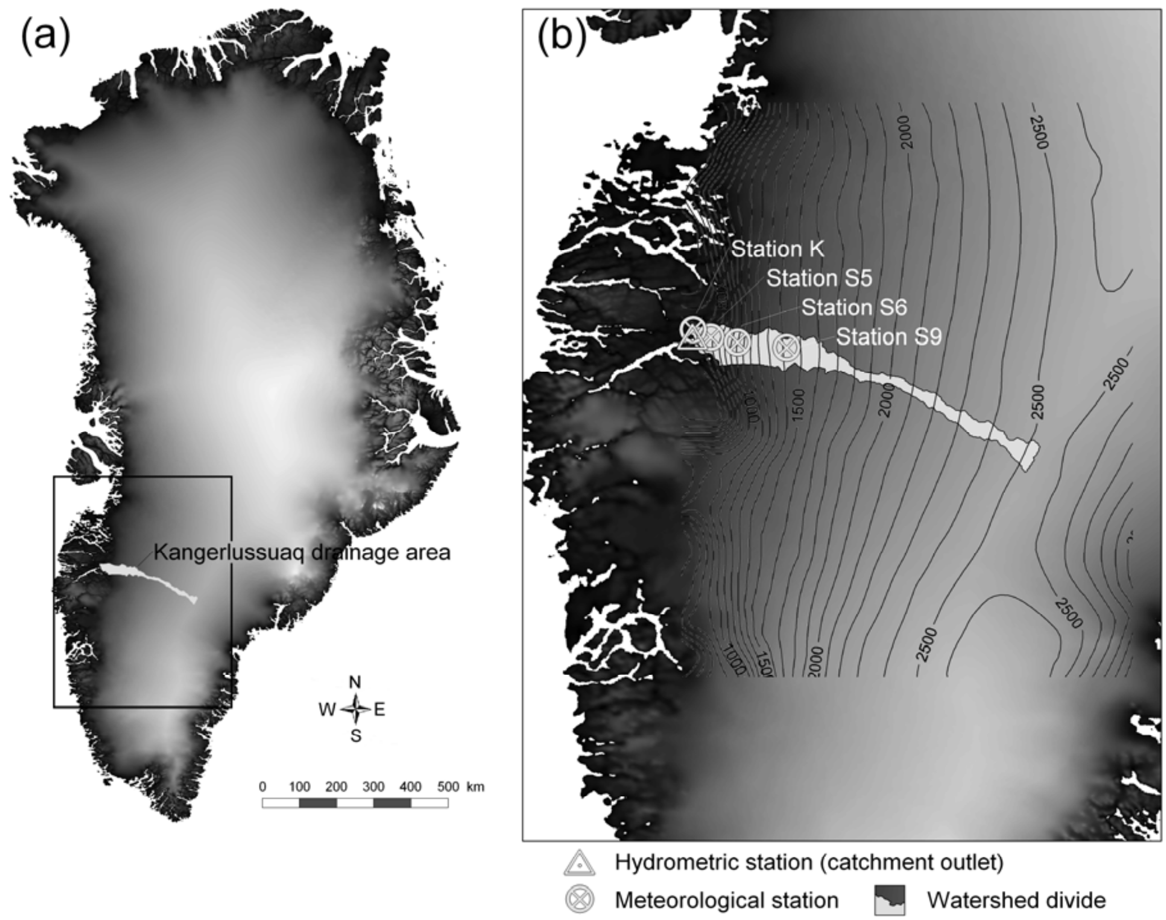

Fig. 1. (a) Greenland including the Kangerlussuaq drainage area (6130 km^2) in West Greenland; **(b)** simulation area with topography (gray shades, and 100-m contour interval), the four meteorological stations: Station K (50 m a.s.l.), S5 (490 m a.s.l.), S6 (1020 m a.s.l.), and S9 (1520 m a.s.l.), the hydrometric station at the catchment outlet, and the catchment watershed divide. The catchment watershed divide was established in River Tools based on the surface DEM by Bamber et al. (2001).

