

Navigation Calculator

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Table of Content

1	Intention.....	3
2	Calculator.....	3
2.1	Unit Conversion.....	3
2.2	Course and Distance.....	4
2.3	Latitude and Longitude.....	5
2.4	Dead Reckoning.....	6
2.5	METAR.....	7
3	Beaufort Scala.....	8
4	Annex METAR.....	9
4.1	METAR.....	9
4.2	Wind.....	9
4.3	Clouds.....	9
4.4	Weather Phenomena.....	10
4.5	Air Pressure.....	10
4.6	Trend.....	10
4.7	Color Code.....	11

1 Intention

This program includes a variety of calculation functions:

- Unit Conversion : Speed, Weight, Length, Temperature, Air Pressure and Coordinate conversion
- Course and Distance : Course and distance calculation between two latitude/longitude points
- Latitude and Longitude : Latitude and longitude calculation from latitude/longitude point and given course/distance
- Dead Reckoning : Dead reckoning data calculation
- METAR : Creating a METAR String
- Beaufort Scala : Overview of the beaufort levels
- Annex METAR

2 Calculator

2.1 Unit Conversion

This module is used for conversion of different measurement units. The conversion can be done in both directions (e.g. km in NM and vice versa). All input fields can be edited and the other values will be calculated immediately.

The screenshot displays the 'Navigation Calculator 1.0' application window. The 'Unit Conversion' module is selected in the left sidebar. The main area contains several input fields for different units:

- Speed:** km/h, m/s, Beaufort, kts, ft/s, ft/min
- Weight:** Tons (metric), Kilograms, Grams, Tons (imperial), Pounds (lb), Ounces
- Length:** Kilometer, Meter, Centimeter, Millimeter, Miles (nautical), Miles (statute), Yards, Feet, Inches
- Temperature:** ° Celsius, ° Fahrenheit, Kelvin
- Air Pressure:** hPa, mmHG, inHG
- Coordinate:** Degree (DD° MM' SS.00000"), Degree (DD° MM' SS.00000'), Decimal

A status bar at the bottom left reads 'Not for real navigation!'.

2.2 Course and Distance

This module is used for calculation of course and distance between two positions, given by latitude and longitude values.

Position 1:

Input starting point. The alignment into North/South or East/West can be chosen via the buttons right beside the input fields. The button label will be changed accordingly. The input format is degree, minutes and seconds.

Position 2:

Input target point. Description analog Position 1

Earth Model:

For the calculation WGS 84 and Spherical are available. The **World Geodetic System 1984 (WGS 84)** is a geodetic reference system as a standard basis for position information on earth and in earthy space.

Spherical is the calculation of coordinates on the basis of a perfect circular earth

Distance Unit:

It can be selected between imperial and metric unit system.

Result:

Calculated course and distance from position 1 to position 2.

2.3 Latitude and Longitude

This module is used to calculate a target point, based on given course and distance. The output will be shown as a latitude and longitude coordinate.

Position 1:

Input starting point. The alignment into North/South or East/West can be chosen via the buttons right beside the input fields. The button label will be changed accordingly. The input format is degree, minutes and seconds.

Course and Distance:

Input of heading in degree and distance in NM for which the position 2 should be calculated.

Earth Model:

For the calculation WGS 84 and Spherical are available. The **World Geodetic System 1984 (WGS 84)** is a geodetic reference system as a standard basis for position information on earth and in earthy space.

Distance Unit:

It can be selected between imperial and metric unit system.

Result:

Calculated latitude and longitude values for the given starting position and course and distance.

2.4 Dead Reckoning

In navigation, dead reckoning is the process of calculating one's current position by using a previously determined position, or fix, and advancing that position based upon known or estimated speeds over elapsed time and course.

This module is used to calculate the navigation value components starting with the input values. For calculating the values you have e.g. to input the values for IAS, TC, Altitude, Distance and the Wind for this flight level und the result is the TAS, GS, HDG, WCA, HWC, XWC, flight time . If you change one of these values the resulting values will be calculated immediately.

