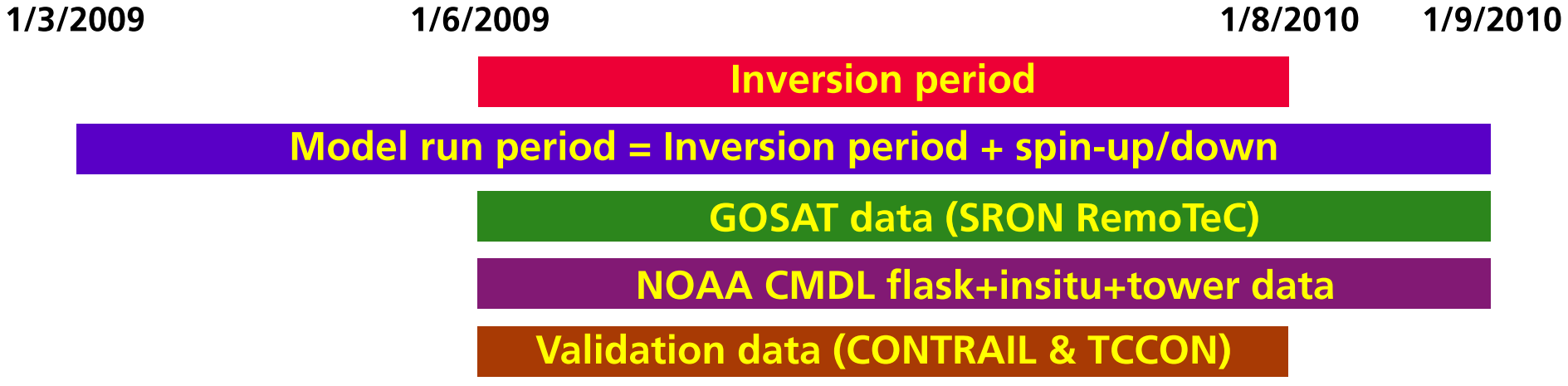
The Effect of TM5 Vertical Resolution on Atmospheric Inverse Modeling

Sourish Basu

SRON
Netherlands Institute for Space Research

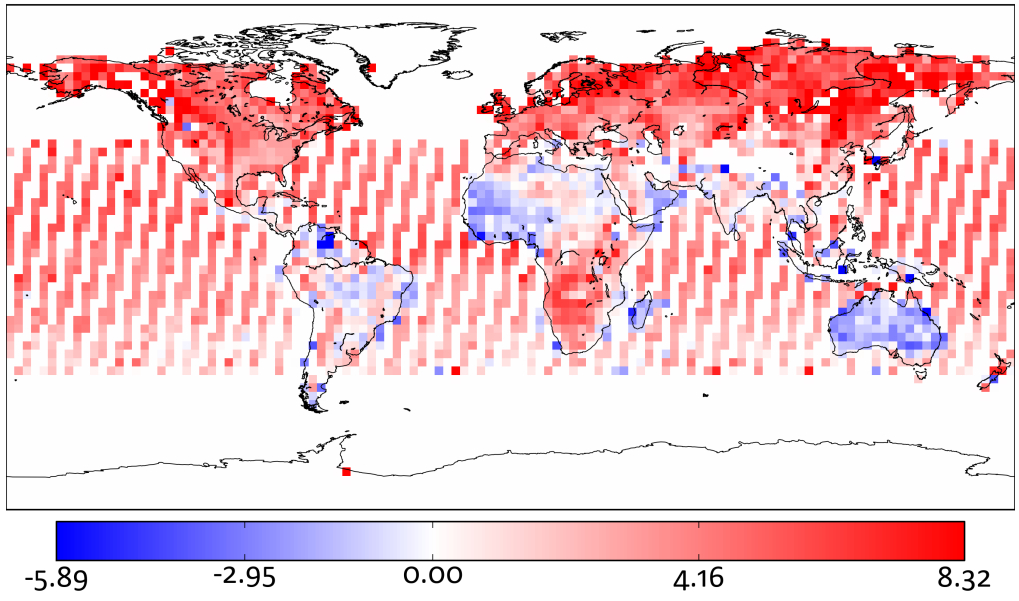
28 November 2011, Wageningen

Parameter	25 layers	60 layers
Horizontal resolution	global 6°x 4°	global 6°x 4°
Vertical resolution	tropo25	ml60
Meteo data	era interim	era interim
Point data	NOAA CMDL	NOAA CMDL
Satellite data	GOSAT	GOSAT

