FIG Working Week 2023
28 May - 1 June 2023 Orlando Florida USA
Protecting Our World, Conquering New Frontiers

Ginan – GNSS Analysis Centre Software from Geoscience Australia

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(on behalf of the Ginan Development Team)

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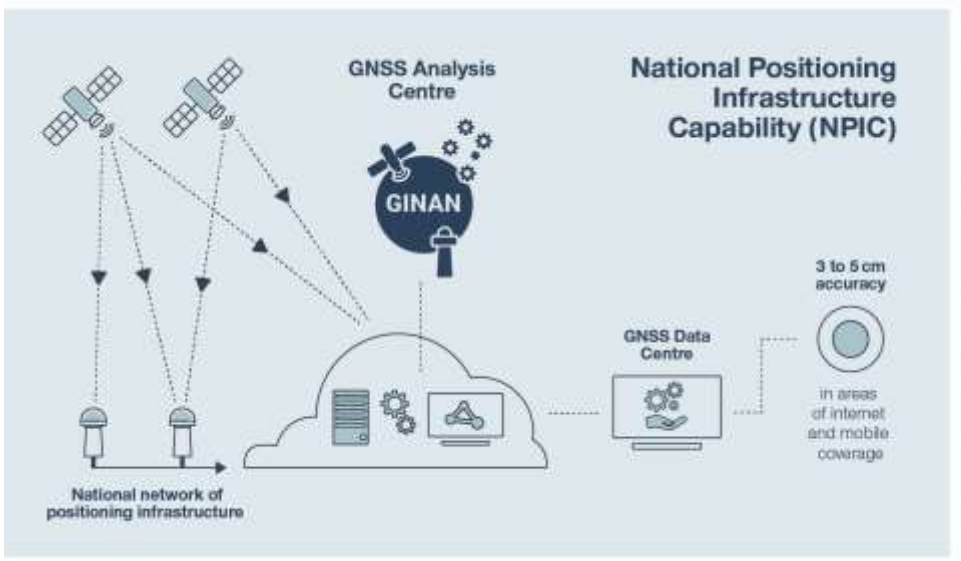
Outline of Presentation

- Introduction
- What is Ginan
- Technical Background
- Ginan Development Timeline
- Downloading and installing Ginan
- Real-time and post-processing performance
- Practical Demonstration
- Ginan Team
- Conclusion

Introduction

- Ginan is an open-source PPP software toolkit and an analysis centre software being developed by Geoscience Australia as part of Positioning Australia National Positioning Infrastructure Capability (NPIC)
- It is one of the two major initiatives of Positioning Australia, with the second being SouthPAN – Australia and New Zealand SBAS

POSITIONING AUSTRALIA



The Ginan Name

- The name Ginan comes from the Wardaman people of Northern Territory
- Is a Wardaman word for a red dilly-bag filled with songs of knowledge
- Is the fifth-brightest star in the Southern Cross
- The Southern Cross helped the First Australians to navigate

What is Ginan

Ginan - Geoscience Australia's GNSS Analysis Centre Software

"Accurate and reliable positioning for everyone"

- Open-source software toolkit for precise positioning and navigation
- Multi-GNSS data processing and analysis capability
- Undifferenced, State Space Representation (SSR) using Precise Point Positioning (PPP) methodology
- Capable of delivering precise positioning products and services for post processed and real-time applications
- Enables centimetre level accuracy positioning in areas with mobile phone/internet coverage

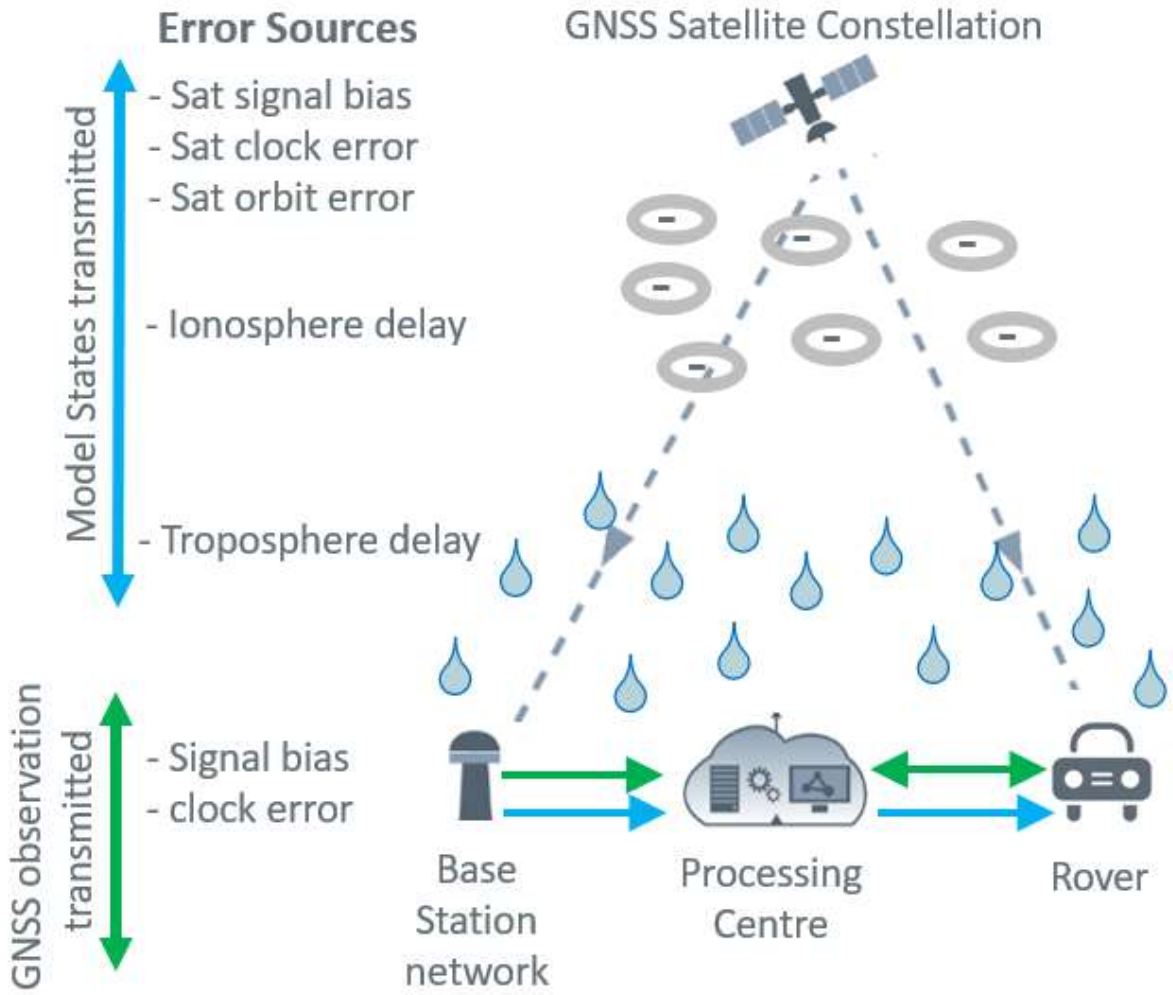
GINAN

Aims of Ginan

- Provide a comprehensive GNSS analysis tool kit capable of producing correction messages that allow users to get to a position accuracy of a few centimetres
- Enhance Positioning Australia's internal expertise in multi-GNSS so that Geoscience Australia can continue to provide expert advice on GNSS system performance to domestic and international GNSS users
- Provide a state-of-art GNSS analysis toolkit to universities and research organisations to enable Australia to lead the development of geospatial technology
- Encourage the development of innovative position dependent technology and services that will be of economic benefit to Australia – to grow the market for OEMs, technology integrators, service providers, the science community and end users, and realise the full benefits of GNSS.
- Help Positioning Australia generate the next generation of geodetic datums and keep track of multi-GNSS performance over Australia and the region

Ginan - Technical Background

Observation Space Representation (RTK) vs State Space Representation (PPP) (OSR vs SSR)



- OSR (RTK) is a baseline positioning technique where errors are eliminated by differencing observations from a base station with known coordinates from local observations
- SSR (PPP) is an absolute positioning technique where errors are eliminated by processing received model State estimates with local observations

