Observation Preprocessor for WRF-Var

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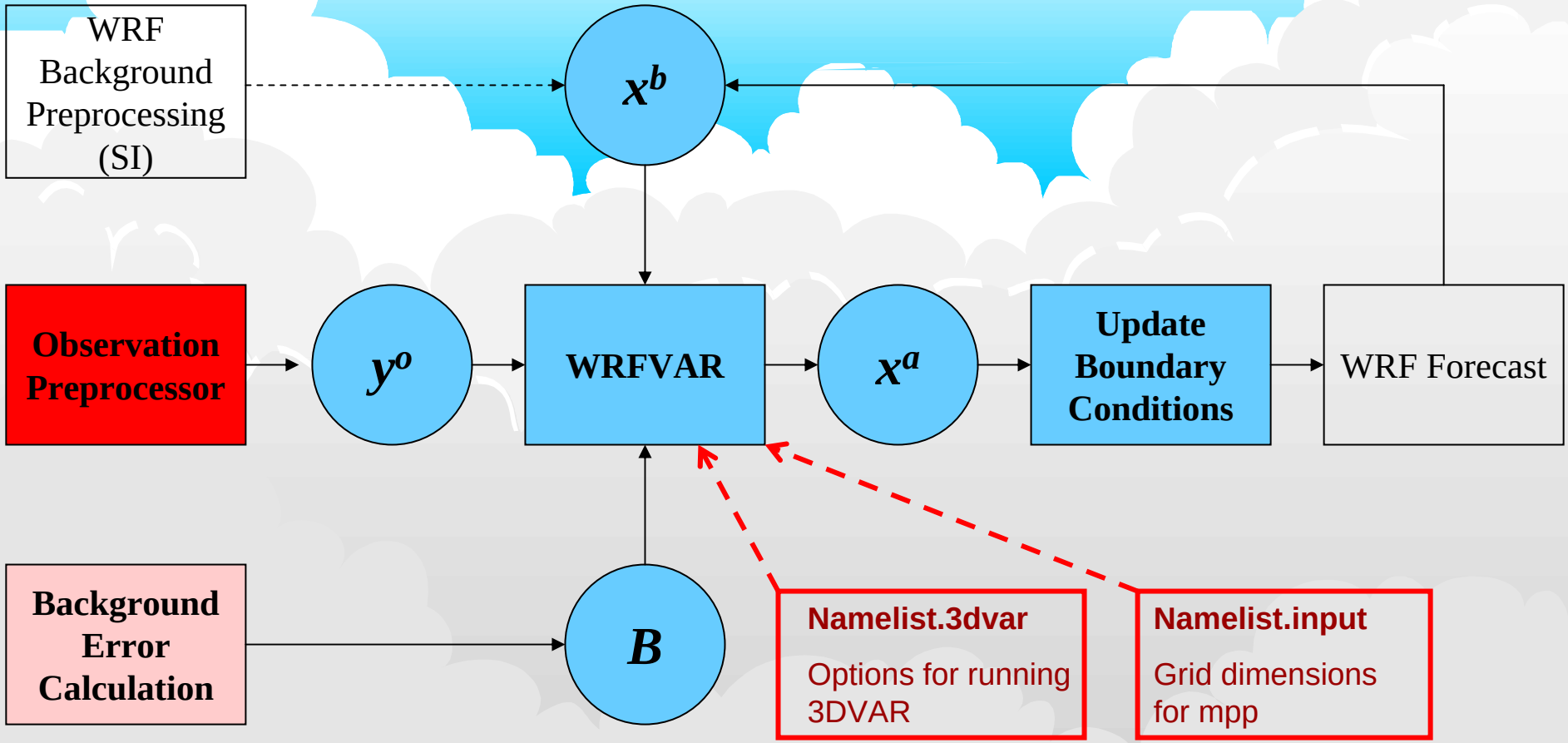
WRF-Var in the WRF Modeling System



The observations are one of the important input files for WRF-Var, no observations will be no data assimilation.

Why do we need the OBS preprocessor?

To prepare the OBS data file suitable for WRF-Var needs

- Screening of the conventional observations (time window, domain, duplication, etc.), and keep the necessary information for WRF-Var assimilation
- Save the OBS data processing time, ***one OBS file*** can be repeatedly used for multiple times of WRF-Var experiments.
- The output file from 3DVAR_OBSPROC is still to be an ACSII format for easy manipulation (read, check, and edit), especially for research purpose.

