

IPS Real Time Mapping Process

Median Maps

IPS has monthly median world maps of foF2. A world map of foF2 exists for each UT hour (24) and month (12), and for two levels of ionospheric effective sunspot number (the IPS T index) $T = 0$ and $T = 100$, giving $24 \times 12 \times 2 = 576$ maps. These maps were constructed from over 30 years of ionospheric data. By interpolation or extrapolation these maps provide a relationship between foF2 and T index at any location in the world.

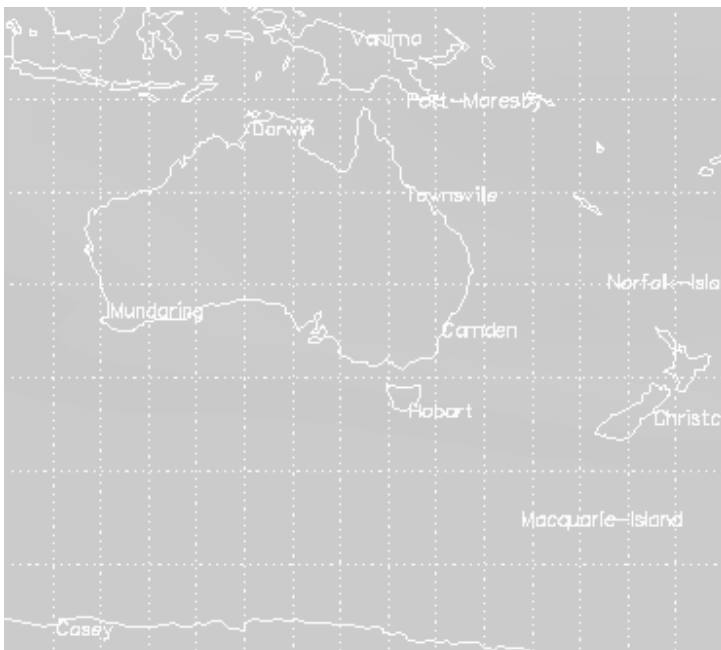
Real Time Mapping

IPS automatic ionosonde data at the following locations is used for the real time mapping process.

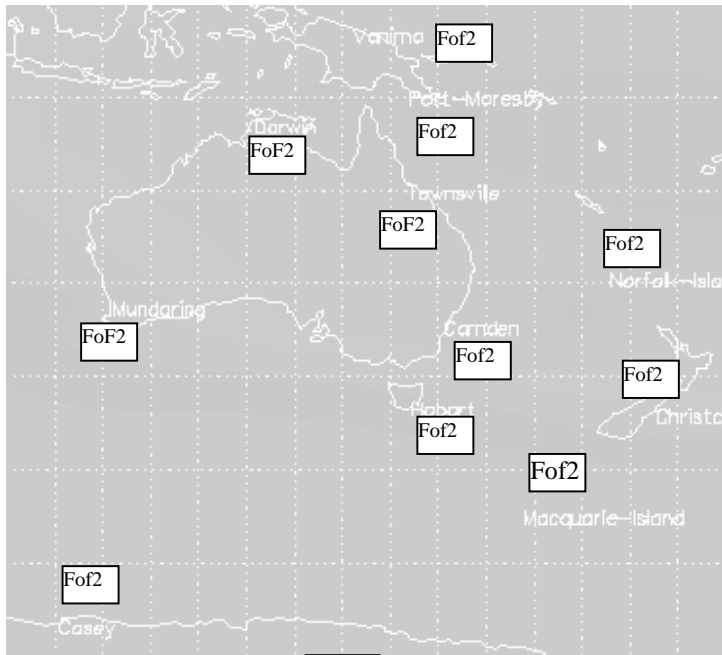
Vanimo	-2.7	141.3
Port Moresby	-9.4	147.1
Darwin	-12.5	131.0
Townsville	-19.6	146.8
Brisbane	-27.5	152.9
Norfolk Island	-29.0	168.0
Canberra	-35.3	149.0
Camden	-34.1	150.7
Hobart	-42.9	147.3
Christchurch	-43.6	172.8
Mundaring	-32.0	116.2
Learmonth	-21.0	115.0
Macquarie Island	-54.5	159.0
Casey	-66.3	110.5

Each station provides each hour 5 minute real time automatic foF2 values. The median of each stations foF2's is then used to compute an observed T index (effective sunspot number). If the regional ionosphere exactly matched the median map all T indices from the stations would be the same.

