**Introduction**

Mixing above slopes is an important contribution to the basin mean. Scalar statistics provide:
- insights into turbulence intermittency,
- hints on mixing mechanisms,
- identification of different scaling regimes.

Statistics are well studied for:
- passive scalars = shear turbulence (Warhaft 2000),
- active scalar = convective turbulence (Zhou and Xia 2002).

**Aims**

- Detailed description of the statistics of temperature in a stratified environment.
- Exploit an observational data set above sloping topography,
  - at this location mixing is at least 2 orders of magnitude the value in the interior.
- Comparison between observed statistics and lab results,
  - consider both passive and active scalars.
- Provide a reference for studies of stratified turbulence in controlled environments.
- Provide estimates of the turbulent flux.

**Data**

Temperature data collected from a moored thermistors array.

The mooring location is marked by the white cross.

**Results**

Generalised structure functions: \( \gamma_q \equiv \gamma_q(r) = \langle (\Delta r \theta)^q \rangle \), \( \Delta, \theta \): horizontal temperature increment at distance \( r \).

According to the non-intermittent (fully self similar) theory of Kolmogorov-Obukhov-Corrsin, \( \gamma_q \sim r^{\zeta(q)} \), with \( \zeta(q) = q/3 \) for \( r \) within the inertial range and \( q \) the order of the function.

Due to intermittency, above \( q \approx 10 \):
- Grid turbulence, shear driven → \( \zeta(q) \approx 1.4 \) (Zhou and Xia 2002)
- Convective turbulence, buoyancy driven → \( \zeta(q) \approx 0.8 \)

Quantify spatial asymmetry (plumes?) by computing the skewness of \( \Delta_r \theta \pm \theta \approx (|\Delta_r \theta| \pm \Delta_r \theta) / 2 \),

(similarly for the vertical increments \( \Delta_z \theta \)).

<table>
<thead>
<tr>
<th>Downslope (warming) phase</th>
<th>Upslope (cooling) phase</th>
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<tbody>
<tr>
<td>Weaker heat flux</td>
<td>Stronger heat flux</td>
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<tr>
<td>Skewness of ( \Delta_r \theta \pm \theta ): cold convective “plumes”</td>
<td>Higher-order ( \gamma_q \approx ) passive scalar</td>
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<tr>
<td>Lower half of the mooring: temperature ≈ active scalar (warm “plumes”)</td>
<td>temperature ≈ passive scalar</td>
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**Conclusions**

- Sharp scaling break between turbulence and waves at \( r = O(100 \text{ m}) \) (kink in \( \gamma_3 \)).
- Outer intermittency (no saturation, large \( \zeta_q \)).
- Smooth, “classical”, \( \Lambda \)-shaped flux-gradient relation.

**References**