

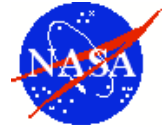
NEW IGS Tropospheric Delay Production Activities at JPL

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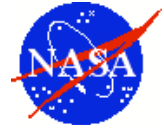
Introduction



-
- **IGS Legacy Tropospheric Product**
 - **IGS New Tropospheric Product**
 - New product and its advantages
 - Comparison and summary report
 - **Applications of the New Product**



The New IGS Tropospheric Product



- Independent of individual contribution by the ACs
 - Directly derived from RINEX files from each site
 - Precise Point Positioning(PPP) approach is used
 - One file per site per day
- Advantages of the new approach
 - Allow for the processing of ALL available IGS sites
 - More efficient processing
 - Offers better quality product
 - Offers several operational advantages
- Back-processing performed up to October 2000

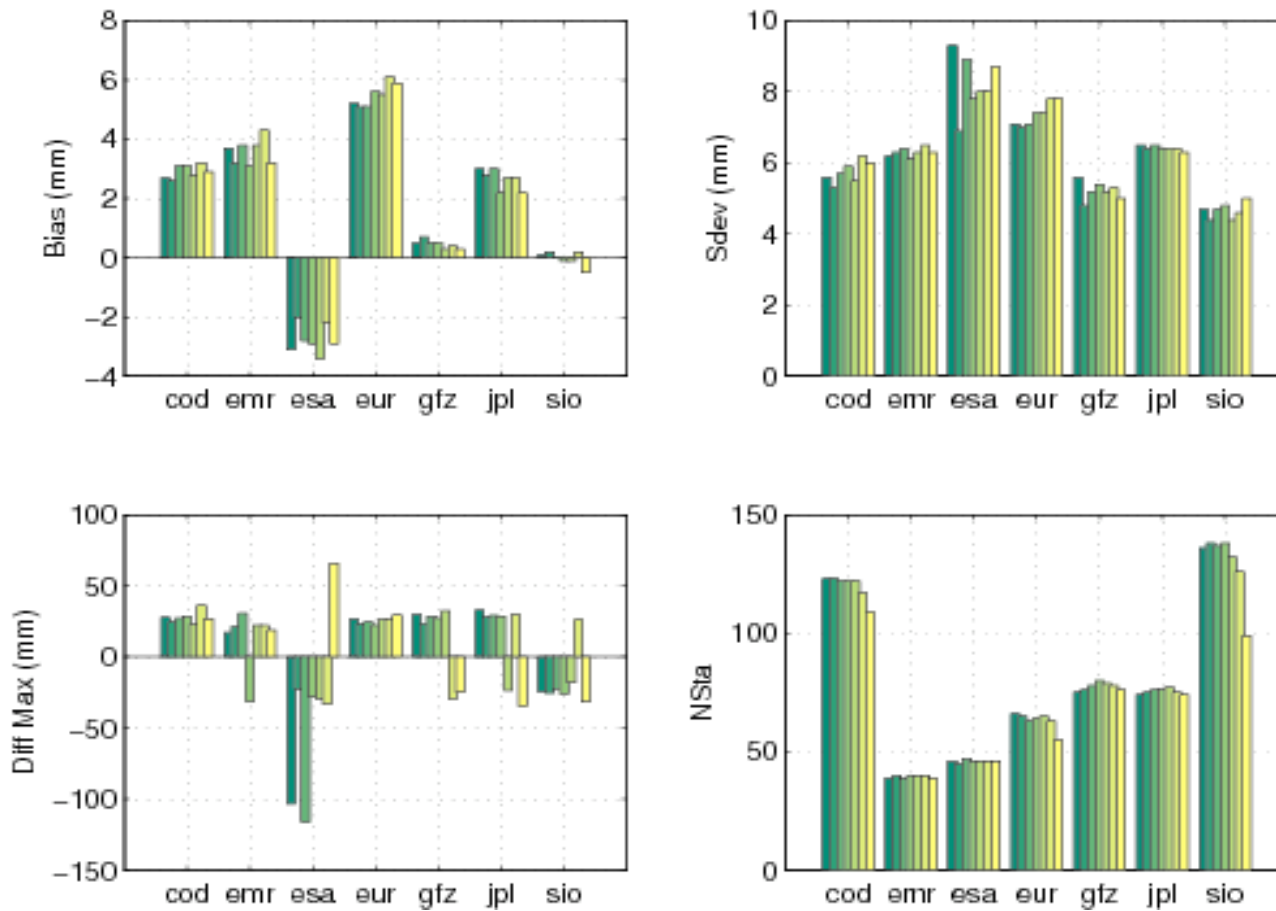


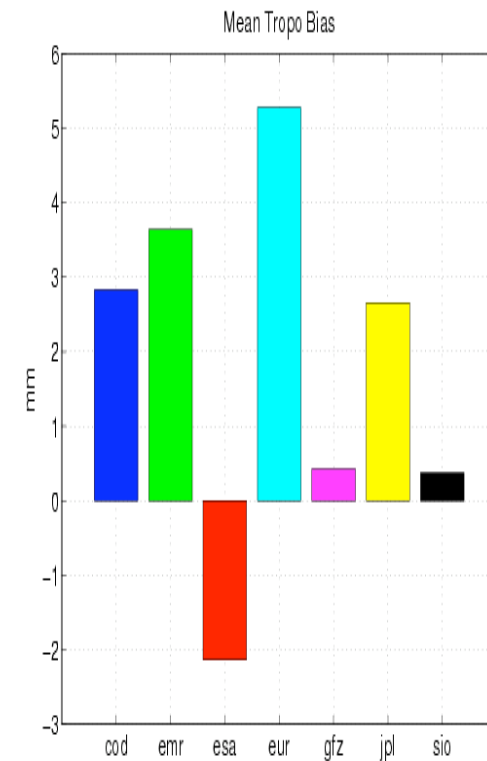
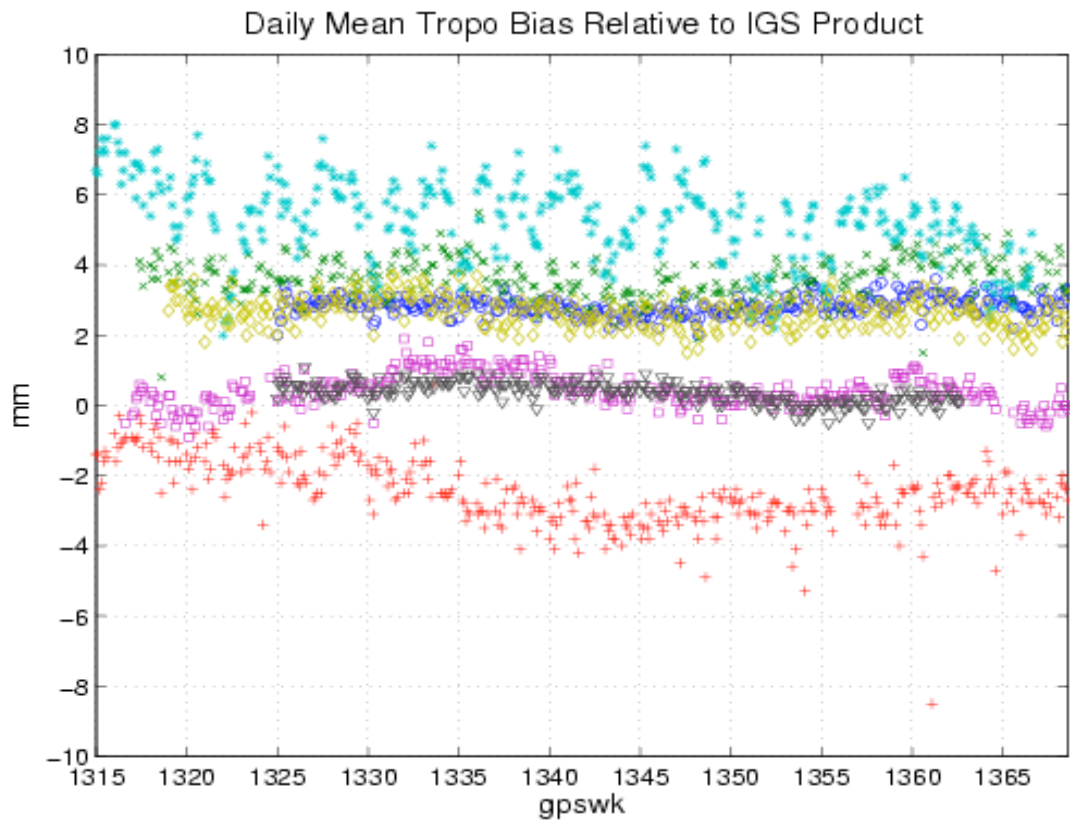
New IGS Tropospheric Product Files



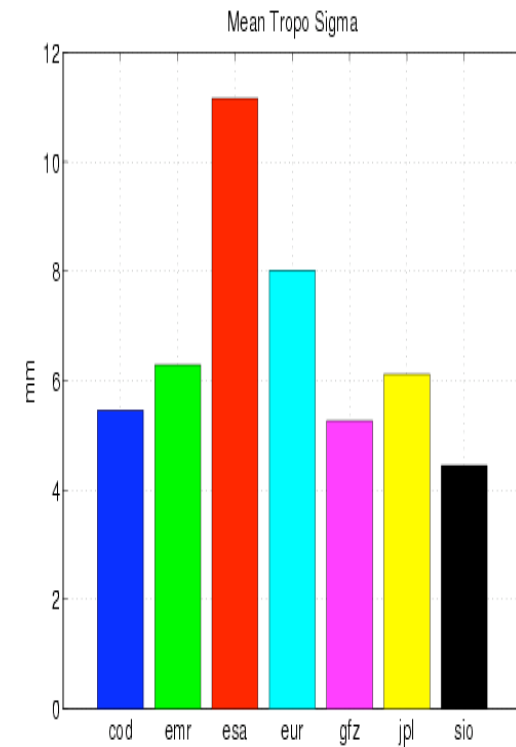
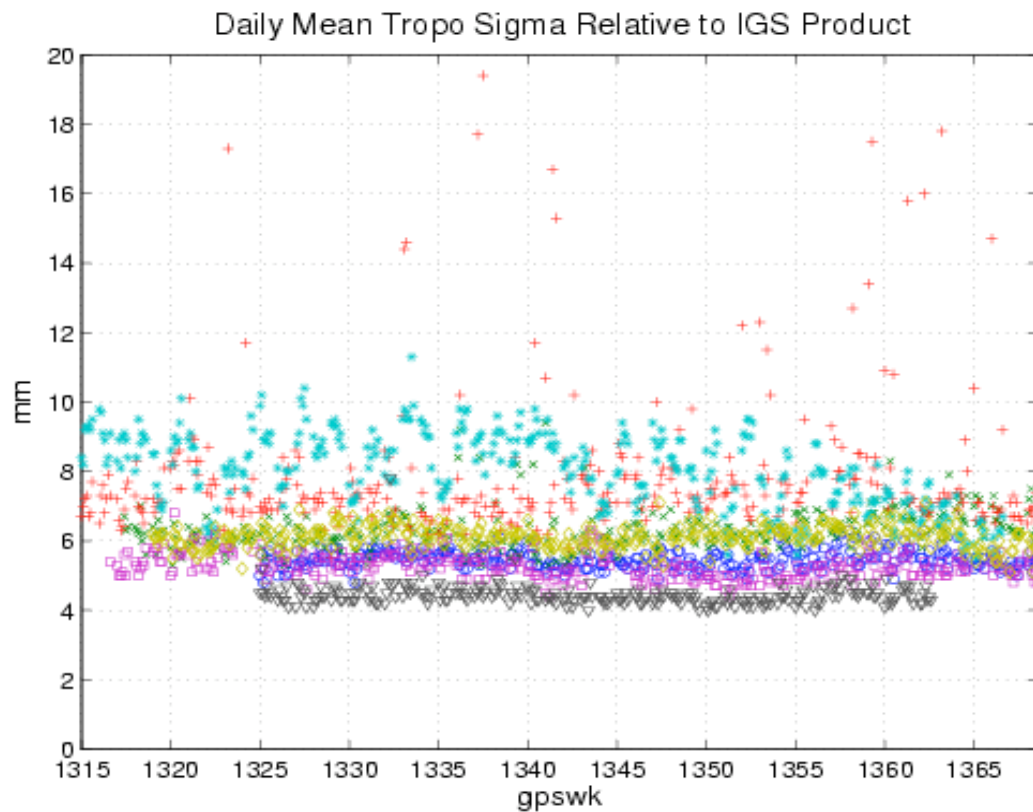
- TROP **new**
 - One file per day per station: `ssssddd0.yyzpd`
- TROP **cmp**
 - Individual AC's submitted solution is compared with the new ZPD product
 - One file per day for all stations: `TROPddd0.yycmp`
- TROP **rpt**
 - Summary comparison report and plots
 - One file per week: `TROPwwwwx.rpt`, `TROPwwwwx.eps`