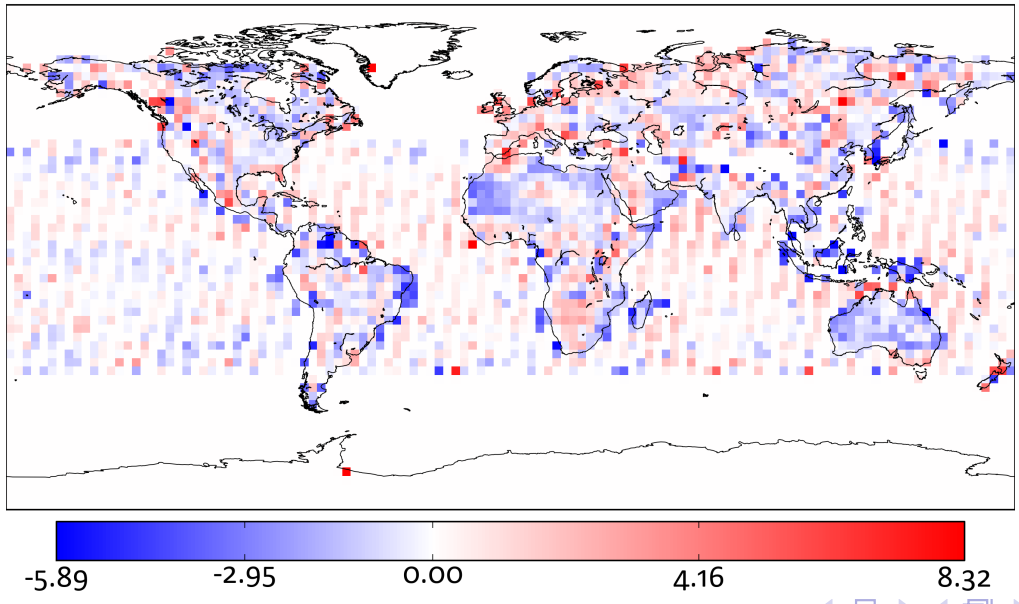


25 layers

Prior residuals

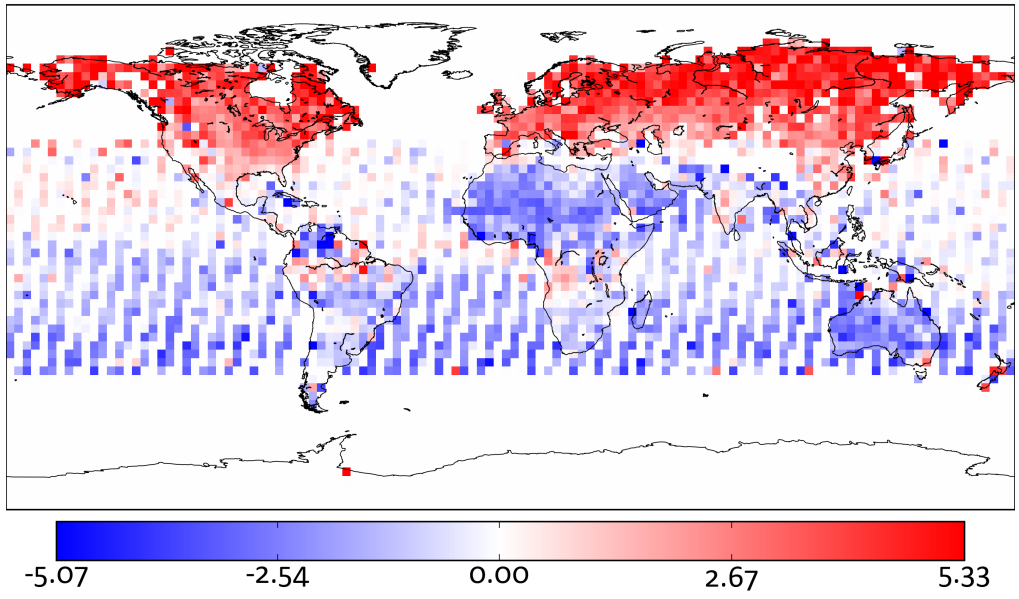


Posterior residuals

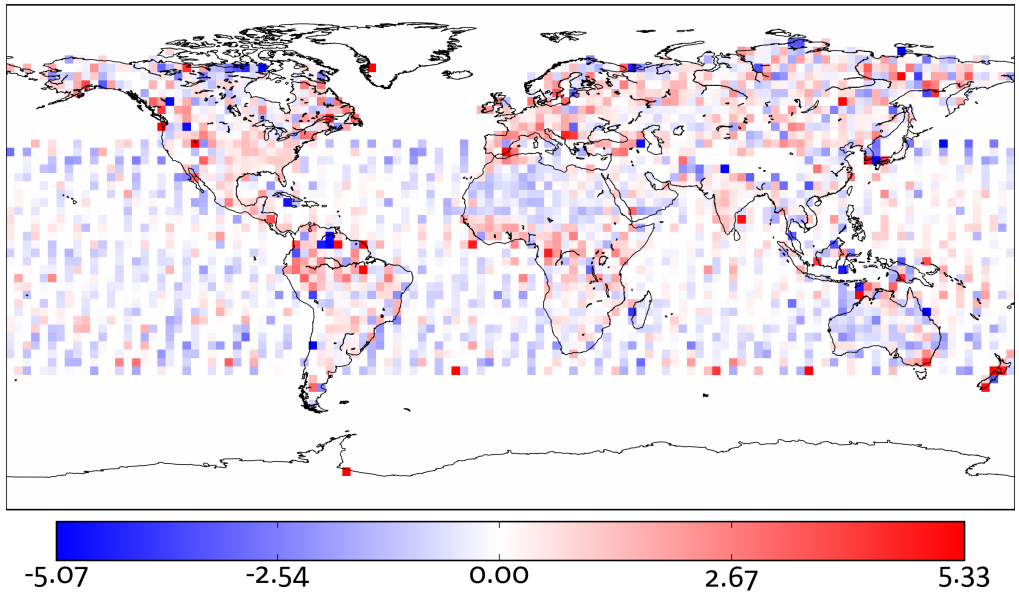


60 layers

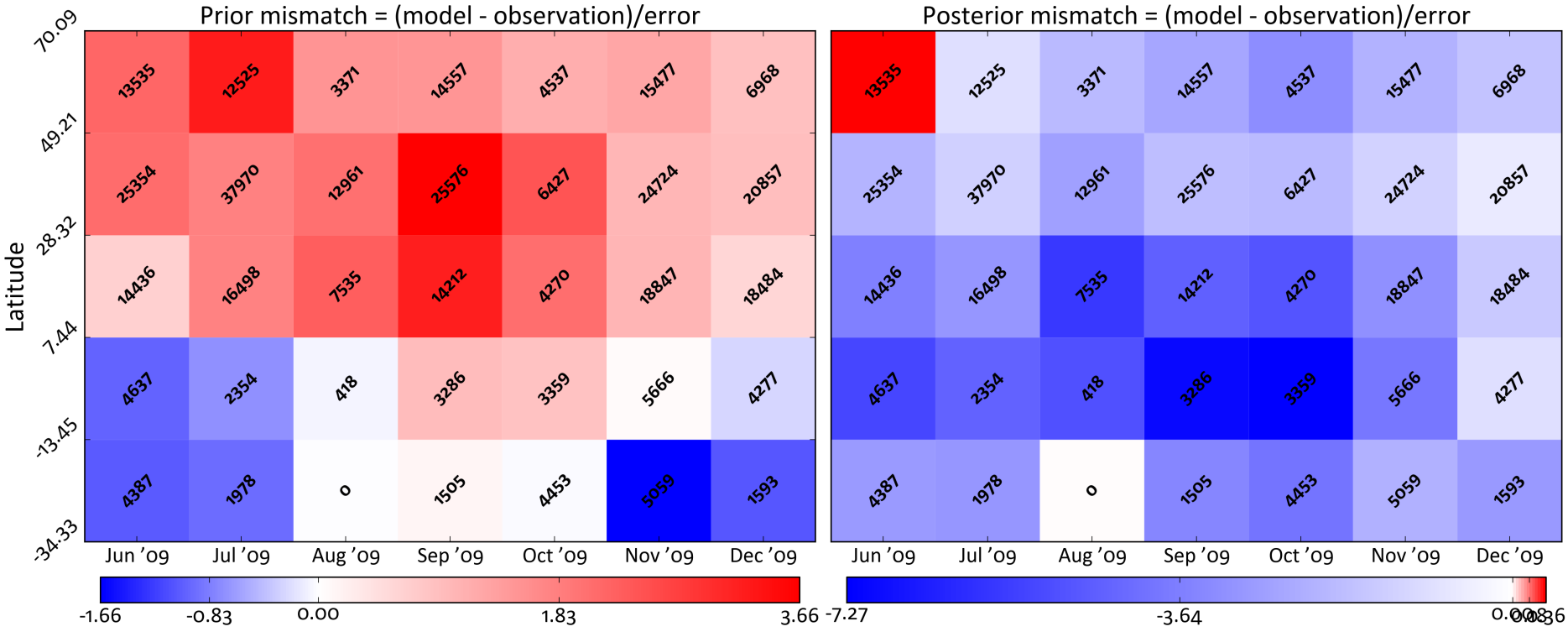
Prior residuals



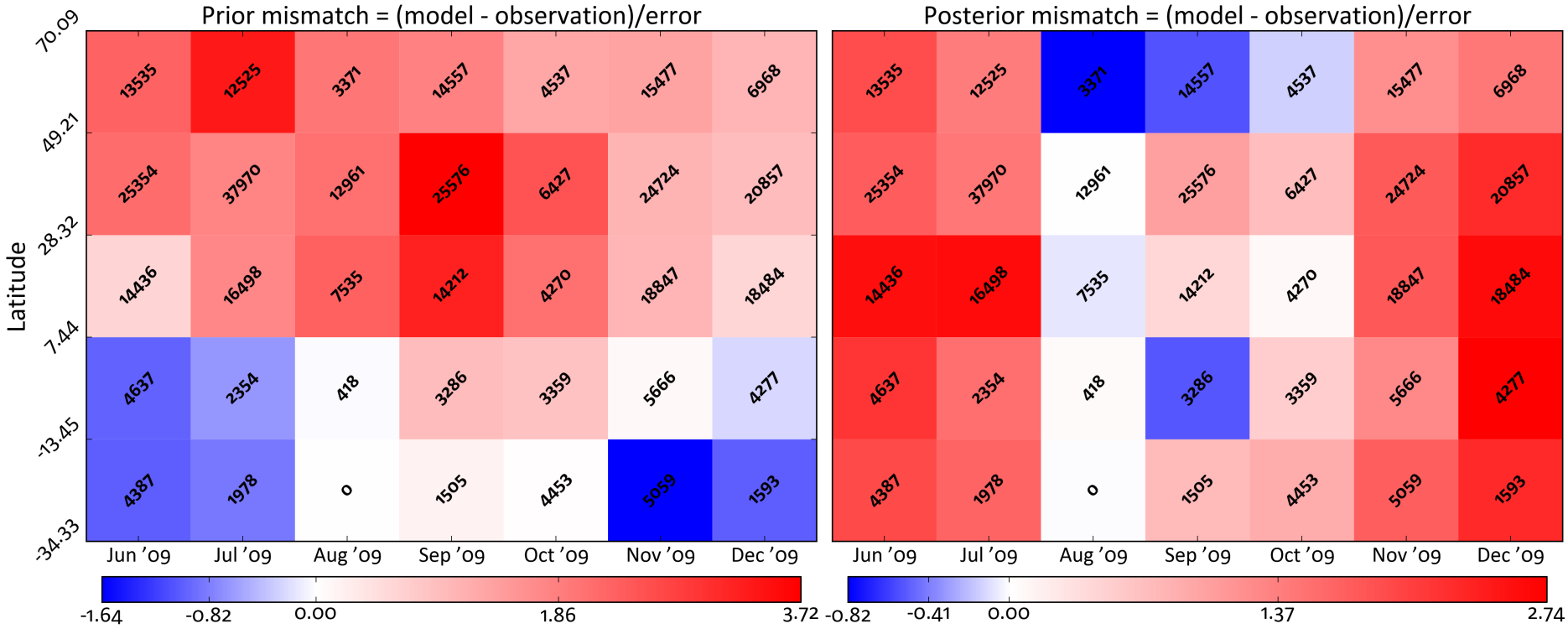
Posterior residuals

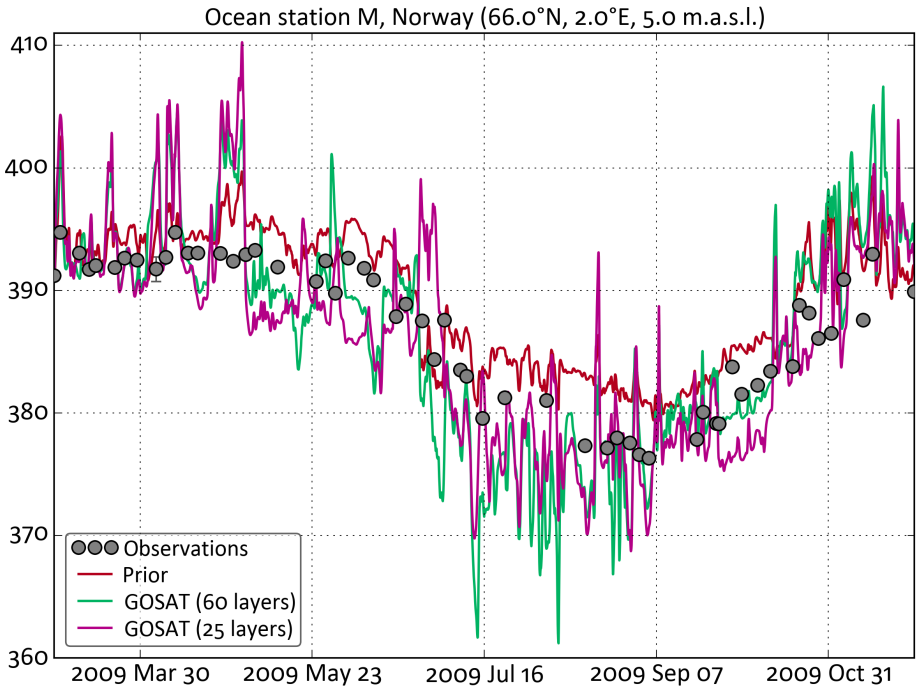


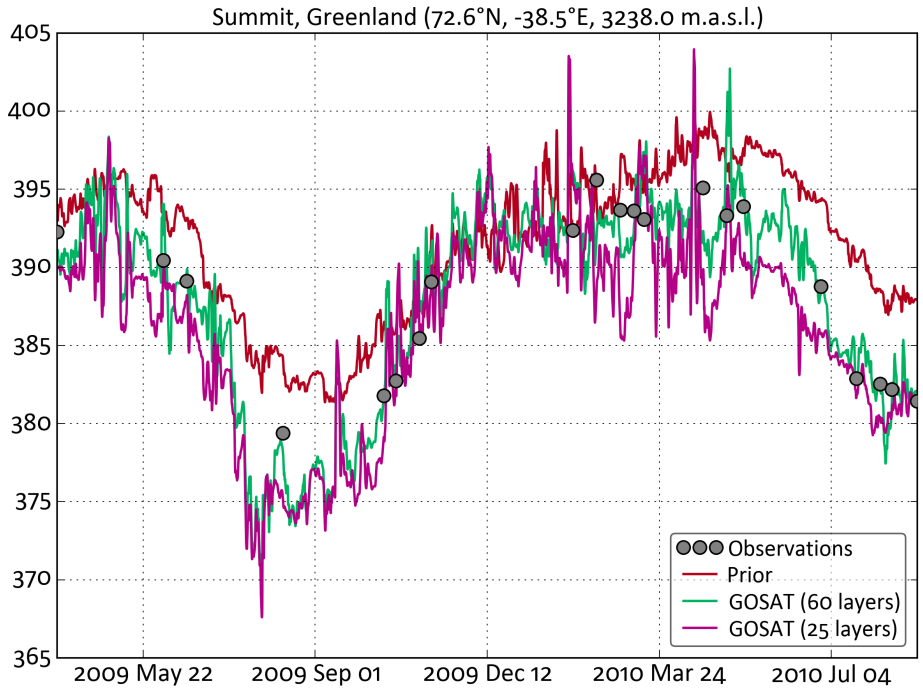
25 layers

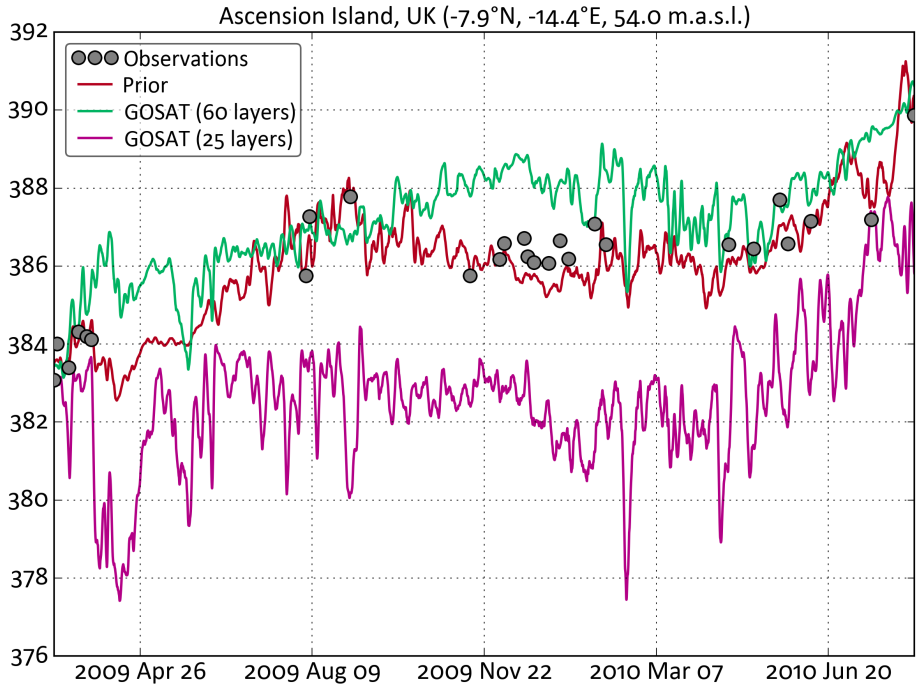

