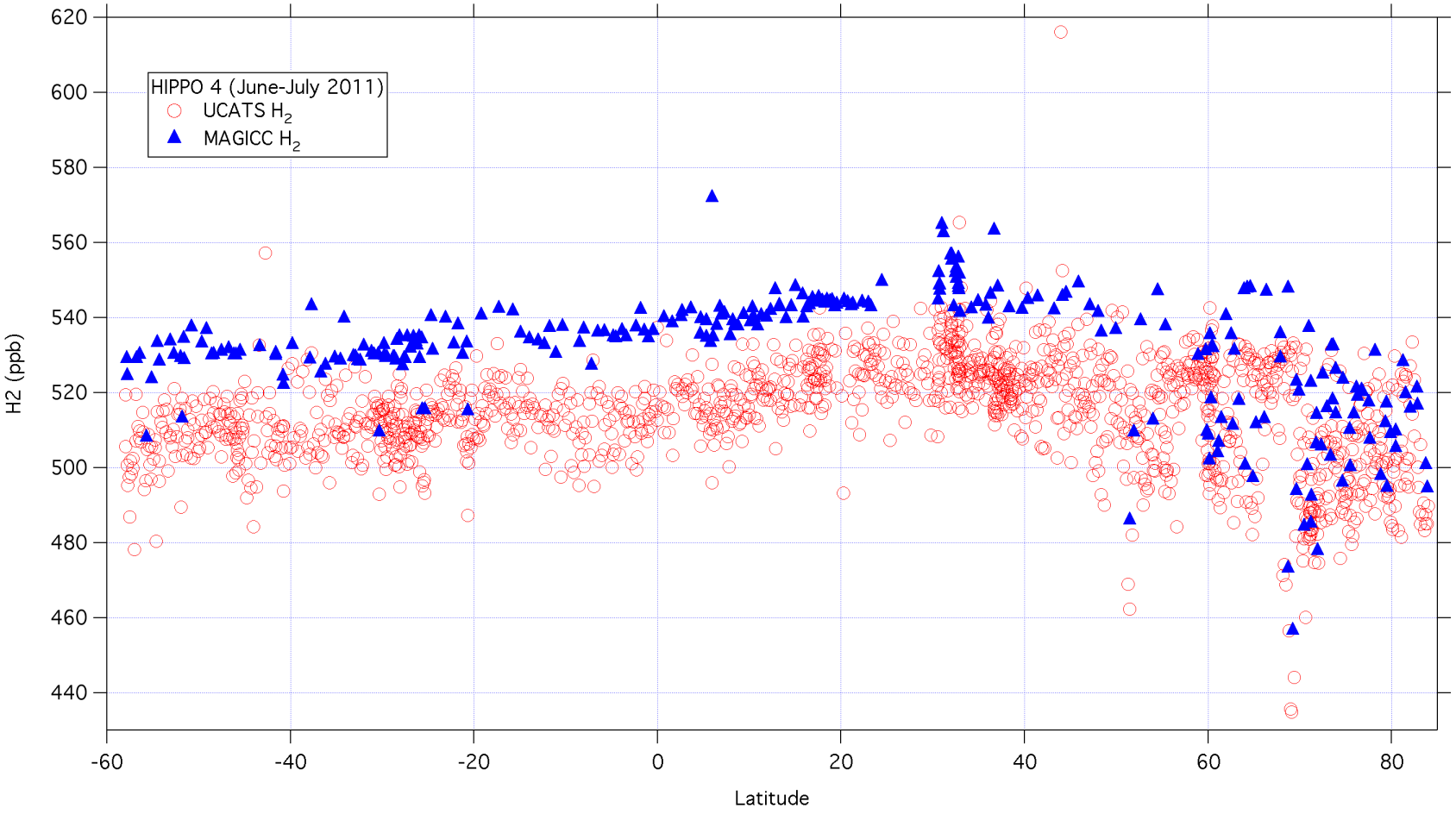
HIPPO 2


H2 (ppb)
600
550
500
450
400
-60
-40
-20
0
20
40
60
80
Latitude
HIPPO 2 (October-November 2009)
UCATS H_2
MAGICC H_2