AC – IGS ZPD Comparison for gpswd: 135/0–135/6

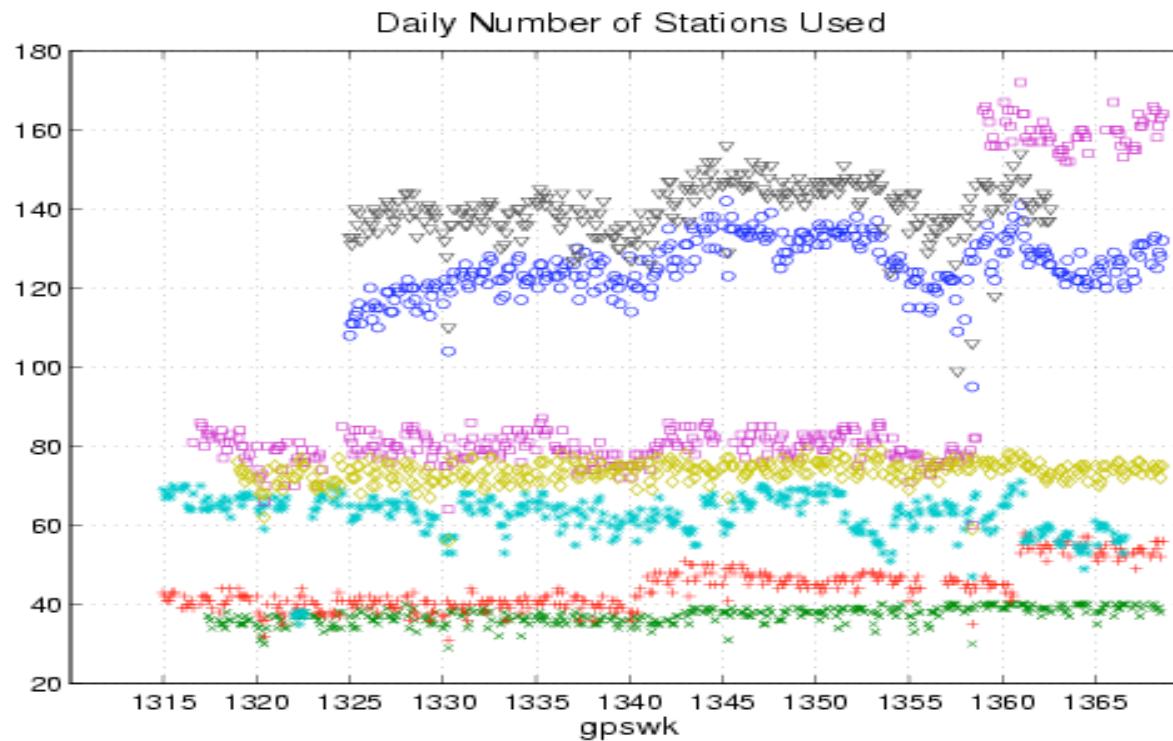




Bias is about the level of AC's tropo solution accuracy



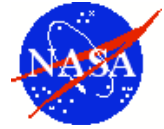
Sdev is about the level of AC's trop solution accuracy



- IGS currently has 350+ active sites
- Legacy trop combination strategy may not be the best approach



