Maximising impact and value from marine observations

- modelling tools for network design

*Boris Kelly-Gerreyn, **Chris Tingwell**,*
Sergei Soldatenko, Peter Steinle,
Robert De Maid and Agnes Lane
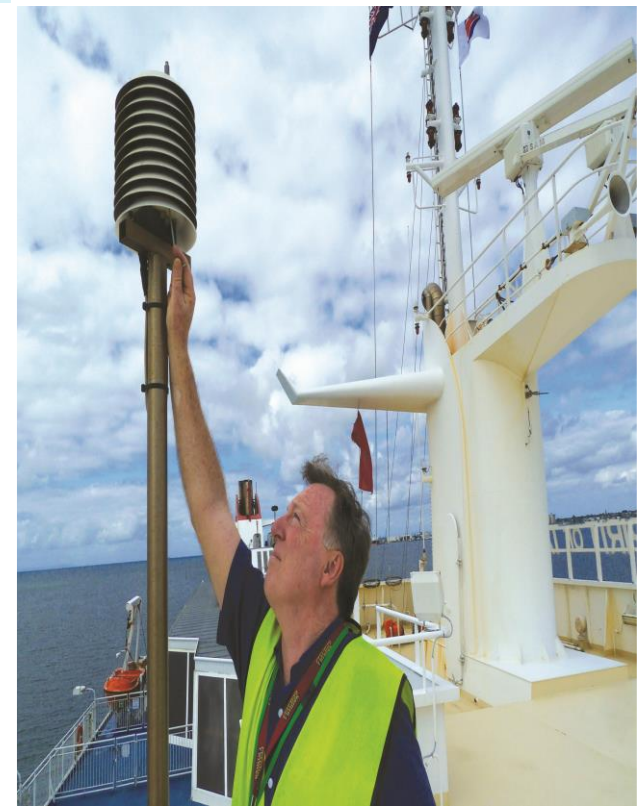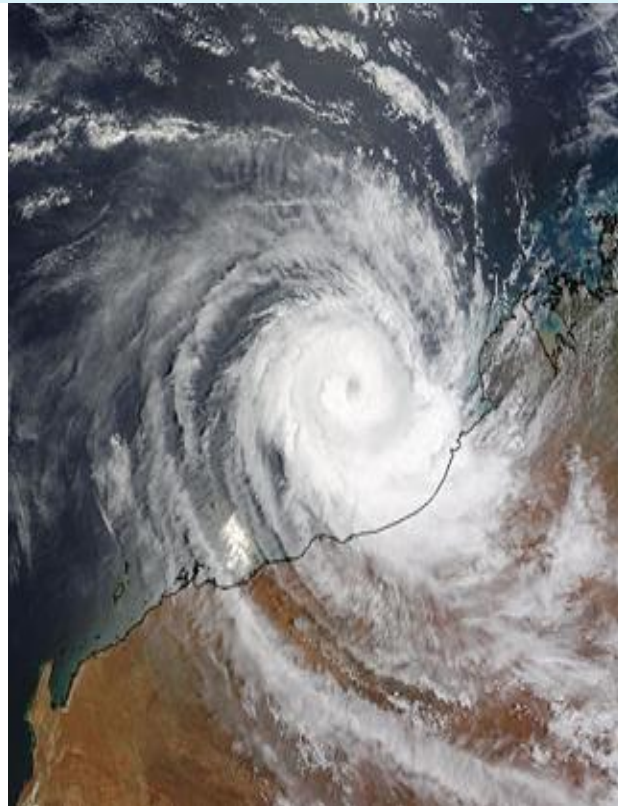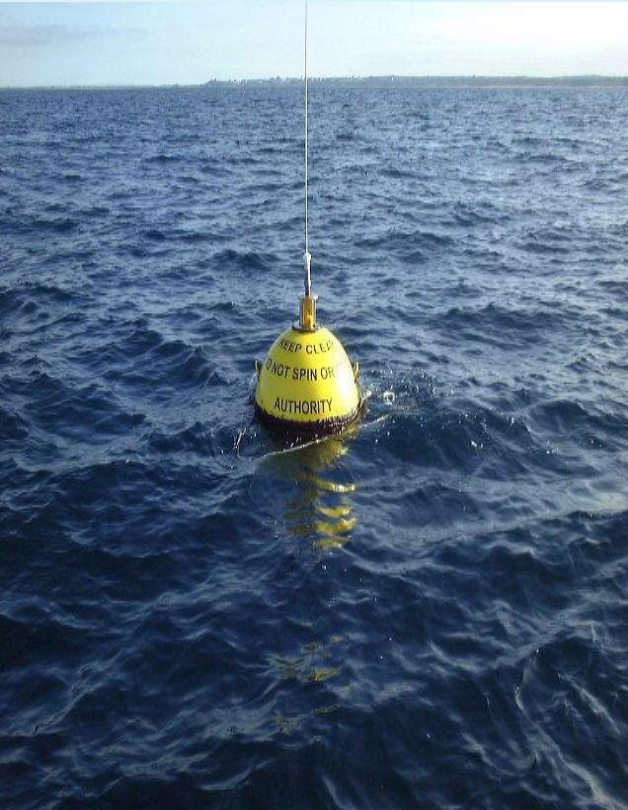
Bureau's National Observing Network - Land, Ocean & Atmosphere

- **Point Data**
- Automatic Weather Stations
- Rainfall Observations
- Upper Air Balloon Flights
- Sea level stations & buoys
- Total ozone

- **Medium-area Coverage (Hundreds of km)**
- Radar
- Lightning Detectors
- Aviation measurements

- **Wide-area Coverage (Thousands of km)**
- Polar-Orbiting Satellites
- Geostationary Satellites