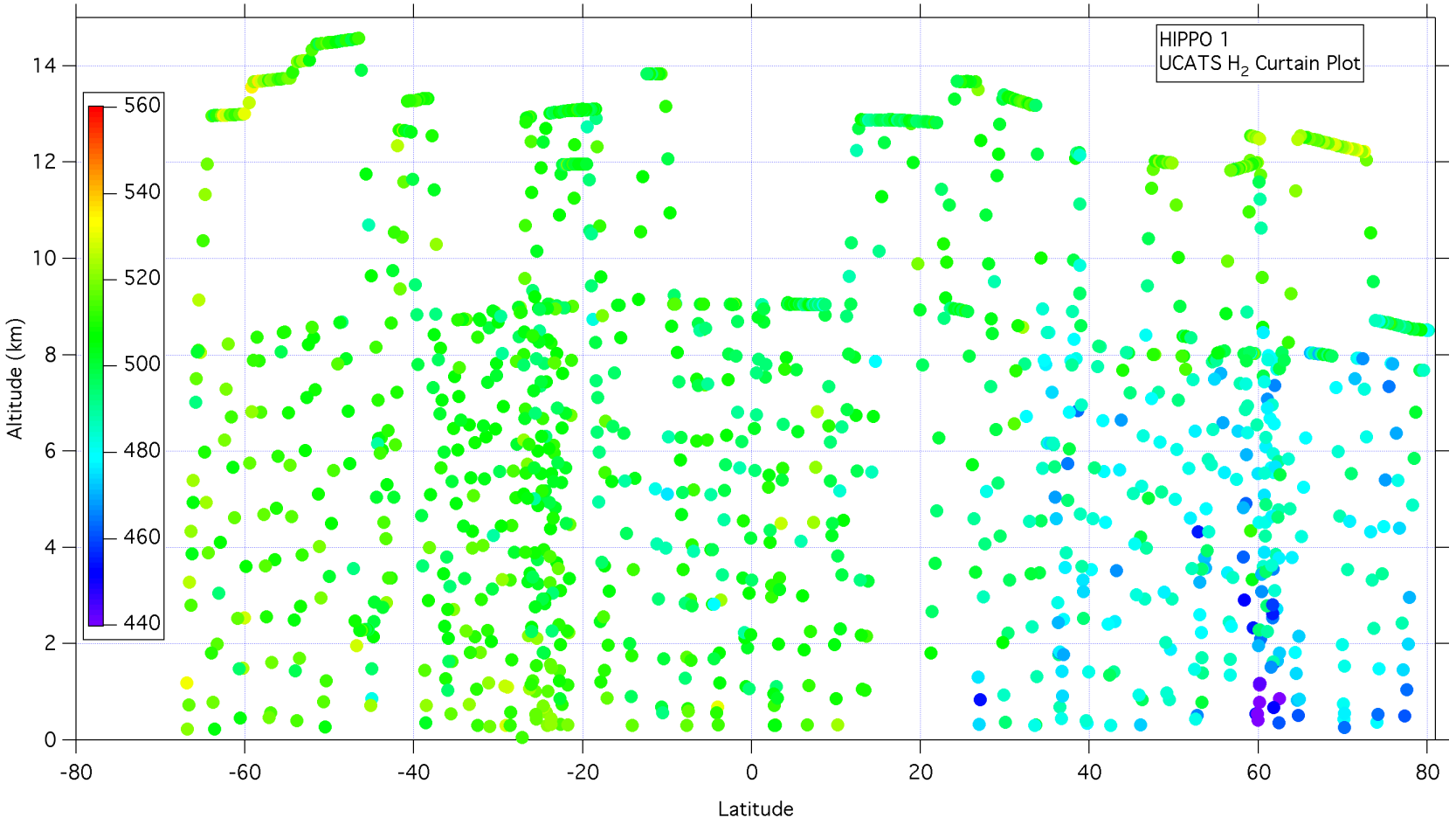
HIPPO 3 (no UCATS)