Region covered by Real Time Map (0,105) to (-70,180):



1. Observed foF2 values for a given UT hour



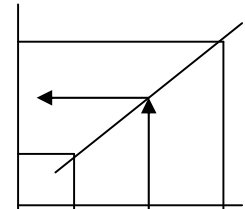
For each station convert each observed station foF2 into an observed effective sunspot number. This gives an irregular grid of T index values.

Conversion of fof2 obs to T obs

T=100

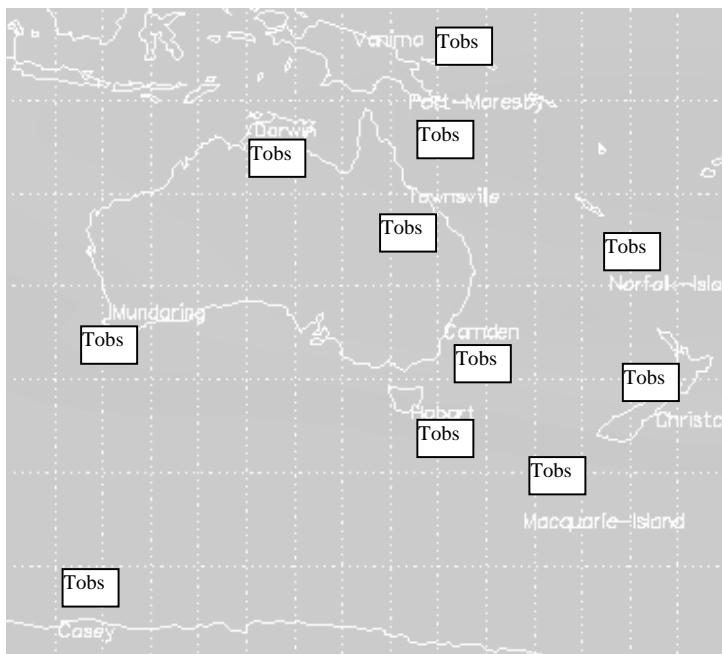
Tobs

T=0



Fof2	fobs	fof2
Map		Map
T=0		T=100

2. Equivalent observed T index values at each station location for a given UT hour



16 09 03 02

dwn	74
tv1	42
lear	72
cdn	39
hbt	72
mun	61
bri	42
cch	67
nlk	35
mac	84
cas	105
sct	60
vno	83
pom	85

Example of observed T index values for 16 Sep 2003 0200UT

Use a 2 dimensional interpolation technique “kriging” to produce regular grid of T indices for a given UT hour.

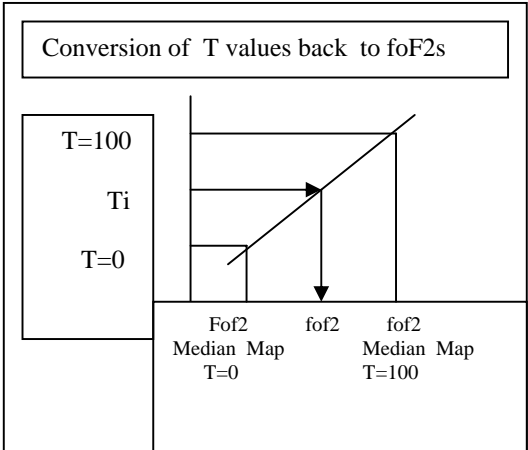
3. Regular grid of observed and interpolated T indices

Ti	Ti	Ti	Ti	Ti	Ti	To	Ti	Ti	Ti	Ti	Ti	Ti
Ti	Ti	Ti	Ti	Ti	Ti	Ti	To	Ti	Ti	Ti	Ti	Ti
Ti	Ti	Ti	Ti	To	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti
Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti
Ti	Ti	Ti	Ti	Ti	Ti	Ti	To	Ti	Ti	Ti	Ti	Ti
Ti	To	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti
Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	To	Ti
Ti	To	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti
Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	To	Ti	Ti	Ti	Ti
Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti
Ti	Ti	Ti	Ti	Ti	Ti	To	Ti	Ti	Ti	Ti	Ti	To
Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti
Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	To	Ti	Ti
Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti
Ti	To	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti	Ti

Ti – interpolated T value
 To - observed T value

Each grid point can be considered to have its own effective sunspot number. This allows non median map gradients to be tracked.

