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Comparison of different oil drift models and different ocean forcing fields with observed drifter trajectories in the Mediterranean

Göran Broström and Many Others

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MERSEA

MERSEA oil spill: Who

Thanks to our coworkers!

- Météo-France (MF): Pierre Daniel, Denis Paradis, David Ayache, Patrick Lelay and Valérie Ulvoas; Stephane Law Chune, Yann Drillet and Gaetan Vinay (Mercator)
- Oceanography Centre, University of Cyprus (OC-UCY): George Zodiatis, Robin Lardner, Xenia Panayidou, Georgios Georgiou, Tom Eleftheriou and Dan Hayes.
- Norwegian Meteorological Institute (met.no): Bruce Hackett Gøran Brostrøm, Ana Carrasco, Aicha Bounaim, Arne Melsom, Reinoud Bokhorst and Øyvind Breivik.

Also special thanks to:

- Francois Parthiot (CEDRE), Petroula Louka (HNMS), Michela De Dominicis (INGV), Nadia Pinardi (INGV), Massimiliano Drudi (INGV), Thomas Loubrieu (Ifremer), Tony Jolibois (CLS), Matthieu Le Gall (TechWorks)

MERSEA oil spill: What

- **Aim**: Show that the use of Mersea ocean data products as forcing can improve operational oil spill fate forecasting services, by:
  - improving the forecast **accuracy** of existing services
  - extending the **reach** of existing services
    local → regional → global longer time horizon
  - leading to new types of forecast **products**
    (e.g., multimodel ensemble)

Drift of oil spill:

- **Parameterization based on observations**
  - **Drifts with say 2-3% of wind speed with a 0-20º deflections**
  - **Simple, reliable**
    - **May not cover all situations**
  - **MOTHY model from Meteo France**
    - **Uses a combination of wind induced drift and ocean currents at 100 m.**
  - **MEDSLIK model from OC-UCY**
    - **Uses a combination of wind induced drift and ocean currents at 50 m.**
- **Full model**
  - **Requires full ocean model**
    - **Ocean currents**
    - **Wave properties (Stokes drift)**
  - **Complicated**
    - **Have a wide range of applications**
  - **OD3D oil drift model met.no**
    - **Uses modelled ocean currents**
    - **Stokes drift from wave model**

t of buoy:

Importance of wave induced drift
Perrier et al 2003, JPO, 2126

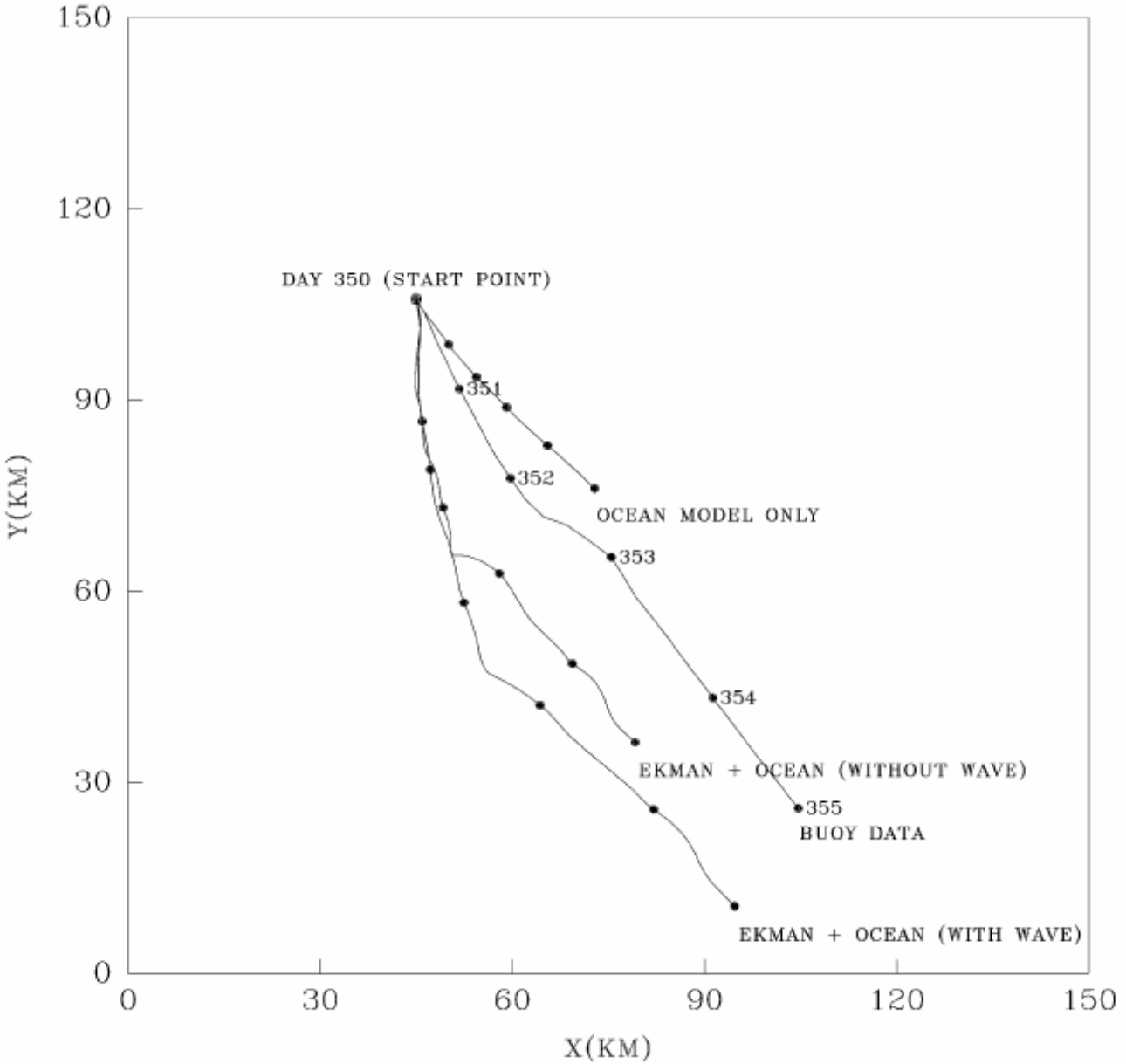


FIG. 12. As in Fig. 11 but a comparison between observed drift for buoy 23549 and model estimates for the ocean model only (*without* Ekman layer or wave-induced currents), with Ekman layer currents (labeled "without wave"), and with wave-modified Ekman layer currents (labeled "with wave").

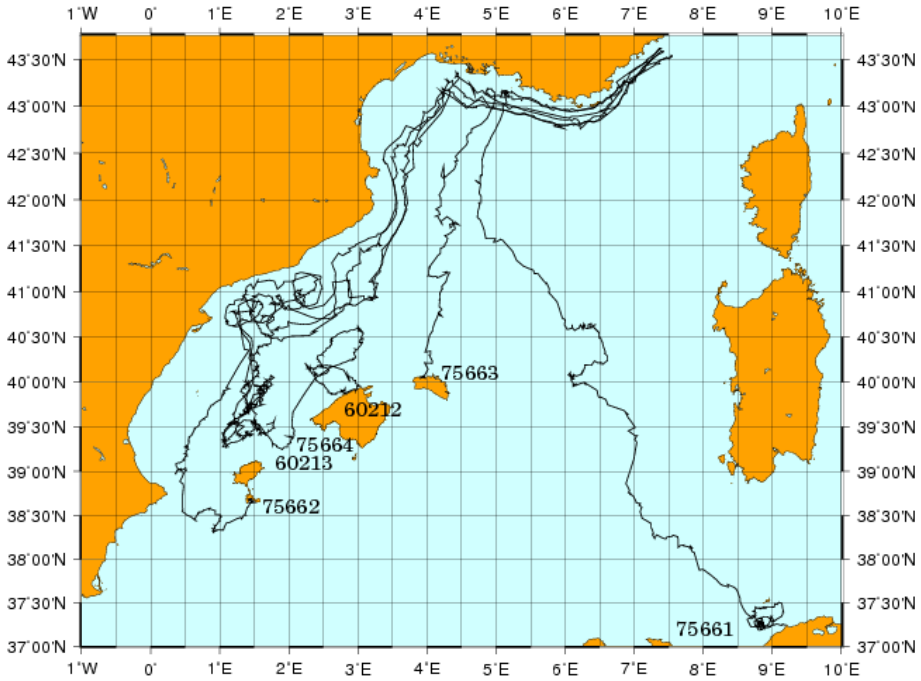
Data needed to force the OD3D model

Wind speed	*U_{10}, V_{10}*	*Fields (GRIB or netcdf)*
Wave parameter (analysed)	***U_{st}, V_{st}***	*Fields (GRIB or netcdf)*
Wave parameter	H_{sig}, T_p	*Fields (GRIB or netcdf)*
Sea surface temperature	SST	*Fields (GRIB or netcdf)*
Ocean surface current	***U, V***	*Fields (GRIB or netcdf)*