OSR vs SSR Positioning

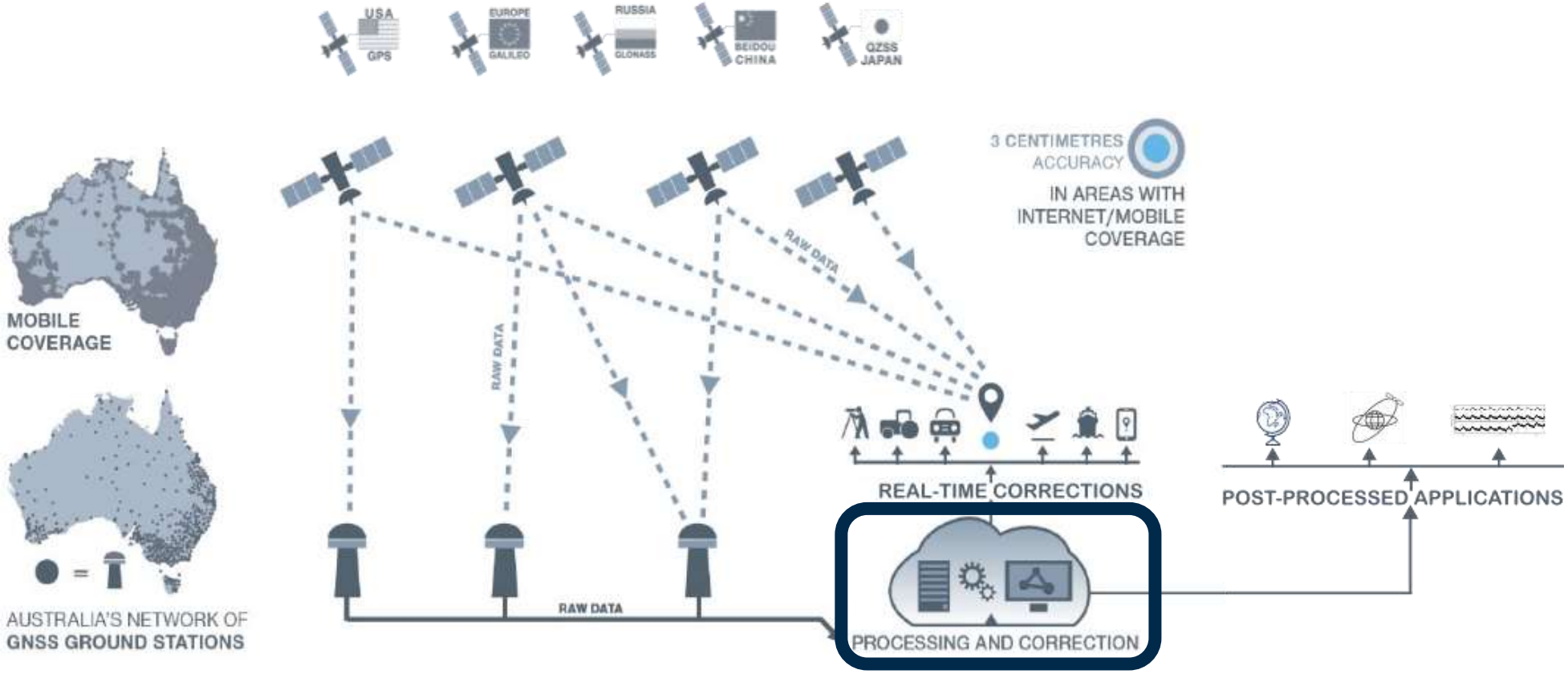
Observation Space Representation (OSR) - RTK

- ✔ Centimetre level accuracy
- ✘ Dense base station network
- ✘ Local coverage
- ✘ High bandwidth
- ✘ Two-way communication
- ✘ Not scalable
- ✔ Fast convergence

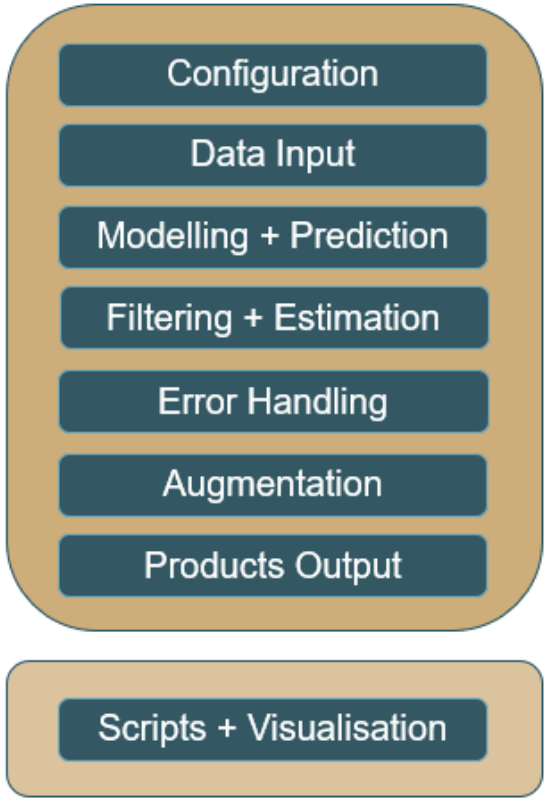
State Space Representation (SSR) - PPP

- ✔ Centimetre level accuracy
- ✔ Sparse base station network
- ✔ Global coverage
- ✔ Low bandwidth
- ✔ One-way communication
- ✔ Easily scalable
- ✘ Slow convergence

The Ginan Concept



Ginan Components



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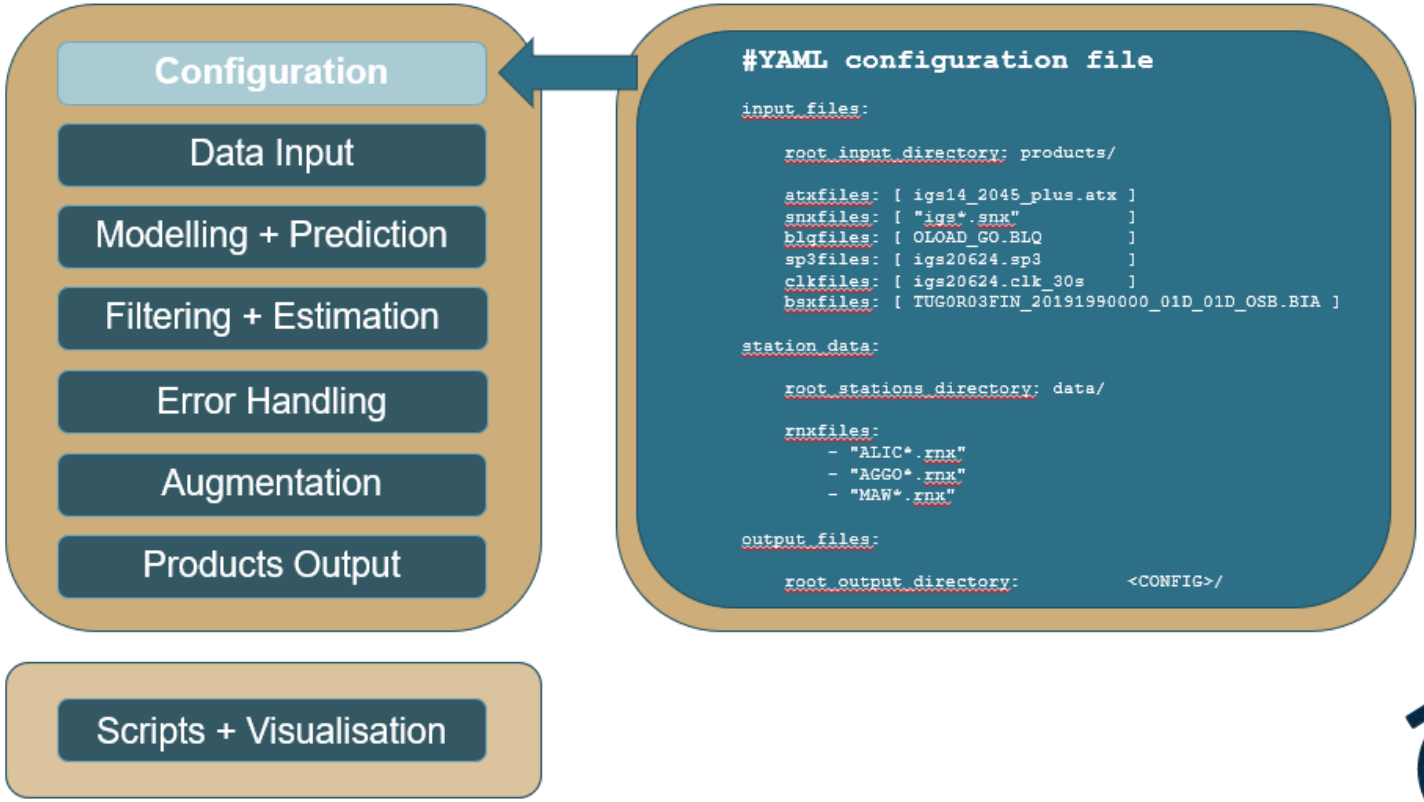

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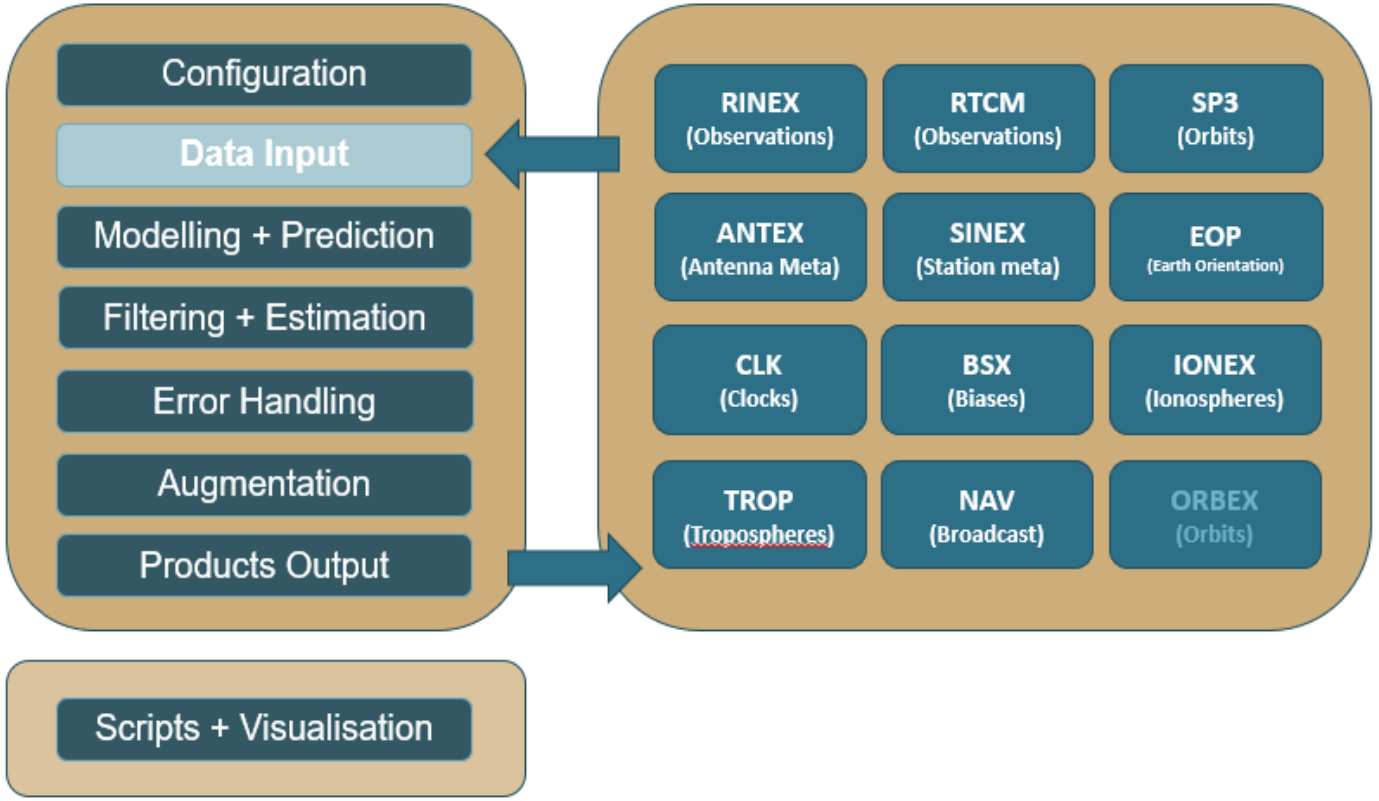