Ocean observation: Many players

Marine Industries

Govt. Agencies

R&D providers

Service providers

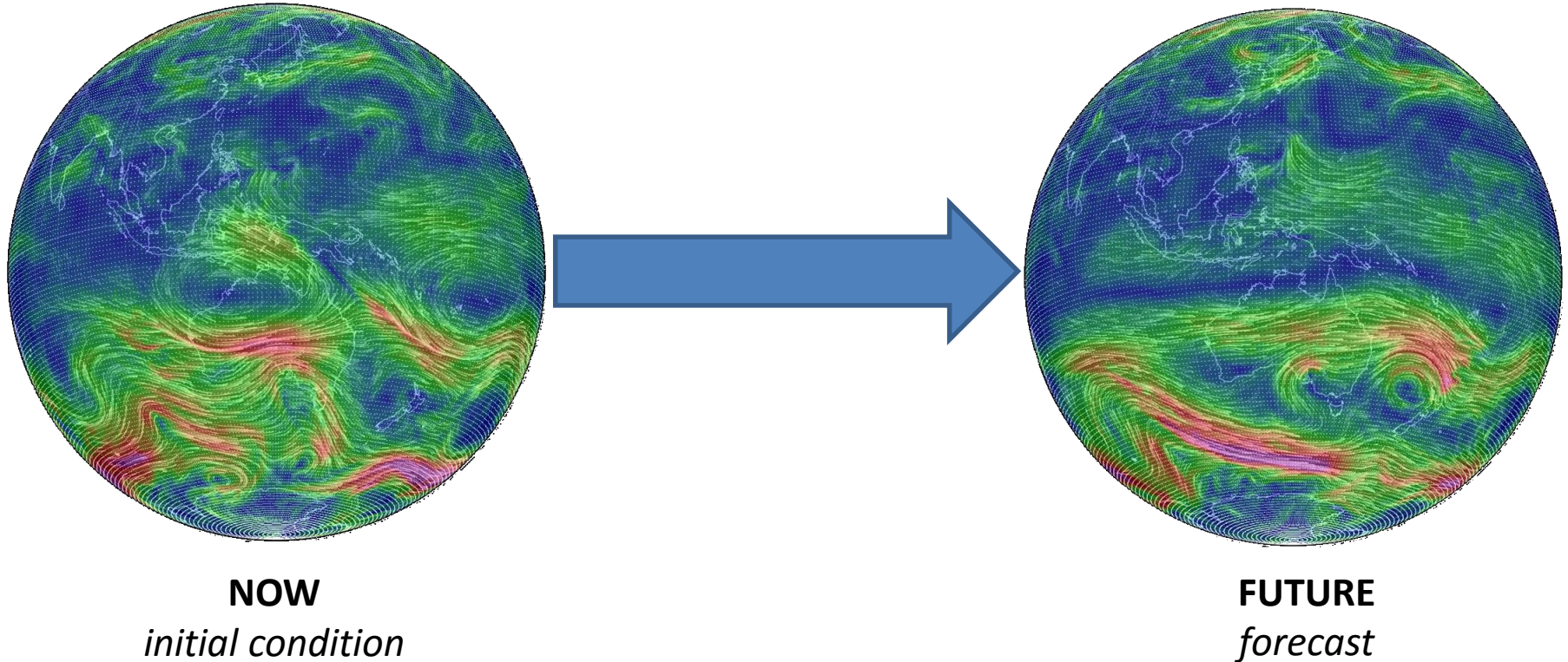But how do we know the
value & impact of these observations ?

