

Introduction

Sea surface temperature is an important parameter governing the interaction between air and sea as far as heat, momentum, moisture and gas exchange is concerned as well as the atmospheric stability and the marine boundary layer height. Strong solar insolation and low wind speeds are favouring conditions for the diurnal variability of sea surface temperature. Exact knowledge of SST is required for applications such as climate monitoring, operational weather forecasting, ocean and atmospheric modelling. Thus, the diurnal variability of SST is important if SST applicability complications are to be resolved.

Satellite based remote sensing techniques are gaining ground as direct and operationally feasible methods for obtaining global wind vector and sea surface temperature information. QuikSCAT, in orbit since 1999, recorded daily information on global wind speed and direction until 2009. Surface wind is an important parameter for air-sea interactions, influencing heat and gas fluxes as well as the diurnal cycle of sea surface temperature. The SEVIRI instrument on board the MSG satellites, has been recording hourly SST fields since July, 2006. The aim of the present study is to combine satellite data of SST from SEVIRI and wind vector from QuikSCAT to obtain an overview of diurnal warming in the North Sea and the Baltic. Night-time reference fields generated from the SEVIRI dataset, were utilized in order to compute the hourly SST anomaly fields of each day. Diurnal warming exceeding 2 [K], occurring most frequently at 15:00 local solar time, was identified during the spring and summer months of every year, starting as early as March and reaching maximum observations in June and July. The two daily passes of QuikSCAT from the areas of interest are not expected to adequately resolve the diurnal cycle. Nonetheless, diurnal wind variability, defined as mean morning minus mean afternoon wind speeds, was maximum 0.5[m/s] in favour of morning winds for certain areas.

Data & Methods

QuikSCAT gridded data (RSS)

- ▶ Active Microwave Radar
- ▶ Measures radiation backscattered from the surface
- ▶ Grid cell: 25 * 25 km
- ▶ August 1999 - October 2009
- ▶ 2 daily passes
- ▶ Only no rain pixels included
- ▶ Potentially: 7466 passes
- ▶ Maximum available: 7085 passes

1. Select only no-rain wind retrievals
2. Compare with in-situ data

- ▶ Met.Mast: averaged (1hr), stability corrected
- ▶ Available wind direction measurements at 28 m
- ▶ Available wind speed measurements at 15 m
- ▶ Estimate U_* from measurements

$$U_{15} = \frac{U_*}{\kappa} \left[\ln\left(\frac{z}{z_0}\right) - \psi_{M15}\left(\frac{z}{L}\right) \right] \quad (1)$$

- ▶ Estimate U_{10} for neutral conditions

$$U_{10} = \frac{U_*}{\kappa} \left[\ln\left(\frac{z}{z_0}\right) \right] \quad (2)$$

SEVIRI gridded data (CMS)

- ▶ Visible-Infrared Imager
- ▶ Does not penetrate clouds
- ▶ Geostationary Orbit, Hourly Measurements
- ▶ Gridded data in 0.05 degrees
- ▶ Grid cell: 5.56 * 3.2 km
- ▶ June 2004 - October 2009
- ▶ Potentially: 46752 hourly measurements
- ▶ Maximum available: 6951 hourly measurements (q.f.=5)

