Marine-MET data

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Ocean Observation System and Ocean data Utilization

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Brief outline

- What is marine met data?
- Sources at INCOIS, data pre-processing
- Quality control (QC)
- Bias corrections
- Gridding

India Meteorology Department (IMD)Data

- AWS masts fixed on ships of opportunity (VOS)
- Log data
- Spatial coverage : Global Oceans with more concentration in Indian ocean
- Scattered ship data
- Data availability from 1961 - 2012
- Data with five different record sizes

• -- 82, 126, 131, 151, 159
• -- IMMT format

NODPAC (Naval Operational Data Processing and Analysis Centre) data

- AWS masts fixed on Indian Navy ships
- Log data
- Spatial coverage : Indian Ocean
- Scattered ship data
- Data availability from 2002

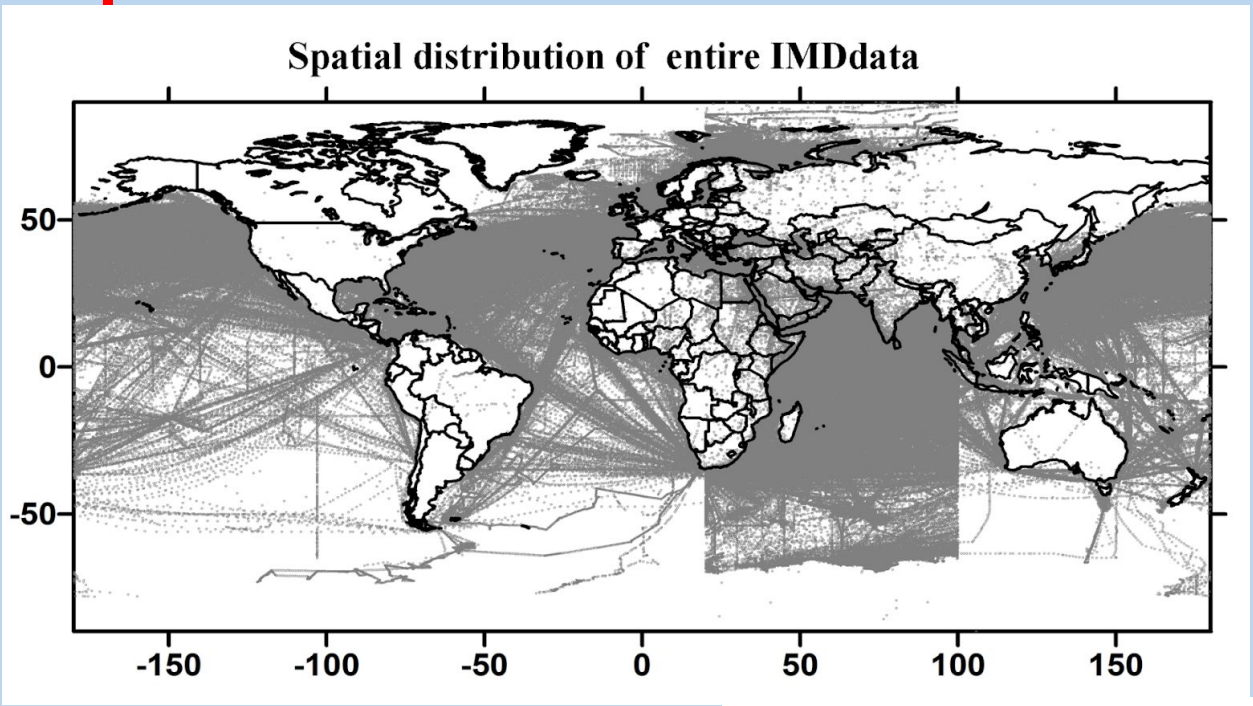
-- GTS format (BBXX)
-- IMMT format

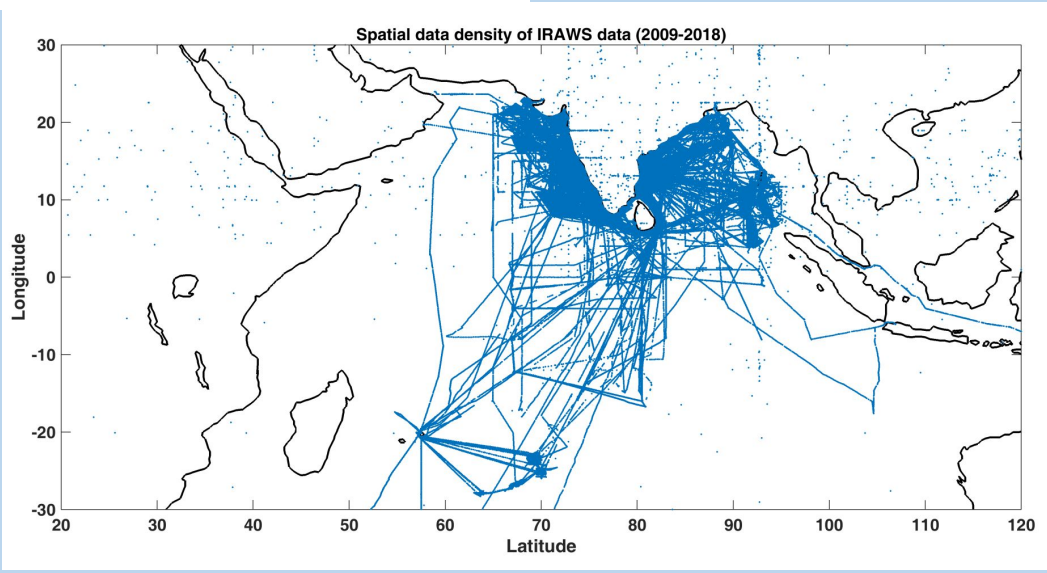
INCOIS Realtime Automatic Weather Station data(IRAWS)

