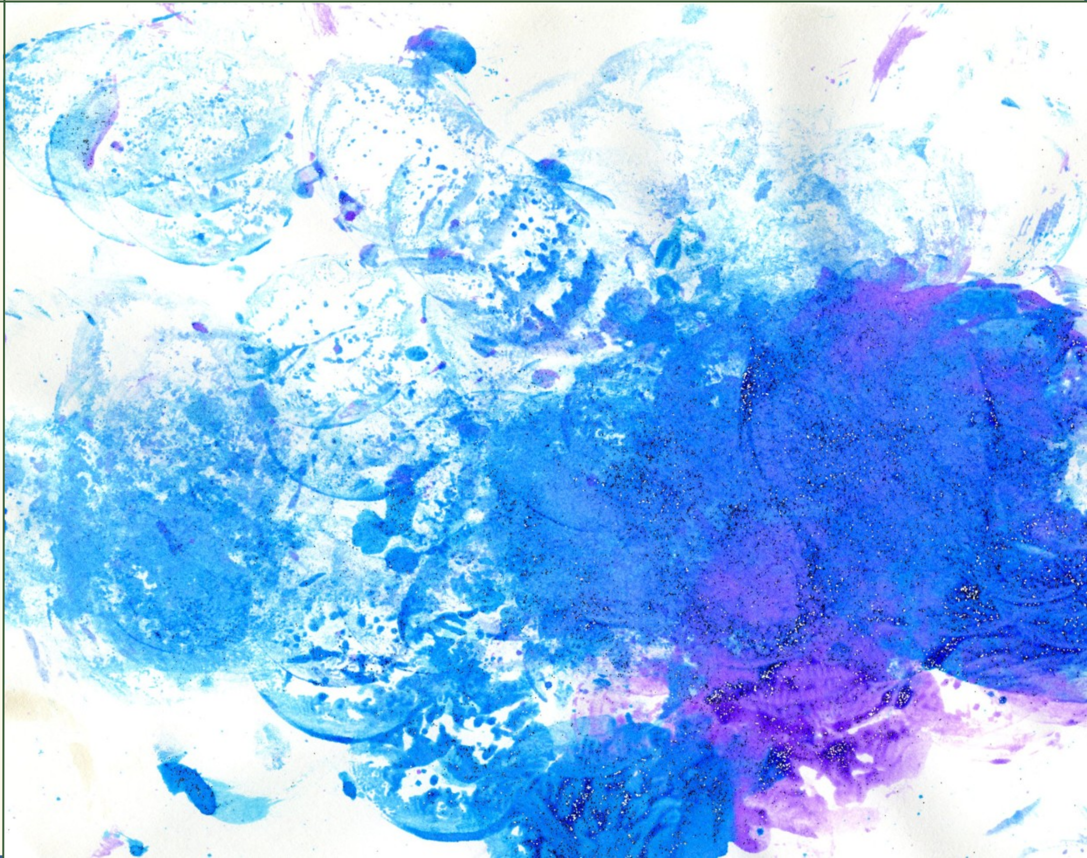
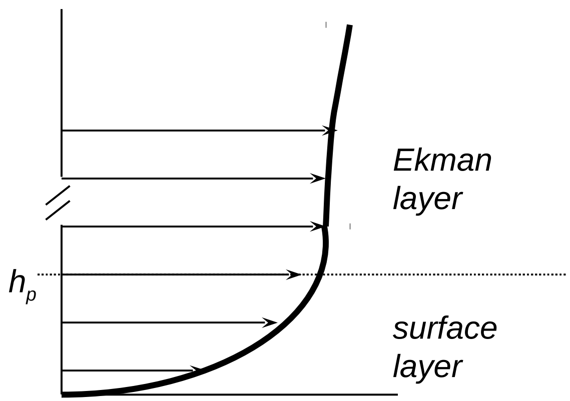
BAROCLINICITY IN THE MARINE BOUNDARY LAYER

Jérôme Patoux
Ralph C. Foster

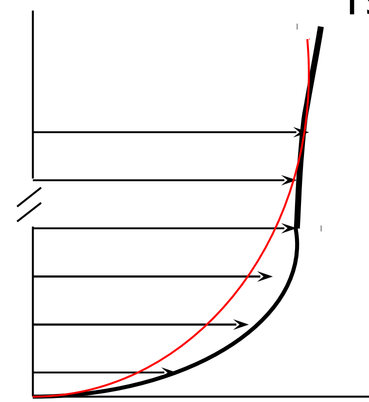
IOVWST 2011

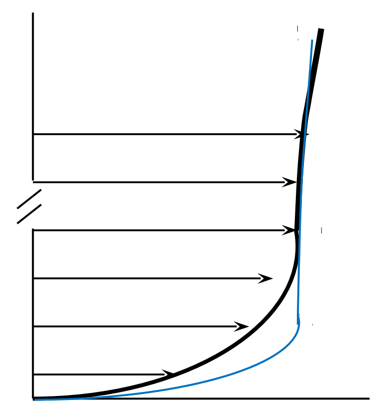


PBL



STABLE Ta > Ts





UNSTABL Ts > Ta

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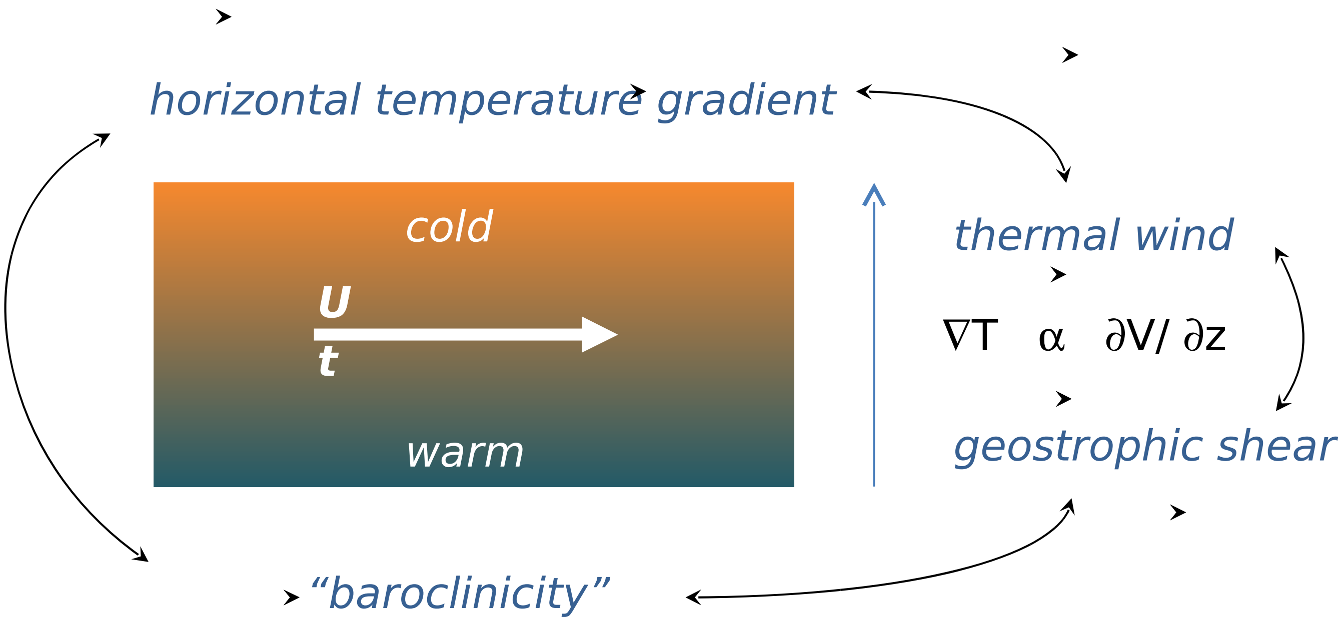
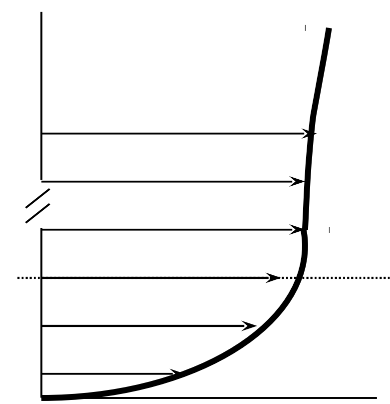
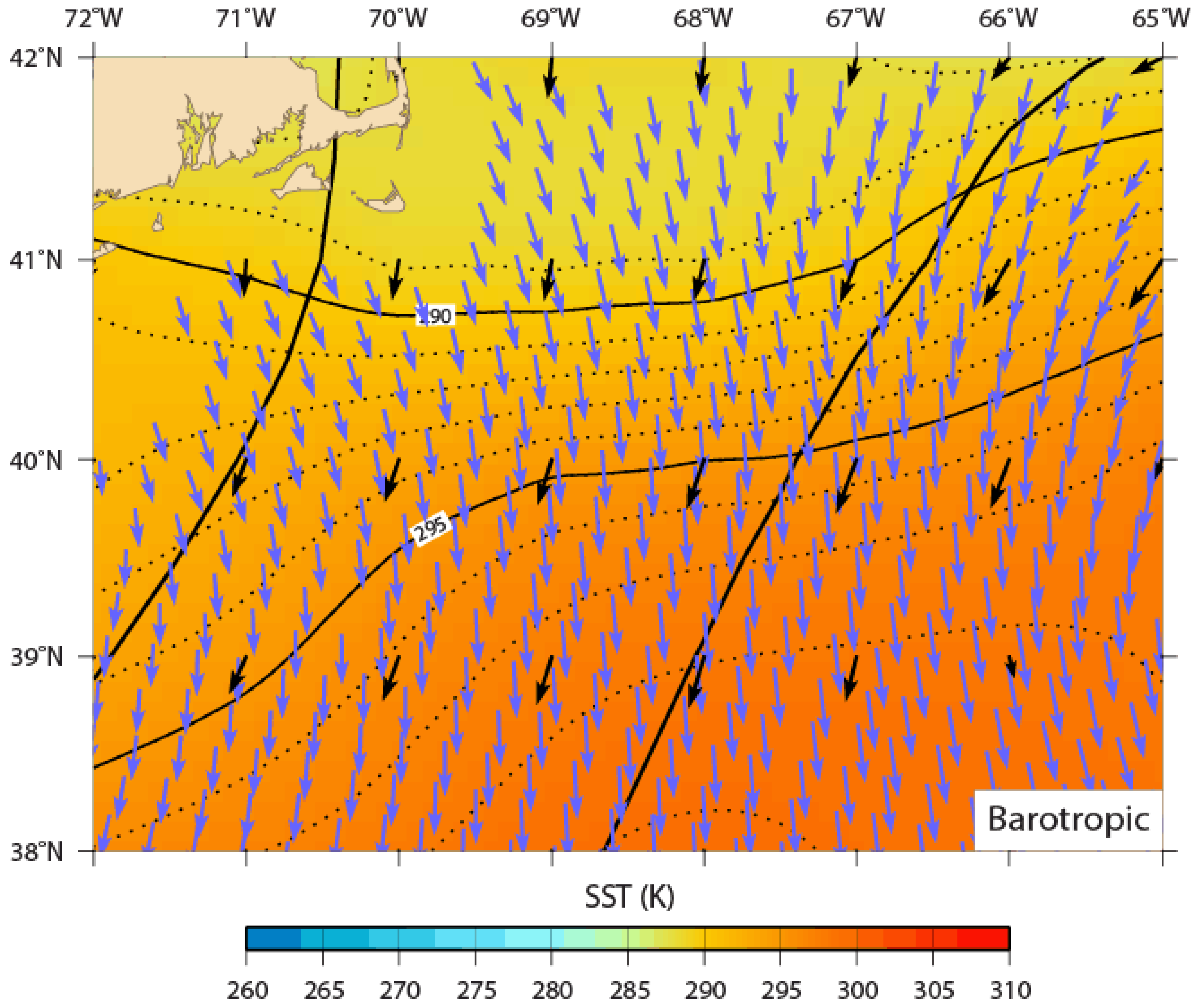


In baroclinic conditions, the geostrophic shear is added to the BL shear, with an effect on both the magnitude and the direction of the wind throughout the profile.



