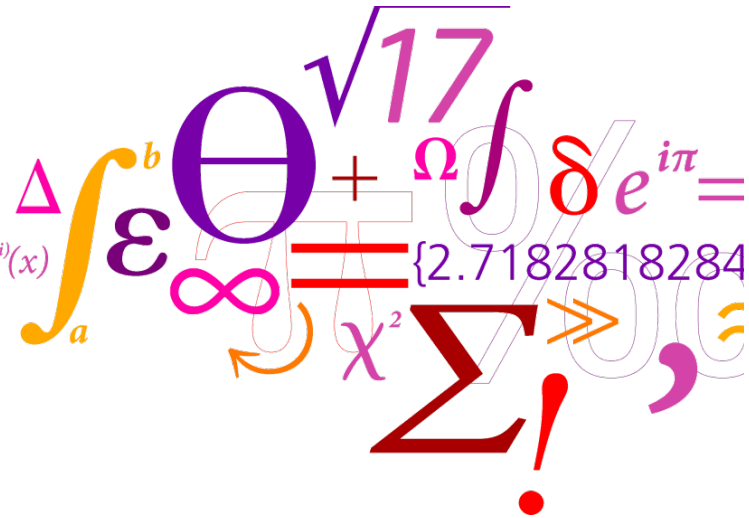
Danmarks Tekniske Universitet

What is the large-scale wind regime in South Africa?

Andrea Hahmann
Wind Energy Division, Risø DTU
Roskilde, Denmark

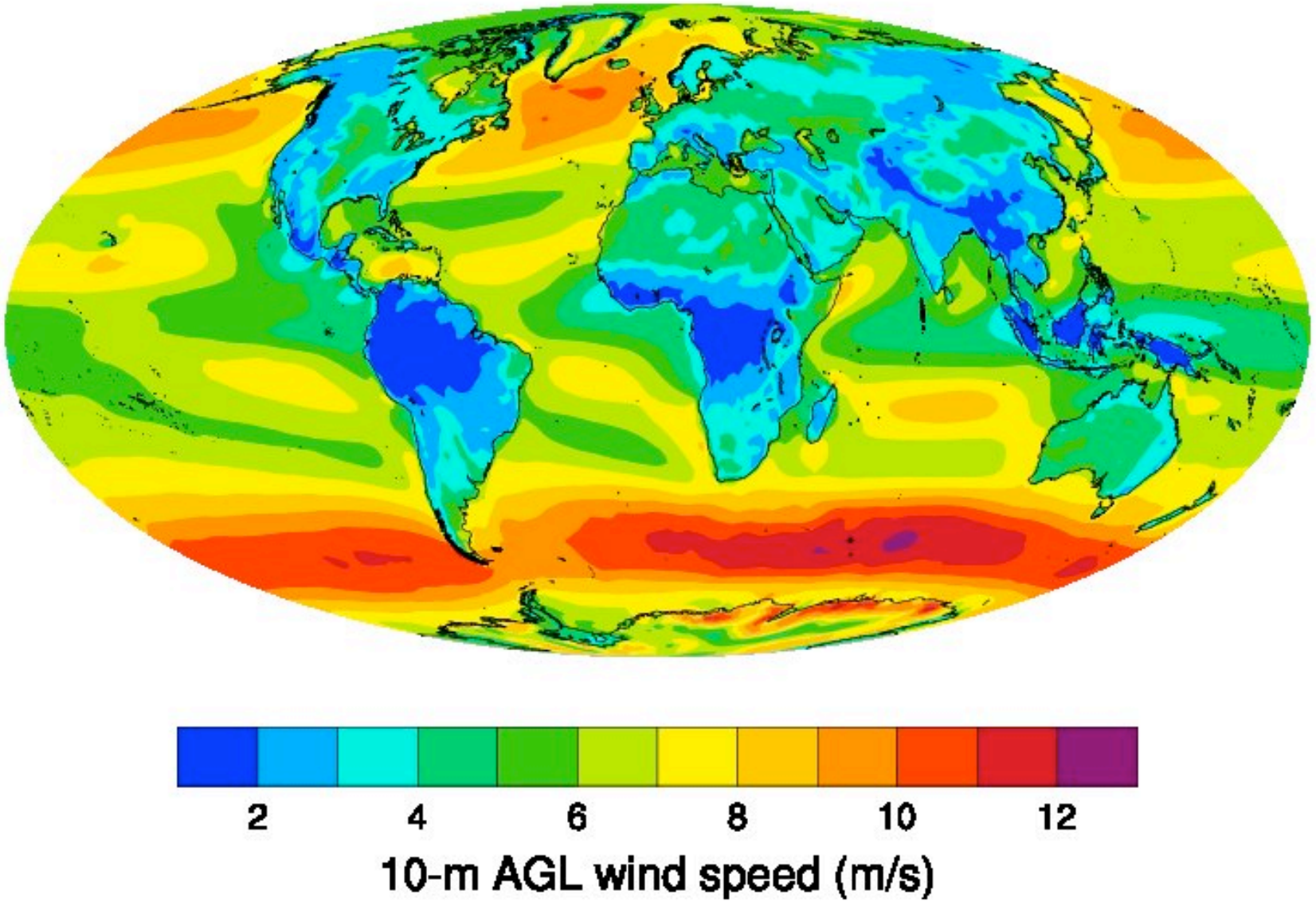
Andries Kruger
S. African Weather Service (SAWS)