- INCOIS AWS masts fixed on Indian ships
- Real time and log data
- Spatial coverage : Indian Ocean
- Scattered ship data
- Data availability from 2009

-- CSV

Spatial distribution





- **Sample data obtained from IMD (82bytes)**
- 161010180028091253210980221010029325022 4 283010322 02173 04000 3 19
- 16101013017659153010999020101122752402 1 01278 03 210 62263 19
- 161010180304061200709980201010226724300900273 06072 01053 03000 3 19
- 16101018031414124050998021 272240324402 78}06052 01042 02000 3 19

- **NODPAC data (GTS and IMMT)**
- BBXX,sunl,01004,99177,10833,41996,30213,**10264**,20231,40122,55005,70500,80001,22200,00278,20301,310//,40501,5////,80240=
- BBXX,sunl,01064,99177,10833,41496,30613,10286,20237,40145,50010,70500,82401,22200,00272,20301,310//,40501,5////,80250=
- BBXX,sunl,01124,99177,10833,41996,00618,10284,20226,40120,55005,70500,80000,22200,00278,20501,309//,41002,5////,80242=
- BBXX,sunl,01184,99177,10833,41496,50113,10282,20226,40135,50002,76111,83420,22200,00272,20301,309//,41002,5////,80242=
- BBXX,sunl,02004,99177,10833,41496,50211,10256,20219,40130,55002,72122,81538,22200,00272,20200,309//,40501,5////,80230=

Metadata

- WMO metadata (IMD data)
- WMO metadata yearly.
- Metadata of unique IMD record ships extracted
- Different versions for different sets of years
- Callsign of each record is searched in the metadata of current year, if not found then searched in the following two years and then for the previous year.

1. Type of VOS ship
2. Vessel type
3. Temperature measurement height
4. Platform height
5. Exposure of hygrometer
6. SST measurement method
7. Depth of SST measurement
8. Height of wind speed measurement

IRAWS setups onboard Matsyavrushti

Variables available

- Dry bulb temperature
- Dew point temperature
- Sea surface temperature
- Wind speed
- Wind direction
- Wet bulb temperature
- Cloud parameters
- Wave parameters
- Weather condition
- QC value for the above parameters
- Brief details of method of observation
- Ship speed, position, date and time of observation

Quality Control Procedure

QC procedures

Primary QC procedure	Secondary QC procedure
Duplicate check	Consistency between wind speed and direction
Range check	Consistency between humidity and air temperature
Climatological standard deviation check	Consistency between sea surface temperature and air temperature
Spike test	Parameter based special tests
Stuck value test	QC test for identifying shadowing effect in SWR
Time sequence check	Algorithm developed for identifying time steps during a weather event

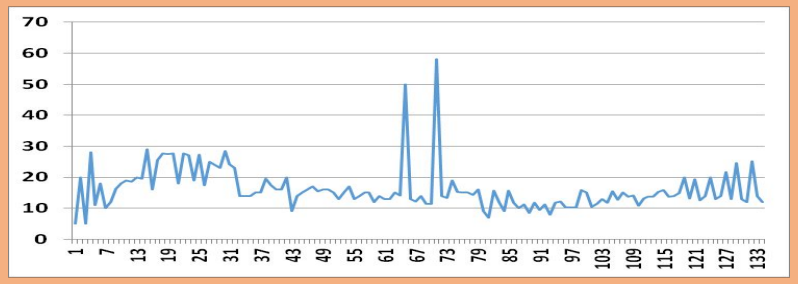
LAT	Change
0 – 39.9	< 0.7 ^{0} / hr
40 – 49.9	< 1.0 ^{0} / hr
50 – 59.9	< 1.4 ^{0} / hr
60 – 69.9	< 2.0 ^{0} / hr
70 -79.9	<2.7 ^{0} / hr

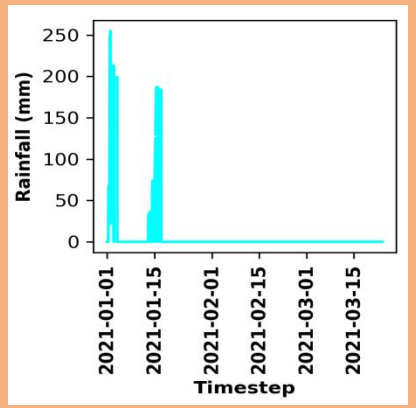
Essential steps in Quality Control procedure:

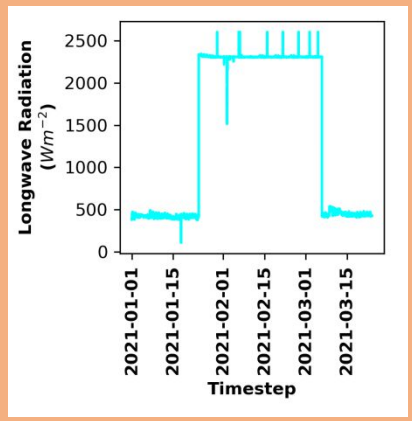
- Valid position
- Time Sequence

  -Change in LAT < 0.7 ^{0} / hr (LATdiff/TIMEdiff)

