OBJECTIVE BEST TRACK
ALGORITHM DESCRIPTION
By
Charles Sampson and Kathryn Payne

The purpose of the objective best track (OBT) is to automatically assign weights based on errors to specific fix sites and types, and then generate an objective best track. This objective best track is independent of the subjective best track used by the Typhoon Duty Officer (TDO), although it relies on the quality control and flagged fixes generated by the TDO. The OBT is not intended to replace the subjective best track, but should be used to trap errors and missing data in the fix files. The objective best track can also serve as an objective starting point for the TDO. The errors used for weights are maintained in a file stored on ATCF; errors prescribed in this file should be set at the beginning of the season, and then altered only in emergencies (e.g., a marked improvement or degradation in performance). Use of preset fix errors in the OBT allows the TDO to consistently and objectively balance fix information received from a multitude of different fix types and fix sites. Additionally, the fix error file enables the TDO to effectively flag developmental fix types so that those fixes are not used in objective best track position, intensity and wind distribution calculations.

Functionally, the objective best track algorithm can be described by these six steps:

1. Read fixes from f-deck,
2. Identify and remove all flagged fixes from calculation,
3. Assign default weights to remaining fixes,
4. Read special override file for weights,
    a. Override weight by fix site,
    b. Override weight by fix type,
5. Independently calculate weighted best track position, intensity and wind distribution for each 6-hour time step,
6. Plot to appropriate display graphic.

Details of the algorithm flow are shown in Figure 1. Note that at least three position fixes are required for the algorithm to run. The reason for this is that the position OBT routine uses a parabolic least squares fit to the data, and the parabolic fitting requires three position fixes. The intensity and wind radii OBTs can either be a least squares fit to the data or a weighted average of fixes within a three-hour time window of the point in question.

The OBT routine is manually initiated by the TDO. Upon initiation in ATCF, the program will read all fixes available in the f-deck. The program identifies all flagged fixes[1], and removes the flagged fixes from the weighted best track (WBT) calculation. The OBT routine then identifies

---

[1] Fixes can be "flagged" or removed from further objective best track calculations. For example, fixes flagged for position are considered unrepresentative of the circulation center. A flagged position fix can also indicate a fix that has a position extrapolated from the JTWC position. Fixes can be flagged for position in the override file, in real-time on the ATCF , or during post-storm analysis. Fixes can also be flagged for position prior to ingest by ATCF (via encoding). Fixes can also be flagged for intensity; this indicates an intensity estimate considered not representative or not

the fix type and fix site (Attachment 1) and assigns default weights (Attachment 2) based on fix site and fix type to the remaining non-flagged fixes. A special file containing user-defined “override” weights[2] (Attachment 3) is read, and the non-flagged fixes are checked against this override file. If an override weight exists for a given fix, that weight is applied when the fix is written to the WBT data file. If no override weight exists, the default weight is retained when the fix is written to the WBT data file. After all the non-flagged fixes and their associated weights have been written to the WBT data file, the WBT is calculated and written to a new WBT file. The WBT for position, intensity and wind distribution are calculated independently, so a fix flagged only for position won’t be removed from the calculation for intensity or wind distribution. Once calculated, the TDO has the option to display track, intensity or wind distribution on the display graphic.

[2] The user has the option to specify weighting factors for each fix site or fix type to override the default weights.

ATTACHMENT 1
Fix Types & Fix Sites

Fix Type	Description
AIRC	Aircraft
ALTG	Geostationary satellite altimeter
AMSR	Advanced Microwave Scanning Radiometer for EOS (AMSR-E)
AMSU	Advanced Microwave Sounding Unit
ANAL	Analysis
AUTO	Automated entry
DRPS	Dropsonde
DVTO	Objective Dvorak
DVTS	Subjective Dvorak
ERS2	European Remote Sensing System Scatterometer
QSCT	Quick Scatterometer (QuikSCAT)
RDRC	Conventional radar
RDRD	Doppler radar
RDRT	Tropical Rainfall Measurement Mission (TRMM) Precipitation Radar
SEAW	SeaWinds Scatterometer
SSMI	Special Sensor Microwave/Imager (SSM/I)
SSMS	Special Sensor Microwave Imager Sounder (SSMIS)
SYNP	Synoptic
TRMM	TRMM Microwave Imager
UNKN	Unknown
WIND	WindSat (37 GHz)

Figure 1.1. Description of each fix type available in ATCF. Note: not all fix types are available to or used by JTWC.