The calculation of TAS and IAS are based on the 2% per 1.000 feet rule:

$$\text{TAS} = \text{IAS} + 2\% \text{ IAS per } 1.000 \text{ ft Alt.}$$

Example: Alt = 20.000` ft

IAS = 250 Kts

$$\rightarrow 250 \text{ Kts IAS} + 2\% \text{ IAS} * 20 = 350 \text{ Kts TAS}$$

The screenshot shows the 'Navigation Calculator 1.0' window with the 'Dead Reckoning' tab selected. On the left is a sidebar with navigation options: 'Unit Conversion', 'Course and Distance', 'Latitude and Longitude', 'Dead Reckoning' (highlighted), 'METAR', and 'Beaufort Scale'. The main area contains a 'Flight Data' form with the following fields:

Flight Data					
WD [°]	360	TC [°]	360	WCA [°]	000
WS [ft/s]	0	Alt. [ft]	0	HDG [°]	000
WS [Kts]	0	IAS [Kts]	0	TAS [Kts]	0
Bft	0	Dist. [NM]	0	GS [Kts]	0
Units: <input type="radio"/> Metric <input checked="" type="radio"/> Imperial				HWC [Kts]	0
				XWC [Kts]	0
				Flight Time	00:00:00

At the bottom of the window, it says 'Not for real navigation!' with an information icon.

Abbreviations:

WD	Wind Direction (blowing from)
WS	Wind speed in ft/s and Kts
BFT	Wind speed in Beaufort
TC	True Course (Track)
Alt.	Altitude in ft
IAS	Indicated Airspeed in Kts
Dist.	Distance to WP in NM
WCA	Wind Correction Angle. Calculated angle on which the desired course has to be corrected.
HDG	Desired Course ± WCA
TAS	True Airspeed in Kts
GS	Groundspeed in Kts
HWC	Headwind Component

XWC	Crosswind Component
Flight time	Flight time for the given distance
Units	Selection between metric or imperial unit system

2.5 METAR

The name METAR means METeorological Aerodrome Report, Aviation Routine Weather Report or Meteorological Aviation Routine Weather Report.

A typical METAR contains - beside the ICAO code - data for the temperature, dew point, wind speed and direction, precipitation, cloud cover and heights, visibility, and barometric pressure. A METAR may also contain information on precipitation amounts, lightning, and other information that would be of interest to pilots or meteorologists such as a pilot report or PIREP, color states and runway visual range (RVR).

In reality, METAR data are updated every 30min and are valid for one hour.

With the METAR module you have two options. On the one hand you can construct a METAR with the given options of the form or on the other hand you import a METAR string via the import button in the upper right corner. For the import and the construction there are some restrictions e.g. that the program can only consider two cloud layers.

Example:

URKA 241200Z 03010KT 9999 FEW060TCU OVC150TCU 10/M02 A2957 NOSIG

- URKA ICAO code Anapa
- 241200Z Indicates the time of the observation (24th of the month, 12:00 ZULU time)
- 03010KT Indicates the wind direction based on geographical north (30°) and speed (10 Kts)
- 9999 Indicates the prevailing visibility (10 km or more) → not to confuse with runway visibility range (RVR)!

- FEW060TCU Cloud coverage (FEW = 1 to 2 oktas), cloud layer (6.000ft AGL) and kind of cloud coverage (TCU = towering cumulus)
- OVC150TCU Cloud coverage (OVC = 8 oktas), cloud layer (15.000ft AGL) and kind of cloud coverage (TCU = towering cumulus)
- 10/M02 Indicates the temperature (10°C) and dew point (an M in front of the number indicates that the temperature/dew point is below zero (0) Celsius).
- A2957 Indicates the altimeter setting inHg is 29,57 hPa or 1001,4 Hectopascal (hPa).
- NOSIG Is an example of a TREND forecast which is appended to METARs at stations while a forecaster is on watch. NOSIG means that no significant change is expected to the reported conditions within the next 2 hours.

