

## Wind Statistics Offshore based on Satellite Images

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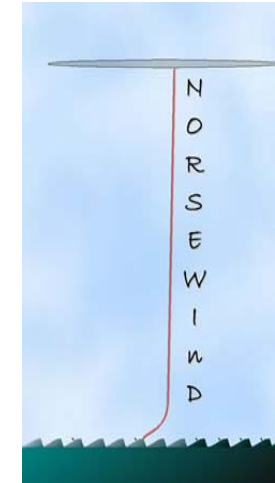
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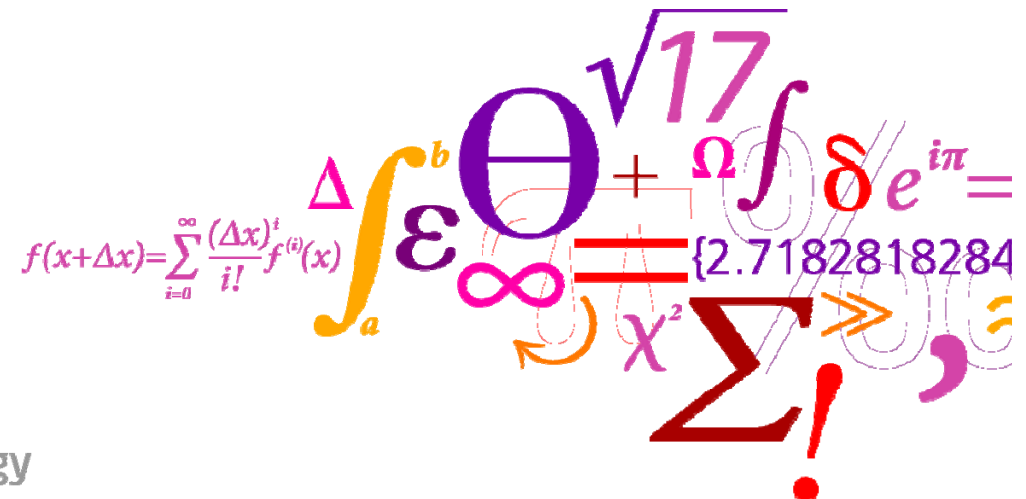
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# Wind statistics offshore based on satellite images

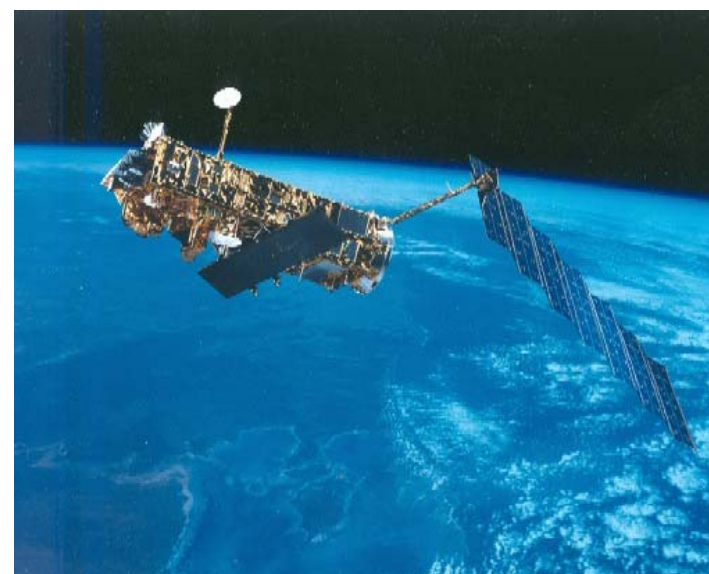
Charlotte Bay Hasager, Merete Badger, Poul Astrup, Morten Nielsen,  
Ioanna Karagali, Risø DTU

Alexis Mouche, CLS, France

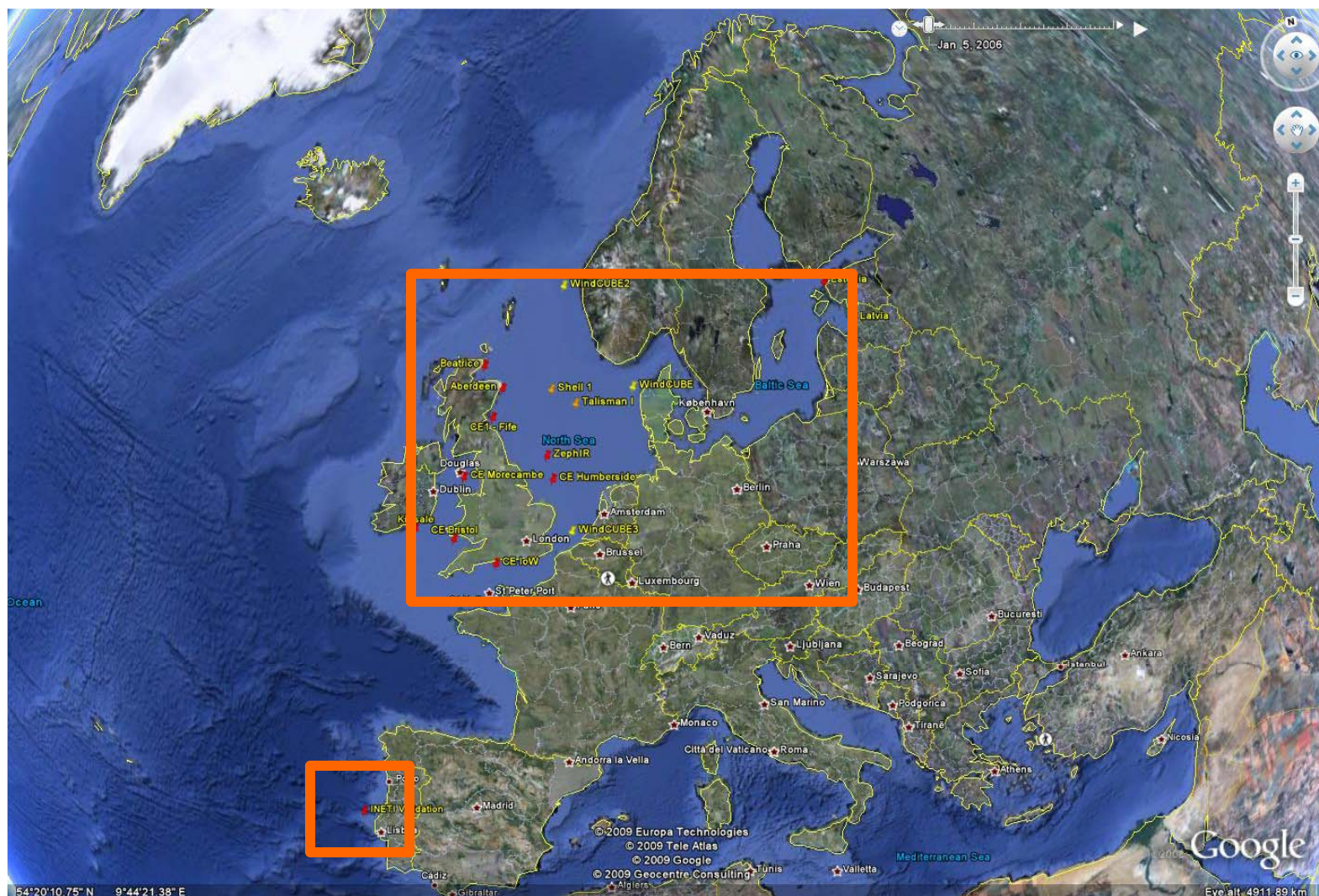


# Content

- Offshore sites
- QuikSCAT analysis
- Envisat SAR analysis
- Future

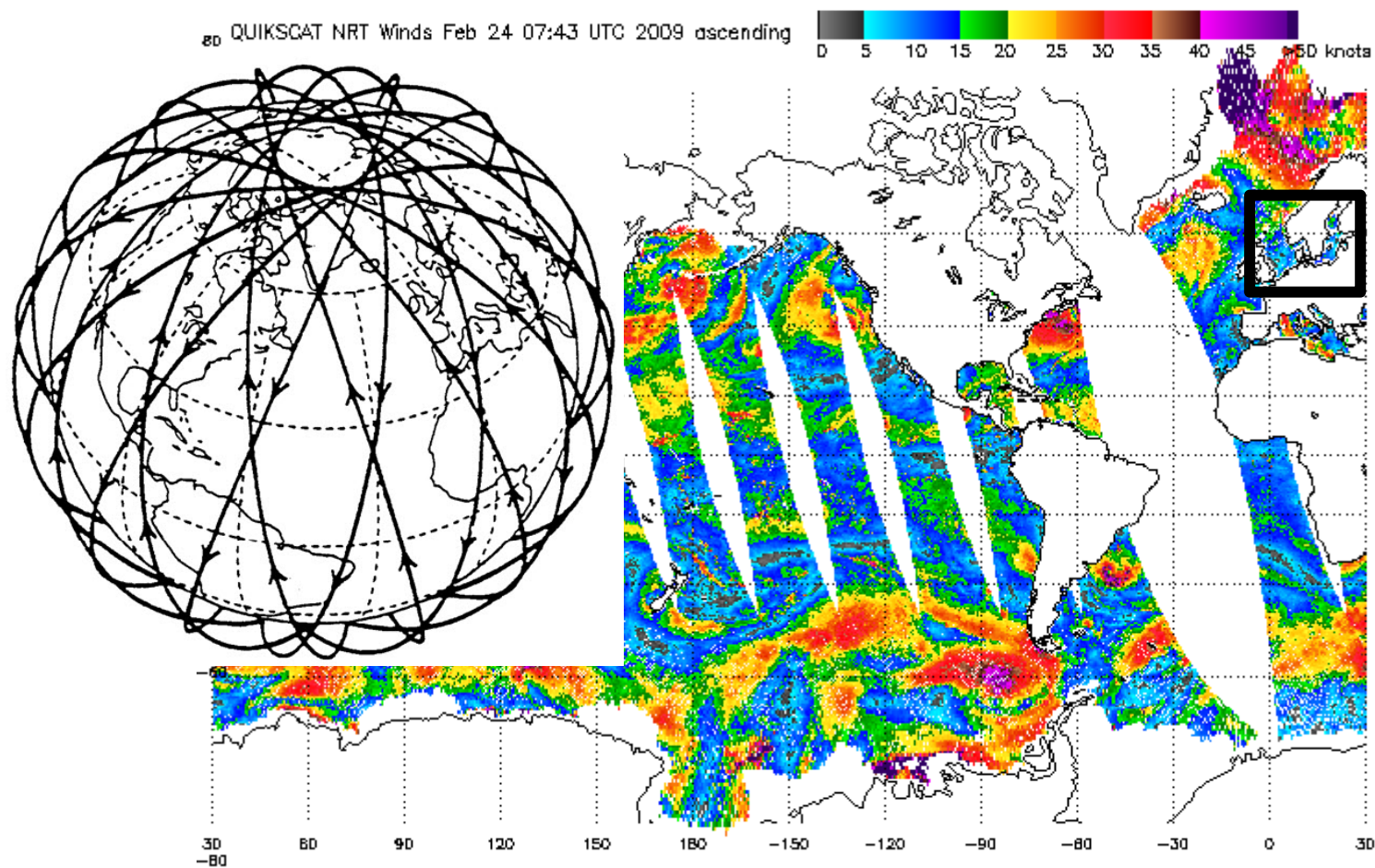


# Norsewind: project domain for offshore wind

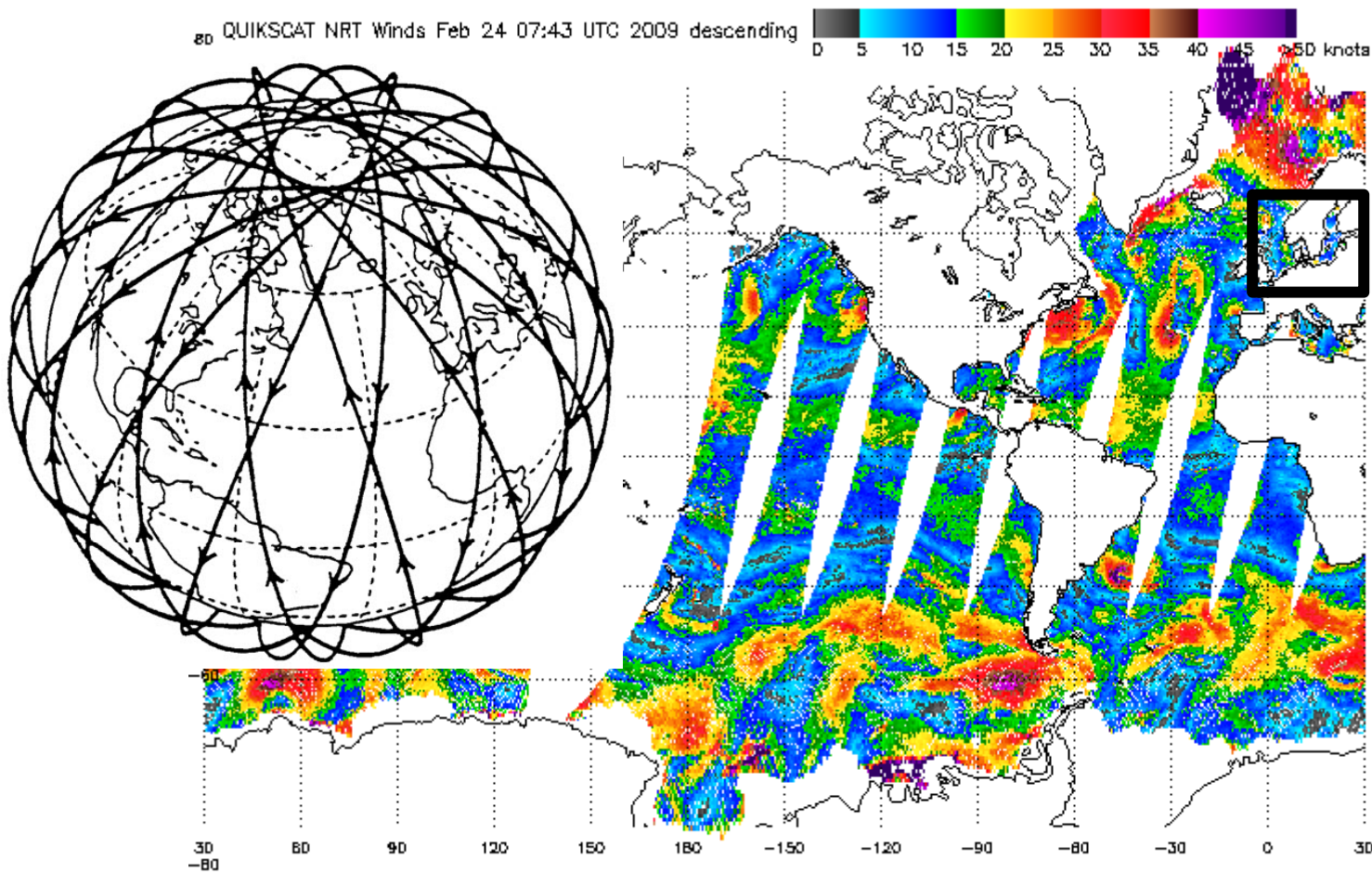




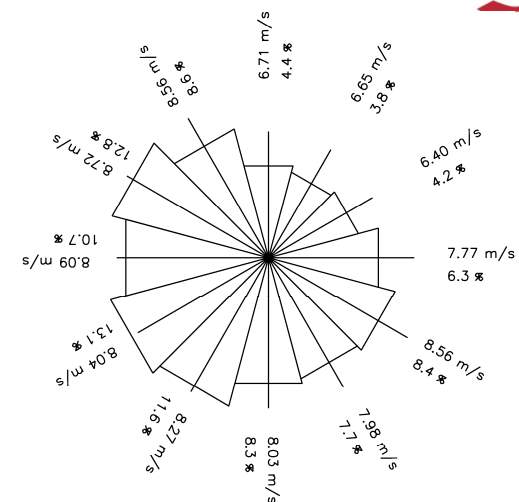
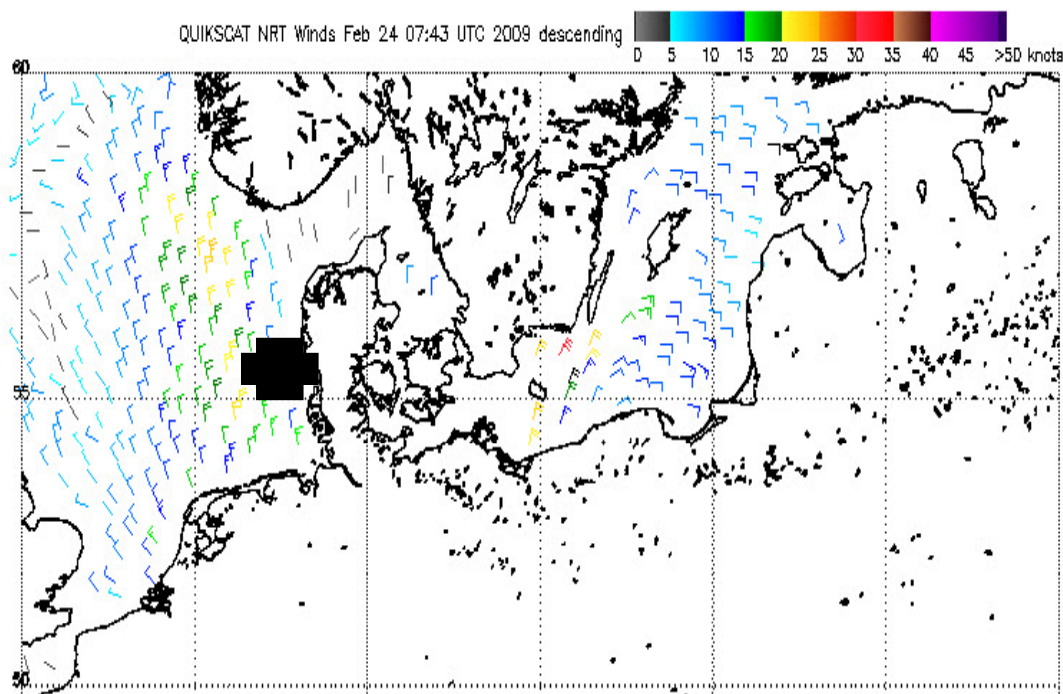
# Wind map: QuikSCAT - morning



