Servei Meteorològic de Catalunya

IMPACT OF LOCAL MEASUREMENTS ON LIMITED AREA FORECASTS

METEOROLOGICAL SERVICE OF CATALONIA

Jordi Moré Pratdesaba

COSMEMOS project WORKSHOP ***Livorno, 23 October 2013***

Generalitat de Catalunya
Departament de Territori i Sostenibilitat

COSMEMOS
Innovation in meteorology for maritime navigation

European GNSS Agency

Servei Meteorològic de Catalunya

INTRODUCTION

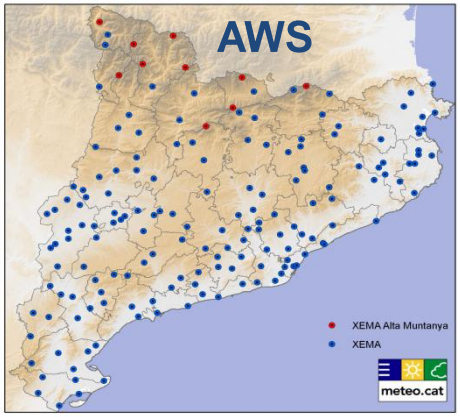
METEOROLOGICAL SERVICE OF CATALONIA

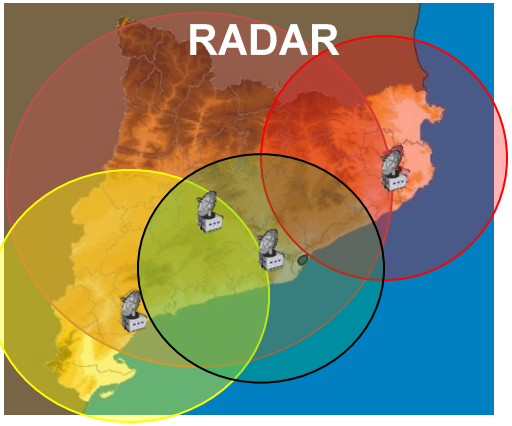
- Climatological studies.
- Meteorological surveillance.
- Warning alerts.

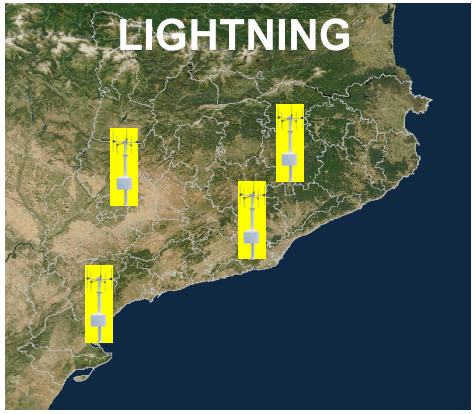
Area = 32.000 km^2

Population = 7.5 millions

Municipalities = 946







Generalitat de Catalunya
Departament de Territori i Sostenibilitat

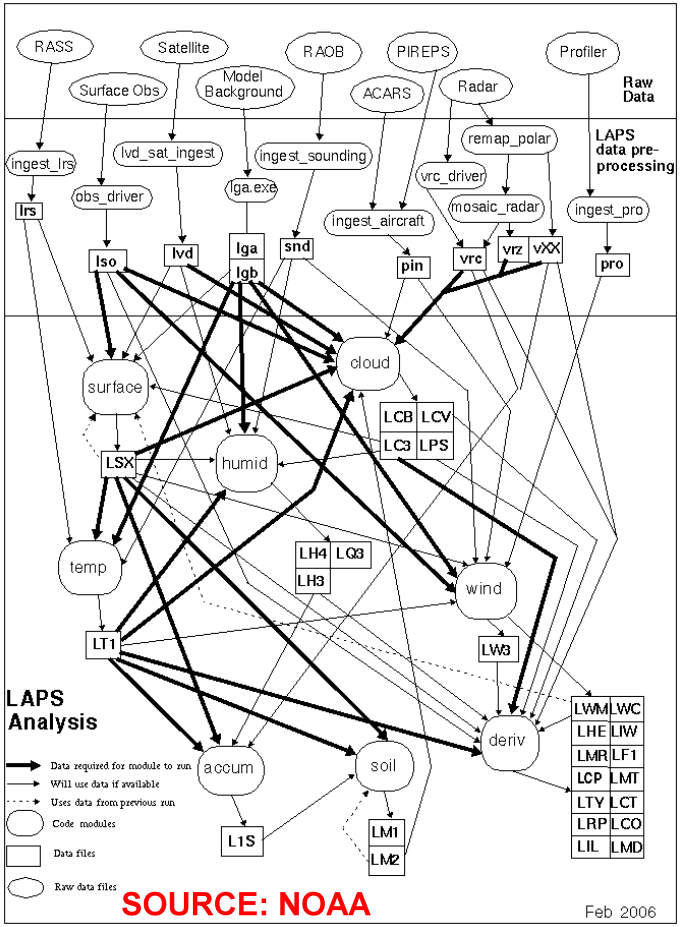
COSMEMOS
Innovation in meteorology for maritime navigation

European GNSS Agency

LAPS: Overview

LOCAL ANALYSIS AND PREDICTION SYSTEM (LAPS)

- Forecast Applications Branch (FAB) at NOAA's Global Systems Division (GSD)
- Data Assimilation System (two-fold):
  - Analyses of local weather conditions
  - Improve short-range forecasts
- Wide variety of observational datasets (spatially and temporally)
- Highly portable and computationally cheap
- Complete set of different modules



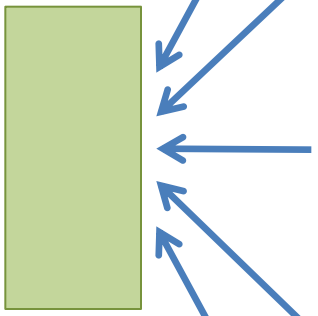
Servei Meteorològic de Catalunya

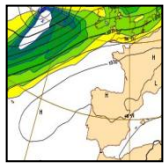
LAPS: Observations

OBSERVATIONAL DATA ROUTINELY ASSIMILATED WITHIN LAPS AT METEOCAT

In test mode

Out of time (> Cut-off Time)

