Gibbs SeaWater (GSW) Oceanographic Toolbox of TEOS–10

**Practical Salinity (SP), PSS-78**
- `gsw_Sp_from_C`: Practical Salinity from conductivity, C (incl. for SP < 2)
- `gsw_C_from_SP`: Conductivity, C, from Practical Salinity (incl. for SP < 2)
- `gsw_R_from_SP`: Practical Salinity from conductivity ratio, R (incl. for SP < 2)
- `gsw_Var_from_SP`: Conductivity ratio, R, from Practical Salinity (incl. for SP < 2)
- `gsw_SA_from_SP`: Practical Salinity from a laboratory salinometer (incl. for SP < 2)
- `gsw_SA_FROM_K`: Practical Salinity from Knudsen Salinity

**Absolute Salinity (SA), Preformed Salinity (Sstar) and Conservative Temperature (CT)**
- `gsw_SA_from_SP`: Absolute Salinity from Practical Salinity
- `gsw_Sstar_from_SP`: Preformed Salinity from Practical Salinity
- `gsw_CT_from_t`: Conservative Temperature from in-situ temperature

**Absolute Salinity – Conservative Temperature plotting function**
- `gsw_SA_CT_plot`: function to plot Absolute Salinity – Conservative Temperature profiles on the SA-CT diagram, including the freezing line and selected potential density contours

**Other conversions between temperatures, salinities, entropy, pressure and height**
- `gsw_SA_FROM_A`: Absolute Salinity from Absolute Salinity
- `gsw_SA_FROM_Sstar`: Absolute Salinity from Preformed Salinity
- `gsw_SA_FROM_CT`: Absolute Salinity from Conservative Temperature
- `gsw_SA_FROM_Ent`: Absolute Salinity from Entropy
- `gsw_SA_FROM_P`: Absolute Salinity from Pressure
- `gsw_SA_FROM_Z`: Absolute Salinity from Height
- `gsw_SA_FROM_R`: Absolute Salinity from Relative Humidity
- `gsw_SA_FROM_T`: Absolute Salinity from Temperature
- `gsw_SA_FROM_H`: Absolute Salinity from Humidity
- `gsw_SA_FROM_P`: Absolute Salinity from Pressure
- `gsw_SA_FROM_Z`: Absolute Salinity from Height
- `gsw_SA_FROM_R`: Absolute Salinity from Relative Humidity
- `gsw_SA_FROM_T`: Absolute Salinity from Temperature
- `gsw_SA_FROM_H`: Absolute Salinity from Humidity

**Specific volume, density and enthalpy**
- `gsw_specvol`: specific volume
- `gsw_alpha`: thermal expansion coefficient with respect to CT
- `gsw_beta`: saline contraction coefficient at constant CT
- `gsw_alpha_on_beta`: alpha divided by beta
- `gsw_specvol_alpha`: specific volume, thermal expansion and saline contraction coefficients
- `gsw_specvol_first_derivatives`: first derivatives of specific volume
- `gsw_specvol_second_derivatives`: second derivatives of specific volume
- `gsw_specvol_first_derivatives_wrt_enthalpy`: first derivatives of specific volume with respect to enthalpy
- `gsw_specvol_second_derivatives_wrt_enthalpy`: second derivatives of specific volume with respect to enthalpy
- `gsw_specvol_anomaly`: specific volume anomaly
- `gsw_specvol_anomaly_relative_to_SSO_0_C`: in-situ density and potential density
- `gsw_specvol_diff`: in-situ density, thermal expansion and saline contraction coefficients
- `gsw_dynamic_enthalpy`: first derivatives of density
- `gsw_enthalpy`: second derivatives of density
- `gsw_enthalpy_enthalpy`: second derivatives of density with respect to enthalpy
- `gsw_sound_speed`: sigma0 with reference pressure of 0 dbar
- `gsw_kappa`: sigma1 with reference pressure of 1000 dbar
- `gsw_kappa`: sigma2 with reference pressure of 2000 dbar
- `gsw_kappa`: sigma3 with reference pressure of 3000 dbar
- `gsw_kappa`: sigma4 with reference pressure of 4000 dbar
- `gsw_kappa`: cabbeling coefficient
- `gsw_kappa`: thermobaric coefficient
- `gsw_kappa`: enthalpy
- `gsw_kappa`: difference of enthalpy between two pressures
- `gsw_kappa`: dynamic enthalpy
- `gsw_kappa`: second derivatives of enthalpy
- `gsw_kappa`: sound speed
- `gsw_kappa`: isotropic compressibility
- `gsw_kappa`: internal energy
- `gsw_kappa`: first derivatives of internal energy
- `gsw_kappa`: second derivatives of internal energy
- `gsw_kappa`: Conservative Temperature from enthalpy
- `gsw_SA_from_rho`: Absolute Salinity from density
- `gsw_SA_from_enthalpy`: Conservative Salinity from density
- `gsw_SA_from_temperature`: Conservative Temperature of maximum density of seawater