New IGS Trop Product Usage



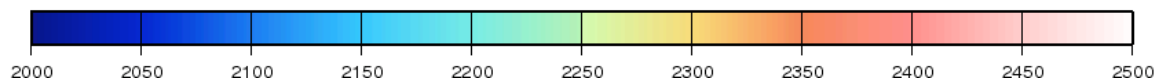
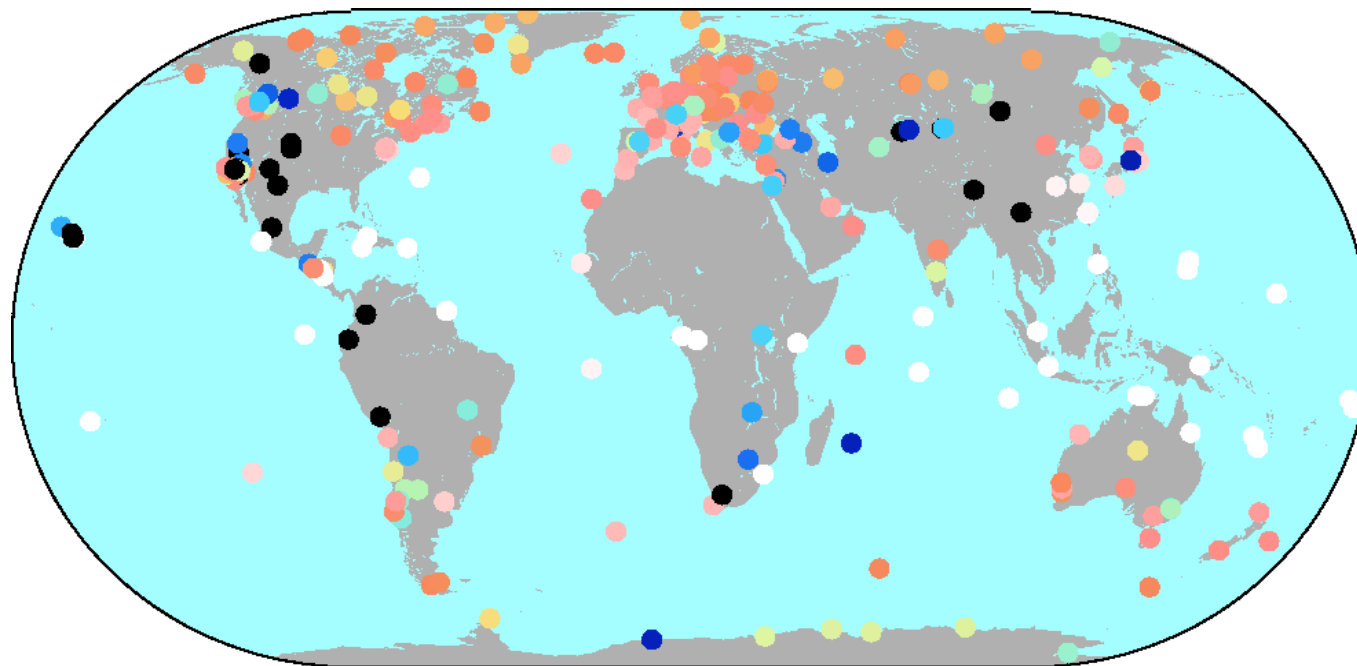
Legacy Product