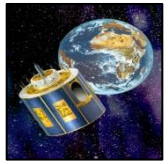




NWP — WRF-ARW 3 km

UPPER AIR DATA — Soundings

SFC DATA — METAR / AWS (XEMA) / Buoys



MSG — IR 12.0 μ / IR 10.8 μ / IR 3.9 μ / VIS / AMV

RADAR (XRAD) — Reflectivity / Radial velocity

Generalitat de Catalunya
Departament de Territori i Sostenibilitat

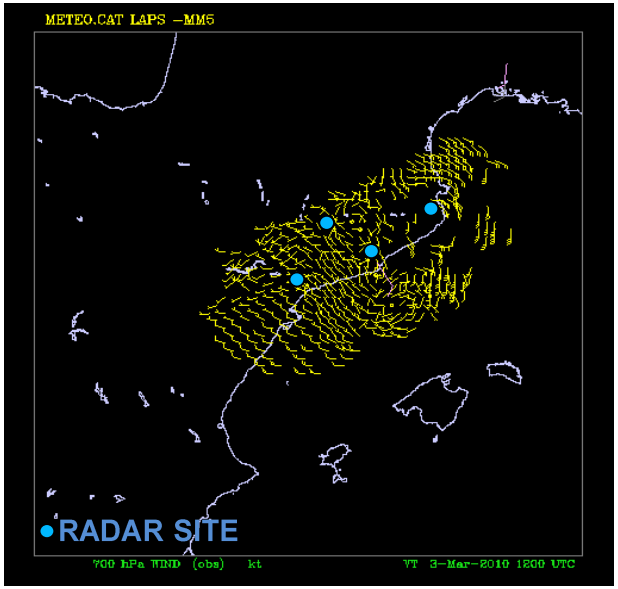
COSMEMOS
Innovation in meteorology for maritime navigation

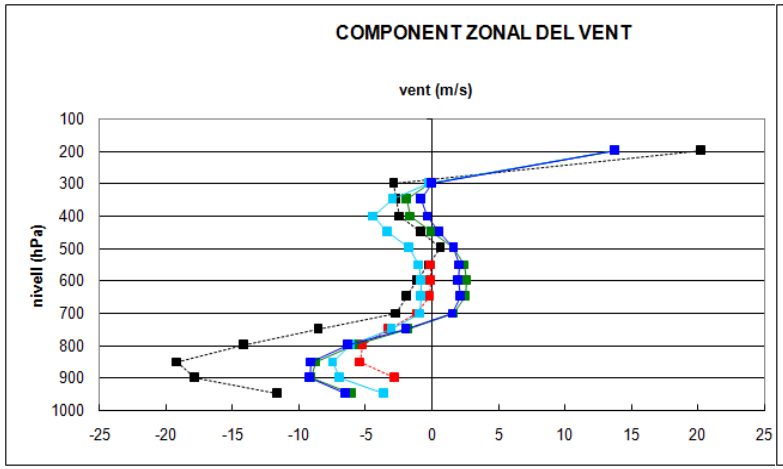
European GNSS Agency

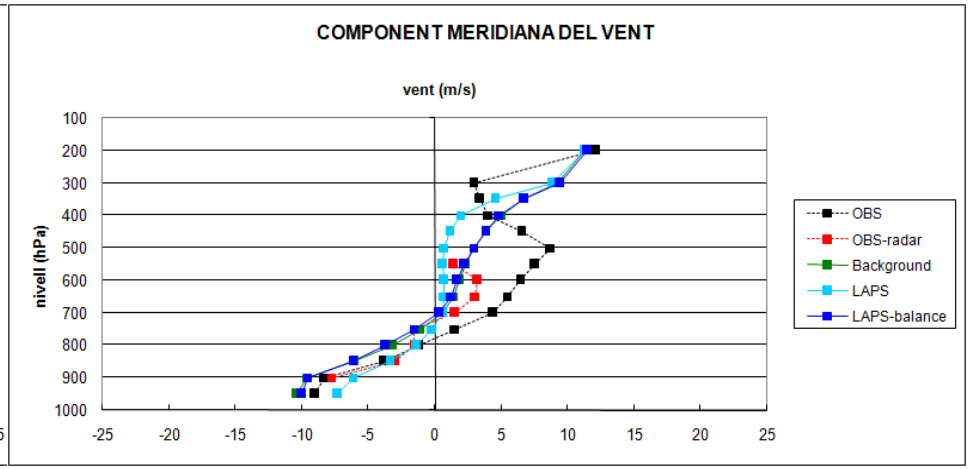
Servei Meteorològic de Catalunya

LAPS: Wind Analysis

- Multiple iteration successive correction technique.
- **Data sources**: Soundings, Cloud-drift winds, Doppler Radar.
- Quality controls & Time tendencies.
- Be aware with **Doppler radial velocities**!







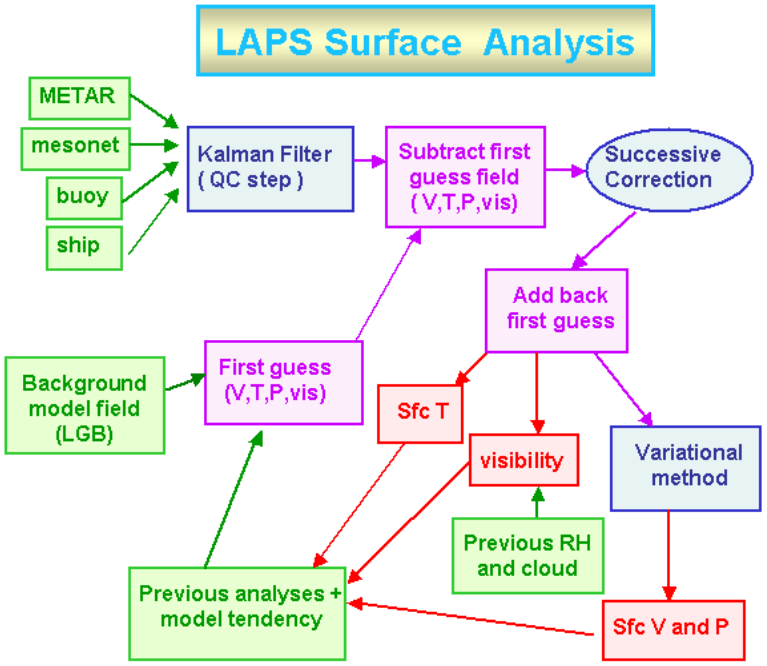
Generalitat de Catalunya
Departament de Territori i Sostenibilitat

