Table S1: List of IGS stations used in this paper with their latitude, longitude, and altitude.

name	city	country	lat (°)	lon (°)	alt (m)
ALBH	Victoria	Canada	48.39	-123.49	50.18
ALGO	Algonquin Park	Canada	45.96	-78.07	236.98
ALIC	Alice Springs	Australia	-23.67	133.89	588.12
ANKR	Ankara	Turkey	39.89	32.76	938.82
AREQ	Arequipa	Peru	-16.47	-71.49	2449.07
AUCK	Whangaparaoa Peninsula	New Zealand	-36.60	174.83	97.79
AZU1	Azusa	United States	34.13	-117.90	178.44
BLYT	Blythe	United States	33.61	-114.72	118.99
BOGT	Bogota	Colombia	4.64	-74.08	2553.82
BOR1	Borowiec	Poland	52.28	17.07	88.84
BRAN	Burbank	United States	34.19	-118.28	280.41
BRAZ	Brasilia	Brazil	-15.95	-47.88	1118.61
BRMU	Bermuda	United Kingdom	32.37	-64.70	20.83
BRUS	Brussels	Belgium	50.80	4.36	104.22
CAGL	Cagliari	Italy	39.14	8.97	192.10
CAS1	Casey	Antarctica	-66.28	110.52	39.41
CCJM	Ogasawara	Japan	27.10	142.19	159.85
CEDU	Ceduna	Australia	-31.87	133.81	153.79
CFAG	Caucete	Argentina	-31.60	-68.23	678.26
CHAT	Chatham Islands	New Zealand	-43.96	-176.57	47.78
CHIL	San Gabriel Mountains	United States	34.33	-118.03	1599.88
CHUR	Churchill	Canada	58.76	-94.09	28.80
CIT1	Pasadena	United States	34.14	-118.13	249.45
CMP9	Sylmar	United States	34.35	-118.41	1171.52
COCO	Cocos (Keeling) Island	Australia	-12.19	96.83	3.29
COSO	Coso Junction	United States	35.98	-117.81	1484.55
CRFP	Yucaipa	United States	34.04	-117.10	721.13
CRO1	Christiansted	Virgin Islands, U.S.	17.76	-64.58	11.73
CSN1	Northridge	United States	34.25	-118.52	296.13
DARW	Darwin	Australia	-12.84	131.13	74.66

DAV1	Davis	Antarctica	-68.58	77.97	27.14
DGAR	Diego Garcia Island	United Kingdom	-7.27	72.37	8.95
DHLG	Durmid Hill	United States	33.39	-115.79	-49.01
DRAO	Penticton	Canada	49.32	-119.63	558.42
DUBO	Lac Du Bonnet	Canada	50.26	-95.87	274.96
EBRE	Roquetes	Spain	40.82	0.49	57.62
FAIR	Fairbanks	United States	64.98	-147.50	307.76
FALE	Faleolo	Samoa	-13.83	-172.00	9.73
FLIN	CFS FLIN FLON	Canada	54.73	-101.98	342.32
GODE	Greenbelt	United States	39.02	-76.83	47.77
GOLD	Goldstone	United States	35.43	-116.89	1017.35
GOPE	Ondrejov	Czech Republic	49.91	14.79	547.60
GRAS	Caussols	France	43.76	6.92	1268.25
GRAZ	Graz	Austria	47.07	15.49	490.83
GUAM	Dededo	Guam	13.59	144.87	146.38
HOB2	Hobart	Australia	-42.81	147.44	44.78
HOLB	Holberg	Canada	50.64	-128.14	575.22
HRAO	Krugersdorp	South Africa	-25.89	27.69	1388.81
IISC	Bangalore	India	13.02	77.57	929.62
IRKT	Irkutsk	Russia	52.22	104.32	540.79
JOZE	Jozefoslaw	Poland	52.10	21.03	109.90
JPLM	Pasadena	United States	34.21	-118.17	457.44
KARR	Karratha	Australia	-20.98	117.10	116.71
KERG	Port aux Francais	French Southern Territories	-49.35	70.26	32.76
KIRU	Kiruna	Sweden	67.86	20.97	362.08
KIT3	Kitab	Uzbekistan	39.14	66.89	659.59
KOKB	Kokee Park, Waimea	United States	22.13	-159.67	1150.34
KOSG	Kootwijk	Netherlands	52.18	5.81	53.36
KOUC	Koumac	New Caledonia	-20.56	164.29	23.71
KOUR	Kourou	French Guiana	5.25	-52.81	8.52
LAMA	Olsztyn	Poland	53.89	20.67	157.66