We can use models
- Ocean forecasting
- Numerical Weather Prediction

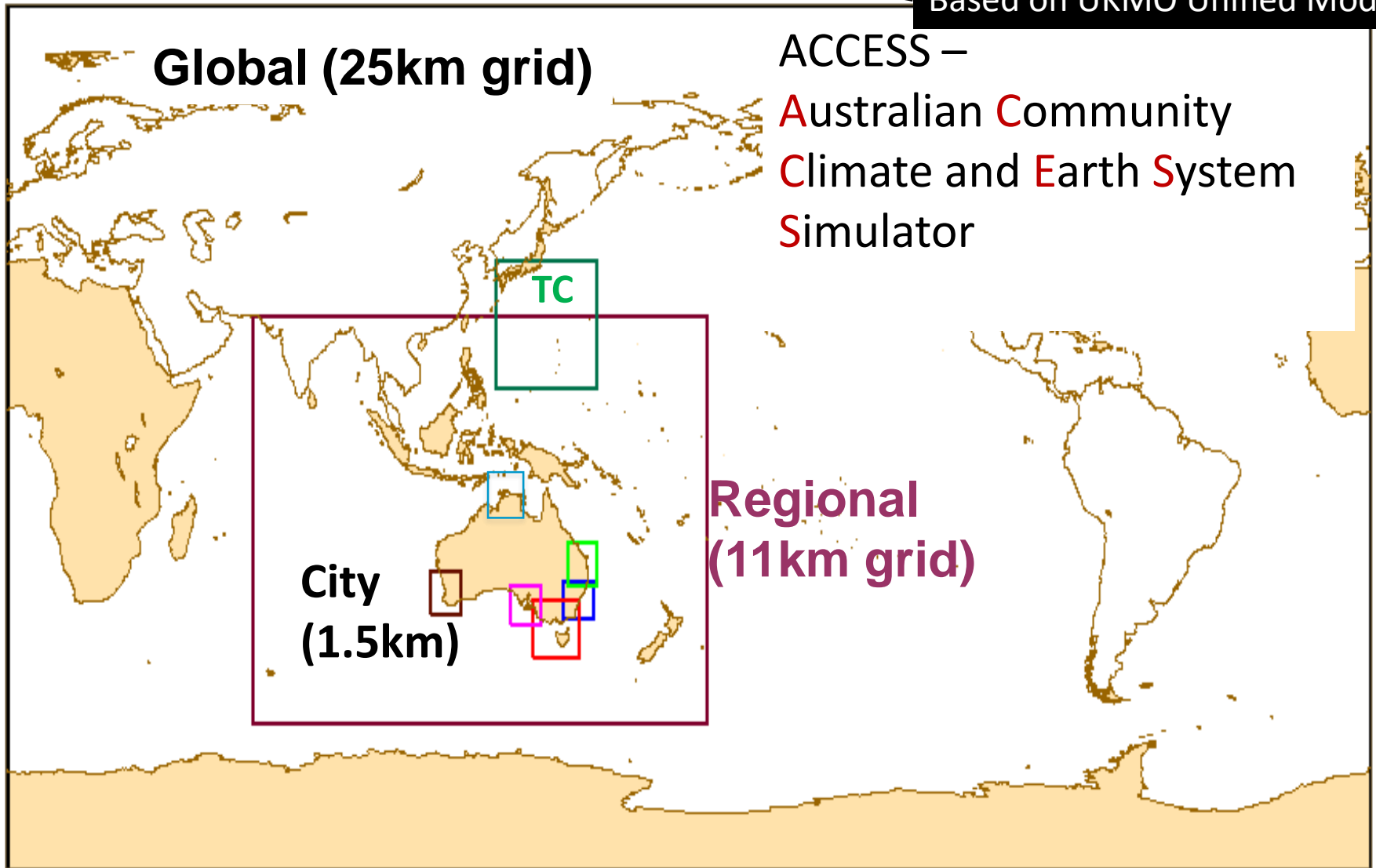Data assimilation

How observations impact on forecast skill

Numerical Weather Prediction (NWP)
is an initial value problem

NOW
initial condition
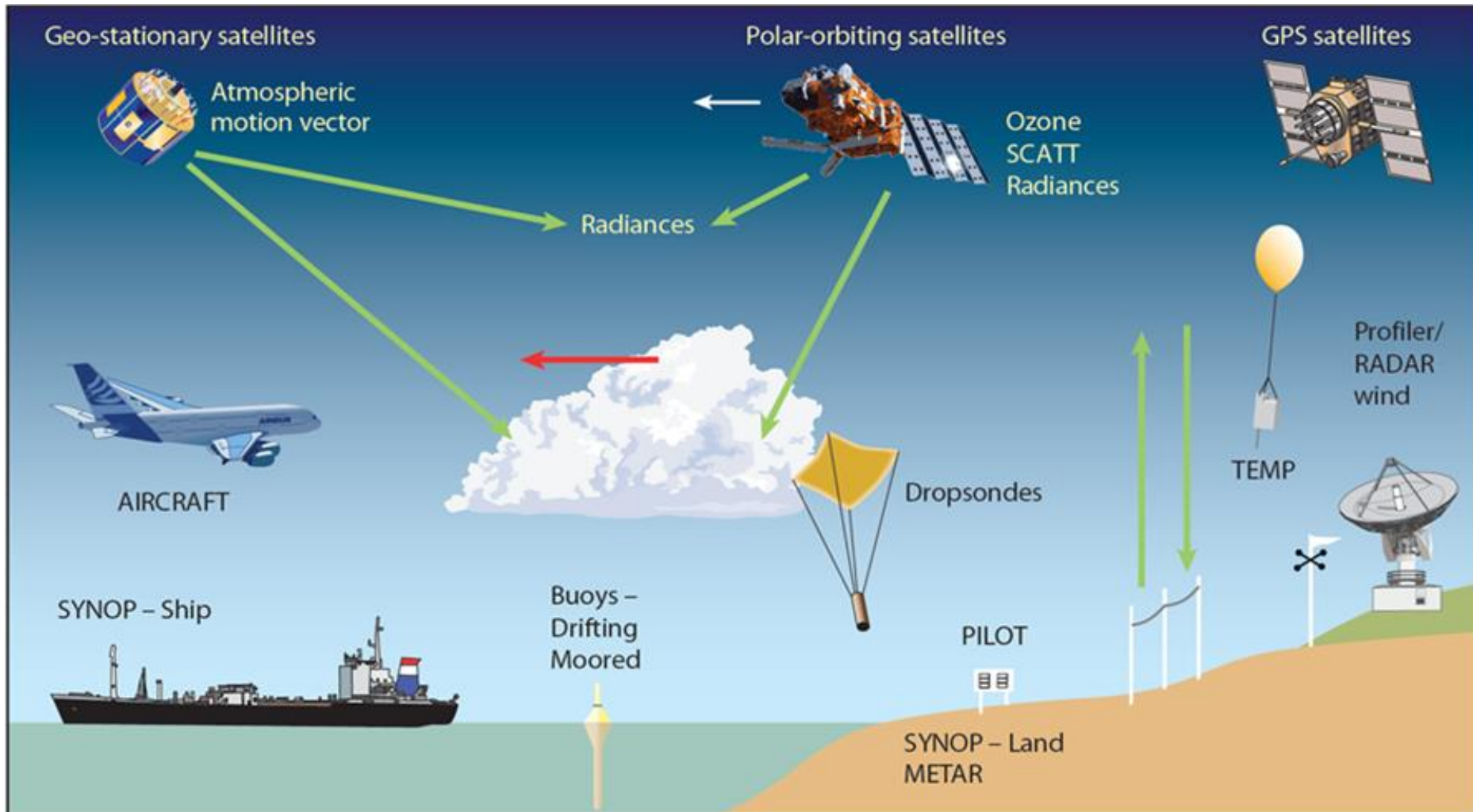
FUTURE
forecast

The role of **data assimilation** in NWP is to
<u>specify the initial condition as accurately as possible</u>.

Bureau's NWP = ACCESS NWP Suites
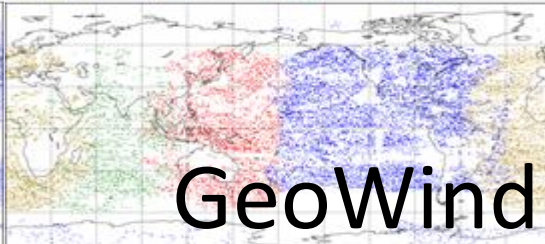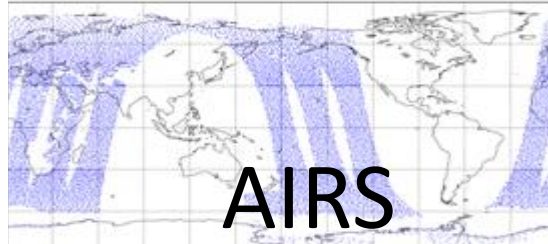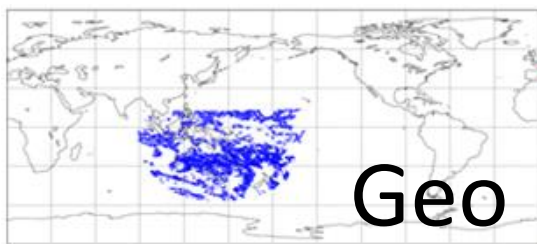

Based on UKMO Unified Model

Global (25km grid)

ACCESS –
Australian **C**ommunity
Climate and **E**arth **S**ystem
Simulator

TC

**Regional
(11km grid)**

**City
(1.5km)**

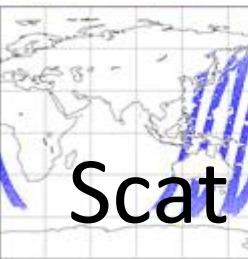# The Assimilation Data Sources

The Assimilation Data Sources

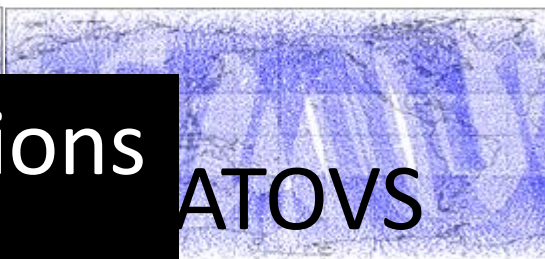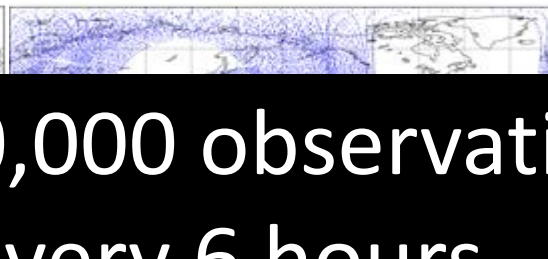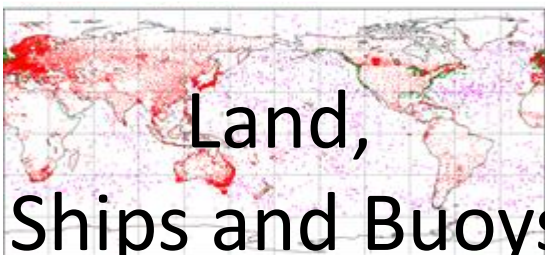Satellites

