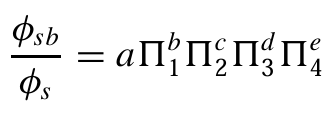
**Ideas/Objectives for POC's stay in the MAQ group (WUR) with Gert-Jan**

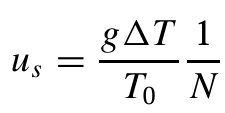
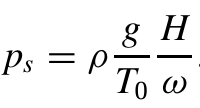
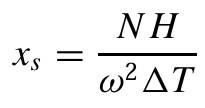
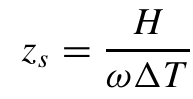
The stay will focus, at least initially, on the scaling of the coastal breeze (sea breeze scaling) in the Dutch region.

**Brief introduction to sea breeze scaling:**

Sea breeze scaling is a set of laws and scales developed to analyze sea breeze circulation, based on turbulent flows of sensible heat and momentum in the surface layer (Steyn et al., 1998). Later, in Steyn (2003), an integrated heat flux was employed, instead of an instantaneous one, allowing for a better representation of the accumulated thermal forcing throughout the day. These scales, which avoid the use of exchange coefficients, allow for the non-dimensionalization of the governing equations of the sea breeze, resulting in four dimensionless parameters/scales that characterize its dynamics. By introducing these parameters into the dynamic equations using the Boussinesq approximation, the following expression is derived (more details in Steyn et al., 1998) :



Where ​ is a measured physical property of the sea breeze (e.g., depth or intensity), and ​ is the appropriate scale for that quantity, with their expressions as follows:



Using observational data, the values for the coefficients a, b, c, and d are derived (through non-linear regression techniques using least squares). These scales also allow for the diagnosis of the diurnal evolution of the sea breeze and facilitates analytical and numerical studies of this phenomenon and their intercomparison with those in other regions. This analysis has been conducted for various locations (Steyn et al., 1998 and 2003, Wichink et al., 2003, Porson et al., 2007a and 2007b, etc.), extracting different empirical values for the coefficients (specific to each location, through different observations). Specifically, the coefficient a is the most interesting as it represents a scaling factor, which, in the case of , represents the depth of the breeze, or the intensity in ​. The coefficients corresponding to these two characteristics are the most explored in the literature.

In this context, there is an MSc thesis report (Ashriah Andani) that, among other things, uses this sea breeze scaling (specifically for intensity ​) to analyze the influence of various factors (absence/presence of mountains, changes in city characteristics, or changes in SST) on the value of coefficient . The data from different simulations in WRF in Jakarta are the ones used for this purpose, instead of observations. Five different experiments are conducted, and the adjusted a value is analyzed in each situation, allowing the impact of each experiment in the intensity of the breeze

**Tasks/ideas proposed for the stay:**

We will focus on the SB days that CR analyzed 2 years ago:

* **16/07/2014 → most ‘canonical’ case**
* 13/07/2017

The ideas that raised up are the following:

**1- Apply a similar approach to Ashriah's but for the Netherlands region**. To do this:

* Find the best WRF model configuration:
  + LES?
  + Horizontal resolution of the inner domain? Is it worth raising the resolution below 1 km?
  + WRF model physics:
    - PBL physics → PBL scheme: TKE prediction (MYJ, BouLac, etc.) vs. Diagnostic non-local (YSU, GFS…). Scale-adaptive (A Three-Dimensional Scale-Adaptive Turbulent Kinetic Energy Scheme in the WRF-ARW Model → Zhang et al., 2018)?
    - Surface physics → Land-surface scheme: Noah, Noah-MP, CLM, RUC...
  + Model validation: Observations in the Netherlands (MAQ group stations, Cabauw, buoys, soundings, lidar, etc.)
* Proposed experiments:
  + Presence of a megacity (entirely artificial, assuming the area between Rotterdam, Utrecht, and Amsterdam as a city).
  + Presence of a mountain
  + Changes in SST:
    - Increase them (following IPCC Global Climate Projections, adding sea level change which may affect the SB system).
    - Decrease them: interesting to see the influence of on the characteristics of the breeze (especially intensity). It seems that although it is one of the most important factors in the formation, it is not as influential in its final characteristics (Porson et al., 2007: "The time-averaged integrated surface heat flux H measured near the coastline captures the mechanism of surface heating better than the land-sea temperature difference"; CRC did some experiments also in the Gulf of Cádiz for the same purpose).
  + Add some type of vegetation cover that could generate an interesting forcing for the atmosphere:
    - Rice paddies (not very realistic): When irrigated, the land is flooded for a period of time, thus providing significant energy and moisture to the atmosphere.
    - In line with IPCC projections, it might be interesting to add some type of vegetation that is drier.
  + Experiment with the WRF irrigation parameterization (Mireia Udina et al., 2024).

**2- Explore other less studied coefficients of sea breeze scaling:**

* ​ (related to the horizontal extension of the SB).
* Scale for the volume flux: combining the scaling parameters for breeze depth and intensity in this way (Porson et al., 2006):

**3- What differences are found when calculating the sea breeze scaling coefficients using the WRF model versus using observations observations (if availability of observations is sufficient for applying sea breeze scaling)?**

4- Analyze the effect of the different experiments on species transport.

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