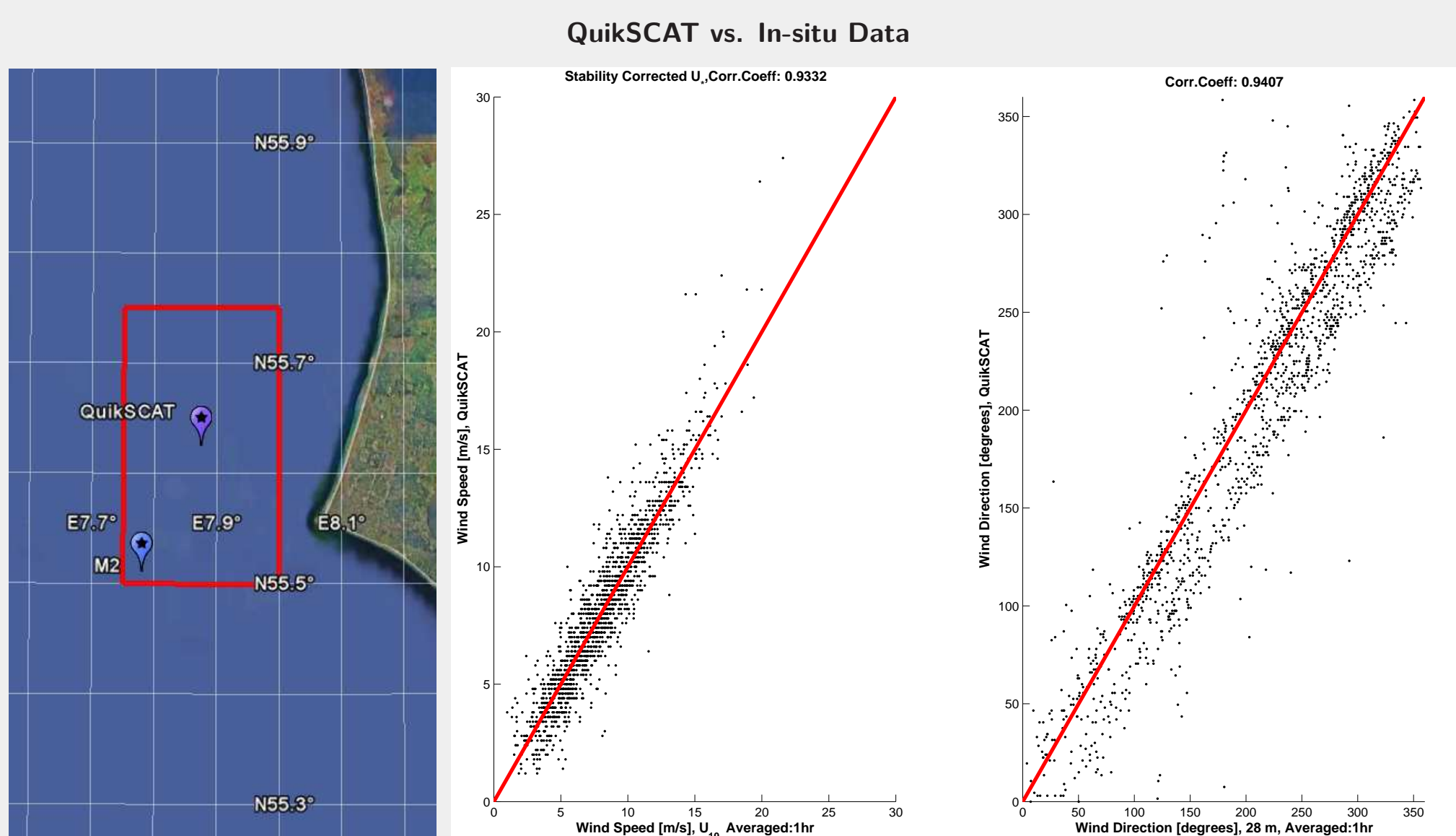
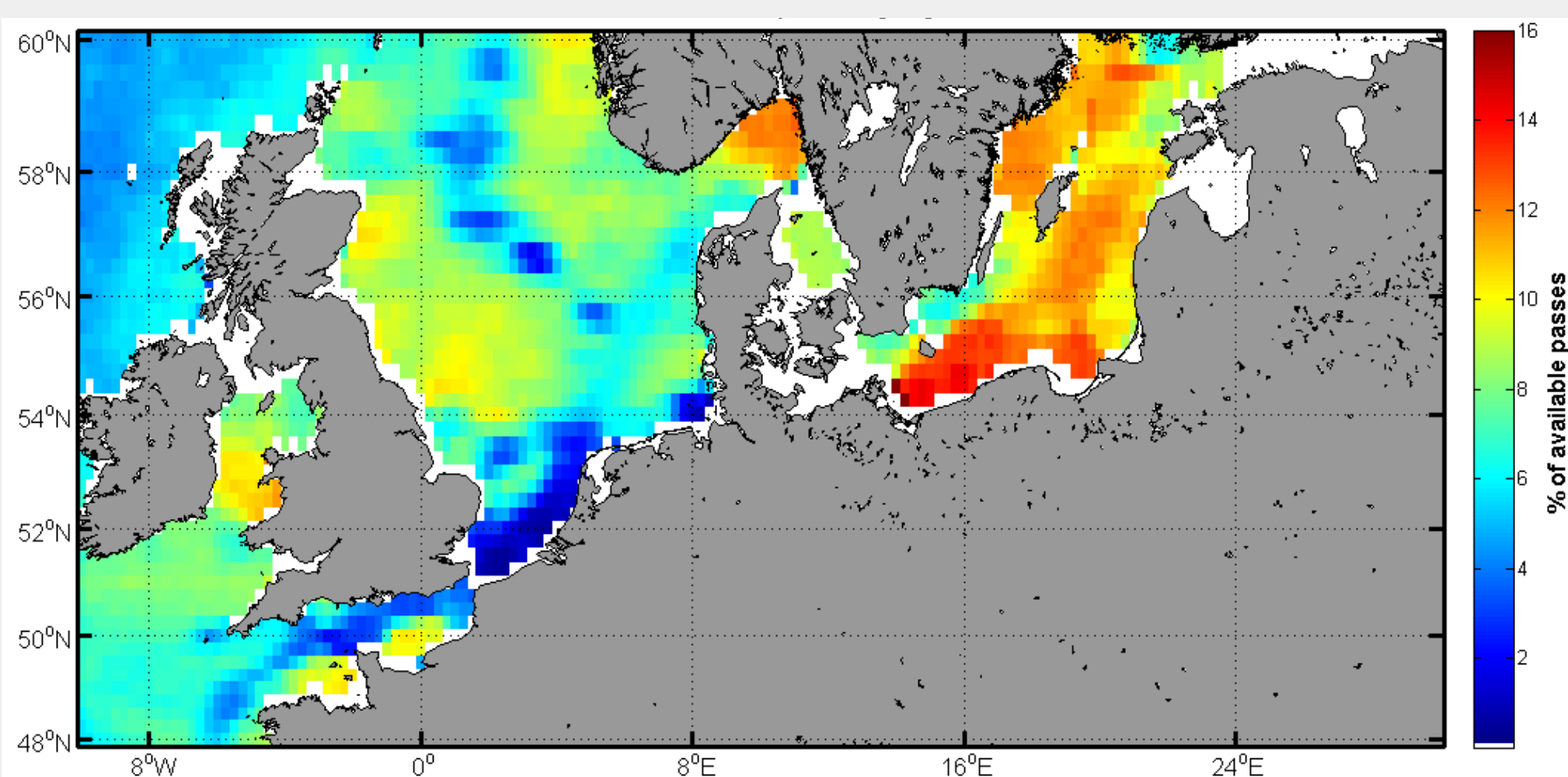
1. Generate Night-Time Reference Fields

