Experience of current velocity fields evaluation using variational method for AVHRR images referred to Black Sea

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Base equation

$$\frac{\partial T}{\partial t} = a\Delta T - u\frac{\partial T}{\partial x} - v\frac{\partial T}{\partial y}$$
(1)

Minimized functional

$$J(T(x, y, t_k), \widehat{T}(x, y, t_k), u, v) = \frac{1}{2} \sum_{k=1}^{N} \int_{\Omega} \chi_k(x, y) \Big(T(x, y, t_k) - \widehat{T}(x, y, t_k) \Big)^2 dx dy + \frac{b}{2} \int_{\Omega} \left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} \right)^2 dx dy + \frac{c}{2} \int_{\Omega} \left(\left(\frac{\partial u}{\partial x} \right)^2 + \left(\frac{\partial u}{\partial y} \right)^2 + \left(\frac{\partial v}{\partial x} \right)^2 + \left(\frac{\partial v}{\partial y} \right)^2 \right) dx dy$$
(2)

- N quantity of images in a sequence
- \hat{T} Observed temperature

 χ_k — indicator of clout free region on the corresponding image













In order to use several flows of data we solve equation of heat transfer for each flow separately. Minimized functional has given by

$$J = \frac{1}{2} \sum_{l=1}^{L} \sum_{k=1}^{N} \int_{\Omega} \chi_{k}(x, y) \Big(T_{l}(x, y, t_{k}) - \hat{T}_{l}(x, y, t_{k}) \Big)^{2} dx dy + \frac{b}{2} \int_{\Omega} \left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} \right)^{2} dx dy + \frac{c}{2} \int_{\Omega} \left(\left(\frac{\partial u}{\partial x} \right)^{2} + \left(\frac{\partial u}{\partial y} \right)^{2} + \left(\frac{\partial v}{\partial x} \right)^{2} + \left(\frac{\partial v}{\partial y} \right)^{2} \right) dx dy$$
(3)









Optic data



Optic data



Velocity field evaluated from only IR data



Velocity field evaluated from IR and optic data



Another examples









Calculated velocity field





Validation

Altimeter tracks

Calculated start velocity

Altimeter tracks

Velocity projections onto normal to tracks

Velocity projections onto normal to tracks

Problems

Results obtained using different regularisation coefficients

Problems

Velocity is not stationary as required

- Surface temperature changes not only as a result of transfer
- > We have too many cloud free images
- Results strongly depend on regularization coefficients

Thank you for attention