BIG DATA AND DATA MINING TECHNIQUES APPLIED TO TROPICAL CYCLONES CHARACTERISATION

REFERENT : CHASKALOVIC

STUDENTS : PLAYE - DUCASSE - EROL

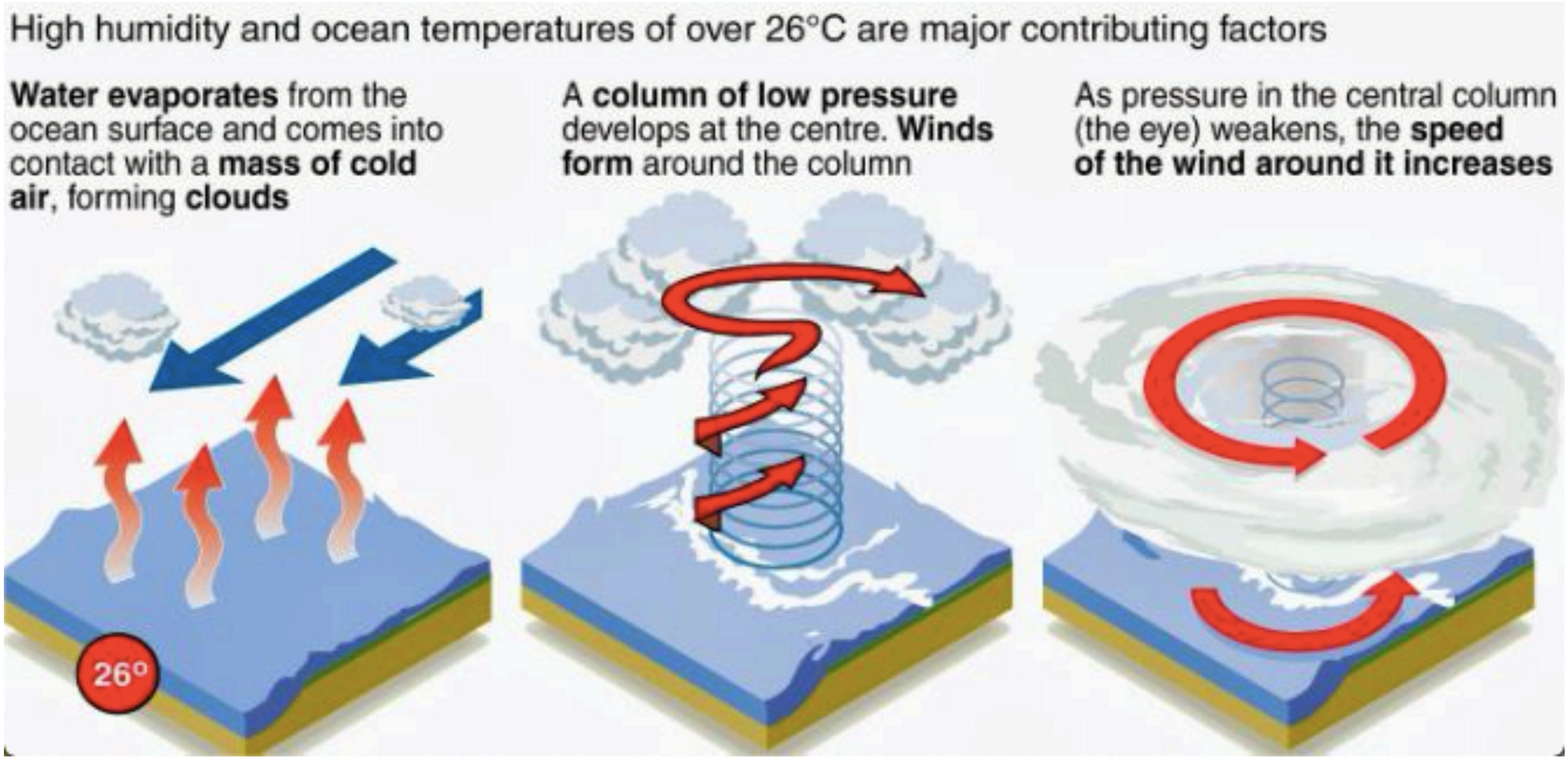
CONTEXT

- mathematical modelling → physical mechanism : viscosity, compressibility, thermal aspects …
- by exploiting database, identify physical mechanism depending on the categories of cyclone
- 4 steps:

    1. bibliographic search
    2. data gathering
    3. data processing
    4. data analysis

