$$\langle S_{grain} S^*_{leaf} \rangle = \sum_{m=1}^{4} \sum_{n=1}^{4} \langle S^m_{grain} S^{n*}_{leaf} \rangle$$

$$S^m_{grain} = S^{m\prime}_{grain}(\bar{s})\ \Phi^m(\bar{p})$$

$\bar{s} =$ **State variables** inclding: moisture
size
shape
radar
extinction

$\bar{p} =$ **Propagation variables** inclding: soil moisture
position
stalk state
radar
extinction

$$\langle S_{grain} S^*_{leaf} \rangle = \sum_{m=1}^{4} \sum_{n=1}^{4} \int S^{m\prime}_{grain}(\bar{s_g})\ p(\bar{s_g})\ d\bar{s_g} \int S^{n\prime *}_{leaf}(\bar{s_l})\ p(\bar{s_l})\ d\bar{s_l}$$
$$\int \Phi^m_{grain}(\bar{p_g}) \Phi^n_{leaf}(\bar{p_l})^* p(\bar{p_g}, \bar{p_l}) d\bar{p}$$

$$\langle S_{stalk} S^*_{leaf} \rangle = \sum_{m=1}^{4} \sum_{n=1}^{4} \langle S^{m\prime}_{stalk} \Phi^{n*}_{leaf} \rangle \langle S^{n\prime *}_{leaf} \rangle$$