



Australia's National Science Agency

# Cross-disciplinary applications and extra-ATNF synergies

Stephanie Smith and Mark Cheung

ATUC Science and Technology Day, 8<sup>th</sup> November 2022

# Science Drivers

- Contributing to the field of space weather; forecasting of space weather events; learning how the sun impacts GEOspace; improving ATNF science.
- Adding to the science of orbital prediction; fostering a constructive relationship with the space industry for the future benefit of radio astronomy.

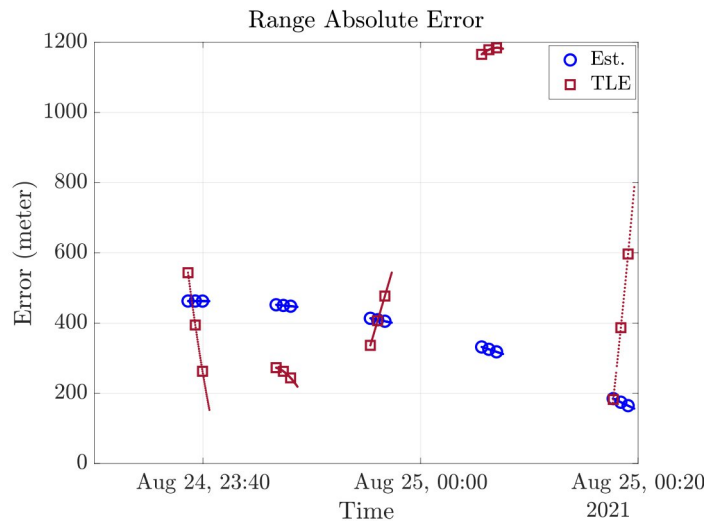
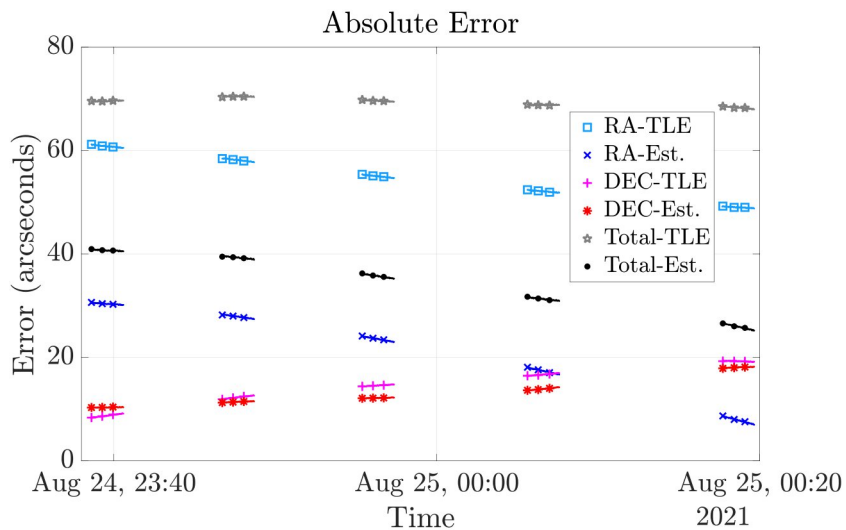
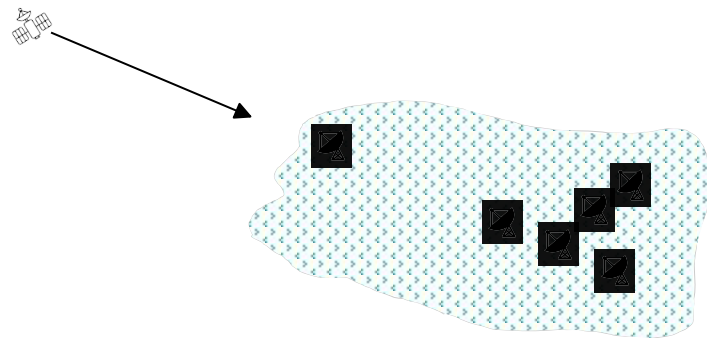
# Status

- Aperture arrays for satellite communications
- Tracking satellites and spacecraft
- Space Situational Awareness
  - Boeing SSA project
  - SSA with ATCA
- Asteroid tracking
- Space weather with MWA & ASKAP
- Space weather from space tracking (joint PhD student with UTas)

