D3D Project Newsletter — Months 13–18

Period: Months 13–18
Project: *Deep 3D Scattering of Solar Radiation in the Atmosphere due to Clouds* (D3D)
Funded by: Hellenic Foundation for Research and Innovation (H.F.R.I.)

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1. Project Overview — Mid-term Scientific Acceleration

Months 13–18 marked a major scientific acceleration for the D3D project. The consortium moved from proof-of-concept developments to large-scale validation, combining real measurements, 3D cloud reconstructions, radiative transfer modeling, and deep learning approaches in a unified pipeline.

During this period, the project reached a true *integration phase*: ASI measurements, 3D cloud fields, and radiative simulations were processed together, enabling quantitative evaluation of radiative errors, uncertainties, and model performance.

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2. News Highlights (Months 13–18)

- The D3D team finalized extended datasets of reconstructed 3D cloud scenes from multiple ASI stations. These datasets were prepared as benchmark test cases for radiative transfer validation and machine learning model training.
- A new methodological visualization was released on the project website, demonstrating how stereoscopic ASI imagery is transformed into volumetric cloud fields and then into radiative flux simulations.
- D3D researchers participated in international scientific meetings, presenting integrated workflows that combine physical modeling with deep learning for atmospheric radiation estimation.

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3. Publications & Dissemination

Conference Presentations

- Christos-Panagiotis Giannaklis 1, Stavros-Andreas Logothetis, Vasileios Salamalikis, Panayiotis Tzoumanikas, Konstantinos Katsidimas and Andreas Kazantzidis, Simulations of Sky Radiances in Red and Blue Channels at Various Aerosol Conditions Using Radiative Transfer Modeling, 16th International Conference on Meteorology, Climatology and Atmospheric Physics COMECAP 2023, 25 29 September 2023, Athens, Greece, https://doi.org/10.3390/environsciproc2023026089
- Christos-Panagiotis Giannaklis, Stavros Andreas Logothetis, Vasileios Salamalikis, Panayiotis Tzoumanikas, and Andreas Kazantzidis , Impact of Aerosol Optical Properties, Precipitable Water, and Solar Geometry on Sky Radiances using Radiative Transfer Modeling, 16th International Conference on Meteorology, Climatology and Atmospheric Physics COMECAP 2023, 25 29 September 2023, Athens, Greece, https://doi.org/10.3390/environsciproc2023026106

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4. Research Progress by Work Package

WP1 — Instrument Stability & Dataset Expansion

The ASI network operated continuously, generating large volumes of synchronized sky imagery.
Quality control pipelines were refined to ensure stable radiometric behavior over long periods, enabling time-series analyses of cloud variability.

WP2 — Advanced 3D Reconstruction

The 3D reconstruction algorithms were optimized to handle:

- Multiple cloud layers
- Variable illumination conditions
- Partial cloud coverage

This resulted in more realistic cloud volumes that preserve spatial coherence and optical properties.

WP3 — Radiative Transfer Benchmarking

The MYSTIC model was fully integrated with reconstructed 3D cloud fields. Extensive simulation campaigns were launched to:

- Compare simulated radiances with ground observations
- Quantify uncertainty due to cloud geometry and optical properties

- Identify conditions where 3D effects dominate radiative errors

WP4 — Deep Learning Integration

Deep neural networks were trained to emulate MYSTIC outputs using reconstructed cloud features as input. Results showed:

- Strong agreement with physical models
- Drastic reductions in computational cost
- Potential for near-real-time radiative estimation

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5. Scientific Milestones

- Creation of a validated pipeline from ASI images to radiative flux estimates
- First large-scale comparison between 3D and traditional radiative approaches
- Demonstration that deep learning can approximate radiative transfer at a fraction of the computational cost
- Public dissemination of visualization tools and methodological workflows

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