Prior mismatch = (model - observation)/error
Posterior mismatch = (model - observation)/error
Latitude
70.09
49.21
28.32
7.44
-13.45
-34.33
13535 12525 3371 14557 4537 15477 6968
25354 37970 12961 25576 6427 24724 20857
14436 16498 7535 14212 4270 18847 18484
4637 2354 418 3286 3359 5666 4277
4387 1978 0 1505 4453 5059 1593
Jun '09 Jul '09 Aug '09 Sep '09 Oct '09 Nov '09 Dec '09
-1.66 -0.83 0.00 1.83 3.66
-7.27 -3.64 0.00 3.36

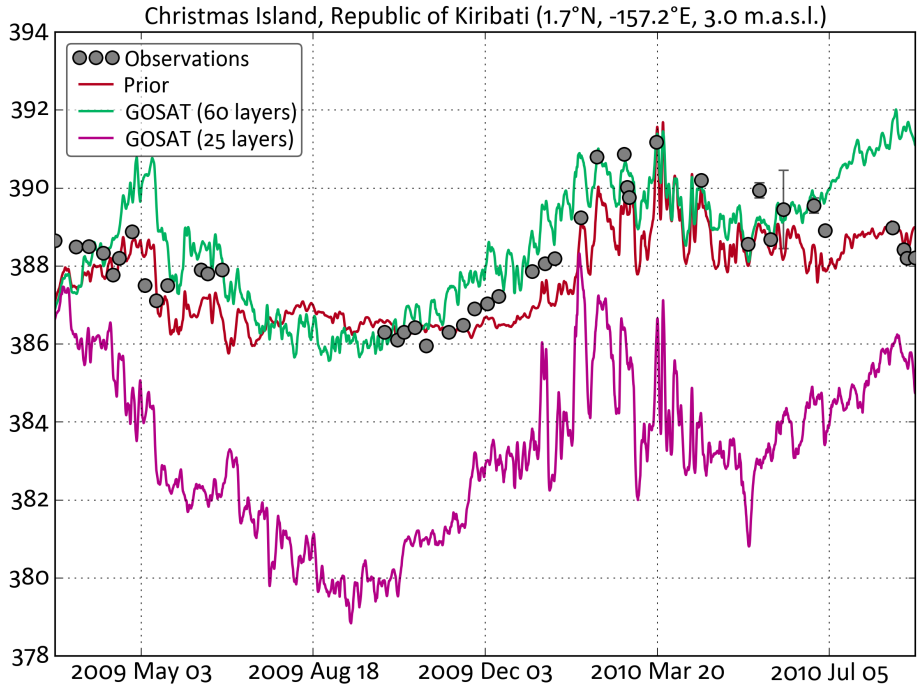
60 layers