- ▶ Use measurements from 00 to 03, local time
- ▶ Quality flags (q.f.): 3, 4, 5
- ▶ Use data of the day \pm 3 days
- ▶ Average per grid cell \rightarrow in 1 field/day

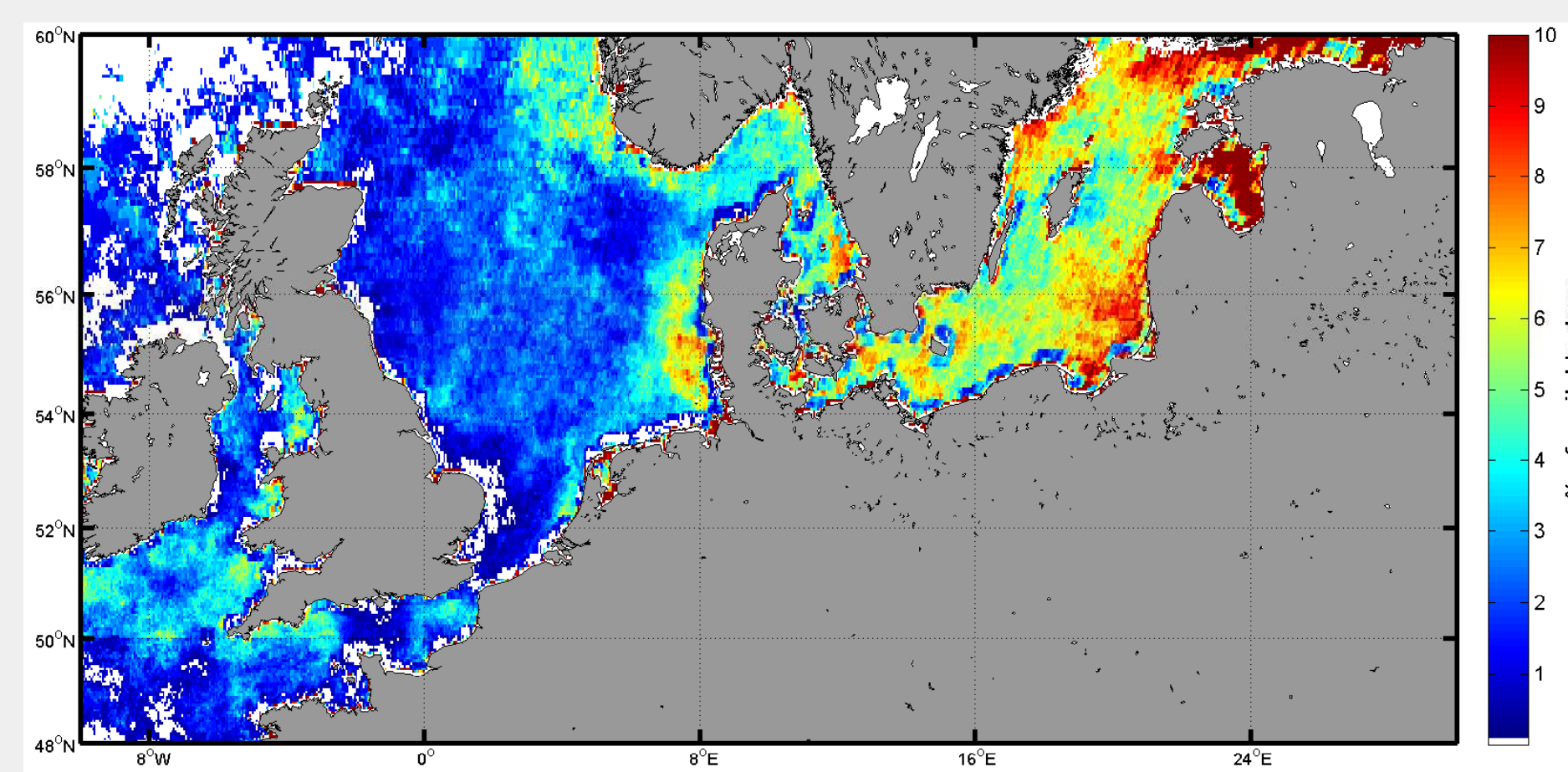
2. Estimate hourly daytime anomalies as:

- ▶ DayTime Measurement - NightTime Reference Field
- ▶ Use DayTime Measurements with q.f.=5