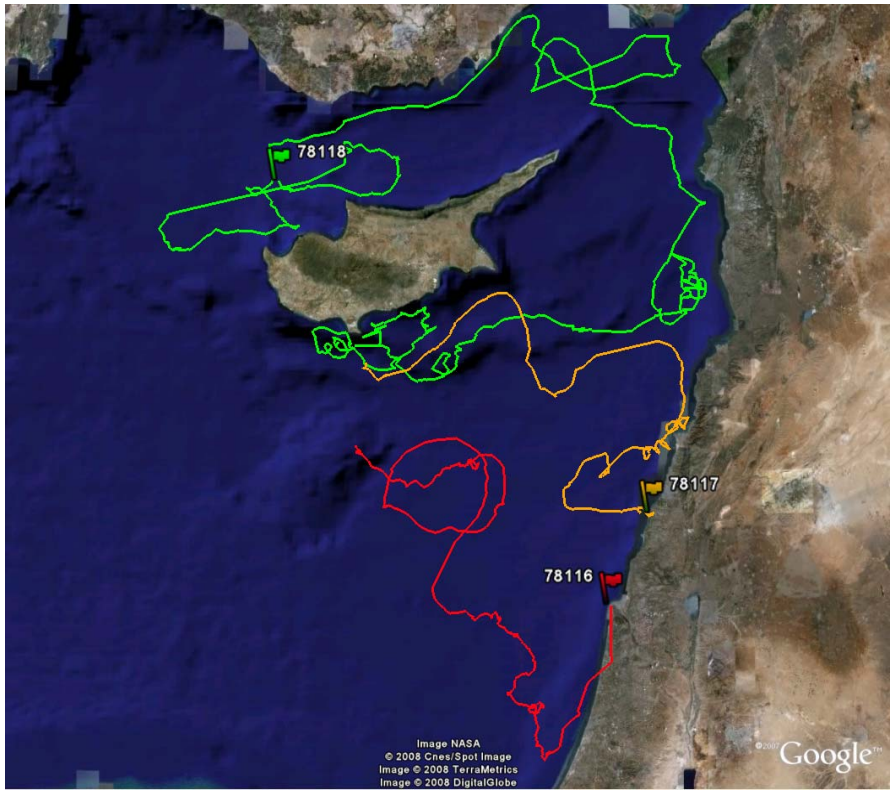
Preferably acquired using OPeNDAP using a single script that always works!

Mersea experiment – Overview

Western Mediterranean
7 drifters



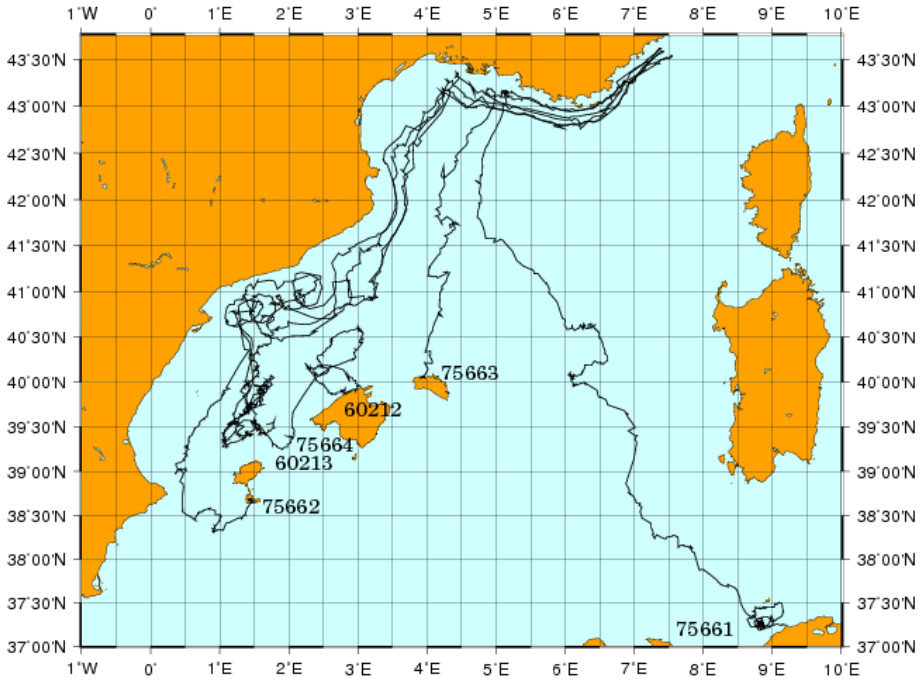
Eastern Mediterranean
3 drifters



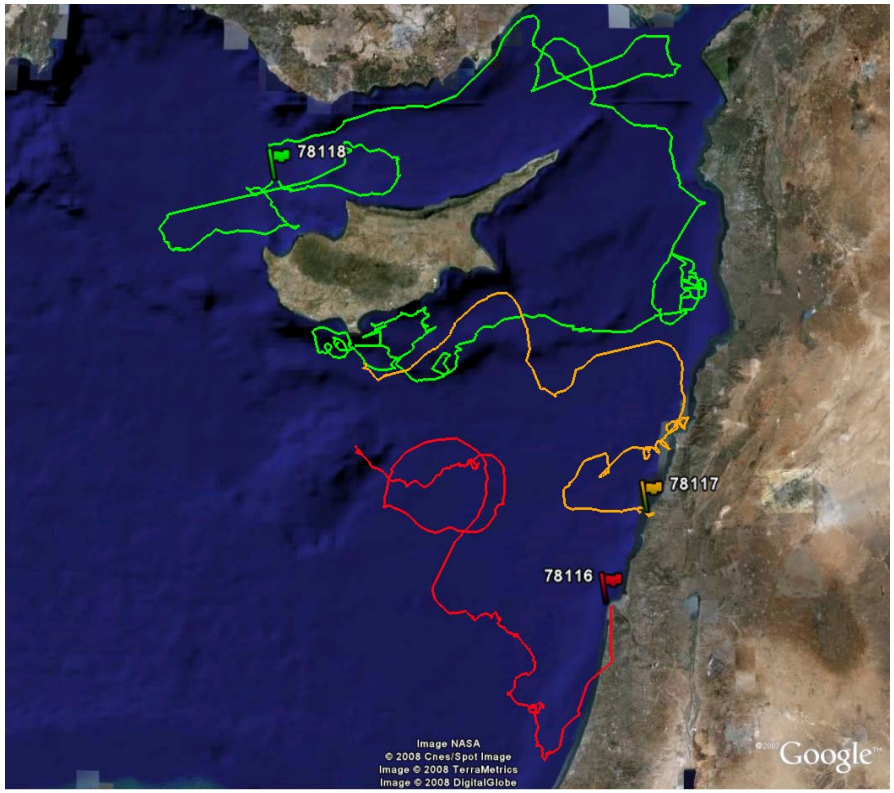
Schematic description of Mediterranean circulation