COSMEMOS
Innovation in meteorology for maritime navigation

European GNSS Agency

LAPS: SFC Analysis

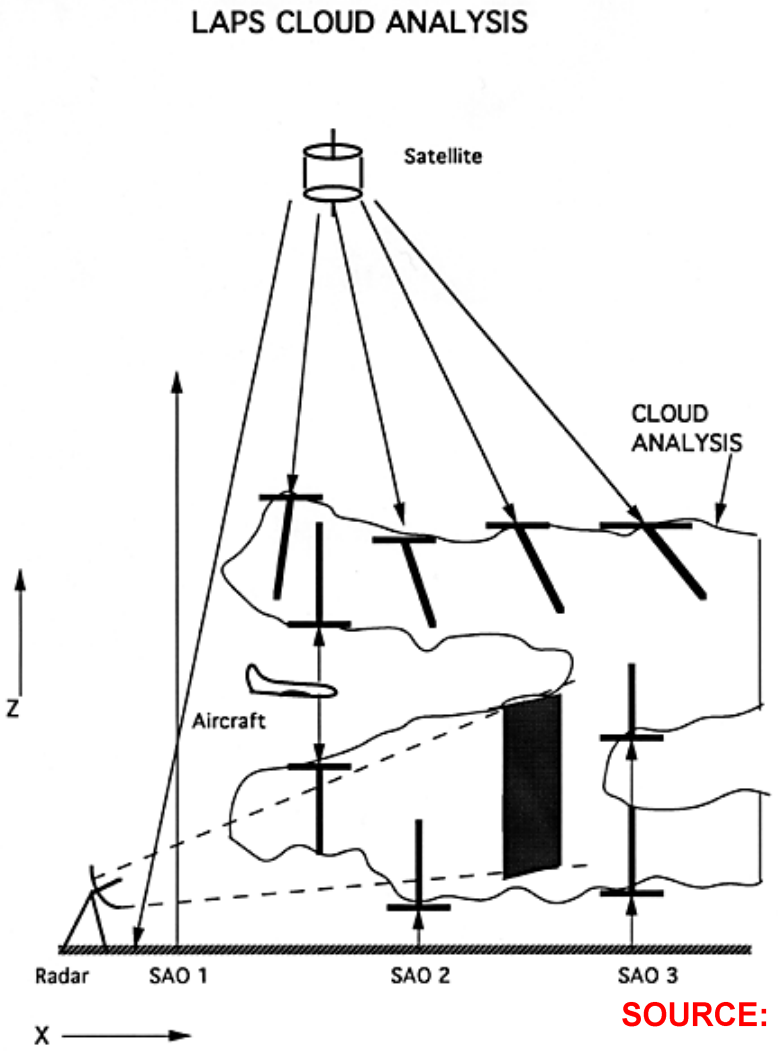
- Several quality controls.
- Successive correction technique (observations increments).
- Analysis innovation constraint.
- Land fraction weight.
- Variational method: Dynamic balance (pressure & wind).



SOURCE: NOAA

LAPS: Cloud Analysis (I)

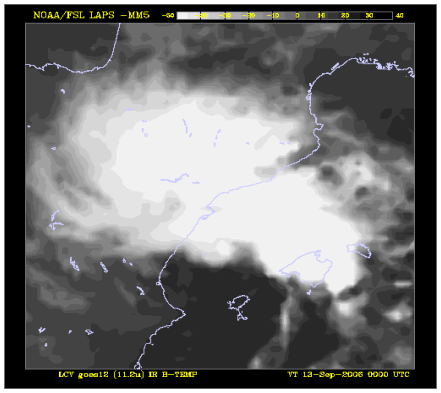
- Preliminary analysis (METAR, PILOT)
- IR Satellite data insertion:
  - Cloud-top height (using 3D temperature analysis).
  - Clear / Add clouds (1D forward model).
  - Check consistencies.
- Reflectivity data insertion.
- VIS Satellite data insertion.



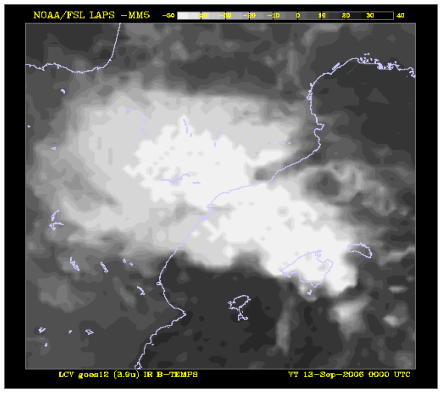
SOURCE: NOAA

Servei Meteorològic de Catalunya

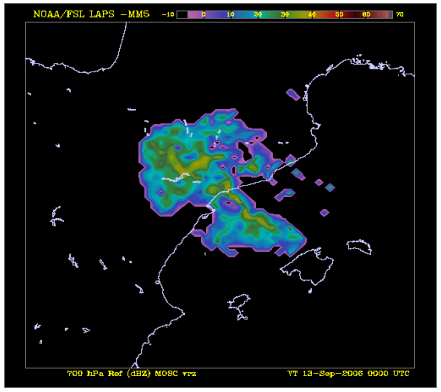
LAPS: Cloud Analysis (II)



MSG IR 10.8 μ

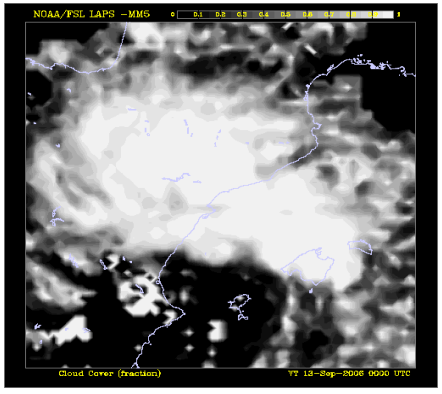


MSG IR 3.9 μ



RADAR (dBZ)

LAPS CLOUD ANALYSIS



CLOUD COVER

Generalitat de Catalunya
Departament de Territori i Sostenibilitat

COSMEMOS
Innovation in meteorology for maritime navigation

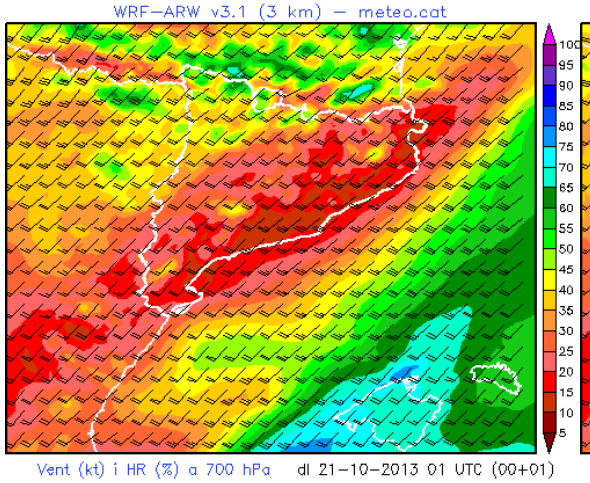
European GNSS Agency

Servei Meteorològic de Catalunya

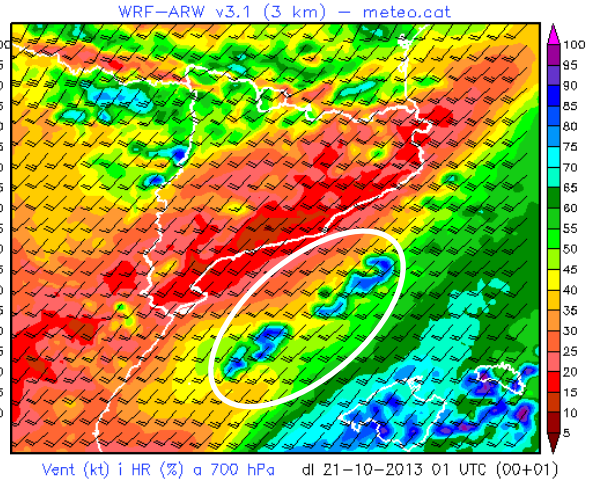
LAPS: Moisture Analysis

- Variational method (Functional minimization).
- Satellite radiance forward model (OPTRAN).
- Clear / cloudy sky treatment (Cloud analysis).
- Humidity adjustment.