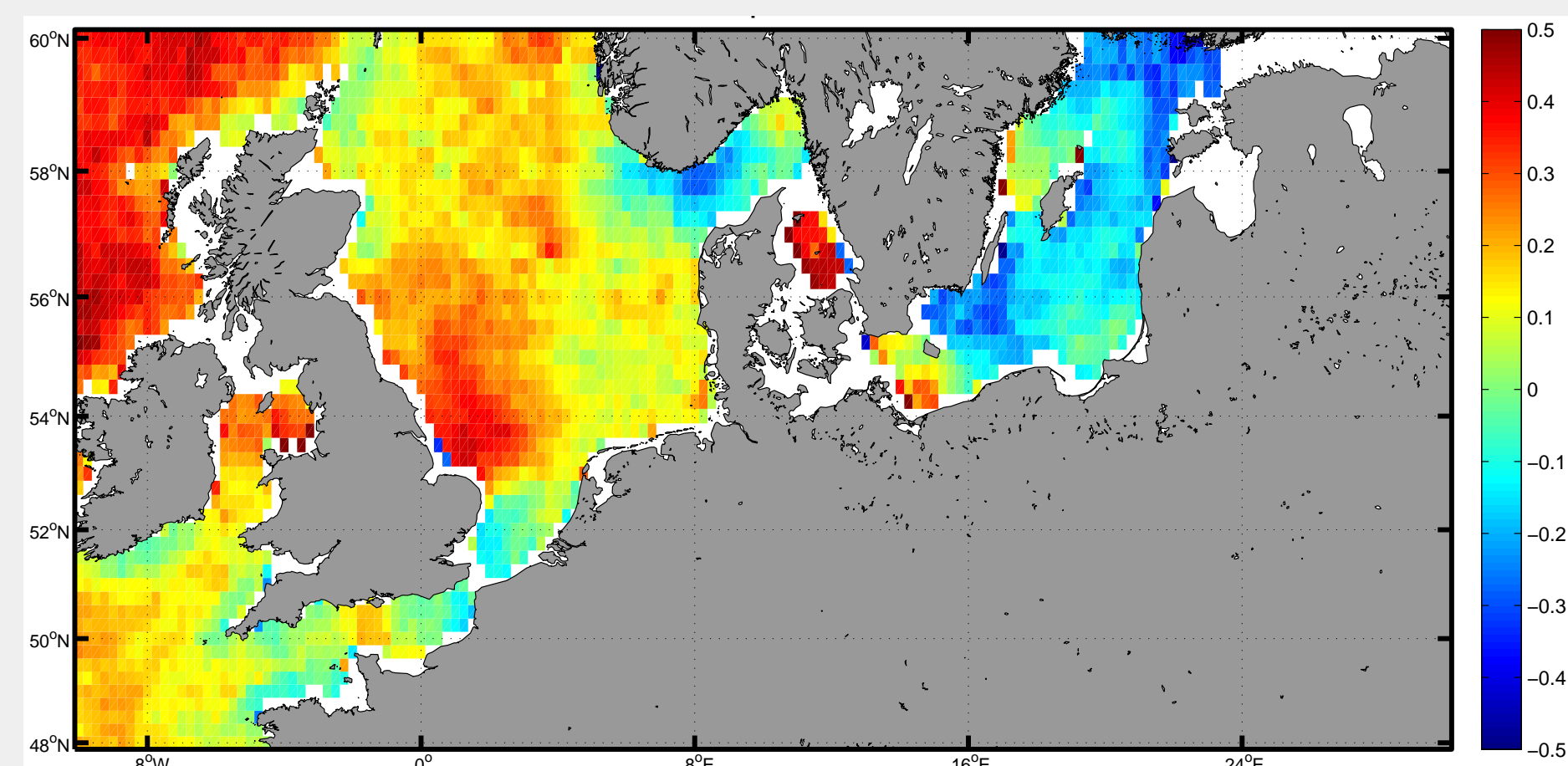
QuikSCAT Winds < 3 [m/s]