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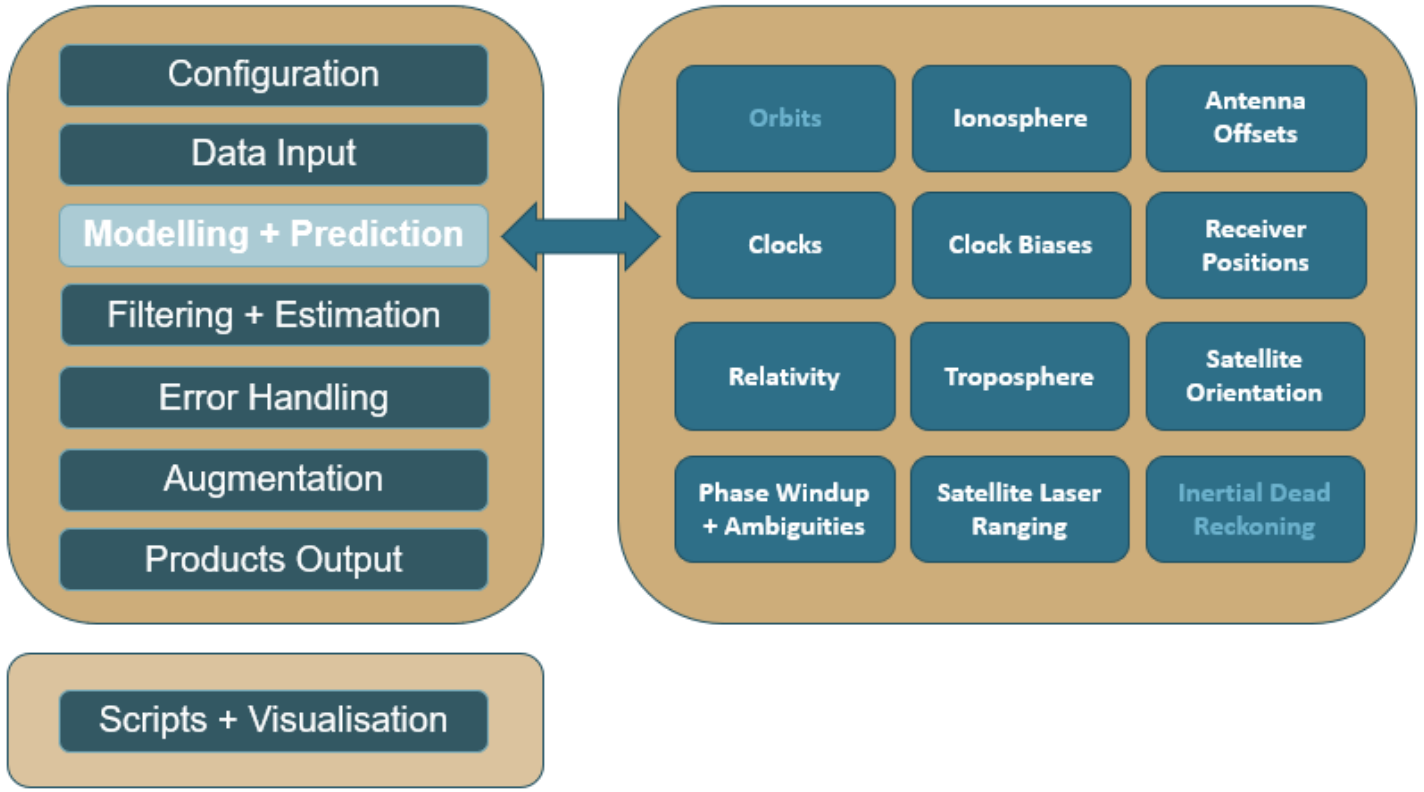

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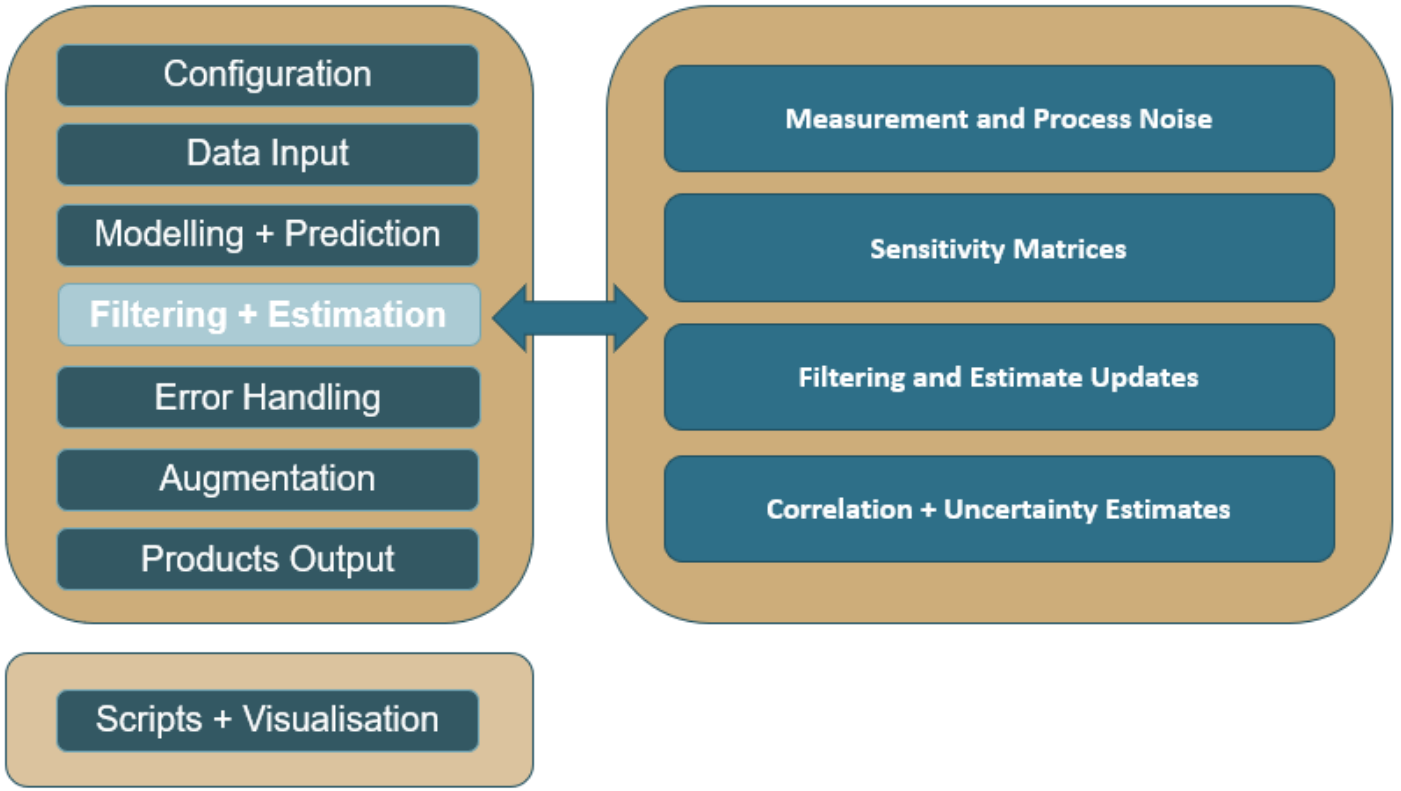

