

# **REAL TIME IONOSPHERIC CHARACTERIZATION**

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SCIENTIFIC SYSTEMS LLC.

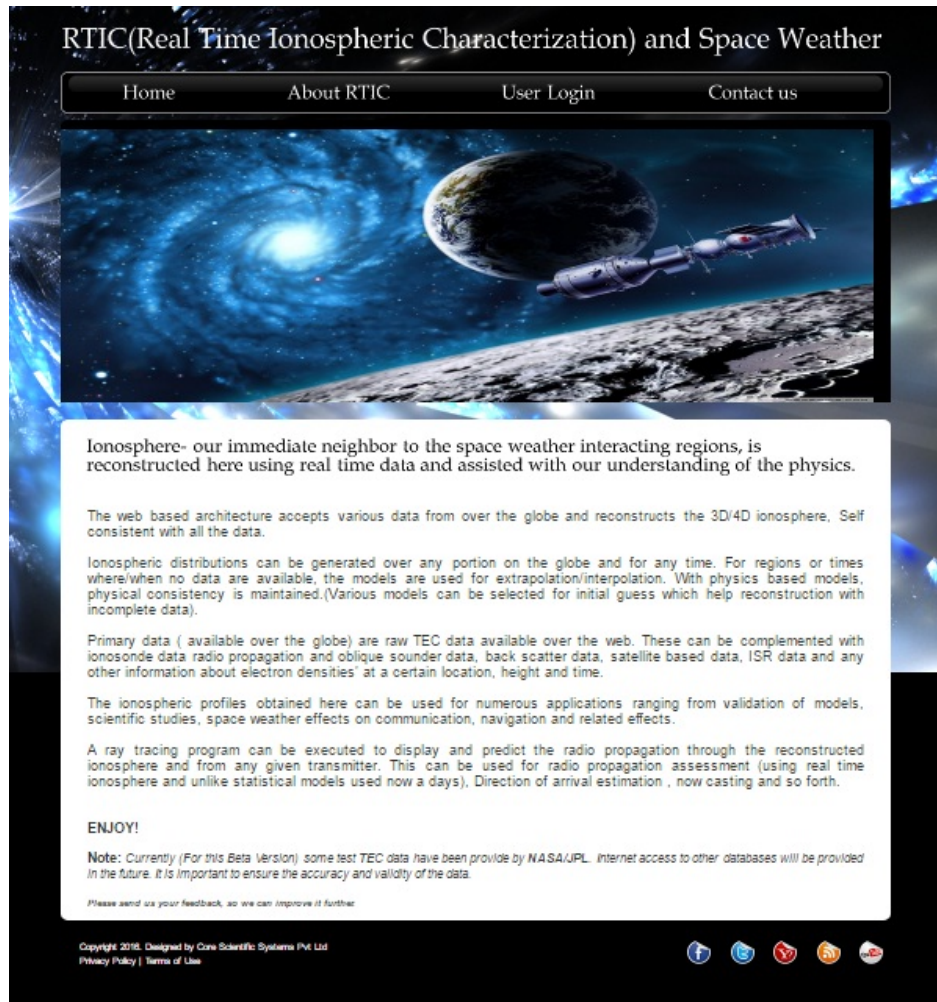
Arlington, VA 22201

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# OVERVIEW



RTIC(Real Time Ionospheric Characterization) and Space Weather

Home About RTIC User Login Contact us

Ionosphere- our immediate neighbor to the space weather interacting regions, is reconstructed here using real time data and assisted with our understanding of the physics.

The web based architecture accepts various data from over the globe and reconstructs the 3D/4D ionosphere. Self consistent with all the data.

Ionospheric distributions can be generated over any portion on the globe and for any time. For regions or times where/when no data are available, the models are used for extrapolation/interpolation. With physics based models, physical consistency is maintained.(Various models can be selected for initial guess which help reconstruction with incomplete data).

Primary data ( available over the globe) are raw TEC data available over the web. These can be complemented with ionosonde data radio propagation and oblique sounder data, back scatter data, satellite based data, ISR data and any other information about electron densities' at a certain location, height and time.

The ionospheric profiles obtained here can be used for numerous applications ranging from validation of models, scientific studies, space weather effects on communication, navigation and related effects.

A ray tracing program can be executed to display and predict the radio propagation through the reconstructed ionosphere and from any given transmitter. This can be used for radio propagation assessment (using real time ionosphere and unlike statistical models used now a days), Direction of arrival estimation , now casting and so forth.

ENJOY!

Note: Currently (For this Beta Version) some test TEC data have been provide by NASA/JPL. internet access to other databases will be provided in the future. It is important to ensure the accuracy and validity of the data.

Please send us your feedback, so we can improve it further.

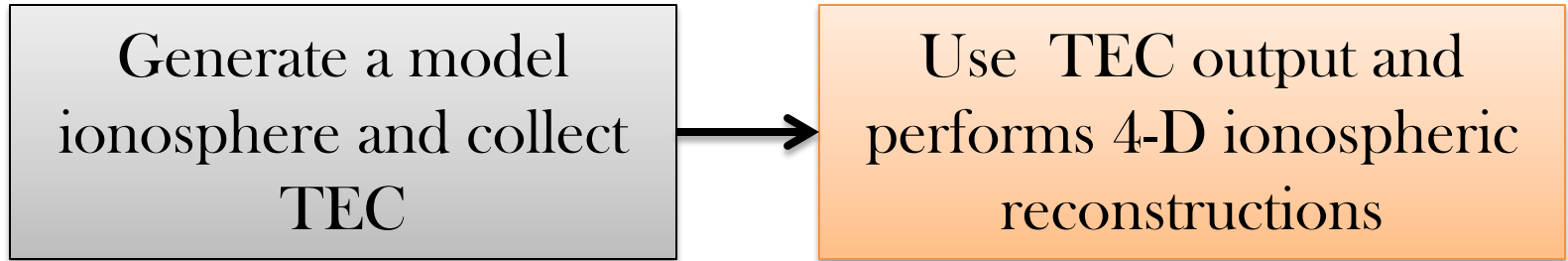
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➤The website allows integration of many disparate types of data over any portion of the Earth.

➤The program accepts a wide variety of data including-  
TEC data from GPS satellites  
Ionosonde data, etc

➤The system utilizes various theoretical and physical models.

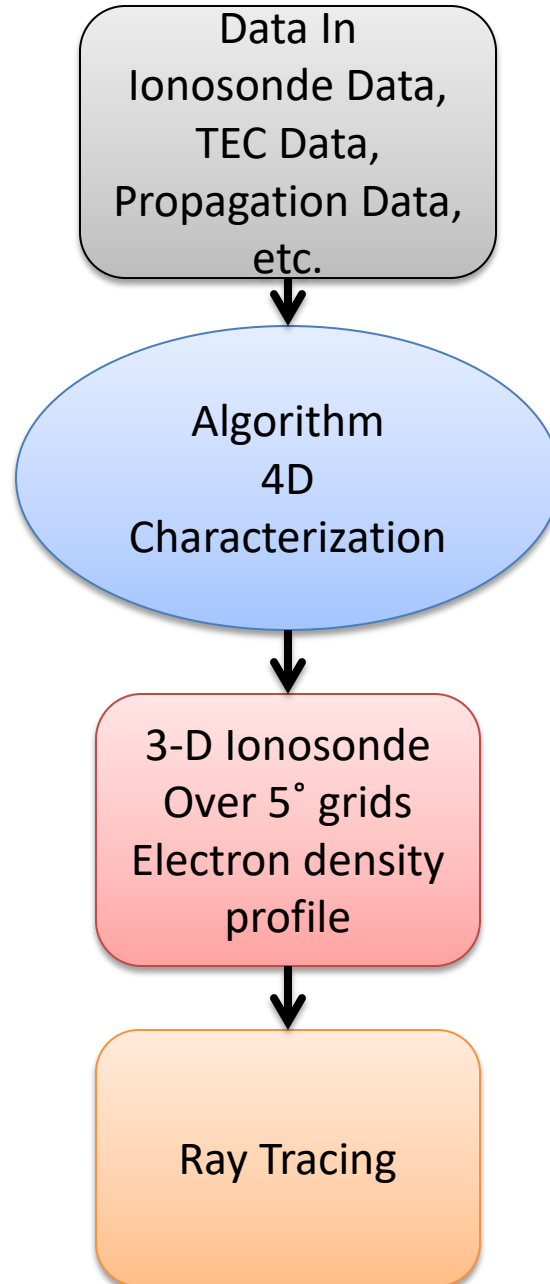
- Calculation are divided into two programs.