The data format of observations accepted by WRF-Var

1. **BUFR and preBUFR --- format**

   Radiance data --- BUFR

   Conventional data --- NCEP preBUFR (under testing)

   ob_format = 1 in WRF-Var

2. **ASCII format --- for research and operational:**

   Current working format,

   ob_format = 2 in WRF-Var

   fully supported

Web sites for 3DVAR_OBSPROC

The 3DVAR OBS preprocessor program can be obtained from:

http://www.mmm.ucar.edu/wrf/users/download/get_source2.html

By click "WRF-Var observation pre-processor".

The files inputted to and Outputted from 3DVAR_OBSPROC are ASCII files.

Advantages of ASCII format observations

- The ***input file*** to 3DVAR_OBSPROC is the LITTLE_R format (see below)

  This is a report-based format, so all types of the observation data can be easily '*cat*'ted together to form a monolithic file.

  It is easily to read, edit,…. with an ASCII file.

- The ***output file*** from observation preprocessor, 3DVAR_OBSPROC program is still an ASCII file. It is easily manipulated for specific purposes of research, such as single point data tests, etc.

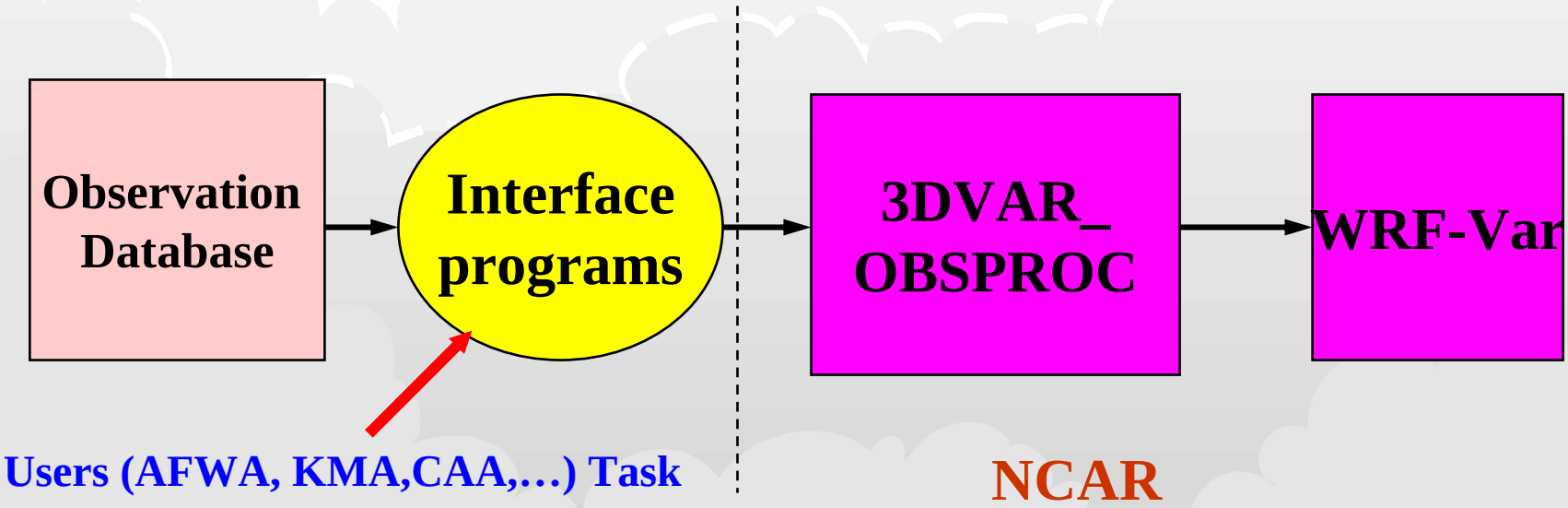
- Users' duty is just to convert their own observations in any format to the LITTLE_R format. Then that data can be processed by 3DVAR_OBSPROC, and an observation file suitable for assimilation with WRF-Var is created.

Disadvantages of ASCII format observations

The size of the observation file is larger in compared with the BUFR format file, not suitable for the remote sensing data, such as Radiance, etc.

Interface programs in AFWA, KMA, CAA,..

- Interface programs to convert the data format from AFWA, KMA, CAA,… observation database to LITTLE_R format to provide the OBS file to WRF-Var OBS preprocessor



- In NCAR, MM5 Utility ***fetch.csh*** will obtain the OBS data file in LITTLE_R format from NCAR archive.