Mersea experiment – Overview

Western Mediterranean
7 drifters

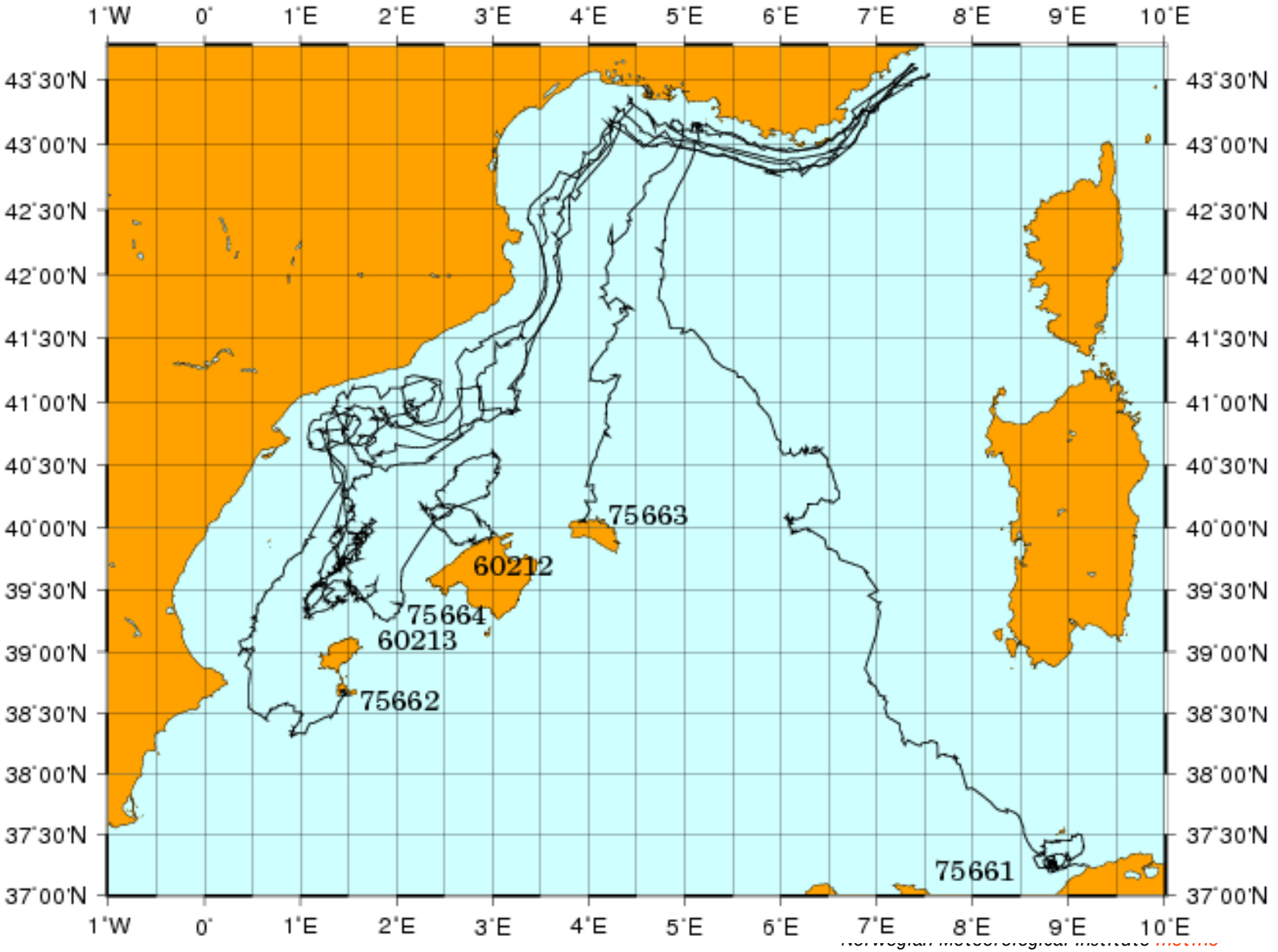


Eastern Mediterranean
3 drifters



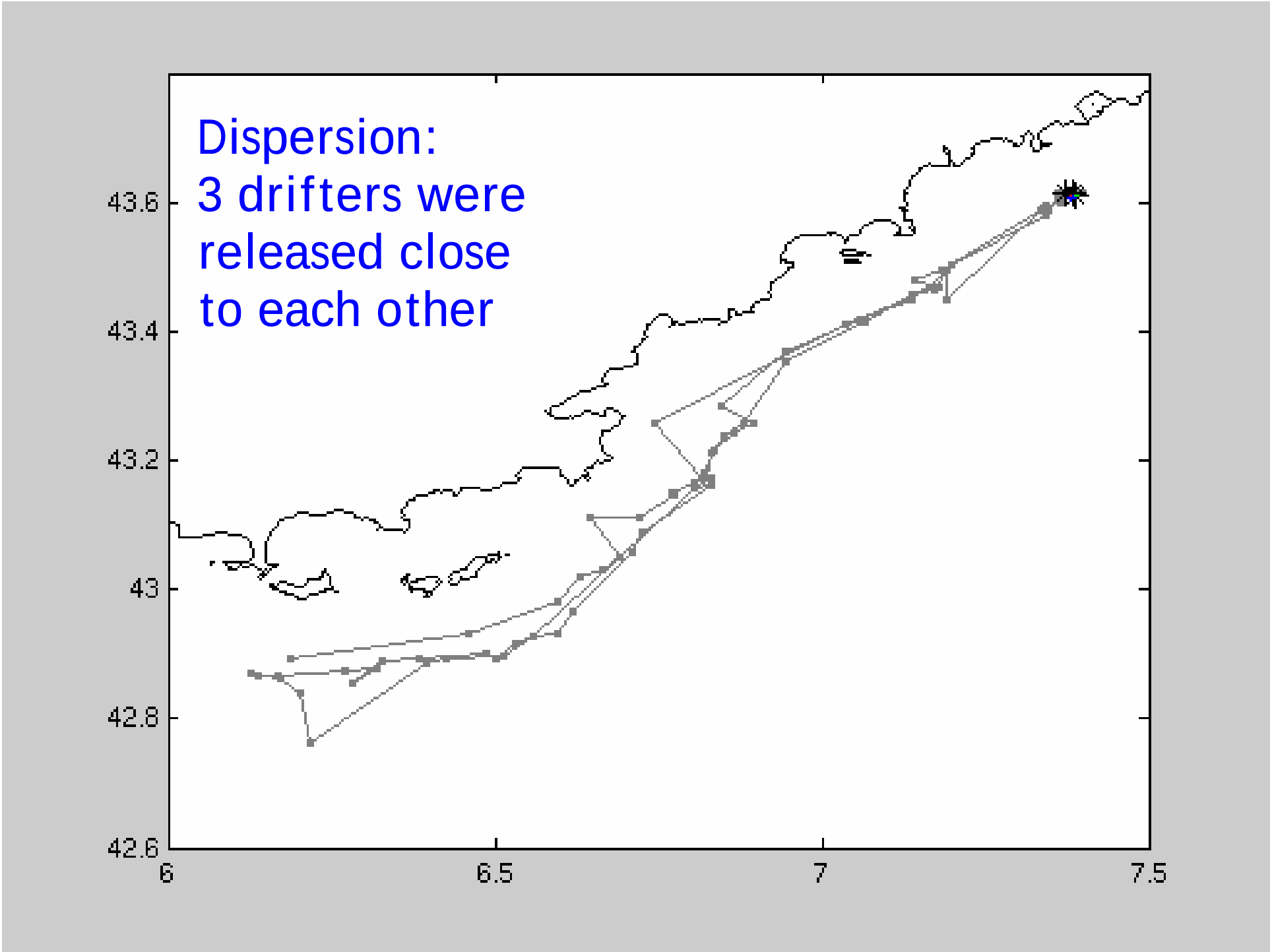
Western Med – Overview

surface buoys used in the Western Med experiment



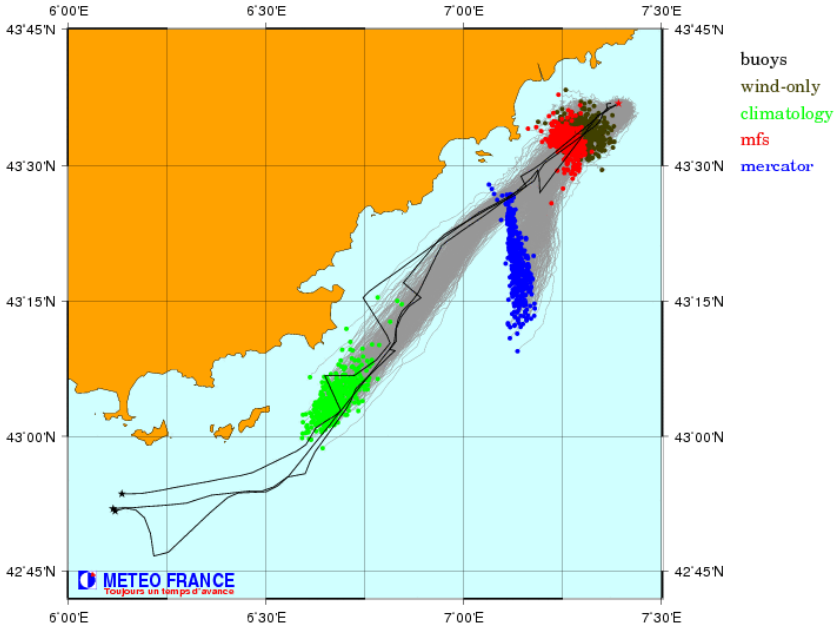
Western Med – Forcing

- met.no
  - ECMWF global wind
  - ECMWF global wave fields
  - Mercator or MFS ocean currents
- Meteo France
  - ECMWF global wind
  - Mercator, MFS or climatological ocean currents

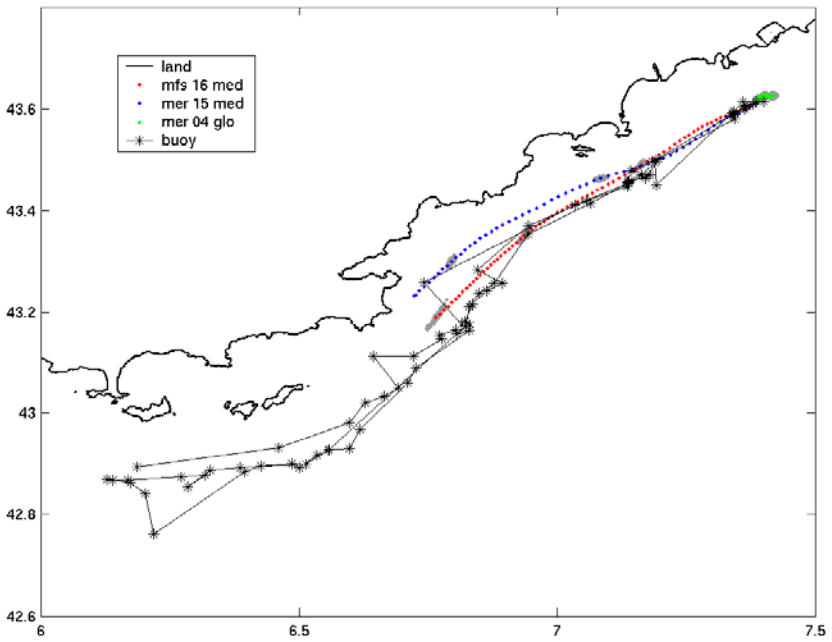

Dispersion:
3 drifters were
released close
to each other
43.6
43.4
43.2
43
42.8
42.6
6
6.5
7
7.5