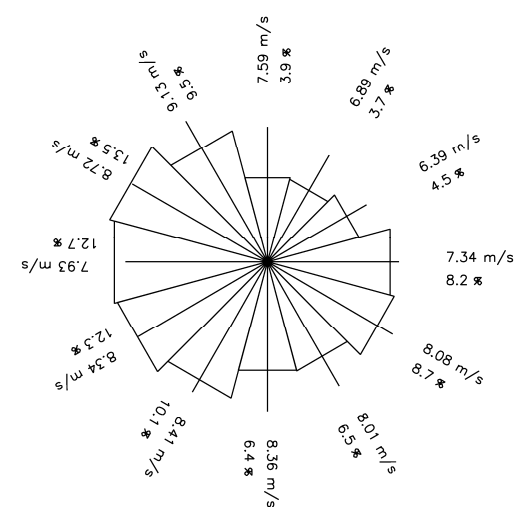
# Wind map: QuikSCAT – afternoon



# Comparison at Horns Rev



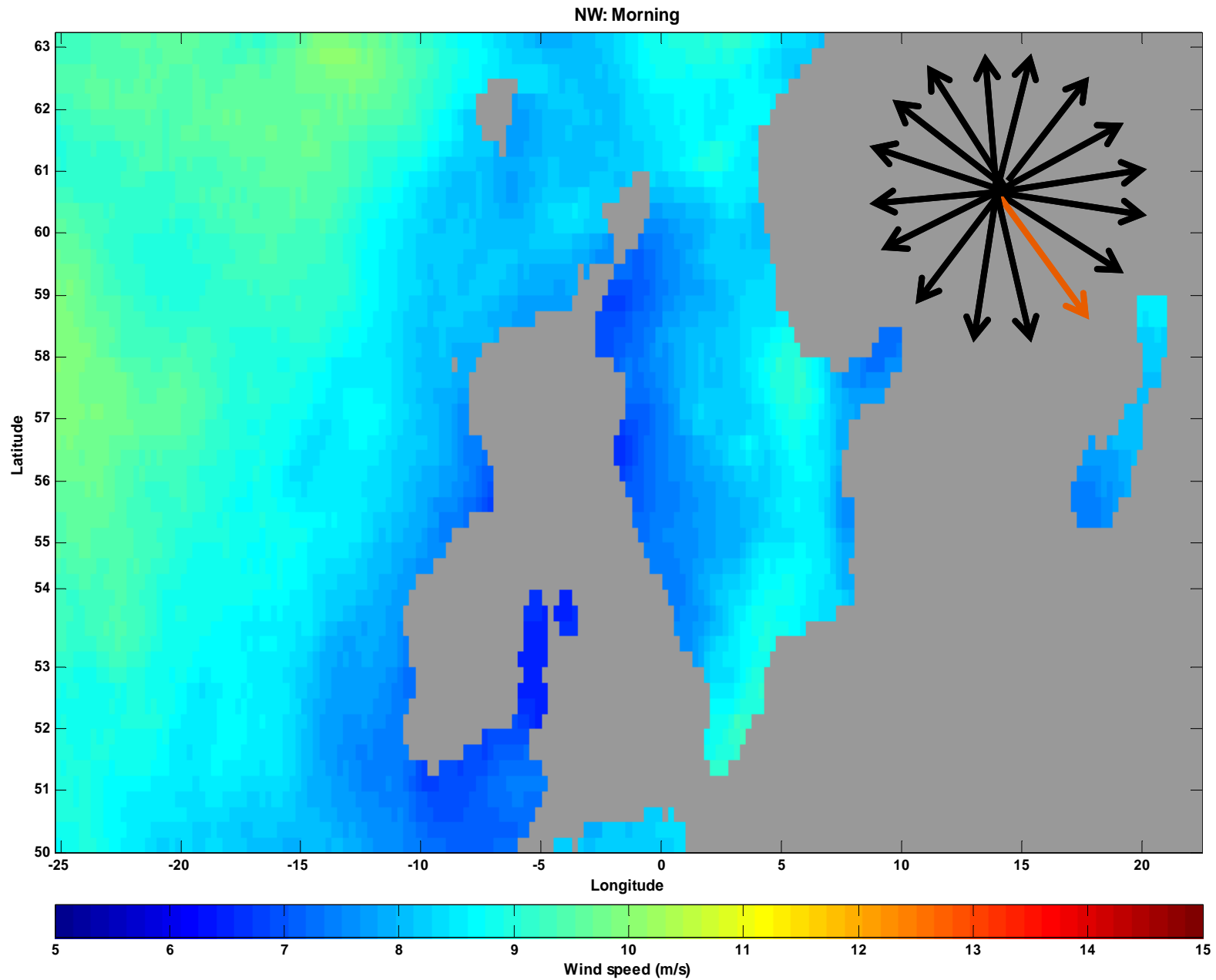
Mast (courtesy DONG energy)



QuikSCAT

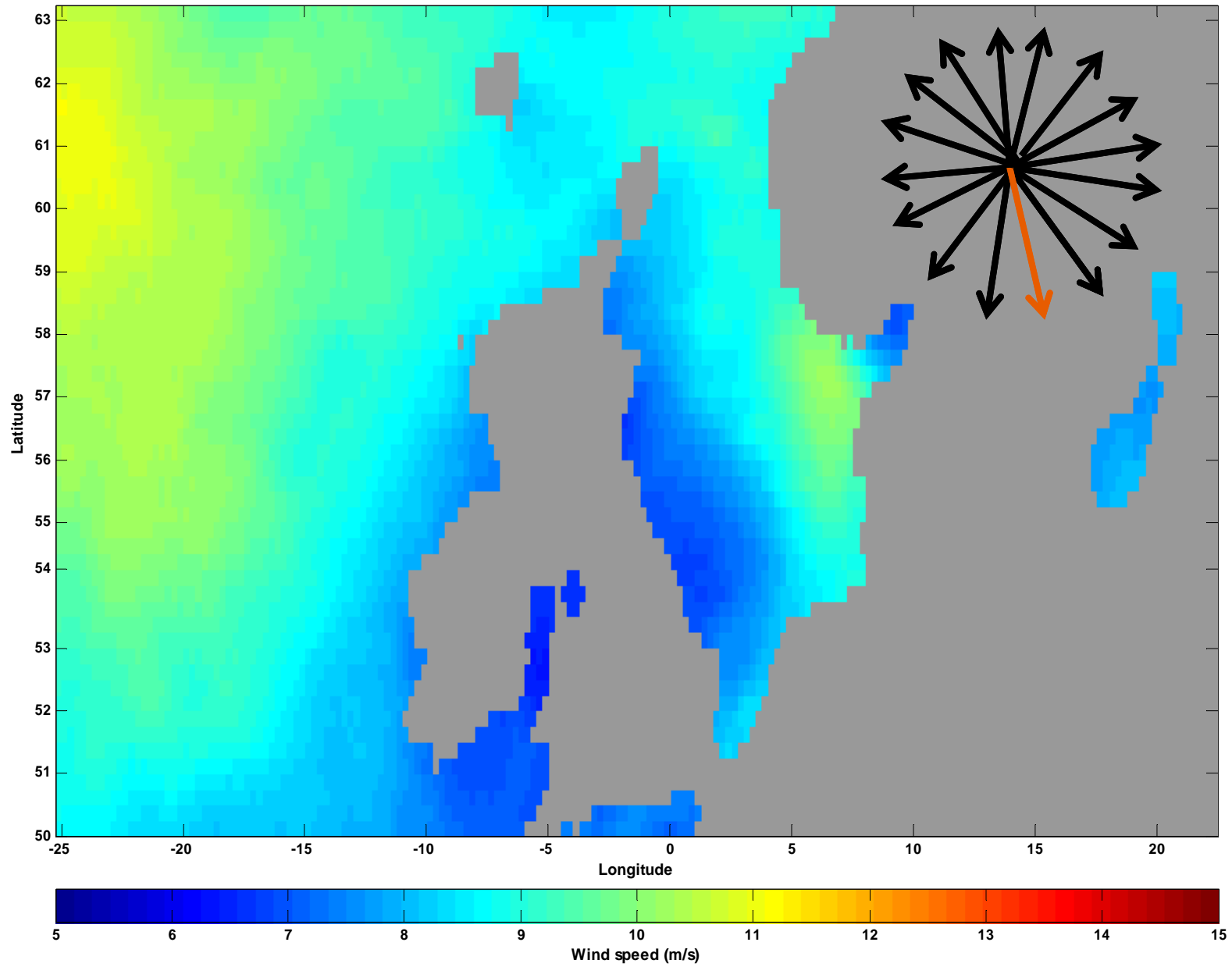
Hasager, C.B., A.Peña, M.B.Christiansen, P.Astrup, M.Nielsen, F.Monaldo, D.R.Thompson, and P.Nielsen. "Remote sensing observations used in wind energy." IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing 1, no. 1(2008): 76-79

