KMITL
พระจอมเกล้าลาดกระบัง

Equatorial Plasma Bubbles in Low-Latitude Region

Hand-on session
29 July, 2022

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- **Purpose**:
  - to plot and study the characteristics of Slant TEC and vertical TEC at Chiangmai GNSS station and compare with the TEC from the IRI model
  - To study the Kp index (disturbance to Earth's magnetic filed)

- **Data**:
  - GPS code pseudorange at L1, L2 frequencies
  - STEC, VTEC
  - DOY: 130, 163, 169, 176

1. Check which date corresponds to DOY130
   DOY130 = (day/mth/year)
   https://www.ngs.noaa.gov/CORS/Gpscal.shtml
2. Download CHMA_DOY130.xls

3. In the file, there are various tabs such as STEC, VTEC, ROTI

4. Plot each graph of VTEC, ROTI and copy from Excel to the slide #4. Repeat from DOY 163, 169, 176

VTEC

IRI-VTEC

ROTI

$$Kp =$$

VTEC

IRI-VTEC

ROTI

$$Kp =$$

VTEC

IRI-VTEC

ROTI

$$Kp =$$

VTEC

IRI-VTEC

ROTI

$$Kp =$$

5. Go to the IRI model website and download the VTEC values on all 4 days separately following the directions on Slide #12 to #16

   Link: https://ccmc.gsfc.nasa.gov/modelweb/models/iri2016_vitmo.php

6. Plot the TEC from IRI model of each DOY and copy to the Slide #4 to #7

7. Check Kp index values on all 4 days from the link

https://spaceweather.gfz-potsdam.de/products-data/nowcasts/nowcast-kp-index/downloads

8. Fill in the information in the Table below

DOY	Date	Max.VTEC (TECU)	Min.VTEC (TECU)	Max. ROTI	EPB (YN)	Max. Kp Index

(if time permits)

9. Compute the differences between Observation VTEC and IRI VTEC of these 4 days below. What is the average mean squared errors (MSE_{avg})?

International Reference Ionosphere (IRI)

=

The Committee on SPAce Research
(COSPAR)

+

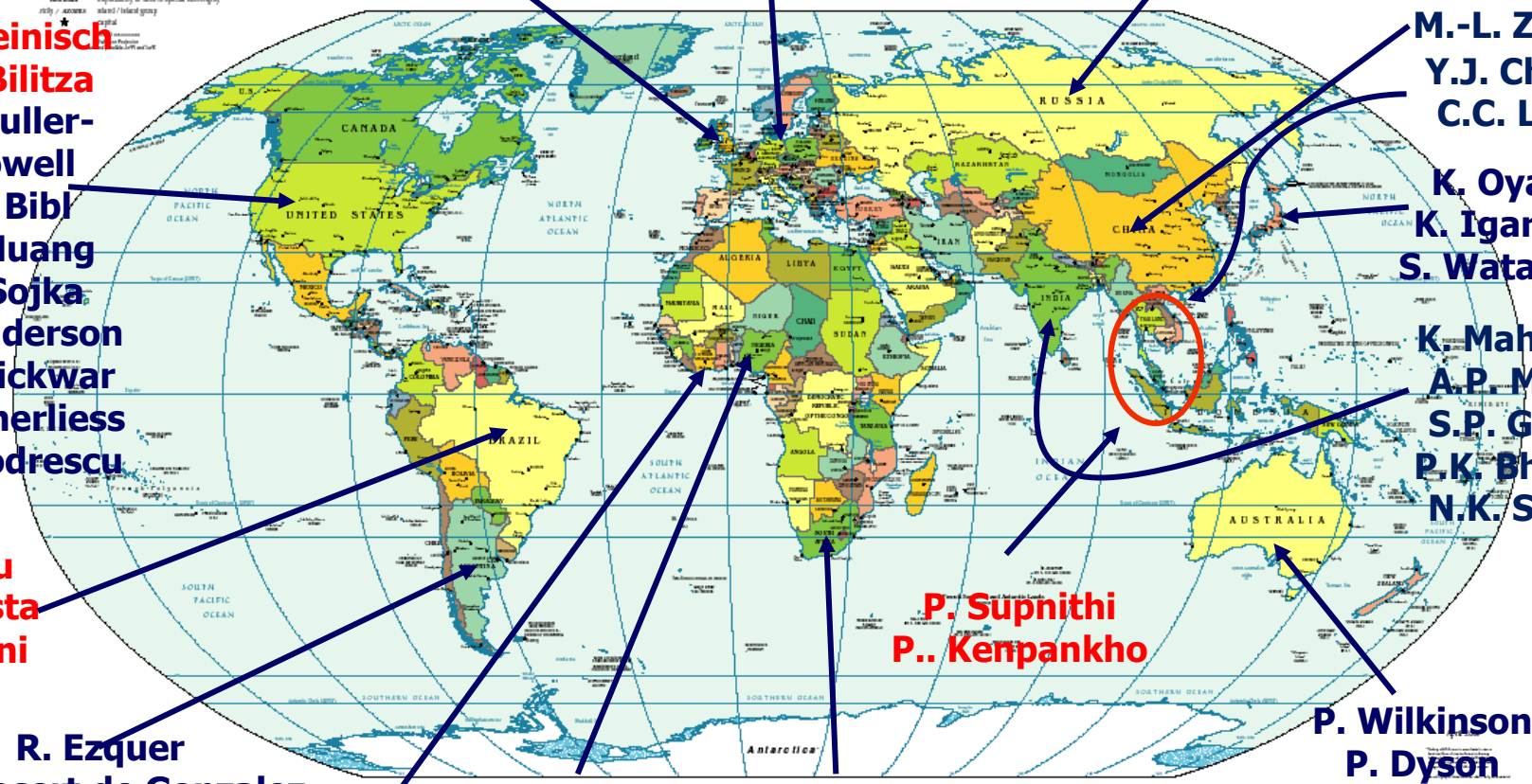
The International Union of Radio Science
(URSI)