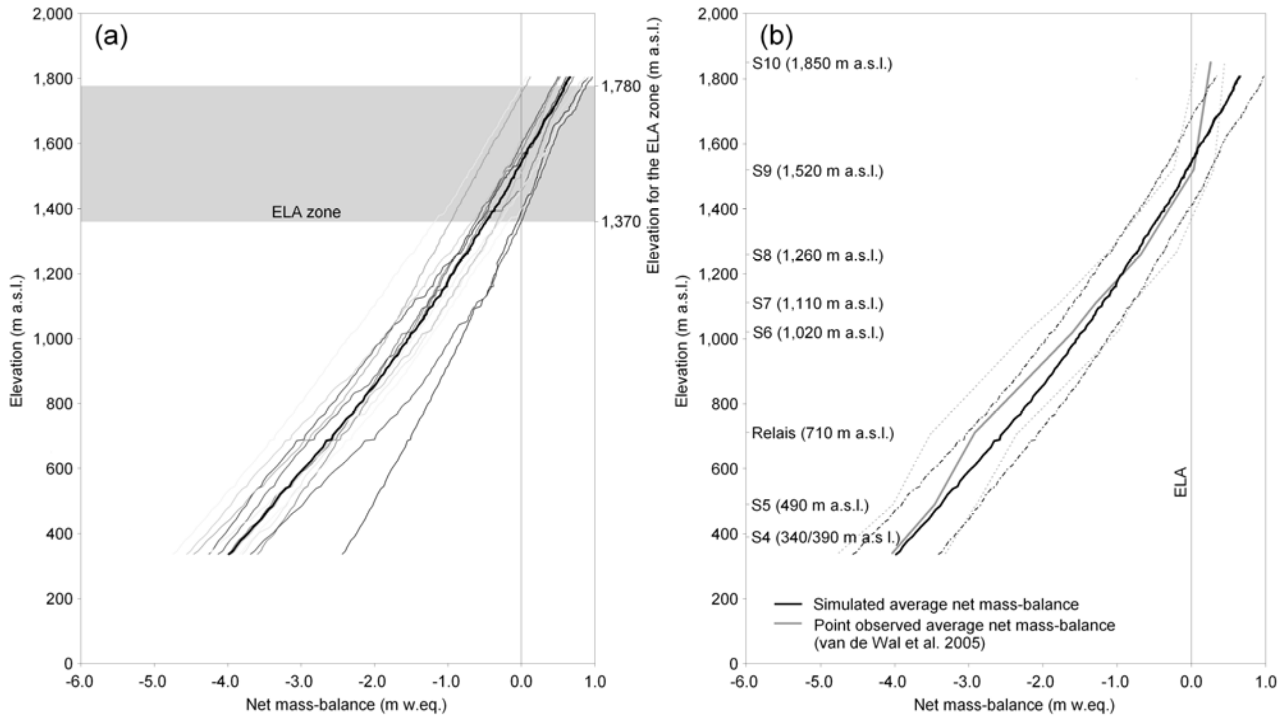

Fig. 2. (a) Simulated GrIS net mass-balance in relation to elevation for the Kangerlussuaq drainage area for the period 1990 through 2003 (similar to the period of observed net mass-balance published in van de Wal et. al 2005). The different years are not displayed individually; **(b)** a comparison between Kangerlussuaq GrIS simulated net mass-balance and point observed net mass-balance from the K-transect. The observed values are collected at different elevations from the K-transect as listed in figure b. The dotted lines in figure b indicate one standard deviation for both simulated and observed values.