Wind Atlas for
South Africa (WASA)
Project Workshop



Risø DTU
National Laboratory for Sustainable Energy

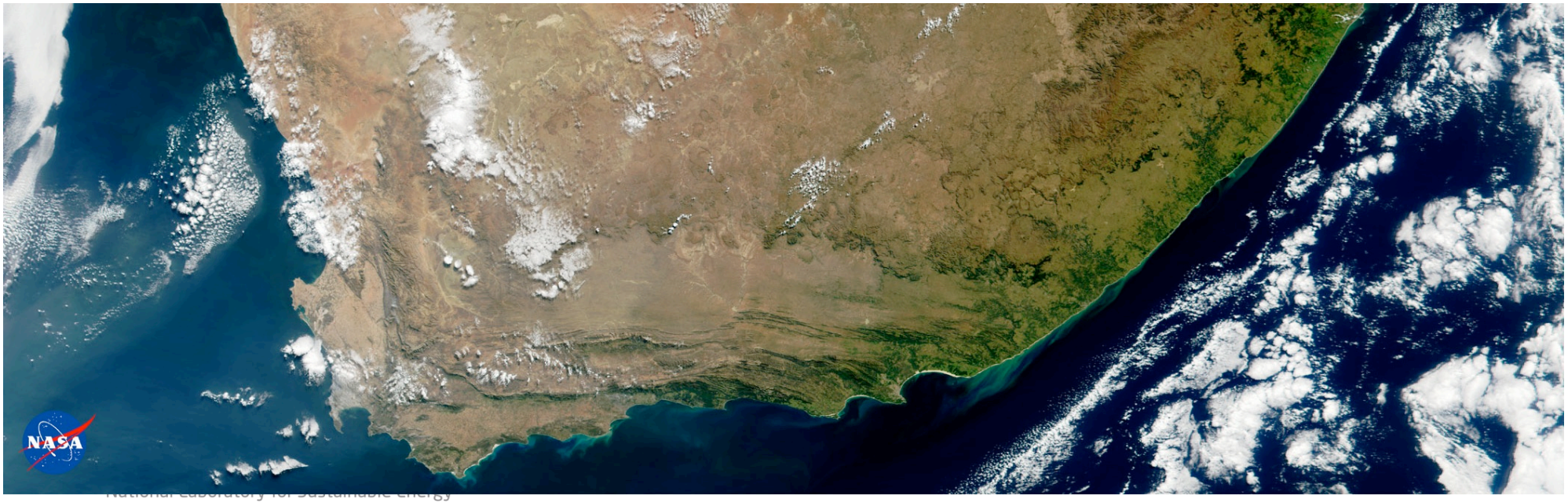
Annually averaged 10-meter winds across the world



Source: European Center for Medium Range Weather Forecasting (ECMWF) - ERA Interim reanalysis

Introduction

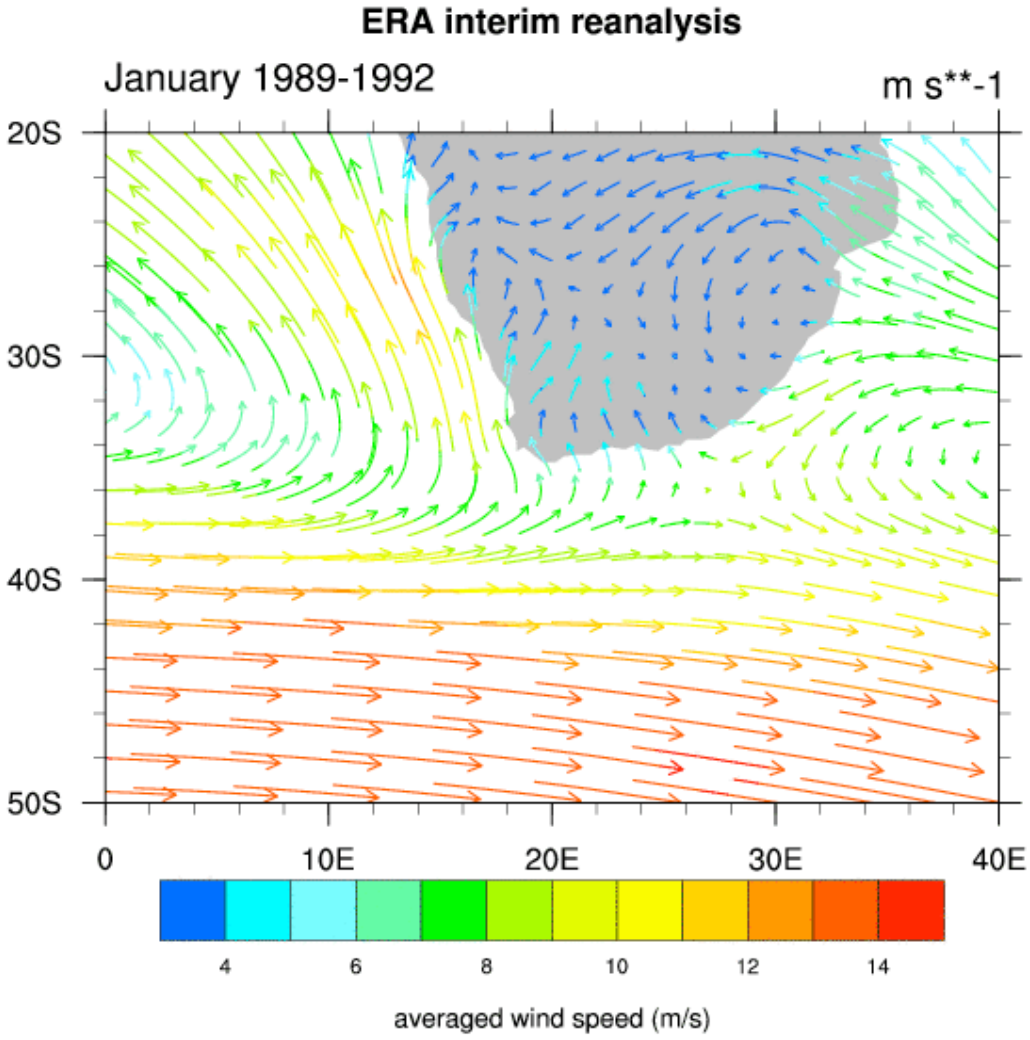
- South Africa has a very diverse climate, and this diversity applies to the wind climate as well
- Different prevailing weather systems dominate the wind climate over different regions of South Africa
- The influence of these weather systems tend to change in their strengths and spheres of influence during the course of a typical year



Background

- The seasonal differences in the circulation features of the atmosphere, near the surface of southern Africa and the surrounding oceans, are mainly the result of the northward displacement of the subtropical high pressure belt by almost five degrees latitude from summer to winter.
- Usually these lower-level anticyclones on land are interrupted once to twice per week by cold-front troughs.

