Performance Analysis of an HPC Implementation for Large-Scale Propagation Prediction

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Presentation Outline

- Background
- Spectrum Observatory Architecture
- Purpose and Problem Statement
- Methodology
- Results
- TVWS Heat Maps
- Conclusion

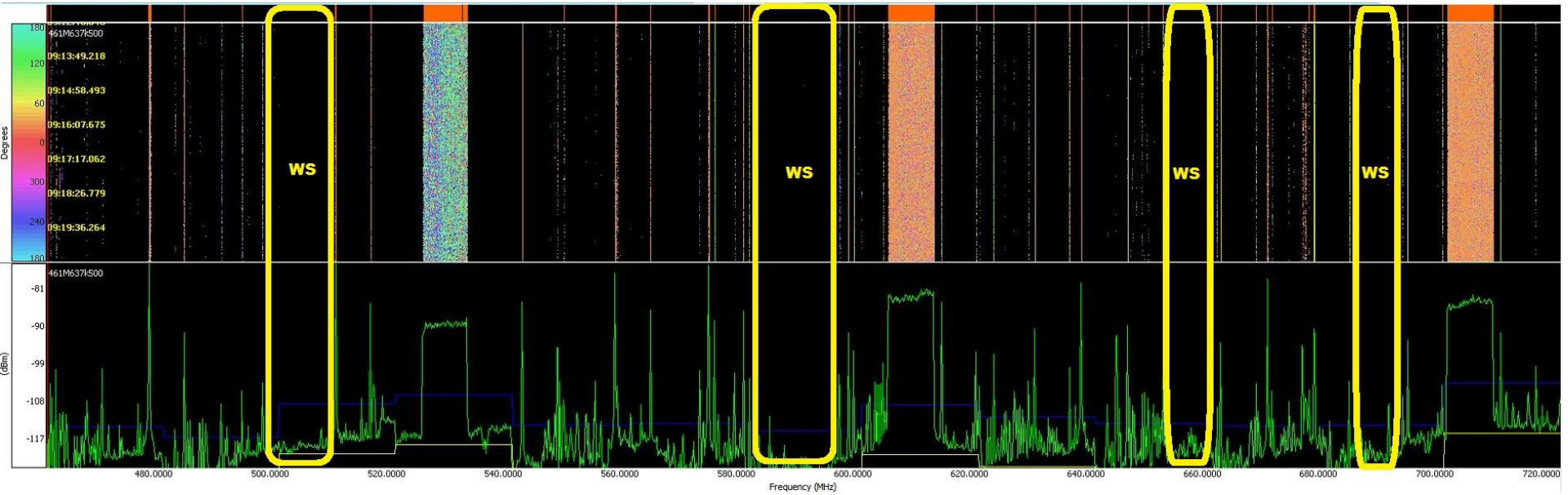
Background

- Need for Secondary Spectrum Access
  - More people means more need for connectivity
  - RF spectrum resources are limited
  - RF spectrum is not used efficiently
  - 470-790 MHz assigned for Terrestrial TV broadcasting by ICASA
  - Secondary Access is a viable solution, especially in TV bands

- TV White Space
  - TVWS refers to spectrum that is not being utilised at the moment in the part of the spectrum originally assigned to TV broadcasting networks.

- Determination of White Space
  - White Space is time and location dependent
  - Methods
    - Spectrum Sensing
    - Geo-location Database

