Uncertainty in the reference evapotranspiration based on FAO Penman-Monteith (PISCOeo_pm)

Adrian Huerta, Waldo Lavado-Casimiro

Servicio Nacional de Meteorología e Hidrología del Perú

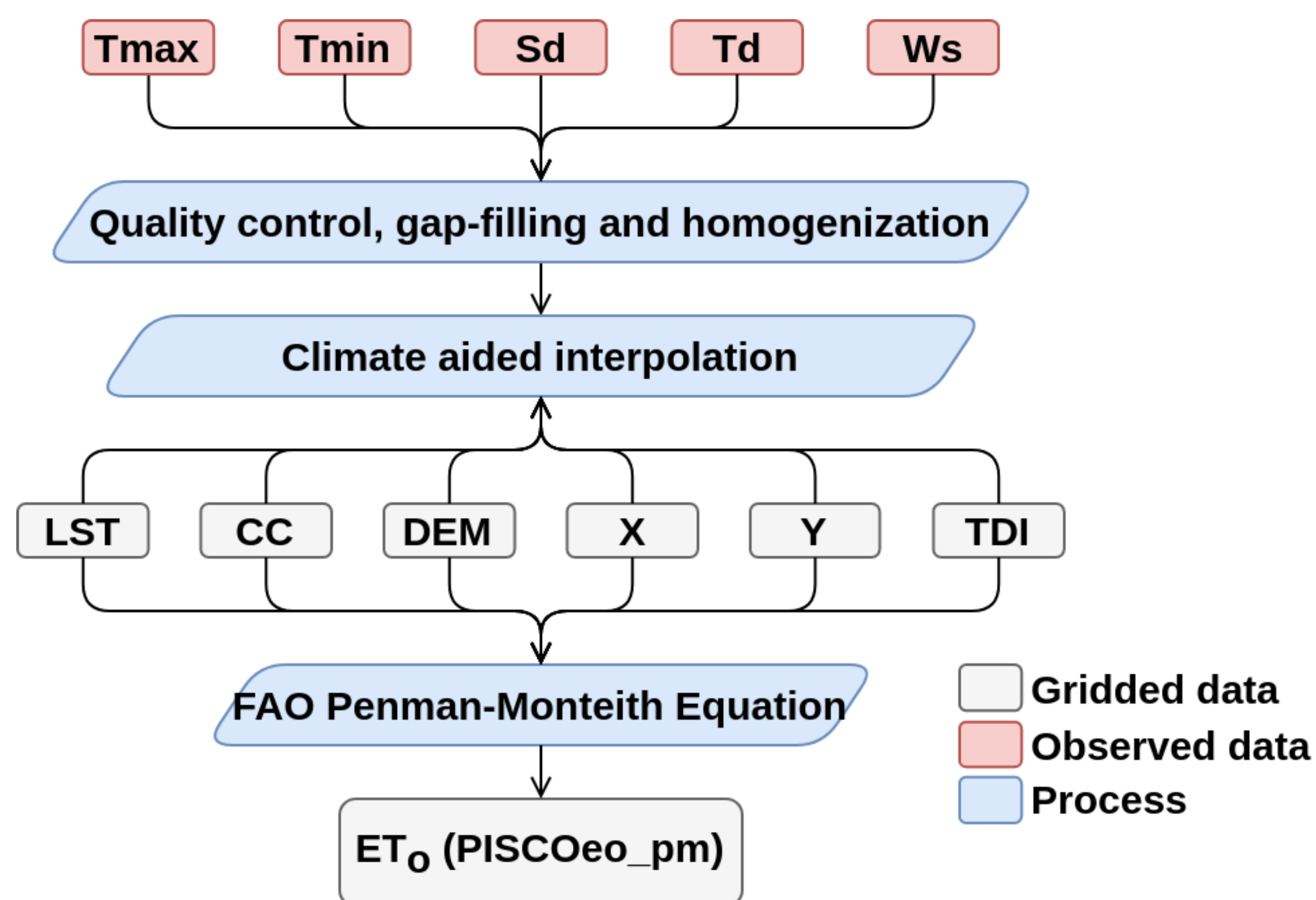## Gridded reference evapotranspiration (ETo) construction: overview
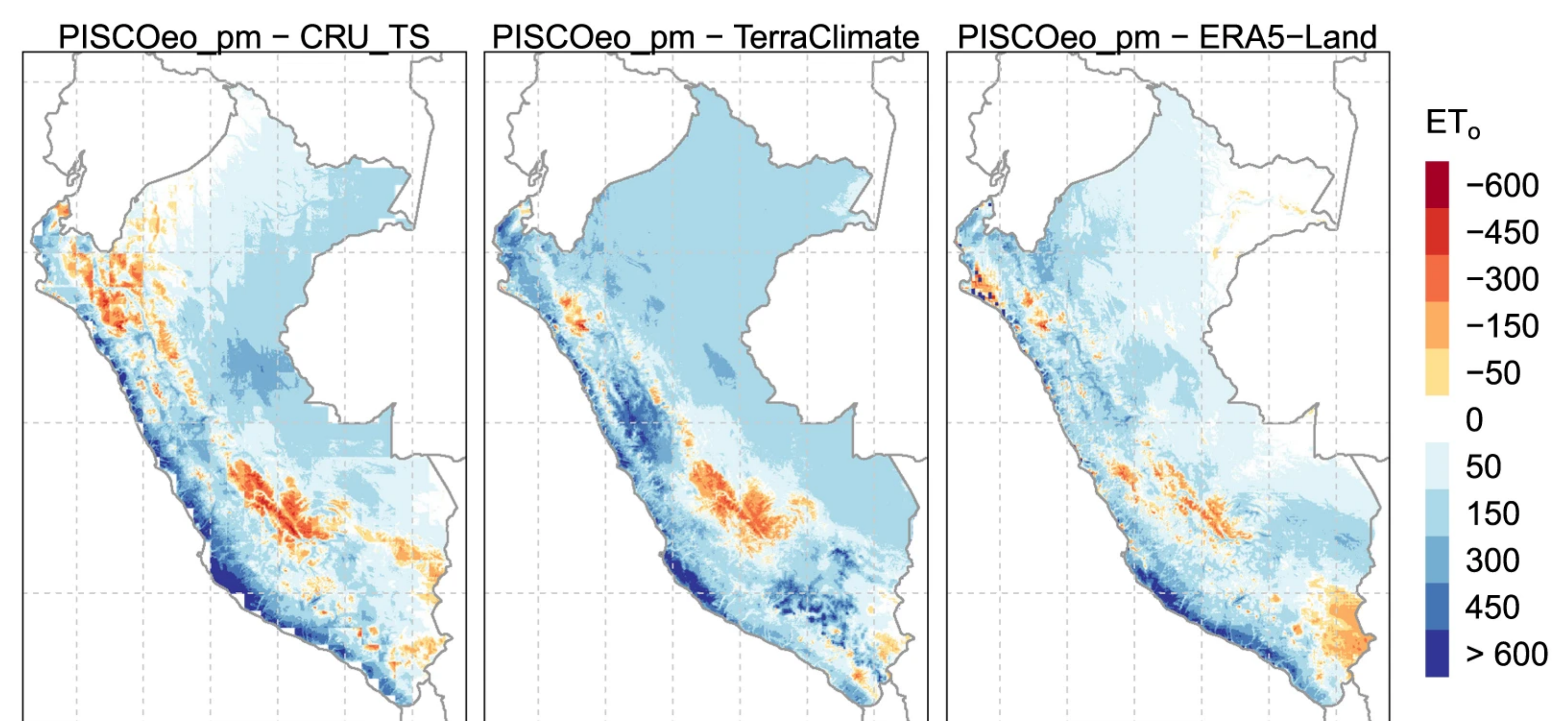