Input OBS (LITTLE_R) file to preprocessor

- *OBS decoded file* in LITTLE_R format containing *Reports*
- *Report* containing *Records* (*header, data,…, and ending*) *and 3 tail integers* (3I7)
- *Record* containing *fields*
  - The *fields* in the *header record* (Fortran format in parenthesis)
  - The *fields* in the *data record* (Fortran format in parenthesis)
  - The *fields* in the *ending record*

No	Field	No	Filed	No	Field
1	Latitude (f20.5)	2	Longitude (f20.5)	3	ID (a40)
4	Name (a40)	5	Platform (a40)	6	Source (a40)
7	Elevation (f20.5)	8	Num_vld_fld (i10)	9	Num_error (i10)
10	Num_warning (i10)	11	Seq_num (i10)	12	Num_dupd (i10)
13	Is_sound (L10)	14	Bogus (L10)	15	Discard (L10)
16	Valid_time%sut (i10)	17	Valid_time%julian (i10)	18	Valid_time%date_char(a20)
19	Slp%data (f13.5)	20	Slp%qc (i7)	21	Ref_pres%data (f13.5)
22	Ref_pres%qc (i7)	23	Ground_t%data (f13.5)	24	Ground_t%qc (i7)
25	SST%data (f13.5)	26	SST%qc (i7)	27	Psfc%data (f13.5)
28	Psfc%qc (i7)	29	Precip%data (f13.5)	30	Precip%qc (i7)
31	T_max%data (f13.5)	32	T_max%qc (i7)	33	T_min%data (f13.5)
34	T_min%qc (i7)	35	T_min_night%data (f13.5)	36	T_min_night%qc (i7)
37	P_tend03%data (f13.5)	38	P_tend03%qc (i7)	39	P_tend24%data (f13.5)
40	P_tend24%qc (i7)	41	Cloud_cvr%data (f13.5)	42	Cloud_cvr%qc (i7)
43	Celling%data (f13.5)	44	Celling%qc (i7)	45	Pw%data (f13.5)
46	Pw%qc (i7)	47	Tb19v%data (f13.5)	48	Tb19v%qc (i7)
49	Tb19h%data (f13.5)	50	Tb19h%qc (i7)	51	Tb22v%data (f13.5)
52	Tb22v%qc (i7)	53	Tb37v%data (f13.5)	54	Tb37v%qc (i7)
55	Tb37h%data (f13.5)	56	Tb37h%qc (i7)	57	Tb85v%data (f13.5)
58	Tb85v%qc (i7)	59	Tb85h%data (f13.5)	60	Tb85h%qc

The fields in the data record (Fortran format in parenthesis)

No	Field	No	Field
1	Pressure%data (f13.5)	2	Pressure%qc (i7)
3	Height%data 9f13.5)	4	Height%qc (i7)
5	Temperature%data (f13.5)	6	Temperature%qc (i7)
7	Dew_point%data (f13.5)	8	Dew_point%qc (i7)
9	Speed%data (f13.5)	10	Speed%qc (i7)
11	Direction%data (f13.5)	12	Direction%qc (i7)
13	U%data (f13.5)	14	U%qc (i7)
15	V%data (f13.5)	16	V%qc (i7)
17	RH%data (f13.5)	18	RH%qc (i7)
19	Thickness%data (f13.5)	20	Thickness%qc (i7)

The fields in the ending record

No	field	No	field	No	field	No	field
1	-777777.00000	2	0	3	-777777.00000	4	0
5	-888888.00000	6	0	7	-888888.00000	8	0
9	-888888.00000	10	0	11	-888888.00000	12	0
13	-888888.00000	14	0	15	-888888.00000	16	0
17	-888888.00000	18	0	19	-888888.00000	20	0

Types of observations to be processed

→18 types (SYNOP, SHIPS, METAR, TEMP , AIREP, PILOT , AMDAR, PROFL, SATOB, SATEM, SSMT1, SSMT2, SSMI, GPSPW, GPSZD, GPSRF, QSCAT, BOGUS)

Each type of the observations is identified by its WMO code in WRF-Var. If the standard WMO code is not available to a new data type, user should assign a 3-digit code to that data type.