West Med – Forecasts vs. drifters

MF MOTHY

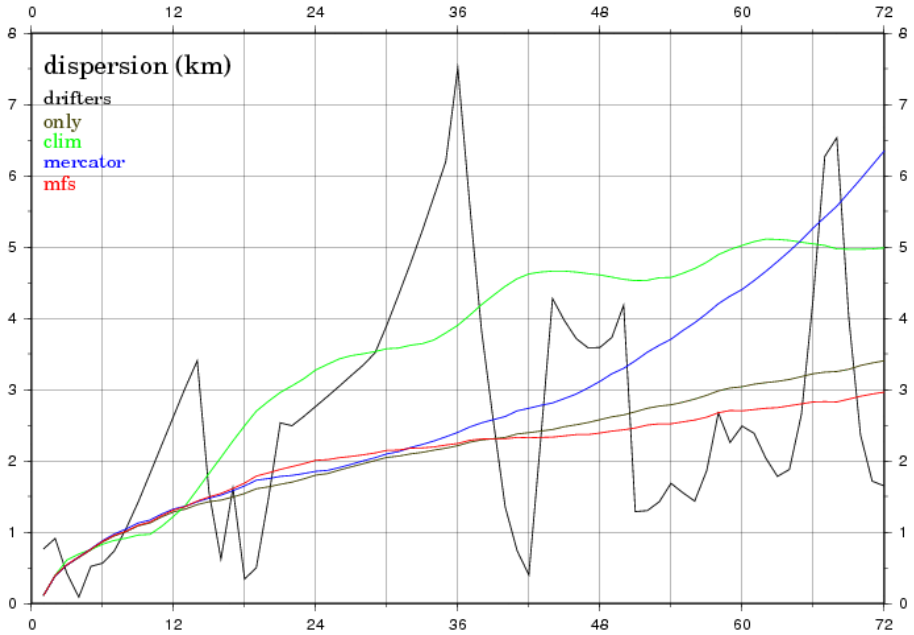


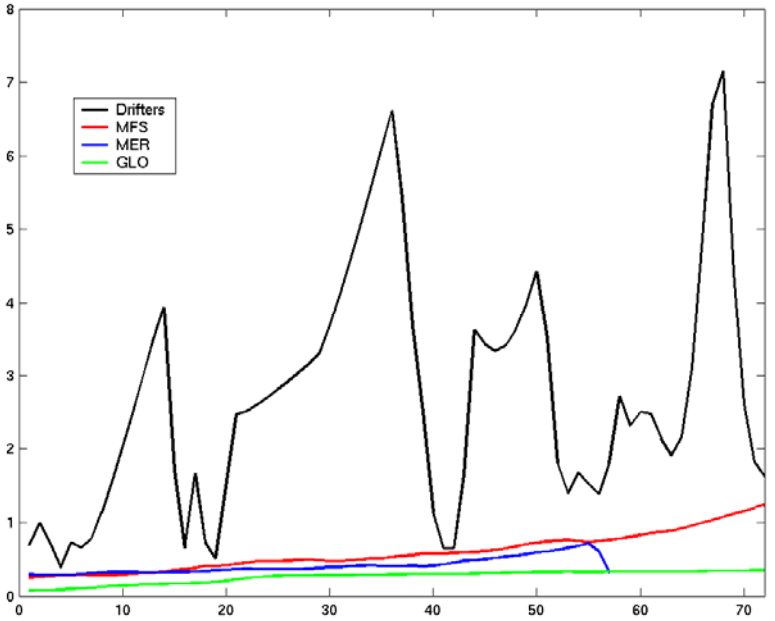
met.no OD3D



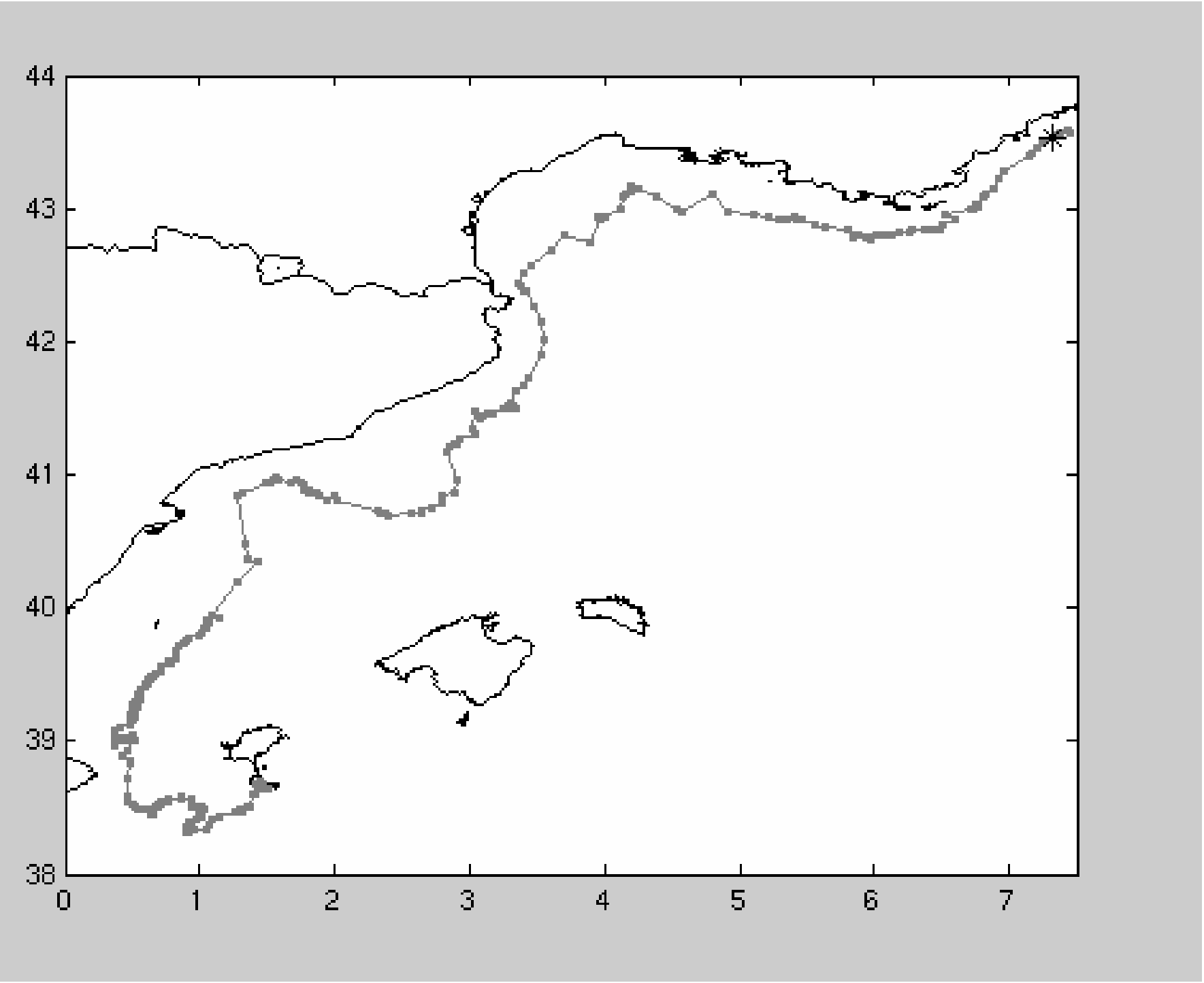
Forecasts (colors) using various ocean forcing data.