Fix Type	PGTW	KGWC	KNES	RSMC*	JTUP JTPA	CIRA	CIRW	CIMS	NRLM
AMSR	X								
AMSU	X								
ANAL					X		X		
AUTO						X		X	
DVTO								X	
DVTS	X	X	X	X					
QSCT	X								X
SSMI	X								
SSMS	X								
SYNP	X								
TRMM	X								
WIND	X								

Figure 1.2. Fix types associated with each fix site. List represents those fixes most commonly available to and used by JTWC. Notes: * RSMC sites include ABRF, ADRM, APRF, DEMS, KNHC (TAFB), FMEE, NFFN, PHFO and RJTD. JTUP and JTPA fixes are the current and archived, respectively, three-hourly position updates produced by the TDO. RDRC fixes (not listed) are generated by PHIK and many international sites (using five-digit WMO number).

ATTACHMENT 2

Default Weights by Fix Type & Fix Sites

Type	Position (nm)	Intensity (kt)	Wind Radii (nm)
DVTS	Function (CI)* or Function (PCN)**	5, 10, 15	N/A
DVTO	Function (CI) or Function (PCN)	5, 10, 15	N/A
Microwave	15, 30, 60	5, 10, 15	10, 30, 50
AIRC	2, 5, 10	5, 10, 15	10, 20, 30
RDRC	10, 15, 25	5, 10, 15	10, 20, 30
ANAL	30, 60, 90	5, 10, 15	10, 30, 50
DRPS	30, 60, 90	5, 10, 15	10, 30, 50

Figure 2.1. Default weights by fix type. Value indicates error entered into denominator of weighting equation. * Error for position and wind radii is determined using a least fit squares equation [value x $(\text{error})^{-4}$]. ** Error for intensity is determined using a weighted average [value x $(\text{error})^{-2}$]. The microwave fix type includes: AMSR, AMSU, SSMI, SSMS, TRMM and WIND.

Conf.	Und	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5
Good	60	60	60	60	60	50	45	45	45	40	40	40	30	30	30	30
Fair	120	120	120	120	120	100	90	90	90	90	80	80	70	70	60	60
Poor	170	170	170	170	170	150	140	140	140	130	130	130	120	120	100	100

Figure 2.2. Error values (nm) used for weighting as a function of Current Intensity (CI) when confidence is indicated. Und indicates undetermined or unclassified intensity (Dvorak Technique intensity too weak to classify).

PCN	1	2	3	4	5	6
Error	15	20	25	30	40	50

Figure 2.3. Error values (nm) used for weighting as a function of position confidence number (PCN) when confidence is not available but PCN is available.

ATTACHMENT 3
Override Weights by Fix Type & Fix Site
(as of 5 Apr 07)

		Position (nm)			Intensity (kt)			Wind Radii (nm)		
Type	Site	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor
AMSU	CIRA	999	999	999	15	20	25	10	20	30
ANAL	CIRW	999	999	999	999	999	999	5	10	20
ANAL	JTPA	999	999	999	999	999	999	999	999	999
ANAL	JTUP	999	999	999	999	999	999	999	999	999
DVTO	CIMS	999	999	999	55	60	65	999	999	999
DVTS	KGWC	30	40	50	20	30	40	999	999	999
DVTS	KNES	30	40	50	20	30	40	999	999	999
DVTS	PGTW	15	25	35	3	7	10	999	999	999
DVTS	TAFB	15	25	35	3	7	10	999	999	999
QSCT	NRLM	999	999	999	999	999	999	40	50	60

Figure 3.1. Override weighting (error) values for specific fix types from specific fix sites. A value of 999 effectively removes the fix from consideration in the weighted calculation.