Geo

AIRS

GeoWind

Scat

~4,000,000 observations every 6 hours

ATOVS

CRiS

GPSRO

IASI

Aircraft

Sondes

Land, Ships and Buoys
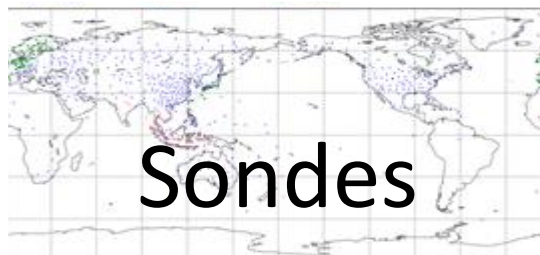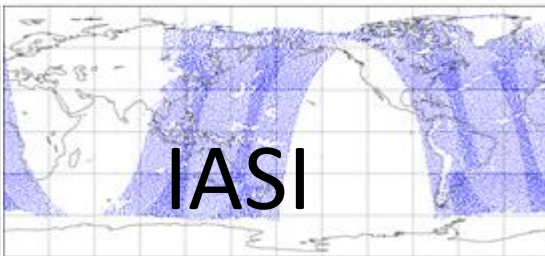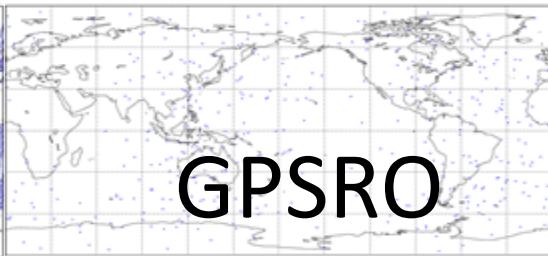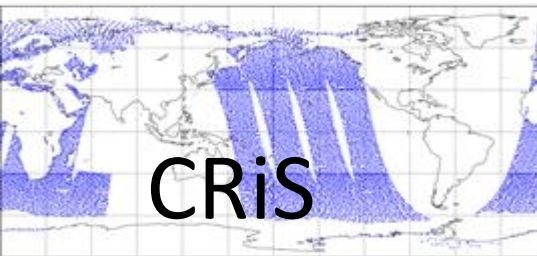
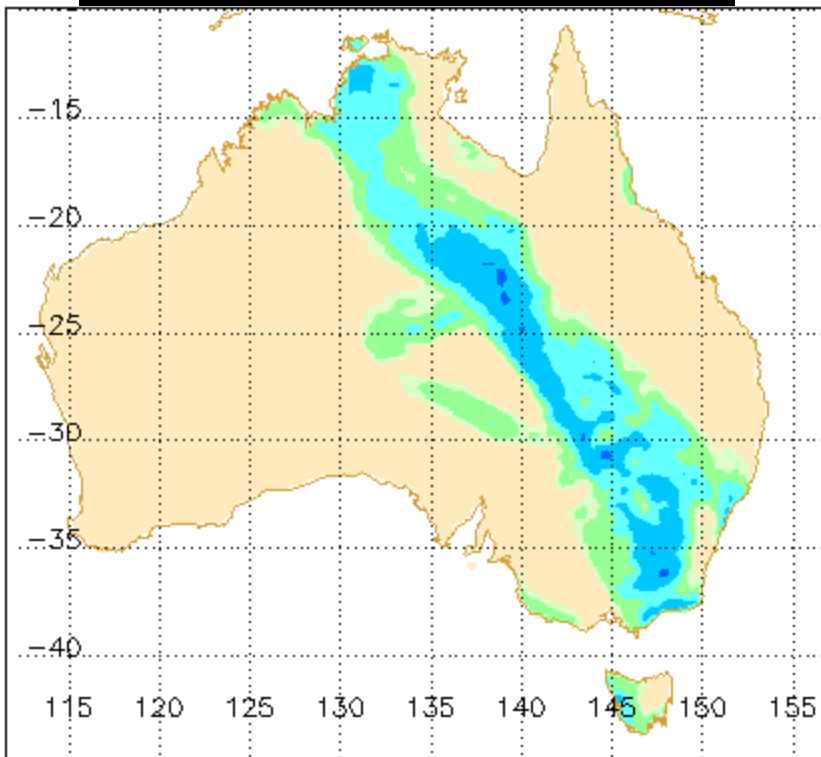Temperature, humidity, pressure and wind are the key observations

How to assess impact of observations

- **Observing System Experiments (OSE)**

- **Observing System Simulation Experiments (OSSE)**

  = Data denial experiments

OSE Forecast rainfall – *NO* satellite data
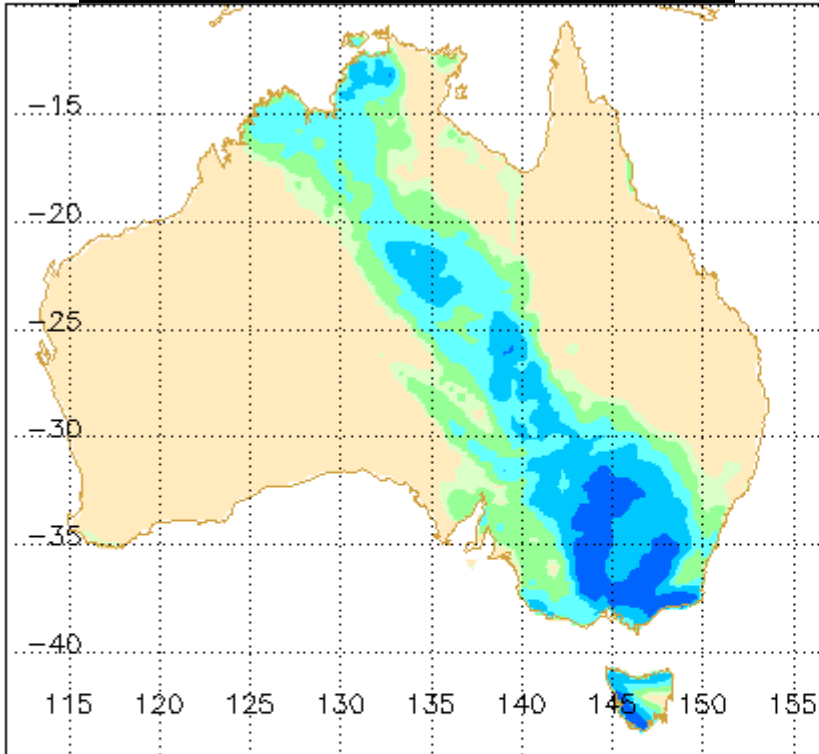
ACCESS NWP