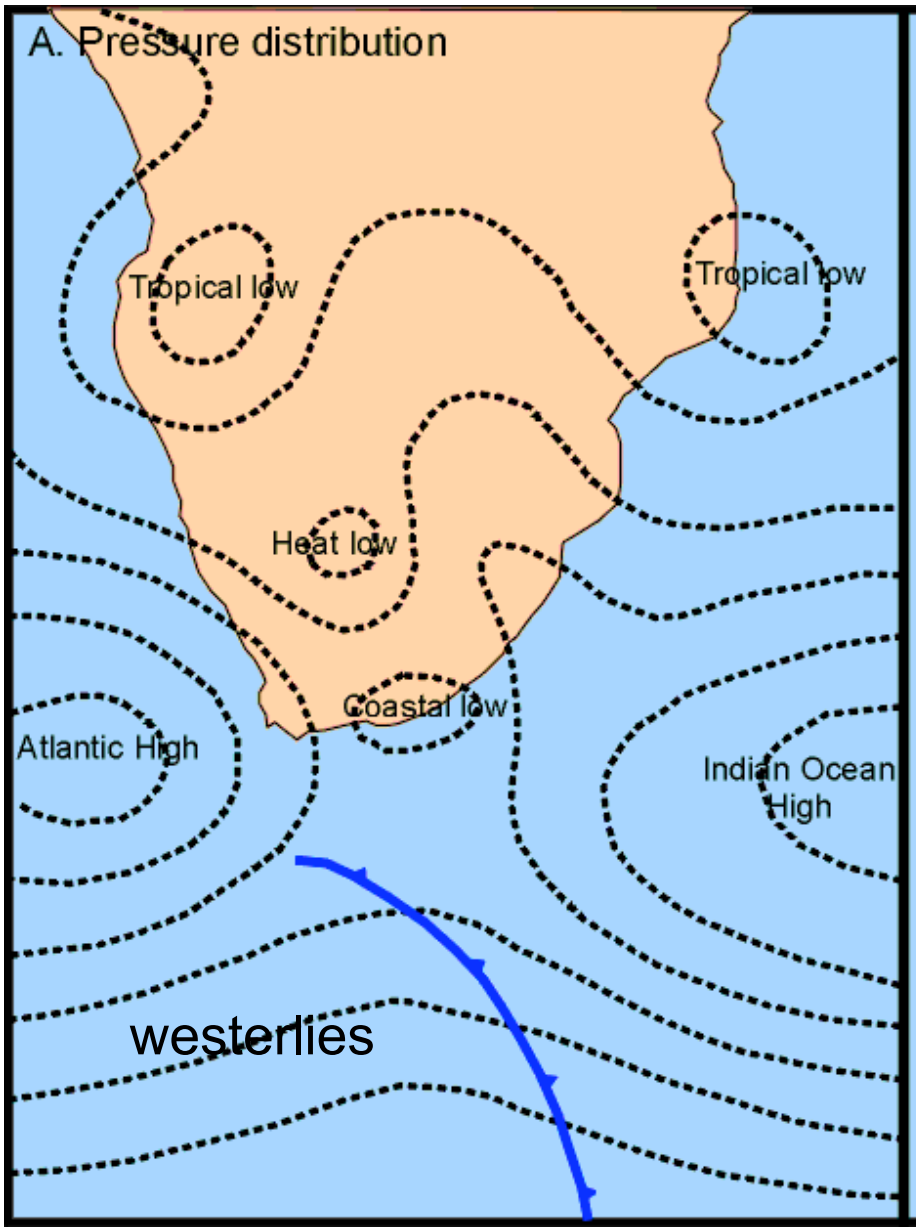
Annual cycle (one picture per month) of the 10-meter winds



Summer Circulation

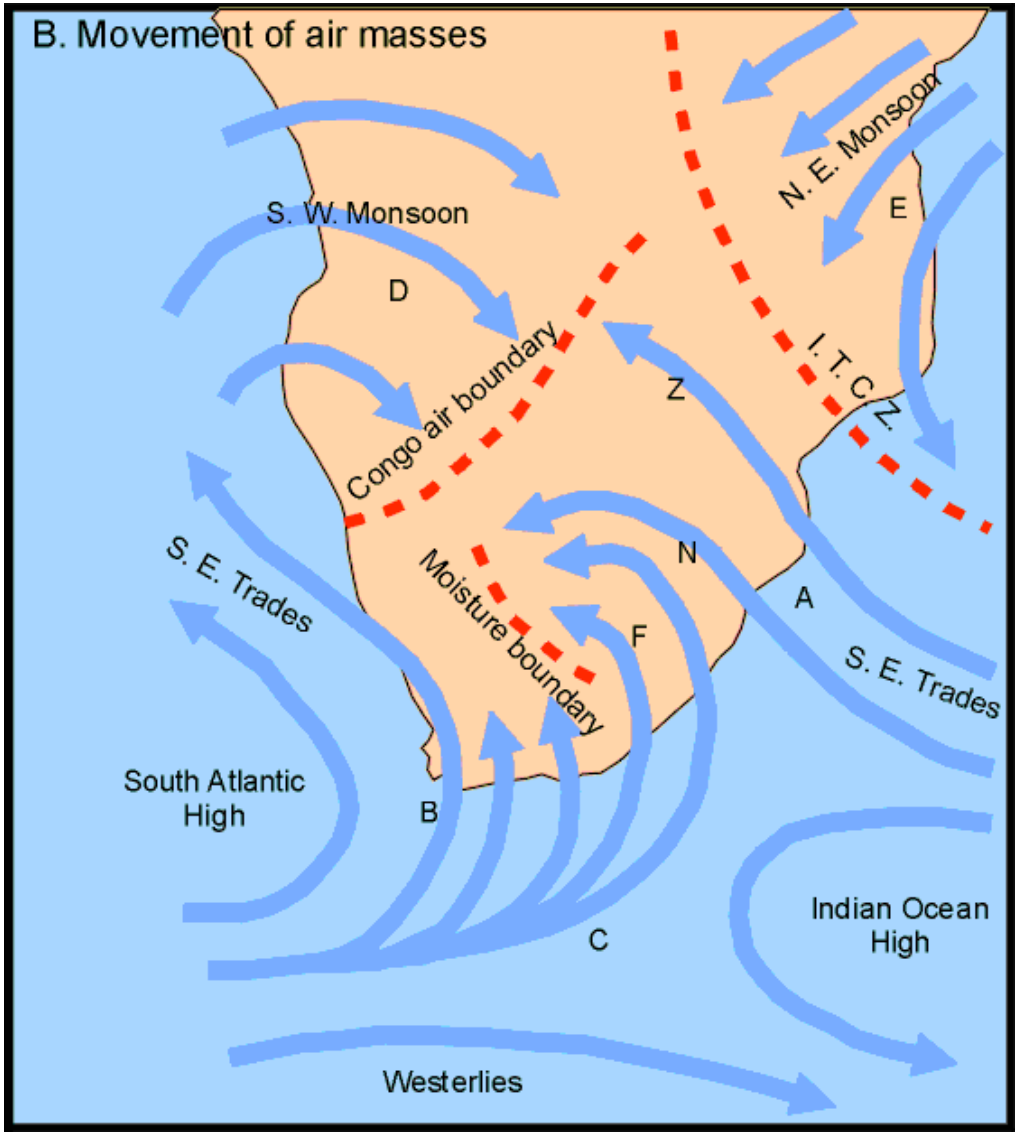
The “westerlies” are situated well to the south of the continent.