Figure 1. Workflow of PISCOeo_pm.

Figure 2. Difference of ETo (mean annual, 1981–2010) of PISCOeo_pm with global products.

Types of uncertainty (△ ETo)

Using the error propagation approach, we can obtain three types of measurements:

- No absolute: $\Delta ETo = \frac{\partial f}{\partial w}\Delta w + \frac{\partial f}{\partial x}\Delta x + \frac{\partial f}{\partial y}\Delta y + ...$

- Absolute: $\Delta ETo = \left|\frac{\partial f}{\partial w}\right|\Delta w + \left|\frac{\partial f}{\partial x}\right|\Delta x + \left|\frac{\partial f}{\partial y}\right|\Delta y + ...$

- Standard deviation:
$\Delta ETo = \left(\frac{\partial f}{\partial w}\right)^2 \Delta w^2 + \left(\frac{\partial f}{\partial x}\right)^2 \Delta x^2 + \left(\frac{\partial f}{\partial y}\right)^2 \Delta y^2 + ...$

The derivatives are applied to each variable on the FAO Penman-Monteith formula!

What type of uncertainty did we compute in PISCOeo_pm? We did calculate the "no absolute" formula. However, here we computed the other ones and chose the "standard deviation" approach which is easier to interpret.
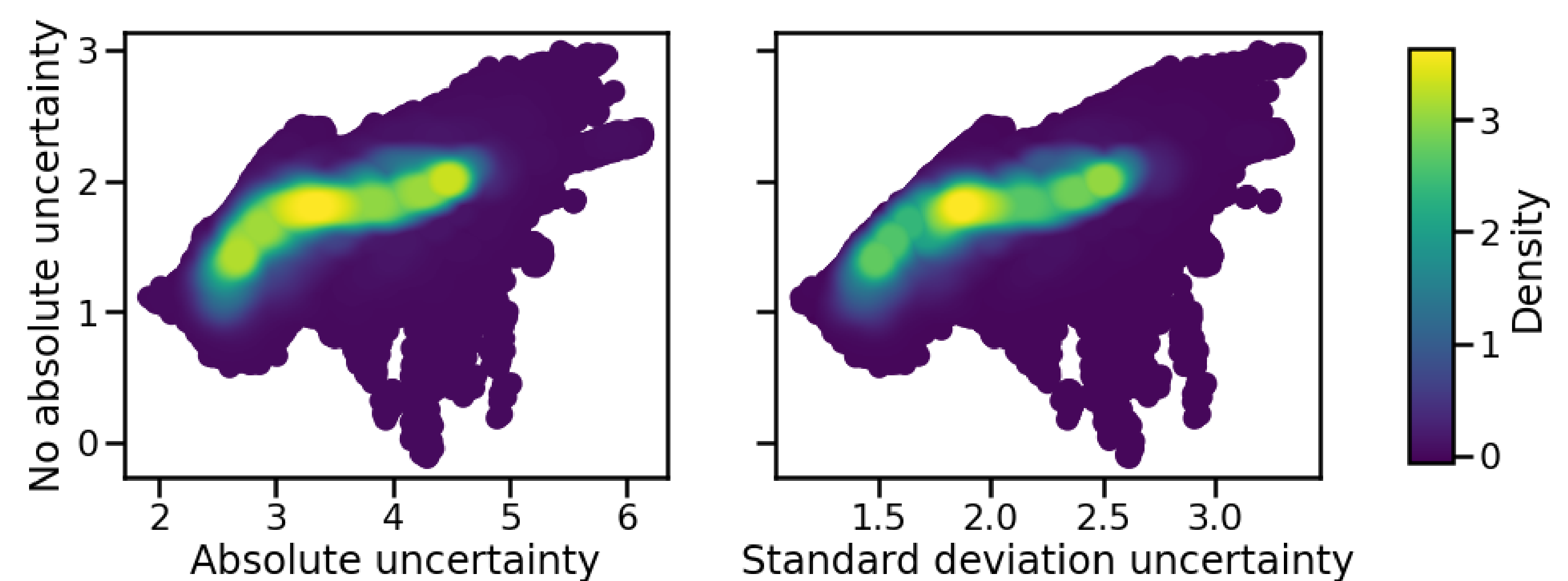
Uncertainty types correlation

Figure 3. Density scatter plot between types of uncertainty measurement of the annual mean ∆ETo (1981-2016) - spatial correlation.