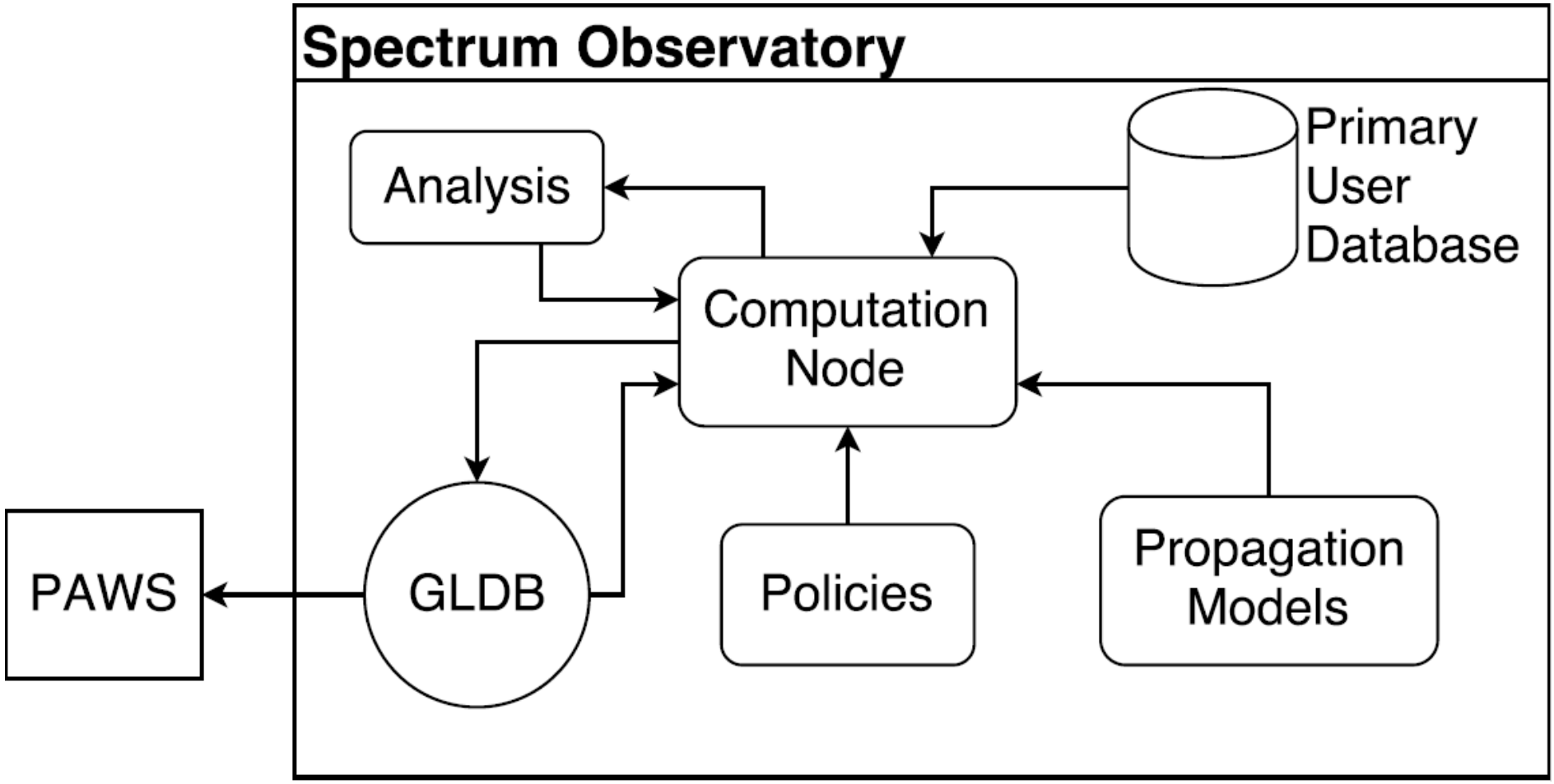
Background



Spectrum Occupancy for 470 – 790 MHz of Dreyersdal, Cape Town on 08/08/2017

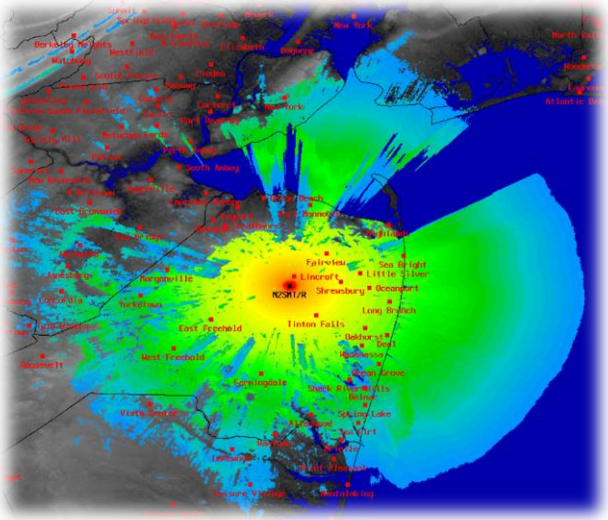
GEW
A Hensoldt Company.