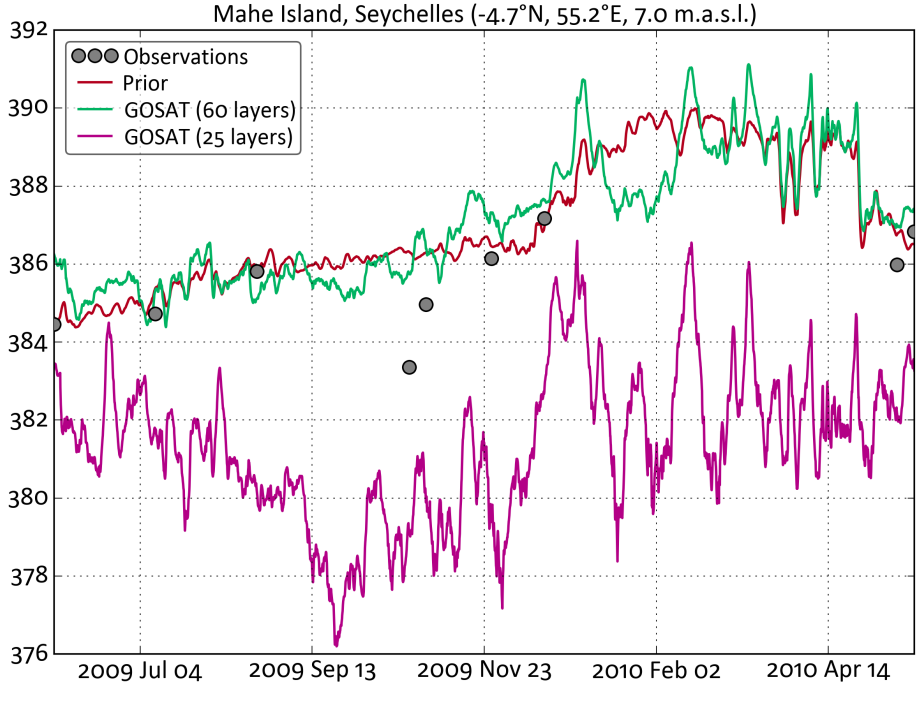

Prior mismatch = (model - observation)/error
Posterior mismatch = (model - observation)/error
Latitude
70.09
49.21
28.32
7.44
-13.45
-34.33
13535 12525 3371 14557 4537 15477 6968
25354 37970 12961 25576 6427 24724 20857
14436 16498 7535 14212 4270 18847 18484
4637 2354 418 3286 3359 5666 4277
4387 1978 0 1505 4453 5059 1593
Jun '09 Jul '09 Aug '09 Sep '09 Oct '09 Nov '09 Dec '09
-1.64 -0.82 0.00 1.86 3.72
-0.82 -0.41 0.00 1.37 2.74