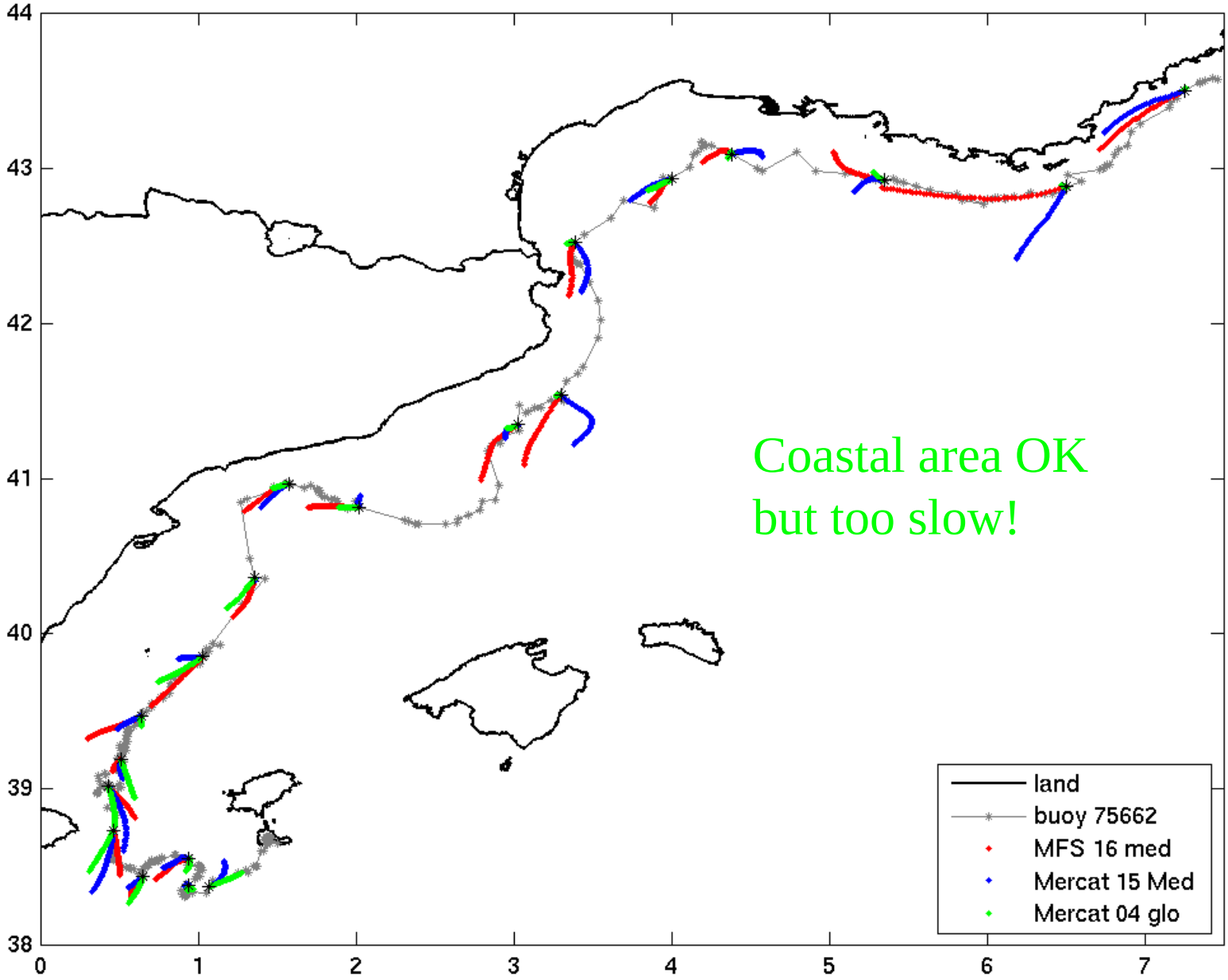
West Med – Dispersion



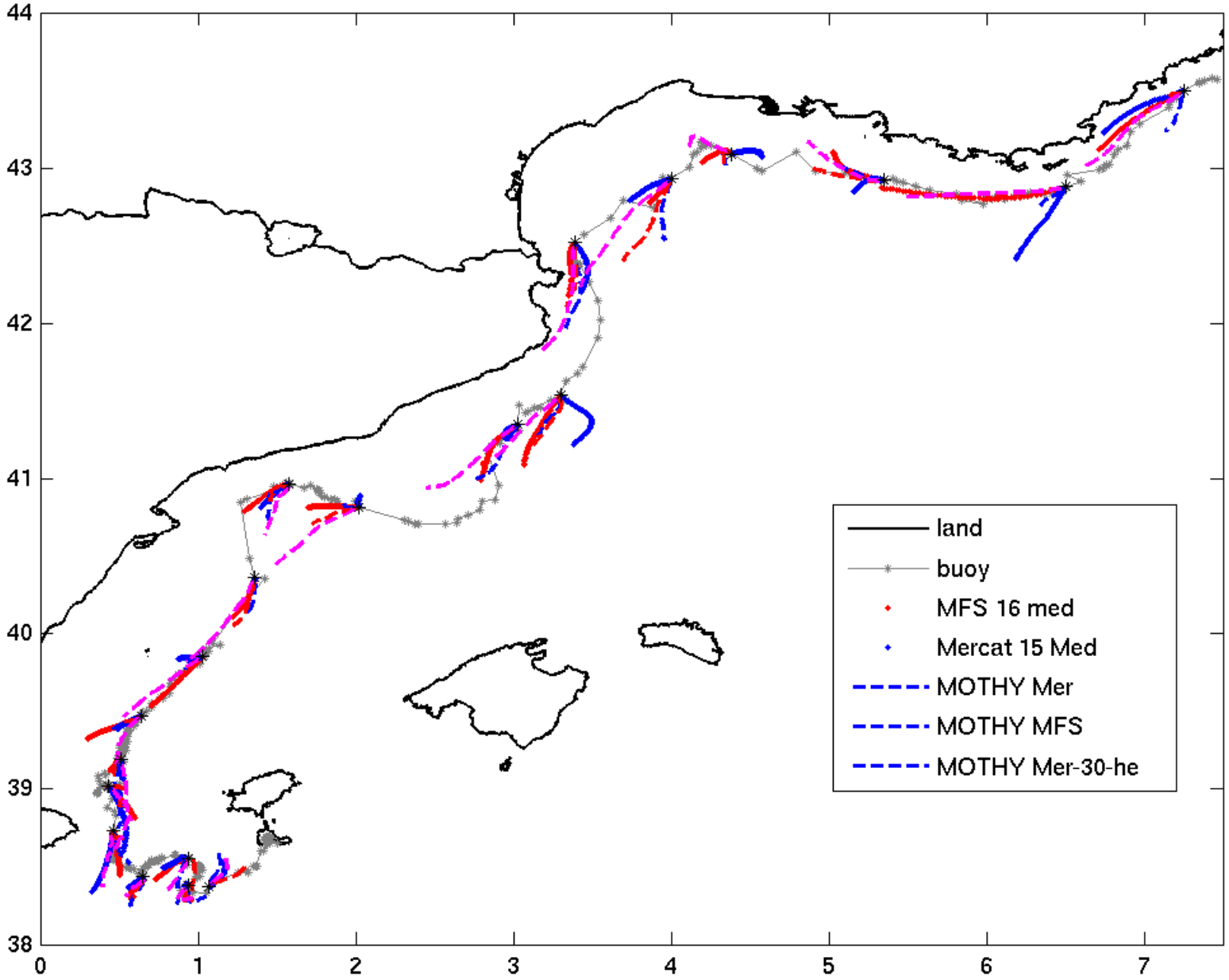


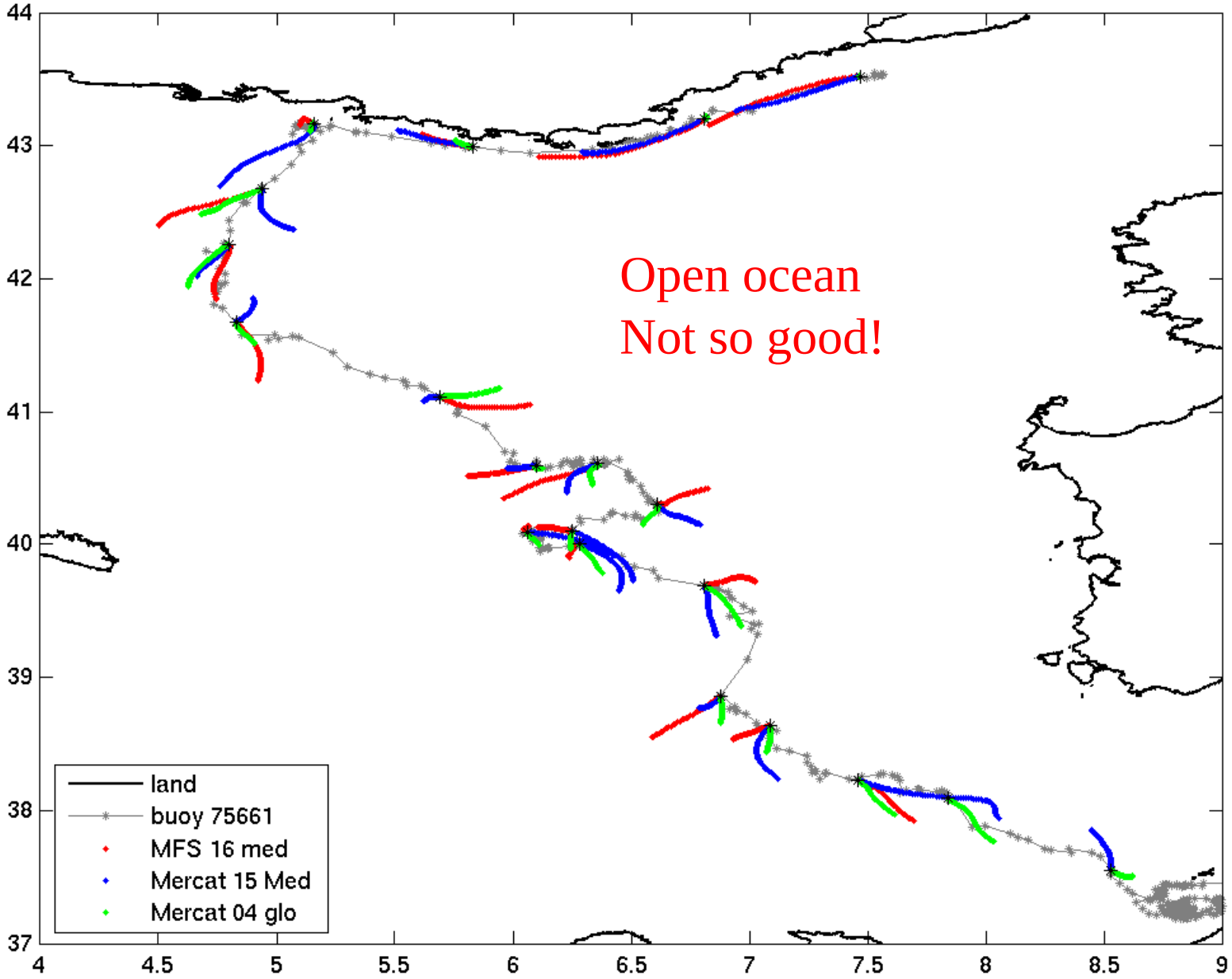
$$rms_{accuracy} = \sqrt{\left(\bar{x}(t) - \overline{x_d}(t)\right)^2 \cos^2\left(\bar{y}(t)\right) + \left(\overline{y}(t) - \overline{y_d}(t)\right)^2}$$

