Mistral and its Siblings in RCMs

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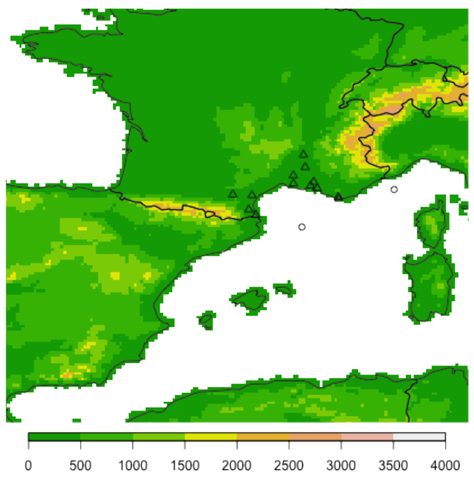
Presented at COSMO/CLM/ART User Seminar 2014 in Offenbach

MISTRAL & SIBLINGS

- **Mistral**: Regional cold and dry north to northwesterly wind following the lower Rhône Valley. It causes deep water formation in the Mediterranean Sea. Therefore it is important for modeling of the circulation in the Mediterranean Sea.
- **Tramontane**: In valley between Pyrenees and Massif Central.
- **Cierzo**: Along Ebro Valley south of Pyrenees.



Terrain height (m) of COSMO-CLM $0.088°$ Med-CORDEX run. Circles: buoys, triangles: surface stations.

DAILY MEAN WIND SPEED DATA

- **Buoy data** daily mean wind speed from hourly measurements at Côte d'Azur and Gulf of Lion [1].
- **QuikSCAT** gridded $0.25°$ scatterometer data of wind speed over sea (measurements $\approx$ 6 a.m and 6 p.m. local time) [2] fitted to buoy measurements at Gulf of Lion [3].
- **SAFRAN** gridded daily mean wind speed over France using optimal interpolation method [4].
- **ERA-Interim** daily mean windspeed [5].

MODELS

ERA-Interim driven runs on Med-CORDEX domain:

- **COSMO-CLM** [6] with $0.44°$ and $0.088°$ resolution.
- **ALADIN-climate** [7] with $0.44°$ and $0.11°$ resolution.

WIND TIME SERIES

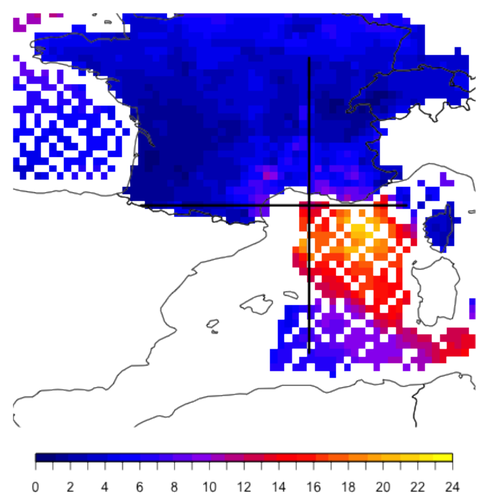
Gusts $\geq 16\frac{m}{s}$ **and gust direction** at 13 stations in France [8].

- **Mistral** ($\approx$ 19%): At least one station in the valley, one at its exit, and one close to sea show gusts.
- **Tramontane** ($\approx$ 43%): At least one inland station and one station close to sea show gusts.