RAINFALL OBS

Gaps in obs. data
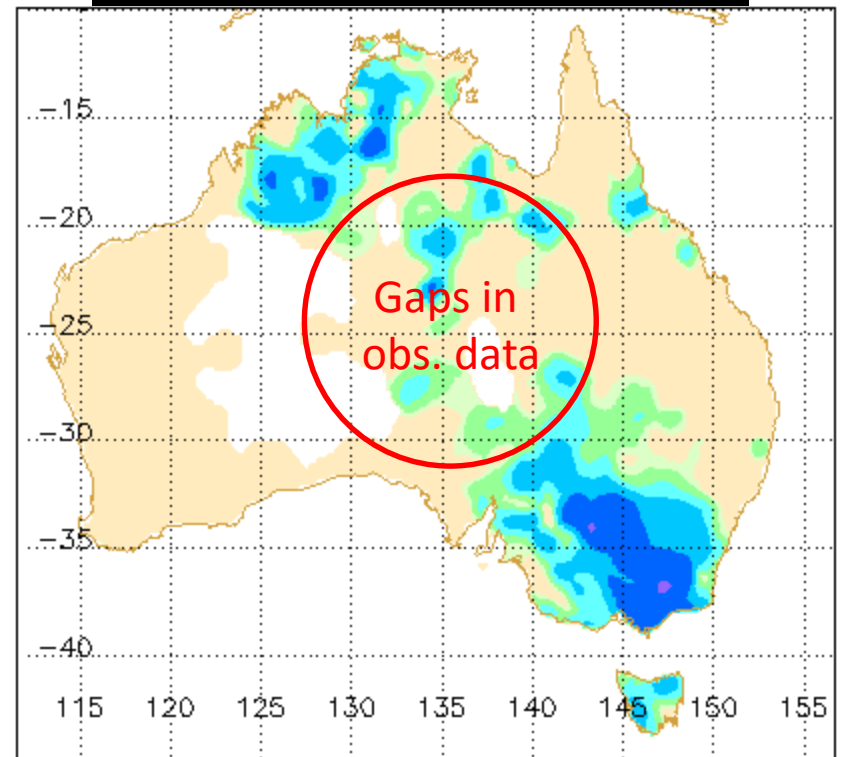
OSE : Forecast rainfall *WITH* satellite data
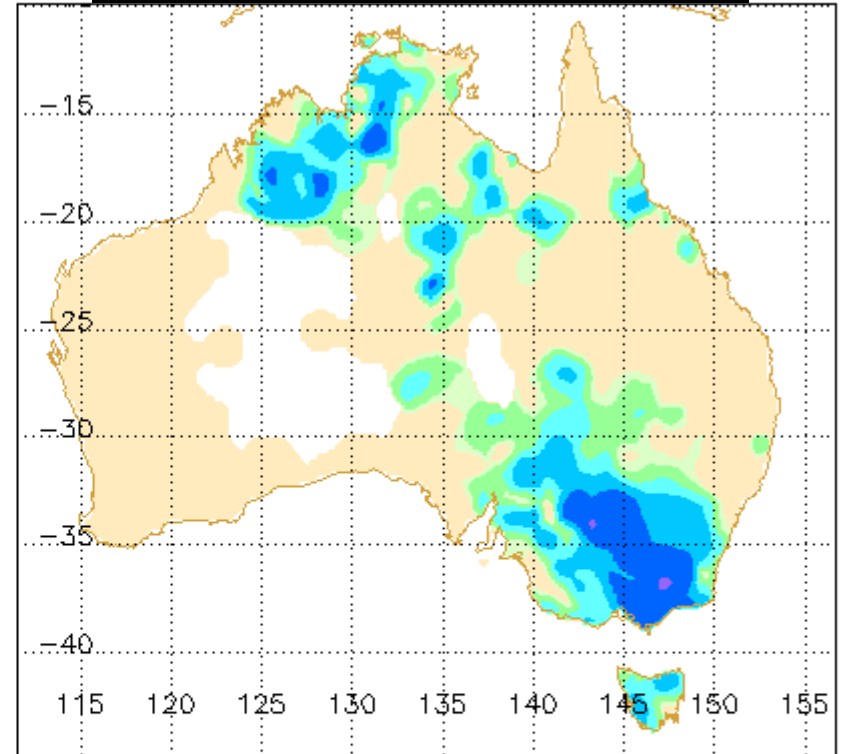

ACCESS NWP

RAINFALL OBS

OSE is a powerful technique

OSE is highly expensive on CPU

Not routinely or often performed

# Assessing the impact of observations

- **Forecast Sensitivity to Observations (FSO)**

  - o **Developed by UK Met Office**

  - o **Adjoint method**

  - o **4D Var assimilation**

Key metric – reduction in 24hr forecast error due to observations

Forecast Sensitivity to Observations

Advantage over OSE	• **Runs in real-time** • **Computationally cheap**
Assesses impact of	• Observation types • Instruments • Networks and subnetworks • Groups of stations etc
Caution	• Not data denial • Impact of an observation amongst all of the observations