LBCH	Long Beach	United States	33.79	-118.20	8.27
LEEP	Hollywood	United States	34.14	-118.32	519.65
LONG	Irwindale	United States	34.11	-118.00	108.41
LPGS	La Plata	Argentina	-34.91	-57.93	13.93
MAC1	Macquarie Island	Australia	-54.50	158.94	12.22
MADR	Robledo	Spain	40.43	-4.25	776.37
MAS1	Maspalomas	Spain	27.76	-15.63	153.62
MATE	Matera	Italy	40.65	16.70	490.15
MAW1	Mawson	Antarctica	-67.61	62.87	30.48
MCM4	Ross Island	Antarctica	-77.84	166.67	150.46
MDO1	Fort Davis	United States	30.68	-104.02	2026.57
MEDI	Medicina	Italy	44.52	11.65	9.91
METS	Kirkkonummi	Finland	60.22	24.40	75.76
MKEA	Mauna Kea	United States	19.80	-155.46	3728.39
MONP	Laguna Mountains	United States	32.89	-116.42	1874.71
NANO	Nanoose Bay	Canada	49.30	-124.09	24.09
NLIB	North Liberty	United States	41.77	-91.58	239.92
NRC1	Ottawa	Canada	45.45	-75.62	116.02
ONSA	Onsala	Sweden	57.40	11.93	8.97
PENC	Penc	Hungary	47.79	19.28	248.27
PERT	Perth	Australia	-31.80	115.89	45.45
PIE1	Pie Town	United States	34.30	-108.12	2369.48
PIN1	Pinyon Flat	United States	33.61	-116.46	1287.75
POL2	Bishkek	Kyrgyzstan	42.68	74.69	1754.27
POTS	Potsdam	Germany	52.38	13.07	103.99
QUIN	Quincy	United States	39.98	-120.94	1129.41
REYK	Reykjavik	Iceland	64.14	-21.96	26.56
ROCK	Simi Valley	United States	34.24	-118.68	588.08
SANT	Santiago	Chile	-33.15	-70.67	695.17
SFER	San Fernando	Spain	36.46	-6.21	39.08
SHAO	Sheshan	China	31.10	121.20	11.26
SNI1	San Nicolas Island	United States	33.25	-119.52	276.75

SPK1	Saddle Peak	United States	34.06	-118.65	475.57
STJO	St. John's	Canada	47.60	-52.68	143.10
SVTL	Svetloe	Russia	60.53	29.78	60.98
SYOG	East Ongle Island	Antarctica	-69.01	39.58	27.76
TABL	Wrightwood	United States	34.38	-117.68	2259.20
TIDB	Tidbinbilla	Australia	-35.40	148.98	646.50
TOW2	Cape Ferguson	Australia	-19.27	147.06	30.20
TRAK	Irvine	United States	33.62	-117.80	150.29
TSKB	Tsukuba	Japan	36.11	140.09	27.35
UCLP	Los Angeles	United States	34.07	-118.44	146.83
UCLU	Ucluelet	Canada	48.93	-125.54	28.74
USC1	Los Angeles	United States	34.02	-118.29	57.41
USUD	Usuda	Japan	36.13	138.36	1465.31
VILL	Villafranca	Spain	40.44	-3.95	595.40
VNDP	Vandenberg Air Force Base	United States	34.56	-120.62	24.62
WES2	Westford	United States	42.61	-71.49	113.65
WHC1	Whittier	United States	33.98	-118.03	129.37
WHIT	Whitehorse	Canada	60.75	-135.22	1419.57
WILL	Williams Lake	Canada	52.24	-122.17	1110.42
WLSN	Mt. Wilson	United States	34.23	-118.06	1738.07
WSLR	Whistler	Canada	50.13	-122.92	924.11
WTZR	Bad Koetzting	Germany	49.14	12.88	619.21
WUHN	Wuhan	China	30.53	114.36	39.76
YELL	Yellowknife	Canada	62.48	-114.48	207.61
ZIMM	Zimmerwald	Switzerland	46.88	7.47	906.72

Table S2: Short description, source of data (or methodology) of parameters (meteorological variables, teleconnection patterns or climate/oceanic indices) used in the stepwise multiple linear regression. The regions for which the explanatory variables are used, are abbreviated as AFR = Africa, ANTARC = Antarctica, AUS = Australia, EU = Europe, LATIN = Latin America, NA = North America.