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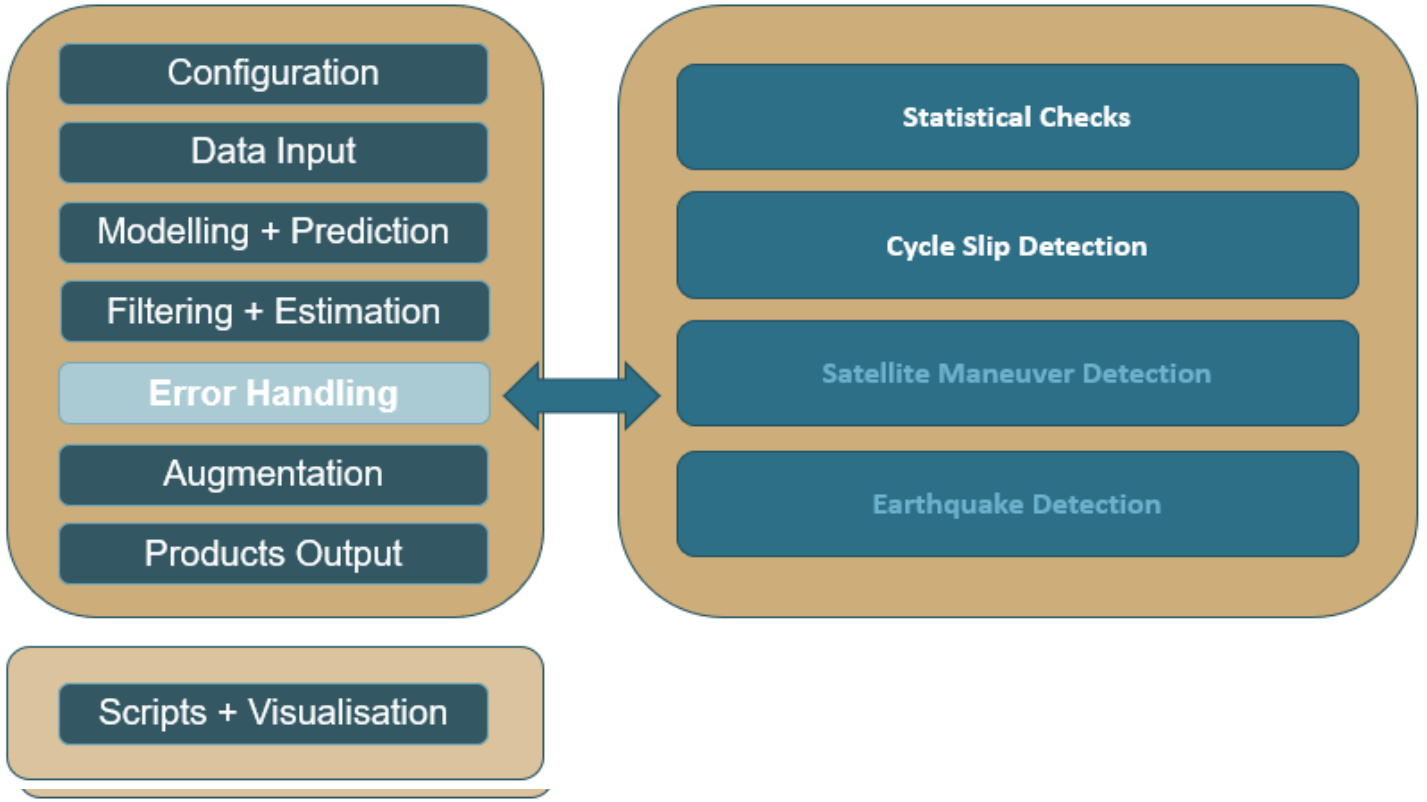
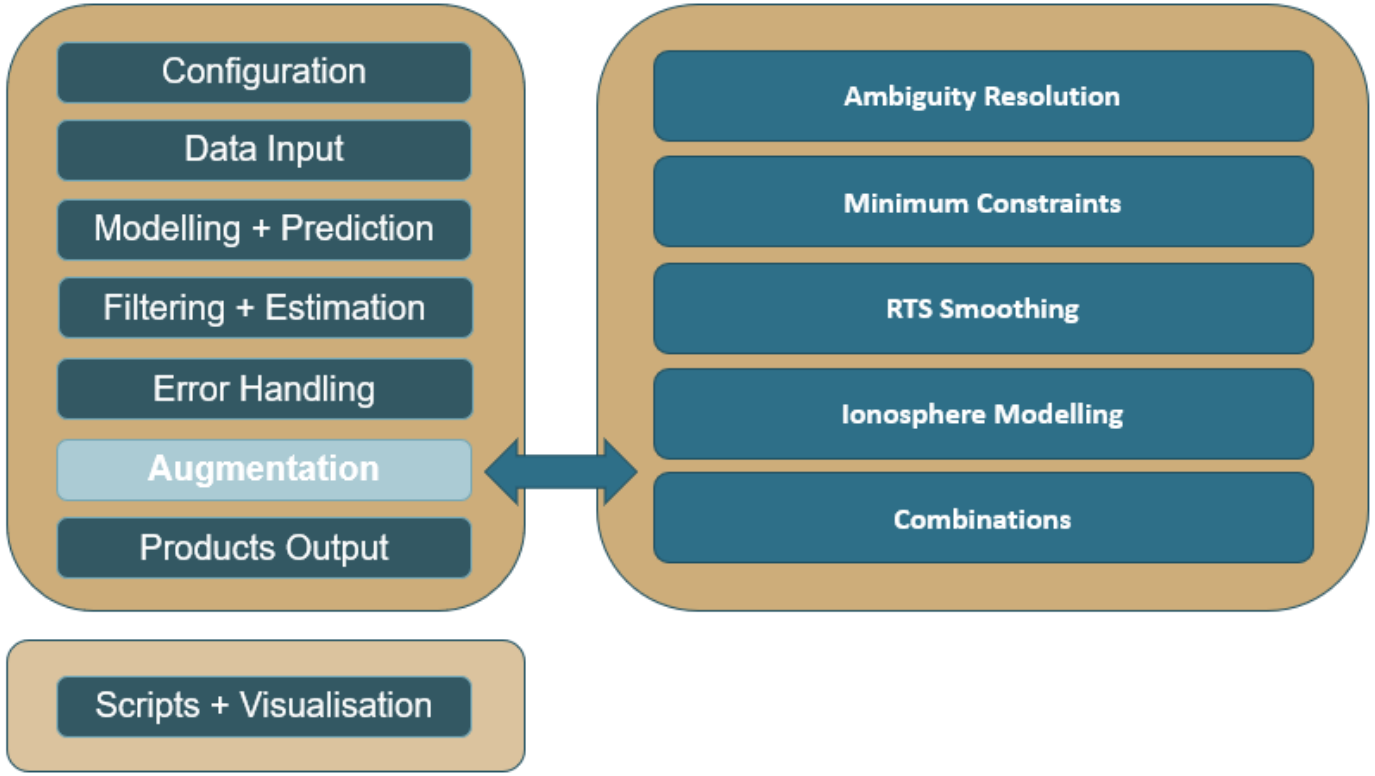


Ginan Components



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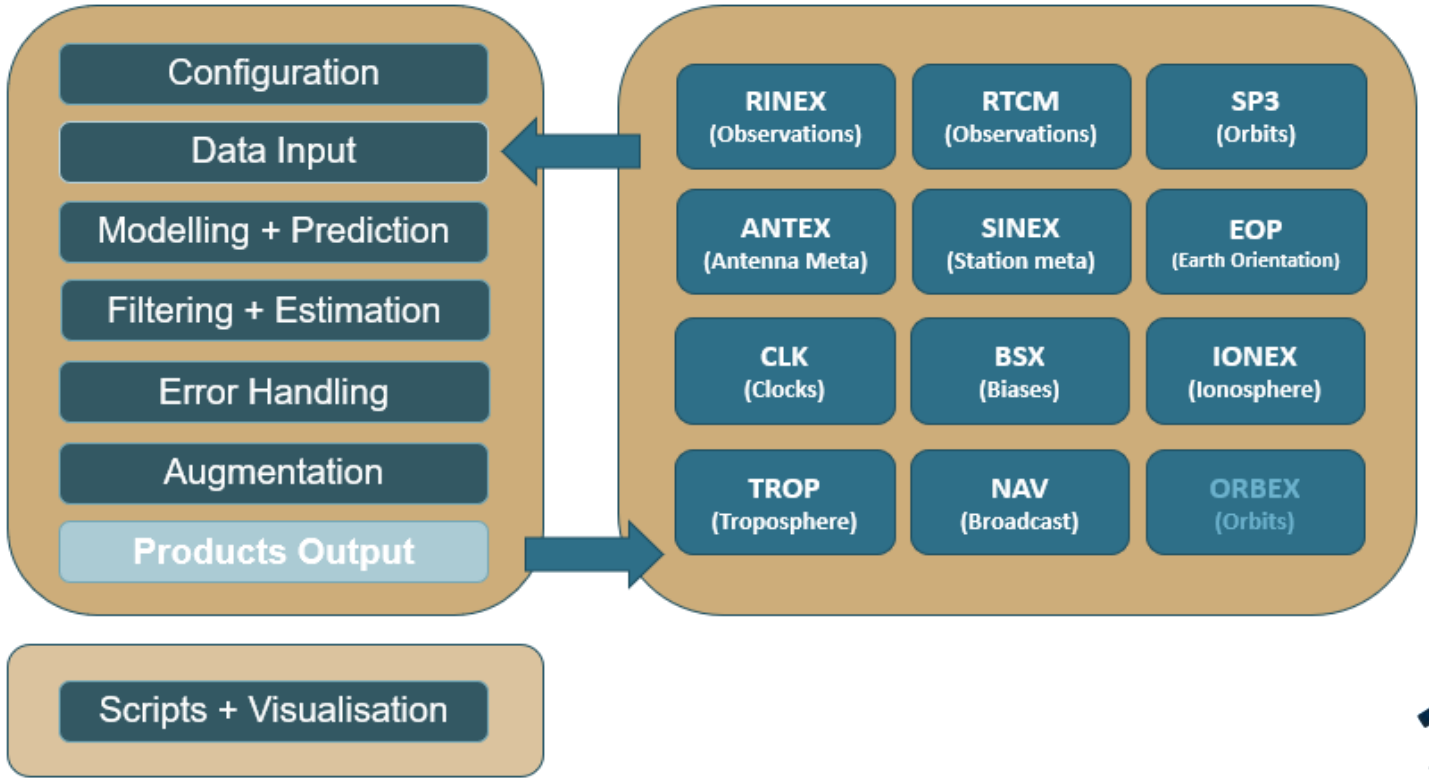