FSO Application
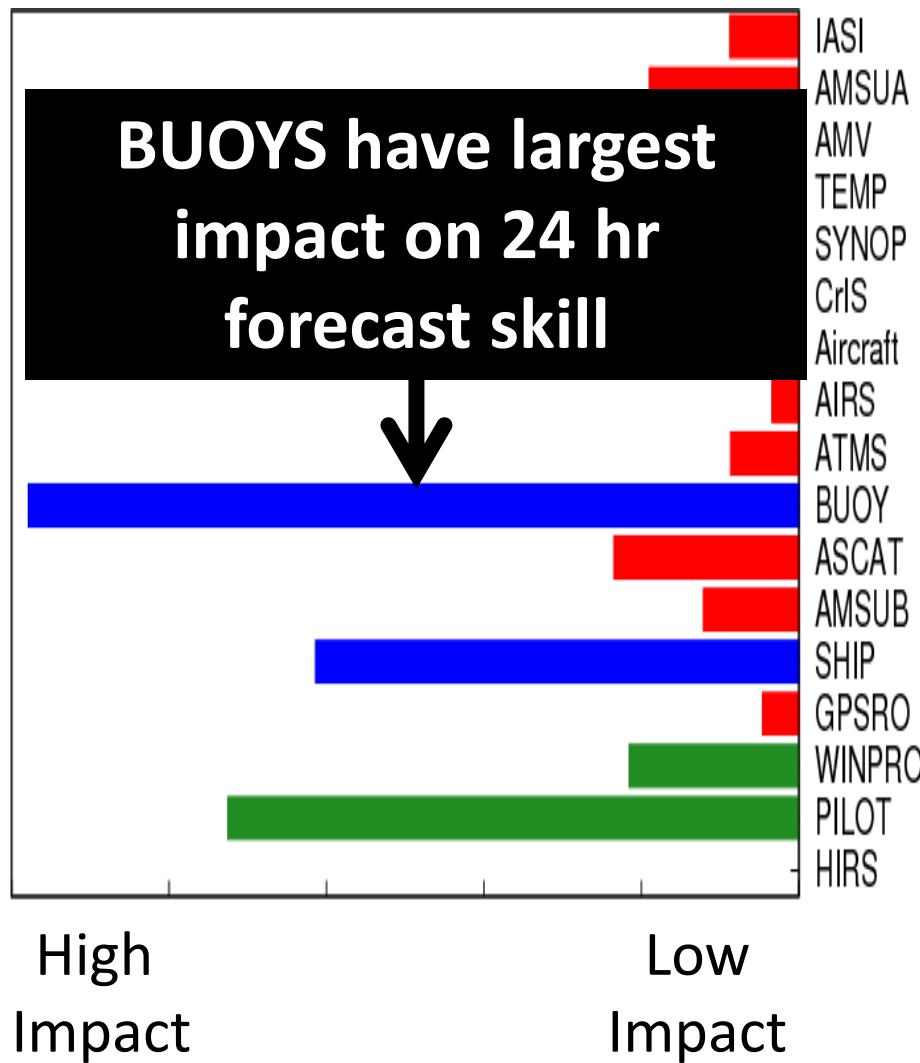

Global forecast error domain

AUS region forecast error domain
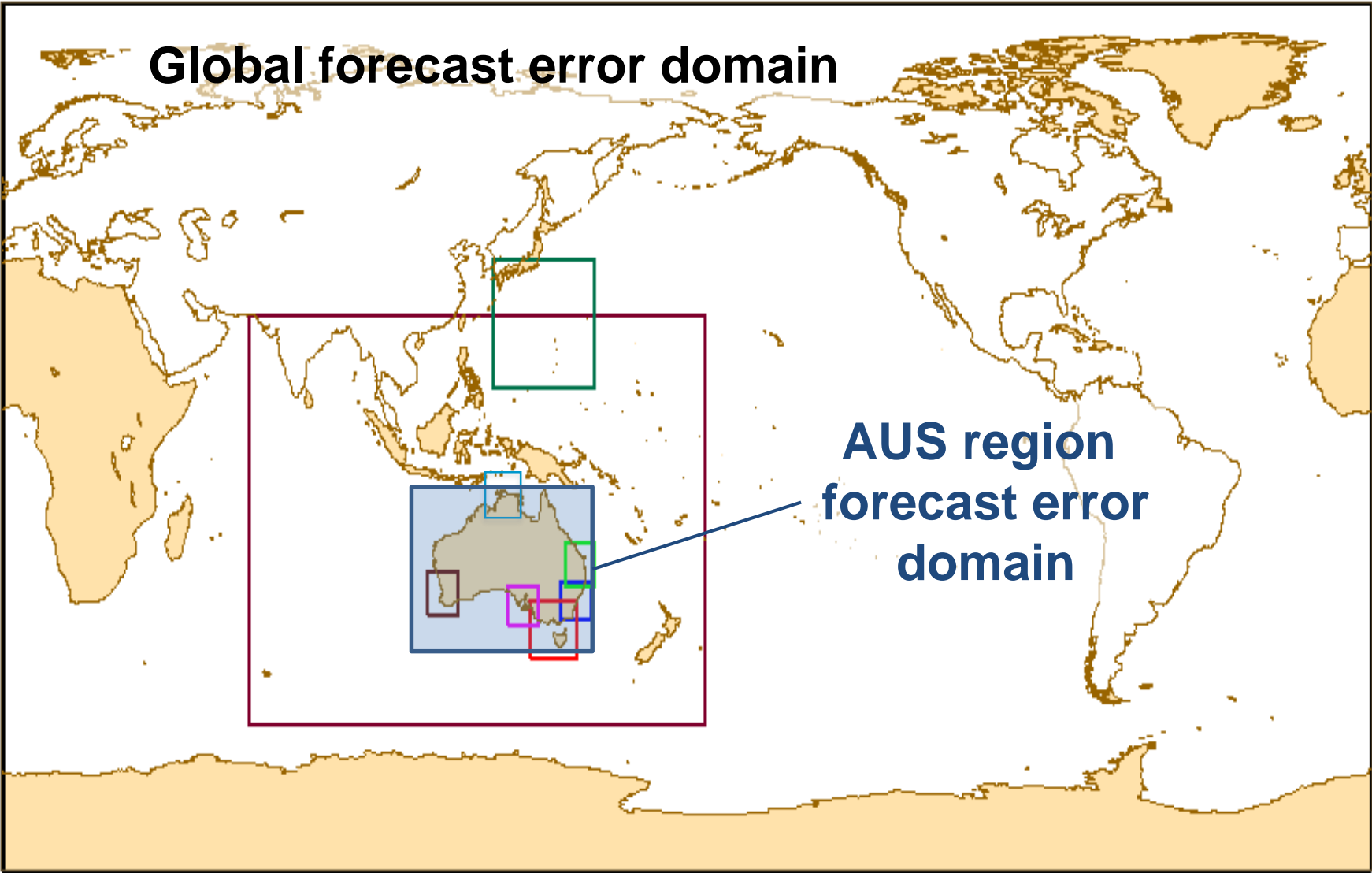
FSO – Global skill impact from each observation type in ACCESS NWP
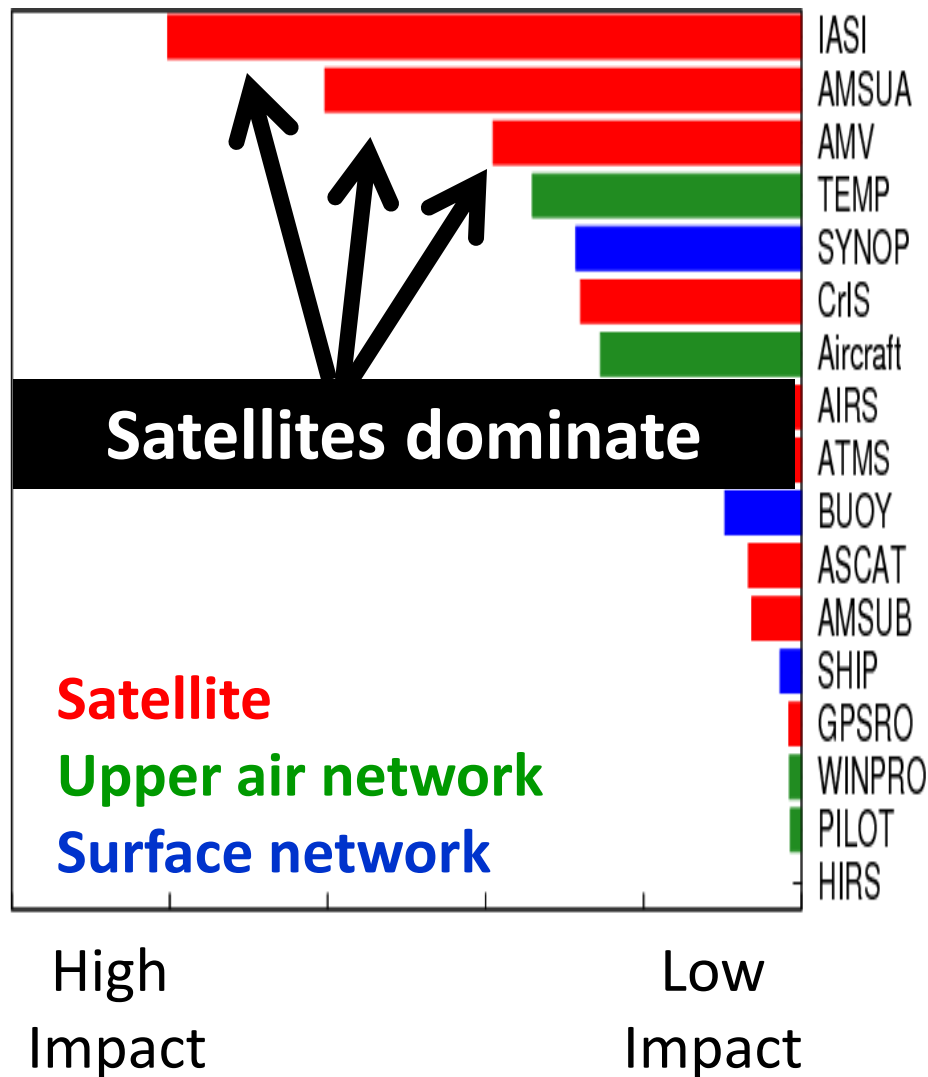
FSO – Buoy impacts Globally