TROPICAL CYCLONE

TROPICAL CYCLONE FORMATION



TROPICAL CYCLONE CLASSIFICATION

10-minute sustained winds (WMO/JMA/MF/BOM/FMS)	NE Pacific & N Atlantic NHC/CPHC[25]	NW Pacific JTWC	NW Pacific JMA	N Indian Ocean IMD[12]	SW Indian Ocean MF	Australia & S Pacific BOM/FMS[18]
<28 knots (32 mph; 52 km/h)	Tropical Depression	Tropical Depression	Tropical Depression	Depression	Zone of Disturbed Weather	Tropical Disturbance
28–29 knots (32–33 mph; 52–54 km/h)				Deep Depression	Tropical Disturbance	Tropical Depression
30–33 knots (35–38 mph; 56–61 km/h)	Tropical Storm	Tropical Storm			Tropical Depression	Tropical Low
34–47 knots (39–54 mph; 63–87 km/h)			Tropical Storm	Cyclonic Storm	Moderate Tropical Storm	Category 1 tropical cyclone
48–55 knots (55–63 mph; 89–102 km/h)			Severe Tropical Storm	Severe Cyclonic Storm	Severe Tropical Storm	Category 2 tropical cyclone
56–63 knots (64–72 mph; 104–117 km/h)	Category 1 hurricane	Typhoon	Typhoon			
64–72 knots (74–83 mph; 119–133 km/h)				Very Severe Cyclonic Storm	Tropical Cyclone	Category 3 severe tropical cyclone
73–83 knots (84–96 mph; 135–154 km/h)	Category 2 hurricane					
84–85 knots (97–98 mph; 156–157 km/h)	Category 3 major hurricane			Extremely Severe Cyclonic Storm	Intense Tropical Cyclone	Category 4 severe tropical cyclone
86–98 knots (99–113 mph; 159–181 km/h)						
99–107 knots (114–123 mph; 183–198 km/h)	Category 4 major hurricane					Category 5 severe tropical cyclone
108–113 knots (124–130 mph; 200–209 km/h)						
114–119 knots (131–137 mph; 211–220 km/h)		Super Typhoon		Super Cyclonic Storm	Very Intense Tropical Cyclone	
>120 knots (140 mph; 220 km/h)	Category 5 major hurricane					

TROPICAL CYCLONE CASUALTY

Saffir - Simpson hurricane scale

Category 1
- Winds 74-95 mph (119-153 km/h)
- Some damage and power cuts

Category 2
- Winds 96-110 mph (154-177 km/h)
- Extensive damage

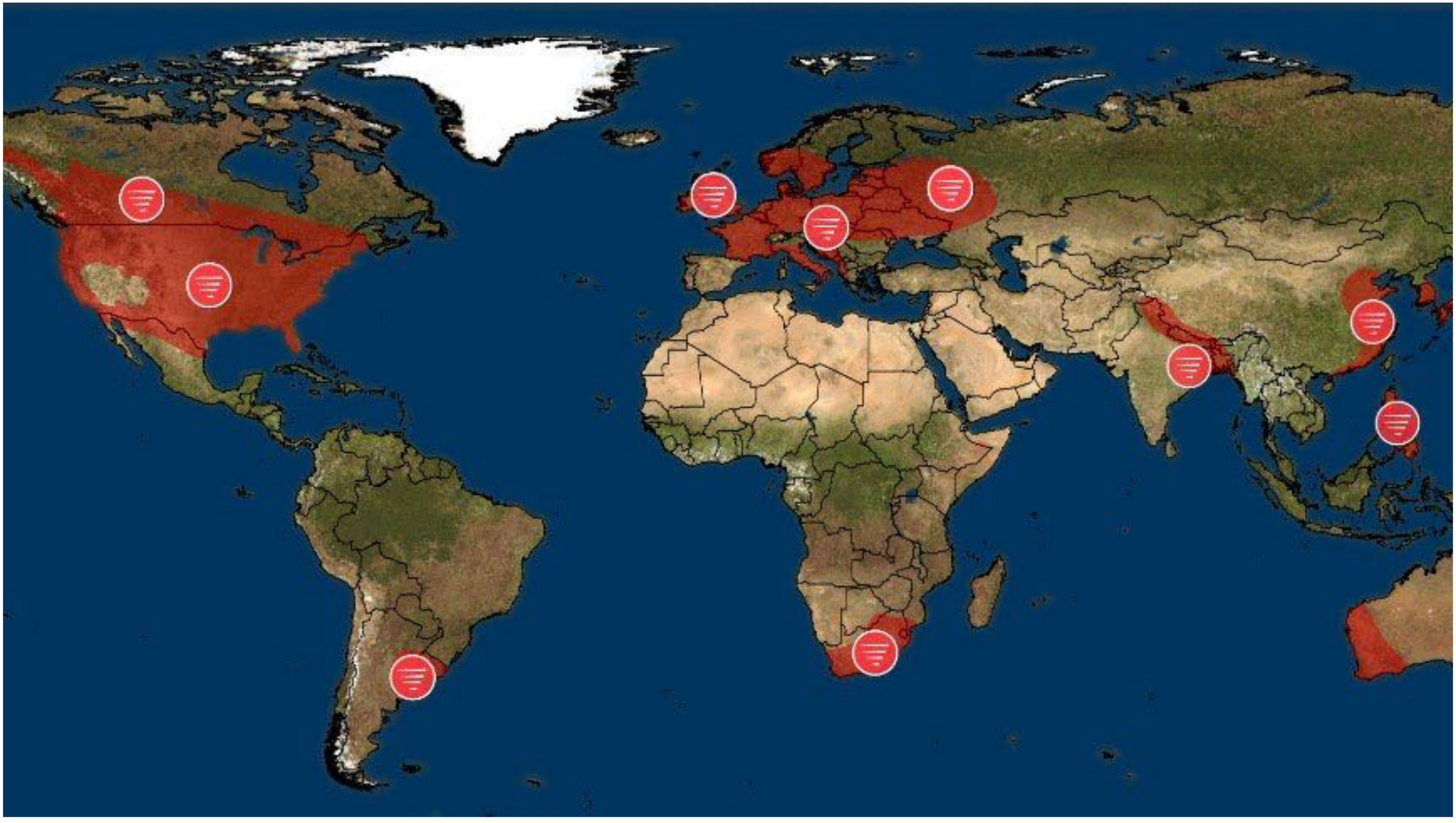
Category 3
- Winds 111-129 mph (178-208 km/h)
- Well-built homes suffer major damage