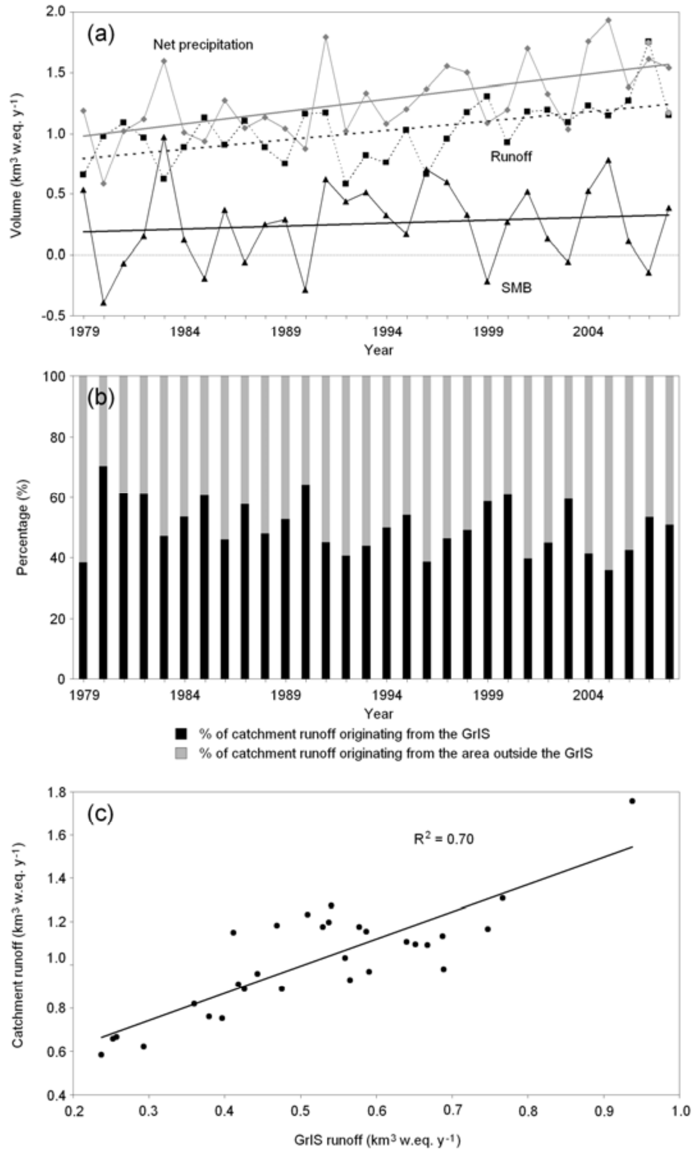

Fig. 3. (a) Kangerlussuaq net precipitation, runoff, and change in storage (ΔS; SMB) series for 1978/79 through 2007/08. For 2007 and 2008, the observed June through August runoff is further illustrated based on data from Mernild et al. (2009); **(b)** percentage of catchment runoff originating from the GrIS and the proglacier landscape (to get the runoff contribution from the proglacier landscape, the GrIS runoff was subtracted from the overall catchment runoff); and **(c)** relationship between GrIS runoff and Kangerlussuaq catchment runoff.