# Average Wind Speed: Morning (based on wind direction at Horns Rev) - 16 Directions

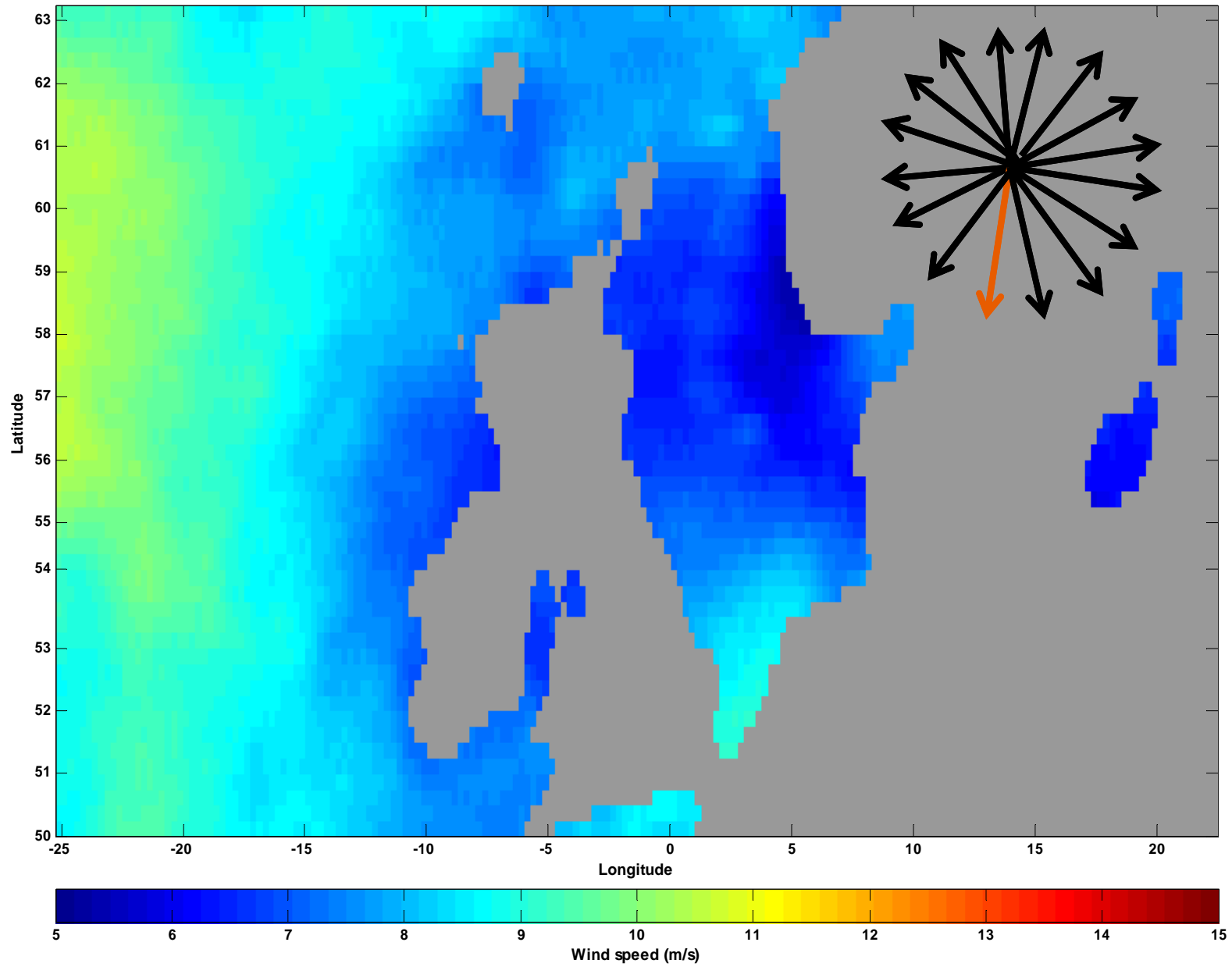




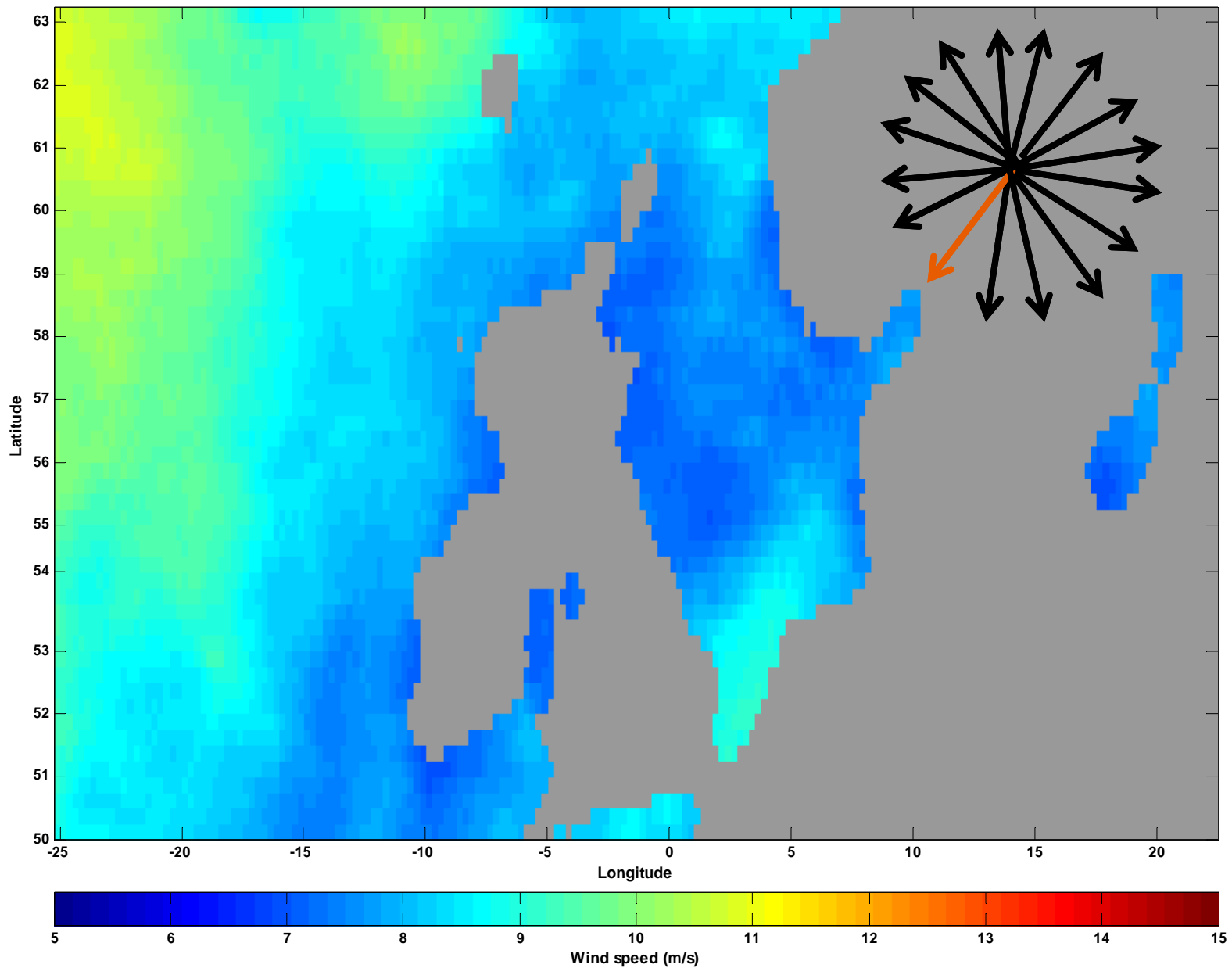
NNW: Morning



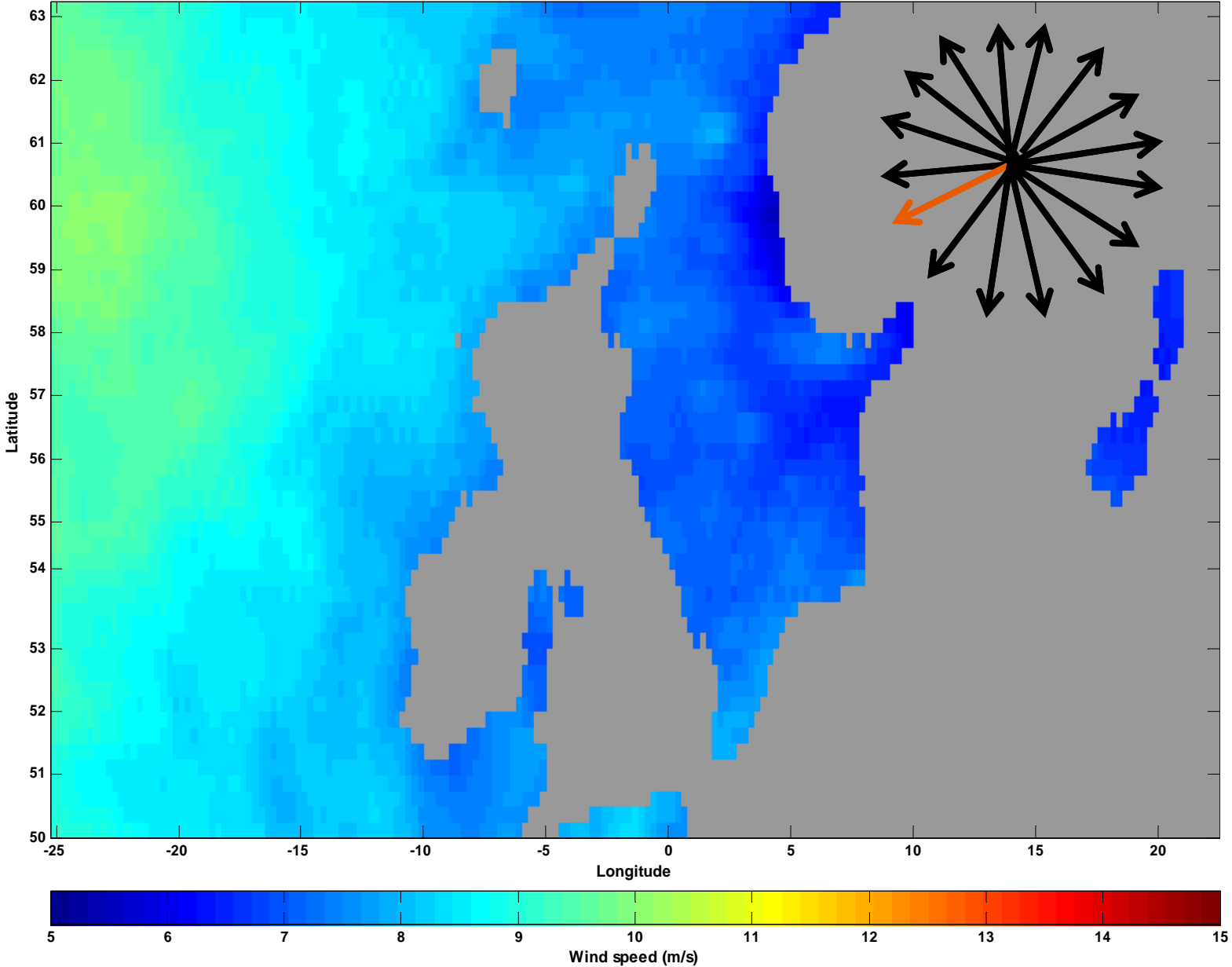
NNE: Morning



NE: Morning

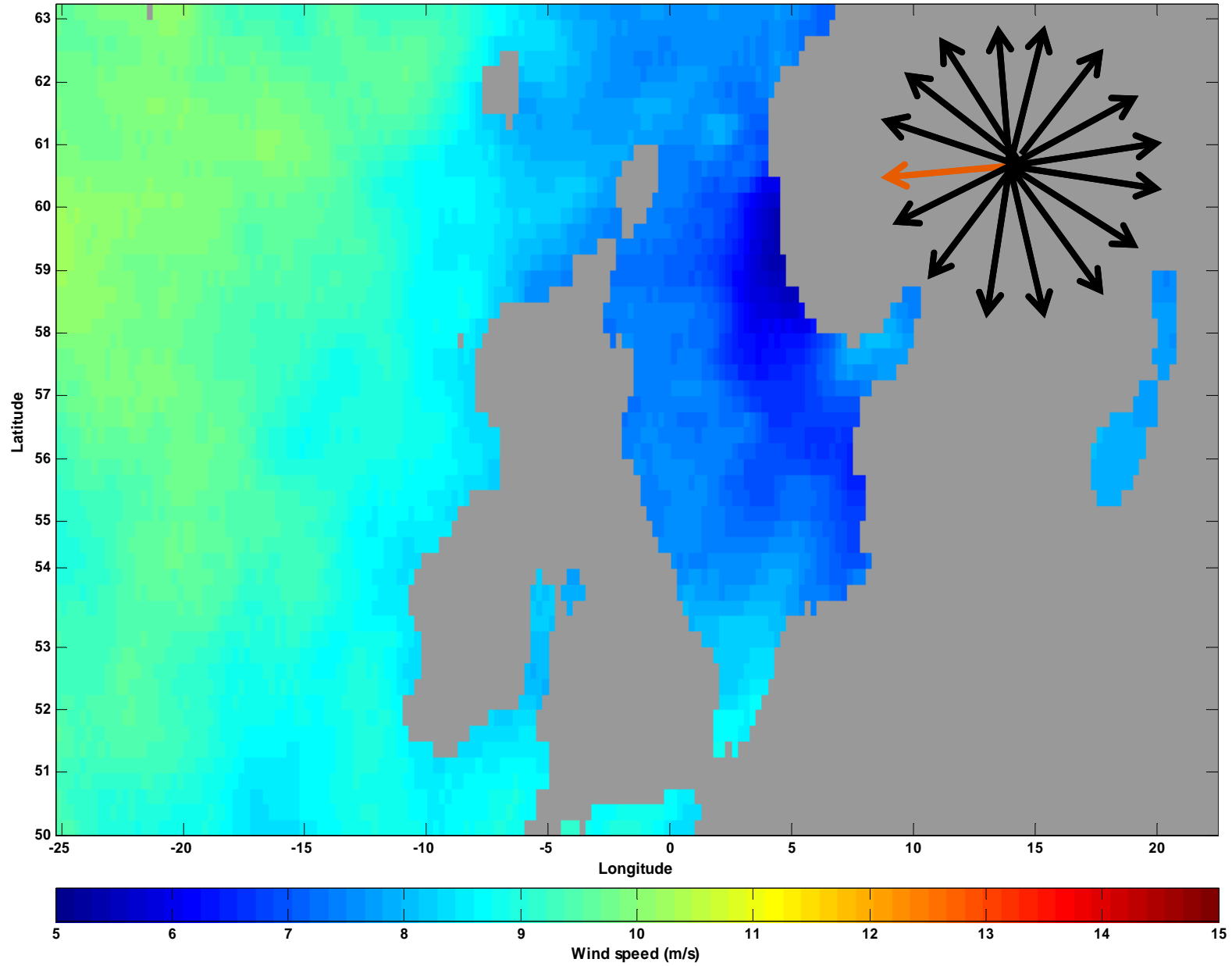


EN: Morning

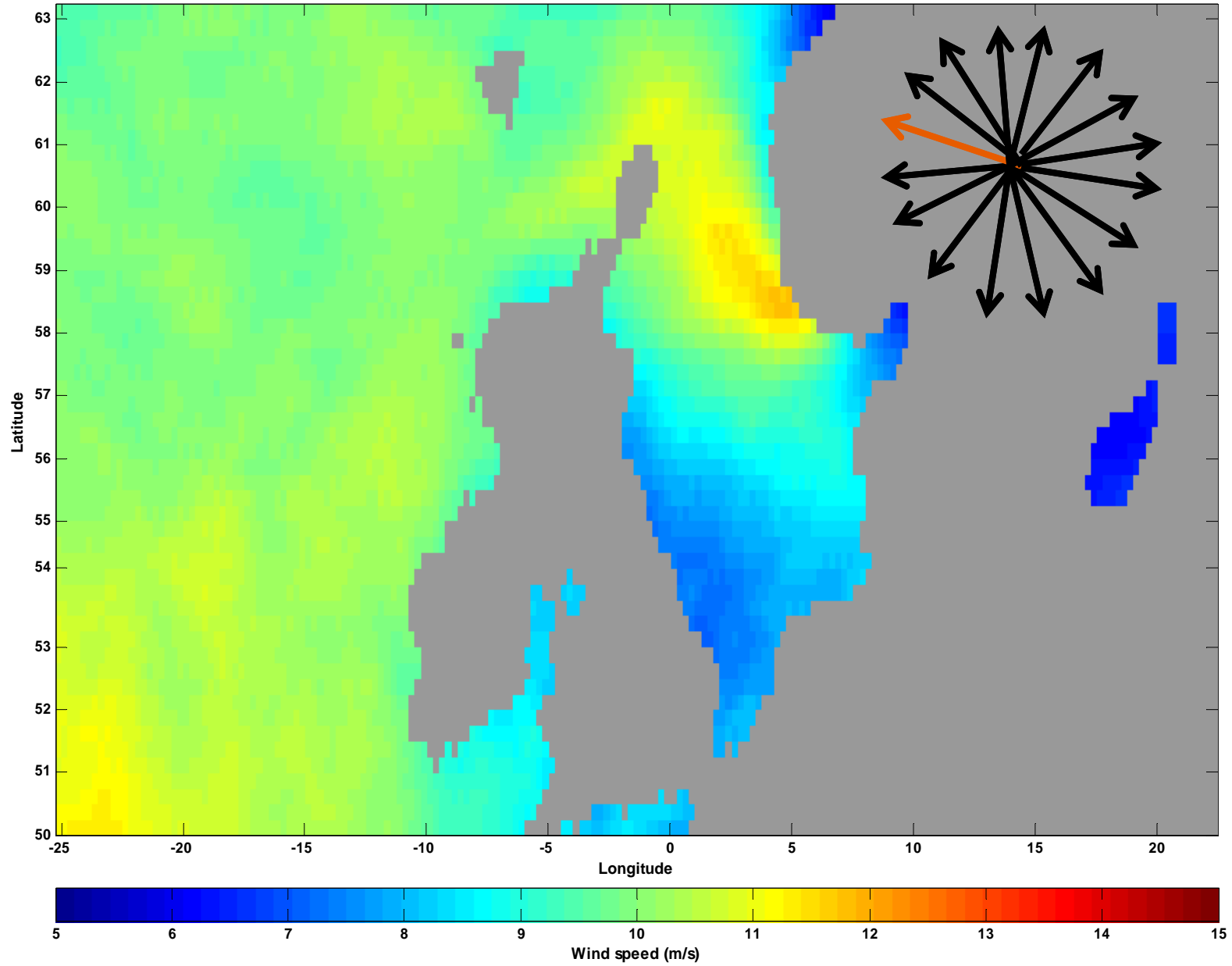




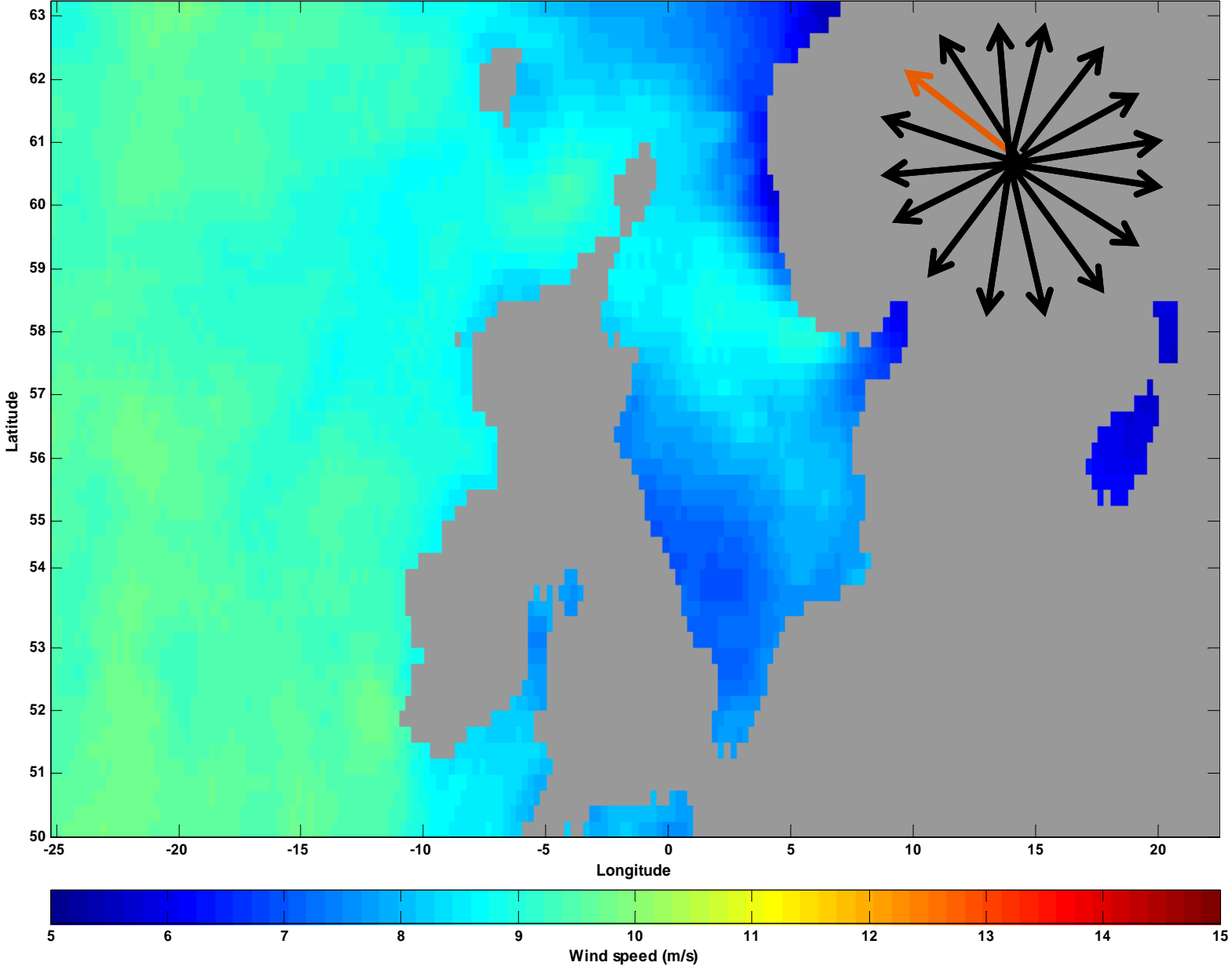
ENE: Morning



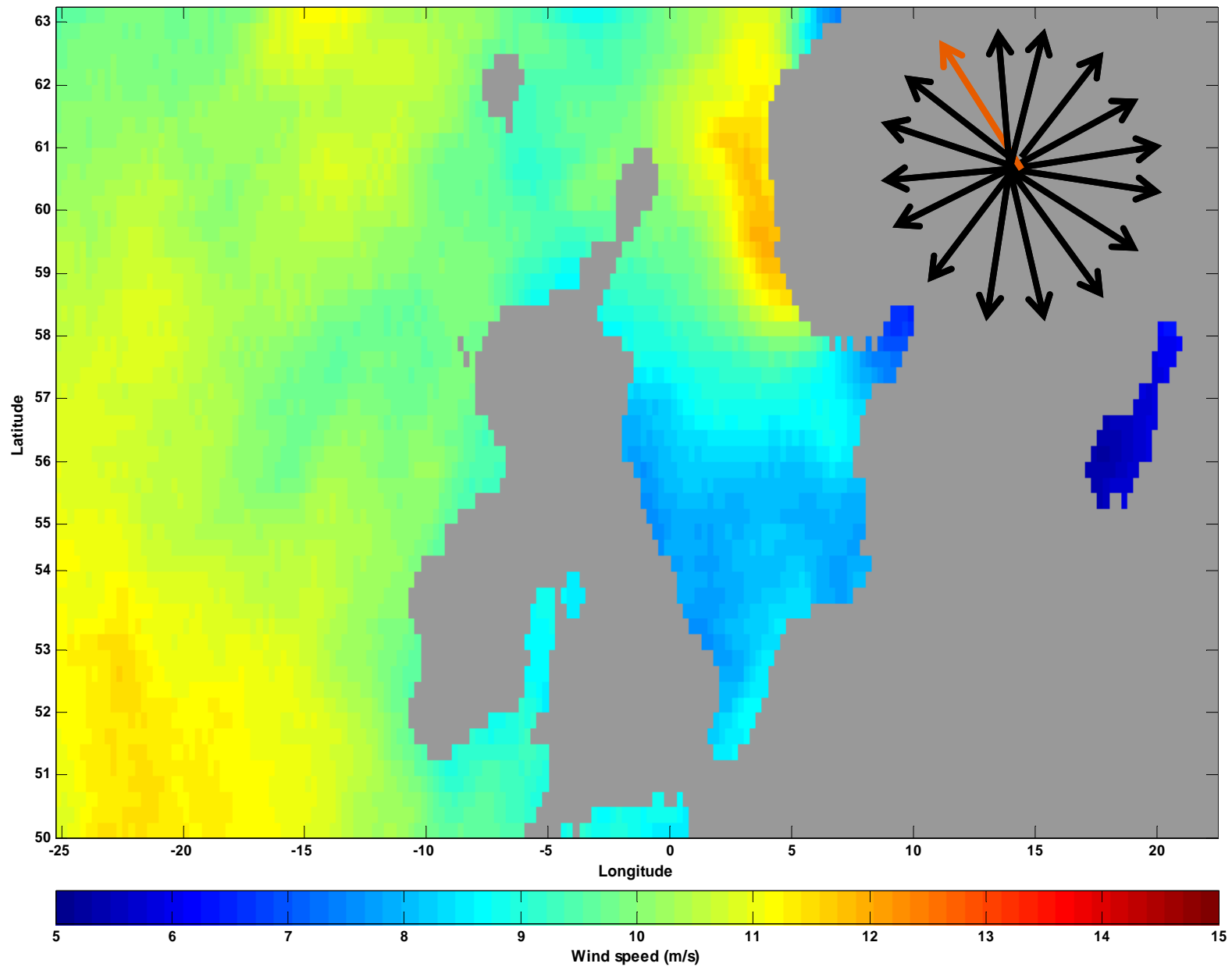
ESE: Morning