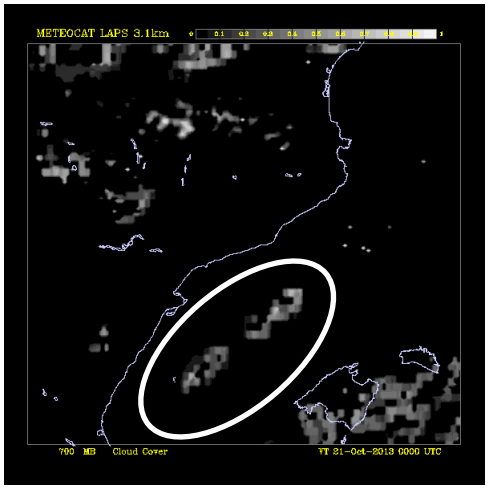
WRF-CTRL (RH)



WRF-LAPS (RH)



LAPS (CLOUD COVER)



Generalitat de Catalunya
Departament de Territori i Sostenibilitat

COSMEMOS
Innovation in meteorology for maritime navigation

European GNSS Agency

LAPS: Other utilities

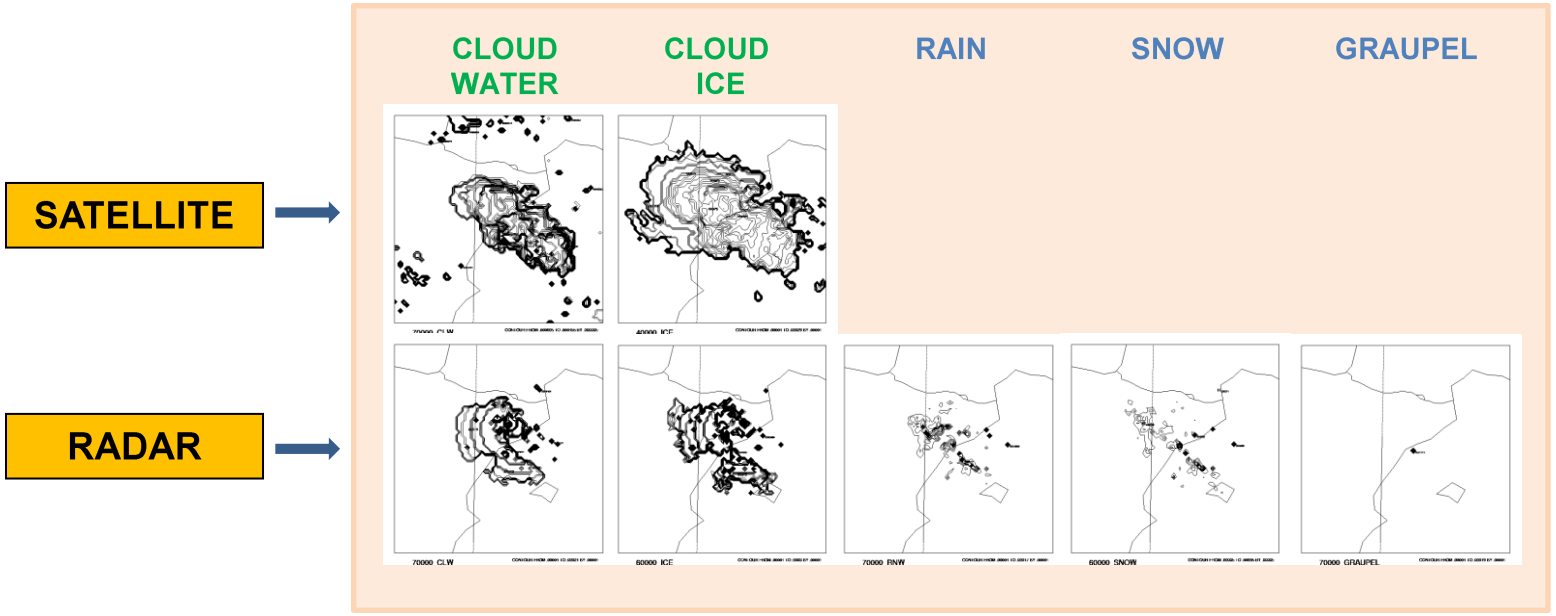
- Quasi-geostrophic balance (module **balance**):
  - Dynamical constraints.
  - 3D cloud fields balanced with the other fields.

- Derive Analysis output (module **derive**):
  - Precipitation types.
  - Cloud types.
  - Instability indexes.
  - Fire weather indexes.

LAPS: Other utilities

DIABATIC INITIALIZATION:

- Hydrometeor species: 5
- Coupling with model: Hot start



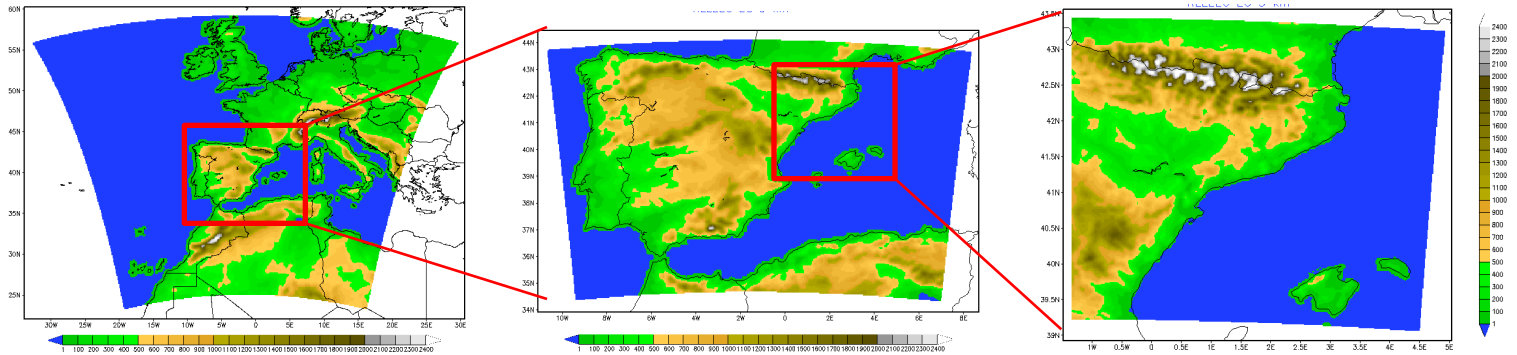
Servei Meteorològic de Catalunya

WRF-LAPS: Configuration

WRF-ARW (version 3.1)