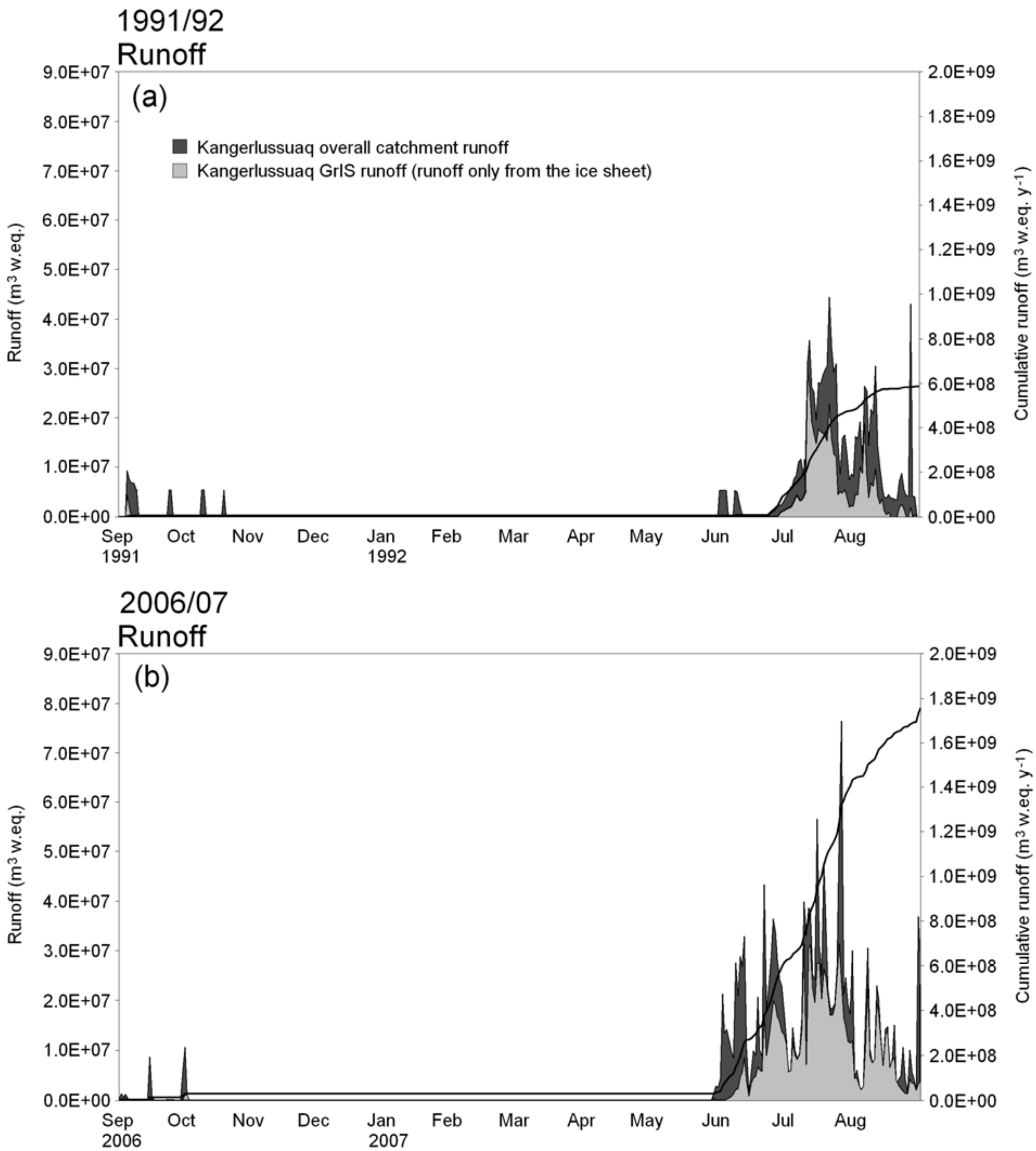

Fig. 4. (a and **b)** Time series of daily modeled runoff for the Kangerlussuaq part of the GrIS and for the Kangerlussuaq drainage area for 1991/92 (the year with the lowest annual cumulative runoff) and 2006/07 (highest cumulative runoff). The period from September through August follows the fixed GrIS mass-balance year.