Name	Description	Source	Regions
T_{surf}	Surface temperature at the site	ERA-Interim	all
P_{surf}	Surface pressure at the site	ERA-Interim	all
P_{trop}	Tropopause pressure at the site	NCEP/NCAR	all
Prep	Precipitation at the site	http://badc.nerc.ac.uk/browse/badc/cru/data/cru_ts/cru_ts_4.01, see University of East Anglia Climatic Research Unit; Harris, I.C.; Jones, P.D. (2017)	all, except ANTARC
SOLAR	Solar radio flux at 10.7 cm	https://www.esrl.noaa.gov/psd/data/correlation/solar.data	all
QBO	Quasi-Biennial Oscillation	http://www.geo.fu-berlin.de/en/met/ag/strat/produkte/qbo/index.html	all
AOD	Stratospheric Aerosol Optical Depth at 550 nm	https://data.giss.nasa.gov/modelforce/strataer/	all
EP flux	Eliassen- Palm flux	ERA-Interim, http://www.atmo-projects.net/	all except AFR
NAO	North Atlantic Oscillation	http://www.cpc.ncep.noaa.gov/data/teledoc/telecontents.shtml	NA, LATIN, EU, AFR, ASIA
EA	East Atlantic	http://www.cpc.ncep.noaa.gov/data/teledoc/telecontents.shtml	NA, EU, AFR,
EA/WR	East Atlantic/West Russia	http://www.cpc.ncep.noaa.gov/data/teledoc/telecontents.shtml	NA, EU, AFR
SCAND	Scandinavia	http://www.cpc.ncep.noaa.gov/data/teledoc/telecontents.shtml	EU
POL	Polar/Eurasia	http://www.cpc.ncep.noaa.gov/data/teledoc/telecontents.shtml	EU
WP	West Pacific	http://www.cpc.ncep.noaa.gov/data/teledoc/telecontents.shtml	NA, ASIA, AUS

EP-NP	East Pacific-North Pacific	http://www.cpc.ncep.noaa.gov/data/teledoc/telecontents.shtml	NA, ASIA
NP	North Pacific	https://www.esrl.noaa.gov/psd/data/correlation/np.data	NA, ASIA
PNA	Pacific/North American	http://www.cpc.ncep.noaa.gov/data/teledoc/telecontents.shtml	NA, AFR
TNH	Tropical/Northern Hemisphere	http://www.cpc.ncep.noaa.gov/data/teledoc/telecontents.shtml	NA, EU
PT	Pacific Transition	http://www.cpc.ncep.noaa.gov/data/teledoc/telecontents.shtml	NA, LATIN, ASIA, AUS
PDO	Pacific Decadal Oscillation	https://www.esrl.noaa.gov/psd/data/correlation/pdo.data	NA, LATIN, ASIA, AUS, ANTARC
PMM	Pacific Meridional Mode SST Index	https://www.esrl.noaa.gov/psd/data/timeseries/monthly/PMM/	NA, LATIN, ASIA, AUS, ANTARC
SOI	Southern Oscillation index, represents El Niño–Southern Oscillation (ENSO)	https://www.esrl.noaa.gov/psd/data/correlation/soi.data	all
NOI	Northern Oscillation index	https://www.esrl.noaa.gov/psd/data/correlation/noi.data	NA
AO	Arctic Oscillation	https://www.esrl.noaa.gov/psd/data/correlation/ao.data	NA, EU, ASIA
AAO	Antarctic Oscillation	https://www.esrl.noaa.gov/psd/data/correlation/aao.data	LATIN, AFR, AUS, ANTARC
Nina 4	Central Tropical Pacific SST *(5N-5S) (160E-150W)	https://www.esrl.noaa.gov/psd/data/correlation/nina4.data	all