Category 4
- Winds 130-156 mph (209-251 km/h)
- Severe damage to well-built homes, trees blown over

Category 5
- Winds 157+ mph (252+ km/h)
- Many buildings destroyed, major roads cut off

BBC

TORNADO LOCALISATION MAP



TORNADO DATA

- om - tornado number
- yr - year
- mo - month
- dy - day
- time
- tz - time zone
- st - state
- stn - state number
- f - Fujita scale
- mws - wind speed
- inj- injuries
- fat - fatalities
- loss - estimated property loss
- closs - estimated crop loss
- slat - starting latitude
- slon - starting longitude
- elat - ending latitude
- elon - ending longitude
- len - length
- wid - width

DATA GATHERING

	Tornado	Cyclone
Diametre	1 km	500 - 1000 km
Lifetime	few minutes to few hours	few days to few weeks
Sampling time	every 6h	
Etude possible	Difficult	Easy

CYCLONE DATA

- NN - storm number
- BB - basin name
- CY - annual cyclone number
- TIME
- Latitude
- Longitude
- VMAX - Maximum sustained wind speed
- RMW - radius of maximum wind
- MIN SLP - minimum sea level pressure
- SHR MAG - shear magnitude
- SHR DIR - shear direction
- STM SPD - storm speed
- STM HDG - storm direction
- SST - sea level temperature
- OHC - ocean heat content
- TPW - total precipitable water
- LAND - distance to closest coastline
- 850TANG - tangential wind at 850hPa
- 850VORT - absolute vorticity at 850hPa
- 200DVRG - divergence at 200hPa
- PRECIP - precipitation
- TOTSHR MAG - total shear magnitude
- POCI - pressure of the outermost closed isobar
- ROCI - radius of the outermost closed isobar
- P - sea level pressure
- T - temperature
- R - relative humidity
- Z - geopotential height
- U - zonal wind averaged
- V - meridional wind
- RAD - Wind intensity
- MRD - radius of max winds
- GUSTS - gusts
- EYE - eye diameter
- SUBREGION - subregion code
- MAXSEAS - max seas
- DIR - storm direction
- DEPTH - system depth

