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CONVEGNO IAGA

Applicazione di OIASA a ionogrammi obliqui di scarsa qualità

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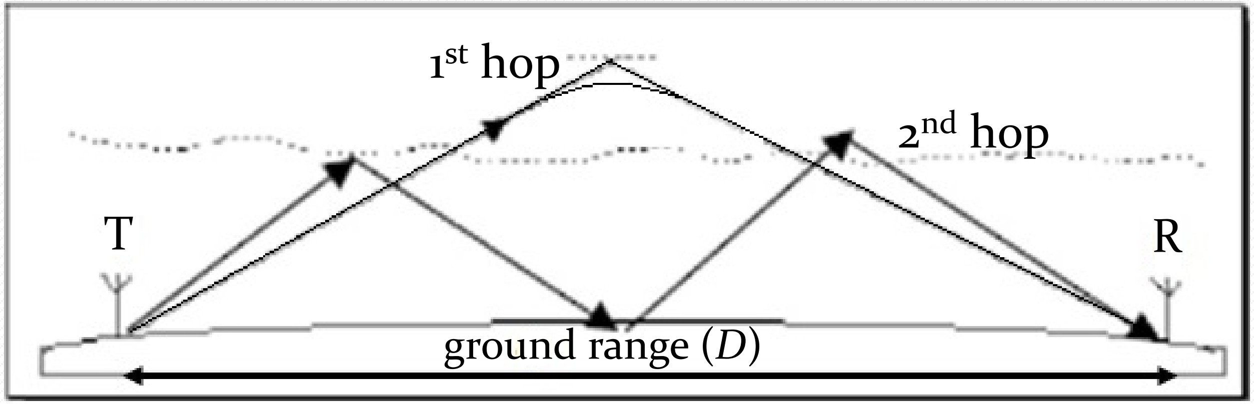
Outline

- ✓ What is an oblique ionogram?
- ✓ What is OIASA?
  - how does OIASA scale the MUF?
  - how does OIASA reject bad input data?
  - how does OIASA reject bad outputs?
- ✓ Results of the application to a poor-quality test-mode ionograms data set

