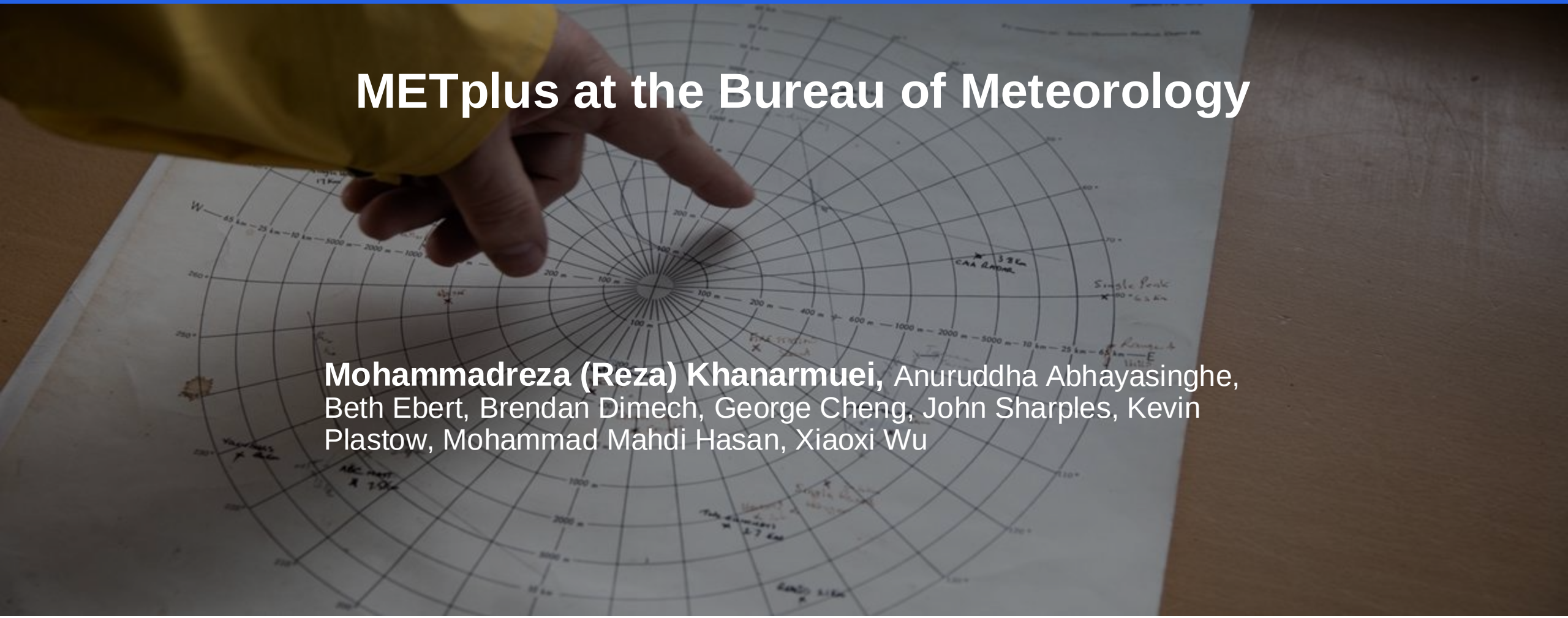
The Bureau of Meteorology

METplus at the Bureau of Meteorology

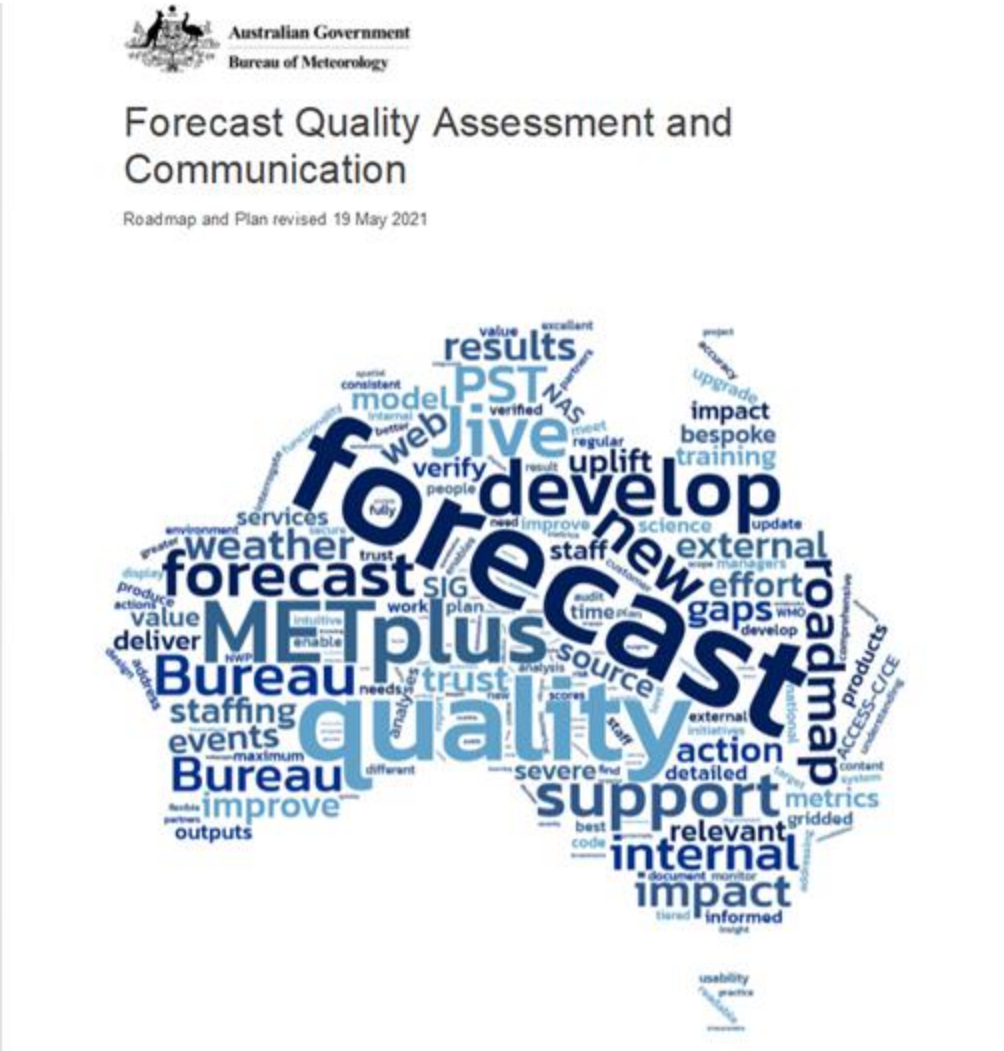


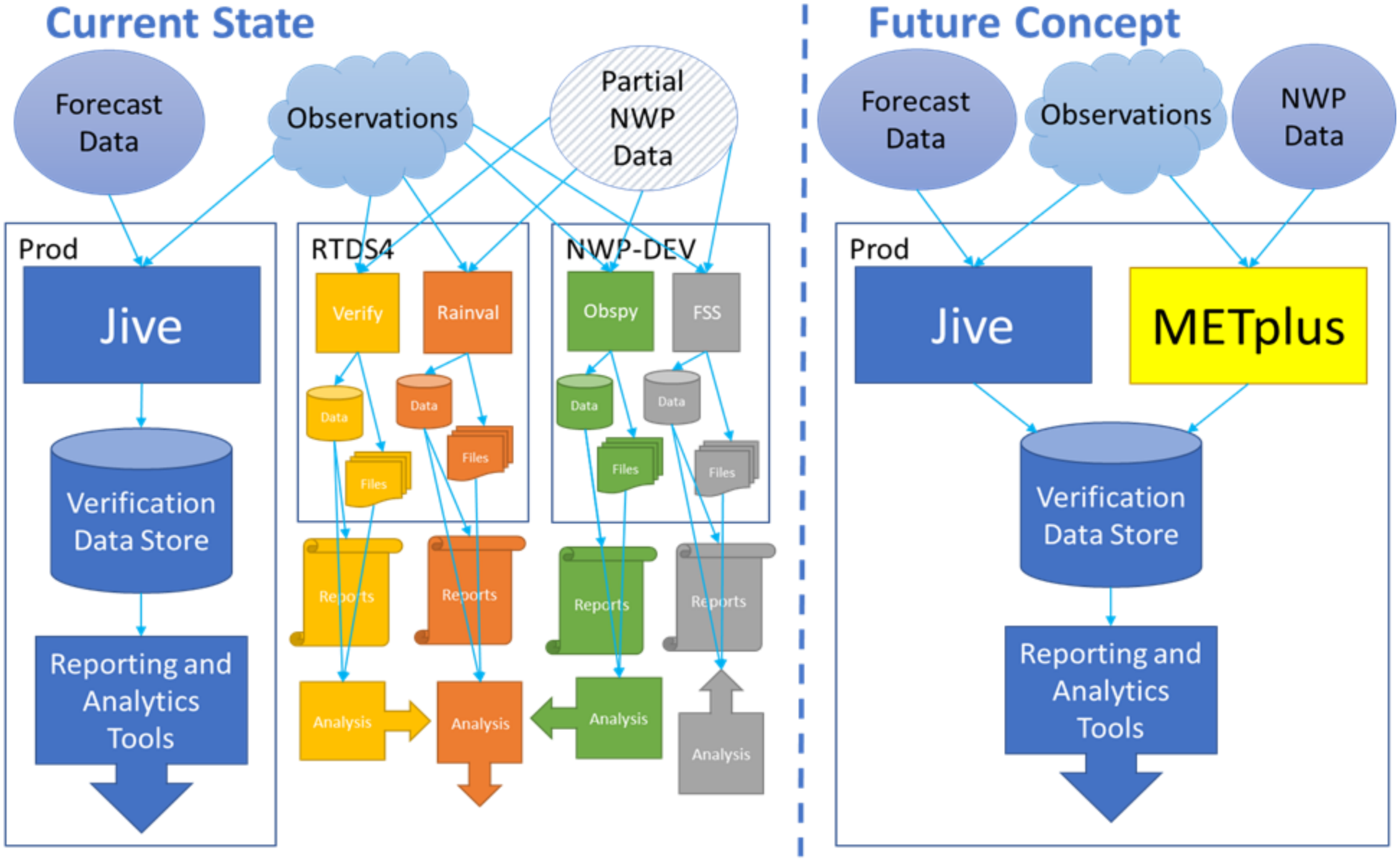
Mohammadreza (Reza) Khanarmuei, Anuruddha Abhayasinghe, Beth Ebert, Brendan Dimech, George Cheng, John Sharples, Kevin Plastow, Mohammad Mahdi Hasan, Xiaoxi Wu