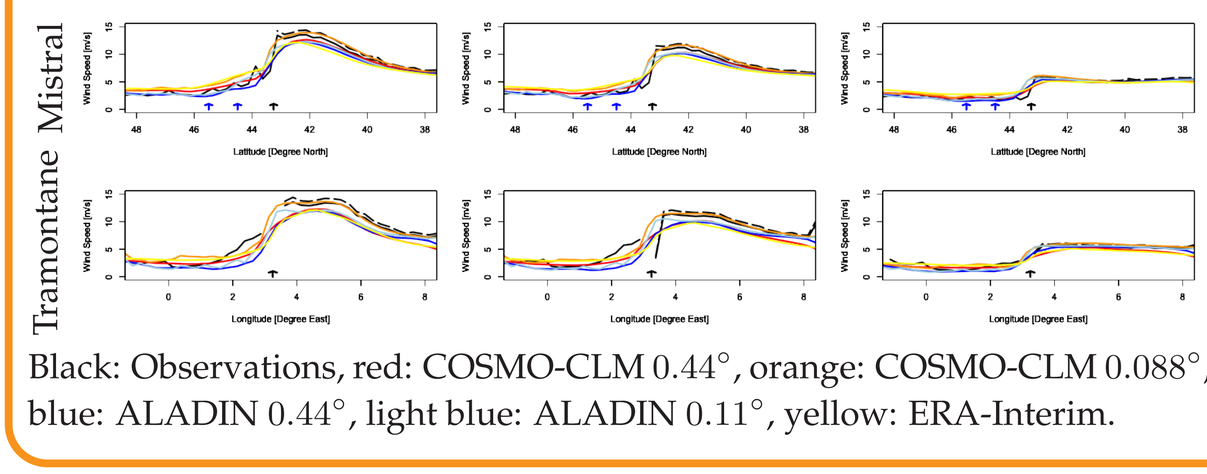
WIND SPEED

Mean wind speed 2000-2008 following Mistral and Tramontane tracks (black lines in right figure).

- **Rhône Valley** (blue arrows): Increase in wind speed during Mistral days.
- **Coast** (black arrows): Location, shape and amount of wind speed gain in models differ from observations for Mistral and Tramontane days.



Observed wind speed (m/s) on 09.02.2000.

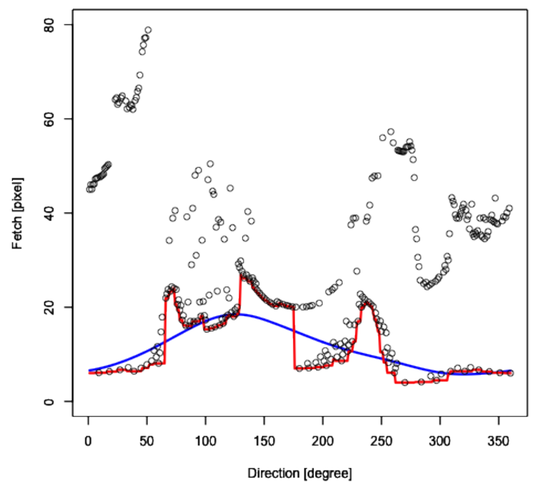


Black: Observations, red: COSMO-CLM $0.44°$, orange: COSMO-CLM $0.088°$, blue: ALADIN $0.44°$, light blue: ALADIN $0.11°$, yellow: ERA-Interim.

ESTIMATING FETCH

Distance the wind travelled over water before reaching grid cell estimated on QuikSCAT grid:

1. **Distance** to coastal cells in each direction (black circles).
2. **Line of Sight**: Shading of far away cells by closer cells (red line).
3. **Avaraging** due to uncertainties in wind direction: Fetch in $\phi \pm 90°$ interval weighted with a $\cos^2$ function (blue line).



Fetch at Gulf of Lion buoy.

REFERENCES

[1] provided by S. Belamari, Meteo France

[2] Physical Oceanography DAAC (2001): SeaWinds on QuikSCAT Level 3 Daily, Gridded Ocean Wind Vectors (JPL SeaWinds Project): Guide Document

[3] P. M. Ruti et Al. (2008): Comparison of analyzed and measured wind speeds in the perspective of oceanic simulations over the Mediterranean basin: Analyses, QuikSCAT and buoy data, Journal of Marine Systems 70: 33-48

[4] J. P. Vidal et Al. (2010): A 50-Year High-Resolution Atmospheric Reanalysis Over France with the Safran System, INT J CLIMATOL 30 (11): 1627-1644

