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CORSO
CO2MVS Research on Supplementary Observations

WP4: NOVEL USE OF SATELLITE OBSERVATIONS TO CONSTRAIN THE NATURAL BIOSPHERE

Kick-off Meeting

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WP4 team and resources

- WP4 Leads: Jean-Christophe Calvet (MF) and Patricia de Rosnay (ECMWF)

Partners	Resources (person months)
1-**ECMWF**	36
4-CEA	8.7
5-iLab	8
6-**MF**	43
10-ULund	10
13-EMPA	6
Total	**111.7**

WP4 objectives and contribution to CO2MVS

Enhance the exploitation of satellite observations in coupled land-atmosphere assimilation to constrain vegetation water and carbon cycle variables:

- Extend the assimilation of observations that we already use for NWP but not yet for CO2MVS, such as SMOS and ASCAT, to analyse vegetation variables,
- Develop assimilation of existing observations that are not yet used such as SIF observations,
- Pave the way for future observations assimilation such as Metop-SG/SCA, Copernicus Expansion CO2 and CIMR missions, which are all relevant to consistently constrain vegetation and carbon fluxes in CO2MVS

Task 4.1: Forward operator developments for multi-satellite data assimilation to analyse land surface variables controlling carbon fluxes (**MF**, ECMWF, CEA)

When: Month-1 to Month-24

Deliverables: 4.1 and 4.2 (public reports)

What:

- Acquisition and pre-process SIF observations from Sentinel-5p/TROPOMI
- Acquisition of low-frequency microwave observations in the L-, C-, and X-bands from ASCAT, SMOS, SMAP, and AMSR2.
- Observation operator developments based on neural network (NN) techniques and tested against physically based forward models making use of three different land surface models (ECLand, ISBA, ORCHIDEE).

Task 4.2: Use low frequency level-1 microwave observations (ASCAT, SMOS, SMAP, AMSR2) in the coupled soil-vegetation-atmosphere IFS (**ECMWF**, MF)

When: Month-1 to Month-36

Deliverables: (see T4.3)

What:

- Use the NN-based microwave observation operators from Task 4.1 in offline experiments in LDAS-Monde and ECLand to assess the impact of coupled soil-vegetation assimilation.
- Implement the best performing operators from these offline tests in the IFS, the prototype system for the future global CO2MVS,
- Assess the impact of microwave data assimilation in the coupled data assimilation system using the L1 observational data from the targeted instruments.

This work will benefit from and build-up on forward operator developments conducted in CERISE (C3S Evolution) for water cycle variables in the IFS, and from preliminary ESA/SMOS assimilation developments conducted in CoCO2 to analyse LAI and soil moisture in the IFS.

Task 4.3: Use SIF level-1 observation assimilation to analyse water and carbon cycle variables in ECLand (**ECMWF**, CEA, MF, ULUND)

When: Month-1 to Month-36

Deliverables: D4.3 and D4.4 (public reports)

What:

- Use the NN-based SIF observation operators from Task 4.1 in offline experiments in LDAS-Monde and ECLand to assess the impact of coupled soil-vegetation assimilation.
  - Assess filtering and length of the data assimilation window configurations.
- Implement and test the best performing operators from these offline tests in the IFS, the prototype system for the future global CO2MVS,
- Assess the impact of SIF L1 data assimilation in the coupled data assimilation system.

Results from the work in CAMS on the use for L2 SIF products will also be taken into account for these assessments.

Task 4.4: Explore the use of other satellite products for potential integration in CO2MVS (**ULUND**, ULUND, iLab, EMPA, CEA)

When: Month-19 to Month-36

Deliverables: 4.5 (public report)

What: Explore the ESA biomass products for potential integration in the future CO2MVS

- Compare sequential and variational assimilation methods to constrain biomass variables with offline LDAS-Monde and ORCHIDEE
  - → Requirements for model complexity for future ECLand evolution to monitor carbon pools.
- Explore high-resolution satellite products to constrain biospheric fluxes at city-scale (ICOS-cities).
  - Simulations with ICON-ART at city scale using biospheric fluxes from high-resolution Sentinel-2 observations (Enhanced Vegetation Index, Land Surface Water Index), with the Vegetation Photosynthesis and Respiration to constrain the biospheric signal in emission plume of cities. In parallel.
  - Simulations with the IFS at 9km and 4km with new urban tile and the latest photosynthesis model to assess the impact on the CO2 biogenic signal from city plumes.