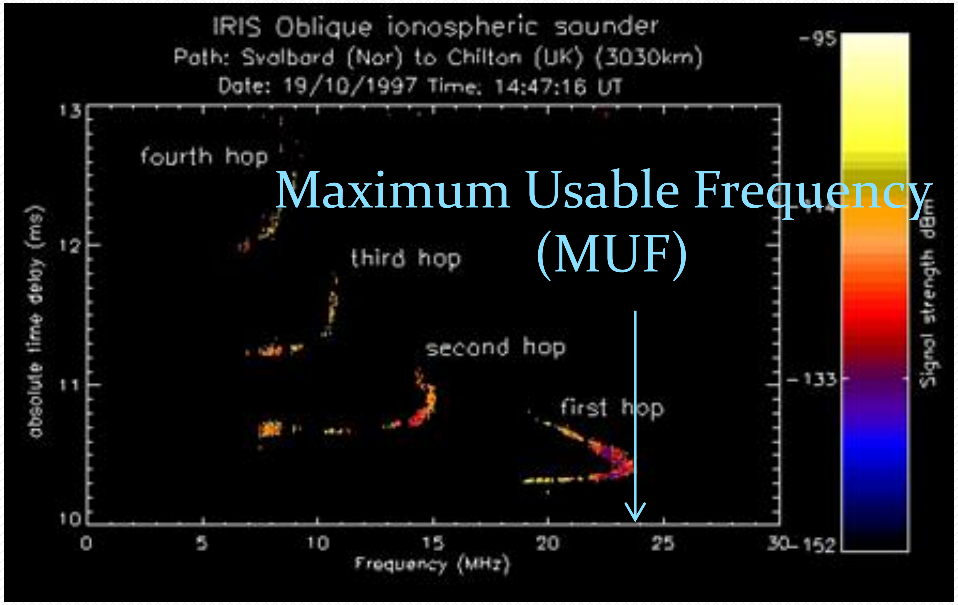
Oblique radio-soundings

✓ Measuring technique



✓ Oblique Ionogram: $\Delta t(f)$

or $p'/2 = \dfrac{c\Delta t(f)}{2}$



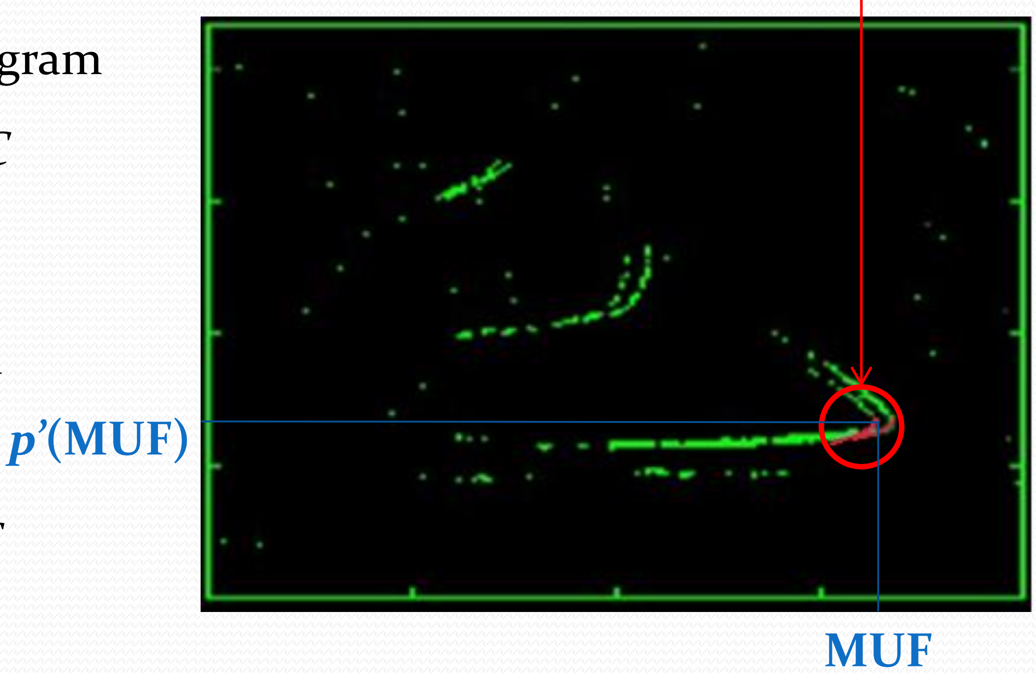
The Oblique Ionogram Automatic Scaling Algorithm (OIASA)

✓ Image recognition technique for the MUF and the corresponding virtual range autoscaling

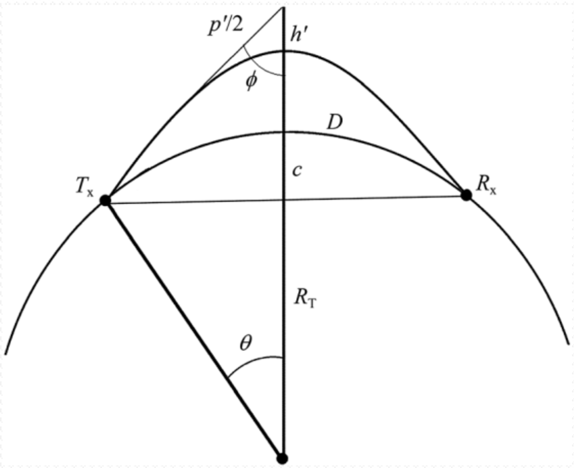
- Ionogram storing in a matrix
- Defining of two empirical curves (branch of a parabola) able to fit the typical shapes of the ordinary and extraordinary oblique ionogram traces
- Curves sliding across the entire ionogram
- Calculation of the local correlation *C* for each curve position
- Determination of the MUF and the corresponding virtual range through the **maximum contrast method**