- Different Ionospheric models used :

- Air Force PIM model
- IRI
- slab
- Chapman

# REAL TIME IONOSPHERIC CHARACTERIZATION(RTIC)



RTIC Flow

## ➤ Operational Needs

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Hi. cssrtic Log Out

### Over View of Simulation Pages

- 1. Gps derived TEC data available through NASA/JPL, NASA/GSFC, MIT/NSF, NOAA and several other stations.
- 2. Ionosonde data available through NOAA.
- 3. Other ancillary data such as in-situ satellite data from various sources.

**Method :**

- 1. Tomographic Reconstruction and data assimilation using model based interpolation.

**Outputs :**

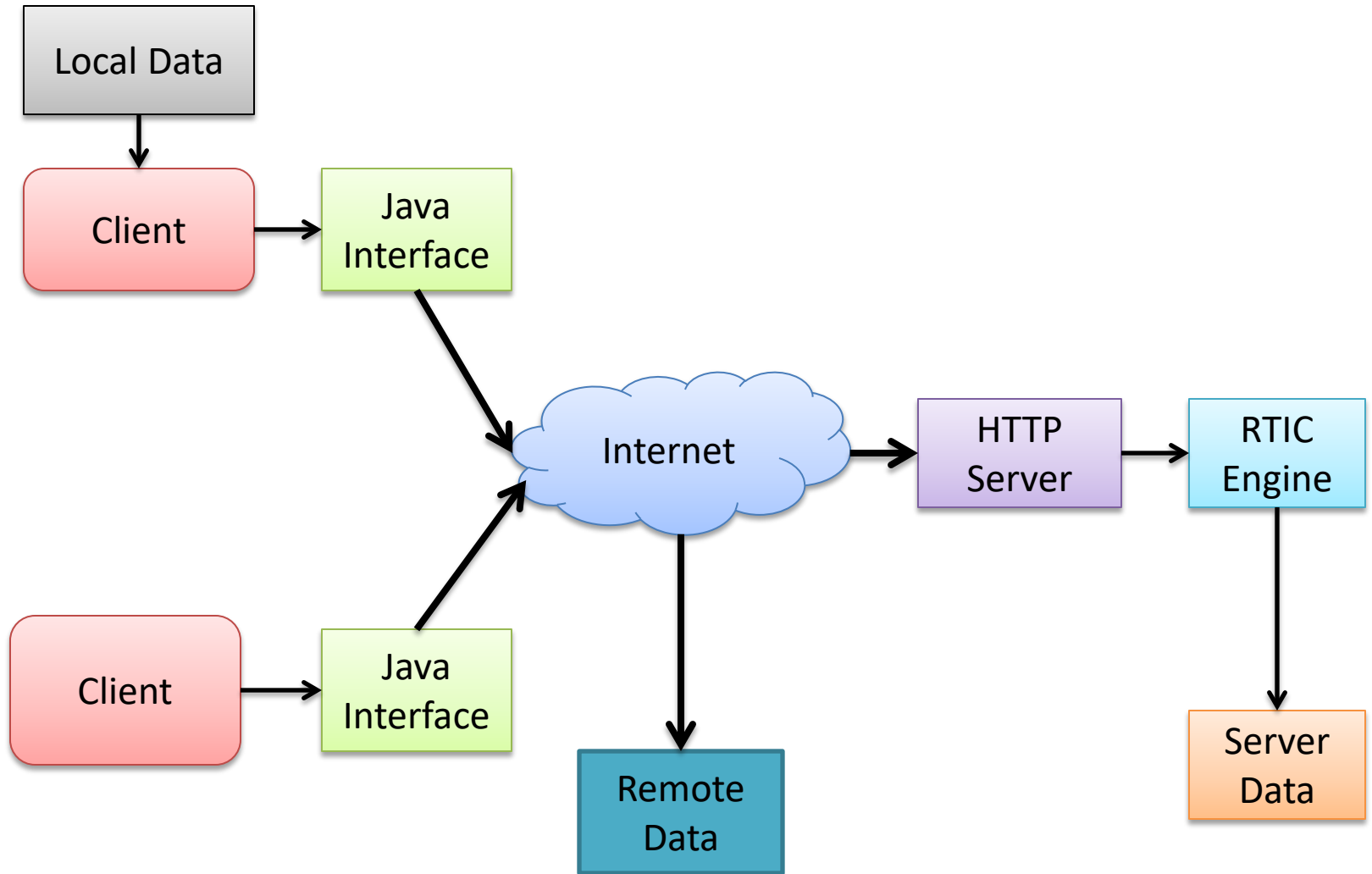
- 1. 3D Ionospheric profile ( using real time data ).
- 2. 4D Ionospheric profile predicted using model based extrapolation.
- 3. Ray Tracing through the derived profiles for HF - UHF.

Click Here To Start

- Software can be visualized online at [www.coresspl.ddns.net](http://www.coresspl.ddns.net)

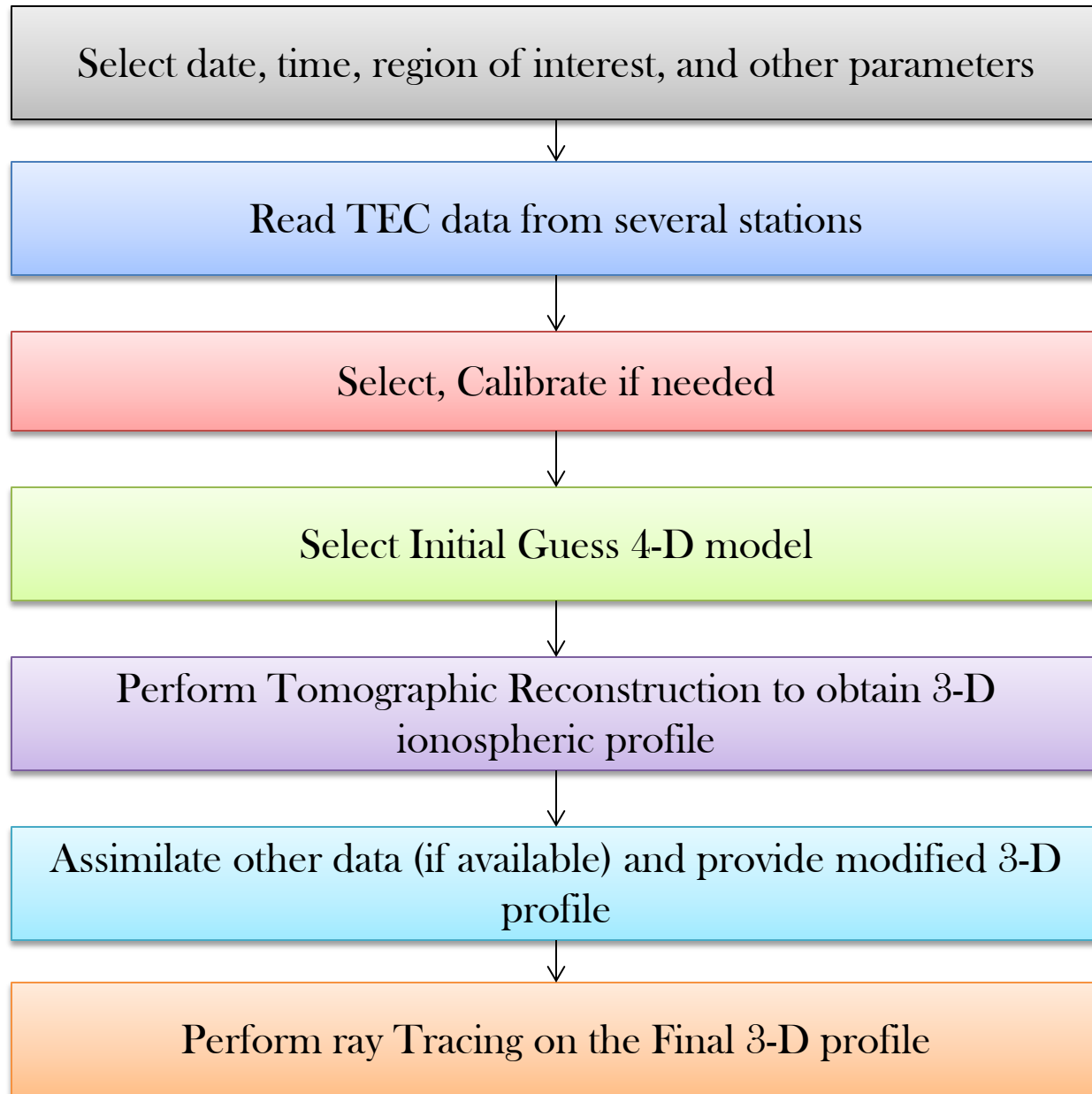
- Operating System must be Windows 7 or higher along with its compatible web browsers.