WMO code for each type of observations

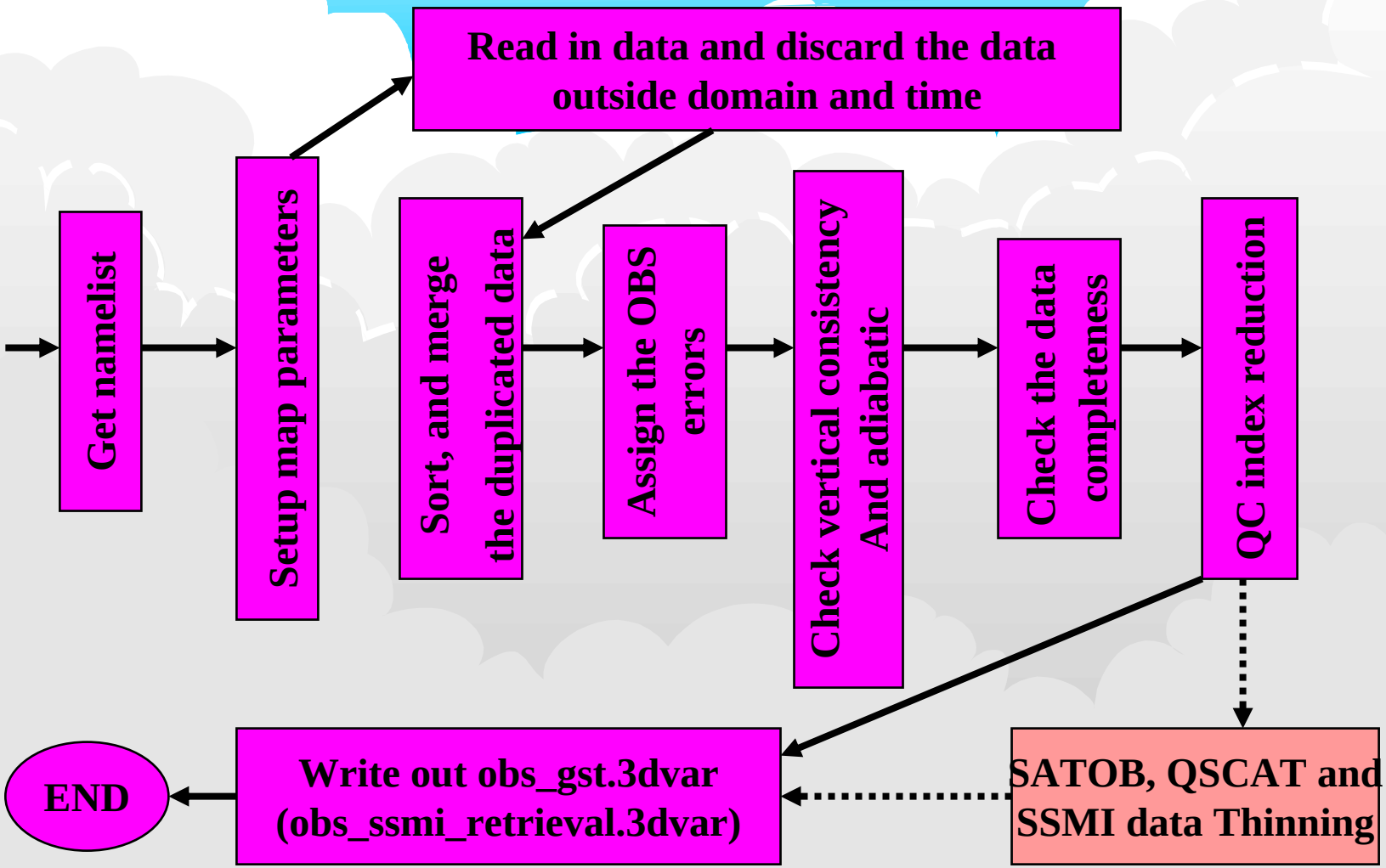
Name	WMO code	WMO code name
SYNOP	12, 14	SYNOP, SYNOP MOBIL
SHIP	13	SHIP
METAR	15, 16	METAR, SPECI
PILOT	32, 33, 34	PILOT, PILOT SHIP, PILOT MOBIL
SOUND	35, 36, 37, 38	TEMP, TEMP SHIP, TEMP DROP, TEMP MOBIL
AMDAR	42	AMDAR
SATEM	86	SATEM
SATOB	88	SATOB
AIREP	96, 97	AIREP
GPSPW	111	GPSPW (Ground-based GPS precipitable water)
GPSZD	114	GPSZD (Ground-based GPS Zenith Total Delay)
GPSRF	116	GPSRF (Space-based GPS Refractivity)
SSMT1	121	SSMT1
SSMT2	122	SSMT2
SSMI	125	SSMI
PROFL	132	WIND PROFILER
BOGUS	135	TCBOU (Typhoon bogus), BOGUS (other bogus)
QSCAT	281	Quik SCAT level-2B SeaWind
OTHER		UNKNOWN