The Indian Ocean and Atlantic Ocean high pressure systems are situated more southward.



Summer winds

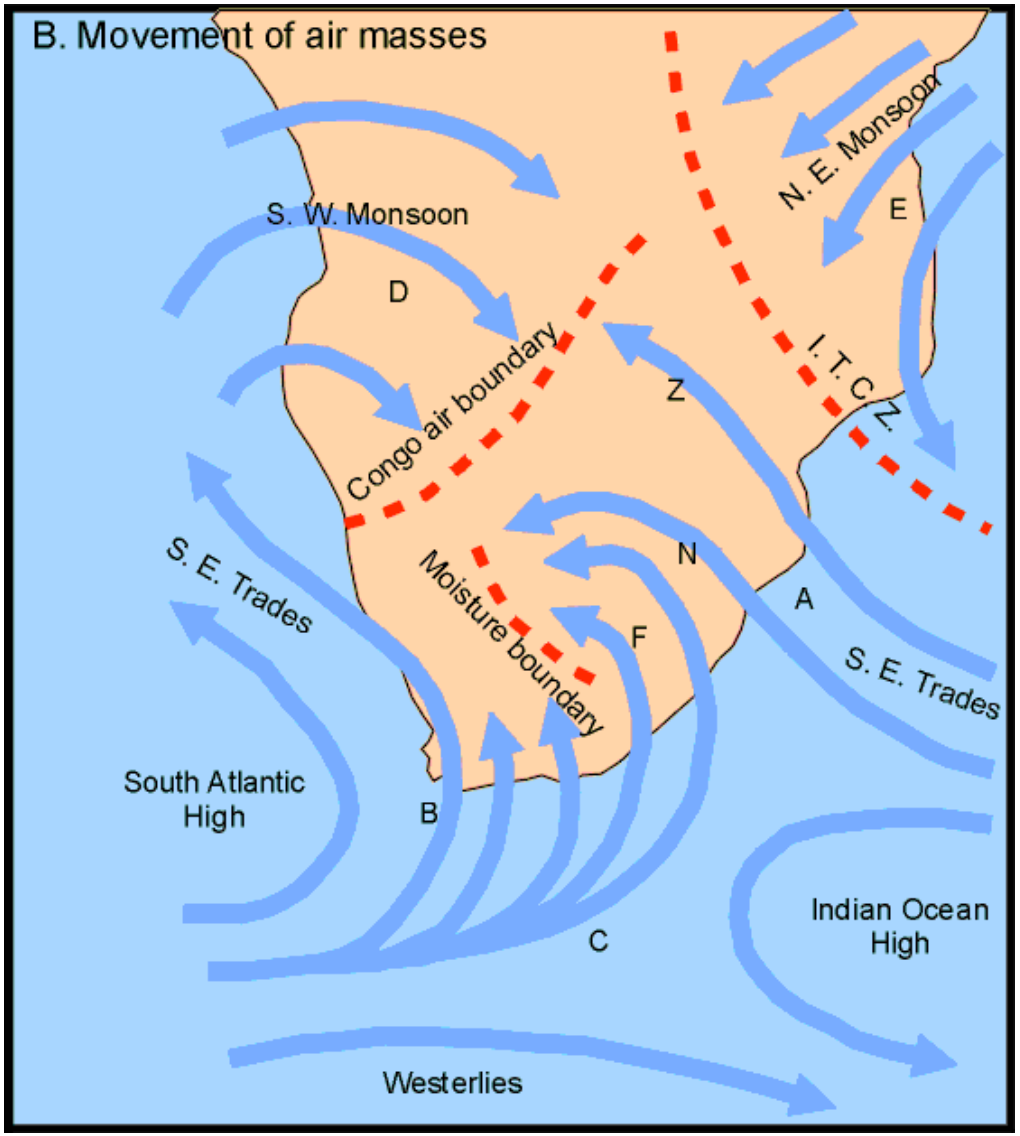
The south-eastern Trades (A) influence the north-eastern part of the region. These winds can be strong, curving sometimes from Limpopo Province (N) into the Free State (F), or moving over far northern areas, such as Zimbabwe and Zambia (Z).



Summer winds (cont)

In the west, the S. E. Trades (B) caused by ridging of South Atlantic High, are often strong and persistent.