- 510K files in 2005
- 343K files in 2006

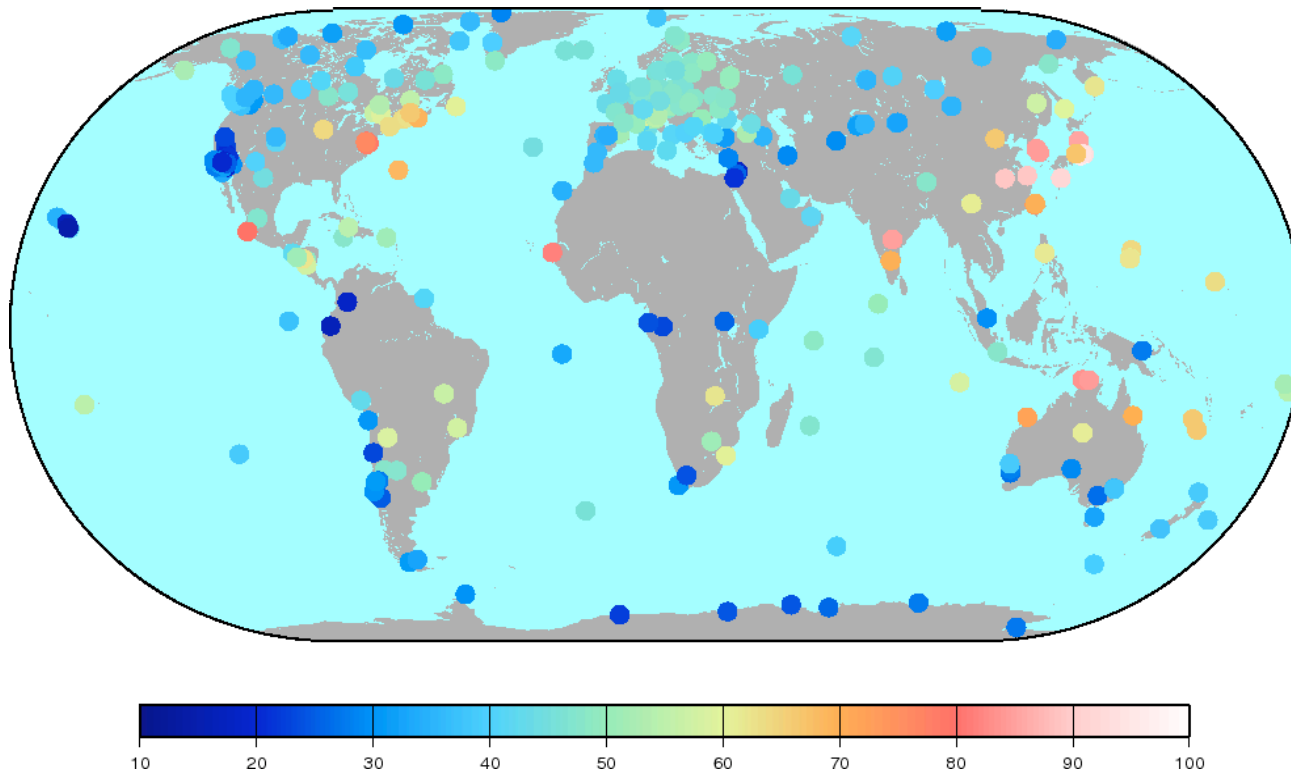
New Product

- 736K files in 2005
- 2,442K files in 2006

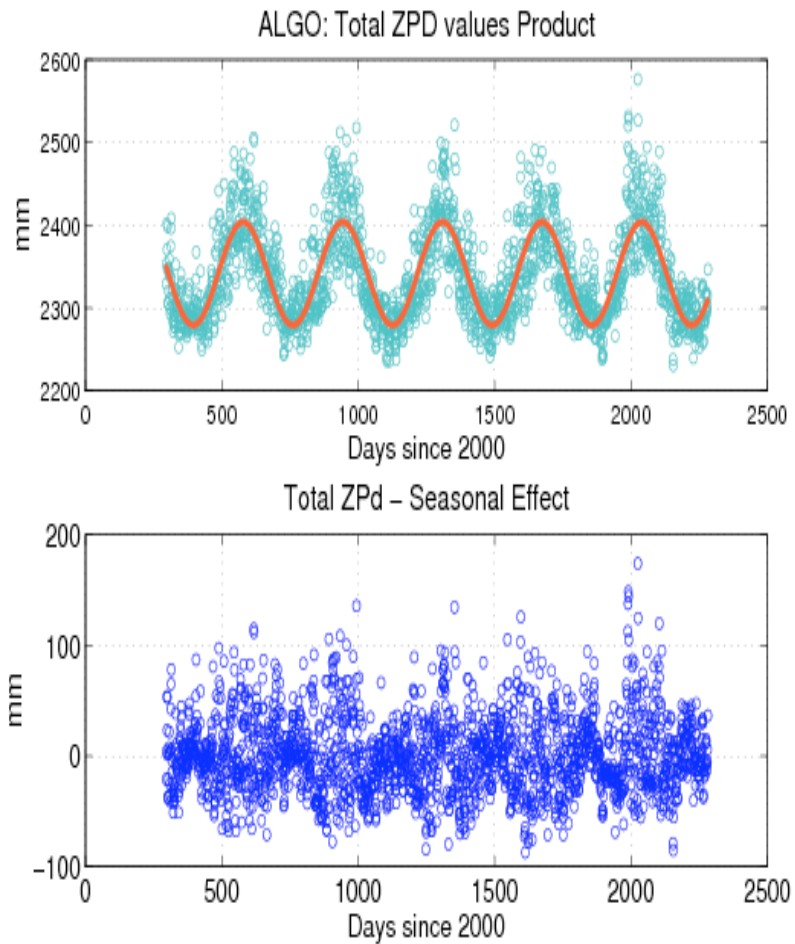
The number of files downloaded from gsfc cddis alone



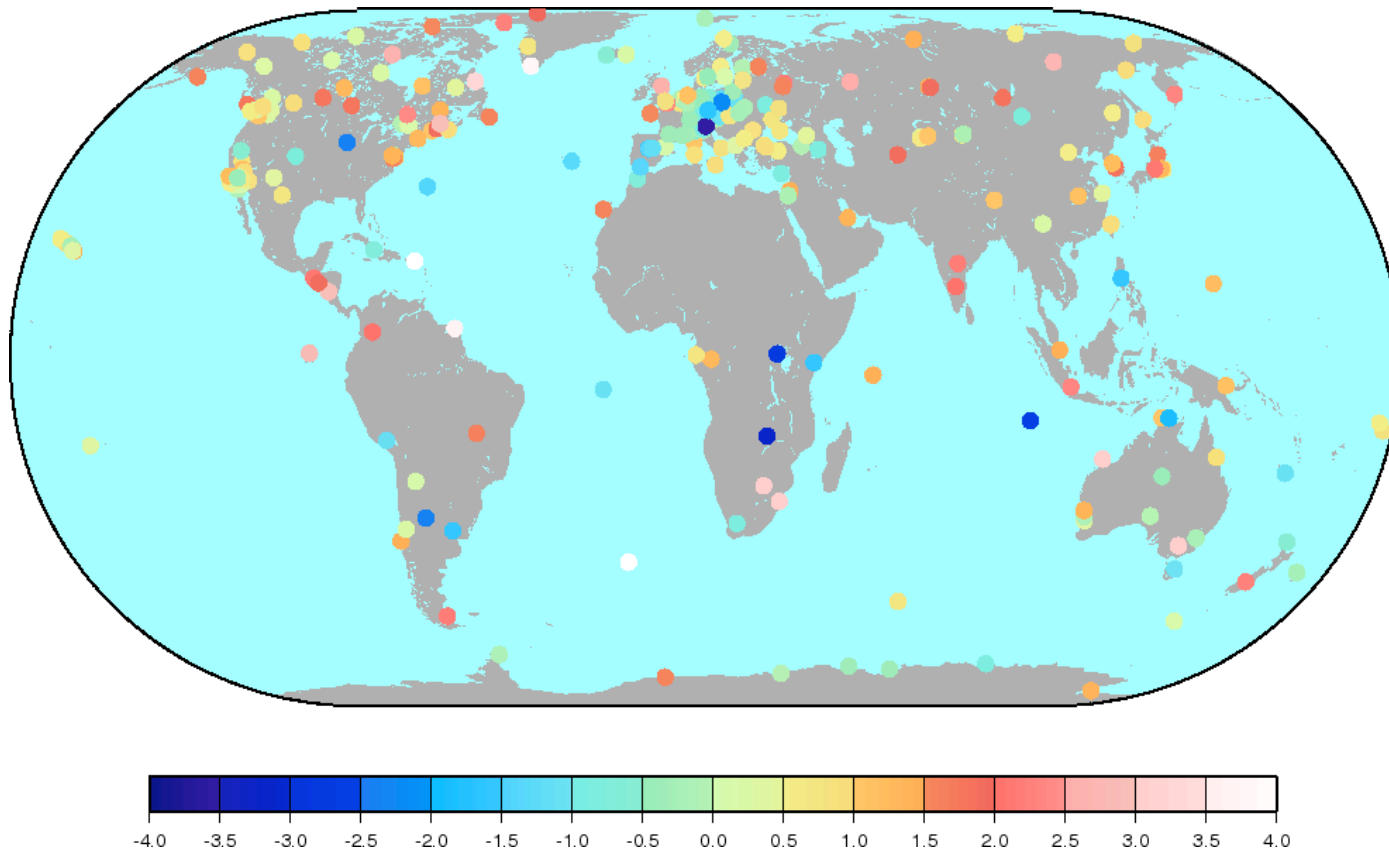
- Mean ZPD (mm) value for 350 IGS sites
- Elevation and weather effects
- Min 1514mm at mkea (Hawaii), Max 2630mm at nklg (Gabon)