Spectrum Observatory Architecture



Background

- Computing is a big concern
  - White space recalculations done every
    - Week (FCC)
    - 6 Months (Ofcom)
  - A lot of fine grained computations are involved
  - Especially true for models using terrain data



Field strengths generated by SPLAT!, source: SPLAT! website

Background

- Solutions:
  - GPGPU Programming
    - Using GPU's for general processing.
  - Cloud Computing
    - The usage of a network of remote servers hosted on the Internet to process data, rather than a local server or a personal computer.
  - High Performance Computing Cluster
    - Multiple high performance computing nodes used for large scale multi-processor computing.

Purpose and Problem Statement

- **Problem Statement**

Do a performance analysis of using an HPC to do Large-Scale Propagation Prediction

- **Purpose**
  - Allow for faster generation of propagation prediction data
  - Leading to faster TVWS identification
  - Enabling faster TVWS research
  - Moving the time it takes to generate results for weeks/months to hours/minutes.
  - Building block in moving WS to other parts of RF Spectrum

Methodology: CHPC Speed-up

TV Transmitter List

- Analog and DTT
- 2325 entries

Local Implementation

- Run simulation on local PC for the Gauteng area using 30 arc-second grid
- Using 4 local CPUs
- All 4 propagation models (Free Space Loss, Hata, ITM Area, ITM P2P)

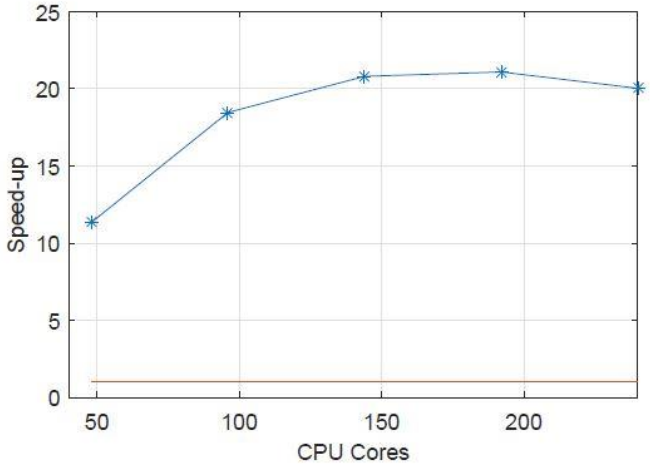
HPCC Implementation

- Run simulation on the CHPC Lengau HPCC for Gauteng area
- Using increasing number of CPUs (48, 92, 144, 192, 240)
- All 4 propagation models

