

The Observation System Simulation Experiment Tool (OSSET) for Global Ionospheric Electron Density

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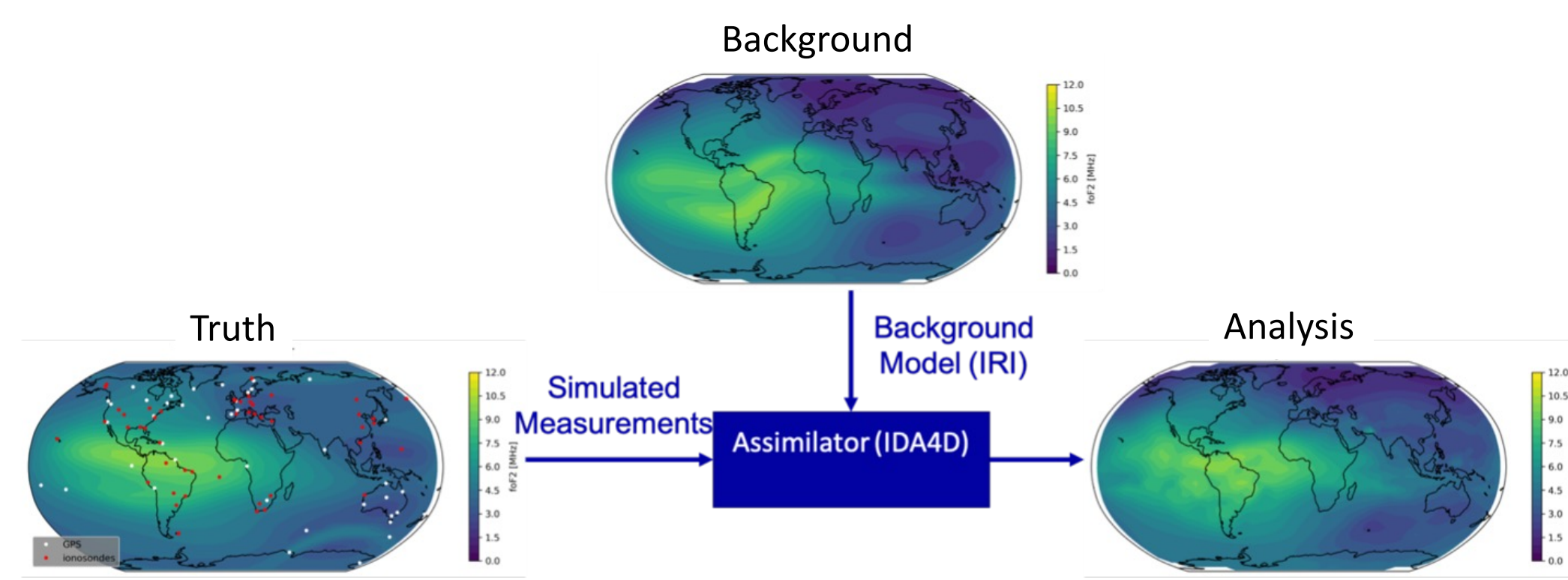
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What's an OSSE?

An OSSE (Observation System Simulation Experiment) is a numerical experiment that can predict the performance of ionospheric specification. It has 3 steps:

1. Simulate measurements from a truth model
 2. Assimilate these measurements and update a background model to make an 'analysis'
 3. Compare the analysis and background to the truth model
- Iterate on steps 1-3 with configurations of the observation system to find the configuration that best meets the operational need at minimum cost. Orion Space Solutions has built and validated our OSSE **Tool** called OSSET