- Grid length: 3 km
- Domain: 166x154x31
- Lead Time: 12 h (outputs every 1 h)
- Initial Conditions (IC): LAPS analysis
- Boundary Conditions (BC): WRF-ARW 9 km

ECMWF GFS



27 km 9 km 3 km

Generalitat de Catalunya
Departament de Territori i Sostenibilitat

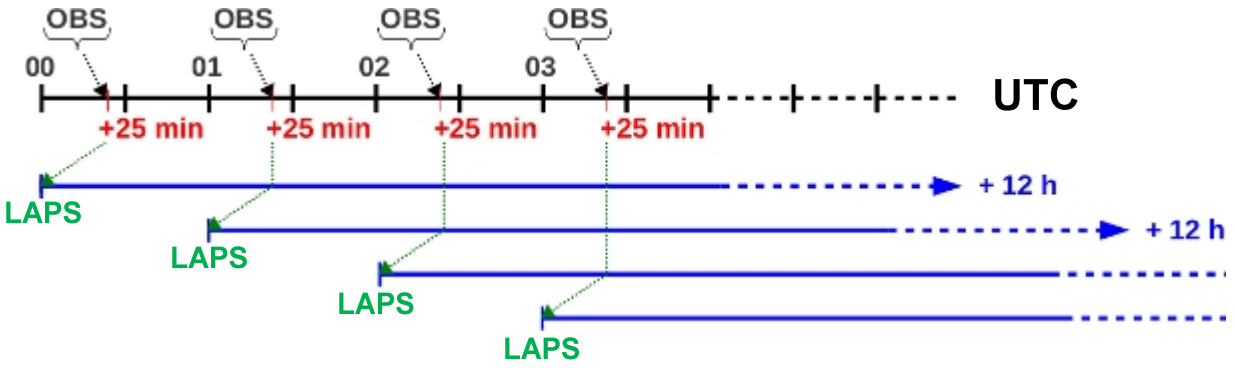
COSMEMOS
Innovation in meteorology for maritime navigation