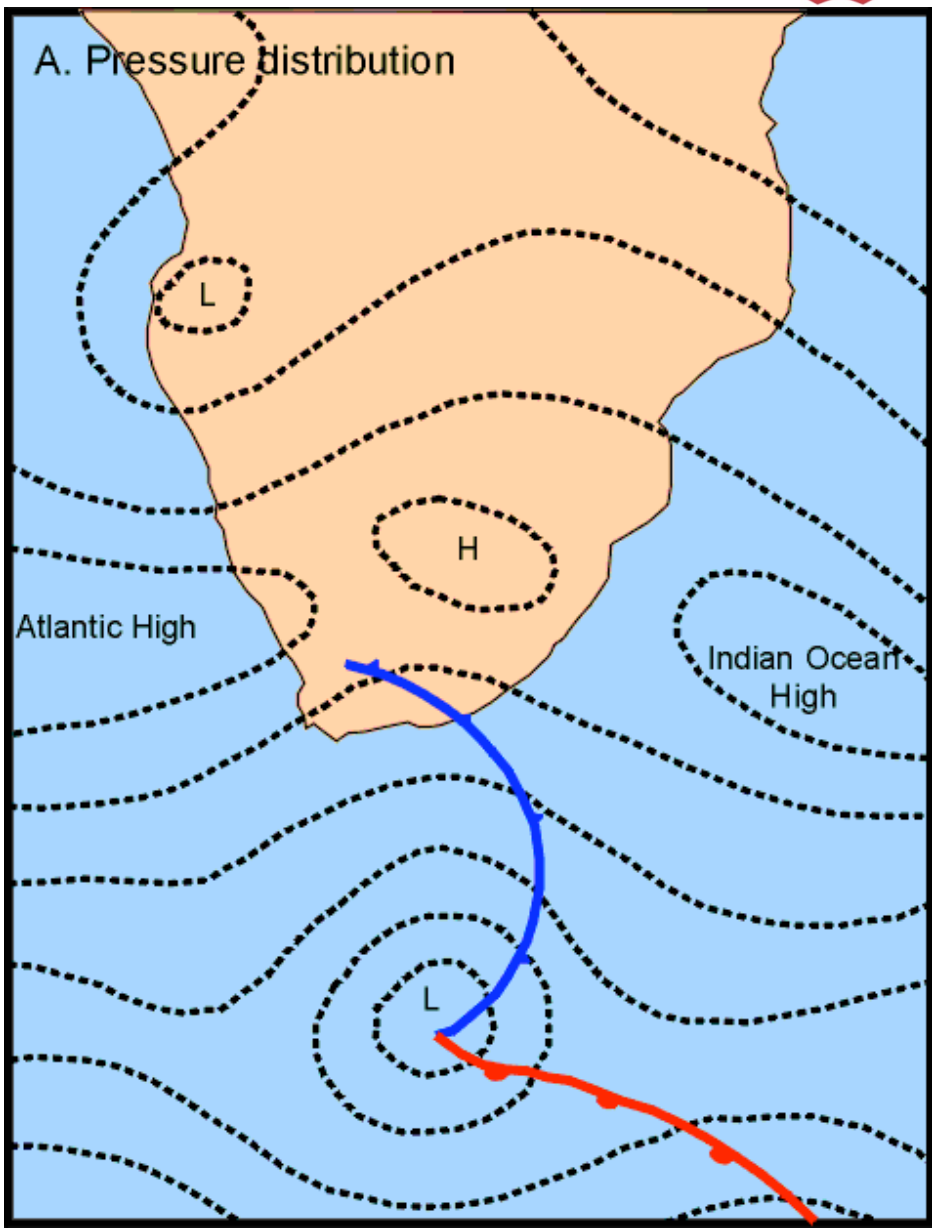
The strong westerlies are only able to influence the western, southern and south-eastern coastal areas and adjacent interior.



Winter Circulation

All circulation features are situated more to the north than in summer.

Strong winds and gusts during winter are usually caused by strong cold fronts, moving mostly over the southern half of South Africa, and also by the ridging of the high pressure systems behind the fronts.