ES: Morning

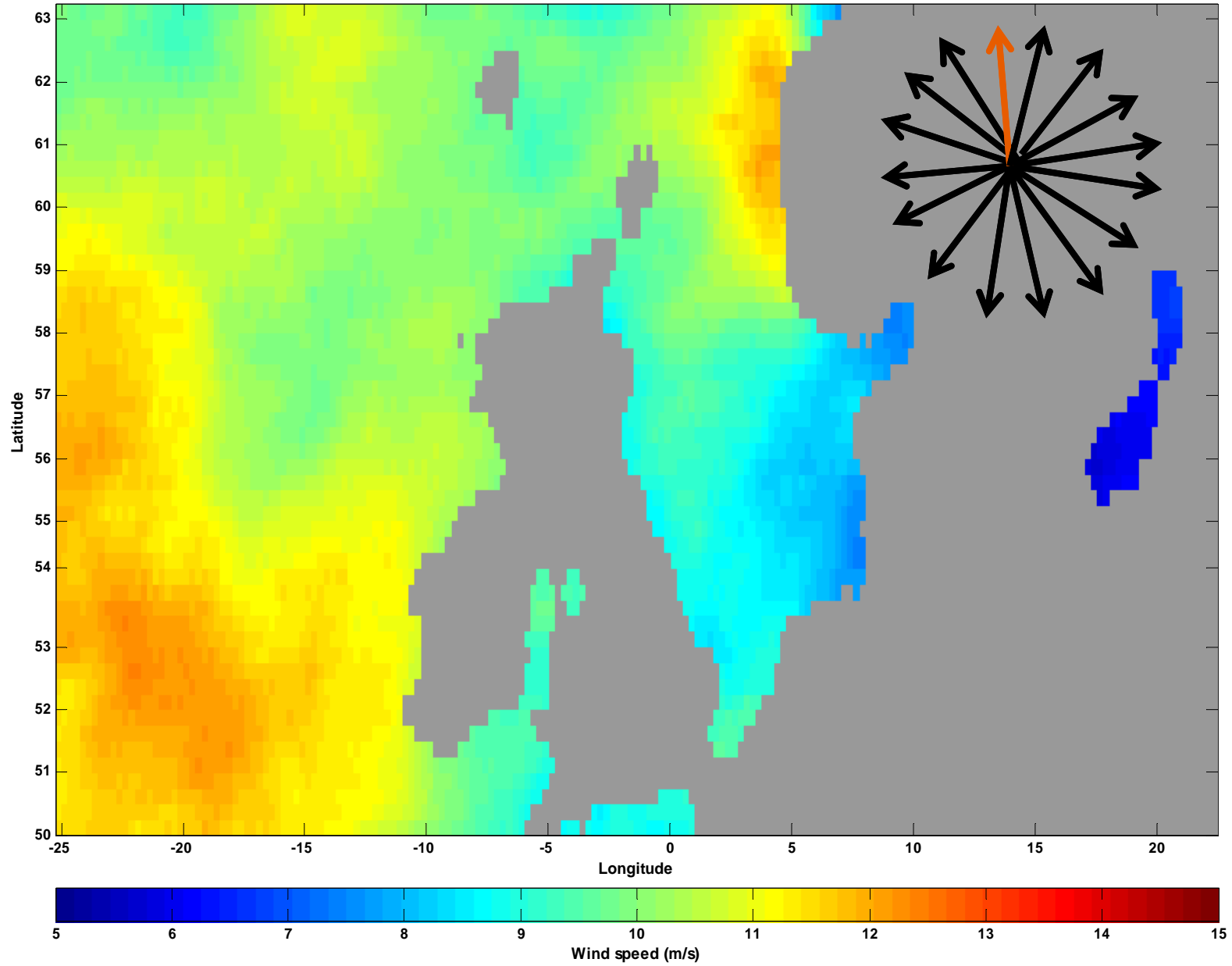


SE: Morning

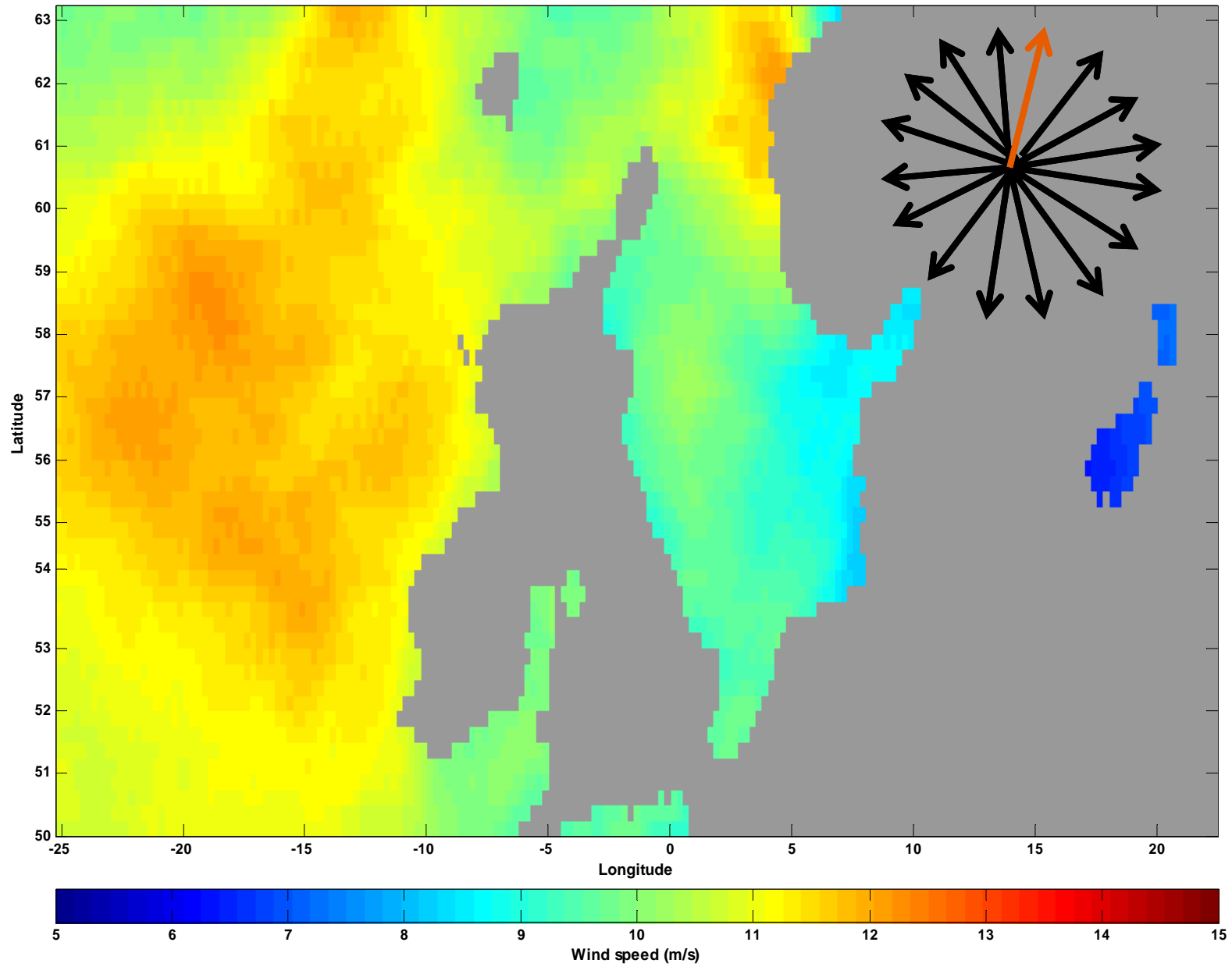




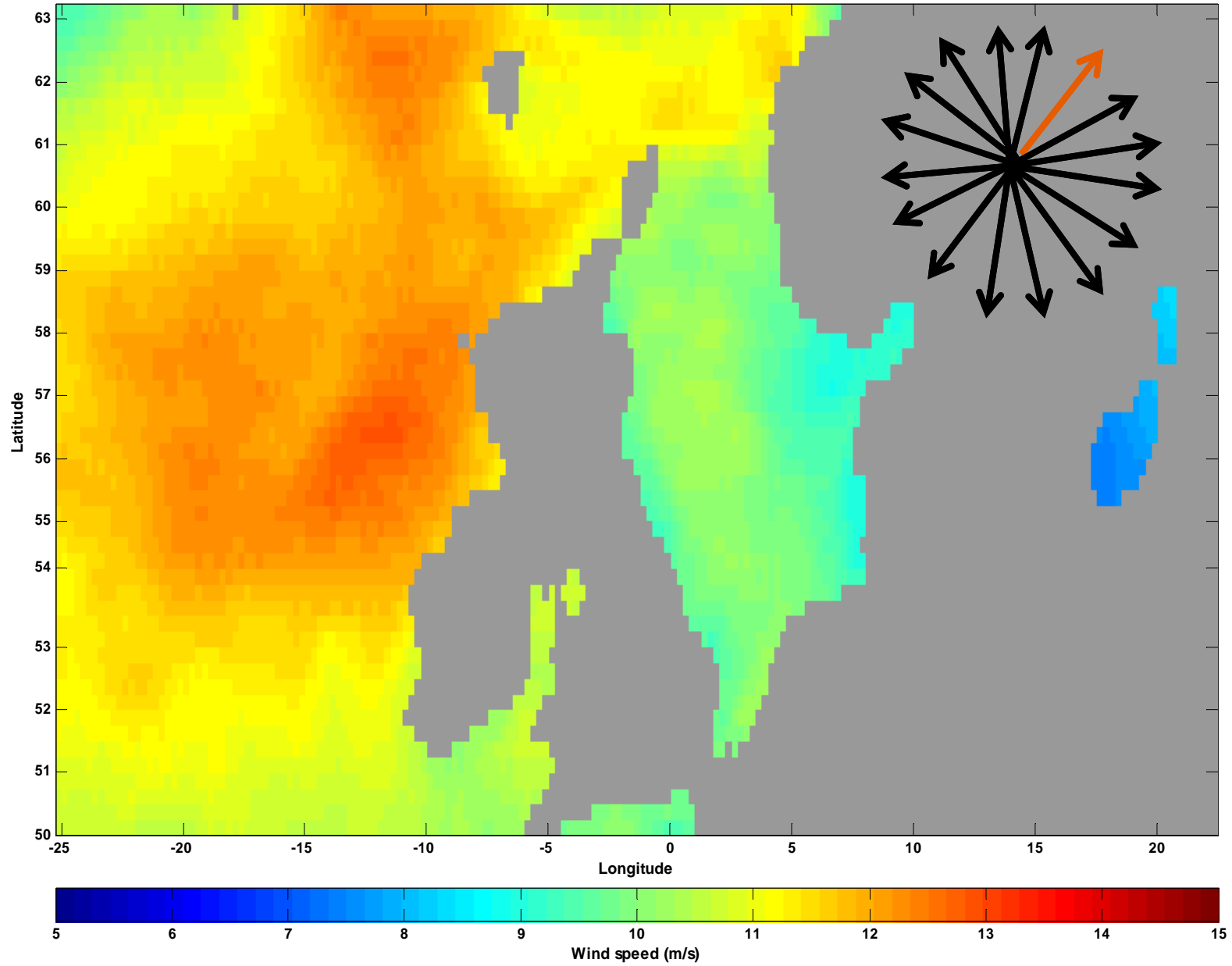
SSE: Morning



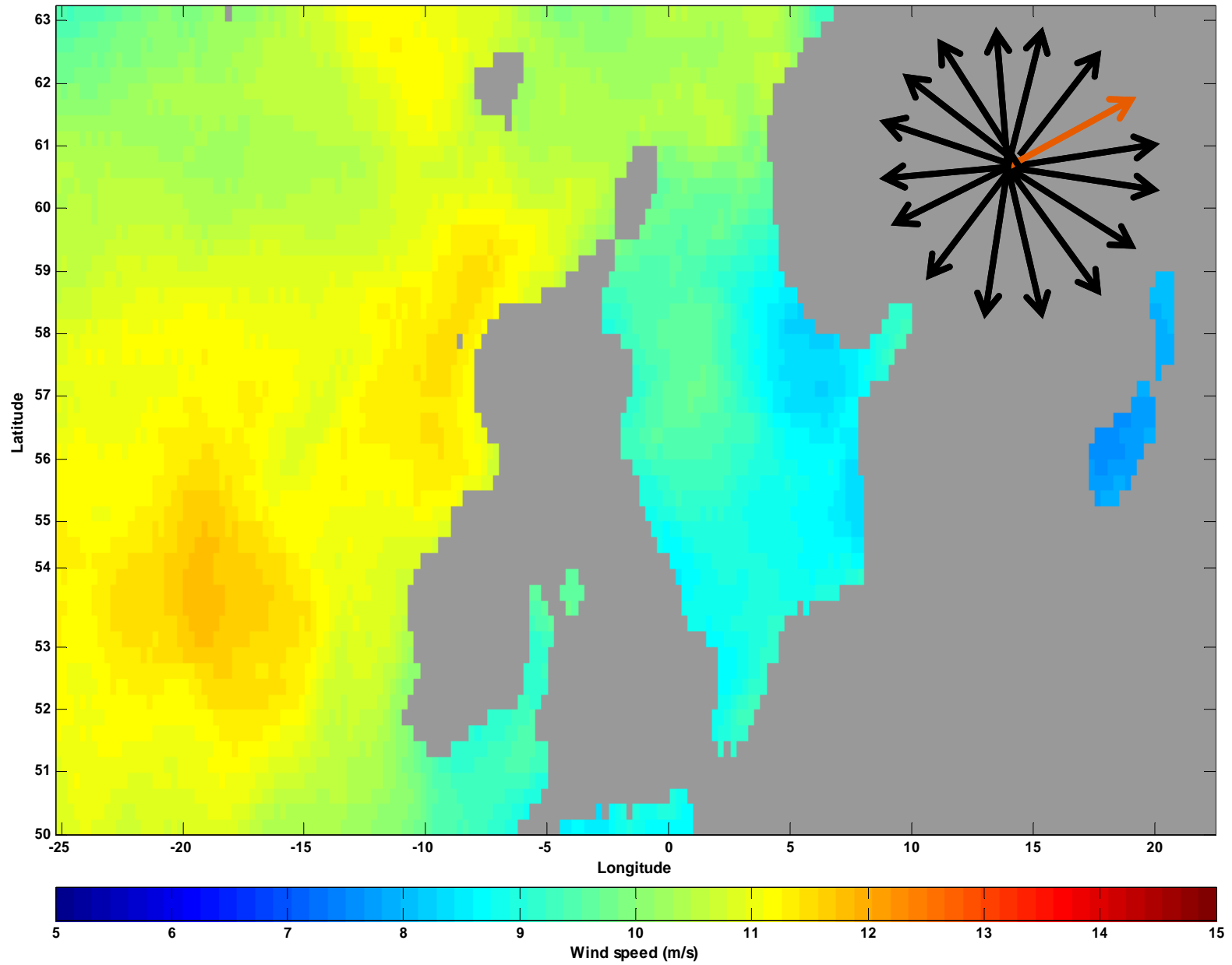
SSW: Morning



SW: Morning

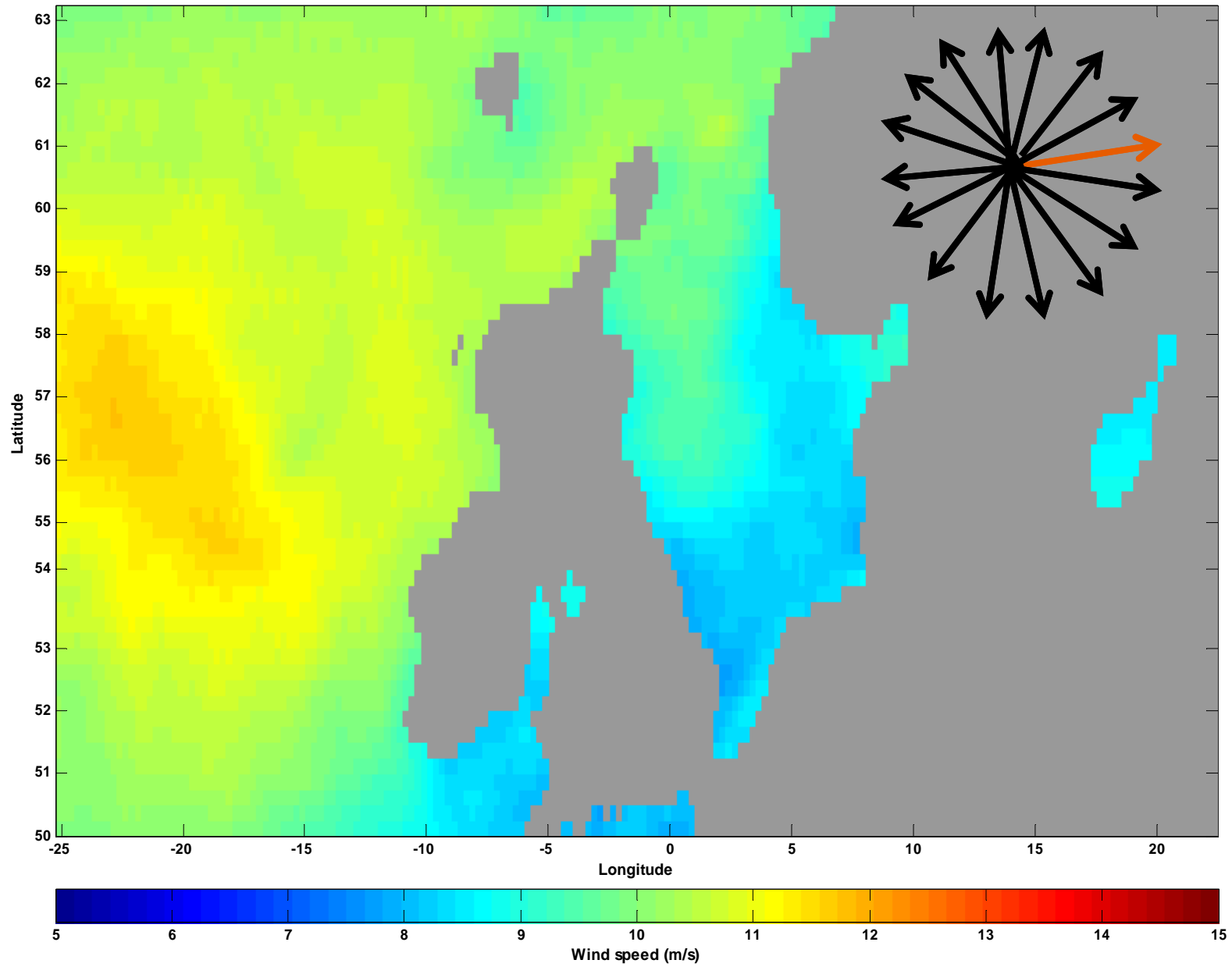


WS: Morning

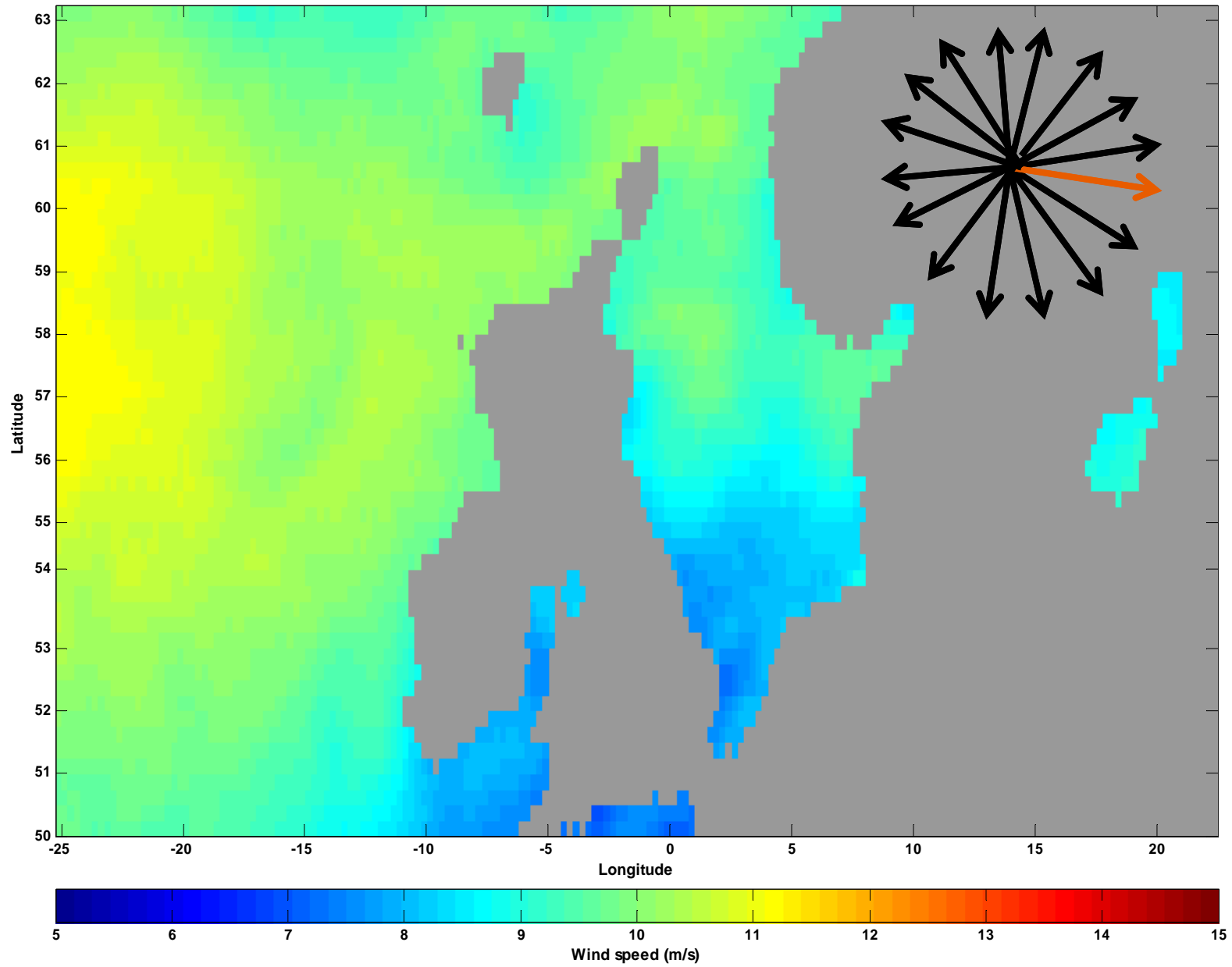




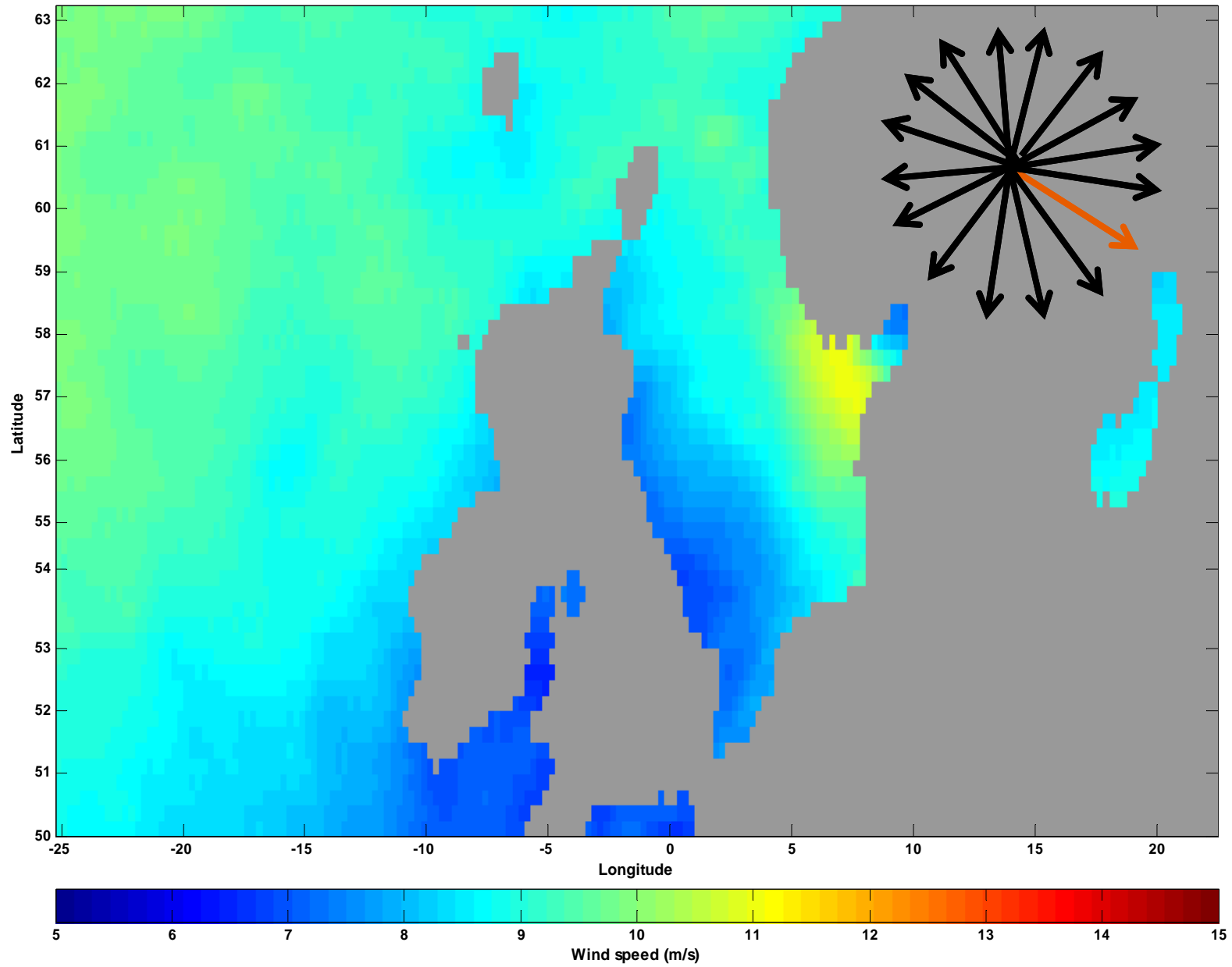
WSW: Morning



WNW: Morning



WN: Morning

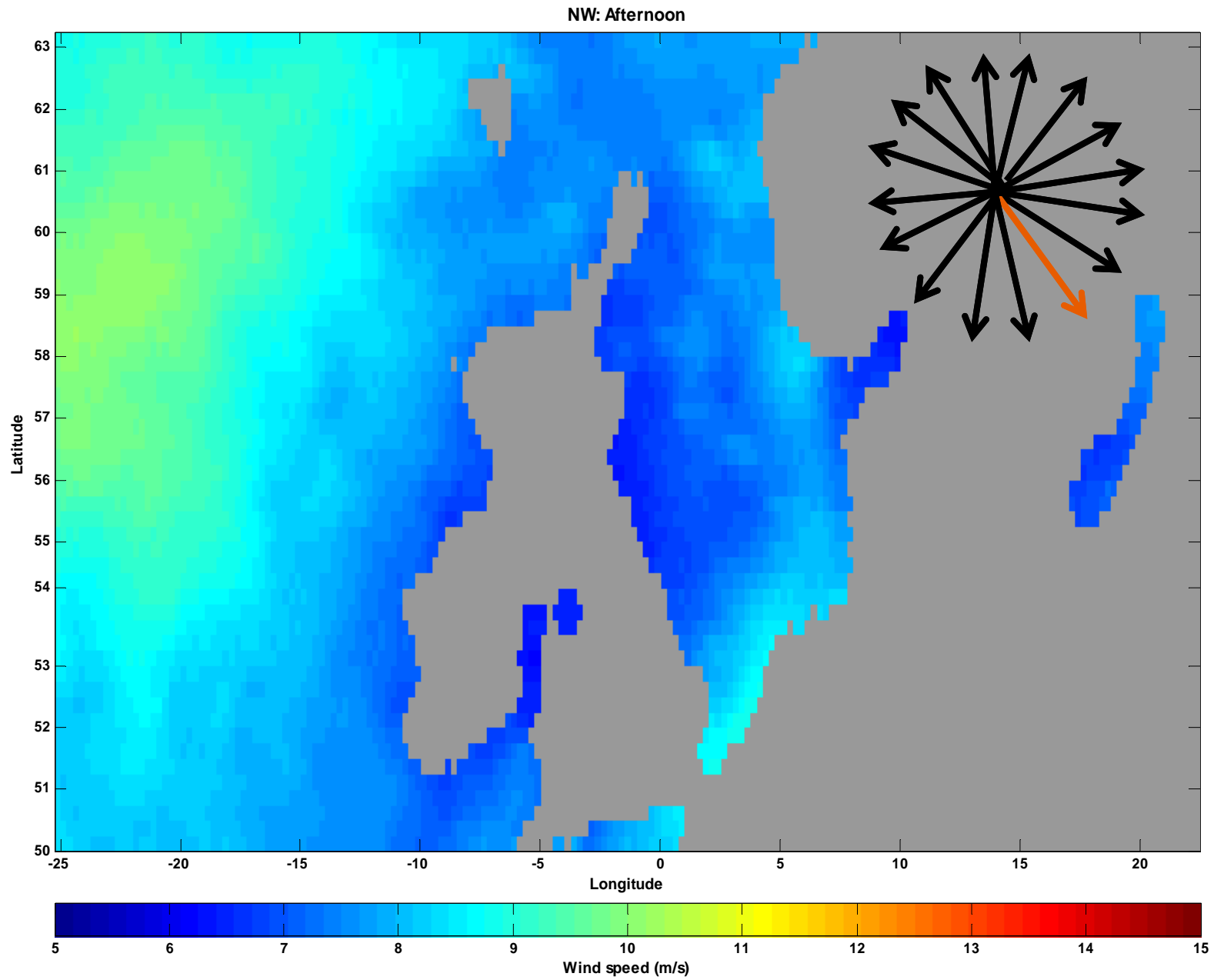