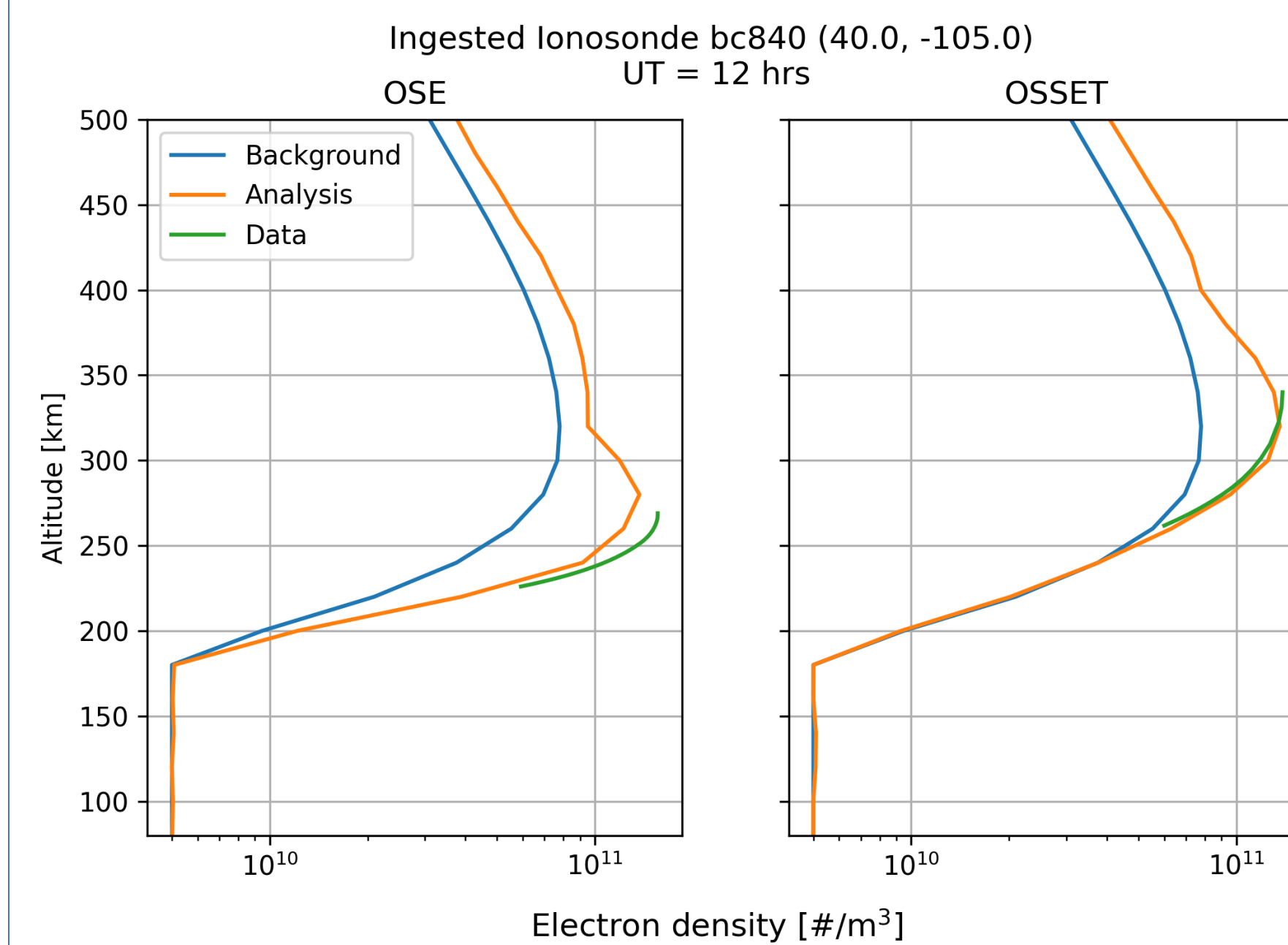


OSSET can answer 'What If?' questions:

- What if we assimilate a new dataset?
- What if we switch assimilators?
- What if we change the configuration of our assimilator?
- What if we suddenly loose a sensor?
- What if ...