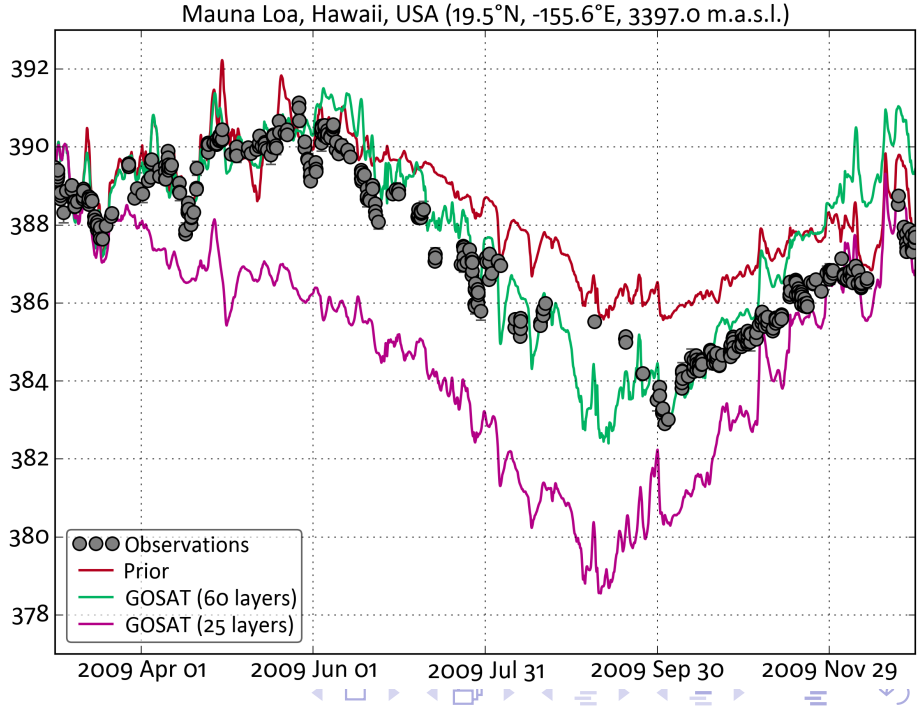

Ocean station M, Norway (66.0°N, 2.0°E, 5.0 m.a.s.l.)
410
400
390
380
370
360
2009 Mar 30
2009 May 23
2009 Jul 16
2009 Sep 07
2009 Oct 31
Observations
Prior
GOSAT (60 layers)
GOSAT (25 layers)

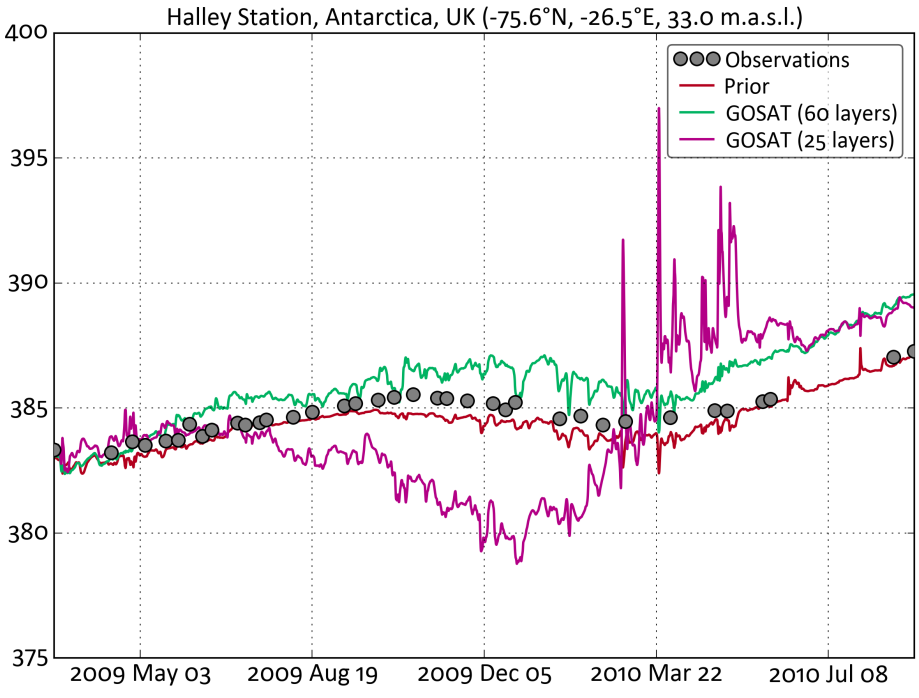

Summit, Greenland (72.6°N, -38.5°E, 3238.0 m.a.s.l.)
405
400
395
390
385
380
375
370
365
2009 May 22
2009 Sep 01
2009 Dec 12
2010 Mar 24
2010 Jul 04
Observations
Prior
GOSAT (60 layers)
GOSAT (25 layers)

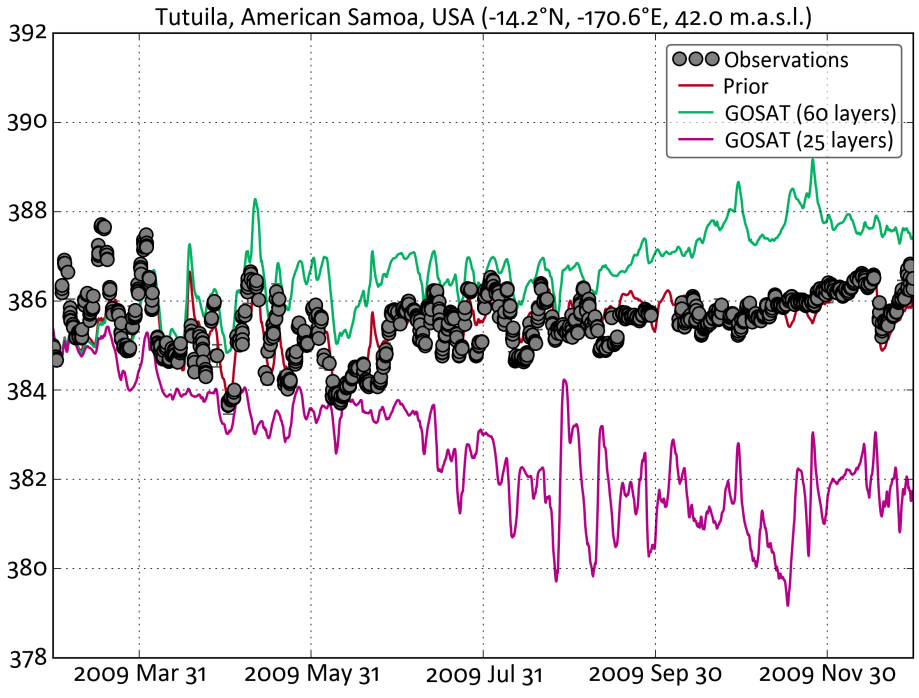

Ascension Island, UK (-7.9°N, -14.4°E, 54.0 m.a.s.l.)
Observations
Prior
GOSAT (60 layers)
GOSAT (25 layers)
392
390
388
386
384
382
380
378
376
2009 Apr 26
2009 Aug 09
2009 Nov 22
2010 Mar 07
2010 Jun 20