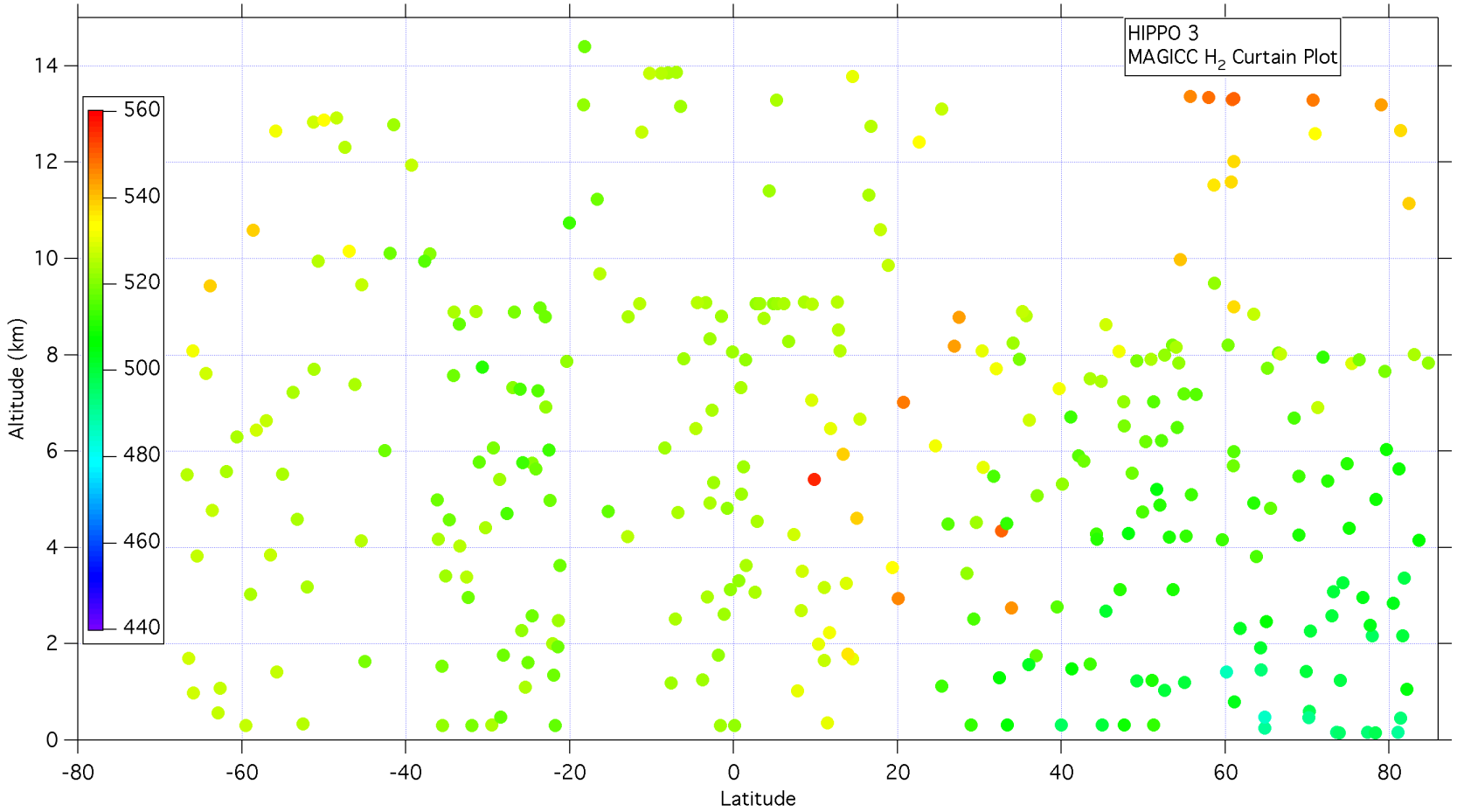
HIPPO 4 (preliminary data)