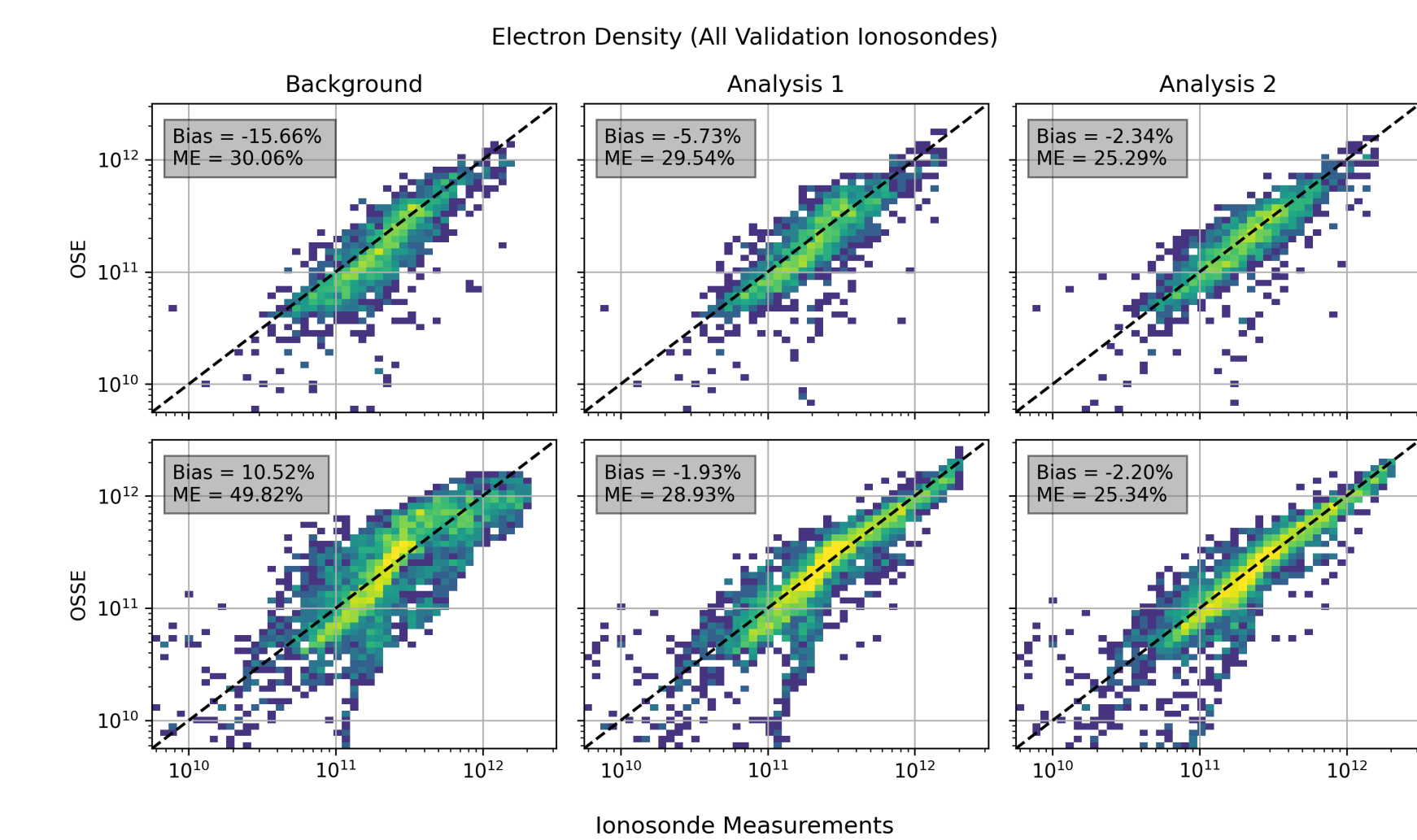
Assimilation Results

As we ingest data, the analysis moves closer to the truth. IDA4D used for this work, but OSSET supports multiple assimilators.