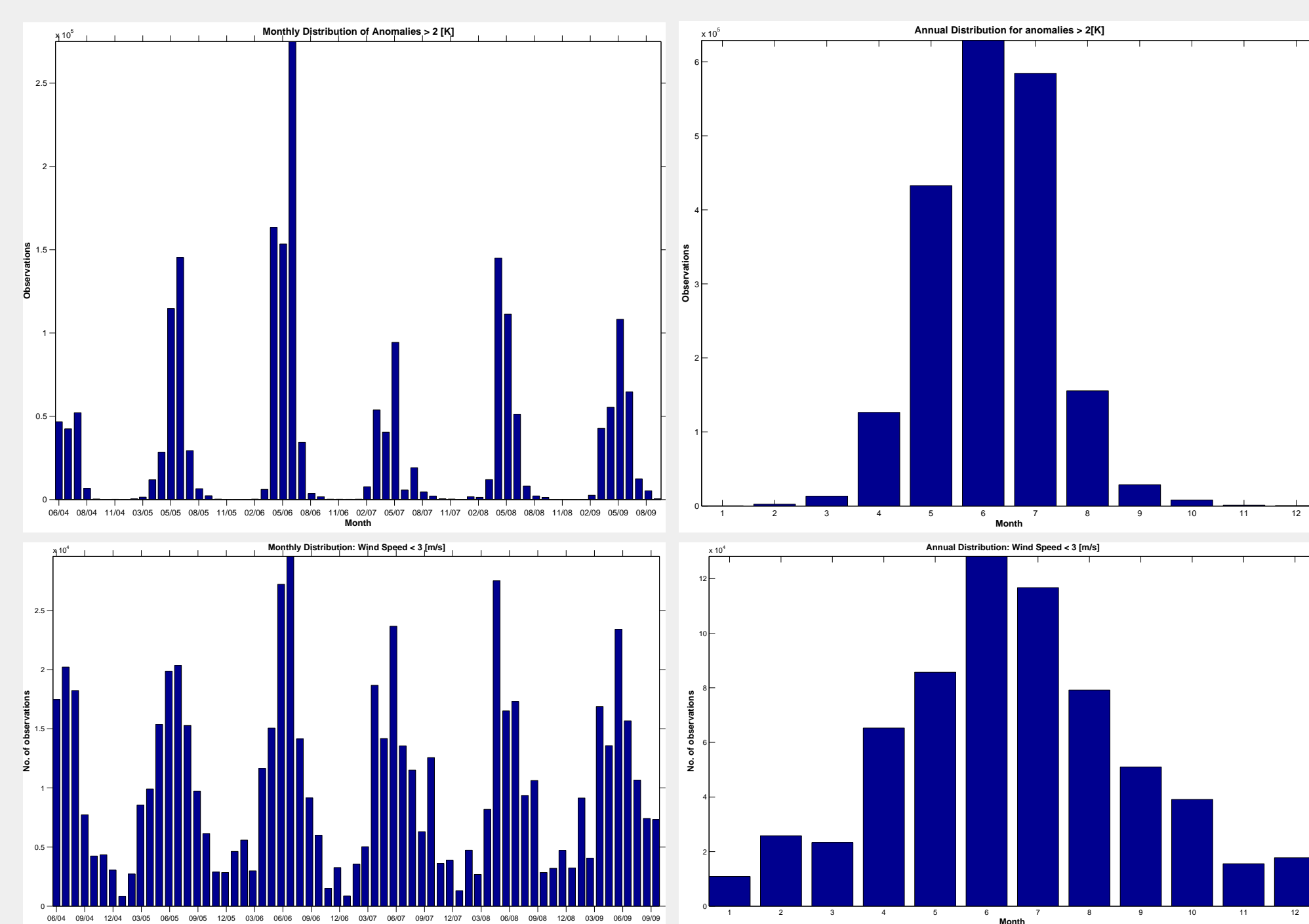
Diurnal Warming > 2 [K]