Sep – Dec 2015
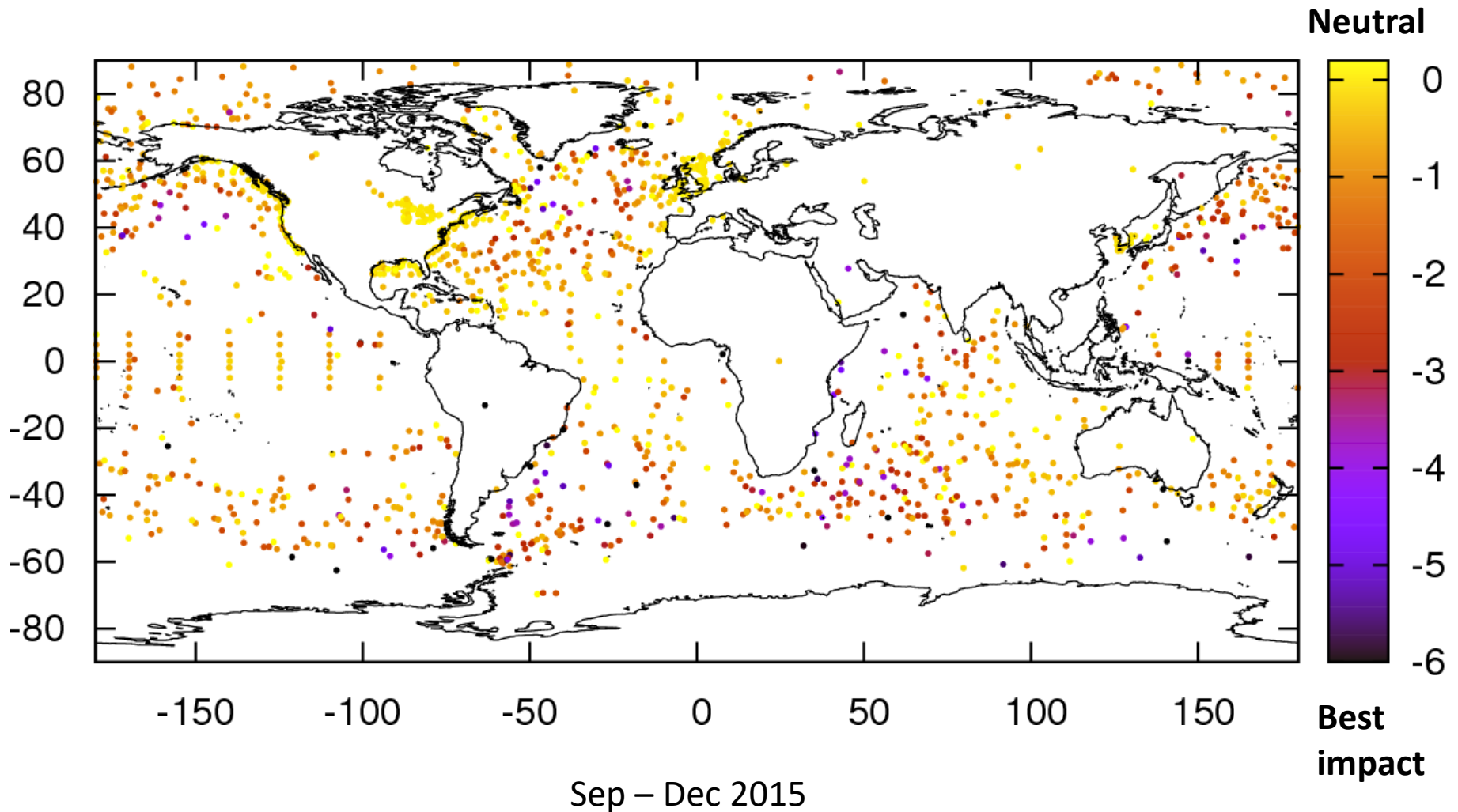
FSO – Buoy impacts in Australian region