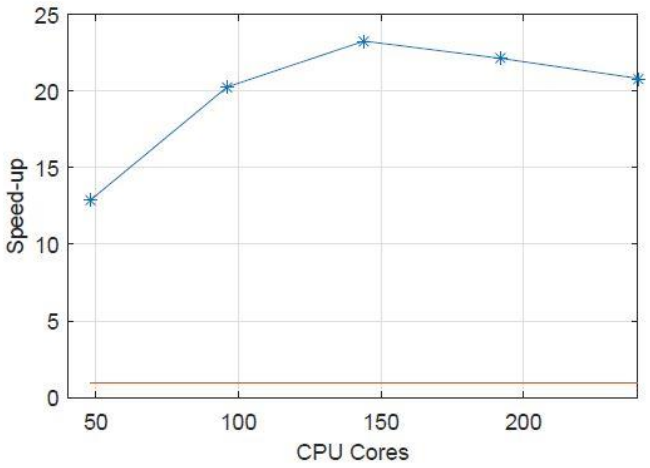
Calculate Speed-up

- Speed-up = Time_local / Time_CHPC
- Plot speed-ups

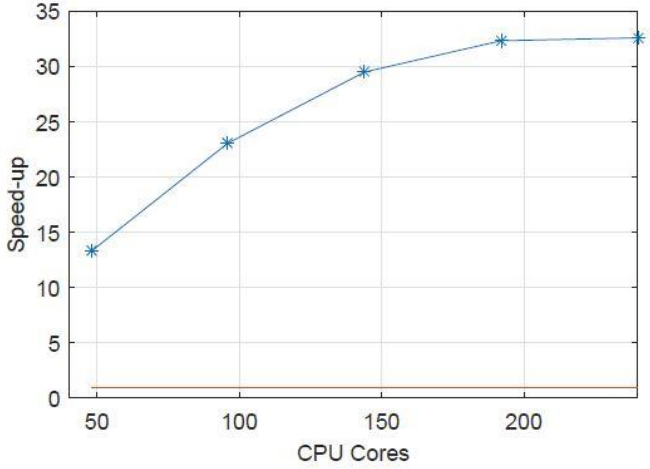
Results: CHPC Speed-up



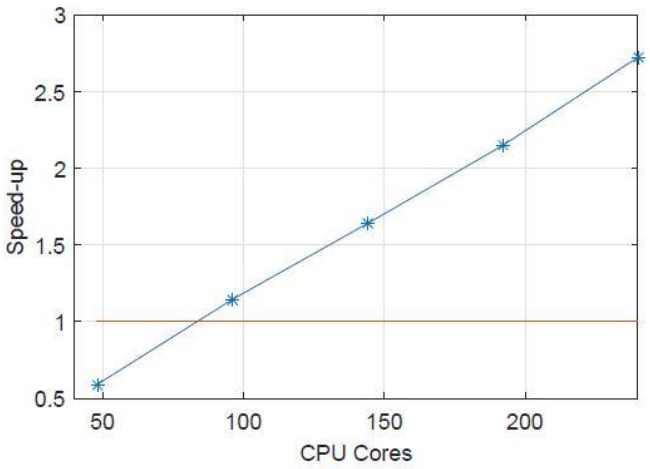
(a) Free-Space Loss



(b) Hata-Davidson



(c) ITM Area



(d) ITM P2P

Methodology: TAU Analysis of ITM P2P

TV Transmitter List

- Analog and DTT
- 2325 entries

HPCC Implementation

- Use TAU (Tuning and Analysis Utilities) compiler
- Run simulation on the CHPC Lengau HPCC for Gauteng area (30”)
- Using 48 CPU
- ITM P2P