Patoux (2011)

Calculating surface winds from GFS SLP at the NOAA OPC (with Joe Sienkiewicz).



Patoux (2011)

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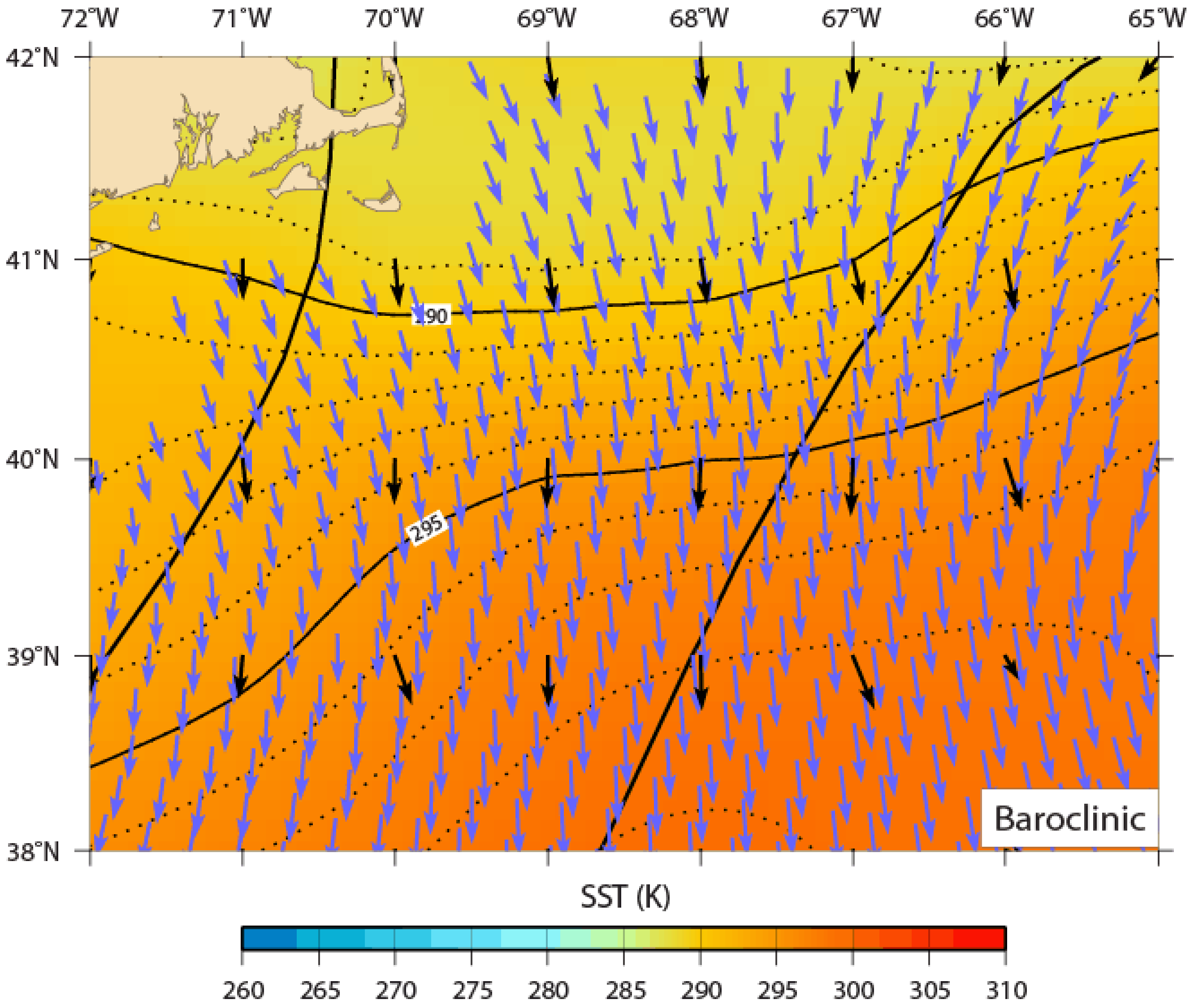

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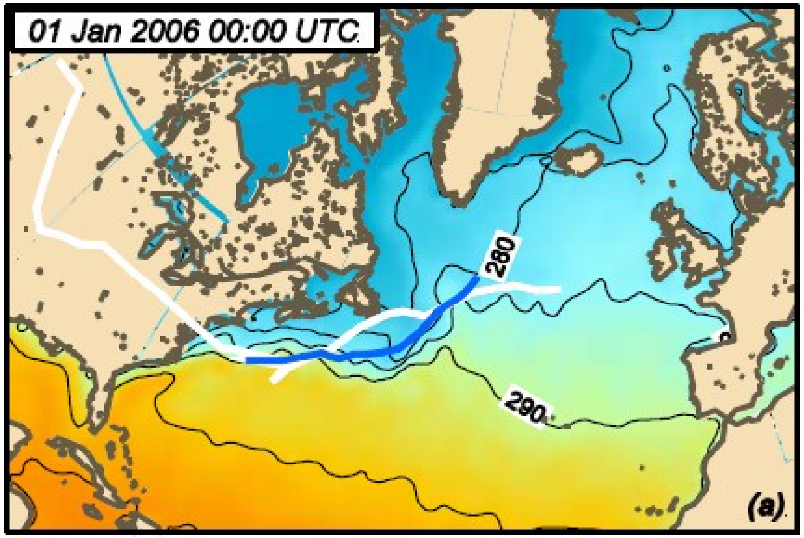
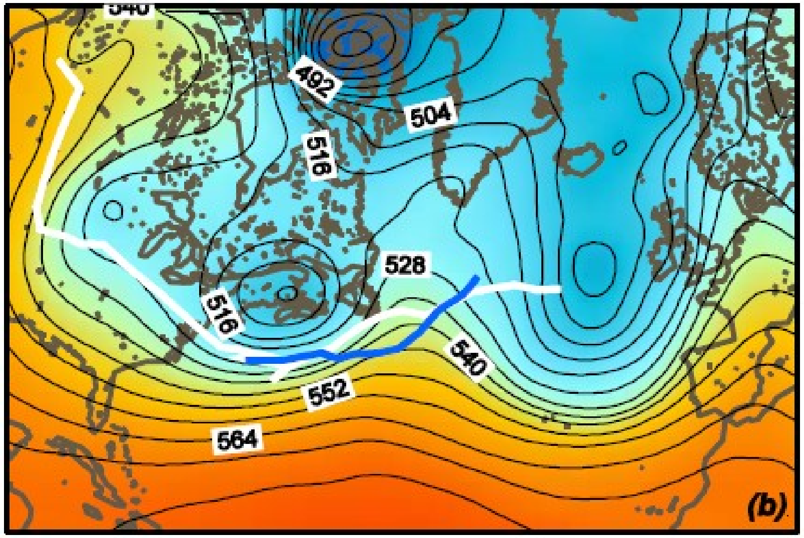
Evaluating the impact of the baroclinicity associated with WBCs on the genesis and intensification of midlatitude cyclones.

An example of two midlatitude cyclone tracks displayed over…



SST



500-hPa heights

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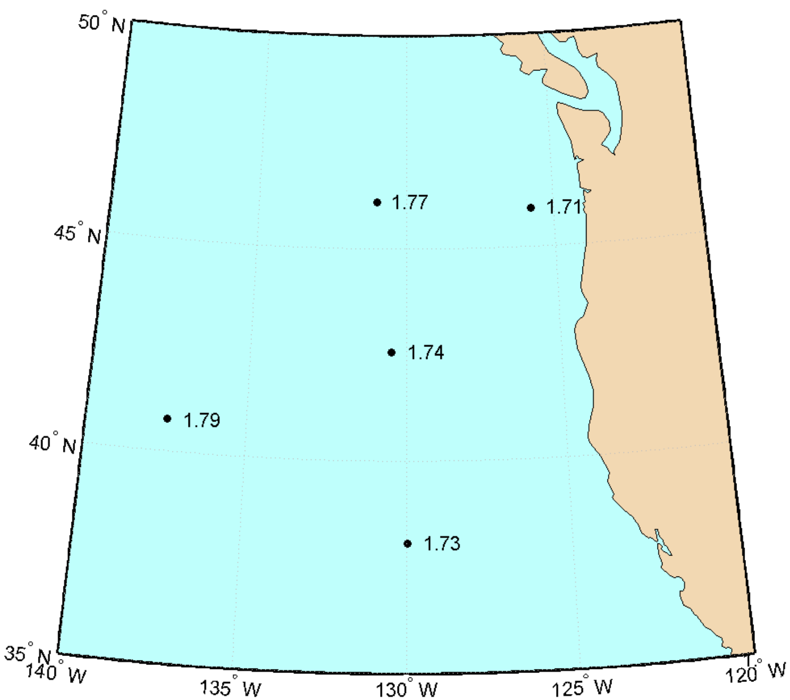
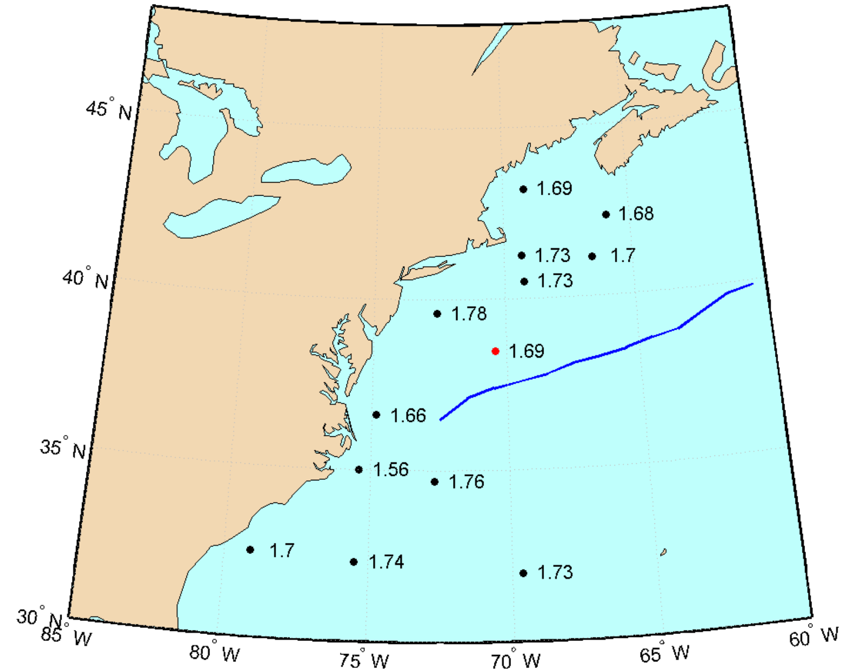
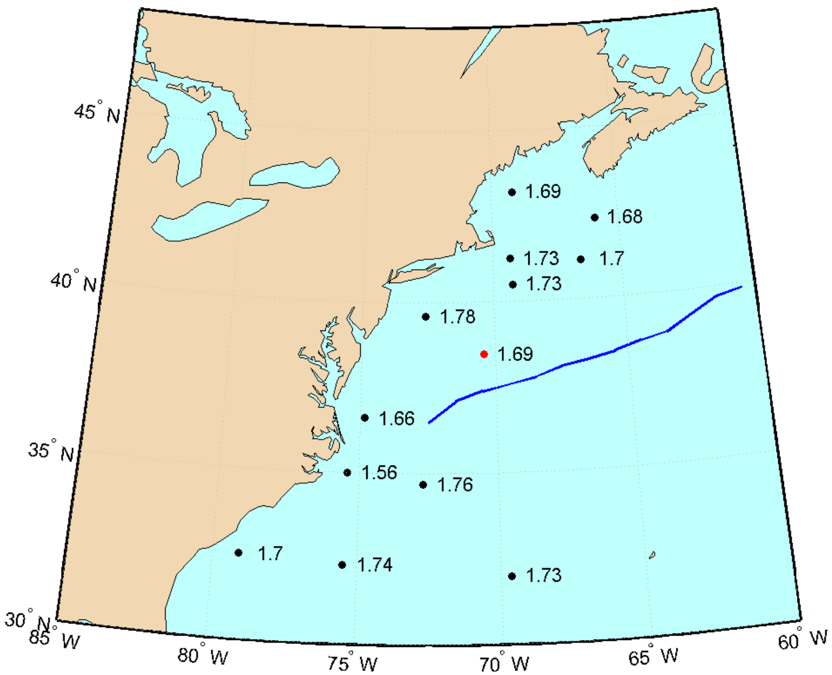
Vector correlations between QS 10m neutral-equivalent winds and NDBC buoy 10m neutral-equivalent winds (1999-2009).