Sep – Dec 2015
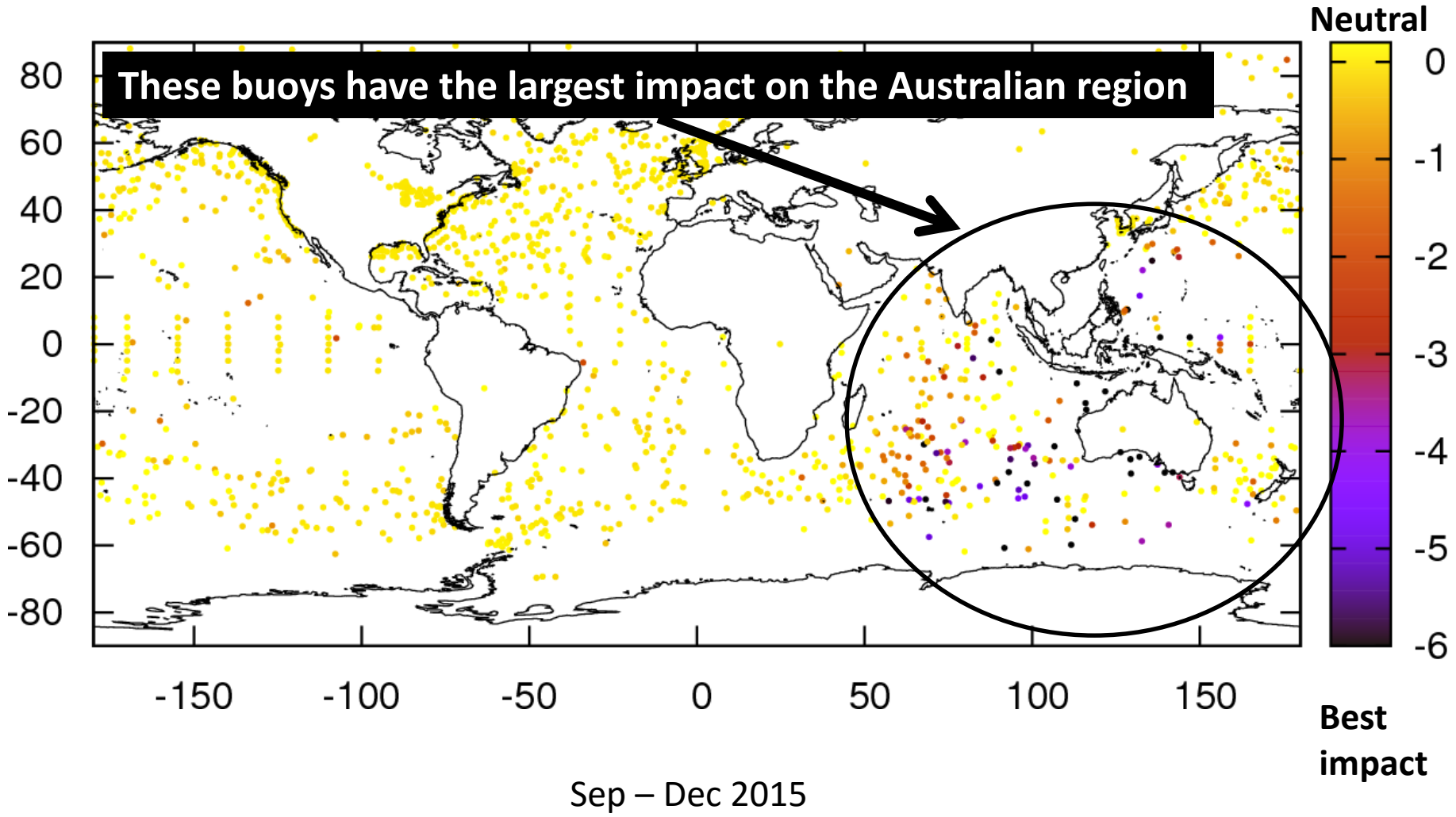
FSO – impact of radiosondes

Average impact over Sept 1 2015 – Dec 31 2015

Temp and Humidity profiles

Remote stations improve skill most of all

Neutral

Best impact
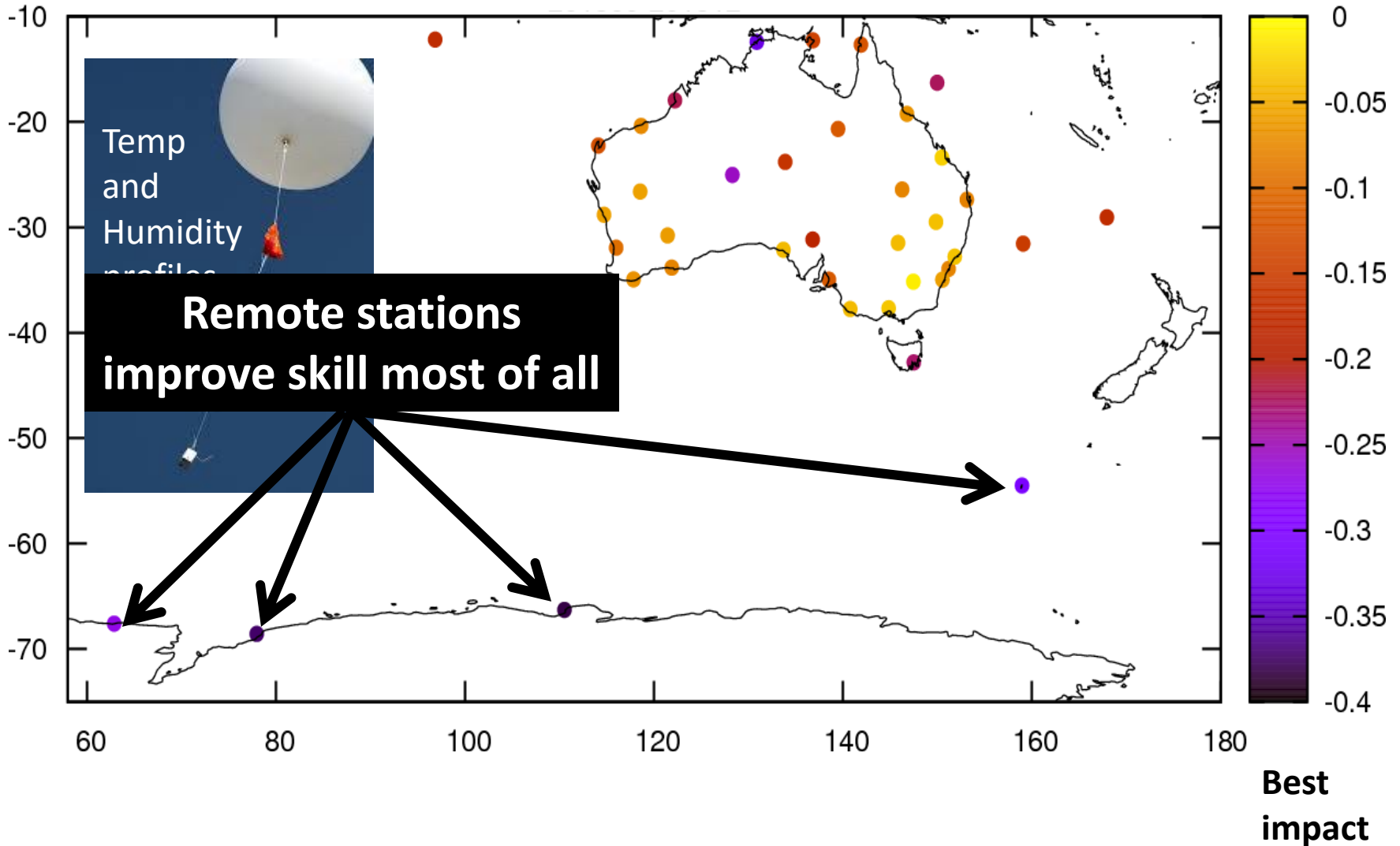
Summary of Progress

- FSO suite developed + analysis and visualisation tools

- Running routinely in real-time

- Evaluation and ranking of Bureau observations

- Supporting network assessment

- Marine, Upper air and Satellite observations have high impact

Next three years…

- Operationalise

- Focus on particular weather events e.g. TC Debbie, Yasi

- Customer engagement : what do you need to improve impact and value

- Impact per dollar invested

- Build hind-cast runs – to yield seasonal sensitivities

- Build performance monitoring systems

- New observation types, instruments etc.

- City scale NWP