DATA PROCESSING

- A - DATA FUSION
- B - DATA SELECTION

DATA PROCESSING

TCDIAG

BESTTRACK

TCGEN

TCTRACK

TCVITALS

DATA PROCESSING

BESTTRACK

```
BASIN, CY, YYYYMMDDHH, TECHNUM/MIN, TECH, TAU, LatN/S, LonE/W, VMAX, MSLP, TY, RAD, WINDCODE, RAD1, RAD2, RAD3, RAD4, RADP ,RRP, MRD, GUSTS, EYE, SUBREGION, MAXSEAS, INITIALS,
SPEED, STORMNAME, DEPTH
AL, 01, 2005060818,   , BEST,   0, 169N,  840W,  25, 1004, TD,   0,    ,    0,    0,    0,    0, 1009,  150,  30,  35,   0,   L,   0,    ,   0,   0,     INVEST, M,
AL, 01, 2005060900,   , BEST,   0, 174N,  839W,  30, 1003, TD,   0,    ,    0,    0,    0,    0, 1007,  150,  60,  35,   0,   L,   0,    ,   0,   0,       ONE, M,
AL, 01, 2005060906,   , BEST,   0, 182N,  839W,  35, 1003, TS,  34, NEQ,  130,    0,    0,    0, 1008,  180,  75,  40,   0,   L,   0,    ,   0,   0,       ONE, M,
AL, 01, 2005060912,   , BEST,   0, 190N,  840W,  35, 1002, TS,  34, NEQ,  130,    0,    0,    0, 1008,  180,  75,  45,   0,   L,   0,    ,   0,   0,    ARLENE, M,
AL, 01, 2005060918,   , BEST,   0, 197N,  841W,  35, 1002, TS,  34, NEQ,  120,    0,    0,    0, 1008,  180,  75,  45,   0,   L,   0,    ,   0,   0,    ARLENE, M,
AL, 01, 2005061000,   , BEST,   0, 204N,  842W,  40, 1001, TS,  34, NEQ,  100,    0,    0,    0, 1006,  150,  60,  45,   0,   L,   0,    ,   0,   0,    ARLENE, M,
AL, 01, 2005061006,   , BEST,   0, 212N,  844W,  45, 1000, TS,  34, NEQ,  120,    0,    0,    0, 1007,  175,  60,  45,   0,   L,   0,    ,   0,   0,    ARLENE, M,
AL, 01, 2005061012,   , BEST,   0, 230N,  847W,  50, 1000, TS,  34, NEQ,  130,    0,   60,   30, 1007,  175,  60,  60,   0,   L,   0,    ,   0,   0,    ARLENE, D,
AL, 01, 2005061012,   , BEST,   0, 230N,  847W,  50, 1000, TS,  50, NEQ,  100,    0,    0,    0, 1007,  175,  60,  60,   0,   L,   0,    ,   0,   0,    ARLENE, D,
AL, 01, 2005061018,   , BEST,   0, 249N,  851W,  55,  995, TS,  34, NEQ,  130,  100,    0,   40, 1007,  175,  60,  60,   0,   L,   0,    ,   0,   0,    ARLENE, D,
AL, 01, 2005061018,   , BEST,   0, 249N,  851W,  55,  995, TS,  50, NEQ,  100,    0,    0,    0, 1007,  175,  60,  60,   0,   L,   0,    ,   0,   0,    ARLENE, D,
AL, 01, 2005061100,   , BEST,   0, 265N,  856W,  60,  990, TS,  34, NEQ,  140,  120,    0,   75, 1007,  175,  50,  75,   0,   L,   0,    ,   0,   0,    ARLENE, D,
AL, 01, 2005061100,   , BEST,   0, 265N,  856W,  60,  990, TS,  50, NEQ,   75,    0,    0,   45, 1007,  175,  50,  75,   0,   L,   0,    ,   0,   0,    ARLENE, D,
AL, 01, 2005061106,   , BEST,   0, 277N,  868W,  60,  993, TS,  34, NEQ,  140,  120,    0,   75, 1006,  180,  50,  75,   0,   L,   0,    ,   0,   0,    ARLENE, D,
```

DATA PROCESSING

TCDIAG

* G01R 2005082900 *
* AL12 KATRINA *

STORM DATA

NTIME 012													
TIME	(HR)	0	6	12	18	24	30	36	42	48	54	60	66
LATITUDE	(DEG)	27.0	27.8	29.0	30.2	31.7	33.5	35.2	36.9	38.7	40.1	41.5	42.9
LONGITUDE	(DEG)	270.9	270.7	270.4	270.4	270.8	271.2	271.5	272.3	273.6	274.9	276.9	279.5
MAX WIND	(KT)	83	73	67	67	50	31	26	22	19	17	18	26
RMW	(KM)	118	116	124	111	143	145	159	176	194	223	202	196
MIN SLP	(MB)	951	961	961	965	968	979	984	989	991	993	994	995
SHR MAG	(KT)	2	7	14	15	22	34	33	34	37	42	40	43
SHR DIR	(DEG)	19	57	36	13	22	48	50	46	48	56	60	62
STM SPD	(KT)	8	12	12	15	18	17	18	21	17	21	24	24
STM HDG	(DEG)	347	348	0	13	11	8	21	30	36	47	54	54
SST	(10C)	304	306	288	114	9999	9999	9999	9999	9999	9999	9999	218
OHC	(KJ/CM2)	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999
TPW	(MM)	72	73	73	71	70	68	65	62	62	60	59	58
LAND	(KM)	234	144	24	0	-145	-320	-502	-690	-865	-842	-715	-596
850TANG	(10M/S)	225	225	229	237	224	207	195	167	151	137	124	111
850VORT	(/S)	91	101	122	111	80	55	62	58	52	68	90	131
200DVRG	(/S)	29	38	72	95	73	33	36	37	28	21	18	26