European GNSS Agency

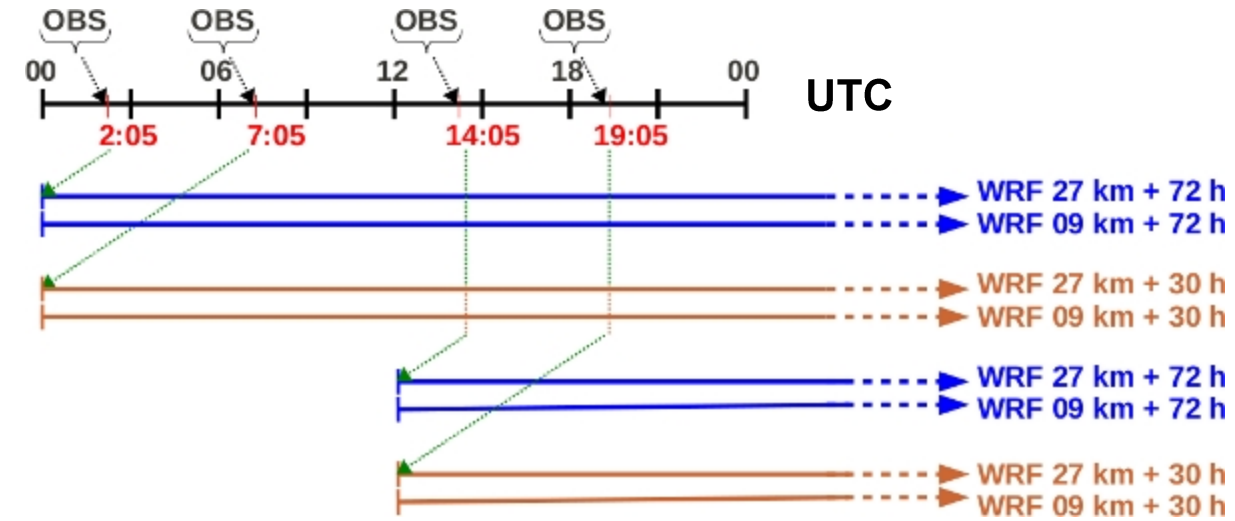
Servei Meteorològic de Catalunya

WRF-LAPS: Schedule

WRF-LAPS 3 km



BOUNDARY CONDITIONS



Generalitat de Catalunya
Departament de Territori i Sostenibilitat

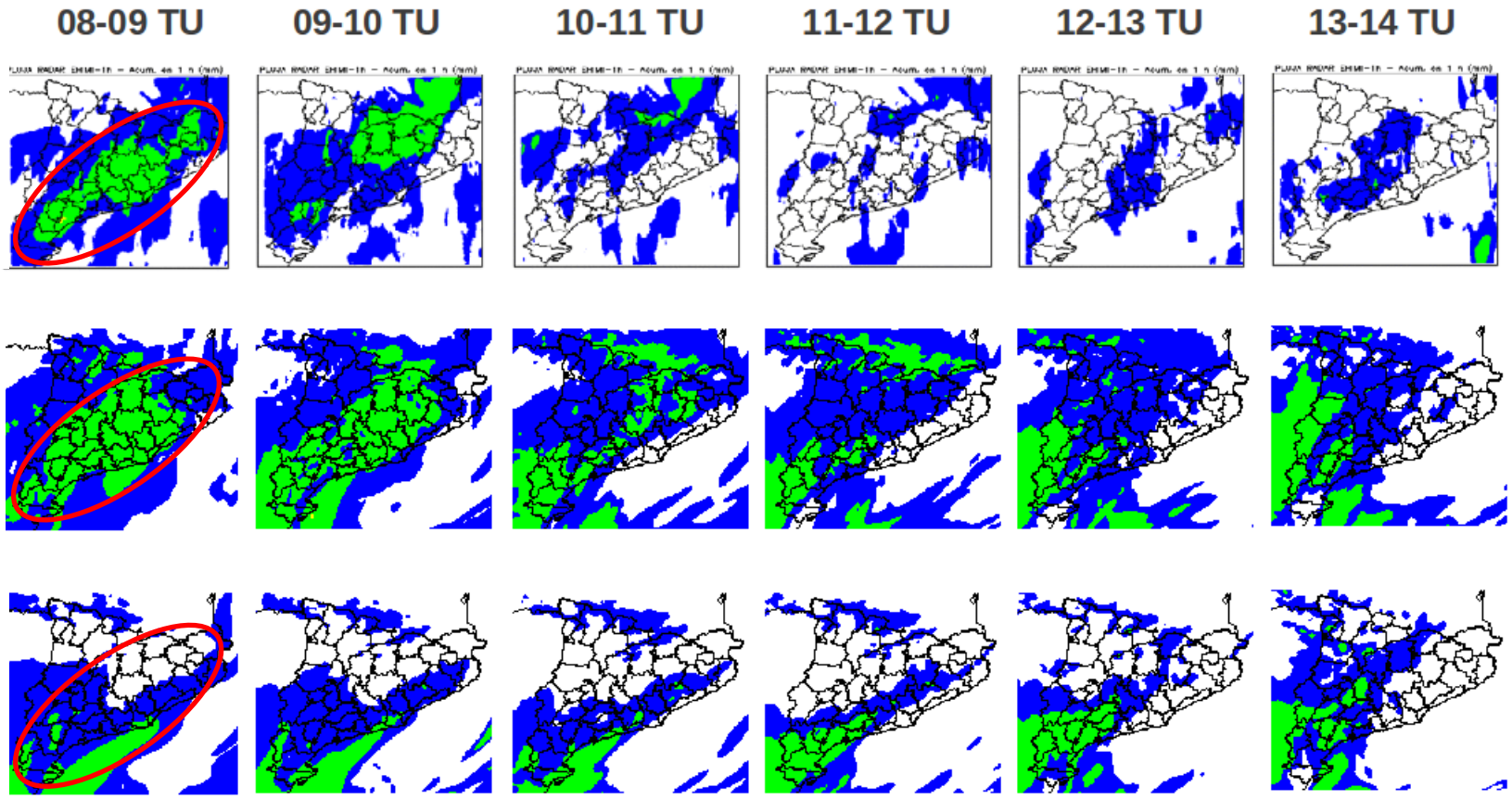
COSMEMOS
Innovation in meteorology for maritime navigation

European GNSS Agency

Servei Meteorològic de Catalunya

WRF-LAPS: Examples

WRF-LAPS – 28/04/2013 – SIM 08 TU



Generalitat de Catalunya
Departament de Territori i Sostenibilitat

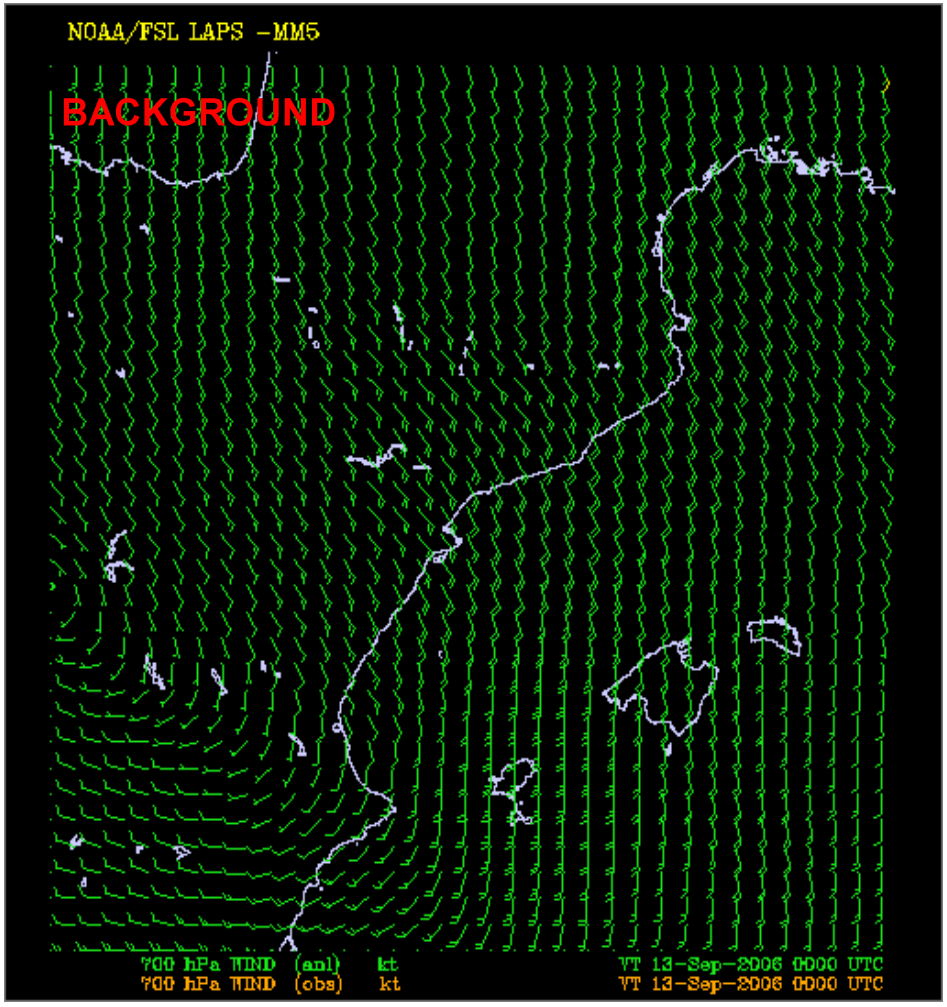
COSMEMOS
Innovation in meteorology for maritime navigation