The "absolute" and "standard deviation" approaches do not fully follow a linear relationship with the "no absolute" approach. The "standard deviation" and "no absolute" strategies have a similar magnitude. The "absolute" approach reaches up to twice the values of the previous methods.

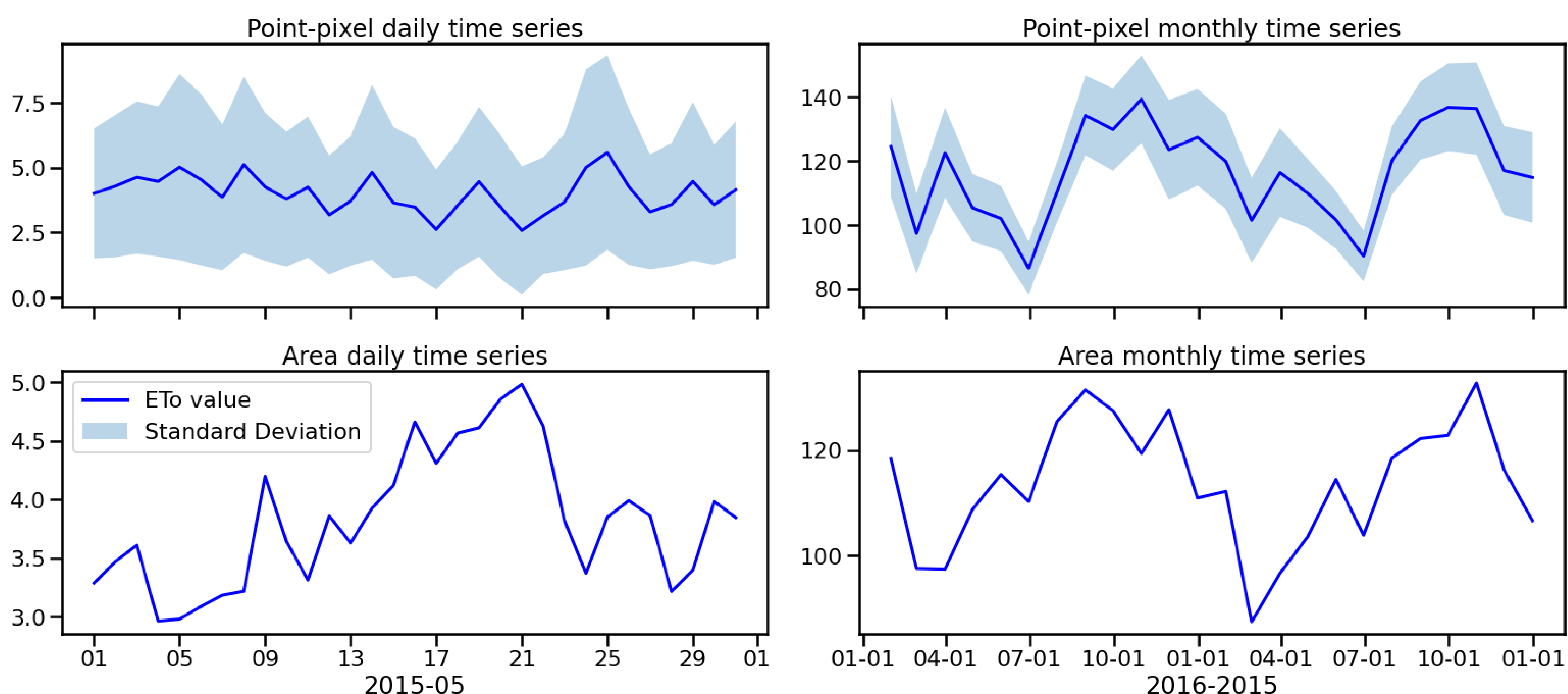## On the use of uncertainty of PISCOeo_pm as standard deviation

Uncertainty accumulation

- Mean: $\frac{\sqrt{\sum_{i=1}^{N}\sigma^2}}{N}$
- Sum: $\sqrt{\sum_{i=1}^{N}\sigma^2}$
- Check the code:

Figure 4. Daily and monthly ETo and ∆ETo time series for point-pixel [latitude = -12.5°, longitude = -70°] and area [Arequipa region] values.