OFFSHORE-TO-NEARSHORE WAVE TRANSFORMATION

(Simplified Approach Using Linear Wave Theory)

Overview

This program processes wave data from an input CSV file, computes nearshore wave parameters at a specified depth, and generates:

- **`output.csv`** – Contains the computed results.
- **`report.txt`** – Provides descriptive statistics of both input and computed variables.

The report includes:

- The command line used to invoke the program.
- Descriptive statistics for each variable (count, mean, standard deviation, minimum, maximum, median, and percentiles at 1%, 10%, 25%, 50%, 75%, 90%, and 99%).
- A table of annual maxima for `swh_offshore` and `swh_local`, with a final row indicating the overall maximum values.

For directional wave data (`mwd_offshore` and `mwd_local`), a hybrid approach is used:

- The circular mean and circular standard deviation are computed using the unit-vector method.
- The minimum, maximum, median, and quantiles are calculated using ordinary linear statistics on the wrapped angles (in [0,360)).

USAGE

```
./transpose input_csv coast_dir depth_d
```

Arguments:

- **`input_csv`** : CSV input file (with columns: `datetime`, `swh`, `mwd`, `pp1d`)
- **`coast_dir`** : Coastline orientation in degrees (clockwise from North)
- **`depth_d`** : Local depth (meters)

CSV INPUT FORMAT

The input CSV file should be comma-separated with at least the following columns:

```
datetime, swh, mwd, pp1d, [additional columns ignored]
```

OUTPUT CSV FORMAT

The generated `output.csv` will contain the following comma-separated columns:

```
datetime,swh_offshore,mwd_offshore,pp1d,L0,L,kh,alpha_offshore,alpha_local,swh_
```

Computed Parameters

Parameter	Description
L0	Deep-water wavelength: `L0 = g * T² / (2π)`
L	Local wavelength, solved from `L = L0 * tanh((2π * depth_d) / L)`
kh	Wave number (`k = 2π / L`) times local depth (`h`)
alpha_offshore	Offshore wave approach angle relative to coastline
alpha_local	Local wave angle after refraction
mwd_local	Local mean wave direction, adjusted from offshore `mwd`
Ks	Shoaling coefficient
Kr	Refraction coefficient
Hb	Breaking wave height (Miche, 1944): `Hb = 0.142 * L * tanh((2π * depth_d) / L)`
swh_local	Local significant wave height (minimum of `swh * Ks * Kr` and `Hb`)

Note: Waves arriving from directions between `coast_dir` and `coast_dir + 180°` (i.e., from the land side) are set to **zero**.

Report File Details

The report.txt file provides:

- **A descriptive statistics report for each output variable with additional percentiles at 1%, 10%, 25%, 50% (median), 75%, 90%, and 99%.
- **A table displaying the annual maxima for swh_offshore and swh_local, with the final row indicating the overall maximum for each variable. The command line used to run the program at the top of the report.

COMPILATION

To compile the program, use the following command:

```
g++ -O3 -fopenmp -march=native -std=c++17 -Wall -Wextra -pedantic -
Wconversion -Wsign-conversion -static -static-libgcc -static-
libstdc++ -o transpose transpose.cpp
```

This command enables **optimizations** and includes several **compiler warnings** to ensure code quality.