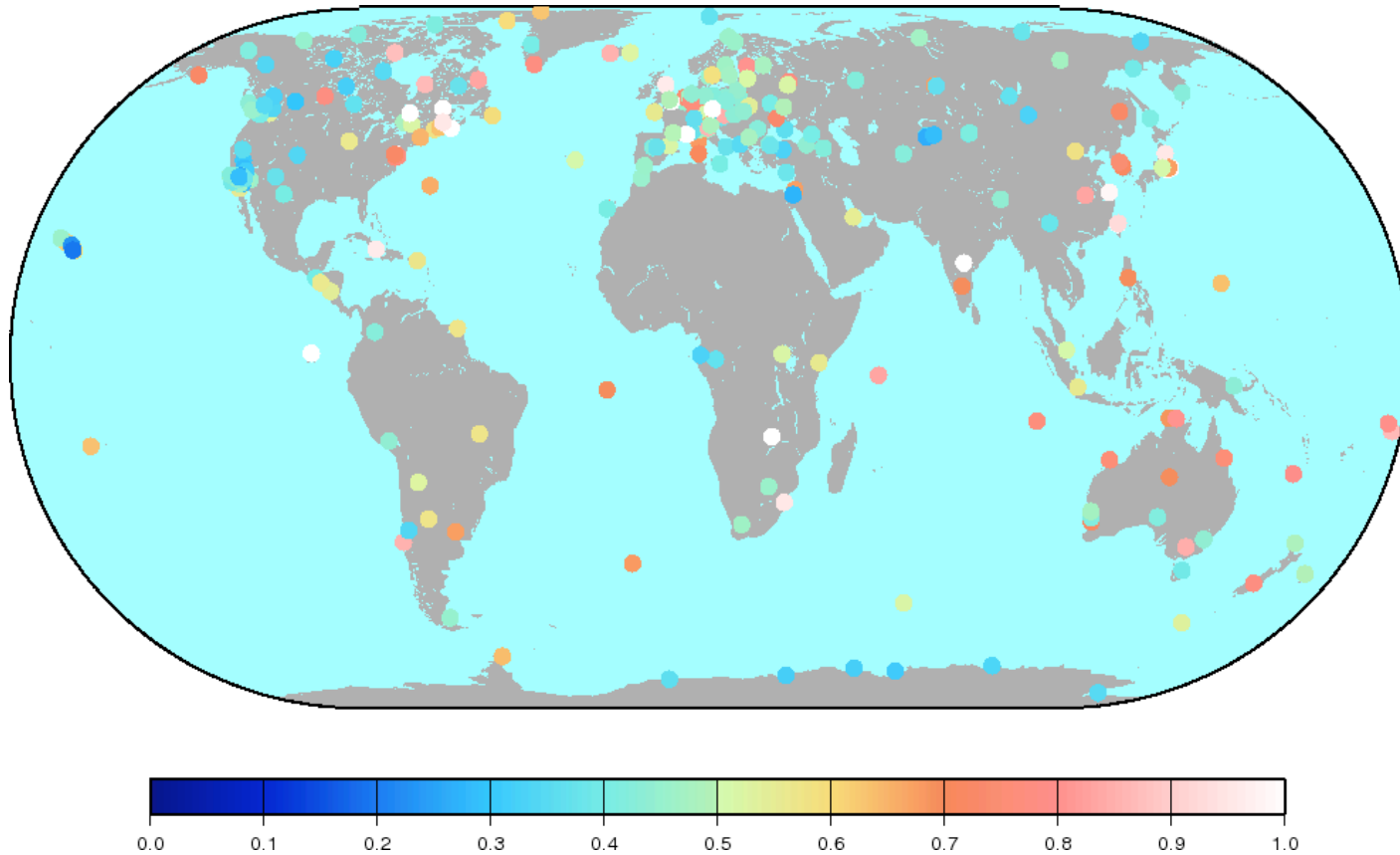


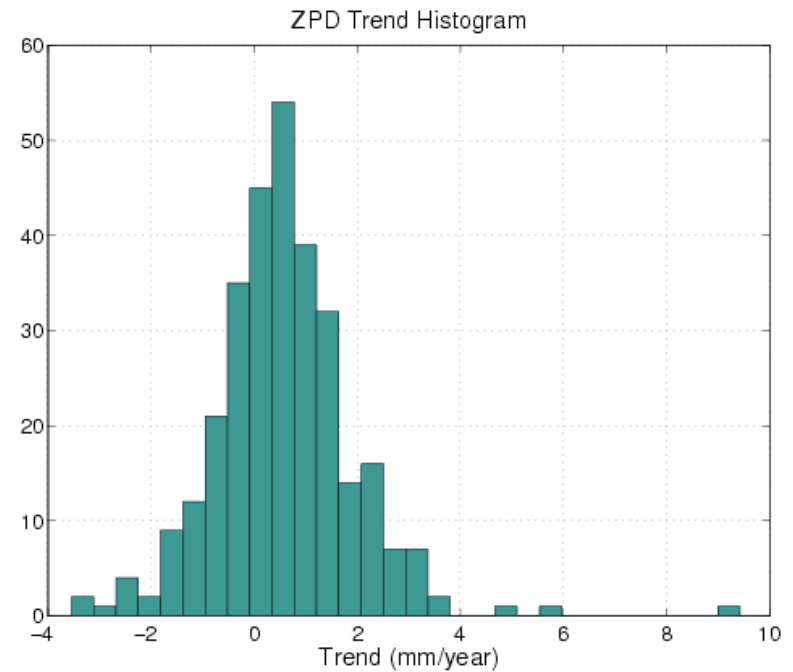
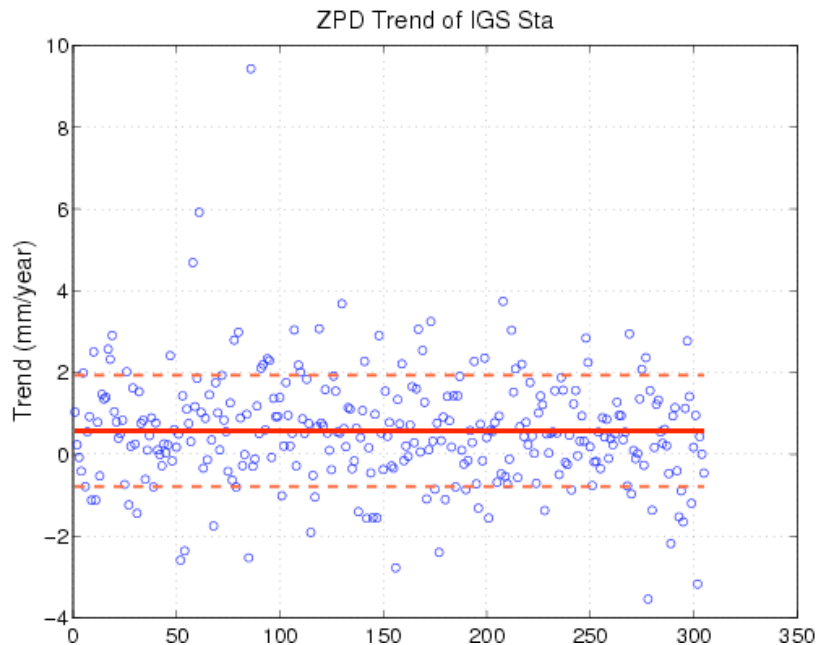
- Continental weather effect on the eastern side of continents
- Monsoon effect on India and Northern Australia
- Min 14.5mm at mkea (Hawaii), Max 97mm at mtka (Japan)