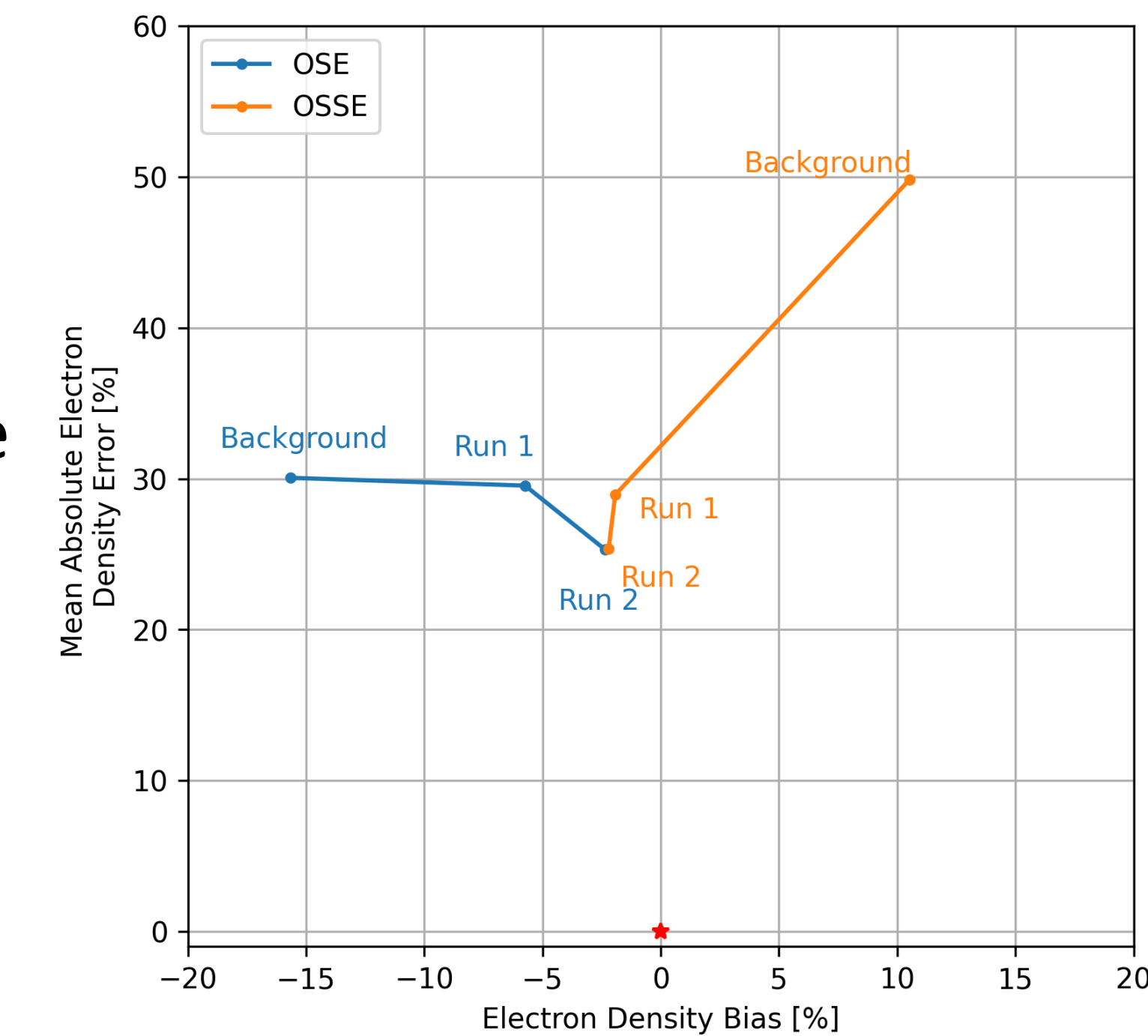
OSSET Validation

Now we compare with the ionosondes that were not ingested, this is a higher bar to clear. The OSE and OSSET predict similar impacts



