CROSS-VALIDATION OF SCATTEROMETER WINDS
VIA SEA-LEVEL PRESSURE RETRIEVAL

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The models are WRONG!
Except one...
The solution for the PBL boundary layer (Brown, 1974, Brown and Liu, 1982), may be written

\[
\frac{U}{V_G} = e^{i\alpha} - e^{-z} \left[ e^{-iz} + ie^{iz} \right] \sin \alpha + U_2
\]

where \( V_G \) is the geostrophic wind vector, the angle between \( U_{10} \) and \( V_G \) is \( \alpha \)\[\alpha[u^*, \nabla_H T, (T_a - T_s)_{PBL}] \] and the effect of the organized large eddies (OLE) in the PBL is represented by \( U_2(u^*, T_a - T_s, \nabla_H T) \)

This may be written:

\[
\frac{U}{V_G} = f\{\alpha(u^*), U_2(u^*), u^*, z_0(u^*), \nabla_T(\nabla_H T), \Psi(T_a - T_s), \lambda\}
\]

Or \( \frac{U}{V_G} = f[u^*, \nabla_T(\nabla_H T), \Psi(T_a - T_s), \lambda, k, a] = f \{u^*, \nabla_H T, T_a - T_s\}, \) for \( \lambda = 0.15, k = 0.4 \) and \( a = 1 \)

In particular,

\[
V_G = f (u^*, \nabla_H T, T_a - T_s) \equiv f_n(\nabla P, \rho, f)
\]

Hence \( \nabla P = f_n [u^*(k, a, \lambda), \nabla_H T, T_a - T_s, \rho, f] \approx f_n(\sigma_0) \)
PBL model

$U_{10}$

$V_{Gr}$

$\nabla p$

swath of pressure gradients

fit a surface pressure field

Patoux (2010)
The scatterometer-derived SLP fields compare well with NCEP and ECMWF SLP analyses.

Patoux (2010)
**Applications:** Identification and diagnosis of frontal wave development.

**Applications:** Midlatitude cyclone intensification, tracking, and climatology of air-sea fluxes.


**Applications:** NRTQS-derived SLP fields at the Ocean Prediction Center.

(In coll. with Joe Sienkiewicz.)
**Applications**: Synergy between scatterometry and altimetry in midlatitude cyclone studies.

What next?

- Is the SLP retrieval methodology applicable to other scatterometers?
- How will the SLP fields derived from different instruments compare with each other?
- Can we consider a long-term multi-instrument climatology of global SLP fields?
- Could such a SLP climatology guide our construction of a wind climatology?

Patoux (2010)
Comparison of QS- and ASCAT-derived SLP fields

Patoux (2010)
Comparison of buoy (bulk) pressure gradients with QS-derived (bulk) pressure gradients

![Comparison of buoy (bulk) pressure gradients with QS-derived (bulk) pressure gradients](image)
Repeat for all possible pairs of buoys...
Good agreement with buoys:

\[ R^2 = 0.927 \]
\[ \text{Slope} = 0.988 \]

Rms differences with ECMWF:

1.2-1.5 hPa across the swath.
Rms differences with ECMWF:

~1-2 hPa, depending on latitude and season.
Spectral analysis:

**Slope = -4.3**
(consistent with wind spectral slope of ~2.2-2.4)

More energy in QS spectra at all scales below ~1000 km.
(ECMWF slope = -4.4)
Compare ASCAT with QS:

QuickSCAT: $R^2 = 0.927$
Slope = 0.988

ASCAT: $R^2 = 0.891$
Slope = 0.908

Patoux (2010)
The rms differences between ASCAT and ECMWF are \textbf{0.2-0.3 hPa} larger than the rms differences between QS and ECMWF.
The rms differences with ECMWF agree within \(~0.1\) hPa and the seasonal variations agree well with each other.
Spectral analysis:

Identical slopes (-4.3)
Slightly less energy in ASCAT spectra, as compared to QS.

Patoux (2010)
Derive a new set of winds from the SLP field (Patoux 2010)
Comparison of QS winds with buoy measurements:

Patoux (2010)
Comparison of QS and ASCAT winds with buoy measurements:
Comparison of QS and ASCAT wind components with buoy measurements:

<table>
<thead>
<tr>
<th></th>
<th>QuikSCAT</th>
<th>DIRTH</th>
<th>QS/SLP_u10</th>
<th>ASCAT</th>
<th>AS/SLP_u10</th>
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<td>$u$</td>
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<tr>
<td></td>
<td>Slope</td>
<td>0.90</td>
<td>0.89</td>
<td>0.93</td>
<td>0.91</td>
</tr>
</tbody>
</table>

Patoux (2010)
Spectral analysis:

The average AS Wind spectrum has the same slope (-2.4) as the SLP-filtered QS winds, and both have a power law behavior down to 50 km.
Conclusions

QS- and ASCAT-derived SLP fields are very similar in a statistical sense (and the agreement could presumably increase with higher ASCAT wind speeds).

The SLP fields can be used as a metric to compare the performance of different scatterometers.

They can also be used to:
• Filter the scatterometer winds
• Guide the ambiguity selection (?)
• Align different scatterometer wind products with each other by filtering each wind data set appropriately to meet specified requirements.

N.B.: QuikSCAT, SeaWinds, and ASCAT SLP fields are archived at: http://pbl.atmos.washington.edu