- The IRI (1978) is an international project sponsored by **COSPAR** and **URSI**.
- Describes the **monthly median** values of electron density, electron temperature, ion temperature and ion composition, for a given location, time and sunspot number
- IRI model has two options for the prediction of the **foF2 and hmF2**:
  - The International Radio Consultative Committee, namely **CCIR**.
  - The International Union of Radio Science, namely **URSI**.

  ➔ IRI is updated yearly during special **IRI Workshops.**

Bilitza, D. The International Reference Ionosphere 1990, National Space Science Data Center, NSSDC/WDC-A-R&S Reports 90-22, Green belt, Maryland, November 1990.

International Reference Ionosphere (IRI)



P. Bradley, M. Rycroft, Lj. Cander (U.K.),
K. Rawer, W. Singer (Germany),
A. Alcayde, R. Hanbaba (France),
B. Zolesi, S. Radicella (Italy),
M. Friedrich(Austria),
E. Kopp (Switzerland),

L. Triskova, V. Truhlik (Czech Rep)
I. Kutiev (Bulgaria)
I. Stanislawska (Poland),
S. Kouris (Greece)

A. Danilov
V. K. Depuev
T. Gulyaeva
G. Ivanov-Kholodny
E. Kazimirovsky
A. Mikhailov
S. Pulinets

B. Reinisch
D. Bilitza
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M. Abdu
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P. Supnithi
P.. Kenpankho

R. Ezquer
M. Mosert de Gonzalez

O. Obrou

J. Adeniyi

A. Poole, L.-A. McKinnell

P. Wilkinson
P. Dyson
B. Ward

IRI Website:
https://ccmc.gsfc.nasa.gov/modelweb/models/iri2016_vitmo.php

Chiangmai location: 18.5006° N, 98.5811° E

Select Date and Time

Year(1958-2020): 2022

Month: June **Day(1-31):** 25

Note: If date is outside the Ap index range (1958/02/14-2022/6/6),then STORM model will be turned off.

Time Local **Time** (0. - 24.0 in decimal hours): 0.0

Select Coordinates

Coord. Type Geographic **Latitude**(-90. - 90. deg.): 18.7883 **Longitude**(0. - 360. deg.) 98.9853

Height (km, from 60. to 2000.): 2000

Select profile type and range:

Hour profile[0.-24.] Start 0.0 Stop 24.0 Stepsize 0.1

Submit Reset

Optional Input:

Sunspot number, R12 (0. - 400.) **Ionospheric index, IG12 (-50. - 400.)**

F10.7 radio flux, daily (0. - 400.) **F10.7 radio flux, 81-day (0. - 400.)**

Electron content: Upper boundary (110. - 10000. km) 10000

Ne Topside NeQuick **Ne F-peak** URSI **F-peak storm model** on **F-peak height** AMTB2013

Bottomside Thickness ABT-2009 **F1 occurrence probability:** Scotto-1997 no L

Select output form:

- ○ List model data
- ◉ Create model data file in ASCII format for downloading
- ○ Plot model data

Note 1: The first selected parameter below always will be along the X-axis, the other selections will be along Y-axis.
(e.g. if you want a Height profile, you may specify Height as the first parameter in the listing below.)