  -Change in LON (LONdiff/TIMEdiff)
- Parameter values are checked for valid range. Ranges are slightly modified based on latitude.
- Consistency check (Checking the magnitude of variables with their related counter variables like dry bulb temperature and dew-point temperatures, etc)
- Climatology based standard deviation trimming $\Delta \in (-3.5*\sigma, 3.5*\sigma)$
- Spike test
- Persistence check







Valid ranges for the various parameters observed:

Variable	Valid range	Variable	Valid range
Air temperature	Tropics :15 to 50 (^{0}C) Midlatitudes : -40 to 50 (^{0}C)	Rainfall	0 to 50 (mm)
Relative Humidity	55 to 100 (%)	Longwave radiation	0 to 700 (W/m^2)
Sea level pressure	950 to 1040 (hPa)	Shortwave radiation	0 to 1400 (W/m^2)
Wind speed	0.5 to 40 (ms^{-1})	Wave period	0 to 26 (s)
Wind direction	0 to 360 (Degrees)	Wave height	0 to 40 (m)
Sea surface temperature	Tropics :12 to 40 (^{0}C) Midlatitudes : -10 to 50 (^{0}C)	Delta theta	-6 to 8 (^{0}C)
Cloud amount	0 to 8 (okta)	Delta sphum	-0.0295 to 0.0280 (kg/kg)

Time series datasets: A novel QC procedure developed based on non-parameteric statistics (k-Means clustering) and cosine similarity

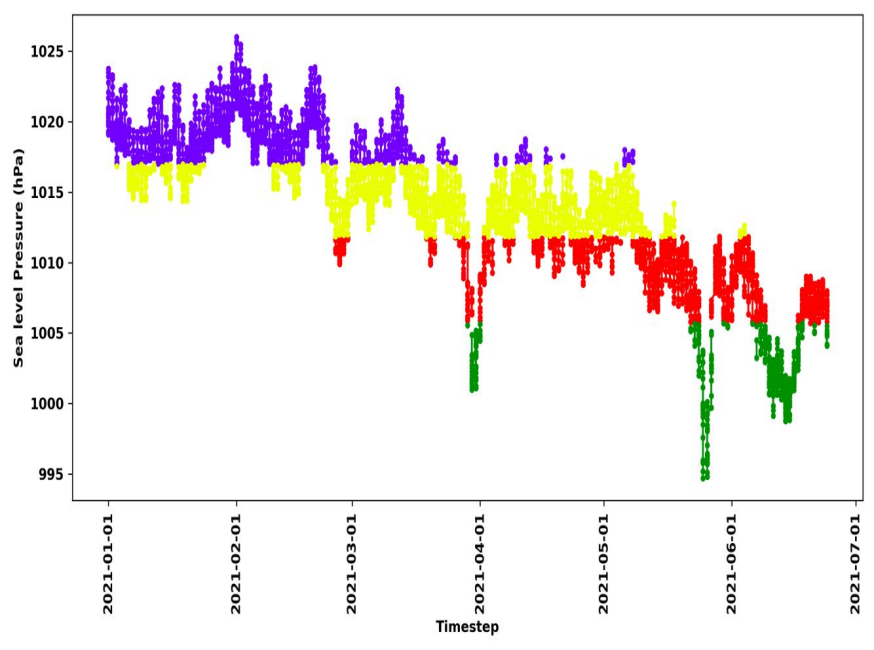


Figure : Clusters in the timeseries of sea level pressure identified by k-Means clustering

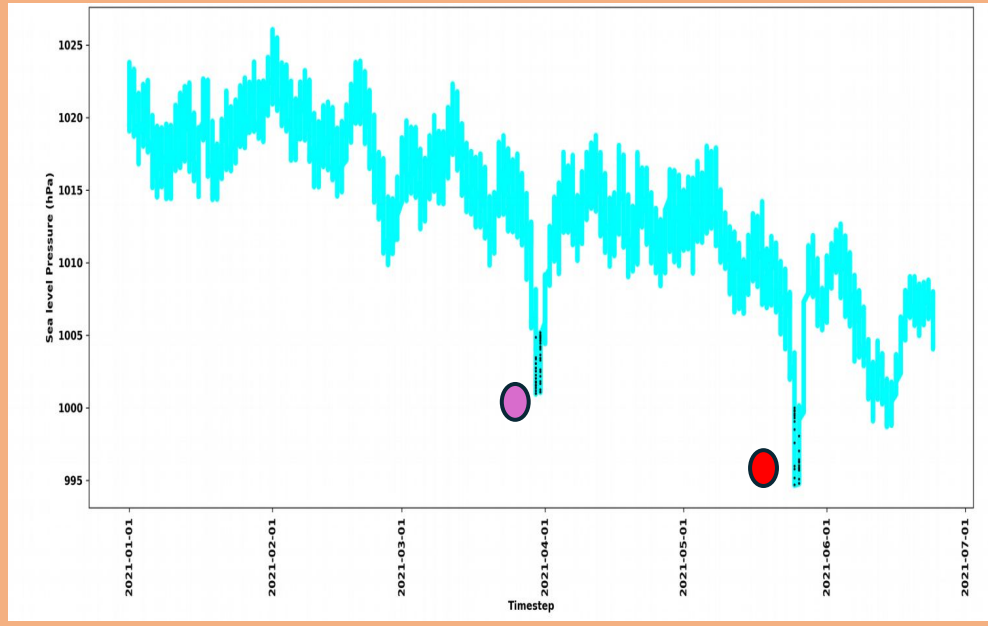


Figure : Observations in timeseries of sea level pressure measured onboard ship MV Nicobar identified by the algorithm as weather event (black points)