## Wind maps

- ~ 3500 morning
- ~ 3500 afternoon



# Average Wind Speed: Afternoon (based on wind direction at Horns Rev) - 16 Directions

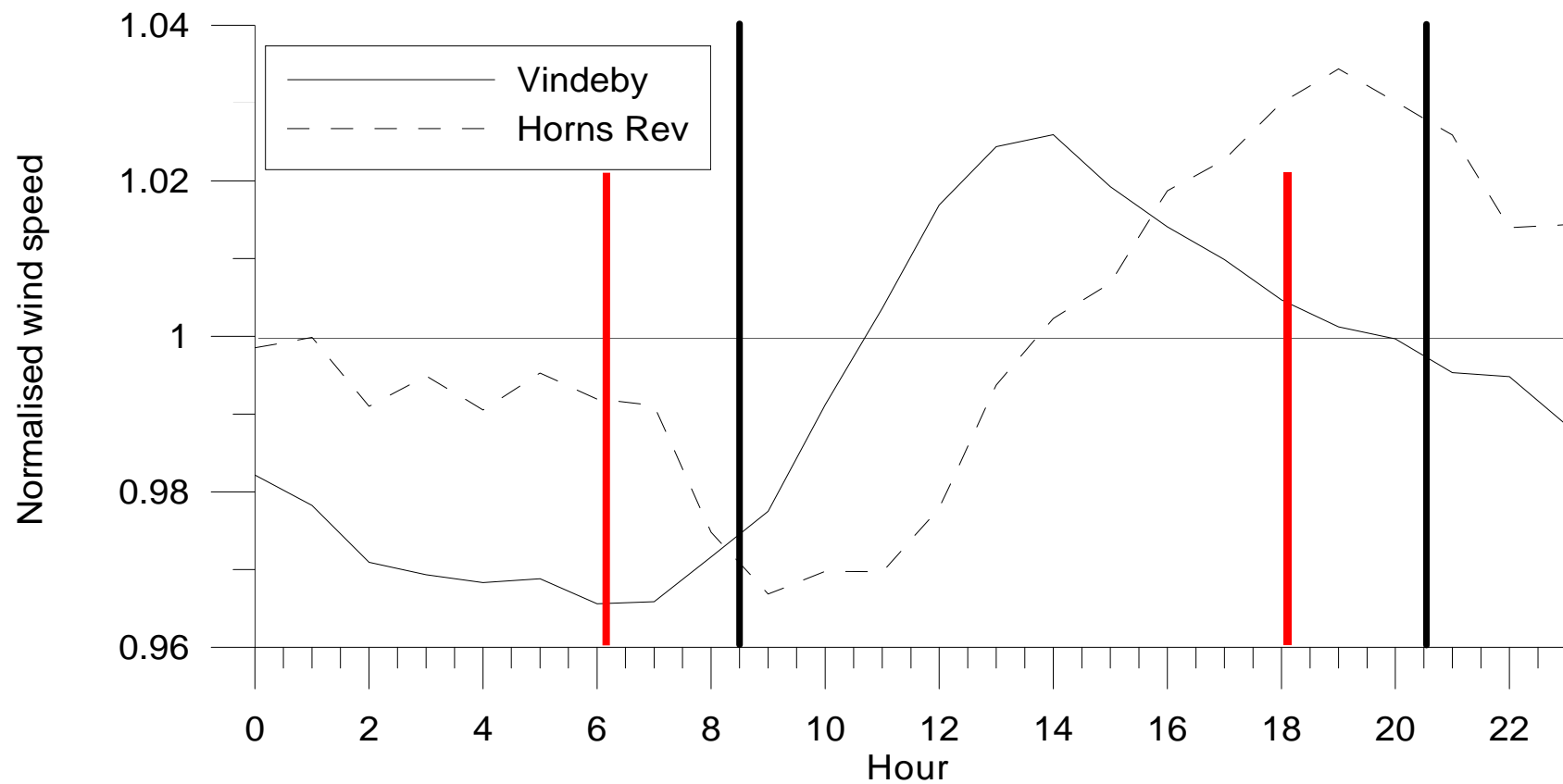


## Diurnal wind speed variation

Vindeby in Baltic Sea

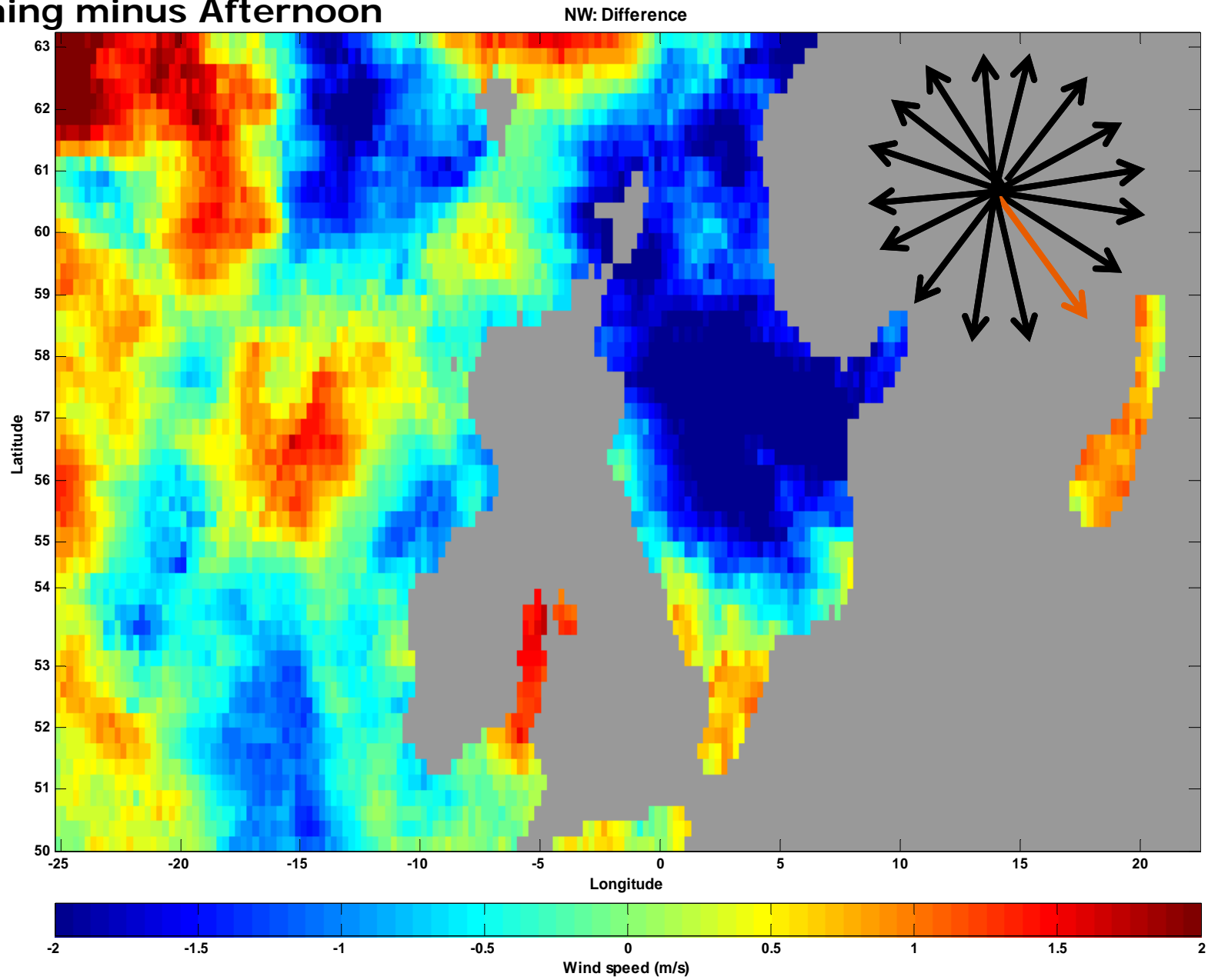
Horns Rev in the North Sea

Sampling times: red vertical QuikSCAT and black Envisat ASAR



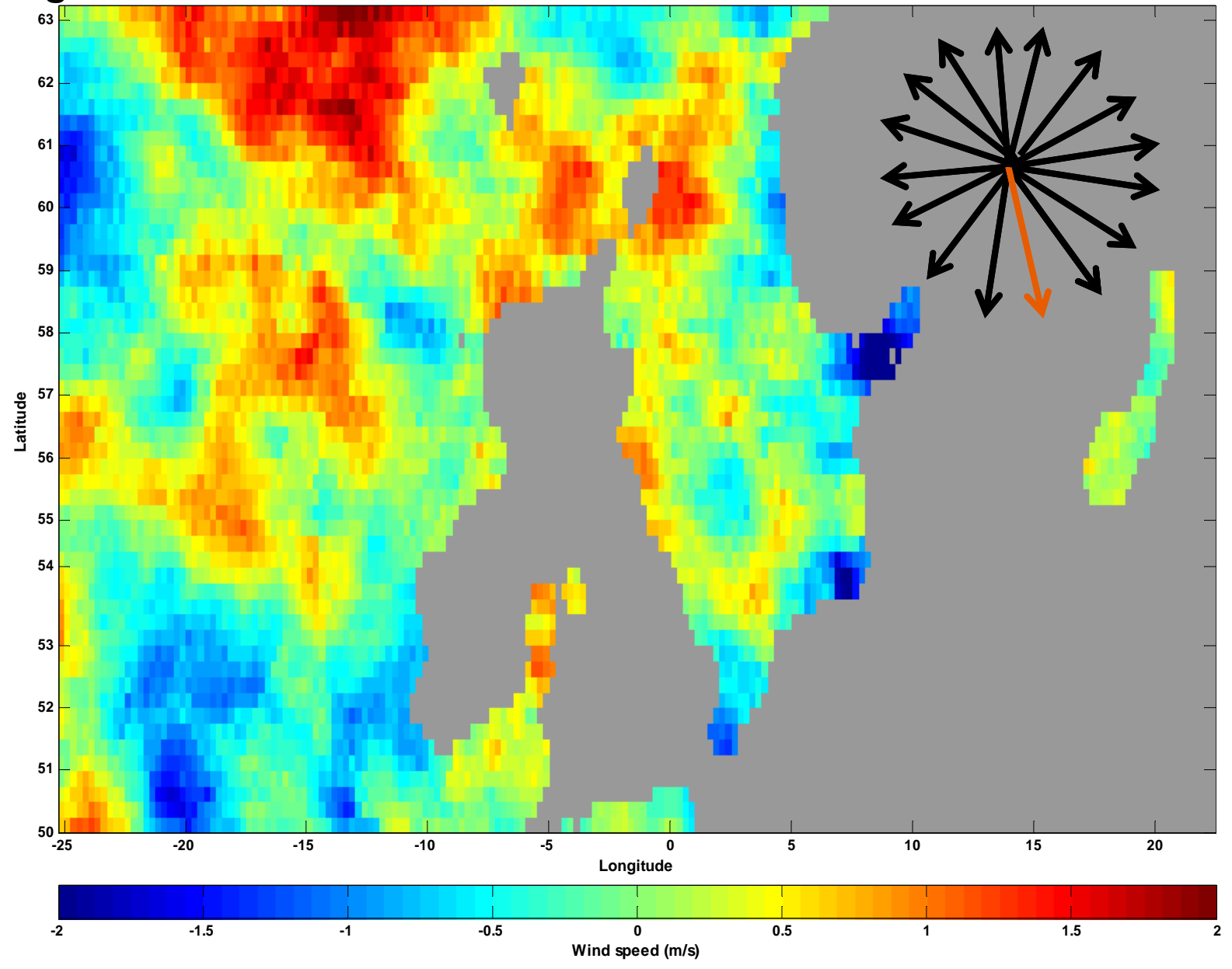
(Barthelmie & Pryor 2003: J. Applied Meteorology 42, 83-94)

