An Integrated Global Greenhouse Gas Information System (IG³IS)

Inverse Modeling Cross Cutting Activities

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IG³IS Inverse Modeling Cross Cutting Activities

Absence of known GHG flux quantities

    Best answer: Inter-comparison projects (e.g. Transcom)

    Use of various metrics at various scales (e.g. Standard deviation for IAV,
                 correlation for detection of anomaly)

    Long discussions on next steps (better transport? better prior? better fossil
fuel/ocean?)

Still assuming that nobody knows the truth but…

We work at much smaller scales.

What we really need are quantifiable metrics at national and sub-national scales

First objective: Evaluation of transport errors, prior errors, background.

IG³IS Inverse Modeling Cross Cutting Activities

New methodologies are emerging. IG3IS needs to be responsive and able to evolve rapidly.

Novel measurement techniques (remote sampling, multiple trace gases)
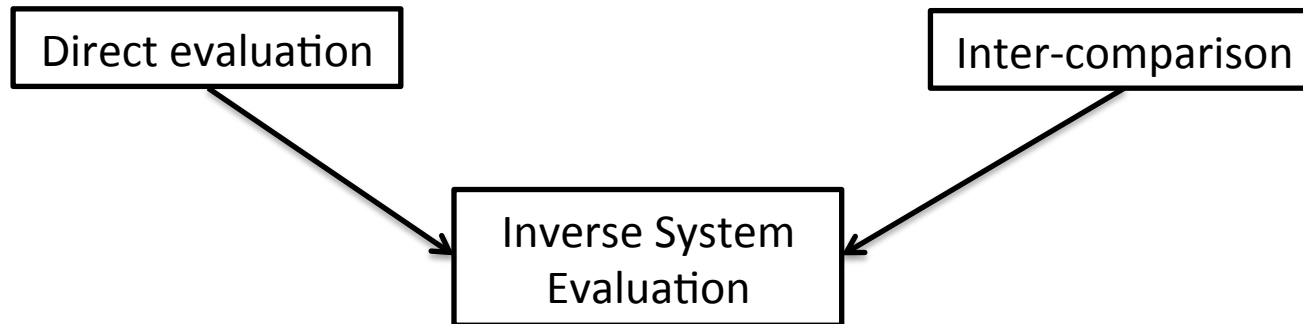
Novel modeling systems (meteorological models)

Novel optimization methods (faster algorithms)

Second objective: Provide an adaptive framework to incorporate new developments.

IG³IS Inverse Modeling Cross Cutting Activities

Benchmarking inversion systems

- Direct evaluation (Weather Forecast approach): study cases with a list of metrics

- Inter-comparison (Transcom approach): informative but not conclusive

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┌──────────────────┐              ┌──────────────────┐
│ Direct evaluation │              │ Inter-comparison │
└──────────────────┘              └──────────────────┘
            ╲                         ╱
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              ┌──────────────────────┐
              │   Inverse System     │
              │     Evaluation       │
              └──────────────────────┘
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Question: Which direct evaluation (metric) is relevant to inversion systems?
For example: William's model has tested his PBL height at one location, over 2 weeks, and got 150m standard deviation and 100m bias. Is it enough? Is it representative?

Question: What can we learn from inter-comparisons?

IG³IS Inverse Modeling Cross Cutting Activities

Benchmarking inversion systems

- Direct evaluation (Weather Forecast approach): study cases with a list of metrics