↓

automatic detection and rejection of poor-quality ionograms



Oblique to vertical ionogram conversion



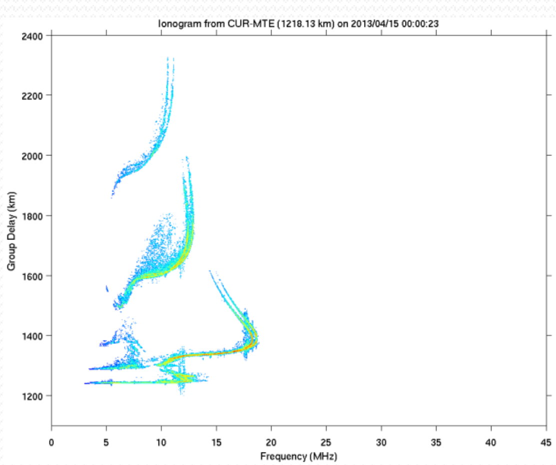
$$\sin\phi = \frac{2R_T}{p'(f_o)}\sin\frac{D}{2R_T}$$

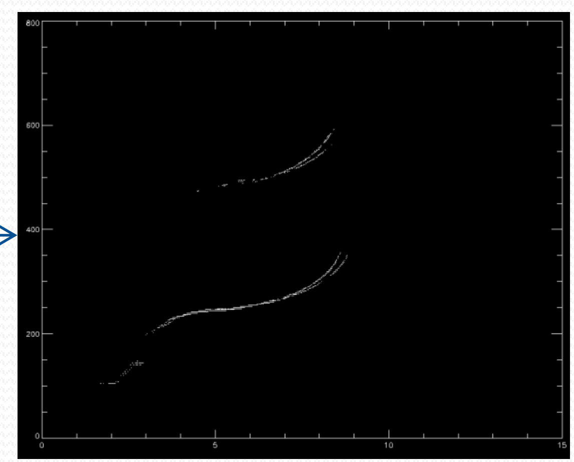
Neglecting the Earth's Magnetic Field we can use

- Secant law: $f_v = \dfrac{f_o}{\sec\phi}$
- Marthyn's theorem: $h'(f_v) = \dfrac{p'(f_o)}{2\sec\phi} - R_T\left(1 - \cos\dfrac{D}{2R_T}\right)$

$(f_o, p') \mapsto (f_v, h')$

vertical equivalent (VE) ionogram at the radio-link midpoint





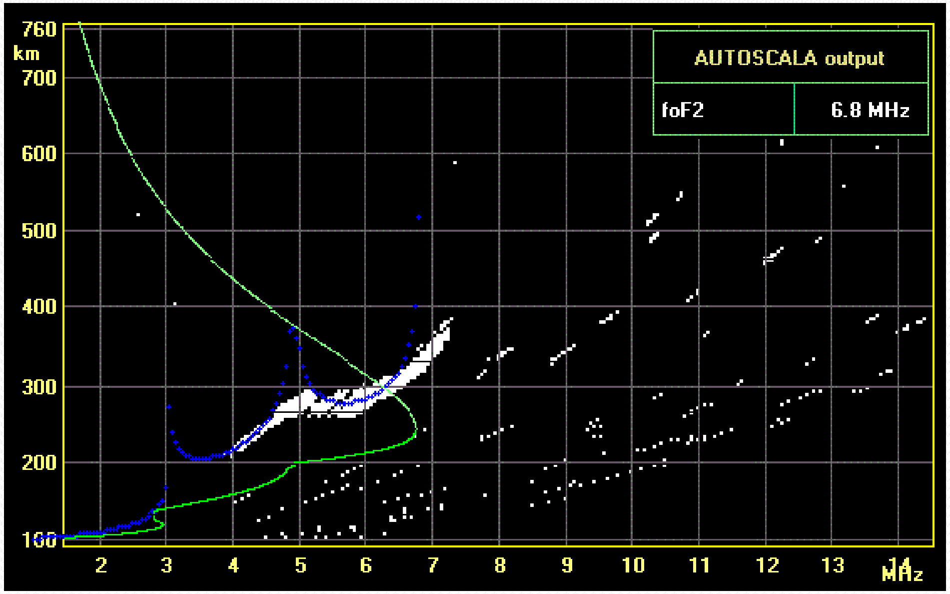
The quality factor *Q*

✓ Autoscala applied to the VE ionogram

⟶ $f_o\mathrm{F}_{2[\mathrm{Autoscala}]}$

✓ Secant law applied to the $\mathrm{MUF}_{[\mathrm{OIASA}]}$

⟶ $f_o\mathrm{F}_{2[\mathrm{OIASA}]} = \dfrac{\mathrm{MUF}_{[\mathrm{OIASA}]}}{\sec\phi}$



$$Q = |\Delta f_o\mathrm{F}_2| = \left| f_o\mathrm{F}_{2[\mathrm{Autoscala}]} - f_o\mathrm{F}_{2[\mathrm{OIASA}]} \right|$$