The Forecast Quality Project

- In 2021 the Bureau released the Forecast Quality Roadmap
  - METplus was a cornerstone of this benefits described in this document

- Following this, The Forecast Quality PST project (P20) adopted the operationlisation of METplus
  - Initially the focus for METplus will be NWP data - replacing existing verification tools, and uplifting capacity

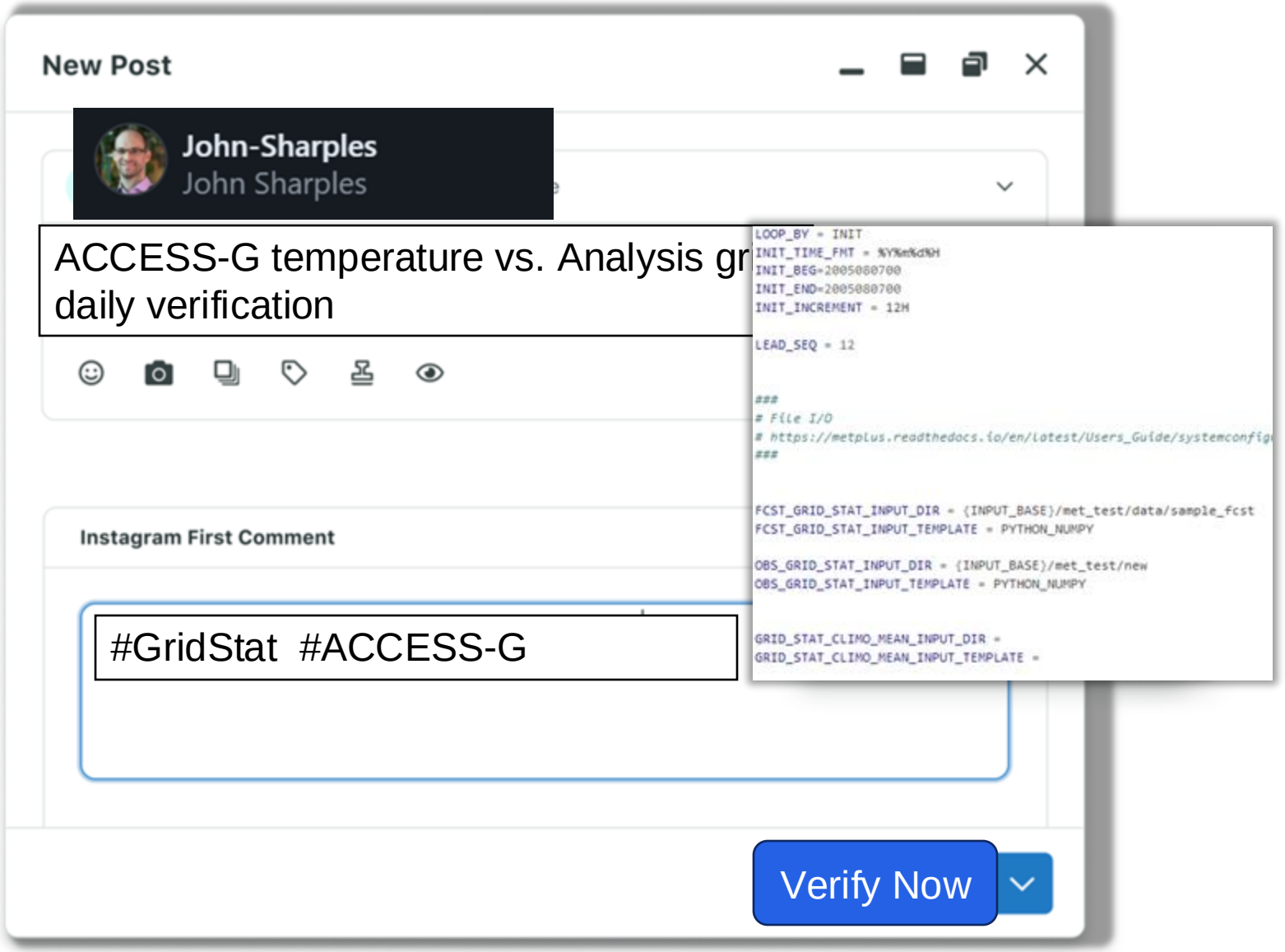



Current State
Forecast Data
Observations
Partial NWP Data
Prod
Jive
Verification Data Store
Reporting and Analytics Tools
RTDS4
Verify
Rainval
Data
Data
Files
Files
Reports
Reports
Analysis
Analysis
NWP-DEV
Obspy
FSS
Data
Data
Files
Files
Reports
Reports
Analysis
Analysis
Future Concept
Forecast Data
Observations
NWP Data
Prod
Jive
METplus
Verification Data Store
Reporting and Analytics Tools