Use IPS Median maps to convert regular grid of T indices back into a regular grid of foF2 values.



3. Regular grid of observed and interpolated foF2 values – real time foF2 map

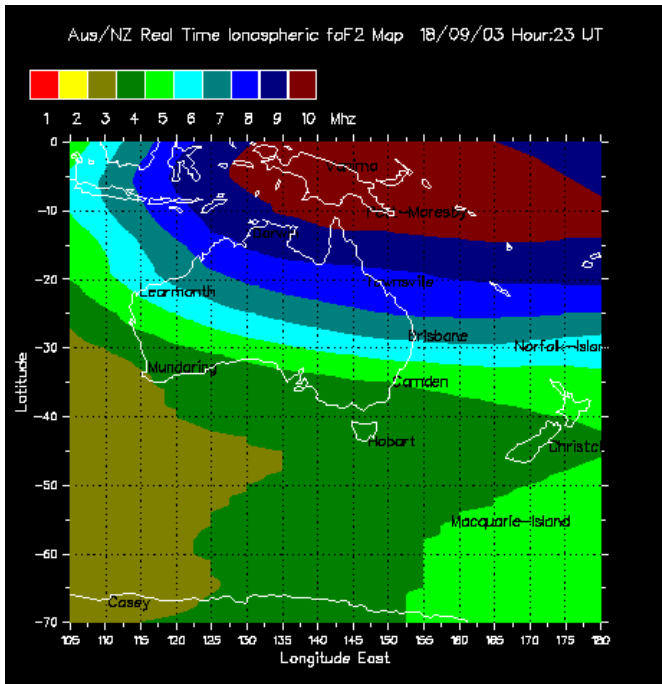
foF2i	foF2i	foF2i	foF2i	foF2o	foF2I	foF2I	foF2I	foF2i
Fof2I	foF2I	foF2I	foF2I	foF2I	foF2o	foF2I	foF2I	foF2i
Fof2I	foF2I	foF2I	foF2o	foF2I	foF2I	foF2I	foF2I	foF2i
Fof2I	foF2I	foF2I	foF2I	foF2I	foF2I	foF2I	foF2I	foF2i
Fof2I	foF2I	foF2I	foF2I	foF2I	foF2o	foF2I	foF2I	foF2i
Fof2I	foF2I	foF2I	foF2I	foF2I	foF2I	foF2I	foF2I	foF2o
Fof2I	foF2o	foF2I	foF2I	foF2I	foF2I	foF2I	foF2I	foF2i
Fof2I	foF2I	foF2I	foF2I	foF2I	foF2o	foF2I	foF2I	foF2i
Fof2I	foF2I	foF2I	foF2I	foF2I	foF2I	foF2I	foF2I	foF2i
Fof2I	foF2I	foF2I	foF2I	foF2I	foF2o	foF2I	foF2I	foF2o
Fof2I	foF2I	foF2I	foF2I	foF2I	foF2I	foF2I	foF2I	foF2i
Fof2I	foF2I	foF2I	foF2I	foF2I	foF2I	foF2I	foF2o	foF2i
Fof2I	foF2I	foF2I	foF2I	foF2I	foF2I	foF2I	foF2I	foF2i
Fof2o	foF2I	foF2I	foF2I	foF2I	foF2i	foF2I	foF2I	foF2i

Fof2o – observed foF2
 Fof2I – interpolated foF2

Note that at stations locations the process is “circular”. Performing the interpolation in T index adds robustness as it can utilize inherent structure in the median map if a low number of stations are contributing to the map for a given hour. If the number of observed values is high and well spaced interpolation could be performed directly with the foF2 values.

Contour regular grid of foF2 values and write as image

3. Contoured foF2 Image for website



Benefits of this technique:

Non median gradients can be followed. For example during coronal hole disturbances when mid to high latitudes are depressed and low latitudes are near or above normal.

Costs of this technique:

Bad auto scale values from an individual station will be followed (if they penetrate time median filters for each station i.e. an hourly foF2 is median of last hours foF2 data), and become false gradients in the map.