# Average Wind Speed: Difference (based on wind direction at Horns Rev) - 16 Directions Morning minus Afternoon



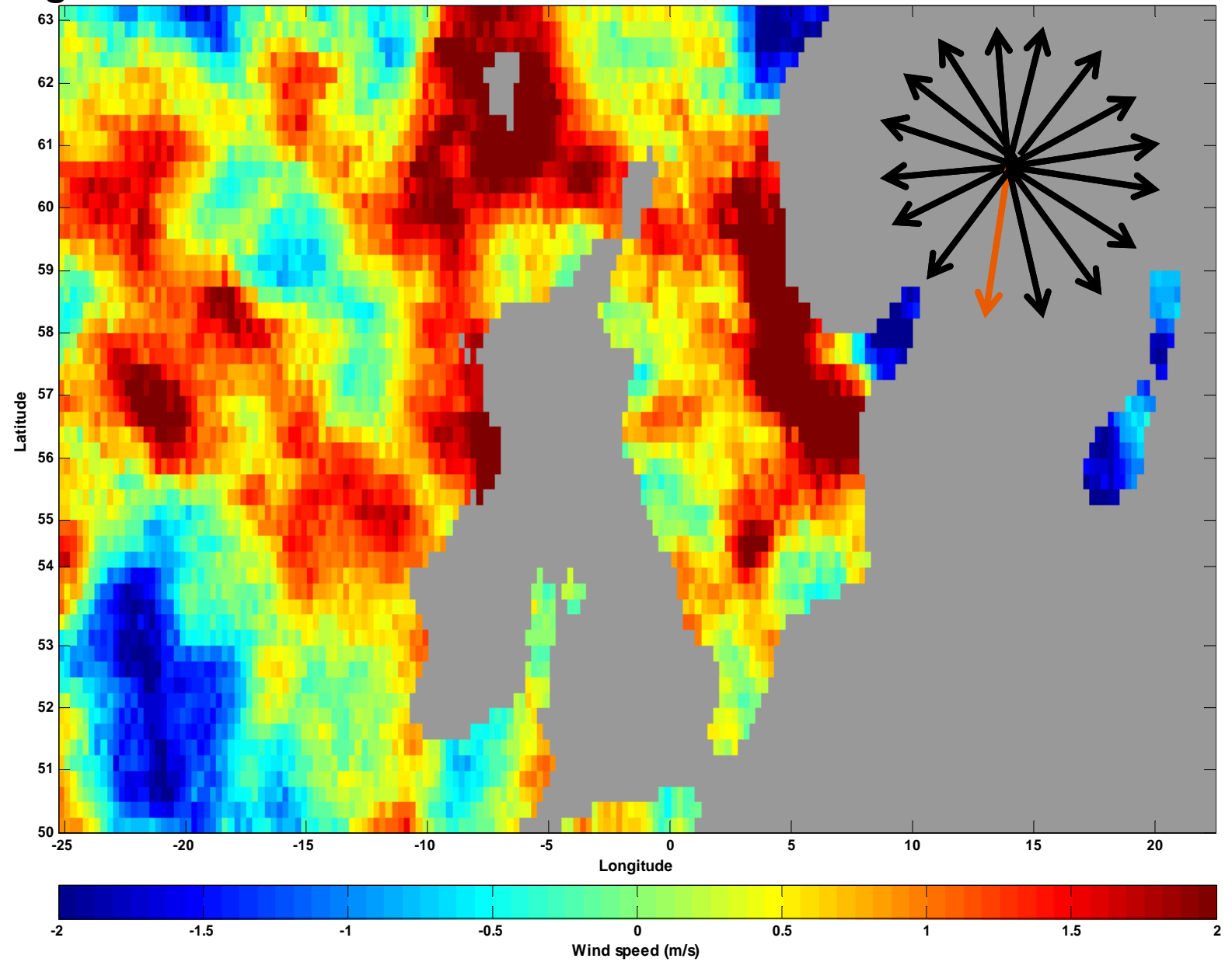
# Morning minus Afternoon

NNW: Difference



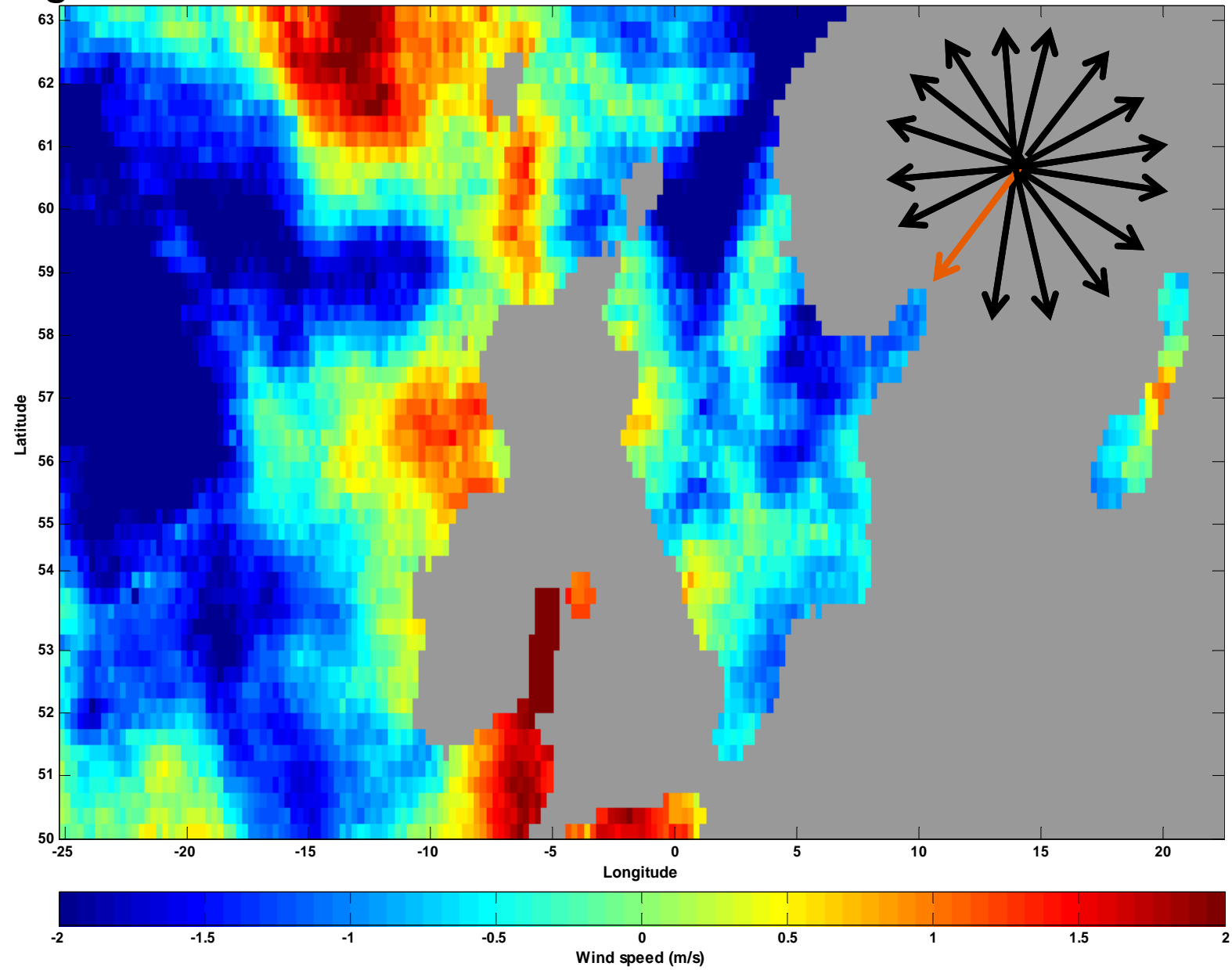
# Morning minus Afternoon

NNE: Difference



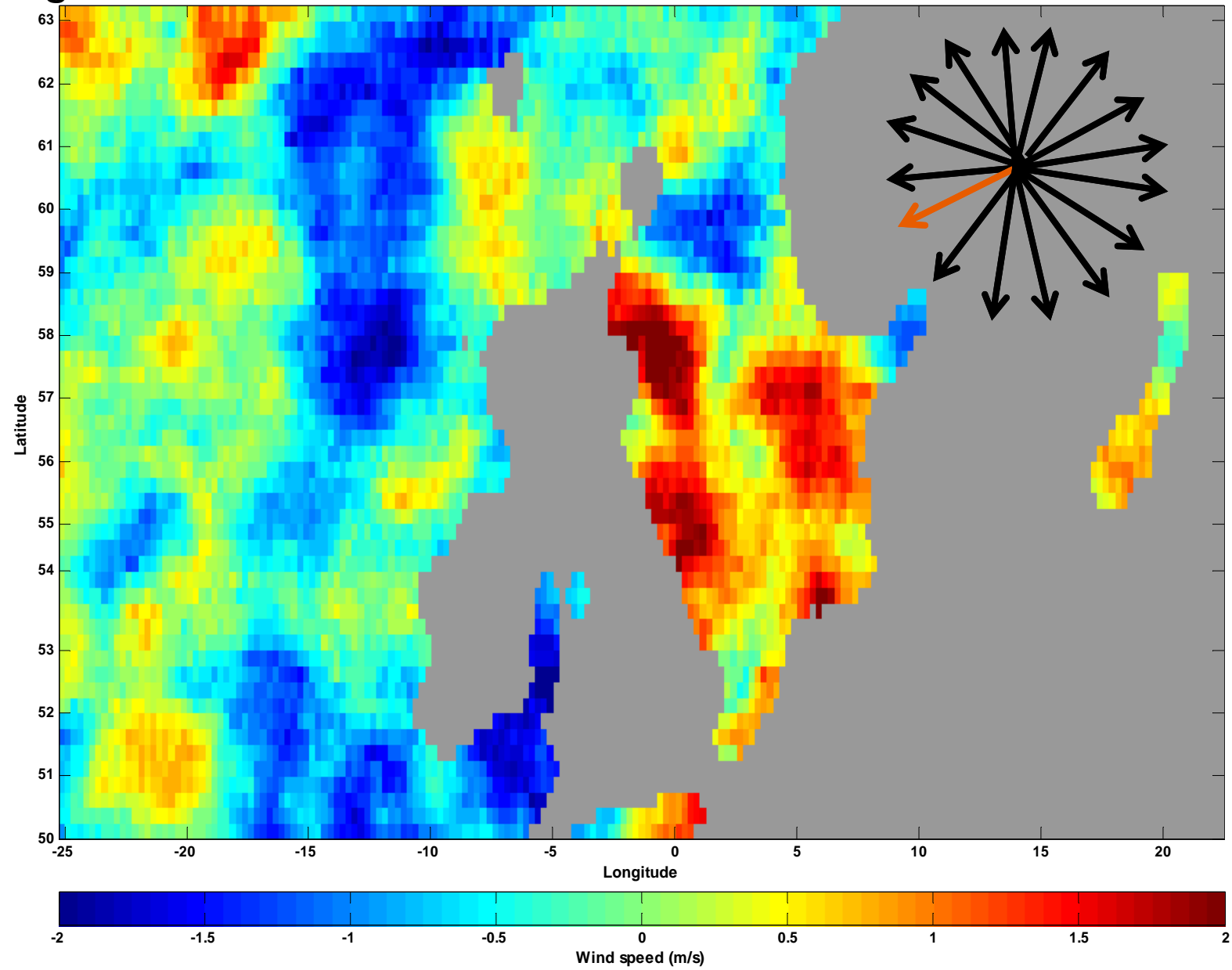
# Morning minus Afternoon

NE: Difference



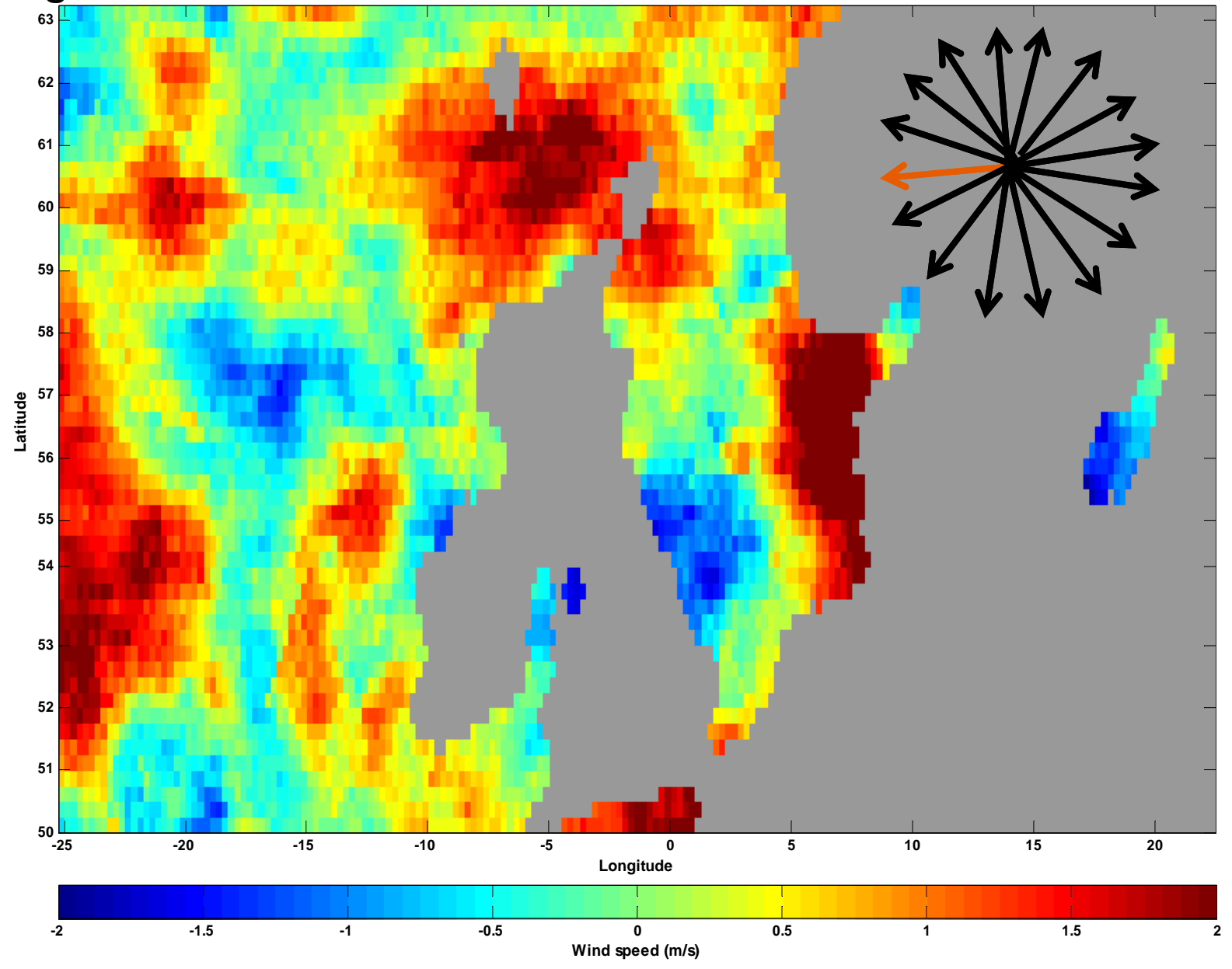
# Morning minus Afternoon

EN: Difference



# Morning minus Afternoon

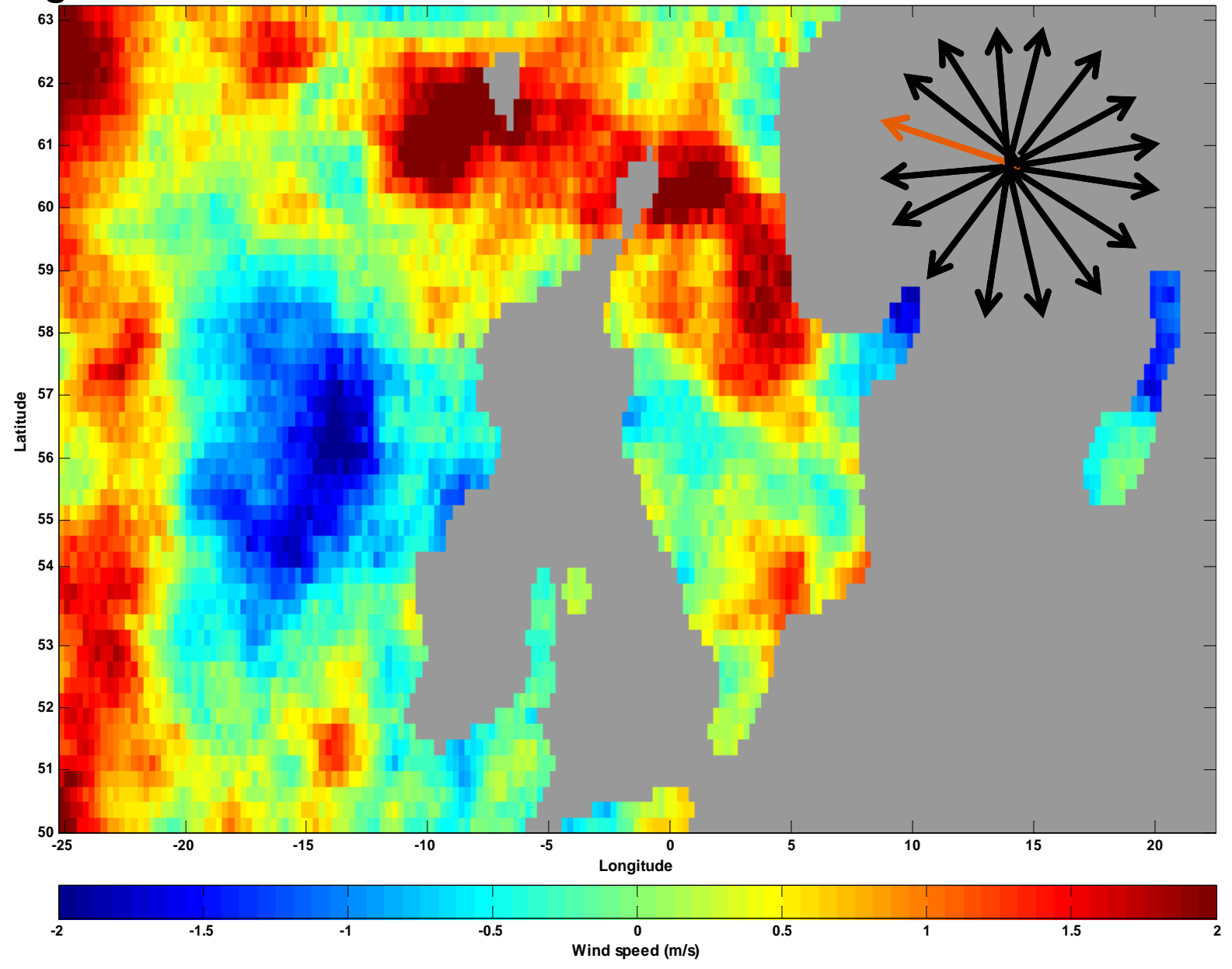
ENE: Difference





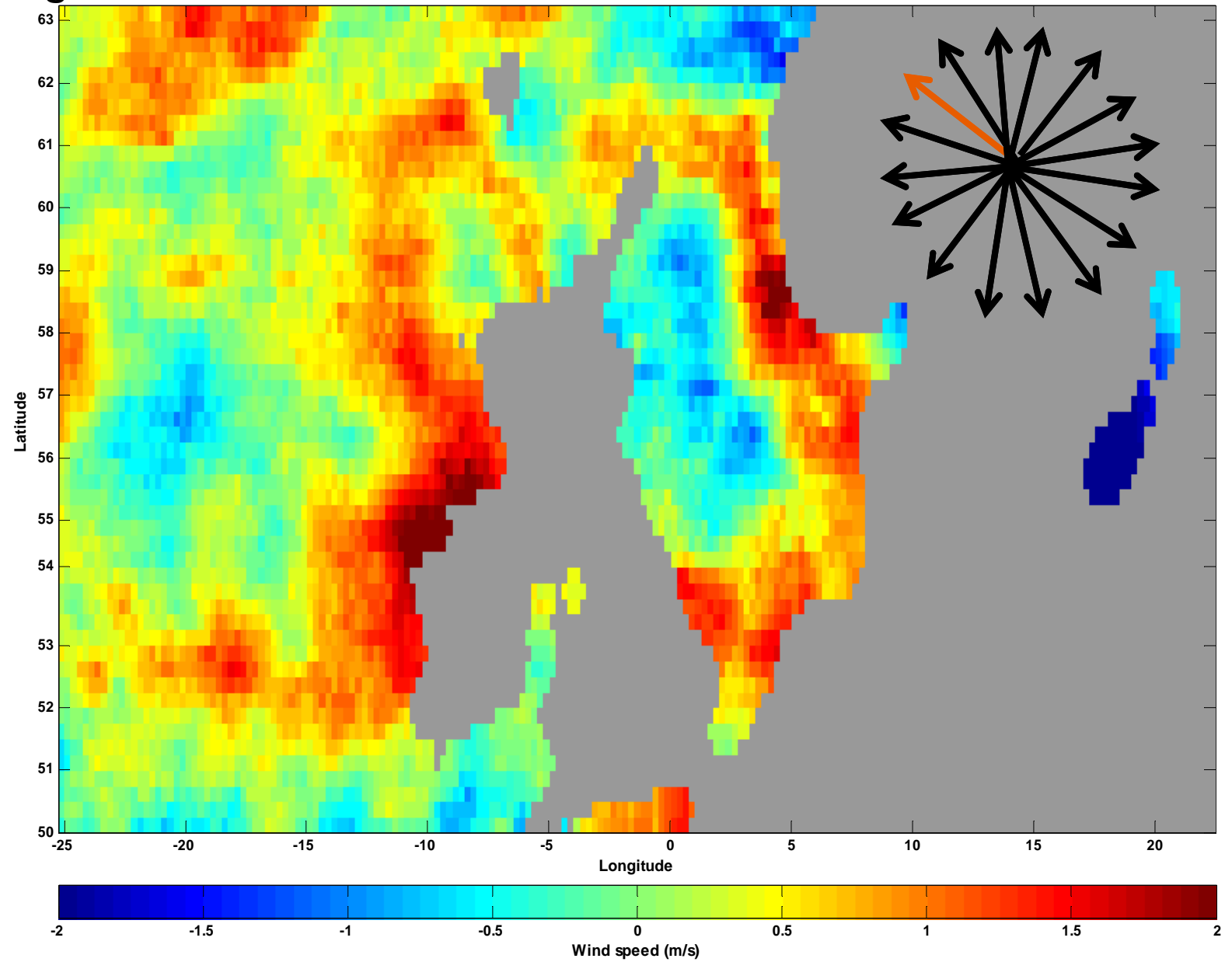
# Morning minus Afternoon

ESE: Difference



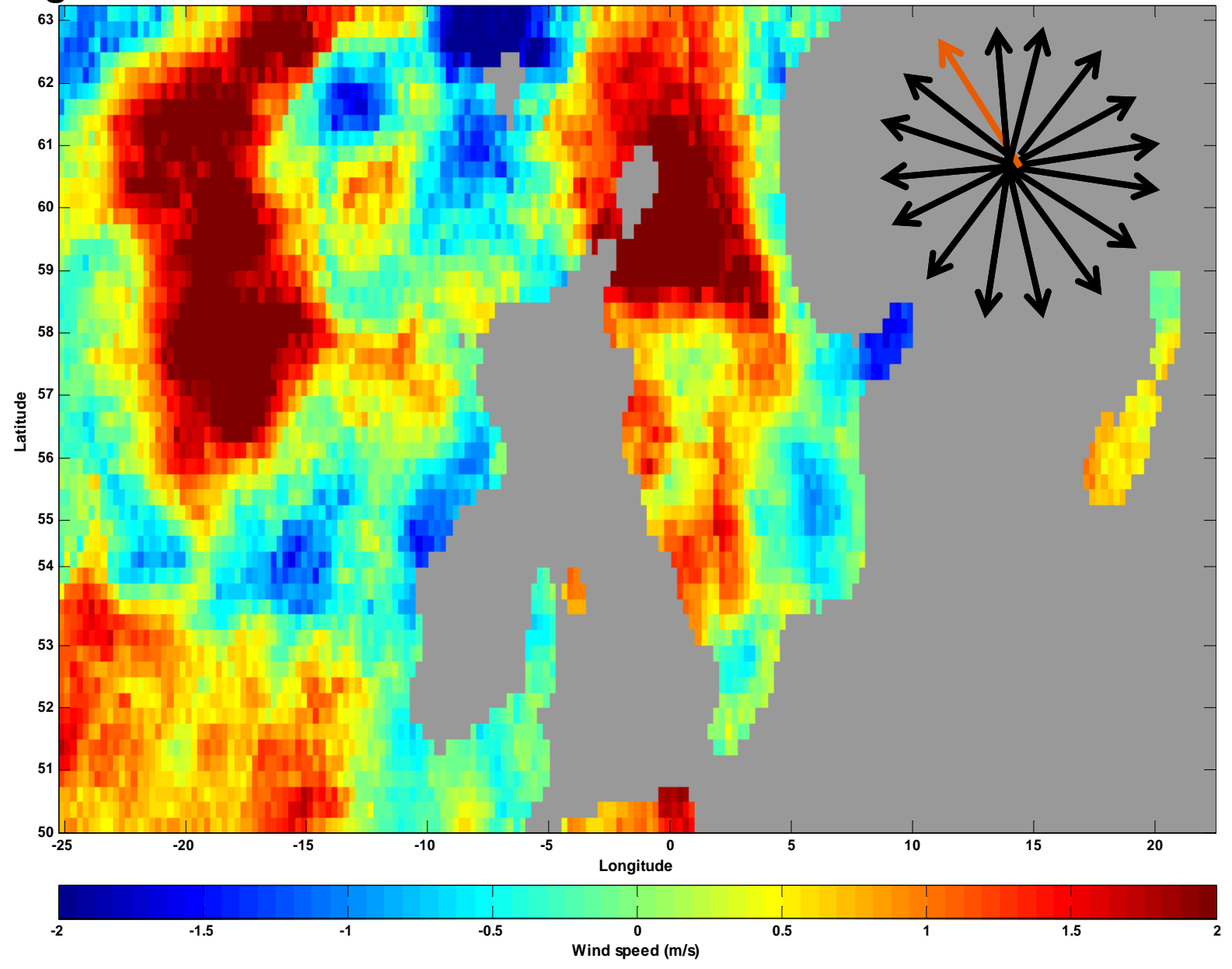
# Morning minus Afternoon

ES: Difference