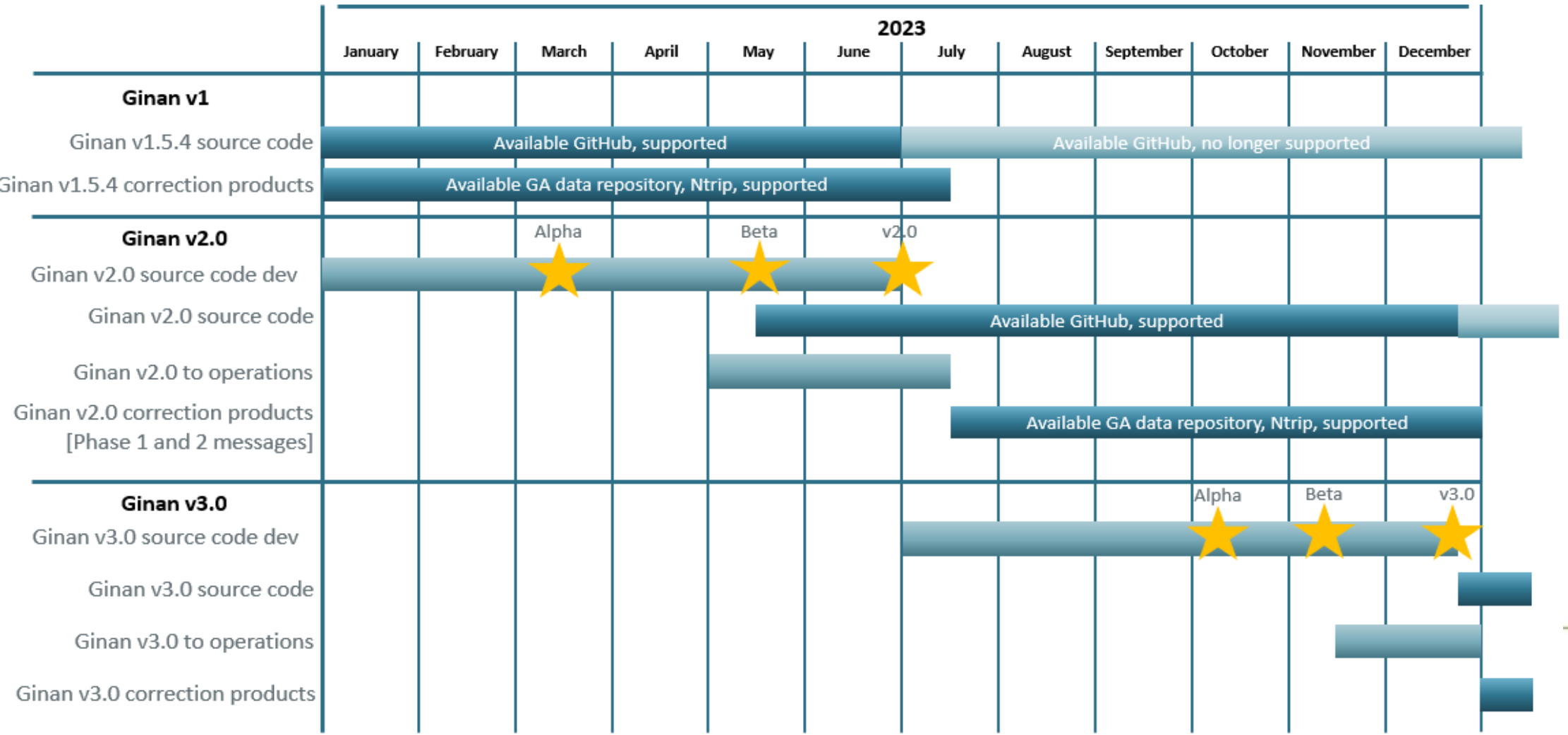
GINAN

Ginan Functional Infrastructure

- **Configuration**:
  - Standard Yet Another Markup Language (YAML)
- **Input**:
  - File based for Post Processing (PP)
  - Streams for Real Time (RT) processing
- **Observations**:
  - Always Un-Differenced (UD)
  - Combined Ionosphere Free (IF) form, or Un-Combined (UC)
  - Dual frequency (IF), or Multi-frequency UC
  - Multi-constellation: GPS, GLO, GAL, QZS, BDS (SBAS in dev)
- **Measurement model**:
  - Positions, Clocks, Phase/Code biases, Troposphere, Ionosphere, PCO, PCV, phase windup, Antenna Ecc, Tides, Relativity, …….
- **Filtering and Estimation**:
  - Robust Kalman filter
  - Flexible full GNSS observation model State estimation
  - Backwards Smoothing (Fixed Lag and Full RTS)
- **Output**: Industry standard file products or RTCM3 stream based

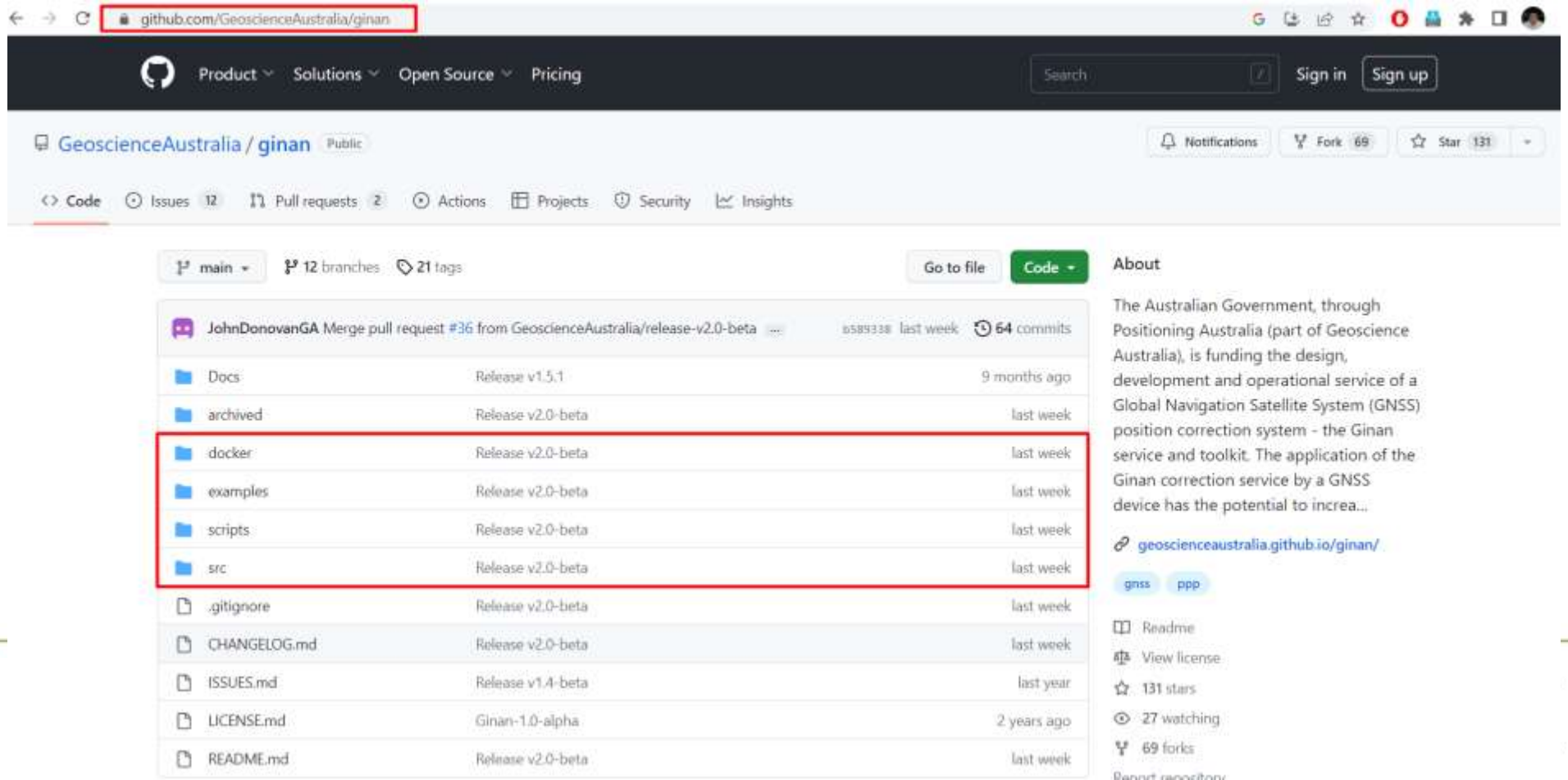
Ginan Development Timeline

Development & Operations timeline



Key Deliverables and Milestones

Ginan v2 has been released earlier this month and is available from GitHub Repository



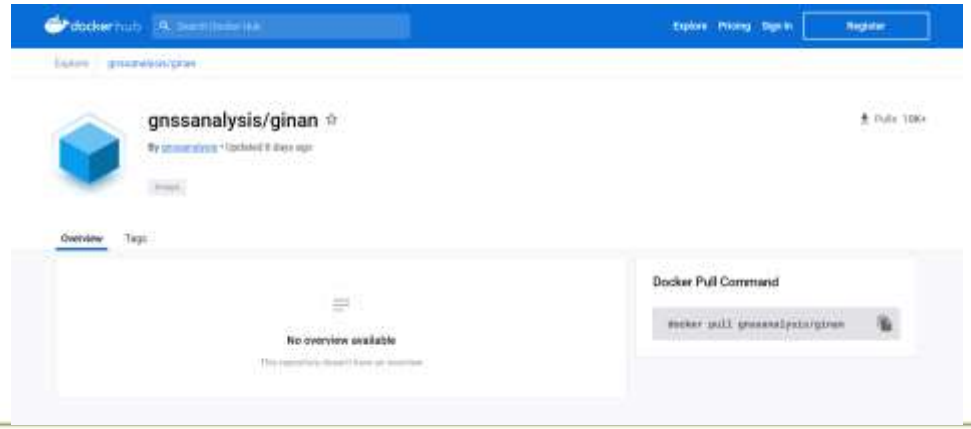
Differences between Ginan v1 and v2

- Unified User and Network operation modes (One Observation Model & Filter)
- More GNSS constellations – Full Multi-Constellation capability (Ex SBAS)
- Better internal frequency indexing (complete Multi-Frequency capability)
- UnDifferenced / UnCombined (UDUC) processing (v1 was Combined IF only)
- Parameter Estimation Algorithm (PEA) integrated and coupled Precise Orbit Determination (POD) capability
- More robust data handling in filter cycle slip and outlier detection and removal
- Complete RTCM3 phase 1 and Phase 2 message decoding and encoding
- SLR data handling fully implemented
- Model & Performance improvements