WP4: focus in the first year

Task 4.1 (**MF**, ECMWF): Forward operator developments for land

- Acquisition and pre-processing of Sentinel-5p SIF data (2018-2021)
- Prepare collocated databases (for LDAS-Monde and ECLand) with vegetation and carbon related surface model variables and MW observations, for 3 frequencies (L-band, C-band, X-band), and Sentinel-5p SIF data for 2018-2021.
- Analyse the information content to identify model variables linked to observed brightness temperatures
- Train neural networks for both LDAS-Monde and ECLand, to link carbon and water cycle model variables to observed brightness temperatures

Task 4.2 (**ECMWF**, MF): MW Forward operator implementation in the IFS

- Develop the technical infrastructure to use T4.1 operators in the IFS to analyse Carbon cycle variables

Task 4.3 (**ECMWF**, CEA, MF, ULUND): SIF observations in ECLand

- Investigate filtering vs. window-length set-up for SIF assimilation in ECLand (LSCE) and evaluation (LSCE, ULund)

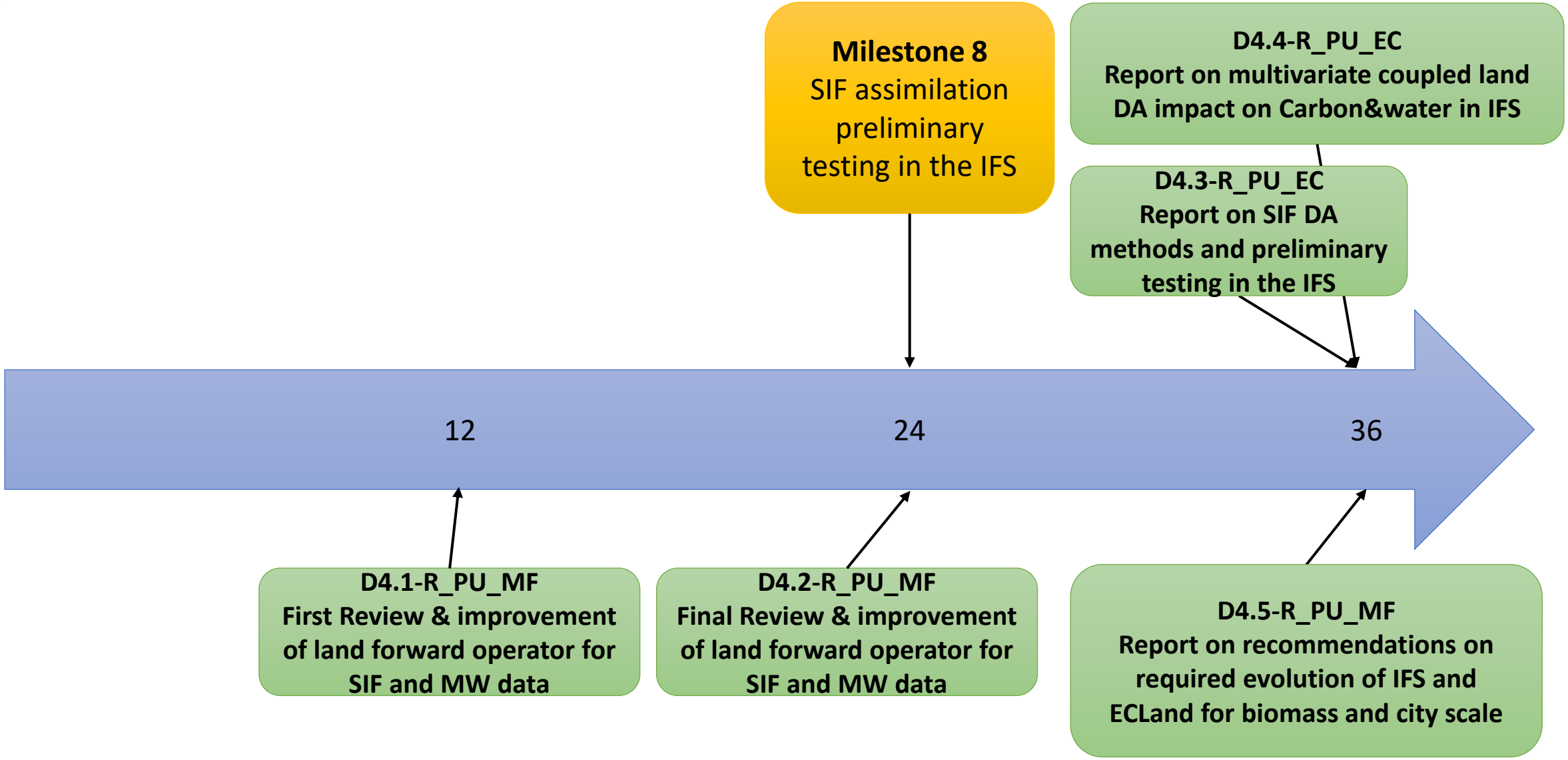
WP4: Interactions with the other WPs

- WP4 is relatively stand-alone with the objective to Enhance the exploitation of satellite observations in coupled land-atmosphere assimilation to constrain vegetation water and carbon cycle variables.

- WP3 will analyse the suitability of implementing $^{14}CO2$ cycling into C-TESSEL/ECLAND together with work done in WP4 on the inclusion of carbon pools".

- Link with WP2 via EMPA (ICON model) to constrain the biospheric signal in emission plume of cities

WP4: 36-month timeline



THANK YOU

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