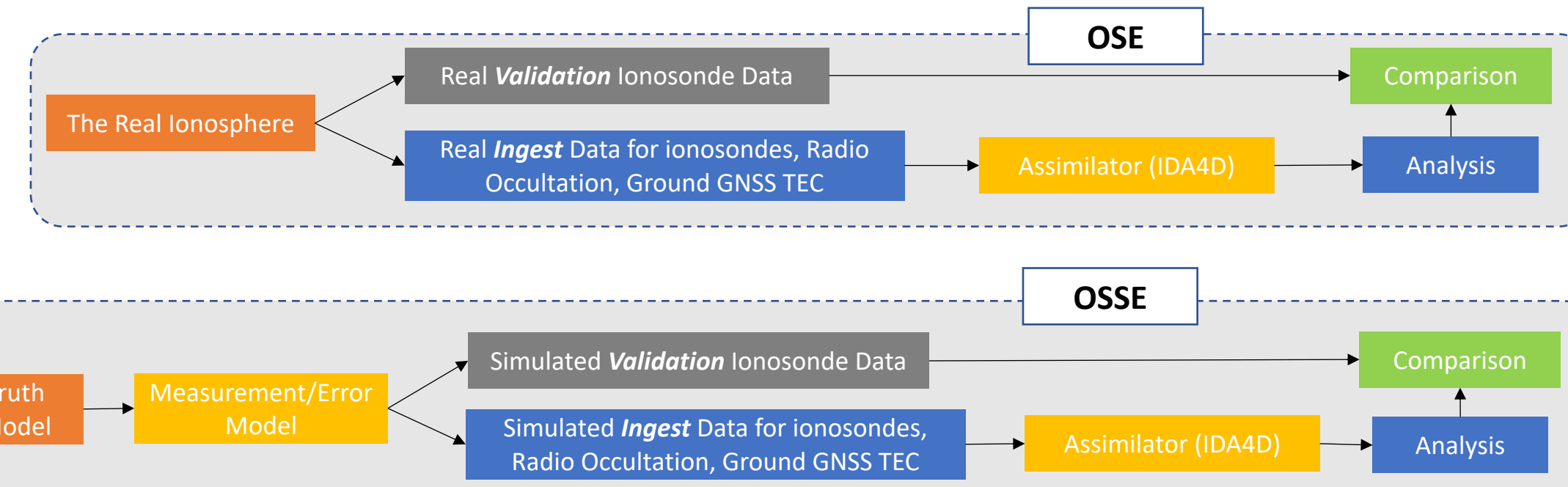
Validation Statistics

Despite very different background errors, the baseline data gets run 1 to a similar place. The OSE and OSSET agree remarkably well for the state of the nowcast after ingesting the additional RO data (run 2)

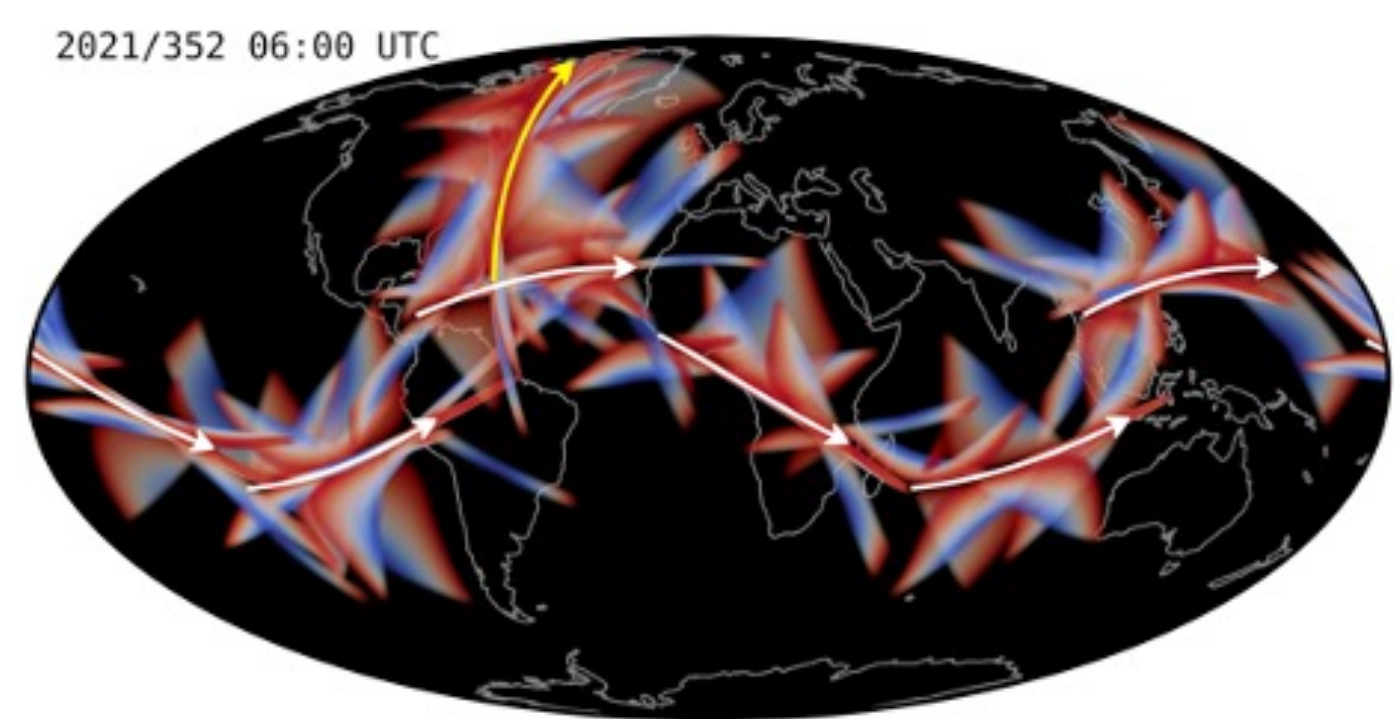


How accurate is OSSET?