Data used : Sea level Pressure data from Jan, 2021 – July 2021 observed onboard the ship MV Nicobar in BoB

Weather events identified : Depression (31–50 kmph) in the first week of April

Cyclone 'Yaas' (Very Severe Cyclonic Storm, 118–168 kmph) during May 2021 – 28 May 2021

Assigning QC flags

Secondary QC flag

1	2	3	4	5	6	7	8
Range test	Climatological standard deviation test	Spike test	Stuck value test	*Internal consistency test between wind speed and direction	*Internal consistency test between humidity and air temperature	*Internal consistency test between sea surface temperature and air temperature	*Parameter based special test

Binary number	Detail
00	QC test not applicable
01	QC test failed
10	Uncertain QC flag assigned
11	QC test passed

11 11 11 11 10 00 00 11

1111111110000011

65411

Bias correction of wind speed

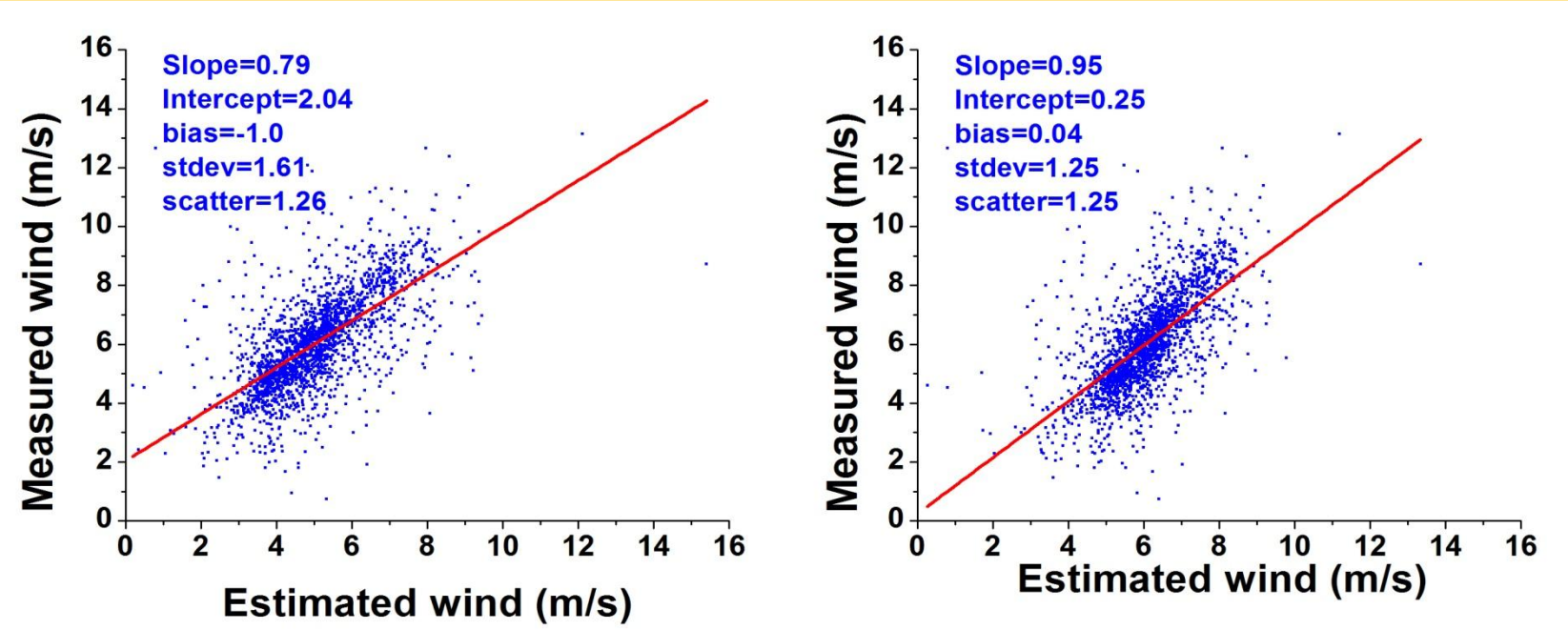
Correcting the Beaufort estimated wind speeds