**Gibbs SeaWater (GSW) Oceanographic Toolbox of TEOS–10**

GSW version 3.06.12
vertical stability and interpolation

gsw_Turner_Rusbrho

gsw_Naquered

gsw_Stabilise_SA_const_t

gsw_CT_freezing_first_derivatives_poly

gsw_CT_freezing_first_derivatives

gsw_SA_freezing_first_derivatives_poly

gsw_SA_freezing_first_derivatives

gsw_IVP_vs_Naquered_ratio

gsw_GEOSTROPHIC_VELOCITY

gsw_Geostrophic_velocity

gsw_Geostrophic_streamfunctions_acoustic_travel_time_and_geostrophic_velocity

gsw_Geo_strf_dyna_height

gsw_Geo_strf_dyna_height_pc

gsw_Geo_strf_isopycnal

gsw_Geo_strf_isopycnal_pc

gsw_Geo_strf_Cunningham

gsw_Geo_strf_Montgomery

gsw_Geo_strf_isopycnal_height

gsw_Geo_strf_PISH

gsw_Geostrophic_velocity

gsw_seawater_and_ice_properties_at_freezing_temperatures

gsw_CT_freezing

gsw_CT_freezing_poly

gsw_t_freezing

gsw_t_freezing_poly

gsw_pot_Enthalpy_ice_freezing

gsw_pot_Enthalpy_ice_freezing_poly

gsw_SA_freezing_from_CT

gsw_SA_freezing_from_CT_poly

gsw_SA_freezing_from_t

gsw_SA_freezing_from_t_poly

gsw_pressure_freezing_CT

gsw_CT_freezing_first_derivatives

gsw_CT_freezing_first_derivatives_poly

gsw_t_freezing_first_derivatives

gsw_t_freezing_first_derivatives_poly

gsw_pot_Enthalpy_ice_freezing_first_derivatives

gsw_pot_Enthalpy_ice_freezing_first_derivatives_poly

gsw_latent_heat_freezing

gsw_pot_Enthalpy_ice_freezing_first_derivatives

gsw_pot_Enthalpy_ice_freezing_first_derivatives_poly

thermodynamic interaction between ice and seawater

gsw_melting_ice_SA_CT_ratio

gsw_melting_ice_SA_CT_ratio_poly

gsw_melting_ice_SA_CT_ratio_equilibrium

gsw_melting_ice_SA_CT_ratio_equilibrium_poly

gsw_melting_ice_fraction_to_freeze_seawater

gsw_melting_ice_fraction_to_freeze_seawater_poly

gsw_melting_ice_SA_CT_ratio

gsw_melting_ice_SA_CT_ratio_poly

gsw_melting_ice_SA_CT_ratio_equilibrium

gsw_melting_ice_SA_CT_ratio_equilibrium_poly

thermodynamic properties of ice

gsw_specvolum_ice

gsw_alpha_wrt_t_ice

gsw_rho_ice

gsw_pressure_coefficient_ice

gsw_sound_speed_ice

gsw_kappa_ice

gsw_kappa_const_t_ice

gsw_internal_energy_ice

gsw_enthalpy_ice

gsw_entrophy_ice

gsw_cp_ice

gsw_chem_potential_water_ice

gsw_Helmholtz_energy_ice

gsw_adiabatic_lapse_rate_ice

gsw_PT0_from_t_ice

gsw_PT0_from_t_ice_poly

gsw_PT0_from_t_ice

gsw_PT0_from_t_ice_poly

gsw_PT0_from_t_ice

gsw_PT0_from_t_ice_poly

gsw_RT0_from_t_ice

gsw_RT0_from_t_ice_poly

gsw_RT0_from_t_ice

gsw_RT0_from_t_ice_poly

gsw_PT0_from_t_ice

gsw_PT0_from_t_ice_poly

gsw_PT0_from_t_ice

gsw_PT0_from_t_ice_poly

seawater and ice properties at freezing temperatures

gsw_CT_freezing

gsw_CT_freezing_poly

gsw_t_freezing

gsw_t_freezing_poly

gsw_pot_Enthalpy_ice_freezing

gsw_pot_Enthalpy_ice_freezing_poly

gsw_SA_freezing_from_CT

gsw_SA_freezing_from_CT_poly

gsw_SA_freezing_from_t

gsw_SA_freezing_from_t_poly

gsw_pressure_freezing_CT

gsw_CT_freezing_first_derivatives

gsw_CT_freezing_first_derivatives_poly

gsw_t_freezing_first_derivatives

gsw_t_freezing_first_derivatives_poly

gsw_pot_Enthalpy_ice_freezing_first_derivatives

gsw_pot_Enthalpy_ice_freezing_first_derivatives_poly

gsw_latent_heat_freezing

gsw_pot_Enthalpy_ice_freezing_first_derivatives

gsw_pot_Enthalpy_ice_freezing_first_derivatives_poly

thermodynamic interaction between sea ice and seawater

gsw_melting_seaice_SA_CT_ratio