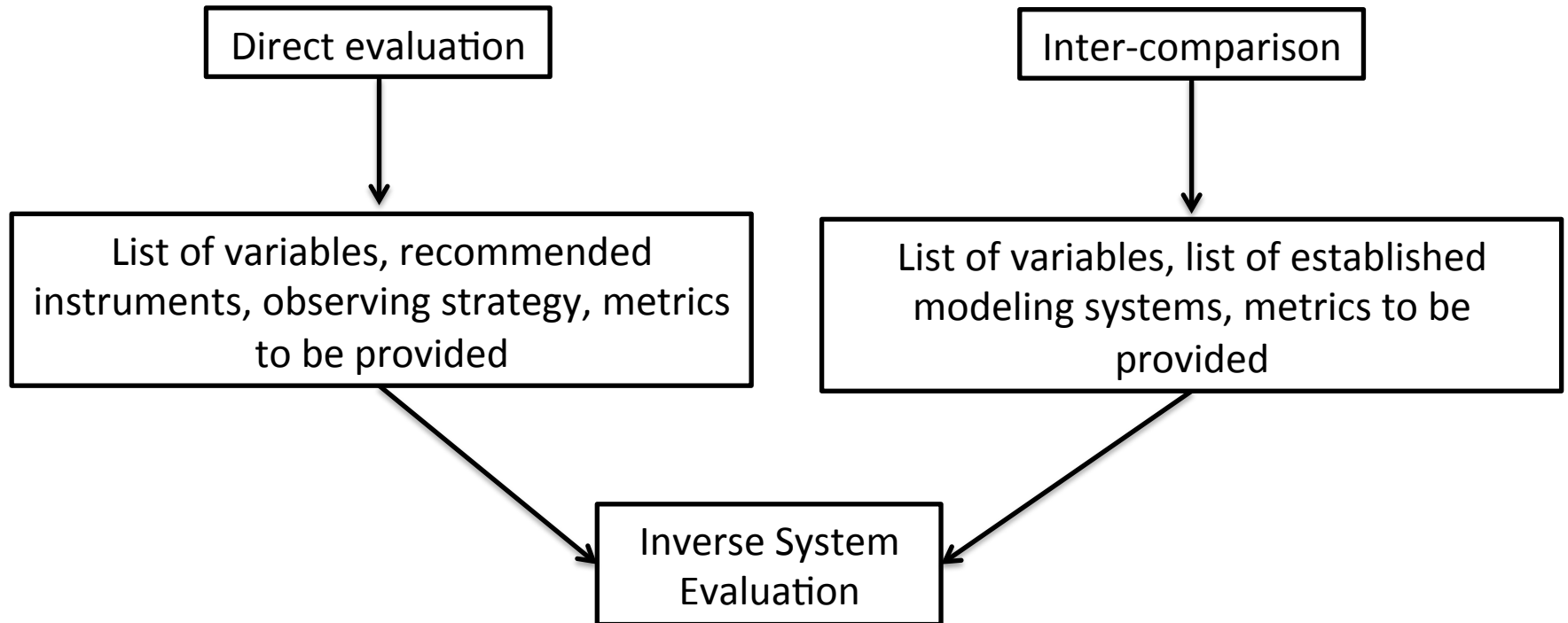**Sensitivity tests: Define what matters. Which variables? Where? How often?**

- Inter-comparison: Re-inventing the Transcom approach

Referenced systems: Comparison to existing calibrated models

IG³IS Inverse Modeling Cross Cutting Activities

First need : Define the metrics that impact inversion systems

For example: transport model evaluation: Which variables? For how long? Where?

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┌─────────────────┐                      ┌─────────────────┐
│ Direct evaluation │                    │ Inter-comparison │
└─────────────────┘                      └─────────────────┘
         │                                        │
         ▼                                        ▼
┌──────────────────────────┐        ┌──────────────────────────┐
│ List of variables,       │        │ List of variables, list  │
│ recommended instruments, │        │ of established modeling   │
│ observing strategy,      │        │ systems, metrics to be    │
│ metrics to be provided   │        │ provided                  │
└──────────────────────────┘        └──────────────────────────┘
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                    ▼                    ▼
                 ┌──────────────────────────┐
                 │ Inverse System Evaluation │
                 └──────────────────────────┘
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IG³IS Inverse Modeling Cross Cutting Activities