$$W_{new} = 0.5172 * W_{beaufort} + 1.5851 * (W_{beaufort})^{1/2}$$

	SLOPE	INTERCEPT	BIAS	STDEV	SCATTER
RAW	0.86	1.83	-1.07	1.53	1.09
CORRECTED	0.98	0.05	0.05	1.08	1.08

-- Median gridding

-- Etopo 5 min file used to mask the land points before and after gridding

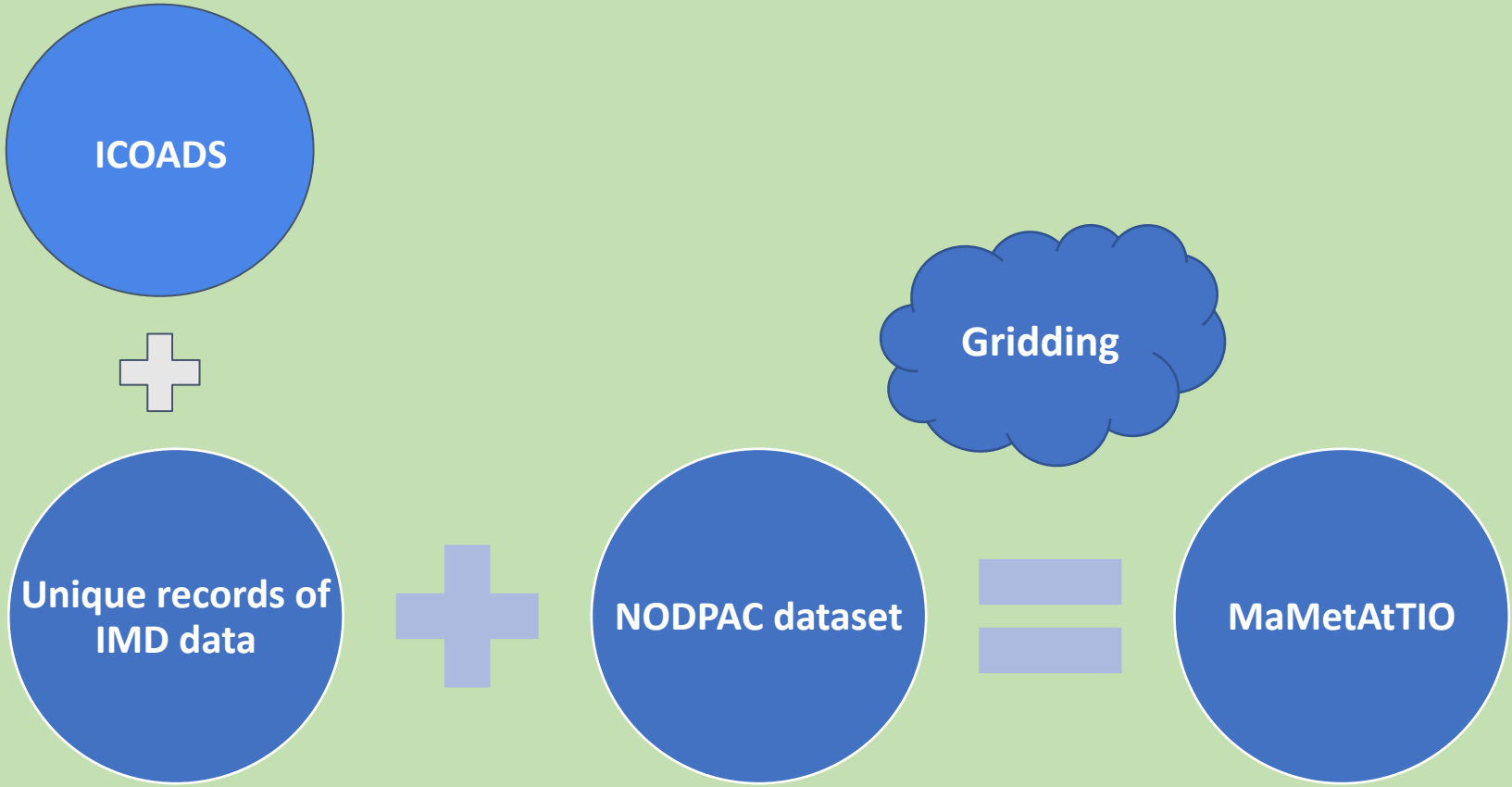


Where Marine MET data is used....

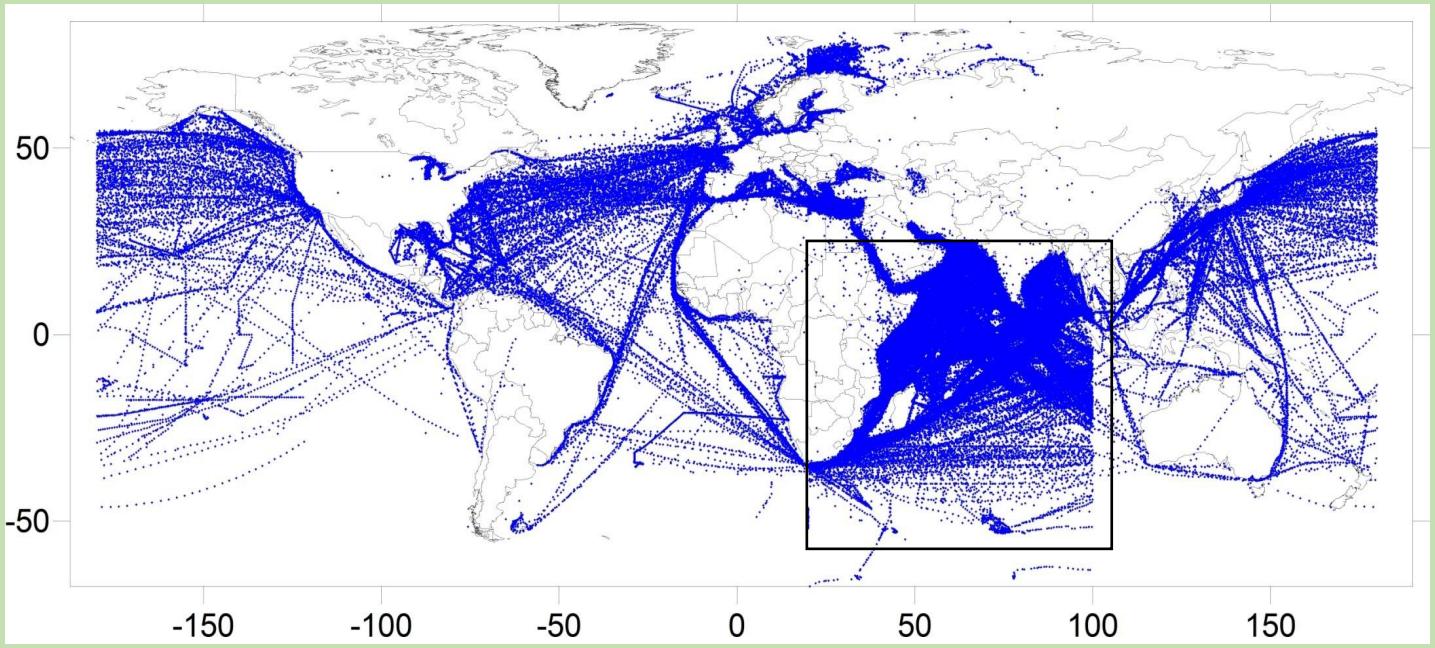
- Climatological Atlas : What is an atlas?