3 Beaufort Scala

The Beaufort scale is an empirical measure that relates wind speed to observed conditions at sea or on land. Its full name is the Beaufort wind force scale. It is the most common system to measure wind speed.

Calculators		Beaufort Scala					
Unit Conversion Speed, Weight, Length, Temperature, Air Pressure and Coordinate conversion Course and Distance Course and distance calculations between two latitude/longitude points Latitude and Longitude Latitude and longitude calculation from latitude/longitude point and given course/distance Dead Reckoning Dead Reckoning data calculation METAR Creating a METAR String Beaufort Scala Overview of the beaufort levels	0	0	0 - 1	0,0 - 0,3	0,0 - 1,0	calm	Calm. Smoke rises vertically.
	1	1 - 5	1 - 4	0,3 - 1,6	1,0 - 5,2	light air	Wind motion visible in smoke.
	2	6 - 11	4 - 7	1,6 - 3,4	5,2 - 11,1	light breeze	Wind felt on exposed skin. Leaves rustle.
	3	12 - 19	7 - 11	3,4 - 5,5	11,1 - 18,0	gentle breeze	Leaves and smaller twigs in constant motion.
	4	20 - 28	11 - 16	5,5 - 8,0	18,0 - 26,2	moderate breeze	Dust and loose paper raised. Small branches begin to move.
	5	29 - 38	16 - 22	8,0 - 10,8	26,2 - 35,4	fresh breeze	Branches of a moderate size move. Small trees begin to sway.
	6	39 - 49	22 - 28	10,8 - 13,9	35,4 - 45,6	strong gale	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic garbage cans tip over.
	7	50 - 61	28 - 34	13,9 - 17,2	45,6 - 56,4	near gale	Whole trees in motion. Effort needed to walk against the wind. Swaying of skyscrapers may be felt, especially by people on upper floors.
	8	62 - 74	34 - 41	17,2 - 20,8	56,4 - 68,2	gale	Some twigs broken from trees. Cars veer on road. Progress on foot is seriously impeded.
	9	75 - 88	41 - 48	20,8 - 24,5	68,2 - 80,4	strong gale	Some branches break off trees, and some small trees blow over. Construction/temporary signs and barricades blow over. Damage to circus tents and canopies.
	10	89 - 102	48 - 56	24,5 - 28,5	80,4 - 93,5	Storm	Trees are broken off or uprooted, saplings bent and deformed. Poorly attached asphalt shingles and shingles in poor condition peel off roofs.
	12	103 - 117	56 - 64	28,5 - 32,7	93,5 - 107,3	violent storm	Widespread damage to vegetation. Many roofing surfaces are damaged; asphalt tiles that have curled up and/or fractured due to age may break away completely.
	Not for real navigation!						

4 Annex METAR

4.1 METAR

METAR is a standardized report in short form, which reflects the weather observation of a single airport. The METAR reports will be updated every 30 minutes and are valid for 1 hour. In any case the METAR report contains the ICAO Code of the airport which has reported the METAR and the observation time. Additionally the report contains the wind direction, visibility, temperature, air pressure, cloud formation and other information.

4.2 Wind

To describe the wind there are different options depending of the kind of wind and wind speeds. Following are some examples:

29010KT	Wind Direction 290°, 10 Kts
00000KT	Calm
29010G30KT	Wind Direction 290°, 10 Kts in gust 30 Kts.
VRB03KT	Variable wind direction (rotating wind), 3 Kts.
29010KT 210V310	Middle wind direction 290°, rotates between 210° and 310° with 10 Kts. At least the minimum or maximum deviation of the middle wind direction has to be greater than 60°.