Verification workflow

- *Instagram for Verification*

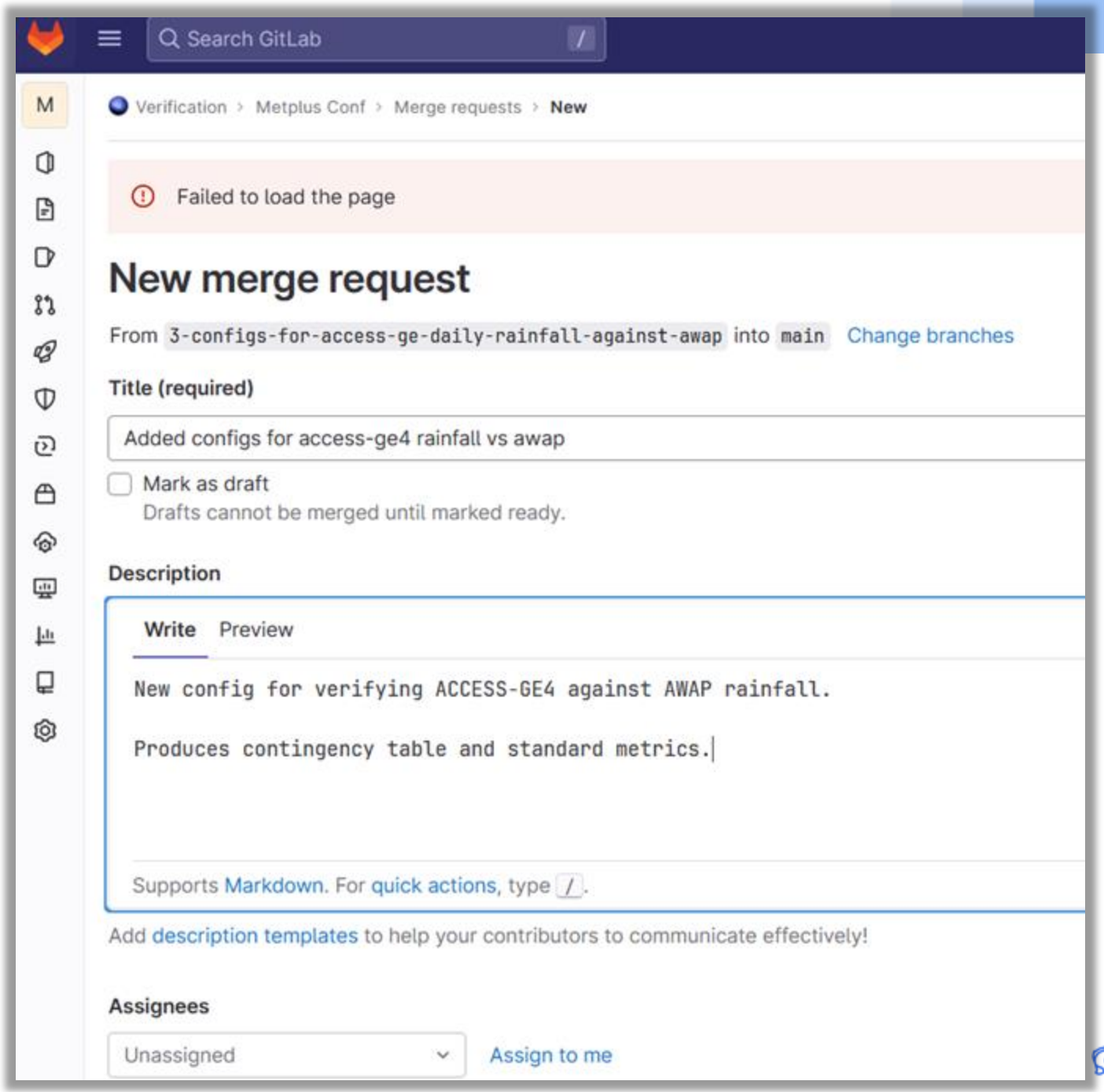
- Developers create the *application*, scientists create the *content*