Benchmarking inversion systems

Optimization systems use two nearly independent quantities: means and errors

 - IG3IS needs to be moving towards the evaluation of the errors

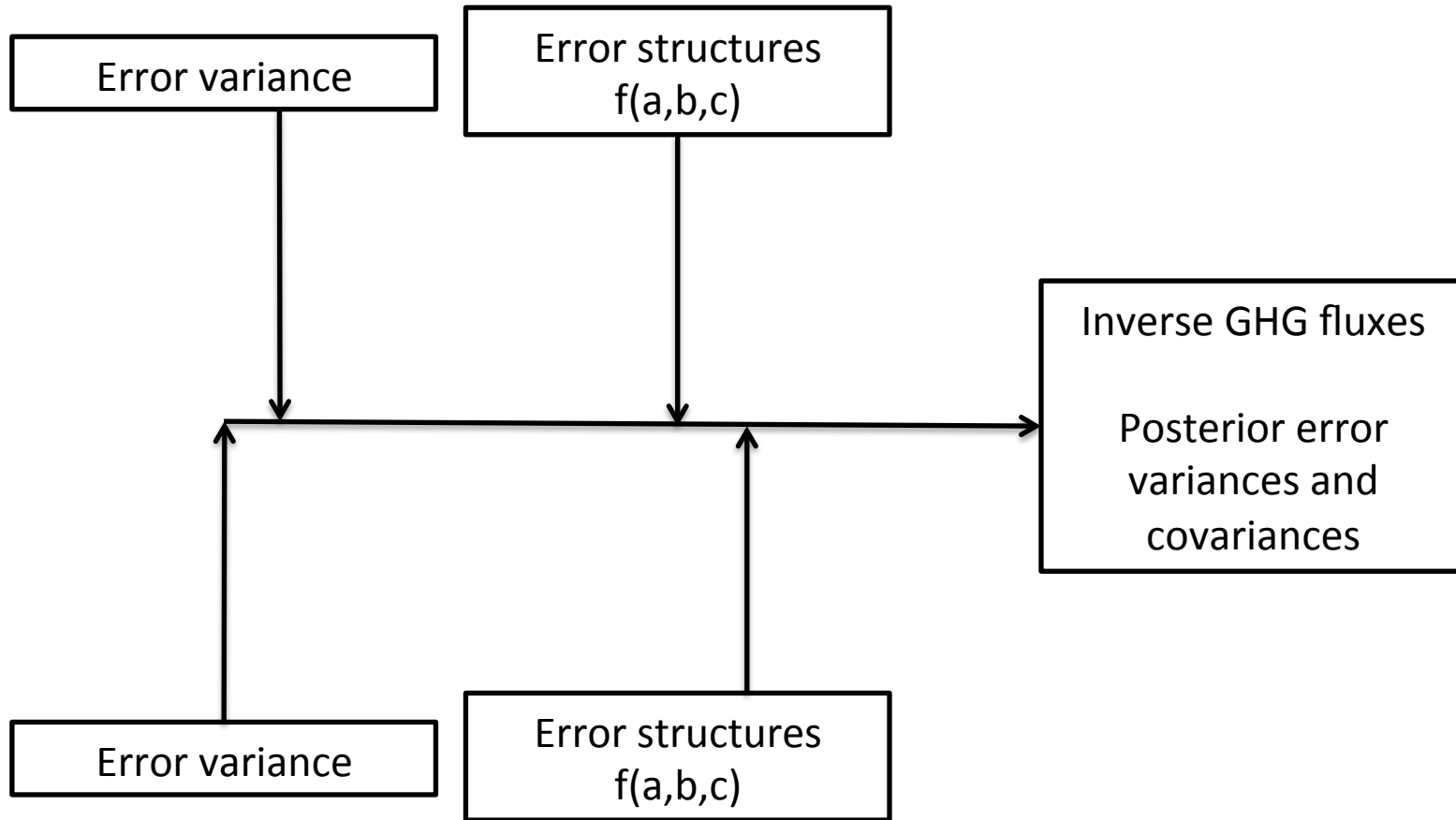*Even more critical than the mean fluxes, we need to evaluate our errors*

which means…

We need to engage with the inventory community!!!
It sounds scary but we need to engage with them to be successful in the implementation of calibrated/evaluated inversion systems

Beyond the mean quantities: Evaluation of Uncertainties

Prior flux error covariances (represent., aggreg., ...)