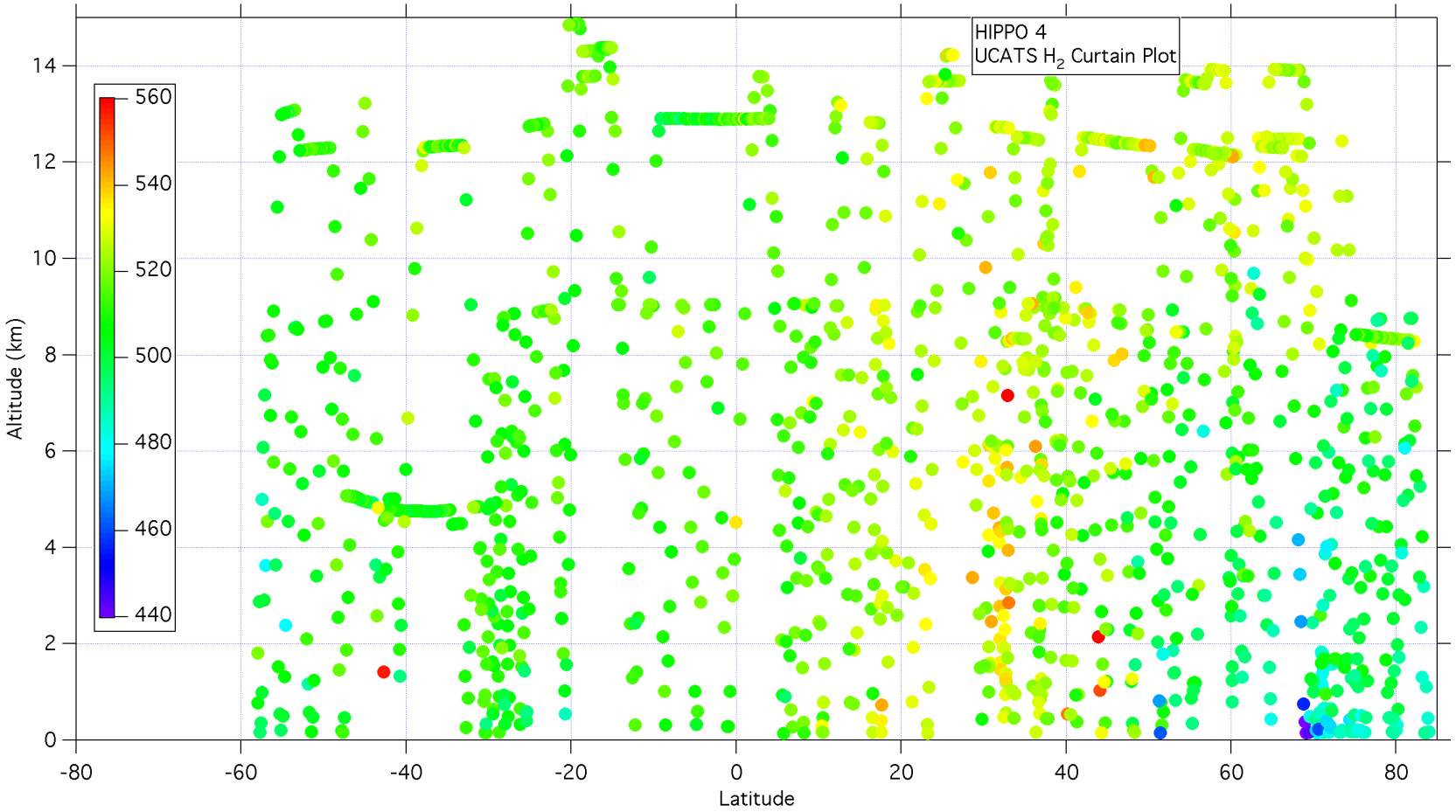
January 2009, SH maximum



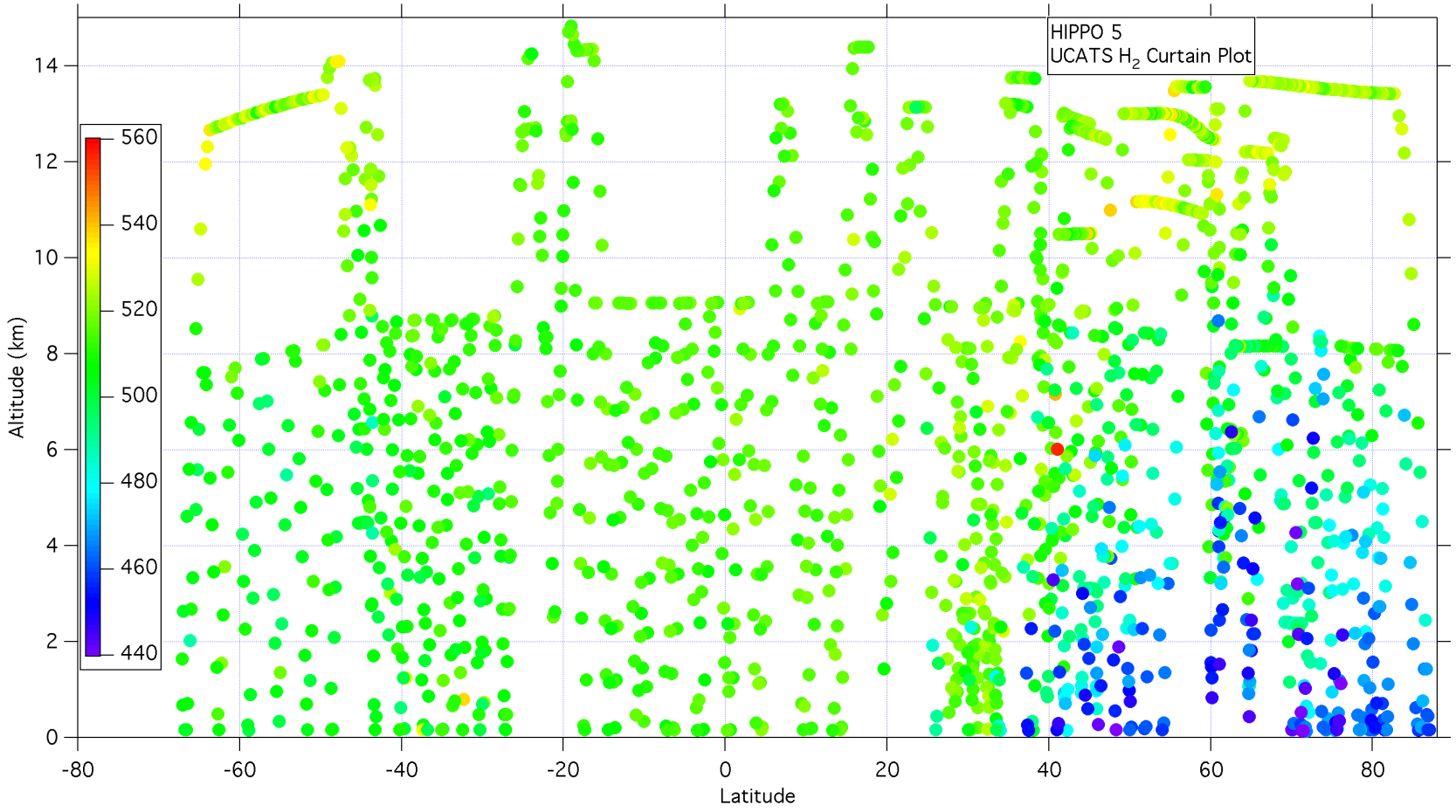
