

# Validation of Real-Time IRI timelines of F2 layer peak height and density

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IRTAM v0.1B

Time UT = 2004/01/07 19:22:00

### Outline



Statistics of IRTAM versus GIRO
Statistics of IRTAM versus IRI
Case study: January 2013 SSW
Case study: November 2004 IP Shock
Future work

IRTAM v0.18

Time UT = 2004/11/07 19:22:00

#### **IRTAM versus GIRO**





## IRTAM versus GIRO (2)





#### Spatial domain smoothing





#### Error Statistics: IRTAM versus GIRO



$$\overline{\varepsilon}_{R} = \frac{\sum_{n=1}^{N} \left| R_{n} - O_{n} \right|}{N}$$

 $R_n$  = IRTAM,  $O_n$  – observation

[Note that  $O_n$  is not error-free]

foF2 average per-point error is 0.40 MHz

hmF2 average per-point error is 15.5 km

N is ~50 stations for 365 days in 2011 =  $1.7 \times 10^{6}$ 

#### **Error Statistics: IRTAM versus IRI**

Percent improvement

Improvement Factor R1 *F* 

$$\overline{\varepsilon}_{I} = \frac{\sum_{n=1}^{|I_{n} - O_{n}|}}{N}$$

$$Q = \frac{\overline{\varepsilon}_{I} - \overline{\varepsilon}_{R}}{\overline{\varepsilon}_{I}} \cdot 100\%$$

$$R1 = \frac{\sum_{n=1}^{N} (I_{n} - O_{n})^{2}}{\sum_{n=1}^{N} (R_{n} - O_{n})^{2}} = \frac{\sum_{n=1}^{N} \varepsilon_{I}^{2}}{\sum_{n=1}^{N} \varepsilon_{R}^{2}}$$

 $\sum_{i=0}^{N} |I_{i}|$ 

Improvement Factor R2  $R2 = \frac{\overline{\varepsilon}_I}{\overline{c}}$ 

Improvement Factor R3

$$Z = \frac{1}{\overline{\mathcal{E}}_R}$$

$$R3 = \sum_{n=1}^N \left[ \frac{I_n - O_n}{R_n - O_n} \right]^2$$

# Error Statistics: IRTAM versus IRI



foF2	hmF2
• IRI average p-p error: 0.83 MHz	IRI average p-p error: 30 km
• IRTAM average p-p error: 0.40 MHz	<ul> <li>IRTAM average p-p error: 15.5 km</li> </ul>
<ul> <li>Improvement R1 = 1.98</li> </ul>	<ul> <li>Improvement R1 = 1.83</li> </ul>
<ul> <li>Improvement R2 = 2.08</li> </ul>	<ul> <li>Improvement R2 = 1.94</li> </ul>

IRTAM v0.16

Time UT = 2004/01/07 19:22:00

## SSW Case of January 2013









#### Plans for South American Ionosondes





# **IP Shock Event November 2004**



Check Qiu-Gang Zong presentation tomorrow for more case study examples

### Red Spot over Africa





## Red spot over Africa (2)



👍 IRI Real-Time Assimilative Map Layers . ✓ Stars a Sky Time UT - 2011.12.25 18:22:00 IRTAM VO.1B ✓ NASA Blue Marble Image Blue Marble (WMS) 2004 -**RTAM Control and Display** 25 2011 12 18 22 Now GIRO Assimilate Report FOF2\_RTAM\_VS\_IRI ¥ Surface FOF2\_GIRO\_VS\_IRI 0 Sites ¥ Color scale 0 World Flat Round \* Projection: Mercator INTERNATIONAL Map: foF2 (IRT/AM-IRI) MHz Circles(sites): foF2 (GIRO-IRI) MHz **Assimilative Map** RI 1.5 29 -1.5 0 1.5 2.9 -2.9 -1.5 0 29 IONOSPHERE Altitude 28,447 km **Off Globe** 

## Predictive IRTAM capabilities?





### Future Work



- Error histograms: compute uncertainties
- Time-domain gap filling technique is needed
- Higher orders? Versus IRI compatibility
- Interface to IRI portals (IRI, CEDAR)
- Build GAMBIT database
  - Cut latency for outside users
  - Statistical studies
  - Dissemination of coefficient updates
- Build web-layer to GAMBIT database