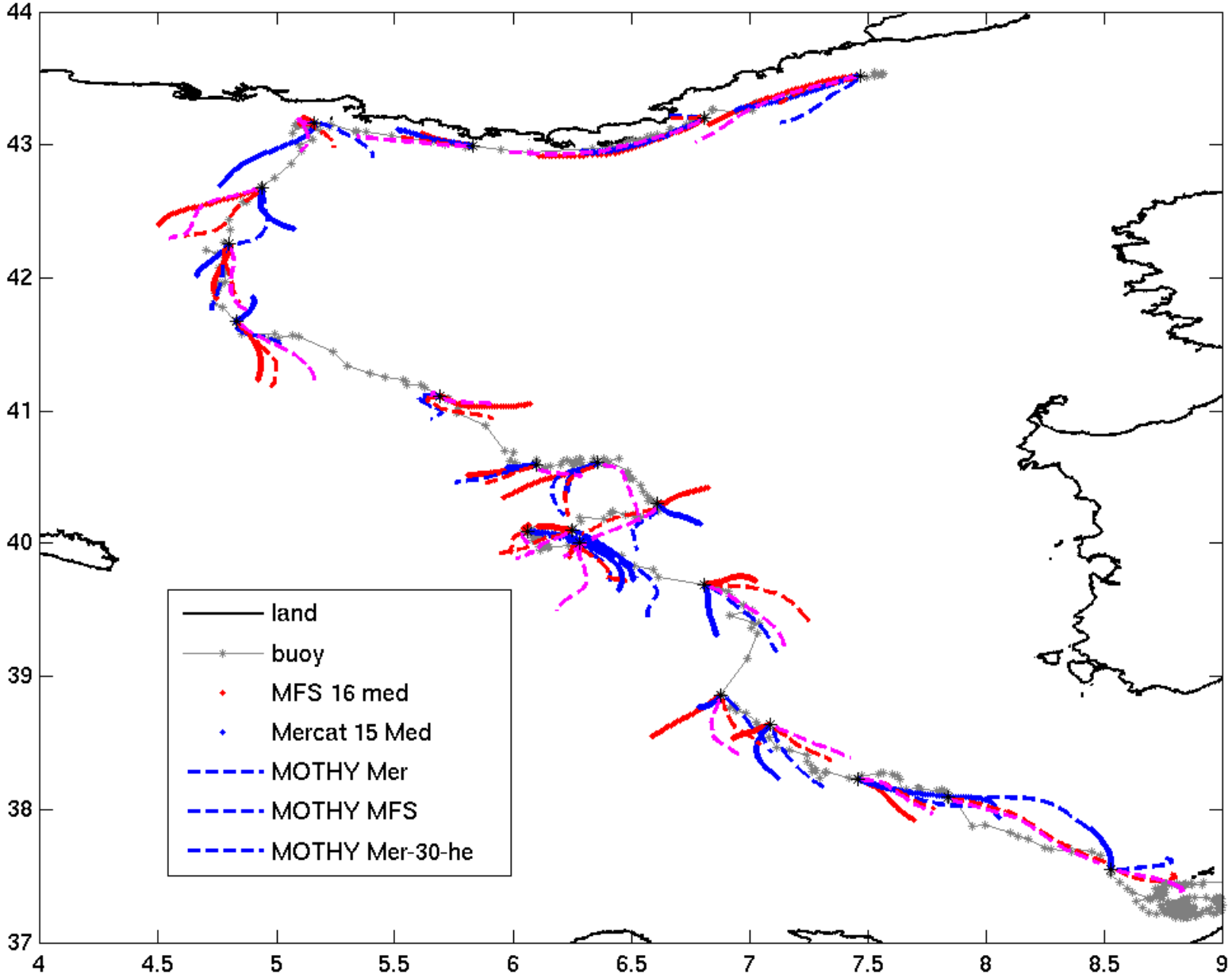

44
43
42
41
40
39
38
0
1
2
3
4
5
6
7


44
43
42
41
40
39
38
0
1
2
3
4
5
6
7
Coastal area OK
but too slow!
land
buoy 75662
MFS 16 med
Mercat 15 Med
Mercat 04 glo

Results from MOTHY and OD3d models using same forcings

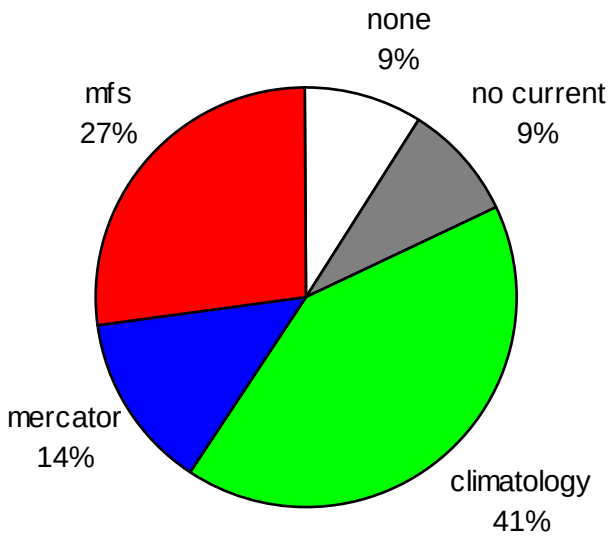



Open ocean
Not so good!
land
buoy 75661
MFS 16 med
Mercat 15 Med
Mercat 04 glo
44
43
42
41
40
39
38
37
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9

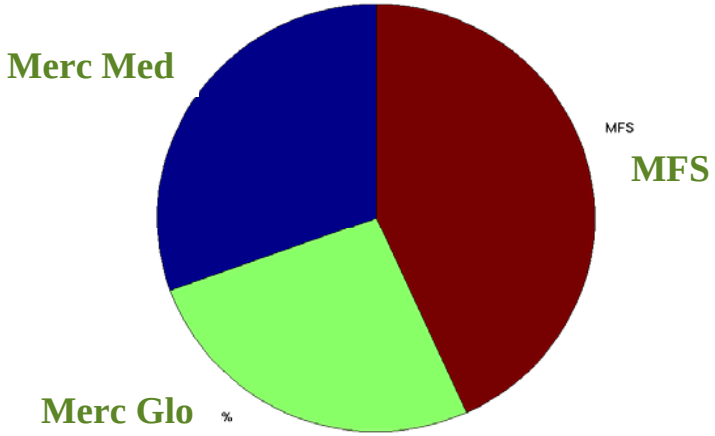

land
buoy
MFS 16 med
Mercat 15 Med
MOTHY Mer
MOTHY MFS
MOTHY Mer-30-he
44
43
42
41
40
39
38
37
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9

DEMO Western Med – Performance

MF MOTHY



met.no OD3D

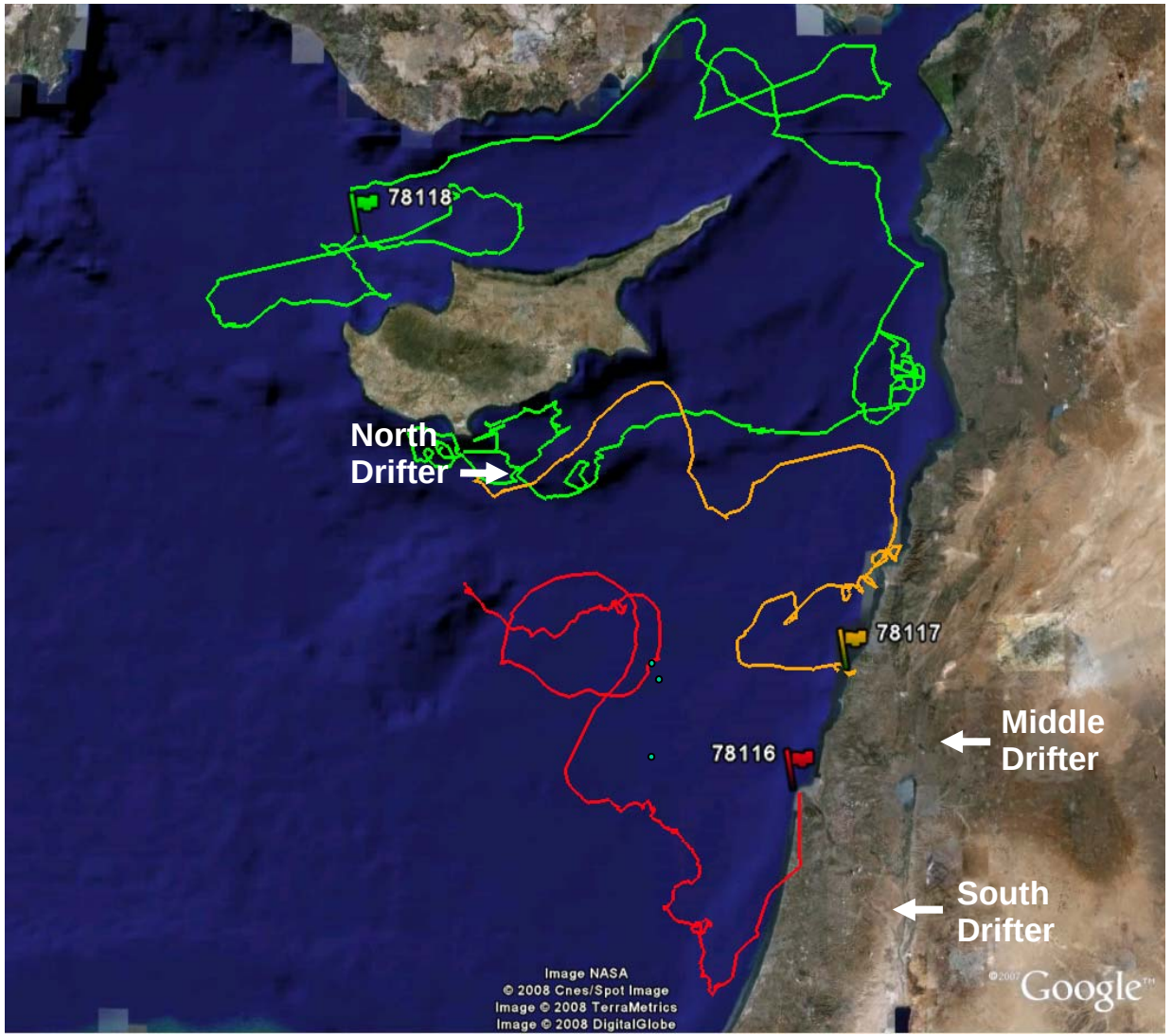


“Winners” of the consecutive forecasts.