Fixing a proper threshold value Q_t and filtering the data in Q lets to decrease the number of wrong MUF estimates

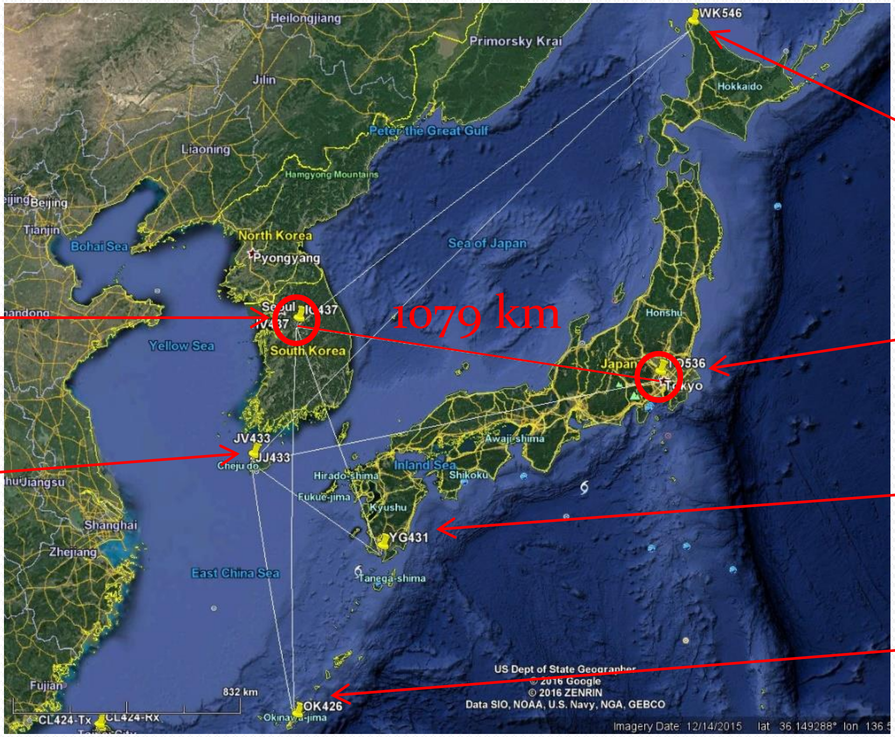
Japan to South Korea oblique radio-soundings

- ✓ New set of test mode oblique ionograms recorded by the Vertical Incidence Pulsed Ionospheric Radar, Version 2 (VIPIR2) ionosonde receivers in Korea
- ✓ Result of the real-time oblique radio-soundings performed every 15 minutes between each couple of Japanese-Korean ionospheric stations

Korean receivers (KSWC)

Icheon (37.14°N, 127.55°E)

Jeju (33.43°N, 126.29°E)



Japanese transmitters (NICT)

Sarabetsu (45.18°N, 141.76°E)

Kokubunji (35.71°N, 139.46°E)

Yamagawa (31.18°N, 130.59°E)

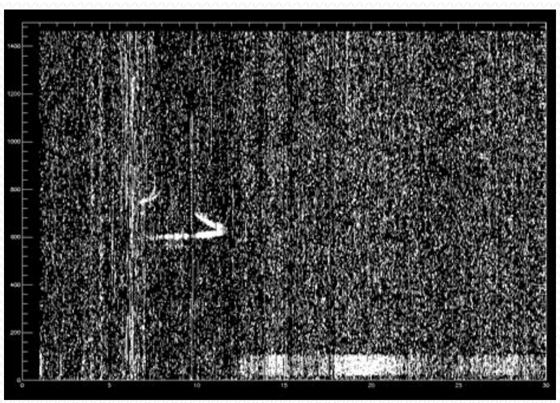
Ogimi (26.70°N, 128.12°E)