TAU Results

- Collect TAU results
- Format mean timing TAU results

Results: TAU Analysis of ITM P2P

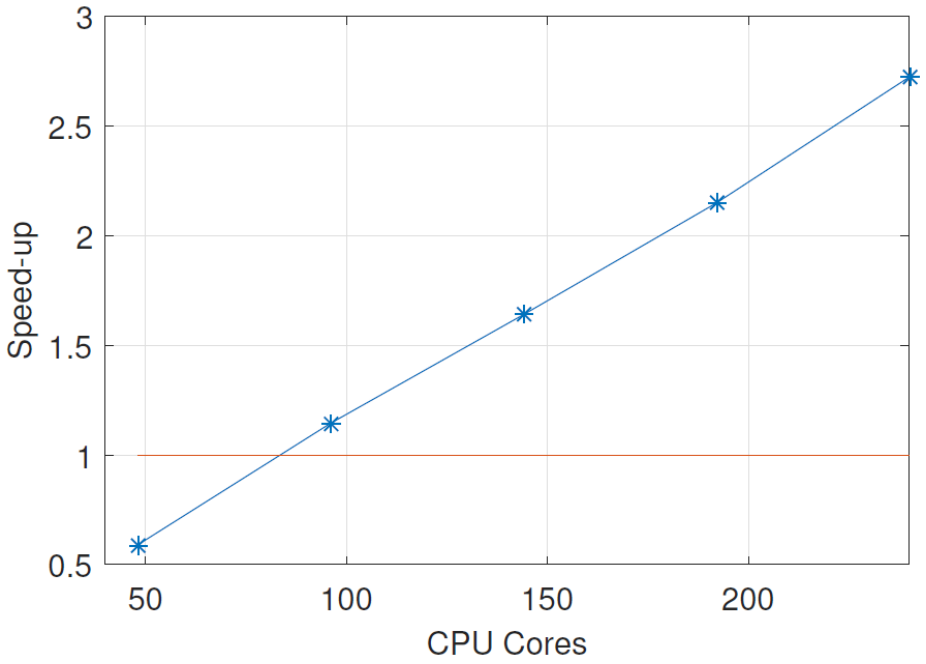
Time %	Exclusive msec	Inclusive total msec	#Calls	Name
100,0	29	35:15,784	1	.TAU application
100,0	1,392	35:15,754	1	main()
85,7	30,684	30:13,981	54720	get_GLOBE_pfl()
84,3	11:12:851	29:43,234	4,3776E+07	GLOBE_elevation()
52,4	18:29,601	18:29,601	1,0579E+08	Get_GLOBE_data()
13,9	4:54,596	4:54,596	3	MPI_Barrier()

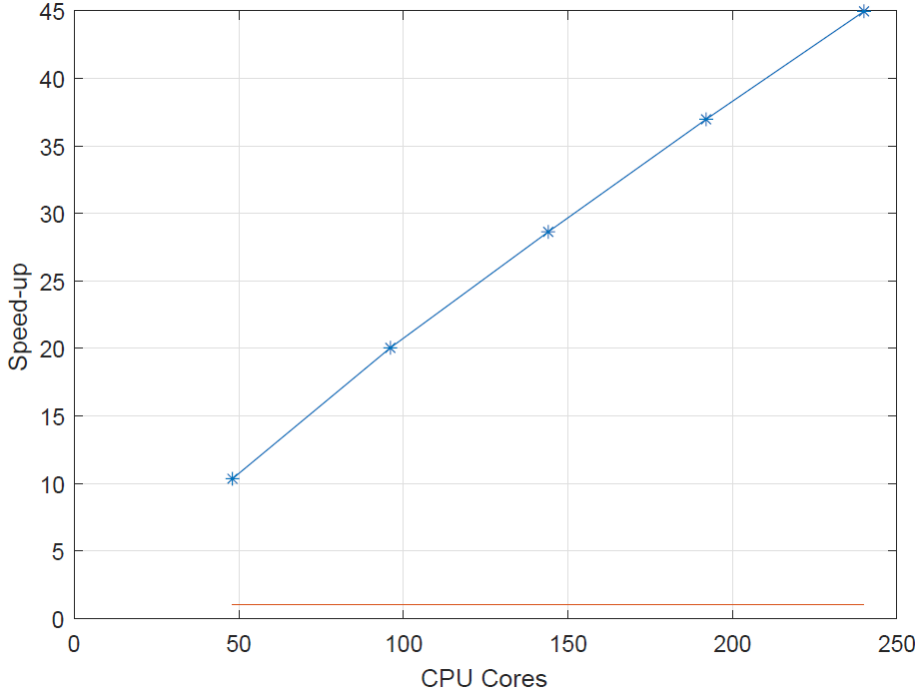
Results: TAU Analysis of ITM P2P

	Before	After
Transmitters	2325	2325
CPUs	240	240
Wall Time (hh:mm:ss)	05:26:29	00:04:22
CPU Time (hh:mm:ss)	1291:06:02	17:17:00