Input and output files for OBS preprocessor

3 *Input files*

- **OBS decoded file (Reports) in little_r format**
  - **A report (F90 pointer linking structure)**
    - ❖ **header record (fields)**
    - ❖ **Level*1* data record (fields)**
    - ❖ **……**
    - ❖ **Level*n* data record (fields)**
    - ❖ **Ending record (fields)**
    - ➢ **3 Integers in format(3i7)**
- **Namelist file (*namelist.3dvar_obs*) (See: README.namelist)**
  - **Record1: input file names**
  - **Record2: analysis times**
  - **Record3: Maximum number of observations allowed**
  - **Record4: quality control switches**
  - **Record5: print switches**
  - **Record6: define the reference state: ptop, etc.**
  - **Record7: Geographic parameters**
  - **Record8: Domain settings**
  - **Record9: Output format: prebufr, ascii, or both**
- **AFWA OBS errors file: *obserr.txt* (provided by 3DVAR system)**

Flow chart of OBS preprocessor



Tasks of the OBS preprocessor: 3DVAR_OBSPROC

1, To perform a time-windowed and, in case of regional application (domain_check_h = .TRUE.), geographically-filtered dump of the ingested observations

Currently, there is *no time-check for observation data in WRF-Var assimilation code*, so to select the observation data within a suitable time-window must be performed in 3DVAR_OBSPROC.

For the regional application with the IPROJ = 1 (Lambert conformal), 2 (Polar Stereographic), or 3 (Mercator), there is a geographic-filtered performed based on the model domain settings. For the global application of WRF-Var, it should set IPROJ = 0 and no geographic-filtered is performed.

Tasks of the OBS preprocessor: 3DVAR_OBSPROC (cont.)

2, To retrieve the pressure or height based on the observed information with the hydrostatic assumption

3, To remove the duplicate reports of observations

4, To re-order (from bottom to top) and merge the data reports with the same platform, time, and location based on the pressure.

5, To discard the data above the model top ($p<p_{top}$) in the upper-air observations (remove_above_lid = .TRUE.)

Tasks of the OBS preprocessor: 3DVAR_OBSPROC (cont.)

6, To assign the observation errors to the different types of observations

Observations errors

→ NCEP OBS error (Parrish and Derber 1992)

→US Air Force (AFWA) OBS error file

→Directly from the observation reports

7, To perform the vertical consistency check and super adiabatic check for the multi-level observations

Tasks of the OBS preprocessor: 3DVAR_OBSPROC (cont.)

8, To complete thinning with the SATOB, SSMI, and QSCAT data

The data points nearest to the model grid-points will be picked up for assimilation.

9, To write out the OBS files in ASCII format as the WRF-Var input

→ GTS data (*obs_gts.3dvar*): pressure, Wind, height, temperature, dewpoint, RH, etc.

→ SSMI data (*obs_ssmi_retrieval.3dvar*): PW and surface wind speed

10, To plot the distribution for each type of observations

→MAP_plot

Output files

1, *Obs_gts.3dvar* and *obs_ssmi_retrieval.3dvar*

Header: the information for this OBS file and data format

Data : *header* record and *data* records for each of levels

- These are the OBS input file to WRF-Var program
- obs_ssmi_retrieval.3dvar needed only when SSMI retrieval data available
- These files can be used as input to MAP_plot to obtain the gmeta plot file with NCAR GRAPHICS

2, 3dvar_obs.out ---- a program execution log file

The printing out from the program execution. It can used to monitor the execution and to identify the troubles if any