Verification workflow

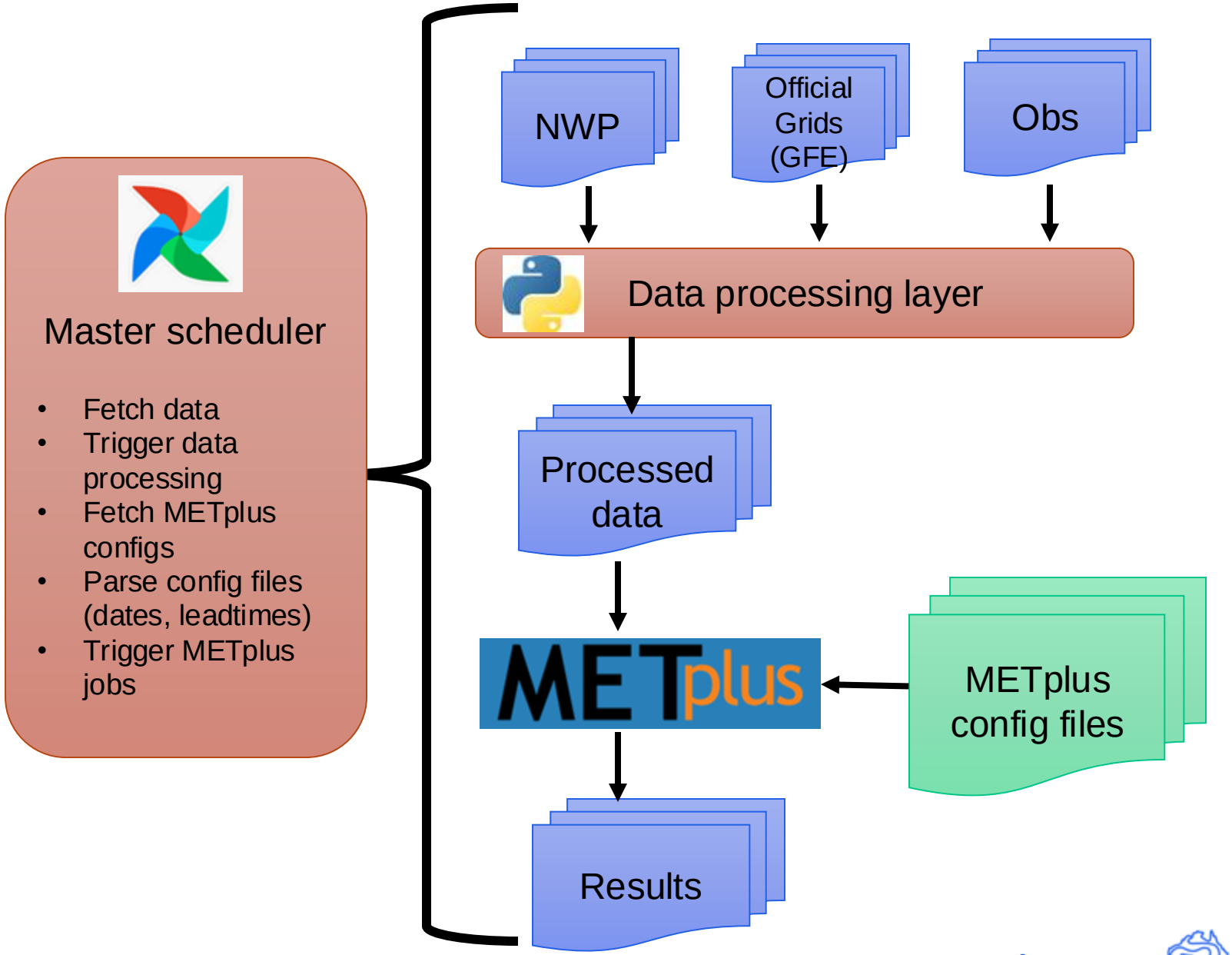
- *Instagram for Verification*

- Developers create the *application*, scientists create the *content*
- Interface and "posting" process will be GitLab
- CI pipelines used to validate and deploy configs



System design

- Not running in a HPC.
- Uses Airflow as a master scheduler
- Significant effort has been spent on Python tools to preprocess data.
- Version control and application deployment controlled via GitLab and internal conda mirrors
- All code is built and deployed as conda packages – *including MET and METplus*



METplus Stage 1

- **Scope**
- Routine gridded verification (over 80 verification cases)
  - Replace existing NWP verification for most variables
  - New spatial verification capability for rainfall
  - GFE gridded (IMPROVER and Official forecasts) verification

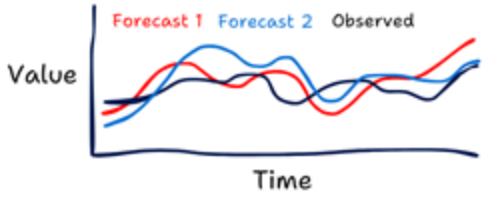
Products:

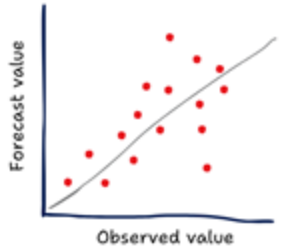
- Verification maps, time series, diagnostics, statistics updated every 12 hrs (global) or 6 hrs (regional)

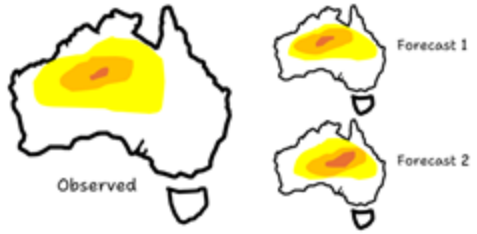
Variable	Forecasts	Observations
Daily rainfall	ACCESS-G/GE, ACCESS-C/CE, IMPROVER, overseas models	AWAP/AGCD, GPM-IMERG, AWS
Probability of precipitation	ACCESS-GE, ACCESS-CE, IMPROVER	AWAP/AGCD, AWS
Surface variables	ACCESS-G/GE, ACCESS-C/CE, IMPROVER	AWS
Upper levels	ACCESS-G/GE, overseas models	Own analysis, radiosondes
Sub-daily rainfall	ACCESS-C/CE, IMPROVER	AWS, Rainfields
Sub-daily PoP	ACCESS-C/CE, IMPROVER	AWS
(stretch goal)		

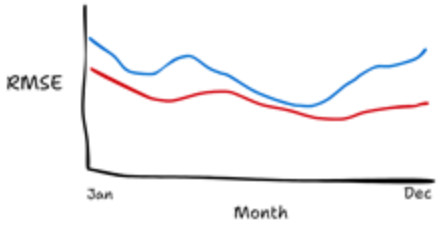
Proposed list of routine METplus verification plots