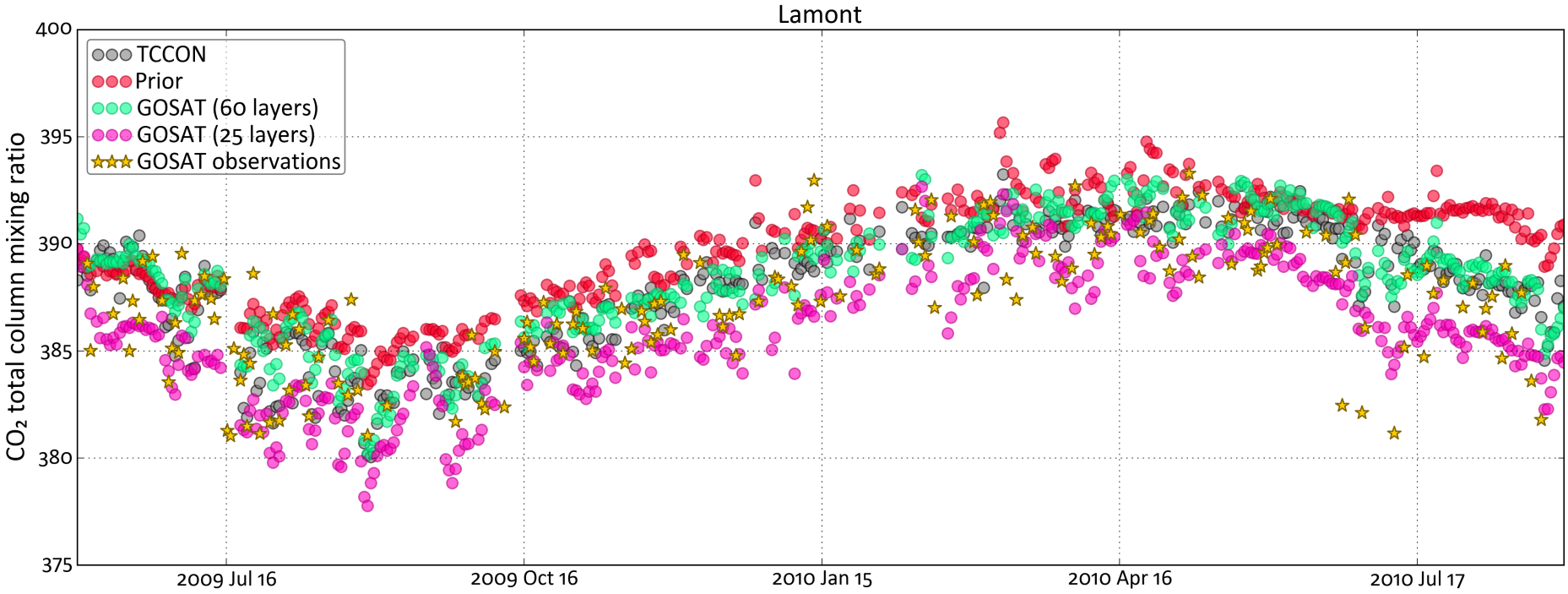

Christmas Island, Republic of Kiribati (1.7°N, -157.2°E, 3.0 m.a.s.l.)
Observations
Prior
GOSAT (60 layers)
GOSAT (25 layers)
394
392
390
388
386
384
382
380
378
2009 May 03
2009 Aug 18
2009 Dec 03
2010 Mar 20
2010 Jul 05

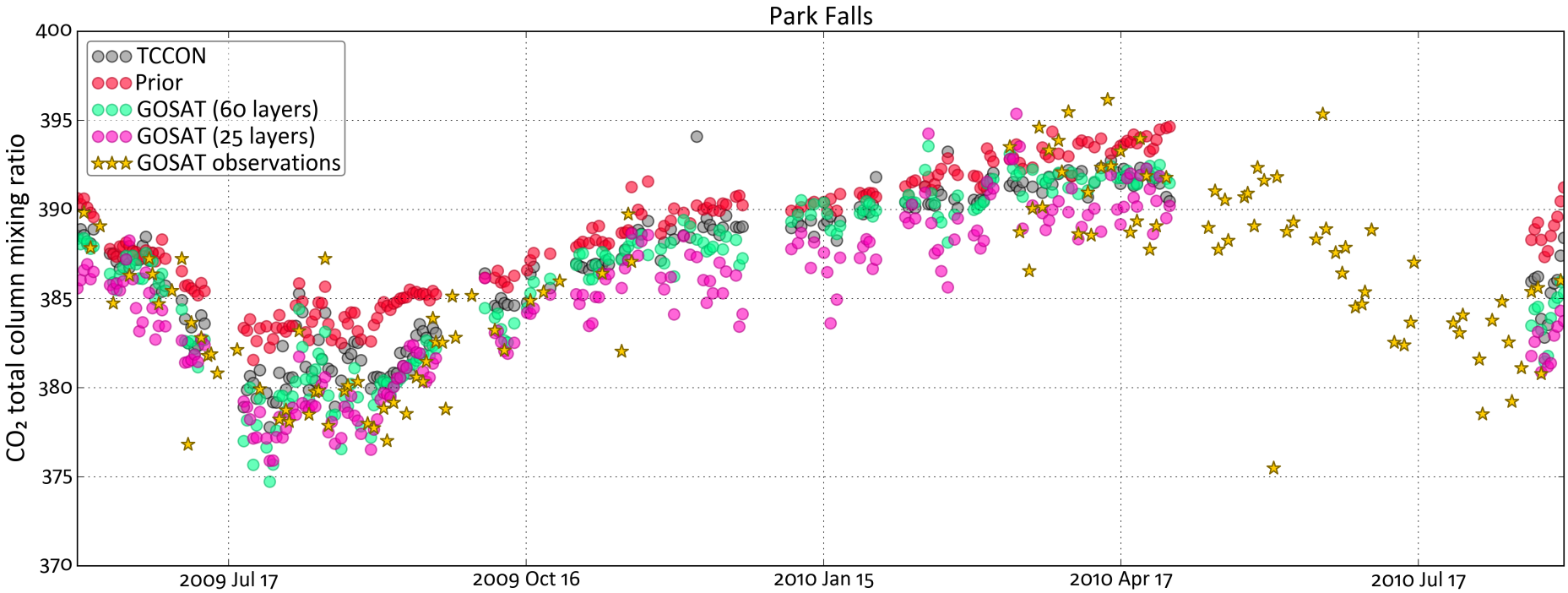

Mahe Island, Seychelles (-4.7°N, 55.2°E, 7.0 m.a.s.l.)
Observations
Prior
GOSAT (60 layers)
GOSAT (25 layers)
392
390
388
386
384
382
380
378
376
2009 Jul 04
2009 Sep 13
2009 Nov 23
2010 Feb 02
2010 Apr 14