Results on poor-quality ionograms

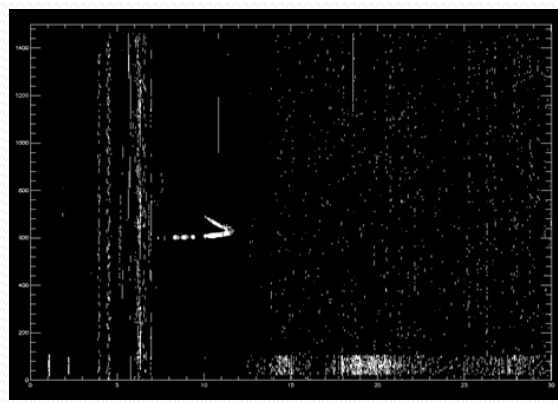
✓ 288 poor-quality test-mode ionograms ← every 15 min = October 5, 2016; November 3, 2016; November 19, 2016

✓ No or little information for more than 40%

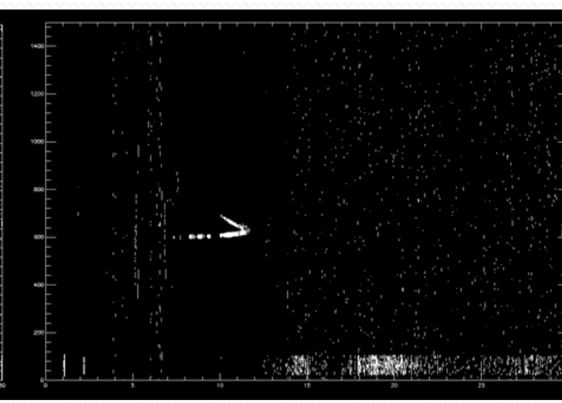
✓ Affected to significant noise ⇒ ✓ double filter procedure



no filters



filter 1 (T_1=6.5 dB)

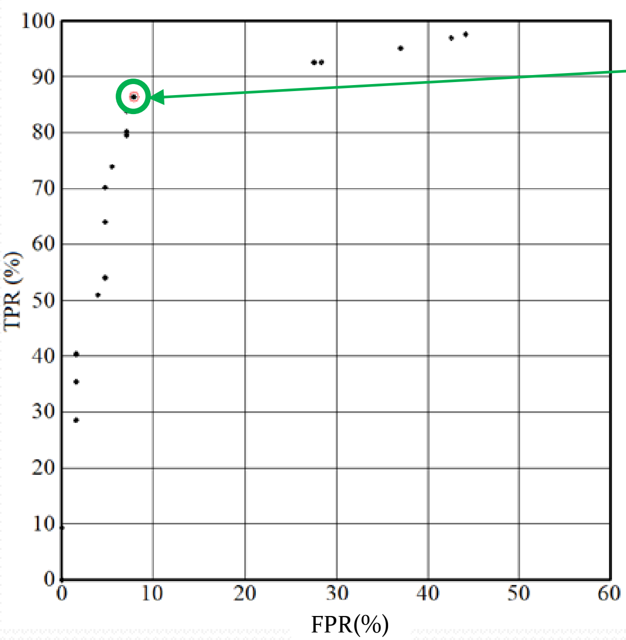


filter 1 (T_1=6.5 dB) + filter 2 (T_2=0.1)

(1) T_1=6.0 dB and T_2=0.1
(2) T_1=6.0 dB and T_2=0.2
(3) T_1=6.5 dB and T_2=0.1
(4) T_1=6.5 dB and T_2=0.2