Patoux (2011)



- **NDBC buoy 44004**
  Calculate buoy 10m neutral-equivalent winds (COARE 3.0).

- Full **QS** period (1999-2009).
  Discard rain-flagged winds.

- Interpolate **OSCAR** currents.

- Interpolate closest-in-time **ECMWF** surface variables: Ta, Ts, Td, SLP.
  Calculate ∇T.

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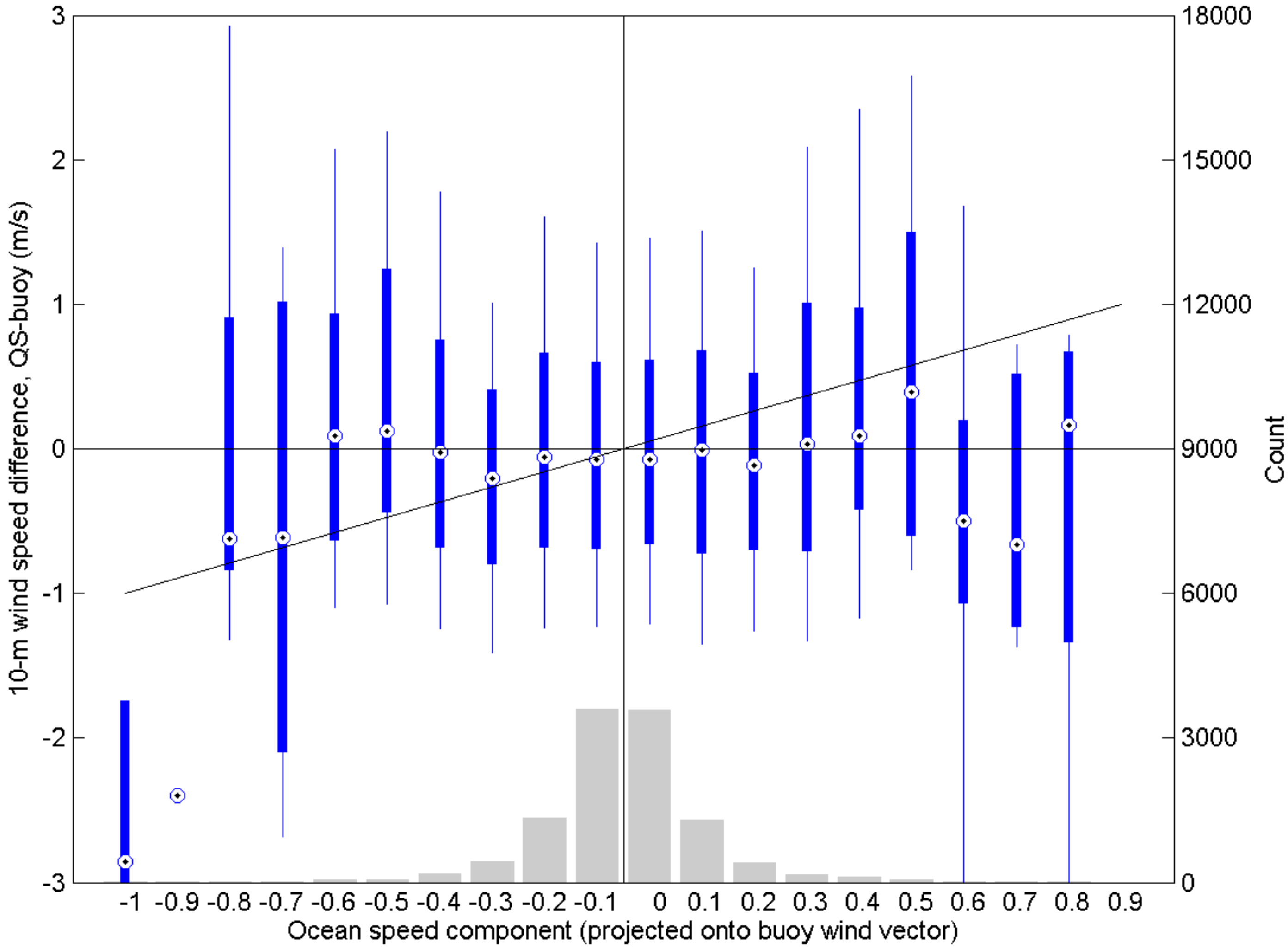
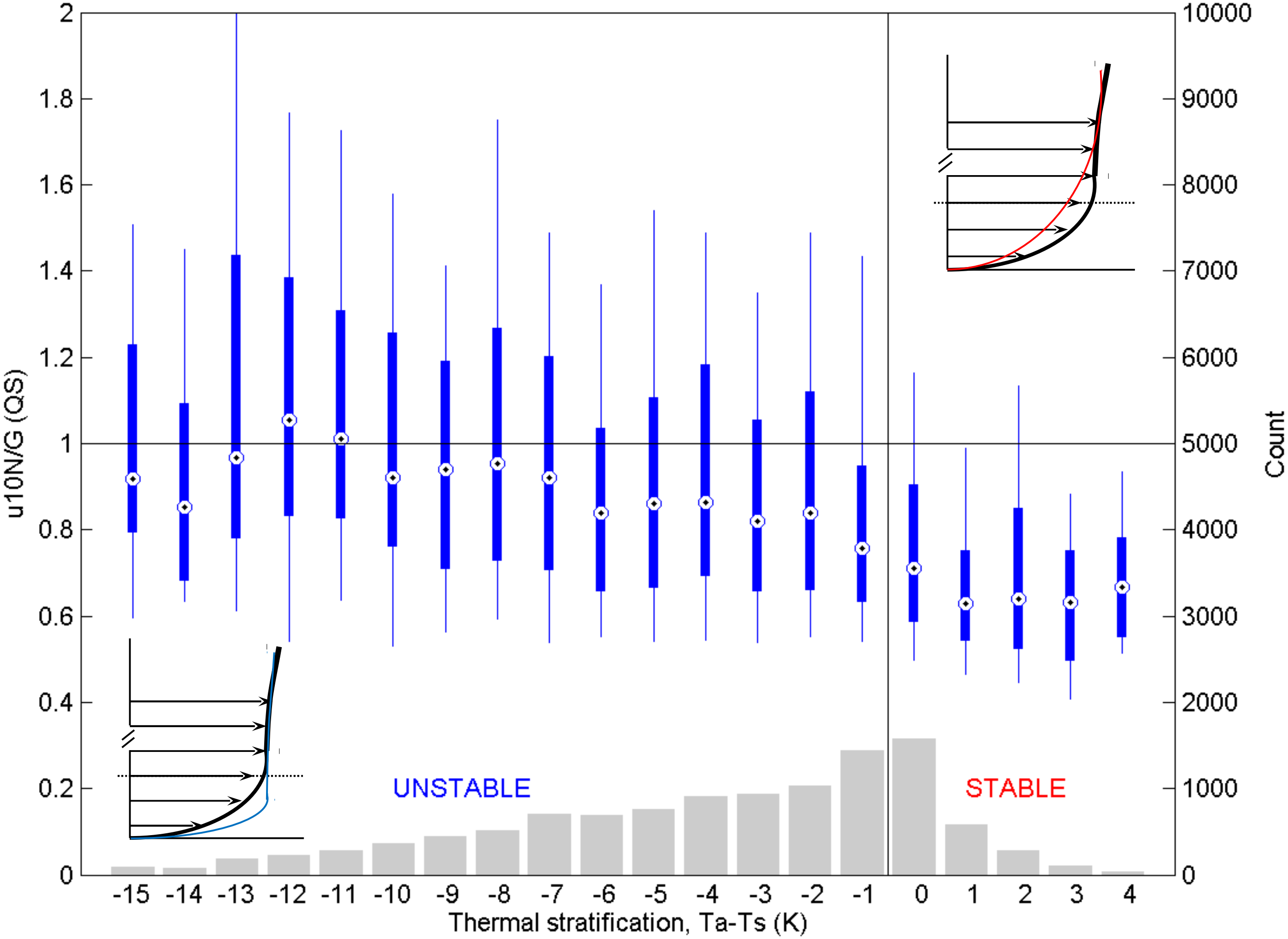