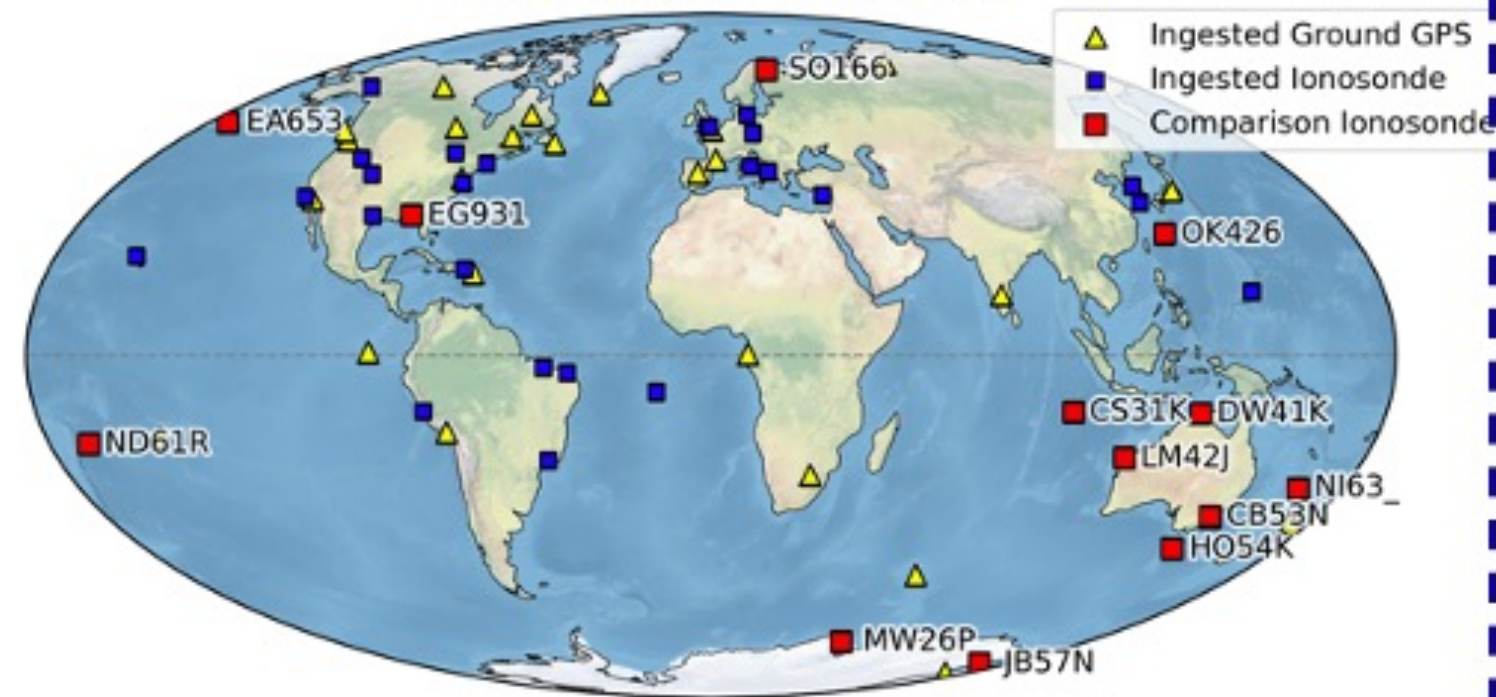
Perform an OSE (observation system experiment) with OSSET and compare to a real OSE. Method shown at right



Radio Occultation Measurements



Ionosonde and Ground GPS Measurements



Our Test Case

We will answer the same question, 'how much does adding commercial RO data to an assimilator improve the nowcast?' with an OSE and an OSSE, and compare the results.