ONI	Oceanic Nino Index	https://www.esrl.noaa.gov/psd/data/correlation/oni.data	all except NA
TNI	Trans-Niño Index	https://www.esrl.noaa.gov/psd/data/correlation/tni.data	NA, ANTARC
WHWP	Western Hemisphere warm pool	https://www.esrl.noaa.gov/psd/data/correlation/whwp.data	NA, LATIN, ASIA, AUS, ANTARC
TNA	Tropical Northern Atlantic Index	https://www.esrl.noaa.gov/psd/data/correlation/tna.data	NA, LATIN, AFR
TSA	Tropical Southern Atlantic Index	https://www.esrl.noaa.gov/psd/data/correlation/tsa.data	LATIN, AFR, ANTARC
AMO	Atlantic multidecadal Oscillation	https://www.esrl.noaa.gov/psd/data/correlation/amon.us.data	all except AUS
AMM	Atlantic Meridional Mode	https://www.esrl.noaa.gov/psd/data/timeseries/monthly/AMM/ammsst.data	NA, LATIN, EU, AFR, ANTARC
CAR	Caribbean SST Index	https://www.esrl.noaa.gov/psd/forecasts/sstlim/timeseries/	NA, LATIN, AFR
IND	Indian Ocean Index	https://www.esrl.noaa.gov/psd/forecasts/sstlim/timeseries/	ASIA, AUS
HAW	Hawaiian Index	https://www.esrl.noaa.gov/psd/forecasts/sstlim/timeseries/	NA,
EqAt	Equatorial Atlantic Index	https://www.esrl.noaa.gov/psd/forecasts/sstlim/timeseries/	NA, AFR

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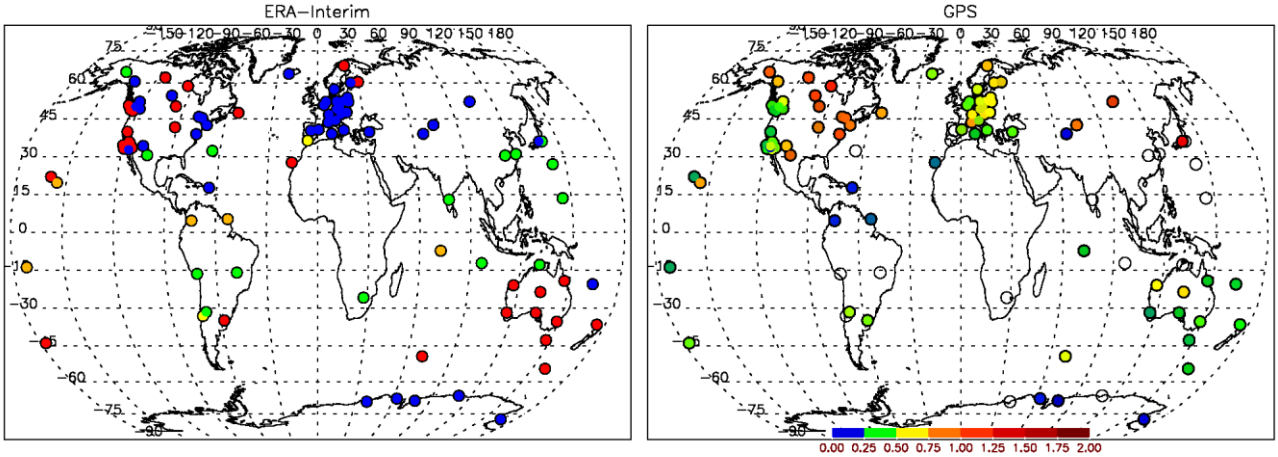

Figure S1: Simular as for Fig. 4, but now a) Classification of the ERA-Interim IWV time series according to their frequency distributions: Gaussian (yellow), standard lognormal (red), reverse lognormal (orange), shouldered lognormal (blue), and bimodal (green). b) Distribution of the geometric standard deviation (GSD) of a single lognormal distribution fitted through the GPS IWV histograms. The sites with unfilled circles have bimodal distributions. Please note that, as for Fig. 4, the colour bar is a discrete indication of the colouring for the specified ranges. The colouring of the dots is done by a continuous scale, to better highlight the subtle GSD differences within a region.