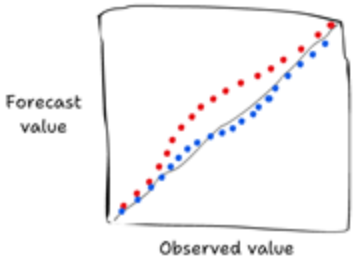
Highest priority plots
Time series of forecasts & observations
Maps of forecast and observations
Scatter plot
Probability integral transform/Q-Q plot
MODE object verification chart
Score vs threshold
Time series of score
Score vs lead time
Gridded map of scores
Gridded map of score difference
Ensemble spread-skill
Reliability diagram
Additions from 24 July workshop
Score vs diurnal cycle
Score vs height (radiosonde)
Rain rate distribution

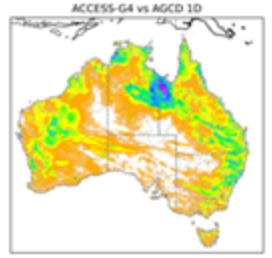


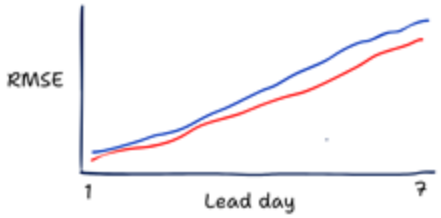


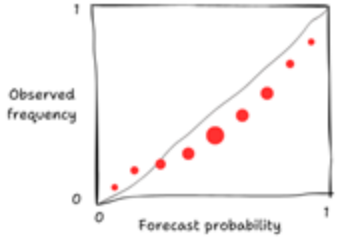


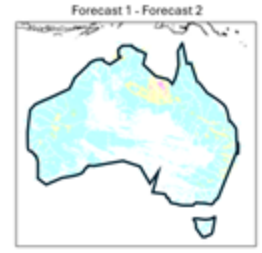