# RTIC ON THE WEB



# SOFTWARE FUNCTIONALITY

General flow:





# EXPLANATION

## 1.CONFIGURING GEOMETRY

Choose Region of Interest.  
Set Latitude and longitude

Enter simulation date

Select number of latitude,  
longitude, and altitude cells

Enter cell height

Click on **UPDATE** to  
continue with the current  
settings

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Geometry → Tec Data → Initial Guess → Assimilation → Reconstruction → Ray Tracing → Current Settings

3D Map 2D Map

### Geometry

Month: September  
Date: 12  
Year: 2015  
Max Latitude: 60  
Min Latitude: 0  
Max Longitude: 110  
Min Longitude: 0  
Maximum Altitude: 1000000.0  
Minimum Altitude: 100000.0  
Edit Advance Options: Disable

No. of Latitude Cell: 12  
No. of Longitude Cell: 22  
No. of Altitude Cell: 45  
Altitude Division Type: Uniform

Update

WebGL Earth - Cesium  
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## 2.CONFIGURING TEC DATA

Select server to access TEC data.

Enter simulation date

Put Start Time and End Time

The receiving stations which are situated in the region of interest will be shown

Click on UPDATE to continue with the current settings

Choose number of receiving station

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Geometry ⇌ **Tec Data** ⇌ Initial Guess ⇌ Assimilation ⇌ Reconstruction ⇌ Ray Tracing ⇌ Current Settings

3D Map 2D Map TEC Plot

### TEC Data

Data Server:

Month:

Date:

Year:

Start Time:

End Time:

Advance Options

Stations :

- BOGI  ANKR  ARTU
- BUCU  ELAT  GRAS
- GRAZ  HUÉG  IISC
- KIT3  LHAZ  MATE
- MEDI  MIKL  MOBN
- NICO  NKLG  NOT1
- NVSK  ONSA  OPMT
- PADO  POL2  POLV
- SASS  SOFI  TLSE
- TUBI  URUM  UZHL
- VIS0  WSRP  WTZZ
- YEBE  YIBL  ZECK

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# 3.CONFIGURING INITIAL GUESS

Select Ionospheric models  
IRI/PIM/Chapman/Slab

Select necessary  
parameters for respective  
model from the menu

Click on UPDATE to  
continue with the current  
settings.

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Geometry ⇨ Tec Data ⇨ **Initial Guess** ⇨ Assimilation ⇨ Reconstruction ⇨ Ray Tracing ⇨ Current Settings

3D Map 2D Map

## Initial Guess

Model

Advance Options

LLF Sector

foE Normalization

foF2 Normalization

Sunspot Number

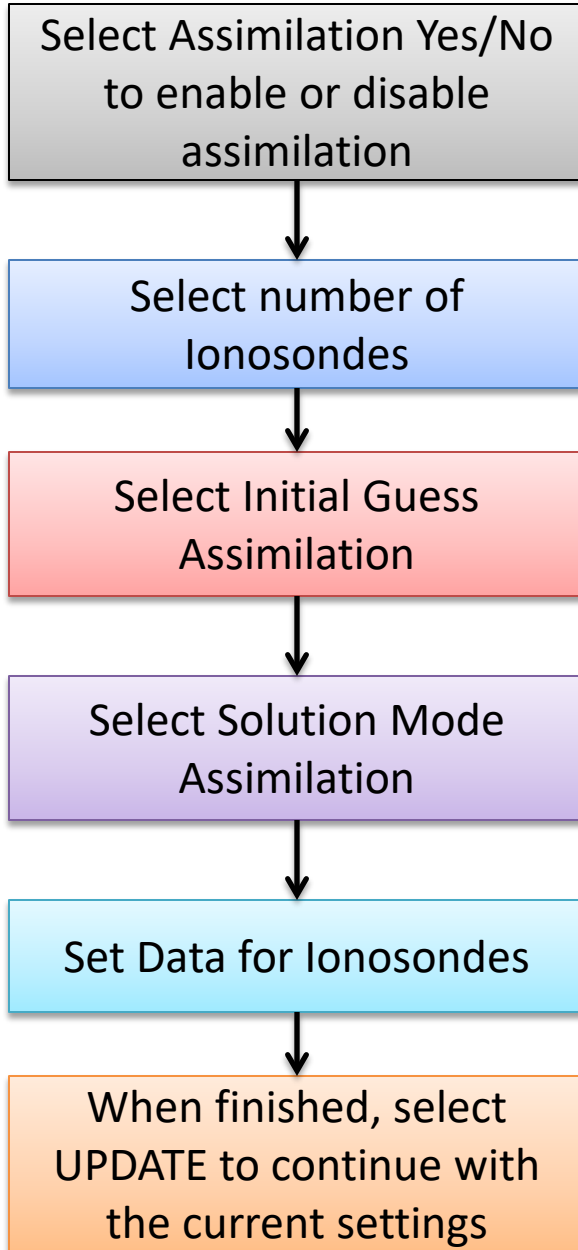
Magnetic Kp Index

IMF by Orientation

IMF bz Orientation

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# 4.CONFIGURING ASSIMILATION



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Geometry ⇨ Tec Data ⇨ Initial Guess ⇨ **Assimilation** ⇨ Reconstruction ⇨ Ray Tracing ⇨ Current Settings