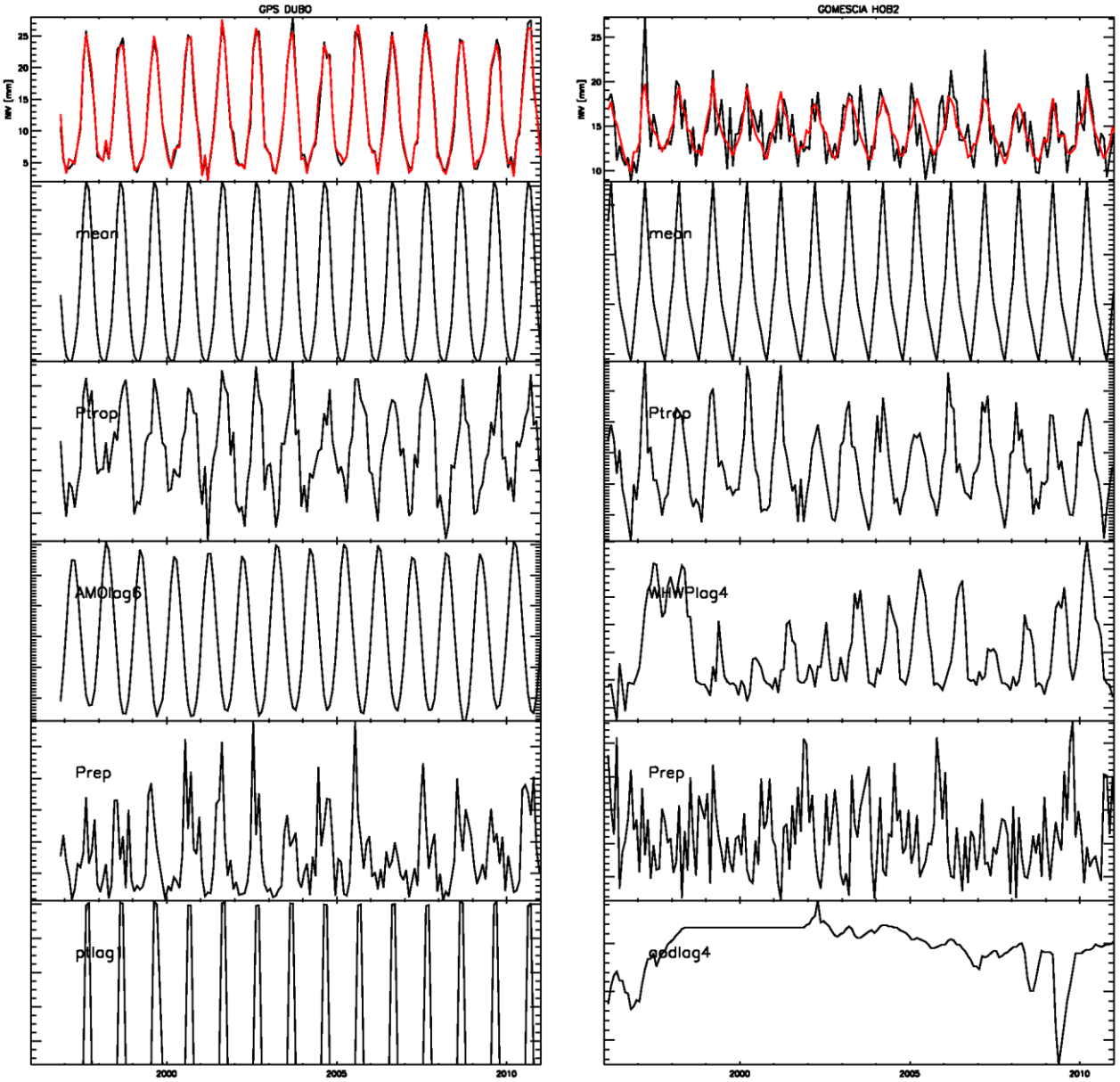

Figure S2: Addendum to Fig. 9. For the multiple linear regression fits (upper panels, in red) to the GPS IWV time series at DUBO (upper left panel, in black) and the GOMESCIA time series at HOB2 (upper right panel, in black), the time series of the 5 explanatory variables that contribute most to the explained IWV variability are shown here from top to bottom. For DUBO, these are the long-term means, P_{trop}, AMO (especially preceding with 6 months), Prep, PT (preceding 1 month), and the long-term means, P_{trop}, WHWP (preceding 4 months), Prep, AOD (preceding 4 months) for HOB2.