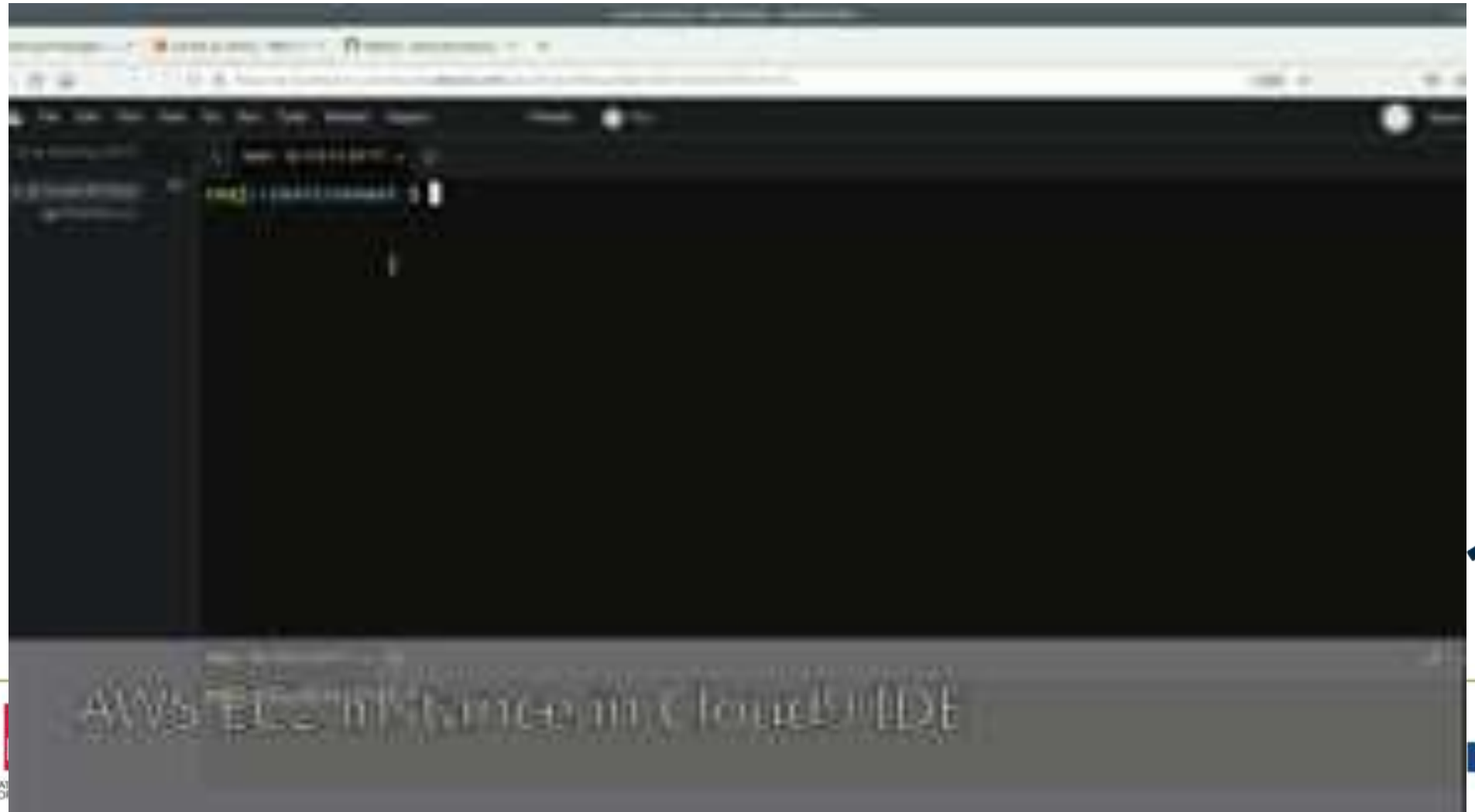
Downloading and Installing Ginan

Installing Ginan

- For native install, the source code is available at GitHub and it supports:
  - Linux
  - Mac
  - Windows (via WSL – Windows Subsystem for Linux)
- Another way to run Ginan is via Docker Image