3, Diagnostic files depended on the print switches in namelist

File: obs_gts.3dvar

```
TOTAL =   8169, MISS. =-888888.,
SYNOP =   1432, METAR =    164, SHIP  =     86, BUOY  =      0, TEMP  =    179, AMDAR =      0,
AIREP =    265, PILOT =      0, SATEM =      0, SATOB =   6043, GPSPW =      0, SSMT1 =      0,
SSMT2 =      0, TOVS  =      0, QSCAT =      0, PROFL =      0, OTHER =      0,
PHIC  =  28.50, XLONC = 116.00, TRUE1 =  10.00, TRUE2 =  45.00, XIM11 =   1.00, XJM11 =   1.00,
TS0   = 275.00, TLP   =  50.00, PTOP  =  7000., PS0   =100000.,
IXC   =     67, JXC   =     81, IPROJ =      1, IDD   =      1, MAXNES=     10,
NESTIX=     67,     67,     67,     67,     67,     67,     67,     67,     67,     67,
NESTJX=     81,     81,     81,     81,     81,     81,     81,     81,     81,     81,
NUMC  =      1,      1,      1,      1,      1,      1,      1,      1,      1,      1,
DIS   = 135.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,   0.00,
NESTI =      1,      1,      1,      1,      1,      1,      1,      1,      1,      1,
NESTJ =      1,      1,      1,      1,      1,      1,      1,      1,      1,      1,
INFO  = PLATFORM, DATE, NAME, LEVELS, LATITUDE, LONGITUDE, ELEVATION, ID.
SRFC  = SLP, PW (DATA,QC,ERROR).
EACH  = PRES, SPEED, DIR, HEIGHT, TEMP, DEW PT, HUMID (DATA,QC,ERROR)*LEVELS.
INFO_FMT = (A12,1X,A19,1X,A40,1X,I6,3(F12.3,11X),6X,A5)
SRFC_FMT = (F12.3,I4,F7.2,F12.3,I4,F7.2)
EACH_FMT = (3(F12.3,I4,F7.2),11X,3(F12.3,I4,F7.2),11X,1(F12.3,I4,F7.2)))
#-------------------------------------------------------------------------------#
FM-35 TEMP   1999-08-19_11:00:00  AHMADABAD / INDIA              17     23.070          72.630          55.000          42647
 -888888.000 -88 200.00 -888888.000 -88   0.20
  100000.000   0 100.00       3.000   0   1.10     225.000   0   5.00          53.000   0   7.00    305.550   0   1.00    298.550   0   1.00          65.984   0  15.00
   92500.000   0 100.00       3.000   0   1.10     220.000   0   5.00         745.000   0   7.48    300.550   0   1.00    295.550   0   1.00          73.714   0  12.60
   91600.000   0 100.00 -888888.000 -88   1.10 -888888.000 -88   5.00         830.000   0   7.54    300.150   0   1.00    295.150   0   1.00          73.653   0  12.30
   87300.000   0 100.00 -888888.000 -88   1.10 -888888.000 -88   5.00        1251.000   0   7.84    297.350   0   1.00    291.350   0   1.00          68.712   0  10.82
   85000.000   0 100.00       6.000   0   1.10     250.000   0   5.00        1498.000   0   8.00    295.350   0   1.00    290.750   0   1.00          74.809   0  10.00
   79200.000   0 100.00 -888888.000 -88   1.13 -888888.000 -88   5.00        2104.000   0   8.22    290.750   0   1.00    288.550   0   1.00          86.755   0  10.00
   78000.000   0 100.00 -888888.000 -88   1.18 -888888.000 -88   5.00        2238.000   0   8.27    292.950   0   1.00    281.950   0   1.00          48.599   0  10.00
   70700.000   0 100.00 -888888.000 -88   1.39 -888888.000 -88   5.00        3076.000   0   8.57    289.950   0   1.00    268.950   0   1.00          23.245   0  10.00
   70000.000   0 100.00       2.000   0   1.40      30.000   0   5.00        3168.000   0   8.60 -888888.000 -11   1.00 -888888.000 -11   1.00          -888888.000 -11  10.00
   61100.000   0 100.00 -888888.000 -88   1.76 -888888.000 -88   5.00        4312.000   3  10.01    282.350   0   1.00    271.350   0   1.00          45.937   0  10.00
   60000.000   0 100.00 -888888.000 -88   1.80 -888888.000 -88   5.00        4463.000   3  10.20    281.350   0   1.00    272.350   0   1.00          52.920   0  10.00
   57400.000   0 100.00 -888888.000 -88   1.90 -888888.000 -88   5.00        4828.000   3  10.66    279.150   0   1.00    274.150   0   1.00          70.188   0  10.00
   52700.000   0 100.00 -888888.000 -88   2.14 -888888.000 -88   5.00        5526.000   3  11.55    275.550   0   1.00    272.650   0   1.00          81.128   0  10.00
   50300.000   0 100.00 -888888.000 -88   2.28 -888888.000 -88   5.00        5902.000   3  12.04    273.350   0   1.00    269.650   0   1.00          76.187   0  10.00
   50200.000   0 100.00 -888888.000 -88   2.29 -888888.000 -88   5.00        5918.000   3  12.06    273.150   0   1.00    269.450   0   1.00          76.157   0  10.00
   50000.000   0 100.00       3.000   0   2.30      95.000   0   5.00        5950.000   0  12.10    272.850   0   1.00    269.250   0   1.00          76.682   0  10.00
   46900.000   0 100.00       2.000   0   2.42     100.000   0   5.00        6461.000   3  12.90    270.450   0   1.00    266.250   0   1.00          72.904   0  10.00
FM-35 TEMP   1999-08-19_11:00:00  BOMBAY / SANTACRUZ / INDIA          25     19.120          72.850          14.000          430
……
```