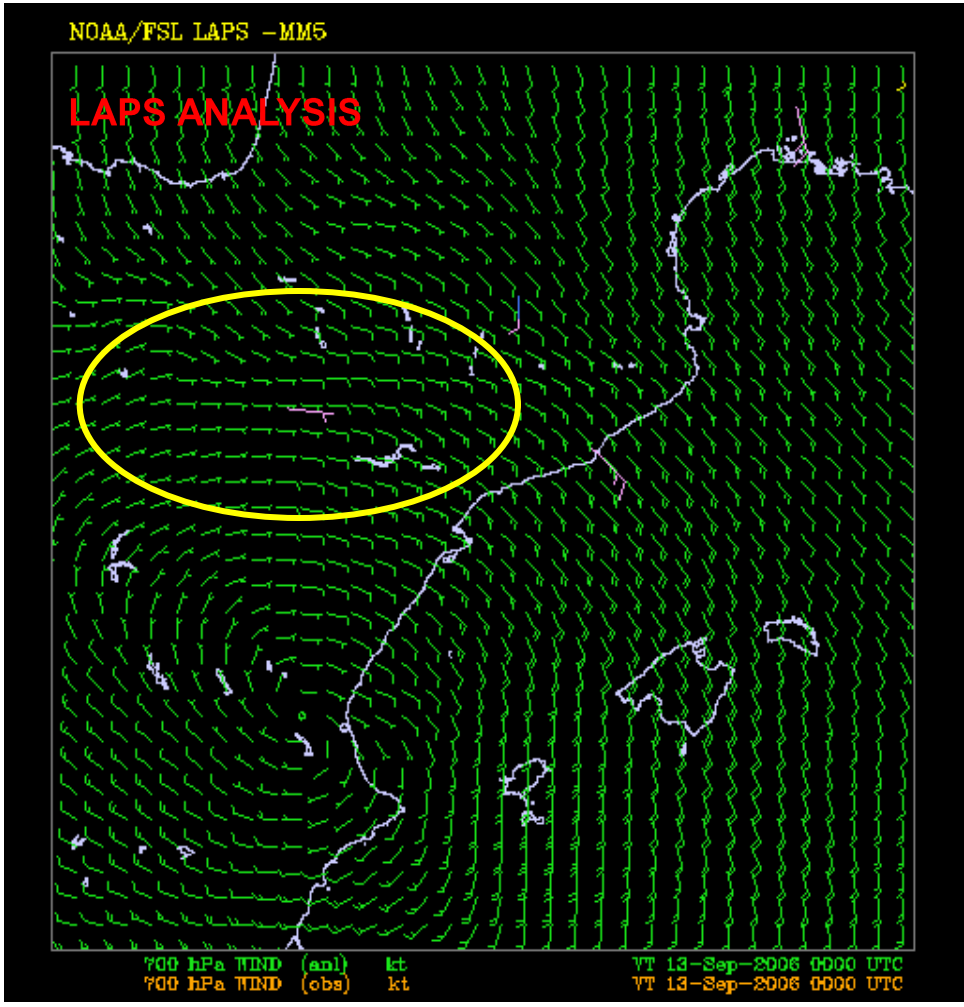
European GNSS Agency

Servei Meteorològic de Catalunya

WRF-LAPS: Examples

RAOB OBSERVATIONS IMPACT





Generalitat de Catalunya
Departament de Territori i Sostenibilitat

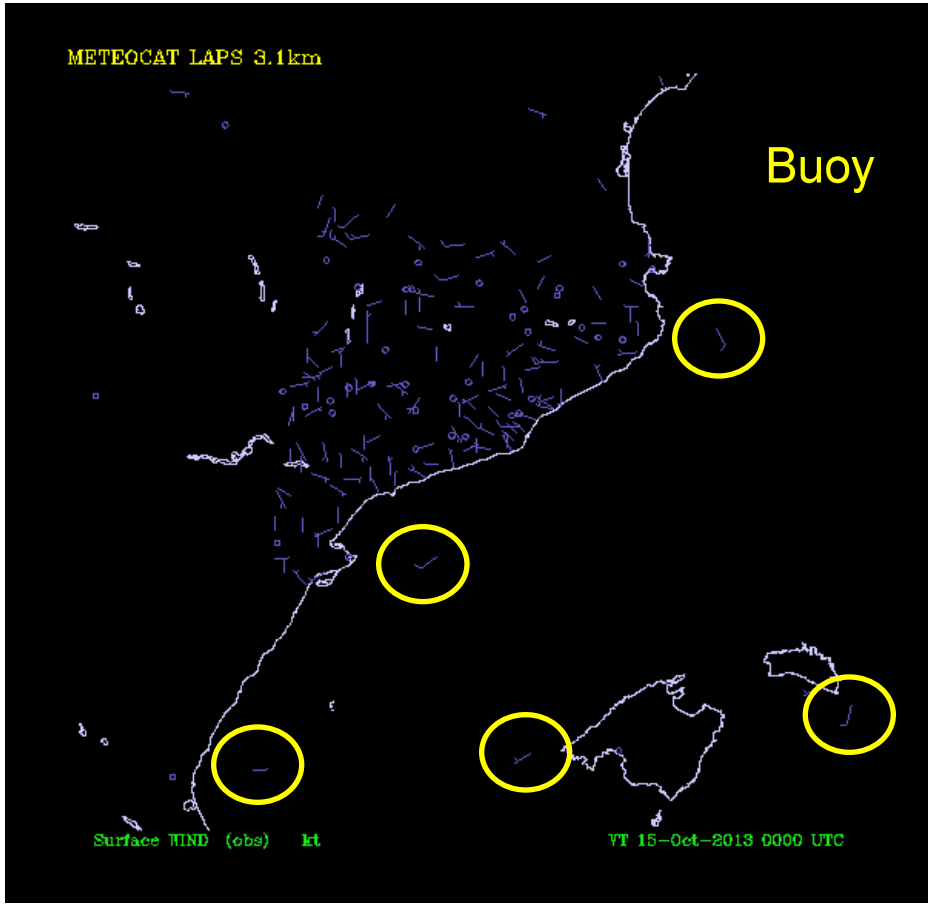
COSMEMOS
Innovation in meteorology for maritime navigation

European GNSS Agency

Servei Meteorològic de Catalunya

WRF-LAPS: Examples

WIND OBSERVATIONS WITHIN LAPS DOMAIN



Generalitat de Catalunya
Departament de Territori i Sostenibilitat

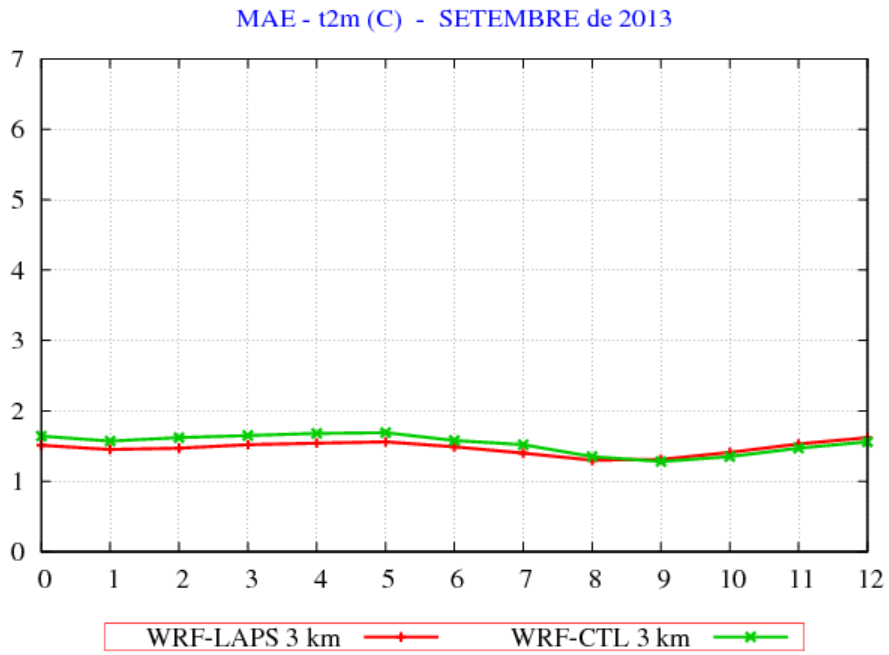
COSMEMOS
Innovation in meteorology for maritime navigation