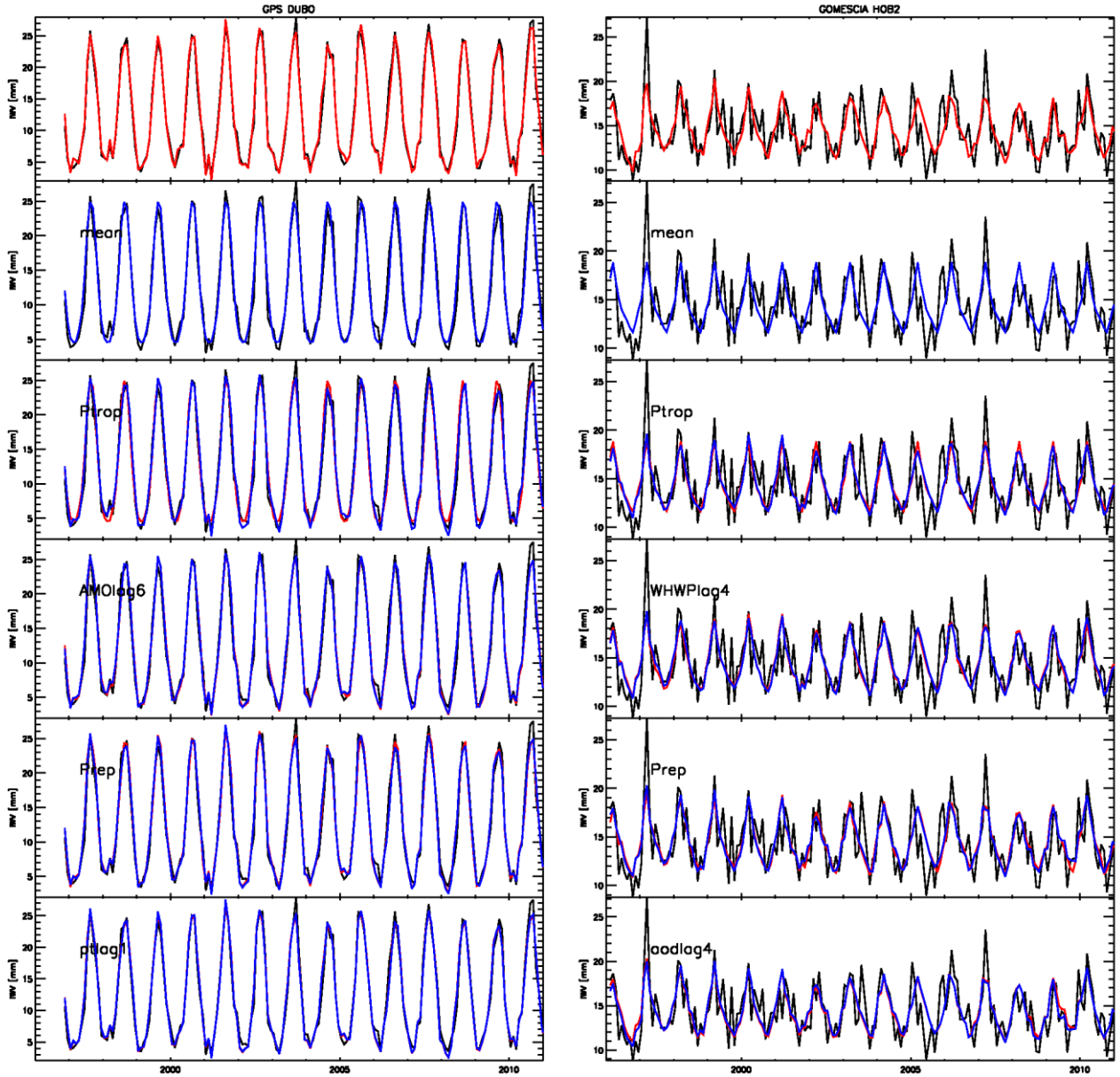

Figure S3: Evolution in the multiple linear regression fits of the GPS IWV time series at DUBO (left) and the GOMESCIA IWV time series at HOB2 (right) when adding, step by step, the time series of the 5 most significant explanatory variables (see Fig. S2) to the multiple linear regression. The observations are in black, the final multiple linear regression fit in red in the upper panels, and the intermediate (multiple) linear regression fits after including 1 to 5 (from top to bottom) explanatory variables in blue. The fits in red in the lowermost 4 panels are the (multiple) linear regression fits of the previous step (i.e. the blue curve of the panel just above it).