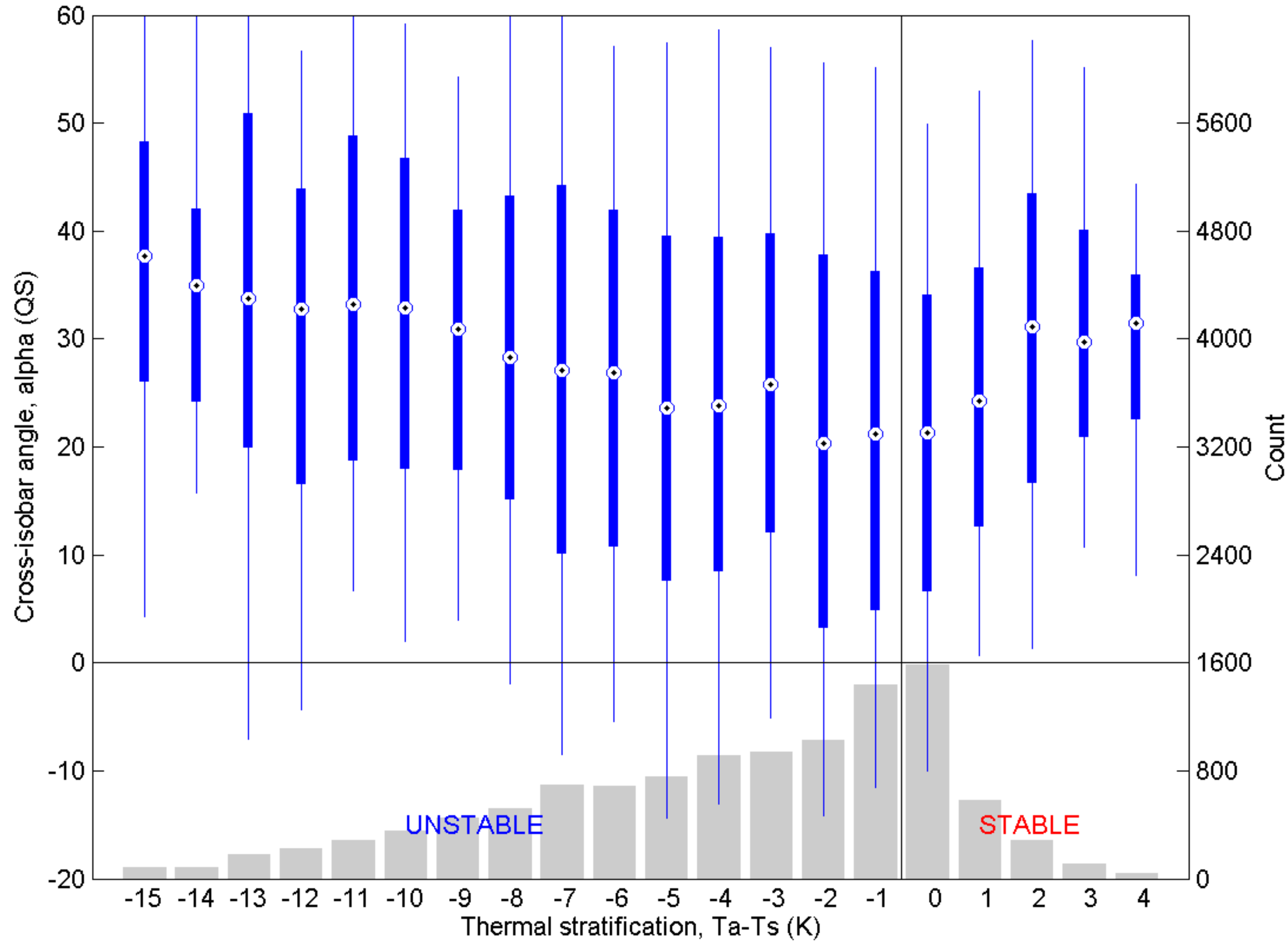
10-m wind speed difference, QS-buoy (m/s)
Count
Ocean speed component (projected onto buoy wind vector)
3
2
1
0
-1
-2
-3
18000
15000
12000
9000
6000
3000
0
-1 -0.9 -0.8 -0.7 -0.6 -0.5 -0.4 -0.3 -0.2 -0.1 0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9

Patoux (2011)

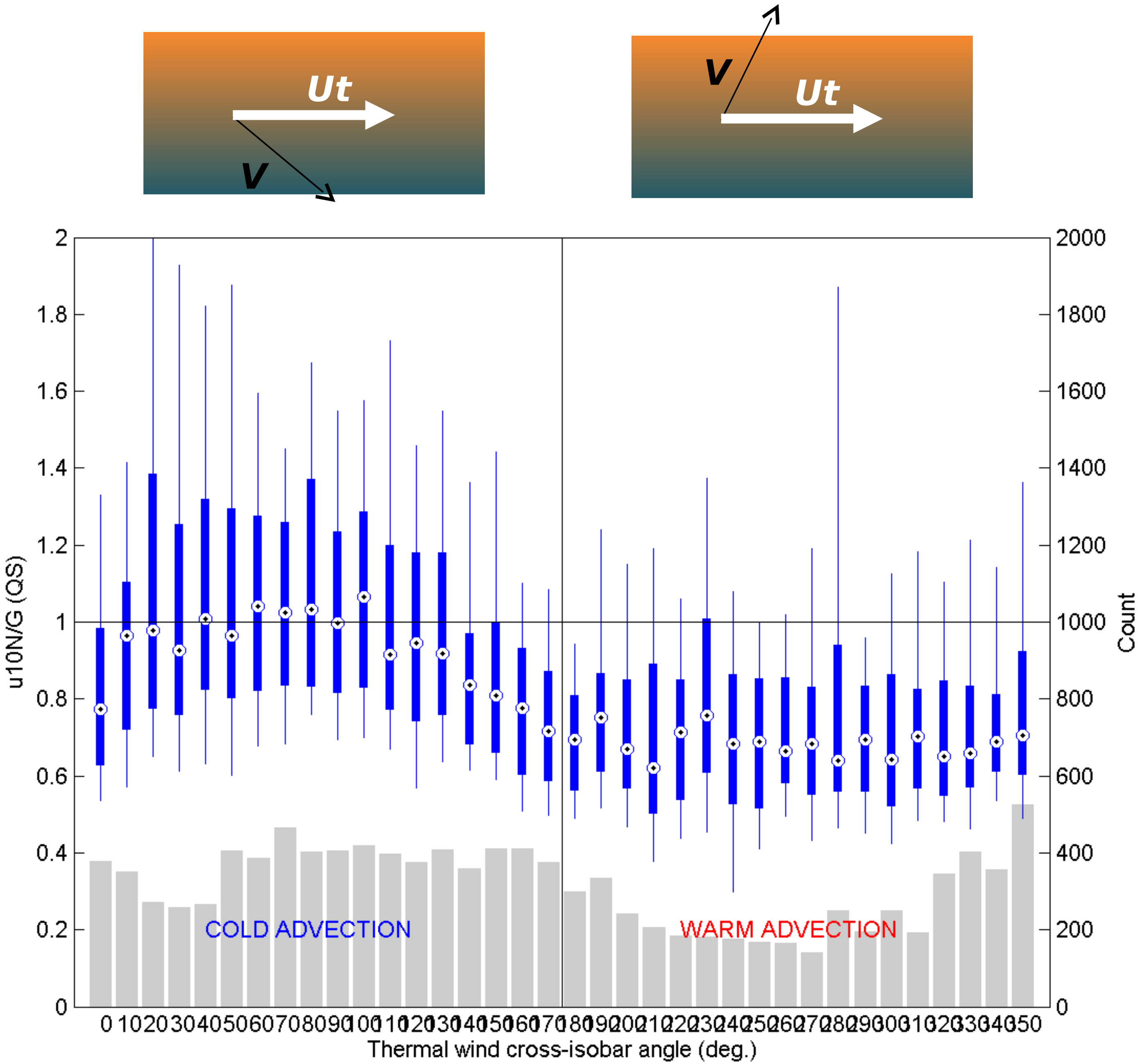


u10N/G (QS)
Count
UNSTABLE
STABLE
Thermal stratification, Ta-Ts (K)
-15 -14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2
0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

Patoux (2011)

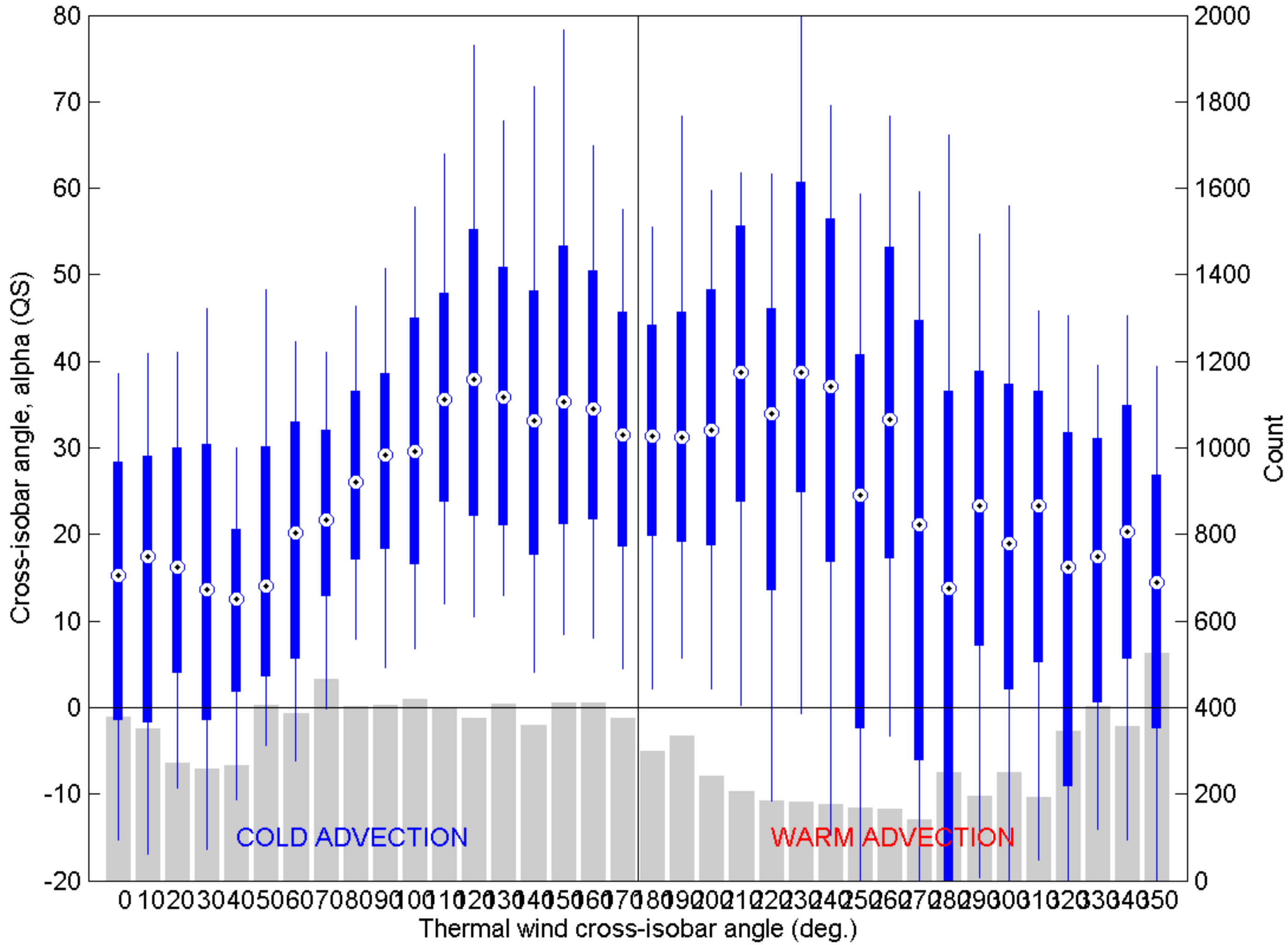

60
50
40
30
20
10
0
-10
-20
Cross-isobar angle, alpha (QS)
5600
4800
4000
3200
2400
1600
800
0
Count
UNSTABLE
STABLE
-15 -14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4
Thermal stratification, Ta-Ts (K)

Patoux (2011)