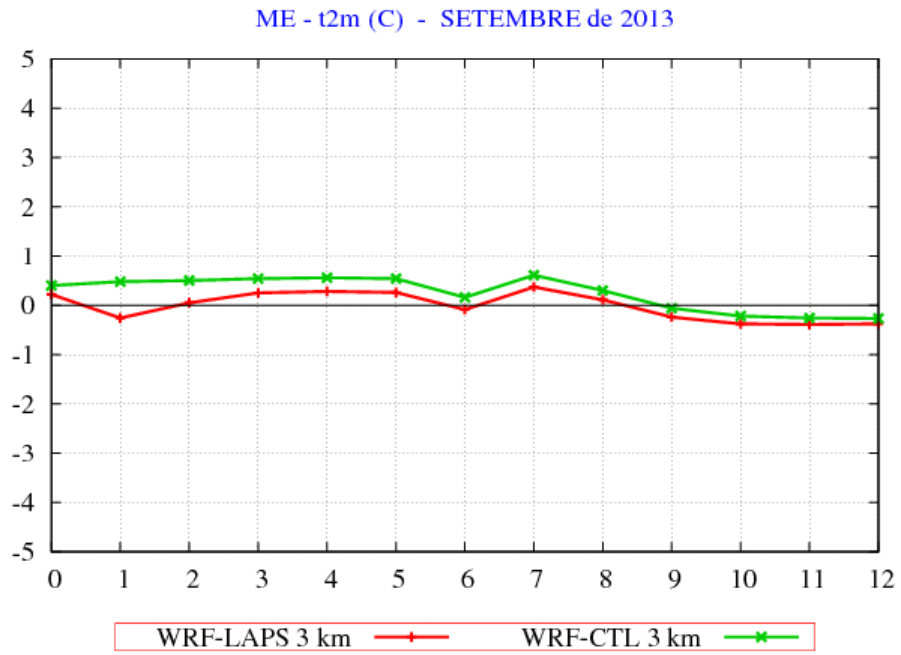
European GNSS Agency

Servei Meteorològic de Catalunya

WRF-LAPS: Examples

Monthly Verification (Temperature at 2 m)





Generalitat de Catalunya
Departament de Territori i Sostenibilitat

COSMEMOS
Innovation in meteorology for maritime navigation

European GNSS Agency

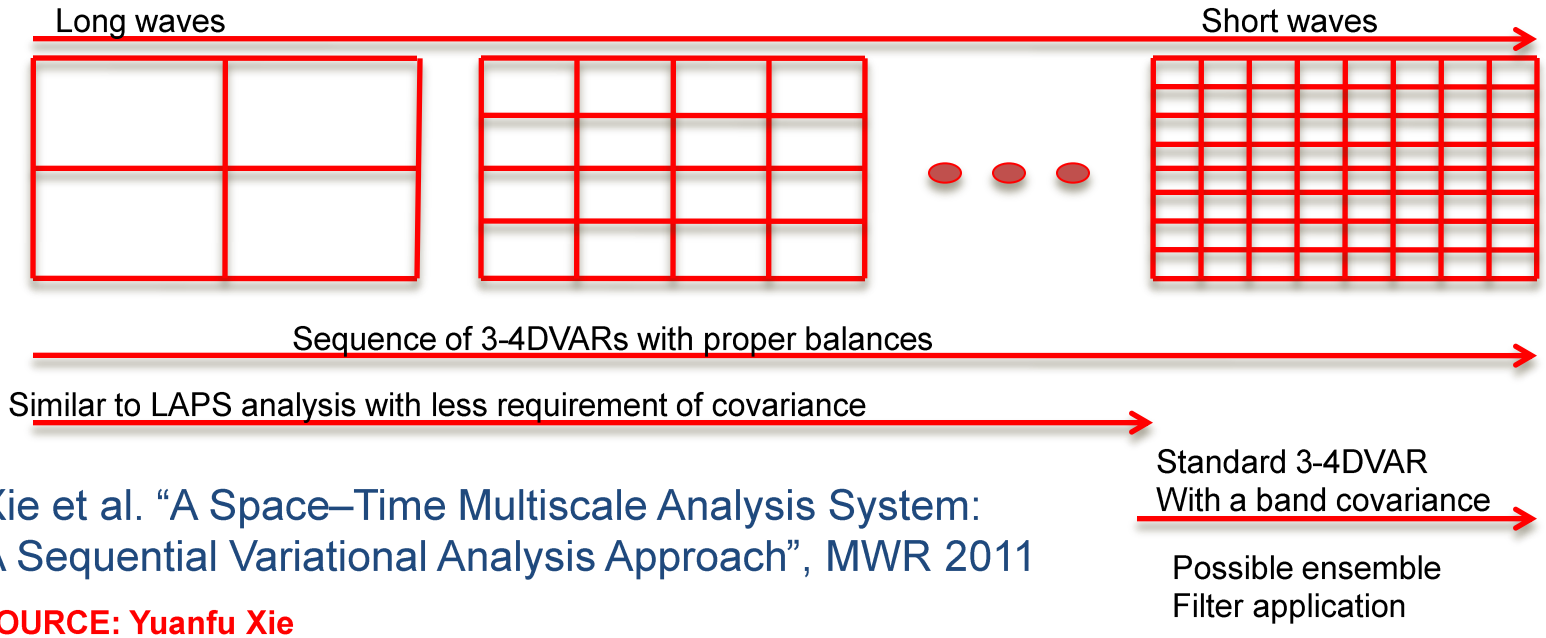
Servei Meteorològic de Catalunya

FUTURE WORK

- Explore new observational platforms:
  - Improve spatial and temporal area coverage.
  - Additional variables.
- Adjust analysis parameters:
  - Cloud analysis.
- Improve LAPS coupling with LAM:
  - Increase vertical levels.
  - Use LAPS in coarser domain (BC).
- Probabilistic products (time-lagged ensemble?)

FUTURE WORK

- Variational LAPS: **Space and Time Multiscale Analysis System (STMAS)**
  - Cross variable covariance errors.
  - Dynamical constraints.
  - Non-conventional observational data.



Xie et al. "A Space–Time Multiscale Analysis System: A Sequential Variational Analysis Approach", MWR 2011

SOURCE: Yuanfu Xie

Servei Meteorològic de Catalunya

THANK YOU

FOR YOUR ATTENTION !

Generalitat de Catalunya
Departament de Territori i Sostenibilitat

COSMEMOS
Innovation in meteorology for maritime navigation

European GNSS Agency