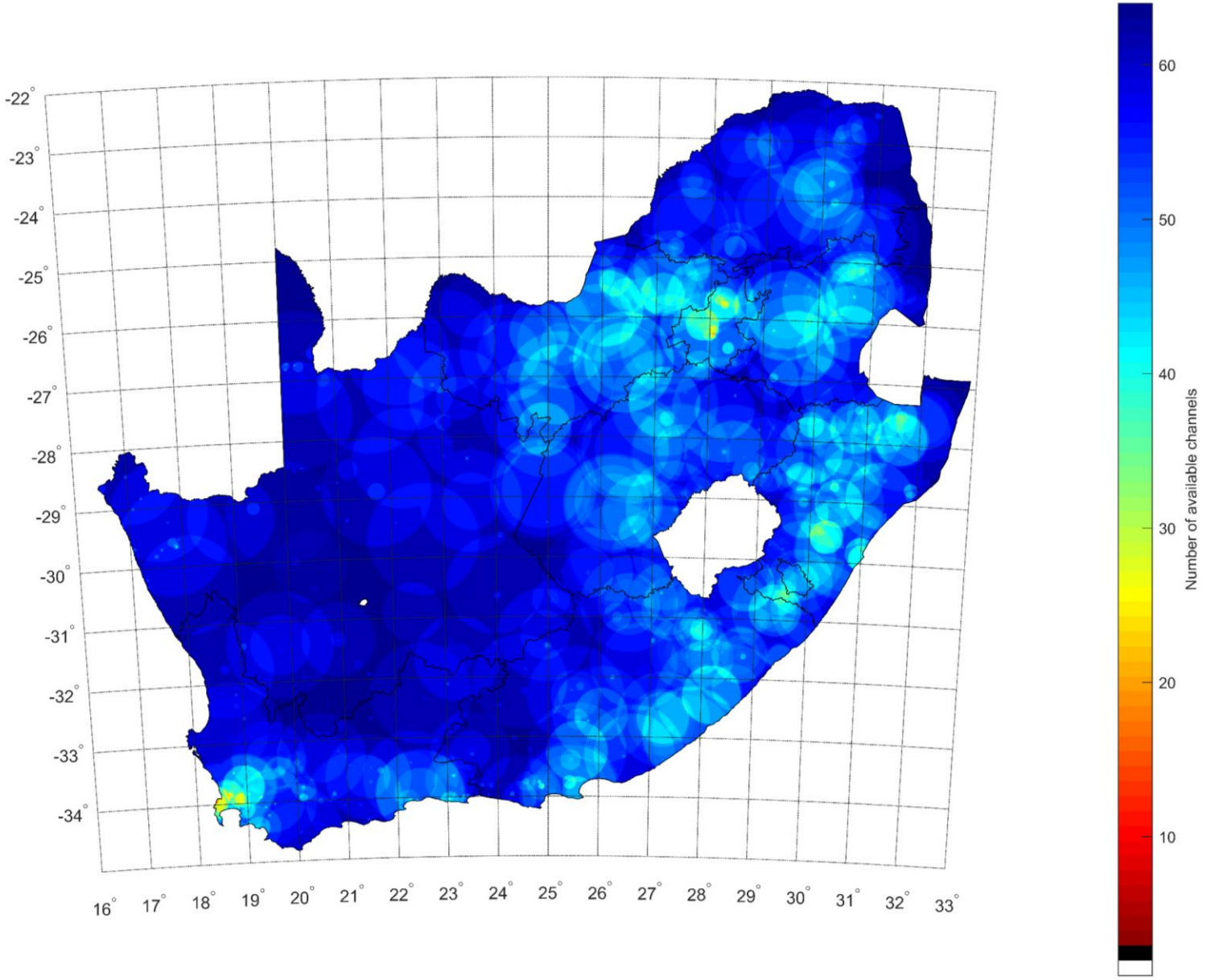
Results before and after **path extraction improvements**