March/April 2010, NH maximum



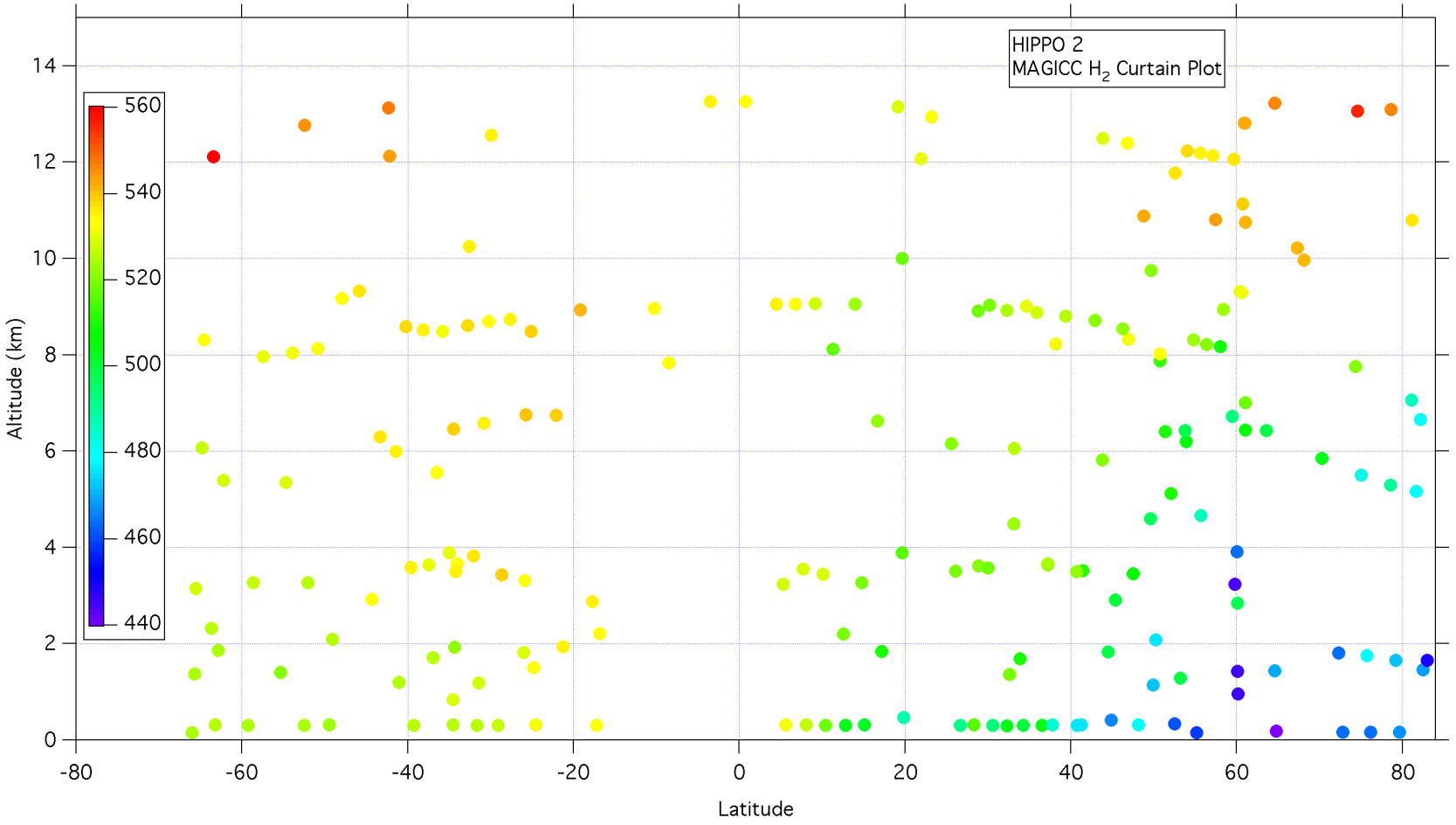
June/July 2011, NH