gsw_melting_seaice_SA_CT_ratio_poly

gsw_melting_seaice_SA_CT_ratio_equilibrium

gsw_melting_seaice_SA_CT_ratio_equilibrium_poly

gsw_melting_seaice_fraction_to_freeze_seawater

gsw_melting_seaice_fraction_to_freeze_seawater_poly

gsw_melting_seaice_SA_CT_ratio

gsw_melting_seaice_SA_CT_ratio_poly

gsw_melting_seaice_SA_CT_ratio_equilibrium

gsw_melting_seaice_SA_CT_ratio_equilibrium_poly

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isobaric evaporation enthalpy

gsw_latentheat_evap_CT
latent heat of evaporation of water from seawater (isobaric evaporation enthalpy) with CT as input temperature

gsw_latentheat_evap_t
latent heat of evaporation of water from seawater (isobaric evaporation enthalpy) with in-situ temperature, t, as input

spiciness

gsw_spiciness0
spiciness with reference pressure of 0 dbar

gsw_spiciness1
spiciness with reference pressure of 1000 dbar

gsw_SA_CT_from_sigma0_spiciness0
SA & CT from given sigma and spiciness with p_ref of 0 dbar

gsw_SA_CT_from_sigma1_spiciness1
SA & CT from given sigma and spiciness with p_ref of 1000 dbar

gsw_SA_CT_from_sigma2_spiciness2
SA & CT from given sigma and spiciness with p_ref of 2000 dbar

neutral versus isopycnal slopes and ratios

gsw_isopycnal_slope_ratio
ratio of the slopes of isopycnals on the SA-CT diagram for p & p_ref

gsw_isopycnal_vs_ntp_CT_ratio
ratio of the gradient of CT in a potential density surface to that in the neutral tangent plane

gsw_ntp_vs_CT_ratio
ratio of gradients of p & CT in a neutral tangent plane

derivatives of entropy, CT and pt

gsw_CT_first_derivatives
first derivatives of Conservative Temperature

gsw_CT_second_derivatives
second derivatives of Conservative Temperature

gsw_entropy_first_derivatives
first derivatives of entropy

gsw_entropy_second_derivatives
second derivatives of entropy

gsw_PT_second_derivatives
second derivatives of potential temperature

gsw_PT_first_derivatives
first derivatives of potential temperature

planet Earth properties

gsw_f
Coriolis parameter

gsw_grav
gravitational acceleration

gsw_distance
spherical earth distance between points in the ocean

TEOS–10 constants

gsw_T0
Celsius zero point; 273.15 K

gsw_P0
one standard atmosphere; 101325 Pa

gsw_SSO
Standard Ocean Reference Salinity; 35.165 04 g/kg

gsw_upS
unit conversion factor for salinities; (35.165 04/35) g/kg

gsw_cp0
the “specific heat” for use with CT; 3991.867 957 119 63 (J/kg)/K

gsw_C5515
conductivity of SSW at SP=35, t=68=15, p=0; 42.9140 mS/cm

gsw_SonCl
ratio of SP to Chlornitry; 1.80655 (g/kg)–1

gsw_valence_factor
valence factor of sea salt; 1.2432898

gsw_atomic_weight
mole-weighted atomic weight of sea salt; 31.4038218... g/mol

laboratory functions, for use with densimeter measurements

gsw_SA_from_rho_t_exact
Absolute Salinity from density

gsw_deltaSA_from_rho_t_exact
Absolute Salinity Anomaly from density

gsw_rho_t_exact
in-situ density

specific volume, density and enthalpy in terms of CT, based on the exact Gibbs function

gsw_specvol_CT_exact
specific volume

gsw_alpha_CT_exact
thermal expansion coefficient with respect to CT

gsw_beta_CT_exact
saline contraction coefficient at constant CT

gsw_alpha_on_beta_CT_exact
alpha divided by beta

gsw_specvol_alpha_beta_CT_exact
specific volume, thermal expansion and saline contraction coefficients