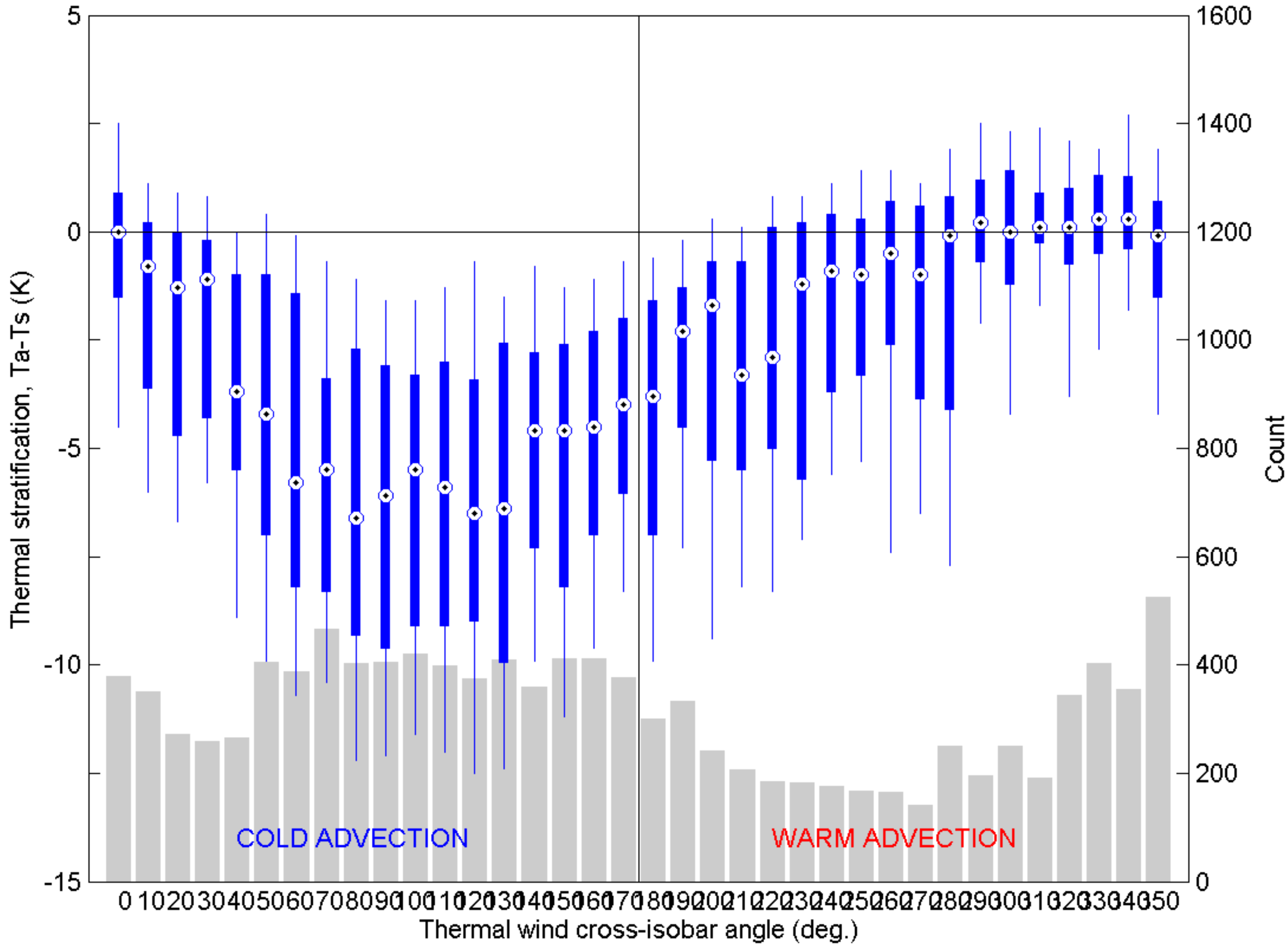
Ut
V
V
Ut
u10N/G (QS)
Count
COLD ADVECTION
WARM ADVECTION
Thermal wind cross-isobar angle (deg.)

(2011)



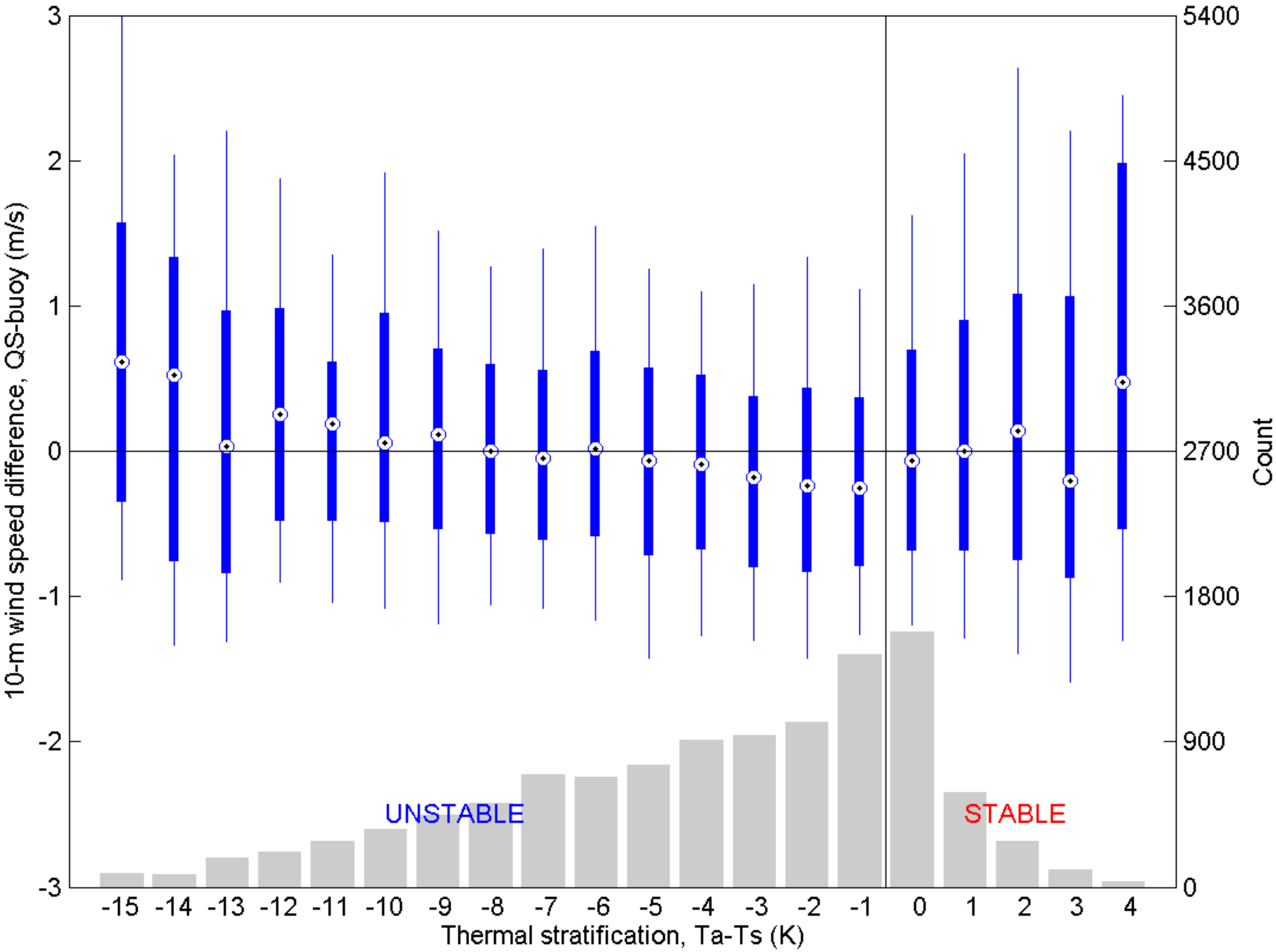
Cross-isobar angle, alpha (QS)
Count
Thermal wind cross-isobar angle (deg.)
COLD ADVECTION
WARM ADVECTION

Patoux (2011)

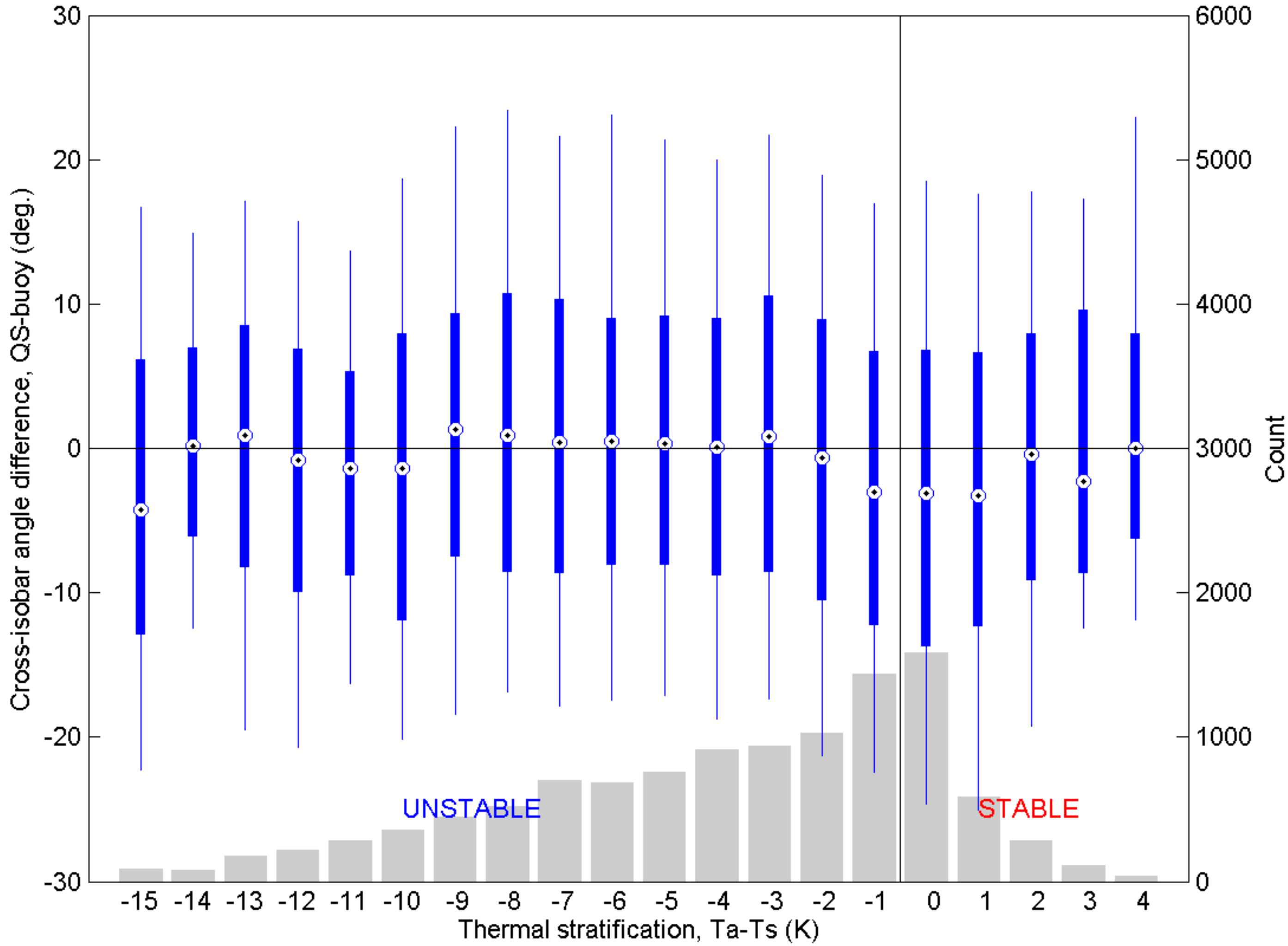


5
0
-5
-10
-15
1600
1400
1200
1000
800
600
400
200
0
Thermal stratification, Ta-Ts (K)
Count
COLD ADVECTION
WARM ADVECTION
Thermal wind cross-isobar angle (deg.)