- ALGO with 5.5 years of data
- Seasonal effect is removed
- Linear fitting for the residual (trend)
- Only for sites with > 1000 days
- Total 305 sites





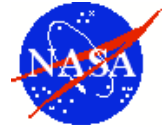


- Total N = 305 sites (> 1000 days) used
- Trend Mean = 0.5724 mm/year
- Standard Error in the Mean = 0.0779 mm/year

-
- **IGS has been exploring the new approach for the Tropospheric product since early 2003**
 - PPP is used instead of combining AC solution
 - More efficient, flexible, and precise
 - **Better Quality Control**
 - More stable, robust, and reliable
 - **More Scientific Opportunity**
 - More stations, longer time series



Backup Slides



- **Derived from submitted **ZPD** solutions from each IGS Analysis Center (7 ACs)**
- **An attempt to optimally **combine** these contributions**
 - Weighted mean ZPD values in every two hours
- **Accuracy (Internal Consistency)**
 - 4-5 mm in the ZPD **stddev** (≤ 1 mm in PWV)
 - **Bias** for individual site varies about ± 3 mm

- **Lack of consistency over time**
 - If an AC changes its estimation strategy, the combined product develops spurious climatological signals
- **Integrity is compromised**
 - Too often there are not enough contributed solutions for a site
- **Not enough number of sites with product**
 - Relatively small subset of common sites in all AC's contribution
- **May not be sufficiently accurate**
 - Depends on uneven set of solutions
- **Above shortcomings may have limited its usage**



TROP0360.06cmp



DESCRIPTION Comparison of IGS tropospheric total zenith path delay with all AC solutions
 DATE(S) 06feb05
 CONTACT Sung.H.Byun@jpl.nasa.gov, Yoaz.E.Bar-Sever@jpl.nasa.gov

Table: Statistics for the difference of the individual AC trop estimates to new IGS tropospheric product

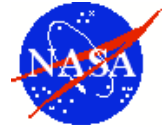
Units: mm of zenith path delay
 bias = mean difference
 max = the max difference in zenith path delay value
 sdev = standard deviation
 npt = number of point used for comparison