3D Map 2D Map

## Assimilation

Assimilation Data

Number Of Ionosonds

Initial Guess Assimilation

Solution Mode Assimilation

Data For Ionosonde

Ionosonde Name

Latitude

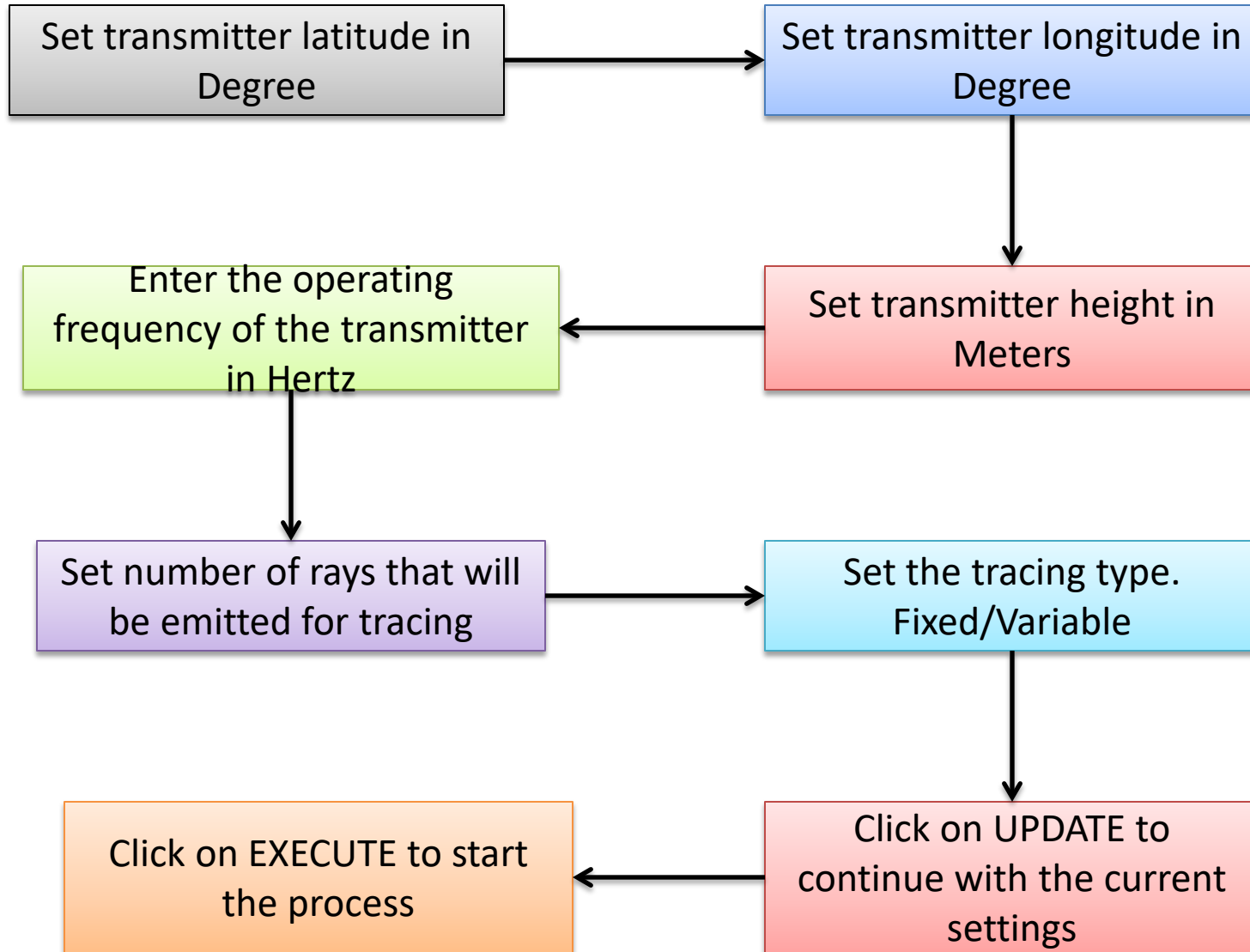
Longitude

Max Density

Max Height

WebGL Earth • Cesium

# 5.CONFIGURING RAY TRACING



3D Map

2D Map

## Ray Tracing

- Do Ray Tracing
- Tx Latitude
- Tx Longitude
- Tx Altitude
- Frequency
- Number Of Rays
- Tracing Type
- Variable Parameter
- Fixed Elevation



Ray Tracing Page

# TYPES OF PLOT

This section is to provide the user with added information so that visualization becomes easy for the user.

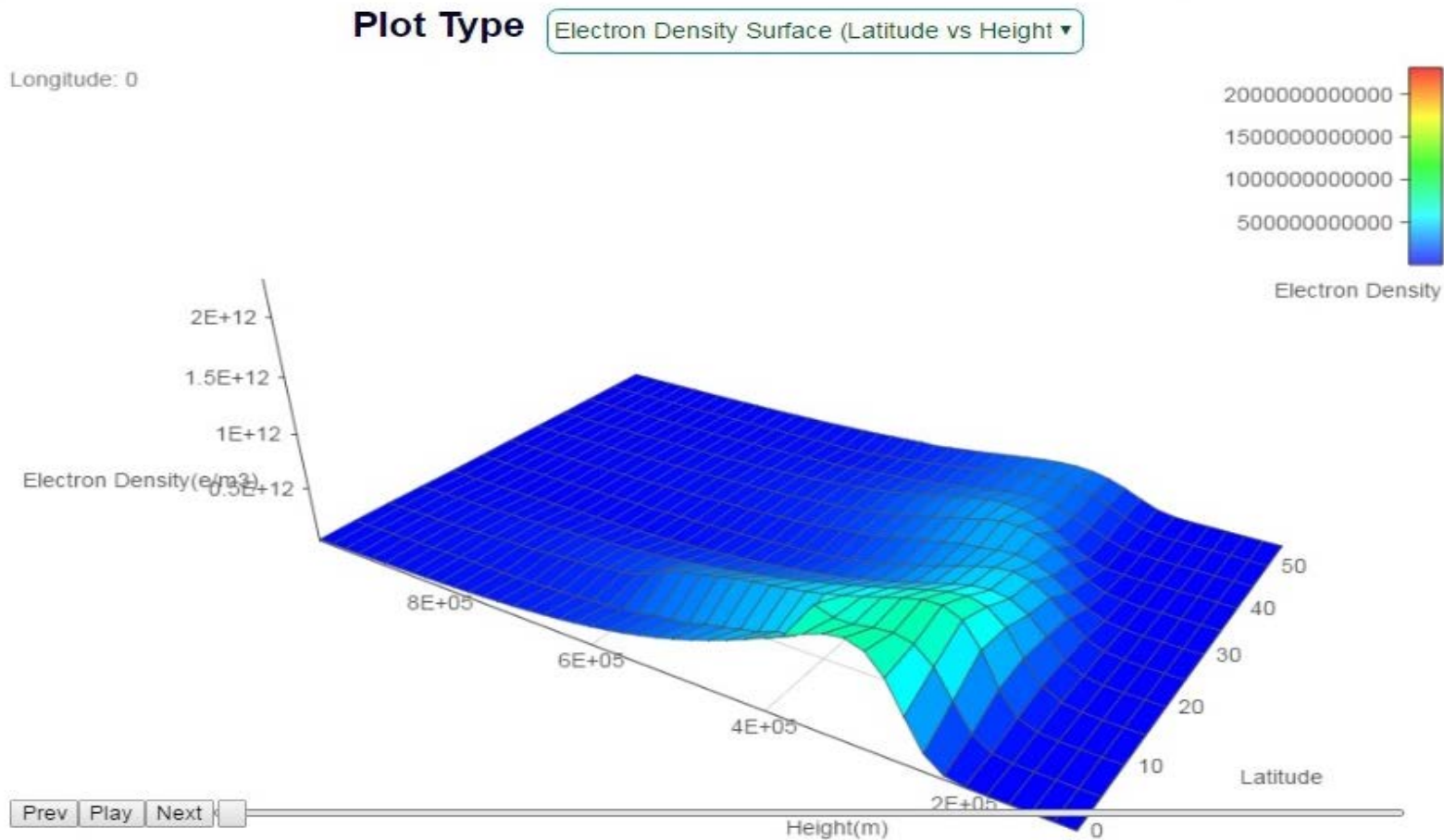
- Surface Plot
- Contour Plot
- 3D Color Plot
- Hmax Plot
- foF Plot
- Ray Tracing Plot

# DESCRIPTION OF PLOTS WITH EXAMPLE

## 1. SURFACE PLOT

Two types of plots are present in this section

- Electron Density Surface (Latitude vs. Height)
- Electron Density Surface (Longitude vs. Height)