CUSTOM DATA

NVAR 018													
TIME	(HR)	0	6	12	18	24	30	36	42	48	54	60	66
ADECK VMAX	(KT)	80	74	65	69	50	30	25	21	19	17	23	27
DIAG VMAX	(KT)	83	73	67	67	50	31	26	22	19	17	18	26
ADECK PMIN	(MB)	961	962	965	965	969	980	984	990	991	993	994	995
DIAG PMIN	(MB)	951	961	961	965	968	979	984	989	991	993	994	995
SSTANOM	(10C)	9	12	14	6	9999	9999	9999	9999	9999	9999	9999	13
PRECIP	(MM/D)	24	41	41	45	44	33	32	28	26	22	22	21
PR ASYM/TOT	(%)	-37	-13	22	11	-13	7	3	-18	-22	-13	13	32
TOTSHR MAG	(KT)	37	33	42	42	43	50	52	52	54	54	52	53
SHR/TOTSHR	(%)	6	22	33	37	51	67	64	65	68	78	77	82
SHR ASYM/TOT	(%)	0	-14	-13	-17	-24	-30	-30	-28	-25	-28	-26	-19
CPS B(AROCLINC)		12	8	10	14	17	21	21	25	23	25	30	36
CPS VTHERM(LO)		248	158	175	128	70	51	34	-20	-41	-7	2	20
CPS VTHERM(HI)		251	225	236	220	211	130	99	63	24	-27	-108	-189
POCI	(MB)	1004	1006	1004	1006	1006	1006	1006	1004	1004	1002	1000	1000
ROCI	(KM)	421	485	430	436	463	423	466	434	486	442	413	406
R34mean	(KM)	251	262	236	213	9999	9999	9999	9999	9999	9999	9999	9999
R50mean	(KM)	177	177	163	9999	9999	9999	9999	9999	9999	9999	9999	9999
R64mean	(KM)	124	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999

DATA PROCESSING

BESTTRACK

```
date1 name1 features1
```

+

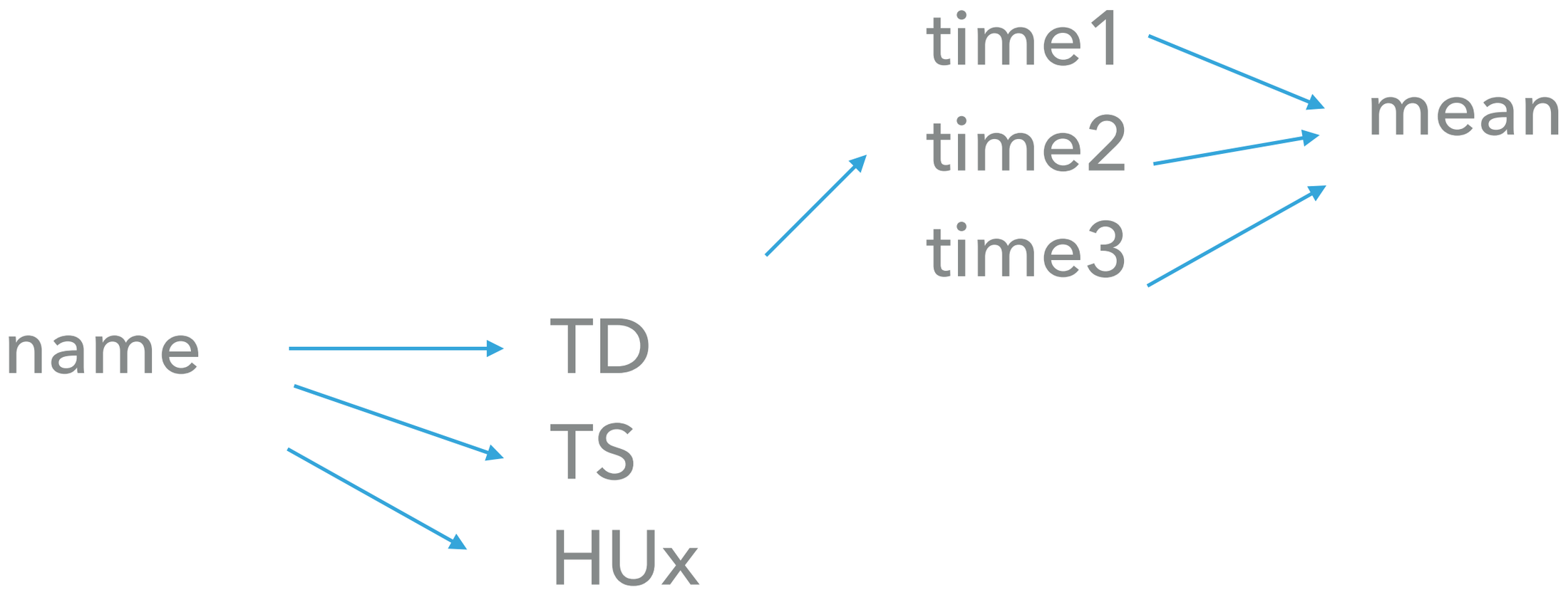
TCDIAG

```
date1 name1 features2.0
date1 name1 features2.1
date1 name1 features2.2
date1 name1 features2.3
date1 name1 features2.4
```