# SSA with ATCA – Hamed Nosrati (Postdoc)

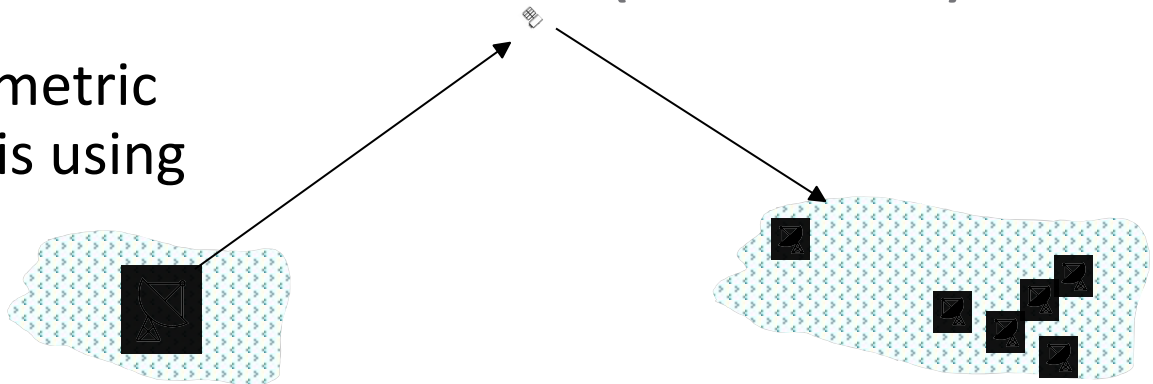
Passive RF – performance characterization using GPS satellite observation

- Range and Direction of Arrival – error less than propagated TLE

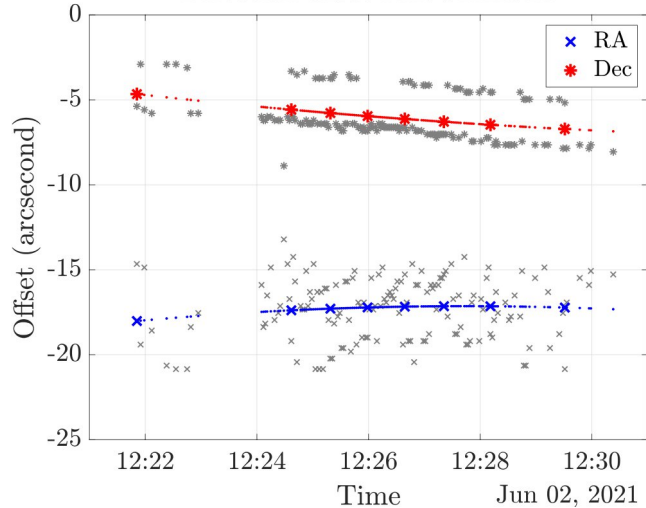


# SSA with ATCA – Hamed Nosrati (Postdoc)

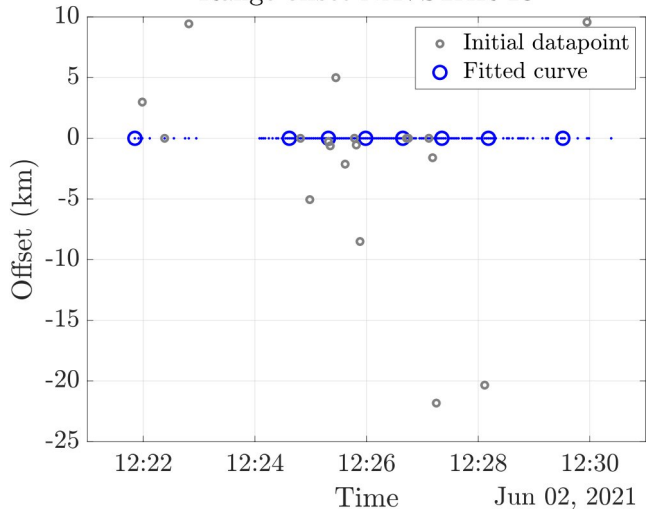
Bi-static radar – interferometric localization of space debris using ATCA and CDSCC Tx



