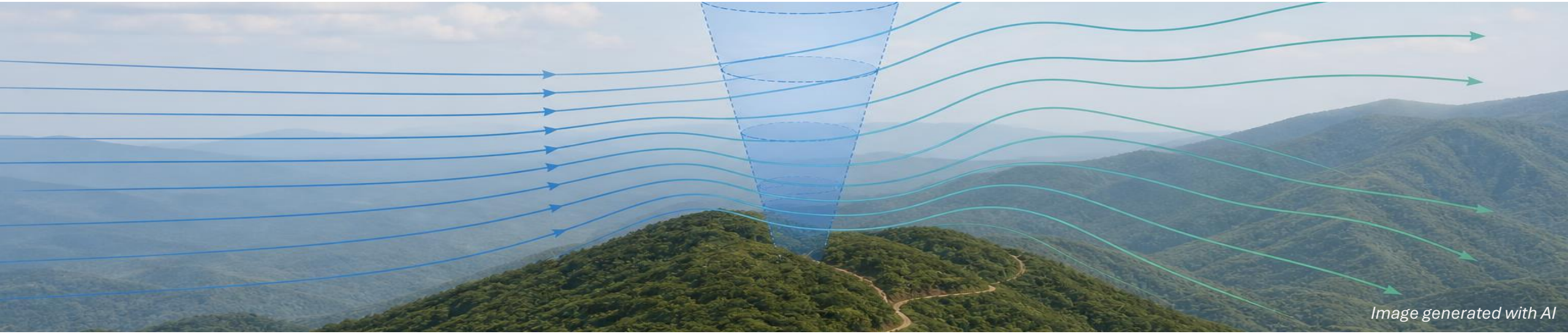
# ASSESSMENT OF VERTICAL PROFILING LIDAR PERFORMANCE IN SEMI COMPLEX AND COMPLEX TERRAIN

**Brazil, 2026**



# Assessment of vertical profiling lidar performance in semi complex and complex terrain

## 1. Motivation

*When is it actually necessary to apply CFD-based terrain correction?*

**Objective of This Work**

- Quantify the real impact of terrain correction
- Assess whether corrections are necessary or negligible
- Evaluate LiDAR reliability in complex terrain conditions
- Understand whether the uncertainty associated with the CFD compensated for applying the correction to the raw data (including uncertainty due to terrain complexity according to IEC).

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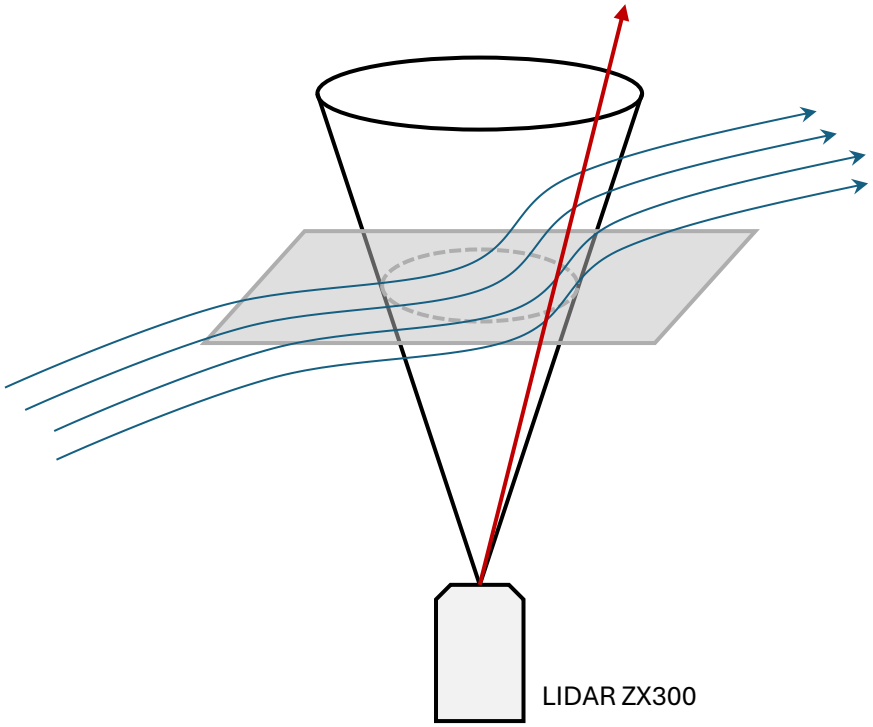
## 1. 1 Wind Measurement with LiDARs in Complex Terrain




**LiDAR and met masts do not measure the wind in the same way.**

| CHARACTERISTIC | METEOROLOGICAL MAST | ZX300 VERTICAL PROFILING LIDAR |
|---|---|---|
| **Measurement principle** | Point measurement | Volume measurement |
| **Sampling region** | Single physical location | Conical measurement volume |
| **Measurement geometry** | Fixed sensor position | Multiple laser beams |
| **Spatial representativeness** | Local wind conditions | Averaged flow inside the probe volume |
| **Sensitivity to terrain distortion** | Lower | Higher |
| **Sensitivity to flow inclination** | Lower | Higher |
| **Impact in complex terrain** | Usually limited | Can introduce reconstruction bias |

In complex terrain, LiDAR measurements may be affected by flow heterogeneity inside the measurement volume, while met masts represent local point conditions.