- Date: Dec 17, 2021
 Conditions: Kp < 3, F10.7 = 117 – calm conditions
 Data:
- 26 ingested Ionosondes (13 validation)
 - 36 Ground GNSS stations (TEC)
 - COSMIC-2 GNSS TEC

Beyond the OSE

OSSEs and OSEs are complimentary – they fill in each other's gaps

OSEs benefit from real data, but are limited in scope

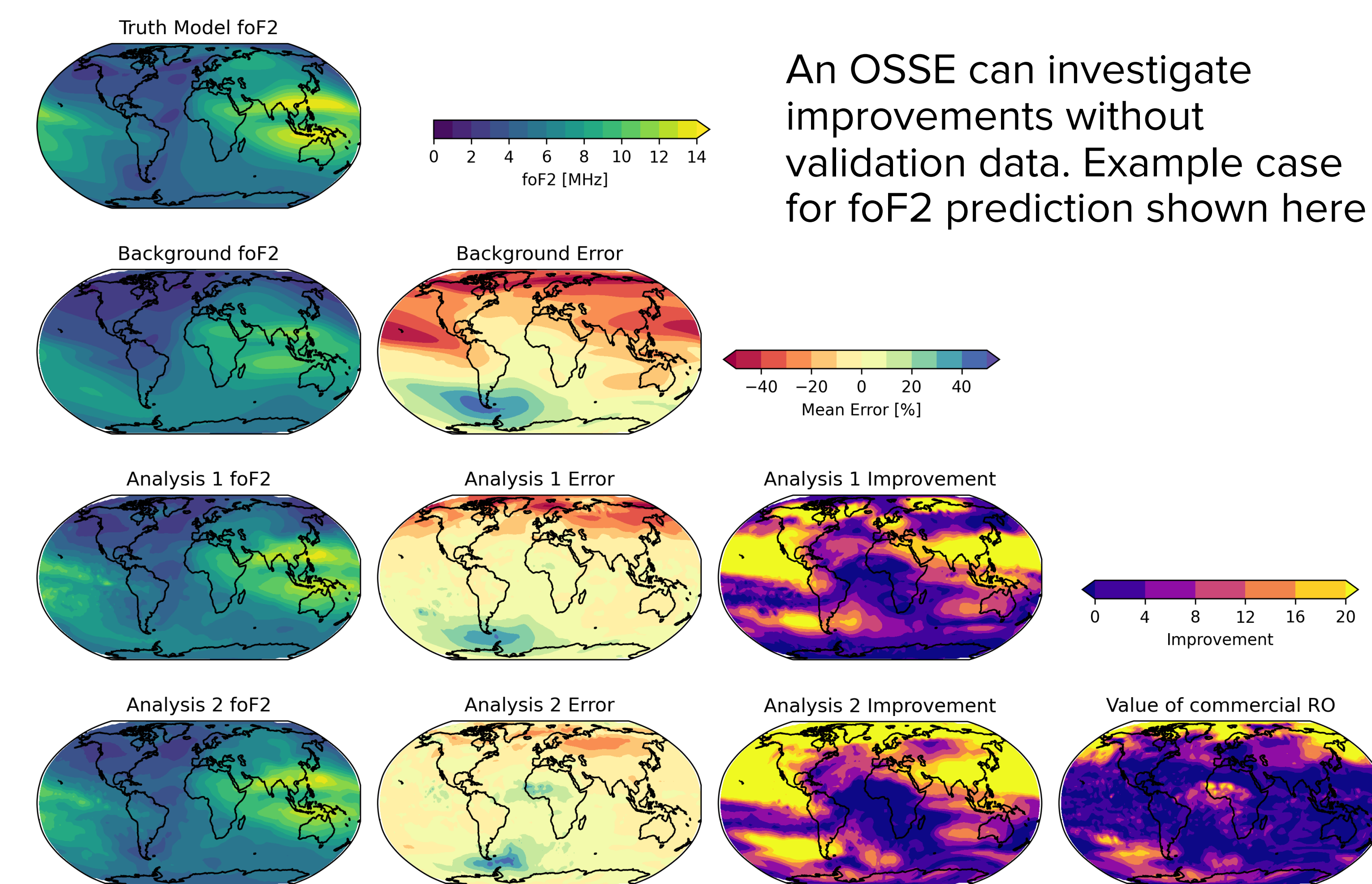
OSSEs do not use real data, but are global in scope

For this OSE we are limited to 13 ionosondes which means we have

- Geographical limitations:** unable to assess in all regions

- Altitude limitations:** No way to measure improvement above hmF2

In an OSSE, we are omniscient and can compare to the truth model



An OSSE can investigate improvements without validation data. Example case for foF2 prediction shown here