Patoux (2011)

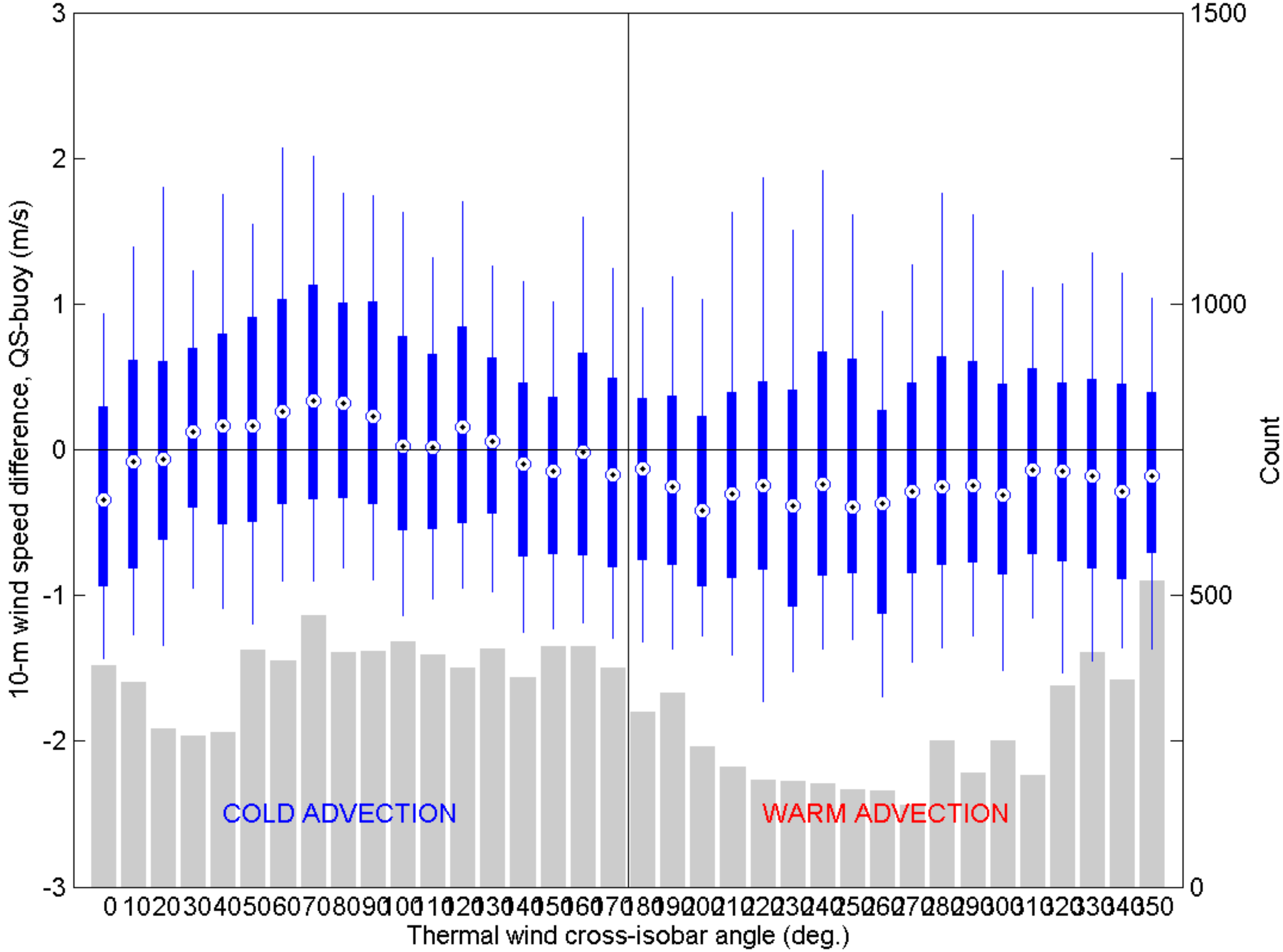

3
2
1
0
-1
-2
-3
5400
4500
3600
2700
1800
900
0
10-m wind speed difference, QS-buoy (m/s)
Count
UNSTABLE
STABLE
-15 -14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4
Thermal stratification, Ta-Ts (K)

Patoux (2011)



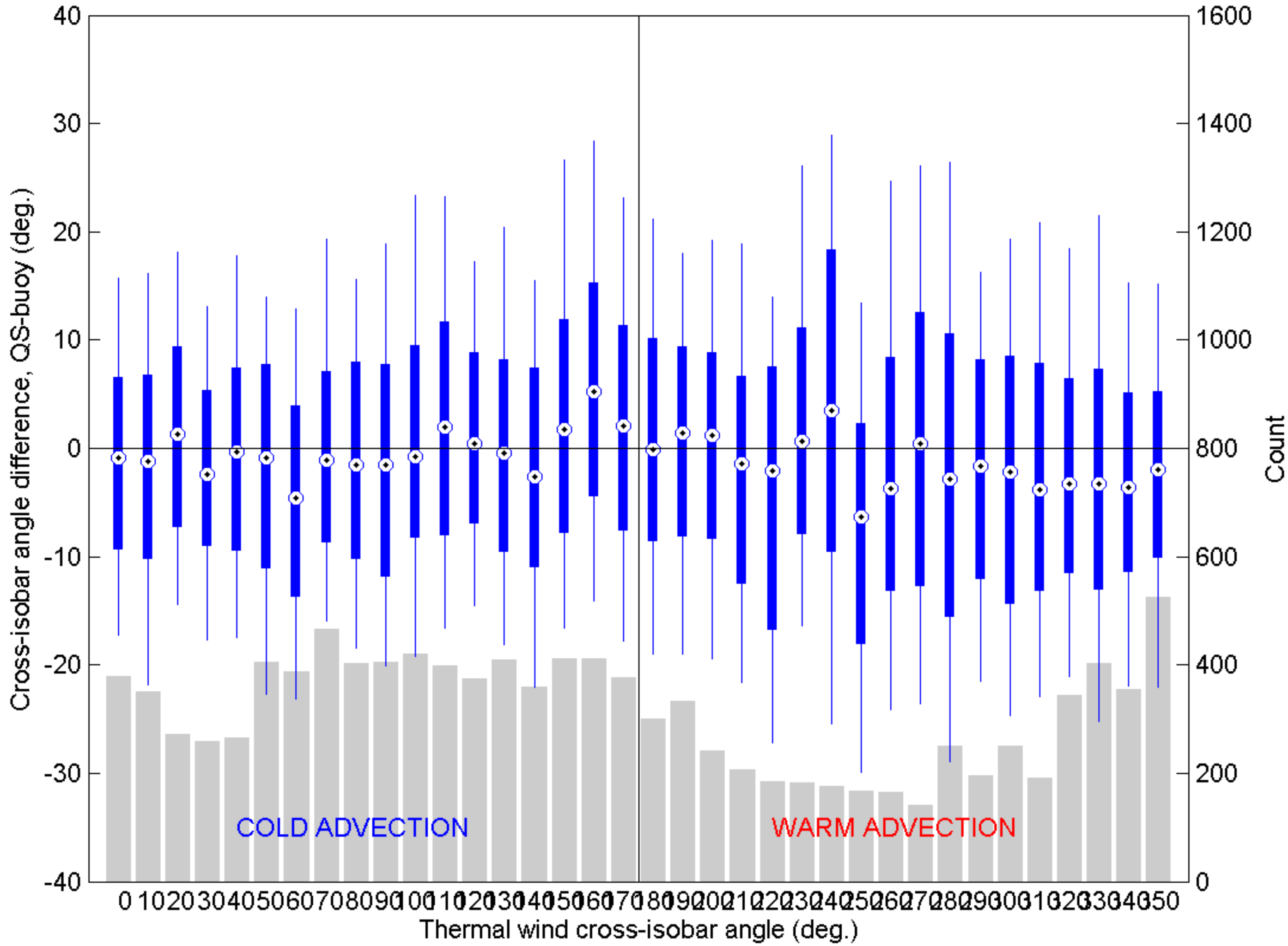
Cross-isobar angle difference, QS-buoy (deg.)
Count
Thermal stratification, Ta-Ts (K)
UNSTABLE
STABLE
30
20
10
0
-10
-20
-30
6000
5000
4000
3000
2000
1000
0
-15 -14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4

Patoux (2011)



COLD ADVECTION
WARM ADVECTION
10-m wind speed difference, QS-buoy (m/s)
Count
Thermal wind cross-isobar angle (deg.)

Patoux (2011)


Cross-isobar angle difference, QS-buoy (deg.)
Count
Thermal wind cross-isobar angle (deg.)
COLD ADVECTION
WARM ADVECTION

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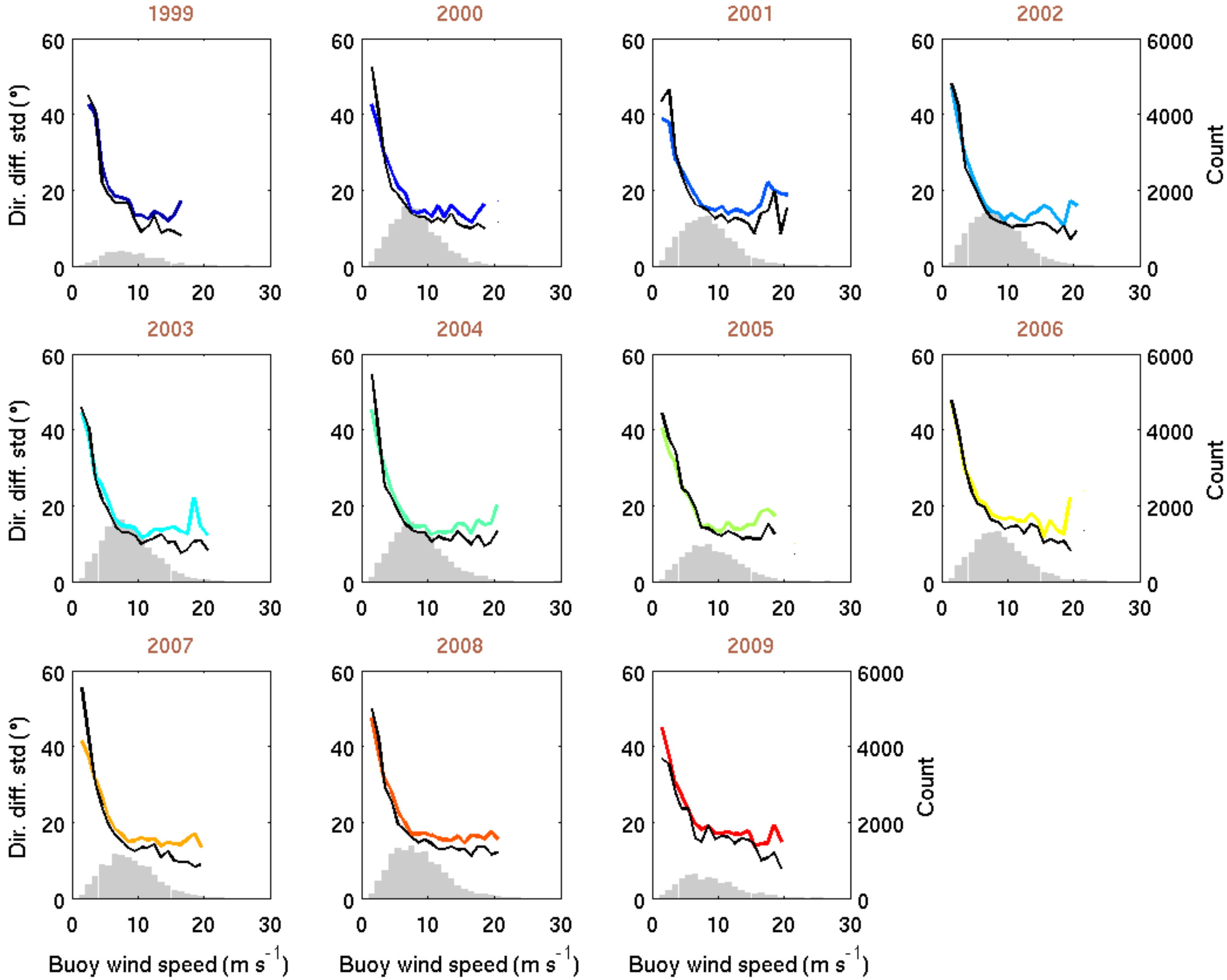
Conclusions

Using one buoy (!) and 10 years of QS measurements (and interpolated ECMWF surface variables), we can reveal the modulation of the boundary layer profile by baroclinicity (i.e., thermal wind, or geostrophic shear).