4.3 Clouds

The height of cloud base shall be indicated in hectofeet above ground. The cloud is coded as follows:

Abbreviation	Subject	Description
CAVOK	clouds and visibility OK	visibility greater than 10 km no clouds below 5000 feet or below the highest minimum sector altitude no CB or a towering cumulus cloud at any height no significant weather phenomena
CLR	clear	0/8 clouds below 12000 feet (automated airport weather stations)
SKC	sky clear	0/8 clouds (manual measurement)
NSC	no significant cloud	no clouds below 5000 ft or below minimum sector altitude, no CB, no TCU, sky clear, if no condition given by CAVOK.
FEW	few	1/8 – 2/8 cloud coverage
SCT	scattered	3/8 – 4/8 cloud coverage
BKN	broken	5/8 – 7/8 cloud coverage
OVC	overcast	8/8 cloud coverage (full cloud coverage)

In case of significant convective clouds, "CB" (cumulonimbus) or "TCU" (towering cumulus) will be suffixed to the height indication of the cloud layer. If the sky is obscured, the vertical visibility, abbreviated to "VV", will be indicated in hectofeet (e.g. VV002).

4.4 Weather Phenomena

If needed the special weather phenomena will be reported by the following rules:

Weather									
Qualifier				Weather Phenomena					
Intensity or Proximity		Description		Precipitation		Obscuration		Other Aspects	
-	light	MI	shallow	DZ	drizzle	BR	mist	PO	dust/sand whirls
	moderate (no qualifier)	BC	patches	RA	rain	FG	fog	SQ	squalls
+	heavy	PR	partial (covering part of the aerodrome)	SN	snow	FU	smoke	FC	funnel cloud(s) (tornado or water spout)
VC	in the vicinity	DR	low drifting	SG	snow grains	VA	volcanic ash	SS	sandstorm
		BL	blowing	IC	ice crystals	DU	widespread dust	DS	duststorm
		SH	shower	PL	ice pellets	SA	widespread Sand		
		TS	thunderstorm	GR	hail	HZ	haze		
		FZ	freezing	GS	small hail and/or snow pellets	PY	spray		
				UP	unknown precipitation				

Notes:

- The weather groups shall be constructed by considering columns 1 to 5 in the table above in sequence, i.e. intensity, followed by description, followed by weather phenomena, e.g. heavy rain shower(s) is coded as +SHRA.
- To denote moderate intensity no entry or symbol is used.
- Tornados and waterspouts shall be coded as +FC.
- The location of weather phenomena shall be reported as "in the vicinity of the station" when between 5 and 10 statute miles of the point(s) of observation. In Germany within 8 km.

4.5 Air Pressure

The air pressure will be always reported with four digits in hPa or hundredth inHg.
e.g.: Q1038 (QNH = 1038 hPa) or A3065 (QNH = 30,65 inHg)

4.6 Trend

Because the METAR will be updated every 30 minutes and is valid for one hour, the trend indicates in which way the weather will change across this period.

Abbreviation	Subject	Description
NOSIG	no significant change	There is no significant change expected to the reported conditions within the next 2 hours.
BECMG	BECOMING	There will be a significant change of weather.
TEMPO	TEMPORARY	There will be temporarily fluctuations but in particular cases less than one hour. In total less than the half forecast period.

4.7 Color Code

Mostly military stations are using at the end of the METAR string Color Codes, sometimes called Color State, to describe the main cloud base and the horizontal visibility.

Main Cloud Base	Visibility					
	< 0,8 km	0,8 - <1,6 km	1,6 - <3,7 km	3,7 - <5 km	5 - <8 km	≥ 8 km
≥ 20000 ft	RED	AMB	YLO	GRN	WHT	BLU+
2500 - <20000 ft	RED	AMB	YLO	GRN	WHT	BLU
1500 - <2500 ft	RED	AMB	YLO	GRN	WHT	WHT
700 - <1500 ft	RED	AMB	YLO	GRN	GRN	GRN
300 - <700 ft	RED	AMB	YLO	YLO	YLO	YLO
200 - <300 ft	RED	AMB	AMB	AMB	AMB	AMB
< 200 ft	RED	RED	RED	RED	RED	RED

The meaning of Code **BLACK** is, that the airfield is closed because of other reasons than visibility and main cloud base and is placed in front of the real color code.