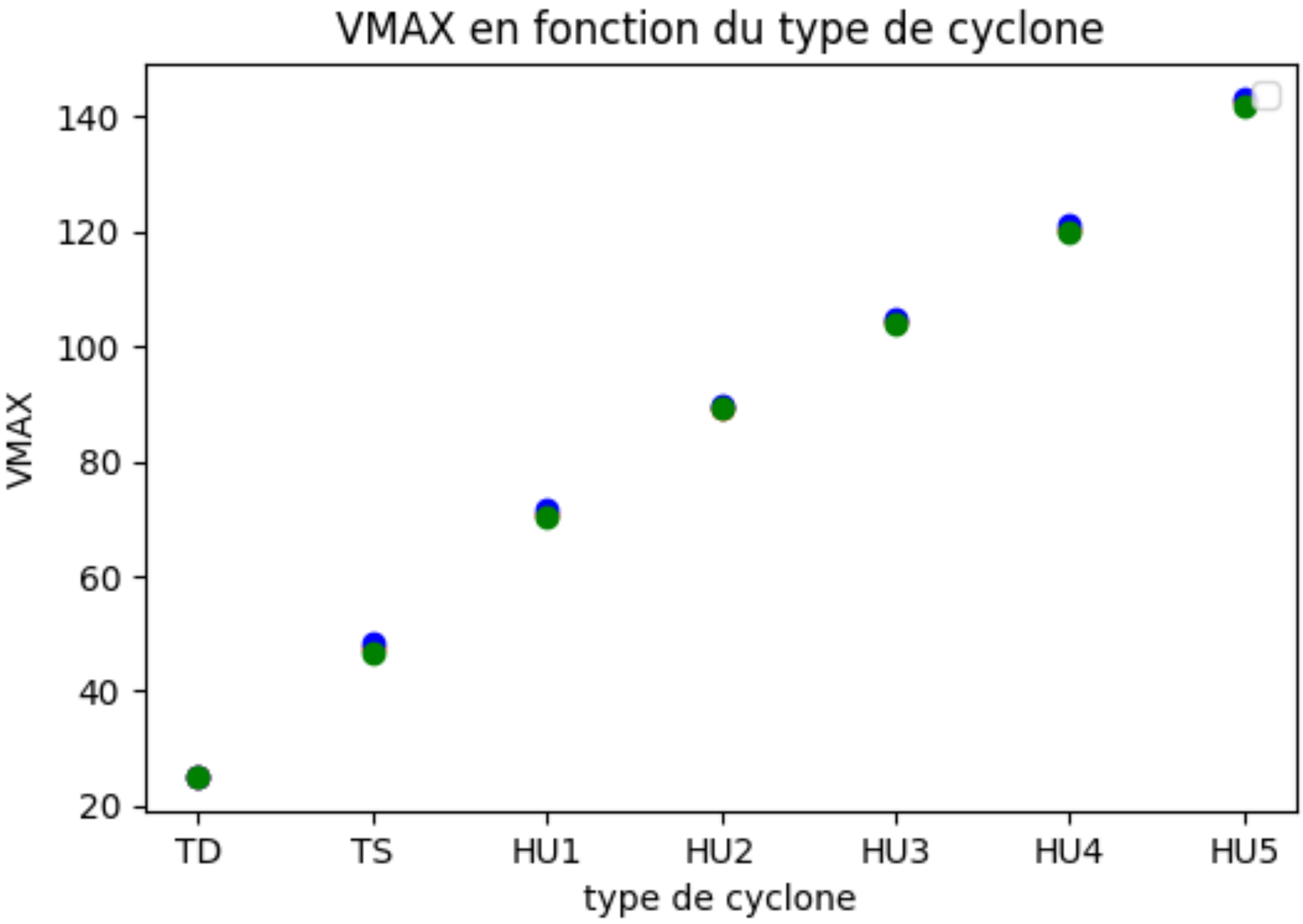
FUSION

```
features1 features2.0 date1 name1
features1 features2.1 date1 name1
features1 features2.2 date1 name1
features1 features2.3 date1 name1
features1 features2.4 date1 name1
```