## 2.CONTOUR PLOT

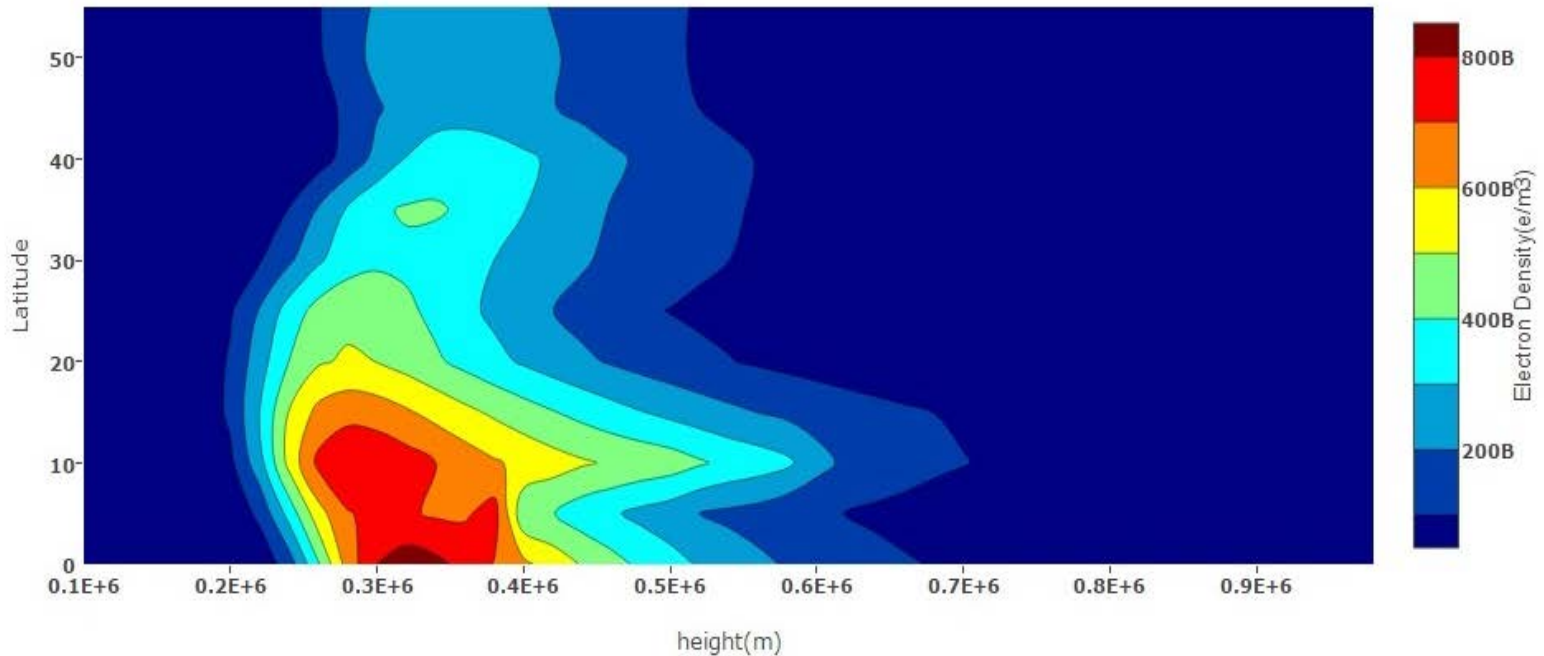
Two types of plots can be seen in this section

- Electron Density Surface (Latitude vs. Height)
- Electron Density Surface (Longitude vs. Height)

Longitude : 0

Plot Type Electron Density Contour (Latitude vs Height ▾)

Electron Density Contour (Latitude vs Height)



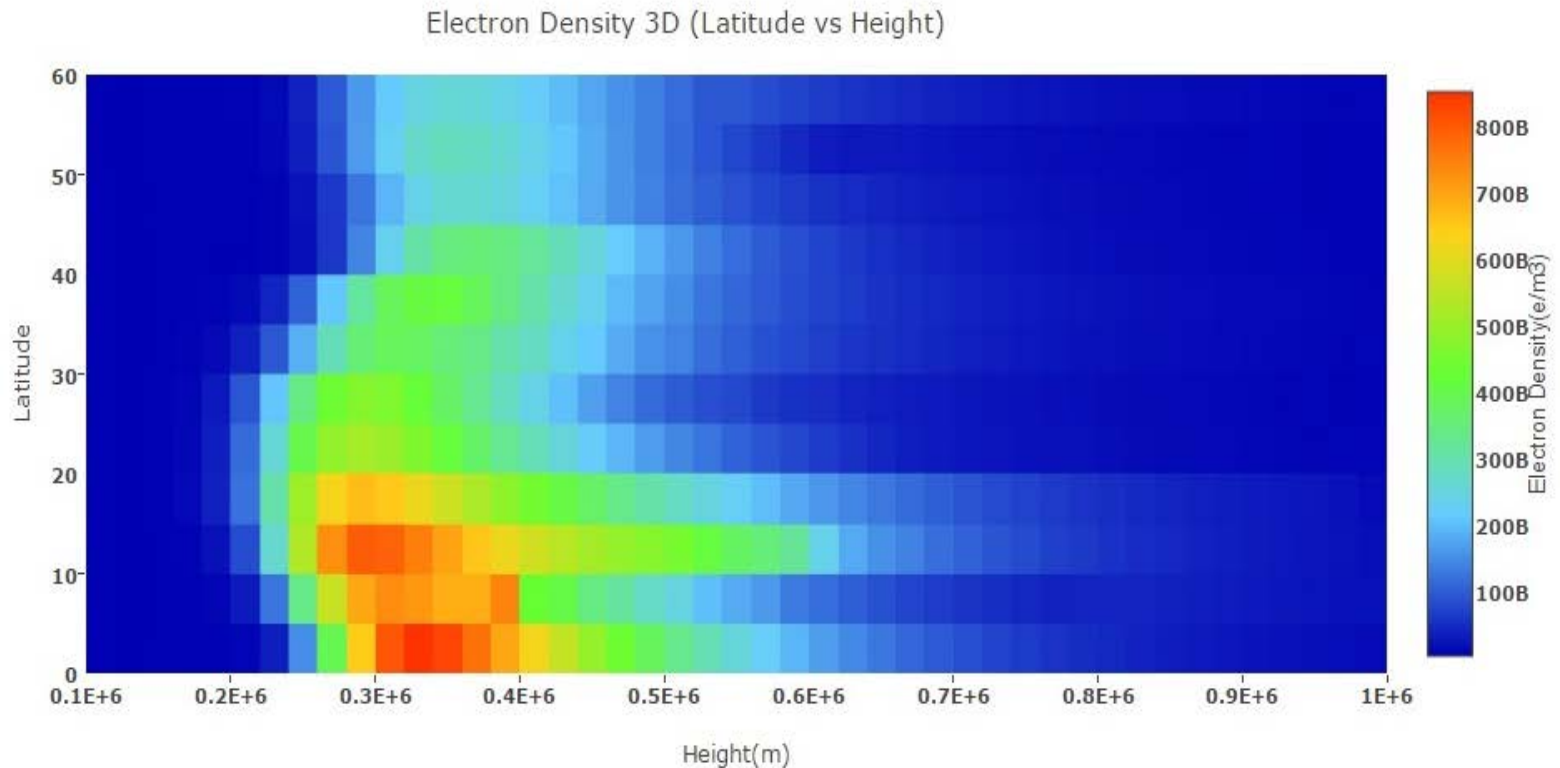
### 3. 3-D COLOR PLOT

Two types of plots can be seen in this section

- Electron Density Surface (Latitude vs. Height)
- Electron Density Surface (Longitude vs. Height)

Plot Type Electron Density 3D (Latitude vs Height ▾)