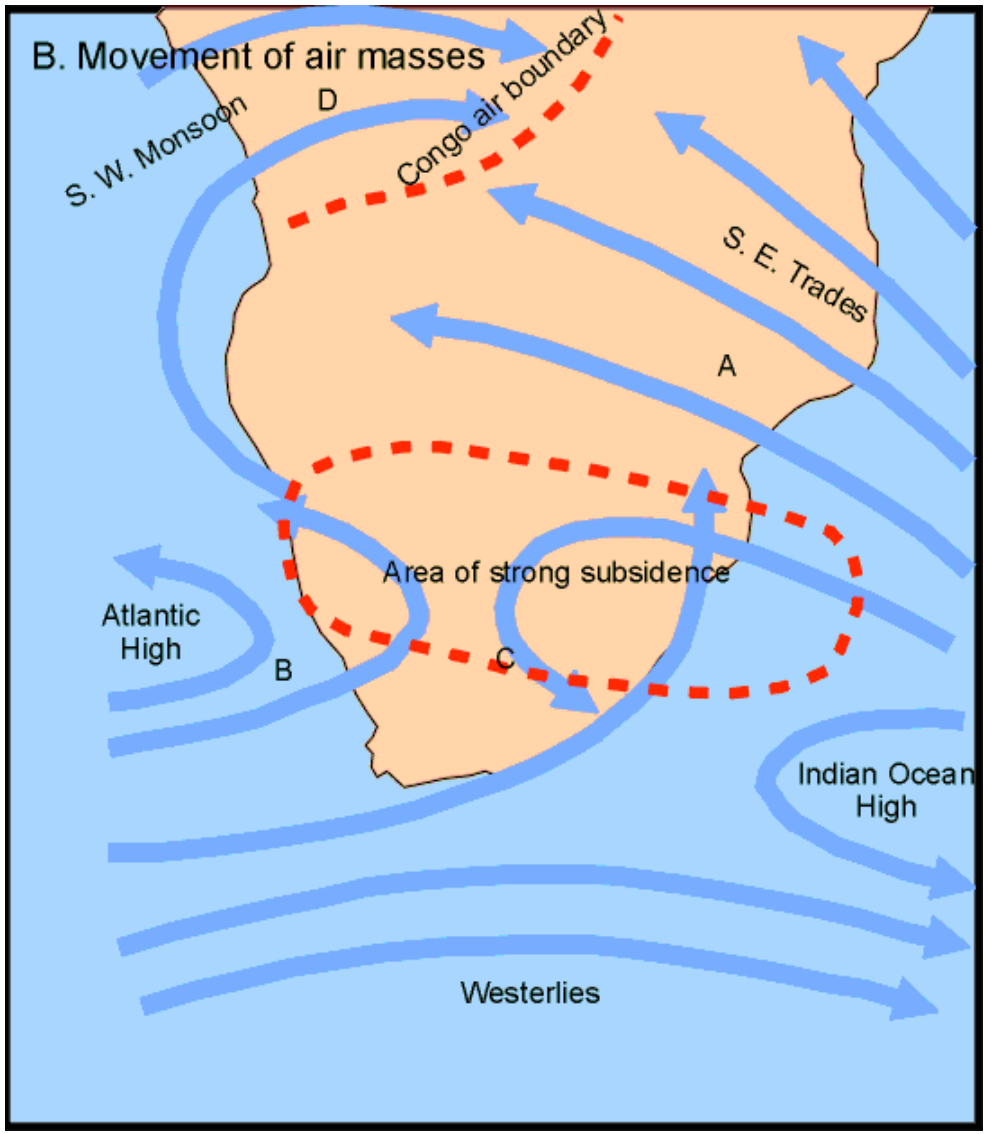


Winter winds

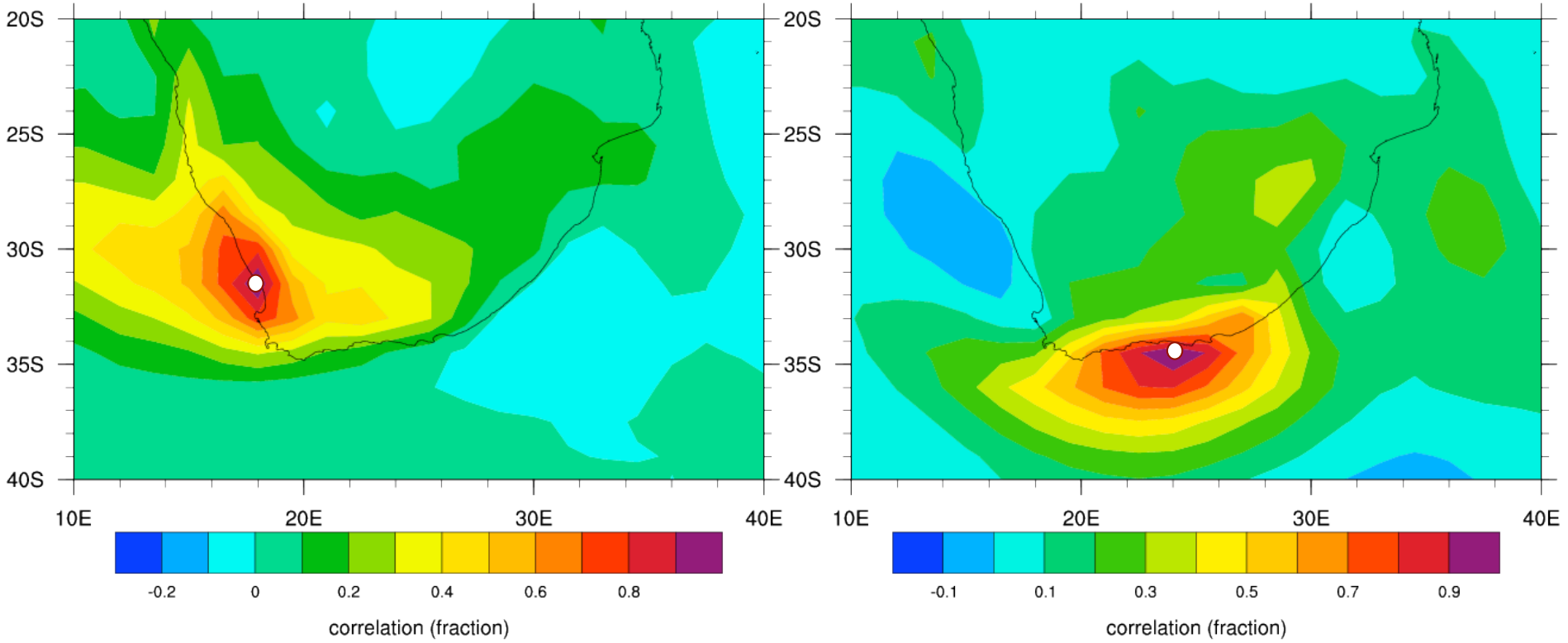
The “westerlies” influence the weather of the southern and central parts of the subcontinent to a large degree. Cold fronts often move over these areas and may reach far to the north.

The strong westerlies are only able to influence the western, southern and south-eastern coastal areas and adjacent interior.

When the Atlantic high pressure system moves more eastwards and stays strong, gale force winds can spread to the KwaZulu-Natal coast as far north as the Mozambique Channel.



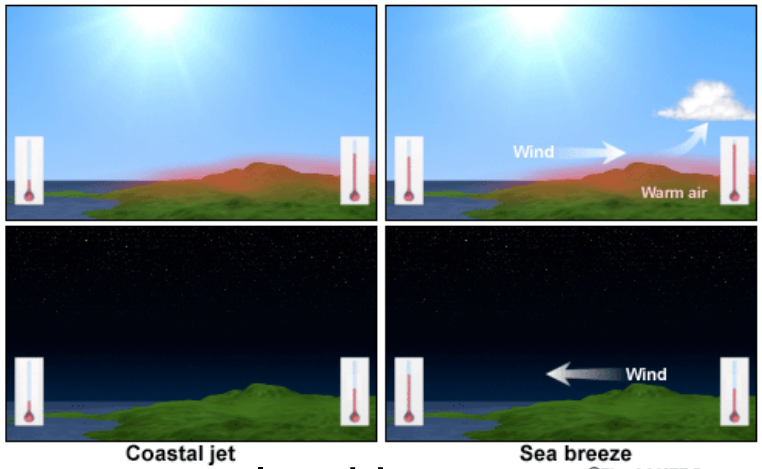
Spatial correlations (lag 0) between 6-hourly wind speed
ERA Interim Annual 1989



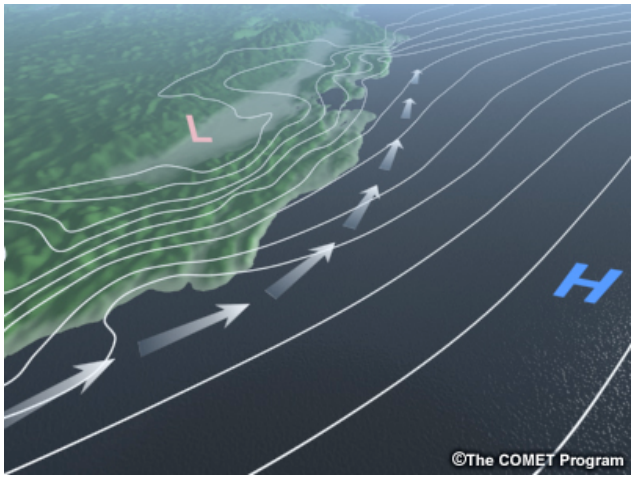
Wind-speed correlations in the large-scale flow.