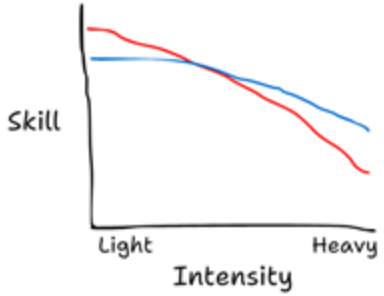


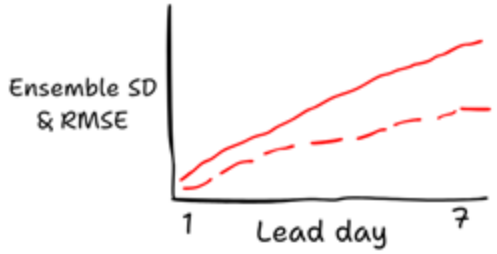


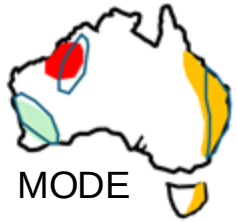












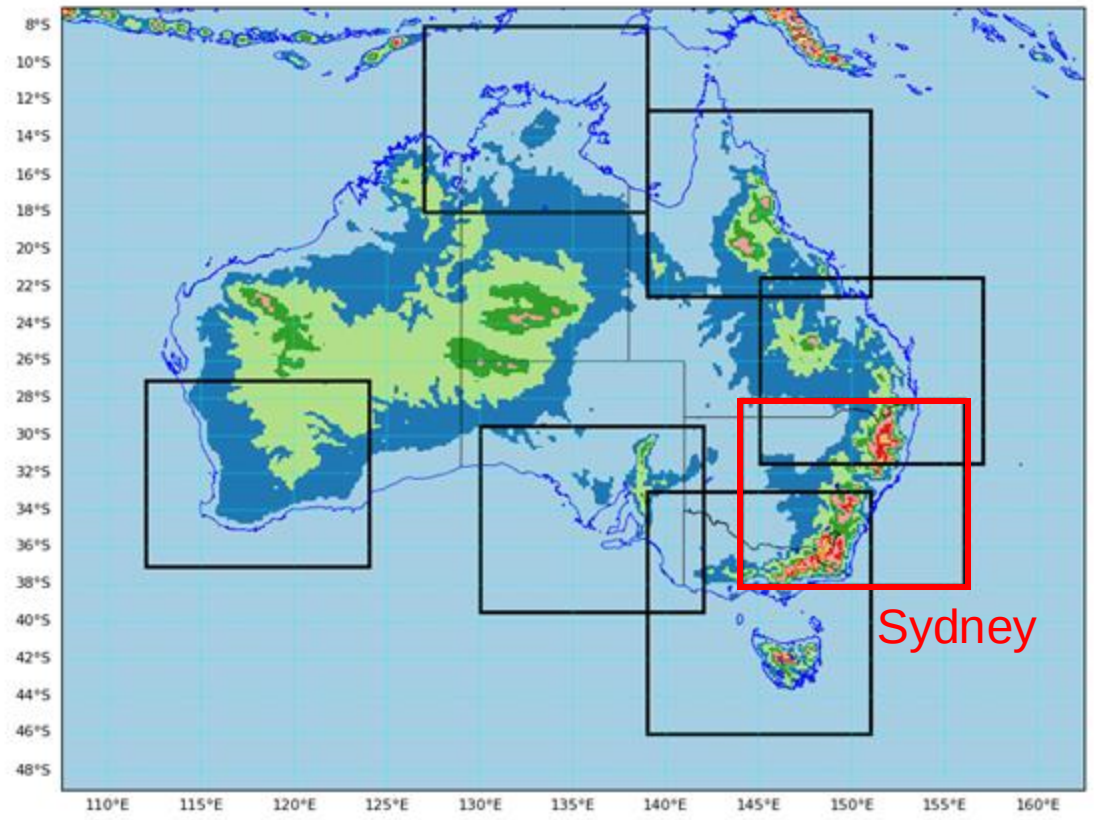
Use Case: ACCESS-C4/CE4 Rainfall

Forecast: 24-h accumulated precipitation (00Z)

Observations: Auto Weather Station (AWS) and Australia Water Availability Project (AWAP)

Domain: Sydney

Verification period: Feb-March 2023

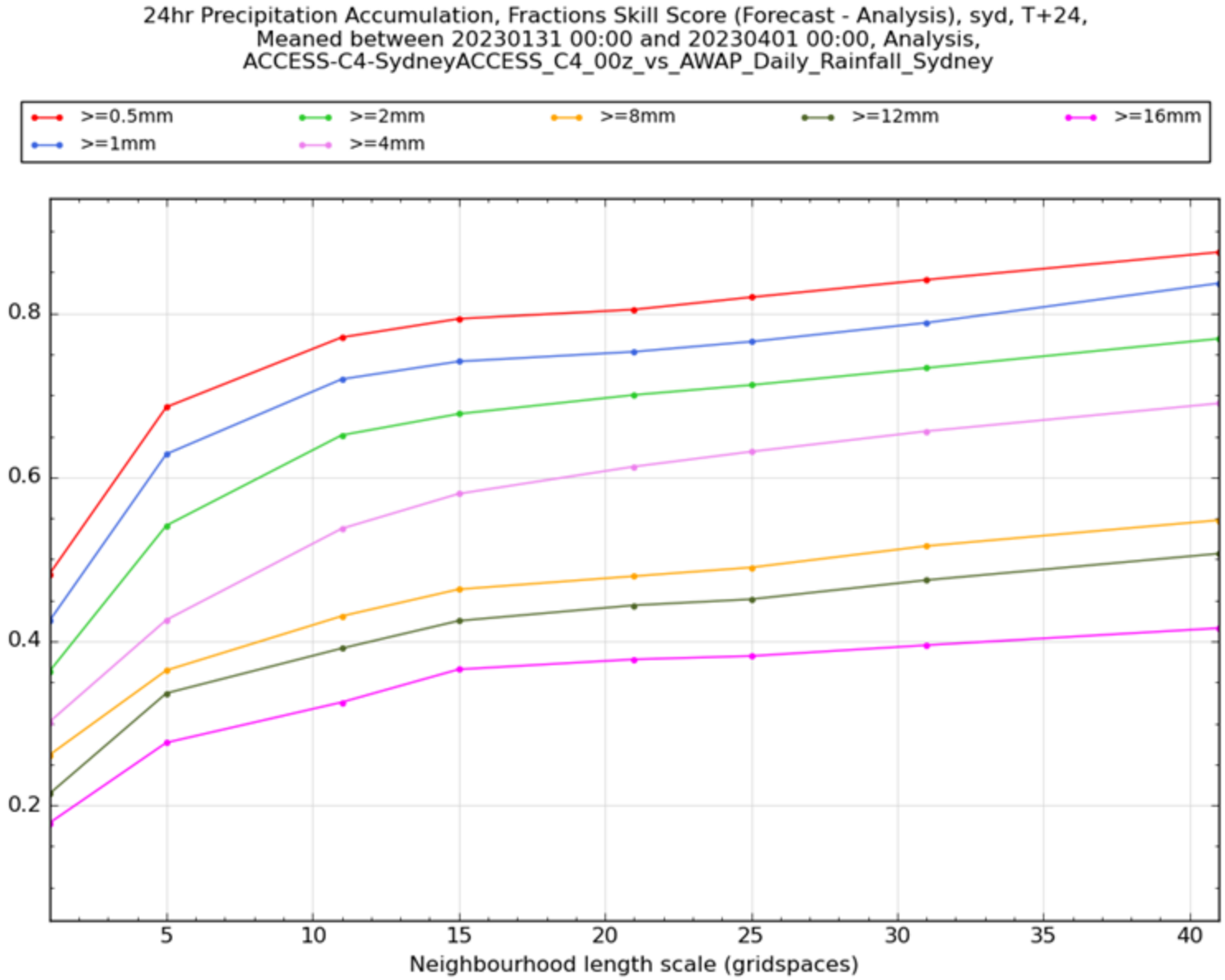


Use Case: ACCESS-C4/CE4 Rainfall

Fractions Skill Score (FSS)

Expected behaviour – Increase in FSS values by increase in window size, and decrease in FSS by increase in event threshold