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┌─────────────────┐    ┌─────────────────┐
│  Error variance │    │ Error structures│
│                 │    │    f(a,b,c)      │
└─────────────────┘    └─────────────────┘
         │                      │
         ▼                      ▼
         ─────────────────────────────────►  ┌──────────────────┐
         ▲                      ▲             │ Inverse GHG fluxes│
         │                      │             │                  │
         │                      │             │  Posterior error │
┌─────────────────┐    ┌─────────────────┐    │  variances and   │
│  Error variance │    │ Error structures│    │   covariances    │
│                 │    │    f(a,b,c)      │    └──────────────────┘
└─────────────────┘    └─────────────────┘
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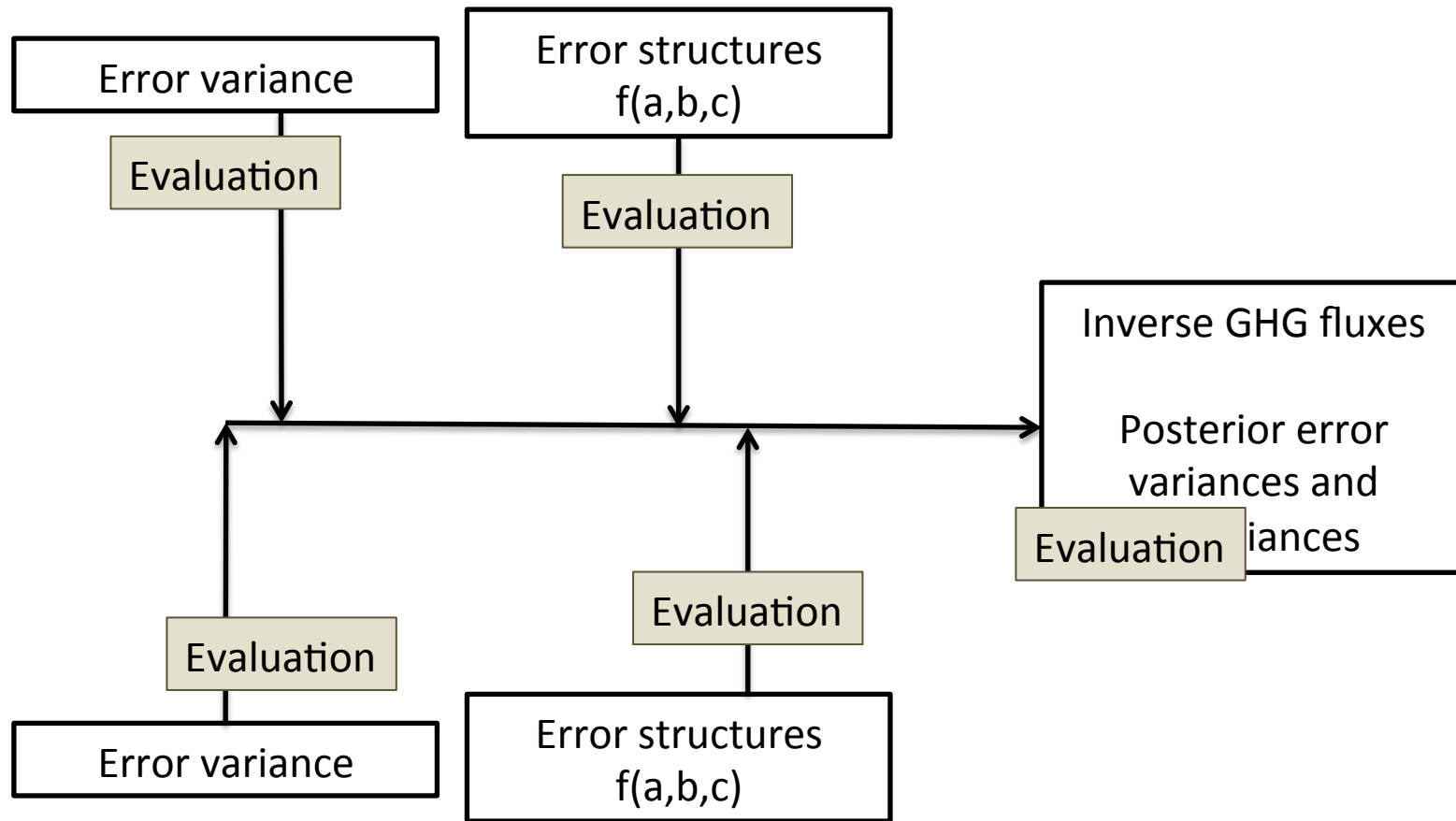
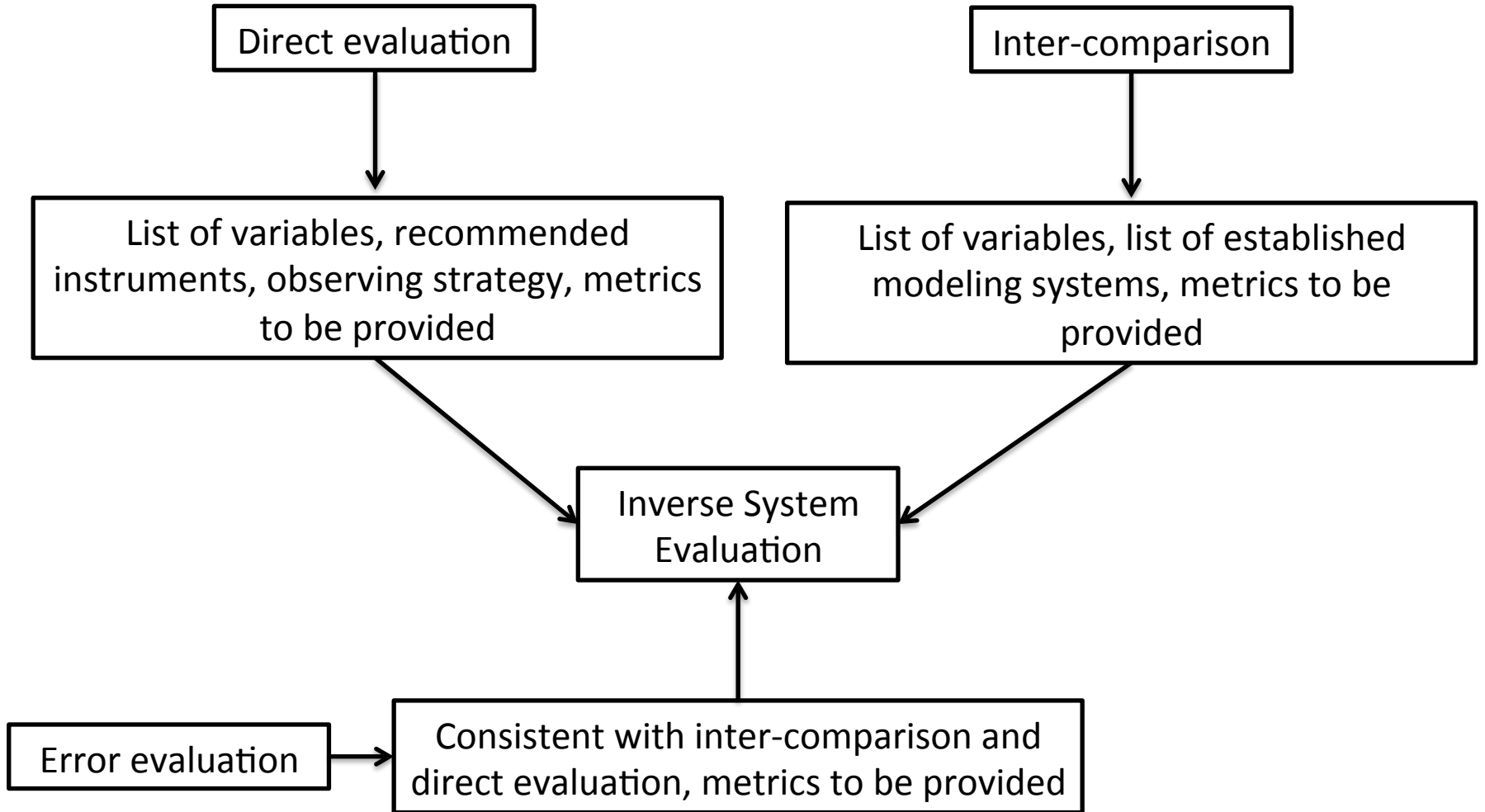*Observation error covariances (transport, measurement)*

Beyond the mean quantities: Evaluation of Uncertainties

Prior flux error covariances (represent., aggreg., ...)

Observation error covariances (transport, measurement)

IG³IS Inverse Modeling Cross Cutting Activities

IG³IS Inverse Modeling Cross Cutting Activities

Novel approaches in inversion systems

- Evolution of the benchmarking framework to adapt to new developments

  For example: instrument calibration, inversion of multiple species

Main objective: Identify needs for the community

  Provide directions and recommendations to improve inversion systems

IG³IS Inverse Modeling Cross Cutting Activities

Establish the direct evaluation protocol for any inversion systems

- Define variables, metrics, field deployment strategies

Revise the Transcom approach: Refer to state-of-the-art systems

- Provide current performances of tested models as a reference

Novel approaches in inversion systems

- Provide a flexible benchmarking for new approaches

Identify needs for the community

- Provide directions and recommendations to improve inversion systems

IG³IS Inverse Modeling Cross Cutting Activities

Implementation Plan being drafted soon: end of November

Please send your feedbacks, thoughts.

- What do you think is critical to inversion systems in terms of evaluation?

- What are we missing as a community to address the issues?

- …

Thanks