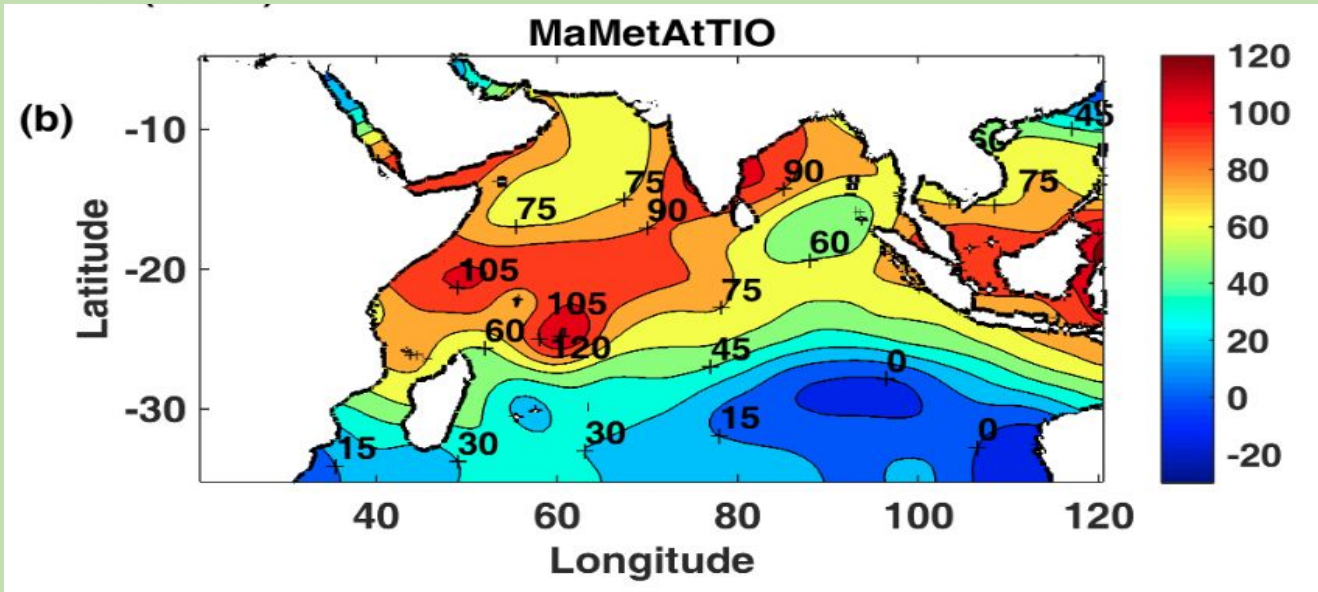
  -a mean representation of climate variables across the globe.

- Climatology mean : several years or decades.


ICOADS
Gridding
Unique records of IMD data
NODPAC dataset
MaMetAtTIO

What is the need for Gridding





Gridding : Cressman iterative difference-correction scheme with Barne's weight function

The procedure is outlined as follows:

- **The first guess V_{q_old} is taken as zeros for the first iteration and the resultant gridded field of the previous iteration is taken for the subsequent iterations.**
- **Calculate Verr**
- **for the first iteration, Verr = V**

for the subsequent iterations, Verr = V - Interpolation (newly gridded field values $V_{q(i,j)}$ to observation locations, X_v)

- **Determine the observations which are within a distance less than radius of influence from X_q**
- **(a) If the number of observations within the radius of influence are greater than or equal to 30 km, compute the weights W of the observations upon the queried grid point.**