Will vary with season and perhaps from year to year

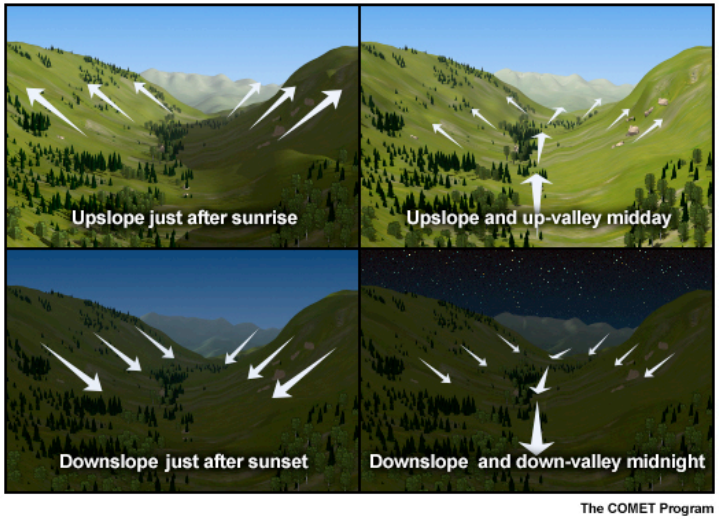
Mesoscale processes generate regional circulation systems and/or modify these general patterns