Eastern Med – experiment

Time schedule: 3 drifters were deployed, 17 Sept until 26 Dec 2007

Argosphere oil-emulating surface drifters used in the E. Med experiment

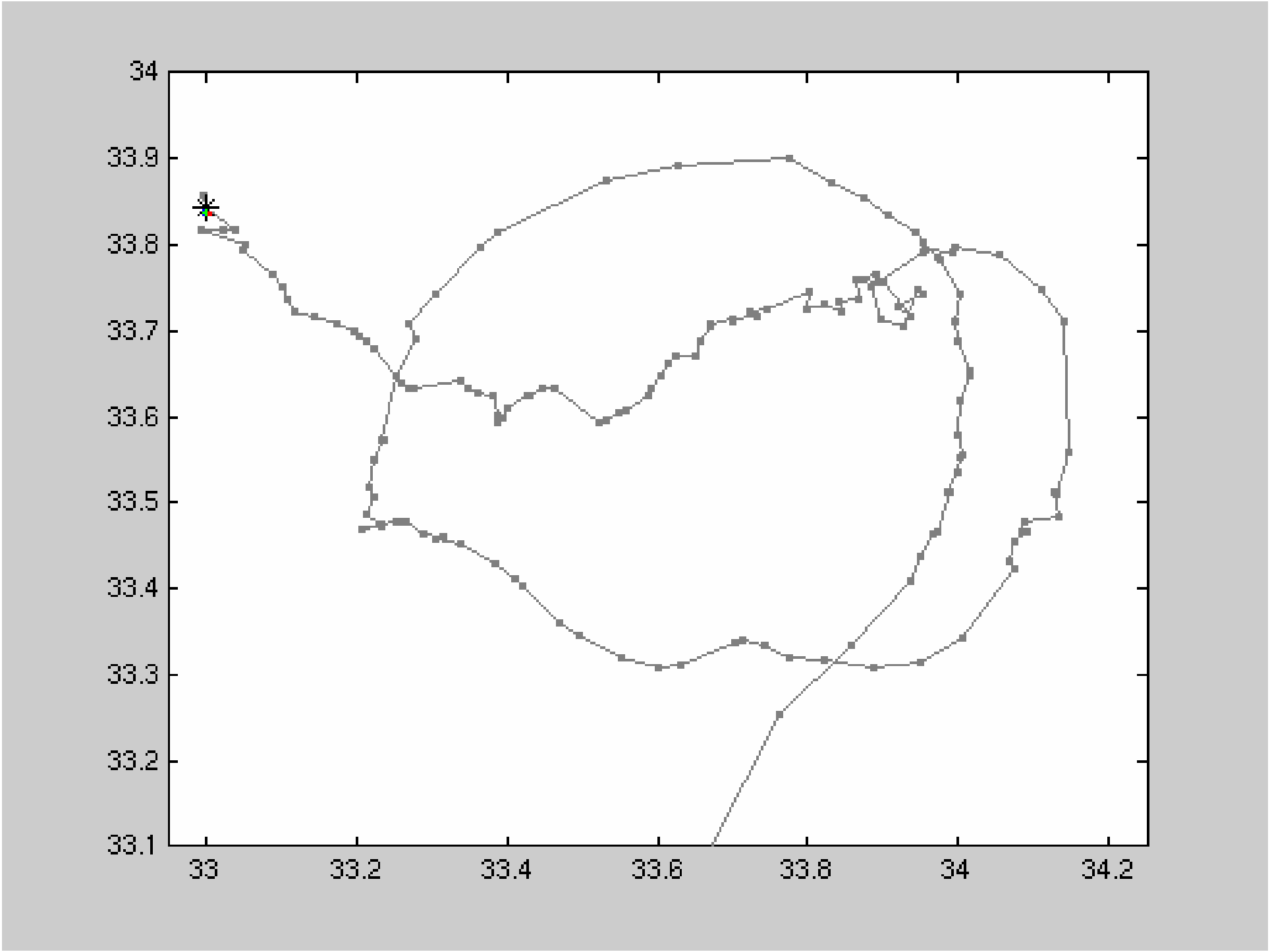


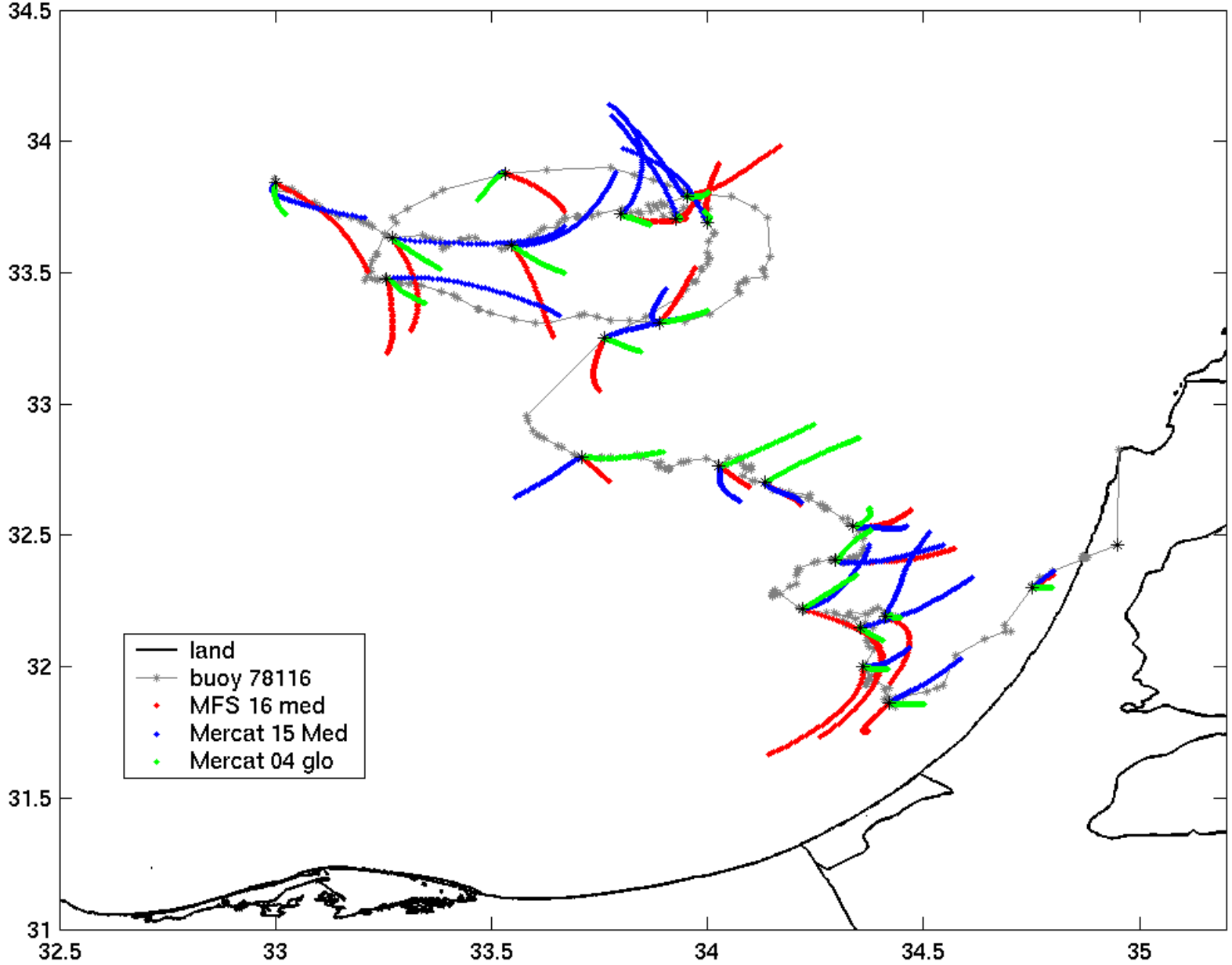
DEMO Eastern Med – OC-UCY forecasts

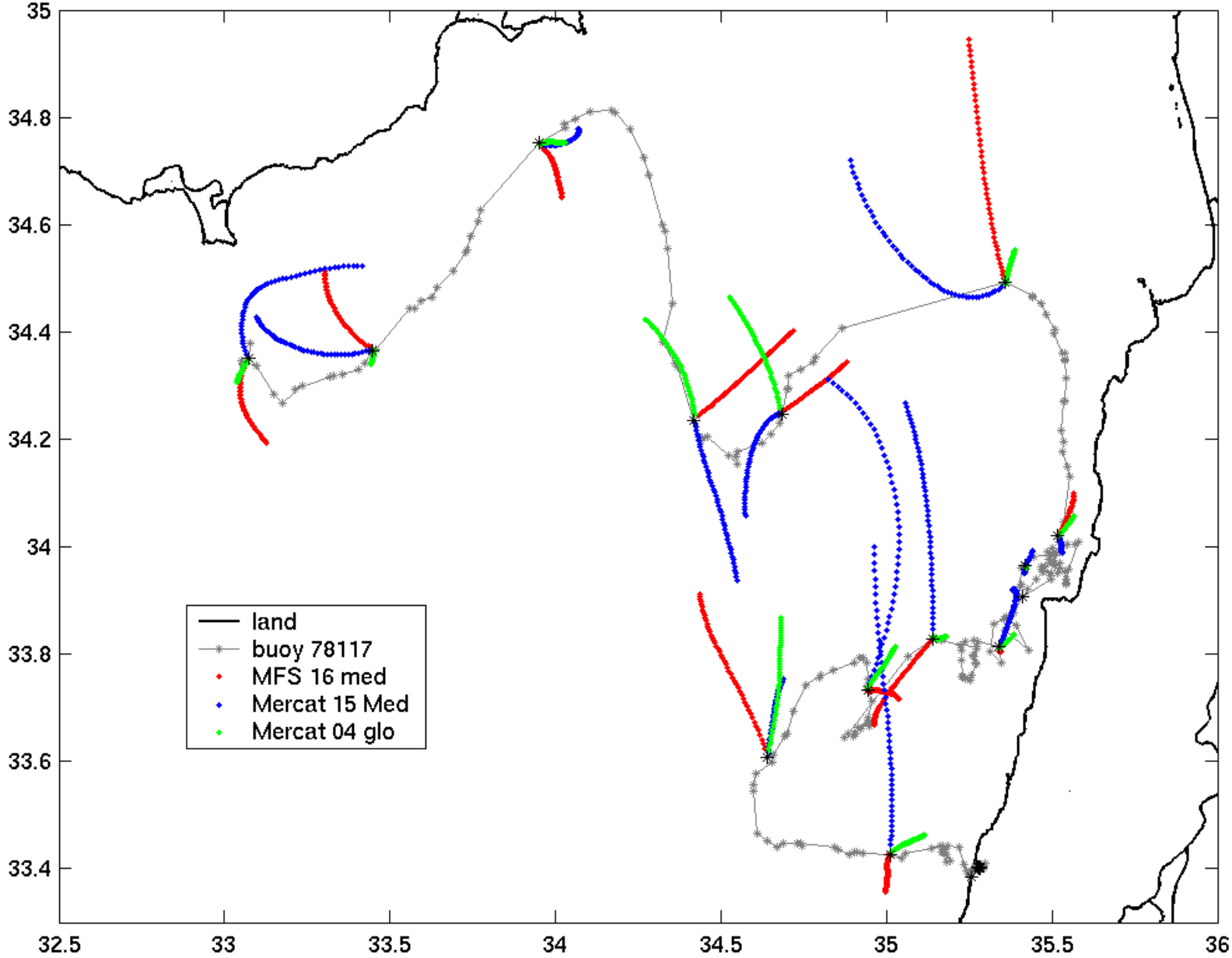
MEDSLIK forcing: CYCOFOS nested in MFS; SKIRON winds

Drifters - red
Forecast - white
First 8 days

Only forecasts for Middle and South are shown


34
33.9
33.8
33.7
33.6
33.5
33.4
33.3
33.2
33.1
33
33.2
33.4
33.6
33.8
34
34.2

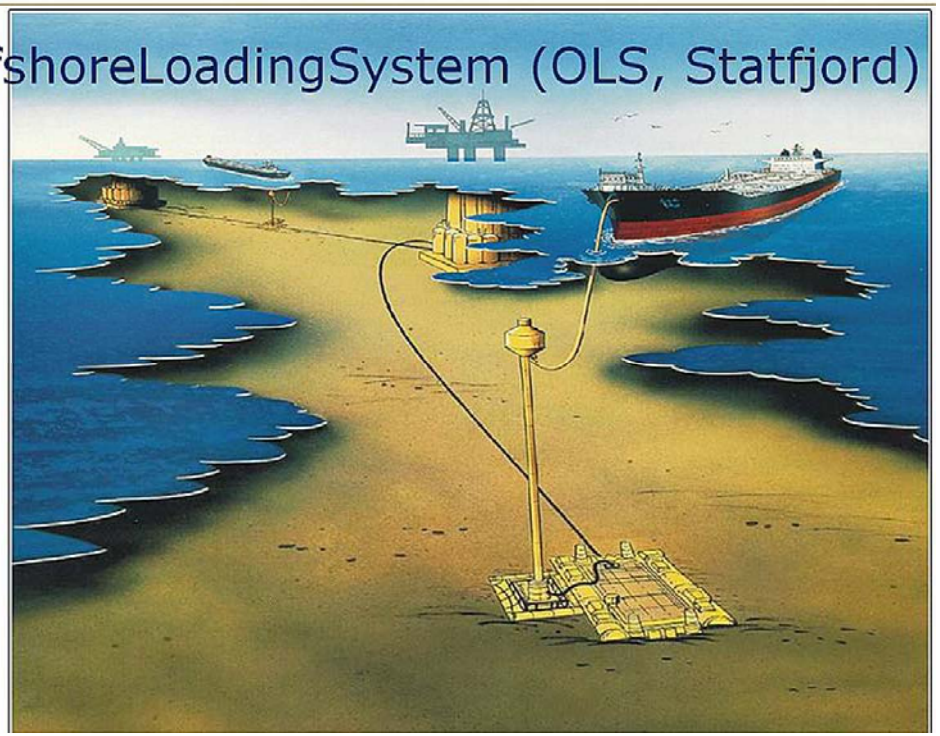

34.5
34
33.5
33
32.5
32
31.5
31
32.5
33
33.5
34
34.5
35
land
buoy 78116
MFS 16 med
Mercat 15 Med
Mercat 04 glo


35
34.8
34.6
34.4
34.2
34
33.8
33.6
33.4
32.5
33
33.5
34
34.5
35
35.5
36
land
buoy 78117
MFS 16 med
Mercat 15 Med
Mercat 04 glo