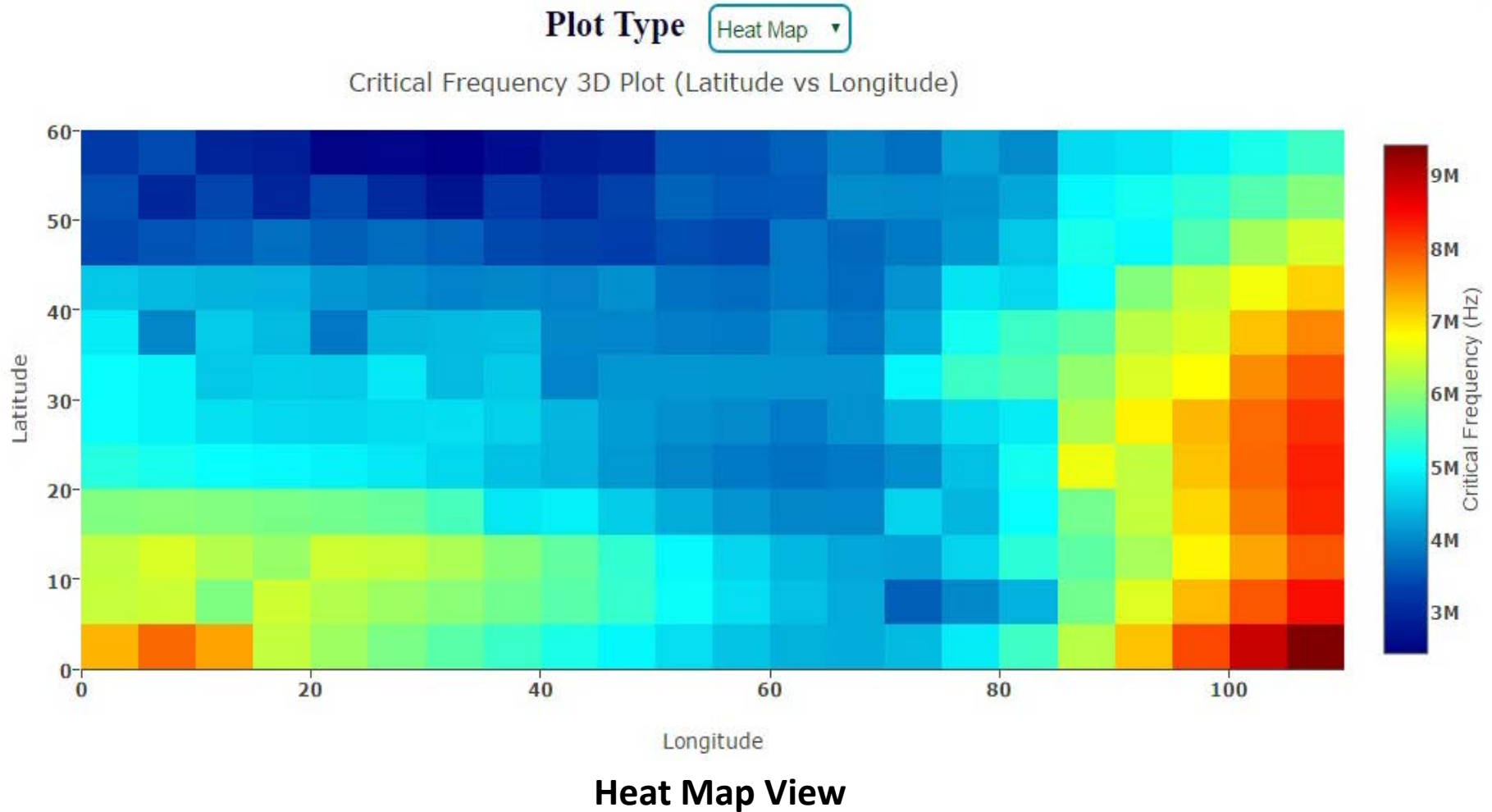
Longitude : 0



## 4. CRITICAL FREQUENCY (FOF) PLOT

Five types of plots can be seen in this section w.r.t the parameters

- Contour
- Surface
- Heat Map
- World Map and
- Globe





## 6. RAY TRACING PLOT

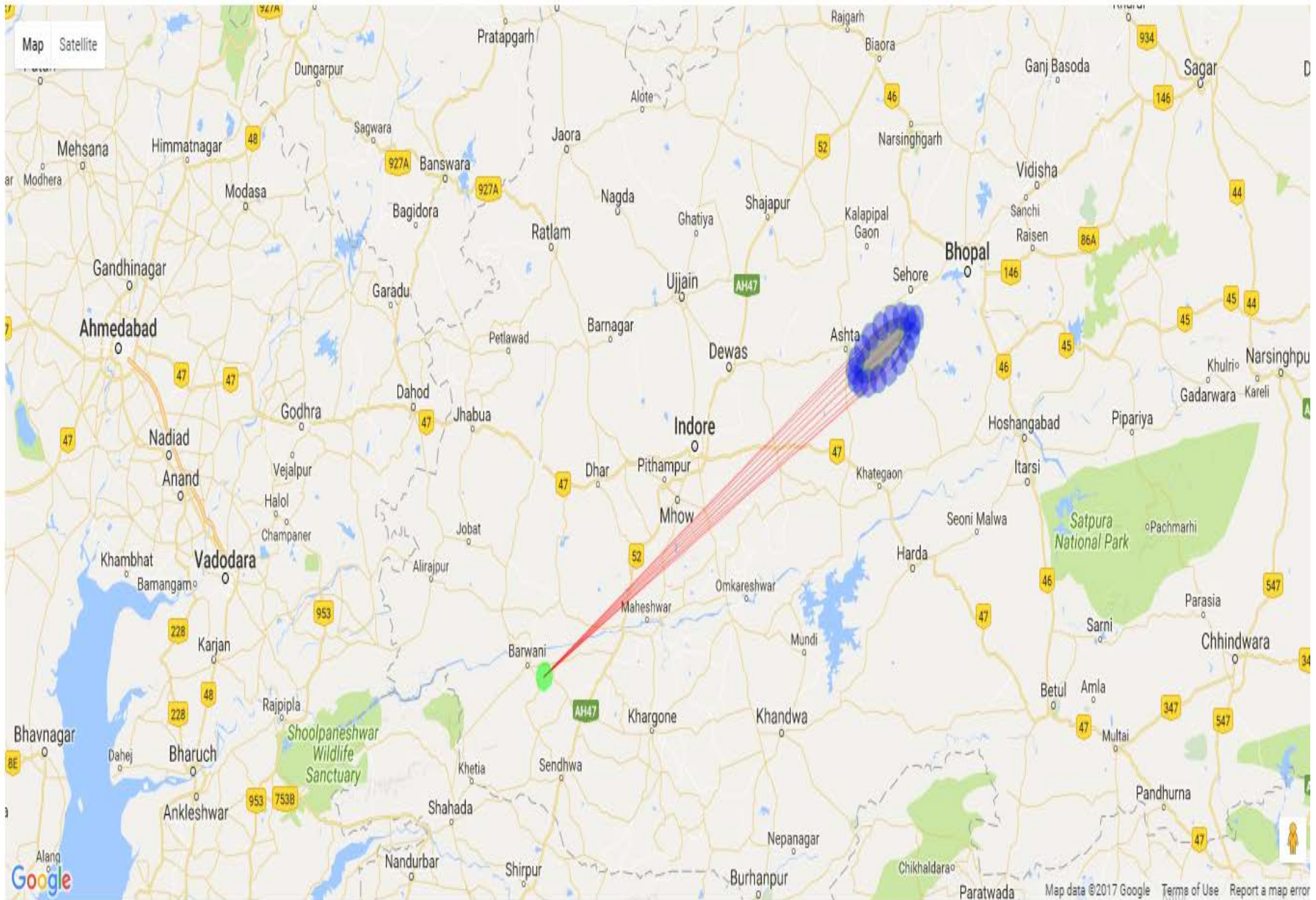
Three types of plots can be seen in this section;

- 1. 2D
  - 2. 3D and
  - 3. Globe
- 2D plot gives a 2dimensional view of the ray tracing from vertical position and the area of ray tracing can be seen
  - 3D plot gives a 3dimensional view of the ray tracing
  - Globe plot gives overview of the ray on the globe. (Encircled with white color for visualization which will not appear on the web)

