d'une couche de brume isolée, dans la zone de formation, où les particules sont soufflées vers les pôles où elles s'accumulent et sédimentent avant d'être redistribuées plus bas sur l'ensemble de la planète. Le refroidissement infrarouge, dans la nuit polaire, contribue autant que les variations d'ensoleillement au forçage de la circulation méridienne dans la stratosphère de Titan. La prise en compte de cette composante est essentielle si on veut reproduire les gradients latitudinaux de température observés par Voyager.

L'enrichissement polaire simulé dans la stratosphère moyenne, causé par la subsidence d'air provenant des régions source de la photochimie, dans la haute stratosphère, est également en très bon accord avec les observations. Pour la plupart des espèces, ce contraste n'a que peu à voir avec la chimie elle-même. Il est dû au contraste entre cet air enrichi dans la subsidence polaire l'air clair montant de la basse troposphère, où la plupart des espèces condensent. L'amplitude de ce contraste est contrôlé par la compétition entre l'advection verticale qui crée le contraste, et le mélange latitudinal soit par la circulation méridienne moyenne, soit par les ondes planétaires, paramétrisées dans le modèle.

Le bon accord en ce qui concerne la composition, est une des indications les plus directes du fait que les mécanismes dynamiques impliqués dans la création de la superrotation (circulation méridienne moyenne et ondes planétaires), sont bien à l'œuvre sur Titan. En particulier, l'enrichissement polaire est la contrainte la plus directe que nous ayons sur l'existence des cellules de Hadley.

En observant la composition, nous voyons donc que Cassini devrait nous donner beaucoup de contraintes sur la dynamique en jeu dans la stratosphère de Titan.

Cette situation présente certaines similitudes avec des études concernant les contrastes d'humidité dans la troposphère terrestre. Pour l'humidité, la source est en surface et la valeur à saturation diminue à mesure qu'on monte vers la tropopause. En absence de mélange, l'humidité spécifique d'une particule d'air est déterminée simplement par l'humidité à saturation la plus faible rencontrée le long de son histoire passée (plus ou moins le point le plus froid le long de la rétro-trajectoire). Là aussi, l'observation d'une espèce condensant (la vapeur d'eau) a été utilisée pour contraindre la dynamique atmosphérique. (e. g. Pierrehumbert et Roca, 1998).

On ne sais pas encore si Cassini réussira à suivre des nuages pour déterminer des vents. Il est clair en revanche que l'observation de la composition foisonnera d'informations directes ou indirectes sur la dynamique atmosphérique, et nous permettra de valider plus finement ce modèle que nous continuerons à développer.

On voit aussi qu'une mission plus longue que les 4 ans nominaux permettrait d'apprendre beaucoup de choses sur cette machine complexe qu'est le climat de Titan, notamment par exemple si on peut observer la période de transition, juste après l'équinoxe de printemps.

Chapitre 6

Conclusions et perspectives

6.1 Quelques enseignements

6.1.1 Décomposition du transport et paramétrisations

Mentionner le parallèle entre l'étude des ondes sur Titan et le transport de couche limite.
Intéreaction d'échelle et intéraction entre différentes composantes de l'écoulement.
Transport par des cellules versus transport diffus
Paramétrisation permettant d'interpréter un comportement.

6.1.2 Des traceurs du transport atmosphérique

Le traceurs peuvent renseigner sur le transport.
Valdiation de la couche limite. Circulation sur Titan Rétro-transport.

6.1.3 Un outil

Le guidage.

6.2 Et après

6.2.1 Paramétrisation, cycle diurne de nuages et transport des traceurs

Prospective sur le transport par les paramétrisations.
AMMA.
Le guidage comme outil de travail sur les paramétrisations. Et comme outil de travail sur le changement climatique.
Le soulèvement des poussières.

6.2.2 Météorologie comparée et climat

Eventuellement une figure de tempêtes de poussières martienes.
Le modèle avec thermiques comme modèle des atmosphères planétaires. IPCC analyses ré-analyses ERA40
ASE CESR CNES LGGE LMD Laboratoire de Météorologie Dynamique LMDZ LOA LSCE NASA NASA/GISS NASA/Ames NCAR SA TICE ECMWF

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