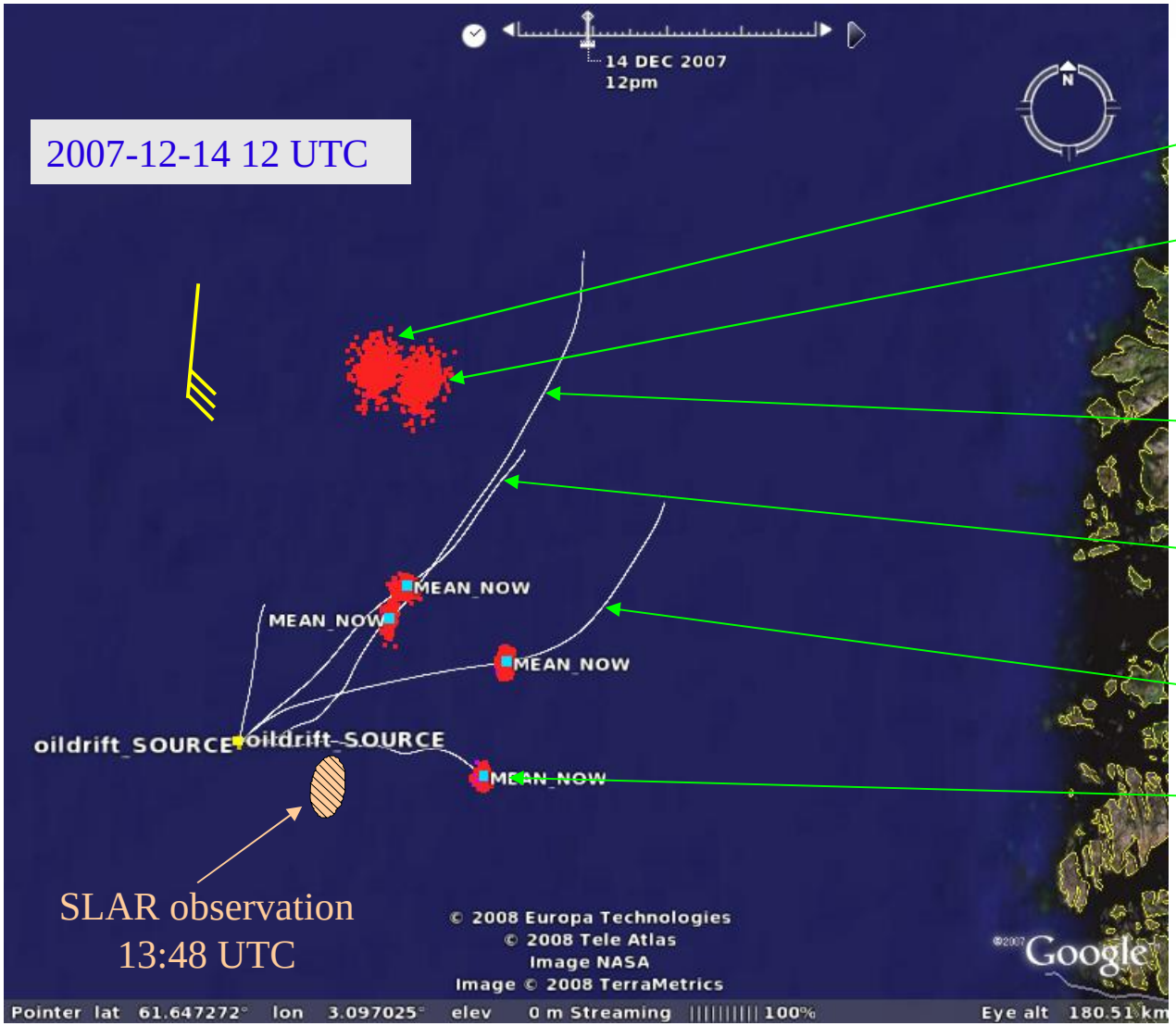
Real case example

- Statfjord A accident
  - Dec. 12, 2007
  - 4000 m^3 oilspill
  - Oil drift trajectories were done within 2 h of the accident (met.no within 30 min from calls from authority)

- Mersea demonstration
  - met.no
    - Own model data
    - MERCATOR global
  - Meteo France
    - MERCATOR North Atlantic



DEMO Statfjord - Results



MeteoFrance (Mercator NAT)

MeteoFrance (wind only)

met.no (Bio4)

met.no (Mercator NAT)

met.no (Mercator global)

met.no (Nordic4)

Conclusions

- Different model formulations give very different results on trajectory
  - MOTHY and OD3D has about same performance.
- Models based on MERSEA products
  - are relatively good in coastal areas
  - do not perform well in open ocean
- Wave drift is most likely important to account for in strong forcing conditions

END