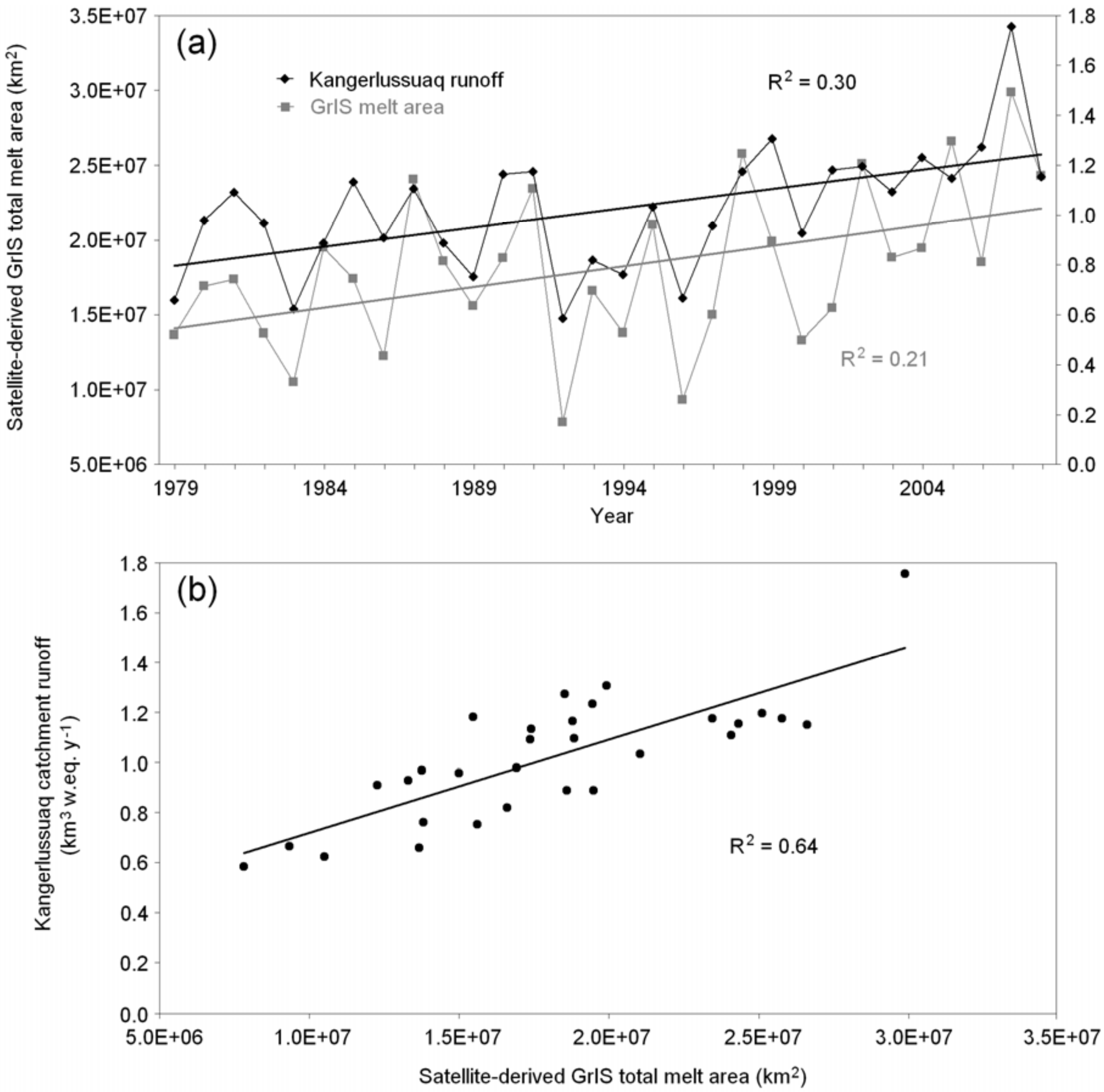

Fig. 5. (a) Time series of Kangerlussuaq simulated runoff and passive microwave satellite-derived GrIS total melt extent area (satellite data provided by CIRES, University of Colorado at Boulder) for 1979 through 2008; and **(b)** relation between satellite-derived GrIS total melt area and Kangerlussuaq catchment runoff. Without the extreme 2006/07 anomaly the r^2 was 0.57.

Table 1. Meteorological input data for the Kangerlussuaq simulations. Meteorological station data on the GrIS (S5, S6, and S9) were provided by Utrecht University, and coastal meteorological station data (K; Kangerlussuaq) by the Danish Meteorological Institute (DMI). For further information about the S-stations see e.g., van den Broeke et al. (2008a).

Meteorological station name	Location	Grid	Data time period for runoff simulations	Altitude (m a.s.l.)	Parameters
K	Town Kangerlussuaq	67°01′N, 50°42′W*	1 Sep 1979 – 31 Aug 2008	50	Air temperature, relative humidity, wind speed, wind direction, and corrected precipitation
S5	Ice Sheet	67°06′N, 50°07′W	1 Sep 2006 – 31 Aug 2007	490	Air temperature, relative humidity, and wind speed
S6	Ice Sheet	67°05′N, 49°23W	1 Sep 2006 – 31 Aug 2007	1,020	Air temperature, relative humidity, and wind speed
S9	Ice Sheet	67°03″N, 48°14′W	1 Sep 2006 – 31 Aug 2007	1,520	Air temperature, relative humidity, and wind speed

* The meteorological station in Kangerlussuaq was moved 660 m, with no change in elevation, in 2004, to the present location at the airport (50ma.s.l.) (personal communication, Juncher Jensen, Danish Meteorological Institute, 2009). No air temperature correction was made to the Kangerlussuaq meteorological data.