A modulation of the *difference* between neutral-equivalent buoy and QS wind speeds suggests that there remains an “error” in the QS 10m neutral-equivalent winds (~0.2-0.3 m/s) due to baroclinicity that is not resolved by the GMF and that cannot be corrected by a simple stratification correction.

Standard deviation of the directional differences between QS 10m neutral-equivalent winds and NDBC buoy 10m neutral-equivalent winds (1999-2009).



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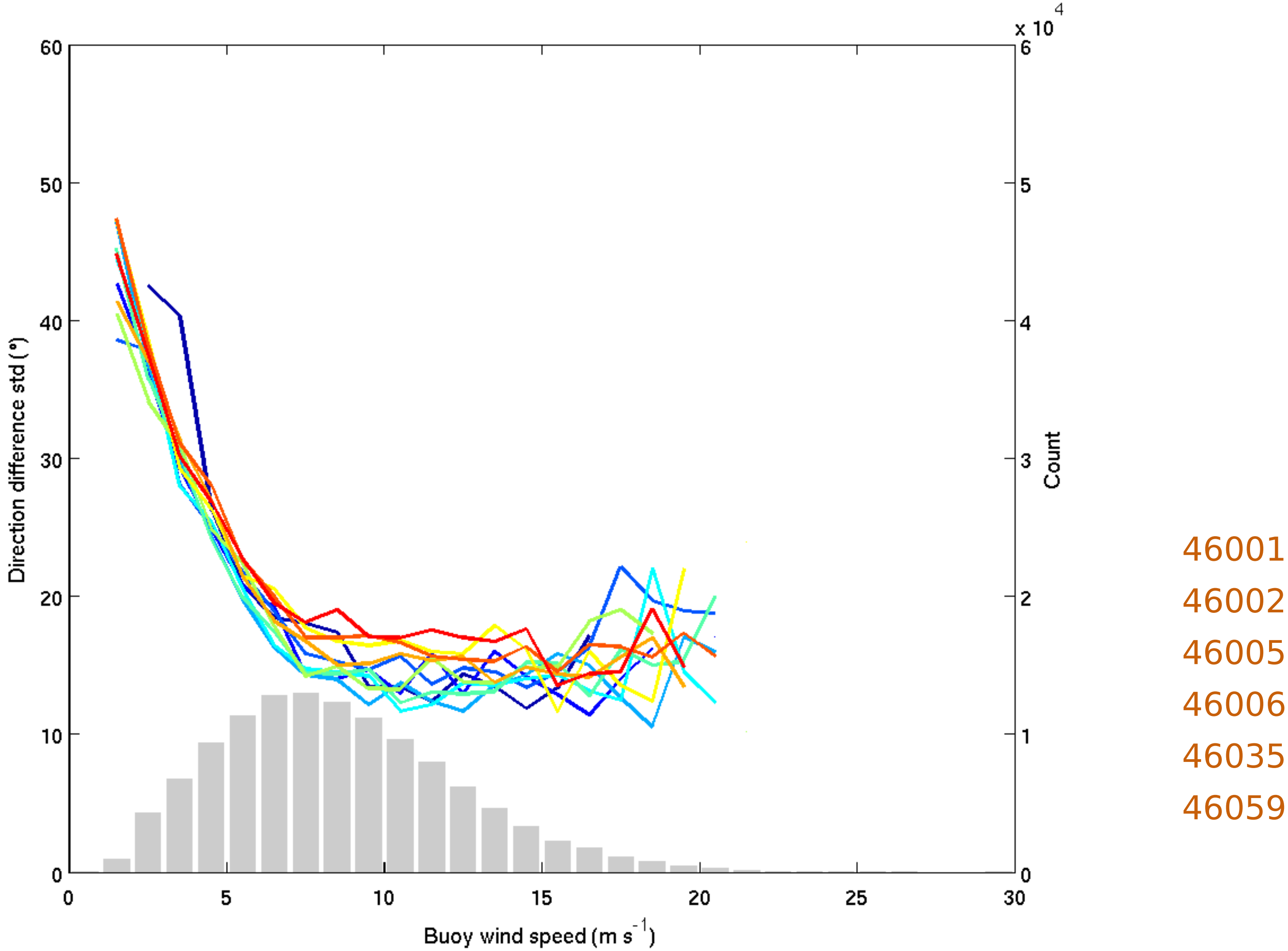
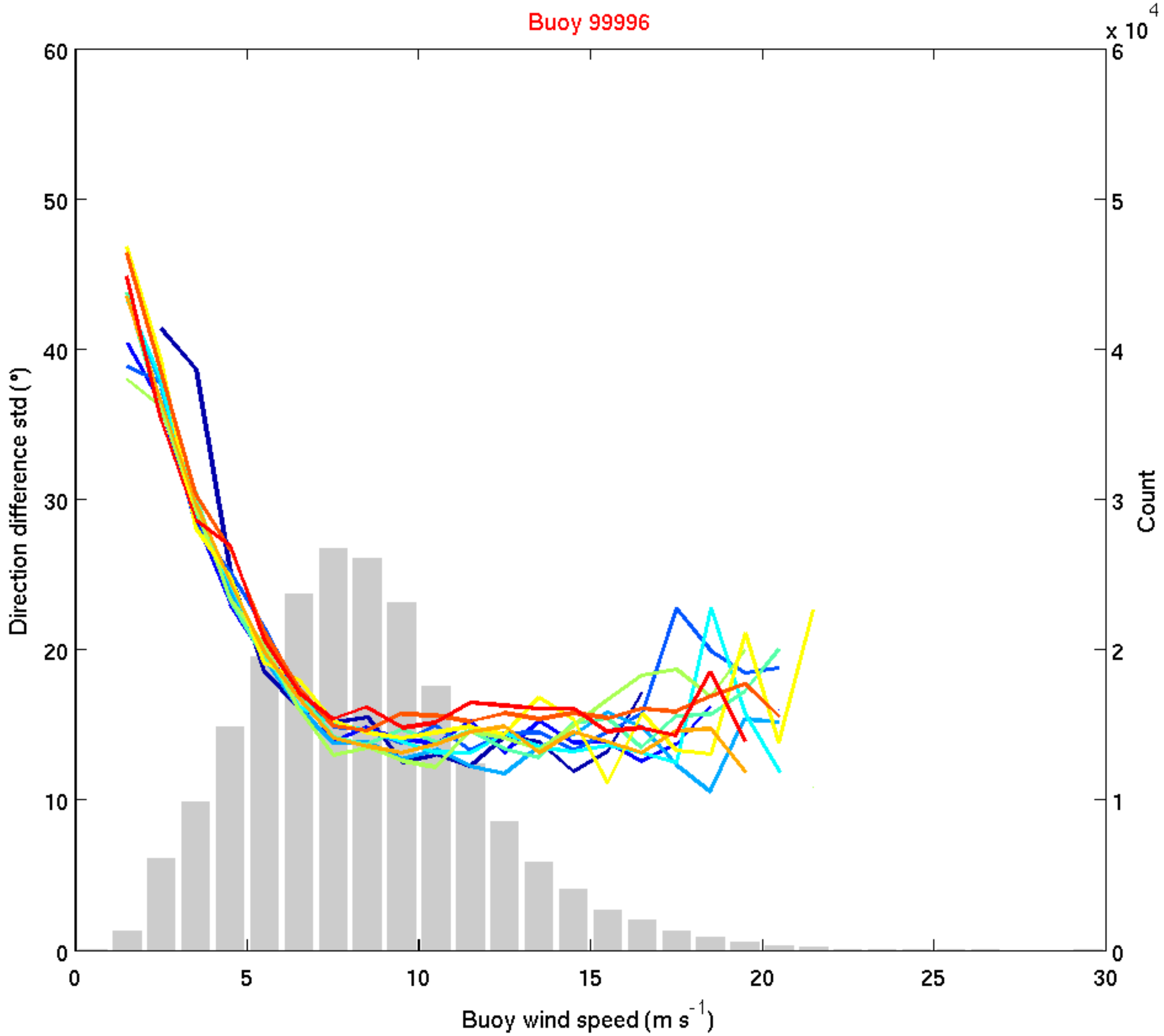
Standard deviation of the directional differences between QS 10m neutral-equivalent winds and NDBC buoy 10m neutral-equivalent winds (1999-2009).



Patoux (2011)

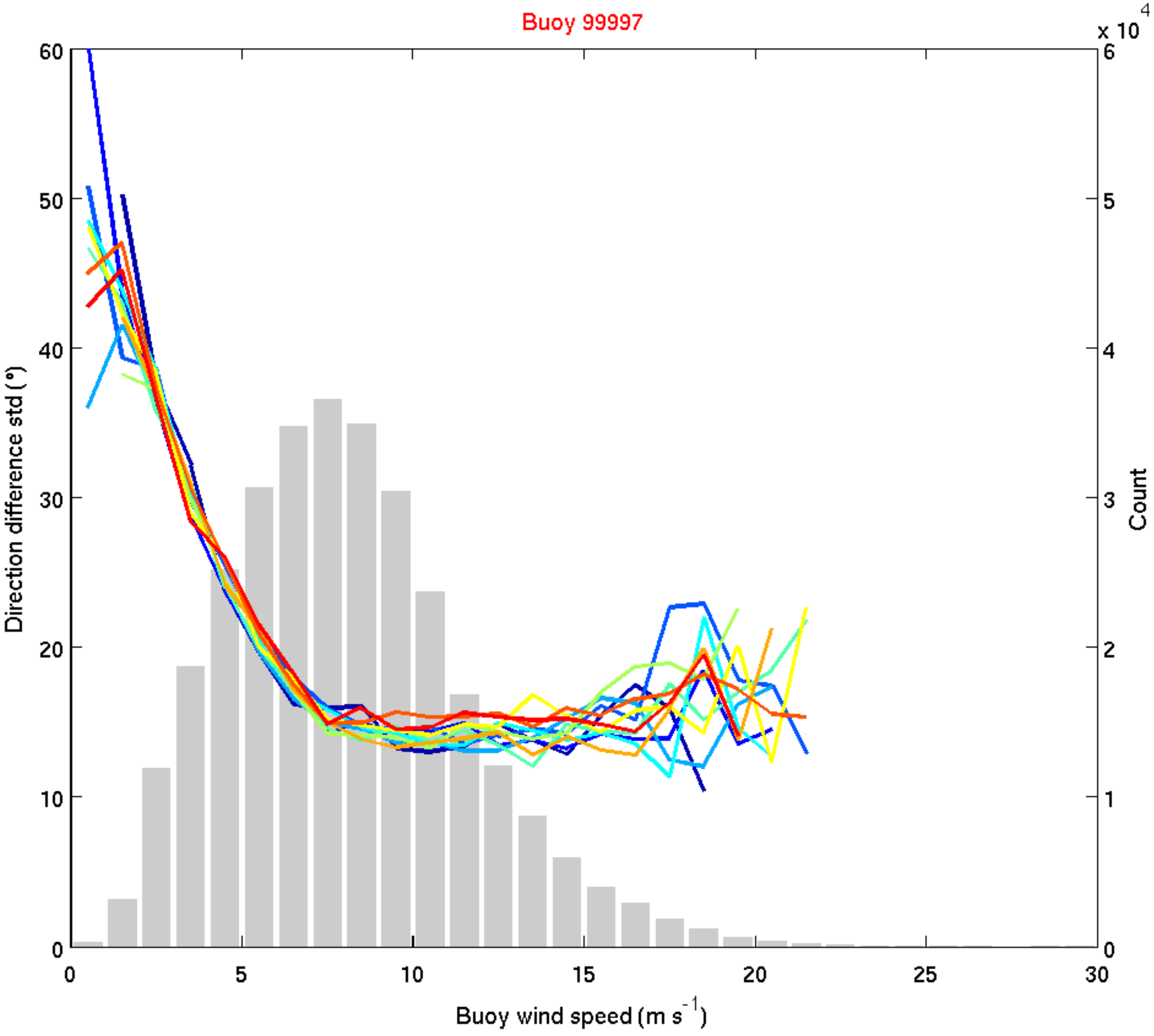
Standard deviation of the directional differences between QS 10m neutral-equivalent winds and NDBC buoy 10m neutral-equivalent winds (1999-2009).