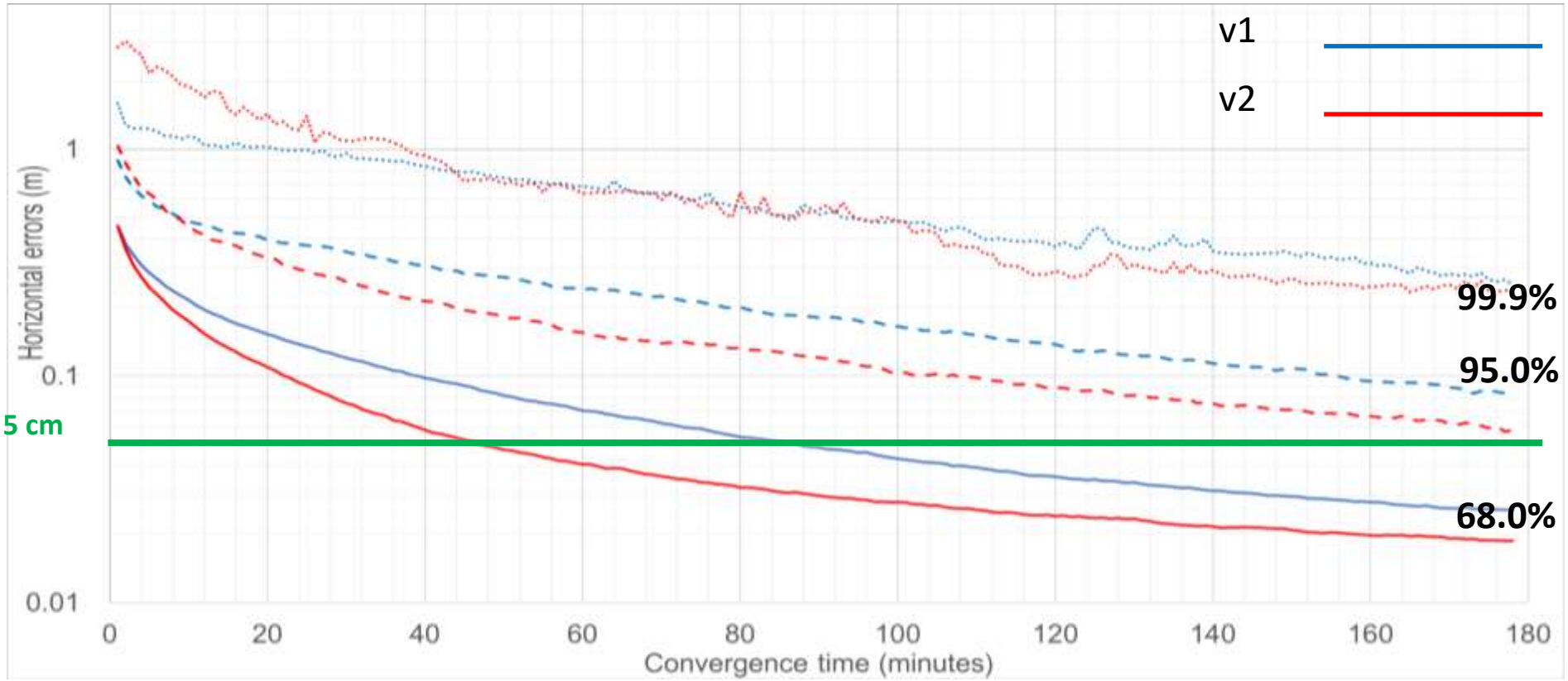


Installing Ginan

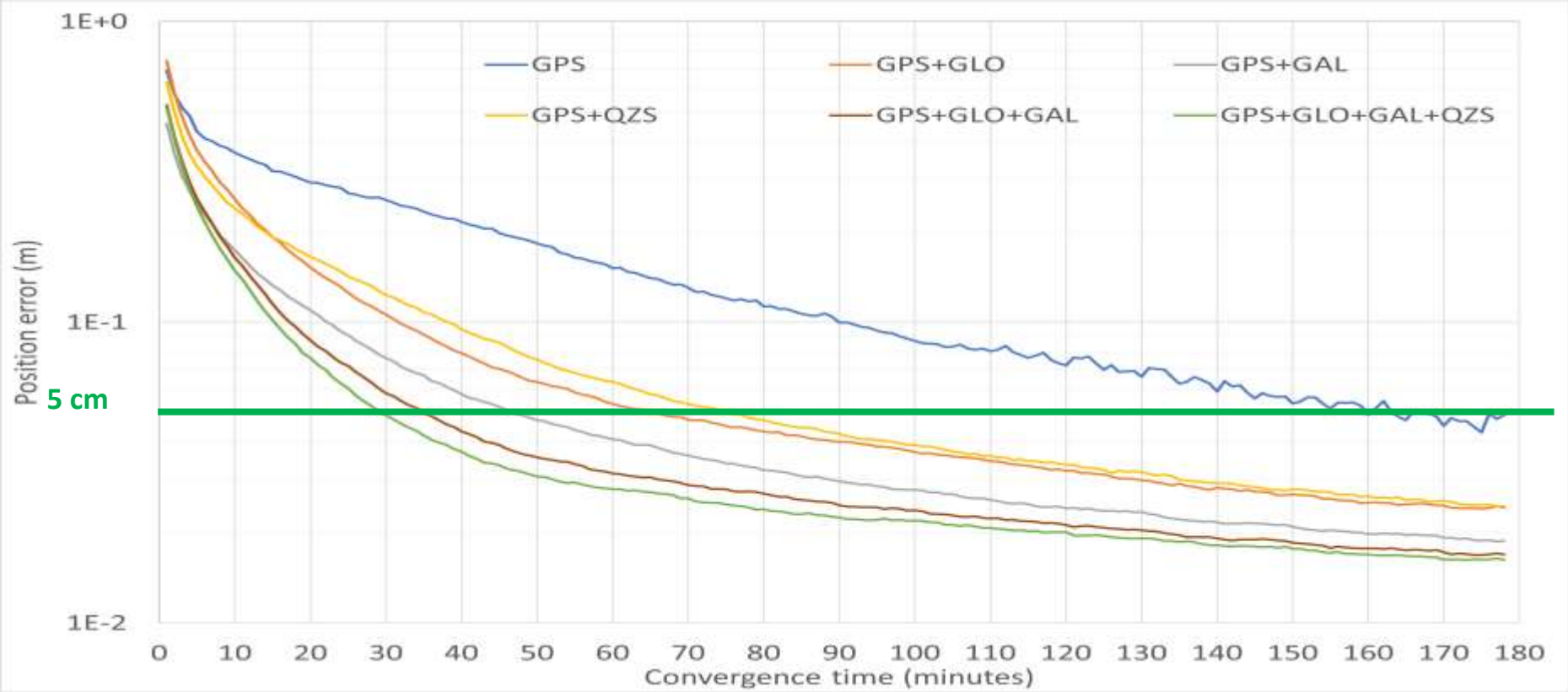


Ginan Performance Real-Time

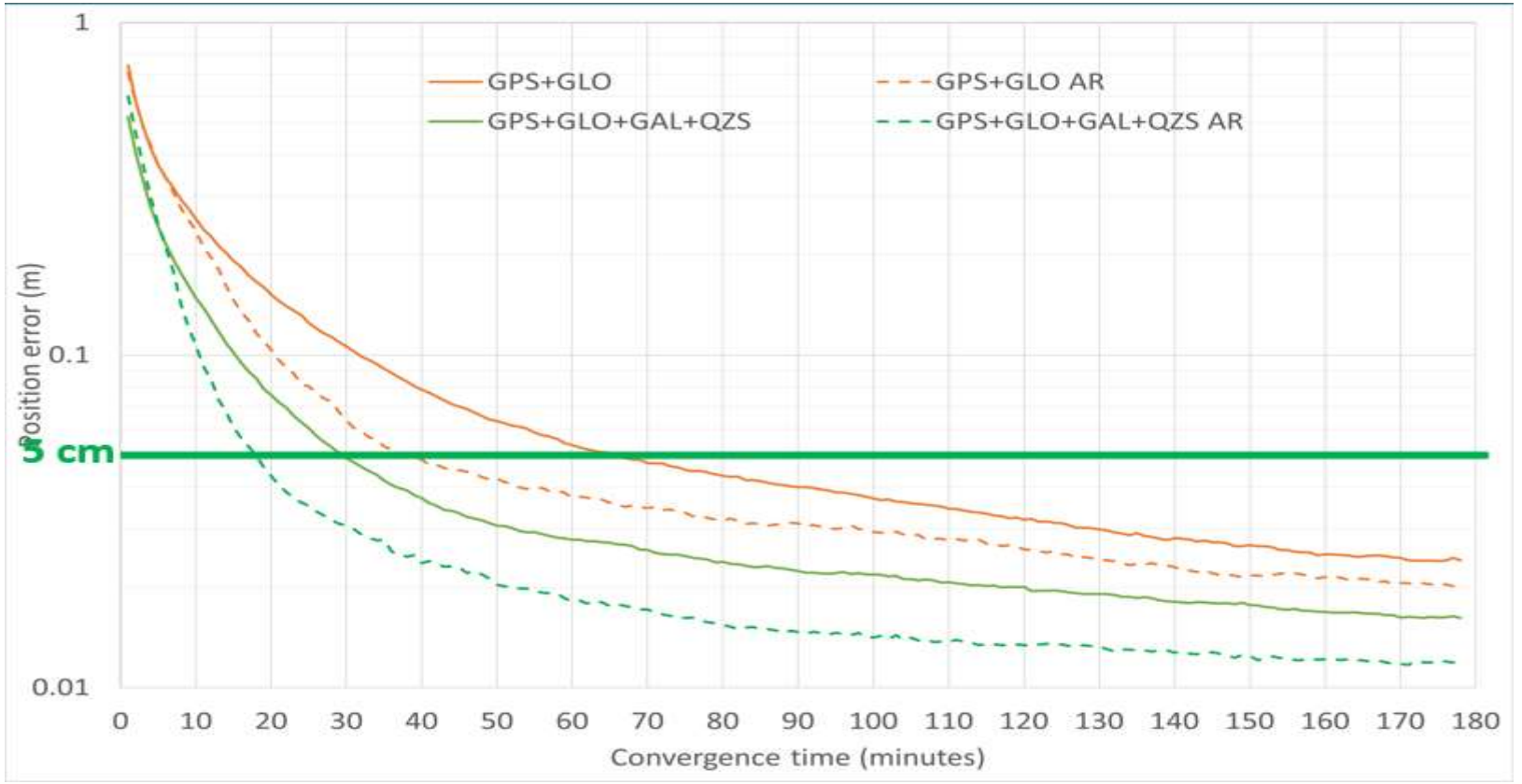
Dual frequency uncombined PPP vs IF PPP in Ginan (i.e. v1 vs v2)



Dual Frequency uncombined PPP – Multi constellation (v2)



Dual Frequency uncombined PPP (AR) – Multi constellation



Ginan Performance Post-Processing

Reference Scientific GNSS Processing Software Packages / Web Services

Bernese (Baseline)

GAMIT/GLOBK (Baseline)

GipsyX (PPP)

NRCAN CSRS (PPP)

New kid on the block

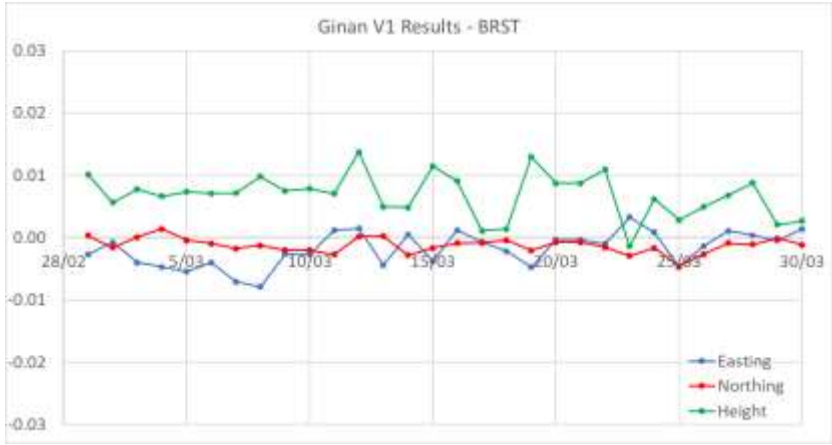
GINAN

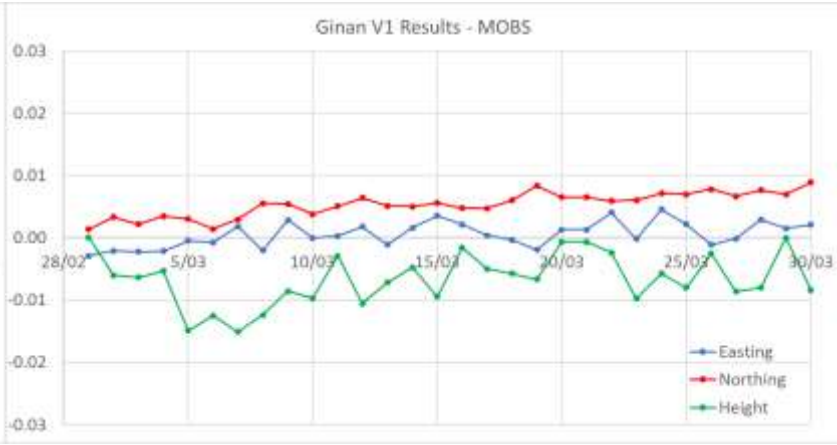
Ginan (PPP)

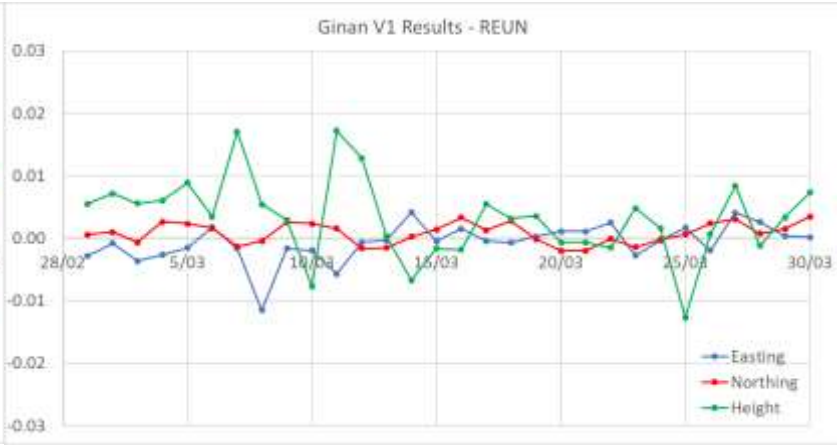
Post-processing Experiment

- Data processed from three stations - MOBS (Australia), REUN (Réunion Island) and BRST (France)
- All three stations were processed in Ginan V1, Ginan V2 and NRCAN CSRS-PPP service for reference