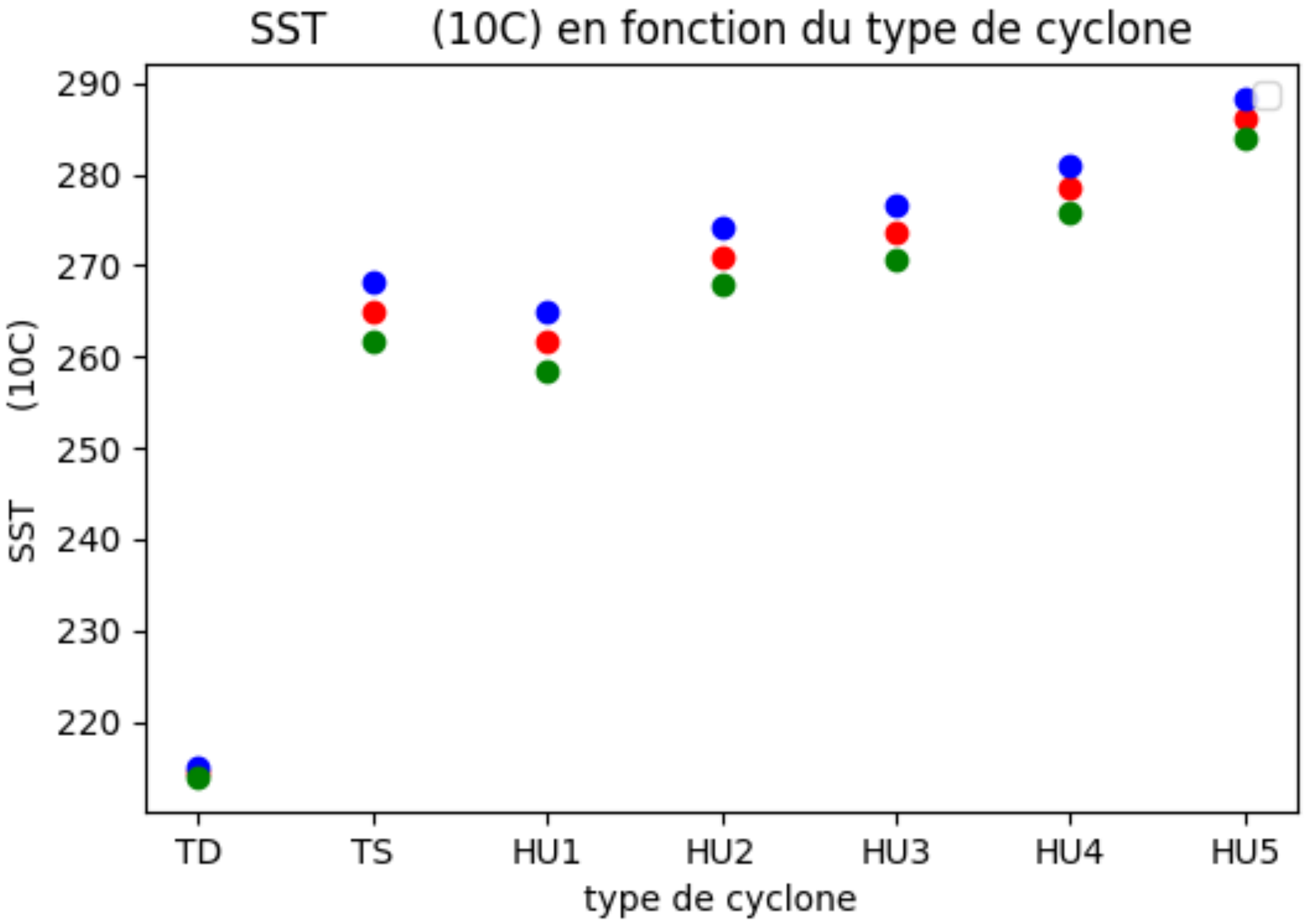
DATA PROCESSING



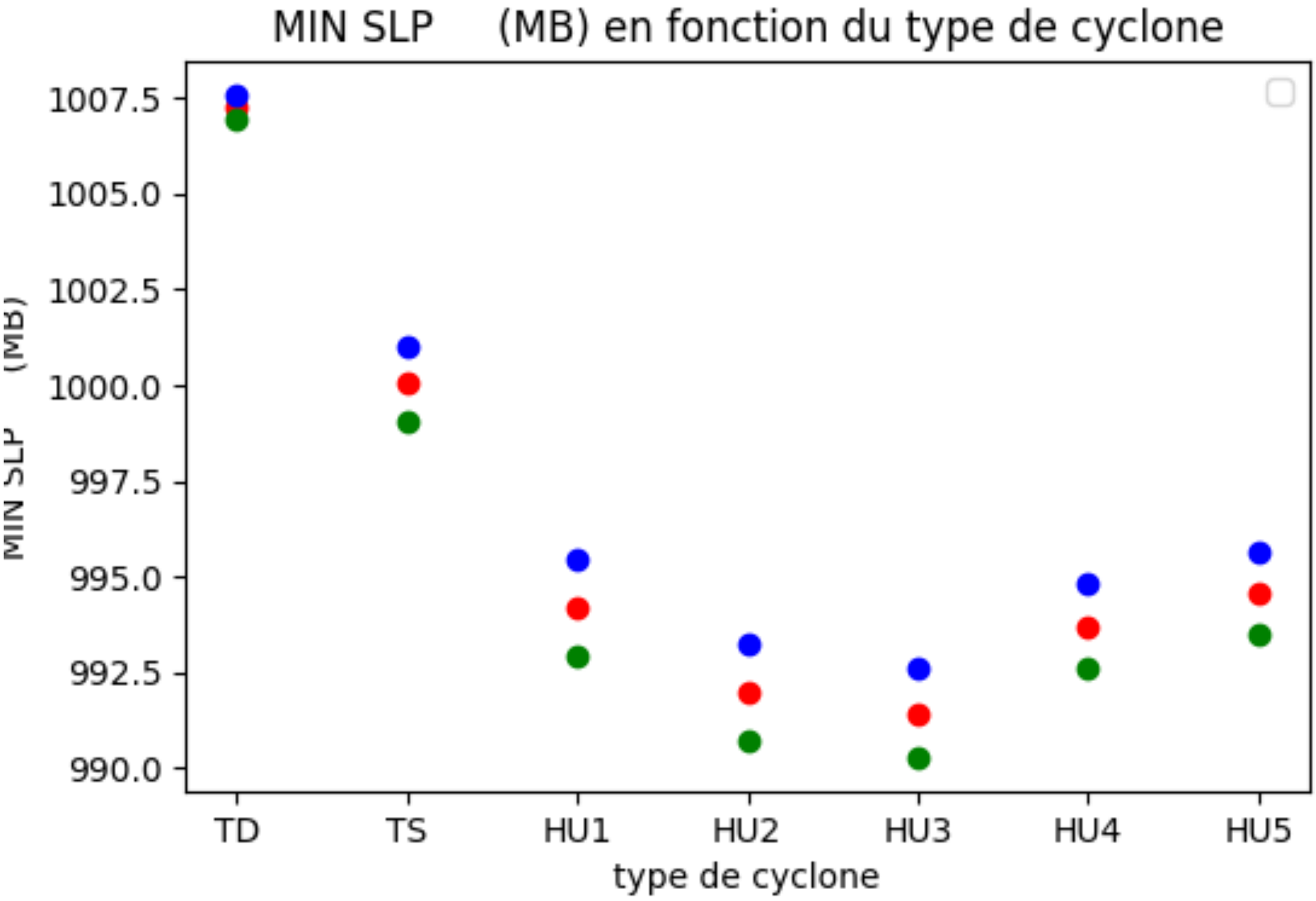
VMAX – MAXIMUM SUSTAINED WIND SPEED



SST – SEA LEVEL TEMPERATURE



MIN SLP – MINIMUM SEA LEVEL PRESSURE



RMW – RADIUS OF MAXIMUM WIND