gsw_specvol0_CT_exact
first derivatives of specific volume

gsw_specvol1_CT_exact
second derivatives of specific volume

first derivatives of specific volume with respect to enthalpy

second derivatives of specific volume with respect to enthalpy

specific volume anomaly

specific volume anomaly relative to SSO & 0°C

in-situ density and potential density

in-situ density, thermal expansion and saline contraction coefficients

first derivatives of density

second derivatives of density

first derivatives of density with respect to enthalpy

second derivatives of density with respect to enthalpy

sigma0 with reference pressure of 0 dbar

sigma1 with reference pressure of 1000 dbar

sigma2 with reference pressure of 2000 dbar

sigma3 with reference pressure of 3000 dbar

sigma4 with reference pressure of 4000 dbar

cabbeling coefficient

thermobaric coefficient

enthalpy

difference of enthalpy between two pressures

dynamic enthalpy

first derivatives of enthalpy

second derivatives of enthalpy

sound speed

isentropic compressibility

internal energy

first derivatives of internal energy

second derivatives of internal energy

Conservative Temperature from enthalpy

Absolute Salinity from density

Conservative Temperature from density

Conservative Temperature of maximum density of seawater
Gibbs SeaWater (GSW) Oceanographic Toolbox of TEOS–10

**dissolved gases**
gsw_ArSol

gsw_ArSol_SP_pt
gsw_Hesol
gsw_Hesol_SP_pt
gsw_KrSol

gsw_KrSol_SP_pt
gsw_N2Sol
gsw_N2Sol_SP_pt
gsw_Nesol
gsw_Nesol_SP_pt
gsw_O2Sol
gsw_O2Sol_SP_pt

**basic thermodynamic properties in terms of in-situ \( t \), based on the exact Gibbs function**
gsw_specvol_t_exact

gsw_alpha_wrt_CT_t_exact

gsw_alpha_wrt_CT_p_t_exact
gsw_beta_const_CT_t_exact
gsw_beta_const_CT_p_t_exact
gsw_beta_const_t_exact
gsw_specvol_anom_standard_t_exact

gsw_rho_t_exact

gsw_pot_rho_t_exact
gsw_sigma0_p_t_exact
gsw_enthalpy_t_exact
gsw_dynamic_enthalpy_t_exact
gsw_CT_first_derivatives_wrt_t_t_exact
gsw_enthality_first_derivatives_wrt_t_t_exact
gsw_sound_speed_t_exact
gsw_kappa_t_exact
gsw_kappa_const_t_exact
gsw_internal_energy_t_exact
gsw_SA_from_rho_t_exact
gsw_jump_rho_t_exact
gsw_infunnel

gsw_internal_energy_maxdensity_exact
gsw_sp_t_exact
gsw_isochoric_heat_cap_t_exact
gsw_chem_potential_relative_t_exact
gsw_chem_potential_water_t_exact
gsw_chem_potential_salt_t_exact
gsw_chem_potential_deriv_water_t_exact
gsw_dilution_coefficient_t_exact
gsw_Gibbs_energy_t_exact

gsw_Helmholtz_energy_t_exact
gsw_osmotic_coefficient_t_exact
gsw_osmotic_pressure_t_exact

argon solubility from SA and CT
argon solubility from SP and pt
helium solubility from SA and CT
helium solubility from SP and pt
krypton solubility from SA and CT
krypton solubility from SP and pt
nitrogen solubility from SA and CT
nitrogen solubility from SP and pt
neon solubility from SA and CT
neon solubility from SP and pt
oxygen solubility from SA and CT
oxygen solubility from SP and pt

**Library functions of the GSW toolbox** *(internal functions; not intended to be called by users)*

The GSW functions call the following library functions:
gsw_gibbs
gsw_gibbs_ice
gsw_SAAR
gsw_Fdelta
gsw_detaSA_atlas
gsw_SA_from_SP_Baltic
gsw_SP_from_SA_Baltic

gsw_infunnel
gsw_entropy_part
gsw_entropy_part_zero

gsw_quadrup
gsw_wigginess
gsw_data_interp
gsw_interp_ref_cast
gsw_linear_interp_SA_CT
gsw_pchip_interp_SA_CT
gsw_r68_interp_SA_CT
gsw_spline_interp_SA_CT
gsw_gibbs_pt_p0

gsw_gibbs_ice_pt_t
gsw_gibbs_ice_pt_0

gsw_specvol_SSO_0

gsw_enthality_SSO_0

gsw_Hill_ratio_at_SP2

The GSW data set:
gsw_data_v3.0

**This file contains:**
(1) the global data set of Absolute Salinity Anomaly Ratio,
(2) the global data set of Absolute Salinity Anomaly Ref.,
(3) a reference cast (for the isopycnal streamfunction),
(4) two reference casts that are used by gsw_demo
(5) three vertical profiles of (SP, \( t \), \( p \)) at known long & lat, plus the outputs of all the GSW functions for these 3 profiles, and the required accuracy of all these outputs.

**documentation set**
gsw_front_page
gsw_check_functions
gsw_demo
gsw_ver
gsw_licence

The GSW Toolbox is available from www.TEOS–10.org