Results: ITMP2P Speed-up

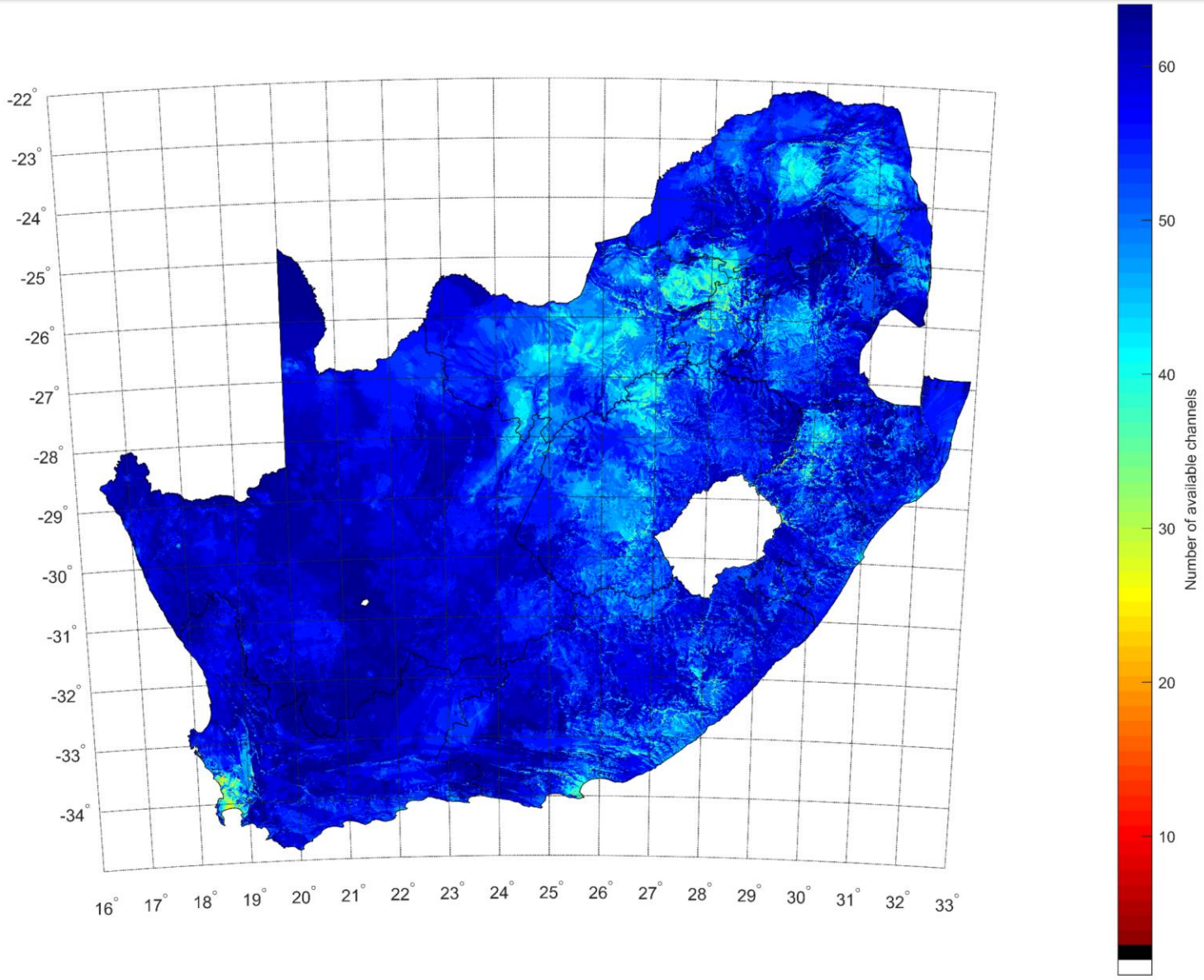




TVWS Heat Map: ITM Area mode



TVWS Heat Map: ITM P2P mode



Conclusion

- Accelerated Propagation Predictions using HPCC
- Improvements done for terrain dependant models
- Using the HPCC leads to faster TVWS identification
- This is possible through the CHPC

Questions?

Thank you