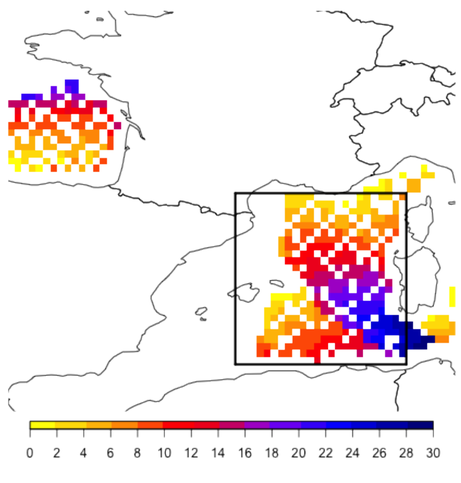
[5] D. P. Dee et Al. (2011): The ERA-Interim reanalysis: configuration and performance of the data assimilation system, Q J ROY METEOR SOC 137 (656): 553-597, April 2011 Part A

[6] G. Doms et Al. (2011): A Description of the Nonhydrostatic Regional COSMO Model, Part II: Physical Parameterization

[7] M. Herrmann et Al. (2011): Representation of daily wind speed spatial and temporal variability and intense wind events over the Mediterranean Sea using dynamical downscaling: impact of the regional climate model configuration, Nat. Hazards Earth Syst. Sci. 11: 1983-2001

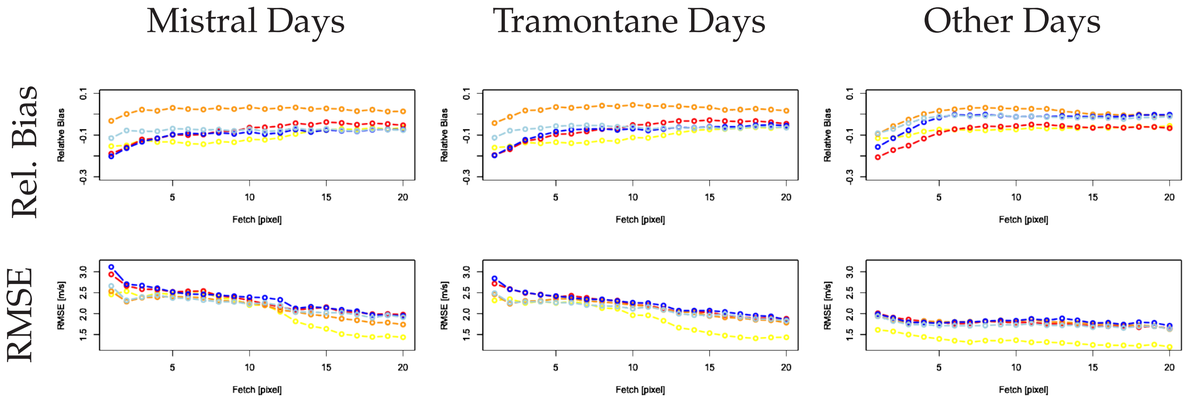
[8] V. Jacq (2011): personal communication

FETCH DEPENDENCE OF ERRORS



Fetch ($0.25°$ pixels) on 09.02.2000.

Relative bias and RMSE 2000-2008 in Mistral and Tramontane area (black square).



Red: COSMO-CLM $0.44°$, orange: COSMO-CLM $0.088°$, blue: ALADIN $0.44°$, light blue: ALADIN $0.11°$, yellow: ERA-Interim.

- Negative **relative bias** decreases with increasing fetch (except for COSMO-CLM $0.088°$).
- **RMSE** decreases with increasing fetch and shows a drop at about 12 pixels on windy days.

OUTLOOK

Models work fine for non-windy days but underestimate wind speed in the Gulf of Lion on windy days.

- Possible modifications of **Charnock formula** for high winds and fetch?
- **Error propagation** from land to sea?
  - Funneling in valley?
  - Deceleration at valley exit?
  - Other effects?
- Effects in **other winds**: Bora, Cierzo, ...