# of observations

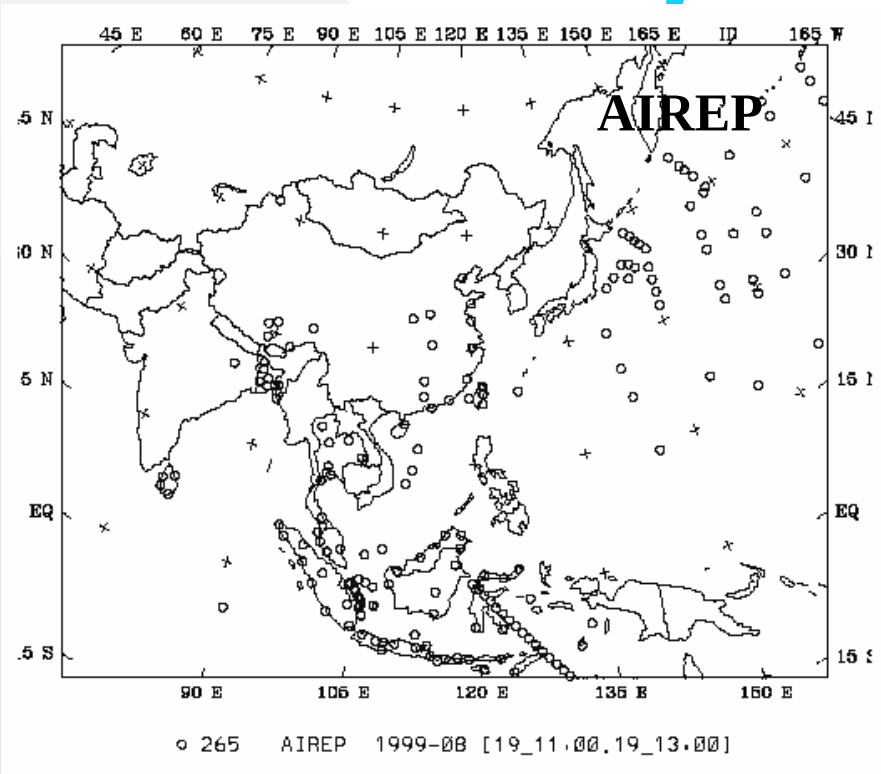
Model domain information

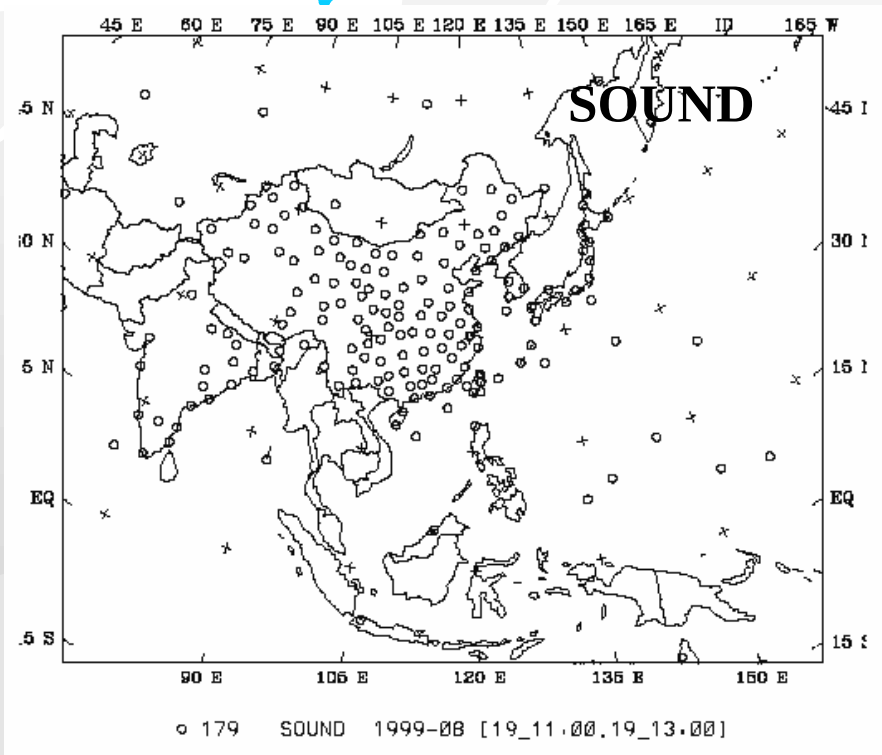
Data format

How to plot the OBS distribution?