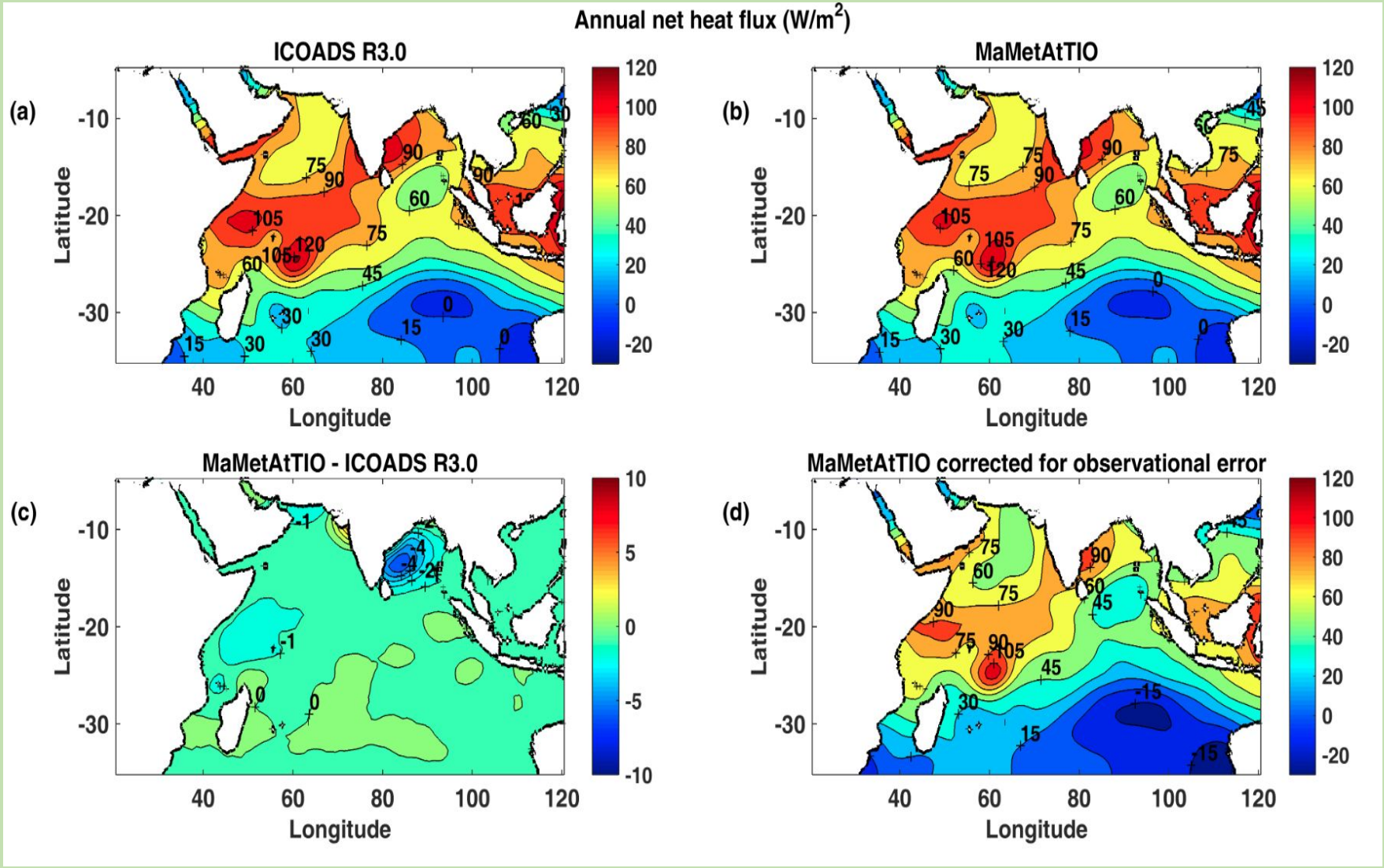
(w: weight of all observations within the radius of influence upon the grid point)

$$w = e^{\frac{-4 * r^2}{R^2}}$$

(b) If the number of observations within the radius of influence is less than 30, $V_{q(i,j)} = undef$

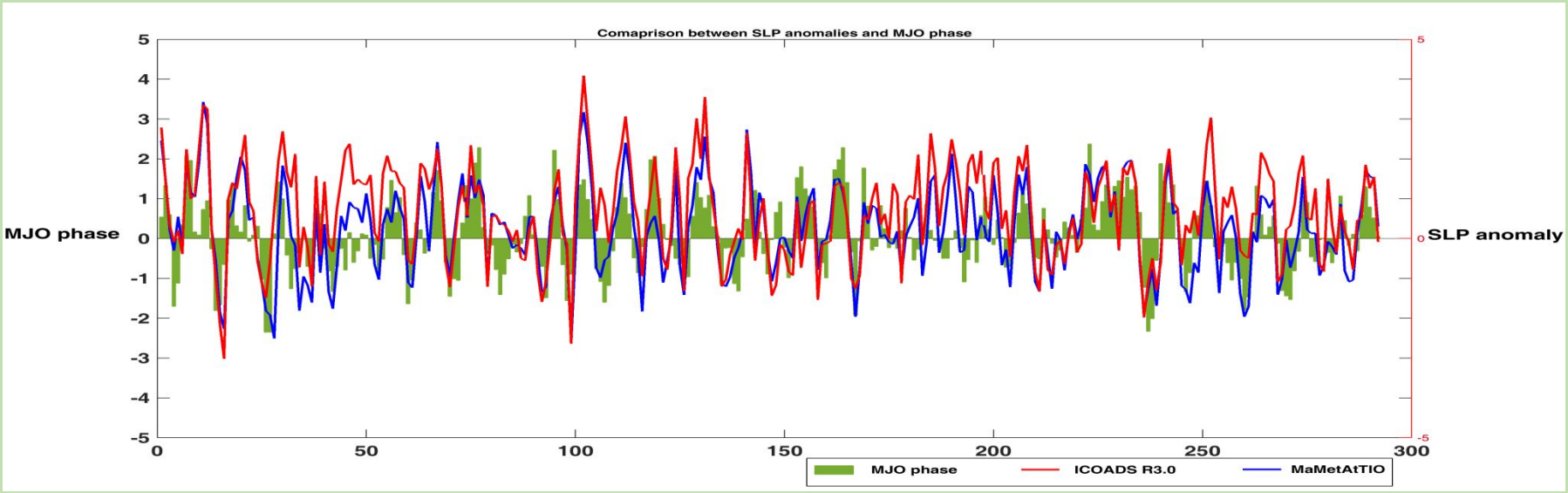
- **Repeat step 4 for all grid points, and from step 1 to step 4 at different radius of influence.**