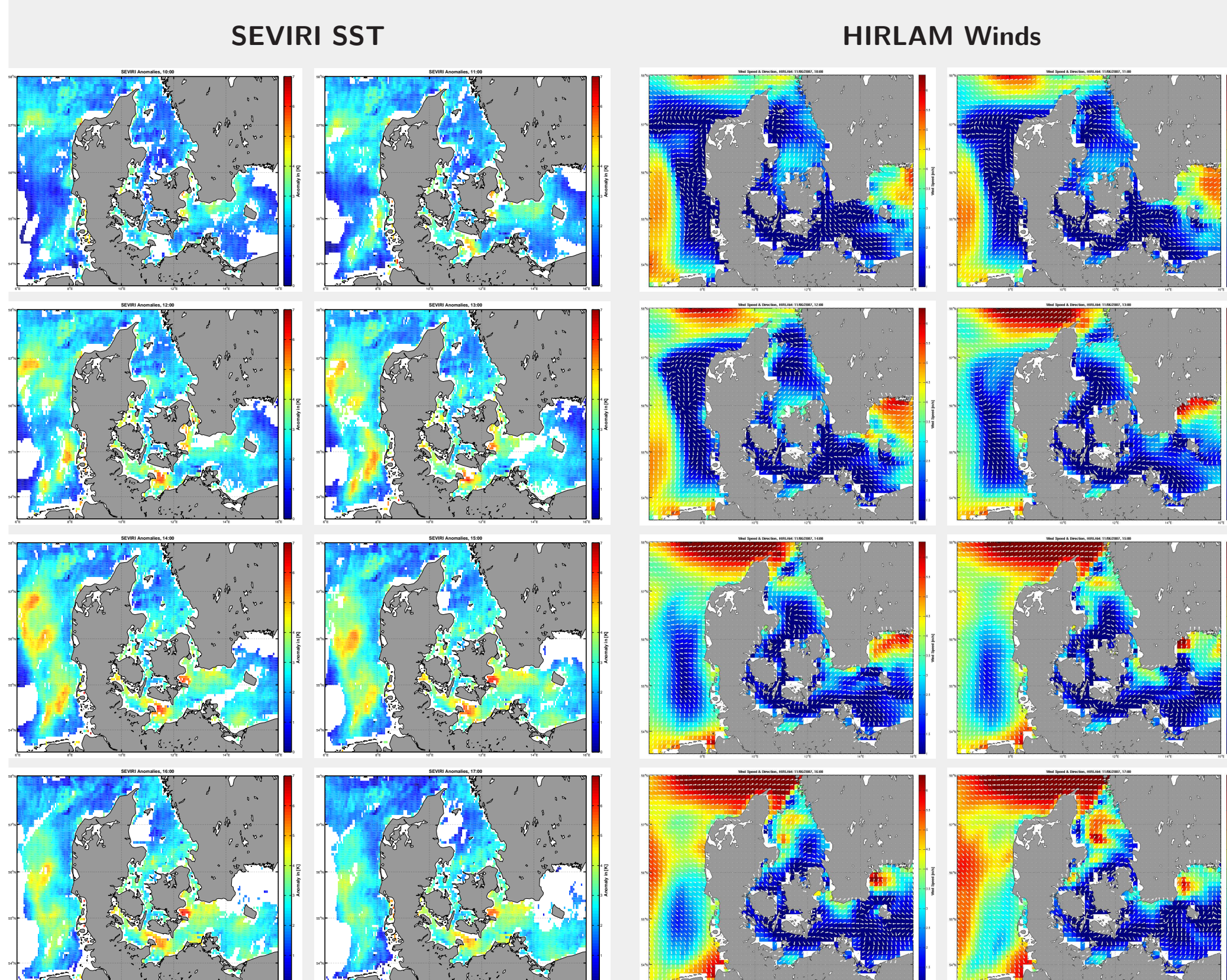
Mean Wind Speed Difference: Morning - Afternoon



Monthly & Annual Distributions



A Large Diurnal Warming Event: 11/6/2007, 10:00-17:00



Conclusions

- ▶ Diurnal Warming does occur in latitudes $> 50^\circ$ North
- ▶ Good spatial and temporal correlation between observations of D.W. & low winds
- ▶ Zero mean wind difference or higher afternoon winds favour D.W.
- ▶ In most areas higher morning winds exclude D.W. occurrences
- ▶ Correlation between QuikSCAT and in-situ data best when stability corrections are included only in U_*
- ▶ Good correlation between met. mast & QuikSCAT, in both speed and direction