

ECMWF land-atmosphere weakly coupled assimilation: status and perspectives



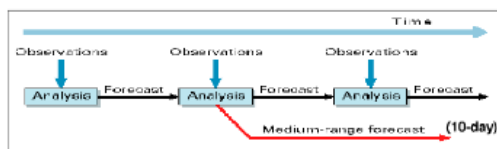
Patricia de Rosnay, Elias Hólm, Massimo Bonavita, Patrick Laloyaux, Dinand Schepers, Per Dahlgren, Hans Hersbach, and Steve English

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Introduction: ECMWF Earth System

The European Centre for Medium-Range Weather Forecasts (ECMWF) forecasting system relies on an Earth System approach, including atmosphere, ocean, waves, land, and sea ice. For Numerical Weather Prediction (NWP) applications different data assimilation methods are used for the each component of the Earth System. A hybrid 4D-Var is used for the atmosphere, a simplified sea-surface temperature (SST) and sea ice analysis is used for medium-range high resolution forecasts and for the ERA-Interim and ERA5 reanalyses. A 3D-Var FGAT ocean analysis is also used to initialise ECMWF's Ensemble system used for medium range, extended range, and seasonal range forecasts.

ECMWF Integrated Forecasting System (IFS)

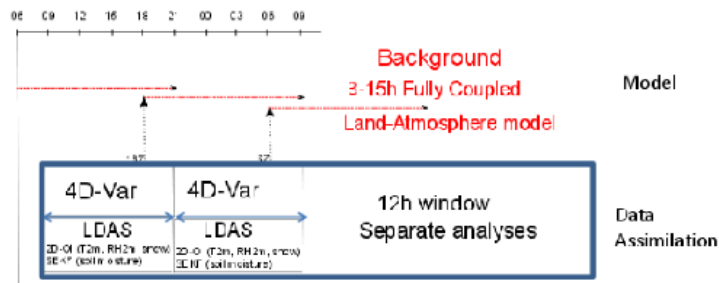


- Forecast Model: GCM including the H-TISSEL land surface model
- Data Assimilation → initial conditions of the forecast model prognostic variables
 - 4D-Var for atmosphere
 - SST and Sea Ice analysis (High Resolution syst.), OCEAN4 analysis (Ensemble)
 - Land Data Assimilation System (LDAS)

Data assimilation coupling approaches

The ECMWF operational ocean-atmosphere data assimilation system is currently uncoupled for NWP. A pioneering coupled ocean-atmosphere data assimilation approach was developed and used for the coupled reanalysis CERA-20C, demonstrating the potential of a coupled ocean-atmosphere assimilation (see presentation by Laloyaux et al. and poster by de Boisséson et al.). The land-atmosphere data assimilation is weakly coupled, using a coupled land-atmosphere background forecast and separate analyses for the atmosphere and for the surface (soil moisture, snow, soil temperature and snow temperature).

Weakly coupled Land Data Assimilation



Weakly coupled approach ⇒ Feedback ensured by coupled background forecasts

Weakly coupled Land Data Assimilation

Justification:

- Vertical correlations dominate land surface processes. Therefore each grid point is analysed independently. Land data assimilation is a 2D problem, whereas the atmosphere DA is a 4D problem.
- Weak coupling gives flexibility to run land analysis without the expensive 4D-Var component (ERA-Land type, PILDAS)

Weaknesses:

Increments related to fast coupled processes (e.g. precip/soil moisture) are potentially inconsistent at the interface.

Illustration of weakly coupled Soil analysis

Land Data Assimilation methods