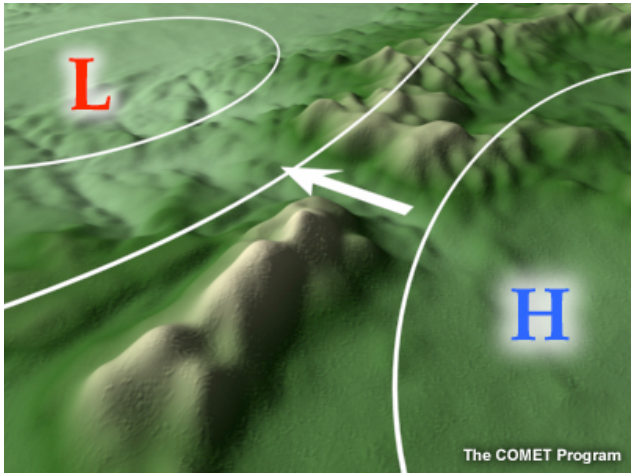
sea-land breeze



coastal jet

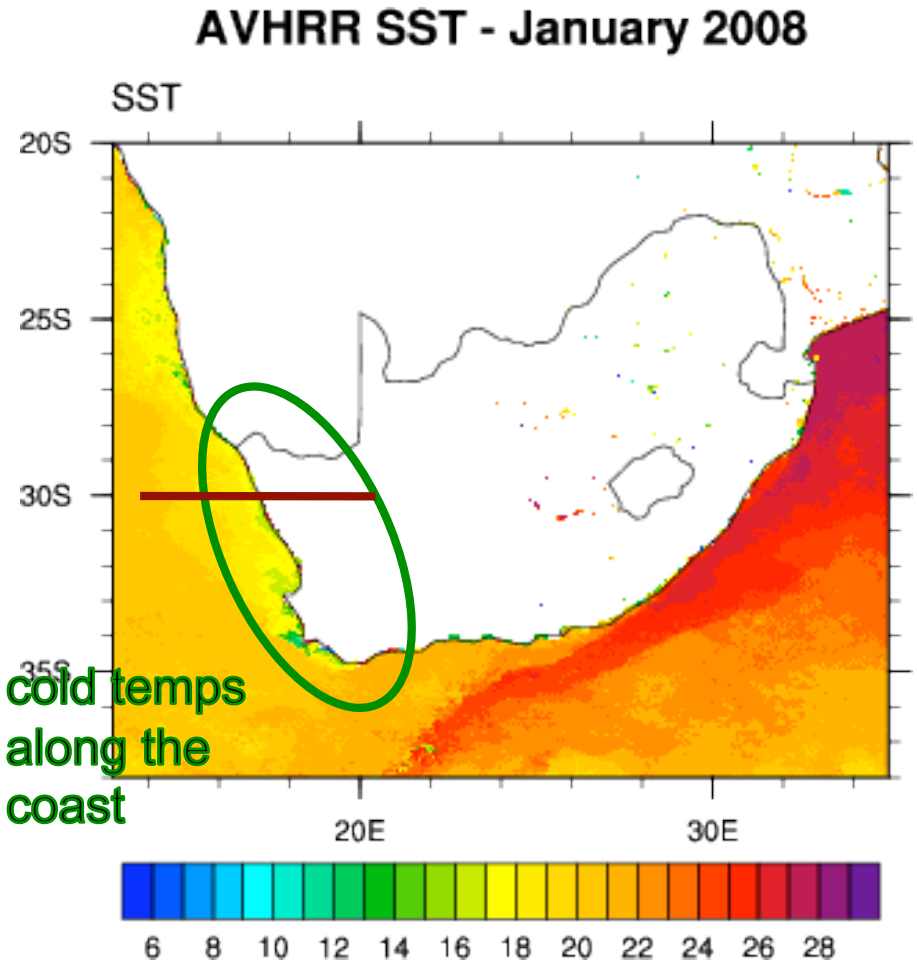


mountain-valley breeze



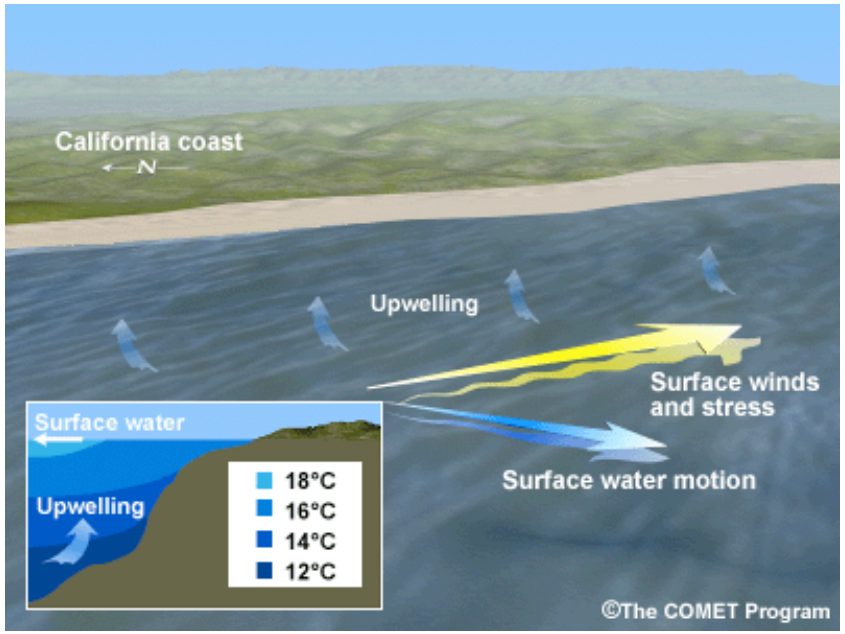
gap flow

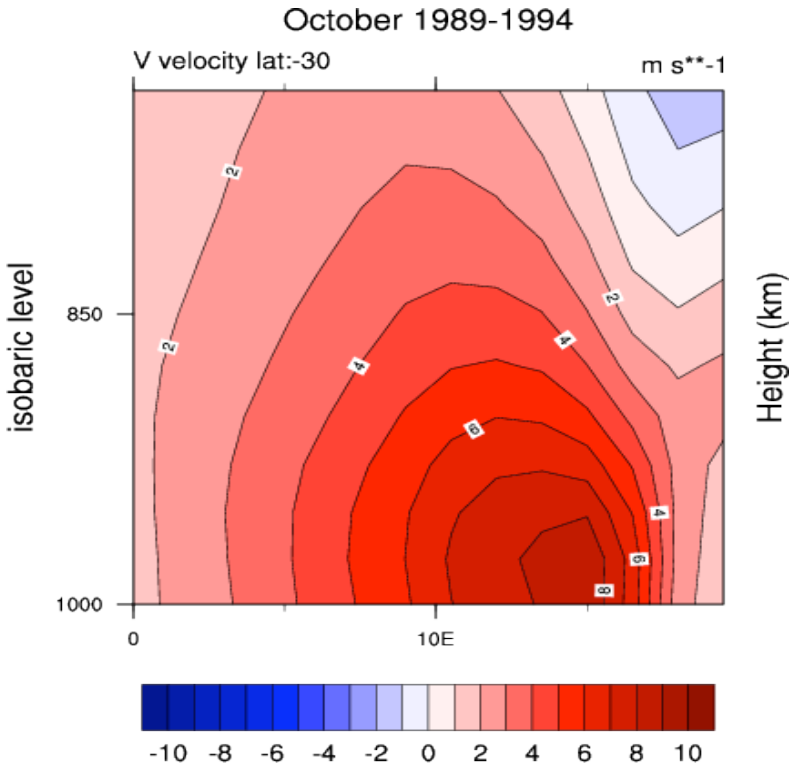
Coastal jet along the west coast summer



cold temps along the coast

sea-surface temperatures

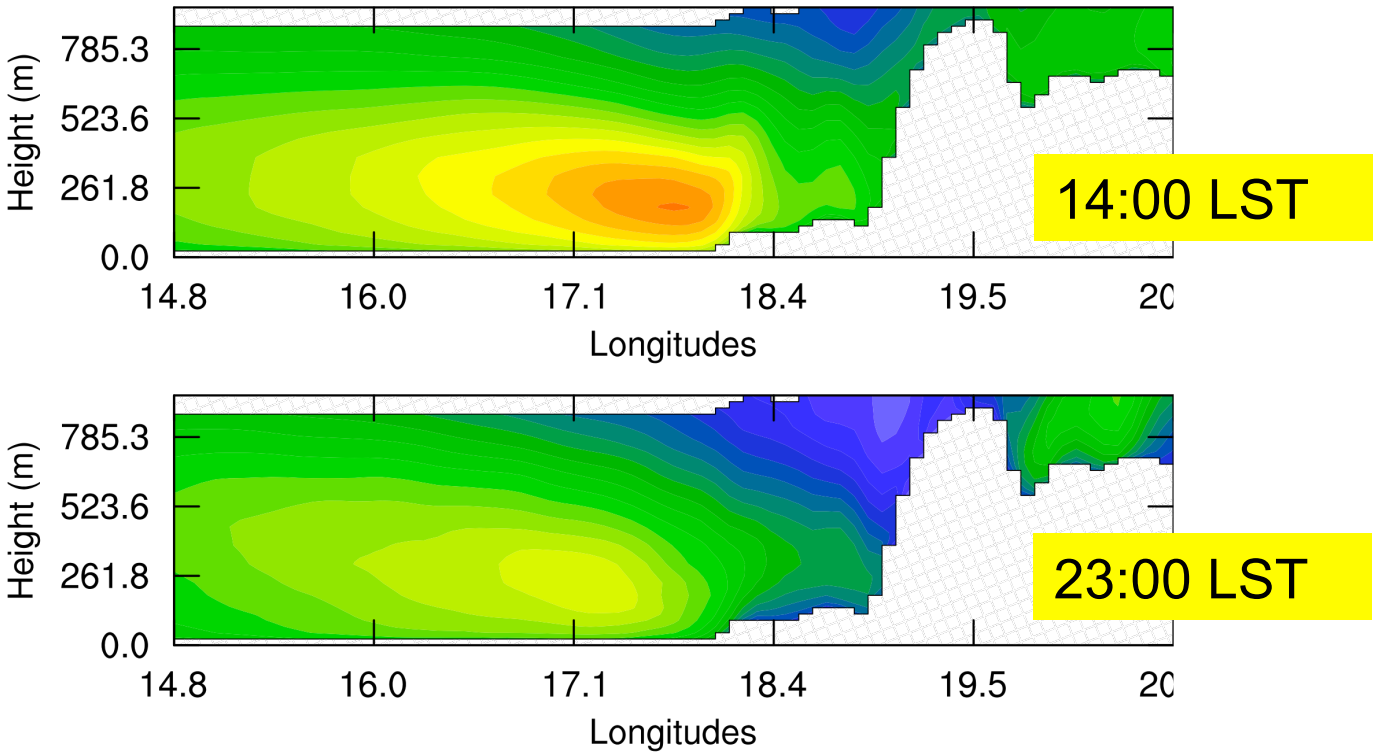




Source: ERA Interim reanalysis

WRF simulations of the low-level jet
January 2009 simulations
Strong diurnal cycle

Cross-sections
across 33°S



January's diurnal avaraged wspd (m/s) along :-33-at hour: 00:00

2 4 6 8 10 12 14