Note 2: User may get scatter plot if he specifies any two parameters below and changes the "connect type"
in the "Advanced plot selections" to "show points only"

Submit Reset

Select desired output parameters

Independent Variables

- [ ] Year
- [ ] Month
- [ ] Day of month
- [ ] Day of year
- [x] Hour of day, UT/LT (depending on user's choice above)
- [ ] Solar zenith angle, degree
- [ ] Height, km
- [ ] Geographic/Geomagnetic Latitude, deg. (depending on user's choice above)
- [ ] Geographic/Geomagnetic Longitude, deg. (depending on user's choice above)
- [ ] CGM Latitude, deg.
- [ ] CGM Longitude, deg.
- [ ] Magnetic inclination (DIP), degree
- [ ] Modified dip latitude, degree
- [ ] Declination, degree
- [ ] InvDip, degree
- [ ] Dip latitude, degree
- [ ] MLT, hour

IRI Model Parameters

- [ ] Electron_density (Ne), m^{-3}
- [ ] Ratio of Ne and F2 peak density(Ne/NmF2)>
- [ ] Neutral Temperature Tn, K
- [ ] Ion Temperature Ti, K
- [ ] Electron Temperature, Te, K
- [ ] Atomic Oxygen ions (O^+), percentage
- [ ] Atomic Hydrogen (H^+),ions, percentage
- [ ] Height of F2 peak (hmF2), km
- [ ] Height of F1 peak (hmF1), km
- [ ] Height of E peak (hmE), km
- [ ] Height of D peak (hmD), km
- [ ] Density of F2 peak (NmF2), m^{-3}
- [ ] Atomic Helium (He^+), ions, percentage
- [ ] Molecular Oxigen (O_2^+) ions, percentage
- [ ] Nitric Oxide ions (NO^+), percentage
- [ ] Cluster ions, percentage
- [ ] Atomic Nitrogen (N^+) ions, percentage
- [x] Total Electron Content (TEC), 10^{16} m^{-2}
- [ ] TEC top, percentage
- [ ] Propagation factor M(3000)F2
- [ ] Bottomside thickness (B0), km
- [ ] Bottomside shape (B1)
- [ ] E-valley width, km
- [ ] E-valley depth (Nmin/NmE)

Optional input parameters:
Sunspot number(Rz12) =not specified
F10.7 radio flux (daily)= not specified
F10.7 radio flux (81-day)= not specified
Ionospheric index(IG12) =not specified
Upper limit for Electron content = 10000.
F peak model = URSI
F-peak height = AMTB2013
Ne Topside = NeQuick
foF2 Storm model = on
Bottomside Thickness = ABT-2009
F1 occurrence probability = Scotto-1997 no L
foE Storm model = off
D-Region Ne = IRI-95
Topside Te = BIL-1995
Ion Composition = RBV10/TBT15
NmF2 or foF2 not specified = 0.,
hmF2 or M(3000)F2 not specified = 0.,
NmE or foE not specified = 0.,
Auroral boundary = on
A value of -1 indicates that the parameter is not available for the specified range
TEC=-1, means you have not entered an upper boundary height in the OPTIONAL INPUT section.

Selected output parametes:
TEC, 10^16 m-2
REQUESTED DATA HAS BEEN CREATED

Data may be downloaded now by clicking on the file hyperlinks below:
https://ccmc.gsfc.nasa.gov/idl_images/MODELWEB_DATA//iri2016_19272823154.lst

Nowcast data for June 2022

(Last update: 23:57:09 UTC, July 1, 2022)

Geomagnetic Planetary Indices

	Kp three-hourly								daily		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Sum**	**Ap**	**Cp**
1	2o	2o	1+	2-	1-	1o	0+	1o	10o	5	0.2
2	1-	1-	0+	1o	1+	1-	1o	2-	7+	4	0.1
3	1o	1-	1o	1-	1-	0+	1-	2-	7-	4	0.1
4	0+	1-	1o	0+	0+	0+	1-	0+	4o	2	0.0
5	1-	1-	1-	1o	1o	1-	2-	1-	7o	4	0.1
6	2-	2-	1+	3+	2+	2o	2+	3o	18-	9	0.5
7	2o	2+	1+	2+	1o	1o	1-	2+	13o	6	0.3
8	2o	0+	1-	2-	0+	0+	2o	1o	8+	4	0.1
9	2-	1+	1-	1o	1+	1o	1-	2-	9+	4	0.2
10	2o	1-	1-	1+	2-	0+	0+	1-	8-	4	0.1
11	2+	2o	3o	1o	1+	2-	1+	2-	14+	7	0.4
12	1+	2+	2-	2+	3-	3+	3-	2-	18o	10	0.5
13	4-	5-	2+	2-	2o	3-	2o	2-	21-	14	0.8
14	2o	2-	2-	1+	2-	2-	1+	3-	14o	7	0.3
15	2-	3o	4-	3+	4+	4o	2-	2+	24o	17	0.9
16	1+	2+	2+	2+	3o	2-	2o	4o	19o	11	0.6
17	3o	2+	2+	3o	3o	2-	3+	2+	21o	12	0.7
18	3+	3o	2o	2+	1-	1+	3+	4+	20+	13	0.8
19	4-	3o	2o	3-	2o	2+	1+	1-	18-	10	0.6
20	1+	1o	2+	2+	3+	3-	3o	1o	17o	10	0.5
21	2-	2-	1+	3-	2-	1+	1+	3-	14+	7	0.4

https://www-app3.gfz-potsdam.de/kp_index/pqlyymm.html

https://www.labsat.co.uk/index.php/en/gps-time-calculator