subtropics



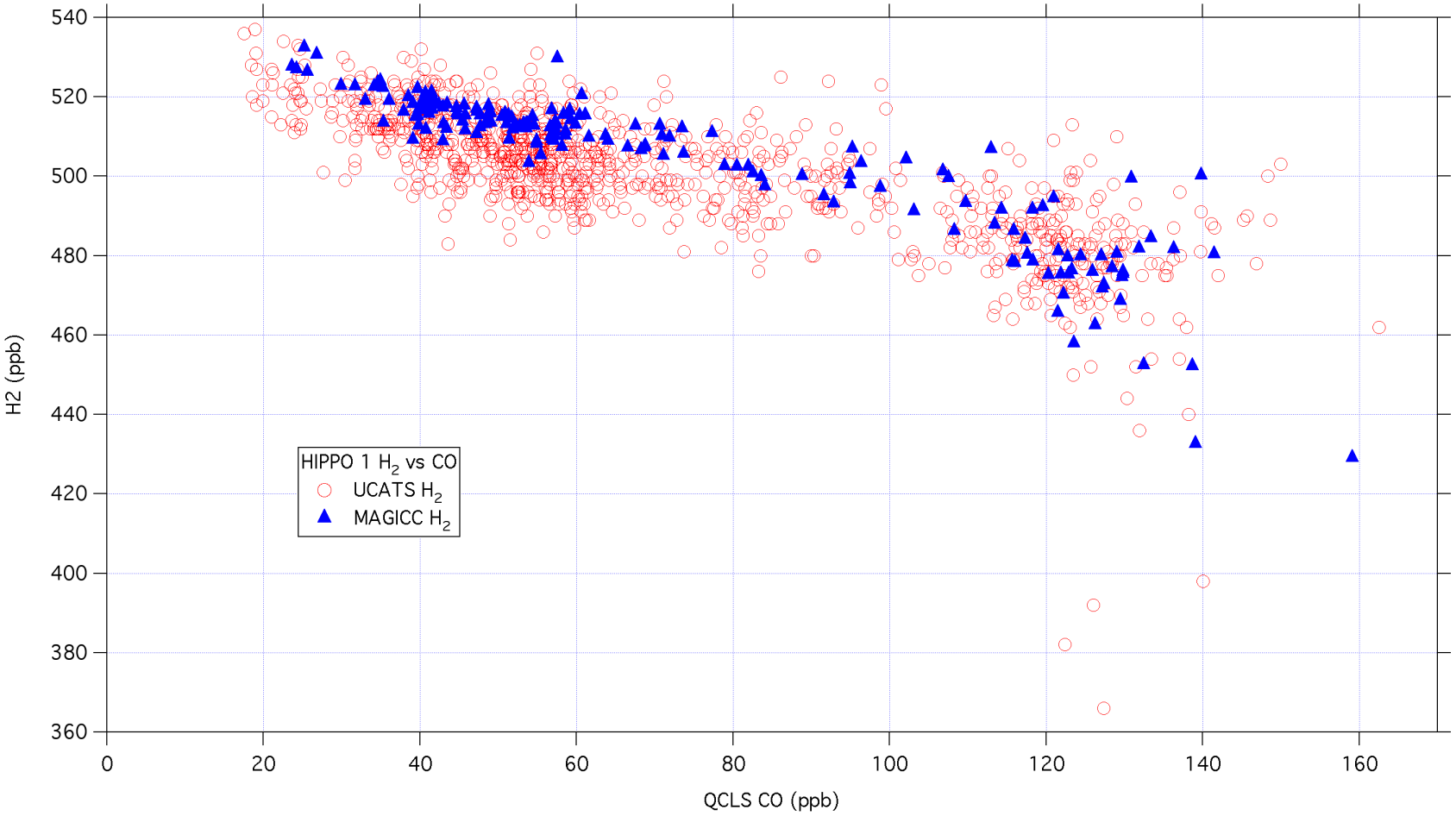
August/Sept. 2011, minima at high lats.