46001
46002
46005
46006
46035
46059
46066
51001
51002
51003
51004
51028

Patoux (2011)

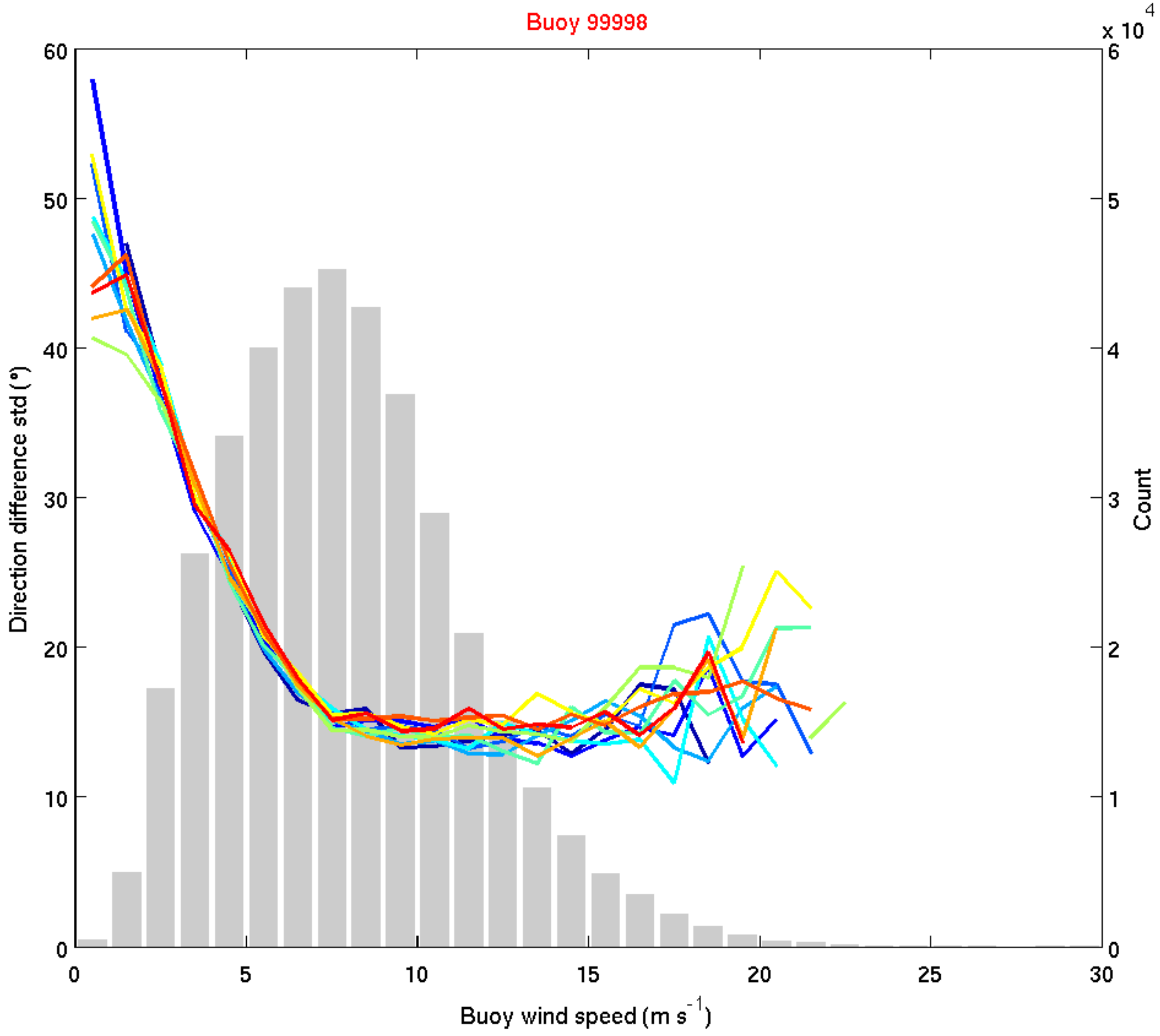
Standard deviation of the directional differences between QS 10m neutral-equivalent winds and NDBC buoy 10m neutral-equivalent winds (1999-2009).



46001
46002
46005
46006
46035
46059
46066
51001
51002
51003
51004
51028
+

Patoux (2011)

Standard deviation of the directional differences between QS 10m neutral-equivalent winds and NDBC buoy 10m neutral-equivalent winds (1999-2009).



46001
46002
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+

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ary Layer Resear...

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Swath: 2000-03-03 01:19 GMT
Synop: 2000-03-03 00:00 GMT
Swath number: 6480

Mar 2000

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

00Z 06Z 12Z 18Z

Increment swath number

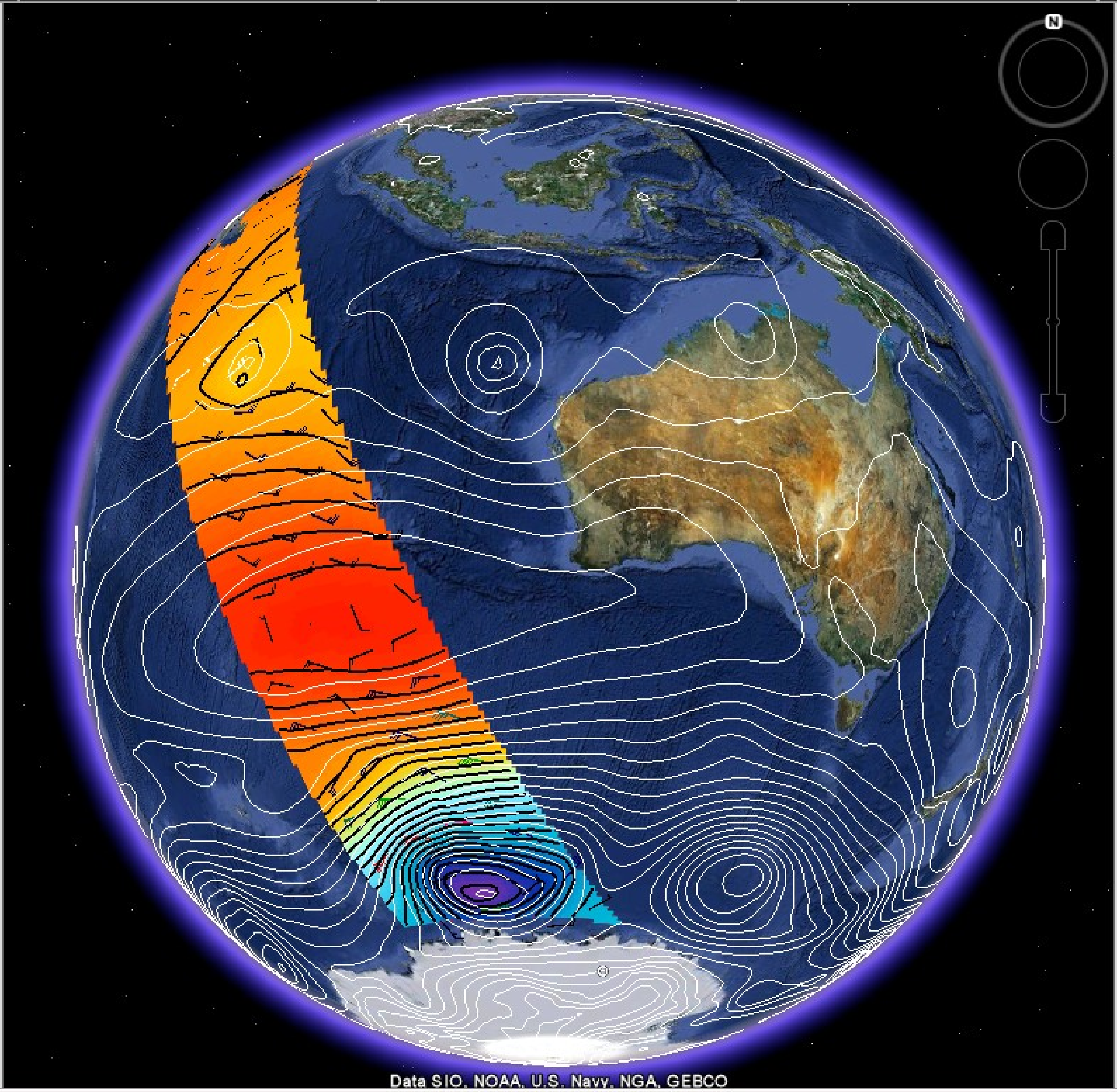
-2 -1 +1 +2

Disable autorotation

ECMWF
- [x] SLP Isobars
- [ ] Surface winds (vector)
- [ ] Sea surface temp. (SST)
- [ ] SST Isotherms
- [ ] Surface (2m) air temp. (SAT)
- [ ] SAT Isotherms
- [ ] ΔT (SAT-SST)
- [ ] ΔT Isotherms

Geostationary satellite
- [ ] VIS
- [ ] IR
- [ ] WV

SSM/I
- [ ] WV
- [ ] Liquid water
- [ ] Rain rate



QuikSCAT
- [x] SLP (color)
- [x] SLP Isobars
- [ ] Vorticity
- [ ] Divergence
- [x] Surface winds (vector)

Seawinds on ADEOS II
- [ ] SLP (color)
- [ ] SLP Isobars
- [ ] Vorticity
- [ ] Divergence
- [ ] Surface winds (vector)
- [ ] Surface winds (color)

WindSat
- [ ] SLP (color)
- [ ] SLP Isobars
- [ ] Vorticity
- [ ] Divergence
- [ ] Surface winds (vector)
- [ ] Surface winds (color)

ASCAT
- [ ] SLP (color)
- [ ] SLP Isobars
- [ ] Vorticity
- [ ] Divergence
- [ ] Surface winds (vector)
- [ ] Surface winds (color)

Oceansat-2
- [ ] SLP (color)
- [ ] SLP Isobars
- [ ] Vorticity
- [ ] Divergence
- [ ] Surface winds (vector)
- [ ] Surface winds (color)