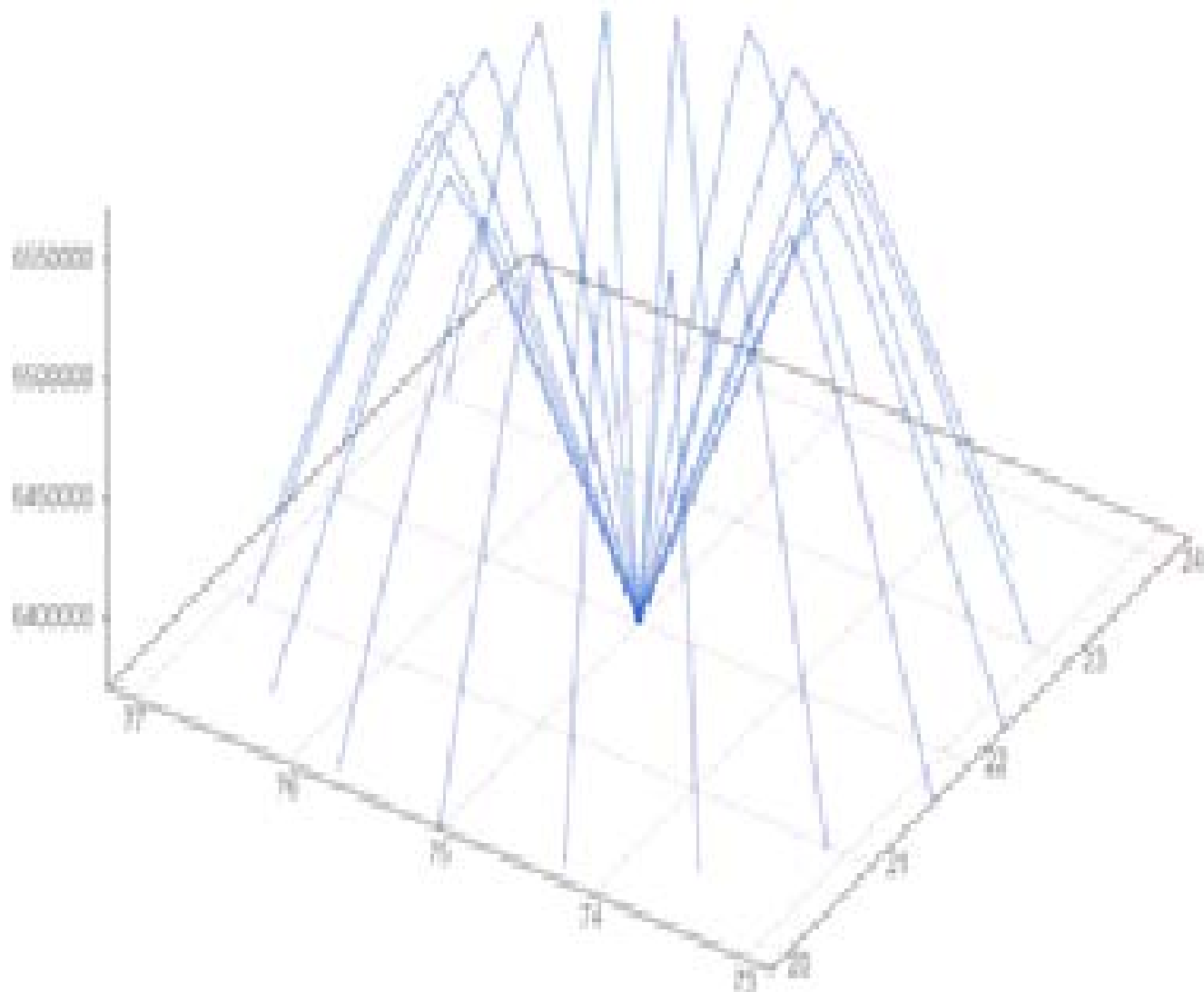
## 2D PLOT (VARIABLE RAY TRACING TYPE)