Ginan V1 - Dual frequency IF PPP

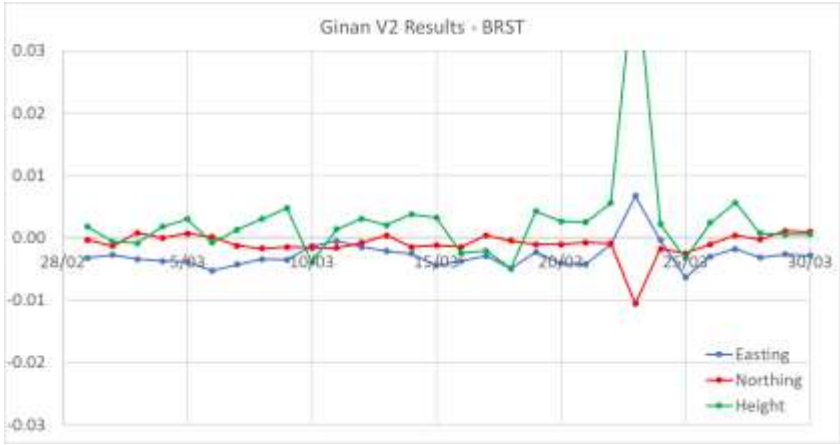


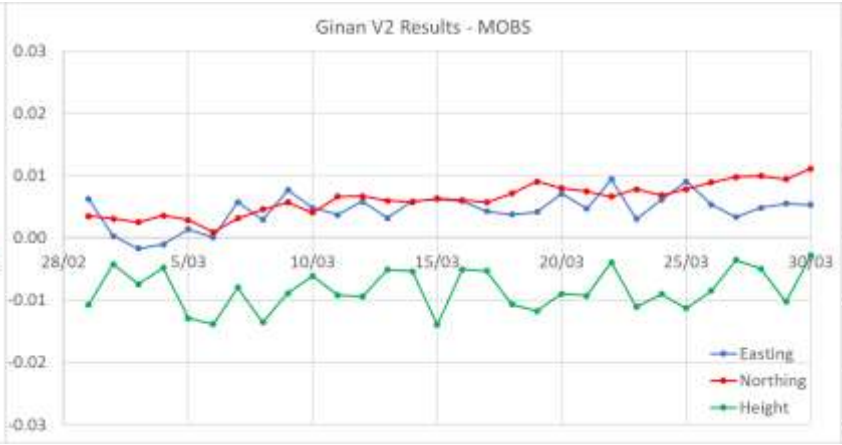


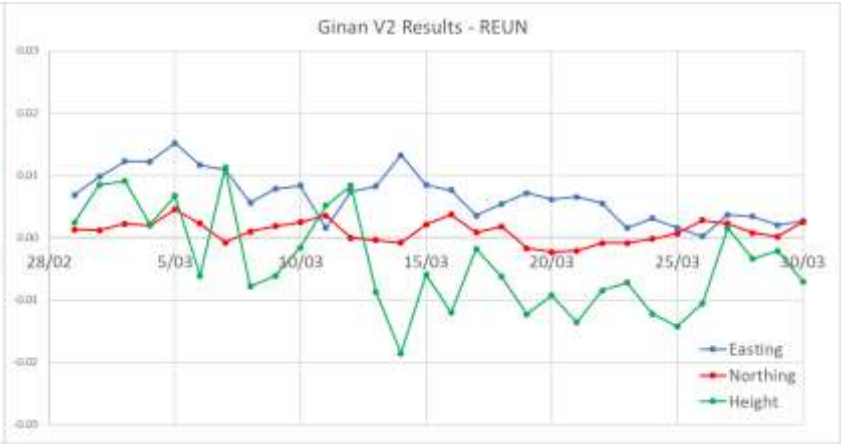


Ginan		BRST			MOBS			REUN	
V1	dE	dN	dU	dE	dN	dU	dE	dN	dU
Mean	-0.002	-0.001	0.007	0.001	0.005	-0.007	-0.001	0.001	0.003
St Dev	0.003	0.001	0.004	0.002	0.002	0.004	0.003	0.002	0.006

Ginan V2 - Dual frequency Uncombined PPP (GPS+GAL)



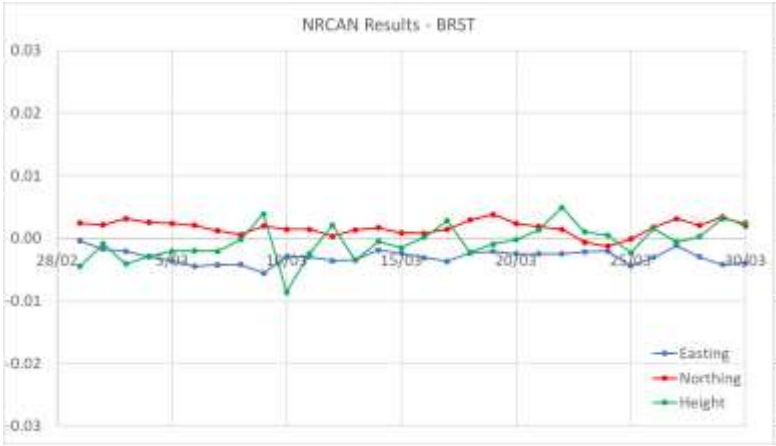


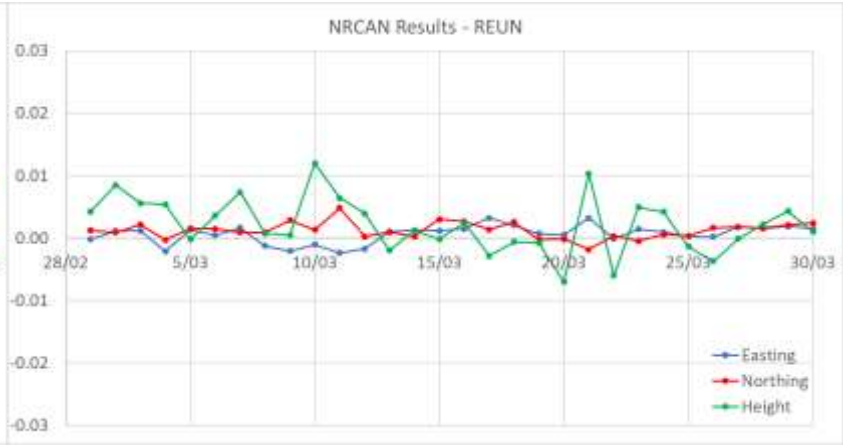


Ginan		BRST			MOBS			REUN	
V2	dE	dN	dU	dE	dN	dU	dE	dN	dU
Mean	-0.003	-0.001	0.003	0.004	0.006	-0.008	0.007	0.001	-0.004
St Dev	0.002	0.002	0.008	0.003	0.003	0.003	0.004	0.002	0.008

NRCAN CSRS-PPP Results

https://webapp.csrs-scrs.nrcan-rncan.gc.ca/geod/tools-outils/ppp.php





NRCAN		BRST			MOBS			REUN	
CSRS-PPP	dE	dN	dU	dE	dN	dU	dE	dN	dU
Mean	-0.003	0.002	-0.001	0.001	0.007	-0.005	0.001	0.001	0.002
St Dev	0.001	0.001	0.003	0.001	0.001	0.003	0.001	0.001	0.004

Summary of Results

Ginan		BRST			MOBS			REUN	
V1	dE	dN	dU	dE	dN	dU	dE	dN	dU
Mean	-0.002	-0.001	0.007	0.001	0.005	-0.007	-0.001	0.001	0.003
St Dev	0.003	0.001	0.004	0.002	0.002	0.004	0.003	0.002	0.006

Ginan		BRST			MOBS			REUN	
V2	dE	dN	dU	dE	dN	dU	dE	dN	dU
Mean	-0.003	-0.001	0.003	0.004	0.006	-0.008	0.007	0.001	-0.004
St Dev	0.002	0.002	0.008	0.003	0.003	0.003	0.004	0.002	0.008

NRCAN		BRST			MOBS			REUN	
CSRS-PPP	dE	dN	dU	dE	dN	dU	dE	dN	dU
Mean	-0.003	0.002	-0.001	0.001	0.007	-0.005	0.001	0.001	0.002
St Dev	0.001	0.001	0.003	0.001	0.001	0.003	0.001	0.001	0.004

Ginan Team

Ginan Team

From left to right:

John Barassi (GA)
Simon McClusky (GA)
Aaron Hamond (GA)
Jacob Shearer (FrontierSI)
Umma Zannat (GA)
Ken Harima (FrontierSI)
Ron Maj (FrontierSI)
Salim Masoumi (GA)
Vincent Rooke (GA)
Rupert Brown (FrontierSI) absent

Conclusion

- Ginan is an open-source PPP software toolkit and an analysis centre software being currently developed by Geoscience Australia
- Ginan can be used both in real-time and post-processing mode
- Version 2 of the software has been released in May 2023 and is available to download and use from GitHub
- Version 3 is currently being scheduled for December 2023

https://github.com/GeoscienceAustralia/ginan

Practical Demonstration

Save the date!

- IGNSS – Australia's premier GNSS conference will be held between 30 Jan – 1 Feb 2024 in Sydney
- Details and call for abstracts will be available shortly at www.ignss.org.au

Questions?

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