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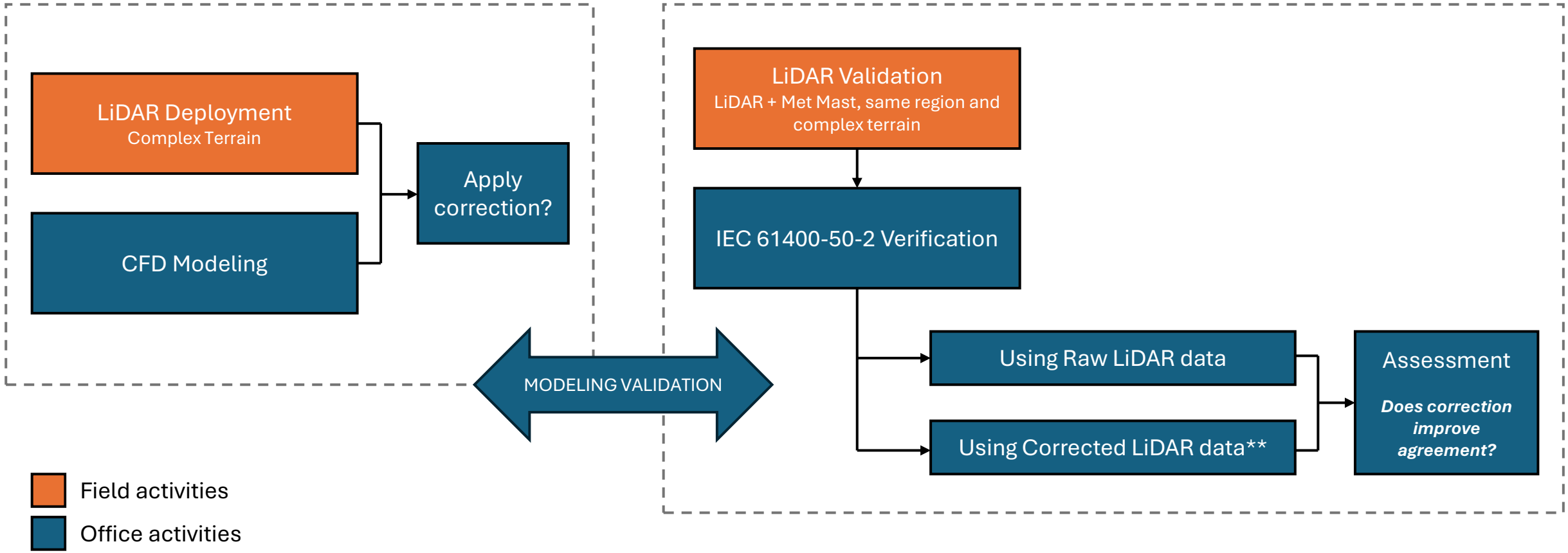
## 2. Terrain correction & validation workflow



## 3. Results

| COMPLEXITY | AVERAGE ABSOLUTE ERROR WITHOUT CORRECTION | AVERAGE ABSOLUTE ERROR WITH CORRECTION | IMPROVEMENT |
|---|---|---|---|
| SEMI-COMPLEX | 0,22 m/s | 0,04 m/s | HIGH |
| COMPLEX | -0,17 m/s | 0,01 m/s | MODERATE |
| NO-COMPLEX | -0,09 m/s | -0,08 m/s | MARGINAL |

## 4. Conclusion and next steps

- ✓ The verification demonstrated that vertical profiling LiDARs can provide reliable wind measurements in those cases when properly validated against reference measurements.
- ✓ CFD-based terrain correction improved agreement between LiDAR and mast measurements in sites classified as **complex terrain**.
- ✓ The largest improvements were observed under terrain conditions where flow distortion effects are expected to be more relevant.
- ✓ In the evaluated non-complex terrain case, the correction produced only marginal improvement. However, this case also presented the lowest absolute error before correction among all evaluated conditions, indicating that the original LiDAR measurements already showed strong agreement with the reference mast.
- ✓ These results indicate that **terrain correction becomes increasingly relevant as terrain complexity increases.**

## 4. Conclusion and next steps

**Answer to the Initial Question:** *When is it actually necessary to apply CFD-based terrain correction?*

Based on the evaluated cases, the results suggest a positive tendency for applying CFD-based terrain correction under semi-complex and complex terrain conditions.

In the evaluated cases, terrain correction produced more noticeable improvements in agreement between LiDAR and mast measurements in terrain conditions where flow distortion effects are expected to be more relevant, while the non-complex case showed only marginal benefit.

**Next Steps**

→ Expand validation to additional sites
→ Investigate TI-specific correction methodologies
→ Evaluate directional and atmospheric stability effects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