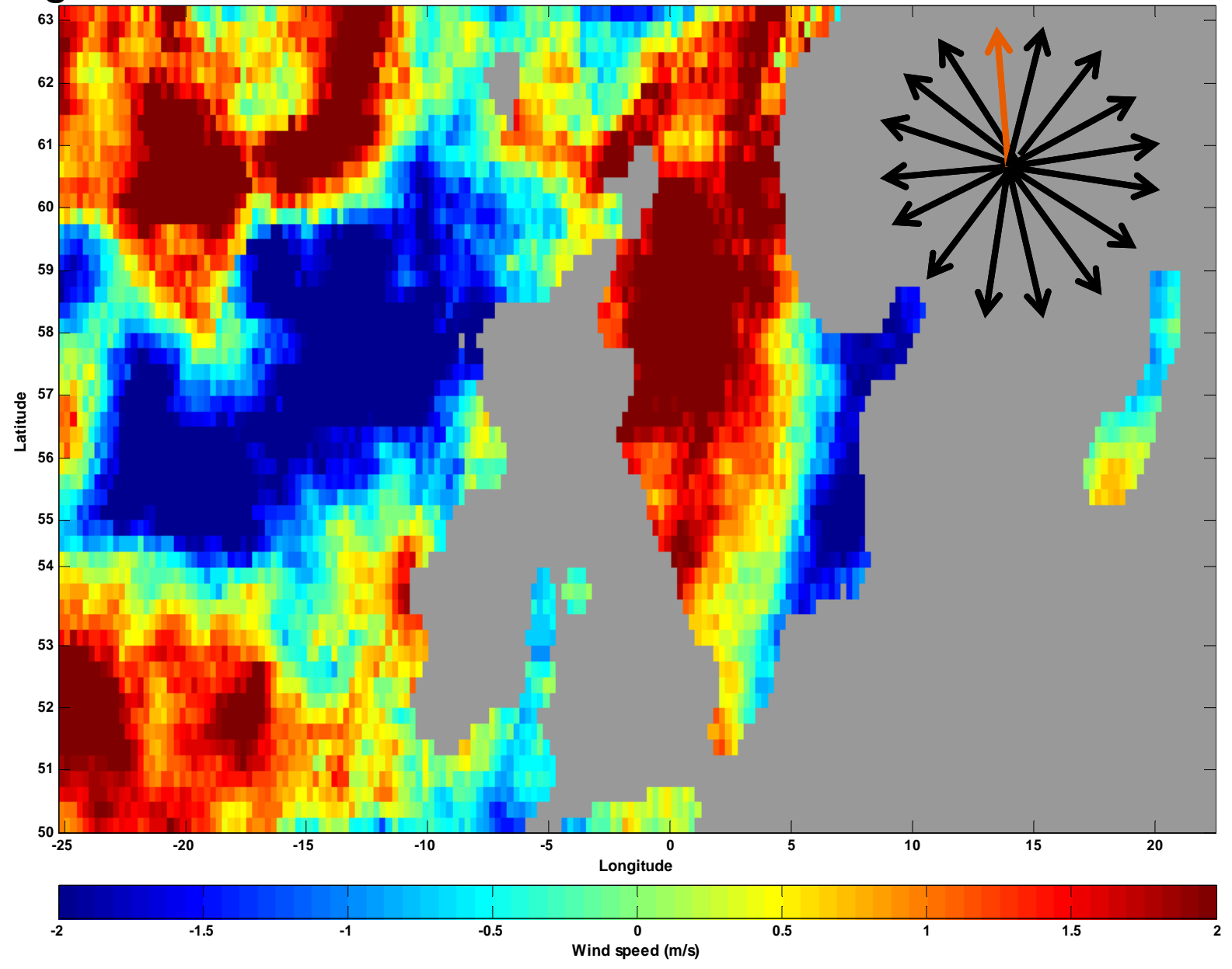
# Morning minus Afternoon

SE: Difference



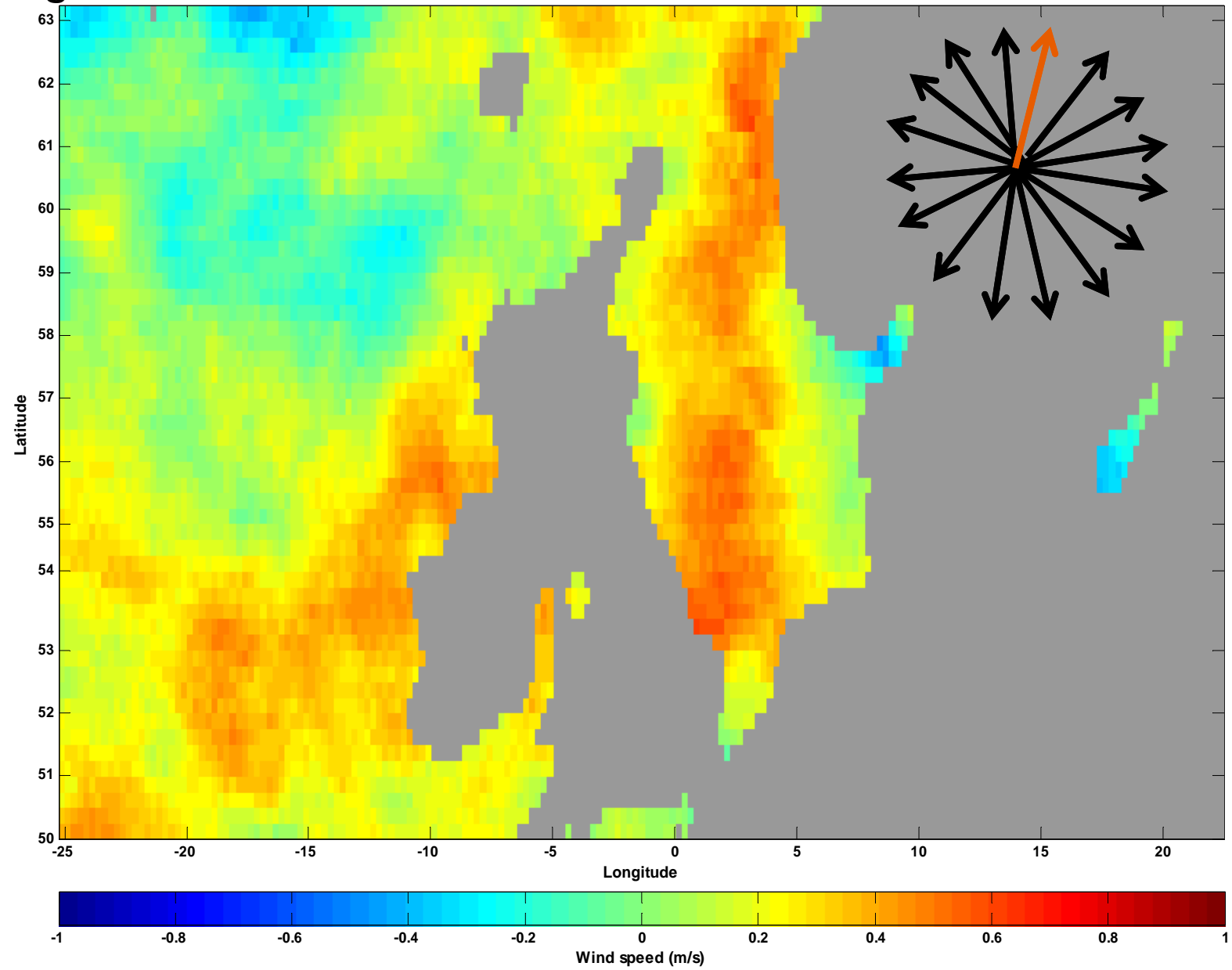
# Morning minus Afternoon

SSE: Difference



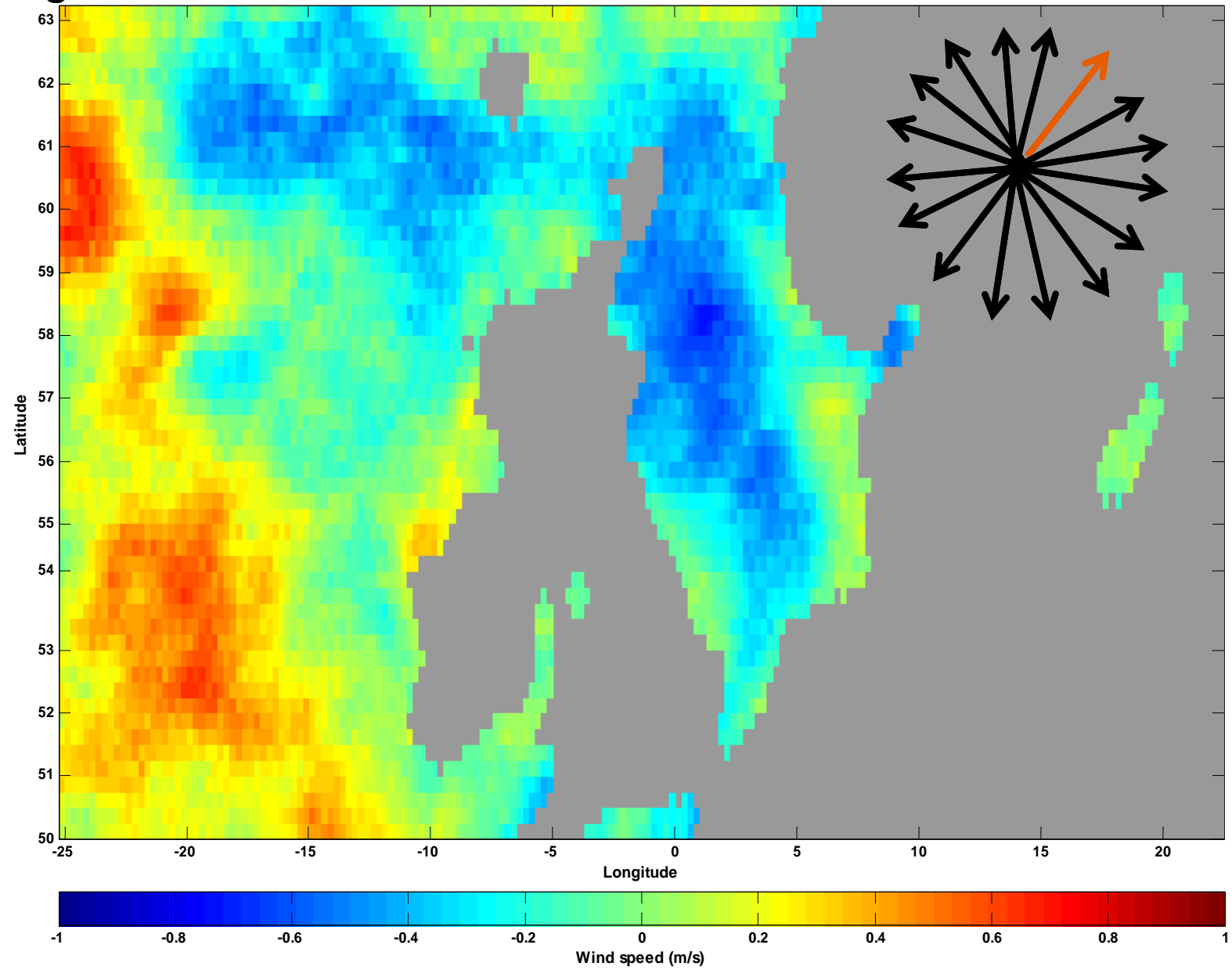
# Morning minus Afternoon

SSW: Difference



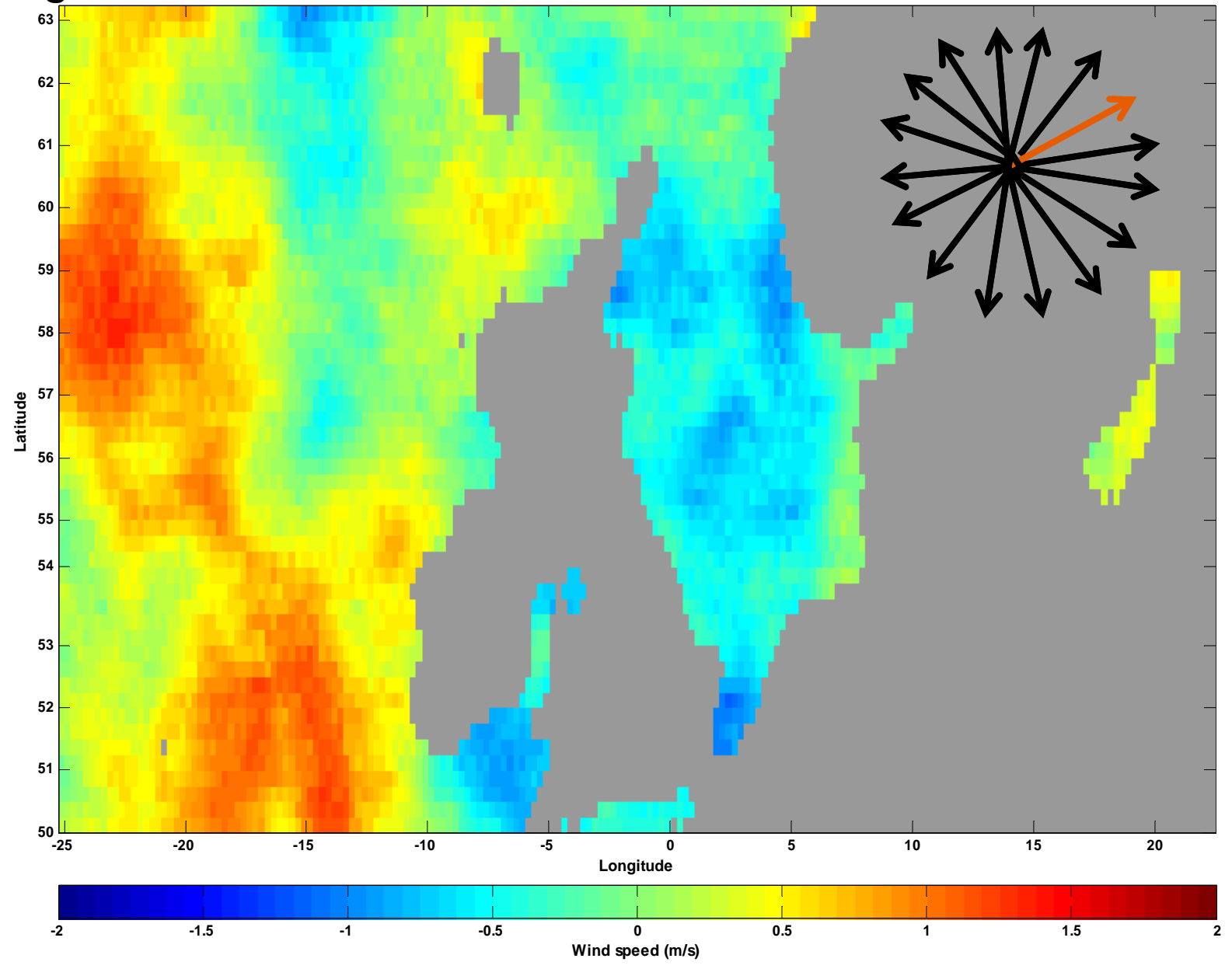
# Morning minus Afternoon

SW: Difference



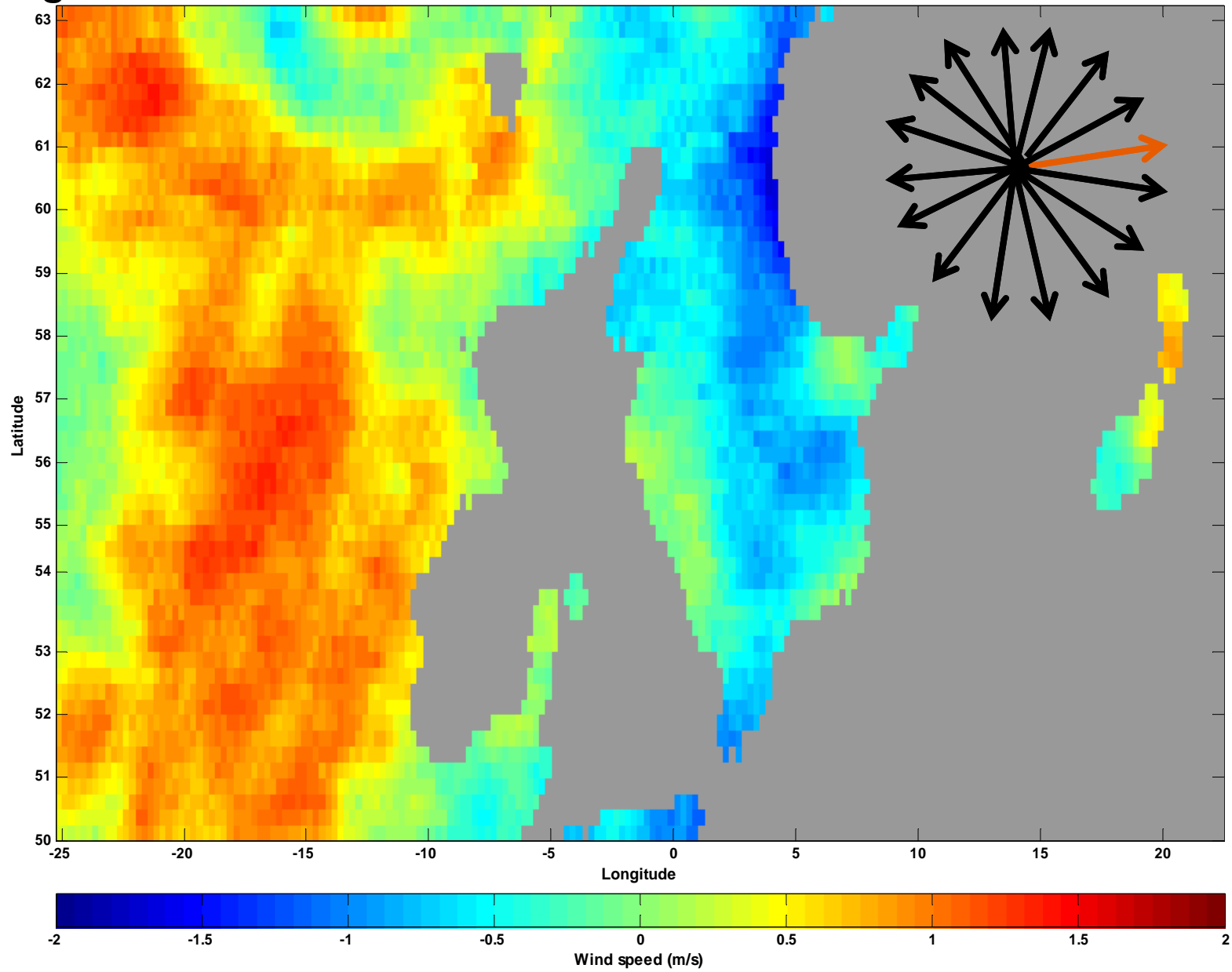
# Morning minus Afternoon

WS: Difference



# Morning minus Afternoon

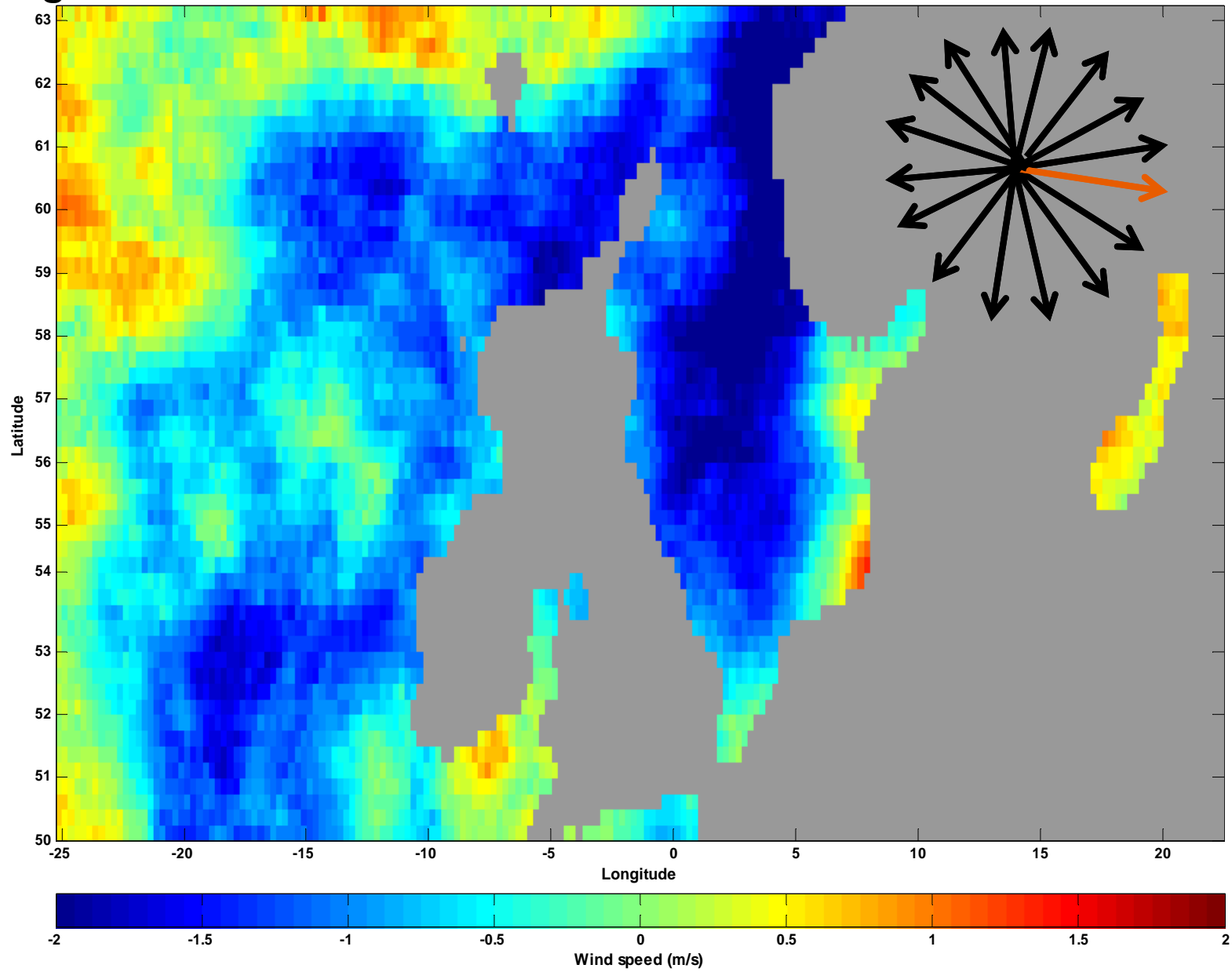
WSW: Difference





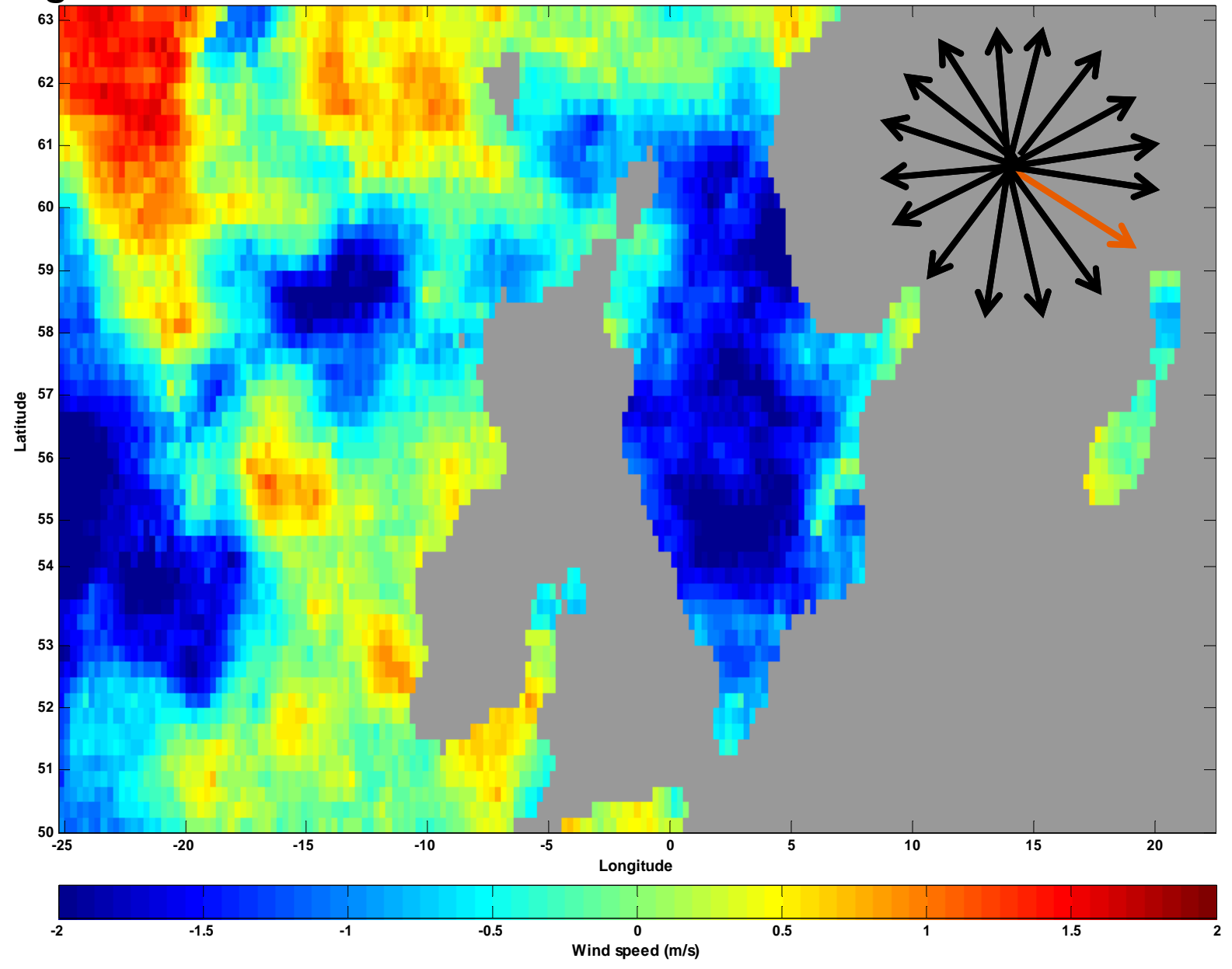
# Morning minus Afternoon

WNW: Difference

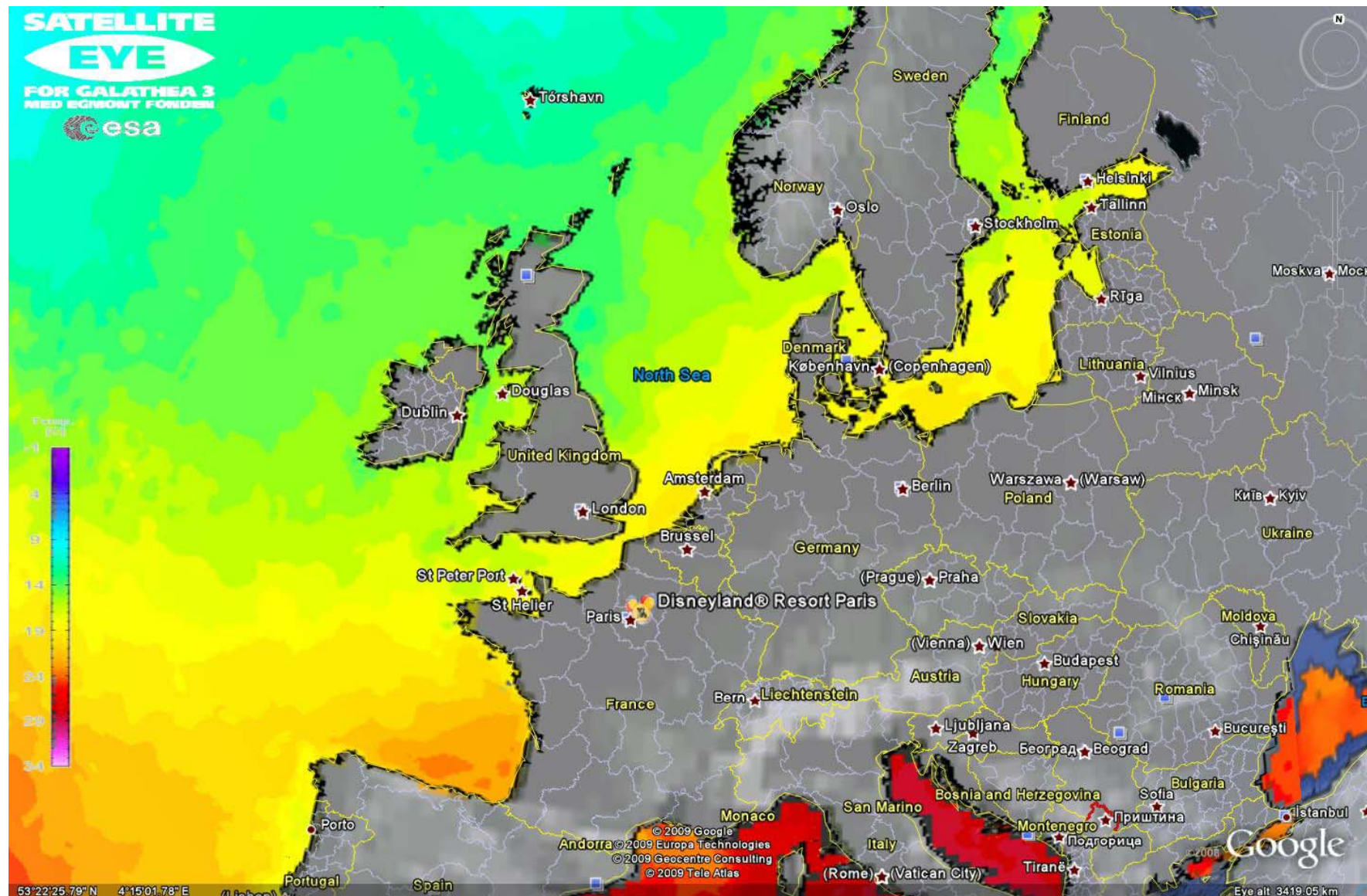


# Morning minus Afternoon

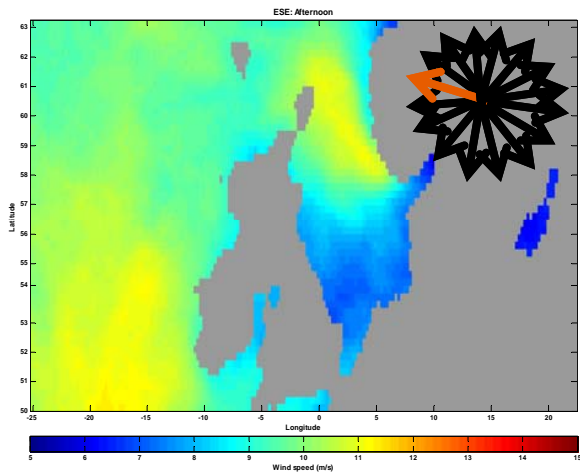
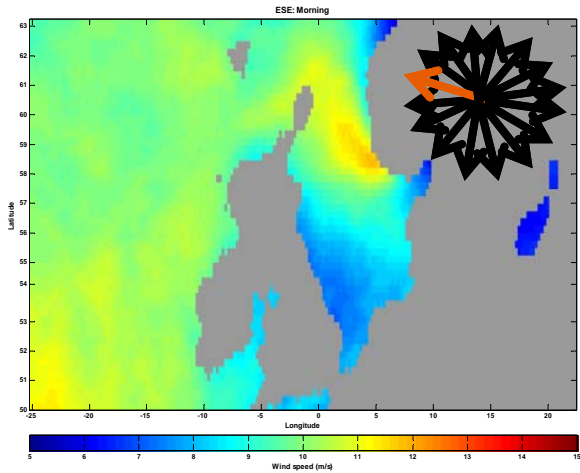