Direction offset NAVSTAR-18

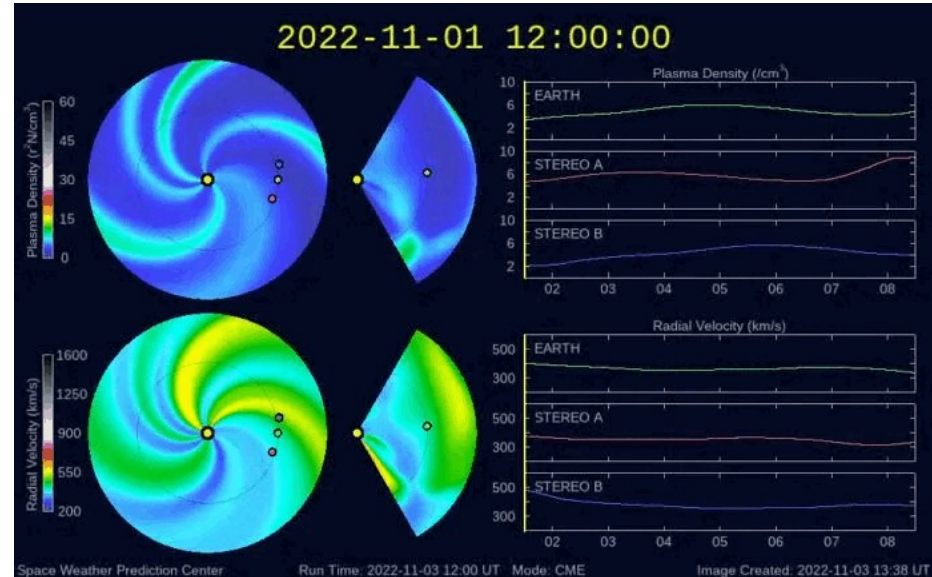


Range offset NAVSTAR-18



# Space Weather with MWA & ASKAP

- Jordon et al. (2017), Hurley-Walker & Hancock (2018), Waszewski, Morgan & Jordan (2022): Ionospheric scintillation with MWA
- Morgan+ (2018), Chhetri+ (2018a,b), Sadler+ (2019), Morgan+ (2019): MWA measurements of interplanetary scintillation (IPS)
- Chhetri+ (2022): First IPS measurement with ASKAP – Potential regular measurements with CRACO.

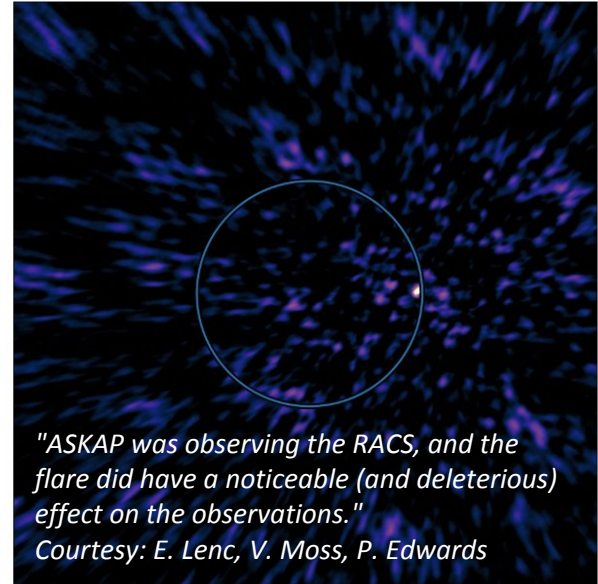


Above: Solar Wind Model @ NOAA / SWPC.  
The solar wind is very sparsely sampled. IPS measurements and data-assimilation needed to improve understanding and predictions.

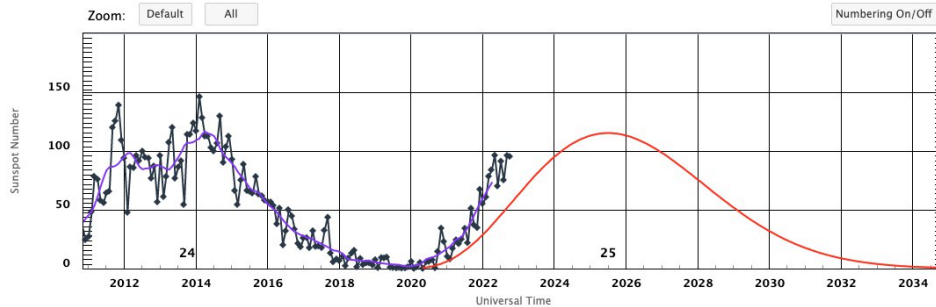
# SpWx impacts on ASKAP

- ASKAP beam-forming (Hotan+ 2014):
  - *"Because of its finite size and intrinsic variability, the Sun is not an obvious candidate for a beam-forming reference, but we have found that it is the only source available in the southern sky with sufficient radio flux for the maximum signal-to-noise method to work ..."*
- Solar activity impacts on ASKAP to escalate with increasing magnetic activity.

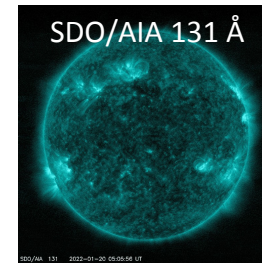
4th of February 2022



ISES Solar Cycle Sunspot Number Progression



RFI at the MRO!



# Space Weather – Jasper Edwards (PhD student)

- Phase scintillations of spacecraft radio signals to study interplanetary coronal mass ejections.
- Using UTas and ATNF, single dish plus VLBI.
- Across frequency ranges, eg. UTas no Ka-band, Mopra Ka-band.



# Future

## SSA

- orbital state vectors

## cislunar SSA

- area of space between earth and moon plus vicinity of earth and moon
- Collaborative network of diverse sensors for best coverage
- No single location on earth can observe all cislunar
- Huge benefit to passive systems for cislunar – do not require ‘pinging’ which can be prohibitive due to the distance.

## Space Weather

- ATCA / VLBI, MWA, ASKAP + CRACO



# Discussion points?

- Do we need to study space weather to enable time domain astronomy? Can this be done in a low cost, low impact way?
- What other activities should we be pursuing with ATNF?



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