# 2D PLOT(FIXED RAY TRACING TYPE)

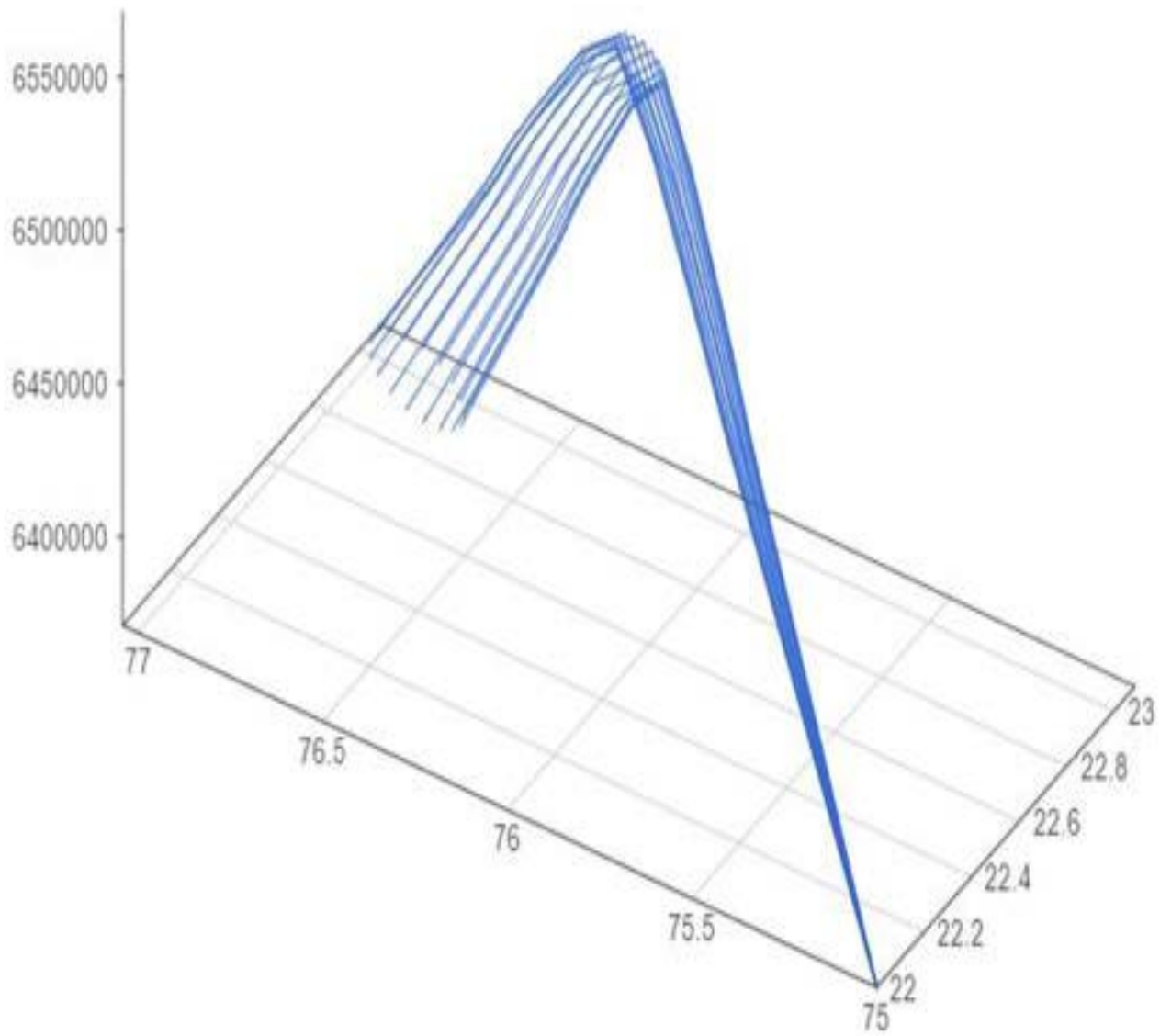


# 3D PLOT(VARIABLE RAY TRACING TYPE)

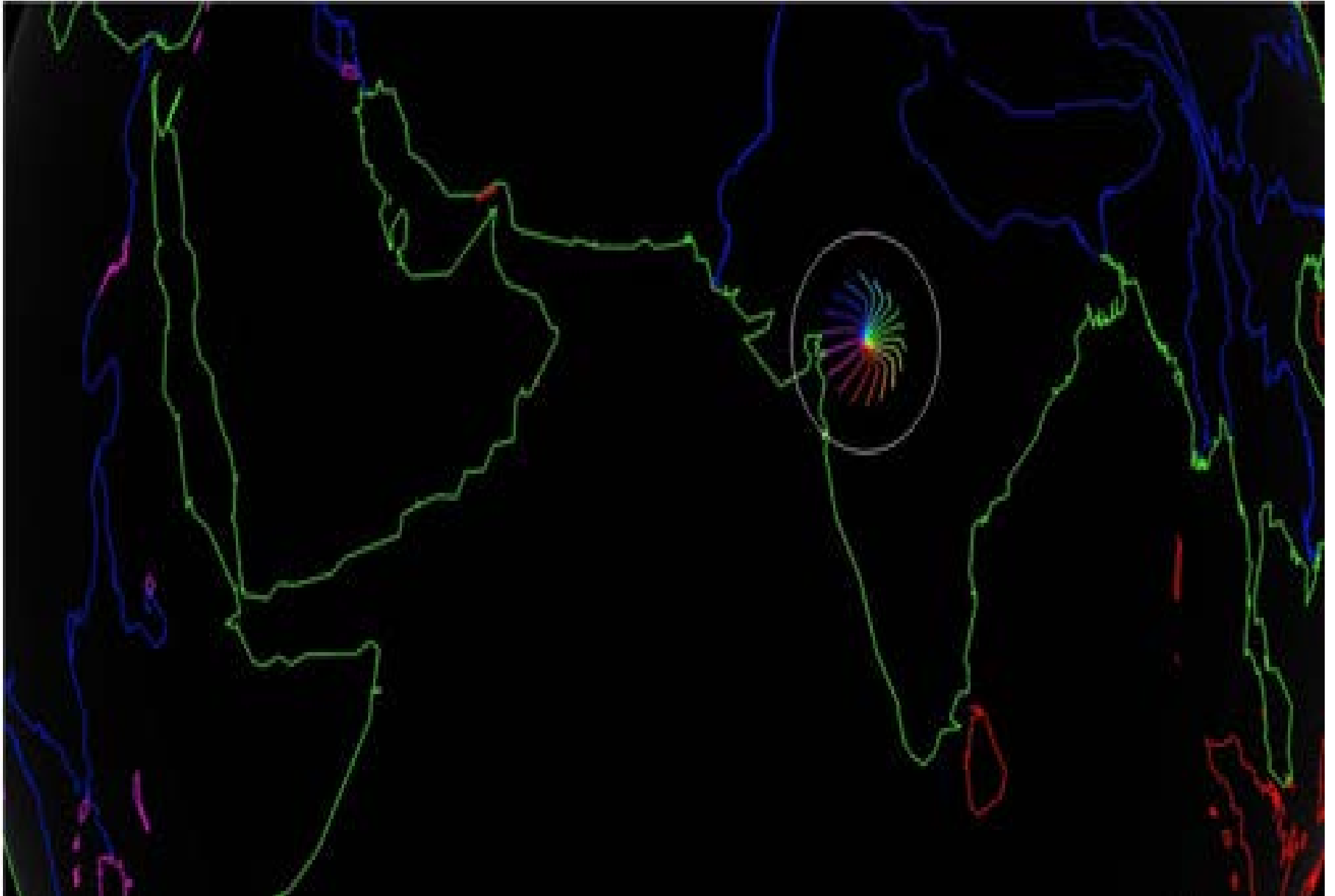




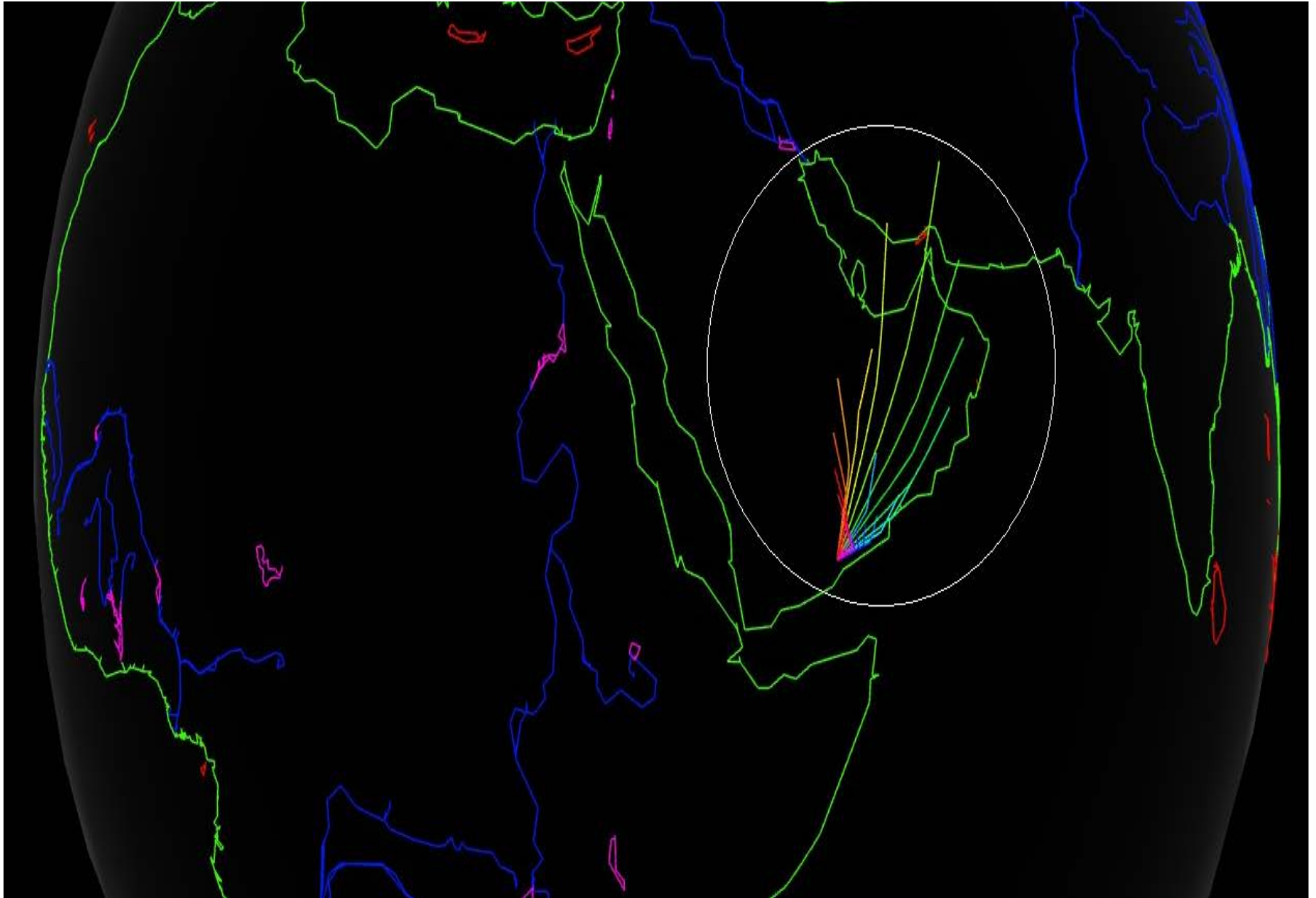
# 3D PLOT(FIXED RAY TRACING TYPE)



## GLOBE PLOT (VARIABLE RAY TRACING TYPE)



## GLOBE PLOT (FIXED RAY TRACING TYPE)



# ON-Going

- Data! Data! Data!– Reliable Data
- Intelligent Assimilation
- Validation

THANK YOU