EMR is NRC; NGS is NOAA

+Center	COD	EMR			ESA			EUR			GFZ			JPL			SIO													
		bias	max	sdev	npt	bias	max	sdev	npt	bias	max	sdev	npt	bias	max	sdev	npt	bias	max	sdev	npt									
.TOTAL		2.9	23.9	5.5	1679	4.3	23.0	6.7	958	111.6	6921.5	1003.8	597	4.7	26.4	6.6	1678	0.6	-56.1	5.7	4114	2.5	25.3	6.1	22171	0.3	-26.0	4.6	3684	
ajac A		-	-	-	-	-	-	-	-	-	-	-	-	6.6	17.2	7.8	23	-	-	-	-	-	-	-	-	-	-	-	-	
albh A		1.8	6.6	4.2	12	-	-	-	-	-	-	-	-	0.9	7.5	3.2	24	-	-	-	-	-	-	-	-2.7	-9.6	4.1	24		
algo A		8.1	12.7	8.7	12	6.5	13.6	7.4	24	-0.7	-11.5	4.9	12	-	-	-	-	-3.3	-7.3	4.1	24	5.3	12.0	6.3	286	1.5	5.0	2.8	24	
alic A		8.7	13.9	9.3	12	-	-	-	-	-	-	-	-	-1.2	9.4	4.3	24	10.7	21.6	11.1	24	10.7	21.6	11.1	286	3.5	11.2	5.1	24	
alrt A		3.2	7.7	3.7	12	-	-	-	-	-	-	-	-	1.3	4.3	1.9	24	3.2	8.8	3.6	24	3.2	8.8	3.6	286	1.9	7.9	3.4	24	
amc2 A		10.7	14.7	11.2	12	-	-	-	-	4.5	9.8	5.4	12	-	-	-	-	4.6	8.4	5.2	24	18.6	25.3	18.7	286	6.4	11.2	7.0	24	
areq A		5.1	7.7	5.2	12	-	-	-	-	-	-	-	-	2.1	8.2	3.7	24	1.5	7.9	3.2	24	1.5	7.9	3.2	286	3.1	11.2	5.0	24	
artu A		6.6	9.7	6.9	12	14.4	20.3	14.6	24	4.9	8.9	5.5	12	-	-	-	-	-1.4	-5.7	2.4	24	12.6	15.6	12.7	286	0.6	5.6	2.4	24	
asc1 A		1.2	10.7	4.3	12	0.5	6.7	3.3	24	-	-	-	-	-	-	-	-	1.3	8.2	3.8	24	-0.5	-7.9	2.9	286	0.1	7.5	3.5	24	
aspa A		7.5	14.2	8.5	12	-	-	-	-	-	-	-	-	15.8	21.0	16.3	24	-6.0	-13.2	7.1	24	-6.0	-13.2	7.1	286	6.5	14.1	7.3	24	
[snip]																														
wroc A		-	-	-	-	-	-	-	-	-	-	-	-	7.4	11.5	7.6	24	-	-	-	-	-	-	-	-	-	-	-	-	
wsrt A		-	-	-	-	-	-	-	-	-	-	-	-	7.3	10.5	7.6	24	1.4	-4.6	2.5	24	-	-	-	-	1.9	5.1	2.6	24	
wuhn A		-	-	-	-	-	-	-	-	-	-	-	-	3.8	10.0	5.2	24	-	-	-	-	-	-	-	-	-0.6	-5.7	3.1	24	
yakt A		5.2	9.1	5.6	12	-	-	-	-	-	-	-	-	-1.9	-8.9	3.6	24	4.4	10.0	5.2	24	4.4	10.0	5.2	286	-0.3	-6.4	2.5	24	
yar2 A		-	-	-	-	-	-	-	-	-	-	-	-	4.5	10.5	5.6	24	-	-	-	-	-	-	-	-	-	3.8	9.5	4.9	24
yarr A		8.7	14.7	9.6	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
yebe A		-	-	-	-	-	-	-	-	-	-	-	-	2.2	8.2	3.2	24	-	-	-	-	-	-	-	-	-	-	-	-	
yell A		6.4	8.9	6.5	12	8.8	13.1	9.0	24	5.4	10.2	6.2	12	-	-	-	-	0.4	3.7	1.9	24	6.9	11.0	7.1	286	1.5	5.8	2.4	24	
yssk A		1.9	5.2	2.5	12	-	-	-	-	-	-	-	-	0.1	3.6	1.9	24	-	-	-	-	-	-	-	-	-	-0.6	-4.1	2.4	24
zimm A		2.1	6.4	3.6	12	-	-	-	-	-	-	-	-	6.3	14.1	7.3	24	3.9	9.2	4.7	24	-	-	-	-	2.0	7.1	3.3	24	
zwe2 A		-	-	-	-	-	-	-	-	-	-	-	-	0.2	3.4	1.3	24	-	-	-	-	-	-	-	-	-	-1.4	-4.7	2.1	24



TROP1357x.rpt



```
#gpswk AC | bias bimax sta | sdev sdmax sta | dfmax sta | nsta npts
#-----#-----#-----#-----#-----#-----#-----#-----#-----#-----#-----#-----#
13570 cod | 2.7 18.6 dwh1 | 5.6 19.0 dwh1 | 27.6 dwh1 | 123 1474
13570 emr | 3.7 10.0 pol2 | 6.2 10.4 pol2 | 17.0 hofn | 39 930
13570 esa | -3.1 -30.2 kit3 | 9.3 51.9 kit3 | -103.2 kit3 | 46 528
13570 eur | 5.2 19.2 joze | 7.1 19.6 joze | 26.6 joze | 66 1574
13570 gfz | 0.5 -11.6 tid2 | 5.6 12.7 guam | 29.9 dgar | 75 924
13570 jpl | 3.0 20.5 amc2 | 6.5 20.7 amc2 | 32.6 brmu | 74 21074
13570 sio | 0.1 -12.0 tid2 | 4.7 12.6 tid2 | -24.4 guam | 136 3255
13571 cod | 2.6 14.0 dwh1 | 5.3 14.6 dwh1 | 24.5 conz | 123 1461
13571 emr | 3.2 11.2 hofn | 6.3 11.8 hofn | 21.4 kokb | 40 952
13571 esa | -2.0 -11.3 dgar | 6.9 11.8 dgar | -22.5 hrao | 45 536

[snip ]

13575 gfz | 0.4 16.1 pimo | 5.3 16.6 pimo | -29.4 ous2 | 78 956
13575 jpl | 2.7 16.1 amc2 | 6.4 16.2 amc2 | 29.7 guao | 75 21352
13575 sio | 0.2 12.6 bako | 4.6 13.0 bako | 26.2 aspa | 126 3015
13576 cod | 2.9 14.6 aspa | 6.0 16.2 bako | 26.7 bako | 109 1300
13576 emr | 3.2 11.2 mbar | 6.3 11.8 mbar | 18.8 mbar | 39 934
13576 esa | -2.9 22.7 kit3 | 8.7 37.9 kit3 | 65.7 kit3 | 46 526
13576 eur | 5.9 19.5 joze | 7.8 19.6 joze | 29.3 rabt | 55 1311
13576 gfz | 0.3 -9.7 syog | 5.0 10.1 syog | -25.0 dgar | 76 934
13576 jpl | 2.2 15.2 amc2 | 6.3 15.4 amc2 | -34.8 dgar | 74 21023
13576 sio | -0.5 -10.6 hrao | 5.0 12.6 scub | -31.5 scub | 99 2363
```



Advantages of the New Product



- **Efficiency**
 - PPP method is relatively simple
 - Enables massive production of ZPD solutions
- **Easy Reanalysis and Long Term Stability**
 - New approach is not susceptible to changes in estimation strategy
- **Flexibility**
 - Combined legacy solution is possible if ZPD solution is provided by several ACs
 - New method can produce ZPD for any site with RINEX file Robustness
- **Robustness**
 - Quality of legacy product depends on the number of submitted solutions by ACs
 - Quality of new product depends on the RINEX data quality
- **Accuracy**
 - Can incorporate the best modeling of troposphere and estimation strategy
- **Better Quality Control**
 - Many metrics can be used for the quality control