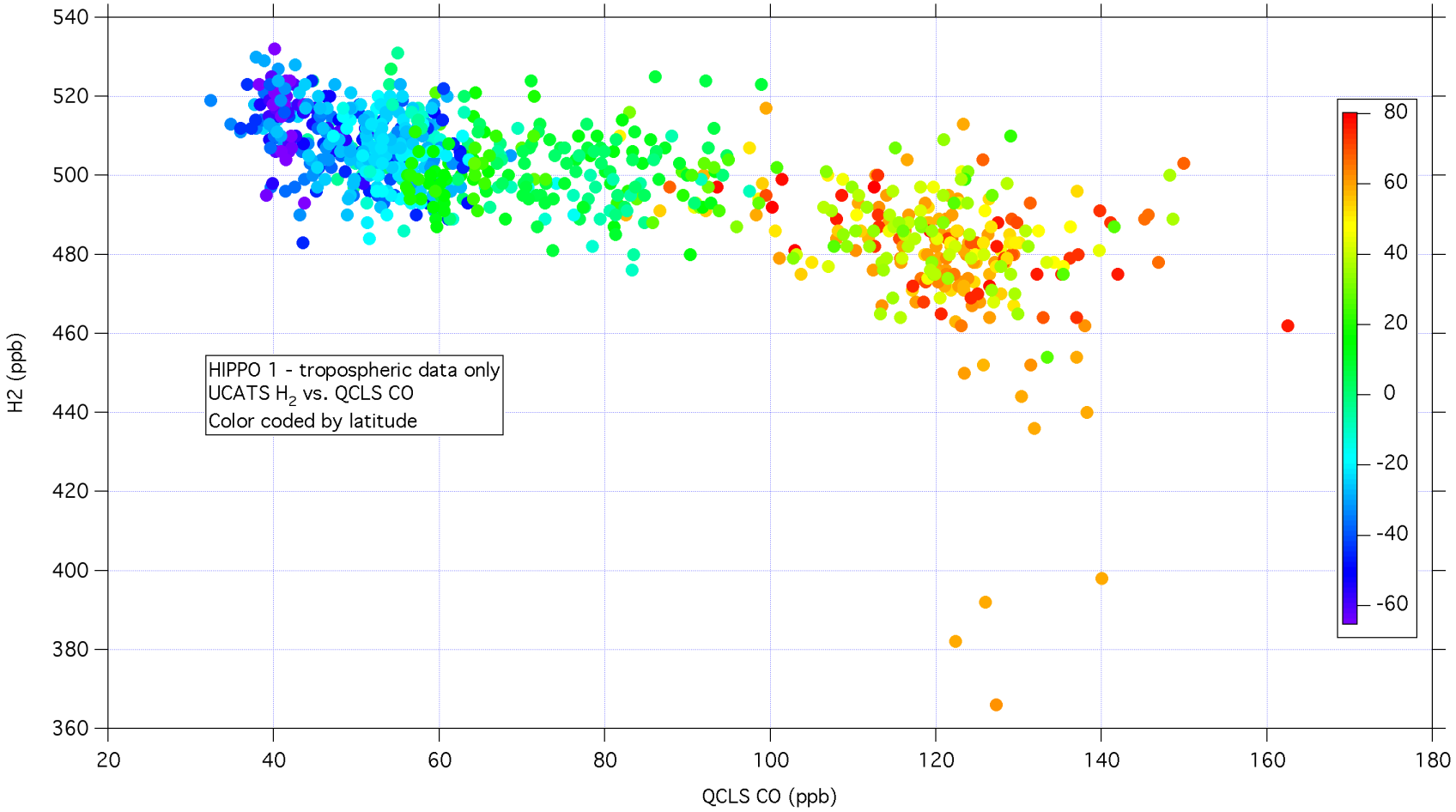
October/November 2009



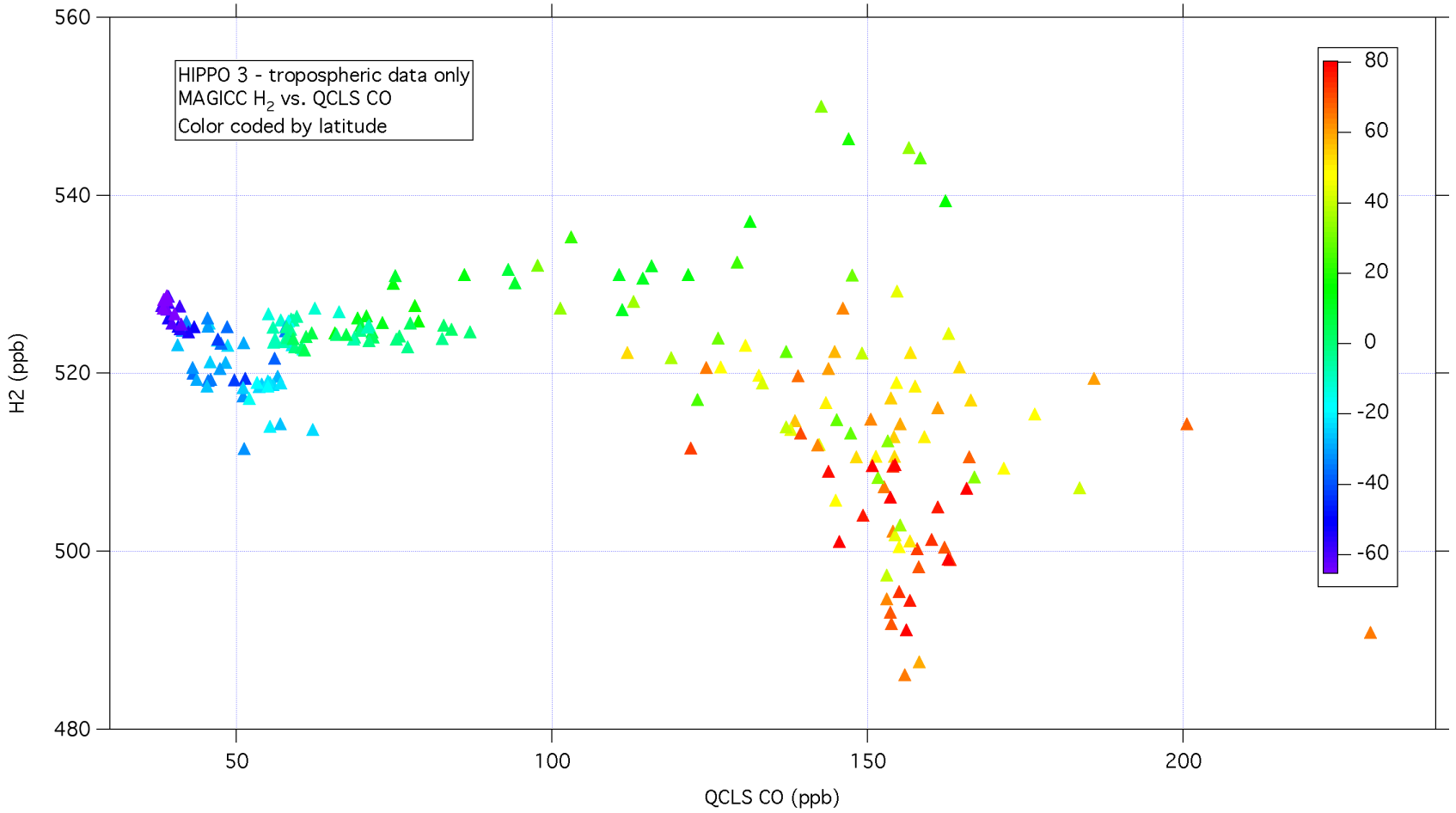
HIPPO 1, H_2 vs. CO, all data



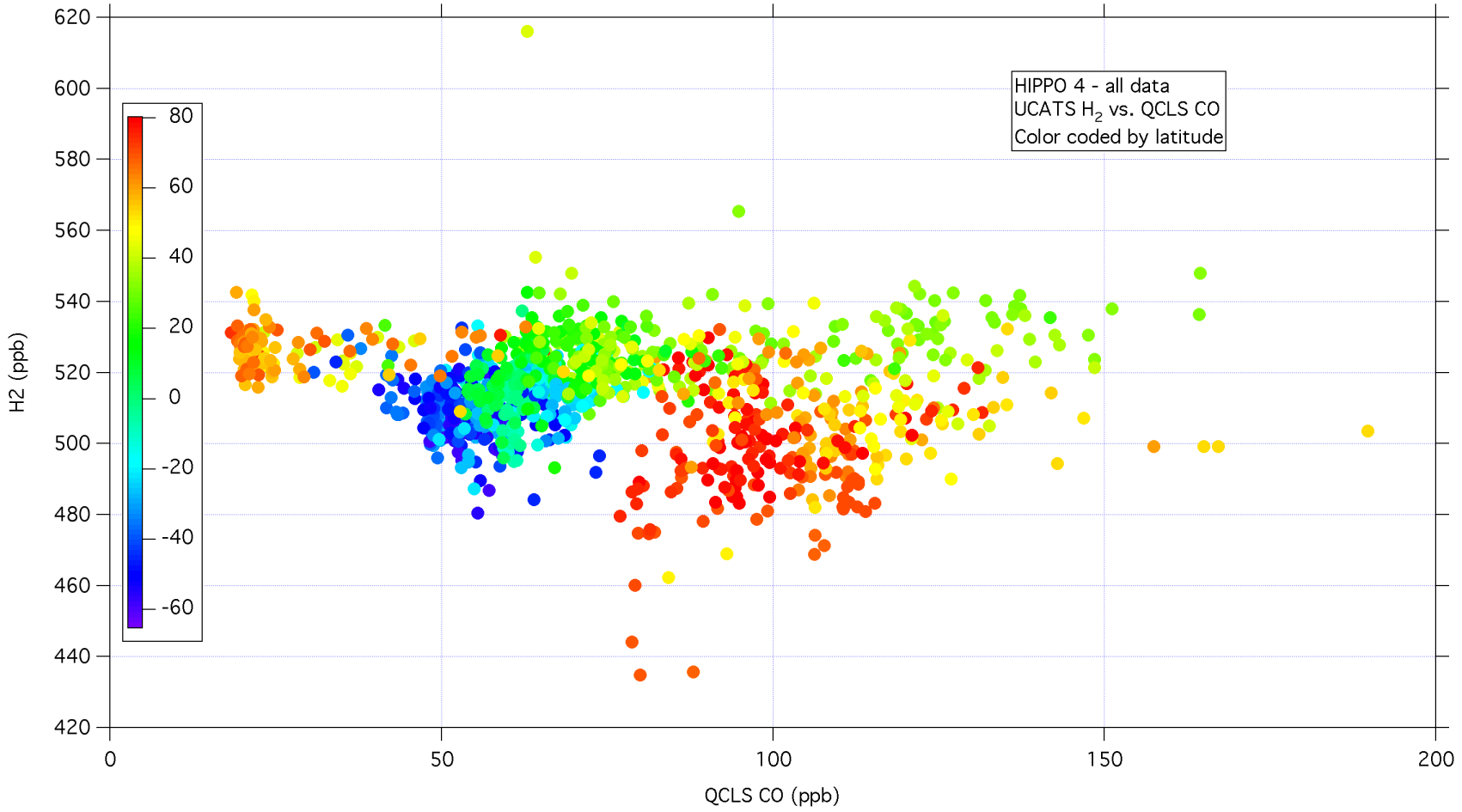
Tropospheric Data, Color = Latitude



Tropospheric Data, Color = Latitude



June/July 2011, all data



Conclusions

- HIPPO transects mostly in agreement with previous results
- There appears to be a local maximum in H_2 at NH midlatitudes in spring and early summer
- Definitive conclusions depend on successful resolution of calibration issues for the second half of HIPPO. Sampling and measurements appear to be good.
- High values of H_2 require further study.

HIPPO 5 (preliminary data)