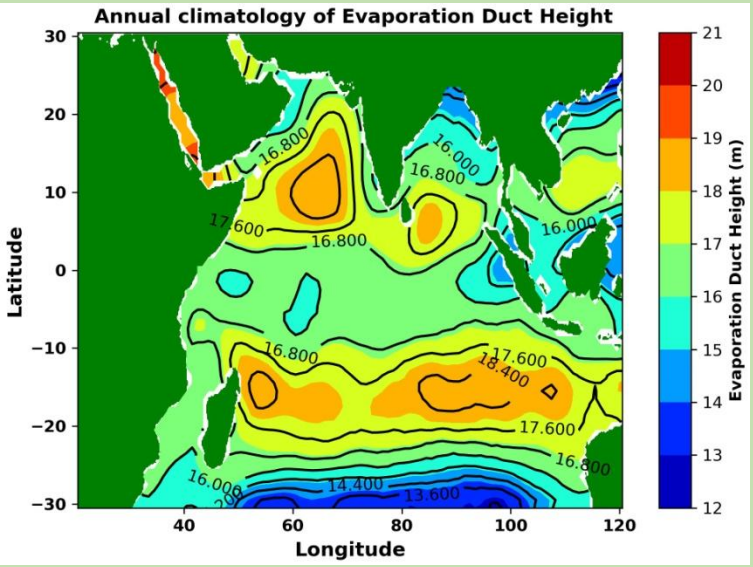
Objective analysis

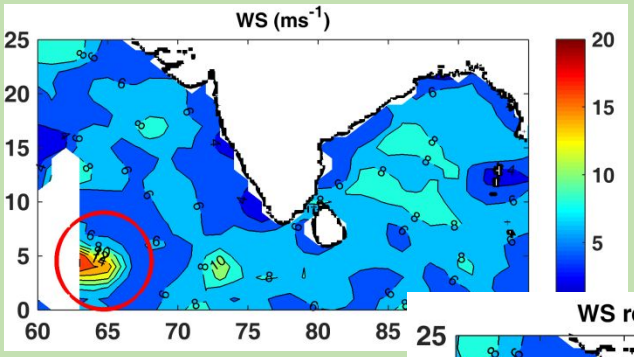


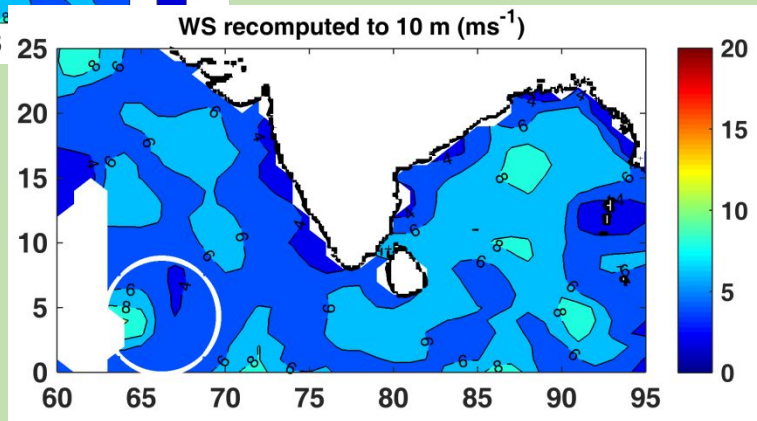
S.No	Monthly Climatology	Annual Climatology	Individual year-month summaries
1	Dry bulb temperature 10 m	Dry bulb temperature 10 m	Dry bulb temperature 10 m
2	Specific Humidity 10 m	Specific Humidity 10 m	Specific Humidity 10 m
3	Sea surface temperature	Sea surface temperature	Sea surface temperature
4	Zonal Wind speed 10 m	Zonal Wind speed 10 m	Zonal Wind speed 10 m
5	Meridional Wind speed 10 m	Meridional Wind speed 10 m	Meridional Wind speed 10 m
6	Sea level pressure	Sea level pressure	Sea level pressure
7	Cloud amount	Cloud amount	Cloud amount
8	U-Momentum Flux	U-Momentum Flux	U-Momentum Flux
9	V-Momentum flux	V-Momentum flux	V-Momentum flux
10	Latent Heat flux	Latent Heat flux	Latent Heat flux
11	Sensible Heat Flux	Sensible Heat Flux	Sensible Heat Flux
12	Longwave radiation	Longwave radiation	Longwave radiation
13	Shortwave radiation	Shortwave radiation	--

Other applications – Phenomenal studies studies









Thank you