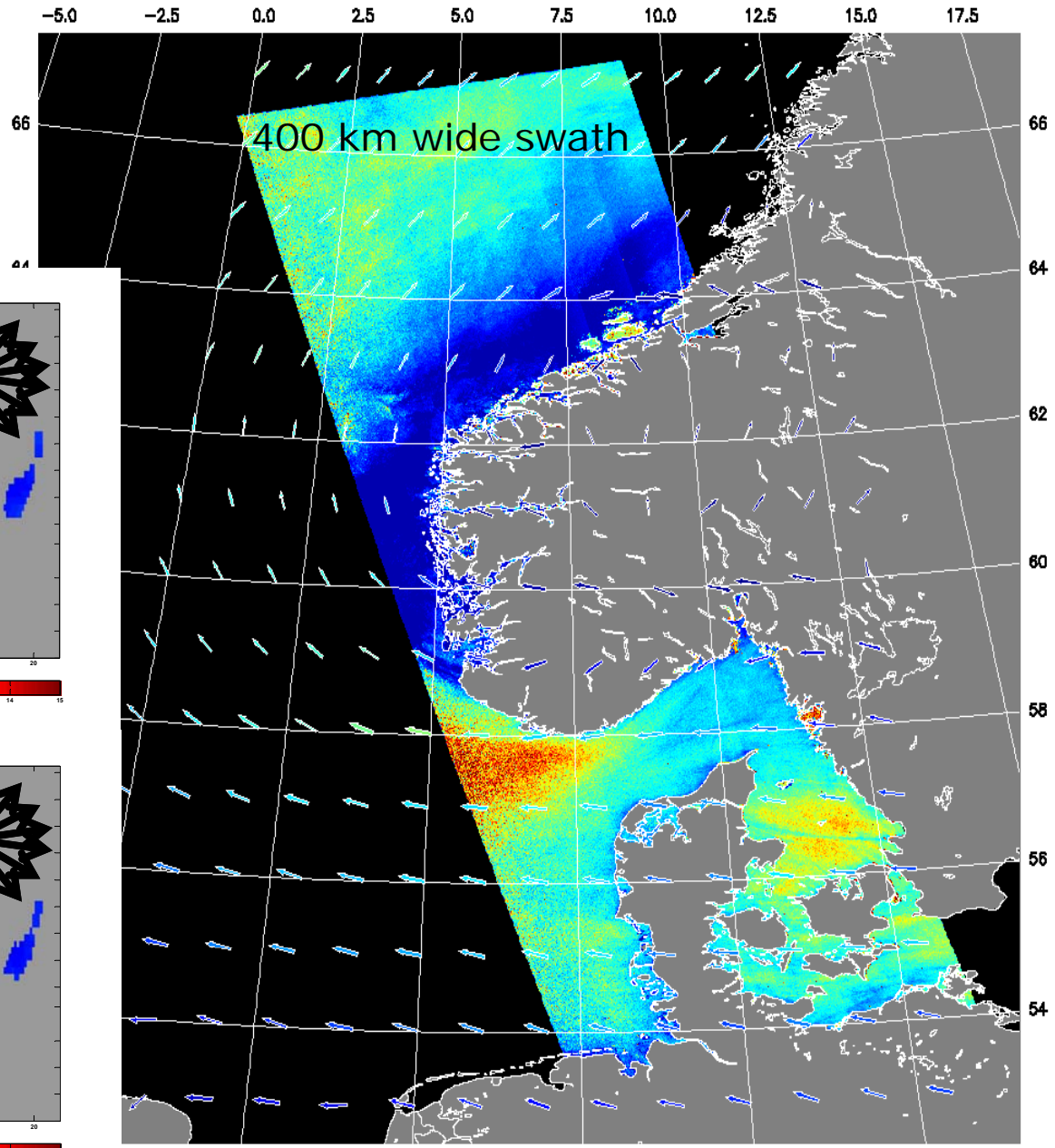
WN: Difference



# Sea surface temperature: 30 August 2009



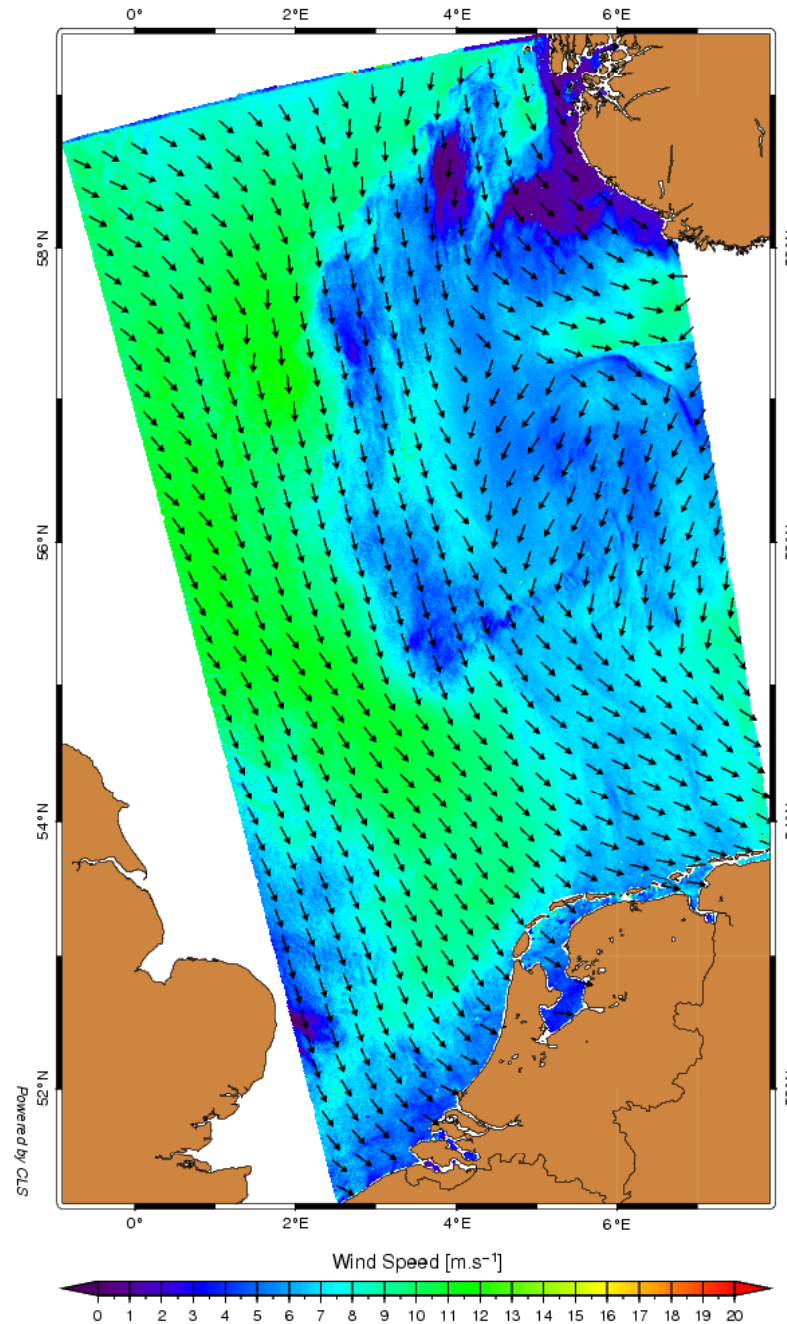
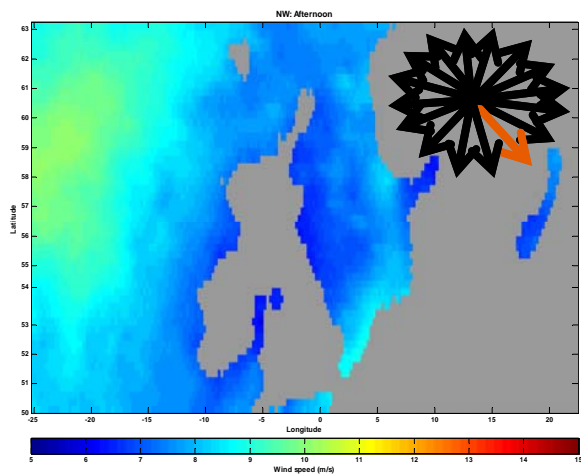
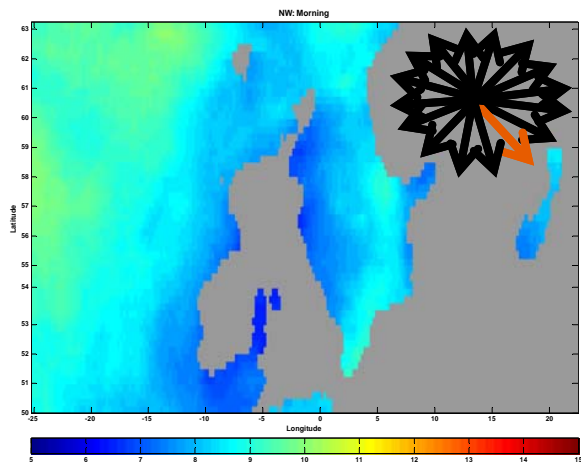
# Wind map from Envisat





# Wind map from Envisat

Processed at



## Future

1. Detailed analysis of coastal, diurnal wind variations (QuikSCAT and Envisat)
2. Detailed analysis of offshore wind and sea surface temperature
3. Comparison to observations (EU-Norsewind)
4. Comparison to mesoscale model results (EU-Norsewind)

Further references:

Hasager et al. 2009 **Satellite winds in EU-Norsewind**, EWEC 2009 Scientific proceedings (ISBN: ) , pages: 144-147.

[www.Norsewind.eu](http://www.Norsewind.eu)