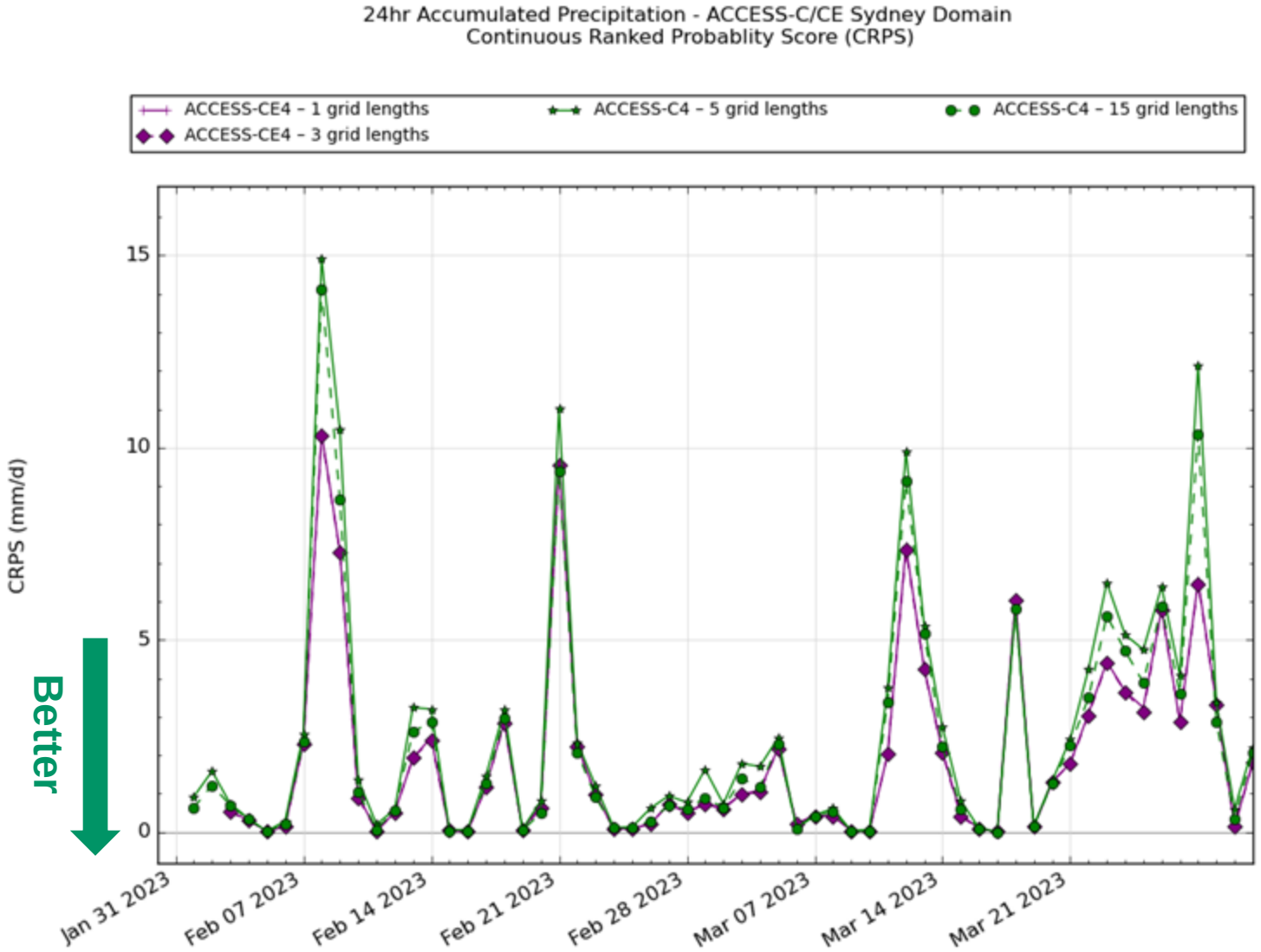
Note: We are currently addressing some issues in calculating FSS for ensemble forecasts.



Read more about FSS for ensemble forecast in Necker et al., 2024

Use Case: ACCESS-C4/CE4 Rainfall

Model	Neighbourhood size	Number of pseudoensemble
ACCESS-C	5	5×5×1 = 25
ACCESS-CE	1	1×1×23 = 23
ACCESS-C	15	15×15×1 = 225
ACCESS-CE	3	3×3×23 = 207



Read more about HiRA in Mittermaier an Csima (2017)

Tools/Data tested so far

Tools

Verification:
- GridStat,
- PointStat,
- EnsembleStat
- SeriesAnalysis
- MODE
- GenEnsProd

Analysis/Processing:
- ASCII2NC
- StatAnalysis
- PCPCombine

Visualisation:
- VerPy
- metplus_bom

Data

Parameters:
- Temperature
- Mean sea level pressure
- Wind
- Rainfall

Model/Forecasts:
- ACCESS-G/GE/C/CE (APS3 and 4)
- GFE IMPROVER

Observations:
- AWS
- Radiosonde
- AWAP/AGCD
- GPM
- Model analysis

What’s next?

Path to production: Making routine verification on EDC to support operations

Adding more routine verification jobs (including Official Forecasts)

Training for Bureau staff how to use METplus and metplus_bom and our Gitlab repo to test verification jobs

Collaborate with scientists to add more verification cases

Exploring visualisation options including VerPy and Jive

ACCESS-A/AE verification using METplus

The Bureau of Meteorology

Thank you

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