Table 2. User-defined constants used in the SnowModel simulations (see Liston and Sturm (1998) for parameter definitions).

Symbol	Value	Parameter
C_v		Vegetation snow-holding depth (equal surface roughness length, Z_0) (m)
	0.50	- Barren bedrock/vegetation
	0.50	- River valley
	0.01	- Ice/snow
F	500.0	Snow equilibrium fetch distance (m)
U_{*t}	0.25	Threshold wind-shear velocity (m s^{-1})
dt	1	Time step (daily)
$dx = dy$		Grid cell increment (km)
	0.5	- Greenland Ice Sheet Kangerlussuaq simulation area
α		Surface albedo
	0.5–0.8	- Snow (variable snow albedo according to surface snow characteristics)
	0.4	- Ice
ρ		Surface density (kg m^{-3})
	280	- Snow
	910	- Ice
ρ_s	550	Saturated snow density (kg m^{-3})

Table 3. Observed and modeled snow depth for Station S9 at the end of winter (31 May).

	2003/04	2004/05	2005/06	2006/07	Average and standard deviation
Observed average snow depth at Station S9 carried out at the end of May, mm	830	1,090	870	730	880(±150)
Modeled snow depth at May 31 at Station S9 based on precipitation data from Station K, mm	1,220	1,590	1,260	1,060	1,280(±220)
Modeled snow depth at May 31 at Station S9 based on iterative precipitation adjustment routines, mm (Liston and Hiemstra, 2008)	840	1,090	880	730	890(±150)

Table 3. Rank-ordered Kangerlussuaq catchment net precipitation (defined as P–(SU+ET)), runoff (R), change in storage (ΔS), and catchment summer (June, July, and August) air temperature anomaly for 1978/79 through 2007/08, where P is the precipitation input from snow and rain (and possible condensation), ET is evapotranspiration (liquid-to-gas phase [atmosphere] flux of water vapor), and SU is sublimation, including blowing-snow sublimation (snow blowing; solid-to-gas phase with no intermediate liquid stage). The yearly water balance equation for the catchment can be described by: $P - (ET + SU) - R \pm \Delta S = 0 \pm \eta$. Here, η is the water balance discrepancy (error).

Rank	Net precipitation (N-(SU+E)) (km^3 w.eq. y^{-1})	Runoff (R) (km^3 w.eq. y^{-1})	Change in storage (ΔS; SMB) (km^3 w.eq. y^{-1})	Catchment summer air temperature anomaly (JJA) (°C)
1	1.93 (2004/05)	1.76 (2006/07)	0.97 (1982/83)	1.89 (2003)
2	1.79 (1990/91)	1.31 (1998/99)	0.78 (2004/05)	1.58 (2000)
3	1.76 (2003/04)	1.27 (2005/06)	0.70 (1995/96)	1.43 (2001)
4	1.70 (2000/01)	1.23 (2003/04)	0.62 (1990/91)	1.42 (2007)
5	1.61 (2006/07)	1.20 (2001/02)	0.60 (1996/97)	1.13 (2008)
26	1.02 (1980/81)	0.75 (1988/89)	-0.14 (2006/07)	-1.08 (1996)
27	1.01 (1983/84)	0.67 (1995/96)	-0.19 (1984/85)	-1.53 (1979)
28	0.94 (1984/85)	0.66 (1978/79)	-0.22 (1998/99)	-1.90 (1992)
29	0.88 (1989/90)	0.62 (1982/83)	-0.29 (1989/90)	-2.89 (1983)
30	0.59 (1979/80)	0.58 (1991/92)	-0.39 (1979/80)	-3.18 (1982)
30-year average and standard deviation	1.28(±0.31)	1.02(±0.25)	0.26(±0.34)	0.00(±1.26)