+ ROC curve method for C_t

✓ FPR-TPR analysis



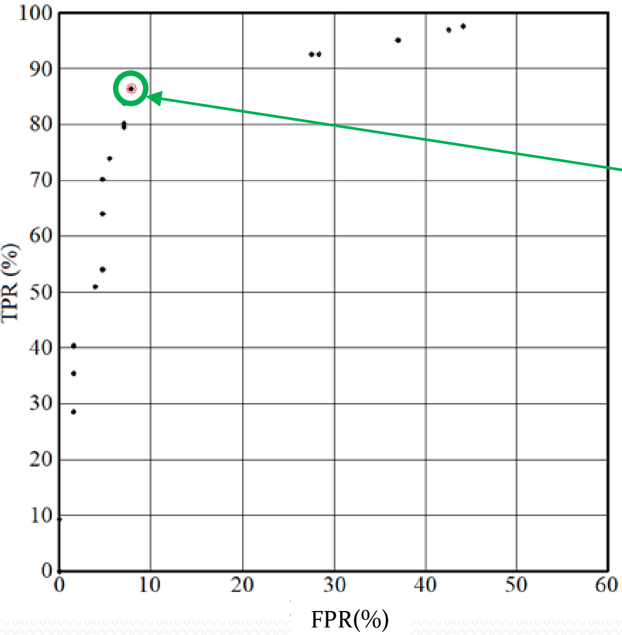
C_t=162

($C_{max} < C_t$)

	Scaled by OIASA	Discarded by OIASA	Total	
Scaled by the operator	139 (TP)	22 (FN)	161 (P)	86.3% (TPR)
Discarded by the operator	10 (FP)	117 (TN)	127 (N)	7.9% (FPR)
Total	149	139		

# of autoscaled MUF values

	Scaled by OIASA and the operator # of cases	%
Accurate	57	41.0
Acceptable	95	68.3
Total	139	100.0

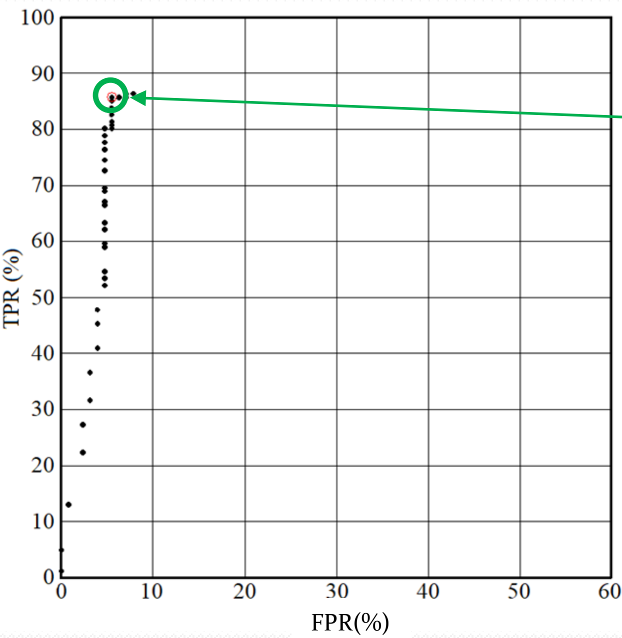


C_t=162

($C_{max} < C_t$)

	Scaled by OIASA	Discarded by OIASA	Total	
Scaled by the operator	139 (TP)	22 (FN)	161 (P)	86.3% (TPR)
Discarded by the operator	10 (FP)	117 (TN)	127 (N)	7.9% (FPR)
Total	149	139		

+4 +3



C_t=162
Q_t=4.7 MHz

($C_{max} < C_t$ or $Q > Q_t$)

	Scaled by OIASA	Discarded by OIASA	Total	
Scaled by the operator	138 (TP)	23 (FN)	161 (P)	85.7% (TPR)
Discarded by the operator	7 (FP)	120 (TN)	127 (N)	5.5% (FPR)
Total	145	143		

- The FPR decreases from 7.9% to 5.5% (-2.4%)
- The TPR decreases from 86.3% to 85.7% (only -0.6%)

Summary and conclusions

- ✓ What is OIASA? software for MUF autoscaling from oblique ionograms
  - how does OIASA scale the MUF? image recognition, maximum contrast method
  - how does OIASA reject bad input data? discarding $C_{max} < C_t$
  - how does OIASA reject bad outputs? discarding $Q > Q_t$

- ✓ Results of the application to a poor-quality test-mode ionograms data set
  - autoscaling → TPR = 85.7%, % acceptable MUF = 68.1%
  - false positive detection and rejection → FPR = 5.5%

Thank you
for your attention

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