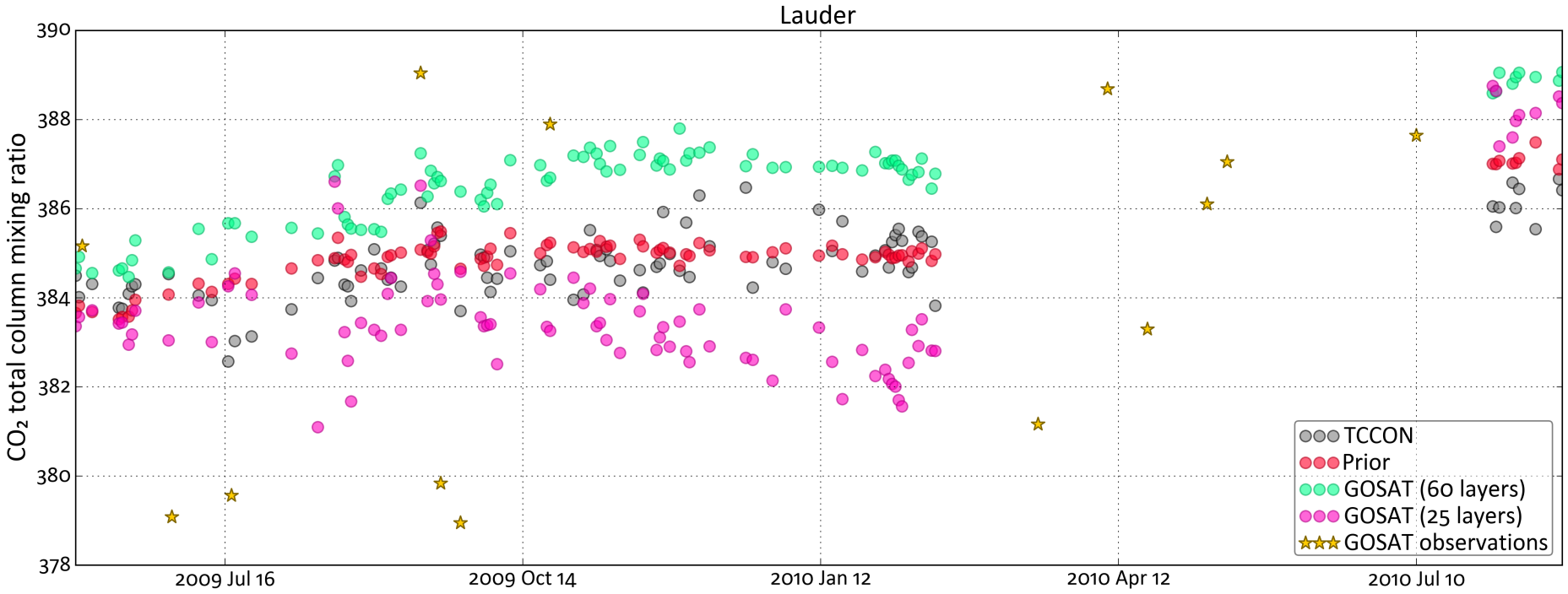

Mauna Loa, Hawaii, USA (19.5°N, -155.6°E, 3397.0 m.a.s.l.)
Observations
Prior
GOSAT (60 layers)
GOSAT (25 layers)
392
390
388
386
384
382
380
378
2009 Apr 01
2009 Jun 01
2009 Jul 31
2009 Sep 30
2009 Nov 29

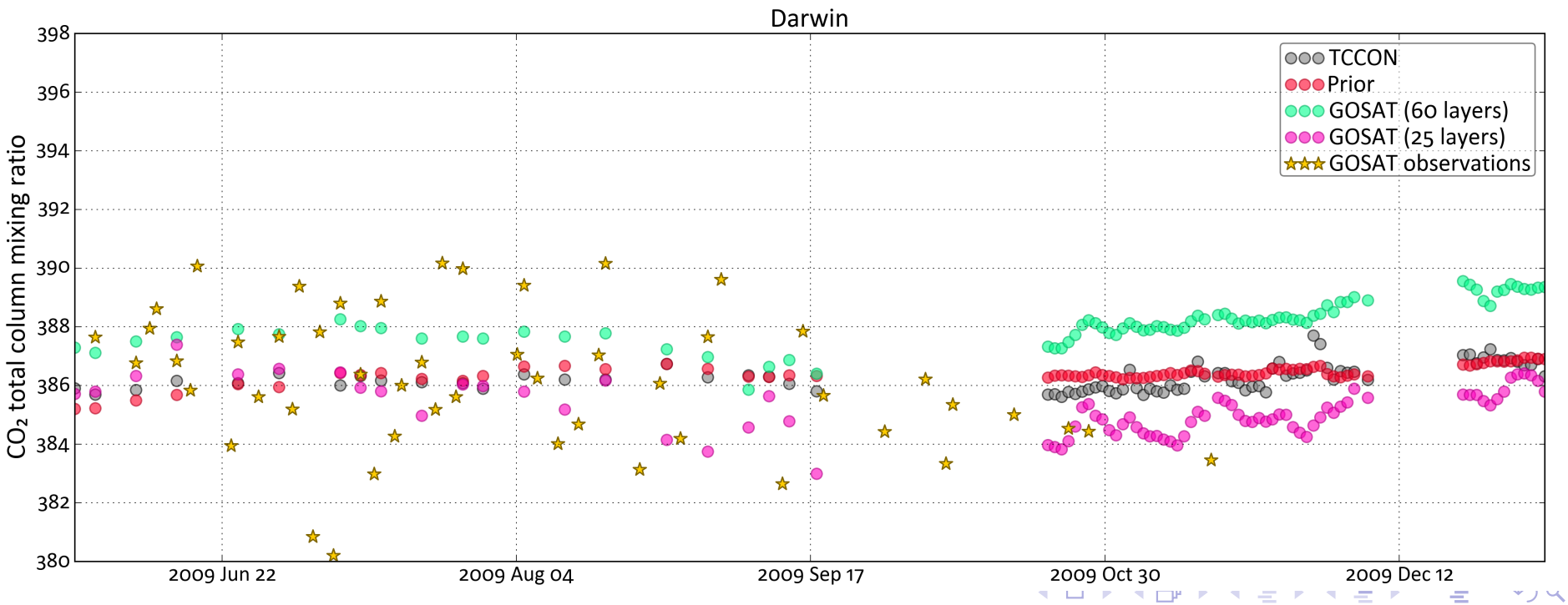

Halley Station, Antarctica, UK (-75.6°N, -26.5°E, 33.0 m.a.s.l.)
Observations
Prior
GOSAT (60 layers)
GOSAT (25 layers)
400
395
390
385
380
375
2009 May 03
2009 Aug 19
2009 Dec 05
2010 Mar 22
2010 Jul 08