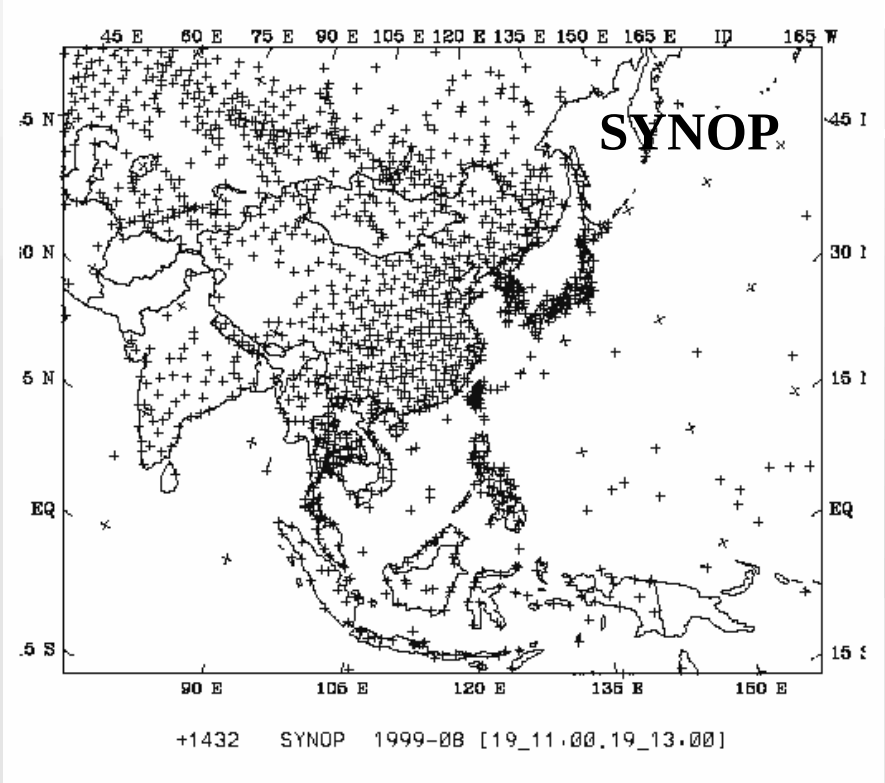
- Go to the directory *3DVAR_OBSPROC/MAP_plot*
- Modify the shell script *Map.csh*
  - To fill in *TIME_ANALYSIS*, etc., and *OBSDATA* file name
- Run shell script *Map.csh*
  - You will have a gmeta file: *gmeta.${TIME_ANALYSIS}* to show the the distribution of observations contained in *OBSDATA* file.

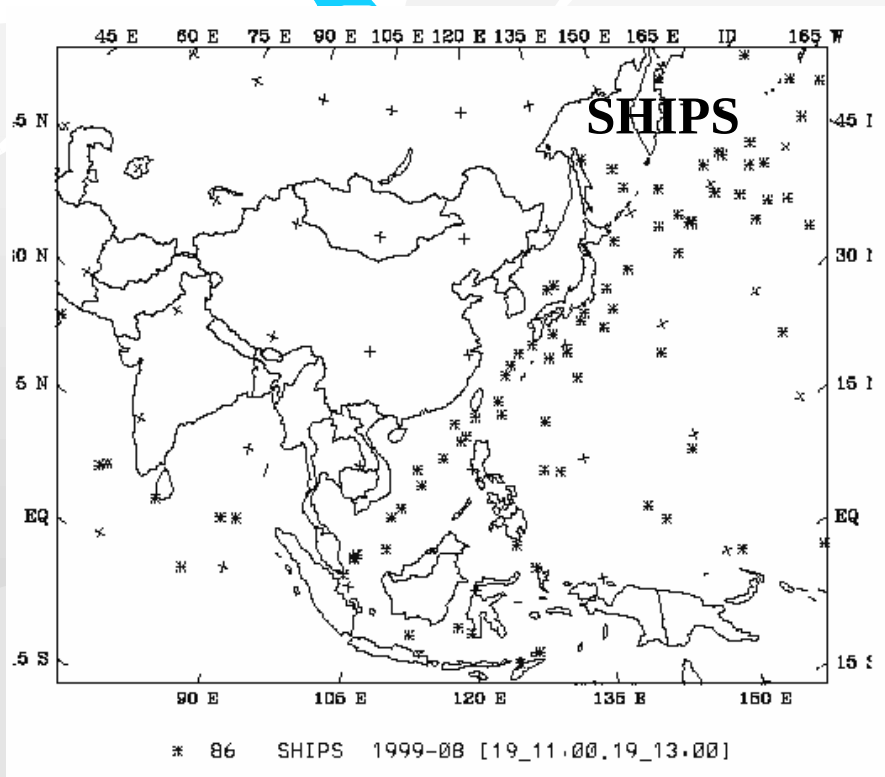
Distribution for each type of observations





Distribution for each type of observations





Distribution for each type of observations