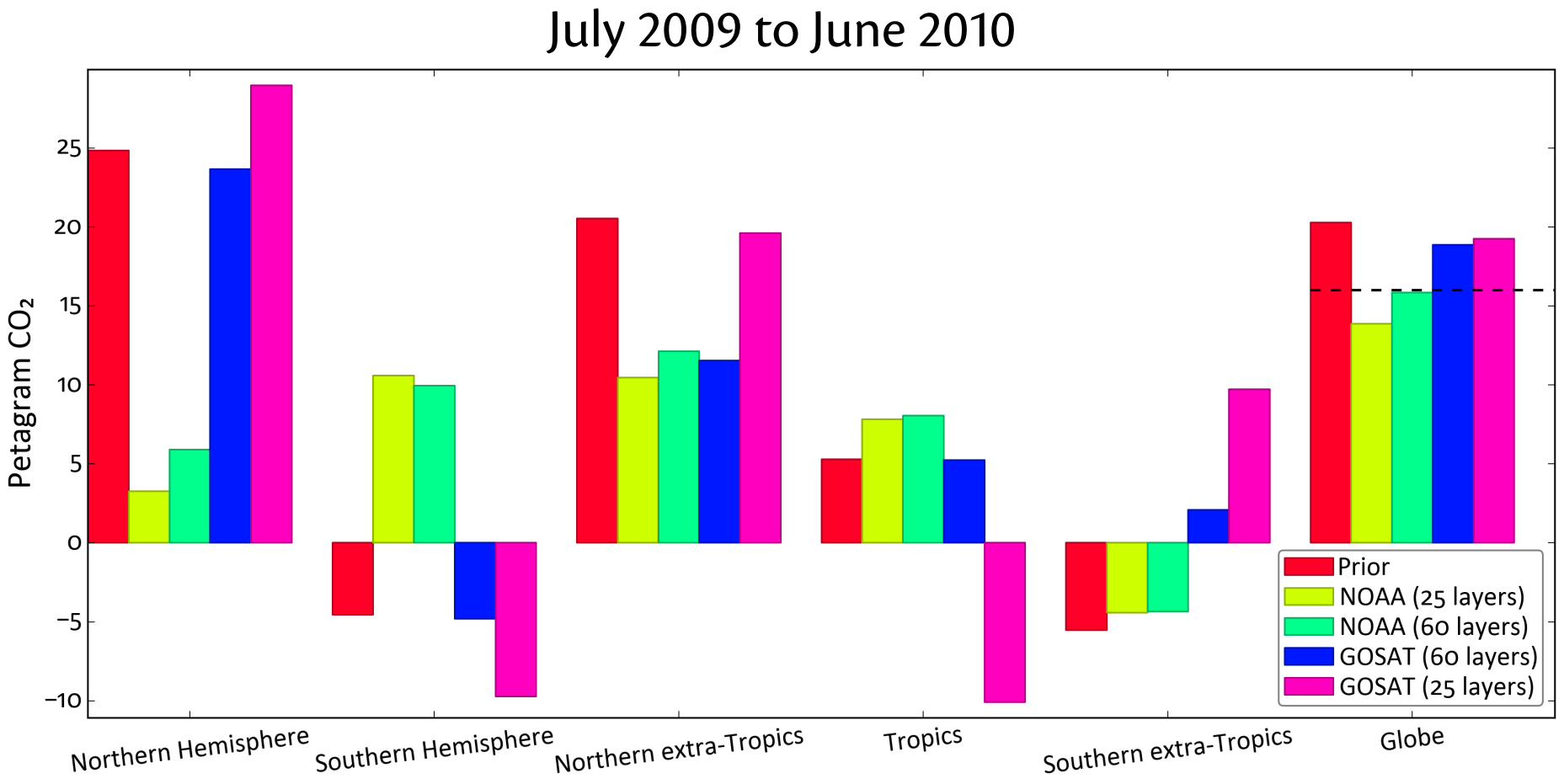

Tutuila, American Samoa, USA (-14.2°N, -170.6°E, 42.0 m.a.s.l.)
Observations
Prior
GOSAT (60 layers)
GOSAT (25 layers)
392
390
388
386
384
382
380
378
2009 Mar 31
2009 May 31
2009 Jul 31
2009 Sep 30
2009 Nov 30

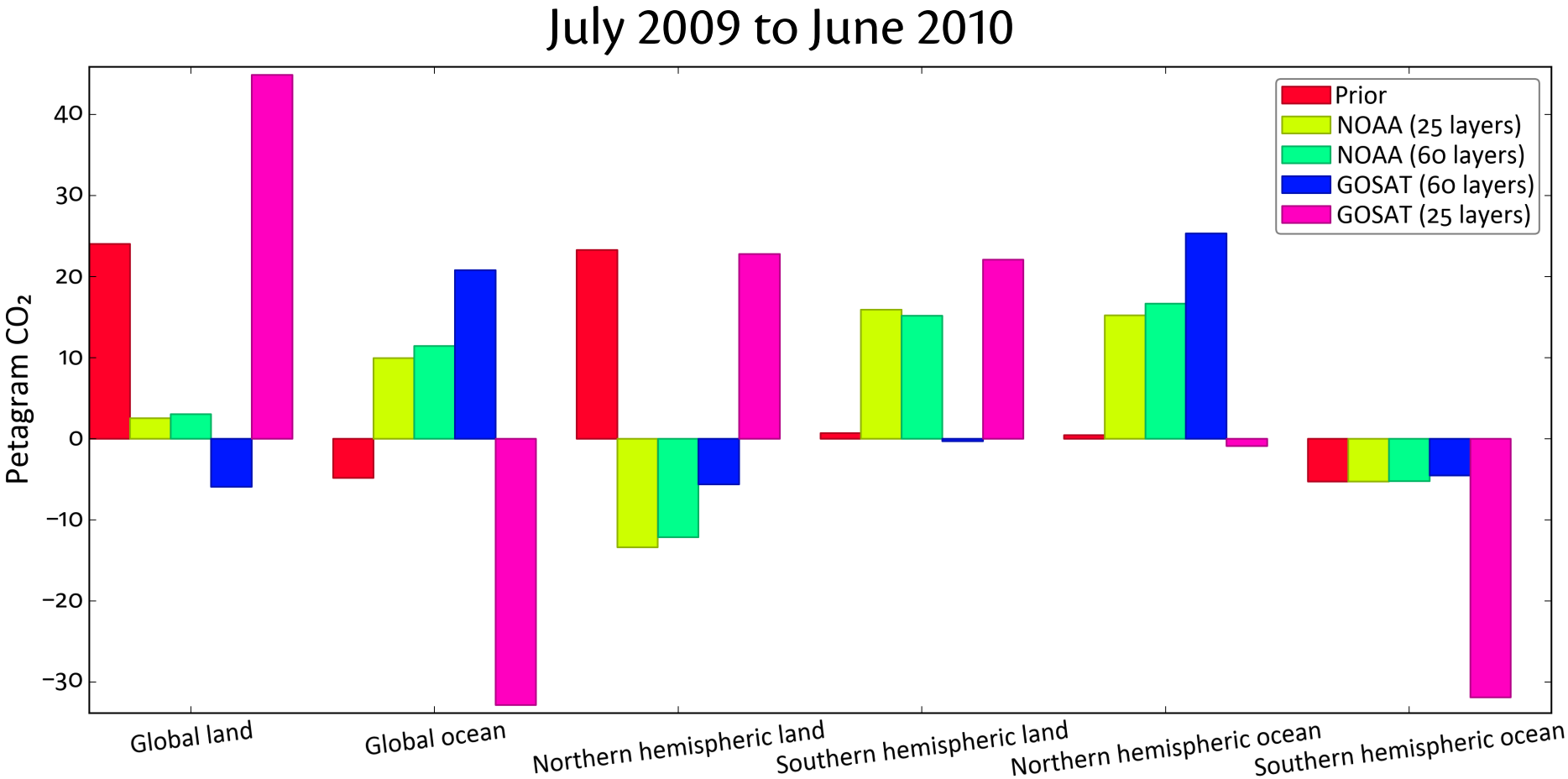

Lamont
TCCON
Prior
GOSAT (60 layers)
GOSAT (25 layers)
GOSAT observations
CO_2 total column mixing ratio
400
395
390
385
380
375
2009 Jul 16
2009 Oct 16
2010 Jan 15
2010 Apr 16
2010 Jul 17


Park Falls
TCCON
Prior
GOSAT (60 layers)
GOSAT (25 layers)
GOSAT observations
CO_2 total column mixing ratio
400
395
390
385
380
375
370
2009 Jul 17
2009 Oct 16
2010 Jan 15
2010 Apr 17
2010 Jul 17


Lauder
CO_2 total column mixing ratio
390
388
386
384
382
380
378
2009 Jul 16
2009 Oct 14
2010 Jan 12
2010 Apr 12
2010 Jul 10
TCCON
Prior
GOSAT (60 layers)
GOSAT (25 layers)
GOSAT observations


Darwin
CO_2 total column mixing ratio
398
396
394
392
390
388
386
384
382
380
2009 Jun 22
2009 Aug 04
2009 Sep 17
2009 Oct 30
2009 Dec 12
TCCON
Prior
GOSAT (60 layers)
GOSAT (25 layers)
GOSAT observations


July 2009 to June 2010
Petagram CO_2
25
20
15
10
5
0
−5
−10
Northern Hemisphere
Southern Hemisphere
Northern extra-Tropics
Tropics
Southern extra-Tropics
Globe
Prior
NOAA (25 layers)
NOAA (60 layers)
GOSAT (60 layers)
GOSAT (25 layers)


July 2009 to June 2010
Petagram CO_2
40
30
20
10
0
−10
−20
−30
Prior
NOAA (25 layers)
NOAA (60 layers)
GOSAT (60 layers)
GOSAT (25 layers)
Global land
Global ocean
Northern hemispheric land
Southern hemispheric land
Northern hemispheric ocean
Southern hemispheric ocean

- Inversions with 25 and 60 layers preserve the global flux, but redistribute them very differently
- A 60-layer GOSAT inversion matches
  - NOAA surface stations
  - TCCON stations in the northern Hemisphere
  - CONTRAIL samples, mostly near the tropopause

  better than a 25-layer GOSAT inversion
- We need to
  - check whether there's a happy medium that's faster than the 60-layer version but better than the 25-layer one
  - check whether 60 layers are sufficient